

Diffusion 6.1 User Guide

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Part I

Welcome

Welcome to the Push Technology User Manual for Diffusion™

The manual is regularly updated, but if you require further help, see the articles and forums in our Support Center: <http://support.pushtechnology.com>.

New to Diffusion?

- Learn what Diffusion is and what it can do for your organization: [Introduction](#)
- Get started with Diffusion: [Quick Start Guide](#) on page 24

Ready to start building your Diffusion solution?

- Decide what your Diffusion solution will look like: [Design Guide](#) on page 32
- Develop your Diffusion clients: [Developer Guide](#) on page 152
- Set up and manage your Diffusion server and solution: [Administrator Guide](#) on page 474

About to upgrade from an earlier version of Diffusion?

- See what's new in the latest version of Diffusion: [What's new in Diffusion 6.1?](#) on page 21
- Check how changes might affect your existing Diffusion solution: [Upgrading](#)

In this section:

- [Introducing Diffusion](#)
- [What's new in Diffusion 6.1?](#)

Introducing Diffusion

Diffusion from Push Technology provides realtime messaging, optimized for streaming data over the internet.

Flexibility, responsiveness and interactivity are some of the fundamental requirements for today's application architecture. But challenges created by unreliable and congested networks stand in the way – particularly for mobile and IoT.

The answer? A realtime integration model, with better data efficiency to address these challenges, while reducing data costs at the same time.

With Push Technology's realtime messaging products – and our unique, data-efficient approach to streaming data – developers are armed with an integration and data delivery platform optimized for today's internet-connected world.

Why realtime messaging?

Many of today's apps are *point-in-time* representations of data, refreshing information only when a user explicitly asks for an update, or continuously polling the backend. However, reactive apps are infinitely more engaging, and interactive – pushing updates in real time as new data becomes available. This allows you to scale your applications, without adding unnecessary load to back-end systems and creates a layer of decoupling that protects applications from data model changes. Realtime messaging integrates seamlessly with modern development frameworks for the web (Angular, Meteor, React, etc) delivering data updates in real time to end users. Stop focusing on point-in-time data, and instead, focus on realtime, event-driven, responsive, and engaging applications.

Benefits of Diffusion

Diffusion offers the most intelligent and data-efficient realtime messaging products available today. Designed to be easily integrated to new and existing application architecture, our technology gives you a flexible, reactive, and efficient data layer for all your business needs.

Publish-subscribe integration

The Diffusion server provides a publish-subscribe integration model. The Diffusion server stores data in a tree of topics, where each topic has a value. This value can be fetched in an ad-hoc fashion, but, more commonly, a client session subscribes to the topics that are of interest to it. The Diffusion server pushes each update to the topic to the client session as a stream of values.

Dynamic data model

Client sessions subscribe to data topics using wildcard selectors. When new topics are added, sessions with matching selectors are automatically subscribed. This avoids the need for separate topic life-cycle processes, and data objects can be frequently created and deleted without impacting existing applications.

Value-oriented programming

A value-oriented programming model is a fundamental feature of a reactive data model. Applications are built against an API that provides streams of values, rather than individual messages that need further decoding. Client SDKs provide a common programming model, making best use of the features particular to their implementation language. This frees developers to focus on application functionality, rather than data integration.

Inverted data grid

Like a data grid, Diffusion stores values in memory. Traditionally, data grids are optimized for query and primarily support a polling paradigm. In Diffusion, the data grid is optimized for a realtime, event-driven communication. Often deployed as a specialized cache, data grids offload processing from a backend system. Diffusion offers the same benefit but is designed to deliver realtime streams to a high number of subscribed clients.

Non-blocking I/O

Network communication is performed by an event-driven kernel that uses non-blocking I/O to interact efficiently with the host networking. Client sessions are partitioned and each partition is assigned to a dedicated thread that manages all subscription matching and outbound communication for that session. This lock-free design avoids contention between these sessions and allows the platform to scale linearly across CPU resources, achieving very high message rates.

Protocol optimization

Messages are serialized into a compact binary representation called CBOR. This reduces bandwidth consumption for every message – up to 30% compared with ASCII. A small binary header is used to frame each message, but this is typically only two bytes when using the default WebSocket-based protocol.

Delta streaming

Topics provide stateful streams of data to each session. Once a client session is subscribed to a topic and receives the current state, all subsequent updates are sent as a *delta* (the difference from the previous value). This happens transparently to the application, with the client SDK reconstructing the full data payload with the delta applied – so neither application or backend require changes.

Message queue optimization

Messages that cannot be immediately delivered to a session are queued. If the network connections fail, bandwidth is limited, or the client is simply slow, messages can back up on the queue. Diffusion can conflate the queue to remove messages that are stale or no longer relevant, or to combine multiple related messages into a single consolidated message.

Bandwidth management

The rate of messages delivered to a session can be artificially constrained by the platform. This can be used to prioritize one client session over another, to place limits on bandwidth utilization, to improve batching, or to encourage conflation. These measures might be desirable in some circumstances, but obviously lead to increased latency for the throttled sessions.

Reliable reconnection

Client connectivity is continuously monitored by the Diffusion server using a variety of bandwidth efficient mechanisms. If a client session is disconnected due to network failure, both the client and server queue messages for a period of time until that session can be re-established. Once the session is reconnected, the client and server reconcile the messages successfully received to ensure none are lost.

Assured delivery

During an active session, messages between the client and the Diffusion server are delivered without loss regardless of the protocol in use. Delivery is considered *assured* rather than guaranteed to account for client/server or network failures that terminate an active session.

Extensive SDK support

With simple client SDKs (Software Development Kits) available for a range of languages and environments, there are no new protocols or technologies to learn. The SDK includes a runtime library, API, documentation, and examples. The supported SDKs include JavaScript[®] (browser and Node.js), Apple[®] (iOS[®], OS X[®]/macOS[®] and tvOS[™]), Android[™], Java[™], .NET, and C

Protocol fallback

By default, clients use the WebSocket protocol to establish bi-directional communication with the Diffusion server. In some cases the WebSocket protocol is not available. For example, WebSocket connections can be blocked by a firewall or load balancer, or disallowed by the network provider. In this case, clients can automatically fallback (*cascade*) to long polling over HTTP.

Session administration

A session with appropriate security permissions can act as a *control client* and instruct the Diffusion server to add and remove topics, send data updates to topics, and receive notifications about events – such as when the number of subscribers for a topic falls to zero. A control client session can also authenticate connection requests, receive notifications about new or modified sessions, modify or close sessions, and send and receive messages to and from individual sessions. Every session has session properties: a set of key-value pairs that can be modified or used to filter groups of related sessions.

Security framework

The Diffusion server has a capable security framework. Authentication can use the built-in security database or be federated to control clients that can integrate with third-party database. Authorization is declarative and based on a configurable hierarchy of roles. Each session is assigned to one or more roles. Roles are granted permissions such as the ability to access, modify, subscribe to, or update specific topics; or the ability to control other sessions. Secure communication over TLS is supported by the Diffusion server and client libraries for all protocols.

What's new in Diffusion 6.1?

The latest version of Diffusion contains new features, performance enhancements and bug fixes.

A complete list of the latest updates and known issues can be found in the Release Notes available at <http://docs.pushtechnology.com/docs/6.1.5/ReleaseNotice.html>.

Automatic topic removal

A common requirement is to remove a topic based on conditions like inactivity, elapsed time or lack of subscribers. The new automatic topic removal feature makes this easy to implement.

Using simple but powerful expressions, you can define the conditions for topic removal. Even complex requirements like "remove this topic if it has less than two subscribers for a continuous period of 1 hour" can be expressed.

You can remove the original topic that the condition is evaluated on, or a set of topics based on a selector expression.

This feature replaces topic event listeners and "remove topic with session", which are now deprecated.

For full details, see [Removing topics automatically](#) on page 319.

Topic ownership

It's often useful to have a 'private' session linked to a particular user, for example to provide a personalised feed that others can't access. Topic ownership provides a simple way to grant read, modify and update access for a topic to a particular security principal.

Combining this with automatic topic removal makes it easy to clean up the topic when the user becomes inactive.

For more information, see [Topic ownership](#) on page 147.

Major improvements to conflation with wider topic support

Conflation improves performance under load by selectively removing out of date topic updates. This reduces server memory footprint, and the amount of network data to bring a client session up to date. Diffusion 6.1 features a brand-new conflation system which is easier to use, leading to increased performance gains and more reliable sessions.

In 6.0, conflation was limited to the deprecated stateless, single value and record topic types. In 6.1, you can use conflation with the full range of topic types: JSON, binary, int64, double, string, recordV2 and time series.

Configuration is now done with a convenient topic property, which offers a choice of four conflation policies.

Conflation is enabled by default, using a policy that only applies conflation to full message queues where it is needed, giving the best all-round performance savings for most applications. In some applications, where receiving every update matters, you may wish not to use conflation.

For more information, see [Using conflation](#) on page 96 and [Configuring conflation](#) on page 429.

Quorum sensing to avoid split-brain clusters

To avoid 'split-brain' problems where a server in a cluster loses connection and tries to rejoin, you can now set a minimum cluster size in `Replication.xml`. Any server that finds itself in a cluster below this threshold will shut down, enabling a clean restart and recovery.

More flexible persistence

A new PERSISTENT topic property enables persistence to be disabled for individual topics, even if it's enabled at the server level.

Improved console

The web-based Diffusion monitoring console has been greatly improved with a new, cleaner interface.

Display of your topics and the data they contain has been improved. You can even drag and drop topic names and values.

Changes to the console layout are now stored locally, so different members of your staff can create different views.

Behind the scenes, the number of topics used to display internal metrics has been reduced for a smaller memory footprint.

Expanded feature support for .NET, C and Apple SDKs

With Diffusion 6.1, .NET developers can now use topic notifications, time series topics and request-response messaging.

Apple developers can take advantage of topic notifications, subscription control and improved messaging support, enabling sending requests to filters.

Finally, the C SDK now supports all topic types except for time series topics, creating topics from specifications, and the use of value streams.

Improved outbound queue management

Message queue size limits can now be configured in terms of a maximum number of bytes using a new `max-bytes` setting. This can be set per session using `Server.xml`, or per connector in `Connectors.xml`.

Smaller Javascript library

The Javascript client has been optimized to reduce file size, bringing the minified file from 575KiB down to 472KiB.

.NET Core 2.0 support

The .NET client is now based on .NET Standard 2.0, meaning it supports the .NET Framework 4.6.1 and .NET Core 2.0 runtimes.

Related concepts

[Upgrading Guide](#) on page 760

If you are planning to move from an earlier version of Diffusion to version 6.1, review the following information about changes between versions.

Part II

Quick Start Guide

Push Technology's Diffusion is the ingredient software required to resolve the limitations and challenges of data distribution by speeding up the delivery of content, enabling rapid scale and optimizing data sent and received.

This guide gives you an overview of installing the Diffusion server and starting to develop your own clients.

In this section:

- [Get Diffusion](#)
- [Install Diffusion](#)
- [Start the Diffusion server](#)
- [Default configuration](#)
- [The Diffusion monitoring console](#)
- [Develop a publishing client](#)
- [Develop a subscribing client](#)
- [Resources](#)

Get Diffusion

To install Diffusion you require the product jar, `Diffusion6.1.5.jar`, and the standalone installer jar, `install.jar`.

You can get both of these files from the Push Technology Download site: <http://download.pushtechnology.com/releases/6.1>

Install Diffusion

Java 8 is required to install Diffusion.

1. Double-click on the `install.jar` file to launch the graphical installer.

The installer locates the Diffusion JAR file if that file is in the same directory as the installer.

2. If the installer cannot locate the Diffusion JAR file, select **File > Load install file** and navigate to the Diffusion JAR file and click **Open**.
3. If you have a production license, select **File > Load license file** and navigate to the license file and click **Open**.

If you do not have a production license, you can use the developer license that is included in the Diffusion server

4. Follow the steps in the graphical installer to install the Diffusion server.

For more information about system requirements and installing the Diffusion server, see [Installing the Diffusion server](#) on page 475.

Start the Diffusion server

The Diffusion start scripts are located in the `bin` directory of your Diffusion installation.

On Windows™: Use `diffusion.bat` to start the Diffusion server.

On Linux™ or OS X/macOS: Use `diffusion.sh` to start the Diffusion server.

Default configuration

The Diffusion server is configured by the files in the `etc` directory.

License

Diffusion includes a development license that allows up to 5 concurrent connections to the Diffusion server.

You can upgrade your Diffusion server to use a production license by copying the production license file into the `etc` directory of your Diffusion installation.

Security

Diffusion uses role-based security for authorization. A client session must have a role with sufficient permissions to perform specific actions on the Diffusion server.

The default security configuration is located in the `etc/SystemAuthentication.store` and `etc/Security.store` files of your Diffusion installation.

This configuration includes principals and passwords for development use:

client	password
control	password
admin	password
operator	password

We recommend that you change these passwords as soon as possible by editing the `etc/SystemAuthentication.store` file.

Configuration

The Diffusion server is configured by the XML files in the `etc` directory of your Diffusion server.

The default configuration makes port 8080 available to connecting clients.

Related concepts

[Security](#) on page 129

Diffusion secures your data by requiring client sessions to authenticate and using role-based authorization to define the actions that a client can perform.

The Diffusion monitoring console

Diffusion includes a monitoring console that shows realtime information about the Diffusion server and its clients, publishers, and topics.

In a browser, go to `http://localhost:8080`. If your browser is not on the same system as your Diffusion server, replace `localhost` with the hostname or IP address of the Diffusion server.

From this landing page you can go to either the demos page, where you can access the Diffusion demos if you opted to deploy them during the install process, or to the Diffusion monitoring console.

The Diffusion monitoring console is secured by username and password. Use the default user 'admin' and password 'password' to log in to the console.

For more information about the Diffusion monitoring console, see [Diffusion monitoring console](#) on page 606

Develop a publishing client

Use the Diffusion JavaScript API to develop a Node.js client that creates a topic and updates it.

This example creates a `double` topic at `foo/counter` and then updates it by increasing its value once per second.

1. Install Node.js and NPM on your development system.

For more information, see <https://nodejs.org/en/>

2. Install the Diffusion JavaScript library on your development system.

```
npm install diffusion
```

3. Create a JavaScript file, `publisher.js`, to contain your client.
4. Include the Diffusion JavaScript library at the top of your `publisher.js` file.

```
var diffusion = require('diffusion');
```

5. Create a connection from the page to the Diffusion server.

```
diffusion.connect({
  host : 'hostname',
  principal : 'control',
  credentials : 'password'
}).then(function(session) {
  console.log('Connected!');
```

Replace 'hostname' and 'port' with the details of your Diffusion server. If running locally, use 'localhost' and '8080'.

6. Create a double topic called `foo/counter`:

```
session.topics.add('foo/counter',
diffusion.topics.TopicType.JSON);
```

The `add()` method takes the name of the topic and the topic type.

7. Start incrementing the value of the topic once per second:

```
var count = 0;

setInterval(function() {
  session.topics.update('foo/counter', count++);
}, 1000);
```

The `update()` method takes the name of the topic and a JSON object.

8. Run the Node.js client:

```
node publisher.js
```

Full example

The following example code shows a Node.js JavaScript client that connects to the Diffusion server, creates a JSON topic, and publishes an update to it.

```
 /
*****
* Copyright (C) 2014, 2015 Push Technology Ltd.
*
* Licensed under the Apache License, Version 2.0 (the "License");
* you may not use this file except in compliance with the License.
* You may obtain a copy of the License at
* http://www.apache.org/licenses/LICENSE-2.0
*
* Unless required by applicable law or agreed to in writing,
software
* distributed under the License is distributed on an "AS IS" BASIS,
* WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or
implied.
```

```

* See the License for the specific language governing permissions
and
* limitations under the License.
*****

var diffusion = require('diffusion');

diffusion.connect({
  host : 'hostname',
  principal : 'control',
  credentials : 'password'
}).then(function(session) {
  console.log('Connected!');

  // Create a topic that contains Double values
  var doubleSpec = new
diffusion.topics.TopicSpecification(diffusion.topics.TopicType.DOUBLE);

  session.topics.add('foo/counter', doubleSpec);

  // Start updating the topic every second
  var count = 0;

  setInterval(function() {
    session.topics.updateValue('foo/counter', count++,
diffusion.datatypes.double());
  }, 1000);
});

```

To run the example:

1. Install Node.js.

For more information, see <https://nodejs.org/en/>

2. Install the Diffusion JavaScript library on your development system.

```
npm install diffusion
```

3. Copy the provided code into a file called `publisher.js`
4. Update the `connect` method to include the URL of your Diffusion server.
5. If you have changed the default security configuration, change the principal and credentials to those of a user that has the `modify_topic` and `update_topic` permissions.
6. Use Node.js to run your publishing client from the command line.

```
node publisher.js
```

The JavaScript client opens a connection to the Diffusion server, creates the topic `foo/counter`, and updates it each second with a timestamp.

You can use the example from [Develop a subscribing client](#) on page 29 to subscribe to the topic.

Publish using other Diffusion APIs:

- [Java](#)
- [.NET](#)
- [Apple](#)
- [Android](#)
- [C](#)

Develop a subscribing client

Use the Diffusion JavaScript API to develop a client that subscribes to a topic and receives updates published through it.

This example subscribes to a [double](#) topic at `foo/counter` and prints updates to the browser window.

1. Ensure that the `diffusion.js` file, located in the `clients/js` directory of your Diffusion installation, is available on your development system.
2. Create a template HTML page which displays the information.

For example, create the following `index.html` in your project's HTML directory.

```
<html>
  <head>
    <title>JavaScript example</title>
  </head>
  <body>
    <p>The value of foo/counter is: <span id="display"></span></p>
  </body>
</html>
```

3. Include the Diffusion JavaScript library in the `<head>` section of your `index.html` file.

```
<head>
  <title>JavaScript example</title>
  <script type="text/javascript" src="path_to_library/
diffusion.js"></script>
</head>
```

Replace `path_to_library` with the path to the `diffusion.js` file in the `clients/js` directory where you installed Diffusion.

4. Create a connection from the page to the Diffusion server. Add a `script` element to the `body` element.

```
<body>
<script>
diffusion.connect({
  // Edit these lines to include the host and port of your
  Diffusion server
  host: 'hostname',
  port : 'port',
  // To connect anonymously you can leave out the following
  parameters
  principal : 'client',
  credentials : 'password'
})
</script>
</body>
```

Replace `'hostname'` and `'port'` with the details of your Diffusion server. If running locally, use `'localhost'` and `'8080'`.

5. Create a stream that matches the topic path, then subscribe to the topic.

Add the following function after the `diffusion.connect()` call:

```
}).then(function(session) {
  session
  .stream('foo/counter')
```

```

        .asType(diffusion.datatypes.double())
        .on('value', function(topic, specification, newValue, oldValue)
        {
            console.log("Update for " + topic, newValue);

            document.getElementById('display').innerHTML = newValue;
        });

        session.subscribe('foo/counter');
    });

```

Full example

The following example code shows a browser JavaScript client that connects to the Diffusion server and subscribes to a JSON topic.

```

<html>
  <head>
    <title>JavaScript example</title>
    <script type="text/javascript" src="path_to_library/
diffusion.js"/></script>

  </head>
  <body>
    <p>The value of foo/counter is: <span id="display"></span></p>
    <script type="text/javascript">

        diffusion.connect({
            // Edit these lines to include the host and port of your
Diffusion server
            host : 'hostname',
            port : 'port',
            // To connect anonymously you can leave out the following
parameters
            principal : 'user',
            credentials : 'password'
        }).then(function(session) {
            // Add a value stream that matches the topic path and
wire it to log the received values
            session
                .addStream('foo/counter',
diffusion.datatypes.double())
                .on('value', function(topic, specification, newValue,
oldValue) {
                    console.log("Update for " + topic, newValue);

                    document.getElementById('display').innerHTML =
newValue;
                });

            // Subscribe to the topic
            session.select('foo/counter');
        });

    </script>
  </body>
</html>

```

To run the example:

1. Copy the provided code into a file called `index.html`
2. Update the `connect` method to include the URL of your Diffusion server.
3. If you have changed the default security configuration, change the principal (username) and credentials to those of a user that has the `read_topic` and `select_topic` permissions.
4. Open `index.html` in a browser.

The JavaScript client opens a connection to the Diffusion server, subscribes to the topic `foo/counter`, and prints the updates it receives to the browser window.

You can use the example from [Develop a publishing client](#) on page 26 to create a suitable topic.

Subscribe using other Diffusion APIs:

- [Apple](#)
- [Android](#)
- [Java](#)
- [.NET](#)
- [C](#)

Resources

- Download site: <http://download.pushtechnology.com/releases/6.1>
- API documentation: <http://docs.pushtechnology.com/6.1>
- Support center: <http://support.pushtechnology.com>
- Stack Overflow: <http://stackoverflow.com/questions/tagged/push-diffusion>
- Github: <https://github.com/pushtechnology/>

Part III

Design Guide

This guide describes the factors to consider when designing your Diffusion solution.

In this section:

- [Support](#)
- [Designing your data model](#)
- [Designing your solution](#)
- [Security](#)

Support

When designing your solution, refer to the support information to ensure compatibility between the Diffusion server and your hardware, software, and operating systems. This section also provides information about the capabilities of the Diffusion clients and the platforms the clients are supported on.

You can also refer to the Upgrading Guide to review the compatibility between different versions of Diffusion. For more information, see [Interoperability](#).

System requirements for the Diffusion server

Review this information before installing the Diffusion server.

The Diffusion server is certified on the system specifications listed here. In addition, the Diffusion server is supported on a further range of systems.

Certification

Push Technology classes a system as certified if the Diffusion server is fully functionally tested on that system.

We recommend that you use certified hardware, virtual machines, operating systems, and other software when setting up your Diffusion servers.

Support

In addition, Push Technology supports other systems that have not been certified.

Other hardware and virtualized systems are supported, but the performance of these systems can vary.

More recent versions of software and operating systems than those we certify are supported.

However, Push Technology can agree to support Diffusion on other systems. For more information, contact Push Technology.

Physical system

The Diffusion server is certified on the following physical system specification:

- Intel™ Xeon™ E-Series Processors
- 8 Gb RAM
- 8 CPUs
- 10 Gigabit NIC

Network, CPU, and RAM (in decreasing order of importance) are the components that have the biggest impact on performance. High performance file system and disk are required. Intel hardware is used because of its ubiquity in the marketplace and proven reliability.

Virtualized system

The Diffusion server is certified on the following virtualized system specification:

Host

- Intel Xeon E-Series Processors
- 32 Gb RAM

- VMware vSphere® 5.5

Virtual machine

- 8 VCPUs
- 8 Gb RAM

When running on a virtualized system, over-committing VCPUs (assigning too many VCPUs compared to the processors available on the host) can cause increased latency and unpredictable performance. Consult the [VMWare Performance Best Practices](#) documentation for details.

Operating system

Diffusion is certified on the following operating systems:

- Red Hat7.2+
- Windows Server 2012 R2 and 2016

We recommend you install your Diffusion server on a Linux-based operating system with enterprise-level support available, such as Red Hat Enterprise Linux.

Operating system configuration

If you install your Diffusion server on a Linux-based operating system and do SSL offloading of secure client connections at the Diffusion server, you must disable transparent huge pages.

If you install your Diffusion server on a Linux-based operating system but do not do SSL offloading of secure client connections at the Diffusion server, disabling transparent huge pages is still recommended.

Having transparent huge pages enabled on the system your Diffusion server runs on can cause extremely long pauses for garbage collection. For more information, see <https://access.redhat.com/solutions/46111>.

Java

The Diffusion server is certified on Oracle® Java Development Kit 8 (minimum update 1.8.0_131-b11).

Only the Oracle JDK is certified.

Ensure that you use the Oracle JDK and not the JRE.

JVM configuration

If you do SSL offloading of secure client connections at the Diffusion server, you must ensure that you constrain the maximum heap size and the maximum direct memory size so that together these to values do not use more than 80% of your system's RAM.

Networking

Push Technology recommends the following network configurations:

- 10 Gigabit network
- Load balancers with SSL offloading
- In virtualized environments, enable SR-IOV.

For more information about how to enable SR-IOV, see the documentation provided by your virtual server provider. SR-IOV might be packaged using a vendor-specific name.

Client requirements

For information about the supported client platforms, see [Platform support for the Diffusion API libraries](#) on page 35.

Related concepts

[The Diffusion license](#) on page 483

Diffusion includes a development license that enables you to use make up to 5 concurrent connections to the Diffusion server.

[Installed files](#) on page 486

After installing Diffusion the following directory structure exists:

Related tasks

[Installing the Diffusion server using the graphical installer](#) on page 477

The Diffusion binary files are available from the Push Technology website. You can install Diffusion using the graphical installer.

[Installing the Diffusion server using the headless installer](#) on page 479

The Diffusion binary files are available from the Push Technology website. You can install Diffusion from the command line.

[Installing the Diffusion server using Red Hat Package Manager](#) on page 480

Diffusion is available as an RPM file from the Push Technology website.

[Installing the Diffusion server using Docker](#) on page 481

Diffusion is available as a Docker® image from Docker Hub.

[Verifying the Diffusion installation](#) on page 488

Start your Diffusion server, review the logs, and connect to the console to verify that your installation is correct.

Platform support for the Diffusion API libraries

Review this information when designing your clients to determine what platforms and transports the Diffusion client libraries are supported on.

Supported platforms and protocols for the client libraries

Table 1: Supported platforms and transport protocols for the client libraries

Platform	Minimum supported versions	Supported transport protocols
JavaScript	es6 (TypeScript 1.8)	WebSocket HTTP (Polling XHR)
Apple for iOS	Development environment Xcode 8 (iOS 10.0 SDK) Runtime support	WebSocket

Platform	Minimum supported versions	Supported transport protocols
	<p>Deployment target: iOS 8.1 or later</p> <p>Device architectures: armv7, armv7s, arm64</p> <p>Simulator architectures: i386, x86_64</p>	
Apple for OS X/macOS	<p>Development environment</p> <p>Xcode 8 (OS X/macOS 10.12 SDK)</p> <p>Runtime support</p> <p>Deployment target: OS X/macOS 10.11 or later</p> <p>Device architectures: x86_64</p>	WebSocket
Apple for tvOS	<p>Development environment</p> <p>Xcode 8 (tvOS 10.0 SDK)</p> <p>Runtime support</p> <p>Deployment target: tvOS 9.0 or later</p> <p>Device architectures: arm64</p> <p>Simulator architectures: x86_64</p>	WebSocket
Android	API 19 / v4.4 / KitKat	WebSocket

Platform	Minimum supported versions	Supported transport protocols
	Note: Push Technology provides only best-effort support for Jelly Bean (API 16-18, v4.1-4.3).	HTTP (polling)
Java	Oracle Java Development Kit 8 (minimum update 1.8.0_131-b11). JDK 9 not supported. Note: We recommend that you run your clients on the JDK rather than the JRE.	WebSocket HTTP (Polling)
.NET	Microsoft® .NET Standard 2.0	WebSocket
C for Linux	Red Hat and CentOS™, version 7.2 and later Ensure that you use a C99-capable compiler.	WebSocket
C for Windows	Visual C Compiler 2013 or later, Windows 7 or later	WebSocket
C for OS X/macOS	For building using GCC, use Xcode 8.0 or later	WebSocket

Note: Protocols are supported for both secure and standard connections.

Feature support in the Diffusion API

Review this information when designing your clients to determine which APIs provide the functionality you require.

Features are sets of capabilities provided by the Diffusion API. Some features are not supported or not fully supported in some APIs.

The Diffusion libraries also provide capabilities that are not exposed through their APIs. Some of these capabilities can be configured.

Table 2: Capabilities provided by the Diffusion client libraries

Capability	JavaScript	Apple	Android	Java	.NET	C
Connecting						
Connect to the Diffusion server	✓	✓	✓	✓	✓	✓
Cascade connection through multiple transports	✓	✗	✓	✓	✗	✗

Capability	JavaScript	Apple	Android	Java	.NET	C
Connect asynchronously	✓	✓	✓	✓	✓	✓
Connect synchronously	✗	✗	✓	✓	✓	✓
Connect using a URL-style string as a parameter	✗	✓	✓	✓	✓	✓
Connect using individual parameters	✓	✗	✓	✓	✗	✗
Connect securely	✓	✓	✓	✓	✓	✓
Configure SSL context or behavior	✓	✓	✓	✓	✓	✗
Connect through an HTTP proxy	✗	✓	✓	✓	✓	✗
Connect through a load balancer	✓	✓	✓	✓	✓	✓
Pass a request path to a load balancer	✓	✓	✓	✓	✗	✗
Reconnecting						
Reconnect to the Diffusion server	✓	✓	✓	✓	✓	✓
Configure a reconnection timeout	✓	✓	✓	✓	✓	✓
Define a custom reconnection strategy	✓	✓	✓	✓	✓	✓
Resynchronize message streams on reconnect	✓	✓	✓	✓	✓	✓
Abort reconnect if resynchronization fails	✓	✓	✓	✓	✓	✗
Maintain a recovery buffer of messages on the client to resend to the Diffusion server on reconnect	✓	✓	✓	✓	✓	✓
Configure the client-side recovery buffer	✗	✓	✓	✓	✓	✗

Capability	JavaScript	Apple	Android	Java	.NET	C
Detect disconnections by monitoring activity	✓	✓	✓	✓	✓	✓
Detect disconnections by using TCP state	✓	✓	✓	✓	✓	✓
Ping the Diffusion server	✓	✓	✓	✓	✓	✓
Change the principal used by the connected client session	✓	✓	✓	✓	✓	✓
Receiving data from topics						
Subscribe to a topic or set of topics	✓	✓	✓	✓	✓	✓
Receive data as a value stream	✓	✓	✓	✓	✓	✓
Receive data as content	✓	✓	✓	✓	✓	✓
Fetch the state of a topic	✓	✓	✓	✓	✓	✓
Managing topics						
Create a topic	✓	✓	✓	✓	✓	✓
Create a slave topic	✓	✓	✓	✓	✓	✓
Create/update/query time series topics	✓	✓	✓	✓	✓	✗
Create a topic from an initial value	✓	✗	✓	✓	✓	✗
Create a topic from a topic specification	✓	✓	✓	✓	✓	✓
Create a topic from topic details	✓	✓	✓	✓	✓	✓
Create a topic with metadata	✓	✓	✓	✓	✓	✓
Listen for topic events (including topic has subscribers and topic has zero subscribers)	✗	✓	✓	✓	✓	✗

Capability	JavaScript	Apple	Android	Java	.NET	C
Receive topic notifications	✓	✓	✓	✓	✓	✗
Delete a topic	✓	✓	✓	✓	✓	✓
Delete a branch of the topic tree	✓	✓	✓	✓	✓	✓
Set an automatic topic removal policy	✓	✓	✓	✓	✓	✓
Mark a branch of the topic tree for deletion when this client session is closed	✓	✓	✓	✓	✓	✓
Updating topics						
Update a topic	✓	✓	✓	✓	✓	✓
Perform exclusive updates	✓	✓	✓	✓	✓	✓
Perform non-exclusive updates	✓	✓	✓	✓	✓	✗
Managing subscriptions						
Subscribe or unsubscribe another client to a topic	✓	✓	✓	✓	✓	✓
Subscribe or unsubscribe another client to a topic based on session properties	✓	✓	✓	✓	✓	✗
Handling subscriptions to routing topics	✓	✗	✓	✓	✓	✗
Handling subscriptions to missing topics	✓	✓	✓	✓	✓	✓
Request-response messaging						
Send a request to a path	✓	✓	✓	✓	✓	✗
Send a request to a client session	✓	✓	✓	✓	✓	✗
Send a request to a set of client sessions based on session properties	✓	✓	✓	✓	✓	✗

Capability	JavaScript	Apple	Android	Java	.NET	C
Respond to requests sent to a session	✓	✓	✓	✓	✓	✗
Respond to requests sent to a path	✓	✓	✓	✓	✓	✗
One-way messaging						
Send a one-way message to a path	✓	✓	✓	✓	✓	✓
Send a one-way message to a client session	✓	✓	✓	✓	✓	✓
Send a one-way message to a set of client sessions based on session properties	✓	✓	✓	✓	✓	✓
Receive one-way messages	✓	✓	✓	✓	✓	✓
Handle one-way messages sent to a path	✓	✓	✓	✓	✓	✓
Managing security						
Authenticate client sessions and assign roles to client sessions	✓	✗	✓	✓	✓	✓
Configure how the Diffusion server authenticates client sessions and assign roles to client sessions	✓	✗	✓	✓	✓	✓
Configure the roles assigned to anonymous sessions and named sessions	✓	✗	✓	✓	✓	✓
Configure the permissions associated with roles assigned to client sessions	✓	✗	✓	✓	✓	✓
Grant permissions to a principal using topic ownership	✓	✓	✓	✓	✓	✓
Managing other clients						

Capability	JavaScript	Apple	Android	Java	.NET	C
Receive notifications about client session events including session properties	✓	✗	✓	✓	✓	✓
Get the properties of a specific client session	✓	✗	✓	✓	✓	✓
Update user-defined session properties of a client session or set of sessions	✗	✗	✓	✓	✓	✗
Receive notifications about client queue events	✗	✗	✓	✓	✓	✗
Conflate and throttle clients	✗	✗	✓	✓	✓	✗
Close a client session	✗	✗	✓	✓	✓	✗
Push notifications (The Push Notification Bridge must be enabled)						
Receive push notifications	✗	✓	✓	✗	✗	✗
Request that push notifications be sent from a topic to a client	✓	✓	✓	✓	✓	✓
Publish an update to a topic that sends push notifications	✓	✓	✓	✓	✓	✓
Other capabilities						
Flow control	✗	✗	✓	✓	✓	✓

Feature packs

Some advanced Diffusion features are available in add-on packs.

Some advanced features are only available for production use if your license includes the correct add-on packs.

The pack you have depends on your license. If you need to upgrade your license, contact sales@pushtechology.com.

Table 3: Feature packs

Feature	Diffusion	Diffusion with Scale & Availability Pack	Diffusion with Scale & Availability and Auto-Scale Packs
All features not mentioned below	✓	✓	✓
Persistence		✓	✓
Fan-out		✓	✓
Replication		✓	✓
Kubernetes support			✓
Prometheus support			✓

Auto-Scale Pack requires Scale & Availability Pack and cannot be bought separately.

Note: The trial developer license you get when you download Diffusion gives you access to all features, but is limited to five concurrent connections.

Specific license restrictions

As well as the differences between packs, each license can also have restrictions such as an expiry date, or a maximum number of concurrent client connections. See [License restrictions](#) on page 484 for details.

Protocol support

Each client supports varying transports. A table of the supported transports for each client is presented here.

All protocols supported by Diffusion can be used for both secure (using TLS) and standard connections. For more information, see [SSL and TLS support](#) on page 44.

The following table lists the protocols supported for each client:

Table 4: Supported protocols by client

Client	WebSocket	HTTP Polling
JavaScript API	✓	✓
Apple API	✓	
Android API	✓	✓

Client	WebSocket	HTTP Polling
Java API	✓	✓
.NET API	✓	
C API	✓	

The JavaScript client is fully supported only on certain browsers. Best effort support is provided for other browsers but the software/hardware combination might not be reproducible, particularly for mobile browsers. For more information about supported browsers, see [Browser support](#) on page 44.

SSL and TLS support

Diffusion supports only those SSL versions and cipher suites with no known vulnerabilities.

The following SSL and TLS versions are supported by default:

- SSLv2Hello
- TLSv1
- TLSv1.1
- TLSv1.2

The following cipher suites are supported by default:

- TLS_RSA_WITH_AES_128_CBC_SHA
- TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA
- TLS_RSA_WITH_AES_128_CBC_SHA256
- TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256
- TLS_ECDHE_RSA_WITH_3DES_EDE_CBC_SHA

For more information, see [Network security](#) on page 555.

Browser support

Some of the client libraries are intended to be run within browser environments. Diffusion clients can use most commercial browsers and their variants. However, some Diffusion API protocols might not be available.

Diffusion supports the latest release of the following browser versions based on the original Diffusion release date.

Table 5: Supported browsers

Browser	Version
Google Chrome™	53
Mozilla Firefox®	49
Microsoft Internet Explorer®	11
Apple Safari®	8

- Push Technology runs full regression tests on the browsers and versions documented above for every patch release.
- Push Technology carries out basic validation testing on the latest versions of these browsers but full support is available only at the next minor release.
- Support for older versions of browsers is provided on a best-effort basis, unless specified otherwise.
- Support for other browsers is provided on a best-effort basis.

Mobile browsers

We do not test our JavaScript client libraries with mobile browsers or within mobile applications that wrap a browser application in native code. If you are developing a Diffusion client for a mobile platform, such as iOS or Android, we recommend that you use the provided client libraries for these platforms to develop a native application.

Diffusion JavaScript clients running within a native wrapper or in a mobile browser are supported on a best effort basis and we might not be able to provide support for older versions of the mobile platform.

Browser limitations

Some browsers cannot use all the Diffusion protocols or features. If you experience problems when developing with protocols or client libraries that use the browser, check whether the browser supports this function.

Browser environments are not uniform and some browsers might have functional limitations. It is important to be aware of these limitations when developing for compliance with target browsers.

WebSocket limitations

WebSocket is an Internet Engineering Task Force (IETF) protocol used by Diffusion to provide a full-duplex communication channel over a single TCP connection. It is not supported by all browser versions.

Table 6: Support for WebSocket

Version	WebSocket support?
Internet Explorer 9.0 and earlier	NO
Internet Explorer 10.0 and later	YES (see note)
Firefox	YES
Chrome	YES
Safari	YES
Opera®	YES
iOS	YES
Android	YES

Note: Internet Explorer 11 contains a bug that causes WebSocket connections to be dropped after 30 seconds of inactivity. To work around this problem set the system ping frequency to 25 seconds or less. You can set the system ping frequency in the `Server.xml` configuration file.

Cross-origin resource sharing limitations

CORS allows resources to be accessed by a web page from a different domain. Some browsers do not support this capability.

Table 7: Support for CORS

Version	WebSocket support?
Internet Explorer 9.0 and earlier	NO
Internet Explorer 10.0 and later	YES
Firefox	YES
Chrome	YES
Safari	YES
Opera	YES
iOS	YES
Android	YES

Browser connection limitations

Browsers limit the number of HTTP connections with the same domain name. This restriction is defined in the HTTP specification (RFC2616). Most modern browsers allow six connections per domain. Most older browsers allow only two connections per domain.

The HTTP 1.1 protocol states that single-user clients should not maintain more than two connections with any server or proxy. This is the reason for browser limits. For more information, see [RFC 2616 – Hypertext Transfer Protocol, section 8 – Connections](#).

Modern browsers are less restrictive than this, allowing a larger number of connections. The RFC does not specify how to prevent the limit being exceeded. Either connections can be blocked from opening or existing connections can be closed.

Table 8: Maximum supported connections

Version	Maximum connections
Internet Explorer 7.0	2
Internet Explorer 8.0 and 9.0	6
Internet Explorer 10.0	8
Internet Explorer 11.0	13
Firefox	6
Chrome	6
Safari	6
Opera	6
iOS	6

Version	Maximum connections
Android	6

Some Diffusion protocols like HTTP Polling (XHR) use up to two simultaneous connections per Diffusion client. It is important to understand that the maximum number of connections is per browser and not per browser tab. Attempting to run multiple clients within the same browser might cause this limit to be reached.

Reconnection can be used to maintain a larger number of clients than is usually allowed. When TCP connections for HTTP requests are closed, the Diffusion sends another HTTP request which the server accepts. Be aware of cases where Diffusion tries to write a response to closed polling connections before the client can re-establish them. This behavior results in an IO Exception and the Diffusion server closes the client unless reconnection is enabled. When the client tries to re-establish the poll, it is aborted.

Another way to get around browser limits is by providing multiple subdomains. Each subdomain is allowed the maximum number of connections. By using numbered subdomains, a client can pick a random subdomain to connect to. Where the DNS server allows subdomains matching a pattern to be resolved as the same server, tab limits can be mitigated substantially.

Designing your data model

Distribute your data in a data model that fits the needs of your organization and customers.

There are a number of things to consider when designing your data model:

- The structure of your topic tree
- The types of topic to use
- The format of your data
- How you publish data to topics
- Your conflation strategy
- Whether you also use messaging to send data.

These considerations are not separate. The decisions you make about one aspect of your data model affect other aspects.

The data model is defined on the Diffusion server by your publishers or clients. The topic structure, topic types, and data format only persist on the Diffusion server through a restart or upgrade if the [topic persistence](#) feature is enabled.

Design your solution to create your data model on the Diffusion server afresh after the Diffusion server is restarted or upgraded.

Topic tree

Diffusion primarily distributes data using a pub-sub model, where content is published to topics. These topics are arranged as a tree.

What is the topic tree?

The topic tree is the organizational structure of the Diffusion topics. A topic of any type can be created any point in the topic tree where a topic does not already exist.

Locations in the topic tree are referred to by their topic path, which is the level names in the tree that lead to the topic, separated by the slash character (/).

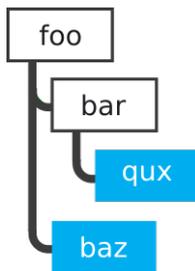


Figure 1: Example topic tree

In the preceding image, topics exist at baz and qux. The topic path for baz is /foo/baz. The topic path for qux is /foo/bar/qux

You can create a topic at /foo/bar/qux without having to create topics at /foo or /foo/bar beforehand.

There can be multiple topics that have the same name, but topic paths are unique.

When interacting with topics in the topic tree, your clients can reference a topic by its topic path or by a *topic selector* with a pattern expression that matches the topic path. Clients can use topic selectors to reference sets of topics in the tree that all match the topic selector's pattern expression.

Considerations when designing your topic tree

- Does the source information have a logical organization?

If the data structure of the source information is complex, it can be mapped to a hierarchical structure.

- How many topics?

If the number of topics is small, a flat topic tree might be appropriate.

- How do clients subscribe to the data?

If there are topics that clients generally subscribe to together, these topics can be organized in the same branch of the topic tree. This enables a client use a topic selector to subscribe to the branch of the topic tree and receive updates for all topics in that branch.

- The size of your topic tree can be constrained by your hardware.

An extremely large topic tree can cause long GC pauses. Ensure that you do sufficient testing with your topic tree before going to production.

If the size of your topic tree structure is caused by a lot of duplication, use routing topics to reduce it.

- A topic cannot be bound to the / topic path. This is because each segment of a topic path must have one or more characters. This means there can be no single topic that acts as the root topic for all possible topics in the topic tree. Instead each top-level topic whose path contains a single part acts as the root topic for their branch of the topic tree.

However, the / path can be used as a routing path when sending or receiving messages, which uses paths but does not use any topics that are bound to them.

Related concepts

[Topic selectors](#) on page 50

A topic selector identifies one or more topics. You can create a topic selector object from a pattern expression.

Topic naming

Consider the following restrictions when deciding on your topic paths.

Restricted characters

Topics are identified by a path. A path is made up of path segments separated by the slash character (/).

Each path segment can be made up of one or more Unicode characters but must not contain any of the restricted characters mentioned below. The slash character (/) is not permitted in any path segment.

Reserved spaces

Paths starting with the path segments Diffusion and @ are reserved for internal use.

Recommendations

Although all Unicode characters except the slash character (/) are supported, we recommend avoiding common regular expression metacharacters such as '*' and '?' in path names to avoid having to quote these characters in topic selector expressions.

Publisher API restricted characters

The Publisher API is used to create Java publishers that are hosted in the Diffusion server. This API has a wider set of restrictions on characters in topic paths.

In addition to the slash character (/), which is restricted in all path segments, the following characters are not permitted in paths to topics that are created by or selected by any publishers:

Table 9: Restricted characters for paths used by publishers.

Character	Reason for restriction
<code>[]\^\$. ?*+()</code>	These are all metacharacters used in regular expressions. Any path String that contains any of these characters is assumed to be a topic selector. These characters cannot be used in path segments.
Control/Reserved	No characters with a hexadecimal value of less than 0x2D. This includes some punctuation characters such as comma (,).
Whitespace	No characters defined as whitespace in Java (as indicated by the <code>isWhiteSpace</code> method of the Java Character class).

Topic selectors

A topic selector identifies one or more topics. You can create a topic selector object from a pattern expression.

Pattern expressions

Use pattern expressions to create a topic selector of one of the types described in the following table. The type of the topic selector is indicated by the first character of the pattern expression.

Table 10: Types of topic selector

Topic selector type	Initial character	Description
Path	>	<p>A path pattern expression must contain a valid topic path. A valid topic path comprises path segments separated by path separators (/). A path segment comprises one or more UTF characters except for slash (/).</p> <p>A PATH selector returns only the topic with the given path. See Path examples on page 52</p>
Abbreviated path	Any character except the following: <ul style="list-style-type: none">• Hash symbol (#)• Question mark (?)• Greater than symbol (>)• Asterisk (*)• Dollar sign (\$)• Percentage symbol (%)• Ampersand (&)• Less than symbol (<)	<p>An abbreviated path pattern expression is an alternative syntax for a path pattern selector. It must be a valid topic path.</p> <p>A path pattern expression must contain a valid topic path. A valid topic path comprises path segments separated by path separators (/). A path segment comprises one or more UTF characters except for slash (/).</p> <p>Abbreviated path pattern expressions are converted into PATHselectors and return only the topic with the given path. See Abbreviated path examples on page 52</p>
Split-path	?	<p>A split-path pattern expression contains a list of regular expressions separated by the / character. Each regular expression describes a part of the topic path. A SPLIT_PATH_PATTERN selector returns topics for which each regular expression matches the part of the topic path at the corresponding level. See Split-path examples on page 53</p>
Full-path	*	<p>A full-path pattern expression contains a regular expression. A FULL_PATH_PATTERN selector returns topics for which the regular expression matches the full topic path. See Full-path examples on page 54</p>

Topic selector type	Initial character	Description
		<p>Note: Full-path pattern topic selectors are more powerful than split-path pattern topic selectors, but are evaluated less efficiently at the server. If you are combining expressions, use selector sets instead.</p>
Selector set	#	<p>A selector set pattern expression contains a list of selectors separated by the separator <code>////</code>. A <code>SELECTOR_SET</code> topic selector returns topics that match any of the selectors.</p> <p>Note: Use the <code>anyOf ()</code> method for a simpler method of constructing <code>SELECTOR_SET</code> topic selectors.</p> <p>See Selector set examples on page 54</p>

Regular expressions

Diffusion topic selectors use regular expressions. Any regular expression can be used in split-path and full-path patterns, with the following restrictions:

- It cannot be empty
- In split-path patterns, it cannot contain the path separator (`/`)
- In full-path patterns, it cannot contain the selector set separator (`////`)

Depending on what the topic selector is used for, regular expressions in topic selectors can be evaluated on the client or on the Diffusion server. For more information, see [Regular expressions](#) on page 55.

Note: Regular expressions have a cost in terms of CPU usage. More complex regular expressions have a higher cost. If a regular expression is evaluated on the client, and you have a large number of client instances running at the same time, the cost will be multiplied by the number of instances. Make sure to test the performance impact of your regular expressions under realistic conditions.

Descendant pattern qualifiers

You can modify split-path or full-path pattern expressions by appending a descendant pattern qualifier. These are described in the following table:

Table 11: Descendant pattern qualifiers

Qualifier	Behavior
None	Select only those topics that match the selector.
<code>/</code>	Select only the descendants of the matching topics and exclude the matching topics.
<code>//</code>	Select both the matching topics and their descendants.

Topic path prefixes

The topic selector capabilities in the Diffusion API provide methods that enable you to get the topic path prefix from a topic selector.

A topic path prefix is a concrete topic path to the most specific part of the topic tree that contains all topics that the selector can specify. For example, for the topic selector `?foo/bar/baz/.*/bing`, the topic path prefix is `foo/bar/baz`.

The topic path prefix of a selector set is the topic path prefix that is common to all topic selectors in the selector set.

Path examples

The following table contains examples of path pattern expressions:

Expression	Matches alpha/beta?	Matches alpha/beta/gamma?	Notes
<code>>alpha/beta</code>	yes	no	
<code>>/alpha/beta/</code>	yes	no	This pattern expression is equivalent to the pattern expression in the preceding row. In an absolute topic path, single leading or trailing slash characters (/) are removed because the topic path is converted to canonical form. A path pattern expression can return a maximum of one topic. The trailing slash in this example is not treated as a descendant qualifier and is removed.
<code>>alpha/beta/gamma</code>	no	yes	
<code>>beta</code>	no	no	The full topic path must be specified for a path pattern expression to match a topic.
<code>>.*.*</code>	no	no	The period (.) and asterisk (*) characters are valid in path segments. In a path pattern expression these characters match themselves and are not evaluated as part of a regular expression.

Abbreviated path examples

The following table contains examples of abbreviated path pattern expressions:

Expression	Matches alpha/beta?	Matches alpha/beta/gamma?	Notes
alpha/beta	yes	no	
/alpha/beta/	yes	no	This pattern expression is equivalent to the pattern expression in the preceding row. In an absolute topic path, single leading and trailing slash characters (/) are removed because the topic path is converted to canonical form. A path pattern expression can return a maximum of one topic. The trailing slash in this example is not treated as a descendant qualifier and is removed.
alpha/beta/gamma	no	yes	
beta	no	no	The full topic path must be specified for a path pattern expression to match a topic.

Split-path examples

The following table contains examples of split-path pattern expressions:

Expression	Matches alpha/beta?	Matches alpha/beta/gamma?	Notes
?alpha/beta	yes	no	
?alpha/beta/	no	yes	The trailing slash character (/) is treated as a descendant pattern qualifier in split-path pattern expressions. It returns descendants of the matching topics, but not the matching topics themselves.
?alpha/beta//	yes	yes	Two trailing slash characters (//) is treated as a descendant pattern qualifier in split-path pattern expressions. It returns matching topics and their descendants.
?alpha/beta/gamma	no	yes	
?beta	no	no	

Expression	Matches alpha/beta?	Matches alpha/beta/gamma?	Notes
?.*	no	no	Each level of a topic path must have a regular expression specified for it for a split-path pattern expression to match a topic.
?.*/*.*	yes	no	
?alpha/.*/	yes	yes	In this pattern expression, “alpha/.*” matches all topics in the alpha branch of the topic tree. The descendant pattern qualifier (/) indicates that the matching topics and their descendants are to be returned.

Full-path examples

The following table contains examples of full-path pattern expressions:

Expression	Matches alpha/beta?	Matches alpha/beta/gamma?	Notes
*alpha/beta	yes	no	
*alpha/beta/gamma	no	yes	
*alpha/beta/	no	yes	The trailing slash character (/) is treated as a descendant pattern qualifier in split-path pattern expressions. It returns descendants of the matching topics, but not the matching topics themselves.
*alpha/beta//	yes	yes	Two trailing slash characters (//) is treated as a descendant pattern qualifier in split-path pattern expressions. It returns matching topics and their descendants.
*beta	no	no	In a full-path pattern selector the regular expression must match the full topic path for a topic to be matched.
*.*beta	yes	no	The regular expression matches the whole topic path including topic separators (/).

Selector set examples

Use the `anyOf` methods to create a `SELECTOR_SET TopicSelector` object.

The following example code shows how to use the `anyOf(TopicSelector... selectors)` method to create a selector set topic selector:

```
// Use your session to create a TopicSelectors instance
TopicSelectors selectors = session.topicSelectors();
```

```
// Create topic selectors for the individual pattern expressions
TopicSelector pathSelector = selectors.parse(">foo/bar");
TopicSelector splitPathSelector = selectors.parse("?f.*/bar\d+");
TopicSelector fullPathSelector = selectors.parse("*f.*\d+");

// Use the individual topic selectors to create the selector set
// topic selector
TopicSelector selector = selectors.anyOf(pathSelector,
    splitPathSelector, fullPathSelector);

// Use the topic selector as a parameter to methods that perform
// actions on topics or groups of topics
```

The following example code shows how to use the `anyOf(String... selectors)` method to create the same topic selector as in the previous code example, but in fewer steps:

```
// Use your session to create a TopicSelectors instance
TopicSelectors selectors = session.topicSelectors();

// Create the selector set topic selector by passing in a list of
// pattern expressions
TopicSelector selector = selectors.anyOf(">foo/bar", "?f.*/bar\d+",
    "*f.*\d+");

// Use the topic selector as a parameter to methods that perform
// actions on topics or groups of topics
```

Related concepts

[Topic tree](#) on page 47

Diffusion primarily distributes data using a pub-sub model, where content is published to topics. These topics are arranged as a tree.

Regular expressions

Depending on what the topic selector is used for, regular expressions in topic selectors can be evaluated on the client or on the Diffusion server. On the Diffusion server, regular expressions are evaluated as Java-style regular expressions. On clients, regular expressions are evaluated according to the conventions of the client library.

The following client uses of topic selectors are evaluated on the Diffusion server:

- Subscribing to topics
- Unsubscribing from topics
- Subscribing another client to topics
- Unsubscribing another client from topics
- Fetching topic states
- Removing topics

The following client uses of topic selectors are evaluated on the client:

- Creating a stream to receive updates published to topics
- Creating a stream to receive messages sent on message paths

The regular expression evaluation on each of the client libraries and on the Diffusion server are all based on the same style of regular expressions. The behavior of topic selectors on the clients and on the Diffusion server is the same for all standard uses of regular expressions. More advanced or complex regular expressions might differ slightly in behavior.

See the following sections for platform-specific information.

On the Diffusion server

Topic selectors evaluated on the Diffusion server are evaluated as Java-style regular expressions and are based on `java.util.regex.Pattern`.

For more information about Java-style regular expressions, see [Java regular expressions](#).

On Java and Android clients

Topic selectors evaluated on these clients are evaluated as Java-style regular expressions. There are no differences between how a regular expression is evaluated on these clients and how it is evaluated on the Diffusion server.

For more information about Java-style regular expressions, see [Java regular expressions](#).

On .NET clients

Topic selectors evaluated on the .NET client are evaluated as .NET Framework regular expressions, these are compatible with Perl 5 regular expressions. For more information about .NET regular expressions, see [https://msdn.microsoft.com/en-us/library/az24scfc\(v=vs.110\).aspx](https://msdn.microsoft.com/en-us/library/az24scfc(v=vs.110).aspx).

The .NET evaluation of regular expressions can differ from the Java evaluation of the same regular expression on the Diffusion server. For examples of how these can differ, see <http://stackoverflow.com/a/545348>.

Ensure that you test the behavior of complex regular expressions that you use with the .NET client.

On Apple clients

Topic selectors evaluated on the Apple client are evaluated according to the `NSRegularExpression` class, which uses ICU regular expression syntax. For more information about Apple regular expressions, see:

- https://developer.apple.com/library/ios/documentation/Foundation/Reference/NSRegularExpression_Class/
- <http://userguide.icu-project.org/strings/regex>
-

The Apple evaluation of regular expressions can differ from the Java evaluation of the same regular expression on the Diffusion server. Ensure that you test the behavior of complex regular expressions that you use with the Apple client.

On JavaScript clients

Topic selectors evaluated on the JavaScript client are based on the ECMAScript standard. For more information about JavaScript regular expressions, see:

- https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Global_Objects/RegExp
- https://developer.mozilla.org/en-US/docs/Web/JavaScript/Guide/Regular_Expressions
- <http://www.ecma-international.org/ecma-262/5.1/#sec-7.8.5>

The JavaScript evaluation of regular expressions can differ from the Java evaluation of the same regular expression on the Diffusion server. Ensure that you test the behavior of complex regular expressions that you use with the JavaScript client.

On C clients

Topic selectors evaluated on the C client use PCRE. For more information about C regular expressions, see <http://www.pcre.org/>.

The C evaluation of regular expressions can differ from the Java evaluation of the same regular expression on the Diffusion server. Ensure that you test the behavior of complex regular expressions that you use with the C client.

Topics

Consider the types of topic you want to use and how.

A topic is a channel through which data can be distributed to clients. Topics provide a logical link between publishing clients and subscribing clients. For more information, see [Pub-sub](#) on page 87.

Diffusion topics are typed. Data sent through topics must match the data type of the topic.

Topics that store values

You can publish data to these topics and the data is streamed to subscribing clients. These topics provide a range of possible data types:

- [JSON](#)
- [Binary](#)
- [String](#)
- [Int64](#)
- [Double](#)
- [RecordV2](#)
- [DEPRECATED: Record](#)
- [DEPRECATED: Single value](#)
- [DEPRECATED: Stateless](#)

Advanced topics

Diffusion includes advanced topic types that provide additional capabilities such as storing a series of events or routing subscriptions to other topics.

- [Time series](#)
- [Routing](#)
- [Slave](#)

Properties

You can also assign properties to topics when you create them. The properties a topic can have can change depending on the topic type. For more information, see [Properties of topics](#) on page 57.

Properties of topics

When you create a topic, you can specify properties that the topic has. The available properties depend on the topic type.

The following table shows which properties are available. Some property names have been abbreviated; see below the table for the full names.

Table 12: Properties available for topics of each type

Typ	PUBLISH VALUES ONLY	DONT RETAIN VALUES	SLAVE MASTER TOPIC	TIDY ON UNSUB	TIME SERIES EVENT VALUE TYPE	TIME SERIES RETAIN RANGE	TIME SERIES SUBSC RANGE	VALIDAT VALUES	SCH	COM	OWI	REM	PER
JSON	✓	✓		✓				✓		✓	✓	✓	✓
Binary	✓	✓		✓				✓		✓	✓	✓	✓
String	✓	✓		✓				✓		✓	✓	✓	✓
Int64		✓		✓				✓		✓	✓	✓	✓
Double		✓		✓				✓		✓	✓	✓	✓
Time series	✓	✓		✓	REQUIRED	✓	✓	✓		✓	✓	✓	✓
Routing				✓									
Slave			REQUIRED	✓									
RecordV2		✓		✓				✓	✓	✓	✓	✓	✓
DEPRECATED: Record				✓						✓	PARTIAL		
DEPRECATED: Single value				✓						✓	PARTIAL		
DEPRECATED: Stateless				✓						✓	✓	✓	✓

PUBLISH_VALUES_ONLY

By default, delta streaming is enabled. If this property is set to `true`, delta streaming is disabled and all values are published in full.

If there is little or no relationship between one value published to a topic and the next, delta streams will not reduce the amount of data transmitted. For such topics, it is better to set `PUBLISH_VALUES_ONLY`.

DONT_RETAIN_VALUE

If set to `true`, the latest value of the topic is not retained by the Diffusion server or the client that publishes it. New clients that subscribe do not receive an initial value. No value will be returned for fetch operations that select the topic.

For time series topics, if `DONT_RETAIN_VALUE` is set to `true`, time series events are still retained, but the latest value is not stored separately.

The `DONT_RETAIN_VALUE` property is useful for applications like a feed of news items, or for values that are only valid at the moment of publication. You can combine this with `VALIDATE_VALUES`.

Using `DONT_RETAIN_VALUE` reduces the topic memory footprint, but disables delta streaming. Disabling delta streaming is likely to increase the bandwidth used unless subsequent values are unrelated.

This property replaces the deprecated [stateless topic type](#) which sends untyped byte data and requires clients to interpret and validate the data.

SLAVE_MASTER_TOPIC

The path to the topic that acts as the master topic to a slave topic. A topic is not required to exist at this path at the time the slave topic is created.

TIDY_ON_UNSUBSCRIBE

If set to `true`, when a session unsubscribes from the topic, any updates for the topic that are still queued for the session are removed.

There is a performance overhead to using this option as the client queue must be scanned to find topic updates to remove, however it may prove useful for preventing unwanted data being sent to sessions. This property is disabled by default.

TIME_SERIES_EVENT_VALUE_TYPE

Set this to the type name of a Diffusion data type. All events in the time series are of this data type. The type name can be one of the following values:

- `json`
- `binary`
- `string`
- `int64`
- `double`
- `record_v2`

TIME_SERIES_RETAINED_RANGE

Set this to a range expression that specifies the range of events retained by a time series topic. When a new event is added to the time series, older events that fall outside of the range are discarded. If the property is not specified, a time series topic retains the ten most recent events.

For more information about range expressions, see [Range expressions](#) on page 61.

TIME_SERIES_SUBSCRIPTION_RANGE

Set this to a range expression that specifies the range of events sent to all new subscribers.

If a range expression is specified for this property, the specified subscription range is sent to the client session. This is true whether delta streams are enabled for the topic or not. However, to receive all the events in the specified range, the subscribing client session must register a stream before it subscribes to the topic. If a stream is not registered before subscription, the session receives only the latest value.

If the property is not specified, new subscribers will be sent the latest event if delta streams are enabled for the topic and no events if delta streams are disabled for the topic.

For more information about range expressions, see [Range expressions](#) on page 61.

VALIDATE_VALUES

If set to `true`, the topic rejects updates that would create invalid instances of the topic's data type.

If set to anything other than `true`, no validation is performed and all values are streamed to subscribing clients whether they are valid data or not.

Validation has a performance overhead and is disabled by default.

Note: If validation is disabled and the value provided is not valid, the client might produce errors or other unexpected behavior. The exact error varies depending on the client platform. To avoid this, use the client-side validation method provided by the Diffusion API.

SCHEMA

Optionally, define valid records and fields of a recordV2 topic.

A recordV2 topic contains records, which can be divided into fields. The schema names the records and fields and provides a mechanism for direct access to the fields. The schema is also used to validate the data to ensure it complies with the schema definition. The schema property is supplied as a JSON string that can be generated from a Schema object.

If no schema is provided, the topic data can be free format.

CONFLATION

Used to set a conflation policy for the topic. Conflation can merge or discard topic updates to reduce server memory and network data usage.

The supported values are:

- `off`
- `conflate`
- `unsubscribe`
- `always`

The default is `"conflate"`.

See [Using conflation](#) on page 96 for details of the policies.

For the deprecated stateless, single value and record topic types, conflation is specified using server-side configuration, but setting the `"off"` value for this property prevents that being applied, and setting the `"unsubscribe"` property will still unsubscribe on conflation.

OWNER

Used to set a security principal as the owner of the topic. The principal receives `READ_TOPIC`, `MODIFY_TOPIC` and `UPDATE_TOPIC` privileges.

The format of the property value is:

```
$Principal is "name"
```

where **name** is the name of the principal.

REMOVAL

Used to set a topic removal policy.

The property is an expression which defines the conditions which will trigger automatic removal of the topic or of a set of topics specified with an optional selector.

See [Removing topics automatically](#) on page 319 for details of the expression format.

PERSISTENT

Used to disable persistence for a topic.

If set to "false", the topic will not be persisted, even if persistence is enabled for the server.

Range expressions

A range expression can contain the following constraints:

A limit constraint

A limit constraint specifies the maximum number of events from the end of the time series.

For example, the following expression requests the five most recent events:

```
limit 5
```

A last constraint

A last constraint specifies the maximum duration of events from the end of the time series. The duration is expressed as an integer followed by one of the following time units:

- MS – milliseconds
- S – seconds
- H – hours

For example, the following expression requests all recent events that are no more than 30 seconds older than the latest event:

```
last 30s
```

Both a limit and a last constraint

For example, the following expression requests the ten most recent events that are no more than one minute older than the latest event:

```
last 60s limit 10
```

If a range expression contains multiple constraints, the constraint that selects the smallest range is used.

Range expressions are not case sensitive.

JSON topics

A topic that provides data in JSON format. The data is transmitted in a binary form for increased efficiency and can be transmitted as a structural delta to reduce the amount of data sent. JSON topics are stateful: each topic stores a JSON value the Diffusion server.

Why use a JSON topic?

JSON is a human-readable, industry-standard format for your data. JSON is natively supported by JavaScript and there are third-party libraries available for other platforms. For more information about JSON, see <http://www.json.org/>.

A JSON topic enables multiple fields to be maintained in the same topic as part of a composite data type. All updates made at the same time to parts of a JSON topic are sent out to the client together. This enables a set of parts to be treated as a transactional group.

Deltas of change are calculated at the Diffusion server such that only those parts that have changed since the last update are sent out to the subscribed clients. These structural deltas ensure that the minimum amount of data is sent to clients.

The current value of the topic is cached on the client. When deltas are sent, the client can automatically apply these deltas to the value to calculate the new value.

If your data structure is too complex to be represented by a topic tree or might make the topic tree structure difficult to manage, it might be more appropriate to represent part of the data structure inside a JSON topic as JSON objects.

The value of the topic is transmitted as CBOR. For more information about CBOR, see <http://cbor.io/>.

The value of the topic is accessible both as JSON and CBOR.

Properties of a JSON topic

When you create a JSON topic you can specify the following properties in the topic specification:

PUBLISH_VALUES_ONLY

By default, delta streaming is enabled. If this property is set to `true`, delta streaming is disabled and all values are published in full.

If there is little or no relationship between one value published to a topic and the next, delta streams will not reduce the amount of data transmitted. For such topics, it is better to set `PUBLISH_VALUES_ONLY`.

DONT_RETAIN_VALUE

If set to `true`, the latest value of the topic is not retained by the Diffusion server or the client that publishes it. New clients that subscribe do not receive an initial value. No value will be returned for fetch operations that select the topic.

For time series topics, if `DONT_RETAIN_VALUE` is set to `true`, time series events are still retained, but the latest value is not stored separately.

The `DONT_RETAIN_VALUE` property is useful for applications like a feed of news items, or for values that are only valid at the moment of publication. You can combine this with `VALIDATE_VALUES`.

Using `DONT_RETAIN_VALUE` reduces the topic memory footprint, but disables delta streaming. Disabling delta streaming is likely to increase the bandwidth used unless subsequent values are unrelated.

This property replaces the deprecated [stateless topic type](#) which sends untyped byte data and requires clients to interpret and validate the data.

TIDY_ON_UNSUBSCRIBE

If set to `true`, when a session unsubscribes from the topic, any updates for the topic that are still queued for the session are removed.

There is a performance overhead to using this option as the client queue must be scanned to find topic updates to remove, however it may prove useful for preventing unwanted data being sent to sessions. This property is disabled by default.

VALIDATE_VALUES

If set to `true`, the topic rejects updates that would create invalid instances of the topic's data type.

If set to anything other than `true`, no validation is performed and all values are streamed to subscribing clients whether they are valid data or not.

Validation has a performance overhead and is disabled by default.

Note: If validation is disabled and the value provided is not valid, the client might produce errors or other unexpected behavior. The exact error varies depending on the client platform. To avoid this, use the client-side validation method provided by the Diffusion API.

CONFLATION

Used to set a conflation policy for the topic. Conflation can merge or discard topic updates to reduce server memory and network data usage.

The supported values are:

- off
- conflate
- unsubscribe
- always

The default is "conflate".

See [Using conflation](#) on page 96 for details of the policies.

For the deprecated stateless, single value and record topic types, conflation is specified using server-side configuration, but setting the "off" value for this property prevents that being applied, and setting the "unsubscribe" property will still unsubscribe on conflation.

OWNER

Used to set a security principal as the owner of the topic. The principal receives `READ_TOPIC`, `MODIFY_TOPIC` and `UPDATE_TOPIC` privileges.

The format of the property value is:

```
$Principal is "name"
```

where **name** is the name of the principal.

REMOVAL

Used to set a topic removal policy.

The property is an expression which defines the conditions which will trigger automatic removal of the topic or of a set of topics specified with an optional selector.

See [Removing topics automatically](#) on page 319 for details of the expression format.

PERSISTENT

Used to disable persistence for a topic.

If set to "false", the topic will not be persisted, even if persistence is enabled for the server.

Considerations when using a JSON topic

It is possible to store any data in a JSON topic, even if it is not valid JSON. However, this can cause problems when clients receive unexpected values.

You can validate JSON in the client, or on the server by setting `VALIDATE_VALUES` to true.

All languages parse JSON as text. Only JavaScript has native support for parsing JSON. Other languages must use third-party libraries. The JavaScript clients provide facilities for converting JSON text to and from a Diffusion JSON value.

Diffusion JSON values are transmitted as a CBOR representation. Applications can also access the CBOR binary data directly, and it is often more efficient to do so than to first convert the data to JSON text. For example, Java applications can use the third party Jackson library to map the CBOR data directly to Java objects.

The Publisher API provides the capability to create and update JSON topics using `TopicDataFactory.newUniversalData`.

Binary topics

A topic that streams binary data as bytes and uses efficient binary deltas to stream only the data that changes between updates. Binary topics are stateful: each topic stores a binary value on the Diffusion server.

Why use a binary topic?

You can use a binary topic to transmit any arbitrary binary data without the overhead of encoding it to a string or the risk of the binary data being incorrectly escaped.

Binary topics can use binary deltas to send only the data that has changed when this is more efficient than sending the full value.

You can use a binary topic to transmit very large strings. This enables a client to use the binary delta capability to transmit only the changed parts of a string rather than the whole value. This reduces the amount of data transmitted over the network.

Binary formats, such as Google protocol buffers, can be streamed using a binary topic.

Properties of a binary topic

When you create a binary topic you can specify the following properties in the topic specification:

PUBLISH_VALUES_ONLY

By default, delta streaming is enabled. If this property is set to `true`, delta streaming is disabled and all values are published in full.

If there is little or no relationship between one value published to a topic and the next, delta streams will not reduce the amount of data transmitted. For such topics, it is better to set `PUBLISH_VALUES_ONLY`.

DONT_RETAIN_VALUE

If set to `true`, the latest value of the topic is not retained by the Diffusion server or the client that publishes it. New clients that subscribe do not receive an initial value. No value will be returned for fetch operations that select the topic.

For time series topics, if `DONT_RETAIN_VALUE` is set to `true`, time series events are still retained, but the latest value is not stored separately.

The `DONT_RETAIN_VALUE` property is useful for applications like a feed of news items, or for values that are only valid at the moment of publication. You can combine this with `VALIDATE_VALUES`.

Using `DONT_RETAIN_VALUE` reduces the topic memory footprint, but disables delta streaming. Disabling delta streaming is likely to increase the bandwidth used unless subsequent values are unrelated.

This property replaces the deprecated [stateless topic type](#) which sends untyped byte data and requires clients to interpret and validate the data.

TIDY_ON_UNSUBSCRIBE

If set to `true`, when a session unsubscribes from the topic, any updates for the topic that are still queued for the session are removed.

There is a performance overhead to using this option as the client queue must be scanned to find topic updates to remove, however it may prove useful for preventing unwanted data being sent to sessions. This property is disabled by default.

VALIDATE_VALUES

If set to `true`, the topic rejects updates that would create invalid instances of the topic's data type.

If set to anything other than `true`, no validation is performed and all values are streamed to subscribing clients whether they are valid data or not.

Validation has a performance overhead and is disabled by default.

Note: If validation is disabled and the value provided is not valid, the client might produce errors or other unexpected behavior. The exact error varies depending on the client platform. To avoid this, use the client-side validation method provided by the Diffusion API.

Binary values are always valid so setting this property has no effect.

CONFLATION

Used to set a conflation policy for the topic. Conflation can merge or discard topic updates to reduce server memory and network data usage.

The supported values are:

- `off`
- `conflate`
- `unsubscribe`
- `always`

The default is `"conflate"`.

See [Using conflation](#) on page 96 for details of the policies.

For the deprecated stateless, single value and record topic types, conflation is specified using server-side configuration, but setting the `"off"` value for this property prevents that being applied, and setting the `"unsubscribe"` property will still unsubscribe on conflation.

OWNER

Used to set a security principal as the owner of the topic. The principal receives `READ_TOPIC`, `MODIFY_TOPIC` and `UPDATE_TOPIC` privileges.

The format of the property value is:

```
$Principal is "name"
```

where **name** is the name of the principal.

REMOVAL

Used to set a topic removal policy.

The property is an expression which defines the conditions which will trigger automatic removal of the topic or of a set of topics specified with an optional selector.

See [Removing topics automatically](#) on page 319 for details of the expression format.

PERSISTENT

Used to disable persistence for a topic.

If set to `"false"`, the topic will not be persisted, even if persistence is enabled for the server.

Considerations when using a binary topic

Data on binary topics contains no implicit information about its structure.

Data on binary topics cannot be viewed in the console.

The Publisher API provides the capability to create and update JSON topics using `TopicDataFactory.newUniversalData`.

String topics

A topic that provides data in string format. The data is transmitted in a binary form for increased efficiency. String topics are stateful: each topic stores a JSON value on the Diffusion server.

Why use a string topic?

A string topic enables you to explicitly type the data that you send through the topic as a string.

String topics support null data values.

Deltas of change are calculated at the Diffusion server such that only those parts that have changed since the last update are sent out to the subscribed clients. This ensures that the minimum amount of data is sent to clients.

The current value of the topic is cached on the client. When deltas are sent, the client can automatically apply these deltas to the value to calculate the new value.

The value of the topic is stored and transmitted as a CBOR-encoded string, or `CBORNull`. CBOR encodes strings using UTF-8. For more information about CBOR, see <http://cbor.io/>.

Properties of a string topic

When you create a string topic you can specify the following properties in the topic specification:

PUBLISH_VALUES_ONLY

By default, delta streaming is enabled. If this property is set to `true`, delta streaming is disabled and all values are published in full.

If there is little or no relationship between one value published to a topic and the next, delta streams will not reduce the amount of data transmitted. For such topics, it is better to set `PUBLISH_VALUES_ONLY`.

DONT_RETAIN_VALUE

If set to `true`, the latest value of the topic is not retained by the Diffusion server or the client that publishes it. New clients that subscribe do not receive an initial value. No value will be returned for fetch operations that select the topic.

For time series topics, if `DONT_RETAIN_VALUE` is set to `true`, time series events are still retained, but the latest value is not stored separately.

The `DONT_RETAIN_VALUE` property is useful for applications like a feed of news items, or for values that are only valid at the moment of publication. You can combine this with `VALIDATE_VALUES`.

Using `DONT_RETAIN_VALUE` reduces the topic memory footprint, but disables delta streaming. Disabling delta streaming is likely to increase the bandwidth used unless subsequent values are unrelated.

This property replaces the deprecated [stateless topic type](#) which sends untyped byte data and requires clients to interpret and validate the data.

TIDY_ON_UNSUBSCRIBE

If set to `true`, when a session unsubscribes from the topic, any updates for the topic that are still queued for the session are removed.

There is a performance overhead to using this option as the client queue must be scanned to find topic updates to remove, however it may prove useful for preventing unwanted data being sent to sessions. This property is disabled by default.

VALIDATE_VALUES

If set to `true`, the topic rejects updates that would create invalid instances of the topic's data type.

If set to anything other than `true`, no validation is performed and all values are streamed to subscribing clients whether they are valid data or not.

Validation has a performance overhead and is disabled by default.

Note: If validation is disabled and the value provided is not valid, the client might produce errors or other unexpected behavior. The exact error varies depending on the client platform. To avoid this, use the client-side validation method provided by the Diffusion API.

CONFLATION

Used to set a conflation policy for the topic. Conflation can merge or discard topic updates to reduce server memory and network data usage.

The supported values are:

- `off`
- `conflate`
- `unsubscribe`
- `always`

The default is `"conflate"`.

See [Using conflation](#) on page 96 for details of the policies.

For the deprecated stateless, single value and record topic types, conflation is specified using server-side configuration, but setting the `"off"` value for this property prevents that being applied, and setting the `"unsubscribe"` property will still unsubscribe on conflation.

OWNER

Used to set a security principal as the owner of the topic. The principal receives `READ_TOPIC`, `MODIFY_TOPIC` and `UPDATE_TOPIC` privileges.

The format of the property value is:

```
$Principal is "name"
```

where **name** is the name of the principal.

REMOVAL

Used to set a topic removal policy.

The property is an expression which defines the conditions which will trigger automatic removal of the topic or of a set of topics specified with an optional selector.

See [Removing topics automatically](#) on page 319 for details of the expression format.

PERSISTENT

Used to disable persistence for a topic.

If set to "false", the topic will not be persisted, even if persistence is enabled for the server.

Considerations when using a string topic

The Publisher API provides the capability to create and update string topics using `TopicDataFactory.newUniversalData`.

Int64 topics

A topic that provides data in 64-bit integer format. The data is transmitted in a binary form for increased efficiency. Int64 topics are stateful: each topic stores a 64-bit integer on the Diffusion server.

Why use an int64 topic?

An int64 topic enables you to explicitly type the data that you send through the topic as a 64-bit integer.

Int64 topics support null data values.

The value of the topic is transmitted as CBOR. For more information about CBOR, see <http://cbor.io/>.

The value of the topic is accessible both as a 64-bit integer and CBOR.

Properties of an int64 topic

When you create an int64 topic you can specify the following properties in the topic specification:

DONT_RETAIN_VALUE

If set to true, the latest value of the topic is not retained by the Diffusion server or the client that publishes it. New clients that subscribe do not receive an initial value. No value will be returned for fetch operations that select the topic.

For time series topics, if DONT_RETAIN_VALUE is set to true, time series events are still retained, but the latest value is not stored separately.

The DONT_RETAIN_VALUE property is useful for applications like a feed of news items, or for values that are only valid at the moment of publication. You can combine this with VALIDATE_VALUES.

Using DONT_RETAIN_VALUE reduces the topic memory footprint, but disables delta streaming. Disabling delta streaming is likely to increase the bandwidth used unless subsequent values are unrelated.

This property replaces the deprecated [stateless topic type](#) which sends untyped byte data and requires clients to interpret and validate the data.

TIDY_ON_UNSUBSCRIBE

If set to true, when a session unsubscribes from the topic, any updates for the topic that are still queued for the session are removed.

There is a performance overhead to using this option as the client queue must be scanned to find topic updates to remove, however it may prove useful for preventing unwanted data being sent to sessions. This property is disabled by default.

VALIDATE_VALUES

If set to true, the topic rejects updates that would create invalid instances of the topic's data type.

If set to anything other than true, no validation is performed and all values are streamed to subscribing clients whether they are valid data or not.

Validation has a performance overhead and is disabled by default.

Note: If validation is disabled and the value provided is not valid, the client might produce errors or other unexpected behavior. The exact error varies depending on the client platform. To avoid this, use the client-side validation method provided by the Diffusion API.

CONFLATION

Used to set a conflation policy for the topic. Conflation can merge or discard topic updates to reduce server memory and network data usage.

The supported values are:

- off
- conflate
- unsubscribe
- always

The default is "conflate".

See [Using conflation](#) on page 96 for details of the policies.

For the deprecated stateless, single value and record topic types, conflation is specified using server-side configuration, but setting the "off" value for this property prevents that being applied, and setting the "unsubscribe" property will still unsubscribe on conflation.

OWNER

Used to set a security principal as the owner of the topic. The principal receives `READ_TOPIC`, `MODIFY_TOPIC` and `UPDATE_TOPIC` privileges.

The format of the property value is:

```
$Principal is "name"
```

where **name** is the name of the principal.

REMOVAL

Used to set a topic removal policy.

The property is an expression which defines the conditions which will trigger automatic removal of the topic or of a set of topics specified with an optional selector.

See [Removing topics automatically](#) on page 319 for details of the expression format.

PERSISTENT

Used to disable persistence for a topic.

If set to "false", the topic will not be persisted, even if persistence is enabled for the server.

Considerations when using an int64 topic

Deltas are not available for data published to int64 topics.

Because of a limitation of the JavaScript platform, the validity of the values converted to an `Int64` from a `Number` or converted to a `Number` from an `Int64` can only be guaranteed for values up to $2^{53} - 1$. Converting between a `String` and an `Int64` has fully guaranteed precision.

The Publisher API provides the capability to create and update int64 topics using `TopicDataFactory.newUniversalData`.

Double topics

A topic that provides data in double precision floating point format (IEEE 754). The data is transmitted in a binary form for increased efficiency. Double topics are stateful: each topic stores a double value on the Diffusion server.

Why use a double topic?

A double topic enables you to explicitly type the data that you send through the topic as a double precision floating point number.

Double topics support null data values.

The value of the topic is transmitted as CBOR. For more information about CBOR, see <http://cbor.io/>.

The value of the topic is accessible both as a double and CBOR.

Properties of a double topic

When you create a double topic you can specify the following properties in the topic specification:

DONT_RETAIN_VALUE

If set to `true`, the latest value of the topic is not retained by the Diffusion server or the client that publishes it. New clients that subscribe do not receive an initial value. No value will be returned for fetch operations that select the topic.

For time series topics, if `DONT_RETAIN_VALUE` is set to `true`, time series events are still retained, but the latest value is not stored separately.

The `DONT_RETAIN_VALUE` property is useful for applications like a feed of news items, or for values that are only valid at the moment of publication. You can combine this with `VALIDATE_VALUES`.

Using `DONT_RETAIN_VALUE` reduces the topic memory footprint, but disables delta streaming. Disabling delta streaming is likely to increase the bandwidth used unless subsequent values are unrelated.

This property replaces the deprecated [stateless topic type](#) which sends untyped byte data and requires clients to interpret and validate the data.

TIDY_ON_UNSUBSCRIBE

If set to `true`, when a session unsubscribes from the topic, any updates for the topic that are still queued for the session are removed.

There is a performance overhead to using this option as the client queue must be scanned to find topic updates to remove, however it may prove useful for preventing unwanted data being sent to sessions. This property is disabled by default.

VALIDATE_VALUES

If set to `true`, the topic rejects updates that would create invalid instances of the topic's data type.

If set to anything other than `true`, no validation is performed and all values are streamed to subscribing clients whether they are valid data or not.

Validation has a performance overhead and is disabled by default.

Note: If validation is disabled and the value provided is not valid, the client might produce errors or other unexpected behavior. The exact error varies depending on the client platform. To avoid this, use the client-side validation method provided by the Diffusion API.

CONFLATION

Used to set a conflation policy for the topic. Conflation can merge or discard topic updates to reduce server memory and network data usage.

The supported values are:

- off
- conflate
- unsubscribe
- always

The default is "conflate".

See [Using conflation](#) on page 96 for details of the policies.

For the deprecated stateless, single value and record topic types, conflation is specified using server-side configuration, but setting the "off" value for this property prevents that being applied, and setting the "unsubscribe" property will still unsubscribe on conflation.

OWNER

Used to set a security principal as the owner of the topic. The principal receives `READ_TOPIC`, `MODIFY_TOPIC` and `UPDATE_TOPIC` privileges.

The format of the property value is:

```
$Principal is "name"
```

where **name** is the name of the principal.

REMOVAL

Used to set a topic removal policy.

The property is an expression which defines the conditions which will trigger automatic removal of the topic or of a set of topics specified with an optional selector.

See [Removing topics automatically](#) on page 319 for details of the expression format.

PERSISTENT

Used to disable persistence for a topic.

If set to "false", the topic will not be persisted, even if persistence is enabled for the server.

Considerations when using a double topic

Deltas are not available for data published to double topics.

The Publisher API provides the capability to create and update double topics using `TopicDataFactory.newUniversalData`.

Time series topics

A time series topic holds a sequence of events.

Note: Time series topics are supported by the JavaScript, Java, Android, .NET and Apple APIs.

Why use a time series topic?

A time series topic holds a sequence of events. Time series topics are useful for collaborative applications such as chat rooms. Multiple users can concurrently update a time series topic.

Each event in a time series topic has a value. Each time series topic has an associated data type which determines what type of value its events have: binary, double, int64, JSON, string or recordV2.

All the events in a given time series topic must have the same value type.

Each event is assigned metadata by the Diffusion server. This metadata consists of a sequence number, a timestamp, and an author (where the author is the principal used by the client session that creates the event).

A time series is an append-only data structure. A session can update the topic by providing a new event, which the server will append to the end of the time series. A session can also edit an existing event in time series, providing a new value. Editing an event does not remove or modify the original event, but instead appends an edit event to the end of the time series. Edit events have an additional metadata field, the sequence number of the original event, allowing subscribers to associate the new value with the replaced value.

You can subscribe to events that are published to a time series topic and receive updates in the same way as for other topics. New subscribers also receive an initial subset of the most recent events. You can configure a subscription range to control how far back in time the initial set goes.

You can query a time series topic to receive a range of events based on the timestamp or sequence number of the events in a series.

By default, queries return a merged view of a time series that includes edit events in the place of the original events. A session with the `QUERY_OBSOLETE_TIME_SERIES_EVENTS` permission can submit a modified query which returns an unmerged view that includes both original events and the edit events that replace them.

Properties of a time series topic

When you create a time series topic you must specify the following property in the topic specification:

TIME_SERIES_EVENT_VALUE_TYPE

Set this to the type name of a Diffusion data type. All events in the time series are of this data type. The type name can be one of the following values:

- json
- binary
- string
- int64
- double
- record_v2

You can also specify the following optional properties in the topic specification:

PUBLISH_VALUES_ONLY

By default, delta streaming is enabled. If this property is set to `true`, delta streaming is disabled and all values are published in full.

If there is little or no relationship between one value published to a topic and the next, delta streams will not reduce the amount of data transmitted. For such topics, it is better to set `PUBLISH_VALUES_ONLY`.

DONT_RETAIN_VALUE

If set to `true`, the latest value of the topic is not retained by the Diffusion server or the client that publishes it. New clients that subscribe do not receive an initial value. No value will be returned for fetch operations that select the topic.

For time series topics, if `DONT_RETAIN_VALUE` is set to `true`, time series events are still retained, but the latest value is not stored separately.

The `DONT_RETAIN_VALUE` property is useful for applications like a feed of news items, or for values that are only valid at the moment of publication. You can combine this with `VALIDATE_VALUES`.

Using `DONT_RETAIN_VALUE` reduces the topic memory footprint, but disables delta streaming. Disabling delta streaming is likely to increase the bandwidth used unless subsequent values are unrelated.

This property replaces the deprecated [stateless topic type](#) which sends untyped byte data and requires clients to interpret and validate the data.

TIDY_ON_UNSUBSCRIBE

If set to `true`, when a session unsubscribes from the topic, any updates for the topic that are still queued for the session are removed.

There is a performance overhead to using this option as the client queue must be scanned to find topic updates to remove, however it may prove useful for preventing unwanted data being sent to sessions. This property is disabled by default.

TIME_SERIES_RETAINED_RANGE

Set this to a range expression that specifies the range of events retained by a time series topic. When a new event is added to the time series, older events that fall outside of the range are discarded. If the property is not specified, a time series topic retains the ten most recent events.

For more information about range expressions, see [Range expressions](#) on page 61.

TIME_SERIES_SUBSCRIPTION_RANGE

Set this to a range expression that specifies the range of events sent to all new subscribers.

If a range expression is specified for this property, the specified subscription range is sent to the client session. This is true whether delta streams are enabled for the topic or not. However, to receive all the events in the specified range, the subscribing client session must register a stream before it subscribes to the topic. If a stream is not registered before subscription, the session receives only the latest value.

If the property is not specified, new subscribers will be sent the latest event if delta streams are enabled for the topic and no events if delta streams are disabled for the topic.

For more information about range expressions, see [Range expressions](#) on page 61.

VALIDATE_VALUES

If set to `true`, the topic rejects updates that would create invalid instances of the topic's data type.

If set to anything other than `true`, no validation is performed and all values are streamed to subscribing clients whether they are valid data or not.

Validation has a performance overhead and is disabled by default.

Note: If validation is disabled and the value provided is not valid, the client might produce errors or other unexpected behavior. The exact error varies depending on the client platform. To avoid this, use the client-side validation method provided by the Diffusion API.

CONFLATION

Used to set a conflation policy for the topic. Conflation can merge or discard topic updates to reduce server memory and network data usage.

The supported values are:

- off
- conflate
- unsubscribe
- always

The default is "conflate".

See [Using conflation](#) on page 96 for details of the policies.

For the deprecated stateless, single value and record topic types, conflation is specified using server-side configuration, but setting the "off" value for this property prevents that being applied, and setting the "unsubscribe" property will still unsubscribe on conflation.

OWNER

Used to set a security principal as the owner of the topic. The principal receives `READ_TOPIC`, `MODIFY_TOPIC` and `UPDATE_TOPIC` privileges.

The format of the property value is:

```
$Principal is "name"
```

where **name** is the name of the principal.

REMOVAL

Used to set a topic removal policy.

The property is an expression which defines the conditions which will trigger automatic removal of the topic or of a set of topics specified with an optional selector.

See [Removing topics automatically](#) on page 319 for details of the expression format.

PERSISTENT

Used to disable persistence for a topic.

If set to "false", the topic will not be persisted, even if persistence is enabled for the server.

Considerations when using a time series topic

All the events in a time series topic are stored in memory on the Diffusion server. If the Diffusion server is restarted, the events in the time series are lost unless topic persistence is enabled.

A time series topic retains a range of the most recent events. Older events are discarded. By default, only the ten most recent events are retained (this includes edit events). You can configure the "retained range" property to retain more events.

Enabling `DONT_RETAIN_VALUE` for a time series does not prevent time series events being retained. It only prevents separate storage of the latest value. Enabling `DONT_RETAIN_VALUE` for a time series only produces a small memory saving compared to using it for other topic types.

If you are considering using `PUBLISH_VALUES_ONLY` for a time series topic, use `DONT_RETAIN_VALUE`, which has the same effect of disabling delta streaming, but additionally saves memory.

A query against a time series topic only returns edit events that refer to original events in the view range of the query. If the original event is no longer stored on the server due to the retained range, related edit events will never be returned. These "orphaned" edit events will stay on the server until more events have been appended and they are pushed out of the retained range.

If subscribing to a time series topic and using a value stream to receive data, ensure that the client adds the value stream before subscribing to the topic to receive all events in the configurable window. If the client session adds the value stream before it subscribes to the time series topic, the client session only receives the latest event on the time series topic.

The Publisher API does not support interaction with time series topics.

Related concepts

[Using time series topics](#) on page 356

A client can subscribe to a time series topic using a value stream, query to retrieve values within a range, append new values, or apply an edit event to override the value of an earlier event.

Routing topics

A special type of topic, which can map to a different real topic for every client that subscribes to it. In this way, different clients can see different values for what is effectively the same topic from the client point of view.

When a client subscribes to a routing topic, the request is either passed to a client that has registered as a routing subscription handler for the topic or handled by a server-side routing handler. The routing handler assigns a linked topic to represent it to that client.

The routing handler can assign a different linked topic to each client that subscribes to the routing topic.

When updates are received on the linked topic, those updates are propagated through the routing topic to the subscribing clients.

The subscribing client is not aware of the linked topic. It is subscribed to the routing topic and all the updates that the client receives contain only the routing topic path and not the linked topic path.

Why use a routing topic?

Use routing topics when you want your subscribing clients to all have the same subscription behavior, but the data they receive to be decided by a routing handler depending on criteria about that client.

For example, your subscribing clients can subscribe to a routing topic called Price, but the routing handler assigns each client a different linked topic depending on the client's geographic location. This way, clients in different countries can act in the same way, but receive localized information.

Properties of a routing topic

When you create a routing topic you can specify the following properties in the topic specification:

TIDY_ON_UNSUBSCRIBE

If set to `true`, when a session unsubscribes from the topic, any updates for the topic that are still queued for the session are removed.

There is a performance overhead to using this option as the client queue must be scanned to find topic updates to remove, however it may prove useful for preventing unwanted data being sent to sessions. This property is disabled by default.

Considerations when using a routing topic

Using routing topics requires that you write a routing handler that is either hosted on the server or registered by a client with the required permissions. The following client APIs can register a routing handler: Java, .NET, or Android API.

A subscribing client only needs permission to subscribe to the routing topic. Permission to subscribe to the linked topic is not required.

If the linked topic is removed, subscribing clients are automatically unsubscribed from the routing topic.

If you attempt to fetch from a routing topic that routes to a stateless topic, no data is returned.

You cannot use topic replication to replicate routing topics between Diffusion servers.

When using automatic fan-out to propagate topics from a primary server to one or more secondary servers, the routing subscription handlers for a routing topic must be registered at the primary and all secondary servers. The routing logic provided by the handlers on the primary and secondary server must be identical.

Slave topics

A special type of topic that has no state of its own but is a reference to the state of another topic.

A slave topic acts as an alias to another topic, the master topic. Updates published to the master are fanned out to subscribers of the slave. The slave cannot be updated directly. The master topic can be any topic type except:

- slave
- routing

The link between a slave topic and a master topic is defined when the slave topic is created. This is different to routing topics where the link between topics is defined when a client session subscribes.

If the master topic does not exist when the slave topic is created, the slave topic is created as an unbound slave topic that is not visible to subscribers. When a topic is created at the master topic path, the slave topic becomes bound and can be subscribed to by client sessions.

Properties of a slave topic

When you create a slave topic you must specify the following property in the topic specification:

SLAVE_MASTER_TOPIC

The path to the topic that acts as the master topic to a slave topic. A topic is not required to exist at this path at the time the slave topic is created.

When you create a slave topic you can specify the following optional properties in the topic specification:

TIDY_ON_UNSUBSCRIBE

If set to `true`, when a session unsubscribes from the topic, any updates for the topic that are still queued for the session are removed.

There is a performance overhead to using this option as the client queue must be scanned to find topic updates to remove, however it may prove useful for preventing unwanted data being sent to sessions. This property is disabled by default.

Why use a slave topic?

You can use slave topics to provide the same data from multiple topic paths and manage the topics from only one topic.

You can use a slave topic to act as a redirection to a succession of master topics. For example, you can create a slave topic called `latest` that is linked to a master topic where data is published about a current event. When that event is no longer current, you can remove the slave topic and recreate it now linked to the master topic where data is published about what is now the current event.

The subscribing client sessions can subscribe to the `latest` slave topic and they continue to be subscribed to the slave topic and receive the latest data, even as the master topic that provides the data changes.

Considerations when using a slave topic

A client only needs permissions on the slave topic. Permission to subscribe to the linked topic is not required.

More than one slave can point to the same master topic.

A slave topic cannot also act as a master topic to another slave topic.

Removing a master topic causes all linked slave topics to become unbound and any clients that are subscribed to the slave topic become unsubscribed. If a new master topic is created at the linked path, the slave topic is bound and the clients are resubscribed.

When using topic replication to replicate slave topics between Diffusion servers, be aware that a replicated slave topic is linked to a master topic located on the same Diffusion server as the replicated slave topic. This is true whether that master topic is created by replication or directly.

Slave topics created by the Publisher API cannot link to master topics created by a client.

Slave topics created by a client cannot link to master topics created by the Publisher API.

Slave topics created by the Publisher API behave differently to those created by the client API. When a publisher creates a slave topic, the master topic must already exist. When a master topic is removed any slave topics that were created by the Publisher API are removed.

RecordV2 topics

A topic that streams data in recordV2 format, where the data is divided into multiple records, each of which can contain multiple fields. RecordV2 topics are stateful: each topic stores a value consisting of one or more records on the Diffusion server.

You can optionally define the format of the data by using a schema that is associated with the recordV2 topic. You can use a schema to validate the data at the server. A schema also provides a convenient way of building a topic value using the fields defined within the schema, or interpreting a topic value in terms of named records and fields. For more information, see [RecordV2 schema](#) on page 80.

If you choose not to provide a schema, the data is treated as free format: the meaning of each field is up to your application, and Diffusion does not perform any validation.

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Why use a recordV2 topic?

A recordV2 topic enables multiple fields to be maintained in the same topic as part of a composite data type. All updates made at the same time to fields on a record topic are sent out to the client together. This enables a set of fields to be treated as a transactional group.

Deltas of change are calculated at the server such that only those fields that have changed since the last update are sent out to the subscribed clients. This ensures that the minimum amount of data is sent to clients.

Properties of a recordV2 topic

When you create a recordV2 topic you can specify the following properties in the topic specification:

PUBLISH_VALUES_ONLY

By default, delta streaming is enabled. If this property is set to `true`, delta streaming is disabled and all values are published in full.

If there is little or no relationship between one value published to a topic and the next, delta streams will not reduce the amount of data transmitted. For such topics, it is better to set `PUBLISH_VALUES_ONLY`.

DONT_RETAIN_VALUE

If set to true, the latest value of the topic is not retained by the Diffusion server or the client that publishes it. New clients that subscribe do not receive an initial value. No value will be returned for fetch operations that select the topic.

For time series topics, if DONT_RETAIN_VALUE is set to true, time series events are still retained, but the latest value is not stored separately.

The DONT_RETAIN_VALUE property is useful for applications like a feed of news items, or for values that are only valid at the moment of publication. You can combine this with VALIDATE_VALUES.

Using DONT_RETAIN_VALUE reduces the topic memory footprint, but disables delta streaming. Disabling delta streaming is likely to increase the bandwidth used unless subsequent values are unrelated.

This property replaces the deprecated [stateless topic type](#) which sends untyped byte data and requires clients to interpret and validate the data.

TIDY_ON_UNSUBSCRIBE

If set to true, when a session unsubscribes from the topic, any updates for the topic that are still queued for the session are removed.

There is a performance overhead to using this option as the client queue must be scanned to find topic updates to remove, however it may prove useful for preventing unwanted data being sent to sessions. This property is disabled by default.

SCHEMA

Optionally, define valid records and fields of a recordV2 topic.

A recordV2 topic contains records, which can be divided into fields. The schema names the records and fields and provides a mechanism for direct access to the fields. The schema is also used to validate the data to ensure it complies with the schema definition. The schema property is supplied as a JSON string that can be generated from a Schema object.

If no schema is provided, the topic data can be free format.

VALIDATE_VALUES

If set to true, the topic rejects updates that would create invalid instances of the topic's data type.

If set to anything other than true, no validation is performed and all values are streamed to subscribing clients whether they are valid data or not.

Validation has a performance overhead and is disabled by default.

Note: If validation is disabled and the value provided is not valid, the client might produce errors or other unexpected behavior. The exact error varies depending on the client platform. To avoid this, use the client-side validation method provided by the Diffusion API.

CONFLATION

Used to set a conflation policy for the topic. Conflation can merge or discard topic updates to reduce server memory and network data usage.

The supported values are:

- off
- conflate
- unsubscribe
- always

The default is "conflate".

See [Using conflation](#) on page 96 for details of the policies.

For the deprecated stateless, single value and record topic types, conflation is specified using server-side configuration, but setting the "off" value for this property prevents that being applied, and setting the "unsubscribe" property will still unsubscribe on conflation.

OWNER

Used to set a security principal as the owner of the topic. The principal receives `READ_TOPIC`, `MODIFY_TOPIC` and `UPDATE_TOPIC` privileges.

The format of the property value is:

```
$Principal is "name"
```

where **name** is the name of the principal.

REMOVAL

Used to set a topic removal policy.

The property is an expression which defines the conditions which will trigger automatic removal of the topic or of a set of topics specified with an optional selector.

See [Removing topics automatically](#) on page 319 for details of the expression format.

PERSISTENT

Used to disable persistence for a topic.

If set to "false", the topic will not be persisted, even if persistence is enabled for the server.

Considerations when using a recordV2 topic

RecordV2 replaces the older, deprecated [record topic type](#). You can migrate your applications from deprecated record topics to recordV2 topics with minimal changes. Using recordV2 instead of the deprecated record type is required to use topic persistence and topic replication.

The data within a recordV2 topic can either be free format or constrained by a schema. If no schema property is specified, the topic will be treated as free format.

Update a recordV2 topic with a value updater. See [Updating topics](#) on page 336 for more information about value updaters.

Receive data from a recordV2 topic with a value stream. See [Using streams for subscription](#) on page 273 for more information.

The Publisher API provides the capability to create and update recordV2 topics using `TopicDataFactory.newUniversalData`.

Related concepts

[RecordV2 schema](#) on page 80

A schema is an optional way to define how data is formatted when it is published on a recordV2 topic. A schema defines and names the permitted records and fields within the topic, and enables direct access to the fields.

[Update recordV2 topics](#) on page 304

The following example demonstrates how to create and update recordV2 topics, including the use of a schema.

[Subscribe to recordV2 topics](#) on page 310

The following example demonstrates how to process information from subscribed recordV2 topics, including the use of a schema.

Related tasks

[Defining a recordV2 schema](#) on page 300

You can use the API to specify a schema that defines the content of a recordV2 topic.

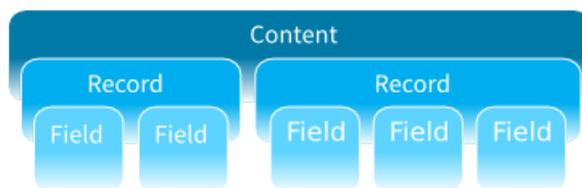
RecordV2 schema

A schema is an optional way to define how data is formatted when it is published on a recordV2 topic. A schema defines and names the permitted records and fields within the topic, and enables direct access to the fields.

The recordV2 topic type contains data organized into records and fields. You can optionally provide a schema which defines the expected structure of the data.

RecordV2 structure

The recordV2 topic type has a value consisting of records, which contain fields. Each recordV2 topic can contain one or more *records*. Each record can contain one or many *fields*.



Using a schema

With a schema, you can define how the records and fields within a recordV2 topic are laid out.

Fields and records within a schema are identified by a name. Every record must have a name that is unique within the content. Every field must have a name that is unique within the enclosing record.

Every field or record defined in the schema can represent one or more possible occurrences of that field or record in the data. The number of possible occurrences of a record or field is described by its multiplicity.

The order in which records and fields are defined within the schema sets the order that they appear within the topic.

Records

A record can contain one or more fields.

Every record has [multiplicity](#).

Fields

A field defines an elementary data item within a record.

Every field has the following properties:

- [Multiplicity](#)
- [Data type](#)

Multiplicity

The multiplicity of a field or record in a schema defines the number of times it can occur in the topic. Multiplicity is set by providing a minimum value and a maximum value.

Fixed multiplicity means the minimum and maximum are the same. For example, if a field has a minimum of 5 and a maximum of 5, there must be exactly five occurrences of the field within its enclosing record.

Variable multiplicity means the minimum and maximum are different. For example, a schema could specify that there must be between one and five occurrences of a field within its enclosing record. Variable multiplicity is only allowed in the last record in a topic, or the last field in a record.

Use a minimum value of 0 to define an optional field/record. A fixed multiplicity of 0 is not allowed.

A maximum value of -1 is used to represent that there is no limit to how many times the field or record can occur.

Data type

The data type of a field defines the type of values it can contain. The following table describes the data types that are available.

Table 13: Data types for schema fields

Data type	Description
String	A character string.
Integer	An integer represented in the content as a character string. If a field is defined as this type, it can only contain numeric digits with an optional leading sign. Fields of this type cannot be empty.
Decimal	A decimal number represented in the content as a character string. Decimal fields have the number of places to the right of the decimal point defined by the scale. Such values can be parsed from a character string with any number of digits to the right of the decimal point. Half-up rounding is applied to achieve the target scale. Output of the field is rendered with the specified scale. Fields of this type cannot be empty. For comparison purposes the scale is ignored: a value of 1.50 is the same as 1.5.

Defining a schema

See [Defining a recordV2 schema](#) on page 300 for details of how to define a schema and apply it to a recordV2 topic.

Related concepts

[RecordV2 topics](#) on page 77

A topic that streams data in recordV2 format, where the data is divided into multiple records, each of which can contain multiple fields. RecordV2 topics are stateful: each topic stores a value consisting of one or more records on the Diffusion server.

[Update recordV2 topics](#) on page 304

The following example demonstrates how to create and update recordV2 topics, including the use of a schema.

[Subscribe to recordV2 topics](#) on page 310

The following example demonstrates how to process information from subscribed recordV2 topics, including the use of a schema.

Related tasks

[Defining a recordV2 schema](#) on page 300

You can use the API to specify a schema that defines the content of a recordV2 topic.

DEPRECATED: Record topics

A topic that streams data in the deprecated record format. You should now use the new recordV2 topic type.

Describe the layout of the data by using content metadata in the schema. For more information, see [Record metadata](#) on page 83.

Why use a record topic?

A record topic enables multiple fields to be maintained in the same topic as part of a composite data type. All updates made at the same time to fields on a record topic are sent out to the client together. This enables a set of fields to be treated as a transactional group.

Deltas of change are calculated at the server such that only those fields that have changed since the last update are sent out to the subscribed clients. This ensures that the minimum amount of data is sent to clients.

Properties of a record topic

When you create a record topic you can specify the following properties in the topic specification:

TIDY_ON_UNSUBSCRIBE

If set to `true`, when a session unsubscribes from the topic, any updates for the topic that are still queued for the session are removed.

There is a performance overhead to using this option as the client queue must be scanned to find topic updates to remove, however it may prove useful for preventing unwanted data being sent to sessions. This property is disabled by default.

Considerations when using a record topic

This topic type is deprecated. Use the new recordV2 topic type instead.

You must define the metadata when you create the record topic. This is more complex than using a JSON topic for composite data.

The metadata format used by record topics is only used by Diffusion. If you require a topic with a composite data type, you can use JSON topics.

Record topic updates represent all possible records and fields within the content. Fields that have not changed are sent within delta updates as zero-length strings. Because unchanged fields are represented this way a client cannot differentiate between a field that has not changed and an empty field. You can specify a special character that is used to represent an empty field.

The current value of a record topic is not cached on the client. Because of this, deltas are not processed automatically and your application code must cache the topic value and correctly apply incoming deltas. This lack of caching also requires that a client must register a stream against a topic before subscribing to the topic in order to receive a value. If a client subscribes to a record topic then registers a stream, the client receives only deltas until the next time a full value is published.

Record metadata

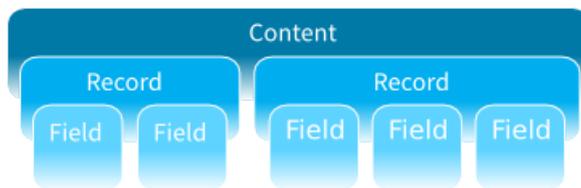
Metadata defines how data is formatted when it is published on a topic. Define the metadata structure for a topic that describes the grouping, order, type, and multiplicity of data items published on a topic.

Updates and messages contain data. This data can be formatted in whatever way your application requires. For example,

- When creating a record topic, define a metadata structure that describes the data format both for updates published on that topic and those sent on to the subscribing clients.
- When creating a single value topic, you can define field metadata that constrains the data type that updates published to the topic can have.
- When sending a message through a message path, you can use metadata to create the content of your message.

Metadata structure

The metadata structure is made up of nested records and fields. The outer container is the *content*. This contains one or more *records*. Each record can contain one or many *fields*.



Fields and records are identified by a name. Every record must have a name that is unique within the content. Every field must have a name that is unique within the enclosing record.

Every field or record defined in the metadata structure can represent one or more possible occurrences of that field or record in the data. The number of possible occurrences of a record or field is described by its multiplicity.

The order in which records and fields are defined within their enclosing container defines the order that they appear in data.

Field metadata

A metadata field defines an elementary data item within a record.

Every field has the following properties:

- [Data type](#)
- [Multiplicity](#)
- [Default value](#)

Data type

The data type of a field defines its actual representation within the data. The following table describes the data types that are available.

Table 14: Data types for metadata fields

Data type	Description	Default
String	A character string.	Zero-length string
Integer string	An integer represented in the content as a character string.	0

Data type	Description	Default
	If a field is defined as this type, it can only contain numeric digits with an optional leading sign. Fields of this type cannot be empty.	
Decimal string	A decimal number represented in the content as a character string. Decimal fields have the number of places to the right of the decimal point defined by the scale, the default being 2. Such values can be parsed from a character string with any number of digits to the right of the decimal point. Half-up rounding is applied to achieve the target scale. Output of the field is rendered with the specified scale. Fields of this type cannot be empty. For comparison purposes the scale is ignored: a value of 1.50 is the same as 1.5.	0.00 (depending on scale)
Custom string	This is a special type where the behavior is delegated to a user-written custom field handler. This type is available in all topic data types.	-

Multiplicity

The multiplicity of a metadata field or record defines the number of times the corresponding data can occur within the enclosing record or content.

Multiplicity is defined in terms of the minimum and maximum number of occurrences. Some data representations support variable numbers of records and field, whereas others (such a record data) only support fixed number of records and fields (where minimum=maximum) except in the last position.

Fixed multiplicity is defined by a single number. For example, a multiplicity of 5 on a field indicates that there must be exactly five occurrences of the field within its enclosing record.

Variable multiplicity is defined by a minimum value and a maximum value and is represented with the notation *n..n*. For example, multiplicity of 1..5 on a field specifies that there must be between one and five occurrences of the field within its enclosing record.

A special maximum value of -1 is used to represent no maximum. For example, a multiplicity of 1..-1 on a field specifies there can be any number of occurrences of the field, but there must be at least one.

Optional nodes are defined by a minimum value of 0. For example, a multiplicity of 0..1 on a field specifies that there can be zero or one occurrences of the field within its enclosing record. A fixed multiplicity of 0 is not allowed.

Variable multiplicity fields must be defined at the end of their containing record. Variable multiplicity records must be defined at the end of the content.

Default value

You can specify a default value for a field. If you do not specify a default value, the default value for the data type is used. When content is created using metadata, default initialization applies the default values specified for each field.

DEPRECATED: Single value topics

A topic that streams data as a single value that can be constrained to a defined data type. Single value topics are stateful: each topic stores a value on the Diffusion server.

Note: The single value topic type is deprecated. Instead use one of the following topics, depending on the format of the data you are publishing:

- [String topics](#) on page 66
- [Double topics](#) on page 70
- [Int64 topics](#) on page 68

The value of the topic state is stored as a string. However, the type of the single value can be constrained in certain ways, for example, to hold a string, an integer, or a decimal number. The type of the single value is described using field metadata in the schema. For more information, see [Record metadata](#) on page 83.

Why use a single value topic?

For the majority of use cases, single value topics are the most appropriate model for your data. Single value topics are easy to create and update, and the data the topic contains is simpler.

If a structure is required for your data, you can use the design of your topic tree to define the structure.

Single value topics are supported by all client APIs.

By defining the type of the single value of the topic, you benefit from automatic validation and formatting of the data.

Properties of a single value topic

When you create a single value topic you can specify the following properties in the topic specification:

TIDY_ON_UNSUBSCRIBE

If set to `true`, when a session unsubscribes from the topic, any updates for the topic that are still queued for the session are removed.

There is a performance overhead to using this option as the client queue must be scanned to find topic updates to remove, however it may prove useful for preventing unwanted data being sent to sessions. This property is disabled by default.

Considerations when using a single value topic

A single value topic can only hold textual data. This type of topic data cannot be used to publish non-textual data, such as a PNG or PDF file.

Single value topics cannot be used to make multiple updates transactionally. If you have multiple items of data that you want to publish at the same time and have received by subscribing clients at the same time, you cannot split these items of data across multiple single value topics. In this case, it is more appropriate to use a topic with a composite data type such as a JSON topic or record topic. A topic with a composite data type can contain fields for each of the data items.

DEPRECATED: Stateless topics

A topic that has no state held on the Diffusion server or on the client that publishes to it.

Note:

The stateless topic type is deprecated. Instead, use one of the following topic types with the `DONT_RETAIN_VALUE` property set to `true`:

- [Binary topics](#) on page 64

- [JSON topics](#) on page 61
- [String topics](#) on page 66
- [Double topics](#) on page 70
- [Int64 topics](#) on page 68
- [RecordV2 topics](#) on page 77
- [Time series topics](#) on page 71

A stateless topic has no state. It can be used for publishing and receiving updates, but not for fetching the current topic state.

Stateless topics are the only type of topic provided in other typical pub-sub solutions.

Why use a stateless topic?

You can use stateless topics for data streams where there is no current state of the data, only updates. For example, a feed of news items.

All handling of the topic and topic data of a stateless topic is done by your client application. Because of this, the format of the data published on a stateless topic is entirely flexible. The topic content is treated as byte data by the Diffusion server. How that byte data is handled and interpreted is determined by your client applications.

Properties of a stateless topic

When you create a stateless topic you can specify the following properties in the topic specification:

TIDY_ON_UNSUBSCRIBE

If set to `true`, when a session unsubscribes from the topic, any updates for the topic that are still queued for the session are removed.

There is a performance overhead to using this option as the client queue must be scanned to find topic updates to remove, however it may prove useful for preventing unwanted data being sent to sessions. This property is disabled by default.

OWNER

Used to set a security principal as the owner of the topic. The principal receives `READ_TOPIC`, `MODIFY_TOPIC` and `UPDATE_TOPIC` privileges.

The format of the property value is:

```
$Principal is "name"
```

where **name** is the name of the principal.

REMOVAL

Used to set a topic removal policy.

The property is an expression which defines the conditions which will trigger automatic removal of the topic or of a set of topics specified with an optional selector.

See [Removing topics automatically](#) on page 319 for details of the expression format.

Considerations when using a stateless topic

A stateless topic does not store state. You cannot fetch the topic state and when you first subscribe to a stateless topic you do not receive the topic state as a value as you do with a stateful topic.

You must write all of the logic in your client to handle the byte data that is published on a stateless topic. This might mean it takes longer to get started using a stateless topic compared to topics that are handled by the Diffusion server.

You also lose some of the benefits of having a topic whose content is understood by the Diffusion server, such as validation, formatting, conflation, and deltas.

Pub-sub

Having decided on your topic structure and the format of your data, consider how you publish the data through the topics.

Pub-sub is the primary model of data distribution used by Diffusion. Clients subscribe to a topic. When data is published to the topic as an update, the Diffusion server pushes that update out to all of the subscribed clients.

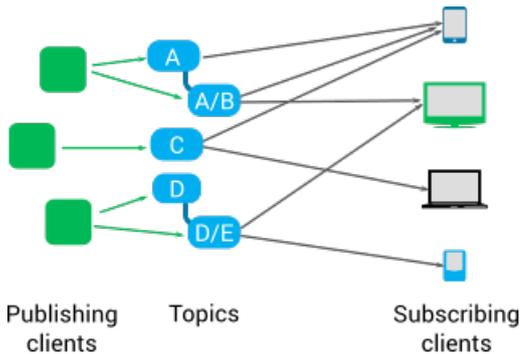


Figure 2: Pub-sub model

A client can both publish to topics and subscribe to topics, depending on the permissions that client has.

Concepts

Update

An update is data published to a topic by a client or publisher that is applied to the topic to change the topic state. The updated data is then pushed out to all subscribing clients.

State

The latest published values of all data items on the topic. The state of a topic is stored on the Diffusion server.

Value

A value is an update that contains the current state of all data on the topic.

Delta

A delta is an update that contains only those items of data that have changed on the topic since the last update was sent.

Topic loading

When a client first subscribes to a topic, it is sent a topic load message. A topic load is a value update that contains the current state of the topic.

Fetch

A request for the current state of all data on the topic. A client can fetch a topic's state without being subscribed to the topic. This request-response mechanism of getting data from a topic is separate from topic subscriptions.

Topic notifications

A client can register to receive topic notifications which provide information about which topics exist in the topic tree, but not the topic values. This is useful if your client needs to monitor the structure of the topic tree (or part of the tree) without the overhead of receiving all the values. Registering for notifications is separate from subscribing to a topic.

Publishing data

Consider the following information when deciding how to publish data to topics.

Data type

The updates that you publish to a topic must have a data type and format that matches the data type of the topic.

For example, if your topic is a single value topic where the data is of type integer, all updates published to the topic must contain a single piece of integer data.

Similarly, if your topic is a record topic with a metadata structure defined, all updates published to the topic must have the same metadata structure.

Updaters

You can use one of the following types of updater:

Value updater

This is the preferred type of updater to use with JSON and binary topics. When used as exclusive updaters, value updaters cache the values they use to update topics. This enables them to calculate and send deltas, reducing the volume of data sent to the Diffusion server.

Standard updater

This type of updater updates topics that use content to represent their data values. Updaters do not cache values and send all of the data passed to them to the Diffusion server without performing any optimization.

Both updater types can be used exclusively or non-exclusively.

For more information, see [Updaters](#).

Exclusive updating

To update a topic exclusively, a client registers as the update source for that topic. Only one client can be the active update source for a topic and any attempts by other clients to update that topic fail.

Implementing exclusive updating is more complex than non-exclusive updating as it involves the extra step of registering as an update source.

A single client acting as the exclusive updater can be an advantage if you require that a single client has ownership of a topic or branch of the topic tree. This requires less coordination and management than updating a single topic from multiple clients.

If the ordering of the updates is important, use exclusive updating to ensure that a single client has control over what data is published and when.

If you are using high-availability topic replication, clients must update the replicated topics exclusively. Non-exclusive updates are not replicated by high-availability topic replication.

Non-exclusive updating

To update a topic non-exclusively, a client publishes updates to the topic and, if no other client has registered to update the topic exclusively, the update is applied to the topic.

Non-exclusive updating is the simpler way to update a topic.

Clients that update a topic non-exclusively risk their updates being overwritten by updates from other clients or that updates from multiple clients are published in a different order than intended.

If you use a value updater non-exclusively, the updater does not cache the value used to update the topic.

Non-exclusive updating is not supported with topics that are replicated using the high-availability capability.

Dynamically adding topics

A publishing client can create topics dynamically as and when the topics are required. For example, in response to a subscription request from another client for a non-existent topic.

Security

To publish data to a topic, a client must have the `update_topic` permission for that topic.

For more information, see [Permissions](#) on page 134.

Subscribing to topics

Consider the following information when deciding how clients subscribe to topics.

For a client to receive a stream of updates from a topic, the following conditions must be met:

- The client must subscribe using a selector that matches the topic.
- The topic must exist on the Diffusion server.
- The client must register at least one stream that matches the topic.

When all these conditions are met, the stream receives a subscription notification and an initial value for the topic. The client receives subsequent updates to the topic through the stream.

The order in which these conditions are met does not affect the receipt of the subscription notification and the initial value of the topic.

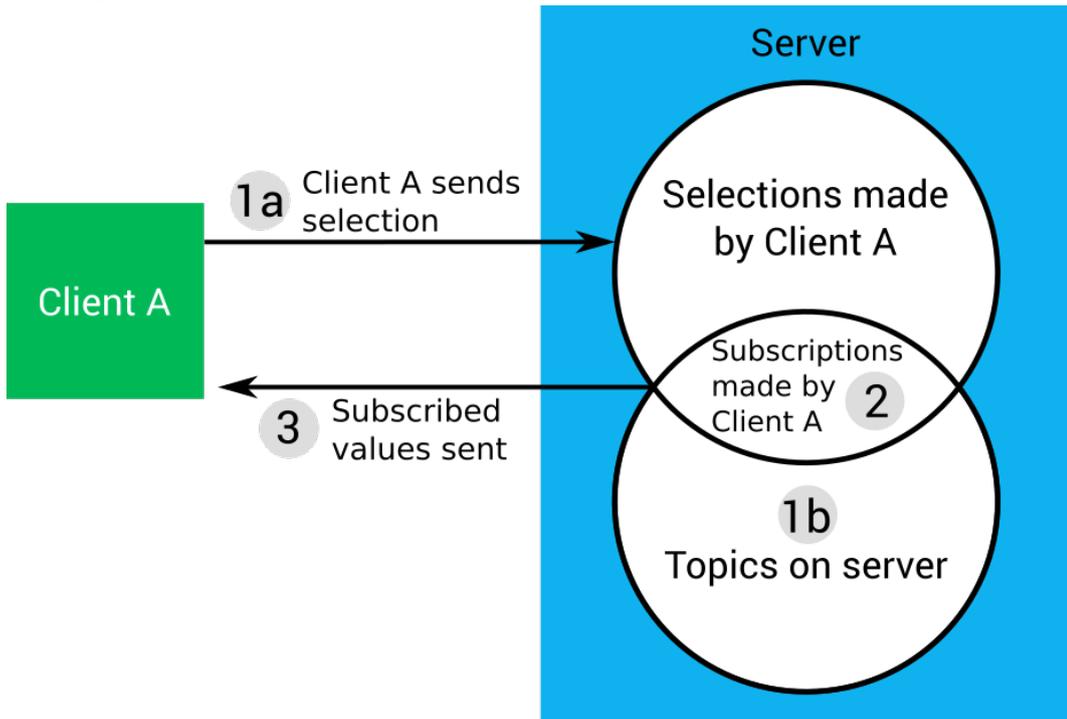
An exception is in the case of record topics. For more information, see [Considerations when using legacy record topics](#) on page 91.

Permissions

To subscribe to a topic, a client must have the `select_topic` permission and the `read_topic` permission for that topic. For more information, see [Permissions](#) on page 134.

The rest of this section assumes that the client has the required permissions to complete the described actions.

Subscription flow



1. The prerequisite conditions for subscribing to a topic are met:

- a.** The client selects a set of topics to subscribe to, or that selection is made on the client's behalf by another client or by a publisher.

A client can select multiple topics using a topic selector. This subscription can be to topics that match a particular regular expression or to topics in a particular branch of the topic tree. For more information, see [Topic selectors](#) on page 50.

The selection made by the subscribe request is persistent and is stored on the Diffusion server. Because selections are stored, the client can subscribe, pre-emptively, to topics that do not currently exist.

- b.** The topic exists on the Diffusion server.

The topic can be created before or after any subscribe request that selects it. In both cases, the client that makes the request is subscribed to the topic when both the selection and the topic exist.

2. Both prerequisite conditions for a subscription are met and the client is subscribed to the topic.

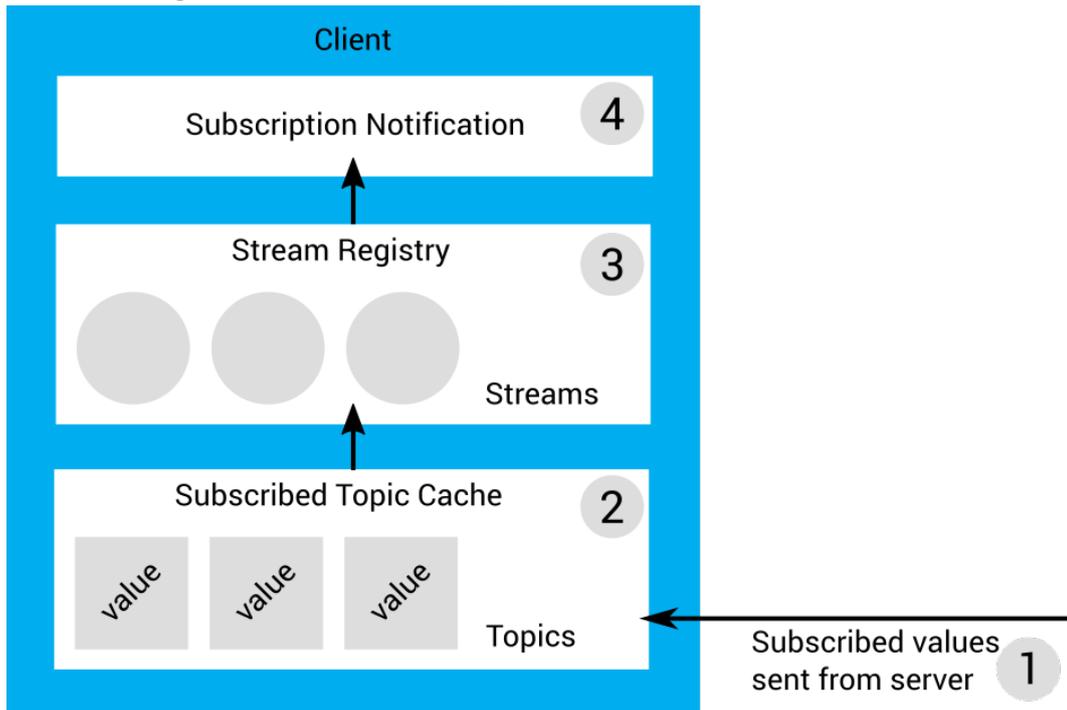
The intersection of the topic paths that the client has selected for subscription and the topics that exist on the Diffusion server defines the list of subscriptions that client has made.

For each client that connects to the Diffusion server, the Diffusion server stores a separate list of subscriptions.

3. When the subscription is made, the value of the subscribed topic is sent to the client.

Subsequent updates are sent as values or as deltas, depending on the topic specification and the nature of the update.

Client handling of data from subscribed topics



1. When the client makes a subscription to a topic, the value of the topic is sent to the client. Subsequent updates are sent as values or as deltas.
2. Values for each subscribed topic are stored in the subscribed topic cache on the client. This is not the case for stateless or record topics, see [Considerations when subscribing](#) on page 91 and [Considerations when using legacy record topics](#) on page 91.
3. The client registers streams against a topic selector. A list of streams is maintained in the stream registry.
4. If one or more streams exists that matches a topic, the value for that topic is received through the matching streams.

Considerations when subscribing

The subscriptions a client has, which are defined by the intersection of the topics that exist on the Diffusion server with the selections made by the client, determine what data is sent to the client from the Diffusion server. To reduce the amount of data sent between the Diffusion server and the client, only subscribe to those topics that the client uses.

The streams a client registers determine what topic values are available for the client to work with. Adding and removing streams as they are needed by the client enables your application to access topic values stored in the subscribed topic cache in real time.

When a client subscribes to a stateless topic, the values received are not stored in the subscribed topic cache. If a stream is created after the topic is subscribed, the stream does not receive a value until the next time the topic is updated.

Considerations when using legacy record topics

When a client subscribes to a topic that uses the deprecated record type, the values received are not stored in the subscribed topic cache. If a stream is created after the topic is subscribed, the stream might only receive delta values. In this case, the client has no value to apply the deltas to and the data is incorrect. When subscribing to record topics, always create the stream before requesting a subscription.

This does not apply to the recordV2 topic type.

Topic notifications

Topic notifications enable a client to receive information about the topic tree structure, without topic values.

A client can receive notifications about changes to selected topics through the topic notifications feature.

The client must use a topic notification listener to receive notifications. Use [topic selectors](#) to specify which topics the client will be notified about.

Selection and deselection

A client can request selections at any time, even if the topics do not exist at the server. Selections are stored on the server and any subsequently added topics that match registered selectors will generate notifications.

Notification contents

Each notification includes:

- The topic specification of the topic
- A notification type describing the change

Table 15: Notification types

Value	Meaning
ADDED	A new topic has been added matching a registered selector
REMOVED	A selected topic has been removed
SELECTED	A newly-registered selector matched a topic that already exists
DESELECTED	An existing topic is no longer selected due to a selector being removed

For example, suppose a topic tree contains only the topic `a/b/c`. A listener registers the topic selector `a//` which selects the topic `a` and all topics below it.

The listener will receive a notification containing the topic specification of the topic at `a/b/c`, and the notification type `SELECTED`.

If a new topic is added at `a/b/c/d`, another notification will be received with the specification of the new topic, and a notification type `ADDED`.

Immediate descendant notifications

Listeners receive notifications about whether each selected topic has unselected immediate descendants.

An immediate descendant means the first bound topic on any branch below a given topic path. By monitoring immediate descendant notifications, you can implement a listener which selects deeper topic paths as more topics are added, in order to walk the topic tree.

For example, in a topic tree which contains only these topics:

- a
- a/b
- a/c
- a/c/d
- a/e/f/g

The immediate descendants of a are a/b, a/c and a/e/f/g.

a/c/d is not an immediate descendant of a, because its parent a/c is a descendant of a.

Immediate descendant notifications provide the topic path and a notification type (with the same possible values as above).

In the example topic tree above, suppose that a topic notification listener had selected topic a using the topic selector "a". If a topic is now added at a/x, the listener receives an immediate descendant notification with the path a/x and the notification type ADDED.

If a topic is then added at a/x/y, the listener does not receive another notification, because a/x/y is not an immediate descendant.

Considerations when using topic notifications

Topic notifications are useful when your client needs to know which topics are present, without the overhead of receiving the topic values. This can be useful when developing monitoring tools or interfaces designed to browse large numbers of topics.

A client will only be notified about topics for which it has both `select_topic` and `read_topic` permissions.

The `select_topic` permission is required to select a topic with a listener. The `read_topic` permission is required to receive notifications for a topic.

Request-response messaging

You can send request messages directly to a client session, a set of client sessions, or a message path. The recipient of a message can respond to the request.

Concepts

Request

A message sent from one client session to another session, to a message path, or to a set of sessions.

Response

A message sent in reply to a request message.

Data type

Request and response messages can contain data of one of the following types: JSON, binary, string, 64-bit integer, or double.

The response message is not required to be the same data type as the request it responds to.

Message path

The path used to address the request messages.

The message path is made up of path segments separated by the slash character (/). Each path segment can be made up of one or more Unicode characters.

Handler

An object registered by client session to handle requests sent on message paths in a specific branch of the path hierarchy, and to respond to those requests.

Stream

An object used by a client session to receive requests sent to that client session, and to respond to those requests.

Session properties

Properties assigned to a session, either by the Diffusion server or by an authentication handler. These properties can be used to select the set of sessions to send requests to.

For more information, see [Session properties](#) on page 266.

Send request messages in the following ways:

Send requests to a message path

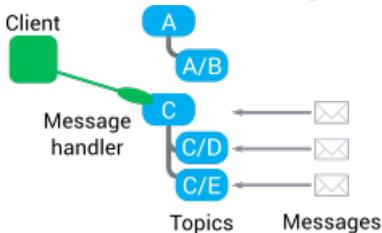


Figure 3: A client session registers a handler on part of the topic tree

A client session with the `send_to_message_handler` permission can send requests on a message path. The sending client session does not know which client session, if any, receives the request.

A client session with the `register_handler` permission can register a handler on a part of the topic tree. This client session receives any requests that are sent on message paths in that part of the topic tree and sends a response.

For more information, see [Sending request messages to a message path](#) on page 372.

Send request messages to a specific client session

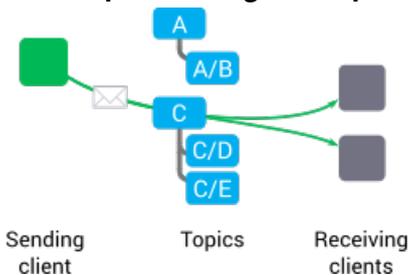


Figure 4: A client session can send requests through a message path to a known client session

A client session with the `send_to_session` permission that knows the session ID of a client session can send requests through a message path to the known client session.

The responding client must have a request stream registered against a message path to receive requests sent through that message path and respond to them.

For more information, see [Sending request messages to a session](#) on page 380.

Send request messages to a set of client sessions

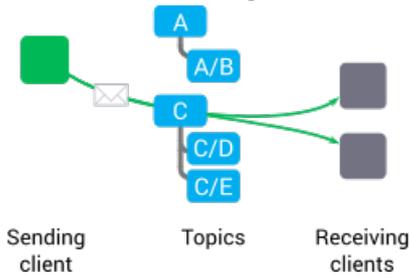


Figure 5: A client can send requests through a message path to a set of client sessions

A client session with the `send_to_session` permission can send requests through a message path to a filter that selects client sessions based on their session properties.

The responding client session must have a request stream registered against a message path to receive and respond to requests sent through that message path.

For more information, see [Sending request messages to a session filter](#) on page 386.

Considerations when using request-response messaging

- The data type of the request is not required to match the data type of the response. For more information, see [Typed requests and responses](#) on page 370.
- Messaging can use message paths that are the same as topic paths with topics bound to them. However, there is no connection between messaging and topics. For more information, see [Message path](#) on page 371.

One-way messaging

Diffusion also provides a capability to send one-way messages to a client session, a set of client sessions, or a message path. These messages cannot be responded to directly.

In one-way messaging, the message data is not typed. Applications are responsible for serializing messages to and from a binary format.

Messages sent using one-way messaging can include additional options, such as headers and a message priority. These additional options are provided to allow compatibility with messaging to publishers.

One-way messaging provides the following guarantees:

- If sending to a message path completes successfully, the message was definitely passed to a publisher or a message handler registered by a client session.
- If sending to a session completes successfully, the message was definitely passed to a message stream registered by the session.

When sending to a filter completes successfully and returns the number of sessions that match the filter, one-way messaging cannot guarantee that the message has been delivered to those sessions.

Conflation

Conflation of messages is the facility to reduce the amount of information sent to clients by combining or discarding updates.

The server has a separate outbound queue for each client session.

Using conflation, the server examines the outbound queue and removes or combines updates which are stale or redundant.

Conflation is an optional feature that can be applied selectively to certain topics or client sessions.

Conflation for new versus deprecated topic types

A new conflation system was introduced in Diffusion 6.1 and is used for most topic types. This system is configured on a per-topic basis through topic properties, and can be enabled by default for each outbound queue.

The legacy conflation system is still used for the deprecated single value, stateless and record (not recordV2) topic types. Legacy conflation is configured using `Server.xml`.

Advantages of message conflation

Conflation can reduce the server memory footprint as well as the amount of network data transmitted. It can also prevent sessions being closed due to the maximum queue size limit being exceeded.

Considerations when using conflation

- Do not use conflation if there are relationships or dependencies between topics. Conflation alters the order of updates. If a conflated topic is temporally or causally related to another topic, conflation can cause unwanted behavior.
- Do not use conflation if individual updates carry forensic storage or audit trail requirements.

Using conflation

You can configure how and when conflation is applied. Configuration works differently for legacy topic types (stateless, single value and record).

Conflation policies

Conflation policies control how conflation is applied to a topic. You can set conflation policy for a topic with a topic property.

These are the available conflation policies:

- off
- conflate (default)
- unsubscribe
- always

"off" disables all conflation for the topic. Topic updates will never be merged or discarded.

"conflate" automatically conflates topic updates when back pressure is detected by the server (that is, when the outgoing message queue exceeds the maximum allowed size in bytes or number of messages).

"unsubscribe" automatically unsubscribes the topic when back pressure is detected by the server, with a `BACK_PRESSURE` message. The unsubscription is not persisted to the cluster, so if a session fails over to a different server it will be resubscribed to the topic. This policy is useful for topics that are not essential to the application, and can be discarded in back pressure situations without affecting the main function of the application.

"always" automatically conflates topic updates as they are queued for the session. This policy ensures only the latest update is queued for the topic, minimising the server memory and network bandwidth used by the session, but potentially increasing the processor cost of conflation.

If no policy is set, the "conflate" policy is applied.

Conflation process

The conflation process considers the value and delta updates in the queue, and the current topic value (unless `DONT_RETAIN_LAST_VALUE` is enabled). It reduces the queued updates to a single value or a composite delta, whichever requires the fewest bytes to send.

Under the default "conflate" policy, no conflation is applied until there is a new message to send to a session with a full queue. The whole queue is then conflated, topic by topic. If conflation is not enough to bring the queue size under the configured limit, the server will close the session.

Legacy conflation policies

Legacy conflation policies configure how conflation takes place on stateless, single value and record topics. One or more conflation policies can be configured, each defining different conflation mechanisms. The policies can define the following behaviors:

- How messages are matched
- Whether replacement is done in place or by appending
- How to merge the two messages

Legacy conflation policies are configured within `Server.xml`.

If an "off" or "unsubscribe" policy is set for one of the legacy topic types (stateless, single value or record) using the topic properties system described above, that policy will be applied and override the settings in `Server.xml`.

If an "always" or "conflate" policy is set, the `Server.xml` configuration will be applied.

Legacy conflation process

When legacy conflation is enabled for a client, every time a new update is enqueued for the client it is considered for conflation.

1. The Diffusion server checks whether a conflation policy is mapped to the topic that the update is published on.
2. If a policy is mapped to the topic, the matching criteria of the policy is used to scan the updates for that topic that exist on the queue (from newest to oldest) for an existing update that matches the one being queued. If no match is found, the new update is queued at the end of the queue as normal.

Note:

Fast caches and lookup mechanisms are used to find policies and updates in the queue. The whole client queue is not scanned when looking for a match, only updates for the same topic.

If default matching (by topic) is used, no comparison with the existing updates is required. This means that the conflation mechanism is as efficient as possible.

3. If the matching criteria finds a matching update in the queue, the conflation policy defines the following behaviors:
 - Whether the update to queue as a result of conflation is the new update or an update produced by merging the content of the matching update and new update.
 - Whether the update to queue replaces the matching update or the matching update is removed and the new update added to the end of the queue.

Legacy conflation occurs on a client-by-client basis in the multiplexer thread. Results of merge actions are cached to ensure that merges of identical message pairs are not repeated for different clients.

Designing your solution

Decide how your solution components interact to most efficiently and securely distribute your data.

There are a number of things to consider when designing your Diffusion solution:

- The number, distribution, and configuration of your Diffusion servers
- How you use clients in your solution
- The additional components to develop
- The third-party components you might include in your solution
- Securing your solution

These considerations are not separate. The decisions you make about one aspect of your solution can affect other aspects.

Servers

Consider the quantity, distribution, location and configuration of your Diffusion servers.

How many Diffusion servers?

Consider the following factors when deciding how many Diffusion servers to use in your solution:

Number of client connections

How many client connections do you expect to occur concurrently? For a greater number of concurrent client connections, you might require more Diffusion servers to spread the load between.

Volume of data

At what rate are you publishing updates and sending messages? How large are the updates and messages? If you are distributing a greater volume of data, you might require more Diffusion servers to spread the load between.

Hardware capabilities

The number of concurrent client connections and the volume of data that a single Diffusion server can handle depend on the hardware that the Diffusion server runs on.

In order of importance, the following hardware components have the biggest impact on the server performance:

- Network interface controller (NIC)
- Central processing unit (CPU)
- Random access memory (RAM)

Resilience and failover requirements

Ensure that you have enough Diffusion servers that if one or more becomes unavailable, for example when updating the server or due to a failure of the hosting system, the remaining Diffusion servers can spread the resulting load increase.

You can also use replication between Diffusion servers to increase your solution's resilience. For more information, see [High availability](#) on page 103.

Distribution of servers

How you wish to distribute your servers has an effect on how many servers you require.

For example, if your client base is distributed geographically, you might want to locate your Diffusion servers in different territories. This enables your servers to be more responsive because of their proximity to clients. In this case, the number of territories your client base is spread over affects the number of servers you require.

You can easily scale your solution by adding additional Diffusion servers if your requirements change.

How are your Diffusion servers configured?

Consider the following factors when deciding how to configure the Diffusion servers in your solution:

Ports

What ports do you want to provide access to your Diffusion server on? By default, your Diffusion server supports client connections on port 8080.

Reconnection behavior

Do you want to allow clients that lose their connection to reconnect to the server? How long do you want to keep client sessions available after the client loses connection?

Replication

Replication enables Diffusion servers to share information about topics and client sessions with each other through a data grid.

For more information, see [High availability](#) on page 103.

Performance

Tuning your Diffusion servers for performance is best done as part of testing your solution before going to production. This enables you to observe the behavior of your solution in action and configure its performance accordingly.

For more information, see [Tuning](#) on page 566.

For more information, see [Configuring your Diffusion server](#) on page 490.

This manual describes the factors that you must consider when designing your Diffusion solution. However, these factors are too many and too interlinked for this manual to provide specific guidance.

Push Technology provides Consulting Services that can work with you to advise on a solution that best fits your requirements. Email for more information.

Fan-out

Consider whether to use fan-out to replicate topic information from primary servers on one or more secondary servers.

A fan-out distribution comprises many servers that host the same topic or topics. When the topic is updated on a primary server, the update is fanned out to replica topics on secondary servers.

Why use fan-out?

Having a primary server feed out updates to a number of secondary servers provides a solution where the same topics and data are available from multiple servers. You can use this solution to load balance a large number of client connections across a set of Diffusion servers and provide those clients with the same access to data.

How fan-out works

Fan-out is configured on the secondary server or secondary servers in the solution.

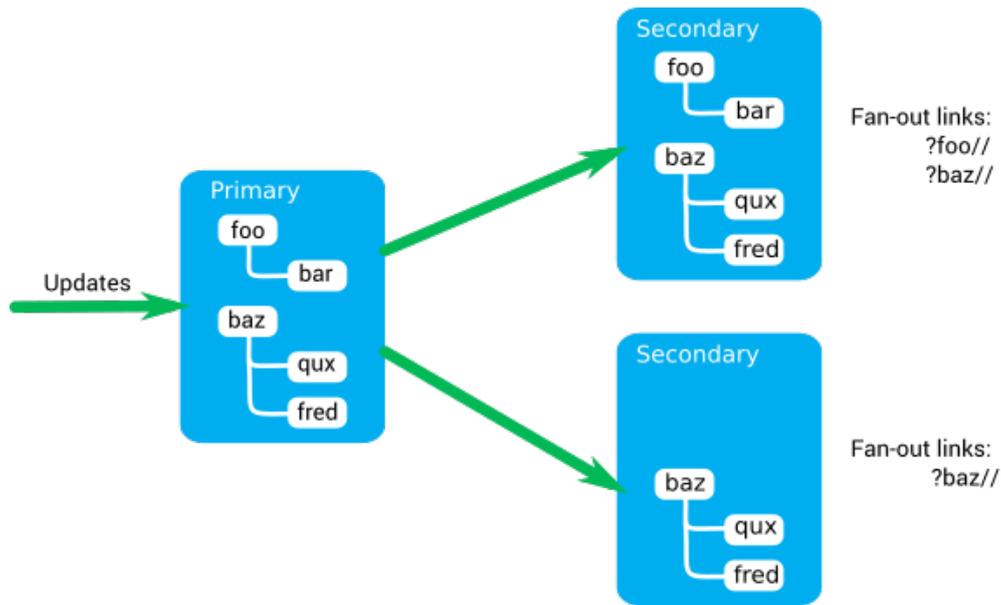


Figure 6: Fan-out

- A secondary server connects to a primary server as a client.
- The secondary server subscribes to a set of topics on the primary server.
 - This set of topics is defined by a selector in the configuration of the secondary server.
- The secondary server replicates the subscribed topics locally.
- When updates are made to the topics on the primary server, the secondary server receives these updates through the standard pub-sub feature in the same way as any other client of the primary server.
- The secondary server applies the updates to its replica topics.
- Any clients subscribed to a replica topic on the secondary server receive the updates through the standard pub-sub feature.
- If a topic is removed at the primary server, the secondary server removes its replica topic.
- If a topic is added at the primary server that matches the set of topics subscribed by the secondary server, the secondary server creates a local replica topic.

A secondary server can connect as a client and subscribe to topics on more than one primary server. However, ensure that the secondary server does not attempt to replicate the same topic from multiple sources as this can cause the data on the topic to be incorrect.

Creating topics on the primary server is an asynchronous action, because of this a client or publisher that creates a topic on the primary server receives a completed callback saying that the topic has been created. However, receiving this callback does not indicate that the topic has been replicated by fan-out and created on a secondary server.

Topic aliasing is not supported for topics that are replicated by fan-out. Ensure that aliasing is not enabled at the primary server.

Routing topics and fan-out

To use fan-out with routing topics, the routing subscription handlers for a routing topic must be registered at all secondary servers, but not at the primary server.

Topic replication and fan-out

A secondary server cannot replicate the same topic from more than one primary server or multiple times from the same primary server. Validation of the path prefix of the selectors is in place to prevent this occurring, but the use of regular expressions in topic selectors can result in an overlap of replication which can cause problems.

Missing topic notifications generated by subscription or fetch requests to a secondary server are propagated to missing topic handlers registered against the primary servers. For more information, see [Using missing topic notifications with fan-out](#) on page 101.

Fan-out and load balancers

If you add a secondary server to a load balancer pool before all topics have propagated from the primary server, it can result in a large number of messages being generated, leading to `MESSAGE_QUEUE_LIMIT_REACHED` errors appearing in the logs.

If you experience this problem, introduce a delay between enabling fan-out and adding any of the secondary servers to a load balancer pool. There is currently no built-in way to determine when propagation is complete, so you will need to experiment to find out how long the delay needs to be for your configuration.

Reconnection and disconnection

You can configure fan-out servers to use the standard reconnect mechanism. If the connection between the secondary server and the primary server is lost, the secondary server can reconnect to the same session. However, if messages are lost between the primary and secondary server, the reconnection is aborted and the session closed. The secondary server must connect again to the primary server with a new session.

If a disconnection between the primary and secondary server results in the session being closed, the secondary server removes all the topics that it has replicated from that primary server. (Only topics explicitly defined by a selector are removed.) Clients subscribing to these topics on the secondary server become unsubscribed. If the secondary server connects again to that primary server with a new session, the secondary server recreates the topics. Clients connecting to the secondary server become resubscribed to the topics.

Related concepts

[Configuring fan-out](#) on page 494

Configure the the Diffusion server to act as a client to one or more other Diffusion servers and replicate topics from those servers.

Using missing topic notifications with fan-out

Missing topic notifications generated by subscription or fetch requests to a secondary server are propagated to missing topic handlers registered against the primary servers.

Control client sessions can use missing topic notifications to monitor the activity of end-user client sessions. In response to subscription or fetch requests to missing topics, the control client session can choose to take an action, such as creating the missing topic.

For more information, see [Handling subscriptions to missing topics](#) on page 288.

How notification propagation works

A missing topic notification is propagated from a secondary server to a missing topic handler registered against a primary server if and only if all of the following conditions are met:

- There is a session between the secondary server and the primary server.

- The selector used for the subscription or fetch request to the secondary server intersects with one or more of the fan-out links to the primary server that are configured at the secondary server.
- On the secondary server, there are no currently replicated topics that match both the fan-out link and selector used in the subscription or fetch request.
- The primary server has no topics that match the selector used in the subscription or fetch request.
- One or more missing topic handlers are registered against the primary server for a path that matches the selector. The following rules are used to select which missing topic handler receives the notification:
 - If multiple handlers are registered for the branch, the handler for the most specific topic path is notified.
 - If there is more than one handler for a path, the Diffusion server notifies a single handler.

The handler can use the supplied callback to respond proceed or cancel. The subscription or fetch operation is delayed until the handler responds, and is abandoned if the response is cancel.

Example flow

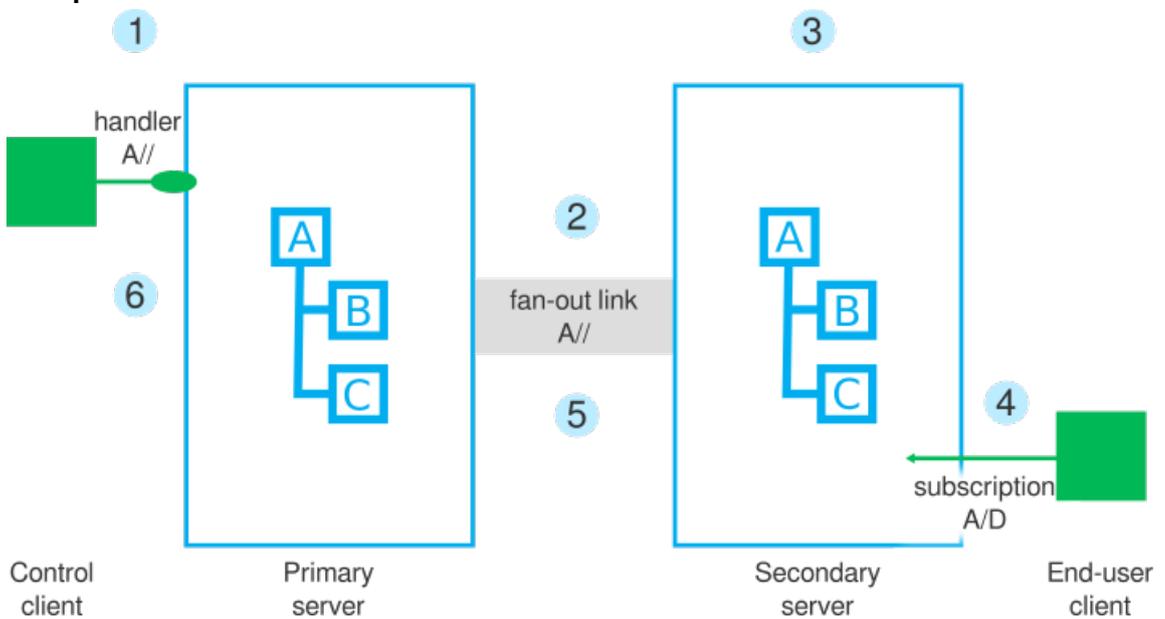


Figure 7: Missing topic notification propagation

1. A control client connects to the primary server and registers a missing topic notification handler against the A branch of the topic tree.
2. A secondary server connects to the primary server and replicates the A branch of the topic tree.
3. On the secondary server the replicated part of the topic tree comprises the following topics: A, A/B and A/C.
4. An end-user client attempts to subscribe to A/D, which does not exist.
5. The topic A/D is in part of the topic tree that is matched by a fan-out link selector, so the secondary server propagates the missing topic notification to the primary server.
6. The topic A/D does not exist on the primary server, so the primary server sends the missing topic notification to the handler registered by the control client.

Missing topic notification handlers at both the primary and secondary servers

A single subscription or fetch can cause a missing topic notification to be sent to a handler registered against the secondary server as well as a handler registered against a primary server.

The decision about whether to notify the handlers registered against a primary server is based on the intersection of the selector used by the subscription or fetch with the selector used to configure the fan-out link. It is possible for a missing topic notification to be sent to the primary server, but not to local handlers because the selector matches other (non-replicated) topics hosted by the secondary.

In particularly complex configurations, multiple primary servers might receive the notification or there can be multiple tiers of fan-out connections.

Where multiple handlers are notified, the subscription or fetch operation is delayed until the all handlers respond, and the operation is abandoned if any response is cancel.

Considerations when using missing topic notifications with fan-out

Missing topic notifications are only propagated if both the primary and secondary server are Diffusion version 5.9.1 or later.

The intersection of the selector used by the subscription or fetch request with a selector used for a fan-out link is calculated based only on the path-prefix of each selector. Complex selectors that use regular expressions can produce false positive results or false negative results. We recommend that you do not use regular expressions in the selectors used to configure fan-out links.

Ensure that the principal that the secondary server uses to make the fan-out connection to the primary server has the `SELECT_TOPIC` permission for the path prefix of the selector that triggered the missing topic notification.

A current session must exist between the secondary server and the primary server to forward notifications. If there is no session or the session fails while the missing topic notification is in-flight, the secondary server logs a warning message and discards the notification. The subscription or fetch operation is completed as if the primary handler had responded proceed.

The robustness of the session between the servers can be improved by configuring reconnection. Fan-out connections can have a large number of messages in flight. It might be necessary to tune the reconnection time-out and increase queue depth and recovery buffer sizes.

Related concepts

[Handling subscriptions to missing topics](#) on page 288

A client can handle subscription or fetch requests for topics that do not exist and can act on those notifications, for example, by creating a topic on demand that matches the request.

High availability

Consider how to replicate session and topic information between Diffusion servers to increase availability and reliability.

Diffusion uses a datagrid to share session and topic information between Diffusion servers and provide high availability for clients connecting to load-balanced servers.



Figure 8: Information sharing using a datagrid

Diffusion uses Hazelcast™ as its datagrid. Hazelcast is a third-party product that is included in the Diffusion server installation and runs within the Diffusion server process.

The datagrid is responsible for the formation of clusters and the exchange of replicated data. These clusters operate on a peer-to-peer basis and by default there is no hierarchy of servers within the cluster.

Servers reflect session and topic information into the datagrid. If a server becomes unavailable, another server can access the session and topic information that is stored in the datagrid and take over the responsibilities of the first server.

See [Configuring the Diffusion server to use replication](#) on page 528 and for more details.

Considerations

Consider the following factors when using replication with Hazelcast:

- By default Hazelcast uses multicast to discover other nodes to replicate data to. This is not secure for production use. In production, configure your Hazelcast nodes to replicate data only with explicitly defined nodes. For more information, see [Configuring the Hazelcast datagrid](#) on page 530.
- When Diffusion servers are merged into a cluster, the servers can have inconsistent replicated data. Unresolved inconsistencies can cause unpredictable behavior, due to issues such as conflicts between updaters. If the inconsistencies cannot be resolved, the inconsistent Diffusion server or servers are shutdown and must be restarted.

Diffusion servers in a cluster can become inconsistent in a number of circumstances; for example, if a network partitions and then heals.

The quorum setting can help prevent inconsistencies due to network partitions. It enables you to set a minimum size for a cluster, below which the servers in a cluster will all shut down.

You should choose a quorum value so that after a network partition, the smaller cluster will shut down instead of attempting to heal. The servers from the smaller cluster can then be restarted and join the cluster cleanly, avoiding inconsistencies.

If you want to use the quorum feature, use an odd number of servers and set the value to just over half the cluster size. For example, if you have 9 servers in a cluster, set the quorum value to 5.

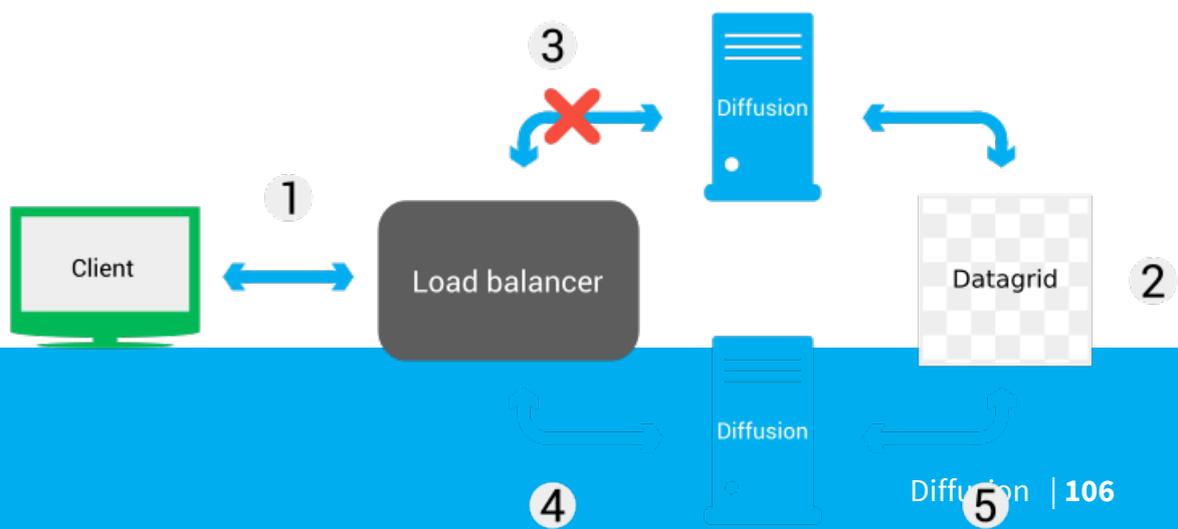
Note that servers shut down by the quorum feature will not restart automatically.

Session replication

You can use session replication to ensure that if a client connection fails over from one server to another the state of the client session is maintained.

When a connection from a client through the load balancer to a Diffusion server fails, the load balancer routes the client connection to another Diffusion server. This server has access to the session and client information that is replicated in the datagrid.

Clients that connect to a specific Diffusion server and not through a load balancer cannot use session replication.



The load balancer is configured to route based on the client's session ID and requests from the client go to the same server until that server becomes unavailable.

2. Information about the client session is reflected into the datagrid.

The following information is replicated:

- session ID
- session principal
- session properties
- list of topic selections

The following information is not replicated and is created anew on the server a client fails over to:

- session start time
- statistics
- client queue

3. A client loses connection to the Diffusion server if the server becomes unavailable.

4. The client can reconnect and the load balancer routes the connection to another Diffusion server.

5. This Diffusion server has access to all of the client information shared into the datagrid by the first Diffusion server.

6. The server uses the list of topic selections to recover the set of subscribed topics and subscribes the client to these topics.

7. Subscribing the client to topics provides full value messages for all topics that contain the current topic state.

The client can reconnect to its session only if it reconnects within the reconnect time specified in the `Connectors.xml` configuration file. If the client does not reconnect within that time, the client session information is removed from the datagrid.

Considerations

Consider the following factors when using session replication:

- Replication of session information into the datagrid is not automatic. It must be configured at the server.
- Messages in transit are not preserved.
- When a client session reconnects it does not need to authenticate again. The client uses a session token to reacquire its session. Ensure that this token is secure by using a secure transport to connect, for example, WSS.
- The failover appears to the client as a disconnection and subsequent reconnection. To take advantage of high server availability, clients must implement a reconnect process.
- The Diffusion server that a client reconnection attempt is forwarded to depends on your load balancer configuration. Sticky load balancing can be turned on to take advantage of reconnection or turned off to rely on session replication and failover.

Differences between session reconnection and session failover

When a client loses a load-balanced connection to Diffusion, one of the following things can occur when the client attempts to reconnect through the load balancer:

Session reconnection

The load balancer forwards the client connection to the Diffusion server it was previously connected to, if that server is still available. For more information, see [Reconnect to the Diffusion server](#) on page 252.

Session failover

The load balancer forwards the client connection to a different Diffusion server that shares information about the client's session, if session replication is enabled between the servers.

Prefer session reconnection to session failover wherever possible by ensuring that the load balancer is configured to route all connections from a specific client to the same server if that server is available.

Session reconnection is more efficient as less data must be sent to the client and has less risk of data loss, as sent messages can be recovered, in-flight requests are not lost, and handlers do not need to be registered again.

For more information, see [Routing strategies at your load balancer](#) on page 703.

To a client the process of disconnection and subsequent reconnection has the following differences for session reconnection or session failover.

Session reconnection	Session failover
The client connects to the same Diffusion server it was previously connected to.	The client connects to a Diffusion server different to the one it was previously connected to.
The client sends its last session token to the server.	
The server authenticates the client connection or validates its session token.	
<p>The server uses the session token to resynchronize the streams of messages between the server and client by resending any messages that were lost in transmission from a buffer of sent messages.</p> <p>If lost messages cannot be recovered because they are no longer present in a buffer, the server aborts the reconnection.</p>	<p>The server uses the session token to retrieve the session state and topic selections from the datagrid.</p>
<p>The server sends any messages that have been queued since the session disconnected.</p>	<p>The server uses the state to recover the session, uses the topic selections to match the subscribed topics, and sends the session the current topic value for each subscribed topic.</p> <p>Any in-flight requests made by the client session to the previous server are cancelled and the client session is notified by a callback. All handlers, including authentication handlers and update sources, that the client session had registered with the previous server are closed and receive a callback to notify them of the closure.</p>

Related concepts

[Session reconnection](#) on page 575

You can configure the session reconnection feature by configuring the connectors at the Diffusion server to keep the client session in a disconnected state for a period before closing the session.

Related tasks

[Configuring the Diffusion server to use replication](#) on page 528

You can configure replication by editing the `etc/Replication.xml` files of your Diffusion servers.

Related reference

[Topic replication](#) on page 109

You can use topic replication to ensure that the structure of the topic tree, topic definitions, and topic data are synchronized between servers.

[Failover of active update sources](#) on page 111

You can use failover of active update sources to ensure that when a server that is the active update source for a section of the topic tree becomes unavailable, an update source on another server is assigned to be the active update source for that section of the topic tree. Failover of active update sources is enabled for any sections of the topic tree that have topic replication enabled.

[Configuring the Hazelcast datagrid](#) on page 530

You can configure how the built-in Hazelcast datagrid replicates data within your solution architecture.

Topic replication

You can use topic replication to ensure that the structure of the topic tree, topic definitions, and topic data are synchronized between servers.

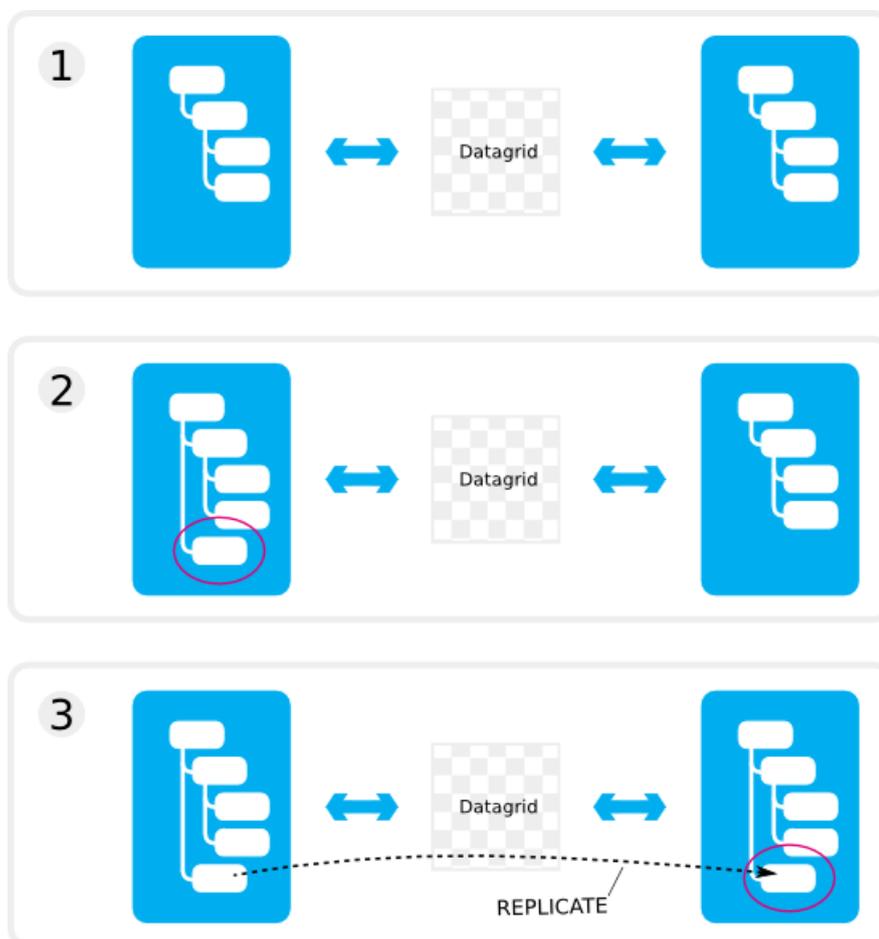


Figure 10: Topic replication

1. Servers with topic replication enabled for a section of the topic tree share information about that section of the topic tree through the datagrid. The topic information and topic data are synchronized on all the servers.
2. A new topic is created on one server in the replicated section of the topic tree.
3. The new topic is replicated on the other servers with identical topic information. When its topic data is updated on the first server, that data is replicated on the other servers.

Considerations

Consider the following factors when using topic replication:

- Avoid registering a large number of update sources. Do not design your solution so that each topic has its own exclusive update source. This will cause performance problems when starting new servers and joining them to existing clusters, due to the overhead of sharing the update source registrations.
- Only publishing topics can be replicated.
- Replication is supported only for the following types of topic:
 - JSON
 - Binary
 - Int64
 - String
 - Double
 - RecordV2(not the older, deprecated record topic type)
 - Stateless
 - Slave

A replicated slave topic is linked to a master topic located on the same Diffusion server as the replicated slave topic. This is true whether that master topic is created by replication or directly.

- Replication is not supported for the deprecated single value and record topic types.
- Replication is not supported for topics created by a publisher.
- Any topic that is part of a replicated branch of the topic tree and is not one of the supported types of topic is not replicated. Instead that topic path remains unbound.
- Only topic-wide messages are replicated. Messages sent to a single client or to all clients except one are not replicated.
- Replication of topic information into the datagrid is not automatic. It must be configured at the server. This gives a performance advantage, as you can choose which parts of your topic tree to replicate.
- Updates to a particular topic will always be delivered to all subscribers in the same order. However, delivery order is not guaranteed across different topics. For example, if you update topic 1 then topic 2, some subscribers might receive the update to topic 2 before the update to topic 1.
- Replication of topic data can impact performance.
- Avoid registering requests for topic removal on client session close against replicated topics. When a replicated topic is removed from a server as a result of a client session closing, it is removed from all other servers that replicate that topic. For more information, see [DEPRECATED: Removing topics with sessions](#) on page 321.

Related tasks

[Configuring the Diffusion server to use replication](#) on page 528

You can configure replication by editing the `etc/Replication.xml` files of your Diffusion servers.

Related reference

[Session replication](#) on page 105

You can use session replication to ensure that if a client connection fails over from one server to another the state of the client session is maintained.

[Failover of active update sources](#) on page 111

You can use failover of active update sources to ensure that when a server that is the active update source for a section of the topic tree becomes unavailable, an update source on another server is assigned to be the active update source for that section of the topic tree. Failover of active update sources is enabled for any sections of the topic tree that have topic replication enabled.

[Configuring the Hazelcast datagrid](#) on page 530

You can configure how the built-in Hazelcast datagrid replicates data within your solution architecture.

Failover of active update sources

You can use failover of active update sources to ensure that when a server that is the active update source for a section of the topic tree becomes unavailable, an update source on another server is assigned to be the active update source for that section of the topic tree. Failover of active update sources is enabled for any sections of the topic tree that have topic replication enabled.

A client must register as an update source to update a replicated topic. Replicated topics cannot be updated non-exclusively. For more information about update sources, see [Updating topics](#) on page 336.

1. A client (CLIENT 1) connects to a Diffusion server (SERVER 1) and registers an update source for a section of the topic tree that has topic replication enabled. This update source is the active update source.
2. Another client (CLIENT 2) connects to another Diffusion server (SERVER 2) and registers an update source for the same section of the topic tree. This update source is a standby update source.
3. The topics on SERVER 2 continue to receive their updates from CLIENT 1 through the datagrid.
4. If SERVER 1 or CLIENT 1 becomes unavailable, the update source registered by CLIENT 2 becomes active. SERVER 2 sends CLIENT 2 a callback to notify it that it is the active update source.

On SERVER 2, the topics in that section of the topic tree receive their updates from CLIENT 2. SERVER 2 reflects this topic data into the datagrid.

Considerations

Consider the following factors when using failover of active update sources:

- If the topic paths that the updating client uses to register an update source do not match the topic paths configured in the `Replication.xml` configuration file of the server, unexpected behavior can occur.
- The mechanism that provides failover of active update sources assumes that all servers have the same configuration and that all control clients implement the same behavior as part of a scalable and highly available deployment. If this is not the case, unexpected behavior can occur.
- Do not use topic replication and failover of active update sources on sections of the topic tree that are owned and updated by publishers. Topic updates sent by publishers are not replicated.

Related concepts

[Updating topics](#) on page 336

A client can use the `TopicUpdateControl` feature to update topics.

Related tasks

[Configuring the Diffusion server to use replication](#) on page 528

You can configure replication by editing the `etc/Replication.xml` files of your Diffusion servers.

Related reference

[Session replication](#) on page 105

You can use session replication to ensure that if a client connection fails over from one server to another the state of the client session is maintained.

[Topic replication](#) on page 109

You can use topic replication to ensure that the structure of the topic tree, topic definitions, and topic data are synchronized between servers.

[Configuring the Hazelcast datagrid](#) on page 530

You can configure how the built-in Hazelcast datagrid replicates data within your solution architecture.

Topic persistence

Consider if you want to enable topic persistence for fast recovery of topic state when Diffusion servers restart.

Topic persistence

Topic persistence enables a server to store the state of topics (and the topic tree) to the local file system as a special persistence log file. When the server restarts, topics are automatically restored to the state they were in when the server was stopped.

The persistence log only stores the most recent state of each topic, not the topic history.

Persistence avoids the need for the server to rebuild the topic tree from scratch when it starts. Persistence is useful to speed up development, as well as for backing up and restoring the state of topics at a particular point in time.

Persistence can be enabled or disabled for the whole server. As of Diffusion 6.1, when persistence is enabled for the server, it can still be disabled for individual topics using the `PERSISTENT` topic property.

Considerations

Consider the following factors when using topic persistence:

- Persistence is disabled by default.
- Persistence does not support the deprecated single value and record topic types.
- Persistence does not support publisher-created topics.
- Each server has an append-only log file of topic events. By default, this is stored in a directory named `persistence` under the Diffusion server home directory.
- The log file is written until it reaches 200MiB in size. It is then switched out of service and automatically compacted to save storage space. Compaction removes redundant information (for example, if a topic has been removed, the history of values for that topic is removed during compaction, and only the last value is retained).
- Enabling persistence consumes a significant amount of storage space. You will need to allow 200MiB for the active log file, plus space for the compacted file. The size of the compacted file depends on the details of your application. The more topics you have, the bigger the file will be.
- As a rough indication of the size of the compacted file, it contains two records for each topic: a topic record and a value record. The size of each topic record will be approximately the length of the topic name plus 20 bytes. The size of each value record will be approximately the length of the value or delta plus 13 bytes. In practice, you should allow extra space and make sure to monitor the free space available on the server.
- You can configure the directory where the persistence files are stored. See [Configuring topic persistence](#) on page 503 for details.
- You should only back up or restore a persistence log while the Diffusion server is not running.
- Enabling persistence increases memory usage. The compaction service uses about as much memory as it takes to store the topics themselves.
- If servers close unexpectedly (for example, due to a crash), the persistence feature may not log the most recent topic updates, resulting in some data loss when the server restarts.
- Current information is always prioritised. During recovery from the file system, if a newer state of a topic is available (for example, from an application update or by replication from another server), that state will be used instead.

- If you do not want topics to be restored when you next start the server, simply delete all the log files.

Related tasks

[Configuring topic persistence](#) on page 503

Use the `Server.xml` configuration file to configure the topic persistence feature.

Automatic topic removal

Automatic topic removal

You can use an automatic topic removal policy to remove topics when a set of conditions you specify is met.

A simple use case would be a policy that automatically removes a topic if it has not been updated for a day.

A policy can remove the topic it applies to, or a set of topics specified with a path selector. For example, a policy could say that if topic `a` has not been updated for a day, topics `b/1` and `b/2` get removed.

An automatic topic removal policy is set with the `REMOVAL` topic property. The property is specified with an expression including the conditions and the optional selector specifying topics to remove.

See [Removing topics automatically](#) on page 319 for details.

Considerations

Consider the following factors when using automatic topic removal:

- If persistence is not enabled for a topic, the topic will be removed when a server shuts down, regardless of the removal policy.
- If persistence is enabled for a topic, the topic's removal policy will persist. After a server is shut down and restarted, the removal policy will continue to be evaluated.
- Policies are evaluated every few seconds, so a time-based removal policy may not be applied at the exact second specified.
- Automatic topic removal is supported for replicated topics. The removal policy conditions will be evaluated across the whole cluster.
- If your application requires a private topic for each user/principal, you can use [Topic ownership](#) on page 147 with an automatic topic removal policy to remove the topic when the user stops being active.

Clients

Consider how you use clients in your solution.

Clients are key to a Diffusion solution. Your solution must include clients as an endpoint to distribute data to. However, clients can also be used for control purposes.

When using clients in your solution, consider the following:

- What types of client you require
- What you use your clients for

Client types

Diffusion provides APIs for many languages and platforms. Some of these APIs have different levels of capability.

A client's type is a combination of the API it uses and the protocol it uses to connect to the Diffusion server.

APIs

JavaScript

Use this API to develop browser or Node.js™ clients.

Apple

Use this API to develop clients in Objective-C for iOS, tvOS, or macOS.

Android

Use this API to develop mobile clients in Java.

Java

Use this API to develop Java clients.

.NET

Use this API to develop clients in C#.

C

Use this API to develop C clients for Linux, Windows, or macOS.

Protocols

The following protocols, and their secure versions, are available:

WebSocket

The WebSocket implementation provides a browser-based full duplex connection, built on top of WebSocket framing. This complies with the WebSocket standards and is usable with any load balancer or proxy with support for WebSocket.

HTTP Polling

The HTTP polling protocol uses HTTP requests with header m=1 to poll the server and HTTP requests with header m=2 to send messages to the server.

Table 16: Supported protocols by client

Client	WebSocket	HTTP Polling
JavaScript API	✓	✓
Apple API	✓	
Android API	✓	✓
Java API	✓	✓
.NET API	✓	

Client	WebSocket	HTTP Polling	
C API	✓		

Using clients

Most clients connect to the Diffusion server only to subscribe to topics and receive message data on those topics. Some clients can also perform control actions such as creating and updating topics or handling events.

Subscribe to topics and receive data

The majority of clients that connect to the Diffusion server, do so to subscribe to topics and receive updates that are published to those topics. These are the clients used by your customers to interact with the data your organization provides.

Control Diffusion, other clients, or the data

You can also develop clients that control aspects of the Diffusion server, other clients, or the data distributed by Diffusion. These are the clients that are used by users or systems inside your organization.

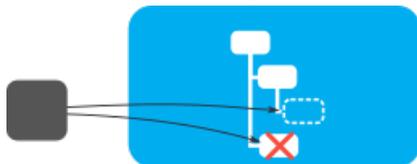
Using clients for control

Clients can perform control actions that affect the Diffusion server, other clients, or the data distributed by Diffusion.

Note: Support for these control features can differ slightly between APIs. For more information, see the documentation for the feature.

When designing your Diffusion solution, decide whether you want to use clients to perform the following actions:

Create and delete topics



Clients can create any type of topic on the Diffusion server. These topics can be created explicitly or dynamically in response to a subscription request from another client.

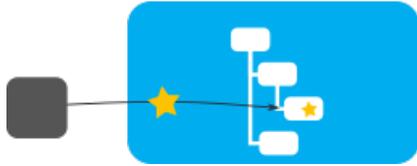
These topics have the lifespan of the Diffusion server unless the client specifies that the topic be removed when the client session closes.

Clients can also delete topics from the Diffusion server.

You can also use publishers to create and delete topics.

For more information, see [Managing topics](#) on page 282.

Publish updates to topics



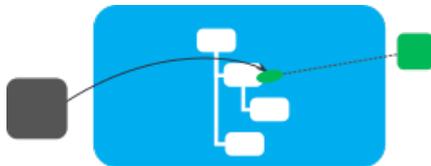
Clients can publish updates to topics that are pushed out to clients subscribed to that topic. These updates can be made exclusively, so that only one client can update a given topic, or non-exclusively, allowing any client to update a given topic.

Note: Do not design your solution to require a large number of update sources (for example, do not give each topic its own exclusive topic updater).

You can also use publishers to publish updates to topics.

For more information, see [Updating topics](#) on page 336.

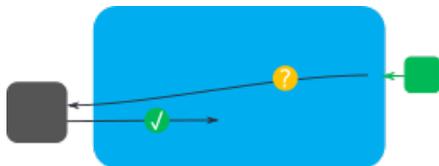
Subscribe other clients to topics



Clients can subscribe other client sessions to topics and also unsubscribe other client session from topics.

For more information, see [Managing subscriptions](#) on page 363.

Authenticate other clients



Clients can provide authentication decisions about whether to allow or deny other client sessions connecting to the Diffusion server. These clients can also assign roles to the connecting client sessions that define the permissions the connecting client has.

You can also use the system authentication handler or an authentication handler located on the Diffusion server to authenticate other clients.

For more information, see [User-written authentication handlers](#) on page 144.

Modify the security information stored on the Diffusion server



Clients can modify the information stored in the security store on the Diffusion server. The security store can be used to specify which permissions are assigned to roles and which roles are assigned to anonymous sessions, and named-principal sessions.

For more information, see [Updating the security store](#) on page 413.

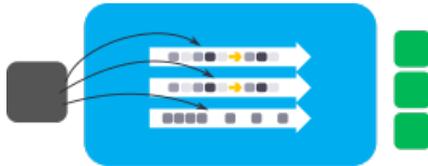
Modify the authentication information stored on the Diffusion server



Clients can modify the information stored in the system authentication store on the Diffusion server. The system authentication store can be used to specify which principals a client session can use to connect and what roles are assigned to an authenticated client session.

For more information, see [Updating the system authentication store](#) on page 403.

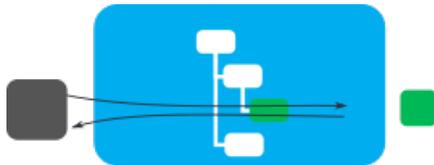
Manage the flow of data to clients



Updates are pushed to subscribing clients through client queues. Clients can receive notifications when client queues reach a certain threshold. These clients can manage the client queues by turning on throttling or conflation for the queue.

For more information, see [Managing sessions](#) on page 422.

To handle messages sent to message paths by clients and send messages to specific clients



Clients can send messages through message paths to specific clients. Clients can also register to handle messages that are sent to a message path. Messages sent using topic paths do not update the topic.

You can also use publishers to handle messages on message paths and send messages to clients.

For more information, see .

User-written components

Consider which components you must develop to create your solution.

Publishers

Consider whether to develop publishers to distribute data in your solution.

Note: We recommend using a client to create and publish to topics, instead of a publisher.

Publishers are written in Java and deployed on the Diffusion server.

You can deploy one or more publishers on a Diffusion server. A publisher can provide the behavior of one or more topics but a topic can belong to only one publisher. The publisher infrastructure is provided by Diffusion and the behavior is provided by the user by writing a publisher.

Why use publishers?

Publishers enable you to manage your topics and updates, and customize their behavior. Unlike clients, publishers are located on the Diffusion server so can communicate more swiftly with the server and do not become disconnected from the server.

Publishers provide the following capabilities:

- Create topics
- Remove publisher-created topics
- Publish updates to topics
- Define topic load data
- Provide topic state to fetch requests
- Send and receive messages to message paths
- Handle requests for topics that do not exist
- Validate client connections
- Receive notifications of client events
- Subscribe clients to topics

Considerations when using a publisher

Publishers can only be written in Java.

Publishers cannot remove topics created by a client.

Clients cannot remove topics created by a publisher.

Other user-written components

Diffusion provides many opportunities to create user-written components that define custom behavior. Consider whether to develop any of these components as part of your solution.

Server-related components

All of these components must be created as Java classes and put on the classpath of the Diffusion server.

Authentication handlers

These components handle authentication of clients that connect to the Diffusion server or change the principal that they use to connect to the Diffusion server. If the client connection is allowed, the authentication handler assigns roles to the client session.

You can have zero, one, or many authentication handlers configured on your Diffusion server.

For more information, see [Developing a local authentication handler](#) on page 455 and [Developing a composite authentication handler](#) on page 457.

Note: Local authentication handlers, on the Diffusion server, can be written only in Java. However, control authentication handlers that are part of a client whose API supports Authentication Control can be written in other languages.

Hooks

Startup and shutdown hooks are called by the Diffusion server. The startup hook is instantiated and called as the Diffusion server starts and before publishers are loaded. The shutdown hook is called as the Diffusion server stops.

For example, you can use a shutdown hook to persist some aspect of the state of the Diffusion server to disk.

HTTP service handlers

These components handle HTTP requests as part of an HTTP service in the Diffusion server's built-in web server. Provide a user-written HTTP service handler to enable the Diffusion web server to handle any kind of HTTP request.

Thread pool handlers

These handlers define custom behavior in the Diffusion server related to the inbound thread pool.

You can provide a rejection handler that customizes the behavior when a task cannot be run by the thread pool. By default, if a task cannot be run by the inbound thread pool — for example, if the thread pool is overloaded — the calling thread blocks until there is space on the queue.

You can provide a notification handler that receives notifications when events occur on the inbound thread pool.

Topic- and data-related components

All of these components must be created as Java classes and put on the classpath of the Diffusion server.

Message matchers

Message matchers are used to customize conflation behavior. These classes that define how the Diffusion server locates messages on a client's message queue that are to be conflated.

By default, messages for conflation are matched if they are on the same topic.

For more information, see [Conflation](#) on page 95.

Message mergers

Message mergers are used to customize conflation behavior. These classes that define how the Diffusion server conflates matching messages.

By default, the older of the matching messages is removed.

For more information, see [Conflation](#) on page 95.

Custom field handlers

These components handle the data in custom fields of your record topics. A custom field handler can define the default value of a custom field, parse incoming data into the format required by the custom field, and compare data in custom fields of the same type for equality.

For more information, see [Record metadata](#) on page 83.

Routing topic handlers

These components handle the behavior of a routing topic. When you create a routing topic, you provide a routing topic handler that, when a subscription to the routing topic is made, maps the routing topic to another topic on the Diffusion server on a client-by-client basis.

For more information, see [Routing topics](#) on page 75.

Third party components

Diffusion interacts with a number of third-party components. Consider how you use these components as part of your solution.

Load balancers

We recommend that you use load balancers in your Diffusion solution.

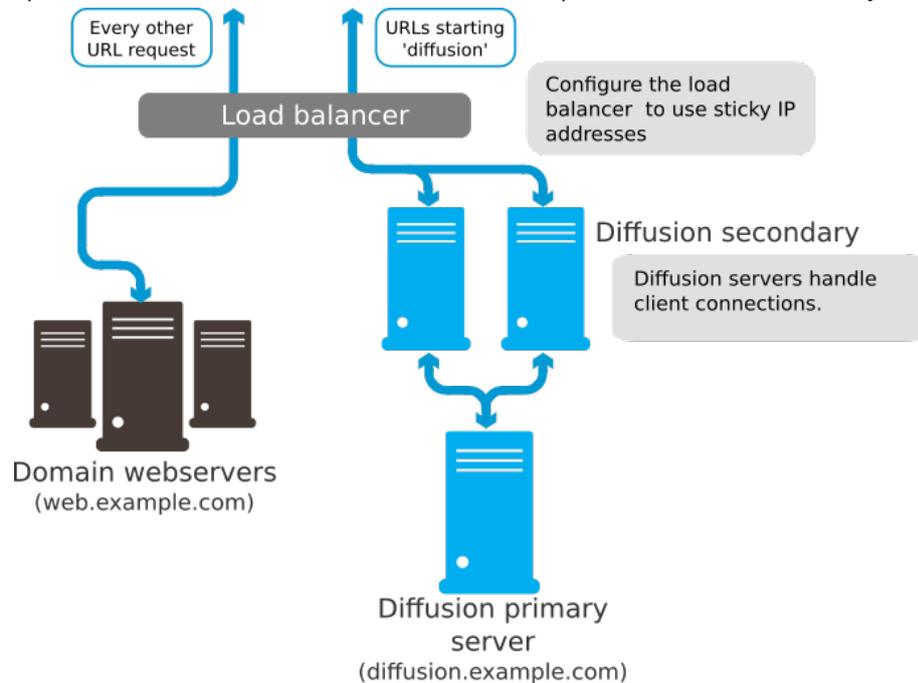
Why use load balancers?

Balancing client traffic across multiple Diffusion servers

Distribute incoming requests from clients fairly over the Diffusion servers in your solution and ensure that all traffic for a specific client is routed to the same Diffusion server.

Compositing URL spaces

If your Diffusion servers are located at a different URL to the Diffusion browser clients hosted by your web servers, you can use a load balancer to composite the URL spaces. This enables Diffusion solutions to interoperate with browser security.



SSL offloading

Diffusion clients can connect to your solution using TLS or SSL. The TLS/SSL can terminate at your load balancer or at your Diffusion server. Terminating the TLS at the load balancer reduces CPU cost on your Diffusion servers.

Considerations when using load balancers

Do not use connection pooling for connections between the load balancer and the Diffusion server. If multiple client connections are multiplexed through a single server-side connection, this can cause client connections to be prematurely closed.

In Diffusion, a client is associated with a single TCP/HTTP connection for the lifetime of that connection. If a Diffusion server closes a client, the connection is also closed. Diffusion makes no distinction between a single client connection and a multiplexed connection, so when a client sharing a multiplexed connection closes, the connection between the load balancer and Diffusion is closed, and subsequently all of the client-side connections multiplexed through that server-side connection are closed.

Multiple users masquerading behind a proxy or access point can have the same IP address, and all requests from clients with that IP address are routed to the same Diffusion instance. Load balancing still occurs, but some hosts might be unfairly loaded.

Web servers

Consider how to use web servers as part of your Diffusion solution.

If you are using Diffusion in conjunction with a web client or web application, this web client or application must be hosted on a web server.

While the Diffusion server includes a web server, this internal web server is intended for the following uses:

- Hosting the Diffusion landing page, demos, and monitoring console
- Providing an endpoint for the HTTP-based transports used by Diffusion clients
- Optionally, hosting a static page you can use to check the status of the Diffusion server

For more information, see [Diffusion web server](#) on page 696.

Do not use the Diffusion web server as the host for your production website. Instead use a third-party web server.

There are two ways you can use Diffusion with a third-party web server:

- As separate, complementary components in your solution.
- With the Diffusion server deployed inside a web application server.

Use a separate web server with the Diffusion server

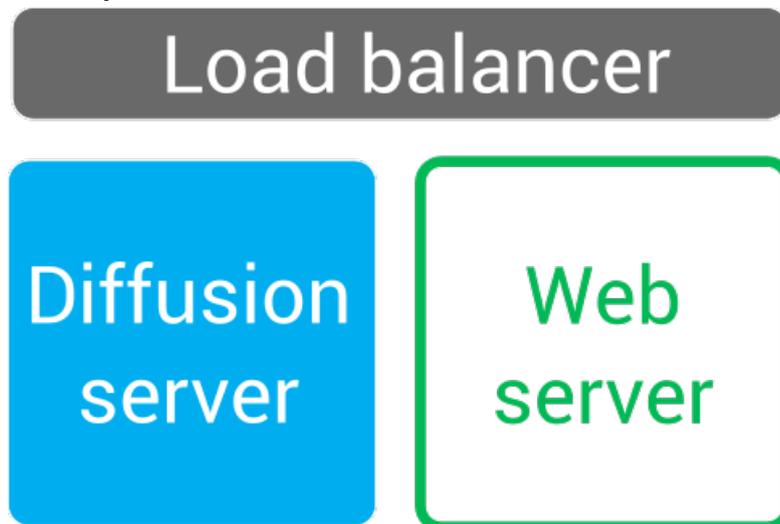


Figure 11: Using a web server with Diffusion

Why use a separate web server with Diffusion?

You can use a third-party web server to host your Diffusion browser clients.

A third-party web server provides the following advantages over the lightweight internal Diffusion web server:

- Greater ability to scale
- More comprehensive security
- Server-side code and dynamic web pages

If your organization already uses a third-party web server, Diffusion augments this component instead of replacing it.

Using a separate web server with the Diffusion server provides the following advantages over deploying the Diffusion server inside a web application server:

- The load balancer set up is simpler
- You can scale the number of Diffusion servers and the number of web servers in your solution independently and more flexibly
- The web server and the Diffusion server do not share a JVM process, which can cause performance advantages
- The web server and the Diffusion server are independent components, which makes them unlikely to be affected by any problems that occur in the other component

For more information, see [Hosting Diffusion web clients in a third-party web server](#) on page 698.

Considerations when using a separate web server with the Diffusion server

If your web server hosts a client that makes requests to a Diffusion server in a different URL space, you can use a load balancer to composite the URL spaces and interoperate with browser security or you can set up cross-domain policy files that allow requests to the different URL space.

When the Diffusion server is separate from the web server, the web server has no access to the Diffusion Publisher API.

Deploy the Diffusion server inside a web application server

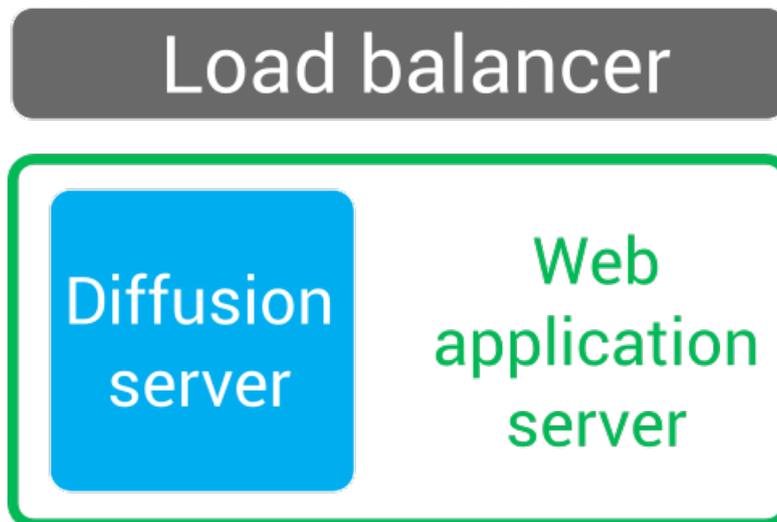


Figure 12: Deploying Diffusion inside a web application server

Why deploy Diffusion inside a web application server?

You can also host your Diffusion server inside a third-party web application server that has the capability to host Java servlets.

This provides the advantage of only setting up a single server and having a single application to manage when hosting your web application.

The web application server has access to the Diffusion Publisher API of the Diffusion server it hosts. This enables your web application to use server-side logic to include Diffusion information in your web pages.

For more information, see [Running the Diffusion server inside of a third-party web application server](#) on page 699.

Considerations when deploying the Diffusion server inside a web server

When running inside a web application server, the Diffusion server still requires its own internal web server to communicate with clients over HTTP-based transports.

Your web application and your Diffusion server, while hosted by the same server, can have different port numbers. This can result in cross-origin security concerns for some browsers. You can use a load balancer to composite the ports or you can set up cross-domain policy files that allow requests to the different ports.

The load balancer configuration can be more complex when deploying the Diffusion server inside a web application server. If you have multiple web application server and Diffusion server pairs, configure your load balancer to ensure that requests from a client always go to a pair and not to the web application server from one pair and the Diffusion server from another pair.

When running the Diffusion server inside of a web application server, the Diffusion server and the web application server share a JVM process. This can lead to large GC pauses. Ensure that you test this configuration and tune the JVM.

Related concepts

[Web servers](#) on page 695

Diffusion incorporates its own basic web server for a limited set of uses. The Diffusion server also interacts with third-party web servers that host Diffusion web clients. The Diffusion server is also capable of being run as a Java servlet inside a web application server.

[Diffusion web server](#) on page 696

Diffusion incorporates its own web server. This web server is required to enable a number of Diffusion capabilities, but we recommend that you do not use it to host your production web applications.

[Configuring the Diffusion web server](#) on page 534

Use the `WebServer.xml` and `Aliases.xml` configuration files to configure the behavior of the Diffusion web server.

[Configuring Diffusion web server security](#) on page 535

When configuring your Diffusion web server, consider the security of your solution.

[Running the Diffusion server inside of a third-party web application server](#) on page 699

Diffusion can run as a Java servlet inside any Java application server.

[Hosting Diffusion web clients in a third-party web server](#) on page 698

Host Diffusion web clients on a third-party web server to enable your customers to access them.

Push notification networks

Consider whether your solution will interact with push notification networks.

Push notification networks can relay data to a client, even when that client is not running.

Diffusion Push Notification Bridge

The Push Notification Bridge is a Diffusion client that subscribes to topics on behalf of other Diffusion clients and uses a push notification network to relay topic updates to the device where the client application is located.

The Push Notification Bridge supports the following push notification networks:

- APNs
- GCM

For more information about how the Push Notification Bridge works, see [Push Notification Bridge](#) on page 737.

Why use the Push Notification Bridge

Diffusion clients on Android or iOS devices might not be running all the time to conserve battery or to enable other processes to run. However, the user might still want to receive realtime updates while the Diffusion client is not running.

By using push notification networks, Diffusion can deliver data to destinations on these devices at any time.

Considerations when using the Push Notification Bridge

- The Push Notification Bridge supports only single value topics.
- Push notification networks identify an app on a device (*a push notification destination*), not an individual user or session.
- If a client requests push notification for a topic and also subscribes to that topic, when the client is connected to Diffusion it receives topic updates once through the Diffusion server and once through the push notification network. The client must handle removing the duplicate messages from the information presented to the user.
- Push notification networks currently limit the size of notifications to 2 KB or less.
- By default, the bridge does not persist the notification subscription requests sent by the clients. If the bridge stops and restarts, this information is lost and notifications are no longer sent.

To ensure that the notification subscriptions are persisted by the bridge, implement a persistence solution. For more information, see [Push Notification Bridge persistence plugin](#) on page 459.

Related concepts

[Push Notification Bridge persistence plugin](#) on page 459

The Push Notification Bridge stores subscription information in memory. To persist this information past the end of the bridge process, implement a persistence plugin.

[Example: Send a request message to the Push Notification Bridge](#) on page 460

The following examples use the API to send a request message on a topic path to communicate with the Push Notification Bridge. The request message is in JSON and can be used to subscribe or unsubscribe from receiving push notifications when specific topics are updated.

[Push Notification Bridge](#) on page 737

The Push Notification Bridge is a Diffusion client that subscribes to topics on behalf of other Diffusion clients and uses a push notification network to relay topic updates to the device where the client application is located.

JMS

Consider whether to incorporate JMS providers into your solution.

If a third-party JMS provider is part of your solution, you can map JMS queues and topics to Diffusion topics by using the Diffusion JMS adapter.

We support integration with JMS providers that conform to version 1.1 or later of the JMS specification.

The following JMS products have been tested and are certified by Push Technology for use with the JMS adapter:

- Apache ActiveMQ v5.11
- IBM MQ v8

Why use a third-party JMS provider

If you are already using a JMS provider to move data in your internal system, you can integrate it with Diffusion to distribute that data to clients and users outside of your organization.

Diffusion JMS adapter

The JMS adapter for Diffusion, enables Diffusion clients to transparently send data to and receive data from destinations (topics and queues) on a JMS server. It is highly configurable and can support the following scenarios:

Pub-sub

Messages on a JMS destination can be published to a Diffusion topic. For more information, see [Publishing using the JMS adapter](#) on page 713.

Messaging

Messages can be sent between JMS destinations and Diffusion clients.

- A message on a JMS destination can be relayed to a Diffusion client through a topic path.
- A Diffusion client can send a message on a message path and the message is relayed to a JMS destination.

For more information, see [Sending messages using the JMS adapter](#) on page 714.

Request-response

The JMS provider can integrate with services that interact using an asynchronous request-response pattern. Diffusion exposes these JMS services through its messaging capabilities. For more information, see [Using JMS request-response services with the JMS adapter](#) on page 716.

Data that flows between JMS and Diffusion must be transformed. JMS messages contain headers, properties, and a payload. Diffusion messages contain just content. For more information about how data is transformed between JMS and Diffusion, see [Transforming JMS messages into Diffusion messages or updates](#) on page 709.

Running the JMS adapter in the Diffusion server or as a standalone application

The JMS adapter is provided in the following forms:

Within the Diffusion server

The JMS adapter can be configured to run as part of the Diffusion server process. A JMS adapter running within the Diffusion server cannot become disconnected from the Diffusion server.

As a standalone client

The JMS adapter is a Java application that can be run on any system and acts as a client to the Diffusion server. Topics created by the JMS adapter running as a standalone client are not deleted from the Diffusion server if the JMS adapter becomes disconnected. You can use this capability to design a highly available solution.

For more information, see [JMS adapter](#) on page 709.

Considerations when using the JMS adapter

Topics defined and created by the JMS adapter when it runs within the Diffusion server are removed when the JMS adapter is stopped.

Topics defined and created by the JMS adapter when it runs as a standalone client are not deleted from the Diffusion server when the JMS adapter client session is closed.

The JMS adapter supports interaction with Diffusion topics that are either stateful (single value) or stateless topics.

Only textual content and JMS TextMessages are supported. Binary content is not currently supported.

You cannot currently publish data to a Diffusion topic and have it sent to a JMS destination.

Data must be transformed between JMS messages and Diffusion content.

If multiple Diffusion servers subscribe to the same JMS queue in a request-response scenario, there is the risk of one server consuming messages intended for another server. Use JMS selectors to ensure that the JMS adapter only receives those messages intended for it.

The creation of temporary queues and topics by the JMS adapter is not currently supported.

Durable subscriptions are not supported.

JMS transactions are not supported.

The only acknowledgment mode that is supported is AUTO_ACKNOWLEDGE.

Session properties are not currently supported. The exception is the `$Principal` property.

Related concepts

[Transforming JMS messages into Diffusion messages or updates](#) on page 709

JMS messages are more complex than Diffusion content. A transformation is required between the two formats.

[Sending messages using the JMS adapter](#) on page 714

The JMS adapter can send messages from a Diffusion client to a JMS destination and messages from a JMS destination to a specific Diffusion client.

[Publishing using the JMS adapter](#) on page 713

The JMS adapter can publish data from a JMS destination onto topics in the Diffusion topic tree.

[Using JMS request-response services with the JMS adapter](#) on page 716

You can use the messaging capabilities of the JMS adapter to interact with a JMS service through request-response.

[Configuring the JMS adapter](#) on page 718

Use the `JMSAdapter.xml` configuration file to configure the JMS adapter to send and receive messages with destinations on a JMS server.

Example solutions

This section includes some example solutions that you can refer to when designing your own solution.

Example: Simple solution

This solution uses a firewall to restrict incoming traffic and a load balancer to balance the traffic between multiple Diffusion servers.

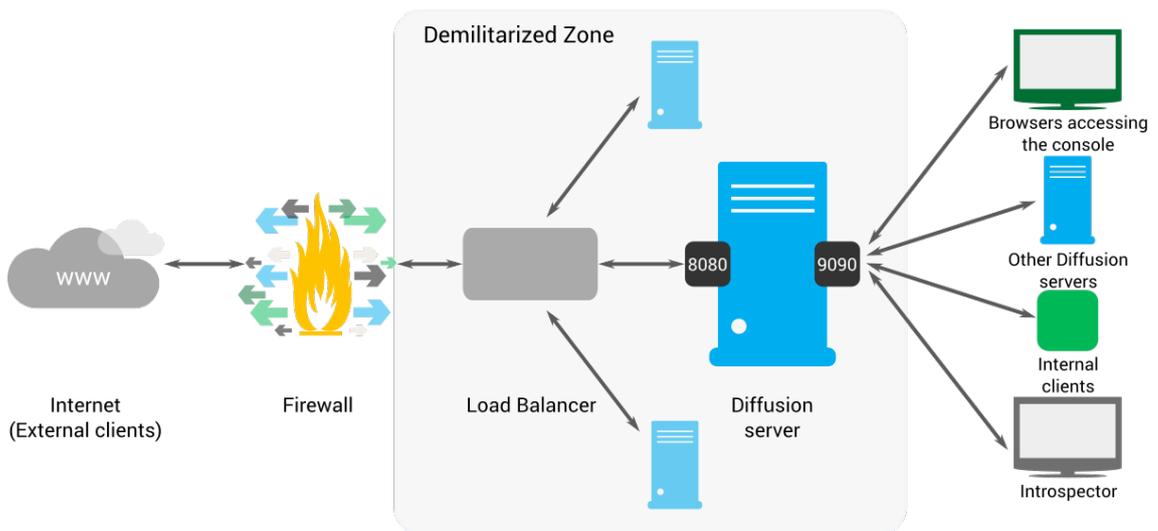


Figure 13: A simple solution

- Client applications can connect to Diffusion from the internet through a firewall.
- The firewall protects the DMZ from unwanted traffic. It allows connections on port 80 and redirects these connections to port 8080.
- The load balancer balances the Diffusion connections between all the Diffusion servers in the DMZ. You can also use the load balancer to filter the URL space and to perform SSL offloading.
- The Diffusion servers receive connections from external clients on port 8080. This port is protected by an authentication handler that performs strict authentication on the incoming connections. Authentication handlers can be local to the server or part of a control client.
- The Diffusion servers receive connections from internal clients on another port, for example 9090. The authentication controls on this port are less strict because these connections come from within your network. Internal connections can come from any of the following components:
 - Browsers accessing the Diffusion console
 - Internal clients, such as control clients.

Example: A solution using clients

Clients with different uses connect to the Diffusion server in this example solution.

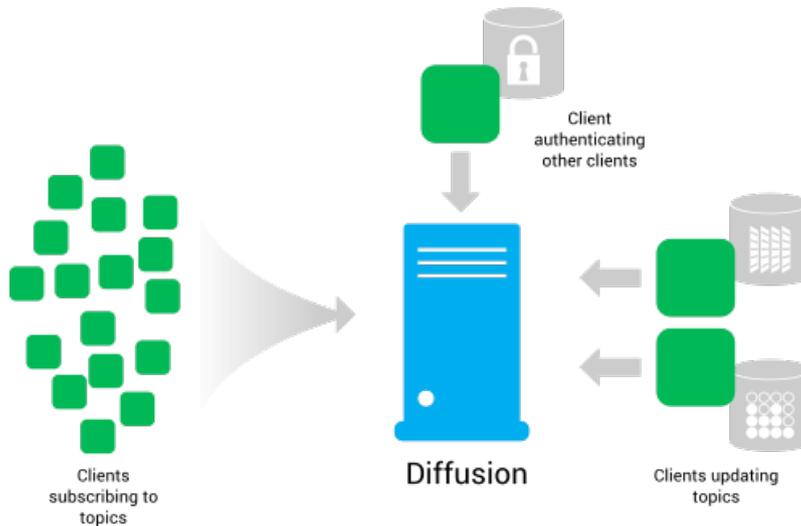


Figure 14: Clients for different purposes

This example solution uses three kinds of client, each for a different purpose:

Clients subscribing to topics

These clients are used by your customers to receive the data you distribute. You can use any of the provided APIs to create these, depending on how your customers want to access your data. For example,

- Use the Apple API to create an iPhone app.
- Use the JavaScript API to create a browser client.

These clients subscribe to the topics that are of interest to your customer, receive updates published on these topics, and display the information to your customers.

Clients creating and updating topics

These clients are used by your organization to distribute your data. You must use an API that provides control features to create these clients. For example, the JavaScript API or the .NET API.

These clients create the topics required to support your data structure and to publish data from your data sources to topics on the Diffusion server.

Clients authenticating other clients

These clients are used by your organization to authenticate connections from other clients. You must use an API that provides control features to create these clients. For example, the Java API.

These clients are called by the Diffusion server to provide an authentication decision when another client connects to the Diffusion server anonymously or with a principal. In addition to deciding whether the other client is allowed to connect, the authenticating client can assign roles to the client session.

The authenticating client can use information stored elsewhere in your system, for example in an LDAP server, to make the authentication decision and assign roles.

Example: Scalable and resilient solution

This solution uses replication to share information between primary servers and make them highly available. The solution also uses fan-out to spread the data from the primary servers behind the firewall to secondary servers in the DMZ.

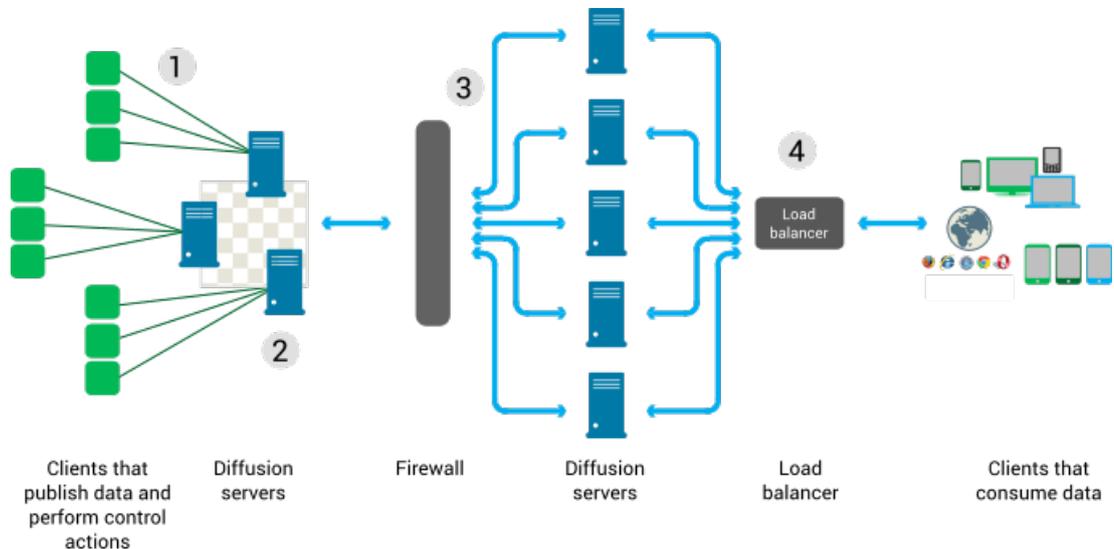


Figure 15: Architecture using replication and fan-out

1. Three clients register handlers with each of the Diffusion servers behind the firewall. These clients can be located on the same system as the server or on remote systems. Each Diffusion server load balances requests between clients that have registered to handle requests of that type. If one of the clients becomes unavailable, the requests can be directed to another client. You can connect more client sessions to deal with higher volumes of requests.
2. The Diffusion servers inside the firewall replicate information into a datagrid. If a Diffusion server that was handling a client session or topic becomes unavailable, the responsibility for that client session or topic can be passed to another Diffusion server that has access to all the information for that session or topic through the datagrid.
3. The Diffusion servers outside of the firewall, in the DMZ, are configured to use automated fan-out to connect to the Diffusion servers inside the firewall. Specified topics on the primary server are fanned out to the secondary servers.
4. You can use a load balancer to spread requests from subscribing clients across many secondary Diffusion servers. If a server becomes unavailable, clients can be directed to another server.

Security

Diffusion secures your data by requiring client sessions to authenticate and using role-based authorization to define the actions that a client can perform.

Concepts

Principal

The principal is a user or system user that has an identity that can be authenticated.

When a principal is authenticated it becomes associated with a session. The default principal that is associated with a session is ANONYMOUS.

Session

A session is a set of communications between the Diffusion server and a client.

Permission

A permission represents the right to perform an action on the Diffusion server or on data.

Role

A role is a named set of permissions and other roles. Principals and sessions can both be assigned roles.

Role hierarchy

Roles are hierarchical. A role can include other roles and, by doing so, have the permissions assigned to the included roles. A role cannot include itself, either directly or indirectly – through a number of included roles.

Related reference

[Default configuration](#) on page 25

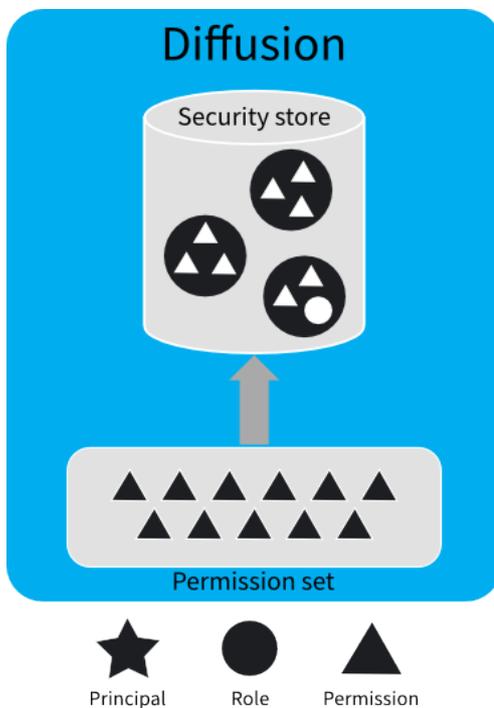
The Diffusion server is configured by the files in the `etc` directory.

Role-based authorization

Diffusion restricts the ability to perform actions to authorized principals. Roles are used to map permissions to principals.

Associating permissions with roles

The association between roles and permissions is defined in the security store.



A fixed set of permissions is defined by the Diffusion server. These permissions are used to control access to actions and data on the Diffusion server.

Roles are used to associate permissions to principals. Permissions are assigned to roles, and roles are assigned to principals.

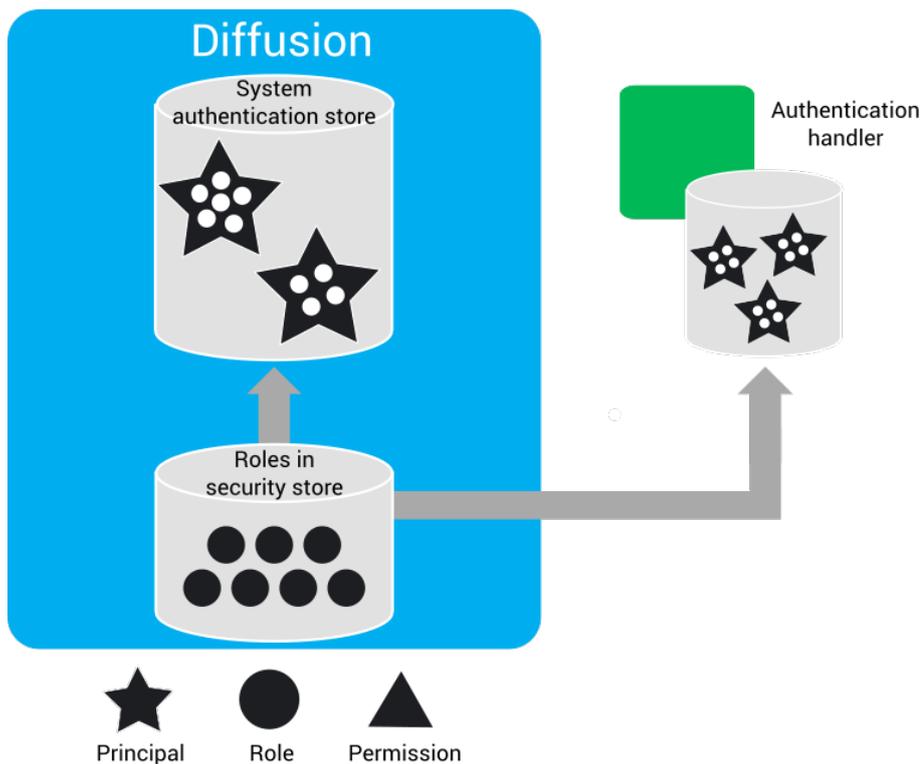
A role can be assigned zero, one, or many permissions. The same permission can be assigned to multiple roles. Roles can also include other roles to form a role hierarchy, and so inherit their permissions. The permissions assigned to a role and the role hierarchy are defined in the security store.

You can update the security store by editing the store file, *installation_directory/etc/Security.store*, and restarting the Diffusion server.

You can update the security store from a client using the SecurityControl feature.

Associating roles with principals

The association between roles and principals is defined in the system authentication store or by user-written authentication handlers.



The association between principals and roles is defined in the following ways:

- In a user-defined store that your user-written authentication handlers refer to. For example, an LDAP server.
- A user-written authentication handler can also hard code the relationship between principals and roles, if that is appropriate.
- In the system authentication store of the Diffusion server

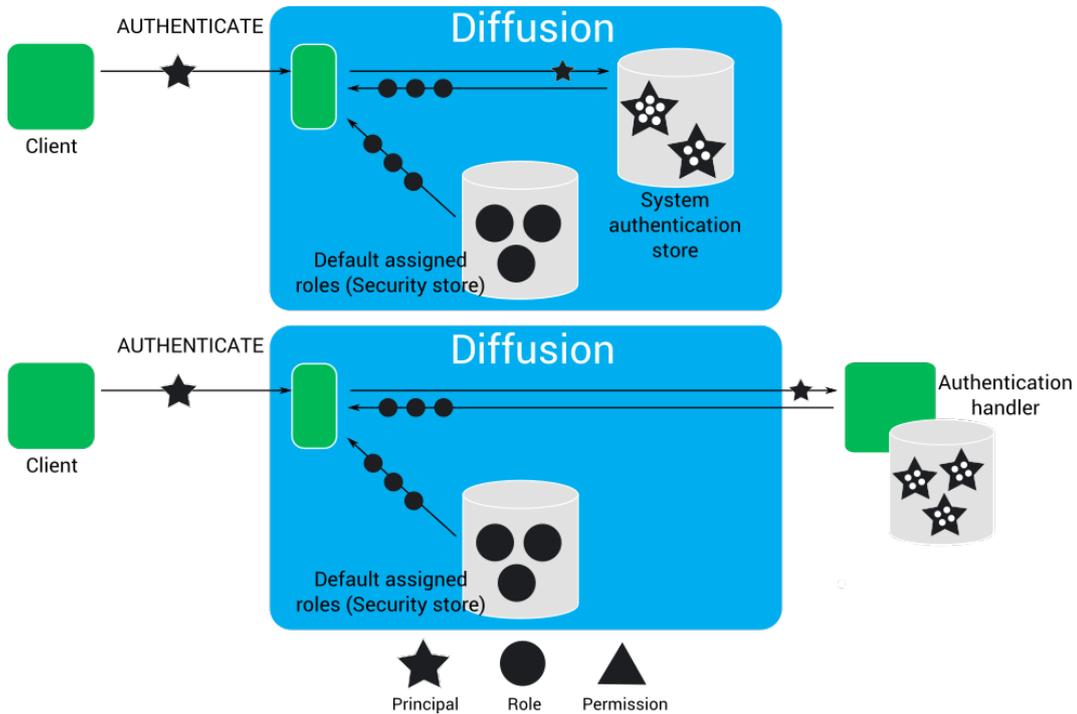
The system authentication store is designed to hold information about Diffusion administration users and system clients. It can manage hundreds or perhaps thousands of principals, but does not provide the administration tools necessary to support millions of principals. We recommend that you delegate such "internet scale" use cases to a third-party identity provider using a custom authentication handler. For example, by using the OAuth or OpenID protocol.

You can update the system authentication store in the following ways:

- From a client using the SystemAuthenticationControl feature.
- By editing the store file, *installation_directory/etc/SystemAuthentication.store*, and restarting the Diffusion server.

Assigning roles to client sessions

Roles are assigned to a new client session after client authentication.



The roles assigned to a client session determine the actions that client session can perform.

A client session is assigned roles in the following ways:

- If the client session connects to the Diffusion server anonymously, the client session is assigned the default assigned roles for the ANONYMOUS principal.

Anonymous authentication can be enabled or disabled in the system authentication store. If enabled, roles can also be specified.

- When a client session authenticates with a principal, the client session can be assigned the following roles:
 - The default assigned roles for a named principal.
 - The set of roles assigned to a principal by the authentication handler that accepts the client session's authentication request. This authentication handler can be one of the following types:
 - The system authentication handler, in which case the roles that are assigned are those associated with that principal in the system authentication store.
 - A user-written authentication handler, in which case the roles that are assigned are those defined by the handler or a user-defined store.

For example: A client session authenticates with the Diffusion server using the principal Armstrong. The first authentication handler that is called is a user-written authentication handler. This authentication handler abstains from the authentication decision, so does not assign roles to the client session. The next authentication handler that is called is the system authentication handler. The system authentication handler does not abstain from the authentication decision. It uses the information in the system authentication store to decide to allow the authentication request. In the system authentication store, the principal Armstrong is associated with the roles ALPHA, BETA, and EPSILON. These roles are assigned to the client session.

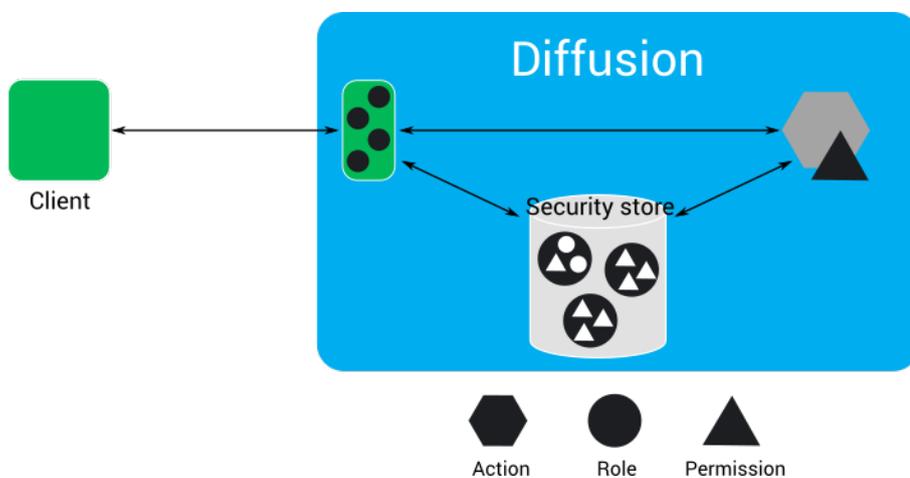
After the authentication request has been allowed, no further authentication handlers are called to make a decision or assign roles. However, the Diffusion server also assigns the default assigned roles for a named principal to the client session. The default assigned roles defined in the security store are GAMMA and RHO.

After authenticating with the principal Armstrong, the client session has the following roles assigned to it:

- ALPHA
- BETA
- EPSILON
- GAMMA
- RHO

Authorizing actions

When a client requests to perform an action or access data that requires a permission, the Diffusion server checks whether the client session is assigned a role that includes the required permission.



The client requests to perform an action. If the action requires that the client session has a permission, the Diffusion server checks what roles the client session is assigned and checks in the security store whether any of these roles have the required permission.

For example: A client requests to subscribe to the topic A/B/C. To subscribe to a topic, a client session must have the `select_topic` permission for that topic. The client session has the ALPHA and BETA roles. In the security store, the ALPHA role does not include the `select_topic` permission, but the BETA role does include the `select_topic` permission for the A/B/C topic. Because the client session is assigned the BETA role, it has the required permission and can subscribe to the topic.

Related concepts

[Authentication](#) on page 141

You can implement and register handlers to authenticate clients when the clients try to perform operations that require authentication.

DEPRECATED: [Authorization handlers](#) on page 148

An authorization handler can control authorization and permissions for clients and users.

Related reference

[Topic ownership](#) on page 147

Topic ownership allows you to grant read, modify and update permissions for a topic to a specific principal. This is useful to provide a 'private' topic for a given user.

[Configuring user security](#) on page 510

You can use the `Security.store` and `SystemAuthentication.store` files in the `etc` directory of your Diffusion server to configure the security roles and how they are assigned.

Permissions

The actions a client session can take in Diffusion are controlled by a set of permissions. These permissions are assigned to roles.

Permissions can have one of the following scopes:

Path

Permissions at path scope apply to actions on a topic path or message path.

Path-scoped permissions are defined against paths. The permissions that apply to a topic path or to a message path are the set of permissions defined at the most specific path.

Global

Permissions at global scope apply to actions on the Diffusion server.

Path permissions

The path-scoped permissions are listed in the following table:

Table 17: List of path-scoped permissions

Name	Description
<code>select_topic</code>	Use a topic selector that selects the topic path. A session must have this permission for the path prefix of any topic selector used to subscribe or fetch.
<code>read_topic</code>	Grant read access to the topics. If a session does not have this permission for a topic, that topic does not match subscriptions and is excluded from fetch requests. Also, the topic's details cannot be retrieved.
<code>query_obsolete_time_series_events</code>	Evaluate a query on a time series topic that can potentially return a non-current view of all or part of a time series. Such queries include value range queries that specify an edit range, and all types of edit range query. Evaluating a query also requires <code>read_topic</code> .
<code>edit_time_series_events</code>	Submit edit events to a time series topic. Updating a time series topic also requires <code>update_topic</code> .
<code>edit_own_time_series_events</code>	Submit edit events to a time series topic where the event author is the same as the principal of the calling session. Updating a time series topic also requires <code>update_topic</code> .
<code>update_topic</code>	Update topics at or below a topic branch.
<code>modify_topic</code>	Create or modify topics at or below a topic branch.

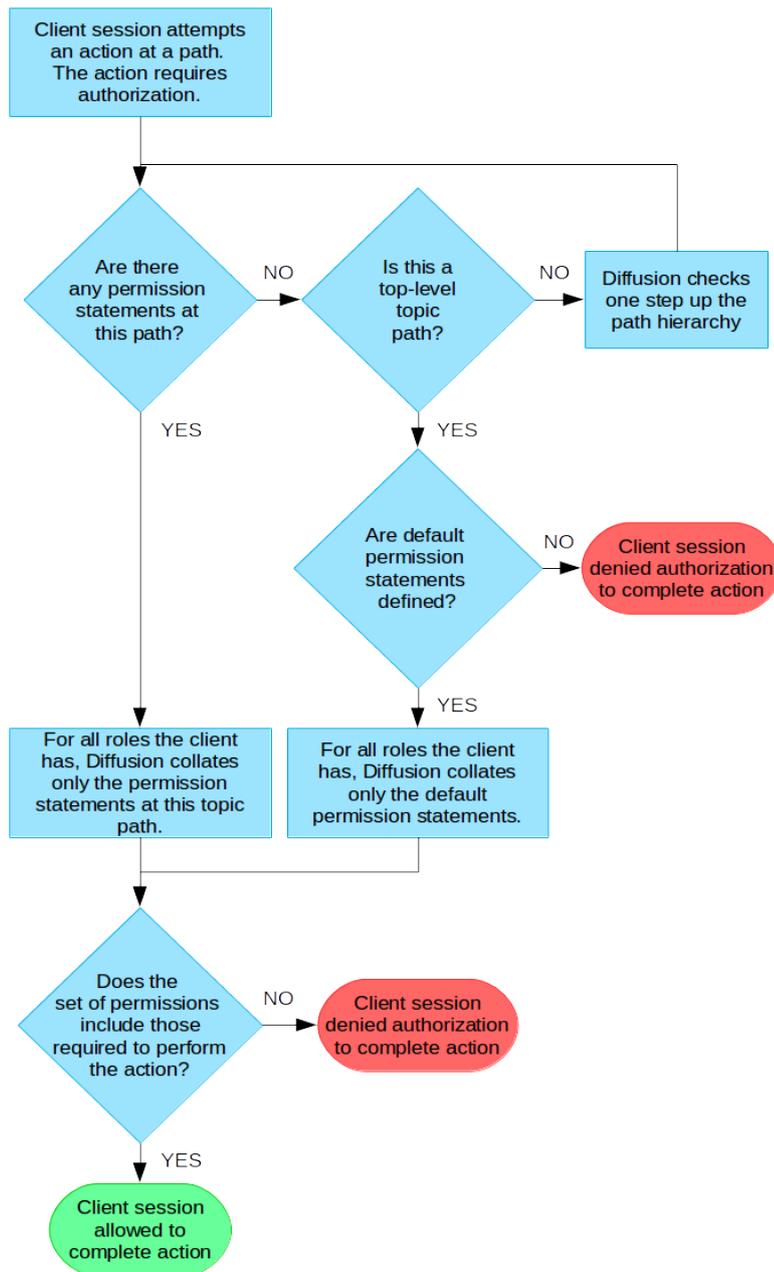
Name	Description
send_to_message_handler	Send a message to the Diffusion server through a message path.
send_to_session	Send a message to a client session through a message path.

Understanding path-scoped permissions

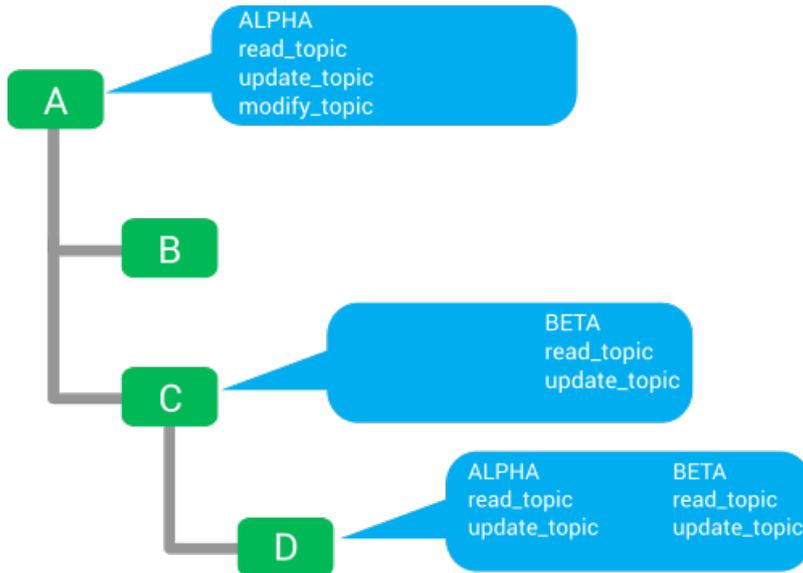
Path-scoped permissions are assigned to roles for specific paths. The permission assignment applies to all descendant paths, unless there is a more specific assignment.

To evaluate whether a client session has access to a permission for a topic or message path, the Diffusion server starts at that path and searches up the path hierarchy to find the nearest permission assignment. The first assignment is the only one considered, even if the client has roles involved in assignments further up the path hierarchy.

Default path-scoped assignments can also be defined. These are used if no path assignment matches.



Path scope example



In this example, client sessions with the role ALPHA have the following permissions on each topic in the topic tree:

A

A permission set is defined for the path A.

These permissions give client sessions with the ALPHA role read_topic, update_topic, and modify_topic permissions on the topic A.

A/B

No permission set is defined for the path A/B. In this case, the permissions at the most specific scope are those defined for the path A

These permissions give client sessions with the ALPHA role read_topic, update_topic, and modify_topic permissions on the topic B.

A/C

A permission set is defined for the path A/C. These permissions do not include any permissions for the ALPHA role.

Client sessions with the ALPHA role have no permissions on the topic C. Permissions are defined for the ALPHA role at a less specific scope. However, these permissions are not referred to or inherited if any permissions are defined at a more specific scope. Only the most specific set of permissions is used. In this case, those permissions are only for the BETA role and not the ALPHA role.

A/C/D

A permission set is defined for the path A/C/D.

These permissions give client sessions with the ALPHA role read_topic and update_topic permissions on the topic D.

The role ALPHA has only these permissions even though at A/C the role has no permissions defined and at A the role has additional permissions. Only the most specific set of permissions is used.

The BETA role also has permissions defined at this scope. These permissions do not affect the permissions that the ALPHA role has at this scope.

Understanding the select_topic and read_topic permissions

The default configuration grants the select_topic and read_topic permissions to all sessions then protects the topics on paths below the Diffusion path using the OPERATOR role. You can alter this configuration to protect sensitive topics.

A session that does not have the select_topic permission for a particular path cannot subscribe directly to topics at that path. However, the session can be independently subscribed to that topic by a control session that has modify_session permission in addition to the select_topic permission for that path. The subscribed session requires the read_topic permission for that topic for the subscription to the topic to occur. The control session cannot subscribe a session to a topic if that session does not have the read_topic permission for the topic. When this occurs, the topic is filtered out of the subscription.

Use the select_topic permission with some care because topic selectors can use wild card expressions. For example, with the default configuration, the OPERATOR role is required to use topic selector expressions such as Diffusion or ?Diffusion//", but the CLIENT role is sufficient to use the topic selector expression ?// which selects all of the topics in the topic tree.

In the default configuration, this does not cause a problem as sessions that do not have the OPERATOR role also do not have the read_topic permission for topic paths below Diffusion. Any matching topics are filtered from subscription and fetch results for those sessions.

Managing all subscriptions from a separate control session

You can prevent client sessions from subscribing themselves to topics and control all subscriptions from a separate control client session that uses SubscriptionControl feature to subscribe clients to topics.

To restrict subscription capability to control sessions, configure the following permissions:

Control session:

- Grant the modify_session permission
- Grant the select_topic permission

This can either be granted for the default path scope or more selectively to restrict the topic selectors the control session can use.

Other sessions:

- Grant read_topic to the appropriate topics.
- Deny the select_topic permission by default.

Do not assign the session a role that has the select_topic permission for the default path scope. This prevents the session from subscribing to all topics using a wildcard selector.

- Optionally, grant the select_topic permission to specific branches of the topic tree to which the session can subscribe freely.

Global permissions

The global permissions are listed in the following table:

Table 18: List of global permissions

Name	Description
view_session	List or listen to client sessions.
modify_session	Alter a client session. This covers a range of actions including the following:

Name	Description
	<ul style="list-style-type: none"> • subscribe a session to a topic • throttle a session • enable conflation for a session • close a session
register_handler	Register any handler with the Diffusion server.
authenticate	Register an authentication handler. The register_handler permission is also required to perform this action.
view_server	Read administrative information about the Diffusion server. For example, through JMX.
control_server	<ul style="list-style-type: none"> • Shut down the Diffusion server. • Start and stop publishers. <p>These actions can be taken only from the console or JMX. Client sessions cannot shut down the Diffusion server or start and stop publishers.</p>
view_security	View the security policy.
modify_security	Change the security policy.

Related reference

[Pre-defined roles](#) on page 139

Diffusion has a pre-defined set of roles with associated permissions.

[Pre-defined users](#) on page 147

Diffusion has a pre-defined set of users with associated password and roles.

Pre-defined roles

Diffusion has a pre-defined set of roles with associated permissions.

Clients can edit this set of roles. For more information, see [Updating the security store](#) on page 413.

	CLIENT	TOPIC_ CONTROL	CLIENT_ CONTROL	AUTHENTICATION _HANDLER	OPERATOR	ADMINISTRATOR and JMX_ ADMINISTRATOR
select topic Default scope	✓	✓	✓	✓	✓	✓
select topic "Diffusion" topic					✓	✓
read topic	✓	✓	✓	✓	✓	✓

	CLIENT	TOPIC_ CONTROL	CLIENT_ CONTROL	AUTHENTICATION _HANDLER	OPERATOR	ADMINISTRATOR and JMX_ ADMINISTRATOR
Default scope						
read topic "Diffusion" topic					✓	✓
modify topic Default scope		✓				✓
modify topic "Diffusion" topic						✓
update topic Default scope		✓				✓
update topic "Diffusion" topic						✓
query_obsolete_time_series_events						
edit_time_series_events						
edit_own_time_series_events						
send to message handler Default scope	✓	✓	✓	✓	✓	✓
send to message handler "Diffusion" topic					✓	✓
send to session Default scope		✓				✓
view session			✓		✓	✓

	CLIENT	TOPIC_ CONTROL	CLIENT_ CONTROL	AUTHENTICATION _HANDLER	OPERATOR	ADMINISTRATOR and JMX_ ADMINISTRATOR
modify session			✓			✓
register handler			✓	✓		✓
authenticate				✓		
view security						✓
modify security						✓
view server					✓	✓
control server						✓

Related reference

[Permissions](#) on page 134

The actions a client session can take in Diffusion are controlled by a set of permissions. These permissions are assigned to roles.

[Pre-defined users](#) on page 147

Diffusion has a pre-defined set of users with associated password and roles.

Authentication

You can implement and register handlers to authenticate clients when the clients try to perform operations that require authentication.

The handlers you can implement and register are the following:

- Any number of local authentication handlers
- Any number of control authentication handlers

The server calls the authentication handlers (local and control) in the order that they are defined in the `Server.xml` file.

If no handlers are defined, the server allows the client operation by default.

Authentication process

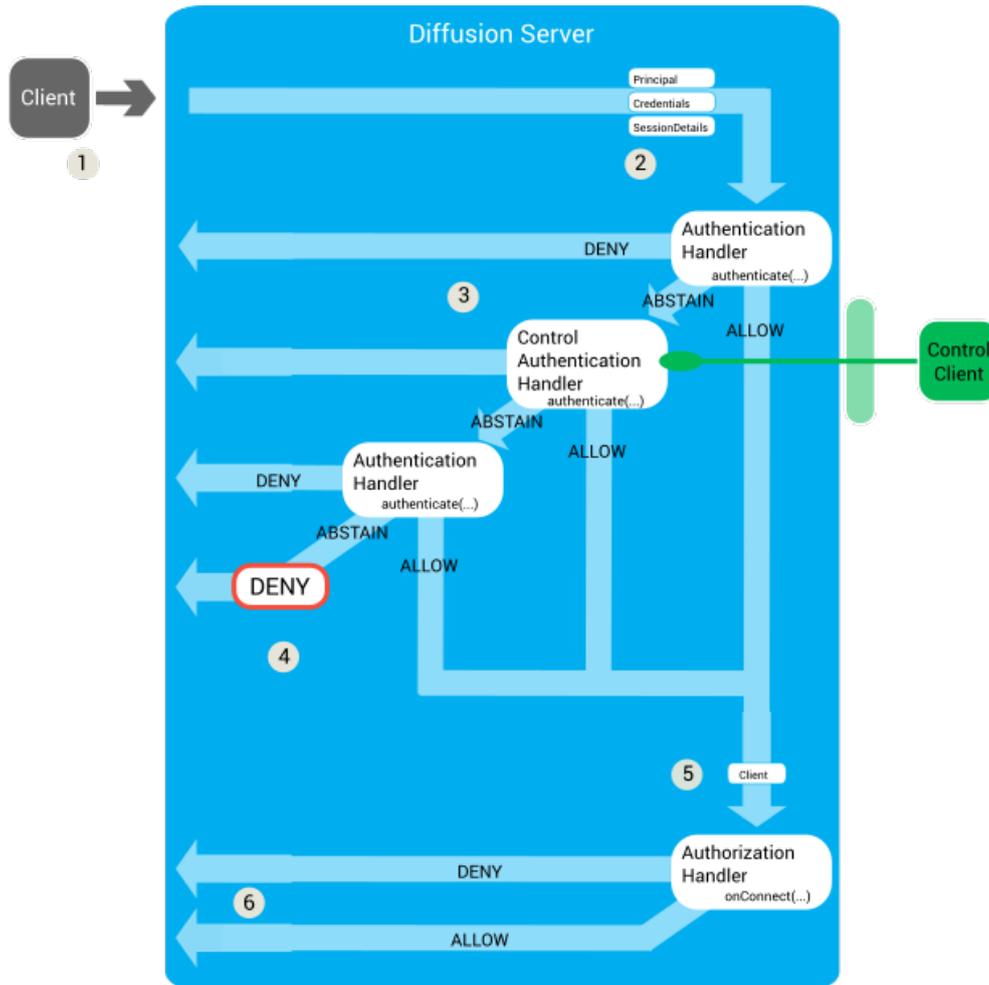


Figure 16: Authentication process for clients

1. A client tries to perform an operation that requires authentication. For more information, see [Client operations that require authentication](#) on page 143.
2. The server calls the authentication handlers one after another in the order that they are listed in the `Server.xml` file. It passes the following parameters to each authentication handler's `authenticate()` method:

Principal

A string that contains the name of the principal or identity that is connecting to the server or performing the action. This can have a value of `Session.ANONYMOUS`.

Credentials

The `Credentials` object contains an array of bytes that holds a piece of information that authenticates the principal. This can be empty or contain a password, a cryptographic key, an image, or any other piece of information. The authentication handler is responsible for interpreting the bytes.

SessionProperties

This contains information about the client. The available properties depend on what information the server holds about the client session. Some session information might not be available on initial connection.

This information can be used in the authentication decision. For example, an authentication handler can allow connection only from clients that connect from a specific country.

When it registers with the server, a control authentication handler can specify what properties it requires, so only these properties are sent by the server (if available). This reduces the amount of data sent across the control client connection.

Callback

A callback that the authentication handler can use to respond to the authentication request by using the callback's `allow()`, `deny()`, or `abstain()` method.

If the authentication handler is a local authentication handler, the authentication logic is done on the server. If the authentication handler is a control authentication handler, the parameters are passed to a control client and the control client handles the authentication logic and returns a response.

3. Each authentication handler can return a response of `ALLOW`, `DENY`, or `ABSTAIN`.
 - If the authentication handler returns `DENY`, the client operation is rejected.
 - If the authentication handler returns `ALLOW`, the decision is passed to the authorization handlers. The authentication handler can also provide a list of roles to assign to the client session.
 - If the authentication handler returns `ABSTAIN`, the decision is passed to the next authentication handler listed in the `Server.xml` configuration file.
4. If all authentication handlers respond with an `ABSTAIN` decision, the response defaults to `DENY`.

Client operations that require authentication

The following client operations require authentication with the server:

Table 19: Client operations that require authentication

Client operation	Behavior if operation is allowed	Behavior if operation is denied
Connect to server	The client connection to the server is accepted.	The client connection to the server is rejected and is dropped.
Change the principal associated with a client session	The principal is changed.	The principal is not changed, but the client session is not dropped.

Related concepts

[Role-based authorization](#) on page 130

Diffusion restricts the ability to perform actions to authorized principals. Roles are used to map permissions to principals.

DEPRECATED: [Authorization handlers](#) on page 148

An authorization handler can control authorization and permissions for clients and users.

Related reference

[Topic ownership](#) on page 147

Topic ownership allows you to grant read, modify and update permissions for a topic to a specific principal. This is useful to provide a 'private' topic for a given user.

User-written authentication handlers

You can implement authentication handlers that authenticate clients that connect to the Diffusion server or perform an action that requires authentication.

The authentication handlers can be implemented either remotely, in a client, or locally, on the server. The authentication handlers can be individual authentication handlers, that perform a single authentication check, or composite authentication handlers, that delegate to one or more individual authentication handlers.

Local authentication handlers

A local authentication handler is an implementation of the `AuthenticationHandler` interface. Local authentication handlers can be implemented only in Java. The class file that contains a local authentication handler must be located on the classpath of the Diffusion server.

Control authentication handlers

A control authentication handler can be implemented in any language where the Diffusion API includes the `AuthenticationControl` feature. A control authentication handler can be registered by any client that has the `authenticate` and `register_handler` permissions.

For more information, see [Authenticating new sessions](#) on page 391.

Composite authentication handlers

A composite authentication handler delegates the authentication decision to an ordered list of one or more individual authentication handlers and returns a combined decision.

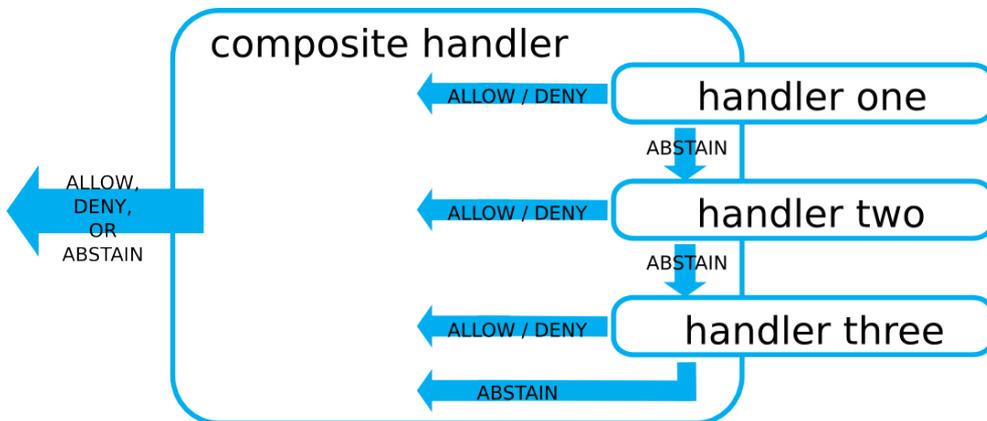


Figure 17: A composite authentication handler

- If an individual handler allows the client action, the composite handler responds with an ALLOW decision.
- If an individual handler denies the client action, the composite handler responds with a DENY decision.
- If an individual authentication handler abstains, the composite handler calls the next individual handler.
- If all individual handlers abstain, the composite handler responds with an ABSTAIN decision.

A composite authentication handler can be either local or control. A local composite authentication handler can delegate the authentication decision to one or more authentication handlers. A composite control authentication handler can delegate the authentication decision to one or more control authentication handlers.

The use of composite authentication handlers is optional. There are two reasons to consider using them:

- Composite authentication handlers enable you to combine authentication handlers together, which reduces the possibility of misconfiguration.
- Composite control authentication handlers improve efficiency by reducing the number of messages sent between the Diffusion server and clients.

The following table matrix shows the four types of authentication handler.

Table 20: Types of authentication handler

	Individual	Composite
Local	Implement the <code>AuthenticationHandler</code> interface. For more information, see Developing a local authentication handler on page 455.	Extend the <code>CompositeAuthenticationHandler</code> class. For more information, see Developing a composite authentication handler on page 457
Control	Implement the <code>ControlAuthenticationHandler</code> interface. For more information, see Developing a control authentication handler on page 398.	Extend the <code>CompositeControlAuthenticationHandler</code> class. For more information, see Developing a composite control authentication handler on page 401

Related concepts

[Configuring authentication handlers](#) on page 501

Authentication handlers and the order that the Diffusion server calls them in are configured in the `Server.xml` configuration file.

Related tasks

[Developing a local authentication handler](#) on page 455

Implement the `AuthenticationHandler` interface to create a local authentication handler.

[Developing a composite authentication handler](#) on page 457

Extend the `CompositeAuthenticationHandler` class to combine the decisions from multiple authentication handlers.

[Developing a control authentication handler](#) on page 398

Implement the `ControlAuthenticationHandler` interface to create a control authentication handler.

[Developing a composite control authentication handler](#) on page 401

Extend the `CompositeControlAuthenticationHandler` class to combine the decisions from multiple control authentication handlers.

[Developing a local authentication handler](#) on page 455

Implement the `AuthenticationHandler` interface to create a local authentication handler.

[Developing a composite authentication handler](#) on page 457

Extend the `CompositeAuthenticationHandler` class to combine the decisions from multiple authentication handlers.

System authentication handler

Diffusion provides an authentication handler that uses principal, credential, and roles information stored in the Diffusion server to make its authentication decision.

System authentication store

The principal, credentials, and role information located in the system authentication store is used by the system authentication handler to authenticate users.

The system authentication store is designed to hold information about Diffusion administration users and system clients. It can manage hundreds or perhaps thousands of principals, but does not provide the administration tools necessary to support millions of principals. We recommend that you delegate such "internet scale" use cases to a third-party identity provider using a custom authentication handler. For example, by using the OAuth or OpenID protocol.

By default the following information is set in the system authentication store file, `SystemAuthentication.store` located in the `etc` directory:

```
allow anonymous connections [ "CLIENT" ]

add principal "client" "password" [ "CLIENT" ]
add principal "control" "password" [ "CLIENT_CONTROL" "TOPIC_CONTROL"
  "AUTHENTICATION_HANDLER" ]
add principal "admin" "password" [ "ADMINISTRATOR" ]
add principal "operator" "password" [ "OPERATOR" ]
```

You can edit the usernames and passwords in this file by hand and restart the Diffusion server to reload the file. However, any password you enter in plaintext is hashed by the Diffusion server when it starts and the plaintext value in this file is replaced with the hashed value.

The default hash scheme used is PBKDF-SHA256-1000. You can specify a different hash scheme in the `Server.xml` configuration file. For more information, see .

Behavior of the system authentication handler

The system authentication handler behaves in the following way:

- If anonymous connections are allowed in the system authentication store and a client session connects anonymously, the system authentication handler returns an ALLOW decision and the list of roles an anonymous client session is assigned.
- If anonymous connections are not allowed in the system authentication store and a client session connects anonymously, the system authentication handler returns a DENY decision.
- If a client session connects with a principal listed in the system authentication store and the correct credentials, the system authentication handler returns an ALLOW decision and the list of roles that client session is assigned.
- If a client session connects with a principal listed in the system authentication store and incorrect credentials, the system authentication handler returns a DENY decision.
- If a client session connects with a principal that is not listed in the system authentication store, the system authentication handler returns an ABSTAIN decision.

Related concepts

[Configuring authentication handlers](#) on page 501

Authentication handlers and the order that the Diffusion server calls them in are configured in the `Server.xml` configuration file.

[Updating the system authentication store](#) on page 403

A client can use the `SystemAuthenticationControl` feature to update the system authentication store. The information in the system authentication store is used by the system authentication handler to authenticate users and assign roles to them.

Pre-defined users

Diffusion has a pre-defined set of users with associated password and roles.

You can use the `SystemAuthenticationControl` feature to edit this set of users.

Note: This set of users and passwords are well known and not secure. Change the passwords or remove the users before putting Diffusion into production.

The users defined in the system authentication store are only authenticated if the system authentication handler is configured. For more information, see [Configuring authentication handlers](#) on page 501.

User	Password	Associated roles
client	password	CLIENT
control	password	CLIENT_CONTROL, TOPIC_CONTROL, AUTHENTICATION_HANDLER
admin	password	ADMINISTRATOR
operator	password	OPERATOR
Anonymous connections		CLIENT

Related reference

[Pre-defined roles](#) on page 139

Diffusion has a pre-defined set of roles with associated permissions.

[Permissions](#) on page 134

The actions a client session can take in Diffusion are controlled by a set of permissions. These permissions are assigned to roles.

Topic ownership

Topic ownership allows you to grant read, modify and update permissions for a topic to a specific principal. This is useful to provide a 'private' topic for a given user.

Topic ownership enables you to give a specific security principal special access to a topic when the topic is created. Ownership grants `READ_TOPIC`, `MODIFY_TOPIC` and `UPDATE_TOPIC` permissions for the topic to sessions authenticated with that principal.

Use the `OWNER` topic property to set ownership.

The format of the property value is:

```
$Principal is "name"
```

where *name* is the name of the principal.

Topic ownership is useful in cases where your application requires a user to have privileged access to their own special topic. For example, it might be a private topic that only the user should see, or each user might have their own topic used to broadcast status information to other users.

All other sessions will only have the permissions granted by the security store.

[Automatic topic removal](#) can be used to remove a principal's private topic if that principal no longer has an active session for a period of time.

Related concepts

[Role-based authorization](#) on page 130

Diffusion restricts the ability to perform actions to authorized principals. Roles are used to map permissions to principals.

[Authentication](#) on page 141

You can implement and register handlers to authenticate clients when the clients try to perform operations that require authentication.

[DEPRECATED: Authorization handlers](#) on page 148

An authorization handler can control authorization and permissions for clients and users.

DEPRECATED: Authorization handlers

An authorization handler can control authorization and permissions for clients and users.

Role-based authorization

Attention: The new role-based security model has superseded authorization handlers. Role-based security enables you to more simply manage permissions and users. We recommend you use role-based authorization instead of authorization handlers. For more information, see [Role-based authorization](#) on page 130.

An authorization handler is a user-written Java class that must implement the `AuthorisationHandler` interface in the `.`

Such a handler can be used to restrict access of clients according to any criteria that is appropriate. One capability within Diffusion is for a client to be able to specify Credentials when they connect that can be checked by the authorization handler.

The handler can either be specified in `etc/Server.xml` in which case it is loaded when the server starts or can be set programmatically within a publisher using the `Publishers.setAuthorisationHandler` method.

There can only be one handler and it is system wide across all publishers, although you can have authorization at the publisher level.

If an authorization handler is not specified, credentials sent by a client are assumed to be valid. A publisher has access to the credentials to perform finer-grained authorization, if required.

The authorization handler interface has the following methods:

Table 21: Authorization handler methods

DEPRECATED: <code>canConnect (Client)</code>	This method is called to establish whether the client can connect and is called before any client validation policy is called.
--	--

<code>canSubscribe(Client, Topic)</code>	<p>This method is called when a client subscribes to a topic. If topic information is sent with the connection, this method is called after the <code>canConnect</code> method.</p> <p>Note: This is called for every topic being subscribed to, even if subscribed as a result of a topic selector being specified. However (by default), if a topic is rejected by this method, it is not called again for any children (or descendants) of the topic.</p>
<code>canSubscribe(Client, TopicSelector)</code>	<p>This method is called when a client attempts to subscribe to a topic selector pattern (as opposed to a simple topic name). If topic information is sent with the connection, this method is called after the <code>canConnect</code> method.</p>
<code>canFetch(Client, Topic)</code>	<p>This method is called when a client sends a fetch request to obtain the current state of a topic.</p> <p>Note: This is called for every topic being fetched, even if fetched as a result of a topic selector being specified. However (by default), if a topic is rejected by this method, it is not be called again for any children (or descendants) of the topic.</p>
<code>canFetch(Client, TopicSelector)</code>	<p>This method is called when a client attempts to fetch topics using a topic selector pattern (as opposed to a simple topic name).</p>
<code>canWrite(Client, Topic)</code>	<p>This method is called when a client sends a message on a given topic, if false is returned the message is ignored, and the publisher will not be notified of the message. When implementing this method, be aware that performance can be impacted if many clients send messages or if a few clients send large messages.</p>
DEPRECATED: <code>credentialsSupplied(Client, Credentials)</code>	<p>This method is called when a client submits credentials after connection. It can be used to validate the credentials and must return true if the credentials are OK. If this returns false, a Credentials Rejected message are sent back to the client.</p>

Authentication

Note: The use of authorization handlers for authentication is deprecated. We recommend that you re-implement your authentication logic using authentication handlers. For more information, see [User-written authentication handlers](#) on page 144.

When a client connects to Diffusion it has the option of supplying user credentials. These credentials are basically tokens called username and password. These tokens can be used for any purpose. When `canConnect` is called, you can get the credentials from the `Client` object.

An example of this is:

```
public boolean canConnect(Client client) {
    Credentials creds = client.getCredentials();

    // No creds supplied, so reject the connection
    if (creds == null) {
        return false;
    }

    String username = creds.getUsername().toLowerCase();
```

If the credentials are null, none were supplied, which is different from empty credentials. If you set the username as an empty string (that is, an anonymous user) the password is not stored and you cannot retrieve it with `getCredentials`.

Clients can connect without credentials and submit them later or replace the credentials at any time whilst connected. The authorization handler is notified when new credentials are submitted and can choose to set the new credentials on the client.

The `Credentials` class has username and password attributes, but also allows for an attachment. It is here that a user normally sets any security object required. Returning true will allow the user to connect, returning false will result in the client connection being refused.

Subscription authorization

Subscription authorization is the allowing of a client to subscribe to a topic. In this case the `canSubscribe` is called. Returning true here allows the publisher to have any topic loaders and subscription methods called. Returning false will not notify the client that the subscription was invalid.

```
public boolean canSubscribe(Client client, Topic topic) {

    // Everyone has access to the top level topic
    if (topic.getName().equals(CHAT_TOPIC)) {
        return true;
    }

    User user = (User) client.getCredentials().attachment();

    return user.isAllowedRoom(topic.getNodeName());
}
```

Authorization handler

Authorization at the publisher level can also be achieved. This is required if there are many publishers running within the same Diffusion Server and they have different security settings. The following code example works if the publishers all implement `AuthorisationHandler`

```
public boolean canSubscribe(Client client, Topic topic) {

    AuthorisationHandler handler =

    (AuthorisationHandler)Publishers.getPublisherForTopic(topic);

    // Call the publisher in question
    return handler.canSubscribe(client, topic);
}
```

Permissions

The permissions process governs whether a client is able to send messages to a publisher, or in other words, is the topic read only. This is handled by the `canWrite` method. Again a good pattern might be to look at the credentials attachment object to see if this is permissible.

```
public boolean canWrite(Client client, Topic topic) {
    User user = (User) client.getClientCredentials().attachment();
    return user.canWriteMessages(topic);
}
```

Related concepts

[Role-based authorization](#) on page 130

Diffusion restricts the ability to perform actions to authorized principals. Roles are used to map permissions to principals.

[Authentication](#) on page 141

You can implement and register handlers to authenticate clients when the clients try to perform operations that require authentication.

Related reference

[Topic ownership](#) on page 147

Topic ownership allows you to grant read, modify and update permissions for a topic to a specific principal. This is useful to provide a 'private' topic for a given user.

Part IV

Developer Guide

This guide describes how to develop clients, publishers, and server-side components that interact with the Diffusion server.

Note: We recommend that you develop clients for most use cases. Our client APIs provide access to the majority of Diffusion capabilities. Publishers and server-side components provide a few advanced features that are not available on clients.

Diffusion clients

The Diffusion client API is a consistent and modular API that provides an asynchronous and session-oriented approach to developing your clients.

The Diffusion client API is available for the following platforms:

- [Java](#)
- [.NET](#)
- [JavaScript](#)
- [Android](#)
- [Apple](#)
- [C](#)

In this section:

- [Best practice for developing clients](#)
- [Feature support in the Diffusion API](#)
- [Getting started](#)
- [Connecting to the Diffusion server](#)
- [Receiving data from topics](#)
- [Managing topics](#)
- [Updating topics](#)
- [Using time series topics](#)
- [Managing subscriptions](#)
- [Using request-response messaging](#)
- [Authenticating new sessions](#)

- Updating the system authentication store
- Updating the security store
- Managing sessions
- Configuring conflation
- Logging from the client
- Developing a publisher
- Developing other components
- Using Maven to build Java Diffusion applications
- Testing

Best practice for developing clients

Follow these best practises to develop resilient and well performing clients.

Use an asynchronous programming model

All calls in the Diffusion API are asynchronous. Ensure that you code your client using asynchronous models to gain the advantages this provides.

Asynchronous calls remove the possibility of your client becoming blocked on a call. The Diffusion API also provides context-specific callbacks, enabling you to pass contextual information with a callback, and a wide range of event notifications.

Write good callbacks

The Diffusion API invokes callbacks using a thread from Diffusion thread pool. Callbacks for a particular session are called in order, one at a time. Consider the following when writing callbacks:

- Do not sleep or call blocking operations in a callback. If you do so, other pending callbacks for the session are delayed. If you must call a blocking operation, schedule it in a separate application thread.
- You can use the full Diffusion API to make other requests to the Diffusion server. If you want to make many requests based on a single callback notification, be aware that Diffusion client flow control is managed differently in callback threads. Less throttling is applied and it is easier to overflow the Diffusion server by issuing many thousands of requests. If you have a lot of requests to make, it is better to schedule the work in an application thread.

Use a modular design

The Diffusion API provides interfaces on a feature-by-feature basis. There is a clear delineation between features. At runtime, the client starts only those services that it uses.

You can take advantage of the modular design of the Diffusion API by designing multiple smaller and more modular control clients. Smaller modules are easier to design, maintain and keep running. Develop separate clients for different control responsibilities. For example, have a client or set of clients responsible for authentication and a different client or set of clients responsible for creating topics.

Also consider separating the responsibility for different parts of the topic tree between clients. For example, have a client or set of clients responsible for updating the Tennis branch of the topic tree and a different client or set of clients responsible for updating the Rugby branch of the topic tree.

Make your client resilient and defensive

If the Diffusion server restarts, all topic information — tree structure and topic state — is removed, all subscription information is removed, and all clients are disconnected. Security and authentication information is persisted.

If your client disconnects and cannot reconnect to the same session, all of its subscriptions and any handlers it has registered are lost.

Ensure that you program your clients to handle and respond to these possibilities.

Feature support in the Diffusion API

Review this information when designing your clients to determine which APIs provide the functionality you require.

Features are sets of capabilities provided by the Diffusion API. Some features are not supported or not fully supported in some APIs.

The Diffusion libraries also provide capabilities that are not exposed through their APIs. Some of these capabilities can be configured.

Table 22: Capabilities provided by the Diffusion client libraries

Capability	JavaScript	Apple	Android	Java	.NET	C
Connecting						
Connect to the Diffusion server	✓	✓	✓	✓	✓	✓
Cascade connection through multiple transports	✓	✗	✓	✓	✗	✗
Connect asynchronously	✓	✓	✓	✓	✓	✓
Connect synchronously	✗	✗	✓	✓	✓	✓
Connect using a URL-style string as a parameter	✗	✓	✓	✓	✓	✓
Connect using individual parameters	✓	✗	✓	✓	✗	✗
Connect securely	✓	✓	✓	✓	✓	✓
Configure SSL context or behavior	✓	✓	✓	✓	✓	✗
Connect through an HTTP proxy	✗	✓	✓	✓	✓	✗
Connect through a load balancer	✓	✓	✓	✓	✓	✓
Pass a request path to a load balancer	✓	✓	✓	✓	✗	✗
Reconnecting						
Reconnect to the Diffusion server	✓	✓	✓	✓	✓	✓

Capability	JavaScript	Apple	Android	Java	.NET	C
Configure a reconnection timeout	✓	✓	✓	✓	✓	✓
Define a custom reconnection strategy	✓	✓	✓	✓	✓	✓
Resynchronize message streams on reconnect	✓	✓	✓	✓	✓	✓
Abort reconnect if resynchronization fails	✓	✓	✓	✓	✓	✗
Maintain a recovery buffer of messages on the client to resend to the Diffusion server on reconnect	✓	✓	✓	✓	✓	✓
Configure the client-side recovery buffer	✗	✓	✓	✓	✓	✗
Detect disconnections by monitoring activity	✓	✓	✓	✓	✓	✓
Detect disconnections by using TCP state	✓	✓	✓	✓	✓	✓
Ping the Diffusion server	✓	✓	✓	✓	✓	✓
Change the principal used by the connected client session	✓	✓	✓	✓	✓	✓
Receiving data from topics						
Subscribe to a topic or set of topics	✓	✓	✓	✓	✓	✓
Receive data as a value stream	✓	✓	✓	✓	✓	✓
Receive data as content	✓	✓	✓	✓	✓	✓
Fetch the state of a topic	✓	✓	✓	✓	✓	✓
Managing topics						
Create a topic	✓	✓	✓	✓	✓	✓

Capability	JavaScript	Apple	Android	Java	.NET	C
Create a slave topic	✓	✓	✓	✓	✓	✓
Create/update/query time series topics	✓	✓	✓	✓	✓	✗
Create a topic from an initial value	✓	✗	✓	✓	✓	✗
Create a topic from a topic specification	✓	✓	✓	✓	✓	✓
Create a topic from topic details	✓	✓	✓	✓	✓	✓
Create a topic with metadata	✓	✓	✓	✓	✓	✓
Listen for topic events (including topic has subscribers and topic has zero subscribers)	✗	✓	✓	✓	✓	✗
Receive topic notifications	✓	✓	✓	✓	✓	✗
Delete a topic	✓	✓	✓	✓	✓	✓
Delete a branch of the topic tree	✓	✓	✓	✓	✓	✓
Set an automatic topic removal policy	✓	✓	✓	✓	✓	✓
Mark a branch of the topic tree for deletion when this client session is closed	✓	✓	✓	✓	✓	✓
Updating topics						
Update a topic	✓	✓	✓	✓	✓	✓
Perform exclusive updates	✓	✓	✓	✓	✓	✓
Perform non-exclusive updates	✓	✓	✓	✓	✓	✗
Managing subscriptions						
Subscribe or unsubscribe another client to a topic	✓	✓	✓	✓	✓	✓

Capability	JavaScript	Apple	Android	Java	.NET	C
Subscribe or unsubscribe another client to a topic based on session properties	✓	✓	✓	✓	✓	✗
Handling subscriptions to routing topics	✓	✗	✓	✓	✓	✗
Handling subscriptions to missing topics	✓	✓	✓	✓	✓	✓
Request-response messaging						
Send a request to a path	✓	✓	✓	✓	✓	✗
Send a request to a client session	✓	✓	✓	✓	✓	✗
Send a request to a set of client sessions based on session properties	✓	✓	✓	✓	✓	✗
Respond to requests sent to a session	✓	✓	✓	✓	✓	✗
Respond to requests sent to a path	✓	✓	✓	✓	✓	✗
One-way messaging						
Send a one-way message to a path	✓	✓	✓	✓	✓	✓
Send a one-way message to a client session	✓	✓	✓	✓	✓	✓
Send a one-way message to a set of client sessions based on session properties	✓	✓	✓	✓	✓	✓
Receive one-way messages	✓	✓	✓	✓	✓	✓
Handle one-way messages sent to a path	✓	✓	✓	✓	✓	✓
Managing security						
Authenticate client sessions and assign	✓	✗	✓	✓	✓	✓

Capability	JavaScript	Apple	Android	Java	.NET	C
roles to client sessions						
Configure how the Diffusion server authenticates client sessions and assign roles to client sessions	✓	✗	✓	✓	✓	✓
Configure the roles assigned to anonymous sessions and named sessions	✓	✗	✓	✓	✓	✓
Configure the permissions associated with roles assigned to client sessions	✓	✗	✓	✓	✓	✓
Grant permissions to a principal using topic ownership	✓	✓	✓	✓	✓	✓
Managing other clients						
Receive notifications about client session events including session properties	✓	✗	✓	✓	✓	✓
Get the properties of a specific client session	✓	✗	✓	✓	✓	✓
Update user-defined session properties of a client session or set of sessions	✗	✗	✓	✓	✓	✗
Receive notifications about client queue events	✗	✗	✓	✓	✓	✗
Conflate and throttle clients	✗	✗	✓	✓	✓	✗
Close a client session	✗	✗	✓	✓	✓	✗
Push notifications (The Push Notification Bridge must be enabled)						
Receive push notifications	✗	✓	✓	✗	✗	✗
Request that push notifications be sent	✓	✓	✓	✓	✓	✓

Capability	JavaScript	Apple	Android	Java	.NET	C
from a topic to a client						
Publish an update to a topic that sends push notifications	✓	✓	✓	✓	✓	✓
Other capabilities						
Flow control	✗	✗	✓	✓	✓	✓

Getting started

Get started developing Diffusion clients by downloading one of our SDKs, discovering its capabilities, and starting to stream realtime data through the Diffusion server.

JavaScript

The JavaScript API is provided in the file `diffusion.js` and can be accessed through the web or through NPM.

Include JavaScript in a web page:

```
<script src="http://download.pushtechology.com/clients/6.1.5/js/diffusion.js"/>
```

This hosted version of the Diffusion JavaScript library is served with GZIP compression enabled. GZIP compression reduces the library to 20% of its uncompressed size and ensuring fast page loads.

Use with Node.js:

Install with npm:

```
npm install diffusion
```

Include in your Node.js application:

```
var diffusion = require('diffusion');
```

You can also download the JavaScript file as a tarball package that can be installed locally by using NPM:

```
http://download.pushtechology.com/clients/6.1.5/js/diffusion-js-6.1.5.tgz
```

Get the minified JavaScript:

Download the latest JavaScript file from the following URL:

```
http://download.pushtechology.com/clients/6.1.5/js/diffusion.js
```

The JavaScript file is also located in your Diffusion server installation:

```
diffusion_directory/clients/js
```

The Diffusion JavaScript client library is a full featured library and as such is provided as a large download file. However, when served with GZIP compression, the size of the served file is significantly smaller than the size of the downloaded file. Ensure that you enable GZIP compression on the web server that hosts the JavaScript client library.

The minified version of the JavaScript client library is approximately 70% of the size of the unminified version.

Get the unminified JavaScript:

Download the latest unminified JavaScript client library from the following URL:

```
http://download.pushtechnology.com/clients/6.1.5/js/diffusion-unminified.js
```

The unminified JavaScript file is also located in your Diffusion server installation:

```
diffusion_directory/clients/js
```

The minified version of the Diffusion JavaScript client library is created with [Browserify](#). The minified version might not be compatible with certain JavaScript frameworks. This unminified version is provided to enable you to include Diffusion in projects using any framework.

The unminified form of JavaScript client library also gives you the option to perform minification of your whole client application and make further size savings.

Use TypeScript definitions with the JavaScript client library:

If you got the JavaScript client library using NPM, the TypeScript definitions are included.

You can also download a TypeScript definition file from the following URL:

```
http://download.pushtechnology.com/clients/6.1.5/js/diffusion-6.1.5.d.ts
```

The TypeScript file is also located in your Diffusion server installation:

```
diffusion_directory/clients/js
```

Include the TypeScript definition file in your IDE project to use the TypeScript definitions when developing a JavaScript client for Diffusion.

Use with webpack

The JavaScript npm client supports the use of webpack and has been tested with webpack 4.16.2.

Targeting Node.js with webpack

When targeting Node.js with webpack, to avoid a dependency issue, add this line to `webpack.config.js`:

```
plugins: [ new webpack.IgnorePlugin(/vertx/) ]
```

Ensure that at the top of `webpack.config.js` you have:

```
const webpack = require('webpack');
```

Capabilities

To see the full list of capabilities supported by the JavaScript API, see [Feature support in the Diffusion API](#) on page 37.

Support

For information about the browsers supported by the Diffusion JavaScript client, see [Browser support](#) on page 44.

Table 23: Supported platforms and transport protocols for the client libraries

Platform	Minimum supported versions	Supported transport protocols
JavaScript	es6 (TypeScript 1.8)	WebSocket HTTP (Polling XHR)

Resources

- [Examples for the JavaScript API.](#)
- [JavaScript API documentation](#)

Using

Promises

The Diffusion JavaScript API uses the [Promises/A+](#) specification.

Views

The JavaScript API provides a view capability.

Use views to subscribe to multiple topics by using a topic selector and receive all the data from all topics in the selector set as a single structure when any of the topics are updated. If the topic selector matches a topic which is subsequently added or removed, the view is updated.

The following example shows views being used to present data from multiple topics as a single structure:

```
diffusion.connect({
  host      : 'localhost',
  port     : 8080,
  secure   : false,
  principal : 'control',
  credentials : 'password'
}).then(function(session) {

  // Assuming a topic tree:
  //
  // scores
  //   |-- football
  //   |-- semi1
  //   |-- semi2
```

```

//      |      |-- final
//      |
//      |-- tennis
//          |-- semi1
//          |-- semi2
//          |-- final

// Use a regular expression to create a view of the
topics tracking the
// scores during the finals for each sport.
var view = session.view('?scores/.*/final');

// Alternatively, we can use a topic set. Note that
the topics do not need
// to be under a common root, they may be anywhere
within the topic tree.
var view2 = session.view('#>scores/football/final////
>scores/tennis/final');

// If any of the topics in the view change, display
which topic changed
// and its new value.
view.on({
  update : function(value) {
    // Get and print the entire view structure.
    console.log('Update: ', JSON.stringify(value,
undefined, 4));

    // Get individual topics. Returns a Buffer,
which is automatically
    // converted to a String during
concatenation, below.
    //
    // Note that the structure may not exist if
the value has not been
    // updated.
    console.log('Football score: ' +
value.scores.football.final);
    console.log('Tennis score : ' +
value.scores.tennis.final);

    // or ...
    // console.log('Football score: ' +
value['scores']['football']['final']);
  }
});

// The structure can also be accessed outside the
update event.
console.log('Football score: ' +
view.get().scores.football.final);
});

```

Regular expressions

The JavaScript client uses a different regular expression engine to the Diffusion server. Some regular expressions in topic selectors are evaluated on the client and others on the Diffusion server. It is possible that topic selectors that include complex or advanced regular expressions can behave differently on the client and on the Diffusion server.

For more information, see [Regular expressions](#) on page 55.

Start subscribing with JavaScript

Create a JavaScript browser client within minutes that connects to the Diffusion server. This example creates a web page that automatically updates and displays the value of a topic.

Before you begin

To complete this example, you need a Diffusion server and a web server where you can host your client application. Get the `diffusion.js` file from the `clients/js` directory of your Diffusion

You also require either a named user that has a role with the `select_topic` and `read_topic` permissions or that anonymous client connections are assigned a role with the `select_topic` and `read_topic` permissions. For example, the “CLIENT” role. For more information about roles and permissions, see [Role-based authorization](#) on page 130.

About this task

This example steps through the lines of code required to subscribe to a topic. There are several different [topic types](#) which provide data in different formats. This example shows you how to subscribe to a JSON topic. The [full code example](#) is provided after the steps.

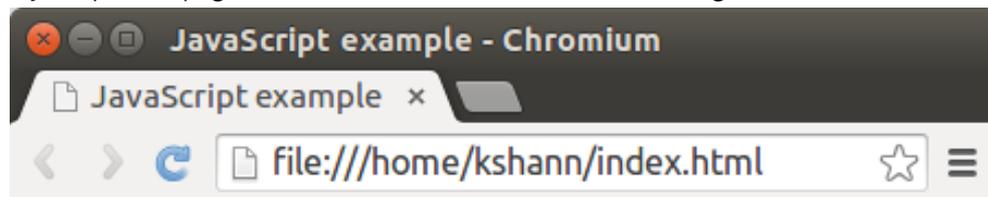
Procedure

1. Create a template HTML page which displays the information.

For example, create the following `index.html` file.

```
<html>
  <head>
    <title>JavaScript example</title>
  </head>
  <body>
    <span>The value of foo/counter is: </span>
    <span id="display"></span>
  </body>
</html>
```

If you open the page in a web browser, it looks like the following screenshot:



The value of foo/counter is: Unknown

2. Include the Diffusion JavaScript library in the `<head>` section of your `index.html` file.

```
<head>
  <title>JavaScript example</title>
```

```

        <script type="text/javascript" src="path_to_library/
diffusion.js"></script>
</head>

```

3. Create a connection from the page to the Diffusion server. Add a script element to the body element.

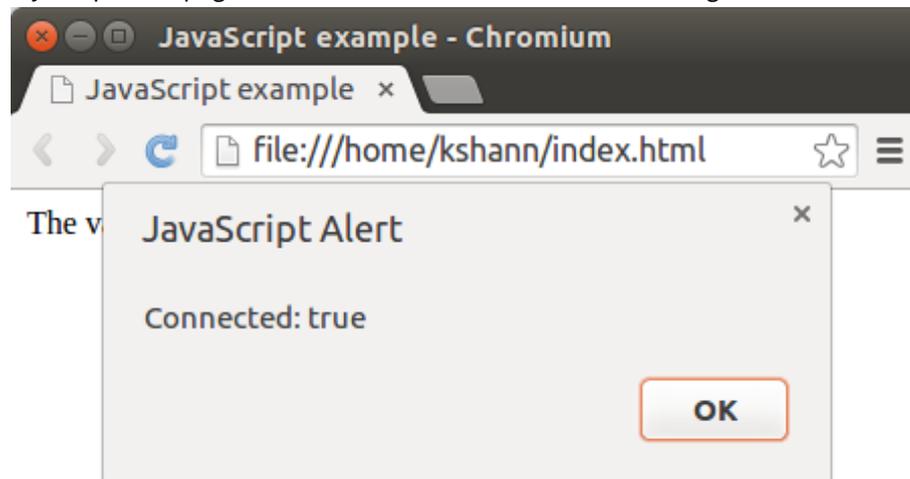
```

<body>
  <span>The value of foo/counter is: </span>
  <span id="display"></span>
  <script type="text/javascript">
    diffusion.connect({
      // Edit these lines to include the host and port of
your Diffusion server
      host : 'hostname',
      port : 'port',
      // To connect anonymously you can leave out the
following parameters
      principal : 'user',
      credentials : 'password'
    }).then(function(session) {
      alert('Connected: ' + session.isConnected());
    }
  );
</script>
</body>

```

Where *hostname* is the name of the system hosting your Diffusion server, *user* is the name of a user with the permissions required to subscribe to a topic, and *password* is the user's password.

If you open the page in a web browser it looks like the following screenshot:



4. Add a value stream that matches the topic path and wire it to log the received values, then subscribe to the topic.

Add the following after the `diffusion.connect()` call:

```

    .then(function(session) {
      session
        .addStream('foo/counter', diffusion.datatypes.double())
        .on('value', function(topic, specification, newValue, oldValue)
        {
          console.log("Update for " + topic, newValue);
          document.getElementById('display').innerHTML =
newValue;
        }
    );

```

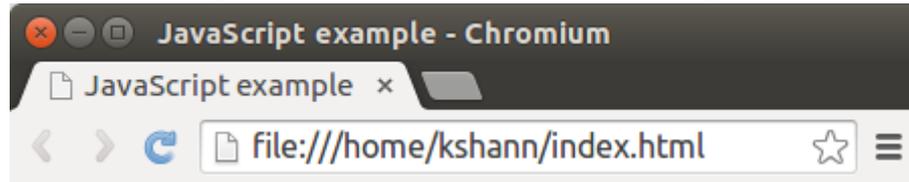
```
    session.select('foo/counter');
  });
```

The `subscribe()` method of the `session` object takes the name of the topic to subscribe to and emits an update event. The attached function takes the data from the topic and updates the update element of the web page with the topic data.

5. Change the function that is called on connection to the `subscribeToJsonTopic` function you just created.

```
.then(subscribeToJsonTopic);
```

If you open the page in a web browser it looks like the following screenshot:



The value of `foo/counter` is: 27

Results

The web page is updated every time the value of the `foo/counter` topic is updated. You can update the value of the `foo/counter` topic by creating a publishing client to update the topic. To create and publish to the `foo/counter` topic, you require a user with the `modify_topic` and `update_topic` permissions. For more information, see [Start publishing with JavaScript](#) on page 167.

Example

The completed `index.html` file contains the following code:

```
<html>
<head>
  <title>JavaScript example</title>
  <script type="text/javascript" src="path_to_library/
diffusion.js"/></script>

</head>
<body>
  <p>The value of foo/counter is: <span id="display"></span></p>
  <script type="text/javascript">

    diffusion.connect({
      // Edit these lines to include the host and port of
your Diffusion server
      host : 'hostname',
      port : 'port',
```

```

        // To connect anonymously you can leave out the
        following parameters
        principal : 'user',
        credentials : 'password'
    }).then(function(session) {
        // Add a value stream that matches the topic path and
        wire it to log the received values
        session
            .addStream('foo/counter',
diffusion.datatypes.double())
            .on('value', function(topic, specification,
newValue, oldValue) {
                console.log("Update for " + topic, newValue);

                document.getElementById('display').innerHTML =
newValue;
            });

        // Subscribe to the topic
        session.select('foo/counter');
    });

</script>
</body>
</html>

```

Start publishing with JavaScript

Create a Node.js client that publishes data through topics on the Diffusion server.

Before you begin

To complete this example, you need a Diffusion server and a development system with [Node.js](#) and [npm](#) installed on it.

You also require either a named user that has a role with the `modify_topic` and `update_topic` permissions. For example, the “ADMINISTRATOR” role. For more information about roles and permissions, see [Role-based authorization](#) on page 130.

About this task

This example steps through the lines of code required to publish to a topic. There are several different [topic types](#) which provide data in different formats. This example shows you how to publish to a JSON topic. The full code example is provided after the steps.

Procedure

1. Install the Diffusion JavaScript library on your development system.

```
npm install --save diffusion
```

2. Create the JavaScript file that will be your publishing client.

For example, `publishing.js`

- a) Require the Diffusion library.

```
const diffusion = require('diffusion');
```

b) Connect to the Diffusion server.

```
diffusion.connect({
  host : 'host-name',
  principal : 'control-user',
  credentials : 'password'
}).then(function(session) {
  console.log('Connected!');
});
```

Where *host-name* is the name of the system that hosts your Diffusion server, *control-user* is the name of a user with the permissions required to create and update topics, and *password* is the user's password.

c) Create a JSON topic called `foo/counter`.

```
session.topics.add("foo/counter",
  diffusion.topics.TopicType.JSON);
```

d) Every second update the value of the topic with the value of the counter.

```
setInterval(function() {
  session.topics.update('foo/counter', { count : i
  ++ });
}, 1000);
```

3. Use Node.js to run your publishing client from the command line.

```
node publishing.js
```

Results

The publisher updates the value of the `foo/counter` topic every second. You can watch the topic value being updated by subscribing to the topic.

- You can use the example subscribing client from [Start subscribing with JavaScript](#) on page 164 to subscribe to `foo/counter` and output the value on a web page.

Example

The completed `publishing.js` file contains the following code:

```
const diffusion = require('diffusion');

diffusion.connect({
  host : 'hostname',
  principal : 'control-user',
  credentials : 'password'
}).then(function(session) {
  console.log('Connected!');

  var i = 0;

  // Create a JSON topic
  session.topics.add("foo/counter",
diffusion.topics.TopicType.JSON);

  // Start updating the topic every second
  setInterval(function() {

    session.topics.update("foo/counter", { count : i++ });
```

```
    }, 1000);  
  });
```

What to do next

Now that you have the outline of a publisher, you can use it to publish your own data instead of a counter.

Apple

The Apple SDK is provided for iOS, OS X/macOS, and tvOS.

Get the Apple SDK for iOS:

Download the SDK from the following URL:

```
http://download.pushtechnology.com/clients/6.1.5/apple/diffusion-iphoneos-6.1.5.zip
```

The SDK file is also located in your Diffusion server installation:

```
diffusion_directory/clients/apple/diffusion-iphoneos-6.1.5.zip
```

Get the Apple SDK for OS X/macOS:

Download the SDK from the following URL:

```
http://download.pushtechnology.com/clients/6.1.5/apple/diffusion-macosx-6.1.5.zip
```

The SDK file is also located in your Diffusion server installation:

```
diffusion_directory/clients/apple/diffusion-macosx-6.1.5.zip
```

Get the Apple SDK for tvOS:

Download the SDK from the following URL:

```
http://download.pushtechnology.com/clients/6.1.5/apple/diffusion-appletvos-6.1.5.zip
```

The SDK file is also located in your Diffusion server installation:

```
diffusion_directory/clients/apple/diffusion-appletvos-6.1.5.zip
```

Capabilities

To see the full list of capabilities supported by the Apple API, see [Feature support in the Diffusion API](#) on page 37.

Support

Table 24: Supported platforms and transport protocols for the client libraries

Platform	Minimum supported versions	Supported transport protocols
Apple for iOS	<p>Development environment</p> <p>Xcode 8 (iOS 10.0 SDK)</p> <p>Runtime support</p> <p>Deployment target: iOS 8.1 or later</p> <p>Device architectures: armv7, armv7s, arm64</p> <p>Simulator architectures: i386, x86_64</p>	WebSocket
Apple for OS X/macOS	<p>Development environment</p> <p>Xcode 8 (OS X/macOS 10.12 SDK)</p> <p>Runtime support</p> <p>Deployment target: OS X/macOS 10.11 or later</p> <p>Device architectures: x86_64</p>	WebSocket
Apple for tvOS	<p>Development environment</p> <p>Xcode 8 (tvOS 10.0 SDK)</p> <p>Runtime support</p>	WebSocket

Platform	Minimum supported versions	Supported transport protocols
	Deployment target: tvOS 9.0 or later Device architectures: arm64 Simulator architectures: x86_64	

Resources

- [Objective-C examples for the Apple API.](#)
- [Apple API documentation](#)

Using

Applications in background state

Apple applications can be sent to the background. When this happens your application is notified by the `applicationDidEnterBackground` callback. Applications go into background state before being suspended.

Applications can be sent to the background or suspended at any time. We recommend that your Diffusion app saves its state – in particular, any topic subscriptions – as this state changes.

When your Diffusion app is sent to the background, we recommend the client closes its session with the Diffusion server. When the Diffusion app returns to the foreground, it can open a new client session with the Diffusion server and use the saved state to restore topic subscriptions.

For more information, see [the Apple App Life Cycle documentation](#) and [Strategies for Handling App State Transitions](#).

Consider using push notifications to deliver data to your users when your client application is in background state.

Regular expressions

The Apple client uses a different regular expression engine to the Diffusion server. Some regular expressions in topic selectors are evaluated on the client and others on the Diffusion server. It is possible that topic selectors that include complex or advanced regular expressions can behave differently on the client and on the Diffusion server.

For more information, see [Regular expressions](#) on page 55.

Start subscribing with iOS

Create an Objective-C iOS client within minutes that connects to the Diffusion server. This example creates a client that prints the value of a topic to the console when the topic is updated.

Before you begin

To complete this example, you need Apple's Xcode installed on your development system and a Diffusion server.

You also require either a named user that has a role with the `select_topic` and `read_topic` permissions or that anonymous client connections are assigned a role with the `select_topic` and `read_topic` permissions. For example, the “CLIENT” role. For more information about roles and permissions, see [Role-based authorization](#) on page 130.

About this task

This example steps through the lines of code required to subscribe to a topic and was created using Xcode version 7.1 and the Diffusion dynamically linked framework targeted at iOS 8.

[Skip to the full example.](#)

Procedure

1. Get the Diffusion Apple SDK for iOS.

The `diffusion-iphoneos-version.zip` file is located in the `clients` directory of your Diffusion installation.

This example uses the iOS framework provided in `diffusion-iphoneos-version.zip`. Frameworks are also available for OS X/macOS-targeted development in `diffusion-macosx-version.zip` and tvOS-targeted development in `diffusion-tvos-version.zip`.

2. Extract the contents of the `diffusion-iphoneos-version.zip` file to your preferred location for third-party SDKs for use within Xcode.

For example, `~/Documents/code/SDKs/diffusion-iphoneos-version`.

3. Create a new project in Xcode.

- a) From the **File** menu, select **New > Project...**

The **Choose a template for your new project** wizard opens.

- b) Select **iOS > Application** on the left.
- c) Select **Single View Application** on the right and click **Next**.

Xcode prompts you to **Choose options for your new project**.

- d) Configure your project appropriately for your requirements.

Select **Objective-C** as the **Language**.

For example, use the following values:

- **Product Name:** `TestClient`
- **Language:** `Objective-C`
- **Devices:** `Universal`

For this example, it is not necessary to select **Use Core Data**, **Include Unit Tests**, or **Include UI Tests**.

- e) Click the **Next** button.

Xcode prompts you to select a destination directory for your new project.

- f) Select a target directory.

For example: `~/Documents/code/`

- g) Click the **Create** button.

Xcode creates a new project that contains the required files.

4. Import the Diffusion framework, `Diffusion.framework`, into Xcode.
 - a) From the **View** menu, select **Navigators > Show Project Navigator**
 - b) Select the root node of the project in the **Project Navigator** in the left sidebar.

The project editor opens in the main panel.
 - c) In the project editor, click on the project name at the top left and select **Targets > TestClient**.

The target editor opens in the main panel.
 - d) In the target editor, select the **General** tab.
 - e) Expand the **Embedded Binaries** section and click the **+** icon (Add Items).

The **Choose items to add** wizard opens.
 - f) Click the **Add Other...** button.
 - g) Navigate to the location of the expanded `Diffusion.framework` SDK for iOS8 and click **Open**.

Xcode prompts you to choose options for adding these files.
 - h) Select the options you require for adding the files and click **Finish**

Unless you require different options, use the following values:

- Do not select **Copy items if needed**.
- Select **Create groups**.

5. Make the framework visible to your code.

Despite the framework now appearing under both **Embedded Binaries** and **Linked Frameworks and Libraries**, it is still necessary to tell Xcode where the header files for the framework can be found.

 - a) Select the **Build Settings** tab in the target editor.

You can also do this at project level if you prefer and depending on your requirements.
 - b) Click on **All** to display All Build Settings.
 - c) Expand the **Search Paths** section.
 - d) Expand the **Framework Search Paths** section and click the **+** icon next to **Release**.

Add the absolute path to the `iOS8` directory that contains `Diffusion.framework`.

Note: Ensure that you use the path to the directory, not to the `Diffusion.framework` file. Linking to the file causes a silent failure.

6. Import the Diffusion module into the `ViewController.h` file.

```
@import Diffusion;
```

7. In the `ViewController.m` file, create a connection to the Diffusion server.

- a) Define a long-lived session property.

Add the session instance to the class extension to maintain a strong reference to the session instance:

```
@interface ViewController ()
@property PTDiffusionSession* session;
@end
```

The strong reference ensures that once the session instance has been opened, it remains open.

- b) Open a session connection to the Diffusion server.

This example opens the session when the view controller loads.

```
- (void)viewDidLoad {
    [super viewDidLoad];
```

```

NSLog(@"Connecting...");

// Connect anonymously.
// Replace 'hostname' with that of your server.
[PTDiffusionSession openWithURL:[NSURL
URLWithString:@"ws://hostname"]
completionHandler:^(PTDiffusionSession
*session, NSError *error)
{
    if (!session) {
        NSLog(@"Failed to open session: %@", error);
        return;
    }

    // At this point we now have a connected session.
    NSLog(@"Connected.");

    // Maintain strong reference to session instance.
    self.session = session;
}]];
}

```

Replace *hostname* with the host name of your Diffusion server.

8. Subscribe to a topic.

- a) In the `ViewController.h` file, conform to the topic stream delegate protocol.

In this example, the single view controller class handles topic stream update messages.

```

@interface ViewController : UIViewController
<PTDiffusionTopicStreamDelegate>

```

- b) In the `ViewController.h` file, create a `UILabel` control.

Add a label to your user interface and bind it to an outlet in the view controller:

```

@property(nonatomic) IBOutlet UILabel *counterLabel;

```

This label is used to display the value of the topic as it updates.

- c) In the `ViewController.m` file, implement the topic stream update method.

This is a required method in the topic stream delegate protocol.

```

-(void)diffusionStream:(PTDiffusionStream *)stream
didUpdateTopicPath:(NSString *)topicPath
content:(PTDiffusionContent *)content
context:(PTDiffusionUpdateContext *)context {
    // Interpret the received content's data as a string.
    NSString *counterString = [[NSString alloc]
initWithData:content.data
encoding:NSUTF8StringEncoding];

    // Diffusion sends messages to delegates on the main
dispatch queue so it's
// safe to update the user interface here.
self.counterLabel.text = counterString;
}

```

- d) In the `ViewController.h` file, within the session's `completionHandler` callback, register with the Topics feature as the fallback topic stream handler.

```
[session.topics addFallbackTopicStreamWithDelegate:self];
```

- e) Next, request that the Diffusion server subscribe your session to the `foo/counter` topic.

```
[session.topics subscribeWithTopicSelectorExpression:@"foo/counter"
completionHandler:^(NSError *error)
{
    if (error) {
        NSLog(@"Subscribe request failed. Error: %@",
error);
    } else {
        NSLog(@"Subscribe request succeeded.");
    }
}];
```

9. Build and Run.

Results

The client app updates the label every time the value of the `foo/counter` topic is updated. You can update the value of the `foo/counter` topic by creating a publishing client to update the topic. To create and publish to the `foo/counter` topic, you require a user with the `modify_topic` and `update_topic` permissions. For more information, see [Start publishing with OS X/macOS](#) on page 177.

Full example

The completed view controller implementation for the subscribing client contains the following code.

`ViewController.h`:

```
@import UIKit;

@interface ViewController : UIViewController
<PTDiffusionTopicStreamDelegate>
@property(n nonatomic) IBOutlet UILabel *counterLabel;
@end
```

`ViewController.m`:

```
#import "ViewController.h"

@interface ViewController ()
@property PTDiffusionSession* session;
@end

@implementation ViewController

- (void)viewDidLoad {
    [super viewDidLoad];

    NSLog(@"Connecting...");

    // Connect anonymously.
    // Replace 'hostname' with that of your server.
```

```

[PTDiffusionSession openWithURL:[NSURL
URLWithString:@"ws://hostname"]
completionHandler:^(PTDiffusionSession *session,
NSError *error)
{
    if (!session) {
        NSLog(@"Failed to open session: %@", error);
        return;
    }

    // At this point we now have a connected session.
    NSLog(@"Connected.");

    // Maintain strong reference to session instance.
    self.session = session;

    // Register self as the fallback handler for topic
updates.
    [session.topics addFallbackTopicStreamWithDelegate:self];

    NSLog(@"Subscribing...");
    [session.topics
subscribeWithTopicSelectorExpression:@"foo/counter"
completionHandler:^(NSError *error)
    {
        if (error) {
            NSLog(@"Subscribe request failed. Error: %@",
error);
        } else {
            NSLog(@"Subscribe request succeeded.");
        }
    }];
}];
}

-(void)diffusionStream:(PTDiffusionStream *)stream
didUpdateTopicPath:(NSString *)topicPath
content:(PTDiffusionContent *)content
context:(PTDiffusionUpdateContext *)context {
    // Interpret the received content's data as a string.
    NSString *counterString = [[NSString alloc]
initWithData:content.data
encoding:NSUTF8StringEncoding];

    // Diffusion sends messages to delegates on the main dispatch
queue so it's
    // safe to update the user interface here.
    self.counterLabel.text = counterString;
}

@end

```

Start publishing with OS X/macOS

Create an OS X/macOS client that publishes data through topics on the Diffusion server.

Before you begin

To complete this example, you need Apple's Xcode installed on your development system and a Diffusion server.

You also require a named user that has a role with the `modify_topic` and `update_topic` permissions. For example, the “`TOPIC_CONTROL`” role. For more information about roles and permissions, see [Role-based authorization](#) on page 130.

About this task

This example steps through the lines of code required to create and publish to a topic and was created using Xcode version 7.1 and the Diffusion dynamically linked framework targeted at OS X/macOS.

[Skip to the full example.](#)

Procedure

1. Get the Diffusion Apple SDK for OS X/macOS.

The `diffusion-macosx-version.zip` file is located in the `clients` directory of your Diffusion installation.

This example uses the OS X/macOS framework provided in `diffusion-macosx-version.zip`. Frameworks are also available for iOS-targeted development in `diffusion-iphonios-version.zip` and tvOS-targeted development in `diffusion-tvos-version.zip`.

2. Extract the contents of the `diffusion-macosx-version.zip` file to your preferred location for third-party SDKs for use within Xcode.

For example, `~/Documents/code/SDKs/diffusion-macosx-version`.

3. Create a new project in Xcode.

- a) From the **File** menu, select **New > Project...**

The **Choose a template for your new project** wizard opens.

- b) Select **OS X > Application** on the left.
- c) Select **Command Line Tool** on the right and click **Next**.

Xcode prompts you to **Choose options for your new project**.

- d) Configure your project appropriately for your requirements.

Select **Objective-C** as the **Language**.

For example, use the following values:

- **Product Name:** CounterPublisher
- **Language:** Objective-C

- e) Click the **Next** button.

Xcode prompts you to select a destination directory for your new project.

- f) Select a target directory.

For example: `~/Documents/code/`

- g) Click the **Create** button.

Xcode creates a new project that contains the required files.

4. Link to the Diffusion framework.

For more information, see the Xcode documentation <http://help.apple.com/xcode/mac/8.1/#/dev51a648b07>.

5. Create a `CounterPublisher.h` file.
 - a) Bring up the context menu for the root node of the project in the **Project Navigator** in the left sidebar.
 - Select **New File**
 - b) In the dialog that opens, select **Header File**
 - c) Name the header file `CounterPublisher.h` and click **Create**.

6. Import the `Foundation` module into the `CounterPublisher.h` file.

```
@import Foundation;
```

7. Define the `CounterPublisher` interface in the `CounterPublisher.h` file.

```
@interface CounterPublisher : NSObject
- (void)startWithURL:(NSURL *)url;
@end
```

8. Create a `CounterPublisher.m` file.
 - a) Bring up the context menu for the root node of the project in the **Project Navigator** in the left sidebar.
 - Select **New File**
 - b) In the dialog that opens, select **Objective-C File**
 - c) Name the file `CounterPublisher.m` and click **Create**.

9. In the `CounterPublisher.m` file, import the required modules and set up properties and variables.

- a) Import `Diffusion` and `CounterPublisher.h`

```
#import "CounterPublisher.h"
#import Diffusion;
```

- b) Define a long-lived session property.

Add the session instance to the class extension to maintain a strong reference to the session instance:

```
@interface CounterPublisher ()
@property(nonatomic) PTDiffusionSession* session;
@end
```

The strong reference ensures that once the session instance has been opened, it remains open.

- c) Declare an integer `_counter` to hold the value to publish to the topic.

```
@implementation CounterPublisher {
    NSInteger _counter;
}
```

- d) Define the topic path of the topic to create and publish to.

```
static NSString *const _TopicPath = @"foo/counter";
```

10. In the `CounterPublisher.m` file, create a method that starts the session with the `Diffusion` server.

- a) Call the method `startWithURL` and give it a signature that matches that defined in `CounterPublisher.h`

```
-(void)startWithURL:(NSURL *)url {
```

```
}
```

- b) Inside the method, define the security principal and credentials that the client uses to connect.

```
PTDiffusionCredentials *credentials =  
    [[PTDiffusionCredentials alloc]  
     initWithPassword:@"password"];  
PTDiffusionSessionConfiguration *sessionConfiguration =  
    [[PTDiffusionSessionConfiguration alloc]  
     initWithPrincipal:@"principal"  
     credentials:credentials];
```

Replace *principal* and *password* with the username and password to connect to the Diffusion server with. This user must have sufficient permissions to create and update the topic, for example, by being assigned the “TOPIC_CONTROL” role.

- c) Open a session on the Diffusion server.

```
[PTDiffusionSession openWithURL:url  
                    configuration:sessionConfiguration  
                    completionHandler:^(PTDiffusionSession  
*session, NSError *error)  
    {  
        if (!session) {  
            NSLog(@"Failed to open session: %@", error);  
            return;  
        }  
  
        // At this point we now have a connected session.  
        NSLog(@"Connected.");  
  
        // Maintain strong reference to session instance.  
        self.session = session;  
  
        // Next step  
  
    }];
```

11. Create a topic.

After connecting a session and creating a strong reference to it, use `session.topicControl` to create a topic:

```
// Send request to add topic for publishing to.  
[session.topicControl addWithTopicPath:_TopicPath  
                      type:PTDiffusionTopicType_SingleValue  
                      value:nil  
                      completionHandler:^(NSError *error)  
    {  
        if (error) {  
            NSLog(@"Failed to add topic: %@", error);  
            return;  
        }  
  
        // Next step  
  
    }];
```

12. Update the topic.

- a) After successfully creating the topic, call the `updateCounter` method:

```
[self updateCounter];
```

- b) At the top-level of the `CounterPublisher.m` file, define the `updateCounter` method:

```
-(void)updateCounter {
    // Get the updater to be used for non-exclusive topic
    updates.
    PTDiffusionTopicUpdater *updater =
    self.session.topicUpdateControl.updater;

    // Format string content for the update.
    NSString *string = [NSString stringWithFormat:@"%lu",
    (unsigned long)_counter++];
    NSData *data = [string
    dataUsingEncoding:NSUTF8StringEncoding];
    PTDiffusionContent *content = [[PTDiffusionContent alloc]
    initWithData:data];

    // Send request to update topic.
    NSLog(@"Updating: %@", string);
    [updater updateWithTopicPath:_TopicPath
    value:content
    completionHandler:^(NSError *error)
    {
        if (error) {
            NSLog(@"Failed to update topic: %@", error);
        }
    }];

    // Schedule another update in one second's time.
    __weak CounterPublisher *const weakSelf = self;
    dispatch_after(dispatch_time(DISPATCH_TIME_NOW, (int64_t)(1.0
    * NSEC_PER_SEC)),
    dispatch_get_main_queue(), ^
    {
        [weakSelf updateCounter];
    });
}
```

This method recursively calls itself via a weak reference to `self`.

- 13.** In the `main.m`, add the code needed to run your publishing client from the command line:

- a) Import the `Foundation` module and the `CounterPublisher.h` file.

```
@import Foundation;
#import "CounterPublisher.h"
```

- b) In a `main` method, create a `CounterPublisher` and call its `startWithURL` method:

```
int main(int argc, const char * argv[]) {
    @autoreleasepool {
        CounterPublisher *const publisher = [CounterPublisher
        new];
        NSURL *const url = [NSURL
        URLWithString:@"wss://hostname"];
        [publisher startWithURL:url];

        // Run in an infinite Loop.
        [[NSRunLoop currentRunLoop] run];
    }
}
```

```
        return 0;
    }
```

Replace *hostname* with the host name of your Diffusion server.

14. Build and Run.

Results

The client publishes a value to the `foo/counter` topic every second. You can subscribe to the `foo/counter` topic by creating a client to subscribe to the topic. For more information, see [Start subscribing with iOS](#) on page 172.

Full example

The completed implementation of the publishing client files contain the following code:

main.m:

```
@import Foundation;
#import "CounterPublisher.h"

/**
 Wrapper around the counter publisher example class demonstrating
 how it can
 be launched as a command line tool.
 */
int main(int argc, const char * argv[]) {
    @autoreleasepool {
        CounterPublisher *const publisher = [CounterPublisher
new];
        NSURL *const url = [NSURL
URLWithString:@"wss://hostname"];
        [publisher startWithURL:url];

        // Run, Infinite Loop.
        [[NSRunLoop currentRunLoop] run];
    }
    return 0;
}
```

CounterPublisher.h:

```
@import Foundation;

@interface CounterPublisher : NSObject

-(void)startWithURL:(NSURL *)url;

@end
```

CounterPublisher.m:

```
@import Diffusion;

@interface CounterPublisher ()
@property(nonatomic) PTDiffusionSession* session;
@end

@implementation CounterPublisher {
    NSInteger _counter;
```

```

}

@synthesize session = _session;

static NSString *const _TopicPath = @"foo/counter";

-(void)startWithURL:(NSURL *)url {
    NSLog(@"Connecting...");

    // Connect with control client credentials.
    PTDiffusionCredentials *credentials =
        [[PTDiffusionCredentials alloc]
         initWithPassword:@"password"];
    PTDiffusionSessionConfiguration *sessionConfiguration =
        [[PTDiffusionSessionConfiguration alloc]
         initWithPrincipal:@"principal"
         credentials:credentials];

    [PTDiffusionSession openWithURL:url
                        configuration:sessionConfiguration
                        completionHandler:^(PTDiffusionSession *session,
NSError *error)
    {
        if (!session) {
            NSLog(@"Failed to open session: %@", error);
            return;
        }

        // At this point we now have a connected session.
        NSLog(@"Connected.");

        // Maintain strong reference to session instance.
        self.session = session;

        // Send request to add topic for publishing to.
        [session.topicControl addWithTopicPath:_TopicPath
                                type:PTDiffusionTopicType_SingleValue
                                value:nil
                                completionHandler:^(NSError *error)
        {
            if (error) {
                NSLog(@"Failed to add topic: %@", error);
                return;
            }

            // At this point we now have a topic.
            [self updateCounter];
        }]];
    }];
}

-(void)updateCounter {
    // Get the updater to be used for non-exclusive topic updates.
    PTDiffusionTopicUpdater *updater =
        self.session.topicUpdateControl.updater;

    // Format string content for the update.
    NSString *string = [NSString stringWithFormat:@"%lu",
        (unsigned long)_counter++];
    NSData *data = [string
        dataUsingEncoding:NSUTF8StringEncoding];
}

```

```

PTDiffusionContent *content = [[PTDiffusionContent alloc]
initWithData:data];

// Send request to update topic.
NSLog(@"Updating: %@", string);
[updater updateWithTopicPath:_TopicPath
                        value:content
                    completionHandler:^(NSError *error)
    {
        if (error) {
            NSLog(@"Failed to update topic: %@", error);
        }
    }];

// Schedule another update in one second's time.
__weak CounterPublisher *const weakSelf = self;
dispatch_after(dispatch_time(DISPATCH_TIME_NOW, (int64_t)(1.0 *
NSEC_PER_SEC)),
                dispatch_get_main_queue(), ^
    {
        [weakSelf updateCounter];
    });
}

@end

```

Start subscribing with Swift on iOS

Create a client that connects to the Diffusion server. This example uses Swift to create a client and subscribe to a string topic.

Before you begin

To use this example, you need Apple's Xcode installed on your development system and a Diffusion server.

You also require that anonymous client connections to the server are assigned a role with the `select_topic` and `read_topic` permissions. For example, the "CLIENT" role. For more information about roles and permissions, see [Role-based authorization](#) on page 130.

Results

This simple subscribing example connects to the Diffusion server. It then adds a local fallback string value stream on which to receive notifications regarding updates, followed by sending a request to Diffusion to subscribe to a topic.

You will need a caller to instantiate a new `SimpleSubscriber` instance and then call `publish()`.

Full example

SimpleSubscriber.swift

```

import Foundation
import Diffusion

let url = NSURL(string: "wss://host_name")

class SimpleSubscriber: PTDiffusionStringValueStreamDelegate {
    var session: PTDiffusionSession?

```

```

func subscribe() {
    // Connect to Diffusion Cloud
    PTDiffusionSession.open(with: url! as URL) { (session,
error) -> Void in
        self.session = session; // maintain strong reference
to session

        // Add a new stream
        let stream =
PTDiffusionPrimitive.stringValueStream(with: self)
        session!.topics.addFallbackStream(stream)

        // Subscribe to the topic
        session!.topics.subscribe(
withTopicSelectorExpression: "example/topic")
{ (error) -> Void in }
    }

    func diffusionStream(_ stream: PTDiffusionStream,
didSubscribeToTopicPath topicPath:
String,
                        specification:
PTDiffusionTopicSpecification) {
        print("Subscribed: \(topicPath)")
    }

    func diffusionStream(_ stream: PTDiffusionValueStream,
didUpdateTopicPath topicPath: String,
specification:
PTDiffusionTopicSpecification,
oldString: String?,
newString: String?) {
        print("Update: \(String(describing: newString))")
    }

    func diffusionStream(_ stream: PTDiffusionStream,
didUnsubscribeFromTopicPath topicPath:
String,
                        specification:
PTDiffusionTopicSpecification,
                        reason:
PTDiffusionTopicUnsubscriptionReason) {
        print("Unsubscribed: \(topicPath)")
    }

    func diffusionDidClose(_ stream: PTDiffusionStream) {
        print("Closed")
    }

    func diffusionStream(_ stream: PTDiffusionStream,
didFailWithError error: Error) {
        print("Failed: \(error)")
    }
}

```

Start publishing with Swift on iOS

Create a client that publishes data through topics on the Diffusion server. This example uses Swift to create a publishing client.

Before you begin

To complete this example, you need Apple's Xcode installed on your development system and a Diffusion server.

You also require a named user that has a role with the `modify_topic` and `update_topic` permissions. For example, the "TOPIC_CONTROL" role. For more information about roles and permissions, see [Role-based authorization](#) on page 130.

Results

This simple publishing example connects to the Diffusion server using a principal and password credentials. It then adds a string topic. Once it has received a response from Diffusion to say that the topic has been created it then updates it to a value of "Hello World" using the non-exclusive string value updater, obtained from the topic update control feature.

You will need a caller to instantiate a new `SimplePublisher` instance and then call `publish()`.

Full example

The completed publishing client class contains the following code:

```
import Foundation
import Diffusion

class SimplePublisher {
    func publish() {
        // Connect to Diffusion Cloud
        let credentials = PTDiffusionCredentials(password:
"<password>")
        let configuration = PTDiffusionSessionConfiguration(
            principal: "<system user>",
            credentials: credentials)
        let url = NSURL(string: "wss://host_name")

        PTDiffusionSession.open(with: url! as URL, configuration:
configuration) {
            (session, error) -> Void in
                // Add the topic
                session!.topicControl.add(withTopicPath: "example/
topic",
                    type: PTDiffusionTopicType.string) {
                        (error) -> Void in
                            // Update the topic
                            let updater =
session!.topicUpdateControl.updater.stringValueUpdater()
                            updater.update(withTopicPath: "example/topic",
value: "Hello World") {
                                (error) -> Void in }
                        }
                    }
            }
        }
    }
}
```

Android

The Android API is bundled in a JAR file and is supported on Android KitKat and later.

Get the Android SDK as a JAR:

Download the JAR from the following URL:

```
http://download.pushtechnology.com/clients/6.1.5/android/diffusion-android-6.1.5.jar
```

The JAR file is also located in your Diffusion server installation:

```
diffusion_directory/clients/android/diffusion-android-6.1.5.jar
```

Capabilities

To see the full list of capabilities supported by the Android API, see [Feature support in the Diffusion API](#) on page 37.

Support

Table 25: Supported platforms and transport protocols for the client libraries

Platform	Minimum supported versions	Supported transport protocols
Android	API 19 / v4.4 / KitKat Note: Push Technology provides only best-effort support for Jelly Bean (API 16-18, v4.1-4.3).	WebSocket HTTP (polling)

Resources

- [Java examples for the Android API.](#)
- [Android API documentation](#)

Using

Considerations and capabilities that are specific to the Android API

Diffusion connections

Ensure that you use the asynchronous `open()` method with a callback. Using the synchronous `open()` method might open a connection on the same thread as the UI and cause a runtime exception. However, the synchronous `open()` method can be used in any thread that is not the UI thread.

Applications in background state

Android applications can be sent to the background and their activity stopped. When this happens your application is notified by the `onStop()` callback of the Android `Activity` class. An application's activity can be stopped when the user switches to another application, starts a new activity from within the application, or receives a phone call.

When your application's activity is stopped, we recommend that it saves its state locally – in particular, any topic subscriptions it has made – and closes its client session with the Diffusion server. When the Diffusion app returns to the foreground, open a new client session with the Diffusion server and use the saved state to restore topic subscriptions.

For more information, see [the Android Activity Lifecycle documentation](#) and [Stopping and Restarting an Activity](#).

Consider using push notifications to deliver data to your users when your client application is in background state. For more information, see [Push notification networks](#) on page 123.

Writing good callbacks

The Android client library invokes callbacks using a thread from Diffusion thread pool. Callbacks for a particular session are called in order, one at a time. Consider the following when writing callbacks:

- Do not sleep or call blocking operations in a callback. If you do so, other pending callbacks for the session are delayed. If you must call a blocking operation, schedule it in a separate application thread.
- You can use the full Diffusion API to make other requests to the server. If you want to make many requests based on a single callback notification, be aware that Diffusion client flow control is managed differently in callback threads. Less throttling is applied and it is easier to overflow the servers by issuing many thousands of requests. If you have a lot of requests to make, it is better to schedule the work in an application thread.

Regular expressions

The Android client uses the same regular expression engine to the Diffusion server. Some regular expressions in topic selectors are evaluated on the client and others on the Diffusion server. There is no difference in how these regular expressions are evaluated in the Android client.

Start subscribing with Android

Create an Android client application within minutes that connects to the Diffusion server. This example creates a client that prints the value of a JSON topic to the console when the topic is updated.

Before you begin

To complete this example, you need Android Studio installed on your development system and a Diffusion server.

This example was tested in Android Studio 2.3.3. If you are using a different version of Android Studio, the details of some steps may vary slightly.

You also require that anonymous client connections are assigned a role with the `select_topic` and `read_topic` permissions. For example, the “CLIENT” role. For more information about roles and permissions, see [Role-based authorization](#) on page 130.

About this task

This example steps through the lines of code required to subscribe to a topic. The full code example is provided after the steps.

Procedure

1. Set up a project in Android Studio that uses the Diffusion API.
 - a) Create a new project using API Level 21 or later.

- b) Copy the `diffusion-android-x.x.x.jar` file into the `app/libs` folder of your project.
- c) In Android Studio, right-click on the `libs` folder in the left-hand panel (the **Project Tool Window**), then select **Add as Library**.

If the `libs` folder is not shown in the left-hand panel, use the pull-down menu at the top of the panel to select **Project** view.

2. In your project's `AndroidManifest.xml` file set the `INTERNET` permission.

```
<uses-permission android:name="android.permission.INTERNET" />
```

Insert the element between the opening `<manifest>` tag and the opening `<application>` tag. This permission is required to use the Diffusion API.

3. Open your project's `MainActivity.java` file.

This file is where you develop the code to interact with the Diffusion server.

The empty `MainActivity.java` file contains the following boilerplate code:

```
import android.support.v7.app.AppCompatActivity;
import android.os.Bundle;

public class MainActivity extends AppCompatActivity {

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);
    }
}
```

4. Import the following packages and classes:

```
import android.support.v7.app.AppCompatActivity;
import android.os.Bundle;
import android.util.Log;

import com.pushtechology.diffusion.client.Diffusion;
import com.pushtechology.diffusion.client.callbacks.ErrorReason;
import com.pushtechology.diffusion.client.features.Topics;
import
    com.pushtechology.diffusion.client.features.Topics.TopicStream;
import com.pushtechology.diffusion.client.session.Session;
import com.pushtechology.diffusion.client.session.SessionFactory;
import
    com.pushtechology.diffusion.client.topics.details.TopicSpecification;
import com.pushtechology.diffusion.datatype.json.JSON;
import com.pushtechology.diffusion.datatype.json.JSONDataType;

public class MainActivity extends AppCompatActivity {

}
```

5. Create a `SessionHandler` inner class that implements `SessionFactory.OpenCallback`. This inner class will contain the code that interacts with the Diffusion server.

```
private class SessionHandler implements SessionFactory.OpenCallback
{
    private Session session = null;

    @Override
    public void onOpened(Session session) {
```

```

        this.session = session;
    }

    @Override
    public void onError(ErrorReason errorReason) {

    }

    public void close() {
        if ( session != null ) {
            session.close();
        }
    }
}

```

6. In the `onOpened` method, create the code required to subscribe to the `foo/counter` topic.
- Get the Topics feature.

```

// Get the Topics feature to subscribe to topics
final Topics topics = session.feature( Topics.class );

```

- Add an instance of `Topics.ValueStream.Default<JSON>` as the topic stream for the `foo/counter` topic, and subscribe to the topic.

```

topics.addStream("foo/counter", JSON.class, new
Topics.ValueStream.Default<JSON>() {
    @Override
    public void onSubscription(String topicPath,
TopicSpecification specification) {
        Log.i("diffusion", "Subscribed to: " + topicPath);
    }
}

```

- Override the `onValue` method to print the value of the topic to the log when it changes.

```

@Override
public void onValue(
    String topicPath,
    TopicSpecification specification,
    JSON oldValue,
    JSON newValue) {

    Log.i("diffusion", topicPath + ": " +
newValue.toJsonString());
}

```

7. In the `MainActivity` class, declare an instance of session handler.

```

private SessionHandler sessionHandler = null;

```

8. Override the `onCreate` method of the `MainActivity` class to open the session with the Diffusion server.

```

private SessionHandler sessionHandler = null;

@Override
protected void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.activity_main);

    if (sessionHandler == null) {
        sessionHandler = new SessionHandler();
    }
}

```

```

        Diffusion.sessions()
            .principal("username")
            .password("password")
            .open("ws://host:port", sessionHandler);
    }
}

```

You can connect securely, using :

```

Diffusion.sessions().open("wss://host:port",
sessionHandler);

```

Or you can connect with a principal and credentials if that principal is assigned a role with the `select_topic` and `read_topic` permissions:

```

Diffusion.sessions().principal("username").password("password").open("wss://host:port",
sessionHandler);

```

Replace the *host*, *port*, *principal*, and *password* values with your own information.

9. Override the `onDestroy` method of the `MainActivity` class to close the session with the Diffusion server.

```

if ( sessionHandler != null ) {
    sessionHandler.close();
    sessionHandler = null;
}
super.onDestroy();

```

10. Compile and run your client.

Results

The client outputs the value to the log console every time the value of the `foo/counter` JSON topic is updated. You can update the value of the `foo/counter` topic by creating a publishing client to update the topic. To create and publish to the `foo/counter` topic, you require a user with the `modify_topic` and `update_topic` permissions. For more information, see [Start publishing with Android](#) on page 192.

Full example

The completed `MainActivity` class contains the following code:

```

package com.pushtechology.demo.subscribe;

import android.support.v7.app.AppCompatActivity;
import android.os.Bundle;
import android.util.Log;

import com.pushtechology.diffusion.client.Diffusion;
import com.pushtechology.diffusion.client.callbacks.ErrorReason;
import com.pushtechology.diffusion.client.features.Topics;
import com.pushtechology.diffusion.client.features.Topics.TopicStream;
import com.pushtechology.diffusion.client.session.Session;
import com.pushtechology.diffusion.client.session.SessionFactory;
import com.pushtechology.diffusion.client.topics.details.TopicSpecification;
import com.pushtechology.diffusion.datatype.json.JSON;
import com.pushtechology.diffusion.datatype.json.JSONDataType;

```

```

public class MainActivity extends AppCompatActivity {
    /**
     * A session handler that maintains the diffusion session.
     */
    private class SessionHandler implements
    SessionFactory.OpenCallback {
        private Session session = null;

        @Override
        public void onOpened(Session session) {
            this.session = session;

            // Get the Topics feature to subscribe to topics
            final Topics topics = session.feature( Topics.class );

            // Subscribe to the "counter" topic and establish a
            JSON value stream
            topics.addStream("foo/counter", JSON.class, new
            Topics.ValueStream.Default<JSON>() {
                @Override
                public void onSubscription(String topicPath,
                TopicSpecification specification) {
                    Log.i("diffusion", "Subscribed to: " +
                    topicPath);
                }

                @Override
                public void onValue(
                    String topicPath,
                    TopicSpecification specification,
                    JSON oldValue,
                    JSON newValue) {

                        Log.i("diffusion", topicPath + ": " +
                        newValue.toJsonString());
                    }
                });

            topics.subscribe("foo/counter", new
            Topics.CompletionCallback.Default());

        }

        @Override
        public void onError(ErrorReason errorReason) {
            Log.e( "Diffusion", "Failed to open session because: "
            + errorReason.toString() );
            session = null;
        }

        public void close() {
            if (session != null) {
                session.close();
            }
        }
    }

    private SessionHandler sessionHandler = null;

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);

```

```

        setContentView(R.layout.activity_main);

        if (sessionHandler == null) {
            sessionHandler = new SessionHandler();

            Diffusion.sessions()
                .principal("username")
                .password("password")
                .open("wss://host:port", sessionHandler);
        }
    }

    @Override
    protected void onDestroy() {
        if (sessionHandler != null) {
            sessionHandler.close();
            sessionHandler = null;
        }

        super.onDestroy();
    }
}

```

Related information

<http://developer.android.com/training/index.html>

Start publishing with Android

Create an Android client that publishes data through topics on the Diffusion server.

Before you begin

To complete this example, you need Android Studio installed on your development system and a Diffusion server.

This example was tested in Android Studio 2.3.3. If you are using a different version of Android Studio, the details of some steps may vary slightly.

You also require a named user that has a role with the `modify_topic` and `update_topic` permissions. For example, the “ADMINISTRATOR” role. For more information about roles and permissions, see [Role-based authorization](#) on page 130.

About this task

This example steps through the lines of code required to publish to a JSON topic. The full code example is provided after the steps.

Procedure

1. Set up a project in Android Studio that uses the Diffusion API.
 - a) Create a new project using API Level 21 or later.
 - b) Copy the `diffusion-android-x.x.x.jar` into the `app/libs` folder of your project.
 - c) In Android Studio, right-click on the `libs` folder in the left-hand panel (the **Project Tool Window**), then select **Add as Library**.

If the `libs` folder is not shown in the left-hand panel, use the pull-down menu at the top of the panel to select **Project** view.

2. In your project's `AndroidManifest.xml` file set the `INTERNET` permission.

```
<uses-permission android:name="android.permission.INTERNET" />
```

Insert the element between the opening `<manifest>` tag and the opening `<application>` tag. This permission is required to use the Diffusion API.

3. Open your project's `MainActivity.java` file.

This file is where you develop the code to interact with the Diffusion server.

The empty `MainActivity.java` file contains the following boilerplate code:

```
import android.support.v7.app.AppCompatActivity;
import android.os.Bundle;

public class MainActivity extends AppCompatActivity {

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);
    }
}
```

4. Import the following packages and classes:

```
import android.support.v7.app.AppCompatActivity;
import android.os.Bundle;
import android.util.Log;

import com.pushtechology.diffusion.client.Diffusion;
import com.pushtechology.diffusion.client.callbacks.ErrorReason;
import com.pushtechology.diffusion.client.features.Topics;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicControl;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicUpdateControl;
import com.pushtechology.diffusion.client.session.Session;
import com.pushtechology.diffusion.client.session.SessionFactory;
import
    com.pushtechology.diffusion.client.topics.details.TopicType;
import com.pushtechology.diffusion.datatype.json.JSON;
import com.pushtechology.diffusion.datatype.json.JSONDataType;

import java.util.concurrent.Executors;
import java.util.concurrent.TimeUnit;
import java.util.concurrent.atomic.AtomicInteger;

public class MainActivity extends AppCompatActivity {

}
```

The `com.pushtechology.diffusion.client` packages contain the classes to use to interact with the Diffusion server.

5. Create a `SessionHandler` inner class that implements `SessionFactory.OpenCallback`.

This inner class will contain the code that interacts with the Diffusion server.

```
private class SessionHandler implements
SessionFactory.OpenCallback {
    private Session session = null;

    @Override
    public void onOpened(Session session) {
        this.session = session;
    }

    @Override
    public void onError(ErrorReason errorReason) {

    }

    public void close() {
        if ( session != null ) {
            session.close();
        }
    }
}
```

6. In the `onOpened` method, add the code required to create the `foo/counter` topic and update it with an incrementing value.
- Use the `TopicControl` feature to create a JSON topic.

```
// Create a JSON topic 'foo/counter'
session.feature(TopicControl.class).addTopic(
    "foo/counter",
    TopicType.JSON,
    new TopicControl.AddCallback.Default());
```

- Get the `TopicUpdateControl` feature and JSON data type.

```
type // Get the TopicUpdateControl feature and JSON data
final JSONDataType jsonDataType =
Diffusion.dataTypes().json();
final TopicUpdateControl updateControl = session
.feature(TopicUpdateControl.class);
```

- Loop once a second updating the `foo/counter` topic with an incrementing count from 0 to 1000. Use the non-exclusive `updateControl.updater().update()` method to update the topic while still allowing other clients to update the topic.

```
final AtomicInteger i = new AtomicInteger(0);

Executors.newSingleThreadScheduledExecutor().scheduleAtFixedRate(new
Runnable() {
    @Override
    public void run() {
        // Create the json value
        final JSON value = jsonDataType.fromJsonString(
            String.format("{\"count\" : %d }",
i.getAndIncrement()));
```

```

        // Update the topic
        updateControl.updater().update(
            "counter",
            value,
            new
            TopicUpdateControl.Updater.UpdateCallback.Default());
    }, 1000, 1000, TimeUnit.MILLISECONDS);

```

7. In the `MainActivity` class, declare an instance of session handler.

```
private SessionHandler sessionHandler = null;
```

8. Override the `onCreate` method of the `MainActivity` class to open the session with the Diffusion server.

```

@Override
protected void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.activity_main);

    if (sessionHandler == null) {
        sessionHandler = new SessionHandler();

        Diffusion.sessions()
            .principal("username")
            .password("password")
            .open("ws://host:port", sessionHandler);
    }
}

```

Or you can connect securely, using :

```
Diffusion.sessions().principal("principal").password("password").open("wss://
sessionHandler);
```

Replace the *host*, *port*, *principal*, and *password* values with your own information.

9. Override the `onDestroy` method of the `MainActivity` class to close the session with the Diffusion server.

```

if ( sessionHandler != null ) {
    sessionHandler.close();
    sessionHandler = null;
}
super.onDestroy();

```

10. Compile and run your client.

Results

The client publishes a JSON value to the `foo/counter` topic every second. You can subscribe to the `foo/counter` topic by creating a client to subscribe to the topic. For more information, see [Start subscribing with Android](#) on page 187.

Full example

The completed `MainActivity` class contains the following code:

```
package com.pushtechology.demo.update;
```

```

import android.support.v7.app.AppCompatActivity;
import android.os.Bundle;
import android.util.Log;

import com.pushtechology.diffusion.client.Diffusion;
import com.pushtechology.diffusion.client.callbacks.ErrorReason;
import com.pushtechology.diffusion.client.features.Topics;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicControl;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicUpdateControl;
import com.pushtechology.diffusion.client.session.Session;
import com.pushtechology.diffusion.client.session.SessionFactory;
import
    com.pushtechology.diffusion.client.topics.details.TopicType;
import com.pushtechology.diffusion.datatype.json.JSON;
import com.pushtechology.diffusion.datatype.json.JSONDataType;

import java.util.concurrent.Executors;
import java.util.concurrent.TimeUnit;
import java.util.concurrent.atomic.AtomicInteger;

public class MainActivity extends AppCompatActivity {

    /**
     * A session handler that maintains the diffusion session.
     */
    private class SessionHandler implements
        SessionFactory.OpenCallback {
        private Session session = null;

        @Override
        public void onOpened(Session session) {
            this.session = session;

            // Create a JSON topic 'foo/counter'
            session.feature(TopicControl.class).addTopic(
                "foo/counter",
                TopicType.JSON,
                new TopicControl.AddCallback.Default());

            // Get the TopicUpdateControl feature and JSON data
            type
            final JSONDataType jsonDataType =
                Diffusion.dataTypes().json();
            final TopicUpdateControl updateControl = session
                .feature(TopicUpdateControl.class);

            final AtomicInteger i = new AtomicInteger(0);

            // Schedule a recurring task that increments the
            counter and updates the "counter" topic with a json value
            // every second

            Executors.newSingleThreadScheduledExecutor().scheduleAtFixedRate(new
                Runnable() {
                    @Override
                    public void run() {
                        // Create the json value

```

```

        final JSON value =
jsonDataType.fromJsonString(
        String.format("{\"count\" : %d }",
i.getAndIncrement()));

        // Update the topic
updateControl.updater().update(
        "counter",
        value,
        new
TopicUpdateControl.Updater.UpdateCallback.Default());
    }
    }, 1000, 1000, TimeUnit.MILLISECONDS);
}

@Override
public void onError(ErrorReason errorReason) {
    Log.e("Diffusion", "Failed to open session because: "
+ errorReason.toString());
    session = null;
}

public void close() {
    if (session != null) {
        session.close();
    }
}

private SessionHandler sessionHandler = null;

@Override
protected void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.activity_main);

    if (sessionHandler == null) {
        sessionHandler = new SessionHandler();

        Diffusion.sessions()
            .principal("username")
            .password("password")
            .open("ws://host:port", sessionHandler);
    }

    @Override
    protected void onDestroy() {
        if (sessionHandler != null) {
            sessionHandler.close();
            sessionHandler = null;
        }

        super.onDestroy();
    }
}

```

Related information

<http://developer.android.com/training/index.html>

Java

The Java API is provided as a JAR file for Oracle Java Development Kit 8 (minimum update 1.8.0_131-b11).

Get the Java client libraries using Maven™ :

Add the Push Technology public repository to your pom.xml file:

```
<repositories>
  <repository>
    <id>push-repository</id>
    <url>https://download.pushtechnology.com/maven/</url>
  </repository>
</repositories>
```

Declare the following dependency in your pom.xml file:

```
<dependency>
  <groupId>com.pushtechnology.diffusion</groupId>
  <artifactId>diffusion-client</artifactId>
  <version>version</version>
</dependency>
```

Get the Java client libraries using Gradle:

Add the Push Technology public repository to your build.gradle file:

```
repositories { maven { url "http://download.pushtechnology.com/
maven/" } }
```

Declare the following dependency in your build.gradle file:

```
compile 'com.pushtechnology.diffusion:diffusion-client:6.1.5'
```

Get the Java client libraries:

Download the JAR file from the following URL:

```
http://download.pushtechnology.com/clients/6.1.5/java/diffusion-client.jar
```

The ZIP file is also located in your Diffusion server installation:

```
diffusion_directory/clients/java/diffusion-client-6.1.5.jar
```

Capabilities

To see the full list of capabilities supported by the Java API, see [Feature support in the Diffusion API](#) on page 37.

Support

Table 26: Supported platforms and transport protocols for the client libraries

Platform	Minimum supported versions	Supported transport protocols
Java	Oracle Java Development Kit 8 (minimum update 1.8.0_131-b11). JDK 9 not supported. Note: We recommend that you run your clients on the JDK rather than the JRE.	WebSocket HTTP (Polling)

Resources

- [Examples for the Java API.](#)
- [Java API documentation](#)

Using

Certificates

Diffusion Java clients use certificates to validate the security of their connection to the Diffusion server. The client validates the certificate sent by the Diffusion server against the set of certificates trusted by the .

If the certificate sent by the Diffusion server cannot be validated against any certificates in the set trusted by the JDK, you receive an exception that contains the following message:

```
sun.security.provider.certpath.SunCertPathBuilderException:  
unable to find valid certification path to requested target.
```

Diffusion is authenticated using the certificates provided by your certificate authority for the domain you host the Diffusion server on.

To ensure that the certificate is validated, set up a trust store for the client and add the appropriate certificates to that trust store:

1. Obtain the appropriate intermediate certificate from the certificate authority.
2. Use keytool to create a trust store for your client that includes this certificate.

For more information, see <https://docs.oracle.com/cd/E19509-01/820-3503/ggfk/index.html>

3. Use system properties to add the trust store to your client.

For example:

```
System.setProperty("javax.net.ssl.trustStore",  
"truststore_name");
```

Or at the command line:

```
-Djavax.net.ssl.keyStore=path_to_truststore
```

Writing good callbacks

The Java client library invokes callbacks using a thread from Diffusion thread pool. Callbacks for a particular session are called in order, one at a time. Consider the following when writing callbacks:

- Do not sleep or call blocking operations in a callback. If you do so, other pending callbacks for the session are delayed. If you must call a blocking operation, schedule it in a separate application thread.
- You can use the full Diffusion API to make other requests to the server. If you want to make many requests based on a single callback notification, be aware that Diffusion client flow control is managed differently in callback threads. Less throttling is applied and it is easier to overflow the servers by issuing many thousands of requests. If you have a lot of requests to make, it is better to schedule the work in an application thread.

Regular expressions

The Java client uses the same regular expression engine to the Diffusion server. Some regular expressions in topic selectors are evaluated on the client and others on the Diffusion server. There is no difference in how these regular expressions are evaluated in the Java client.

Start subscribing with Java

Create a Java client within minutes that connects to the Diffusion server. This example creates a client that prints the value of a topic to the console when the topic is updated.

Before you begin

To complete this example, you need a Diffusion server.

You also require either a named user that has a role with the `select_topic` and `read_topic` permissions or that anonymous client connections are assigned a role with the `select_topic` and `read_topic` permissions. For example, the “CLIENT” role. For more information about roles and permissions, see [Role-based authorization](#) on page 130.

About this task

This example steps through the lines of code required to subscribe to a topic. There are several different [topic types](#) which provide data in different formats. This example shows you how to subscribe to a JSON topic. The full code example is provided after the steps.

Procedure

1. Include the client jar file on the build classpath of your Java client. You can use one of the following methods:

- You can use Maven to declare the dependency. First add the Push Technology public repository to your `pom.xml` file:

```
<repositories>
  <repository>
    <id>push-repository</id>
    <url>https://download.pushtechnology.com/maven/</url>
  </repository>
</repositories>
```

Next declare the following dependency in your `pom.xml` file:

```
<dependency>
  <groupId>com.pushtechnology.diffusion</groupId>
  <artifactId>diffusion-client</artifactId>
```

```
<version>version</version>
</dependency>
```

Where *version* is the Diffusion version, for example 6.1.5.

- If you are not using Maven, you can include the `diffusion-client-version.jar` file that is located in the `clients/java` directory of your Diffusion server installation.

A `diffusion-api-version.jar` is also provided. This file contains only the development interfaces without any client library capabilities and can be used for developing and compiling your Java clients. However, to run your Diffusion Java client you must use the `diffusion-client-version.jar` file.

2. Create a client class that imports the following packages and classes:

```
import com.pushtechology.diffusion.client.Diffusion;
import com.pushtechology.diffusion.client.content.Content;
import com.pushtechology.diffusion.client.features.Topics;
import
    com.pushtechology.diffusion.client.features.Topics.ValueStream;
import com.pushtechology.diffusion.client.session.Session;
import
    com.pushtechology.diffusion.client.topics.details.TopicSpecification;
import com.pushtechology.diffusion.datatype.json.JSON;

public class SubscribingClient {
}
```

3. Create a main method for the client.

```
public class SubscribingClient {
    public static void main(String... arguments) throws
        Exception {
    }
}
```

4. In the main method, connect to the Diffusion server.

```
// Connect anonymously
// Replace 'host' with your hostname
final Session session =
    Diffusion.sessions().open("ws://host:port");
```

Or you can connect securely, using:

```
final Session session =
    Diffusion.sessions().open("ws://host:port");
```

Or you can connect with a principal and credentials if that principal is assigned a role with the `read_topic` permission:

```
final Session session =
    Diffusion.sessions().principal("principal")
        .password("password").open("ws://host:port");
```

Replace the *host*, *port*, *principal*, and *password* values with your own information.

5. Next, in the main method, get the Topics feature.

```
// Get the Topics feature to subscribe to topics
```

```
final Topics topics = session.feature(Topics.class);
```

The Topics feature enables a client to subscribe to a topic or fetch its state. For more information, see .

6. Within the `SubscribingClient` class, create an inner class that extends `ValueStream.Default<JSON>` and overrides the `onValue` method.

This inner class defines the behavior that occurs when a topic that the client subscribes to is updated. In this example, the value stream prints the topic name and the value of the update to the console.

```
private static class ValueStreamPrintLn extends
ValueStream.Default<Content> {
    @Override
    public void onValue(
        String topicPath,
        TopicSpecification specification,
        Content oldValue,
        Content newValue) {
        System.out.println(topicPath + ": " +
newValue.asString());
    }
}
```

7. Back in the main method of the `SubscribingClient` class, use the `addStream` method to associate an instance of the value stream that you created with the JSON topic you want to subscribe to.

```
// Add a new stream for 'foo/counter'
topics.addStream("foo/counter", JSON.class, new
Topics.ValueStream.Default<JSON>() {
    @Override
    public void onSubscription(String topicPath,
TopicSpecification specification) {
        System.out.println("Subscribed to: " + topicPath);
    }

    @Override
    public void onValue(String topicPath,
TopicSpecification specification, JSON oldValue, JSON newValue) {
        System.out.println(topicPath + " : " +
newValue.toJsonString());
    }
});
```

8. Next, use the `subscribe` method to subscribe to the topic `foo/counter`.

```
// Subscribe to the topic 'foo/counter'
topics.subscribe("foo/counter", new
Topics.CompletionCallback.Default());
```

9. Use a `Thread.sleep()` to hold the client open for a minute while the updates are received and output.

```
// Wait for a minute while the stream prints updates
Thread.sleep(60000);
```

10. Compile and run your client.

Ensure that the `diffusion-client-version.jar` file is included in your compiled client or on its classpath.

We recommend that you run your client using the JDK rather than the JRE. The JDK includes additional diagnostic capabilities that might be useful.

Results

The client outputs the value to the console every time the value of the foo/counter topic is updated. You can update the value of the foo/counter topic by creating a publishing client to update the topic. To create and publish to the foo/counter topic, you require a user with the modify_topic and update_topic permissions. For more information, see [Start publishing with Java](#) on page 204.

Full example

The completed `SubscribingClient` class contains the following code:

```
import com.pushtechology.diffusion.client.Diffusion;
import com.pushtechology.diffusion.client.Diffusion;
import com.pushtechology.diffusion.client.content.Content;
import com.pushtechology.diffusion.client.features.Topics;
import
    com.pushtechology.diffusion.client.features.Topics.ValueStream;
import com.pushtechology.diffusion.client.session.Session;
import
    com.pushtechology.diffusion.client.topics.details.TopicSpecification;
import com.pushtechology.diffusion.datatype.json.JSON;

/**
 * A client that subscribes to the topic 'foo/counter'.
 *
 * @author Push Technology Limited
 * @since 5.9
 */
public class SubscribingClient {

    /**
     * Main.
     */
    public static void main(String... arguments) throws Exception
    {

        // Connect anonymously
        // Replace 'host' with your hostname
        final Session session =
Diffusion.sessions().open("ws://host:port");

        // Get the Topics feature to subscribe to topics
        final Topics topics = session.feature(Topics.class);

        // Add a new stream for 'foo/counter'
        topics.addStream("foo/counter", JSON.class, new
Topics.ValueStream.Default<JSON>() {
            @Override
            public void onSubscription(String topicPath,
TopicSpecification specification) {
                System.out.println("Subscribed to: " + topicPath);
            }
        }

        @Override
        public void onValue(String topicPath,
TopicSpecification specification, JSON oldValue, JSON newValue) {
            System.out.println(topicPath + " : " +
newValue.toJsonString());
        }
    }
}
```

```

    });

    // Subscribe to the topic 'foo/counter'
    topics.subscribe("foo/counter", new
Topics.CompletionCallback.Default());

    // Wait for a minute while the stream prints updates
    Thread.sleep(60000);
}

/**
 * A topic stream that prints updates to the console.
 */
private static class ValueStreamPrintLn extends
ValueStream.Default<Content> {
    @Override
    public void onValue(
        String topicPath,
        TopicSpecification specification,
        Content oldValue,
        Content newValue) {
        System.out.println(topicPath + ": " +
newValue.asString());
    }
}
}

```

Start publishing with Java

Create a Java client that publishes data through topics on the Diffusion server.

Before you begin

To complete this example, you need a Diffusion server and a development system with Java installed on it.

You also require a principal that has a role with the `modify_topic` and `update_topic` permissions. For example, the “ADMINISTRATOR” role. For more information about roles and permissions, see [Role-based authorization](#) on page 130.

About this task

This example steps through the lines of code required to publish a value to a JSON topic. The full code example is provided after the steps.

Procedure

1. Include the client jar file on the build classpath of your Java client. You can use one of the following methods:
 - You can use Maven to declare the dependency. First add the Push Technology public repository to your `pom.xml` file:

```

<repositories>
  <repository>
    <id>push-repository</id>
    <url>https://download.pushtechnology.com/maven/</url>
  </repository>
</repositories>

```

Next declare the following dependency in your `pom.xml` file:

```
<dependency>
  <groupId>com.pushtechology.diffusion</groupId>
  <artifactId>diffusion-client</artifactId>
  <version>version</version>
</dependency>
```

Where *version* is the Diffusion version, for example 6.1.5.

- If you are not using Maven, you can include the `diffusion-client.jar` file that is located in the `clients/java` directory of your Diffusion server installation.

2. Create a `PublishingClient` class that imports the following packages and classes:

```
import com.pushtechology.diffusion.client.Diffusion;
import
  com.pushtechology.diffusion.client.features.control.topics.TopicControl;
import
  com.pushtechology.diffusion.client.features.control.topics.TopicUpdateControl;
import
  com.pushtechology.diffusion.client.features.control.topics.TopicUpdateControl;
import com.pushtechology.diffusion.client.session.Session;
import
  com.pushtechology.diffusion.client.topics.details.TopicType;
import com.pushtechology.diffusion.datatype.json.JSON;
import com.pushtechology.diffusion.datatype.json.JSONDataType;

import java.util.concurrent.CompletableFuture;
import java.util.concurrent.TimeUnit;

public final class PublishingClient {
}
}
```

The `com.pushtechology.diffusion.client` packages contain the classes to use to interact with the Diffusion server. The `java.util.concurrent.CompletableFuture` and `java.util.concurrent.TimeUnit` classes are used to simplify this example. The `CompletableFuture` result is accessed with `get`, which is synchronous. However, the Diffusion API is designed to be most powerful when used asynchronously.

3. Create a main method.

```
public final class PublishingClient {
    public static void main(String... arguments) throws
      InterruptedException, ExecutionException, TimeoutException {
    }
}
}
```

4. Inside the `main` method, connect to the Diffusion server.

Make sure to edit the `host` value in the example to match your Diffusion server's hostname or IP address.

The principal you use to connect must have `modify_topic` and `update_topic` permissions. In this example, we use the default `control` principal.

```
final Session session =
  Diffusion.sessions().principal("control")
    .password("password").open("ws://host:8080");
```

Or you can connect securely to the Diffusion server using :

```
.open("wss://host:port");
```

Replace the *host*, *port*, *principal*, and *password* values with your own information.

You can choose to connect anonymously if anonymous sessions are assigned the `modify_topic` and `update_topic` permissions. However, we do not recommend that anonymous sessions are given write access to data on the Diffusion server.

5. Next, in the main method, get the `TopicControl` and `TopicUpdateControl` features.

```
// Get the TopicControl and TopicUpdateControl feature
TopicControl topicControl =
    session.feature(TopicControl.class);

TopicUpdateControl updateControl = session
    .feature(TopicUpdateControl.class);
```

The `TopicControl` feature enables a client to create and delete topics. For more information, see [Managing topics](#) on page 282.

The `TopicUpdateControl` feature enables a client to publish updates to a topic. For more information, see [Updating topics](#) on page 336.

6. Next, create an instance of `JSONDataType` to store the value of the JSON topic.

```
final JSONDataType jsonDataType =
    Diffusion.dataTypes().json();
```

7. Next, in the main method, use the `TopicControl` feature to create the `foo/counter` topic.

```
// Create a JSON topic 'foo/counter'
final CompletableFuture<TopicControl.AddTopicResult> future
    = topicControl.addTopic(
        "foo/counter",
        TopicType.JSON);

// Wait for the CompletableFuture to complete
future.get(10, TimeUnit.SECONDS);
```

8. Next, in the main method, loop once a second updating the `foo/counter` topic with an incrementing count from 0 to 1000.

Use the `updateControl.updater().update()` method to update a topic without locking that topic.

```
// Update the topic
final UpdateCallback updateCallback = new
UpdateCallback.Default();
for (int i = 0; i < 1000; ++i) {
    final JSON value =
jsonDataType.fromJsonString(String.format("{\"count\" : %d }",
i));
    // Use the non-exclusive updater to update the topic
without locking it
    updateControl.updater().update(
        "foo/counter",
        Integer.toString(i),
        updateCallback);

    Thread.sleep(1000);
}
```

```
}
```

9. Compile and run your client.

We recommend that you run your client using the JDK rather than the JRE. The JDK includes additional diagnostic capabilities that might be useful.

Results

The client publishes a value to the `foo/counter` topic every second. You can subscribe to the `foo/counter` topic by creating a client to subscribe to the topic. For more information, see [Start subscribing with Java](#) on page 200.

Full example

The completed `PublishingClient` class contains the following code:

```
import com.pushtechology.diffusion.client.Diffusion;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicControl;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicUpdateControl;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicUpdateControl;
import com.pushtechology.diffusion.client.session.Session;
import
    com.pushtechology.diffusion.client.topics.details.TopicType;
import com.pushtechology.diffusion.datatype.json.JSON;
import com.pushtechology.diffusion.datatype.json.JSONDataType;

import java.util.concurrent.CountDownLatch;

/**
 * A client that publishes an incrementing count to the topic
 * 'foo/counter'.
 *
 * @author Push Technology Limited
 * @since 5.9
 */
public final class PublishingClient {

    /**
     * Main.
     */
    public static void main(String... arguments) throws
        InterruptedException, ExecutionException, TimeoutException {

        // Connect using a principal with 'modify_topic' and
        // 'update_topic'
        // permissions
        // Change 'host' to the hostname/address of your Diffusion
        // server
        final Session session =
            Diffusion.sessions().principal("control")
                .password("password").open("ws://host:port");

        // Get the TopicControl and TopicUpdateControl feature
        final TopicControl topicControl =
            session.feature(TopicControl.class);

        final TopicUpdateControl updateControl =
            session.feature(TopicUpdateControl.class);
```

```

        final JSONDataType jsonDataType =
Diffusion.dataTypes().json();

        // Create a JSON topic 'foo/counter'
        final CompletableFuture<TopicControl.AddTopicResult>
future = topicControl.addTopic(
            "foo/counter",
            TopicType.JSON);

        // Wait for the CompletableFuture to complete
        future.get(10, TimeUnit.SECONDS);

        // Update the topic
        final UpdateCallback updateCallback = new
UpdateCallback.Default();
        for (int i = 0; i < 1000; ++i) {
            final JSON value =
jsonDataType.fromJsonString(String.format("{\"count\" : %d }",
i));
            // Use the non-exclusive updater to update the topic
without locking it
            updateControl.updater().update(
                "foo/counter",
                value,
                updateCallback);

            Thread.sleep(1000);
        }
    }
}

```

.NET

The .NET API is provided as a package compatible with Microsoft .NET Standard 2.0.

Get the .NET SDK from NuGet:

Use the following .NET CLI command:

```
dotnet add package Diffusion.Client -v 6.1.5
```

Get the .NET SDK:

Download the .NET SDK files from the following URL:

```
http://download.pushtechnology.com/clients/6.1.5/dotnet/diffusion-dotnet-6.1.5.zip
```

These files are also located in your Diffusion server installation:

```
diffusion_directory/clients/dotnet
```

Capabilities

To see the full list of capabilities supported by the .NET API, see [Feature support in the Diffusion API](#) on page 37.

Support

Table 27: Supported platforms and transport protocols for the client libraries

Platform	Minimum supported versions	Supported transport protocols
.NET	Microsoft .NET Standard 2.0	WebSocket

Resources

- [Examples for the .NET API.](#)
- [.NET API documentation](#)

Using

Certificates

Diffusion .NET clients use certificates to validate the security of their connection to the Diffusion server. The client validates the certificate sent by the Diffusion server against the set of certificates trusted by the .NET Framework.

If the certificate sent by the Diffusion server cannot be validated against any certificates in the set trusted by the .NET Framework, you must set up a trust store for the client and add the appropriate certificates to that trust store.

Diffusion is authenticated using the certificates provided by your certificate authority for the domain you host the Diffusion server on.

1. Obtain the appropriate intermediate certificate from the certificate authority.
2. Use the **Microsoft Management Console** to import the certificate into the **Trusted Root Certification Authorities** folder. For more information, see [https://msdn.microsoft.com/en-us/library/aa738659\(v=vs.110\).aspx](https://msdn.microsoft.com/en-us/library/aa738659(v=vs.110).aspx)

Writing good callbacks

The .NET client library invokes callbacks using a single inbound thread. Callbacks for a particular session are called in order, one at a time. Consider the following when writing callbacks:

- Do not sleep or call blocking operations in a callback. If you do so, other pending callbacks for the session are delayed. If you must call a blocking operation, schedule it in a separate application thread.
- You can use the full Diffusion API to make other requests to the server. If you want to make many requests based on a single callback notification, be aware that Diffusion client flow control is managed differently in callback threads. Less throttling is applied and it is easier to overflow the servers by issuing many thousands of requests. If you have a lot of requests to make, it is better to schedule the work in an application thread.

Regular expressions

The .NET client uses a different regular expression engine to the Diffusion server. Some regular expressions in topic selectors are evaluated on the client and others on the Diffusion server. It is possible that topic selectors that include complex or advanced regular expressions can behave differently on the client and on the Diffusion server.

For more information, see [Regular expressions](#) on page 55.

Start subscribing with .NET

Create a .NET client within minutes that connects to the Diffusion server. This example creates a client that prints the value of a JSON topic to the console when the topic is updated.

Before you begin

To complete this example, you need a Diffusion server.

You also require either a named user that has a role with the `select_topic` and `read_topic` permissions or that anonymous client connections are assigned a role with the `select_topic` and `read_topic` permissions. For example, the “CLIENT” role. For more information about roles and permissions, see [Role-based authorization](#) on page 130.

About this task

This example steps through the lines of code required to subscribe to a topic. The full code example is provided after the steps.

Procedure

1. Create a .NET project that references the following DLL file located in the `clients/dotnet` directory of your .NET installation:

Diffusion.Client

The assembly contains the interface classes and interfaces that you use when creating a control client.

The .NET assembly is also available through NuGet.

Use the following .NET CLI command:

```
dotnet add package Diffusion.Client -v 6.1.5
```

2. In your project, create a C# file that uses the following packages:

```
using System.Threading;
using System.Threading.Tasks;
using PushTechnology.ClientInterface.Client.Callbacks;
using PushTechnology.ClientInterface.Client.Factories;
using PushTechnology.ClientInterface.Client.Features;
using PushTechnology.ClientInterface.Client.Features.Topics;
using PushTechnology.ClientInterface.Client.Topics.Details;
using PushTechnology.ClientInterface.Data.JSON;
using static
    PushTechnology.ClientInterface.Examples.Runner.Program;
using static System.Console;

namespace PushTechnology.ClientInterface.Example.Consuming {
    public sealed class ConsumingJSONTopics : IExample {
    }
}
```

3. Create a Main method.

```
public sealed class SubscribingClient
{
    public static void Main( string[] args ) {
    }
}
```

4. In the Main method, connect to the Diffusion server.

```
public static void Main( string[] args ) {
    // Connect anonymously
    // Replace 'host' with your hostname
    var session =
Diffusion.Sessions.Open( "ws://host:port" );
}
```

Or you can connect securely, using :

```
var session =
Diffusion.sessions().Open( "wss://host:port" );
```

Or you can connect with a principal and credentials if that principal is assigned a role with the read_topic permission:

```
var session =
Diffusion.Sessions().Principal( "principal" )
.Password( "password" ).Open( "wss://host:port" );
```

Replace the *host*, *port*, *principal*, and *password* values with your own information.

5. Next, in the Main method, get the Topics feature.

```
// Get the Topics feature to subscribe to topics
var topics = session.Topics;
```

The Topics feature enables a client to subscribe to a topic or fetch its state.

6. Within the subscribing client class, create an inner class that implements IValueStream for a JSON topic.

This inner class defines the behavior that occurs when a topic that the client subscribes to is updated. In this example, the topic stream prints the topic path and the content of the update to the console.

```
internal sealed class JSONStream : IValueStream<IJJSON> {
    public void OnClose() {
        Console.WriteLine( "The subscription stream is now
closed." );
    }

    public void OnError( ErrorReason errorReason ) {
        Console.WriteLine( "An error has occurred : {0}",
errorReason );
    }

    public void OnSubscription( string topicPath,
ITopicSpecification specification ) {
        Console.WriteLine( "Client subscribed to {0} ",
topicPath );
    }

    public void OnUnsubscription( string topicPath,
ITopicSpecification specification, TopicUnsubscribeReason reason )
    {
        Console.WriteLine( "Client unsubscribed from {0} :
{1}", topicPath, reason );
    }
}
```

```

    }

    public void OnValue( string topicPath, ITopicSpecification
specification, IJSON oldValue, IJSON newValue ) {
        Console.WriteLine( "New value of {0} is {1}",
topicPath, newValue.ToJSONString() );
    }
}

```

7. Back in the `Main` method of the subscribing client class, use the `AddStream` method to associate an instance of the topic stream that you created with the topic you want to subscribe to. In this example, the topic path is `"foo/counter"`.

```

var topic = ">foo/counter";
// Add a topic stream for 'foo/counter' and request
subscription
var jsonStream = new JSONStream();
topics.AddStream( topic, jsonStream );
topics.Subscribe( topic, new
TopicsCompletionCallbackDefault() );

```

8. Use a `Thread.sleep()` to hold the client open for 10 minutes while the updates are received and output.

```

//Stay connected for 10 minutes
Thread.Sleep( TimeSpan.FromMinutes( 10 ) );

session.Close();

```

9. Compile and run your client.

Results

The client outputs the value to the console every time the value of the `foo/counter` topic is updated. You can update the value of the `foo/counter` topic by creating a publishing client to update the topic. To create and publish to the `foo/counter` topic, you require a user with the `modify_topic` and `update_topic` permissions. For more information, see [Start publishing with .NET](#) on page 214.

Full example

The completed subscribing client class contains the following code:

```

/**
 * Copyright © 2016, 2017 Push Technology Ltd.
 *
 * Licensed under the Apache License, Version 2.0 (the "License");
 * you may not use this file except in compliance with the
 * License.
 * You may obtain a copy of the License at
 * http://www.apache.org/licenses/LICENSE-2.0
 *
 * Unless required by applicable law or agreed to in writing,
 * software
 * distributed under the License is distributed on an "AS IS"
 * BASIS,
 * WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or
 * implied.
 * See the License for the specific language governing permissions
 * and
 * limitations under the License.

```

```

*/

using System;
using System.Threading;
using PushTechnology.ClientInterface.Client.Callbacks;
using PushTechnology.ClientInterface.Client.Factories;
using PushTechnology.ClientInterface.Client.Features;
using PushTechnology.ClientInterface.Client.Features.Topics;
using PushTechnology.ClientInterface.Client.Topics.Details;
using PushTechnology.ClientInterface.Data.JSON;

namespace PushTechnology.ClientInterface.Example {
    class Program {
        static void Main( string[] args ) {
            // Connect anonymously
            var session = Diffusion.Sessions.Open( "ws://
localhost:8080" );

            // Get the Topics feature to subscribe to topics
            var topics = session.Topics;
            var topic = ">foo/counter";

            // Add a topic stream for 'random/JSON' and request
subscription
            var jsonStream = new JSONStream();
            topics.AddStream( topic, jsonStream );
            topics.SubscribeAsync( topic ).Wait();

            //Stay connected for 10 minutes
            Thread.Sleep( TimeSpan.FromMinutes( 10 ) );

            session.Close();
        }

        /// <summary>
        /// Basic implementation of the IValueStream<TValue> for
JSON topics.
        /// </summary>
        internal sealed class JSONStream : IValueStream<IJSON> {
            /// <summary>
            /// Notification of stream being closed normally.
            /// </summary>
            public void OnClose()
                => Console.WriteLine( "The subscription stream is
now closed." );

            /// <summary>
            /// Notification of a contextual error related to this
callback.
            /// </summary>
            /// <remarks>
            /// Situations in which <code>OnError</code> is called
include the session being closed, a communication
            /// timeout, or a problem with the provided
parameters. No further calls will be made to this callback.
            /// </remarks>
            /// <param name="errorReason">Error reason.</param>
            public void OnError( ErrorReason errorReason )
                => Console.WriteLine( $"An error has occured :
{errorReason}" );

            /// <summary>
            /// Notification of a successful subscription.

```

```

        /// </summary>
        /// <param name="topicPath">Topic path.</param>
        /// <param name="specification">Topic specification.</
param>
        public void OnSubscription( string topicPath,
ITopicSpecification specification )
            => Console.WriteLine( $"Client subscribed to
{topicPath}" );

        /// <summary>
        /// Notification of a successful unsubscription.
        /// </summary>
        /// <param name="topicPath">Topic path.</param>
        /// <param name="specification">Topic specification.</
param>
        /// <param name="reason">Error reason.</param>
        public void OnUnsubscription( string topicPath,
ITopicSpecification specification, TopicUnsubscribeReason
reason )
            => Console.WriteLine( $"Client unsubscribed from
{topicPath} : {reason}" );

        /// <summary>
        /// Topic update received.
        /// </summary>
        /// <param name="topicPath">Topic path.</param>
        /// <param name="specification">Topic specification.</
param>
        /// <param name="oldValue">Value prior to update.</
param>
        /// <param name="newValue">Value after update.</param>
        public void OnValue( string topicPath,
ITopicSpecification specification, IJSON oldValue, IJSON
newValue )
            => Console.WriteLine( $"New value of {topicPath}
is {newValue.ToJSONString()}" );
    }
}
}

```

Start publishing with .NET

Create a .NET client that publishes data through topics on the Diffusion server.

Before you begin

To complete this example, you need a Diffusion server and a development system with the .NET Framework installed on it.

You also require either a named user that has a role with the `modify_topic` and `update_topic` permissions. For example, the "ADMINISTRATOR" role. For more information about roles and permissions, see [Role-based authorization](#) on page 130.

About this task

This example steps through the lines of code required to subscribe to a JSON topic. The full code example is provided after the steps.

Procedure

1. Create a .NET project that references the following DLL file located in the `clients/dotnet` directory of your .NET installation:

Diffusion.Client

The assembly contains the interfaces classes and interfaces that you use when creating a control client.

Use the following .NET CLI command:

```
dotnet add package Diffusion.Client -v 6.1.5
```

2. In your project, create a C# file that uses the following packages:

```
using System;
using System.Threading;
using PushTechnology.ClientInterface.Client.Callbacks;
using PushTechnology.ClientInterface.Client.Factories;
using
    PushTechnology.ClientInterface.Client.Features.Control.Topics;
using PushTechnology.ClientInterface.Data.JSON;

namespace PushTechnology.ClientInterface.GettingStarted {
}
```

3. Create a Main method.

```
public sealed class PublishingClient
{
    public static void Main( string[] args ) {

    }
}
```

4. Inside the Main method, connect to the Diffusion server.

```
public static void Main( string[] args ) {
    // Connect using a principal with 'modify_topic' and
    'update_topic'
    // permissions
    var session =
    Diffusion.Sessions.Principal("principal").Password("password").Open("ws://hos
}
```

Or you can connect securely to the Diffusion server using :

```
.Open("wss://host:port");
```

Replace the *host*, *port*, *principal*, and *password* values with your own information.

You can choose to connect anonymously if anonymous sessions are assigned the `modify_topic` and `update_topic` permissions. However, we do not recommend that anonymous sessions are given write access to data on the Diffusion server.

5. Next, in the Main method, get the TopicControl and TopicUpdateControl features.

```
// Get the TopicControl and TopicUpdateControl features
var topicControl = session.TopicControl;
var updateControl = session.TopicUpdateControl;
```

The TopicControl feature enables a client to create and delete topics. For more information, see .
 The TopicUpdateControl feature enables a client to publish updates to a topic. For more information, see .

6. Next, in the Main method, use the TopicControl feature to create the foo/counter JSON topic.

```

        // Create a JSON topic 'foo/counter'
        var topic = "foo/counter";
        var addCallback = new AddCallback();
        topicControl.AddTopicFromValue(
            topic,
            Diffusion.DataTypes.JSON.FromJSONString( "{ \"date
            \": \"To be updated\", \"time\": \"To be updated\" }" ),
            addCallback );

        // Wait for the OnTopicAdded callback, or a failure
        if ( !
addCallback.Wait( TimeSpan.FromSeconds( 5 ) ) ) {
            Console.WriteLine( "Callback not received
            within timeout." );
            session.Close();
            return;
        } else if ( addCallback.Error != null ) {
            Console.WriteLine( "Error : {0}",
addCallback.Error.ToString() );
            session.Close();
            return;
        }
    }

```

The AddTopicFromValue() method requires a callback, which you must create.

7. Implement an instance of ITopicControlAddCallback as an internal sealed class.

```

    internal sealed class AddCallback : ITopicControlAddCallback {
        private readonly AutoResetEvent resetEvent = new
        AutoResetEvent( false );

        /// <summary>
        /// Any error from this AddCallback will be stored here.
        /// </summary>
        public Exception Error {
            get;
            private set;
        }

        /// <summary>
        /// Constructor.
        /// </summary>
        public AddCallback() {
            Error = null;
        }

        /// <summary>
        /// This is called to notify that a call context was closed
        prematurely, typically due to a timeout or the
        /// session being closed.
        /// </summary>
        /// <remarks>
        /// No further calls will be made for the context.
        /// </remarks>
        public void OnDiscard() {

```

```

        Error = new Exception( "This context was closed
prematurely." );
        resetEvent.Set();
    }

    /// <summary>
    /// This is called to notify that the topic has been added.
    /// </summary>
    /// <param name="topicPath">The full path of the topic that
was added.</param>
    public void OnTopicAdded( string topicPath ) {
        Console.WriteLine( "Topic {0} added.", topicPath );
        resetEvent.Set();
    }

    /// <summary>
    /// This is called to notify that an attempt to add a topic
has failed.
    /// </summary>
    /// <param name="topicPath">The topic path as supplied to
the add request.</param>
    /// <param name="reason">The reason for failure.</param>
    public void OnTopicAddFailed( string topicPath,
TopicAddFailReason reason ) {
        Error = new Exception( string.Format( "Failed to add
topic {0} : {1}", topicPath, reason ) );
        resetEvent.Set();
    }

    /// <summary>
    /// Wait for one of the callbacks for a given time.
    /// </summary>
    /// <param name="timeout">Time to wait for the callback.</
param>
    /// <returns><c>>true</c> if either of the callbacks has
been triggered. Otherwise <c>>false</c>.</returns>
    public bool Wait( TimeSpan timeout ) {
        return resetEvent.WaitOne( timeout );
    }
}

```

8. Back in the Main method, loop once a second updating the foo/counter topic with an incrementing count.

Use the `updateControl.Updater.Update()` method to update a topic without locking that topic.

```

        var updateCallback = new UpdateCallback( topic );
        for ( var i = 0; i < 1000; ++i ) {
            updateControl.Updater.Update( topic, i.ToString(),
updateCallback );

            Thread.Sleep( 1000 );
        }

```

The `Update()` method requires a callback, which you must create.

9. Implement an instance of `ITopicUpdaterUpdateCallback` as an internal sealed class.

```

    internal sealed class UpdateCallback :
ITopicUpdaterUpdateCallback {
        private readonly string topicPath;

```

```

        /// <summary>
        /// Constructor.
        /// </summary>
        /// <param name="topicPath">The topic path.</param>
        public UpdateCallback( string topicPath ) {
            this.topicPath = topicPath;
        }

        /// <summary>
        /// Notification of a contextual error related to
        this callback.
        /// </summary>
        /// <remarks>
        /// Situations in which <code>OnError</code> is
        called include the session being closed, a communication
        parameters. No further calls will be made to this callback.
        /// </remarks>
        /// <param name="errorReason">A value representing
        the error.</param>
        public void OnError( ErrorReason errorReason ) {
            Console.WriteLine( "Topic {0} could not be
            updated : {1}", topicPath, errorReason );
        }

        /// <summary>
        /// Indicates a successful update.
        /// </summary>
        public void OnSuccess() {
            Console.WriteLine( "Topic {0} updated
            successfully.", topicPath );
        }
    }

```

10. Finally, in the `Main` method, close the session between your client and the Diffusion server.

```

// Close session
session.Close();

```

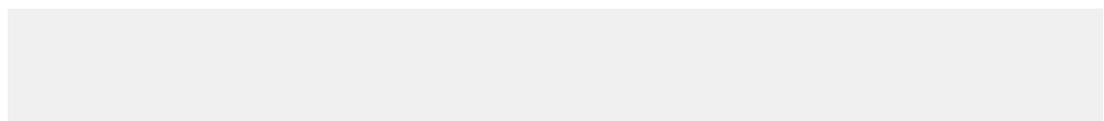
11. Compile and run your client.

Results

The client publishes a value to the `foo/counter` topic every second. You can subscribe to the `foo/counter` topic by creating a client to subscribe to the topic. For more information, see [Start subscribing with .NET](#) on page 210.

Full example

The completed publishing client class contains the following code:



C

The C client libraries are provided for Linux, Windows, and OS X/macOS.

Get the C client libraries for Linux:

Download the ZIP file from the following URL:

```
http://download.pushtechnology.com/clients/6.1.5/c/diffusion-c-6.1.5.zip
```

The ZIP file is also located in your Diffusion server installation:

```
diffusion_directory/clients/c/diffusion-c-6.1.5.zip
```

Get the C client libraries for Windows:

Download the ZIP file from the following URL:

```
http://download.pushtechnology.com/clients/6.1.5/c/diffusion-c-windows-6.1.5.zip
```

The ZIP file is also located in your Diffusion server installation:

```
diffusion_directory/clients/c/diffusion-c-windows-6.1.5.zip
```

Get the C client libraries for OS X/macOS:

Download the ZIP file from the following URL:

```
http://download.pushtechnology.com/clients/6.1.5/c/diffusion-c-osx-6.1.5.zip
```

The ZIP file is also located in your Diffusion server installation:

```
diffusion_directory/clients/c/diffusion-c-osx-6.1.5.zip
```

Capabilities

To see the full list of capabilities supported by the C API, see [Feature support in the Diffusion API](#) on page 37.

Support

Table 28: Supported platforms and transport protocols for the client libraries

Platform	Minimum supported versions	Supported transport protocols
C for Linux	Red Hat and CentOS, version 7.2 and later Ensure that you use a C99-capable compiler.	WebSocket
C for Windows	Visual C Compiler 2013 or later, Windows 7 or later	WebSocket

Platform	Minimum supported versions	Supported transport protocols
C for OS X/macOS	For building using GCC, use Xcode 8.0 or later	WebSocket

If you require libraries compiled on a different platform, this can be provided as an additional service by our Consulting Services team. Contact support@pushtechnology.com to discuss your requirements.

Resources

- [Examples for the C API.](#)
- [C API documentation](#)

Using

On Linux

The C libraries are provided compiled for 64-bit Linux in the file `diffusion-c-version.zip`. A dynamic library, `libdiffusion.so`, and a static library, `libdiffusion.a`, are available.

To use the C API on Linux ensure that the following dependencies are available on your development system:

- Perl Compatible Regular Expressions (PCRE) library, version 8.3 or later
For more information, see <http://pcre.org>
- OpenSSL library, version 1.0.2a or later
For more information, see <https://www.openssl.org>
- zLib library, version 1.2 or later
For more information, see <http://www.zlib.net>

You can download these dependencies through your operating system's package manager.

The C client library statically links to APR version 1.5 with APR-util. Ensure that you set `APR_DECLARE_STATIC` and `APU_DECLARE_STATIC` before you use any APR includes. You can set these values in the following ways:

- By including `diffusion.h` before any APR includes. The `diffusion.h` sets these values.
- As command-line flags

For more information, see <http://apr.apache.org>

On Windows

The C library is provided as a static library compiled for 32-bit and 64-bit Windows in the file `diffusion-c-windows-version.zip`. This static library, `uci.lib`, is compiled with Visual C Compiler 2013 (version 120), which is shipped by default with Microsoft Visual Studio 2013. You must use this version of Visual C Compiler or later and use Windows 7 or later. Earlier versions are not supported.

Other Windows compilers, such as Clang and GCC, are not supported.

When compiling with Visual C Compiler 2013, define `/D WIN32` in the compiler settings.

To use the C API on Windows ensure that the following dependencies are available on your development system:

- Perl Compatible Regular Expressions (PCRE) library, version 8.3 or later
For more information, see <http://pcre.org>
- OpenSSL library, version 1.0.2a or later
For more information, see <https://www.openssl.org>
- zLib library, version 1.2 or later
For more information, see <http://www.zlib.net>

We provide these dependencies in the `diffusion-c-windows-version.zip` file.

The C client library statically links to APR version 1.5 with APR-util. Ensure that you set `APR_DECLARE_STATIC` and `APU_DECLARE_STATIC` before you use any APR includes. You can set these values in the following ways:

- By including `diffusion.h` before any APR includes. The `diffusion.h` file sets these values.
- As command-line flags

For more information, see <http://apr.apache.org>

On OS X/macOS

The C library is provided as a static library, `libdiffusion.a`, compiled for 64-bit OS X/macOS in the file `diffusion-c-osx-version.zip`.

To use the C API on OS X/macOS ensure that the following dependencies are available on your development system:

- Perl Compatible Regular Expressions (PCRE) library, version 8.3 or later
For more information, see <http://pcre.org>
- zLib library, version 1.2 or later
For more information, see <http://www.zlib.net>

You can download this dependencies using `brew`.

The C client library statically links to APR version 1.5 with APR-util. Ensure that you set `APR_DECLARE_STATIC` and `APU_DECLARE_STATIC` before you use any APR includes. You can set these values in the following ways:

- By including `diffusion.h` before any APR includes. The `diffusion.h` file sets these values.
- As command-line flags

For more information, see <http://apr.apache.org>

For building using GCC, use Xcode 7.1 or later, which includes Apple LLVM.

Defining the structure of record topic data using XML

Data on record topics can be structured using metadata. Other Diffusion APIs provide builder methods you can use to define the metadata structure. The C API uses XML to define the structure of a record topic's metadata.

The following schema describes the structure of that XML:

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<xs:schema version="1.0" xmlns:xs="http://
www.w3.org/2001/XMLSchema">

  <xs:element name="field" type="field"/>
```

```

<xs:element name="message" type="message" />

<xs:element name="record" type="record" />

<xs:complexType name="record">
  <xs:complexContent>
    <xs:extension base="node">
      <xs:sequence>
        <xs:choice minOccurs="0" maxOccurs="unbounded">
          <xs:element ref="record" />
          <xs:element ref="field" />
        </xs:choice>
      </xs:sequence>
    </xs:extension>
  </xs:complexContent>
</xs:complexType>

<xs:complexType name="node">
  <xs:sequence />
  <xs:attribute name="name" type="xs:string"
use="required" />
  <xs:attribute name="multiplicity" type="xs:string" />
</xs:complexType>

<xs:complexType name="field">
  <xs:complexContent>
    <xs:extension base="node">
      <xs:sequence />
      <xs:attribute name="type" type="dataType"
use="required" />
      <xs:attribute name="default" type="xs:string" />
      <xs:attribute name="scale" type="xs:integer" />
      <xs:attribute name="allowsEmpty"
type="xs:boolean" />
      <xs:attribute name="customFieldHandlerClassName"
type="xs:string" />
    </xs:extension>
  </xs:complexContent>
</xs:complexType>

<xs:complexType name="message">
  <xs:complexContent>
    <xs:extension base="record">
      <xs:sequence />
      <xs:attribute name="topicDataType"
type="topicDataType" />
    </xs:extension>
  </xs:complexContent>
</xs:complexType>

<xs:simpleType name="dataType">
  <xs:restriction base="xs:string">
    <xs:enumeration value="integerString" />
    <xs:enumeration value="string" />
    <xs:enumeration value="customString" />
    <xs:enumeration value="decimalString" />
  </xs:restriction>
</xs:simpleType>

<xs:simpleType name="topicDataType">
  <xs:restriction base="xs:string">
    <xs:enumeration value="record" />
  </xs:restriction>

```

```
</xs:simpleType>
</xs:schema>
```

Threading model

The C API is not thread-safe. Session and their derived artifacts must belong to a single thread or only be acted upon by a single thread at any time.

Internally, the C client creates threads for managing the connection to the Diffusion server. All callbacks into user-defined code are synchronous and it usually the case that these must execute as quickly as possible. If this code runs for a non-trivial amount of time, ensure that it hands off work to your own threads.

It is safe to send messages while processing callbacks, as outbound messages are queued and are sent as soon as possible.

Ensure that callbacks do not alter the session as this can lead to undefined behavior. This includes calling functions such as `session_close()` from the session state change callback.

Always call `session_close()` and `session_free()` from the same thread that created the session with `session_create()` or `session_create_async()`. This allows the threads to be joined and reaped correctly, and is a requirement of the APR library which the C API relies on.

Regular expressions

The C client uses a different regular expression engine to the Diffusion server. Some regular expressions in topic selectors are evaluated on the client and others on the Diffusion server. It is possible that topic selectors that include complex or advanced regular expressions can behave differently on the client and on the Diffusion server.

For more information, see [Regular expressions](#) on page 55.

Start subscribing with C

Create a C client within minutes that connects to the Diffusion server. This example creates a client that subscribes to a JSON topic called "processes" and prints its value to the console when the topic is updated.

Before you begin

The C client libraries rely on a number of dependencies. Depending on the platform you are using, these dependencies might be included in the client library. If they are not included in the client library, ensure that the dependencies are available on your development system.

For more information about dependencies on each supported platform, see [C](#) on page 219.

The C client library statically links to APR version 1.5 with APR-util. Ensure that you set `APR_DECLARE_STATIC` and `APU_DECLARE_STATIC` before you use any APR includes. You can set these values in the following ways:

- By including `diffusion.h` before any APR includes. The `diffusion.h` file sets these values.
- As command-line flags

For more information, see <http://apr.apache.org>

To complete this example, you need a Diffusion server.

You also must either:

- create a named user that has a role with the `select_topic` and `read_topic` permissions
- assign a role with those permissions to anonymous client sessions.

An example of a suitable role is “CLIENT”. For more information about roles and permissions, see [Role-based authorization](#) on page 130.

About this task

This example steps through the lines of code required to subscribe to a topic. The [full code example](#) is provided after the steps.

Procedure

1. Get the Diffusion C client library for your platform and extract the ZIP file.
The C client library is available in the `clients/c` directory of the Diffusion installation.
2. Create a C file called `cjson-subscribing-example.c`.
 - a) Include the following libraries:

```
#include <stdio.h>
#include <apr.h>

#include "diffusion.h"
#include "args.h"
```

- b) Define some values to be used later.

```
#define SYNC_DEFAULT_TIMEOUT 5000 * 1000

apr_pool_t *pool = NULL;
apr_thread_mutex_t *mutex = NULL;
apr_thread_cond_t *cond = NULL;

ARG_OPTS_T arg_opts[] = {
    ARG_OPTS_HELP,
    {'u', "url", "Diffusion server URL", ARG_OPTIONAL,
     ARG_HAS_VALUE, "ws://localhost:8080"},
    {'p', "principal", "Principal (username) for the
     connection", ARG_OPTIONAL, ARG_HAS_VALUE, "user"},
    {'c', "credentials", "Credentials (password) for the
     connection", ARG_OPTIONAL, ARG_HAS_VALUE, "password"},
    {'t', "topic", "Topic name to subscribe", ARG_OPTIONAL,
     ARG_HAS_VALUE, "time"},
    END_OF_ARG_OPTS
};
```

The `ARG_OPTS_T` array is used to store arguments that can be passed when running the code, along with defaults if a value is not provided. You may wish to replace the defaults with your own values. *hostname* is the name of the system hosting your Diffusion server, *port* is the port the Diffusion server accepts client connections on, *user* is the name of a principal with the permissions required to subscribe to a topic, and *password* is the principal's password.

3. Create a main method.

Inside the main method add the following lines:

```
int
main(int argc, char **argv)
{
    /*
     * Standard command-line parsing.
     */
    HASH_T *options = parse_cmdline(argc, argv, arg_opts);
    if(options == NULL || hash_get(options, "help") != NULL) {
        show_usage(argc, argv, arg_opts);
    }
}
```

```

        return EXIT_FAILURE;
    }

    const char *url = hash_get(options, "url");
    const char *principal = hash_get(options, "principal");
    CREDENTIALS_T *credentials = NULL;
    const char *password = hash_get(options, "credentials");
    if(password != NULL) {
        credentials =
        credentials_create_password(password);
    }
    const char *topic_name = hash_get(options, "topic");
}

```

This does standard parsing of the command-line parameters.

4. Set up a mutex and condition variable, then create a session with the server.

```

    apr_initialize();
    apr_pool_create(&pool, NULL);
    apr_thread_mutex_create(&mutex, APR_THREAD_MUTEX_UNNESTED,
pool);
    apr_thread_cond_create(&cond, pool);

    DIFFUSION_ERROR_T error = { 0 };
    SESSION_T *session = session_create(url, principal,
credentials, NULL, NULL, &error);
    if(session == NULL) {
        fprintf(stderr, "Failed to create session: %s\n",
error.message);
        return EXIT_FAILURE;
    }
}

```

5. Handle any incoming subscription notifications, subscribe to a topic provided in the command line parameters (or the default one), process topic updates for 60 seconds then shut down.

```

    notify_subscription_register(session,
(NOTIFY_SUBSCRIPTION_PARAMS_T) { .on_notify_subscription =
on_notify_subscription });

    subscribe(session, (SUBSCRIPTION_PARAMS_T)
{ .topic_selector = topic_name, .on_topic_message =
on_topic_message, .on_subscribe = on_subscribe });

    // Receive updates for 2 minutes
    sleep(120);

    session_close(session, NULL);
    session_free(session);

    credentials_free(credentials);
    hash_free(options, NULL, free);

    apr_thread_cond_destroy(cond);
    apr_thread_mutex_destroy(mutex);
    apr_pool_destroy(pool);
    apr_terminate();

    return EXIT_SUCCESS;
}

```

Note that this code relies on callbacks which we will add in the following steps.

6. Above the main method, create the `on_notify_subscription` callback to handle when this client receives a notification that it has been subscribed to a topic. Note that this could be called for topics that we have not explicitly subscribed to. Other control clients (or publishers) may request to subscribe this client to a topic.

```
static int
on_notify_subscription(SESSION_T *session, const
    SVC_NOTIFY_SUBSCRIPTION_REQUEST_T *request, void *context)
{
    printf("on_notify_subscription: %d: \"%s\"\n",
        request->topic_info.topic_id,
        request->topic_info.topic_path);
    return HANDLER_SUCCESS;
}
```

7. Create the `on_subscribe` callback to handle when the server responds to say that a topic * subscription request has been received and processed.

```
static int
on_subscribe(SESSION_T *session, void *context_data)
{
    printf("on_subscribe\n");
    return HANDLER_SUCCESS;
}
```

8. Create the `on_topic_message` callback. When a subscribed message is received, this callback is invoked to print the JSON value.

```
static int
on_topic_message(SESSION_T *session, const TOPIC_MESSAGE_T *msg)
{
    printf("Received message for topic %s (%ld bytes)\n", msg->name, msg->payload->len);

    if(msg->details != NULL) {
        if(msg->details->topic_type == TOPIC_TYPE_JSON) {
            // Convert payload to a JSON string
            BUF_T *json = cbor_to_json(msg->payload->data, msg->payload->len);
            printf("As JSON: %.*s\n", (int)json->len, json->data);
            buf_free(json);
        }
        else {
            printf("Hexdump of binary data:\n");
            hexdump_buf(msg->payload);
        }
    }
    else {
        printf("Payload: %.*s\n",
            (int)msg->payload->len,
            msg->payload->data);
    }

    return HANDLER_SUCCESS;
}
```

9. Build your C client.
 - a) Create a Makefile in the same directory as your C file.

An [example Makefile](#) is provided after the steps.

b) Run the make command to build the example.

The `cjson-subscribing-example` binary is created in the `target/bin` directory.

10. Run your C client from the command line.

Results

The client prints to the console every time the value of the subscribed topic is updated. You can update the value of the topic by creating a publishing client to update the topic. By default, the client subscribes to the `processes` topic used in the [Start publishing with C](#) on page 228 example.

Example

The completed `cjson-subscribing-example.c` file contains the following code:

The Makefile contains the following code:

```
# The following two variables must be set.
#
# Directory containing the C client include files.
# DIFFUSION_C_CLIENT_INCDIR =
#
# Directory containing libdiffusion.a
# DIFFUSION_C_CLIENT_LIBDIR =
ifndef DIFFUSION_C_CLIENT_INCDIR
$(error DIFFUSION_C_CLIENT_INCDIR is not set)
endif
ifndef DIFFUSION_C_CLIENT_LIBDIR
$(error DIFFUSION_C_CLIENT_LIBDIR is not set)
endif
CC = gcc
# Extra definitions from parent directory, if they exist.
-include ../makefile.defs
CFLAGS += -g -Wall -Werror -std=c99
-D_POSIX_C_SOURCE=200112L -D_XOPEN_SOURCE=700 -I
$(DIFFUSION_C_CLIENT_INCDIR)
LDFLAGS += $(DIFFUSION_C_CLIENT_LIBDIR)/libdiffusion.a
-lpthread -lpcrc -lz $(LIBS)
# If you have openssl installed then you can uncomment
these.
ifdef HAVE_OPEN_SSL
LDFLAGS += -lssl -lcrypto
endif
ARFLAGS +=
SOURCES = json/cjson-subscribing-example.c
TARGETDIR = target
OBJDIR = $(TARGETDIR)/objs
BINDIR = $(TARGETDIR)/bin
OBJECTS = $(SOURCES:.c=.o)
TARGETS = cjson-subscribing-example
all: prepare $(TARGETS)
.PHONY: all
prepare:
mkdir -p $(OBJDIR) $(BINDIR)
$(OBJDIR)/%.o: %.c
$(CC) $(CFLAGS) -c -o $@ $<
cjson-subscribing-example: json/cjson-subscribing-
example.c
```

```
$(CC) $^ $(CFLAGS) $(LDFLAGS) -lm -o $(BINDIR)/$@
clean:
rm -rf $(TARGETS) $(OBJECTS) $(TARGETDIR) core a.out
```

Start publishing with C

Create a C client that publishes data through topics on the Diffusion server.

Before you begin

The C client libraries rely on a number of dependencies. Depending on the platform you are using, these dependencies might be included in the client library. If they are not included in the client library, ensure that the dependencies are available on your development system.

For more information about dependencies on each supported platform, see [C](#) on page 219.

The C client library statically links to APR version 1.5 with APR-util. Ensure that you set `APR_DECLARE_STATIC` and `APU_DECLARE_STATIC` before you use any APR includes. You can set these values in the following ways:

- By including `diffusion.h` before any APR includes. The `diffusion.h` file sets these values.
- As command-line flags

For more information, see <http://apr.apache.org>

To complete this example, you need a Diffusion server and a development system with the .NET Framework installed on it.

You also require a named user that has a role with the `modify_topic` and `update_topic` permissions. For example, the “ADMINISTRATOR” role. For more information about roles and permissions, see [Role-based authorization](#) on page 130.

This example also requires the external cJSON library which can be downloaded from <https://github.com/DaveGamble/cJSON/>.

About this task

This example illustrates how to create a client that publishes a list of running processes to a JSON topic. The [full code example](#) is provided after the steps.

Procedure

1. Get the Diffusion C client library for your platform and extract the ZIP file.
The C client library is available in the `clients/c` directory of the Diffusion installation.
2. Get the `cJSON.c` and `cJSON.h` files from <https://github.com/DaveGamble/cJSON/> and add them to the same directory.
3. Create a C file called `cjson-publishing-example.c`.
 - a) Include the following libraries:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <math.h>
#include <time.h>

#ifdef WIN32
#define sleep(x) Sleep(1000 * x) // Windows specific
#endif

#include <apr.h>
```

```
#include "diffusion.h"
#include "args.h"

#include "cJSON.h"
```

b) Set up JSON parsing with cJSON.

```
static void json_to_cbor(cJSON *item, CBOR_GENERATOR_T
    *cbor_generator);
```

c) Create some required values:

```
#define SYNC_DEFAULT_TIMEOUT 5000 * 1000

int volatile g_active = 0;
CONVERSATION_ID_T volatile *g_updater_id;

apr_pool_t *pool = NULL;
apr_thread_mutex_t *mutex = NULL;
apr_thread_cond_t *cond = NULL;

ARG_OPTS_T arg_opts[] = {
    ARG_OPTS_HELP,
    {'u', "url", "Diffusion server URL", ARG_OPTIONAL,
    ARG_HAS_VALUE, "ws://localhost:8080"},
    {'p', "principal", "Principal (username) for the
    connection", ARG_OPTIONAL, ARG_HAS_VALUE, "control" },
    {'c', "credentials", "Credentials (password) for the
    connection", ARG_OPTIONAL, ARG_HAS_VALUE, "password" },
    {'t', "topic", "Topic name to create and update",
    ARG_OPTIONAL, ARG_HAS_VALUE, "time" },
    ARG_OPTS_END_OF_ARG_OPTS
};
```

d) Add the main method:

```
int
main(int argc, char **argv)
{
    /*
    * Standard command-line parsing.
    */
    HASH_T *options = parse_cmdline(argc, argv, arg_opts);
    if(options == NULL || hash_get(options,
    "help") != NULL) {
        show_usage(argc, argv, arg_opts);
        return EXIT_FAILURE;
    }

    const char *url = hash_get(options, "url");
    const char *principal = hash_get(options, "principal");
    CREDENTIALS_T *credentials = NULL;
    const char *password = hash_get(options, "credentials");
    if(password != NULL) {
        credentials =
        credentials_create_password(password);
    }
    const char *topic_name = hash_get(options, "topic");

    /*
    * Setup mutex and condition variable.
```

```

    */
    apr_initialize();
    apr_pool_create(&pool, NULL);
    apr_thread_mutex_create(&mutex,
        APR_THREAD_MUTEX_UNNESTED, pool);
    apr_thread_cond_create(&cond, pool);

    /*
     * Create a session with the Diffusion server.
     */
    DIFFUSION_ERROR_T error = { 0 };
    SESSION_T *session = session_create(url, principal,
        credentials, NULL, NULL, &error);
    if(session == NULL) {
        fprintf(stderr, "Failed to create session: %s
\n", error.message);
        return EXIT_FAILURE;
    }

    /*
     * Synchronously create a topic holding JSON content.
     */
    TOPIC_DETAILS_T *topic_details =
        create_topic_details_json();
    const ADD_TOPIC_PARAMS_T add_topic_params = {
        .topic_path = topic_name,
        .details = topic_details,
        .on_topic_added = add_topic_callback,
        .on_topic_add_failed = add_topic_callback
    };
    apr_thread_mutex_lock(mutex);
    add_topic(session, add_topic_params);
    apr_status_t rc = apr_thread_cond_timedwait(cond, mutex,
        SYNC_DEFAULT_TIMEOUT);
    apr_thread_mutex_unlock(mutex);
    topic_details_free(topic_details);
    if(rc != APR_SUCCESS) {
        fprintf(stderr, "Timed out while waiting for
topic to be created\n");
        return EXIT_FAILURE;
    }

    /*
     * Register an updater for the topic.
     */
    const UPDATE_SOURCE_REGISTRATION_PARAMS_T
    update_reg_params = {
        .topic_path = topic_name,
        .on_active = register_updater_callback,
        .on_standby = register_updater_callback,
        .on_close = register_updater_callback
    };
    apr_thread_mutex_lock(mutex);
    g_updater_id = register_update_source(session,
        update_reg_params);
    rc = apr_thread_cond_timedwait(cond, mutex,
        SYNC_DEFAULT_TIMEOUT);
    apr_thread_mutex_unlock(mutex);
    if(rc != APR_SUCCESS) {
        fprintf(stderr, "Timed out while waiting to
register an updater\n");
        return EXIT_FAILURE;
    }
}

```

```

/*
 * Define default parameters for an update source.
 */
UPDATE_VALUE_PARAMS_T update_value_params_base = {
    .updater_id = (CONVERSATION_ID_T *)g_updater_id,
    .topic_path = (char *)topic_name,
    .on_success = on_update_success,
    .on_failure = on_update_failure
};

time_t current_time;
struct tm *time_info;
char json[255];
char format_string[] = "{\"day\":\"%d\", \"month\":\"%m
\", \"year\":\"%Y\", \"hour\":\"%H\", \"minute\":\"%M\", \"second\":
\"%S\"}";

/*
 * Forever, until deactivated.
 */
while(g_active) {
    // Get current time
    current_time = time(NULL);
    if(current_time == ((time_t)-1)) {
current time\n");
        return EXIT_FAILURE;
    }

    // Get UTC time info
    time_info = gmtime( &current_time );
    if(time_info == NULL) {
time info\n");
        return EXIT_FAILURE;
    }

    // Construct JSON string based on current time
    //if(strftime(json, sizeof(json), "{\"day\":
%e}", &time_info) == 0) {
    if(strftime(json, sizeof(json), format_string,
time_info) == 0) {
JSON value\n");
        return EXIT_FAILURE;
    }

    printf("Updated value: %s\n", json);

    // Convert JSON to CBOR
    cJSON *json_object = cJSON_Parse(json);
    CBOR_GENERATOR_T *cbor_generator =
cbor_generator_create();
    json_to_cbor(json_object, cbor_generator);

    // Extract the CBOR-encoded data and wrap it in
a BUF_T structure.
    BUF_T *cbor_buf = buf_create();
    buf_write_bytes(cbor_buf, cbor_generator->data,
cbor_generator->len);

```

```

        // Issue an update request to Diffusion. Under
the covers,
        // this transmits a binary delta of changes,
assuming those
        // changes are smaller than sending the entire
value.
        UPDATE_VALUE_PARAMS_T update_value_params =
update_value_params_base;
        update_value_params.data = cbor_buf;
        update_value(session, update_value_params);

        buf_free(cbor_buf);
        cbor_generator_free(cbor_generator);
        cJSON_Delete(json_object);

        // Sleep for a second
        sleep(1);
    }

    puts("Updater not active, exiting.");

    session_close(session, NULL);
    session_free(session);

    credentials_free(credentials);
    hash_free(options, NULL, free);

    apr_thread_cond_destroy(cond);
    apr_thread_mutex_destroy(mutex);
    apr_pool_destroy(pool);
    apr_terminate();

    return EXIT_SUCCESS;
}

```

4. Add handlers.

```

/*
 * Handler for add topic feature.
 */
static int
add_topic_callback(SESSION_T *session, const
SVC_ADD_TOPIC_RESPONSE_T *response, void *context)
{
    if(response->reason != ADD_TOPIC_FAILURE_REASON_SUCCESS &&
        response->reason != ADD_TOPIC_FAILURE_REASON_EXISTS) {
        fprintf(stderr, "Failed to add topic\n");
        exit(EXIT_FAILURE);
    }
    apr_thread_mutex_lock(mutex);
    apr_thread_cond_broadcast(cond);
    apr_thread_mutex_unlock(mutex);
    return HANDLER_SUCCESS;
}

/*
 * Handler for processing updater registration callbacks.
 */
static int
register_updater_callback(SESSION_T *session,
                        const CONVERSATION_ID_T *updater_id,

```

```

                                const SVC_UPDATE_REGISTRATION_RESPONSE_T
*response,
                                void *context)
{
    apr_thread_mutex_lock(mutex);

    switch(response->state) {
    case UPDATE_SOURCE_STATE_ACTIVE:
        g_active = 1;
        break;
    default:
        g_active = 0;
        break;
    }
    apr_thread_cond_broadcast(cond);
    apr_thread_mutex_unlock(mutex);
    return HANDLER_SUCCESS;
}

/*
 * Handlers for update of data.
 */
static int
on_update_success(SESSION_T *session,
                  const CONVERSATION_ID_T *updater_id,
                  const SVC_UPDATE_RESPONSE_T *response,
                  void *context)
{
    char *id_str = conversation_id_to_string(*updater_id);
    printf("on_update_success for updater \"%s\"\n", id_str);
    free(id_str);
    return HANDLER_SUCCESS;
}

static int
on_update_failure(SESSION_T *session,
                  const CONVERSATION_ID_T *updater_id,
                  const SVC_UPDATE_RESPONSE_T *response,
                  void *context)
{
    char *id_str = conversation_id_to_string(*updater_id);
    printf("on_update_failure for updater \"%s\"\n", id_str);
    free(id_str);
    return HANDLER_SUCCESS;
}

```

5. Add functions using the cJSON library to process JSON.

```

/*
 * This function takes a JSON token, and writes an equivalent CBOR
 * token to
 * the supplied CBOR generator.
 */
static void
cbor_write_json_token(cJSON *item, CBOR_GENERATOR_T
*cbor_generator)
{
    if(item->string) {
        // The item is a JSON key/value pair; write out the
        key.
        cbor_write_text_string(cbor_generator, item-
>string, strlen(item->string));
    }
}

```

```

switch(item->type) {
case cJSON_False:
    cbor_write_false(cbor_generator);
    break;
case cJSON_True:
    cbor_write_true(cbor_generator);
    break;
case cJSON_NULL:
    cbor_write_null(cbor_generator);
    break;
case cJSON_Number:
    if(floor(item->valuedouble) == item->valuedouble) {
        cbor_write_uint(cbor_generator, item-
>valueint);
    }
    else {
        cbor_write_float(cbor_generator, item-
>valuedouble);
    }
    break;
case cJSON_String:
    cbor_write_text_string(cbor_generator, item-
>valuestring, strlen(item->valuestring));
    break;
case cJSON_Array:
    cbor_write_array(cbor_generator,
cJSON_GetArraySize(item));
    break;
case cJSON_Object:
    cbor_write_map(cbor_generator,
cJSON_GetArraySize(item));
    break;
default:
    printf("Unknown type\n");
    break;
}
}

/*
 * Iterate/recurse through a JSON object, building up a stream of
 * CBOR tokens
 * inside a CBOR generator.
 */
static void
json_to_cbor(cJSON *item, CBOR_GENERATOR_T *cbor_generator)
{
    while(item) {
        cbor_write_json_token(item, cbor_generator);
        if(item->child) {
            json_to_cbor(item->child, cbor_generator);
        }
        item = item->next;
    }
}

```

6. Build your C client.

a) Create a Makefile in the same directory as your C file.

An [example Makefile](#) is provided after the steps.

b) Ensure that your Makefile links to the `include` and `lib` directory of the Diffusion C library.

```
DIFFUSION_C_CLIENT_INCDIR = ../path-to-client/include
```

```
DIFFUSION_C_CLIENT_LIBDIR = ../path-to-client/lib
```

c) Run the make command to build the example.

The `cjson-publishing-example` binary is created in the `target/bin` directory.

7. Run your C client from the command line.

Results

The client updates the value of the `processes` topic. You can see the value of the `processes` topic by creating a subscribing client to subscribe to the topic. For more information, see [Start subscribing with C](#) on page 223.

Example

The completed `cjson-publishing-example` file contains the following code:

The Makefile contains the following code:

```
# The following two variables must be set.
#
# Directory containing the C client include files.
# DIFFUSION_C_CLIENT_INCDIR =
#
# Directory containing libdiffusion.a
# DIFFUSION_C_CLIENT_LIBDIR =

ifndef DIFFUSION_C_CLIENT_INCDIR
$(error DIFFUSION_C_CLIENT_INCDIR is not set)
endif

ifndef DIFFUSION_C_CLIENT_LIBDIR
$(error DIFFUSION_C_CLIENT_LIBDIR is not set)
endif

CC      = gcc

# Extra definitions from parent directory, if they exist.
-include ../makefile.defs

CFLAGS      += -g -Wall -Werror -std=c99 -D_POSIX_C_SOURCE=200112L
             -D_XOPEN_SOURCE=700 -I$(DIFFUSION_C_CLIENT_INCDIR)
LDFLAGS     += $(DIFFUSION_C_CLIENT_LIBDIR)/libdiffusion.a -
             lpthread -lpcrc -lz $(LIBS)
# If you have openssl installed then you can uncomment these.
ifdef HAVE_OPENSSL
LDFLAGS     += -lssl -lcrypto
endif

ARFLAGS    +=
SOURCES    = json/cjson-publishing-example.c

TARGETDIR  = target
OBJDIR     = $(TARGETDIR)/objs
BINDIR     = $(TARGETDIR)/bin
OBJECTS    = $(SOURCES:.c=.o)
TARGETS    = cjson-publishing-example
```

```

all:          prepare $(TARGETS)
.PHONY:      all

prepare:
    mkdir -p $(OBJDIR) $(BINDIR)

$(OBJDIR)/%.o: %.c
    $(CC) $(CFLAGS) -c -o $@ $<

cjson-publishing-example: json/cjson-publishing-example.c json/
cJSON.c
    $(CC) $^ $(CFLAGS) $(LDFLAGS) -lm -o $(BINDIR)/$@

clean:
    rm -rf $(TARGETS) $(OBJECTS) $(TARGETDIR) core a.out

```

Connecting to the Diffusion server

One of the first actions your Diffusion client takes is to connect to the Diffusion server. Clients connect to the Diffusion server by opening a session. A session represents a logical context between a client and the Diffusion server. All interactions with the Diffusion server happen within a session.

Sessions

The act of opening the session establishes a connection with the the Diffusion server. When a session is opened it is assigned a unique session identifier by the Diffusion server, which identifies the session even if it becomes connected to another server.

The session does not receive input from the Diffusion server until it is started, but can be used to obtain features and perform certain setup actions before it is started.

Session state

The session between a client and the Diffusion server can be in one of a number of states.

The following diagram shows the session state model:

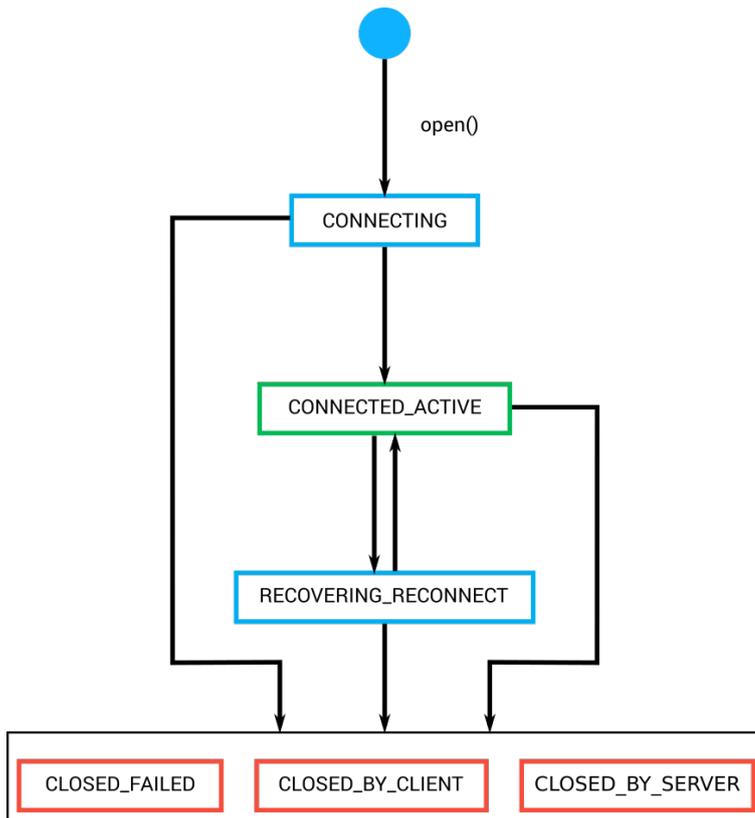


Figure 18: Session state model

CONNECTING

The client session is in this state while it attempts to connect to the Diffusion server. If the connection attempt is successful, the session changes to `CONNECTED_ACTIVE` state. If the connection is not successful, the session changes to one of the closed states.

CONNECTED_ACTIVE

The client session is in this state while it is connected to the Diffusion server. The session spends the majority of its lifetime in this state. If the session becomes disconnected and reconnect is enabled, the session changes to `RECOVERING_CONNECT` state. If the session closes, it changes to one of the closed states.

RECOVERING_CONNECT

The client session is in this state while it attempts to reconnect to the Diffusion server after a disconnection. If the reconnection attempt is successful, the session changes back to `CONNECTED_ACTIVE` state. If the reconnection attempt is not successful, the session changes to one of the closed states.

CLOSED_BY_CLIENT

The client session is in this state when it is closed by the client. If a session is in closed state, it cannot be reopened. A new session must be established.

CLOSED_BY_SERVER

The client session is in this state when it is closed by the Diffusion server. If a session is in closed state, it cannot be reopened. A new session must be established.

CLOSED_FAILED

The client session is in this state when it is closed for any reason other than a close by the client or by the Diffusion server. If a session is in closed state, it cannot be reopened. A new session must be established.

For more information, see [Managing your session](#) on page 242.

Session properties

When you connect to the Diffusion server by opening a session, the session is assigned a set of properties. These properties are assigned by either the Diffusion server or an authentication handler and can be used by clients to filter the set of connected client sessions to take actions on.

For more information, see [Session properties](#) on page 266.

Session roles

When a session authenticates with the Diffusion server, the session is assigned a set of roles. These roles are assigned by either the Diffusion server or an authentication handler and define the set of permissions a client session has.

For more information, see [Role-based authorization](#) on page 130.

Connecting basics

To make a connection to the Diffusion server the client must specify the host name and port number of the Diffusion server, the transport to use to connect, and whether that connection is secure.

The Diffusion API is an asynchronous API. As such, the client APIs for all languages provide asynchronous connect methods.

A subset of the Diffusion APIs also provide synchronous connect methods: the Android, Java, .NET, and C APIs. In the following sections, all examples for these APIs are synchronous for simplicity. For asynchronous examples for these APIs, see [Asynchronous connections](#) on page 240.

Connection parameters

host

The host name or IP address of the system on which the Diffusion server is located.

port

The port on which the Diffusion server accepts connections from clients using the Diffusion API. You can configure which ports to provide connectors for in the `Connectors.xml` configuration file. For more information, see .

transport

The transport used to make the connection. For example, WebSocket (`ws`). The transports your client can use to make a connection depend on the client library capabilities. For more information, see [Platform support for the Diffusion API libraries](#) on page 35.

secure

Whether the connection is made over SSL.

Connecting

In JavaScript, Android and Java, you can define each of these parameters individually:

JavaScript

```
diffusion.connect({
  host : 'host_name',
  port : 'port', // If not specified, port defaults to 80 for
                // standard connections or 443 for secure connections
  transports : 'transport', // If not specified, transports
                // defaults to 'WS' and the client uses a WebSocket connection
  secure : false // If not specified, secure defaults to false
}).then(function(session) { ... } );
```

Java and Android

```
final Session session = Diffusion
    .sessions()
    .serverHost("host_name")
    // If no port is specified, the port defaults to 80 for standard
    // connections or 443 for secure connections
    .serverPort(port)
    // If no transports are specified, the connection defaults to
    // use the WebSocket transport
    .transports(transport)
    // If not specified, secure transport defaults to false
    .secureTransport(false)
    .open();
```

In Apple, Android, Java, .NET and C, composite the host, port, transport, and whether the connection is secure into a single URL-style string of the following form: *transport[s]://host:port*.

For example, *ws://diffusion.example.com:8080*.

Use this URL to open the connection to the Diffusion server:

Apple

```
[PTDiffusionSession openWithURL:[NSURL URLWithString:@"url"]
    completionHandler:^(PTDiffusionSession *session,
    NSError *error)
{
    // Check error is `nil`, then use session as required.
    // Ensure to maintain a strong reference to the session beyond
    // the lifetime
    // of this callback, for example by assigning it to an instance
    // variable.
}];
```

Java and Android

```
Session session = Diffusion.sessions().open("url");
```

.NET

```
var session = Diffusion.Sessions.Open( "url" );
```

C

```
SESSION_T *session = session_create(url, NULL, NULL,
    &session_listener, NULL, NULL);
```

Connecting with multiple transports

In JavaScript, you can specify a list of transports. The client uses these transports to provide a *transport cascading* capability.

JavaScript

```
diffusion.connect({
  host : 'host_name',
  transports : ['transport', 'transport', 'transport']
}).then(function(session) { ... } );
```

Java and Android

```
final Session session = Diffusion
    .sessions()
    .serverHost("host_name")
    .serverPort(port)
    .transports(transport, transport, transport)
    .open();
```

1. The client attempts to connect using the first transport listed.
2. If the connection is unsuccessful, the client attempts to connect using the next transport listed.
3. This continues until the one of the following events happens:
 - The client makes a connection
 - The client has attempted to make a connection using every listed transport. If this happens, the connection fails.

You can use specify that a client attempt to connect with a transport more than once. This enables you to define retry behavior. For example:

JavaScript

```
transports: ['WS', 'XHR', 'WS']
```

Java and Android

```
.transports(WEBSOCKET, WEBSOCKET, WEBSOCKET)
```

Transport cascading is useful to specify in your clients as it enables them to connect from many different environments. Factors such as the firewall in use, your end-user's mobile provider, or your end-user's browser can affect which transports can successfully make a connection to the Diffusion server.

Asynchronous connections

All Diffusion APIs can connect asynchronously to the Diffusion server:

JavaScript

```
diffusion.connect({
  host : 'host_name',
  port : 'port'
}).then(function(session) { ... } );
```

Apple

```
// Excluding the port from the URL defaults to 80, or 443 for secure
connections
[PTDiffusionSession openWithURL:[NSURL URLWithString:@"url"]
```

```

        completionHandler:^(PTDiffusionSession * newSession,
NSError * error)
    {
        // Check error is `nil`, then use session as required.
        // Ensure to maintain a strong reference to the session beyond
        the lifetime
        // of this callback, for example by assigning it to an instance
        variable.
    }];

```

Java and Android

```

// openAsync returns a CompletableFuture that completes with a
// Session when a response is received from the server
Diffusion.sessions().openAsync("url").thenApply(session -> { ... });

```

.NET

```

// Define a callback that implements ISessionOpenCallback and pass
// this to the open method
Diffusion.Sessions.Open("url", callback );

```

C

```

/*
 * Asynchronous connections have callbacks for notifying that
 * a connection has been made, or that an error occurred.
 */
SESSION_CREATE_CALLBACK_T *callbacks = calloc(1,
sizeof(SESSION_CREATE_CALLBACK_T));
callbacks->on_connected = &on_connected;
callbacks->on_error = &on_error;

session_create_async(url, principal, credentials,
&session_listener, reconnection_strategy, callbacks, &error);

```

Synchronous connections

The following APIs can connect synchronously to the Diffusion server:

Java and Android

```

Session session = Diffusion.sessions().open("url");

```

.NET

```

var session = Diffusion.Sessions.Open( "url" );

```

C

```

SESSION_T *session = session_create(url, NULL, NULL,
&session_listener, NULL, NULL);

```

When connecting to the Diffusion server using the Android API, prefer the asynchronous `open()` method with a callback. Using the synchronous `open()` method might open a connection on the same thread as the UI and cause a runtime exception. However, the synchronous `open()` method can be used in any thread that is not the UI thread.

Managing your session

When your client has opened a session with the Diffusion server, you can listen for session events to be notified when the session state changes. For more information about session states, see [Session state](#) on page 236.

JavaScript

In JavaScript, listen for the following events on the session:

- `disconnect`: The session has lost connection to the Diffusion server.
The session state changes from `CONNECTED_ACTIVE` to `RECOVERING_RECONNECT`. This event is only emitted if `reconnect` is enabled.
- `reconnect`: The session has re-established connection to the Diffusion server.
The session state changes from `RECOVERING_RECONNECT` to `CONNECTED_ACTIVE`.
- `close`: The session has closed. The provided close reason indicates whether this was caused by the client, the Diffusion server, a failure to connect, or an error.
The session state changes to one of `CLOSED_FAILED`, `CLOSED_BY_SERVER`, or `CLOSED_BY_CLIENT`.
- `error`: A session error occurs.

JavaScript

```
session.on('disconnect', function() {
    console.log('Lost connection to the server.');
```

```
});
session.on('reconnect', function() {
    console.log('Reconnected to the session on the server.');
```

```
});
session.on('close', function() {
    console.log('Session is closed.');
```

```
});
session.on('error', function() {
    console.log('A session error occurred.');
```

```
});
```

Apple

In Apple, the following boolean properties are available on the states that are broadcast through the default notification center for the application process and posted on the main dispatch queue:

- `isConnected`: If true, the state is equivalent to the `CONNECTED_ACTIVE` state.
- `isRecovering`: If true, the state is equivalent to the `RECOVERING_RECONNECT` state.
- `isClosed`: If true, the state is one of `CLOSED_FAILED`, `CLOSED_BY_SERVER`, or `CLOSED_BY_CLIENT`.

The broadcast includes both the old state and new state of the session. It also includes an error property that is `nil` unless the session closure was caused by a failure.

Apple

```
NSNotificationCenter * nc = [NSNotificationCenter defaultCenter];
[nc addObserverForName:PTDiffusionSessionStateDidChangeNotification
    object:session
    queue:nil
    usingBlock:^(NSNotification * note)
{
    PTDiffusionSessionStateChange * change =
    note.userInfo[PTDiffusionSessionStateChangeUserInfoKey];
    NSLog(@"Session state change: %@", change);
```

```
}];
```

Other SDKs

In Android, Java, .NET, and C listen for changes to the session state. The listener provides both the old state and new state of the session. The states provided are those listed in the session state diagram. For more information, see [Session state](#) on page 236.

Java and Android

```
// Add the listener to the session
session.addListener(new Listener() {
    @Override
    public void onSessionStateChanged(Session session, State
oldState, State newState) {

        System.out.println("Session state changed from " +
oldState.toString() + " to " + newState.toString());

    }
});
```

.NET

```
// Add the listener to the session factory you will use to create the
session
var sessionFactory =
Diffusion.Sessions.SessionStateChangedHandler( ( sender, args ) => {

    Console.WriteLine( "Session state changed from " +
args.OldState.ToString() + " to " + args.NewState.ToString() );

} );
```

C

```
// Define a session listener
static void
on_session_state_changed(SESSION_T *session,
    const SESSION_STATE_T old_state,
    const SESSION_STATE_T new_state)
{
    printf("Session state changed from %s (%d) to %s (%d)\n",
        session_state_as_string(old_state), old_state,
        session_state_as_string(new_state), new_state);
}

// ...

// Use the session listener when opening your session
SESSION_LISTENER_T session_listener = { 0 };
session_listener.on_state_changed =
&on_session_state_changed;

session_create_async(url, principal, credentials,
&session_listener, &reconnection_strategy, callbacks, &error);
```

Connecting securely

A Diffusion client can make secure connections to the Diffusion server over TLS. All supported transports can connect securely.

To connect securely do one of the following:

- In JavaScript, set the `secure` parameter to `true`
- In Android and Java, when specifying parameters individually, pass `true` to the `secureTransport()` method.
- If using a URL to connect, insert an “s” after the transport value in the `url` parameter. For example, `wss://diffusion.example.com:443`.

Configure the SSL context or behavior

A secure connection to the Diffusion server uses SSL to secure the communication.

When connecting over SSL, you might need to configure SSL.

- In JavaScript, the SSL context is provided by the browser.
- In Android, Java, and .NET, you can provide an SSL context when creating the session.
- In Apple, you can use the `sslOptions` property to provide a dictionary of values that specify the SSL behavior. For more information, see the [CFStreamConstants documentation](#).

Java and Android

```
Session session =  
Diffusion.sessions().sslContext(ssl_context).open("secure_url");
```

.NET

```
var session =  
Diffusion.Sessions.SslContext(ssl_context).Open("secure_url");
```

If no SSL context or behavior is specified, the client uses the default context or configuration.

Validating server-side certificates

Diffusion clients that connect over a secure transport use certificates to validate the security of their connection to the Diffusion server. These certificates are validated against any certificates in the set trusted by the framework, runtime, or platform that the client library runs on.

If the client does not trust the certificate provided by a CA, you can configure the client to add certificates to its trust store:

- For Java, see [Certificates](#) on page 199
- For .NET, see [Certificates](#) on page 209

You can also write a trust manager that explicitly allows the CA's certificates.

Disabling certificate validation on the client

You can disable client validation of the server-side certificates.

Note: We do not recommend disabling this validation on your production clients. However, it can be useful for testing.

Certificates can only be strictly validated if they have been issued by an appropriate Certificate Authority (CA) and if the CA's certificates are also known to your client.

Since certificates are specific to the domain name that the server is deployed on, Diffusion ships with demo certificates and these cannot be strictly validated. To test against a server with demo certificates, disable client-side SSL certificate validation as shown in the following examples:

Apple

```
// Create a session configuration with non-standard SSL options...
PTDiffusionMutableSessionConfiguration *const configuration =
    [PTDiffusionMutableSessionConfiguration new];
configuration.sslOptions = @{
    (__bridge id)kCFStreamSSLValidatesCertificateChain
        : (__bridge id)kCFBooleanFalse
};

// Use the configuration to open a new session...
[PTDiffusionSession openWithURL:[NSURL URLWithString:@"wss://
TestServer"]
                    configuration:configuration
                    completionHandler:^(PTDiffusionSession *session,
                                        NSError *error)
{
    // Check error is `nil`, then use session as required.
    // Ensure to maintain a strong reference to the session beyond
    the lifetime
    // of this callback, for example by assigning it to an instance
    variable.
}];
```

Java and Android

```
TrustManager tm = new X509TrustManager() {
    public void checkClientTrusted(X509Certificate[] chain,
    String authType) throws CertificateException {
    }

    public void checkServerTrusted(X509Certificate[] chain,
    String authType) throws CertificateException {
    }

    public X509Certificate[] getAcceptedIssuers()
    {
        return new X509Certificate[0];
    }
};

final SSLContext context = SSLContext.getInstance("TLS");
context.init( null, new TrustManager[] { tm }, null );

Session session =
Diffusion.sessions().sslContext(context).open("secure_url");
```

C

```
//Set this environmental variable
DIFFUSION_TRUST_SELF_SIGNED_CERTS=1
```

Connecting to the Diffusion server with a security principal and credentials

The Diffusion server can accept anonymous connections. However, if your clients specify a security principal (for example, a username) and its associated credentials (for example, a password) when they connect, these client sessions can be authenticated and authorized in a more granular way.

Authentication parameters

principal

A string that contains the name of the principal or identity that is connecting to the Diffusion server. If a value is not specified when connecting, the principal defaults to ANONYMOUS.

credentials

Credentials are a piece of information that authenticates the principal. This can be empty or contain a password, a cryptographic key, an image, or any other piece of information.

If you connect to the Diffusion server using a principal and credentials, connect over SSL to ensure that these details are encrypted.

Connecting using any type of credentials

In JavaScript and C the method that opens a connection to the Diffusion server takes `principal` and `credentials` as parameters:

JavaScript

```
diffusion.connect({
  host : 'host_name',
  port : 'port',
  principal: 'principal',
  credentials: 'credentials'
});
```

C

```
SESSION_T *session = session_create(url, principal, credentials,
&session_listener, NULL, NULL);
```

Any form of credentials can be wrapped in a credentials object. This can be empty or contain a password, a cryptographic key, an image, or any other piece of information. The authentication handler is responsible for interpreting the bytes.

In the Apple, Android, Java, and .NET API specify the credentials as a credentials object. The principal and credentials are specified when configuring the session before opening it:

Apple

```
PTDiffusionCredentials *const credentials =
    [[PTDiffusionCredentials alloc] initWithData:data];

PTDiffusionSessionConfiguration *const configuration =
    [[PTDiffusionSessionConfiguration alloc]
    initWithPrincipal:@"principal"
    credentials:credentials];

[PTDiffusionSession openWithURL:[NSURL URLWithString:@"wss://
push.example.com"]
    configuration:configuration
```

```

        completionHandler:^(PTDiffusionSession *session,
NSError *error)
{
    // Check error is `nil`, then use session as required.
    // Ensure to maintain a strong reference to the session beyond
the lifetime
    // of this callback, for example by assigning it to an instance
variable.
}];

```

Java and Android

```

Session session = Diffusion.sessions()
                    .principal("principal")
                    .credentials("credentials")
                    .open("url");

```

.NET

```

var session = Diffusion.Sessions
                .Principal("principal")
                .Credentials("credentials")
                .Open( "url" );

```

Connecting using a string password as credentials

A string password is the most commonly used type of credentials. The Apple, Android, Java, and .NET API provide a convenience method that enables you to specify credentials as a string password. The principal and credentials are specified when configuring the session before opening it:

Apple

```

// Create a credentials object encapsulating a string password.
PTDiffusionCredentials *const credentials =
    [[PTDiffusionCredentials alloc] initWithPassword:@"password"];

PTDiffusionSessionConfiguration *const configuration =
    [[PTDiffusionSessionConfiguration alloc]
initWithPrincipal:@"principal"
credentials:credentials];

[PTDiffusionSession openWithURL:[NSURL URLWithString:@"url"]
configuration:configuration
completionHandler:^(PTDiffusionSession *session,
NSError *error)
{
    // Check error is `nil`, then use session as required.
    // Ensure to maintain a strong reference to the session beyond
the lifetime
    // of this callback, for example by assigning it to an instance
variable.
}];

```

Java and Android

```

Session session = Diffusion.sessions()
                    .principal("principal")
                    .password("credentials")
                    .open("url");

```

.NET

```
var session = Diffusion.Sessions
    .Principal("principal")
    .Password("credentials")
    .Open("url");
```

Connecting using a byte array as credentials

The Android, Java, and .NET API provide a convenience method that enables you to specify credentials as a byte array. The principal and credentials are specified when configuring the session before opening it:

Java and Android

```
Session session = Diffusion.sessions()
    .principal("principal")
    .customCredentials(byte_credentials)
    .open("url");
```

.NET

```
var session = Diffusion.Sessions
    .Principal("principal")
    .CustomCredentials(byte_credentials)
    .Open("url");
```

Changing the principal and credentials a session uses

The client session can change the principal and credentials it uses to connect to the Diffusion server at any time. For more information, see [Change the security principal and credentials associated with your client session](#) on page 265.

Connecting through an HTTP proxy

Clients can connect to the Diffusion server through an HTTP proxy by using the HTTP CONNECT verb to create the connection and tunneling any of the supported transports through that connection.

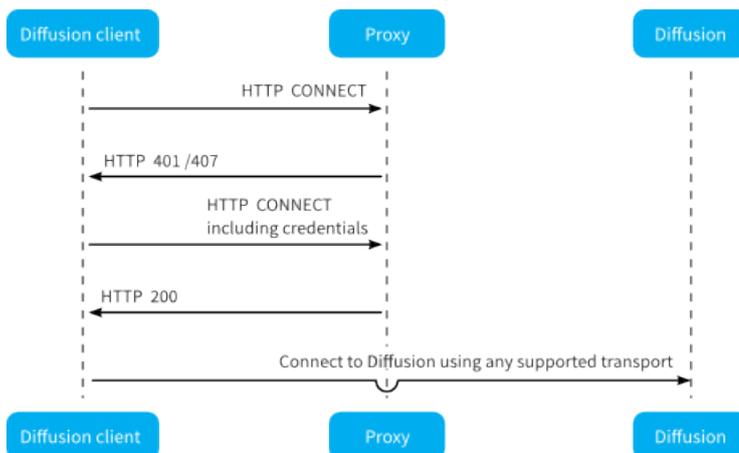


Figure 19: Flow of requests and responses when connecting to Diffusion through a proxy.

Apple, Android, Java, and .NET clients can connect to the Diffusion server through an HTTP proxy by specifying additional information on connection.

With no authentication at the proxy

When creating your session, add an HTTP proxy to the session by passing in the host and port number of the proxy.

Apple

```
// Create a mutable session configuration.
PTDiffusionMutableSessionConfiguration *const configuration =
    [PTDiffusionMutableSessionConfiguration new];

// Create an unauthenticated HTTP proxy configuration.
PTDiffusionHTTPProxyConfiguration *const proxyConfiguration =
    [[PTDiffusionHTTPProxyConfiguration alloc] initWithHost:@"proxy"
                                                         port:80];

// Specify the proxy configuration.
configuration.httpProxyConfiguration = proxyConfiguration;

// Open the session, specifying this configuration.
[PTDiffusionSession openWithURL:[NSURL URLWithString:@"wss://
push.example.com"]
                        configuration:configuration
                        completionHandler:^(PTDiffusionSession *session,
                                           NSError *error)
{
    // Check error is `nil`, then use session as required.
    // Ensure to maintain a strong reference to the session beyond
    the lifetime
    // of this callback, for example by assigning it to an instance
    variable.
}];
```

Java and Android

```
Diffusion.sessions().httpProxy(host, port)
```

.NET

```
var session = Diffusion.Sessions
    .HttpProxy( host, port )
    .Open( diffusionUrl );
```

With basic authentication at the proxy

If the proxy requires basic authentication, the client can use the implementation in the Diffusion API to authenticate.

When creating your session, add an HTTP proxy to the session by passing in the host and port number of the proxy and a proxy authentication object that provides the challenge handler for basic authentication.

Apple

```
// Create a mutable session configuration.
PTDiffusionMutableSessionConfiguration *const configuration =
    [PTDiffusionMutableSessionConfiguration new];

// Create an authentication provider for the HTTP proxy.
const id<PTDiffusionHTTPAuthentication> authentication =
    [[PTDiffusionBasicHTTPProxyAuthentication alloc]
     initWithUsername:@"user"]
```

```

password:@"pass"];

// Create an authenticated HTTP proxy configuration using the
// provider.
PTDiffusionHTTPProxyConfiguration *const proxyConfiguration =
    [[PTDiffusionHTTPProxyConfiguration alloc] initWithHost:@"proxy"
                                                         port:80

    authentication:authentication];

// Specify the proxy configuration.
configuration.httpProxyConfiguration = proxyConfiguration;

// Open the session, specifying this configuration.
[PTDiffusionSession openWithURL:[NSURL URLWithString:@"wss://
push.example.com"]
                        configuration:configuration
                        completionHandler:^(PTDiffusionSession *session,
NSError *error)
{
    // Check error is `nil`, then use session as required.
    // Ensure to maintain a strong reference to the session beyond
the lifetime
    // of this callback, for example by assigning it to an instance
variable.
}]];

```

Java and Android

```

HTTPProxyAuthentication auth =
    Diffusion.proxyAuthentication().basic(username, password);
Diffusion.sessions().httpProxy(host, port, auth);

```

.NET

```

var clientAuth = Diffusion.ProxyAuthentication.Basic( username,
password );
var session = Diffusion.Sessions
                .HttpProxy( host, port, clientAuth )
                .Open( diffusionUrl );

```

With another form of authentication at the proxy

If the proxy requires another form of authentication, the client can implement a challenge handler that the client uses to authenticate.

Implement the `HTTPProxyAuthentication` interface to provide a challenge handler that can handle the type of authentication your proxy uses. When creating your session, add an HTTP proxy to the session by passing in the host and port number of the proxy and a proxy authentication object that provides your challenge handler.

Note: The proxy authentication mechanism is separate from the client authentication mechanism and is transparent to the Diffusion server.

Connecting through a load balancer

Connections between Diffusion clients and Diffusion servers can be routed through a load balancer. Some clients can pass additional information to a load balancer in the request path of their URL.

Supported in: JavaScript, Apple, Android, C and Java APIs

An additional request path can be specified to define the connection URL context.

JavaScript

```
diffusion.connect({
  host : 'host_name',
  port : 'port',
  transports : 'transport',
  secure : false,
  path: '/path/diffusion'
}).then(function(session) { ... } );
```

Apple

```
NSString *const host = @"host";
NSString *const additionalInformationAsPath = @"path";

// Formulate the URL string for connection via secure WebSocket,
// appending the required '/diffusion' suffix.
NSString *const url = [NSString stringWithFormat:@"wss://%@/%@/
diffusion",
    host, additionalInformationAsPath];

// Open the session, using the formulated URL.
[PTDiffusionSession openWithURL:[NSURL URLWithString:url]
    completionHandler:^(PTDiffusionSession *session,
        NSError *error)
{
    // Check error is `nil`, then use session as required.
    // Ensure to maintain a strong reference to the session beyond
    the lifetime
    // of this callback, for example by assigning it to an instance
    variable.
}];
```

Java and Android

```
final Session session = Diffusion
    .sessions()
    .serverHost("host_name")
    .serverPort(port)
    .transports(transport)
    .secureTransport(false)
    .requestPath("/path/diffusion");
    .open();
```

Specify a request path that begins with / and ends with /diffusion. The default value is /diffusion.

Load balancer configuration

Connections between Diffusion clients and Diffusion servers have specific requirements. If your load balancer handles Diffusion connections incorrectly, for example by routing subsequent client requests to different backend Diffusion servers, this can cause problems for your solution.

For more information about how to configure your load balancers to work with Diffusion, see [Load balancers](#) on page 703.

Reconnect to the Diffusion server

When clients connect to the Diffusion server over unreliable networks these connections can be lost. Clients can attempt to reconnect to the Diffusion server after they lose connection.

Diffusion keeps client sessions in the DISCONNECTED state for a period of time, during which the client can reconnect to the same session. The length of time the Diffusion server keeps a client session in the DISCONNECTED state for is configured for the connector that the client uses. For more information, see [Configuring connectors](#) on page 503.

Configuring reconnection on the client

Clients have reconnection enabled by default.

You can configure a reconnection timeout that restricts the amount of time the client can be disconnected and still reconnect to its session on the Diffusion server. The period of time that the Diffusion server keeps the session available for reconnect is the lowest of the following values:

- The reconnection timeout configured by the client when it creates its session
- The reconnection timeout configured on the Diffusion server for the connector that the client connects on

When the reconnection timeout period configured by the client ends, the client stops attempting to reconnect and closes its session.

JavaScript

```
diffusion.connect({
  host : 'url',
  reconnect : {
    // Specify the timeout in milliseconds
    timeout : reconnection_time
  }
})
```

Apple

```
PTDiffusionMutableSessionConfiguration *const configuration =
    [PTDiffusionMutableSessionConfiguration new];

// Specify the timeout in seconds
configuration.reconnectionTimeout = @10;

[PTDiffusionSession openWithURL:[NSURL URLWithString:@"url"]
    configuration:configuration
    completionHandler:^(PTDiffusionSession *session,
        NSError *error)
    {
        // Check error is `nil`, then use session as required.
        // Ensure to maintain a strong reference to the session beyond
        the lifetime
        // of this callback, for example by assigning it to an instance
        variable.
    }];
```

Java and Android

```
final Session session = Diffusion
    .sessions()
    // Specify the timeout in milliseconds
```

```
.reconnectionTimeout(reconnection_time)
.open("url");
```

.NET

```
var session = Diffusion.Sessions
    // Specify the timeout in milliseconds
    .ReconnectionTimeout(reconnection_time)
    .Open("url");
```

C

```
reconnection_strategy_set_timeout(&reconnection_strategy, reconnection_time);
SESSION_T *session = session_create(url, NULL, NULL, NULL,
    &reconnection_strategy, NULL);
```

Set the value of the reconnection timeout to zero to disable reconnection. If no reconnection timeout is specified, a default of 60 seconds (60000 ms) is used.

You can also define your own custom reconnection behavior using reconnection strategies. For more information, see [Specifying a reconnection strategy](#) on page 255.

If no custom reconnection strategy is defined, the client attempts to reconnect at five second intervals until the reconnection timeout is reached.

Reliable reconnection

If a client loses connection to the Diffusion server, data sent between the client and the Diffusion server in either direction might be lost in transmission. If this happens and the client reconnects to its session on the Diffusion server, lost data might cause the client state or topic data to be incorrect.

To prevent any data being lost, the reconnection process re-synchronizes the streams of messages from the client session to the Diffusion server and from the Diffusion server to the client session. When reconnecting, the client notifies the Diffusion server of the last message received and the earliest message it can send again. The Diffusion server resends any missing messages and instructs the client session to resume from the appropriate message.

To be able to send messages again, the Diffusion server maintains a recovery buffer of sent messages. Some types of client also maintain a recovery buffer of sent messages that can be sent again if necessary.

If a message has been lost and is no longer present in the recovery buffer, the server will abort the reconnection. If reconnection succeeds, delivery of all messages is assured.

Configuring the recovery buffer on the client

All Diffusion clients can retain a buffer of messages that they have sent to the Diffusion server. If messages from the client are lost in transmission during a disconnection and subsequent reconnection, the client can resend the missing messages to the Diffusion server.

In the Apple, Java, Android and .NET APIs, you can configure the size of this buffer, in messages, when creating your session on the Diffusion server:

Apple

```
PTDiffusionMutableSessionConfiguration *const configuration =
    [PTDiffusionMutableSessionConfiguration new];

configuration.recoveryBufferSize = 1000;

[PTDiffusionSession openWithURL:[NSURL URLWithString:@"url"]]
```

```

        configuration:configuration
        completionHandler:^(PTDiffusionSession *session,
NSError *error)
    {
        // Check error is `nil`, then use session as required.
        // Ensure to maintain a strong reference to the session beyond
the lifetime
        // of this callback, for example by assigning it to an instance
variable.
    }];

```

Java and Android

```

final Session session = Diffusion
    .sessions()
    .recoveryBufferSize(number_of_messages)
    .open("url");

```

.NET

```

var session =
    Diffusion.Sessions.RecoveryBufferSize( number_of_messages
    ).Open("url");

```

The default size of the recovery buffer is 128 messages.

The larger this buffer is, the greater the chance of successful reconnection. However, a larger buffer of messages increases the memory footprint of a client.

Configuring the recovery buffer on the Diffusion server

The recovery buffers on the Diffusion server can be configured on a per-connector basis in the `Connectors.xml` configuration file. For more information, see [Configuring connectors](#) on page 503.

Related concepts

[Session reconnection](#) on page 575

You can configure the session reconnection feature by configuring the connectors at the Diffusion server to keep the client session in a disconnected state for a period before closing the session.

Detecting connection problems

A client can automatically detect if there are problems with its connection to the Diffusion server and take action to handle any disconnection.

When a client detects that it has become disconnected from the Diffusion server, the session state changes from `CONNECTED` to one of the following states:

- If reconnection is enabled at the client and at the Diffusion server, the session state changes to `RECOVERING`.
- If reconnection is not enabled, the session state changes to `DISCONNECTED`.

The client can detect that it has become disconnected from the Diffusion server using the following methods:

Monitoring the connection activity

The client automatically monitors the activity between the client and the Diffusion server and uses this information to quickly discover any connection problems.

Using TCP state

Depending on the transport the client uses to connect to the Diffusion server, the client can use the TCP state to detect whether to change its state from CONNECTED to one of RECOVERING or DISCONNECTED.

- WebSocket: The client uses the TCP state to detect whether to trigger a state change.
- HTTP Polling: The client uses the TCP state at certain points during an HTTP request to detect whether to trigger a state change.

Specifying a reconnection strategy

Reconnection behavior can be configured using custom reconnection strategies.

The reconnection behavior of a client session can be configured using reconnection strategies. A reconnection strategy is applied when the session enters the RECOVERING_RECONNECT state, enabling the session to attempt to reconnect and recover its previous state.

Reconnection can only succeed if the client session is still available on the Diffusion server. The maximum time that the Diffusion server keeps client sessions in the DISCONNECTED state before closing them can be configured using the `Connectors.xml` configuration file. For more information, see [Configuring connectors](#) on page 503.

Individual client sessions can request a shorter reconnection timeout for their sessions or request to disable reconnection when they first connect to the Diffusion server

Examples

JavaScript

```
// When establishing a session, it is possible to specify whether
// reconnection
// should be attempted in the event of an unexpected disconnection.
// This allows
// the session to recover its previous state.

// Set the maximum amount of time we'll try and reconnect for to 10
// minutes
var maximumTimeoutDuration = 1000 * 60 * 10;

// Set the maximum interval between reconnect attempts to 60 seconds
var maximumAttemptInterval = 1000 * 60;

// Set an upper limit to the number of times we'll try to reconnect
// for
var maximumAttempts = 25;

// Count the number of reconnection attempts we've made
var attempts = 0;

// Create a reconnection strategy that applies an exponential back-
// off
// The strategy will be called with two arguments, start & abort.
// Both
// of these are functions, which allow the strategy to either start a
// reconnection attempt, or to abort reconnection (which will close
// the session)
var reconnectionStrategy = function(start, abort) {
    if (attempts > maximumAttempts) {
        abort();
    } else {
```

```

        var wait = Math.min(Math.pow(2, attempts++) * 100,
maximumAttemptInterval);

        // Wait the specified time period, and then start the
reconnection attempt
        setTimeout(start, wait);
    }
};

// Connect to the server.
diffusion.connect({
    host : 'diffusion.example.com',
    port : 443,
    secure : true,
    principal : 'control',
    credentials : 'password',
    reconnect : {
        timeout : maximumTimeoutDuration,
        strategy : reconnectionStrategy
    }
}).then(function(session) {

    session.on('disconnect', function() {
        // This will be called when we lose connection. Because we've
specified the
        // reconnection strategy, it will be called automatically
when this event
        // is dispatched
    });

    session.on('reconnect', function() {
        // If the session is able to reconnect within the reconnect
timeout, this
        // event will be dispatched to notify that normal operations
may resume
        attempts = 0;
    });

    session.on('close', function() {
        // If the session is closed normally, or the session is
unable to reconnect,
        // this event will be dispatched to notify that the session
is no longer
        // operational.
    });
});
});

```

Apple

```

@import Diffusion;

@interface ExponentialBackoffReconnectionStrategy : NSObject
<PTDiffusionSessionReconnectionStrategy>
@end

@implementation CustomReconnectionStrategyExample {
    PTDiffusionSession* _session;
}

-(void)startWithURL:(NSURL*)url {
    NSLog(@"Connecting...");
}

```

```

    PTDiffusionMutableSessionConfiguration *const
sessionConfiguration =
    [PTDiffusionMutableSessionConfiguration new];

    // Set the maximum amount of time we'll try and reconnect for to
10 minutes.
    sessionConfiguration.reconnectionTimeout = @(10.0 * 60.0); //
seconds

    // Set the reconnection strategy to be used.
    sessionConfiguration.reconnectionStrategy =
[ExponentialBackoffReconnectionStrategy new];

    // Start connecting asynchronously.
    [PTDiffusionSession openWithURL:url
        configuration:sessionConfiguration
        completionHandler:^(PTDiffusionSession *session,
NSError *error)
    {
        if (!session) {
            NSLog(@"Failed to open session: %@", error);
            return;
        }

        // At this point we now have a connected session.
        NSLog(@"Connected.");

        // Set ivar to maintain a strong reference to the session.
        _session = session;
    }];
}

@end

@implementation ExponentialBackoffReconnectionStrategy {
    NSUInteger _attemptCount;
}

-(void) diffusionSession:(PTDiffusionSession *const)session
wishesToReconnectWithAttempt:
(PTDiffusionSessionReconnectionAttempt *const)attempt {
    // Limit the maximum time to delay between reconnection attempts
to 60 seconds.
    const NSTimeInterval maximumAttemptInterval = 60.0;

    // Compute delay for exponential backoff based on the number of
attempts so far.
    const NSTimeInterval delay = MIN(pow(2.0, _attemptCount++) * 0.1,
maximumAttemptInterval);

    // Schedule asynchronous execution.
    NSLog(@"Reconnection attempt scheduled for %.2fs", delay);
    dispatch_after(dispatch_time(DISPATCH_TIME_NOW, (int64_t)(delay *
NSEC_PER_SEC)),
        dispatch_get_main_queue(), ^
    {
        NSLog(@"Attempting reconnection.");
        [attempt start];
    });
}

@end

```

Java and Android

```
import java.util.concurrent.Executors;
import java.util.concurrent.ScheduledExecutorService;
import java.util.concurrent.TimeUnit;

import com.pushtechology.diffusion.client.Diffusion;
import com.pushtechology.diffusion.client.session.Session;
import com.pushtechology.diffusion.client.session.Session.Listener;
import com.pushtechology.diffusion.client.session.Session.State;
import
    com.pushtechology.diffusion.client.session.reconnect.ReconnectionStrategy;

/**
 * This example class demonstrates the ability to set a custom {@link
 * ReconnectionStrategy}
 * when creating sessions.
 *
 * @author Push Technology Limited
 * @since 5.5
 */
public class ClientWithReconnectionStrategy {

    private volatile int retries = 0;
    /**
     * Constructor.
     */
    public ClientWithReconnectionStrategy() {

        // Set the maximum amount of time we'll try and reconnect for
        to 10 minutes.
        final int maximumTimeoutDuration = 1000 * 60 * 10;

        // Set the maximum interval between reconnect attempts to 60
        seconds.
        final long maximumAttemptInterval = 1000 * 60;

        // Create a new reconnection strategy that applies an
        exponential backoff
        final ReconnectionStrategy reconnectionStrategy = new
        ReconnectionStrategy() {
            private final ScheduledExecutorService scheduler =
            Executors.newScheduledThreadPool(1);

            @Override
            public void performReconnection(final ReconnectionAttempt
            reconnection) {
                final long exponentialWaitTime =
                    Math.min((long) Math.pow(2, retries++) * 100L,
                    maximumAttemptInterval);

                scheduler.schedule(new Runnable() {
                    @Override
                    public void run() {
                        reconnection.start();
                    }
                }, exponentialWaitTime, TimeUnit.MILLISECONDS);
            }
        };
    }
};
```

```

        final Session session =
Diffusion.sessions().reconnectionTimeout(maximumTimeoutDuration)

        .reconnectionStrategy(reconnectionStrategy)
                                                                    .open("ws://
diffusion.example.com:80");
        session.addListener(new Listener() {
            @Override
            public void onSessionStateChanged(Session session, State
oldState, State newState) {

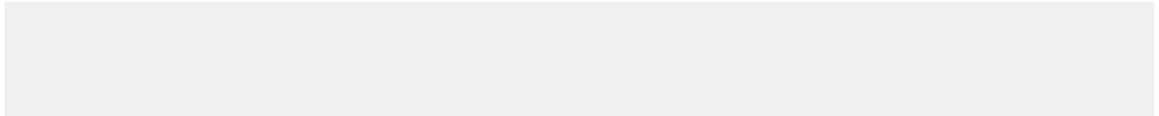
                if (newState == State.RECOVERING_RECONNECT) {
                    // The session has been disconnected, and has
entered recovery state. It is during this state that
                    // the reconnect strategy will be called
                }

                if (newState == State.CONNECTED_ACTIVE) {
                    // The session has connected for the first time,
or it has been reconnected.
                    retries = 0;
                }

                if (oldState == State.RECOVERING_RECONNECT) {
                    // The session has left recovery state. It may
either be attempting to reconnect, or the attempt has
                    // been aborted; this will be reflected in the
newState.
                }
            }
        });
    }
}

```

.NET



C

```

/*
 * This example shows how to make a synchronous connection to
 * Diffusion, with user-provided reconnection logic.
 */
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#include <unistd.h>

#include <apr_time.h>

#include "diffusion.h"
#include "args.h"

ARG_OPTS_T arg_opts[] = {
    ARG_OPTS_HELP,
    {'u', "url", "Diffusion server URL", ARG_OPTIONAL,
    ARG_HAS_VALUE, "ws://localhost:8080"},

```

```

        {'p', "principal", "Principal (username) for the connection",
ARG_OPTIONAL, ARG_HAS_VALUE, NULL},
        {'c', "credentials", "Credentials (password) for the
connection", ARG_OPTIONAL, ARG_HAS_VALUE, NULL},
        {'s', "sleep", "Time to sleep before disconnecting (in
seconds).", ARG_OPTIONAL, ARG_HAS_VALUE, "5" },
        END_OF_ARG_OPTS
};

/*
 * This callback is used when the session state changes, e.g. when a
session
 * moves from a "connecting" to a "connected" state, or from
"connected" to
 * "closed".
 */
static void
on_session_state_changed(SESSION_T *session,
        const SESSION_STATE_T old_state,
        const SESSION_STATE_T new_state)
{
    printf("Session state changed from %s (%d) to %s (%d)\n",
        session_state_as_string(old_state), old_state,
        session_state_as_string(new_state), new_state);
}

typedef struct {
    long current_wait;
    long max_wait;
} BACKOFF_STRATEGY_ARGS_T;

static RECONNECTION_ATTEMPT_ACTION_T
backoff_reconnection_strategy(SESSION_T *session, void *args)
{
    BACKOFF_STRATEGY_ARGS_T *backoff_args = args;

    printf("Waiting for %ld ms\n", backoff_args->current_wait);

    apr_sleep(backoff_args->current_wait * 1000); // µs -> ms

    // But only up to some maximum time.
    if(backoff_args->current_wait > backoff_args->max_wait) {
        backoff_args->current_wait = backoff_args->max_wait;
    }

    return RECONNECTION_ATTEMPT_ACTION_START;
}

static void
backoff_success(SESSION_T *session, void *args)
{
    printf("Reconnection successful\n");

    BACKOFF_STRATEGY_ARGS_T *backoff_args = args;
    backoff_args->current_wait = 0; // Reset wait.
}

static void
backoff_failure(SESSION_T *session, void *args)
{
    printf("Reconnection failed (%s)\n",
        session_state_as_string(session->state));
}

```

```

        BACKOFF_STRATEGY_ARGS_T *backoff_args = args;

        // Exponential backoff.
        if(backoff_args->current_wait == 0) {
            backoff_args->current_wait = 1;
        }
        else {
            backoff_args->current_wait *= 2;
        }
    }

    /*
     * Entry point for the example.
     */
    int
    main(int argc, char **argv)
    {
        /*
         * Standard command-line parsing.
         */
        HASH_T *options = parse_cmdline(argc, argv, arg_opts);
        if(options == NULL || hash_get(options, "help") != NULL) {
            show_usage(argc, argv, arg_opts);
            return EXIT_FAILURE;
        }

        const char *url = hash_get(options, "url");
        const char *principal = hash_get(options, "principal");
        CREDENTIALS_T *credentials = NULL;
        const char *password = hash_get(options, "credentials");
        if(password != NULL) {
            credentials = credentials_create_password(password);
        }

        const unsigned int sleep_time = atol(hash_get(options,
"sleep"));

        SESSION_T *session;
        DIFFUSION_ERROR_T error = { 0 };

        SESSION_LISTENER_T session_listener = { 0 };
        session_listener.on_state_changed =
&on_session_state_changed;

        /*
         * Set the arguments to our exponential backoff strategy.
         */
        BACKOFF_STRATEGY_ARGS_T *backoff_args = calloc(1,
sizeof(BACKOFF_STRATEGY_ARGS_T));
        backoff_args->current_wait = 0;
        backoff_args->max_wait = 5000;

        /*
         * Create the backoff strategy.
         */
        RECONNECTION_STRATEGY_T *reconnection_strategy =
make_reconnection_strategy_user_function(backoff_reconnection_strategy,
backoff_args,
backoff_success,

```

```

backoff_failure,
                                                                    NULL);

    /*
     * Only ever retry for 30 seconds.
     */
    reconnection_strategy_set_timeout(reconnection_strategy, 30 *
1000);

    /*
     * Create a session, synchronously.
     */
    session = session_create(url, principal, credentials,
&session_listener, reconnection_strategy, &error);
    if(session != NULL) {
        char *sid_str = session_id_to_string(session->id);
        printf("Session created (state=%d, id=%s)\n",
session_state_get(session), sid_str);
        free(sid_str);
    }
    else {
        printf("Failed to create session: %s\n",
error.message);
        free(error.message);
    }

    // With the exception of backoff_args, the reconnection
strategy is
    // copied withing session_create() and may be freed now.
    free(reconnection_strategy);

    /*
     * Sleep for a while.
     */
    sleep(sleep_time);

    /*
     * Close the session, and release resources and memory.
     */
    session_close(session, NULL);
    session_free(session);

    free(backoff_args);

    credentials_free(credentials);
    hash_free(options, NULL, free);

    return EXIT_SUCCESS;
}

```

Related concepts

[Session reconnection](#) on page 575

You can configure the session reconnection feature by configuring the connectors at the Diffusion server to keep the client session in a disconnected state for a period before closing the session.

Session failover

Session failover occurs when a client that disconnects from a Diffusion server attempts to connect to a different Diffusion server that also has information about that client's session.

For session failover to occur, session replication must be configured for a cluster of Diffusion servers. For more information, see [Configuring replication](#) on page 528.

Differences between session reconnection and session failover

When a client loses a load-balanced connection to Diffusion, one of the following things can occur when the client attempts to reconnect through the load balancer:

Session reconnection

The load balancer forwards the client connection to the Diffusion server it was previously connected to, if that server is still available. For more information, see [Reconnect to the Diffusion server](#) on page 252.

Session failover

The load balancer forwards the client connection to a different Diffusion server that shares information about the client's session, if session replication is enabled between the servers.

Prefer session reconnection to session failover wherever possible by ensuring that the load balancer is configured to route all connections from a specific client to the same server if that server is available.

Session reconnection is more efficient as less data must be sent to the client and has less risk of data loss, as sent messages can be recovered, in-flight requests are not lost, and handlers do not need to be registered again.

For more information, see [Routing strategies at your load balancer](#) on page 703.

To a client the process of disconnection and subsequent reconnection has the following differences for session reconnection or session failover.

Session reconnection	Session failover
The client connects to the same Diffusion server it was previously connected to.	The client connects to a Diffusion server different to the one it was previously connected to.
The client sends its last session token to the server.	
The server authenticates the client connection or validates its session token.	
The server uses the session token to resynchronize the streams of messages between the server and client by resending any messages that were lost in transmission from a buffer of sent messages. If lost messages cannot be recovered because they are no longer present in a buffer, the server aborts the reconnection.	The server uses the session token to retrieve the session state and topic selections from the datagrid.
The server sends any messages that have been queued since the session disconnected.	The server uses the state to recover the session, uses the topic selections to match the subscribed topics, and sends the session the current topic value for each subscribed topic.

Session reconnection	Session failover
	Any in-flight requests made by the client session to the previous server are cancelled and the client session is notified by a callback. All handlers, including authentication handlers and update sources, that the client session had registered with the previous server are closed and receive a callback to notify them of the closure.

Pinging the Diffusion server

Ping the Diffusion server from your client. If the ping is successful it reports the round-trip time between your client and the Diffusion server.

The Diffusion client libraries and the Diffusion server include capabilities that automatically check whether the connection is active. However, there might be times when you want to check the connection from within your client code. For example, if the client is aware that the device it is hosted on has recently changed from a 3G connection to a WiFi connection.

Use the pings capability to asynchronously ping the Diffusion server.

JavaScript

```
session.pingServer().then(function(pingResult) {
    // Take action based on ping details.
});
```

Apple

```
[session.pings pingServerWithCompletionHandler:
 ^{PTDiffusionPingDetails *details, NSError *error}
 {
    // Check error is `nil`, indicating success.
}];
```

Java and Android

```
Pings pings = session.feature(Pings.class);
pings.pingServer(context, callback);
```

.NET

```
IPings pings = session.Ping;
pings.PingServer( context, callback );
```

C

```
PING_USER_PARAMS_T params = {
    .on_ping_response = on_ping_response_user
};
ping_user(session, params);
```

Change the security principal and credentials associated with your client session

A client session can change the credentials it uses to authenticate with the Diffusion server at any time.

JavaScript

```
session.security.changePrincipal('principal',
'password').then(function() {
    console.log('Authenticated as admin');
});
```

Apple

```
// Create a credentials object encapsulating a string password.
PTDiffusionCredentials *const credentials =
    [[PTDiffusionCredentials alloc] initWithPassword:@"password"];

// Use the Security feature from your session...
[session.security changePrincipal:@"principal"
    credentials:credentials
    completionHandler:^(NSError *error)
{
    // Check error is `nil`, indicating success.
}];
```

Java and Android

```
security = session.feature(Security.class);
security.changePrincipal(
    principal,
    Diffusion.credentials().password(password),
    callback);
```

.NET

```
security = session.Security;
security.ChangePrincipal( principal,
Diffusion.Credentials.Password( password ), callback );
```

C

```
// Specify callbacks for the change_principal request.
CHANGE_PRINCIPAL_PARAMS_T params = {
    .principal = hash_get(options, "principal"),
    .credentials = credentials,
    .on_change_principal = on_change_principal,
    .on_change_principal_failure =
on_change_principal_failure
};

// Do the change.
change_principal(session, params);
```

When the principal associated with a session changes, the following happens:

- The \$Principal session property is updated to contain the new principal.
- The roles associated with the old principal are removed from the session and those roles associated with the new principal are assigned to the session.

- Topic subscriptions made with the old principal are not re-evaluated. The session remains subscribed to any topics the new principal does not have permissions for.

Session properties

A client session has a number of properties associated with it. Properties are key-value pairs. Both the key and the value are case sensitive.

Session properties provide a powerful way for client sessions to target actions at a specific session or set of sessions whose session properties match a given criteria. Client sessions can use session filtering to select a set of client sessions upon which to perform one of the following actions:

- Send messages directly to that session or set of sessions.
For more information, see [Sending request messages to a session filter](#) on page 386.
- Subscribe that session or set of sessions to a topic.
For more information, see [Managing subscriptions](#) on page 363.
- Unsubscribe that session or set of sessions from a topic.
For more information, see [Managing subscriptions](#) on page 363.

For more information, see [Session filtering](#) on page 267.

A client session with the appropriate permissions can also view all of the session properties and modify the user-defined session properties. For more information, see [Working with session properties](#) on page 422.

Fixed properties

Fixed properties are set by the Diffusion server when a client opens a session with it. Fixed property keys are prefixed by a dollar sign (\$). The fixed session properties are:

\$SessionId

The session identifier.

\$Principal

The security principal the session uses to connect to the Diffusion server.

\$ClientType

The client type of the session. For more information, see [Client types](#) on page 114.

\$Transport

The transport the client session uses to connect to the Diffusion server. For more information, see [Client types](#) on page 114.

\$ServerName

The name of the Diffusion server that the client connects to.

\$Connector

The name of the connector on which the client connected to the Diffusion server.

\$Country

The two letter country code for the country where the client's internet address is located. The value is uppercase.

\$Language

The two letter language code for the most common language of the country where the client's internet address is located. The value is lowercase.

\$ClientIP

The session's IP address represented as a string.

\$Latitude

The client session's geographic latitude, if this can be ascertained.

\$Longitude

The client session's geographic longitude, if this can be ascertained.

\$StartTime

The client session's start time in milliseconds since the epoch.

User-defined properties

An authentication handler that allows the client session to connect can assign additional properties to the session. This is achieved by supplying an `AuthenticationResult` to `callback.allow()`. The keys of these properties are case sensitive, must begin with an alphabetic character, must be alphanumeric, and must not include any whitespace.

Related concepts

[Session filtering](#) on page 267

Session filters enable you to query the set of connected client sessions on the Diffusion server based on their session properties.

[Managing subscriptions](#) on page 363

A client can use the `SubscriptionControl` feature to subscribe other client sessions to topics that they have not requested subscription to themselves and also to unsubscribe clients from topics. It also enables the client to register as the handler for routing topic subscriptions.

[Managing sessions](#) on page 422

A client session with the appropriate permissions can receive notifications and information about other client sessions. A client session with the appropriate permissions can also manage other client sessions.

Session filtering

Session filters enable you to query the set of connected client sessions on the Diffusion server based on their session properties.

To perform an action on a subset of the connected client sessions, you can create a query expression that filters the set of connected client sessions by the values of their session properties. Filter query expressions are parsed and evaluated by the Diffusion server.

The query expression used to filter the session is made up of one or more search clauses chained together by boolean operators.

Creating a single search clause

Search clauses have the following form:

```
key operator 'value'
```

key

The key name of the session property to be tested. The key name is case sensitive.

operator

The operator that defines the test to be performed. The operator is not case sensitive.

value

The test value to be compared to the session property value. This value is a string and must be contained in single or double quotation marks. Any special characters must be escaped with Java escaping. The value is case sensitive.

Table 29: Session filter search clause operators

Operator	Description
IS	Tests whether the session property value associated with the property key matches the test value.
EQ	Equals. Tests whether the session property value associated with the property key matches the test value. Equivalent to 'IS'.
NE	Not equal. Tests whether the session property value associated with the key is not equal to the test value.

Examples: single search clause

Filter by clients that connect with the principal Ellington:

```
$Principal IS 'Ellington'
```

Filter by clients that connect to the Diffusion server using WebSocket:

```
$Transport EQ 'WEBSOCKET'
```

Filter by clients that are not located in the United Kingdom:

```
$Country NE 'GB'
```

Filter by clients that have the user-defined property Location set to San Jose:

```
Location IS "San Jose"
```

Filter by clients that have the user-defined property Status set to Active:

```
Status EQ 'Active'
```

Filter by clients that do not have the user-defined property Tier set to Premium:

```
Tier NE 'Premium'
```

Chaining multiple search clauses

Chain individual search clauses together using boolean operator or use the NOT operator to negate a search clause. Boolean operators are not case sensitive.

Table 30: Session filter boolean operators

Operator	Description
AND	Specifies that both joined search clauses must be true.

Operator	Description
OR	Specifies that at least one of the joined search clauses must be true.
NOT	Specifies that the following search clause or set of search clauses must not be true.

Use parentheses to group sets of search clauses and indicate the order of precedence for evaluation. If no order of precedence is explicitly defined, the AND operator takes precedence over the OR operator.

Examples: multiple search clauses

Filter by clients that connect with one of the principals Fitzgerald, Gillespie, or Hancock:

```
$Principal IS 'Fitzgerald' OR $Principal IS 'Gillespie' OR $Principal IS 'Hancock'
```

Filter by clients that connect to the Diffusion server using WebSocket and are located in France and have the user-defined property Status set to Active:

```
$Transport EQ 'WEBSOCKET' AND $Country IS 'FR' AND Status EQ 'Active'
```

Filter by clients that are located in the United States, but do not connect with either of the principals Monk or Peterson:

```
$Country EQ 'US' AND NOT ($Principal IS 'Monk' OR $Principal IS 'Peterson')
```

Filter by clients excluding those that have both the user-defined property Status set to Inactive and the user-defined property Tier set to Free:

```
NOT (Status IS 'Inactive' AND Tier IS 'Free')
```

Related concepts

[Session properties](#) on page 266

A client session has a number of properties associated with it. Properties are key-value pairs. Both the key and the value are case sensitive.

[Managing subscriptions](#) on page 363

A client can use the SubscriptionControl feature to subscribe other client sessions to topics that they have not requested subscription to themselves and also to unsubscribe clients from topics. It also enables the client to register as the handler for routing topic subscriptions.

[Managing sessions](#) on page 422

A client session with the appropriate permissions can receive notifications and information about other client sessions. A client session with the appropriate permissions can also manage other client sessions.

Receiving data from topics

A client can subscribe to a topic to receive a stream of updates or can fetch the current state of a topic.

Topics

A topic is a logical channel through which data can be distributed to clients. Topics provide a logical link between publishing clients and subscribing clients.

Diffusion provides different types of topic that can be used to stream different data formats or can be used for special purposes. For more information about topic types and uses, see [Topics](#) on page 57.

Subscribing

To receive data published to a topic as a stream of updates, a client takes the following actions:

- Subscribe to a topic or set of topics.
- Register a stream that matches the topic or set of topics, or register a matching fallback stream.

For topics that exist and that the client is subscribed to, data is received through a stream that is registered against that topic - if one exists and is of the appropriate type.

Note: The subscription flow is fully described in the design section of the documentation. For more information, see [Subscribing to topics](#) on page 89.

Fetching

To fetch the current value of a topic or set of topics, a client makes a fetch request, passing in a fetch stream, and uses the fetch stream to receive the data.

Streams

Clients use streams to receive data from topics.

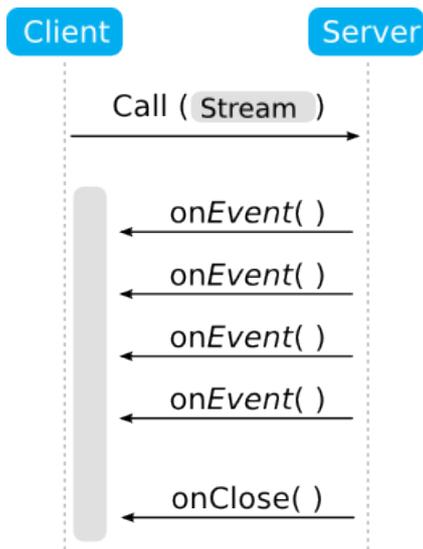


Figure 20: A stream

Streams are API objects that can receive multiple calls from the Diffusion server on the same method while the stream is open. After the stream is closed or discarded, it can no longer receive responses on any of its other methods.

Subscribing to topics

Subscribe to topics with topic selectors. When topics exist that match the selections made by the client, data from those topics is sent to the client from the Diffusion server.

The client must register a stream to access topic data that has been sent from the Diffusion server. For more information, see [Subscribing to topics](#) on page 89.

Required permissions: `select_topic` and `read_topic` permissions for the specified topics

Subscribing to topics

A client can subscribe to a topic to receive updates that are published to the topic. If the topic has state, when the client subscribes to that topic the Diffusion server sends the topic state as a full value. Subsequent updates to the data on the topic are sent as deltas or as full values depending on the type of the topic and the structure of its data.

JavaScript

```
session.select('topic_selector');
```

Apple

```
[session.topics subscribeWithTopicSelectorExpression:topic_selector
                           completionHandler:^(NSError *
const error)
{
    if (error) {
        NSLog(@"Subscribe request failed. Error: %@", error);
    } else {
        NSLog(@"Subscribe request succeeded.");
    }
}];
```

Java and Android

```
topics.subscribe(topic_selector).whenComplete((voidResult, exception)
-> {
    //Do something
});
```

.NET

```
topics.Subscribe( topic, new TopicsCompletionCallbackDefault() );
```

C

```
// Define the required callbacks elsewhere
subscribe(session, (SUBSCRIPTION_PARAMS_T) { .topic_selector
= topic_selector,
                                           .on_topic_message =
on_topic_message,
                                           .on_subscribe =
on_subscribe });
```

A client can subscribe to multiple topics in a single request by using topic selectors. Topic selectors enable you to select whole branches of the topic tree or use regular expressions to select topics based on the names in the topic path.

For more information, see [Topic selectors](#) on page 50.

Unsubscribing from topics

To stop receiving updates from a topic or set of topics, unsubscribe from the topic or topics:

JavaScript

```
session.unsubscribe('topic_selector');
```

Apple

```
[session.topics unsubscribeFromTopicSelectorExpression:topic_selector
                               completionHandler:^(NSError *
const error)
{
    if (error) {
        NSLog(@"Unsubscribe request failed. Error: %@", error);
    } else {
        NSLog(@"Unsubscribe request succeeded.");
    }
}];
```

Java and Android

```
topics.unsubscribe(topic_selector).whenComplete((voidResult,
exception) -> {
    //Do something
});
```

.NET

```
topics.Unsubscribe( topic, new TopicsCompletionCallbackDefault() );
```

C

```
// Define an on_unsubscribe callback elsewhere
unsubscribe(session, (UNSUBSCRIPTION_PARAMS_T) { .topic_selector
  = topic_selector,
  .on_unsubscribe =
  on_unsubscribe } );
```

Using streams for subscription

Register a stream against a set of topics to access values published to those topics. For a registered stream to access the value of a topic, the topic type must match the stream and the client must be subscribed to the topic.

Subscribing to a topic causes the value of the topic to be sent from the Diffusion server to the client. Registering a stream that matches the topic enables the client to access these values. For more information, see [Subscribing to topics](#) on page 89

Two kinds of stream are provided to receive updates from subscribed topics: value streams and topic streams.

Value streams

Value streams are typed. Register value streams against a set of topics by using a topic selector. A value stream receives updates for any subscribed topics that match the value stream's type and the topic selector used when registering the value stream.

A value stream can have one of the following types:

JSON

JSON topics are routed to this type of stream.

Binary

Binary topics are routed to this type of stream.

String

String topics are routed to this type of stream.

Int64

Int64 topics are routed to this type of stream.

Double

Double topics are routed to this type of stream.

RecordV2

RecordV2 topics are routed to this type of stream.

Content

JSON, binary, string, int64, double, recordV2 and single value topics are routed to this type of stream.

If a value stream receives a delta update, this delta is automatically applied to a locally cached value so that the stream always receives full values.

Using a value stream

Register the typed stream against the topic or topics that you want the stream to receive updates from:

JavaScript

```
// Register a JSON value stream
session.addStream('topic_selector', diffusion.datatypes.json()
    .on('value', function(path, specification, newValue, oldValue)
    {
        // Action to take when update is received
    }));

// Register a binary value stream
session.addStream('topic_selector', diffusion.datatypes.binary()
    .on('value', function(path, specification, newValue, oldValue)
    {
        // Action to take when update is received
    }));
```

Apple

```
// Register a JSON value stream
PTDiffusionValueStream *const jsonValueStream = [PTDiffusionJSON
valueStreamWithDelegate:self];
[session.topics addStream : jsonValueStream,
withSelector : topic_selector];

// Register a binary value stream
PTDiffusionValueStream *const binaryValueStream = [PTDiffusionBinary
valueStreamWithDelegate:self];
[session.topics addStream : binaryValueStream,
withSelector : topic_selector];
```

Java and Android

```
final Topics topics = session.feature(Topics.class);

// Register a JSON value stream
topics.addStream(topic_selector, JSON.class, new
Topics.ValueStream.Default<JSON>());

// Register a binary value stream
topics.addStream(topic_selector, Binary.class, new
Topics.ValueStream.Default<Binary>());
```

.NET

```
var topics = session.Topics;

// Register a JSON value stream
topics.AddStream( "topic_selector", new
Topics.DefaultValueStream<IJSON>() );

// Register a binary value stream
topics.AddStream( "topic_selector", new
Topics.DefaultValueStream<IBinary>() );
```

Use topic selectors to register the stream against multiple topics. For more information, see [Topic selectors](#) on page 50.

The examples above show how to register a default or no-op value stream against a set of topics. The stream receives values from any topic in the set whose topic data type matches the stream data type.

To make use of the values sent to your client, implement a value stream that takes the required action when an update is received from a subscribed topic that matches the type of the stream:

JavaScript

```
session.addStream('topic_selector', diffusion.datatypes.json())
  .on({
    value : function(topic, specification, newValue, oldValue) {
      console.log('Update from: ', topic, newValue.get());
    },
    subscribe : function(topic, specification) {
      console.log('Subscribed to: ', topic);
    },
    unsubscribe : function(topic, specification, reason) {
      console.log('Unsubscribed from: ', topic);
    }
  });
```

Apple

```
@implementation JSONSubscribeExample
(PTDiffusionJSONValueStreamDelegate)

-(void) diffusionStream:(PTDiffusionStream *const)stream
  didSubscribeToTopicPath:(NSString *const)topicPath
  specification:(PTDiffusionTopicSpecification
 *const)specification {
  NSLog(@"Subscribed: %@", topicPath);
}

-(void)diffusionStream:(PTDiffusionValueStream *const)stream
  didUpdateTopicPath:(NSString *const)topicPath
  specification:(PTDiffusionTopicSpecification
 *const)specification
  oldJSON:(PTDiffusionJSON *const)oldJSON
  newJSON:(PTDiffusionJSON *const)newJSON {

  NSError * error;
  NSDictionary *const map = [newJSON objectWithError:&error];
  if (!map) {
    NSLog(@"Failed to create map from received JSON. Error: %@",
error);
    return;
  }

  // For the purposes of a meaningful example, only emit a log line
if we
  // have a rate for GBP to USD.
  if ([currency isEqualToString:@"GBP"]) {
    const id rate = map[@"USD"];
    if (rate) {
      NSLog(@"Rate for GBP to USD: %@", rate);
    }
  }
}

-(void) diffusionStream:(PTDiffusionStream *const)stream
  didUnsubscribeFromTopicPath:(NSString *const)topicPath
  specification:(PTDiffusionTopicSpecification
 *const)specification
  reason:(const
PTDiffusionTopicUnsubscriptionReason)reason {
```

```

        NSLog(@"Unsubscribed: %@", topicPath);
    }

@end

```

Java and Android

```

private class JSONStream extends ValueStream.Default<JSON> {
    @Override
    public void onValue(
        String topicPath,
        TopicSpecification specification,
        JSON oldValue,
        JSON newValue) {
        LOG.info(newValue.toJsonString());
    }
}

```

.NET

```

/// Basic implementation of IValueStream<TValue> for JSON topics.
internal sealed class JSONStream : IValueStream<IJSON> {

    /// Notification of stream being closed normally.
    public void OnClose() {
        Console.WriteLine( "The subscription stream is now closed." );
    }

    /// Notification of a contextual error related to this callback.
    public void OnError( ErrorReason errorReason ) {
        Console.WriteLine( "An error has occurred : {0}",
errorReason );
    }

    /// Notification of a successful subscription.
    public void OnSubscription( string topicPath, ITopicSpecification
specification ) {
        Console.WriteLine( "Client subscribed to {0} ", topicPath );
    }

    /// Notification of a successful unsubscription.
    public void OnUnsubscription( string topicPath,
ITopicSpecification specification, TopicUnsubscribeReason reason ) {
        Console.WriteLine( "Client unsubscribed from {0} : {1}",
topicPath, reason );
    }

    /// Topic update received.
    public void OnValue( string topicPath, ITopicSpecification
specification, IJSON oldValue, IJSON newValue ) {
        Console.WriteLine( "New value of {0} is {1}", topicPath,
newValue.ToJSONString() );
    }
}

```

Topic streams

Note: Where a value stream is available for your topic type, we recommend you use a value stream instead of a topic stream.

Topic streams are not typed and are used to receive value and delta updates for all subscribed topics that match the topic selectors used when registering the value stream.

This type of stream provides the value and the deltas but relies upon the application to apply the deltas to a client-maintained current value. It is important, when using a topic stream with a record topic, to register the stream before subscribing to the topic. This ensures that a full value is received by the subscribing client.

Using a topic stream

Register the stream against the topic or topics that you want the stream to receive updates from:

JavaScript

```
session.stream('topic_selector')
  .on('update', function(update, topic) {
    // Do something
  });
```

Apple

```
// Register self as the handler for topic updates on a set of topics.
[session.topics addTopicStreamWithSelector : topic_selector,
  delegate : self];
```

Java and Android

```
Topics topics = session.feature(Topics.class);
// Add a topic stream that you implemented elsewhere
topics.addTopicStream(topic_selector, new myTopicStream(data));
```

.NET

```
var topics = session.Topics;

// Add a topic stream that you implemented elsewhere
topics.AddTopicStream(topic_selector, myTopicStream );
```

Use topic selectors to register the stream against multiple topics. For more information, see [Topic selectors](#) on page 50.

Registering a fallback stream

You can register one or more fallback streams to receive updates to subscribed topics that do not have a value stream or topic stream registered against them:

JavaScript

```
session.addFallbackStream(diffusion.datatypes.json())
  .on('value', function(topic, specification, newValue, oldValue)
  {
    // Do something
  });
```

Apple

```
// Register self as the fallback handler for JSON value updates.
PTDiffusionValueStream *const valueStream = [PTDiffusionJSON
  valueStreamWithDelegate:self];
[session.topics addFallbackStream:valueStream];
```

Java and Android

```
final Topics topics = session.feature(Topics.class);

topics.addFallbackStream(topic_selector, JSON.class, new
    Topics.ValueStream.Default());
```

.NET

```
var topics = session.Topics;

topics.AddFallbackStream<IJSON>( new
    Topics.DefaultValueStream<IJSON>( ) );
```

C

```
/*
 * Install a global topic handler to capture messages for
 * topics we haven't explicitly subscribed to, and therefore
 * don't have a specific handler for.
 */
session->global_topic_handler = on_unexpected_topic_message;
```

A fallback value stream receives all updates for topics of the matching type that do not have a stream already registered against them.

A fallback topic stream receives all updates for topics of any type that do not have a stream already registered against them.

Fetching the current value of a topic

A client can send a fetch request for the state of a topic. If the topic is of a type that maintains its state, the Diffusion server provides the current state of that topic to the client.

Required permissions: `select_topic` and `read_topic` permissions for the specified topics

A fetch request enables you to get the current value of a topic without subscribing to the topic.

The value fetched from a topic are received through a fetch stream, not through any value streams or topic streams registered against the topic.

Fetch streams are not typed and are used to receive responses to fetch requests for all topics that match the topic selectors used when registering the fetch stream.

Fetch the value of a topic or set of topics by using a topic selector to make a fetch request:

JavaScript

```
session.fetch("topic_selector").on('value', function(value, path) {
    // Do something
});
```

Apple

```
[session.topics fetchWithTopicSelectorExpression:@"topic_selector"
    delegate:self];
```

Java and Android

```
Topics topics = session.feature(Topics.class);
```

```
topics.fetch(topic_selector, new FetchStream.Default);
```

.NET

```
var topics = session.Topics;  
topics.Fetch( topic_selector, new FetchStreamDefault );
```

C

```
FETCH_PARAMS_T params = {  
    .selector = topic_selector,  
    .on_topic_message = on_topic_message,  
    .on_fetch = on_fetch,  
    .on_status_message = on_fetch_status_message  
};  
  
/*  
 * Issue the fetch request.  
 */  
fetch(session, params);
```

These examples pass in a default or no-op fetch stream.

To make use of the fetched values, implement a fetch stream to handle the values:

JavaScript

```
session.fetch("topic_selector").on({  
    value : function(value, path) {  
        console.log("Value for topic '" + path + "' is: " +  
value);  
    },  
    error : function(error) {  
        console.log("Error on fetch: '" + error);  
    },  
    close : function() {  
        console.log("Fetch stream closed.");  
    }  
});
```

Apple

```
@implementation FetchExample (PTDiffusionFetchStreamDelegate)  
  
-(void)diffusionStream:(PTDiffusionStream * const)stream  
    didFetchTopicPath:(NSString * const)topicPath  
        content:(PTDiffusionContent * const)content {  
    NSLog(@"Fetch Result: %@ = \"%@\\"", topicPath, content);  
}  
  
-(void)diffusionDidCloseStream:(PTDiffusionStream * const)stream {  
    NSLog(@"Fetch stream finished.");  
}  
  
-(void)diffusionStream:(PTDiffusionStream * const)stream  
    didFailWithError:(NSError * const)error {  
    NSLog(@"Fetch stream failed error: %@", error);  
}
```

```
@end
```

Java and Android

```
private final class myFetchStream implements Topics.FetchStream {

    @Override
    public void onClose() {
        LOG.info("Fetch stream closed.");
    }

    @Override
    public void onDiscard() {
        LOG.info("Fetch stream discarded.");
    }

    @Override
    public void onFetchReply(String topicPath, Content content) {
        LOG.info("Fetched value " + content.asString() + " from topic " +
            topicPath);
    }

}
```

.NET

```
internal sealed class myFetchStream : IFetchStream {

    public void OnClose() {
        Console.WriteLine( "The fetch stream is now closed." );
    }

    public void OnDiscard() {
        Console.WriteLine( "The fetch stream was discarded." );
    }

    public void OnFetchReply( string topicPath, IContent content ) {
        Console.WriteLine( "Fetched value {0} from topic {1}",
            topicPath, content.AsString() );
    }

}
```

C

```
/*
 * When a fetched message is received, this callback is invoked.
 */
static int
on_topic_message(SESSION_T *session, const TOPIC_MESSAGE_T *msg)
{
    printf("Received message for topic %s\n", msg->name);
    printf("Payload: %.*s\n", (int)msg->payload->len, msg->
        payload->data);

#ifdef DEBUG
        topic_message_debug(response->payload);
#endif

    return HANDLER_SUCCESS;
}
```

Receiving topic notifications

Receive topic notifications using topic selectors. This enables a client to receive updates when topics are added or removed, without the topic values.

Note: Topic notifications are supported by the Android API, Java API and JavaScript API.

The client must register a listener object to receive notifications about selected topics. Use a [topic selector](#) to specify the topics.

For more details about topic notifications, see [Topic notifications](#) on page 92.

Required permissions: `select_topic` and `read_topic` permissions for the specified topics

Receiving topic notifications

A client can register to receive notifications about a set of topics via a listener object.

JavaScript

```
var listener = {
  onDescendantNotification: function(topicPath, type) {},
  onTopicNotification: function(topicPath, topicSpecification,
  type) {},
  onClose: function() {},
  onError: function(error) {}
};

session.notifications.addListener(listener).then(function(reg) {
  reg.select("foo");
});
```

Java and Android

```
final TopicNotifications notifications =
    session.feature(TopicNotifications.class);

final TopicNotificationListener listener = new
    TopicNotificationListener() {
    @Override
    public void onTopicNotification(String topicPath,
    TopicSpecification specification, NotificationType type) {
        // Handle notifications for selected/deselected topics
    }

    @Override
    public void onDescendantNotification(String topicPath,
    NotificationType type) {
        // Handle notifications for immediate descendants
    }

    @Override
    public void onClose() {
        // The listener has been closed
    }

    @Override
    public void onError(ErrorReason error) {
        // The listener has encountered an error
    }
}
```

```
} ;  
  
final CompletableFuture<NotificationRegistration> future =  
    notifications.addListener(listener);  
final NotificationRegistration registration = future.get();  
  
registration.select("foo");
```

Managing topics

A client can add and remove topics at the Diffusion server.

Required permissions: modify_topic

Adding topics is an asynchronous operation and calls back to notify of either successful creation of the topic or failure to create the topic.

If the topic add fails at the Diffusion server, the reason for failure is returned. Possible reasons for failure include the following:

- The topic already exists at the Diffusion server
- The name of the supplied topic is not valid
- The supplied details are not valid. This can occur only if properties are supplied.
- Permission to create the topic was denied
- An error occurred trying to initialize the newly created topic with the supplied content, possibly because it was not validly formatted

Note: Sometimes you may wish to "add or update" a topic: add it if it does not exist, but update if it does. There is no single method for this. Instead, the updating client can try to add the topic first, and if it receives a response that the topic exists, can then update it.

A client can create topics subordinate to topics created by another client.

Note:

It is not currently possible to add new topics under branches of the topic tree that have been created by internal publishers..

Currently all topics created using a client have a lifespan the same as the Diffusion server (unless persistence is enabled). The topics remain at the Diffusion server even after the client session that created them has closed unless you explicitly specify that the topic is removed with the session.

Adding topics with topic specifications

The recommended way to add topics is to use a topic specification. Some deprecated topic types use topic details.

Adding topics with topic specifications

Required permissions: modify_topic

To create most topic types, you can either create the topic by defining just the topic type or use the more complex topic specification to specify other properties of the topic.

A topic is specified in terms of its type and a map of optional property settings which can alter the default behavior of the topic.

You can use the same instance of topic specification to create many topics.

Adding topics with topic details (deprecated)

Required permissions: modify_topic

Only use topic details if you are creating the deprecated record or single value topic types.

Clients can use full topic details to describe a topic when creating it. Builders (and convenience methods) are available for creating details relating to all the different topic types.

You can use the same instance of topic details to create many topics. This is recommended when many topics with the same definition are to be created, because caching optimizations occur that prevent complex definitions from being transmitted to the Diffusion server many times.

For some types of topic, setting up metadata is part of the task of describing the topic.

Example: Create a JSON topic

The following examples create a JSON topic and receive a stream of values from the topic.

JavaScript

```
diffusion.connect({
  host    : 'diffusion.example.com',
  port    : 443,
  secure  : true,
  principal : 'control',
  credentials : 'password'
}).then(function(session) {

  // 1. Data Types are exposed from the top level Diffusion
  namespace. It is often easier
  // to assign these directly to a local variable.
  var jsonDataType = diffusion.datatypes.json();

  // 2. Data Types are currently provided for JSON and Binary topic
  types.
  session.topics.add('topic/json',
diffusion.topics.TopicType.JSON);

  // 3. Values can be created directly from the data type.
  var jsonValue = jsonDataType.from({
    "foo" : "bar"
  });

  // Topics are updated using the standard update mechanisms
  session.topics.update('topic/json', jsonValue);

  // Subscriptions are performed normally
  session.subscribe('topic/json');

  // 4. Streams can be specialised to provide values from a
  specific datatype.
  session.stream('topic/json').asType(jsonDataType).on('value',
function(topic, specification, newValue, oldValue) {
  // When a JSON or Binary topic is updated, any value handlers
  on a subscription will be called with both the
  // new value, and the old value.

  // The oldValue parameter will be undefined if this is the
  first value received for a topic.

  // For JSON topics, value#get returns a JavaScript object
```

```

        // For Binary topics, value#get returns a Buffer instance
        console.log("Update for " + topic, newValue.get());
    });

    // 5. Raw values of an appropriate type can also be used for JSON
    and Binary topics.
    // For example, plain JSON objects can be used to update JSON
    topics.
    session.topics.update('topic/json', {
        "foo" : "baz",
        "numbers" : [1, 2, 3]
    });
});

```

Java and Android

```

package com.pushtechology.diffusion.examples;

import static java.util.Objects.requireNonNull;

import java.io.ByteArrayOutputStream;
import java.io.IOException;
import java.util.Map;

import com.fasterxml.jackson.databind.ObjectMapper;
import com.fasterxml.jackson.dataformat.cbor.CBORFactory;
import com.fasterxml.jackson.dataformat.cbor.CBORGenerator;
import com.pushtechology.diffusion.client.Diffusion;
import com.pushtechology.diffusion.client.callbacks.Registration;
import
    com.pushtechology.diffusion.client.callbacks.TopicTreeHandler;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicControl;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicControl.AddCon
import
    com.pushtechology.diffusion.client.features.control.topics.TopicControl.Remove
import
    com.pushtechology.diffusion.client.features.control.topics.TopicUpdateControl;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicUpdateControl.
import
    com.pushtechology.diffusion.client.features.control.topics.TopicUpdateControl.
import
    com.pushtechology.diffusion.client.features.control.topics.TopicUpdateControl.
import com.pushtechology.diffusion.client.session.Session;
import
    com.pushtechology.diffusion.client.session.SessionClosedException;
import com.pushtechology.diffusion.client.topics.details.TopicType;
import com.pushtechology.diffusion.datatype.json.JSON;
import com.pushtechology.diffusion.datatype.json.JSONDataType;

/**
 * This example shows a control client creating a JSON topic and
 * sending updates
 * to it.
 * <P>
 * There will be a topic for each currency for which rates are
 * provided. The
 * topic will be created under the FX topic - so, for example FX/GBP
 * will

```

```

* contain a map of all rate conversions from the base GBP currency.
The rates
* are represented as string decimal values (e.g. "12.457").
* <P>
* The {@code addRates} method shows how to create a new rates topic,
specifying
* its initial map of values.
* <P>
* The {@code changeRates} method which takes a map shows how to
completely
* replace the set of rates for a currency with a new map of rates.
* <P>
* The {@code changeRates} method which takes a string shows an
alternative
* mechanism where the new rates are simply supplied as a JSON
string.
* <P>
* Either of the changeRates methods could be used and after the
first usage for
* any topic the values is cached, and so subsequent set calls can
compare with
* the last value and send only the differences to the server.
*
* @author Push Technology Limited
* @since 5.7
* @see ClientConsumingJSONTopics
*/
public final class ControlClientUpdatingJSONTopics {

    private static final String ROOT_TOPIC = "FX";

    private final Session session;
    private final TopicControl topicControl;
    private volatile TopicUpdateControl.ValueUpdater<JSON>
valueUpdater;
    private volatile Registration updateSourceRegistration;
    private final CBORFactory cborFactory = new CBORFactory();
    private final JSONDataType jsonDataType =
Diffusion.dataTypes().json();

    /**
     * Constructor.
     *
     * @param serverUrl for example "ws://diffusion.example.com:80"
     */
    public ControlClientUpdatingJSONTopics(String serverUrl) {

        cborFactory.setCodec(new ObjectMapper());

        session =

Diffusion.sessions().principal("control").password("password")
        .open(serverUrl);

        topicControl = session.feature(TopicControl.class);

        // Register as an updater for all topics under the root and
request
        // that all topics created are removed when the session
closes

        session.feature(TopicUpdateControl.class).registerUpdateSource(
            ROOT_TOPIC,

```

```

        new UpdateSource.Default() {
            @Override
            public void onRegistered(
                String topicPath,
                Registration registration) {
                updateSourceRegistration = registration;
            }

            @Override
            public void onActive(String topicPath, Updater
updater) {
                topicControl.removeTopicsWithSession(
                    ROOT_TOPIC,
                    new TopicTreeHandler.Default());
                valueUpdater = updater.valueUpdater(JSON.class);
            }

            @Override
            public void onClose(String topicPath) {
                session.close();
            }
        });
    }

    /**
     * Add a new rates topic.
     *
     * @param currency the base currency
     * @param values the full map of initial rates values
     * @param callback reports outcome
     * @throws IOException if unable to convert rates map
     */
    public void addRates(
        String currency,
        Map<String, String> values,
        AddContextCallback<String> callback) throws IOException {

        topicControl.addTopic(
            rateTopicName(currency),
            TopicType.JSON,
            mapToJSON(values),
            currency,
            callback);
    }

    /**
     * Update an existing rates topic, replacing the rates mappings
with a new
     * set of mappings.
     *
     * @param currency the base currency
     * @param values the new rates values
     * @param callback reports outcome
     * @throws IOException if unable to convert rates map
     */
    public void changeRates(
        String currency,
        Map<String, String> values,
        UpdateContextCallback<String> callback) throws IOException {

        if (valueUpdater == null) {

```

```

        throw new IllegalStateException("Not registered as
updater");
    }

    valueUpdater.update(
        rateTopicName(currency),
        mapToJSON(values),
        currency,
        callback);
}

/**
 * Update an existing rates topic, replacing the rates mappings
with a new
 * set of mappings specified as a JSON string, for example
 * {"USD":"123.45","HKD":"456.3"}.
 *
 * @param currency the base currency
 * @param jsonString a JSON string specifying the map of currency
rates
 * @param callback reports the outcome
 * @throws IOException if unable to convert string
 */
public void changeRates(
    String currency,
    String jsonString,
    UpdateContextCallback<String> callback) throws
SessionClosedException,
    IllegalArgumentException, IOException {

    if (valueUpdater == null) {
        throw new IllegalStateException("Not registered as
updater");
    }

    valueUpdater.update(
        rateTopicName(currency),
        jsonDataType.fromJsonString(jsonString),
        currency,
        callback);
}

/**
 * Convert a given map to a JSON object.
 */
private JSON mapToJSON(Map<String, String> values) throws
IOException {
    // Use the third-party Jackson library to write out the
values map as a
    // CBOR-format binary.
    final ByteArrayOutputStream baos = new
ByteArrayOutputStream();
    final CBORGenerator generator =
cborFactory.createGenerator(baos);
    generator.writeObject(values);
    return jsonDataType.readValue(baos.toByteArray());
}

/**
 * Remove a rates entry (removes its topic) and clear cached
value for the
 * topic.

```

```

    *
    * @param currency the currency
    *
    * @param callback reports the outcome
    */
public void removeRates(
    String currency,
    RemovalContextCallback<String> callback) {

    final String topicName = rateTopicName(currency);

    if (valueUpdater != null) {
        valueUpdater.removeCachedValues(topicName);
    }

    topicControl.remove(topicName, currency, callback);
}

/**
 * Close the session.
 */
public void close() {
    updateSourceRegistration.close();
}

/**
 * Generate a hierarchical topic name for a rates topic.
 * <P>
 * e.g. for currency=GBP would return "FX/GBP".
 *
 * @param currency the currency
 * @return the topic name
 */
private static String rateTopicName(String currency) {
    return String.format("%s/%s", ROOT_TOPIC,
requireNonNull(currency));
}
}

```

.NET

Change the URL from that provided in the example to the URL of the Diffusion server.

Handling subscriptions to missing topics

A client can handle subscription or fetch requests for topics that do not exist and can act on those notifications, for example, by creating a topic on demand that matches the request.

Required permissions: modify_topic, register_handler

The client can register itself as a handler for missing topics for any branch of the topic tree. The client is notified of attempts to subscribe to or fetch topics that are subordinate to that topic and that do not exist. This enables the client to create the topics and notify the Diffusion server that the client operation subscribe or fetch can proceed.

Note: The handler is called only when a client attempts to subscribe or fetch using a single topic path. If another type of selector is used to subscribe to or fetch the topic, the handler is not notified.

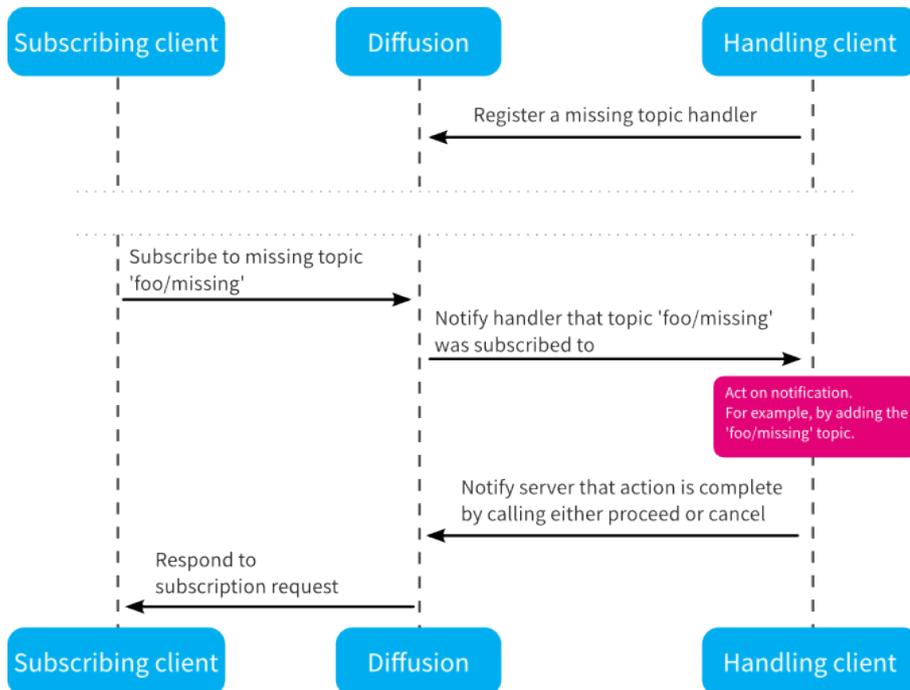


Figure 21: Flow from a subscribing client to the client that handles a missing topic subscription

The missing topic handler is removed when the registering session is closed. If the registering session loses connection, it goes into DISCONNECTED state. When in DISCONNECTED state the handler remains active but cannot pass on the notifications to the client. In this case, cancel or proceed callbacks for these notifications might not function as expected because of timeouts. If the client then closes, these notifications are discarded.

To ensure that missing topic notifications are always received by your solution, you can use multiple clients to register missing topic handlers. Ensure that if any of these clients lose connection they go straight to CLOSED state by setting the reconnection timeout to zero. When the client loses connect it closes straight away, the handler is registered is removed, and further missing topic notifications are routed to a handler registered by another client.

Registering a missing topic notification handler

Register a handler against a branch of the topic tree:

JavaScript

```
session.topics.addMissingTopicHandler("topic_branch", {
  // Implement handling code
});
```

Apple

```
-(void)registerAsMissingTopicHandlerForSession:(PTDiffusionSession
*const)session {
    [session.topicControl addMissingTopicHandler:self
                        forTopicPath:@"topic_branch"]
}
```

```

completionHandler:^(PTDiffusionTopicTreeRegistration *const
registration, NSError *const error)
{
    if (registration) {
        NSLog(@"Registered as missing topic handler.");
    } else {
        NSLog(@"Failed to register as missing topic handler.
Error: %@", error);
    }
}];
}

```

Java and Android

```

TopicControl topicControl = session.feature(TopicControl.class);

topicControl.addMissingTopicHandler("topic_branch", new
MissingTopicNotificationHandler());

```

.NET

```

ITopicControl topicControl = session.TopicControl;
var missingTopicHandler = new MissingTopicHandler();
topicControl.AddMissingTopicHandler( topic_branch,
missingTopicHandler );

```

C

```

MISSING_TOPIC_PARAMS_T handler = {
    .on_missing_topic = on_missing_topic,
    .topic_path = topic_branch,
    .context = NULL
};

missing_topic_register_handler(session, handler);

```

Implementing a missing topic handler

The sample registration code shows default or no-op missing topic handlers being registered. To take the required action when a missing topic notification is received, implement a missing topic handler:

JavaScript

```

session.topics.addMissingTopicHandler("topic_branch", {

onRegister : function(path, close) {
    console.log("Registered missing topic handler on path: " + path);
},

onClose : function(path) {
    console.log("Missing topic handler on path '" + path + "' has been
closed");
},

onError : function(path, error) {
    console.log("Error on missing topic handler");
},

onMissingTopic : function(notification) {

```

```

    console.log("Received missing topic notification with selector: " +
notification.selector);

    // Action to take in response to the notification, for example,
creating a topic.

    // If the action is successful, you can indicate that by calling
proceed
notification.proceed();
}
});

```

Apple

```

@implementation MissingTopicHandlerExample
(PTDiffusionMissingTopicHandler)

-(void)diffusionTopicTreeRegistration:
(PTDiffusionTopicTreeRegistration *const)registration
hadMissingTopicNotification:
(PTDiffusionMissingTopicNotification *const)notification {
    NSString *const expression =
notification.topicSelectorExpression;
    NSLog(@"Received Missing Topic Notification: %@", expression);

    // Action to take in response to the notification, for example,
creating a topic.

    // If the action is successful, you can indicate that by calling
proceed
[notification proceed];
}

@end

```

Java and Android

```

private final class MissingTopicNotificationHandler implements
MissingTopicHandler {
    /**
     * @param topicPath
     * - the path that the handler is active for
     * @param registeredHandler
     * - allows the handler to be closed
     */
    @Override
    public void onActive(String topicPath, RegisteredHandler
registeredHandler) {
    }

    /**
     * @param topicPath
     * - the branch of the topic tree for which the
handler was
     * registered
     */
    @Override
    public void onClose(String topicPath) {
    }

    /**
     * @param notification

```

```

        *           - the missing topic details
        */
        @Override
        public void onMissingTopic(MissingTopicNotification notification)
        {
            // Action to take in response to the notification, for
            // example, creating a topic.

            // If the action is successful, you can indicate that by
            // calling proceed
            notification.proceed();
        }
    }
}

```

.NET

```

        private class MissingTopicHandler : IMissingTopicHandler {
            private readonly TaskCompletionSource<IRegisteredHandler>
onActive =
                new TaskCompletionSource<IRegisteredHandler>();

            private readonly
TaskCompletionSource<IMissingTopicNotification> onMissingTopic =
                new
TaskCompletionSource<IMissingTopicNotification>();

            private readonly TaskCompletionSource<bool> onClose = new
TaskCompletionSource<bool>();

            public Task<IRegisteredHandler> OnActiveCalled {
                get {
                    return onActive.Task;
                }
            }

            public Task<IMissingTopicNotification>
OnMissingTopicCalled {
                get {
                    return onMissingTopic.Task;
                }
            }

            public Task OnCloseCalled {
                get {
                    return onClose.Task;
                }
            }

            void
IMissingTopicHandler.OnMissingTopic( IMissingTopicNotification
notification ) {
                onMissingTopic.SetResult( notification );
            }

            void ITopicTreeHandler.OnActive( string topicPath,
IRegisteredHandler registeredHandler ) {
                onActive.SetResult( registeredHandler );
            }

            void ITopicTreeHandler.OnClose( string topicPath ) {
                onClose.TrySetResult( false );
            }
        }

```

```

    }
}
}

```

C

```

static int
on_missing_topic(SESSION_T *session, const
    SVC_MISSING_TOPIC_REQUEST_T *request, void *context)
{
    printf("Missing topic: %s\n", request->topic_selector);

    // Action to take in response to the notification, for
    // example, creating a topic.

    // If the action is successful, you can indicate that by
    // calling proceed
    missing_topic_proceed(session, (SVC_MISSING_TOPIC_REQUEST_T
*) request);

    return HANDLER_SUCCESS;
}

```

Related concepts

[Using missing topic notifications with fan-out](#) on page 101

Missing topic notifications generated by subscription or fetch requests to a secondary server are propagated to missing topic handlers registered against the primary servers.

Example: Receive missing topic notifications

The following examples use the TopicControl feature in the Diffusion API to register a missing topic notification handler.

JavaScript

```

var diffusion = require('diffusion');

// Connect to the server. Change these options to suit your own
// environment.
// Node.js will not accept self-signed certificates by default. If
// you have
// one of these, set the environment variable
// NODE_TLS_REJECT_UNAUTHORIZED=0
// before running this example.
diffusion.connect({
    host    : 'diffusion.example.com',
    port    : 443,
    secure  : true
}).then(function(session) {

    // Register a missing topic handler on the "example" root topic
    // Any subscriptions to missing topics along this path will invoke
    // this handler
    session.topics.addMissingTopicHandler("example", {
        // Called when a handler is successfully registered
        onRegister : function(path, close) {
            console.log("Registered missing topic handler on path: " + path);
            // Once we've registered the handler, we initiate a subscription
            // with the selector "?example/topic/*"
            // This will invoke the handler.

```

```

    session.subscribe("?example/topic/.*").on('subscribe',
function(type, path) {
    console.log("Subscribed to topic: " + path);
    });
},
// Called when the handler is closed
onClose : function(path) {
    console.log("Missing topic handler on path '" + path + "' has been
closed");
},
// Called if there is an error on the handler
onError : function(path, error) {
    console.log("Error on missing topic handler");
},
// Called when we've received a missing topic notification on our
registered handler path
onMissingTopic : function(notification) {
    console.log("Received missing topic notification with selector: "
+ notification.selector);
    // Once we've received the missing topic notification initiated
from subscribing to "?example/topic/.*",
    // we add a topic that will match the selector

    var topic = "example/topic/foo";

    session.topics.add(topic).then(function(result) {
        console.log("Topic add success: " + topic);
        // If the topic addition is successful, we proceed() with the
session's subscription.
        // The client will now be subscribed to the topic
notification.proceed();
    }, function(reason) {
        console.log("Topic add failed: " + reason);
        // If the topic addition fails, we cancel() the session's
subscription request.
        notification.cancel();
    });
}
});
});

```

Apple

```

@import Diffusion;

@interface MissingTopicHandlerExample
(PTDiffusionMissingTopicHandler) <PTDiffusionMissingTopicHandler>
@end

@implementation MissingTopicHandlerExample {
    PTDiffusionSession* _session;
}

-(void)startWithURL:(NSURL*)url {
    PTDiffusionCredentials *const credentials =
[[PTDiffusionCredentials alloc]
initWithPassword:@"password"];

    PTDiffusionSessionConfiguration *const sessionConfiguration =
[[PTDiffusionSessionConfiguration alloc]
initWithPrincipal:@"control"

```

```

credentials:credentials];

    NSLog(@"Connecting...");

    [PTDiffusionSession openWithURL:url
                        configuration:sessionConfiguration
                        completionHandler:^(PTDiffusionSession *session,
NSError *error)
    {
        if (!session) {
            NSLog(@"Failed to open session: %@", error);
            return;
        }

        // At this point we now have a connected session.
        NSLog(@"Connected.");

        // Set ivar to maintain a strong reference to the session.
        _session = session;

        // Register as missing topic handler for a branch of the
        topic tree.
        [self registerAsMissingTopicHandlerForSession:session];
    }];
}

-(void)registerAsMissingTopicHandlerForSession:(PTDiffusionSession
*const)session {
    [session.topicControl addMissingTopicHandler:self
                        forTopicPath:@"Example/Control
Client Handler"

completionHandler:^(PTDiffusionTopicTreeRegistration *const
registration, NSError *const error)
    {
        if (registration) {
            NSLog(@"Registered as missing topic handler.");
        } else {
            NSLog(@"Failed to register as missing topic handler.
Error: %@", error);
        }
    }];
}

@end

@implementation MissingTopicHandlerExample
(PTDiffusionMissingTopicHandler)

-(void)diffusionTopicTreeRegistration:
(PTDiffusionTopicTreeRegistration *const)registration
hadMissingTopicNotification:
(PTDiffusionMissingTopicNotification *const)notification {
    NSString *const expression =
notification.topicSelectorExpression;
    NSLog(@"Received Missing Topic Notification: %@", expression);

    // Expect a path pattern expression.
    if (![expression hasPrefix:@">"]) {
        NSLog(@"Topic selector expression is not a path pattern.");
        return;
    }
}

```

```

// Extract topic path from path pattern expression.
NSString *const topicPath = [expression substringFromIndex:1];

// Add a stateless topic at this topic path.
[_session.topicControl addWithTopicPath:topicPath

type:PTDiffusionTopicType_Stateless
                                value:nil
                                completionHandler:^(NSError *const error)
{
    if (error) {
        NSLog(@"Failed to add topic.");
        return;
    }

    // Topic added so allow subscriber to proceed.
    [notification proceed];
}]];
}

@end

```

Java and Android

```

/
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* distributed under the License is distributed on an "AS IS" BASIS,
* WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or
implied.
* See the License for the specific language governing permissions
and
* limitations under the License.
*****
package com.pushtechology.diffusion.examples;

import java.util.concurrent.ExecutionException;
import java.util.concurrent.TimeUnit;
import java.util.concurrent.TimeoutException;

import com.pushtechology.diffusion.client.Diffusion;
import com.pushtechology.diffusion.client.callbacks.ErrorReason;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicControl;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicControl.Missing
import
    com.pushtechology.diffusion.client.features.control.topics.TopicControl.Missing
import com.pushtechology.diffusion.client.session.Session;
import com.pushtechology.diffusion.client.topics.details.TopicType;

/**

```

```

* An example of registering a missing topic notification handler and
processing
* notifications using a control client.
*
* @author Push Technology Limited
*/
public final class ControlClientHandlingMissingTopicNotification {

    // UCI features
    private final Session session;
    private final TopicControl topicControl;

    /**
     * Constructor.
     */
    public ControlClientHandlingMissingTopicNotification()
        throws InterruptedException, ExecutionException,
        TimeoutException {
        // Create a session
        session =
        Diffusion.sessions().password("password").principal("admin")
            .open("ws://diffusion.example.com:8080");

        topicControl = session.feature(TopicControl.class);

        // Registers a missing topic notification on a topic path
        topicControl.addMissingTopicHandler(
            "A",
            new NotificationStream().get(5, TimeUnit.SECONDS);
        }

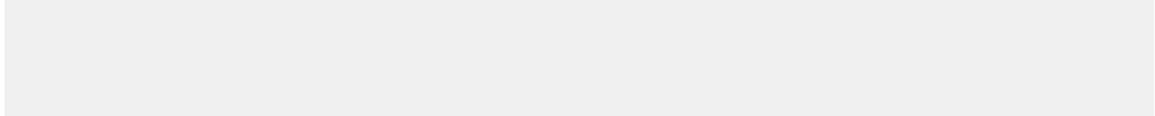
    private final class NotificationStream implements
        MissingTopicNotificationStream {
        @Override
        public void onClose() {
        }

        @Override
        public void onError(ErrorReason errorReason) {
        }

        @Override
        public void onMissingTopic(MissingTopicNotification
notification) {
            topicControl.addTopic(
                notification.getTopicPath(),
                TopicType.STRING).whenComplete((result, ex) -> {
                    if (ex == null) {
                        notification.proceed();
                    }
                    else {
                        notification.cancel();
                    }
                });
        }
    }
}

```

.NET



C

```
/*
 * This example shows how to register a missing topic notification
 * handler and return a missing topic notification response - calling
 * missing_topic_proceed() once we've created the topic.
 */
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#include <unistd.h>

#include <apr.h>
#include <apr_thread_mutex.h>
#include <apr_thread_cond.h>

#include "diffusion.h"
#include "args.h"

ARG_OPTS_T arg_opts[] = {
    ARG_OPTS_HELP,
    {'u', "url", "Diffusion server URL", ARG_OPTIONAL,
    ARG_HAS_VALUE, "ws://localhost:8080"},
    {'p', "principal", "Principal (username) for the connection",
    ARG_OPTIONAL, ARG_HAS_VALUE, NULL},
    {'c', "credentials", "Credentials (password) for the
    connection", ARG_OPTIONAL, ARG_HAS_VALUE, NULL},
    {'r', "topic_root", "Topic root to process missing topic
    notifications on", ARG_OPTIONAL, ARG_HAS_VALUE, "foo"},
    END_OF_ARG_OPTS
};

static int
on_topic_added(SESSION_T *session, const SVC_ADD_TOPIC_RESPONSE_T
 *response, void *context)
{
    puts("Topic added");
    return HANDLER_SUCCESS;
}

static int
on_topic_add_failed(SESSION_T *session, const
 SVC_ADD_TOPIC_RESPONSE_T *response, void *context)
{
    puts("Topic add failed");
    printf("Reason code: %d\n", response->reason);
    return HANDLER_SUCCESS;
}

static int
on_topic_add_discard(SESSION_T *session, void *context)
{
    puts("Topic add discarded");
    return HANDLER_SUCCESS;
}
```

```

/*
 * A request has been made for a topic that doesn't exist; create it
 * and inform Diffusion that the client's subscription request can
 * proceed.
 */
static int
on_missing_topic(SESSION_T *session, const
SVC_MISSING_TOPIC_REQUEST_T *request, void *context)
{
    printf("Missing topic: %s\n", request->topic_selector);

    BUF_T *sample_data_buf = buf_create();
    buf_write_string(sample_data_buf, "Hello, world");

    // Add the missing topic.
    ADD_TOPIC_PARAMS_T topic_params = {
        .on_topic_added = on_topic_added,
        .on_topic_add_failed = on_topic_add_failed,
        .on_discard = on_topic_add_discard,
        .topic_path = strdup(request->topic_selector+1),
        .details =
create_topic_details_single_value(M_DATA_TYPE_STRING),
        .content = content_create(CONTENT_ENCODING_NONE,
sample_data_buf)
    };

    add_topic(session, topic_params);

    // Proceed with the client's subscription to the topic
missing_topic_proceed(session, (SVC_MISSING_TOPIC_REQUEST_T
*) request);

    return HANDLER_SUCCESS;
}

/*
 * Entry point for the example.
 */
int
main(int argc, char **argv)
{
    /*
     * Standard command-line parsing.
     */
    HASH_T *options = parse_cmdline(argc, argv, arg_opts);
    if(options == NULL || hash_get(options, "help") != NULL) {
        show_usage(argc, argv, arg_opts);
        return EXIT_FAILURE;
    }

    const char *url = hash_get(options, "url");
    const char *principal = hash_get(options, "principal");
    const char *topic_root = hash_get(options, "topic_root");

    CREDENTIALS_T *credentials = NULL;
    const char *password = hash_get(options, "credentials");
    if(password != NULL) {
        credentials = credentials_create_password(password);
    }

    SESSION_T *session;
    DIFFUSION_ERROR_T error = { 0 };

```

```

        session = session_create(url, principal, credentials, NULL,
NULL, &error);
        if(session != NULL) {
            printf("Session created (state=%d, id=%s)\n",
                session_state_get(session),
                session_id_to_string(session->id));
        }
        else {
            printf("Failed to create session: %s\n",
error.message);
            free(error.message);
            return EXIT_FAILURE;
        }

        /*
         * Register the missing topic handler
         */
        MISSING_TOPIC_PARAMS_T handler = {
            .on_missing_topic = on_missing_topic,
            .topic_path = topic_root,
            .context = NULL
        };

        missing_topic_register_handler(session, handler);

        /*
         * Run for 5 minutes.
         */
        sleep(5 * 60);

        /*
         * Close session and clean up.
         */
        session_close(session, NULL);
        session_free(session);

        hash_free(options, NULL, free);

        return EXIT_SUCCESS;
    }

```

Change the URL from that provided in the example to the URL of the Diffusion server.

Defining a recordV2 schema

You can use the API to specify a schema that defines the content of a recordV2 topic.

About this task

Publishing clients can define an optional schema for a recordV2 topic. The topic value must conform to the schema.

No client session is required to create a schema.

The Diffusion API for the following platforms provides builder methods that enable you to define a schema:

- Java
- Android

The following example demonstrates how to create a schema using the Java API.

Procedure

1. Import the required classes.

```
import com.pushtechology.diffusion.client.Diffusion;
import
    com.pushtechology.diffusion.datatype.recordv2.RecordV2DataType;
import
    com.pushtechology.diffusion.datatype.recordv2.schema.Schema;
import
    com.pushtechology.diffusion.datatype.recordv2.schema.SchemaBuilder;
```

2. Create an example class with a recordV2 datatype and a constructor.

```
public final class ClientCreatingRecordV2Schema {

    private final RecordV2DataType dataType =
        Diffusion.dataTypes().recordV2();

    /**
     * Constructor.
     */
    public ClientCreatingRecordV2Schema() {
    }
}
```

3. Create a schema.

This schema specifies that the topic will contain a record containing a field that can occur from two to five times, and a different record with a field that can occur unlimited times.

```
public Schema createVariableRepeatingFieldsSchema() {
    final SchemaBuilder builder = dataType.schemaBuilder();
    return builder
        .record("A").string("repeatingField", 2, 5)
        .record("B").string("repeatingFieldUnlimited", 1, -1)
        .build();
}
```

See the full example code below for how to construct a variety of different schemas.

For more information, see [Java API documentation](#).

Example: A class that shows how to create different schemas.

```
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```

```

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implied.
* See the License for the specific language governing permissions
and
* limitations under the License.
*****
package com.pushtechology.diffusion.examples;

import com.pushtechology.diffusion.client.Diffusion;
import
  com.pushtechology.diffusion.datatype.recordv2.RecordV2DataType;
import
  com.pushtechology.diffusion.datatype.recordv2.schema.Schema;
import
  com.pushtechology.diffusion.datatype.recordv2.schema.SchemaBuilder;

/**
 * This example class has a number of methods that demonstrate the
creation of
 * schemas for RECORD_V2 topics, using the Diffusion Client API.
 * <P>
 * Note that no client session is required in order to create a
schema.
 *
 * @author Push Technology Limited
 * @since 6.0
 */
public final class ClientCreatingRecordV2Schema {

    private final RecordV2DataType dataType =
Diffusion.dataTypes().recordV2();

    /**
     * Constructor.
     */
    public ClientCreatingRecordV2Schema() {
    }

    /**
     * Example of a schema consisting of a single record with
three fields each
     * of s different data type.
     *
     * @return a schema
     */
    public Schema createSimpleSchema() {
        final SchemaBuilder builder = dataType.schemaBuilder();
        return builder
            .record("Record")

            .string("string").integer("integer").decimal("decimal", 3)
                .build();
    }

    /**
     * Example of a schema consisting of multiple records, each
record with a
     * single field of a specific type.
     *
     * @return a schema
     */
    public Schema createMultipleRecordsSchema() {
        final SchemaBuilder builder = dataType.schemaBuilder();

```

```

        return builder
            .record("StringRecord").string("string")
            .record("IntegerRecord").integer("integer")
            .record("DecimalRecord").decimal("decimal", 3)
            .build();
    }

    /**
     * Example of a schema consisting of a record (with a single
     string field)
     * repeating exactly 10 times.
     *
     * @return a schema
     */
    public Schema createFixedRepeatingRecordsSchema() {
        final SchemaBuilder builder = dataType.schemaBuilder();
        return builder
            .record("RepeatingRecord", 10).string("string")
            .build();
    }

    /**
     * Example of a schema consisting of 2 record types.
     "FixedRecord" is a
     * record that occurs 5 times. "RepeatingRecord" is an
     optional record that
     * can be repeated as many times as required (unlimited).
     *
     * @return a schema
     */
    public Schema createVariableRepeatingRecordsSchema() {
        final SchemaBuilder builder = dataType.schemaBuilder();
        return builder
            .record("FixedRecord", 5).string("a")
            .record("RepeatingRecord", 0, -1).string("b")
            .build();
    }

    /**
     * Example of a schema consisting of a single record with a
     string field
     * that occurs exactly 10 times.
     *
     * @return a schema
     */
    public Schema createFixedRepeatingFieldsSchema() {
        final SchemaBuilder builder = dataType.schemaBuilder();
        return builder
            .record("Record").string("repeatingString", 10)
            .build();
    }

    /**
     * Example of a schema consisting of two records. The first
     record (A) has a
     * field, "repeatingField", which can occur between 2 and 5
     times. The
     * second record (B) has a field, "repeatingFieldUnlimited",
     which can occur
     * as many times as required but at least once.
     *
     * @return a schema
     */

```

```

public Schema createVariableRepeatingFieldsSchema() {
    final SchemaBuilder builder = dataType.schemaBuilder();
    return builder
        .record("A").string("repeatingField", 2, 5)
        .record("B").string("repeatingFieldUnlimited", 1, -1)
        .build();
}

/**
 * Example of a schema consisting of a single record and
 * multiple fields
 * encapsulating a person's name and address.
 *
 * @return a schema
 */
public Schema createNameAndAddressSchema() {
    final SchemaBuilder builder = dataType.schemaBuilder();
    return builder
        .record("nameAndAddress")
        .string("firstName")
        .string("surname")
        .integer("houseNumber")
        .string("street")
        .string("town")
        .string("state")
        .string("postCode")
        .build();
}
}

```

Related concepts

[RecordV2 topics](#) on page 77

A topic that streams data in recordV2 format, where the data is divided into multiple records, each of which can contain multiple fields. RecordV2 topics are stateful: each topic stores a value consisting of one or more records on the Diffusion server.

[RecordV2 schema](#) on page 80

A schema is an optional way to define how data is formatted when it is published on a recordV2 topic. A schema defines and names the permitted records and fields within the topic, and enables direct access to the fields.

[Update recordV2 topics](#) on page 304

The following example demonstrates how to create and update recordV2 topics, including the use of a schema.

[Subscribe to recordV2 topics](#) on page 310

The following example demonstrates how to process information from subscribed recordV2 topics, including the use of a schema.

Update recordV2 topics

The following example demonstrates how to create and update recordV2 topics, including the use of a schema.

This example demonstrates a Java control client updating recordV2 topics containing currency exchange rate information.

Each topic contains a record with two decimal fields, representing the buy and sell rates between a pair of currencies.

The example can be run either with or without a schema.

```

/
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 * WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or
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 * See the License for the specific language governing permissions
 * and
 * limitations under the License.
*****
package com.pushtechology.diffusion.examples;

import static
    com.pushtechology.diffusion.client.topics.details.TopicSpecification.REMOVAL;
import static
    com.pushtechology.diffusion.client.topics.details.TopicSpecification.SCHEMA;
import static
    com.pushtechology.diffusion.client.topics.details.TopicType.RECORD_V2;
import static
    com.pushtechology.diffusion.client.topics.details.TopicType.STRING;
import static java.util.concurrent.TimeUnit.SECONDS;

import java.util.concurrent.ExecutionException;
import java.util.concurrent.TimeoutException;

import com.pushtechology.diffusion.client.Diffusion;
import com.pushtechology.diffusion.client.callbacks.Registration;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicControl;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicUpdateControl;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicUpdateControl;
import com.pushtechology.diffusion.client.session.Session;
import
    com.pushtechology.diffusion.client.topics.details.TopicSpecification;
import com.pushtechology.diffusion.datatype.recordv2.RecordV2;
import
    com.pushtechology.diffusion.datatype.recordv2.RecordV2DataType;
import
    com.pushtechology.diffusion.datatype.recordv2.model.MutableRecordModel;
import com.pushtechology.diffusion.datatype.recordv2.schema.Schema;

/**
 * An example of using a control client to create and update a
 * RecordV2 topic in
 * exclusive mode.
 * <P>
 * This uses the 'TopicControl' feature to create a topic and the

```

```

* 'TopicUpdateControl' feature to send updates to it.
* <P>
* To send updates to a topic, the client session requires the
'update_topic'
* permission for that branch of the topic tree.
* <P>
* The example can be used with or without the use of a schema. This
is simply
* to demonstrate the different mechanisms and is not necessarily
demonstrating
* the most efficient way to update such a topic.
*
* @author Push Technology Limited
* @since 6.0
* @see ClientConsumingRecordV2Topics
*/
public final class ControlClientUpdatingRecordV2Topics {

    private static final String ROOT_TOPIC = "FX";

    private final Session session;
    private final TopicControl topicControl;
    private final TopicSpecification topicSpecification;
    private volatile Registration updateSourceRegistration;
    private final Schema schema;
    private final RecordV2DataType dataType;

    private volatile TopicUpdateControl.ValueUpdater<RecordV2>
valueUpdater;

    /**
     * Constructor.
     *
     * @param serverUrl for example "ws://diffusion.example.com:80"
     */
    public ControlClientUpdatingRecordV2Topics(
        String serverUrl,
        boolean withSchema)
        throws InterruptedException, ExecutionException,
TimeoutException {

        session =
Diffusion.sessions().principal("control").password("password")
        .open(serverUrl);

        topicControl = session.feature(TopicControl.class);

        // Create the root topic that will remove itself when the
session closes
        final TopicSpecification specification =
            topicControl.newSpecification(STRING)
                .withProperty(
                    REMOVAL,
                    "when this session closes remove '?' + ROOT_TOPIC
+ "///'");

        topicControl.addTopic(ROOT_TOPIC, specification).get(5,
SECONDS);

        dataType = Diffusion.dataTypes().recordV2();

        if (withSchema) {

```

```

        schema = dataType.schemaBuilder()
            .record("Rates").decimal("Bid", 5).decimal("Ask",
5).build());
        // Create the topic specification to be used for all
rates topics
        topicSpecification =
            topicControl.newSpecification(RECORD_V2)
                .withProperty(
                    SCHEMA,
                    schema.asJSONString());
    }
    else {
        schema = null;
        // Create the topic specification to be used for all
rates topics
        topicSpecification =
            topicControl.newSpecification(RECORD_V2);
    }

    final TopicUpdateControl updateControl =
        session.feature(TopicUpdateControl.class);

    // Register as an updater for all topics under the root
updateControl.registerUpdateSource(
    ROOT_TOPIC,
    new TopicUpdateControl.UpdateSource.Default() {
        @Override
        public void onRegistered(
            String topicPath,
            Registration registration) {
            updateSourceRegistration = registration;
        }

        @Override
        public void onActive(
            String topicPath,
            TopicUpdateControl.Updater updater) {
            valueUpdater =
updater.valueUpdater(RecordV2.class);
        }
    });
}

/**
 * Adds a new conversion rate in terms of base currency and
target currency.
 *
 * The bid and ask rates are entered as strings which may be a
decimal value
 * which will be parsed and validated, rounding to 5 decimal
places.
 *
 * @param currency the base currency (e.g. GBP)
 *
 * @param targetCurrency the target currency (e.g. USD)
 */
public void addRateTopic(
    String currency,
    String targetCurrency)
    throws InterruptedException, ExecutionException,
TimeoutException {

```

```

        topicControl.addTopic(
            rateTopicName(currency, targetCurrency),
            topicSpecification).get(5, SECONDS);
    }

    /**
     * Set a rate.
     * <P>
     * The rate topic in question must have been added first using
     * {@link #addRateTopic} otherwise this will fail.
     *
     * @param currency the base currency
     *
     * @param targetCurrency the target currency
     *
     * @param bid the new bid rate
     *
     * @param ask the new ask rate
     *
     * @param callback a callback which will be called to report the
     * outcome.
     * The context in the callback will be currency/
     * targetCurrency (e.g.
     * "GBP/USD")
     */
    public void setRate(
        String currency,
        String targetCurrency,
        String bid,
        String ask,
        UpdateContextCallback<String> callback) {

        if (valueUpdater == null) {
            throw new IllegalStateException("Not registered as
            updater");
        }

        final RecordV2 value;
        if (schema == null) {
            value = dataType.valueBuilder().addFields(bid,
            ask).build();
        }
        else {
            // Mutable models could be kept and reused but for this
            simple
            // example one is created every time
            final MutableRecordModel model =
                schema.createMutableModel();
            model.set("Bid", bid);
            model.set("Ask", ask);
            value = model.asValue();
        }

        valueUpdater.update(
            rateTopicName(currency, targetCurrency),
            value,
            String.format("%s/%s", currency, targetCurrency),
            callback);
    }

    /**
     * Remove a rate (removes its topic).

```

```

    *
    * @param currency the base currency
    *
    * @param targetCurrency the target currency
    */
    public void removeRate(
        String currency,
        String targetCurrency)
        throws InterruptedException, ExecutionException,
        TimeoutException {

        topicControl.removeTopics(
            rateTopicName(currency, targetCurrency))
            .get(5, SECONDS);
    }

    /**
     * Removes a currency (removes its topic and all subordinate rate
     topics).
     *
     * @param currency the base currency
     */
    public void removeCurrency(String currency)
        throws InterruptedException, ExecutionException,
        TimeoutException {
        topicControl
            .removeTopics(String.format("'%s/%s'", ROOT_TOPIC,
currency))
            .get(5, SECONDS);
    }

    /**
     * Close the session.
     */
    public void close() throws InterruptedException {
        // Close the registered update source
        final Registration registration =
this.updateSourceRegistration;
        if (registration != null) {
            registration.close();
        }
        session.close();
    }

    /**
     * Generates a hierarchical topic name for a rate topic.
     * <P>
     * e.g. for currency=GBP and targetCurrency=USD would return "FX/
GBP/USD".
     *
     * @param currency the base currency
     * @param targetCurrency the target currency
     * @return the topic name
     */
    private static String rateTopicName(String currency,
        String targetCurrency) {
        return String.format("%s/%s/%s", ROOT_TOPIC, currency,
targetCurrency);
    }
}

```

Related concepts

[RecordV2 topics](#) on page 77

A topic that streams data in recordV2 format, where the data is divided into multiple records, each of which can contain multiple fields. RecordV2 topics are stateful: each topic stores a value consisting of one or more records on the Diffusion server.

[RecordV2 schema](#) on page 80

A schema is an optional way to define how data is formatted when it is published on a recordV2 topic. A schema defines and names the permitted records and fields within the topic, and enables direct access to the fields.

[Subscribe to recordV2 topics](#) on page 310

The following example demonstrates how to process information from subscribed recordV2 topics, including the use of a schema.

Related tasks

[Defining a recordV2 schema](#) on page 300

You can use the API to specify a schema that defines the content of a recordV2 topic.

Subscribe to recordV2 topics

The following example demonstrates how to process information from subscribed recordV2 topics, including the use of a schema.

This example demonstrates a Java client consuming recordV2 topics which contain currency conversion rates.

Each topic contains a record with two decimal fields, representing the buy and sell rates between a pair of currencies.

The example can be run either with or without a schema.

```

/
*****
 * Copyright (C) 2017 Push Technology Ltd.
 *
 * Licensed under the Apache License, Version 2.0 (the "License");
 * you may not use this file except in compliance with the License.
 * You may obtain a copy of the License at
 * http://www.apache.org/licenses/LICENSE-2.0
 *
 * Unless required by applicable law or agreed to in writing,
 * software
 * distributed under the License is distributed on an "AS IS" BASIS,
 * WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or
 * implied.
 * See the License for the specific language governing permissions
 * and
 * limitations under the License.
*****
package com.pushtechology.diffusion.examples;

import static java.util.Objects.requireNonNull;

import java.util.HashMap;
import java.util.List;
import java.util.Map;
import java.util.concurrent.ConcurrentHashMap;

import org.slf4j.Logger;
```

```

import org.slf4j.LoggerFactory;

import com.pushtechology.diffusion.client.Diffusion;
import com.pushtechology.diffusion.client.features.Topics;
import
    com.pushtechology.diffusion.client.features.Topics.UnsubscribeReason;
import
    com.pushtechology.diffusion.client.features.Topics.ValueStream;
import com.pushtechology.diffusion.client.session.Session;
import
    com.pushtechology.diffusion.client.topics.details.TopicSpecification;
import com.pushtechology.diffusion.datatype.recordv2.RecordV2;
import com.pushtechology.diffusion.datatype.recordv2.RecordV2Delta;
import
    com.pushtechology.diffusion.datatype.recordv2.RecordV2Delta.Change;
import
    com.pushtechology.diffusion.datatype.recordv2.model.RecordModel;
import com.pushtechology.diffusion.datatype.recordv2.schema.Schema;
import
    com.pushtechology.diffusion.datatype.recordv2.schema.SchemaParseException;

/**
 * This demonstrates a client consuming RecordV2 topics.
 * <P>
 * It has been contrived to demonstrate the various techniques for
 * Diffusion
 * record topics and is not necessarily realistic or efficient in its
 * processing.
 * <P>
 * It can be run using a schema or not using a schema and
 * demonstrates how the
 * processing could be done in both cases.
 * <P>
 * This makes use of the 'Topics' feature only.
 * <P>
 * To subscribe to a topic, the client session must have the
 * 'select_topic' and
 * 'read_topic' permissions for that branch of the topic tree.
 * <P>
 * This example receives updates to currency conversion rates via a
 * branch of
 * the topic tree where the root topic is called "FX" which under it
 * has a topic
 * for each base currency and under each of those is a topic for each
 * target
 * currency which contains the bid and ask rates. So a topic FX/GBP/
 * USD would
 * contain the rates for GBP to USD.
 * <P>
 * This example maintains a local map of the rates and also notifies
 * a listener
 * of any rates changes.
 *
 * @author Push Technology Limited
 * @since 6.0
 * @see ControlClientUpdatingRecordV2Topics
 */
public final class ClientConsumingRecordV2Topics {

    private static final Logger LOG =
        LoggerFactory.getLogger(ClientConsumingRecordV2Topics.class);

    private static final String ROOT_TOPIC = "FX";

```

```

/**
 * The map of currency codes to currency objects which each
 maintain rates
 * for each target currency.
 */
private final Map<String, Currency> currencies = new
ConcurrentHashMap<>();

private Schema schema;

private final RatesListener listener;

private final Session session;

/**
 * Constructor.
 *
 * @param serverUrl for example "ws://diffusion.example.com:80"
 * @param listener a listener that will be notified of all rates
and rate
 * changes
 */
public ClientConsumingRecordV2Topics(String serverUrl,
RatesListener listener) {

    this.listener = requireNonNull(listener);

    session =
Diffusion.sessions().principal("client").password("password")
.open(serverUrl);

    // Use the Topics feature to add a record value stream and
subscribe to
// all topics under the root.
final Topics topics = session.feature(Topics.class);
final String topicSelector = String.format("%s/",
ROOT_TOPIC);

    topics.addStream(
        topicSelector,
        RecordV2.class,
        new RatesValueStream());

    topics.subscribe(topicSelector)
        .whenComplete((voidResult, exception) -> {
            if (exception != null) {
                LOG.info("subscription failed", exception);
            }
        });
}

/**
 * Returns the rates for a given base and target currency.
 *
 * @param currency the base currency
 * @param targetCurrency the target currency
 * @return the rates or null if there is no such base or target
currency
 */
public Rates getRates(String currency, String targetCurrency) {
    final Currency currencyObject = currencies.get(currency);

```

```

        if (currencyObject != null) {
            return currencyObject.getRates(targetCurrency);
        }
        return null;
    }

    /**
     * This is used to apply topic stream updates to the local map
and notify
     * listener of changes.
     */
    private void applyUpdate(
        String currency,
        String targetCurrency,
        RecordV2 oldValue,
        RecordV2 newValue) {

        Currency currencyObject = currencies.get(currency);
        if (currencyObject == null) {
            currencyObject = new Currency();
            currencies.put(currency, currencyObject);
        }

        if (schema == null) {
            updateWithoutSchema(
                currency,
                targetCurrency,
                oldValue,
                newValue,
                currencyObject);
        }
        else {
            updateWithSchema(
                currency,
                targetCurrency,
                oldValue,
                newValue,
                currencyObject);
        }
    }

    private void updateWithSchema(
        String currency,
        String targetCurrency,
        RecordV2 oldValue,
        RecordV2 newValue,
        Currency currencyObject) {

        // A data model is generated using the schema allowing direct
access to
        // the fields within it
        final RecordModel model = newValue.asModel(schema);
        final String bid = model.get("Bid");
        final String ask = model.get("Ask");

        currencyObject.setRate(targetCurrency, bid, ask);

        if (oldValue == null) {
            listener.onNewRate(currency, targetCurrency, bid, ask);
        }
        else {
            // Generate a structural delta to determine what has
changed

```

```

        final RecordV2Delta delta = newValue.diff(oldValue);
        for (Change change : delta.changes(schema)) {
            final String fieldName = change.fieldName();
            listener.onRateChange(
                currency,
                targetCurrency,
                fieldName,
                model.get(fieldName));
        }
    }
}

private void updateWithoutSchema(
    String currency,
    String targetCurrency,
    RecordV2 oldValue,
    RecordV2 newValue,
    Currency currencyObject) {

    // All of the fields in the value are obtained.
    final List<String> fields = newValue.asFields();
    final String bid = fields.get(0);
    final String ask = fields.get(1);

    currencyObject.setRate(targetCurrency, bid, ask);

    if (oldValue == null) {
        listener.onNewRate(currency, targetCurrency, bid, ask);
    }
    else {
        // Fields in the old value are obtained to determine what
has
        // changed
        final List<String> oldfields = oldValue.asFields();
        final String oldBid = oldfields.get(0);
        final String oldAsk = oldfields.get(1);
        if (!bid.equals(oldBid)) {
            listener.onRateChange(currency, targetCurrency,
"Bid", bid);
        }
        if (!ask.equals(oldAsk)) {
            listener.onRateChange(currency, targetCurrency,
"Ask", ask);
        }
    }
}

private void removeCurrency(String currency) {
    final Currency oldCurrency = currencies.remove(currency);
    for (String targetCurrency : oldCurrency.rates.keySet()) {
        listener.onRateRemoved(currency, targetCurrency);
    }
}

private void removeRate(
    String currency,
    String targetCurrency) {

    final Currency currencyObject = currencies.get(currency);
    if (currencyObject != null) {
        if (currencyObject.rates.remove(targetCurrency) != null)
{
            listener.onRateRemoved(currency, targetCurrency);

```

```

    }
}

/**
 * Close session.
 */
public void close() {
    currencies.clear();
    session.close();
}

/**
 * Encapsulates a base currency and all of its known rates.
 */
private static class Currency {

    private final Map<String, Rates> rates = new HashMap<>();

    private Rates getRates(String currency) {
        return rates.get(currency);
    }

    private void setRate(String currency, String bid, String ask)
    {
        rates.put(currency, new Rates(bid, ask));
    }

}

/**
 * Encapsulates the rates for a particular base/target currency
pair.
 */
public static final class Rates {

    private final String bidRate;
    private final String askRate;

    /**
     * Constructor.
     *
     * @param bid the bid rate or ""
     * @param ask the ask rate or ""
     */
    private Rates(String bid, String ask) {
        bidRate = bid;
        askRate = ask;
    }

    /**
     * Returns the bid rate.
     *
     * @return bid rate or "" if not available
     */
    public String getBidRate() {
        return bidRate;
    }

    /**
     * Returns the ask rate.
     *
     * @return ask rate or "" if not available

```

```

        */
        public String getAskRate() {
            return askRate;
        }
    }

    /**
     * A listener for Rates updates.
     */
    public interface RatesListener {

        /**
         * Notification of a new rate or rate update.
         *
         * @param currency the base currency
         * @param targetCurrency the target currency
         * @param bid rate
         * @param ask rate
         */
        void onNewRate(String currency, String targetCurrency, String
bid,
            String ask);

        /**
         * Notification of a change to the bid or ask value for a
rate.
         *
         * @param currency the base currency
         * @param targetCurrency the target currency
         * @param bidOrAsk "Bid" or "Ask"
         * @param rate the new rate
         */
        void onRateChange(String currency, String targetCurrency,
            String bidOrAsk, String rate);

        /**
         * Notification of a rate being removed.
         *
         * @param currency the base currency
         * @param targetCurrency the target currency
         */
        void onRateRemoved(String currency, String targetCurrency);
    }

    private final class RatesValueStream
        extends ValueStream.Default<RecordV2> {

        @Override
        public void onSubscription(String topicPath,
TopicSpecification specification) {
            final boolean isRatesTopic =
Diffusion.topicSelectors().parse("?FX/.*/.*").selects(topicPath);
            // Only retrieve a schema when subscribing to a rates
topic
            if (isRatesTopic) {
                final String schemaString =
specification.getProperties().get(TopicSpecification.SCHEMA);
                // If a schema is provided on subscription, retrieve
it and set it once
                // All schemas are identical for rates topics.
                if (schemaString != null && schema == null) {
                    try {

```

```

        schema =
Diffusion.dataTypes().recordV2().parseSchema(schemaString);
    }
    catch (SchemaParseException e) {
        LOG.error("Unable to parse recordV2 schema",
e);
    }
}
}

@Override
public void onValue(String topicPath, TopicSpecification
specification,
RecordV2 oldValue, RecordV2 newValue) {
    final String[] topicElements = elements(topicPath);
    // It is only a rate update if topic has 2 elements below
root path
    if (topicElements.length == 2) {
        applyUpdate(
            topicElements[0], // The base currency
            topicElements[1], // The target currency
            oldValue,
            newValue);
    }
}

@Override
public void onUnsubscription(String topicPath,
TopicSpecification specification, UnsubscribeReason
reason) {
    final String[] topicElements = elements(topicPath);
    if (topicElements.length == 2) {
        removeRate(topicElements[0], topicElements[1]);
    }
    else if (topicElements.length == 1) {
        removeCurrency(topicElements[0]);
    }
}

private String[] elements(String topicPath) {
    final String subPath =
        topicPath.replaceFirst("^" + ROOT_TOPIC + "/", "");
    return subPath.split("/");
}
}
}

```

Related concepts

[RecordV2 topics](#) on page 77

A topic that streams data in recordV2 format, where the data is divided into multiple records, each of which can contain multiple fields. RecordV2 topics are stateful: each topic stores a value consisting of one or more records on the Diffusion server.

[RecordV2 schema](#) on page 80

A schema is an optional way to define how data is formatted when it is published on a recordV2 topic. A schema defines and names the permitted records and fields within the topic, and enables direct access to the fields.

[Update recordV2 topics](#) on page 304

The following example demonstrates how to create and update recordV2 topics, including the use of a schema.

Related tasks

[Defining a recordV2 schema](#) on page 300

You can use the API to specify a schema that defines the content of a recordV2 topic.

Removing topics

A client can use the TopicControl feature of the Diffusion API to add and remove topics at the server.

Required permissions: `modify_topic`

Currently all topics created using a client have a lifespan the same as the Diffusion server (unless persistence is enabled). The topics remain at the Diffusion server even after the client session that created them has closed unless you explicitly specify that the topic is removed with the session.

A client can remove topics anywhere in the topic tree. The remove operation takes a topic selector, which enables the client to remove many topics at once.

You can also remove all topics beneath a selected topic path by appending the descendant pattern qualifiers, `/` and `//`.

Only topics for which the client has `modify_topic` permission are removed.

If there are topics for which the client does not have `modify_topic` permission, they are unaffected and the operation completes without throwing an exception.

A client cannot remove topics created by a [publisher](#).

A publisher cannot remove topics created by a client.

For more information, see [Topic selectors](#) on page 50.

JavaScript

```
session.topics.removeSelector('topic_selector')
  .then(function() {
    console.log('Removed all topics that match the selector.');
```

Apple

```
// Remove topic.
[session.topicControl
 removeDiscreteWithTopicSelectorExpression: topic_selector

 completionHandler:^(NSError *const error)
 {
   if (error) {
     NSLog(@"Failed to remove topic. Error: %@", error);
   } else {
     NSLog(@"Topic removal request succeeded.");
   }
 }];
```

Java and Android

```
TopicControl topicControl = session.feature(TopicControl.class);
topicControl.remove(topic_selector, callback);
```

.NET

```
ITopicControl topicControl = session.GetTopicControlFeature();  
topicControl.RemoveTopics( topic_selector, callback );
```

C

```
// Define callbacks elsewhere  
REMOVE_TOPICS_PARAMS_T remove_params = {  
    .on_removed = on_topic_removed,  
    .on_discard = on_topic_remove_discard,  
    .topic_selector = "topic_selector"  
};  
  
remove_topics(session, remove_params);
```

Removing topics automatically

You can specify an automatic removal policy that specifies under what conditions that topic and/or other topics will be removed automatically.

Specifying automatic removal policies

The automatic removal policy for a topic is specified using the REMOVAL topic property. The property is specified as an expression which defines one or more conditions that are to be satisfied before automatic removal occurs, and an optional clause that specifies which topics to remove.

The format of the expression is:

```
when conditions [remove "selector"]
```

where:

- **conditions** is one or more of the condition types in the table below, separated by and or or logical operators.
- the `remove` clause is optional. If not added, only the topic with the removal policy will be removed.
- **selector** is a `TopicSelector` expression representing a set of topics to be removed. If a `remove` clause is specified, the topic with the removal policy will only be removed if its path matches the selector expression.

Table 31: Removal condition types

Condition type	Format	Usage
time after	<code>time after <i>absoluteTime</i></code>	Removal should occur after a specified absolute time. Absolute time may be specified as a number of milliseconds since 00:00:00 on 1 January 1970 UTC, or as a quoted date and time formatted in RFC_1123 date time format. Either single or double quotes may be used.
subscriptions less than	<code>subscriptions < n for <i>forPeriod</i> [after <i>afterPeriod</i>]</code>	Removal should occur when the topic has had less than the specified number (n) of subscriptions for

Condition type	Format	Usage
		a given period (<i>forPeriod</i>) of time. Optionally, an initial period (<i>afterPeriod</i>) may be specified by which to delay the initial checking of this condition. See below for period formats.
no updates for	<code>no updates for <i>forPeriod</i> [after <i>afterPeriod</i>]</code>	Removal should occur when the topic has had no updates for a given period (<i>forPeriod</i>) of time. Optionally, an initial period (<i>afterPeriod</i>) may be specified by which to delay the initial checking of this condition. See below for period formats.
no session has	<code>no session has "criteria" [for <i>forPeriod</i>] [after <i>afterPeriod</i>]</code>	Removal should occur when there are no sessions satisfying the specified criteria. Optionally, the criteria can be required to be satisfied for a period of time (<i>forPeriod</i>). Optionally, an initial period (<i>afterPeriod</i>) can be specified to delay the initial check of the criteria. Session selection criteria are specified as defined in Session filtering on page 267 and must be surrounded by single or double quotes. See below for period formats.
	<code>this session closes</code>	This is a shorthand form of 'no session has' that may be used to indicate that the topic is to be removed when the session that created it closes.

The meaning of the 'for' period on 'no session has' conditions is subtly different from on other conditions. It does not guarantee that there has been no session satisfying the condition at some point between evaluations, only that when evaluated the given period of time has passed since it was last evaluated and found to have no matching sessions.

If quotes or backslashes (\) are required within quoted values such as selectors or session criteria then they may be escaped by preceding with \.

Time period format

Time periods are specified as a number followed (with no intermediate space) by a single letter representing the time unit. The time unit may be 's' (seconds), 'm' (minutes), 'h' (hours) or 'd' (days).

For example, 10 minutes would be specified as 10m.

Counting subscriptions and sessions

Subscriptions is the number of subscriptions to a topic, including those that occur through routing or slave topics. When monitoring across a cluster the 'subscriptions less than' condition is first checked on the server that owns the topic and if satisfied there then each cluster member is queried to check if the condition has also been satisfied there. The topic will only be removed if the total number of subscriptions across the cluster is less than that specified in the condition.

Automatic topic removal is supported for replicated topics. A 'subscriptions less than' condition for a replicated topic will be evaluated against the total number of subscriptions to the topic across the cluster. A 'no session has' condition will consider all sessions hosted across the cluster.

The 'subscriptions less than' condition does not count indirect subscriptions to a topic from sessions hosted on a secondary server connected using fan-out. Similarly, the 'no session has' condition does not count sessions on secondary servers connected using fan-out.

DEPRECATED: Removing topics with sessions

A client can specify that the Diffusion server removes a topic or topics after the client session closes or fails.

Note: Topic event listeners are deprecated from Diffusion 6.1 onwards in favor of automatic topic removal.

Required permissions: modify_topic

Register a branch of the topic tree to be removed when the session closes:

JavaScript

```
// Remove all topics under a topic path
session.topics.removeWithSession('topic_path').then(
  function(registration) {
    // Registration complete

    // Deregister this action
    registration.deregister().then(
      function() {
        // Deregistration complete
      },
      function(err) {
        // Failure while deregistering
      }
    );
  },
  function(err) {
    // Could not register
  }
);
```

Apple

```
PTDiffusionTopicControlFeature *const tc = session.topicControl;

// Register to remove the Example topic tree when the session closes.
[tc removeTopicsWithSessionForTopicPath:@"topic_path"
  delegate:self

  completionHandler:^(PTDiffusionTopicTreeRegistration *const
  registration, NSError *const error)
  {
    if (registration) {
```

```

        NSLog(@"Registered.");
    } else {
        NSLog(@"Registration failed. Error: %@", error);
    }
}];

```

Java and Android

```

TopicControl topicControl = session.feature(TopicControl.class);
topicControl.removeTopicsWithSession(topic_path, new
    TopicTreeHandler.Default());

```

.NET

```

ITopicControl topicControl = session.TopicControl;
topicControl.RemoveTopicsWithSession(topic_path, new
    DefaultTopicTreeHandler());

```

C

```

SESSION_WILLS_REMOVE_TOPIC_PARAMS_T params = {
    .topic_path = topic_path,
    .on_registered = on_will_registered,
    .on_close = on_will_closed
};

session_wills_remove_topics(session, params);

```

Note: Only topics for which the client has `modify_topic` permission when the session closes will be removed. Topics in the registered branch for which the client does not have permission will not be removed.

How topic removal with the session works

When a client registers that branch of the topic tree to be removed when its session closes, the following events occur:

1. The client registers the removal request on a branch of the topic tree and passes in a topic tree handler.
 - The removal request is registered against a topic path. This is a path that identifies a branch of the topic tree, for example `foo/bar`. The removal request is registered for the branch of the topic tree, for example the topics `foo/bar/baz` and `foo/bar/fred/qux` are included in the specified branch of the topic tree.
 - You cannot register a removal request above or below an existing removal request. For example, if a client has registered a removal request against `foo/bar/fred` another client cannot register a removal request against `foo/bar` or `foo/bar/fred/qux`.
2. The server validates the request and gives one of the following responses:
 - If the request is not valid, the Diffusion server calls the `onError` callback of the topic tree handler.

For example, a registration request is not valid if it registers against a topic branch that is above or below a branch where an existing removal request is registered.
 - If the request is valid, the Diffusion server calls the `OnActive` callback of the topic tree handler and provides a `Registration` object to the client.
3. If the client wants to deregister a removal request, it can call the `onClose` method of the `Registration` object for that removal request.

4. Other clients can register removal requests against a topic that already has a removal request registered against it. For example, if one session on the Diffusion server has registered a removal request against `foo/bar/baz`, another session on the Diffusion server can also register a removal request against `foo/bar/baz`.
5. When a client session closes or fails, if it has registered removal requests, one of the following things happens:
 - If there are still open sessions that have removal requests for the same branch of the topic tree, the Diffusion server takes no action.
 - If there are no open sessions that have removal requests for that branch of the topic tree, the Diffusion server removes all topics in that branch of the topic tree where the client has the required `modify_topic` permission.

Note: The client session must be in a closed state for a removal request to be acted upon. If a client becomes disconnected, the removal request is not acted upon until the reconnection timeout has elapsed and the client session is closed.

Remove topic requests and topic replication

If all sessions on a Diffusion server that have a removal request for a branch of the topic tree close, the topics are removed even if that topic is replicated and sessions on other Diffusion servers have removal requests registered against that part of the tree. When the topics are removed on the server, that change is replicated to all other servers that participate in replication for these topics.

Handling subscriptions to missing topics

A client can handle subscription or fetch requests for topics that do not exist and can act on those notifications, for example, by creating a topic on demand that matches the request.

Required permissions: `modify_topic`, `register_handler`

The client can register itself as a handler for missing topics for any branch of the topic tree. The client is notified of attempts to subscribe to or fetch topics that are subordinate to that topic and that do not exist. This enables the client to create the topics and notify the Diffusion server that the client operation subscribe or fetch can proceed.

Note: The handler is called only when a client attempts to subscribe or fetch using a single topic path. If another type of selector is used to subscribe to or fetch the topic, the handler is not notified.

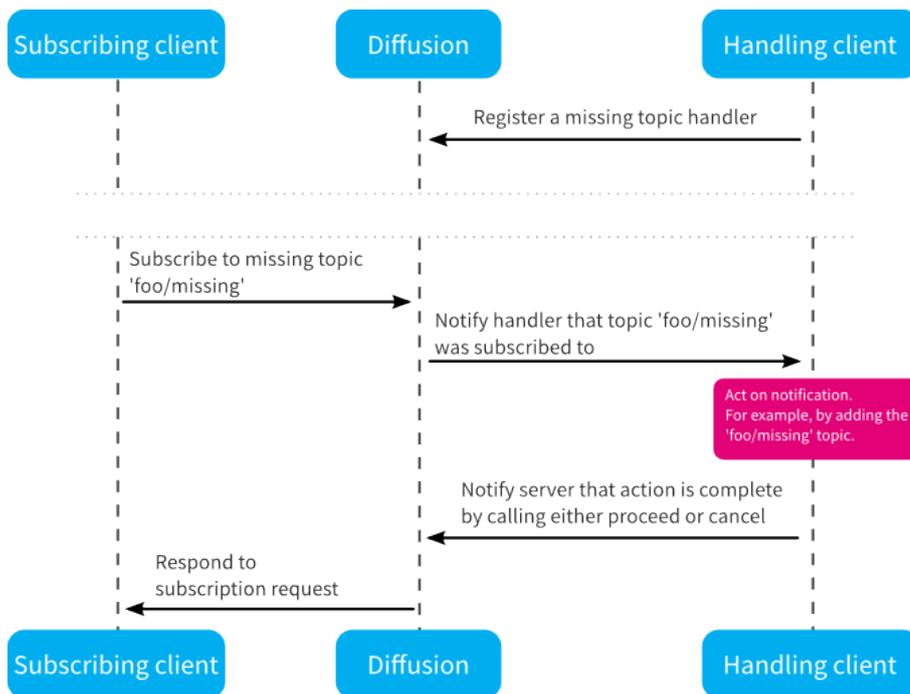


Figure 22: Flow from a subscribing client to the client that handles a missing topic subscription

The missing topic handler is removed when the registering session is closed. If the registering session loses connection, it goes into DISCONNECTED state. When in DISCONNECTED state the handler remains active but cannot pass on the notifications to the client. In this case, cancel or proceed callbacks for these notifications might not function as expected because of timeouts. If the client then closes, these notifications are discarded.

To ensure that missing topic notifications are always received by your solution, you can use multiple clients to register missing topic handlers. Ensure that if any of these clients lose connection they go straight to CLOSED state by setting the reconnection timeout to zero. When the client loses connect it closes straight away, the handler is registered is removed, and further missing topic notifications are routed to a handler registered by another client.

Registering a missing topic notification handler

Register a handler against a branch of the topic tree:

JavaScript

```
session.topics.addMissingTopicHandler("topic_branch", {
  // Implement handling code
});
```

Apple

```
-(void)registerAsMissingTopicHandlerForSession:(PTDiffusionSession
*const)session {
    [session.topicControl addMissingTopicHandler:self
                        forTopicPath:@"topic_branch"

    completionHandler:^(PTDiffusionTopicTreeRegistration *const
registration, NSError *const error)
    {
        if (registration) {
            NSLog(@"Registered as missing topic handler.");
        }
    }
}
```

```

    } else {
        NSLog(@"Failed to register as missing topic handler.
Error: %@", error);
    }
}];
}

```

Java and Android

```

TopicControl topicControl = session.feature(TopicControl.class);

topicControl.addMissingTopicHandler("topic_branch", new
MissingTopicNotificationHandler());

```

.NET

```

ITopicControl topicControl = session.TopicControl;
var missingTopicHandler = new MissingTopicHandler();
topicControl.AddMissingTopicHandler( topic_branch,
missingTopicHandler );

```

C

```

MISSING_TOPIC_PARAMS_T handler = {
    .on_missing_topic = on_missing_topic,
    .topic_path = topic_branch,
    .context = NULL
};

missing_topic_register_handler(session, handler);

```

Implementing a missing topic handler

The sample registration code shows default or no-op missing topic handlers being registered. To take the required action when a missing topic notification is received, implement a missing topic handler:

JavaScript

```

session.topics.addMissingTopicHandler("topic_branch", {

  onRegister : function(path, close) {
    console.log("Registered missing topic handler on path: " + path);
  },

  onClose : function(path) {
    console.log("Missing topic handler on path '" + path + "' has been
closed");
  },

  onError : function(path, error) {
    console.log("Error on missing topic handler");
  },

  onMissingTopic : function(notification) {
    console.log("Received missing topic notification with selector: " +
notification.selector);

    // Action to take in response to the notification, for example,
creating a topic.

```

```

        // If the action is successful, you can indicate that by calling
        proceed
        notification.proceed();
    }
});

```

Apple

```

@implementation MissingTopicHandlerExample
    (PTDiffusionMissingTopicHandler)

-(void)diffusionTopicTreeRegistration:
    (PTDiffusionTopicTreeRegistration *const)registration
    hadMissingTopicNotification:
    (PTDiffusionMissingTopicNotification *const)notification {
    NSString *const expression =
    notification.topicSelectorExpression;
    NSLog(@"Received Missing Topic Notification: %@", expression);

    // Action to take in response to the notification, for example,
    creating a topic.

    // If the action is successful, you can indicate that by calling
    proceed
    [notification proceed];
}

@end

```

Java and Android

```

private final class MissingTopicNotificationHandler implements
    MissingTopicHandler {
    /**
     * @param topicPath
     *         - the path that the handler is active for
     * @param registeredHandler
     *         - allows the handler to be closed
     */
    @Override
    public void onActive(String topicPath, RegisteredHandler
    registeredHandler) {
    }

    /**
     * @param topicPath
     *         - the branch of the topic tree for which the
    handler was
     *         registered
     */
    @Override
    public void onClose(String topicPath) {
    }

    /**
     * @param notification
     *         - the missing topic details
     */
    @Override
    public void onMissingTopic(MissingTopicNotification notification)
    {
    }
}

```

```

        // Action to take in response to the notification, for
        // example, creating a topic.

        // If the action is successful, you can indicate that by
        // calling proceed
        notification.proceed();
    }
}

```

.NET

```

    private class MissingTopicHandler : IMissingTopicHandler {
        private readonly TaskCompletionSource<IRegisteredHandler>
onActive =
            new TaskCompletionSource<IRegisteredHandler>();

        private readonly
TaskCompletionSource<IMissingTopicNotification> onMissingTopic =
            new
TaskCompletionSource<IMissingTopicNotification>();

        private readonly TaskCompletionSource<bool> onClose = new
TaskCompletionSource<bool>();

        public Task<IRegisteredHandler> OnActiveCalled {
            get {
                return onActive.Task;
            }
        }

        public Task<IMissingTopicNotification>
onMissingTopicCalled {
            get {
                return onMissingTopic.Task;
            }
        }

        public Task OnCloseCalled {
            get {
                return onClose.Task;
            }
        }

        void
IMissingTopicHandler.OnMissingTopic( IMissingTopicNotification
notification ) {
            onMissingTopic.SetResult( notification );
        }

        void ITopicTreeHandler.OnActive( string topicPath,
IRegisteredHandler registeredHandler ) {
            onActive.SetResult( registeredHandler );
        }

        void ITopicTreeHandler.OnClose( string topicPath ) {
            onClose.TrySetResult( false );
        }
    }
}

```

C

```
static int
on_missing_topic(SESSION_T *session, const
SVC_MISSING_TOPIC_REQUEST_T *request, void *context)
{
    printf("Missing topic: %s\n", request->topic_selector);

    // Action to take in response to the notification, for
    // example, creating a topic.

    // If the action is successful, you can indicate that by
    // calling proceed
    missing_topic_proceed(session, (SVC_MISSING_TOPIC_REQUEST_T
*) request);

    return HANDLER_SUCCESS;
}
```

Related concepts

[Using missing topic notifications with fan-out](#) on page 101

Missing topic notifications generated by subscription or fetch requests to a secondary server are propagated to missing topic handlers registered against the primary servers.

DEPRECATED: Listening for topic events

A client can listen for events that happen on topics in a specific topic branch.

Note: Topic event listeners are deprecated from Diffusion 6.1 onwards in favor of automatic topic removal.

Registering a topic event listener

Required permissions: register_handler

You can use the TopicControl feature to receive a notification whenever one of the following topic events occurs:

- A topic that previously had zero subscribers gains one or more subscribers
- A topic that previously had one or more subscribers goes to zero subscribers

Note: Subscriber numbers also include indirect subscriptions, for example: subscriptions via a slave topic or routing topic; subscriptions by another Diffusion server for fan-out replication; or replication of the topic using high-availability replication.

A client can register a topic event listener against any branch of the topic tree. When a topic event occurs on one of the topics in that branch of the topic tree the listening client receives a notification.

If multiple clients register listeners against the same branch of the topic tree, all receive notifications. However, if a client registers a listener at a more specific branch of the topic tree, the most specific listener or listeners receive a notification and any less specific listeners within that same branch do not receive a notification.

For example: Client One registers a topic event listener against A, Client Two registers a topic event listener against A, and Client Three registers a topic event listener against A/B/C. If a topic event occurs on A/B, both Client One and Client Two receive notifications. If a topic event occurs on A/B/C/D, only Client Three receives a notification.

Receiving topic notifications

Receive topic notifications using topic selectors. This enables a client to receive updates when topics are added or removed, without the topic values.

Note: Topic notifications are supported by the Android API, Java API and JavaScript API.

The client must register a listener object to receive notifications about selected topics. Use a [topic selector](#) to specify the topics.

For more details about topic notifications, see [Topic notifications](#) on page 92.

Required permissions: `select_topic` and `read_topic` permissions for the specified topics

Receiving topic notifications

A client can register to receive notifications about a set of topics via a listener object.

JavaScript

```
var listener = {
  onDescendantNotification: function(topicPath, type) {},
  onTopicNotification: function(topicPath, topicSpecification,
  type) {},
  onClose: function() {},
  onError: function(error) {}
};

session.notifications.addListener(listener).then(function(reg) {
  reg.select("foo");
});
```

Java and Android

```
final TopicNotifications notifications =
    session.feature(TopicNotifications.class);

final TopicNotificationListener listener = new
    TopicNotificationListener() {
    @Override
    public void onTopicNotification(String topicPath,
    TopicSpecification specification, NotificationType type) {
        // Handle notifications for selected/deselected topics
    }

    @Override
    public void onDescendantNotification(String topicPath,
    NotificationType type) {
        // Handle notifications for immediate descendants
    }

    @Override
    public void onClose() {
        // The listener has been closed
    }

    @Override
    public void onError(ErrorReason error) {
        // The listener has encountered an error
    }
}
```

```
};

final CompletableFuture<NotificationRegistration> future =
    notifications.addListener(listener);
final NotificationRegistration registration = future.get();

registration.select("foo");
```

Creating a metadata definition

You can use the API to specify the metadata structure that describes the byte data content of a message.

About this task

Publishing clients define the metadata structure for messages. This metadata structure can be used when defining a topic. All messages placed on the topic must conform to the metadata structure.

The Diffusion API for the following platforms provides builder methods that enable you to define the metadata structure:

- JavaScript
- Java
- .NET

The C API does not provide builder methods, but instead takes the definition of the metadata as XML. For more information, see [C API overview](#).

The following example demonstrates how to define the metadata structure using the Java API.

Note: Where there notation `c.p.d` is used in class or package names, it indicates `com.pushtechnology.diffusion`.

Procedure

1. Define the metadata structure.

- a) Use the `Diffusion.metadata` method to get a `MetadataFactory`.

```
private final MetadataFactory factory = Diffusion.metadata();
```

- b) Use the methods on the `MetadataFactory` to specify the content, record, and field definitions that make up the metadata structure.

For example, the following code uses a content builder to create content metadata with a single record type that can occur zero to n times.

```
public MContent createContentRepeating() {
    return
        factory.contentBuilder("Content").
            add(
                factory.record(
                    "Rec1",
                    factory.string("A"),
                    factory.string("B")),
                0,
                -1).
            build();
}
```

```
}
```

For more information, see [Java API documentation](#).

2. Create a record topic and apply the metadata definition to it.

- a) Import the TopicControl feature, Session class, and RecordTopicDetails class.

```
import
    com.pushtechology.diffusion.client.features.control.topics.TopicControl;
import com.pushtechology.diffusion.client.session.Session;
import
    com.pushtechology.diffusion.client.topics.details.RecordTopicDetails;
```

- b) Create a Session instance and use it to get the TopicControl feature.

```
final Session session = Diffusion.sessions().open("ws://
diffusion.example.com:80");
final TopicControl tc = session.feature(TopicControl.class);
```

- c) Get a topic builder for a record topic from the TopicControl feature.

```
final RecordTopicDetails.Builder builder =
    tc.newDetailsBuilder(RecordTopicDetails.Builder.class);
```

- d) Use the metadata method of the topic builder to create the topic definition.

```
tc.addTopic(
    TOPIC_NAME,
    builder.metadata(metadata).build(),
    new TopicControl.AddCallback.Default() {
        @Override
        public void onTopicAdded(String topic) {
            theTopic = topic;
        }
    });
```

Example: A client that creates a metadata definition and uses it when creating a topic.

```
package com.example.metadata;

import com.pushtechology.diffusion.client.Diffusion;
import
    com.pushtechology.diffusion.client.content.metadata.MContent;
import
    com.pushtechology.diffusion.client.content.metadata.MDecimalString;
import
    com.pushtechology.diffusion.client.content.metadata.MField;
import
    com.pushtechology.diffusion.client.content.metadata.MRecord;
import
    com.pushtechology.diffusion.client.content.metadata.MetadataFactory;
import
    com.pushtechology.diffusion.client.topics.details.TopicType;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicControl;
import com.pushtechology.diffusion.client.session.Session;
import
    com.pushtechology.diffusion.client.topics.details.RecordTopicDetails;
import com.pushtechology.diffusion.client.types.UpdateOptions;
```

```

/**
 * An example of a client creating metadata definition and using
 * it when creating a
 * topic definition.
 */
public class ControlClient {

    private final static String TOPIC_NAME = "foo/record";
    private String theTopic;
    private final MetadataFactory factory = Diffusion.metadata();

    /**
     * Creates control client instance.
     */
    public ControlClient() {

        // Create the Session
        final Session session = Diffusion.sessions()
            .open("ws://diffusion.example.com:80");

        // Add the TopicControl feature
        final TopicControl tc =
            session.feature(TopicControl.class);

        // Create metadata for the topic
        final MContent metadata = defineMetadata();

        // Get a topic builder
        final RecordTopicDetails.Builder builder =
            tc.newDetailsBuilder(RecordTopicDetails.Builder.class);

        // Create the topic with metadata
        tc.addTopic(
            TOPIC_NAME,
            builder.metadata(metadata).build(),
            new TopicControl.AddCallback.Default() {
                @Override
                public void onTopicAdded(String topic) {
                    theTopic = topic;
                }
            }
        );

    }

    /**
     * A simple example of creating content metadata with two
     records.
     *
     * @return content metadata
     */
    public MContent defineMetadata() {
        return factory.content(
            "Content",
            createNameAndAddressRecord(),
            createMultipleRateCurrencyRecord("Exchange Rates",
2));
    }

    /**

```

```

    * Creates a simple name and address record with fixed name
single
    * multiplicity fields.
    *
    * @return record definition.
    */
    public MRecord createNameAndAddressRecord() {
        return factory.record(
            "NameAndAddress",
            factory.string("FirstName"),
            factory.string("Surname"),
            factory.string("HouseNumber"),
            factory.string("Street"),
            factory.string("Town"),
            factory.string("State"),
            factory.string("PostCode"));
    }

    /**
    * This creates a record with two fields, a string called
    "Currency" and a
    * decimal string called "Rate" with a default value of 1.00
    which repeats a
    * specified number of times.
    *
    * @param name the record name
    * @param occurs the number of occurrences of the "Rate" field
    * @return the metadata record
    */
    public MRecord createMultipleRateCurrencyRecord(String name,
    int occurs) {
        return factory.recordBuilder(name).
            add(factory.string("Currency")).
            add(factory.decimal("Rate", "1.00"), occurs).
            build();
    }
}

```

DEPRECATED: Add a topic using an initial value

A client can add a topic and define its type by providing an initial value, but this is now deprecated. It is better to create a topic, then separately update it with an initial value.

Required permissions: modify_topic

Supported platforms: JavaScript, Android, Java, .NET

Add a topic, providing a value to the method from which the Diffusion server can derive the type of the topic:

JavaScript

```

// Create a topic with string values, and an initial value of "xyz".
session.topics.add('topic/string', 'xyz');

// Create a topic with integer values, and an initial value of 123.
session.topics.add('topic/integer', 123);

```

```

// Create a topic with decimal values, with an implicit scale of 2
// and an initial value of 1.23.
session.topics.add('topic/decimal', 1.23);

// Create record content from previously defined metadata
var builder = metadata.builder();

// Values must be set before a value can be created
builder.add('game', { title : 'Planet Express!', count : 3 });

builder.add('player', { name : 'Fry', score : 0 });
builder.add('player', { name : 'Amy', score : 0 });
builder.add('player', { name : 'Kif', score : 0 });

// Build a content instance
var initial_value = builder.build();

// Create a topic with record content. The metadata structure is
// derived from the structure of the initial value.
session.topics.add('games/game', initial_value).then(function() {
    console.log('Topic was added with initial value');
});

```

Java and Android

```

// Create a topic with string values, and an initial value of "xyz".
topicControl.addTopicFromValue( "topic/string", "xyz", callback);

// Create a topic with integer values, and an initial value of 42.
topicControl.addTopicFromValue( "topic/integer", "42", callback);

// Create a topic with decimal values, with an implicit scale of 3
// and an initial value of 2.718.
topicControl.addTopicFromValue( "topic/decimal", "2.718", callback);

// Create a topic with record content. Use RecordContentBuilder and
// its methods to construct the content.
// The metadata structure is derived from the structure of the
// initial value.
topicControl.addTopicFromValue( "topic/record",

    Diffusion.content().newBuilder(RecordContentBuilder.class)

    .putFields(initialValues).build(),
        callback);

```

.NET

```

var topicControl = session.TopicControl;

var callback = new TopicControlAddCallbackDefault();

// Create a topic with string values and an initial value of 'xyz'.
topicControl.AddTopicFromValue( "topic/string", "xyz", callback );

// Create a topic with integer values and an initial value of 42.
topicControl.AddTopicFromValue( "topic/integer", "42", callback );

// Create a topic with decimal values with an implicit scale of 3 and
// an initial value of 2.718.
topicControl.AddTopicFromValue( "topic/decimal", "2.718", callback );

```

```
// Create a topic with record content. Use IRecordContentBuilder and
// its methods to construct the content.
// The metadata structure is derived from the structure of the
// initial value.
var initialValues = new[]{"1","2","3"};

topicControl.AddTopicFromValue(
    "topic/record",
    Diffusion.Content.NewBuilder<IRecordContentBuilder>().PutFields( initialValues
    callback );
```

The value used to create the topic is set as the initial value of the topic and sent to any subscribed clients.

Derived topic types

The following table lists the topic types derived from different types of provided values:

Value type	Topic type	Metadata	Initial value
JSON	JSON	Not applicable	The supplied value
Binary	Binary	Not applicable	The supplied value
Content created using a builder method	Record	The metadata of the content is derived from the records and fields in the content with the following assumptions: <ul style="list-style-type: none"> Numeric values are assumed to be <code>MIntegerString</code> Numeric values that contain a decimal point (.) are assumed to be <code>MDecimalString</code> with a scale equal to the number of places after the decimal point All other values are assumed to be <code>MString</code> 	The supplied content
Content not created using a builder method	Single value	<code>MString</code>	The supplied content as a string
Integer, Long, Short, Byte, BigInteger, AtomicInteger, AtomicLong	Single value	<code>MIntegerString</code>	A value derived from the string representation of the supplied value
BigDecimal	Single value	<code>MDecimalString</code> with scale from supplied value	A value derived from the string representation of the supplied value

Value type	Topic type	Metadata	Initial value
Double, Float	Single value	MDecimalString with scale 2	A value derived from the string representation of the supplied value Note: We do not recommend using floating point numbers. If used, the number is converted to decimal using <i>half even</i> rounding.
Other	Single value	MString	A string representation of the supplied value

Note: Ensure that you correctly format the data provided as an initial value according to the standards of the language you are using. Incorrectly formatted data can cause errors when using the data to add topics.

For more information about the format of the initial value in each API and how metadata structure and data types are derived from that value, see the API documentation for that API.

Record topics

If the topic type is a record topic, Diffusion derives the structure of the metadata of the topic from the provided initial value. This metadata structure or data type must be adhered to by all subsequent updates to the topic.

Note: Using this method to define the metadata structure for record topics has limitations.

- Field types are derived from the values provided. Avoid providing initial values that are ambiguous. For example, if you intend that a field have a string data type, do not provide an initial value that is numeric. In this case a decimal or integer type is derived.
- It is not possible for Diffusion to detect the intent to use repeating records or fields. If your metadata structure is to contain repeating records or fields, you cannot define your topic using a value. Instead create your metadata definition explicitly, using the provided builder methods.
- In some APIs (for example, JavaScript you must have defined the metadata in order to create record content. In many cases, it is better when adding a topic to use this metadata definition in addition to providing an initial value.

Updating topics

A client can use the TopicUpdateControl feature to update topics.

A client can update a topic in one of the following ways:

Exclusive updating

By registering with the Diffusion server as an update source for the branch of the topic tree that contains the topic to be updated.

If a client is registered as the active update source for a branch of the topic tree, no other clients can update topics in that branch of the topic tree.

Non-exclusive updating

By getting a non-exclusive updater from the `TopicUpdateControl` feature. This updater can be used to update any topic that does not already have an active update source registered against it.

Registering as an exclusive update source

Required permissions: `update_topic`, `register_handler`

A client must register as an update source for a branch of the topic tree to be able to exclusively publish content to topics in that branch. This locks the branch of the topic tree and prevents other clients from publishing updates to topics in the branch.

When a client registers as an update source the following events occur:

1. The client requests to register as an update source on a branch of the topic tree.
 - The update source is registered against a topic path. This is a path that identifies a branch of the topic tree, for example `foo/bar`. The update source is registered as a source for that branch of the topic tree, for example the topics `foo/bar/baz` and `foo/bar/fred/qux` are included in the specified branch of the topic tree.
 - You cannot register an update source above or below an existing update source. For example, if a client has registered an update source against `foo/bar/fred` another client cannot register an update source against `foo/bar` or `foo/bar/fred/qux`.
 - You can register an update source against a topic owned by an existing publisher or a topic that has an update source created by the server that is used for topic failover.
2. The server validates the registration request and returns one of the following responses:
 - If the request is valid, the Diffusion server calls the `onRegister` callback of the update source and passes a `RegisteredHandler` that you can use to deregister the update source.
 - If the request is not valid, the Diffusion server calls the `onClose` callback of the update source.
For example, a registration request is not valid if it registers against a topic branch that is above or below a branch where an existing update source is registered.
3. When the update source is registered, the Diffusion server calls one of the following callbacks:
 - If the update source is the primary update source, the Diffusion server calls the `onActive` callback of the update source.
 - If another update source is already the primary source for this branch of the topic tree, the Diffusion server calls the `onStandby` callback of the update source.
4. If an update source is on standby, the update source cannot update the topics it is registered against. If the active update source for a branch of the topic tree closes or becomes inactive, a standby update source can then become active and become the primary update source for that branch of the topic tree.
5. If an update source is active, the Diffusion server provides the update source with an `Updater`. The update source can use the `Updater` to update the topics it is registered against.
6. If an active update source exists for a branch of the topic tree, no other clients can update topics in that branch of the topic tree.

Updating a topic non-exclusively

Required permissions: `update_topic`

To non-exclusively update topics, a client must get a non-exclusive updater from the `TopicUpdateControl` feature. This updater can be used to update any topic under the following conditions:

- The topic does not already have an active update source registered against it
- The client has the `update_topic` permission for the topic

Types of updater

Updater type	Description
Value updater	Use a value updater to update one of the following topic types: JSON, Binary, Int64, String, Double, RecordV2. When a topic is updated with a value updater, the value is cached. Subsequent updates can use the cached value to calculate a delta of change between the two values and just send that to the Diffusion server, thus reducing the data volume to the Diffusion server.
Updater	Use an updater to update one of the following topic types: single value, record, stateless.

Using a value updater to stream values through topics

Required permissions: `update_topic`

A client uses a value updater to publish a value to a topic. Value updaters are typed and can only be used to update topics whose data type matches the data type of the value updater.

Value updaters can be used for exclusive or non-exclusive updating, depending on how the value updater is acquired.

When used exclusively, value updaters cache the values that are passed to them. When a value is passed to a value updater, the value updater compared that value with the previously cached value. If it is more efficient to do so, the value updater publishes a delta of changes between the previous value and the new value instead of publishing the full new value.

For non-exclusive updating, the complete value is always sent to the server and the value is not cached.

When the client uses a value updater method to publish values, it passes in the following parameters:

Topic path

The path to the topic to be updated.

If the value updater is an exclusive updater, this topic must be in the branch of the topic tree that the client is the active update source for and that the updater is associated with.

Value

The value to use to update the topic. This value is of the data type that matches the data type of the topic being updated.

Context

OPTIONAL: A context object can be passed in to the update method that provides application state information.

Callback

The server uses the callback to return the result of the update. If the update completes successfully, the Diffusion server calls the callback's `onComplete` method. Otherwise, the Diffusion server calls the callback's `onError` method.

Using an updater to publish content to topics

Required permissions: `update_topic`

A client uses an updater to publish content to topics. Updaters can be used for exclusive or non-exclusive updating, depending on how the updater is acquired. When the client uses an updater method to publish content, it passes in the following parameters:

Topic path

The path to the topic to be updated.

If the updater is an exclusive updater, this topic must be in the branch of the topic tree that the client is the active update source for and that the updater is associated with.

Content

The information about the update can be provided as either a simple `Content` object or as a more complex `Update` object.

The content that is to be published to the topic. The client must use the appropriate content type when formatting the content. If the content uses the wrong content type for the topic, it can cause an error.

Update

The information about the update can be provided as either a simple `Content` object or as a more complex `Update` object.

An update that contains the content that is to be published to the topic and other information about the update, such as its type.

Use the `Builder` methods provided in the Diffusion API to build your `Update` objects.

Context

OPTIONAL: A context object can be passed in to the update method that provides application state information.

Callback

The server uses the callback to return the result of the update. If the update completes successfully, the Diffusion server calls the callback's `onComplete` method. Otherwise, the Diffusion server calls the callback's `onError` method.

Related reference

[Failover of active update sources](#) on page 111

You can use failover of active update sources to ensure that when a server that is the active update source for a section of the topic tree becomes unavailable, an update source on another server is assigned to be the active update source for that section of the topic tree. Failover of active update sources is enabled for any sections of the topic tree that have topic replication enabled.

Example: Make exclusive updates to a topic

The following examples use the Diffusion API to register as the update source of a topic and to update that topic with content. A client that updates a topic using this method locks the topic and prevents other clients from updating the topic.

JavaScript

```
diffusion.connect({
```

```

    host    : 'diffusion.example.com',
    port    : 443,
    secure  : true,
    principal : 'control',
    credentials : 'password'
  }).then(function(session) {
    // A session may establish an exclusive update source. Once
    // active, only this session may update topics at or
    // under the registration branch.

    session.topics.registerUpdateSource('exclusive/topic', {
      onRegister : function(topic, deregister) {
        // The handler provides a deregistration function to
        // remove this registration and allow other sessions to
        // update topics under the registered path.
      },
      onActive : function(topic, updater) {
        // Once active, a handler may use the provided updater to
        // update any topics at or under the registered path
        updater.update('exclusive/topic/bar',
123).then(function() {
          // The update was successful.
        }, function(err) {
          // There was an error updating the topic
        });
      },
      onStandBy : function(topic) {
        // If there is another update source registered for the
        // same topic path, any subsequent registrations will
        // be put into a standby state. The registration is still
        // held by the server, and the 'onActive' function
        // will be called if the pre-existing registration is
        // closed at a later point in time
      },
      onClose : function(topic, err) {
        // The 'onClose' function will be called once the
        // registration is closed, either by the session being closed
        // or the 'deregister' function being called.
      }
    });
  });
});

```

Apple

```

#import Diffusion;

@interface TopicUpdateSourceExample (PTDiffusionTopicUpdateSource)
<PTDiffusionTopicUpdateSource>
@end

@implementation TopicUpdateSourceExample {
    PTDiffusionSession* _session;
}

-(void)startWithURL:(NSURL*)url {
    PTDiffusionCredentials *const credentials =
    [[PTDiffusionCredentials alloc]
initWithPassword:@"password"];

    PTDiffusionSessionConfiguration *const sessionConfiguration =
    [[PTDiffusionSessionConfiguration alloc]
initWithPrincipal:@"control"

```

```

credentials:credentials];

    NSLog(@"Connecting...");

    [PTDiffusionSession openWithURL:url
                        configuration:sessionConfiguration
                        completionHandler:^(PTDiffusionSession *session,
NSError *error)
    {
        if (!session) {
            NSLog(@"Failed to open session: %@", error);
            return;
        }

        // At this point we now have a connected session.
        NSLog(@"Connected.");

        // Set ivar to maintain a strong reference to the session.
        _session = session;

        // Add topic.
        [self addTopicForSession:session];
    }];
}

static NSString *const _TopicPath = @"Example/Exclusively Updating";

-(void)addTopicForSession:(PTDiffusionSession *const)session {
    // Add a single value topic without an initial value.
    [session.topicControl addWithTopicPath:_TopicPath

type:PTDiffusionTopicType_SingleValue
                                value:nil
                                completionHandler:^(NSError * _Nullable
error)
    {
        if (error) {
            NSLog(@"Failed to add topic. Error: %@", error);
        } else {
            NSLog(@"Topic created.");

            // Register as an exclusive update source.
            [self registerAsUpdateSourceForSession:session];
        }
    }];
}

-(void)registerAsUpdateSourceForSession:(PTDiffusionSession
*const)session {
    [session.topicUpdateControl registerUpdateSource:self
                                forTopicPath:_TopicPath

completionHandler:^(PTDiffusionTopicTreeRegistration *const
registration, NSError *const error)
    {
        if (registration) {
            NSLog(@"Registered as an update source.");
        } else {
            NSLog(@"Failed to register as an update source. Error:
%@", error);
        }
    }];
}

```

```

}

-(void)updateTopicWithUpdater:(PTDiffusionTopicUpdater *const)updater
    value:(const NSUInteger)value {
    // Prepare data to update topic with.
    NSString *const string =
        [NSString stringWithFormat:@"Update #%lu", (unsigned
long)value];
    NSData *const data = [string
dataUsingEncoding:NSUTF8StringEncoding];
    PTDiffusionContent *const content =
        [[PTDiffusionContent alloc] initWithData:data];

    // Update the topic.
    [updater updateWithTopicPath:_TopicPath
        value:content
        completionHandler:^(NSError *const error)
    {
        if (error) {
            NSLog(@"Failed to update topic. Error: %@", error);
        } else {
            NSLog(@"Topic updated to \"%@\\"", string);

            // Update topic after a short wait.
            dispatch_after(dispatch_time(DISPATCH_TIME_NOW, (int64_t)
(1.0 * NSEC_PER_SEC)),
                dispatch_get_main_queue(), ^
            {
                [self updateTopicWithUpdater:updater value:value +
1];
            });
        }
    }];
}

@end

@implementation TopicUpdateSourceExample
    (PTDiffusionTopicUpdateSource)

-(void)diffusionTopicTreeRegistration:
    (PTDiffusionTopicTreeRegistration *const)registration
        isActiveWithUpdater:(PTDiffusionTopicUpdater
*const)updater {
    NSLog(@"Registration is active.");

    // Start updating.
    [self updateTopicWithUpdater:updater value:1];
}

@end

```

Java and Android

```

/
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```

```

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* distributed under the License is distributed on an "AS IS" BASIS,
* WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or
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and
* limitations under the License.
*****
package com.pushtechology.diffusion.examples;

import static
    com.pushtechology.diffusion.client.topics.details.TopicSpecification.REMOVAL;
import static
    com.pushtechology.diffusion.client.topics.details.TopicType.STRING;
import static java.util.concurrent.TimeUnit.SECONDS;

import java.util.concurrent.ExecutionException;
import java.util.concurrent.ScheduledExecutorService;
import java.util.concurrent.ScheduledFuture;
import java.util.concurrent.TimeoutException;

import com.pushtechology.diffusion.client.Diffusion;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicControl;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicUpdateControl;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicUpdateControl;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicUpdateControl;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicUpdateControl;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicUpdateControl;
import com.pushtechology.diffusion.client.session.Session;
import
    com.pushtechology.diffusion.client.topics.details.TopicSpecification;

/**
 * An example of using a control client as an event feed to a topic.
 * <P>
 * This uses the 'TopicControl' feature to create a topic and the
 * 'TopicUpdateControl' feature to send updates to it.
 * <P>
 * To send updates to a topic, the client session requires the
 * 'update_topic'
 * permission for that branch of the topic tree.
 *
 * @author Push Technology Limited
 * @since 5.0
 */
public class ControlClientAsUpdateSource {

    private static final String TOPIC_NAME = "Feeder";

    private final Session session;
    private final UpdateCallback updateCallback;

    /**
     * Constructor.

```

```

    *
    * @param callback for updates
    */
    public ControlClientAsUpdateSource(UpdateCallback callback) {

        updateCallback = callback;

        session =

Diffusion.sessions().principal("control").password("password")
        .open("ws://diffusion.example.com:80");
    }

    /**
    * Start the feed.
    *
    * @param provider the provider of prices
    * @param scheduler a scheduler service to schedule a periodic
feeder task
    * @throws TimeoutException if the topic was not created within 5
seconds
    * @throws ExecutionException if topic creation failed
    * @throws InterruptedException if the current thread was
interrupted whilst
    *         waiting for the topic to be created
    */
    public void start(
        final PriceProvider provider,
        final ScheduledExecutorService scheduler)
        throws InterruptedException, ExecutionException,
TimeoutException {

        // Add the topic with a REMOVAL policy indicating that the
topic
        // will be removed when the session no longer exists.
        final TopicControl topicControl =
session.feature(TopicControl.class);

        final TopicSpecification specification =
            topicControl.newSpecification(STRING)
                .withProperty(REMOVAL, "when this session closes");

        topicControl.addTopic(
            TOPIC_NAME,
            specification).get(5, SECONDS);

        // Declare a custom update source implementation. When the
source is set
        // as active start a periodic task to poll the provider every
second and
        // update the topic. When the source is closed, stop the
scheduled task.
        final UpdateSource source = new UpdateSource.Default() {
            private ScheduledFuture<?> theFeeder;

            @Override
            public void onActive(String topicPath, Updater updater) {
                theFeeder =
                    scheduler.scheduleAtFixedRate(
                        new FeederTask(provider,
                            updater.valueUpdater(String.class)),
                        1, 1, SECONDS);
            }
        }
    }

```

```

        @Override
        public void onClose(String topicPath) {
            if (theFeeder != null) {
                theFeeder.cancel(true);
            }
        }
    };

    final TopicUpdateControl updateControl =
        session.feature(TopicUpdateControl.class);

    updateControl.registerUpdateSource(TOPIC_NAME, source);
}

/**
 * Close the session.
 */
public void close() {
    session.close();
}

/**
 * Periodic task to poll from provider and send update to server.
 */
private final class FeederTask implements Runnable {

    private final PriceProvider priceProvider;
    private final ValueUpdater<String> priceUpdater;

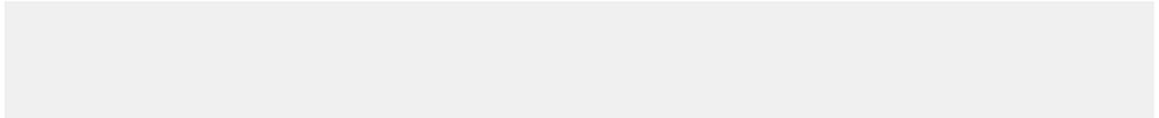
    private FeederTask(PriceProvider provider,
        ValueUpdater<String> updater) {
        priceProvider = provider;
        priceUpdater = updater;
    }

    @Override
    public void run() {
        priceUpdater.update(
            TOPIC_NAME,
            priceProvider.getPrice(),
            updateCallback);
    }
}

/**
 * Interface of a price provider that can periodically be polled
for a
 * price.
 */
public interface PriceProvider {
    /**
     * Get the current price.
     *
     * @return current price as a decimal string
     */
    String getPrice();
}
}

```

.NET



C

```
/**
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 * distributed under the License is distributed on an "AS IS" BASIS,
 * WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or
 * implied.
 * See the License for the specific language governing permissions
 * and
 * limitations under the License.
 *
 * This example is written in C99. Please use an appropriate C99
 * capable compiler
 *
 * @author Push Technology Limited
 * @since 5.0
 */

/*
 * This example creates a simple single-value topic and periodically
 * updates
 * the data it contains.
 */
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#include <unistd.h>

#include <apr.h>
#include <apr_thread_mutex.h>
#include <apr_thread_cond.h>

#include "diffusion.h"
#include "args.h"
#include "conversation.h"
#include "service/svc-update.h"

int active = 0;

apr_pool_t *pool = NULL;
apr_thread_mutex_t *mutex = NULL;
apr_thread_cond_t *cond = NULL;

ARG_OPTS_T arg_opts[] = {
    ARG_OPTS_HELP,
    {'u', "url", "Diffusion server URL", ARG_OPTIONAL,
     ARG_HAS_VALUE, "ws://localhost:8080"},
```

```

        {'p', "principal", "Principal (username) for the connection",
ARG_OPTIONAL, ARG_HAS_VALUE, NULL},
        {'c', "credentials", "Credentials (password) for the
connection", ARG_OPTIONAL, ARG_HAS_VALUE, NULL},
        {'t', "topic", "Topic name to create and update",
ARG_OPTIONAL, ARG_HAS_VALUE, "time"},
        {'s', "seconds", "Number of seconds to run for before
exiting", ARG_OPTIONAL, ARG_HAS_VALUE, "30"},
        END_OF_ARG_OPTS
};

/*
 * Handlers for add topic feature.
 */
static int
on_topic_added(SESSION_T *session, const SVC_ADD_TOPIC_RESPONSE_T
 *response, void *context)
{
    printf("Added topic\n");
    apr_thread_mutex_lock(mutex);
    apr_thread_cond_broadcast(cond);
    apr_thread_mutex_unlock(mutex);
    return HANDLER_SUCCESS;
}

static int
on_topic_add_failed(SESSION_T *session, const
SVC_ADD_TOPIC_RESPONSE_T *response, void *context)
{
    printf("Failed to add topic (%d)\n", response-
>response_code);
    apr_thread_mutex_lock(mutex);
    apr_thread_cond_broadcast(cond);
    apr_thread_mutex_unlock(mutex);
    return HANDLER_SUCCESS;
}

static int
on_topic_add_discard(SESSION_T *session, void *context)
{
    apr_thread_mutex_lock(mutex);
    apr_thread_cond_broadcast(cond);
    apr_thread_mutex_unlock(mutex);
    return HANDLER_SUCCESS;
}

/*
 * Handlers for registration of update source feature
 */
static int
on_update_source_init(SESSION_T *session,
                    const CONVERSATION_ID_T *updater_id,
                    const SVC_UPDATE_REGISTRATION_RESPONSE_T
 *response,
                    void *context)
{
    char *id_str = conversation_id_to_string(*updater_id);
    printf("Topic source \"%s\" in init state\n", id_str);
    free(id_str);
    apr_thread_mutex_lock(mutex);
    apr_thread_cond_broadcast(cond);
    apr_thread_mutex_unlock(mutex);
    return HANDLER_SUCCESS;
}

```

```

}

static int
on_update_source_registered(SESSION_T *session,
                           const CONVERSATION_ID_T *updater_id,
                           const SVC_UPDATE_REGISTRATION_RESPONSE_T
*response,
                           void *context)
{
    char *id_str = conversation_id_to_string(*updater_id);
    printf("Registered update source \"%s\"\n", id_str);
    free(id_str);
    apr_thread_mutex_lock(mutex);
    apr_thread_cond_broadcast(cond);
    apr_thread_mutex_unlock(mutex);
    return HANDLER_SUCCESS;
}

static int
on_update_source_deregistered(SESSION_T *session,
                              const CONVERSATION_ID_T *updater_id,
                              void *context)
{
    char *id_str = conversation_id_to_string(*updater_id);
    printf("Deregistered update source \"%s\"\n", id_str);
    free(id_str);
    apr_thread_mutex_lock(mutex);
    apr_thread_cond_broadcast(cond);
    apr_thread_mutex_unlock(mutex);
    return HANDLER_SUCCESS;}

static int
on_update_source_active(SESSION_T *session,
                        const CONVERSATION_ID_T *updater_id,
                        const SVC_UPDATE_REGISTRATION_RESPONSE_T
*response,
                        void *context)
{
    char *id_str = conversation_id_to_string(*updater_id);
    printf("Topic source \"%s\" active\n", id_str);
    free(id_str);
    active = 1;
    apr_thread_mutex_lock(mutex);
    apr_thread_cond_broadcast(cond);
    apr_thread_mutex_unlock(mutex);
    return HANDLER_SUCCESS;
}

static int
on_update_source_standby(SESSION_T *session,
                         const CONVERSATION_ID_T *updater_id,
                         const SVC_UPDATE_REGISTRATION_RESPONSE_T
*response,
                         void *context)
{
    char *id_str = conversation_id_to_string(*updater_id);
    printf("Topic source \"%s\" on standby\n", id_str);
    free(id_str);
    apr_thread_mutex_lock(mutex);
    apr_thread_cond_broadcast(cond);
    apr_thread_mutex_unlock(mutex);
    return HANDLER_SUCCESS;
}

```

```

}

static int
on_update_source_closed(SESSION_T *session,
                        const CONVERSATION_ID_T *updater_id,
                        const SVC_UPDATE_REGISTRATION_RESPONSE_T
                        *response,
                        void *context)
{
    char *id_str = conversation_id_to_string(*updater_id);
    printf("Topic source \"%s\" closed\n", id_str);
    free(id_str);
    apr_thread_mutex_lock(mutex);
    apr_thread_cond_broadcast(cond);
    apr_thread_mutex_unlock(mutex);
    return HANDLER_SUCCESS;
}

/*
 * Handlers for update of data.
 */
static int
on_update_success(SESSION_T *session,
                  const CONVERSATION_ID_T *updater_id,
                  const SVC_UPDATE_RESPONSE_T *response,
                  void *context)
{
    char *id_str = conversation_id_to_string(*updater_id);
    printf("on_update_success for updater \"%s\"\n", id_str);
    free(id_str);
    return HANDLER_SUCCESS;
}

static int
on_update_failure(SESSION_T *session,
                  const CONVERSATION_ID_T *updater_id,
                  const SVC_UPDATE_RESPONSE_T *response,
                  void *context)
{
    char *id_str = conversation_id_to_string(*updater_id);
    printf("on_update_failure for updater \"%s\"\n", id_str);
    free(id_str);
    return HANDLER_SUCCESS;
}

/*
 * Program entry point.
 */
int
main(int argc, char** argv)
{
    /*
     * Standard command-line parsing.
     */
    const HASH_T *options = parse_cmdline(argc, argv, arg_opts);
    if(options == NULL || hash_get(options, "help") != NULL) {
        show_usage(argc, argv, arg_opts);
        return EXIT_FAILURE;
    }

    const char *url = hash_get(options, "url");
    const char *principal = hash_get(options, "principal");
    CREDENTIALS_T *credentials = NULL;

```

```

const char *password = hash_get(options, "credentials");
if(password != NULL) {
    credentials = credentials_create_password(password);
}
const char *topic_name = hash_get(options, "topic");
const long seconds = atol(hash_get(options, "seconds"));

/*
 * Setup for condition variable.
 */
apr_initialize();
apr_pool_create(&pool, NULL);
apr_thread_mutex_create(&mutex, APR_THREAD_MUTEX_UNNESTED,
pool);
apr_thread_cond_create(&cond, pool);

/*
 * Create a session with the Diffusion server.
 */
SESSION_T *session;
DIFFUSION_ERROR_T error = { 0 };
session = session_create(url, principal, credentials, NULL,
NULL, &error);
if(session == NULL) {
    fprintf(stderr, "TEST: Failed to create session\n");
    fprintf(stderr, "ERR : %s\n", error.message);
    return EXIT_FAILURE;
}

/*
 * Create a topic holding simple string content.
 */
TOPIC_DETAILS_T *string_topic_details =
create_topic_details_single_value(M_DATA_TYPE_STRING);
const ADD_TOPIC_PARAMS_T add_topic_params = {
    .topic_path = topic_name,
    .details = string_topic_details,
    .on_topic_added = on_topic_added,
    .on_topic_add_failed = on_topic_add_failed,
    .on_discard = on_topic_add_discard,
};

apr_thread_mutex_lock(mutex);
add_topic(session, add_topic_params);
apr_thread_cond_wait(cond, mutex);
apr_thread_mutex_unlock(mutex);

topic_details_free(string_topic_details);

/*
 * Define the handlers for add_update_source()
 */
const UPDATE_SOURCE_REGISTRATION_PARAMS_T update_reg_params =
{
    .topic_path = topic_name,
    .on_init = on_update_source_init,
    .on_registered = on_update_source_registered,
    .on_active = on_update_source_active,
    .on_standby = on_update_source_standby,
    .on_close = on_update_source_closed
};

/*

```

```

    * Register an updater.
    */
    apr_thread_mutex_lock(mutex);
    CONVERSATION_ID_T *updater_id =
register_update_source(session, update_reg_params);
    apr_thread_cond_wait(cond, mutex);
    apr_thread_mutex_unlock(mutex);

    /*
    * Define default parameters for an update source.
    */
    UPDATE_SOURCE_PARAMS_T update_source_params_base = {
        .updater_id = updater_id,
        .topic_path = topic_name,
        .on_success = on_update_success,
        .on_failure = on_update_failure
    };

    time_t end_time = time(NULL) + seconds;

    while(time(NULL) < end_time) {

        if(active) {
            /*
            * Create an update structure containing the
current time.
            */
            BUF_T *buf = buf_create();
            const time_t time_now = time(NULL);
            buf_write_string(buf, ctime(&time_now));

            CONTENT_T *content =
content_create(CONTENT_ENCODING_NONE, buf);

            UPDATE_T *upd =
update_create(UPDATE_ACTION_REFRESH,
UPDATE_TYPE_CONTENT,
                                                    content);

            UPDATE_SOURCE_PARAMS_T update_source_params =
update_source_params_base;
            update_source_params.update = upd;

            /*
            * Update the topic.
            */
            update(session, update_source_params);

            content_free(content);
            update_free(upd);
            buf_free(buf);
        }

        sleep(1);
    }

    if(active) {
        UPDATE_SOURCE_DEREGISTRATION_PARAMS_T
update_dereg_params = {
            .updater_id = updater_id,
            .on_deregistered =
on_update_source_deregistered

```

```

        };

        apr_thread_mutex_lock(mutex);
        deregister_update_source(session,
update_dereg_params);
        apr_thread_cond_wait(cond, mutex);
        apr_thread_mutex_unlock(mutex);
    }

    /*
     * Close session and free resources.
     */
    session_close(session, NULL);
    session_free(session);

    conversation_id_free(updater_id);
    credentials_free(credentials);

    apr_thread_mutex_destroy(mutex);
    apr_thread_cond_destroy(cond);
    apr_pool_destroy(pool);
    apr_terminate();

    return EXIT_SUCCESS;
}

```

Change the URL from that provided in the example to the URL of the Diffusion server.

Example: Make non-exclusive updates to a topic

The following examples use the Diffusion API to update a topic with content. Updating a topic this way does not prevent other clients from updating the topic.

JavaScript

```

// 1. A session may update any existing topic. Update values must be
// of the same type as the topic being updated.

// Add a topic first with a string type
session.topics.add('foo', '').then(function() {
    // Update the topic
    return session.topics.update('foo', 'hello');
}).then(function() {
    // Update the topic again
    return session.topics.update('foo', 'world');
});

// 2. If using RecordContent metadata, update values are
// constructed from the metadata

// Create a new metadata instance
var meta = new diffusion.metadata.RecordContent();

meta.addRecord('record', 1, {
    'field' : meta.integer()
});

// Create a builder to set values
var builder = meta.builder();

```

```

builder.add('record', {
    field : 123
});

// Update the topic with the new value
session.topics.add('topic', '').then(function() {
    session.topics.update('topic', builder.build());
});

```

Apple

```

#import Diffusion;

@implementation TopicUpdateExample {
    PTDiffusionSession* _session;
}

-(void)startWithURL:(NSURL*)url {

    PTDiffusionCredentials *const credentials =
        [[PTDiffusionCredentials alloc]
         initWithPassword:@"password"];

    PTDiffusionSessionConfiguration *const sessionConfiguration =
        [[PTDiffusionSessionConfiguration alloc]
         initWithPrincipal:@"control"
         credentials:credentials];

    NSLog(@"Connecting...");

    [PTDiffusionSession openWithURL:url
                        configuration:sessionConfiguration
                        completionHandler:^(PTDiffusionSession *session,
                                           NSError *error)
     {
        if (!session) {
            NSLog(@"Failed to open session: %@", error);
            return;
        }

        // At this point we now have a connected session.
        NSLog(@"Connected.");

        // Set ivar to maintain a strong reference to the session.
        _session = session;

        // Add topic.
        [self addTopicForSession:session];
    }];

}

static NSString *const _TopicPath = @"Example/Updating";

-(void)addTopicForSession:(PTDiffusionSession *const)session {
    // Add a single value topic without an initial value.
    [session.topicControl addWithTopicPath:_TopicPath

    type:PTDiffusionTopicType_SingleValue
                                value:nil
                                completionHandler:^(NSError * _Nullable
    error)

```

```

    {
        if (error) {
            NSLog(@"Failed to add topic. Error: %@", error);
        } else {
            NSLog(@"Topic created.");

            // Update topic after a short wait.
            [self updateTopicForSession:session withValue:1];
        }
    }
}

-(void)updateTopicForSession:(PTDiffusionSession *const)session
    withValue:(const NSUInteger)value {
    dispatch_after(dispatch_time(DISPATCH_TIME_NOW, (int64_t)(1.0 *
NSEC_PER_SEC)),
        dispatch_get_main_queue(), ^
    {
        // Get the non-exclusive updater.
        PTDiffusionTopicUpdater *const updater =
session.topicUpdateControl.updater;

        // Prepare data to update topic with.
        NSString *const string =
            [NSString stringWithFormat:@"Update #%lu", (unsigned
long)value];
        NSData *const data = [string
dataUsingEncoding:NSUTF8StringEncoding];
        PTDiffusionContent *const content =
            [[PTDiffusionContent alloc] initWithData:data];

        // Update the topic.
        [updater updateWithTopicPath:_TopicPath
            value:content
            completionHandler:^(NSError *const error)
        {
            if (error) {
                NSLog(@"Failed to update topic. Error: %@", error);
            } else {
                NSLog(@"Topic updated to \"%@\\"", string);

                // Update topic after a short wait.
                [self updateTopicForSession:session withValue:value +
1];
            }
        }
    });
}

@end

```

Java and Android

```

import com.pushtechology.diffusion.client.Diffusion;
import
    com.pushtechology.diffusion.client.callbacks.TopicTreeHandler;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicControl;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicControl.AddCal
import
    com.pushtechology.diffusion.client.features.control.topics.TopicUpdateControl;

```

```

import
    com.pushtechnology.diffusion.client.features.control.topics.TopicUpdateControl;
import com.pushtechnology.diffusion.client.session.Session;
import com.pushtechnology.diffusion.client.topics.details.TopicType;

/**
 * An example of using a control client to create and update a topic
 * in non
 * exclusive mode (as opposed to acting as an exclusive update
 * source). In this
 * mode other clients could update the same topic (on a last update
 * wins basis).
 * <P>
 * This uses the 'TopicControl' feature to create a topic and the
 * 'TopicUpdateControl' feature to send updates to it.
 * <P>
 * To send updates to a topic, the client session requires the
 * 'update_topic'
 * permission for that branch of the topic tree.
 *
 * @author Push Technology Limited
 * @since 5.3
 */
public final class ControlClientUpdatingSingleValueTopic {

    private static final String TOPIC = "MyTopic";

    private final Session session;
    private final TopicControl topicControl;
    private final TopicUpdateControl updateControl;

    /**
     * Constructor.
     */
    public ControlClientUpdatingSingleValueTopic() {

        session =

Diffusion.sessions().principal("control").password("password")
        .open("ws://diffusion.example.com:80");

        topicControl = session.feature(TopicControl.class);
        updateControl = session.feature(TopicUpdateControl.class);

        // Create the topic and request that it is removed when the
        session
        // closes
        topicControl.addTopic(
            TOPIC,
            TopicType.SINGLE_VALUE,
            new AddCallback.Default() {
                @Override
                public void onTopicAdded(String topicPath) {
                    topicControl.removeTopicsWithSession(
                        TOPIC,
                        new TopicTreeHandler.Default());
                }
            }
        );
    }

    /**
     * Update the topic with a string value.

```

```

    *
    * @param value the update value
    * @param callback the update callback
    */
    public void update(String value, UpdateCallback callback) {
        updateControl.updater().update(TOPIC, value, callback);
    }

    /**
     * Close the session.
     */
    public void close() {
        session.close();
    }
}

```

.NET

Change the URL from that provided in the example to the URL of the Diffusion server.

Using time series topics

A client can subscribe to a time series topic using a value stream, query to retrieve values within a range, append new values, or apply an edit event to override the value of an earlier event.

Note: Time series topics are supported by the JavaScript, Java, Android and Apple APIs.

A [time series topic](#) stores an ordered series of events.

Each event stores a value, and has associated metadata.

An event value can be binary, double, int64, JSON, string or recordV2 value. Every event within a given time series has values with the same data type.

Table 32: Time series event metadata

Sequence number	Timestamp	Author
Unique number within time series, assigned when event created. Number increased by one with each new event.	Timestamp for event creation. Not guaranteed unique.	Principal that created the event. May be ANONYMOUS if session was not authorised.

Subscribing to a time series topic

Required permissions: read_topic

A client session can subscribe to a time series topic using a value stream to receive the latest events.

On subscribing to a time series topic, a session receives a set of the most recent events. By default, the latest event is sent. You can configure the [TIME_SERIES_SUBSCRIPTION_RANGE](#) property to determine how many recent events a new subscriber will receive.

Setting the DONT_RETAIN_VALUE property to true will prevent an initial event being sent, unless you have configured a subscription range.

Appending to a time series topic

Required permissions: update_topic

A session can append a value to a time series. The server will assign metadata to the event. The timestamp will be set to the current server time. The author will be set to the authenticated principal of the client session. The sequence number will be one higher than the previous event in the time series.

Editing a time series topic

Required permissions: update_topic, edit_time_series_events or edit_own_time_series_events

A client session can edit a time series. This provides a new value for an existing event.

The server retains both the original event and the edit event.

Subscribers receive two sets of metadata: the metadata for the edit event, and the metadata of the original event that was replaced.

Consider this example time series containing two events:

Sequence	Value	Type
0	A	original event
1	B	original event

Now an edit event is applied to the event with sequence number 0, changing the value to X. This information is now stored on the server:

Sequence	Value	Type
0	A	original event
1	B	original event
2	X	edit of sequence 0

The edit event is assigned a sequence number like a normal event. Both the original event 0 and the edit event are retained on the server.

If an original event has several edit events, the latest edit event (the one with the highest sequence number) determines its current value. Each edit event refers to an original event, never to another edit event.

For example, suppose another edit event is applied to change the value of the first event from X to Y. Now the information stored looks like this:

Sequence	Value	Type
0	A	original event
1	B	original event
2	X	edit of sequence 0
3	Y	edit of sequence 0

Querying a time series topic

There are two ways to query a time series topic and select a range of events, which differ only in how they handle edit events.

Value range query

Required permissions: read_topic

A value range query returns part of a time series, using the latest available value for each event.

Events are returned in order of the original sequence number. If an event has never been edited, it is simply returned. If it has been edited, the most recent edit event is returned instead.

For example, consider the example time series above after the two edits have been applied. A value range query which selected the whole topic would return:

Sequence	Value	Original event sequence
3	Y	0
1	B	-

The original value of the first event is not returned. The fact that the metadata of the original event is provided tells you that the event was edited.

A value range query is suitable for most use cases. If the client only needs the most recent value, or your application is not using edit events at all, use a value range query.

Edit range query

Required permissions: read_topic, query_obsolete_time_series_events

An edit range query can provide the history of values for events that have been edited. You are only likely to use this if you are implementing auditing or administrative features.

Because the history of edits is potentially sensitive information, an edit range query requires the additional `query_obsolete_time_series_events` permission.

There are two types of edit range query:

All edits

An all edits query returns all original events selected by the query, and all subsequent edit events that affect the originals. The results are provided in time series order.

An all edits query which selected all of the example above would return:

Sequence	Value	Original event sequence
0	A	-
1	B	-
2	X	0
3	Y	0

Both of the edit events for the original event 0 are returned.

This sort of query provides the maximum amount of information about the edit history of event values.

Latest edits

A latest edits query returns all original events selected by the query, plus the most recent edit event for each original event. The results are provided in time series order.

A latest edits query which selected all of the example above would return:

Sequence	Value	Original event sequence
0	A	N/A
1	B	N/A
3	Y	0

There were two edit events applied to the original event 0, but only the most recent edit event is returned in the query result.

This sort of query is useful if you need the original and latest value for an event, but not any intermediate values.

Note: Time series topics only retain a range of the most recent events (configured with the [TIME_SERIES_RETAINED_RANGE property](#)). By default, only the ten most recent events are retained, counting both original and edit events. Range queries only return edit events if the original event is selected. If you find that your queries do not return the results you expect, you may need to increase the retained range.

Related concepts

[Time series topics](#) on page 71

A time series topic holds a sequence of events.

Example: Publish a time series

The following example uses the Diffusion API to create and update a time series topic.

This example creates a time series topic at `foo/timeseries`. It demonstrates how to append and edit values.

```
/
*****
* Copyright (C) 2017, 2018 Push Technology Ltd.
*
* Licensed under the Apache License, Version 2.0 (the "License");
* you may not use this file except in compliance with the License.
* You may obtain a copy of the License at
* http://www.apache.org/licenses/LICENSE-2.0
*
* Unless required by applicable law or agreed to in writing,
software
* distributed under the License is distributed on an "AS IS" BASIS,
* WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or
implied.
* See the License for the specific language governing permissions
and
* limitations under the License.
*****
package com.pushtechnology.diffusion.examples;

import static
    com.pushtechnology.diffusion.datatype.DataTypes.INT64_DATATYPE_NAME;

import java.util.concurrent.ExecutionException;
import java.util.concurrent.TimeUnit;
import java.util.concurrent.TimeoutException;
```

```

import org.slf4j.Logger;
import org.slf4j.LoggerFactory;

import com.pushtechology.diffusion.client.Diffusion;
import com.pushtechology.diffusion.client.features.TimeSeries;
import
    com.pushtechology.diffusion.client.features.TimeSeries.EventMetadata;
import
    com.pushtechology.diffusion.client.features.control.topics.TopicControl;
import com.pushtechology.diffusion.client.session.Session;
import
    com.pushtechology.diffusion.client.topics.details.TopicSpecification;
import com.pushtechology.diffusion.client.topics.details.TopicType;

/**
 * This example shows a control client creating a {@link TimeSeries}
 * topic.
 * Values can be appended to the topic using {@link
 * #appendValue(long)}, and
 * the last value of the topic can be edited using {@link
 * #editLast(long)}.
 *
 * @author Push Technology Limited
 * @since 6.0
 * @see ClientConsumingTimeSeriesTopics
 * @see TimeSeriesQueryExample
 */
public class ControlClientUpdatingTimeSeriesTopics {

    private static final String TOPIC_PATH = "foo/timeseries";
    private static final Logger LOG =

LoggerFactory.getLogger(ControlClientUpdatingTimeSeriesTopics.class);

    private final Session session;
    private final TimeSeries timeSeries;
    private final TopicControl topicControl;

    /**
     * Constructor.
     *
     * @param serverUrl server URL to connect to example "ws://
diffusion.example.com:80"
     */
    public ControlClientUpdatingTimeSeriesTopics(String serverUrl)
        throws InterruptedException, ExecutionException,
        TimeoutException {

        session =
Diffusion.sessions().principal("control").password("password")
        .open(serverUrl);

        timeSeries = session.feature(TimeSeries.class);
        topicControl = session.feature(TopicControl.class);

        final TopicSpecification spec =
topicControl.newSpecification(TopicType.TIME_SERIES)

        .withProperty(TopicSpecification.TIME_SERIES_EVENT_VALUE_TYPE,
INT64_DATATYPE_NAME);

        topicControl.addTopic(TOPIC_PATH, spec)

```

```

        .thenAccept(result -> LOG.info("Add topic result: {}",
result)).get(5, TimeUnit.SECONDS);
    }

    /**
     * Appends a value to the time series topic.
     *
     * @param value value to append
     * @return the event metadata from the successful append
     */
    public EventMetadata appendValue(long value)
        throws IllegalArgumentException, InterruptedException,
        ExecutionException, TimeoutException {
        return timeSeries.append(TOPIC_PATH, Long.class,
value).get(5, TimeUnit.SECONDS);
    }

    /**
     * Close the session and remove the time series topic.
     */
    public void close()
        throws IllegalArgumentException, InterruptedException,
        ExecutionException, TimeoutException {
        topicControl.removeTopics("?foo//").get(5, TimeUnit.SECONDS);
        session.close();
    }

    /**
     * Edit the last value in a time series topic.
     *
     * @param value value to edit with
     */
    public void editLast(long value) {
        //Obtain the last value in the time series topic
        timeSeries.rangeQuery().fromLast(1).as(Long.class).selectFrom(TOPIC_PATH)
            .whenComplete((query, ex) -> {
                if (ex != null) {
                    LOG.error("Error obtaining the range query: {}",
ex);
                    return;
                }
                //Perform the value edit
                query.stream().forEach(event -> {
                    timeSeries.edit(TOPIC_PATH, event.sequence(),
Long.class, value)
                        .whenComplete((metadata, e) -> {
                            if (e != null) {
                                LOG.error("Error editing topic: {}",
e);
                                return;
                            }
                            LOG.info("EventMetadata from edit: {}",
metadata);
                        });
                });
            });
    }
}

```

Example: Subscribe to a time series

The following example uses Diffusion API to subscribe to a time series topic.

This example demonstrates subscribing to a time series topic at foo/timeseries.

```

/
*****
 * Copyright (C) 2017 Push Technology Ltd.
 *
 * Licensed under the Apache License, Version 2.0 (the "License");
 * you may not use this file except in compliance with the License.
 * You may obtain a copy of the License at
 * http://www.apache.org/licenses/LICENSE-2.0
 *
 * Unless required by applicable law or agreed to in writing,
 * software
 * distributed under the License is distributed on an "AS IS" BASIS,
 * WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or
 * implied.
 * See the License for the specific language governing permissions
 * and
 * limitations under the License.
*****
package com.pushtechology.diffusion.examples;

import java.util.concurrent.ExecutionException;
import java.util.concurrent.TimeUnit;
import java.util.concurrent.TimeoutException;

import com.pushtechology.diffusion.client.Diffusion;
import com.pushtechology.diffusion.client.features.TimeSeries;
import com.pushtechology.diffusion.client.features.TimeSeries.Event;
import com.pushtechology.diffusion.client.features.Topics;
import
    com.pushtechology.diffusion.client.features.Topics.ValueStream;
import com.pushtechology.diffusion.client.session.Session;

/**
 * This demonstrates a client session subscribing to a
 * {@link TimeSeries} topic.
 *
 * @author Push Technology Limited
 * @since 6.0
 * @see ControlClientUpdatingTimeSeriesTopics
 * @see TimeSeriesQueryExample
 */
public class ClientConsumingTimeSeriesTopics {

    private static final String TOPIC_PATH = "foo/timeseries";

    private Session session;

    /**
     * Constructor.
     *
     * @param serverUrl for example "ws://diffusion.example.com:80"
     * @param valueStream value stream to receive time series topic
     * events
     */

```

```

    public ClientConsumingTimeSeriesTopics(String serverUrl,
    ValueStream<Event<Long>> valueStream)
        throws InterruptedException, ExecutionException,
        TimeoutException {
        session =
        Diffusion.sessions().principal("client").password("password")
            .open(serverUrl);

        final Topics topics = session.feature(Topics.class);
        topics.addTimeSeriesStream(TOPIC_PATH, Long.class,
        valueStream);
        topics.subscribe(TOPIC_PATH).get(5, TimeUnit.SECONDS);
    }

    /**
     * Close the session.
     */
    public void close() {
        session.close();
    }
}

```

Managing subscriptions

A client can use the SubscriptionControl feature to subscribe other client sessions to topics that they have not requested subscription to themselves and also to unsubscribe clients from topics. It also enables the client to register as the handler for routing topic subscriptions.

Subscribing and unsubscribing clients

Required permissions: modify_session, select_topic permission for the topics being subscribed to

A client can subscribe client sessions that it knows about to topics that those clients have not explicitly requested. It can also unsubscribe clients from topics.

A session identifier is required to specify the client session that is to be subscribed or unsubscribed. Use the ClientControl feature to get the identifiers for connected client sessions.

The SubscriptionControl feature uses topic selectors to specify topics for subscription and unsubscription. Many topics can be specified in a single operation.

The client being subscribed to topics must have read_topic permission for the topics it is being subscribed to.

Using session properties to select clients to subscribe and unsubscribe

Required permissions: view_session, modify_session, select_topic permission for the topics being subscribed to

When managing client subscriptions, a client can specify a filter for which client sessions it subscribes to topics or unsubscribes from topics. The filter is a query expression on the values of session properties.

The managing client defines a filter and sends a subscription request with this filter to the Diffusion server. The Diffusion server evaluates the query and subscribes those currently connected client sessions whose session properties match the filter to the topic or topics.

The filter is evaluated only once. Clients that subsequently connect or clients whose properties change are do not cause the subscription request to be reevaluated. Even if these clients match the filter, they are not subscribed.

Managing all subscriptions from a separate control session

You can prevent client sessions from subscribing themselves to topics and control all subscriptions from a separate control client session that uses SubscriptionControl feature to subscribe clients to topics.

To restrict subscription capability to control sessions, configure the following permissions:

Control session:

- Grant the `modify_session` permission
- Grant the `select_topic` permission

This can either be granted for the default path scope or more selectively to restrict the topic selectors the control session can use.

Other sessions:

- Grant `read_topic` to the appropriate topics.
- Deny the `select_topic` permission by default.

Do not assign the session a role that has the `select_topic` permission for the default path scope. This prevents the session from subscribing to all topics using a wildcard selector.

- Optionally, grant the `select_topic` permission to specific branches of the topic tree to which the session can subscribe freely.

Acting as a routing subscription handler

Required permissions: `view_session`, `modify_session`, `register_handler`

Routing topics can be created with a server-side handler that assigns clients to real topics. However, you can omit the server-side handler such that subscriptions to routing topics are directed at a client acting as a routing subscription handler.

A client can register a routing subscription handler for a branch of the topic tree. Any subscription requests to routing topics in that branch that do not have server-side handlers are passed to the client for action.

On receipt of a routing subscription request the client can respond with a route request that specifies the path of the actual topic that the routing topic maps to for the requesting client. This subscription fails if the target topic does not already exist or if the requesting client does not have `read_topic` permission for the routing topic or target topic.

The client can complete other actions before calling back to route. For example, it could use the TopicControl feature to create the topic that the client is to map to.

Alternatively, the client can defer the routing subscription request in which case the requesting client remains unsubscribed. This is similar to denying it from an authorization point of view.

The client must reply with a route or defer for all routing requests.

Related concepts

[Topic selectors](#) on page 50

A topic selector identifies one or more topics. You can create a topic selector object from a pattern expression.

[Session properties](#) on page 266

A client session has a number of properties associated with it. Properties are key-value pairs. Both the key and the value are case sensitive.

[Session filtering](#) on page 267

Session filters enable you to query the set of connected client sessions on the Diffusion server based on their session properties.

Example: Subscribe other clients to topics

The following examples use the SubscriptionControl feature in the Diffusion API to subscribe other client sessions to topics.

Java and Android

```
package com.pushtechology.diffusion.examples;

import com.pushtechology.diffusion.client.Diffusion;
import
    com.pushtechology.diffusion.client.features.control.topics.SubscriptionControl;
import
    com.pushtechology.diffusion.client.features.control.topics.SubscriptionControl;
import com.pushtechology.diffusion.client.session.Session;
import com.pushtechology.diffusion.client.session.SessionId;

/**
 * This demonstrates using a client to subscribe and unsubscribe
 * other clients
 * to topics.
 * <P>
 * This uses the 'SubscriptionControl' feature.
 *
 * @author Push Technology Limited
 * @since 5.0
 */
public class ControlClientSubscriptionControl {

    private final Session session;

    private final SubscriptionControl subscriptionControl;

    /**
     * Constructor.
     */
    public ControlClientSubscriptionControl() {

        session =

Diffusion.sessions().principal("control").password("password")
        .open("ws://diffusion.example.com:80");

        subscriptionControl =
session.feature(SubscriptionControl.class);
    }

    /**
     * Subscribe a client to topics.
     *
     * @param sessionId client to subscribe
     * @param topicSelector topic selector expression
     * @param callback for subscription result
     */
}
```

```

    */
    public void subscribe(
        SessionId sessionId,
        String topicSelector,
        SubscriptionCallback callback) {

        // To subscribe a client to a topic, this client session
        // must have the 'modify_session' permission.
        subscriptionControl.subscribe(
            sessionId,
            topicSelector,
            callback);
    }

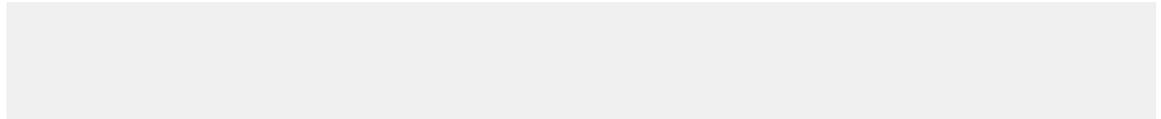
    /**
     * Unsubscribe a client from topics.
     *
     * @param sessionId client to unsubscribe
     * @param topicSelector topic selector expression
     * @param callback for unsubscription result
     */
    public void unsubscribe(
        SessionId sessionId,
        String topicSelector,
        SubscriptionCallback callback) {

        // To unsubscribe a client from a topic, this client session
        // must have the 'modify_session' permission.
        subscriptionControl.unsubscribe(
            sessionId,
            topicSelector,
            callback);
    }

    /**
     * Close the session.
     */
    public void close() {
        session.close();
    }
}

```

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```

/*
 * This example waits to be notified of a client connection, and then
 * subscribes that client to a named topic.
 */

#include <stdio.h>
#include <unistd.h>

#include <apr.h>
#include <apr_thread_mutex.h>
#include <apr_thread_cond.h>

```

```

#include "diffusion.h"
#include "args.h"

ARG_OPTS_T arg_opts[] = {
    ARG_OPTS_HELP,
    {'u', "url", "Diffusion server URL", ARG_OPTIONAL,
    ARG_HAS_VALUE, "ws://localhost:8080"},
    {'p', "principal", "Principal (username) for the connection",
    ARG_OPTIONAL, ARG_HAS_VALUE, NULL},
    {'c', "credentials", "Credentials (password) for the
connection", ARG_OPTIONAL, ARG_HAS_VALUE, NULL},
    {'t', "topic_selector", "Topic selector to subscribe/
unsubscribe clients from", ARG_OPTIONAL, ARG_HAS_VALUE, ">foo"},
    END_OF_ARG_OPTS
};
HASH_T *options = NULL;

/*
 * Callback invoked when a client has been successfully subscribed to
 * a topic.
 */
static int
on_subscription_complete(SESSION_T *session, void *context)
{
    printf("Subscription complete\n");
    return HANDLER_SUCCESS;
}

/*
 * Callback invoked when a client session has been opened.
 */
static int
on_session_open(SESSION_T *session, const SESSION_PROPERTIES_EVENT_T
 *request, void *context)
{
    if(session_id_cmp(*session->id, request->session_id) == 0) {
        // It's our own session, ignore.
        return HANDLER_SUCCESS;
    }

    char *topic_selector = hash_get(options, "topic_selector");

    char *sid_str = session_id_to_string(&request->session_id);
    printf("Subscribing session %s to topic selector %s\n",
sid_str, topic_selector);
    free(sid_str);

    /*
     * Subscribe the client session to the topic.
     */
    SUBSCRIPTION_CONTROL_PARAMS_T subscribe_params = {
        .session_id = request->session_id,
        .topic_selector = topic_selector,
        .on_complete = on_subscription_complete
    };
    subscribe_client(session, subscribe_params);

    return HANDLER_SUCCESS;
}

int
main(int argc, char **argv)
{

```

```

/*
 * Standard command-line parsing.
 */
options = parse_cmdline(argc, argv, arg_opts);
if(options == NULL || hash_get(options, "help") != NULL) {
    show_usage(argc, argv, arg_opts);
    return EXIT_FAILURE;
}

const char *url = hash_get(options, "url");
const char *principal = hash_get(options, "principal");
CREDENTIALS_T *credentials = NULL;
const char *password = hash_get(options, "credentials");
if(password != NULL) {
    credentials = credentials_create_password(password);
}

/*
 * Create a session with Diffusion.
 */
DIFFUSION_ERROR_T error = { 0 };
SESSION_T *session = session_create(url, principal,
credentials, NULL, NULL, &error);
if(session == NULL) {
    fprintf(stderr, "Failed to create session: %s\n",
error.message);
    return EXIT_FAILURE;
}

/*
 * Register a session properties listener, so we are notified
 * of new client connections.
 * In the callback, we will subscribe the client to topics
 * according to the topic_selector argument.
 */
SET_T *required_properties = set_new_string(1);
set_add(required_properties,
PROPERTIES_SELECTOR_ALL_FIXED_PROPERTIES);
SESSION_PROPERTIES_REGISTRATION_PARAMS_T params = {
    .on_session_open = on_session_open,
    .required_properties = required_properties
};
session_properties_listener_register(session, params);
set_free(required_properties);

/*
 * Pretend to do some work.
 */
sleep(10);

/*
 * Close session and tidy up.
 */
session_close(session, NULL);
session_free(session);

return EXIT_SUCCESS;
}

```

Change the URL from that provided in the example to the URL of the Diffusion server.

Example: Receive notifications when a client subscribes to a routing topic

The following examples use the SubscriptionControl feature in the Diffusion API to listen for notifications of when a client subscribes to a routing topic.

Java and Android

```
package com.pushtechology.diffusion.examples;

import com.pushtechology.diffusion.client.Diffusion;
import
    com.pushtechology.diffusion.client.features.control.topics.SubscriptionControl
import
    com.pushtechology.diffusion.client.features.control.topics.SubscriptionControl
import
    com.pushtechology.diffusion.client.features.control.topics.SubscriptionControl
import com.pushtechology.diffusion.client.session.Session;

/**
 * This demonstrates using a control client to be notified of
 * subscription
 * requests to routing topics.
 * <P>
 * This uses the 'SubscriptionControl' feature.
 *
 * @author Push Technology Limited
 * @since 5.0
 */
public class ControlClientSubscriptionControlRouting {

    private final Session session;

    /**
     * Constructor.
     *
     * @param routingCallback for routing subscription requests
     */
    public ControlClientSubscriptionControlRouting(
        final SubscriptionCallback routingCallback) {

        session =

Diffusion.sessions().principal("control").password("password")
        .open("ws://diffusion.example.com:80");

        final SubscriptionControl subscriptionControl =
            session.feature(SubscriptionControl.class);

        // Sets up a handler so that all subscriptions to topic a/b
are routed
        // to routing/target/topic
        // To do this, the client session requires the
'view_session',
        // 'modify_session', and 'register_handler' permissions.
        subscriptionControl.addRoutingSubscriptionHandler(
            "a/b",
            new
SubscriptionControl.RoutingSubscriptionRequest.Handler
            .Default() {
```

```

        @Override
        public void onSubscriptionRequest(
            final RoutingSubscriptionRequest request) {

            request.route(
                "routing/target/topic",
                routingCallback);
        }
    });
}

/**
 * Close the session.
 */
public void close() {
    session.close();
}
}

```

.NET

Change the URL from that provided in the example to the URL of the Diffusion server.

Using request-response messaging

You can send request messages directly to a client session, a set of client sessions, or a message path. The recipient of a message can respond to the request.

Typed requests and responses

Each request and response messages has a data type. The data type can be one of the following types:

- JSON
- Binary
- String
- Int64
- Double

The data type of the response is not required to be the same as the data type of the request it responds to.

When you send a request, you specify the data type of the request message and the data type of the response message it expects. When you register a handler or a stream to receive requests and respond to them, you specify the data type of the requests it receives and the data type of the responses it sends.

Data types are organized in a hierarchy of compatibility.

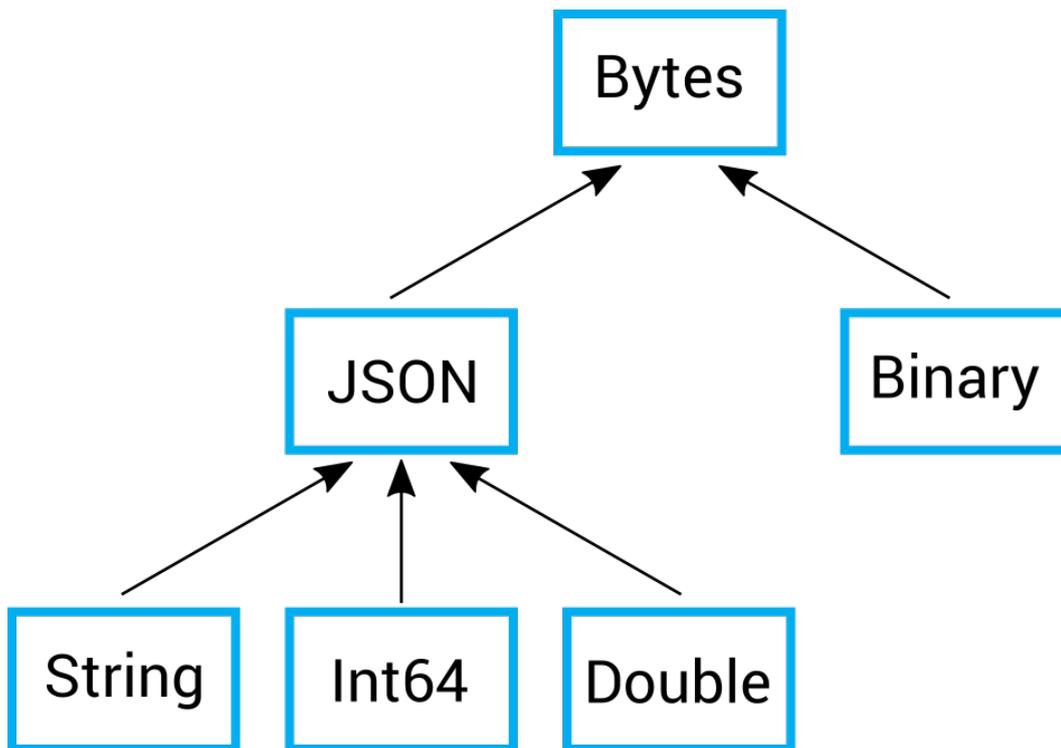


Figure 23: Data type hierarchy

A request or response with a data type at a lower (more specific) level of the hierarchy can be received by a stream, handler, or requester that is expecting a message with a data type at a higher (more general) level of the hierarchy. For example, a request message with a string data type, can be received by a stream or handler that specifies string, JSON, or bytes as the request type.

Message path

The message path is made up of path segments separated by the slash character (/). Each path segment can be made up of one or more Unicode characters. The slash character (/) is not permitted in any path segment. The restrictions for message paths are the same as those for paths at which topics can be bound. For more information, see [Topic naming](#) on page 49.

However, messaging is entirely separate from streaming data through topics:

- Message paths are unrelated topic paths. Sending a message does not change the state of any topic and does not publish the message to topic subscribers.
- An application can bind a topic to a topic path and use the same path as a message path. This is a useful convention where the messages are related to the topic in some way. The messages sent to the message path do not interact with the topic in any way.
- If a topic is bound to the path used by messaging, the data type of the topic does not affect the data type of any messages sent using the message path.
- The security permissions required to use a path for messaging are separate from those required to use a topic bound to that path to stream data.

One-way messaging

Diffusion also provides a capability to send one-way messages to a client session, a set of client sessions, or a message path. These messages cannot be responded to directly.

In one-way messaging, the message data is not typed. Applications are responsible for serializing messages to and from a binary format.

Messages sent using one-way messaging can include additional options, such as headers and a message priority. These additional options are provided to allow compatibility with messaging to publishers.

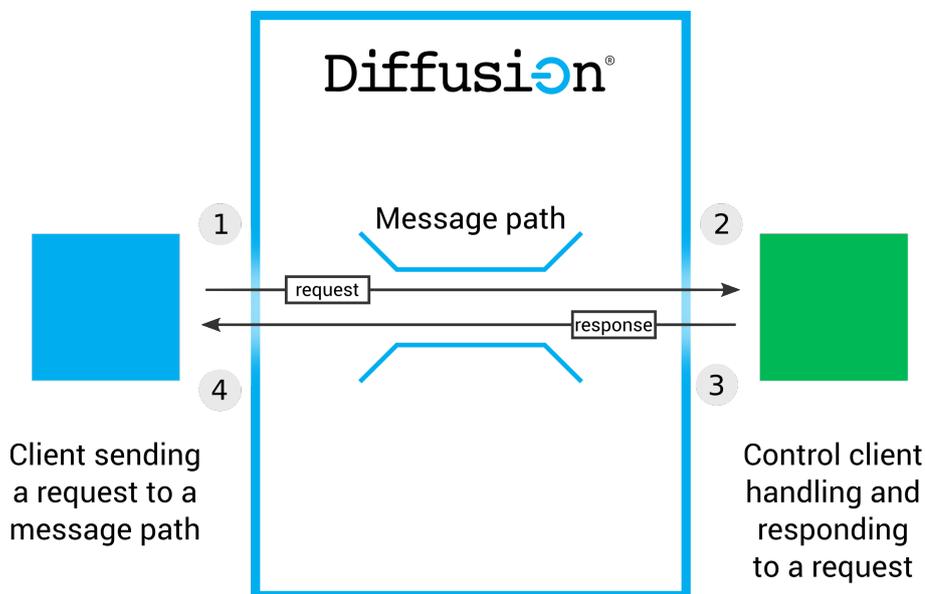
One-way messaging provides the following guarantees:

- If sending to a message path completes successfully, the message was definitely passed to a publisher or a message handler registered by a client session.
- If sending to a session completes successfully, the message was definitely passed to a message stream registered by the session.

When sending to a filter completes successfully and returns the number of sessions that match the filter, one-way messaging cannot guarantee that the message has been delivered to those sessions.

Sending request messages to a message path

A client session can send a request message containing typed data to a message path. One or more client sessions can register to handle messages sent to that message path. The handling client session can then send a response message containing typed data. The response message is sent to the requesting client session directly, through the same message path.



When a request message is sent to a message path and a client session that handles that message path responds, the following events occur:

1. A client session sends a request message to a message path.
2. The control client session receives the request message through a request handler.
3. The session client session uses sends a response to the request message.
4. The client session receives the response.

Both the request message and the response message contain typed values. The messages can contain data of one of the following types: JSON, binary, string, 64-bit integer, or double. The response message is not required to be the same data type as the request it responds to.

Sending to a message path

Required permissions: send_to_handler permission for the specified message path

Send the request message specifying the following information:

- The message path to send the request to and receive the response through
- The request message
- The datatype of the request message
- The datatype of the response message

JavaScript

```
// Example with json topic type.
var jsonType = diffusion.datatypes.json();
// Create a JSON object to send as a request.
var requestJson = jsonType.from("hello");

// Send the request to a message path "foo".
session.messages.sendRequest('foo', requestJson,
  jsonType).then(function(response) {
  console.log(response.get());
}, function(error) {});
```

Apple

```
[session.messaging sendRequest:[PTDiffusionPrimitive
  requestWithLongLong:42]
                    toPath:message_path
  int64NumberCompletionHandler:^(NSNumber *response, NSError *error)
{
    if (error) {
        NSLog(@"Failed to send to %@. Error: %@", message_path,
error);
    } else {
        NSLog(@"Received response: %@", response);
    }
}];
```

Java and Android

```
//Establish client session
final Session session =
Diffusion.sessions().principal("client").password("password").open("ws://
localhost:8080");

//Obtain the Messaging feature
final Messaging messaging = session.feature(Messaging.class);

//Create a JSON object to send as a request
final JSON request =
Diffusion.dataTypes().json().fromJsonString("\"hello\"");

//Send the request to a message path "foo" and wait for (at most)
5 seconds until the response is received.
final JSON response = messaging.sendRequest("foo", request,
JSON.class, JSON.class).get(5, TimeUnit.SECONDS);
```

Responding to request messages sent to a message path

Required permissions: `send_to_session` permission for the specified message path, `register_handler` permission, and `view_session` permission to register to receive session property values with the request message

Define a request handler to receive and respond to request messages that have a specific data type.

JavaScript

```
var jsonType = diffusion.datatypes.json();
var requestJson = jsonType.from({ "foo": "bar" });
var responseJson = jsonType.from({ "ying": "yang" });
// Define a request handler for json topic type
var handler = {
  onRequest: function(request, context, responder) {
    responder.respond(responseJson, jsonType);
  },
  onError: function() {},
  onClose: function() {}
};
```

Apple

```
@interface NumberRequestDelegate :
  NSObject<PTDiffusionNumberRequestDelegate>
@end

@implementation NumberRequestDelegate

-(void)diffusionTopicTreeRegistration:
  (PTDiffusionTopicTreeRegistration *)registration
  didReceiveRequestWithNumber:(nullable NSNumber *)number
  context:(PTDiffusionRequestContext
  *)context
  responder:(PTDiffusionResponder
  *)responder;
{
  // Do something when a request is received.
}

- (void)diffusionTopicTreeRegistration:(nonnull
PTDiffusionTopicTreeRegistration *)registration
  didFailWithError:(nonnull NSError *)error
{
  // Do something if the registration fails.
}

- (void)diffusionTopicTreeRegistrationDidClose:(nonnull
PTDiffusionTopicTreeRegistration *)registration
{
  // Do something if the registration closes.
}
```

Java and Android

```
private final class JSONRequestHandler implements
  MessagingControl.RequestHandler<JSON, JSON> {
  @Override
  public void onClose() {
    ...
  }

  @Override
  public void onError(ErrorReason errorReason) {
    ...
  }

  @Override
```

```

    public void onRequest(JSON request, RequestContext context,
        Responder<JSON> responder) {
        ....
        responder.respond(response);
    }
}

```

Register the request handler against a message path. You can only register one request handler against each message path.

JavaScript

```

var handler = {
    onRequest: function(request, context, responder) {},
    onError: function() {},
    onClose: function() {}
};
session.messages.addRequestHandler('topic', handler);

```

Apple

```

// Ensure to maintain a strong reference to your delegate as it
// is referenced weakly by the Diffusion client library.
NumberRequestDelegate *const delegate = [NumberRequestDelegate new];
PTDiffusionRequestHandler *const handler = [PTDiffusionPrimitive
    int64RequestHandlerWithDelegate:delegate];

[session.messagingControl addRequestHandler:handler
    forPath:path

    completionHandler:^(PTDiffusionTopicTreeRegistration *registration,
        NSError *error)
    {
        // Check error is `nil`, indicating success.
    }];

```

Java and Android

```

messagingControl.addRequestHandler(messagePath, JSON.class,
    JSON.class, new JSONRequestHandler());

```

One-way messaging to a path

Diffusion also provides a capability to send one-way messages to a message path. This message is not typed. The handling session cannot respond directly to this message.

Send a one-way message specifying the following information:

- The message path to send the message through
- The request message
- Any additional options, such as headers or a message priority

JavaScript

```

session.messages.send('message_path', content);

```

Apple

```

PTDiffusionContent *const content = [[PTDiffusionContent alloc]
    initWithData:data];

```

```
[session.messaging sendWithPath:message_path
                        value:content
                        options:[PTDiffusionSendOptions new]
                        completionHandler:^(NSError *const error)
{
    if (error) {
        NSLog(@"Failed to send. Error: %@", error);
    } else {
        NSLog(@"Sent");
    }
}];
```

Java and Android

```
messaging = session.feature(Messaging.class);
messaging.send(message_path, message_content,
messaging.sendOptionsBuilder().headers(headers).build());
```

.NET

```
var messaging = session.Messaging;
messaging.Send( message_path, message_content,
messaging.CreateSendOptionsBuilder().SetHeaders( headers ).Build() );
```

C

```
SEND_MSG_PARAMS_T params = {
    .topic_path = message_path,
    .payload = *content,
    .headers = headers,
    .priority = CLIENT_SEND_PRIORITY_NORMAL,
    .on_send = on_send,
    .context = context
};

/*
 * Send the message and wait for the callback to acknowledge
 * delivery.
 */
send_msg(session, params);
```

To receive a message sent to a message path, a client session must define a message handler:

JavaScript

```
// Create a message handler
var handler = {
    onMessage : function(message) {
        console.log(message); // Log the received message
    },
    onActive : function(unregister) {

    },
    onClose : function() {

    }
};
```

Apple

```
@interface MessageDelegate : NSObject <PTDiffusionMessageDelegate>
@end

@implementation MessageDelegate

-(void)diffusionTopicTreeRegistration:
(PTDiffusionTopicTreeRegistration *)registration
      hadMessageFromSessionId:(PTDiffusionSessionId
 *)sessionId
      path:(NSString *)path
      content:(PTDiffusionContent *)content
      context:(PTDiffusionReceiveContext
 *)context
{
    // Do something when a message is received.
}

-(void)diffusionTopicTreeRegistrationDidClose:
(PTDiffusionTopicTreeRegistration *)registration
{
    // Do something if the registration closes.
}

-(void)diffusionTopicTreeRegistration:
(PTDiffusionTopicTreeRegistration *)registration didFailWithError:
(NSError *)error
{
    // Do something if the registration fails.
}
}
```

Java and Android

```
private class MyHandler extends MessageHandler.Default {
    @Override
    public void onMessage(
        SessionId sessionId,
        String topicPath,
        Content content,
        ReceiveContext context) {
        // Do something when a message is received.
    }
}
```

.NET

```
private class MyHandler : MessageReceiverDefault {
    public override void OnMessage(
        SessionId sessionId,
        string topicPath,
        IContent content,
        IReceiveContext context) {
        // Take action when a message is received.
    }
}
```

C

```
/*
 * Function called on receipt of a message from a client.
```

```

*
* We print the following information:
* 1. The message path on which the message was received.
* 2. A hexdump of the message content.
* 3. The headers associated with the message.
* 4. The session properties that were requested when the handler
was
* registered.
* 5. The user context, as a string.
*/
int
on_msg(SESSION_T *session, const SVC_SEND_RECEIVER_CLIENT_REQUEST_T
*request, void *context)
{
    printf("Received message on path %s\n", request->topic_path);
    hexdump_buf(request->content->data);
    printf("Headers:\n");
    if(request->send_options.headers->first == NULL) {
        printf("  No headers\n");
    }
    else {
        for(LIST_NODE_T *node = request-
>send_options.headers->first;
            node != NULL;
            node = node->next) {
            printf("  Header: %s\n", (char *)node->data);
        }
    }

    printf("Session properties:\n");
    char **keys = hash_keys(request->session_properties);
    if(keys == NULL || *keys == NULL) {
        printf("  No properties\n");
    }
    else {
        for(char **k = keys; *k != NULL; k++) {
            char *v = hash_get(request-
>session_properties, *k);
            printf("  %s=%s\n", *k, v);
        }
    }
    free(keys);

    if(context != NULL) {
        printf("Context: %s\n", (char *)context);
    }

    return HANDLER_SUCCESS;
}

```

Register the message handler against a message path and its descendants:

JavaScript

```

// Register the handler
session.messages.addHandler('message_path', handler).then(function()
{
    // Registration happened successfully
}, function(error) {
    // Registration failed
});

```

Apple

```
// Ensure to maintain a strong reference to your message delegate as
// it is
// referenced weakly by the Diffusion client library.
MessageDelegate *const messageDelegate = [MessageDelegate new];

// Use the Messaging Control feature to send a registration request
// to the
// server.
[session.messagingControl addMessageHandlerForPath:message_path
                        withDelegate:messageDelegate
                        completionHandler:
^(PTDiffusionTopicTreeRegistration* registration, NSError* error)
{
    // Check error is `nil`, indicating success.
    // Optionally store a strong reference to registration in order
    // to allow the
    // handler to be unregistered at the server.
}];
```

Java and Android

```
session.feature(MessagingControl.class).addMessageHandler(message_path,
new MyHandler());
```

.NET

```
session.MessagingControl.AddMessageHandler( message_path, new
MyHandler() );
```

C

```
/*
 * Register a message handler, and for each message ask for
 * the $Principal property to be provided.
 */
LIST_T *requested_properties = list_create();
list_append_last(requested_properties, "$Principal");

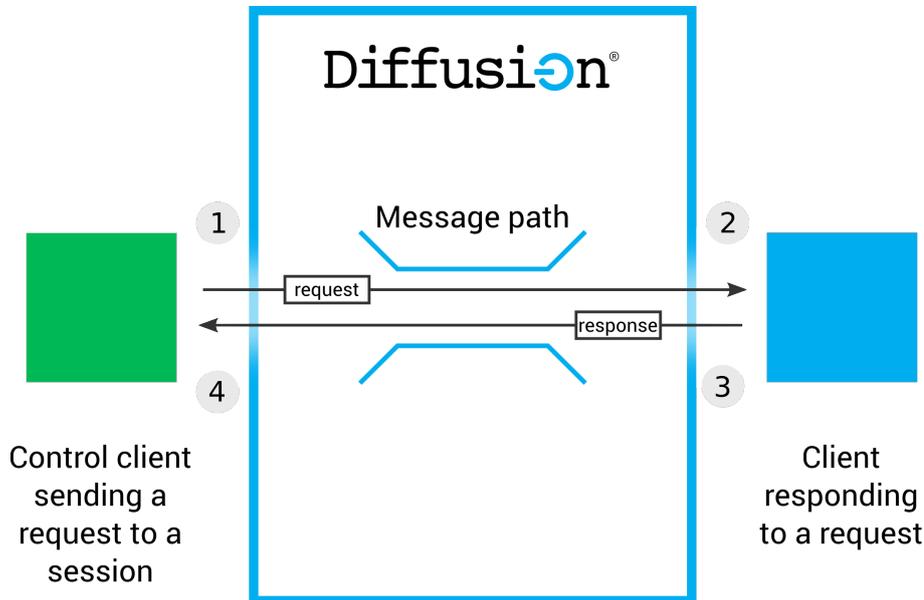
MSG_RECEIVER_REGISTRATION_PARAMS_T params = {
    .on_registered = on_registered,
    .topic_path = topic,
    .on_message = on_msg,
    .session_properties = requested_properties
};
list_free(requested_properties, free);

register_msg_handler(session, params);
```

To respond to this message, the receiving client session sends a separate message to the session that sent the message. For more information, see [One-way messaging to a session](#) on page 383.

Sending request messages to a session

A client session can send a request message containing typed data directly to a client session. The receiving client session can then send a response message containing typed data. The request and response messages are addressed through the same message path.



When a request message is sent to a specific client session and that session responds, the following events occur:

1. A control client session sends a request message to a client session, specifying the message path to send the message through and the session ID of the client session to send the request message to.
2. The client session receives the request message through a request stream.
3. The client session uses a responder to send a response to the request message.
4. The control client session receives the response.

Both the request message and the response message contain typed values. The messages can contain data of one of the following types: JSON, binary, string, 64-bit integer, or double. The response message is not required to be the same data type as the request it responds to.

Sending a request to a session

Required permissions: `send_to_session` permission for the specified message path and `register_handler` permission

Usually, it is a control client session in your organization's backend that sends messages directly to other sessions.

Send the request message specifying the following information:

- The session ID of the client session to send the request to
- The message path to send the request and receive the response through
- The request message
- The datatype of the request message
- The datatype of the response message

JavaScript

```
control.messages.sendRequest('foo', 'Hello client', session_id,
diffusion.datatypes.json(), diffusion.datatypes.json())
```

Apple

```
[session.messagingControl sendRequest:[PTDiffusionPrimitive
requestWithLongLong:42]
                                toSessionId:sessionId
                                path:message_path
                                int64NumberCompletionHandler:^(NSNumber *response, NSError*
error)
{
    if (error) {
        NSLog(@"Failed to send to %@. Error: %@", message_path,
error);
    } else {
        NSLog(@"Received response: %@", response);
    }
}];
```

Java and Android

```
//Establish client session and control session
final Session control =
Diffusion.sessions().principal("control").password("password").open("ws://
localhost:8080");
final Session client =
Diffusion.sessions().principal("client").password("password").open("ws://
localhost:8080");

//Obtain the Messaging and MessagingControl features
final MessagingControl messagingControl =
control.feature("MessagingControl.class");
final Messaging messaging = client.feature(Messaging.class);

//Create a JSON object to send as a request
final JSON request =
Diffusion.dataTypes().json().fromJsonString("\"hello\"");

//Create a local request stream for the client to receive direct
requests from the control session
messaging.setRequestStream("foo", JSON.class, JSON.class,
requestStream);

//Send the request to a message path "foo" and wait for (at most)
5 seconds until the response is received.
final JSON response =
messagingControl.sendRequest(client.getSessionId(), "foo", request,
JSON.class, JSON.class).get(5, TimeUnit.SECONDS);
```

Responding to messages sent to a session

Required permissions: send_to_message_handler for the specified message path

Define a request stream to receive and respond to request messages that have a specific data type.

JavaScript

```
var handler = {
```

```

    onRequest : function(request, context, responder) {
        ....
        responder.respond(response);
    },
    onError : function(error) {},
    onClose : function() {}
}

```

Apple

```

@interface NumberRequestStreamDelegate :
    NSObject<PTDiffusionNumberRequestStreamDelegate>
@end

@implementation NumberRequestStreamDelegate
- (void) diffusionStream:(nonnull PTDiffusionStream *)stream
    didReceiveRequestWithNumber:(nullable NSNumber *)number
        responder:(nonnull PTDiffusionResponder *)responder
{
    // Do something when a request is received.
}

- (void)diffusionStream:(nonnull PTDiffusionStream *)stream
    didFailWithError:(nonnull NSError *)error
{
    // Do something if the stream fails.
}

- (void)diffusionDidCloseStream:(nonnull PTDiffusionStream *)stream
{
    // Do something if the stream closes.
}

```

Java and Android

```

private final class JSONRequestStream implements
    Messaging.RequestStream<JSON, JSON> {

    @Override
    public void onClose() {
        ....
    }

    @Override
    public void onError(ErrorReason errorReason) {
        ....
    }

    @Override
    public void onRequest(String path, JSON request, Responder<JSON>
        responder) {
        ....
    }
}

```

Add the request stream against a message path. You can only add one request stream for each message path.

JavaScript

```
control.messages.setRequestStream("foo", diffusion.datatypes.json(),
diffusion.datatypes.json(), request_stream);
```

Apple

```
// Ensure to maintain a strong reference to your request stream as it
// is referenced weakly by the Diffusion client library.
NumberRequestStreamDelegate *delegate = [NumberRequestStreamDelegate
new];
PTDiffusionRequestStream *requestStream = [PTDiffusionPrimitive
int64RequestStreamWithDelegate:delegate];
[session.messaging setRequestStream:requestStream
forPath:message_path];
```

Java and Android

```
messaging.setRequestStream("foo", JSON.class, JSON.class,
requestStream);
```

One-way messaging to a session

Diffusion also provides a legacy capability to send one-way messages to a session. This message is not typed. The receiving session cannot respond directly to this message.

Send a one-way message specifying the following information:

- The session ID of the client session to send the message to
- The message path to send the message through
- The message content
- Any additional options, such as headers or a message priority

JavaScript

```
session.messages.send('message_path', content, session_id);
```

Apple

```
[session.messagingControl sendToSessionId:sessionId
                           path:message_path
                           message:[[PTDiffusionBytes alloc]
initWithData:data]
                           completionHandler:^(NSError* error)
{
    if (error) {
        NSLog(@"Failed to send to %@. Error: %@", message_path,
error);
    } else {
        NSLog(@"Sent");
    }
}];
```

Java and Android

```
session.feature(MessagingControl.class).send(session_id, message_path, content,
```

.NET

```
session.MessagingControl.Send( session_id, message_path, content,
    send_callback );
```

C

```
SEND_MSG_TO_SESSION_PARAMS_T params = {
    .topic_path = message_path,
    .session_id = *session_id,
    .content = *content,
    .options.headers = headers,
    .options.priority = CLIENT_SEND_PRIORITY_NORMAL,
    .on_send = on_send,
    .context = context
};

/*
 * Send the message and wait for the callback to acknowledge
 * delivery.
 */
send_msg_to_session(session, params);
```

To receive a message sent directly to a client session, that client session must add a message stream to receive messages sent through that message path:

JavaScript

```
// Create with a default listener function
session.messages.listen('message_path', function(message) {
    // Do something with the message
});
```

Apple

```
@interface MessageStreamDelegate : NSObject
<PTDiffusionMessageStreamDelegate>
@end

@implementation MessageStreamDelegate

-(void) diffusionStream:(PTDiffusionStream *)stream
    didReceiveMessageOnTopicPath:(NSString *)path
        content:(PTDiffusionContent *)content
        context:(PTDiffusionReceiveContext *)context
{
    // Do something when a message is received.
}

-(void)diffusionDidCloseStream:(PTDiffusionStream *)stream
{
    // Do something if the stream closes.
}

-(void)diffusionStream:(PTDiffusionStream *)stream didFailWithError:
(NSError *)error
{
    // Do something if the stream fails.
}

// ... in later code
```

```

// Ensure to maintain a strong reference to your message stream
// delegate as it
// is referenced weakly by the Diffusion client library.
MessageStreamDelegate *const delegate = [MessageStreamDelegate new];

// Create a locally evaluated topic selector specifying the messaging
// paths that
// should be captured by the stream.
PTDiffusionTopicSelector *const topicSelector =
    [PTDiffusionTopicSelector
     topicSelectorWithExpression:message_path];

// Use the Messaging feature to add a local stream using your
// delegate against
// the topic selector.
[session.messaging addMessageStreamWithSelector:topicSelector
                  delegate:delegate];

```

Java and Android

```
session.feature(Messaging.class).addMessageStream(message_path, stream);
```

.NET

```
session.Messaging.AddMessageStream( message_path, stream );
```

C

```

/*
 * Register a listener for messages on the given path.
 */
MSG_LISTENER_REGISTRATION_PARAMS_T listener_params = {
    .topic_path = message_path,
    .listener = on_stream_message,
    .context = context
};
register_msg_listener(session, listener_params);

```

You can also add a fallback message stream to receive messages sent through any message path that does not have a stream add against it:

Apple

```

// Ensure to maintain a strong reference to your message stream
// delegate as it
// is referenced weakly by the Diffusion client library.
MessageStreamDelegate *const delegate = [MessageStreamDelegate new];

// Use the Messaging feature to add a local fallback stream using
// your delegate.
[session.messaging addFallbackMessageStreamWithDelegate:delegate];

```

Java and Android

```
messaging.addFallbackMessageStream(message_stream);
```

.NET

```
session.Messaging.AddFallbackMessageStream( stream );
```

C

```
/*  
 * Register a listener for any other messages.  
 * (.topic_path is NULL).  
 */  
MSG_LISTENER_REGISTRATION_PARAMS_T global_listener_params = {  
    .listener = on_stream_message,  
    .context = context  
};  
register_msg_listener(session, global_listener_params);
```

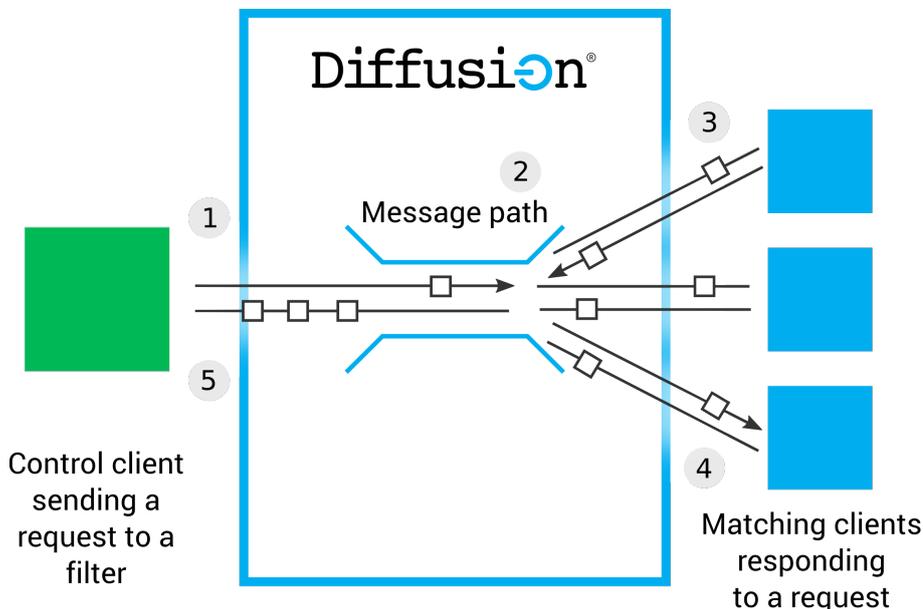
To respond to this message, the receiving client session sends a separate message to the message path through which the received message was sent. For more information, see [One-way messaging to a path](#) on page 375. However, if multiple client sessions have added message handlers on this message path, the one-way message sent in response is not guaranteed to be received by the client session that sent the original one-way message.

Sending request messages to a session filter

A client session can send a request message containing typed data directly to each client session in the set of connected client sessions that match a specified session properties filter. The receiving client sessions can then send a response message containing typed data. The request and response messages are addressed through the same message path.

Note: Sending messages to a set of client sessions defined by a filter is not intended for high throughput of data. If you have a lot of data to send or want to send data to a lot of client sessions, use the pub-sub capabilities of Diffusion. Subscribe the set of client sessions to a topic and publish the data as updates through that topic.

For more information about session properties and how to filter connected client sessions using their properties, see [Session properties](#) on page 266 and [Session filtering](#) on page 267.



When a request message is sent to a set of client sessions and those sessions respond, the following events occur:

1. A control client session sends a request message, specifying the filter that selects the client sessions to receive the request and specifying the message path to send the message through.

2. The Diffusion server evaluates the query and sends the message on to connected client sessions whose session properties match the filter
3. The client sessions in the filtered set each receive the request message through a request stream.
4. Each client session uses a responder to send a response to the request message.
5. The control client session receives responses from each of the clients sessions specified by the filter.

The request messages and the response messages contain typed values. The messages can contain data of one of the following types: JSON, binary, string, 64-bit integer, or double. The response messages are not required to be the same data type as the request or as the response messages from other client sessions.

Sending a request message to a filter

Required permissions: send_to_session permission for the specified message path and register_handler permission

Usually, it is a control client session in your organization's backend that sends messages to a filter. For more information about defining a session filter, see [Session filtering](#) on page 267.

Send the request message specifying the following information:

- The query to use to filter which client sessions to send the requests to
- The message path to send the request and receive the responses through
- The request message
- The datatype of the request message
- The datatype of the response message

JavaScript

```
var handler = {
  onResponse : function(sessionID, response) {},
  onResponseError : function(sessionID, error) {},
  onError : function(error) {}
}
control.messages.sendRequestToFilter(filter, 'foo', 'Hello clients',
  handler, diffusion.datatypes.json(), diffusion.datatypes.json());
```

Java and Android

```
//Establish control session
final Session control =
Diffusion.sessions().principal("control").password("password").open("ws://
localhost:8080");

//Obtain the MessagingControl feature
final MessagingControl messagingControl =
control.feature(MessagingControl.class);

//Create a JSON object to send as a request
final JSON request =
Diffusion.dataTypes().json().fromJsonString("\"hello\"");

//Send the request to a message path "foo", to all sessions which
do not have a 'control' principal and wait for (at most) 5 seconds
until the response (number of responses) is received.
final int numberOfResponses =
messagingControl.sendRequestToFilter("$Principal NE 'control'",
"foo", request, JSON.class, JSON.class).get(5, TimeUnit.SECONDS);
```

Responding to messages sent to a filter

Required permissions: `send_to_message_handler` for the specified message path

To the receiving client session, a request message sent to a filter is the same as a request message sent directly to the session. The receiving client session responds in the same way.

See [Responding to messages sent to a session](#) for details.

One-way messaging

Diffusion also provides a capability to send one-way messages to a filter. This message is not typed. The specified sessions cannot respond directly to this message.

Send a one-way message specifying the following information:

- The query to use to filter which client sessions to send the message to
- The message path to send the messages through
- The message content
- Any additional options, such as headers or a message priority

JavaScript

```
session.messages.send('message_path', filter_query);
```

Apple

```
[session.messagingControl sendToFilter:filter
                             path:message_path
                             message:[[PTDiffusionBytes alloc]
initWithData:data]
                             completionHandler:^(NSUInteger count, NSError*
error)
{
    if (error) {
        NSLog(@"Failed to send to %@. Error: %@", message_path,
error);
    } else {
        NSLog(@"Sent to %lu sessions", (unsigned long)count);
    }
}];
```

Java and Android

.NET

```
var options =
    session.MessagingControl.CreateSendOptionsBuilder().SetHeaders( headers ).Build
session.MessagingControl.SendToFilter( filter_query, message_path,
content, options, send_callback );
```

C

```
/*
 * Parameters for send_msg_to_session() call.
 */
SEND_MSG_TO_FILTER_PARAMS_T params = {
    .topic_path = message_path,
    .filter = filter,
    .content = message_content,
```

```

        .options.headers = headers,
        .options.priority = CLIENT_SEND_PRIORITY_NORMAL,
        .on_send = on_send_callback,
        .context = context
    };

    /*
     * Send the message and wait for the callback to acknowledge
     * delivery.
     */
    send_msg_to_filter(session, params);

```

To the receiving client session, a one-way message sent to a filter is the same as a one-way message sent directly to that session. The receiving client session receives the message in the same way.

To receive a message sent directly to a client session, that client session must add a message stream to receive messages sent through that message path:

JavaScript

```

// Create with a default listener function
session.messages.listen('message_path', function(message) {
    // Do something with the message
});

```

Apple

```

@interface MessageStreamDelegate : NSObject
<PTDiffusionMessageStreamDelegate>
@end

@implementation MessageStreamDelegate

-(void) diffusionStream:(PTDiffusionStream *)stream
    didReceiveMessageOnTopicPath:(NSString *)path
    content:(PTDiffusionContent *)content
    context:(PTDiffusionReceiveContext *)context
{
    // Do something when a message is received.
}

-(void)diffusionDidCloseStream:(PTDiffusionStream *)stream
{
    // Do something if the stream closes.
}

-(void)diffusionStream:(PTDiffusionStream *)stream didFailWithError:
(NSError *)error
{
    // Do something if the stream fails.
}

// ... in later code

// Ensure to maintain a strong reference to your message stream
// delegate as it
// is referenced weakly by the Diffusion client library.
MessageStreamDelegate *const delegate = [MessageStreamDelegate new];

// Create a locally evaluated topic selector specifying the messaging
// paths that
// should be captured by the stream.

```

```
PTDiffusionTopicSelector *const topicSelector =
    [PTDiffusionTopicSelector
    topicSelectorWithExpression:message_path];

// Use the Messaging feature to add a local stream using your
// delegate against
// the topic selector.
[session.messaging addMessageStreamWithSelector:topicSelector
                    delegate:delegate];
```

Java and Android

```
session.feature(Messaging.class).addMessageStream(message_path, stream);
```

.NET

```
session.Messaging.AddMessageStream( message_path, stream );
```

C

```
/*
 * Register a listener for messages on the given path.
 */
MSG_LISTENER_REGISTRATION_PARAMS_T listener_params = {
    .topic_path = message_path,
    .listener = on_stream_message,
    .context = context
};
register_msg_listener(session, listener_params);
```

You can also add a fallback message stream to receive messages sent through any message path that does not have a stream add against it:

Apple

```
// Ensure to maintain a strong reference to your message stream
// delegate as it
// is referenced weakly by the Diffusion client library.
MessageStreamDelegate *const delegate = [MessageStreamDelegate new];

// Use the Messaging feature to add a local fallback stream using
// your delegate.
[session.messaging addFallbackMessageStreamWithDelegate:delegate];
```

Java and Android

```
messaging.addFallbackMessageStream(message_stream);
```

.NET

```
session.Messaging.AddFallbackMessageStream( stream );
```

C

```
/*
 * Register a listener for any other messages.
 * (.topic_path is NULL).
 */
MSG_LISTENER_REGISTRATION_PARAMS_T global_listener_params = {
    .listener = on_stream_message,
```

```
        .context = context
    };
    register_msg_listener(session, global_listener_params);
```

To respond to this message, the receiving client session sends a separate message to the message path through which the received message was sent. For more information, see [One-way messaging to a path](#) on page 375. However, if multiple client sessions have added messages handlers on this message path, the one-way message sent in response is not guaranteed to be received by the client session that sent the original one-way message.

Authenticating new sessions

A client session can use the `AuthenticationControl` feature to authenticate other client sessions.

Registering a control authentication handler

Required permissions: `authenticate`, `register_handler`

A client can register an authentication handler that can be called when a client connects to the Diffusion server or changes the principal and credentials it is connected with.

The authentication handler can decide whether a client's authentication request is allowed or denied, or the authentication handler can abstain from the decision. In which case the next configured authentication handler is called.

If the authentication handler allows a client's authentication request, it can assign roles to that client's session.

For more information about authentication and role-based security, see [Authentication](#) on page 141.

Related concepts

[Configuring authentication handlers](#) on page 501

Authentication handlers and the order that the Diffusion server calls them in are configured in the `Server.xml` configuration file.

Example: Register an authentication handler

The following examples use the Diffusion API to register a control authentication handler with the Diffusion server. The examples also include a simple or empty authentication handler.

The name by which the control authentication handler is registered must be configured in the `Server.xml` configuration file of the Diffusion server for the control authentication handler to be called to handle authentication requests.

Java and Android

```
package com.pushtechology.diffusion.examples;

import java.nio.charset.Charset;
import java.util.Arrays;
import java.util.EnumSet;

import com.pushtechology.diffusion.client.Diffusion;
import com.pushtechology.diffusion.client.details.SessionDetails;
import
    com.pushtechology.diffusion.client.details.SessionDetails.DetailType;
```

```

import com.pushtechology.diffusion.client.features.ServerHandler;
import
    com.pushtechology.diffusion.client.features.control.clients.AuthenticationCont
import
    com.pushtechology.diffusion.client.features.control.clients.AuthenticationCont
import com.pushtechology.diffusion.client.session.Session;
import com.pushtechology.diffusion.client.types.Credentials;

/**
 * This demonstrates the use of a control client to authenticate
 * client
 * connections.
 * <P>
 * This uses the 'AuthenticationControl' feature.
 *
 * @author Push Technology Limited
 * @since 5.0
 */
public class ControlClientIdentityChecks {

    private final Session session;

    /**
     * Constructor.
     */
    public ControlClientIdentityChecks() {

        session =

Diffusion.sessions().principal("control").password("password")
        .open("ws://diffusion.example.com:80");

        final AuthenticationControl authenticationControl =
            session.feature(AuthenticationControl.class);

        // To register the authentication handler, this client
        session must
        // have the 'authenticate' and 'register_handler'
        permissions.
        authenticationControl.setAuthenticationHandler(
            "example-handler",
            EnumSet.allOf(DetailType.class),
            new Handler());
    }

    /**
     * Authentication handler.
     */
    private static class Handler extends ServerHandler.Default
        implements ControlAuthenticationHandler {
        @Override
        public void authenticate(
            final String principal,
            final Credentials credentials,
            final SessionDetails sessionDetails,
            final Callback callback) {

            final byte[] passwordBytes =
                "password".getBytes(Charset.forName("UTF-8"));

            if ("admin".equals(principal) &&
                credentials.getType() ==
                Credentials.Type.PLAIN_PASSWORD &&

```

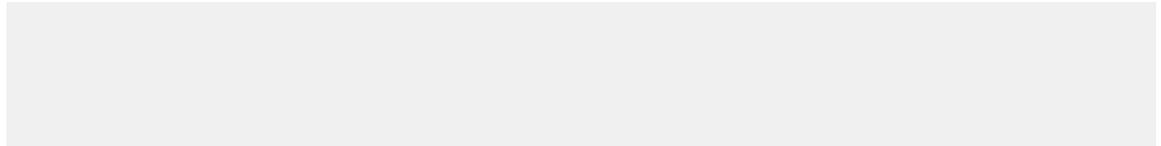
```

        Arrays.equals(credentials.toBytes(), passwordBytes))
    {
        callback.allow();
    }
    else {
        callback.deny();
    }
}

/**
 * Close the session.
 */
public void close() {
    session.close();
}
}

```

.NET



C

```

/*
 * Diffusion can be configured to delegate authentication requests to
 * an external handler. This program provides an authentication
 * handler to demonstrate this feature. A detailed description of
 * security and authentication handlers can be found in the Diffusion
 * user manual.
 *
 * Authentication handlers are registered with a name, which is
 * typically specified in
 * Server.xml
 *
 * Two handler names are provided by default;
 * before-system-handler and after-system-handler, and additional
 * handlers may be specified for Diffusion through the Server.xml
 * file
 * and an accompanying Java class that implements the
 * AuthenticationHandler interface.
 *
 * This control authentication handler connects to Diffusion and
 * attempts
 * to register itself with a user-supplied name, which should match
 * the name
 * configured in Server.xml.
 *
 * The default behavior is to install as the "before-system-handler",
 * which means that it will intercept authentication requests before
 * Diffusion has a chance to act on them.
 *
 * It will:
 * <ul>
 * <li>Deny all anonymous connections</li>
 * <li>Allow connections where the principal and credentials (i.e.,
 * username and password) match some hardcoded values</li>
 * <li>Abstain from all other decisions, thereby letting Diffusion
 * and other authentication handlers decide what to do.</li>

```

```

* </ul>
*/

#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>

#include "diffusion.h"
#include "args.h"
#include "conversation.h"

struct user_credentials_s {
    const char *username;
    const char *password;
};

/*
 * Username/password pairs that this handler accepts.
 */
static const struct user_credentials_s USERS[] = {
    { "fish", "chips" },
    { "ham", "eggs" },
    { NULL, NULL }
};

ARG_OPTS_T arg_opts[] = {
    ARG_OPTS_HELP,
    {'u', "url", "Diffusion server URL", ARG_OPTIONAL,
    ARG_HAS_VALUE, "ws://localhost:8080"},
    {'n', "name", "Name under which to register the
    authentication handler", ARG_OPTIONAL, ARG_HAS_VALUE, "before-
    system-handler"},
    {'p', "principal", "Principal (username) for the connection",
    ARG_OPTIONAL, ARG_HAS_VALUE, NULL},
    {'c', "credentials", "Credentials (password) for the
    connection", ARG_OPTIONAL, ARG_HAS_VALUE, NULL},
    END_OF_ARG_OPTS
};

/*
 * When the authentication service has been registered, this function
 * will be
 * called.
 */
static int
on_registration(SESSION_T *session, void *context)
{
    printf("Registered authentication handler\n");
    return HANDLER_SUCCESS;
}

/*
 * When the authentication service has be deregistered, this function
 * will be
 * called.
 */
static int
on_deregistration(SESSION_T *session, void *context)
{
    printf("Deregistered authentication handler\n");
    return HANDLER_SUCCESS;
}

```

```

/*
 * This is the function that is called when authentication has been
 * delegated
 * from Diffusion.
 *
 * The response may return one of three values via the response
 * parameter:
 * ALLOW: The user is authenticated.
 * ALLOW_WITH_RESULT: The user is authenticated, and additional roles
 * are
 * to be applied to the user.
 * DENY: The user is NOT authenticated.
 * ABSTAIN: Allow another handler to make the decision.
 *
 * The handler should return HANDLER_SUCCESS in all cases, unless an
 * actual
 * error occurs during the authentication process (in which case,
 * HANDLER_FAILURE is appropriate).
 */
static int
on_authentication(SESSION_T *session,
                  const SVC_AUTHENTICATION_REQUEST_T *request,
                  SVC_AUTHENTICATION_RESPONSE_T *response,
                  void *context)
{
    // No credentials, or not password type. We're not an
    // authority for
    // this type of authentication so abstain in case some other
    // registered
    // authentication handler can deal with the request.
    if(request->credentials == NULL) {
        printf("No credentials specified, abstaining\n");
        response->value = AUTHENTICATION_ABSTAIN;
        return HANDLER_SUCCESS;
    }
    if(request->credentials->type != PLAIN_PASSWORD) {
        printf("Credentials are not PLAIN_PASSWORD,
        abstaining\n");
        response->value = AUTHENTICATION_ABSTAIN;
        return HANDLER_SUCCESS;
    }

    printf("principal = %s\n", request->principal);
    printf("credentials = %*s\n",
           (int)request->credentials->data->len,
           request->credentials->data->data);

    if(request->principal == NULL || strlen(request->principal)
    == 0) {
        printf("Denying anonymous connection (no
        principal)\n");
        response->value = AUTHENTICATION_DENY; // Deny anon
        connections
        return HANDLER_SUCCESS;
    }

    char *password = malloc(request->credentials->data->len + 1);
    memmove(password, request->credentials->data->data, request-
    >credentials->data->len);
    password[request->credentials->data->len] = '\0';

    int auth_decided = 0;
    int i = 0;

```

```

        while(USERS[i].username != NULL) {
            printf("Checking username %s vs %s\n", request-
>principal, USERS[i].username);
            printf("        and password %s vs %s\n", password,
USERS[i].password);

            if(strcmp(USERS[i].username, request->principal) == 0
&&
                strcmp(USERS[i].password, password) == 0) {

                puts("Allowed");
                response->value = AUTHENTICATION_ALLOW;
                auth_decided = 1;
                break;
            }
            i++;
        }

        free(password);

        if(auth_decided == 0) {
            puts("Abstained");
            response->value = AUTHENTICATION_ABSTAIN;
        }

        return HANDLER_SUCCESS;
    }

int
main(int argc, char** argv)
{
    HASH_T *options = parse_cmdline(argc, argv, arg_opts);
    if (options == NULL || hash_get(options, "help") != NULL) {
        show_usage(argc, argv, arg_opts);
        return EXIT_FAILURE;
    }

    char *url = hash_get(options, "url");
    char *name = hash_get(options, "name");
    char *principal = hash_get(options, "principal");
    char *credentials = hash_get(options, "credentials");

    /*
     * Create a session with Diffusion.
     */
    puts("Creating session");
    DIFFUSION_ERROR_T error = { 0 };
    SESSION_T *session = session_create(url,
                                        principal,
                                        credentials != NULL ?
credentials_create_password(credentials) : NULL,
                                        NULL, NULL,
                                        &error);

    if (session == NULL) {
        fprintf(stderr, "TEST: Failed to create session\n");
        fprintf(stderr, "ERR : %s\n", error.message);
        return EXIT_FAILURE;
    }

    /*
     * Provide a set (via a hash map containing keys and NULL

```

```

    * values) to indicate what information about the connecting
    * client that we'd like Diffusion to send us.
    */
    HASH_T *detail_set = hash_new(5);
    char buf[2];
    sprintf(buf, "%d", SESSION_DETAIL_SUMMARY);
    hash_add(detail_set, strdup(buf), NULL);
    sprintf(buf, "%d", SESSION_DETAIL_LOCATION);
    hash_add(detail_set, strdup(buf), NULL);
    sprintf(buf, "%d", SESSION_DETAIL_CONNECTOR_NAME);
    hash_add(detail_set, strdup(buf), NULL);

    /*
     * Register the authentication handler.
     */
    AUTHENTICATION_REGISTRATION_PARAMS_T auth_registration_params
= {
        .name = name,
        .detail_set = detail_set,
        .on_registration = on_registration,
        .authentication_handlers.on_authentication =
on_authentication
    };

    puts("Sending registration request");
    SVC_AUTHENTICATION_REGISTER_REQUEST_T *reg_request =
        authentication_register(session,
auth_registration_params);

    /*
     * Wait a while before moving on to deregistration.
     */
    sleep(30);

    AUTHENTICATION_DEREGISTRATION_PARAMS_T
auth_deregistration_params = {
        .on_deregistration = on_deregistration,
        .original_request = reg_request
    };

    /*
     * Deregister the authentication handler.
     */
    printf("Deregistering authentication handler\n");
    authentication_deregister(session,
auth_deregistration_params);

    session_close(session, NULL);
    session_free(session);

    return EXIT_SUCCESS;
}

```

Change the URL from that provided in the example to the URL of the Diffusion server.

Related concepts

[Configuring authentication handlers](#) on page 501

Authentication handlers and the order that the Diffusion server calls them in are configured in the `Server.xml` configuration file.

Developing a control authentication handler

Implement the `ControlAuthenticationHandler` interface to create a control authentication handler.

About this task

A control authentication handler can be implemented in any language where the Diffusion API includes the `AuthenticationControl` feature.

For more information, see .

This example demonstrates how to implement a control authentication handler in Java.

Note: Where `c.p.d` is used in package names, it indicates `com.pushtechnology.diffusion`.

Procedure

1. Edit the `etc/Server.xml` configuration file to include a name that the control authentication handler can register with.

Include the `control-authentication-handler` element in the list of authentication handlers. The order of the list defines the order in which the authentication handlers are called. The value of the `handler-name` attribute is the name that your control authentication handler registers as. For example:

```
<security>
  <authentication-handlers>
    <!-- Include a local authentication handler that can
    authenticate the control client -->
    <authentication-handler class="com.example.LocalHandler" />

    <!-- Register your control authentication handler -->
    <control-authentication-handler handler-name="before-system-
    handler" />

  </authentication-handlers>
</security>
```

The client that registers your control authentication handler must first authenticate with the Diffusion server. Configure a local authentication handler that allows the client to connect.

2. Start the Diffusion server.
 - On UNIX[®]-based systems, run the `diffusion.sh` command in the `diffusion_installation_dir/bin` directory.
 - On Windows systems, run the `diffusion.bat` command in the `diffusion_installation_dir\bin` directory.
3. Create a Java class that implements `ControlAuthenticationHandler`.

```
package com.example.client;

import com.pushtechnology.diffusion.client.details.SessionDetails;
import
    com.pushtechnology.diffusion.client.features.control.clients.AuthenticationCo
```

```

import com.pushtechology.diffusion.client.types.Credentials;

public class ExampleControlAuthenticationHandler implements
    ControlAuthenticationHandler{

    public void authenticate(String principal, Credentials
        credentials,
            SessionDetails sessionDetails, Callback callback) {

        // Logic to make the authentication decision.

        // Authentication decision
        callback.abstain();

        // callback.deny();
        // callback.allow();

    }

    @Override
    public void onActive(RegisteredHandler handler) {

    }

    @Override
    public void onClose() {

    }

}

```

- a) Implement the `authenticate` method.
- b) Use the `allow`, `deny`, or `abstain` method on the `Callback` object to respond with the authentication decision.
- c) You can override the `onActive` and `onClose` to include actions the control authentication handler performs when the client opens its connection to the Diffusion server and when the client closes its session with the Diffusion server.

For example, when the client session becomes active, the control authentication handler uses the `onActive` method to open a connection to a database. When the client session is closed, the control authentication handler uses the `onClose` method to close the connection to the database.

4. Create a simple client that registers your control authentication handler with the Diffusion server.

```

package com.example.client;

import com.example.client.ExampleControlAuthenticationHandler;
import com.pushtechology.diffusion.client.Diffusion;
import
    com.pushtechology.diffusion.client.details.SessionDetails.DetailType;
import
    com.pushtechology.diffusion.client.features.control.clients.AuthenticationC
import com.pushtechology.diffusion.client.session.Session;
import com.pushtechology.diffusion.client.session.SessionFactory;

import java.util.EnumSet;

public class ExampleControlClient {

    public static void main(String[] args) {

```

```

final Session session;

// Create the client session
SessionFactory sf = Diffusion.sessions();
session = sf.principal("ControlClient1")
    .passwordCredentials("Passw0rd")
    .open("ws://diffusion.example.com:80");

// Get the AuthenticationControl feature
AuthenticationControl authControl =
session.feature(AuthenticationControl.class);

// Use the AuthenticationControl feature to register your
control authentication
// handler with the name that you configured in Server.xml

authControl.setAuthenticationHandler("before-system-
handler",
    EnumSet.allOf(DetailType.class), new
ExampleControlAuthenticationHandler());
}
}

```

a) Create a session.

Change the URL from that provided in the example to the URL of the Diffusion server.

b) Use the session to get the `AuthenticationControl` feature.

c) Use the `AuthenticationControl` feature to register your control authentication handler, `ExampleControlAuthenticationHandler`, using the name that you configured in the `etc/Server.xml` configuration file, `before-system-handler`.

5. Start your client.

It connects to the Diffusion server and registers the control authentication handler with the name `before-system-handler`.

Results

When a client authenticates, the Diffusion server forwards the authentication request to the authentication handler you have registered. Your authentication handler can ALLOW, DENY, or ABSTAIN from the authentication decision. If your authentication handler returns an ALLOW or DENY decision, this decision is used as the response to the authenticating client. If your authentication handler returns an ABSTAIN decision, the Diffusion server forwards the authentication request to the next authentication handler. For more information, see [Authentication](#) on page 141.

Related concepts

[User-written authentication handlers](#) on page 144

You can implement authentication handlers that authenticate clients that connect to the Diffusion server or perform an action that requires authentication.

[Authentication](#) on page 141

You can implement and register handlers to authenticate clients when the clients try to perform operations that require authentication.

Related tasks

[Developing a local authentication handler](#) on page 455

Implement the `AuthenticationHandler` interface to create a local authentication handler.

[Developing a composite authentication handler](#) on page 457

Extend the `CompositeAuthenticationHandler` class to combine the decisions from multiple authentication handlers.

[Developing a composite control authentication handler](#) on page 401

Extend the `CompositeControlAuthenticationHandler` class to combine the decisions from multiple control authentication handlers.

Developing a composite control authentication handler

Extend the `CompositeControlAuthenticationHandler` class to combine the decisions from multiple control authentication handlers.

About this task

Using a composite control authentication handler reduces the number of messages that are sent between the Diffusion server and the client to perform authentication.

This example describes how to use a composite control authentication handler as part of a client remote from the Diffusion server.

Procedure

1. Edit the `etc/Server.xml` configuration file to point to your composite control authentication handler.

Include the `control-authentication-handler` element in the list of authentication handlers. The order of the list defines the order in which the authentication handlers are called. The value of the `handler-name` attribute is the name that your composite control authentication handler registers as. For example:

```
<security>
  <authentication-handlers>
    <!-- Include a local authentication handler that can
    authenticate the control client -->
    <authentication-handler class="com.example.LocalHandler" />

    <!-- Register your composite control authentication handler -->
    <control-authentication-handler handler-name="example-
    composite-control-authentication-handler" />

  </authentication-handlers>
</security>
```

The client that registers your control authentication handler must first authenticate with the Diffusion server. Configure a local authentication handler that allows the client to connect.

2. Start the Diffusion server.
 - On UNIX-based systems, run the `diffusion.sh` command in the `diffusion_installation_dir/bin` directory.
 - On Windows systems, run the `diffusion.bat` command in the `diffusion_installation_dir\bin` directory.
3. Create the individual control authentication handlers that your composite control authentication handler calls.

You can follow steps in the task [Developing a control authentication handler](#) on page 398.

In this example, the individual control authentication handlers are referred to as `HandlerOne`, `HandlerTwo`, and `HandlerThree`.

4. Extend the `CompositeControlAuthenticationHandler` class.

```
package com.example.client;

import com.example.client.HandlerOne;
import com.example.client.HandlerTwo;
import com.example.client.HandlerThree;

import
    com.pushtechology.diffusion.client.features.control.clients.CompositeControlAuthenticationHandler;

public class ExampleHandler extends
    CompositeControlAuthenticationHandler {

    public ExampleHandler() {
        super(new HandlerOne(), new HandlerTwo(), new
            HandlerThree());
    }

}
```

- a) Import your individual control authentication handlers.
 - b) Create a no-argument constructor that calls the super class constructor with a list of your individual handlers.
5. Create a simple client that registers your composite control authentication handler with the Diffusion server.

You can follow steps in the task [Developing a control authentication handler](#) on page 398.

Ensure that you register your composite control authentication handler, `ExampleHandler`, using the name that you configured in the `etc/Server.xml` configuration file, `example-composite-control-authentication-handler`.

6. Start your client.

It connects to the Diffusion server and registers the composite control authentication handler.

Results

When the client session starts, the composite control authentication handler calls the `onActive` methods of the individual control authentication handlers in the order in which they are passed in to the composite handler.

When the composite control authentication handler is called, it calls the individual control authentication handlers that are passed to it as parameters in the order they are passed in.

- If an individual handler responds with `ALLOW`, the composite handler responds with that decision to the Diffusion server and a list of any roles to assign to the authenticated principal.
- If an individual handler responds with `DENY`, the composite handler responds with that decision to the Diffusion server.
- If an individual handler responds with `ABSTAIN`, the composite handler calls the next individual handler in the list.
- If all individual handlers respond with `ABSTAIN`, the composite handler responds to the Diffusion server with an `ABSTAIN` decision.

When the client session closes, the composite control authentication handler calls the `onClose` methods of the individual control authentication handlers in the order in which they are passed in to the composite handler.

Related concepts

[User-written authentication handlers](#) on page 144

You can implement authentication handlers that authenticate clients that connect to the Diffusion server or perform an action that requires authentication.

[Authentication](#) on page 141

You can implement and register handlers to authenticate clients when the clients try to perform operations that require authentication.

Related tasks

[Developing a local authentication handler](#) on page 455

Implement the `AuthenticationHandler` interface to create a local authentication handler.

[Developing a composite authentication handler](#) on page 457

Extend the `CompositeAuthenticationHandler` class to combine the decisions from multiple authentication handlers.

[Developing a control authentication handler](#) on page 398

Implement the `ControlAuthenticationHandler` interface to create a control authentication handler.

Updating the system authentication store

A client can use the `SystemAuthenticationControl` feature to update the system authentication store. The information in the system authentication store is used by the system authentication handler to authenticate users and assign roles to them.

Querying the store

Required permissions: `view_security`

The client can get a snapshot of the current information in the system authentication store. This information is returned as an object model.

Updating the store

Required permissions: `modify_security`

The client can use a command script to update the system authentication store. The command script is a string that contains a command on each line. These commands are applied to the current state of the system authentication store.

The update is transactional. Unless all of the commands in the script can be applied, none of them are.

Using a script builder

You can use a script builder to create the command script used to update the system authentication store. Use the script builder to create commands for the following actions:

- Set the authentication decision for anonymous principals
- Add principals to the store
- Delete principals from the store
- Change the password of a principal
- Assign roles to principals

Related reference

[System authentication handler](#) on page 146

Diffusion provides an authentication handler that uses principal, credential, and roles information stored in the Diffusion server to make its authentication decision.

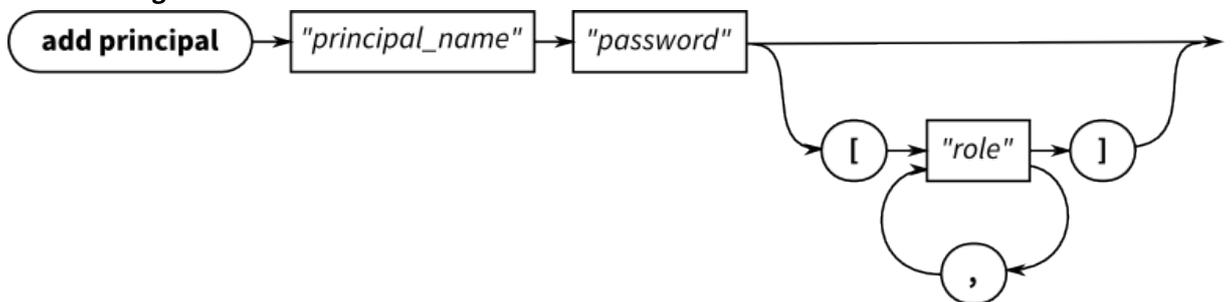
DSL syntax: system authentication store

The scripts that you can use with the SystemAuthenticationControl feature to update the system authentication store are formatted according to a domain-specific language (DSL). You can use the script builders provided in the APIs to create a script to update the system authentication store. However, if you want to create the script by some other method, ensure that it conforms to the DSL.

The following sections each describe the syntax for a single line of the file.

Adding a principal

Railroad diagram



Backus-Naur form

```
add_principal "principal_name" "password" [ '[' "role" [ , "role" ] ' ] ]
```

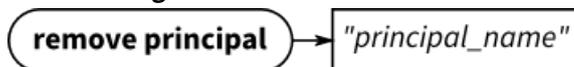
Example

```
add_principal "user6" "passwd"
add_principal "user13" "passwd" [ "CLIENT", "TOPIC_CONTROL" ]
```

The password is passed in as plain text, but is stored in the system authentication store as a secure hash.

Removing a principal

Railroad diagram



Backus-Naur form

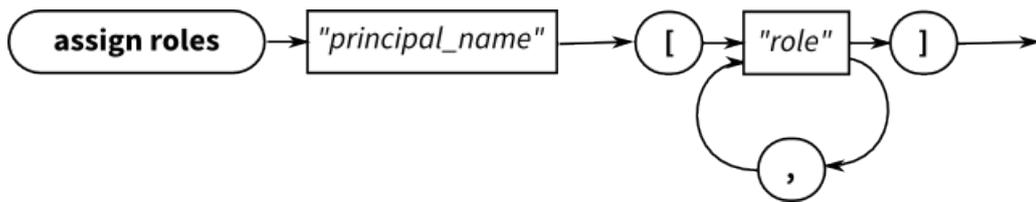
```
remove_principal "principal_name"
```

Example

```
remove_principal "user25"
```

Assigning roles to a principal

Railroad diagram



Backus-Naur form

`assign roles "principal_name" '[' "role" [, "role"]]'`

Example

```
assign roles "agent77" ["CLIENT", "CLIENT_CONTROL"]
```

When you use this command to assign roles to a principal, it overwrites any existing roles assigned to that principal. Ensure that all the roles you want the principal to have are listed in the command.

Setting the password for a principal

Railroad diagram



Backus-Naur form

`set password "principal_name" "password"`

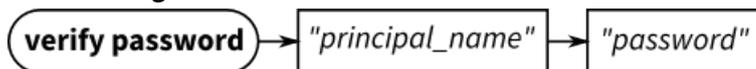
Example

```
set password "user1" "passw0rd"
```

The password is passed in as plain text, but is stored in the system authentication store as a secure hash.

Verifying the password for a principal

Railroad diagram



Backus-Naur form

`verify password "principal_name" "password"`

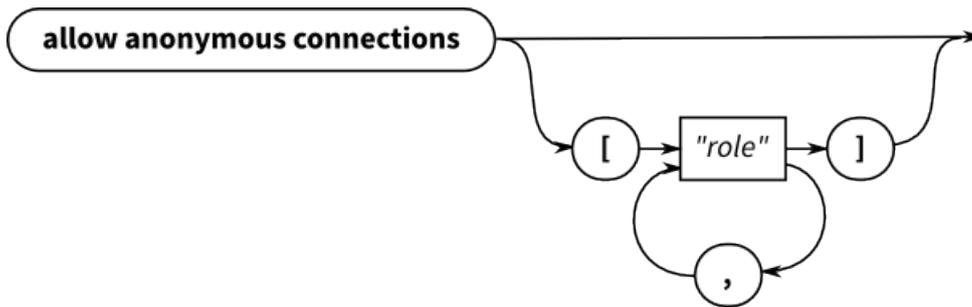
Example

```
verify password "user1" "passw0rd"
```

The password is passed in as plain text, but is stored in the system authentication store as a secure hash.

Allowing anonymous connections

Railroad diagram



Backus-Naur form

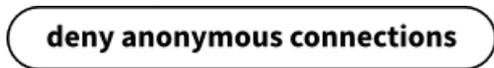
allow anonymous connections ['["role" [, "role"]']']

Example

```
allow anonymous connections [ "CLIENT" ]
```

Denying anonymous connections

Railroad diagram



Backus-Naur form

deny anonymous connections

Example

```
deny anonymous connections
```

Abstaining from providing a decision about anonymous connections

Railroad diagram



Backus-Naur form

abstain anonymous connections

Example

```
abstain anonymous connections
```

Example: Update the system authentication store

The following examples use the SystemAuthenticationControl feature in the Diffusion API to update the system authentication store.

JavaScript

Note: Only steps 4 and 5 deal with the system authentication store.

```
// Session security allows you to change the principal that a session
// is authenticated as. It also allows users to
// query and update server-side security and authentication stores,
// which control users, roles and permissions.
```

```

// This enables you to manage the capabilities that any logged in
user will have access to.

// Connect to Diffusion with control client credentials
diffusion.connect({
  host    : 'diffusion.example.com',
  port    : 443,
  secure  : true,
  principal : 'control',
  credentials : 'password'
}).then(function(session) {

  // 1. A session change their principal by re-authenticating
  session.security.changePrincipal('admin',
'password').then(function() {
    console.log('Authenticated as admin');
  });

  // 2. The security configuration provides details about roles and
their assigned permissions
  session.security.getSecurityConfiguration().then(function(config)
  {
    console.log('Roles for anonymous sessions: ',
config.anonymous);
    console.log('Roles for named sessions: ', config.named);
    console.log('Available roles: ', config.roles);
  }, function(error) {
    console.log('Unable to fetch security configuration', error);
  });

  // 3. Changes to the security configuration are done with a
SecurityScriptBuilder
  var securityScriptBuilder =
session.security.securityScriptBuilder();

  // Set the permissions for a particular role - global and topic-
scoped
  // Each method on a script builder returns a new builder
  var setPermissionScript =
securityScriptBuilder.setGlobalPermissions('SUPERUSER',
['REGISTER_HANDLER'])

.setTopicPermissions('SUPERUSER', '/foo', ['UPDATE_TOPIC'])
    .build();

  // Update the server-side store with the generated script
  session.security.updateSecurityStore(setPermissionScript).then(function()
  {
    console.log('Security configuration updated successfully');
  }, function(error) {
    console.log('Failed to update security configuration: ',
error);
  });

  // 4. The system authentication configuration lists all users &
roles

  session.security.getSystemAuthenticationConfiguration().then(function(config)
  {
    console.log('System principals: ', config.principals);
    console.log('Anonymous sessions: ', config.anonymous);
  }, function(error) {

```

```

        console.log('Unable to fetch system authentication
configuration', error);
    });

    // 5. Changes to the system authentication config are done with a
SystemAuthenticationScriptBuilder
    var authenticationScriptBuilder =
session.security.authenticationScriptBuilder();

    // Add a new user and set password & roles.
    var addUserScript =
authenticationScriptBuilder.addPrincipal('Superman',
'correcthorsebatterystapler')

.assignRoles('Superman', ['SUPERUSER'])

        .build();

    // Update the system authentication store
session.security.updateAuthenticationStore(addUserScript).then(function()
{
    console.log('Updated system authentication config');
}, function(error) {
    console.log('Failed to update system authentication: ',
error);
});
});

```

Java and Android

```

package com.pushtechology.diffusion.examples;

import java.util.HashSet;
import java.util.Set;

import org.slf4j.Logger;
import org.slf4j.LoggerFactory;

import com.pushtechology.diffusion.client.Diffusion;
import com.pushtechology.diffusion.client.callbacks.ErrorReason;
import
    com.pushtechology.diffusion.client.features.control.clients.SystemAuthenticati
import
    com.pushtechology.diffusion.client.features.control.clients.SystemAuthenticati
import
    com.pushtechology.diffusion.client.features.control.clients.SystemAuthenticati
import
    com.pushtechology.diffusion.client.features.control.clients.SystemAuthenticati
import
    com.pushtechology.diffusion.client.features.control.clients.SystemAuthenticati
import
    com.pushtechology.diffusion.client.features.control.clients.SecurityStoreFeatu
import com.pushtechology.diffusion.client.session.Session;

/**
 * An example of using a control client to alter the system
authentication
 * configuration.
 * <P>
 * This uses the {@link SystemAuthenticationControl} feature only.
 *
 * @author Push Technology Limited

```

```

* @since 5.2
*/
public class ControlClientChangingSystemAuthentication {

    private static final Logger LOG =
        LoggerFactory.getLogger(
            ControlClientChangingSystemAuthentication.class);

    private final SystemAuthenticationControl
systemAuthenticationControl;

    /**
     * Constructor.
     */
    public ControlClientChangingSystemAuthentication() {

        final Session session = Diffusion.sessions()
// Authenticate with a user that has the VIEW_SECURITY
and
// MODIFY_SECURITY permissions.
.principal("admin").password("password")
// Use a secure channel because we're transferring
sensitive
// information.
.open("wss://diffusion.example.com:80");

        systemAuthenticationControl =
            session.feature(SystemAuthenticationControl.class);
    }

    /**
     * For all system users, update the assigned roles to replace the
     * "SUPERUSER" role and with "ADMINISTRATOR".
     *
     * @param callback result callback
     */
    public void changeSuperUsersToAdministrators(UpdateStoreCallback
callback) {

        systemAuthenticationControl.getSystemAuthentication(
            new ChangeSuperUsersToAdministrators(callback));
    }

    private final class ChangeSuperUsersToAdministrators
implements ConfigurationCallback {

        private final UpdateStoreCallback callback;

        ChangeSuperUsersToAdministrators(UpdateStoreCallback
callback) {
            this.callback = callback;
        }

        @Override
        public void onReply(SystemAuthenticationConfiguration
configuration) {

            ScriptBuilder builder =
                systemAuthenticationControl.scriptBuilder();

            // For all system users ...
            for (SystemPrincipal principal :
configuration.getPrincipals()) {

```

```

        final Set<String> assignedRoles =
principal.getAssignedRoles();

        // ... that have the SUPERUSER assigned role ...
        if (assignedRoles.contains("SUPERUSER")) {
            final Set<String> newRoles = new
HashSet<>(assignedRoles);
            newRoles.remove("SUPERUSER");
            newRoles.add("ADMINISTRATOR");

            // ... add a command to the script that updates
the user's
            // assigned roles, replacing SUPERUSER with
"ADMINISTRATOR".
            builder =
newRoles);
                builder.assignRoles(principal.getName(),
            }
        }

        final String script = builder.script();

        LOG.info(
            "Sending the following script to the server:\n{}",
            script);

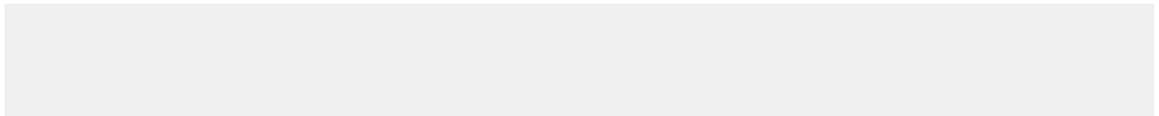
        systemAuthenticationControl.updateStore(
            script,
            callback);
    }

    @Override
    public void onError(ErrorReason errorReason) {
        // This might fail if the session lacks the required
permissions.
        callback.onError(errorReason);
    }
}

/**
 * Close the session.
 */
public void close() {
    systemAuthenticationControl.getSession().close();
}
}

```

.NET



C

```

/*
 * This examples demonstrates how to interact with the system
 * authentication store.
 */

#include <stdio.h>

```

```

#include <apr.h>
#include <apr_thread_mutex.h>
#include <apr_thread_cond.h>

#include "diffusion.h"
#include "args.h"
#include "service/svc-system-auth-control.h"

apr_pool_t *pool = NULL;
apr_thread_mutex_t *mutex = NULL;
apr_thread_cond_t *cond = NULL;

ARG_OPTS_T arg_opts[] = {
    ARG_OPTS_HELP,
    {'u', "url", "Diffusion server URL", ARG_OPTIONAL,
    ARG_HAS_VALUE, "ws://localhost:8080"},
    {'p', "principal", "Principal (username) for the connection",
    ARG_OPTIONAL, ARG_HAS_VALUE, NULL},
    {'c', "credentials", "Credentials (password) for the
    connection", ARG_OPTIONAL, ARG_HAS_VALUE, NULL},
    END_OF_ARG_OPTS
};

/*
 * This callback is invoked when the system authentication store is
 * received, and prints the contents of the store.
 */
int
on_get_system_authentication_store(SESSION_T *session,
                                   const
                                   SYSTEM_AUTHENTICATION_STORE_T store,
                                   void *context)
{
    puts("on_get_system_authentication_store()");

    printf("Got %ld principals\n", store.system_principals-
>size);

    char **names = get_principal_names(store);
    for(char **name = names; *name != NULL; name++) {
        printf("Principal: %s\n", *name);

        char **roles = get_roles_for_principal(store, *name);
        for(char **role = roles; *role != NULL; role++) {
            printf("  |- Role: %s\n", *role);
        }
        free(roles);
    }
    free(names);

    switch(store.anonymous_connection_action) {
    case ANONYMOUS_CONNECTION_ACTION_ALLOW:
        puts("Allow anonymous connections");
        break;
    case ANONYMOUS_CONNECTION_ACTION_DENY:
        puts("Deny anonymous connections");
        break;
    case ANONYMOUS_CONNECTION_ACTION_ABSTAIN:
        puts("Abstain from making anonymous connection
decision");
        break;
    }
}

```

```

puts("Anonymous connection roles:");
char **roles = get_anonymous_roles(store);
for(char **role = roles; *role != NULL; role++) {
    printf("  |- Role: %s\n", *role);
}
free(roles);

apr_thread_mutex_lock(mutex);
apr_thread_cond_broadcast(cond);
apr_thread_mutex_unlock(mutex);

return HANDLER_SUCCESS;
}

int
main(int argc, char **argv)
{
    /*
     * Standard command-line parsing.
     */
    const HASH_T *options = parse_cmdline(argc, argv, arg_opts);
    if(options == NULL || hash_get(options, "help") != NULL) {
        show_usage(argc, argv, arg_opts);
        return EXIT_FAILURE;
    }

    const char *url = hash_get(options, "url");
    const char *principal = hash_get(options, "principal");
    CREDENTIALS_T *credentials = NULL;
    const char *password = hash_get(options, "credentials");
    if(password != NULL) {
        credentials = credentials_create_password(password);
    }

    /*
     * Setup for condition variable
     */
    apr_initialize();
    apr_pool_create(&pool, NULL);
    apr_thread_mutex_create(&mutex, APR_THREAD_MUTEX_UNNESTED,
pool);
    apr_thread_cond_create(&cond, pool);

    /*
     * Create a session with Diffusion.
     */
    SESSION_T *session;
    DIFFUSION_ERROR_T error = { 0 };
    session = session_create(url, principal, credentials, NULL,
NULL, &error);
    if(session == NULL) {
        fprintf(stderr, "TEST: Failed to create session\n");
        fprintf(stderr, "ERR : %s\n", error.message);
        return EXIT_FAILURE;
    }

    /*
     * Request the system authentication store.
     */
    const GET_SYSTEM_AUTHENTICATION_STORE_PARAMS_T params = {
        .on_get = on_get_system_authentication_store
    };
};

```

```

    apr_thread_mutex_lock(mutex);

    get_system_authentication_store(session, params);

    apr_thread_cond_wait(cond, mutex);
    apr_thread_mutex_unlock(mutex);

    /*
     * Close the session and tidy up.
     */
    session_close(session, NULL);
    session_free(session);

    apr_thread_mutex_destroy(mutex);
    apr_thread_cond_destroy(cond);
    apr_pool_destroy(pool);
    apr_terminate();

    return EXIT_SUCCESS;
}

```

Change the URL from that provided in the example to the URL of the Diffusion server.

Updating the security store

A client can use the SecurityControl feature to update the security store. The information in the security store is used by the Diffusion server to define the permissions assigned to roles and the roles assigned to anonymous sessions and named sessions.

Querying the store

Required permissions: view_security

The client can get a snapshot of the current information in the security store. This information is returned as an object model.

Updating the store

Required permissions: modify_security

The client can use a command script to update the security store. The command script is a string that contains a command on each line. These commands are applied to the current state of the security store.

The update is transactional. Unless all of the commands in the script can be applied, none of them are.

Using a script builder

You can use a script builder to create the command script used to update the security store. Use the script builder to create commands for the following actions:

- Set the global permissions assigned to a named role
- Set the default path permissions assigned to a named role
- Set the path permissions associated with a specific path assigned to a named role

This can include explicitly setting a role to have no permissions at a path.

- Remove the path permissions associated with a specific path assigned to a named role
- Set the roles included in a named role

- Set the roles assigned to sessions authenticated with a named principal
- Set the roles assigned to anonymous sessions

DSL syntax: security store

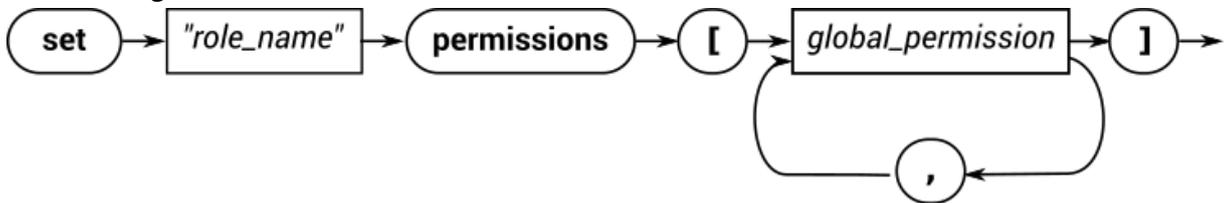
The scripts that you can use with the SecurityControl feature to update the security store are formatted according to a domain-specific language (DSL). You can use the script builders provided in the APIs to create a script to update the security store. However, if you want to create the script by some other method, ensure that it conforms to the DSL.

The following sections each describe the syntax for a single line of the script file.

Note: The **path** keyword is synonymous with the **topic** keyword used in previous releases of Diffusion. Both keywords are accepted. Prefer **path**.

Assigning global permissions to a role

Railroad diagram



Backus-Naur form

```
set "role_name" permissions [ '[' global_permission [ , global_permission ] ' ] ]
```

Example

```
set "ADMINISTRATOR" permissions [CONTROL_SERVER, VIEW_SERVER,
VIEW_SECURITY, MODIFY_SECURITY]
set "CLIENT_CONTROL" permissions [VIEW_SESSION, MODIFY_SESSION,
REGISTER_HANDLER]
```

Assigning default path permissions to a role

Railroad diagram



Backus-Naur form

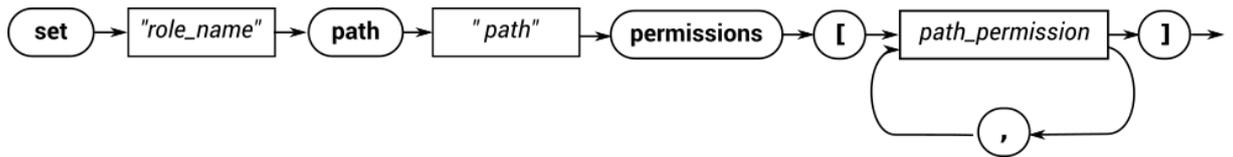
```
set "role_name" default path permissions [ '[' path_permission [ , path_permission ] ' ] ]
```

Example

```
set "CLIENT" default path permissions [READ_TOPIC ,
SEND_TO_MESSAGE_HANDLER]
```

Assigning path permissions associated with a specific path to a role

Railroad diagram



Backus-Naur form

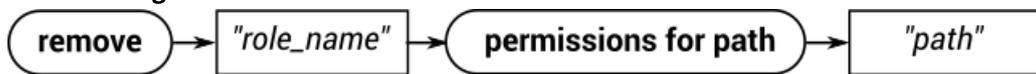
set "role_name" path "path" permissions ['[' path_permission [, path_permission] ']']

Example

```
set "CLIENT" path "foo/bar" permissions [READ_TOPIC,
SEND_TO_MESSAGE_HANDLER]
set "ADMINISTRATOR" path "foo" permissions [ MODIFY_TOPIC ]
set "CLIENT_CONTROL" path "foo" permissions [ ]
```

Removing all path permissions associated with a specific path to a role

Railroad diagram



Backus-Naur form

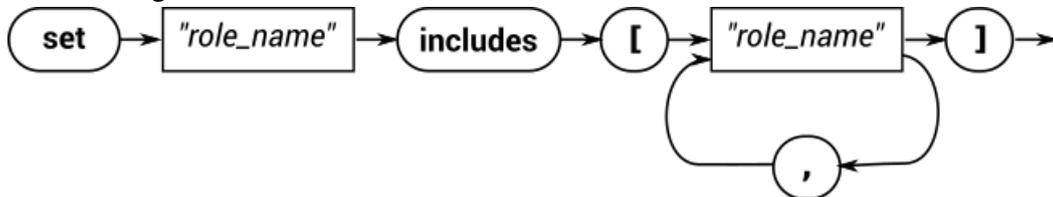
remove "role_name" permissions for path "path"

Example

```
remove "CLIENT" permissions for path "foo/bar"
```

Including roles within another role

Railroad diagram



Backus-Naur form

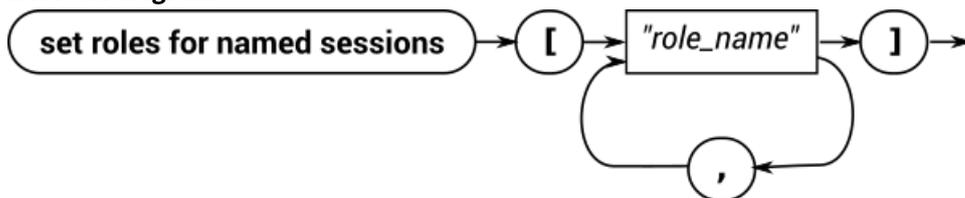
set "role_name" includes ['[' "role_name" [, "role_name"] ']']

Example

```
set "ADMINISTRATOR" includes ["CLIENT_CONTROL" , "TOPIC_CONTROL"]
set "CLIENT_CONTROL" includes ["CLIENT"]
```

Assigning roles to a named session

Railroad diagram



Backus-Naur form

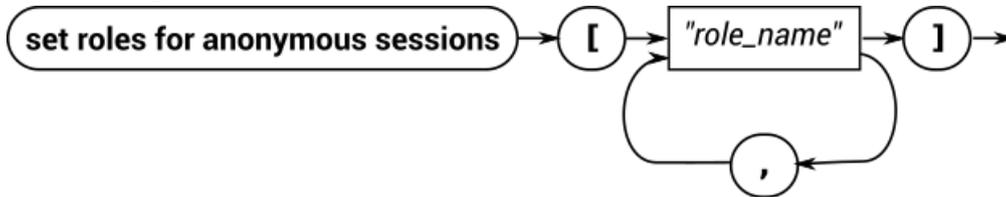
```
set roles for named sessions['[' "role_name " [ , "role_name " ]']']
```

Example

```
set roles for named sessions ["CLIENT"]
```

Assigning roles to an anonymous session

Railroad diagram



Backus-Naur form

```
set roles for anonymous sessions['[' "role_name " [ , "role_name " ]']']
```

Example

```
set roles for anonymous sessions ["CLIENT"]
```

Example: Update the security store

The following examples use the SecurityControl feature in the Diffusion API to update the security store.

JavaScript

Note: Only steps 2 and 3 deal with the security store.

```
// Session security allows you to change the principal that a session
// is authenticated as. It also allows users to
// query and update server-side security and authentication stores,
// which control users, roles and permissions.
// This enables you to manage the capabilities that any logged in
// user will have access to.

// Connect to Diffusion with control client credentials
diffusion.connect({
  host    : 'diffusion.example.com',
  port    : 443,
  secure  : true,
  principal : 'control',
  credentials : 'password'
}).then(function(session) {

  // 1. A session change their principal by re-authenticating
  session.security.changePrincipal('admin',
  'password').then(function() {
    console.log('Authenticated as admin');
  });

  // 2. The security configuration provides details about roles and
  // their assigned permissions
  session.security.getSecurityConfiguration().then(function(config)
  {
```

```

        console.log('Roles for anonymous sessions: ',
config.anonymous);
        console.log('Roles for named sessions: ', config.named);
        console.log('Available roles: ', config.roles);
    }, function(error) {
        console.log('Unable to fetch security configuration', error);
    });

    // 3. Changes to the security configuration are done with a
SecurityScriptBuilder
    var securityScriptBuilder =
session.security.securityScriptBuilder();

    // Set the permissions for a particular role - global and topic-
scoped
    // Each method on a script builder returns a new builder
    var setPermissionScript =
securityScriptBuilder.setGlobalPermissions('SUPERUSER',
['REGISTER_HANDLER'])

.setTopicPermissions('SUPERUSER', '/foo', ['UPDATE_TOPIC'])
        .build();

    // Update the server-side store with the generated script
session.security.updateSecurityStore(setPermissionScript).then(function()
{
    console.log('Security configuration updated successfully');
}, function(error) {
    console.log('Failed to update security configuration: ',
error);
});

    // 4. The system authentication configuration lists all users &
roles
session.security.getSystemAuthenticationConfiguration().then(function(config)
{
    console.log('System principals: ', config.principals);
    console.log('Anonymous sessions: ', config.anonymous);
}, function(error) {
    console.log('Unable to fetch system authentication
configuration', error);
});

    // 5. Changes to the system authentication config are done with a
SystemAuthenticationScriptBuilder
    var authenticationScriptBuilder =
session.security.authenticationScriptBuilder();

    // Add a new user and set password & roles.
    var addUserScript =
authenticationScriptBuilder.addPrincipal('Superman',
'correcthorsebatterystapler')

.assignRoles('Superman', ['SUPERUSER'])
        .build();

    // Update the system authentication store
session.security.updateAuthenticationStore(addUserScript).then(function()
{
    console.log('Updated system authentication config');
});

```

```

    }, function(error) {
        console.log('Failed to update system authentication: ',
            error);
    });
});

```

Java and Android

```

package com.pushtechology.diffusion.examples;

import java.util.Collections;
import java.util.Map;
import java.util.Set;
import java.util.TreeSet;

import org.slf4j.Logger;
import org.slf4j.LoggerFactory;

import com.pushtechology.diffusion.client.Diffusion;
import com.pushtechology.diffusion.client.callbacks.ErrorReason;
import
    com.pushtechology.diffusion.client.features.control.clients.SecurityControl;
import
    com.pushtechology.diffusion.client.features.control.clients.SecurityControl.Co
import
    com.pushtechology.diffusion.client.features.control.clients.SecurityControl.Ro
import
    com.pushtechology.diffusion.client.features.control.clients.SecurityControl.Sc
import
    com.pushtechology.diffusion.client.features.control.clients.SecurityControl.Se
import
    com.pushtechology.diffusion.client.features.control.clients.SecurityStoreFeatu
import com.pushtechology.diffusion.client.session.Session;
import com.pushtechology.diffusion.client.types.GlobalPermission;
import com.pushtechology.diffusion.client.types.TopicPermission;

/**
 * An example of using a control client to alter the security
 * configuration.
 * <P>
 * This uses the {@link SecurityControl} feature only.
 *
 * @author Push Technology Limited
 * @since 5.3
 */
public class ControlClientChangingSecurity {

    private static final Logger LOG =
        LoggerFactory.getLogger(
            ControlClientChangingSecurity.class);

    private final SecurityControl securityControl;

    /**
     * Constructor.
     */
    public ControlClientChangingSecurity() {

        final Session session = Diffusion.sessions()
            // Authenticate with a user that has the VIEW_SECURITY
and
            // MODIFY_SECURITY permissions.

```

```

        .principal("admin").password("password")
        // Use a secure channel because we're transferring
sensitive
        // information.
        .open("wss://diffusion.example.com:80");

        securityControl = session.feature(SecurityControl.class);
    }

    /**
     * This will update the security store to ensure that all roles
start with a
     * capital letter (note that this does not address changing the
use of the
     * roles in the system authentication store).
     *
     * @param callback result callback
     */
    public void capitalizeRoles(UpdateStoreCallback callback) {
        securityControl.getSecurity(new CapitalizeRoles(callback));
    }

    private final class CapitalizeRoles implements
ConfigurationCallback {

        private final UpdateStoreCallback callback;

        CapitalizeRoles(UpdateStoreCallback callback) {
            this.callback = callback;
        }

        @Override
        public void onReply(SecurityConfiguration configuration) {

            ScriptBuilder builder =
                securityControl.scriptBuilder();

            builder = builder.setRolesForAnonymousSessions(
capitalize(configuration.getRolesForAnonymousSessions()));

            builder = builder.setRolesForNamedSessions(
capitalize(configuration.getRolesForNamedSessions()));

            for (Role role : configuration.getRoles()) {

                final String oldName = role.getName();
                final String newName = capitalize(oldName);

                // Only if new name is different
                if (!oldName.equals(newName)) {

                    // Global Permissions
                    final Set<GlobalPermission> globalPermissions =
                        role.getGlobalPermissions();
                    if (!globalPermissions.isEmpty()) {
                        // Remove global permissions for old role
                        builder =
                            builder.setGlobalPermissions(
                                oldName,
                                Collections.<GlobalPermission>emptySet());
                    }
                }
            }
        }
    }
}

```

```

        // Set global permissions for new role
        builder =
            builder.setGlobalPermissions(
                newName,
                role.getGlobalPermissions());
    }

    final Set<TopicPermission>
defaultTopicPermissions =
    role.getDefaultTopicPermissions();
    if (!defaultTopicPermissions.isEmpty()) {
// Remove default topic permissions for old
role
        builder =
            builder.setDefaultTopicPermissions(
                oldName,
                Collections.<TopicPermission>emptySet());
// Set default topic permissions for new role
        builder =
            builder.setDefaultTopicPermissions(
                newName,
                role.getDefaultTopicPermissions());
    }

    final Map<String, Set<TopicPermission>>
topicPermissions =
    role.getTopicPermissions();

    if (!topicPermissions.isEmpty()) {
for (Map.Entry<String, Set<TopicPermission>>
entry : topicPermissions
        .entrySet()) {
            final String topicPath = entry.getKey();
// Remove old topic permissions
            builder =
                builder.removeTopicPermissions(
                    oldName,
                    topicPath);
// Set new topic permissions
            builder =
                builder.setTopicPermissions(
                    newName,
                    topicPath,
                    entry.getValue());
        }
    }

    final Set<String> oldIncludedRoles =
role.getIncludedRoles();
    if (!oldIncludedRoles.isEmpty()) {

        if (!oldName.equals(newName)) {
// Remove old included roles
            builder =
                builder.setRoleIncludes(
                    oldName,
                    Collections.<String>emptySet());
        }
    }

```

```

// This is done even if role name did not change
as it is
// possible that roles included may have
final Set<String> newIncludedRoles =
    capitalize(oldIncludedRoles);
builder =
    builder.setRoleIncludes(
        newName,
        newIncludedRoles);
    }

}

final String script = builder.script();

LOG.info(
    "Sending the following script to the server:\n{}",
    script);

securityControl.updateStore(
    script,
    callback);
}

private Set<String> capitalize(Set<String> roles) {
    final Set<String> newSet = new TreeSet<>();
    for (String role : roles) {
        newSet.add(capitalize(role));
    }
    return newSet;
}

private String capitalize(String role) {
    return Character.toUpperCase(role.charAt(0)) +
role.substring(1);
}

@Override
public void onError(ErrorReason errorReason) {
    // This might fail if the session lacks the required
permissions.
    callback.onError(errorReason);
}
}

/**
 * Close the session.
 */
public void close() {
    securityControl.getSession().close();
}
}

```

.NET

Change the URL from that provided in the example to the URL of the Diffusion server.

Managing sessions

A client session with the appropriate permissions can receive notifications and information about other client sessions. A client session with the appropriate permissions can also manage other client sessions.

Closing client sessions

Required permissions: `view_session`, `modify_session`

A client can close any client session, providing the requesting client knows the session ID of the target client.

Java and Android

```
ClientControl clientControl = session.feature(ClientControl.class);
clientControl.close(sessionID, callback);
```

.NET

```
var _clientControl = session.ClientControl;
_clientControl.Close( sessionID, callback );
```

Related concepts

[Session properties](#) on page 266

A client session has a number of properties associated with it. Properties are key-value pairs. Both the key and the value are case sensitive.

[Session filtering](#) on page 267

Session filters enable you to query the set of connected client sessions on the Diffusion server based on their session properties.

Working with session properties

A client session with the appropriate permissions can view, request, or update the session properties of another client session.

Session properties

Each client session has a number of properties associated with it. Properties are keys and values. Both the key and the value are case sensitive. These session properties can be used by other clients to select sets of client session to perform actions on.

For more information, see [Session properties](#) on page 266.

Receiving notifications of client session events and their session properties

Required permissions: `view_session`

To receive notifications when any client session opens, closes, or is updated, register a listener to listen for these events:

JavaScript

```
// Register a listener for session properties
```

```

session.clients.setSessionPropertiesListener(diffusion.clients.PropertyKeys.ALL_
    .then(function() {

        var listener =
session.clients.getSessionPropertiesListener();
        listener
            .on('onSessionOpen', function(event) {
notification
                // The action to take on a client session open
            })
            .on('onSessionUpdate', function(event) {
notification
                // The action to take on a client session update
            })
            .on('onSessionClose', function(event) {
notification
                // The action to take on a client session close
            });
    }, function(err) {
        console.log('An error has occurred:', err);
    });
}

```

Java and Android

```

ClientControl clientControl = session.feature(ClientControl.class);

clientControl.setSessionPropertiesListener(
    new ClientControl.SessionPropertiesListener.Default() {
        @Override
        public void onSessionOpen(){
notification
            // The action to take on a client session open
        }
        @Override
        public void onSessionEvent(){
notification
            // The action to take on a client session update
        }
        @Override
        public void onSessionClose(){
notification
            // The action to take on a client session close
        }
    },
    // The session properties to receive
    "$Country", "$Department");

```

.NET

```

var _clientControl = session.ClientControlGet;

// Set up a listener to receive notification of all sessions
_clientControl.SetSessionPropertiesListener( propertyListener,
    "$Country", "Department" );

```

C

```

/*
 * Register a session properties listener.
 *
 * Requests all "fixed" properties, i.e. those defined by
 * Diffusion rather than user-defined properties.

```

```

*/
SET_T *required_properties = set_new_string(5);
set_add(required_properties,
        PROPERTIES_SELECTOR_ALL_FIXED_PROPERTIES);

// Set the parameters to callbacks previously defined
SESSION_PROPERTIES_REGISTRATION_PARAMS_T params = {
    .on_registered = on_registered,
    .on_registration_error = on_registration_error,
    .on_session_open = on_session_open,
    .on_session_close = on_session_close,
    .on_session_update = on_session_update,
    .on_session_error = on_session_error,
    .required_properties = required_properties
};
session_properties_listener_register(session, params);

```

When registering this listener, specify which session properties to receive for each client session:

JavaScript

```

// Receive all fixed properties
session.clients.setSessionPropertiesListener(diffusion.clients.PropertyKeys.ALL_
    listener)
    .then(function() {

        });
// OR
// Receive all user-defined properties
session.clients.setSessionPropertiesListener(diffusion.clients.PropertyKeys.ALL_
    listener)
    .then(function() {

        });
// OR
// Receive all properties
session.clients.setSessionPropertiesListener([diffusion.clients.PropertyKeys.ALL_
    diffusion.clients.PropertyKeys.ALL_USER_PROPERTIES], listener)
    .then(function() {

        });

```

Java and Android

```

// Define individual session properties to receive
clientControl.setSessionPropertiesListener(
    new ClientControl.SessionPropertiesListener.Default() {
        // Define callbacks
    },
    "$Country", "$Department");
// OR
// Receive all fixed properties
clientControl.setSessionPropertiesListener(
    new ClientControl.SessionPropertiesListener.Default() {
        // Define callbacks
    },
    Session.ALL_FIXED_PROPERTIES);
// OR
// Receive all user-defined properties
clientControl.setSessionPropertiesListener(
    new ClientControl.SessionPropertiesListener.Default() {
        // Define callbacks
    },
    Session.ALL_USER_PROPERTIES);

```

```
    },  
    Session.ALL_USER_PROPERTIES);
```

.NET

```
// Define individual session properties to receive  
_clientControl.SetSessionPropertiesListener(propertiesListener,  
    "$Country", "Department" );  
// OR  
// Receive all fixed properties  
_clientControl.SetSessionPropertiesListener(propertiesListener,  
    SessionControlConstants.AllFixedProperties );  
// OR  
// Receive all user-defined properties  
_clientControl.SetSessionPropertiesListener(propertiesListener,  
    SessionControlConstants.AllUserProperties );
```

C

```
// Receive all fixed properties  
SET_T *required_properties = set_new_string(5);  
set_add(required_properties,  
    PROPERTIES_SELECTOR_ALL_FIXED_PROPERTIES);  
  
SESSION_PROPERTIES_REGISTRATION_PARAMS_T params = {  
    //Other parameters  
    .required_properties = required_properties  
};  
// OR  
// Receive all user-defined properties  
SET_T *required_properties = set_new_string(5);  
set_add(required_properties,  
    PROPERTIES_SELECTOR_ALL_USER_PROPERTIES);  
  
SESSION_PROPERTIES_REGISTRATION_PARAMS_T params = {  
    //Other parameters  
    .required_properties = required_properties  
};  
// OR  
// Receive all properties  
SET_T *required_properties = set_new_string(5);  
set_add(required_properties,  
    PROPERTIES_SELECTOR_ALL_FIXED_PROPERTIES);  
set_add(required_properties,  
    PROPERTIES_SELECTOR_ALL_USER_PROPERTIES);  
  
SESSION_PROPERTIES_REGISTRATION_PARAMS_T params = {  
    //Other parameters  
    .required_properties = required_properties  
};
```

When the listening client first registers a listener, it receives a notification for every client session that is currently open. When subsequent client sessions open, the listening client receives a notification for those clients.

When the listening client is notified of a session event, it receives the requested session properties as a map of keys and values.

When the listening client is notified of a session closing, it also receives the reason that the session was closed. If the client session becomes disconnected from the Diffusion server, the listener might not receive notification of session close immediately. If reconnection is configured for the client, when the client disconnects, its session goes into reconnecting state for the configured time (the default is 60 seconds) before going into a closed state.

Getting properties of specific client sessions

Required permissions: view_session

A client can make an asynchronous request the session properties of any client session from the Diffusion server, providing the requesting client knows the session ID of the target client.

JavaScript

```
// Get fixed session properties
session.clients.getSessionProperties(sessionID,
diffusion.clients.PropertyKeys.ALL_FIXED_PROPERTIES)
    .then(function{

    });
```

Java and Android

```
// Get fixed session properties
ClientControl clientControl = session.feature(ClientControl.class);
clientControl.getSessionProperties(sessionID,
    Session.ALL_FIXED_PROPERTIES, sessionPropertiesCallback);
```

.NET

```
var _clientControl = session.ClientControl;
_clientControl.GetSessionProperties( sessionID,
    SessionControlConstants.AllFixedProperties, sessionPropertiesCallback
);
```

C

```
GET_SESSION_PROPERTIES_PARAMS_T params = {
    .session_id = session_id,
    .required_properties = properties,
    .on_session_properties = on_session_properties
};

get_session_properties(session, params);
```

Update the properties of specific client sessions

Required permissions: view_session, modify_session

A client session with the appropriate permissions can update the value of existing user-defined session properties or add new user-defined properties for any client session or set of client sessions.

As part of the update session properties request, provide a map of the keys for the session properties you want to update or add and the new values. If you provide a null value for a session property, that property is deleted from the session. A successful update session properties request returns a map of the updated properties and their old values.

Specify a single session to change the user-defined session properties for the session by providing the session ID.

Java and Android

```
// Change the session properties of a single session
ClientControl clientControl = session.feature(ClientControl.class);
final CompletableFuture<Map<String, String>> result =
    clientControl.setSessionProperties(sessionID, map_of_properties);
```

Specify a set of client sessions to change the user-defined session properties for by providing a filter query expression. For more information about filter query expressions, see [Session filtering](#) on page 267.

Java and Android

```
// Change the session properties of set of sessions defined by a
    filter expression
ClientControl clientControl = session.feature(ClientControl.class);
final CompletableFuture<Map<String, String>> result =
    clientControl.setSessionProperties(filter, map_of_properties);
```

Handling client queues

Each client session has a queue on the Diffusion server. Messages to be sent to the client are queued here. You can monitor the state of these queues and set client queue behavior.

Receiving notifications of client queue events

Required permissions: view_session, register_handler

A client can register a handler that is notified when outbound client queues at the Diffusion server reach pre-configured thresholds.

Java and Android

```
ClientControl clientControl = session.feature(ClientControl.class);
clientControl.setQueueEventHandler(
    new ClientControl.QueueEventHandler.Default {

        @Override
        public void onUpperThresholdCrossed(
            final SessionId client,
            final MessageQueuePolicy policy) {

            // The action to perform when the queue upper threshold
            is crossed.
        }

        @Override
        public void onLowerThresholdCrossed(
            final SessionId client,
            final MessageQueuePolicy policy) {

            // The action to perform when the queue lower threshold
            is crossed.
        }
    }
);
```

Handling client queue events

Required permissions: view_session, modify_session

A client can respond to a client queue getting full by setting conflation on for the client. Conflation must be configured at the Diffusion server to have an effect.

A client is also able to set throttling on for specific clients, which also sets conflation. Using throttling without conflation can result in client queues overflowing.

Always use throttling and conflation in conjunction with a well-designed conflation strategy configured at the Diffusion server. For more information, see [Conflation](#) on page 95 and [Configuring conflation](#) on page 429.

Java and Android

```
ClientControl clientControl = session.feature(ClientControl.class);
clientControl.setThrottled(client, MESSAGE_INTERVAL, 1000,
    clientCallback);
```

.NET

```
var clientControl = session.ClientControl();
clientControl.SetThrottled( client, ThrottlerType.MESSAGE_INTERVAL,
    10, theClientCallback );
```

Flow control

A client application rapidly making thousands of calls to the Diffusion server might overflow the internal queues for the client, which results in that client session being closed. Flow control automatically protects against these queues overflowing by progressively delaying messages from the client to the Diffusion server.

Supported platforms: Android, Java, .NET, and C

The flow control mechanism is a feature of the Diffusion client libraries that works automatically to protect the following internal queues for an individual client from overflowing:

- The outbound queue on the client where messages are queued to be sent to the Diffusion server
- The queue on the Diffusion server where responses to service requests are queued.

If these queues overflow, the client session is terminated.

Flow control is intended to benefit those clients that send a lot of data to the Diffusion server – for example, updates to publish to topics. Usually, these clients are those located in the back-end of your solution that perform control functions.

When is flow control enabled?

The client determines whether to enable flow control and the amount of delay to introduce into the client processing based on a calculated value called back pressure. Back pressure is calculated using the following criteria:

- Depth of the outbound client queue
- The number of pending responses to service requests
- Whether the current active thread is a callback thread

Back pressure can have a value between 0.0 and 1.0. 1.0 is the maximum amount of back pressure. The method used to calculate back pressure might be subject to change in future releases.

Flow control introduces sleeps into the client processing. The length of these sleeps depends on the value of the back pressure. The maximum amount of delay introduced into client processing by flow control is 100 ms. The amount of delay introduced by flow control might be subject to change in future releases.

The flow control behavior of a client cannot be configured.

How to tell that flow control is enabled

When flow control is enabled for a Android, Java, or .NET client, the client logs messages at DEBUG level. The client logs each time a delay is introduced. The log message has the following form:

```
2016-09-26 11:15:48,344 DEBUG [PushConnectorPool-thread-18]
c.p.d.f.SleepingFlowControl(apply) - pressure=1.0 => sleep for 100
ms
```

The log message includes the current back pressure and the length of delay introduced.

The C client does not log its flow control behavior.

Actions to take

Diffusion clients can occasionally become flow controlled in response to very heavy load or unusual network conditions. However, if your clients are constantly being flow controlled, your Diffusion solution might not be correctly configured for the traffic load.

Consider taking the following actions:

- In your client design, ensure that if you have many requests to make to the Diffusion server that these requests are made from an application thread instead of a callback thread. Less flow control is applied when the active thread is a callback thread. For more information, see [Best practice for developing clients](#) on page 154.
- Ensure that your Diffusion server can handle the incoming messages from the clients. The default memory configuration might be causing the JVM running the Diffusion server to spend a lot of time in GC. For more information about tuning your JVM, see [Memory considerations](#).
- Increase the maximum queue size on the connector your client uses. This can be configured for individual connectors in the `Connectors.xml` configuration file or as a default value for all connectors in the `Server.xml` configuration file. For more information, see [and](#) .

Configuring conflation

Use the `CONFLATION` topic property to select a conflation policy for a topic.

Conflation settings

Conflation is configured through several settings.

Conflation can be enabled or disabled on a per session basis using the `setConflated` API call. The default value for this is set using the `conflates` value in the `queue-definition` section of `Server.xml`. In Diffusion 6.1, this is set to `true` for a fresh installation.

You can specify the conflation policy for each topic when it is created, using the `CONFLATION` topic property. The default policy is "conflate" (see below).

As a result, for non-deprecated topics, the "conflate" policy will be applied by default.

Conflation policies

Use the `CONFLATION` topic property to set a topic's conflation policy using one of the following values.

Table 33: Conflation topic properties

Property	Description
conflate (default)	Only conflate topics when a session with a full queue receives a new message.
always	An 'eager' policy that conflates updates as they arrive. If enabled, the queue will only ever contain one update.
off	Disable conflation for this topic. Sessions receive every update.
unsubscribe	When a session with a full queue receives a new message, unsubscribe the session with unsubscribe reason <code>BACK_PRESSURE</code> .

For the deprecated single value, record and stateless topic types, if you set "always" or "conflate", the legacy conflation system described in [Configuring legacy conflation](#) on page 496 is applied instead. If you set "off", the legacy conflation system will not be used. If you set "unsubscribe", the legacy conflation system will be used, and the "unsubscribe" policy will be applied when a session with a full queue receives a new message.

Logging from the client

Ensuring that your Diffusion client logs messages to inform of events and errors can be a valuable tool in developing and maintaining your clients.

Logging in JavaScript

The JavaScript client library logs messages to the console.

Log levels

Events are logged at different levels of severity. The log levels, ordered from most severe to least severe, are as follows:

Table 34: Log levels

Level	Description
error	Events that indicate a failure.
warn	Events that indicate a problem with operation.
info	Significant events.
debug	Verbose logging. Not usually enabled for production.
trace	High-volume logging of interest only to Push Technology Support. Push Technology Support may occasionally ask you to enable this log level to diagnose issues.

Configuring logging in the JavaScript client

You can use the JavaScript API to enable and configure logging at runtime.

```
diffusion.log( level )
```

To disable logging at runtime, set the level to `silent`.

```
diffusion.log( 'silent' )
```

Note: Do not enable logging in your production clients. Use logging only during development of your clients.

Logging in Apple

The Apple client logs messages to the Apple system log facility.

Log levels

Events are logged at different levels of severity. The log levels, ordered from most severe to least severe, are as follows:

Table 35: Log levels

Level	Description
ERROR	Events that indicate a failure.
WARN	Events that indicate a problem with operation.
INFO	Significant events.
DEBUG	Verbose logging. Not usually enabled for production.
TRACE	High-volume logging of interest only to Push Technology Support. Push Technology Support may occasionally ask you to enable this log level to diagnose issues.

Configuring logging in the Apple client

You can use the Apple API to enable and configure logging at runtime.

```
PTDiffusionLogging *const l = [PTDiffusionLogging logging];  
  
// Enable logging in the client library  
l.enabled = YES;  
  
// Change the level that the client logs at  
l.level = [PTDiffusionLoggingLevel trace];
```

Note: Do not enable logging in your production clients. Use logging only during development of your clients.

Logging in Android

The Android client uses `slf4j-android-logger` to log messages to the Android logging system.

Log levels

Events are logged at different levels of severity. The log levels, ordered from most severe to least severe, are as follows:

Table 36: Log levels

Level	Description
ERROR	Events that indicate a failure.
WARN	Events that indicate a problem with operation.
INFO	Significant events.
DEBUG	Verbose logging. Not usually enabled for production.
TRACE	High-volume logging of interest only to Push Technology Support. Push Technology Support may occasionally ask you to enable this log level to diagnose issues.

Configuring logging in the Android client

The Android JAR, `diffusion-android-x.x.x.jar`, contains a properties file, `logger.properties`. Edit this properties file to configure logging in the Diffusion Android client.

The default `logger.properties` file contains the following properties:

```
de.psdev.slf4j.android.logger.logTag=DiffusionAndroidClient
de.psdev.slf4j.android.logger.defaultLogLevel=INFO
```

For more information about `slf4j-android-logger`, see <https://github.com/PSDev/slf4j-android-logger>

Logging in Java

The Java client uses SLF4J to log messages. Provide a bindings library to implement the SLF4J API and log out the messages.

Log levels

Events are logged at different levels of severity. The log levels, ordered from most severe to least severe, are as follows:

Table 37: Log levels

Level	Description
ERROR	Events that indicate a failure.
WARN	Events that indicate a problem with operation.
INFO	Significant events.
DEBUG	Verbose logging. Not usually enabled for production.

Level	Description
TRACE	High-volume logging of interest only to Push Technology Support. Push Technology Support may occasionally ask you to enable this log level to diagnose issues.

Configuring logging in the Java client

The Java JAR, `diffusion-client-x.x.x.jar`, uses the SLF4J API to log messages. It does not include an implementation that outputs the log messages.

Many SLF4J implementations are available.

1. Choose your preferred SLF4J implementation.
2. Ensure that the bindings JAR is on the classpath of your Java client.
3. Configure the SLF4J implementation to provide the logging behavior you require.

Log4j2

Log4j2 is a third-party SLF4J implementation provided by the Apache Software Foundation. For more information, see <http://logging.apache.org/log4j/2.x/>.

You can configure your Java clients to use log4j2 by completing the following steps:

1. Get the log4j2 bindings libraries.

The JAR files can be downloaded from <https://logging.apache.org/log4j/2.0/download.html>.

The log4j2 JAR files are also located in the `lib/thirdparty` directory of the Diffusion installation.

2. Ensure that the `log4j-api.jar` and `log4j-core.jar` files are on the client classpath.
3. Create a configuration file and ensure that is present on the client classpath.

The following example `log4j2.xml` file outputs the log messages to a rolling set of files:

```
<Configuration status="warn" name="DiffusionClient">
  <Properties>
    <Property name="my.log.dir">../logs</Property>

    <!-- The log directory can be overridden using the
    system property 'my.log.dir'. -->
    <Property name="log.dir">${sd:my.log.dir}</Property>

    <Property name="pattern">%date{yyyy-MM-dd HH:mm:ss.SSS} |
%level | %thread | %marker | %replace{%msg}{\|}{ } | %logger%n%xEx
    </Property>
  </Properties>

  <Appenders>

    <RollingRandomAccessFile name="file" immediateFlush="false"
    fileName="${log.dir}/client.log"
    filePattern="${log.dir}/${date:yyyy-MM}/client-%d{MM-
dd-yyyy}-%i.log.gz">

      <PatternLayout pattern="${pattern}" />

    <Policies>
      <OnStartupTriggeringPolicy />
      <TimeBasedTriggeringPolicy />
      <SizeBasedTriggeringPolicy size="250 MB" />
    </Policies>
  </RollingRandomAccessFile>
</Appenders>
</Configuration>
```

```
        </Policies>

        <DefaultRolloverStrategy max="20" />
    </RollingRandomAccessFile>
</Appenders>

<Loggers>
    <AsyncRoot level="info" includeLocation="false">
        <AppenderRef ref="file" />
    </AsyncRoot>
</Loggers>
</Configuration>
```

For more information about configuring log4j2, see <https://logging.apache.org/log4j/2.0/manual/configuration.html>.

Logging in .NET

The .NET API produces logging information. The logging facility uses NLog.

NLog is included in the .NET client assembly. For more information about logging with NLog, see <https://github.com/NLog/NLog/wiki/>.

Logging basics

The NLog `Logger` class acts as the source of the log messages. In general, use one logger per class and pass in the name of the class as the logger name.

To log a message at a certain level use the write methods provided by the `Logger` class.

The following log levels are provided:

- Fatal
- Error
- Warn
- Info
- Debug
- Trace

These levels are listed in order from most severe to least severe.

Configuring the log output

You must configure NLog to output the log messages produced by your application to a target or targets. NLog provides a large number of targets for your output, including File and Console. NLog also enables you to create your own targets.

In addition to specifying targets for the log output, use NLog configuration to define rules that specify to which target log messages with particular levels or logger names are directed.

You can configure NLog in the following ways:

- Using a configuration file, `NLog.config`, that is located in the same directory as your client application.

For more information, see <https://github.com/NLog/NLog/wiki/Configuration-file>.

- Using the Configuration API to configure NLog in your application code.

For more information, see <https://github.com/NLog/NLog/wiki/Configuration-API>.

Logging in C

The C API provides no integrated logging feature. You can log out from your client code using your preferred method or framework.

Developing a publisher

You can develop a publisher in Java by using the Publisher API.

Note: We recommend using a client to create and publish to topics, instead of a publisher.

Publisher basics

A publisher is a user-defined object deployed within a Diffusion server which provides one or more topics on which it publishes messages to clients.

There can be one or more publishers deployed with a Diffusion server.

Clients connect to the server and subscribe to topics. Messages relate to topics and when a publisher publishes a message it is broadcast to all clients that are currently subscribed to the message topic. A publisher can also send messages to individual clients and receive messages sent from clients. Clients can request (fetch) topic state, even when not subscribed.

A publisher must be written by the user in Java (utilizing the publisher API) and deployed within the server. This is done by extending a supplied publisher class and implementing methods as required. Implement the methods relating to the functionality that you require. For more information, see [Writing a publisher](#) on page 442.

Defining publishers

How to define publishers that start with Diffusion.

The Diffusion server is able to start the publishers defined in the `etc/Publishers.xml` file when the server starts. The XML file can contain any number of publishers. Each publisher must have at least a name and a class. The class must implement the publisher by extending the `Publisher` class. For more information, see [Creating a Publisher class](#) on page 443.

```
<publishers>
  <publisher name="Publisher">
    <class>com.example.Publisher</class>
  </publisher>
  ...
</publishers>
```

The name must be unique on the server, and the class must exist on the classpath of the Diffusion server (For more information, see [Classic deployment](#) on page 753). This is sufficient for the publisher to start when Diffusion does. There are other options, including those that can prevent the publisher from starting.

When the `enabled` element is `false`, the publisher class is not loaded. If the `start` element is `false`, the publisher is not started when the server starts.

You can define properties in the `etc/Publishers.xml` that can be accessed from the publisher. For more information, see .

The full configuration file options can be found in the XSD document for the `etc/Publishers.xml` or in .

Loading publisher code

This describes how to load publisher classes or code it is dependent upon.

When you write a publisher class (or any other classes it uses), you can deploy them in any folder as long as it is specified in the configuration (`usr-lib` in `etc/Server.xml`). JAR files can also be deployed in user libraries and any other software libraries that the publisher requires can be specified in this way.

Also, when Diffusion starts, the `data` directory is on the class path. The `ext` folder, and its sub-directories are scanned for jar files and class loaded. This means that you can easily add new jars to the Diffusion runtime, without having to edit the startup scripts.

Take care when creating backup jars in the `ext` folder as anything that ends in `.jar` is class loaded.

Related tasks

[Building a publisher with mvndar](#) on page 469

Use the Maven plugin `mvndar` to build and deploy your publisher DAR file. This plugin is available from the Push Public Maven Repository.

Load publishers by using the API

You can configure and load custom publishers using the Diffusion API at any point in the Diffusion server's lifecycle.

Similarly to loading publishers using configuration files, each publisher must have at least a name and a class. The class must implement the publisher by extending the `Publisher` class. For more information, see [Creating a Publisher class](#) on page 443.

```
PublisherConfig config =
    ConfigurationManager.getServerConfig().addPublisher("MyPublisher",
        "com.acme.foo.MyPublisher");
Publisher publisher = Publishers.loadPublisher(config);
```

The name must be unique on the server, and the class must exist on the classpath of the Diffusion server. For more information, see [Classic deployment](#) on page 753. By default the `autostart` property is enabled on the `PublisherConfig`, so the publisher starts once it is loaded. If this option is disabled, you can load a publisher and retain a reference to it, to start at a later point in time.

If the default configuration options are suitable for your requirements (as detailed within the API docs for `com.pushtechnology.diffusion.api.config.PublisherConfig`) there are several convenience methods that can be used to load a given publisher and get a reference to it without the need for construction a specific `PublisherConfig` instance.

```
// Create Publisher with classname
Publisher publisher = Publishers.createPublisher("MyPublisher",
    "com.acme.foo.MyPublisher");

// Create Publisher with Class
Publisher publisher = Publishers.createPublisher("MyPublisher",
    MyPublisher.class);
```

You can load a default publisher instance. This facilitates programmatic access any features exposed through the publisher abstract class that do not require method overriding.

```
Publisher publisher =
    Publishers.createPublisher("MyDefaultPublisher");
```

Starting and stopping publishers

Typically publishers are started when the server starts but you can prevent such automatic start up and allow publishers to be started using System Management.

Publishers can also be stopped and restarted using System Management functions and are automatically stopped and removed when the server closes.

In order for a publisher to function properly on being stopped and restarted from System Management it must be able to cater for the integrity of its data and client connections. For this reason a publisher cannot be stopped by default and must override the `isStoppable` method to enable this functionality.

Publisher startup steps

When a publisher is started it goes through its initial processing in the order shown below:

Table 38: Start publisher

Add initial topics	Initial topics configured for the publisher are added.
<code>initialLoad</code>	The <code>initialLoad</code> notification method is called. This can be used to perform any initial processing required for the publisher. Topics can be added here. Other aspects of the publisher, such as topic loaders and client listeners can also be set up here. If an exception is thrown by this method, the publisher fails to start.
STARTED	At this point the publisher is considered to have started.
<code>publisherStarted</code>	The <code>publisherStarted</code> notification method is called.

Publisher closedown steps

When a publisher is stopped, either during server closedown or by System Management it goes through the following steps:

Table 39: Stop publisher

<code>publisherStopping</code>	The <code>publisherStopping</code> notification method is called to allow the publisher to perform any preliminary close processing.
Remove topics	All topics owned by the publisher are removed.
STOPPED	At this point the publisher is considered to be stopped.
<code>publisherStopped</code>	The <code>publisherStopped</code> notification method is called.
Client events Stopped	Client event notifications are stopped.

Publisher removal

A publisher is removed after it is stopped during server closedown but you can also remove a stopped publisher at any time using System Management. Once removed a publisher cannot be restarted again until the server is restarted.

In either case, after removal the `publisherRemoved` notification method is called.

Publisher topics

Topics are the mechanism by which publishers provide data to clients.

Each publisher can provide one or more topics but each topic must be unique by name within the server. Topics are hierarchical in nature and so topics can be parents of topics and a tree of topics can be set up. Using hierarchies allows clients to subscribe to branches of the hierarchy rather than having to subscribe to individual topics. Only the owner of a topic can create new topics below it in the hierarchy.

Adding topics

In the simplest case a publisher can name the topics it provides within its configuration. In this case such topics are automatically added as the publisher is started. These topics can be obtained from within the publisher using the `getInitialTopicSet` method.

More typically a publisher adds the topics it requires itself as it starts up. A Publisher can choose to add some topics at start up and others later. Topics can be added at any time using the publisher's `addTopic` or `addTopics` method. They can be added only if they are added by the owner of the parent topic.

A topic can be a simple topic where all of the handling of the topic state is provided by the publisher. Alternatively a topic can be created with topic data which handles the state of the topic automatically.

As soon as a topic has been added clients can subscribe to it.

Loading topics

Simple topic processing involves sending all of the data that defines a topic (the topic load) to a client when they first subscribe and then subsequently sending deltas (or changes to the data). There are two mechanisms for performing the topic load:

Send on subscribe

When the publisher is notified of subscription it creates, populates and sends a topic load message to the client.

Topic loaders

Define a topic loader for the topic which is automatically called to perform the topic loading when a client subscribes.

If a topic has topic data, the current state is automatically provided to a client when they subscribe.

Subscribing clients to topics

Clients normally request subscription to a topic and if the topic exists the clients become subscribed to it at that point.

A client can subscribe to a topic that does not exist at that time – this is called pre-emptive subscription. When the publisher creates a topic, any clients that have pre-emptively subscribed to a topic are subscribed to that topic automatically.

A publisher can also force all currently connected clients to become subscribed to a topic by calling `subscribeClients` with `force=true`.

Subscribing clients to topics that they were already subscribed to causes the topic load to be performed again.

A publisher can also cause individual clients to be subscribed to a topic using the client's `subscribe` method or unsubscribed using the `unsubscribe` method.

Providing topic state

A publisher can provide state on request for stateless topics. Implement the publisher method `fetchForClient` to respond to fetch requests that clients make to stateless topics. Stateful topics return values to fetch requests automatically.

Handling topics that do not exist

A topic is an entity that notionally has state but in some circumstances a client might request access to a topic that does not exist. Client notifications provide a mechanism whereby this situation can be handled.

Where a client attempts to subscribe to a topic that does not exist, a `clientSubscriptionInvalid` notification occurs which gives the publisher the opportunity to dynamically create the topic (and subscribe the client to it) if that is what is required.

Where a client attempts to fetch the state of a topic that does not exist, a `clientFetchInvalid` notification occurs which gives the publisher the opportunity to return a response to the fetch request (using `sendFetchReply`) even if the topic does not exist. This can provide an efficient request/response mechanism without the overhead of actually creating topics.

Removing topics

A publisher can also remove topics at any time using its `removeTopic` or `removeTopics` methods. Removing a topic causes all clients that are subscribed to it to be unsubscribed.

Receiving and maintaining data

A publisher can obtain the data it is to publish and transform that data in any way that is appropriate.

The publisher maintains the state of its own data by updating it whenever any changes are received so that as a new client subscribes it can be sent the latest state of the data as a whole. As such changes are received they are also published as deltas to all currently subscribed clients.

Receiving messages from a remote service

Remote service can also provided a data feed into a publisher. The remote service can publish to topics and the updates are applied to the topics and passed onto subscribed clients.

Publishing and sending messages

Publishing messages to clients and sending messages to clients

Creating messages

Messages can be created using the factory methods on the publisher or on a topic for creating messages (called `createLoadMessage` and `createDeltaMessage`).

If within a class that does not have a direct reference to the publisher or topic objects, the equivalent static methods in the `Publishers` class can be used. Messages can be populated with data using the many variants of the `put` method.

Publishing messages

Messages (whether load or delta) can be sent to all clients that are subscribed to the message topic. For stateless topics, use `Topic.publishMessage()`. For stateful topics (those with topic data), use `PublishingTopicData.publishMessage()`.

Exclusive publishing

You might want to publish a message to all but a particular client. For example, a message can be sent to the publisher from a client and the publisher can, publish the message to all of the other subscribed clients.

This is done using the publisher's `publishExclusiveMessage` method.

Sending messages to individual clients

To send a message to an individual client the `Client.send` method can be used.

Publisher notifications

A publisher is notified of certain events by certain methods on it being called. These methods can be overridden by the user to perform processing at these points as required.

By default these methods (other than those indicated) perform no processing. You do not have to override any of these methods unless you choose to. The notification methods are:

Table 40: Notification methods

<code>initialLoad</code>	Called when the publisher is first loaded. Is typically overridden to perform any initial processing required to prepare the publisher.
<code>publisherStarted</code>	Called after <code>initialLoad</code> (see startup steps).
<code>subscription</code>	Called when a client subscribes to a topic that the publisher owns. References to the topic and the client are passed and also a flag to indicate if the topic has already been loaded by a <code>TopicLoader</code> . If the topic has not been loaded already, typically a publisher sends an initial load message to the client at this point. It might not be necessary to override this method if topic loaders are in use.
<code>unsubscription</code>	Called when a client unsubscribes from a topic that the publisher owns.
<code>messageFromClient</code>	Called when a message is received from a client. References to the message and the client are passed.
<code>messageFromServer</code>	Called when a message is received from a server connection. References to the message and the server connection are passed.
<code>fetchForClient</code>	Called when a client requests a fetch of the topic state for stateless topics.
<code>messageNotAcknowledged</code>	DEPRECATED: acknowledgements have been removed and this method will not be called.
<code>publisherStopping</code>	This is called when the publisher has been requested to stop. It gives the publisher the opportunity to tidily perform any close processing.

<code>publisherStopped</code>	This is called after a publisher has stopped. The publisher can still be restarted (but only if <code>isStoppable</code> is true).
<code>publisherRemoved</code>	This is called when a publisher is removed and provides the opportunity for final tidy up. The publisher cannot be restarted after this is called.
<code>systemStarted</code>	This is called when the Diffusion system has completed loading and is ready to accept connections. Publishers are started before connectors, so this notification is used all Diffusion sub systems are loaded.

Publisher notification threads

To understand issues of concurrency when writing a publisher it is necessary to understand in which threads the various publisher notifications occur.

When a message or request is received from a client connection, the inbound thread pool is used to process it. Depending upon the number of threads in the pool this can mean that the publisher can receive such notifications concurrently.

Other notifications come from various control threads.

All of the above considerations mean that concurrency must always be taken into account in publisher code and it must be made thread safe as appropriate.

Client handling

A publisher can receive notifications about and perform actions on individual clients.

Closing/Aborting clients

A publisher can close a client at any time using the `close` method. This disconnects the client which might choose to subsequently reconnect.

Alternatively a publisher can use the `abort` method, which sends an abort notification to the client before disconnecting it. A client receiving an abort notification must not attempt to reconnect.

Client notifications

A publisher can choose to receive additional client notifications so that it can be informed when clients connect, disconnect etc.

Client pings

A client ping message is one that can be sent to a client which reflects it back to the server to measure latency. A publisher can send a ping message to a client using the `Client.ping` method and receives a response on the `ClientListener.clientPingResponse` method within which the message passed can be queried to establish the round trip time.

Client message filtering

You can filter the messages that get queued for any particular client. For more information, see .

Publisher properties

Properties for a publisher are defined in the `etc/Publishers.xml` configuration file.

As well as the standard properties a publisher can have user-defined properties. These properties can be read using convenience methods available on the publisher (for example, `getProperty`, `getIntegerProperty` etc).

Using concurrent threads

Often within a publisher you might have to initiate some processing in a separate thread so that the publisher itself is not blocked.

For example, a thread can be used to poll data from some data source.

Diffusion provides a mechanism for easily managing concurrent processing using the threads API.

Publisher logging

Every publisher is assigned its own `Logger` which can be used within the publisher itself for logging diagnostic messages.

This `Logger` is obtained using the `getLogger` method.

The log level of the publisher can be changed dynamically at any time using the `setLogLevel` method.

General utilities

General purpose utilities that can be used from within a publisher

There are a number of general purpose utilities available which can aid in the process of writing a publisher, for example:

Table 41: General publisher utilities

Utils	A set of general purpose utilities which include file handling, property handling, date and time formatting and more.
XMLUtils	A set of utilities to aid in the processing of XML.
HTTPUtils	A set of utilities to aid in HTTP processing.

Writing a publisher

How to approach writing a publisher

Note: This section covers only the main aspects of the publisher API. See the API documentation for full details.

There are demo publishers issued with Diffusion which have the source provided and these act as examples of working publishers.

In its simplest sense a publisher is responsible for providing topics, and publishing messages relating to those topics.

Before a publisher is written you need to carefully consider what it needs to do and what methods need to be implemented. The areas that need to be considered and the methods relating to them are discussed in the following sections.

Related concepts

[Classic deployment](#) on page 753

Installing publishers into a stopped Diffusion instance.

Creating a Publisher class

A publisher is written by extending the abstract `Publisher` class (see [Publisher API](#)) and overriding any methods that must be implemented to achieve the functionality required by the publisher.

In all but the simplest of publishers it is likely that other classes must be written to perform the functionality required of the publisher.

The considerations of which methods must be overridden are discussed further within this section.

After the class is written and compiled, you can deploy it in the Diffusion server by specifying its details in `etc/Publishers.xml`

Publishers can also be deployed as a DAR file, sidestepping `etc/Publishers.xml`

See the section on testing for information about how to test the publisher.

Related tasks

[Building a publisher with mvndar](#) on page 469

Use the Maven plugin `mvndar` to build and deploy your publisher DAR file. This plugin is available from the Push Public Maven Repository.

Publisher startup

When a publisher is first loaded by the Diffusion server it can also be automatically started.

If not automatically started (or if it has been manually stopped), a publisher can be manually started by using the System Management interface. In either case the publisher processing goes through a number of startup steps. During these steps the `initialLoad` and `publisherStarted` methods are called and these methods can be implemented by the publisher to perform any initial processing like setting up the initial data state or adding initial topics.

Data state

A publisher typically holds some data on topics which it updates according to any data update events it might receive.

The data held by the publisher on the topics it provides is referred to as its state. It is up to the publisher whether the data state is managed as a whole or on topic by topic basis.

It is the responsibility of the publisher to initialize its state and keep it updated as appropriate. Clients that subscribe to topics usually want to know the current state of the data relating to that topic and the publisher provides this as an initial topic load message. Clients are notified of all changes to that state by the publisher sending out delta messages.

A publisher typically has its own data model represented by classes written to support the data for the publisher. Ways in which such a data model can be managed are discussed in [Designing your data model](#) on page 47.

Initial state

A publisher's data typically has some initial state which can be updated during the life of the publisher. The state clearly must be set up before a client requires it but exactly when this is done is up to the publisher.

The state of the data as a whole can be set up when the publisher starts. This can be done in the `initialLoad` method where all topics required can be set up and the data loaded as appropriate.

Alternatively, the state of the data relating to a topic can be initialized when the topic is added, which is not necessarily when the publisher is started.

Another option is that the initial state is provided by a data feed as it connects (or is connected to). If data is provided by a server connection, the initial state can be set up when the server connection is notified to the publisher or more typically the server provides an initial topic load message.

Data integrity

The integrity of the data is also the responsibility of the publisher and care must be taken to ensure that all updating of data state is thread-safe. For example, it must be borne in mind that a client can request a load of current state (for example, by subscription) at the same time as the state is being updated.

Note: The topic data feature automatically handles such data locking and in other cases topics might be locked as and when required.

Providing data state

If clients are to use the fetch facility to obtain the current state of topics, it will be necessary to consider the implementation of the `fetchForClient` method of the publisher.

Stateful and stateless topics

The topics that the publisher provides can store data state, but not all topics store data state. Topics that store data state are called *stateful topics*. Topics that do not store data state are called *stateless topics*.

The publisher has different mechanisms for publishing data through stateful or stateless topics. For more information, see [Publishing messages](#) on page 446.

Data inputs

For a publisher to be able to publish data to clients it must have a source for that data.

The data can be obtained from some type of feed, perhaps provided by some external API or it can be from some other application communicating using Diffusion protocols. This is entirely up to the publisher but Diffusion does offer some mechanisms.

Control clients

A publisher can receive input from a control client.

Control clients can use the `TopicUpdateControl` feature to publish messages to topics. Where such topics have topic data the topic state is automatically updated and deltas are published to subscribed clients. Where topics do not have topic data, published messages are forwarded to subscribed clients (that is, it is assumed that the control client maintains the data state).

Control clients can also send messages to specific clients and these are forwarded to the clients automatically.

Handling client subscriptions

Clients subscribe to topics provided by publishers and whenever this occurs the publisher is notified through its subscription method. The publisher can perform any processing it requires on subscription.

Performance considerations

Any queries about subscriptions are expensive on resources and time, because these queries are synchronous and blocking. For example, querying whether a client is subscribed to a topic, what clients are subscribed to a specific topic, or what topic a specific client subscribes to.

If your publishers respond to add topic notifications or subscription notifications, ensure that these responses are efficient. These publisher actions are now serialized in a single thread and as a result the publisher can become a bottleneck and hold up processing.

Using topic data

Where a topic is inherently stateful and has associated data, the use of topic data is recommended. Topic data automatically handles topic loading.

Topic loading

Typically, on subscription, the publisher provides the client with the current state of the data for the topic. It can do this by creating a new topic load message and populating it with a representation of the state. Rather than doing this every time a client subscribes it is generally more efficient for the publisher to create a topic load message only when the state changes and send this same message out to every client that subscribes.

This provision of the current state is known as the topic load. This can be done in one of the following ways:

Topic load in subscription method

If the topic has not already been loaded by a topic loader (see below), the loaded parameter of the subscription method is false. In this case, the normal action is for the publisher to send a topic load message to the client (passed as a parameter to subscription) through its send method.

Topic loaders

A topic loader is an object that implements the `TopicLoader` interface and can be used to perform any topic load processing that is required for one or more topics. Topic loaders can be declared for a `Publisher` using the `Publisher.addTopicLoader` method. This is typically done in the `initialLoad` processing and must be done before any topics that are loaded by the topic loader are added.

Hierarchic subscription

When a client subscribes to a topic the publisher can choose to subscribe the client to other topics or to subordinate topics. This can be done using the `Client.subscribe` methods.

A client itself can request subscription to a hierarchy of topics using topic selectors but this is an alternative method of handling hierarchies.

Publishing messages

Publishing a message means sending it to all clients subscribed to a topic. The message itself nominates the topic to which it relates.

A message for publishing can be created and populated by the publisher and then published using publishing methods on the topic or the publisher itself.

Exclusive messages

To send a message from a publisher to all clients subscribed to a topic except one single client, it can use the `publishExclusiveMessage` method. This might be appropriate if the message being published is a result of receiving a message from a client which you do not want to send back to that client.

Message priority

The priority at which a message is to be sent can be altered from the normal priority. For example, an urgent message can be sent with high priority causing it to go to the front of the client's queue.

DEPRECATED: Message acknowledgment

Note: Acknowledgements have been removed from the product. The Publisher API methods and configuration that control acknowledgements now have no effect and are deprecated.

Publishing using stateful topics

Stateful topics are topics that store a current value in the Diffusion server. You can publish using stateful topics in a simple way or as part of a more complex transactional update.

This section covers working with topics that have associated topic data that extends the `PublishingTopicData` interface.

Simple updates to a stateful topic

Use the `updateAndPublish` or `updateAndPublishFromDelta` method on the topic data of a stateful topic to update the topic state. Updating the topic data of a stateful topic publishes a delta to all subscribed client that includes the changes to the topic data.

```
topic.getData().updateAndPublish(update);  
// OR  
topic.getData().updateAndPublishFromDelta(deltaUpdate);
```

Transactional updates to a stateful topic

Stateful topics can be updated transactionally by bracketing the updates with the `startUpdate` and `endUpdate` methods of the associated topic data.

Combining updates to the topic data as part of a single transaction can be useful when the stateful topic is a record topic that has multiple records and fields that can be updated from separate sources. These fields can be updated separately within the transaction, but all updates in the topic state are published to the subscribing clients at the same time.

```
// Start the transaction  
data.startUpdate();  
try {  
    // Make multiple updates as part of a single transaction  
    data.update(firstUpdate);  
    data.update(secondUpdate);  
    data.update(thirdUpdate);  
    data.update(fourthUpdate);  
    data.update(fifthUpdate);  
}
```

```

        // Publish the updates that have been made in this transaction
        if (data.hasChanges()){
            data.publishMessage(data.generateDeltaMessage());
        }
    }
    finally {
        // Complete the transaction
        data.endUpdate()
    }
}

```

Publishing using stateless topics

Stateless topics are topics that have no associated current value in the Diffusion server. You can publish using a stateless topic in a simple way or as part of a complex action triggered by a client subscription to that topic.

Stateless topics have no associated topic data. These topics simply pass through any updates that are made to them to the subscribing clients.

Simple updates using a stateless topic

Use the `publishMessage` method on the topic to publish data using the stateless topic at any time. This data is not stored on the Diffusion server and is sent as-is to all current subscribers to the stateless topic.

```
topic.publishMessage(data);
```

On-subscription updates using a stateless topic

Stateless topics pass through data from the publisher to the subscribing clients. This published data can be a full update or a delta on previous updates. If a client subscribes to a stateless topic after a full update and before a delta, the client receives the delta, but does not have the base data to apply it to.

To ensure that a newly subscribing client receives a full update for that topic, the publisher `subscription` method — which is called every time a client subscribes to a topic managed by the publisher — can publish an update that contains all the data required by the subscriber to that topic. This data is not published until the client subscription to the topic is complete.

Using the `subscription` method can cause performance issues. For more information, see [Handling client subscriptions](#) on page 445.

To publish a message to the topic whenever a client subscribes to the topic, override the `Publisher.subscription()` method in your own publisher class and include in the method a call to `topic.publishMessage()` that passes in all the data to publish.

```

@Override
protected void subscription(final Client client, final Topic
    topic, final boolean loaded)
    throws APIException {

    // Do the required processing to create the full update
    message to
    // publish for the newly subscribed client.

    // Publish that message to the stateless topic
    topic.publishMessage(data);
}

```

Handling clients

Interacting with clients from within a publisher

A publisher is notified when a client subscribes to one of its topics through the `subscription` method and when the client unsubscribes the `unsubscription` method is called.

A publisher can receive message from clients and send messages to clients (see below).

A client can request the state of any topic or topics at any time even if not subscribed to it. This is referred to as 'fetch' request. Such a request can routed to the publisher's `fetchForClient` method if a topic has no topic data.

Other than the above, a publisher is not normally notified of any other client activity. However a publisher can choose to receive client notifications using the `Publishers.addEventListener` method. Using client notifications, a publisher can even handle a fetch request for a topic that does not exist and return a reply (using `Client.sendFetchReply`) without the overhead of actually creating a topic.

A publisher can also choose to close or abort clients.

Sending and receiving client messages

In addition to publishing messages to all clients subscribed to a topic, you can send a message to only a single client using the `Client.send` method.

A client can also send messages to the publisher and these are received on the `messageFromClient` method which handles them accordingly. Only implement this method if messages are expected from clients. Alternatively the publisher specifies topic listeners to handle the messages on a per topic basis.

The message is mapped to a delta `TopicMessage`.

Publisher closedown

A publisher is stopped and removed when the Diffusion server closes but can also be stopped and restarted, or stopped and removed by using the System Management interface.

However a publisher is stopped it always goes through a set of closedown steps, during which the `publisherStopping` and `publisherStopped` methods are called. A publisher can implement these methods if required to perform any special processing such as tidying up resources used.

Publisher removal

When a publisher is finally removed (either during server closedown or by using System Management), it cannot be restarted again within the same server instance. After removal the `publisherRemoved` method is called and this gives the publisher the opportunity to perform any final tidy up processing.

Stopping and restarting using System Management

By default, you cannot stop and restart a publisher using the System Management functions because in order for this to work the publisher must cater for the integrity of its state when this happens. As topics are also removed during stopping, the publisher must also be able to restore these topics if it were restarted.

If a publisher does want to cater for stop and restart using System Management, it must override the `isStoppable` method to return true. The publisher code must be able to recover topics and data state on restart.

Testing a publisher

There are various ways you can test your publishers after you have written them and deployed them on a Diffusion server instance.

The easiest way to perform some initial tests is to start it and try it out using some of the supplied testing tools. For example, use the JavaScript test tool provided from the landing page (<http://localhost:8080>), connect each to the test server and subscribe to the publisher's topic or topics. The initial topic load data is displayed and any messages sent as deltas are also displayed in each client. This tool can also be used to send messages to the publisher from the client.

Test as soon as possible with the actual clients that are going to be used. So, for example, you might want to develop browser clients.

It can help to diagnose problems with the publisher if it has diagnostic logging encoded within it. Such logging can be provided only at fine level and this logging level used only during testing.

Client queues

How messages sent to clients are queued and how such queues can be manipulated by publishers

The Diffusion server maintains an outbound queue of messages for each client. Whenever a message is published to a topic, it is placed in the queue of each client subscribed to that topic as will any message sent explicitly to the client. Messages are sent to the client strictly in the order that they are queued.

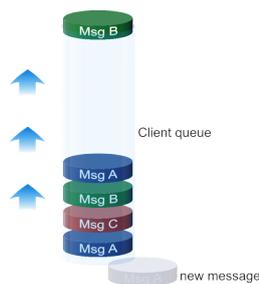


Figure 24: The message queue

A publisher is able to enquire upon the details of a particular client's queue and even to change some aspects of the queue's behavior.

Queue enquiries

How the publisher can access details of client queues

A publisher can enquire upon the following information about a particular client's queue using the client interface:

- The current queue size
- The maximum queue size (The limit the queue can reach before the client is automatically disconnected.)
- The largest queue size (The largest size the client queue has been since the client connected.)

Maximum queue depth

To limit the backlog of messages queued for a client that is not consuming them quickly enough you can indicate a maximum queue depth for clients.

Choose this size carefully as a large queue size can lead to excessive memory usage and vulnerability to Denial of Service attacks, whilst a small queue size can lead to slow clients being disconnected too frequently.

The maximum queue depth for clients can be configured for a client connector in `etc/Connectors.xml`. A default value can also be configured in `etc/Server.xml` for connectors that do not explicitly specify a value.

These values can be changed dynamically at run time using System Management but they only take effect for new clients.

Queue notification thresholds

A publisher can receive notifications when a client queue has reached a certain size and use this information to decide whether or not to act on the situation.

For example, the publisher might want to notify the client so that it can take some action (like suspending processing). As there is little point in queuing a message to tell the client that their queue is becoming full, this is probably done using a high priority message which goes to the front of the queue.

To this end, an upper notification threshold can be set for a client's queue. This is expressed as a percentage of the maximum queue depth at which a notification is sent to any client listeners that are declared. A client listener is any object that implements the `ClientListener` interface and such a listener can be added from within a publisher using the `Publishers.addEventListener` method. Listeners are notified of the limit breach using the `clientQueueThresholdReached` method.

In addition a lower notification threshold can be specified. The lower threshold is a percentage of the maximum queue depth at which a notification occurs when a message is removed from the queue causing the queue size to reach the threshold if (and only if) the upper threshold has been breached.

When the `clientQueueThresholdReached` method is called on the client listener it indicates whether it was the upper or lower threshold that was reached.

The thresholds to use for clients can be configured for a connector in `connectors.properties`. If not specified, the default thresholds specified in `etc/Server.xml` are used.

The thresholds on a client connector can be changed dynamically at run time using System Management, but the new values only take effect for new clients.

Thresholds can also be set or changed from within the publisher for a connected client using the `Client.setQueueNotificationThresholds` method.

Tidy on unsubscribe

When a client unsubscribes from a topic, the topic updates that are already queued for delivery to the client are delivered. These messages can be cleared from the queue if the client does not want to receive them.

After a message is queued for a client, it will be delivered. This means that a client can unsubscribe from a topic but still receive messages queued for it on it on that topic. This is generally what is required as the messages were sent whilst the client was subscribed.

However, it can be decided that once the client has unsubscribed from a topic then the client no longer has any interest in any messages for that topic and such messages are removed from the queue. To achieve this there is an option on a topic (using the `setTidyOnUnsubscribe` method) to indicate that messages for the topic must be removed from client queues when the client unsubscribes from that topic.

Client Geo and Whols information

When a client connects to Diffusion, information about that client's geographic location is looked up and the information is made available to publishers.

When a client first connects to a Diffusion server, its remote IP address is immediately available (using the `Client.getRemoteAddress` method) as well as other details obtained from the embedded Geolp database. Further host and geographic details about the client are obtained using the Diffusion "WhoIs service".

Geolp information

Diffusion ships with a GeolP database from [MaxMind](#). This provides information about Locale and geographic co-ordinates. The Java API includes utilities (`GeoIPUtils`) to make use of this database.

This is a public domain database and is free to use. You can purchase the more accurate database from MaxMind and change the configuration in the `etc/Server.xml` properties to use the new database.

The database can be disabled but its use is mandatory if you are going to use client connection or subscription validation policies.

Whols

The inbuilt Whols service can provide additional information about clients, however the lookup of the Whols information might take some time, especially if it is not already cached. This means that notification of the connection and further processing of the client cannot wait for this information to become available. For this reason the resolution of the client's Whols details is notified to client listeners separately from client connection on the `clientResolved` method.

When a client is first connected it is likely that the Whols details of the client are not available. This can be checked using the `Client.isResolved` method. When the details become available they can be obtained from the client using the `getWhoIsDetails` method which returns an object containing the following information:

Table 42: Whols

Address	The client's IP Address – this is the same as that obtained using <code>Client.getRemoteAddress</code> .
Host	The resolved host name of the client. If the host name cannot be resolved, the address is returned.
Resolved name	The fully resolved name of the client. Exactly what this means depends upon the Whols provider in use. If a fully resolved name cannot be obtained, the host name value is returned.
Locale	Returns the result of a geographic lookup of the IP address indicating where the address was allocated. The country of the locale is set to the international two-letter code for the country where the internet

	<p>address was allocated (for example, NZ for New Zealand). If the internet address cannot be found in the database, the country and language of the returned locale are set to empty Strings.</p> <p>Three country values can be returned that do not exist within the international standard (ISO 3166). These are EU (for a non-specific European address), AP (for a non-specific Asia-Pacific address) and ** (an internet address reserved for private use, for example on a corporate network not available from the public internet).</p> <p>The language of the returned locale is set to the international two-letter code for the official language of the country where the internet address was allocated. Where a country has more than one official language, the language is set to that which has the majority of native speakers. For example, the language for Canada is set to English (en) rather than French (fr). Non-specific addresses (EU and AP), private internet addresses (**), and addresses not found within the database, all return an empty string for language.</p>
WhoIsData	This is data extracted from an enquiry upon a 'WhoIs' data provider.
Local	Indicates whether the client address is a local address, in which case no locale or WhoIsData is available.
Loopback	Indicates whether the client address is a loopback address in which case no locale or WhoIsData is available.

The Diffusion WhoIs service

The Diffusion WhoIs service runs as a background task in the Diffusion server. It looks up client details and caches them in case the same client reconnects later.

The behavior of the WhoIs service is configured in `etc/Server.xml`. This allows the following to be specified:

Table 43: WhoIs service

The WhoIs provider	This specifies a class to use for WhoIs lookups. A default WhoIs provider is provided with Diffusion.
Number of threads	The number of background threads that processes WhoIs resolver requests. More threads will improve the WhoIs performance. Setting this to 0 disables WhoIs.
WhoIs Host/Port	These details provide the location of an internet based WhoIs lookup server that adheres to the RFC3912 WhoIs protocol. This is used by the default WhoIs provider. This defaults to using the RIPE database.
Cache details	<p>Specifying the maximum size of the cache of details and how long cache entries are retained before being deleted.</p> <p>If you envisage large numbers of different clients connecting over time, it is important to consider the automatic cache tidying options on the service.</p>

The WhoIs service can be disabled both by setting the number of threads to zero and removing the whois configuration element.

WhoIs providers

The Diffusion WhoIs provider is a class which implements the `WhoIsProvider` interface of the `WhoIs` API. This is used by the `WhoIs` service to lookup WhoIs details for connected clients.

Default provider

A default `WhoIsProvider` (`WhoIsDefaultProvider`) is provided with Diffusion.

A connection is made to the WhoIs server specified in `etc/Server.xml` and returned details are parsed and used to update the supplied details. Child details objects are added for any separate WhoIs records found and the type of such objects is the key of the first WhoIs record entry (for example, person). Where duplicate field names occur then all but the first are suffixed by “_n”, where *n* is a number distinguishing the entries.

The netname entry is used as the resolved name if present.

Custom provider

If the behavior of the issued default WhoIs provider is not exactly what is required then users can write their own WhoIs provider which must implement the `WhoIsProvider` interface. The name of the user-written class can be specified in `etc/Server.xml` and must be deployed on the Diffusion server's classpath.

Client notifications

A publisher can opt to receive certain notifications regarding clients. It does this by adding a `ClientListener` which can be the publisher itself or any other object that implements the `ClientListener` interface.

A listener is added using the `Publishers.addEventListener` method.

All notifications are passed a reference to the client in question which can be interrogated for further information as required.

Notifications received on the `ClientListener` interface are as follows:

Table 44: Client listener notifications

<code>clientConnected</code>	This is called whenever a new client connects. It is not necessarily a client that is subscribing to one of the publisher's topics.
<code>clientResolved</code>	This is called when a newly connected client is resolved. A client's full geographical information is not necessarily available as soon as a client connects and so this method is called separately after the client has been resolved.
<code>clientSubscriptionInvalid</code>	This is called whenever a client attempts to subscribe to a topic that does not exist. This might be because the topic is not yet available and this gives a publisher the opportunity to create the topic and subscribe the client to it.

<code>clientFetchInvalid</code>	This is called whenever a client attempts to fetch a topic that does not exist. This gives the publisher the opportunity to respond to fetch request on a non-existent topic. A publisher can even reply to such a request without having to create a topic using the <code>sendFetchReply</code> method.
<code>clientSendInvalid</code>	This is called whenever a client attempts to send a message to a topic that does not exist, or to which the client is not subscribed. This enables a client to send a message to a topic and for that topic to be created and subscribed to on demand, or send data when a response is never expected.
<code>clientQueueThresholdReached</code>	This is called whenever a client's queue breaches an upper queue notification threshold or returns to a lower queue notification threshold. Parameters indicate which threshold has been reached and the threshold value.
<code>clientCredentials</code>	This is called whenever a client supplies new credentials after connection. It is called after the authentication handlers have validated the credentials.
<code>clientClosed</code>	This is called whenever a client disconnects. The reason for disconnection can be obtained using the <code>getClient.getCloseReason</code> method.

Adding a ClientListener

You can add a `ClientListener` to listen for client notifications.

About this task

Procedure

So a publisher can add itself as a listener for client notifications as follows:

Results

```
public class MyPublisher extends Publisher implements ClientListener
{
    protected void initialLoad() throws APIException {
        Publishers.addEventListener(this);
    }
}
```

Using DefaultClientListener

How to use the default client listener to avoid implementing all methods.

About this task

The publisher must implement all of the `ClientListener` methods.

Procedure

For convenience, an abstract `DefaultClientListener` class is provided which has empty implementations of all methods. This can be extended to produce a class which implements only the methods you are interested in. Alternatively an anonymous class can be used within the publisher as follows:

Results

```
protected void initialLoad() throws APIException {
    Publishers.addListener(
        new DefaultClientListener() {
            public void clientConnected(Client client) {
                LOG.info("Client {} connected",client);
            }

            public void clientClosed(Client client) {
                LOG.info("Client {} closed",client);
            }
        });
}
```

Developing other components

Diffusion provides Java APIs that enable you to customize the behavior of your Diffusion server and related components.

Local authentication handlers

You can implement authentication handlers that authenticate client connections to the Diffusion server.

A local authentication handler is an implementation of the `AuthenticationHandler` interface. Local authentication handlers can be implemented only in Java. The class file that contains a local authentication handler must be located on the classpath of the Diffusion server.

Related concepts

[Configuring authentication handlers](#) on page 501

Authentication handlers and the order that the Diffusion server calls them in are configured in the `Server.xml` configuration file.

Developing a local authentication handler

Implement the `AuthenticationHandler` interface to create a local authentication handler.

About this task

Local authentication handlers can be implemented only in Java.

Note: Where `c.p.d` is used in package names, it indicates `com.pushtechnology.diffusion`.

Procedure

1. Create a Java class that implements `AuthenticationHandler`.

```
package com.example;

import com.pushtechnology.diffusion.client.details.SessionDetails;
import
    com.pushtechnology.diffusion.client.security.authentication.AuthenticationHan
import com.pushtechnology.diffusion.client.types.Credentials;
```

```

public class ExampleAuthenticationHandler implements
    AuthenticationHandler{

    public void authenticate(String principal, Credentials
        credentials,
            SessionDetails sessionDetails, Callback callback) {

        // Logic to make the authentication decision.

        // Authentication decision
        callback.abstain();

        // callback.deny();
        // callback.allow();

    }
}

```

- a) Implement the `authenticate` method.
 - b) Use the `allow`, `deny`, or `abstain` method on the `Callback` object to respond with the authentication decision.
2. Package your compiled Java class in a JAR file and put the JAR file in the `ext` directory of your Diffusion installation.
This includes the authentication handler on the server classpath.
 3. Edit the `etc/Server.xml` configuration file to point to your authentication handler.
Include the `authentication-handler` element in the list of authentication handlers. The order of the list defines the order in which the authentication handlers are called. The value of the `class` attribute is the fully qualified name of your authentication handler class. For example:

```

<security>
  <authentication-handlers>

    <authentication-handler
      class="com.example.ExampleAuthenticationHandler" />

  </authentication-handlers>
</security>

```

4. Start or restart the Diffusion server.
 - On UNIX-based systems, run the `diffusion.sh` command in the `diffusion_installation_dir/bin` directory.
 - On Windows systems, run the `diffusion.bat` command in the `diffusion_installation_dir\bin` directory.

Related concepts

[User-written authentication handlers](#) on page 144

You can implement authentication handlers that authenticate clients that connect to the Diffusion server or perform an action that requires authentication.

[Authentication](#) on page 141

You can implement and register handlers to authenticate clients when the clients try to perform operations that require authentication.

Related tasks

[Developing a composite authentication handler](#) on page 457

Extend the `CompositeAuthenticationHandler` class to combine the decisions from multiple authentication handlers.

[Developing a control authentication handler](#) on page 398

Implement the `ControlAuthenticationHandler` interface to create a control authentication handler.

[Developing a composite control authentication handler](#) on page 401

Extend the `CompositeControlAuthenticationHandler` class to combine the decisions from multiple control authentication handlers.

Developing a composite authentication handler

Extend the `CompositeAuthenticationHandler` class to combine the decisions from multiple authentication handlers.

About this task

If there are several, discrete authentication steps that must always be performed in the same order, packaging them as a composite authentication handler simplifies the server configuration.

This example describes how to use a composite authentication handler to call multiple local authentication handlers in sequence.

Procedure

1. Create the individual authentication handlers that your composite authentication handler calls. You can follow steps in the task [Developing a local authentication handler](#) on page 455. In this example, the individual authentication handlers are referred to as `HandlerA`, `HandlerB`, and `HandlerC`.
2. Extend the `CompositeAuthenticationHandler` class.

```
package com.example;

import com.example.HandlerA;
import com.example.HandlerB;
import com.example.HandlerC;

import
    com.pushtechology.diffusion.client.security.authentication.CompositeAuthenti

public class CompositeHandler extends
    CompositeAuthenticationHandler {

    public CompositeHandler() {
        super(new HandlerA(), new HandlerB(), new HandlerC());
    }

}
```

- a) Import your individual authentication handlers.
 - b) Create a no-argument constructor that calls the super class constructor with a list of your individual handlers.
3. Package your compiled Java class in a JAR file and put the JAR file in the `ext` directory of your Diffusion installation. This includes the composite authentication handler on the server classpath.
 4. Edit the `etc/Server.xml` configuration file to point to your composite authentication handler.

Include the `authentication-handler` element in the list of authentication handlers. The order of the list defines the order in which the authentication handlers are called. The value of the `class` attribute is the fully qualified class name of your composite authentication handler. For example:

```
<security>
  <authentication-handlers>

    <authentication-handler class="com.example.CompositeHandler" />

  </authentication-handlers>
</security>
```

5. Start the Diffusion server.

- On UNIX-based systems, run the `diffusion.sh` command in the `diffusion_installation_dir/bin` directory.
- On Windows systems, run the `diffusion.bat` command in the `diffusion_installation_dir\bin` directory.

Results

When the composite authentication handler is called, it calls the individual authentication handlers that are passed to it as parameters in the order they are passed in.

- If an individual handler responds with `ALLOW` or `DENY`, the composite handler responds with that decision to the server.
- If an individual handler responds with `ABSTAIN`, the composite handler calls the next individual handler in the list.
- If all individual handlers respond with `ABSTAIN`, the composite handler responds to the server with an `ABSTAIN` decision.

Related concepts

[User-written authentication handlers](#) on page 144

You can implement authentication handlers that authenticate clients that connect to the Diffusion server or perform an action that requires authentication.

[Authentication](#) on page 141

You can implement and register handlers to authenticate clients when the clients try to perform operations that require authentication.

Related tasks

[Developing a local authentication handler](#) on page 455

Implement the `AuthenticationHandler` interface to create a local authentication handler.

[Developing a control authentication handler](#) on page 398

Implement the `ControlAuthenticationHandler` interface to create a control authentication handler.

[Developing a composite control authentication handler](#) on page 401

Extend the `CompositeControlAuthenticationHandler` class to combine the decisions from multiple control authentication handlers.

Push Notification Bridge persistence plugin

The Push Notification Bridge stores subscription information in memory. To persist this information past the end of the bridge process, implement a persistence plugin.

The persistence API

The Push Notification Bridge persistence API provides the following interfaces for you to use to develop your persistence plugin:

SaverFactory

Your implementation of this interface is referenced by the bridge configuration and is called by the bridge to build the `Saver` object.

Saver

Your implementation of this interface is called by the bridge when push notification subscriptions and unsubscriptions are made. It uses this information to update the persisted model of the subscriptions.

Loader

Your implementation of this interface is called by the bridge when it starts and is used to update the model of subscriptions held in memory by the bridge.

Context

This provides a context for events passed to the `Saver` interface. It is used for logging and audit trail purposes.

Full API documentation is available at the following location: [Java API documentation](#).

An example implementation of the persistence API is available on GitHub: <https://github.com/pushtechnology/push-notification-persistence-example>. This example is basic and uses Java serialization to persist the subscription model.

Note: The example persistence plugin is not suitable for production use.

Developing the persistence plugin

A JAR file that contains the persistence API is available on the Push Technology Maven repository.

To use Maven to declare the dependency, first add the Push Technology public repository to your `pom.xml` file:

```
<repositories>
  <repository>
    <id>push-repository</id>
    <url>https://download.pushtechnology.com/maven/</url>
  </repository>
</repositories>
```

Next declare the following dependency in your `pom.xml` file:

```
<dependency>
  <groupId>com.pushtechnology</groupId>
  <artifactId>push-notification-persistence-api</artifactId>
  <version>1.0</version>
```

```
</dependency>
```

Using the persistence plugin

1. Compile your persistence code.
2. Ensure that the compiled code is on the classpath of the JVM that runs the bridge.
3. Configure the bridge to use your persistence plugin.

Use the `saverFactory` attribute of the `persistence` element to specify the name of the `SaverFactory` class in your plugin. For example:

```
<persistence saverFactory="com.example.pnb.SaverFactory" />
```

The content of the `persistence` element can be text content. This content is passed into the saver factory as arguments.

For more information, see [Configuring your Push Notification Bridge](#) on page 740.

Related concepts

[Push notification networks](#) on page 123

Consider whether your solution will interact with push notification networks.

[Example: Send a request message to the Push Notification Bridge](#) on page 460

The following examples use the API to send a request message on a topic path to communicate with the Push Notification Bridge. The request message is in JSON and can be used to subscribe or unsubscribe from receiving push notifications when specific topics are updated.

[Push Notification Bridge](#) on page 737

The Push Notification Bridge is a Diffusion client that subscribes to topics on behalf of other Diffusion clients and uses a push notification network to relay topic updates to the device where the client application is located.

Example: Send a request message to the Push Notification Bridge

The following examples use the API to send a request message on a topic path to communicate with the Push Notification Bridge. The request message is in JSON and can be used to subscribe or unsubscribe from receiving push notifications when specific topics are updated.

Objective-C

```
                                // Diffusion Client Library for iOS,  
tvOS and OS X / macOS - Examples  
//  
// Copyright (C) 2016, 2017 Push Technology Ltd.  
//  
// Licensed under the Apache License, Version 2.0 (the "License");  
// you may not use this file except in compliance with the License.  
// You may obtain a copy of the License at  
// http://www.apache.org/licenses/LICENSE-2.0  
//  
// Unless required by applicable law or agreed to in writing,  
software  
// distributed under the License is distributed on an "AS IS" BASIS,  
// WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or  
implied.  
// See the License for the specific language governing permissions  
and
```

```

// limitations under the License.

/** The default path at which the Push Notification Bridge listens
    for messaging
#define SERVICE_PATH @"push/notifications"

#import "MessagingToPushNotificationBridgeExample.h"

#import Diffusion;

@implementation MessagingToPushNotificationBridgeExample {
    PTDiffusionSession* _session;
}

-(void)startWithURL:(NSURL*)url {
    NSLog(@"Connecting...");

    [PTDiffusionSession openWithURL:url
        completionHandler:^(PTDiffusionSession *session,
        NSError *error)
    {
        if (!session) {
            NSLog(@"Failed to open session: %@", error);
            return;
        }

        // At this point we now have a connected session.
        NSLog(@"Connected.");

        // Set ivar to maintain a strong reference to the session.
        _session = session;

        // An example APNs device token
        unsigned char tokenBytes[] =
            {0x5a, 0x88, 0x3a, 0x57, 0xe2, 0x89, 0x77, 0x84,
            0x1d, 0xc8, 0x1a, 0x0a, 0xa1, 0x4e, 0x2f, 0xdf,
            0x64, 0xc6, 0x5a, 0x8f, 0x7b, 0xb1, 0x9a, 0xa1,
            0x6e, 0xaf, 0xc3, 0x16, 0x13, 0x18, 0x1c, 0x97};
        NSData *const deviceToken =
            [NSData dataWithBytes:(void *)tokenBytes length:32];

        [self doPnSubscribe:@"some/topic/name"
            deviceToken:deviceToken];
    }];
}

/**
 * Compose a URI understood by the Push Notification Bridge from an
 * APNs device token.
 * @param deviceID APNs device token.
 * @return string in format expected by the push notification bridge.
 */
-(NSString*)formatAsURI:(NSData*)deviceID {
    NSString *const base64 = [deviceID
        base64EncodedStringWithOptions:0];
    return [NSString stringWithFormat:@"apns://%@", base64];
}

/**
 * Compose and send a subscription request to the Push Notification
 * bridge
 * @param topicPath Diffusion topic path subscribed-to by the Push
 * Notification Bridge.

```

```

*/
- (void)doPnSubscribe:(NSString*) topicPath deviceToken:
(NSData*)deviceToken {
    // Compose the JSON request from Obj-C literals
    NSDictionary *const requestDict = @{
        @"pnsb": @{
            @"destination": [self formatAsURI:deviceToken],
            @"topic": topicPath
        }
    };

    // Build a JSON request from that
    PTDiffusionJSON *const json =
    [[PTDiffusionJSON alloc] initWithObject:requestDict
    error:nil];

    [_session.messaging sendRequest:json.request
                        toPath:SERVICE_PATH
                        JSONCompletionHandler:^(PTDiffusionJSON *json, NSError
*error)
    {
        if (error) {
            NSLog(@"Send to \"%@\\" failed: %@", SERVICE_PATH, error);
        } else {
            NSLog(@"Response: %@", json);
        }
    }];
}

@end

```

Swift

```

// Diffusion Client Library for iOS, tvOS
and OS X / macOS - Examples
//
// Copyright (C) 2017 Push Technology Ltd.
//
// Licensed under the Apache License, Version 2.0 (the "License");
// you may not use this file except in compliance with the License.
// You may obtain a copy of the License at
// http://www.apache.org/licenses/LICENSE-2.0
//
// Unless required by applicable law or agreed to in writing,
software
// distributed under the License is distributed on an "AS IS" BASIS,
// WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or
implied.
// See the License for the specific language governing permissions
and
// limitations under the License.

import Foundation
import Diffusion

class MessagingToPushNotificationBridgeExample {
    static let servicePath = "push/notifications"
    var session: PTDiffusionSession?

    func startWithURL(url: NSURL) throws {
        print("Connecting...")
    }
}

```

```

        PTDiffusionSession.open(with: url as URL) { (session, error)
-> Void in
            if session == nil {
                print("Failed to open session: \(error!)")
                return
            }

            // At this point we now have a connected session.
            print("Connected")

            // Set ivar to maintain a strong reference to the
session.
            self.session = session

            // An example APNs device token

            let tokenBytes:[UInt8] = [0x5a, 0x88, 0x3a, 0x57, 0xe2,
0x89, 0x77, 0x84,
                                0x1d, 0xc8, 0x1a, 0x0a, 0xa1, 0x4e,
0x2f, 0xdf,
                                0x64, 0xc6, 0x5a, 0x8f, 0x7b, 0xb1,
0x9a, 0xa1,
                                0x6e, 0xaf, 0xc3, 0x16, 0x13, 0x18,
0x1c, 0x97]
            let deviceToken = NSData(bytes: tokenBytes, length: 32)

            self.doPnSubscribe(topicPath: "some/topic/path",
deviceToken: deviceToken)
        }
    }

    /**
     * Compose a URI understood by the Push Notification Bridge from
an APNs device token.
     * @param deviceID APNs device token.
     * @return string in format expected by the push notification
bridge.
     */
    func formatAsURI(token:NSData) -> String {
        return String(format:"apns://", token.base64EncodedString())
    }

    func doPnSubscribe(topicPath: String, deviceToken: NSData) {
        // Compose the JSON request from literals
        let requestDict = [
            "pnsub" : [
                "destination": formatAsURI(token: deviceToken),
                "topic": topicPath
            ]
        ]

        // Build a JSON request from that
        let json = try! PTDiffusionJSON(object: requestDict)

        session?.messaging.send(
            json.request,
            toPath:
MessagingToPushNotificationBridgeExample.servicePath,
            jsonCompletionHandler: {
                (json, error) -> Void in

                if (nil == json) {

```

```

        print("Send to
\\(MessagingToPushNotificationBridgeExample.servicePath)\" failed:
\\(error!)")
    } else {
        print("Response: \\(json!)")
    }
    })
}
}
}

```

Android

```

/
*****
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*
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* you may not use this file except in compliance with the License.
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software
* distributed under the License is distributed on an "AS IS" BASIS,
* WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or
implied.
* See the License for the specific language governing permissions
and
* limitations under the License.
*****
package com.pushtechology.diffusion.examples;

import java.util.concurrent.CompletableFuture;
import java.util.concurrent.ExecutionException;

import org.json.JSONObject;
import org.slf4j.Logger;
import org.slf4j.LoggerFactory;

import com.pushtechology.diffusion.client.Diffusion;
import com.pushtechology.diffusion.client.features.Messaging;
import com.pushtechology.diffusion.client.session.Session;
import com.pushtechology.diffusion.datatype.json.JSON;

/**
 * An example of a client using the 'Messaging' feature to request
the Push
 * Notification Bridge subscribe to a topic and relay updates to a
GCM
 * registration ID.
 *
 * @author Push Technology Limited
 * @since 5.9
 */
public class ClientSendingPushNotificationSubscription {

    private static final Logger LOG = LoggerFactory
        .getLogger(ClientSendingPushNotificationSubscription.class);

    private final String pushServiceTopicPath;

```

```

private final Session session;
private final Messaging messaging;

/**
 * Constructs message sending application.
 *
 * @param pushServiceTopicPath topic path on which the Push
Notification
 *      Bridge is taking requests.
 */
public ClientSendingPushNotificationSubscription(
    String pushServiceTopicPath) {
    this.pushServiceTopicPath = pushServiceTopicPath;
    this.session =
        Diffusion.sessions().principal("client")
            .password("password").open("ws://
diffusion.example.com:80");
    this.messaging = session.feature(Messaging.class);
}

/**
 * Close the session.
 */
public void close() {
    session.close();
}

/**
 * Compose & send a subscription request to the Push Notification
Bridge.
 *
 * @param subscribedTopic topic to which the bridge subscribes.
 * @param gcmRegistrationID GCM registration ID to which the
bridge relays
 *      updates.
 * @throws ExecutionException If the Push Notification Bridge
cannot process
 *      the request
 * @throws InterruptedException If the current thread was
interrupted while
 *      waiting for a response
 */
public void requestPNSubscription(String gcmRegistrationID,
    String subscribedTopic)
    throws InterruptedException, ExecutionException {

    // Compose the request
    final String gcmDestination = "gcm://" + gcmRegistrationID;
    final JSONObject jsonObject =
        buildSubscriptionRequest(gcmDestination,
subscribedTopic);
    final JSON request =

Diffusion.dataTypes().json().fromJsonString(jsonObject.toString());

    // Send the request
    final CompletableFuture<JSON> response =
        messaging.sendRequest(
            pushServiceTopicPath,
            request,
            JSON.class,
            JSON.class);
}

```

```

        LOG.info("Received response from PN Bridge: {}",
            response.get().toJsonString());
    }

    /**
     * Compose a subscription request.
     * <P>
     *
     * @param destination The {@code gcm://} or {@code apns://}
destination for
     *         any push notifications.
     * @param topic Diffusion topic subscribed-to by the Push
Notification
     *         Bridge.
     * @return a complete request
     */
    private static JSONObject buildSubscriptionRequest(
        String destination,
        String topic) {

        final JSONObject subObject = new JSONObject();

        subObject
            .put("destination", destination)
            .put("topic", topic);

        final JSONObject contentObj = new JSONObject();
        contentObj.put("pnsub", subObject);

        return contentObj;
    }
}

```

Related concepts

[Push notification networks](#) on page 123

Consider whether your solution will interact with push notification networks.

[Push Notification Bridge persistence plugin](#) on page 459

The Push Notification Bridge stores subscription information in memory. To persist this information past the end of the bridge process, implement a persistence plugin.

[Push Notification Bridge](#) on page 737

The Push Notification Bridge is a Diffusion client that subscribes to topics on behalf of other Diffusion clients and uses a push notification network to relay topic updates to the device where the client application is located.

Using Maven to build Java Diffusion applications

Apache™ Maven is a popular Java build tool and is well supported by Java IDEs. You can use Apache Maven to build your Diffusion applications.

The Push Technology public Maven repository

Push Technology publishes Diffusion components and related artifacts to a public Maven repository at the following location: <http://download.pushtechnology.com/maven>.

The published artifacts include the following:

Table 45: Artifacts

Artifact	Maven coordinates	Description
Diffusion API	com.pushtechnology.diffusion:api:jar:6.0.0	The Diffusion API interfaces only. Use this artifact for compilation only. The JAR includes the source and Javadoc attachments.
Diffusion Clients	com.pushtechnology.diffusion:client:jar:6.1.5	The Diffusion client library.
mvndar	com.pushtechnology.tools:dar-maven-plugin:maven-plugin:1.2	A Maven plugin for building DAR files.

To use the Push Technology public Maven repository, add the following repository description to your pom.xml file:

```
<repositories>
  <repository>
    <id>push-repository</id>
    <url>https://download.pushtechnology.com/maven/</url>
  </repository>
</repositories>
```

Build client applications

You can build and run Diffusion Java client applications without installing the Diffusion product. The Diffusion client JAR is all you need.

The following pom.xml shows how to declare the appropriate dependencies:

```
<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/xsd/maven-4.0.0.xsd">
  <modelVersion>4.0.0</modelVersion>

  <groupId>com.example</groupId>
  <artifactId>myclient</artifactId>
  <version>1.0-SNAPSHOT</version>

  <repositories>
    <repository>
      <id>push-repository</id>
      <url>https://download.pushtechnology.com/maven/</url>
    </repository>
  </repositories>

  <dependencies>
    <dependency>
      <groupId>com.pushtechnology.diffusion</groupId>
      <artifactId>diffusion-client</artifactId>
      <version>6.1.5</version>
    </dependency>
  </dependencies>
</project>
```

Build publishers with Maven

The Diffusion API for publishers is not available in the Push Technology public Maven repository. To build publishers, you must install the product locally and depend on `diffusion.jar` using a Maven system scope.

DAR files

The preferred way to deploy publishers is to build them into a DAR. DARs are JAR format files that contain compiled code, libraries, and configuration. They have a similar purpose to Java EE EAR or WAR files, and can be dynamically deployed to and undeployed from a running Diffusion server



Figure 25: Example folder structure inside a DAR file

The root folder name is the name of the publisher. For example, `MyPublisher`.

- The `META-INF` directory contains the `MANIFEST.MF` file.

This file contains an attribute, `Diffusion-Version`, which specifies the minimum version number of Diffusion on which this publisher runs. This prevents deployment of publishers to Diffusion instances which might not support features of the publisher or have different API signatures.

```
Manifest-Version: 1.0
Diffusion-Version: 6.1.5
```

- The `etc` directory can contain the following files.

etc/Publishers.xml

You must include this file.

The `Publishers.xml` file has the same structure and the one in a Diffusion installation's `etc` directory. For more information, see .

For example:

```
<publishers>
  <publisher name="MyPublisher">

  <class>com.pushtechnology.diffusion.test.publisher.MyPublisher</class>
    <start>true</start>
    <enabled>true</enabled>
  </publisher>
```

```
</publishers>
```

etc/Aliases.xml (optional)

Include this file if there are associated HTML files.

etc/SubscriptionValidationPolicy.xml

Include this file if it is referenced from the `etc/Publishers.xml` file.

These files are normally found in the Diffusion server installation's `etc` directory, but contain only information relating to the publisher being deployed. Files that affect the operation of the Diffusion server and have no relationship to the publisher are not loaded.

- The `ext` directory contains all Java code required by your publisher.
You can also include any required third-party JAR files or resources in this folder.
- The `html` is optional and can contain any HTML files or web assets required by the publisher.

mvndar

The preferred way to build a DAR *mvndar* is a Maven plugin for creating DAR files. More information about *mvndar* is available at the following locations:

- <http://pushtechology.github.io/mvndar/index.html>

Example: Using Maven to build the demo applications

If you selected the demo applications when you installed Diffusion, the source files and an example Maven `pom.xml` can be found in the directories beneath the `demo/src` directory. The example uses *mvndar*, and depends on `diffusion.jar` using system scope.

For more information, see .

Related concepts

[Classic deployment](#) on page 753

Installing publishers into a stopped Diffusion instance.

[Hot deployment](#) on page 754

Installing publishers into a running Diffusion instance.

[Deployment methods](#) on page 754

There are two ways to deploy a DAR file: file copy or HTTP.

Building a publisher with mvndar

Use the Maven plugin *mvndar* to build and deploy your publisher DAR file. This plugin is available from the Push Public Maven Repository.

Before you begin

This task describes how to build existing publisher code into a DAR file for deployment on the Diffusion server. Develop your publisher code before beginning this task. For more information, see [Writing a publisher](#) on page 442.

You must have an installation of the Diffusion server on the system you use to build the DAR file.

Procedure

1. Create a Maven project.

```
mvn archetype:generate -DgroupId=group_id -DartifactId=publisher_id
-DarchetypeArtifactId=maven-archetype-quickstart -
-DinteractiveMode=false
```

Replace *group_id* with the group identifier for your publisher, for example, *com.example*. Replace *publisher_id* with the artifact name for your publisher, for example, *my-first-publisher*.

This command creates a *publisher_id* directory that contains a *pom.xml* and sample files.

2. Replace the sample code in the new *publisher_id* Maven project with your publisher code.

Put your Java code in the *publisher_id/src/main/java/* directory.

3. Add a *Publishers.xml* file to your Maven project.

Create the file at *publisher_id/src/main/diffusion/etc/Publishers.xml*:

```
<publishers>
  <publisher name="publisher_name">
    <class>fq_publisher_name</class>
    <start>true</start>
  </publisher>
</publishers>
```

Replace *publisher_name* with the name of the class that extends the *Publisher* class, for example, *MyFirstPublisher*. Replace *fq_publisher_name* with the fully qualified name of the class that extends the *Publisher* class, for example, *com.example.publish.MyFirstPublisher*.

4. Edit the *pom.xml* file in the *publisher_id* directory:

- a) Remove the boilerplate code and ensure that the group and artifact IDs are set to the correct values.

```
<project xmlns="http://maven.apache.org/POM/4.0.0"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://maven.apache.org/POM/4.0.0
    http://maven.apache.org/maven-v4_0_0.xsd">

  <modelVersion>4.0.0</modelVersion>
  <groupId>group_id</groupId>
  <artifactId>publisher_id</artifactId>
  <packaging>jar</packaging>
  <version>1.0-SNAPSHOT</version>
  <name>publisher_id</name>

</project>
```

- b) Create a system-scoped dependency on the Diffusion JAR.

```
<dependencies>
  <dependency>
    <groupId>com.pushtechonology</groupId>
    <artifactId>diffusion</artifactId>
    <version>6.1.5</version>
    <scope>system</scope>
    <systemPath>diffusion_installation_directory/lib/
diffusion.jar</systemPath>
    <optional>true</optional>
  </dependency>
```

```
</dependencies>
```

- c) Add the Push Public Maven Repository as a repository that plugins can be fetched from

```
<pluginRepositories>
  <pluginRepository>
    <id>push-repository</id>
    <url>http://download.pushtechology.com/maven/</url>
  </pluginRepository>
</pluginRepositories>
```

- d) Add mvndar as configured plugin

```
<build>
  <plugins>
    <plugin>
      <groupId>com.pushtechology.tools</groupId>
      <artifactId>dar-maven-plugin</artifactId>
      <version>1.2</version>
      <extensions>>true</extensions>
    </plugin>
  </plugins>
</build>
```

- e) Set the packaging method to dar instead of jar:

```
<packaging>dar</packaging>
```

5. Build your DAR file.

Run the `mvn clean package` command in the `publisher_id` directory.

Results

A DAR file is created in the `publisher_id/target` directory. This DAR file is ready to deploy to the Diffusion server. For more information, see [Deploying publishers on your Diffusion server](#) on page 753

Related concepts

[Classic deployment](#) on page 753

Installing publishers into a stopped Diffusion instance.

[Hot deployment](#) on page 754

Installing publishers into a running Diffusion instance.

[Deployment methods](#) on page 754

There are two ways to deploy a DAR file: file copy or HTTP.

[Creating a Publisher class](#) on page 443

A publisher is written by extending the abstract `Publisher` class (see [Publisher API](#)) and overriding any methods that must be implemented to achieve the functionality required by the publisher.

[Loading publisher code](#) on page 436

This describes how to load publisher classes or code it is dependent upon.

Build server application code with Maven

The Diffusion API for server application code is not available in the Push Technology public Maven repository. To build server components, you must install the product locally and depend on `diffusion.jar` using a Maven system scope.

The following `pom.xml` shows to declare the dependency on `diffusion.jar`. To use it, you must set the `DIFFUSION_HOME` environment variable to the absolute file path of your Diffusion installation.

```
<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://
www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://maven.apache.org/POM/4.0.0
http://maven.apache.org/xsd/maven-4.0.0.xsd">
    <modelVersion>4.0.0</modelVersion>

    <groupId>com.examplecorp</groupId>
    <artifactId>mypublisher</artifactId>
    <version>1.0-SNAPSHOT</version>

    <dependencyManagement>
        <dependency>
            <groupId>com.pushtechnology.diffusion</groupId>
            <artifactId>diffusion</artifactId>
            <version>local-installation</version>
        </dependency>
    </dependencyManagement>

    <profiles>
        <profile>
            <activation>
                <property>
                    <name>env.DIFFUSION_HOME</name>
                </property>
            </activation>

            <dependencyManagement>
                <dependencies>
                    <dependency>
                        <groupId>com.pushtechnology.diffusion</
groupId>
                        <artifactId>diffusion</artifactId>
                        <version>local-installation</version>
                        <scope>system</scope>
                        <systemPath>${DIFFUSION_HOME}/lib/
diffusion.jar</systemPath>
                    </dependency>
                </dependencies>
            </dependencyManagement>
        </profile>
    </profiles>
</project>
```

Related concepts

[Classic deployment](#) on page 753

Installing publishers into a stopped Diffusion instance.

[Hot deployment](#) on page 754

Installing publishers into a running Diffusion instance.

[Deployment methods](#) on page 754

There are two ways to deploy a DAR file: file copy or HTTP.

Testing

This section covers some aspects of testing a Diffusion system.

Benchmarking suite

A benchmarking suite for Diffusion is available on GitHub. You can use this suite to test the latency and throughput of publishers.

The benchmarking suite is available at the following location: <https://github.com/pushtechology/diffusion-benchmark-suite>.

The benchmarking suite works on Linux only and requires the following software be installed on the system:

- Apache Ant™
- Java with JDK
- Diffusion server

For more information about using the benchmarking suite, see the readme file in the GitHub project.

Part V

Administrator Guide

This guide describes how to deploy, configure, and manage your Diffusion solution.

In this section:

- [Installing the Diffusion server](#)
- [Configuring your Diffusion server](#)
- [Starting the Diffusion server](#)
- [Network security](#)
- [Going to production](#)
- [Tuning](#)
- [Managing and monitoring your running Diffusion server](#)
- [Web servers](#)
- [Load balancers](#)
- [JMS adapter](#)
- [Push Notification Bridge](#)
- [Deploying publishers on your Diffusion server](#)
- [Demos](#)
- [Tools](#)

Installing the Diffusion server

You can install the Diffusion server from a JAR file, through Docker, or through Red Hat Package Manager.

Review the system requirements before installing Diffusion.

Download Diffusion from the following location: <http://download.pushtechnology.com/releases/6.1>

The Diffusion installation includes a developer license that allows up to five concurrent connections to the Diffusion server. To use Diffusion in production, you can obtain a production license from .

System requirements for the Diffusion server

Review this information before installing the Diffusion server.

The Diffusion server is certified on the system specifications listed here. In addition, the Diffusion server is supported on a further range of systems.

Certification

Push Technology classes a system as certified if the Diffusion server is fully functionally tested on that system.

We recommend that you use certified hardware, virtual machines, operating systems, and other software when setting up your Diffusion servers.

Support

In addition, Push Technology supports other systems that have not been certified.

Other hardware and virtualized systems are supported, but the performance of these systems can vary.

More recent versions of software and operating systems than those we certify are supported.

However, Push Technology can agree to support Diffusion on other systems. For more information, contact Push Technology.

Physical system

The Diffusion server is certified on the following physical system specification:

- Intel Xeon E-Series Processors
- 8 Gb RAM
- 8 CPUs
- 10 Gigabit NIC

Network, CPU, and RAM (in decreasing order of importance) are the components that have the biggest impact on performance. High performance file system and disk are required. Intel hardware is used because of its ubiquity in the marketplace and proven reliability.

Virtualized system

The Diffusion server is certified on the following virtualized system specification:

Host

- Intel Xeon E-Series Processors
- 32 Gb RAM

- VMware vSphere 5.5

Virtual machine

- 8 VCPUs
- 8 Gb RAM

When running on a virtualized system, over-committing VCPUs (assigning too many VCPUs compared to the processors available on the host) can cause increased latency and unpredictable performance. Consult the [VMWare Performance Best Practices](#) documentation for details.

Operating system

Diffusion is certified on the following operating systems:

- Red Hat 7.2+
- Windows Server 2012 R2 and 2016

We recommend you install your Diffusion server on a Linux-based operating system with enterprise-level support available, such as Red Hat Enterprise Linux.

Operating system configuration

If you install your Diffusion server on a Linux-based operating system and do SSL offloading of secure client connections at the Diffusion server, you must disable transparent huge pages.

If you install your Diffusion server on a Linux-based operating system but do not do SSL offloading of secure client connections at the Diffusion server, disabling transparent huge pages is still recommended.

Having transparent huge pages enabled on the system your Diffusion server runs on can cause extremely long pauses for garbage collection. For more information, see <https://access.redhat.com/solutions/46111>.

Java

The Diffusion server is certified on Oracle Java Development Kit 8 (minimum update 1.8.0_131-b11).

Only the Oracle JDK is certified.

Ensure that you use the Oracle JDK and not the JRE.

JVM configuration

If you do SSL offloading of secure client connections at the Diffusion server, you must ensure that you constrain the maximum heap size and the maximum direct memory size so that together these to values do not use more than 80% of your system's RAM.

Networking

Push Technology recommends the following network configurations:

- 10 Gigabit network
- Load balancers with SSL offloading
- In virtualized environments, enable SR-IOV.

For more information about how to enable SR-IOV, see the documentation provided by your virtual server provider. SR-IOV might be packaged using a vendor-specific name.

Client requirements

For information about the supported client platforms, see [Platform support for the Diffusion API libraries](#) on page 35.

Related concepts

[The Diffusion license](#) on page 483

Diffusion includes a development license that enables you to use make up to 5 concurrent connections to the Diffusion server.

[Installed files](#) on page 486

After installing Diffusion the following directory structure exists:

Related tasks

[Installing the Diffusion server using the graphical installer](#) on page 477

The Diffusion binary files are available from the Push Technology website. You can install Diffusion using the graphical installer.

[Installing the Diffusion server using the headless installer](#) on page 479

The Diffusion binary files are available from the Push Technology website. You can install Diffusion from the command line.

[Installing the Diffusion server using Red Hat Package Manager](#) on page 480

Diffusion is available as an RPM file from the Push Technology website.

[Installing the Diffusion server using Docker](#) on page 481

Diffusion is available as a Docker® image from Docker Hub.

[Verifying the Diffusion installation](#) on page 488

Start your Diffusion server, review the logs, and connect to the console to verify that your installation is correct.

Installing the Diffusion server using the graphical installer

The Diffusion binary files are available from the Push Technology website. You can install Diffusion using the graphical installer.

Before you begin

You must have Oracle Java Development Kit 8 (minimum update 1.8.0_131-b11) installed on your system to install and use Diffusion.

About this task

To install Diffusion using the graphical installer, complete the following steps:

Procedure

1. Go to the Diffusion download page:
<http://download.pushtechnology.com/releases/6.1>
2. Click on the following download links to download the required jar files into a temporary directory:
 - Diffusion (`Diffusion version_id.jar`)
 - Installer (`install.jar`)
3. In the temporary directory, double-click the `install.jar` file.
The graphical installer launches.

4. Optional: If you have a production license, you can load it into the Diffusion installation at this point.
You can skip this step if you are using the included development license.
 - a) Ensure that the license file is available on your system.
 - b) At the **Introduction** step, select **File > Load license file**
 - c) In the window that opens, navigate to the license file (`licence.lic`). Click **Open**.
5. At the **Introduction** step, click **Continue**.
6. At the **License agreement** step, select **Accept** to accept the End User License Agreement (EULA) and click **Continue**.
7. At the **Destination directory** step, select the install destination.
We recommend you create a `Diffusion` directory on your system. Click **Continue**.
8. At the **Select products** step, select the components you want to install, then click **Continue**.
For a test installation, we recommend you select **All**. For a production installation, deselect components you do not need (for example, **Demos**, **Deploy demos** and **Examples**).
9. At the **Confirmation** step, review the install information. If the information is correct, click **Continue** to confirm.
The installer installs Diffusion into the directory specified.
10. At the **Summary** step, click **Done** to exit the graphical installer.

Results

You have successfully downloaded and installed Diffusion.

What to do next

Next:

- Edit the configuration of your Diffusion server to suit your requirements. For more information, see [Configuring your Diffusion server](#) on page 490.
- Edit the security setup of your Diffusion server.
- Start your Diffusion server using the `diffusion.bat` file, if on Windows, or the `diffusion.sh` file, if on Linux or OS X/macOS.

These start up scripts are located in the `bin` directory of your Diffusion installation.

Related concepts

[The Diffusion license](#) on page 483

Diffusion includes a development license that enables you to use make up to 5 concurrent connections to the Diffusion server.

[Installed files](#) on page 486

After installing Diffusion the following directory structure exists:

Related tasks

[Installing the Diffusion server using the headless installer](#) on page 479

The Diffusion binary files are available from the Push Technology website. You can install Diffusion from the command line.

[Installing the Diffusion server using Red Hat Package Manager](#) on page 480

Diffusion is available as an RPM file from the Push Technology website.

[Installing the Diffusion server using Docker](#) on page 481

Diffusion is available as a Docker® image from Docker Hub.

[Verifying the Diffusion installation](#) on page 488

Start your Diffusion server, review the logs, and connect to the console to verify that your installation is correct.

Related reference

[System requirements for the Diffusion server](#) on page 33

Review this information before installing the Diffusion server.

Installing the Diffusion server using the headless installer

The Diffusion binary files are available from the Push Technology website. You can install Diffusion from the command line.

Before you begin

You must have Oracle Java Development Kit 8 (minimum update 1.8.0_131-b11) installed on your system to install and use Diffusion.

About this task

You can install in headless mode in circumstances where the graphical installer cannot be used or is not appropriate.

Procedure

1. Go to the Diffusion download page:
<http://download.pushtechnology.com/releases/6.1>
2. Click on the following download links to download the required jar files into a temporary directory:
 - Diffusion (`Diffusion version_id.jar`)
 - Installer (`install.jar`)
3. Copy these files to a temporary directory on the system where Diffusion is to be installed.
4. In the terminal window, change to the directory where the Diffusion jar files are located.
5. Type the following command:

```
java -jar install.jar Diffusionn.n.n.jar
```

where *n.n.n* is the Diffusion release number.

6. If you agree to the terms of the license agreement, type `Y` and Enter.
7. Enter the full path to the directory in which to install Diffusion and type Enter.
8. Type `Y` to install all packages.
If you choose not to install all packages, the installer asks you about each package individually.

Results

You have successfully downloaded and installed Diffusion.

What to do next

Next:

- Edit the configuration of your Diffusion server to suit your requirements. For more information, see [Configuring your Diffusion server](#) on page 490.
- Edit the security setup of your Diffusion server.
- Start your Diffusion server using the `diffusion.bat` file, if on Windows, or the `diffusion.sh` file, if on Linux or OS X/macOS.

These start up scripts are located in the `bin` directory of your Diffusion installation.

Related concepts

[The Diffusion license](#) on page 483

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[Installed files](#) on page 486

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[Installing the Diffusion server using Red Hat Package Manager](#) on page 480

Diffusion is available as an RPM file from the Push Technology website.

[Installing the Diffusion server using Docker](#) on page 481

Diffusion is available as a Docker® image from Docker Hub.

[Verifying the Diffusion installation](#) on page 488

Start your Diffusion server, review the logs, and connect to the console to verify that your installation is correct.

Related reference

[System requirements for the Diffusion server](#) on page 33

Review this information before installing the Diffusion server.

Installing the Diffusion server using Red Hat Package Manager

Diffusion is available as an RPM file from the Push Technology website.

About this task

On Linux systems that have Red Hat Package Manager installed, you can use it to install Diffusion.

Procedure

1. Go to the Diffusion download page:
<http://download.pushtechnology.com/releases/6.1>
2. Click on the following download link to download the required RPM file:
 - Diffusion RPM (`diffusion-n.n.n_build.noarch.rpm`)
3. Copy this file to a temporary directory on the system where Diffusion is to be installed.
4. In the terminal window, change to the directory where the Diffusion RPM file is located.
5. Type the following command:

```
rpm -ivh diffusion-n.n.n_build.noarch.rpm
```

where *n.n.n* is the Diffusion release number and *build* is an additional string containing numbers to represent the build level.

Results

Diffusion is installed in the following directory: `/opt/Diffusion`. A startup script is installed in the `/etc/init.d` directory that enables Diffusion to start when you start the system.

What to do next

Your Diffusion installation includes a development license that allows connections from up to five clients. To use Diffusion in production, you can obtain a production license from .

Copy the license file into the `/etc` directory of your Diffusion installation.

Related concepts

[The Diffusion license](#) on page 483

Diffusion includes a development license that enables you to use make up to 5 concurrent connections to the Diffusion server.

[Installed files](#) on page 486

After installing Diffusion the following directory structure exists:

Related tasks

[Installing the Diffusion server using the graphical installer](#) on page 477

The Diffusion binary files are available from the Push Technology website. You can install Diffusion using the graphical installer.

[Installing the Diffusion server using the headless installer](#) on page 479

The Diffusion binary files are available from the Push Technology website. You can install Diffusion from the command line.

[Installing the Diffusion server using Docker](#) on page 481

Diffusion is available as a Docker[®] image from Docker Hub.

[Verifying the Diffusion installation](#) on page 488

Start your Diffusion server, review the logs, and connect to the console to verify that your installation is correct.

Related reference

[System requirements for the Diffusion server](#) on page 33

Review this information before installing the Diffusion server.

Installing the Diffusion server using Docker

Diffusion is available as a Docker[®] image from Docker Hub.

Before you begin

You must have Docker installed on your system to run Diffusion from a Docker image. For more information, see <https://docs.docker.com/userguide/>.

About this task

You can use Docker to install the Diffusion server, and a minimal complete set of its dependencies, on a Linux system. This image contains a Diffusion server with a trial license and default configuration and security.

Using Docker enables you to install the Diffusion server in an isolated and reproducible way.

Procedure

1. Pull the latest version of the Diffusion image.

```
docker pull pushtechology/docker-diffusion:6.1.5
```

If you receive an error about the license file, check you are pulling the latest version available.

2. Run the image.

```
docker run -p 8080:8080 image_id
```

Where *image_id* is the ID of the image to run. You can find the image ID using

```
docker images
```

Port 8080 is the port that is configured to allow client connections by default.

Results

Diffusion is now running in a container on your system. Clients can connect through port 8080.

Note: This Diffusion instance contains well known security principals and credentials. Do not use it in production without changing these values.

Related concepts

[The Diffusion license](#) on page 483

Diffusion includes a development license that enables you to use make up to 5 concurrent connections to the Diffusion server.

[Installed files](#) on page 486

After installing Diffusion the following directory structure exists:

Related tasks

[Installing the Diffusion server using the graphical installer](#) on page 477

The Diffusion binary files are available from the Push Technology website. You can install Diffusion using the graphical installer.

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The Diffusion binary files are available from the Push Technology website. You can install Diffusion from the command line.

[Installing the Diffusion server using Red Hat Package Manager](#) on page 480

Diffusion is available as an RPM file from the Push Technology website.

[Verifying the Diffusion installation](#) on page 488

Start your Diffusion server, review the logs, and connect to the console to verify that your installation is correct.

Related reference

[System requirements for the Diffusion server](#) on page 33

Review this information before installing the Diffusion server.

Next steps with Docker

The Diffusion image on Docker Hub includes the default configuration, default security, and trial license. Additional steps are required to secure and configure the Diffusion server.

Procedure

1. Create a Dockerfile that contains commands to configure a Diffusion image for your use.
 - a) Base your Docker image on the Diffusion image.

```
FROM pushtechnology/docker-diffusion:6.1.5
```

- b) To use Diffusion in production, obtain a production license from .

The default Diffusion image includes a development license that allows connections from up to five clients.

- c) Copy the production license into the `/opt/Diffusion/etc` directory of your Diffusion image.

```
ADD license_file /opt/Diffusion/etc/licence.lic
```

Where `license_file` is the path to the production license relative to the location of the Dockerfile.

- d) Create versions of the Diffusion configuration files that define your required configuration. For more information, see [Configuring your Diffusion server](#) on page 490.
- e) Copy these configuration files into the `/opt/Diffusion/etc` directory of your Diffusion image.

```
ADD configuration_file /opt/Diffusion/etc/file_name
```

Where `configuration_file` is the path to the configuration file relative to the location of the Dockerfile and `file_name` is the name of the configuration file.

- f) Create versions of the `Security.store` and `SystemAuthentication.store` that define roles, principals and authentication actions for your security configuration.

For more information, see [Pre-defined roles](#) on page 139, [DSL syntax: security store](#) on page 414, and [DSL syntax: system authentication store](#) on page 404.

You can instead choose to edit these files using a Diffusion client. However, your Diffusion server is not secure for production use until you do so.

- g) Copy these store files into the `/opt/Diffusion/etc` directory of your Diffusion image.

```
ADD store_file /opt/Diffusion/etc/file_name
```

Where `store_file` is the path to the store file relative to the location of the Dockerfile and `file_name` is the name of the store file.

- h) Include any additional configuration actions you want to perform on your image in the Dockerfile.

2. Build your image.

Run the following command in the directory where your Dockerfile is located:

```
docker build .
```

Results

The image you created contains a configured Diffusion server ready for you to use in your solution. You can run multiple identically configured Diffusion servers from this image.

The Diffusion license

Diffusion includes a development license that enables you to use make up to 5 concurrent connections to the Diffusion server.

To use Diffusion in production, contact for production licenses.

Related concepts

[Installed files](#) on page 486

After installing Diffusion the following directory structure exists:

Related tasks

[Installing the Diffusion server using the graphical installer](#) on page 477

The Diffusion binary files are available from the Push Technology website. You can install Diffusion using the graphical installer.

[Installing the Diffusion server using the headless installer](#) on page 479

The Diffusion binary files are available from the Push Technology website. You can install Diffusion from the command line.

[Installing the Diffusion server using Red Hat Package Manager](#) on page 480

Diffusion is available as an RPM file from the Push Technology website.

[Installing the Diffusion server using Docker](#) on page 481

Diffusion is available as a Docker[®] image from Docker Hub.

[Verifying the Diffusion installation](#) on page 488

Start your Diffusion server, review the logs, and connect to the console to verify that your installation is correct.

Related reference

[System requirements for the Diffusion server](#) on page 33

Review this information before installing the Diffusion server.

License restrictions

The Diffusion license can include restrictions on how the Diffusion server is used.

Environments

A Production license must not be used on a Development server, and a Development license must not be used on a Production server. Order separate licenses defined as Production, QA/Testing, Disaster Recovery, and Development.

License expiry

All license files provided by Push Technology include an expiry date. To continue to use Diffusion after this date you must replace your license file with an updated license file.

The Diffusion server logs the number of days remaining on your license every day at midnight and when the server starts ([PUSH-000202](#) on page 630).

When the license has expired, the Diffusion server stops working within 24 hours. A message is logged when the license expires ([PUSH-000203](#) on page 630).

Concurrent client connections

An instance of the Diffusion server is licensed to only allow up to a certain number of client connections at the same time.

A license can include a soft limit and a hard limit on concurrent client connections. When the soft limit is reached, the Diffusion server logs a message ([PUSH-000201](#) on page 629) to say that the soft limit has been reached. When the hard limit is exceeded, the Diffusion server rejects connections and logs a message ([PUSH-000056](#) on page 620) to say that the hard limit has been reached.

Connection limit pooling

If you have a license for or and have a cluster of servers using replication, the soft and hard limits are pooled between servers.

For example, you have a cluster of three servers, each with a soft limit of 5 and a hard limit of 10. The cluster-wide limits are the total of each individual server's limits, giving a cluster-wide soft limit of 15 (3x5) and a hard limit of 30 (3x10).

Any new client connections are checked against the cluster-wide limits. A server can exceed the hard limit of its individual license, provided that the cluster-wide limit is not exceeded. For example, one of the servers in our example above could have more than 10 client connections, provided the total number of connections to the cluster did not exceed 30.

Fan-out limit pooling

If you have a license for or the hard limit for fan-out connections is pooled between servers in a cluster.

Total number of topics

A Diffusion license can specify a maximum total number of topics. If the number of topics is exceeded, the server logs a message ([PUSH-000711](#) on page 686).

MAC addresses or IP addresses

An instance of the Diffusion server can be licensed to run only on systems with a certain range of IP addresses or MAC addresses.

On startup, the Diffusion server checks the IP address or MAC address of the system the server runs on. If the Diffusion server cannot read the IP or MAC address of the host system, it logs a message ([PUSH-000207](#) on page 630 or [PUSH-000208](#) on page 631) and does not start. If the IP or MAC address of the host system is not in the licensed address range, the server logs a message ([PUSH-000200](#) on page 629 or [PUSH-000209](#) on page 631) and does not start.

CPU cores

An instance of the Diffusion server can be licensed to run only on systems with a certain number of CPU cores.

On startup, the Diffusion server checks the number of CPU cores available to the JVM at runtime.

Diffusion version

A Diffusion license can be valid for specific versions of Diffusion only.

If you use a license file with a version of Diffusion that it is not valid for, the Diffusion server logs a message ([PUSH-000199](#) on page 629) and does not start.

Updating your license file

You can update your Diffusion license file without having to restart the Diffusion server. Copy the new file over the old and ensure that the timestamp is updated.

Before you begin

Obtain a new or renewed license file from Push Technology.

About this task

When your license file expires, the Diffusion server continues to run for another day before it stops. We recommend you update your license file before your existing license file expires.

Procedure

1. Copy the new license file (`licence.lic`) over the existing file in the `diffusion_directory/etc` directory.
You do not need to stop or restart the server.
2. Check that the timestamp of `licence.lic` has updated.

- On Windows, you might have to use the following command to copy the file over and force the timestamp to update: `COPY /B licence.lic +,,`
3. Diffusion checks the timestamp of the `licence.lic` every minute. If the license file has been updated, Diffusion reloads it and logs this to stdout.
 4. You can verify that the license file has been updated in the server by accessing the mbean **`com.pushtechology.diffusion > Server > LicenseExpiryDate`**

Installed files

After installing Diffusion the following directory structure exists:

Table 46: Installed files

Folder name	Contents
<code>adapters</code>	Adapters to connect Diffusion to other messaging systems: <ul style="list-style-type: none"> • JMS • Push Notifications
<code>bin</code>	Executables for starting Diffusion
<code>clients</code>	Client Diffusion API libraries and related artifacts for all supported platforms.
<code>data</code>	Files used by publishers, the console, and third-party components. This directory is always on the server classpath. However, the <code>ext</code> directory is the preferred place to store resource files that are loaded by publishers.
<code>demos</code>	The compiled DAR files and source code for the demos issued with Diffusion. For more information, see Demos on page 755.
<code>deploy</code>	Publisher DAR files that are deployed when the Diffusion server starts. If you selected during the install process to deploy the demos, the demo DAR files are in this directory.
<code>docs</code>	License information, release notes, and install notes.
<code>etc</code>	Diffusion configuration files and store files for security configuration. For more information, see Configuring your Diffusion server on page 490.
<code>examples</code>	Example code that uses the Diffusion APIs.
<code>ext</code>	This directory, together with any jar files in this directory or subdirectories, are available through the classloader used to deploy application code to the Diffusion server. You can add library jar files to this directory that are required by application code such as publishers and local authentication handlers.

Folder name	Contents
html	Files that are used by the default web server for issuales accessible through the browser.
lib	The main Diffusion server JAR file, third-party libraries, and additional server-side components.
logs	The directory to which Diffusion server and web server logs are written.
tools	Tools and utilities that help with testing and deploying Diffusion. For more information, see Tools and utilities on page 487
xsd	The schema files for the XML configuration files used by the server.

Tools and utilities

The following table describes the some of the contents of the `tools` directory.

Note: The files present and their suffixes vary according to the platform that the product is installed on.

Table 47: Tools and utilities

Tool	Description
<code>/ec2</code>	A sample configuration for setting up the Diffusion server in an Amazon™ EC2 instance.
<code>/init.d</code>	Sample <code>init.d</code> files to start the Diffusion server as daemon on macOS, Linux, or UNIX systems.
<code>/joyent</code>	A sample configuration for setting up the Diffusion server in a Joyent™ instance.
<code>war.xml</code>	Example <code>war.xml</code> file
<code>web.xml</code> and <code>sun-web.xml</code>	Example <code>web.xml</code> files

Related concepts

[The Diffusion license](#) on page 483

Diffusion includes a development license that enables you to use make up to 5 concurrent connections to the Diffusion server.

Related tasks

[Installing the Diffusion server using the graphical installer](#) on page 477

The Diffusion binary files are available from the Push Technology website. You can install Diffusion using the graphical installer.

[Installing the Diffusion server using the headless installer](#) on page 479

The Diffusion binary files are available from the Push Technology website. You can install Diffusion from the command line.

[Installing the Diffusion server using Red Hat Package Manager](#) on page 480

Diffusion is available as an RPM file from the Push Technology website.

[Installing the Diffusion server using Docker](#) on page 481

Diffusion is available as a Docker® image from Docker Hub.

[Verifying the Diffusion installation](#) on page 488

Start your Diffusion server, review the logs, and connect to the console to verify that your installation is correct.

Related reference

[System requirements for the Diffusion server](#) on page 33

Review this information before installing the Diffusion server.

Verifying the Diffusion installation

Start your Diffusion server, review the logs, and connect to the console to verify that your installation is correct.

About this task

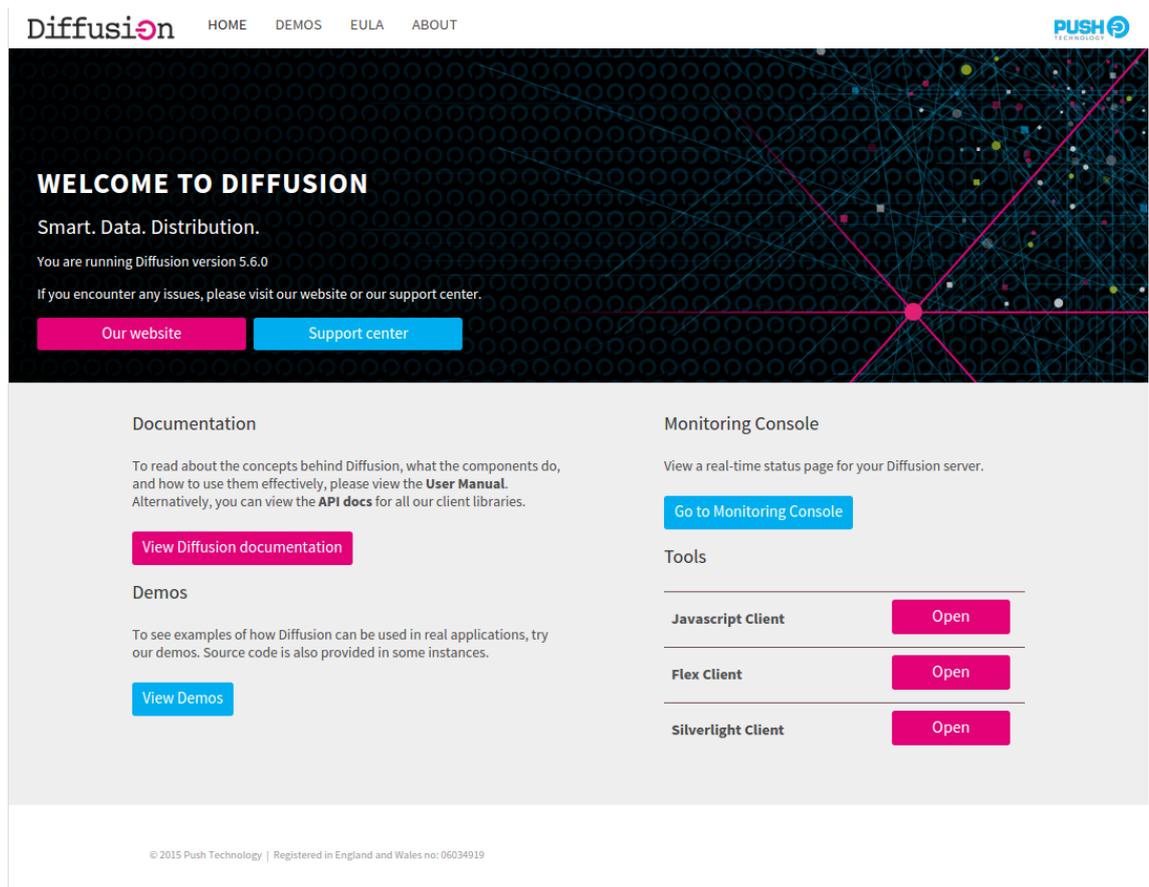
After installation, all of the Diffusion files are available in the directory specified during installation.

Procedure

1. Start the Diffusion server using one of the start script located in the `bin` directory of your Diffusion installation.
 - On Windows, use the `diffusion.bat` file.
 - On Linux, macOS, or UNIX, use the `diffusion.sh` file.
2. Inspect the log messages to ensure that the Diffusion server started successfully.

The terminal window displays logging information about the status of the Diffusion server. A log message containing the following text indicates that the server started successfully: `INFO|main|PUSH0165|Diffusion Server started.|com.pushtechnology.diffusion.DiffusionController` This line is typically the last one to be printed on terminal.
3. Inspect all log messages displayed in the terminal to search for `WARN` messages to ensure that all components have started correctly.
4. Open a browser and navigate to `http://serverAddress:8080` (or `http://localhost:8080`)

The browser shows the Diffusion landing page.



The landing page provides links to information regarding legal terms and conditions (for example, EULA), user guides, API documentation and demos.

The Diffusion server is ready to be used.

5. If you chose to install the demos, you can access them from the landing page. Use these demo publishers to verify your installation.

Related concepts

[The Diffusion license](#) on page 483

Diffusion includes a development license that enables you to use make up to 5 concurrent connections to the Diffusion server.

[Installed files](#) on page 486

After installing Diffusion the following directory structure exists:

Related tasks

[Installing the Diffusion server using the graphical installer](#) on page 477

The Diffusion binary files are available from the Push Technology website. You can install Diffusion using the graphical installer.

[Installing the Diffusion server using the headless installer](#) on page 479

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[Installing the Diffusion server using Docker](#) on page 481

Diffusion is available as a Docker® image from Docker Hub.

Related reference

[System requirements for the Diffusion server](#) on page 33

Review this information before installing the Diffusion server.

Configuring your Diffusion server

You can configure the Diffusion server using XML files which normally reside in the `etc` directory. You can also configure user security on the Diffusion server using the `.store` files in the `etc` directory.

Alternatively, a Diffusion server can be instantiated in a Java application and configured programmatically. Some properties can also be changed at runtime programmatically from within publishers.

In a Java client environment certain properties can also be configured programmatically.

All properties (whether configured from XML or programmatically) are available to read programmatically from within the Java API.

XML configuration

Configuring a Diffusion server using XML property files

XML Property files

A Diffusion server is configured using a set of XML property files typically loaded from the `etc` folder. In a new Diffusion installation example versions of these files are provided which can be edited as required.

XML is used rather than standard property files due to the hierarchic nature and the ability to support repeating groups.

XSD files are issued that define the content of the XML property files and this section summarizes the XSD content.

Configuration path loading

You can pass a parameter to Diffusion upon startup so that files are not automatically loaded from the `etc` folder but loaded from a different folder. This folder does not have to contain the complete set of XML files, but the file is loaded from the specified folder first, if it exists. If it does not, Diffusion loads the configuration file from the `etc` folder. When Diffusion starts, it logs where each configuration file has been loaded from.

XML Value types

When XML values are loaded, the schema is checked so that we know that it is valid, but to aid configuration, there are some extra data types. When values are loaded, they are trimmed of leading and trailing white space.

Table 48: XML Value types

Data type	Meaning
push:boolean	true or false

Data type	Meaning
push:string	String value
push:int	A number between -2,147,483,648 and 2,147,483,647
push:long	A number between -9,223,372,036,854,775,808 and 9,223,372,036,854,775,807
push:double	An 8 byte IEEE 754 floating point number: from +/- 2 ⁻¹⁰⁷⁴ to +/- (2 - (2 ⁻⁵²))·2 ¹⁰²³
push:port	A positive number but less than 65535
push:millis	<p>A string that represents the number of milliseconds. Append the mnemonic for the time unit. The mnemonic can be either upper or lower case.</p> <p>s Seconds</p> <p>m Minutes</p> <p>h Hours</p> <p>d Days</p> <p>360000, 360s, 6m all represent 6 minutes</p>
push:bytes	<p>A string that represents the number of bytes. Append the mnemonic size unit. The mnemonic can be either upper or lower case.</p> <p>k Kilobytes</p> <p>m Megabytes</p> <p>g Gigabytes</p> <p>6291456, 6144k, 6m, all represent 6 Megabytes</p>
push:log-level	A log level can be ERROR, WARN, INFO, DEBUG, or TRACE.
push:percent	A value that represents a percentage, this can have the trailing percent sign (%)
push:positiveNonZeroInt	A number between 1 and 2,147,483,647
push:positiveInt	A number between 0 and 2,147,483,647
push:positiveNonZeroLong	A number between 1 and 9,223,372,036,854,775,807
push:positiveLong	A number between 0 and 9,223,372,036,854,775,807
<element>	This notation is used to indicate a complex element type. It can also be List<element> to indicate a repeating property group.

Environmental values

When defining custom configurations, you can define environmental variables that can be reused in all XML property files. These variables can be defined in the `etc/Env.xml` property file to be used in all other property files. Suppose, for example, the `etc/Env.xml` file defines a `server-name` variable, with value `d-unit` as follows:

```
<env>
  <property name="server-name">d-unit</property>
</env>
```

The `server-name` variable can be used in all other property files, where the value `d-unit` is appropriate, either as a value for an attribute, as in

```
<server name={server-name}>
  ...
</server>
```

or as a name for an element as in:

```
<server>{server-name}</server>
```

As a side remark, it is worth noting that names can be combined to provide malleable environmental variables. Suppose for instance `Env.xml` contains the following entries:

```
<env>
  <property name="server-name">myServer</property>
  <property name="server-version">V2.0</property>
</env>
```

Then `server-name` and `server-version` can be combined, for instance within the same `etc/Env.xml`, as

```
<property name="server-and-version">{server-name}-{server-version}</property>
```

and used in all other configuration files.

Obfuscation tool

Use the obfuscation tool to protect sensitive strings such as passwords in configuration files.

Obfuscation tool

The Diffusion configuration files can contain sensitive data like:

- fan-out connection passwords
- keystore passwords

Use the obfuscation tool to make it harder for an attacker to read the passwords. The tool converts them to a form that the server can understand, but which is not easily readable by a casual observer.

The tool is a command-line script in the `bin` directory called `obfuscate.sh` (or `obfuscate.bat` for Windows).

The script takes strings representing the passwords or other values you want to protect as command line arguments.

It writes out the obfuscated version of each argument in order.

Copy the output and use it in the Diffusion configuration file in place of the original string.

Note: The obfuscation method provides superficial protection against casual browsers. To provide better protection, ensure the file can only be read by trusted users.

Programmatic configuration

An alternative to configuring a Diffusion server using XML property files is to instantiate a Diffusion server within a Java application and configure it programmatically before starting it.

If desired, some properties can be loaded from XML files and some supplied programmatically or default properties can be bootstrapped from XML files and overridden programmatically before the server is started.

Most server properties can be configured only before the server is started. Instantiate the server within an application and configure before starting the server. However, certain configuration items (examples being conflation and connection policies) can be configured at any time during the life of the server. The API documentation makes it clear if a property can be changed at runtime.

Because the properties that can be set programmatically reflect those that can be set in XML this section does not describe the properties in detail. The XSD property descriptions or the API documentation for the configuration API can be consulted for full details.

As well as allowing configuration properties to be set the configuration API also allows all properties that can be configured to be read at runtime. So publisher code has direct access to all property settings.

Using the configuration API

General use

The configuration API only affects server-side configuration.

From within server-side code (for example, a publisher) the server configuration root can be obtained using `ConfigManager.getServerConfig()` which exposes all of the server side configuration also.

From the configuration root you can navigate to any subordinate configuration objects to view them or set their properties.

Most properties cannot be changed after the server has started and they become locked so any attempt to change them results in an exception. Certain properties (such as conflation and connection policies) can be changed at runtime. The API documentation makes it clear which properties can be changed at runtime.

For configuration objects which are optional but there can be many (multiplicity 0..n), there are appropriate add methods to add new objects.

In these cases there are also methods to obtain the full list (for example, `getPublishers()`) or to obtain a specific one by name (for example, `getPublisher("MyPublisher")`). In many cases there are also methods to remove an object.

Note: When there must be at least one object (multiplicity 1..n), you must configure at least one. However, if a server is started with missing configuration of this kind, suitable defaults are normally created and a warning logged.

Single instance configuration objects (multiplicity 1..1) subordinate to the root can be obtained so that their properties can be changed (or read). So, for example the `Queues` object (an instance of `QueuesConfig`) can be obtained using the `getQueues()` method.

When a single configuration object is optional (multiplicity 0..1), the `get` method can return null if it has not been defined. In this case to set it the `set` method (as opposed to `add`) returns the object created. An example of this is the file service (`FileServiceConfig`) on a web server (`WebServerConfig`) as shown in the following example code:

```
ServerConfig config = ConfigManager.getServerConfig();
WebServerConfig webServer = config.addWebServer("MyWebServer");
FileServiceConfig fileService = webServer.setFileService("File
Service");
```

Configuring a server

After instantiating a Diffusion server in Java the root of the server configuration tree can be obtained from the server object itself and configuration objects can be navigated to and changed as required before starting the server.

For example, the following code shows how to add a connector that accepts client connections on port 9090:

```
DiffusionServer server = new DiffusionServer();
ServerConfig config = server.getConfig();
ConnectorConfig connector = config.addConnector("Client Connector");
connector.setPort(9090);
connector.setType(Type.CLIENT);
server.start();
```

In reality, it is best to configure far more values. However, if any essential objects are omitted (such as queues), suitable defaults are created when the server starts and a warning is logged.

Configuration access from a publisher

Within a publisher the configuration object for the publisher itself can be obtained using the `getConfig` method which returns the publisher configuration (`PublisherConfig`) object.

Configuring the Diffusion server

Use the `Server.xml` configuration file to configure the core behaviors of the Diffusion server.

Configuring fan-out

Configure the the Diffusion server to act as a client to one or more other Diffusion servers and replicate topics from those servers.

Use the `fanout` section of the `Server.xml` configuration files to define client connections for this secondary server to make to one or more primary servers and the topics on those primary servers to replicate locally.

Each `fanout-connection` element represents a client connection that your Diffusion server makes to another Diffusion server in your solution.

```
<fanout>
  <connection>
    <url>ws://primary_server_hostname:8080</url>
    <principal>client</principal>
    <password>password</password>
    <retry-delay>1000</retry-delay>
    <reconnect-timeout>60s</reconnect-timeout>
    <recovery-buffer-size>1024</recovery-buffer-size>
```

```
<input-buffer-size>1024k</input-buffer-size>
<output-buffer-size>1024k</output-buffer-size>
<link><selector>?topic_path//</selector></link>
</connection>
</fanout>
```

Connection

Use the `url` element to specify the URL of the primary server and the transport and port used for the connection.

Permissions

When connecting to another Diffusion server as a client, this secondary server can provide a principal and associated password. If a principal is not provided, the secondary server connects anonymously

To subscribe to topics on the primary server and replicate them locally, the secondary server's client session must have the `select_topic` and `read_topic` permissions for those topics. Ensure that the principal this secondary server uses is assigned a role with the appropriate permissions on the primary server. If the secondary server connects anonymously to the primary server, ensure anonymous sessions on the primary server are assigned the appropriate permissions.

Reconnection

Use the `retry-delay` element to specify the time in milliseconds between the connection or reconnection attempts that the secondary server makes to the primary server.

Use the `reconnect-timeout` element to specify the maximum time in milliseconds that the secondary server will attempt to reconnect to its existing session on the primary server after a disconnection. If this element is not specified, a value of 0 is assumed and reconnection is not attempted.

If the secondary server is configured to attempt to reconnect, it keeps a buffer of messages sent to the primary server. Use the `recovery-buffer-size` element to configure the size of this buffer.

Replicating topics

Each `fanout-connection` has one or more `link` elements. Each `link` element uses a topic selector to specify a set of topics on the primary server to replicate on this secondary server.

Note: The set of topics specified by a link cannot overlap the set of topics specified by any other link within either this `fanout-connection` or any of the others.

If you want missing topic handlers registered on the primary server to receive missing topic notifications when a subscription or fetch request is made on the secondary server to a part of the topic tree that matches a link selector, consider the following when configuring your secondary server links:

- Avoid using regular expressions in the selectors you use to configure when setting up fan-out links on the secondary server. Topic selectors containing regular expressions increase the likelihood of false negatives and false positives when propagating missing topic notifications.
- Ensure that the principal that the secondary server uses to make the fan-out connection to the primary server has the `SELECT_TOPIC` permission for the path prefix of the selector that triggered the missing topic notification.

For more information, see [Using missing topic notifications with fan-out](#) on page 101.

Configuring your primary server

The primary server in a fan-out configuration must be configured to handle serving the topics replicated by fan-out to the secondary server or servers.

Ensure that the primary server connector that the secondary server or servers connect to has a large enough queue to handle the number of primary server topics that will be replicated by fan-out. In the `Connectors.xml` file, inside the `<connector>` element that defines the connector used for fan-out connections, set the queue depth to greater than the number of fanned out topics:

```
<queue-definition>depth</queue-definition>
```

To allow the secondary server to reconnect, enable reconnection on the connector that the primary server uses to accept connections from the secondary server or servers. Ensure that the reconnection timeout (`keep-alive`) value for the connector is long enough to allow the secondary server time to reconnect. Set the maximum queue depth and recovery buffer sizes to values that are appropriate to the volume of messages you expect to occur between the primary and secondary servers.

For more information, see .

Related concepts

[Fan-out](#) on page 99

Consider whether to use fan-out to replicate topic information from primary servers on one or more secondary servers.

Configuring legacy conflation

Use the `conflation` section of the `Server.xml` configuration file to define conflation policies for deprecated topics that use the legacy conflation system (stateless, single value and record topics).

Note: The legacy conflation system is only used with deprecated topic types, and will be removed when the deprecated topic types are removed.

Legacy conflation versus new topic properties system

The legacy system to configure conflation policy described below is only used for these deprecated topic types:

- single value
- record
- stateless

Other topic types use a new system based on topic properties, described in [Configuring conflation](#) on page 429.

If the new system is used to set an "off" policy on a deprecated topic, that policy will be applied and any legacy conflation policy will be ignored.

If the new system is used to set an "unsubscribe" policy on a deprecated topic, the legacy policy is evaluated for each message, and the "unsubscribe" policy is applied when the message queue is full.

If the new system is used to set an "always" or "conflate" policy, the legacy conflation policy will be applied and the new system will not otherwise be used.

Note: Legacy conflation policies can be also be configured programmatically using the `addPolicy` methods on `ConflationConfig`. Such policies can also be added dynamically after the Diffusion server has started.

Legacy conflation policies

One or more conflation policies can be configured, each defining different conflation mechanisms by using `conflation-policy` elements. Conflation policies comprise the following:

Table 49: Conflation policy elements

Property	Description
name	A unique name by which the policy is referred to.
mode	Indicating whether the new (or merged) message is to replace the current message in place or whether the current message is to be removed and the new one appended to the end of the queue.
matcher	A Java class which matches two messages and is used to locate an existing queued message as a candidate for conflation. If no matcher is specified then default matching finds a message that is of the same topic.
merger	A Java class which performs the merge of two messages of the same topic to produce a new message containing the data from both messages (or any resulting data required). If no merger is specified, no merging takes place and the current message is removed from the queue and the new message either replaces it or is appended to the queue depending upon the mode. The merger can also indicate that either the current or new message is to be used or even that no conflation takes place in this instance.

Having defined one or more conflation policies, you can map topics to them. This is done by specifying a topic path or topic selector which maps to a particular conflation policy.

Conflation policies can be added or removed at runtime and the removal of a conflation policy automatically removes any mappings to it.

Conflation policy mode

The conflation policy mode determines whether the new (or merged) message is to replace the existing message in the client queue or be appended to the end of the client queue.

Available modes are:

Table 50: Conflation policy modes

Mode	Definition
REPLACE	The new (or merged) message will replace the existing message at its current position in the client queue.
APPEND	The current message is removed from the client queue and the new (or merged) message is appended to the end of the queue.

If no mode is specified, `REPLACE` is assumed.

The mode is specified in the `mode` property of a `conflation-policy` section in `etc/Server.xml`.

When defining conflation policies programmatically the mode is specified when creating the policy.

Message matchers

A message matcher is used by a conflation policy when queuing a new message for a client that has conflation enabled for a topic that has a conflation policy defined for it. The message matcher is used to locate the last message queued for a client that is a candidate for conflation.

If no message matcher is explicitly defined for a conflation policy, a default matcher is used which locates a message of the same topic.

A message matcher can be supplied if the matching is to be somehow dependent upon the content of the messages.

To implement a message matcher, write a Java class that implements `com.pushtechnology.diffusion.api.conflation.MessageMatcher`. This has a single method called `matches` to which is passed the current message in the queue being tested and the new message to be queued.

Note: The existing message is always of the same topic as the new message so you do not have to check that is the case.

An example of a `MessageMatcher` implementation is shown below:

```
public class ExampleMessageMatcher implements messageMatcher {
    @Override
    public boolean matches(TopicMessage currentMessage, TopicMessage
newMessage) {
        return
currentMessage.nextField().equals(newMessage.nextField());
    }
}
```

`MessageMatcher` implementations must be thread safe and stateless. The same `MessageMatcher` instance can be supplied to more than one different conflation policy if so required.

Message mergers

A message merger can be specified on a conflation policy if the action of the policy is to merge the content of an existing queued message with the new message being queued. This technique can be used when message data comprises more than one data item and it is desirable to reduce the number of messages sent to the client whilst preserving the data from all messages.

If no message merger is specified for a conflation policy, the policy replaces the current message with the new.

To implement a message merger, write a Java class that implements `com.pushtechnology.diffusion.api.conflation.MessageMerger`. This has a single method called `merge` to which is passed the current message in the queue and the new message to be queued.

Note: The existing message is always of the same topic as the new message so you do not have to check that is the case.

The action of conflation will depend upon the message that is returned from the merger method, as follows:

Table 51: Action depending upon merge result

Returned message	Action
A new message	It is assumed that the new message represents a merging of the data of the two messages input and so the returned message either replaces the current message in the queue or the current message is removed and the returned message added to the end of the queue, depending upon the policy mode.
The current message	The current message is retained at its current queue position and the new message is not queued.
The new message	The new message either replaces the current message in the queue or the current message is removed and the new message appended to the end of the queue depending upon the policy mode. This is effectively the same as the result that occurs if there is no merger.
Null	No conflation will occur. The current message remains where it is in the queue and the new message is appended to the end of the queue,

An example of a message merger implementation is shown below:

```

package com.pushtechology.diffusion.examples;

import com.pushtechology.diffusion.api.message.MessageReader;
import com.pushtechology.diffusion.api.message.Record;
import org.slf4j.Logger;
import org.slf4j.LoggerFactory;

import com.pushtechology.diffusion.api.APIException;
import com.pushtechology.diffusion.api.conflation.MessageMerger;
import com.pushtechology.diffusion.api.message.TopicMessage;
import com.pushtechology.diffusion.api.publisher.Publishers;

import java.util.ArrayList;
import java.util.List;

public final class MessageMergerExample implements MessageMerger {
    private static final Logger LOG =
        LoggerFactory.getLogger(MessageMergerExample.class);

    @Override
    public TopicMessage merge(TopicMessage currentMessage,
        TopicMessage newMessage) throws APIException {

        final MessageReader currentMessageReader =
            currentMessage.getReader();
        final MessageReader newMessageReader =
            newMessage.getReader();

        final TopicMessage result =
            Publishers.createDeltaMessage(currentMessage.getTopicName());

        Record cRecord = currentMessageReader.nextRecord();
        Record nRecord = newMessageReader.nextRecord();

        while (nRecord != null) {
            final List<String> mergedRecord = new
                ArrayList<>(nRecord.size());
            for (int i = 0; i < nRecord.size(); i++) {

```

```

        final String nField = nRecord.getField(i);
        if (!nField.isEmpty() || cRecord == null || i >=
cRecord.size()) {
            mergedRecord.add(nField);
        }
        else {
            mergedRecord.add(cRecord.getField(i));
        }
    }

    result.putRecord(mergedRecord);

    nRecord = newMessageReader.nextRecord();
    cRecord = currentMessageReader.nextRecord();
}

    if (LOG.isTraceEnabled()) {
        LOG.trace("MessageMerger merging - currentMessage: {},
newMessage: {}, merged: {}",
            currentMessage.asRecords(),
newMessage.asRecords(), result.asRecords());
    }

    return result;
}
}

```

The above example merges delta messages for record topics with variable records and fields.

`MessageMerger` implementations must be thread safe and stateless. The same `MessageMerger` instance can be supplied to more than one different conflation policy if so required.

Default conflation policy

You can specify a default conflation policy that is used for any topics that do not have explicit policy mappings.

Use a default conflation policy only if you want to apply conflation to all topics when conflation is enabled for a client.

This can be specified using the `default-conflation-policy` property in the `conflation` section of `etc/Server.xml`. Alternatively it can be set programmatically at any time using the `setDefaultPolicy` method on `ConflationConfig`.

If no default policy is set, conflation will not occur for topics that have no explicit mappings even when conflation is enabled.

Mapping topics to policies

Having defined one or more conflation policies, you can map topics to the conflation policies that are to be used for them.

Use a topic selector pattern when mapping to a conflation policy.

As the use of topic selectors makes it possible for more than one mapping to potentially apply to the same topic, the last mapping defined that matches a specific topic is the one that is used for conflating messages of that topic.

A default conflation policy can be specified which is selected to map to if no other mapping matches a topic.

Messages for topics that have no mappings (when there is no default policy) are not conflated, even if conflation is enabled for a client.

Conflation mappings can be defined using `topic-conflation` elements within the `conflation` section of the `etc/Server.xml` property file.

Conflation mappings can also be set programmatically using the `setTopicPolicy` method of `ConflationConfig`. Mappings can be set at any time during the running of a server. Mappings can also be removed at any time using `unsetTopicPolicy`.

Note: Removing a conflation policy at runtime will automatically remove any mappings to it.

Enabling conflation

Specify conflation for a queue-definition by setting the `conflates` property to `true`. This queue definition can then be used wherever required, for example by connectors that have conflation enabled for all clients.

Configuring authentication handlers

Authentication handlers and the order that the Diffusion server calls them in are configured in the `Server.xml` configuration file.

To configure authentication handlers for your server, edit the `Server.xml` configuration file to include the following elements:

```
<security>
  <authentication-handlers>
    <authentication-handler class="com.example.LocalLDAPHandler" />
    <system-authentication-handler/>
    <control-authentication-handler handler-name="RemoteHandler" />
  </authentication-handlers>
</security>
```

Ordering your configuration handlers

The order of handler elements within the `<authentication-handlers>` element defines the order in which the authentication handlers are called. In the preceding example, `LocalLDAPHandler` is called first. If `LocalLDAPHandler` returns an `ABSTAIN` result, the system authentication handler is called next. If the system authentication handler returns an `ABSTAIN` result, `RemoteHandler` is called next.

Order your authentication handlers from least to most restrictive and configure your handlers to abstain unless they are to explicitly allow or deny the authentication request.

For more information, see [Authentication](#) on page 141.

Configuring local authentication handlers

Configure local authentication handlers by using the `<authentication-handler/>` element. The value of the attribute `class` is the class name for the handler.

You can configure any number of distinct local authentication handlers in the `Server.xml` file.

Configuring the system authentication handler

You can configure Diffusion to use the system authentication handler by using the `<system-authentication-handler/>` element. The system authentication handler uses information in the system authentication store to make authentication decisions.

You can configure the system authentication handler to be called at most once. This restriction is not enforced by the XSD for the `Server.xml` file, but the Diffusion server does enforce this restriction on the configuration.

Configuring control authentication handlers

Control authentication handlers are configured by using the `<control-authentication-handler/>` element. The value of the attribute `handler-name` is the name by which the handler was registered by the control client. Control clients use the `AuthenticationControl` feature to register the handler and passing the binding name as a parameter.

If no control client has registered a control authentication handler with the name defined in the configuration file, the response for that handler is `ABSTAIN`.

Multiple control clients can register a control authentication handler with the same name. Registering a control authentication handler from multiple clients gives the following advantages:

- If one of the control clients becomes unavailable, another can handle the authentication request.
- Control clients can be changed or updated without affecting the authentication behavior.
- Authentication requests can be load balanced between the control clients.

You can configure any number of distinct control authentication handlers in the `Server.xml` file.

Note: To register a control authentication handler, an authenticating client must first connect to and authenticate with the server. We recommend that you configure a local authentication handler or the system authentication handler in the `Server.xml` file to authenticate the control client.

Related concepts

[User-written authentication handlers](#) on page 144

You can implement authentication handlers that authenticate clients that connect to the Diffusion server or perform an action that requires authentication.

[Local authentication handlers](#) on page 455

You can implement authentication handlers that authenticate client connections to the Diffusion server.

[Example: Register an authentication handler](#) on page 391

The following examples use the Diffusion API to register a control authentication handler with the Diffusion server. The examples also include a simple or empty authentication handler.

[Authenticating new sessions](#) on page 391

A client session can use the `AuthenticationControl` feature to authenticate other client sessions.

Related reference

[System authentication handler](#) on page 146

Diffusion provides an authentication handler that uses principal, credential, and roles information stored in the Diffusion server to make its authentication decision.

Configuring performance

Use the `Server.xml` configuration file to configure behaviors and parameters that affect the performance of the Diffusion server.

For more information on the factors to consider when configuring the performance of your Diffusion server, see the [Tuning](#) on page 566 section of this guide.

Configuring topic persistence

Use the `Server.xml` configuration file to configure the topic persistence feature.

Procedure

1. Edit this section of the `etc/Server.xml` file to configure persistence.

```
<persistence enabled="false">
  <!--
    <store-directory>dirName</store-directory>
  -->
</persistence>
```

- In the `persistence` element, set the `enabled` property to `true` to enable persistence. Removing the `enabled` property will also enable persistence.
 - By default, log files will be created in a directory called `persistence` in the Diffusion installation directory. If you want to use a different directory, uncomment the `store-directory` element and enter the full path to the directory where you want the files to be stored.
2. Restart the Diffusion server to load the configuration.

What to do next

Enabling persistence creates log files which can use a significant amount of file storage. Make sure to monitor the amount of space available in the server file system. See [Topic persistence](#) on page 112 for information about the approximate storage requirements.

If you want to back up or restore the persistence log, you should stop the Diffusion server.

When enabled, persistence is applied to all topics by default. You can disable persistence for an individual topic using the `PERSISTENT` topic property.

Related concepts

[Topic persistence](#) on page 112

Consider if you want to enable topic persistence for fast recovery of topic state when Diffusion servers restart.

Configuring connectors

A connector provides a connection point for external applications to connect to the Diffusion server over a TCP connection. Use the `Connectors.xml` configuration file to configure your connectors.

Each connector has a socket server thread which reacts to an incoming connection. The socket information is defined by the connector. Suitable connectors must be defined for inbound connections expected by the Diffusion server.

The following properties are common to all connectors:

Table 52: Connectors properties

Name	A name by which the connector can be identified.
Port	A port number on which to accept requests.
Host	The host to accept requests (only relevant on a multi-homed machine).

Input buffer size	The size of the socket input buffer to use for each connection.
Output buffer size	The size of the socket output buffer to use for each connection.

Socket buffer sizes are very important in achieving the best performance. For more information, see [Tuning](#) on page 566.

Client connections

Connectors can accept connections from any type of client. Any number of connectors can be defined to provide different connection points with different properties.

Each client connection has an input buffer to receive messages from the client. The configured input buffer size must be large enough to accommodate the largest message expected from the client. If the maximum message size and the input buffer size are configured as different values, the larger of the two is used as the input buffer size.

The output buffer size is used to assign an output buffer per client multiplexer into which messages are dequeued prior to transmission. This can have an important effect on performance. For more information, see [Tuning](#) on page 566.

Enabling session reconnection

Specify a reconnection timeout, maximum queue depth, and recovery buffer size by using the `<reconnect>` element in the `etc/Connectors.xml` configuration file.

Reconnection timeout (`keep-alive`)

How long a disconnected client's session remains available on the server before being closed. By default, this is 300 seconds.

Maximum queue depth (`max-depth`)

Optional maximum limit on the number of messages to queue for a disconnected client session. By default, this is the same as the queue depth for a connected client session, which is defined by the queue definitions in `Connectors.xml` and `Server.xml`.

Recovery buffer size (`recovery-buffer-size`)

The maximum number of sent messages to keep in a buffer. These messages can then be recovered on reconnection.

Here is an example connector configuration:

```
<connector>
...
<reconnect>
  <keep-alive>60s</keep-alive>
  <max-depth>1000</max-depth>
  <recovery-buffer-size>64</recovery-buffer-size>
</reconnect>
...
</connector>
```

Using the above example, a client can reconnect to the server through this connector within 60 seconds of becoming disconnected. While the client is disconnected, up to 1000 messages are queued for it. These messages are delivered to the client when it reconnects. A buffer of up to 64 sent messages are retained in the recovery buffer. When a client reconnects, the Diffusion server uses this buffer to re-send any messages that the client has not received.

Connectors.xml

This file specifies the schema for the connectors properties.

connectors

Connectors

The following table lists the elements that an element of type `connectors` can contain:

Name	Type	Description	Min occurs	Max occurs
connector	connector	Connector definition	0	unbounded

connector

Connector definition

The following table lists the attributes that an element of type `connector` can have:

Name	Type	Description	Required
name	push:string	The connector name	true

The following table lists the elements that an element of type `connector` can contain:

Name	Type	Description	Min occurs	Max occurs
required	push:boolean	This setting specifies if the connector must start successfully when the server is started. By default, the server will stop if the connector listen port cannot be initialised. If the value is set to false, the server will continue even if the connector failed to start.	0	1
type	connectorType	DEPRECATED: Since 6.0 this setting is no longer used	0	1
host	push:string	The name or the IP address that the connector binds to. This is optional.	0	1
port	push:port	The port on which the connector accepts connections.	1	1
backlog	push:positiveNonZero	The requested maximum queue length for incoming connection requests. It is rarely necessary to tune this value. Operating System settings must be adjusted in tandem. On Linux, the appropriate setting is <code>net.core.somaxconn</code> . If a value is not specified, a default of 1000 is used.	0	1
socket-conditioning	socket-conditioning	Describes the properties associated with TCP socket connections.	1	1
max-queued-bytes	push:long-bytes	The maximum number of bytes that can be queued for all sessions connected through this connector. If the number of	0	1

Name	Type	Description	Min occurs	Max occurs
		bytes queued for a connector exceeds this number, the server may disconnect clients. If not set then no limit is applied.		
web-server	push:string	If this connector is required to serve HTTP requests, this element specifies a web-server entry in WebServer.xml. If a value is not specified, the connector cannot serve HTTP requests. This is also required in order to be able to service websocket connections.	0	1
policy-file	push:string	DEPRECATED: Since 6.0 policy files are no longer supported	0	1
validation-policy-file	push:string	The location/name of a connection validation policy file to use for this connector. Applies only to type 'all' or 'client'.	0	1
key-store	key-store-definition	Keystore details for any connector that is to support secure (SSL) connections. If this is not specified, SSL connections are not supported.	0	1
queue-definition	push:string	An optional queue definition to use for this connector. This applies only to connectors of type 'all' or 'client'. The definition must exist in Server.xml. If this is not specified, the default queue definition specified in Server.xml is used.	0	1
reconnect	reconnect	Optional reconnection properties which apply only to connectors that accept 'client' connections. If this is not specified, reconnection of client connections is not supported.	0	1
ignore-errors-from	ignore-errors-from	Specifies addresses from which connection errors can be ignored. This is useful for masking errors that might be reported due to the connector port being pinged by some known external entity.	0	1
thread-pool-definition	push:string	Optionally, this can be used to specify a thread pool definition to be used for this connector to create its own inbound thread pool. If specified, the thread pool definition must exist in Server.xml. If a value is not specified, the default inbound thread pool is used.	0	1
selector-thread-pool-definition	push:string	Optionally, this can be used to specify a selector thread pool definition to be used for this connector to deal with NIO operations. If specified, the selector	0	1

Name	Type	Description	Min occurs	Max occurs
		thread pool definition must exist in Server.xml. If a value is not specified, the default selector thread pool is used.		
system-ping-frequency	push:millis	This indicates the interval at which clients are pinged by the server to ensure that they are still connected. If a response is not received from the client before the expiry of another interval period, the client is assumed to be disconnected. If this is not specified or a value of 0 is supplied, clients are not automatically pinged.	0	1
fetch-policy	fetch-policy	Specifies a policy for batching fetch requests. If a value is not specified, no policy is applied and fetches are not batched.	0	1
proxy-protocol	proxyProtocol	Indicates the proxy protocol required for connection. Can have the values 'NONE' or 'HA_PROXY'. The default value is 'NONE'. Only connections with the protocol specified are allowed. On publicly accessible connectors, ensure that this value is set to NONE. 'HA_PROXY' refers to the proxy protocol that was first implemented by HAProxy but it is also supported by others including Amazon's Elastic Load Balancer.	0	1
connection-timeout	push:millis	This is the time in milliseconds allowed for a connection to take place and complete its handshake processing. If this value is not specified for a connector, the value set in Server.xml is used.	0	1

socket-conditioning

Describes properties associated with TCP socket connections.

The following table lists the elements that an element of type `socket-conditioning` can contain:

Name	Type	Description	Min occurs	Max occurs
input-buffer-size	push:bytes	Specifies the size of the socket input buffer to use for each connection. If a value is not specified, a default of 128k is used. The greater of this value and the max-message-size set in Server.xml is used when setting the socket input buffer size.	0	1

Name	Type	Description	Min occurs	Max occurs
output-buffer-size	push:bytes	This value specifies the size of the output buffer to use for each connection. This must be large enough to accommodate the largest message to be sent. Messages are 'batched' into this buffer and so the larger the buffer, the more messages can be sent in a single write. If a value is not specified, a default of 128k is used.	0	1
keep-alive	push:boolean	This enables or disables TCP keep-alive. If a value is not specified, a default of true is used.	0	1
no-delay	push:boolean	This enables or disables TCP_NODELAY (disable/enable Nagle's algorithm). If a value is not specified, a default of true is used.	0	1
reuse-address	push:boolean	When a TCP connection is closed the connection can remain in a timeout state for a period of time after the connection is closed (typically known as the TIME_WAIT state or 2MSL wait state). For applications using a well-known socket address or port, it might not be possible to bind a socket to the required SocketAddress if there is a connection in the timeout state involving the socket address or port. Enabling this feature allows the socket to be bound even though a previous connection is in a timeout state. If this value is not specified, the feature is enabled.	0	1

reconnect

Reconnect properties.

The following table lists the elements that an element of type `reconnect` can contain:

Name	Type	Description	Min occurs	Max occurs
keep-alive	push:millis	This specifies the reconnection timeout. During this period a disconnected client can reconnect to the same client session. Messages for the client continue to be queued during this period. The default is 5 minutes, meaning reconnection is enabled. Set this value to 0 to disable reconnection.	0	1

Name	Type	Description	Min occurs	Max occurs
max-depth	push:positiveInt	As messages continue to be queued for a client whilst it is disconnected, this enables you to specify a larger maximum queue size that is used during the period that the client is disconnected. When the client reconnects, the maximum reverts back to its previous size (once any backlog had been cleared). If the specified size is not greater than the current maximum size, this has no effect. If this value is not specified, a default of 0 is used which means that no attempt is made to extend the queue size when a client is disconnected.	0	1
recovery-buffer-size	push:positiveInt	If the keep-alive time is not zero, this connector supports reconnection. For each client connected via this connector, the server will retain a buffer of up to recovery-buffer-size sent messages. If a client disconnects and reconnects, the server uses the buffer to re-send messages that the client has not received. The default value is 128 messages. Higher values increase the chance of successful reconnection, but increase the per-client memory footprint.	0	1

key-store-definition

The keystore definition that allows SSL connection to a connector.

The following table lists the attributes that an element of type `key-store-definition` can have:

Name	Type	Description	Required
mandatory	push:boolean	If this is set to true, all connections must use this keystore and SSL connection is mandatory. If a value is not specified, a default of false is used, meaning that the connector accepts either SSL or non-SSL connections.	false

The following table lists the elements that an element of type `key-store-definition` can contain:

Name	Type	Description	Min occurs	Max occurs
file	push:string	The keystore file path.	1	1
password	push:string	The password for the keystore.	1	1

ignore-errors-from

Some external monitors cause the Diffusion server to log errors, as it is not a valid Diffusion connection. Adding the remote IP address to this list ensure that the errors are not logged.

The following table lists the elements that an element of type `ignore-errors-from` can contain:

Name	Type	Description	Min occurs	Max occurs
ip-address	<code>push:string</code>	An IP address or unknown if the remote IP address is being masked.	1	unbounded

fetch-policy

This is the policy for batching fetch requests. This can be used when fetches on topic sets might be large and lead to an excessive number of fetch reply messages being queued for a client at one time. The policy can define that the replies are sent in periodic batches to allow the client time to process them and prevent client queues filling.

The following table lists the elements that an element of type `fetch-policy` can contain:

Name	Type	Description	Min occurs	Max occurs
batch-size	<code>push:positiveInt</code>	Specifies the maximum number of fetch reply messages to send per batch. If this is set to 0, no batching occurs.	1	1
delay	<code>push:millis</code>	Specifies the time period between submissions of batches. If a batch size is specified, this must be a positive value.	1	1

connectorType

This value must be a `push:string`.

The following values are allowed:

- all
- client
- policy

proxyProtocol

This value must be a `push:string`.

The following values are allowed:

- NONE
- HA_PROXY

Configuring user security

You can use the `Security.store` and `SystemAuthentication.store` files in the `etc` directory of your Diffusion server to configure the security roles and how they are assigned.

Clients can update these files on the running Diffusion server.

Related concepts

[Updating the security store](#) on page 413

A client can use the SecurityControl feature to update the security store. The information in the security store is used by the Diffusion server to define the permissions assigned to roles and the roles assigned to anonymous sessions and named sessions.

[Role-based authorization](#) on page 130

Diffusion restricts the ability to perform actions to authorized principals. Roles are used to map permissions to principals.

Security.store

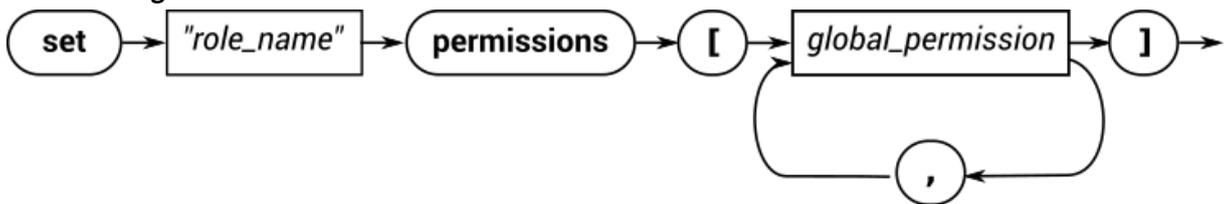
The `Security.store` file defines the security roles and the permissions associated with them. It also defines the default set of roles that are assigned to named or anonymous client sessions.

The following sections each describe the syntax for a single line of the script file.

Note: The **path** keyword is synonymous with the **topic** keyword used in previous releases of Diffusion. Both keywords are accepted. Prefer **path**.

Assigning global permissions to a role

Railroad diagram



Backus-Naur form

```
set "role_name" permissions [ '[' global_permission [ , global_permission ] ' ] ]
```

Example

```
set "ADMINISTRATOR" permissions [CONTROL_SERVER, VIEW_SERVER,
VIEW_SECURITY, MODIFY_SECURITY]
set "CLIENT_CONTROL" permissions [VIEW_SESSION, MODIFY_SESSION,
REGISTER_HANDLER]
```

Assigning default path permissions to a role

Railroad diagram



Backus-Naur form

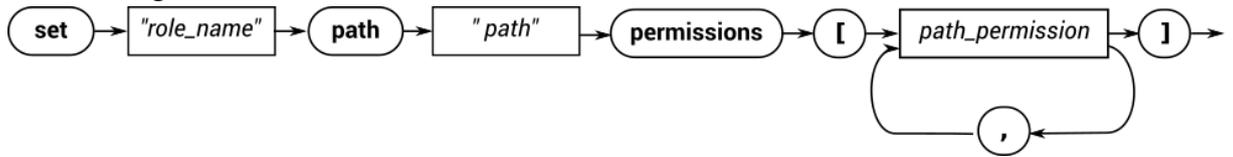
```
set "role_name" default path permissions [ '[' path_permission [ , path_permission ] ' ] ]
```

Example

```
set "CLIENT" default path permissions [READ_TOPIC ,
SEND_TO_MESSAGE_HANDLER]
```

Assigning path permissions associated with a specific path to a role

Railroad diagram



Backus-Naur form

```
set " role_name " path " path " permissions [ '[' path_permission [ , path_permission ] ' ] ]
```

Example

```
set "CLIENT" path "foo/bar" permissions [READ_TOPIC,  
SEND_TO_MESSAGE_HANDLER]  
set "ADMINISTRATOR" path "foo" permissions [ MODIFY_TOPIC ]  
set "CLIENT_CONTROL" path "foo" permissions [ ]
```

Removing all path permissions associated with a specific path to a role

Railroad diagram



Backus-Naur form

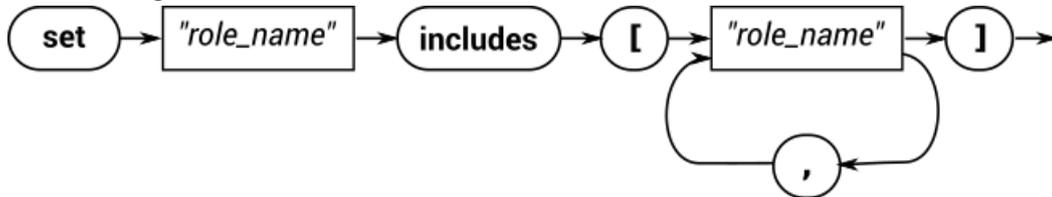
```
remove " role_name " permissions for path " path "
```

Example

```
remove "CLIENT" permissions for path "foo/bar"
```

Including roles within another role

Railroad diagram



Backus-Naur form

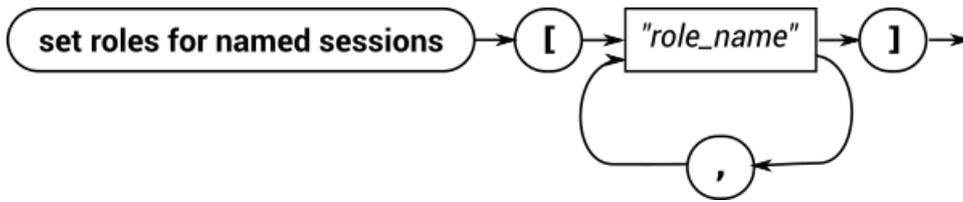
```
set " role_name " includes [ '[' " role_name " [ , " role_name " ] ' ] ]
```

Example

```
set "ADMINISTRATOR" includes ["CLIENT_CONTROL" , "TOPIC_CONTROL"]  
set "CLIENT_CONTROL" includes ["CLIENT"]
```

Assigning roles to a named session

Railroad diagram



Backus-Naur form

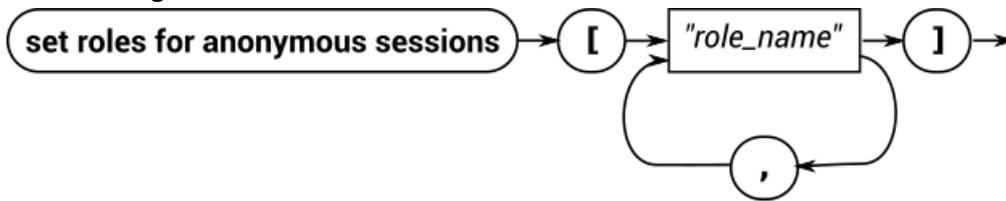
set roles for named sessions [' ' "role_name" [, "role_name"]]'

Example

```
set roles for named sessions ["CLIENT"]
```

Assigning roles to an anonymous session

Railroad diagram



Backus-Naur form

set roles for anonymous sessions [' ' "role_name" [, "role_name"]]'

Example

```
set roles for anonymous sessions ["CLIENT"]
```

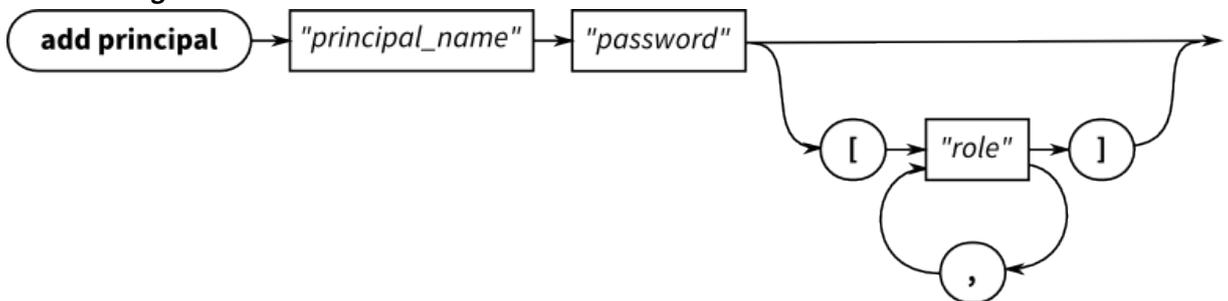
SystemAuthentication.store

The `SystemAuthentication.store` file defines the roles that are assigned by the system authentication handler to client sessions that have authenticated with a specific security principal. It also defines whether anonymous connections are allowed or denied.

The following sections each describe the syntax for a single line of the file.

Adding a principal

Railroad diagram



Backus-Naur form

add principal "principal_name" "password" [' ' "role" [, "role"]]'

Example

```
add principal "user6" "passw0rd"
```

```
add principal "user13" "passw0rd" ["CLIENT", "TOPIC_CONTROL"]
```

The password is passed in as plain text, but is stored in the system authentication store as a secure hash.

Removing a principal

Railroad diagram



Backus-Naur form

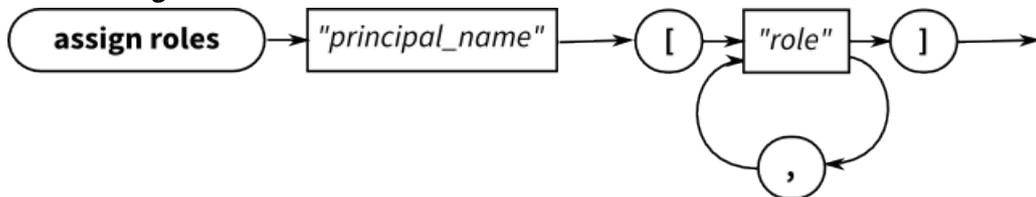
```
remove principal " principal_name "
```

Example

```
remove principal "user25"
```

Assigning roles to a principal

Railroad diagram



Backus-Naur form

```
assign roles " principal_name " '[' " role " [ , " role " ] ]'
```

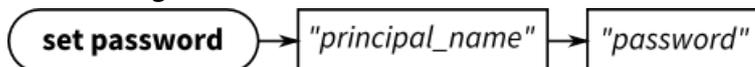
Example

```
assign roles "agent77" ["CLIENT", "CLIENT_CONTROL"]
```

When you use this command to assign roles to a principal, it overwrites any existing roles assigned to that principal. Ensure that all the roles you want the principal to have are listed in the command.

Setting the password for a principal

Railroad diagram



Backus-Naur form

```
set password " principal_name " " password "
```

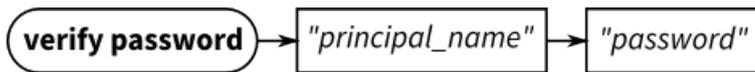
Example

```
set password "user1" "passw0rd"
```

The password is passed in as plain text, but is stored in the system authentication store as a secure hash.

Verifying the password for a principal

Railroad diagram



Backus-Naur form

`verify password " principal_name " " password "`

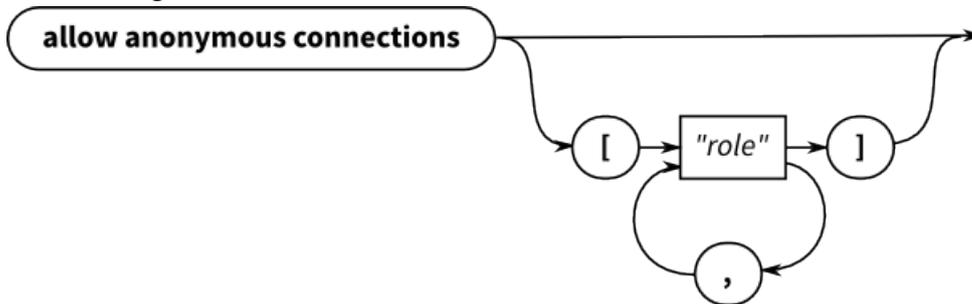
Example

```
verify password "user1" "passw0rd"
```

The password is passed in as plain text, but is stored in the system authentication store as a secure hash.

Allowing anonymous connections

Railroad diagram



Backus-Naur form

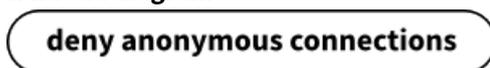
`allow anonymous connections ['[' " role " [, " role "]]'`

Example

```
allow anonymous connections [ "CLIENT" ]
```

Denying anonymous connections

Railroad diagram



Backus-Naur form

`deny anonymous connections`

Example

```
deny anonymous connections
```

Abstaining from providing a decision about anonymous connections

Railroad diagram



Backus-Naur form

`abstain anonymous connections`

Example

```
abstain anonymous connections
```

Securing the console

Configuration is required to enable additional security around connections from the Diffusion console.

Allow the console to connect only on a specific connector

We strongly recommend that you only allow the console to connect to Diffusion through a single connector. The port this connector listens on can be blocked from connections from outside of your organization by your load balancer.

You can configure this in the following way:

1. In your `etc/Connectors.xml` configuration file, wherever the line `<web-server>default</web-server>` appears in a connector that receives external connections, replace it with a web server definition that contains only a `client-service` definition. For example:

```
<web-server name="external">
  <!-- This section enables HTTP-type clients for this Web
  Server -->
  <client-service name="client" debug="true">
    <!-- This parameter is used to re-order out-of-order
    messages received
    over separate HTTP connections opened by client
    browsers. It is rarely
    necessary to set this to more than a few tens of
    seconds.
    If you attempt to set this value to more than one
    hour, a warning is logged
    and a timeout of one hour is used. -->
    <message-sequence-timeout>4s</message-sequence-timeout>
    <!-- This is used to control access from client web
    socket to diffusion.
    This is a REGEX pattern that will match the origin
    of the request (.*) matches
    anything so all requests are allowed -->
    <websocket-origin>.*</websocket-origin>
    <!-- This is used to control cross-origin resource
    sharing client connection to Diffusion
    This is a REGEX pattern that will match the origin
    of the request (.*) matches anything -->
    <cors-origin>.*</cors-origin>
    <!-- Enable compression for HTTP responses (Client and
    File). If the response
    is bigger than threshold -->
    <compression-threshold>256</compression-threshold>
  </client-service>
</web-server>
```

2. Create a new connector in your `etc/Connectors.xml` configuration file that defines a specific port that you use for internal connections to the console.

In this connector, set the value of the `web-server` element to default.

3. In your load balancer, prevent outside traffic from having access to the port specified in the new connector.

4. If required, apply additional connection restrictions.
 - You can use a connection validation policy. For more information, see .
 - You can set these restrictions in your load balancer.

Disable console features in the configuration (as required)

The actions that a user can perform using the console are controlled by roles and permissions. The principal that the user uses to log in to the console must have a role with the permissions required to perform an action in the console.

A principal with the ADMINISTRATOR or OPERATOR role can use all of the functions of the Diffusion console.

To restrict users to using a smaller set of console features, ensure they use a principal with a more restrictive set of roles and permissions. For more information, see [Pre-defined roles](#) on page 139.

Configuring logging on the Diffusion server

Your Diffusion installation provides a default logging framework and the log4j2 logging framework. Configure the Diffusion server to use your preferred framework.

The Diffusion server uses the JAR file located at `lib/slf4j-binding.jar` as its logging framework. When you first install your Diffusion server, the logging framework used is the Diffusion default logging.

Use log4j2

The `log4j-slf4j-impl-version.jar` file controls the log4j2 logging. This file is included in the Diffusion installation in the `lib/thirdparty` directory.

To use log4j2 instead of the default Diffusion logging implementation, copy `lib/thirdparty/log4j-slf4j-impl-version.jar` to `lib/slf4j-binding.jar`.

Configure the log4j2 logging framework with the `log4j2.xml` configuration file.

Use the default logging

To revert to the standard Diffusion logging implementation, copy `lib/diffusion-slf4j-binding.jar` to `lib/slf4j-binding.jar`.

Configure the default logging framework with the `Logs.xml` configuration file.

Use another SLF4J implementation

To use an alternative SLF4J implementation, remove the `lib/slf4j-binding.jar` and add the appropriate classes for the alternative implementation to the Diffusion server classpath.

Note: Alternative implementations of SLF4J are not supported for production use.

Related reference

[Logging](#) on page 611

Diffusion uses the Simple Logging Facade for Java (SLF4J) API to log messages from the Diffusion server or from publishers running on the Diffusion server. SLF4J separates the logging of messages in the Diffusion server from the logging framework. This separation enables you to configure an independent back-end implementation to format and write out the log messages.

[Logging back-end](#) on page 612

The work of formatting and writing out messages logged by the Diffusion server and publishers running on the Diffusion server is done by the logging back-end. The logging back-end is a logging framework that is independent of the Diffusion server. Diffusion provides a default logging framework, but you can configure the Diffusion server to use other SLF4J implementations.

[Logging reference](#) on page 613

Messages logged by the Diffusion server are logged at different levels depending on their severity.

Configuring default logging

To use the default logging, ensure that the Diffusion logging JAR is at `lib/slf4j-binding.jar`. The default logging implementation is already located here when you first install the Diffusion server. Use the `Logs.xml` configuration file to configure the behavior of the Diffusion default logging.

Log messages created by the Diffusion server, and by publishers deployed to the server, are filtered by the configuration in `etc/Logs.xml`.

You can configure the following aspects of logging:

- The level of logging to the console
- The level of logging to a file
- The name and location of the file
- Whether the log files rotate based on time or file size or both
- The time interval to use to rotate the files
- The file size to use to rotate the files
- The number of old log files to keep

Warning: Logging can use considerable CPU resources. In a production environment, enable only significant log messages (`INFO` and above). Performance degrades significantly when running at finer logging levels as more messages are produced, each requiring processing.

Logging on the Diffusion server cannot be configured using the configuration API. The `LoggingConfig` object is read-only.

Related reference

[Logging](#) on page 611

Diffusion uses the Simple Logging Facade for Java (SLF4J) API to log messages from the Diffusion server or from publishers running on the Diffusion server. SLF4J separates the logging of messages in the Diffusion server from the logging framework. This separation enables you to configure an independent back-end implementation to format and write out the log messages.

[Logging back-end](#) on page 612

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[Logging reference](#) on page 613

Messages logged by the Diffusion server are logged at different levels depending on their severity.

Logs.xml

This file specifies the schema for the log properties used to configure the Diffusion default logging back-end. If you use a different logging back-end, this file is ignored.

logs

Properties defining logging options.

The following table lists the elements that an element of type `logs` can contain:

Name	Type	Description	Min occurs	Max occurs
console-log-level	<code>push:log-level</code>	The log level to start console logging at. Can be ERROR, WARN, INFO, DEBUG, or TRACE. If a value is not specified, a default of INFO is used.	0	1
server-log	<code>push:string</code>	The log to use for the server. This must specify the name of a configured log definition.	1	1
default-log-directory	<code>push:string</code>	The default log folder for all logs, although this can be over-ridden for each log.	1	1
async-logging	<code>push:boolean</code>	Indicates whether logging is asynchronous. Asynchronous logging is performed by a separate thread as opposed to being performed in-line by the logging thread. This is normally set to true for performance reasons, but asynchronous logging might cause problems in some OS environments. This element provides the option to turn asynchronous logging off, if so advised. If a value is not specified, a default of true is used.	0	1
logging-queue-size	<code>push:positiveInt</code>	The size of the asynchronous logging queue. In normal cases, leave this value at the default value of 128k entries.	0	1
thread-name-logging	<code>push:boolean</code>	Indicates whether the thread name is logged with messages. If this is not specified, thread names are logged.	0	1
log	<code>log</code>	A log definition.	0	unbounded

log

A log definition.

The following table lists the attributes that an element of type `log` can have:

Name	Type	Description	Required
name		Name of the log definition	true
rotation-period	<code>push:positiveNonZeroInt</code>	A time period that the log exists for before being rotated. This is a positive non-zero integer, with unit specified by rotation-unit. If a rotation-period is specified, the value of file-append must be false.	false
rotation-unit	<code>push:timeunit</code>	A time unit to specify the unit used alongside rotation-period. This can be "day(s)", "hour(s)", "minute(s)".	false

The following table lists the elements that an element of type `log` can contain:

Name	Type	Description	Min occurs	Max occurs
log-directory	push:string	The name of the directory to which this log file is written. If a value is not specified, the default-log-directory is used.	0	1
file-pattern	push:string	This is used to specify the name of the log file. The following values can be used within the pattern. "/" - the local pathname separator. "%t" - the system temporary directory. "%g" - the generation number to distinguish rotated logs. "%h" - the value of the "user.home" system property. "%s" - the system type - for example, 'Diffusion'. "%n" - the system name as defined in Server.xml. "%d" - the date as specified in diffusion.properties (date.format), this is included when using daily rotation. "%%" - translates to a single percent sign "%". If a log file name is not specified, a default of "%s.log" is used.	0	1
level	push:log-level	Specifies the starting log level. This can be ERROR, WARN, INFO, DEBUG, or TRACE. If a value is not specified, a default of INFO is used.	0	1
xml-format	push:boolean	Indicates whether the log file is output in XML format. If a value is not specified, a default of false is used.	0	1
date-format	push:string	Specifies a date format to name a log. Specify the format according to the Java SimpleDateFormat specification. If a format is not specified, a default of "yyyy-MM-dd" is used.	0	1
file-limit	push:bytes	Specifies an approximate maximum amount to write (in bytes) to any one log file. If this is zero, there is no limit. If a value is not specified, a default of 0 is used.	0	1
file-append	push:boolean	Specifies whether log records are appended to existing log files. If a rotation-period is specified, the value of file-append must be false. If a value is not specified, a default of false is used and log files are overwritten.	0	1
file-count	push:positiveNon	Specifies the number of log files to use. Must be at least 1. If a value is not specified, a default of 1 is used.	0	1

Configuring log4j2

To use log4j2, replace the default logging JAR file with the log4j2 JAR file. Use the `log4j2.xml` configuration file to configure the behavior of log4j2.

To use log4j2 instead of the standard Diffusion logging implementation, copy `lib/thirdparty/log4j-slf4j-impl-*.jar` to `lib/slf4j-binding.jar`. This file controls the log4j2 logging. The Diffusion logging configuration in `etc/Logs.xml` will be ignored.

To revert to the standard Diffusion logging implementation, copy `lib/diffusion-slf4j-binding.jar` to `lib/slf4j-binding.jar`.

When the Diffusion server is configured to use the log4j2 logging framework, the Diffusion server ignores the configuration in the `Logs.xml` file. Instead, it uses the `log4j2.xml` configuration file.

The `log4j2.xml` configuration file is located in the `etc` directory of your Diffusion installation. For more information about how to use this file to configure log4j2, see the log4j2 documentation: <http://logging.apache.org/log4j/2.x/manual/configuration.html>

By default, the provided `log4j2.xml` file is configured to output log messages in the same format as used by the default logging framework. In your configuration file, create a property that defines the format to output log messages in:

```
<Property name="pattern">%date{yyyy-MM-dd HH:mm:ss.SSS} | %level |
%thread | %marker | %replace{%msg}{\|}{ } | %logger%n%xEx</Property>
```

You can use this property to specify the format used by your appenders. The property `%marker` indicates the message code. For more information, see [Logging reference](#) on page 613.

By default, the provided `log4j2.xml` file is configured to append log output to the console and to a file. This is the same behavior as the default logging framework.

```
<Loggers>
  <AsyncRoot level="info" includeLocation="false">
    <AppenderRef ref="console" />
    <AppenderRef ref="file" />
  </AsyncRoot>
</Loggers>
```

You can configure other appenders to output the log messages to different destinations. For more information about using appenders, see <https://logging.apache.org/log4j/2.x/manual/appenders.html>.

Related reference

[Logging](#) on page 611

Diffusion uses the Simple Logging Facade for Java (SLF4J) API to log messages from the Diffusion server or from publishers running on the Diffusion server. SLF4J separates the logging of messages in the Diffusion server from the logging framework. This separation enables you to configure an independent back-end implementation to format and write out the log messages.

[Logging back-end](#) on page 612

The work of formatting and writing out messages logged by the Diffusion server and publishers running on the Diffusion server is done by the logging back-end. The logging back-end is a logging framework that is independent of the Diffusion server. Diffusion provides a default logging framework, but you can configure the Diffusion server to use other SLF4J implementations.

[Logging reference](#) on page 613

Messages logged by the Diffusion server are logged at different levels depending on their severity.

Log4j2.xml

Use the `Log4j2.xml` configuration file to configure the behavior of the log4j2 logging framework.

```
<Configuration status="warn" name="Diffusion">
  <Properties>
    <Property name="diffusion.log.dir">../logs</Property>

    <!-- The log directory can be overridden using the
    system property 'diffusion.log.dir'. -->
    <Property name="log.dir">${sd:diffusion.log.dir}</
Property>

    <Property name="pattern">%date{yyyy-MM-dd HH:mm:ss.SSS} |
%level| %thread| %marker| %replace{%msg}{\|}{ }| %logger%n%xEx
</Property>
  </Properties>

  <Appenders>
    <Console name="console">
      <PatternLayout pattern="${pattern}" />
    </Console>

    <RollingRandomAccessFile name="file"
immediateFlush="false" fileName="${log.dir}/diffusion.log"
      filePattern="${log.dir}/${date:yyyy-MM}/diffusion-
%d{MM-dd-yyyy}-%i.log.gz">

      <PatternLayout pattern="${pattern}" />

      <Policies>
        <OnStartupTriggeringPolicy />
        <TimeBasedTriggeringPolicy />
        <SizeBasedTriggeringPolicy size="250 MB" />
      </Policies>

      <DefaultRolloverStrategy max="20" />
    </RollingRandomAccessFile>
  </Appenders>

  <Loggers>
    <AsyncRoot level="info" includeLocation="false">
      <AppenderRef ref="console" />
      <AppenderRef ref="file" />
    </AsyncRoot>
  </Loggers>
</Configuration>
```

Related reference

[Logging](#) on page 611

Diffusion uses the Simple Logging Facade for Java (SLF4J) API to log messages from the Diffusion server or from publishers running on the Diffusion server. SLF4J separates the logging of messages

in the Diffusion server from the logging framework. This separation enables you to configure an independent back-end implementation to format and write out the log messages.

[Logging back-end](#) on page 612

The work of formatting and writing out messages logged by the Diffusion server and publishers running on the Diffusion server is done by the logging back-end. The logging back-end is a logging framework that is independent of the Diffusion server. Diffusion provides a default logging framework, but you can configure the Diffusion server to use other SLF4J implementations.

[Logging reference](#) on page 613

Messages logged by the Diffusion server are logged at different levels depending on their severity.

Logging using another SLF4J implementation

You can use other implementations of SLF4J for your logging. However, this is not supported for production use.

To use an alternative SLF4J implementation, remove the `lib/slf4j-binding.jar` and add the appropriate classes for the alternative implementation to the Diffusion server classpath.

Alternative implementations of SLF4J are not supported for production use.

Related reference

[Logging](#) on page 611

Diffusion uses the Simple Logging Facade for Java (SLF4J) API to log messages from the Diffusion server or from publishers running on the Diffusion server. SLF4J separates the logging of messages in the Diffusion server from the logging framework. This separation enables you to configure an independent back-end implementation to format and write out the log messages.

[Logging back-end](#) on page 612

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[Logging reference](#) on page 613

Messages logged by the Diffusion server are logged at different levels depending on their severity.

Configuring JMX

Use the `Management.xml` configuration file to configure Diffusion to be manageable through JMX. Use the `Publishers.xml` configuration file to configure the JMX adapter to make MBeans available through topics.

Configuring the Diffusion JMX connector server

Connect to JMX through the Diffusion connector server. This connector server is integrated with the Diffusion server and enables you to use role-based access control to define how connecting users can use the MBeans.

About this task

Diffusion binds to the specified ports to listen for connections from JMX clients such as JConsole and Java VisualVM.

Procedure

1. Optional: If you are running Diffusion on a Linux server, check that the host name is not `127.0.1.1`.

You can do this by running the following command:

```
hostname -i
```

If the output to this command is `127.0.1.1`, add an entry to `/etc/hosts` that defines the host name.

2. Edit the `etc/Management.xml` configuration file to enable and configure the management features:

- a) Set the value of the `enabled` attribute in the `management` element to `true`.

```
<management enabled="true">
```

- b) Specify the hostname to allow JMX connections on in the `host` element.

```
<host>localhost</host>
```

The default value is `localhost`. If you set the contents of the `host` element to a value, connections are only allowed to that value. For example, a JMX connection to `localhost` is allowed, but connecting to the same system by IP address is not.

To allow JMX connections on any applicable hostname or IP address, leave the `host` element blank.

- c) Optional: Specify the ports to use for the JMX service.

```
<!-- The RMI Registry port -->  
<registry-port>1099</registry-port>  
<!-- The JMX service port -->  
<connection-port>1100</connection-port>
```

These two ports can be set to the same value, which can simplify firewall configuration.

You can use the default values:

- **1099** The RMI registry port
- **1100** The JMX service port

3. Configure the principals that are allowed to use the JMX service. You can do this in one of the following ways.

- Update the system authentication store to assign a role with the required permissions to the principal and configure the Diffusion server to call the system authentication handler.

For more information, see [System authentication handler](#) on page 146.

- Implement a custom authentication handler that assigns a role with the required permissions to the principal and configure the Diffusion server to call your custom authentication handler.

For more information, see [User-written authentication handlers](#) on page 144.

4. **Note:** If you are using a firewall that employs NAT, you might still be unable to connect to Diffusion even when the JMX ports are left open.

Optional: To make a secure connection or a connection through a firewall, you can use SSH tunnelling:

- a) Establish an SSH connection to the fire-walled Diffusion server.
- b) Tunnel the RMI registry port and JMX service port through SSH.
- c) Use JMX to connect to the local ends of the tunneled ports.

Results

Use the ports you have configured to connect a JMX management console to the Diffusion server.

This connection cannot be made through SSL. However, you can use SSH tunnelling to secure your connection. For more information, see step 4 on page 524.

Related concepts

[JMX](#) on page 583

You can use JMX to manage Diffusion. By default, the RMI registry port is 1099 and the JMX service port is 1100.

Related reference

[Using Java VisualVM](#) on page 584

You can manage Diffusion using the JMX system management console Java VisualVM.

[Using JConsole](#) on page 586

You can manage Diffusion using the JMX system management console JConsole.

Configuring a remote JMX server connector

Connect to JMX through a remote connector to the JVM that runs the Diffusion. This connector is not integrated with the Diffusion server security and you must configure additional security in the JVM.

About this task

Important: We recommend that you use the Diffusion connector server to connect to the JMX service. For more information, see [Configuring the Diffusion JMX connector server](#) on page 523.

The JVM that runs Diffusion accepts remote connections from JMX clients such as JConsole and Java VisualVM.

Procedure

1. Configure security for your remote JMX connection.

For more information, see <https://docs.oracle.com/javase/8/technotes/guides/management/agent.html>.

The security users and roles defined for the JVM do not integrate with the security provided by the Diffusion server

2. When starting Diffusion, set the properties required for your remote JMX connection.

For more information, see <https://docs.oracle.com/javase/8/technotes/guides/management/agent.html>.

3. **Note:** If you are using a firewall that employs NAT, you might still be unable to connect to Diffusion even when the JMX ports are left open.

Optional: To make a secure connection or a connection through a firewall, you can use SSH tunnelling:

- a) Establish an SSH connection to the fire-walled Diffusion server.
- b) Tunnel the RMI registry port and JMX service port through SSH.
- c) Use JMX to connect to the local ends of the tunneled ports.

Results

Use the ports you have configured to connect a JMX management console to the Diffusion server. These connections can be made over SSL.

Related concepts

[JMX](#) on page 583

You can use JMX to manage Diffusion. By default, the RMI registry port is 1099 and the JMX service port is 1100.

Related reference

[Using Java VisualVM](#) on page 584

You can manage Diffusion using the JMX system management console Java VisualVM.

[Using JConsole](#) on page 586

You can manage Diffusion using the JMX system management console JConsole.

Configuring a local JMX connector server

Connect to JMX through a local connector to the JVM that runs the Diffusion. This connector is not integrated with the Diffusion server security and you must configure additional security in the JVM.

About this task

The JVM that runs Diffusion accepts local connections from JMX clients such as JConsole and Java VisualVM.

Procedure

Review the JVM documentation for any actions to take before connecting your JMX client.

For more information, see <https://docs.oracle.com/javase/8/technotes/guides/management/agent.html>.

Results

You can connect a JMX management console running on the same server as Diffusion to the JVM.

Related concepts

[JMX](#) on page 583

You can use JMX to manage Diffusion. By default, the RMI registry port is 1099 and the JMX service port is 1100.

Related reference

[Using Java VisualVM](#) on page 584

You can manage Diffusion using the JMX system management console Java VisualVM.

[Using JConsole](#) on page 586

You can manage Diffusion using the JMX system management console JConsole.

Management.xml

This file specifies the schema for the management properties that enable JMX access over an RMI JMXConnectorServer.

management

The management configuration.

The following table lists the attributes that an element of type `management` can have:

Name	Type	Description	Required
enabled	push:boolean	Specifies if an RMI JMXConnectorServer is enabled, making JMX remotely available.	true

The following table lists the elements that an element of type management can contain:

Name	Type	Description	Min occurs	Max occurs
host	push:string	The local interface used for the RMI registry and the JMX service. Empty values declare that the RMI registry binds to all local network interfaces.	0	1
registry-port	push:port	The RMI registry port. If a value is not specified, a default of 1099 is used.	0	1
connection-port	push:port	The JMX service port. If a value is not specified, a default of 1100 is used.	0	1

Configuring the JMX adapter

The JMX adapter can reflect JMX MBeans their properties and notifications as topics. Configure the JMX adapter using the `Publishers.xml` configuration file.

Before you begin

The JMX adapter is packaged in the Diffusion publisher. The Diffusion publisher must be running for the JMX adapter be enabled.

About this task

You can configure the adapter to reflect the state of JMX MBeans and MXBeans as topics. These MBeans can be built-in, Diffusion, or third-party in origin.

Many statistics are available as MBean properties, for example, CPU load, OS version, number of file-descriptors, threads. Making these statistics available as topics to Diffusion clients makes possible the implementation of system monitoring solutions to the web, and all other Diffusion platforms.

Note: Publishing MBean data to topics can constitute a security risk. Ensure that crucial information about your Diffusion server is protected by permissions.

Procedure

1. Add the following properties to the `<publisher name="Diffusion">` section of the `Publishers.xml` configuration file located in the `etc` directory of your Diffusion installation.
 - a) Use the `JMSAdapter.enabled` property to enable the JMX adapter.

```
<property name="JMXAdapter.enabled">true</property>
```

- b) Use the `JMSAdapter.refreshFrequency` property to specify how often, in milliseconds, the data on the topics is updated.

```
<property name="JMXAdapter.refreshFrequency">3000</property>
```

The default value is 3 seconds.

- c) Use the `JMSAdapter.mbeans` property to specify which MBeans to reflect as topics.

Specify the MBeans using ObjectName format. For more information, see <https://docs.oracle.com/javase/7/docs/api/javax/management/ObjectName.html>

Specify each ObjectName on a new line.

```
<property name="JMXAdapter.mbeans">java.nio:*
  java.lang:*
  java.util.logging:*
  com.pushtechnology.diffusion:*</property>
```

2. Restart the Diffusion server to reload the configuration.

Results

The specified MBeans and MXBeans are reflected as topics in the Diffusion/MBeans branch of the topic tree.

Related concepts

[The JMX adapter](#) on page 599

The JMX adapter reflects JMX MBeans and their properties and notifications as topics.

Configuring replication

Use the `Replication.xml` configuration file to configure the Diffusion server to replicate sessions and topics.

You can also use the `hazelcast.xml` configuration file to configure your datagrid provider.

Configuring the Diffusion server to use replication

You can configure replication by editing the `etc/Replication.xml` files of your Diffusion servers.

About this task

Ensure that you use the same replication configuration on all of the Diffusion servers in your cluster.

Ensure that each server in the cluster has a unique name, as set in `etc/Server.xml` or the host name if not set.

Procedure

1. Edit the `Replication.xml` file to configure replication.

```
<replication>
  <provider>HAZELCAST</provider>

  <customConfigurator/>

  <connector>High Volume Connector</connector>

  <sessionReplication enabled="true" />

  <topicReplication enabled="true">
    <topics>
      <excludes>Diffusion</excludes>
    </topics>
  </topicReplication>
</replication>
```

- In the `sessionReplication` element, set `enabled` to `true` to configure the server to replicate sessions between servers in the cluster.
- In the `topicReplication` element, set `enabled` to `true` to configure the server to replicate topics between servers in the cluster.
- Inside the `topics` element, use either `includes` or `excludes` elements to define the topics for topic replication and failover of the active update source.

You can use one or more `includes` elements, or one or more `excludes` elements. You cannot mix `includes` and `excludes`.

Each element should contain a path identifying a branch of the topic tree.

If you use `includes` elements, topic replication and failover are applied to the specified branches.

If you use `excludes` elements, topic replication and failover are applied to all topics except those belonging to the specified branches.

Unlike a topic selector, the topic path does not contain any leading or trailing characters. For example, use `<includes>foo/bar</includes>` to select all topics in the branch `foo/bar`.

2. In the `etc/Connectors.xml` file, check there is a connector element with the same name as the connector specified in `Replication.xml`.

By default, `Connectors.xml` contains a "High Volume Connector" profile which you can use for replication. You should tune the profile based on your particular requirements.

3. Consider adding a `quorum` element inside the `replication` element. This defines a minimum number of servers in a cluster, below which all servers will shut down.

Using this setting can prevent issues after a network partition separates a cluster, and the two resulting clusters try to rejoin, leading to inconsistent data (a "split-brain" condition). See [High availability](#) on page 103 for details.

4. Restart the Diffusion server to load the configuration.
5. Ensure that your clients are configured to reconnect if they lose their connection to the server.

Related reference

[Session replication](#) on page 105

You can use session replication to ensure that if a client connection fails over from one server to another the state of the client session is maintained.

[Topic replication](#) on page 109

You can use topic replication to ensure that the structure of the topic tree, topic definitions, and topic data are synchronized between servers.

[Failover of active update sources](#) on page 111

You can use failover of active update sources to ensure that when a server that is the active update source for a section of the topic tree becomes unavailable, an update source on another server is assigned to be the active update source for that section of the topic tree. Failover of active update sources is enabled for any sections of the topic tree that have topic replication enabled.

[Configuring the Hazelcast datagrid](#) on page 530

You can configure how the built-in Hazelcast datagrid replicates data within your solution architecture.

Configuring the Hazelcast datagrid

You can configure how the built-in Hazelcast datagrid replicates data within your solution architecture.

Configuring Hazelcast

By default, the Hazelcast node in your Diffusion server multicasts to all other Hazelcast nodes in your network.

We recommend that in a production environment you disable multicast and explicitly define the nodes in your Hazelcast cluster. This configuration is more secure and removes the risk of nodes in your development environment connecting to the production environment and interfering with the production data.

To define which Hazelcast nodes can communicate with each other, use the `hazelcast.xml` configuration file.

We recommend you configure Hazelcast as a mesh (where every node can connect to the others), not a chain (where each node only connects to one other).

The following example shows the structure of the `hazelcast.xml` file:

```
<hazelcast xsi:schemaLocation="http://www.hazelcast.com/schema/config
  http://www.hazelcast.com/schema/config/hazelcast-config-3.9.xsd"
  xmlns="http://www.hazelcast.com/schema/config" xmlns:xsi="http://
  www.w3.org/2001/XMLSchema-instance">

  <properties>
    <property name="hazelcast.logging.type">slf4j</property>
    <property name="hazelcast.phone.home.enabled">>false</
  property>
  </properties>

  <network>
    <join>
      <multicast enabled="false" />
      <tcp-ip enabled="true">
        <member>node1.example.com</member>
        <member>203.0.113.1</member>
        <member>203.0.113.2:5757</member>
        <member>203.0.113.3-7</member>
      </tcp-ip>
    </join>

  </network>
</hazelcast>
```

This example configuration disables the multicast capability and defines the Hazelcast nodes that can be connected to.

The Hazelcast nodes can be defined by hostname, by IP address, or by IP range. The default port used by Hazelcast is 5701. If you want to connect on a different port, you can specify this when you define the node, using the format *host:port*.

Ensure that the `hazelcast.xml` file is on the Diffusion server classpath. For example, by putting the file in the `diffusion_installation/data` directory. Restart the Diffusion server to load the configuration.

For more information about using the `hazelcast.xml` file to configure Hazelcast, see the [Hazelcast™ Reference Manual](#).

Diagnosing problems with Hazelcast

If you enable logging for Hazelcast, you can use the log files to diagnose problems with Hazelcast.

To enable logging, include the following line in your `hazelcast.xml` file:

```
<property name="hazelcast.logging.type">slf4j</property>
```

Ensure that the `hazelcast.xml` file is on the Diffusion server classpath. For example, by putting the file in the `diffusion_installation/data` directory. Restart the Diffusion server to load the configuration.

You can also enable logging by starting the Diffusion server that contains the node with the following parameter `-Dhazelcast.logging.type=slf4j`

You can enable JMX for your Hazelcast nodes and use a JMX tool to examine the MBeans.

To enable JMX for a Hazelcast node, include the following line in your `hazelcast.xml` file:

```
<property name="hazelcast.jmx">true</property>
```

Ensure that the `hazelcast.xml` file is on the Diffusion server classpath. For example, by putting the file in the `diffusion_installation/data` directory. Restart the Diffusion server to load the configuration.

You can also enable JMX by starting the Diffusion server that contains the node with the following parameter `-Dhazelcast.jmx=true`

For more information about using Hazelcast, see the [Hazelcast™ Reference Manual](#).

Related tasks

[Configuring the Diffusion server to use replication](#) on page 528

You can configure replication by editing the `etc/Replication.xml` files of your Diffusion servers.

Related reference

[Session replication](#) on page 105

You can use session replication to ensure that if a client connection fails over from one server to another the state of the client session is maintained.

[Topic replication](#) on page 109

You can use topic replication to ensure that the structure of the topic tree, topic definitions, and topic data are synchronized between servers.

[Failover of active update sources](#) on page 111

You can use failover of active update sources to ensure that when a server that is the active update source for a section of the topic tree becomes unavailable, an update source on another server is assigned to be the active update source for that section of the topic tree. Failover of active update sources is enabled for any sections of the topic tree that have topic replication enabled.

Replication.xml

This file specifies the schema for the replication properties.

replication

Properties defining replication.

The following table lists the attributes that an element of type `replication` can have:

Name	Type	Description	Required
enabled	push:boolean	DEPRECATED: Since 6.0 you should rely on enabling or disabling session and topic replication individually. Specifies whether replication is enabled for this server. Defaults to 'true'.	false
kubernetes-enabled	push:boolean	Specifies whether Kubernetes replication configuration is enabled for this server. Defaults to 'false'.	false

The following table lists the elements that an element of type `replication` can contain:

Name	Type	Description	Min occurs	Max occurs
provider	push:string	The type of replication provider to use to replicate the data. Currently only Hazelcast is supported.	1	1
customConfigurator	push:string	DEPRECATED: this element is ignored and will be removed in a future version.	0	1
connector	push:string	The name of the connector used to configure connections to other servers in the cluster. A connector with the corresponding name should be configured in <code>Connectors.xml</code> . The connector determines the listen host and port, buffer sizes, and the outbound queue size. If this element is not set, the first configured connector will be used instead and a warning will be issued.	0	1
external-host	push:string	Optional override of the host name peer servers should use to connect to this server. If not specified, the host name will be derived from the configured connector. The <code>external-host</code> and <code>external-port</code> attributes allow for deployments to environments that use network address translation.	0	1
external-port	push:port	Optional override of the port peer servers should use to connect to this server. If not specified, the port will be derived from the configured connector. The <code>external-host</code> and <code>external-port</code> attributes allow for deployments to environments that use network address translation.	0	1
quorum	push:int	Optional quorum size. Diffusion will only start once the size of the cluster satisfies the quorum. Diffusion will shutdown	0	1

Name	Type	Description	Min occurs	Max occurs
		if the size of the cluster falls below the quorum. The quorum size must be at least two.		
sessionReplication	sessionReplication	The definition for session replication	1	1
topicReplication	topicReplication	The definition for topic replication	1	1

sessionReplication

Properties defining session replication.

The following table lists the attributes that an element of type `sessionReplication` can have:

Name	Type	Description	Required
enabled	push:boolean	Specifies whether session replication is enabled for this server.	true

topicReplication

Properties defining topic replication.

The following table lists the attributes that an element of type `topicReplication` can have:

Name	Type	Description	Required
enabled	push:boolean	Specifies whether topic replication is enabled for this server.	true

The following table lists the elements that an element of type `topicReplication` can contain:

Name	Type	Description	Min occurs	Max occurs
topics	topics	The topics that are configured to use replication.	1	1

topics

Properties defining the topics to replicate. Paths must all be either inclusive or exclusive. It is not possible to include some paths and exclude others.

The following table lists the elements that an element of type `topics` can contain:

Name	Type	Description	Min occurs	Max occurs
topicPath	push:string	DEPRECATED: Since 6.0 you should prefer to use the <code>includes</code> element. A topic path that identifies the root of a tree that will be replicated by this server. The path can be of any depth.	1	unbounded
includes	push:string	A path that identifies the root of a tree that will be replicated by this server. The path can be of any depth.	0	unbounded

Name	Type	Description	Min occurs	Max occurs
excludes	push:string	A path that identifies the root of a tree that will not be replicated by this server. The path cannot be more than one level deep.	0	unbounded

Configuring the Diffusion web server

Use the `WebServer.xml` and `Aliases.xml` configuration files to configure the behavior of the Diffusion web server.

Diffusion can act as a web server by modifying the `Connectors.xml` configuration file to add a `web-server` definition to a connector. If a connector is required to serve HTTP requests, the connector requires a `web-server` definition. A valid `web-server` entry must also exist in the `WebServer.xml` configuration file.

The Diffusion web server is a lightweight web server with very basic features. It hosts the Diffusion landing page, monitoring console, and demos.

The Diffusion web server also provides the endpoint for clients connecting to the Diffusion server using HTTP-based transports.

Note: Do not use the Diffusion web server as the host for your production website. Instead use a third-party web server.

For more information about using Diffusion with third-party web servers, see [Web servers](#) on page 695.

Related concepts

[Configuring Diffusion web server security](#) on page 535

When configuring your Diffusion web server, consider the security of your solution.

[Running the Diffusion server inside of a third-party web application server](#) on page 699

Diffusion can run as a Java servlet inside any Java application server.

[Hosting Diffusion web clients in a third-party web server](#) on page 698

Host Diffusion web clients on a third-party web server to enable your customers to access them.

[Web servers](#) on page 695

Diffusion incorporates its own basic web server for a limited set of uses. The Diffusion server also interacts with third-party web servers that host Diffusion web clients. The Diffusion server is also capable of being run as a Java servlet inside a web application server.

[Diffusion web server](#) on page 696

Diffusion incorporates its own web server. This web server is required to enable a number of Diffusion capabilities, but we recommend that you do not use it to host your production web applications.

[Web servers](#) on page 121

Consider how to use web servers as part of your Diffusion solution.

Configuring Diffusion web server security

When configuring your Diffusion web server, consider the security of your solution.

Digest authentication

Digest authentication can be utilized to negotiate credentials with a user's web browser. It is applied to specific directories on your web site. The protection of one directory automatically applies protection to all lower directories as well.

Use the `realms` element in the `WebServer.xml` configuration file to add new realms to a virtual host and to store the user's name and the passwords.

HTTP deployment

You can deploy DAR files to a Diffusion server through a web service. This web service does not run by default, but can be enabled for your test environment by editing the provided `WebServer.xml` configuration file to include the commented out `deploy-service`.

Warning: Access to the deploy web service is not restricted. Do not enable this web service in your production environment unless you restrict access to the `diffusion-url/deploy` URL by other means, for example through your firewall setup.

Related concepts

[Configuring the Diffusion web server](#) on page 534

Use the `WebServer.xml` and `Aliases.xml` configuration files to configure the behavior of the Diffusion web server.

[Web servers](#) on page 695

Diffusion incorporates its own basic web server for a limited set of uses. The Diffusion server also interacts with third-party web servers that host Diffusion web clients. The Diffusion server is also capable of being run as a Java servlet inside a web application server.

[Diffusion web server](#) on page 696

Diffusion incorporates its own web server. This web server is required to enable a number of Diffusion capabilities, but we recommend that you do not use it to host your production web applications.

[Web servers](#) on page 121

Consider how to use web servers as part of your Diffusion solution.

WebServer.xml

This file specifies the schema for the web server properties.

web-servers

Definitions of one or more web servers.

The following table lists the elements that an element of type `web-servers` can contain:

Name	Type	Description	Min occurs	Max occurs
web-server	web-server	Web server definition.	0	unbounded

web-server

Web server definition.

The following table lists the attributes that an element of type `web-server` can have:

Name	Type	Description	Required
name	push:string	Name of the web server definition.	true

The following table lists the elements that an element of type `web-server` can contain:

Name	Type	Description	Min occurs	Max occurs
client-service	client-service	Optional client service.	0	1
http-service	http-service	HTTP service.	0	unbounded
file-service	file-service	Optional file service.	0	1

virtual-host

Virtual host definition.

The following table lists the attributes that an element of type `virtual-host` can have:

Name	Type	Description	Required
name	push:string	Virtual host name.	true
debug	push:boolean	Debug flag. Set to true for debugging. Default is false.	false

The following table lists the elements that an element of type `virtual-host` can contain:

Name	Type	Description	Min occurs	Max occurs
host	push:string	Specifies the host which the virtual host is to serve, for example, <code>download.pushtechnology.com</code> or <code>*</code> for all.	1	1
document-root	push:string	The physical directory for this virtual host. If a relative path is configured, it is resolved relative to the Diffusion home directory.	1	1
home-page	push:string	The default home page. This file is used with directory browsing.	1	1
error-page	push:string	This is used to control the 404 response. The server looks for one of these files in the directory of the request. If the file does not exist, it looks for this file in the virtual directory. If the file is not supplied or the file does not exist, a standard 404 response HTML document is sent.	0	1

Name	Type	Description	Min occurs	Max occurs
static	push:boolean	If this is set to true, after loading the resource once, the file system is not checked again. This improves performance for simple static usage. By default this is false.	0	1
minify	push:boolean	Set to true to minify the html. This happens before the file is compressed. By default this is false.	0	1
cache	cache	The virtual host cache configuration.	1	1
compression-threshold	push:bytes	All HTTP responses over this size are compressed. If not specified, a default value of 512 is used.	0	1
alias-file	push:string	Optionally specifies an alias file. This allows for URL aliasing if required. If a relative path is configured, it is resolved relative to the Diffusion configuration directory.	0	1
realms	realms	Virtual host realms.	0	1

realms

Virtual host realms.

The following table lists the elements that an element of type `realms` can contain:

Name	Type	Description	Min occurs	Max occurs
realm	realm	A virtual host realm.	0	unbounded

realm

A virtual host realm.

The following table lists the attributes that an element of type `realm` can have:

Name	Type	Description	Required
name	push:string	Virtual host realm name.	true
path	push:string	Virtual host realm path.	true

The following table lists the elements that an element of type `realm` can contain:

Name	Type	Description	Min occurs	Max occurs
users	users	Virtual host realm users.	0	1

users

Virtual host realm users.

The following table lists the elements that an element of type `users` can contain:

Name	Type	Description	Min occurs	Max occurs
user	<code>user</code>	Virtual host realm user.	1	unbounded

user

Virtual host realm user.

The following table lists the attributes that an element of type `user` can have:

Name	Type	Description	Required
name	<code>push:string</code>	Virtual host realm user name.	true
password	<code>push:string</code>	Virtual host realm user password.	true

cache

Virtual host cache.

The following table lists the attributes that an element of type `cache` can have:

Name	Type	Description	Required
debug	<code>push:boolean</code>	Set true to debug the cache. If a value is not specified, a default of false is used.	false

The following table lists the elements that an element of type `cache` can contain:

Name	Type	Description	Min occurs	Max occurs
file-size-limit	<code>push:bytes</code>	If the file to be served is over this size, do not cache the entire contents, but map the file instead. If a size is not specified, a default value of 1m is used.	0	1
cache-size-limit	<code>push:bytes</code>	Total size of the cache for this web server definition. If a size is not specified, a default value of 10m is used.	0	1
file-life-time	<code>push:millis</code>	If the file has not been accessed within the time specified, remove the entry from the cache. If a time is not specified, a default value of 1d is used.	0	1

http-service

HTTP service.

The following table lists the attributes that an element of type `http-service` can have:

Name	Type	Description	Required
name	<code>push:string</code>	HTTP service name.	true
debug	<code>push:boolean</code>	Set true to debug the HTTP service. If a value is not specified, a default of false is used.	false

The following table lists the elements that an element of type `http-service` can contain:

Name	Type	Description	Min occurs	Max occurs
class	<code>push:string</code>	The user HTTP service class name. This class must implement the <code>HTTPServiceHandler</code> interface in the web server API.	1	1
url-pattern	<code>push:string</code>	The pattern that the URL must match for this service to be invoked.	1	1
log	<code>push:string</code>	An optional log file can be specified and, if so, HTTP access can be logged. The log definition must exist in <code>Logs.xml</code> .	0	1
max-inbound-request-size	<code>push:bytes</code>	The maximum number of bytes that the HTTP request can have. If this is not specified, a default of the maximum message size is used.	0	1
property	<code>property</code>	HTTP service property.	0	unbounded

property

A property.

The following table lists the attributes that an element of type `property` can have:

Name	Type	Description	Required
name	<code>push:string</code>	Property name.	true
type	<code>push:string</code>	Optional property type.	false

file-service

File service.

The following table lists the attributes that an element of type `file-service` can have:

Name	Type	Description	Required
name	<code>push:string</code>	File service name.	true

The following table lists the elements that an element of type `file-service` can contain:

Name	Type	Description	Min occurs	Max occurs
virtual-host	<code>virtual-host</code>	Virtual host.	1	unbounded
write-timeout	<code>push:millis</code>	Write timeout for serving files. This does not affect HTTP clients. If a value is not specified, a default value of 3s is used.	0	1

client-service

Client service.

The following table lists the attributes that an element of type `client-service` can have:

Name	Type	Description	Required
name	push:string	Client service name.	true
debug	push:boolean	Set true to debug the client service. If a value is not specified, a default of false is used.	false

The following table lists the elements that an element of type `client-service` can contain:

Name	Type	Description	Min occurs	Max occurs
message-sequence-timeout	push:millis	This is used with HTTP clients to indicate how long to wait for a missing message in a sequence of messages before assuming it has been lost and closing the client session. If a value is not specified, a default of 4 seconds is used. If this exceeds one hour (3600000ms) a warning will be logged and the time-out will be set to one hour.	0	1
websocket-origin	push:string	This is used to control access from client web socket to Diffusion. This is a regular expression pattern that matches the origin of the request. A value of <code>.*</code> matches anything, so all requests are allowed. If this is not specified, the service is unable to handle web socket requests.	0	1
cors-origin	push:string	This is used to control access from client web (XHR) to Diffusion. This element will enable Cross Origin Resource Sharing (CORS). This is a regular expression pattern that matches the origin of the request. A value of <code>.*</code> matches anything, so all requests are allowed. If a value is not specified, the service cannot handle CORS requests.	0	1
compression-threshold	push:bytes	Enable compression for HTTP client responses over this size. If a value is not specified, a default of 256 bytes is used.	0	1
max-inbound-request-size	push:bytes	The maximum number of bytes that the HTTP request can have. If a value is not specified, a default of the maximum message size is used.	0	1
comet-bytes-before-new-poll	push:bytes	DEPRECATED. Since 6.0 – the HTTP Comet protocol is no longer supported and this parameter is unused.	0	1
comet-initial-message-padding	push:bytes	DEPRECATED. Since 6.0 – the HTTP Comet protocol is no longer supported and this parameter is unused.	0	1

Name	Type	Description	Min occurs	Max occurs
disable-cookies	push:boolean	Set true to disable session cookie from being in the "Set-Cookie" header. If a value is not specified, cookies are enabled.	0	1

property-value

This value must be a push:string.

Aliases.xml

This file specifies the schema for the aliases properties used in a web server.

aliases

List of aliases

The following table lists the elements that an element of type `aliases` can contain:

Name	Type	Description	Min occurs	Max occurs
alias	alias	An alias definition	0	unbounded

alias

An alias definition

The following table lists the attributes that an element of type `alias` can have:

Name	Type	Description	Required
name	push:string	A name for the alias.	true

The following table lists the elements that an element of type `alias` can contain:

Name	Type	Description	Min occurs	Max occurs
source	push:string	The source URL, which can be expressed as a regular expression.	1	1
destination	push:string	The destination path.	1	1

ConnectionValidationPolicy.xml

This file specifies the schema for the connection validation policy.

connection-validation-policies

Connection validation policies

The following table lists the elements that an element of type `connection-validation-policies` can contain:

Name	Type	Description	Min occurs	Max occurs
policy	policy	A connection validation policy.	0	unbounded

policy

A connection validation policy.

The following table lists the attributes that an element of type `policy` can have:

Name	Type	Description	Required
name	push:string	Each policy must be supplied with a unique name for easy reference.	true
type	push:string	The policy type should be either "blacklist" or "whitelist". A blacklist indicates that if any of the policy rules in this policy match the incoming connection, that connection is to be rejected. A whitelist requires that at least one policy rule matches for the connection to be accepted.	true
automatic	push:boolean	Policies which are set to automatic are applied by Diffusion and the publishers do not need to perform any checks themselves. If this attribute is set to false, the policy is not applied unless it is done so by the publisher. If a value is not specified, a default of true is used.	false

The following table lists the elements that an element of type `policy` can contain:

Name	Type	Description	Min occurs	Max occurs
addresses	addresses	Connection validation policy addresses. These are addresses that are blacklisted/whitelisted.	0	1
locale	locale	Connection validation policy locale. This is locale details that are blacklisted/whitelisted.	0	unbounded

addresses

The following table lists the elements that an element of type `addresses` can contain:

Name	Type	Description	Min occurs	Max occurs
address	push:string	An IP address (or regular expression) of a connecting client.	0	unbounded
hostname	push:string	The hostname (or regular expression) of a connecting client.	0	unbounded
resolved-name	push:string	The resolved hostname (or regular expression) of a connecting client, as returned by the Whois service.	0	unbounded

locale

The following table lists the elements that an element of type `locale` can contain:

Name	Type	Description	Min occurs	Max occurs
country	push:string	The ISO country code of the connecting client, as returned by the Whols service.	0	1
language	push:string	The ISO language code of the connecting client, as returned by the Whols service.	0	1

Env.xml

This file specifies the schema for the environment properties.

env

The following table lists the elements that an element of type `env` can contain:

Name	Type	Description	Min occurs	Max occurs
property	property	Environment variable value	0	unbounded

property

The following table lists the attributes that an element of type `property` can have:

Name	Type	Description	Required
name	<code>xsd:token</code>	Name of the environment variable.	true

propertyValue

This value must be a `xsd:token`.

Mime.xml

This file specifies the schema for the mime properties.

mimes

The following table lists the elements that an element of type `mimes` can contain:

Name	Type	Description	Min occurs	Max occurs
mime	mime	Mime.	0	unbounded

mime

The following table lists the attributes that an element of type `mime` can have:

Name	Type	Description	Required
type	push:string	Mime type.	true
extension	push:string	Mime extension.	true

mimeValue

This value must be a xsd:string.

Publishers.xml

This file specifies the schema for the publisher properties.

publishers

The set of publishers that the Diffusion server is aware of at startup.

The following table lists the elements that an element of type `publishers` can contain:

Name	Type	Description	Min occurs	Max occurs
publisher	<code>publisher</code>	A publisher definition.	0	unbounded

publisher

A publisher definition.

The following table lists the attributes that an element of type `publisher` can have:

Name	Type	Description	Required
name	push:string	The publisher name.	true

The following table lists the elements that an element of type `publisher` can contain:

Name	Type	Description	Min occurs	Max occurs
topics	<code>push:string</code>	An optional, comma-separated list of topic names specifying topics to be automatically created for the publisher as it is started. This technique does not allow for topics to be set up with data and so it is more usual to define the topics you require in the <code>initialLoad</code> method of the <code>Publisher</code> . This property remains mostly for backwards compatibility. DEPRECATED: since 6.0. This configuration setting only allows the creation of stateless topics, which are deprecated. <code>Publisher</code> implementations should create initial topics in the <code>initialLoad()</code> method.	0	1

Name	Type	Description	Min occurs	Max occurs
class	push:string	The full class name of a Java class that implements the publisher. This class must extend the Java API Publisher class and provide implementations of methods as required. The class file must be available on the classpath of the Diffusion server (or in the configured usr-lib or ext folder).	1	1
enabled	push:boolean	By default, the publisher is loaded as the server starts. By setting this to false, the publisher is not loaded.	0	1
start	push:boolean	By default, the publisher is started after it is loaded. By specifying this as false, the publisher can be loaded but not started and then can be started later using JMX.	0	1
topic-aliasing	push:boolean	DEPRECATED: since 6.0. This value is no longer used.	0	1
ack-timeout	push:millis	DEPRECATED: since 6.0. This value is no longer used.	0	1
auto-ack	push:boolean	DEPRECATED: since 6.0. This value is no longer used.	0	1
subscription-policy-file	push:string	Path of a subscription validation policy file. If this value is specified, the file is used to validate client subscriptions to topics owned by the publisher.	0	1
stop-server-if-not-loaded	push:boolean	If this is set to true and the publisher fails to load, the Diffusion server stops. By default, this is false.	0	1
log-level	push:log-level	Specifies the log level for the publisher. If this value is not specified, the publisher logs at the default log level.	0	1
web-server	web-server	If the publisher has associated web content, it can be deployed with the publisher by specifying this property.	0	1
launch	launch	Launch detail describes how the publisher might be accessed externally, if it has an associated webpage.	0	unbounded
property	property	A property available to the publisher. This can be used to configure publisher-specific variables or parameters.	0	unbounded

launch

Launch detail.

The following table lists the attributes that an element of type `launch` can have:

Name	Type	Description	Required
name	push:string	The launcher name.	true
category	push:string	An optional category to which this launcher belongs. For example, "demo" for the Diffusion demo landing page.	false

The following table lists the elements that an element of type `launcher` can contain:

Name	Type	Description	Min occurs	Max occurs
description	push:string	A short description of this launcher.	0	1
url	push:string	The URL at which a webpage associated with this publisher can be found.	1	1
icon	push:string	A URL or path at which an icon representing this launcher can be reached.	0	1

property

A publisher property.

The following table lists the attributes that an element of type `property` can have:

Name	Type	Description	Required
name	push:string	The property value	true
type	push:string	An optional property type. Usage of this is implementation specific.	false

web-server

A web server definition.

The following table lists the elements that an element of type `web-server` can contain:

Name	Type	Description	Min occurs	Max occurs
virtual-host	push:string	The name of the virtual host to deploy to. If this value is not supplied, <code>default-files-default</code> is used.	0	1
alias-file	push:string	The alias file to use for this publisher	1	1

propertyValue

This value must be a `push:string`.

Statistics.xml

This file specifies the schema for the properties defining statistics collection. The statistics are broken into sections: client, topic, server and publisher.

statistics

Properties defining statistics collection.

The following table lists the attributes that an element of type `statistics` can have:

Name	Type	Description	Required
enabled	push:boolean	A global switch to toggle collection of all statistics.	true

The following table lists the elements that an element of type `statistics` can contain:

Name	Type	Description	Min occurs	Max occurs
client-statistics	client-statistics	Optional client statistics. Aggregate and per-instance statistics can be enabled. If client statistics are enabled, summary reports will regularly be written to the server log. The log message gives a count of all of the different client types. Each counter is reset according to the configured frequency.	0	1
topic-statistics	topic-statistics	Optional topic statistics.	0	1
publisher-statistics	publisher-statistics	Optional publisher statistics.	0	1
reporters	reporters	Optional set of <code>StatisticsReporters</code> to be loaded with Diffusion, which are registered with the internal <code>StatisticsService</code> and used to generate output.	0	1

client-statistics

The following table lists the attributes that an element of type `client-statistics` can have:

Name	Type	Description	Required
enabled	push:boolean	Specifies if aggregate client statistics are enabled.	true

The following table lists the elements that an element of type `client-statistics` can contain:

Name	Type	Description	Min occurs	Max occurs
log-name	push:string	DEPRECATED: since 6.1. This setting is no longer used and will be removed in a future version of the product. Session statistics are now written to the server log. If separate log files are required or	0	1

Name	Type	Description	Min occurs	Max occurs
		the reports are not desired, use a third-party SLF4J logging back-end such as Log4j 2, and configure it appropriately to partition or filter the server log.		
output-frequency	push:millis	Specifies the output frequency of the log. There is one entry per specified interval. If this is not specified, a default of 1h is used.	0	1
reset-frequency	push:millis	Specifies when the counters are reset. The reset interval must be a multiple of the output frequency. Zero specifies that the counters are never reset. If this is not specified, a default of 1h is used.	0	1
monitor-instances	push:boolean	Specifies if individual client statistics are enabled. This also enables the regular reports of the session statistics summaries to the server log.	0	1

topic-statistics

The following table lists the attributes that an element of type `topic-statistics` can have:

Name	Type	Description	Required
enabled	push:boolean	Specifies if aggregate topic statistics are enabled.	true

The following table lists the elements that an element of type `topic-statistics` can contain:

Name	Type	Description	Min occurs	Max occurs
monitor-instances	push:boolean	Specifies if individual topic statistics are enabled.	0	1

publisher-statistics

The following table lists the attributes that an element of type `publisher-statistics` can have:

Name	Type	Description	Required
enabled	push:boolean	Specifies if aggregate publisher statistics are enabled.	true

The following table lists the elements that an element of type `publisher-statistics` can contain:

Name	Type	Description	Min occurs	Max occurs
monitor-instances	push:boolean	Specifies if individual publisher statistics are enabled. DEPRECATED: since 6.1. To simplify the statistics model and reduce	0	1

Name	Type	Description	Min occurs	Max occurs
		the cost of reporting, per-publisher statistics are being retired in favour of server-scoped statistics.		

reporters

The set of StatisticsReporters that the Diffusion server is aware of at startup. Used to output the statistics gathered for clients, publishers, or topics.

The following table lists the elements that an element of type `reporters` can contain:

Name	Type	Description	Min occurs	Max occurs
reporter	reporter	A reporter definition.	0	unbounded

reporter

A StatisticsReporter definition.

The following table lists the attributes that an element of type `reporter` can have:

Name	Type	Description	Required
name	push:string	The reporter name.	true
enabled	push:boolean	Whether the reporter is enabled. If this is set to true, the reporter is automatically loaded when Diffusion starts. Otherwise, you must manually load the reporter config at run-time using the statistics API.	true

The following table lists the elements that an element of type `reporter` can contain:

Name	Type	Description	Min occurs	Max occurs
type	push:string	The type of reporter to be used. Currently options are: TOPIC - exposes metrics in the Diffusion topic tree; JMX - exposes metrics on the local JMX server.	1	1
property	property	A property available to the reporter. This can be used to configure reporter-specific variables or parameters.	0	unbounded

property

A StatisticsReporter property. Currently accepted values: 'interval' - used by the topic reporter. Specifies an integer value, in seconds, used to set the period of update publishing.

The following table lists the attributes that an element of type `property` can have:

Name	Type	Description	Required
name	push:string	The property value	true

Name	Type	Description	Required
type	push:string	An optional property type. Usage of this is implementation specific.	false

propertyValue

This value must be a push:string.

SubscriptionValidationPolicy.xml

This file specifies the schema for the subscription validation policy.

subscription-validation-policies

Subscription validation policies

The following table lists the elements that an element of type `subscription-validation-policies` can contain:

Name	Type	Description	Min occurs	Max occurs
topics	topics	A map of topics to policies.	0	1
policy	policy	A subscription validation policy.	0	unbounded

topics

A map of topics to policies.

The following table lists the elements that an element of type `topics` can contain:

Name	Type	Description	Min occurs	Max occurs
topic	topic	A topic to policy mapping.	0	unbounded

topic

The following table lists the attributes that an element of type `topic` can have:

Name	Type	Description	Required
policy	push:string	The name of the policy to apply to this topic.	true

policy

A subscription validation policy.

The following table lists the attributes that an element of type `policy` can have:

Name	Type	Description	Required
name	push:string	Each policy must be supplied with a unique name for easy reference.	true

Name	Type	Description	Required
type	push:string	The policy type is either "blacklist" or "whitelist". A blacklist indicates that if any of the policy rules in this policy match the incoming connection, that connection is to be rejected. A whitelist requires that at least one policy rule matches for the connection to be accepted.	true
automatic	push:boolean	Policies which are set to automatic are applied by Diffusion and the publishers do not need to perform any checks themselves. If this is set to false, the policy is not applied unless it is done by the publisher. If this value is not specified, a default of true is used.	false
validate-children	xsd:boolean	Controls whether to perform validation on child topics if the parent topic fails validation. If a value is not specified, a default of false is used.	false

The following table lists the elements that an element of type `policy` can contain:

Name	Type	Description	Min occurs	Max occurs
addresses	addresses	Subscription validation policy addresses. These are addresses that are blacklisted/whitelisted.	0	1
locale	locale	Connection validation policy locale. This is locale details that are blacklisted/whitelisted.	0	unbounded

addresses

The following table lists the elements that an element of type `addresses` can contain:

Name	Type	Description	Min occurs	Max occurs
address	push:string	An IP address (or regular expression) of a subscribing client.	0	unbounded
hostname	push:string	The hostname (or regular expression) of a subscribing client.	0	unbounded
resolved-name	push:string	The resolved hostname (or regular expression) of a subscribing client, as returned by the Whois service.	0	unbounded

locale

The following table lists the elements that an element of type `locale` can contain:

Name	Type	Description	Min occurs	Max occurs
country	push:string	The ISO country code of the subscribing client, as returned by the Whois service.	0	1
language	push:string	The ISO language code of the subscribing client, as returned by the Whois service.	0	1

Cross domain

The `etc` directory contains an additional `crossdomain.xml` XML file. The format of this XML file is not defined by Push Technology.

The following XML file is included in the `etc` directory. For more information, see [Cross domain policies](#) on page 702.

crossdomain.xml

Use this file to grant a web client permission to handle data across multiple domains.

Starting the Diffusion server

After you have installed and configured your Diffusion server, you can start it using one of a number of methods.

Use the provided Diffusion start scripts

Your Diffusion installation includes The `diffusion.sh` or `diffusion.bat` command (issued in the `bin` directory) starts Diffusion. An optional properties directory can be specified as a parameter to be used instead of the default `../etc` directory.

Important: Do not run your Diffusion server as root on Linux or UNIX. To run the Diffusion server on a port number of 1024 or lower, use another means. For some examples of ways of doing this, see <http://www.debian-administration.org/articles/386>.

Use a script in `init.d`

On Linux, Diffusion can be started using a script in your `/etc/init.d` folder that starts your Diffusion server when the host server starts.

If you installed your Diffusion server using RPM, this script already exists in your `/etc/init.d` folder.

If you installed your Diffusion using another method, you can use the sample script files in the `tools/init.d` directory of your Diffusion. Edit the sample script file to include the location of your installation and make any other changes that are required. Copy the edited script file to `/etc/init.d`. Ensure that the file is executable.

When your host server starts, it starts your Diffusion server.

Use Docker

Diffusion is provided as a Docker image on DockerHub. When you use Docker to run this image, the Diffusion server inside the image is started.

For more information, see [Installing the Diffusion server using Docker](#) on page 481.

Run embedded in a Java process

You can run the Diffusion server from within a Java process by including the `diffusion.jar` on the classpath of the Java process.

For more information, see [Running from within a Java application](#) on page 553.

Running from within a Java application

To run Diffusion from within a Java application instantiate, configure and start a `DiffusionServer` object.

Creating a server

`DiffusionServer` is available in the `com.pushtechology.diffusion.api.server`. You can instantiate it with one of the following constructors:

Default configuration

```
DiffusionServer server = new DiffusionServer();
```

This instantiates the server with default configuration options. The default configuration is read from the XML configuration files in the `etc` directory of your Diffusion installation. Required aspects of the server must be configured before it is started. These can be configured programmatically. For more information, see [Programmatic configuration](#) on page 493.

Bootstrap properties

```
DiffusionServer server = new  
DiffusionServer(bootstrapProperties);
```

This specifies a set of properties inside a `Properties` object. The following properties are supported:

<code>diffusion.home</code>	The base installation directory	Calculated from the location of the <code>diffusion.jar</code> file.
<code>diffusion.config.dir</code>	The configuration directory, where the XML configuration files are located.	<code>diffusion.home/etc</code>
<code>diffusion.license.file</code>	The license file	<code>diffusion.config.dir/licence.lic</code>
<code>diffusion.keystore.file</code>	The keystore file required to decrypt the license	<code>diffusion.config.dir/licence.keystore</code>

These properties can also be set as system properties.

Whichever approach to instantiation that you use, a full set of XML configuration files can be present in the configuration directory and tuned as required or just a partial set of the files can be present and all missing configuration supplied programmatically.

Configuring the Diffusion server

Once the server object has been instantiated some properties can be configured. The root configuration object can be obtained from the server object as follows:

```
ServerConfig config = server.getConfig();
```

Alternatively the root can be obtained using `ConfigManager.getServerConfig()`.

The configuration is populated from the XML configuration files in the installation or in the configuration directory specified by *diffusion.config.dir*. You can further customize the configuration to fit your requirements. For an example, see the following sample code:

```
DiffusionServer server = new DiffusionServer();

ServerConfig config = server.getConfig();

// Publisher
PublisherConfig publisher = config.addPublisher("My
  Publisher", "com.company.MyPublisherClass");

// Connector ConnectorConfig connector = config.addConnector("Client
  Connector");
// Configure connector as required....

// Thread Pools
ThreadsConfig threads = config.getThreads();
ThreadPoolConfig inbound = threads.addPool("Inbound");
inbound.setCoreSize(3);
inbound.setMaximumSize(10);
inbound.setQueueSize(2000);
threads.setInboundPool(inbound.getName());
threads.setBackgroundPoolSize(2);

// Queues QueuesConfig queues = config.getQueues();
QueueConfig queue = queues.addQueue("DefaultQueue");
queue.setMaximumDepth(10000);
queues.setDefaultQueue("DefaultQueue");

// Multiplexer MultiplexerConfig multiplexer =
  config.addMultiplexer("Multiplexer");
multiplexer.setSize(4);
```

Note: The logging configuration cannot be changed using the `ServerConfig` object. By the time the configuration objects are available to your Java application, the logging properties are locked. The `LoggingConfig` object is read-only.

Monitoring the Diffusion server lifecycle

The `DiffusionServer` class provides methods to add and remove a lifecycle listener on the server instance.

```
addLifecycleListener(LifecycleListener stateCallback);
```

```
removeLifecycleListener(LifecycleListener stateCallback);
```

The lifecycle listener is a callback that is called whenever the server state changes. The Diffusion server can have the following states:

INITIAL

An instance of the `DiffusionServer` exists, but has not been started.

STARTING

The server is starting.

STARTED

The server has started and all publishers are deployed.

STOPPING

The server is stopping.

STOPPED

The server has stopped.

Starting the server

After the server configuration has been completed, the server can be started using `server.start()`.

The declared publishers are then loaded and connectors start to listen on the configured ports.

Stopping the server

The server can be stopped using `server.stop()` at which point the server is no longer available.

Run requirements

A simple way to use Diffusion as a library within your application is to install Diffusion and include the path to `diffusion.jar` in your CLASSPATH.

If you want to repack the Diffusion code more extensively, be aware of the following concerns:

- `diffusion.jar` depends on other library files in the installation's `lib` directory and are referenced in the jar's manifest `Class-Path` entry. You must also make the code in these libraries available.
- You still require a Diffusion installation. The installation provides the configuration, licence, and log directories. The installation directory is calculated from the location of `diffusion.jar`. If `diffusion.jar` is not loaded from a URL classloader, or has been moved from the product installation, use the bootstrap properties constructor and set the `diffusion.home` system property to the installation directory.

Limitations

Currently only one Diffusion server can be instantiated in a Java VM and it can be started only once.

Network security

This section describes how to deploy network security, which can be used in conjunction with data security.

Secure clients

Diffusion clients can connect to your solution using TLS or SSL. The secure connection can terminate at your load balancer or at your Diffusion server. Terminating the TLS/SSL at the load balancer reduces CPU cost on your Diffusion servers.

The following SSL and TLS versions are supported by default:

- SSLv2Hello

- TLSv1
- TLSv1.1
- TLSv1.2

You can use the system property `diffusion.tls.protocols` with the JVM that runs the Diffusion server, a Java client or an Android client to provide a different list of secure protocols to use.

The following cipher suites are supported by default:

- TLS_RSA_WITH_AES_128_CBC_SHA
- TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA
- TLS_RSA_WITH_AES_128_CBC_SHA256
- TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256
- TLS_ECDHE_RSA_WITH_3DES_EDE_CBC_SHA

You can use the system property `https.cipherSuites` with the JVM that runs the Diffusion server, a Java client or an Android client to provide a different list of cipher suites to use.

Session tokens

Diffusion clients use session tokens to authenticate when reconnecting to their existing session. To protect the credentials supplied in the original connection request and the returned session token, ensure that the client uses a secure transport to communicate with the Diffusion server. For example, WSS.

Session tokens are generated by using `java.security.SecureRandom` with the default algorithm supplied by the Java environment used to run the Diffusion server. Each token is a 24-character string encoded in base-64, representing 18 bytes (144 bits) of random data.

A new session token is generated when a client connects to the Diffusion server, is authenticated, and creates a session. The server returns the session token to the client in the connection response. The client library keeps the session token in memory. If the client connection is lost, the client attempts to reconnect and supplies the session token. The server is configured with a reconnection timeout. If the Diffusion server detects the loss of the client connection and the client fails to reconnect to the Diffusion server before the reconnection timeout has elapsed, the Diffusion server closes the session and the session token is no longer valid. If the client reconnects before the reconnection timeout has elapsed, the Diffusion server accepts the new connection using the session token is used as proof of authentication.

Web server configuration

The web server can be configured in your test environment to allow you to deploy and undeploy DAR files by using a web service. By default this capability is not enabled.

For security, if you choose to enable this web service in your production environment, you must restrict access to the `diffusion-url/deploy` URL by other means. For example, by setting up restrictions in your firewall.

To configure the web server, use the `WebServer.xml` file. For more information, see [WebServer.xml](#). An example of this file is provided in the `/etc` directory of the Diffusion installation. The XSD is provided in the `/xsd` directory of the Diffusion installation.

Connector configuration

If secure connections are required, Diffusion connectors must be configured to support HTTPS, WSS, or a combination of these transports. Any connector can accept secure connections. A connector does not have to be dedicated to only secure connections. To enable secure connections a keystore entry

is required in the connector configuration. This informs the connector that it is enabled for secure connections. If HTTPS is required, a keystore section and a web-server entry are also required, even for secure Diffusion clients.

To configure the connectors, use the `Connectors.xml` file. For more information, see [Connectors.xml](#). An example of this file is provided in the `/etc` directory of the Diffusion installation. The XSD is provided in the `/xsd` directory of the Diffusion installation.

Keystores

The default Diffusion installation includes a sample keystore containing a self-signed certificate. This is suitable for development. The certificate will not be trusted by browsers and other clients without additional configuration. If you use TLS in production, you must create a new keystore, using a certificate obtained from a certificate authority.

The following steps use the Java Keytool to create a keystore. The steps can vary depending on your certificate authority. For more information, refer to your certificate authority's documentation.

1. Generate a key and place it in your keystore.

```
keytool -genkeypair -alias my_alias -keyalg RSA -  
keystore keystore_name -keysize
```

2. Generate a CSR file.

```
keytool -certreq -keyalg RSA -alias my_alias -file certreq.csr -  
keystore keystore_name
```

3. Send the CSR file to your certificate authority.
4. Receive the signed certificate from your certificate authority.
5. Install any intermediate certificates that you require.

```
keytool -import -trustcacerts -alias intermediate_alias -  
keystore keystore_name -file intermediate_certificate_file.crt
```

6. Install your own certificate. Use the same alias as when you generated the key and the signing request.

```
keytool -import -trustcacerts -alias my_alias -  
keystore keystore_name -file certificate_file.crt
```

Provided keystores

The `etc` directory of the Diffusion directory contains the following keystores:

sample.keystore

This keystore is an example keystore that contains a self-signed certificate. In production, we recommend you create your own keystore that contains a certificate signed by a certificate authority.

licence.keystore

This keystore contains the public key used for the Diffusion license file. Do not edit or delete this keystore. Diffusion requires this keystore to verify your Diffusion license.

Related information

<https://www.ssldesk.com/java-keytool-commands/>

Going to production

When going to production with Diffusion review this information for recommendations on preparing for a successful production deployment.

The advice in this section is not an exhaustive list of steps to take when getting ready to take your Diffusion solution into production. You might have additional requirements based on your solution. Push Technology provides Professional Services that can work with you to advise on a pre-production testing strategy specific to your requirements. Email consulting@pushtechnology.com for more information.

Pre-production testing

The most important part of taking your solution into production is to ensure that you fully test it under as wide a range of expected conditions as possible.

Setting up your test environment

Ensure that the environment you set up to test your solution is as close as possible to the production environment you intend to deploy.

About this task

There are many benefits to creating a test environment that is the same as your production environment:

- It enables you to do regression testing when you change the version or configuration of any of the components in your solution.
- It enables you to test your solution's performance under different levels of stress and load.
- It provides a controlled environment where you can reproduce any issues that you encounter in your production system.
- It provides an environment where you can capture runtime data that cannot easily be captured in production without affecting the behavior or performance of the production system.

To create a test environment that closely reflects your production environment, consider taking the following steps:

Procedure

1. Use the same hardware as you intend to deploy your production solution on.

Consider the following aspects:

- Hardware specifications
- Operating system version and patch version

For more information, see [Requirements](#).

2. Use the same network specifications as you intend to use in your production solution.

Consider the following aspects:

- Speed
- Connection reliability

Note: This is especially important when testing mobile applications. The behavior of your mobile client can be different depending on whether the client connects through WiFi or 3G, for example.

3. Use the same JDK version as you intend to use to run your Diffusion server.

Consider the following aspects:

- The JVM version
- Any tuning parameters you intend to use

For more information, see [Requirements](#).

4. Include third-party components that will be used in your production solution.

Consider your use of the following components:

- Load balancers

For more information, see [Load balancers](#) on page 120 and [Common issues when using a load balancer](#) on page 708.

- Web servers

For more information, see [Web servers](#) on page 121 and [Web servers](#) on page 695.

- Push notification networks

For more information, see [Push notification networks](#) on page 123 and [Push Notification Bridge](#) on page 737.

- JMS servers

For more information, see [JMS](#) on page 125 and [JMS adapter](#) on page 709.

There are special considerations for using these third-party components with Diffusion. Ensure that you have fully reviewed the linked documentation for any of the components you are using.

5. Ensure your Diffusion servers use the same version and configuration as in your production solution.

Consider the following aspects:

- Diffusion server version
- Diffusion server configuration
- Diffusion server security configuration

6. Include all the components you have developed for use in your production system.

Consider your use of the following components:

- Clients

Both those within your organization and those used by your customers.

- Publishers
- Server-side components

Understanding production usage conditions

Consider the flow of data and the actions of clients in your Diffusion server. Pre-production testing that closely models the usage you expect to see in production is most useful in understanding how your solution will respond in production.

The following sections contain some of the questions to consider when deciding how to test your solution before going to production. For each of these questions consider both average use values and edge case values.

Client connections

- How many clients do you expect to attempt to connect simultaneously?
- How many clients do you expect to be connected concurrently?
- Do you have session replication enabled and, if so, in a failover situation do you expect all of your concurrently connected clients to attempt reconnect at the same time?

- How long is a client connection expected to last?
- What is the expected geographic distribution of client connections?
- How does your load balancer decide how to distribute incoming client connections?
- How are your expected client connections distributed by platform or API?
- How are your incoming client connections authenticated?

Topics

- At what frequency do you expect to create topics?
- How many topics do you expect to create at the same time?
- At what frequency do you expect to delete topics?
- How many topics do you expect to delete at the same time?
- How many topics do you expect your clients to be subscribed to?
- How many topics do you expect your clients to subscribe to in a single action?

Topic updating

- How many topics is a given client expected to update?
- How frequently do you expect topics to be updated?
- How many topics do you expect to send updates to at the same time?
- How many topics do you expect a given client to send updates to at the same time?
- How big do you expect the data in your topic updates to be?

Other client actions

- How many client authentication requests is a given client expected to handle?
- How many messages sent to a message path is a given client expected to handle?
- How many messages sent directly to the client is a given client expected to receive?
- How many messages is a given client expected to send to a message path?
- How many messages is a given client expected to send directly to another client?
- How often do you expect clients to manage other clients?
- How many clients do you expect a given client to manage?

[How to create production usage conditions in your test environment](#)

You can create production usage conditions in your test environment by either recording live production usage and playing it back or by simulating production usage.

Recording production conditions

Recording production conditions involves inserting components within your production system to track specific actions. For example:

- A recording tool upstream of the Diffusion server that records the data stream being fed in to Diffusion topics
- A recording tool at your load balancer to record incoming connections, where they come from, when they connect, and how long they remain connected.

After this data has been captured in production test tools use the data to replay or simulate identical conditions in your test environment.

The record and playback approach has the following advantages:

- The data and client actions have occurred in production and reflect realistic production conditions.

The record and playback approach has the following disadvantages:

- You cannot use the recorded data to test conditions that have not occurred in your production environment, but that you might expect to occur.
- You must have an existing production environment to capture data from.
- You must develop the tools to capture and store production conditions. Introducing these components to your production system might effect its behavior.
- You must develop the tools to replay production conditions in your test environment.

Simulating production conditions

Simulating production conditions involves developing tools or test harnesses that generate data or client behavior in your test environment.

The simulation approach has the following advantages:

- You can test a wider range of conditions than those that have occurred in production.

The simulation approach has the following disadvantages:

- There is a risk that the simulation might not create realistic production conditions.
- You must develop the tools to simulate the conditions you want to test.

Using live production data

You can create production conditions in your data by using the same data stream as the production environment uses to feed into your test environment.

The live production data approach has the following advantages:

- The data stream being fed in to Diffusion is real.
- You do not need to create tools to record and playback or to simulate production data.

The live production data approach has the following disadvantages:

- Depending on the type of client information in the production data and your data protection policies and legal requirements, you might not be permitted to use live production data in a test environment.
- Depending on the type of client information in the production data and your data protection policies and legal requirements, you might not be permitted to send certain diagnostics to Push Technology when requesting support.
- You must ensure that nothing in your test environment can affect either the production data or the production environment.
- You must have an existing production environment to use data from.
- If you want to test specific data conditions, you are restricted to doing so at the times when these conditions occur.

Using live production traffic

You can simulate production conditions in your client traffic by duplicating client requests coming into your live production environment in your test environment and by suppressing the responses made by the test server from reaching the production client.

The live production traffic approach has the following advantages:

- The client requests to Diffusion are real.
- You do not need to create tools to record and playback or to simulate production traffic.

The live production traffic approach has the following disadvantages:

- Depending on the type of client information in the traffic and your data protection policies and legal requirements, you might not be permitted to use live production traffic in a test environment.

- Depending on the type of client information in the production traffic and your data protection policies and legal requirements, you might not be permitted to send certain diagnostics to Push Technology when requesting support.
- You must have an existing production environment to use the traffic from.
- You must ensure that responses from your test environment do not reach the client.
- Because the responses from the test environment do not reach the production clients, who instead receive responses from the production environment, the behavior does not accurately reflect server-client interactions.
- If you want to test specific traffic conditions, you are restricted to doing so at the times when these conditions occur.

These techniques can be used separately or together to give the fullest range of test conditions.

Both involve the development of custom tooling to create the required conditions. Push Technology provides Professional Services that can work with you to create these tools. Email consulting@pushtechnology.com for more information.

Types of testing

Consider performing the following types of testing before taking your solution into production.

Component testing

Before setting up your test environment, test the clients and other components that you have developed. For each component, consider doing the following testing:

- Unit testing with a high level of code coverage
- End-to-end testing
- Performance testing
- Stress testing
- Usability and accessibility testing, if the component is customer-facing.

For more information, see [Testing](#) on page 473

Smoke testing

On first setting up your test environment, smoke test your solution to ensure that all basic expected function works before proceeding to more in-depth testing.

For more information, see [Smoke Testing on Wikipedia](#)

Regression testing

If you have an existing Diffusion solution in production and are updating one or more components or their configuration, perform regression testing in your test environment to ensure that the behavior of your solution has not changed in unintended ways before updating your production environment.

For more information, see [Regression Testing on Wikipedia](#)

Load testing

Ensure that you test your Diffusion solution at peak expected load to discover how your solution handles these conditions. This load can be client connections, topics, topic updates, and combinations of load types.

For more information, see [Load Testing on Wikipedia](#)

Soak testing

Most Diffusion solutions are expected to run continuously under varying load. Ensure that you test how your solution behaves when it is left in operation for a long time, for example, 24 hours. Long test runs can uncover potential resource leaks, long garbage collections, or previously unforeseen timeouts.

For more information, see [Soak Testing on Wikipedia](#)

Failover and recovery testing

If your solution has failover or replication configured on your Diffusion servers, test that these work as you expect when one of the Diffusion becomes unavailable. For resiliency of your whole solution, other components – for example, load balancers – can be configured to failover or provide redundancy. Ensure that these measures work as you expect.

For more information, see [Configuring the Diffusion server to use replication](#) on page 528 and [Using load balancers for resilience](#) on page 707

Penetration testing

Diffusion provides mechanisms to secure which ports clients can connect to your Diffusion server on, what actions those clients can take, and what data they can view or update. You also can use load balancers and firewalls to secure your solution.

However, security flaws can occur in any system. Many companies offer a penetration testing service that can help uncover any vulnerabilities in your solution. If you do not have the resource or knowledge to perform penetration testing on your solution, we recommend that you use a third-party penetration testing company.

For more information, see [Penetration Testing on Wikipedia](#)

Testing your security

Your Diffusion solution is made up of multiple components. Ensure that you consider and test for potential security problems in all your components and in their interactions.

It is important to design your solution for security before you even begin any development or configuration. For more information about designing a secure solution, see [Design Guide](#) on page 32.

Note: Many companies offer a penetration testing service that can help uncover any vulnerabilities in your solution. If you do not have the resource or knowledge to perform penetration testing on your solution, we recommend that you use a third-party penetration testing company.

Consider these aspects of security for your solution.

URL spaces and ports exposed by your load balancer

What routes does your solution offer to connections from outside?

For more information, see [Load balancers](#) on page 703.

Connectors

What ports allow connections to the Diffusion server? What kind of connections are these ports configured to allow?

For more information, see [Configuring connectors](#) on page 503.

Users and roles on your Diffusion server

How are connections to the Diffusion server authenticated? What roles and permissions are assigned to authenticated connections? How are different parts of your topic tree secured?

For more information, see [Role-based authorization](#) on page 130.

Console

Are connections from outside your organization permitted to access the Diffusion console? Which users are assigned the permission to access the console?

For more information, see [Diffusion monitoring console](#) on page 606.

Tools you can use in your pre-production testing

There are many available tools that are useful when doing pre-production testing of your solution.

Amazon Web Services (AWS)

Use AWS to host large numbers of test clients that connect to your test environment for capacity and load testing. Using a cloud provider enables you to scale up your testing without being constrained by how much hardware resource you have in your organization.

Amazon Web Services is one of many cloud providers that you can choose between for your load and capacity testing.

For more information, see <https://aws.amazon.com/dev-test/>

Eclipse Memory Analyser Tool (MAT)

Use Eclipse MAT to analyze how your Diffusion server memory behaves under different usage conditions. You can also use this tool to analyze the memory behavior of any Java clients that you use in your solution.

For more information, see <http://www.eclipse.org/mat/>

VisualVM

VisualVM is a Java monitoring tool that you can use to monitor the behavior of the Diffusion server and other Java-based components in your solution.

For more information, see <https://visualvm.java.net/>

VisualVM also provides the ability to view the MBeans that the Diffusion server registers with the JMX service. These MBeans provide statistics and information about many of the primary features of the Diffusion server.

For more information, see [JMX](#) on page 583

Java Flight Recorder and Java Mission Control

These tools provide the capability to capture low-level JVM metrics during the test cycle. Java Flight Recorder is built into the Oracle JDK. Java Mission Control enables you to analyse the data collected by the Flight Recorder.

For more information, see [Java Mission Control documentation](#)

Diffusion monitoring console

Use the Diffusion monitoring console to validate, in real time, the metrics presented by the Diffusion server.

For more information, see [Diffusion monitoring console](#) on page 606

Diffusion JavaScript test client

Use the JavaScript test client, which is available from the Diffusion landing page at `http://localhost:8080` to perform basic feature testing and smoke testing against your test servers.

Diffusion benchmarking suite

Push Technology provide a suite of benchmarks that you can use to test the behavior of the Diffusion server on your hardware and with your configuration.

For more information, see <https://github.com/pushtechology/diffusion-benchmark-suite>

Planning for production

The key to a successful production deployment is planning and preparation.

Consider the following questions when planning for production deployment:

Hard launch or soft launch?

In a hard launch, your solution is rolled out to all of your users at the same time. In a soft launch, your solution is rolled out to only a select group of users.

The advantage of a soft launch is that it enables you to trial your new solution with a subset of your users and discover any remaining issues before rolling out to your whole user base.

Will your users experience any down-time?

How will your deployment affect existing users? Will their clients experience a disconnection? Will the deployment of your new solution force them to upgrade their client version before they can continue to use your solution?

Understand what your users will experience during your deployment and what experience you want them to have.

When are you going to roll out to production?

Select a time that fits best with your business. Consider when you have the most users, when you have certain events for which your system needs to be up, and when your team are available to support and troubleshoot the deployment.

Who do you need to notify in advance?

Do you need to notify your users of upcoming down-time? Do you need to notify your user of actions they must take? Do you have any third parties that provide data or services who need to be notified?

How are you deploying your solution to production?

Are you rolling out all of the components of your solution or just changing some of them? What order are you deploying your components in? Are you going to automate all or some of the deployment process?

What is your roll back plan if something unforeseen happens?

Even with the best testing and planning, problems can occur in a production environment. Developing a strategy in advance for handling problems ensures that you can react quickly if problems occur.

Prepare a go-live checklist

After you have considered all aspects of your deployment, we recommend that you create a go-live checklist detailing all of the tasks necessary across your organization in order to go live.

Deploying to your production environment

For the best results, consider automating deployment of your components and configuration.

Automated deployment to your test environment enables you to quickly iterate your development and roll out new changes into testing. Removing the overheads of setting up a test environment by automating the process, gives your team more time to perform testing.

Automated deployment to your production environment helps reduce the risk of human error. By automating all the steps required to deploy your solution to production, you can easily test your deployment process. Automated deployment is quicker than manual deployment and can reduce the amount of down-time that a deployment might cause. Testing your automated deployment process gives you the chance to measure this down-time duration. You can use this information to appropriately set your service-level agreements.

Tuning

Aspects of tuning Diffusion for better performance or resilience

This section covers aspects of configuring Diffusion to achieve higher levels of performance and covers some of the more advanced features which enable users to get more out of Diffusion.

Concurrency

Diffusion is a multi-threaded server and utilizes concurrent processing to achieve maximum performance. Java NIO technology is utilized so that a separate thread is not required for each concurrent connection and very large numbers of concurrent connections can be handled.

Because Diffusion is a multi-threaded environment it is necessary to have an understanding of concurrency issues when writing publishers and when configuring Diffusion for best performance.

This section discusses issues of threading and concurrent processing.

Publisher threads

The processing that occurs within the user-written code of a publisher can be executed in different threads as discussed below. Any publisher method can be called at the same time as another. Because of this all publisher processing must be thread safe and it is the user's responsibility to synchronize processing as required. It is recommended that synchronization is maintained at the smallest scope possible to avoid performance bottlenecks.

Inbound threads

Any input that is received on an NIO connection is processed by a thread from the inbound thread pool. This includes most publisher notifications from clients, event publishers or other publishers with the exception of control notifications (such as `initialLoad`, `publisherStarted`) which occurs in the controlling thread.

Note: The act of publishing or sending messages to clients is asynchronous that is to say that the message is queued for the client or clients. Publisher processing is not blocked whilst messages are delivered to clients. For best performance it is recommended that any code executed in the inbound threads is non-blocking (for example, avoid database access, locking, and disk IO as much as possible).

Client notification threads

If a publisher uses client notifications, the publisher has its own dedicated thread to process those notifications.

By default here is one notification thread per publisher, no matter how many listeners are defined. Each event is processed by the thread in the order in which they occur and two client notification event methods are not called concurrently. If the order of such events is not critical, you can specify that a user thread pool is used for client notifications this increasing throughput.

User threads

Publishers or other users of the Diffusion Java API can make use of the Java threads API to schedule tasks for processing of their own in a separate thread of processing.

You can execute any object of a class that implements the `RunnableTask` interface using one of the `ThreadService.schedule` methods. You can to request a one-off execution of a task, periodic execution at a given interval or execution according to a schedule. Periodic processing can be important to publishers that pull data updates from elsewhere.

Such tasks issued using the thread service are executed using threads from the background thread pool.

Alternatively, users can define their own thread pools to use using the thread service and execute tasks using these thread pools.

NIO Threads

Each connector that is configured in `etc/Connectors.xml` comprises a connector thread that listens for incoming socket connections, accepts them and registers them with an acceptor thread that handles any incoming data notifications. Message decoding, routing to publishers and appropriate publisher callbacks are all run in the inbound thread pool. Connector and acceptor threads are occupied for the minimum amount of time and are completely non-blocking.

Though performance can be improved in extreme case by adjusting the numbers of these NIO threads, no significant processing occurs within them.

Client multiplexers

A client multiplexer is a separate thread which is responsible for processing messages on the publisher event queue, queuing for clients (conflating if necessary), taking messages from client queues and sending them to the client or clients. A number of these multiplexers can be configured to improve concurrent processing when there are a large number of clients.

The number of multiplexers can be configured. By default, the number of multiplexers is the same as the number of available cores on the host system of the Diffusion server.

Multiplexers typically batch these output messages into output buffers according to the output buffer size configured for the client connectors.

Thread pools

Diffusion maintains a number of configurable thread pools which are used for a number of purposes

For more information, see [Thread pools](#) on page 572. Thread pools can also be accessed programmatically using the `ThreadService` class of Diffusion server API. Refer to the API documentation for more information about this.

The various types of thread pools are as follows:

Inbound thread pool

This is used to obtain a thread to process any inbound message received on an NIO connection. The maximum number of threads configured for this pool must cater for the maximum required concurrency for incoming requests.

Diffusion does not maintain a separate thread for each client connection but rather passes each inbound request from a connection to the inbound thread pool for processing.

For example, when a client subscribes, the input processing happens on an inbound thread from the pool, the subscribe method and topic loader methods are run in one of these threads.

Connector inbound thread pools

Individual connectors can configure their own separate inbound thread pool to override the use of the default. This cannot be required if you want different behaviors for each connector or if there are a lot of connectors. Due to locking on the inbound thread pool, you get better performance if each connector to have its own inbound thread pool.

Background thread pool

The background thread pool is used for executing scheduled tasks. These tasks can be issued by Diffusion itself or using a publisher using the Java threads API.

Diffusion uses scheduled tasks for various reasons such as retrying connections. If a Diffusion server cannot connect to another server and there is a retry policy, a scheduled task will be used to retry the connection.

If any publisher uses a lot of scheduled tasks, the number of threads in this pool might have to be increased waiting tasks might queue.

Unlike other types of pool when the specified number of threads are in use, tasks are queued in an unbounded queue.

User thread pools

Within the Java threads API user can define thread pools that can be used for multi-threaded processing.

Buffer sizing

There are a number of places within the configuration of Diffusion where buffer sizes must be specified and getting these right can have a significant impact upon performance.

Connector output buffers

An output buffer size must be configured for each connector.

The output buffer size configured for a connector must be at least as large as the largest message that is expected to be sent to any client connecting through that connector. However, the buffer size can be much larger so that the messages can be batched at the server, which improves performance.

Each connected client is assigned a socket buffer of the specified size if possible. A warning is logged if a smaller socket buffer was allocated than requested.

In addition each client multiplexer has a buffer of the configured size (as a multiplexer writes to only one of its clients at any one time). The multiplexer buffer is used to batch messages from the client queue before writing and, if the socket buffer does end up being smaller than the configured buffer and the throughput is high, the allocated socket buffer size might become a bottleneck.

Getting the correct output buffer size is vital. Make this too small and the Diffusion server does not batch and write messages to clients at optimal rates. Make them too big, extra memory is consumed or messages might time out and cause the client connection to be closed.

If the output buffer size is larger than the TCP output buffer size, this can cause problems if the client is slow consuming. If a slow-consuming client does not clear messages from the TCP buffer fast enough, messages on the connector buffer which are waiting to move to the TCP output buffer can time out. You can avoid this problem by setting the TCP output buffers for your operating system and the connector output buffers for your Diffusion server to the same value. You can also increase your message timeout interval.

Note: For maximum performance, ideally all clients configure their input buffer size to match the connector's output buffer size.

Client output buffers

As at the server, the output buffer sizes in use must be configured for a client.

In the Java client this is specified in the `ServerDetails` object used to make the connection. As the Java client does not buffer messages, this only has to be large enough to cater for the largest message size that is sent to the server.

Publisher client output buffers

A publisher client (a connection made from a publisher to another Diffusion server) is slightly different from a normal client in that it does queue and buffer messages for sending. It is advantageous to throughput to use a larger output buffer size.

The output buffer size is configured in the server element in `Publishers.xml` or in the `ServerDetails` object depending upon how the connection is being made.

Connector input buffers

Each connector also specifies an input buffer size.

Input buffers receive messages from clients. This buffer must be as large as the largest message expected. If you specify an input buffer size that is less than the maximum message size, the maximum message size is used as the input buffer size.

This size is also used to allocate a receive socket buffer for the client. The socket buffer allocated might actually be less than requested in which case a warning is logged.

For maximum performance, the size used for this buffer must match up with the output buffer size used by clients.

Client input buffers

Clients must also specify the buffer size to use for input.

In the Java client this is specified in the `ServerDetails` object used to make the connection (or possibly `Publishers.xml` for a publisher client connection).

Matching buffer sizes

For optimal throughput it is desirable to match the size of buffers at each end of every connection. The input buffer size used by clients ideally matches the output buffer size at the connector that they connect to. Also the output buffer size specified by clients must match the input buffer size of the connector they connect to.

Note: Because publisher server connections queue and batch messages at both ends, use a separate connector for such connections such that optimal buffer sizing can be achieved.

Message batching

The size of output buffers configured for a connector can be much larger than the largest expected message size because the server uses these buffers to batch client messages which improves performance. Ideally the buffer size is a multiple of the average message size.

Note: When using for HTTP clients, allow between 20 and 250 bytes extra for control information.

Each client multiplexer assigns an output buffer of each size specified by client connectors. So if there were 3 client connectors, each specifying a different output buffer size, and 2 client multiplexers, each multiplexer assigns 3 different buffers (6 in total).

When a client multiplexer is unable to write the contents of an output buffer to a client in one go, the writing is deferred and the multiplexer takes a copy of the remaining data in the output buffer into its own temporary buffer.

Message sizing

The sizing of messages that are sent to clients is very important to the overall performance and this must be carefully considered within the design of publishers.

Every topic message has a fixed header of 6 bytes. It then has the topic path terminated by one byte, plus any user header information that is also included with the message.

It is important to work out the size of the message so that the connector buffers can be set correctly, otherwise Diffusion is unable to put the messages on the wire quickly enough.

Byte pinching

With any messaging system, the smaller the messages, the lower the latency and the faster the system performs. There is a consultancy exercise that Push Technology performs as a service to analyze the messages and reduce them as much as possible. The following list includes a few of the best practices to use:

- Only send data that is required by the client.
- Look at the data format and strip any fat off the message.
- Is the information being sent a true delta?
- Client side data models

Message encoding

If you are sending large messages, it is worth compressing the messages. This happens only once on the server, and then the clients have the technology to decompress them, this also includes JavaScript clients. If other encoding is used, it is worth bearing in mind the CPU overhead required.

Client queues

A maximum queue depth can be configured for client queues so that clients are closed if their message backlog becomes too large.

The maximum queue depth must be chosen carefully as a large size might lead to excessive memory usage and vulnerability to Denial of Service attacks, whilst a small size can lead to slow clients being disconnected too frequently.

Client queues do not take any memory, as Diffusion uses a Zero Copy paradigm, but there are consequences in setting them too small or too large. If the client queue is set too small, once the client has filled its queue the Diffusion server closes the client.

When considering queue depth take into account the average message size and publication rate. Messages that are held in the client queue are not garbage collected and can get promoted, which increases their impact on GC pressure. If messages in the client queue build up, consider the maximum delay in the context of your application. For example: Assuming 100 bytes is the average message size and the application is publishing an average of 100 messages per second. If the client queue is setup to have a maximum depth of 1000 messages this means we allow messages to build up for a slow client for up to 10 seconds, during this time a slow client is building up a cache of 100,000 bytes of messages to be sent.

Note: It is natural for queues to build up a little with spikes in publication rate or momentary bandwidth limits, but the tolerance to such delays is expressed in the client queue depth and must be considered in that context.

Client multiplexers

Tuning multiplexers for optimal performance

The load of batching, conflating and merging messages being sent from publishers to outbound clients is spread across client multiplexers. The number of configured client multiplexers must take into account the expected message load and concurrent client connections. The more clients are assigned to a multiplexer the more load it must contend with.

By default, the number of client multiplexers is equal to the number of cores on the host system of the Diffusion server

A client multiplexer processes all client messages into the client queue. Clients are added to the multiplexers according to a round-robin load balancing policy.

Publishers either broadcast on a topic to all subscribed clients or send clients direct messages. When broadcasting all multiplexers are notified and go on to find all subscribed clients which are assigned to the particular multiplexer. When a message is sent to a particular client only that client's multiplexer is notified. It is more efficient to broadcast than it is to send the same message to a large number of clients by iterating over them.

Client multiplexers are non-blocking, high priority threads so having too many can be detrimental, as they are competing for the same resource (CPU). As a rule of thumb, the number of multiplexers must not exceed the number of available logical cores. If a client multiplexer becomes over-subscribed, message latency can increase. For maximum throughput, the number of multiplexers can be set to the number of available cores, but this configuration is only recommended in the case where other threads are assumed to be mostly idle (for example, little inbound traffic, low publisher overhead).

Client multiplexers performance is influenced by the use of merge and conflation policies as those are executed in the multiplexer thread. It is recommended that conflation policy changes and in particular changes to merge conflation logic be profiled and written with performance in mind. In particular the use of locks or any other blocking code is highly discouraged.

Each multiplexer uses a different buffer for each output buffer size that is specified to any connector. If there were three connectors with different output buffer sizes specified, each multiplexer assigns three different buffers. Each multiplexer might also assign an extra buffer for HTTP use. A larger output buffer enables more efficient batching of messages per write, as large writes are generally more efficient but care must be taken to not overwhelm client connections regularly and causing them to be blocked for any period of time.

When a multiplexer is unable to write a message to a client because the buffer has become full, a selector thread is notified. The selector thread is responsible for watching the client and notifying the multiplexer when it becomes writable. The multiplexer remains responsible for writing the message.

Connectors

You can tune your connectors to handle multiple connections and improve performance.

Configuring multiple connectors

When there is more than one publisher application running on a server, configure a separate connector for each publisher so that buffer requirements can be specific to the connector.

It might also be beneficial to configure different connectors for different client types as their requirements can be different. This is especially true for publisher clients where there are low numbers of connections which benefit from very large buffer sizes in both directions.

Buffers

As Diffusion can have tens of thousands of connections at any one time on a machine it is important to make sure that the buffers are set correctly.

Small buffer sizes increase the number of network operations that must be performed to receive and transmit data, reducing efficiency. However, larger buffer sizes require more server-side memory. The server reserves a buffer for each pending network read or write.

For more information, see [Buffer sizing](#) on page 568.

Backlog of incoming connections

By default, the Diffusion server requests that the operating system restricts the maximum number of unaccepted TCP connections to the network port managed by the connector to 1000. Additional clients attempting to connect are refused connection.

This maximum number of unaccepted connections can be configured using the `backlog` element to the connector definition in the `Connectors.xml` configuration file. Diffusion accepts new connections very rapidly, so it is rarely necessary to tune this parameter.

In addition, the number of unaccepted client connections on a socket is further constrained by the system-wide limits set by the operating system that you run the Diffusion server. Ensure that the operating system allows at least as many incoming connections as the Diffusion server.

- On Linux, you can do this by setting the value of `net.core.somaxconn`.

Thread pools

Thread pools are used within Diffusion to optimize the use of threads.

It is important to understand balance when tuning thread usage for a system. There must be sufficient thread resources required but not so many as to starve other parts of the system. At the end of the day there are only so many threads that a system can provide.

In general, when provisioning threads, separate the blocking and non-blocking activities. While it is beneficial to have more threads than cores for blocking tasks it is detrimental to the server if more threads than cores are runnable at any given time.

There are a number of places where thread pools are used within Diffusion. For more information, see [Concurrency](#) on page 566.

Configurable properties

The following key values can be configured for a thread pool to influence its behavior and use of resource:

Table 53: Values that can be configured for a thread pool

Property	Usage
Core size	<p>The core number of threads to have running in the thread pool.</p> <p>Whenever a thread is required a new one is created until this number is reached, even if there are idle threads already in the pool. After reaching this number of threads then at least this number of threads is maintained within the pool.</p>
Maximum size	<p>The maximum number of threads that can be created in the thread pool before tasks are queued.</p> <p>If this is specified as 0, the pool is unbounded and so the task queue size value is ignored. Generally an unbounded pool is not recommended as it can potentially consume all machine resources.</p>
Queue size	<p>The pool queue size. When the maximum pool size is reached then tasks are queued.</p> <p>If the value is zero, the queue is unbounded. If not zero then the value must be at least 10 (it is automatically adjusted if it is not).</p>
Keep-alive time	<p>The time limit for which threads can remain idle before being terminated.</p> <p>If there are more than the core number of threads currently in the pool, after waiting this amount of time without processing a task, excess threads are terminated.</p> <p>A value of zero (the default) causes excess threads to terminate immediately after executing tasks.</p>
Notification handler	<p>A thread pool can have a notification handler associated with it to handle certain events relating to the pool. This allows for user written actions to be performed (for example, sending an email) when certain pool events (like too much task queuing) occur.</p>

Property	Usage
	See below for more details.
Rejection handler	A thread pool can have a rejection handler associated with it to handle a runnable task that has been rejected. This allows user written actions to handle a runnable task that can not be executed by the thread pool. See below for more details.

Notification handler

A thread pool notification handler can be configured to act upon certain thread pool events.

These events are:

Table 54: Events that a thread pool notification handler can act on

Event	Description
Upper threshold reached	A specified upper threshold for the pool has been reached. This means the pool size has reached the specified size. The event is notified only once and is not notified again until the lower threshold reached event has occurred.
Lower threshold reached	A specified lower threshold for the pool has been reached after an upper threshold reached event has been notified. This means the pool size has now shrunk the specified size.
Task rejected	The pool has rejected a task because there are no idle threads available and the task queue has filled. What happens to the rejected task depends upon the type of pool. Typically, the task is run within the thread that passes the task to the pool, which is not desirable. This is why the thread ought to be notified when it occurs. This differs from the rejection handler in that it does not expose the runnable task. This means it can be used only for notification.

The notification handler is a user written class which must implement the `ThreadPoolNotificationHandler` interface in the threads Java API. The name of such a class can be configured for in-bound or out-bound thread pools or for connector thread pools in which case an instance of the class is created (and must have a no arguments constructor) when the thread pool is created.

Rejection handler

A thread pool can have a rejection handler associated with it to handle a runnable task that has been rejected.

Two rejection handlers are provided with Diffusion. These are the `ThreadService CallerRunsRejectionPolicy` and `ThreadService.AbortRejectionPolicy`.

The `ThreadService.CallerRunsRejectionPolicy` executes the runnable task in the thread that tried to pass the runnable task to the thread service. This can cause inconsistencies and out of order processing.

The `ThreadService.CallerRunsRejectionPolicy` does not execute the task and instead generates an exception.

Note: By default, the thread that tried to pass the runnable task to the thread service blocks until there is space on the thread pool queue.

The rejection handler is a user written class which must implement the `ThreadPoolRejectionHandler` interface in the threads Java API. The name of such a class can be configured for inbound or outbound thread pools or for connector thread pools in which case an instance of the class is created (and must have a no arguments constructor) when the thread pool is created.

Adjusting the configuration

Adjust thread pools gradually. Ideally, duplicate expected maximum loads in test environment. This environment can be used to tune the thread pools to satisfy the load. Tune the thread pools so they are just able to cope with the maximum load, increasing them beyond this might degrade overall performance.

Background thread pool:

In general, the defaults suffice for the tasks assigned to the background thread pool by Diffusion. If you assign tasks to the pool yourself, consider increasing the number of threads.

Inbound thread pool:

This pool is used to handle inbound connections and messages. Increasing the thread pool allows new connections and received messages to be handled over a greater number of threads. However, much of the behavior in this pool can involve locking the clients or parts of the topic tree. This can cause lock contention that delays processing.

Due to the underlying implementation of Java NIO sockets a high rate of threads being added/removed from the incoming thread pool will result in the allocation of off-heap byte buffers. In extreme cases this can result in an out of memory exception being thrown as the server runs out of off heap allocation space.

Session reconnection

You can configure the session reconnection feature by configuring the connectors at the Diffusion server to keep the client session in a disconnected state for a period before closing the session.

When a client detects connection loss, it will automatically attempt to re-establish connection to the server based on the reconnection settings.

Reconnection is enabled by default.

If reconnection is successful, the client session can continue without loss of subscriptions, topic updates, and messages that were queued for it whilst disconnected.

If reconnection is disabled, or fails to re-establish a connection, the client application must create a new session, and re-initialise subscriptions and other application state.

Server configuration

To enable clients to reconnect, connectors must be configured to keep client sessions in the DISCONNECTED state for a period during which the client can reconnect. To do this a reconnection timeout must be specified for the connector.

Specify a reconnection timeout, maximum queue depth, and recovery buffer size by using the `<reconnect>` element in the `etc/Connectors.xml` configuration file.

Reconnection timeout (`keep-alive`)

How long a disconnected client's session remains available on the server before being closed. By default, this is 300 seconds.

Maximum queue depth (`max-depth`)

Optional maximum limit on the number of messages to queue for a disconnected client session. By default, this is the same as the queue depth for a connected client session, which is defined by the queue definitions in `Connectors.xml` and `Server.xml`.

Recovery buffer size (`recovery-buffer-size`)

The maximum number of sent messages to keep in a buffer. These messages can then be recovered on reconnection.

Here is an example connector configuration:

```
<connector>
...
<reconnect>
  <keep-alive>60s</keep-alive>
  <max-depth>1000</max-depth>
  <recovery-buffer-size>64</recovery-buffer-size>
</reconnect>
...
</connector>
```

Using the above example, a client can reconnect to the server through this connector within 60 seconds of becoming disconnected. While the client is disconnected, up to 1000 messages are queued for it. These messages are delivered to the client when it reconnects. A buffer of up to 64 sent messages are retained in the recovery buffer. When a client reconnects, the Diffusion server uses this buffer to re-send any messages that the client has not received.

If a client signals that it wants to disconnect, the client state on the server is removed when the client disconnects. However, in all other circumstances where the client loses connection, the client goes into the DISCONNECTED state, where the subscriptions are retained and messages are queued as normal for the amount of time specified by the reconnection timeout of the connector.

If the server is configured to expect reconnecting clients, sessions that are currently disconnected and might reconnect are excluded from the regular system pings that the server sends to clients.

If the client then reconnects during the period that the session is in DISCONNECTED state, the sending of messages to the client resumes from the point when the failure occurred.

Disabling session reconnection

Session reconnection is on by default. Disabling reconnection can be useful in some circumstances where it is better for a session to fail quickly than for it to be kept alive and await reconnection.

- For example, when you have a control client in the same data center as the Diffusion server, enabling reconnection for the session between the control client and the server can make it harder to diagnose connection problems.

- During development you may want to kill and recompile or reconfigure a client, then restart it. If reconnection is enabled, the original session will not end when the original client is killed. This can lead to problems like preventing the new client from registering as an updater until the reconnection timeout expires.

You can either disable reconnection in the server configuration, or a client can specify that a session should not use reconnection.

Message queue management

When a client session is in DISCONNECTED state, messages for the client continue queuing for the client until the reconnection timeout expires or the client reconnects. This puts an unusual load on the client queue and the facility exists to adjust the maximum client queue depth for the period of disconnection.

This is done by specifying a queue depth which is greater than the normal maximum queue depth. When disconnected, the queue can expand to the higher value. After reconnection occurs and the queue starts to drain, once the queue size goes down to a value of 80% of its previous limit, the maximum queue depth reverts to the normal value.

The queue depth has an effect only if has a value higher than the normal maximum queue depth.

Related concepts

[Reconnect to the Diffusion server](#) on page 252

When clients connect to the Diffusion server over unreliable networks these connections can be lost. Clients can attempt to reconnect to the Diffusion server after they lose connection.

[Specifying a reconnection strategy](#) on page 255

Reconnection behavior can be configured using custom reconnection strategies.

Client failover

You can configure a client to fail over to another Diffusion server after it loses connection to the Diffusion server it was previously connected to.

Client failover is when a client loses its connection to a server and attempts to connect to a different one. The client is provided with a list of servers. If a client loses its connection to a server it can automatically attempt to connect to the next server in the list. If it fails to connect or loses its connection to that server, it tries the next server on the list. This is referred to as autofailover. Generally the list of servers to connect to must be provided before attempting to make the connection. How the list of servers is provided differs between client APIs and the JavaScript client does not support autofailover but it can be implemented using the callback methods.

Using automatic failover

If a client has an established connection that it loses, autofailover attempts to open a new connection in the next connection in the list. This is not compatible with reconnection because reconnection attempts to preserve the state of the client (the client ID and the subscribed topics). As the new server has no knowledge of the client it is unable to preserve this state. Autofailover must be enabled and a list of servers to connect to provided.

Using load balancing with autofailover

You can enable load balancing in conjunction with autofailover. When load balancing is enabled and a client loses connection, the list of servers is shuffled before the client selects the next server to attempt to connect to.

In Java, for example, you can enable load balancing by using the `setLoadBalancing` method on the `ConnectionDetails` object.

Using server cascading

When a client attempts to place a connection, if the attempt fails, the next server in the list is chosen. Server cascading is similar to autofailover except this logic is applied prior to a connection, whereas autofailover applies once a connection is in place.

In Java, for example, you can enable server cascading by using the `setCascading` method on the `ConnectionDetails` object.

Note: Server cascading is different to protocol cascading, which attempts to connect to the same server using different protocols before a connection has been opened.

Client throttling

Throttling is a method of ensuring that the Diffusion server limits (throttle) the volume of messages it transmits to a client within a specified period of time. This can be used to limit bandwidth usage or to prevent more messages being sent to a client than it can cope with.

How does throttling work?

Throttling is applied to a client queue so that the number or volume of messages sent to that client is restricted. Diffusion only dequeues a message to send to a client if that client has not breached its throttling limit.

Throttle types;

- Messages per second (Only a specified number of messages are sent every second.)
- Bytes per second (Only a specified number of bytes are sent every second)
- Message interval (A single message is sent every n milliseconds.)
- Buffer interval (A full output buffer (or the equivalent of) is sent every n milliseconds)

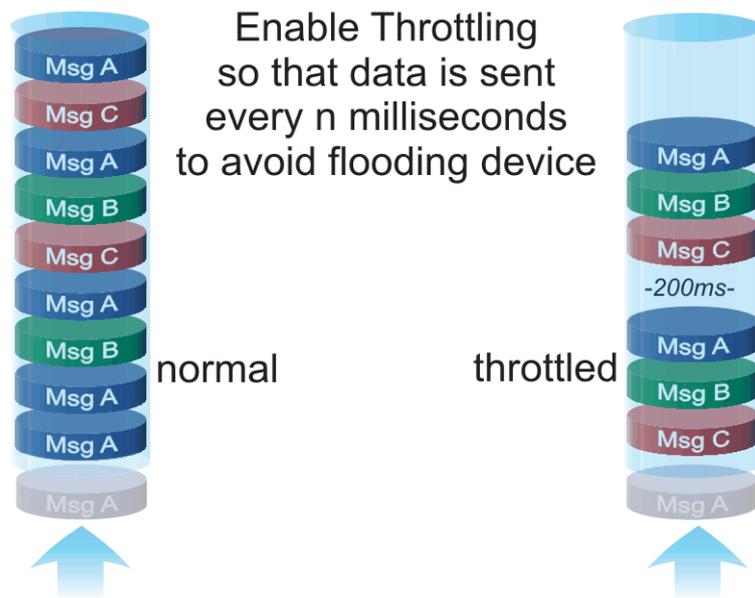


Figure 26: Normal and throttled client queues

Enabling throttling

Throttling can be enabled on a client-by-client basis from within the publisher.

To throttle a `Client`, call the `throttle` method which allows you to specify the type of throttling and a limit. A `ClientThrottler` reference is returned.

If the throttle method is called for a client that is already throttled, it has the effect of removing the old throttler and adding a new one.

Call the `Client.removeThrottler` method to stop throttling.

The `Client.isThrottling` method can be used to determine whether a client is currently throttled and, if it is, the `getThrottler` method can be used to determine the type of throttling and the current limit.

Java memory usage

Typically you do not have to tune the Java VM's use of memory. However, in certain conditions, consider using runtime options to change the default behavior.

If you use SSL-offloading at Diffusion

If your clients make secure connections to the Diffusion server and these connections are SSL offloaded at the Diffusion server, ensure that you tune the following runtime options:

-Xmx

Sets the maximum heap size.

-XX:MaxDirectMemorySize

Sets the maximum total size (in bytes) of direct-buffer allocations. By default, the JVM chooses the size for direct-buffer allocations automatically.

Diffusion uses direct memory to offload SSL connections.

Ensure that the combined total of these two values does not exceed 80% of the RAM available on your system.

When terminating SSL connections at Diffusion, Java can consume significant CPU resource in encryption library code. Run the Diffusion server on Java 8 update 121 or later to take advantage of flags which enable optimizations which significantly reduce CPU utilization when the Diffusion server receives a sustained and high client session connection rate.

Platform-specific issues

To run Diffusion it might be necessary to increase the number of sockets and reduce timewait.

It might also be necessary to increase the number of open files that is allowed on UNIX or Linux systems

Socket issues

To fix these problems, complete the following steps based on platform.

Windows

Setting values on Windows

Setting TCP timed wait

This parameter determines the length of time that a connection stays in the TIME_WAIT state when it is closed. When a connection is in the TIME_WAIT state, the socket pair cannot be reused. This is also known as the 2MSL state because the value is twice the maximum segment lifetime on the network. See RFC 793 for further details.

Add TcpTimedWaitDelay registry values as a workaround. You can set these values through REGEDIT command.

Set TcpTimedWaitDelay to 30:

1. Select **Start > Run**.
2. In the available field, enter `regedit`.
3. Go to the key directory file: `HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\Tcpip\Parameters\TcpTimedWaitDelay`. The value type is REG_DWORD.
4. Double-click **TcpTimedWaitDelay**.
5. Select **Decimal**.
6. Type 30 in the **Value** data field. The default value for this field is 0xF0 (240 decimal). The valid range is 30-300 (decimal).

Setting MaxUserPort

This parameter controls the maximum port number used when an application requests any available user port from the system. Normally, short-lived ports are allocated in the range from 1024 through 5000. Setting this parameter to a value outside of the valid range causes the nearest valid value to be used (5000 or 65534).

Add MaxUserPort registry values as a workaround. You can set these values through REGEDIT command.

Set the MaxUserPort to 65534

1. Select **Start > Run**.
2. In the available field, enter `regedit`.
3. Go to the key directory file: `HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\Tcpip\Parameters\MaxUserPort`. The value type is REG_DWORD.
4. Double-click **MaxUserPort**.

5. Select **Decimal**.

6. Type 65534 in the **Value** data field. The default value for this field is 0x1388 (5000 decimal). The valid range is 5000 – 65534(decimal).

Linux

Configuring sockets values on Linux

Decrease the time wait before closing the sockets by entering:

```
# echo 3 > /proc/sys/net/ipv4/tcp_fin_timeout
```

Sometimes systems are now configured to prevent one from using a large number of ports, check the port range and modify if required.

```
# cat /proc/sys/net/ipv4/ip_local_port_range
```

This can be increased by issuing the following command

```
# echo "1025 65535" > /proc/sys/net/ipv4/ip_local_port_range
```

To have these new values take effect you might have to do (as root)

```
# /etc/rc.d/init.d/network restart
```

If you want these new values to survive across reboots you can add them to `/etc/sysctl.conf`.

```
# Allowed local port range
net.ipv4.ip_local_port_range = 1025 65535
# net.ipv4.tcp_tw_recycle = 1
net.ipv4.tcp_fin_timeout = 3
```

UNIX

Increasing the number of files a process on a UNIX system can open also increases the number of sockets that process can open. The operating system uses file descriptors to handle filesystem files as well as pseudo files, such as connections and sockets.

You need the following number of sockets for each client connection:

- WS — one socket per connection
- HTTP Polling — two sockets per connection

Use the `ulimit` command to increase the number of open files. You can do this in one of the following ways:

- As a global setting.
This can be set by your network administrator.
- In the start script for Diffusion.

Edit the `diffusion_installation/bin/diffusion.sh` file to add the following line at the start:

```
ulimit -n open_files
```

Where the value of `open_files` is any suitable integer value, for example 8192.

You can use the `java.lang:type=OperatingSystem MBean` to inspect the number of files on your UNIX operating system. See the following properties:

MaxFileDescriptorCount

The total number of files that a process on a UNIX system can open. This is the number that you can set with `ulimit -n`.

OpenFileDescriptorCount

The number of files that are currently open.

The difference between these values is the number of files you have available to use for sockets.

Publisher design

Considerations when designing a publisher

Consider the following points when designing and writing a publisher:

Data modeling

The way that the data is fed to a publisher and the way in which the state of the data is maintained within a publisher is key to good performance. Keep message sizes to a minimum and this can be achieved using fine data granularity enabled by the topic tree.

Caching

Cache messages wherever possible rather than building new ones every time one must be sent. This particularly applies to topic load messages which can be cached to send to every new client that subscribes, and rebuilt only when the data actually changes. The ideal place to keep such cached messages is with a data object attached to the topic (see topic data pattern).

String handling

Building of Strings by concatenation is very inefficient in Java. Keep String concatenation to a minimum. When String content is used, message caching can help to some degree and wherever possible cache Strings that must be built.

Conditional processing

Excessive use of conditional processing (Checking of topic paths, and so on) can be expensive. Use of the topic data pattern can significantly reduce the need for such processing when many topics are in use.

Concurrency

Concurrent programming means that access to data often must be synchronized but care must be taken not to synchronize more than is necessary as performance can be significantly affected.

Managing and monitoring your running Diffusion server

This section discusses how to manage your Diffusion server and system as a whole.

We recommend that you actively monitor the health of your Diffusion server to pre-empt failures and to minimize unplanned downtime.

You can monitor your Diffusion server using the tools listed in this section.

JMX

You can use JMX to manage Diffusion. By default, the RMI registry port is 1099 and the JMX service port is 1100.

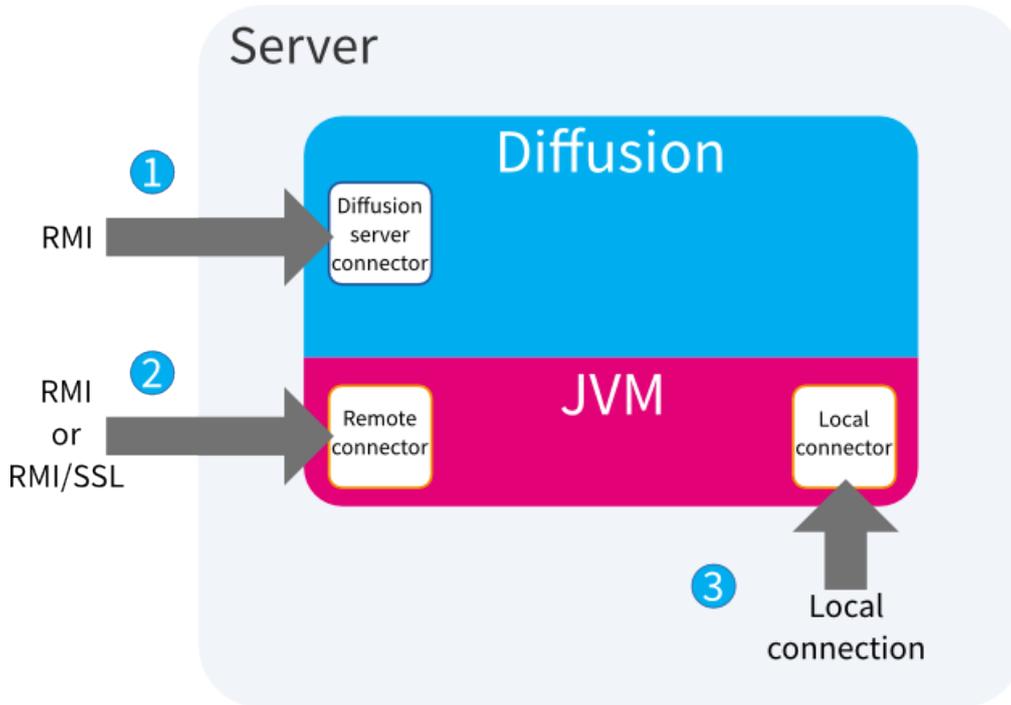


Figure 27: Connecting to Diffusion JMX

The following methods of connecting to Diffusion JMX are available:

- 1. Recommended:** Through the RMI JMX connector server provided by the Diffusion server.

This feature is integrated with Diffusion security, enabling you to use roles and permissions to control access to the MBeans. However, this connection does not use SSL.

For more information, see [Configuring the Diffusion JMX connector server](#) on page 523.

- 2.** Through the RMI JMX connector server provided by JVM that runs Diffusion.

You can use SSL to make a secure connection. However, the JVM does not use Diffusion security. You must add additional configuration to your JVM to control access to the MBeans.

For more information, see [Configuring a remote JMX server connector](#) on page 525.

- 3.** Through the local JMX connector server provided by JVM that runs Diffusion.

You make this connection from the server that Diffusion runs on. However, the JVM does not use Diffusion security. You must add additional configuration to your JVM to control access to the MBeans.

For more information, see [Configuring a local JMX connector server](#) on page 526.

Related tasks

[Configuring the Diffusion JMX connector server](#) on page 523

Connect to JMX through the Diffusion connector server. This connector server is integrated with the Diffusion server and enables you to use role-based access control to define how connecting users can use the MBeans.

[Configuring a local JMX connector server](#) on page 526

Connect to JMX through a local connector to the JVM that runs the Diffusion. This connector is not integrated with the Diffusion server security and you must configure additional security in the JVM.

[Configuring a remote JMX server connector](#) on page 525

Connect to JMX through a remote connector to the JVM that runs the Diffusion. This connector is not integrated with the Diffusion server security and you must configure additional security in the JVM.

Related reference

[Statistics](#) on page 602

Diffusion can provide statistics in three ways: via MBeans, via the Publisher API, and via Prometheus-compatible endpoints. Statistics provide information about the server, clients and topics.

[Diffusion monitoring console](#) on page 606

A web console for monitoring the Diffusion server.

[Logging](#) on page 611

Diffusion uses the Simple Logging Facade for Java (SLF4J) API to log messages from the Diffusion server or from publishers running on the Diffusion server. SLF4J separates the logging of messages in the Diffusion server from the logging framework. This separation enables you to configure an independent back-end implementation to format and write out the log messages.

[Integration with Splunk](#) on page 692

How to achieve basic integration between Diffusion and the Splunk™ analysis and monitoring application

Using Java VisualVM

You can manage Diffusion using the JMX system management console Java VisualVM.

Java VisualVM is usually installed with JDK's but can be downloaded from <https://visualvm.dev.java.net/>.

Connecting to the Diffusion connector server

1. Start Java VisualVM.
2. Right-click on the **Remote** section of the **Applications** panel and select **Add Remote Host**.
3. In the **Host name** field, type the host name or IP address of the server where Diffusion is running. Click **OK**.
4. In the **Applications** panel, right-click on the name of the server where Diffusion is running. Select **Add JMX Connection**.
5. In the **Connection** field, enter the host name and RMI registry port for the Diffusion server.
6. Select **Use security credentials** and enter the username and password of a principal that you have configured to be able to use JMX. For more information, see [Configuring the Diffusion JMX connector server](#) on page 523. Click **OK**.

Information about the Diffusion process is displayed in the main panel.

Connecting to the JVM remote connector server

Note: We recommend you use the Diffusion connector server to access the JMX service.

1. Start Java VisualVM.
2. Right-click on the **Remote** section of the **Applications** panel and select **Add Remote Host**.
3. In the **Host name** field, type the host name or IP address of the server where Diffusion is running. Click **OK**.
4. In the **Applications** panel, right-click on the name of the server where Diffusion is running. Select **Add JMX Connection**.
5. In the **Connection** field, enter the host name and RMI registry port for the Diffusion server.

6. Select **Use security credentials** and enter the username and password of a user that you have configured in the JVM. For more information, see [Configuring a remote JMX server connector](#) on page 525. Click OK.

Information about the Diffusion process is displayed in the main panel.

Connecting to the JVM local connector server

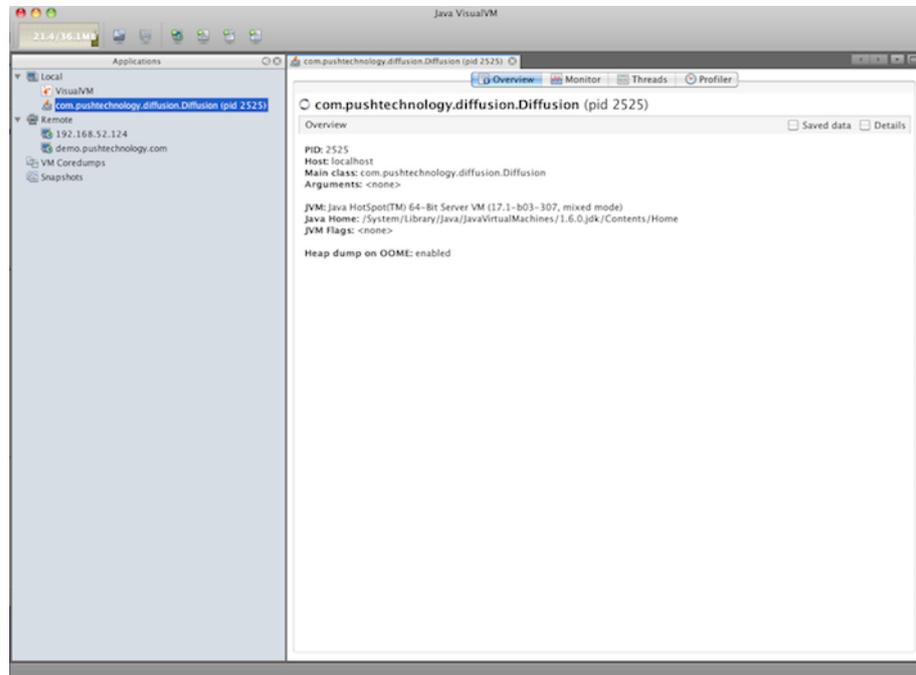


Figure 28: Java VisualVM: Overview tab

Note: We recommend you use the Diffusion connector server to access the JMX service.

1. Start Java VisualVM.
2. From the **Local** section of the **Applications** panel, select the Diffusion process, `com.pushtechnology.diffusion.Diffusion`.
3. Right-click `com.pushtechnology.diffusion.Diffusion` and select **Open**.

Information about the Diffusion process is displayed in the main panel.

Once connected to JMX, several aspects of the system are available to monitor and tune. For more information, see the Java VisualVM documentation: <http://visualvm.java.net/docindex.html>.

Related tasks

[Configuring the Diffusion JMX connector server](#) on page 523

Connect to JMX through the Diffusion connector server. This connector server is integrated with the Diffusion server and enables you to use role-based access control to define how connecting users can use the MBeans.

[Configuring a local JMX connector server](#) on page 526

Connect to JMX through a local connector to the JVM that runs the Diffusion. This connector is not integrated with the Diffusion server security and you must configure additional security in the JVM.

[Configuring a remote JMX server connector](#) on page 525

Connect to JMX through a remote connector to the JVM that runs the Diffusion. This connector is not integrated with the Diffusion server security and you must configure additional security in the JVM.

Using JConsole

You can manage Diffusion using the JMX system management console JConsole.

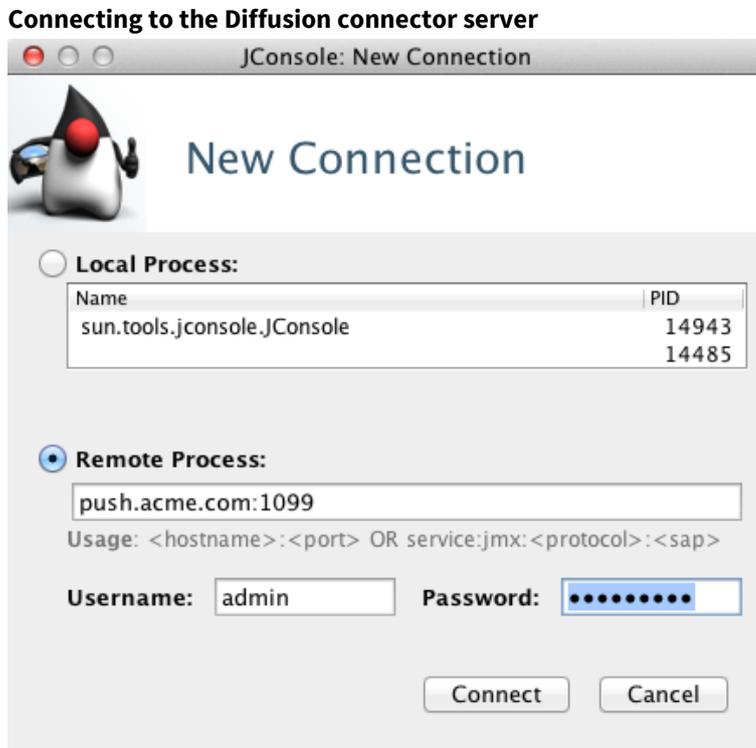


Figure 29: JConsole New Connection dialog: Remote Process

In the **Remote Process** section of JConsole's **New Connection** dialog, enter the following information:

- The host name and RMI registry port of the Diffusion connector server. The default RMI registry port is 1099.
- The username and password of a principal that you have configured to be able to use MBeans. For more information, see [Configuring the Diffusion JMX connector server](#) on page 523



Figure 30: JConsole New Connection dialog: Remote Process

Note: We recommend you use the Diffusion connector server to access the JMX service.

In the **Remote Process** section of JConsole's **New Connection** dialog, enter the following information:

- The host name and RMI port of the Diffusion connector server. The default port is 1099.
- A username and password that you have configured in the JVM to be able to connect to the JMX service. For more information, see [Configuring a remote JMX server connector](#) on page 525

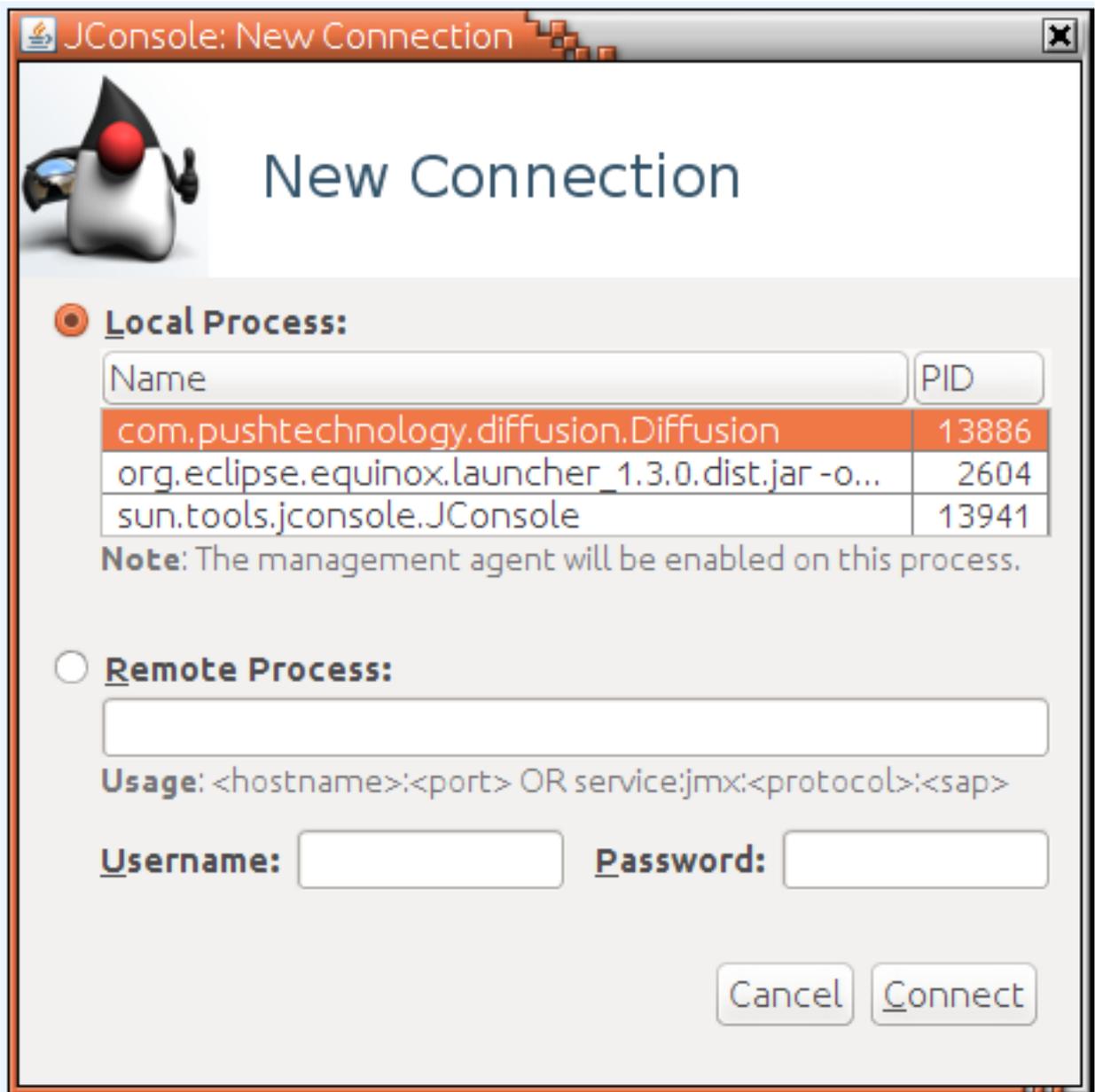


Figure 31: JConsole New Connection dialog: Local Process

Note: We recommend you use the Diffusion connector server to access the JMX service.

In the **Local Process** section of JConsole's **New Connection** dialog, select the Diffusion process, `com.pushtechnology.diffusion.Diffusion`.

Once connected to JMX, several aspects of the system are available to monitor and tune. For more information, see the JConsole documentation: <https://docs.oracle.com/javase/8/technotes/guides/management/jconsole.html>.

Related tasks

[Configuring the Diffusion JMX connector server](#) on page 523

Connect to JMX through the Diffusion connector server. This connector server is integrated with the Diffusion server and enables you to use role-based access control to define how connecting users can use the MBeans.

[Configuring a local JMX connector server](#) on page 526

Connect to JMX through a local connector to the JVM that runs the Diffusion. This connector is not integrated with the Diffusion server security and you must configure additional security in the JVM.

[Configuring a remote JMX server connector](#) on page 525

Connect to JMX through a remote connector to the JVM that runs the Diffusion. This connector is not integrated with the Diffusion server security and you must configure additional security in the JVM.

Detecting deadlocks with JConsole

To check if your publisher is experiencing a deadlock, you can use JConsole to inspect the threads.

Procedure

1. Connect JConsole to the JMX service on the Diffusion server.
For more information, see [Using JConsole](#) on page 586.
2. Go to the **Threads** tab.
This tab provides information about thread use: number of threads, a list of active threads, and details for a selected thread.
3. On the **Threads** tab, click the **Detect Deadlock** button.
If deadlocks are present, new tabs open next to the **Threads** tab. You can use the information in these tabs to diagnose any deadlocks.

What to do next

For more information, see <http://docs.oracle.com/javase/7/docs/technotes/guides/management/jconsole.html>.

MBeans

Diffusion registers MBeans with the JMX service for many of its principal features.

Annotations on each of the MBeans employed are used to produce the following pages in this manual as well as feeding JMX clients with descriptive information. MBeans, attributes and operations have descriptions; operation arguments have names; operations also have JMX impact information.

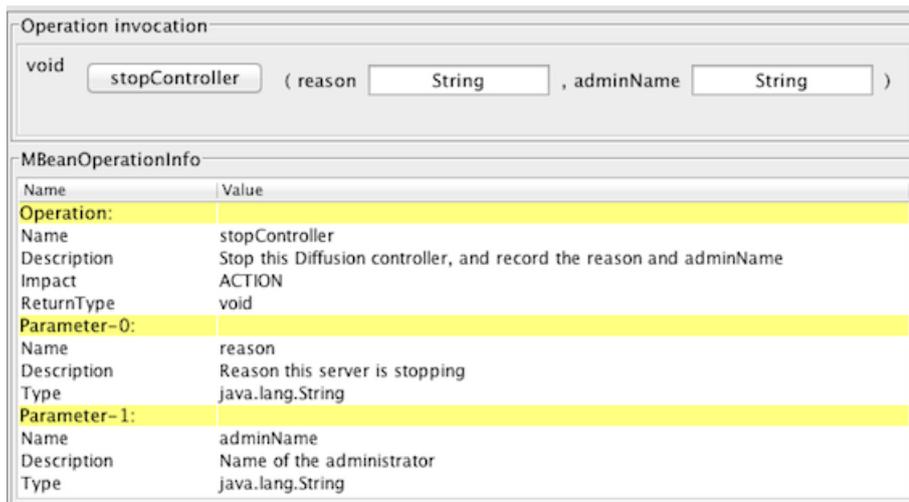


Figure 32: The server MBean stopController operation showing in JConsole

AggregateStatistics

Interface for a specific StatisticsCollector

Object name format

The objectName for MBeans of this type is of the following form:

`com.pushtechnology.diffusion:type=AggregateStatistics,name="name",server="server_`

Attributes

Attribute Name	Type	Access	Description
instanceStatisticsEnabled	boolean	read-write	Whether statistics collection is enabled or not.
managementName	String	read	A name describing the set of statistics being aggregated.

AuthorisationManager

Management interface to the optional AuthorisationManager

Object name format

The objectName for MBeans of this type is of the following form:

`com.pushtechnology.diffusion:type=AuthorisationManager,server="server_name"`

Attributes

Attribute Name	Type	Access	Description
connections	int	read	Number of connections authorized
connectionsDenied	int	read	Number of connections denied authorization
fetches	int	read	Number of fetches authorized
fetchesDenied	int	read	Number of fetches denied authorization

handlerClassName	String	read	Class name of any configured AuthorisationHandler
hasHandler	boolean	read	True if this server has an AuthorisationHandler configured
subscriptions	int	read	Number of subscriptions authorized
subscriptionsDenied	int	read	Number of subscriptions denied authorization
writes	int	read	Number of writes authorized
writesDenied	int	read	Number of writes denied authorization

Notifications

javax.management.Notification	News that a client interaction with a topic was not allowed (deprecated)
-------------------------------	--

ClientStatistics

Monitoring interface to the client session statistics MBean

Object name format

The objectName for MBeans of this type is of the following form:

`com.pushtechnology.diffusion:type=ClientStatistics,server="server_name"`

Attributes

clientOutputFrequency	long	read-write	Statistics output frequency in milliseconds
clientResetFrequency	long	read-write	The frequency at which the counters are reset
concurrentClientCount	int	read	The current client session count
connectionCounts	Map	read	The current client session count, broken down by client type
maximumConcurrentClientCount	int	read	The maximum number of concurrent client sessions
maximumDailyClientCount	int	read	The count of client sessions started in a day

Connector

Management interface to a connector

Object name format

The objectName for MBeans of this type is of the following form:

```
com.pushtechnology.diffusion:type=Connector,name="name",server="server_name"
```

Attributes

Attribute Name	Type	Access	Description
keepAliveQueueMaximumDepth	int	read-write	The maximum queue depth used for clients in the keep-alive state
keepAliveTime	long	read-write	The time in milliseconds that a unexpectedly disconnected client is kept alive before closing
numberOfAcceptors	int	read	The number of acceptors
queueDefinition	String	read-write	The queue definition
totalNumberOfConnections	long	read	The number of connections accepted since the connector was started
uptime	String	read	The time this connector has been running as a formatted string, or 0 if the connector is not running
uptimeMillis	long	read	The time this connector has been running in milliseconds, or 0 if the connector is not running

Operations

Operation Name	Return Type	Parameters	Access	Description
remove	void	0	ACTION	Remove the connector. It will not be possible to restart the connector again (until system restart).
start	void	0	ACTION	Start the connector
stop	void	0	ACTION	Stop the connector. Allows it to be restarted.

JMXAdapter

Management interface to the adapter that reflects MBean attributes and notifications as Diffusion topics

Object name format

The objectName for MBeans of this type is of the following form:

```
com.pushtechnology.diffusion:type=JMXAdapter,server="server_name"
```

Attributes

Attribute Name	Attribute Type	Access	Description
MBeanFilter	String	read	the filter applied to the set of all MBeans, as a flattened AST
adapterState	String	read	Values: STOPPED, STARTED
updateFrequency	long	read	MBean attribute poll frequency, in milliseconds

Operations

Operation Name	Return Type	Timeout	Access	Description
start	void	0	UNKNOWN	Build the topic tree and periodically refresh it

stop	void	0	UNKNOWN	Cease refresh and remove topics
------	------	---	---------	---------------------------------

Log

Management interface for Log Definition

Object name format

The objectName for MBeans of this type is of the following form:

```
com.pushtechnology.diffusion:type=Log,name="name",server="server_name"
```

Attributes

Attribute Name	Attribute Type	Access	Description
description	LogDescription	read	The LogDescription for this log
filename	String	read	The fully qualified filename of this log
logLevel	String	read-write	The current log level as a string

Multiplexer

Management interface to a multiplexer

Object name format

The objectName for MBeans of this type is of the following form:

`com.pushtechnology.diffusion:type=Multiplexer,name="name",server="server_name"`

Attributes

Attribute Name	Type	Read/Write	Description
latencyWarningTime	long	read	The latency threshold of this multiplexer, after which notifications will be sent
pendingEvents	int	read	The number of operations pending on the multiplexer queue
name	String	read	The Multiplexer name
numberOfClients	int	read	The current number of clients assigned to multiplexer

Operations

Operation Name	Parameters	Return Type	Description
diagnosticReportString	0	UNKNOWN	Generate a diagnostic report describing the state of this multiplexer

Notifications

Notification Name	Description
javax.management.Notification	Published in case of multiplexer latency (deprecated)

MultiplexerManager

Management interface to the multiplexer manager

Object name format

The objectName for MBeans of this type is of the following form:

`com.pushtechnology.diffusion:type=MultiplexerManager,name="name",server="server_name"`

Attributes

Attribute Name	Type	Read/Write	Description
numberOfMultiplexers	int	read	The number of multiplexers

Operations

diagnosticReport	String	0	UNKNOWN	Generate a diagnostic report for each multiplexer

Publisher

Management interface for a publisher

Object name format

The objectName for MBeans of this type is of the following form:

`com.pushtechnology.diffusion:type=Publisher,name="name",server="server_name"`

Attributes

inboundClientAverageMessageSize	long	read		The average size of a message received from clients
inboundClientNumberOfMessages	long	read		The count of messages received from clients
logLevel	String	read-write		The log level for this publisher
numberOfTopics	int	read		The count of topics associated with this publisher
outboundAverageMessageSize	long	read		The average size of a message sent to clients
outboundNumberOfMessages	long	read		The count of messages sent to clients
started	boolean	read		True if the publisher is started

Operations

removePublisher	void	0	ACTION	Permanently remove the publisher

startPublisher	void	0	ACTION	Start this publisher

stopPublisher	void	0	ACTION	Stop this publisher

undeploy	void	0	ACTION	Undeploy this publisher

Server

Diffusion Controller

Object name format

The objectName for MBeans of this type is of the following form:

```
com.pushtechnology.diffusion:type=Server,server="server_name"
```

Attributes

Attribute Name	Attribute Type	Attribute Mode	Description
buildDate	String	read	The build date and time
freeMemory	long	read	The amount of free memory in the Java virtual machine
licenseExpiryDate	Date	read	The license expiry date
maxMemory	long	read	The total amount of memory in the Java virtual machine
numberOfTopics	long	read	The number of topics on this server
release	String	read	The Diffusion release string, for example, 5.1.2_01
startDate	Date	read	The date and time at which this Diffusion server was started
startDateMillis	long	read	The time at which this Diffusion server was started, as milliseconds since the epoch
timeZone	String	read	The name of the time zone to which this Diffusion server belongs
totalMemory	long	read	The total amount of memory in the Java virtual machine
uptime	String	read	The time that this controller has been running, as a formatted string. For example, "3 hours 4 minutes 23 seconds"
uptimeMillis	long	read	The time this controller has been running, in milliseconds
usedPhysicalMemorySize	long	read	Used physical memory, in bytes
usedSwapSpaceSize	long	read	Used swap space, in bytes
userDirectory	String	read	The directory in which the Diffusion server was started
userName	String	read	The name of the user to whom the Diffusion server belongs

Operations

checkLicense	void	0	ACTION	Recheck the license being used

stopController	void	0	ACTION	Stop this Diffusion controller

stopController	void	2	ACTION	Stop this Diffusion controller, and record the reason and adminName

reason	String	The reason this server is stopping		
adminName	String	The name of the administrator		

StatisticsService

Interface for StatisticsService controller

Object name format

The objectName for MBeans of this type is of the following form:

```
com.pushtechonology.diffusion:type=StatisticsService,server="server_name"
```

Attributes

clientStatisticsEnabled	boolean	read-write	True if aggregate statistics for clients are enabled
enabled	boolean	read-write	True if the statistics service is enabled
publisherStatisticsEnabled	boolean	read-write	True if aggregate statistics for publishers are enabled
topicStatisticsEnabled	boolean	read-write	True if aggregate statistics for topics are enabled

ThreadPool

Management interface to the basic thread pool

Object name format

The objectName for MBeans of this type is of the following form:

```
com.pushtechonology.diffusion:type=ThreadPool,name="name",server="server_name"
```

Attributes

activeCount	int	read	The number of active threads
coreSize	int	read-write	The number of threads to maintain
keepAlive	long	read-write	Keep-alive time in milliseconds
largestSize	int	read	The largest number of threads that have simultaneously been in the pool
maximumSize	int	read-write	Maximum pool size
queueLowerThreshold	int	read	The lower queue size at which the notification handler will be notified
queueMaximumSize	int	read	The maximum queue size that the task queue can reach
queueSize	int	read	The size of the embedded task queue
queueUpperThreshold	int	read	The upper queue size at which the notification handler will be notified
size	int	read	The current number of threads in the pool
taskCount	long	read	The approximate total number of tasks that have ever been scheduled for execution

VirtualHost

HTTP virtual host management interface

Object name format

The objectName for MBeans of this type is of the following form:

`com.pushtechnology.diffusion:type=VirtualHost,name="name",server="server_name",we`

Attributes

cacheSizeBytes	int	read	The cache size in bytes
cacheSizeEntries	int	read	The number of entries in the cache
aliasFile	String	read	the alias file name
compressionThreshold	int	read	the compression threshold
debug	boolean	read	true if debug is set
documentRoot	String	read	the document root directory
errorPage	String	read	the error-page file name
fileServiceName	String	read	the file service name
homePage	String	read	the home-page file name
host	String	read	the host name

minify	boolean	read	true if the minify property is set
name	String	read	the virtual host name
numberOfRequests	int	read	number of requests actioned since service was started
static	boolean	read	true if static
webServerName	String	read	the web server name

Operations

startService	void	0	ACTION	Restart a previously stopped virtual host

stopService	void	0	ACTION	Stops the virtual host from processing requests

clearCache	void	0	ACTION	Clear the cache of all entries

The JMX adapter

The JMX adapter reflects JMX MBeans and their properties and notifications as topics.

The JMX adapter is packaged in the Diffusion publisher. The Diffusion publisher must be running for the JMX adapter be enabled.

You can configure the adapter to reflect the state of JMX MBeans and MXBeans as topics. These MBeans can be built-in, Diffusion, or third-party in origin.

The following aspects of the JMX adapter can be configured:

- Whether it is enabled or disabled.
By default, the adapter is enabled.
- Which MBeans are reflected as topics.
By default, all Diffusion MBeans, `java.nio:*`, `java.lang:*`, and `java.util.logging:*` are reflected as topics.
- How often the data on those topics is refreshed.
By default, the topics are refreshed every 3 seconds.

For more information about configuring the JMX adapter, see [Configuring the JMX adapter](#) on page 527

Many statistics are available as MBean properties, for example, CPU load, OS version, number of file-descriptors, and threads. Making these statistics available as topics to Diffusion clients makes possible the implementation of system monitoring solutions to the web, and all other Diffusion platforms.

Note: Publishing MBean data to topics can constitute a security risk. Ensure that crucial information about your Diffusion server is protected by permissions.

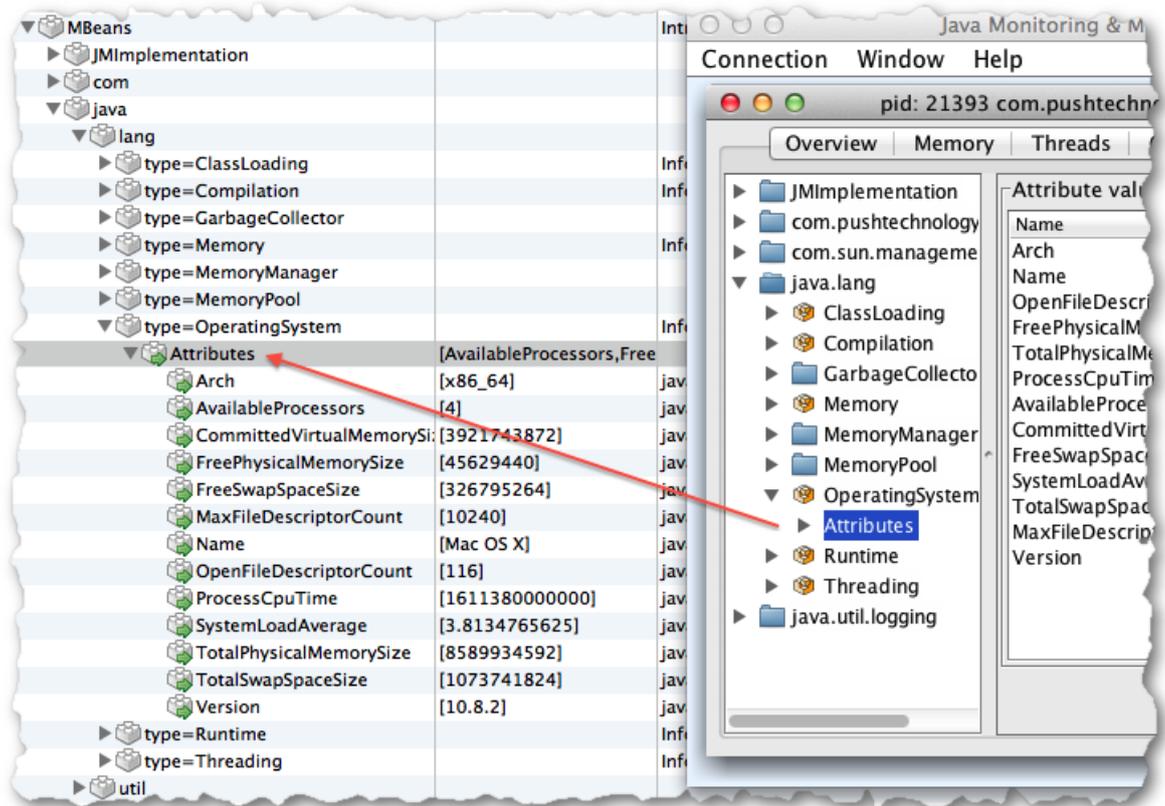


Figure 33: Reflecting MBeans as topics

MBean notifications are also available as topics. Whenever a notification is thrown and the matching topic is subscribed and a message holding a number of key attributes is published to it.

Table 55: Notifications as topics

Record starting ...	Holding
message	<code>javax.management.Notification.getMessage()</code>
sequenceNumber	<code>javax.management.Notification.getSequenceNumber()</code>
timeStamp	<code>javax.management.Notification.getTimeStamp()</code>
userData	<code>javax.management.Notification.getUserData()</code> if present
source	<code>javax.management.Notification.getSource()</code>

The JMX Adapter is itself an MBean with object-name `com.pushtechnology.diffusion:name=JMXAdapter`, which exposes the polling frequency in milliseconds as attribute 'UpdateFrequency'. A value less than or equal to zero prevents polling.

MXBeans versus Simple MBeans

The JMX adapter caters for both MXBeans and simpler MBeans. All MBean attributes are serialized as strings when converted to topics, this might be impractical if a solution returns an object or an array of objects. MXBean attributes with `ArrayType` and `CompositeType` types are treated differently.

- `CompositeType` Fields within the composite attribute are mapped to discrete topics.

▼ MBeans		Introspect JMX Mbeans as Diffusion topics
▶ JMImplementation		
▶ com		
▼ java		
▼ lang		
▶ type=ClassLoading		Information on the management interface of the MB
▶ type=Compilation		Information on the management interface of the MB
▼ type=GarbageCollector		
▶ name=ConcurrentMarkSweep		Information on the management interface of the MB
▼ name=ParNew		Information on the management interface of the MB
▼ Attributes	[LastGcInfo,MemoryPoolN	
CollectionCount	[5]	java.lang.Long
CollectionTime	[44]	java.lang.Long
▼ LastGcInfo	[endTime,memoryUsageB	javax.management.openmbean.CompositeData
duration	[5]	java.lang.Long
endTime	[3551376]	java.lang.Long
id	[5]	java.lang.Long
memoryUsageAfterGc	[CMS Old Gen,java.x.mana	table of java.util.Map<java.lang.String, java.lang.ma
memoryUsageBeforeGc	[CMS Old Gen,java.x.mana	table of java.util.Map<java.lang.String, java.lang.ma
startTime	[3551371]	java.lang.Long
MemoryPoolNames	[Par Eden Space,Par Survi	array of java.lang.String with 1 dimension
Name	[ParNew]	java.lang.String
Valid	[true]	java.lang.Boolean

Figure 34: Showing a composite attribute as a topic nest

- ArrayType One dimensional arrays are presented as a single record with many values. Two dimensional arrays are not supported. ArrayType attributes holding attributes that are not SimpleType are not supported (for example, an ArrayType attribute holding Composite or ArrayType values)

▼ type=Runtime		Information on the management interface of
▼ Attributes	[VmVersion,SpecVendor,ClassPath,SystemPrope	
BootClassPath	[/Library/Java/JavaVirtualMachines/1.6.0_31-b	java.lang.String
BootClassPathSupport	[true]	java.lang.Boolean
ClassPath	[/Users/martincowie/Development/Diffusion/M	java.lang.String
InputArguments	[-Xmx1g,-Dcom.sun.management.jmxremote,	array of java.lang.String with 1 dimension
LibraryPath	[./Library/Java/Extensions:/System/Library/Jav	java.lang.String
ManagementSpecVer	[1.2]	java.lang.String
Name	[17400@roobarb.local]	java.lang.String
SpecName	[Java Virtual Machine Specification]	java.lang.String
SpecVendor	[Sun Microsystems Inc.]	java.lang.String
SpecVersion	[1.0]	java.lang.String
StartTime	[1351772970790]	java.lang.Long
SystemProperties	[awt.nativeDoubleBuffering,true][awt.toolkit,ap	table of java.util.Map<java.lang.String, java
Uptime	[106824079]	java.lang.Long
VmName	[Java HotSpot(TM) 64-Bit Server VM]	java.lang.String
VmVendor	[Apple Inc.]	java.lang.String
VmVersion	[20.6-b01-415]	java.lang.String

Figure 35: Topics reflecting an ArrayType MXBean attributes

Related tasks

[Configuring the JMX adapter](#) on page 527

The JMX adapter can reflect JMX MBeans their properties and notifications as topics. Configure the JMX adapter using the `Publishers.xml` configuration file.

Statistics

Diffusion can provide statistics in three ways: via MBeans, via the Publisher API, and via Prometheus-compatible endpoints. Statistics provide information about the server, clients and topics.

Statistics exposed by MBeans

Diffusion provides a set of statistics as MBeans. For more information about these statistics, see [MBeans](#) on page 589.

These statistics can be accessed in the following ways:

- Using a JMX tool, such as VisualVM or JConsole. For more information, see [Using Java VisualVM](#) on page 584 or [Using JConsole](#) on page 586.
- Using the Diffusion monitoring console. For more information, see [Diffusion monitoring console](#) on page 606.
- Through topics under the topic `Diffusion/Metrics`.

Note: By default, JMX reporting and some detailed statistics are disabled for performance reasons. Use `etc/Statistics.xml` to configure this: see [Configuring statistics](#) on page 605.

You can configure Diffusion to report the top-level statistics through JMX. These statistics appear under `com.pushtechology.diffusion.metrics`. Reporting statistics through JMX can have a significant performance impact. Ensure that you test how using MBeans for statistics affects your solution.

The following is a list of all the top level statistics and their attributes.

- `clients.concurrent`
 - Count
- `clients.concurrent_max`
 - Value
- `client.connections`
 - Count
 - FifteenMinuteRate
 - FiveMinuteRate
 - MeanRate
 - OneMinuteRate
- `clients.disconnections`
 - Count
 - FifteenMinuteRate
 - FiveMinuteRate
 - MeanRate
 - OneMinuteRate
- `eventpublishers.concurrent`
 - Count
- `eventpublishers.connections`
 - Count

- FifteenMinuteRate
- FiveMinuteRate
- MeanRate
- OneMinuteRate
- eventpublishers.disconnections
 - Count
 - FifteenMinuteRate
 - FiveMinuteRate
 - MeanRate
 - OneMinuteRate
- publishers.loaded
 - Count
- publishers.started
 - Count
- server.client_subscriptions
 - Count
- server.inbound.messages
 - Count
- server.inbound.bytes
 - Count
- server.outbound.messages
 - Count
- server.outbound.bytes
 - Count
- topics.additions
 - Count
 - FifteenMinuteRate
 - FiveMinuteRate
 - MeanRate
 - OneMinuteRate
- topics.count
 - Count
- topics.deletions
 - Count
 - FifteenMinuteRate
 - FiveMinuteRate
 - MeanRate
 - OneMinuteRate

In all top-level statistics, attributes have the following values:

Count

The total number of items or events of this type over the lifetime of the metric.

MeanRate

The count divided by the lifetime of the metric.

OneMinuteRate, FiveMinuteRate, FifteenMinuteRate

A moving average across the given time period that is exponentially weighted towards new data.

Statistics via Prometheus endpoints

and provide statistics as endpoints compatible with the [Prometheus](#) monitoring tool.

You must have a license for or to use this feature.

Use `http://localhost:8080/metrics` to access Prometheus statistics. If not accessing from the same machine as the Diffusion server, replace `localhost` with the IP address or hostname.

Note: By default, some statistics are disabled for performance reasons. Use `etc/Statistics.xml` to configure the statistics that are available: see [Configuring statistics](#) on page 605.

You can access an individual metric with: `localhost:8080/metrics?name[]=diffusion_publishers_diffusion_outbound_bytes`.

Statistics in the Publisher API

You can get some statistics from the Publisher API. For more information, see the [Java API documentation](#).

The following statistics are provided through the Publisher API:

- PublisherStatistics
 - InboundClientMessageStatistics
 - AverageMessageSize
 - BytesOnWire
 - NumberOfMessages
 - OutboundMessageStatistics
 - AverageMessageSize
 - BytesOnWire
 - NumberOfMessages
- ClientStatistics
 - InboundMessageStatistics
 - AverageMessageSize
 - BytesOnWire
 - NumberOfMessages
 - OutboundMessageStatistics
 - AverageMessageSize
 - BytesOnWire
 - NumberOfMessages
- TopicStatistics
 - InboundMessageStatistics
 - AverageMessageSize
 - BytesOnWire
 - NumberOfMessages
 - OutboundMessageStatistics
 - AverageMessageSize
 - BytesOnWire

- `NumberOfMessages`
- `TotalNumberOfSubscribers`

Related concepts

[JMX](#) on page 583

You can use JMX to manage Diffusion. By default, the RMI registry port is 1099 and the JMX service port is 1100.

Related reference

[Diffusion monitoring console](#) on page 606

A web console for monitoring the Diffusion server.

[Logging](#) on page 611

Diffusion uses the Simple Logging Facade for Java (SLF4J) API to log messages from the Diffusion server or from publishers running on the Diffusion server. SLF4J separates the logging of messages in the Diffusion server from the logging framework. This separation enables you to configure an independent back-end implementation to format and write out the log messages.

[Integration with Splunk](#) on page 692

How to achieve basic integration between Diffusion and the Splunk™ analysis and monitoring application

Configuring statistics

You can configure statistics using the `etc/Statistics.xml` configuration file or programmatically using the Publisher API.

Statistics and performance

Collecting and communicating statistics introduces a performance overhead on the Diffusion server.

Enabling client instance statistics in a solution with significant numbers of clients can cause up to 20% reduction in the maximum throughput achieved. This performance impact can inhibit the system from supporting further connections.

If your system has more than 20,000 concurrent client connections per Diffusion instance, we recommend that client instance statistics be turned off.

Enabling topic instance statistics causes the creation of 5 statistics topics for each of your own topics.

If your system supports very large number of topics, we recommend that topic instance statistics are turned off.

The `Statistics.xml` configuration file

Diffusion servers provide statistics which are made available in several ways:

- JMX MBeans
- as topics under `Diffusion/Metrics`
- through the Diffusion monitoring console
- as endpoints for Prometheus

If statistics is enabled via `etc/Statistics.xml`, users can take measurements including the average message size, number of messages per topic per second, etc.

The statistics configuration has several distinct elements, that allow granular control over what is enabled on server start.

- `<statistics>`

The top-level element. Setting the `enabled` property to `false` will disable all statistics for the server.

- `<topic-statistics>`, `<client-statistics>`, `<publisher-statistics>`, and `<server-statistics>` (DEPRECATED)

Enabling these elements provides aggregate metrics for each given class.

The collection of metrics is configured separately from the distribution thereof. Within the `Statistics.xml` configuration file, there is also a `<reporters>` element which contains definitions of available reporters, which expose metrics over different mediums.

Some reporters allow certain properties to be passed to them. For instance, the topics reporter allows the use of `<property name="interval">` to provide the desired update frequency in seconds. Details of valid properties is documented within the `etc/Statistics.xml` file itself.

Configuring a reporter to distribute statistics through JMX

Inside the `reporters` element of the `Statistics.xml` configuration file, add the following XML:

```
<reporter name="JMX" enabled="true">
  <type>JMX</type>
</reporter>
```

Reporting statistics through JMX can have a significant performance impact. Ensure that you test how using MBeans for statistics affects your solution.

Configuring a reporter to distribute statistics through topics

Inside the `reporters` element of the `Statistics.xml` configuration file, add the following XML:

```
<reporter name="Topics" enabled="true">
  <type>TOPIC</type>
</reporter>
```

Programmatic configuration

You can programmatically query and configure the recording and calculation of statistics for the classes:

- `com.pushtechology.diffusion.api.publisher.Client`
- `com.pushtechology.diffusion.api.topic.Topic`
- `com.pushtechology.diffusion.api.publisher.Publisher`

Developers are able to query the state of each class, to discover whether it is recording statistics using `isStatisticsEnabled()`, stop recording with `stopStatistics()` and start recording using `startStatistics()`. The relevant API documentation holds more detail on the subject.

Diffusion monitoring console

A web console for monitoring the Diffusion server.

About

The Diffusion monitoring console is an optional publisher, provided as `console.dar`. It is deployed by default and can be undeployed in the same manner as any DAR file. It exists to give you an easy way to monitor your Diffusion solution using a web browser.

Dependencies

The console depends on the Diffusion publisher to mirror JMX MBeans as topics. The console also makes use of the statistics controlled by `etc/Statistics.xml`

Most modern web browsers implement the features required by the console. If you are using Microsoft Internet Explorer, version 11 or higher is required.

Logging in

The console is available in a fresh local installation at <https://localhost:8080/console>.

The console is secured by a principal (username) and password. The principal you use to log in must have permissions to view and act on information on the Diffusion server, for example by having the ADMINISTRATOR role.

The default configuration of the Diffusion server can be accessed with these credentials:

- principal: 'admin'
- password: 'password'

This user has the correct permissions to use all of the console's capabilities. For more information, see [Pre-defined users](#) on page 147.

Note: We recommend that you change the default security configuration before putting your solution into production. For more information, see [Configuring user security](#) on page 510

Features: Overview tab

The Overview tab of the console contains panels providing key information about the server.

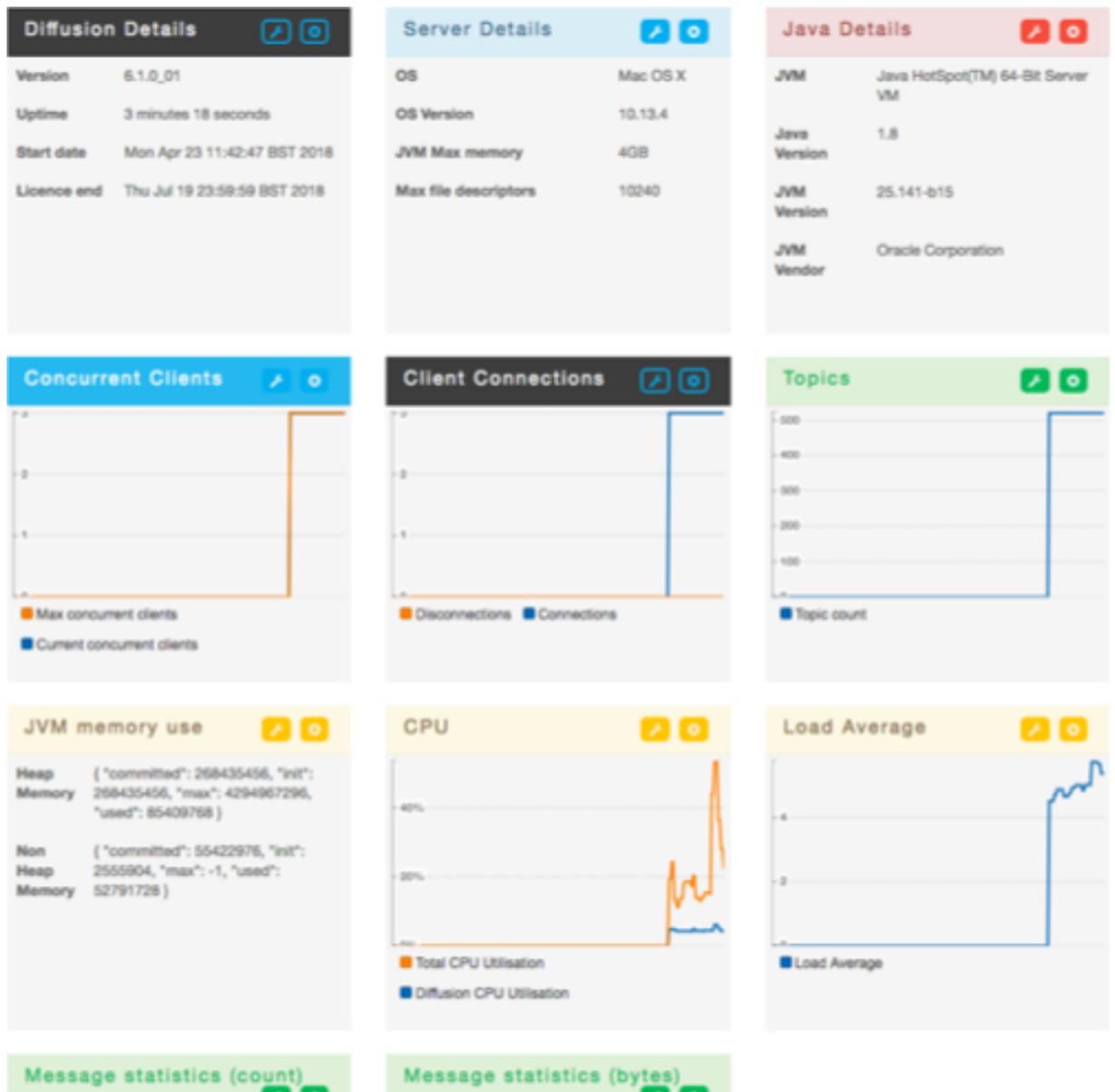


Figure 36: The default console layout

Changing the panel layout

You can edit the panels on the Overview screen.

- Grab a panel header and drag it to move a panel.
- Click the X icon to remove a panel.
- Click on the wrench icon to configure a panel.

Sourcing monitoring metrics

While configuring a panel, you can add any topic in the topic tree to the metrics that the panel tracks (including both built-in metrics and topics you have created).

Use the **Topics** tab to find topics.

You can add topics to a panel using the **Add to Overview** button in the **Topics** tab.

Features: Topics tab

The Topics tab brings to the web browser the ability to browse and interact with the Diffusion topic tree.

You can browse the live topic tree and subscribe to topics.

If individual topic statistics are enabled, the table also shows the number of subscribed clients, messages sent and bytes sent. Enable individual topic statistics through `etc/Statistics.xml`, for example,

```
<!-- Enable global topic statistics -->
<topic-statistics enabled="true">
  <!-- Enable individual topic instance statistics -->
  <monitor-instances>true</monitor-instances>
</topic-statistics>
```

Features: Clients tab

The Client tab shows a live list of the clients connected to the Diffusion server. Additionally it shows the number of messages to and from the server, the client IP address, connection type and connection time.

Configure the Diffusion server to provide live client statistics through `etc/Statistics.xml`

```
<!-- Enable global client statistics -->
<client-statistics enabled="true">
  <!-- Definition of the log in Logs.xml -->
  <log-name>stats</log-name>
  <!-- Specifies the output frequency of the log, this is one entry
  per frequency -->

  <output-frequency>lh</output-frequency>
  <!-- Enable individual client instance statistics -->
  <monitor-instances>true</monitor-instances>
</client-statistics>
```

Features: Logs tab

The Logs tab shows a live color-coded display of log entries emitted by the server at the levels of **INFO**, **WARN**, and **ERROR**.

You can also perform simple filtering on log entries. Unlike other monitoring metrics the Diffusion server retains up to 250 log entries in memory.

Features: Security tab

The Security tab shows a live list of security principals and roles that are configured on the Diffusion server.

For more information about security, see [Security](#) on page 129.

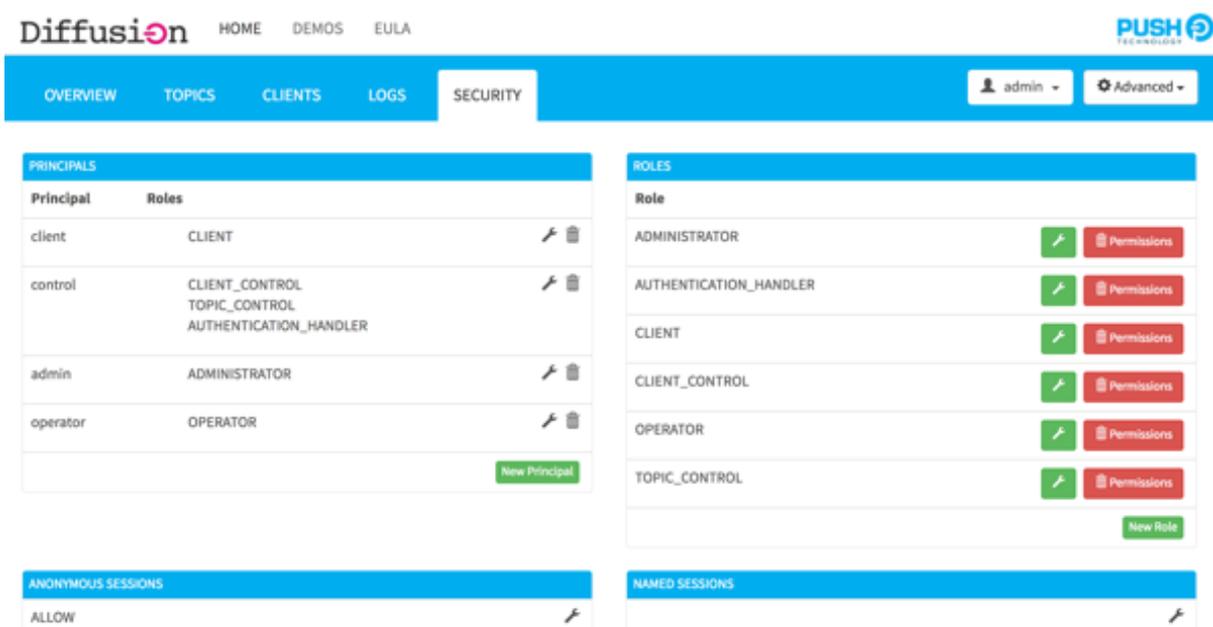


Figure 37: Security tables

Create, edit, or delete principals: The **Principals** table shows a list of the principals that the system authentication handler is configured to allow to connect to the Diffusion server. The table also shows the roles that are assigned to any client session that authenticates with the principal.

Click the **New Principal** button to add a new principal and define its associated password and roles.

Click the spanner icon next to an existing principal to edit that its password or roles.

Click the trashcan icon next to an existing principal to delete that principal.

Edit authentication policy and roles for anonymous users: The **Anonymous Users** table shows the authentication decision for client session that connect anonymously to the Diffusion server. You can choose to ALLOW or DENY anonymous connections or to ABSTAIN from the authentication decision, which then passes to the next configured authentication handler.

Click the spanner icon to edit the authentication decision for anonymous connections and, if that decision is ALLOW, edit any roles that are assigned to anonymous sessions.

Create, edit, or delete roles: The **Roles** table shows a list of roles that have been configured in the security store of the Diffusion server. These are the roles that you can choose to assign to any principals that connect to the Diffusion server.

Click the **New Role** button to add a new role and define its permissions and any roles it inherits from.

Click the spanner icon next to an existing role to edit its permissions and any roles it inherits from.

Click the trashcan icon next to an existing role to delete that role.

Production deployment notes

Securing the Diffusion/ topics

The topics in the Diffusion/ tree convey a great deal of power and it is highly probable that bringing a Diffusion based solution to production requires limiting their access to suitable users: for example, users with an IP address in a specific range. Solution implementers can achieve this by implementing an authentication handler.

Related concepts

[JMX](#) on page 583

You can use JMX to manage Diffusion. By default, the RMI registry port is 1099 and the JMX service port is 1100.

Related reference

[Statistics](#) on page 602

Diffusion can provide statistics in three ways: via MBeans, via the Publisher API, and via Prometheus-compatible endpoints. Statistics provide information about the server, clients and topics.

[Logging](#) on page 611

Diffusion uses the Simple Logging Facade for Java (SLF4J) API to log messages from the Diffusion server or from publishers running on the Diffusion server. SLF4J separates the logging of messages in the Diffusion server from the logging framework. This separation enables you to configure an independent back-end implementation to format and write out the log messages.

[Integration with Splunk](#) on page 692

How to achieve basic integration between Diffusion and the Splunk™ analysis and monitoring application

Logging

Diffusion uses the Simple Logging Facade for Java (SLF4J) API to log messages from the Diffusion server or from publishers running on the Diffusion server. SLF4J separates the logging of messages in the Diffusion server from the logging framework. This separation enables you to configure an independent back-end implementation to format and write out the log messages.

Note: The information in this section applies to logging that occurs at the Diffusion server or publishers running on the Diffusion server. Some clients provide logging capabilities. For information about using logging with your Diffusion clients, see the Developer Guide section for the client API you are using.

Related concepts

[JMX](#) on page 583

You can use JMX to manage Diffusion. By default, the RMI registry port is 1099 and the JMX service port is 1100.

[Configuring logging on the Diffusion server](#) on page 517

Your Diffusion installation provides a default logging framework and the log4j2 logging framework. Configure the Diffusion server to use your preferred framework.

[Configuring default logging](#) on page 518

To use the default logging, ensure that the Diffusion logging JAR is at `lib/slf4j-binding.jar`. The default logging implementation is already located here when you first install the Diffusion server. Use the `Logs.xml` configuration file to configure the behavior of the Diffusion default logging.

[Configuring log4j2](#) on page 521

To use log4j2, replace the default logging JAR file with the log4j2 JAR file. Use the `log4j2.xml` configuration file to configure the behavior of log4j2.

Related reference

[Statistics](#) on page 602

Diffusion can provide statistics in three ways: via MBeans, via the Publisher API, and via Prometheus-compatible endpoints. Statistics provide information about the server, clients and topics.

[Diffusion monitoring console](#) on page 606

A web console for monitoring the Diffusion server.

[Integration with Splunk](#) on page 692

How to achieve basic integration between Diffusion and the Splunk™ analysis and monitoring application

[Log4j2.xml](#) on page 522

Use the `Log4j2.xml` configuration file to configure the behavior of the log4j2 logging framework.

[Logging using another SLF4J implementation](#) on page 523

You can use other implementations of SLF4J for your logging. However, this is not supported for production use.

Logging back-end

The work of formatting and writing out messages logged by the Diffusion server and publishers running on the Diffusion server is done by the logging back-end. The logging back-end is a logging framework that is independent of the Diffusion server. Diffusion provides a default logging framework, but you can configure the Diffusion server to use other SLF4J implementations.

Default logging framework

The default logging framework provided by Diffusion is configured to log messages out to the console and write them to a file. You can configure the behavior of the default logging framework using the `Logs.xml` configuration file.

For more information, see [Configuring default logging](#) on page 518.

Log4j2 logging framework

Diffusion supports log4j2 as an alternative logging implementation. Log4j2 is a third-party SLF4J implementation provided by the Apache Software Foundation. For more information, see <http://logging.apache.org/log4j/2.x/>.

You can replace the Diffusion default logging with the log4j2 implementation of SLF4J. The log4j2 implementation of SLF4J supports a wide range of appenders and allows fine-grained tuning of logged events.

By default, log4j2 is configured to behave in the same way as the default logging. Change this configuration by editing the provided `Log4j2.xml` configuration file.

For more information, see [Configuring log4j2](#) on page 521.

Note: Messages logged using the deprecated LogWriter publisher API are passed directly to the default logging framework, not to log4j2. To use log4j2, you must update your publisher to use SLF4J.

Other logging frameworks

Your Diffusion server can be configured to use any logging framework that implements SLF4J. However, only the default and log4j2 frameworks are supported for production use.

For more information, see [Logging using another SLF4J implementation](#) on page 523.

Note: Messages logged using the deprecated LogWriter publisher API are passed directly to the default logging framework, not to log4j2. To use log4j2, you must update your publisher to use SLF4J.

Related concepts

[Configuring logging on the Diffusion server](#) on page 517

Your Diffusion installation provides a default logging framework and the log4j2 logging framework. Configure the Diffusion server to use your preferred framework.

[Configuring default logging](#) on page 518

To use the default logging, ensure that the Diffusion logging JAR is at `lib/slf4j-binding.jar`. The default logging implementation is already located here when you first install the Diffusion server. Use the `Logs.xml` configuration file to configure the behavior of the Diffusion default logging.

[Configuring log4j2](#) on page 521

To use log4j2, replace the default logging JAR file with the log4j2 JAR file. Use the `log4j2.xml` configuration file to configure the behavior of log4j2.

Related reference

[Log4j2.xml](#) on page 522

Use the `Log4j2.xml` configuration file to configure the behavior of the log4j2 logging framework.

[Logging using another SLF4J implementation](#) on page 523

You can use other implementations of SLF4J for your logging. However, this is not supported for production use.

Logging reference

Messages logged by the Diffusion server are logged at different levels depending on their severity.

Log levels

Diffusion events are logged at different levels of severity. The log levels, ordered from most severe to least severe, are as follows:

Table 56: Log levels

Level	Description
ERROR	Events that indicate a failure.
WARN	Events that indicate a problem with operation.
INFO	Significant events.
DEBUG	Verbose logging. Not usually enabled for production.
TRACE	High-volume logging of interest only to Push Technology Support. Push Technology Support may occasionally ask you to enable this log level to diagnose issues.

Warning: Logging can use considerable CPU resources. In a production environment, enable only significant log messages (INFO and above). Performance degrades significantly when running at finer logging levels as more messages are produced, each requiring processing.

Log format

Log messages output by the Diffusion default logging back-end are output in the following format.

Each log line is made up of a number of fields. All of the fields except for the Exception are formatted on a single line, delimited by pipe (|) characters.

```
yyyy-MM-dd HH:mm:ss.SSS | Level | Thread | Code | Message | LoggerName  
Exception
```

If you use log4j2 as your logging back-end it also produces output in this format if you use the provided `Log4j2.xml` configuration file. However, you can edit the configuration file to change the log format. For more information, see [Configuring log4j2](#) on page 521.

Note: Sometimes log messages that are output to the same location as Diffusion messages can be from other products. You can see which messages are Diffusion messages by looking for the message code of the format `PUSH-XXXXXX`. All messages that Diffusion outputs at INFO level or above include this code.

The meaning of each field is described in the following table.

Table 57: Fields included in the logs

Field	Optional or Mandatory	Format/values stable between releases	Description
Time stamp	Mandatory	Yes	<p>The time and date the log event occurred.</p> <p>Asynchronous logging is enabled by default. The server might log a message in a different thread to the one that produced the log event, and at a slightly later time. Consequently, log lines might not be logged in exact time stamp order.</p> <p>The time stamp is displayed using the timezone configured for the JVM running the server. The date format can be changed in the <code>Server.xml</code> configuration file.</p>
Level	Mandatory	Yes	<p>The log severity, using the SLF4J levels: ERROR, WARN, INFO, DEBUG, TRACE.</p>
Thread	Mandatory	No	<p>The name of the Java thread that logged the event.</p>
Code	Optional	Yes	<p>Diffusion log messages have a unique code. For example, <code>PUSH-000123</code>. For more information, see .</p> <p>All messages at that are logged at INFO or above are documented.</p>

Field	Optional or Mandatory	Format/values stable between releases	Description
Message	Mandatory	No	A natural language description of the event.
Logger name	Mandatory	No	The logger name. Usually the fully qualified name of the Java class that produced the event.
Exception	Optional	No	If the log event has an associated Java Throwable, the exception message and stack trace directly follows the message line.

Optional fields are empty if the log event does not have the information.

The third column indicates whether fields are stable between releases. Where possible, Push Technology will not change the format or values of these fields so they can be relied on for automated log monitoring. The fields not marked as stable are more likely to change between releases, including patch releases.

Log message examples

The following examples show the log format output by the Diffusion default logging back-end. Log4j2 also produces output in this format if you use the provided `Log4j2.xml` configuration file.

Most log messages are formatted on a single line.

```
2016-02-19 14:01:31.199|INFO|main|PUSH-000159|
The maximum message size is 32768 bytes.|
com.pushtechnology.diffusion.DiffusionController
```

If a log event has an exception, the exception message and stack trace directly follows the message line. The exception can span multiple lines.

```
2016-02-19 14:14:54.095|ERROR|main|PUSH-000164|Diffusion Server not
started.|com.pushtechnology.diffusion.api.server.DiffusionServer
com.pushtechnology.diffusion.server.security.persistence.store.StoreException:
Error parsing SystemAuthentication.store
at
com.pushtechnology.diffusion.server.security.persistence.store.systemauthenticac
at
com.pushtechnology.diffusion.server.security.persistence.store.AbstractFileProv
at
com.pushtechnology.diffusion.server.security.persistence.store.AbstractStoreImp
at
com.pushtechnology.diffusion.server.security.authentication.systemhandler.Syste
at
com.pushtechnology.diffusion.server.security.persistence.store.systemauthenticac
at
com.pushtechnology.diffusion.server.security.authentication.AuthenticationManag
at sun.reflect.NativeMethodAccessorImpl.invoke0(Native Method)
```

```
at
sun.reflect.NativeMethodAccessorImpl.invoke(NativeMethodAccessorImpl.java:62)
at
sun.reflect.DelegatingMethodAccessorImpl.invoke(DelegatingMethodAccessorImpl.java:
at java.lang.reflect.Method.invoke(Method.java:498)
```

Log headers

Currently, log files output by the Diffusion default logging back-end start with a special header.

```
2016-02-19 14:14:53.376 : Starting log for Diffusion 5.7.0_01
(Server) 29689@tangerine (2016-02-08 12:22:07)
```

Do not depend on this header. In a future release, this header will be replaced with a standard log message.

This does not apply to log files output by log4j2 or other third-party SLF4J implementations.

Log stopped

When the Diffusion default logging back-end rotates the log files, it outputs the message `Log stopped` at the end of the log file before creating a new log file and continuing to log messages in that new file.

This does not apply to log files output by log4j2 or other third-party SLF4J implementations.

Related concepts

[Configuring logging on the Diffusion server](#) on page 517

Your Diffusion installation provides a default logging framework and the log4j2 logging framework. Configure the Diffusion server to use your preferred framework.

[Configuring default logging](#) on page 518

To use the default logging, ensure that the Diffusion logging JAR is at `lib/slf4j-binding.jar`. The default logging implementation is already located here when you first install the Diffusion server. Use the `Logs.xml` configuration file to configure the behavior of the Diffusion default logging.

[Configuring log4j2](#) on page 521

To use log4j2, replace the default logging JAR file with the log4j2 JAR file. Use the `log4j2.xml` configuration file to configure the behavior of log4j2.

Related reference

[Log4j2.xml](#) on page 522

Use the `Log4j2.xml` configuration file to configure the behavior of the log4j2 logging framework.

[Logging using another SLF4J implementation](#) on page 523

You can use other implementations of SLF4J for your logging. However, this is not supported for production use.

Log messages

The Diffusion server outputs log messages. Each log message contains an ID, a message, and a description.

Log messages

The Diffusion server outputs log messages. Each log message contains an ID, a message, and a description.

[PUSH-000004](#)

Discarding non-TextMessage from JMS: '{}'.

Description

The JMS adapter only supports TextMessage types but it received another message type.

Related concepts

[JMS adapter](#) on page 709

The JMS adapter for Diffusion, enables Diffusion clients to transparently send data to and receive data from destinations (topics and queues) on a JMS server.

[PUSH-000005](#)

Exception from JMS provider '{}'.

Description

The JMS adapter received notification of an exception from the JMS server. Typically, this happens when the connection between the adapter and the server has been terminated.

Related concepts

[JMS adapter](#) on page 709

The JMS adapter for Diffusion, enables Diffusion clients to transparently send data to and receive data from destinations (topics and queues) on a JMS server.

[PUSH-000011](#)

Failed to send message to JMS destination '{}'.

Description

An error occurred while sending a message from the JMS adapter to the JMS server.

Related concepts

[JMS adapter](#) on page 709

The JMS adapter for Diffusion, enables Diffusion clients to transparently send data to and receive data from destinations (topics and queues) on a JMS server.

[PUSH-000012](#)

Failed to start JMS Adapter.

Description

The JMS adapter was unable to start.

Related concepts

[JMS adapter](#) on page 709

The JMS adapter for Diffusion, enables Diffusion clients to transparently send data to and receive data from destinations (topics and queues) on a JMS server.

[PUSH-000017](#)

Unable to create a subscription to '{}', exception is {}.

Description

The JMS adapter failed to create a subscription to the JMS destination associated with the given topic name.

Related concepts

[JMS adapter](#) on page 709

The JMS adapter for Diffusion, enables Diffusion clients to transparently send data to and receive data from destinations (topics and queues) on a JMS server.

[PUSH-000018](#)

Unable to create new topic '{}'.

Description

The JMS adapter has received a message from the JMS server and needs to create a corresponding Diffusion topic, but was unable to.

Related concepts

[JMS adapter](#) on page 709

The JMS adapter for Diffusion, enables Diffusion clients to transparently send data to and receive data from destinations (topics and queues) on a JMS server.

[PUSH-000023](#)

Client Auto Failover failed.

Description

A connection to a server has failed, and the auto failover process has encountered an error.

[PUSH-000024](#)

Mime extension '{}' was already mapped to '{}': overwriting map with {}.

Description

A configured Mime extension was already mapped to another value but has now been remapped to a new value. This indicates duplicate mime extension values in the mimes configuration.

[PUSH-000025](#)

Connection attempt failed with {} - trying next server.

Description

An attempt to connect to a server has failed but more than one possible server has been specified and so the next is being tried.

[PUSH-000047](#)

Client {} closing - {}. {}.

Description

The given client is closing due to an exception.

Related concepts

[Common issues when using a load balancer](#) on page 708

There are some configuration options on your load balancer that can cause problems or inefficient behavior in your Diffusion solution.

[PUSH-000049](#)

Error subscribing client {} to topic '{}', publisher '{}'. {}.

Description

An error has occurred while trying to subscribe the specified client to the specified topic.

[PUSH-000056](#)

{} license hard limit ({}) breached, connection rejected.

Description

The maximum number of licensed connections has been exceeded.

Related concepts

[License restrictions](#) on page 484

The Diffusion license can include restrictions on how the Diffusion server is used.

Related tasks

[Updating your license file](#) on page 485

You can update your Diffusion license file without having to restart the Diffusion server. Copy the new file over the old and ensure that the timestamp is updated.

[PUSH-000061](#)

Failed to subscribe client {} to topic(s) '{} ' - Invalid topic name or selector.

Description

The client sent an invalid topic selector pattern for subscription.

Related concepts

[Topic selectors](#) on page 50

A topic selector identifies one or more topics. You can create a topic selector object from a pattern expression.

[PUSH-000064](#)

Failed to unsubscribe Client {} from '{}' - Invalid Topic name or selector.

Description

The client sent an invalid topic selector pattern for unsubscription.

Related concepts

[Topic selectors](#) on page 50

A topic selector identifies one or more topics. You can create a topic selector object from a pattern expression.

[PUSH-000065](#)

Failure processing message from server.

Description

An error has occurred at the client end of a connection to a server while processing a message from the server.

[PUSH-000070](#)

Invalid connection from {}.

Description

An invalid connection has been attempted from the given address.

[PUSH-000072](#)

Connector '{}' created, listening on {}.

Description

The given connector was created to support the given types of connection.

[PUSH-000074](#)

Connector '{}' received an HTTP connection but does not support HTTP.

Description

Connector has received an HTTP connection attempt but does not support HTTP connections. The connector does not define a valid web server.

[PUSH-000075](#)

Unable to start Connector {}.

Description

An error occurred while trying to start a connector.

Depending on the operating system configuration, the operating system might not provide you with a socket buffer of the specified size and you might be allocated a smaller one.

To ensure that the socket buffer is set to the same size as the input buffer in the client multiplexer, change your OS socket configuration.

On Linux

To see the current maximum size of the input socket buffer, run the following command:

```
sysctl -a | grep rmem_max
```

To set the maximum size of the input socket buffer, run the following command:

```
sudo sysctl -w net.core.rmem_max=number_of_bytes
```

PUSH-000086

{}: Requested output buffer size could not be allocated, requested: {} allocated: {}.

Description

The send buffer of the socket was assigned a different amount of memory than requested. This is configured by the output buffer size. The configured output buffer size is a hint to the operating system. Refer to your OS documentation for any socket buffer limits. This can have performance implications.

Additional information

When you change the `output-buffer-size` in the `Connectors.xml` configuration file, this configures the following buffers:

- A buffer in the client multiplexer, which will be of the configured size
- A socket buffer managed by the operating system

Depending on the operating system configuration, the operating system might not provide you with a socket buffer of the specified size and you might be allocated a smaller one.

To ensure that the socket buffer is set to the same size as the output buffer in the client multiplexer, change your OS socket configuration.

On Linux

To see the current maximum size of the output socket buffer, run the following command:

```
sysctl -a | grep wmem_max
```

To set the maximum size of the output socket buffer, run the following command:

```
sudo sysctl -w net.core.wmem_max=number_of_bytes
```

PUSH-000087

Connector '{}'' received an unidentified connection request [{}] from {}.

Description

An unidentified connection attempt has been made via a connector. The hexadecimal representation of the initial bytes of the connection request are logged in order to aid in identifying the origin.

[PUSH-000089](#)

Failed to update Child List Topic Data for Topic '{}'.

Description

An unforeseen error occurred while updating this ChildListTopicData.

[PUSH-000100](#)

Command topic data '{}': received invalid command message '{}'.

Description

A client has sent an invalid command message to command topic.

[PUSH-000144](#)

Routing topic failed to subscribe client {} to routing topic '{}' with target topic '{}'.

Description

A routing topic failed to subscribe a client to a topic.

Related concepts

[Routing topics](#) on page 75

A special type of topic, which can map to a different real topic for every client that subscribes to it. In this way, different clients can see different values for what is effectively the same topic from the client point of view.

[PUSH-000147](#)

Failure in TopicDataListener '{}' topicDataChanged method.

Description

An exception has been thrown by an implementation of the TopicDataListener.topicDataChanged method. The exception is simply logged and has no other effect.

[PUSH-000151](#)

Unable to get JMX MBean attribute.

Description

It was not possible to retrieve an attribute from a JMX MBean.

Related concepts

[JMX](#) on page 583

You can use JMX to manage Diffusion. By default, the RMI registry port is 1099 and the JMX service port is 1100.

[PUSH-000152](#)

Unable to load shutdown hook class '{}': {}.

Description

An error occurred loading the given third party class.

[PUSH-000153](#)

Unable to load startup hook class '{}': {}.

Description

An error occurred loading the given third party class.

[PUSH-000154](#)

The JVM has been signalled to shut down.

Description

The JVM has been signalled to shut down, most likely by the operating system.

[PUSH-000155](#)

No connectors have been configured. Creating a default client connector listening on port {} and a default high volume connector listening on port {}.

Description

No connectors have been configured therefore a default client connector and a default high volume connector (suitable for fan-out) have been created, listening on the specified ports.

[PUSH-000158](#)

No thread pools configured. Created new pool definition called '{}'.
'

Description

No thread pools were configured therefore a default one has been added.

[PUSH-000159](#)

The maximum message size is {} bytes.

Description

The maximum message size has been established.

[PUSH-000160](#)

No inbound pool has been configured - using '{}'.
'

Description

No inbound thread pool has been configured therefore the first configured thread pool has been assumed to define the inbound pool.

[PUSH-000161](#)

Diffusion - removing publishers.

Description

The server is exiting, and all publishers within are being unloaded.

[PUSH-000162](#)

Running shutdown hook '{}'.

Description

The given third party class is being executed at server shutdown.

[PUSH-000163](#)

Running startup hook '{}'.

Description

The given third party class is being executed at server startup.

[PUSH-000164](#)

Diffusion server not started.

Description

Diffusion server failed to start.

Related concepts

[Starting the Diffusion server](#) on page 552

After you have installed and configured your Diffusion server, you can start it using one of a number of methods.

[PUSH-000165](#)

Diffusion server started.

Description

Diffusion started successfully.

Related concepts

[Starting the Diffusion server](#) on page 552

After you have installed and configured your Diffusion server, you can start it using one of a number of methods.

[PUSH-000166](#)

Diffusion server '{}' starting.

Description

The Diffusion server is starting.

Related concepts

[Starting the Diffusion server](#) on page 552

After you have installed and configured your Diffusion server, you can start it using one of a number of methods.

[PUSH-000167](#)

Diffusion stopped.

Description

The Diffusion server has been stopped.

[PUSH-000168](#)

Diffusion stopping, reason='{}' by administrator='{}'.

Description

Diffusion is processing a shutdown request.

[PUSH-000169](#)

Diffusion - stopping connectors.

Description

Connectors are being stopped during a shutdown of Diffusion.

[PUSH-000173](#)

Exception notifying '{}' of {}'.

Description

An exception occurred while processing an internal asynchronous event.

[PUSH-000174](#)

Unable to submit event '{}' to {}' for execution.

Description

A failure has occurred while submitting a notification event for execution.

[PUSH-000175](#)

SHA1 algorithm not found, unable to respond to WebSocket request.

Description

The WebSocket protocol requires the SHA1 algorithm, but it was not found. This can only happen with an incomplete or incompatible Java installation.

[PUSH-000183](#)

Message channel '{}' closed - {}.

Description

A communication error has occurred on a message channel.

[PUSH-000185](#)

Failed to accept connection on connector '{}'.

Description

This can occur when a socket connection has been made to Diffusion, but a failure occurred while initializing it.

[PUSH-000188](#)

Shutting down selector '{}' due to fatal error.

Description

An error has occurred in a selector thread and the selector will be shutdown.

[PUSH-000191](#)

Connector '{}' - Unable to accept connection: {}.

Description

An exception occurred while attempting to accept a socket connection.

[PUSH-000193](#)

Connector '{}' has loaded SSL Keystore from {}.

Description

Connector has loaded SSL keystore from the specified location.

Related concepts

[Network security](#) on page 555

This section describes how to deploy network security, which can be used in conjunction with data security.

[PUSH-000195](#)

JMX: Cannot register object '{}' at MBean ObjectName {}.

Description

An error occurred registering the given object with the given JMX ObjectName with the JMX server.

[PUSH-000198](#)

The license file '{}' is invalid.

Description

Failed to verify the content of the Diffusion license file.

Related concepts

[License restrictions](#) on page 484

The Diffusion license can include restrictions on how the Diffusion server is used.

Related tasks

[Updating your license file](#) on page 485

You can update your Diffusion license file without having to restart the Diffusion server. Copy the new file over the old and ensure that the timestamp is updated.

[PUSH-000199](#)

License is not valid for this version of Diffusion (license='{}' vs '{}').

Description

The license file does not match this version of Diffusion.

Related concepts

[License restrictions](#) on page 484

The Diffusion license can include restrictions on how the Diffusion server is used.

Related tasks

[Updating your license file](#) on page 485

You can update your Diffusion license file without having to restart the Diffusion server. Copy the new file over the old and ensure that the timestamp is updated.

[PUSH-000200](#)

Product '{}' not licensed for this address scheme.

Description

A product is not licensed for either IP address or MAC addressing schemes.

Related concepts

[License restrictions](#) on page 484

The Diffusion license can include restrictions on how the Diffusion server is used.

Related tasks

[Updating your license file](#) on page 485

You can update your Diffusion license file without having to restart the Diffusion server. Copy the new file over the old and ensure that the timestamp is updated.

[PUSH-000201](#)

Soft user limit ({} for {} exceeded. Hard limit at {}.

Description

Once the number of connections for a product reaches its soft limit, a warning is emitted. The product might cease to function if this number reaches the hard limit.

Related concepts

[License restrictions](#) on page 484

The Diffusion license can include restrictions on how the Diffusion server is used.

Related tasks

[Updating your license file](#) on page 485

You can update your Diffusion license file without having to restart the Diffusion server. Copy the new file over the old and ensure that the timestamp is updated.

[PUSH-000202](#)

Product license expires in {} day(s).

Description

The installed license file is nearing expiration. A new license will be required soon for Diffusion to continue running.

Related concepts

[License restrictions](#) on page 484

The Diffusion license can include restrictions on how the Diffusion server is used.

Related tasks

[Updating your license file](#) on page 485

You can update your Diffusion license file without having to restart the Diffusion server. Copy the new file over the old and ensure that the timestamp is updated.

[PUSH-000203](#)

License has expired.

Description

The Diffusion license has expired.

Related concepts

[License restrictions](#) on page 484

The Diffusion license can include restrictions on how the Diffusion server is used.

Related tasks

[Updating your license file](#) on page 485

You can update your Diffusion license file without having to restart the Diffusion server. Copy the new file over the old and ensure that the timestamp is updated.

[PUSH-000206](#)

Licensor stopping Diffusion. Invalid license.

Description

The Diffusion license is invalid.

[PUSH-000207](#)

License check failed : Unable to check server-side addressing for product [IP] '{}'.

Description

During the license check, Diffusion attempts to check the server's IP addresses but it was unable to do so.

Related concepts

[License restrictions](#) on page 484

The Diffusion license can include restrictions on how the Diffusion server is used.

Related tasks

[Updating your license file](#) on page 485

You can update your Diffusion license file without having to restart the Diffusion server. Copy the new file over the old and ensure that the timestamp is updated.

[PUSH-000208](#)

License check failed : Unable to check server-side addressing for product [MAC] '{}'.
`[MAC]`

Description

Diffusion is licensed to run on a server with a specific MAC address, but an error occurred while looking for MAC addresses on the server.

Related concepts

[License restrictions](#) on page 484

The Diffusion license can include restrictions on how the Diffusion server is used.

Related tasks

[Updating your license file](#) on page 485

You can update your Diffusion license file without having to restart the Diffusion server. Copy the new file over the old and ensure that the timestamp is updated.

[PUSH-000209](#)

License check failed : Unable to match MAC address for [{}].
`[{}]`

Description

The product is licensed for a particular MAC address, but the server does not have this MAC.

Related concepts

[License restrictions](#) on page 484

The Diffusion license can include restrictions on how the Diffusion server is used.

Related tasks

[Updating your license file](#) on page 485

You can update your Diffusion license file without having to restart the Diffusion server. Copy the new file over the old and ensure that the timestamp is updated.

[PUSH-000210](#)

License check failed : Unable to parse CIDR Address: '{}'.
`{}`

Description

The product is licensed to run on machines with IP addresses matching a CIDR expression, but the expression could not be parsed. Contact Push Technology for an updated license file.

Related concepts

[License restrictions](#) on page 484

The Diffusion license can include restrictions on how the Diffusion server is used.

Related tasks

[Updating your license file](#) on page 485

You can update your Diffusion license file without having to restart the Diffusion server. Copy the new file over the old and ensure that the timestamp is updated.

[PUSH-000211](#)

License version is empty, this is not allowed.

Description

License version is empty, this is not allowed. Contact Push Technology for a replacement license file.

Related concepts

[License restrictions](#) on page 484

The Diffusion license can include restrictions on how the Diffusion server is used.

Related tasks

[Updating your license file](#) on page 485

You can update your Diffusion license file without having to restart the Diffusion server. Copy the new file over the old and ensure that the timestamp is updated.

[PUSH-000212](#)

Log level set to '{}' for '{}'.
'{}' is not a valid log level.

Description

The logging level of the specified log file has been changed as indicated.

Related reference

[Logging](#) on page 611

Diffusion uses the Simple Logging Facade for Java (SLF4J) API to log messages from the Diffusion server or from publishers running on the Diffusion server. SLF4J separates the logging of messages in the Diffusion server from the logging framework. This separation enables you to configure an independent back-end implementation to format and write out the log messages.

[PUSH-000214](#)

Invalid JMX credentials.

Description

The supplied JMX credentials are incorrect.

Related concepts

[JMX](#) on page 583

You can use JMX to manage Diffusion. By default, the RMI registry port is 1099 and the JMX service port is 1100.

[PUSH-000215](#)

Remote JMX management service is disabled.

Description

The remote JMX service is configured not to start.

Related concepts

[JMX](#) on page 583

You can use JMX to manage Diffusion. By default, the RMI registry port is 1099 and the JMX service port is 1100.

[PUSH-000216](#)

Remote JMX management service has started. Listening to {}.

Description

The remote JMX service has started.

Related concepts

[JMX](#) on page 583

You can use JMX to manage Diffusion. By default, the RMI registry port is 1099 and the JMX service port is 1100.

[PUSH-000226](#)

Multiplexer error while processing client {}.

Description

A multiplexer tried to send messages for a client, but failed.

[PUSH-000227](#)

Multiplexer event is delayed as the queue current size is beyond threshold '{}', capacity = '{}'.
The event will be delayed.

Description

A multiplexer cannot accept an event because its queue is full. Adding the event will be delayed.

Additional information

The depth of the multiplexer event queue has exceeded the value of the `max-event-queue-size` element in the `Server.xml` configuration file.

Set this value to 0 to make the size of the queue unbounded. If the value is not set to 0, it must be at least as large as the expected number of concurrent connections to avoid the possibility of deadlock.

[PUSH-000228](#)

Multiplexer event is significantly delayed as the queue current size is beyond threshold '{}', capacity = '{}'.
'{}'.

Description

Because the queue is full, a multiplexer cannot queue an event after a significant amount of time, but it is continuing to try to do so.

[PUSH-000229](#)

Error while handling a multiplexer event.

Description

Error while handling a multiplexer event.

[PUSH-000230](#)

Failed to schedule event.

Description

A multiplexer tried to schedule an event for some time in the future, but was not able to do so.

[PUSH-000231](#)

Long multiplexer cycle [cycle {}]: processed {} events in {} ms; processed {} clients in {} ms].

Description

A multiplexer processing cycle exceeded the configured notification threshold. On the server, this can be due to subscription processing for many clients. Consider allocating more CPU cores and increasing the number of multiplexers correspondingly.

[PUSH-000233](#)

Multiplexer '{}' started.

Description

A multiplexer has started.

[PUSH-000239](#)

Cannot create topic for MBean {}.

Description

It was not possible to create a topic to mirror the content of the given JMX MBean.

Related concepts

[JMX](#) on page 583

You can use JMX to manage Diffusion. By default, the RMI registry port is 1099 and the JMX service port is 1100.

[PUSH-000241](#)

Cannot remove topic for MBean {}.

Description

It was not possible to remove a topic that mirrors the content of the given JMX MBean.

Related concepts

[JMX](#) on page 583

You can use JMX to manage Diffusion. By default, the RMI registry port is 1099 and the JMX service port is 1100.

[PUSH-000244](#)

JMX exception interacting with MBean '{}'.

Description

An error occurred creating the tree of topics to represent a JMX MBean.

Related concepts

[JMX](#) on page 583

You can use JMX to manage Diffusion. By default, the RMI registry port is 1099 and the JMX service port is 1100.

[PUSH-000245](#)

JMX exception while updating topic '{}'.

Description

An error occurred while polling an MBean attribute that the given topic reflects.

Related concepts

[JMX](#) on page 583

You can use JMX to manage Diffusion. By default, the RMI registry port is 1099 and the JMX service port is 1100.

[PUSH-000246](#)

Caught exception removing notification listener from JMX.

Description

Diffusion is no longer listening to notification from the given MBean, and this has caused a problem.

Related concepts

[JMX](#) on page 583

You can use JMX to manage Diffusion. By default, the RMI registry port is 1099 and the JMX service port is 1100.

[PUSH-000247](#)

Cannot find MBean '{}' to listen for notifications.

Description

Diffusion is attempting to add a notification to the given MBean, and this has caused a problem.

Related concepts

[JMX](#) on page 583

You can use JMX to manage Diffusion. By default, the RMI registry port is 1099 and the JMX service port is 1100.

[PUSH-000249](#)

Cannot send message given notification object {}.

Description

A JMX notification was detected and serialized as a message, but it was not possible to send the message.

[PUSH-000250](#)

Unexpected notification object {}'.

Description

A JMX notification of an unexpected type was detected.

[PUSH-000251](#)

Unexpected notification type {}'.

Description

MBeanServerNotification received that was neither about an MBean registering or deregistering.

[PUSH-000253](#)

Exception caught in {} method of authorization handler {}.

Description

An exception has been thrown by the specified method of the user-written authorization handler - the exception has been logged and the requested action rejected.

[PUSH-000254](#)

Authorization manager started with authorization handler class {}'.

Description

Authorization manager has been started with the specified handler class.

[PUSH-000256](#)

Deploying publishers compiled for Diffusion version '{}'.

Description

Publishers compiled for the specified version of Diffusion are being deployed.

Related concepts

[Deploying publishers on your Diffusion server](#) on page 753

If you developed a publisher as part of your Diffusion solution, you must deploy the publisher on the Diffusion server for it to run.

[PUSH-000260](#)

Diffusion-Version not present in manifest file, not deploying.

Description

The publisher will not be deployed because Diffusion-Version is not present in its DAR manifest file.

Related concepts

[Deploying publishers on your Diffusion server](#) on page 753

If you developed a publisher as part of your Diffusion solution, you must deploy the publisher on the Diffusion server for it to run.

[PUSH-000261](#)

Error deploying publisher from file '{}'.

Description

An exception has occurred while trying to deploy a publisher from a DAR file.

Related concepts

[Deploying publishers on your Diffusion server](#) on page 753

If you developed a publisher as part of your Diffusion solution, you must deploy the publisher on the Diffusion server for it to run.

[PUSH-000262](#)

Error writing file for deployment: {}.

Description

When hot-deploying publishers, the contents of DAR files must be extracted to disk. Check for write permissions to the deployment directory and that there is sufficient free disk space.

Related concepts

[Deploying publishers on your Diffusion server](#) on page 753

If you developed a publisher as part of your Diffusion solution, you must deploy the publisher on the Diffusion server for it to run.

[PUSH-000263](#)

Exception caught in publisher '{}' in method '{}'.

Description

A publisher implementation has thrown an exception in the given method. The exception has been logged but otherwise ignored.

Related concepts

[Deploying publishers on your Diffusion server](#) on page 753

If you developed a publisher as part of your Diffusion solution, you must deploy the publisher on the Diffusion server for it to run.

[PUSH-000264](#)

Exception caught in publisher '{}' in systemStarted method.

Description

Publishers declared in etc/Publishers.xml can be informed that Diffusion is ready by overriding the systemStarted() method. This message is emitted if an exception is thrown by the publisher's systemStarted() method.

Related concepts

[Deploying publishers on your Diffusion server](#) on page 753

If you developed a publisher as part of your Diffusion solution, you must deploy the publisher on the Diffusion server for it to run.

[PUSH-000265](#)

Failed to load publisher '{}'.

Description

Diffusion was unable to load a publisher, probably because of a problem with the publisher's configuration files.

Related concepts

[Deploying publishers on your Diffusion server](#) on page 753

If you developed a publisher as part of your Diffusion solution, you must deploy the publisher on the Diffusion server for it to run.

[PUSH-000266](#)

This DAR file is for Diffusion version {} or greater. Not deploying on Diffusion version {}.

Description

The META-INF/MANIFEST.MF of the DAR file contains the "Diffusion-Version" attribute that specifies with which versions of Diffusion it is compatible. The DAR is marked as incompatible with this version of Diffusion and will not be deployed.

Related concepts

[Deploying publishers on your Diffusion server](#) on page 753

If you developed a publisher as part of your Diffusion solution, you must deploy the publisher on the Diffusion server for it to run.

PUSH-000268

Publisher '{}' is not stoppable, not undeploying.

Description

An attempt has been to undeploy a publisher, but its `isStoppable()` method returns false. The publisher will not be undeployed.

Related concepts

[Deploying publishers on your Diffusion server](#) on page 753

If you developed a publisher as part of your Diffusion solution, you must deploy the publisher on the Diffusion server for it to run.

PUSH-000269

JMX adapter threw exception while starting.

Description

An unexpected exception prevented the JMX adapter from starting.

Related concepts

[JMX](#) on page 583

You can use JMX to manage Diffusion. By default, the RMI registry port is 1099 and the JMX service port is 1100.

PUSH-000273

JMX adapter starting.

Description

The JMX adapter has begun construction.

Related concepts

[JMX](#) on page 583

You can use JMX to manage Diffusion. By default, the RMI registry port is 1099 and the JMX service port is 1100.

[PUSH-000274](#)

DeploymentMonitor: The DAR file '{}' has not been fully undeployed. The publisher(s) {} have not been undeployed. The DAR file will be ignored from now on.

Description

An error occurred during an attempt to undeploy a publisher, which had been deployed using the "hot deploy" feature. This can happen if a DAR contains multiple publishers, but not all of them return "true" from the isStoppable() method.

Related concepts

[Deploying publishers on your Diffusion server](#) on page 753

If you developed a publisher as part of your Diffusion solution, you must deploy the publisher on the Diffusion server for it to run.

[PUSH-000282](#)

Removed publisher '{}'.

Description

The given publisher has been removed from the server.

[PUSH-000285](#)

Started publisher '{}'.

Description

A publisher has been started.

[PUSH-000286](#)

Starting publisher '{}'.

Description

A publisher is starting.

[PUSH-000288](#)

Stopped publisher '{}'.

Description

The given publisher has been stopped, and can be restarted.

[PUSH-000289](#)

Stopping Diffusion server due to stop-server-if-not-loaded flag for publisher '{}'.

Description

Diffusion failed to start a publisher which has the "stop-server-if-not-loaded" configuration value set to "true" in Publishers.xml. Diffusion will now be stopped.

Related concepts

[Deploying publishers on your Diffusion server](#) on page 753

If you developed a publisher as part of your Diffusion solution, you must deploy the publisher on the Diffusion server for it to run.

PUSH-000290

Failure fetching state of {} from publisher {}.

Description

While handling a fetch request for a topic with no topic data, an error occurred while generating a topic load message.

PUSH-000294

Failed to read DAR file '{}'.

Description

Diffusion tried to deploy a publisher from a DAR file, but the DAR was unreadable. Check file permissions and for corruption with the "jar" tool.

Related concepts

[Deploying publishers on your Diffusion server](#) on page 753

If you developed a publisher as part of your Diffusion solution, you must deploy the publisher on the Diffusion server for it to run.

PUSH-000295

Publisher '{}' not currently deployed, cannot undeploy.

Description

An attempt was made to undeploy a publisher which is not deployed. Either check that this is the case, or that you have the correct spelling of the publisher's name.

Related concepts

[Deploying publishers on your Diffusion server](#) on page 753

If you developed a publisher as part of your Diffusion solution, you must deploy the publisher on the Diffusion server for it to run.

PUSH-000296

DeploymentMonitor: One or more of the publishers in '{}' cannot be stopped. Not undeploying file. The DAR file will be ignored from now on.

Description

An attempt was made to undeploy a hot-deployed publisher, but that publisher does not return "true" from its isStoppable() method.

Related concepts

[Deploying publishers on your Diffusion server](#) on page 753

If you developed a publisher as part of your Diffusion solution, you must deploy the publisher on the Diffusion server for it to run.

[PUSH-000298](#)

No queue definitions configured : Adding {}.

Description

No queue definitions have been configured therefore a default queue configuration is being assumed.

[PUSH-000299](#)

A conflation merge error has occurred in '{}'.
'{}' used.

Description

An instance of MessageMerger has thrown an exception from its merge method. The exception is logged and no conflation occurs.

[PUSH-000301](#)

Default queue definition {} does not exist. '{}' used.

Description

There is no configured queue definition with the name as specified as the default queue therefore the first configured queue is assumed to be the default.

[PUSH-000302](#)

Default queue definition not configured. '{}' used.

Description

No default queue definition has been specified in the configuration therefore the first configured queue definition has been assumed to be the default.

[PUSH-000303](#)

Queue definition '{}' not known - using default.

Description

The specified queue definition is not known within the configuration therefore the default queue definition has been assumed.

[PUSH-000306](#)

Deployment service failed to process HTTP request.

Description

The publisher deployment service failed to return an HTTP response to the deploying client.

[PUSH-000309](#)

REST Failed to process service request.

Description

REST service failed to process a request.

[PUSH-000310](#)

Method '{}' from Diffusion servlet called, not being processed.

Description

The Diffusion servlet's implementation of the given method does nothing.

[PUSH-000311](#)

Diffusion servlet: {}.

Description

Indicates the startup status of the Diffusion servlet.

[PUSH-000316](#)

Failed to update statistics file '{}'.

Description

It was not possible to write the given statistics file.

Related reference

[Statistics](#) on page 602

Diffusion can provide statistics in three ways: via MBeans, via the Publisher API, and via Prometheus-compatible endpoints. Statistics provide information about the server, clients and topics.

[PUSH-000318](#)

Registering statistics reporter '{}'.

Description

A configured statistics reporter of the given name is about to be registered.

Related reference

[Statistics](#) on page 602

Diffusion can provide statistics in three ways: via MBeans, via the Publisher API, and via Prometheus-compatible endpoints. Statistics provide information about the server, clients and topics.

[PUSH-000321](#)

Statistics service failed to load statistics reporter '{}'.

Description

A failure has occurred while attempting to load a configured statistics reporter.

Related reference

[Statistics](#) on page 602

Diffusion can provide statistics in three ways: via MBeans, via the Publisher API, and via Prometheus-compatible endpoints. Statistics provide information about the server, clients and topics.

[PUSH-000326](#)

Thread pool {} execution of {} failed.

Description

Failure executing a task in the specified thread pool.

[PUSH-000327](#)

Thread pool {} lower limit notification failed.

Description

The specified thread pool was unable to schedule the notification of the lower threshold limit being reached.

[PUSH-000328](#)

Thread pool {} notification of {} to {} failed.

Description

The execution of a notification to a ThreadPoolNotificationHandler failed.

[PUSH-000331](#)

Thread pool '{}' queue full - aborting execution of '{}'.

Description

Specified thread pool queue has become full and the rejection policy is to abort the task. Consider increasing the pool maximum size.

[PUSH-000332](#)

Thread pool {} queue full - task running in current thread.

Description

Specified thread pool queue has become full and the rejection policy is to run the task in the current thread, which might be inefficient. Consider increasing the pool maximum size.

[PUSH-000333](#)

Thread pool {} was unable to schedule the execution of notification of rejected execution.

Description

The specified thread pool failed to schedule the notification of a rejected task.

[PUSH-000334](#)

Thread Pool {} upper threshold notification failed.

Description

The specified thread pool failed to schedule notification of upper threshold reached.

[PUSH-000335](#)

Uncaught exception in thread '{}': {}.

Description

An uncaught exception has been thrown from a specified thread and logged.

[PUSH-000337](#)

File service: [{}] adding virtual hosts {} and mapping to {}.

Description

A virtual host has been added to the web server's file service.

[PUSH-000338](#)

Unable to process alias entry in file '{}': {}.

Description

Diffusion tried to add a new alias to the web server, but failed.

[PUSH-000341](#)

Missing attribute '{}' from DiffusionTag {} [{}].

Description

The given DiffusionTag incorrect omits the given attribute.

[PUSH-000342](#)

Topic '{}' has '{}' TopicData instead of single value TopicData. DiffusionTag (TopicData) [{}].

Description

The given topic lacks SingleValueTopicData, making it impossible to insert here.

[PUSH-000343](#)

Topic {} does not have topic data. DiffusionTag (TopicData) [{}].

Description

The given topic lacks TopicData and therefore any state, making it impossible to insert here.

[PUSH-000344](#)

Cannot find file attribute in DiffusionTag [{}].

Description

The given DiffusionTag incorrectly omits the 'file' attribute.

[PUSH-000345](#)

Cannot load include file '{}' from DiffusionInclude '{}'.

Description

An error occurred loading the given file.

[PUSH-000346](#)

Cannot read specified file for DiffusionTag '{}' [{}].

Description

An error occurred loading the given file specified in the DiffusionTag.

[PUSH-000347](#)

Unknown publisher in DiffusionTag {} [{}].

Description

The publisher named in this DiffusionTag is not loaded, or does not exist.

[PUSH-000348](#)

Unknown topic for DiffusionTag (TopicData) {} [{}].

Description

The topic named in this DiffusionTag does not exist.

[PUSH-000349](#)

Unknown type attribute '{}' for DiffusionTag [{}].

Description

The type attribute of this DiffusionTag holds an unexpected value.

[PUSH-000350](#)

Web server service cannot process HTML tag '{}' for the publisher '{}'.

Description

An error occurred while processing an HTML embedded tag.

[PUSH-000351](#)

{}: Connection rejected as request was missing the HTTP header field '{}'.

Description

This connection was rejected as it was missing the given HTTP header. The connection is likely not from a Diffusion client, or an intermediary (firewall/load-balancer) has removed the header.

[PUSH-000352](#)

{}: Connection rejected as {} did not match '{}'.

Description

The connection from an untrusted host was rejected, in accordance with CORS configuration.

[PUSH-000353](#)

{}: Connection rejected as {} did not match '{}'.

Description

The connection was rejected because its WebSocket origin did not match the regular expression stored in the configuration.

[PUSH-000354](#)

{}: cors-origin not defined or invalid. Aborting request.

Description

CORS (Cross Origin Resource Sharing) request has been received by the web server client service but no "cors-origin" has been configured or the configured value was invalid. The request has been aborted.

[PUSH-000355](#)

{} unable to process HTTP Request '{}'.

Description

Web server file service was unable to process the given HTTP request.

[PUSH-000356](#)

Client service {}: HTTP processing error on connector '{}'.

Description

An error occurred handling an HTTP request.

[PUSH-000357](#)

{}: Invalid regular expression '{}' for CORS origin '{}' - feature disabled.

Description

An invalid regular expression was given for the CORS origin configuration.

Related concepts

[Cross domain policies](#) on page 702

Cross domain policies grant permission to communicate with servers other than the one the client is hosted on.

[PUSH-000359](#)

Poll request for client {} from '{}' failed because no matching client session can be found. The client session might have been closed previously. Poll request will be ignored.

Description

The server has received a poll request for an unknown client session. This might be because the client has been closed by the server, or indicate an incorrectly configured load balancer routing an HTTP connection to a server that was not hosting the session. Consider enabling session-stickness for HTTP clients.

[PUSH-000360](#)

FileService [{}]: not adding virtual hosts '{}' mapping to '{}' as it is not a directory.

Description

Failed to add a virtual host to the web server's file service because the configured mapping does not point to a directory.

[PUSH-000361](#)

Unable to service HTTP request for service {}'.

Description

An HTTP service was invoked, but it failed to process the incoming request.

[PUSH-000362](#)

Started HTTP service for {}'.

Description

An HTTP service was successfully started.

[PUSH-000363](#)

{} Unable to create log.

Description

An HTTP service has its own log file defined, but Diffusion was unable to create the logger.

[PUSH-000364](#)

Web server {} failed to instantiate HTTP service '{}' : {}.

Description

A web server failed to instantiate the named configured HTTP service.

[PUSH-000366](#)

Virtual host HTTP request {} is invalid.

Description

An HTTP request being handled by a virtual host is trying to break out of the virtual root.

[PUSH-000367](#)

Virtual Host HTTP request {} - unable to read file {}.

Description

A failure has occurred trying to read the specified HTML file.

[PUSH-000368](#)

{}: websocket-origin not defined or invalid. Aborting request.

Description

Web Server Client Service has received a Web Socket request but "websocket-origin" has not been configured or is invalid. The request has been aborted.

[PUSH-000370](#)

Whols Provider class instantiation failure calling '{}'.
'{}'.

Description

Unable to instantiate the configured Whols provider. Will use the default Whols provider.

[PUSH-000372](#)

Unable to load GeoIP Database '{}'.
'{}'.

Description

An error occurred while loading or initializing the GeoIP database.

[PUSH-000373](#)

Whols Service failed to lookup address '{}'.
'{}'.

Description

A failure has occurred in the Whols service when trying to look up the given address.

[PUSH-000374](#)

Whols service starting with {} thread(s).

Description

The Whols service is starting.

[PUSH-000376](#)

Deprecated element '{}' found in {}.xml.

Description

A deprecated element has been found in specified properties file and should be removed.

[PUSH-000378](#)

Failed to load publisher '{}' configuration from XML properties.

Description

Diffusion was unable to load the configuration for the named publisher from an XML properties file.

[PUSH-000379](#)

Failed to load subscription validation policy '{}' from file '{}': {}.

Description

A failure has occurred loading an XML subscription validation policy file.

[PUSH-000380](#)

Failed to parse {} at line {}, column {}: {}.

Description

An XML validation event has occurred while validating an XML property file.

[PUSH-000381](#)

Loaded XML {} properties from '{}'

Description

The specified XML properties have been loaded from the file indicated.

[PUSH-000382](#)

Unable to load publisher configuration file {}.

Description

Attempted to load a publisher's configuration file (Publishers.xml), but it cannot be found or is unreadable.

[PUSH-000385](#)

Failed to load subscription validation topic mapping for publisher {} topic {} from file {}: {}.

Description

A failure has occurred loading a publisher topic mapping for a subscription validation policy.

[PUSH-000386](#)

Failed to load connection validation policy {} from {}.

Description

A failure has occurred loading XML connection validation policy from the specified file.

[PUSH-000396](#)

Unable to perform substitution within property value '{}' due to syntax error.

Description

A syntax error has been detected while trying to perform environment variable substitution on a configuration property.

[PUSH-000397](#)

Deploying publishers in DAR file {}.

Description

Deploying the publishers in a single DAR file. There can be multiple publishers in a single DAR file. The publishers will be extracted from the DAR file and the additional configuration files loaded.

Related concepts

[Deploying publishers on your Diffusion server](#) on page 753

If you developed a publisher as part of your Diffusion solution, you must deploy the publisher on the Diffusion server for it to run.

[PUSH-000399](#)

Directory '{}' does not exist or is not a directory. Using '{}' as a log directory.

Description

The directory of a log definition or the default log directory does not exist or it is not a directory. In this case the temporary file directory is used instead. This is specified by 'java.io.tmpdir'. If the intended directory does exist the problem might be that the relative path is incorrect because the working directory is not what you expect. The simplest way to resolve this is to use absolute file paths to reference log directories. This message might be shown when the log is created and when checking if it needs to be rotated.

[PUSH-000406](#)

Application handler threw exception. [cid={}].

Description

An application handler threw an exception when called.

[PUSH-000412](#)

Executor {}: task finished abnormally.

Description

A background task has thrown an exception. See the log for more information.

[PUSH-000415](#)

Received request from client {} to close client {}.

Description

The server has received a request from a client to close a client session.

[PUSH-000416](#)

Received request from client {} to close client {}. The client session does not exist.

Description

The server has received a request from a client to close an unknown client session.

[PUSH-000417](#)

Fetch operation {} for {} was aborted due to missing responses for the following topics: {}.

Description

A fetch operation failed, possibly because of an issue at the publisher or state providing client. Look for earlier messages in the server log.

[PUSH-000420](#)

One or more clients have registered to handle queue events, but none was available for a {} event for client {}.

Description

No client was available to handle the queue event, or one was chosen and failed while processing.

[PUSH-000421](#)

Received request from client {} to set conflation for client {} to '{}'.
'{}'.

Description

The server has received a request from a client to change the conflation setting for a client queue.

[PUSH-000422](#)

Received request from client {} to set conflation for client {} to '{}'. The client session does not exist.

Description

The server has received a request from a client to change the conflation setting for an unknown client session.

[PUSH-000423](#)

Received request from client {} to throttle message queue for client {} using the {} policy, limit={}.

Description

The server has received a request from a client to change the throttling policy of a client session.

[PUSH-000424](#)

Received request from client {} to throttle message queue for client {} using the {} policy, limit={}. The client session does not exist.

Description

The server has received a request from a client to change the throttling policy of an unknown client session.

[PUSH-000426](#)

{}: command service call failed, reporting error to {}: {} {}.

Description

An internal service call has failed. An error will be reported to the client session listener.

[PUSH-000430](#)

There are currently no controllers for {}.

Description

A control binding has been established, but there are no available controllers.

[PUSH-000431](#)

Rejected attempt by session {} to bind a control handler: {}.

Description

This might indicate that another control group has established a binding, or that the client already has a binding.

[PUSH-000432](#)

Attempt by session {} to register or unregister from an unknown control point: {}.

Description

This is unexpected and possibly indicates the server and client versions are incompatible.

[PUSH-000434](#)

Diffusion finished deploying {} components.

Description

Diffusion deployments completed.

[PUSH-000435](#)

Task failure in selector thread '{}'.
'{}'.

Description

A task failed to be executed in a selector thread.

[PUSH-000436](#)

Unable to create file handler for logger '{}'. Log messages will still appear in the console.

Description

A file handler was unable to be created for the requested logger. Messages will continue to be logged to the console, but will not be recorded to their own file.

[PUSH-000439](#)

The authentication manager failed to start because an authentication handler of class {} could not be created.

Description

An instance of a configured authentication handler could not be created.

Related concepts

[User-written authentication handlers](#) on page 144

You can implement authentication handlers that authenticate clients that connect to the Diffusion server or perform an action that requires authentication.

[PUSH-000440](#)

Authentication handler {} threw an exception, denying authentication to {}.

Description

A configured authentication handler failed to process an authentication request.

Related concepts

[User-written authentication handlers](#) on page 144

You can implement authentication handlers that authenticate clients that connect to the Diffusion server or perform an action that requires authentication.

[PUSH-000441](#)

The authorization manager failed to start because an authorization handler of class {} cannot be created.

Description

An instance of a configured authorization handler cannot be created.

[PUSH-000444](#)

Unable to read aliases file '{}'.

Description

The configured aliases file could not be read.

[PUSH-000445](#)

Discarding WhoIs request for {} due to backlog. There are currently {} pending requests.

Description

A WhoIs request has been discarded because there is currently a large number of pending requests. The WhoIsListener will be notified with basic locale information based on the caller's IP.

[PUSH-000446](#)

Unable to read subscription policies from '{}'.
{}

Description

The configured subscription policy file could not be read.

[PUSH-000447](#)

Failed to load publisher '{}'.
{}

Description

Diffusion was unable to register a publisher, probably because of a problem with the publisher's definition.

Related concepts

[Deploying publishers on your Diffusion server](#) on page 753

If you developed a publisher as part of your Diffusion solution, you must deploy the publisher on the Diffusion server for it to run.

[PUSH-000457](#)

More multiplexers configured than available CPU cores ({} vs {}).
{}

Description

Assigning more multiplexers than there are available CPU cores might lead to degraded performance.

[PUSH-000458](#)

Application classpath entry '{} in is not a directory. Check user libraries in the server configuration.
{}

Description

The names in the user library configuration must identify directories.

[PUSH-000459](#)

The configured auto-deployment directory '{} does not exist.
{}

Description

The configured auto-deployment directory '{} does not exist.

[PUSH-000460](#)

Class loader failed to enumerate files in directory '{}'.
[View on GitHub](#)

Description

An error occurred reading the files within the given directory.

[PUSH-000461](#)

Unable to add file '{}' to the class loader.
[View on GitHub](#)

Description

A server class loader failed to load the given file.

[PUSH-000462](#)

Multiplexer '{}' overflowed before start up - event discarded.
[View on GitHub](#)

Description

A multiplexer queue overflowed before the multiplexer was started.

[PUSH-000464](#)

Update failed for {} topic '{}' [data type={}]: {}.
[View on GitHub](#)

Description

An error was encountered while attempting to update a topic.

[PUSH-000465](#)

Connector '{}' has pings disabled. Unresponsive HTTP polling clients will not be detected.
[View on GitHub](#)

Description

The server relies on pinging in order to detect unresponsive HTTP polling clients. Unresponsive clients might go unnoticed if the ping frequency is not set.

[PUSH-000466](#)

Message stream '{}' threw exception.
[View on GitHub](#)

Description

A message stream callback raised an exception when called.

[PUSH-000467](#)

Unable to establish a tunnel through the proxy at {}:{}.
[View on GitHub](#)

Description

There was a problem in establishing a tunnel through the specified proxy. There might be an issue in reading from or writing to the proxy.

Related concepts

[Connecting through an HTTP proxy](#) on page 248

Clients can connect to the Diffusion server through an HTTP proxy by using the HTTP `CONNECT` verb to create the connection and tunneling any of the supported transports through that connection.

[PUSH-000468](#)

Topic stream '{}' threw exception.

Description

A topic stream callback raised an exception when called.

Related concepts

[Using streams for subscription](#) on page 273

Register a stream against a set of topics to access values published to those topics. For a registered stream to access the value of a topic, the topic type must match the stream and the client must be subscribed to the topic.

[PUSH-000469](#)

Failure to forward message from {} to {} for message path '{}'

Description

The server failed to forward a message from a client to another client. The message might have been delivered. See the log for further detail.

[PUSH-000470](#)

The server failed to forward a message from {} to unknown session {} for message path '{}'

Description

The server failed to forward a message as the target client session does not exist.

[PUSH-000472](#)

Service call to server from session {} failed: {}.

Description

The server rejected a service call due to an error. See the log message for further details.

[PUSH-000473](#)

Service call to client {} failed: {}.

Description

The client rejected a service call due to an error. See the log message for further details.

[PUSH-000474](#)

Failed to deliver missing topic notification for subscription or fetch to selector '{}' by session '{}'

Description

A request made by the server to a missing topic handler resulted in an error.

[PUSH-000475](#)

The '{}' secret key encryption algorithm is not available.

Description

The specified password encryption algorithm is not available which means that a less secure default mode of password encryption will be used.

Related concepts

[Network security](#) on page 555

This section describes how to deploy network security, which can be used in conjunction with data security.

[PUSH-000476](#)

No authentication handlers are configured. All sessions will be anonymous.

Description

No authentication handlers are configured. All sessions will be anonymous.

Related concepts

[User-written authentication handlers](#) on page 144

You can implement authentication handlers that authenticate clients that connect to the Diffusion server or perform an action that requires authentication.

[PUSH-000477](#)

Configurations that specify only control authentication handlers are invalid.

Description

If a control authentication handler is configured, you must also configure a local authentication handler (such as the system authentication handler) to allow a client that registers a control authentication handler to connect.

Related concepts

[User-written authentication handlers](#) on page 144

You can implement authentication handlers that authenticate clients that connect to the Diffusion server or perform an action that requires authentication.

[PUSH-000478](#)

"{}" at line {} column {}.

Description

An error occurred while parsing security store language commands at the indicated line and column number.

[PUSH-000479](#)

Recovery of {} after a write error failed - store must be manually recovered from backup.

Description

Writing of a store file failed and automatic recovery from backup was attempted but also failed. In this event the store has been disabled and must be recovered manually from the backup file.

[PUSH-000480](#)

Recovery of "{}" required as backup "{}" exists.

Description

A store backup file has been found which suggests that recovery of the named store might be required. Inspect the store file and replace it with the backup if necessary, and then delete the backup.

[PUSH-000481](#)

Errors detected while parsing persistent store file "{}".

Description

Errors were detected while parsing the specified persistent store file - a detailed list of the errors will follow in the log.

[PUSH-000482](#)

Error reading persistent store file "{}".

Description

A read error has occurred on a security persistence file.

[PUSH-000483](#)

Failure writing to the {} persistence store.

Description

An error has occurred while writing to the named persistence store. The store file could be corrupt and might need to be recovered from a backup.

[PUSH-000485](#)

{}: backlog during initialization - {} queued events sent so far, {} remain on queue.

Description

A session details dispatcher is taking a while to deliver the backlog of pending events to the control client session.

[PUSH-000486](#)

{}: closed.

Description

A session details dispatcher was closed.

[PUSH-000487](#)

{}: draining queued updates.

Description

A session details dispatcher is starting. It is about to process a backlog of pending events.

[PUSH-000488](#)

{}: initialized.

Description

A session details dispatcher has completed initialization.

[PUSH-000489](#)

{}: initialising. Sending {} initial client notifications.

Description

A session details dispatcher is starting.

[PUSH-000490](#)

Session error handler {} threw an exception.

Description

An application session error handler threw an exception when called.

[PUSH-000491](#)

Session listener {} threw an exception.

Description

An application session listener threw an exception when called.

[PUSH-000492](#)

Failed to register topic update source for path '{}' for session '{}'.
The server rejected a request to register an update source.

Description

[PUSH-000493](#)

Whols Service failed unexpectedly.

Description

The Whols Service failed.

[PUSH-000495](#)

Will {} for session {} found no topics below the branch.

Description

A client session will to remove a branch found no topics below the branch to remove.

[PUSH-000498](#)

Connector '{}' has received data on {} that has not come from a proxy.

Description

The connector has been configured to require all connections use a proxy protocol but a connection has been made that has not provided proxy information.

[PUSH-000501](#)

Diffusion publisher failed to publish a log message to internal topics, disabling handler.

Description

The Diffusion publisher failed to publish a log message. The log handler has been disabled.

[PUSH-000503](#)

A blocking operation failed because the multiplexers failed to process it within {} milliseconds.

Description

This indicates that the server is severely overloaded or deadlocked.

[PUSH-000504](#)

No control handler found for routing topic '{}', subscription for client {} will be deferred until one is available.

Description

A routing handler must be registered for routing subscriptions to complete.

[PUSH-000506](#)

Flow control pressure {}%.

Description

Flow control back pressure has reached this value.

[PUSH-000507](#)

Flow control off.

Description

Back pressure has reduced, flow control is no longer being applied.

[PUSH-000510](#)

Unable to rotate metrics file {}'.

Description

The internal FileMetricsWriter was unable to rotate out the specified file.

[PUSH-000511](#)

Unable to write metrics to file '{}'.

Description

The internal FileMetricsWriter was unable to write to the specified file.

[PUSH-000512](#)

Session property {} not allowed.

Description

An attempt has been made to define a session property with a name that is not allowed.

[PUSH-000513](#)

{} - failed to create load message.

Description

An error was encountered while updating topic data.

[PUSH-000514](#)

Cannot parse "server-name/sessionId" expression required for delivery to Diffusion client: {}.

Description

The nominated routing property lacks a valid "server-name/sessionId" expression.

[PUSH-000515](#)

Cannot place JMS session to provider {}.

Description

An error occurred when trying to place a JMS session to the given provider.

[PUSH-000516](#)

Cannot publish message to topic {}.

Description

An error occurred while publishing a Diffusion topic update.

[PUSH-000518](#)

Connected to JMS provider '{}'.

Description

The JMS adapter has connected to the JMS provider with the given name.

[PUSH-000520](#)

Exception closing JMS Connection to {}.

Description

An error occurred while the JMS connection was being closed.

[PUSH-000521](#)

Failed to deliver message to client {}.

Description

An error occurred during an attempt to deliver a message to a Diffusion client.

[PUSH-000523](#)

Retrying delivery of message to {}: {}.

Description

Following a failed delivery the delivery re-attempted once.

[PUSH-000524](#)

Returning message '{}' to origin: {}.

Description

A message received from a client could not be delivered to a JMS destination, and is being returned to the sender.

[PUSH-000525](#)

Routing-property {} absent from message.

Description

To relay a message to an individual Diffusion client a "server-name/sessionId" expression must be retrieved from a JMS header or property. The configured header/property is absent from this message.

[PUSH-000527](#)

Cannot establish publication to destination {}: {}.

Description

It was not possible to build a MessageProducer for the given JMS destination.

[PUSH-000528](#)

Connected to JMS provider {} v{}, JMS {}.

Description

Recording JMS provider and version, and JMS API version in use.

[PUSH-000531](#)

Topic.publishMessage() methods should not be used for topics with topic data, but topic '{}' is of type '{}'. This operation will fail in a future release. This message is logged for the first occurrence only.

Description

Topics with topic data should be updated using the PublishingTopicData API because Topic.publishMessage() does not update the topic data. Calling Topic.publishMessage() for a topic with topic data will not be supported in future releases.

[PUSH-000532](#)

Failed to initialize Diffusion client.

Description

Fatal error initializing the Diffusion client.

[PUSH-000533](#)

Request to remote routing subscription handler for client {} / routing topic '{}' failed.

Description

A request to a remote routing subscription handler failed.

[PUSH-000534](#)

Routing subscription for client {} to routing topic '{}' failed because no topic exists with resolved topic path '{}'.
A routing topic failed to subscribe a client to a topic because the handler returned an unknown topic path.

Description

A routing topic failed to subscribe a client to a topic because the handler returned an unknown topic path.

[PUSH-000536](#)

Fan-out connection '{}' to primary server at '{}' has failed ({}).

Description

A fan-out connection has failed to connect to the primary server.

[PUSH-000537](#)

Fan-out connection '{}' (session {}) to primary server at '{}' has been lost.

Description

A fan-out connection to a primary server has been lost.

[PUSH-000538](#)

Fan-out connection '{}' will attempt to connect to '{}' again every {} milliseconds.

Description

A fan-out connection to a primary server could not be established or has been lost and will now try to connect again at the specified interval.

[PUSH-000539](#)

Fan-out connection '{}' (session {}) - unexpected session error : '{}'.
A fan-out connection has received an unexpected session error.

Description

A fan-out connection has received an unexpected session error.

[PUSH-000543](#)

Fan-out started.

Description

Fan-out processing has been started.

[PUSH-000544](#)

Fan-out link '{}' failed to create replicated topic {}.

Description

A failure has occurred creating a replicated topic for a specified fan-out link.

[PUSH-000546](#)

Fan-out update of topic '{}' by '{}' has failed with {}.

Description

A failure has occurred whilst updating a fan-out secondary topic.

[PUSH-000547](#)

Failed to close selector {}.

Description

An error occurred closing a selector.

[PUSH-000548](#)

Failed to interrupt thread for selector {}.

Description

A selector thread could not be stopped cleanly.

[PUSH-000549](#)

Stopping selector thread {}.

Description

A selector thread is being stopped.

[PUSH-000552](#)

Remote JMX management service could not be started.

Description

The remote JMX management service was not started correctly. The rmiConnectorServer is not active.

[PUSH-000553](#)

Multiplexer blocked because it has a maximum-sized batch of {} notifications to deliver to the publisher(s).

Description

A multiplexer has encountered a severe backlog dispatching publisher notifications. The notifications will be delayed. This message indicates the publishers cannot keep up with the rate of notifications. The server may be overloaded or the publisher may be blocked.

[PUSH-000554](#)

Delayed dispatch of {} notifications because the notification queue is full.

Description

A publisher is failing to keep up with the rate of multiplexer notifications. The server may be overloaded or the publisher may be blocked.

[PUSH-000555](#)

Closing '{}' because its outbound message queue cannot accept a {} byte message. Queue details: {}.

Description

The messages in the outbound queue for a session have reached the configured limit of messages or bytes. The session will be closed. This can indicate problems with the network performance or the receiving process.

[PUSH-000557](#)

{}: closed.

Description

A session properties dispatcher was closed.

[PUSH-000558](#)

{}: draining queued updates.

Description

A session properties dispatcher is starting. It is about to process a backlog of pending events.

[PUSH-000559](#)

{}: initialised.

Description

A session properties dispatcher has completed initialisation.

[PUSH-000560](#)

{}: initialising. Sending {} initial client notifications.

Description

A session properties dispatcher is starting.

[PUSH-000561](#)

PublishingTopicData.publishMessage() methods called without an update block for topic '{}' of type '{}'. This operation will fail in a future release. This message is logged for the first occurrence only.

Description

PublishingTopicData.publishMessage() should be combined with an update to the topic data. Calling this method outside an update block will not be supported in future releases.

[PUSH-000563](#)

A message could not be sent to client as it is not subscribed to the topic {}.

Description

A classic client can only receive messages on a topic to which it is subscribed. Either the publisher aborted the subscription, or the topic or client has been deleted.

[PUSH-000564](#)

Fan-out connection '{}' has established session '{}' with primary server at {}.

Description

A fan-out connection to the primary server has been established.

[PUSH-000565](#)

Failed to register topic event listener for path '{}' by session {}.

Description

The server rejected a request to register a topic event listener.

[PUSH-000566](#)

Daily statistics have been written in the ConnectionCount file.

Description

The server is shutting down - the daily statistics registered so far have been written in the ConnectionCount file.

[PUSH-000567](#)

Memory to calculate delta message exceeds limit of {} bytes - the full message will be used.

Description

A binary difference calculation failed because insufficient memory was available. This is a rare condition that only occurs when there are many differences between two huge messages.

[PUSH-000571](#)

Failed to start required connector, {}.

Description

A required connector, in Connectors.xml, has not been started.

[PUSH-000572](#)

Fan-out connection '{}' is removing topics '{}'.

Description

A fan-out connection is removing a set of replicated topics.

[PUSH-000575](#)

HTTP poll rejected - Invalid message channel '{}' cannot be cast to HTTPMessageChannel.

Description

HTTP poll attempted on transport that does not support polling.

[PUSH-000576](#)

A third-party SLF4J logger is installed. The Diffusion log configuration will be ignored.

Description

The Diffusion classpath has been modified to use a third-party SLF4J logging library.

[PUSH-000577](#)

No server log has been configured.

Description

The log configuration does not specify a server log. Messages will only be logged to the console (stderr).

[PUSH-000578](#)

{}, {}, {} {}.

Description

Diffusion and Java product versions information.

[PUSH-000581](#)

Client service {}: unrecognized HTTP request received on connector '{}'.

Description

The server failed to understand an HTTP request.

[PUSH-000582](#)

JMS adapter cannot apply configuration update from {}.

Description

Configuration changes loaded from the JMS configuration file cannot be applied.

[PUSH-000583](#)

JMS adapter configuration file {} cannot be loaded.

Description

The JMS adapter configuration file cannot be loaded.

[PUSH-000584](#)

JMS adapter cannot roll back the configuration change from {}, step {}.

Description

Following a failed configuration change a roll back was attempted which also failed. Behavior of the JMS adapter here on is unknown.

[PUSH-000586](#)

JMS adapter configuration file {} has been removed.

Description

The JMS adapter configuration file has been removed.

[PUSH-000587](#)

The value of {} ms configured for '{}' is excessive and has been limited to {} ms.

Description

The maximum value of the connect and write timeouts has been limited. A future version of Diffusion will enforce the new limits by failing to accept configurations with excessive values.

[PUSH-000588](#)

The connection activity monitor has detected that the connection '{}' has been idle and it has been closed, attempting to recover.

Description

Clients can use a connection activity monitor to listen for the system ping sent by the server. If the expected system pings are not received the connection will be closed and the client will enter a recovery state.

[PUSH-000589](#)

SSL channel {} was closed with data still pending.

Description

SSL connection was closed with data still pending.

[PUSH-000590](#)

Host JVM/JDK failed to provide an expected feature {}.

Description

The JVM/JDK failed to behave as expected at runtime. Please check the platform is supported.

[PUSH-000592](#)

Sending {} message(s) of {} bytes to {} was delayed by {} ms.

Description

The message took an unreasonably long time to be sent. This could be caused by network backpressure, flow-control or application delays.

[PUSH-000593](#)

Cannot get value attribute {} on MBean {}.

Description

An exception was thrown retrieving an attribute from a given JMX MBean.

[PUSH-000594](#)

JMX adapter stopping.

Description

The JMX adapter is stopping and removing its topics.

[PUSH-000595](#)

Unable to look up session {} in the data grid.

Description

A protocol 4 reconnection was attempted. A new identity will be issued to the client. See the exception for more information on the cause of the failure.

[PUSH-000596](#)

Unable to look up session by token in the data grid.

Description

A protocol 5 or above reconnection was attempted and has failed. See the exception for more information on the cause of the failure.

[PUSH-000597](#)

Unable to recover the session {} from the data grid.

Description

During session fail over Diffusion updates the data grid and recovers information from it. This update or recovery did not succeed both the data grid and the session may have stale information. See the exception for more information on the cause of the failure.

[PUSH-000598](#)

Unable to remove sessions from the data grid.

Description

A server failed and the sessions did not fail over within the timeout. The sessions were not removed from the data grid. They will continue to take up memory in the data grid. See the exception for more information on the cause of the failure.

[PUSH-000599](#)

Unable to remove session {} from the data grid.

Description

The session has been closed but not removed from the data grid. It will continue to take up memory in the data grid. See the exception for more information on the cause of the failure.

[PUSH-000600](#)

Unable to store session {} in the data grid.

Description

An attempt to store a new session in the data grid failed. The session is known to a single server. See the exception for more information on the cause of the failure.

[PUSH-000601](#)

Failed to replicate change to session {}.

Description

An attempt to update the data grid with changes to a principal, properties or subscription level of a session failed. The data grid may have stale information. See the exception for more information on the cause of the failure.

[PUSH-000602](#)

Unable to replicate change to session principal, properties or subscription level for session {}. The session could not be found.

Description

An attempt was made to update the data grid with changes to the principal, properties or subscription level of a session but the session was unknown.

[PUSH-000603](#)

Unable to replicate change to topic selections for session {}.

Description

An attempt to update the data grid with topic selections for a session failed. The data grid may have state information. See the exception for more information on the cause of the failure.

[PUSH-000604](#)

Suppressed {} further {} messages.

Description

Repeated log messages have been suppressed.

[PUSH-000605](#)

An error occurred while stopping the remote JMX management service.

Description

The remote JMX management service was not stopped correctly.

[PUSH-000607](#)

Authentication failed for connection {}.

Description

An AuthorisationManager rejected a connection attempt.

[PUSH-000608](#)

Validation failed for connection {}.

Description

An connector validator rejected a connection attempt.

[PUSH-000609](#)

Reconnection aborted because server did not receive {} messages from {}.

Description

Reconnection aborted because messages sent from a client session were not recoverable.

[PUSH-000610](#)

Reconnection aborted because {} messages sent by the server were not received by {}.

Description

Reconnection aborted because messages sent to a client session were not recoverable.

[PUSH-000611](#)

Unable to complete reconnection, recovery failed for unknown session {}.

Description

A session could not be reconnected because it was unknown.

[PUSH-000612](#)

Reconnection aborted because {} messages sent to the server were not received by {}.

Description

Reconnection aborted because messages sent to the server were not recoverable.

[PUSH-000613](#)

{} reconnected, but messages may have been lost.

Description

A session has re-establish communication with a server, but messages may have been lost. This can happen when reconnecting to another server in an HA cluster.

PUSH-000614

Failed to register topic update source for path {} by session {} because of an unchecked exception.

Description

While registering an update source with the distributed update source registry an unchecked exception was thrown. This may have happened on a different member of the cluster.

PUSH-000615

Failed to send a checkpoint to a new member of the cluster.

Description

A new node attempted to join the cluster but the cluster failed to send the current state of the distributed update source registry to it.

PUSH-000616

Failed to remove update source {} from distributed update source registry.

Description

While removing an update source from the distributed update source registry an unchecked exception was thrown. This may have happened on a different member of the cluster.

PUSH-000617

Connection '{}' was closed due to timeout.

Description

A network connection was timed out due to inactivity on the channel.

Additional information

The Diffusion server gives a client connection a limited time to complete its handshake processing. If the network connection takes longer than the timeout, the connection is closed and the Diffusion server PUSH-000617 is logged.

This issue can be caused by the following circumstances:

- Diffusion is heavily loaded.
To reduce the number of refused connections, you can increase the connection timeout value in one of the following ways:
 - Update the `connection-timeout` element in the `Server.xml` configuration file to increase the default timeout value for all connectors. In the default configuration, this value is set to 5s. If the value is not defined here, a value of 2s is used.
 - Update the `connection-timeout` element in the `Connectors.xml` configuration file to increase the timeout value for a specific connector. If a timeout value is not defined for a connector, the value set in the `Server.xml` configuration file is used instead.
- Connections are being made by an application that pings or investigates the Diffusion connector ports without using the Diffusion API.

If this is the case, you can suppress the log messages about invalid connections by using the `ignore-errors-from` element in the `Connectors.xml` configuration file to specify the source IP address of the invalid connection.

[PUSH-000618](#)

Input queue for inbound thread '{}' of size {} overflowed due to large number of connections. Risk of deadlock.

Description

The queue of work for an inbound thread overflowed. To avoid the risk of deadlock, reconfigure the inbound pool to have a queue at least as large as the number of concurrent connections.

[PUSH-000619](#)

Thread pool {} queue full - blocking calling thread.

Description

The calling thread is blocked until the specified thread pool can accept a new task. Consider increasing the pool maximum size.

[PUSH-000620](#)

Cannot retrieve session properties for {}: {} {}.

Description

The JMS adapter cannot retrieve the session properties for the given session.

[PUSH-000621](#)

Client {} closing - {} - {}, {}.

Description

A client session was closed.

[PUSH-000622](#)

Unsupported service {} requested by peer {}.

Description

The peer has requested an unsupported internal service. This can be due to a version mismatch between client and server. Some services are not unsupported for deprecated network protocols.

[PUSH-000623](#)

Fan-out connection '{}' (session {}) lost - attempting reconnection.

Description

A fan-out connection has been lost and is now attempting to reconnect.

[PUSH-000624](#)

Connection '{}' closed - {}.

Description

A network communication error occurred. The connection has been closed.

[PUSH-000625](#)

Session {} has received a message for path '{}', but has registered no streams that match that path.

Description

A session has received a message from the server that cannot be delivered because the application has not registered any matching streams.

[PUSH-000627](#)

Failed to redeliver missing topic notification for subscription or fetch to selector '{}' by session '{}' after {} attempts.

Description

Redelivery of a missing topic notification has been canceled after retrying a number of times.

[PUSH-000628](#)

Handler {} callback method threw an exception.

Description

A handler callback raised an exception when called. If the handler was open it has been closed with the CALLBACK_EXCEPTION ErrorReason. See the log for more information.

[PUSH-000629](#)

Created {} of {} topics.

Description

Logged every 5s by the JMS Adapter if creating all configured topics exceeds that threshold.

[PUSH-000630](#)

Removed {} of {} topics.

Description

Logged every 5s by the JMS Adapter if removing previously configured topics exceeds that threshold.

[PUSH-000631](#)

Fan-out connection '{}' could not propagate missing topic notification for subscription or fetch to selector '{}' by session '{}' because there is no connection to primary server at '{}'.

Description

Fan-out propagation of a missing topic notification failed because the primary server is disconnected.

[PUSH-000632](#)

Fan-out connection '{}' failed to propagate missing topic notification for subscription or fetch to selector '{}' by session '{}' to primary server at '{}'.

Description

Fan-out propagation of a missing topic notification failed.

[PUSH-000633](#)

Failed to redeliver missing topic notification for subscription or fetch to selector '{}' by session '{}'
because there is no longer a suitable registered handler.

Description

Redelivery of a missing topic notification has been canceled by the server because there is no longer a registered handler.

[PUSH-000634](#)

'{}': reconnect attempt failed: {}.

Description

An attempt to reconnect has failed. Further attempts to reconnect may be made depending on the reconnection strategy.

[PUSH-000635](#)

'{}': reconnection rejected by server: {}.

Description

The server has rejected the reconnection attempt. No further attempts to reconnect will be made - the session will be closed.

[PUSH-000636](#)

'{}': reconnection failed due to timeout.

Description

The timeout to successfully reconnect has been reached. The session will be closed.

[PUSH-000638](#)

The '{}' file cannot be found.

Description

The store file was not found. A default store has been created.

[PUSH-000640](#)

Started the JMS adapter with configuration {}.

Description

The JMS adapter was started with the given configuration file.

[PUSH-000642](#)

Allocating larger buffer to accommodate a message larger than the default configured input buffer size. The new buffer size is {}. Consider increasing the input buffer size for channel {}.

Description

Client has sent a message larger than the input buffer size. A new buffer has been allocated to contain the message. If this happens frequently consider increasing the input buffer of the connectors to reduce buffer allocations.

[PUSH-000643](#)

Request {} callback method threw an exception.

Description

A request callback raised an exception when called. See the log for more information.

[PUSH-000644](#)

Completed diagnostic report to {}.

Description

A multiplexer diagnostic report has completed.

[PUSH-000645](#)

Failed to write diagnostic report to {}.

Description

A multiplexer diagnostic report could not be produced.

[PUSH-000646](#)

Starting diagnostic report to {}.

Description

A multiplexer diagnostic report has started.

[PUSH-000647](#)

Subscription to {} has neither a <publish> nor a <messaging> element.

Description

The JMS adapter is configured to subscribe to a JMS destination, but to do nothing with messages originating from that.

[PUSH-000648](#)

Cluster member {} is connected to this server.

Description

A Diffusion server is connected to this server as a cluster member. It is possible to route service requests to it.

[PUSH-000649](#)

Failed to connect to cluster member {}.

Description

This server failed to establish a connection to another Diffusion server. The connection will be retried.

[PUSH-000650](#)

Cluster member {} is disconnected from this server.

Description

A Diffusion server is disconnected from this server. It is not possible to route service requests to it. The connection will be recreated.

[PUSH-000651](#)

Cluster member {} joined the cluster.

Description

A Diffusion server has joined the cluster. It has been discovered but may not be connected.

[PUSH-000652](#)

Cluster member {} left the cluster.

Description

A Diffusion server has left the cluster.

[PUSH-000654](#)

{} reconnected, but messages recovery was disabled.

Description

A session has re-established communication with a server, but in-flight messages were not recovered as this feature is disabled or is not supported by the server.

[PUSH-000655](#)

{} reconnected, and messages were recovered successfully.

Description

A session has re-established communication with a server, and in-flight messages were recovered.

[PUSH-000656](#)

Unable to start Connector '{}' on port {}, address already in use.

Description

The address requested by the connector is already in use by a different process. Often this means that you already have a Diffusion server running or you have multiple connectors trying to use the same port.

[PUSH-000657](#)

Session{} failed to register or unregister a control handler: {}.

Description

A session failed to register or unregister a control handler.

[PUSH-000658](#)

Fan-out connection '{}' {}.

Description

A fan-out connection has changed to the specified state.

[PUSH-000659](#)

Fan-out connection '{}' request to change from {} to {} but current state is {}.

Description

A state change has been requested for a fan-out connection which is inconsistent with its current state. This may not be an issue but is reported for diagnostic purposes.

[PUSH-000660](#)

Fan-out link '{}' failed to start.

Description

A fan-out link has failed to start.

[PUSH-000661](#)

Fan-out link '{}' {}.

Description

A fan-out link has changed to the specified state.

[PUSH-000662](#)

Fan-out link '{}' request to change from {} to {} but current state is {}.

Description

A state change has been requested for a fan-out link which is inconsistent with its current state. This may not be an issue but is reported for diagnostic purposes.

[PUSH-000663](#)

Fan-out link '{}' subscription has failed : {}.

Description

A fan-out link subscription has been terminated.

[PUSH-000664](#)

Unhandled network processing failure during read '{}':.

Description

An unhandled exception occurred while attempting to process incoming data. This is a bug, please report it to Push support.

[PUSH-000666](#)

Failed to apply delta for topic cache entry: {}.

Description

A session failed to apply a received delta to the current value it has for the topic.

[PUSH-000667](#)

Failed to convert value to {} for topic '{}'.

Description

A session failed to convert a received value to the type expected by a value stream.

[PUSH-000668](#)

Delta received before value for topic cache entry: {}.

Description

A session received a delta for a topic for which it has no current value.

[PUSH-000669](#)

Uncaught exception in inbound thread.

Description

An uncaught exception was thrown in an inbound thread.

[PUSH-000670](#)

Received request from session {} to change session properties for session {}. The client session does not exist.

Description

The server has received a request from a session to change the session properties for an unknown session.

[PUSH-000671](#)

A message received from another server in the cluster [{}] could not be parsed: {}.

Description

A message used to communicate between two members of a cluster cannot be parsed. The session between the two members will be closed. Check the servers are using compatible product versions.

[PUSH-000672](#)

Shutting down server. Failed to merge Diffusion server into cluster.

Description

While trying to merge a Diffusion server into the cluster a fatal inconsistency was found. The server was shutdown to preserve cluster consistency. This will most likely happen after recovering from a network partition. A new server should be able to join the cluster as usual.

[PUSH-000681](#)

'{}': connection failed and reconnect was not enabled.

Description

A connection failed to be established and reconnection was not enabled. The session will be closed.

[PUSH-000682](#)

Session {} closed due to {} - This is due to the session failing to respond to a ping from the server.

Description

The frequency of server pings is dictated by the system-ping-frequency element for each connector in Connectors.xml. Consider configuring this value.

[PUSH-000683](#)

Received corrupt topic replication data from cluster peer {}.

Description

Topic replication has failed.

[PUSH-000684](#)

Filter callback '{}' threw an exception.

Description

A messaging filter callback raised an exception in your application code. This occurred when attempting to process a response.

[PUSH-000685](#)

Exception whilst handling the request.

Description

The application threw an exception whilst handling a request.

[PUSH-000686](#)

Failed to convert value to {} for message path '{}'

Description

A session failed to convert a received value to the type expected by a request handler.

[PUSH-000687](#)

Existing slave topics cannot be bound to topic '{}' because it is of incompatible type '{}'. The referencing slave topics are {}.

Description

A topic is being created which has existing slave topics that reference its path but the topic is of an incompatible type. The topic will be created but the slaves will not be bound to it. If the topic is later recreated with a compatible type, the slaves will then become bound.

[PUSH-000688](#)

Slave topic cannot be bound to existing topic {} as it is of an incompatible type.

Description

A slave topic is being created which references an existing topic of an incompatible type. The slave will be created, but in an 'unbound' state. If the master is later recreated but with a compatible type then the slave will then become bound.

[PUSH-000689](#)

Deprecated attribute '{}' found on element {} in {}.xml.

Description

A deprecated attribute has been found in specified properties file and should be removed.

[PUSH-000691](#)

A partition of the cluster log could not be compacted.

Description

Topic replication failed. The log is compacted to reduce the memory consumption but compaction failed. See the log for further detail.

[PUSH-000692](#)

A partition of the cluster log could not be recovered. The compacted log contains errors.

Description

Topic replication failed. The compacted log could not be loaded into the compacter. This implies it contains invalid data.

[PUSH-000693](#)

Request to the Kubernetes API failed.

Description

Request to the Kubernetes API failed.

[PUSH-000694](#)

Finding Hazelcast endpoints from Kubernetes registry at {}.

Description

Finding Hazelcast endpoints from the Kubernetes registry.

[PUSH-000695](#)

Found {} Kubernetes endpoints running Hazelcast, {}.

Description

Found Kubernetes endpoints running Hazelcast.

[PUSH-000696](#)

Product '{}' is not licensed.

Description

A product is not licensed for this environment.

[PUSH-000697](#)

Atomic move of persistence file {} to {} could not be performed. A non-atomic move will be attempted.

Description

The move of a persistence file as an atomic file system operation could not be performed. A non-atomic move will be attempted, but if that fails then it could leave files in an inconsistent state.

[PUSH-000698](#)

File persistence compaction has failed. Compaction disabled.

Description

The file persistence service failed to compact files. Compaction has been disabled. Persistence files will now grow indefinitely. You should stop the server and address the problem.

[PUSH-000699](#)

File persistence logging has failed. Topic logging has been disabled.

Description

The file persistence service failed to log and has been disabled. No further changes to topics will be logged. If the server is restarted, it will restore topics up to the point the logging failed. If you do not want this to happen, delete the log files manually before restarting.

[PUSH-000700](#)

The file persistence service has successfully completed restore of topics.

Description

The file persistence service has finished restoring topics from files.

[PUSH-000701](#)

The file persistence service has failed whilst restoring topics.

Description

The file persistence service has failed whilst restoring topics from files. The server will continue but some or all persisted topics may not exist.

[PUSH-000702](#)

The file persistence service is restoring topics from {}.

Description

The file persistence service is starting to restore topics from files in the specified store directory.

[PUSH-000703](#)

Failed to handle Prometheus instrumentation request.

Description

Failed to handle Prometheus instrumentation request.

[PUSH-000704](#)

JMX adapter is enabled and configured to poll MBeans every {} ms using filter '{}'.
The JMX adapter is enabled and configured to poll available MBeans.

Description

The JMX adapter is enabled and configured to poll available MBeans.

[PUSH-000705](#)

JMX adapter started.

Description

The JMX adapter has completed construction and begun execution.

[PUSH-000706](#)

Rejected attempt to add a {} topic bound to the replicated path '{}'.
Topic replication does not support Single Value and Record topics.

Description

Topic replication does not support Single Value and Record topics.

[PUSH-000707](#)

Rejected attempt by publisher '{}' to add a topic bound to the replicated path '{}'.
Topic replication does not support publisher-created topics.

Description

Topic replication does not support publisher-created topics.

[PUSH-000709](#)

The replication configuration does not specify a connector or connections between servers in the cluster. Using the connector '{}'.
An arbitrary connector has been selected for connections between servers in the cluster. To prevent this message, add a connector element to Replication.xml.

Description

An arbitrary connector has been selected for connections between servers in the cluster. To prevent this message, add a connector element to Replication.xml.

[PUSH-000710](#)

Did not find any Kubernetes endpoints, will retry in {}ms.

Description

Did not find any Kubernetes endpoints running Hazelcast.

[PUSH-000711](#)

Failed to add a topic because the number of topics would exceed the license limit of {}.

Description

The number of topics has reached the limit specified in the license.

[PUSH-000712](#)

Connector '{}' has scheduled pings every {}ms.

Description

The server relies on pinging in order to detect unresponsive HTTP polling clients.

[PUSH-000713](#)

Fan-out connection '{}' changed from '{}' to {}'.

Description

The state of a connection from a fan-out secondary server has changed.

[PUSH-000714](#)

There was a problem with the cluster log and Diffusion failed to write out records to the dump file {}.

Description

Topic replication failed. The cluster log contained invalid data and could not be written to the disk for debugging. This may happen if there are issues with multiple partitions, each partition races to stop the server and may interrupt other threads still writing out the file. It may also happen for other, file system related, reasons such as running out of disk space.

[PUSH-000715](#)

A request to {} failed. See the log for more information.

Description

A service request between members of the cluster failed. The logged exception should contain more information about the failure.

[PUSH-000716](#)

Fan-out connection '{}' session '{}' changed from '{}' to {}'.

Description

The session state of a fan-out client connection has changed.

[PUSH-000717](#)

Failed to delete persistence temporary directory {}.

Description

Persistence service temporary files could not be deleted on server closedown. Large files might remain in the 'tmp' directory within the persistence directory. You can delete the files manually to recover file system space. They will be deleted automatically when the server is restarted with persistence enabled.

[PUSH-000718](#)

The server is not licensed to accept fan-out connections.

Description

The license does not allow fan-out connections.

[PUSH-000719](#)

A partition of the cluster log could not be updated with {}.

Description

Topic replication failed. An attempt to append information to the partition log failed. See the log for further detail.

[PUSH-000720](#)

Unsupported Log4j configuration. Logging may not be cleanly shut down on exit.

Description

Diffusion expects the configured Log4j library to be at least version 2.6. Earlier versions do not provide a public LogManager.shutdown() API.

[PUSH-000721](#)

Replication is not licensed.

Description

The license for this server does not allow replication to be enabled.

[PUSH-000722](#)

Fan-out link '{}' selector '{}' replaced by '{}' to avoid replicating Diffusion topics.

Description

The named fan-out link had a selector which would have selected all topics but this has been replaced with a selector which will exclude Diffusion specific topics.

[PUSH-000732](#)

Failed to update the license cluster pool statistics.

Description

The operation to update the cluster license pool statistics was completed with an error.

[PUSH-000733](#)

The file persistence service has failed to secure invalid files - manual recovery required.

Description

After failing to compact old files the persistence service moves such old files into a recovery directory. This file move has failed meaning invalid files may still exist in the persistence directory and cause future compaction or restore to fail. The server should be closed and the problem addressed by moving all files out of the persistence directory.

[PUSH-000734](#)

The file persistence service has failed to restore from existing files and has moved all old files to {}. These files will need to be manually deleted.

Description

The file persistence service failed to restore from old files and has moved the files into a recovery directory. The server will continue without having restored from any persistence files. The problem will need to be addressed and files should be manually deleted from the recovery directory.

[PUSH-000735](#)

Update failed for {} topic '{}': {}.

Description

An error was encountered while attempting to update a single value or record topic.

[PUSH-000737](#)

Persistence is not licensed.

Description

The license for this server does not allow persistence to be enabled.

[PUSH-000738](#)

Cluster wide hard user limit {} exceeded.

Description

The maximum number of licensed connections for a cluster has been exceeded.

[PUSH-000739](#)

Cluster wide soft user limit {} exceeded. Cluster hard limit is at {}.

Description

Once the number of connections for a cluster exceeds its soft limit, a warning is emitted.

[PUSH-000740](#)

{}.

Description

Regular log of client connection statistics.

[PUSH-000741](#)

Cluster wide hard user limit {} exceeded.

Description

The maximum number of licensed connections for a cluster has been exceeded.

[PUSH-000742](#)

Cluster wide soft user limit {} exceeded. Cluster hard limit is at {}.

Description

Once the number of connections for a cluster exceeds its soft limit, a warning is emitted.

[PUSH-000743](#)

Unable to bind outbound connection to local address {}.

Description

The application has requested a socket be bound to a specific local address but this is unsupported by the runtime platform. This will happen on Android versions earlier than API Level 24 ("Nougat").

[PUSH-000744](#)

The selector thread pool {} specified for connector {} was not found. Using default selector thread pool.

Description

A selector thread pool has been configured for a connector that has not been defined for the server. The default selector thread pool will be used.

[PUSH-000745](#)

Failed to return details of topic '{}' because client does not support {} topics.

Description

The server cannot return topic details because the client session doesn't support the topic type.

[PUSH-000746](#)

Installed new license.

Description

A new license file has been found and has been installed.

[PUSH-000747](#)

Installing new license '{}'.
'

Description

A new license file has been found and will be installed.

[PUSH-000748](#)

Conflation failed because the merger configured for topic with id={},path='{}' returned a message with a different topic id={}, path='{}'.

Description

If a conflation merger returns a new topic message, it must be created for the same topic as the conflated message.

[PUSH-000749](#)

The server is waiting for the cluster to reach a quorum of {} servers.

Description

The start of the server has blocked while it waits for the quorum of servers to join the Hazelcast cluster.

[PUSH-000750](#)

The cluster is small enough for the quorum to mitigate split-brain. The cluster can't be divided into smaller clusters where more than one cluster can satisfy the quorum.

Description

The cluster is small enough to be protected against split-brain by the quorum. Split-brains may occur but they are mitigated by shutting down minority clusters.

[PUSH-000751](#)

The cluster is too large to completely mitigate split-brain. It is possible to divide the cluster into multiple clusters that satisfy the quorum requirements. The cluster has {} servers, should be less than {}.

Description

The cluster is too large to completely mitigate split-brain. It is possible to divide the cluster into multiple clusters that satisfy the quorum requirements. The cluster size should be smaller than twice the quorum size.

[PUSH-000752](#)

The cluster this server is in has lost enough members to lose the quorum. This server will shut down.

Description

The cluster this server is in has lost enough members to lose the quorum. The server previously had a quorum. It will now shut down. Other servers may be in a cluster with enough servers to satisfy the quorum.

[PUSH-000753](#)

The cluster has enough members to satisfy the quorum.

Description

The cluster has enough members to satisfy the quorum. It will now continue starting the server.

[PUSH-000754](#)

Failed to satisfy the quorum within the timeout. Not enough servers joined the cluster to satisfy the quorum. The server is shutting down without completing start up.

Description

Failed to satisfy the quorum within the timeout. Not enough servers joined the cluster to satisfy the quorum. The server has not completed starting up and the process will exit.

[PUSH-000755](#)

Record topic compatibility mode is enabled.

Description

Subscriptions to recordV2 topics by pre-6.0 clients will be presented as record topics.

[PUSH-000756](#)

Failed to add topic {} - REMOVAL property parse failure {}.

Description

Adding a topic failed because parsing of the REMOVAL property failed.

[PUSH-000757](#)

The supplied topic path '{}' is invalid. Registration of the session '{}' as an update source has failed.

Description

The server rejected a request to register an update source because the topic path is invalid.

[PUSH-000758](#)

Topic removal for topic '{}' failed with {} : {}.

Description

Removal of topics was attempted due to the removal policy of the named topic being satisfied but failed to complete.

[PUSH-000759](#)

Removing topics matching '{}' due to topic removal policy of topic '{}' created by {}.

Description

A removal policy specified on creation of the named topic by the named principal has been satisfied and the selection of topics covered by the given selector are now being removed.

[PUSH-000760](#)

Removing topic '{}' created by {} due to its topic removal policy.

Description

A removal policy specified on creation of the named topic by the named principal has been satisfied and the topic is now being removed.

[PUSH-000761](#)

Default web server {} created.

Description

A default web server has been created to support default connectors.

Connection counts

The Diffusion server produces connection summaries.

At one minute past midnight Diffusion creates an entry in the file `logs/ConnectionCount`, and resets the counter.

The value in the third column is the number of new client connections that have been established that day.

The value in the fourth column is the maximum number of concurrent sessions that have been active that day.

Note: The fourth column value (maximum number of concurrent sessions) can be higher than the third column value (number of new client connections) because of sessions established on previous days which are still active.

If you shut down the Diffusion server, the server updates this file with the client connection information for the day up to the point of shutdown. However, if the Diffusion server is killed instead of shut down, it does not update the file.

An example is shown here:

```
2019-09-27 00:01:40 6.1.5_01 128 31
2019-09-28 00:01:48 6.1.5_01 139 28
2019-09-29 00:01:56 6.1.5_01 177 28
2019-09-30 00:01:05 6.1.5_01 118 41
2019-10-01 00:01:22 6.1.5_01 207 36
2019-10-02 00:01:31 6.1.5_01 188 19
2019-10-03 00:01:41 6.1.5_01 244 44
2019-10-04 00:01:41 6.1.5_01 188 26
2019-10-05 00:01:41 6.1.5_01 195 39
```

Integration with Splunk

How to achieve basic integration between Diffusion and the Splunk™ analysis and monitoring application

About

Splunk is a third-party application from Splunk, Inc., which provides monitoring and analysis of other applications, primarily by parsing their logs and extracting information of interest. The information is displayed through a web interface, which allows the creation of dashboards and alerts on user-defined events. Splunk is available for all major operating systems.

The Diffusion log format is designed to be consistent and to allow for easy parsing by monitoring tools, not limited to Splunk.

Installation

Installation typically takes just a few minutes, see the appropriate section of the [Splunk Installation Manual](#). For simplicity, we assume that Diffusion and Splunk are installed on the same machine.

Basic configuration

This is easier to do with existing log files to import, so configure Diffusion to write log files. To better demonstrate Splunk, set the server log file to TRACE logging in `etc/Logs.xml` and start Diffusion.

```
<!-- Example server log configuration -->
<log name="server">
```

```
<log-directory>../logs</log-directory>
<file-pattern>%s.log</file-pattern>
<level>TRACE</level>
<xml-format>>false</xml-format>
<file-limit>0</file-limit>
<file-append>>false</file-append>
<file-count>1</file-count>
<rotate-daily>>false</rotate-daily>
</log>
```

On startup, access the Splunk web UI at <http://localhost:8000>. After logging in (and changing the default admin password), choose the **Add data** option.

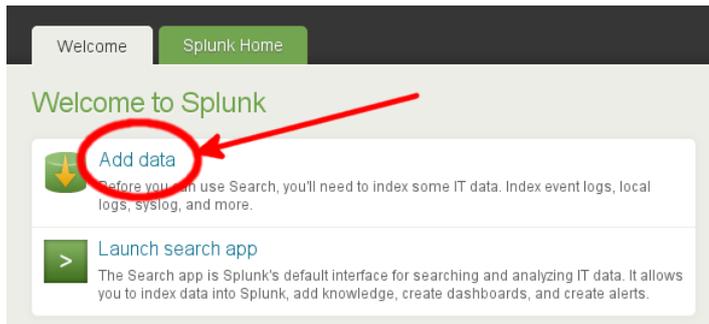
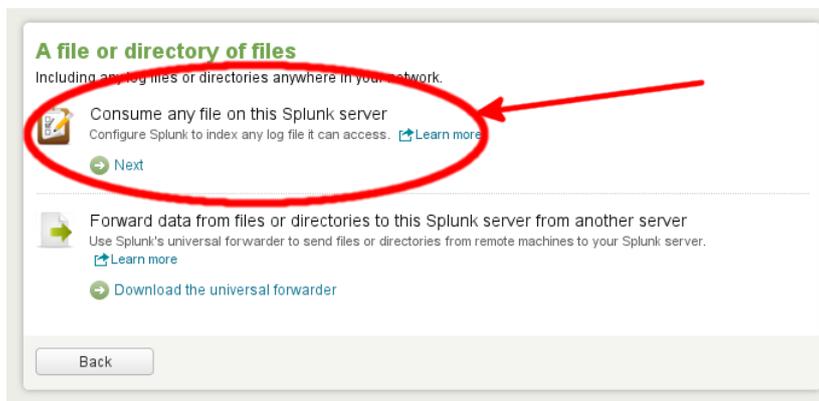


Figure 38: Welcome tab of the Splunk web UI

In the **Add Data to Splunk** screen that follows, choose the link **A file or directory of files** followed by **Consume any file on this Splunk server**.



Splunk might not be able to immediately identify the format of the log files; if this is the case, a dialog box similar to the following is presented. Select **csv** from the existing source types. Diffusion uses a pipe symbol rather than a comma as a separator but this is acceptable to the Splunk CSV parser.

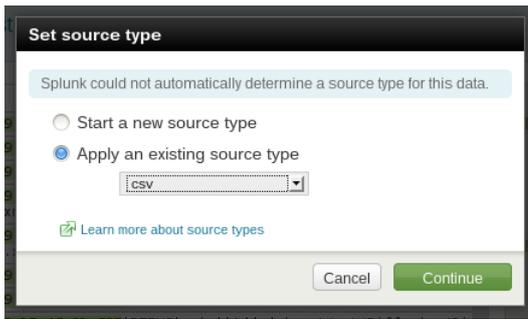


Figure 39: The Splunk Set source type dialog

The next dialog allows you to select the `Diffusion logs/Server.log` file under the **Preview data before indexing** option, which Splunk reads and parses. On the **Data Preview** screen, there are numbered log entries with the timestamp highlighted. This indicates that the log file has been correctly parsed. Accept this, and on the next screen, set the source to be continuously indexing the data. You can leave the parameters in **More settings** at their default values. Once this is done, you have given the new data source a name (for example, Diffusion Server Log) and finally accepted the settings, you can begin searching and generating reports based on the log contents.

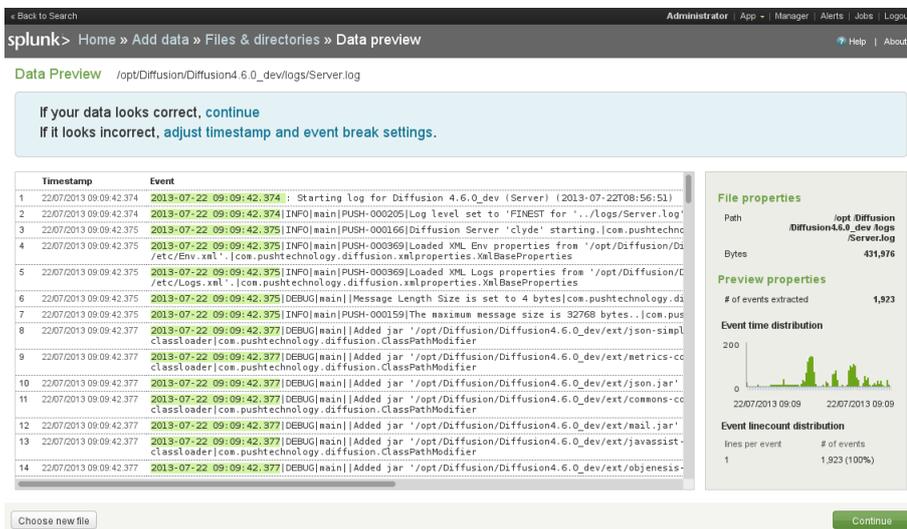


Figure 40: The Data Preview panel

Simple searches

Now we have a data source configured, we can start to execute basic searches.

On the Splunk launch page, select the **Search** option. On the **Search Summary** page that opens, select the Source relating to the file `logs/Server.log` previously imported. The page changes to include the source in the Search area. Additional search terms can be added to the end, for example, “Started Publisher”.

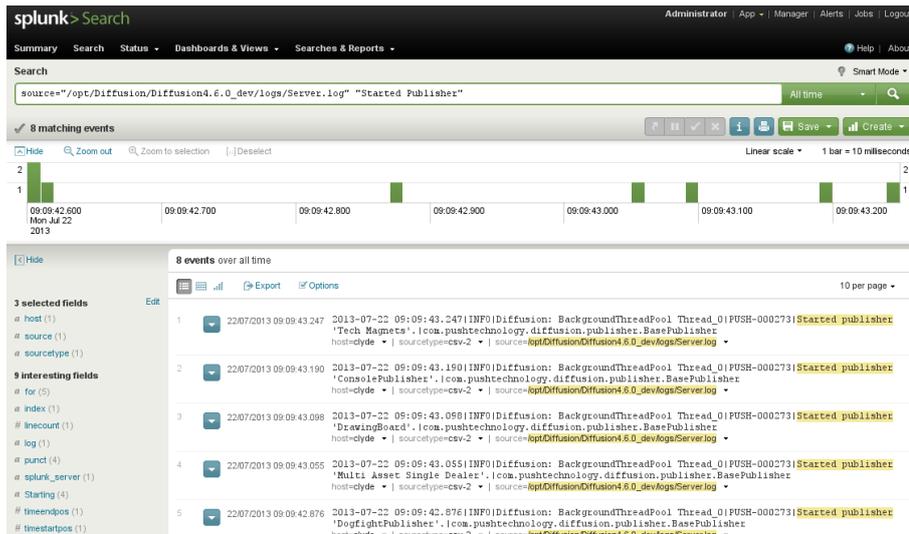


Figure 41: The Splunk search summary panel

Related concepts

[JMX on page 583](#)

You can use JMX to manage Diffusion. By default, the RMI registry port is 1099 and the JMX service port is 1100.

Related reference

[Statistics on page 602](#)

Diffusion can provide statistics in three ways: via MBeans, via the Publisher API, and via Prometheus-compatible endpoints. Statistics provide information about the server, clients and topics.

[Diffusion monitoring console on page 606](#)

A web console for monitoring the Diffusion server.

[Logging on page 611](#)

Diffusion uses the Simple Logging Facade for Java (SLF4J) API to log messages from the Diffusion server or from publishers running on the Diffusion server. SLF4J separates the logging of messages in the Diffusion server from the logging framework. This separation enables you to configure an independent back-end implementation to format and write out the log messages.

Related information

<http://docs.splunk.com>

Web servers

Diffusion incorporates its own basic web server for a limited set of uses. The Diffusion server also interacts with third-party web servers that host Diffusion web clients. The Diffusion server is also capable of being run as a Java servlet inside a web application server.

Related concepts

[Diffusion web server on page 696](#)

Diffusion incorporates its own web server. This web server is required to enable a number of Diffusion capabilities, but we recommend that you do not use it to host your production web applications.

[Web servers on page 121](#)

Consider how to use web servers as part of your Diffusion solution.

[Running the Diffusion server inside of a third-party web application server](#) on page 699

Diffusion can run as a Java servlet inside any Java application server.

[Hosting Diffusion web clients in a third-party web server](#) on page 698

Host Diffusion web clients on a third-party web server to enable your customers to access them.

[Configuring the Diffusion web server](#) on page 534

Use the `WebServer.xml` and `Aliases.xml` configuration files to configure the behavior of the Diffusion web server.

[Configuring Diffusion web server security](#) on page 535

When configuring your Diffusion web server, consider the security of your solution.

Diffusion web server

Diffusion incorporates its own web server. This web server is required to enable a number of Diffusion capabilities, but we recommend that you do not use it to host your production web applications.

Any Diffusion connector can be configured to act as a web server and provide the following capabilities:

- Providing an endpoint for the HTTP-based transports used by Diffusion clients
- Hosting the Diffusion server landing page
- Hosting the Diffusion demos
- Hosting the Diffusion monitoring console
- Optionally, hosting a static page you can use to check the status of the Diffusion server

For more information about configuring the Diffusion web server for these uses, see [Configuring the Diffusion web server](#) on page 534.

Related concepts

[Web servers](#) on page 695

Diffusion incorporates its own basic web server for a limited set of uses. The Diffusion server also interacts with third-party web servers that host Diffusion web clients. The Diffusion server is also capable of being run as a Java servlet inside a web application server.

[Web servers](#) on page 121

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[Configuring Diffusion web server security](#) on page 535

When configuring your Diffusion web server, consider the security of your solution.

Server-side processing

A basic level of server-side processing can be utilized with any file hosted on the Diffusion web server that has a text mime type and JavaScript.

There are three server-side tags: Include, Publisher and Topic Data. These tags are stored in HTML comments so as to not interfere with normal HTML

Include Tag

Include stubs load the file specified in the file attribute and are loaded as is into the parent HTML document. They do not necessarily have to be valid HTML. They can be positioned anywhere within the HTML file.

These includes are synonymous with #Include statements of ANSI C.

Below is an example of the syntax:

```
<!--@DiffusionTag type="Include" file="stub.html" -->
```

Include files can be nested so an include file can contain an include tag

Publisher tag

Publisher tags enable a publisher to interact with the web page during the serving process. Again these tags can appear anywhere within the HTML document. In the case below the publisher method `processHTMLTag` of the `Trade` publisher is called with the tag argument of `table`. The publisher can return a String of HTML that is inserted into the document at the position of the tag and the tag is removed. The `processHTMLTag` method is also called with the HTTP Request, although the request cannot be written to. Below is an example of the syntax

```
<!--@DiffusionTag type="publisher" publisher="Trade" tagid="table" -->
```

TopicData

Topic data tags allow for `SingleValueTopicData` items to be rendered in the HTML page. Again these tags can appear anywhere within the HTML document. The following example shows the syntax:

```
<!--@DiffusionTag type="TopicData" name="Assets/FX/EURUSD/0" -->
```

HTTP listener

Publishers can listen to all file HTTP requests by registering as a `HTTPRequestListener`. This exposes the interface

```
void handleHTTPRequest(HTTPVirtualHost virtualHost, HTTPRequest request)
```

This enables for more detailed statistics to be captured from the HTTP request

Hosting a status page on the Diffusion web server

You can host a simple status page on the Diffusion.

When setting up your Diffusion server to act as a web server for a status page, ensure that the web service uses a different connector to the Diffusion clients. This enables the web server to use a different thread pool and ensures that requests for status are not slowed by heavy client traffic.

You can use server-side tags to include topic data or call on publisher methods from within the status page. For more information, see [Server-side processing](#) on page 697.

Receiving no response from the status page might not indicate that the server hosting it is down. If you use a non-response from the status page as an indicator for failing over to another Diffusion server, ensure that you kill all processes belonging to the non-responsive Diffusion server before failing over.

Hosting Diffusion web clients in a third-party web server

Host Diffusion web clients on a third-party web server to enable your customers to access them.

If your Diffusion clients are web clients, they must be hosted on a web server to enable your customers to access them. We recommend that you use a third-party web server to host your clients instead of the built-in web server provided by Diffusion.

This approach requires additional configuration of your solution to account for cross-origin requests.

Cross-origin requests

Cross-origin requests occur when your web client requests resources (for example, data from the Diffusion server) that are hosted on a different domain, or in some cases a different port on the same domain, to your web client.

Some browsers do not support cross-origin resource sharing. For more information, see [Cross-origin resource sharing limitations](#) on page 46.

You can use one of the following approaches to enable cross-origin requests for your solution:

- Define a cross domain policy. For more information, see [Cross domain policies](#) on page 702.
- Use a load balancer to composite the URL spaces.

Related concepts

[Web servers](#) on page 695

Diffusion incorporates its own basic web server for a limited set of uses. The Diffusion server also interacts with third-party web servers that host Diffusion web clients. The Diffusion server is also capable of being run as a Java servlet inside a web application server.

[Diffusion web server](#) on page 696

Diffusion incorporates its own web server. This web server is required to enable a number of Diffusion capabilities, but we recommend that you do not use it to host your production web applications.

[Running the Diffusion server inside of a third-party web application server](#) on page 699

Diffusion can run as a Java servlet inside any Java application server.

[Configuring the Diffusion web server](#) on page 534

Use the `WebServer.xml` and `Aliases.xml` configuration files to configure the behavior of the Diffusion web server.

[Web servers](#) on page 121

Consider how to use web servers as part of your Diffusion solution.

Running the Diffusion server inside of a third-party web application server

Diffusion can run as a Java servlet inside any Java application server.

When running the Diffusion server inside a third-party web application server, the Diffusion server can have a different port number to clients that are hosted on the same server. This can cause cross-origin .

Some browsers do not support cross-origin resource sharing. For more information, see [Cross-origin resource sharing limitations](#) on page 46.

You can use one of the following approaches to enable cross-origin requests for your solution:

- Define a cross domain policy. For more information, see [Cross domain policies](#) on page 702.
- Use a load balancer to composite the URL spaces.

When using a third-party web server at least some of the functionality of the built-in Diffusion web server can be disabled. The file-service and http-service entries can be removed as Tomcat™ provides this functionality. The client-service is needed to support WebSocket and HTTP connection protocols. If these are not used, the client-service can be disabled as well.

Related concepts

[Web servers](#) on page 695

Diffusion incorporates its own basic web server for a limited set of uses. The Diffusion server also interacts with third-party web servers that host Diffusion web clients. The Diffusion server is also capable of being run as a Java servlet inside a web application server.

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[Configuring the Diffusion web server](#) on page 534

Use the `WebServer.xml` and `Aliases.xml` configuration files to configure the behavior of the Diffusion web server.

[Web servers](#) on page 121

Consider how to use web servers as part of your Diffusion solution.

Example: Deploying the Diffusion server within Tomcat

Run the Diffusion server inside Tomcat as a Java servlet.

About this task

The Tomcat servlet container and the Diffusion server run in the same Java process and can communicate directly through shared memory. Tomcat and the Diffusion server listen on different ports. Clients can connect directly to the Diffusion server without going through Tomcat.

Procedure

1. Configure an installation of the Diffusion server for how you want your Diffusion servlet to behave.

Ensure, when editing the configuration files in the `etc` directory, that all paths are expressed as absolute paths.

Ensure that a valid license file is present in the `etc` directory.

Place any additional JARs that are required by your servlet in the `ext` directory of your Diffusion installation.

2. Use the `war.xml` Ant script in the `tools` directory of your Diffusion to package the Diffusion server as a WAR file.

```
ant -f war.xml
```

The script creates the `diffusion.war` file in the `build` directory of your Diffusion installation.

The `diffusion.war` file includes the following files and directories:

META-INF/manifest.xml

The manifest file for the WAR

WEB-INF/web.xml

This file contains information about the servlet.

WEB-INF/classes

This directory contains the configuration files for the Diffusion server. These files are copied from the `etc` directory of the Diffusion installation.

WEB-INF/lib/diffusion.jar

The `diffusion.jar` file contains the Diffusion server

WEB-INF/lib

This directory also contains JAR files copied from the `ext` directory of the Diffusion installation.

WEB-INF/lib/thirdparty

This directory contains the third-party libraries that are required by the Diffusion server. These files are copied from the `lib/thirdparty` directory of the Diffusion installation.

lib/DIFFUSION

This directory contains the browser API libraries. These files are copied from the `html/lib/DIFFUSION` directory of the Diffusion installation.

Additional files and directories

The WAR file contains additional files and directories that are not listed here.

The top level of the WAR file contains resources that can be served by Tomcat.

3. Verify the WAR file.
 - a) Check that the WAR structure is the same as described in the previous step and that all necessary files have been copied into the WAR structure.
 - b) Check that the `WEB-INF/web.xml` file contains the following information.

```
<servlet>
  <servlet-name>Diffusion</servlet-name>
  <display-name>Diffusion Servlet</display-name>
  <servlet-
class>com.pushtechnology.diffusion.servlet.DiffusionServlet</
servlet-class>
  <load-on-startup>1</load-on-startup>
</servlet>
```

The WAR is now ready to be deployed inside a Java web application server. The rest of this task describes how to run the WAR inside of Tomcat, but you can use any Java web application server.

4. Define the Tomcat connectors for incoming connections in the `Server.xml` file.

A connector defines the port, protocol, and various properties of how the connection is handled. The following is an example connector for handling HTTP 1.1 connections on port 8080:

```
<Connector port="8080"
    connectionTimeout="20000"
    URIEncoding="UTF-8"
    maxThreads="3"
    protocol="HTTP/1.1" />
```

See the Tomcat documentation for more information.

5. When starting Tomcat, ensure that the following parameters are set:

a) Set the `diffusion.home` parameter to the path to the Diffusion JAR file.

```
-Ddiffusion.home=diffusion_installation/lib
```

Tomcat must be aware of Diffusion.

b) Set the `java.util.prefs.userRoot` parameter to a directory that Tomcat can write to.

For example:

```
-Djava.util.prefs.userRoot=/var/lib/tomcat/diffusion/prefs/user
```

Diffusion uses the `java.util.prefs` mechanism to store preference information. If Tomcat, does not set this parameter, the Diffusion server logs warning messages.

What to do next

Accessing publishers from Tomcat

Diffusion started within Tomcat allows Tomcat to access the publishers. Tomcat can be used to serve JSP files providing dynamically generated content. These files can access publishers using the publishers class static methods.

```
<%@ page import="java.util.List,com.pushtechology.api.publisher.*"
%>
<html>
  <head>
    <title>Publisher Information</title>
  </head>
  <body>
    <table>
      <tr>
        <th>Publisher Name</th>
        <th>Topics</th>
      </tr>
      <% for (Publisher pub : Publishers.getPublishers()) { %>
      <tr>
        <td><%= pub.getPublisherName() %></td>
        <td><%= pub.getNumberOfTopics() %></td>
      </tr>
      <% } %>
    </table>
  </body>
</html>
```

The above is the content of a JSP file that return a list of the publisher Diffusion is running with the number of topics each publisher owns.

Other considerations when running the Diffusion server inside of a third-party web application server

Diffusion can run as a Java servlet inside any Java application server.

Apache Mod Proxy installation

Apache Mod Proxy can be used to forward HTTP requests from an Apache web server to Diffusion. It does not support persistent connections or WebSocket so the WebSocket connections do not work. Make sure that you include the following into the Apache configuration file (Virtual host setting).

```
ProxyPass /diffusion/ http://localhost:8080/diffusion/
```

For more information, see the Apache Mod Proxy documentation.

Apache AJP13 Installation

Apache AJP can be used to forward requests from an Apache web server to Tomcat. In the Apache virtual host configuration, mount the path

```
JkMount /diffusion/*dfnjetty
```

Workers definition file

```
worker.dfnjetty.port=8009
worker.dfnjetty.host=(host IP)
worker.dfnjetty.type=ajp13
worker.dfnjetty.lbfactor=1
worker.dfnjetty.cachesize=50
worker.dfnjetty.socket_keepalive=1

worker.list=dfnjetty
```

A connector that handles the AJP/1.3 protocol is needed running on port 8009 (because of the Workers file described above). See the Tomcat documentation for more information on this.

IIS Installation

Use an ISAPI_Rewrite tool. For example, http://www.helicontech.com/isapi_rewrite

The rewrite rule is as follows:

```
RewriteEngine on
RewriteRule ^diffusion/ http://localhost:8080/diffusion/ [p]
```

Diffusion home directory

The servlet container must be aware of Diffusion. Add the path to the directory that contains the Diffusion JAR file to the Java VM arguments that you use to start the servlet container.

```
-Ddiffusion.home=diffusion_installation/lib
```

Cross domain policies

Cross domain policies grant permission to communicate with servers other than the one the client is hosted on.

Cross-domain XML file

The cross-domain policy is defined in an XML file

A cross-domain policy file is an XML document that grants a web client permission to handle data across multiple domains. When a client hosts content from a particular source domain and that content makes requests directed towards a domain other than its own, the remote domain must host a cross-domain policy file that grants access to the source domain, allowing the client to continue with the transaction. Policy files grant read access to data, permit a client to include custom headers in cross-domain requests, and are also used with sockets to grant permissions for socket-based connections.

For example, say that the Diffusion client is loaded from `static.example.com` and the connection URL to the Diffusion client is `http://streaming.example.com`, a `crossdomain.xml` file must be loaded from `static.example.com`

A `crossdomain.xml` is required if one of the following is true:

- You are using Diffusion as a streaming data server and a separate web server which are on different domains
- The Diffusion connection type is HTTP or HTTPS
- You are not using a load balancer to HTTP rewrite Diffusion traffic

Note: You cannot use the `iframe` streaming transport with cross-domain requests. This is not supported by Diffusion.

Load balancers

Load balancers provide many capabilities that are key to creating a seamless Diffusion solution. We recommend that you use a load balancer with Diffusion.

In addition to balancing client connections across multiple Diffusion servers, you can use load balancers to composite URL spaces or do SSL offloading.

Connections between Diffusion clients and Diffusion servers have specific requirements. If your load balancer handles Diffusion connections incorrectly, this can cause problems for your solution.

Ensure that you fully review this section of the user guide when using load balancers with Diffusion.

Routing strategies at your load balancer

Your load balancer can present a number of different strategies for choosing which Diffusion server a new client connection is routed to. After a client connection has been routed to a Diffusion server, ensure that the client is always routed to the Diffusion server that its session exists on.

The routing strategies that are available to you depend on the load balancer that you choose to use. The following table lists some examples of routing strategies:

Table 58: Examples of routing strategies

Name	Description
Round-robin	Each available Diffusion server is chosen in turn, with none favored.
Fewest clients	The Diffusion server with the fewest number of client connections in progress is chosen.
Least loaded	The Diffusion server with the lowest CPU load is chosen.

Routing connection that use HTTP protocols

To route HTTP traffic, the load balancer must be able to inspect the HTTP headers and extract session information.

Diffusion sets an HTTP cookie named `session` with a connection-specific ID specifically for this purpose. Your load balancer can use this cookie to maintain a table of client to server mappings.

The session cookie is flagged with `HttpOnly`, which prevents scripts accessing the cookie. The session cookie is not flagged with `Secure`, which prevents the cookie from being sent over non-secure connections.

Sample HTTP conversation, cookie highlighted:

```
POST /diffusion/ HTTP/1.1
Host: localhost:8080
Connection: keep-alive
Content-Length: 0
tt: 90
Origin: http://localhost:8080
User-Agent: Mozilla/5.0 (X11; Linux x86_64) AppleWebKit/537.36
  (KHTML, like Gecko) Ubuntu Chromium/48.0.2564.82 Chrome/48.0.2564.82
  Safari/537.36
m: 0
ty: B
v: 4
Content-Type: text/plain;charset=UTF-8
Accept: */*
Referer: http://localhost:8080/tools/DhtmlClient.html
Accept-Encoding: gzip, deflate
Accept-Language: en-GB,en-US;q=0.8,en;q=0.6

HTTP/1.1 200 OK
Set-Cookie: session=c04815df73a1646d-0000000000000000; HttpOnly
Access-Control-Allow-Origin:http://localhost:8080
Cache-Control:no-store, no-cache
Content-Type:text/plain; charset=UTF-8
Content-Length:41

4.100.4.c04815df73a1646d-0000000000000000

POST /diffusion/ HTTP/1.1
Host: localhost:8080
Connection: keep-alive
Content-Length: 0
Origin: http://localhost:8080
c: c04815df73a1646d-0000000000000000
User-Agent: Mozilla/5.0 (X11; Linux x86_64) AppleWebKit/537.36
  (KHTML, like Gecko) Ubuntu Chromium/48.0.2564.82 Chrome/48.0.2564.82
  Safari/537.36
m: 1
Content-Type: text/plain;charset=UTF-8
Accept: */*
Referer: http://localhost:8080/tools/DhtmlClient.html
Accept-Encoding: gzip, deflate
Accept-Language: en-GB,en-US;q=0.8,en;q=0.6
Cookie: session=c04815df73a1646d-0000000000000000
```

Diffusion uses a session ID for the cookie. This enables the load balancer to maintain a map of each session ID to its target Diffusion server.

Instead, you can disable the Diffusion cookie and configure the load balancer to set a cookie that identifies the target server instead of the session. While the overhead of transmitting a cookie is still present between client and load balancer, the identifier can be smaller because there are a smaller number of servers than client sessions. Load balancers that use the cookie to identify the Diffusion server can send less data down the wire and consume fewer resources.

If you want to configure your load balancer to inject its own cookie, you can disable this Diffusion cookie. To disable the Diffusion cookie, set the `<disable-cookie>` element in the `WebServer.xml` configuration file of your Diffusion to `true`.

Routing connections that use streaming protocols

Streaming protocols that open a single socket and remain connected until they are no longer required appear immune to requiring any special routing considerations. However, in the event that connection keep-alive is enabled to handle reconnections in case of temporary connection loss, it is important that the reconnection attempt is routed to the original server.

Without the ability to parse headers (and indeed, the absence of a session ID at all), the most common method for routing a streaming protocol such as WebSocket is to create a client/server mapping based on the IP addresses of the endpoints. This technique is generally referred to as Sticky-IP, and has the advantage of also working with HTTP transports, if required.

For F5's Sticky IP, ensure that the Source Address Translation option is set to Auto Map.



Figure 42: Sticky-IP in F5 BIG-IP

The drawback of this approach is that multiple users masquerading behind a proxy or access point can have the same IP address, and all requests from clients with that IP address are routed to the same Diffusion instance. Load balancing still occurs, but some hosts might be unfairly loaded.

Monitoring available Diffusion servers from your load balancer

To route your client connections most effectively, your load balancer must know which Diffusion servers are available to accept connections.

There are a number of ways to determine the availability of a Diffusion server:

- Implement a custom monitor using a scripting language that is supported by your load balancer.

For example, create a custom Diffusion client that connects and subscribes to a status topic.

This is the most effective way of determine availability as can check the connector used by your client applications.

- Use an HTTP probe against the built-in web server.

This has the advantage of being simple; most system administrators are familiar with HTTP requests. In the simplest case, a `GET` request can be made against the root context of the web server, for example:

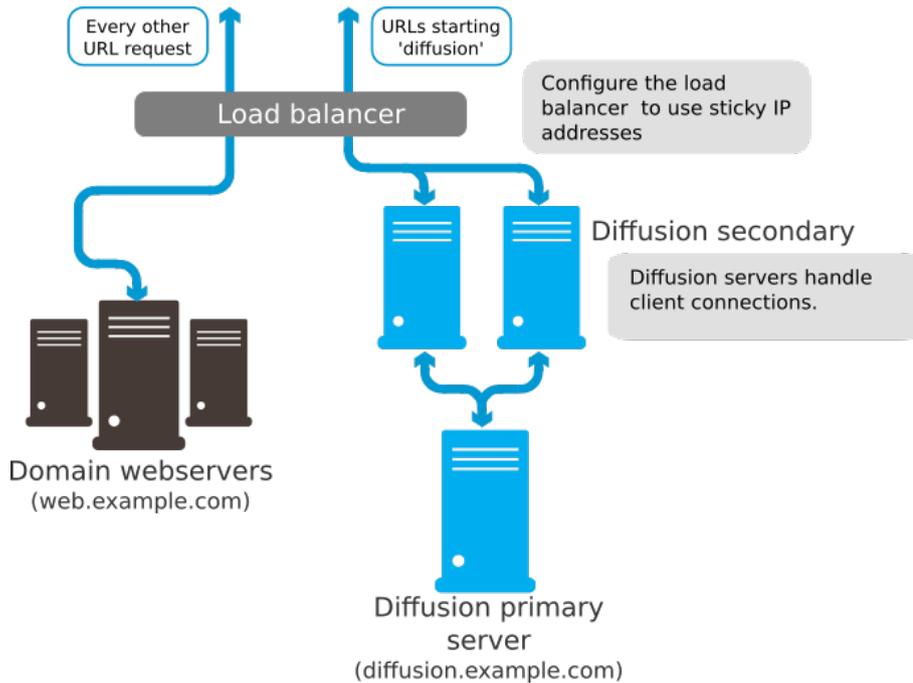
```
GET / HTTP/1.0\r\n
```

However, this only tests the availability of the Diffusion server as a whole, and not the applications within it.

Compositing URL spaces using your load balancer

If your Diffusion servers are located at a different URL to the Diffusion browser clients hosted by your web servers, you can use a load balancer to composite the URL spaces.

Security features in some browsers prevent web-based Diffusion clients from making requests to your Diffusion server if your Diffusion server is in a different URL space to the web server you use to host your client.



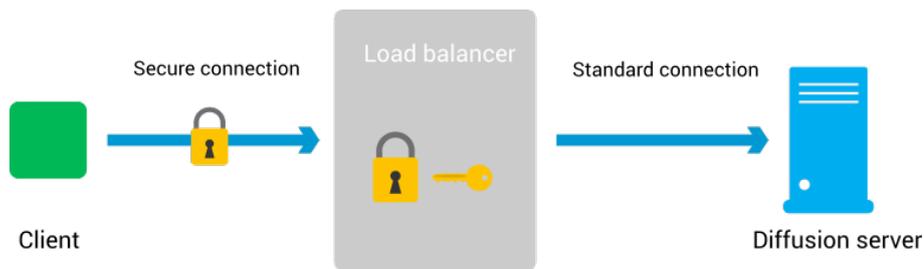
- Your web content is hosted on `web.example.com` and your Diffusion servers are hosted on `diffusion.example.com`.
- The load balancer composites the URL space so that requests to Diffusion at `web.example.com` are routed to Diffusion servers hosted on `diffusion.example.com`
- To the client, both the web and the Diffusion content appear to be hosted on `web.example.com`. This avoids any cross-domain security issues.

If you choose not to use your load balancer to composite the URL spaces, you can set up cross-domain policy files that allow requests to the different URL spaces.

Secure Sockets Layer (SSL) offloading at your load balancer

Diffusion clients can connect to your solution using TLS or SSL. The TLS/SSL can terminate at your load balancer or at your Diffusion server.

Note: If you have sensitive client data that you must secure, use a secure connection all the way from the client to the Diffusion server. Either do not perform SSL offloading at the load balancer or re-encrypt the connection between load balancer and the Diffusion server.



SSL offloading is when you terminate the TLS at the load balancer. The processing burden of encrypting and/or decrypting a Diffusion client connection made over SSL can then be offloaded to a component that can perform SSL termination more efficiently.

After the SSL connection has been decrypted, the client connection can travel between the load balancer and the Diffusion server using an unsecured transport. Doing this reduces CPU cost on your Diffusion servers.

Using load balancers for resilience

An important part of creating your Diffusion solution is ensuring that it is resilient if one of its components fails.

Load balancer redundancy

If you only have one load balancer in your Diffusion solution, this load balancer can become a single point of failure. For a more resilient solution, have more than one load balancer.

You can have a cluster of active load balancers, each with a different IP address, behind a DNS that uses a round-robin strategy to direct client connections to a hostname to the IP of each load balancer in turn. With a round-robin routing strategy at your DNS, there can be a lag between a load balancer becoming unavailable and this being detected.

Alternatively, you can configure your network so that all of your load balancers are available on the same IP address.

If you use multiple load balancers, ensure that all load balancers have access to any client/server mapping information.

Refer to the documentation for your load balancer for further information about load balancer redundancy.

Using load balancers with Diffusion replication

Diffusion replication is designed to be used with Diffusion servers that are load balanced. If a Diffusion server in your solution becomes unavailable, your load balancer must re-route any of that server's client connections to other Diffusion servers in your solution.

For more information, see [High availability](#) on page 103.

Common issues when using a load balancer

There are some configuration options on your load balancer that can cause problems or inefficient behavior in your Diffusion solution.

Load balancer closing silent connections

Many load balancers have a default configuration that closes TCP connections after a few seconds of the connection being silent. This is appropriate for a load balancer handling connections to a web server. However, Diffusion traffic is different and there can be long intervals of silence on the connection.

Do not configure load balancers or firewalls to close TCP connections that are not transmitting data. Diffusion maintains a connection for every live session so that data can be pushed.

If a network device terminates a TCP connection autonomously, the Diffusion server might interpret this as a close initiated by the client and close the session. If this happens, any reconnection attempts made by the client fail.

Connection pooling

Many load balancers include a connection pooling feature where connections between the load balancer and the Diffusion server are kept alive and reused by other clients. In fact, multiple clients can be multiplexed through a single server-side connection.

In Diffusion, a client is associated with a single TCP/HTTP connection for the lifetime of that connection. If a Diffusion server closes a client, the connection is also closed. Diffusion makes no distinction between a single client connection and a multiplexed connection, so when a client sharing a multiplexed connection closes, the connection between the load balancer and Diffusion is closed, and subsequently all of the client-side connections multiplexed through that server-side connection are closed.

For this reason, it is required that load balancers are not configured to pool connections when working with Diffusion.

Reuse TCP connection

If your load balancer is configured to create a new TCP connection between the load balancer and the Diffusion server for each request from a specific client, this can be expensive. Creating a new TCP connection per request, increases the time each request takes to be processed and increases the amount of traffic between the load balancer and the Diffusion server.

To avoid this, ensure that your load balancer is configured to reuse a TCP connection for requests from the same client.

Sticky-IP

We recommend that you use the sticky-by-IP routing strategy when your clients connect using streaming protocols. This ensures that client connections are always routed to the Diffusion server where their sessions are located.

However, the drawback of this approach is that multiple users masquerading behind a proxy or access point can have the same IP address, and all requests from clients with that IP address are routed to the same Diffusion server. Load balancing still occurs, but some hosts might be unfairly loaded.

TCP retransmission timeout

If you use Diffusion failover, the TCP retransmission timeout on your load balancer's host server can cause long waits for clients whose connections failover from one Diffusion server to another. When a Diffusion server becomes unavailable, the load balancer can hold open existing client connections to this server. These connections can continue to receive and buffer data from the client for the duration of the timeout, before being closed. This data is discarded when the connection closes.

You can avoid this problem by changing the TCP retransmission timeout of the host server of your load balancer or by configuring the load balancer to shutdown connections to Diffusion servers it knows are unhealthy.

JMS adapter

The JMS adapter for Diffusion, enables Diffusion clients to transparently send data to and receive data from destinations (topics and queues) on a JMS server.

The JMS adapter can be run within the Diffusion server or as a standalone client application.

JMS adapter

The JMS adapter comprises the following files all located in the `adapters/jms` directory of your Diffusion installation:

`jmsadapter.jar`

This JAR file contains the Diffusion Java application that links the Diffusion server and a JMS server.

`JMSAdapter.xml`

This XML file is used to configure the JMS adapter. For more information, see .

`JMSAdapter.xsd`

This XSD file defines the schema of the `JMSAdapter.xml` file.

`jms_adapter.sh` and `jms_adapter.bat`

These executable files can be used to start the JMS adapter when running it as a standalone client on UNIX, Linux, or Windows systems.

The JMS adapter can be run as a client on any system that has a Java 8 JRE installed on it - Oracle Java Development Kit 8 (minimum update 1.8.0_131-b11) is recommended.

Using the JMS adapter

To use the JMS adapter, first configure it by editing the `JMSAdapter.xml` to define the adapter behavior. For more information, see [Configuring the JMS adapter](#) on page 718.

The method for running the JMS adapter differs depending on whether you run it within the . For more information, see [Running the JMS adapter](#) on page 736.

Transforming JMS messages into Diffusion messages or updates

JMS messages are more complex than Diffusion content. A transformation is required between the two formats.

The following modes of transformation are provided:

Basic

Only the textual content of a message is relayed.

JSON

All JMS headers and properties are relayed, in addition to the textual content of the message. These values are expressed as JSON in the corresponding Diffusion message.

You can configure which one of these transformation modes your JMS adapter uses at the per topic level.

JMS message structure

JMS messages comprise headers, properties, and a payload. Currently, only JMS TextMessages are supported by the JMS adapter.

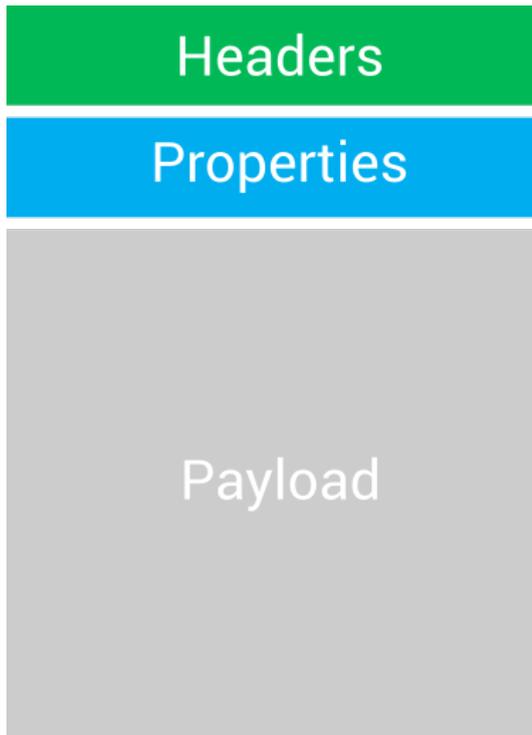


Figure 43: JMS message structure

Headers

This is a fixed set of properties whose names all begin with 'JMS'. Some, such as `JMSDestination`, are mandatory. Others are optional. For more information, see <https://docs.oracle.com/javaee/7/api/javax/jms/Message.html>.

Properties

A set of name-value pairs.

Payload

The contents of the message. This is a String.

Basic transformation

In a basic transformation only the textual payload or content of the message is relayed in either direction.

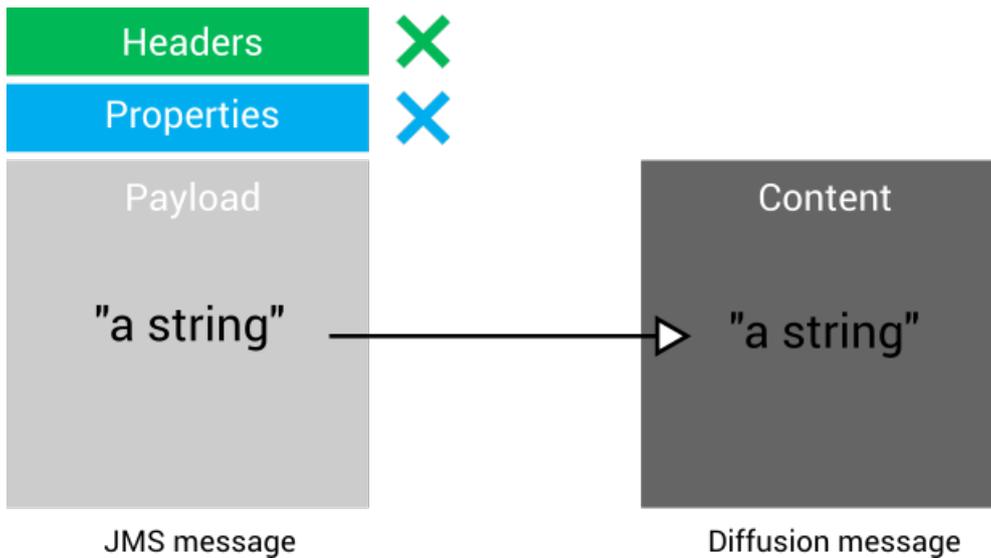


Figure 44: Basic mapping from a JMS message to a Diffusion message

When relaying a JMS message to Diffusion, the JMS adapter creates a Diffusion message whose content is the JMS message payload. The headers and properties of the JMS message are ignored.

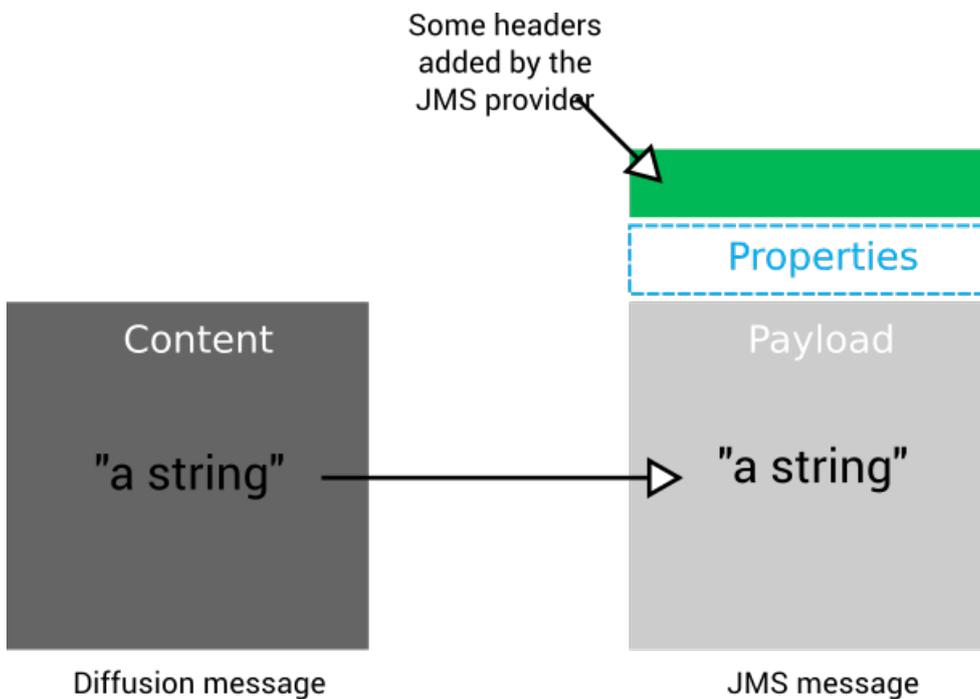


Figure 45: Basic mapping from a Diffusion message to a JMS message

When relaying a Diffusion message to JMS, the JMS adapter sets the JMS message payload to be the Diffusion content. The JMS adapter does not set any properties or headers on the JMS message. The JMS provider sets any mandatory headers that are required on the JMS message.

JSON transformation

In a JSON transformation all information is relayed both directions. The JMS message information is expressed in JSON format inside the Diffusion message content.

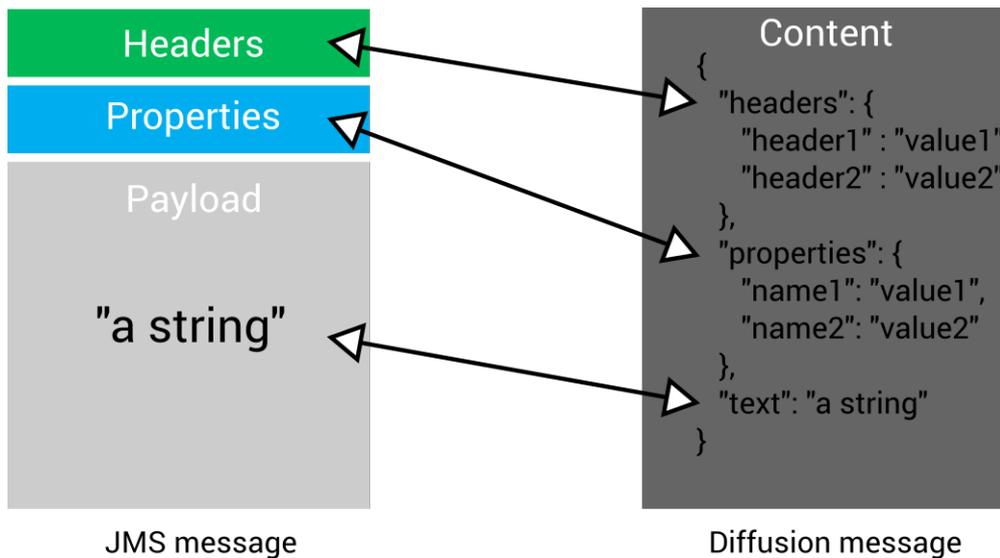


Figure 46: Mapping from a JMS message to and from JSON in a Diffusion message

When relaying a JMS message to Diffusion, the JMS adapter performs the following actions:

- Expresses the Diffusion content as a single JSON object.
- Maps the JMS message headers to a JSON object called “headers” inside of the Diffusion message content. The “headers” object contains all of the JMS message headers as name-value pairs. For example,

```
"headers": {
  "JMSType": "abc",
  "JMSPriority": 9
}
```

- Maps the JMS message properties to a JSON object called “properties” inside of the Diffusion message content. The “properties” object contains all of the JMS message properties as name-value pairs. For example,

```
"properties": {
  "AString": "def",
  "ABoolean": true
}
```

- Maps the textual payload of the JMS message to a JSON item called “text” inside of the Diffusion message content. For example,

```
"text": "Message content"
```

When relaying a Diffusion message to JMS, the JMS adapter parses the JSON content of the Diffusion message and uses the information to set the headers, properties, and payload of the JMS message accordingly.

Related concepts

[JMS](#) on page 125

Consider whether to incorporate JMS providers into your solution.

[Sending messages using the JMS adapter](#) on page 714

The JMS adapter can send messages from a Diffusion client to a JMS destination and messages from a JMS destination to a specific Diffusion client.

[Publishing using the JMS adapter](#) on page 713

The JMS adapter can publish data from a JMS destination onto topics in the Diffusion topic tree.

[Using JMS request-response services with the JMS adapter](#) on page 716

You can use the messaging capabilities of the JMS adapter to interact with a JMS service through request-response.

[Configuring the JMS adapter](#) on page 718

Use the `JMSAdapter.xml` configuration file to configure the JMS adapter to send and receive messages with destinations on a JMS server.

Publishing using the JMS adapter

The JMS adapter can publish data from a JMS destination onto topics in the Diffusion topic tree.

Publishing data from a JMS destination onto a Diffusion topic

You can configure the JMS adapter to subscribe to a JMS destination and to associate that subscription with a Diffusion topic.

The Diffusion topic can be stateful or stateless, but stateful topics must be created with an initial value. For more information, see [Example: Configuring topics for use with the JMS adapter](#) on page 722.

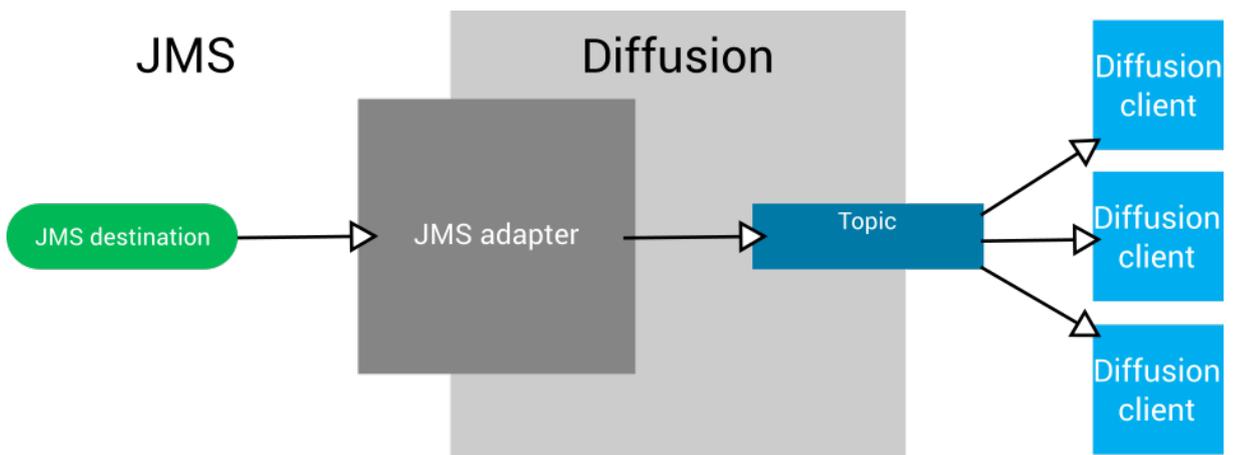


Figure 47: JMS adapter: Publishing from JMS to Diffusion

1. A message is published to the JMS destination.
2. The JMS adapter receives the JMS message.
3. The JMS adapter transforms the JMS message into a Diffusion message. For more information, see [Transforming JMS messages into Diffusion messages or updates](#) on page 709.
4. The JMS adapter publishes the transformed message to the Diffusion topic.
5. Diffusion clients that are subscribed to the Diffusion topic receive the transformed message.

Publishing data from a Diffusion topic to a JMS destination

This is not currently supported.

Related concepts

[JMS](#) on page 125

Consider whether to incorporate JMS providers into your solution.

[Transforming JMS messages into Diffusion messages or updates](#) on page 709

JMS messages are more complex than Diffusion content. A transformation is required between the two formats.

[Sending messages using the JMS adapter](#) on page 714

The JMS adapter can send messages from a Diffusion client to a JMS destination and messages from a JMS destination to a specific Diffusion client.

[Using JMS request-response services with the JMS adapter](#) on page 716

You can use the messaging capabilities of the JMS adapter to interact with a JMS service through request-response.

[Configuring the JMS adapter](#) on page 718

Use the `JMSAdapter.xml` configuration file to configure the JMS adapter to send and receive messages with destinations on a JMS server.

[Example: Configuring pub-sub with the JMS adapter](#) on page 722

Use the `subscriptions` element of the `JMSAdapter.xml` configuration file to define JMS adapter subscriptions to JMS destinations and the Diffusion topics to publish updates to.

Sending messages using the JMS adapter

The JMS adapter can send messages from a Diffusion client to a JMS destination and messages from a JMS destination to a specific Diffusion client.

Sending a message from a Diffusion client to a JMS destination

You can configure the JMS adapter to handle messages sent on a Diffusion message path and to associated messages received on that message path with a JMS destination.

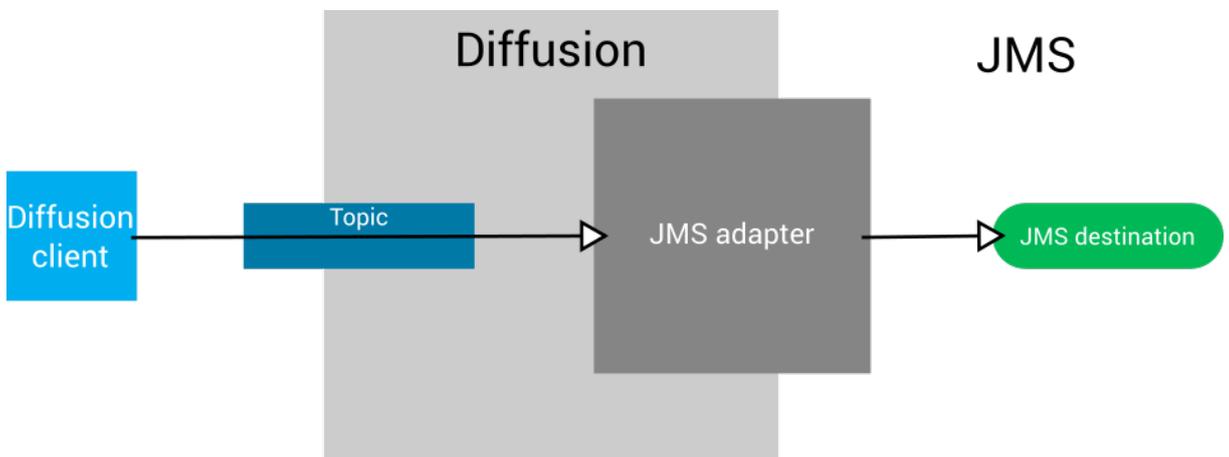


Figure 48: JMS adapter: Message flow from Diffusion to JMS

1. A Diffusion client sends a message to a topic path.
2. The JMS adapter receives the message.
3. The JMS adapter transforms the Diffusion message into a JMS message. For more information, see [Transforming JMS messages into Diffusion messages or updates](#) on page 709.
4. The JMS adapter sets a JMS header or property to include the Diffusion server name of the JMS adapter and the session ID of the Diffusion client.

This header or property is used as a return address for any response messages and is nominated using the `routingProperty` configuration element. By convention, `JMS CorrelationID` is often used. For more information, see .

5. The JMS adapter publishes the transformed message to the JMS destination.

Sending a message from a JMS destination to a Diffusion client

You can configure the JMS adapter to subscribe to a JMS destination and to associate that subscription with a Diffusion message path to send a message through.

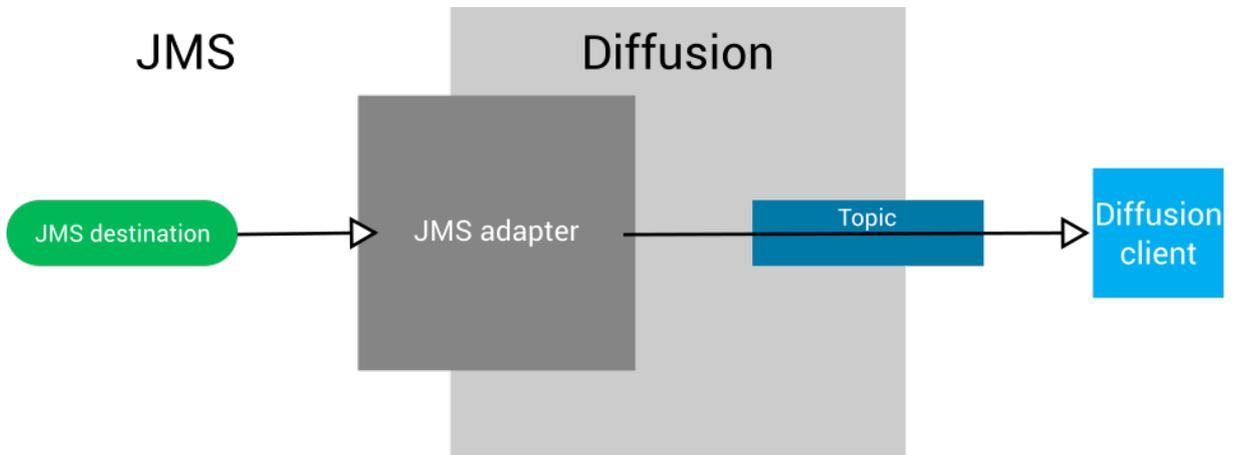


Figure 49: JMS adapter: Message flow from JMS to Diffusion

1. The JMS adapter receives a message from a JMS destination.
2. The JMS adapter transforms the JMS message into a Diffusion message. For more information, see [Transforming JMS messages into Diffusion messages or updates](#) on page 709.
3. The JMS adapter checks the nominated JMS header or property for the server name and session ID of the recipient client.

This header or property is nominated using the `routingProperty` configuration element. For more information, see .

4. The JMS adapter sends the transformed message through the message path to the recipient client session.

Error scenarios

- The JMS adapter consumes a message from a JMS destination that is not intended for it. That is, the routing property or header does not contain the Diffusion server name of the JMS adapter.

In this case, the JMS adapter drops the message and logs the failure to deliver.

You can avoid this scenario by using a JMS selector when subscribing to the JMS destination that specifies the JMS adapter is only interested in messages whose routing property or header include its Diffusion server name.

- The JMS adapter receives a message from a Diffusion client, but cannot send it on to JMS because the JMS provider is not connected.

In this case, the JMS adapter returns the message to the client on the same topic and logs the failure to deliver.

- The JMS adapter receives a message from a JMS destination, but cannot send it on to the Diffusion client because the Diffusion client is not connected.

In this case, the JMS adapter drops the message and logs the failure to deliver.

Related concepts

[JMS](#) on page 125

Consider whether to incorporate JMS providers into your solution.

[Transforming JMS messages into Diffusion messages or updates](#) on page 709

JMS messages are more complex than Diffusion content. A transformation is required between the two formats.

[Publishing using the JMS adapter](#) on page 713

The JMS adapter can publish data from a JMS destination onto topics in the Diffusion topic tree.

[Using JMS request-response services with the JMS adapter](#) on page 716

You can use the messaging capabilities of the JMS adapter to interact with a JMS service through request-response.

[Configuring the JMS adapter](#) on page 718

Use the `JMSAdapter.xml` configuration file to configure the JMS adapter to send and receive messages with destinations on a JMS server.

[Example: Configuring messaging with the JMS adapter](#) on page 723

Use the `publications` element of the `JMSAdapter.xml` configuration file to define how Diffusion clients send messages to JMS destinations. Use the `subscriptions` element of the `JMSAdapter.xml` configuration file to define how Diffusion clients receive messages from JMS destinations.

Using JMS request-response services with the JMS adapter

You can use the messaging capabilities of the JMS adapter to interact with a JMS service through request-response.

Exposing a JMS service through Diffusion messaging is a typical use case for the JMS adapter.

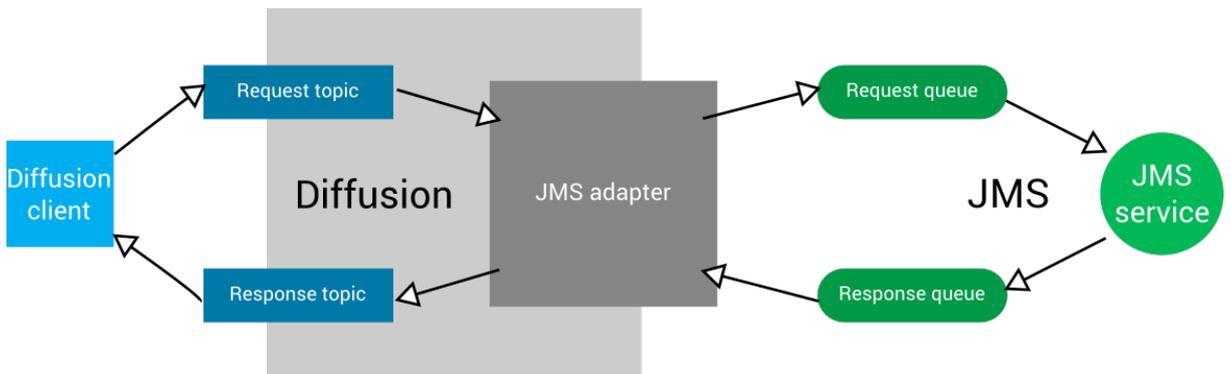


Figure 50: JMS adapter: Request-response message flow

1. A Diffusion client sends a message to a Diffusion message path configured in the JMS adapter to receive service requests.
2. The JMS adapter receives the message on the request message path.
3. The JMS adapter transforms the Diffusion message into a JMS message. For more information, see [Transforming JMS messages into Diffusion messages or updates](#) on page 709.
4. The JMS adapter adds a routing property or header to the JMS message identifying the Diffusion server and client to return a response to. This return information is of the form `server_name/client_session_id`.
5. The JMS adapter sends the message to the JMS service request queue.
6. The JMS service receives the request.
7. The JMS service acts on the request.
8. The JMS service places a response message on its response queue. This message must include the routing property or header that identifies the Diffusion server and client to return the response to.
9. The JMS adapter receives the response message from the JMS response queue.

10. The JMS adapter transforms the response message into a Diffusion message. For more information, see [Transforming JMS messages into Diffusion messages or updates](#) on page 709.
11. The JMS adapter uses the information in the routing property or header to discover the connected client session to relay the response to.
12. The JMS adapter sends the response message to the Diffusion client through a message path.

Error scenarios

- The JMS adapter consumes a message from a JMS service response queue that is not intended for it. That is, the routing property or header does not contain the Diffusion server name of the JMS adapter.

In this case, the JMS adapter drops the message and logs the failure to deliver.

You can avoid this scenario by using a JMS selector when subscribing to the JMS queue that specifies the JMS adapter is only interested in messages whose routing property or header include its Diffusion server name.

- The JMS adapter receives a message from a Diffusion client, but cannot send it on to JMS because the JMS provider is not connected.

In this case, the JMS adapter returns the message to the client on the same topic and logs the failure to deliver.

- The JMS adapter receives a message from a JMS destination, but cannot send it on to the Diffusion client because the Diffusion client is not connected.

In this case, the JMS adapter drops the message and logs the failure to deliver.

Related concepts

[JMS](#) on page 125

Consider whether to incorporate JMS providers into your solution.

[Transforming JMS messages into Diffusion messages or updates](#) on page 709

JMS messages are more complex than Diffusion content. A transformation is required between the two formats.

[Sending messages using the JMS adapter](#) on page 714

The JMS adapter can send messages from a Diffusion client to a JMS destination and messages from a JMS destination to a specific Diffusion client.

[Publishing using the JMS adapter](#) on page 713

The JMS adapter can publish data from a JMS destination onto topics in the Diffusion topic tree.

[Configuring the JMS adapter](#) on page 718

Use the `JMSAdapter.xml` configuration file to configure the JMS adapter to send and receive messages with destinations on a JMS server.

[Example: Configuring the JMS adapter to work with JMS services](#) on page 725

Use the `publications` and `subscriptions` elements of the `JMSAdapter.xml` configuration file to define the message flow for using Diffusion with JMS services.

Configuring the JMS adapter

Use the `JMSAdapter.xml` configuration file to configure the JMS adapter to send and receive messages with destinations on a JMS server.

The format of the `JMSAdapter.xml` configuration file is the same whether you run it within the Diffusion server or as a standalone client. However, the `server-connection` element and child elements are only used when the JMS adapter is run as a standalone client. If the `server-connection` element is included in a `JMSAdapter.xml` configuration file used when the JMS adapter runs within the Diffusion server, the JMS adapter ignores the element.

The `JMSAdapter.xml` and the `JMSAdapter.xsd` schema file that describes its format are available in the `adapters/jms` directory of the Diffusion installation. For more information, see .

In the `JMSAdapter.xml` file, you can configure the following aspects of the JMS adapter behavior:

- The JMS provider to connect to.
For more information, see [Example: Configuring JMS providers for the JMS adapter](#) on page 720.
- The Diffusion topics to create and use.
For more information, see [Example: Configuring topics for use with the JMS adapter](#) on page 722.
- The JMS destinations to subscribe to and the Diffusion topics to publish data from the JMS destination to.
For more information, see [Example: Configuring pub-sub with the JMS adapter](#) on page 722.
- How messages are sent between Diffusion clients and JMS destinations through Diffusion topics.
For more information, see [Example: Configuring messaging with the JMS adapter](#) on page 723.
- A request-response message flow.
For more information, see [Example: Configuring the JMS adapter to work with JMS services](#) on page 725.

Configuring the JMS adapter to run within the Diffusion server

The JMS adapter running inside the Diffusion server uses the `JMSAdapter.xml` configuration file that is located in the `adapters` directory of the Diffusion installation.

When running inside the Diffusion server, the JMS adapter polls the `JMSAdapter.xml` file at five second intervals. If the timestamp changes in that interval, the JMS adapter reloads the configuration file.

When the JMS adapter reloads the configuration file, changes to the configuration are reflected in the set of Diffusion topics created and used by the JMS adapter:

- If the topic configuration is not changed, the topic is not changed on the Diffusion server.
- If a topic configuration is added, that topic is added on the Diffusion server.
- If a topic configuration is removed, that topic is deleted from the Diffusion server.
- If a topic configuration is changed – for example, if its definition is changed from stateful to stateless – that topic is deleted from the Diffusion server and a new topic is created at the same path.

Any removal of topics as part of a configuration update causes clients to become unsubscribed from the deleted topic.

When updating the `JMSAdapter.xml` configuration file on your running Diffusion server, consider using the following practices:

- Back up your original configuration file. For example, by moving it to `JMSAdapter.xml.bak`.
If a configuration file is not present, the JMS adapter continues to use its current configuration.
- Do not copy the new configuration file into place. Use a move operation instead. Move operations are atomic and remove the risk of the JMS adapter reading an incomplete file.
- In a production environment, rigorously test any new configuration file before deploying on a production server.

If the new configuration file contains an error, the configuration changes it contains are not applied. Instead the configuration rolls back to the original version and an error is logged.

Configuring the JMS adapter to run as a standalone client

When running as a standalone client, the JMS adapter uses the `JMSAdapter.xml` configuration file that is passed to the `jms_adapter.sh` or `jms_adapter.bat` file used to start the JMS adapter.

The JMS adapter standalone client loads the `JMSAdapter.xml` file only once, when the JMS adapter is started. To update the configuration used by the JMS adapter, edit the `JMSAdapter.xml` file and restart the JMS adapter.

Topics created by the JMS adapter when it runs as a standalone client remain on the Diffusion server after the JMS adapter session closes.

The `server-connection` element of the `JMSAdapter.xml` configuration file is used by the standalone client version of JMS adapter to define the connection that the JMS adapter makes to the Diffusion server. For more information, see [Example: Configuring the Diffusion connection for the JMS adapter running as a standalone client](#) on page 720.

Related concepts

[JMS](#) on page 125

Consider whether to incorporate JMS providers into your solution.

[Transforming JMS messages into Diffusion messages or updates](#) on page 709

JMS messages are more complex than Diffusion content. A transformation is required between the two formats.

[Sending messages using the JMS adapter](#) on page 714

The JMS adapter can send messages from a Diffusion client to a JMS destination and messages from a JMS destination to a specific Diffusion client.

[Publishing using the JMS adapter](#) on page 713

The JMS adapter can publish data from a JMS destination onto topics in the Diffusion topic tree.

[Using JMS request-response services with the JMS adapter](#) on page 716

You can use the messaging capabilities of the JMS adapter to interact with a JMS service through request-response.

[Example: Configuring JMS providers for the JMS adapter](#) on page 720

Use the `providers` element of the `JMSAdapter.xml` configuration file to define the JMS providers that the JMS adapter can connect to.

[Example: Configuring topics for use with the JMS adapter](#) on page 722

Use the `topics` element of the `JMSAdapter.xml` configuration file to define the Diffusion topics that the JMS adapter uses. These topics are created when the JMS adapter starts.

[Example: Configuring messaging with the JMS adapter](#) on page 723

Use the `publications` element of the `JMSAdapter.xml` configuration file to define how Diffusion clients send messages to JMS destinations. Use the `subscriptions` element of the

JMSAdapter.xml configuration file to define how Diffusion clients receive messages from JMS destinations.

[Example: Configuring pub-sub with the JMS adapter](#) on page 722

Use the `subscriptions` element of the JMSAdapter.xml configuration file to define JMS adapter subscriptions to JMS destinations and the Diffusion topics to publish updates to.

[Example: Configuring the JMS adapter to work with JMS services](#) on page 725

Use the `publications` and `subscriptions` elements of the JMSAdapter.xml configuration file to define the message flow for using Diffusion with JMS services.

Example: Configuring the Diffusion connection for the JMS adapter running as a standalone client

Standalone client only: Use the `server-connection` element of the JMSAdapter.xml configuration file to define the connection that the JMS adapter makes to the Diffusion server.

```
<server-connection>
  <server url="transport://host:port" reconnection="timeout">
    <authentication principal="principal">
      <password>password</password>
    </authentication>
  </server>
  <properties>
    <serverName>name</serverName>
  </properties>
</server-connection>
```

- The `url` attribute of the `server` element is the URL of the Diffusion server to connect to, including the transport protocol and the port to use for the connection.
- The `authentication` element defines the principal and password to use to make the connection to the Diffusion server

Note: The JMS adapter requires a session that has the `TOPIC_CONTROL` role. Specify a principal with this role for the JMS adapter to use to make the connection.

- The `serverName` element is where you define a unique identifier to be used by the JMS adapter in correlation IDs used in messaging. This

Example: Configuring JMS providers for the JMS adapter

Use the `providers` element of the JMSAdapter.xml configuration file to define the JMS providers that the JMS adapter can connect to.

Copy any provider JAR files that are required into the `ext` directory of your Diffusion server to ensure that they are on the server classpath.

ActiveMQ

You can connect to an ActiveMQ instance by defining a `provider` element that contains the required JNDI, credentials, and session information. See the following example:

```
<providers>
  <provider name="myActiveMQ">
    <jndiProperties>
      <property name="java.naming.factory.initial"
value="org.apache.activemq.jndi.ActiveMQInitialContextFactory"/>
      <property name="java.naming.provider.url"
value="tcp://hostname:61616"/>
    </jndiProperties>
```

```

    <jmsProperties connectionFactoryName="ConnectionFactory">
      <credentials>
        <username>user</username>
        <password>password</password>
      </credentials>
    </jmsProperties>

    <sessions>
      <anonymousSessions number="1" transacted="false"
acknowledgeMode="AUTO_ACKNOWLEDGE" />
    </sessions>

  </provider>
</providers>

```

IBM MQ

You can connect to an IBM MQ instance by defining a `provider` element that contains the required information. See the following example:

```

<providers>
  <provider name="myIBMMQ">
    <jndiProperties>
      <property name="java.naming.factory.initial"
value="com.sun.jndi.fscontext.RefFSContextFactory" />
      <property name="java.naming.provider.url"
value="hostname:1414" />
    </jndiProperties>

    <jmsProperties connectionFactoryName="CF2">
      <sessions>
        <anonymousSessions number="2" transacted="false"
acknowledgeMode="AUTO_ACKNOWLEDGE" />
      </sessions>
    </jmsProperties>

  </provider>
</providers>

```

Related concepts

[Example: Configuring topics for use with the JMS adapter on page 722](#)

Use the `topics` element of the `JMSAdapter.xml` configuration file to define the Diffusion topics that the JMS adapter uses. These topics are created when the JMS adapter starts.

[Example: Configuring messaging with the JMS adapter on page 723](#)

Use the `publications` element of the `JMSAdapter.xml` configuration file to define how Diffusion clients send messages to JMS destinations. Use the `subscriptions` element of the `JMSAdapter.xml` configuration file to define how Diffusion clients receive messages from JMS destinations.

[Example: Configuring pub-sub with the JMS adapter on page 722](#)

Use the `subscriptions` element of the `JMSAdapter.xml` configuration file to define JMS adapter subscriptions to JMS destinations and the Diffusion topics to publish updates to.

[Example: Configuring the JMS adapter to work with JMS services on page 725](#)

Use the `publications` and `subscriptions` elements of the `JMSAdapter.xml` configuration file to define the message flow for using Diffusion with JMS services.

[Configuring the JMS adapter on page 718](#)

Use the `JMSAdapter.xml` configuration file to configure the JMS adapter to send and receive messages with destinations on a JMS server.

Example: Configuring topics for use with the JMS adapter

Use the `topics` element of the `JMSAdapter.xml` configuration file to define the Diffusion topics that the JMS adapter uses. These topics are created when the JMS adapter starts.

The following example shows the definitions for a stateless and a stateful topic:

```
<topics>
  <stateless name="example/updates/stateless" />
  <stateful name="example/updates/stateful" initialState="rhubarb" />
</topics>
```

- The JMS adapter cannot create or use topics that are in a branch of the topic tree that is created by another publisher or client. For example, if `example/updates` already exists and was created by a Diffusion client, the JMS adapter cannot create and use `example/updates/stateless`.
- Similarly, other clients and publishers cannot create or use topics in a branch of the topic tree that was created by the JMS adapter.
- All stateful topics are created as single value topics.
- When defining a stateful topic, you must set the initial state of the topic.

Related concepts

[Example: Configuring JMS providers for the JMS adapter](#) on page 720

Use the `providers` element of the `JMSAdapter.xml` configuration file to define the JMS providers that the JMS adapter can connect to.

[Example: Configuring messaging with the JMS adapter](#) on page 723

Use the `publications` element of the `JMSAdapter.xml` configuration file to define how Diffusion clients send messages to JMS destinations. Use the `subscriptions` element of the `JMSAdapter.xml` configuration file to define how Diffusion clients receive messages from JMS destinations.

[Example: Configuring pub-sub with the JMS adapter](#) on page 722

Use the `subscriptions` element of the `JMSAdapter.xml` configuration file to define JMS adapter subscriptions to JMS destinations and the Diffusion topics to publish updates to.

[Example: Configuring the JMS adapter to work with JMS services](#) on page 725

Use the `publications` and `subscriptions` elements of the `JMSAdapter.xml` configuration file to define the message flow for using Diffusion with JMS services.

[Configuring the JMS adapter](#) on page 718

Use the `JMSAdapter.xml` configuration file to configure the JMS adapter to send and receive messages with destinations on a JMS server.

Example: Configuring pub-sub with the JMS adapter

Use the `subscriptions` element of the `JMSAdapter.xml` configuration file to define JMS adapter subscriptions to JMS destinations and the Diffusion topics to publish updates to.

The following example shows subscriptions to JMS destinations defined by the `destination` elements. When the JMS adapter receives an update message through the subscription, it publishes that update message to the Diffusion topic defined in the corresponding `publish` element.

```
<subscriptions>
  <subscription>
```

```

    <destination>jms:topic:EXAMPLE.UPDATE.TOPIC</destination>
    <publish topicName="example/updates/stateless"/>
  </subscription>
  <subscription>
    <destination>jms:topic:EXAMPLE.UPDATE.TOPICTWO</destination>
    <publish topicName="example/updates/stateful"/>
  </subscription>
</subscriptions>

```

The Diffusion topics must be defined in the `topics` section of the `JMSAdapter.xml` configuration file.

Related concepts

[Example: Configuring JMS providers for the JMS adapter](#) on page 720

Use the `providers` element of the `JMSAdapter.xml` configuration file to define the JMS providers that the JMS adapter can connect to.

[Example: Configuring topics for use with the JMS adapter](#) on page 722

Use the `topics` element of the `JMSAdapter.xml` configuration file to define the Diffusion topics that the JMS adapter uses. These topics are created when the JMS adapter starts.

[Example: Configuring messaging with the JMS adapter](#) on page 723

Use the `publications` element of the `JMSAdapter.xml` configuration file to define how Diffusion clients send messages to JMS destinations. Use the `subscriptions` element of the `JMSAdapter.xml` configuration file to define how Diffusion clients receive messages from JMS destinations.

[Example: Configuring the JMS adapter to work with JMS services](#) on page 725

Use the `publications` and `subscriptions` elements of the `JMSAdapter.xml` configuration file to define the message flow for using Diffusion with JMS services.

[Publishing using the JMS adapter](#) on page 713

The JMS adapter can publish data from a JMS destination onto topics in the Diffusion topic tree.

[Configuring the JMS adapter](#) on page 718

Use the `JMSAdapter.xml` configuration file to configure the JMS adapter to send and receive messages with destinations on a JMS server.

Example: Configuring messaging with the JMS adapter

Use the `publications` element of the `JMSAdapter.xml` configuration file to define how Diffusion clients send messages to JMS destinations. Use the `subscriptions` element of the `JMSAdapter.xml` configuration file to define how Diffusion clients receive messages from JMS destinations.

From Diffusion clients to JMS destinations

The following example defines the Diffusion path through which the JMS adapter receives messages from a Diffusion client and the JMS destination to send those messages to.

```

<publications>
  <publication>
    <destination>jms:queue:EXAMPLE.REQUEST.QUEUE</destination>
    <messaging
      topicName="example/topic/requests"
      routingProperty="JMSCorrelationID">
      <transformation type="basic">
        <sessionProperties>
          <sessionProperty from="$Principal"
            to="diffusionPrincipal"/>

```

```

        </sessionProperties>
    </transformation>
</messaging>
</publication>
</publications>

```

- The `routingProperty` attribute describes the JMS header or property that the JMS adapter uses to set or get the client session ID.
- The `transformation` section defines how a message is transformed between a JMS message and a Diffusion message. For more information, see [Transforming JMS messages into Diffusion messages or updates](#) on page 709.
- The `sessionProperties` section defines whether the Diffusion session properties of the client that sends the message are included as JMS headers or properties in the transformed message. Currently, only `$Principal` is supported.

From JMS destinations to Diffusion clients

The following example defines the JMS destination that the JMS adapter retrieves messages on and the Diffusion path through which the JMS adapter relays those messages to a Diffusion client.

```

<subscriptions>
  <subscription>
    <destination>jms:queue:EXAMPLE.UPDATE.QUEUE</destination>
    <options noLocal="true" />
    <messaging
      topicName="example/direct/messages"
      routingProperty="JMSCorrelationID" />
  </subscription>
</subscriptions>

```

- The `routingProperty` attribute describes the JMS header or property that the JMS adapter uses to set or get the client session ID.
- The `noLocal` attribute of the `options` element defines whether the JMS adapter does not retrieve messages from a JMS queue that it is the originator of.

Related concepts

[Example: Configuring JMS providers for the JMS adapter](#) on page 720

Use the `providers` element of the `JMSAdapter.xml` configuration file to define the JMS providers that the JMS adapter can connect to.

[Example: Configuring topics for use with the JMS adapter](#) on page 722

Use the `topics` element of the `JMSAdapter.xml` configuration file to define the Diffusion topics that the JMS adapter uses. These topics are created when the JMS adapter starts.

[Example: Configuring pub-sub with the JMS adapter](#) on page 722

Use the `subscriptions` element of the `JMSAdapter.xml` configuration file to define JMS adapter subscriptions to JMS destinations and the Diffusion topics to publish updates to.

[Example: Configuring the JMS adapter to work with JMS services](#) on page 725

Use the `publications` and `subscriptions` elements of the `JMSAdapter.xml` configuration file to define the message flow for using Diffusion with JMS services.

[Sending messages using the JMS adapter](#) on page 714

The JMS adapter can send messages from a Diffusion client to a JMS destination and messages from a JMS destination to a specific Diffusion client.

[Configuring the JMS adapter](#) on page 718

Use the `JMSAdapter.xml` configuration file to configure the JMS adapter to send and receive messages with destinations on a JMS server.

Example: Configuring the JMS adapter to work with JMS services

Use the `publications` and `subscriptions` elements of the `JMSAdapter.xml` configuration file to define the message flow for using Diffusion with JMS services.

In the following example, the `publications` section defines the JMS destination to put request messages on and the Diffusion path through which the JMS adapter receives those request messages from a Diffusion client. The `subscriptions` section defines the JMS destination that the JMS adapter retrieves response messages on and the Diffusion path through which the JMS adapter relays those messages to a Diffusion client.

```
<publications>
  <publication>
    <destination>jms:queue:REQUEST.QUEUE</destination>
    <messaging topicName="example/requests"
      routingProperty="JMSCorrelationID" />
  </publication>
</publications>
<subscriptions>
  <subscription>
    <destination>jms:queue:RESPONSE.QUEUE</destination>
    <options noLocal="true">
      <selector>JMSCorrelationID like '${serverName}/%'</
selector>
    </options>
    <messaging topicName="example/responses"
      routingProperty="JMSCorrelationID" />
  </subscription>
</subscriptions>
```

- The `routingProperty` attribute describes the JMS header or property that the JMS adapter uses to set or get the client session ID.
- The `noLocal` attribute of the `options` element defines whether the JMS adapter does not retrieve messages from a JMS queue that it is the originator of.
- When subscribing to a JMS destination, the JMS adapter can use selectors. In this example, the selector used requires that the routing property, in this case `JMSCorrelationID`, contains the name of the Diffusion server where the JMS adapter is deployed. This prevents the JMS adapter from consuming messages that are not intended for it.

The JMS adapter replaces the variable `${serverName}` with the name of its server. The server name is defined in the `serverName` element of the `JMSAdapter.xml` file when the JMS adapter runs as a standalone client. When the JMS adapter runs within the Diffusion server, the server name is defined by the `Server.xml` configuration file.

Related concepts

[Example: Configuring JMS providers for the JMS adapter](#) on page 720

Use the `providers` element of the `JMSAdapter.xml` configuration file to define the JMS providers that the JMS adapter can connect to.

[Example: Configuring topics for use with the JMS adapter](#) on page 722

Use the `topics` element of the `JMSAdapter.xml` configuration file to define the Diffusion topics that the JMS adapter uses. These topics are created when the JMS adapter starts.

[Example: Configuring messaging with the JMS adapter](#) on page 723

Use the `publications` element of the `JMSAdapter.xml` configuration file to define how Diffusion clients send messages to JMS destinations. Use the `subscriptions` element of the

JMSAdapter.xml configuration file to define how Diffusion clients receive messages from JMS destinations.

[Example: Configuring pub-sub with the JMS adapter](#) on page 722

Use the `subscriptions` element of the JMSAdapter.xml configuration file to define JMS adapter subscriptions to JMS destinations and the Diffusion topics to publish updates to.

[Using JMS request-response services with the JMS adapter](#) on page 716

You can use the messaging capabilities of the JMS adapter to interact with a JMS service through request-response.

[Configuring the JMS adapter](#) on page 718

Use the JMSAdapter.xml configuration file to configure the JMS adapter to send and receive messages with destinations on a JMS server.

JMSAdapter.xml

This file specifies the schema for the configuration required by the JMS adapter. Note that JMS topics and queues are referred to only as destinations. Topics refers exclusively to Diffusion topics.

JMSRootConfig

The mandatory root node of the JMS adapter configuration.

The following table lists the elements that an element of type `JMSRootConfig` can contain:

Name	Type	Description	Min occurs	Max occurs
topics	JMSTopicsConfig	The set of Diffusion topics created at startup.	0	1
providers	JMSProvidersConfig	The set of JMS providers.	1	1
server-connection	ServerConnectionConfig	Configuration specific to the JMS adapter when run as a client. When run as a publisher this is ignored.	0	1

JMSTopicsConfig

The set of Diffusion topics created at startup. Diffusion Unified client messaging does not require an existing topic, but Diffusion publishing and Diffusion Classic client messaging do.

The following table lists the elements that an element of type `JMSTopicsConfig` can contain:

Name	Type	Description	Min occurs	Max occurs
stateful	JMSStatefulTopicConfig	The configuration required to create a stateful Diffusion topic, including the initial state of the topic.	0	unbounded
stateless	JMSTopicConfig	The configuration required to create a Diffusion topic.	0	unbounded

JMSTopicConfig

The configuration required to create a Diffusion .

The following table lists the attributes that an element of type `JMSTopicConfig` can have:

Name	Type	Description	Required
name	xs:string	The full topic path of the topic to create. For example, 'foo/bar/baz'.	true
reference	xs:string	A string value to associate with this topic. For example, a description of the topic. Topic references are honored only when the JMS adapter runs as a publisher. DEPRECATED: Future versions of the product might not support this.	false

JMSStatefulTopicConfig

The following table lists the attributes that an element of type `JMSStatefulTopicConfig` can have:

Name	Type	Description	Required
initialState	xs:string	The initial state of a topic when the topic is created.	false

JNDIPropertiesConfig

The set of named values required to to create an InitialContext to access the JNDI configuration of the JMS server. Individual JMS providers will provide documentation on this step.

The following table lists the elements that an element of type `JNDIPropertiesConfig` can contain:

Name	Type	Description	Min occurs	Max occurs
property	JNDIProperty	A named value.	0	unbounded

JNDIProperty

A named value.

The following table lists the attributes that an element of type `JNDIProperty` can have:

Name	Type	Description	Required
name	xs:string	The property name.	true
value	xs:string	The property value.	true

JMSProviderConfig

The configuration model to connect to a JMS provider (a broker), establish sessions, subscribe, and publish to destinations.

The following table lists the attributes that an element of type `JMSProviderConfig` can have:

Name	Type	Description	Required
name	xs:string	The name associated with this configuration model.	false

The following table lists the elements that an element of type `JMSProviderConfig` can contain:

Name	Type	Description	Min occurs	Max occurs
jndiProperties	JNDIPropertiesConfig	The set of named values required to create an InitialContext to access the JNDI configuration of the JMS server.	1	1
jmsProperties	JMSConnectionConfig	The configuration related to connection to the JMS provider.	1	1
sessions	JMSSessionsConfig	The configuration for all JMS sessions related to this JMS provider.	1	1
reconnection	JMSReconnectionConfig	The configuration for reconnection behavior.	0	1
subscriptions	JMSSubscriptionsConfig	The set of subscriptions to JMS destinations.	0	1
publications	JMSPublicationsConfig	The set of publications to JMS destinations.	0	1

JMSProvidersConfig

The set of JMS providers.

The following table lists the elements that an element of type `JMSProvidersConfig` can contain:

Name	Type	Description	Min occurs	Max occurs
provider	JMSProviderConfig	The configuration model to connect to a JMS provider.	0	unbounded

JMSSessionsConfig

The configuration for all JMS sessions related to this JMS provider.

The following table lists the elements that an element of type `JMSSessionsConfig` can contain:

Name	Type	Description	Min occurs	Max occurs
anonymousSessions	JMSAnonymousSessionsConfig	A number of JMS sessions shared between JMSSubscriptions.	1	1
namedSessions	JMSNamedSessionsConfig	The set of named JMS sessions, optionally used by JMSSubscription nodes in order to guarantee ordering, or use specific JMS session properties.	0	1

JMSAnonymousSessionsConfig

A number of JMS sessions shared between JMSSubscriptions.

The following table lists the attributes that an element of type `JMSAnonymousSessionsConfig` can have:

Name	Type	Description	Required
number	PositiveInteger	The number of shared JMS sessions	true

JMSNamedSessionsConfig

The set of named JMS sessions, optionally used by JMSSubscription nodes in order to guarantee ordering, or use specific JMS session properties.

The following table lists the elements that an element of type `JMSNamedSessionsConfig` can contain:

Name	Type	Description	Min occurs	Max occurs
session	<code>JMSNamedSessionConfig</code>	A named set of configuration relating to the placing of a JMS session.	1	unbounded

JMSReconnectionConfig

Following a disconnection event the adapter optionally attempts periodic reconnection. The first reconnection attempt occurs after `minFrequency` seconds, and the following after twice that number. The back-off time value doubles until it reaches the `maxFrequency` value in seconds. For example, where `minFrequency=2` and `maxFrequency=10`, the reconnection will be attempted after 2s, 4s, 8s, 10s, 10s and so on.

The following table lists the attributes that an element of type `JMSReconnectionConfig` can have:

Name	Type	Description	Required
<code>minFrequency</code>	<code>PositiveInteger</code>	The interval between disconnection and the first reconnection attempt (in seconds). The interval is doubled for each subsequent reconnection attempt.	true
<code>maxFrequency</code>	<code>PositiveInteger</code>	The maximum interval between reconnection attempts.	true

JMSSubscriptionsConfig

The set of subscriptions to JMS destinations.

The following table lists the elements that an element of type `JMSSubscriptionsConfig` can contain:

Name	Type	Description	Min occurs	Max occurs
subscription	<code>JMSSubscriptionConfig</code>	Configuration to subscribe to a JMS destination and relay to Diffusion topics or messaging or both.	0	unbounded

JMSPublicationsConfig

The set of publications to JMS destinations.

The following table lists the elements that an element of type `JMSPublicationsConfig` can contain:

Name	Type	Description	Min occurs	Max occurs
publication	<code>JMSPublicationConfig</code>	Configuration to receive Diffusion topic messaging and relay to a JMS destination.	0	unbounded

JMSSubscriptionConfig

Configuration to subscribe to a JMS destination and relay to Diffusion topics

The following table lists the attributes that an element of type `JMSSubscriptionConfig` can have:

Name	Type	Description	Required
sessionName	xs:string	The name of the session to use. This session name must be defined in the <code>namedSessions</code> element. If this element is not defined, the JMS adapter does not start.	false

The following table lists the elements that an element of type `JMSSubscriptionConfig` can contain:

Name	Type	Description	Min occurs	Max occurs
destination	<code>JmsURI</code>	The URI of the JMS destination.	1	1
options	<code>JMSSubscriptionConfig</code>	Configuration relating to publishing in JMS.	0	1
messaging	<code>ClientMessagingConfig</code>	Configuration relating to the sending of a Diffusion message to a single Diffusion client.	0	1
publish	<code>TopicPublishingConfig</code>	Configuration relating to the publishing of a message or setting of a topic's state.	0	1

JMSPublicationConfig

Configuration to receive Diffusion topic messaging and relay to a JMS destination.

The following table lists the elements that an element of type `JMSPublicationConfig` can contain:

Name	Type	Description	Min occurs	Max occurs
destination	<code>JmsURI</code>	The URI of the JMS destination.	1	1
options	<code>JMSPublicationConfig</code>	Configuration relating to publishing to JMS destinations.	0	1
messaging	<code>ClientMessagingConfig</code>	Configuration relating to the sending of a Diffusion message to a single Diffusion client.	0	1

JMSSubscriptionOptions

Options employed when subscribing to a JMS destination.

The following table lists the attributes that an element of type `JMSSubscriptionOptions` can have:

Name	Type	Description	Required
noLocal	xs:boolean	Inhibits the delivery of messages published through its own connection.	false

The following table lists the elements that an element of type `JMSSubscriptionOptions` can contain:

Name	Type	Description	Min occurs	Max occurs
selector	<code>xs:string</code>	SQL 92 compliant expression used to filter messages received from a JMS destination.	0	1

JMSPublicationOptionsConfig

The following table lists the attributes that an element of type `JMSPublicationOptionsConfig` can have:

Name	Type	Description	Required
ttl	<code>PositiveInteger</code>	The Time-To-Live value for a published JMS message, in milliseconds	false
priority	<code>JMSPriorityRange</code>	The higher the number, the higher the priority.	false
deliveryMode	<code>JMSDeliveryMode</code>	Maps to <code>javax.jms.DeliveryMode</code>	false

ClientEndpointConfig

The following table lists the attributes that an element of type `ClientEndpointConfig` can have:

Name	Type	Description	Required
topicName	<code>xs:string</code>	The topic path used by this end point. Depending on the task it might not need to relate to an existing topic.	true

The following table lists the elements that an element of type `ClientEndpointConfig` can contain:

Name	Type	Description	Min occurs	Max occurs
transformation	<code>MessageTransformation</code>	The transformation type to use for messages relayed to and from this topic.	0	1

MessageTransformationConfig

The following table lists the attributes that an element of type `MessageTransformationConfig` can have:

Name	Type	Description	Required
type	<code>MessageTransformationType</code>	The transformation employed when relaying Diffusion to JMS messages, or JMS to Diffusion messages.	false

The following table lists the elements that an element of type `MessageTransformationConfig` can contain:

Name	Type	Description	Min occurs	Max occurs
sessionProperties	SessionPropertyMapping	The set of session property mappings.	0	1

TopicPublishingConfig

Configuration relating to the publishing of a message or setting of a topic's state.

ClientMessagingConfig

Configuration relating to the sending of a Diffusion message to a single Diffusion client.

The following table lists the attributes that an element of type `ClientMessagingConfig` can have:

Name	Type	Description	Required
routingProperty	xs:string	The routingProperty attribute describes a facet of the JMS TextMessage that contains the destination Diffusion client SessionID.	false

SessionPropertyMapping

A mapping from Diffusion session properties to JMS message metadata (JMS headers or properties).

The following table lists the attributes that an element of type `SessionPropertyMapping` can have:

Name	Type	Description	Required
from	xs:string	Currently limited to \$Principal	true
to	xs:string	Values starting with "JMS" are mapped into JMS headers (for example, JMSType), others are mapped into JMS message properties.	true

SessionPropertyMappings

The set of SessionPropertyMappings.

The following table lists the elements that an element of type `SessionPropertyMappings` can contain:

Name	Type	Description	Min occurs	Max occurs
sessionProperty	SessionPropertyMapping	A session property name. Currently, only \$Principal is supported.	1	1

JMSCredentialsConfig

A username and password pair.

The following table lists the elements that an element of type `JMSCredentialsConfig` can contain:

Name	Type	Description	Min occurs	Max occurs
username	xs:string	A username to use to connect to the JMS provider.	1	1

Name	Type	Description	Min occurs	Max occurs
password	xs:string	The password associated with the username.	1	1

JMSConnectionConfig

The configuration related to connection to the JMS provider.

The following table lists the attributes that an element of type `JMSConnectionConfig` can have:

Name	Type	Description	Required
connectionFactoryName	xs:string	The name of the connection factory to use.	true

The following table lists the elements that an element of type `JMSConnectionConfig` can contain:

Name	Type	Description	Min occurs	Max occurs
credentials	JMSCredentialsConfig	Optional credentials, used when connecting to the JMS provider	0	1

JMSSessionConfig

All configuration relating to the placing of a JMS session.

The following table lists the attributes that an element of type `JMSSessionConfig` can have:

Name	Type	Description	Required
transacted	xs:boolean	Currently unsupported.	false
acknowledgeMode	JMSSessionAcknowledgeMode	Currently unsupported.	false

JMSNamedSessionConfig

A `JMSSessionConfig` that can be referred to by name.

The following table lists the attributes that an element of type `JMSNamedSessionConfig` can have:

Name	Type	Description	Required
name	xs:string	Name used to refer to the session elsewhere in the <code>JMSProviderConfig</code> .	true

ServerAuthenticationConfig

Optional session authentication details. The adapter defaults to establishing an anonymous session.

Note: The JMS adapter requires a session that has the `TOPIC_CONTROL` role. Either assign the `TOPIC_CONTROL` role to the anonymous principal or specify a principal with this role for the JMS adapter to use to make the connection.

The following table lists the attributes that an element of type `ServerAuthenticationConfig` can have:

Name	Type	Description	Required
principal	xs:string	The principal used during authentication.	true

The following table lists the elements that an element of type `ServerAuthenticationConfig` can contain:

Name	Type	Description	Min occurs	Max occurs
password	<code>xs:string</code>	Optional plain text password using during authentication.	1	1

ServerConfig

The following table lists the attributes that an element of type `ServerConfig` can have:

Name	Type	Description	Required
reconnection	<code>SessionReconnection</code>	The timeout duration in milliseconds used when attempting to reconnect, or 'none' to prevent any reconnection attempts.	false
url	<code>xs:string</code>	Location of the server to which the adapter connects.	false

The following table lists the elements that an element of type `ServerConfig` can contain:

Name	Type	Description	Min occurs	Max occurs
authentication	<code>ServerAuthenticationConfig</code>	Optional session authentication details. The adapter defaults to establishing an anonymous session. Note: The JMS adapter requires a session that has the <code>TOPIC_CONTROL</code> role. Either assign the <code>TOPIC_CONTROL</code> role to the anonymous principal or specify a principal with this role for the JMS adapter to use to make the connection.	0	1

ClientEditionProperties

Set of properties defined for the JMS adapter running as a client.

The following table lists the elements that an element of type `ClientEditionProperties` can contain:

Name	Type	Description	Min occurs	Max occurs
serverName	<code>xs:string</code>	Mandatory value for placeholder <code>'\${serverName}'</code> used in JMS request-reply scenarios.	1	1

ServerConnectionConfig

Configuration specific to the JMS adapter when run as a client. When run as a publisher this is ignored

The following table lists the elements that an element of type `ServerConnectionConfig` can contain:

Name	Type	Description	Min occurs	Max occurs
server	ServerConfig	Location and authentication details of the Diffusion server.	1	1
properties	ClientEditionProperties	Set of properties defined for the JMS adapter running as a client.	1	1

PositiveInteger

Any whole number greater than or equal to 1.

This value must be a xs:int.

SessionReconnection

Any integer or the string 'none'.

This value must be a xs:string.

JmsURI

A URI string conforming to RFC6167 (<https://tools.ietf.org/html/rfc6167>).

This value must be a xs:string.

HexString

Arbitrary number of hex pairs. Decodable as binary data

This value must be a xs:string.

JMSPriorityRange

JMS message priorities range from 0 to 9. Higher numbers are higher priority. The default is 4.

This value must be a xs:int.

JMSSessionAcknowledgeMode

The set of all JMS acknowledgment options. Currently only AUTO_ACKNOWLEDGE is supported. Relates to the constants defined in `javax.jms.Session`.

This value must be a xs:string.

The following values are allowed:

- AUTO_ACKNOWLEDGE
- CLIENT_ACKNOWLEDGE
- DUPS_OK_ACKNOWLEDGE
- SESSION_TRANSACTED

JMSDeliveryMode

The set of all JMS delivery options. Relates to the constants defined in `javax.jms.DeliveryMode`

This value must be a xs:string.

The following values are allowed:

- NON_PERSISTENT

- PERSISTENT

MessageTransformationType

The set of message transformation options, used when relaying messages in both directions between JMS and Diffusion.

This value must be a xs:string.

The following values are allowed:

- basic
- JSON

Running the JMS adapter

The JMS adapter is not enabled by default.

Running the JMS adapter within the Diffusion server

The JMS adapter can run within the Diffusion server, but is not enabled by default. To enable the JMS adapter within the Diffusion server, complete the following steps:

1. Copy the `adapters/jms/JMSAdapter.xml` configuration file into the `etc` directory.
2. Use the `JMSAdapter.xml` configuration file to define the JMS adapter behavior.

For more information, see [Configuring the JMS adapter](#) on page 718.

3. Use the `Publishers.xml` file to define and deploy the JMS adapter as a publisher on your Diffusion server:

```
<publisher name="JMSAdapter">
  <class>com.pushtechology.diffusion.adapters.jms.JMSAdapterPublisher</class>
  <enabled>true</enabled>
  <start>true</start>
</publisher>
```

4. Copy the `adapters/jms/jmsadapter.jar` file into the `ext` directory of your Diffusion server to ensure that it is on the Diffusion server classpath.
5. Start or restart the Diffusion server.

Running the JMS adapter as a standalone client

The JMS adapter is a Java application. The adapter requires Oracle Java Development Kit 8 (minimum update 1.8.0_131-b11).

To run the JMS adapter as a client, complete the following steps:

1. To run the JMS adapter as a client on a different system to the Diffusion server, copy the following files from the Diffusion server system to the system where you want to locate the JMS adapter.
 - All files in the `adapters/jms` directory
 - The Diffusion Java client library: `clients/java/diffusion-client.jar`
 - The SLF4J JAR file: `lib/thirdparty/slf4j-simple-1.7.21.jar`
 - A SLF4J bindings JAR files. For example Log4J2, which is provided in the Diffusion installation: `lib/thirdparty/log4j-*.jar`
2. Get the JAR file for the third-party JMS provider you use.
3. Use the `JMSAdapter.xml` configuration file to define the JMS adapter behavior.

For more information, see [Configuring the JMS adapter](#) on page 718.

4. Edit the `jms_adapter.sh` or `jms_adapter.bat` file to include the path to the Diffusion Java client library, SLF4J, and the JMS provider JAR on the classpath.
5. Use the `jms_adapter.sh` or `jms_adapter.bat` file to start the JMS adapter:

```
jms_adapter.sh relative_path/JMSAdapter.xml
```

Push Notification Bridge

The Push Notification Bridge is a Diffusion client that subscribes to topics on behalf of other Diffusion clients and uses a push notification network to relay topic updates to the device where the client application is located.

The Push Notification Bridge comprises the following files all located in the `pushnotification` directory of your Diffusion installation:

pn_bridge.jar

This JAR file contains the Diffusion Java client that acts as a bridge between Diffusion and push notification networks.

pn_bridge.bat and pn_bridge.sh

These scripts can be used to start the Push Notification Bridge.

PushNotifications.xml

This XML file is used to configure the Push Notification Bridge.

PushNotifications.xsd

This XSD file defines the schema of the `PushNotifications.xml` file.

How the Push Notification Bridge works

A client sends a JSON message through a request topic to the Push Notification Bridge, requesting push notifications for a specific topic.

The topic that notifications are received for must be a single value topic.

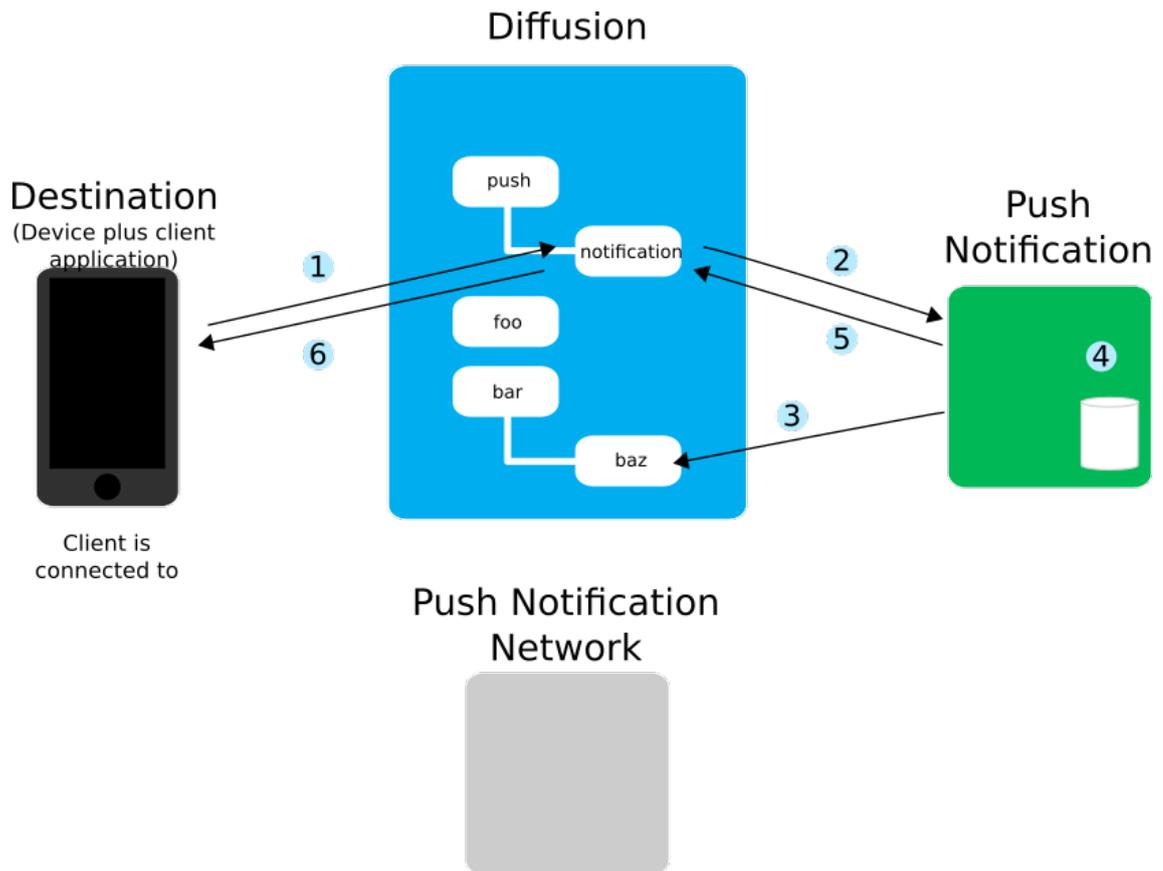


Figure 51: Requests to the Push Notification Bridge

1. The client sends a request message to the service topic path that the bridge listens on.
This topic path is defined in the `PushNotifications.xml` configuration file. For more information, see [Configuring your Push Notification Bridge](#) on page 740.
The request message is in JSON format. For more information about the request message format, see [Request and response JSON formats](#) on page 747.
2. The Push Notification Bridge receives the message through the service topic path.
3. The bridge attempts to subscribe to the topic.
4. If the subscription is successful, the bridge stores the association between the topic and the *push notification destination*. This can be represented by either an APNs device token or a GCM registration ID. The destination is the combination of the client application and the device on which the client is hosted. It is not the same as a client session.

The association between topic and destination is stored in memory, by default. You can persist this information by implementing your own persistence solution. For more information, see [Push Notification Bridge persistence plugin](#) on page 459.

5. The bridge sends a response message to the client through its service topic path.
The response message is in JSON format. For more information about the response message format, see [Request and response JSON formats](#) on page 747.
6. The client receives the response message and can act on it.

The client can also request to be unsubscribed from receiving push notifications for a topic.

When an update is received on a subscribed topic, the bridge sends a push notification to the destinations associated with that topic.

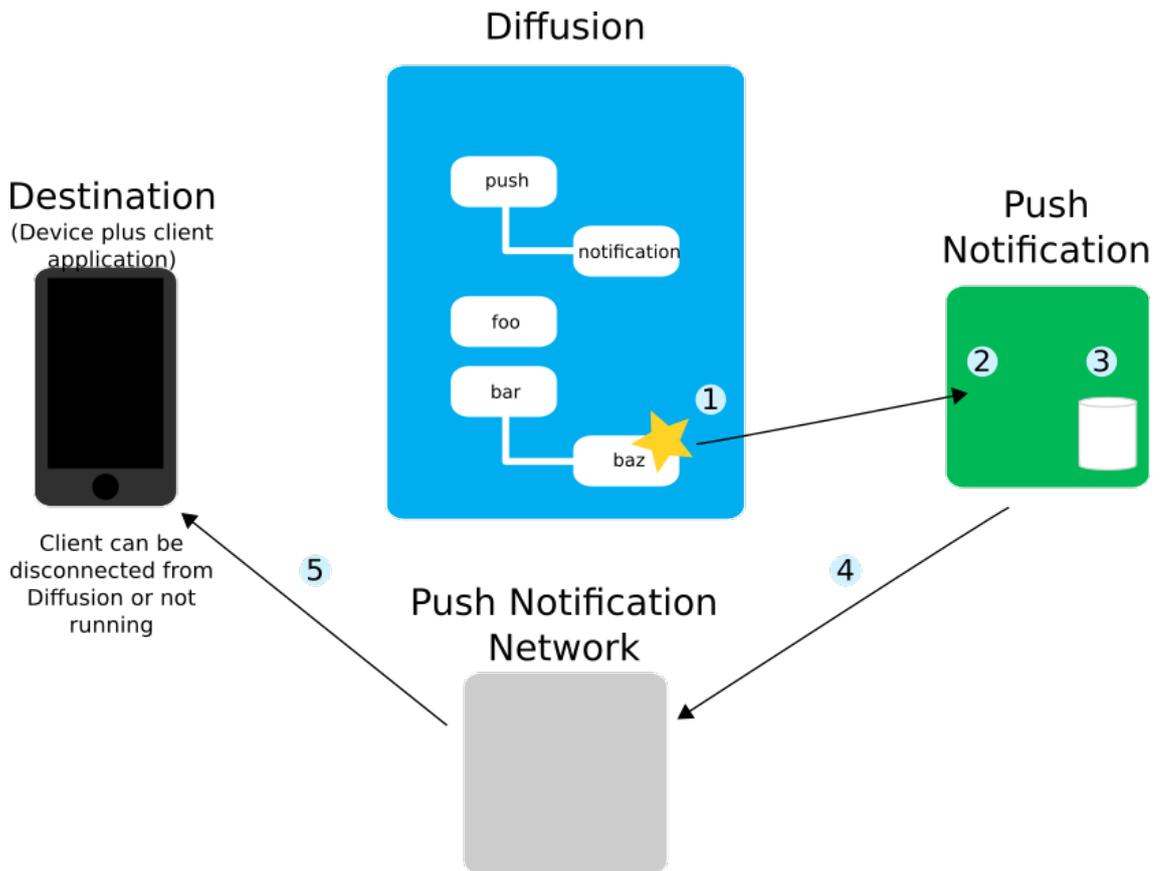


Figure 52: Notifications from the Push Notification Bridge

1. The topic is updated.
2. The Push Notification Bridge receives topic update and transforms the update into JSON according to the template that is configured for the topic.

For more information about the JSON format of notifications, see [Push notification JSON format](#) on page 750. For more information about configuring templates, see .

3. The bridge looks up the destinations that have subscribed to receive push notifications for this topic.
4. The bridge sends the push notifications to the push notification network.

The push notification network that the bridge uses depends on the transport prefix in the destination URI provided in the subscription request message.

5. The push notification network sends the notification to the destination.

If the client is active when the topic update occurs and is subscribed to that topic, the update is received twice: once through the Diffusion server and once through the push notification network. It is the responsibility of the client to handle any duplication.

Related concepts

[Configuring your Push Notification Bridge](#) on page 740

Use the `PushNotification.xml` configuration file to define the behavior of your Push Notification Bridge.

[Running the Push Notification Bridge](#) on page 746

The Diffusion installation includes scripts that you can use to start the Push Notification Bridge.

[Push notification networks](#) on page 123

Consider whether your solution will interact with push notification networks.

[Push Notification Bridge persistence plugin](#) on page 459

The Push Notification Bridge stores subscription information in memory. To persist this information past the end of the bridge process, implement a persistence plugin.

[Example: Send a request message to the Push Notification Bridge](#) on page 460

The following examples use the API to send a request message on a topic path to communicate with the Push Notification Bridge. The request message is in JSON and can be used to subscribe or unsubscribe from receiving push notifications when specific topics are updated.

Related reference

[JSON formats used by the Push Notification Bridge](#) on page 747

Requests and responses sent between clients and the Push Notification Bridge on the bridge's request path and the push notifications sent by the bridge to devices are all JSON format.

[Push notification JSON format](#) on page 750

When a topic is updated, the Push Notification Bridge sends a notification through either APNS or GCM. This message is in JSON format. You can define the format of the message in a template in the `PushNotifications.xml` configuration file. If the update is in the correct JSON format, you can relay the update verbatim to the push notification network.

[Request and response JSON formats](#) on page 747

A client sends push notification requests to the message path that the Push Notification Bridge listens on. The bridge responds through the same path. The default path is `push/notifications`. These requests and responses are in JSON format.

Configuring your Push Notification Bridge

Use the `PushNotification.xml` configuration file to define the behavior of your Push Notification Bridge.

Configuring the Diffusion server connection

Consider the following when configuring the server connection:

- The URL to the Diffusion server must include both the prefix for the transport that the bridge uses to connect to the Diffusion server and the port number that the Diffusion server accepts client connections on.

The following transport prefixes are supported:

- `ws://`
- `wss://`
- `http://`
- `https://`
- The principal you use to connect to the Diffusion server must have a role that includes the following permissions:
 - `select_topic` and `read_topic` permissions for all topics that the bridge sends push notifications for.
 - `send_to_session` permission for the path that the bridge sends responses through.
 - `register_handler` permission

Configuring templates

You can define template notification messages within the configuration file that are associated with one or more topics. When an update is received on a topic, the associated template is used to format the update information into the JSON that is passed to the push notification networks.

Because the templates are defined in an XML configuration file, ensure that the configuration file remains valid by escaping any characters that are not valid XML. (For example, use `&` to escape `&`.)

You can also specify that topic updates be passed to the push notification network verbatim. In this case, it is the responsibility of the client or publisher updating the topic to ensure that the update content is in the correct JSON format. If the update content is not in the correct JSON format, the Push Notification Bridge logs an error.

If there is no matching template, verbatim relay is the default.

For more information about the JSON format of push notifications, see [Push notification JSON format](#) on page 750.

Configuring persistence

The Push Notification Bridge stores its data in memory. If you want the bridge to persist the notification requests your clients set up after the bridge has restarted, you must persist the data.

Use the `persistence` element to specify the implementation of the `com.pushtechnology.diffusion.pushnotifications.persistence` API to use.

For more information about implementing a persistence solution for your Push Notification Bridge, see [Push Notification Bridge persistence plugin](#) on page 459.

Configuring authentication

The Push Notification Bridge must authenticate with the push notification network you are using. Google Cloud Messaging uses an API key to authenticate your requests. Apple Push Notification Service uses a certificate. You must acquire these credentials before you can configure your Push Notification Bridge to use the push notification network.

For more information about getting the required credentials, see [Getting an Apple certificate for the Push Notification Bridge](#) on page 745 and [Getting a Google API key for the Push Notification Bridge](#) on page 746.

Related concepts

[Push Notification Bridge](#) on page 737

The Push Notification Bridge is a Diffusion client that subscribes to topics on behalf of other Diffusion clients and uses a push notification network to relay topic updates to the device where the client application is located.

[Running the Push Notification Bridge](#) on page 746

The Diffusion installation includes scripts that you can use to start the Push Notification Bridge.

Related reference

[JSON formats used by the Push Notification Bridge](#) on page 747

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[Push notification JSON format](#) on page 750

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[Request and response JSON formats](#) on page 747

A client sends push notification requests to the message path that the Push Notification Bridge listens on. The bridge responds through the same path. The default path is push/notifications. These requests and responses are in JSON format.

PushNotifications.xml

This file specifies the schema for the configuration required by the Push Notification Bridge.

PNRootConfig

The mandatory root node of the Push Notification bridge.

The following table lists the elements that an element of type `PNRootConfig` can contain:

Name	Type	Description	Min occurs	Max occurs
server	<code>PNDiffusionConfig</code>	Diffusion server connection details.	1	1
apns	<code>PNAPNSConfig</code>	Apple Push Notification Service connection and configuration details.	0	1
gcm	<code>PNGCMConfig</code>	Google Cloud Messaging connection and configuration details.	0	1
transformation	<code>PNTransformationConfig</code>	Transformation from topic updates to Push notifications.	1	1
persistence	<code>PNPersistenceConfig</code>	Optional Java plugin to persist topic subscriptions between bridge process lifetimes.	0	1
delivery	<code>PNDeliveryConfig</code>	Options relating to the delivery of notifications to all Push Notification networks.	1	1

PNDeliveryConfig

Options relating to the delivery of notifications to all Push Notification networks.

The following table lists the attributes that an element of type `PNDeliveryConfig` can have:

Name	Type	Description	Required
threads	<code>xs:int</code>	The number of threads used for notification delivery, processing client requests and collecting feedback from APNS.	true

PNTransformationConfig

Transformation from topic updates to Push notifications.

The following table lists the attributes that an element of type `PNTransformationConfig` can have:

Name	Type	Description	Required
default	<code>xs:string</code>		true

The following table lists the elements that an element of type `PNTransformationConfig` can contain:

Name	Type	Description	Min occurs	Max occurs
templates	PNTemplatesConfig	The set of uniquely named templates.	1	1
map	PNTemplatesMappingConfig	Relates topics to one or more templates.	1	1

PNTemplatesConfig

The set of uniquely named templates.

The following table lists the elements that an element of type PNTemplatesConfig can contain:

Name	Type	Description	Min occurs	Max occurs
template	PNTemplateConfig	A named template.	1	unbounded

PNTemplateConfig

A named template. May contain placeholders `${topic.name}` and/or `${topic.update}` which are replaced with real values at run time.

The following table lists the attributes that an element of type PNTemplateConfig can have:

Name	Type	Description	Required
name	xs:string	Name for this template, e.g. "london-underground-status-updates".	true

PNTemplatesMappingConfig

Establishes the relations between topic paths and templates. Alternatively updates can be passed through 'verbatim', meaning the topic update must be a valid push notification message.

The following table lists the elements that an element of type PNTemplatesMappingConfig can contain:

Name	Type	Description	Min occurs	Max occurs
from	PNTemplatesMappingConfig	Relates updates from topics covered by a topic-selector to interpolation with a named template.	1	unbounded
verbatim	PNTemplatesMappingConfig	Relates a single topic-path to straight-through processing.	1	unbounded

PNAPNSConfig

Apple Push Notification Service connection and configuration details.

The following table lists the attributes that an element of type PNAPNSConfig can have:

Name	Type	Description	Required
certificate	xs:string	Name of a PKCS12 format file containing the certificate. The certificate needs to be of PKCS12 format and the keystore needs to be encrypted using the SunX509 algorithm. Both of these settings are the default.	true

Name	Type	Description	Required
passphrase	xs:string	Mandatory certificate passphrase.	true
servers	PNAPNSServers	A choice of "production", "sandbox" or "hostname:gatewayport:feedbackport"	true

PNGCMConfig

Google Cloud Messaging connection and configuration details.

The following table lists the attributes that an element of type PNGCMConfig can have:

Name	Type	Description	Required
apiKey	xs:string	The Google provided GCM API Key.	true
retryMax	xs:int	The number of attempts to make following an HTTP 50x response on posting. An increasing pause occurs prior to each repeated attempt.	false

PNDiffusionConfig

Diffusion server connection details.

The following table lists the attributes that an element of type PNDiffusionConfig can have:

Name	Type	Description	Required
url	xs:string	URL for a Diffusion connector configured to accept Unified clients.	true
principal	xs:string	The optional principal used when authenticating. The principal requires permissions 'send_to_session', 'read_topic' and 'register_handler'.	false
credentials	xs:string	The credentials matching the principal used when authenticating.	false
topicPath	xs:string	The topic path used by the Push Notification bridge to receive subscription and other service requests.	true

PNPersistenceConfig

Optional Java plugin to persist topic subscriptions between processes lifetimes.

The following table lists the attributes that an element of type PNPersistenceConfig can have:

Name	Type	Description	Required
saverFactory	xs:string	Name of the class present on the JVM classpath used to build a com.pushtechnology.diffusion.pushnotifications.persistence.Saver object.	true

PNTemplatesMappingFrom

Relates updates from topics covered by a topic-selector to interpolation with a named template.

The following table lists the attributes that an element of type PNTemplatesMappingFrom can have:

Name	Type	Description	Required
selector	xs:string	Diffusion topic selector expression.	true
toTemplate	xs:string	Name of a defined template.	true

PNTemplatesMappingVerbatim

The following table lists the attributes that an element of type `PNTemplatesMappingVerbatim` can have:

Name	Type	Description	Required
selector	xs:string	Relates a single topic-path to straight-through processing.	true

PNAPNSServers

A choice of "production", "sandbox" or "hostname:gatewayport:feedbackport"

This value must be a xs:string.

Getting an Apple certificate for the Push Notification Bridge

For the Push Notification Bridge to connect to APNs, it must authenticate with a certificate. You can get a certificate from the Apple Developer Center.

About this task

Note:

These steps relate to the original APNs Provider API, where sandbox and production services each require a different certificate.

The Push Notification Bridge does not yet support the new APNs Provider API, which is based on HTTP/2 and requires only a single certificate for both sandbox and production roles.

Procedure

1. In the Apple Developer Center, go to the Member Center.
<https://developer.apple.com>
2. Go to **Certificates, Identities & Profiles**.
3. Click the plus sign (+) to add a new certificate.
4. From the **Development** section, select **Apple Push Notification service SSL (Sandbox)**.
After you have developed and tested your solution, you can get a production certificate.
5. Click Continue. Follow the instructions provided to generate a certificate.

What to do next

For more information, see [iOS Developer Library – App Distribution Guide](#).

Getting a Google API key for the Push Notification Bridge

For the Push Notification Bridge to connect to GCM, it must authenticate with an API key. You can get an API key from the Google Developers Console.

Procedure

1. In the Google Developers Console, create or select a project.
<https://console.developers.google.com/home/>
2. Go to **Use Google APIs**.
3. Select **Cloud Messaging for Android**.
4. Click **Enable API**.
You are prompted to create credentials.
5. Choose to skip the step and create an **API key**.
6. In the **Create a new key** dialog, select **Server key**.
7. Type a name for the key.
You can choose at this time to restrict the IP addresses that requests the use this API key can come from. If possible, restrict the key to the IP address your Push Notification Bridge uses.
8. Click **OK**.
A dialog displays your new API key.

Running the Push Notification Bridge

The Diffusion installation includes scripts that you can use to start the Push Notification Bridge.

System requirements

The Push Notification Bridge is a Java application. The bridge requires Oracle Java Development Kit 8 (minimum update 1.8.0_131-b11).

Starting with the scripts

The following startup scripts are provided in the `adapters/pushnotifications` directory of your Diffusion installation:

- `pn_bridge.bat` for use on Windows platforms
- `pn_bridge.sh` for use on Linux and UNIX platforms

Related concepts

[Push Notification Bridge](#) on page 737

The Push Notification Bridge is a Diffusion client that subscribes to topics on behalf of other Diffusion clients and uses a push notification network to relay topic updates to the device where the client application is located.

[Configuring your Push Notification Bridge](#) on page 740

Use the `PushNotification.xml` configuration file to define the behavior of your Push Notification Bridge.

Related reference

[JSON formats used by the Push Notification Bridge](#) on page 747

Requests and responses sent between clients and the Push Notification Bridge on the bridge's request path and the push notifications sent by the bridge to devices are all JSON format.

[Push notification JSON format](#) on page 750

When a topic is updated. The Push Notification Bridge sends a notification through either APNS or GCM. This message is in JSON format. You can define the format of the message in a template in the `PushNotifications.xml` configuration file. If the update is in the correct JSON format, you can relay the update verbatim to the push notification network.

[Request and response JSON formats](#) on page 747

A client sends push notification requests to the message path that the Push Notification Bridge listens on. The bridge responds through the same path. The default path is `push/notifications`. These requests and responses are in JSON format.

JSON formats used by the Push Notification Bridge

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Related concepts

[Push Notification Bridge](#) on page 737

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[Request and response JSON formats](#) on page 747

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Request and response JSON formats

A client sends push notification requests to the message path that the Push Notification Bridge listens on. The bridge responds through the same path. The default path is `push/notifications`. These requests and responses are in JSON format.

The following pieces of information are included in request messages:

destination_token

Push notification networks use binary tokens to represent an app installed on a device. This token combined with the transport prefix for the push notification network is the URI that the Push Notification Bridge uses to identify the device to send push notifications to.

topic_selector

The topic selector that the client subscribes to receive push notifications from or unsubscribes from receiving push notifications.

Note: This is not the same as the path that the request and response messages are sent through.

The results of including the contents of a subscription request with an unsubscription request are undefined.

Destination tokens

The destination token associated with the device and application to send a push notification to is provided to the application when the application registers with the push notification network.

Google Cloud Messaging

The destination token used by GCM is called *registration token* or *instance ID*. To get the instance ID for GCM, your client registers with the GCM connection servers using `instanceId.getToken`.

For more information, see [the GCM documentation](#).

Apple Push Notification service

The destination token used by APNs is called *device token*. Use the `registerForRemoteNotifications` method on your `UIApplication` instance to get a device token.

For more information, see [the APNs documentation](#).

When your app has successfully registered with the APNs, your `UIApplicationDelegate` instance is supplied with a device token through `application:didRegisterForRemoteNotificationsWithDeviceToken`.

Encode the device token in base 64 before you supply it to the Push Notification Bridge as an `apns://` URI in a bridge subscription request:

```
-(void)application:(UIApplication *)application
didRegisterForRemoteNotificationsWithDeviceToken:(NSData
*)deviceToken {
    NSString * base64 = [deviceToken
base64EncodedStringWithOptions:0];
    NSString * destination = [@"apns://"
stringByAppendingString:base64];
    [self sendRequestWithDestination:destination];
}
```

Subscription request

The following message requests that updates to the topic at *topic_selector* be sent by APNs to the device identified by *destination_token*. The destination token is encoded in base64.

```
{
  "pnsub": {
    "destination": "apns://destination_token",
    "topic": "topic_selector"
  }
}
```

The following message requests that updates to the topic at *topic_selector* be sent by GCM to the device identified by *destination_token*.

```
{
  "pnsub": {
    "destination": "gcm://destination_token",
    "topic": "topic_selector"
  }
}
```

Unsubscription request

The following message requests that updates to the topic at *topic_selector* be no longer sent by APNs to the device identified by *destination_token*.

```
{
  "pnunsub": {
    "destination": "apns://destination_token",
    "topic": "topic_selector"
  }
}
```

The following message requests that updates to the topic at *topic_selector* be no longer sent by GCM to the device identified by *destination_token*.

```
{
  "pnunsub": {
    "destination": "gcm://destination_token",
    "topic": "topic_selector"
  }
}
```

Response

The following message is the response that the bridge sends to a requesting client if the request is successful.

```
{
  "response": {
    "content": result_json
  }
}
```

If the response message contains a `content` element, the request was successful.

Error response

The following message is the response that the bridge sends to a requesting client if an error occurs when processing the request.

```
{
  "response": {
    "error": "exception_text"
  }
}
```

If the response message contains an `error` element, the request was not successful. More information about the reason for the failure, is available in the *exception_text*

Related concepts

[Push Notification Bridge](#) on page 737

The Push Notification Bridge is a Diffusion client that subscribes to topics on behalf of other Diffusion clients and uses a push notification network to relay topic updates to the device where the client application is located.

[Configuring your Push Notification Bridge](#) on page 740

Use the `PushNotification.xml` configuration file to define the behavior of your Push Notification Bridge.

[Running the Push Notification Bridge](#) on page 746

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Related reference

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Push notification JSON format

When a topic is updated, the Push Notification Bridge sends a notification through either APNS or GCM. This message is in JSON format. You can define the format of the message in a template in the `PushNotifications.xml` configuration file. If the update is in the correct JSON format, you can relay the update verbatim to the push notification network.

Using templates

Templates are configured in the `PushNotification.xml` file. These templates are associated with specific topics. When a topic is updated, the associated template is applied to that update before the update is sent through the push notification network. The template uses the following placeholders to include topic and update information in the notification message:

`${topic.path}`

The path that the update is received on.

`${topic.update}`

The content of the update.

A template notification message can include both an `apns` section and a `gcm` section. The size of the data within each of these sections is restricted by the push notification network and currently cannot be greater than 2 KB.

After the update is transformed by the template, only the section of the notification message that is in the appropriate format for that push notification network is passed to the push notification network to be sent on to the client.

Verbatim relay

You can also specify that topic updates be passed to the push notification network verbatim. In this case, it is the responsibility of the client or publisher updating the topic to ensure that the update content is in the correct JSON format. If the update content is not in the correct JSON format, the Push Notification Bridge logs an error.

If there is no matching template, verbatim relay is the default.

APNs

The `apns` section wraps Apple's JSON format for an APNs message. For more information, see <https://developer.apple.com/library/ios/documentation/NetworkingInternet/Conceptual/RemoteNotificationsPG/Chapters/ApplePushService.html>

The `apns` section of the transformed notification message is used when the destination URI starts with `apns://` and the notification is sent through the Apple Push Notification Service

```
"apns": {
  "aps": {
    "alert": {
      "title": "notification_title",
      "body": "notification_content"
    },
    User-defined key-value pairs
  }
}
```

GCM

The `gcm` segment is a representation of Google's package `com.google.android.gcm.server`, which defines the following headers:

`collapseKey`

A unique identifier for a group of notifications that can be collapsed. When an idle device becomes active again, only the most recent notification for any given collapse key is sent.

For example, the topic path of the topic that the bridge subscribes to can be used as the collapse key and inactive devices are sent only the most recent update to that topic when they become active again.

Note: A maximum of 4 different collapse keys are stored simultaneously by GCM.

`delayWhileIdle`

When the value of this field is set to true, notifications are not be sent until the device becomes active. The default value is false.

`dryRun`

When the value of this field is set to true, you can test a request without actually sending a message. The default value is false.

`timeToLive`

How long in seconds the notification is kept in GCM storage if the device is offline. The maximum time to live supported is 4 weeks.

The `gcm` segment also contains a `data` section that contains a JSON payload. This JSON payload must be a dictionary of key-value pairs where both the key and the value are strings.

The `gcm` section of the transformed notification message is used when the destination URI starts with `gcm://` and the notification is sent through the Google Cloud Messaging

```
"gcm": {
  "collapseKey": "group_identifier",
  "delayWhileIdle": boolean,
  "timeToLive": integer,
  "data": {
```

User-defined key-value pairs

```
}  
}
```

Notification message example

The following example shows the results of an online auction being sent as a push notification in both APNs and GCM format.

```
{  
  "apns": {  
    "aps": {  
      "alert": {  
        "title": "Auction Result",  
        "body": "You won the auction for 'Antique oak table'"  
      }  
    },  
    "auctionID": "abc123xyz789",  
    "auctionConclusion": 123456789  
  },  
  "gcm": {  
    "collapseKey": "abc123xyz789",  
    "delayWhileIdle": false,  
    "timeToLive": 60,  
    "data": {  
      "result": "You won the auction for 'Antique oak table'",  
      "auctionID": "abc123xyz789",  
      "auctionConclusion": 123456789  
    }  
  }  
}
```

Related concepts

[Push Notification Bridge](#) on page 737

The Push Notification Bridge is a Diffusion client that subscribes to topics on behalf of other Diffusion clients and uses a push notification network to relay topic updates to the device where the client application is located.

[Configuring your Push Notification Bridge](#) on page 740

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[Running the Push Notification Bridge](#) on page 746

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[Request and response JSON formats](#) on page 747

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Deploying publishers on your Diffusion server

If you developed a publisher as part of your Diffusion solution, you must deploy the publisher on the Diffusion server for it to run.

All publishers that run on the Diffusion server must be defined in the `Publishers.xml` configuration file located in the `etc` directory

If a publisher is defined in the Diffusion server configuration, you can deploy it on the Diffusion server by using either *classic deployment* or *hot deployment*. Classic deployment is deploying a publisher to a stopped Diffusion server. The publisher then starts when the Diffusion server starts. Hot deployment is deploying a publisher to a running Diffusion server.

Classic deployment

Installing publishers into a stopped Diffusion instance.

The publishers that are started when Diffusion starts must be defined in the configuration file `etc/Publishers.xml`. Publishers that do not start with Diffusion can also be defined in the `etc/Publishers.xml` and these can be started later using JMX.

The publishers must be present on the classpath of the Diffusion server. The recommended way to do this is to compile the publisher source code with the `diffusion.jar` they run with on the classpath. Package the publisher class files into a JAR file. This JAR file must be deployed to the `ext/` directory of the Diffusion installation. The Diffusion server will search the `ext/` directory and load all the JAR files it finds.

Related concepts

[Writing a publisher](#) on page 442

How to approach writing a publisher

[Build server application code with Maven](#) on page 472

The Diffusion API for server application code is not available in the Push Technology public Maven repository. To build server components, you must install the product locally and depend on `diffusion.jar` using a Maven system scope.

[Build publishers with Maven](#) on page 468

The Diffusion API for publishers is not available in the Push Technology public Maven repository. To build publishers, you must install the product locally and depend on `diffusion.jar` using a Maven system scope.

Related tasks

[Building a publisher with mvndar](#) on page 469

Use the Maven plugin *mvndar* to build and deploy your publisher DAR file. This plugin is available from the Push Public Maven Repository.

Hot deployment

Installing publishers into a running Diffusion instance.

In addition to starting publishers by defining them in `etc/Publishers.xml`, you can install them into an already running Diffusion instance by a process known as hot deployment. Publishers can also be undeployed and redeployed, providing they implement the `isStoppable` method, and it returns true. You can also deploy dependent JAR files, configuration files and associated web pages for a publisher. All artifacts required for deployment are packaged within a DAR file.

Related concepts

[Build server application code with Maven](#) on page 472

The Diffusion API for server application code is not available in the Push Technology public Maven repository. To build server components, you must install the product locally and depend on `diffusion.jar` using a Maven system scope.

[Build publishers with Maven](#) on page 468

The Diffusion API for publishers is not available in the Push Technology public Maven repository. To build publishers, you must install the product locally and depend on `diffusion.jar` using a Maven system scope.

Related tasks

[Building a publisher with mvndar](#) on page 469

Use the Maven plugin *mvndar* to build and deploy your publisher DAR file. This plugin is available from the Push Public Maven Repository.

Deployment methods

There are two ways to deploy a DAR file: file copy or HTTP.

File copy

To use this method, copy your DAR file to the deployment directory on the file system. If you enable auto-deployment in the `Server.xml` configuration file, Diffusion periodically scans a directory for new or updated DAR files and deploys them. In the case of an updated DAR, the existing publisher is undeployed (if possible) before being redeployed.

HTTP

If the deploy web service is running, you can `POST` the DAR file over HTTP. For example, you can use command line tools such as `curl` to deploy the publisher:

```
curl --data-binary @MyPublisher.dar http://localhost:8080/deploy
```

Warning: We recommend you use the HTTP method of deployment in your test environments only. If you enable the deploy web service in your production environment, you must take additional security measures to prevent unauthorized or malicious access to the web service URL. For example, by setting up restrictions in your firewall.

To enable deployment through HTTP, you must enable the web service in the `WebServer.xml` configuration file. For example, include the following XML:

```
<http-service name="deploy-service" debug="true">
  <class>com.pushtechnology.diffusion.service.DeploymentService</class>
  <url-pattern>^/deploy.*</url-pattern>
  <max-inbound-request-size>128m</max-inbound-request-size>
</http-service>
```

Ensure that the HTTP connector is configured to have an input buffer large enough to contain the entire DAR file. You can configure this in the `Connectors.xml` configuration file.

Undeployment

For publishers deployed using the file copy method, you can delete the DAR file from the deployment directory and on the next scan the server undeploys the publisher. A DAR file can be undeployed only if all of the publishers it contains are stoppable. If a DAR file fails to be undeployed, any future modifications to it are ignored.

It is important that any files that the deployment process has extracted from the DAR are not deleted until the publisher has been successfully undeployed. Publishers can also be undeployed through JMX by invoking the undeploy operation on associated MBean, for example

```
localhost/Server/com.pushtechnology.diffusion - Publisher -
MyPublisher - undeploy()
```

Related concepts

[Build server application code with Maven](#) on page 472

The Diffusion API for server application code is not available in the Push Technology public Maven repository. To build server components, you must install the product locally and depend on `diffusion.jar` using a Maven system scope.

[Build publishers with Maven](#) on page 468

The Diffusion API for publishers is not available in the Push Technology public Maven repository. To build publishers, you must install the product locally and depend on `diffusion.jar` using a Maven system scope.

Related tasks

[Building a publisher with mvndar](#) on page 469

Use the Maven plugin `mvndar` to build and deploy your publisher DAR file. This plugin is available from the Push Public Maven Repository.

Demos

Diffusion comes with demo applications that demonstrate certain features of Diffusion.

If you chose the option to deploy the demos as part of the installation process, you can access them through the Diffusion landing page in your browser (typically at <https://localhost:8080>).

If you installed the demos but did not deploy them, see [Deploying the demos](#) on page 756.

Demos

The demos in the **Demos** section of the default Diffusion installation web page demonstrate various applications of Diffusion.

To access the Diffusion web page and demos, start the server and type in the following URL into a browser: <https://localhost:8080>. (You may need to modify this if your Diffusion server is on a different machine or has been set to use a different port.)

Table 59: Demos provided with the Diffusion server

Drawing Board demo	Multiple users draw on a virtual blackboard with colored chalk. All clients are updated in real time with strokes from the other clients. Open this demo in multiple browsers to see the responsiveness of client interactions. Requires Canvas support in the browser.
Sportsbook demo	Demonstrates live, high-frequency updating of betting odds for a list of football matches. Includes a Java publishing client which provides a list of odds as a JSON topic, and a viewer which subscribes to the topic using in-browser JavaScript.

To view the source code of the demos, go to `/demos/src` within your Diffusion installation folder.

Deploying the demos

You can deploy the demos by copying their DAR files into the `/deploy` folder.

The Diffusion installer has separate options to install the demo files and to deploy the demos.

By default, the demo files are installed in the `/demos` directory of your Diffusion installation, but are not deployed.

In this situation, follow these steps to deploy the demos:

1. Go to the `/demos` directory within your Diffusion installation directory.
2. Locate the DAR file of the demo you want to install.
3. Copy the DAR file into the `/deploy` directory within your Diffusion installation directory.
4. Start the Diffusion server if it is not already running.

You do not need to copy over the contents of `/demos/src`. This directory contains the source code for the demos which is packaged into the DAR files.

Tools

If the tools were installed during the installation process, there are some tools that can help with the monitoring of Diffusion plus some handy utilities.

There are additional tools and utilities that are available in public repositories, such as GitHub and Maven.

Tools for Amazon Elastic Compute Cloud (EC2)

This is a description of a number of tools and adaptations which are provided for use when using Diffusion with Amazon EC2™.

Diffusion includes in `tools/ec2/` a number of files useful when deploying Diffusion to an Ubuntu® image on an EC2 virtual machine.

diffusion.conf

Ubuntu makes use of the [Upstart daemon](#) as a replacement for `init`. Copied to `/etc/init/diffusion.conf` this file contains configuration for Upstart to begin Diffusion at boot-time in a background process as a unprivileged user. It establishes [iptables](#) rules to route traffic from privileged ports to Diffusion.

Users can stop and start Diffusion using Upstart commands, for example, to start the server

```
service diffusion start
```

To stop Diffusion

```
service diffusion stop
```

To check the status of Diffusion

```
service diffusion status
```

In the event that something goes amiss Upstart writes a log file to `/var/log/upstart/diffusion.log`

etc/Connectors.xml

Except for two port number changes this is an otherwise regular copy of `etc/Connectors.xml` normally found in a Diffusion installation. Use this file in conjunction with the `iptables` rules established in `diffusion.conf`

ec.xml

An illustrative Apache Ant script that can be used to start, stop, and get status from a Diffusion server running on an Amazon EC2 Linux host. It also demonstrates an inelegant means of deploying and undeploying a DAR file to/from the remote server, by copying the file to the remote server, then moving it into the deploy directory.

Table 60: Targets

Property	Purpose
start	Runs <code>sudo service diffusion start</code> on remote host using SSH
stop	Runs <code>sudo service diffusion stop</code> on remote host using SSH
status	Runs <code>sudo service diffusion status</code> on remote host using SSH
deploy	Uploads local DAR file to staging dir, then moves it into Diffusion deploy directory

Property	Purpose
undeploy	Removes DAR file from deploy directory, signaling Diffusion to undeploy related publishers (where possible)

The script is driven by named properties:

Table 61: Properties for targets start, stop and status

Property	Purpose
remote.host	EC2 host running sshd
remote.username	Authentication username, default of ubuntu
remote.keyfile	PEM encoded key use during authentication

Table 62: Additional properties for targets deploy and undeploy

Property	Purpose
dar.file	Name of a DAR file to deploy or undeploy
remote.diffusion.dir	Root directory of the remote Diffusion installation

Example deployment:

```
ant -Dremote.host=54.235.65.36 \
-Dremote.keyfile=$HOME/.ssh/ec2-push1.pem \
-Ddar.file=$HOME/Applications/Diffusion6.1.5/demos/drawingboard.dar \
-Dremote.diffusion.dir=/home/ubuntu/Diffusion/Diffusion6.1.5 \
deploy
```

The script uses no proprietary Diffusion code and is open to extension during development of a solution. Both the `sshexec` and `scp` tasks depend on the [jsch library](#) which might have to be downloaded.

Tools for Joyent

This is a description of adaptations which are provided for use when using Diffusion within the Joyent Cloud.

Diffusion includes in `tools/joyent/files` useful when deploying Diffusion to an SmartOS virtual machine in the [Joyent cloud](#).

diffusion.xml

SmartOS makes use of [SMF](#) to start services at boot-time. Once tailored for the host and installed into SMF this file contains configuration for SMF to begin Diffusion at boot-time in a background process as an unprivileged user called `push`. This file does not create or assert the existence of a `push` user.

Users can stop and start Diffusion using SMF commands. For example, to start the server

```
sudo svcadm enable diffusion
```

To stop the server

```
sudo svcadm disable diffusion
```

Part VI

Upgrading Guide

If you are planning to move from an earlier version of Diffusion to version 6.1, review the following information about changes between versions.

We recommend that you upgrade to the latest version of Diffusion as soon as you can.

Note: A more detailed upgrade guide for version 6.1 is coming soon.

When upgrading across multiple versions, ensure that you review the release notes and upgrade steps for all intermediate versions. For example, if you are upgrading from version 5.8 to version 6.1, first review the upgrade steps from version 5.8 to 5.9, then follow the steps to upgrade from version 5.9 to 6.0.

Release notes including known issues are available at the following location: <http://docs.pushtechology.com/docs/6.1.5/ReleaseNotice.html>

For more information about [Diffusion versions](#) and [support and upgrade policy](#), see the [Support Center](#).

Related concepts

[What's new in Diffusion 6.1?](#) on page 21

The latest version of Diffusion contains new features, performance enhancements and bug fixes.

In this section:

- [Interoperability](#)
- [Upgrading from version 6.0 to version 6.1](#)
- [Upgrading to a new patch release](#)

Interoperability

If you plan to use Diffusion servers and clients of different versions together, review the following information that summarizes support between versions.

Interoperation between clients and servers

The following table describes which API client versions interoperate with which server versions.

Note: A 5.x client cannot use the security control feature to query or update the security store of a 6.x server. This is because new security permissions have been added in 6.0.

Table 63: API interoperation

Client version	Server version		
	5.9	6.0	6.1
5.9	✓	✓ See note below	✓ See note below
6.0	✗	✓	✓
6.1	✗	✗	✓

Note: A 5.x client cannot subscribe to these new topic types introduced in 6.0: time series, int64, double, string, recordV2.

Interoperation between servers

Replication

All Diffusion servers within a cluster must be at the same minor version level (such as 5.8, 5.9, or 6.0).

For example, a cluster can include both 5.9.7 servers and 5.9.9 servers, but a cluster with a mixture of 5.9 servers and 6.0 servers is not supported.

Server versions	5.1	5.8	5.9	6.0
5.1	✓	✗	✗	✗
5.8	✗	✓	✗	✗
5.9	✗	✗	✓ See note below	✗
6.0	✗	✗	✗	✓

Note: If some of the 5.9 Diffusion servers in your cluster are version 5.9.4 and earlier and others are 5.9.5 and later, this change can cause inconsistent behaviors when replicating branches of the topic tree that contain slave topics. To ensure consistent behavior when replicating slave topics, update all of your Diffusion servers to 5.9.5 and later.

Fan out

Fan-out distribution is supported between servers of different versions.

To receive propagated missing topic notifications through fan-out connections, all servers must be version 5.9 or later.

Server versions	5.8	5.9	6.0
5.8	✓	✓	✓
5.9	✓	✓	✓
6.0	✓	✓	✓

Related concepts

[Upgrading from version 6.0 to version 6.1](#) on page 762

Consider the following information when upgrading from Diffusion version 6.0 to version 6.1.

[Upgrading to a new patch release](#) on page 766

When upgrading to a new patch release there are typically no changes to the configuration values or the APIs. All that is required is to copy your existing files from the old installation to the new installation.

Upgrading from version 6.0 to version 6.1

Consider the following information when upgrading from Diffusion version 6.0 to version 6.1.

Upgrading your applications

Server-side components

Recompile all Java application components that are deployed to the Diffusion server, such as publishers and authorization handlers, against the new version `diffusion.jar` file. This file is located in the `lib` directory of your new Diffusion server installation.

Some features that your Java application components might use have been removed or deprecated. Pay attention to new deprecation warnings and compilation failures that occur during recompilation and review the API changes information in the following section to see if these changes affect your applications.

Clients

You can choose not to recompile your client applications and continue to use client libraries from a previous release. If you choose to use client libraries from a previous release, ensure that the libraries are compatible with the new server. For more information, see [Interoperability](#) on page 761.

You can choose to upgrade your client applications to use the new client libraries. To do this, recompile the client applications against the client libraries located in the `clients` directory of your new Diffusion server installation and repackage your client application with the new library.

The .NET client library is now fully compatible with the .NET Standard 2.0. Officially supported platforms are Windows (via .NET Framework, .NET Core), MacOS (.NET Core), and various Linux distributions (via .NET Core). In order to make this change clear we removed the old `PushTechnology.ClientInterface` library and NuGet package and replaced it with `Diffusion.Client`. This requires re-compilation of your project.

In the Javascript client, Zlib code for message decompression has been separated out into `zlib-bundle.js`. Include `zlib-bundle.js` for clients that want to make use of the client compression capability. Clients will log out a warning at startup if `zlib-bundle.js` is not included. The client's initial connection request will set the per-message compression capability depending on whether `zlib-bundle.js` is included. This will indicate to the server whether messages should be compressed before they are sent to the client.

The Java client now supports Java 9, 10 and 11. Java 8 is still required for the server.

Some features that your client applications might use have been removed or deprecated. Review the API changes information in the following section to see if these changes affect your applications.

API changes

Further information about removed or deprecated features is available in following locations:

- The release notes provided online at <http://docs.pushtechnology.com/docs/6.1.5/ReleaseNotice.html>
- The API documentation located at <http://docs.pushtechnology.com/docs/6.1>

The following table lists API classes and methods that have been removed. If you attempt to recompile application code that uses these classes or methods against the version 6.1 APIs, it fails. Rewrite your application code to not include these features.

Table 64: API features removed in version 6.1

API affected	Removed feature	Suggested alternative
.NET API	<code>ISession.GetXXXFeature()</code> methods	<code>ISession.GetXXXFeature()</code> methods Use the equivalent <code>ISession.XXX</code> property instead. For example, instead of <code>ISession.GetClientControlFeature()</code> use <code>ISession.ClientControl</code>
.NET API	<code>SessionId</code> class	Use <code>ISessionId</code> property instead.
.NET API	<code>DefaultStreamCallback</code> and <code>StreamDefault</code>	Use <code>DefaultStream</code> instead.
.NET API	<code>ISubscriptionRequest</code>	
.NET API	<code>IClientSession</code>	
.NET API	<code>IClientControlFeatureHandler</code>	
.NET API	<code>IQueueListener</code>	
.NET API	<code>IStateListener</code>	

API affected	Removed feature	Suggested alternative
.NET API	IAuthControlFeatureHandler	
.NET API	ITopicManagementHandler & ITopicManagementFactory	
.NET API	IClientInfo	
.NET API	IPingDetails.RoundTripTime property	

The following table lists API classes and methods that have been deprecated. If your application code uses these classes or methods, consider rewriting your application code to not include these features.

Table 65: API features deprecated in version 6.1

API affected	Deprecated feature	Suggested alternative
All	removeTopicsWithSession	Use the new REMOVAL topic property.
	TopicEventListener (subscriber notifications) methods in the TopicControl feature	These methods have been deprecated as they only worked for local sessions. The use case for these methods was typically removal of unused topics which is now better addressed using the REMOVAL topic property (which is cluster aware).
	Content interface	The Content interface is being phased out. It is still used in some interfaces, such as Fetch and Messaging when receiving data. In all other cases its use should be avoided as it will be removed at a future release. At this release some remaining interfaces that used Content (such as builders and readers) have been deprecated.
.NET API	IServiceRequest	
.NET API	ISessionFactory.SslContext(RemoteCertificateValidationCallback, LocalCertificateSelectionCallback)	Use the ISessionFactory.SslContext(RemoteCertificateValidationCallback) method instead.
.NET API	IClientEndpoint	None
Publisher API	See release notes for details	

Removed components

The following components have been removed from Diffusion in version 6.0:

- Cascade URLs for reconnection strategies have been removed from the C client API. Applications will no longer be able to supply a list of server URLs to connect to in the scenario that a C client session loses its connection a server. Reconnection is now targeted only at the server to which the connection was lost.

Upgrading your server installation

To upgrade your Diffusion server installation, complete the following steps:

1. Use the graphical or headless installer to install the new version of Diffusion.

For more information, see [Installing the Diffusion server](#) on page 475.

2. Contact Push Technology for an updated license file.
3. You can copy most of your existing configuration files from the `etc` directory of your previous installation to the `etc` directory of your new installation. When you do, consider making the following changes:
 - The `server-statistics` elements in `Statistics.xml` and the `ServerStatisticsConfig` are no longer valid and should be removed.
 - The `customConfigurator` element in `Replication.xml` configuration is deprecated and is ignored by the server. This was intended to enable Kubernetes support but was never documented. Consider removing it from your `Replication.xml`. (Use `<replication kubernetes-enabled="true"/>` to enable Kubernetes support if it is included in your licence.)

Behavior changes at the Diffusion server

The following list includes behavior that has changed at the server. If your solution relies on the previous behavior, adjust your solution to take into account the new behavior.

1. Fan-out connections no longer appear in session property queries and session property listener notifications. Previously fan-out connections would appear in session property queries and would also be notified to session property listeners as if they were client connections. This is no longer the case.
2. If client statistics are enabled in `Statistics.xml`, a summary of the connected sessions is regularly logged. In previous releases, these reports were logged to a separate log file, specified by the `log-file` configuration property. From this release, the reports are logged to the server log. The `log-file` configuration property now has no purpose, and has been deprecated together with the corresponding configuration API property. If separate log files are required or the reports are not desired, use a third-party SLF4J logging back-end such as Log4j 2, and configure it appropriately to partition or filter the server log.
3. The server no longer maintains rates for statistic metrics. Previously, the server maintained exponentially-weighted moving averages for some metric values, calculated over 1 minute, 5 minute and 15 minute intervals. These were available through the JMX statistics API and (if specially configured) the Diffusion console. The derived rates were rarely used and have been removed to reduce the CPU and memory overhead of statistics.
4. Some rarely used statistics have been removed to improve performance. These statistics were only available through JMX and include the connection count per connection type; the number of publishers started and loaded; the publisher name; the per-publisher subscription count; the global count of subscriptions; the per-session connection type; and the per-topic counts of subscriptions added and removed.
5. At previous releases, if a server was created in a programmatic environment (without XML configuration files) then it was necessary to set up certain configuration items in order to establish a working server that could accept normal web clients. All configuration items now have sensible defaults, enabling a working server to be started without any specific configuration.

Related concepts

[Upgrading to a new patch release](#) on page 766

When upgrading to a new patch release there are typically no changes to the configuration values or the APIs. All that is required is to copy your existing files from the old installation to the new installation.

Related reference

[Interoperability](#) on page 761

If you plan to use Diffusion servers and clients of different versions together, review the following information that summarizes support between versions.

Upgrading to a new patch release

When upgrading to a new patch release there are typically no changes to the configuration values or the APIs. All that is required is to copy your existing files from the old installation to the new installation.

To upgrade to a new patch release, complete the following steps:

1. Use the graphical or headless installer to install the new version of Diffusion.
For more information, see [Installing the Diffusion server](#) on page 475.
2. Copy your existing license file from your previous installation to the `etc` directory of your new installation.
3. Copy your existing configuration files from the `etc` directory of your previous installation to the `etc` directory of your new installation.
4. Copy any publishers located in the `ext` directory of the previous installation into the `ext` directory of the new installation.

Related concepts

[Upgrading from version 6.0 to version 6.1](#) on page 762

Consider the following information when upgrading from Diffusion version 6.0 to version 6.1.

Related reference

[Interoperability](#) on page 761

If you plan to use Diffusion servers and clients of different versions together, review the following information that summarizes support between versions.

Appendix

Appendices

The appendices contain reference information.

In this section:

- [Document conventions](#)
- [Glossary](#)
- [Trademarks](#)
- [Copyright Notices](#)

Appendix

A

Document conventions

This user manual uses certain typographic conventions to distinguish between different types of information.

The following table describes how different types of information are represented typographically.

Table 66: Typographic conventions used in this manual

Convention	Usage
Monospace	Indicates the following items: <ul style="list-style-type: none">• Source code• Class or method names• Command names• File paths• Information input by the user
Bold	Indicates the following items: <ul style="list-style-type: none">• Interface element titles (buttons, menu items, field names)• Window or panel titles
<i>Italic</i>	Indicates the following items: <ul style="list-style-type: none">• New terms – when appearing in the text• Variable values – when appearing in code or syntax examples
Greater than sign (>)	Indicates a menu item or sequence of menu items. For example, “Choose File > Save ” means choose the Save item from the File menu.
Highlighting	Indicates an example value in descriptive text.

Appendix

B

Glossary

The glossary contains key terms associated with Diffusion and their definitions.

In this section:

- [A](#)
- [C](#)
- [D](#)
- [E](#)
- [F](#)
- [G](#)
- [H](#)
- [I](#)
- [J](#)
- [L](#)
- [M](#)
- [N](#)
- [P](#)
- [Q](#)
- [R](#)
- [S](#)
- [T](#)
- [U](#)
- [V](#)
- [W](#)
- [X](#)

A

acknowledgment

A deprecated mechanism for the recipient of a message or update to inform the sender of that message or update that it was received. Acknowledgements were removed in Diffusion 6.0. Methods related to acknowledgements are still present in the Publisher API, but are deprecated.

ack

API

Application Programming Interface

A set of contracts that you can program against to interact with Diffusion.

The following APIs are available:

- Publisher API
- Client APIs

API

API

API

APNs

Apple Push Notification service

Apple Push Notification service (APNs)

APNs

APNs

APR

Apache Portable Runtime

Apache Portable Runtime (APR)

APR

APR

ASCII

American Standard Code for Information Interchange

A character-encoding scheme that encodes 128 specified characters into 7-bit binary integers.

ASCII

ASCII

ASCII

C

callback

An object, specific to a single call, that is used to respond to a request.

CBOR

Concise Binary Object Representation

Concise Binary Object Representation (CBOR)

CBOR

CBOR

certify

Push Technology certifies specific hardware and software version for use with Diffusion. Certified versions have been fully functional tested and performance tested with the Diffusion server. In addition, Push Technology supports some hardware and software that has not been certified.

client

An entity that connects to the Diffusion server and subscribes to topics.

Typically a client is a user-written application communicating with the Diffusion server through a client API or the Diffusion protocol. A publisher can be a client of another publisher in a distributed environment.

client library

A library that is included in a client application to enable interaction with the Diffusion server.

conflation

The merging or replacing of a queued update with a newer update to reduce network traffic. Conflation removes outdated information from the queue of content to be sent and either replaces the outdated information with the conflated information or appends the conflated information to the end of the queue.

connector

A configured point of connection to a server.

There can be one or more connectors (each listening on a different port). Each connector can accept single or multiple types of connection.

consume

When a message or update is received by a topic listener and that listener chooses not to pass on the message or update to subsequent topic listeners. Topic streams cannot choose to consume messages or updates they receive.

CORS

Cross-Origin Resource Sharing
cross-origin resource sharing (CORS)

CORS

CORS

CPU

Central Processing Unit
CPU

CPU

CPU

credentials

A piece of information that is used to authenticate a principal.

CSR

Certificate Signing Request
certificate signing request (CSR)

CSR

CSR

CSS

Cascading Style Sheet
CSS

CSS

CSS

D

DAR file

A Diffusion archive file. This file contains a publisher and can be deployed on the Diffusion server.
DAR

DAR

DAR

delimiter

A byte value that is used as a separator in messages or updates.

Depending on the type of message or update, it can contain field delimiters or record delimiters.

delta

Data that is sent to a client subscribed to a topic. The delta contains only information that has been updated on the topic since the last data was sent to the client. Topics that contain only a single item of data cannot use delta messages.

Diffusion

The Diffusion product comprising the Diffusion server and client libraries.

DLL

Dynamic Link Library

DLL

DLL

DLL

DOM

Document Object Model

DOM

DOM

DOM

DMZ

De-militarized Zone

de-militarized zone (DMZ)

DMZ

DMZ

E

EULA

End User License Agreement

EULA

EULA

EULA

F

feature

An API module that contains a conceptual set of facilities.

fetch

A request from a client for the current state of all data on a topic. A client can fetch a topic's state without being subscribed to the topic. This request-response mechanism of getting data from a topic is separate from the pub-sub mechanism.

flow control

A mechanism within a Diffusion client that limits the rate that client sends messages as the load level from that client increases. A client application rapidly making thousands of calls to the Diffusion server might overflow the internal queues, which results in the client session being closed. Flow control protects against these queues overflowing by progressively delaying messages from the client to the Diffusion server.

field

A section of content that contains data of a specific type. Fields are nested inside records. A record can contain one or many fields.

G

GBE

Gigabit Ethernet

GBE

GBE

GBE

GCM

Google Cloud Messaging

Google Cloud Messaging (GCM)

GCM

GCM

global-scoped permission

Permissions at global scope apply to actions on the Diffusion server.

GUI

Graphical User Interface

GUI

GUI

GUI

H

handler

A handler is an object responsible for responding to one or more instances of a single type of request.

HDD

Hard Disk Drive

HDD

HDD

HDD

HTML

Hypertext Markup Language

HTML

HTML

HTML

HTTP

Hypertext Transfer Protocol

HTTP

HTTP

HTTP

I

IDE

Integrated Development Environment

integrated development environment (IDE)

IDE

IDE

ISAPI

Internet Server Application Programming Interface

ISAPI

initial topic load

The data sent to a client when it first subscribes to a topic. This data contains the value of the current state of the topic.

initial topic load (ITL)

ITL

ITL

J

JAR

Java Archive

JAR

JAR

JAR

JDK

Java Development Kit

Java Development Kit (JDK)

JDK

JDK

JMS

Java Message Service

Java Message Service (JMS)

JMS

JMS

JMX

Java Management Extensions

Java Management Extensions (JMX)

JMX

JMX

JRE

Java Runtime Environment

Java Runtime Environment (JRE)

JRE

JRE

JSON

JavaScript Object Notation

JavaScript Object Notation (JSON)

JSON

JSON

JVM

Java Virtual Machine

Java Virtual Machine (JVM)

JVM

JVM

L

LDAP

Lightweight Directory Access Protocol

Lightweight Directory Access Protocol (LDAP)

LDAP

LDAP

listener

In the API, a listener is an object that is always called when a particular event occurs.

M

message

A message is a series of bytes of information formatted according to the Diffusion protocol which can be sent between components utilizing Diffusion.

message queue

A queue of messages. Each client connection to Diffusion has such a queue on the Diffusion server upon which messages are put for sending to the client.

queue

metadata

Data about data. In Diffusion metadata is used to define the structure of messages.

message metadata

multicast

To send data to several recipients at the same time.

The datagrid uses multicasting to locate other datagrid nodes.

N

NAT

Network Address Translation

network address translation (NAT)

NAT

NAT

NIC

Network Interface Controller

NIC

NIC

NIC

NIO

New Input-Output

NIO

NIO

Non-blocking Input/Output

NIO

notification

...

P

path

A string representation of a location at which a topic can exist or through which messages can be sent.

A path consists of parts separated by a slash character (/).

Paths describe a location where a topic can be bound and used for pub-sub distribution of data. When used this way they can be referred to as topic paths.

Paths can be used for bi-directional messaging. When used this way they can be referred to as message paths. A client can send a message to a message path and the Diffusion server routes the message to the message handler for the message path.

topic name

topic path

message path

hierarchic topic name

full topic name

PNG

Portable Network Graphics

PNG

PNG

PNG

permission

A permission represents the right to perform an action on the Diffusion server or on data hosted by the Diffusion server. Permissions can be global- or topic-scoped.

PID

Process ID

PID

PID

PID

ping

A query sent by a publisher, client or by the Diffusion server to a connected component to check that the connection exists and the latency of the connection.

The following types of ping are available:

server ping

A client pings the Diffusion server.

client ping

A publisher pings a specific client.

system ping

Diffusion pings all clients at a regular interval.

PDF

Portable Document Format

PDF

PDF

PDF

primary server

In a fan-out solution, the server from which updates are fanned out to replica servers.

In previous releases, this server was called the master server. This terminology is no longer used.

master server

principal

An identity that can be authenticated by the Diffusion server or by a client.

A principal functions like a username, except that instead of identifying a particular person, it denotes an identity that can be used by a person or client. For example, you can use the 'admin' principal to log in to the Diffusion console. After a principal has been authenticated, it can be assigned roles that enable it to access actions or resources.

protocol

A protocol defines the exact format of data passed between the Diffusion server and a client.

publisher

A server-side component which publishes messages relating to one or more topics.

A server can host one or more publishers. Messages sent by clients on particular topics are routed to the Publisher that owns the topic. Publisher functionality is provided by users by writing a Java publisher class.

A publisher is distinct from a publishing client that can create and publish to topics. We recommend using a publishing client rather than a publisher.

publishing topic

A topic where data is published and from which the data is distributed to subscribing clients.

push notification destination

An endpoint, described by either an APNs device token or a GCM registration ID, where push notifications are received.

Q

message queue

A queue of messages. Each client connection to Diffusion has such a queue on the Diffusion server upon which messages are put for sending to the client.

queue

R

RAID

Redundant Array of Independent Disks

RAID

RAID

RAID

RAM

Random Access Memory

RAM

RAM

RAM

record

A section of content that acts as a container for a set of fields. Inside the content of a message or update you can have one or many records. A record can contain one or many fields.

regular expression

A string that uses special characters to describe a search pattern.

Diffusion uses Java-style regular expressions.

regex

replica server

In a fan-out solution, a server to which updates are fanned out from the primary server.

In previous releases, this server was called the slave server. This terminology is no longer used.

slave server

RMI

Remote Method Invocation

remote method invocation (RMI)

RMI

RMI

role

A role is a named set of permissions and other roles. Principals and sessions can both be assigned roles.

role hierarchy

Roles are hierarchical. A role can include other roles and, by doing so, have the permissions assigned to the included roles. A role cannot include itself, either directly or indirectly – through a number of included roles.

RPM

Redhat Package Manager

Redhat Package Manager (RPM)

RPM

RPM

S

SAS

Serial Attached SCSI

SAS

SAS

SAS

SDK

Software Development Kit

software development kit (SDK)

SDK

SDK

server

The component that hosts topics and publishers. A server broadcasts topic updates to all subscribed clients.

Clients can connect to servers through the API.

Diffusion server

session

An ongoing dialog between a client and the Diffusion server.

Typically, a session represents a single client connection to a single server. However, in the event of connection failure the session can automatically reconnect to the same server or even fail over to another server and still retain its context.

session will

A set of actions to be completed after a session closes.

A client session can specify actions that are completed by the Diffusion server that the session connects to after the session has closed. A session will can be used to close or tidy up topics managed or updated by the client session.

will

SLF4J

Simple Logging Facade for Java

SLF4J

SLF4J

SLF4J

SSH

Secure Shell

SSH

SSH

SSH

SSL

Secure Sockets Layer

Secure Sockets Layer (SSL)

SSL

SSL

state

The latest published values of all data items on the topic. The state of a topic is stored on the Diffusion server.

stateful topic

A topic that stores a current value as topic data on the Diffusion server.

stateless topic

A deprecated topic type that does not store a current value on the Diffusion server. Replaced by the `DONT_RETAIN_VALUE` property.

structural conflation

A form of conflation that enables you to define the operations performed on outdated content. You can merge, aggregate, reverse or combine the effects of multiple changes into a single consistent and current notification to the client.

stream

In the API, a stream is a sequence of responses to a single request.

subscribe

A client registers interest in a topic such that the client receives messages sent to that topic.

support

Push Technology supports a number of hardware and software versions, these versions have not necessarily been tested. Those hardware and software versions that we have tested are listed as 'certified'.

T

TCP

Transmission Control Protocol

TCP

TCP

TCP

throttling

Limiting the volume of messages that the Diffusion server transmits to a client within a specified period of time.

Throttling can be used to limit bandwidth usage or to prevent more messages being sent to a client than the client can handle.

TLS

Transport Layer Security

Transport Layer Security (TLS)

TLS

TLS

topic

A logical channel through which messages are distributed.

Topics provide a logical link between publishers and subscribers. Clients or publishers publish messages to topics. Clients subscribe to topics to receive messages published to that topic.

topic path prefix

The root part of a topic selector.

A concrete topic path to the most specific part of the topic tree that contains all topics that the selector can specify. For example, for the topic selector `?foo/bar/baz/.*/bing`, the topic path prefix is `foo/bar/baz`.

path prefix

topic selector

An object that retrieves one or more topics based on their topic paths.

A topic selector uses a pattern expression, which can include one or more regular expressions, to match to the path of one or more topics.

selector

topic-scoped permission

Permissions at topic scope apply to actions on a topic.

Topic-scoped permissions are defined against topic branches. The permissions that apply to a topic are the set of permissions defined at the most specific branch of the topic tree.

topic tree

The organization structure of topics on the Diffusion server.

A topic can have subtopics and can itself be a subtopic of another topic. All topics created on the Diffusion server by a publisher or client are in the topic tree.

topic hierarchy

transport

An implementation of a network protocol. The mechanism by which clients communicate with the Diffusion server.

U

update

Data published to a topic by a client or publisher that is applied to the topic to change the topic state. The updated data is then pushed out to all subscribing clients.

URL

Uniform Resource Locator

URL

URL

URL

UTF-8

Universal Character Set Transformation Format 8-bit

A character encoding capable of encoding all possible characters in Unicode.

UTF-8

UTF-8

UTF-8

V

VCPU

Virtual Central Processing Unit

VCPU

VCPU

VCPU

W

WAR

Web Application Archive

WAR

WAR

WAR

X

XHR

XmlHttpRequest

XHR

XHR

XHR

XML

Extensible Markup Language

XML

XML

XML

XSD

XML Schema Definition

XSD

XSD

XSD

Appendix

C

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D

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Version 1.2.13

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Related concepts

[streamsupport](#) on page 803

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Related concepts

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Related concepts

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[Fluidbox](#) on page 795

[hashmap](#) on page 796

[jQuery](#) on page 798

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