Spring XD Guide

1.0.0

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Part I. Reference Guide

1. Introduction

1.1 Overview

Spring XD is a unified, distributed, and extensible service for data ingestion, real time analytics, batch processing, and data export. The Spring XD project is an open source Apache 2 License licenced project whose goal is to tackle big data complexity. Much of the complexity in building real-world big data applications is related to integrating many disparate systems into one cohesive solution across a range of use-cases. Common use-cases encountered in creating a comprehensive big data solution are

- High throughput distributed data ingestion from a variety of input sources into big data store such as HDFS or Splunk
- Real-time analytics at ingestion time, e.g. gathering metrics and counting values.
- Workflow management via batch jobs. The jobs combine interactions with standard enterprise systems (e.g. RDBMS) as well as Hadoop operations (e.g. MapReduce, HDFS, Pig, Hive or Cascading).
- High throughput data export, e.g. from HDFS to a RDBMS or NoSQL database.

The Spring XD project aims to provide a one stop shop solution for these use-cases.

2. Getting Started

3. Requirements

To get started, make sure your system has as a minimum **Java JDK 6** or newer installed. **Java JDK 7** is recommended.

3.1 Download Spring XD

If you want to try out Spring XD, we'd recommend downloading a snapshot build, since things are changing quite fast. A snapshot distribution can be downloaded from the spring snapshots repository. You can also build the project from source if you wish. The wiki content should also be kept up to date with the current snapshot so if you are reading this on the github website, things may have changed since the last milestone.

Unzip the distribution which will unpack to a single installation directory. All the commands below are executed from this directory, so change into it before proceeding.

If you are sure you want the previous milestone release, you can also download the distribution **spring-xd-1.0.0.M6-dist.zip** and its accompanying documentation.

```
$ cd spring-xd-1.0.0.M6
```

Set the environment variable `XD_HOME` to the installation directory `<root-install-dir>\spring-xd\xd`

3.2 Install Spring XD

Spring XD can be run in two different modes. There's a single-node runtime option for testing and development, and there's a distributed runtime which supports distribution of processing tasks across multiple nodes. This document will get you up and running quickly with a single-node runtime. See Running Distributed Mode for details on setting up a distributed runtime.

You can also install Spring XD using homebrew on OSX and yum on RedHat/CentOS.

3.3 Start the Runtime and the XD Shell

The single node option is the easiest to get started with. It runs everything you need in a single process. To start it, you just need to `cd` to the `xd` directory and run the following command

```
xd/bin>$ ./xd-singlenode
```

In a separate terminal, `cd` into the `shell` directory and start the XD shell, which you can use to issue commands.

```
shell/bin>$ ./xd-shell
 _____                           __   _______
/  ___|          (-)             \ \ / /  _  \
\ `--. _ __  _ __ _ _ __   __ _   \ V /| | | |
 `--. \ '_ \| '__| | '_ \ / _` |  / ^ \| | | |
/\__/ / |_) | |  | | | | | (_| | / / \ \ |/ /
\____/| .__/|_|  |_|_| |_|\__, | \/   \/___/
      | |                  __/ |
      |_|                 |___/
eXtreme Data
1.0.0.M6 | Admin Server Target: http://localhost:8080
Welcome to the Spring XD shell. For assistance hit TAB or type "help".
xd:>
```

The shell is a more user-friendly front end to the REST API which Spring XD exposes to clients. The URL of the currently targeted Spring XD server is shown at startup.

Note

If the server could not be reached, the prompt will read

```
server-unknown:>
```

You can then use the `admin config server <url>` to attempt to reconnect to the admin REST endpoint once you've figured out what went wrong:

```
admin config server http://localhost:9393
```

You should now be able to start using Spring XD.

Tip

Spring XD uses ZooKeeper internally which typically runs as an external process. XD singlenode runs with an embedded ZooKeeper server and assigns a random available port. This keeps things very simple. However if you already have a ZooKeeper ensemble set up and want to connect to it, you can edit `xd\config\servers.yml`:

```
#Zookeeper properties
# client connect string: host1:port1,host2:port2,...,hostN:portN
zk:
  client:
     connect: localhost:2181
```

Also, sometimes it is useful in troubleshooting to connect the ZooKeeper CLI to the embedded server. The assigned server port is listed in the console log, but you can also set the port directly by setting the property `zk.embedded.server.port` in `servers.yml`

3.4 Create a Stream

In Spring XD, a basic stream defines the ingestion of event driven data from a source to a sink that passes through any number of processors. You can create a new stream by issuing a `stream create` command from the XD shell. Stream definitions are built from a simple DSL. For example, execute:

```
xd:> stream create --name ticktock --definition "time | log" --deploy
```

This defines a stream named `ticktock` based off the DSL expression `time | log`. The DSL uses the "pipe" symbol `|`, to connect a source to a sink. The stream server finds the `time` and `log` definitions in the modules directory and uses them to setup the stream. In this simple example, the time source simply sends the current time as a message each second, and the log sink outputs it using the logging framework at the WARN logging level. Since the `--deploy` flag was provided, this stream will be deployed immediately. In the console where you started the server, you will see log output similar to that listed below

```
13:09:53,812  INFO http-bio-8080-exec-1 module.SimpleModule:109 - started module: Module
 [name=log, type=sink]
13:09:53,813  INFO http-bio-8080-exec-1 module.ModuleDeployer:111 - launched sink module:
 ticktock:log:1
13:09:53,911  INFO http-bio-8080-exec-1 module.SimpleModule:109 - started module: Module
 [name=time, type=source]
13:09:53,912  INFO http-bio-8080-exec-1 module.ModuleDeployer:111 - launched source
 module: ticktock:time:0
13:09:53,945  WARN task-scheduler-1 logger.ticktock:141 - 2013-06-11 13:09:53
13:09:54,948  WARN task-scheduler-1 logger.ticktock:141 - 2013-06-11 13:09:54
13:09:55,949  WARN task-scheduler-2 logger.ticktock:141 - 2013-06-11 13:09:55
```

To stop the stream, and remove the definition completely, you can use the `stream destroy` command:

```
xd:>stream destroy --name ticktock
```

It is also possible to stop and restart the stream instead, using the `undeploy` and `deploy` commands. The shell supports command completion so you can hit the `tab` key to see which commands and options are available.

3.5 Explore Spring XD

Learn about the modules available in Spring XD in the Sources, Processors, and Sinks sections of the documentation.

Don't see what you're looking for? Create a custom module: source, processor or sink (and then consider contributing it back to Spring XD).

Want to add some analytics to your stream? Check out the Taps and Analytics sections.

3.6 OSX Homebrew installation

If you are on a Mac and using homebrew, all you need to do to install *Spring XD* is:

```
$ brew tap pivotal/tap
$ brew install springxd
```

Homebrew will install `springxd` to `/usr/local/bin`. Now you can jump straight into using **Spring XD**:

```
$ xd-singlenode
```

Brew install also allows you to run *Spring XD* in distributed mode on you OSx. See Running Distributed Mode for details on setting up a distributed runtime.

3.7 RedHat/CentOS Installation

If you are using RHEL or CentOS (5 or 6) you can install *Spring XD* using our yum repository.

```
wget -q -O http://packages.gopivotal.com | sh
yum install spring-xd
```

This installs *Spring XD* and init.d services for managing Admin Server and Container runtimes. Before you can run Admin Server and Container you will need to install and start distributed components. See Running Distributed Mode for details on setting up a distributed runtime. After distributed component are configured, Admin Server and Container can be started as follows:

```
service spring-xd-admin start
service spring-xd-container start
```

You can configure arguments to spring-xd-admin and spring-xd-container scripts by setting them in /etc/sysconfig/spring-xd. For example to run spring-xd-container with transport=RabbitMQ update this property in /etc/sysconfig/spring-xd:

```
TRANSPORT=rabbit
```

To stop *Spring XD*

```
service spring-xd-admin stop
service spring-xd-container stop
```

4. Running in Distributed Mode

4.1 Introduction

The Spring XD distributed runtime (DIRT) supports distribution of processing tasks across multiple nodes. See Getting Started for information on running Spring XD as a single node.

The XD distributed runtime architecture consists of the following distributed components:

- Admin - Manages Stream and Job deployments and other end user operations and provides REST services to access runtime state, system metrics, and analytics
- Container - Hosts deployed Modules (stream processing tasks) and batch jobs
- ZooKeeper - Provides all runtime information for the XD cluster. Tracks running containers, in which containers modules and jobs are deployed, stream definitions, deployment manifests, and the like, see XD Distributed Runtime for an overview on how XD uses ZooKeeper.
- Spring Batch Job Repository Database - An RDBMS is required for jobs. The XD distribution comes with HSQLDB, but this is not appropriate for a production installation. XD supports any JDBC compliant database.
- A Message Broker - Used for data transport. XD data transport is designed to be pluggable. Currently XD supports Rabbit MQ and Redis for messaging during stream and job processing. A production installation must configure one of these transport options. Rabbit MQ is recommended as it is considered the more reliable of the two. In either case, a separate server must be running to provide the messaging middleware.
- Analytics Repository - XD currently uses Redis to store the counters and gauges provided Analytics)

In addition, XD provides a Command Line Interface (CLI), XD Shell as well as a web application, XD-UI to interact with the XD runtime.

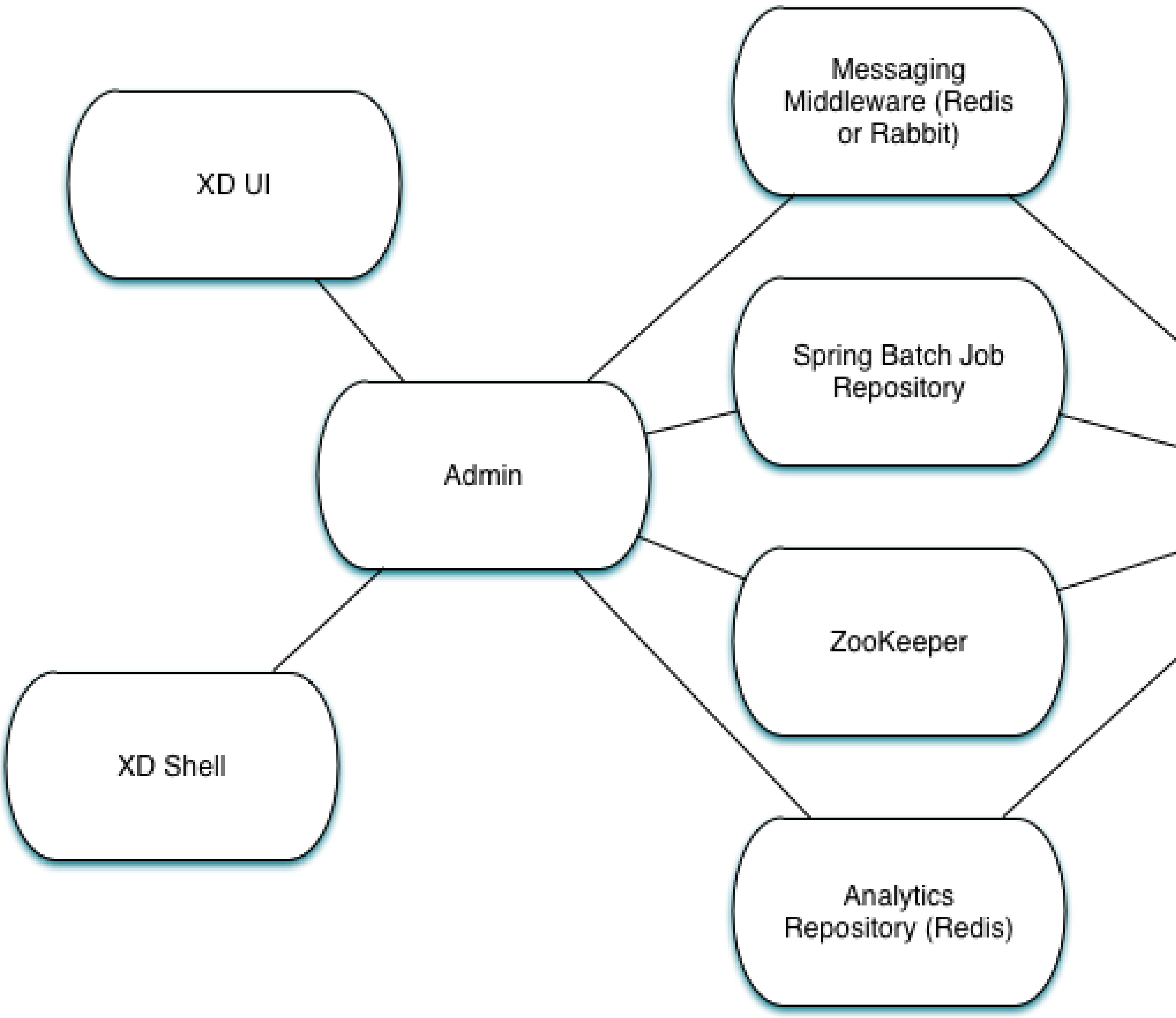

Messaging Middleware (Redis or Rabbit)
XD UI
Spring Batch Job Repository
Admin
ZooKeeper
XD Shell
Analytics Repository (Redis)

Figure 4.1.

XD CommandLine Options

The XD distribution provides shell scripts to start its runtime components under the *xd* directory of the XD installation:

Whether you are running _xd-admin, xd-container or even xd-singlenode you can always get help by typing the command followed by --help. For example:

```
xd/bin/xd-admin --help

 _____                           __   _______
/  ___|          (-)             \ \ / /  _  \
\ `--. _ __  _ __ _ _ __   __ _   \ V /| | | |
 `--. \ '_ \| '__| | '_ \ / _` |  / ^ \| | | |
/\__/ / |_) | |  | | | | | (_| | / / \ \ |/ /
\____/| .__/|_|  |_|_| |_|\__, | \/   \/___/
      | |                  __/ |
      |_|                 |___/
1.0.0.BUILD-SNAPSHOT             eXtreme Data


Started : AdminServerApplication
Documentation: https://github.com/spring-projects/spring-xd/wiki

Usage:
 --analytics [redis]   : How to persist analytics such as counters and gauges
 --help (-?, -h)       : Show this help screen
 --httpPort <httpPort> : Http port for the REST API server
 --mgmtPort <mgmtPort> : The port for the management server
```

xd-admin command line args:

- **analytics** - The data store that will be used to store the analytics data. The default is **redis**
- **help** - Displays help for the command args. Help information may be accessed with a -? or -h.
- **httpPort** - The http port for the REST API server. Defaults to 9393.
- **mgmtPort** - The port for the management server. Defaults to 9393.

xd-container command line args:

- **analytics** - How to persist analytics such as counters and gauges. The default is **redis**
- **groups** - The assigned group membership for this container as a comma delimited list
- **hadoopDistro** - The Hadoop distribution to be used for HDFS access. HDFS is not available if not set.
- **help** - Displays help for the command args. Help information may be accessed with a -? or -h.
- **mgmtPort** - The port for the management server. Defaults to the container server port.

4.2 Setting up a RDBMS

The distributed runtime requires an RDBMS. The XD distrubution comes with an HSQLDB in memory database for testing purposes, but an alternate is expected. To start HSQLDB:

```
$ cd hsqldb/bin
$ ./hsqldb-server
```

To configure XD to connect to a different RDBMS, have a look at `xd/config/servers.yml` in the `spring:datasource` section for details. Note that `spring.batch.initializer.enabled` is set to true by default which will initialize the Spring Batch schema if it is not already set up. However, if those tables have already been created, they will be unaffected.

4.3 Setting up ZooKeeper

Currently XD does not ship with ZooKeeper. At the time of this writing, the compliant version is 3.4.6 and you can download it from here. Please refer to the ZooKeeper Getting Started Guide for more information. A ZooKeeper ensemble consisting of at least three members is recommended for production installations, but a single server is all that is needed to have XD up and running.

4.4 Setting up Redis

Redis is the default transport when running in distributed mode.

Installing Redis

If you already have a running instance of **Redis** it can be used for Spring XD. By default Spring XD will try to use a *Redis* instance running on **localhost** using **port 6379**. You can change that in the `servers.yml` file residing in the `config/` directory.

If you don't have a pre-existing installation of *Redis*, you can use the *Spring XD* provided instance (For Linux and Mac). Inside the *Spring XD* installation directory (spring-xd) do:

```
$ cd redis/bin
$ ./install-redis
```

This will compile the *Redis* source tar and add the *Redis* executables under redis/bin:

- redis-check-dump
- redis-sentinel
- redis-benchmark
- redis-cli
- redis-server

You are now ready to start *Redis* by executing

```
$ ./redis-server
```

Tip

For further information on installing *Redis* in general, please checkout the Redis Quick Start guide. If you are using *Mac OS*, you can also install *Redis* via Homebrew

Troubleshooting

Redis on Windows

Presently, *Spring XD* does not ship *Windows* binaries for *Redis* (See XD-151). However, *Microsoft* is actively working on supporting *Redis* on *Windows*. You can download *Windows Redis* binaries from:

https://github.com/MSOpenTech/redis/tree/2.6/bin/release

Redis is not running

If you try to run *Spring XD* and Redis is NOT running, you will see the following exception:

```
11:26:37,830 ERROR main launcher.RedisContainerLauncher:85 - Unable to connect to Redis
 on localhost:6379; nested exception is com.lambdaworks.redis.RedisException: Unable to
 connect
Redis does not seem to be running. Did you install and start Redis? Please see the Getting
 Started section of the guide for instructions.
```

Starting Redis

```
$ redis-server
```

You should see something like this:

```
[35142] 01 May 14:36:28.939 # Warning: no config file specified, using the default config.
 In order to specify a config file use redis-server /path/to/redis.conf
[35142] 01 May 14:36:28.940 * Max number of open files set to 10032
                _._
           _.-``__ ''-._
      _.-``    `.  `_.  ''-._           Redis 2.6.12 (00000000/0) 64 bit
  .-`` .-```.  ```\/    _.,_ ''-._
 (    '      ,       .-`  | `,    )     Running in stand alone mode
 |`-._`-...-` __...-.``-._|'` _.-'|     Port: 6379
 |    `-._   `._    /     _.-'    |     PID: 35142
  `-._    `-._  `-./  _.-'    _.-'
 |`-._`-._    `-.__.-'    _.-'_.-'|
 |    `-._`-._        _.-'_.-'    |           http://redis.io
  `-._    `-._`-.__.-'_.-'    _.-'
 |`-._`-._    `-.__.-'    _.-'_.-'|
 |    `-._`-._        _.-'_.-'    |
  `-._    `-._`-.__.-'_.-'    _.-'
      `-._    `-.__.-'    _.-'
          `-._        _.-'
              `-.__.-'

[35142] 01 May 14:36:28.941 # Server started, Redis version 2.6.12
[35142] 01 May 14:36:28.941 * The server is now ready to accept connections on port 6379
```

4.5 Using RabbitMQ

Installing RabbitMQ

If you already have a running instance of *RabbitMQ* it can be used for Spring XD. By default Spring XD will try to use a *Rabbit* instance running on **localhost** using **port 5672**. The default account credentials of **guest/guest** are assumed. You can change that in the `servers.yml` file residing in the `config/` directory.

If you don’t have a *RabbitMQ* installation already, head over to http://www.rabbitmq.com and follow the instructions. Packages are provided for Windows, Mac and various flavor of unix/linux.

Launching RabbitMQ

Start the **RabbitMQ** broker by running the rabbitmq-server script:

```
$ rabbitmq-server
```

You should see something similar to this:

```
            RabbitMQ 3.3.0. Copyright (C) 2007-2013 GoPivotal, Inc.
##  ##      Licensed under the MPL.  See http://www.rabbitmq.com/
##  ##
##########  Logs: /usr/local/var/log/rabbitmq/rabbit@localhost.log
######  ##        /usr/local/var/log/rabbitmq/rabbit@localhost-sasl.log
##########
            Starting broker... completed with 10 plugins.
```

4.6 Starting Spring XD in Distributed Mode

Spring XD consists of two servers

- XDAdmin - controls deployment of modules into containers
- XDContainer - executes modules

You can start the `xd-container` and `xd-admin` servers individually as follows:

```
xd/bin>$ ./xd-admin
xd/bin>$ ./xd-container
```

Choosing a Transport

Spring XD uses data transport for sending data from the output of one module to the input of the next module. In general, this requires remote transport between container nodes. The Admin server also uses the data bus to launch batch jobs by sending a message to the job's launch channel. Since the same transport must be shared by the Admin and all Containers, the transport configuration is centrally configured in xd/config/servers.yml. The default transport is redis. Open servers.yml with a text editor and you will see the transport configuration near the top. To change the transport, you can uncomment this section and change the transport to `rabbit` or any other supported transport. Any changes to the transport configuration must be replicated to every XD node in the cluster.

Note

XD singlenode also supports a --transport command line argument, useful for testing streams under alternate transports.

```
#xd:
#  transport: redis
```

Note

If you have multiple XD instances running share a single RabbitMQ server for transport, you may encounter issues if each system contains streams of the same name. We recommend using a different RabbitMQ virtual host for each system. Update the `spring.rabbitmq.virtual_host` property in `$XD_HOME/config/servers.yml` to point XD at the correct virtual host.

Choosing an Analytics provider

By default, the xd-container will store Analytics data in redis. At the time of writing, this is the only supported option (when running in distributed mode). Use the --analytics option to specify another backing store for Analytics data.

```
xd/bin>$ ./xd-container --analytics redis
```

Other Options

There are additional configuration options available for these scripts:

To specify the location of the Spring XD install other than the default configured in the script

```
export XD_HOME=<Specific XD install directory>
```

To specify the http port of the XDAdmin server,

```
xd/bin>$ ./xd-admin --httpPort <httpPort>
```

The XDContainer nodes by default start up with server.port 0 (which means they will scan for an available HTTP port). You can disable the HTTP endpoints for the XDContainer by setting server.port=-1. Note that in this case HTTP source support will not work in a PaaS environment because typically it would require XD to bind to a specific port. Both the XDAdmin and XDContainer processes bind to server.port $PORT (i.e. an environment variable if one is available, as is typical in a PaaS).

4.7 Using Hadoop

Spring XD supports the following Hadoop distributions:

- hadoop12 - Apache Hadoop 1.2.1
- hadoop22 - Apache Hadoop 2.2.0 (default)
- phd1 - Pivotal HD 1.1
- cdh4 - Cloudera CDH 4.6.0
- hdp13 - Hortonworks Data Platform 1.3
- hdp20 - Hortonworks Data Platform 2.0

To specify the distribution to use for Hadoop client connections,

```
xd/bin>$ ./xd-shell --hadoopDistro <distribution>
xd/bin>$ ./xd-admin --hadoopDistro <distribution>
xd/bin>$ ./xd-container --hadoopDistro <distribution>
```

Pass in the `--help` option to see other configuration properties.

4.8 XD-Shell in Distributed Mode

If you wish to use a XD-Shell that is on a different machine than where you deployed your admin server.

1) Open your shell

```
shell/bin>$ ./xd-shell
```

2) From the xd shell use the "admin config server" command i.e.

```
admin config server <yourhost>:9393
```

5. Running on YARN

5.1 Introduction

The Spring XD distributed runtime (DIRT) supports distribution of processing tasks across multiple nodes. See Running Distributed Mode for information on running Spring XD in distributed mode. One option is to run these nodes on a Hadoop YARN cluster rather than on VMs or physical servers managed by you.

5.2 What do you need?

To begin with, you need to have access to a Hadoop cluster running a version based on Apache Hadoop 2.2.0 or later. This includes Apache Hadoop 2.2.0, Hortonworks HDP 2.0 and Cloudera CDH5.

You also need a supported transport, see Running Distributed Mode for installation of Redis or Rabbit MQ. Spring XD on YARN currently uses Redis as the default data transport.

You also need Zookeeper running. If your Hadoop cluster doesn't have Zookeeper installed you need to install and run it specifically for Spring XD. See the Setting up ZooKeeper section of the "Running Distributed Mode" chapter.

Lastly, you need an RDBMs to support batch jobs and JDBC operations.

5.3 Download Spring XD on YARN binaries

In addition to the regular `spring-xd-<version>-dist.zip` files we also distribute a zip file that includes all you need to deploy on YARN. The name of this zip file is `spring-xd-<version>-yarn.zip`. You can download it from the Spring Repo. Unzip the downloaded file and you should see a `spring-xd-<version>-yarn` directory.

5.4 Configure your deployment

Configuration options are contained in a `spring-xd-<version>-yarn\config\xd-config.yml` file. You need to configure the hadoop settings, the transport choice plus redis/rabbit settings, the zookeeper settings and the JDBC datasource properties.

XD options

For Spring XD you need to define how many admin servers and containers you need. You also need to define the HDFS location (spring.yarn.applicationDir) where the Spring XD binary and config files will be stored.

```
spring:
    xd:
        adminServers: 1
        containers: 3
    yarn:
        applicationDir: /xd/app/
```

Hadoop settings

You need to specify the host where the YARN Resource Manager is running as well as the HDFS URL.

```
# Hadoop configuration
spring:
    hadoop:
        fsUri: hdfs://localhost:8020
        resourceManagerHost: localhost
```

Transport options

You should choose either redis (default) or rabbit as the transport and include the host and port for the choice you made.

```
# Transport used
transport: rabbit

---
# Redis properties
#spring:
#  redis:
#   port: 6379
#   host: localhost

---
# RabbitMQ properties
spring:
  rabbitmq:
   host: localhost
   port: 5672
   username: guest
   password: guest
   virtual_host: /
```

Zookeeper settings

You should specify the Zookeeper connection settings

```
---
#Zookeeper properties
# client connect string: host1:port1,host2:port2,...,hostN:portN
zk:
  client:
     connect: localhost:2181
```

JDBC datasource properties

You should specify the JDBC connection properties based on the RDBMs that you use for the batch jobs and JDBC sink

```
---
#Config for use with MySQL - uncomment and edit with relevant values for your environment
spring:
  datasource:
    url: jdbc:mysql://yourDBhost:3306/yourDB
    username: yourUsername
    password: yourPassword
    driverClassName: com.mysql.jdbc.Driver
```

5.5 Push and start the jobs

Change current directory to be the directory that was unzipped (spring-xd-<version>-yarn).

Push the Spring XD application binaries and config to HDFS

Run the command

```
./bin/xd-yarn push
```

Submit the Spring XD admin server

Run the command

```
./bin/xd-yarn start admin
```

Submit the Spring XD container

Run the command

```
./bin/xd-yarn start container
```

Check the status of the app

You can use the regular `yarn` command to check the status. Simply run:

```
yarn application -list
```

You should see two applications running named xd-admin and xd-container.

6. Application Configuration

6.1 Introduction

There are two main parts of Spring XD that can be configured, servers and modules.

The servers (`xd-singlenode`, `xd-admin`, `xd-container`) are Spring Boot applications and are configured as described in the Spring Boot Reference documentation. In the most simple case this means editing values in the YAML based configuration file `servers.yml`. The values in this configuration file will overwrite the values in the default application.yml file that is embedded in the XD jar.

Note

The use of YAML is an alternative to using property files. YAML is a superset of JSON, and as such is a very convenient format for specifying hierarchical configuration data.

For modules, each module has its own configuration file located in its own directory, for example `source/http/http.properties`. Shared configuration values for modules can be placed in a common `modules.yml` file.

For both server and module configuration, you can have environment specific settings through the use of application profiles and the ability to override values in files by setting OS environment variables.

In this section we will walk though how to configure servers and modules.

6.2 Server Configuration

The startup scripts for `xd-singlenode`, `xd-admin`, and `xd-container` will by default look for the file `$XD_HOME\config\servers.yml` as a source of externalized configuration information.

The location and name of this resourse can be changed by using the environment variables `XD_CONFIG_LOCATION` and `XD_CONFIG_NAME`. The start up script takes the value of these environment variables to set the Spring Boot properties `spring.config.location` and `spring.config.name`. Note, that for `XD_CONFIG_LOCATION` you can reference any Spring Resource implementation, most commonly denoted using the prefixes `classpath:`, `file:` and `http:`.

It is common to keep your server configuration separate form the installation directory of XD itself. To do this, here is an example environment variable setting

```
export XD_CONFIG_LOCATION=file:/xd/config/
export XD_CONFIG_NAME=region1-servers
```

Profile support

Profiles provide a way to segregate parts of your application configuration and change their availability and/or values based on the environment. This lets you have different configuration settings for qa and `prod` environments and to easily switch between them.

To activate a profile, set the OS environment variable `SPRING_PROFILES_ACTIVE` to a comma delimited list of profile names. The server looks to load profile specific variants of the servers.yml file based on the naming convention servers-{profile}.yml. For example, if SPRING_PROFILES_ACTIVE=prod the following files would be searched for in the following order.

1. XD_CONFIG_LOCATION/servers-prod.yml
2. XD_CONFIG_LOCATION/servers.yml

You may also put multiple profile specific configuration in a single servers.yml file by using the key spring.profiles in different sections of the configuration file. See Multi-profile YAML documents for more information.

Database Configuration

Spring XD saves the state of the batch job workflows in a relational database. When running xd-singlenode a embedded HSQLDB database is run. When running in distributed mode a standalone HSQLDB instance can be used, the startup script hsqldb-server is in is provided the installation directory under the folder *hsqldb/bin*. It is recommended to use HSQLDB only for development and learning.

When deploying in a production environment, you will need to select another database. Spring XD is actively tested on MySql (Version: 5.1.23) and Postgres (Version 9.2-1002). All batch workflow tables are automatically created, if they do not exist, for HSQLDB, MySQL and Postgres. The JDBC driver jars for the HSQLDB, MySql, and Postgres are already on the XD classpath.

Note

Until full schema support is added for Oracle, Sybase and other database, you will need to put a .jar file in the xd/lib directory that contains the equivalent functionality as these DDL scripts.

The provided configuration file servers.yml located in $XD_HOME\config has commented out configuration for some commonly used databases. You can use these as a basis to support your database environment.

HSQLDB

When in distributed mode and you want to use HSQLDB, you need to change the value of spring.datasource properties. As an example,

```
hsql:
 server:
   host: localhost
   port: 9102
   dbname: xdjob
spring:
   datasource:
   url: jdbc:hsqldb:hsql://${hsql.server.host:localhost}:${hsql.server.port:9101}/
${hsql.server.dbname:xdjob}
   username: sa
   password:
   driverClassName: org.hsqldb.jdbc.JDBCDriver
```

The properties under hsql.server are substituted in the spring.datasource.url property value. This lets you create short variants of existing Spring Boot properties. Using this style, you can override the value of these configuration variables by setting an OS environment variable, such as xd_server_host. Alternatively, you can not use any placeholders and set spring.datasource.url directly to known values.

MySQL

When in distributed mode and you want to use MySQL, you need to change the value of `spring.datasource.*` properties. As an example,

```
spring:
 datasource:
 url: jdbc:mysql://yourDBhost:3306/yourDB
 username: yourUsername
 password: yourPassword
 driverClassName: com.mysql.jdbc.Driver
```

To override these settings set an OS environment variable such as `spring_datasource_url` to the value you require.

PostgreSQL

When in distributed mode and you want to use PostgreSQL, you need to change the value of `spring.datasource.*` properties. As an example,

```
spring:
  datasource:
    url: jdbc:postgresql://yourDBhost:5432/yourDB
    username: yourUsername
    password: yourPassword
    driverClassName: org.postgresql.Driver
```

To override these settings set an OS environment variable such as `spring_datasource_url` to the value you require.

Redis

If you want to use Redis for analytics or data transport you should set the host and port of the Redis server.

```
spring:
  redis:
   port: 6379
   host: localhost
```

To override these settings set an OS environment variable such as `spring_redis_port` to the value you require.

RabbitMQ

If you want to use RabbitMQ as a data transport use the following configuration setting

```
spring:
  rabbitmq:
   host: localhost
   port: 5672
   username: guest
   password: guest
   virtual_host: /
```

To override these settings set an OS environment variable such as `spring_rabbitmq_host` to the value you require.

Admin Server HTTP Port

The default HTTP port of the `xd-admin` server is 9393. To change the value use the following configuration setting

```
server:
  port: 9876
```

Management Port

The XD servers provide general health and JMX exported management endpoints via Jolokia.

By default the management and health endpoints are available on port 9393. To change the value of the port use the following configuration setting.

```
management:
  port: 9876
```

You can also disable http management endpoints by setting the port value to -1.

By default JMX MBeans are exported. You can disable JMX by setting `spring.jmx.enabled=false`.

The section on Monitoring and management over HTTP provides details on how to configure these endpoint.

Local transport

Local transport uses a QueueChannel to pass data between modules. There are a few properties you can configure on the QueueChannel

- `xd.local.transport.named.queueSize` - The capacity of the queue, the default value is `Integer.MAX_VALUE`
- `xd.local.transport.named.polling` - Messages that are buffered in a QueueChannel need to be polled to be consumed. This property controls the fixed rate at which polling occurs. The default value is 1000 ms.

6.3 Module Configuration

Modules are configured by placing property files in a nested directory structure based on their type and name. The root of the nested directory structure is by default `XD_HOME/config/modules`. This location can be customized by setting the OS environment variable `XD_MODULE_CONFIG_LOCATION`, similar to how the environment variable `XD_CONFIG_LOCATION` is used for configuring the server.

Note

The `XD_MODULE_CONFIG_LOCATION` can reference any any Spring Resource implementation, most commonly denoted using the prefixes `classpath:`, `file:` and `http:`.

As an example, if you wanted to configure the twittersearch module, you would create a file

```
XD_MODULE_CONFIG_LOCATION\source\twittersearch\twittersearch.properties
```

and the contents of that file would be property names such as `consumerKey` and `consumerSecret`.

Note

You **do not** need to prefix these property names with a `source.twittersearch` prefix.

You can override the values in the module property file in various ways. The following sources of properties are considered in the following order.

1. Properties specified in the stream or job `DSL` definition
2. Java System Properties
3. OS environment variables.
4. `XD_MODULE_CONFIG_LOCATION\<type>\<name>\<name>.properties` (including profile variants)
5. Default values specified in module metadata (if available).

Values in `XD_MODULE_CONFIG_LOCATION\<type>\<name>\<name>.properties` can be property placeholder references to keys defined in another resource location. By default the resource is the file `XD_MODULE_CONFIG_LOCATION\modules.yml`. You can customize the name of the resource by using setting the OS environment variable `XD_MODULE_CONFIG_NAME` before running a server startup script.

The `modules.yml` file can be used to specify the values of keys that should be shared across different modules. For example, it is common to use the same twitter developer credentials in both the twittersearch and twitterstream modules. To avoid repeating the same credentials in two property files, you can use the following setup.

`modules.yml` contains

```
sharedConsumerKey: alsdjfqwopieur
sharedConsumerSecret: pqwieouralsdjkqwpo
sharedAccessToken: llixzchvpiawued
sharedAccessTokenSecret: ewoqirudhdsldke
```

and `XD_MODULE_CONFIG_LOCATION\source\twitterstream\twitterstream.properties` contains

```
consumerKey=${sharedConsumerKey}
consumerSecret=${sharedConsumerSecret}
accessToken=${sharedAccessToken}
accessTokenSecret=${sharedAccessTokenSecret}
```

and `XD_MODULE_CONFIG_LOCATION\source\twittersearch\twittersearch.properties` contains

```
consumerKey=${sharedConsumerKey}
consumerSecret=${sharedConsumerSecret}
```

Profiles

When resolving property file names, the server will look to load profile specific variants based on the naming convention `<name>-{profile}.properties`. For example, if given the OS environment variable `spring_profiles_active=default,qa` the following configuration file names for the twittersearch module would be searched in this order

1. `XD_MODULE_CONFIG_LOCATION\source\twittersearch\twittersearch.properties`
2. `XD_MODULE_CONFIG_LOCATION\source\twittersearch\twittersearch-default.properties`
3. `XD_MODULE_CONFIG_LOCATION\source\twittersearch\twittersearch-qa.properties`

Also, the shared module configuration file is refernced using profile variants, so given the OS environment variable `spring_profiles_active=default,qa` the following shared module configuration files would be searched for in this order

1. `XD_MODULE_CONFIG_LOCATION\modules.yml`
2. `XD_MODULE_CONFIG_LOCATION\modules-default.yml`
3. `XD_MODULE_CONFIG_LOCATION\modules-qa.yml`

Batch Jobs or modules accessing JDBC

Another common case is access to a relational database from a job or the JDBC Sink module.

As an example, to provide the properties for the batch job `jdbchdfs` the file `XD_MODULE_CONFIG_LOCATION\job\jdbchdfs\jdbchdfs.properites` should contain

```
driverClass=org.hsqldb.jdbc.JDBCDriver
url=jdbc:hsqldb:mem:xd
username=sa
password=
```

A property file with the same keys, but likely different values would be located in `XD_MODULE_CONFIG_LOCATION\sink\jdbc\jdbc.properites`.

7. Architecture

7.1 Introduction

Spring XD is a unified, distributed, and extensible service for data ingestion, real time analytics, batch processing, and data export. The foundations of XD’s architecture are based on the over 100+ man years of work that have gone into the Spring Batch, Integration and Data projects. Building upon these projects, Spring XD provides servers and a configuration DSL that you can immediately use to start processing data. You do not need to build an application yourself from a collection of jars to start using Spring XD.

Spring XD has two modes of operation - single and multi-node. The first is a single process that is responsible for all processing and administration. This mode helps you get started easily and simplifies the development and testing of your application. The second is a distributed mode, where processing tasks can be spread across a cluster of machines and an administrative server reacts to user commands and runtime events managed within a shared runtime state to coordinate processing tasks executing on the cluster.

Runtime Architecture

The key components in Spring XD are the XD Admin and XD Container Servers. Using a high-level DSL, you post the description of the required processing tasks to the Admin server over HTTP. The Admin server then maps the processing tasks into processing modules. A module is a unit of execution and is implemented as a Spring ApplicationContext. A distributed runtime is provided that will assign modules to execute across multiple XD Container servers. A single XD Container server can run multiple modules. When using the single node runtime, all modules are run in a single XD Container and the XD Admin server is run in the same process.

DIRT Runtime

A distributed runtime, called Distributed Integration Runtime, aka DIRT, will distribute the processing tasks across multiple XD Container instances. The XD Admin server breaks up a processing task into individual module definitions and assigns each module to a container instance using ZooKeeper (see XD Distributed Runtime). Each container listens for module definitions to which it has been assigned and deploys the module, creating a Spring ApplicationContext to run it.

Modules share data by passing messages using a configured messaging middleware (Rabbit, Redis, or Local for single node). To reduce the number of hops across messaging middleware between them, multiple modules may be composed into larger deployment units that act as a single module. To learn more about that feature, refer to the Composing Modules section.

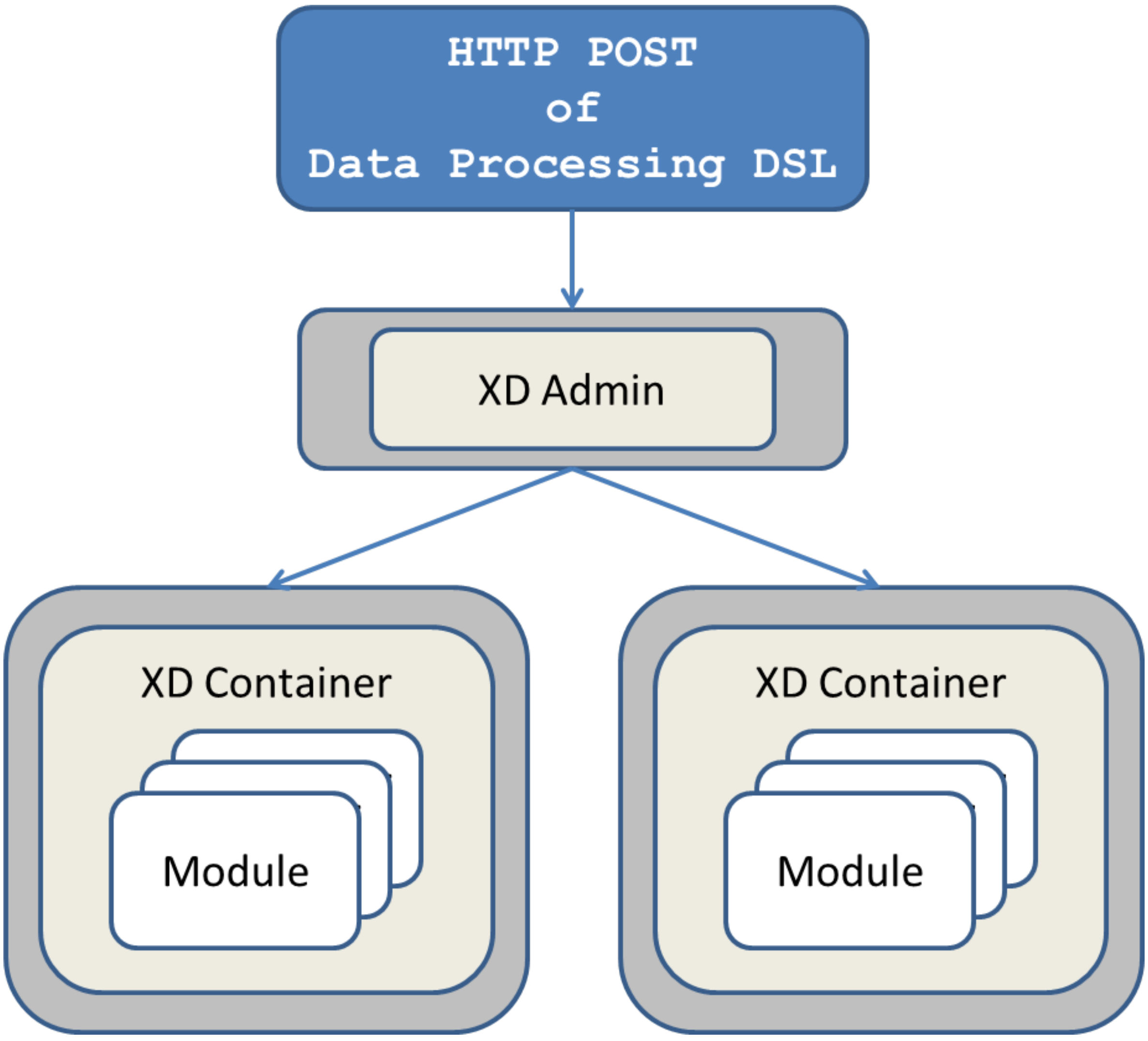


Figure 7.1. The XD Admin Server sending module definitions to each XD Container

How the processing task is broken down into modules is discussed in the section Container Server Architecture.

Support for other distributed runtimes

In the 1.0 release, you are responsible for starting up a single XD Admin server and one or more XD Containers. The 1.1 release will support running XD on top of other distributed runtime environments such as Hadoop’s YARN architecture and CloudFoundry.

Single Node Runtime

For testing and development purposes, a single node runtime is provided that runs the Admin and Container servers, ZooKeeper, and HSQLDB in the same process. The communication to the XD Admin server is over HTTP and the XD Admin server communicates to an in-process XD Container using an embedded ZooKeeper server.

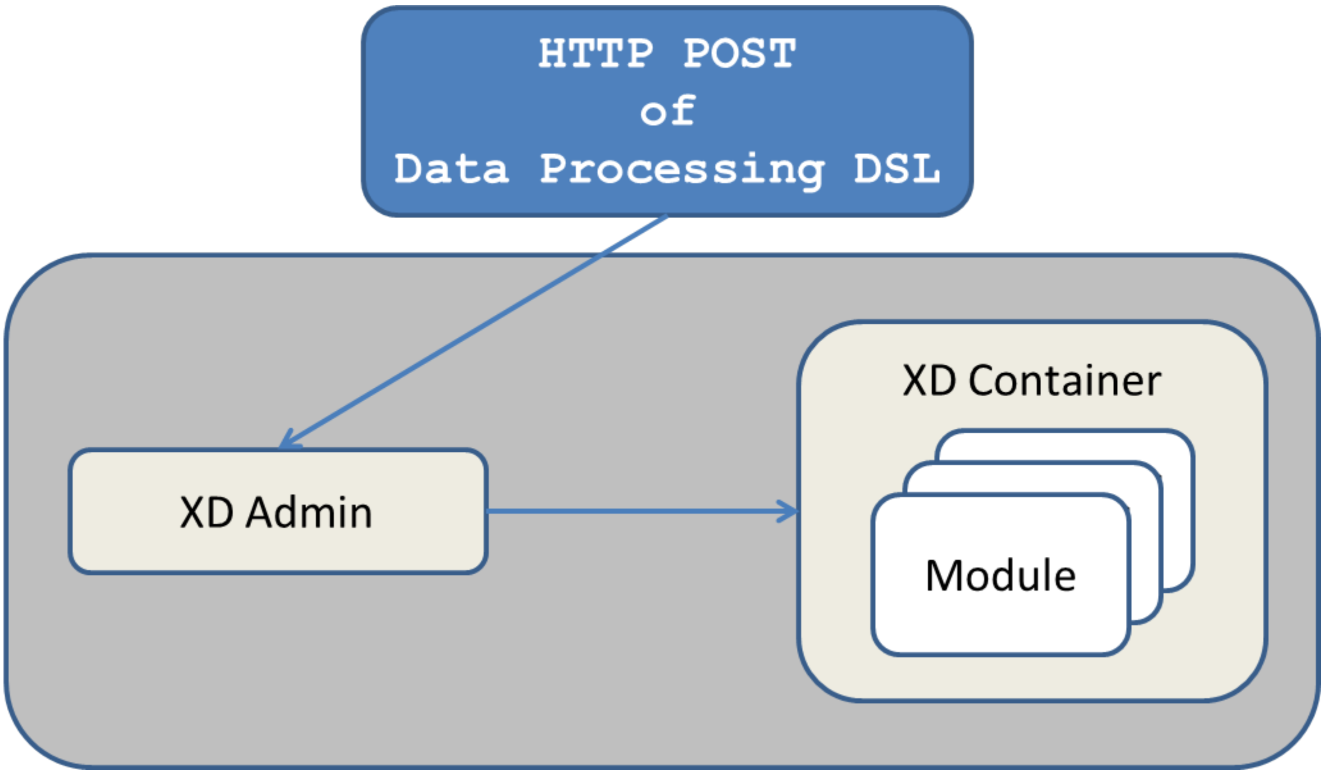


Figure 7.2. Single Node Runtime

Admin Server Architecture

The Admin Server uses an embedded servlet container and exposes REST endpoints for creating, deploying, undeploying, and destroying streams and jobs, querying runtime state, analytics, and the like. The Admin Server is implemented using Spring's MVC framework and the Spring HATEOAS library to create REST representations that follow the HATEOAS principle. The Admin Server and Container Servers monitor and update runtime state using ZooKeeper (see XD Distributed Runtime).

Container Server Architecture

The key components of data processing in Spring XD are

- Streams
- Jobs
- Taps

Streams define how event driven data is collected, processed, and stored or forwarded. For example, a stream might collect syslog data, filter, and store it in HDFS.

Jobs define how coarse grained and time consuming batch processing steps are orchestrated, for example a job could be be defined to coordinate performing HDFS operations and the subsequent execution of multiple MapReduce processing tasks.

Taps are used to process data in a non-invasive way as data is being processed by a Stream or a Job. Much like wiretaps used on telephones, a Tap on a Stream lets you consume data at any point along the Stream's processing pipeline. The behavior of the original stream is unaffected by the presence of the Tap.

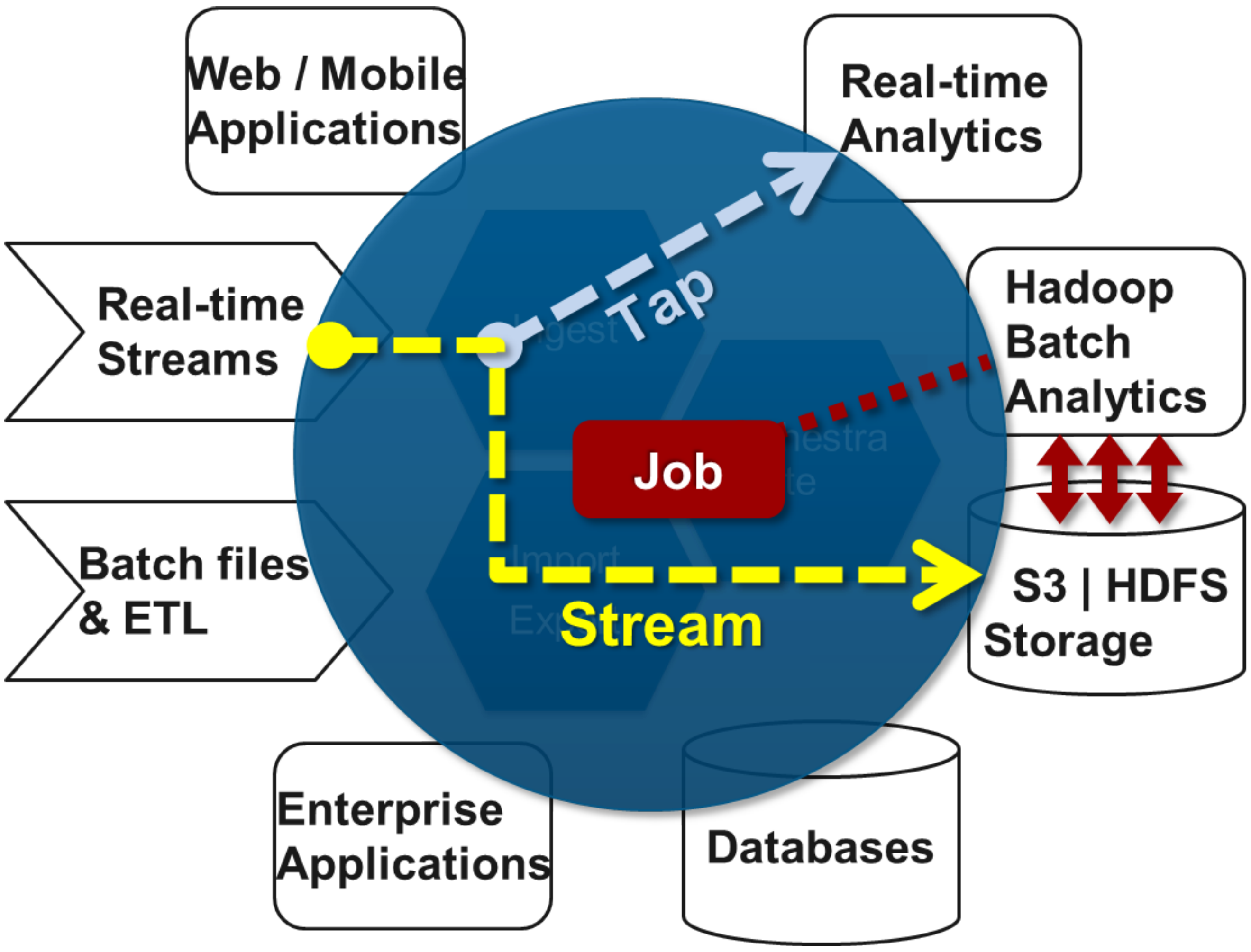


Figure 7.3. Taps, Jobs, and Streams

Streams

The programming model for processing event streams in Spring XD is based on the well known Enterprise Integration Patterns as implemented by components in the Spring Integration project. The programming model was designed so that it is easy to test components.

A Stream consist of the following types of modules: * An Input source * Processing steps * An Output sink

An Input source produces messages from an external source. XD supports a variety of sources, e.g. syslog, tcp, http. The output from a module is a Spring Message containing a payload of data and a collection of key-value headers. Messages flow through message channels from the source, through optional processing steps, to the output sink. The output sink delivers the message to an external resource. For example, it is common to write the message to a file system, such as HDFS, but you may also configure the sink to forward the message over tcp, http, or another type of middleware, or route the message to another stream.

A stream that consists of a input source and a output sink is shown below

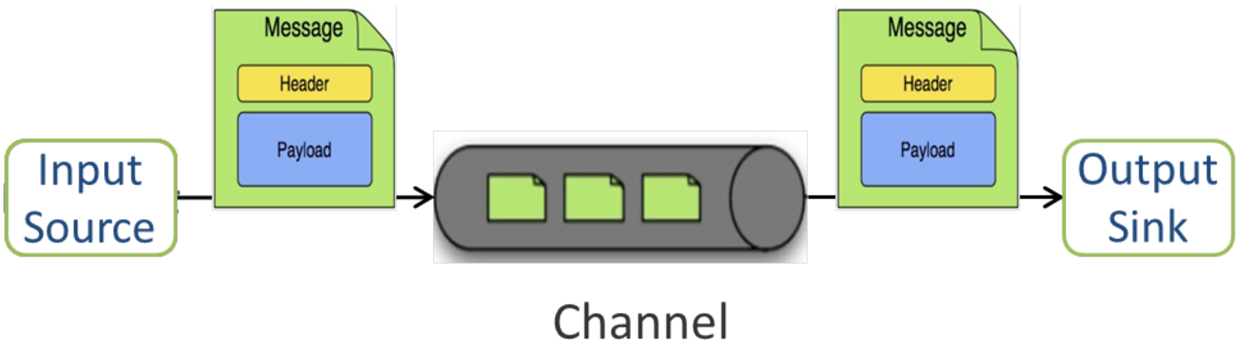


Figure 7.4. Foundational components of the Stream processing model

A stream that incorporates processing steps is shown below

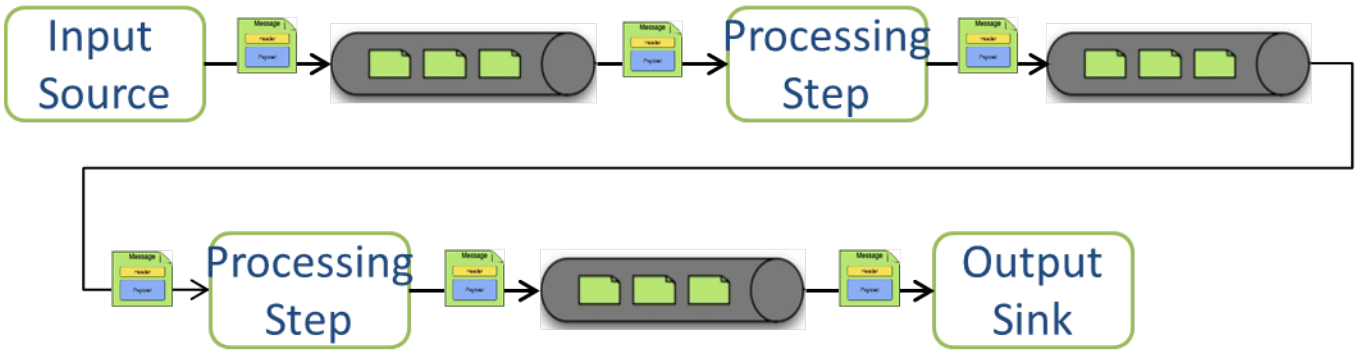


Figure 7.5. Stream processing with multiple steps

For simple linear processing streams, an analogy can be made with the UNIX pipes and filters model. Filters represent any component that produces, processes or consumes events. This corresponds to the modules (source, processing steps, and sink) in a stream. Pipes represent the way data is transported between the Filters. This corresponds to the Message Channel that moves data through a stream.

A simple stream definition using UNIX pipes and filters syntax that takes data sent via a HTTP post and writes it to a file (with no processing done in between) can be expressed as

```
http | file
```

The pipe symbol represents a message channel that passes data from the HTTP source to the File sink. The message channel implementation can either be backed with a local in-memory transport, Redis queues, or RabbitMQ. The message channel abstraction and the XD architecture are designed to support a pluggable data transport. Future releases will support other transports such as JMS.

Note that the UNIX pipes and filter syntax is the basis for the DSL that Spring XD uses to describe simple linear flows. Non-linear processing is partially supported using named channels which can be combined with a router sink to effectively split a single stream into multiple streams (see Dynamic Router Sink). Additional capabilities for non-linear processing are planned for future releases.

The programming model for processing steps in a stream originates from the Spring Integration project and is included in the core Spring Framework as of version 4. The central concept is one of a Message Handler class, which relies on simple coding conventions to Map incoming messages to processing methods. For example, using an http source you can process the body of an HTTP POST request using the following class

```
public class SimpleProcessor {

  public String process(String payload) {
    return payload.toUpperCase();
  }

}
```

The payload of the incoming Message is passed as a string to the method `process`. The contents of the payload is the body of the http request as we are using a http source. The non-void return value is used as the payload of the Message passed to the next step. These programming conventions make it very easy to test your Processor component in isolation. There are several processing components provided in Spring XD that do not require you to write any code, such as a filter and transformer that use the Spring Expression Language or Groovy. For example, adding a processing step, such as a transformer, in a stream processing definition can be as simple as

```
http | transformer --expression=payload.toUpperCase() | file
```

For more information on processing modules, refer to the Processors section.

Stream Deployment

The Container Server listens for module deployment events initiated from the Admin Server via ZooKeeper. When the container node handles a module deployment event, it connects the module's input and output channels to the data bus used to transport messages during stream processing. In a single node configuration, the data bus uses in-memory direct channels. In a distributed configuration, the data bus communications are backed by the configured transport middleware. Redis and Rabbit are both provided with the Spring XD distribution, but other transports are envisioned for future releases.

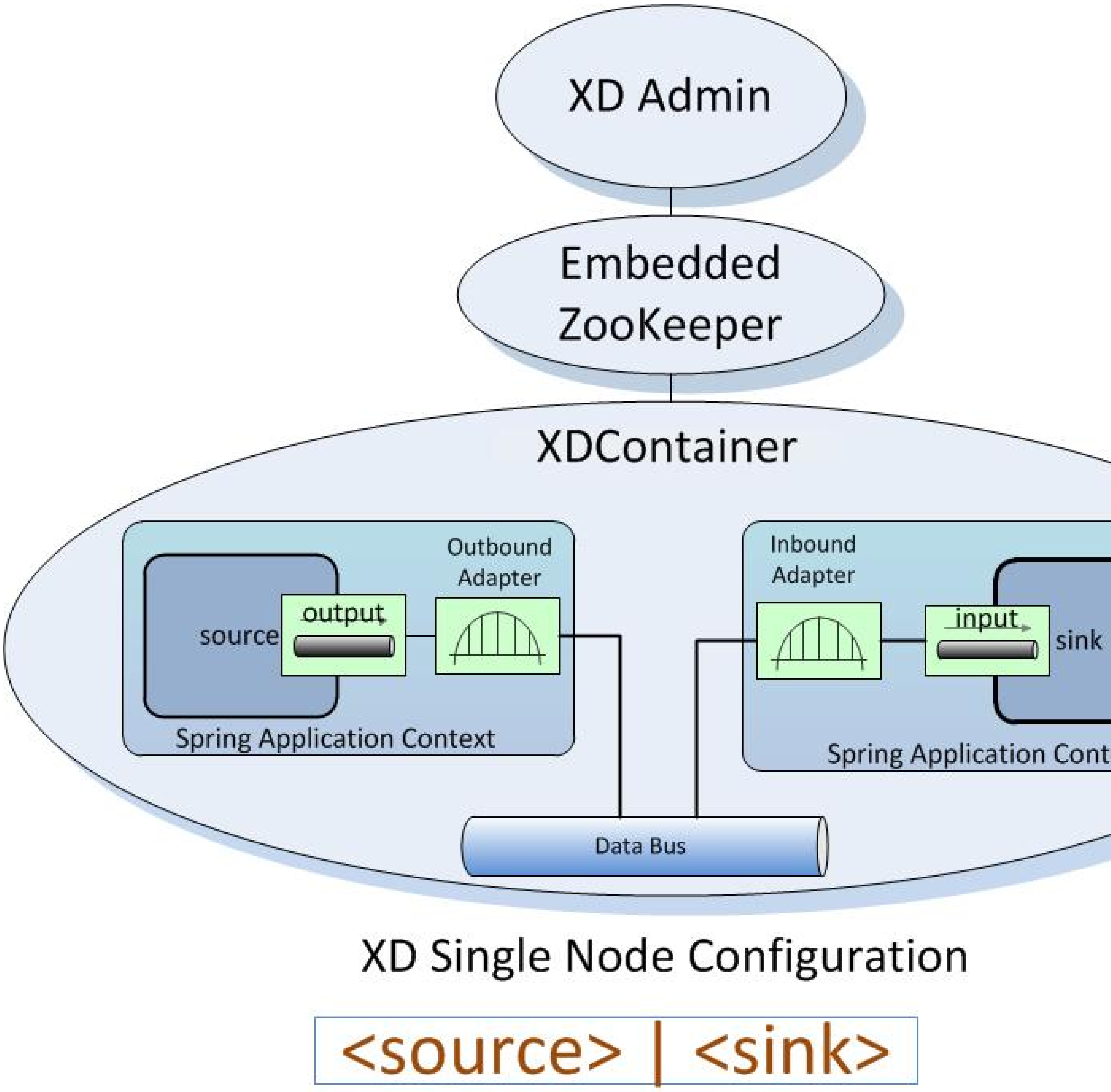


Figure 7.6. A Stream Deployed in a single node server

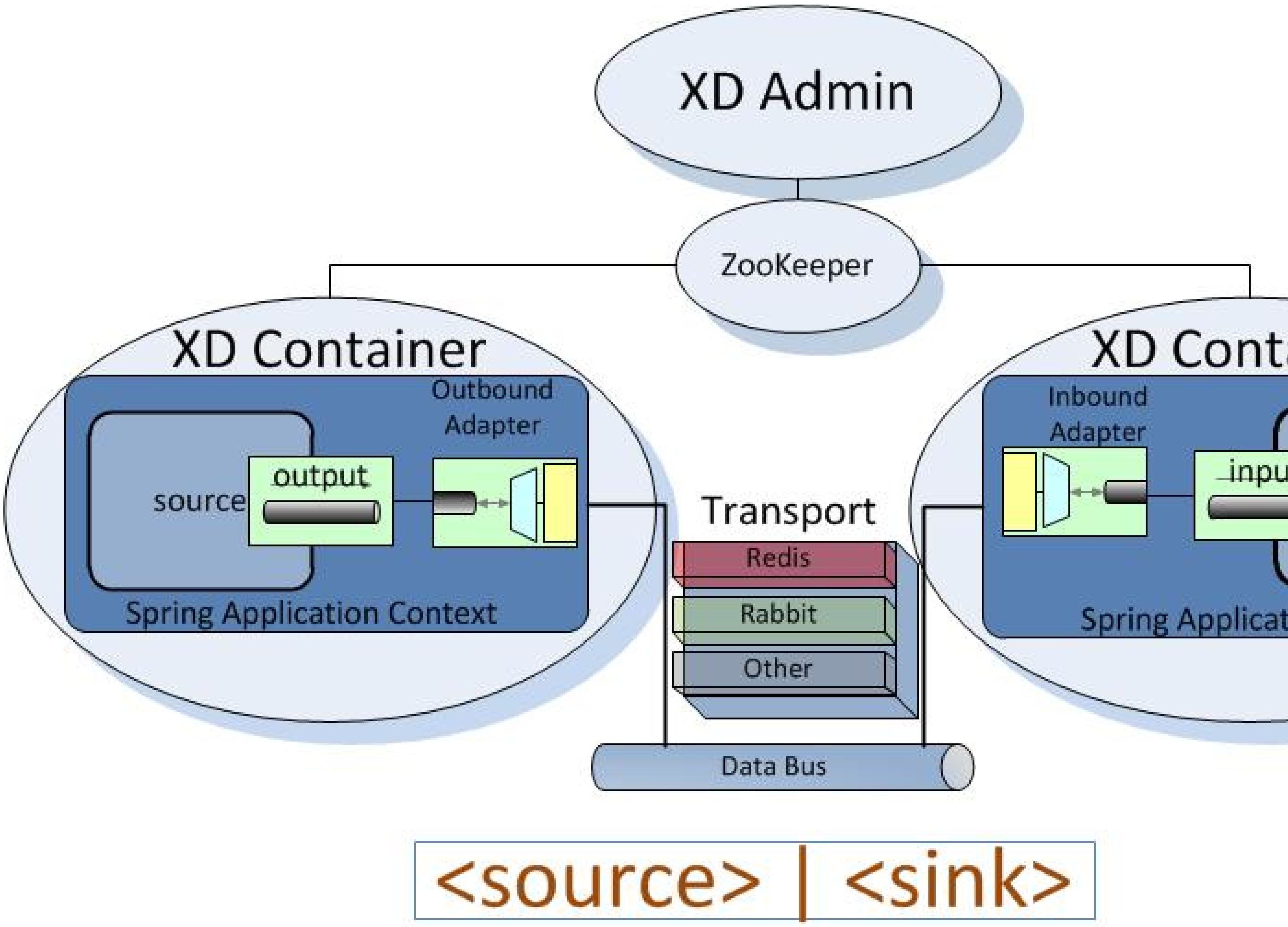


Figure 7.7. A Stream Deployed in a distributed runtime

In the `http | file` example, the Admin assigns each module to a separate Container instance, provided there are at least two Containers available. The `file` module is deployed to one container and the `http` module to another. The definition of a module is stored in a Module Registry. A module definition consists of a Spring XML configuration file, some classes used to validate and handle options defined by the module, and dependent jars. The module definition contains variable placeholders, corresponding to DSL parameters (called *options*) that allow you to customize the behavior of the module. For example, setting the http listening port would be done by passing in the option `--port`, e.g. `http --port=8090 | file`, which is in turn used to substitute a placeholder value in the module definition.

The Module Registry is backed by the filesystem and corresponds to the directory `<xd-install-directory>/modules`. When a module deployment is handled by the Container, the module definition is loaded from the registry and a new Spring ApplicationContext is created in the Container process to run the module. Dependent classes are loaded via the Module Classloader which first looks at jars in the modules /lib directory before delegating to the parent classloader.

Using the DIRT runtime, the http | file example would map onto the following runtime architecture

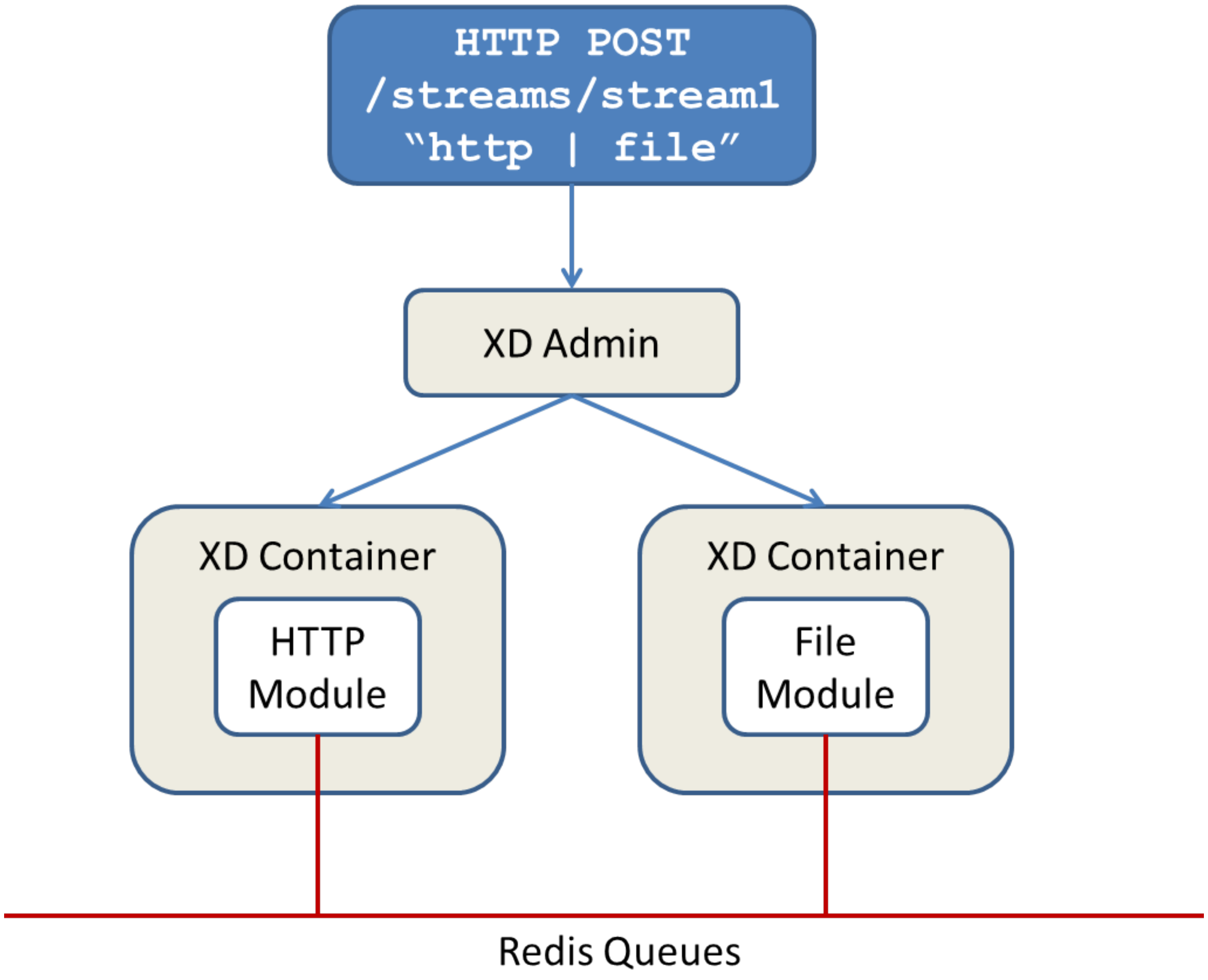


Figure 7.8. Distributed HTTP to File Stream

Data produced by the HTTP module is sent over a Redis Queue and is consumed by the File module. If there was a filter processing module in the steam definition, e.g `http | filter | file` that would map onto the following DIRT runtime architecture.

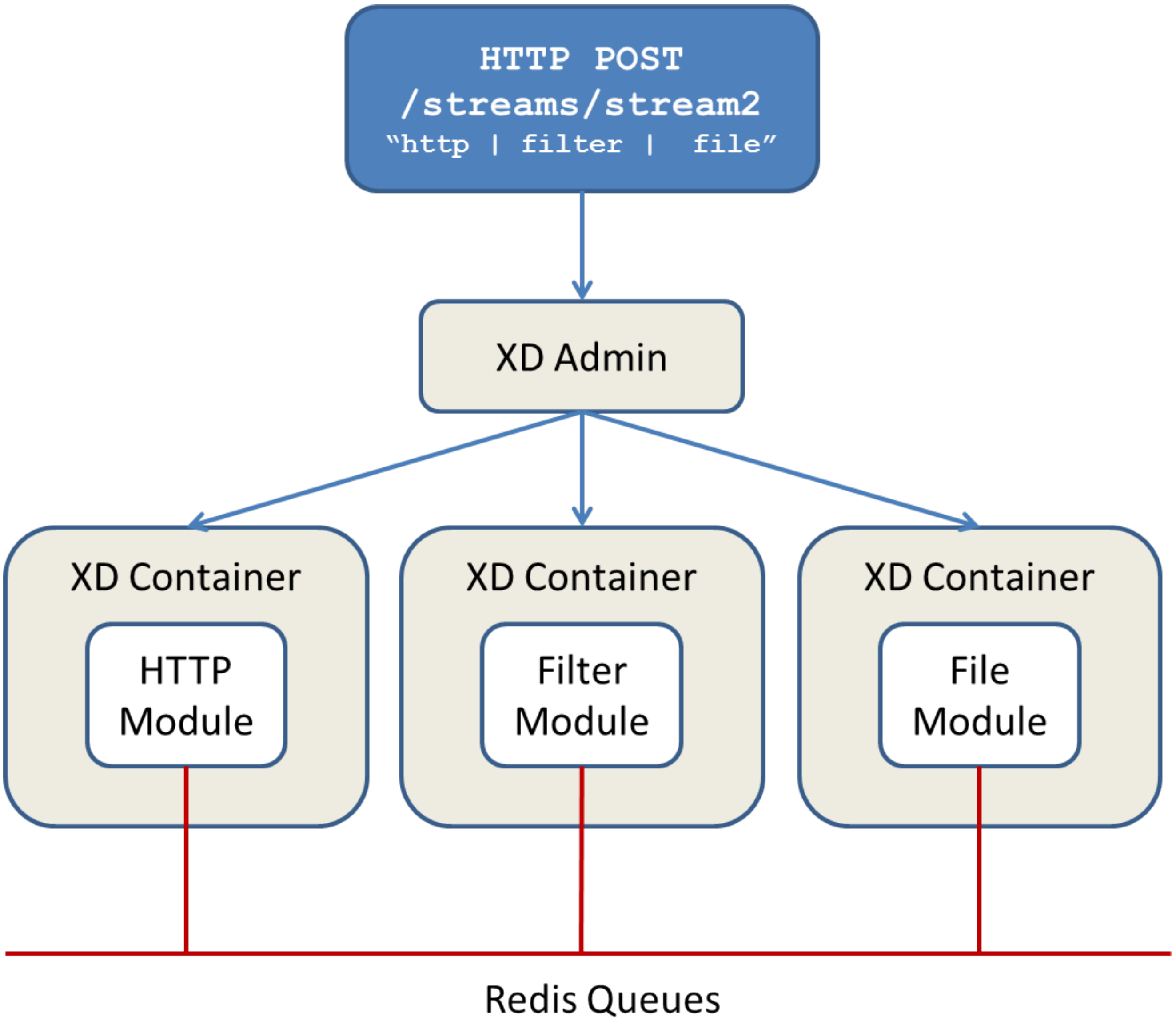


Figure 7.9. Distributed HTTP to Filter to File Stream

7.2 Jobs

The creation and execution of Batch jobs builds upon the functionality available in the Spring Batch and Spring for Apache Hadoop projects. See the Batch Jobs section for more information.

7.3 Taps

Taps provide a non-invasive way to consume the data that is being processed by either a Stream or a Job, much like a real time telephone wire tap lets you eavesdrop on telephone conversations. Taps are recommended as way to collect metrics and perform analytics on a Stream of data. See the section Taps for more information.

8. XD Distributed Runtime

8.1 Introduction

This document describes what’s happening "under the hood" of the XD Distributed Runtime (DIRT) and, in particular, how the runtime architecture achieves high availability and failover in a clustered production environment. See Running in Distributed Mode for more information on installing and running Spring XD in distributed mode.

This discussion will focus on the core runtime components and the role of ZooKeeper.

8.2 Configuring XD for High Availabilty (HA)

A production XD environment is typically distributed among multiple hosts in a clustered environment. XD scales horizontally by providing additional Container instances. In the simplest case, all containers are replicas, that is, they are interchangeable and a module may be deployed to any instance in a round-robin fashion. XD supports a flexible container matching algorithm to target modules to specific container configurations. The matching algorithm will be covered in more detail later, but for now, let’s assume the simple case. Running multiple containers not only supports horizontal scalability, but allows for failover. If one container goes down, any modules deployed to that container will be deployed to another available instance.

XD requires that a single active Admin server handle interactions with the containers, such as stream deployment requests, as these types of operations must be carefully coordinated and processed in the order received. Without a backup Admin server, this component becomes single point of failure. Therefore, two (or more for the risk averse) Admin servers are recommended for a production environment. Note that every Admin server can accept all requests via REST endpoints but only one instance, the "Leader", will actually perform requests that update the runtime state. If the Leader goes down, another available Admin server will assume the role.

An HA XD installation also requires that additional required servers - ZooKeeper, messaging middleware, and data stores listed above - be configured for HA as well. Please consult the product documentation for specific recommendations regarding these components.

8.3 ZooKeeper Overview

In the previous section, we claimed that if a container goes down, XD will redeploy anything that is deployed on that instance to another available container. We also claimed that if the Admin Leader goes down, another Admin server will assume that role. ZooKeeper is what makes this all possible. ZooKeeper is a widely used Apache project designed primarily for cluster management and coordination. This section will cover some basic concepts necessary to understand its role in XD. See The ZooKeeper Wiki for a more complete overview.

ZooKeeper is based on a simple hierarchical data structure, formally a tree, but conceptually and semantically similar to a file directory structure. As such, data is stored in *nodes*. A node is referenced via a *path*, e.g., */xd/streams/mystream*. Each node can store additional data, serialized as a byte array. In XD, all data is a java.util.Map serialized as JSON.

A node is created to be either *ephemeral* or *persistent*. An ephemeral node exists only as long as the process that created it. A persistent node is, well, persistent. For example, ephemeral nodes are appropriate for registering Container instances. When an XD container starts up, it registers itself as an ephemeral node, */xd/containers/<container-id>*, where XD generates a unique container id. When the container goes down, its node is removed. Persistent nodes are used to manage state needed for recovery and failover that must be available independent of a Container instance. This includes data such as stream definitions, job definitions, deployment manifests, and module deployments.

Obviously ZooKeeper is critically important to the XD runtime and must itself be HA. ZooKeeper itself supports a clustered architecture, called an *ensemble*. The details are beyond the scope of this document, but for the sake of discussion, there should be at least three ZooKeeper server instances running (an odd number is always recommended). The XD Container and Admin nodes are clients to the ZooKeeper ensemble and must connect to ZooKeeper at startup. XD components are configured with a *zk.client.connect* property which may designate a single <host>:<port> or a comma separated list. The ZooKeeper client will attempt to connect to each server in order until it succeeds. If it is unable to connect, it will keep trying. If a connection goes down, the ZooKeeper client will attempt to reconnect to one of the servers. The ZooKeeper cluster guarantees consistent replication of data across the ensemble. ZooKeeper maintains data primarily in memory backed by a disk cache.

In addition to performing CRUD operations on nodes, A ZooKeeper client can register a callback on a node to respond to any events or state changes to that node or any of its children. Such node operations and callbacks are the mechanism that control the XD runtime.

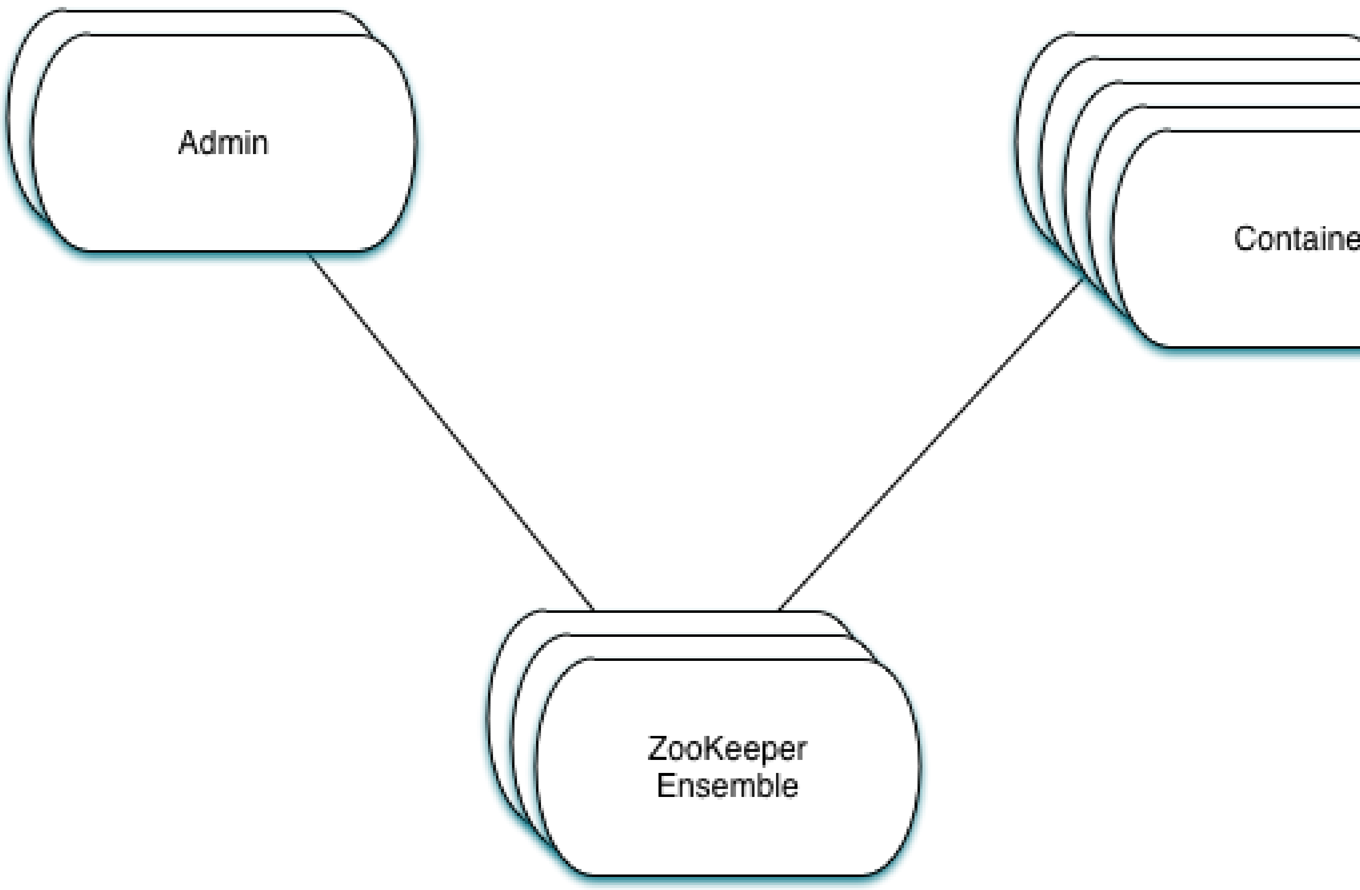


Figure 8.1.

8.4 The Admin Server Internals

Assuming more than one Admin instance is running, Each instance requests leadership at start up. If there is already a designated leader, the instance will watch the *xd/admin* node to be notified if the Leader goes away. The instance designated as the "Leader", using the Leader Selector recipe provided by Curator, a ZooKeeper client library that implements some common patterns. Curator also provides some Listener callback interfaces that the client can register on a node. The AdminServer creates the top level nodes for xd:

- **/xd/admin** - children are ephemeral nodes for each available Admin instance and used for Leader Selector
- **/xd/containers** - children are ephemeral nodes containing runtime attributes for each available container
- **/xd/streams** - children are persistent nodes containing the definition for each stream, however the leaf nodes for a deployed stream, at the module level, are ephemeral nodes added by the container to which the module is deployed.
- **/xd/jobs** - children are persistent nodes containing the definition for each job, however the leaf node for a deployed job is an ephemeral node added by the container to which the job is deployed.
- **/xd/deployments/streams** - children are persistent nodes containing stream deployment status
- **/xd/deployments/jobs** - children are persistent nodes containing job deployment status

and regiseters a LeaderListener which is used by the selected Leader.

The Leader registers listeners on /xd/deployments/streams, /xd/deployments/jobs, and /xd/containers to handle events related to stream deployments, job deployments, and be notified when containers are added and removed from the cluster. Note that any Admin instance can handle user requests. For example, if you enter the following commands via XD shell,

```
xd>stream create ticktock --definition "time | log"
```

This command will invoke a REST service on its connected Admin instance to create a new node /xd/streams/ticktock

```
xd>stream deploy ticktock
```

This will create a new node /xd/deployments/streams/ticktock

If the Admin instance connected to the shell is not the Leader, it will perform no further action. The Leader listening to /xd/deployments/streams will respond to the newly added child node and deploy each module in the stream definition to a different Container, if possible, and update the runtime state accordingly.

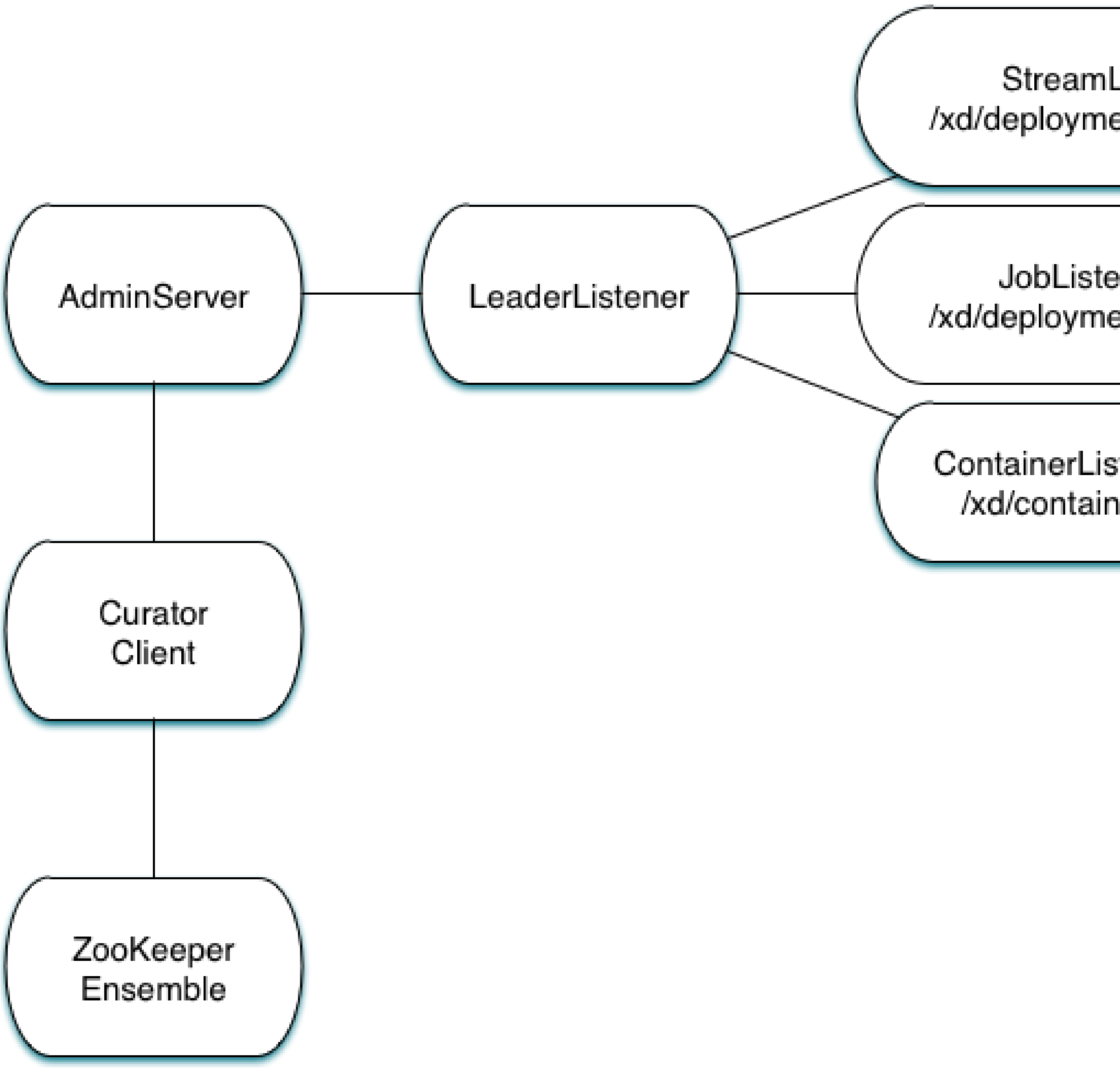


Figure 8.2.

Example

Let’s walk through a simple example. If you don’t have an XD cluster set up, the basics can be illustrated by running XD in single node. From the XD install directory:

```
$export JAVA_OPTS="-Dzk.embedded.server.port=5555"
$xd/bin/xd-singlenode
```

XD single node runs with an embedded zookeeper server by default and will assign a random unused port. The *zk.embedded.server.port* property will assign the requested port if available.

In another terminal session, start the ZooKeeper CLI included with ZooKeeper to connect to the embedded server and inspect the contents of the nodes (NOTE: tab completion works) :

```
$zkCli.sh -server localhost:5555
```

After some console output, you should see a prompt:

```
WatchedEvent state:SyncConnected type:None path:null
[zk: localhost:5555(CONNECTED) 0]
```

navigate using the *ls* command:

```
[[zk: localhost:5555(CONNECTED) 0] ls /xd
[containers, jobs, streams, admin, deployments]
[zk: localhost:5555(CONNECTED) 1] ls /xd/streams
[]
[zk: localhost:5555(CONNECTED) 2] ls /xd/deployments
[jobs, streams, modules]
[zk: localhost:5555(CONNECTED) 3] ls /xd/deployments/streams
[]
[zk: localhost:5555(CONNECTED) 4] ls /xd/deployments/modules
[2ebbbc9b-63ac-4da4-aa32-e39d69eb546b]
[zk: localhost:5555(CONNECTED) 5] ls /xd/deployments/modules/2ebbbc9b-63ac-4da4-aa32-
e39d69eb546b
[]
[zk: localhost:5555(CONNECTED) 6] ls /xd/containers
[2ebbbc9b-63ac-4da4-aa32-e39d69eb546b]
[zk: localhost:5555(CONNECTED) 7]
```

The above reflects the initial state of XD. Nothing is deployed yet and there are no stream definitions. Note that *xd/deployments/modules* has a child which is the id corresponding to the embedded container. If you are running in a clustered environment and connected to one of the ZooKeeper servers in the same ensemble that XD is connected to, you should see multiple nodes under */xd/containers* and there may be some existing deployments.

Start the XD Shell in a new terminal session and create a stream:

```
$ shell/bin/xd-shell
 _____                           __   _______
/  ___|          (-)             \ \ / /  _  \
\ `--. _ __  _ __ _ _ __   __ _   \ V /| | | |
 `--. \ '_ \| '__| | '_ \ / _` |  / ^ \| | | |
/\__/ / |_) | |  | | | | | (_| | / / \ \ |/ /
\____/| .__/|_|  |_|_| |_|\__, | \/   \/___/
      | |                  __/ |
      |_|                 |___/
eXtreme Data
1.0.0.BUILD-SNAPSHOT | Admin Server Target: http://localhost:9393
Welcome to the Spring XD shell. For assistance hit TAB or type "help".
xd:>stream create ticktock --definition "time | log"
Created new stream 'ticktock'
xd:>
```

Back to the ZK CLI session:

```
[zk: localhost:5555(CONNECTED) 7] ls /xd/streams
[ticktock]
[zk: localhost:5555(CONNECTED) 8] get /xd/streams/ticktock
{"definition":"time | log"}
cZxid = 0x31
ctime = Wed Apr 09 15:22:03 EDT 2014
mZxid = 0x31
mtime = Wed Apr 09 15:22:03 EDT 2014
pZxid = 0x31
cversion = 0
dataVersion = 0
aclVersion = 0
ephemeralOwner = 0x0
dataLength = 27
numChildren = 0
[zk: localhost:5555(CONNECTED) 9]
```

using the *get* command on the new stream node, we can see the stream definition represented as JSON, along with some standard ZooKeeper node information.

Note

ephemeralOwner = 0x0, indicating this is not an ephemeral node. At this point, nothing else should have changed from the initial state.

Now, Using the XD shell, let’s deploy the stream,

```
xd>stream deploy ticktock
Deployed stream 'ticktock'
```

and verify with ZooKeeper:

```
[zk: localhost:5555(CONNECTED) 9] ls /xd/deployments/streams
[ticktock]
[zk: localhost:2181(CONNECTED) 10] ls /xd/streams/ticktock
[sink, source]
[zk: localhost:2181(CONNECTED) 11] ls /xd/streams/ticktock/source
[time-0]
[zk: localhost:2181(CONNECTED) 12] ls /xd/streams/ticktock/sink
[log-1]
[zk: localhost:2181(CONNECTED) 13] ls /xd/streams/ticktock/source/time-0
[<container-id>]
[zk: localhost:2181(CONNECTED) 14] ls /xd/streams/ticktock/sink/log-1
[<container-id>]
[zk: localhost:5555(CONNECTED) 15] ls /xd/deployments/modules/<container-id>
[ticktock.sink.log-1, ticktock.source.time-0]
```

Since XD is running as single node, both modules (time and log) are deployed to the same container instance, corresponding to the *<container-id>*. The module node name is *<stream_name>.<module-type>.<module-name>-<module-index>*, where *<module-index>* represents the position of the module in the stream.

The information stored in ZooKeeper is provided to XD shell queries. For example:

```
xd:>runtime modules
  Module                  Container Id                          Options
  ----------------------  ------------------------------------
 ------------------------------------------
  ticktock.sink.log-1     186d3b36-b005-45ff-b46f-cb2c5cf61ea4
  ticktock.source.time-0  186d3b36-b005-45ff-b46f-cb2c5cf61ea4  {format=yyyy-MM-dd
 HH:mm:ss, fixedDelay=1}
```

8.5 Module Deployment

A Stream is composed of Modules. In general, each module is deployed to one or more Container instance(s). In this way the Stream processing is distributed among multiple containers. The Admin decides to which container(s) each Module is deployed and writes the module information to */xd/deployments/modules/<container-id>*. The Container has a Deploymentlistener to monitor this node for new modules to deploy. If the deployment is successful, the Container writes it's id as an ephemeral node to *xd/streams/<stream_name>/<module-type>/<module-name>-<module-index>/<container-id>*.

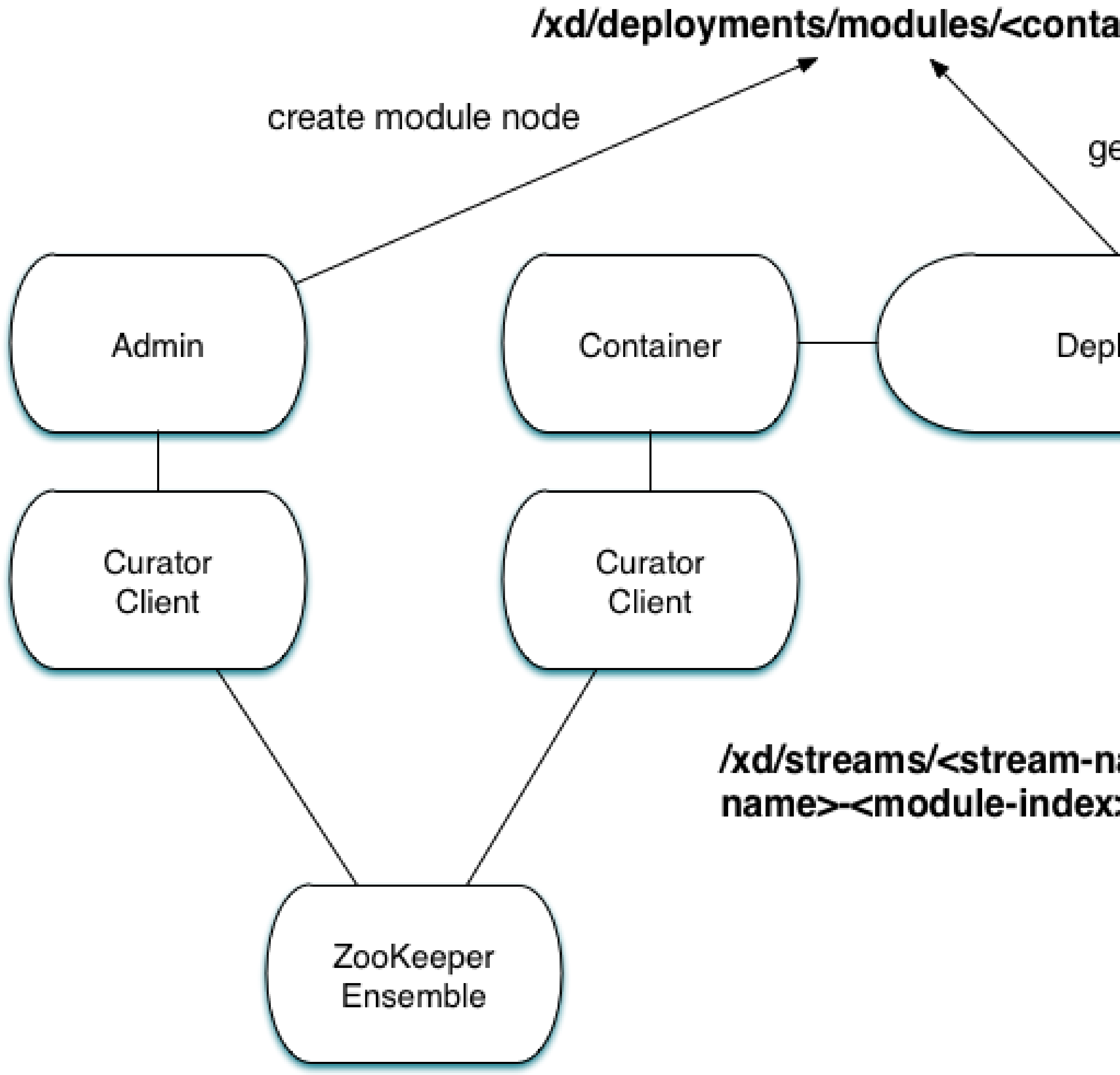


Figure 8.3.

By default, deploying a stream in a distributed configuration uses simple round robin logic. For example if there are 3 containers and 3 modules in a stream definition, s1= m1 | m2 | m3, then XD will attempt distribute the work load evenly among each container. This is a very simplistic strategy and does not take into account things like:

- server load - how many modules are already deployed to a container? How close is it to exhausting available memory, cpu, etc.?
- server affinity - some containers may have external software installed with which specific modules should be co-located. For example, an hdfs sink could be deployed only to servers running Hadoop. Or perhaps a file sink should be deployed to servers configured with more disk space.

- scalability - Suppose the stream s1, above, can achieve higher throughput with multiple instances of m2 running, so we want to deploy m2 to every container.
- fault tolerance - the ability to target physical servers on redundant networks, routers, racks, etc.

Deployment Manifest

More complex strategies are critical to tuning and operating XD. Additionally, we must consider various features and constraints when deploying to a PaaS, Yarn or some other cluster manager. Furthermore, such deployment concerns should be addressed independently from the stream definition which is really an expression of the processing logic. To accommodate deployment concerns, XD provides a Deployment Manifest which is submitted with the deployment request, in the form of in-line properties, or a reference to a persisted document containing deployment properties.

When you execute a *stream deploy* shell command, you can optionally pass a --properties parameter which is a comma delimited list of key=value pairs. The key is either *module.[modulename].count* or *module.[modulename].criteria*. The value for a count is a positive integer, and the value for criteria is a valid SpEL expression. The Admin server will match the available containers to the deployment manifest. The stream is considered to be successfully deployed if at least one of each module instance is deployed to a container. For example,

```
xd:>stream create test1 --definition "http | transform --expression=payload.toUpperCase()
 | log"
Created new stream 'test1'
```

Next, deploy it requesting three transformer instances:

```
xd:>stream deploy --name test1 --properties "module.transform.count=3"
Deployed stream 'test1'
```

If there are only two container instances available, only two instances of transform will be deployed. The stream deployment is successful since it is functional. However the unfulfilled deployment request remains active and a third instance will be deployed if a new container comes on line that matches the criteria.

Container Attributes

The SpEL context (root object) for the Deployment Manifest is ContainerAtrtributes, basically a map derivative that contains some standard attributes:

- **id** - the generated container ID
- **pid** - the process ID of the container instance
- **host** - the host name of the machine running the container instance
- **ip** — the IP address of the machine running the container instance

ContainerAttributes also includes any user-defined attribute values configured for the container. These attributes are configured by editing *xd/config/servers.yml* the file included in the XD distribution contains some commented out sections as examples. In this case, the container attributes configuration looks something like:

```
xd:
  container:
      groups: group2
      color: red
```

Note

Groups may also be assigned to a container via the optional command line argument *--groups* or by setting the environment variable *XD_CONTAINER_GROUPS*. As the property name suggests, a container may belong to more than one group, represented as comma-delimited string. XD considers the concept of groups a useful convention for targeting groups of servers for deployment in a variety of scenarios, so it enjoys special treatment. However, there is nothing technically different from groups and other user defined attribute.

8.6 Stream Deployment Examples

To Illustrate how to use the Deployment Manifest, We will use the following runtime configuration, as displayed in the XD shell:

```
xd:>runtime containers
  Container Id                          Host              IP Address     PID   Groups
 Custom Attributes
  ------------------------------------  ----------------  -------------  ----  ------
 -----------------
  bc624816-f8a8-4f35-83f6-a125ed147b7c  ip-10-110-18-10   10.110.18.10   1708  group2
 {color=red}
  018b7c8d-6fa9-4759-8471-76899766f892  ip-10-139-36-168  10.139.36.168  1852  group2
 {color=blue}
  afc3741c-217a-415a-9d86-a1f62de03613  ip-10-139-17-116  10.139.17.116  1861  group1
 {color=green}
```

Each of the three containers is running on a different host and has configured Groups and Custom Attributes as shown.

First, create a stream:

```
xd:>stream create test1 --definition "http | transform --expression=payload.toUpperCase()
 | log"
Created new stream 'test1'
```

Next, deploy it using a manifest:

```
xd:>stream deploy --name test1 --properties
 "module.transform.count=3,module.log.criteria=groups.contains('group1')"
Deployed stream 'test1'
```

Verify the deployment:

```
xd:>runtime modules
  Module                       Container Id                          Properties
  --------------------------  ------------------------------------
 ----------------------------------------------
  test1.source.http-0          bc624816-f8a8-4f35-83f6-a125ed147b7c  {port=9000}
  test1.processor.transform-1  bc624816-f8a8-4f35-83f6-a125ed147b7c  {valid=true,
 expression=payload.toUpperCase()}
  test1.processor.transform-1  018b7c8d-6fa9-4759-8471-76899766f892  {valid=true,
 expression=payload.toUpperCase()}
  test1.processor.transform-1  afc3741c-217a-415a-9d86-a1f62de03613  {valid=true,
 expression=payload.toUpperCase()}
  test1.sink.log-2             afc3741c-217a-415a-9d86-a1f62de03613
```

We can see that three instances of the processor have been deployed, one to each container instance. Also the log module has been deployed to the container id corresponding to *group1*. Now we can undeploy and deploy the stream using a different manifest:

```
xd:>stream undeploy test1
Un-deployed stream 'test1'
xd:>runtime modules
  Module  Container Id  Properties
  ------  ------------  ----------

xd:>stream deploy --name test1 --properties "module.log.count=3,module.log.criteria=!
groups.contains('group1')"
Deployed stream 'test1'

xd:>runtime modules
  Module                       Container Id                          Properties
  --------------------------  ------------------------------------
 ----------------------------------------------
  test1.sink.log-2             bc624816-f8a8-4f35-83f6-a125ed147b7c
  test1.processor.transform-1  018b7c8d-6fa9-4759-8471-76899766f892  {valid=true,
 expression=payload.toUpperCase()}
  test1.sink.log-2             018b7c8d-6fa9-4759-8471-76899766f892
  test1.source.http-0          afc3741c-217a-415a-9d86-a1f62de03613  {port=9000}
```

Note that there are only two instances of *log* deployed. We asked for three however the criteria specified only containers not in *group1* are eligible. Since only two containers matched the criteria, we have a *log* module deployed on each one. If we start a new container not in *group1*, the third instance will be deployed. The stream is currently shown as deployed since it is functional even though the manifest is not completely satisfied.

9. Streams

9.1 Introduction

In Spring XD, a basic stream defines the ingestion of event driven data from a *source* to a *sink* that passes through any number of *processors*. Stream processing is performed inside the XD Containers and the deployment of stream definitions to containers is done via the XD Admin Server. The Getting Started section shows you how to start these servers and how to start and use the Spring XD shell

Sources, sinks and processors are predefined configurations of a *module*. Module definitions are found in the `xd/modules` directory. [1]. Modules definitions are standard Spring configuration files that use existing Spring classes, such as Input/Output adapters and Transformers from Spring Integration that support general Enterprise Integration Patterns.

A high level DSL is used to create stream definitions. The DSL to define a stream that has an http source and a file sink (with no processors) is shown below

```
http | file
```

The DSL mimics a UNIX pipes and filters syntax. Default values for ports and filenames are used in this example but can be overriden using `--` options, such as

```
http --port=8091 | file --dir=/tmp/httpdata/
```

To create these stream definitions you make an HTTP POST request to the XD Admin Server. More details can be found in the sections below.

9.2 Creating a Simple Stream

The XD Admin server [5] exposes a full RESTful API for managing the lifecycle of stream definitions, but the easiest way to use the XD shell. Start the shell as described in the Getting Started section

New streams are created by posting stream definitions. The definitions are built from a simple DSL. For example, let's walk through what happens if we execute the following shell command:

```
xd:> stream create --definition "time | log" --name ticktock
```

This defines a stream named `ticktock` based off the DSL expression `time | log`. The DSL uses the "pipe" symbol `|`, to connect a source to a sink.

Then to deploy the stream execute the following shell command (or alternatively add the `--deploy` flag when creating the stream so that this step is not needed):

```
xd:> stream deploy --name ticktock
```

The stream server finds the `time` and `log` definitions in the modules directory and uses them to setup the stream. In this simple example, the time source simply sends the current time as a message each second, and the log sink outputs it using the logging framework.

[1]Using the filesystem is just one possible way of storing module defintions. Other backends will be supported in the future, e.g. Redis.
[5]The server is implemented by the `AdminMain` class in the `spring-xd-dirt` subproject

```
processing module 'Module [name=log, type=sink]' from group 'ticktock' with index: 1
processing module 'Module [name=time, type=source]' from group 'ticktock' with index: 0
17:26:18,774  WARN ThreadPoolTaskScheduler-1 logger.ticktock:141 - Thu May 23 17:26:18 EDT
 2013
```

If you would like to have multiple instances of a module in the stream, you can include a property with the deploy command:

```
xd:> stream deploy --name ticktock --properties "module.time.count=3"
```

You can also include a SpEL Expression as a `criteria` property for any module. That will be evaluated against the attributes of each currently available Container. Instances of the module will only be deployed to Containers for which the expression evaluates to true.

```
xd:> stream deploy --name ticktock --properties
 "module.time.count=3,module.log.criteria=groups.contains('x')"
```

9.3 Deleting a Stream

You can delete a stream by issuing the `stream destroy` command from the shell:

```
xd:> stream destroy --name ticktock
```

9.4 Deploying and Undeploying Streams

Often you will want to stop a stream, but retain the name and definition for future use. In that case you can `undeploy` the stream by name and issue the `deploy` command at a later time to restart it.

```
xd:> stream undeploy --name ticktock
xd:> stream deploy --name ticktock
```

9.5 Other Source and Sink Types

Let’s try something a bit more complicated and swap out the `time` source for something else. Another supported source type is `http`, which accepts data for ingestion over HTTP POSTs. Note that the `http` source accepts data on a different port (default 9000) from the Admin Server (default 8080).

To create a stream using an `http` source, but still using the same `log` sink, we would change the original command above to

```
xd:> stream create --definition "http | log" --name myhttpstream --deploy
```

which will produce the following output from the server

```
processing module 'Module [name=log, type=sink]' from group 'myhttpstream' with index: 1
processing module 'Module [name=http, type=source]' from group 'myhttpstream' with index:
 0
```

Note that we don’t see any other output this time until we actually post some data (using shell command)

```
xd:> http post --target http://localhost:9000 --data "hello"
xd:> http post --target http://localhost:9000 --data "goodbye"
```

and the stream will then funnel the data from the http source to the output log implemented by the log sink

```
15:08:01,676  WARN ThreadPoolTaskScheduler-1 logger.myhttpstream:141 - hello
15:08:12,520  WARN ThreadPoolTaskScheduler-1 logger.myhttpstream:141 - goodbye
```

Of course, we could also change the sink implementation. You could pipe the output to a file (`file`), to hadoop (`hdfs`) or to any of the other sink modules which are provided. You can also define your own modules.

9.6 Simple Stream Processing

As an example of a simple processing step, we can transform the payload of the HTTP posted data to upper case using the stream definitions

```
http | transform --expression=payload.toUpperCase() | log
```

To create this stream enter the following command in the shell

```
xd:> stream create --definition "http | transform --expression=payload.toUpperCase() |
 log" --name myprocstrem --deploy
```

Posting some data (using shell command)

```
xd:> http post --target http://localhost:9000 --data "hello"
```

Will result in an uppercased *hello* in the log

```
15:18:21,345  WARN ThreadPoolTaskScheduler-1 logger.myprocstream:141 - HELLO
```

See the Processors section for more information.

9.7 DSL Syntax

In the examples above, we connected a source to a sink using the pipe symbol `|`. You can also pass parameters to the source and sink configurations. The parameter names will depend on the individual module implementations, but as an example, the `http` source module exposes a `port` setting which allows you to change the data ingestion port from the default value. To create the stream using port 8000, we would use

```
xd:> stream create --definition "http --port=8000 | log" --name myhttpstream
```

If you know a bit about Spring configuration files, you can inspect the module definition to see which properties it exposes. Alternatively, you can read more in the source and sink documentation.

9.8 Advanced Features

In the examples above, simple module definitions are used to construct each stream. However, modules may be grouped together in order to avoid duplication and/or reduce the amount of chattiness over the messaging middleware. To learn more about that feature, refer to the Composing Modules section.

If directed graphs are needed instead of the simple linear streams described above, two features are relevant. First, named channels may be used as a way to combine multiple flows upstream and/or downstream from the channel. The behavior of that channel may either be queue-based or topic-based depending on what prefix is used ("queue:myqueue" or "topic:mytopic", respectively). To learn more, refer to the Named Channels section. Second, you may need to determine the output channel of a stream based on some information that is only known at runtime. To learn about such content-based routing, refer to the Dynamic Router section.

10. Modules

10.1 Introduction

The XD runtime environment supports data ingestion by allowing users to define streams. Streams are composed of *modules* which encapsulate a unit of work into a reusable component.

Modules are categorized by type, typically representing the role or function of the module. Current XD module types include *source*, *sink*, and *processor* which indicate how they modules may be composed in a stream. Specifically, a source polls an external resource, or is triggered by an event and only provides an output. The first module in a stream is always a source. A processor performs some type of transformation or business logic and provides an input and one or more outputs. A sink provides only an input and outputs data to an external resource to terminate the stream.

XD comes with a number of modules used for assembling streams which perform common input and/or output operations with files, HDFS, http, twitter, syslog, GemFire, and more. Users can easily assemble these into streams to build complex big data applications without having to know the underlying Spring products on which XD is built.

However, if you are interested in extending XD with your own modules, some knowledge of Spring, Spring Integration, and Spring Batch is essential. The remainder of this document assumes the reader has some familiarity with these topics.

10.2 Creating a Module

This section provides details on how to write and register custom modules. For a quick start, dive into the examples of creating source, processor, and sink modules.

A ModuleDefinition has the following required attributes:

- name - the name of the component, normally a single word representing the purpose of the module. Examples are *file*, *http*, *syslog*.
- type - the module type, current XD module types include *source*, *sink*, and *processor*
- instance id - This represents a named instance of a module with a given name and type, with a specific configuration.

Modules and Spring

At the core, a module is any component that may be implemented using a Spring application context. In this respect, the concept may be extended for purposes other than data ingestion. The types mentioned above (source, processor,sink) are specific to XD and constructing streams. But other module types are envisioned.

A module is typically configured using property placeholders which are bound to the module’s attributes. Attributes may be required or optional and this coincides with whether a default value is provided for the placeholder.

For example, here is part of the Spring configuration for a *twittersearch* source that runs a query against Twitter:

```
<beans>
  ...
  <int:inbound-channel-adapter id="results" auto-startup="false"
 ref="twitterSearchMessageSource" method="getTweets">
 <int:poller fixed-delay="${fixedDelay:5000}"/>
  </int:inbound-channel-adapter>

  <bean id="twitterSearchMessageSource" class="org.springframework.integration.x.twitter.TwitterSearchMessa
 <constructor-arg ref="oauth2Template"/>
 <constructor-arg value="${query}"/>
  </bean>

  <bean id="oauth2Template" class="org.springframework.social.oauth2.OAuth2Template">
 <constructor-arg index="0" value="${consumerKey:${twitter.oauth.consumerKey}}" />
 <constructor-arg index="1" value="${consumerSecret:${twitter.oauth.consumerSecret}}" />
 <constructor-arg index="2" value="http://notused" />
 <constructor-arg index="3" value="http://notused" />
 <constructor-arg index="4" value="https://api.twitter.com/oauth2/token" />
  </bean>
</beans>
```

Note the property placeholders for *query*, *fixedDelay*, *consumerKey* and *consumerSecret*. The *query* property defines no default value, so it is a required attribute for this module. *fixedDelay* defaults to 5000, so it is an optional attribute. Note the defaults for *consumerKey* and *consumerSecret*. The property names prefixed by *twitter* are globally defined for the entire XD system in *config/twitter.properties*. So if the user does not specify a *consumerKey* or *consumerSecret* when creating the stream, XD's twitter configuration will be used instead.

The XD server will substitute values for all of these properties as configured for each module instance. For example, we can create two streams each creating an instance of the *twittersearch* module with a different configuration.

```
xd:> stream create --name tweettest --definition "twittersearch --query='java' | file"
```

or

```
xd:> stream create --name tweettest2 --definition "twittersearch --query-'java' --
consumerKey='mykey' --consumerSecret='mysecret' | file"
```

In addition to properties, modules may reference Spring beans which are defined externally such that each module instance may inject a different implementation of a bean. The ability to configure each module instance differently is only possible if each module is created in its own application context. The module may be configured with a parent context, but this should be done with care. In the simplest case, the module context is completely separate. This results in some very useful features, such as being able to create multiple bean instances with the same id, possibly with different configurations. More generally, this allows modules to adhere to the KISS principle.

Integration Modules

In Spring Integration terms,

- A *source* is a valid message flow that contains a direct channel named *output* which is fed by an inbound adapter, either configured with a poller, or triggered by an event.

- A *processor* is a valid message flow that contains a direct channel named *input* and a subscribable channel named *output* (direct or publish subscribe). It should perform some type of transformation on the message. (TBD: Describe multiple outputs, routing, etc.)

- A *sink* is a valid message flow that contains a direct channel named *input* and an outbound adapter, or service activator used to consume a message payload.

Modules of type source, processor, and sink are built with Spring Integration and are typically very fine-grained.

For example, take a look at the file source which simply polls a directory using a file inbound adapter and file sink which appends incoming message payloads to a file using a file outbound adapter. On the surface, there is nothing special about these components. They are plain old Spring XML bean definition files.

Upon closer inspection, you will notice that modules adhere to some important conventions. For one thing, the file name is the module name. Also note the channels named *input* and *output*, in keeping with the KISS principle (let us know if you come up with some simpler names). These names are by convention what XD uses to discover a module's input and/or output channels which it wires together to compose streams. Another thing you will observe is the use of property placeholders with sensible defaults where possible. For example, the file source requires a directory. An appropriate strategy is to define a common root path for XD input files (At the time of this writing it is /tmp/xd/input/. This is subject to change, but illustrates the point). An instance of this module may specify the directory by providing *name* property. If not provided, it will default to the stream name, which is contained in the *xd.stream.name* property defined by the XD runtime. By convention, XD defined properties are prefixed with *xd*

```
directory="/tmp/xd/input/${name:${xd.stream.name}}"
```

10.3 Registering a Module

XD provides a strategy interface ModuleRegistry which it uses to find a module of a given name and type. Currently XD provides RedisModuleRegistry and FileModuleRegistry, The ModuleRegistry is a required component for the XD Server. By default the XD Server is configured with the FileModuleRegistry which looks for modules in `${xd.home:..}/modules`. Where `xd.home` is a Java System Property or may be passed as a command line argument to the container launcher. So out of the box, the modules are contained in the XD modules directory. The modules directory organizes module types in sub-directories. So you will see something like:

```
modules/processor
modules/sink
modules/source
```

Using the default server configuration, you simply drop your module file into the modules directory and deploy a stream to the server.

Modules with isolated classpath

In addition to the simple format described above, where you would have a `foo` source module implemented as a `modules/source/foo.xml` file, there is also preliminary support for modules that wish to bring their own library dependencies, in an isolated fashion.

This is accomplished by creating a *folder* named after your module name and moving the xml file to a `config` subdirectory. As an example, the `foo.xml` file would then reside in

```
modules/source/foo/config/foo.xml
```

Additional jar files can then be added to a sibling `lib` directory, like so:

```
modules/source/foo/
                   config/
                          foo.xml
                   lib/
                       commons-foo.jar
                       foo-ext.jar
```

Classes will first be loaded from any of the aforementioned jar files and, only if they're not found will they be loaded from the parent, global ClassLoader that Spring XD normally uses. Still, there are a couple of caveats that one should be aware of:

1. refrain from putting into the `lib/` folder jar files that are also part of Spring XD, or you'll likely end up with ClassCastExceptions

2. any class that is directly or indirectly referenced from the payload type of your messages (*i.e.* the types that transit from module to module) must not belong to a particular module `lib/` folder but should rather be loaded by the global Spring XD classloader

10.4 Composing Modules

As described above, a stream is defined as a sequence of modules, minimally a source module followed by a sink module. One or more processor modules may be added in between the source and sink, but they are not mandatory. Sometimes streams are similar for a subset of their modules. For example, consider the following two streams:

```
stream1 = http | filter --expression=payload.contains('foo') | file
stream2 = file | filter --expression=payload.contains('foo') | file
```

Other than the source module, the definitions of those two streams are the same. It would be better to avoid this degree of duplication. This is the first problem that composed modules address.

Each module within a stream represents a unit of deployment. Therefore, in each of the streams defined above, there would be 3 such units (the source, the processor, and the sink). In a singlenode runtime, it doesn't make much of a difference since the communication between each module would be a bridge between in-memory channels. When deploying a stream to a distributed runtime environment, however, the communication between each module occurs over messaging middleware. That decoupling between modules is useful in that it promotes loose-coupling and thus enables load-balancing and buffering of messages when the consuming module(s) are temporarily busy or down. Nevertheless, at times the individual module boundaries are more fine-grained than necessary for these middleware "hops". Overhead may be avoided by reducing the overall number of deployment units and therefore the number of hops. In such cases, it's convenient to be able to wrap multiple modules together so that they act as a single "black box" unit for deployment. In other words, if "foo | bar" are composed together as a new module named "baz", the input and/or output to "baz" would still occur as a hop over the middleware, but the communication from foo to bar would occur directly, in-process. This is the second problem that composed modules address.

Now let’s look at an example. Returning to the two similar streams above, the filter processor and file sink could be combined into a single module. In the shell, the following command would take care of that:

```
xd:> module compose foo --definition "filter --expression=payload.contains('foo') | file"
```

Then, to verify the new module composition was successful, check if it exists:

```
xd:> module list --type sink
Module Name          Module Type
-------------------  -----------
...
foo                  sink
```

Notice that the composed module shows up in the list of **sink** modules. That is because logically, it has the structure of a sink: it provides an input channel (which is bridged to the filter processor’s input channel), but it provides no output channel (since the file sink has no output).

If a module were composed of two processors, it would be classified as a processor itself:

```
xd:> module compose myprocessor --definition "splitter | filter --
expression=payload.contains('foo')"
```

If a module were composed of a source and a processor, it would be classified as a source itself:

```
xd:> module compose mysource --definition "http | filter --
expression=payload.contains('foo')"
```

Based on the logical type of the composed module, it may be used in a stream as if it were a simple module instance. For example, to redefine the two streams from the first problem case above, now that the "foo" sink module has been composed, you would issue the following shell commands:

```
xd:> stream create httpfoo --definition "http | foo" --deploy
xd:> stream create filefoo --definition "file --outputType=text/plain | foo"  --deploy
```

To test the "httpfoo" stream, try the following:

```
xd:> http post --data hi
xd:> http post --data hifoo
```

The first message should have been ignored due to the filter, but the second one should exist in the file:

```
xd:> ! cat /tmp/xd/output/httpfoo.out
command is:cat /tmp/xd/output/httpfoo.out
hifoo
```

To test the "filefoo" stream, echo "foo" to a file in the /tmp/xd/input/filefoo directory, then verify:

```
xd:> ! cat /tmp/xd/output/filefoo.out
command is:cat /tmp/xd/output/filefoo.out
foo
```

When you no longer need a composed module, you may delete it with the "module delete" command in the shell. However, if that composed module is currently being used by one or more streams, the deletion will fail as shown below:

```
xd:> module delete --name foo --type sink
16:51:37,349  WARN Spring Shell client.RestTemplate:566 - DELETE request for "http://
localhost:9393/modules/sink/foo" resulted in 500 (Internal Server Error); invoking error
 handler
Command failed org.springframework.xd.rest.client.impl.SpringXDException: Cannot delete
 module sink:foo because it is used by [stream:filefoo, stream:httpfoo]
```

As you can see, the failure message shows which stream(s) depend upon the composed module you are trying to delete.

If you destroy both of those streams and try again, it will work:

```
xd:> stream destroy --name filefoo
Destroyed stream 'filefoo'
xd:> stream destroy --name httpfoo
Destroyed stream 'httpfoo'
xd:> module delete --name foo --type sink
Successfully destroyed module 'foo' with type sink
```

When creating a module, if you duplicate the name of an existing module for the same type, you will receive an error. In the example below the user tried to compose a tcp module, however one already exists:

```
xd:>module compose tcp --definition "filter --expression=payload.contains('foo') | file"
14:52:27,781  WARN Spring Shell client.RestTemplate:566 - POST request for "http://
ec2-50-16-24-31.compute-1.amazonaws.com:9393/modules" resulted in 409 (Conflict); invoking
 error handler
Command failed org.springframework.xd.rest.client.impl.SpringXDException: There is already
 a module named 'tcp' with type 'sink'
```

However, you can create a module for a given type even though a module of that name exists but as a different type. For example: I can create a sink module named filter, even though a filter module exists already as a processor.

Finally, it’s worth mentioning that in some cases duplication may be avoided by reusing an actual stream rather than a composed module. That is possible when named channels are used in the source and/or sink position of a stream definition. For example, the same overall functionality as provided by the two streams above could also be achieved as follows:

```
xd:> stream create foofilteredfile --definition "queue:foo > filter --
expression=payload.contains('foo') | file"
xd:> stream create httpfoo --definition "http > queue:foo"
xd:> stream create filefoo --definition "file > queue:foo"
```

This approach is more appropriate for use-cases where individual streams on either side of the named channel may need to be deployed or undeployed independently. Whereas the queue typed channel will load-balance across multiple downstream consumers, the "topic:" prefix may be used if broadcast behavior is needed instead. For more information about named channels, refer to the Named Channels section.

10.5 Getting Information about Modules

To view the available modules use the the `module list` command. Modules appearing with a `(c)` marker are composed modules. For example:

```
xd:>module list
      Source              Processor           Sink                     Job
  ------------------  ------------------  -----------------------  ----------------
      file                aggregator          aggregate-counter        filejdbc
      gemfire             analytic-pmml       counter                  ftphdfs
      gemfire-cq          http-client         field-value-counter      hdfsjdbc
      http                bridge              file                     hdfsmongodb
      jms                 filter              gauge                    jdbchdfs
      mail                json-to-tuple       gemfire-json-server      filepollhdfs
      mqtt                object-to-json      gemfire-server
      post                script              jdbc
      reactor-syslog      splitter            mail
      reactor-tcp         transform           mqtt
      syslog-tcp      (c) myfilter            rich-gauge
      syslog-udp                              splunk
      tail                                    tcp
      tcp                                     throughput-sampler
      tcp-client                              avro
      trigger                                 hdfs
      twittersearch                           log
      twitterstream                           rabbit
      rabbit                                  router
      time
```

To get information about a particular module (such as what options it accepts), use the `module info --<module type>:<module name>` command. For example:

```
xd:>module info --name source:file
Information about source module 'file':

  Option Name        Description
        Default  Type
  -----------------
 ---------------------------------------------------------------------------  -------
 ---------
  dir                the absolute path to the directory to monitor for files
        <none>   String
  pattern            a filter expression (Ant style) to accept only files that match the
 pattern  *        String
  outputType         how this module should emit messages it produces
        <none>   MediaType
  preventDuplicates  whether to prevent the same file from being processed twice
        true     boolean
  ref                set to true to output the File object itself
        false    boolean
  fixedDelay         the fixed delay polling interval specified in seconds
        5        int
```

To display the actual definition file of a module use the `module display --name <module type>:<module name>` command. For example:

```
xd:>module display --name tcp --type source
Configuration file contents for module definition 'tcp' (source):

-------------------------------------------------------------------------------
...
    <int-ip:tcp-connection-factory id="connectionFactory"
        type="server"
        port="${port}"
        lookup-host="${reverseLookup}"
        so-timeout="${socketTimeout}"
        using-nio="${nio}"
        using-direct-buffers="${useDirectBuffers}"
        deserializer="${decoder}"/>

    <int-ip:tcp-inbound-channel-adapter id="adapter" channel="toString"
        auto-startup="false"
        connection-factory="connectionFactory"/>

    <int:transformer input-channel="toString" output-channel="output" expression="new
 String(payload, '${charset}')"/>

    <int:channel id="output"/>
...
```

10.6 How module options are resolved

As we've seen so far, a module is a re-usable piece of Spring Integration (or Spring Batch) software that can be dynamically configured thru the use of **module options**.

A module option is any value that the module author has deemed worthy of configuration at deployment time. Preferably, the module author will have provided metadata to describe the available options. This section explains how default values are computed for each module option.

In a nutshell, actual values are drawn from the following 3 sources, from most precedent to least precedent:

1. actual values in the stream definition (*e.g.* `--foo=bar`)
2. platform-wide defaults (appearing *e.g.* in .yml and .properties files, see below)
3. defaults the module author chose (see metadata)

Going into more detail, the mid layer above (platform-wide defaults) will resolve like so, assuming option `<optionname>` of module `<modulename>` (which is of type `<moduletype>`):

a. a **system property** named `<moduletype>.<modulename>.<optionname>`

b. an **environment variable** named `<moduletype>.<modulename>.<optionname>` (or `<MODULETYPE>_<MODULENAME>_<OPTIONNAME>`)

c. a key named `<optionname>` in the **properties** file `<root>/<moduletype>/<modulename>/<modulename>.properties`

d. a key named `<moduletype>.<modulename>.<optionname>` in the **YaML** file `<root>/<module-config>.yml`

where

`<root>`
: is the value of the `xd.module.config.location` system property (driven by the `XD_MODULE_CONFIG_LOCATION` env var when using the canonical Spring XD shell scripts). Defaults to `${xd.config.home}/modules/`

`<module-config>`
: is the value of the `xd.module.config.name` system property (driven by the `XD_MODULE_CONFIG_NAME` env var). Defaults to `xd-module-config`

Note that YaML is particularly well suited for hierarchical configuration, so for example, instead of

```
source.file.dir: foo
source.file.pattern: *.txt

source.http.port: 1234
```

one can write

```
source:
  file:
    dir: foo
    pattern: *.txt
  http:
    port: 1234
```

11. Sources

11.1 Introduction

In this section we will show some variations on input sources. As a prerequisite start the XD Container as instructed in the Getting Started page.

The Sources covered are

- HTTP
- Tail
- File
- Mail
- Twitter Search
- Twitter Stream
- Gemfire
- Gemfire CQ
- Syslog
- TCP
- TCP Client
- Reactor IP
- JMS
- RabbitMQ
- Time
- MQTT
- Stdout Capture

Future releases will provide support for other currently available Spring Integration Adapters. For information on how to adapt an existing Spring Integration Adapter for use in Spring XD see the section Creating a Source Module.

The following sections show a mix of Spring XD shell and plain Unix shell commands, so if you are trying them out, you should open two separate terminal prompts, one running the XD shell and one to enter the standard commands for sending HTTP data, creating directories, reading files and so on.

11.2 HTTP

To create a stream definition in the server using the XD shell

```
xd:> stream create --name httptest --definition "http | file" --deploy
```

Post some data to the http server on the default port of 9000

```
xd:> http post --target http://localhost:9000 --data "hello world"
```

See if the data ended up in the file

```
$ cat /tmp/xd/output/httptest
```

HTTP with options

The http source has one option

port
: The http port where data will be posted **(default: `9000`)**

Here is an example

```
xd:> stream create --name httptest9020 --definition "http --port=9020 | file" --deploy
```

Post some data to the new port

```
xd:> http post --target http://localhost:9020 --data "hello world"
```

```
$ cat /tmp/xd/output/httptest9020
```

11.3 Tail

Make sure the default input directory exists

```
$ mkdir -p /tmp/xd/input
```

Create an empty file to tail (this is not needed on some platforms such as Linux)

```
touch /tmp/xd/input/tailtest
```

To create a stream definition using the XD shell

```
xd:> stream create --name tailtest --definition "tail | file" --deploy
```

Send some text into the file being monitored

```
$ echo blah >> /tmp/xd/input/tailtest
```

See if the data ended up in the file

```
$ cat /tmp/xd/output/tailtest
```

Tail with options

The tail source has 3 options:

name
: the absolute path to the file to tail **(default: `/tmp/xd/input/<streamName>`)**

lines
: the number of lines from the end of an existing file to tail **(default: `0`)**

fileDelay
: on platforms that don't wait for a missing file to appear, how often (ms) to look for the file **(default: `5000`)**

Here is an example

```
xd:> stream create --name tailtest --definition "tail --name=/tmp/foo | file --name=bar"
 --deploy
```

```
$ echo blah >> /tmp/foo
```

```
$ cat /tmp/xd/output/bar
```

Tail Status Events

Some platforms, such as linux, send status messages to `stderr`. The tail module sends these events to a logging adapter, at WARN level; for example…

```
[message=tail: cannot open `/tmp/xd/input/tailtest' for reading: No such file or
 directory, file=/tmp/xd/input/tailtest]
[message=tail: `/tmp/xd/input/tailtest' has become accessible, file=/tmp/xd/input/
tailtest]
```

11.4 File

The file source provides the contents of a File as a byte array by default but may be configured to provide the file reference itself.

To log the contents of a file create a stream definition using the XD shell

```
xd:> stream create --name filetest --definition "file | log" --deploy
```

The file source by default will look into a directory named after the stream, in this case /tmp/xd/input/filetest

Note the above will log the raw bytes. For text files, it is normally desirable to output the contents as plain text. To do this, set the *outputType* parameter:

```
xd:> stream create --name filetest --definition "file --outputType=text/plain | log" --
deploy
```

For more details on the use of the *outputType* parameter see Type Conversion

Copy a file into the directory `/tmp/xd/input/filetest` and observe its contents being logged in the XD Container.

File with options

The file source has 5 options

dir
: The absolute path to the directory to monitor for files **(default: `/tmp/xd/input/<streamName>`)**

preventDuplicates
: Default value is `true` to prevent the same file from being processed twice.

pattern
: A filter expression (Ant style) that accepts only files that match the pattern.

fixedDelay
: The fixed delay polling interval specified in seconds **(default: 5)**

ref
: Set to true to output the File object itself. This is useful in some cases in which the file contents are large and it would be more efficient to send the file path across the network than the contents. This option requires that the file be in a shared file system.

11.5 Mail

Spring XD provides a source module for receiving emails, named `mail`. Depending on the protocol used, in can work by polling or receive mails as they become available.

Let’s see an example:

```
xd:> stream create --name mailstream --definition "mail --host=imap.gmail.com --
username=your.user@gmail.com --password=secret | file" --deploy
```

Then send an email to yourself and you should see it appear inside a file at `/tmp/xd/output/mailstream`

The full list of options for the `mail` source is below:

protocol
: the protocol to use amongst pop3, pop3s, imap, imaps **(default: `imaps`)**

username
: the username to use to connect to the mail server **(no default)**

password
: the password to use to connect to the mail server **(no default)**

host
: the hostname of the mail server **(default: `localhost`)**

port
: the port of the mail server **(default: `25`)**

folder
: the folder to take emails from **(default: `INBOX`)**

markAsRead
: whether to mark emails as read once they’ve been fetched by the module **(default: `false`)**

delete
: whether to delete the emails once they’ve been fetched by the module **(default: `true`)**

usePolling
: whether to use polling or not (no-polling works with imap(s) only) **(default: `false`)**

fixedDelay
: the polling interval used for looking up messages, expressed in seconds. **(default: `60`)**

charset
: the charset used to transform the body of the incoming emails to Strings. **(default: `UTF-8`)**

expression
: a SpEL expression which filters which mail messages will be processed (non polling imap only) **(no default)**

Warning

Of special attention are the `markAsRead` and `delete` options, which by default will **delete** the emails once they are consumed. It is hard to come up with a sensible default option for this (please refer to the Spring Integration documentation section on mail handling for a discussion about this), so just be aware that the default for XD is to delete incoming messages.

11.6 Twitter Search

The twittersearch source has four parameters

query
: The query that will be run against Twitter **(required)** For information on how to construct a query, visit Using Search.

consumerKey
: An application consumer key issued by twitter

consumerSecret
: The secret corresponding to the `consumerKey`

fixedDelay
: The fixed delay polling interval specified in miliseconds **(default: 5000)**

To get a `consumerKey` and `consumerSecret` you need to register a twitter application. If you don't already have one set up, you can create an app at the Twitter Developers site to get these credentials.

To create a stream definition in the server using the XD shell

```
xd:> stream create --name springone2gx --definition "twittersearch --
consumerKey=<your_key> --consumerSecret=<your_secret> --query='#springone2gx' | file" --
deploy
```

Make sure the default output directory for the `file` sink exists

```
$ mkdir -p /tmp/xd/output/
```

Let the twittersearch run for a little while and then check to see if some data ended up in the file

```
$ cat /tmp/xd/output/springone2gx
```

Tip

For both `twittersearch` and `twitterstream` you can put the keys in a module properties file instead of supplying them in the stream definition. For twittersearch, the file would be `config/modules/source/twittersearch/twittersearch.properties`.

Note

`twittersearch` by default emits Spring Social Tweet objects. You may easily configure `twittersearch` to emit JSON by setting --output=application/json. This will cause XD to transform the objects JSON internally, resulting in properties corresponding to the Java type. This yields a format slightly different than the native Twitter JSON emitted by `twitterstream`. While logically identical, property names and types, notably dates, are different. Thus the JSON strings produced by `twittersearch` and `twitterstream` are generally incompatible.

11.7 Twitter Stream

This source ingests data from Twitter's streaming API. It uses the sample and filter stream endpoints rather than the full "firehose" which needs special access. The endpoint used will depend on the parameters you supply in the stream definition (some are specific to the filter endpoint).

You need to supply all keys and secrets (both consumer and accessToken) to authenticate for this source, so it is easiest if you just add these to the `XD_HOME/config/modules/source/twitterstream/twitterstream.properties` file. Stream creation is then straightforward:

```
xd:> stream create --name tweets --definition "twitterstream | file" --deploy
```

The parameters available are pretty much the same as those listed in the API docs and unless otherwise stated, the accepted formats are the same.

delimited
: set to `true` to get length delimiters in the stream data (defaults to `false`)

stallWarnings
: set to `true` to enable stall warnings (defaults to `false`)

filterLevel
: controls which tweets make it through to the stream (defaults to `null`)

language
: comma delimited set of languages to retain (defaults to `null`)

follow
: comma delimited set of user ids whose tweets should be sent to the stream (defaults to `null`)

track
: which terms to look for in tweets (defaults to `null`)

locations
: a comma-separated list of longitude,latitude pairs specifying a set of bounding boxes to filter Tweets (defaults to `null`)

Note

`twitterstream` emits JSON in a native Twitter format. This format is incompatible with content produced by `twittersearch` (see note above regarding `twittersearch`)

11.8 GemFire

This source configures a cache and replicated region in the XD container process along with a Spring Integration GemFire inbound channel adapter, backed by a CacheListener that outputs messages triggered by an external entry event on the region. By default the payload contains the updated entry value, but may be controlled by passing in a SpEL expression that uses the EntryEvent as the evaluation context.

Options

The Gemfire CacheListener source has the following options

regionName
: The name of the region for which events are to be monitored **(required, String)**

cacheEventExpression
: An optional SpEL expression referencing the event. **(default: `newValue`)**

Example

Use of the gemfire source requires an external process that creates or updates entries in a GemFire region. Such events may trigger an XD process. For example, suppose a sales application creating and updating orders in a replicated GemFire region named `orders` . To trigger an XD stream, the XD container must join the GemFire distributed system and create a replica of the region, to which a cache listener is bound via the GemFire inbound channel adapter.

```
xd:>stream create --name orderStream --definition "gemfire --regionName=orders | file --
inputType=application/json"
```

In the above example, it is presumed the cache entries are Order POJOs. In this case, it may be convenient to convert to JSON before writing to the file.

11.9 GemFire Continuous Query (CQ)

Continuous query allows client applications to create a GemFire query using Object Query Language(OQL) and register a CQ listener which subscribes to the query and is notified every time the query 's result set changes. The *gemfire_cq* source registers a CQ which will post CQEvent messages to the stream.

Launching the XD GemFire Server

This source requires a cache server to be running in a separate process and its host and port must be known (NOTE: GemFire locators are not supported yet). The XD distribution includes a GemFire server executable suitable for development and test purposes. This is a Java main class that runs with a Spring configured cache server. The configuration is passed as a command line argument to the server's main method. The configuration includes a cache server port and one or more configured region. XD includes a sample cache configuration called cq-demo. This starts a server on port 40404 and creates a region named *Stocks*. A Logging cache listener is configured for the region to log region events.

Run Gemfire cache server by changing to the gemfire/bin directory and execute

```
$ ./gemfire-server ../config/cq-demo.xml
```

Options

The qemfire-cq source has the following options

query
: The query string in Object Query Language(OQL) **(required, String)**

host
: The host on which the GemFire server is running. **(default: `localhost`)**

port
: The port on which the GemFire server is running. **(default: `40404`)**

Here is an example. Create two streams: One to write http messages to a Gemfire region named *Stocks*, and another to execute the CQ.

```
xd:> stream create --name stocks --definition "http --port=9090 | gemfire-json-server --
regionName=Stocks --keyExpression=payload.getField('symbol')" --deploy
xd:> stream create --name cqtest --definition "gemfire-cq --query='Select * from /Stocks
 where symbol=''FAKE''' | file" --deploy
```

Now send some messages to the stocks stream.

```
xd:> http post --target http://localhost:9090 --data "{"symbol":"FAKE","price":73}"
xd:> http post --target http://localhost:9090 --data "{"symbol":"FAKE","price":78}"
xd:> http post --target http://localhost:9090 --data "{"symbol":"FAKE","price":80}"
```

Please do not put spaces when separating the JSON key-value pairs, only a comma.

The *cqtest* stream is now listening for any stock quote updates for VMW. Presumably, another process is updating the cache. You may create a separate stream to test this (see GemfireServer for instructions).

As updates are posted to the cache you should see them captured in the output file:

```
$cat /tmp/xd/output/cqtest.out
```

```
{"symbol":"FAKE","price":73}
{"symbol":"FAKE","price":78}
{"symbol":"FAKE","price":80}
```

11.10 Syslog

Three syslog sources are provided: `reactor-syslog`, `syslog-udp`, and `syslog-tcp`. The reactor-syslog adapter uses tcp and builds upon the functionality available in the Reactor project and provides improved throughput over the syslog-tcp adapter. They all support the following option:

port
: the port on which the system will listen for syslog messages **(default: `5140`)**

To create a stream definition (using shell command)

```
xd:> stream create --name syslogtest --definition "reactor-syslog --port=5140 | file" --
deploy
```

or

```
xd:> stream create --name syslogtest --definition "syslog-udp --port=5140 | file" --deploy
```

or

```
xd:> stream create --name syslogtest --definition "syslog-tcp --port=5140 | file" --deploy
```

(`--port` is not required when using the default `5140`)

Send a test message to the syslog

```
logger -p local3.info -t TESTING "Test Syslog Message"
```

See if the data ended up in the file

```
$ cat /tmp/xd/output/syslogtest
```

Refer to your syslog documentation to configure the syslog daemon to forward syslog messages to the stream; some examples are:

UDP - Mac OSX (syslog.conf) and Ubuntu (rsyslog.conf)

```
*.*    @localhost:5140
```

TCP - Ubuntu (rsyslog.conf)

```
$ModLoad omfwd
*.*    @@localhost:5140
```

Restart the syslog daemon after reconfiguring.

11.11 TCP

The `tcp` source acts as a server and allows a remote party to connect to XD and submit data over a raw tcp socket.

To create a stream definition in the server, use the following XD shell command

```
xd:> stream create --name tcptest --definition "tcp | file" --deploy
```

This will create the default TCP source and send data read from it to the `tcptest` file.

TCP is a streaming protocol and some mechanism is needed to frame messages on the wire. A number of decoders are available, the default being *CRLF* which is compatible with Telnet.

```
$ telnet localhost 1234
Trying ::1...
Connected to localhost.
Escape character is '^]'.
foo
^]

telnet> quit
Connection closed.
```

See if the data ended up in the file

```
$ cat /tmp/xd/output/tcptest
```

TCP with options

The TCP source has the following options

port
: the port on which to listen **(default: `1234`)**

reverseLookup
: perform a reverse DNS lookup on the remote IP Address **(default: `false`)**

socketTimeout
: the timeout (ms) before closing the socket when no data received **(default: `120000`)**

nio
: whether or not to use NIO. NIO is more efficient when there are many connections. **(default: `false`)**

decoder
: how to decode the stream - see below. **(default: `CRLF`)**

binary
: whether the data is binary (true) or text (false). **(default: `false`)**

charset
: the charset used when converting text to `String`. **(default: `UTF-8`)**

Available Decoders

Text Data

CRLF (default)
: text terminated by carriage return (0x0d) followed by line feed (0x0a)

LF
: text terminated by line feed (0x0a)

NULL
: text terminated by a null byte (0x00)

STXETX
: text preceded by an STX (0x02) and terminated by an ETX (0x03)

Text and Binary Data

RAW
: no structure - the client indicates a complete message by closing the socket

L1
: data preceded by a one byte (unsigned) length field (supports up to 255 bytes)

L2
: data preceded by a two byte (unsigned) length field (up to 2^{16}-1 bytes)

L4
: data preceded by a four byte (signed) length field (up to 2^{31}-1 bytes)

Examples

The following examples all use `echo` to send data to `netcat` which sends the data to the source.

The echo options `-en` allows echo to interpret escape sequences and not send a newline.

CRLF Decoder.

```
xd:> stream create --name tcptest --definition "tcp | file" --deploy
```

This uses the default (CRLF) decoder and port 1234; send some data

```
$ echo -en 'foobar\r\n' | netcat localhost 1234
```

See if the data ended up in the file

```
$ cat /tmp/xd/output/tcptest
```

LF Decoder.

```
xd:> stream create --name tcptest2 --definition "tcp --decoder=LF --port=1235 | file" --
deploy
```

```
$ echo -en 'foobar\n' | netcat localhost 1235
```

```
$ cat /tmp/xd/output/tcptest2
```

NULL Decoder.

```
xd:> stream create --name tcptest3 --definition "tcp --decoder=NULL --port=1236 | file" --
deploy
```

```
$ echo -en 'foobar\x00' | netcat localhost 1236
```

```
$ cat /tmp/xd/output/tcptest3
```

STXETX Decoder.

```
xd:> stream create --name tcptest4 --definition "tcp --decoder=STXETX --port=1237 | file"
 --deploy
```

```
$ echo -en '\x02foobar\x03' | netcat localhost 1237
```

```
$ cat /tmp/xd/output/tcptest4
```

RAW Decoder.

```
xd:> stream create --name tcptest5 --definition "tcp --decoder=RAW --port=1238 | file" --
deploy
```

```
$ echo -n 'foobar' | netcat localhost 1238
$ cat /tmp/xd/output/tcptest5
```

L1 Decoder.

```
xd:> stream create --name tcptest6 --definition "tcp --decoder=L1 --port=1239 | file" --
deploy
```

```
$ echo -en '\x06foobar' | netcat localhost 1239
```

```
$ cat /tmp/xd/output/tcptest6
```

L2 Decoder.

```
xd:> stream create --name tcptest7 --definition "tcp --decoder=L2 --port=1240 | file" --
deploy
```

```
$ echo -en '\x00\x06foobar' | netcat localhost 1240
```

```
$ cat /tmp/xd/output/tcptest7
```

L4 Decoder.

```
xd:> stream create --name tcptest8 --definition "tcp --decoder=L4 --port=1241 | file" --
deploy
```

```
$ echo -en '\x00\x00\x00\x06foobar' | netcat localhost 1241
```

```
$ cat /tmp/xd/output/tcptest8
```

Binary Data Example

```
xd:> stream create --name tcptest9 --definition "tcp --decoder=L1 --port=1242 | file --
binary=true" --deploy
```

Note that we configure the `file` sink with `binary=true` so that a newline is not appended.

```
$ echo -en '\x08foo\x00bar\x0b' | netcat localhost 1242
```

```
$ hexdump -C /tmp/xd/output/tcptest9
00000000  66 6f 6f 00 62 61 72 0b                           |foo.bar.|
00000008
```

Implementing a simple conversation

That "stimulus" counter concept bears some explanation. By default, the module will emit (at interval set by `fixedDelay`) an incrementing number, starting at 1. Given that the default is to use an `expression` of `payload.toString()`, this results in the module sending `1, 2, 3, ...` to the remote server.

By using another expression, or more certainly a `script`, one can implement a simple conversation, assuming it is time based. As an example, let’s assume we want to join some kind of chat server where one first needs to authenticate, then specify which rooms to join. Lastly, all clients are supposed to send some keepalive commands to make sure that the connection is open.

The following groovy script could be used to that effect:

```
def commands = ['', // index 0 is not used
'LOGIN user=johndoe', // first command sent
'JOIN weather',
'JOIN news',
'JOIN gossip'
]


// payload will contain an incrementing counter, starting at 1
if (commands.size > payload)
  return commands[payload] + "\n"
else
  return "PING\n"  // send keep alive after 4th 'real' command
```

11.12 TCP Client

The `tcp-client` source module uses raw tcp sockets, as does the `tcp` module but contrary to the `tcp` module, acts as a client. Whereas the `tcp` module will open a listening socket and wait for connections from a remote party, the `tcp-client` will initiate the connection to a remote server and emit as messages what that remote server sends over the wire. As an optional feature, the `tcp-client` can itself emit messages to the remote server, so that a simple conversation can take place.

TCP Client options

The following options are supported:

host
: the host to connect to **(default: `localhost`)**

port
: the port to connect to **(default: `1234`)**

reverseLookup
: whether to attempt to resolve the host address **(default: `false`)**

nio
: whether to use NIO **(default: `false`)**

encoder
: the encoder to use when sending messages **(default: `LF`, see TCP module)**

decoder
: the decoder to use when receiving messages **(default: `LF`, see TCP module)**

charset
: the charset to use when converting bytes to String **(default: `UTF-8`)**

bufferSize
: the size of the emitting/receiving buffers **(default: `2048`, i.e. 2KB)**

fixedDelay
: the rate at which *stimulus* messages will be emitted **(default: 5 seconds)**

script
: reference to a script that should transform the counter stimulus to messages to send **(default: use `expression`)**

expression
: a SpEL expression to convert the counter stimulus to a message **(default: `payload.toString()`, i.e. emit "1", "2", "3", etc.)**

11.13 Reactor IP

The `reactor-ip` source acts as a server and allows a remote party to connect to XD and submit data over a raw TCP or UDP socket. The reactor-ip source differs from the standard tcp source in that it is based on the Reactor Project and can be configured to use the LMAX Disruptor RingBuffer library allowing for extremely high ingestion rates, e.g. ~ 1M/sec.

To create a stream definition use the following XD shell command

```
xd:> stream create --name tcpReactor --definition "reactor-ip | file" --deploy
```

This will create the reactor TCP source and send data read from it to the file named tcpReactor.

The reactor-ip source has the following options

transport
: `tcp` or `udp` **(default: `tcp`)**

framing
: `linefeed` or `length`. How to frame the data to tell individual messages apart. **(default: `linefeed`)**

lengthFieldLength
: Byte precision of the length field when using `length` framing. 2, 4 or 8. **(default: 4)**

codec
: How to decode the stream. Either bytes, string or syslog. **(default: `string`)**

dispatcher
: `ringBuffer`, `threadPoolExecutor`, `workQueue`, `sync`. **(default: `ringBuffer`)**

host
: the host to connect to **(default: `0.0.0.0`)**

port
: the port to connect to **(default: `3000`)**

11.14 RabbitMQ

The "rabbit" source enables receiving messages from RabbitMQ.

The following example shows the default settings.

Configure a stream:

```
xd:> stream create --name rabbittest --definition "rabbit | file --binary=true" --deploy
```

This receives messages from a queue named `rabbittest` and writes them to the default file sink (`/tmp/xd/output/rabbittest.out`). It uses the default RabbitMQ broker running on localhost, port 5672.

The queue(s) must exist before the stream is deployed. We do not create the queue(s) automatically. However, you can easily create a Queue using the RabbitMQ web UI. Then, using that same UI, you can navigate to the "rabbittest" Queue and publish test messages to it.

Notice that the `file` sink has `--binary=true`; this is because, by default, the data emitted by the source will be bytes. This can be modified by setting the `content_type` property on messages to `text/plain`. In that case, the source will convert the message to a `String`; you can then omit the `--binary=true` and the file sink will then append a newline after each message.

To destroy the stream, enter the following at the shell prompt:

```
xd:> stream destroy --name rabbittest
```

RabbitMQ with Options

The RabbitMQ Source has the following options

username
: the username to connect to the RabbitMQ broker **(default: `guest`)**

password
: the password to connect to the RabbitMQ broker **(default: `guest`)**

host
: the host (or IP Address) to connect to **(default: `localhost`)**

port
: the port on the `host` **(default: `5672`)**

vhost
: the virtual host **(default: `/` unless)**

queues
: the queue(s) from which messages will be received; use a comma-delimited list to receive messages from multiple queues **(default: `<streamname>`)**

11.15 JMS

The "jms" source enables receiving messages from JMS.

The following example shows the default settings.

Configure a stream:

```
xd:> stream create --name jmstest --definition "jms | file" --deploy
```

This receives messages from a queue named `jmstest` and writes them to the default file sink (`/tmp/xd/output/jmstest`). It uses the default ActiveMQ broker running on localhost, port 61616.

To destroy the stream, enter the following at the shell prompt:

```
xd:> stream destroy --name jmstest
```

To test the above stream, you can use something like the following…

```
public class Broker {

 public static void main(String[] args) throws Exception {
  BrokerService broker = new BrokerService();
  broker.setBrokerName("broker");
  String brokerURL = "tcp://localhost:61616";
  broker.addConnector(brokerURL);
  broker.start();
  ConnectionFactory cf = new ActiveMQConnectionFactory(brokerURL);
  JmsTemplate template = new JmsTemplate(cf);
  while (System.in.read() >= 0) {
   template.convertAndSend("jmstest", "testFoo");
  }
 }
}
```

and `tail -f /tmp/xd/output/jmstest`

Run this as a Java application; each time you hit <enter> in the console, it will send a message to queue `jmstest`.

JMS with Options

The JMS Source has the following options

provider
: the JMS provider **(default: `activemq`)**

destination
: the destination name (a `queue` by default) from which messages will be received **(default: `[stream name]`)**

pubSub
: when true, indicates that the destination is a `topic` **(default: `false`)**

durableSubScription
: when true, indicates the subscription to a topic is durable **(default: `false`)**

subscriptionName
: a name that will be assigned to the topic subscription **(default: `[none]`)**

clientId
: an identifier for the client, to be associated with a durable topic subscription **(default: `[none]`)**

Note: the selected broker requires an infrastructure configuration file `jms-<provider>-infrastructure-context.xml` in `modules/common`. This is used to declare any infrastructure beans needed by the provider. See the default (`jms-activemq-infrastructure-context.xml`) for an example. Typically, all that is required is a `ConnectionFactory`. The activemq provider uses a properties file `jms-activemq.properties` which can be found in the `config` directory. This contains the broker URL.

11.16 Time

The time source will simply emit a String with the current time every so often. It supports the following options:

fixedDelay
: how often to emit a message, expressed in seconds **(default: `1` second)**

format
: how to render the current time, using SimpleDateFormat **(default: `'yyyy-MM-dd HH:mm:ss'`)**

11.17 MQTT

The mqtt source connects to an mqtt server and receives telemetry messages.

Configure a stream:

```
xd:> stream create tcptest --definition "mqtt --url='tcp://localhost:1883' --
topics='xd.mqtt.test' | log" --deploy
```

If you wish to use the MQTT Source defaults you can execute the command as follows:

```
xd:> stream create tcptest --definition "mqtt | log" --deploy
```

Options

The defaults are set up to connect to the RabbitMQ MQTT adapter on localhost:

url
: location of the mqtt broker **(default: `tcp://localhost:1883`)**

clientId
: identifies the client **(default: `xd.mqtt.client.id.snk`)**

username
: the username to use when connecting to the broker **(default: `guest`)**

password
: the password to use when connecting to the broker **(default: `guest`)**

topics
: the topic(s) to which the source will subscribe **(default: `xd.mqtt.test`)**

11.18 Stdout Capture

There isn't actually a source named "stdin" but it is easy to capture stdin by redirecting it to a `tcp` source. For example if you wanted to capture the output of a command, you would first create the `tcp` stream, as above, using the appropriate sink for your requirements:

```
xd:> stream create tcpforstdout --definition "tcp --decoder=LF | log" --deploy
```

You can then capture the output from commands using the `netcat` command:

```
$ cat mylog.txt | netcat localhost 1234
```

12. Processors

12.1 Introduction

This section will cover the processors available out-of-the-box with Spring XD. As a prerequisite, start the XD Container as instructed in the Getting Started page.

The Processors covered are

- Filter
- Transform
- Script
- Splitter
- Aggregator

See the section Creating a Processor Module for information on how to create custom processor modules.

12.2 Filter

Use the filter module in a stream to determine whether a Message should be passed to the output channel.

Filter with SpEL expression

The simplest way to use the filter processor is to pass a SpEL expression when creating the stream. The expression should evaluate the message and return true or false. For example:

```
xd:> stream create --name filtertest --definition "http | filter --
expression=payload=='good' | log" --deploy
```

This filter will only pass Messages to the log sink if the payload is the word "good". Try sending "good" to the HTTP endpoint and you should see it in the XD log:

```
xd:> http post --target http://localhost:9000 --data "good"
```

Alternatively, if you send the word "bad" (or anything else), you shouldn’t see the log entry.

Filter using jsonPath evaluation

As part of the SpEL expression you can make use of the pre-registered JSON Path function.

This filter example shows to pass messages to the output channel if they contain a specific JSON field matching a specific value.

```
xd:> stream create --name jsonfiltertest --definition "http --port=9002 | filter --
expression=#jsonPath(payload,'$.firstName').contains('John') | log" --deploy
```

Note: There is no space between payload JSON and the jsonPath in the expression

This filter will only pass Messages to the log sink if the JSON payload contains the *firstName* "John". Try sending this payload to the HTTP endpoint and you should see it in the XD log:

```
xd:> http post --target http://localhost:9002 --data "{\"firstName\":\"John\", \"lastName
\":\"Smith\"}"
```

Alternatively, if you send a different *firstName*, you shouldn't see the log entry.

Here is another example usage of filter

```
filter --expression=#jsonPath(payload,'$.entities.hashtags[*].text').contains('obama')
```

This is an example that is operating on a JSON payload of tweets as consumed from the twitter search module.

Filter with Groovy Script

For more complex filtering, you can pass the location of a Groovy script using the *script* attribute. If you want to pass variable values to your script, you can optionally pass the path to a properties file using the *properties-location* attribute. All properties in the file will be made available to the script as variables.

Note that an implicit variable named *payload* is available to give you access to the data contained in a message.

```
xd:> stream create --name groovyfiltertest --definition "http --port=9001 | filter --
script=custom-filter.groovy --properties-location=custom-filter.properties | log" --deploy
```

By default, Spring XD will search the classpath for *custom-filter.groovy* and *custom-filter.properties*. You can place the script in *${xd.home}/modules/processor/scripts* and the properties file in *${xd.home}/config* to make them available on the classpath. Alternatively, you can prefix the *script* and *properties-location* values with *file:* to load from the file system.

12.3 Transform

Use the transform module in a stream to convert a Message's content or structure.

Transform with SpEL expression

The simplest way to use the transform processor is to pass a SpEL expression when creating the stream. The expression should return the modified message or payload. For example:

```
xd:> stream create --name transformtest --definition "http --port=9003 | transform --
expression='FOO' | log" --deploy
```

This transform will convert all message payloads to the word "FOO". Try sending something to the HTTP endpoint and you should see "FOO" in the XD log:

```
xd:> http post --target http://localhost:9003 --data "some message"
```

As part of the SpEL expression you can make use of the pre-registered JSON Path function. The syntax is #jsonPath(payload,<*json path expression*>)

Transform with Groovy Script

For more complex transformations, you can pass the location of a Groovy script using the *script* attribute. If you want to pass variable values to your script, you can optionally pass the path to a properties file using the *properties-location* attribute. All properties in the file will be made available to the script as variables.

```
xd:> stream create --name groovytransformtest --definition "http --port=9004 | transform
 --script=custom-transform.groovy --properties-location=custom-transform.properties | log"
 --deploy
```

By default, Spring XD will search the classpath for *custom-transform.groovy* and *custom-transform.properties*. You can place the script in *${xd.home}/modules/processor/scripts* and the properties file in *${xd.home}/config* to make them available on the classpath. Alternatively, you can prefix the *script* and *properties-location* values with *file:* to load from the file system.

12.4 Script

The script processor contains a *Service Activator* that invokes a specified Groovy script. This is a slightly more generic way to accomplish processing logic, as the provided script may simply terminate the stream as well as transform or filter Messages.

To use the module, pass the location of a Groovy script using the *location* attribute. If you want to pass variable values to your script, you can optionally pass the path to a properties file using the *properties-location* attribute. All properties in the file will be made available to the script as variables.

```
xd:> stream create --name groovyprocessortest --definition "http --port=9006 | script --
location=custom-processor.groovy --properties-location=custom-processor.properties | log"
 --deploy
```

By default, Spring XD will search the classpath for *custom-processor.groovy* and *custom-processor.properties*. You can place the script in *${xd.home}/modules/processor/scripts* and the properties file in *${xd.home}/config* to make them available on the classpath. Alternatively, you can prefix the *location* and *properties-location* values with *file:* to load from the file system.

12.5 Splitter

The splitter module builds upon the concept of the same name in Spring Integration and allows the splitting of a single message into several distinct messages.

The splitter module accepts the following options:

expression
: a SpEL expression which should evaluate to an array or collection. Each element will then be emitted as a separate message **(default: `payload`, which actually does not split, unless the message is already a collection)**

As part of the SpEL expression you can make use of the pre-registered JSON Path function. The syntax is #jsonPath(payload,*<json path expression>*)

Extract the value of a specific field

This splitter converts a JSON message payload to the value of a specific JSON field.

```
xd:> stream create --name jsontransformtest --definition "http --port=9005 | splitter --
expression=#jsonPath(payload,'$.firstName') | log" --deploy
```

Try sending this payload to the HTTP endpoint and you should see just the value "John" in the XD log:

```
xd:> http post --target http://localhost:9005 --data "{\"firstName\":\"John\", \"lastName
\":\"Smith\"}"
```

Note: JSON fields should be separated by a comma without any spaces.

12.6 Aggregator

The aggregator module does the opposite of the splitter, and builds upon the concept of the same name found in Spring Integration. By default, it will consider all incoming messages from a stream to belong to the same group:

```
xd:> stream create --name aggregates --definition "http | aggregator --count=3 --
aggregation=T(org.springframework.util.StringUtils).collectionToDelimitedString(#this.!
[payload],' ') | log" --deploy
```

This uses a SpEL expression that will basically concatenate all payloads together, inserting a space character in between. As such,

```
xd:> http post --data Hello
xd:> http post --data World
xd:> http post --data !
```

would emit a single message whose contents is "Hello World !". This is because we set the aggregator release strategy to accumulate 3 messages.

The aggregator modules comes with many more options, as shown below:

correlation
: a SpEL expression to be evaluated against all incoming message and that should evaluate to the "key" used to group messages together **(default: `<streamname>`, which means that all messages from the same stream are actually considered correlated)**

release
: a SpEL expression to be evaluated against a group of messages accumulated so far (a collection) and that should return true when such a group is ready to be released. Using this overrides the *count* option. **(default: use the `'count'` approach)**

count
: the number of messages to group together before emitting a group **(default: `50`)**

aggregation
: a SpEL expression, to be evaluated against the list of accumulated messages. This should return what the new message will be made of. **(default: `#this.![payload]`, which uses the list of message payloads to form the new message)**

timeout
: the delay (in milliseconds) after which messages should be released and aggregated, even though the completion criteria was not met. Due to the way this is implemented (see MessageGroupStoreReaper in the Spring Integration documentation), the actual observed delay may vary between `timeout` and `2xtimeout`. **(default: `60000`, i.e. one minute)**

Additionally, the message store used to retain messages can be configured using the `store` option. Valid options are `memory` (the default), `redis` and `jdbc`.

- When using `redis`, additional options are available: `hostname`, `port` and `password` with defaults pointing to the default redis install on localhost.
- When using `jdbc`, one must configure the datasource access, using `driverClass`, `url`, `username` and `password` with no defaults. On first use, the database tables must be created. To that effect, one can use set the `initdb` option to `true`. The database kind should be auto-detected, but one can always provide `dbkind` to override.

13. Sinks

13.1 Introduction

In this section we will show some variations on output sinks. As a prerequisite start the XD Container as instructed in the Getting Started page.

The Sinks covered are

- Log
- File
- HDFS
- HDFS Dataset
- JDBC
- TCP
- Mail
- RabbitMQ
- GemFire Server
- Splunk Server
- MQTT
- Dynamic Router

See the section Creating a Sink Module for information on how to create sink modules using other Spring Integration Adapters.

13.2 Log

Probably the simplest option for a sink is just to log the data. The `log` sink uses the application logger to output the data for inspection. The log level is set to `WARN` and the logger name is created from the stream name. To create a stream using a `log` sink you would use a command like

```
xd:> stream create --name mylogstream --definition "http --port=8000 | log" --deploy
```

You can then try adding some data. We've used the `http` source on port 8000 here, so run the following command to send a message

```
xd:> http post --target http://localhost:8000 --data "hello"
```

and you should see the following output in the XD container console.

```
13/06/07 16:12:18 WARN logger.mylogstream: hello
```

The logger name is the sink name prefixed with the string "logger.". The sink name is the same as the stream name by default, but you can set it by passing the `--name` parameter

```
xd:> stream create --name myotherlogstream --definition "http --port=8001 | log --
name=mylogger" --deploy
```

13.3 File Sink

Another simple option is to stream data to a file on the host OS. This can be done using the `file` sink module to create a stream.

```
xd:> stream create --name myfilestream --definition "http --port=8000 | file" --deploy
```

We've used the `http` source again, so run the following command to send a message

```
xd:> http post --target http://localhost:8000 --data "hello"
```

The `file` sink uses the stream name as the default name for the file it creates, and places the file in the `/tmp/xd/output/` directory.

```
$ less /tmp/xd/output/myfilestream
hello
```

You can cutomize the behavior and specify the `name` and `dir` options of the output file. For example

```
xd:> stream create --name otherfilestream --definition "http --port=8000 | file --
name=myfile --dir=/some/custom/directory" --deploy
```

File with Options

The file sink, by default, will add a newline at the end of each line; the actual newline will depend on the operating system.

This can be disabled by using `--binary=true`.

13.4 Hadoop (HDFS)

If you do not have Hadoop installed, you can install Hadoop 1.2.1 as described in our separate guide. Spring XD supports 4 Hadoop distributions, see using Hadoop for more information on how to start Spring XD to target a specific distribution.

Once Hadoop is up and running, you can then use the `hdfs` sink when creating a stream

```
xd:> stream create --name myhdfsstream1 --definition "time | hdfs" --deploy
```

In the above example, we've scheduled `time` source to automatically send ticks to `hdfs` once in every second. If you wait a little while for data to accumuluate you can then list can then list the files in the hadoop filesystem using the shell's built in hadoop fs commands. Before making any access to HDFS in the shell you first need to configure the shell to point to your name node. This is done using the `hadoop config` command.

```
xd:>hadoop config fs --namenode hdfs://localhost:8020
```

In this example the hdfs protocol is used but you may also use the webhdfs protocol. Listing the contents in the output directory (named by default after the stream name) is done by issuing the following command.

```
xd:>hadoop fs ls /xd/myhdfsstream1
Found 1 items
-rw-r--r--   3 jvalkealahti supergroup          0 2013-12-18 18:10 /xd/myhdfsstream1/
myhdfsstream1-0.txt.tmp
```

While the file is being written to it will have the `tmp` suffix. When the data written exceeds the rollover size (default 1GB) it will be renamed to remove the `tmp` suffix. There are several options to control the in use file file naming options. These are `--inUsePrefix` and `--inUseSuffix` set the file name prefix and suffix respectfully.

When you destroy a stream

```
xd:>stream destroy --name myhdfsstream1
```

and list the stream directory again, in use file suffix doesn’t exist anymore.

```
xd:>hadoop fs ls /xd/myhdfsstream1
Found 1 items
-rw-r--r--   3 jvalkealahti supergroup        380 2013-12-18 18:10 /xd/myhdfsstream1/
myhdfsstream1-0.txt
```

To list the list the contents of a file directly from a shell execute the hadoop cat command.

```
xd:> hadoop fs cat /xd/myhdfsstream1/myhdfsstream1-0.txt
2013-12-18 18:10:07
2013-12-18 18:10:08
2013-12-18 18:10:09
...
```

In the above examples we didn’t yet go through why the file was written in a specific directory and why it was named in this specific way. Default location of a file is defined as `/xd/<stream name>/<stream name>-<rolling part>.txt`. These can be changed using options `--directory` and `--fileName` respectively. Example is shown below.

```
xd:>stream create --name myhdfsstream2 --definition "time | hdfs --directory=/xd/tmp --
fileName=data" --deploy
xd:>stream destroy --name myhdfsstream2
xd:>hadoop fs ls /xd/tmp
Found 1 items
-rw-r--r--   3 jvalkealahti supergroup        120 2013-12-18 18:31 /xd/tmp/data-0.txt
```

It is also possible to control the size of a files written into HDFS. The `--rollover` option can be used to control when file currently being written is rolled over and a new file opened by providing the rollover size in bytes, kilobytes, megatypes, gigabytes, and terabytes.

```
xd:>stream create --name myhdfsstream3 --definition "time | hdfs --rollover=100" --deploy
xd:>stream destroy --name myhdfsstream3
xd:>hadoop fs ls /xd/myhdfsstream3
Found 3 items
-rw-r--r--   3 jvalkealahti supergroup        100 2013-12-18 18:41 /xd/myhdfsstream3/
myhdfsstream3-0.txt
-rw-r--r--   3 jvalkealahti supergroup        100 2013-12-18 18:41 /xd/myhdfsstream3/
myhdfsstream3-1.txt
-rw-r--r--   3 jvalkealahti supergroup        100 2013-12-18 18:41 /xd/myhdfsstream3/
myhdfsstream3-2.txt
```

Shortcuts to specify sizes other than bytes are written as `--rollover=64M`, `--rollover=512G` or `--rollover=1T`.

The stream can also be compressed during the write operation. Example of this is shown below.

```
xd:>stream create --name myhdfsstream4 --definition "time | hdfs --codec=gzip" --deploy
xd:>stream destroy --name myhdfsstream4
xd:>hadoop fs ls /xd/myhdfsstream4
Found 1 items
-rw-r--r--   3 jvalkealahti supergroup         80 2013-12-18 18:48 /xd/myhdfsstream4/
myhdfsstream4-0.txt.gzip
```

From a native os shell we can use hadoop’s fs commands and pipe data into gunzip.

```
# bin/hadoop fs -cat /xd/myhdfsstream4/myhdfsstream4-0.txt.gzip | gunzip
2013-12-18 18:48:10
2013-12-18 18:48:11
...
```

Often a stream of data may not have a high enough rate to roll over files frequently, leaving the file in an opened state. This prevents users from reading a consistent set of data when running mapreduce jobs. While one can alleviate this problem by using a small rollover value, a better way is to use the `idleTimeout` option that will automatically close the file if there was no writes during the specified period of time. This feature is also useful in cases where burst of data is written into a stream and you’d like that data to become visible in HDFS.

```
xd:> stream create --name myhdfsstream5 --definition "http --port=8000 | hdfs --
rollover=20 --idleTimeout=10000" --deploy
```

In the above example we changed a source to `http` order to control what we write into a `hdfs` sink. We defined a small rollover size and a timeout of 10 seconds. Now we can simply post data into this stream via source end point using a below command.

```
xd:> http post --target http://localhost:8000 --data "hello"
```

If we repeat the command very quickly and then wait for the timeout we should be able to see that some files are closed before rollover size was met and some were simply rolled because of a rollover size.

```
xd:>hadoop fs ls /xd/myhdfsstream5
Found 4 items
-rw-r--r--   3 jvalkealahti supergroup         12 2013-12-18 19:02 /xd/myhdfsstream5/
myhdfsstream5-0.txt
-rw-r--r--   3 jvalkealahti supergroup         24 2013-12-18 19:03 /xd/myhdfsstream5/
myhdfsstream5-1.txt
-rw-r--r--   3 jvalkealahti supergroup         24 2013-12-18 19:03 /xd/myhdfsstream5/
myhdfsstream5-2.txt
-rw-r--r--   3 jvalkealahti supergroup         18 2013-12-18 19:03 /xd/myhdfsstream5/
myhdfsstream5-3.txt
```

HDFS with Options

The HDFS Sink has the following options:

directory
: Where to output the files in the Hadoop FileSystem **(default: `/xd/<streamname>`)**

fileName
: The base filename to use for the created files (a counter will be appended before the file extension). **(default: `<streamname>`)**

fileExtension
: The file extension to use **(default: `txt`)**

rollover
: When to roll files over, expressed in bytes. Option can also expressed with a pattern as, `1M`, `1G`, `512G`, `1T` **(default: `1G`)**

codec
: If compression is used for stream. Possible values are `gzip`, `snappy`, `bzip2`, `lzo`. **(default: no `compression`)**

idleTimeout
: Idle timeout in millis when Hadoop file resource is automatically closed. **(default: `0`, no timeout)**

inUseSuffix
: Temporary file suffix indicating that file is currently written and in use. **(default: `.tmp`)**

inUsePrefix
: Temporary file prefix indicating that file is currently written and in use. **(default: none)**

overwrite
: Flag indicating if file resources in Hadoop is allowed to be overwritten. **(default: `false`)**

13.5 HDFS Dataset (Avro/Parquet)

The HDFS Dataset sink is used to store Java classes that are sent as the payload on the stream. It uses the Kite SDK Data Module's Dataset implementation to store the payload data serialized in either Avro or Parquet format. The Avro schema is generated from the Java class that is persisted. For Parquet the Java object must follow JavaBean conventions with properties for any fields to be persisted. The fields can only be simple scalar values like Strings and numbers.

The HDFS Dataset sink requires that you have a Hadoop installation that is based on Hadoop v2 (Hadoop 2.2.0, Pivotal HD 1.0, Cloudera CDH4 or Hortonworks HDP 2.0), see using Hadoop for more information on how to start Spring XD to target a specific distribution.

Once Hadoop is up and running, you can then use the `hdfs-dataset` sink when creating a stream

```
xd:>stream create --name mydataset --definition "time | hdfs-dataset --batchSize=20" --
deploy
```

In the above example, we've scheduled `time` source to automatically send ticks to the `hdfs-dataset` sink once every second. The data will be stored in a directory named `/xd/<streamname>` by default, so in this example it will be `/xd/mydataset`. You can change this by supplying a `##directory` parameter. The Avro format is usd by default and the data files are stored in a sub-directory named after the payload Java class. In this example the stream payload is a String so the name of the data sub-directory is `string`. If you have multiple Java classes as payloads, each class will get its own sub-directory.

Let the stream run for a minute or so. You can then list the contents of the hadoop filesystem using the shell's built in hadoop fs commands. You will first need to configure the shell to point to your name node using the hadoop config command. We use the hdfs protocol is to access the hadoop name node.

```
xd:>hadoop config fs --namenode hdfs://localhost:8020
```

Then list the contents of the stream's data directory.

```
xd:>hadoop fs ls /xd/mydataset/string
Found 3 items
drwxr-xr-x   - trisberg supergroup          0 2013-12-19 12:23 /xd/mydataset/
string/.metadata
-rw-r--r--   3 trisberg supergroup        202 2013-12-19 12:23 /xd/mydataset/
string/1387473825754-63.avro
-rw-r--r--   3 trisberg supergroup        216 2013-12-19 12:24 /xd/mydataset/
string/1387473846708-80.avro
```

You can see that the sink has created two files containing the first two batches of 20 stream payloads each. There is also a `.metadata` directory created that contains the metadata that the Kite SDK Dataset implementation uses as well as the generated Avro schema for the persisted type.

```
xd:>hadoop fs ls /xd/mydataset/string/.metadata
Found 2 items
-rw-r--r--   3 trisberg supergroup        136 2013-12-19 12:23 /xd/mydataset/
string/.metadata/descriptor.properties
-rw-r--r--   3 trisberg supergroup          8 2013-12-19 12:23 /xd/mydataset/
string/.metadata/schema.avsc
```

Now destroy the stream.

```
xd:>stream destroy --name mydataset
```

HDFS Dataset with Options

The HDFS Dataset Sink has the following options:

batchSize
: The number of payload objects that will be stored in each write operation. **(default: `10000`)**

directory
: Where the files will be written in the Hadoop FileSystem **(default: `/xd/<streamname>`)**

idleTimeout
: Idle timeout in milliseconds for when the aggregated batch of payload objects will be written even if the batchSize has not been reached. **(default: `-1`, no timeout)**

allowNullValues
: Whether to allow null values in fields of the Java class to be written to the sink. If this is set to true then each field in the generated schema will use a union of *null* and the data type of the field. **(default: `true`)**

format
: The format to use when writing the dataset data. Options are `avro` and `parquet`. **(default: `avro`)**

13.6 JDBC

The JDBC sink can be used to insert message payload data into a relational database table. By default it inserts the entire payload into a table named after the stream name in the HSQLDB database that XD uses to store metadata for batch jobs. To alter this behavior, the jdbc sink accepts several options that you can pass using the `--foo=bar` notation in the stream, or change globally. There is also a *config/init_db.sql* file that contains the SQL statements used to initialize the database table. You can modify this file if you'd like to create a table with your specific layout when the sink starts. You should also change the *initializeDatabase* property to *true* to have this script execute when the sink starts up.

The payload data will be inserted as-is if the *names* option is set to *payload*. This is the default behavior. If you specify any other column names the payload data will be assumed to be a JSON document that will be converted to a hash map. This hash map will be used to populate the data values for the SQL insert statement. A matching of column names with underscores like *user_name* will match onto camel case style keys like *userName* in the hash map. There will be one insert statement executed for each message.

To create a stream using a `jdbc` sink relying on all defaults you would use a command like

```
xd:> stream create --name mydata --definition "time | jdbc --initializeDatabase=true" --
deploy
```

This will insert the time messages into a *payload* column in a table named *mydata*. Since the default is using the XD batch metadata HSQLDB database we can connect to this database instance from an external tool. After we let the stream run for a little while, we can connect to the database and look at the data stored in the database.

You can query the database with your favorite SQL tool using the following database URL: `jdbc:hsqldb:hsql://localhost:9101/xdjob` with sa as the user name and a blank password. You can also use the HSQL provided SQL Tool (download from HSQLDB) to run a quick query from the command line:

```
$ java -cp ~/Downloads/hsqldb-2.3.0/hsqldb/lib/sqltool.jar org.hsqldb.cmdline.SqlTool
 --inlineRc url=jdbc:hsqldb:hsql://localhost:9101/xdjob,user=sa,password= --sql "select
 payload from mydata;"
```

This should result in something similar to the following output:

```
2014-01-06 09:33:25
2014-01-06 09:33:26
2014-01-06 09:33:27
2014-01-06 09:33:28
2014-01-06 09:33:29
2014-01-06 09:33:30
2014-01-06 09:33:31
2014-01-06 09:33:32
2014-01-06 09:33:33
2014-01-06 09:33:34
2014-01-06 09:33:35
2014-01-06 09:33:36
2014-01-06 09:33:37
```

Now we can destroy the stream using:

```
xd:> stream destroy --name mydata
```

JDBC with Options

The JDBC Sink has the following options:

driverClassName
: the JDBC driver to use **(default: same as batch config)**

url
: the JDBC URL for the database **(default: same as batch config)**

username
: the JDBC usernmae **(default: same as batch config)**

password
: the JDBC password **(default: same as batch config)**

initializeDatabase
: whether to initialize the database using the initializer script **(default: `false`)**

initializerScript
: the file name for the script containing SQL statements used to initialize the database when the sink starts (will search `config/` directory for this file) **(default: `init_db.sql`)**

tableName
: the name of the table to insert payload data into **(default: `<streamname>`)**

names
: comma separated list of column names to include in the insert statement. Use *payload* to include the entire message payload into a payload column. **(default: `payload`)**

13.7 TCP Sink

The TCP Sink provides for outbound messaging over TCP.

The following examples use `netcat` (linux) to receive the data; the equivalent on Mac OSX is `nc`.

First, start a netcat to receive the data, and background it

```
$ netcat -l 1234 &
```

Now, configure a stream

```
xd:> stream create --name tcptest --definition "time --interval=3 | tcp" --deploy
```

This sends the time, every 3 seconds to the default tcp Sink, which connects to port `1234` on `localhost`.

```
$ Thu May 30 10:28:21 EDT 2013
Thu May 30 10:28:24 EDT 2013
Thu May 30 10:28:27 EDT 2013
Thu May 30 10:28:30 EDT 2013
Thu May 30 10:28:33 EDT 2013
```

TCP is a streaming protocol and some mechanism is needed to frame messages on the wire. A number of encoders are available, the default being *CRLF*.

Destroy the stream; netcat will terminate when the TCP Sink disconnects.

```
http://localhost:8080> stream destroy --name tcptest
```

TCP with Options

The TCP Sink has the following options

host
: the host (or IP Address) to connect to **(default: `localhost`)**

port
: the port on the `host` **(default `1234`)**

reverse-lookup
: perform a reverse DNS lookup on IP Addresses **(default: `false`)**

nio
: whether or not to use NIO **(default: `false`)**

encoder
: how to encode the stream - see below **(default: `CRLF`)**

close
: whether to close the socket after each message **(default: `false`)**

charset
: the charset used when converting text from `String` to bytes **(default: `UTF-8`)**

Retry Options

retry-max-attempts
: the maximum number of attempts to send the data **(default: `5` - original request and 4 retries)**

retry-initial-interval
: the time (ms) to wait for the first retry **(default: `2000`)**

retry-multiplier
: the multiplier for exponential back off of retries **(default: `2`)**

With the default retry configuration, the attempts will be made after 0, 2, 4, 8, and 16 seconds.

Available Encoders

Text Data

CRLF (default)
: text terminated by carriage return (0x0d) followed by line feed (0x0a)

LF
: text terminated by line feed (0x0a)

NULL
: text terminated by a null byte (0x00)

STXETX
: text preceded by an STX (0x02) and terminated by an ETX (0x03)

Text and Binary Data

RAW
: no structure - the client indicates a complete message by closing the socket

L1
: data preceded by a one byte (unsigned) length field (supports up to 255 bytes)

L2
: data preceded by a two byte (unsigned) length field (up to 2^{16}-1 bytes)

L4
: data preceded by a four byte (signed) length field (up to 2^{31}-1 bytes)

An Additional Example

Start netcat in the background and redirect the output to a file `foo`

```
$ netcat -l 1235 > foo &
```

Create the stream, using the `L4` encoder

```
xd:> stream create --name tcptest --definition "time --interval=3 | tcp --encoder=L4 --
port=1235" --deploy
```

Destroy the stream

```
http://localhost:8080> stream destroy --name tcptest
```

Check the output

```
$ hexdump -C foo
00000000  00 00 00 1c 54 68 75 20  4d 61 79 20 33 30 20 31  |....Thu May 30 1|
00000010  30 3a 34 37 3a 30 33 20  45 44 54 20 32 30 31 33  |0:47:03 EDT 2013|
00000020  00 00 00 1c 54 68 75 20  4d 61 79 20 33 30 20 31  |....Thu May 30 1|
00000030  30 3a 34 37 3a 30 36 20  45 44 54 20 32 30 31 33  |0:47:06 EDT 2013|
00000040  00 00 00 1c 54 68 75 20  4d 61 79 20 33 30 20 31  |....Thu May 30 1|
00000050  30 3a 34 37 3a 30 39 20  45 44 54 20 32 30 31 33  |0:47:09 EDT 2013|
```

Note the 4 byte length field preceding the data generated by the `L4` encoder.

13.8 Mail

The "mail" sink allows sending of messages as emails, leveraging Spring Integration mail-sending channel adapter. Please refer to Spring Integration documentation for the details, but in a nutshell, the sink is able to handle String, byte[] and MimeMessage messages out of the box.

Here is a simple example of how the mail module is used:

```
xd:> stream create mystream --definition "http | mail --to='"your.email@gmail.com"' --
host=your.imap.server --subject=payload+' world'" --deploy
```

Then,

```
xd:> http post --data Hello
```

You would then receive an email whose body contains "Hello" and whose subject is "Hellow world". Of special attention here is the way you need to escape strings for most of the parameters, because they're actually SpEL expressions (so here for example, we used a String literal for the `to` parameter).

The full list of options available to the mail module is below:

to
: The primary recipient(s) of the email. **(default: `null`, SpEL Expression)**

from
: The sender address of the email. **(default: `null`, SpEL Expression)**

subject
: The email subject. **(default: `null`, SpEL Expression)**

cc
: The recipient(s) that should receive a carbon copy. **(default: `null`, SpEL Expression)**

bcc
: The recipient(s) that should receive a blind carbon copy. **(default: `null`, SpEL Expression)**

replyTo
: The address that will become the recipient if the original recipient decides to "reply to" the email. **(default: `null`, SpEL Expression)**

contentType
: The content type to use when sending the email. **(default: `null`, SpEL Expression)**

host
: The hostname of the sending server to use. **(default: `localhost`)**

port
: The port of the sending server. **(default: `25`)**

username
: The username to use for authentication against the sending server. **(default: none)**

password
: The password to use for authentication against the sending server. **(default: none)**

13.9 RabbitMQ

The "rabbit" sink enables outbound messaging over RabbitMQ.

The following example shows the default settings.

Configure a stream:

```
xd:> stream create --name rabbittest --definition "time --interval=3 | rabbit" --deploy
```

This sends the time, every 3 seconds to the default (no-name) Exchange for a RabbitMQ broker running on localhost, port 5672.

The routing key will be the name of the stream by default; in this case: "rabbittest". Since the default Exchange is a direct-exchange to which all Queues are bound with the Queue name as the binding key, all messages sent via this sink will be passed to a Queue named "rabbittest", if one exists. We do not create that Queue automatically. However, you can easily create a Queue using the RabbitMQ web UI. Then, using that same UI, you can navigate to the "rabbittest" Queue and click the "Get Message(s)" button to pop messages off of that Queue (you can choose whether to requeue those messages).

To destroy the stream, enter the following at the shell prompt:

```
xd:> stream destroy --name rabbittest
```

RabbitMQ with Options

The RabbitMQ Sink has the following options

username
: the username to connect to the RabbitMQ broker **(default: `guest`)**

password
: the password to connect to the RabbitMQ broker **(default: `guest`)**

host
: the host (or IP Address) to connect to **(default: `localhost`)**

port
: the port on the `host` **(default: `5672`)**

vhost
: the virtual host **(default: `/`)**

exchange
: the Exchange on the RabbitMQ broker to which messages should be sent **(default: `` (empty: therefore, the default no-name Exchange))**

routingKey
: the routing key to be passed with the message. Note: If the routing key is not passed with the message and simply be a string literal (like the queue name), please make sure to specify it as SpEL literal. **(default: <streamname>)**

Also, if the routingKey is specified as string literal, the SpEL literal needs to be specified like this:

```
xd:> stream create rabbitSinkStream --definition "http | rabbit --routingKey='\"myqueue
\"'" --deploy
```

13.10 GemFire Server

Currently XD supports GemFire’s client-server topology. A sink that writes data to a GemFire cache requires at least one cache server to be running in a separate process and may also be configured to use a Locator. While Gemfire configuration is outside of the scope of this document, details are covered in the GemFire Product documentation. The XD distribution includes a standalone GemFire server executable suitable for development and test purposes and bootstrapped using a Spring configuration file provided as a command line argument. The GemFire jar is distributed freely under GemFire’s development license and is subject to the license’s terms and conditions. Sink modules provided with the XD distrubution that write data to GemFire create a client cache and client region. No data is cached on the client.

Launching the XD GemFire Server

To start the GemFire cache server GemFire Server included in the Spring XD distribution, go to the XD install directory:

```
$cd gemfire/bin
$./gemfire-server ../config/cq-demo.xml
```

The command line argument is the path of a Spring Data Gemfire configuration file with including a configured cache server and one or more regions. A sample cache configuration is provided cq-demo.xml located in the `config` directory. Note that Spring interprets the path as a relative path unless it is explicitly preceded by `file:`. The sample configuration starts a server on port 40404 and creates a region named *Stocks*.

Gemfire sinks

There are 2 implementation of the gemfire sink: *gemfire-server* and *gemfire-json-server*. They are identical except the latter converts JSON string payloads to a JSON document format proprietary to GemFire and provides JSON field access and query capabilities. If you are not using JSON, the gemfire-server module will write the payload using java serialization to the configured region. Either of these modules accepts the following attributes:

regionName
: the name of the GemFire region. This must be the name of a region configured for the cache server. This module creates the corresponding client region. **(default: `<streamname>`)**

keyExpression
: A SpEL expression which is evaluated to create a cache key. Typically, the key value is derived from the payload. **(default: `<streamname>`**, which will overwrite the same entry for every message received on the stream)

host
: The host name or IP address of the cache server or locator **(default: `localhost`)**

port
: The TCP port number of the cache server or locator **(default: `40404`)**

useLocator
: A boolean flag indicating that the above host and port refer to a locator **(default: `false`)**

Note

The locator option is mostly intended for integration with an existing GemFire installation in which the cache servers are configured to use locators in accordance with best practice. While GemFire supports configuration of multiple locators for failover, this is currently not supported in XD. However, using a single virtual IP backed by hardware routers for failover has proven to be an effective and simpler alternative.

Example

Suppose we have a JSON document containing a stock price:

```
{"symbol":"FAKE", "price":73}
```

We want this to be cached using the stock symbol as the key. The stream definition is:

```
http | gemfire-json-server --regionName=Stocks --keyExpression=payload.getField('symbol')
```

The keyExpression is a SpEL expression that depends on the payload type. In this case, *com.gemstone.org.json.JSONObject. JSONObject* which provides the *getField* method. To run this example:

```
xd:> stream create --name stocks --definition "http --port=9090 | gemfire-json-server --
regionName=Stocks --keyExpression=payload.getField('symbol')"
```

```
xd:> http post --target http://localhost:9090 --data {"symbol":"FAKE","price":73}
```

This will write an entry to the GemFire *Stocks* region with the key *FAKE*. Please do not put spaces when separating the JSON key-value pairs, only a comma.

You should see a message on STDOUT for the process running the GemFire server like:

```
INFO [LoggingCacheListener] - updated entry FAKE
```

13.11 Splunk Server

A Splunk sink that writes data to a TCP Data Input type for Splunk.

Splunk sinks

The Splunk sink converts an object payload to a string using the object's toString method and then converts this to a SplunkEvent that is sent via TCP to Splunk. The module accepts the following attributes:

host	The host name or IP address of the Splunk server **(default: `localhost`)**
port	The TCP port number of the Splunk Server **(default: `8089`)**
username	The login name that has rights to send data to the tcp-port **(default: `admin`)**
password	The password associated with the username **(default: `password`)**
owner	The owner of the tcp-port **(default: `admin1`)**
tcp-port	The TCP port number to where XD will send the data **(default: `9500`)**

Setup Splunk for TCP Input

1. From the Manager page select `Manage Inputs` link
2. Click the `Add data` Button
3. Click the `From a TCP port` link
4. `TCP Port` enter the port you want Splunk to monitor

5. `Set Source Type` select `Manual`

6. `Source Type` enter `tcp-raw`

7. Click `Save`

Example

An example stream would be to take data from a twitter search and push it through to a splunk instance.

```
xd:> stream create --name springone2gx --definition "twittersearch --consumerKey= --
consumerSecret= --query='#LOTR' | splunk" --deploy
```

13.12 MQTT Sink

The mqtt sink connects to an mqtt server and publishes telemetry messages.

Options

The defaults are set up to connect to the RabbitMQ MQTT adapter on localhost:

url
: location of the mqtt broker **(default: `tcp://localhost:1883`)**

clientId
: identifies the client **(default: `xd.mqtt.client.id.snk`)**

username
: the username to use when connecting to the broker **(default: `guest`)**

password
: the password to use when connecting to the broker **(default: `guest`)**

topic
: the topic to which the sink will publish **(default: `xd.mqtt.test`)**

qos
: the Quality of Service **(default: `1`)**

retained
: whether the retained flag is set **(default: `false`)**

13.13 Dynamic Router

The Dynamic Router support allows for routing Spring XD messages to **named channels** based on the evaluation of SpEL expressions or Groovy Scripts.

SpEL-based Routing

In the following example, 2 streams are created that listen for message on the **foo** and the **bar** channel. Furthermore, we create a stream that receives messages via HTTP and then delegates the received messages to a router:

```
xd:>stream create f --definition "queue:foo > transform --expression=payload+'-foo' | log"
 --deploy
Created new stream 'f'

xd:>stream create b --definition "queue:bar > transform --expression=payload+'-bar' | log"
 --deploy
Created new stream 'b'

xd:>stream create r --definition "http | router --
expression=payload.contains('a')?'queue:foo':'queue:bar'" --deploy
Created new stream 'r'
```

Now we make 2 requests to the HTTP source:

```
xd:>http post --data "a"
> POST (text/plain;Charset=UTF-8) http://localhost:9000 a
> 200 OK

xd:>http post --data "b"
> POST (text/plain;Charset=UTF-8) http://localhost:9000 b
> 200 OK
```

In the server log you should see the following output:

```
11:54:19,868  WARN ThreadPoolTaskScheduler-1 logger.f:145 - a-foo
11:54:25,669  WARN ThreadPoolTaskScheduler-1 logger.b:145 - b-bar
```

For more information, please also consult the Spring Integration Reference manual: http://static.springsource.org/spring-integration/reference/html/messaging-routing-chapter.html#router-namespace particularly the section "Routers and the Spring Expression Language (SpEL)".

Groovy-based Routing

Instead of SpEL expressions, Groovy scripts can also be used. Let's create a Groovy script in the file system at "/my/path/router.groovy"

```
println("Groovy processing payload '" + payload +"'");
if (payload.contains('a')) {
 return ":foo"
}
else {
 return ":bar"
}
```

Now we create the following streams:

```
xd:>stream create f --definition ":foo > transform --expression=payload+'-foo' | log" --
deploy
Created new stream 'f'

xd:>stream create b --definition ":bar > transform --expression=payload+'-bar' | log" --
deploy
Created new stream 'b'

xd:>stream create g --definition "http | router --script='file:/my/path/router.groovy'" --
deploy
```

Now post some data to the HTTP source:

```
xd:>http post --data "a"
> POST (text/plain;Charset=UTF-8) http://localhost:9000 a
> 200 OK

xd:>http post --data "b"
> POST (text/plain;Charset=UTF-8) http://localhost:9000 b
> 200 OK
```

In the server log you should see the following output:

```
Groovy processing payload 'a'
11:29:27,274  WARN ThreadPoolTaskScheduler-1 logger.f:145 - a-foo
Groovy processing payload 'b'
11:34:09,797  WARN ThreadPoolTaskScheduler-1 logger.b:145 - b-bar
```

Note

You can also use Groovy scripts located on your classpath by specifying:

```
--script='org/my/package/router.groovy'
```

For more information, please also consult the Spring Integration Reference manual: "Groovy support" http://static.springsource.org/spring-integration/reference/html/messaging-endpoints-chapter.html#groovy

Options

expression
: The SpEL expression to use for routing

script
: Indicates that Groovy Script based routing is used. If this property is set, then the "Expression" attribute will be ignored. The groovy script is checked for updates every 60 seconds. The script can be loaded from the classpath or from the file system e.g. "--script=*org/springframework/springxd/samples/batch/router.groovy*" or "--script=*file:/my/path/router.groovy*"

properties-location
: Will be made available as script variables for Groovy Script based routing. Will only be evaluated once at initialization time. By default the following script variables will be made available: "payload" and "headers".

14. Taps

14.1 Introduction

A Tap allows you to "listen" to data while it is processed in an existing stream and process the data in a separate stream. The original stream is unaffected by the tap and isn't aware of its presence, similar to a phone wiretap. (WireTap is included in the standard catalog of EAI patterns and implemented in the Spring Integration EAI framework used by Spring XD).

Simply put, a Tap is a stream that uses a point in another stream as a source.

Example

The following XD shell commands create a stream `foo1` and a tap named `foo1tap`:

```
xd:> stream create --name foo1 --definition "time | log" --deploy
xd:> stream create --name foo1tap --definition "tap:stream:foo1 > log" --deploy
```

Since a tap is a type of stream, use the `stream create` command to create the tap. The tap source is specified using the named channel syntax and always begins with `tap:`. In this case, we are tapping the stream named `foo1` specified by `:stream:foo1`

Note

`stream:` is required in this case as it is possible to tap alternate XD targets such as jobs. This tap consumes data at the source of the target stream.

A tap can consume data from any point along the target stream's processing pipeline. XD provides a few ways to tap a stream after a given processor has been applied:

Example - tap after a processor has been applied

If the module name is unique in the target stream, use tap:stream:<stream_name>.<module_name>

If you have a stream called `mystream`, defined as

```
http | filter --expression=payload.startsWith('A') | transform --
expression=payload.toLowerCase() | file
```

Create a tap after the filter is applied using

```
tap:stream:mystream.filter > ....
```

Example - using the module index

If the module name is repeated in the target stream, use tap:stream:<stream_name>.<module_name>.<module_index> .

If you have a stream called `mystream`, defined as

```
http | transform --expression=payload.toLowerCase() | transform --expression=payload+'!' |
 file
```

Create a tap after the first transformer is applied using

```
tap:stream:mystream.transform.1 > ....
```

Note

the `module index` is the position of the module in the stream, starting with 0. It is also valid to tap the source using this syntax, e.g., tap:stream:mystream.http.0

Example - using a label

You may also use labels to create an alias for a module and reference the label in the tap

If you have a stream called `mystream`, defined as

```
http | transform --expression=payload.toLowerCase() | flibble: transform --
expression=payload.reverse() | file
```

Create a tap after the second transformer is applied using

```
tap:stream:mystream.flibble > ....
```

A primary use case for a Tap is to perform realtime analytics at the same time as data is being ingested via its primary stream. For example, consider a Stream of data that is consuming Twitter search results and writing them to HDFS. A tap can be created before the data is written to HDFS, and the data piped from the tap to a counter that correspond to the number of times specific hashtags were mentioned in the tweets.

Creating a tap on a named channel, a stream whose source is a named channel, or a label is not yet supported. This is planned for a future release.

You'll find specific examples of creating taps on existing streams in the Analytics section.

14.2 Tap Lifecycle

A side effect of a stream being unaware of any taps on its pipeline is that deleting the stream will not automatically delete the taps. The taps have to be deleted separately. However if the tapped stream is re-created, the existing tap will continue to function.

15. Type Conversion

15.1 Introduction

XD allows you to declaratively configure type conversion within processing streams using *inputType* and *outputType* parameters on module definitions. Note that general type conversion may be accomplished easily within a transformer or a custom module. Currently, XD natively supports the following type conversions commonly used in streams:

- **JSON** to/from **POJO**
- **JSON** to/from org.springframework.xd.tuple.Tuple
- **Object** to/from **byte[]** : Either the raw bytes serialized for remote transport, bytes emitted by a module, or converted to bytes using Java serialization(requires the object to be Serializable)
- **String** to/from **byte[]**
- **Object** to **plain text** (invokes the object's *toString()* method)

Where *JSON* represents JSON content. Currently, Objects may be unmarshalled from a JSON byte array or String. Converting to JSON produces a String. Registration of custom type converters will likely be supported in a future release.

15.2 MIME media types

inputType and *outputType* values are parsed as media types, e.g., *application/json* or *text/plain;charset=UTF-8*. Media types are especially useful for indicating how to convert to String or byte[] content. XD also uses standard media type format to represent Java types, using the general type *application/x-java-object* with a *type* parameter. For example, *application/x-java-object;type=java.util.Map* or *application/x-java-object;type=com.bar.Foo* . For convenience, you can specify the class name by itself and XD will map it to the corresponding media type. In addition, XD provides a namespace for internal types, notably, *application/x-xd-tuple* to specify a Tuple.

Stream Definition examples

```
twittersearch --query='#springone2gx' --outputType=application/json |  file
```

The *twittersearch* module produces Tweet objects. Producing a domain object is useful in many cases, however writing a Tweet directly to a file would produce something like:

org.springframework.social.twitter.api.Tweet@6e878e7c

Arguably, this output is not as useful as the JSON representation. Setting the outputType to application/json causes XD to convert the default type to a JSON string before piping it to the next module. This is almost equivalent to:

```
twittersearch --query='#springone2gx' | file --inputType=application/json
```

There are some technical differences: In the first case, the transformation is done before the object is marshalled (serialized) for remote transport. In the second case, the transformation follows unmarshalling. Perhaps a more significant difference is that a tap created on the file sink would consume JSON in the first case, and Tweets in the second.

```
twittersearch --query='#springone2gx' --outputType=application/json |  transform --
inputType=application/x-xd-tuple ...
```

The above example illustrates a combination of outputType and inputType conversion. the Tweet is converted to a JSON string which is then converted to a Tuple. XD does not know how to convert an arbitrary type to a Tuple, but it can write an object to JSON and read JSON into a Tuple, so we have effectively performed an Object to Tuple conversion. In many cases, combining conversion this way is not necessary, and care must be taken since XD does not validate that such combinations are possible.

The following serializes a java.io.Serializable object to a file. Presumably the *foo* module outputs a Serializable type. If not, this will result in an exception. If remote transport is configured, the output of *foo* will be marshalled using XD's internal serialization mechanism. The object will be reconstituted in the *file* module's local JVM and then converted to a byte array using Java serialization.

```
foo  | --inputType=application/x-java-serialized-object file
```

15.3 Media types and Java types

Internally, XD implements type conversion using Spring Integration's datatype channels. The data type channel converts payloads to the configured datatype using Spring's MessageConverter.

Note

The use of *MessageCoverter* for data type channels was introduced in Spring Integration 4 to pass the Message to the converter method to allow it to access the Message's *content-type* header. This provides greater flexibility. For example, it is now possible to support multiple strategies for converting a String or byte array to a POJO, depending on the content-type header.

When XD processes a module with a declared type conversion, it modifies the module's input and/or output channel definition to set the required Java type and registers MessageConverters associated with the target media type and Java type to the channel. The type conversions XD provides out of the box are summarized in the following table:

Source Payload	Target Payload	content-type header	outputType/ inputType	Comments	
POJO	JSON String	ignored	application/ json		
Tuple	JSON String	ignored	application/ json	JSON is tailored for Tuple	
POJO	String (toString())	ignored	text/plain, java.lang.String		
POJO	byte[] (java.io serialized)	ignored	application/ x-java- serialized- object		
JSON byte[] or String	POJO	application/ json (or none)	application/x- java-object		

Source Payload	Target Payload	content-type header	outputType/ inputType	Comments	
byte[] or String	Serializable	application/ x-java-serialized-object	application/x-java-object		
JSON byte[] or String	Tuple	application/ json (or none)	application/x-xd-tuple		
byte[]	String	any	text/plain, java.lang.String	will apply any Charset specified in the content-type header	
String	byte[]	any	application/ octet-stream	will apply any Charset specified in the content-type header	

Caveats

Note that that inputType and outputType parameters only apply to payloads that require type conversion. For example, if a module produces an XML string and outputType=application/json, the payload will not be converted from XML to JSON. This is because the payload at the module's output channel is already a String so no conversion will be applied at runtime.

16. Batch Jobs

16.1 Introduction

One of the features that XD offers is the ability to launch and monitor batch jobs based on Spring Batch. The Spring Batch project was started in 2007 as a collaboration between SpringSource and Accenture to provide a comprehensive framework to support the development of robust batch applications. Batch jobs have their own set of best practices and domain concepts which have been incorporated into Spring Batch building upon Accenture's consulting business. Since then Spring Batch has been used in thousands of enterprise applications and is the basis for the recent JSR standardization of batch processing, JSR-352.

Spring XD builds upon Spring Batch to simplify creating batch workflow solutions that span traditional use-cases such as moving data between flat files and relational databases as well as Hadoop use-cases where analysis logic is broken up into several steps that run on a Hadoop cluster. Steps specific to Hadoop in a workflow can be MapReduce jobs, executing Hive/Pig scripts or HDFS operations.

16.2 Workflow

The concept of a workflow translates to a Job, not to be confused with a MapReduce job. A Job is a directed graph, each node of the graph is a processing Step. Steps can be executed sequentially or in parallel, depending on the configuration. Jobs can be started, stopped, and restarted. Restarting jobs is possible since the progress of executed steps in a Job is persisted in a database via a JobRepository. The following figures shows the basic components of a workflow.

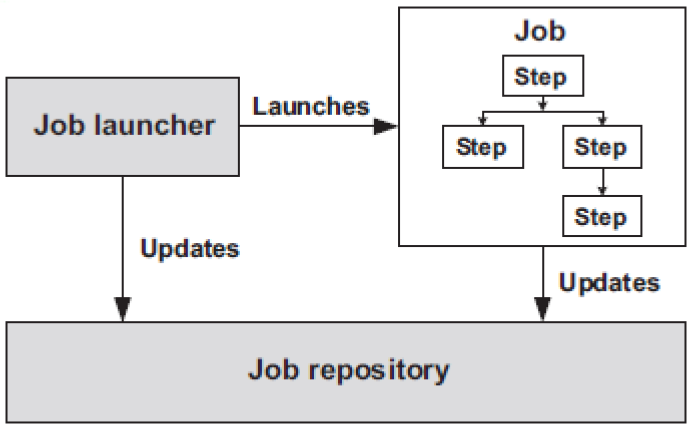


Figure 16.1.

A Job that has steps specific to Hadoop is shown below.

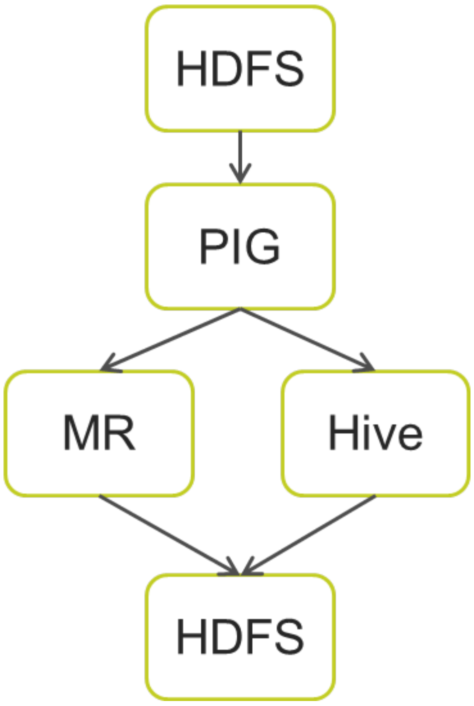


Figure 16.2.

A JobLauncher is responsible for starting a job and is often triggered via a scheduler. Other options to launch a job are through Spring XD's RESTful administration API, the XD web application, or in response to an external event from and XD stream definition, *e.g.* file polling using the file source.

16.3 Features

Spring XD allows you to create and launch jobs. The launching of a job can be triggered using a cron expression or in reaction to data on a stream. When jobs are executing, they are also a souce of event data that can be subscribed to by a stream. There are several type of events sent during a job's execution, the most common being the status of the job and the steps taken within the job. This bi-direction communication between stream processing and batch processing allows for more complex chains of processing to be developed.

As a starting point, jobs for the following cases are provided to use out of the box

- Poll a Directory and import CSV files to HDFS
- Import CSV files to JDBC
- HDFS to JDBC Export
- JDBC to HDFS Import
- HDFS to MongoDB Export

These are described in the section below.

This purpose of this section is to show you how to create, schedule and monitor a job.

16.4 Developing your Job

The Jobs definitions provided as part of the Spring XD distribution as well as those included in the Spring XD Samples repository can be used a basis for building your own custom Jobs. The development of a Job largely follows the development of a Spring Batch job, for which there are several references.

- Spring Batch home page
- Spring Batch In Action - Manning
- Pro Spring Batch - APress

For help developing Job steps specific to Hadoop, e.g. HDFS, Pig, Hive, the Spring XD Samples is useful as well as the following resources

- Spring for Apache Hadoop home page
- Spring Data - O'Reilly - Chapter 13

Once your Jobs have been developed and unit tested, they are integrated into Spring XD by copying the resulting .jar file and Job XML definition to $XD_HOME/lib and $XD_HOME/modules/jobs.

16.5 Creating a Job

To describe the creation of a job we will use the job definition that is part of the batch-simple example.

To create a job in the XD shell, execute the job create command composed of:

- name - the "name" that will be associated with the Job
- definition - the name of the context file that describes the tasklet.

So using our example above where we have a myjob.xml job definition file in the $XD_HOME/modules/jobs directory, this will look like:

```
xd:> job create --name helloSpringXD --definition "myjob" --deploy
```

Note: by default, deploy is set to *false*. "--deploy" or "--deploy true" will deploy the job along with job creation.

In the logging output of the XDContainer you should see the following:

```
14:17:46,793  INFO http-bio-8080-exec-5 job.JobPlugin:87 - Configuring module
 with the following properties: {numberFormat=, dateFormat=, makeUnique=true,
 xd.job.name=helloSpringXD}
14:17:46,837  INFO http-bio-8080-exec-5 module.SimpleModule:140 - initialized module:
 SimpleModule [name=myjob, type=job, group=helloSpringXD, index=0]
14:17:46,840  INFO http-bio-8080-exec-5 module.SimpleModule:154 - started module:
 SimpleModule [name=job, type=job, group=helloSpringXD, index=0]
14:17:46,840  INFO http-bio-8080-exec-5 module.ModuleDeployer:152 - launched job module:
 helloSpringXD:myjob:0
```

Creating Jobs - Additional Options

When creating jobs, the following options are available to all job definitions:

dateFormat
: The optional date format for job parameters **(default: `yyyy/MM/dd`)**

numberFormat
: Defines the number format when parsing numeric parameters **(default: `NumberFormat.getInstance(Locale.US)`)**

makeUnique
: Shall job parameters be made unique? **(default: `true`)**

Also, similar to the `stream create` command, the `job create` command has an optional `--deploy` option to create the job definition and deploy it. `--deploy` option is false by default.

Below is an example of some of these options combined:

```
job create myjob --definition "fooJob --makeUnique=false"
```

Remember that you can always find out about available options for a job by using the `module info` command.

16.6 Launching a job

XD uses triggers as well as regular event flow to launch the batch jobs. So in this section we will cover how to:

- Launch the Batch Job Ad-hoc
- Launch the Batch Job using a named Cron-Trigger
- Launch the Batch Job as sink.

Ad-hoc

To launch a job one time, use the launch option of the job command. So going back to our example above, we've created a job module instance named helloSpringXD. Launching that Job Module Instance would look like:

```
xd:> job launch helloSpringXD
```

In the logging output of the XDContainer you should see the following

```
16:45:40,127  INFO http-bio-9393-exec-1 job.JobPlugin:98 - Configuring module with the
 following properties: {numberFormat=, dateFormat=, makeUnique=true, xd.job.name=myjob}
16:45:40,185  INFO http-bio-9393-exec-1 module.SimpleModule:140 - initialized module:
 SimpleModule [name=job, type=job, group=myjob, index=0 @3a9ecb9d]
16:45:40,198  INFO http-bio-9393-exec-1 module.SimpleModule:161 - started module:
 SimpleModule [name=job, type=job, group=myjob, index=0 @3a9ecb9d]
16:45:40,199  INFO http-bio-9393-exec-1 module.ModuleDeployer:161 - deployed SimpleModule
 [name=job, type=job, group=myjob, index=0 @3a9ecb9d]
Hello Spring XD!
```

To re-launch the job just execute the launch command. For example:

```
xd:> job launch helloSpringXD
```

Launch the Batch using Cron-Trigger

To launch a batch job based on a cron scheduler is done by creating a stream using the trigger source.

```
xd:> stream create --name cronStream --definition "trigger --cron='0/5 * * * * *'  >
 queue:job:myCronJob" --deploy
```

A batch job can receive parameters from a source (in this case a trigger) or process. A trigger uses the --payload expression to declare its payload.

```
xd:> stream create --name cronStream --definition "trigger --cron='0/5 * * * * *'  --
payload={\"param1\":\"Kenny\"} > queue:job:myCronJob" --deploy
```

Note

The payload content must be in a JSON-based map representation.

To pause/stop future scheduled jobs from running for this stream, the stream must be undeployed for example:

```
xd:> stream undeploy --name cronStream
```

Launch the Batch using a Fixed-Delay-Trigger

A fixed-delay-trigger is used to launch a Job on a regular interval. Using the --fixedDelay parameter you can set up the number of seconds between executions. In the example below we are running myXDJob every 10 seconds and passing it a payload containing a single attribute.

```
xd:> stream create --name fdStream --definition "trigger --payload={\"param1\":
\"fixedDelayKenny\"} --fixedDelay=5 > queue:job:myXDJob" --deploy
```

To pause/stop future scheduled jobs from running for this stream, you must undeploy the stream for example:

```
xd:> stream undeploy --name cronStream
```

Launch job as a part of event flow

A batch job is always used as a sink, with that being said it can receive messages from sources (other than triggers) and processors. In the case below we see that the user has created an http source (http source receives http posts and passes the payload of the http message to the next module in the stream) that will pass the http payload to the "myHttpJob".

```
 stream create --name jobStream --definition "http > queue:job:myHttpJob" --deploy
```

To test the stream you can execute a http post, like the following:

```
xd:> http post --target http://localhost:9000 --data "{\"param1\":\"fixedDelayKenny\"}"
```

16.7 Retrieve job notifications

Spring XD offers the facilities to capture the notifications that are sent from the job as it is executing. When a batch job is deployed, by default it registers the following listeners along with pub/sub channels that these listeners send messages to.

- Job Execution Listener
- Chunk Listener
- Item Listener
- Step Execution Listener
- Skip Listener

Along with the pub/sub channels for each of these listeners, there will also be a pub/sub channel that the aggregated events from all these listeners are published to.

In the following example, we setup a Batch Job called *myHttpJob*. Afterwards we create a stream that will tap into the pub/sub channels that were implicitly generated when the *myHttpJob* job was deployed.

To receive aggregated events

The stream receives aggregated event messages from all the default batch job listeners and sends those messages to the log.

```
xd>job create --name myHttpJob --definition "httpJob" --deploy
xd>stream create --name aggregatedEvents --definition "tap:job:myHttpJob >log" --deploy
xd>job launch myHttpJob
```

Note: The syntax for the tap that receives the aggregated events is: `tap:job:<job-name>`

In the logging output of the container you should see something like the following when the job completes (with the aggregated events

```
09:55:53,532  WARN SimpleAsyncTaskExecutor-1 logger.aggregatedEvents:150
 - JobExecution: id=2, version=1, startTime=Sat Apr 12 09:55:53 PDT 2014,
 endTime=null, lastUpdated=Sat Apr 12 09:55:53 PDT 2014, status=STARTED,
 exitStatus=exitCode=UNKNOWN;exitDescription=, job=[JobInstance: id=2, version=0,
 Job=[myHttpJob]], jobParameters=[{random=0.07002785662707867}]
09:55:53,554  WARN SimpleAsyncTaskExecutor-1 logger.aggregatedEvents:150 - StepExecution:
 id=2, version=1, name=step1, status=STARTED, exitStatus=EXECUTING, readCount=0,
 filterCount=0, writeCount=0 readSkipCount=0, writeSkipCount=0, processSkipCount=0,
 commitCount=0, rollbackCount=0, exitDescription=
09:55:53,561  WARN SimpleAsyncTaskExecutor-1 logger.aggregatedEvents:150 -
 XdChunkContextInfo [complete=false, stepExecution=StepExecution: id=2, version=1,
 name=step1, status=STARTED, exitStatus=EXECUTING, readCount=0, filterCount=0,
 writeCount=0 readSkipCount=0, writeSkipCount=0, processSkipCount=0, commitCount=0,
 rollbackCount=0, exitDescription=, attributes={}]
09:55:53,567  WARN SimpleAsyncTaskExecutor-1 logger.aggregatedEvents:150 -
 XdChunkContextInfo [complete=false, stepExecution=StepExecution: id=2, version=2,
 name=step1, status=STARTED, exitStatus=EXECUTING, readCount=0, filterCount=0,
 writeCount=0 readSkipCount=0, writeSkipCount=0, processSkipCount=0, commitCount=1,
 rollbackCount=0, exitDescription=, attributes={}]
09:55:53,573  WARN SimpleAsyncTaskExecutor-1 logger.aggregatedEvents:150 - StepExecution:
 id=2, version=2, name=step1, status=COMPLETED, exitStatus=COMPLETED, readCount=0,
 filterCount=0, writeCount=0 readSkipCount=0, writeSkipCount=0, processSkipCount=0,
 commitCount=1, rollbackCount=0, exitDescription=
09:55:53,580  WARN SimpleAsyncTaskExecutor-1 logger.aggregatedEvents:150 - JobExecution:
 id=2, version=1, startTime=Sat Apr 12 09:55:53 PDT 2014, endTime=Sat Apr 12
 09:55:53 PDT 2014, lastUpdated=Sat Apr 12 09:55:53 PDT 2014, status=COMPLETED,
 exitStatus=exitCode=COMPLETED;exitDescription=, job=[JobInstance: id=2, version=0,
 Job=[myHttpJob]], jobParameters=[{random=0.07002785662707867}]
```

To receive job execution events

```
xd>job create --name myHttpJob --definition "httpJob" --deploy
xd>stream create --name jobExecutionEvents --definition "tap:job:myHttpJob.job >log" --
deploy
xd>job launch myHttpJob
```

Note: The syntax for the tap that receives the job execution events is: `tap:job:<job-name>.job`

In the logging output of the container you should see something like the following when the job completes

```
10:06:41,579  WARN SimpleAsyncTaskExecutor-1 logger.jobExecutionEvents:150
 - JobExecution: id=3, version=1, startTime=Sat Apr 12 10:06:41 PDT 2014,
 endTime=null, lastUpdated=Sat Apr 12 10:06:41 PDT 2014, status=STARTED,
 exitStatus=exitCode=UNKNOWN;exitDescription=, job=[JobInstance: id=3, version=0,
 Job=[myHttpJob]], jobParameters=[{random=0.3774227747555795}]
10:06:41,626  INFO SimpleAsyncTaskExecutor-1 support.SimpleJobLauncher:136
 - Job: [FlowJob: [name=myHttpJob]] completed with the following parameters:
 [{random=0.3774227747555795}] and the following status: [COMPLETED]
10:06:41,626  WARN SimpleAsyncTaskExecutor-1 logger.jobExecutionEvents:150 -
 JobExecution: id=3, version=1, startTime=Sat Apr 12 10:06:41 PDT 2014, endTime=Sat
 Apr 12 10:06:41 PDT 2014, lastUpdated=Sat Apr 12 10:06:41 PDT 2014, status=COMPLETED,
 exitStatus=exitCode=COMPLETED;exitDescription=, job=[JobInstance: id=3, version=0,
 Job=[myHttpJob]], jobParameters=[{random=0.3774227747555795}]
```

To receive step execution events

```
xd>job create --name myHttpJob --definition "httpJob" --deploy
xd>stream create --name stepExecutionEvents --definition "tap:job:myHttpJob.step >log" --
deploy
xd>job launch myHttpJob
```

Note: The syntax for the tap that receives the step execution events is: `tap:job:<job-name>.step`

In the logging output of the container you should see something like the following when the job completes

```

10:13:16,072  WARN SimpleAsyncTaskExecutor-1 logger.stepExecutionEvents:150 -
 StepExecution: id=6, version=1, name=step1, status=STARTED, exitStatus=EXECUTING,
 readCount=0, filterCount=0, writeCount=0 readSkipCount=0, writeSkipCount=0,
 processSkipCount=0, commitCount=0, rollbackCount=0, exitDescription=
10:13:16,092  WARN SimpleAsyncTaskExecutor-1 logger.stepExecutionEvents:150 -
 StepExecution: id=6, version=2, name=step1, status=COMPLETED, exitStatus=COMPLETED,
 readCount=0, filterCount=0, writeCount=0 readSkipCount=0, writeSkipCount=0,
 processSkipCount=0, commitCount=1, rollbackCount=0, exitDescription=
```

To receive item, skip and chunk events

```
xd>job create --name myHttpJob --definition "httpJob" --deploy

xd>stream create --name itemEvents --definition "tap:job:myHttpJob.item >log" --deploy
xd>stream create --name skipEvents --definition "tap:job:myHttpJob.skip >log" --deploy
xd>stream create --name chunkEvents --definition "tap:job:myHttpJob.chunk >log" --deploy

xd>job launch myHttpJob
```

Note: The syntax for the tap that receives the item events: `tap:job:<job-name>.item`,for skip events: `tap:job:<job-name>.skip` and for chunk events: `tap:job:<job-name>.chunk`

To disable the default listeners

```
xd>job create --name myHttpJob --definition "httpJob --listeners=disable" --deploy
```

To select specific listeners

To select specific listeners, specify comma separated list in `--listeners` option. Following example illustrates the selection of job and step execution listeners only:

```
xd>job create --name myHttpJob --definition "httpJob --listeners=job,step" --deploy
```

Note: List of options are: job, step, item, chunk and skip The aggregated channel is registered if at least one of these default listeners are enabled.

For a complete example, please see the Batch Notifications Sample which is part of the Spring XD Samples repository.

16.8 Removing Batch Jobs

Batch Jobs can be deleted by executing:

```
xd:> job destroy helloSpringXD
```

Alternatively, one can just undeploy the job, keeping its definition for a future redeployment:

```
xd:> job undeploy helloSpringXD
```

16.9 Pre-Packaged Batch Jobs

Spring XD comes with several batch import and export modules. You can run them out of the box or use them as a basis for building your own custom modules.

Note HDFS Configuration

To use the hdfs based jobs below, XD needs to have append enabled for hdfs. Update the hdfs-site.xml with the following settings:

For Hadoop 1.x

```
    <property>
      <name>dfs.support.broken.append</name>
      <value>true</value>
    </property>
```

For Hadoop 2.x

```
    <property>
        <name>dfs.support.append</name>
        <value>true</value>
    </property>
```

Poll a Directory and Import CSV Files to HDFS (`filepollhdfs`)

This module is designed to be driven by a stream polling a directory. It imports data from CSV files and requires that you supply a list of named columns for the data using the `names` parameter. For example:

```
xd:> job create myjob --definition "filepollhdfs --names=forename,surname,address" --
deploy
```

You would then use a stream with a file source to scan a directory for files and drive the job. A separate file will be started for each job found:

```
xd:> stream create csvStream --definition "file --ref=true --dir=/mycsvdir --pattern=*.csv
 > queue:job:myjob" --deploy
```

The job also supports a boolean `deleteFiles` option if you want the files to be removed after they have been successfully imported.

Import CSV Files to JDBC (`filejdbc`)

A module which loads CSV files into a JDBC table using a single batch job. By default it uses the internal HSQL DB which is used by Spring Batch. Refer to how module options are resolved for further details on how to change defaults (one can of course always use `--foo=bar` notation in the job definition to achieve the same effect). The job should be defined with the `resources` parameter defining the files which should be loaded. It also requires a `names` parameter (for the CSV field names) and these should match the database column names into which the data should be stored. You can either pre-create the database table or the module will create it for you if you use `--initializeDatabase=true` when the job is created. The table initialization is configured in a similar way to the JDBC sink and uses the same parameters. The default table name is the job name and can be customized by setting the `tableName` parameter. As an example, if you run the command

```
xd:> job create myjob --definition "filejdbc --resources=file:///mycsvdir/*.csv --
names=forename,surname,address --tableName=people --initializeDatabase=true" --deploy
```

it will create the table "people" in the database with three varchar columns called "forename", "surname" and "address". When you launch the job it will load the files matching the resources pattern and write the data to this table. As with the `filepollhdfs` job, this module also supports the `deleteFiles` parameter which will remove the files defined by the `resources` parameter on successful completion of the job.

Launch the job using:

```
xd:> job launch myjob
```

HDFS to JDBC Export (`hdfsjdbc`)

This module functions very similarly to the `filejdbc` one except that the resources you specify should actually be in HDFS, rather than the OS filesystem.

```
xd:> job create myjob --definition "hdfsjdbc --resources=/xd/data/*.csv --
names=forename,surname,address --tableName=people --initializeDatabase=true" --deploy
```

Launch the job using:

```
xd:> job launch myjob
```

JDBC to HDFS Import (`jdbchdfs`)

Performs the reverse of the previous module. The database configuration is the same as for `filejdbc` but without the initialization options since you need to already have the data to import into HDFS. When creating the job, you must either supply the select statement by setting the `sql` parameter, or you can supply both `tableName` and `columns` options (which will be used to build the SQL statement).

To import data from the database table `some_table`, you could use

```
xd:> job create myjob --definition "jdbchdfs --sql='select col1,col2,col3 from
 some_table'" --deploy
```

You can customize how the data is written to HDFS by supplying the options `directory` (defaults to `/xd/(job name)`), `fileName` (defaults to job name), `rollover` (in bytes, default 1000000) and `fileExtension` (defaults to *csv*).

Launch the job using:

```
xd:> job launch myjob
```

HDFS to MongoDB Export (`hdfsmongodb`)

Exports CSV data from HDFS and stores it in a MongoDB collection which defaults to the job name. This can be overridden with the `collectionName` parameter. Once again, the field names should be defined by supplying the `names` parameter. The data is converted internally to a Spring XD `Tuple` and the collection items will have an `id` matching the tuple's UUID. You can override this by setting the `idField` parameter to one of the field names if desired.

An example:

```
xd:> job create myjob --definition "hdfsmongodb --resources=/data/*.log --
names=employeeId,forename,surname,address --idField=employeeId --collectionName=people" --
deploy
```

FTP to HDFS Export (`ftphdfs`)

Copies files from FTP directory into HDFS. Job is partitioned in a way that each separate file copy is executed on its own partitioned step.

An example which copies files:

```
job create --name ftphdfsjob --definition "ftphdfs --host=ftp.example.com --port=21" --
deploy
job launch --name ftphdfsjob --params {"remoteDirectory":"/pub/files","hdfsDirectory":"/
ftp"}
```

Full path is preserved so that above command would result files in HDFS shown below:

```
/ftp/pub/files
/ftp/pub/files/file1.txt
/ftp/pub/files/file2.txt
```

Parameters for Job definition `host`, `port`, `username` and `password` can be used to control access to the FTP server. Additionally parameter `stepConcurrency` which defaults to 2 can be used to control how many simultaneous connections are used towards the FTP server.

Parameters for Job execution, `remoteDirectory` and `hdfsDirectory` are used to define source and destination directories.

17. Analytics

17.1 Introduction

Spring XD provides support for the real-time evaluation of various machine learning scoring algorithms as well simple real-time data analytics using various types of counters and gauges. The analytics functionality is provided via modules that can be added to a stream. In that sense, real-time analytics is accomplished via the same exact model as data-ingestion. It's possible that the primary role of a stream is to perform real-time analytics, but it's quite common to add a tap to initiate a secondary stream where analytics, e.g. a field-value-counter, is applied to the same data being ingested through a primary stream. You will see both approaches in the examples below.

17.2 Predictive analytics

Spring XD's support for implementing predictive analytics by scoring analytical models that leverage machine learning algorithms begins with an extensible class library foundation upon which implementations can be built, such as the PMML Module that we describe here.

That module integrates with the JPMML-Evaluator library that provides support for a wide range of model types and is interoperable with models exported from R, Rattle, KNIME, and RapidMiner. For counter and gauge analytics, in-memory and Redis implementations are provided.

Incorporating the evaluation of machine learning algorithms into stream processing is as easy as using any other processing module. Here is a simple example

```
http --outputType=application/x-xd-tuple | analytic-pmml --location=/models/iris-flower-
naive-bayes.pmml.xml
       --
inputFieldMapping='sepalLength:Sepal.Length,sepalWidth:Sepal.Width,petalLength:Petal.Length,petalWidth:Peta
  --outputFieldMapping='Predicted_Species:predictedSpecies' | log"
```

The `http` source converts posted data to a Tuple. The `analytic-pmml` processor loads the model from the specifed file and creates two mappings so that fields from the Tuple can be mapped into the input and output model names. The `log` sink writes the payload of the event message to the log file of the XD container.

Posting the following JSON data to the http source

```
{
  "sepalLength": "6.4",
  "sepalWidth":  "3.2",
  "petalLength": "4.5",
  "petalWidth":  "1.5"
}
```

will produce output in the log file as shown below.

```
{
   "id":"1722ec00-baad-11e3-b988-005056c00008",
   "timestamp":1396473833152,
   "sepalLength":"6.4",
   "sepalWidth":"3.2",
   "petalLength":"4.5",
   "petalWidth":"1.5",
   "predictedSpecies":"versicolor"
}
```

The next section on analytical models goes into more detail on the general infrastructure

17.3 Analytical Models

We provide some core abstractions for implementing analytical models in stream processing applications. The main interface for integrating analytical models is **Analytic**. Some analytical models need to adjust the domain input and the model output in some way, therefore we provide a special base class **MappedAnalytic** which has core abstractions for implementing that mapping via **InputMapper** and **OutputMapper**.

Since **Spring XD 1.0.0.M6** we support the integration of analytical models, also called statistical models or mining models, that are defined via PMML. **PMML** is the abbreviation for **Predictive Model Markup Language** and is a standard XML representation that allows specifications of different mining models, their ensembles, and associated preprocessing.

Note

PMML is maintained by the **Data Mining Group** (**DMG**) and supported by several state-of-the-art statistics and data mining software tools such as InfoSphere Warehouse, R / Rattle, SAS Enterprise Miner, SPSS®, and Weka. The current version of the **PMML** specification is 4.2 at the time of this writing. Applications can produce and consume **PMML** models, thus allowing an analytical model created in one application to be implemented and used for scoring or prediction in another.

PMML is just one of many other technologies that one can integrate to implement analytics with, more will follow in upcoming releases.

Modeling and Evaluation

Analytical models are usually defined by a statistician *aka* data scientist or quant by using some statistical tool to analyze the data and build an appropriate model. In order to implement those models in a business application they are usually transformed and exported in some way (*e.g.* in the form of a **PMML** definition). This model is then loaded into the application which then evaluates it against a given input (event, tuple, example).

Modeling

Analytical models can be defined in various ways. For the sake of brevity we use **R** from the **r-project** to demonstrate how easy it is to export an analytical model to **PMML** and use it later in stream processing.

For our example we use the **iris** example dataset in **R** to generate a classifier for iris flower species by applying the **Naive Bayes** algorithm.

```
library(e1071) # Load library with the naive bayes algorithm support.

library(pmml) # Load library with PMML export support.

data(iris) # Load the IRIS example dataset

#Helper function to split the given dataset into a dataset used for training (trainset)
 and (testset) used for evaulation.
splitDataFrame <- function(dataframe, seed = NULL, n = trainSize) {

   if (!is.null(seed)){
      set.seed(seed)
   }

   index <- 1:nrow(dataframe)
   trainindex <- sample(index, n)
   trainset <- dataframe[trainindex, ]
   testset <- dataframe[-trainindex, ]

   list(trainset = trainset, testset = testset)
}

#We want to use 95% of the IRIS data as training data and 5% as test data for evaluation.
datasets <- splitDataFrame(iris, seed = 1337, n= round(0.95 * nrow(iris)))

#Create a naive Bayes classifier to predict iris flower species (iris[,5]) from [,1:4] =
 Sepal.Length Sepal.Width Petal.Length Petal.Width
model <- naiveBayes(datasets$trainset[,1:4], datasets$trainset[,5])

#The name of the model and it's externalId could be used to uniquely identify this version
 of the model.
modelName = "iris-flower-classifier"
externalId = 42

#Convert the given model into a PMML model definition
pmmlDefinition = pmml.naiveBayes(model,model.name=paste(modelName,externalId,sep = ";"),
 predictedField='Species')

#Print the PMML definition to stdout
cat(toString(pmmlDefinition))
```

The r script above should produce the following **PMML** document that contains the abstract definition of the naive bayes classifier that we derived from the training dataset of the IRIS dataset.

```
<PMML version="4.1" xmlns="http://www.dmg.org/PMML-4_1" xmlns:xsi="http://www.w3.org/2001/
XMLSchema-instance" xsi:schemaLocation="http://www.dmg.org/PMML-4_1 http://www.dmg.org/
v4-1/pmml-4-1.xsd">
<Header copyright="Copyright (c) 2014 tom" description="NaiveBayes Model">
 <Extension name="user" value="tom" extender="Rattle/PMML"/>
 <Application name="Rattle/PMML" version="1.4"/>
 <Timestamp>2014-04-02 13:22:15</Timestamp>
</Header>
<DataDictionary numberOfFields="6">
 <DataField name="Species" optype="categorical" dataType="string">
  <Value value="setosa"/>
  <Value value="versicolor"/>
  <Value value="virginica"/>
 </DataField>
 <DataField name="Sepal.Length" optype="continuous" dataType="double"/>
 <DataField name="Sepal.Width" optype="continuous" dataType="double"/>
 <DataField name="Petal.Length" optype="continuous" dataType="double"/>
 <DataField name="Petal.Width" optype="continuous" dataType="double"/>
 <DataField name="DiscretePlaceHolder" optype="categorical" dataType="string">
  <Value value="pseudoValue"/>
 </DataField>
</DataDictionary>
<NaiveBayesModel modelName="iris-flower-
classifier;42" functionName="classification" threshold="0.001">
 <MiningSchema>
  <MiningField name="Species" usageType="predicted"/>
  <MiningField name="Sepal.Length" usageType="active"/>
  <MiningField name="Sepal.Width" usageType="active"/>
  <MiningField name="Petal.Length" usageType="active"/>
  <MiningField name="Petal.Width" usageType="active"/>
  <MiningField name="DiscretePlaceHolder" usageType="active" missingValueReplacement="pseudoValue"/
>
 </MiningSchema>
 <Output>
  <OutputField name="Predicted_Species" feature="predictedValue"/>
  <OutputField name="Probability_setosa" optype="continuous" dataType="double" feature="probability" value="
>
  <OutputField name="Probability_versicolor" optype="continuous" dataType="double" feature="probability" va
>
  <OutputField name="Probability_virginica" optype="continuous" dataType="double" feature="probability" valu
>
 </Output>
 <BayesInputs>
  <Extension>
   <BayesInput fieldName="Sepal.Length">
    <TargetValueStats>
     <TargetValueStat value="setosa">
      <GaussianDistribution mean="5.006" variance="0.124248979591837"/>
     </TargetValueStat>
     <TargetValueStat value="versicolor">
      <GaussianDistribution mean="5.8953488372093" variance="0.283311184939092"/>
     </TargetValueStat>
     <TargetValueStat value="virginica">
      <GaussianDistribution mean="6.58163265306122" variance="0.410697278911565"/>
     </TargetValueStat>
    </TargetValueStats>
   </BayesInput>
  </Extension>
  <Extension>
   <BayesInput fieldName="Sepal.Width">
    <TargetValueStats>
     <TargetValueStat value="setosa">
      <GaussianDistribution mean="3.428" variance="0.143689795918367"/>
     </TargetValueStat>
     <TargetValueStat value="versicolor">
      <GaussianDistribution mean="2.76279069767442" variance="0.0966777408637874"/>
     </TargetValueStat>
     <TargetValueStat value="virginica">
      <GaussianDistribution mean="2.97142857142857" variance="0.105833333333333"/>
```

Evaluation

The above defined **PMML** model can be evaluated in a Spring XD stream definition by using the **analytic-pmml** module as a processor in your stream definition. The actual evaluation of the **PMML** is performed via the **PmmlAnalytic** which uses the **jpmml-evaluator** library.

Model Selection

The PMML standard allows multiple models to be defined within a single PMML document. The model to be used can be configured through the **modelName** option.

NOTE The PMML standard also supports other ways for selection models, *e.g.* based on a predicate. This is currently not supported.

In order to perform the evaluation in Spring XD you need to save the generated PMML document to some folder, typically the with the extension "pmml.xml". For this example we save the PMML document under the name **iris-flower-classification-naive-bayes-1.pmml.xml**.

In the following example we set up a stream definition with an `http` source that produces iris-flower-records that are piped to the `analytic-pmml` module which applies our iris flower classifier to predict the species of a given flower record. The result of that is a new record extended by a new attribute **predictedSpecies** which simply sent to a `log` sink.

The definition of the stream, which we call **iris-flower-classification**, looks as follows:

```
xd:>stream create --name iris-flower-classification --definition
 "http --outputType=application/x-xd-tuple | analytic-pmml --
location=/models/iris-flower-classification-naive-bayes-1.pmml.xml --
inputFieldMapping='sepalLength:Sepal.Length,sepalWidth:Sepal.Width,petalLength:Petal.Length,petalWidth:Peta
 --outputFieldMapping='Predicted_Species:predictedSpecies' | log" --deploy
```

- The **location** parameter can be used to specify the exact location of the pmml document. The value must be a valid spring **resource** location
- The **inputFieldMapping** parameter defines a mapping of domain input fields to model input fields. It is just a list of fields or optional field:alias mappings to control which fields and how they are going to end up in the model-input. If no inputFieldMapping is defined then all domain input fields are used as model input.
- The **outputFieldMapping** parameter defines a mapping of model output fields to domain output fields with semantics analog to the inputFieldMapping.
- The optional **modelName** parameter of the analytic-pmml module can be used to refer to a particular named model within the PMML definition. If modelName is not defined the first model is selected by default.

NOTE Some analytical models like for instance **association rules** require a different typ of mapping. You can implement your own custom mapping strategies by implementing a custom **InputMapper** and **OutputMapper** and defining a new **PmmlAnalytic** or **TuplePmmlAnalytic** bean that uses your custom mappers.

After the stream has been successfully deployed to **Spring XD** we can eventually start to throw some data at it by issuing the following http request via the **XD-Shell** (or `curl`, or any other tool):

Note that our example record contains no information about which species the example belongs to - this will be added by our classifier.

```
xd:>http post --target http://localhost:9000 --contentType application/json --data
 "{ \"sepalLength\": 6.4, \"sepalWidth\": 3.2, \"petalLength\":4.5, \"petalWidth\":1.5 }"
```

After posting the above json document to the stream we should see the following output in the console:

```
   {
     "id":"1722ec00-baad-11e3-b988-005056c00008"
   , "timestamp":1396473833152
   , "sepalLength":"6.4"
   , "sepalWidth":"3.2"
   , "petalLength":"4.5"
   , "petalWidth":"1.5"
   , "predictedSpecies":"versicolor"
   }
```

NOTE the generated field **predictedSpecies** which now identifies our input as belonging to the iris species **versicolor**.

We verify that the generated **PMML** classifier produces the same result as **R** by executing the issuing the following commands in **rproject**:

```
datasets$testset[,1:4][1,]
# This is the first example record that we sent via the http post.
   Sepal.Length Sepal.Width Petal.Length Petal.Width
52          6.4         3.2          4.5         1.5

#Predict the class for the example record by using our naiveBayes model.
> predict(model, datasets$testset[,1:4][1,])
[1] versicolor
```

17.4 Counters and Gauges

Counter and Gauges are analytical data structures collectively referred to as metrics. Metrics can be used directly in place of a sink just as if you were creating any other stream, but you can also analyze data from an existing stream using a tap. We'll look at some examples of using metrics with taps in the following sections. As a prerequisite start the XD Container as instructed in the Getting Started page.

The 1.0 release provides the following types of metrics

- Counter
- Field Value Counter
- Aggregate Counter
- Gauge
- Rich Gauge

Spring XD supports these metrics and analytical data structures as a general purpose class library that works with several backend storage technologies. The 1.0 release provides in memory and Redis implementations.

Counter

A counter is a Metric that associates a unique name with a long value. It is primarily used for counting events triggered by incoming messages on a target stream. You create a counter with a unique name and optionally an initial value then set its value in response to incoming messages. The most straightforward use for counter is simply to count messages coming into the target stream. That is, its value is incremented on every message. This is exactly what the *counter* module provided by Spring XD does.

Here’s an example:

Start by creating a data ingestion stream. Something like:

```
xd:> stream create --name springtweets --definition "twittersearch --
consumerKey=<your_key> --consumerSecret=<your_secret> --query=spring | file --dir=/
tweets/" --deploy
```

Next, create a tap on the *springtweets* stream that sets a message counter named *tweetcount*

```
xd:> stream create --name tweettap --definition "tap:stream:springtweets > counter --
name=tweetcount" --deploy
```

The results are written to redis under the key counter.${name}. To retrieve the count:

```
$ redis-cli
redis 127.0.0.1:6379> get counters.tweetcount
```

Field Value Counter

A field value counter is a Metric used for counting occurrences of unique values for a named field in a message payload. XD Supports the following payload types out of the box:

- POJO (Java bean)
- Tuple
- JSON String

For example suppose a message source produces a payload with a field named *user* :

```
class Foo {
   String user;
   public Foo(String user) {
       this.user = user;
   }
}
```

If the stream source produces messages with the following objects:

```
   new Foo("fred")
   new Foo("sue")
   new Foo("dave")
   new Foo("sue")
```

The field value counter on the field *user* will contain:

```
fred:1, sue:2, dave:1
```

Multi-value fields are also supported. For example, if a field contains a list, each value will be counted once:

```
users:["dave","fred","sue"]
users:["sue","jon"]
```

The field value counter on the field *users* will contain:

```
dave:1, fred:1, sue:2, jon:1
```

field_value_counter has the following options:

fieldName
: The name of the field for which values are counted **(required)**

name
: A key used to access the counter values. **(default: stream name)**

To try this out, create a stream to ingest twitter feeds containing the word *spring* and output to a file:

```
xd:> stream create --name springtweets --definition "twittersearch --
consumerKey=<your_key> --consumerSecret=<your_secret> --query=spring | file" --deploy
```

Now create a tap for a field value counter:

```
xd:> stream create --name fromUserCount --definition "tap:stream:springtweets > field-
value-counter --fieldName=fromUser" --deploy
```

The *twittersearch* source produces JSON strings which contain the user id of the tweeter in the *fromUser* field. The *field_value_counter* sink parses the tweet and updates a field value counter named *fromUserCount* in Redis. To view the counts:

```
$ redis-cli
redis 127.0.0.1:6379>zrange fieldvaluecounters.fromUserCount 0 -1 withscores
```

Aggregate Counter

The aggregate counter differs from a simple counter in that it not only keeps a total value for the count, but also retains the total count values for each minute, hour day and month of the period for which it is run. The data can then be queried by supplying a start and end date and the resolution at which the data should be returned.

Creating an aggregate counter is very similar to a simple counter. For example, to obtain an aggregate count for our spring tweets stream:

```
xd:> stream create --name springtweets --definition "twittersearch --query=spring | file"
 --deploy
```

you'd simply create a tap which pipes the input to `aggregate-counter`:

```
xd:> stream create --name tweettap --definition "tap:stream:springtweets > aggregate-
counter --name=tweetcount" --deploy
```

The Redis back-end stores the aggregate counts in buckets prefixed with `aggregatecounters.${name}`. The rest of the string contains the date information. So for our `tweetcount` counter you might see something like the following keys appearing in Redis:

```
redis 127.0.0.1:6379> keys aggregatecounters.tweetcount*
1) "aggregatecounters.tweetcount"
2) "aggregatecounters.tweetcount.years"
3) "aggregatecounters.tweetcount.2013"
4) "aggregatecounters.tweetcount.201307"
5) "aggregatecounters.tweetcount.20130719"
6) "aggregatecounters.tweetcount.2013071914"
```

The general format is

1. One total value
2. One years hash with a field per year eg. { 2010: value, 2011: value }
3. One hash per year with a field per month { 01: value, …}
4. One hash per month with a field per day
5. One hash per day with a field per hour
6. One hash per hour with a field per minute

Gauge

A gauge is a Metric, similar to a counter in that it holds a single long value associated with a unique name. In this case the value can represent any numeric value defined by the application.

The *gauge* sink provided with XD stores expects a numeric value as a payload, typically this would be a decimal formatted string, and stores its values in Redis. The gauge includes the following attributes:

name
: The name for the gauge **(default: `<streamname>`)**

Note:

When using gauges and rich gauges with these examples you will need a redis instance running. Also if you are using singlenode, start your single node with the --analytics redis parameter

```
xd-singlenode --analyttics redis
```

Here is an example of creating a tap for a gauge:

Simple Tap Example

Create an ingest stream

```
xd:> stream create --name test --definition "http --port=9090 | file" --deploy
```

Next create the tap:

```
xd:> stream create --name simplegauge --definition "tap:stream:test > gauge" --deploy
```

Now Post a message to the ingest stream:

```
xd:> http post --target http://localhost:9090 --data "10"
```

Check the gauge:

```
$ redis-cli
redis 127.0.0.1:6379> get gauges.simplegauge
"10"
```

Rich Gauge

A rich gauge is a Metric that holds a double value associated with a unique name. In addition to the value, the rich gauge keeps a running average, along with the minimum and maximum values and the sample count.

The *richgauge* sink provided with XD expects a numeric value as a payload, typically this would be a decimal formatted string, and keeps its value in a store. The rich-gauge includes the following attributes:

name
: The name for the gauge **(default: `<streamname>`)**

alpha
: A smoothing factor between 0 and 1, that if set will compute an exponential moving average **(default: `-1, simple average`)**

When stored in Redis, the values are kept as a space delimited string, formatted as *value alpha mean max min count*

Here are some examples of creating a tap for a rich gauge:

Simple Tap Example

Create an ingest stream

```
xd:> stream create --name test --definition "http --port=9090 | file" --deploy
```

Next create the tap:

```
xd:> stream create --name testgauge --definition "tap:stream:test > rich-gauge" --deploy
```

Now Post some messages to the ingest stream:

```
xd:> http post --target http://localhost:9090 --data "10"
xd:> http post --target http://localhost:9090 --data "13"
xd:> http post --target http://localhost:9090 --data "16"
```

Check the gauge:

```
$ redis-cli
redis 127.0.0.1:6379> get richgauges.testgauge
"16.0 -1 13.0 16.0 10.0 3"
```

Stock Price Example

In this example, we will track stock prices, which is a more practical example. The data is ingested as JSON strings like

```
{"symbol":"VMW","price":72.04}
```

Create an ingest stream

```
xd:> stream create --name stocks --definition "http --port=9090 | file"
```

Next create the tap, using the transform module to extract the stock price from the payload:

```
xd:> stream create --name stockprice --definition "tap:stream:stocks > transform --
expression=#jsonPath(payload,'$.price') | rich-gauge"
```

Now Post some messages to the ingest stream:

```
xd:> http post --target http://localhost:9090 --data {"symbol":"VMW","price":72.04}
xd:> http post --target http://localhost:9090 --data {"symbol":"VMW","price":72.06}
xd:> http post --target http://localhost:9090 --data {"symbol":"VMW","price":72.08}
```

Note: JSON fields should be separated by a comma without any spaces. Alternatively, enclose the whole argument to `--data` with quotes and escape inner quotes with a backslash.

Check the gauge:

```
$ redis-cli
redis 127.0.0.1:6379> get richgauges.stockprice
"72.08 -1 72.04 72.08 72.02 3"
```

Improved Stock Price Example

In this example, we will track stock prices for selected stocks. The data is ingested as JSON strings like

```
{"symbol":"VMW","price":72.04}
{"symbol":"EMC","price":24.92}
```

The previous example would feed these prices to a single gauge. What we really want is to create a separate tap for each ticker symbol in which we are interested:

Create an ingest stream

```
xd:> stream create --name stocks --definition "http --port=9090 | file"
```

Next create the tap, using the transform module to extract the stock price from the payload:

```
xd:> stream create --name vmwprice --definition "tap:stream:stocks >
 filter --expression=#jsonPath(payload,'$.symbol')==VMW | transform --
expression=#jsonPath(payload,'$.price') | rich-gauge" --deploy
xd:> stream create --name emcprice --definition "tap:stream:stocks >
 filter --expression=#jsonPath(payload,'$.symbol')==EMC | transform --
expression=#jsonPath(payload,'$.price') | rich-gauge" --deploy
```

Now Post some messages to the ingest stream:

```
xd:> http post --target http://localhost:9090 --data {"symbol":"VMW","price":72.04}
xd:> http post --target http://localhost:9090 --data {"symbol":"VMW","price":72.06}
xd:> http post --target http://localhost:9090 --data {"symbol":"VMW","price":72.08}
```

```
xd:> http post --target http://localhost:9090 --data {"symbol":"EMC","price":24.92}
xd:> http post --target http://localhost:9090 --data {"symbol":"EMC","price":24.90}
xd:> http post --target http://localhost:9090 --data {"symbol":"EMC","price":24.96}
```

Check the gauge:

```
$ redis-cli
redis 127.0.0.1:6379> get richgauges.emcprice
"24.96 -1 24.926666666666666 24.96 24.9 3"
```

```
redis 127.0.0.1:6379> get richgauges.vmwprice
"72.08 -1 72.04 72.08 72.02 3"
```

Accessing Analytics Data over the RESTful API

Spring XD has a discoverable RESTful API based on the Spring HATEAOS library. You can discover the resources available by making a GET request on the root resource of the Admin server. Here is an example where navigate down to find the data for a counter named *httptap* that was created by these commands

```
xd:>stream create --name httpStream --definition "http | file" --deploy
xd:>stream create --name httptap --definition "tap:stream:httpStream > counter" --deploy
xd:>http post --target http://localhost:9000 --data "helloworld"
```

The root resource returns

```
xd:>! wget  -q -S -O - http://localhost:9393/
{
  "links":[
    {},
    {
      "rel":"jobs",
      "href":"http://localhost:9393/jobs"
    },
    {
      "rel":"modules",
      "href":"http://localhost:9393/modules"
    },
    {
      "rel":"runtime/modules",
      "href":"http://localhost:9393/runtime/modules"
    },
    {
      "rel":"runtime/containers",
      "href":"http://localhost:9393/runtime/containers"
    },
    {
      "rel":"counters",
      "href":"http://localhost:9393/metrics/counters"
    },
    {
      "rel":"field-value-counters",
      "href":"http://localhost:9393/metrics/field-value-counters"
    },
    {
      "rel":"aggregate-counters",
      "href":"http://localhost:9393/metrics/aggregate-counters"
    },
    {
      "rel":"gauges",
      "href":"http://localhost:9393/metrics/gauges"
    },
    {
      "rel":"rich-gauges",
      "href":"http://localhost:9393/metrics/rich-gauges"
    }
  ]
}
```

Following the resource location for the counter

```
xd:>! wget  -q -S -O - http://localhost:9393/metrics/counters
{
  "links":[

  ],
  "content":[
    {
      "links":[
        {
          "rel":"self",
          "href":"http://localhost:9393/metrics/counters/httptap"
        }
      ],
      "name":"httptap"
    }
  ],
  "page":{
    "size":0,
    "totalElements":1,
    "totalPages":1,
    "number":0
  }
}
```

And then the data for the counter itself

```
xd:>! wget  -q -S -O - http://localhost:9393/metrics/counters/httptap
{
  "links":[
    {
      "rel":"self",
      "href":"http://localhost:9393/metrics/counters/httptap"
    }
  ],
  "name":"httptap",
  "value":2
}
```

18. DSL Reference

18.1 Introduction

Spring XD provides a DSL for defining a stream. Over time the DSL is likely to evolve significantly as it gains the ability to define more and more sophisticated streams as well as the steps of a batch job.

18.2 Pipes and filters

A simple linear stream consists of a sequence of modules. Typically an Input Source, (optional) Processing Steps, and an Output Sink. As a simple example consider the collection of data from an HTTP Source writing to a File Sink. Using the DSL the stream description is:

```
http | file
```

A stream that involves some processing:

```
http | filter | transform | file
```

The modules in a stream definition are connected together using the pipe symbol `|`.

18.3 Module parameters

Each module may take parameters. The parameters supported by a module are defined by the module implementation. As an example the `http` source module exposes `port` setting which allows the data ingestion port to be changed from the default value.

```
http --port=1337
```

It is only necessary to quote parameter values if they contain spaces or the `|` character. Here the transform processor module is being passed a SpEL expression that will be applied to any data it encounters:

```
transform --expression='new StringBuilder(payload).reverse()'
```

If the parameter value needs to embed a single quote, use two single quotes:

```
// Query is: Select * from /Customers where name='Smith'
scan --query='Select * from /Customers where name=''Smith'''
```

18.4 Named channels

Instead of a source or sink it is possible to use a named channel. Normally the modules in a stream are connected by anonymous internal channels (represented by the pipes), but by using explicitly named channels it becomes possible to construct more sophisticated flows. In keeping with the unix theme, sourcing/sinking data from/to a particular channel uses the > character. A named channel is specified by using a channel type, followed by a `:` followed by a name. The channel types available are:

```
queue - this type of channel has point-to-point (p2p) semantics
```

```
topic - this type of channel has pub/sub semantics
```

Here is an example that shows how you can use a named channel to share a data pipeline driven by different input sources.

```
queue:foo > file
```

```
http > queue:foo
```

```
time > queue:foo
```

Now if you post data to the http source, you will see that data intermingled with the time value in the file.

The opposite case, the fanout of a message to multiple streams, is planned for a future release. However, taps are a specialization of named channels that do allow publishing data to multiple sinks. For example:

```
tap:stream:mystream > file
```

```
tap:stream:mystream > log
```

Once data is received on `mystream`, it will be written to both file and log.

Support for routing messages to different streams based on message content is also planned for a future release.

18.5 Labels

Labels provide a means to alias or group modules. Labels are simply a name followed by a `:` When used as an alias a label can provide a more descriptive name for a particular configuration of a module and possibly something easier to refer to in other streams.

```
mystream = http | obfuscator: transform --expression=payload.replaceAll('password','*') |
 file
```

Labels are especially useful for disambiguating when multiple modules of the same name are used:

```
mystream = http | uppercaser: transform --expression=payload.toUpperCase() | exclaimer:
 transform --expression=payload+'!' | file
```

Refer to this section of the Taps chapter to see how labels facilitate the creation of taps in these cases where a stream contains ambiguous modules.

19. Tuples

19.1 Introduction

The Tuple class is a central data structure in Spring XD. It is an ordered list of values that can be retrieved by name or by index. Tuples are created by a TupleBuilder and are immutable. The values that are stored can be of any type and null values are allowed.

The underlying Message class that moves data from one processing step to the next can have an arbitrary data type as its payload. Instead of creating a custom Java class that encapsulates the properties of what is read or set in each processing step, the Tuple class can be used instead. Processing steps can be developed that read data from specific named values and write data to specific named values.

There are accessor methods that perform type conversion to the basic primitive types as well as BigDecimal and Date. This avoids you from having to cast the values to specific types. Insteam you can rely on the Tuple's type conversion infastructure to perform the conversion.

The Tuple's types conversion is performed by Spring's Type Conversion Infrastructure which supports commonly encountered type conversions and is extensible.

There are several overloads for getters that let you provide default values for primitive types should the field you are looking for not be found. Date format patterns and Locale aware NumberFormat conversion are also supported. A best effort has been made to preserve the functionality available in Spring Batch's `FieldSet` class that has been extensively used for parsing String based data in files.

Creating a Tuple

The `TupleBuilder` class is how you create new `Tuple` instances. The most basic case is

```
Tuple tuple = TupleBuilder.tuple().of("foo", "bar");
```

This creates a Tuple with a single entry, a key of *foo* with a value of *bar*. You can also use a static import to shorten the syntax.

```
import static org.springframework.xd.tuple.TupleBuilder.tuple;

Tuple tuple = tuple().of("foo", "bar");
```

You can use the `of` method to create a Tuple with up to 4 key-value pairs.

```
Tuple tuple2 = tuple().of("up", 1, "down", 2);
Tuple tuple3 = tuple().of("up", 1, "down", 2, "charm", 3 );
Tuple tuple4 = tuple().of("up", 1, "down", 2, "charm", 3, "strange", 4);
```

To create a Tuple with more then 4 entries use the fluent API that strings together the `put` method and terminates with the `build` method

```
Tuple tuple6 = tuple().put("up", 1)
                     .put("down", 2)
        .put("charm", 3)
        .put("strange", 4)
        .put("bottom", 5)
        .put("top", 6)
        .build();
```

To customize the underlying type conversion system you can specify the `DateFormat` to use for converting `String` to `Date` as well as the `NumberFormat` to use based on a `Locale`. For more advanced customization of the type conversion system you can register an instance of a `FormattingConversionService`. Use the appropriate setter methods on `TupleBuilder` to make these customizations.

You can also create a Tuple from a list of `String` field names and a List of `Object` values.

```
Object[] tokens = new String[]
 { "TestString", "true", "C", "10", "-472", "354224", "543", "124.3", "424.3", "1,3245",
    null, "2007-10-12", "12-10-2007", "" };
String[] nameArray = new String[]
 { "String", "Boolean", "Char", "Byte", "Short", "Integer", "Long", "Float", "Double",
    "BigDecimal", "Null", "Date", "DatePattern", "BlankInput" };

List<String> names = Arrays.asList(nameArray);
List<Object> values = Arrays.asList(tokens);
tuple = tuple().ofNamesAndValues(names, values);
```

Getting Tuple values

There are getters for all the primitive types and also for BigDecimal and Date. The primitive types are

- `Boolean`
- `Byte`
- `Char`
- `Double`
- `Float`
- `Int`
- `Long`
- `Short`
- `String`

Each getter has an overload for providing a default value. You can access the values either by field name or by index.

The overloaded methods for asking for a value to be converted into an integer are

- `int getInt(int index)`
- `int getInt(String name)`
- `int getInt(int index, int defaultValue)`
- `int getInt(String name, int defaultValue)`

There are similar methods for other primitive types. For `Boolean` there is a special case of providing the `String` value that represents a `trueValue`.

- `boolean getBoolean(int index, String trueValue)`
- `boolean getBoolean(String name, String trueValue)`

If the value that is stored for a given field or index is null and you ask for a primitive type, the standard Java defalt value for that type is returned.

The `getString` method will remove and leading and trailing whitespace. If you want to get the String and preserve whitespace use the methods `getRawString`

There is extra functionality for getting \`Date\`s. The are overloaded getters that take a String based date format

- `Date getDateWithPattern(int index, String pattern)`
- `Date getDateWithPattern(int index, String pattern, Date defaultValue)`
- `Date getDateWithPattern(String name, String pattern)`
- `Date getDateWithPattern(String name, String pattern, Date defaultValue)`

There are a few other more generic methods available. Their functionality should be obvious from their names

- `size()`
- `getFieldCount()`
- `getFieldNames()`
- `getFieldTypes()`
- `getTimestamp()` - the time the tuple was created - milliseconds since epoch
- `getId()` - the UUID of the tuple
- `Object getValue(int index)`
- `Object getValue(String name)`
- `T getValue(int index, Class<T> valueClass)`
- `T getValue(String name, Class<T> valueClass)`
- `List<Object> getValues()`
- `List<String> getFieldNames()`
- `boolean hasFieldName(String name)`

Using SpEL expressions to filter a tuple

SpEL provides support to transform a source collection into another by selecting from its entries. We make use of this functionalty to select a elements of a the tuple into a new one.

```
Tuple tuple = tuple().put("red", "rot")
                     .put("brown", "braun")
       .put("blue", "blau")
       .put("yellow", "gelb")
       .put("beige", "beige")
       .build();

Tuple selectedTuple = tuple.select("?[key.startsWith('b')]");
assertThat(selectedTuple.size(), equalTo(3));
```

To select the first match use the ^ operator

```
selectedTuple = tuple.select("^[key.startsWith('b')]");

assertThat(selectedTuple.size(), equalTo(1));
assertThat(selectedTuple.getFieldNames().get(0), equalTo("brown"));
assertThat(selectedTuple.getString(0), equalTo("braun"));
```

Gradle Dependencies

If you wish to use Spring XD Tuples in you project add the following dependencies:

```
//Add this repo to your repositories if it does not already exist.
maven { url "http://repo.spring.io/libs-snapshot" }

//Add this dependency
compile 'org.springframework.xd:spring-xd-tuple:1.0.0.M6'
```

20. Samples

We have a number of sample projects in the Spring XD Samples GitHub repository. Below are some additional examples for ingesting syslog data to HDFS.

20.1 Syslog ingestion into HDFS

In this section we will show a simple example on how to setup syslog ingestion from multiple hosts into HDFS.

Create the streams with syslog as source and HDFS as sink (Please refer to source and sink)

If you're using syslog over TCP and need the highest throughput, use the Reactor-backed syslog module.

```
xd:> stream create --definition "reactor-syslog --port=<tcp-port> | hdfs" --name <stream-
name>
```

The `reactor-syslog` module doesn't yet support UDP (though it soon will), so if you're using syslog over UDP you'll want to use the standard syslog module.

```
xd:> stream create --definition "syslog-udp --port=<udp-port> | hdfs" --name <stream-name>
```

```
xd:> stream create --definition "syslog-tcp --port=<tcp-port> | hdfs" --name <stream-name>
```

Please note for hdfs sink, set `rollover` parameter to a smaller value to avoid buffering and to see the data has made to HDFS (incase of smaller volume of log).

Configure the external hosts' syslog daemons forward their messages to the xd-container host's UDP/TCP port (where the syslog-udp/syslog-tcp source module is deployed).

A sample configuration using syslog-ng

Edit syslog-ng configuration (for example: /etc/syslog-ng/syslog-ng.conf):

1) Add destination

```
destination <destinationName> {
      tcp("<host>" port("<tcp-port>"));
};
```

or,

```
destination <destinationName> {
      udp("<host>" port("<udp-port>"));
};
```

where "host" is the container(launcher) host where the syslog module is deployed.

2) Add log rule to log message sources:

```
log {
  source(<message_source>); destination(<destinationName>);
};
```

3) Make sure to restart the service after the change:

```
sudo service syslog-ng restart
```

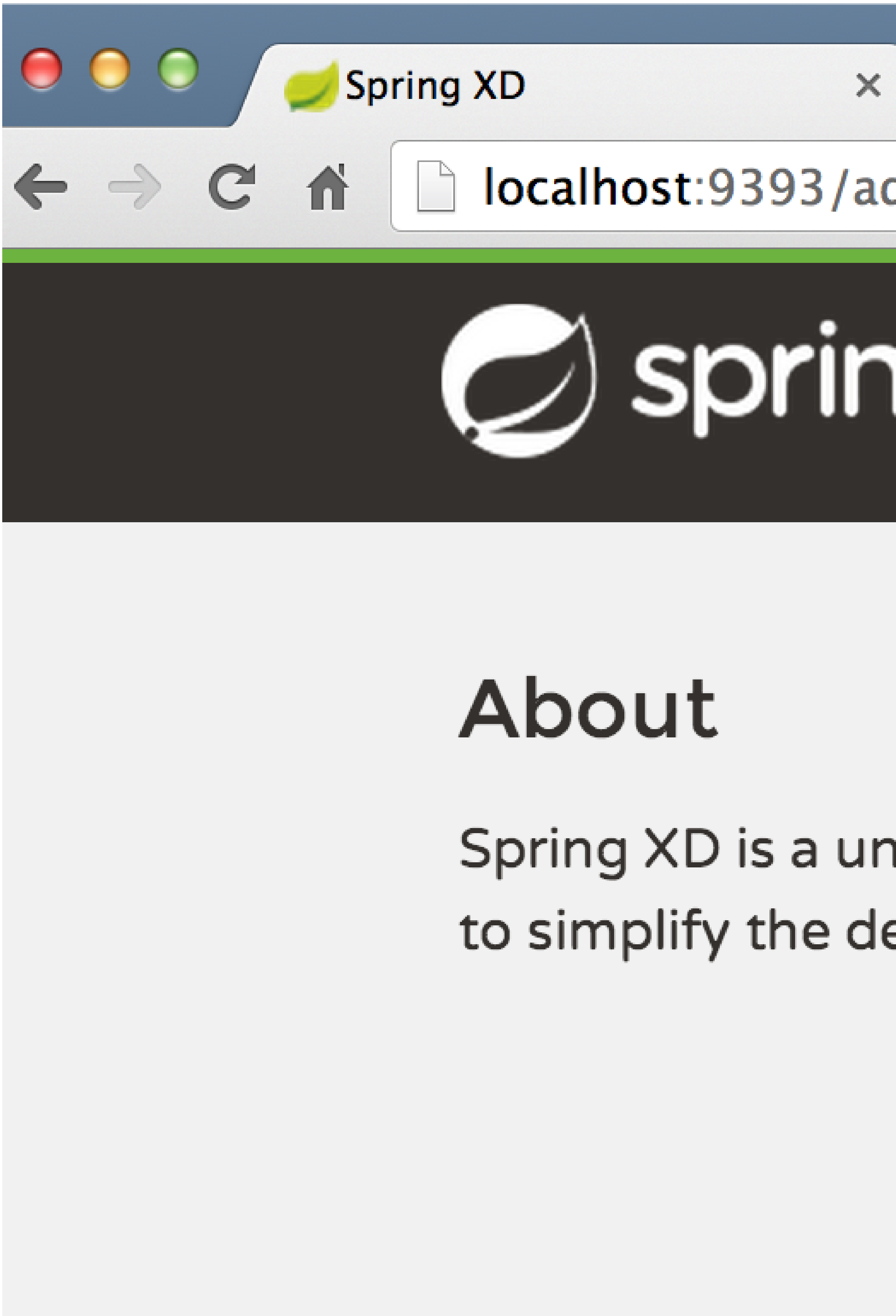
Now, the syslog messages from the syslog message sources are written into HDFS /xd/<stream-name>/

21. Admin UI

21.1 Introduction

Spring XD provides a browser-based GUI which currently allows you to perform Batch Job related tasks. Upon starting Spring XD, the Admin UI is available at:

http://localhost:9393/admin-ui


Spring XD

localhost:9393/ac

About

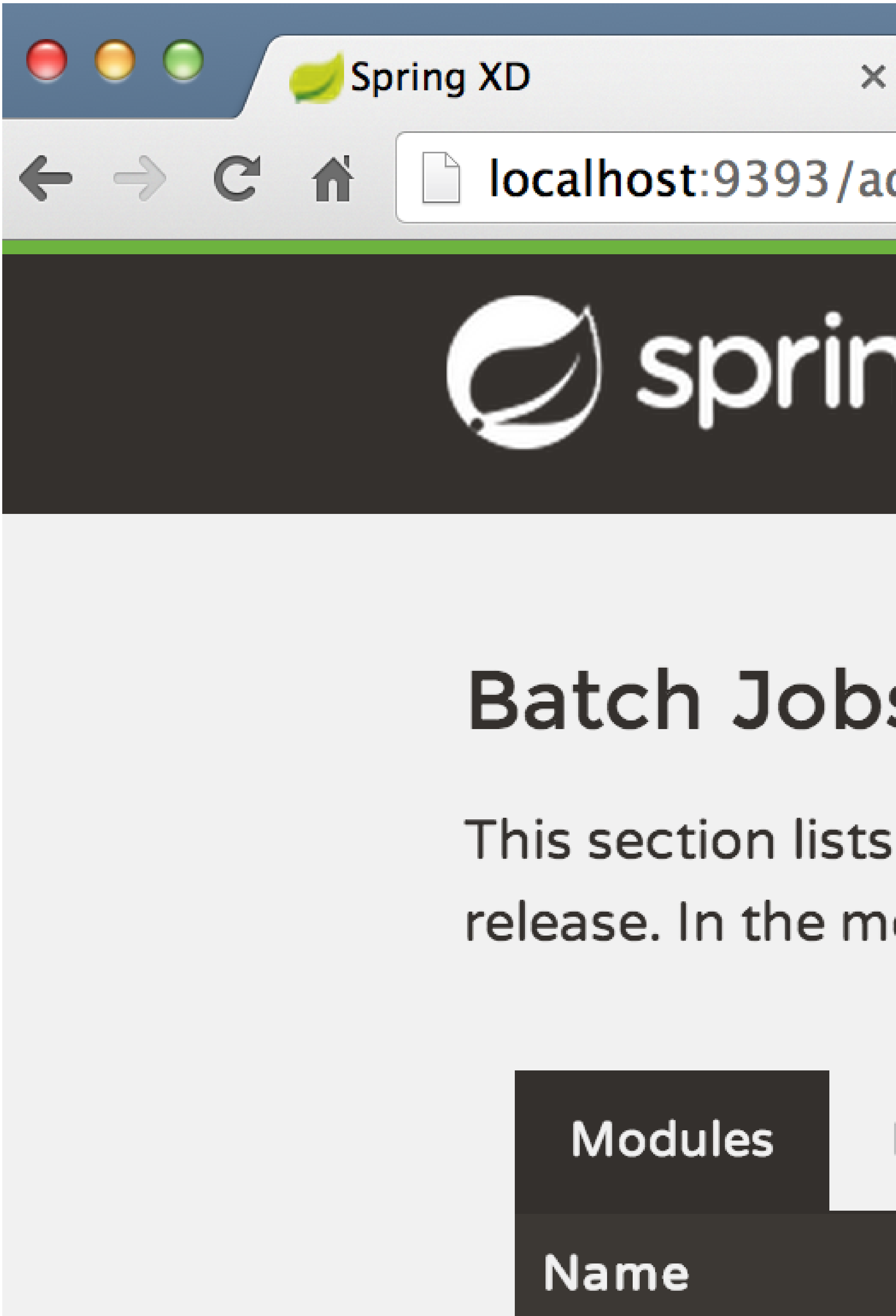
Spring XD is a un
to simplify the de

The admin UI currently has four main tabs for **Batch Jobs**

- Modules
- Definitions
- Deployments
- Executions

21.2 List available batch job modules

This page lists the available batch job modules and more details (such as the job module options and the module XML configuration file).



Batch Jobs

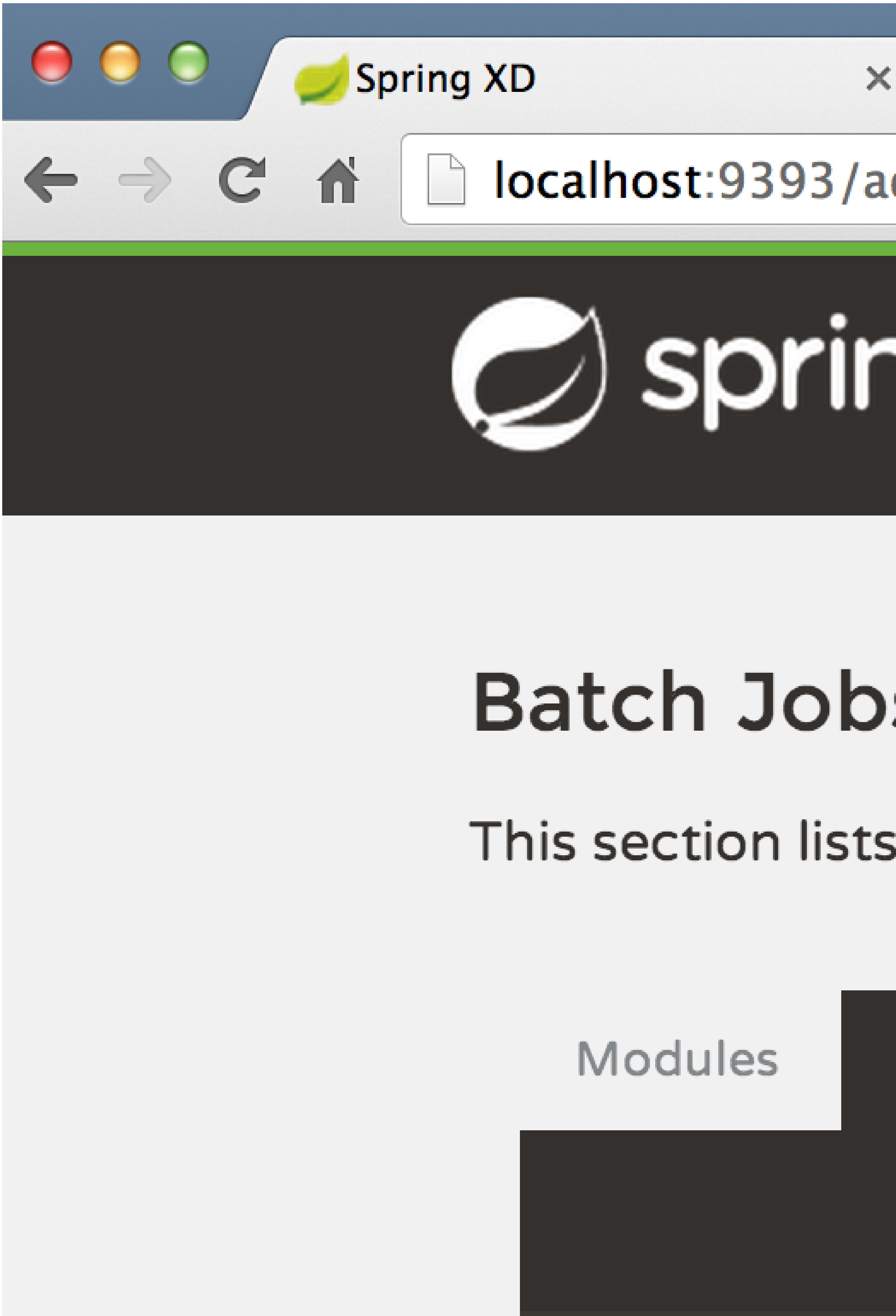
This section lists
release. In the m

Modules

Name

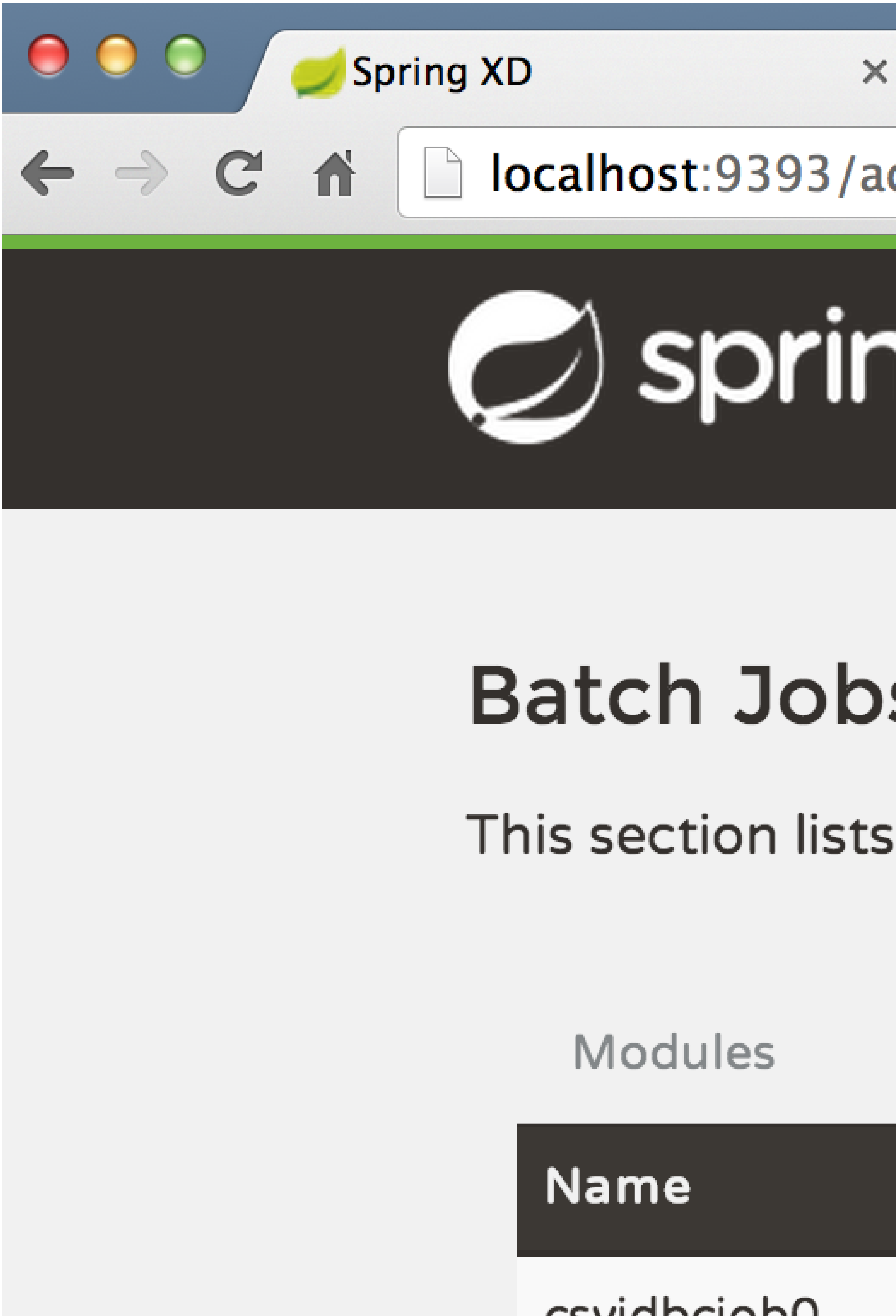
21.3 List job definitions

This page lists the XD batch job definitions and provides actions to **deploy** or **un-deploy** those jobs.


Spring XD
localhost:9393/a
sprin
Batch Job
This section lists
Modules

21.4 List job deployments

This page lists all the deployed jobs and provides option to **launch** the deployed job.


Spring XD

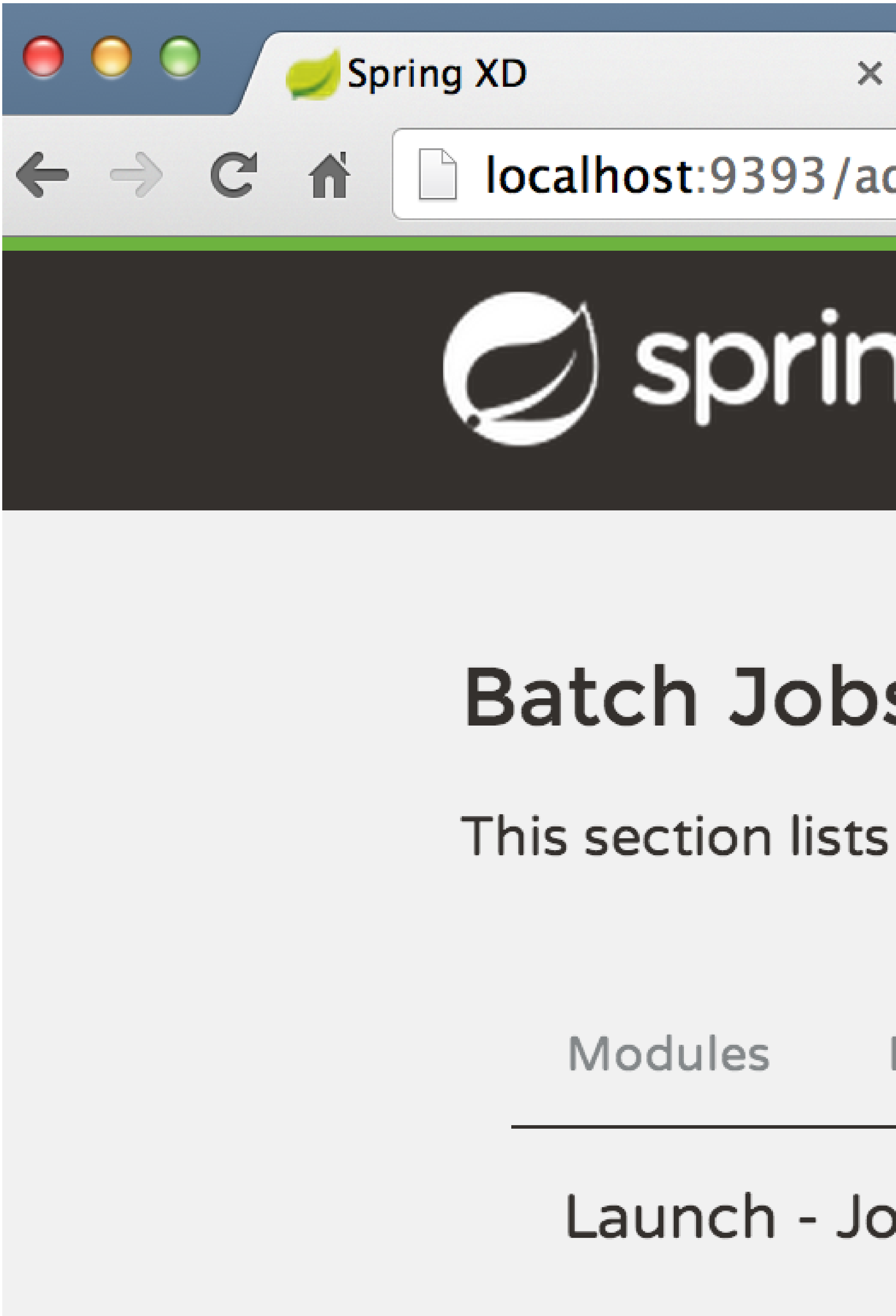
localhost:9393/ac

Batch Jobs

This section lists

Launching a batch Job

Once the job is deployed, they can be launched through the Admin UI as well. Navigate to the **Deployments** tab. Select the job you want to launch and press `Launch`. The following modal dialog should appear:

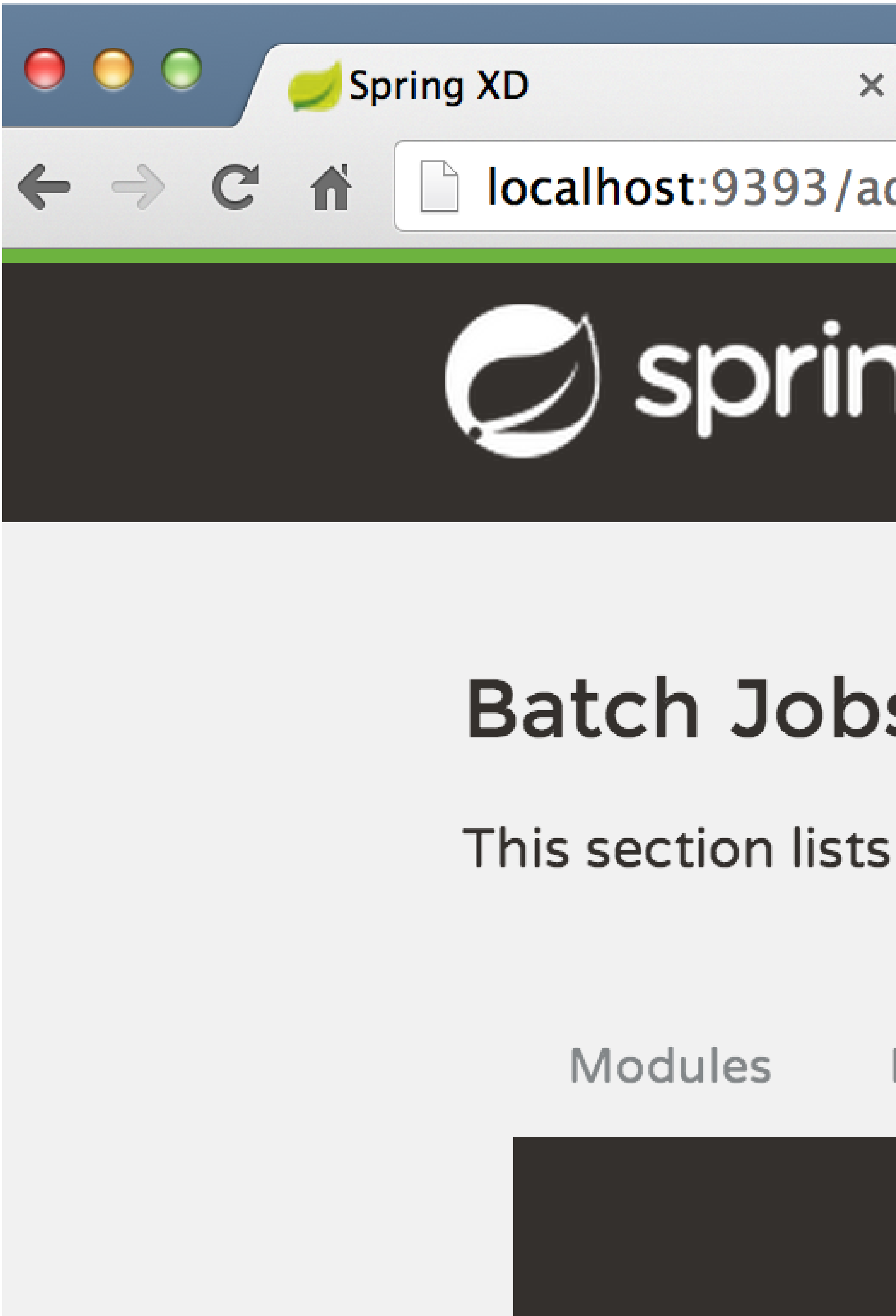

Spring XD
localhost:9393/ac
sprin
Batch Jobs
This section lists
Modules
Launch - Jo

Using this screen, you can define one or more job parameters. Job parameters can be typed and the following data types are available:

- String (The default)
- Date (The default date format is: *yyyy/MM/dd*)
- Long
- Double

21.5 List job executions

This page lists the batch job executions and provides option to **restart** if the batch job is restartable and stopped/failed.


Spring XD
localhost:9393/ac
sprin
Batch Jobs
This section lists
Modules

Part II. Appendices

Appendix A. Installing Hadoop

A.1 Installing Hadoop

If you don’t have a local *Hadoop* cluster available already, you can do a local single node installation (v1.2.1) and use that to try out *Hadoop* with *Spring XD*.

Tip

This guide is intended to serve as a quick guide to get you started in the context of *Spring XD*. For more complete documentation please refer back to the documentation provided by your respective *Hadoop* distribution.

Download

First, download an installation archive and unpack it locally. Linux users can also install *Hadoop* through the system package manager and on Mac OS X, you can use Homebrew. However, the manual installation is self-contained and it’s easier to see what’s going on if you just unpack it to a known location.

If you have `wget` available on your system, you can also execute:

```
$ wget http://archive.apache.org/dist/hadoop/common/hadoop-1.2.1/hadoop-1.2.1.tar.gz
```

Unpack the distribution with:

```
$ tar xzf hadoop-1.2.1.tar.gz
```

Change into the directory and have a look around

```
$ cd hadoop-1.2.1
$ ls
$ bin/hadoop
Usage: hadoop [--config confdir] COMMAND
where COMMAND is one of:
  namenode -format     format the DFS filesystem
  secondarynamenode    run the DFS secondary namenode
  namenode             run the DFS namenode
  ...
```

The `bin` directory contains the start and stop scripts as well as the `hadoop` script which allows us to interact with *Hadoop* from the command line. The next place to look at is the `conf` directory.

Java Setup

Make sure that you set `JAVA_HOME` in the `conf/hadoop-env.sh` script, or you will get an error when you start *Hadoop*. For example:

```
# The java implementation to use.  Required.
# export JAVA_HOME=/usr/lib/j2sdk1.5-sun
export JAVA_HOME=/usr/lib/jdk1.6.0_45
```

Tip

When using *Mac OS X* you can determine the *Java 6* home directory by executing `$ /usr/libexec/java_home -v 1.6`

Important

When using *MAC OS X* (Other systems possible also) you may still encounter `Unable to load realm info from SCDynamicStore` (For details see Hadoop Jira HADOOP-7489). In that case, please also add to `conf/hadoop-env.sh` the following line: `export HADOOP_OPTS="-Djava.security.krb5.realm= -Djava.security.krb5.kdc="`.

Setup SSH

As described in the installation guide, you also need to set up SSH login to `localhost` without a passphrase. On Linux, you may need to install the `ssh` package and ensure the `sshd` daemon is running. On Mac OS X, ssh is already installed but the `sshd` daemon isn't usually running. To start it, you need to enable "Remote Login" in the "Sharing" section of the control panel. Then you can carry on and setup SSH keys as described in the installation guide:

```
$ ssh-keygen -t dsa -P '' -f ~/.ssh/id_dsa
$ cat ~/.ssh/id_dsa.pub >> ~/.ssh/authorized_keys
```

Make sure you can log in at the command line using `ssh localhost` before trying to start *Hadoop*:

```
$ ssh localhost
Last login: Thu May 30 12:52:47 2013
```

You also need to decide where in your local filesystem you want *Hadoop* to store its data. Let's say you decide to use `/data`.

First create the directory and make sure it is writeable:

```
$ mkdir /data
$ chmod 777 /data
```

Now edit `conf/core-site.xml` and add the following property:

```
<property>
    <name>hadoop.tmp.dir</name>
    <value>/data</value>
</property>
```

You're then ready to format the filesystem for use by HDFS

```
$ bin/hadoop namenode -format
```

Setting the Namenode Port

By default Spring XD will use a *Namenode* setting of `hdfs://localhost:8020` which is defined in `${xd.home}/config/hadoop.properties`, depending on the used *Hadoop* distribution and version the by-default-defined port `8020` may be different, e.g. port `9000`. Therefore, please ensure you have the following setting in `conf/core-site.xml`:

```
<configuration>
    <property>
        <name>fs.default.name</name>
        <value>hdfs://localhost:8020</value>
    </property>
</configuration>
```

Further Configuration File Changes

In `conf/hdfs-site.xml` add:

```
<configuration>
    <property>
        <name>dfs.replication</name>
        <value>1</value>
    </property>
</configuration>
```

In `conf/mapred-site.xml` add:

```
<configuration>
    <property>
        <name>mapred.job.tracker</name>
        <value>localhost:9001</value>
    </property>
</configuration>
```

A.2 Running Hadoop

You should now finally be ready to run *Hadoop*. Run the `start-all.sh` script

```
$ bin/start-all.sh
```

You should see five Hadoop Java processes running:

```
$ jps
4039 TaskTracker
3713 NameNode
3802 DataNode
3954 JobTracker
3889 SecondaryNameNode
4061 Jps
```

Try a few commands with `hadoop dfs` to make sure the basic system works

```
$ bin/hadoop dfs -ls /
Found 1 items
drwxr-xr-x   - luke supergroup          0 2013-05-30 17:28 /data
```

```
$ bin/hadoop dfs -mkdir /test
$ bin/hadoop dfs -ls /
Found 2 items
drwxr-xr-x   - luke supergroup          0 2013-05-30 17:28 /data
drwxr-xr-x   - luke supergroup          0 2013-05-30 17:31 /test
```

```
$ bin/hadoop dfs -rmr /test
Deleted hdfs://localhost:8020/test
```

Lastly, you can also browse the web interface for *NameNode* and *JobTracker* at:

- NameNode: http://localhost:50070/
- JobTracker: http://localhost:50030/

At this point you should be good to create a *Spring XD* stream using a *Hadoop* sink.

Appendix B. Creating a Source Module

B.1 Introduction

As outlined in the modules document, XD currently supports 3 types of modules: source, sink, and processor. This document walks through creation of a custom source module.

The first module in a stream is always a source. Source modules are built with Spring Integration and are typically very fine-grained. A module of type *source* is responsible for placing a message on a channel named *output*. This message can then be consumed by the other processor and sink modules in the stream. A source module is typically fed data by an inbound channel adapter, configured with a poller.

Spring Integration provides a number of adapters out of the box to support various transports, such as JMS, File, HTTP, Web Services, Mail, and more. You can typically create a source module that uses these inbound channel adapters by writing just a single Spring application context file.

These steps will demonstrate how to create and deploy a source module using the Spring Integration Feed Inbound Channel Adapter.

B.2 Create the module Application Context file

Create the Inbound Channel Adapter in a file called *feed.xml*:

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xmlns:int="http://www.springframework.org/schema/integration"
 xmlns:int-feed="http://www.springframework.org/schema/integration/feed"
 xsi:schemaLocation="http://www.springframework.org/schema/beans
  http://www.springframework.org/schema/beans/spring-beans.xsd
  http://www.springframework.org/schema/integration
  http://www.springframework.org/schema/integration/spring-integration.xsd
  http://www.springframework.org/schema/integration/feed
  http://www.springframework.org/schema/integration/feed/spring-integration-feed.xsd">

 <int-feed:inbound-channel-adapter id="xdFeed" channel="output" url="http://
feeds.bbci.co.uk/news/rss.xml">
  <int:poller fixed-rate="5000" max-messages-per-poll="100" />
 </int-feed:inbound-channel-adapter>

 <int:channel id="output"/>
</beans>
```

The adapter is configured to poll the BBC News Feed every 5 seconds. Once an item is found, it will create a message with a SyndEntryImpl domain object payload and write it to a message channel called *output*. The name *output* should be used by convention so that your source module can easily be combined with any processor and sink module in a stream.

Make the module configurable

Users may want to pull data from feeds other than BBC News. Spring XD will automatically make a PropertyPlaceholderConfigurer available to your application context. You can simply reference property names and users can then pass in values when creating a stream using the DSL.

```
<int-feed:inbound-channel-adapter  id="xdFeed" channel="output" url="${url:http://
feeds.bbci.co.uk/news/rss.xml}">
  <int:poller fixed-rate="5000" max-messages-per-poll="100" />
</int-feed:inbound-channel-adapter>
```

Now users can optionally pass a *url* property value on stream creation. If not present, the specified default will be used.

B.3 Test the module locally

This section covers setup of a local project containing some code for testing outside of an XD container. This step can be skipped if you prefer to test the module by deploying to Spring XD.

Create a project

The module can be tested by writing a Spring integration test to load the context file and validate that news items are received. In order to write the test, you will need to create a project in an IDE such as STS, Eclipse, or IDEA. Eclipse will be used for this example.

Create a *feed* directory and add *feed.xml* to *src/main/resources*. Add the following *build.gradle* (or an equivalent *pom.xml*) to the root directory:

```
description = 'Feed Source Module'
group = 'org.springframework.xd.samples'

repositories {
  maven { url "http://repo.spring.io/libs-snapshot" }
  maven { url "http://repo.spring.io/plugins-release" }
}

apply plugin: 'java'
apply plugin: 'eclipse'
apply plugin: 'idea'

ext {
    junitVersion = '4.11'
    springVersion = '4.0.3.RELEASE'
    springIntegrationVersion = '4.0.0.M4'
}

dependencies {
    compile("org.springframework:spring-core:$springVersion")
    compile "org.springframework:spring-context-support:$springVersion"
    compile "org.springframework.integration:spring-integration-feed:
$springIntegrationVersion"

    // Testing
    testCompile "junit:junit:$junitVersion"
    testCompile "org.springframework:spring-test:$springVersion"
}

defaultTasks 'build'
```

Run *gradle eclipse* to generate the Eclipse project. Import the project into Eclipse.

Create the Spring integration test

The main objective of the test is to ensure that news items are received once the module’s Application Context is loaded. This can be tested by adding an Outbound Channel Adapter that will direct items to a POJO that can store them for validation.

Add the following *src/test/resources/org/springframework/xd/samples/test-context.xml*:

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xmlns:int="http://www.springframework.org/schema/integration"
 xmlns:context="http://www.springframework.org/schema/context"
 xsi:schemaLocation="http://www.springframework.org/schema/beans
  http://www.springframework.org/schema/beans/spring-beans.xsd
  http://www.springframework.org/schema/context
  http://www.springframework.org/schema/context/spring-context.xsd
  http://www.springframework.org/schema/integration
  http://www.springframework.org/schema/integration/spring-integration.xsd">

 <context:property-placeholder/>

 <int:outbound-channel-adapter channel="output" ref="target" method="add" />

 <bean id="target" class="org.springframework.xd.samples.FeedCache" />

</beans>
```

This context creates an Outbound Channel Adapter that will subscribe to all messages on the *output* channel and pass the message payload to the *add* method of a *FeedCache* object. The context also creates the PropertyPlaceholderConfigurer that is ordinarily provided by the XD container.

Create the *src/test/java/org/springframework/xd/samples/FeedCache* class:

```
package org.springframework.xd.samples;
import ...

public class FeedCache {

 final BlockingDeque<SyndEntry> entries = new LinkedBlockingDeque<SyndEntry>(99);

 public void add(SyndEntry entry) {
  entries.add(entry);
 }
}
```

The *FeedCache* places all received SyndEntry objects on a *BlockingDeque* that our test can use to validate successful routing of messages.

Lastly, create and run the *src/test/java/org/springframework/xd/samples/FeedSourceModuleTest*:

```
package org.springframework.xd.samples;
import ...

@RunWith(SpringJUnit4ClassRunner.class)
@ContextConfiguration(locations={"classpath:feed.xml", "test-context.xml"})
public class FeedSourceModuleTest {

 @Autowired
 FeedCache feedCache;

 @Test
 public void testFeedPolling() throws Exception {
  assertNotNull(feedCache.entries.poll(5, TimeUnit.SECONDS));
 }

}
```

The test will load an Application Context using our feed and test context files. It will fail if a item is not placed into the FeedCache within 5 seconds.

You now have a way to build and test your new module independently. Time to deploy to Spring XD!

B.4 Deploy the module

Spring XD looks for modules in the ${xd.home}/modules directory. The modules directory organizes module types in sub-directories. So you will see something like:

```
modules/processor
modules/sink
modules/source
```

Simply drop *feed.xml* into the *modules/source* directory and add the dependencies to the lib directory by copying the following jars from your gradle cache to `${xd.home}/lib`:

```
spring-integration-feed-4.0.0.M4.jar
jdom-1.0.jar
rome-1.0.0.jar
rome-fetcher-1.0.0.jar
```

Note

For a more sophisticated handling of module dependencies, please see Modules with isolated classpath.

Now fire up the server. See Getting Started to learn how to start the Spring XD server.

B.5 Test the deployed module

Once the XD server is running, create a stream to test it out. This stream will write SyndEntry objects to the XD log:

```
xd:> stream create --name feedtest --definition "feed | log" --deploy
```

You should start seeing messages like the following in the container console window:

```
   WARN logger.feedtest: SyndEntryImpl.contributors=[]
SyndEntryImpl.contents=[]
SyndEntryImpl.updatedDate=null
SyndEntryImpl.link=http://www.bbc.co.uk/news/uk-22850006#sa-
ns_mchannel=rss&ns_source=PublicRSS20-sa
SyndEntryImpl.titleEx.value=VIDEO: Queen visits Prince Philip in hospital
...
```

As you can see, the *SyndEntryImpl* toString is fairly verbose. To make the output more concise, create a processor module to further transform the SyndEntry or consider converting the entry to JSON and using the JSON Field Extractor to send a single attribute value to the output channel.

Appendix C. Creating a Processor Module

C.1 Introduction

As outlined in the modules document, XD currently supports 3 types of modules: source, sink, and processor. This document walks through creation of a custom processor module.

One or more processors can be included in a stream definition to modify the data as it passes between the initial source and the destination sink. The architecture section covers the basics of processors modules provided out of the box are covered in the processors section.

Here we'll look at how to create and deploy a custom processor module to transform the input from an incoming `twittersearch`. The steps are essentially the same for any source though. Rather than using built-in functionality, we'll write a custom processor implementation class and wire it up using Spring Integration.

C.2 Write the Transformer Code

The tweet messages from `twittersearch` contain quite a lot of data (id, author, time and so on). The transformer we'll write will discard everything but the text content and output this as a string. The output messages from the `twittersearch` source are also strings, containing the tweet data as JSON. We first parse this into a map using Jackson library code, then extract the "text" field from the map.

```java
package custom;

import java.io.IOException;
import java.util.Map;

import org.codehaus.jackson.map.ObjectMapper;
import org.codehaus.jackson.type.TypeReference;
import org.springframework.integration.transformer.MessageTransformationException;

public class TweetTransformer {
  private ObjectMapper mapper = new ObjectMapper();

  public String transform(String payload) {
    try {
      Map<String, Object> tweet = mapper.readValue(payload, new TypeReference<Map<String,
 Object>>() {});
      return tweet.get("text").toString();
    } catch (IOException e) {
      throw new MessageTransformationException("Unable to transform tweet: " +
 e.getMessage(), e);
    }
  }
}
```

C.3 Create the module Application Context File

Create the following file as *tweettransformer.xml*:

```
<?xml version="1.0" encoding="UTF-8"?>

<beans:beans xmlns="http://www.springframework.org/schema/integration"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:beans="http://www.springframework.org/schema/beans"
  xsi:schemaLocation="http://www.springframework.org/schema/beans
    http://www.springframework.org/schema/beans/spring-beans.xsd
    http://www.springframework.org/schema/integration
    http://www.springframework.org/schema/integration/spring-integration.xsd">
  <channel id="input"/>

  <transformer input-channel="input" output-channel="output">
    <beans:bean class="custom.TweetTransformer" />
  </transformer>

  <channel id="output"/>
</beans:beans>
```

C.4 Deploy the Module

To deploy the module, you need to copy the *tweettransformer.xml* file to the `${xd.home}/modules/processors` directory. We also need to make the custom module code available. Spring XD looks for code in the jars it finds in the `${xd.home}/lib` directory. So create a jar with the `TweetTransformer` class in it (and the correct package structure) and drop it into `lib`.

Note

For a more sophisticated handling of module dependencies, please see Modules with isolated classpath.

C.5 Test the deployed module

Start the XD server and try creating a stream to test your processor:

```
xd:> stream create --name javatweets --definition "twittersearch --query=java --
consumerKey=<your_key> --consumerSecret=<your_secret> | tweettransformer | file" --deploy
```

If you haven't already used `twittersearch`, read the sources section for more details. This command should stream tweets to the file `/tmp/xd/output/javatweets` but, unlike the normal `twittersearch` output, you should just see the plain tweet text there, rather than the full JSON data.

Appendix D. Creating a Sink Module

D.1 Introduction

As outlined in the modules document, XD currently supports 3 types of modules: source, sink, and processor. This document walks through creation of a custom sink module.

The last module in a stream is always a sink. Sink modules are built with Spring Integration and are typically very fine-grained. A module of type *sink* listens on a channel named *input* and is responsible for outputting received messages to an external resource to terminate the stream.

Spring Integration provides a number of adapters out of the box to support various transports, such as JMS, File, HTTP, Web Services, Mail, and more. You can typically create a sink module that uses these outbound channel adapters by writing just a single Spring application context file.

These steps will demonstrate how to create and deploy a sink module using the Spring Integration RedisStore Outbound Channel Adapter.

D.2 Create the module Application Context file

Create the Outbound Channel Adapter in a file called *redis-store.xml*:

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:int="http://
www.springframework.org/schema/integration"
 xmlns:int-redis="http://www.springframework.org/schema/integration/redis"
 xsi:schemaLocation="http://www.springframework.org/schema/beans
  http://www.springframework.org/schema/beans/spring-beans.xsd
  http://www.springframework.org/schema/integration
  http://www.springframework.org/schema/integration/spring-integration.xsd
  http://www.springframework.org/schema/integration/redis
  http://www.springframework.org/schema/integration/redis/spring-integration-redis.xsd">

 <int:channel id="input" />

 <int-redis:store-outbound-channel-adapter
  id="redisListAdapter" collection-type="LIST" channel="input" key="myCollection" />

 <bean id="redisConnectionFactory"
  class="org.springframework.data.redis.connection.lettuce.LettuceConnectionFactory">
  <constructor-arg index="0" value="${localhost}" />
  <constructor-arg index="1" value="${6379}" />
 </bean>

</beans>
```

The adapter is configured to listen on a channel named *input*. The name *input* should be used by convention so that your sink module will receive all messages sent in the stream. Once a message is received, it will write the payload to a Redis list with key *myCollection*. By default, the RedisStore Outbound Channel Adapter uses a bean named *redisConnectionFactory* to connect to the Redis server.

Note

By default, the adapter uses a *StringRedisTemplate*. Therefore, this module will store all payloads directly as Strings. Create a custom *RedisTemplate* with different value Serializers to serialize other forms of data like Java objects to the Redis collection.

D.3 Make the module configurable

Users may want to specify a different Redis server or key to use for storing data. Spring XD will automatically make a PropertyPlaceholderConfigurer available to your application context. You can simply reference property names and users can then pass in values when creating a stream using the DSL

```
        <int-redis:store-outbound-channel-adapter
   id="redisListAdapter" collection-type="LIST" channel="input" key="${key:myCollection}" /
>

 <bean id="redisConnectionFactory"
  class="org.springframework.data.redis.connection.lettuce.LettuceConnectionFactory">
  <constructor-arg index="0" value="${hostname:localhost}" />
  <constructor-arg index="1" value="${port:6379}" />
 </bean>
```

Now users can optionally pass *key*, *hostname*, and *port* property values on stream creation. If not present, the specified defaults will be used.

D.4 Test the module locally

This section covers setup of a local project containing some code for testing outside of an XD container. This step can be skipped if you prefer to test the module by deploying to Spring XD.

Create a project

The module can be tested by writing a Spring integration test to load the context file and validate that messages are stored in Redis. In order to write the test, you will need to create a project in an IDE such as STS, Eclipse, or IDEA. Eclipse will be used for this example.

Create a *redis-store* directory and add *redis-store.xml* to *src/main/resources*. Add the following *build.gradle* (or an equivalent *pom.xml*) to the root directory:

```
description = 'Redis Store Sink Module'
group = 'org.springframework.xd.samples'

repositories {
  maven { url "http://repo.spring.io/libs-snapshot" }
  maven { url "http://repo.spring.io/plugins-release" }
}

apply plugin: 'java'
apply plugin: 'eclipse'
apply plugin: 'idea'

ext {
    junitVersion = '4.11'
    lettuceVersion = '2.3.3'
    springVersion = '4.0.3.RELEASE'
    springIntegrationVersion = '4.0.0.M4'
    springDataRedisVersion = '1.1.1.RELEASE'
}

dependencies {
    compile("org.springframework:spring-core:$springVersion")
    compile "org.springframework:spring-context-support:$springVersion"
    compile "org.springframework.integration:spring-integration-core:
$springIntegrationVersion"
    compile "org.springframework.integration:spring-integration-redis:
$springIntegrationVersion"
    compile "org.springframework.data:spring-data-redis:$springDataRedisVersion"

    // Testing
    testCompile "junit:junit:$junitVersion"
    testCompile "org.springframework:spring-test:$springVersion"
    testCompile "com.lambdaworks:lettuce:$lettuceVersion"
}

defaultTasks 'build'
```

Run *gradle eclipse* to generate the Eclipse project. Import the project into Eclipse.

Create the Spring integration test

The main objective of the test is to ensure that messages are stored in a Redis list once the module’s Application Context is loaded. This can be tested by adding an Inbound Channel Adapter that will direct test messages to the *input* channel.

Add the following *src/test/resources/org/springframework/xd/samples/test-context.xml*:

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:int="http://
www.springframework.org/schema/integration"
 xmlns:context="http://www.springframework.org/schema/context"
 xsi:schemaLocation="http://www.springframework.org/schema/beans
  http://www.springframework.org/schema/beans/spring-beans.xsd
  http://www.springframework.org/schema/context
  http://www.springframework.org/schema/context/spring-context.xsd
  http://www.springframework.org/schema/integration
  http://www.springframework.org/schema/integration/spring-integration.xsd">

 <context:property-placeholder />

 <int:inbound-channel-adapter channel="input" expression="'TESTING'">
  <int:poller fixed-rate="1000" />
 </int:inbound-channel-adapter>

 <bean id="redisTemplate" class="org.springframework.data.redis.core.StringRedisTemplate">
  <property name="connectionFactory" ref="redisConnectionFactory" />
 </bean>

</beans>
```

This context creates an Inbound Channel Adapter that will generate messages with the payload "TESTING". The context also creates the PropertyPlaceholderConfigurer that is ordinarily provided by the XD container. The *redisTemplate* is configured for use by the test to verify that data is placed in Redis.

Lastly, create and run the *src/test/java/org/springframework/xd/samples/RedisStoreSinkModuleTest*:

```
package org.springframework.xd.samples;
import ...

@RunWith(SpringJUnit4ClassRunner.class)
@ContextConfiguration(locations={"classpath:redis-store.xml", "test-context.xml"})
public class RedisStoreSinkModuleTest {

 @Autowired
 RedisTemplate<String,String> redisTemplate;

 @Test
 public void testTweetSearch() throws Exception {
      assertNotNull(redisTemplate.boundListOps("myCollection").leftPop(5,
 TimeUnit.SECONDS));
 }
}
```

The test will load an Application Context using our redis-store and test context files. It will fail if an item is not placed in the Redis list within 5 seconds.

Run the test

The test requires a running Redis server. See Getting Started for information on installing and starting Redis.

You now have a way to build and test your new module independently. Time to deploy to Spring XD!

D.5 Deploy the module

Spring XD looks for modules in the ${xd.home}/modules directory. The modules directory organizes module types in sub-directories. So you will see something like:

```
modules/processor
modules/sink
modules/source
```

Simply drop *redis-store.xml* into the *modules/sink* directory and fire up the server. See Getting Started to learn how to start the Spring XD server.

D.6 Test the deployed module

Once the XD server is running, create a stream to test it out. This stream will write tweets containing the word "java" to Redis as a JSON string:

```
xd:> stream create --name javasearch --definition "twittersearch --consumerKey=<your_key>
 --consumerSecret=<your_secret> --query=java | redis-store --key=javatweets" --deploy
```

Note that you need to have a consumer key and secret to use the `twittersearch` module. See the description in the streams section for more information.

Fire up the redis-cli and verify that tweets are being stored:

```
$ redis-cli
redis 127.0.0.1:6379> lrange javatweets 0 -1
1) {\"id\":342386150738120704,\"text\":\"Now Hiring: Senior Java Developer\",\"createdAt
\":1370466194000,\"fromUser\":\"jencompgeek\",...\"}"
```

Appendix E. Providing Module Options Metadata

E.1 Introduction

Each available module can expose metadata about the options it accepts. This is useful to enhance the user experience, and is the foundation to advanced features like contextual help and code completion.

For example, provided that the file source module has been enriched with options metadata (and it has), one can use the `module info` command in the shell to get information about the module:

```
xd:> module info source:file
Information about source module 'file':

  Option Name        Description
        Default   Type
  -----------------
 ---------------------------------------------------------------------------  -------
 ---------
  dir                the absolute path to the directory to monitor for files
        <none>   String
  pattern            a filter expression (Ant style) to accept only files that match the
 pattern  *        String
  outputType         how this module should emit messages it produces
        <none>   MediaType
  preventDuplicates  whether to prevent the same file from being processed twice
        true     boolean
  ref                set to true to output the File object itself
        false    boolean
  fixedDelay         the fixed delay polling interval specified in seconds
        5        int
```

For this to be available, module authors have to provide a little bit of extra information, known as "Module Options Metadata". That metadata can take two forms, depending on the needs of the module: one can either use the "simple" approach, or the "POJO" approach. If one does not need advanced features like profile activation, validation or options encapsulation, then the "simple" approach is sufficient.

E.2 Using the "Simple" approach

To use the simple approach, simply create a file named `<module>.properties` right next to the `<module>.xml` file for your module.

Declaring and documenting an option

In that file, each option `<option>` is declared by adding a line of the form

```
options.<option>.description = the description
```

The description for the option is the only required part, and is a very important piece of information for the end user, so pay special attention to it (see also Style remarks)

That sole line in the properties file makes a `--<option>=` construct available in the definition of a stream using your module.

About plugin provided options metadata

Some options are automatically added to a module, depending on its type. For example, every source module automatically inherits a `outputType` option, that controls the type conversion feature between modules. You don't have to do anything for that to happen.

Similarly, every job module benefits from a handful of job specific options.

Here is a recap of those automatically provided options:

Module Type	Options
Source	outputType
Processor	outputType, inputType
Sink	inputType
Job	makeUnique, numberFormat, dateFormat

Advertising default values

In addition to this, one can also provide a default value for the option, using

```
options.<option>.default = SomeDefault
```

Doing this, the default value should **not** be used in the placeholder syntax in the xml file. Assuming this is the contents of `foo.properties`:

```
options.bar.description = a very useful option
options.bar.default = 5
```

then in `foo.xml`:

```
<!-- this is correct -->
<feature the-bar="${bar}"" />

<!-- this is incorrect/not needed -->
<feature the-bar="${bar:5}" />
```

The only case(s) where using a default in the `${}` construct is necessary are

1. when the default is computed from a value known only at deployment time. This is typically the case of `${xd.stream.name}`
2. when the default should be sourced from some configuration file. There will then typically be a `PropertyPlaceholderConfigurer` defined in the module and the default will read like `${<option>:<key-in-thefile>}`

Exposing the option type

Lastly, one can document the option type using a construct like

```
options.<option>.type = fully.qualified.class.Name
```

For simple "primitive" types, one can use short names, like so:

```
options.<option>.type = String
or
options.<option>.type = boolean
or
options.<option>.type = Integer
```

Note that there is support for both wrapper types (*e.g.* Integer) and primitive types (*e.g.* int). Although this is used for documentation purposes only, the primitive type would typically be used to indicate a **required** option (`null` being prohibited).

E.3 Using the "POJO" approach

To use advanced features such as profile activation driven by the values provided by the end user, one would need to leverage the "POJO" approach.

Instead of writing a properties file, you will need to write a custom java class that will hold the values at runtime. That class is also introspected to derive metadata about your module.

Declaring options to the module

For the simplest cases, the class you need to write does not need to implement or inherit from anything. The only thing you need to do is to reference it in a properties file named after your module (the same file location you would have used had you been leveraging the "simple" approach):

```
options_class = fully.qualified.name.of.your.Pojo
```

Note that the key is `options_class`, with an *s* and an underscore (not to be confused with `option.<optionname>` that is used in the "simple" approach)

For each option you want available using the `--<option>=` syntax, you must write a public setter annotated with `@ModuleOption`, providing the option description in the annotation.

The type accepted by that setter will be used as the documented type.

That setter will typically be used to store the value in a private field. How the module application can get ahold of the value is the topic of the next section.

Exposing values to the context

For a provided value to be used in the module definition (using the `${foo}` syntax), your POJO class needs to expose a `getFoo()` getter.

At runtime, an instance of the POJO class will be created (it requires a no-arg constructor, by the way) and values given by the user will be bound (using setters). The POJO class thus acts as an intermediate `PropertySource` to provide values to `${foo}` constructs.

Providing defaults

To provide default values, one would most certainly simply store a default value in the backing field of a getter/setter pair. That value (actually, the result of invoking the matching getter to a setter on a newly instanciated object) is what is advertised as the default.

Encapsulating options

Although one would typically use the combination of a `foo` field and a `getFoo(), setFoo(x)` pair, one does not have to.

In particular, if your module definition requires some "complex" (all things being relative here) value to be computed from "simpler" ones (*e.g.* a *suffix* value would be computed from an *extension* option, that would take care of adding a dot, depending on whether it is blank or not), then you'd simply do the following:

```
public class MyOptions {
  private String extension;

  @ModuleOption("the file extension to use")
  public void setExtension(String extension) {
      this.extension = extension;
  }

  public String getSuffix() {
      return extension == null ? null : "." + extension;
  }
}
```

This would expose a `--extension=` option, being surfaced as a `${suffix}` placeholder construct.

The astute reader will have realized that the default can not be computed then, because there is no `getExtension()` (and there should not be, as this could be mistakenly used in `${extension}`). To provide the default value, you should use the `defaultValue` attribute of the `@ModuleOption` annotation.

Using profiles

The real benefit of using a POJO class for options metadata comes with advanced features though, one of which is dynamic profile activation.

If the set of beans (or xml namespaced elements) you would define in the module definition file depends on the value that the user provided for one or several options, then you can make your POJO class implement `ProfileNamesProvider`. That interface brings one contract method, `profilesToActivate()` that you must implement, returning the names of the profiles you want to use (this method is invoked **after** user option values have been bound, so you can use any logic involving those to compute the list of profile names).

As an example of this feature, see *e.g.* `TriggerSourceOptionsMetadata`.

Using validation

Your POJO class can optionally bear JSR303 annotations. If it does, then validation will occur after values have been successfully bound (understand that injection can fail early due to type incoherence by the way. This comes for free and does not require JSR303 annotations).

This can be used to validate a set of options passed in (some are often mutually exclusive) or to catch misconfiguration earlier than deployment time (*e.g.* a port number cannot be negative).

E.4 Metadata style remarks

To provide a uniform user experience, it is better if your options metadata information adheres to the following style:

- option names should follow the `camelCase` syntax, as this is easier with the POJO approach. If we later decide to switch to a more `unix-style`, this will be taken care of by XD itself, with no change to the metadata artifacts described here
- description sentences should be concise
- descriptions should start with a **lowercase** letter and should **not** end with a dot
- use primitive types for required numbers
- descriptions should mention the unit for numbers (*e.g* ms)
- descriptions should **not** describe the default value, to the best extent possible (this is surfaced thru the actual *default* metadata awareness)
- options metadata should know about the default, rather than relying on the `${foo:default}` construct

Appendix F. Building Spring XD

F.1 Instructions

Here are some useful steps to build and run Spring XD.

To build all sub-projects and run tests for Spring XD (please note tests require a running Redis instance):

```
./gradlew build
```

To build and bundle the distribution of Spring XD

```
./gradlew dist
```

The above gradle task creates spring-xd-<version>.zip binary distribution archive and spring-xd-<version>-docs.zip documentation archive files under *build/distributions*. This will also create a *build/dist/spring-xd* directory which is the expanded version of the binary distribution archive.

To just create the Spring XD expanded binary distribution directory

```
./gradlew copyInstall
```

The above gradle task creates the distribution directory under *build/dist/spring-xd*.

Once the binary distribution directory is created, please refer to Getting Started on how to run Spring XD.

F.2 IDE support

If you would like to work with the Spring XD code in your IDE, please use the following project generation depending on the IDE you use:

For Eclipse/Spring Tool Suite

```
./gradlew eclipse
```

For IntelliJ IDEA

```
./gradlew idea
```

Then just import the project as an existing project.

F.3 Running script tests

Apart from the unit and integration tests, the directory `src/test/scripts` contains set of scripts that run end-to-end tests on XD runtime. Please see the instructions to setup and run:

- Once XD is built (with copyInstall), from the distribution directory: `build/dist/spring-xd/xd/bin/xd/bin/xd-singlenode(.bat)`
- Setup XD_HOME environment variable that points to `build/dist/spring-xd/xd`
- From the directory `src/test/scripts`, run `basic_stream_tests`

- For the `jdbc_tests`, we need to run `install_sqlite_jar` first that installs sqlite jar into `$XD_HOME/lib`
- For the `hdfs_import_export_tests`, make sure you have setup hadoop environment and have the `xd-singlenode` started with appropriate hadoopDistro option and hadoop lib jars for the version chosen
- For `tweet_tests`, make sure you have the twitter properties updated before running the tests

Appendix G. Monitoring and Management

Spring XD uses Spring Boot's monitoring and management support over HTTP and JMX along with Spring Integration's MBean Exporters

G.1 Monitoring XD Admin, Container and Single-node servers

Following are available by **default**

JMX is enabled `XD_JMX_ENABLED=true`

The spring boot management endpoints are exposed over `HTTP` and since `JMX` is enabled these endpoints are exposed over `JMX`

Spring integration components are exposed over `JMX` using `IntegrationMBeanExporter`

All the availble MBeans can be accessed over `HTTP` using `Jolokia`

To enable boot provided management endpoints over HTTP

By **default** `management.port` is set to use admin/container server port and all the exposed endpoints can be accessed from the root context of admin and container servers.

When starting admin, container or singlenode server, the command-line option `--mgmtPort` can be specified to use an explicit port for management server. With the given valid management port, the management endpoints can be accessed from that port. Please refer Spring Boot document here for more details on the endpoints.

For instance, once XD admin is started on localhost and the management port set to use the admin port (9393)

```
http://localhost:9393/health
http://localhost:9393/env
http://localhost:9393/beans etc.,
```

To disable boot endpoints over HTTP

Set `management.port=-1` for both default and container profiles in config/servers.yml

Management over JMX

All the boot endpoints are exposed over JMX with the domain name `org.springframework.boot` The MBeans that are exposed within XD admin, container server level are available with the domain names `xd.admin` (for XD admin), `xd.container` (for XD container), `xd.shared.server` and `xd.parent` representing the application contexts common to both XD admin and container. Singlenode server will have all these domain names exposed. When the stream/job gets deployed into the XD container, the stream/job MBeans are exposed with specific domain/object naming strategy.

To disable management over JMX

Set `XD_JMX_ENABLED=false` in config/servers.yml or set it as an environment variable to disable the management over JMX

G.2 Monitoring deployed modules in XD container

When a module is deployed (with JMX is enabled on the XD container), the **IntegrationMBeanExporter** is injected into module's context via MBeanExportingPlugin and this exposes all the spring integration components inside the module. For the given module, the IntegrationMBeanExporter uses a specific object naming strategy that assigns domain name as `xd.<stream/job name>` and, object name as `<module name>.<module index>`.

For a stream name `mystream` with DSL `http | log` will have

MBeans with domain name `xd.mystream` with two objects `http.0` and `log.1`

For a job name `myjob` with DSL `jdbchdfs` will have

MBeans with domain name `xd.myjob` with an object `jdbchdfs.0`

G.3 Using Jolokia to access JMX over http

When JMX is enabled (which is **default** via `XD_JMX_ENABLED` property), Jolokia is auto-configured to expose the XD admin, container and singenode server MBeans.

For example, with XD singlenode running management port 9080

```
http://localhost:9080/jolokia/search/xd.*:type=*,*
```

will list all the MBeans exposed in XD admin/container servers. Apart from this, other available domain and types can be accessed via Jolokia.

Please note that the deployed modules MBeans aren't exposed via Jolokia yet.But, those are accessible using tools like jconsole etc.,

Appendix H. XD Shell Command Reference

H.1 Base Commands

admin config server

Configure the XD admin server to use.

```
admin config server [[--uri] <uri>]
```

uri
: the location of the XD Admin REST endpoint. **(default: `http://localhost:9393/`)**

admin config info

Show the XD admin server being used.

```
admin config info
```

H.2 Runtime Commands

runtime containers

List runtime containers.

```
runtime containers
```

runtime modules

List runtime modules.

```
runtime modules [[--containerId] <containerId>]
```

containerId
: to filter by container id.

H.3 Stream Commands

stream create

Create a new stream definition.

```
stream create [--name] <name> --definition <definition> [--deploy [<deploy>]]
```

name
: the name to give to the stream. **(required)**

definition
: a stream definition, using XD DSL (e.g. "http --port=9000 | hdfs"). **(required)**

deploy
whether to deploy the stream immediately. **(default: `false`, or `true` if `--deploy` is specified without a value)**

stream destroy

Destroy an existing stream.

```
stream destroy [--name] <name>
```

name
the name of the stream to destroy. **(required)**

stream all destroy

Destroy all existing streams.

```
stream all destroy [--force [<force>]]
```

force
bypass confirmation prompt. **(default: `false`, or `true` if `--force` is specified without a value)**

stream deploy

Deploy a previously created stream.

```
stream deploy [--name] <name> [--properties <properties>]
```

name
the name of the stream to deploy. **(required)**

properties
the properties for this deployment.

stream undeploy

Un-deploy a previously deployed stream.

```
stream undeploy [--name] <name>
```

name
the name of the stream to un-deploy. **(required)**

stream all undeploy

Un-deploy all previously deployed stream.

```
stream all undeploy [--force [<force>]]
```

force
bypass confirmation prompt. **(default: `false`, or `true` if `--force` is specified without a value)**

stream list

List created streams.

```
stream list
```

H.4 Job Commands

job create

Create a job.

```
job create [--name] <name> --definition <definition> [--deploy [<deploy>]]
```

name
: the name to give to the job. **(required)**

definition
: job definition using xd dsl . **(required)**

deploy
: whether to deploy the job immediately. **(default: `false`, or `true` if `--deploy` is specified without a value)**

job list

List all jobs.

```
job list
```

job execution list

List all job executions.

```
job execution list
```

job execution step list

List all step executions for the provided job execution id.

```
job execution step list [--id] <id>
```

id
: the id of the job execution. **(required)**

job execution step progress

Get the progress info for the given step execution.

```
job execution step progress [--id] <id> --jobExecutionId <jobExecutionId>
```

id
: the id of the step execution. **(required)**

jobExecutionId
: the job execution id. **(required)**

job execution step display

Display the details of a Step Execution.

```
job execution step display [--id] <id> --jobExecutionId <jobExecutionId>
```

id
: the id of the step execution. **(required)**

jobExecutionId
: the job execution id. **(required)**

job execution display

Display the details of a Job Execution.

```
job execution display [--id] <id>
```

id
: the id of the job execution. **(required)**

job execution all stop

Stop all the job executions that are running.

```
job execution all stop [--force [<force>]]
```

force
: bypass confirmation prompt. **(default: `false`, or `true` if `--force` is specified without a value)**

job execution stop

Stop a job execution that is running.

```
job execution stop [--id] <id>
```

id
: the id of the job execution. **(required)**

job execution restart

Restart a job that failed or interrupted previously.

```
job execution restart [--id] <id>
```

id
: the id of the job execution that failed or interrupted. **(required)**

job deploy

Deploy a previously created job.

```
job deploy [--name] <name>
```

name
: the name of the job to deploy. **(required)**

job launch

Launch previously deployed job.

```
job launch [[--name] <name>] [--params <params>]
```

name
: the name of the job to deploy.

params
: the parameters for the job. **(default: ``)**

job undeploy

Un-deploy an existing job.

```
job undeploy [--name] <name>
```

name
: the name of the job to un-deploy. **(required)**

job all undeploy

Un-deploy all existing jobs.

```
job all undeploy [--force [<force>]]
```

force
: bypass confirmation prompt. **(default: `false`, or `true` if `--force` is specified without a value)**

job instance display

Display information about a given job instance.

```
job instance display [[--id] <id>]
```

id
: the id of the job instance to retrieve.

job destroy

Destroy an existing job.

```
job destroy [--name] <name>
```

name
: the name of the job to destroy. **(required)**

job all destroy

Destroy all existing jobs.

```
job all destroy [--force [<force>]]
```

force
: bypass confirmation prompt. **(default: `false`, or `true` if `--force` is specified without a value)**

H.5 Module Commands

module info

Get information about a module.

```
module info [--name] <name>
```

name
: name of the module to query, in the form *type:name*. **(required)**

module compose

Create a virtual module.

```
module compose [--name] <name> --definition <definition>
```

name
: the name to give to the module. **(required)**

definition
: module definition using xd dsl. **(required)**

module delete

Delete a virtual module.

```
module delete [--name] <name>
```

name
: name of the module to delete, in the form *type:name*. **(required)**

module list

List all modules.

```
module list
```

module display

Display the configuration file of a module.

```
module display [--name] <name>
```

name
: name of the module to display, in the form *type:name*. **(required)**

H.6 Metrics Commands

counter list

List all available counter names.

```
counter list
```

counter delete

Delete the counter with the given name.

```
counter delete [--name] <name>
```

name
: the name of the counter to delete. **(required)**

counter display

Display the value of a counter.

```
counter display [--name] <name> [--pattern <pattern>]
```

name
: the name of the counter to display. **(required)**

pattern
: the pattern used to format the value (see DecimalFormat). **(default: `<use platform locale>`)**

field-value-counter list

List all available field-value-counter names.

```
field-value-counter list
```

field-value-counter delete

Delete the field-value-counter with the given name.

```
field-value-counter delete [--name] <name>
```

name
: the name of the field-value-counter to delete. **(required)**

field-value-counter display

Display the value of a field-value-counter.

```
field-value-counter display [--name] <name> [--pattern <pattern>] [--size <size>]
```

name
: the name of the field-value-counter to display. **(required)**

pattern
: the pattern used to format the field-value-counter’s field count (see DecimalFormat). **(default: `<use platform locale>`)**

size
: the number of values to display. **(default: `25`)**

aggregate-counter list

List all available aggregate counter names.

```
aggregate-counter list
```

aggregate-counter delete

Delete an aggregate counter.

```
aggregate-counter delete [--name] <name>
```

name
: the name of the aggregate counter to delete. **(required)**

aggregate-counter display

Display aggregate counter values by chosen interval and resolution(minute, hour).

```
aggregate-counter display [--name] <name> [--from <from>] [--to <to>] [--lastHours
 <lastHours>] [--lastDays <lastDays>] [--resolution <resolution>] [--pattern <pattern>]
```

name
: the name of the aggregate counter to display. **(required)**

from
: start-time for the interval. format: *yyyy-MM-dd HH:mm:ss*.

to
: end-time for the interval. format: *yyyy-MM-dd HH:mm:ss*. defaults to now.

lastHours
: set the interval to last *n* hours.

lastDays
: set the interval to last *n* days.

resolution
: the size of the bucket to aggregate (minute, hour, day, month). **(default: `hour`)**

pattern
: the pattern used to format the count values (see DecimalFormat). **(default: `<use platform locale>`)**

gauge list

List all available gauge names.

```
gauge list
```

gauge delete

Delete a gauge.

```
gauge delete [--name] <name>
```

name
the name of the gauge to delete. **(required)**

gauge display

Display the value of a gauge.

```
gauge display [--name] <name> [--pattern <pattern>]
```

name
the name of the gauge to display. **(required)**

pattern
the pattern used to format the value (see DecimalFormat). **(default: `<use platform locale>`)**

rich-gauge list

List all available richgauge names.

```
rich-gauge list
```

rich-gauge delete

Delete the richgauge.

```
rich-gauge delete [--name] <name>
```

name
the name of the richgauge to delete. **(required)**

rich-gauge display

Display Rich Gauge value.

```
rich-gauge display [--name] <name> [--pattern <pattern>]
```

name
the name of the richgauge to display value. **(required)**

pattern
the pattern used to format the richgauge value (see DecimalFormat). **(default: `<use platform locale>`)**

H.7 Http Commands

http post

POST data to http endpoint.

```
http post [[--target] <target>] [--data <data>] [--file <file>] [--contentType
 <contentType>]
```

target
: the location to post to. **(default: `http://localhost:9000`)**

data
: the text payload to post. exclusive with file. embedded double quotes are not supported if next to a space character.

file
: filename to read data from. exclusive with data.

contentType
: the content-type to use. file is also read using the specified charset. **(default: `text/plain; Charset=UTF-8`)**

http get

Make GET request to http endpoint.

```
http get [[--target] <target>]
```

target
: the URL to make the request to. **(default: `http://localhost:9393`)**

H.8 Hadoop Configuration Commands

hadoop config props set

Sets the value for the given Hadoop property.

```
hadoop config props set [--property] <property>
```

property
: what to set, in the form <name=value>. **(required)**

hadoop config props get

Returns the value of the given Hadoop property.

```
hadoop config props get [--key] <key>
```

key
: property name. **(required)**

hadoop config info

Returns basic info about the Hadoop configuration.

```
hadoop config info
```

hadoop config load

Loads the Hadoop configuration from the given resource.

```
hadoop config load [--location] <location>
```

location
: configuration location (can be a URL). **(required)**

hadoop config props list

Returns (all) the Hadoop properties.

```
hadoop config props list
```

hadoop config fs

Sets the Hadoop namenode.

```
hadoop config fs [--namenode] <namenode>
```

namenode
: namenode address - can be local|<namenode:port>. **(required)**

hadoop config jt

Sets the Hadoop job tracker.

```
hadoop config jt [--jobtracker] <jobtracker>
```

jobtracker
: job tracker address - can be local|<jobtracker:port>. **(required)**

H.9 Hadoop FileSystem Commands

hadoop fs get

Copy files to the local file system.

```
hadoop fs get --from <from> --to <to> [--ignoreCrc [<ignoreCrc>]] [--crc [<crc>]]
```

from
: source file names. **(required)**

to
: destination path name. **(required)**

ignoreCrc
: whether ignore CRC. **(default: `false`, or `true` if `--ignoreCrc` is specified without a value)**

crc
: whether copy CRC. **(default: `false`, or `true` if `--crc` is specified without a value)**

hadoop fs put

Copy single src, or multiple srcs from local file system to the destination file system.

```
hadoop fs put --from <from> --to <to>
```

from
: source file names. **(required)**

to
: destination path name. **(required)**

hadoop fs count

Count the number of directories, files, bytes, quota, and remaining quota.

```
hadoop fs count [--quota [<quota>]] --path <path>
```

quota
: whether with quta information. **(default: `false`, or `true` if `--quota` is specified without a value)**

path
: path name. **(required)**

hadoop fs mkdir

Create a new directory.

```
hadoop fs mkdir [--dir] <dir>
```

dir
: directory name. **(required)**

hadoop fs tail

Display last kilobyte of the file to stdout.

```
hadoop fs tail [--file] <file> [--follow [<follow>]]
```

file
: file to be tailed. **(required)**

follow
: whether show content while file grow. **(default: `false`, or `true` if `--follow` is specified without a value)**

hadoop fs ls

List files in the directory.

```
hadoop fs ls [[--dir] <dir>] [--recursive [<recursive>]]
```

dir
: directory to be listed. **(default: `.`)**

recursive
: whether with recursion. **(default: `false`, or `true` if `--recursive` is specified without a value)**

hadoop fs cat

Copy source paths to stdout.

```
hadoop fs cat [--path] <path>
```

path
file name to be shown. **(required)**

hadoop fs chgrp

Change group association of files.

```
hadoop fs chgrp [--recursive [<recursive>]] --group <group> [--path] <path>
```

recursive
whether with recursion. **(default: `false`, or `true` if `--recursive` is specified without a value)**

group
group name. **(required)**

path
path of the file whose group will be changed. **(required)**

hadoop fs chown

Change the owner of files.

```
hadoop fs chown [--recursive [<recursive>]] --owner <owner> [--path] <path>
```

recursive
whether with recursion. **(default: `false`, or `true` if `--recursive` is specified without a value)**

owner
owner name. **(required)**

path
path of the file whose ownership will be changed. **(required)**

hadoop fs chmod

Change the permissions of files.

```
hadoop fs chmod [--recursive [<recursive>]] --mode <mode> [--path] <path>
```

recursive
whether with recursion. **(default: `false`, or `true` if `--recursive` is specified without a value)**

mode
permission mode. **(required)**

path
path of the file whose permissions will be changed. **(required)**

hadoop fs copyFromLocal

Copy single src, or multiple srcs from local file system to the destination file system. Same as put.

```
hadoop fs copyFromLocal --from <from> --to <to>
```

from
source file names. **(required)**

to
destination path name. **(required)**

hadoop fs moveFromLocal

Similar to put command, except that the source localsrc is deleted after it's copied.

```
hadoop fs moveFromLocal --from <from> --to <to>
```

from
source file names. **(required)**

to
destination path name. **(required)**

hadoop fs copyToLocal

Copy files to the local file system. Same as get.

```
hadoop fs copyToLocal --from <from> --to <to> [--ignoreCrc [<ignoreCrc>]] [--crc [<crc>]]
```

from
source file names. **(required)**

to
destination path name. **(required)**

ignoreCrc
whether ignore CRC. **(default: `false`, or `true` if `--ignoreCrc` is specified without a value)**

crc
whether copy CRC. **(default: `false`, or `true` if `--crc` is specified without a value)**

hadoop fs copyMergeToLocal

Takes a source directory and a destination file as input and concatenates files in src into the destination local file.

```
hadoop fs copyMergeToLocal --from <from> --to <to> [--endline [<endline>]]
```

from
source file names. **(required)**

to
destination path name. **(required)**

endline

whether add a newline character at the end of each file. **(default: `false`, or `true` if `--endline` is specified without a value)**

hadoop fs cp

Copy files from source to destination. This command allows multiple sources as well in which case the destination must be a directory.

```
hadoop fs cp --from <from> --to <to>
```

from

source file names. **(required)**

to

destination path name. **(required)**

hadoop fs mv

Move source files to destination in the HDFS.

```
hadoop fs mv --from <from> --to <to>
```

from

source file names. **(required)**

to

destination path name. **(required)**

hadoop fs du

Displays sizes of files and directories contained in the given directory or the length of a file in case its just a file.

```
hadoop fs du [[--dir] <dir>] [--summary [<summary>]]
```

dir

directory to be listed. **(default: `.`)**

summary

whether with summary. **(default: `false`, or `true` if `--summary` is specified without a value)**

hadoop fs expunge

Empty the trash.

```
hadoop fs expunge
```

hadoop fs rm

Remove files in the HDFS.

```
hadoop fs rm [[--path] <path>] [--skipTrash [<skipTrash>]] [--recursive [<recursive>]]
```

path
: path to be deleted. **(default: `.`)**

skipTrash
: whether to skip trash. **(default: `false`, or `true` if `--skipTrash` is specified without a value)**

recursive
: whether to recurse. **(default: `false`, or `true` if `--recursive` is specified without a value)**

hadoop fs setrep

Change the replication factor of a file.

```
hadoop fs setrep --path <path> --replica <replica> [--recursive [<recursive>]] [--waiting
 [<waiting>]]
```

path
: path name. **(required)**

replica
: source file names. **(required)**

recursive
: whether with recursion. **(default: `false`, or `true` if `--recursive` is specified without a value)**

waiting
: whether wait for the replic number is eqal to the number. **(default: `false`, or `true` if `--waiting` is specified without a value)**

hadoop fs text

Take a source file and output the file in text format.

```
hadoop fs text [--file] <file>
```

file
: file to be shown. **(required)**

hadoop fs touchz

Create a file of zero length.

```
hadoop fs touchz [--file] <file>
```

file
: file to be touched. **(required)**