Sahara

Release 6.0.1.dev47

OpenStack Foundation

Feb 27, 2017

Contents

The sahara project aims to provide users with a simple means to provision data processing frameworks (such as Apache Hadoop, Apache Spark and Apache Storm) on OpenStack. This is accomplished by specifying configuration parameters such as the framework version, cluster topology, node hardware details and more.

CHAPTER 1

Overview

Rationale

Introduction

Apache Hadoop is an industry standard and widely adopted MapReduce implementation, it is one among a growing number of data processing frameworks. The aim of this project is to enable users to easily provision and manage clusters with Hadoop and other data processing frameworks on OpenStack. It is worth mentioning that Amazon has provided Hadoop for several years as Amazon Elastic MapReduce (EMR) service.

Sahara aims to provide users with a simple means to provision Hadoop, Spark, and Storm clusters by specifying several parameters such as the version, cluster topology, hardware node details and more. After a user fills in all the parameters, sahara deploys the cluster in a few minutes. Also sahara provides means to scale an already provisioned cluster by adding or removing worker nodes on demand.

The solution will address the following use cases:

- fast provisioning of data processing clusters on OpenStack for development and quality assurance(QA).
- utilization of unused compute power from a general purpose OpenStack IaaS cloud.
- "Analytics as a Service" for ad-hoc or bursty analytic workloads (similar to AWS EMR).

Key features are:

- designed as an OpenStack component.
- managed through a REST API with a user interface(UI) available as part of OpenStack Dashboard.
- support for a variety of data processing frameworks:
  - multiple Hadoop vendor distributions.
  - Apache Spark and Storm.
  - pluggable system of Hadoop installation engines.

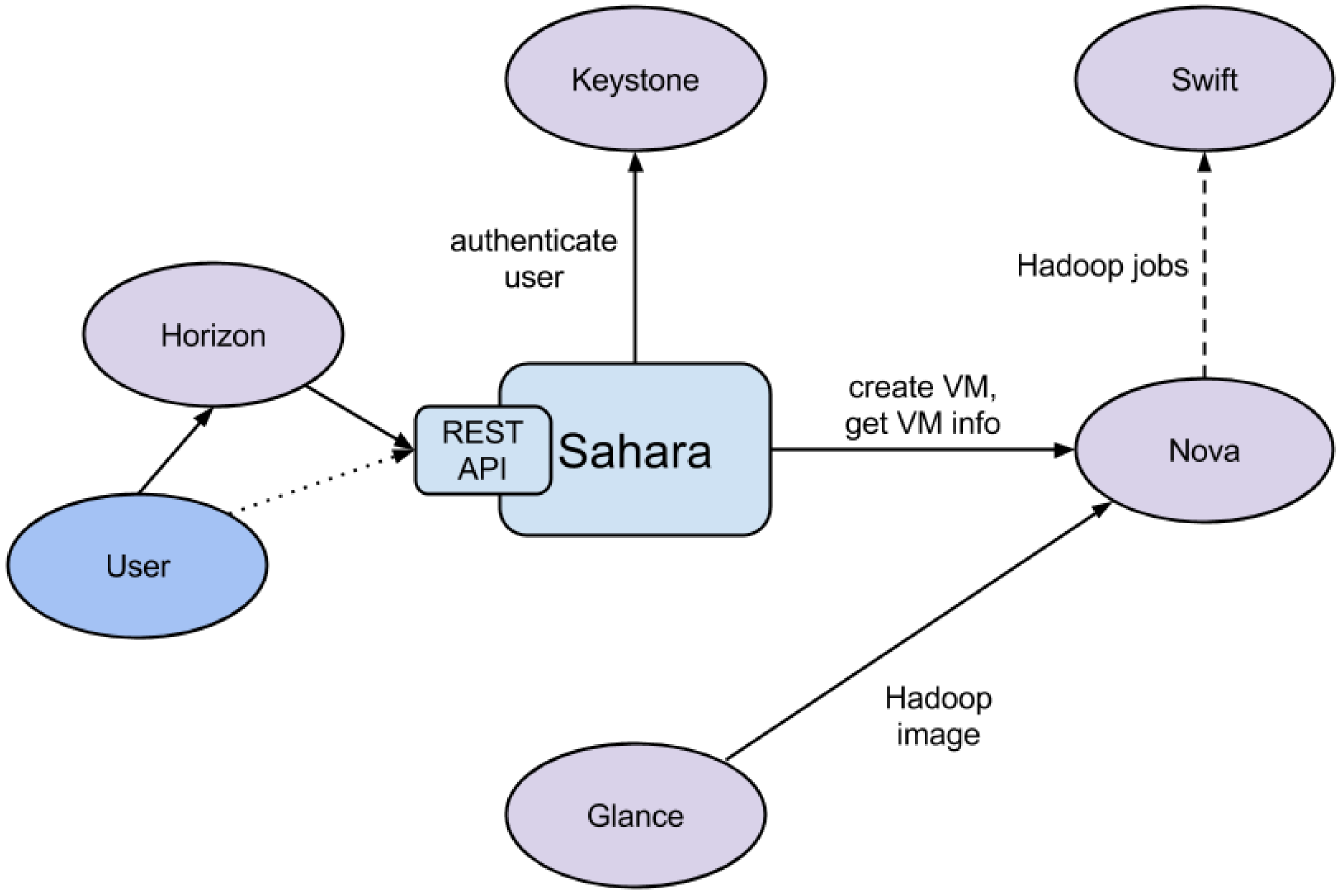
    - integration with vendor specific management tools, such as Apache Ambari and Cloudera Management Console.

- predefined configuration templates with the ability to modify parameters.

Details

The sahara product communicates with the following OpenStack services:

- Dashboard (horizon) - provides a GUI with ability to use all of sahara's features.
- Identity (keystone) - authenticates users and provides security tokens that are used to work with OpenStack, limiting a user's abilities in sahara to their OpenStack privileges.
- Compute (nova) - used to provision VMs for data processing clusters.
- Orchestration (heat) - used to provision and orchestrate the deployment of data processing clusters.
- Image (glance) - stores VM images, each image containing an operating system and a pre-installed data processing distribution or framework.
- Object Storage (swift) - can be used as storage for job binaries and data that will be processed or created by framework jobs.
- Block Storage (cinder) - can be used to provision block storage for VM instances.
- Networking (neutron) - provides networking services to data processing clusters.
- DNS service (designate) - provides ability to communicate with cluster instances and Hadoop services by their hostnames.
- Telemetry (ceilometer) - used to collect measures of cluster usage for metering and monitoring purposes.
- Shared file systems (manila) - can be used for storage of framework job binaries and data that will be processed or created by jobs.
- Key manager (barbican & castellan) - persists the authentication data like passwords and private keys in a secure storage.



General Workflow

Sahara will provide two levels of abstraction for the API and UI based on the addressed use cases: cluster provisioning and analytics as a service.

For fast cluster provisioning a generic workflow will be as following:

- select a Hadoop (or framework) version.
- select a base image with or without pre-installed data processing framework:
  - for base images without a pre-installed framework, sahara will support pluggable deployment engines that integrate with vendor tooling.
  - you can download prepared up-to-date images from http://sahara-files.mirantis.com/images/upstream/
- define cluster configuration, including cluster size, topology, and framework parameters (for example, heap size):

    - to ease the configuration of such parameters, configurable templates are provided.
- provision the cluster; sahara will provision VMs, install and configure the data processing framework.
- perform operations on the cluster; add or remove nodes.
- terminate the cluster when it is no longer needed.

For analytics as a service, a generic workflow will be as following:

- select one of the predefined data processing framework versions.
- configure a job:
    - choose the type of job: pig, hive, jar-file, etc.
    - provide the job script source or jar location.
    - select input and output data location.
- set the limit for the cluster size.
- execute the job:
    - all cluster provisioning and job execution will happen transparently to the user.
    - cluster will be removed automatically after job completion.
- get the results of computations (for example, from swift).

User's Perspective

While provisioning clusters through sahara, the user operates on three types of entities: Node Group Templates, Cluster Templates and Clusters.

A Node Group Template describes a group of nodes within cluster. It contains a list of hadoop processes that will be launched on each instance in a group. Also a Node Group Template may provide node scoped configurations for those processes. This kind of template encapsulates hardware parameters (flavor) for the node VM and configuration for data processing framework processes running on the node.

A Cluster Template is designed to bring Node Group Templates together to form a Cluster. A Cluster Template defines what Node Groups will be included and how many instances will be created in each. Some data processing framework configurations can not be applied to a single node, but to a whole Cluster. A user can specify these kinds of configurations in a Cluster Template. Sahara enables users to specify which processes should be added to an anti-affinity group within a Cluster Template. If a process is included into an anti-affinity group, it means that VMs where this process is going to be launched should be scheduled to different hardware hosts.

The Cluster entity represents a collection of VM instances that all have the same data processing framework installed. It is mainly characterized by a VM image with a pre-installed framework which will be used for cluster deployment. Users may choose one of the pre-configured Cluster Templates to start a Cluster. To get access to VMs after a Cluster has started, the user should specify a keypair.

Sahara provides several constraints on cluster framework topology. You can see all constraints in the documentation for the appropriate plugin.

Each Cluster belongs to an Identity service project determined by the user. Users have access only to objects located in projects they have access to. Users can edit and delete only objects they have created or exist in their projects. Naturally, admin users have full access to every object. In this manner, sahara complies with general OpenStack access policy.

Integration with Object Storage

The swift project provides the standard Object Storage service for OpenStack environments; it is an analog of the Amazon S3 service. As a rule it is deployed on bare metal machines. It is natural to expect data processing on OpenStack to access data stored there. Sahara provides this option with a file system implementation for swift HADOOP-8545 and Change I6b1ba25b which implements the ability to list endpoints for an object, account or container. This makes it possible to integrate swift with software that relies on data locality information to avoid network overhead.

To get more information on how to enable swift support see *Swift Integration*.

Pluggable Deployment and Monitoring

In addition to the monitoring capabilities provided by vendor-specific Hadoop management tooling, sahara provides pluggable integration with external monitoring systems such as Nagios or Zabbix.

Both deployment and monitoring tools can be installed on standalone VMs, thus allowing a single instance to manage and monitor several clusters at once.

Architecture

The Sahara architecture consists of several components:

- Auth component - responsible for client authentication & authorization, communicates with the OpenStack Identity service (keystone).
- DAL - Data Access Layer, persists internal models in DB.
- Secure Storage Access Layer - persists the authentication data like passwords and private keys in a secure storage.
- Provisioning Engine - component responsible for communication with the OpenStack Compute (nova), Orchestration (heat), Block Storage (cinder), Image (glance), and DNS (designate) services.
- Vendor Plugins - pluggable mechanism responsible for configuring and launching data processing frameworks on provisioned VMs. Existing management solutions like Apache Ambari and Cloudera Management Console could be utilized for that purpose as well.
- EDP - *Elastic Data Processing (EDP)* responsible for scheduling and managing data processing jobs on clusters provisioned by sahara.
- REST API - exposes sahara functionality via REST HTTP interface.
- Python Sahara Client - like other OpenStack components, sahara has its own python client.
- Sahara pages - a GUI for the sahara is located in the OpenStack Dashboard (horizon).

CHAPTER 2

User guide

Installation

Sahara Installation Guide

We recommend installing sahara in a way that will keep your system in a consistent state. We suggest the following options:

- Install via Fuel
- Install via RDO
- Install into a virtual environment

To install with Fuel

1. Start by following the MOS Quickstart to install and setup OpenStack.
2. Enable the sahara service during installation.

To install with RDO

1. Start by following the RDO Quickstart to install and setup OpenStack.
2. Install sahara:

```
# yum install openstack-sahara
```

3. Configure sahara as needed. The configuration file is located in `/etc/sahara/sahara.conf`. For details see *Sahara Configuration Guide*
4. Create the database schema:

```
# sahara-db-manage --config-file /etc/sahara/sahara.conf upgrade head
```

5. Go through *Common installation steps* and make any necessary changes.
6. Start the sahara-api and sahara-engine services:

```
# systemctl start openstack-sahara-api
# systemctl start openstack-sahara-engine
```

7. *(Optional)* Enable sahara services to start on boot

```
# systemctl enable openstack-sahara-api
# systemctl enable openstack-sahara-engine
```

To install into a virtual environment

1. First you need to install a number of packages with your OS package manager. The list of packages depends on the OS you use. For Ubuntu run:

```
$ sudo apt-get install python-setuptools python-virtualenv python-dev
```

For Fedora:

```
$ sudo yum install gcc python-setuptools python-virtualenv python-devel
```

For CentOS:

```
$ sudo yum install gcc python-setuptools python-devel
$ sudo easy_install pip
$ sudo pip install virtualenv
```

2. Setup a virtual environment for sahara:

```
$ virtualenv sahara-venv
```

This will install a python virtual environment into `sahara-venv` directory in your current working directory. This command does not require super user privileges and can be executed in any directory where the current user has write permissions.

3. You can get a sahara archive from http://tarballs.openstack.org/sahara/ and install it using pip:

```
$ sahara-venv/bin/pip install 'http://tarballs.openstack.org/sahara/sahara-master.tar.
↪gz'
```

Note that `sahara-master.tar.gz` contains the latest changes and might not be stable at the moment. We recommend browsing http://tarballs.openstack.org/sahara/ and selecting the latest stable release. For installation just execute (where replace the 'release' word with release name, e.g. 'mitaka'):

```
$ sahara-venv/bin/pip install 'http://tarballs.openstack.org/sahara/sahara-stable-
↪release.tar.gz'
```

For example, you can get Sahara Mitaka release by executing:

```
$ sahara-venv/bin/pip install 'http://tarballs.openstack.org/sahara/sahara-stable-
↪mitaka.tar.gz'
```

4. After installation you should create a configuration file from the sample file located in `sahara-venv/share/sahara/sahara.conf.sample-basic`:

```
$ mkdir sahara-venv/etc
$ cp sahara-venv/share/sahara/sahara.conf.sample-basic sahara-venv/etc/sahara.conf
```

   Make any necessary changes to `sahara-venv/etc/sahara.conf`. For details see *Sahara Configuration Guide*

Common installation steps

The steps below are common to both the RDO and virtual environment installations of sahara.

1. If you use sahara with a MySQL database, then for storing big job binaries in the sahara internal database you must configure the size of the maximum allowed packet. Edit the `my.cnf` file and change the `max_allowed_packet` parameter as follows:

```
...
[mysqld]
...
max_allowed_packet = 256M
```

   Then restart the mysql server to ensure these changes are active.

2. Create the database schema:

```
$ sahara-venv/bin/sahara-db-manage --config-file sahara-venv/etc/sahara.conf upgrade␣
↪head
```

3. Start sahara services from different terminals:

```
# first terminal
$ sahara-venv/bin/sahara-api --config-file sahara-venv/etc/sahara.conf

# second terminal
$ sahara-venv/bin/sahara-engine --config-file sahara-venv/etc/sahara.conf
```

4. For sahara to be accessible in the OpenStack Dashboard and for python-saharaclient to work properly you must register sahara in the Identity service catalog. For example:

```
openstack service create --name sahara --description \
    "Sahara Data Processing" data-processing

openstack endpoint create --region RegionOne \
--publicurl http://10.0.0.2:8386/v1.1/%\(project_id\)s \
--adminurl http://10.0.0.2:8386/v1.1/%\(project_id\)s \
--internalurl http://10.0.0.2:8386/v1.1/%\(project_id\)s \
data-processing
```

Note: You have to install the openstack-client package in order to execute `openstack` command.

5. For more information on configuring sahara with the OpenStack Dashboard please see *OpenStack Dashboard Configuration Guide*.

Optional installation of default templates

Sahara bundles default templates that define simple clusters for the supported plugins. These templates may optionally be added to the sahara database using a simple CLI included with sahara.

The default template CLI is described in detail in a *README* file included with the sahara sources at `<sahara_home>/db/templates/README.rst` but it is summarized here.

Flavor id values must be specified for the default templates included with sahara. The recommended configuration values below correspond to the *m1.medium* and *m1.large* flavors in a default OpenStack installation (if these flavors have been edited, their corresponding values will be different). Values for flavor_id should be added to `/etc/sahara/sahara.conf` or another configuration file in the sections shown here:

```
[DEFAULT]
# Use m1.medium for {flavor_id} unless specified in another section
flavor_id = 2

[cdh-5-default-namenode]
# Use m1.large for {flavor_id} in the cdh-5-default-namenode template
flavor_id = 4

[cdh-530-default-namenode]
# Use m1.large for {flavor_id} in the cdh-530-default-namenode template
flavor_id = 4
```

The above configuration values are included in a sample configuration file at `<sahara_home>/plugins/default_templates/template.conf`

The command to install all of the default templates is as follows, where `$PROJECT_ID` should be a valid project id and the above configuration values have been set in `myconfig`:

```
$ sahara-templates --config-file /etc/sahara/sahara.conf --config-file myconfig␣
↪update -t $PROJECT_ID
```

Help is available from the `sahara-templates` command:

```
$ sahara-templates --help
$ sahara-templates update --help
```

Notes:

Ensure that your operating system is not blocking the sahara port (default: 8386). You may need to configure iptables in CentOS and other Linux distributions to allow this access.

To get the list of all possible options run:

```
$ sahara-venv/bin/python sahara-venv/bin/sahara-api --help
$ sahara-venv/bin/python sahara-venv/bin/sahara-engine --help
```

Further, consider reading *Getting Started* for general sahara concepts and *Provisioning Plugins* for specific plugin features/requirements.

Sahara Configuration Guide

This guide covers the steps for a basic configuration of sahara. It will help you to configure the service in the most simple manner.

Basic configuration

Sahara is packaged with a basic sample configuration file: `sahara.conf.sample-basic`. This file contains all the essential parameters that are required for sahara. We recommend creating your configuration file based on this basic example.

If a more thorough configuration is needed we recommend using the `tox` tool to create a full configuration file by executing the following command:

```
$ tox -e genconfig
```

Running this command will create a file named `sahara.conf.sample` in the `etc/sahara` directory of the project.

After creating a configuration file by either copying the basic example or generating one, edit the `connection` parameter in the `[database]` section. The URL provided here should point to an empty database. For example, the connection string for a MySQL database will be:

```
connection=mysql://username:password@host:port/database
```

Next you will configure the Identity service parameters in the `[keystone_authtoken]` section. The `auth_uri` parameter should point to the public Identity API endpoint. The `identity_uri` should point to the admin Identity API endpoint. For example:

```
auth_uri=http://127.0.0.1:5000/v2.0/
identity_uri=http://127.0.0.1:35357/
```

Specify the `admin_user`, `admin_password` and `admin_tenant_name`. These parameters must specify an Identity user who has the `admin` role in the given project. These credentials allow sahara to authenticate and authorize its users.

Next you will configure the default Networking service. If using neutron for networking the following parameter should be set in the `[DEFAULT]` section:

```
use_neutron=true
```

If you are using nova-network for networking then this parameter should be set to `false`.

With these parameters set, sahara is ready to run.

By default the sahara's log level is set to INFO. If you wish to increase the logging levels for troubleshooting, set `debug` to `true` in the `[DEFAULT]` section of the configuration file.

Networking configuration

By default sahara is configured to use the neutron. Additionally, if the cluster supports network namespaces the `use_namespaces` property can be used to enable their usage.

```
[DEFAULT]
use_neutron=True
use_namespaces=True
```

Note: If a user other than `root` will be running the Sahara server instance and namespaces are used, some additional configuration is required, please see *Non-root users* for more information.

If an OpenStack cluster uses the deprecated nova-network, then the `use_neutron` parameter should be set to `False` in the sahara configuration file.

Floating IP management

During cluster setup sahara must access instances through a secure shell (SSH). To establish this connection it may use either the fixed or floating IP address of an instance. By default sahara is configured to use floating IP addresses for access. This is controlled by the `use_floating_ips` configuration parameter. With this setup the user has two options for ensuring that the instances in the node groups templates that requires floating IPs gain a floating IP address:

- If using the nova-network, it may be configured to assign floating IP addresses automatically by setting the `auto_assign_floating_ip` parameter to `True` in the nova configuration file (usually `nova.conf`).
- The user may specify a floating IP address pool for each node group that requires floating IPs directly.

From Newton changes were made to allow the coexistence of clusters using floating IPs and clusters using fixed IPs. If `use_floating_ips` is True it means that the floating IPs can be used by Sahara to spawn clusters. But, differently from previous versions, this does not mean that all instances in the cluster must have floating IPs and that all clusters must use floating IPs. It is possible in a single Sahara deploy to have clusters setup using fixed IPs, clusters using floating IPs and cluster that use both.

If not using floating IP addresses (`use_floating_ips=False`) sahara will use fixed IP addresses for instance management. When using neutron for the Networking service the user will be able to choose the fixed IP network for all instances in a cluster. Whether using nova-network or neutron it is important to ensure that all instances running sahara have access to the fixed IP networks.

Notifications configuration

Sahara can be configured to send notifications to the OpenStack Telemetry module. To enable this functionality the following parameter `enable` should be set in the `[oslo_messaging_notifications]` section of the configuration file:

```
[oslo_messaging_notifications]
enable = true
```

And the following parameter `driver` should be set in the `[oslo_messaging_notifications]` section of the configuration file:

```
[oslo_messaging_notifications]
driver = messaging
```

By default sahara is configured to use RabbitMQ as its message broker.

If you are using RabbitMQ as the message broker, then you should set the following parameter in the `[DEFAULT]` section:

```
rpc_backend = rabbit
```

You may also need to specify the connection parameters for your RabbitMQ installation. The following example shows the default values in the `[oslo_messaging_rabbit]` section which may need adjustment:

```
rabbit_host=localhost
rabbit_port=5672
rabbit_hosts=$rabbit_host:$rabbit_port
rabbit_userid=guest
rabbit_password=guest
rabbit_virtual_host=/
```

Orchestration configuration

By default sahara is configured to use the heat engine for instance creation. The heat engine uses the OpenStack Orchestration service to provision instances. This engine makes calls directly to the services required for instance provisioning.

Policy configuration

Sahara's public API calls may be restricted to certain sets of users by using a policy configuration file. The location of the policy file(s) is controlled by the `policy_file` and `policy_dirs` parameters in the `[oslo_policy]` section. By default sahara will search for a `policy.json` file in the same directory as the `sahara.conf` configuration file.

Examples

Example 1. Allow all method to all users (default policy).

```
{
    "default": ""
}
```

Example 2. Disallow image registry manipulations to non-admin users.

```
{
    "default": "",

    "data-processing:images:register": "role:admin",
    "data-processing:images:unregister": "role:admin",
    "data-processing:images:add_tags": "role:admin",
    "data-processing:images:remove_tags": "role:admin"
}
```

API configuration

Sahara uses the `api-paste.ini` file to configure the data processing API service. For middleware injection sahara uses pastedeploy library. The location of the api-paste file is controlled by the `api_paste_config` parameter in the `[default]` section. By default sahara will search for a `api-paste.ini` file in the same directory as the configuration file.

OpenStack Dashboard Configuration Guide

Sahara UI panels are integrated into the OpenStack Dashboard repository. No additional steps are required to enable Sahara UI in OpenStack Dashboard. However there are a few configurations that should be made to configure

OpenStack Dashboard.

Dashboard configurations are applied through the local_settings.py file. The sample configuration file is available here.

1. Networking

Depending on the Networking backend (Nova Network or Neutron) used in the cloud, Sahara panels will determine automatically which input fields should be displayed.

While using Nova Network backend the cloud may be configured to automatically assign floating IPs to instances. If Sahara service is configured to use those automatically assigned floating IPs the same configuration should be done to the dashboard through the `SAHARA_AUTO_IP_ALLOCATION_ENABLED` parameter.

Example:

```
SAHARA_AUTO_IP_ALLOCATION_ENABLED = True
```

2. Different endpoint

Sahara UI panels normally use `data-processing` endpoint from Keystone to talk to Sahara service. In some cases it may be useful to switch to another endpoint, for example use locally installed Sahara instead of the one on the OpenStack controller.

To switch the UI to another endpoint the endpoint should be registered in the first place.

Local endpoint example:

```
openstack service create --name sahara_local --description \
    "Sahara Data Processing (local installation)" \
    data_processing_local

openstack endpoint create --region RegionOne \
--publicurl http://127.0.0.1:8386/v1.1/%\(project_id\)s \
--adminurl http://127.0.0.1:8386/v1.1/%\(project_id\)s \
--internalurl http://127.0.0.1:8386/v1.1/%\(project_id\)s \
data_processing_local
```

Then the endpoint name should be changed in `sahara.py` under the module of sahara-dashboard/sahara_dashboard/api/sahara.py.

```
# "type" of Sahara service registered in keystone
SAHARA_SERVICE = 'data_processing_local'
```

Sahara Advanced Configuration Guide

This guide addresses specific aspects of Sahara configuration that pertain to advanced usage. It is divided into sections about various features that can be utilized, and their related configurations.

Custom network topologies

Sahara accesses instances at several stages of cluster spawning through SSH and HTTP. Floating IPs and network namespaces (see *Networking configuration*) will be automatically used for access when present. When floating IPs are not assigned to instances and namespaces are not being used, sahara will need an alternative method to reach them.

The `proxy_command` parameter of the configuration file can be used to give sahara a command to access instances. This command is run on the sahara host and must open a netcat socket to the instance destination port. The `{host}` and `{port}` keywords should be used to describe the destination, they will be substituted at runtime. Other keywords that can be used are: `{tenant_id}`, `{network_id}` and `{router_id}`.

For example, the following parameter in the sahara configuration file would be used if instances are accessed through a relay machine:

```
[DEFAULT]
proxy_command='ssh relay-machine-{tenant_id} nc {host} {port}'
```

Whereas the following shows an example of accessing instances though a custom network namespace:

```
[DEFAULT]
proxy_command='ip netns exec ns_for_{network_id} nc {host} {port}'
```

DNS Hostname Resolution

Sahara can resolve hostnames of cluster instances by using DNS. For this Sahara uses Designate. With this feature, for each instance of the cluster Sahara will create two `A` records (for internal and external ips) under one hostname and one `PTR` record. Also all links in the Sahara dashboard will be displayed as hostnames instead of just ip addresses.

You should configure DNS server with Designate. Designate service should be properly installed and registered in Keystone catalog. The detailed instructions about Designate configuration can be found here: Designate manual installation and here: Configuring OpenStack Networking with Designate. Also if you use devstack you can just enable Designate plugin: Designate devstack.

When Designate is configured you should create domain(s) for hostname resolution. This can be done by using the Designate dashboard or by CLI. Also you have to create `in-addr.arpa.` domain for reverse hostname resolution because some plugins (e.g. `HDP`) determine hostname by ip.

Sahara also should be properly configured. In `sahara.conf` you must specify two config properties:

```
[DEFAULT]
# Use Designate for internal and external hostnames resolution:
use_designate=true
# IP addresses of Designate nameservers:
nameservers=1.1.1.1,2.2.2.2
```

An OpenStack operator should properly configure the network. It must enable DHCP and specify DNS server ip addresses (e.g. 1.1.1.1 and 2.2.2.2) in `DNS Name Servers` field in the `Subnet Details`. If the subnet already exists and changing it or creating new one is impossible then Sahara will manually change `/etc/resolv.conf` file on every instance of the cluster (if `nameservers` list have been specified in `sahara.conf`). In this case, though, Sahara cannot guarantee that these changes will not be overwritten by DHCP or other services of the existing network. Sahara has a health check for track this situation (and if it occurs the health status will be red).

In order to resolve hostnames from your local machine you should properly change your `/etc/resolv.conf` file by adding appropriate ip addresses of DNS servers (e.g. 1.1.1.1 and 2.2.2.2). Also the VMs with DNS servers should be available from your local machine.

Data-locality configuration

Hadoop provides the data-locality feature to enable task tracker and data nodes the capability of spawning on the same rack, Compute node, or virtual machine. Sahara exposes this functionality to the user through a few configuration parameters and user defined topology files.

To enable data-locality, set the `enable_data_locality` parameter to `true` in the sahara configuration file

```
[DEFAULT]
enable_data_locality=true
```

With data locality enabled, you must now specify the topology files for the Compute and Object Storage services. These files are specified in the sahara configuration file as follows:

```
[DEFAULT]
compute_topology_file=/etc/sahara/compute.topology
swift_topology_file=/etc/sahara/swift.topology
```

The `compute_topology_file` should contain mappings between Compute nodes and racks in the following format:

```
compute1 /rack1
compute2 /rack2
compute3 /rack2
```

Note that the Compute node names must be exactly the same as configured in OpenStack (`host` column in admin list for instances).

The `swift_topology_file` should contain mappings between Object Storage nodes and racks in the following format:

```
node1 /rack1
node2 /rack2
node3 /rack2
```

Note that the Object Storage node names must be exactly the same as configured in the object ring. Also, you should ensure that instances with the task tracker process have direct access to the Object Storage nodes.

Hadoop versions after 1.2.0 support four-layer topology (for more detail please see HADOOP-8468 JIRA issue). To enable this feature set the `enable_hypervisor_awareness` parameter to `true` in the configuration file. In this case sahara will add the Compute node ID as a second level of topology for virtual machines.

Distributed mode configuration

Sahara can be configured to run in a distributed mode that creates a separation between the API and engine processes. This allows the API process to remain relatively free to handle requests while offloading intensive tasks to the engine processes.

The `sahara-api` application works as a front-end and serves user requests. It offloads 'heavy' tasks to the `sahara-engine` process via RPC mechanisms. While the `sahara-engine` process could be loaded with tasks, `sahara-api` stays free and hence may quickly respond to user queries.

If sahara runs on several hosts, the API requests could be balanced between several `sahara-api` hosts using a load balancer. It is not required to balance load between different `sahara-engine` hosts as this will be automatically done via the message broker.

If a single host becomes unavailable, other hosts will continue serving user requests. Hence, a better scalability is achieved and some fault tolerance as well. Note that distributed mode is not a true high availability. While the failure of a single host does not affect the work of the others, all of the operations running on the failed host will stop. For example, if a cluster scaling is interrupted, the cluster will be stuck in a half-scaled state. The cluster might continue working, but it will be impossible to scale it further or run jobs on it via EDP.

To run sahara in distributed mode pick several hosts on which you want to run sahara services and follow these steps:

- On each host install and configure sahara using the installation guide except:
  - Do not run `sahara-db-manage` or launch sahara with `sahara-all`
  - Ensure that each configuration file provides a database connection string to a single database for all hosts.
- Run `sahara-db-manage` as described in the installation guide, but only on a single (arbitrarily picked) host.
- The `sahara-api` and `sahara-engine` processes use oslo.messaging to communicate with each other. You will need to configure it properly on each host (see below).
- Run `sahara-api` and `sahara-engine` on the desired hosts. You may run both processes on the same or separate hosts as long as they are configured to use the same message broker and database.

To configure oslo.messaging, first you will need to choose a message broker driver. Currently there are two drivers provided: RabbitMQ or ZeroMQ. For the RabbitMQ drivers please see the *Notifications configuration* documentation for an explanation of common configuration options.

For an expanded view of all the options provided by each message broker driver in oslo.messaging please refer to the options available in the respective source trees:

- For Rabbit MQ see
  - rabbit_opts variable in impl_rabbit.py
  - amqp_opts variable in amqp.py
- For Zmq see
  - zmq_opts variable in impl_zmq.py
  - matchmaker_opts variable in matchmaker.py
  - matchmaker_redis_opts variable in matchmaker_redis.py
  - matchmaker_opts variable in matchmaker_ring.py

These options will also be present in the generated sample configuration file. For instructions on creating the configuration file please see the *Sahara Configuration Guide*.

Distributed periodic tasks configuration

If sahara is configured to run in distributed mode (see *Distributed mode configuration*), periodic tasks can also be launched in distributed mode. In this case tasks will be split across all `sahara-engine` processes. This will reduce overall load.

Distributed periodic tasks are based on Hash Ring implementation and the Tooz library that provides group membership support for a set of backends. In order to use periodic tasks distribution, the following steps are required:

- One of the supported backends should be configured and started.
- Backend URL should be set in the sahara configuration file with the `periodic_coordinator_backend_url` parameter. For example, if the ZooKeeper backend is being used:

  ```
  [DEFAULT]
  periodic_coordinator_backend_url=kazoo://IP:PORT
  ```

- Tooz extras should be installed. When using Zookeeper as coordination backend, `kazoo` library should be installed. It can be done with pip:

```
pip install tooz[zookeeper]
```

- Periodic tasks can be performed in parallel. Number of threads to run periodic tasks on a single engine can be set with `periodic_workers_number` parameter (only 1 thread will be launched by default). Example:

```
[DEFAULT]
periodic_workers_number=2
```

- `coordinator_heartbeat_interval` can be set to change the interval between heartbeat execution (1 second by default). Heartbeats are needed to make sure that connection to the coordination backend is active. Example:

```
[DEFAULT]
coordinator_heartbeat_interval=2
```

- `hash_ring_replicas_count` can be set to change the number of replicas for each engine on a Hash Ring. Each replica is a point on a Hash Ring that belongs to a particular engine. A larger number of replicas leads to better task distribution across the set of engines. (40 by default). Example:

```
[DEFAULT]
hash_ring_replicas_count=100
```

External key manager usage

Sahara generates and stores several passwords during the course of operation. To harden sahara's usage of passwords it can be instructed to use an external key manager for storage and retrieval of these secrets. To enable this feature there must first be an OpenStack Key Manager service deployed within the stack.

With a Key Manager service deployed on the stack, sahara must be configured to enable the external storage of secrets. Sahara uses the castellan library to interface with the OpenStack Key Manager service. This library provides configurable access to a key manager. To configure sahara to use barbican as the key manager, edit the sahara configuration file as follows:

```
[DEFAULT]
use_barbican_key_manager=true
```

Enabling the `use_barbican_key_manager` option will configure castellan to use barbican as its key management implementation. By default it will attempt to find barbican in the Identity service's service catalog.

For added control of the barbican server location, optional configuration values may be added to specify the URL for the barbican API server.

```
[castellan]
barbican_api_endpoint=http://{barbican controller IP:PORT}/
barbican_api_version=v1
```

The specific values for the barbican endpoint will be dictated by the IP address of the controller for your installation.

With all of these values configured and the Key Manager service deployed, sahara will begin storing its secrets in the external manager.

Indirect instance access through proxy nodes

Warning: The indirect VMs access feature is in alpha state. We do not recommend using it in a production environment.

Sahara needs to access instances through SSH during cluster setup. This access can be obtained a number of different ways (see *Networking configuration*, *Floating IP management*, *Custom network topologies*). Sometimes it is impossible to provide access to all nodes (because of limited numbers of floating IPs or security policies). In these cases access can be gained using other nodes of the cluster as proxy gateways. To enable this set `is_proxy_gateway=true` for the node group you want to use as proxy. Sahara will communicate with all other cluster instances through the instances of this node group.

Note, if `use_floating_ips=true` and the cluster contains a node group with `is_proxy_gateway=true`, the requirement to have `floating_ip_pool` specified is applied only to the proxy node group. Other instances will be accessed through proxy instances using the standard private network.

Note, the Cloudera Hadoop plugin doesn't support access to Cloudera manager through a proxy node. This means that for CDH clusters only nodes with the Cloudera manager can be designated as proxy gateway nodes.

Multi region deployment

Sahara supports multi region deployment. To enable this option each instance of sahara should have the `os_region_name=<region>` parameter set in the configuration file. The following example demonstrates configuring sahara to use the `RegionOne` region:

```
[DEFAULT]
os_region_name=RegionOne
```

Non-root users

In cases where a proxy command is being used to access cluster instances (for example, when using namespaces or when specifying a custom proxy command), rootwrap functionality is provided to allow users other than `root` access to the needed operating system facilities. To use rootwrap the following configuration parameter is required to be set:

```
[DEFAULT]
use_rootwrap=true
```

Assuming you elect to leverage the default rootwrap command (`sahara-rootwrap`), you will need to perform the following additional setup steps:

- Copy the provided sudoers configuration file from the local project file `etc/sudoers.d/sahara-rootwrap` to the system specific location, usually `/etc/sudoers.d`. This file is setup to allow a user named `sahara` access to the rootwrap script. It contains the following:

```
sahara ALL = (root) NOPASSWD: /usr/bin/sahara-rootwrap /etc/sahara/rootwrap.conf *
```

When using devstack to deploy sahara, please pay attention that you need to change user in script from `sahara` to `stack`.

- Copy the provided rootwrap configuration file from the local project file `etc/sahara/rootwrap.conf` to the system specific location, usually `/etc/sahara`. This file contains the default configuration for rootwrap.

- Copy the provided rootwrap filters file from the local project file `etc/sahara/rootwrap.d/sahara.filters` to the location specified in the rootwrap configuration file, usually `/etc/sahara/rootwrap.d`. This file contains the filters that will allow the `sahara` user to access the `ip netns exec`, `nc`, and `kill` commands through the rootwrap (depending on `proxy_command` you may need to set additional filters). It should look similar to the followings:

```
[Filters]
ip: IpNetnsExecFilter, ip, root
nc: CommandFilter, nc, root
kill: CommandFilter, kill, root
```

If you wish to use a rootwrap command other than `sahara-rootwrap` you can set the following parameter in your sahara configuration file:

```
[DEFAULT]
rootwrap_command='sudo sahara-rootwrap /etc/sahara/rootwrap.conf'
```

For more information on rootwrap please refer to the official Rootwrap documentation

Object Storage access using proxy users

To improve security for clusters accessing files in Object Storage, sahara can be configured to use proxy users and delegated trusts for access. This behavior has been implemented to reduce the need for storing and distributing user credentials.

The use of proxy users involves creating an Identity domain that will be designated as the home for these users. Proxy users will be created on demand by sahara and will only exist during a job execution which requires Object Storage access. The domain created for the proxy users must be backed by a driver that allows sahara's admin user to create new user accounts. This new domain should contain no roles, to limit the potential access of a proxy user.

Once the domain has been created, sahara must be configured to use it by adding the domain name and any potential delegated roles that must be used for Object Storage access to the sahara configuration file. With the domain enabled in sahara, users will no longer be required to enter credentials for their data sources and job binaries referenced in Object Storage.

Detailed instructions

First a domain must be created in the Identity service to hold proxy users created by sahara. This domain must have an identity backend driver that allows for sahara to create new users. The default SQL engine is sufficient but if your keystone identity is backed by LDAP or similar then domain specific configurations should be used to ensure sahara's access. Please see the Keystone documentation for more information.

With the domain created, sahara's configuration file should be updated to include the new domain name and any potential roles that will be needed. For this example let's assume that the name of the proxy domain is `sahara_proxy` and the roles needed by proxy users will be `Member` and `SwiftUser`.

```
[DEFAULT]
use_domain_for_proxy_users=true
proxy_user_domain_name=sahara_proxy
proxy_user_role_names=Member,SwiftUser
```

A note on the use of roles. In the context of the proxy user, any roles specified here are roles intended to be delegated to the proxy user from the user with access to Object Storage. More specifically, any roles that are required for Object Storage access by the project owning the object store must be delegated to the proxy user for authentication to be successful.

Finally, the stack administrator must ensure that images registered with sahara have the latest version of the Hadoop swift filesystem plugin installed. The sources for this plugin can be found in the sahara extra repository. For more information on images or swift integration see the sahara documentation sections *Building Images for Vanilla Plugin* and *Swift Integration*.

Volume instance locality configuration

The Block Storage service provides the ability to define volume instance locality to ensure that instance volumes are created on the same host as the hypervisor. The `InstanceLocalityFilter` provides the mechanism for the selection of a storage provider located on the same physical host as an instance.

To enable this functionality for instances of a specific node group, the `volume_local_to_instance` field in the node group template should be set to `true` and some extra configurations are needed:

- The cinder-volume service should be launched on every physical host and at least one physical host should run both cinder-scheduler and cinder-volume services.
- `InstanceLocalityFilter` should be added to the list of default filters (`scheduler_default_filters` in cinder) for the Block Storage configuration.
- The Extended Server Attributes extension needs to be active in the Compute service (this is true by default in nova), so that the `OS-EXT-SRV-ATTR:host` property is returned when requesting instance info.
- The user making the call needs to have sufficient rights for the property to be returned by the Compute service. This can be done by:
  - by changing nova's `policy.json` to allow the user access to the `extended_server_attributes` option.
  - by designating an account with privileged rights in the cinder configuration:

    ```
    os_privileged_user_name =
    os_privileged_user_password =
    os_privileged_user_tenant =
    ```

It should be noted that in a situation when the host has no space for volume creation, the created volume will have an `Error` state and can not be used.

Autoconfiguration for templates

../userdoc/configs_recommendations

NTP service configuration

By default sahara will enable the NTP service on all cluster instances if the NTP package is included in the image (the sahara disk image builder will include NTP in all images it generates). The default NTP server will be `pool.ntp.org`; this can be overridden using the `default_ntp_server` setting in the `DEFAULT` section of the sahara configuration file.

If you are creating cluster templates using the sahara UI and would like to specify a different NTP server for a particular cluster template, use the `URL of NTP server` setting in the `General Parameters` section when you create the template. If you would like to disable NTP for a particular cluster template, deselect the `Enable NTP service` checkbox in the `General Parameters` section when you create the template.

If you are creating clusters using the sahara CLI, you can specify another NTP server or disable NTP service using the examples below.

If you want to enable configuring the NTP service, you should specify the following configs for the cluster:

```
cluster_configs: {
    "general": {
        "URL of NTP server": "your_server.net",
    }
}
```

If you want to disable configuring NTP service, you should specify following configs for the cluster:

```
"cluster_configs": {
    "general": {
        "Enable NTP service": false,
    }
}
```

CORS (Cross Origin Resource Sharing) Configuration

Sahara provides direct API access to user-agents (browsers) via the HTTP CORS protocol. Detailed documentation, as well as troubleshooting examples, may be found in the OpenStack Administrator Guide.

To get started quickly, use the example configuration block below, replacing the `allowed origin` field with the host(s) from which your API expects access.

```
[cors]
allowed_origin=https://we.example.com:443
max_age=3600
allow_credentials=true

[cors.additional_domain_1]
allowed_origin=https://additional_domain_1.example.com:443

[cors.additional_domain_2]
allowed_origin=https://additional_domain_2.example.com:443
```

For more information on Cross Origin Resource Sharing, please review the W3C CORS specification.

Cleanup time for incomplete clusters

Sahara provides maximal time (in hours) for clusters allowed to be in states other than "Active", "Deleting" or "Error". If a cluster is not in "Active", "Deleting" or "Error" state and last update of it was longer than `cleanup_time_for_incomplete_clusters` hours ago then it will be deleted automatically. You can enable this feature by adding appropriate config property in the `DEFAULT` section (by default it set up to `0` value which means that automatic clean up is disabled). For example, if you want cluster to be deleted after 3 hours if it didn't leave "Starting" state then you should specify:

```
[DEFAULT]
cleanup_time_for_incomplete_clusters = 3
```

Security Group Rules Configuration

When auto_security_group is used, the amount of created security group rules may be bigger than the default values configured in `neutron.conf`. Then the default limit should be raised up to some bigger value which is proportional to the number of cluster node groups. You can change it in `neutron.conf` file:

```
[quotas]
quota_security_group = 1000
quota_security_group_rule = 10000
```

Or you can execute openstack CLI command:

```
openstack quota set --secgroups 1000 --secgroup-rules 10000 $PROJECT_ID
```

Sahara Upgrade Guide

This page contains details about upgrading sahara between releases such as configuration file updates, database migrations, and architectural changes.

Icehouse -> Juno

Main binary renamed to sahara-all

The All-In-One sahara binary has been renamed from `sahara-api` to `sahara-all`. The new name should be used in all cases where the All-In-One sahara is desired.

Authentication middleware changes

The custom auth_token middleware has been deprecated in favor of the keystone middleware. This change requires an update to the sahara configuration file. To update your configuration file you should replace the following parameters from the `[DEFAULT]` section with the new parameters in the `[keystone_authtoken]` section:

Old parameter name	New parameter name
os_admin_username	admin_user
os_admin_password	admin_password
os_admin_tenant_name	admin_tenant_name

Additionally, the parameters `os_auth_protocol`, `os_auth_host`, and `os_auth_port` have been combined to create the `auth_uri` and `identity_uri` parameters. These new parameters should be full URIs to the keystone public and admin endpoints, respectively.

For more information about these configuration parameters please see the *Sahara Configuration Guide*.

Database package changes

The oslo based code from sahara.openstack.common.db has been replaced by the usage of the oslo.db package. This change does not require any update to sahara's configuration file.

Additionally, the usage of SQLite databases has been deprecated. Please use MySQL or PostgreSQL databases for sahara. SQLite has been deprecated because it does not, and is not going to, support the `ALTER COLUMN` and `DROP COLUMN` commands required for migrations between versions. For more information please see http://www.sqlite.org/omitted.html

Sahara integration into OpenStack Dashboard

The sahara dashboard package has been deprecated in the Juno release. The functionality of the dashboard has been fully incorporated into the OpenStack Dashboard. The sahara interface is available under the “Project” -> “Data Processing” tab.

The Data processing service endpoints must be registered in the Identity service catalog for the Dashboard to properly recognize and display those user interface components. For more details on this process please see *registering Sahara in installation guide*.

The sahara-dashboard project is now used solely to host sahara user interface integration tests.

Virtual machine user name changes

The HEAT infrastructure engine has been updated to use the same rules for instance user names as the direct engine. In previous releases the user name for instances created by sahara using HEAT was always ‘ec2-user’. As of Juno, the user name is taken from the image registry as described in the *Registering an Image* document.

This change breaks backward compatibility for clusters created using the HEAT infrastructure engine prior to the Juno release. Clusters will continue to operate, but we do not recommended using the scaling operations with them.

Anti affinity implementation changed

Starting with the Juno release the anti affinity feature is implemented using server groups. From the user perspective there will be no noticeable changes with this feature. Internally this change has introduced the following behavior:

1. Server group objects will be created for any clusters with anti affinity enabled.
2. Affected instances on the same host will not be allowed even if they do not have common processes. Prior to Juno, instances with differing processes were allowed on the same host. The new implementation guarantees that all affected instances will be on different hosts regardless of their processes.

The new anti affinity implementation will only be applied for new clusters. Clusters created with previous versions will continue to operate under the older implementation, this applies to scaling operations on these clusters as well.

Juno -> Kilo

Sahara requires policy configuration

Sahara now requires a policy configuration file. The `policy.json` file should be placed in the same directory as the sahara configuration file or specified using the `policy_file` parameter. For more details about the policy file please see the *policy section in the configuration guide*.

Kilo -> Liberty

Direct engine deprecation

In the Liberty release the direct infrastructure engine has been deprecated and the heat infrastructure engine is now default. This means, that it is preferable to use heat engine instead now. In the Liberty release you can continue to operate clusters with the direct engine (create, delete, scale). Using heat engine only the delete operation is available on clusters that were created by the direct engine. After the Liberty release the direct engine will be removed, this means that you will only be able to delete clusters created with the direct engine.

Policy namespace changed (policy.json)

The “data-processing:” namespace has been added to the beginning of the all Sahara’s policy based actions, so, you need to update the policy.json file by prepending all actions with “data-processing:”.

Liberty -> Mitaka

Direct engine is removed.

Mitaka -> Newton

Sahara CLI command is deprecated, please use OpenStack Client.

Note: Since Mitaka release sahara actively uses release notes so you can see all required upgrade actions here: http://docs.openstack.org/releasenotes/sahara/

Sample sahara.conf file

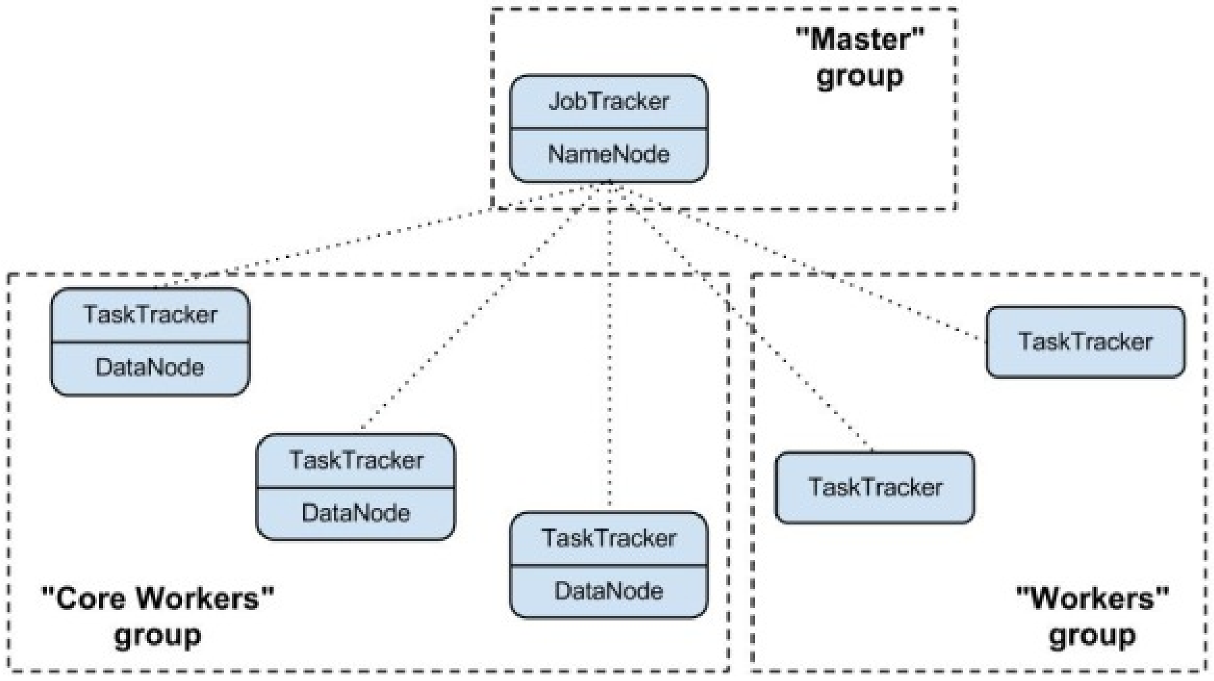
This is an automatically generated sample of the sahara.conf file.

How To

Getting Started

Clusters

A cluster deployed by sahara consists of node groups. Node groups vary by their role, parameters and number of machines. The picture below illustrates an example of a Hadoop cluster consisting of 3 node groups each having a different role (set of processes).



Node group parameters include Hadoop parameters like `io.sort.mb` or `mapred.child.java.opts`, and several infrastructure parameters like the flavor for VMs or storage location (ephemeral drive or cinder volume).

A cluster is characterized by its node groups and its parameters. Like a node group, a cluster has data processing framework and infrastructure parameters. An example of a cluster-wide Hadoop parameter is `dfs.replication`. For infrastructure, an example could be image which will be used to launch cluster VMs.

Templates

In order to simplify cluster provisioning sahara employs the concept of templates. There are two kinds of templates: node group templates and cluster templates. The former is used to create node groups, the latter - clusters. Essentially templates have the very same parameters as corresponding entities. Their aim is to remove the burden of specifying all of the required parameters each time a user wants to launch a cluster.

In the REST interface, templates have extended functionality. First you can specify node-scoped parameters here, they will work as defaults for node groups. Also with the REST interface, during cluster creation a user can override template parameters for both cluster and node groups.

Provisioning Plugins

A provisioning plugin is a component responsible for provisioning a data processing cluster. Generally each plugin is capable of provisioning a specific data processing framework or Hadoop distribution. Also the plugin can install management and/or monitoring tools for a cluster.

Since framework configuration parameters vary depending on the distribution and the version, templates are always plugin and version specific. A template cannot be used if the plugin, or framework, versions are different than the ones they were created for.

You may find the list of available plugins on that page: *Provisioning Plugins*

Image Registry

OpenStack starts VMs based on a pre-built image with an installed OS. The image requirements for sahara depend on the plugin and data processing framework version. Some plugins require just a basic cloud image and will install the framework on the VMs from scratch. Some plugins might require images with pre-installed frameworks or Hadoop distributions.

The Sahara Image Registry is a feature which helps filter out images during cluster creation. See *Registering an Image* for details on how to work with Image Registry.

Features

Sahara has several interesting features. The full list could be found there: *Features Overview*

Sahara (Data Processing) UI User Guide

This guide assumes that you already have the sahara service and Horizon dashboard up and running. Don't forget to make sure that sahara is registered in Keystone. If you require assistance with that, please see the installation guide.

The sections below give a panel by panel overview of setting up clusters and running jobs. For a description of using the guided cluster and job tools, look at *Launching a cluster via the Cluster Creation Guide* and *Running a job via the Job Execution Guide*.

Launching a cluster via the sahara UI

Registering an Image

1. Navigate to the "Project" dashboard, then the "Data Processing" tab, then click on the "Clusters" panel and finally the "Image Registry" tab.
2. From that page, click on the "Register Image" button at the top right
3. Choose the image that you'd like to register with sahara
4. Enter the username of the cloud-init user on the image
5. Choose plugin and version to make the image available only for the intended clusters
6. Click the "Done" button to finish the registration

Create Node Group Templates

1. Navigate to the "Project" dashboard, then the "Data Processing" tab, then click on the "Clusters" panel and then the "Node Group Templates" tab.
2. From that page, click on the "Create Template" button at the top right
3. Choose your desired Plugin name and Version from the dropdowns and click "Next"
4. Give your Node Group Template a name (description is optional)
5. Choose a flavor for this template (based on your CPU/memory/disk needs)
6. Choose the storage location for your instance, this can be either "Ephemeral Drive" or "Cinder Volume". If you choose "Cinder Volume", you will need to add additional configuration

7. Switch to the Node processes tab and choose which processes should be run for all instances that are spawned from this Node Group Template
8. Click on the "Create" button to finish creating your Node Group Template

Create a Cluster Template

1. Navigate to the "Project" dashboard, then the "Data Processing" tab, then click on the "Clusters" panel and finally the "Cluster Templates" tab.
2. From that page, click on the "Create Template" button at the top right
3. Choose your desired Plugin name and Version from the dropdowns and click "Next"
4. Under the "Details" tab, you must give your template a name
5. Under the "Node Groups" tab, you should add one or more nodes that can be based on one or more templates

- To do this, start by choosing a Node Group Template from the dropdown and click the "+" button
- You can adjust the number of nodes to be spawned for this node group via the text box or the "-" and "+" buttons
- Repeat these steps if you need nodes from additional node group templates

6. Optionally, you can adjust your configuration further by using the "General Parameters", "HDFS Parameters" and "MapReduce Parameters" tabs
7. If you have Designate DNS service you can choose the domain name in "DNS" tab for internal and external hostname resolution
8. Click on the "Create" button to finish creating your Cluster Template

Launching a Cluster

1. Navigate to the "Project" dashboard, then the "Data Processing" tab, then click on the "Clusters" panel and lastly, click on the "Clusters" tab.
2. Click on the "Launch Cluster" button at the top right
3. Choose your desired Plugin name and Version from the dropdowns and click "Next"
4. Give your cluster a name (required)
5. Choose which cluster template should be used for your cluster
6. Choose the image that should be used for your cluster (if you do not see any options here, see *Registering an Image* above)
7. Optionally choose a keypair that can be used to authenticate to your cluster instances
8. Click on the "Create" button to start your cluster

- Your cluster's status will display on the Clusters table
- It will likely take several minutes to reach the "Active" state

Scaling a Cluster

1. From the Data Processing/Clusters page (Clusters tab), click on the "Scale Cluster" button of the row that contains the cluster that you want to scale
2. You can adjust the numbers of instances for existing Node Group Templates

3. You can also add a new Node Group Template and choose a number of instances to launch

- This can be done by selecting your desired Node Group Template from the dropdown and clicking the "+" button
- Your new Node Group will appear below and you can adjust the number of instances via the text box or the "+" and "-" buttons

4. To confirm the scaling settings and trigger the spawning/deletion of instances, click on "Scale"

Elastic Data Processing (EDP)

Data Sources

Data Sources are where the input and output from your jobs are housed.

1. From the Data Processing/Jobs page (Data Sources tab), click on the "Create Data Source" button at the top right
2. Give your Data Source a name
3. Enter the URL of the Data Source

- For a swift object, enter <container>/<path> (ie: *mycontainer/inputfile*). sahara will prepend *swift://* for you
- For an HDFS object, enter an absolute path, a relative path or a full URL:
  - */my/absolute/path* indicates an absolute path in the cluster HDFS
  - *my/path* indicates the path */user/hadoop/my/path* in the cluster HDFS assuming the defined HDFS user is *hadoop*
  - *hdfs://host:port/path* can be used to indicate any HDFS location

4. Enter the username and password for the Data Source (also see *Additional Notes*)
5. Enter an optional description
6. Click on "Create"
7. Repeat for additional Data Sources

Job Binaries

Job Binaries are where you define/upload the source code (mains and libraries) for your job.

1. From the Data Processing/Jobs (Job Binaries tab), click on the "Create Job Binary" button at the top right
2. Give your Job Binary a name (this can be different than the actual filename)
3. Choose the type of storage for your Job Binary

- For "swift", enter the URL of your binary (<container>/<path>) as well as the username and password (also see *Additional Notes*)
- For "Internal database", you can choose from "Create a script" or "Upload a new file"

4. Enter an optional description
5. Click on "Create"
6. Repeat for additional Job Binaries

Job Templates (Known as "Jobs" in the API)

Job templates are where you define the type of job you'd like to run as well as which "Job Binaries" are required.

1. From the Data Processing/Jobs page (Job Templates tab), click on the "Create Job Template" button at the top right
2. Give your Job Template a name
3. Choose the type of job you'd like to run
4. Choose the main binary from the dropdown
    - This is required for Hive, Pig, and Spark jobs
    - Other job types do not use a main binary
5. Enter an optional description for your Job Template
6. Click on the "Libs" tab and choose any libraries needed by your job template
    - MapReduce and Java jobs require at least one library
    - Other job types may optionally use libraries
7. Click on "Create"

Jobs (Known as "Job Executions" in the API)

Jobs are what you get by "Launching" a job template. You can monitor the status of your job to see when it has completed its run

1. From the Data Processing/Jobs page (Job Templates tab), find the row that contains the job template you want to launch and click either "Launch on New Cluster" or "Launch on Existing Cluster" the right side of that row
2. Choose the cluster (already running–see *Launching a Cluster* above) on which you would like the job to run
3. Choose the Input and Output Data Sources (Data Sources defined above)
4. If additional configuration is required, click on the "Configure" tab

- Additional configuration properties can be defined by clicking on the "Add" button
- An example configuration entry might be mapred.mapper.class for the Name and org.apache.oozie.example.SampleMapper for the Value

5. Click on "Launch". To monitor the status of your job, you can navigate to the Data Processing/Jobs panel and click on the Jobs tab.
6. You can relaunch a Job from the Jobs page by using the "Relaunch on New Cluster" or "Relaunch on Existing Cluster" links

- Relaunch on New Cluster will take you through the forms to start a new cluster before letting you specify input/output Data Sources and job configuration
- Relaunch on Existing Cluster will prompt you for input/output Data Sources as well as allow you to change job configuration before launching the job

Example Jobs

There are sample jobs located in the sahara repository. In this section, we will give a walkthrough on how to run those jobs via the Horizon UI. These steps assume that you already have a cluster up and running (in the "Active" state).

You may want to clone into https://git.openstack.org/cgit/openstack/sahara-tests/ so that you will have all of the source code and inputs stored locally.

1. Sample Pig job - https://git.openstack.org/cgit/openstack/sahara-tests/tree/sahara_tests/scenario/defaults/edp-examples/edp-pig/cleanup-string/example.pig

- Load the input data file from https://git.openstack.org/cgit/openstack/sahara-tests/tree/sahara_tests/scenario/defaults/edp-examples/edp-pig/cleanup-string/data/input into swift
  - Click on Project/Object Store/Containers and create a container with any name ("samplecontainer" for our purposes here)
  - Click on Upload Object and give the object a name ("piginput" in this case)
- Navigate to Data Processing/Jobs/Data Sources, Click on Create Data Source
  - Name your Data Source ("pig-input-ds" in this sample)
  - Type = Swift, URL samplecontainer/piginput, fill-in the Source username/password fields with your username/password and click "Create"
- Create another Data Source to use as output for the job
  - Name = pig-output-ds, Type = Swift, URL = samplecontainer/pigoutput, Source username/password, "Create"
- Store your Job Binaries in the sahara database
  - Navigate to Data Processing/Jobs/Job Binaries, Click on Create Job Binary
  - Name = example.pig, Storage type = Internal database, click Browse and find example.pig wherever you checked out the sahara project <sahara-tests root>/etc/edp-examples/edp-pig/trim-spaces
  - Create another Job Binary: Name = edp-pig-udf-stringcleaner.jar, Storage type = Internal database, click Browse and find edp-pig-udf-stringcleaner.jar wherever you checked out the sahara project <sahara-tests root>/sahara_tests/scenario/defaults/edp-examples/ edp-pig/cleanup-string/
- Create a Job Template
  - Navigate to Data Processing/Jobs/Job Templates, Click on Create Job Template
  - Name = pigsample, Job Type = Pig, Choose "example.pig" as the main binary
  - Click on the "Libs" tab and choose "edp-pig-udf-stringcleaner.jar", then hit the "Choose" button beneath the dropdown, then click on "Create"
- Launch your job
  - To launch your job from the Job Templates page, click on the down arrow at the far right of the screen and choose "Launch on Existing Cluster"
  - For the input, choose "pig-input-ds", for output choose "pig-output-ds". Also choose whichever cluster you'd like to run the job on
  - For this job, no additional configuration is necessary, so you can just click on "Launch"
  - You will be taken to the "Jobs" page where you can see your job progress through "PENDING, RUNNING, SUCCEEDED" phases
  - When your job finishes with "SUCCEEDED", you can navigate back to Object Store/Containers and browse to the samplecontainer to see your output. It should be in the "pigoutput" folder

2. Sample Spark job - https://git.openstack.org/cgit/openstack/sahara-tests/tree/sahara_tests/scenario/defaults/edp-examples/edp-spark You can clone into https://git.openstack.org/cgit/openstack/sahara-tests/ for quicker access to the files for this sample job.

- Store the Job Binary in the sahara database
  - Navigate to Data Processing/Jobs/Job Binaries, Click on Create Job Binary
  - Name = sparkexample.jar, Storage type = Internal database, Browse to the location <sahara-tests root>/sahara_tests/scenario/defaults/ edp-examples/edp-spark/ and choose spark-wordcount.jar, Click "Create"
- Create a Job Template
  - Name = sparkexamplejob, Job Type = Spark, Main binary = Choose sparkexample.jar, Click "Create"
- Launch your job
  - To launch your job from the Job Templates page, click on the down arrow at the far right of the screen and choose "Launch on Existing Cluster"
  - Choose whichever cluster you'd like to run the job on
  - Click on the "Configure" tab
  - Set the main class to be: sahara.edp.spark.SparkWordCount
  - Under Arguments, click Add and fill url for the input file, once more click Add and fill url for the output file.
  - Click on Launch
  - You will be taken to the "Jobs" page where you can see your job progress through "PENDING, RUNNING, SUCCEEDED" phases
  - When your job finishes with "SUCCEEDED", you can see your results in your output file.
  - The stdout and stderr files of the command used for executing your job are located at /tmp/spark-edp/<name of job template>/<job id> on Spark master node in case of Spark clusters, or on Spark JobHistory node in other cases like Vanilla, CDH and so on.

Additional Notes

1. Throughout the sahara UI, you will find that if you try to delete an object that you will not be able to delete it if another object depends on it. An example of this would be trying to delete a Job Template that has an existing Job. In order to be able to delete that job, you would first need to delete any Job Templates that relate to that job.
2. In the examples above, we mention adding your username/password for the swift Data Sources. It should be noted that it is possible to configure sahara such that the username/password credentials are *not* required. For more information on that, please refer to: *Sahara Advanced Configuration Guide*

Launching a cluster via the Cluster Creation Guide

1. Under the Data Processing group, choose "Clusters" and then click on the "Clusters" tab. The "Cluster Creation Guide" button is above that table. Click on it.
2. Click on the "Choose Plugin" button then select the cluster type from the Plugin Name dropdown and choose your target version. When done, click on "Select" to proceed.
3. Click on "Create a Master Node Group Template". Give your template a name, choose a flavor and choose which processes should run on nodes launched for this node group. The processes chosen here should be things that are more server-like in nature (namenode, oozieserver, spark master, etc). Optionally, you can set other options here such as availability zone, storage, security and process specific parameters. Click on "Create" to proceed.

4. Click on "Create a Worker Node Group Template". Give your template a name, choose a flavor and choose which processes should run on nodes launched for this node group. Processes chosen here should be more worker-like in nature (datanode, spark slave, task tracker, etc). Optionally, you can set other options here such as availability zone, storage, security and process specific parameters. Click on "Create" to proceed.
5. Click on "Create a Cluster Template". Give your template a name. Next, click on the "Node Groups" tab and enter the count for each of the node groups (these are pre-populated from steps 3 and 4). It would be common to have 1 for the "master" node group type and some larger number of "worker" instances depending on you desired cluster size. Optionally, you can also set additional parameters for cluster-wide settings via the other tabs on this page. Click on "Create" to proceed.
6. Click on "Launch a Cluster". Give your cluster a name and choose the image that you want to use for all instances in your cluster. The cluster template that you created in step 5 is already pre-populated. If you want ssh access to the instances of your cluster, select a keypair from the dropdown. Click on "Launch" to proceed. You will be taken to the Clusters panel where you can see your cluster progress toward the Active state.

Running a job via the Job Execution Guide

1. Under the Data Processing group, choose "Jobs" and then click on the "Jobs" tab. The "Job Execution Guide" button is above that table. Click on it.
2. Click on "Select type" and choose the type of job that you want to run.
3. If your job requires input/output data sources, you will have the option to create them via the "Create a Data Source" button (Note: This button will not be shown for job types that do not require data sources). Give your data source a name and choose the type. If you have chosen swift, you may also enter the username and password. Enter the URL for your data source. For more details on what the URL should look like, see *Data Sources*.
4. Click on "Create a job template". Give your job template a name. Depending on the type of job that you've chosen, you may need to select your main binary and/or additional libraries (available from the "Libs" tab). If you have not yet uploaded the files to run your program, you can add them via the "+" icon next to the "Choose a main binary" select box.
5. Click on "Launch job". Choose the active cluster where you want to run you job. Optionally, you can click on the "Configure" tab and provide any required configuration, arguments or parameters for your job. Click on "Launch" to execute your job. You will be taken to the Jobs tab where you can monitor the state of your job as it progresses.

Features Overview

This page highlights some of the most prominent features available in sahara. The guidance provided here is primarily focused on the runtime aspects of sahara. For discussions about configuring the sahara server processes please see the *Sahara Configuration Guide* and *Sahara Advanced Configuration Guide*.

Anti-affinity

One of the problems with running data processing applications on OpenStack is the inability to control where an instance is actually running. It is not always possible to ensure that two new virtual machines are started on different physical machines. As a result, any replication within the cluster is not reliable because all replicas may be co-located on one physical machine. To remedy this, sahara provides the anti-affinity feature to explicitly command all instances of the specified processes to spawn on different Compute nodes. This is especially useful for Hadoop data node processes to increase HDFS replica reliability.

Starting with the Juno release, sahara can create server groups with the `anti-affinity` policy to enable this feature. Sahara creates one server group per cluster and assigns all instances with affected processes to this server group. Refer to the Nova documentation on how server groups work.

This feature is supported by all plugins out of the box, and can be enabled during the cluster template creation.

Block Storage support

OpenStack Block Storage (cinder) can be used as an alternative for ephemeral drives on instances. Using Block Storage volumes increases the reliability of data which is important for HDFS services.

A user can set how many volumes will be attached to each instance in a node group and the size of each volume. All volumes are attached during cluster creation and scaling operations.

If volumes are used for the HDFS storage it's important to make sure that the linear read-write operations as well as IOpS level are high enough to handle the workload. Volumes placed on the same compute host provide a higher level of performance.

In some cases cinder volumes can be backed by a distributed storage like Ceph. In this type of installation it's important to make sure that the network latency and speed do not become a blocker for HDFS. Distributed storage solutions usually provide their own replication mechanism. HDFS replication should be disabled so that it does not generate redundant traffic across the cloud.

Cluster scaling

Cluster scaling allows users to change the number of running instances in a cluster without needing to recreate the cluster. Users may increase or decrease the number of instances in node groups or add new node groups to existing clusters. If a cluster fails to scale properly, all changes will be rolled back.

Data locality

For optimal performance, it is best for data processing applications to work on data local to the same rack, OpenStack Compute node, or virtual machine. Hadoop supports a data locality feature and can schedule jobs to task tracker nodes that are local for the input stream. In this manner the task tracker nodes can communicate directly with the local data nodes.

Sahara supports topology configuration for HDFS and Object Storage data sources. For more information on configuring this option please see the *Data-locality configuration* documentation.

Volume-to-instance locality

Having an instance and an attached volume on the same physical host can be very helpful in order to achieve high-performance disk I/O operations. To achieve this, sahara provides access to the Block Storage volume instance locality functionality.

For more information on using volume instance locality with sahara, please see the *Volume instance locality configuration* documentation.

Distributed Mode

The *Sahara Installation Guide* suggests launching sahara in distributed mode with `sahara-api` and `sahara-engine` processes potentially running on several machines simultaneously. Running in distributed mode allows sahara to offload intensive tasks to the engine processes while keeping the API process free to handle requests.

For an expanded discussion of configuring sahara to run in distributed mode please see the *Distributed mode configuration* documentation.

Hadoop HDFS and YARN High Availability

Currently HDFS and YARN HA are supported with the HDP 2.4 plugin and CDH 5.7 plugins.

Hadoop HDFS and YARN High Availability provide an architecture to ensure that HDFS or YARN will continue to work in the result of an active namenode or resourcemanager failure. They use 2 namenodes and 2 resourcemanagers in an active/passive state to provide this availability.

In the HDP 2.4 plugin, the feature can be enabled through dashboard in the Cluster Template creation form. High availability is achieved by using a set of journalnodes, Zookeeper servers, and ZooKeeper Failover Controllers (ZKFC), as well as additional configuration changes to HDFS and other services that use HDFS.

In the CDH 5.7 plugin, HA for HDFS and YARN is enabled through adding several HDFS_JOURNALNODE roles in the node group templates of cluster template. The HDFS HA is enabled when HDFS_JOURNALNODE roles are added and the roles setup meets below requirements:

- HDFS_JOURNALNODE number is odd, and at least 3.
- Zookeeper is enabled.
- NameNode and SecondaryNameNode are on different physical hosts by setting anti-affinity.
- Cluster has both ResourceManager and StandByResourceManager.

In this case, the original SecondrayNameNode node will be used as the Standby NameNode.

Networking support

Sahara supports both the nova-network and neutron implementations of OpenStack Networking. By default sahara is configured to behave as if the nova-network implementation is available. For OpenStack installations that are using the neutron project please see *Networking configuration*.

Object Storage support

Sahara can use OpenStack Object Storage (swift) to store job binaries and data sources utilized by its job executions and clusters. In order to leverage this support within Hadoop, including using Object Storage for data sources for EDP, Hadoop requires the application of a patch. For additional information about enabling this support, including patching Hadoop and configuring sahara, please refer to the *Swift Integration* documentation.

Shared Filesystem support

Sahara can also use NFS shares through the OpenStack Shared Filesystem service (manila) to store job binaries and data sources. See *Elastic Data Processing (EDP)* for more information on this feature.

Orchestration support

Sahara may use the OpenStack Orchestration engine (heat) to provision nodes for clusters. For more information about enabling Orchestration usage in sahara please see *Orchestration configuration*.

DNS support

Sahara can resolve hostnames of cluster instances by using DNS. For this Sahara uses designate. For additional details see *Sahara Advanced Configuration Guide*.

Kerberos support

You can protect your HDP or CDH cluster using MIT Kerberos security. To get more details about this, please, see documentation for the appropriate plugin.

Plugin Capabilities

The following table provides a plugin capability matrix:

Feature	Plugin			
	Vanilla	HDP	Cloudera	Spark
Nova and Neutron network	x	x	x	x
Cluster Scaling	x	x	x	x
Swift Integration	x	x	x	x
Cinder Support	x	x	x	x
Data Locality	x	x	x	x
DNS	x	x	x	x
Kerberos	•	x	x	•
HDFS HA	•	x	x	•
EDP	x	x	x	x

Security group management

Security groups are sets of IP filter rules that are applied to an instance's networking. They are project specified, and project members can edit the default rules for their group and add new rules sets. All projects have a "default" security group, which is applied to instances that have no other security group defined. Unless changed, this security group denies all incoming traffic.

Sahara allows you to control which security groups will be used for created instances. This can be done by providing the `security_groups` parameter for the node group or node group template. The default for this option is an empty list, which will result in the default project security group being used for the instances.

Sahara may also create a security group for instances in the node group automatically. This security group will only contain open ports for required instance processes and the sahara engine. This option is useful for development and for when your installation is secured from outside environments. For production environments we recommend controlling the security group policy manually.

Shared and protected resources support

Sahara allows you to create resources that can be shared across projects and protected from modifications.

To provide this feature all sahara objects that can be accessed through REST API have `is_public` and `is_protected` boolean fields. They can be initially created with enabled `is_public` and `is_protected` parameters or these parameters can be updated after creation. Both fields are set to `False` by default.

If some object has its `is_public` field set to `True`, it means that it's visible not only from the project in which it was created, but from any other projects too.

If some object has its `is_protected` field set to `True`, it means that it can not be modified (updated, scaled, canceled or deleted) unless this field is set to `False`.

Public objects created in one project can be used from other projects (for example, a cluster can be created from a public cluster template which is created in another project), but modification operations are possible only from the project in which object was created.

Data source placeholders support

Sahara supports special strings that can be used in data source URLs. These strings will be replaced with appropriate values during job execution which allows the use of the same data source as an output multiple times.

There are 2 types of string currently supported:

- `%JOB_EXEC_ID%` - this string will be replaced with the job execution ID.
- `%RANDSTR(len)%` - this string will be replaced with random string of lowercase letters of length `len`. `len` must be less than 1024.

After placeholders are replaced, the real URLs are stored in the `data_source_urls` field of the job execution object. This is used later to find objects created by a particular job run.

Registering an Image

Sahara deploys a cluster of machines using images stored in Glance.

Each plugin has its own requirements on the image contents (see specific plugin documentation for details). Two general requirements for an image are to have the cloud-init and the ssh-server packages installed.

Sahara requires the images to be registered in the Sahara Image Registry. A registered image must have two properties set:

- username - a name of the default cloud-init user.
- tags - certain tags mark image to be suitable for certain plugins. The tags depend on the plugin used, you can find required tags in the plugin's documentations.

The default username specified for these images is different for each distribution:

OS	username
Ubuntu 12,14	ubuntu
Fedora	fedora
CentOS 6.x	cloud-user
CentOS 7.x	centos

Plugins

Provisioning Plugins

This page lists all available provisioning plugins. In general a plugin enables sahara to deploy a specific data processing framework (for example, Hadoop) or distribution, and allows configuration of topology and management/monitoring tools.

- *Vanilla Plugin* - deploys Vanilla Apache Hadoop
- *Ambari Plugin* - deploys Hortonworks Data Platform
- *Spark Plugin* - deploys Apache Spark with Cloudera HDFS
- *MapR Distribution Plugin* - deploys MapR plugin with MapR File System
- *Cloudera Plugin* - deploys Cloudera Hadoop

Managing plugins

Since the Newton release a project admin can configure plugins by specifying additional values for plugin's labels.

To disable a plugin (Vanilla Apache Hadoop, for example), the admin can run the following command:

```
cat update_configs.json
{
    "plugin_labels": {
        "enabled": {
            "status": true
        }
    }
}
openstack dataprocessing plugin update vanilla update_configs.json
```

Additionally, specific versions can be disabled by the following command:

```
cat update_configs.json
{
    "version_labels": {
        "2.7.1": {
            "enabled": {
                "status": true
            }
        }
    }
}
openstack dataprocessing plugin update vanilla update_configs.json
```

Finally, to see all labels of a specific plugin and to see the current status of the plugin (is it stable or not, deprecation status) the following command can be executed from the CLI:

```
openstack dataprocessing plugin show vanilla
```

The same actions are available from UI respectively.

Vanilla Plugin

The vanilla plugin is a reference implementation which allows users to operate a cluster with Apache Hadoop.

Since the Newton release Spark is integrated into the Vanilla plugin so you can launch Spark jobs on a Vanilla cluster.

For cluster provisioning prepared images should be used. They already have Apache Hadoop 2.7.1 installed.

You may build images by yourself using *Building Images for Vanilla Plugin* or you could download prepared images from http://sahara-files.mirantis.com/images/upstream

Vanilla plugin requires an image to be tagged in Sahara Image Registry with two tags: 'vanilla' and '<hadoop version>' (e.g. '2.7.1').

The default username specified for these images is different for each distribution:

OS	username
Ubuntu 14	ubuntu
Fedora 20	fedora
CentOS 6	cloud-user
CentOS 7	centos

Cluster Validation

When user creates or scales a Hadoop cluster using a Vanilla plugin, the cluster topology requested by user is verified for consistency.

Currently there are the following limitations in cluster topology for Vanilla plugin:

For Vanilla Hadoop version 2.x.x:

- Cluster must contain exactly one namenode
- Cluster can contain at most one resourcemanager
- Cluster can contain at most one secondary namenode
- Cluster can contain at most one historyserver
- Cluster can contain at most one oozie and this process is also required for EDP
- Cluster can't contain oozie without resourcemanager and without historyserver
- Cluster can't have nodemanager nodes if it doesn't have resourcemanager
- Cluster can have at most one hiveserver node.
- Cluster can have at most one spark history server and this process is also required for Spark EDP (Spark is available since the Newton release).

Ambari Plugin

The Ambari sahara plugin provides a way to provision clusters with Hortonworks Data Platform on OpenStack using templates in a single click and in an easily repeatable fashion. The sahara controller serves as the glue between Hadoop and OpenStack. The Ambari plugin mediates between the sahara controller and Apache Ambari in order to deploy and configure Hadoop on OpenStack. Core to the HDP Plugin is Apache Ambari which is used as the orchestrator for deploying HDP on OpenStack. The Ambari plugin uses Ambari Blueprints for cluster provisioning.

Apache Ambari Blueprints

Apache Ambari Blueprints is a portable document definition, which provides a complete definition for an Apache Hadoop cluster, including cluster topology, components, services and their configurations. Ambari Blueprints can be consumed by the Ambari plugin to instantiate a Hadoop cluster on OpenStack. The benefits of this approach is that it allows for Hadoop clusters to be configured and deployed using an Ambari native format that can be used with as well as outside of OpenStack allowing for clusters to be re-instantiated in a variety of environments.

Images

The sahara Ambari plugin is using minimal (operating system only) images.

For more information about Ambari images, refer to https://github.com/openstack/sahara-image-elements.

You could download well tested and up-to-date prepared images from http://sahara-files.mirantis.com/images/upstream/

HDP plugin requires an image to be tagged in sahara Image Registry with two tags: 'ambari' and '<plugin version>' (e.g. '2.5').

Also in the Image Registry you will need to specify username for an image. The username specified should be 'cloud-user' in case of CentOS 6.x image, 'centos' for CentOS 7 images and 'ubuntu' for Ubuntu images.

High Availability for HDFS and YARN

High Availability (Using the Quorum Journal Manager) can be deployed automatically with the Ambari plugin. You can deploy High Available cluster through UI by selecting `NameNode HA` and/or `ResourceManager HA` options in general configs of cluster template.

The NameNode High Availability is deployed using 2 NameNodes, one active and one standby. The NameNodes use a set of JournalNodes and Zookepeer Servers to ensure the necessary synchronization. In case of ResourceManager HA 2 ResourceManagers should be enabled in addition.

A typical Highly available Ambari cluster uses 2 separate NameNodes, 2 separate ResourceManagers and at least 3 JournalNodes and at least 3 Zookeeper Servers.

HDP Version Support

The HDP plugin currently supports deployment of HDP 2.3, 2.4 and 2.5.

Cluster Validation

Prior to Hadoop cluster creation, the HDP plugin will perform the following validation checks to ensure a successful Hadoop deployment:

- Ensure the existence of Ambari Server process in the cluster;
- Ensure the existence of a NameNode, Zookeeper, ResourceManagers processes HistoryServer and App TimeLine Server in the cluster

Enabling Kerberos security for cluster

If you want to protect your clusters using MIT Kerberos security you have to complete a few steps below.

- If you would like to create a cluster protected by Kerberos security you just need to enable Kerberos by checkbox in the `General Parameters` section of the cluster configuration. If you prefer to use the OpenStack CLI for cluster creation, you have to put the data below in the `cluster_configs` section:

```
"cluster_configs": {
  "Enable Kerberos Security": true,
}
```

Sahara in this case will correctly prepare KDC server and will create principals along with keytabs to enable authentication for Hadoop services.

- Ensure that you have the latest hadoop-openstack jar file distributed on your cluster nodes. You can download one at `http://tarballs.openstack.org/sahara/dist/`
- Sahara will create principals along with keytabs for system users like `oozie`, `hdfs` and `spark` so that you will not have to perform additional auth operations to execute your jobs on top of the cluster.

Spark Plugin

The Spark plugin for sahara provides a way to provision Apache Spark clusters on OpenStack in a single click and in an easily repeatable fashion.

Currently Spark is installed in standalone mode, with no YARN or Mesos support.

Images

For cluster provisioning, prepared images should be used. The Spark plugin has been developed and tested with the images generated by sahara-image-elements:

- https://github.com/openstack/sahara-image-elements

The latest Ubuntu images generated by sahara-image-elements have Cloudera CDH 5.4.0 HDFS and Apache Spark installed. A prepared image for Spark can be found at the following location:

- http://sahara-files.mirantis.com/images/upstream/

The Spark plugin requires an image to be tagged in the sahara image registry with two tags: 'spark' and '<Spark version>' (e.g. '1.6.0').

Also you should specify the username of the default cloud-user used in the image. For the images available at the URLs listed above and for all the ones generated with the DIB it is *ubuntu*.

Note that the Spark cluster is deployed using the scripts available in the Spark distribution, which allow the user to start all services (master and slaves), stop all services and so on. As such (and as opposed to CDH HDFS daemons), Spark is not deployed as a standard Ubuntu service and if the virtual machines are rebooted, Spark will not be restarted.

Spark configuration

Spark needs few parameters to work and has sensible defaults. If needed they can be changed when creating the sahara cluster template. No node group options are available.

Once the cluster is ready, connect with ssh to the master using the *ubuntu* user and the appropriate ssh key. Spark is installed in */opt/spark* and should be completely configured and ready to start executing jobs. At the bottom of the cluster information page from the OpenStack dashboard, a link to the Spark web interface is provided.

Cluster Validation

When a user creates an Hadoop cluster using the Spark plugin, the cluster topology requested by user is verified for consistency.

Currently there are the following limitations in cluster topology for the Spark plugin:

- Cluster must contain exactly one HDFS namenode
- Cluster must contain exactly one Spark master
- Cluster must contain at least one Spark slave
- Cluster must contain at least one HDFS datanode

The tested configuration co-locates the NameNode with the master and a DataNode with each slave to maximize data locality.

Cloudera Plugin

The Cloudera plugin is a Sahara plugin which allows the user to deploy and operate a cluster with Cloudera Manager.

The Cloudera plugin is enabled in Sahara by default. You can manually modify the Sahara configuration file (default /etc/sahara/sahara.conf) to explicitly enable or disable it in "plugins" line.

You need to build images using *Building Images for Cloudera Plugin* to produce images used to provision cluster or you could download prepared images from http://sahara-files.mirantis.com/images/upstream/ They already have Cloudera Express installed (version 5.0.0, 5.3.0, 5.4.0, 5.5.0, 5.7.x and 5.9.x).

The cloudera plugin requires an image to be tagged in Sahara Image Registry with two tags: 'cdh' and '<cloudera version>' (e.g. '5', '5.3.0', '5.4.0', '5.5.0', '5.7.0', '5.9.0' or '5.9.1', here '5' stands for '5.0.0').

The default username specified for these images is different for each distribution:

for 5.0.0, 5.3.0 and 5.4.0 version:

OS	username
Ubuntu 12.04	ubuntu
CentOS 6.6	cloud-user

for 5.5.0 and higher versions:

OS	username
Ubuntu 14.04	ubuntu
CentOS 6.6	cloud-user
CentOS 7	centos

Services Supported

Currently below services are supported in both versions of Cloudera plugin: HDFS, Oozie, YARN, Spark, Zookeeper, Hive, Hue, HBase. 5.3.0 version of Cloudera Plugin also supported following services: Impala, Flume, Solr, Sqoop, and Key-value Store Indexer. In version 5.4.0 KMS service support was added based on version 5.3.0. Kafka 2.0.2 was added for CDH 5.5 and higher.

Note: Sentry service is enabled in Cloudera plugin. However, as we do not enable Kerberos authentication in the cluster for CDH version < 5.5 (which is required for Sentry functionality) then using Sentry service will not really take any effect, and other services depending on Sentry will not do any authentication too.

High Availability Support

Currently HDFS NameNode High Availability is supported beginning with Cloudera 5.4.0 version. You can refer to *Features Overview* for the detail info.

YARN ResourceManager High Availability is supported beginning with Cloudera 5.4.0 version. This feature adds redundancy in the form of an Active/Standby ResourceManager pair to avoid the failure of single RM. Upon failover, the Standby RM become Active so that the applications can resume from their last check-pointed state.

Cluster Validation

When the user performs an operation on the cluster using a Cloudera plugin, the cluster topology requested by the user is verified for consistency.

The following limitations are required in the cluster topology for all cloudera plugin versions:

- Cluster must contain exactly one manager.
- Cluster must contain exactly one namenode.
- Cluster must contain exactly one secondarynamenode.
- Cluster must contain at least `dfs_replication` datanodes.
- Cluster can contain at most one resourcemanager and this process is also required by nodemanager.
- Cluster can contain at most one jobhistory and this process is also required for resourcemanager.
- Cluster can contain at most one oozie and this process is also required for EDP.
- Cluster can't contain oozie without datanode.
- Cluster can't contain oozie without nodemanager.
- Cluster can't contain oozie without jobhistory.
- Cluster can't contain hive on the cluster without the following services: metastore, hive server, webcat and resourcemanager.
- Cluster can contain at most one hue server.
- Cluster can't contain hue server without hive service and oozie.
- Cluster can contain at most one spark history server.
- Cluster can't contain spark history server without resourcemanager.
- Cluster can't contain hbase master service without at least one zookeeper and at least one hbase regionserver.
- Cluster can't contain hbase regionserver without at least one hbase maser.

In case of 5.3.0, 5.4.0, 5.5.0, 5.7.x or 5.9.x version of Cloudera Plugin there are few extra limitations in the cluster topology:

- Cluster can't contain flume without at least one datanode.
- Cluster can contain at most one sentry server service.
- Cluster can't contain sentry server service without at least one zookeeper and at least one datanode.
- Cluster can't contain solr server without at least one zookeeper and at least one datanode.
- Cluster can contain at most one sqoop server.
- Cluster can't contain sqoop server without at least one datanode, nodemanager and jobhistory.

- Cluster can't contain hbase indexer without at least one datanode, zookeeper, solr server and hbase master.
- Cluster can contain at most one impala catalog server.
- Cluster can contain at most one impala statestore.
- Cluster can't contain impala catalogserver without impala statestore, at least one impalad service, at least one datanode, and metastore.
- If using Impala, the daemons must be installed on every datanode.

In case of version 5.5.0, 5.7.x or 5.9.x of Cloudera Plugin additional services in the cluster topology are available:

- Cluster can have the kafka service and several kafka brokers.

Enabling Kerberos security for cluster

If you want to protect your clusters using MIT Kerberos security you have to complete a few steps below.

- If you would like to create a cluster protected by Kerberos security you just need to enable Kerberos by checkbox in the `General Parameters` section of the cluster configuration. If you prefer to use the OpenStack CLI for cluster creation, you have to put the data below in the `cluster_configs` section:

  ```
  "cluster_configs": {
    "Enable Kerberos Security": true,
  }
  ```

  Sahara in this case will correctly prepare KDC server and will create principals along with keytabs to enable authentication for Hadoop services.

- Ensure that you have the latest hadoop-openstack jar file distributed on your cluster nodes. You can download one at `http://tarballs.openstack.org/sahara/dist/`
- Sahara will create principals along with keytabs for system users like `hdfs` and `spark` so that you will not have to perform additional auth operations to execute your jobs on top of the cluster.

MapR Distribution Plugin

The MapR Sahara plugin allows to provision MapR clusters on OpenStack in an easy way and do it, quickly, conveniently and simply.

Operation

The MapR Plugin performs the following four primary functions during cluster creation:

1. MapR components deployment - the plugin manages the deployment of the required software to the target VMs
2. Services Installation - MapR services are installed according to provided roles list
3. Services Configuration - the plugin combines default settings with user provided settings
4. Services Start - the plugin starts appropriate services according to specified roles

Images

The Sahara MapR plugin can make use of either minimal (operating system only) images or pre-populated MapR images. The base requirement for both is that the image is cloud-init enabled and contains a supported operating system (see http://maprdocs.mapr.com/home/InteropMatrix/r_os_matrix.html).

The advantage of a pre-populated image is that provisioning time is reduced, as packages do not need to be downloaded which make up the majority of the time spent in the provisioning cycle. In addition, provisioning large clusters will put a burden on the network as packages for all nodes need to be downloaded from the package repository.

For more information about MapR images, refer to https://github.com/openstack/sahara-image-elements.

There are VM images provided for use with the MapR Plugin, that can also be built using the tools available in sahara-image-elements: https://s3-us-west-2.amazonaws.com/sahara-images/index.html

MapR plugin needs an image to be tagged in Sahara Image Registry with two tags: 'mapr' and '<MapR version>' (e.g. '5.2.0.mrv2').

The default username specified for these images is different for each distribution:

OS	username
Ubuntu 14	ubuntu
CentOS 6	cloud-user
CentOS 7	centos

Hadoop Version Support

The MapR plugin currently supports Hadoop 2.7.0 (5.2.0.mrv2).

Cluster Validation

When the user creates or scales a Hadoop cluster using a mapr plugin, the cluster topology requested by the user is verified for consistency.

Every MapR cluster must contain:

- at least 1 *CLDB* process
- exactly 1 *Webserver* process
- odd number of *ZooKeeper* processes but not less than 1
- *FileServer* process on every node
- at least 1 ephemeral drive (then you need to specify the ephemeral drive in the flavor not on the node group template creation) or 1 Cinder volume per instance

Every Hadoop cluster must contain exactly 1 *Oozie* process

Every MapReduce v1 cluster must contain:

- at least 1 *JobTracker* process
- at least 1 *TaskTracker* process

Every MapReduce v2 cluster must contain:

- exactly 1 *ResourceManager* process
- exactly 1 *HistoryServer* process
- at least 1 *NodeManager* process

Every Spark cluster must contain:

- exactly 1 *Spark Master* process
- exactly 1 *Spark HistoryServer* process
- at least 1 *Spark Slave* (worker) process

HBase service is considered valid if:

- cluster has at least 1 *HBase-Master* process
- cluster has at least 1 *HBase-RegionServer* process

Hive service is considered valid if:

- cluster has exactly 1 *HiveMetastore* process
- cluster has exactly 1 *HiveServer2* process

Hue service is considered valid if:

- cluster has exactly 1 *Hue* process
- *Hue* process resides on the same node as *HttpFS* process

HttpFS service is considered valid if cluster has exactly 1 *HttpFS* process

Sqoop service is considered valid if cluster has exactly 1 *Sqoop2-Server* process

The MapR Plugin

For more information, please contact MapR.

Elastic Data Processing

Elastic Data Processing (EDP)

Overview

Sahara's Elastic Data Processing facility or *EDP* allows the execution of jobs on clusters created from sahara. EDP supports:

- Hive, Pig, MapReduce, MapReduce.Streaming, Java, and Shell job types on Hadoop clusters
- Spark jobs on Spark standalone clusters, MapR (v5.0.0 - v5.2.0) clusters, Vanilla clusters (v2.7.1) and CDH clusters (v5.3.0 or higher).
- storage of job binaries in the OpenStack Object Storage service (swift), the OpenStack Shared file systems service (manila), or sahara's own database
- access to input and output data sources in
  - HDFS for all job types
  - swift for all types excluding Hive
  - manila (NFS shares only) for all types excluding Pig
- configuration of jobs at submission time
- execution of jobs on existing clusters or transient clusters

Interfaces

The EDP features can be used from the sahara web UI which is described in the *Sahara (Data Processing) UI User Guide*.

The EDP features also can be used directly by a client through the REST api

EDP Concepts

Sahara EDP uses a collection of simple objects to define and execute jobs. These objects are stored in the sahara database when they are created, allowing them to be reused. This modular approach with database persistence allows code and data to be reused across multiple jobs.

The essential components of a job are:

- executable code to run
- input and output data paths, as needed for the job
- any additional configuration values needed for the job run

These components are supplied through the objects described below.

Job Binaries

A *Job Binary* object stores a URL to a single script or Jar file and any credentials needed to retrieve the file. The file itself may be stored in the sahara internal database (but it is deprecated now), in swift, or in manila.

deprecated: Files in the sahara database are stored as raw bytes in a *Job Binary Internal* object. This object's sole purpose is to store a file for later retrieval. No extra credentials need to be supplied for files stored internally.

Sahara requires credentials (username and password) to access files stored in swift unless swift proxy users are configured as described in *Sahara Advanced Configuration Guide*. The swift service must be running in the same OpenStack installation referenced by sahara.

To reference a binary file stored in manila, create the job binary with the URL `manila://{share_id}/{path}`. This assumes that you have already stored that file in the appropriate path on the share. The share will be automatically mounted to any cluster nodes which require access to the file, if it is not mounted already.

There is a configurable limit on the size of a single job binary that may be retrieved by sahara. This limit is 5MB and may be set with the *job_binary_max_KB* setting in the `sahara.conf` configuration file.

Jobs

A *Job* object specifies the type of the job and lists all of the individual Job Binary objects that are required for execution. An individual Job Binary may be referenced by multiple Jobs. A Job object specifies a main binary and/or supporting libraries depending on its type:

Job type	Main binary	Libraries
`Hive`	required	optional
`Pig`	required	optional
`MapReduce`	not used	required
`MapReduce.Streaming`	not used	optional
`Java`	not used	required
`Shell`	required	optional
`Spark`	required	optional
`Storm`	required	not used
`Storm Pyelus`	required	not used

Data Sources

A *Data Source* object stores a URL which designates the location of input or output data and any credentials needed to access the location.

Sahara supports data sources in swift. The swift service must be running in the same OpenStack installation referenced by sahara.

Sahara also supports data sources in HDFS. Any HDFS instance running on a sahara cluster in the same OpenStack installation is accessible without manual configuration. Other instances of HDFS may be used as well provided that the URL is resolvable from the node executing the job.

Sahara supports data sources in manila as well. To reference a path on an NFS share as a data source, create the data source with the URL `manila://{share_id}/{path}`. As in the case of job binaries, the specified share will be automatically mounted to your cluster's nodes as needed to access the data source.

Some job types require the use of data source objects to specify input and output when a job is launched. For example, when running a Pig job the UI will prompt the user for input and output data source objects.

Other job types like Java or Spark do not require the user to specify data sources. For these job types, data paths are passed as arguments. For convenience, sahara allows data source objects to be referenced by name or id. The section *Using Data Source References as Arguments* gives further details.

Job Execution

Job objects must be *launched* or *executed* in order for them to run on the cluster. During job launch, a user specifies execution details including data sources, configuration values, and program arguments. The relevant details will vary by job type. The launch will create a *Job Execution* object in sahara which is used to monitor and manage the job.

To execute Hadoop jobs, sahara generates an Oozie workflow and submits it to the Oozie server running on the cluster. Familiarity with Oozie is not necessary for using sahara but it may be beneficial to the user. A link to the Oozie web console can be found in the sahara web UI in the cluster details.

For Spark jobs, sahara uses the *spark-submit* shell script and executes the Spark job from the master node in case of Spark cluster and from the Spark Job History server in other cases. Logs of spark jobs run by sahara can be found on this node under the */tmp/spark-edp* directory.

General Workflow

The general workflow for defining and executing a job in sahara is essentially the same whether using the web UI or the REST API.

1. Launch a cluster from sahara if there is not one already available
2. Create all of the Job Binaries needed to run the job, stored in the sahara database, in swift, or in manila

  - When using the REST API and internal storage of job binaries, the Job Binary Internal objects must be created first
  - Once the Job Binary Internal objects are created, Job Binary objects may be created which refer to them by URL

3. Create a Job object which references the Job Binaries created in step 2
4. Create an input Data Source which points to the data you wish to process
5. Create an output Data Source which points to the location for output data
6. Create a Job Execution object specifying the cluster and Job object plus relevant data sources, configuration values, and program arguments
   - When using the web UI this is done with the *Launch On Existing Cluster* or *Launch on New Cluster* buttons on the Jobs tab
   - When using the REST API this is done via the */jobs/<job_id>/execute* method

The workflow is simpler when using existing objects. For example, to construct a new job which uses existing binaries and input data a user may only need to perform steps 3, 5, and 6 above. Of course, to repeat the same job multiple times a user would need only step 6.

Specifying Configuration Values, Parameters, and Arguments

Jobs can be configured at launch. The job type determines the kinds of values that may be set:

Job type	Configuration Values	Parameters	Arguments
`Hive`	Yes	Yes	No
`Pig`	Yes	Yes	Yes
`MapReduce`	Yes	No	No
`MapReduce.Streaming`	Yes	No	No
`Java`	Yes	No	Yes
`Shell`	Yes	Yes	Yes
`Spark`	Yes	No	Yes
`Storm`	Yes	No	Yes
`Storm Pyelus`	Yes	No	Yes

- *Configuration values* are key/value pairs.
  - The EDP configuration values have names beginning with *edp.* and are consumed by sahara
  - Other configuration values may be read at runtime by Hadoop jobs
  - Currently additional configuration values are not available to Spark jobs at runtime
- *Parameters* are key/value pairs. They supply values for the Hive and Pig parameter substitution mechanisms. In Shell jobs, they are passed as environment variables.
- *Arguments* are strings passed as command line arguments to a shell or main program

These values can be set on the *Configure* tab during job launch through the web UI or through the *job_configs* parameter when using the */jobs/<job_id>/execute* REST method.

In some cases sahara generates configuration values or parameters automatically. Values set explicitly by the user during launch will override those generated by sahara.

Using Data Source References as Arguments

Sometimes it's necessary or desirable to pass a data path as an argument to a job. In these cases, a user may simply type out the path as an argument when launching a job. If the path requires credentials, the user can manually add the credentials as configuration values. However, if a data source object has been created that contains the desired path and credentials there is no need to specify this information manually.

As a convenience, sahara allows data source objects to be referenced by name or id in arguments, configuration values, or parameters. When the job is executed, sahara will replace the reference with the path stored in the data source object and will add any necessary credentials to the job configuration. Referencing an existing data source object is much faster than adding this information by hand. This is particularly useful for job types like Java or Spark that do not use data source objects directly.

There are two job configuration parameters that enable data source references. They may be used with any job type and are set on the `Configuration` tab when the job is launched:

- `edp.substitute_data_source_for_name` (default **False**) If set to **True**, causes sahara to look for data source object name references in configuration values, arguments, and parameters when a job is launched. Name references have the form **datasource://name_of_the_object**.

  For example, assume a user has a WordCount application that takes an input path as an argument. If there is a data source object named **my_input**, a user may simply set the **edp.substitute_data_source_for_name** configuration parameter to **True** and add **datasource://my_input** as an argument when launching the job.

- `edp.substitute_data_source_for_uuid` (default **False**) If set to **True**, causes sahara to look for data source object ids in configuration values, arguments, and parameters when a job is launched. A data source object id is a uuid, so they are unique. The id of a data source object is available through the UI or the sahara command line client. A user may simply use the id as a value.

Creating an Interface for Your Job

In order to better document your job for cluster operators (or for yourself in the future), sahara allows the addition of an interface (or method signature) to your job template. A sample interface for the Teragen Hadoop example might be:

Name	Mapping Type	Location	Value Type	Required	Default
Example Class	args	0	string	false	teragen
Rows	args	1	number	true	unset
Output Path	args	2	data_source	false	hdfs://ip:port/path
Mapper Count	configs	mapred. map.tasks	number	false	unset

A "Description" field may also be added to each interface argument.

To create such an interface via the REST API, provide an "interface" argument, the value of which consists of a list of JSON objects, as below:

```
[
    {
        "name": "Example Class",
        "description": "Indicates which example job class should be used.",
        "mapping_type": "args",
        "location": "0",
        "value_type": "string",
        "required": false,
        "default": "teragen"
    },
]
```

Creating this interface would allow you to specify a configuration for any execution of the job template by passing an "interface" map similar to:

```
{
    "Rows": "1000000",
    "Mapper Count": "3",
    "Output Path": "hdfs://mycluster:8020/user/myuser/teragen-output"
}
```

The specified arguments would be automatically placed into the args, configs, and params for the job, according to the mapping type and location fields of each interface argument. The final `job_configs` map would be:

```
{
    "job_configs": {
        "configs":
            {
                "mapred.map.tasks": "3"
            },
        "args":
            [
                "teragen",
                "1000000",
                "hdfs://mycluster:8020/user/myuser/teragen-output"
            ]
    }
}
```

Rules for specifying an interface are as follows:

- Mapping Type must be one of `configs`, `params`, or `args`. Only types supported for your job type are allowed (see above.)
- Location must be a string for `configs` and `params`, and an integer for `args`. The set of `args` locations must be an unbroken series of integers starting from 0.
- Value Type must be one of `string`, `number`, or `data_source`. Data sources may be passed as UUIDs or as valid paths (see above.) All values should be sent as JSON strings. (Note that booleans and null values are serialized differently in different languages. Please specify them as a string representation of the appropriate constants for your data processing engine.)
- `args` that are not required must be given a default value.

The additional one-time complexity of specifying an interface on your template allows a simpler repeated execution path, and also allows us to generate a customized form for your job in the Horizon UI. This may be particularly useful in cases in which an operator who is not a data processing job developer will be running and administering the jobs.

Generation of Swift Properties for Data Sources

If swift proxy users are not configured (see *Sahara Advanced Configuration Guide*) and a job is run with data source objects containing swift paths, sahara will automatically generate swift username and password configuration values based on the credentials in the data sources. If the input and output data sources are both in swift, it is expected that they specify the same credentials.

The swift credentials may be set explicitly with the following configuration values:

Name
fs.swift.service.sahara.username
fs.swift.service.sahara.password

Setting the swift credentials explicitly is required when passing literal swift paths as arguments instead of using data source references. When possible, use data source references as described in *Using Data Source References as Arguments*.

Additional Details for Hive jobs

Sahara will automatically generate values for the `INPUT` and `OUTPUT` parameters required by Hive based on the specified data sources.

Additional Details for Pig jobs

Sahara will automatically generate values for the `INPUT` and `OUTPUT` parameters required by Pig based on the specified data sources.

For Pig jobs, `arguments` should be thought of as command line arguments separated by spaces and passed to the `pig` shell.

`Parameters` are a shorthand and are actually translated to the arguments `-param name=value`

Additional Details for MapReduce jobs

Important!

If the job type is MapReduce, the mapper and reducer classes *must* be specified as configuration values.

Note that the UI will not prompt the user for these required values; they must be added manually with the `Configure` tab.

Make sure to add these values with the correct names:

Name	Example Value
mapred.mapper.new-api	true
mapred.reducer.new-api	true
mapreduce.job.map.class	org.apache.oozie.example.SampleMapper
mapreduce.job.reduce.class	org.apache.oozie.example.SampleReducer

Additional Details for MapReduce.Streaming jobs

Important!

If the job type is MapReduce.Streaming, the streaming mapper and reducer classes *must* be specified.

In this case, the UI *will* prompt the user to enter mapper and reducer values on the form and will take care of adding them to the job configuration with the appropriate names. If using the python client, however, be certain to add these values to the job configuration manually with the correct names:

Name	Example Value
edp.streaming.mapper	/bin/cat
edp.streaming.reducer	/usr/bin/wc

Additional Details for Java jobs

Data Source objects are not used directly with Java job types. Instead, any input or output paths must be specified as arguments at job launch either explicitly or by reference as described in *Using Data Source References as Arguments*. Using data source references is the recommended way to pass paths to Java jobs.

If configuration values are specified, they must be added to the job's Hadoop configuration at runtime. There are two methods of doing this. The simplest way is to use the **edp.java.adapt_for_oozie** option described below. The other method is to use the code from this example to explicitly load the values.

The following special configuration values are read by sahara and affect how Java jobs are run:

- `edp.java.main_class` (required) Specifies the full name of the class containing `main(String[] args)`

  A Java job will execute the **main** method of the specified main class. Any arguments set during job launch will be passed to the program through the **args** array.

- `oozie.libpath` (optional) Specifies configuration values for the Oozie share libs, these libs can be shared by different workflows
- `edp.java.java_opts` (optional) Specifies configuration values for the JVM
- `edp.java.adapt_for_oozie` (optional) Specifies that sahara should perform special handling of configuration values and exit conditions. The default is **False**.

  If this configuration value is set to **True**, sahara will modify the job's Hadoop configuration before invoking the specified **main** method. Any configuration values specified during job launch (excluding those beginning with **edp.**) will be automatically set in the job's Hadoop configuration and will be available through standard methods.

  Secondly, setting this option to **True** ensures that Oozie will handle program exit conditions correctly.

At this time, the following special configuration value only applies when running jobs on a cluster generated by the Cloudera plugin with the **Enable Hbase Common Lib** cluster config set to **True** (the default value):

- `edp.hbase_common_lib` (optional) Specifies that a common Hbase lib generated by sahara in HDFS be added to the **oozie.libpath**. This for use when an Hbase application is driven from a Java job. Default is **False**.

The **edp-wordcount** example bundled with sahara shows how to use configuration values, arguments, and swift data paths in a Java job type. Note that the example does not use the **edp.java.adapt_for_oozie** option but includes the code to load the configuration values explicitly.

Additional Details for Shell jobs

A shell job will execute the script specified as `main`, and will place any files specified as `libs` in the same working directory (on both the filesystem and in HDFS). Command line arguments may be passed to the script through the `args` array, and any `params` values will be passed as environment variables.

Data Source objects are not used directly with Shell job types but data source references may be used as described in *Using Data Source References as Arguments*.

The **edp-shell** example bundled with sahara contains a script which will output the executing user to a file specified by the first command line argument.

Additional Details for Spark jobs

Data Source objects are not used directly with Spark job types. Instead, any input or output paths must be specified as arguments at job launch either explicitly or by reference as described in *Using Data Source References as Arguments*. Using data source references is the recommended way to pass paths to Spark jobs.

Spark jobs use some special configuration values:

- `edp.java.main_class` (required) Specifies the full name of the class containing the Java or Scala main method:
  - `main(String[] args)` for Java

- `main(args: Array[String]` for Scala

  A Spark job will execute the **main** method of the specified main class. Any arguments set during job launch will be passed to the program through the **args** array.

- `edp.spark.adapt_for_swift` (optional) If set to **True**, instructs sahara to modify the job's Hadoop configuration so that swift paths may be accessed. Without this configuration value, swift paths will not be accessible to Spark jobs. The default is **False**.
- `edp.spark.driver.classpath` (optional) If set to empty string sahara will use default classpath for the cluster during job execution. Otherwise this will override default value for the cluster for particular job execution.

The **edp-spark** example bundled with sahara contains a Spark program for estimating Pi.

Special Sahara URLs

Sahara uses custom URLs to refer to objects stored in swift, in manila, or in the sahara internal database. These URLs are not meant to be used outside of sahara.

Sahara swift URLs passed to running jobs as input or output sources include a ".sahara" suffix on the container, for example:

```
swift://container.sahara/object
```

You may notice these swift URLs in job logs, however, you do not need to add the suffix to the containers yourself. sahara will add the suffix if necessary, so when using the UI or the python client you may write the above URL simply as:

```
swift://container/object
```

Sahara internal database URLs have the form:

```
internal-db://sahara-generated-uuid
```

This indicates a file object in the sahara database which has the given uuid as a key.

Manila NFS filesystem reference URLS take the form:

```
manila://share-uuid/path
```

This format should be used when referring to a job binary or a data source stored in a manila NFS share.

EDP Requirements

The OpenStack installation and the cluster launched from sahara must meet the following minimum requirements in order for EDP to function:

OpenStack Services

When a Hadoop job is executed, binaries are first uploaded to a cluster node and then moved from the node local filesystem to HDFS. Therefore, there must be an instance of HDFS available to the nodes in the sahara cluster.

If the swift service *is not* running in the OpenStack installation:

- Job binaries may only be stored in the sahara internal database
- Data sources require a long-running HDFS

If the swift service *is* running in the OpenStack installation:

- Job binaries may be stored in swift or the sahara internal database
- Data sources may be in swift or a long-running HDFS

Cluster Processes

Requirements for EDP support depend on the EDP job type and plugin used for the cluster. For example a Vanilla sahara cluster must run at least one instance of these processes to support EDP:

- For Hadoop version 1:
  - jobtracker
  - namenode
  - oozie
  - tasktracker
  - datanode
- For Hadoop version 2:
  - namenode
  - datanode
  - resourcemanager
  - nodemanager
  - historyserver
  - oozie
  - spark history server

EDP Technical Considerations

There are several things in EDP which require attention in order to work properly. They are listed on this page.

Transient Clusters

EDP allows running jobs on transient clusters. In this case the cluster is created specifically for the job and is shut down automatically once the job is finished.

Two config parameters control the behaviour of periodic clusters:

- periodic_enable - if set to 'false', sahara will do nothing to a transient cluster once the job it was created for is completed. If it is set to 'true', then the behaviour depends on the value of the next parameter.
- use_identity_api_v3 - set it to 'false' if your OpenStack installation does not provide keystone API v3. In that case sahara will not terminate unneeded clusters. Instead it will set their state to 'AwaitingTermination' meaning that they could be manually deleted by a user. If the parameter is set to 'true', sahara will itself terminate the cluster. The limitation is caused by lack of 'trusts' feature in Keystone API older than v3.

If both parameters are set to 'true', sahara works with transient clusters in the following manner:

1. When a user requests for a job to be executed on a transient cluster, sahara creates such a cluster.

2. Sahara drops the user's credentials once the cluster is created but prior to that it creates a trust allowing it to operate with the cluster instances in the future without user credentials.
3. Once a cluster is not needed, sahara terminates its instances using the stored trust. sahara drops the trust after that.

API

Sahara REST API v1.1

1 General API information

This section contains base info about the sahara REST API design.

1.1 Authentication and Authorization

The sahara API uses the OpenStack Identity service as the default authentication service. When the Identity service is enabled, users who submit requests to the sahara service must provide an authentication token in the `X-Auth-Token` request header. A user can obtain the token by authenticating to the Identity service endpoint. For more information about the Identity service, please see the keystone project developer documentation

With each request, a user must specify the keystone project in the url path, for example: '/v1.1/{project_id}/clusters'. Sahara will perform the requested operation in the specified project using the provided credentials. Therefore, clusters may be created and managed only within projects to which the user has access.

1.2 Request / Response Types

The sahara API supports the JSON data serialization format. This means that for requests that contain a body, the `Content-Type` header must be set to the MIME type value `application/json`. Also, clients should accept JSON serialized responses by specifying the `Accept` header with the MIME type value `application/json` or adding the `.json` extension to the resource name. The default response format is `application/json` if the client does not specify an `Accept` header or append the `.json` extension in the URL path.

Example:

```
GET /v1.1/{project_id}/clusters.json
```

or

```
GET /v1.1/{project_id}/clusters
Accept: application/json
```

1.3 Navigation by response

Sahara API supports delivering response data by pages. User can pass two parameters in API GET requests which return an array of objects. The parameters are:

`limit` - maximum number of objects in response data. This parameter must be a positive integer number.

`marker` - ID of the last element on the list which won't be in response.

Example: Get 15 clusters after cluster with id=d62ad147-5c10-418c-a21a-3a6597044f29:

```
GET /v1.1/{project_id}/clusters?limit=15&marker=d62ad147-5c10-418c-a21a-3a6597044f29
```

For convenience, response contains markers of previous and following pages which are named 'prev' and 'next' fields. Also there is `sort_by` parameter for sorting objects. Sahara API supports ascending and descending sorting.

Examples: Sort clusters by name:

```
GET /v1.1/{project_id}/clusters?sort_by=name
```

Sort clusters by date of creation in descending order:

```
GET /v1.1/{project_id}/clusters?sort_by=-created_at
```

1.4 Faults

The sahara API returns an error response if a failure occurs while processing a request. Sahara uses only standard HTTP error codes. 4xx errors indicate problems in the particular request being sent from the client and 5xx errors indicate server-side problems.

The response body will contain richer information about the cause of the error. An error response follows the format illustrated by the following example:

```
HTTP/1.1 400 BAD REQUEST
Content-type: application/json
Content-length: 126

{
    "error_name": "CLUSTER_NAME_ALREADY_EXISTS",
    "error_message": "Cluster with name 'test-cluster' already exists",
    "error_code": 400
}
```

The `error_code` attribute is an HTTP response code. The `error_name` attribute indicates the generic error type without any concrete ids or names, etc. The last attribute, `error_message`, contains a human readable error description.

2 API

- Sahara REST API Reference (OpenStack API Complete Reference - DataProcessing)

Miscellaneous

Requirements for Guests

Sahara manages guests of various platforms (for example Ubuntu, Fedora, RHEL, and CentOS) with various versions of the Hadoop ecosystem projects installed. There are common requirements for all guests, and additional requirements based on the plugin that is used for cluster deployment.

Common Requirements

- The operating system must be Linux

- cloud-init must be installed
- ssh-server must be installed
  - if a firewall is active it must allow connections on port 22 to enable ssh

Vanilla Plugin Requirements

If the Vanilla Plugin is used for cluster deployment the guest is required to have

- ssh-client installed
- Java (version >= 6)
- Apache Hadoop installed
- 'hadoop' user created

See *Swift Integration* for information on using Swift with your sahara cluster (for EDP support Swift integration is currently required).

To support EDP, the following components must also be installed on the guest:

- Oozie version 4 or higher
- mysql
- hive

See *Building Images for Vanilla Plugin* for instructions on building images for this plugin.

Hortonworks Plugin Requirements

This plugin does not have any additional requirements. Currently, only the CentOS Linux and Ubuntu distributions are supported but other distributions will be supported in the future. To speed up provisioning, the HDP packages can be pre-installed on the image used. The packages' versions depend on the HDP version being used.

Cloudera Plugin Requirements

Cloudera Plugin does not have any additional requirements, just build a CDH image to deploy the cluster.

See *Building Images for Cloudera Plugin* for instructions on building images for this plugin.

Swift Integration

Hadoop and Swift integration are the essential continuation of the Hadoop/OpenStack marriage. The key component to making this marriage work is the Hadoop Swift filesystem implementation. Although this implementation has been merged into the upstream Hadoop project, Sahara maintains a version with the most current features enabled.

- The original Hadoop patch can be found at https://issues.apache.org/jira/browse/HADOOP-8545
- The most current Sahara maintained version of this patch can be found in the Sahara Extra repository https://github.com/openstack/sahara-extra
- The latest compiled version of the jar for this component can be downloaded from http://tarballs.openstack.org/sahara/dist/hadoop-openstack/master/

Now the latest version of this jar (which uses Keystone API v3) is used in the plugins' images automatically during build of these images. But for Ambari plugin we need to explicitly put this jar into /opt directory of the base image **before** cluster launching.

Hadoop patching

You may build the jar file yourself by choosing the latest patch from the Sahara Extra repository and using Maven to build with the pom.xml file provided. Or you may get the latest jar pre-built at http://tarballs.openstack.org/sahara/dist/hadoop-openstack/master/

You will need to put this file into the hadoop libraries (e.g. /usr/lib/share/hadoop/lib, it depends on the plugin which you use) on each ResourceManager and NodeManager node (for Hadoop 2.x) in the cluster.

Hadoop configurations

In general, when Sahara runs a job on a cluster it will handle configuring the Hadoop installation. In cases where a user might require more in-depth configuration all the data is set in the `core-site.xml` file on the cluster instances using this template:

```
<property>
    <name>${name} + ${config}</name>
    <value>${value}</value>
    <description>${not mandatory description}</description>
</property>
```

There are two types of configs here:

1. General. The `${name}` in this case equals to `fs.swift`. Here is the list of `${config}`:
   - `.impl` - Swift FileSystem implementation. The ${value} is `org.apache.hadoop.fs.swift.snative.SwiftNativeFileSystem`
   - `.connect.timeout` - timeout for all connections by default: 15000
   - `.socket.timeout` - how long the connection waits for responses from servers. by default: 60000
   - `.connect.retry.count` - connection retry count for all connections. by default: 3
   - `.connect.throttle.delay` - delay in millis between bulk (delete, rename, copy operations). by default: 0
   - `.blocksize` - blocksize for filesystem. By default: 32Mb
   - `.partsize` - the partition size for uploads. By default: 4608*1024Kb
   - `.requestsize` - request size for reads in KB. By default: 64Kb
2. Provider-specific. The patch for Hadoop supports different cloud providers. The `${name}` in this case equals to `fs.swift.service.${provider}`.

   Here is the list of `${config}`:
   - `.auth.url` - authorization URL
   - `.auth.endpoint.prefix` - prefix for the service url, e.g. `/AUTH_`
   - `.tenant` - project name
   - `.username`
   - `.password`

- `.domain.name` - Domains can be used to specify users who are not in the project specified.
- `.domain.id` - You can also specify domain using id.
- `.trust.id` - Trusts are optionally used to scope the authentication tokens of the supplied user.
- `.http.port`
- `.https.port`
- `.region` - Swift region is used when cloud has more than one Swift installation. If region param is not set first region from Keystone endpoint list will be chosen. If region param not found exception will be thrown.
- `.location-aware` - turn On location awareness. Is false by default
- `.apikey`
- `.public`

Example

For this example it is assumed that you have setup a Hadoop instance with a valid configuration and the Swift filesystem component. Furthermore there is assumed to be a Swift container named `integration` holding an object named `temp`, as well as a Keystone user named `admin` with a password of `swordfish`.

The following example illustrates how to copy an object to a new location in the same container. We will use Hadoop's `distcp` command (http://hadoop.apache.org/docs/r0.19.0/distcp.html) to accomplish the copy. Note that the service provider for our Swift access is `sahara`, and that we will not need to specify the project of our Swift container as it will be provided in the Hadoop configuration.

Swift paths are expressed in Hadoop according to the following template: `swift://${container}.${provider}/${object}`. For our example source this will appear as `swift://integration.sahara/temp`.

Let's run the job:

```
$ hadoop distcp -D fs.swift.service.sahara.username=admin \
 -D fs.swift.service.sahara.password=swordfish \
 swift://integration.sahara/temp swift://integration.sahara/temp1
```

After that just confirm that `temp1` has been created in our `integration` container.

Limitations

Note: Please note that container names should be a valid URI.

Building Images for Vanilla Plugin

In this document you will find instruction on how to build Ubuntu, Fedora, and CentOS images with Apache Hadoop version 2.x.x.

As of now the vanilla plugin works with images with pre-installed versions of Apache Hadoop. To simplify the task of building such images we use Disk Image Builder.

Disk Image Builder builds disk images using elements. An element is a particular set of code that alters how the image is built, or runs within the chroot to prepare the image.

Elements for building vanilla images are stored in the Sahara image elements repository

Note: Sahara requires images with cloud-init package installed:

- For Fedora
- For Ubuntu 14
- For CentOS 6
- For CentOS 7

To create vanilla images follow these steps:

1. Clone repository "https://github.com/openstack/sahara-image-elements" locally.
2. Use tox to build images.

   You can run the command below in sahara-image-elements directory to build images. By default this script will attempt to create cloud images for all versions of supported plugins and all operating systems (subset of Ubuntu, Fedora, and CentOS depending on plugin).

   ```
   tox -e venv -- sahara-image-create -u
   ```

   If you want to build Vanilla 2.7.1 image with centos 7 just execute:

   ```
   tox -e venv -- sahara-image-create -p vanilla -v 2.7.1 -i centos7
   ```

   Tox will create a virtualenv and install required python packages in it, clone the repositories "https://github.com/openstack/diskimage-builder" and "https://github.com/openstack/sahara-image-elements" and export necessary parameters.

   - `DIB_HADOOP_VERSION` - version of Hadoop to install
   - `JAVA_DOWNLOAD_URL` - download link for JDK (tarball or bin)
   - `OOZIE_DOWNLOAD_URL` - download link for OOZIE (we have built Oozie libs here: `http://sahara-files.mirantis.com/oozie-4.2.0-hadoop-2.7.1.tar.gz`)
   - `SPARK_DOWNLOAD_URL` - download link for Spark
   - `HIVE_VERSION` - version of Hive to install (currently supports only 0.11.0)
   - `ubuntu_image_name`
   - `fedora_image_name`
   - `DIB_IMAGE_SIZE` - parameter that specifies a volume of hard disk of instance. You need to specify it only for Fedora because Fedora doesn't use all available volume
   - `DIB_COMMIT_ID` - latest commit id of diskimage-builder project
   - `SAHARA_ELEMENTS_COMMIT_ID` - latest commit id of sahara-image-elements project

   NOTE: If you don't want to use default values, you should set your values of parameters.

   Then it will create required cloud images using image elements that install all the necessary packages and configure them. You will find created images in the parent directory.

Note: Disk Image Builder will generate QCOW2 images, used with the default OpenStack Qemu/KVM hypervisors. If your OpenStack uses a different hypervisor, the generated image should be converted to an appropriate format.

VMware Nova backend requires VMDK image format. You may use qemu-img utility to convert a QCOW2 image to VMDK.

```
qemu-img convert -O vmdk <original_image>.qcow2 <converted_image>.vmdk
```

For finer control of diskimage-create.sh see the official documentation

Building Images for Cloudera Plugin

In this document you will find instructions on how to build Ubuntu and CentOS images with Cloudera Express (now only versions {5.0.0, 5.3.0 5.4.0, 5.5.0, 5.7.x, 5.9.x} are supported).

To simplify the task of building such images we use Disk Image Builder.

Disk Image Builder builds disk images using elements. An element is a particular set of code that alters how the image is built, or runs within the chroot to prepare the image.

Elements for building Cloudera images are stored in Sahara extra repository

---

Note: Sahara requires images with cloud-init package installed:

- For CentOS 6
- For CentOS 7
- For Ubuntu 14

To create cloudera images follow these steps:

1. Clone repository "https://github.com/openstack/sahara-image-elements" locally.
2. Use tox to build images.

   You can run "tox -e venv – sahara-image-create" command in sahara-image-elements directory to build images. By default this script will attempt to create cloud images for all versions of supported plugins and all operating systems (subset of Ubuntu, Fedora, and CentOS depending on plugin). To only create Cloudera images, you should use the "-p cloudera" parameter in the command line. If you want to create the image only for a specific operating system, you should use the "-i ubuntu|centos|centos7" parameter to assign the operating system (the cloudera plugin only supports Ubuntu and Centos). If you want to create the image only for a specific Cloudera version, you should use the "-v 5.0|5.3|5.4|5.5|5.7|5.9" parameter to assign the version. Note that Centos 7 can only be used with CDH 5.5 and higher. Below is an example to create Cloudera images for both Ubuntu and CentOS with Cloudera Express 5.5.0 version.

   ```
   tox -e venv -- sahara-image-create -p cloudera -v 5.5
   ```

   If you want to create only an Ubuntu image, you may use following example for that:

   ```
   tox -e venv -- sahara-image-create -p cloudera -i ubuntu -v 5.5
   ```

   For CDH 5.7 and higher we support minor versions. If you want to build a minor version just export DIB_CDH_MINOR_VERSION before sahara-image-create launch, e.g.:

   ```
   export DIB_CDH_MINOR_VERSION=5.7.1
   ```

NOTE: If you don't want to use default values, you should explicitly set the values of your required parameters.

The script will create required cloud images using image elements that install all the necessary packages and configure them. You will find the created images in the parent directory.

Note: Disk Image Builder will generate QCOW2 images, used with the default OpenStack Qemu/KVM hypervisors. If your OpenStack uses a different hypervisor, the generated image should be converted to an appropriate format.

The VMware Nova backend requires the VMDK image format. You may use qemu-img utility to convert a QCOW2 image to VMDK.

```
qemu-img convert -O vmdk <original_image>.qcow2 <converted_image>.vmdk
```

For finer control of diskimage-create.sh see the official documentation

CHAPTER 3

Developer Guide

Programming HowTos and Tutorials

Development Guidelines

Coding Guidelines

For all the Python code in Sahara we have a rule - it should pass PEP 8. All Bash code should pass bashate.

To check your code against PEP 8 and bashate run:

```
$ tox -e pep8
```

Note: For more details on coding guidelines see file `HACKING.rst` in the root of Sahara repo.

Static analysis

The static analysis checks are optional in Sahara. but they are still very useful. The gate job will inform you if the number of static analysis warnings has increased after your change. We recommend to always check the static warnings.

To run the check commit yor change first and execute the following command:

```
$ tox -e pylint
```

Modification of Upstream Files

We never modify upstream files in Sahara. Any changes in upstream files should be made in the upstream project and then merged back in to Sahara. This includes whitespace changes, comments, and typos. Any change requests containing upstream file modifications are almost certain to receive lots of negative reviews. Be warned.

Examples of upstream files are default xml configuration files used to configure Hadoop, or code imported from the OpenStack Oslo project. The xml files will usually be found in `resource` directories with an accompanying `README` file that identifies where the files came from. For example:

```
$ pwd
/home/me/sahara/sahara/plugins/vanilla/v2_7_1/resources

$ ls
core-default.xml     hdfs-default.xml    oozie-default.xml   README.rst
create_oozie_db.sql  mapred-default.xml  post_conf.template  yarn-default.xml
```

Testing Guidelines

Sahara has a suite of tests that are run on all submitted code, and it is recommended that developers execute the tests themselves to catch regressions early. Developers are also expected to keep the test suite up-to-date with any submitted code changes.

Unit tests are located at `sahara/tests/unit`.

Sahara's suite of unit tests can be executed in an isolated environment with Tox. To execute the unit tests run the following from the root of Sahara repo:

```
$ tox -e py27
```

Documentation Guidelines

All Sahara docs are written using Sphinx / RST and located in the main repo in the `doc` directory. You can add or edit pages here to update the http://docs.openstack.org/developer/sahara site.

The documentation in docstrings should follow the PEP 257 conventions (as mentioned in the PEP 8 guidelines).

More specifically:

1. Triple quotes should be used for all docstrings.
2. If the docstring is simple and fits on one line, then just use one line.
3. For docstrings that take multiple lines, there should be a newline after the opening quotes, and before the closing quotes.
4. Sphinx is used to build documentation, so use the restructured text markup to designate parameters, return values, etc.

Run the following command to build docs locally.

```
$ tox -e docs
```

After it you can access generated docs in `doc/build/` directory, for example, main page - `doc/build/html/index.html`.

To make the doc generation process faster you can use:

```
$ SPHINX_DEBUG=1 tox -e docs
```

To avoid sahara reinstallation to virtual env each time you want to rebuild docs you can use the following command (it can be executed only after running `tox -e docs` first time):

```
$ SPHINX_DEBUG=1 .tox/docs/bin/python setup.py build_sphinx
```

Note: For more details on documentation guidelines see HACKING.rst in the root of the Sahara repo.

Event log Guidelines

Currently Sahara keeps useful information about provisioning for each cluster. Cluster provisioning can be represented as a linear series of provisioning steps, which are executed one after another. Each step may consist of several events. The number of events depends on the step and the number of instances in the cluster. Also each event can contain information about its cluster, instance, and node group. In case of errors, events contain useful information for identifying the error. Additionally, each exception in sahara contains a unique identifier that allows the user to find extra information about that error in the sahara logs. You can see an example of provisioning progress information here: http://developer.openstack.org/api-ref/data-processing/#event-log

This means that if you add some important phase for cluster provisioning to the sahara code, it's recommended to add a new provisioning step for this phase. This will allow users to use event log for handling errors during this phase.

Sahara already has special utils for operating provisioning steps and events in the module `sahara/utils/cluster_progress_ops.py`.

Note: It's strictly recommended not to use `conductor` event log ops directly to assign events and operate provisioning steps.

Note: You should not start a new provisioning step until the previous step has successfully completed.

Note: It's strictly recommended to use `event_wrapper` for event handling.

OpenStack client usage guidelines

The sahara project uses several OpenStack clients internally. These clients are all wrapped by utility functions which make using them more convenient. When developing sahara, if you need to use an OpenStack client you should check the `sahara.utils.openstack` package for the appropriate one.

When developing new OpenStack client interactions in sahara, it is important to understand the `sahara.service.sessions` package and the usage of the keystone `Session` and auth plugin objects (for example, `Token` and `Password`). Sahara is migrating all clients to use this authentication methodology, where available. For more information on using sessions with keystone, please see http://docs.openstack.org/developer/keystoneauth/using-sessions.html

Storing sensitive information

During the course of development, there is often cause to store sensitive information (for example, login credentials) in the records for a cluster, job, or some other record. Storing secret information this way is **not** safe. To mitigate the risk of storing this information, sahara provides access to the OpenStack Key Manager service (implemented by the barbican project) through the castellan library.

To utilize the external key manager, the functions in `sahara.service.castellan.utils` are provided as wrappers around the castellan library. These functions allow a developer to store, retrieve, and delete secrets from the manager. Secrets that are managed through the key manager have an identifier associated with them. These identifiers are considered safe to store in the database.

The following are some examples of working with secrets in the sahara codebase. These examples are considered basic, any developer wishing to learn more about the advanced features of storing secrets should look to the code and docstrings contained in the `sahara.service.castellan` module.

Storing a secret

```
from sahara.service.castellan import utils as key_manager

password = 'SooperSecretPassword'
identifier = key_manager.store_secret(password)
```

Retrieving a secret

```
from sahara.service.castellan import utils as key_manager

password = key_manager.get_secret(identifier)
```

Deleting a secret

```
from sahara.service.castellan import utils as key_manager

key_manager.delete_secret(identifier)
```

When storing secrets through this interface it is important to remember that if an external key manager is being used, each stored secret creates an entry in an external service. When you are finished using the secret it is good practice to delete it, as not doing so may leave artifacts in those external services.

For more information on configuring sahara to use the OpenStack Key Manager service, see *External key manager usage*.

Setting Up a Development Environment

This page describes how to setup a Sahara development environment by either installing it as a part of DevStack or pointing a local running instance at an external OpenStack. You should be able to debug and test your changes without having to deploy Sahara.

Setup a Local Environment with Sahara inside DevStack

See *the main article*.

Setup a Local Environment with an external OpenStack

1. Install prerequisites

On OS X Systems:

```
# we actually need pip, which is part of python package
$ brew install python mysql postgresql rabbitmq
$ pip install virtualenv tox
```

On Ubuntu:

```
$ sudo apt-get update
$ sudo apt-get install git-core python-dev python-virtualenv gcc libpq-dev␣
↪libmysqlclient-dev python-pip rabbitmq-server
$ sudo pip install tox
```

On Red Hat and related distributions (CentOS/Fedora/RHEL/Scientific Linux):

```
$ sudo yum install git-core python-devel python-virtualenv gcc python-pip mariadb-
↪devel postgresql-devel erlang
$ sudo pip install tox
$ sudo wget http://www.rabbitmq.com/releases/rabbitmq-server/v3.2.2/rabbitmq-server-3.
↪2.2-1.noarch.rpm
$ sudo rpm --import http://www.rabbitmq.com/rabbitmq-signing-key-public.asc
$ sudo yum install rabbitmq-server-3.2.2-1.noarch.rpm
```

On openSUSE-based distributions (SLES 12, openSUSE, Factory or Tumbleweed):

```
$ sudo zypper in gcc git libmysqlclient-devel postgresql-devel python-devel python-
↪pip python-tox python-virtualenv
```

2. Grab the code

```
$ git clone git://github.com/openstack/sahara.git
$ cd sahara
```

3. Generate Sahara sample using tox

```
tox -e genconfig
```

4. Create config file from the sample

```
$ cp ./etc/sahara/sahara.conf.sample ./etc/sahara/sahara.conf
```

5. Look through the sahara.conf and modify parameter values as needed For details see *Sahara Configuration Guide*

6. Create database schema

```
$ tox -e venv -- sahara-db-manage --config-file etc/sahara/sahara.conf upgrade head
```

7. To start Sahara API and Engine processes call

```
$ tox -e venv -- sahara-api --config-file etc/sahara/sahara.conf --debug
$ tox -e venv -- sahara-engine --config-file etc/sahara/sahara.conf --debug
```

Setup local OpenStack dashboard with Sahara plugin

Sahara UI Dev Environment Setup

This page describes how to setup Horizon for developing Sahara by either installing it as part of DevStack with Sahara or installing it in an isolated environment and running from the command line.

Install as a part of DevStack

See the DevStack guide for more information on installing and configuring DevStack with Sahara.

Sahara UI can be installed as a DevStack plugin by adding the following line to your `local.conf` file

```
# Enable sahara-dashboard
enable_plugin sahara-dashboard git://git.openstack.org/openstack/sahara-dashboard
```

Isolated Dashboard for Sahara

These installation steps serve two purposes:

1. Setup a dev environment
2. Setup an isolated Dashboard for Sahara

Note The host where you are going to perform installation has to be able to connect to all OpenStack endpoints. You can list all available endpoints using the following command:

```
$ openstack endpoint list
```

You can list the registered services with this command:

```
$ openstack service list
```

Sahara service should be present in keystone service list with service type *data-processing*

1. Install prerequisites

   ```
   $ sudo apt-get update
   $ sudo apt-get install git-core python-dev gcc python-setuptools \
            python-virtualenv node-less libssl-dev libffi-dev libxslt-dev
   ```

   On Ubuntu 12.10 and higher you have to install the following lib as well:

   ```
   $ sudo apt-get install nodejs-legacy
   ```

2. Checkout Horizon from git and switch to your version of OpenStack

   Here is an example:

   ```
   $ git clone https://git.openstack.org/cgit/openstack/horizon/ {HORIZON_DIR}
   ```

   Then install the virtual environment:

   ```
   $ python {HORIZON_DIR}/tools/install_venv.py
   ```

3. Create a `local_settings.py` file

   ```
   $ cp {HORIZON_DIR}/openstack_dashboard/local/local_settings.py.example
            {HORIZON_DIR}/openstack_dashboard/local/local_settings.py
   ```

4. Modify `{HORIZON_DIR}/openstack_dashboard/local/local_settings.py`

   Set the proper values for host and url variables:

```
OPENSTACK_HOST = "ip of your controller"
```

If you are using Nova-Network with `auto_assign_floating_ip=True` add the following parameter:

```
SAHARA_AUTO_IP_ALLOCATION_ENABLED = True
```

5. Clone sahara-dashboard repository and checkout the desired branch

```
$ git clone https://git.openstack.org/cgit/openstack/sahara-dashboard/ \
    {SAHARA_DASHBOARD_DIR}
```

6. Copy plugin-enabling files from sahara-dashboard repository to horizon

```
$ cp -a {SAHARA_DASHBOARD_DIR}/sahara_dashboard/enabled/* {HORIZON_DIR}/openstack_
↪dashboard/local/enabled/
```

7. Install sahara-dashboard project into your horizon virtualenv in editable mode

```
$ source {HORIZON_DIR}/.venv/bin/activate
$ pip install -e {SAHARA_DASHBOARD_DIR}
```

8. Start Horizon

```
$ source {HORIZON_DIR}/.venv/bin/activate
$ python {HORIZON_DIR}/manage.py runserver 0.0.0.0:8080
```

This will start Horizon in debug mode. That means the logs will be written to console and if any exceptions happen, you will see the stack-trace rendered as a web-page.

Debug mode can be disabled by changing `DEBUG=True` to `False` in `local_settings.py`. In that case Horizon should be started slightly differently, otherwise it will not serve static files:

```
$ source {HORIZON_DIR}/.venv/bin/activate
$ python {HORIZON_DIR}/manage.py runserver --insecure 0.0.0.0:8080
```

Note: It is not recommended to use Horizon in this mode for production.

Tips and tricks for dev environment

1. Pip speedup

Add the following lines to ~/.pip/pip.conf

```
[global]
download-cache = /home/<username>/.pip/cache
index-url = <mirror url>
```

Note that the `~/.pip/cache` folder should be created manually.

2. Git hook for fast checks

Just add the following lines to .git/hooks/pre-commit and do chmod +x for it.

```
#!/bin/sh
# Run fast checks (PEP8 style check and PyFlakes fast static analysis)
tox -epep8
```

You can add also other checks for pre-push, for example pylint (see below) and tests (tox -epy27).

3. Running static analysis (PyLint)

Just run the following command

```
tox -e pylint
```

Setup DevStack

DevStack can be installed on Fedora, Ubuntu, and CentOS. For supported versions see DevStack documentation

We recommend that you install DevStack in a VM, rather than on your main system. That way you may avoid contamination of your system. You may find hypervisor and VM requirements in the next section. If you still want to install DevStack on your baremetal system, just skip the next section and read further.

Start VM and set up OS

In order to run DevStack in a local VM, you need to start by installing a guest with Ubuntu 14.04 server. Download an image file from Ubuntu's web site and create a new guest from it. Virtualization solution must support nested virtualization. Without nested virtualization VMs running inside the DevStack will be extremely slow lacking hardware acceleration, i.e. you will run QEMU VMs without KVM.

On Linux QEMU/KVM supports nested virtualization, on Mac OS - VMware Fusion. VMware Fusion requires adjustments to run VM with fixed IP. You may find instructions which can help *below*.

Start a new VM with Ubuntu Server 14.04. Recommended settings:

- Processor - at least 2 cores
- Memory - at least 8GB
- Hard Drive - at least 60GB

When allocating CPUs and RAM to the DevStack, assess how big clusters you want to run. A single Hadoop VM needs at least 1 cpu and 1G of RAM to run. While it is possible for several VMs to share a single cpu core, remember that they can't share the RAM.

After you installed the VM, connect to it via SSH and proceed with the instructions below.

Install DevStack

The instructions assume that you've decided to install DevStack into Ubuntu 14.04 system.

1. Clone DevStack:

```
$ sudo apt-get install git-core
$ git clone https://git.openstack.org/openstack-dev/devstack.git
```

2. Create the file `local.conf` in devstack directory with the following content:

```
[[local|localrc]]
ADMIN_PASSWORD=nova
MYSQL_PASSWORD=nova
RABBIT_PASSWORD=nova
SERVICE_PASSWORD=$ADMIN_PASSWORD
SERVICE_TOKEN=nova

# Enable Swift
enable_service s-proxy s-object s-container s-account

SWIFT_HASH=66a3d6b56c1f479c8b4e70ab5c2000f5
SWIFT_REPLICAS=1
SWIFT_DATA_DIR=$DEST/data

# Force checkout prerequisites
# FORCE_PREREQ=1

# keystone is now configured by default to use PKI as the token format
# which produces huge tokens.
# set UUID as keystone token format which is much shorter and easier to
# work with.
KEYSTONE_TOKEN_FORMAT=UUID

# Change the FLOATING_RANGE to whatever IPs VM is working in.
# In NAT mode it is the subnet VMware Fusion provides, in bridged mode
# it is your local network. But only use the top end of the network by
# using a /27 and starting at the 224 octet.
FLOATING_RANGE=192.168.55.224/27

# Enable logging
SCREEN_LOGDIR=$DEST/logs/screen

# Set ``OFFLINE`` to ``True`` to configure ``stack.sh`` to run cleanly
# without Internet access. ``stack.sh`` must have been previously run
# with Internet access to install prerequisites and fetch repositories.
# OFFLINE=True

# Enable sahara
enable_plugin sahara git://git.openstack.org/openstack/sahara
```

In cases where you need to specify a git refspec (branch, tag, or commit hash) for the sahara in-tree devstack plugin (or sahara repo), it should be appended to the git repo URL as follows:

```
enable_plugin sahara git://git.openstack.org/openstack/sahara <some_git_refspec>
```

3. Sahara can send notifications to Ceilometer, if Ceilometer is enabled. If you want to enable Ceilometer add the following lines to the `local.conf` file:

```
enable_plugin ceilometer git://git.openstack.org/openstack/ceilometer
```

4. Start DevStack:

```
$ ./stack.sh
```

5. Once the previous step is finished Devstack will print a Horizon URL. Navigate to this URL and login with login "admin" and password from `local.conf`.

6. Congratulations! You have OpenStack running in your VM and you're ready to launch VMs inside that VM. :)

Managing sahara in DevStack

If you install DevStack with sahara included you can rejoin screen with the `screen -c stack-screenrc` command and switch to the `sahara` tab. Here you can manage the sahara service as other OpenStack services. Sahara source code is located at `$DEST/sahara` which is usually `/opt/stack/sahara`.

Setting fixed IP address for VMware Fusion VM

1. Open file `/Library/Preferences/VMware Fusion/vmnet8/dhcpd.conf`
2. There is a block named "subnet". It might look like this:

```
subnet 192.168.55.0 netmask 255.255.255.0 {
        range 192.168.55.128 192.168.55.254;
```

3. You need to pick an IP address outside of that range. For example - `192.168.55.20`
4. Copy VM MAC address from VM settings->Network->Advanced
5. Append the following block to file `dhcpd.conf` (don't forget to replace `VM_HOSTNAME` and `VM_MAC_ADDRESS` with actual values):

```
host VM_HOSTNAME {
        hardware ethernet VM_MAC_ADDRESS;
        fixed-address 192.168.55.20;
}
```

6. Now quit all the VMware Fusion applications and restart vmnet:

```
$ sudo /Applications/VMware\ Fusion.app/Contents/Library/vmnet-cli --stop
$ sudo /Applications/VMware\ Fusion.app/Contents/Library/vmnet-cli --start
```

7. Now start your VM; it should have new fixed IP address.

Quickstart guide

Launching a cluster via Sahara CLI commands

This guide will help you setup a vanilla Hadoop cluster using a combination of OpenStack command line tools and the sahara *REST API*.

1. Install sahara

- If you want to hack the code follow *Setting Up a Development Environment*.

OR

- If you just want to install and use sahara follow *Sahara Installation Guide*.

2. Identity service configuration

To use the OpenStack command line tools you should specify environment variables with the configuration details for your OpenStack installation. The following example assumes that the Identity service is at `127.0.0.1:5000`, with a user `admin` in the `admin` project whose password is `nova`:

```
$ export OS_AUTH_URL=http://127.0.0.1:5000/v2.0/
$ export OS_PROJECT_NAME=admin
$ export OS_USERNAME=admin
$ export OS_PASSWORD=nova
```

3. Upload an image to the Image service

You will need to upload a virtual machine image to the OpenStack Image service. You can download pre-built images with vanilla Apache Hadoop installed, or build the images yourself. This guide uses the latest available Ubuntu upstream image, referred to as `sahara-vanilla-latest-ubuntu.qcow2` and the latest version of vanilla plugin as an example. Sample images are available here:

Sample Images

- Download a pre-built image

Note: For the steps below, substitute `<openstack_release>` with the appropriate OpenStack release and `<sahara_image>` with the image of your choice.

```
$ ssh user@hostname
$ wget http://sahara-files.mirantis.com/images/upstream/<openstack_release>/<sahara_
↪image>.qcow2
```

Upload the image downloaded above into the OpenStack Image service:

```
$ openstack image create sahara-vanilla-latest-ubuntu --disk-format qcow2 \
    --container-format bare --file sahara-vanilla-latest-ubuntu.qcow2
+------------------+--------------------------------------+
| Field            | Value                                |
+------------------+--------------------------------------+
| checksum         | 3da49911332fc46db0c5fb7c197e3a77     |
| container_format | bare                                 |
| created_at       | 2016-02-29T10:15:04.000000           |
| deleted          | False                                |
| deleted_at       | None                                 |
| disk_format      | qcow2                                |
| id               | 71b9eeac-c904-4170-866a-1f833ea614f3 |
| is_public        | False                                |
| min_disk         | 0                                    |
| min_ram          | 0                                    |
| name             | sahara-vanilla-latest-ubuntu         |
| owner            | 057d23cddb864759bfa61d730d444b1f     |
| properties       |                                      |
| protected        | False                                |
| size             | 1181876224                           |
| status           | active                               |
| updated_at       | 2016-02-29T10:15:41.000000           |
| virtual_size     | None                                 |
+------------------+--------------------------------------+
```

OR

- Build the image using: diskimage-builder script

Remember the image name or save the image ID. This will be used during the image registration with sahara. You can get the image ID using the `openstack` command line tool as follows:

```
$ openstack image list --property name=sahara-vanilla-latest-ubuntu
+--------------------------------------+------------------------------+
| ID                                   | Name                         |
+--------------------------------------+------------------------------+
| 71b9eeac-c904-4170-866a-1f833ea614f3 | sahara-vanilla-latest-ubuntu |
+--------------------------------------+------------------------------+
```

4. Register the image with the sahara image registry

Now you will begin to interact with sahara by registering the virtual machine image in the sahara image registry.

Register the image with the username `ubuntu`.

Note: The username will vary depending on the source image used, as follows: Ubuntu: `ubuntu` CentOS 7: `centos` CentOS 6: `cloud-user` Fedora: `fedora` Note that the Sahara team recommends using CentOS 7 instead of CentOS 6 as a base OS wherever possible; it is better supported throughout OpenStack image maintenance infrastructure and its more modern filesystem is much more appropriate for large-scale data processing. For more please see *Vanilla Plugin*

```
$ openstack dataprocessing image register sahara-vanilla-latest-ubuntu \
    --username ubuntu
```

Tag the image to inform sahara about the plugin and the version with which it shall be used.

Note: For the steps below and the rest of this guide, substitute `<plugin_version>` with the appropriate version of your plugin.

```
$ openstack dataprocessing image tags add sahara-vanilla-latest-ubuntu \
    --tags vanilla <plugin_version>
+-------------+--------------------------------------+
| Field       | Value                                |
+-------------+--------------------------------------+
| Description | None                                 |
| Id          | 71b9eeac-c904-4170-866a-1f833ea614f3 |
| Name        | sahara-vanilla-latest-ubuntu         |
| Status      | ACTIVE                               |
| Tags        | <plugin_version>, vanilla            |
| Username    | ubuntu                               |
+-------------+--------------------------------------+
```

5. Create node group templates

Node groups are the building blocks of clusters in sahara. Before you can begin provisioning clusters you must define a few node group templates to describe node group configurations.

You can get information about available plugins with the following command:

```
$ openstack dataprocessing plugin list
```

Also you can get information about available services for a particular plugin with the `plugin show` command. For example:

```
$ openstack dataprocessing plugin show vanilla --plugin-version <plugin_version>
+---------------------+---------------------------------------------------------------
↪-------------------------------------------------------+
| Field               | Value                                                         ␣
↪                                                       |
+---------------------+---------------------------------------------------------------
↪-------------------------------------------------------+
| Description         | The Apache Vanilla plugin provides the ability to launch␣
↪upstream Vanilla Apache Hadoop cluster without any           |
|                     | management consoles. It can also deploy the Oozie component. ␣
↪                                                       |
| Name                | vanilla                                                       ␣
↪                                                       |
| Required image tags | <plugin_version>, vanilla                                     ␣
↪                                                       |
| Title               | Vanilla Apache Hadoop                                         ␣
↪                                                       |
|                     |                                                               ␣
↪                                                       |
| Service:            | Available processes:                                          ␣
↪                                                       |
|                     |                                                               ␣
↪                                                       |
| HDFS                | datanode, namenode, secondarynamenode                         ␣
↪                                                       |
| Hadoop              |                                                               ␣
↪                                                       |
| Hive                | hiveserver                                                    ␣
↪                                                       |
| JobFlow             | oozie                                                         ␣
↪                                                       |
| Spark               | spark history server                                          ␣
↪                                                       |
| MapReduce           | historyserver                                                 ␣
↪                                                       |
| YARN                | nodemanager, resourcemanager                                  ␣
↪                                                       |
+---------------------+---------------------------------------------------------------
↪-------------------------------------------------------+
```

Note: These commands assume that floating IP addresses are being used. For more details on floating IP please see *Floating IP management*.

Create a master node group template with the command:

```
$ openstack dataprocessing node group template create \
    --name vanilla-default-master --plugin vanilla \
    --plugin-version <plugin_version> --processes namenode resourcemanager \
    --flavor 2 --auto-security-group --floating-ip-pool <pool-id>
+---------------------+--------------------------------------+
| Field               | Value                                |
+---------------------+--------------------------------------+
| Auto security group | True                                 |
| Availability zone   | None                                 |
| Flavor id           | 2                                    |
| Floating ip pool    | dbd8d1aa-6e8e-4a35-a77b-966c901464d5 |
| Id                    | 0f066e14-9a73-4379-bbb4-9d9347633e31 |
| Is default            | False                                |
| Is protected          | False                                |
| Is proxy gateway      | False                                |
| Is public             | False                                |
| Name                  | vanilla-default-master               |
| Node processes        | namenode, resourcemanager            |
| Plugin name           | vanilla                              |
| Security groups       | None                                 |
| Use autoconfig        | False                                |
| Version               | <plugin_version>                     |
| Volumes per node      | 0                                    |
+-----------------------+--------------------------------------+
```

Create a worker node group template with the command:

```
$ openstack dataprocessing node group template create \
    --name vanilla-default-worker --plugin vanilla \
    --plugin-version <plugin_version> --processes datanode nodemanager \
    --flavor 2 --auto-security-group --floating-ip-pool <pool-id>
+-----------------------+--------------------------------------+
| Field                 | Value                                |
+-----------------------+--------------------------------------+
| Auto security group   | True                                 |
| Availability zone     | None                                 |
| Flavor id             | 2                                    |
| Floating ip pool      | dbd8d1aa-6e8e-4a35-a77b-966c901464d5 |
| Id                    | 6546bf44-0590-4539-bfcb-99f8e2c11efc |
| Is default            | False                                |
| Is protected          | False                                |
| Is proxy gateway      | False                                |
| Is public             | False                                |
| Name                  | vanilla-default-worker               |
| Node processes        | datanode, nodemanager                |
| Plugin name           | vanilla                              |
| Security groups       | None                                 |
| Use autoconfig        | False                                |
| Version               | <plugin_version>                     |
| Volumes per node      | 0                                    |
+-----------------------+--------------------------------------+
```

Alternatively you can create node group templates from JSON files:

If your environment does not use floating IPs, omit defining floating IP in the template below.

Sample templates can be found here:

Sample Templates

Create a file named `my_master_template_create.json` with the following content:

```
{
    "plugin_name": "vanilla",
    "hadoop_version": "<plugin_version>",
    "node_processes": [
        "namenode",
        "resourcemanager"
    ],
    "name": "vanilla-default-master",
    "floating_ip_pool": "<floating_ip_pool_id>",
    "flavor_id": "2",
    "auto_security_group": true
}
```

Create a file named `my_worker_template_create.json` with the following content:

```
{
    "plugin_name": "vanilla",
    "hadoop_version": "<plugin_version>",
    "node_processes": [
        "nodemanager",
        "datanode"
    ],
    "name": "vanilla-default-worker",
    "floating_ip_pool": "<floating_ip_pool_id>",
    "flavor_id": "2",
    "auto_security_group": true
}
```

Use the `openstack` client to upload the node group templates:

```
$ openstack dataprocessing node group template create \
    --json my_master_template_create.json
$ openstack dataprocessing node group template create \
    --json my_worker_template_create.json
```

List the available node group templates to ensure that they have been added properly:

```
$ openstack dataprocessing node group template list --name vanilla-default
+------------------------+--------------------------------------+-------------+-------
↪-------------+
| Name                   | Id                                   | Plugin name |␣
↪Version            |
+------------------------+--------------------------------------+-------------+-------
↪-------------+
| vanilla-default-master | 0f066e14-9a73-4379-bbb4-9d9347633e31 | vanilla     |
↪<plugin_version>   |
| vanilla-default-worker | 6546bf44-0590-4539-bfcb-99f8e2c11efc | vanilla     |
↪<plugin_version>   |
+------------------------+--------------------------------------+-------------+-------
↪-------------+
```

Remember the name or save the ID for the master and worker node group templates, as they will be used during cluster template creation.

For example:

- vanilla-default-master: `0f066e14-9a73-4379-bbb4-9d9347633e31`
- vanilla-default-worker: `6546bf44-0590-4539-bfcb-99f8e2c11efc`

6. Create a cluster template

The last step before provisioning the cluster is to create a template that describes the node groups of the cluster.

Create a cluster template with the command:

```
$ openstack dataprocessing cluster template create \
    --name vanilla-default-cluster \
    --node-groups vanilla-default-master:1 vanilla-default-worker:3

+----------------+----------------------------------------------------+
| Field          | Value                                              |
+----------------+----------------------------------------------------+
| Anti affinity  |                                                    |
| Description    | None                                               |
| Id             | 9d871ebd-88a9-40af-ae3e-d8c8f292401c               |
| Is default     | False                                              |
| Is protected   | False                                              |
| Is public      | False                                              |
| Name           | vanilla-default-cluster                            |
| Node groups    | vanilla-default-master:1, vanilla-default-worker:3 |
| Plugin name    | vanilla                                            |
| Use autoconfig | False                                              |
| Version        | <plugin_version>                                   |
+----------------+----------------------------------------------------+
```

Alternatively you can create cluster template from JSON file:

Create a file named `my_cluster_template_create.json` with the following content:

```
{
    "plugin_name": "vanilla",
    "hadoop_version": "<plugin_version>",
    "node_groups": [
        {
            "name": "worker",
            "count": 3,
            "node_group_template_id": "6546bf44-0590-4539-bfcb-99f8e2c11efc"
        },
        {
            "name": "master",
            "count": 1,
            "node_group_template_id": "0f066e14-9a73-4379-bbb4-9d9347633e31"
        }
    ],
    "name": "vanilla-default-cluster",
    "cluster_configs": {}
}
```

Upload the cluster template using the `openstack` command line tool:

```
$ openstack dataprocessing cluster template create --json my_cluster_template_create.
↪json
```

Remember the cluster template name or save the cluster template ID for use in the cluster provisioning command. The cluster ID can be found in the output of the creation command or by listing the cluster templates as follows:

```
$ openstack dataprocessing cluster template list --name vanilla-default
+-------------------------+---------------------------------------+-------------+------
↪--------------+
| Name                    | Id                                    | Plugin name |␣
↪Version        |
+-------------------------+---------------------------------------+-------------+------
↪--------------+
| vanilla-default-cluster | 9d871ebd-88a9-40af-ae3e-d8c8f292401c | vanilla     |
↪<plugin_version>   |
+-------------------------+--------------------------------------+-------------+------
↪--------------+
```

7. Create cluster

Now you are ready to provision the cluster. This step requires a few pieces of information that can be found by querying various OpenStack services.

Create a cluster with the command:

```
$ openstack dataprocessing cluster create --name my-cluster-1 \
    --cluster-template vanilla-default-cluster --user-keypair my_stack \
    --neutron-network private --image sahara-vanilla-latest-ubuntu

+----------------------------+----------------------------------------------------+
| Field                      | Value                                              |
+----------------------------+----------------------------------------------------+
| Anti affinity              |                                                    |
| Cluster template id        | 9d871ebd-88a9-40af-ae3e-d8c8f292401c               |
| Description                |                                                    |
| Id                         | 1f0dc6f7-6600-495f-8f3a-8ac08cdb3afc               |
| Image                      | 71b9eeac-c904-4170-866a-1f833ea614f3               |
| Is protected               | False                                              |
| Is public                  | False                                              |
| Is transient               | False                                              |
| Name                       | my-cluster-1                                       |
| Neutron management network | fabe9dae-6fbd-47ca-9eb1-1543de325efc               |
| Node groups                | vanilla-default-master:1, vanilla-default-worker:3 |
| Plugin name                | vanilla                                            |
| Status                     | Validating                                         |
| Use autoconfig             | False                                              |
| User keypair id            | my_stack                                           |
| Version                    | <plugin_version>                                   |
+----------------------------+----------------------------------------------------+
```

Alternatively you can create a cluster template from a JSON file:

Create a file named `my_cluster_create.json` with the following content:

```
{
    "name": "my-cluster-1",
    "plugin_name": "vanilla",
    "hadoop_version": "<plugin_version>",
    "cluster_template_id" : "9d871ebd-88a9-40af-ae3e-d8c8f292401c",
    "user_keypair_id": "my_stack",
    "default_image_id": "71b9eeac-c904-4170-866a-1f833ea614f3",
    "neutron_management_network": "fabe9dae-6fbd-47ca-9eb1-1543de325efc"
}
```

The parameter `user_keypair_id` with the value `my_stack` is generated by creating a keypair. You can create your own keypair in the OpenStack Dashboard, or through the `openstack` command line client as follows:

```
$ openstack keypair create my_stack --public-key $PATH_TO_PUBLIC_KEY
```

If sahara is configured to use neutron for networking, you will also need to include the `--neutron-network` argument in the `cluster create` command or the `neutron_management_network` parameter in `my_cluster_create.json`. If your environment does not use neutron, you should omit these arguments. You can determine the neutron network id with the following command:

```
$ openstack network list
```

Create and start the cluster:

```
$ openstack dataprocessing cluster create --json my_cluster_create.json
```

Verify the cluster status by using the `openstack` command line tool as follows:

```
$ openstack dataprocessing cluster show my-cluster-1 -c Status
+--------+--------+
| Field  | Value  |
+--------+--------+
| Status | Active |
+--------+--------+
```

The cluster creation operation may take several minutes to complete. During this time the "status" returned from the previous command may show states other than `Active`. A cluster also can be created with the `wait` flag. In that case the cluster creation command will not be finished until the cluster is moved to the `Active` state.

8. Run a MapReduce job to check Hadoop installation

Check that your Hadoop installation is working properly by running an example job on the cluster manually.

- Login to the NameNode (usually the master node) via ssh with the ssh-key used above:

```
$ ssh -i my_stack.pem ubuntu@<namenode_ip>
```

- Switch to the hadoop user:

```
$ sudo su hadoop
```

- Go to the shared hadoop directory and run the simplest MapReduce example:

```
$ cd /opt/hadoop-<plugin_version>/share/hadoop/mapreduce
$ /opt/hadoop-<plugin_version>/bin/hadoop jar hadoop-mapreduce-examples-<plugin_
↪version>.jar pi 10 100
```

Congratulations! Your Hadoop cluster is ready to use, running on your OpenStack cloud.

Elastic Data Processing (EDP)

Job Binaries are the entities you define/upload the source code (mains and libraries) for your job. First you need to download your binary file or script to swift container and register your file in Sahara with the command:

```
(openstack) dataprocessing job binary create --url "swift://integration.sahara/hive.
↪sql" \
  --username username --password password --description "My first job binary" hive-
↪binary
```

Data Sources

Data Sources are entities where the input and output from your jobs are housed. You can create data sources which are related to Swift, Manila or HDFS. You need to set the type of data source (swift, hdfs, manila, maprfs), name and url. The next two commands will create input and output data sources in swift.

```
$ openstack dataprocessing data source create --type swift --username admin --
↪password admin \
   --url "swift://integration.sahara/input.txt" input

$ openstack dataprocessing data source create --type swift --username admin --
↪password admin \
   --url "swift://integration.sahara/output.txt" input
```

If you want to create data sources in hdfs, use valid hdfs urls:

```
$ openstack dataprocessing data source create --type hdfs --url "hdfs://tmp/input.txt
↪" input

$ openstack dataprocessing data source create --type hdfs --url "hdfs://tmp/output.txt
↪" output
```

Job Templates (Jobs in API)

In this step you need to create a job template. You have to set the type of the job template using the *type* parameter. Choose the main library using the job binary which was created in the previous step and set a name for the job template.

Example of the command:

```
$ openstack dataprocessing job template create --type Hive \
   --name hive-job-template --main hive-binary
```

Jobs (Job Executions in API)

This is the last step in our guide. In this step you need to launch your job. You need to pass the following arguments:

- The name or ID of input/output data sources for the job
- The name or ID of the job template
- The name or ID of the cluster on which to run the job

For instance:

```
$ openstack dataprocessing job execute --input input --output output \
  --job-template hive-job-template --cluster my-first-cluster
```

You can check status of your job with the command:

```
$ openstack dataprocessing job show <id_of_your_job>
```

Once the job is marked as successful you can check the output data source. It will contain the output data of this job. Congratulations!

How to Participate

Getting started

- Create an account on Github (if you don't have one)
  - Make sure that your local git is properly configured by executing `git config --list`. If not, configure `user.name`, `user.email`
- Create account on Launchpad (if you don't have one)
- Subscribe to OpenStack general mail-list
- Subscribe to OpenStack development mail-list
- Create OpenStack profile
- Login to OpenStack Gerrit with your Launchpad id
  - Sign OpenStack Individual Contributor License Agreement
  - Make sure that your email is listed in identities
- Subscribe to code-reviews. Go to your settings on http://review.openstack.org
  - Go to `watched projects`
  - Add `openstack/sahara`, `openstack/sahara-extra`, `openstack/python-saharaclient`, and `openstack/sahara-image-elements`

How to stay in touch with the community

- If you have something to discuss use OpenStack development mail-list. Prefix the mail subject with `[Sahara]`
- Join `#openstack-sahara` IRC channel on freenode
- Attend Sahara team meetings
  - Weekly on Thursdays at 1400 UTC and 1800 UTC (on alternate weeks)
  - IRC channel: `#openstack-meeting-alt` (1800UTC) or `#openstack-meeting-3` (1400UTC)
  - See agenda at https://wiki.openstack.org/wiki/Meetings/SaharaAgenda

How to post your first patch for review

- Checkout Sahara code from Github
- Carefully read http://docs.openstack.org/infra/manual/developers.html#development-workflow
  - Pay special attention to http://docs.openstack.org/infra/manual/developers.html#committing-a-change
- Apply and commit your changes
- Make sure that your code passes `PEP8` checks and unit-tests. See *Development Guidelines*
- Post your patch for review
- Monitor the status of your patch review on https://review.openstack.org/#/

How to build Oozie

Note: Apache does not make Oozie builds, so it has to be built manually.

Download

- Download tarball from Apache mirror
- Unpack it with

```
$ tar -xzvf oozie-4.0.1.tar.gz
```

Hadoop Versions

To build Oozie the following command can be used:

```
$ {oozie_dir}/bin/mkdistro.sh -DskipTests
```

By default it builds against Hadoop 1.1.1. To built it with Hadoop version 2.x:

- The hadoop-2 version should be changed in pom.xml. This can be done manually or with the following command (you should replace 2.x.x with your hadoop version):

```
$ find . -name pom.xml | xargs sed -ri 's/2.3.0/2.x.x/'
```

- The build command should be launched with the `-P hadoop-2` flag

JDK Versions

By default, the build configuration enforces that JDK 1.6.* is being used.

There are 2 build properties that can be used to change the JDK version requirements:

- `javaVersion` specifies the version of the JDK used to compile (default 1.6).
- `targetJavaVersion` specifies the version of the generated bytecode (default 1.6).

For example, to specify JDK version 1.7, the build command should contain the `-D javaVersion=1.7 -D tagetJavaVersion=1.7` flags.

Build

To build Oozie with Hadoop 2.6.0 and JDK version 1.7, the following command can be used:

```
$ {oozie_dir}/bin/mkdistro.sh assembly:single -P hadoop-2 -D javaVersion=1.7 -D␣
↪targetJavaVersion=1.7 -D skipTests
```

Also, the pig version can be passed as a maven property with the flag `-D pig.version=x.x.x`.

You can find similar instructions to build oozie.tar.gz here: http://oozie.apache.org/docs/4.0.0/DG_QuickStart.html#Building_Oozie

Adding Database Migrations

The migrations in `sahara/db/migration/alembic_migrations/versions` contain the changes needed to migrate between Sahara database revisions. A migration occurs by executing a script that details the changes needed to upgrade or downgrade the database. The migration scripts are ordered so that multiple scripts can run sequentially. The scripts are executed by Sahara's migration wrapper which uses the Alembic library to manage the migration. Sahara supports migration from Icehouse or later.

Any code modifications that change the structure of the database require a migration script so that previously existing databases will continue to function when the new code is released. This page gives a brief overview of how to add the migration.

Generate a New Migration Script

New migration scripts can be generated using the `sahara-db-manage` command.

To generate a migration stub to be filled in by the developer:

```
$ sahara-db-manage --config-file /path/to/sahara.conf revision -m "description of␣
↪revision"
```

To autogenerate a migration script that reflects the current structure of the database:

```
$ sahara-db-manage --config-file /path/to/sahara.conf revision -m "description of␣
↪revision" --autogenerate
```

Each of these commands will create a file of the form `revision_description` where `revision` is a string generated by Alembic and `description` is based on the text passed with the `-m` option.

Follow the Sahara Naming Convention

By convention Sahara uses 3-digit revision numbers, and this scheme differs from the strings generated by Alembic. Consequently, it's necessary to rename the generated script and modify the revision identifiers in the script.

Open the new script and look for the variable `down_revision`. The value should be a 3-digit numeric string, and it identifies the current revision number of the database. Set the `revision` value to the `down_revision` value + 1. For example, the lines:

```
# revision identifiers, used by Alembic.
revision = '507eb70202af'
down_revision = '006'
```

will become:

```
# revision identifiers, used by Alembic.
revision = '007'
down_revision = '006'
```

Modify any comments in the file to match the changes and rename the file to match the new revision number:

```
$ mv 507eb70202af_my_new_revision.py 007_my_new_revision.py
```

Add Alembic Operations to the Script

The migration script contains method `upgrade()`. Sahara has not supported downgrades since the Kilo release. Fill in this method with the appropriate Alembic operations to perform upgrades. In the above example, an upgrade will move from revision '006' to revision '007'.

Command Summary for sahara-db-manage

You can upgrade to the latest database version via:

```
$ sahara-db-manage --config-file /path/to/sahara.conf upgrade head
```

To check the current database version:

```
$ sahara-db-manage --config-file /path/to/sahara.conf current
```

To create a script to run the migration offline:

```
$ sahara-db-manage --config-file /path/to/sahara.conf upgrade head --sql
```

To run the offline migration between specific migration versions:

```
$ sahara-db-manage --config-file /path/to/sahara.conf upgrade <start version>:<end␣
↪version> --sql
```

To upgrade the database incrementally:

```
$ sahara-db-manage --config-file /path/to/sahara.conf upgrade --delta <# of revs>
```

To create a new revision:

```
$ sahara-db-manage --config-file /path/to/sahara.conf revision -m "description of␣
↪revision" --autogenerate
```

To create a blank file:

```
$ sahara-db-manage --config-file /path/to/sahara.conf revision -m "description of␣
↪revision"
```

This command does not perform any migrations, it only sets the revision. Revision may be any existing revision. Use this command carefully:

```
$ sahara-db-manage --config-file /path/to/sahara.conf stamp <revision>
```

To verify that the timeline does branch, you can run this command:

```
$ sahara-db-manage --config-file /path/to/sahara.conf check_migration
```

If the migration path does branch, you can find the branch point via:

```
$ sahara-db-manage --config-file /path/to/sahara.conf history
```

Sahara Testing

We have a bunch of different tests for Sahara.

Unit Tests

In most Sahara sub-repositories we have a directory that contains Python unit tests, located at *_package_/tests/unit* or *_package_/tests*.

Scenario integration tests

New scenario integration tests were implemented for Sahara. They are available in the sahara-tests repository (https://git.openstack.org/cgit/openstack/sahara-tests).

Tempest tests

Sahara has a Tempest plugin in the sahara-tests repository covering all major API features.

Additional tests

Additional tests reside in the sahara-tests repository (as above):

- REST API tests checking to ensure that the Sahara REST API works. The only parts that are not tested are cluster creation and EDP.
- CLI tests check read-only operations using the Sahara CLI.

For more information about these tests, please read http://docs.openstack.org/developer/sahara-tests/tempest-plugin.html

Log Guidelines

Levels Guidelines

During the Kilo release cycle the sahara community defined the following log levels:

- Debug: Shows everything and is likely not suitable for normal production operation due to the sheer size of logs generated (e.g. scripts executions, process execution, etc.).
- Info: Usually indicates successful service start/stop, versions and such non-error related data. This should include largely positive units of work that are accomplished (e.g. service setup and configuration, cluster start, job execution information).
- Warning: Indicates that there might be a systemic issue; potential predictive failure notice (e.g. job execution failed).
- Error: An error has occurred and the administrator should research the error information (e.g. cluster failed to start, plugin violations of operation).
- Critical: An error has occurred and the system might be unstable, anything that eliminates part of sahara's intended functionalities; immediately get administrator assistance (e.g. failed to access keystone/database, failed to load plugin).

Formatting Guidelines

Sahara uses string formatting defined in PEP 3101 for logs.

```
LOG.warning(_LW("Incorrect path: {path}").format(path=path))
```

Translation Guidelines

All log levels except Debug require translation. None of the separate CLI tools packaged with sahara contain log translations.

- Debug: no translation
- Info: _LI
- Warning: _LW
- Error: _LE
- Critical: _LC

API Version 2 Development

The sahara project is currently in the process of creating a new RESTful application programming interface (API). This interface is experimental and will not be enabled until it has achieved feature parity with the current (version 1.1) API.

This document defines the steps necessary to enable and communicate with the new API. This API has a few fundamental changes from the previous APIs and they should be noted before proceeding with development work.

Warning: This API is currently marked as experimental. It is not supported by the sahara python client. These instructions are included purely for developers who wish to help participate in the development effort.

Enabling the experimental API

There are a few changes to the WSGI pipeline that must be made to enable the new v2 API. These changes will leave the 1.0 and 1.1 API versions in place and will not adjust their communication parameters.

To begin, uncomment, or add, the following sections in your api-paste.ini file:

```
[app:sahara_apiv2]
paste.app_factory = sahara.api.middleware.sahara_middleware:RouterV2.factory

[filter:auth_validator_v2]
paste.filter_factory = sahara.api.middleware.auth_valid:AuthValidatorV2.factory
```

These lines define a new authentication filter for the v2 API, and define the application that will handle the new calls.

With these new entries in the paste configuration, we can now enable them with the following changes to the api-paste.ini file:

```
[pipeline:sahara]
pipeline = cors request_id acl auth_validator_v2 sahara_api

[composite:sahara_api]
use = egg:Paste#urlmap
/: sahara_apiv2
```

There are 2 significant changes occurring here; changing the authentication validator in the pipline, and changing the root "/" application to the new v2 handler.

At this point the sahara API server should be configured to accept requests on the new v2 endpoints.

Communicating with the v2 API

The v2 API makes at least one major change from the previous versions, removing the OpenStack project identifier from the URL. Instead of adding this UUID to the URL, it is now required to be included as a header named `OpenStack-Project-ID`.

For example, in previous versions of the API, a call to get the list of clusters for project "12345678-1234-1234-1234-123456789ABC" would have been made as follows:

```
GET /v1.1/12345678-1234-1234-1234-123456789ABC/clusters
X-Auth-Token: {valid auth token}
```

This call would now be made to the following URL, while including the project identifier in a header named `OpenStack-Project-ID`:

```
GET /v2/clusters
X-Auth-Token: {valid auth token}
OpenStack-Project-ID: 12345678-1234-1234-1234-123456789ABC
```

Using a tool like HTTPie, the same request could be made like this:

```
$ httpie http://{sahara service ip:port}/v2/clusters \
  X-Auth-Token:{valid auth token} \
  OpenStack-Project-ID:12345678-1234-1234-1234-123456789ABC
```

Following the implementation progress

As the creation of this API will be under regular change until it moves out of the experimental phase, a wiki page has been established to help track the progress.

https://wiki.openstack.org/wiki/Sahara/api-v2

This page will help to coordinate the various reviews, specs, and work items that are a continuing facet of this work.

The API service layer

When contributing to the version 2 API, it will be necessary to add code that modifies the data and behavior of HTTP calls as they are sent to and from the processing engine and data abstraction layers. Most frequently in the sahara codebase, these interactions are handled in the modules of the `sahara.service.api` package. This package contains code for all versions of the API and follows a namespace mapping that is similar to the routing functions of `sahara.api`

Although these modules are not the definitive end of all answers to API related code questions, they are a solid starting point when examining the extent of new work. Furthermore, they serve as a central point to begin API debugging efforts when the need arises.

Background Concepts for Sahara

Pluggable Provisioning Mechanism

Sahara can be integrated with 3rd party management tools like Apache Ambari and Cloudera Management Console. The integration is achieved using the plugin mechanism.

In short, responsibilities are divided between the Sahara core and a plugin as follows. Sahara interacts with the user and uses Heat to provision OpenStack resources (VMs, baremetal servers, security groups, etc.) The plugin installs and configures a Hadoop cluster on the provisioned instances. Optionally, a plugin can deploy management and monitoring tools for the cluster. Sahara provides plugins with utility methods to work with provisioned instances.

A plugin must extend the *sahara.plugins.provisioning:ProvisioningPluginBase* class and implement all the required methods. Read *Plugin SPI* for details.

The *instance* objects provided by Sahara have a *remote* property which can be used to interact with instances. The *remote* is a context manager so you can use it in *with instance.remote:* statements. The list of available commands can be found in *sahara.utils.remote.InstanceInteropHelper*. See the source code of the Vanilla plugin for usage examples.

Plugin SPI

Plugin interface

get_versions()

Returns all available versions of the plugin. Depending on the plugin, this version may map directly to the HDFS version, or it may not; check your plugin's documentation. It is responsibility of the plugin to make sure that all required images for each hadoop version are available, as well as configs and whatever else that plugin needs to create the Hadoop cluster.

Returns: list of strings representing plugin versions

Example return value: ["1.2.1", "2.3.0", "2.4.1"]

get_configs(hadoop_version)

Lists all configs supported by the plugin with descriptions, defaults, and targets for which this config is applicable.

Returns: list of configs

Example return value: (("JobTracker heap size", "JobTracker heap size, in MB", "int", "512", *"mapreduce"*, "node", True, 1))

get_node_processes(hadoop_version)

Returns all supported services and node processes for a given Hadoop version. Each node process belongs to a single service and that relationship is reflected in the returned dict object. See example for details.

Returns: dictionary having entries (service -> list of processes)

Example return value: {“mapreduce”: [”tasktracker”, “jobtracker”], “hdfs”: [”datanode”, “namenode”]}

get_required_image_tags(hadoop_version)

Lists tags that should be added to OpenStack Image via Image Registry. Tags are used to filter Images by plugin and hadoop version.

Returns: list of tags

Example return value: [”tag1”, “some_other_tag”, ...]

validate(cluster)

Validates a given cluster object. Raises a *SaharaException* with a meaningful message in the case of validation failure.

Returns: None

Example exception: <NotSingleNameNodeException {code=’NOT_SINGLE_NAME_NODE’, message=’Hadoop cluster should contain only 1 NameNode instance. Actual NN count is 2’ }>

validate_scaling(cluster, existing, additional)

To be improved.

Validates a given cluster before scaling operation.

Returns: list of validation_errors

update_infra(cluster)

This method is no longer used now that Sahara utilizes Heat for OpenStack resource provisioning, and is not currently utilized by any plugin.

Returns: None

configure_cluster(cluster)

Configures cluster on the VMs provisioned by sahara. In this function the plugin should perform all actions like adjusting OS, installing required packages (including Hadoop, if needed), configuring Hadoop, etc.

Returns: None

start_cluster(cluster)

Start already configured cluster. This method is guaranteed to be called only on a cluster which was already prepared with configure_cluster(...) call.

Returns: None

scale_cluster(cluster, instances)

Scale an existing cluster with additional instances. The instances argument is a list of ready-to-configure instances. Plugin should do all configuration operations in this method and start all services on those instances.

Returns: None

get_edp_engine(cluster, job_type)

Returns an EDP job engine object that supports the specified job_type on the given cluster, or None if there is no support. The EDP job engine object returned must implement the interface described in *Elastic Data Processing (EDP) SPI*. The job_type is a String matching one of the job types listed in *Job Types*.

Returns: an EDP job engine object or None

decommission_nodes(cluster, instances)

Scale cluster down by removing a list of instances. The plugin should stop services on the provided list of instances. The plugin also may need to update some configurations on other instances when nodes are removed; if so, this method must perform that reconfiguration.

Returns: None

on_terminate_cluster(cluster)

When user terminates cluster, sahara simply shuts down all the cluster VMs. This method is guaranteed to be invoked before that, allowing the plugin to do some clean-up.

Returns: None

get_open_ports(node_group)

When user requests sahara to automatically create a security group for the node group (`auto_security_group` property set to True), sahara will call this plugin method to get a list of ports that need to be opened.

Returns: list of ports to be open in auto security group for the given node group

get_edp_job_types(versions)

Optional method, which provides the ability to see all supported job types for specified plugin versions.

Returns: dict with supported job types for specified versions of plugin

recommend_configs(self, cluster, scaling=False)

Optional method, which provides recommendations for cluster configuration before creating/scaling operation.

get_image_arguments(self, hadoop_version):

Optional method, which gets the argument set taken by the plugin's image generator, or NotImplemented if the plugin does not provide image generation support. See image-gen.

Returns: A sequence with items of type sahara.plugins.images.ImageArgument.

pack_image(self, hadoop_version, remote, reconcile=True, ...):

Optional method which packs an image for registration in Glance and use by Sahara. This method is called from the image generation CLI rather than from the Sahara api or engine service. See image-gen.

Returns: None (modifies the image pointed to by the remote in-place.)

validate_images(self, cluster, reconcile=True, image_arguments=None):

Validates the image to be used to create a cluster, to ensure that it meets the specifications of the plugin. See image-gen.

Returns: None; may raise a sahara.plugins.exceptions.ImageValidationError

Object Model

Here is a description of all the objects involved in the API.

Notes:

- clusters and node_groups have 'extra' fields allowing the plugin to persist any supplementary info about the cluster.
- node_process is just a process that runs on some node in cluster.

Example list of node processes:

1. jobtracker
2. namenode
3. tasktracker
4. datanode

- Each plugin may have different names for the same processes.

Config

An object, describing one configuration entry

Property	Type	Description
name	string	Config name.
description	string	A hint for user, what this config is used for.
config_type	enum	possible values are: 'string', 'integer', 'boolean', 'enum'.
config_values	list	List of possible values, if config_type is enum.
default_value	string	Default value for config.
applicable_target	string	The target could be either a service returned by get_node_processes(...) call in form of 'service:<service name>', or 'general'.
scope	enum	Could be either 'node' or 'cluster'.
is_optional	bool	If is_optional is False and no default_value is specified, user must provide a value.
priority	int	1 or 2. A Hint for UI. Configs with priority *1* are always displayed. Priority *2* means user should click a button to see the config.

User Input

Value provided by user for a specific config.

Property	Type	Description
config	config	A config object for which this user_input is provided.
value	...	Value for the config. Type depends on Config type.

Instance

An instance created for cluster.

Property	Type	Description
instance_id	string	Unique instance identifier.
instance_name	string	OpenStack instance name.
internal_ip	string	IP to communicate with other instances.
management_ip	string	IP of instance, accessible outside of internal network.
volumes	list	List of volumes attached to instance. Empty if ephemeral drive is used.
nova_info	object	Nova instance object.
username	string	Username, that sahara uses for establishing remote connections to instance.
hostname	string	Same as instance_name.
fqdn	string	Fully qualified domain name for this instance.
remote	helpers	Object with helpers for performing remote operations.

Node Group

Group of instances.

Property	Type	Description
name	string	Name of this Node Group in Cluster.
flavor_id	string	OpenStack Flavor used to boot instances.
image_id	string	Image id used to boot instances.
node_processes	list	List of processes running on each instance.
node_configs	dict	Configs dictionary, applied to instances.
volumes_per_node	int	Number of volumes mounted to each instance. 0 means use ephemeral drive.
volumes_size	int	Size of each volume (GB).
vol-umes_mount_prefix	string	Prefix added to mount path of each volume.
floating_ip_pool	string	Floating IP Pool name. All instances in the Node Group will have Floating IPs assigned from this pool.
count	int	Number of instances in this Node Group.
username	string	Username used by sahara to establish remote connections to instances.
configuration	dict	Merged dictionary of node configurations and cluster configurations.
storage_paths	list	List of directories where storage should be placed.

Cluster

Contains all relevant info about cluster. This object is is provided to the plugin for both cluster creation and scaling. The "Cluster Lifecycle" section below further specifies which fields are filled at which moment.

Property	Type	Description
name	string	Cluster name.
project_id	string	OpenStack Project id where this Cluster is available.
plugin_name	string	Plugin name.
hadoop_version	string	Hadoop version running on instances.
default_image_id	string	OpenStack image used to boot instances.
node_groups	list	List of Node Groups.
cluster_configs	dict	Dictionary of Cluster scoped configurations.
cluster_template_id	string	Cluster Template used for Node Groups and Configurations.
user_keypair_id	string	OpenStack keypair added to instances to make them accessible for user.
neutron_management_network	string	Neutron network ID. Instances will get fixed IPs in this network if 'use_neutron' config is set to True.
anti_affinity	list	List of processes that will be run on different hosts.
description	string	Cluster Description.
info	dict	Dictionary for additional information.

Validation Error

Describes what is wrong with one of the values provided by user.

Property	Type	Description
config	config	A config object that is not valid.
error_message	string	Message that describes what exactly is wrong.

Elastic Data Processing (EDP) SPI

The EDP job engine objects provide methods for creating, monitoring, and terminating jobs on Sahara clusters. Provisioning plugins that support EDP must return an EDP job engine object from the *get_edp_engine(cluster, job_type)* method described in *Plugin SPI*.

Sahara provides subclasses of the base job engine interface that support EDP on clusters running Oozie, Spark, and/or Storm. These are described below.

Job Types

Some of the methods below test job type. Sahara supports the following string values for job types:

- Hive
- Java
- Pig
- MapReduce
- MapReduce.Streaming
- Spark
- Shell
- Storm

Note: Constants for job types are defined in *sahara.utils.edp*.

Job Status Values

Several of the methods below return a job status value. A job status value is a dictionary of the form:

{'status': *job_status_value*}

where *job_status_value* is one of the following string values:

- DONEWITHERROR
- FAILED
- TOBEKILLED
- KILLED
- PENDING
- RUNNING
- SUCCEEDED

Note, constants for job status are defined in *sahara.utils.edp*

EDP Job Engine Interface

The sahara.service.edp.base_engine.JobEngine class is an abstract class with the following interface:

cancel_job(job_execution)

Stops the running job whose id is stored in the job_execution object.

Returns: None if the operation was unsuccessful or an updated job status value.

get_job_status(job_execution)

Returns the current status of the job whose id is stored in the job_execution object.

Returns: a job status value.

run_job(job_execution)

Starts the job described by the job_execution object

Returns: a tuple of the form (job_id, job_status_value, job_extra_info).

- *job_id* is required and must be a string that allows the EDP engine to uniquely identify the job.
- *job_status_value* may be None or a job status value
- *job_extra_info* may be None or optionally a dictionary that the EDP engine uses to store extra information on the job_execution_object.

validate_job_execution(cluster, job, data)

Checks whether or not the job can run on the cluster with the specified data. Data contains values passed to the */jobs/<job_id>/execute* REST API method during job launch. If the job cannot run for any reason, including job configuration, cluster configuration, or invalid data, this method should raise an exception.

Returns: None

get_possible_job_config(job_type)

Returns hints used by the Sahara UI to prompt users for values when configuring and launching a job. Note that no hints are required.

See *Elastic Data Processing (EDP)* for more information on how configuration values, parameters, and arguments are used by different job types.

Returns: a dictionary of the following form, containing hints for configs, parameters, and arguments for the job type:

{'job_config': {'configs': [], 'params': {}, 'args': []}}

- *args* is a list of strings
- *params* contains simple key/value pairs
- each item in *configs* is a dictionary with entries for 'name' (required), 'value', and 'description'

get_supported_job_types()

This method returns the job types that the engine supports. Not all engines will support all job types.

Returns: a list of job types supported by the engine.

Oozie Job Engine Interface

The sahara.service.edp.oozie.engine.OozieJobEngine class is derived from JobEngine. It provides implementations for all of the methods in the base interface but adds a few more abstract methods.

Note that the *validate_job_execution(cluster, job, data)* method does basic checks on the job configuration but probably should be overloaded to include additional checks on the cluster configuration. For example, the job engines for plugins that support Oozie add checks to make sure that the Oozie service is up and running.

get_hdfs_user()

Oozie uses HDFS to distribute job files. This method gives the name of the account that is used on the data nodes to access HDFS (such as 'hadoop' or 'hdfs'). The Oozie job engine expects that HDFS contains a directory for this user under */user/*.

Returns: a string giving the username for the account used to access HDFS on the cluster.

create_hdfs_dir(remote, dir_name)

The remote object *remote* references a node in the cluster. This method creates the HDFS directory *dir_name* under the user specified by *get_hdfs_user()* in the HDFS accessible from the specified node. For example, if the HDFS user is 'hadoop' and the dir_name is 'test' this method would create '/user/hadoop/test'.

The reason that this method is broken out in the interface as an abstract method is that different versions of Hadoop treat path creation differently.

Returns: None

get_oozie_server_uri(cluster)

Returns the full URI for the Oozie server, for example *http://my_oozie_host:11000/oozie*. This URI is used by an Oozie client to send commands and queries to the Oozie server.

Returns: a string giving the Oozie server URI.

get_oozie_server(self, cluster)

Returns the node instance for the host in the cluster running the Oozie server.

Returns: a node instance.

get_name_node_uri(self, cluster)

Returns the full URI for the Hadoop NameNode, for example *http://master_node:8020*.

Returns: a string giving the NameNode URI.

get_resource_manager_uri(self, cluster)

Returns the full URI for the Hadoop JobTracker for Hadoop version 1 or the Hadoop ResourceManager for Hadoop version 2.

Returns: a string giving the JobTracker or ResourceManager URI.

Spark Job Engine

The sahara.service.edp.spark.engine.SparkJobEngine class provides a full EDP implementation for Spark standalone clusters.

Note: The *validate_job_execution(cluster, job, data)* method does basic checks on the job configuration but probably should be overloaded to include additional checks on the cluster configuration. For example, the job engine returned by the Spark plugin checks that the Spark version is >= 1.0.0 to ensure that *spark-submit* is available.

get_driver_classpath(self)

Returns driver class path.

Returns: a string of the following format ' –driver-class-path *class_path_value*'.

Sahara Cluster Statuses Overview

All Sahara Cluster operations are performed in multiple steps. A Cluster object has a `Status` attribute which changes when Sahara finishes one step of operations and starts another one. Also a Cluster object has a `Status description` attribute which changes whenever Cluster errors occur.

Sahara supports three types of Cluster operations:

- Create a new Cluster
- Scale/Shrink an existing Cluster
- Delete an existing Cluster

Creating a new Cluster

1. Validating

Before performing any operations with OpenStack environment, Sahara validates user input.

There are two types of validations, that are done:

- Check that a request contains all necessary fields and that the request does not violate any constraints like unique naming, etc.
- Plugin check (optional). The provisioning Plugin may also perform any specific checks like a Cluster topology validation check.

If any of the validations fails during creating, the Cluster object will still be kept in the database with an `Error` status. If any validations fails during scaling the `Active` Cluster, it will be kept with an `Active` status. In both cases status description will contain error messages about the reasons of failure.

2. InfraUpdating

This status means that the Provisioning plugin is performing some infrastructure updates.

3. Spawning

Sahara sends requests to OpenStack for all resources to be created:

- VMs
- Volumes
- Floating IPs (if Sahara is configured to use Floating IPs)

It takes some time for OpenStack to schedule all the required VMs and Volumes, so sahara will wait until all of the VMs are in an `Active` state.

4. Waiting

Sahara waits while VMs' operating systems boot up and all internal infrastructure components like networks and volumes are attached and ready to use.

5. Preparing

Sahara prepares a Cluster for starting. This step includes generating the `/etc/hosts` file or changing `/etc/resolv.conf` file (if you use Designate service), so that all instances can access each other by a hostname. Also Sahara updates the `authorized_keys` file on each VM, so that VMs can communicate without passwords.

6. Configuring

Sahara pushes service configurations to VMs. Both XML and JSON based configurations and environmental variables are set on this step.

7. Starting

Sahara is starting Hadoop services on Cluster's VMs.

8. Active

Active status means that a Cluster has started successfully and is ready to run EDP Jobs.

Scaling/Shrinking an existing Cluster

1. Validating

Sahara checks the scale/shrink request for validity. The Plugin method called for performing Plugin specific checks is different from the validation method in creation.

2. Scaling

Sahara performs database operations updating all affected existing Node Groups and creating new ones to join the existing Node Groups.

3. Adding Instances

Status is similar to `Spawning` in Cluster creation. Sahara adds required amount of VMs to the existing Node Groups and creates new Node Groups.

4. Configuring

Status is similar to `Configuring` in Cluster creation. New instances are being configured in the same manner as already existing ones. The VMs in the existing Cluster are also updated with a new `/etc/hosts` file or `/etc/resolv.conf` file.

5. Decommissioning

Sahara stops Hadoop services on VMs that will be deleted from a Cluster. Decommissioning a Data Node may take some time because Hadoop rearranges data replicas around the Cluster, so that no data will be lost after that Data Node is deleted.

6. Deleting Instances

Sahara sends requests to OpenStack to release unneeded resources:

- VMs
- Volumes
- Floating IPs (if they are used)

7. Active

The same `Active` status as after Cluster creation.

Deleting an existing Cluster

1. Deleting

The only step, that releases all Cluster's resources and removes it from the database.

Error State

If the Cluster creation fails, the Cluster will enter the `Error` state. This status means the Cluster may not be able to perform any operations normally. This cluster will stay in the database until it is manually deleted. The reason for failure may be found in the sahara logs. Also, the status description will contain information about the error.

If an error occurs during the `Adding Instances` operation, Sahara will first try to rollback this operation. If a rollback is impossible or fails itself, then the Cluster will also go into an `Error` state. If a rollback was successful, Cluster will get into an `Active` state and status description will contain a short message about the reason of `Adding Instances` failure.

How to run a Sahara cluster on bare metal servers

Hadoop clusters are designed to store and analyze extremely large amounts of unstructured data in distributed computing environments. Sahara enables you to boot Hadoop clusters in both virtual and bare metal environments. When Booting Hadoop clusters with Sahara on bare metal servers, you benefit from the bare metal performance with self-service resource provisioning.

1. Create a new OpenStack environment using Devstack as described in the Devstack Guide
2. Install Ironic as described in the Ironic Installation Guide
3. Install Sahara as described in the Sahara Installation Guide
4. Build the Sahara image and prepare it for uploading to Glance:
   - Build an image for Sahara plugin with the `-b` flag. Use sahara image elements when building the image. See https://github.com/openstack/sahara-image-elements
   - Convert the qcow2 image format to the raw format. For example:

```
$ qemu-img convert -O raw image-converted.qcow image-converted-from-qcow2.raw
```

- Mount the raw image to the system.

- `chroot` to the mounted directory and remove the installed grub.
- Build grub2 from sources and install to `/usr/sbin`.
- In `/etc/sysconfig/selinux`, disable selinux `SELINUX=disabled`
- In the configuration file, set `onboot=yes` and `BOOTPROTO=dhcp` for every interface.
- Add the configuration files for all interfaces in the `/etc/sysconfig/network-scripts` directory.

5. Upload the Sahara disk image to Glance, and register it in the Sahara Image Registry. Referencing its separate kernel and initramfs images.
6. Configure the bare metal network for the Sahara cluster nodes:
   - Add bare metal servers to your environment manually referencing their IPMI addresses (Ironic does not detect servers), for Ironic to manage the servers power and network. For example:

```
$ ironic node-create -d pxe_ipmitool \
$ -i ipmi_address=$IP_ADDRESS \
$ -i ipmi_username=$USERNAME \
$ -i ipmi_password=$PASSWORD \
$ -i pxe_deploy_kernel=$deploy.kernel.id \
$ -i pxe_deploy_ramdisk=$deploy.ramfs.id

$ ironic port-create -n $NODE_ID -a "$MAC_eth1"
```

- Add the hardware information:

```
$ ironic node-update $NODE_ID add properties/cpus=$CPU \
$ properties/memory_mb=$RAM properties/local_gb=$ROOT_GB \
$ properties/cpu_arch='x86_64'
```

7. Add a special flavor for the bare metal instances with an arch meta parameter to match the virtual architecture of the server's CPU with the metal one. For example:

```
$ nova flavor-create baremetal auto $RAM $DISK_GB $CPU
$ nova flavor-key baremetal set cpu_arch=x86_64
```

Note:

The vCPU ad vRAM parameters (x86_64 in the example) will not be applied because the operating system has access to the real CPU cores and RAM. Only the root disk parameter is applied, and Ironic will resize the root disk partition. Ironic supports only a flat network topology for the bare metal provisioning, you must use Neutron to configure it.

8. Launch your Sahara cluster on Ironic from the cluster template:
   - Log in to Horizon.
   - **Go to Data Processing > Node Group Templates.**
     - Find the templates that belong to the plugin you would like to use
     - Update those templates to use 'bare metal' flavor instead of the default one
   - Go to Data Processing > Cluster Templates.
   - Click Launch Cluster.
   - **On the Launch Cluster dialog:**
     - Specify the bare metal network for cluster nodes

The cluster provisioning time is slower compared to the cluster provisioning of the same size that runs on VMs. Ironic does real hardware reports which is time consuming, and the whole root disk is filled from `/dev/zero` for security reasons.

Known limitations:

- Security groups are not applied.
- When booting a nova instance with a bare metal flavor, the user can not provide a pre-created neutron port to `nova boot` command. LP1544195
- Nodes are not isolated by projects.
- VM to Bare Metal network routing is not allowed.
- The user has to specify the count of ironic nodes before Devstack deploys an OpenStack.
- The user cannot use the same image for several ironic node types. For example, if there are 3 ironic node types, the user has to create 3 images and 3 flavors.
- Multiple interfaces on a single node are not supported. Devstack configures only one interface.

Other Resources

Project hosting

Launchpad hosts the Sahara project. The Sahara project homepage on Launchpad is http://launchpad.net/sahara.

Launchpad credentials

Creating a login on Launchpad is important even if you don't use the Launchpad site itself, since Launchpad credentials are used for logging in on several OpenStack-related sites. These sites include:

- Wiki
- Gerrit (see *Code Reviews with Gerrit*)
- Jenkins (see *Continuous Integration with Jenkins*)

Mailing list

The mailing list email is `openstack-dev@lists.openstack.org`; use the subject prefix `[sahara]` to address the team. To participate in the mailing list subscribe to the list at http://lists.openstack.org/cgi-bin/mailman/listinfo

Bug tracking

Report Sahara bugs at https://bugs.launchpad.net/sahara

Feature requests (Blueprints)

Sahara uses specs to track feature requests. Blueprints are at https://blueprints.launchpad.net/sahara. They provide a high-level summary of proposed changes and track associated commits. Sahara also uses specs for in-depth descriptions and discussions of blueprints. Specs follow a defined format and are submitted as change requests to the openstack/sahara-specs repository. Every blueprint should have an associated spec that is agreed on and merged to the sahara-specs repository before it is approved, unless the whole team agrees that the implementation path for the feature described in the blueprint is completely understood.

Technical support

Sahara uses Ask OpenStack to track Sahara technical support questions. Questions related to Sahara should be tagged with 'sahara'.

Code Reviews with Gerrit

Sahara uses the Gerrit tool to review proposed code changes. The review site is http://review.openstack.org.

Gerrit is a complete replacement for Github pull requests. *All Github pull requests to the Sahara repository will be ignored*.

See Development Workflow for information about how to get started using Gerrit.

Continuous Integration with Jenkins

Each change made to Sahara core code is tested with unit and integration tests and style checks using flake8.

Unit tests and style checks are performed on public OpenStack Jenkins managed by Zuul.

Unit tests are checked using python 2.7.

The result of those checks and Unit tests are represented as a vote of +1 or -1 in the *Verify* column in code reviews from the *Jenkins* user.

Integration tests check CRUD operations for the Image Registry, Templates, and Clusters. Also a test job is launched on a created Cluster to verify Hadoop work.

All integration tests are launched by Jenkins on the internal Mirantis OpenStack Lab.

Jenkins keeps a pool of VMs to run tests in parallel. Even with the pool of VMs integration testing may take a while.

Jenkins is controlled for the most part by Zuul which determines what jobs are run when.

Zuul status is available at this address: Zuul Status.

For more information see: Sahara Hadoop Cluster CI.

The integration tests result is represented as a vote of +1 or -1 in the *Verify* column in a code review from the *Sahara Hadoop Cluster CI* user.

You can put *sahara-ci-recheck* in comment, if you want to recheck sahara-ci jobs. Also, you can put *recheck* in comment, if you want to recheck both Jenkins and sahara-ci jobs. Finally, you can put *reverify* in a comment, if you only want to recheck Jenkins jobs.