

Kylo Data Lake Operations Guide

V1.0

# Purpose

This guide provides sample instructions for operating and maintaining the Kylo solution. The information is used by the Operations and Support Team in the deployment, installation, updating, monitoring and support of Kylo.

# Scope

This guide is not a step-by-step process for the Operations Team, but a set of examples that we have assembled from our previous experiences.

# Audience

This guide assumes its user to be knowledgeable in IT terms and skills. As an operations and maintenance (O&M) runbook, it describes the information necessary to effectively manage:

* Production processing
* Ongoing maintenance
* Performance monitoring

This document specifically serves to guide those who will be maintaining, supporting, and using the Kylo solution in day-to-day operational basis.

# Abbreviations and Definitions

|  |  |
| --- | --- |
| **Abbreviations/Key term** | **Definition** |
| **O&M** | Operations and Maintenance |
| **AWS** | Amazon Web Services |
| **IAAS** | Infrastructure-as-a-Service, usually used in the context of the Hadoop cluster deployment |
| **PCF** | Pivotal Cloud Foundry |
| **HDP** | Hortonworks Data Platform |
| **CLI** | Command Line Interface |
| **ES** | ElasticSearch |

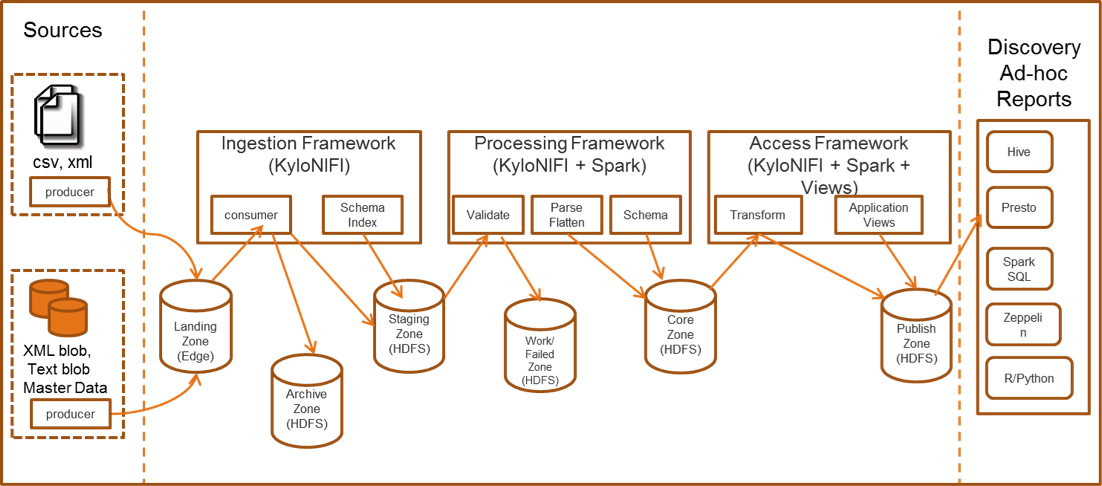
# System Overview

This section provides an overview of the network, servers and service components deployed in an environment. Details of each component and specific responsibilities, configurations, installations and maintenance tasks are outlined in subsequent sections of this document.

## System architecture overview

The Kylo-based Data Lake platform is composed of two main components:

* The **data processing framework** (Hive or Spark jobs running on Hortonworks Data Platform 2.4) is the core of the platform hosting data storage and analytics jobs runtime.
* The **microservices,** which can be broken down into two sub-components:
  + The **ingestion framework** (Kylo/NiFi load, validation and profiling processing)
  + The **Processing Framework**  (NiFi + Spark)
  + The **Access Framework** (Kylo/NiFi, SparkSQL, Views, Presto, Hive, Elastic Search )
  + The graphic shown here depicts the solution architecture overview:



## Functional system overview

### Data processing framework

Kylo provides support for the following pipelines functions:

* pipeline definition
* pipeline deployment
* pipeline execution
* pipeline management
* pipeline monitoring

### Microservices

The microservices are materialized in a string of containerized executables. These services are generated, developed and orchestrated through Kylo (Kylo + Apache NiFi). Each will need to link up with a Providence Service

* **Provenance:**
* All services are responsible for sending provenance or trace messages to an external/pluggable provenance system. Provenance messages are a step above basic logging in that they will be more well defined (what should be logged) and they will be collected by a central provenance system.
* The Provenance Service collects provenance messages posted by the ingestion microservices and persists the messages for traceability and obtaining lineage of a message through the various services. The Provenance Service consists of two components: Provenance Persistence and Provenance Query Service.
* The Provenance Persistence Service is a microservice that reads the messages posted by the ingestion microservice and persists them to Elasticsearch.
* The Provenance Query Service is a microservice that responds to user queries on data traceability by searching Elasticsearch.

#### Ingestion framework

The Ingestion framework supports reception and storage of incoming data files to a “landing zone” from which it is available for processing. The framework consists of several microservices:

* **Producer:**
* Source Data systems are the entry point for all data that is to be ingested. Source Producers will be developed to extract and to post their data sets and/or requests to transfer data sets. It receives data in a variety of formats (for example: XML, CSV, binary, or by URI reference) through a variety of protocols (for example: HTTP/REST, SFTP Kafka/JSON).
* In addition to extracting payload information from the source systems to the Landing Zone, each producer instance extracts metadata relating to the request. Further, data type and validation classification information is also extracted if it is part of the request URI.
* Each Producer instance logs each request to “some enterprise providence service”. On completion of processing, if a failure occurred (for example: the payload is missing information), the request is logged into the Exception Service. This is part of the processing of ensuring full tracking of successful and failed processing.
* Messages successfully processed are put into a standard Ingestion Framework message format for downstream processing. These messages are output to a message queue that is configurable, that will be read by the next microservice in the ingestion workflow.
* **Consumer:**
* Consumer is a simple, configurable, message-driven microservice for transferring data from point A to point B.
* It stores data to long-term, durable storage for subsequent processing (Staging Zone).
* The Consumer Service (NiFi processor) listens for requests on an inbound queue. Each message represents a request to copy a blob (payload of data) from a source location to a target location. The source and target locations are configurable The specific process for determining the source blob name and the destination blob name from the metadata request are also configurable via the transfer service plugins.
* After successful completion of the copy from the source location to staging zone and the archive zone, the consumer service posts a new message on the configured outbound queue as a notification to any interested parties to indicate that the resource is available in the new location.
* **Checkpoint:**
  + Checkpoint service is a microservice that updates and conveys the outcome of the processing of an Ingestion F) to the Provenance service. Both successful and failed processing IMF notify the Checkpoint service. Checkpoint updates the IMF (see Checkpoint IMF classification below) and posts the updated message to Checkpoint outbound Provenance service's message queue.
  + Checkpoint service currently supports configurations for the ingestion pipeline and for the Data Processing Framework (DPF).
  + For ingestion pipeline processing Checkpoint service listens for messages on an inbound message queue and posts modifications to the IMF to the outbound Provenance and Regulator message queues.
  + For the Data Processing Framework (DPF) configurations, messages are posted to Checkpoint's secure HTTPS endpoint by Kylo, as well as the aforementioned outbound queues.

#### Processing Framework

This framework is responsible for validating the data, parsing and converting it to a Relational Format, and adding a Hive Schema to it.

* **Validate:**
* Validation determines if data has any exceptions and pushes validated data to the core zone.
* Exception service is a microservice indicating that an error occurred and conveys the error to the Checkpoint and Provenance services. When an ingestion step fails, the message is posted on the inbound Exception service queue, and then the Exception service posts the update.
* Exception service currently supports configurations for the ingestion pipeline.
* For ingestion pipeline processing, the Exception service listens for messages on an inbound message queue and posts modifications to the Provenance message queues as well as the secure HTTPS endpoint for Kylo.
* **Flatten & Schema:**
* The flattening process parses the data (XML unbundling, or mapping of text fields and keys) and puts the fields into Hive columns with hive data types (because Spark reads Hive Tables faster).
* This creates the new Hive Schema.
* If exceptions occur, interfacing is with the same exception service identified in Validate, and the same processes are followed.

#### Access Framework

This framework is responsible for validating the data, parsing and converting it to a Relational Format, and then adding a Hive Schema to it.

* **Transform:**
* Transformation Services in this example is for future use and is not part of the scope beyond the processing framework identified above.
* Conceptually, data mappings can be generated with NiFi and executed and monitored by Kylo.
* **Application Views:**
* Hive/Presto Views should be created to provide specific data access protections in addition to the other security measures being put in place (for example: Encrypted files in flight, Kerberos, Ranger Policies and Vormetric Transparent Encryption, and Files at rest). This limits what can be retrieved by individual users.
* Semantic mapping to application specific requirements can also be generated here, which can represent logical mapping that occurs during access and not during the traditional ETL phase of processing.

## Introduction

Kylo is a software application that provides scheduling, monitoring, and control for data processing jobs. Kylo includes its own web-based interface intended for an Operations user to visualize status of processing and assist with troubleshooting problems.

Please note, this Operations Guide is provided in its entirety, despite the fact that not all features may be utilized within a particular solution.

## Common Definitions

The following terms are used in this document or are relevant to understanding the nature of Kylo processing.

|  |  |
| --- | --- |
| **Term** | **Definition** |
| Job | A Job consists of a sequence of processing tasks called *steps*.  A Job has both status and state that indicate its outcome. |
| Feed | A feed is a pipeline, jobs are run for feeds. The “health” status of a feed (regardless of its running state) can be visualized on the Kylo Overview page. |
| Check Data Job | An optional job type employed for independent data quality checks against customer data with results contributing to a “Data Confidence” metric visible on the Overview page. |
| Step | A unit of processing in a job sequence. A job consists of one or more steps. Each step also has both status and state, similar to that of a job. Steps may capture metadata, stored in Postgres and viewable in the application. |
| Job Instance Id | The Job Instance and its corresponding Job Instance Id refer to a logical Job run (i.e. A Job with a set of Job Parameters).  A Job Instance can have multiple Job Executions, but only one successful Job Execution. |
| Job Execution Id | The Job Execution and corresponding Job Execution Id refer to a single attempt to run a Job Instance. A Job Instance can have multiple Job Executions if some fail and are restarted. |

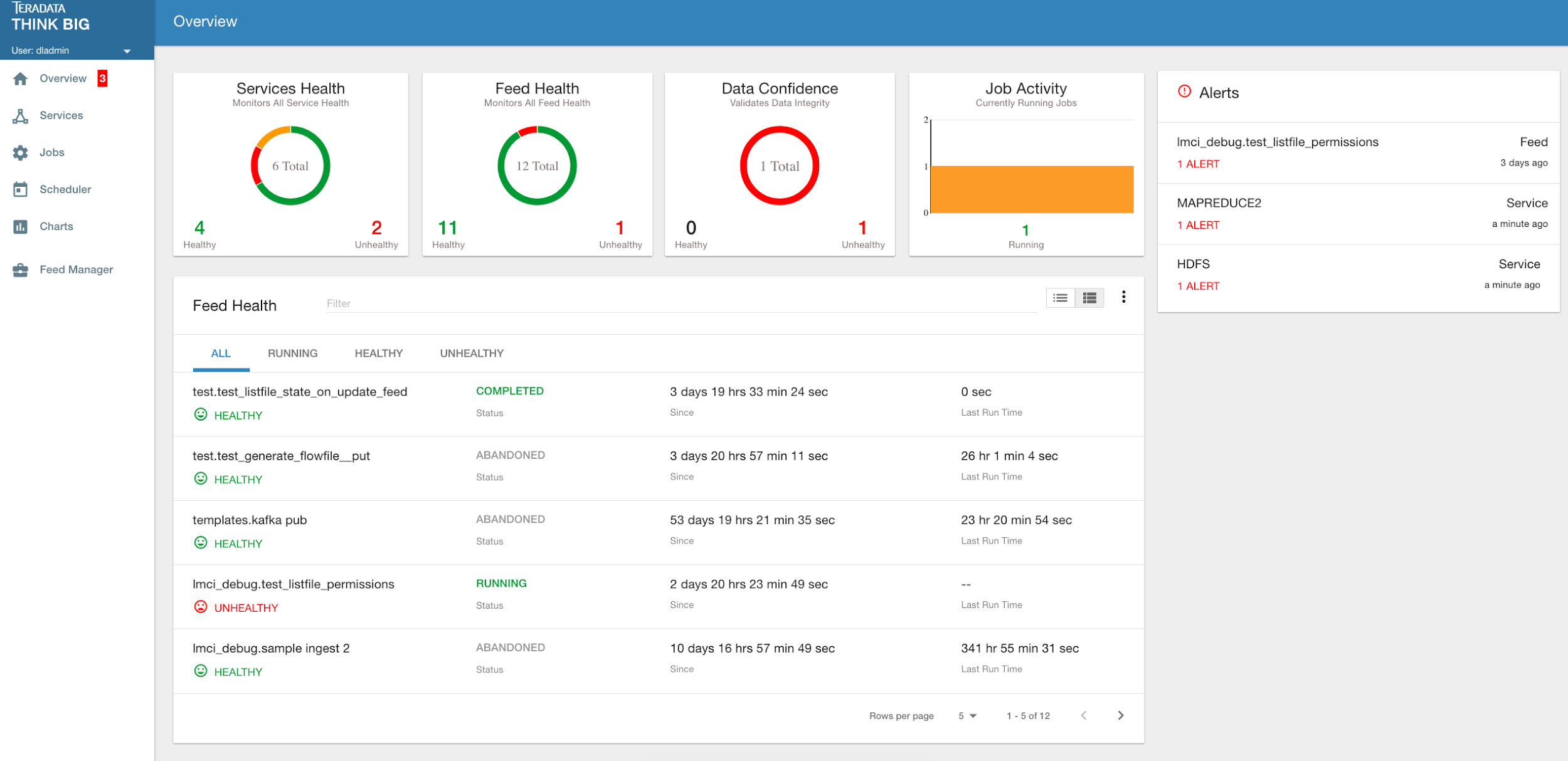
## User Interface

Kylo has a web-based user interface designed for an Operations user to monitor and managing data processing. The default URL is http://<hostname>:8400/, however the port may be configured via the application.properties.

The following sections describe characteristics of the user interface.

## Overview Page

The Overview tab performs the role of an Operations Dashboard. Content in the page automatically refreshes showing real-time health and statistics about data feeds and job status.



Kylo Overview Page

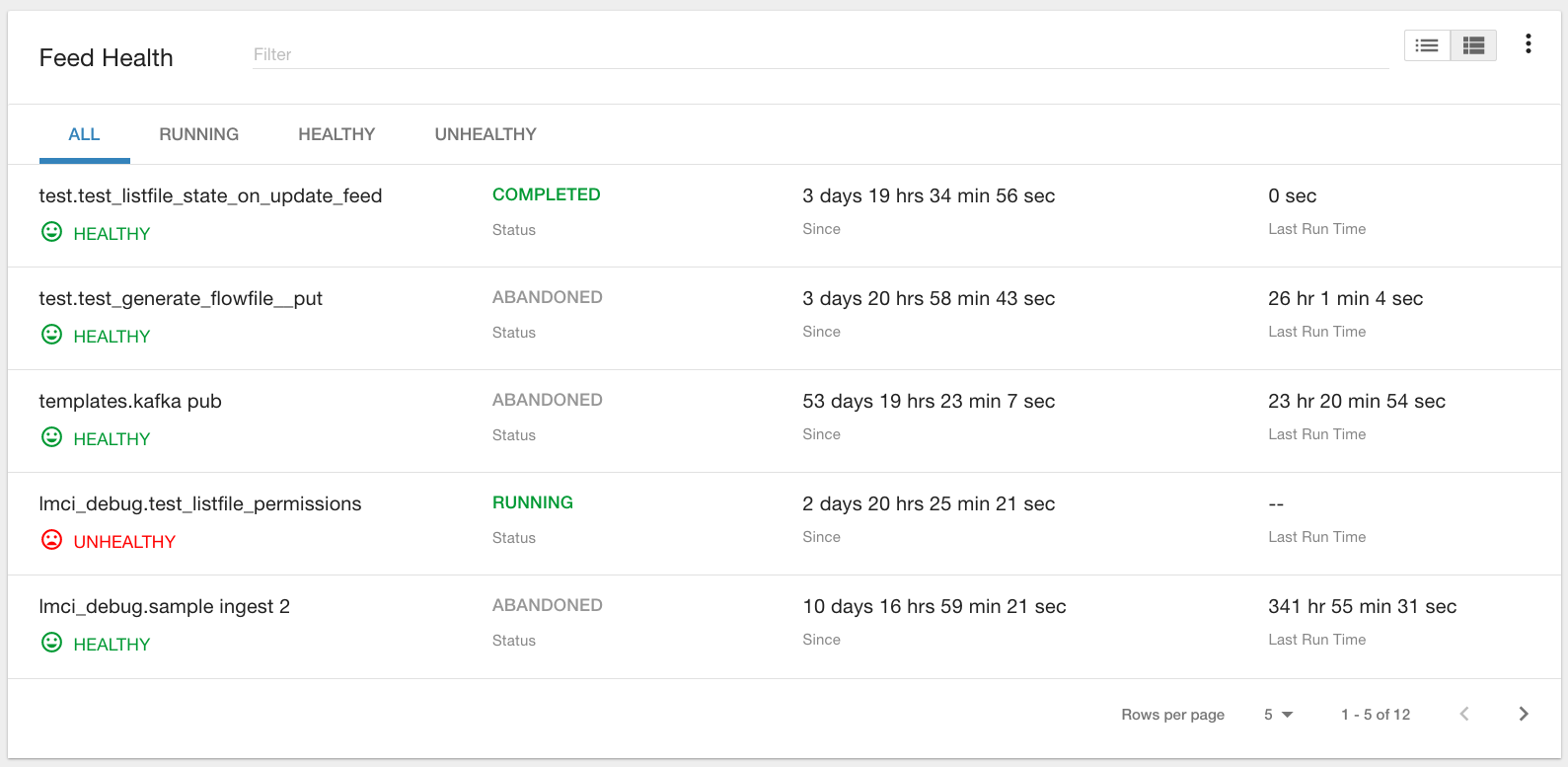
## Key Performance Indicators

The Overview page has multiple indicators that help you quickly assess the health of the system:

|  |  |
| --- | --- |
| Macintosh HD:Users:gh186017:Desktop:Screen Shot 2016-09-26 at 8.58.01 AM.png | Provides a health status of external dependencies such as MySQL or Postgres, Hadoop services. |
| Macintosh HD:Users:gh186017:Desktop:Screen Shot 2016-09-26 at 8.58.05 AM.png | Provides a summary health status of all data feeds. Details of these feeds are shown in a table, Feed Summary, also on the Overview Page |
| Macintosh HD:Users:gh186017:Desktop:Screen Shot 2016-09-26 at 8.58.09 AM.png | Optional. Displays a confidence metric updated by any Data Quality Check jobs. |
| Macintosh HD:Users:gh186017:Desktop:Screen Shot 2016-09-26 at 8.58.12 AM.png | Displays all running jobs. |
| Macintosh HD:Users:gh186017:Desktop:Screen Shot 2016-09-26 at 8.58.51 AM.png | Displays alerts for services and feeds. Click on them for more information. |

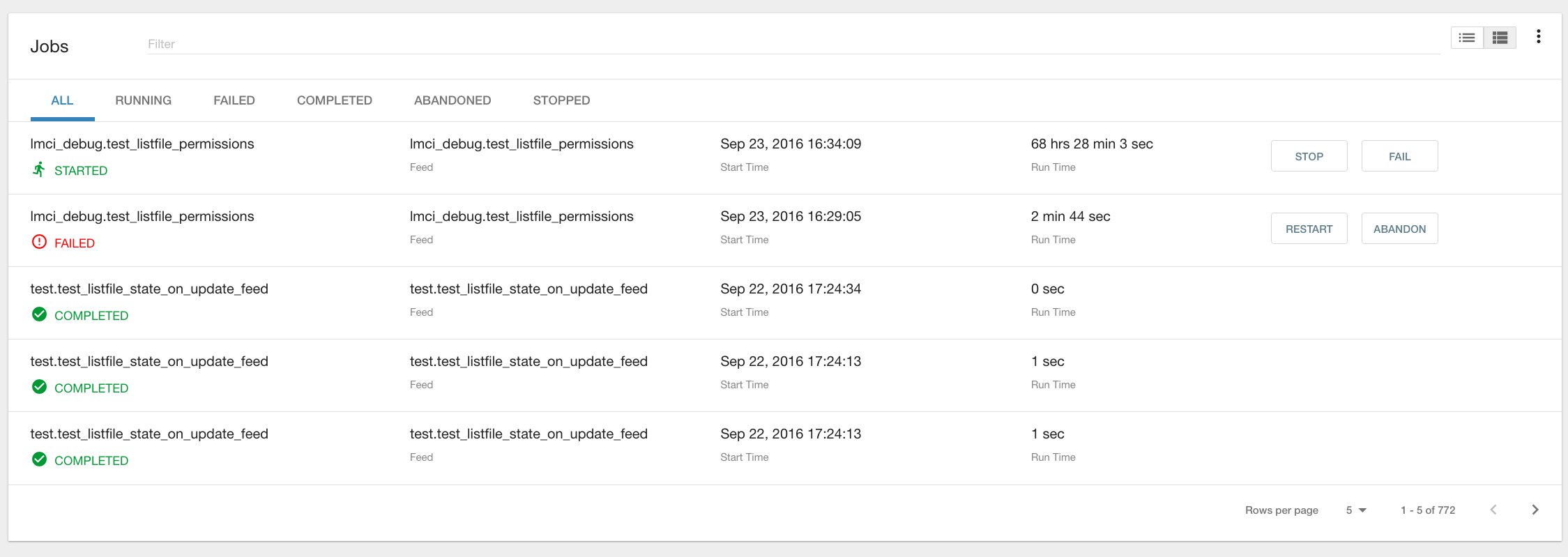
## Feed Summary

The Feed Summary Table provides the state and status of each data feed managed by Kylo. The state is either HEALTHY or UNHEALTHY. The status is the status of the most recent job of the feed. You can drill into a specific feed and see its [history](#_2bn6wsx) by clicking on the name of the feed in the table.



## Active Jobs

The Active Jobs table shows currently running jobs as well as any failed jobs that require user attention. The table displays all jobs. A user may drill-in to view [Job Details](#_1pxezwc) by clicking on the corresponding Job Name cell. Jobs can be controlled via action buttons. Refer to the [Controlling Jobs](#_1ci93xb) section to see the different actions that can be performed for a Job.



## Understanding Job Status

Jobs have two properties that indicate their status and state, Job Status and Exit Code respectively.

## Job Status

The Job Status is the final outcome of a Job.

* COMPLETED – The Job finished.
* FAILED – The Job failed to finish.
* STARTED – The Job is currently running.
* ABANDONED – The Job was abandoned.

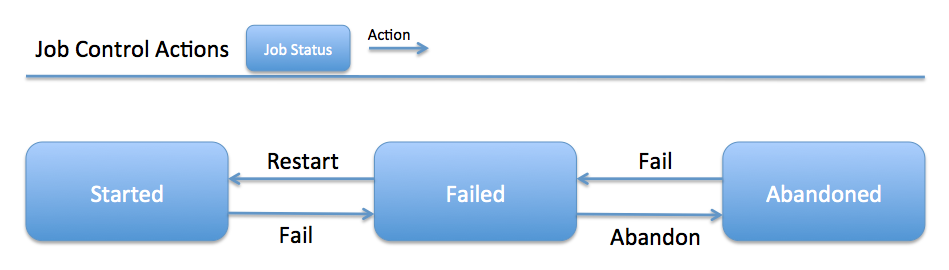
## Job Exit Codes

The Exit Code is the state of the Job.

* COMPLETED – The Job Finished Processing
* EXECUTING - The Job is currently in a processing state
* FAILED – The Job finished with an error
* ABANDONED – The Job was manually abandoned

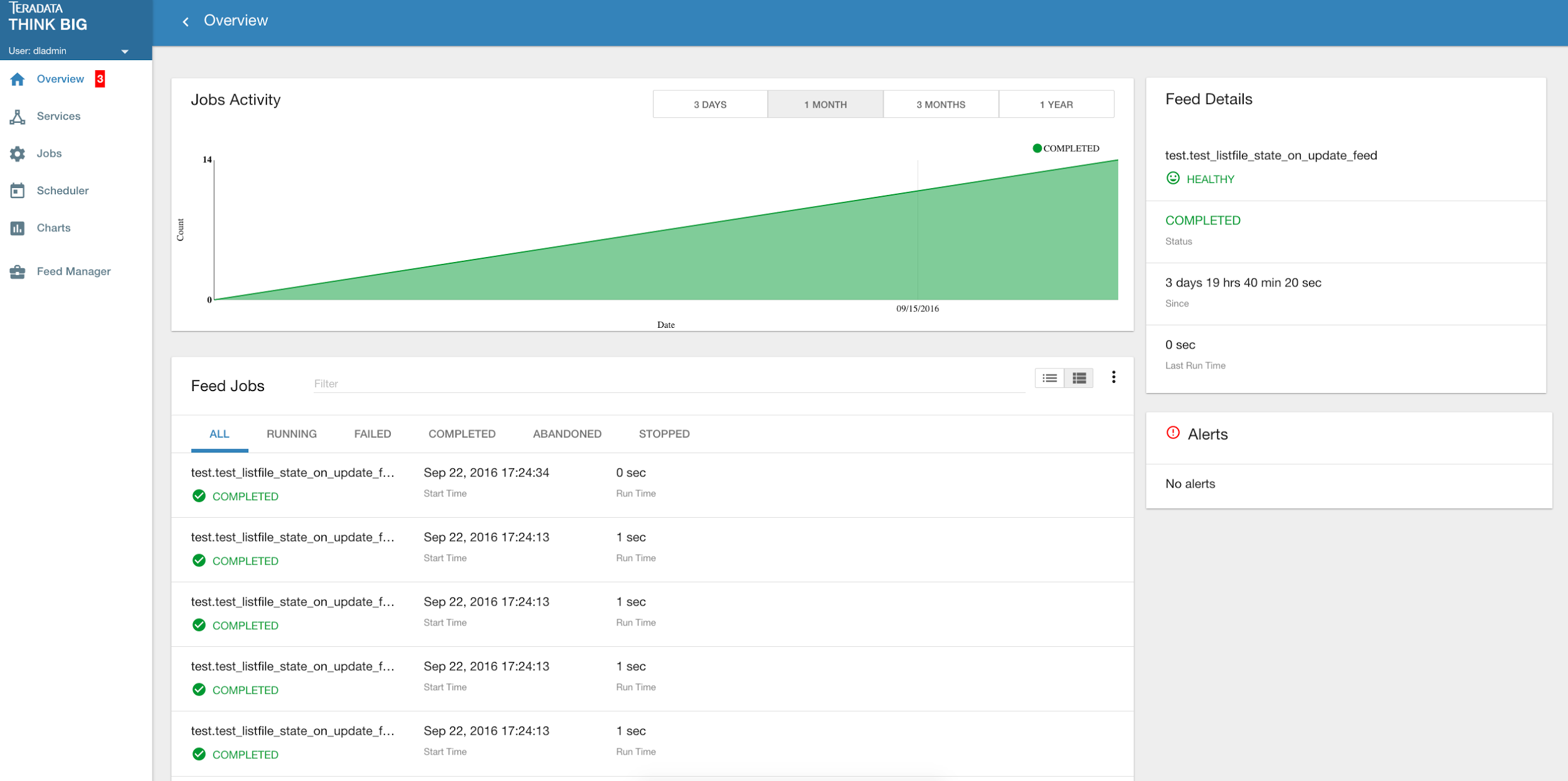
## Controlling Jobs

The image below illustrates the different *actions* that can be performed based on its Job Status:



## Feed History Page

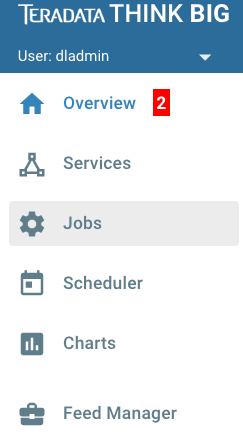
Kylo stores history of each time a feed is executed. You can access this data by clicking on the specific feed name in the Feed Summary table on the Overview page. Initially the Feeds table provides high-level data about the feed.



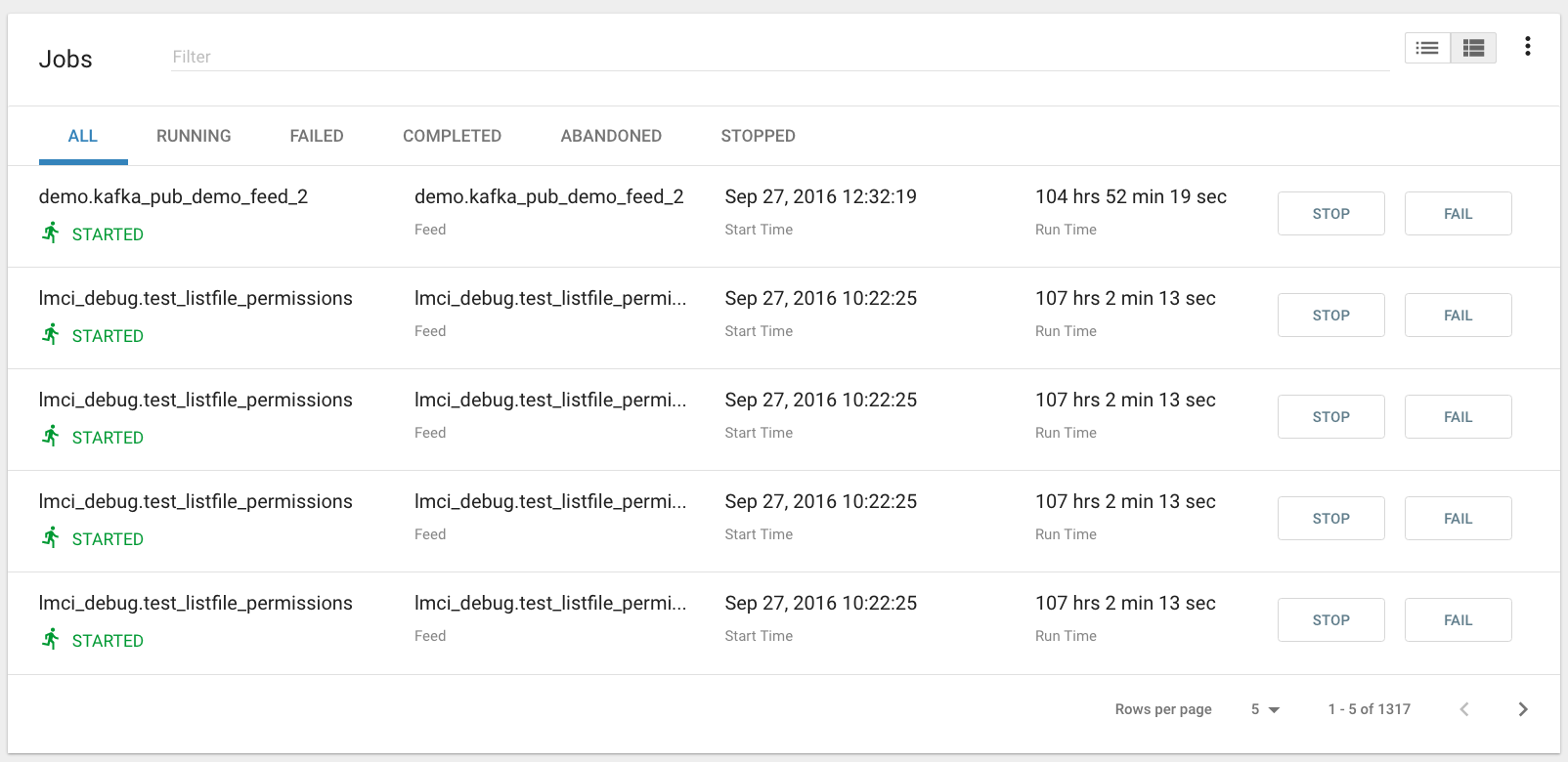
You can get more data by clicking on a job in the Feed Jobs table. This will go into the Job Details page for that job.

## Job History Page

Job history can be accessed in the Jobs Tab.



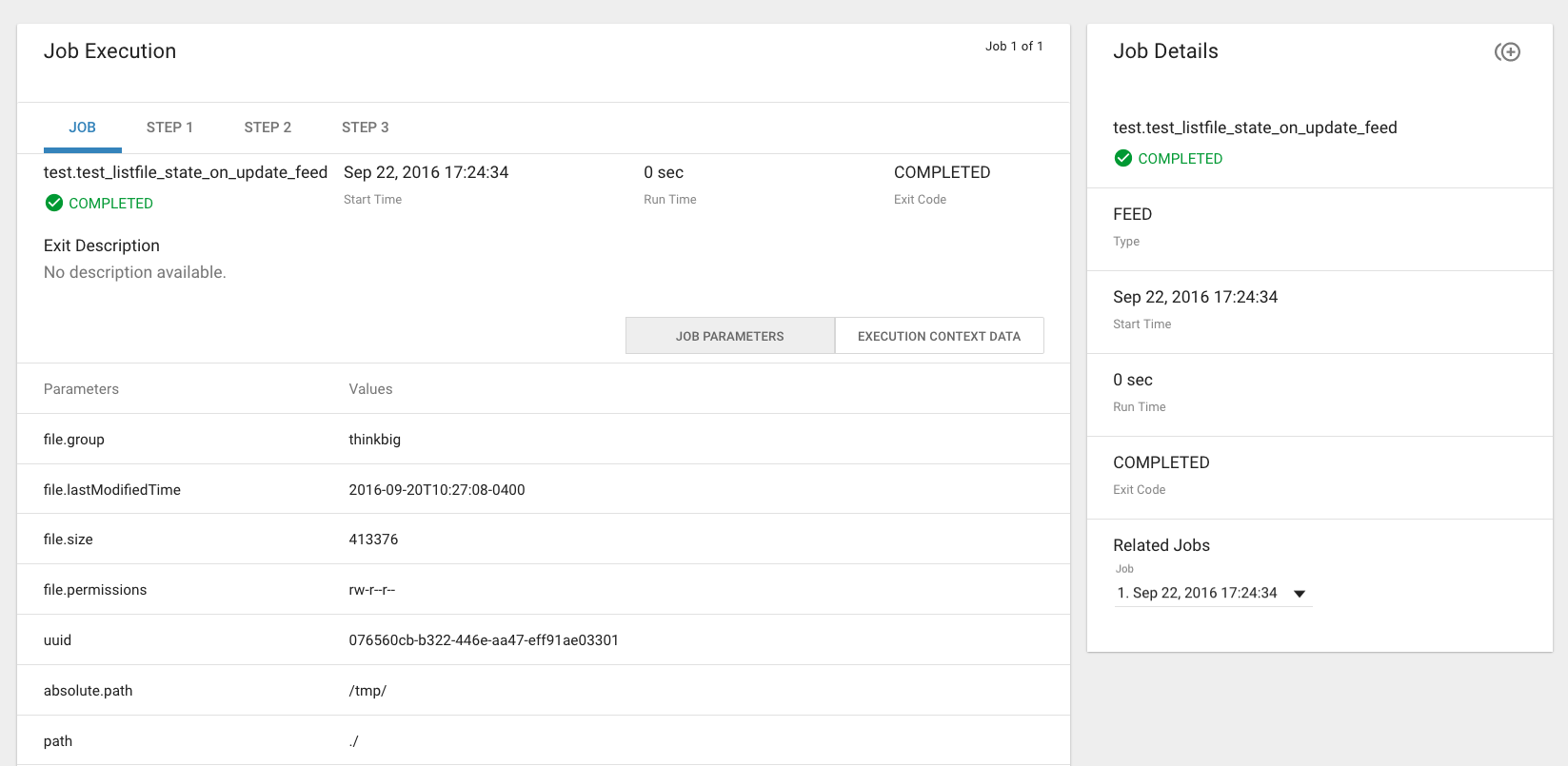
The Job History page provides a searchable table displaying job information, seen below. You can click on the Job Name to view the [Job Details](#_1pxezwc) for the selected Job.



## Job Detail Drill-Down

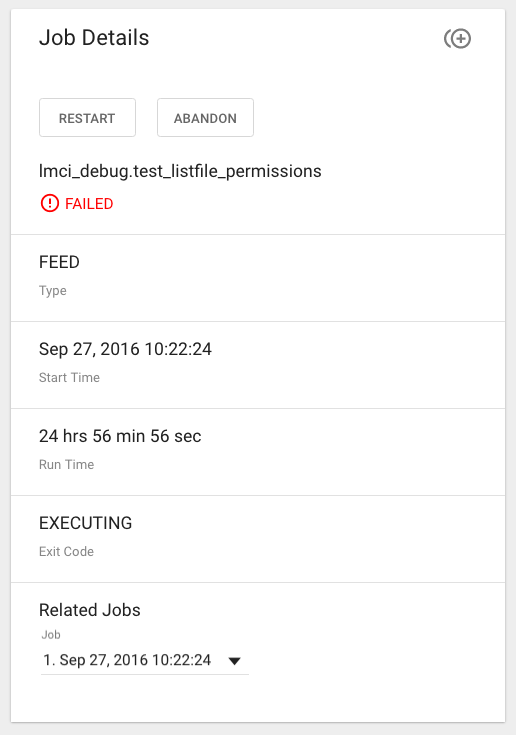
Clicking on the Job Name from either the Jobs Tab or Feeds Tab accesses the Job Details. It shows all information about a job including any metadata captured during the Job run.

The detail page is best source for troubleshooting unexpected behavior of an individual job.

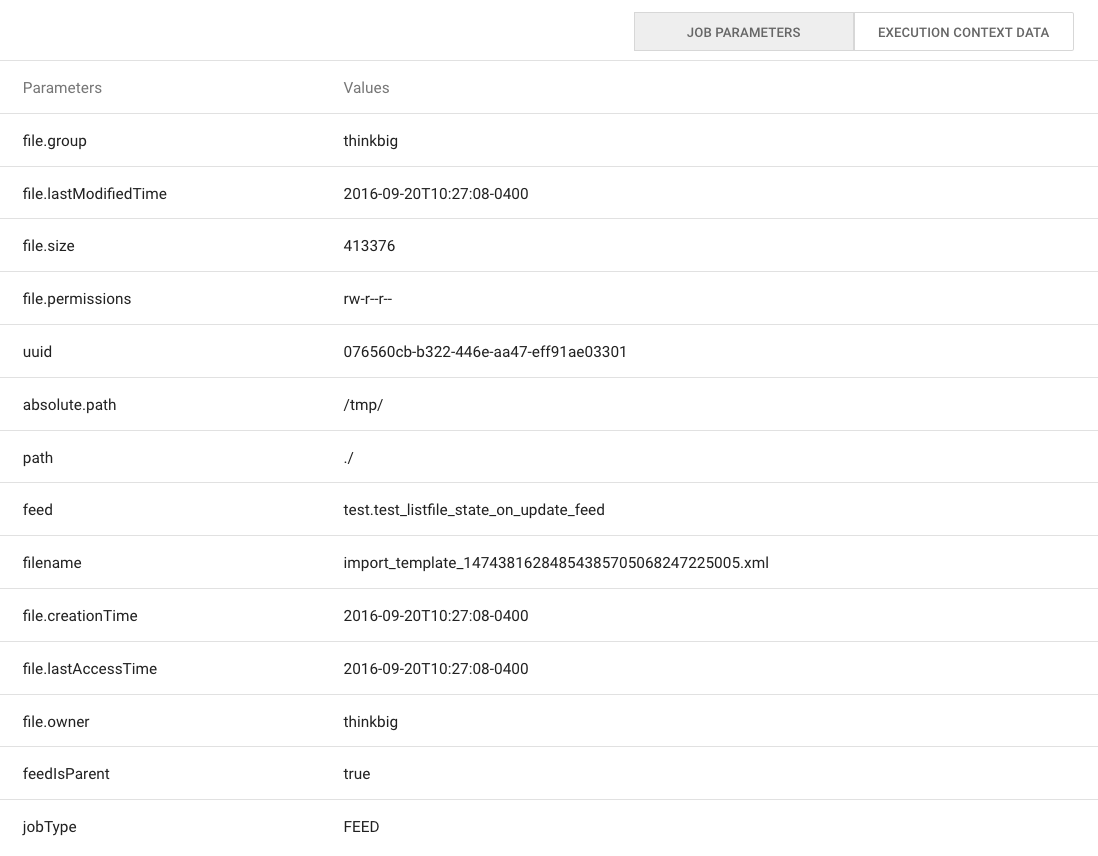


## Job Status Info

Job Status information such as start and run time, along with any control actions, are displayed on the right.



## Job Parameters

A Job has a set of parameters that are used as inputs into that job. The top section of the Job Details page displays these parameters.

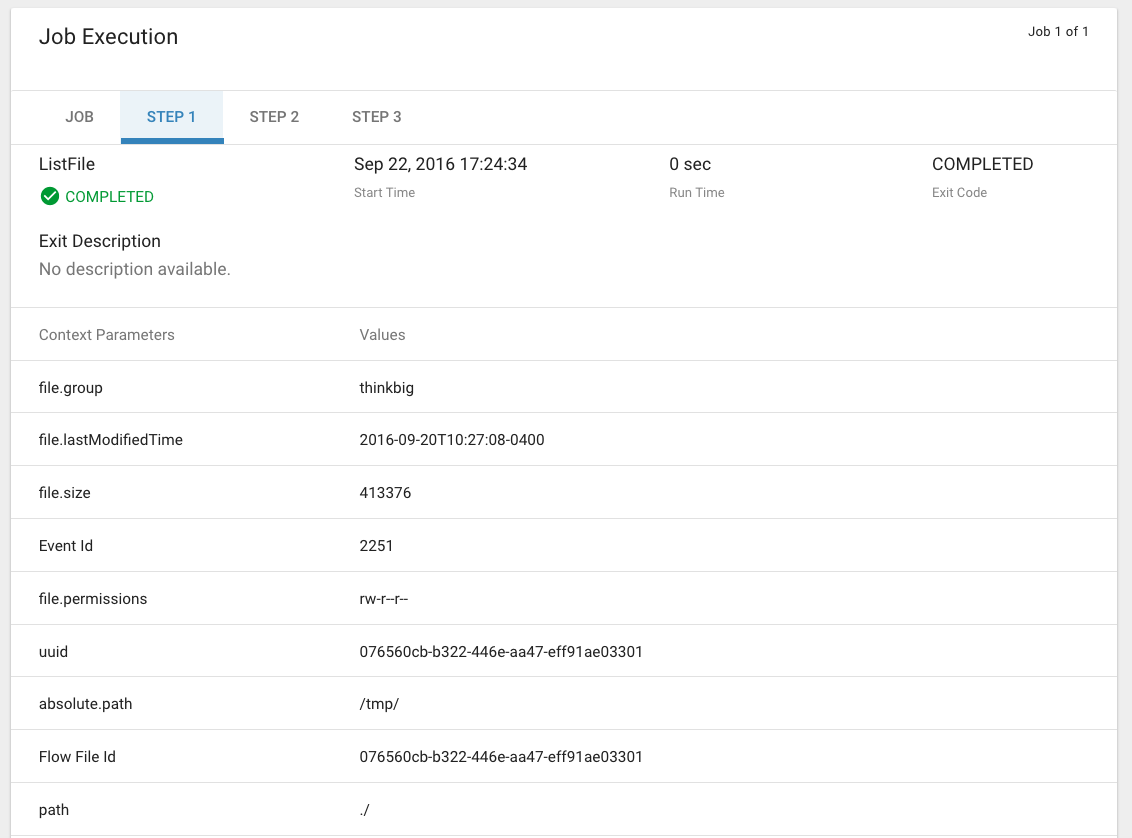
## Job Context Data

As a Job runs it can capture metadata related to the Job itself.

This metadata is stored in the Job Context section. Access this section by clicking on the **Execution Context Data** button next to the Job Parameters button in the previous figure.

## Step Context Data

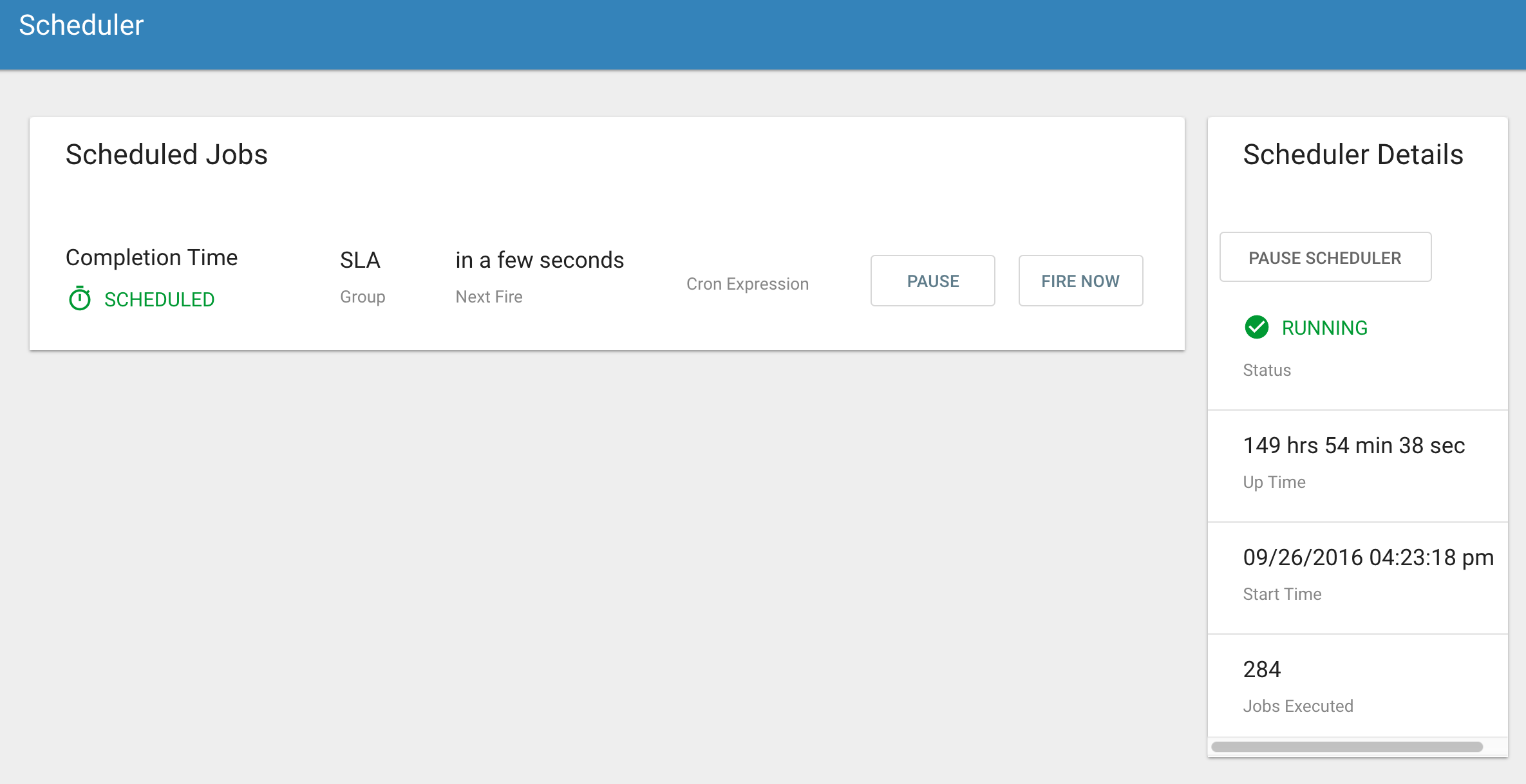
A job can have multiple steps, each of which capture and store metadata as it relates to that step.



## Scheduler Page

The scheduling of SLAs can be viewed and via the “Scheduler” tab.

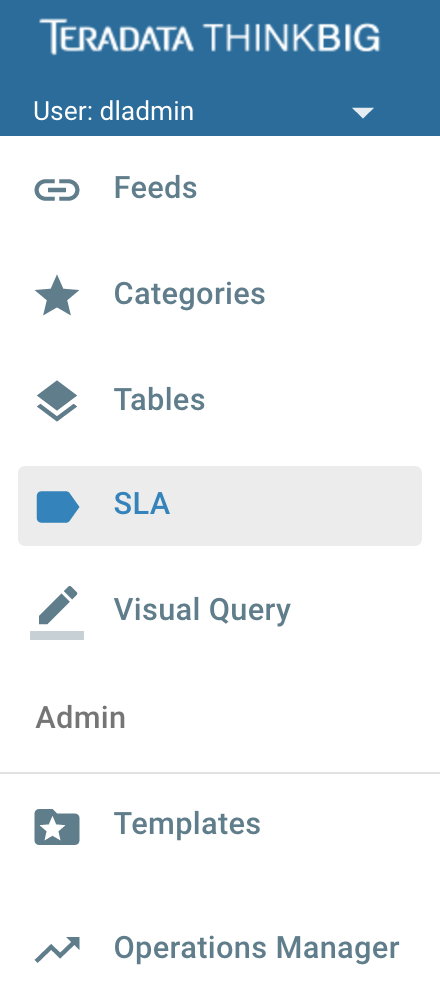
This allows a user to pause the entire Scheduler, pause specific SLAs, and even manually trigger SLAs to execute.



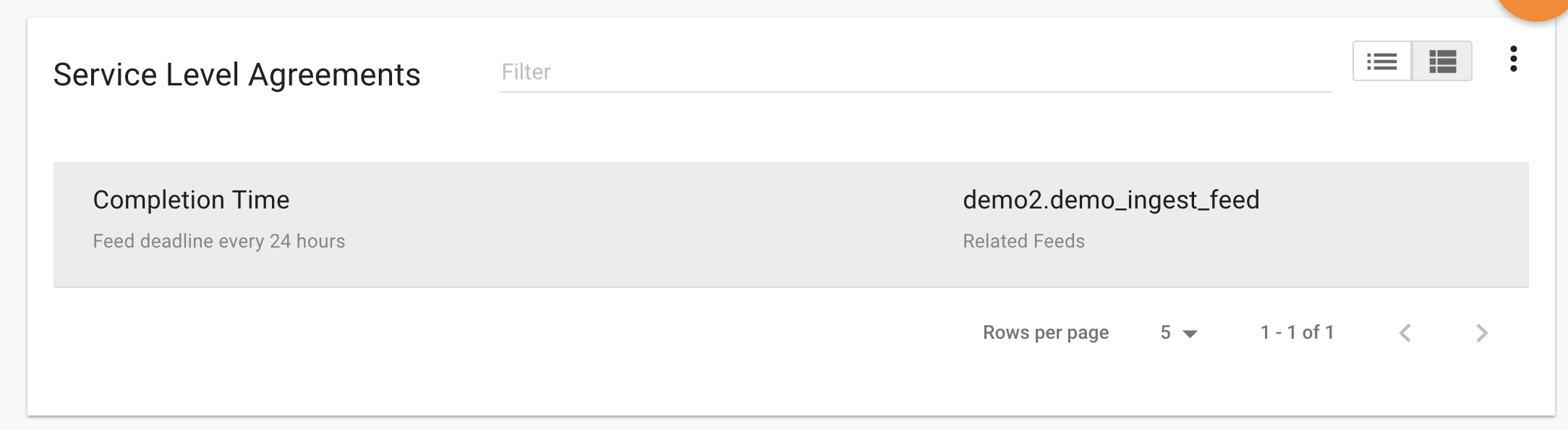
## Changing an SLA

To change the schedule of a given SLA :

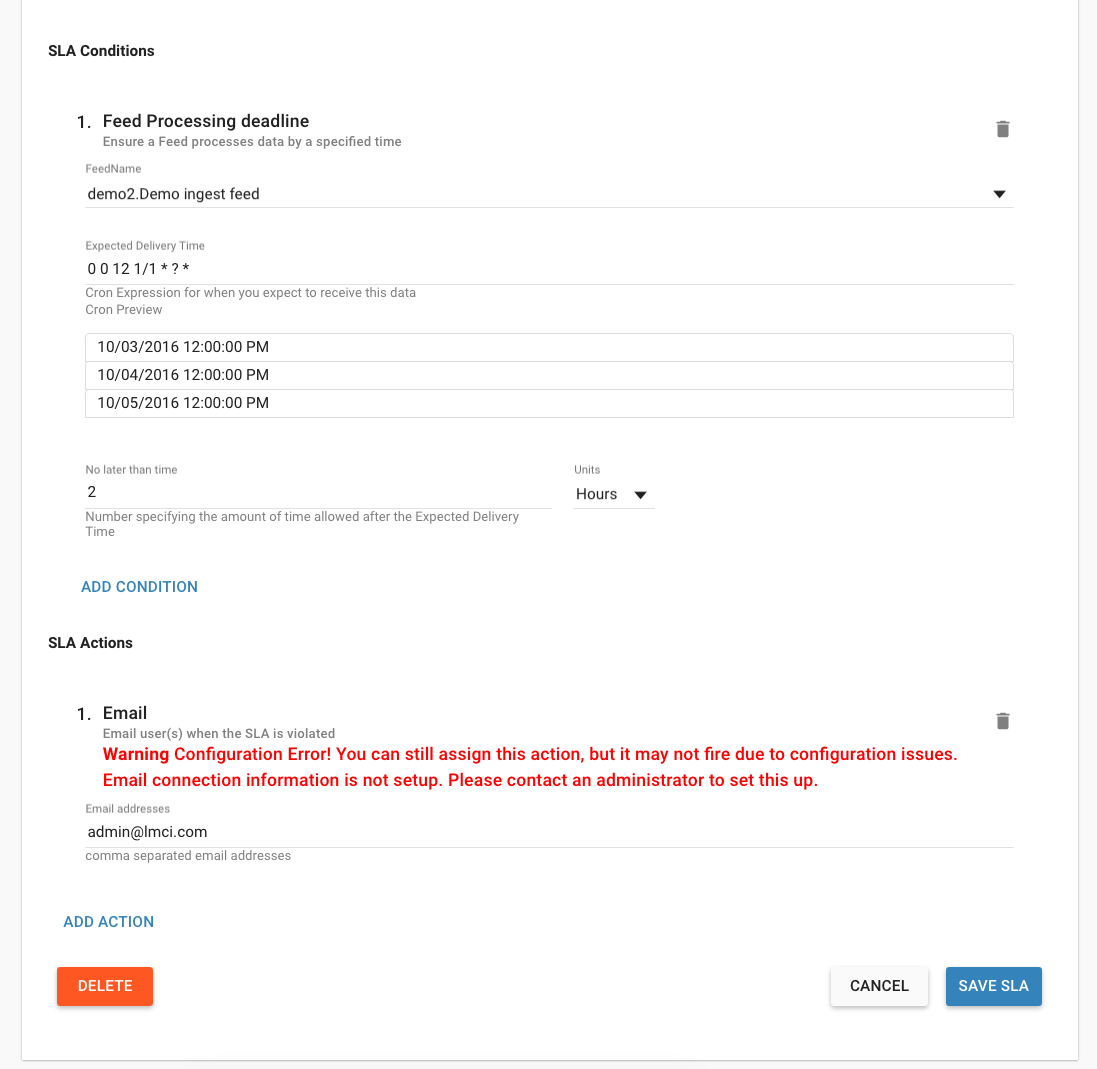
1. Click on the SLA tab in the Feed Manager site.



Select the SLA whose schedule you would like to change.



Edit the configurations and click Save SLA



## Filtering Job History

The following section describes how to filter the job and feed history tables. Kylo provides a dynamic filter capability for any table displaying multiple rows of information.

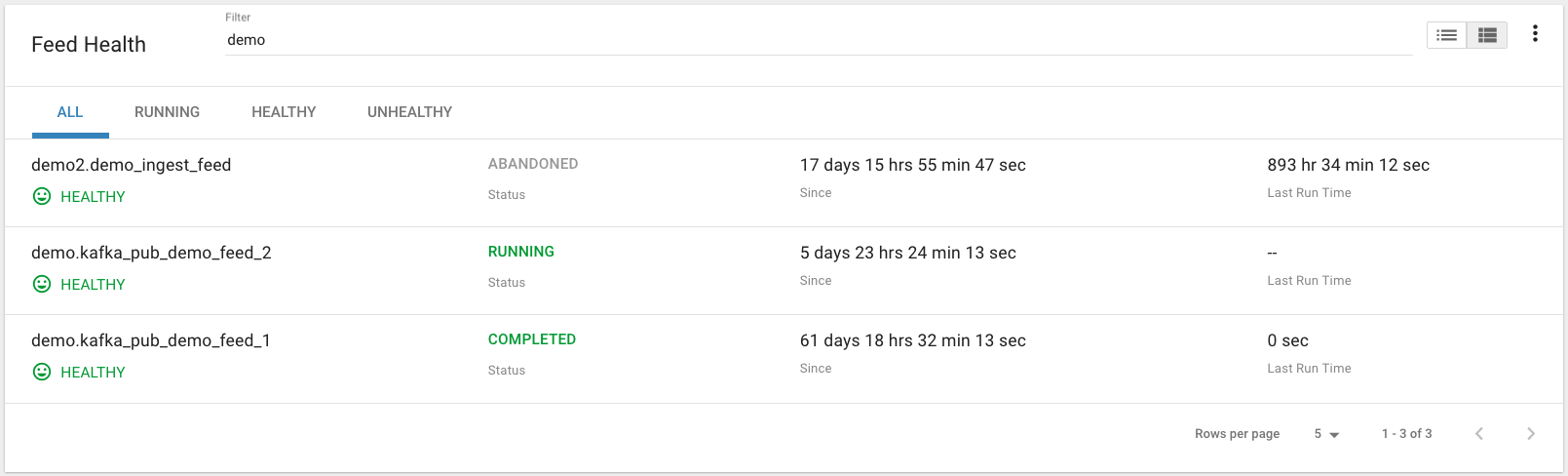
## Data Table Operations

## Sorting Content

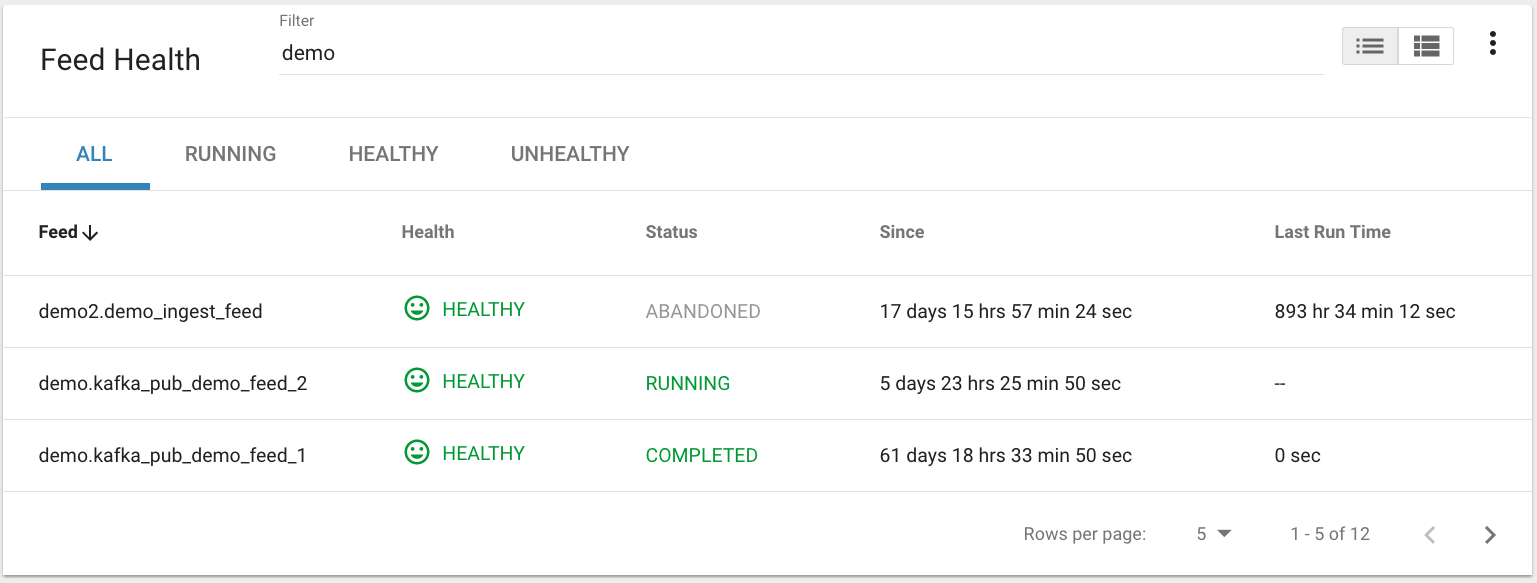
All tables allow for the columns to be sorted. An arrow will appear next to the column indicating the sort direction. Click on the column header to change the sort.

## Filtering Tables

All Tables in Kylo have a Filter bar above them. The rows can be filtered using the search bar at the top.



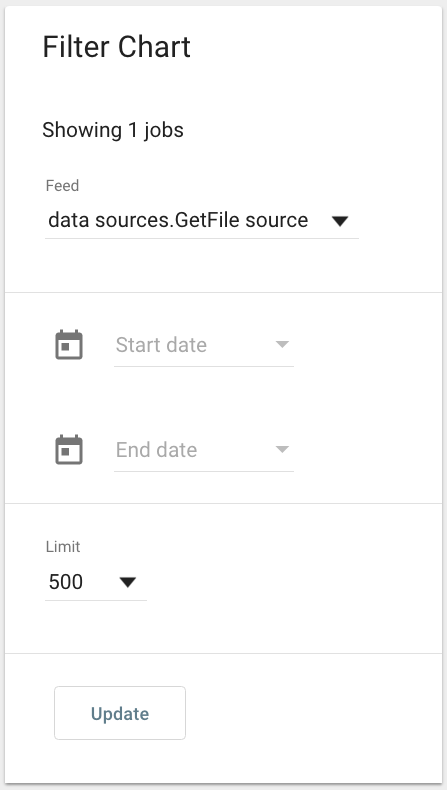
Clicking on the Macintosh HD:Users:gh186017:Desktop:Screen Shot 2016-10-03 at 7.57.08 AM.png icon in the top right of the table will display the table so that you can sort by column.



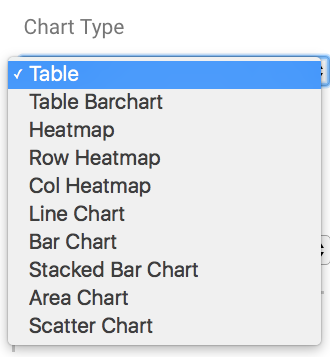
Click on any of the column headers, or click on the Macintosh HD:Users:gh186017:Desktop:Screen Shot 2016-10-03 at 7.58.41 AM.png icon in the top right of the table, to sort.

## Charts and Pivot Tables

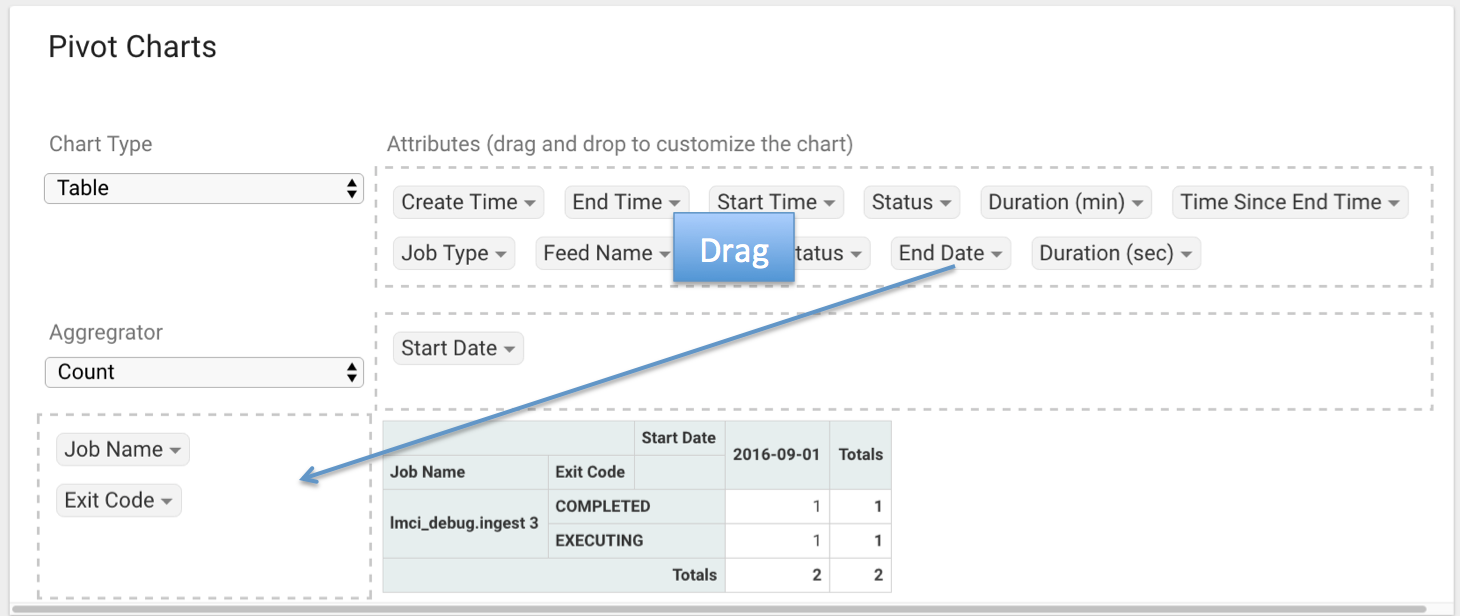
The Charts tab allows you to query and perform data analysis on the Jobs in the system. The right panel allows you to provide filter input that will drive the bottom Pivot Chart panel.



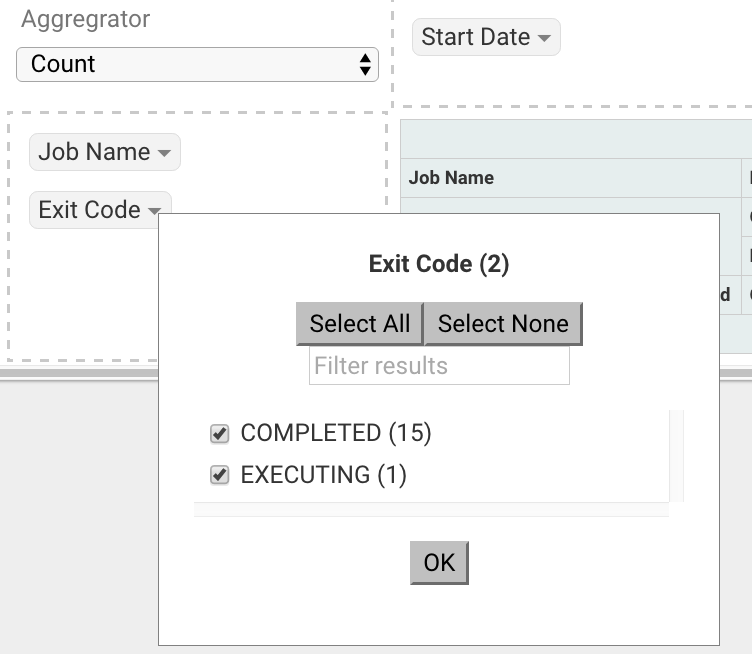
The Pivot Charts panel is a rich drag and drop section that allows you to create custom tables and charts by dragging attributes around. The drop down at the top left allows you to choose how you want to display the data



The data attributes at the top can be dragged into either Column Header or Row level attributes for the rendered pivot.



Clicking the down arrow on each attribute allows you to filter out certain fields.



This interface allows you to filter the job data and create many different combinations of tables and charts.

## Software Components

The following provides a basic overview of the components and dependencies for Kylo:

* Web-based UI (tested with Safari, Firefox, Chrome)
* Embedded Tomcat web container (configurable HTTP port)
* Java 8
* Stores job history and metadata in Postgres or MySQL
* NiFi 0.5 – 0.7
* ActiveMQ
* Elasticsearch (optional, but required for full featureset)

## Installation

Please refer to the installation guide for Kylo installation procedures.

## Application Configuration

Configuration files for Kylo are located at:

/opt/thinkbig/thinkbig-services/conf/application.properties

/opt/thinkbig/thinkbig-ui/conf/application.properties

/opt/thinkbig/thinkbig-ui/conf/application.properties

## Application Properties

The *application.properties* file in thinkbig-services specifies most of the standard configuration in pipeline.

Note: any change to the application properties will require an application restart.

Below is a sample properties file:

# Spring Datasource properties for spring batch and the default data source

# NOTE: Cloudera default password for root access to mysql is "cloudera"

#

spring.datasource.url=jdbc:mysql://localhost:3306/thinkbig

spring.datasource.username=root

spring.datasource.password=

spring.datasource.maxActive=10

spring.datasource.validationQuery=SELECT 1

spring.datasource.testOnBorrow=true

spring.datasource.driverClassName=com.mysql.jdbc.Driver

spring.jpa.database-platform=org.hibernate.dialect.MySQL5InnoDBDialect

spring.jpa.open-in-view=true

#

#Postgres datasource configuration

#

#spring.datasource.url=jdbc:postgresql://localhost:5432/pipeline\_db

#spring.datasource.driverClassName=org.postgresql.Driver

#spring.datasource.username=root

#spring.datasource.password=thinkbig

#spring.jpa.database-platform=org.hibernate.dialect.PostgreSQLDialect

###

# Current available authentication/authorization profiles:

# \* auth-simple - Uses authenticationService.username and authenticationService.password for authentication (development only)

# \* auth-file - Uses users.properties and roles.properties for authentication and role assignment

#

spring.profiles.active=auth-simple

authenticationService.username=dladmin

authenticationService.password=thinkbig

###Ambari Services Check

ambariRestClientConfig.username=admin

ambariRestClientConfig.password=admin

ambariRestClientConfig.serverUrl=http://127.0.0.1:8080/api/v1

ambari.services.status=HDFS,HIVE,MAPREDUCE2,SQOOP

###Cloudera Services Check

#clouderaRestClientConfig.username=cloudera

#clouderaRestClientConfig.password=cloudera

#clouderaRestClientConfig.serverUrl=127.0.0.1

#cloudera.services.status=

##HDFS/[DATANODE,NAMENODE,SECONDARYNAMENODE],HIVE/[HIVEMETASTORE,HIVESERVER2],YARN,SQOOP

#

# Server port

#

server.port=8420

#

# General configuration - Note: Supported configurations include STANDALONE, BUFFER\_NODE\_ONLY, BUFFER\_NODE, EDGE\_NODE

#

application.mode=STANDALONE

#

# Turn on debug mode to display more verbose error messages in the UI

#

application.debug=true

#

# Prevents execution of jobs at startup. Change to true, and the name of the job that should

# be run at startup if we want that behavior

#

spring.batch.job.enabled=false

spring.batch.job.names=

#spring.jpa.show-sql=true

#spring.jpa.hibernate.ddl-auto=validate

# NOTE: For Cloudera metadata.datasource.password=cloudera is required

metadata.datasource.driverClassName=com.mysql.jdbc.Driver

metadata.datasource.url=jdbc:mysql://localhost:3306/thinkbig

metadata.datasource.username=root

metadata.datasource.password=

metadata.datasource.validationQuery=SELECT 1

metadata.datasource.testOnBorrow=true

# NOTE: For Cloudera hive.datasource.username=hive is required

hive.datasource.driverClassName=org.apache.hive.jdbc.HiveDriver

hive.datasource.url=jdbc:hive2://localhost:10000/default

hive.datasource.username=

hive.datasource.password=

# NOTE: For Cloudera hive.metastore.datasource.password=cloudera is required

##Also Clouder url should be /metastore instead of /hive

hive.metastore.datasource.driverClassName=com.mysql.jdbc.Driver

hive.metastore.datasource.url=jdbc:mysql://localhost:3306/hive

#hive.metastore.datasource.url=jdbc:mysql://localhost:3306/metastore

hive.metastore.datasource.username=root

hive.metastore.datasource.password=

hive.metastore.validationQuery=SELECT 1

hive.metastore.testOnBorrow=true

nifi.rest.host=localhost

nifi.rest.port=8079

elasticsearch.host=localhost

elasticsearch.port=9300

elasticsearch.clustername=demo-cluster

## used to map Nifi Controller Service connections to the User Interface

## naming convention for the property is nifi.service.NIFI\_CONTROLLER\_SERVICE\_NAME.NIFI\_PROPERTY\_NAME

##anything prefixed with nifi.service will be used by the UI. Replace Spaces with underscores and make it lowercase.

nifi.service.mysql.password=

nifi.service.example\_mysql\_connection\_pool.password=

jms.activemq.broker.url:tcp://localhost:61616

jms.client.id=thinkbig.feedmgr

## nifi Property override with static defaults

##Static property override supports 2 usecases

# 1) store properties in the file starting with the prefix defined in the "PropertyExpressionResolver class" default = config.

# 2) store properties in the file starting with "nifi.<PROCESSORTYPE>.<PROPERTY\_KEY> where PROCESSORTYPE and PROPERTY\_KEY are all lowercase and the spaces are substituted with underscore

##Below are Ambari configuration options for Hive Metastore and Spark location

config.hive.schema=hive

nifi.executesparkjob.sparkhome=/usr/hdp/current/spark-client

##cloudera config

#config.hive.schema=metastore

#nifi.executesparkjob.sparkhome=/usr/lib/spark

## how often should SLAs be checked

sla.cron.default=0 0/5 \* 1/1 \* ? \*

## Startup and Shutdown

Kylo service automatically starts on system boot.

* Manual startup and shutdown from command-line:

sudo /etc/init.d/thinkbig-services start

sudo /etc/init.d/thinkbig-ui start

sudo /etc/init.d/thinkbig-spark-shell start

sudo /etc/init.d/thinkbig-services stop

sudo /etc/init.d/thinkbig-ui stop

sudo /etc/init.d/thinkbig-spark-shell stop

## Log Files

Kylo uses Log4J as its logging provider.

* Default location of application log file is:

/var/log/thinkbig-<ui, services, or spark-shell>/

* Log files roll nightly with pipeline-application.log.<YYYY-MM-DD>
* Log levels, file rotation, and location can be configured via: /opt/thinkbig/thinkbig-<ui, services, or spark-shell>/conf/log4j.properties

## Additional Configuration

The following section contains additional configuration that is possible.

## Configuring JVM Memory

You can adjust the memory setting of the Kylo Service using the THINKBIG\_SERVICES \_OPTS environment variable. This may be necessary if the application is experiencing OutOfMemory errors. These would appear in the log files.

export THINKBIG\_SERVICES\_OPTS=Xmx2g

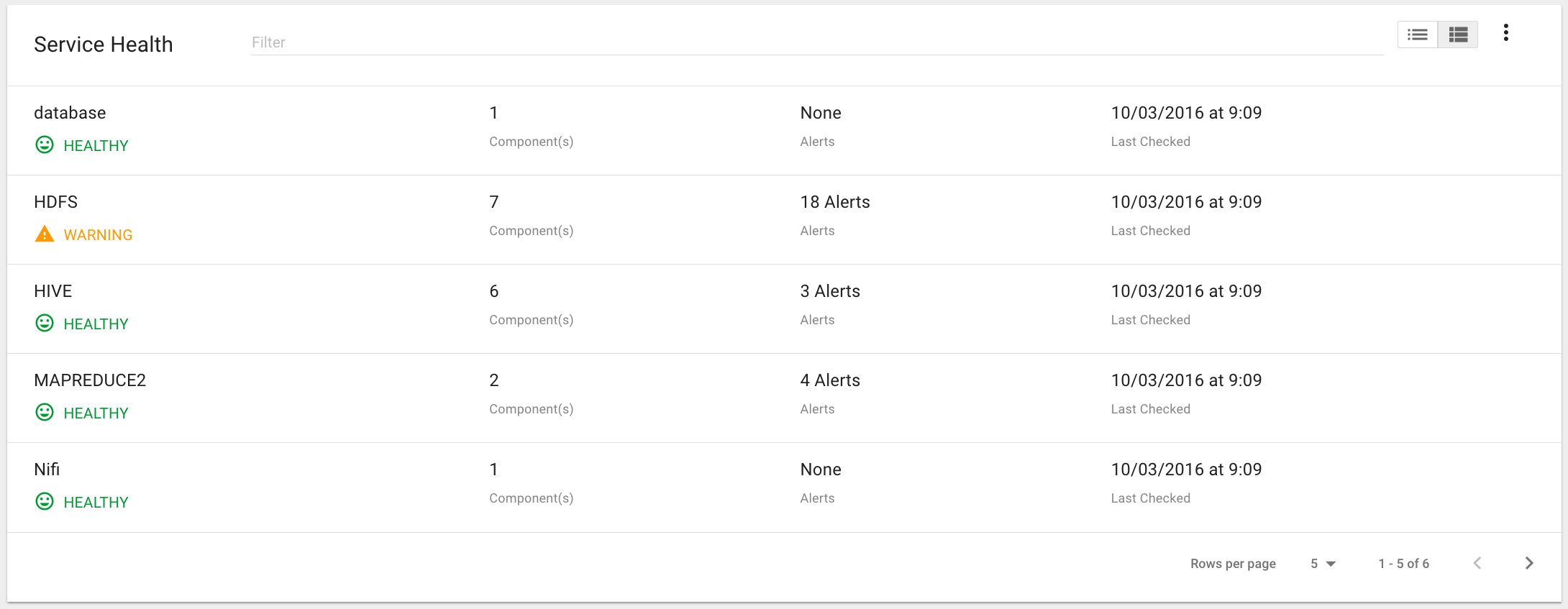
The setting above would set the Java maximum heap size to 2 GB.

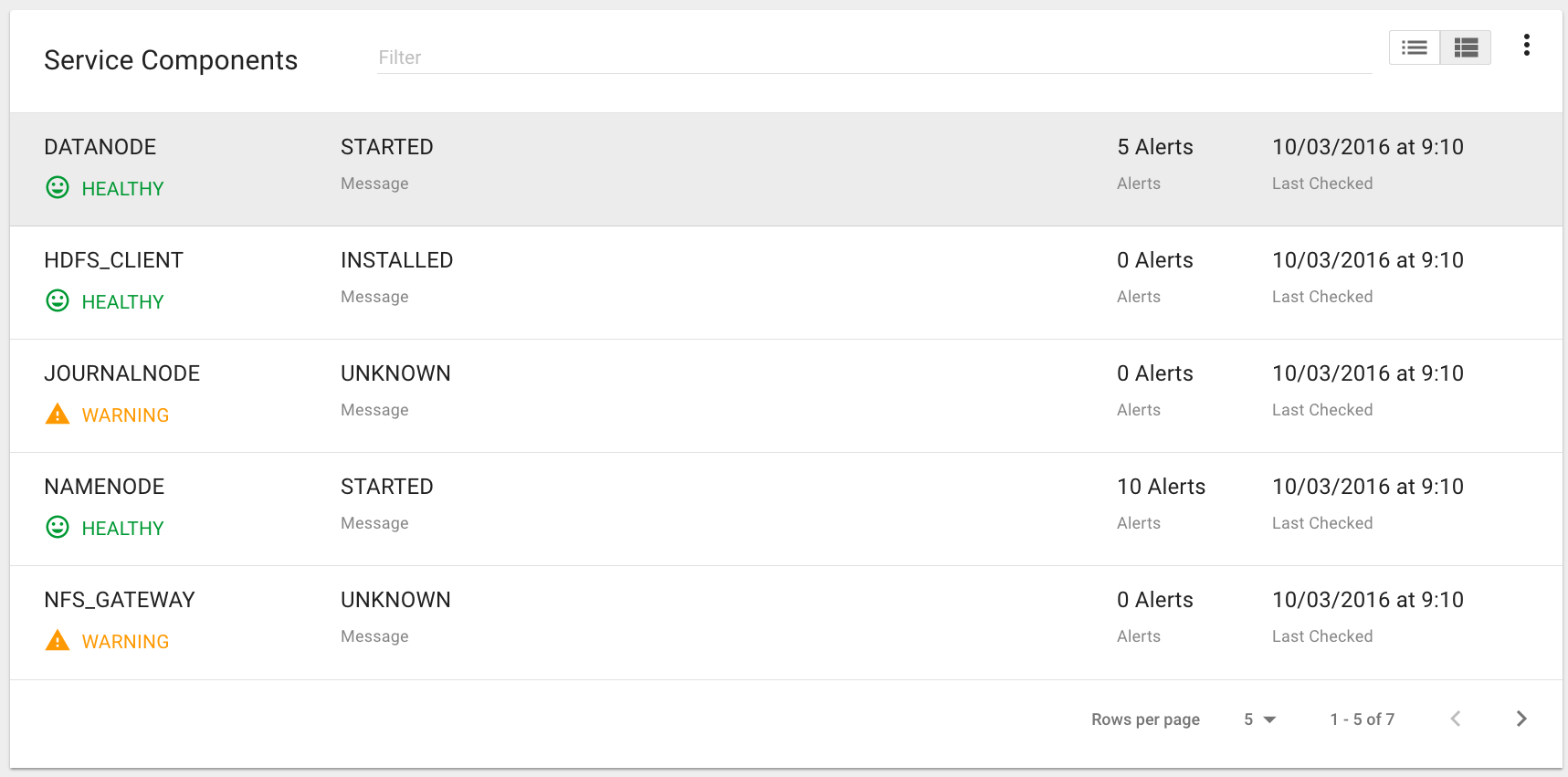
## Service Status Configuration

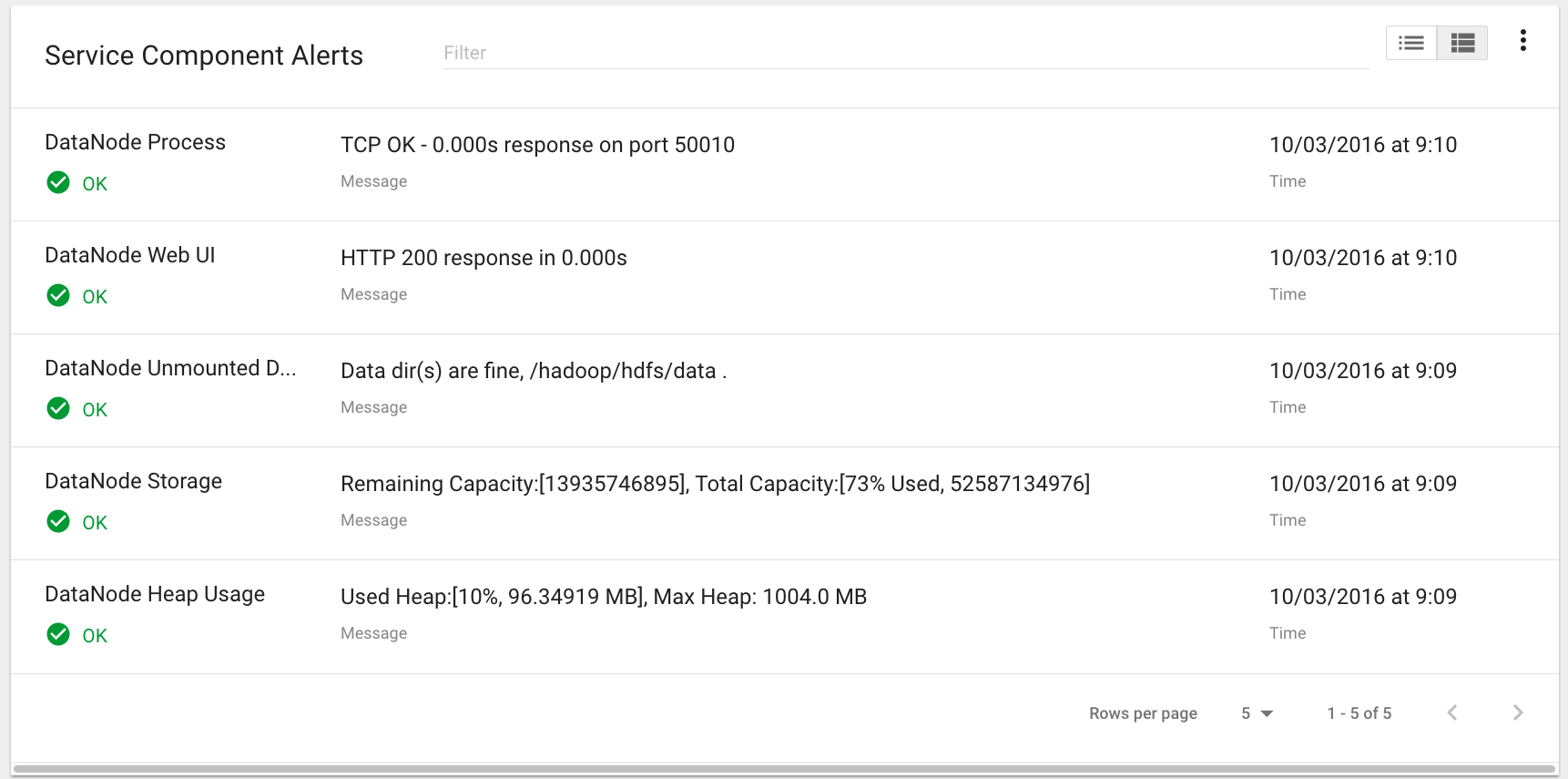
The Overview page displays Service Status as a Key Performance Indicator. The list of services is configurable using the following instructions:

## Viewing Service Details

Within Kylo on the Overview tab the “Services” indicator box shows the services it is currently monitoring. You can get details of this by clicking on the Services tab:







The Services Indicator automatically refreshes every 15 seconds to provide live updates on service status.

## Example Service Configuration

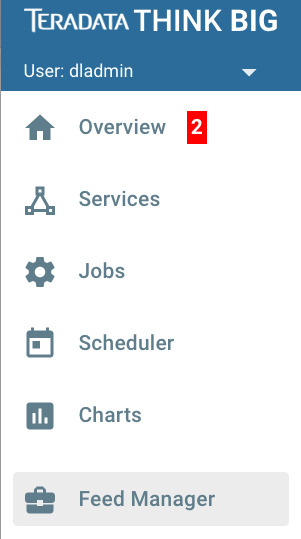
The below is the service configuration monitoring 4 services:

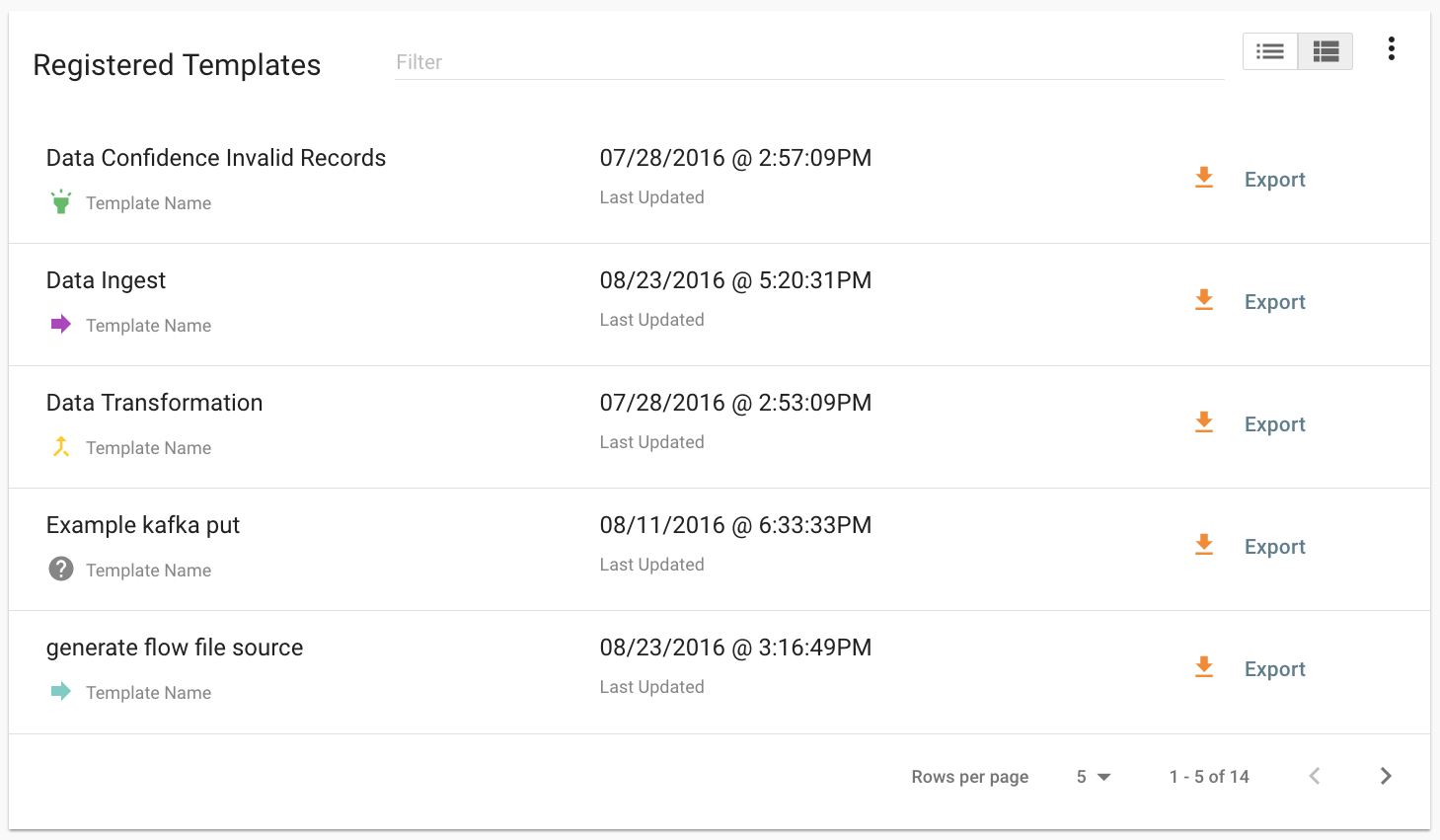
ambari.services.status=HDFS,HIVE,MAPREDUCE2,SQOOP

## Migrating templates and feeds

## Exporting registered templates

In Kylo, a template can be exported from one instance of Kylo to another. To export a template, navigate to the Feed Manager site by clicking Feed Manager on the left pane.

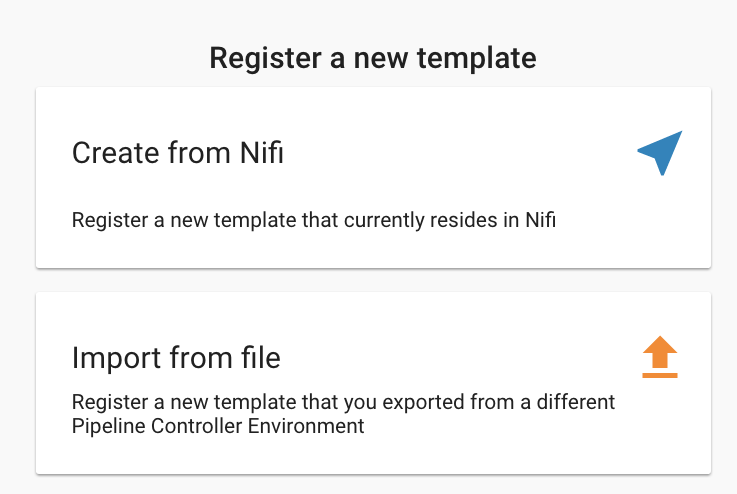


Then navigate to the Templates tab. All of the templates that have been registered in this instance of Kylo will be listed here.

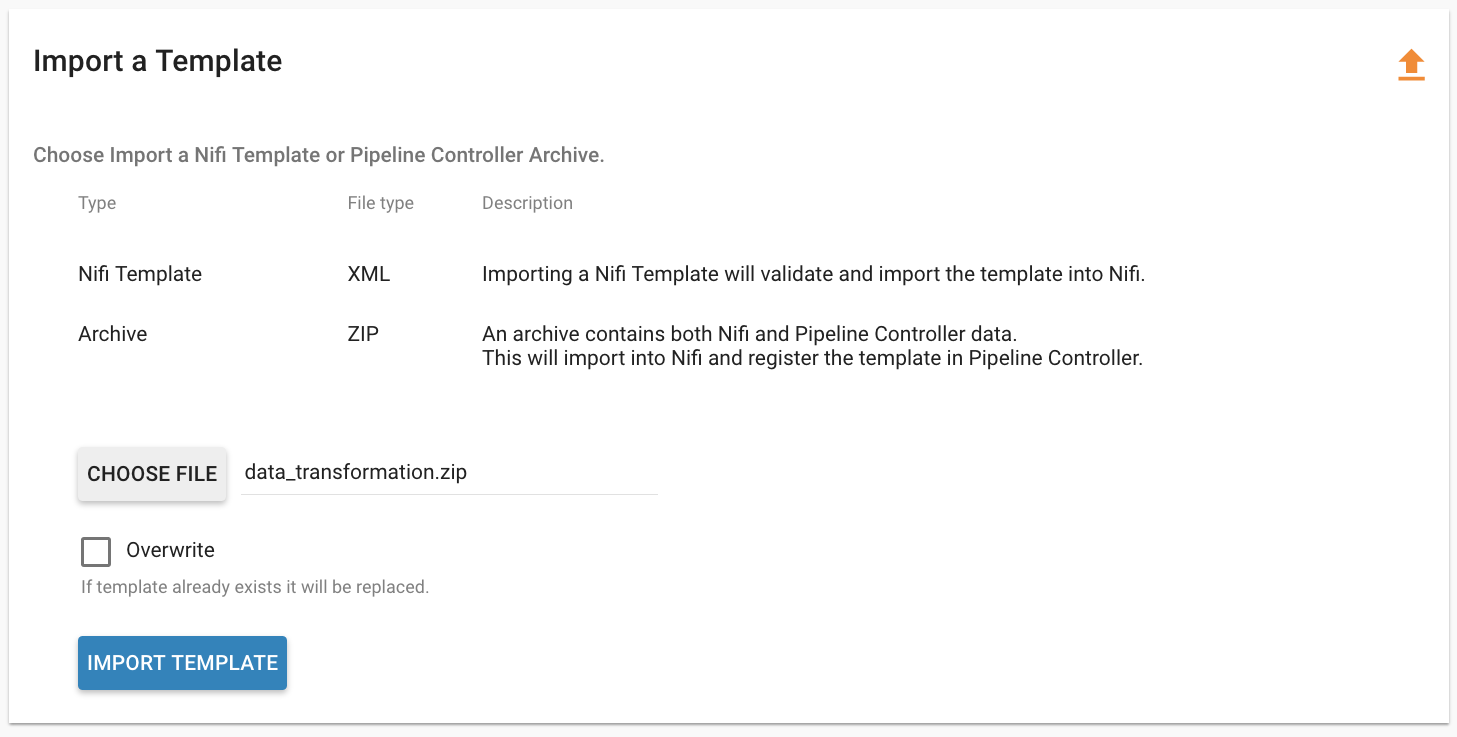
To export a template, click the Export button for that template. This will download a zip archive of the template

## Importing registered templates

To import a registered template, on the Templates tab click on the  button in the top right. Select Import from File.



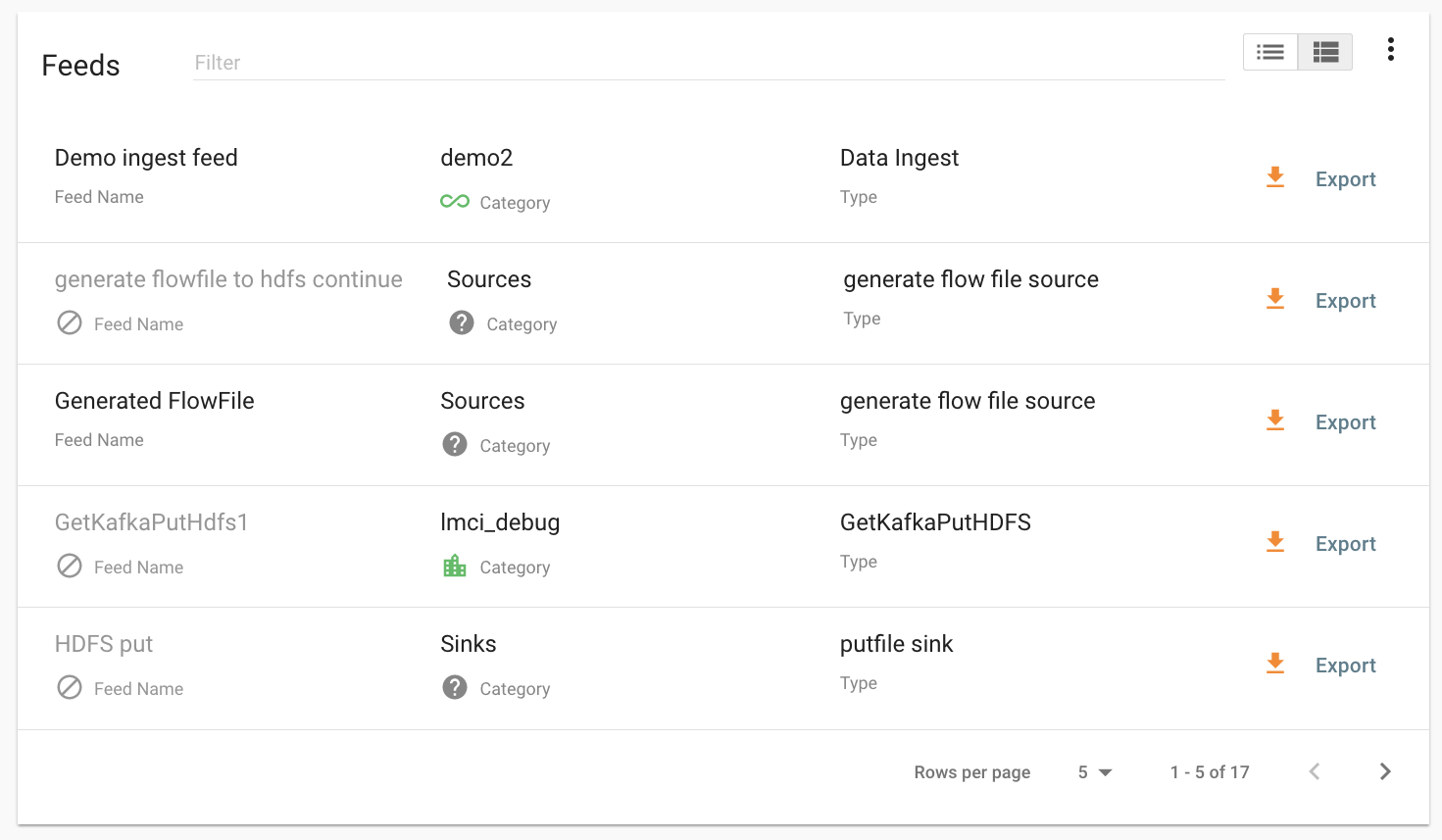
Browse for the zip archive of the registered template, select whether or not to overwrite any existing registered templates with the same name, and click upload.



The template is now in the list of registered templates, and a feed can be created from it. This will also import the associated NiFi template into NiFi.

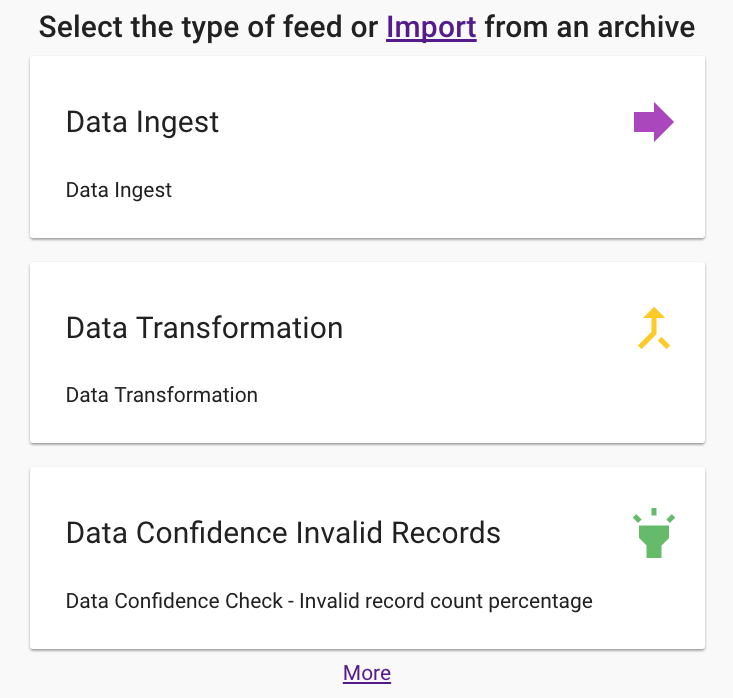
## Exporting feeds

To export a feed for deployment in another instance of Kylo, click on the **Feeds** tab. Similarly to the templates page, there will be a list, this time with feeds instead of templates. Click the export button to export a feed as a zip archive.

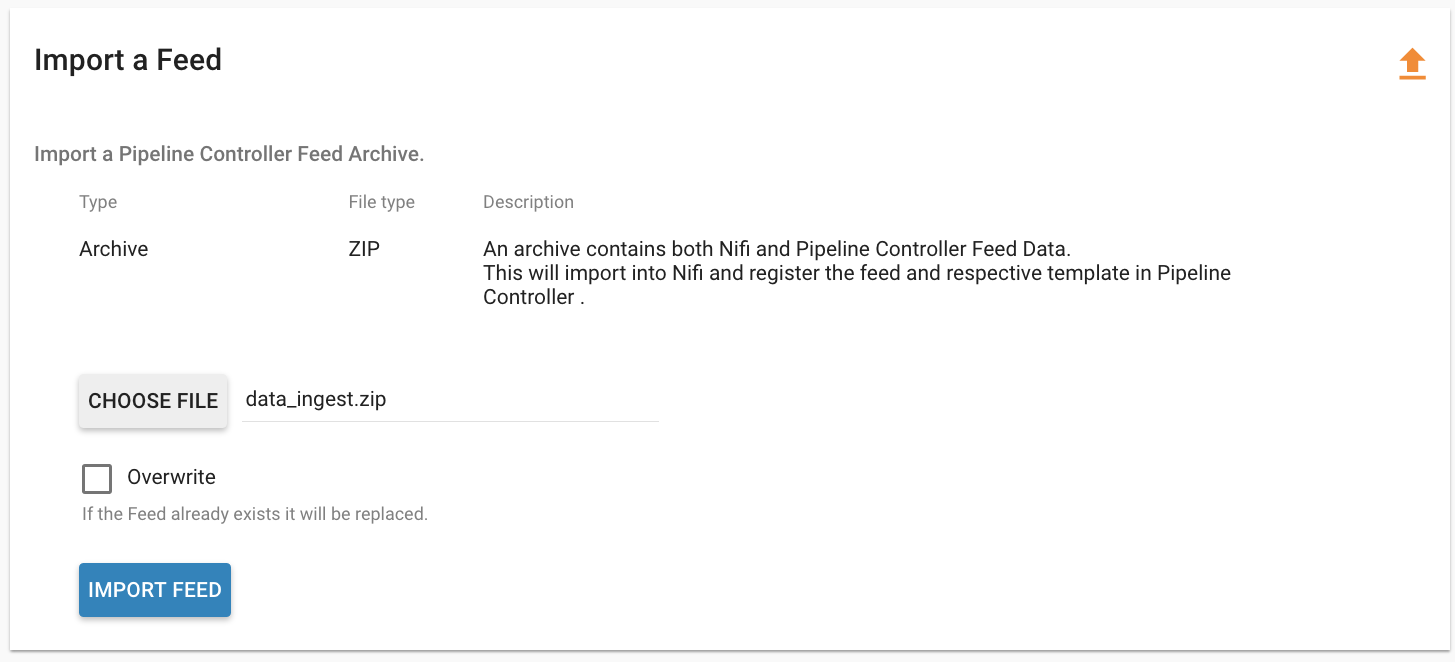


## Importing feeds

To import a feed, click the  button in the top right of the Feeds page. Click “Import” text at the top of the screen.



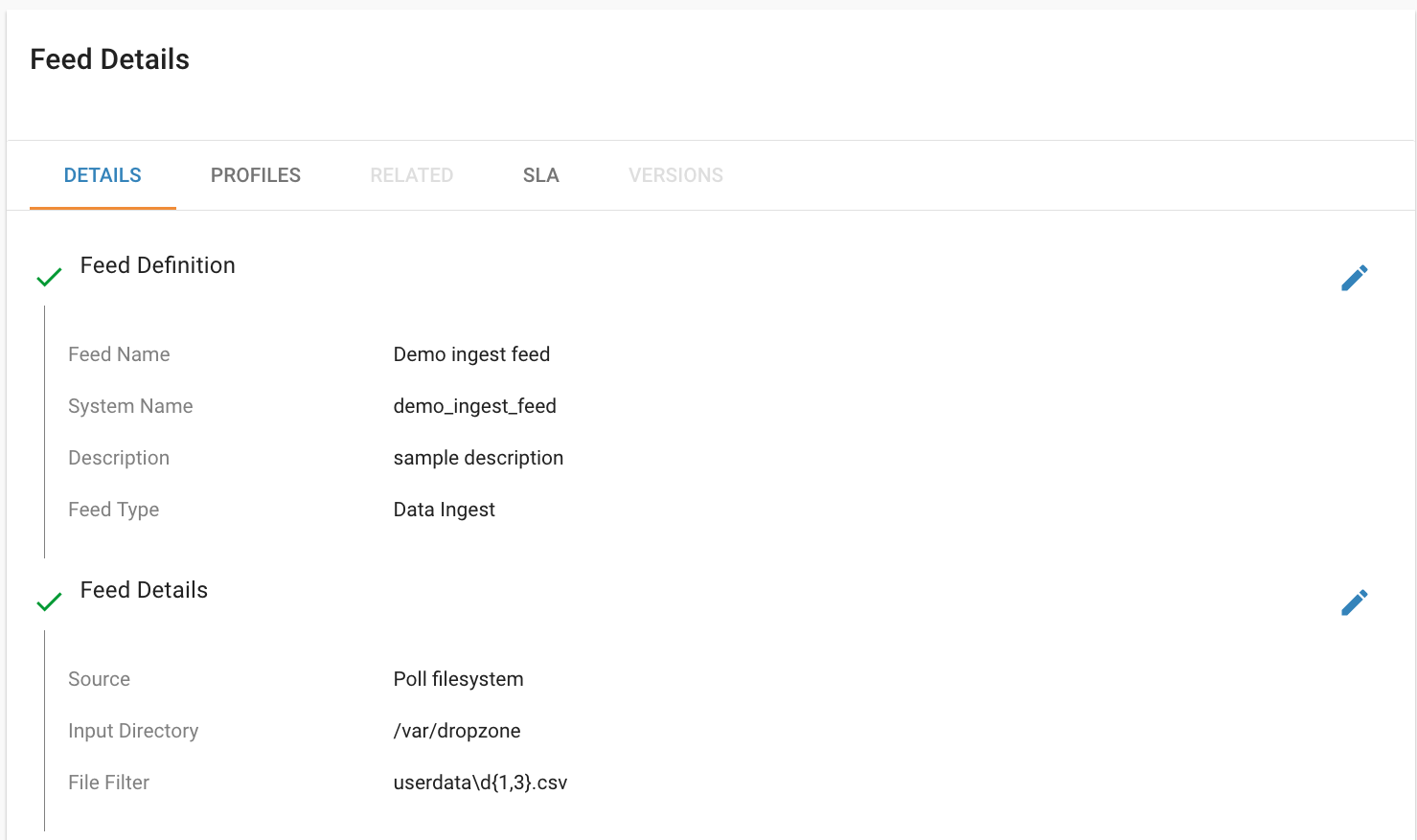
Browse for the exported feed and then click **Import Feed**.



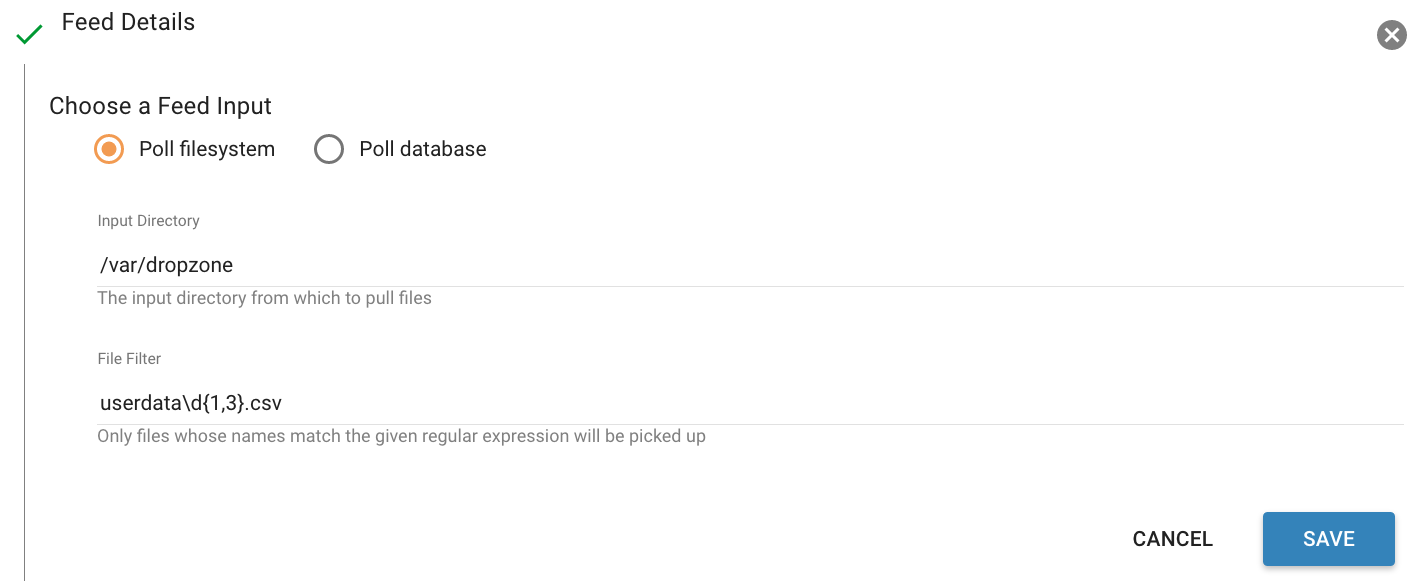
If the import is successful, you should now see a running feed in the Feeds tab.

## Altering feed configurations

A feed that has been imported may have configurations specific to an environment, depending on its registered template. To change configurations on a feed, click on the **Feeds** tab in the Feed Manager site and then click on the name of the feed you want to update. A list of configurations will be present.



Click on the Macintosh HD:Users:gh186017:Desktop:Screen Shot 2016-10-03 at 9.41.02 AM.png icon to allow editing the fields. When done editing the fields for a section, click **Save**.



Kylo recreates the flow in NiFi with the new values. Keep in mind that the values that are configurable here are determined by the registered template, so registered templates need to expose environment-specific properties if they are to be configured or updated at a feed level.

## Updating sensitive properties in NiFi

Some NiFi processors and controller services have properties that are deemed sensitive, and are therefore not saved when exporting from Kylo. Because of this, some Kylo templates and feeds are not directly portable from one instance of Kylo to another, without some changes in NiFi. In these situations, sensitive values need to be entered directly into NiFi running on the target environment, and then the changes must be saved in a new NiFi template and used to overwrite the imported NiFi template. If the sensitive properties are only within controller services for the imported artifact, then the controller service must be disabled, the sensitive value entered, and the controller service re-enabled, but a new NiFi template does not need to be made.

It is uncommon for NiFi processors to have sensitive properties, and is most often seen in controller services, such as a DBCPConnectionPool for connection to a database. If the controller services used by a template or feed are already in existence in NiFi in the target environment, then Kylo uses those controller services. This issue only exists when importing a template or feed that has NiFi processors with sensitive properties or that use controller services that do not exist in the target environment.

## Continuous Integration / Continuous Deployment (CICD)

Kylo currently does not have built-in or integrated CICD. However, Kylo allows you to export both templates (along with any registered properties) and feeds thatcan then be imported to any environment.

The following approach for CICD should be incorporated:

1. Build a flow in Nifi and get it configured and working in a dev instance of Nifi and Kylo as a Feed.

Once its ready to be tested export that Feed from Kylo. This export is a zip containing the feed metadata along with the categories and teiomplates used to create the feed.

Have a separate VM running Kylo and NiFi. This would be where the scripts would create, run, and test the feeds and flows.

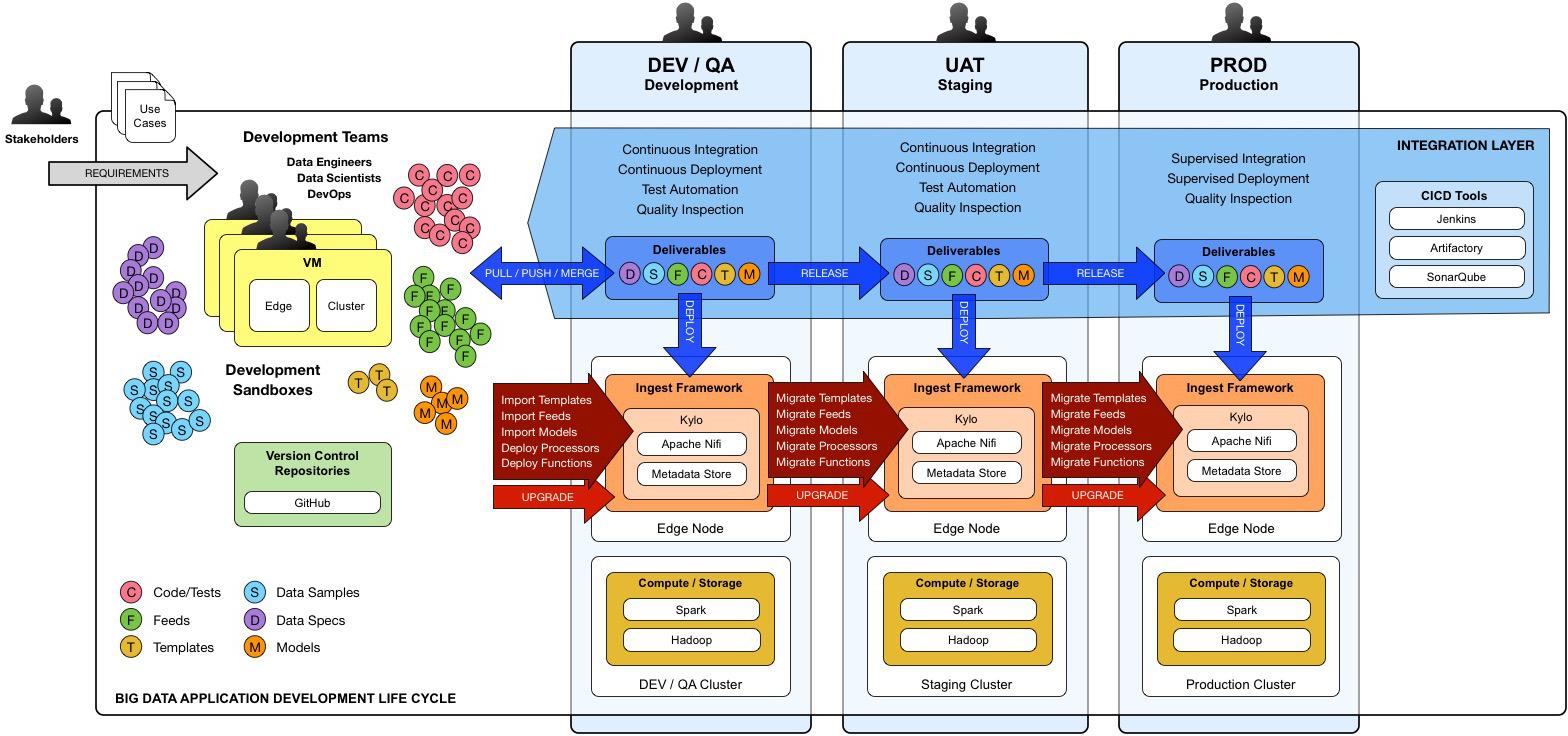
Have a separate Script/Maven project running to instantiate this feed and run it. This could look something like the following: Have a maven module running that has a TestCase that looks for these exported feed zip files and then uses NiFi and Kylos Rest apis to create them, run the feed, verify the results, and then tear down the flow.

Kylo operates over REST and has many rest endpoints that can be called to achieve the same results as you see in the Kylo UI. For example importing a feed can be done by posting the zip file to the endpoint:

* /v1/feedmgr/admin/import-feed

1. Once the tests all are passed you could take that exported Feed/Template, save it in a version control system (i.e. git), and import it into a different environment.

Figure 4.8 below depicts an example of an overall CICD ecosystem that could be implemented with Kylo with an approach similar to what Think Big R&D has put forward.



**Figure 4.8**

## Migrating Kylo and NiFi extensions

If custom NiFi or Kylo plugins/extensions have been built, they must copied to all instances of NiFi and Kylo where you wish to use them. Custom NiFi extensions are packaged in .nar format, and must be place in NiFi’s lib directory. With a default Kylo installation, this directory is /opt/nifi/current/lib. Place all custom .nar files there, and restart the NiFi service.

Custom Kylo plugins belong in the /opt/thinkbig/thinkbig-services/plugin directory in a default Kylo installation. Place the .jar files for custom plugins in this directory and manually start and stop the thinkbig-services service.

### Operational Considerations

When considering promoting Kylo/NiFi metatdata you will need to restart Kylo:

* Upon changing/adding any new NiFi processors/services  (changing code that creates a new Nifi plugin .nar file) you will need to bounce NiFi
* Upon changing/adding any new Kylo plugin/extension (changing the java jar)  you will need to bounce Kylo (thinkbig-services)

## Disaster Recovery (DR)

## Kylo metadata

Kylo stores its metadata in the database configured in /opt/thinkbig/thinkbig-services/conf/application.properties in the following lines:

metadata.datasource.driverClassName=com.mysql.jdbc.Driver

metadata.datasource.url=jdbc:mysql://localhost:3306/thinkbig

metadata.datasource.username=root

metadata.datasource.password=

The metadata database needs to be configured in order to have Kylo metadata backed up and recovered.

For example, MySQL backup can be configured using the methods provided at http://dev.mysql.com/doc/refman/5.7/en/backup-methods.html.

## NiFi data

Data and metadata in NiFi is intended to be transient, and depends on the state of the flows in NiFi. However, NiFi can be configured to keep metadata and data in certain directories, and those directories can be backed up as seen fit. For example, in the nifi.properties file, changing

nifi.flow.configuration.file=/opt/nifi/data/conf/flow.xml.gz

will have NiFi store its flows in /opt/nifi/data/conf/flow.xml.gz.

With a default Kylo installation, NiFi is configured to put all of its flows, templates, data in the content repository, data in the flowfile repository, and data in the provenance repository in /opt/nifi/data. For more information about these configurations, the NiFi system administrator’s guide is the authority.

<https://nifi.apache.org/docs/nifi-docs/html/administration-guide.html>