kayobe Documentation

OpenStack Foundation

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Contents

CHAPTER 1

Kayobe

Kayobe enables deployment of containerised OpenStack to bare metal.

Containers offer a compelling solution for isolating OpenStack services, but running the control plane on an orchestrator such as Kubernetes or Docker Swarm adds significant complexity and operational overheads.

The hosts in an OpenStack control plane must somehow be provisioned, but deploying a secondary OpenStack cloud to do this seems like overkill.

Kayobe stands on the shoulders of giants:

- OpenStack bifrost discovers and provisions the cloud
- OpenStack kolla builds container images for OpenStack services
- OpenStack kolla-ansible delivers painless deployment and upgrade of containerised OpenStack services

To this solid base, kayobe adds:

- Configuration of cloud host OS & flexible networking
- Management of physical network devices
- A friendly openstack-like CLI

All this and more, automated from top to bottom using Ansible.

- Free software: Apache license
- Documentation: https://kayobe.readthedocs.io/en/latest/
- Source: https://git.openstack.org/cgit/openstack/kayobe
- Bugs: https://storyboard.openstack.org/#!/project/openstack/kayobe
- Release Notes: https://kayobe-release-notes.readthedocs.io/en/latest/
- IRC: #openstack-kayobe

1.1 Features

- Heavily automated using Ansible
- *kayobe* Command Line Interface (CLI) for cloud operators
- Deployment of a *seed* VM used to manage the OpenStack control plane
- Configuration of physical network infrastructure
- Discovery, introspection and provisioning of control plane hardware using OpenStack bifrost
- Deployment of an OpenStack control plane using OpenStack kolla-ansible
- Discovery, introspection and provisioning of bare metal compute hosts using OpenStack ironic and ironic inspector
- Virtualised compute using OpenStack nova
- Containerised workloads on bare metal using OpenStack magnum
- Big data on bare metal using OpenStack sahara

In the near future we aim to add support for the following:

- Control plane and workload monitoring and log aggregation using OpenStack monasca

1.2 Documentation

Note: Kayobe and its documentation is currently under heavy development, and therefore may be incomplete or out of date. If in doubt, contact the project's maintainers.

1.2.1 Architecture

Hosts in the System

In a system deployed by Kayobe we define a number of classes of hosts.

Ansible control host The Ansible control host is the host on which kayobe, kolla and kolla-ansible will be installed, and is typically where the cloud will be managed from.

Seed host The seed host runs the bifrost deploy container and is used to provision the cloud hosts. By default, container images are built on the seed. Typically the seed host is deployed as a VM but this is not mandatory.

Cloud hosts The cloud hosts run the OpenStack control plane, network, monitoring, storage, and virtualised compute services. Typically the cloud hosts run on bare metal but this is not mandatory.

Bare metal compute hosts In a cloud providing bare metal compute services to tenants via ironic, these hosts will run the bare metal tenant workloads. In a cloud with only virtualised compute this category of hosts does not exist.

Note: In many cases the control and seed host will be the same, although this is not mandatory.

Cloud Hosts

Cloud hosts can further be divided into subclasses.

Controllers Controller hosts run the OpenStack control plane services.

Network Network hosts run the neutron networking services and load balancers for the OpenStack API services.

Monitoring Monitoring host run the control plane and workload monitoring services. Currently, kayobe does not deploy any services onto monitoring hosts.

Virtualised compute hypervisors Virtualised compute hypervisors run the tenant Virtual Machines (VMs) and associated OpenStack services for compute, networking and storage.

Networks

Kayobe's network configuration is very flexible but does define a few default classes of networks. These are logical networks and may map to one or more physical networks in the system.

Overcloud out-of-band network Name of the network used by the seed to access the out-of-band management controllers of the bare metal overcloud hosts.

Overcloud provisioning network The overcloud provisioning network is used by the seed host to provision the cloud hosts.

Workload out-of-band network Name of the network used by the overcloud hosts to access the out-of-band management controllers of the bare metal workload hosts.

Workload provisioning network The workload provisioning network is used by the cloud hosts to provision the bare metal compute hosts.

Internal network The internal network hosts the internal and admin OpenStack API endpoints.

Public network The public network hosts the public OpenStack API endpoints.

External network The external network provides external network access for the hosts in the system.

1.2.2 Installation

Kayobe can be installed via the released Python packages on PyPI, or from source. Installing from PyPI ensures the use of well used and tested software, whereas installing from source allows for the use of unreleased or patched code. Installing from a Python package is supported from Kayobe 5.0.0 onwards.

Prerequisites

Currently Kayobe supports the following Operating Systems on the Ansible control host:

- CentOS 7.3
- Ubuntu 16.04

To avoid conflicts with python packages installed by the system package manager it is recommended to install Kayobe in a virtualenv. Ensure that the `virtualenv` python module is available on the Ansible control host. It is necessary to install the GCC compiler chain in order to build the extensions of some of kayobe's python dependencies.

On CentOS:

```
$ yum install -y python-devel python-virtualenv gcc
```

On Ubuntu:

```
$ apt install -y python-dev python-virtualenv gcc
```

If installing Kayobe from source, then Git is required for cloning and working with the source code repository.

On CentOS:

```
$ yum install -y git
```

On Ubuntu:

```
$ apt install -y git
```

Local directory structure

The directory structure for a Kayobe Ansible control host environment is configurable, but the following is recommended, where `<base_path>` is the path to a top level directory:

```
<base_path>/
    src/
        kayobe/
        kayobe-config/
        kolla-ansible/
    venvs/
        kayobe/
        kolla-ansible/
```

This pattern ensures that all dependencies for a particular environment are installed under a single top level path, and nothing is installed to a shared location. This allows for the option of using multiple Kayobe environments on the same control host.

Creation of a `kayobe-config` source code repository will be covered in the *configuration guide*. The Kolla Ansible source code checkout and Python virtual environment will be created automatically by kayobe.

Not all of these directories will be used in all scenarios - if Kayobe or Kolla Ansible are installed from a Python package then the source code repository is not required.

Installation from PyPI

This section describes how to install Kayobe from a Python package in a virtualenv. This is supported from Kayobe 5.0.0 onwards.

First, change to the top level directory, and make the directories for source code repositories and python virtual environments:

```
$ cd <base_path>
$ mkdir -p src venvs
```

Create a virtualenv for Kayobe:

```
$ virtualenv <base_path>/venvs/kayobe
```

Activate the virtualenv and update pip:

```
$ source <base_path>/venvs/kayobe/bin/activate
(kayobe) $ pip install -U pip
```

If using the latest version of Kayobe:

```
(kayobe) $ pip install kayobe
```

Alternatively, to install a specific release of Kayobe:

```
(kayobe) $ pip install kayobe==5.0.0
```

Finally, deactivate the virtualenv:

```
(kayobe) $ deactivate
```

Installation from source

This section describes how to install Kayobe from source in a virtualenv.

First, change to the top level directory, and make the directories for source code repositories and python virtual environments:

```
$ cd <base_path>
$ mkdir -p src venvs
```

Next, obtain the Kayobe source code. For example:

```
$ cd <base_path>/src
$ git clone https://git.openstack.org/openstack/kayobe.git
```

Create a virtualenv for Kayobe:

```
$ virtualenv <base_path>/venvs/kayobe
```

Activate the virtualenv and update pip:

```
$ source <base_path>/venvs/kayobe/bin/activate
(kayobe) $ pip install -U pip
```

Install Kayobe and its dependencies using the source code checkout:

```
(kayobe) $ cd <base_path>/src/kayobe
(kayobe) $ pip install .
```

Finally, deactivate the virtualenv:

```
(kayobe) $ deactivate
```

Editable source installation

From Kayobe 5.0.0 onwards it is possible to create an editable install of Kayobe. In an editable install, any changes to the Kayobe source tree will immediately be visible when running any Kayobe commands. To create an editable install, add the `-e` flag:

```
(kayobe) $ cd <base_path>/src/kayobe
(kayobe) $ pip install -e .
```

This is particularly useful when installing Kayobe for development.

1.2.3 Usage

Command Line Interface

Note: Where a prompt starts with `(kayobe)` it is implied that the user has activated the Kayobe virtualenv. This can be done as follows:

```
$ source /path/to/venv/bin/activate
```

To deactivate the virtualenv:

```
(kayobe) $ deactivate
```

To see information on how to use the `kayobe` CLI and the commands it provides:

```
(kayobe) $ kayobe help
```

As the `kayobe` CLI is based on the `cliff` package (as used by the `openstack` client), it supports tab auto-completion of subcommands. This can be activated by generating and then sourcing the bash completion script:

```
(kayobe) $ kayobe complete > kayobe-complete
(kayobe) $ source kayobe-complete
```

Working with Ansible Vault

If Ansible vault has been used to encrypt Kayobe configuration files, it will be necessary to provide the `kayobe` command with access to vault password. There are three options for doing this:

Prompt Use `kayobe --ask-vault-pass` to prompt for the password.

File Use `kayobe --vault-password-file <file>` to read the password from a (plain text) file.

Environment variable Export the environment variable `KAYOBE_VAULT_PASSWORD` to read the password from the environment.

Limiting Hosts

Sometimes it may be necessary to limit execution of kayobe or kolla-ansible plays to a subset of the hosts. The `--limit <SUBSET>` argument allows the kayobe ansible hosts to be limited. The `--kolla-limit <SUBSET>` argument allows the kolla-ansible hosts to be limited. These two options may be combined in a single command. In both cases, the argument provided should be an Ansible host pattern, and will ultimately be passed to `ansible-playbook` as a `--limit` argument.

Tags

Ansible tags provide a useful mechanism for executing a subset of the plays or tasks in a playbook. The `--tags <TAGS>` argument allows execution of kayobe ansible playbooks to be limited to matching plays and tasks. The `--kolla-tags <TAGS>` argument allows execution of kolla-ansible ansible playbooks to be limited to matching plays and tasks. The `--skip-tags <TAGS>` and `--kolla-skip-tags <TAGS>` arguments allow for avoiding execution of matching plays and tasks.

1.2.4 Configuration Guide

Kayobe Configuration

This section covers configuration of Kayobe. As an Ansible-based project, Kayobe is for the most part configured using YAML files.

Configuration Location

Kayobe configuration is by default located in `/etc/kayobe` on the Ansible control host. This location can be overridden to a different location to avoid touching the system configuration directory by setting the environment variable `KAYOBE_CONFIG_PATH`. Similarly, kolla configuration on the Ansible control host will by default be located in `/etc/kolla` and can be overridden via `KOLLA_CONFIG_PATH`.

Configuration Directory Layout

The Kayobe configuration directory contains Ansible `extra-vars` files and the Ansible inventory. An example of the directory structure is as follows:

```
extra-vars1.yml
extra-vars2.yml
inventory/
    group_vars/
        group1-vars
        group2-vars
    groups
    host_vars/
        host1-vars
        host2-vars
    hosts
```

Configuration Patterns

Ansible's variable precedence rules are fairly well documented and provide a mechanism we can use for providing site localisation and customisation of OpenStack in combination with some reasonable default values. For global configuration options, Kayobe typically uses the following patterns:

- Playbook group variables for the *all* group in `<kayobe repo>/ansible/group_vars/all/*` set **global defaults**. These files should not be modified.
- Playbook group variables for other groups in `<kayobe repo>/ansible/group_vars/<group>/*` set **defaults for some subsets of hosts**. These files should not be modified.

- Extra-vars files in `${KAYOBE_CONFIG_PATH}/*.yml` set **custom values for global variables** and should be used to apply global site localisation and customisation. By default these variables are commented out.

Additionally, variables can be set on a per-host basis using inventory host variables files in `${KAYOBE_CONFIG_PATH}/inventory/host_vars/*`. It should be noted that variables set in extra-vars files take precedence over per-host variables.

Configuring Kayobe

The kayobe-config git repository contains a Kayobe configuration directory structure and unmodified configuration files. This repository can be used as a mechanism for version controlling Kayobe configuration. As Kayobe is updated, the configuration should be merged to incorporate any upstream changes with local modifications.

Alternatively, the baseline Kayobe configuration may be copied from a checkout of the Kayobe repository to the Kayobe configuration path:

```
$ mkdir -p ${KAYOBE_CONFIG_PATH:-/etc/kayobe/}
$ cp -r etc/kayobe/* ${KAYOBE_CONFIG_PATH:-/etc/kayobe/}
```

Once in place, each of the YAML and inventory files should be manually inspected and configured as required.

Inventory

The inventory should contain the following hosts:

Ansible Control host This should be localhost.

Seed hypervisor If provisioning a seed VM, a host should exist for the hypervisor that will run the VM, and should be a member of the `seed-hypervisor` group.

Seed The seed host, whether provisioned as a VM by Kayobe or externally managed, should exist in the `seed` group.

Cloud hosts and bare metal compute hosts are not required to exist in the inventory if discovery of the control plane hardware is planned, although entries for groups may still be required.

Use of advanced control planes with multiple server roles and customised service placement across those servers is covered in *Control Plane Service Placement*.

Site Localisation and Customisation

Site localisation and customisation is applied using Ansible extra-vars files in `${KAYOBE_CONFIG_PATH}/*.yml`.

Encryption of Secrets

Kayobe supports the use of Ansible vault to encrypt sensitive information in its configuration. The `ansible-vault` tool should be used to manage individual files for which encryption is required. Any of the configuration files may be encrypted. Since encryption can make working with Kayobe difficult, it is recommended to follow best practice, adding a layer of indirection and using encryption only where necessary.

Physical Network Configuration

Kayobe supports configuration of physical network devices. This feature is optional, and this section may be skipped if network device configuration will be managed via other means.

Devices are added to the Ansible inventory, and configured using Ansible's networking modules. Configuration is applied via the `kayobe physical network configure` command. See *Physical Network* for details.

The following switches are currently supported:

- Dell OS 6
- Dell OS 9
- Dell PowerConnect
- Juniper Junos OS
- Mellanox MLNX OS

Adding Devices to the Inventory

Network devices should be added to the Kayobe Ansible inventory, and should be members of the `switches` group.

Listing 1: `inventory/hosts`

```
[switches]
switch0
switch1
```

In some cases it may be useful to differentiate different types of switches, For example, a `mgmt` network might carry out-of-band management traffic, and a `ctl` network might carry control plane traffic. A group could be created for each of these networks, with each group being a child of the `switches` group.

Listing 2: `inventory/hosts`

```
[switches:children]
mgmt-switches
ctl-switches

[mgmt-switches]
switch0

[ctl-switches]
switch1
```

Network Device Configuration

Configuration is typically specific to each network device. It is therefore usually best to add a `host_vars` file to the inventory for each device. Common configuration for network devices can be added in a `group_vars` file for the `switches` group or one of its child groups.

Listing 3: `inventory/host_vars/switch0`

```
---
# Host configuration for switch0
ansible_host: 1.2.3.4
```

Listing 4: inventory/host_vars/switch1

```
---
# Host configuration for switch1
ansible_host: 1.2.3.5
```

Listing 5: inventory/group_vars/switches

```
---
# Group configuration for 'switches' group.
ansible_user: alice
```

Common Configuration Variables

The type of switch should be configured via the switch_type variable. See *Device-specific Configuration Variables* for details of the value to set for each device type.

ansible_host should be set to the management IP address used to access the device. ansible_user should be set to the user used to access the device.

Global switch configuration is specified via the switch_config variable. It should be a list of configuration lines to apply.

Per-interface configuration is specified via the switch_interface_config variable. It should be an object mapping switch interface names to configuration objects. Each configuration object contains a description item and a config item. The config item should contain a list of per-interface configuration lines.

The switch_interface_config_enable_discovery and switch_interface_config_disable_discovery variables take the same format as the switch_interface_config variable. They define interface configuration to apply to enable or disable hardware discovery of bare metal compute nodes.

Listing 6: inventory/host_vars/switch0

```
---
ansible_host: 1.2.3.4

ansible_user: alice

switch_config:
  - global config line 1
  - global config line 2

switch_interface_config:
  interface-0:
    description: controller0
    config:
      - interface-0 config line 1
      - interface-0 config line 2
  interface-1:
    description: compute0
    config:
      - interface-1 config line 1
      - interface-1 config line 2
```

Network device configuration can become quite repetitive, so it can be helpful to define group variables that can be referenced by multiple devices. For example:

Listing 7: inventory/group_vars/switches

```
---
# Group configuration for the 'switches' group.
switch_config_default:
  - default global config line 1
  - default global config line 2

switch_interface_config_controller:
  - controller interface config line 1
  - controller interface config line 2

switch_interface_config_compute:
  - compute interface config line 1
  - compute interface config line 2
```

Listing 8: inventory/host_vars/switch0

```
---
ansible_host: 1.2.3.4

ansible_user: alice

switch_config: "{{ switch_config_default }}"

switch_interface_config:
  interface-0:
    description: controller0
    config: "{{ switch_interface_config_controller }}"
  interface-1:
    description: compute0
    config: "{{ switch_interface_config_compute }}"
```

Device-specific Configuration Variables

Dell OS6 and OS9

Configuration for these devices is applied using the `dellos6_config` and `dellos9_config` Ansible modules.

`switch_type` should be set to `dellos6` or `dellos9`.

Provider

- `ansible_host` is the hostname or IP address. Optional.
- `ansible_user` is the SSH username.
- `ansible_ssh_pass` is the SSH password.
- `switch_auth_pass` is the 'enable' password.

Alternatively, set `switch_dellos_provider` to the value to be passed as the `provider` argument to the `dellos*_config` module.

Dell PowerConnect

Configuration for these devices is applied using the `stackhpc.dell-powerconnect-switch` Ansible role. The role uses the `expect` Ansible module to automate interaction with the switch CLI via SSH.

`switch_type` should be set to `dell-powerconnect`.

Provider

- `ansible_host` is the hostname or IP address. Optional.
- `ansible_user` is the SSH username.
- `switch_auth_pass` is the SSH password.

Juniper Junos OS

Configuration for these devices is applied using the `junos_config` Ansible module.

`switch_type` should be set to `junos`.

`switch_junos_config_format` may be used to set the format of the configuration. The variable is passed as the `src_format` argument to the `junos_config` module. The default value is `text`.

Provider

- `ansible_host` is the hostname or IP address. Optional.
- `ansible_user` is the SSH username.
- `ansible_ssh_pass` is the SSH password. Mutually exclusive with `ansible_ssh_private_key_file`.
- `ansible_ssh_private_key_file` is the SSH private key file. Mutually exclusive with `ansible_ssh_pass`.
- `switch_junos_timeout` may be set to a timeout in seconds for communicating with the device.

Alternatively, set `switch_junos_provider` to the value to be passed as the `provider` argument to the `junos_config` module.

Mellanox MLNX OS

Configuration for these devices is applied using the `stackhpc.mellanox-switch` Ansible role. The role uses the `expect` Ansible module to automate interaction with the switch CLI via SSH.

`switch_type` should be set to `mellanox`.

Provider

- `ansible_host` is the hostname or IP address. Optional.
- `ansible_user` is the SSH username.
- `switch_auth_pass` is the SSH password.

Network Configuration

Kayobe provides a flexible mechanism for configuring the networks in a system. Kayobe networks are assigned a name which is used as a prefix for variables that define the network's attributes. For example, to configure the `cidr` attribute of a network named `arpanet`, we would use a variable named `arpanet_cidr`.

Global Network Configuration

Global network configuration is stored in `${KAYOBE_CONFIG_PATH}/networks.yml`. The following attributes are supported:

`cidr` CIDR representation (<IP>/<prefix length>) of the network's IP subnet.

`allocation_pool_start` IP address of the start of Kayobe's allocation pool range.

`allocation_pool_end` IP address of the end of Kayobe's allocation pool range.

`inspection_allocation_pool_start` IP address of the start of ironic inspector's allocation pool range.

`inspection_allocation_pool_end` IP address of the end of ironic inspector's allocation pool range.

`neutron_allocation_pool_start` IP address of the start of neutron's allocation pool range.

`neutron_allocation_pool_end` IP address of the end of neutron's allocation pool range.

`gateway` IP address of the network's default gateway.

`inspection_gateway` IP address of the gateway for the hardware introspection network.

`neutron_gateway` IP address of the gateway for a neutron subnet based on this network.

`vlan` VLAN ID.

`mtu` Maximum Transmission Unit (MTU).

`vip_address` Virtual IP address (VIP) used by API services on this network.

`fqdn` Fully Qualified Domain Name (FQDN) used by API services on this network.

`routes` List of static IP routes. Each item should be a dict containing the item `cidr`, and optionally `gateway` and `table`. `cidr` is the CIDR representation of the route's destination. `gateway` is the IP address of the next hop. `table` is the name or ID of a routing table to which the route will be added.

`rules` List of IP routing rules. Each item should be an `iproute2` IP routing rule.

`physical_network` Name of the physical network on which this network exists. This aligns with the physical network concept in neutron.

`libvirt_network_name` A name to give to a Libvirt network representing this network on the seed hypervisor.

Configuring an IP Subnet

An IP subnet may be configured by setting the `cidr` attribute for a network to the CIDR representation of the subnet.

To configure a network called `example` with the `10.0.0.0/24` IP subnet:

Listing 9: `networks.yml`

```
example_cidr: 10.0.0.0/24
```

Configuring an IP Gateway

An IP gateway may be configured by setting the `gateway` attribute for a network to the IP address of the gateway.

To configure a network called `example` with a gateway at `10.0.0.1`:

Listing 10: `networks.yml`

```
example_gateway: 10.0.0.1
```

This gateway will be configured on all hosts to which the network is mapped. Note that configuring multiple IP gateways on a single host will lead to unpredictable results.

Configuring an API Virtual IP Address

A virtual IP (VIP) address may be configured for use by Kolla Ansible on the internal and external networks, on which the API services will be exposed. The variable will be passed through to the `kolla_internal_vip_address` or `kolla_external_vip_address` Kolla Ansible variable.

To configure a network called `example` with a VIP at `10.0.0.2`:

Listing 11: `networks.yml`

```
example_vip_address: 10.0.0.2
```

Configuring an API Fully Qualified Domain Name

A Fully Qualified Domain Name (FQDN) may be configured for use by Kolla Ansible on the internal and external networks, on which the API services will be exposed. The variable will be passed through to the `kolla_internal_fqdn` or `kolla_external_fqdn` Kolla Ansible variable.

To configure a network called `example` with an FQDN at `api.example.com`:

Listing 12: `networks.yml`

```
example_fqdn: api.example.com
```

Configuring Static IP Routes

Static IP routes may be configured by setting the `routes` attribute for a network to a list of routes.

To configure a network called `example` with a single IP route to the `10.1.0.0/24` subnet via `10.0.0.1`:

Listing 13: `networks.yml`

```
example_routes:
  - cidr: 10.1.0.0/24
    gateway: 10.0.0.1
```

These routes will be configured on all hosts to which the network is mapped.

Configuring a VLAN

A VLAN network may be configured by setting the `vlan` attribute for a network to the ID of the VLAN.

To configure a network called `example` with VLAN ID `123`:

Listing 14: `networks.yml`

```
example_vlan: 123
```

IP Address Allocation

IP addresses are allocated automatically by Kayobe from the allocation pool defined by `allocation_pool_start` and `allocation_pool_end`. The allocated addresses are stored in `${KAYOBE_CONFIG_PATH}/network-allocation.yml` using the global per-network attribute `ips` which maps Ansible inventory hostnames to allocated IPs.

If static IP address allocation is required, the IP allocation file `network-allocation.yml` may be manually populated with the required addresses.

Configuring Dynamic IP Address Allocation

To configure a network called `example` with the `10.0.0.0/24` IP subnet and an allocation pool spanning from `10.0.0.4` to `10.0.0.254`:

Listing 15: `networks.yml`

```
example_cidr: 10.0.0.0/24
example_allocation_pool_start: 10.0.0.4
example_allocation_pool_end: 10.0.0.254
```

Note: This pool should not overlap with an inspection or neutron allocation pool on the same network.

Configuring Static IP Address Allocation

To configure a network called `example` with statically allocated IP addresses for hosts `host1` and `host2`:

Listing 16: `network-allocation.yml`

```
example_ips:
  host1: 10.0.0.1
  host2: 10.0.0.2
```

Advanced: Policy-Based Routing

Policy-based routing can be useful in complex networking environments, particularly where asymmetric routes exist, and strict reverse path filtering is enabled.

Configuring IP Routing Tables

Custom IP routing tables may be configured by setting the global variable `network_route_tables` in `${KAYOBE_CONFIG_PATH}/networks.yml` to a list of route tables. These route tables will be added to `/etc/iproute2/rt_tables`.

To configure a routing table called `exampleroutetable` with ID `1`:

Listing 17: `networks.yml`

```
network_route_tables:
  - name: exampleroutetable
    id: 1
```

To configure route tables on specific hosts, use a host or group variables file.

Configuring IP Routing Policy Rules

IP routing policy rules may be configured by setting the `rules` attribute for a network to a list of rules. The format of a rule is the string which would be appended to `ip rule <add|del>` to create or delete the rule.

To configure a network called `example` with an IP routing policy rule to handle traffic from the subnet `10.1.0.0/24` using the routing table `exampleroutetable`:

Listing 18: `networks.yml`

```
example_rules:
  - from 10.1.0.0/24 table exampleroutetable
```

These rules will be configured on all hosts to which the network is mapped.

Configuring IP Routes on Specific Tables

A route may be added to a specific routing table by adding the name or ID of the table to a `table` attribute of the route:

To configure a network called `example` with a default route and a 'connected' (local subnet) route to the subnet `10.1.0.0/24` on the table `exampleroutetable`:

Listing 19: `networks.yml`

```
example_routes:
  - cidr: 0.0.0.0/0
    gateway 10.1.0.1
    table: exampleroutetable
  - cidr: 10.1.0.0/24
    table: exampleroutetable
```

Per-host Network Configuration

Some network attributes are specific to a host's role in the system, and these are stored in `${KAYOBE_CONFIG_PATH}/inventory/group_vars/<group>/network-interfaces`. The following attributes are supported:

interface The name of the network interface attached to the network.

bootproto Boot protocol for the interface. Valid values are `static` and `dhcp`. The default is `static`. When set to `dhcp`, an external DHCP server must be provided.

defroute Whether to set the interface as the default route. This attribute can be used to disable configuration of the default gateway by a specific interface. This is particularly useful to ignore a gateway address provided via DHCP. Should be set to a boolean value. The default is unset. This attribute is only supported on distributions of the Red Hat family.

bridge_ports For bridge interfaces, a list of names of network interfaces to add to the bridge.

bond_mode For bond interfaces, the bond's mode, e.g. 802.3ad.

bond_slaves For bond interfaces, a list of names of network interfaces to act as slaves for the bond.

bond_miimon For bond interfaces, the time in milliseconds between MII link monitoring.

bond_updelay For bond interfaces, the time in milliseconds to wait before declaring an interface up (should be multiple of `bond_miimon`).

bond_downdelay For bond interfaces, the time in milliseconds to wait before declaring an interface down (should be multiple of `bond_miimon`).

bond_xmit_hash_policy For bond interfaces, the xmit_hash_policy to use for the bond.

bond_lacp_rate For bond interfaces, the lacp_rate to use for the bond.

IP Addresses

An interface will be assigned an IP address if the associated network has a `cidr` attribute. The IP address will be assigned from the range defined by the `allocation_pool_start` and `allocation_pool_end` attributes, if one has not been statically assigned in `network-allocation.yml`.

Configuring Ethernet Interfaces

An Ethernet interface may be configured by setting the `interface` attribute for a network to the name of the Ethernet interface.

To configure a network called `example` with an Ethernet interface on `eth0`:

Listing 20: `inventory/group_vars/<group>/network-interfaces`

```
example_interface: eth0
```

Configuring Bridge Interfaces

A Linux bridge interface may be configured by setting the `interface` attribute of a network to the name of the bridge interface, and the `bridge_ports` attribute to a list of interfaces which will be added as member ports on the bridge.

To configure a network called `example` with a bridge interface on `breth1`, and a single port `eth1`:

Listing 21: inventory/group_vars/<group>/network-interfaces

```
example_interface: breth1
example_bridge_ports:
  - eth1
```

Bridge member ports may be Ethernet interfaces, bond interfaces, or VLAN interfaces. In the case of bond interfaces, the bond must be configured separately in addition to the bridge, as a different named network. In the case of VLAN interfaces, the underlying Ethernet interface must be configured separately in addition to the bridge, as a different named network.

Configuring Bond Interfaces

A bonded interface may be configured by setting the `interface` attribute of a network to the name of the bond's master interface, and the `bond_slaves` attribute to a list of interfaces which will be added as slaves to the master.

To configure a network called `example` with a bond with master interface `bond0` and two slaves `eth0` and `eth1`:

Listing 22: inventory/group_vars/<group>/network-interfaces

```
example_interface: bond0
example_bond_slaves:
  - eth0
  - eth1
```

Optionally, the bond mode and MII monitoring interval may also be configured:

Listing 23: inventory/group_vars/<group>/network-interfaces

```
example_bond_mode: 802.3ad
example_bond_miimon: 100
```

Bond slaves may be Ethernet interfaces, or VLAN interfaces. In the case of VLAN interfaces, underlying Ethernet interface must be configured separately in addition to the bond, as a different named network.

Configuring VLAN Interfaces

A VLAN interface may be configured by setting the `interface` attribute of a network to the name of the VLAN interface. The interface name must be of the form `<parent interface>.<VLAN ID>`.

To configure a network called `example` with a VLAN interface with a parent interface of `eth2` for VLAN `123`:

Listing 24: inventory/group_vars/<group>/network-interfaces

```
example_interface: eth2.123
```

To keep the configuration DRY, reference the network's `vlan` attribute:

Listing 25: inventory/group_vars/<group>/network-interfaces

```
example_interface: "eth2.{{ example_vlan }}"
```

Ethernet interfaces, bridges, and bond master interfaces may all be parents to a VLAN interface.

Bridges and VLANs

Adding a VLAN interface to a bridge directly will allow tagged traffic for that VLAN to be forwarded by the bridge, whereas adding a VLAN interface to an Ethernet or bond interface that is a bridge member port will prevent tagged traffic for that VLAN being forwarded by the bridge.

Domain Name Service (DNS) Resolver Configuration

Kayobe supports configuration of hosts' DNS resolver via `resolv.conf`. DNS configuration should be added to `dns.yml`. For example:

Listing 26: `dns.yml`

```
resolv_nameservers:
  - 8.8.8.8
  - 8.8.4.4
resolv_domain: example.com
resolv_search:
  - kayobe.example.com
```

It is also possible to prevent kayobe from modifying `resolv.conf` by setting `resolv_is_managed` to `false`.

Network Role Configuration

In order to provide flexibility in the system's network topology, Kayobe maps the named networks to logical network roles. A single named network may perform multiple roles, or even none at all. The available roles are:

Overcloud admin network (`admin_oc_net_name`) Name of the network used to access the overcloud for admin purposes, e.g for remote SSH access.

Overcloud out-of-band network (`oob_oc_net_name`) Name of the network used by the seed to access the out-of-band management controllers of the bare metal overcloud hosts.

Overcloud provisioning network (`provision_oc_net_name`) Name of the network used by the seed to provision the bare metal overcloud hosts.

Workload out-of-band network (`oob_wl_net_name`) Name of the network used by the overcloud hosts to access the out-of-band management controllers of the bare metal workload hosts.

Workload provisioning network (`provision_wl_net_name`) Name of the network used by the overcloud hosts to provision the bare metal workload hosts.

Workload cleaning network (`cleaning_net_name`) Name of the network used by the overcloud hosts to clean the baremetal workload hosts.

Internal network (`internal_net_name`) Name of the network used to expose the internal OpenStack API endpoints.

Public network (`public_net_name`) Name of the network used to expose the public OpenStack API endpoints.

Tunnel network (`tunnel_net_name`) Name of the network used by Neutron to carry tenant overlay network traffic.

External networks (`external_net_names`, deprecated: `external_net_name`) List of names of networks used to provide external network access via Neutron. If `external_net_name` is defined, `external_net_names` defaults to a list containing only that network.

Storage network (`storage_net_name`) Name of the network used to carry storage data traffic.

Storage management network (`storage_mgmt_net_name`) Name of the network used to carry storage management traffic.

Workload inspection network (`inspection_net_name`) Name of the network used to perform hardware introspection on the bare metal workload hosts.

These roles are configured in `${KAYOBE_CONFIG_PATH}/networks.yml`.

Configuring Network Roles

To configure network roles in a system with two networks, `example1` and `example2`:

Listing 27: `networks.yml`

```
admin_oc_net_name: example1
oob_oc_net_name: example1
provision_oc_net_name: example1
oob_wl_net_name: example1
provision_wl_net_name: example2
internal_net_name: example2
public_net_name: example2
tunnel_net_name: example2
external_net_name: example2
storage_net_name: example2
storage_mgmt_net_name: example2
inspection_net_name: example2
cleaning_net_name: example2
```

Overcloud Admin Network

The admin network is intended to be used for remote access to the overcloud hosts. Kayobe will use the address assigned to the host on this network as the `ansible_host` when executing playbooks. It is therefore a necessary requirement to configure this network.

By default Kayobe will use the overcloud provisioning network as the admin network. It is, however, possible to configure a separate network. To do so, you should override `admin_oc_net_name` in your networking configuration.

If a separate network is configured, the following requirements should be taken into consideration:

- The admin network must be configured to use the same physical network interface as the provisioning network. This is because the PXE MAC address is used to lookup the interface for the cloud-init network configuration that occurs during bifrost provisioning of the overcloud.
- If the admin network is configured as a tagged VLAN, you must configure Kayobe to upgrade cloud-init. This is a temporary workaround for a bug in the current version of cloud-init shipped with CentOS 7.5. Please see *Workaround VLAN cloud-init issue* for more details.

Overcloud Provisioning Network

If using a seed to inspect the bare metal overcloud hosts, it is necessary to define a DHCP allocation pool for the seed's ironic inspector DHCP server using the `inspection_allocation_pool_start` and `inspection_allocation_pool_end` attributes of the overcloud provisioning network.

Note: This example assumes that the `example` network is mapped to `provision_oc_net_name`.

To configure a network called `example` with an inspection allocation pool:

```
example_inspection_allocation_pool_start: 10.0.0.128
example_inspection_allocation_pool_end: 10.0.0.254
```

Note: This pool should not overlap with a kayobe allocation pool on the same network.

Workload Cleaning Network

A separate cleaning network, which is used by the overcloud to clean baremetal workload (compute) hosts, may optionally be specified. Otherwise, the Workload Provisoning network is used. It is necessary to define an IP allocation pool for neutron using the `neutron_allocation_pool_start` and `neutron_allocation_pool_end` attributes of the cleaning network. This controls the IP addresses that are assigned to workload hosts during cleaning.

Note: This example assumes that the `example` network is mapped to `cleaning_net_name`.

To configure a network called `example` with a neutron provisioning allocation pool:

```
example_neutron_allocation_pool_start: 10.0.1.128
example_neutron_allocation_pool_end: 10.0.1.195
```

Note: This pool should not overlap with a kayobe or inspection allocation pool on the same network.

Workload Provisioning Network

If using the overcloud to provision bare metal workload (compute) hosts, it is necessary to define an IP allocation pool for the overcloud's neutron provisioning network using the `neutron_allocation_pool_start` and `neutron_allocation_pool_end` attributes of the workload provisioning network.

Note: This example assumes that the `example` network is mapped to `provision_wl_net_name`.

To configure a network called `example` with a neutron provisioning allocation pool:

```
example_neutron_allocation_pool_start: 10.0.1.128
example_neutron_allocation_pool_end: 10.0.1.195
```

Note: This pool should not overlap with a kayobe or inspection allocation pool on the same network.

Workload Inspection Network

If using the overcloud to inspect bare metal workload (compute) hosts, it is necessary to define a DHCP allocation pool for the overcloud's ironic inspector DHCP server using the `inspection_allocation_pool_start` and `inspection_allocation_pool_end` attributes of the workload provisioning network.

Note: This example assumes that the `example` network is mapped to `provision_wl_net_name`.

To configure a network called `example` with an inspection allocation pool:

```
example_inspection_allocation_pool_start: 10.0.1.196
example_inspection_allocation_pool_end: 10.0.1.254
```

Note: This pool should not overlap with a kayobe or neutron allocation pool on the same network.

Neutron Networking

Note: This assumes the use of the neutron `openvswitch` ML2 mechanism driver for control plane networking.

Certain modes of operation of neutron require layer 2 access to physical networks in the system. Hosts in the `network` group (by default, this is the same as the `controllers` group) run the neutron networking services (Open vSwitch agent, DHCP agent, L3 agent, metadata agent, etc.).

The kayobe network configuration must ensure that the neutron Open vSwitch bridges on the network hosts have access to the external network. If bare metal compute nodes are in use, then they must also have access to the workload provisioning network. This can be done by ensuring that the external and workload provisioning network interfaces are bridges. Kayobe will ensure connectivity between these Linux bridges and the neutron Open vSwitch bridges via a virtual Ethernet pair. See *Configuring Bridge Interfaces*.

Network to Host Mapping

Networks are mapped to hosts using the variable `network_interfaces`. Kayobe's playbook group variables define some sensible defaults for this variable for hosts in the top level standard groups. These defaults are set using the network roles typically required by the group.

Seed

By default, the seed is attached to the following networks:

- overcloud admin network
- overcloud out-of-band network
- overcloud provisioning network

This list may be extended by setting `seed_extra_network_interfaces` to a list of names of additional networks to attach. Alternatively, the list may be completely overridden by setting `seed_network_interfaces`. These variables are found in `${KAYOBE_CONFIG_PATH}/seed.yml`.

Seed Hypervisor

By default, the seed hypervisor is attached to the same networks as the seed.

This list may be extended by setting `seed_hypervisor_extra_network_interfaces` to a list of names of additional networks to attach. Alternatively, the list may be completely overridden by setting `seed_hypervisor_network_interfaces`. These variables are found in `${KAYOBE_CONFIG_PATH}/seed-hypervisor.yml`.

Controllers

By default, controllers are attached to the following networks:

- overcloud admin network
- workload (compute) out-of-band network
- workload (compute) provisioning network
- workload (compute) inspection network
- workload (compute) cleaning network
- internal network
- storage network
- storage management network

In addition, if the controllers are also in the `network` group, they are attached to the following networks:

- public network
- external network
- tunnel network

This list may be extended by setting `controller_extra_network_interfaces` to a list of names of additional networks to attach. Alternatively, the list may be completely overridden by setting `controller_network_interfaces`. These variables are found in `${KAYOBE_CONFIG_PATH}/controllers.yml`.

Monitoring Hosts

By default, the monitoring hosts are attached to the same networks as the controllers when they are in the `controllers` group. If the monitoring hosts are not in the `controllers` group, they are attached to the following networks by default:

- overcloud admin network
- internal network
- public network

This list may be extended by setting `monitoring_extra_network_interfaces` to a list of names of additional networks to attach. Alternatively, the list may be completely overridden by setting `monitoring_network_interfaces`. These variables are found in `${KAYOBE_CONFIG_PATH}/monitoring.yml`.

Virtualised Compute Hosts

By default, virtualised compute hosts are attached to the following networks:

- overcloud admin network
- internal network
- storage network
- tunnel network

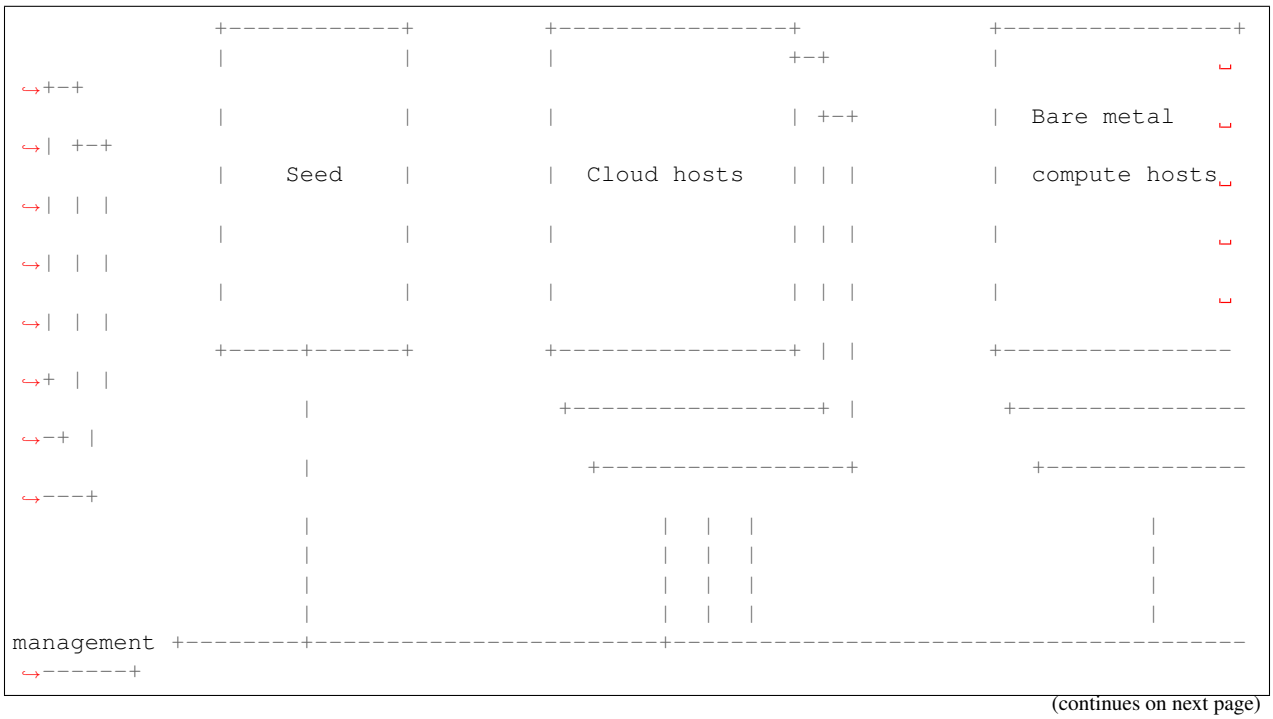
This list may be extended by setting `compute_extra_network_interfaces` to a list of names of additional networks to attach. Alternatively, the list may be completely overridden by setting `compute_network_interfaces`. These variables are found in `${KAYOBE_CONFIG_PATH}/compute.yml`.

Other Hosts

If additional hosts are managed by kayobe, the networks to which these hosts are attached may be defined in a host or group variables file. See *Control Plane Service Placement* for further details.

Complete Example

The following example combines the complete network configuration into a single system configuration. In our example cloud we have three networks: `management`, `cloud` and `external`:



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```
                                                |  |                                |
cloud       +-----------------------------------+--+--------------------------------+------
 ↪------+
                                                   |
external    +--------------------------------------+-----------------------------------
 ↪------+
```

The `management` network is used to access the servers' BMCs and by the seed to inspect and provision the cloud hosts. The `cloud` network carries all internal control plane and storage traffic, and is used by the control plane to provision the bare metal compute hosts. Finally, the `external` network links the cloud to the outside world.

We could describe such a network as follows:

Listing 28: `networks.yml`

```
---
# Network role mappings.
oob_oc_net_name: management
provision_oc_net_name: management
oob_wl_net_name: management
provision_wl_net_name: cloud
internal_net_name: cloud
public_net_name: external
external_net_name: external
storage_net_name: cloud
storage_mgmt_net_name: cloud
inspection_net_name: cloud

# management network definition.
management_cidr: 10.0.0.0/24
management_allocation_pool_start: 10.0.0.1
management_allocation_pool_end: 10.0.0.127
management_inspection_allocation_pool_start: 10.0.0.128
management_inspection_allocation_pool_end: 10.0.0.254

# cloud network definition.
cloud_cidr: 10.0.1.0/24
cloud_allocation_pool_start: 10.0.1.1
cloud_allocation_pool_end: 10.0.1.127
cloud_inspection_allocation_pool_start: 10.0.1.128
cloud_inspection_allocation_pool_end: 10.0.1.195
cloud_neutron_allocation_pool_start: 10.0.1.196
cloud_neutron_allocation_pool_end: 10.0.1.254

# external network definition.
external_cidr: 10.0.3.0/24
external_allocation_pool_start: 10.0.3.1
external_allocation_pool_end: 10.0.3.127
external_neutron_allocation_pool_start: 10.0.3.128
external_neutron_allocation_pool_end: 10.0.3.254
external_routes:
  - cidr 10.0.4.0/24
    gateway: 10.0.3.1
```

We can map these networks to network interfaces on the seed and controller hosts:

Listing 29: inventory/group_vars/seed/network-interfaces

```
---
management_interface: eth0
```

Listing 30: inventory/group_vars/controllers/network-interfaces

```
---
management_interface: eth0
cloud_interface: breth1
cloud_bridge_ports:
  - eth1
external_interface: eth2
```

We have defined a bridge for the cloud network on the controllers as this will allow it to be plugged into a neutron Open vSwitch bridge.

Kayobe will allocate IP addresses for the hosts that it manages:

Listing 31: network-allocation.yml

```
---
management_ips:
  seed: 10.0.0.1
  control0: 10.0.0.2
  control1: 10.0.0.3
  control2: 10.0.0.4
cloud_ips:
  control0: 10.0.1.1
  control1: 10.0.1.2
  control2: 10.0.1.3
external_ips:
  control0: 10.0.3.1
  control1: 10.0.3.2
  control2: 10.0.3.3
```

Note that although this file does not need to be created manually, doing so allows for a predictable IP address mapping which may be desirable in some cases.

Host Configuration

This section covers configuration of hosts. It does not cover configuration or deployment of containers. Hosts that are configured by Kayobe include:

- Seed hypervisor (kayobe seed hypervisor host configure)
- Seed (kayobe seed host configure)
- Overcloud (kayobe overcloud host configure)

Unless otherwise stated, all host configuration described here is applied to each of these types of host.

Configuration Location

Some host configuration options are set via global variables, and others have a variable for each type of host. The latter variables are included in the following files under `${KAYOBE_CONFIG_PATH}`:

- `seed-hypervisor.yml`
- `seed.yml`
- `compute.yml`
- `controller.yml`
- `monitoring.yml`
- `storage.yml`

Note that any variable may be set on a per-host or per-group basis, by using inventory host or group variables - these delineations are for convenience.

Paths

Several directories are used by Kayobe on the remote hosts. There is a hierarchy of variables in `${KAYOBE_CONFIG_PATH}/globals.yml` that can be used to control where these are located.

- `base_path` (default `/opt/kayobe/`) sets the default base path for various directories.
- `config_path` (default `{{ base_path }}/etc`) is a path in which to store configuration files.
- `image_cache_path` (default `{{ base_path }}/images`) is a path in which to cache downloaded or built images.
- `source_checkout_path` (default `{{ base_path }}/src`) is a path into which to store clones of source code repositories.
- `virtualenv_path` (default `{{ base_path }}/venvs`) is a path in which to create Python virtual environments.

SSH Known Hosts

While strictly this configuration is applied to the Ansible control host (`localhost`), it is applied during the `host configure` commands. The `ansible_host` of each host is added as an SSH known host. This is typically the host's IP address on the admin network (`admin_oc_net_name`), as defined in `${KAYOBE_CONFIG_PATH}/network-allocation.yml` (see *IP Address Allocation*).

Kayobe User Bootstrapping

Kayobe uses a user account defined by the `kayobe_ansible_user` variable (in `${KAYOBE_CONFIG_PATH}/globals.yml`) for remote SSH access. By default, this is `stack`.

Typically, the image used to provision these hosts will not include this user account, so Kayobe performs a bootstrapping step to create it, as a different user. In cloud images, there is often a user named after the OS distro, e.g. `centos` or `ubuntu`. This user defaults to the name of the user running Kayobe, but may be set via the following variables:

- `seed_hypervisor_bootstrap_user`
- `seed_bootstrap_user`
- `compute_bootstrap_user`

- controller_bootstrap_user
- monitoring_bootstrap_user
- storage_bootstrap_user

For example, to set the bootstrap user for controllers to centos:

Listing 32: controllers.yml

```
controller_bootstrap_user: centos
```

PyPI Mirror

Kayobe supports configuration of a PyPI mirror, via variables in ${KAYOBE_CONFIG_PATH}/pip.yml. This functionality is enabled by setting the pip_local_mirror variable to true.

Kayobe will generate configuration for pip and easy_install to use the mirror, for the list of users defined by pip_applicable_users (default kayobe_ansible_user and root), in addition to the user used for Kolla Ansible (kolla_ansible_user). The mirror URL is configured via pip_index_url, and pip_trusted_hosts is a list of 'trusted' hosts, for which SSL verification will be disabled.

For example, to configure use of the test PyPI mirror at https://test.pypi.org/simple/:

Listing 33: pip.yml

```
pip_local_mirror: true
pip_index_url: https://test.pypi.org/simple/
```

Kayobe Remote Virtual Environment

By default, Ansible executes modules remotely using the system python interpreter, even if the Ansible control process is executed from within a virtual environment (unless the local connection plugin is used). This is not ideal if there are python dependencies that must be installed with isolation from the system python packages. Ansible can be configured to use a virtualenv by setting the host variable ansible_python_interpreter to a path to a python interpreter in an existing virtual environment.

If kayobe detects that ansible_python_interpreter is set and references a virtual environment, it will create the virtual environment if it does not exist. Typically this variable should be set via a group variable in the inventory for hosts in the seed, seed-hypervisor, and/or overcloud groups.

The default Kayobe configuration in the kayobe-config repository sets ansible_python_interpreter to {{ virtualenv_path }}/kayobe/bin/python for the seed, seed-hypervisor, and overcloud groups.

Disk Wiping

Using hosts that may have stale data on their disks could affect the deployment of the cloud. This is not a configuration option, since it should only be performed once to avoid losing useful data. It is triggered by passing the --wipe-disks argument to the host configure commands.

Users and Groups

Linux user accounts and groups can be configured using the `users_default` variable in `${KAYOBE_CONFIG_PATH}/users.yml`. The format of the list is that used by the `users` variable of the singleplatform-eng.users role. The following variables can be used to set the users for specific types of hosts:

- `seed_hypervisor_users`
- `seed_users`
- `compute_users`
- `controller_users`
- `monitoring_users`
- `storage_users`

In the following example, a single user named `bob` is created. A password hash has been generated via `mkpasswd --method=sha-512`. The user is added to the `wheel` group, and an SSH key is authorised. The SSH public key should be added to the Kayobe configuration.

Listing 34: `users.yml`

```
users_default:
 - username: bob
   name: Bob
   password: "$6$wJt9MLWrHlWN8$oXJHbdaslm9guD5EC3Dry1mphuqF9NPeQ43OXk3cXZa2ze/
↪F9FOTxm2KvvDkbdxBDs7ouwdiLTUJ1Ff40.cFU."
   groups:
     - wheel
   append: True
   ssh_key:
     - "{{ lookup('file', kayobe_config_path ~ '/ssh-keys/id_rsa_bob.pub') }}"
```

Package Repositories

Kayobe supports configuration of package repositories via Yum, via variables in `${KAYOBE_CONFIG_PATH}/yum.yml`.

Configuration of yum.conf

Global configuration of Yum is stored in `/etc/yum.conf`, and options can be set via the `yum_config` variable. Options are added to the `[main]` section of the file. For example, to configure Yum to use a proxy server:

Listing 35: `yum.yml`

```
yum_config:
  proxy: https://proxy.example.com
```

CentOS and EPEL Mirrors

CentOS and EPEL mirrors can be enabled by setting `yum_use_local_mirror` to `true`. CentOS repository mirrors are configured via the following variables:

- `yum_centos_mirror_host` (default `mirror.centos.org`) is the mirror hostname.
- `yum_centos_mirror_directory` (default `centos`) is a directory on the mirror in which repositories may be accessed.

EPEL repository mirrors are configured via the following variables:

- `yum_epel_mirror_host` (default `download.fedoraproject.org`) is the mirror hostname.
- `yum_epel_mirror_directory` (default `pub/epel`) is a directory on the mirror in which repositories may be accessed.

For example, to configure CentOS and EPEL mirrors at mirror.example.com:

Listing 36: `yum.yml`

```
yum_use_local_mirror: true
yum_centos_mirror_host: mirror.example.com
yum_epel_mirror_host: mirror.example.com
```

Custom Yum Repositories

It is also possible to configure a list of custom Yum repositories via the `yum_custom_repos` variable. The format is a dict/map, with repository names mapping to a dict/map of arguments to pass to the Ansible `yum` module.

For example, the following configuration defines a single Yum repository called `widgets`.

Listing 37: `yum.yml`

```
yum_custom_repos:
  widgets:
    baseurl: http://example.com/repo
    file: widgets
    gpgkey: http://example.com/gpgkey
    gpgcheck: yes
```

Disabling EPEL

It is possible to disable the EPEL Yum repository by setting `yum_install_epel` to `false`.

SELinux

SELinux is not supported by Kolla Ansible currently, so it is disabled by Kayobe. If necessary, Kayobe will reboot systems in order to apply a change to the SELinux configuration. The timeout for waiting for systems to reboot is `disable_selinux_reboot_timeout`. Alternatively, the reboot may be avoided by setting `disable_selinux_do_reboot` to `false`.

Network Configuration

Configuration of host networking is covered in depth in *Network Configuration*.

Sysctls

Arbitrary `sysctl` configuration can be applied to hosts. The variable format is a dict/map, mapping parameter names to their required values. The following variables can be used to set `sysctl` configuration specific types of hosts:

- `seed_hypervisor_sysctl_parameters`
- `seed_sysctl_parameters`
- `compute_sysctl_parameters`
- `controller_sysctl_parameters`
- `monitoring_sysctl_parameters`
- `storage_sysctl_parameters`

For example, to set the `net.ipv4.ip_forward` parameter to `1` on controllers:

Listing 38: `controllers.yml`

```
controller_sysctl_parameters:
  net.ipv4.ip_forward: 1
```

Disable cloud-init

cloud-init is a popular service for performing system bootstrapping. If you are not using cloud-init, this section can be skipped.

If using the seed's Bifrost service to provision the control plane hosts, the use of cloud-init may be configured via the `kolla_bifrost_dib_init_element` variable.

cloud-init searches for network configuration in order of increasing precedence; each item overriding the previous. In some cases, on subsequent boots cloud-init can automatically reconfigure network interfaces and cause some issues in network configuration. To disable cloud-init from running after the initial server bootstrapping, set `disable_cloud_init` to `true` in `${KAYOBE_CONFIG_PATH}/overcloud.yml`.

Disable Glean

The `glean` service can be used to perform system bootstrapping, serving a similar role to `cloud-init`. If you are not using `glean`, this section can be skipped.

If using the seed's Bifrost service to provision the control plane hosts, the use of `glean` may be configured via the `kolla_bifrost_dib_init_element` variable.

After the initial server bootstrapping, the glean service can cause problems as it attempts to enable all network interfaces, which can lead to timeouts while booting. To avoid this, the `glean` service is disabled. Additionally, any network interface configuration files generated by `glean` and not overwritten by Kayobe are removed.

Timezone

The timezone can be configured via the `timezone` variable in `${KAYOBE_CONFIG_PATH}/ntp.yml`. The value must be a valid Linux timezone. For example:

Listing 39: ntp.yml

```
timezone: Europe/London
```

NTP

Network Time Protocol (NTP) may be configured via variables in ${KAYOBE_CONFIG_PATH}/ntp.yml. The list of NTP servers is configured via ntp_config_server, and by default the pool.ntp.org servers are used. A list of restrictions may be added via ntp_config_restrict, and a list of interfaces to listen on via ntp_config_listen. Other options and their default values may be found in the resmo.ntp Ansible role.

Listing 40: ntp.yml

```
ntp_config_server:
  - 1.ubuntu.pool.ntp.org
  - 2.ubuntu.pool.ntp.org

ntp_config_restrict:
  - '-4 default kod notrap nomodify nopeer noquery'

ntp_config_listen:
  - eth0
```

The NTP service may be disabled as follows:

Listing 41: ntp.yml

```
ntp_package_state: absent
ntp_service_state: stopped
ntp_service_enabled: false
```

LVM

Logical Volume Manager (LVM) physical volumes, volume groups, and logical volumes may be configured via the lvm_groups variable. For convenience, this is mapped to the following variables:

- seed_hypervisor_lvm_groups
- seed_lvm_groups
- compute_lvm_groups
- controller_lvm_groups
- monitoring_lvm_groups
- storage_lvm_groups

The format of these variables is as defined by the lvm_groups variable of the mrlesmithjr.manage-lvm Ansible role.

LVM for libvirt

LVM is not configured by default on the seed hypervisor. It is possible to configure LVM to provide storage for a libvirt storage pool, typically mounted at /var/lib/libvirt/images.

To use this configuration, set the `seed_hypervisor_lvm_groups` variable to "`{{ seed_hypervisor_lvm_groups_with_data }}`" and provide a list of disks via the `seed_hypervisor_lvm_group_data_disks` variable.

LVM for Docker

The default LVM configuration is optimised for the `devicemapper` Docker storage driver, which requires a thin provisioned LVM volume. A second logical volume is used for storing Docker volume data, mounted at `/var/lib/docker/volumes`. Both logical volumes are created from a single `data` volume group.

To use this configuration, a list of disks must be configured via the following variables:

- `seed_lvm_group_data_disks`
- `compute_lvm_group_data_disks`
- `controller_lvm_group_data_disks`
- `monitoring_lvm_group_data_disks`
- `storage_lvm_group_data_disks`

For example, to configure two of the seed's disks for use by LVM:

Listing 42: `seed.yml`

```
seed_lvm_group_data_disks:
  - /dev/sdb
  - /dev/sdc
```

The Docker volumes LVM volume is assigned a size given by the following variables, with a default value of 75% (of the volume group's capacity):

- `seed_lvm_group_data_lv_docker_volumes_size`
- `compute_lvm_group_data_lv_docker_volumes_size`
- `controller_lvm_group_data_lv_docker_volumes_size`
- `monitoring_lvm_group_data_lv_docker_volumes_size`
- `storage_lvm_group_data_lv_docker_volumes_size`

If using a Docker storage driver other than `devicemapper`, the remaining 25% of the volume group can be used for Docker volume data. In this case, the LVM volume's size can be increased to 100%:

Listing 43: `controllers.yml`

```
controller_lvm_group_data_lv_docker_volumes_size: 100%
```

If using a Docker storage driver other than `devicemapper`, it is possible to avoid using LVM entirely, thus avoiding the requirement for multiple disks. In this case, set the appropriate `<host>_lvm_groups` variable to an empty list:

Listing 44: `storage.yml`

```
storage_lvm_groups: []
```

Custom LVM

To define additional logical logical volumes in the default `data` volume group, modify one of the following variables:

- seed_lvm_group_data_lvs
- compute_lvm_group_data_lvs
- controller_lvm_group_data_lvs
- monitoring_lvm_group_data_lvs
- storage_lvm_group_data_lvs

Include the variable <host>_lvm_group_data_lv_docker_volumes in the list to include the LVM volume for Docker volume data:

Listing 45: monitoring.yml

```
monitoring_lvm_group_data_lvs:
  - "{{ monitoring_lvm_group_data_lv_docker_volumes }}"
  - lvname: other-vol
    size: 1%
    create: true
    filesystem: ext4
    mount: true
    mntp: /path/to/mount
```

It is possible to define additional LVM volume groups via the following variables:

- seed_lvm_groups_extra
- compute_lvm_groups_extra
- controller_lvm_groups_extra
- monitoring_lvm_groups_extra
- storage_lvm_groups_extra

For example:

Listing 46: compute.yml

```
compute_lvm_groups_extra:
  - vgname: other-vg
    disks: /dev/sdb
    create: true
    lvnames:
      - lvname: other-vol
        size: 100%
        create: true
        mount: false
```

Alternatively, replace the entire volume group list via one of the <host>_lvm_groups variables to replace the default configuration with a custom one.

Listing 47: controllers.yml

```
controller_lvm_groups:
  - vgname: only-vg
    disks: /dev/sdb
    create: true
    lvnames:
      - lvname: only-vol
        size: 100%
```

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```
        create: true
        mount: false
```

Kolla-ansible bootstrap-servers

Kolla Ansible provides some host configuration functionality via the `bootstrap-servers` command, which may be leveraged by Kayobe. Due to the bootstrapping nature of the command, Kayobe uses `kayobe_ansible_user` to execute it, and uses the Kayobe remote Python virtual environment (or the system Python interpreter if no virtual environment is in use).

See the Kolla Ansible documentation for more information on the functions performed by this command, and how to configure it.

Kolla-ansible Remote Virtual Environment

See *Remote Execution Environment* for information about remote Python virtual environments for Kolla Ansible.

Docker Engine

Docker engine configuration is applied by both Kayobe and Kolla Ansible (during bootstrap-servers).

The `docker_storage_driver` variable sets the Docker storage driver, and by default the `devicemapper` driver is used. If using this driver, see *LVM* for information about configuring LVM for Docker.

Various options are defined in `${KAYOBE_CONFIG_PATH}/docker.yml` for configuring the `devicemapper` storage.

A private Docker registry may be configured via `docker_registry`, with a Certificate Authority (CA) file configured via `docker_registry_ca`.

To use one or more Docker Registry mirrors, use the `docker_registry_mirrors` variable.

If using an MTU other than 1500, `docker_daemon_mtu` can be used to configure this. This setting does not apply to containers using `net=host` (as Kolla Ansible's containers do), but may be necessary when building images.

Docker's live restore feature can be configured via `docker_daemon_live_restore`, although it is disabled by default due to issues observed.

Ceph Block Devices

If using Kolla Ansible to deploy Ceph, some preparation of block devices is required. The list of disks to configure for use by Ceph is specified via `ceph_disks`. This is mapped to the following variables:

- `compute_ceph_disks`
- `controller_ceph_disks`
- `storage_ceph_disks`

The format of the variable is a list of dict/mapping objects. Each mapping should contain an `osd` item that defines the full path to a block device to use for data. Optionally, each mapping may contain a `journal` item that specifies the full path to a block device to use for journal data.

The following example defines two OSDs for use by controllers, one of which has a journal:

Listing 48: controller.yml

```
controller_ceph_disks:
  - osd: /dev/sdb
  - osd: /dev/sdc
    journal: /dev/sdd
```

Kolla Configuration

Anyone using Kayobe to build images should familiarise themselves with the Kolla project's documentation.

Container Image Build Host

Images are built on hosts in the container-image-builders group. The default Kayobe Ansible inventory places the seed host in this group, although it is possible to put a different host in the group, by modifying the inventory.

For example, to build images on localhost:

Listing 49: inventory/groups

```
[container-image-builders:children]
```

Listing 50: inventory/hosts

```
[container-image-builders]
localhost
```

Kolla Installation

Prior to building container images, Kolla and its dependencies will be installed on the container image build host. The following variables affect the installation of Kolla:

kolla_ctl_install_type Type of installation, either binary (PyPI) or source (git). Default is source.

kolla_source_path Path to directory for Kolla source code checkout. Default is {{ source_checkout_path ~ '/kolla' }}.

kolla_source_url URL of Kolla source code repository if type is source. Default is https://git.openstack.org/openstack/kolla.

kolla_source_version Version (branch, tag, etc.) of Kolla source code repository if type is source. Default is the same as the Kayobe upstream branch name.

kolla_venv Path to virtualenv in which to install Kolla on the container image build host. Default is {{ virtualenv_path ~ '/kolla' }}.

kolla_build_config_path Path in which to generate kolla configuration. Default is {{ config_path ~ '/kolla' }}.

For example, to install from a custom Git repository:

Listing 51: kolla.yml

```
kolla_source_url: https://git.example.com/kolla
kolla_source_version: downstream
```

Global Configuration

The following variables are global, affecting all container images. They are used to generate the Kolla configuration file, kolla-build.conf.

kolla_base_distro Kolla base container image distribution. Default is centos.

kolla_install_type Kolla container image type: binary or source. Default is binary.

kolla_docker_namespace Docker namespace to use for Kolla images. Default is kolla.

kolla_docker_registry URL of docker registry to use for Kolla images. Default is to use the value of docker_registry variable (see *Docker Engine*).

kolla_docker_registry_username Username to use to access a docker registry. Default is not set, in which case the registry will be used without authentication.

kolla_docker_registry_password Password to use to access a docker registry. Default is not set, in which case the registry will be used without authentication.

kolla_openstack_release Kolla OpenStack release version. This should be a Docker image tag. Default is the OpenStack release name (e.g. rocky) on stable branches and tagged releases, or master on the Kayobe master branch.

For example, to build the Kolla centos binary images with a namespace of example, and a private Docker registry at registry.example.com:4000, tagged with 7.0.0.1:

Listing 52: kolla.yml

```
kolla_base_distro: centos
kolla_install_type: binary
kolla_docker_namespace: example
kolla_docker_registry: registry.example.com:4000
kolla_openstack_release: 7.0.0.1
```

The ironic-api image built with this configuration would be referenced as follows:

```
registry.example.com:4000/example/centos-binary-ironic-api:7.0.0.1
```

Further customisation of the Kolla configuration file can be performed by writing a file at ${KAYOBE_CONFIG_PATH/kolla/kolla-build.conf. For example, to enable debug logging:

Listing 53: kolla/kolla-build.conf

```
[DEFAULT]
debug = True
```

Seed Images

The kayobe seed container image build command builds images for the seed services. The only image required for the seed services is the bifrost-deploy image.

Overcloud Images

The `kayobe overcloud container image build` command builds images for the control plane. The default set of images built depends on which services and features are enabled via the `kolla_enable_<service>` flags in `$KAYOBE_CONFIG_PATH/kolla.yml`.

For example, the following configuration will enable the Magnum service and add the `magnum-api` and `magnum-conductor` containers to the set of overcloud images that will be built:

Listing 54: `kolla.yml`

```
kolla_enable_magnum: true
```

If a required image is not built when the corresponding flag is set, check the image sets defined in `overcloud_container_image_sets` in `ansible/group_vars/all/kolla`.

Image Customisation

There are three main approaches to customising the Kolla container images:

1. Overriding Jinja2 blocks
2. Overriding Jinja2 variables
3. Source code locations

Overriding Jinja2 blocks

Kolla's images are defined via Jinja2 templates that generate Dockerfiles. Jinja2 blocks are frequently used to allow specific statements in one or more Dockerfiles to be replaced with custom statements. See the Kolla documentation for details.

Blocks are configured via the `kolla_build_blocks` variable, which is a dict mapping Jinja2 block names in to their contents.

For example, to override the block `header` to add a custom label to every image:

Listing 55: `kolla.yml`

```
kolla_build_blocks:
  header: |
    LABEL foo="bar"
```

This will result in Kayobe generating a `template-override.j2` file with the following content:

Listing 56: `template-override.j2`

```
{% extends parent_template %}

{% block header %}
LABEL foo="bar"
{% endblock %}
```

Overriding Jinja2 variables

Jinja2 variables offer another way to customise images. See the Kolla documentation for details of using variable overrides to modify the list of packages to install in an image.

Variable overrides are configured via the `kolla_build_customizations` variable, which is a dict/map mapping names of variables to override to their values.

For example, to add `mod_auth_openidc` to the list of packages installed in the `keystone-base` image, we can set the variable `keystone_base_packages_append` to a list containing `mod_auth_openidc`.

Listing 57: `kolla.yml`

```
kolla_build_customizations:
  keystone_base_packages_append:
    - mod_auth_openidc
```

This will result in Kayobe generating a `template-override.j2` file with the following content:

Listing 58: `template-override.j2`

```
{% extends parent_template %}

{% set keystone_base_packages_append = ["mod_auth_openidc"] %}
```

Note that the variable value will be JSON-encoded in `template-override.j2`.

Source code locations

For `source` image builds, configuration of source code locations for packages installed in containers by Kolla is possible via the `kolla_sources` variable. The format is a dict/map mapping names of sources to their definitions. See the Kolla documentation for details. The default is to specify the URL and version of Bifrost, as defined in `${KAYOBE_CONFIG_PATH}/bifrost.yml`.

For example, to specify a custom source location for the `ironic-base` package:

Listing 59: `kolla.yml`

```
kolla_sources:
  bifrost-base:
    type: "git"
    location: "{{ kolla_bifrost_source_url }}"
    reference: "{{ kolla_bifrost_source_version }}"
  ironic-base:
    type: "git"
    location: https://git.example.com/ironic
    reference: downstream
```

This will result in Kayobe adding the following configuration to `kolla-build.conf`:

Listing 60: `kolla-build.conf`

```
[bifrost-base]
type = git
location = https://git.openstack.org/openstack/bifrost
reference = stable/rocky

```

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```
[ironic-base]
type = git
location = https://git.example.com/ironic
reference = downstream
```

Note that is is currently necessary to include the Bifrost source location if using a seed.

Plugins & additions

These features can also be used for installing plugins and additions to `source` type images.

For example, to install a `networking-ansible` plugin in the `neutron-server` image:

Listing 61: `kolla.yml`

```
kolla_sources:
  bifrost-base:
    type: "git"
    location: "{{ kolla_bifrost_source_url }}"
    reference: "{{ kolla_bifrost_source_version }}"
  neutron-server-plugin-networking-ansible:
    type: "git"
    location: https://git.example.com/networking-ansible
    reference: downstream
```

The `neutron-server` image automatically installs any plugins provided to it. For images that do not, a block such as the following may be required:

Listing 62: `kolla.yml`

```
kolla_build_blocks:
  neutron_server_footer: |
    ADD plugins-archive /
    pip --no-cache-dir install /plugins/*
```

A similar approach may be used for additions.

Kolla-ansible Configuration

Kayobe relies heavily on kolla-ansible for deployment of the OpenStack control plane. Kolla-ansible is installed locally on the Ansible control host (the host from which kayobe commands are executed), and kolla-ansible commands are executed from there.

Local Environment

Environment variables are used to configure the environment in which kolla-ansible is installed and executed.

Table 1: Kolla-ansible environment variables

Variable	Purpose	Default
`$KOLLA_CONFIG_PATH`	Path on the Ansible control host in which the kolla-ansible configuration will be generated. These files should not be manually edited.	`/etc/kolla`
`$KOLLA_SOURCE_PATH`	Path on the Ansible control host in which the kolla-ansible source code will be cloned.	`$PWD/src/kolla-ansible`
`$KOLLA_VENV_PATH`	Path on the Ansible control host in which the kolla-ansible virtualenv will be created.	`$PWD/venvs/kolla-ansible`

Extra Python packages can be installed inside the kolla-ansible virtualenv, such as when required by Ansible plugins, using the `kolla_ansible_venv_extra_requirements` list variable in `$KAYOBE_CONFIG_PATH/kolla.yml`. For example, to use the hashi_vault Ansible lookup plugin, its `hvac` dependency can be installed using:

Listing 63: `$KAYOBE_CONFIG_PATH/kolla.yml`

```
---
# Extra requirements to install inside the kolla-ansible virtualenv.
kolla_ansible_venv_extra_requirements:
  - "hvac"
```

Remote Execution Environment

By default, ansible executes modules remotely using the system python interpreter, even if the ansible control process is executed from within a virtual environment (unless the `local` connection plugin is used). This is not ideal if there are python dependencies that must be installed with isolation from the system python packages. Ansible can be configured to use a virtualenv by setting the host variable `ansible_python_interpreter` to a path to a python interpreter in an existing virtual environment.

If the variable `kolla_ansible_target_venv` is set, kolla-ansible will be configured to create and use a virtual environment on the remote hosts. This variable is by default set to `{{ virtualenv_path }}/kolla-ansible`. The previous behaviour of installing python dependencies directly to the host can be used by setting `kolla_ansible_target_venv` to `None`.

Control Plane Services

Kolla-ansible provides a flexible mechanism for configuring the services that it deploys. Kayobe adds some commonly required configuration options to the defaults provided by kolla-ansible, but also allows for the free-form configuration supported by kolla-ansible. The kolla-ansible documentation should be used as a reference.

Global Variables

Kolla-ansible uses a single file for global variables, `globals.yml`. Kayobe provides configuration variables for all required variables and many of the most commonly used the variables in this file. Some of these are in `$KAYOBE_CONFIG_PATH/kolla.yml`, and others are determined from other sources such as the networking configuration in `$KAYOBE_CONFIG_PATH/networks.yml`.

Configuring Custom Global Variables

Additional global configuration may be provided by creating `$KAYOBE_CONFIG_PATH/kolla/globals.yml`. Variables in this file will be templated using Jinja2, and merged with the Kayobe `globals.yml` configuration.

Listing 64: `$KAYOBE_CONFIG_PATH/kolla/globals.yml`

```
---
# Use a custom tag for the nova-api container image.
nova_api_tag: v1.2.3
```

Passwords

Kolla-ansible auto-generates passwords to a file, `passwords.yml`. Kayobe handles the orchestration of this, as well as encryption of the file using an ansible vault password specified in the `KAYOBE_VAULT_PASSWORD` environment variable, if present. The file is generated to `$KAYOBE_CONFIG_PATH/kolla/passwords.yml`, and should be stored along with other kayobe configuration files. This file should not be manually modified.

Configuring Custom Passwords

In order to write additional passwords to `passwords.yml`, set the kayobe variable `kolla_ansible_custom_passwords` in `$KAYOBE_CONFIG_PATH/kolla.yml`.

Listing 65: `$KAYOBE_CONFIG_PATH/kolla.yml`

```
---
# Dictionary containing custom passwords to add or override in the Kolla
# passwords file.
kolla_ansible_custom_passwords: >
  {{ kolla_ansible_default_custom_passwords |
     combine({'my_custom_password': 'correcthorsebatterystaple'}) }}
```

Service Configuration

Kolla-ansible's flexible configuration is described in the kolla-ansible service configuration documentation. We won't duplicate that here, but essentially it involves creating files under a directory which for users of kayobe will be `$KOLLA_CONFIG_PATH/config`. In kayobe, files in this directory are auto-generated and managed by kayobe. Instead, users should create files under `$KAYOBE_CONFIG_PATH/kolla/config` with the same directory structure. These files will be templated using Jinja2, merged with kayobe's own configuration, and written out to `$KOLLA_CONFIG_PATH/config`.

The following files, if present, will be templated and provided to kolla-ansible. All paths are relative to `$KAYOBE_CONFIG_PATH/kolla/config`. Note that typically kolla-ansible does not use the same wildcard patterns, and has a more restricted set of files that it will process. In some cases, it may be necessary to inspect the kolla-ansible configuration tasks to determine which files are supported.

Configuring an OpenStack Component

To provide custom configuration to be applied to all glance services, create `$KAYOBE_CONFIG_PATH/kolla/config/glance.conf`. For example:

Listing 66: `$KAYOBE_CONFIG_PATH/kolla/config/glance.conf`

```
[DEFAULT]
api_limit_max = 500
```

Configuring an OpenStack Service

To provide custom configuration for the glance API service, create `$KAYOBE_CONFIG_PATH/kolla/config/glance/glance-api.conf`. For example:

Listing 67: `$KAYOBE_CONFIG_PATH/kolla/config/glance/glance-api.conf`

```
[DEFAULT]
api_limit_max = 500
```

1.2.5 Deployment

This section describes usage of Kayobe to install an OpenStack cloud onto a set of bare metal servers. We assume access is available to a node which will act as the hypervisor hosting the seed node in a VM. We also assume that this seed hypervisor has access to the bare metal nodes that will form the OpenStack control plane. Finally, we assume that the control plane nodes have access to the bare metal nodes that will form the workload node pool.

Ansible Control Host

Before starting deployment we must bootstrap the Ansible control host. Tasks performed here include:

- Install Ansible and role dependencies from Ansible Galaxy.
- Generate an SSH key if necessary and add it to the current user's authorised keys.

To bootstrap the Ansible control host:

```
(kayobe) $ kayobe control host bootstrap
```

Physical Network

The physical network can be managed by Kayobe, which uses Ansible's network modules. Currently Dell Network OS 6 and Dell Network OS 9 switches are supported but this could easily be extended. To provision the physical network:

```
(kayobe) $ kayobe physical network configure --group <group> [--enable-discovery]
```

The `--group` argument is used to specify an Ansible group containing the switches to be configured.

The `--enable-discovery` argument enables a one-time configuration of ports attached to baremetal compute nodes to support hardware discovery via ironic inspector.

It is possible to limit the switch interfaces that will be configured, either by interface name or interface description:

```
(kayobe) $ kayobe physical network configure --group <group> --interface-limit
↪<interface names>
(kayobe) $ kayobe physical network configure --group <group> --interface-description-
↪limit <interface descriptions>
```

The names or descriptions should be separated by commas. This may be useful when adding compute nodes to an existing deployment, in order to avoid changing the configuration interfaces in use by active nodes.

The `--display` argument will display the candidate switch configuration, without actually applying it.

Seed Hypervisor

Note: It is not necessary to run the seed services in a VM. To use an existing bare metal host or a VM provisioned outside of Kayobe, this section may be skipped.

Host Configuration

To configure the seed hypervisor's host OS, and the Libvirt/KVM virtualisation support:

```
(kayobe) $ kayobe seed hypervisor host configure
```

Seed

VM Provisioning

Note: It is not necessary to run the seed services in a VM. To use an existing bare metal host or a VM provisioned outside of Kayobe, this step may be skipped. Ensure that the Ansible inventory contains a host for the seed.

The seed hypervisor should have CentOS and `libvirt` installed. It should have `libvirt` networks configured for all networks that the seed VM needs access to and a `libvirt` storage pool available for the seed VM's volumes. To provision the seed VM:

```
(kayobe) $ kayobe seed vm provision
```

When this command has completed the seed VM should be active and accessible via SSH. Kayobe will update the Ansible inventory with the IP address of the VM.

Host Configuration

To configure the seed host OS:

```
(kayobe) $ kayobe seed host configure
```

Note: If the seed host uses disks that have been in use in a previous installation, it may be necessary to wipe partition and LVM data from those disks. To wipe all disks that are not mounted during host configuration:

```
(kayobe) $ kayobe seed host configure --wipe-disks
```

Building Container Images

Note: It is possible to use prebuilt container images from an image registry such as Dockerhub. In this case, this step can be skipped.

It is possible to use prebuilt container images from an image registry such as Dockerhub. In some cases it may be necessary to build images locally either to apply local image customisation or to use a downstream version of kolla. Images are built by hosts in the `container-image-builders` group, which by default includes the `seed`.

To build container images:

```
(kayobe) $ kayobe seed container image build
```

It is possible to build a specific set of images by supplying one or more image name regular expressions:

```
(kayobe) $ kayobe seed container image build bifrost-deploy
```

In order to push images to a registry after they are built, add the `--push` argument.

Workaround VLAN cloud-init issue

If you wish to configure the overcloud hosts to use a tagged VLAN for the admin network interface, you must set `overcloud_host_image_workaround_cloud_init_enabled` to True in `${KAYOBE_CONFIG_PATH}/etc/kayobe/overcloud.yml`:

```
overcloud_host_image_workaround_cloud_init_enabled: True
```

prior to deploying the containerised services with:

```
(kayobe) $ kayobe seed service deploy
```

Kayobe will then patch the overcloud host image to include a more recent version of cloud-init. This is to workaround a bug in the version of cloud-init currently shipped with CentOS 7.5 (0.7.9-24 at the time of writing), which doesn't set the IP address of VLAN subinterfaces. See: https://bugs.centos.org/view.php?id=14964.

The default repository used to obtain the package is currently hosted on github in the cloud-init-repo repository. You can override this by setting `overcloud_host_image_workaround_cloud_init_repo` in `${KAYOBE_CONFIG_PATH}/etc/kayobe/overcloud.yml`:

```
overcloud_host_image_workaround_cloud_init_repo: https://stackhpc.github.io/cloud-
↪init-repo/
```

The source code used to build the updated package can be obtained from the cloud-init-repo-source repository.

As this is not an offical package, there may be latent bugs when using functionality the kayobe developers have not used themselves.

Deploying Containerised Services

At this point the seed services need to be deployed on the seed VM. These services are deployed in the `bifrost_deploy` container. This command will also build the Operating System image that will be used to deploy the overcloud nodes using Disk Image Builder (DIB).

To deploy the seed services in containers:

```
(kayobe) $ kayobe seed service deploy
```

After this command has completed the seed services will be active.

Building Deployment Images

Note: It is possible to use prebuilt deployment images. In this case, this step can be skipped.

It is possible to use prebuilt deployment images from the OpenStack hosted tarballs or another source. In some cases it may be necessary to build images locally either to apply local image customisation or to use a downstream version of Ironic Python Agent (IPA). In order to build IPA images, the `ipa_build_images` variable should be set to `True`. To build images locally:

```
(kayobe) $ kayobe seed deployment image build
```

If images have been built previously, they will not be rebuilt. To force rebuilding images, use the `--force-rebuild` argument.

Accessing the Seed via SSH (Optional)

For SSH access to the seed, first determine the seed's IP address. We can use the `kayobe configuration dump` command to inspect the seed's IP address:

```
(kayobe) $ kayobe configuration dump --host seed --var-name ansible_host
```

The `kayobe_ansible_user` variable determines which user account will be used by Kayobe when accessing the machine via SSH. By default this is `stack`. Use this user to access the seed:

```
$ ssh <kayobe ansible user>@<seed VM IP>
```

To see the active Docker containers:

```
$ docker ps
```

Leave the seed VM and return to the shell on the Ansible control host:

```
$ exit
```

Overcloud

Discovery

Note: If discovery of the overcloud is not possible, a static inventory of servers using the bifrost `servers.yml` file format may be configured using the `kolla_bifrost_servers` variable in `${KAYOBE_CONFIG_PATH}/bifrost.yml`.

Discovery of the overcloud is supported by the ironic inspector service running in the `bifrost_deploy` container on the seed. The service is configured to PXE boot unrecognised MAC addresses with an IPA ramdisk for introspection. If an introspected node does not exist in the ironic inventory, ironic inspector will create a new entry for it.

Discovery of the overcloud is triggered by causing the nodes to PXE boot using a NIC attached to the overcloud provisioning network. For many servers this will be the factory default and can be performed by powering them on.

On completion of the discovery process, the overcloud nodes should be registered with the ironic service running in the seed host's `bifrost_deploy` container. The node inventory can be viewed by executing the following on the seed:

```
$ docker exec -it bifrost_deploy bash
(bifrost_deploy) $ source env-vars
(bifrost_deploy) $ ironic node-list
```

In order to interact with these nodes using Kayobe, run the following command to add them to the Kayobe and Kolla-Ansible inventories:

```
(kayobe) $ kayobe overcloud inventory discover
```

Saving Hardware Introspection Data

If ironic inspector is in use on the seed host, introspection data will be stored in the local nginx service. This data may be saved to the control host:

```
(kayobe) $ kayobe overcloud introspection data save
```

`--output-dir` may be used to specify the directory in which introspection data files will be saved. `--output-format` may be used to set the format of the files.

BIOS and RAID Configuration

Note: BIOS and RAID configuration may require one or more power cycles of the hardware to complete the operation. These will be performed automatically.

Configuration of BIOS settings and RAID volumes is currently performed out of band as a separate task from hardware provisioning. To configure the BIOS and RAID:

```
(kayobe) $ kayobe overcloud bios raid configure
```

After configuring the nodes' RAID volumes it may be necessary to perform hardware inspection of the nodes to reconfigure the ironic nodes' scheduling properties and root device hints. To perform manual hardware inspection:

```
(kayobe) $ kayobe overcloud hardware inspect
```

Provisioning

Provisioning of the overcloud is performed by the ironic service running in the bifrost container on the seed. To provision the overcloud nodes:

```
(kayobe) $ kayobe overcloud provision
```

After this command has completed the overcloud nodes should have been provisioned with an OS image. The command will wait for the nodes to become `active` in ironic and accessible via SSH.

Host Configuration

To configure the overcloud hosts' OS:

```
(kayobe) $ kayobe overcloud host configure
```

Note: If the controller hosts use disks that have been in use in a previous installation, it may be necessary to wipe partition and LVM data from those disks. To wipe all disks that are not mounted during host configuration:

```
(kayobe) $ kayobe overcloud host configure --wipe-disks
```

Building Container Images

Note: It is possible to use prebuilt container images from an image registry such as Dockerhub. In this case, this step can be skipped.

In some cases it may be necessary to build images locally either to apply local image customisation or to use a downstream version of kolla. Images are built by hosts in the `container-image-builders` group, which by default includes the `seed`. If no seed host is in use, for example in an all-in-one controller development environment, this group may be modified to cause containers to be built on the controllers.

To build container images:

```
(kayobe) $ kayobe overcloud container image build
```

It is possible to build a specific set of images by supplying one or more image name regular expressions:

```
(kayobe) $ kayobe overcloud container image build ironic- nova-api
```

In order to push images to a registry after they are built, add the `--push` argument.

Pulling Container Images

Note: It is possible to build container images locally avoiding the need for an image registry such as Dockerhub. In this case, this step can be skipped.

In most cases suitable prebuilt kolla images will be available on Dockerhub. The stackhpc account provides image repositories suitable for use with kayobe and will be used by default. To pull images from the configured image registry:

```
(kayobe) $ kayobe overcloud container image pull
```

Building Deployment Images

Note: It is possible to use prebuilt deployment images. In this case, this step can be skipped.

Note: Deployment images are only required for the overcloud when Ironic is in use. Otherwise, this step can be skipped.

It is possible to use prebuilt deployment images from the OpenStack hosted tarballs or another source. In some cases it may be necessary to build images locally either to apply local image customisation or to use a downstream version of Ironic Python Agent (IPA). In order to build IPA images, the `ipa_build_images` variable should be set to `True`. To build images locally:

```
(kayobe) $ kayobe overcloud deployment image build
```

If images have been built previously, they will not be rebuilt. To force rebuilding images, use the `--force-rebuild` argument.

Deploying Containerised Services

To deploy the overcloud services in containers:

```
(kayobe) $ kayobe overcloud service deploy
```

Once this command has completed the overcloud nodes should have OpenStack services running in Docker containers.

Interacting with the Control Plane

Kolla-ansible writes out an environment file that can be used to access the OpenStack admin endpoints as the admin user:

```
$ source ${KOLLA_CONFIG_PATH:-/etc/kolla}/admin-openrc.sh
```

Kayobe also generates an environment file that can be used to access the OpenStack public endpoints as the admin user which may be required if the admin endpoints are not available from the Ansible control host:

```
$ source ${KOLLA_CONFIG_PATH:-/etc/kolla}/public-openrc.sh
```

Performing Post-deployment Configuration

To perform post deployment configuration of the overcloud services:

```
(kayobe) $ source ${KOLLA_CONFIG_PATH:-/etc/kolla}/admin-openrc.sh
(kayobe) $ kayobe overcloud post configure
```

This will perform the following tasks:

- Register Ironic Python Agent (IPA) images with glance
- Register introspection rules with ironic inspector
- Register a provisioning network and subnet with neutron
- Configure Grafana organisations, dashboards and datasources

1.2.6 Upgrading

This section describes how to upgrade from one OpenStack release to another.

Preparation

Before you start, be sure to back up any local changes, configuration, and data.

Upgrading Kayobe

If a new, suitable version of kayobe is available, it should be installed. As described in *Installation*, Kayobe can be installed via the released Python packages on PyPI, or from source. Installation from a Python package is supported from Kayobe 5.0.0 onwards.

Upgrading from PyPI

This section describes how to upgrade Kayobe from a Python package in a virtualenv. This is supported from Kayobe 5.0.0 onwards.

Ensure that the virtualenv is activated:

```
$ source <base_path>/venvs/kayobe/bin/activate
```

Update the pip package:

```
(kayobe) $ pip install -U pip
```

If upgrading to the latest version of Kayobe:

```
(kayobe) $ pip install -U kayobe
```

Alternatively, to upgrade to a specific release of Kayobe:

```
(kayobe) $ pip install kayobe==5.0.0
```

Upgrading from source

This section describes how to install Kayobe from source in a virtualenv.

First, check out the required version of the Kayobe source code. This may be done by pulling down the new version from Github. Make sure that any local changes to kayobe are committed and merged with the new upstream code as necessary. For example, to pull version 5.0.0 from the `origin` remote:

```
$ cd <base_path>/src/kayobe
$ git pull origin 5.0.0
```

Ensure that the virtualenv is activated:

```
$ source <base_path>/venvs/kayobe/bin/activate
```

Update the pip package:

```
(kayobe) $ pip install -U pip
```

If using a non-editable install of Kayobe:

```
(kayobe) $ cd <base_path>/src/kayobe
(kayobe) $ pip install -U .
```

Alternatively, if using an editable install of Kayobe (version 5.0.0 onwards, see *Editable source installation* for details):

```
(kayobe) $ cd <base_path>/src/kayobe
(kayobe) $ pip install -U -e .
```

Migrating Kayobe Configuration

Kayobe configuration options may be changed between releases of kayobe. Ensure that all site local configuration is migrated to the target version format. If using the kayobe-config git repository to manage local configuration, this process can be managed via git. For example, to fetch version 1.0.0 of the configuration from the `origin` remote and merge it into the current branch:

```
$ git fetch origin 1.0.0
$ git merge 1.0.0
```

The configuration should be manually inspected after the merge to ensure that it is correct. Any new configuration options may be set at this point. In particular, the following options may need to be changed if not using their default values:

- `kolla_openstack_release`
- `kolla_sources`
- `kolla_build_blocks`
- `kolla_build_customizations`

Once the configuration has been migrated, it is possible to view the global variables for all hosts:

```
(kayobe) $ kayobe configuration dump
```

The output of this command is a JSON object mapping hosts to their configuration. The output of the command may be restricted using the `--host`, `--hosts`, `--var-name` and `--dump-facts` options.

If using the `kayobe-env` environment file in `kayobe-config`, this should also be inspected for changes and modified to suit the local ansible control host environment if necessary. When ready, source the environment file:

```
$ source kayobe-env
```

Upgrading the Ansible Control Host

Before starting the upgrade we must upgrade the Ansible control host. Tasks performed here include:

- Install updated Ansible role dependencies from Ansible Galaxy.
- Generate an SSH key if necessary and add it to the current user's authorised keys.

To upgrade the Ansible control host:

```
(kayobe) $ kayobe control host upgrade
```

Upgrading the Seed Hypervisor

Currently, upgrading the seed hypervisor services is not supported. It may however be necessary to upgrade some host services:

```
(kayobe) $ kayobe seed hypervisor host upgrade
```

Note that this will not perform full configuration of the host, and will instead perform a targeted upgrade of specific services where necessary.

Upgrading the Seed

The seed services are upgraded in two steps. First, new container images should be obtained either by building them locally or pulling them from an image registry. Second, the seed services should be replaced with new containers created from the new container images.

Upgrading Host Packages

Prior to upgrading the seed, it may be desirable to upgrade system packages on the seed host.

To update all eligible packages, use `*`, escaping if necessary:

```
(kayobe) $ kayobe seed host package update --packages *
```

To only install updates that have been marked security related:

```
(kayobe) $ kayobe seed host package update --packages <packages> --security
```

Note that these commands do not affect packages installed in containers, only those installed on the host.

Building Ironic Deployment Images

Note: It is possible to use prebuilt deployment images. In this case, this step can be skipped.

It is possible to use prebuilt deployment images from the OpenStack hosted tarballs or another source. In some cases it may be necessary to build images locally either to apply local image customisation or to use a downstream version of Ironic Python Agent (IPA). In order to build IPA images, the `ipa_build_images` variable should be set to `True`. To build images locally:

```
(kayobe) $ kayobe seed deployment image build
```

To overwrite existing images, add the `--force-rebuild` argument.

Upgrading Host Services

It may be necessary to upgrade some host services:

```
(kayobe) $ kayobe seed host upgrade
```

Note that this will not perform full configuration of the host, and will instead perform a targeted upgrade of specific services where necessary.

Building Container Images

Note: It is possible to use prebuilt container images from an image registry such as Dockerhub. In this case, this step can be skipped.

In some cases it may be necessary to build images locally either to apply local image customisation or to use a downstream version of kolla. To build images locally:

```
(kayobe) $ kayobe seed container image build
```

In order to push images to a registry after they are built, add the `--push` argument.

Migrating to Ironic Hardware Types

Classic drivers in ironic were deprecated in the Queens release, and removed in the Rocky release. Nodes registered with ironic in Pike and earlier releases of Bifrost use the classic drivers by default, and will need to be migrated to use the new hardware types. The ironic documentation provides details for how to do this, but for the default case of the `agent_ipmitool` driver the following procedure may be used, replacing `<node>` with the name of the host to migrate:

```
$ docker exec -it bifrost_deploy bash
(bifrost_deploy) $ export OS_URL=http://localhost:6385
(bifrost_deploy) $ export OS_TOKEN=fake
(bifrost_deploy) $ openstack baremetal node maintenance set <node>
(bifrost_deploy) $ openstack baremetal node set <node> --driver ipmi
(bifrost_deploy) $ openstack baremetal node maintenance unset <node>
```

Upgrading Containerised Services

Containerised seed services may be upgraded by replacing existing containers with new containers using updated images which have been pulled from a registry or built locally.

To upgrade the containerised seed services:

```
(kayobe) $ kayobe seed service upgrade
```

Upgrading the Overcloud

The overcloud services are upgraded in two steps. First, new container images should be obtained either by building them locally or pulling them from an image registry. Second, the overcloud services should be replaced with new containers created from the new container images.

Upgrading Host Packages

Prior to upgrading the OpenStack control plane, it may be desirable to upgrade system packages on the overcloud hosts.

To update all eligible packages, use `*`, escaping if necessary:

```
(kayobe) $ kayobe overcloud host package update --packages *
```

To only install updates that have been marked security related:

```
(kayobe) $ kayobe overcloud host package update --packages <packages> --security
```

Note that these commands do not affect packages installed in containers, only those installed on the host.

Upgrading Host Services

Prior to upgrading the OpenStack control plane, the overcloud host services should be upgraded:

```
(kayobe) $ kayobe overcloud host upgrade
```

Note that this will not perform full configuration of the host, and will instead perform a targeted upgrade of specific services where necessary.

Building Ironic Deployment Images

Note: It is possible to use prebuilt deployment images. In this case, this step can be skipped.

It is possible to use prebuilt deployment images from the OpenStack hosted tarballs or another source. In some cases it may be necessary to build images locally either to apply local image customisation or to use a downstream version of Ironic Python Agent (IPA). In order to build IPA images, the `ipa_build_images` variable should be set to `True`. To build images locally:

```
(kayobe) $ kayobe overcloud deployment image build
```

To overwrite existing images, add the `--force-rebuild` argument.

Upgrading Ironic Deployment Images

Prior to upgrading the OpenStack control plane you should upgrade the deployment images. If you are using prebuilt images, update the following variables in `etc/kayobe/ipa.yml` accordingly:

- `ipa_kernel_upstream_url`
- `ipa_kernel_checksum_url`
- `ipa_kernel_checksum_algorithm`
- `ipa_ramdisk_upstream_url`
- `ipa_ramdisk_checksum_url`
- `ipa_ramdisk_checksum_algorithm`

Alternatively, you can update the files that the URLs point to. If building the images locally, follow the process outlined in *Building Ironic Deployment Images*.

To get Ironic to use an updated set of overcloud deployment images, you can run:

```
(kayobe) $ kayobe baremetal compute update deployment image
```

This will register the images in Glance and update the `deploy_ramdisk` and `deploy_kernel` properties of the Ironic nodes.

Before rolling out the update to all nodes, it can be useful to test the image on a limited subset. To do this, you can use the `baremetal-compute-limit` option. See *Update Deployment Image* for more details.

Building Container Images

Note: It is possible to use prebuilt container images from an image registry such as Dockerhub. In this case, this step can be skipped.

In some cases it may be necessary to build images locally either to apply local image customisation or to use a downstream version of kolla. To build images locally:

```
(kayobe) $ kayobe overcloud container image build
```

It is possible to build a specific set of images by supplying one or more image name regular expressions:

```
(kayobe) $ kayobe overcloud container image build ironic- nova-api
```

In order to push images to a registry after they are built, add the `--push` argument.

Pulling Container Images

Note: It is possible to build container images locally avoiding the need for an image registry such as Dockerhub. In this case, this step can be skipped.

In most cases suitable prebuilt kolla images will be available on Dockerhub. The stackhpc account provides image repositories suitable for use with kayobe and will be used by default. To pull images from the configured image registry:

```
(kayobe) $ kayobe overcloud container image pull
```

Saving Overcloud Service Configuration

It is often useful to be able to save the configuration of the control plane services for inspection or comparison with another configuration set prior to a reconfiguration or upgrade. This command will gather and save the control plane configuration for all hosts to the Ansible control host:

```
(kayobe) $ kayobe overcloud service configuration save
```

The default location for the saved configuration is `$PWD/overcloud-config`, but this can be changed via the `output-dir` argument. To gather configuration from a directory other than the default `/etc/kolla`, use the `node-config-dir` argument.

Generating Overcloud Service Configuration

Prior to deploying, reconfiguring, or upgrading a control plane, it may be useful to generate the configuration that will be applied, without actually applying it to the running containers. The configuration should typically be generated in a directory other than the default configuration directory of `/etc/kolla`, to avoid overwriting the active configuration:

```
(kayobe) $ kayobe overcloud service configuration generate --node-config-dir /path/to/
↪generated/config
```

The configuration will be generated remotely on the overcloud hosts in the specified directory, with one subdirectory per container. This command may be followed by `kayobe ovecloud service configuration save` to gather the generated configuration to the Ansible control host.

Upgrading Containerised Services

Containerised control plane services may be upgraded by replacing existing containers with new containers using updated images which have been pulled from a registry or built locally.

To upgrade the containerised control plane services:

```
(kayobe) $ kayobe overcloud service upgrade
```

It is possible to specify tags for Kayobe and/or kolla-ansible to restrict the scope of the upgrade:

```
(kayobe) $ kayobe overcloud service upgrade --tags config --kolla-tags keystone
```

1.2.7 Administration

This section describes how to use kayobe to simplify post-deployment administrative tasks.

General Administration

Running Kayobe Playbooks on Demand

In some situations it may be necessary to run an individual Kayobe playbook. Playbooks are stored in `<kayobe repo>/ansible/*.yml`. To run an arbitrary Kayobe playbook:

```
(kayobe) $ kayobe playbook run <playbook> [<playbook>]
```

Running Kolla-ansible Commands

To execute a kolla-ansible command:

```
(kayobe) $ kayobe kolla ansible run <command>
```

Dumping Kayobe Configuration

The Ansible configuration space is quite large, and it can be hard to determine the final values of Ansible variables. We can use Kayobe's `configuration dump` command to view individual variables or the variables for one or more hosts. To dump Kayobe configuration for one or more hosts:

```
(kayobe) $ kayobe configuration dump
```

The output is a JSON-formatted object mapping hosts to their hostvars.

We can use the `--var-name` argument to inspect a particular variable or the `--host` or `--hosts` arguments to view a variable or variables for a specific host or set of hosts.

Checking Network Connectivity

In complex networking environments it can be useful to be able to automatically check network connectivity and diagnose networking issues. To perform some simple connectivity checks:

```
(kayobe) $ kayobe network connectivity check
```

Note that this will run on the seed, seed hypervisor, and overcloud hosts. If any of these hosts are not expected to be active (e.g. prior to overcloud deployment), the set of target hosts may be limited using the `--limit` argument.

Seed Administration

Deprovisioning The Seed VM

Note: This step will destroy the seed VM and its data volumes.

To deprovision the seed VM:

```
(kayobe) $ kayobe seed vm deprovision
```

Updating Packages

It is possible to update packages on the seed host. To update one or more packages:

```
(kayobe) $ kayobe seed host package update --packages <package1>,<package2>
```

To update all eligible packages, use `*`, escaping if necessary:

```
(kayobe) $ kayobe seed host package update --packages *
```

To only install updates that have been marked security related:

```
(kayobe) $ kayobe seed host package update --packages <packages> --security
```

Note that these commands do not affect packages installed in containers, only those installed on the host.

Examining the Bifrost Container

The seed host runs various services required for a standalone Ironic deployment. These all run in a single `bifrost_deploy` container.

It can often be helpful to execute a shell in the bifrost container for diagnosing operational issues:

```
$ docker exec -it bifrost_deploy bash
```

Services are run via Systemd:

```
(bifrost_deploy) systemctl
```

Logs are stored in `/var/log/kolla/`, which is mounted to the `kolla_logs` Docker volume.

Accessing the Seed Services

The Ironic API can be accessed via the `openstack` command line interface:

```
(bifrost_deploy) $ source env-vars
(bifrost_deploy) $ openstack baremetal node list
```

Ironic inspector API requires some environment variables to be set:

```
(bifrost_deploy) $ unset OS_CLOUD
(bifrost_deploy) $ export OS_URL=http://localhost:5050
(bifrost_deploy) $ export OS_TOKEN=fake-token
(bifrost_deploy) $ openstack baremetal introspection list
```

Backup & Restore

There are two main approaches to backing up and restoring data on the seed. A backup may be taken of the Ironic databases. Alternatively, a Virtual Machine backup may be used if running the seed services in a VM. The former will consume less storage. Virtual Machine backups are not yet covered here, neither is scheduling of backups. Any backup and restore procedure should be tested in advance.

Database Backup & Restore

A backup may be taken of the database, using one of the many tools that exist for backing up MariaDB databases.

A simple approach that should work for the typically modestly sized seed database is `mysqldump`. The following commands should all be executed on the seed.

Backup

It should be safe to keep services running during the backup, but for maximum safety they may optionally be stopped:

```
docker exec -it bifrost_deploy \
systemctl stop ironic-api ironic-conductor ironic-inspector
```

Then, to perform the backup:

```
docker exec -it bifrost_deploy \
mysqldump --all-databases --single-transaction --routines --triggers > seed-backup.sql
```

If the services were stopped prior to the backup, start them again:

```
docker exec -it bifrost_deploy \
systemctl start ironic-api ironic-conductor ironic-inspector
```

Restore

Prior to restoring the database, the Ironic and Ironic Inspector services should be stopped:

```
docker exec -it bifrost_deploy \
systemctl stop ironic-api ironic-conductor ironic-inspector
```

The database may then safely be restored:

```
docker exec -i bifrost_deploy \
mysql < seed-backup.sql
```

Finally, start the Ironic and Ironic Inspector services again:

```
docker exec -it bifrost_deploy \
systemctl start ironic-api ironic-conductor ironic-inspector
```

Running Commands

It is possible to run a command on the seed host:

```
(kayobe) $ kayobe seed host command run --command "<command>"
```

For example:

```
(kayobe) $ kayobe seed host command run --command "service docker restart"
```

Commands can also be run on the seed hypervisor host, if one is in use:

```
(kayobe) $ kayobe seed hypervisor host command run --command "<command>"
```

To execute the command with root privileges, add the `--become` argument. Adding the `--verbose` argument allows the output of the command to be seen.

Overcloud Administration

Updating Packages

It is possible to update packages on the overcloud hosts. To update one or more packages:

```
(kayobe) $ kayobe overcloud host package update --packages <package1>,<package2>
```

To update all eligible packages, use `*`, escaping if necessary:

```
(kayobe) $ kayobe overcloud host package update --packages *
```

To only install updates that have been marked security related:

```
(kayobe) $ kayobe overcloud host package update --packages <packages> --security
```

Note that these commands do not affect packages installed in containers, only those installed on the host.

Running Commands

It is possible to run a command on the overcloud hosts:

```
(kayobe) $ kayobe overcloud host command run --command "<command>"
```

For example:

```
(kayobe) $ kayobe overcloud host command run --command "service docker restart"
```

To execute the command with root privileges, add the `--become` argument. Adding the `--verbose` argument allows the output of the command to be seen.

Reconfiguring Containerised Services

When configuration is changed, it is necessary to apply these changes across the system in an automated manner. To reconfigure the overcloud, first make any changes required to the configuration on the Ansible control host. Next, run the following command:

```
(kayobe) $ kayobe overcloud service reconfigure
```

In case not all services' configuration have been modified, performance can be improved by specifying Ansible tags to limit the tasks run in kayobe and/or kolla-ansible's playbooks. This may require knowledge of the inner workings of these tools but in general, kolla-ansible tags the play used to configure each service by the name of that service. For example: `nova`, `neutron` or `ironic`. Use `-t` or `--tags` to specify kayobe tags and `-kt` or `--kolla-tags` to specify kolla-ansible tags. For example:

```
(kayobe) $ kayobe overcloud service reconfigure --tags config --kolla-tags nova,ironic
```

Upgrading Containerised Services

Containerised control plane services may be upgraded by replacing existing containers with new containers using updated images which have been pulled from a registry or built locally. If using an updated version of Kayobe or

upgrading from one release of OpenStack to another, be sure to follow the *kayobe upgrade guide*. It may be necessary to upgrade one or more services within a release, for example to apply a patch or minor release.

To upgrade the containerised control plane services:

```
(kayobe) $ kayobe overcloud service upgrade
```

As for the reconfiguration command, it is possible to specify tags for Kayobe and/or kolla-ansible:

```
(kayobe) $ kayobe overcloud service upgrade --tags config --kolla-tags keystone
```

Destroying the Overcloud Services

Note: This step will destroy all containers, container images, volumes and data on the overcloud hosts.

To destroy the overcloud services:

```
(kayobe) $ kayobe overcloud service destroy --yes-i-really-really-mean-it
```

Deprovisioning The Cloud

Note: This step will power down the overcloud hosts and delete their nodes' instance state from the seed's ironic service.

To deprovision the overcloud:

```
(kayobe) $ kayobe overcloud deprovision
```

Saving Overcloud Service Configuration

It is often useful to be able to save the configuration of the control plane services for inspection or comparison with another configuration set prior to a reconfiguration or upgrade. This command will gather and save the control plane configuration for all hosts to the Ansible control host:

```
(kayobe) $ kayobe overcloud service configuration save
```

The default location for the saved configuration is `$PWD/overcloud-config`, but this can be changed via the `output-dir` argument. To gather configuration from a directory other than the default `/etc/kolla`, use the `node-config-dir` argument.

Generating Overcloud Service Configuration

Prior to deploying, reconfiguring, or upgrading a control plane, it may be useful to generate the configuration that will be applied, without actually applying it to the running containers. The configuration should typically be generated in a directory other than the default configuration directory of `/etc/kolla`, to avoid overwriting the active configuration:

```
(kayobe) $ kayobe overcloud service configuration generate --node-config-dir /path/to/
↪generated/config
```

The configuration will be generated remotely on the overcloud hosts in the specified directory, with one subdirectory per container. This command may be followed by `kayobe ovecloud service configuration save` to gather the generated configuration to the Ansible control host.

Baremetal Compute Node Management

When enrolling new hardware or performing maintenance, it can be useful to be able to manage many bare metal compute nodes simultaneously.

In all cases, commands are delegated to one of the controller hosts, and executed concurrently. Note that ansible's `forks` configuration option, which defaults to 5, may limit the number of nodes configured concurrently.

By default these commands wait for the state transition to complete for each node. This behavior can be changed by overriding the variable `baremetal_compute_wait` via `-e baremetal_compute_wait=False`

Manage

A node may need to be set to the `manageable` provision state in order to perform certain management operations, or when an enrolled node is transitioned into service. In order to manage a node, it must be in one of these states: `enroll`, `available`, `cleaning`, `clean failed`, `adopt failed` or `inspect failed`. To move the baremetal compute nodes to the `manageable` provision state:

```
(kayobe) $ kayobe baremetal compute manage
```

Provide

In order for nodes to be scheduled by nova, they must be `available`. To move the baremetal compute nodes from the `manageable` state to the `available` provision state:

```
(kayobe) $ kayobe baremetal compute provide
```

Inspect

Nodes must be in one of the following states: `manageable`, `inspect failed`, or `available`. To trigger hardware inspection on the baremetal compute nodes:

```
(kayobe) $ kayobe baremetal compute inspect
```

Rename

Once nodes have been discovered, it is helpful to associate them with a name to make them easier to work with. If you would like the nodes to be named according to their inventory host names, you can run the following command:

```
(kayobe) $ kayobe baremetal compute rename
```

This command will use the `ipmi_address` host variable from the inventory to map the inventory host name to the correct node.

Update Deployment Image

When the overcloud deployment images have been rebuilt or there has been a change to one of the following variables:

- `ipa_kernel_upstream_url`
- `ipa_ramdisk_upstream_url`

either by changing the url, or if the image to which they point has been changed, you need to update the `deploy_ramdisk` and `deploy_kernel` properties on the Ironic nodes. To do this you can run:

```
(kayobe) $ kayobe baremetal compute update deployment image
```

You can optionally limit the nodes in which this affects by setting `baremetal-compute-limit`:

```
(kayobe) $ kayobe baremetal compute update deployment image --baremetal-compute-limit␣
↪sand-6-1
```

which should take the form of an ansible host pattern. This is matched against the Ironic node name.

Ironic Serial Console

To access the baremetal nodes from within Horizon you need to enable the serial console. For this to work the you must set `kolla_enable_nova_serialconsole_proxy` to `true` in `etc/kayobe/kolla.yml`:

```
kolla_enable_nova_serialconsole_proxy: true
```

The console interface on the Ironic nodes is expected to be `ipmitool-socat`, you can check this with:

```
openstack baremetal node show <node_id> --fields console_interface
```

where <node_id> should be the UUID or name of the Ironic node you want to check.

If you have set `kolla_ironic_enabled_console_interfaces` in `etc/kayobe/ironic.yml`, it should include `ipmitool-socat` in the list of enabled interfaces.

The playbook to enable the serial console currently only works if the Ironic node name matches the inventory hostname.

Once these requirements have been satisfied, you can run:

```
(kayobe) $ kayobe baremetal compute serial console enable
```

This will reserve a TCP port for each node to use for the serial console interface. The allocations are stored in `${KAYOBE_CONFIG_PATH}/console-allocation.yml`. The current implementation uses a global pool, which is specified by `ironic_serial_console_tcp_pool_start` and `ironic_serial_console_tcp_pool_end`; these variables can set in `etc/kayobe/ironic.yml`.

To disable the serial console you can use:

```
(kayobe) $ kayobe baremetal compute serial console disable
```

The port allocated for each node is retained and must be manually removed from `${KAYOBE_CONFIG_PATH}/console-allocation.yml` if you want it to be reused by another Ironic node with a different name.

You can optionally limit the nodes targeted by setting `baremetal-compute-limit`:

```
(kayobe) $ kayobe baremetal compute serial console enable --baremetal-compute-limit␣
↪sand-6-1
```

which should take the form of an ansible host pattern.

Serial console auto-enable

To enable the serial consoles automatically on `kayobe overcloud post configure`, you can set `ironic_serial_console_autoenable` in `etc/kayobe/ironic.yml`:

```
ironic_serial_console_autoenable: true
```

1.3 Advanced Documentation

1.3.1 Control Plane Service Placement

Note: This is an advanced topic and should only be attempted when familiar with kayobe and OpenStack.

The default configuration in kayobe places all control plane services on a single set of servers described as 'controllers'. In some cases it may be necessary to introduce more than one server role into the control plane, and control which services are placed onto the different server roles.

Configuration

Overcloud Inventory Discovery

If using a seed host to enable discovery of the control plane services, it is necessary to configure how the discovered hosts map into kayobe groups. This is done using the `overcloud_group_hosts_map` variable, which maps names of kayobe groups to a list of the hosts to be added to that group.

This variable will be used during the command `kayobe overcloud inventory discover`. An inventory file will be generated in `${KAYOBE_CONFIG_PATH}/inventory/overcloud` with discovered hosts added to appropriate kayobe groups based on `overcloud_group_hosts_map`.

Kolla-ansible Inventory Mapping

Once hosts have been discovered and enrolled into the kayobe inventory, they must be added to the kolla-ansible inventory. This is done by mapping from top level kayobe groups to top level kolla-ansible groups using the `kolla_overcloud_inventory_top_level_group_map` variable. This variable maps from kolla-ansible groups to lists of kayobe groups, and variables to define for those groups in the kolla-ansible inventory.

Variables For Custom Server Roles

Certain variables must be defined for hosts in the `overcloud` group. For hosts in the `controllers` group, many variables are mapped to other variables with a `controller_` prefix in files under `ansible/group_vars/controllers/`. This is done in order that they may be set in a global extra variables file, typically `controllers`.

yml, with defaults set in ansible/group_vars/all/controllers. A similar scheme is used for hosts in the monitoring group.

Table 2: Overcloud host variables

Variable	Purpose
ansible_user	Username with which to access the host via SSH.
bootstrap_user	Username with which to access the host before ansible_user is configured.
lvm_groups	List of LVM volume groups to configure. See mrlesmithjr.manage-lvm role for format.
network_interfaces	List of names of networks to which the host is connected.
sysctl_parameters	Dict of sysctl parameters to set.
users	List of users to create. See singleplatform-eng.users role

If configuring BIOS and RAID via kayobe overcloud bios raid configure, the following variables should also be defined:

Table 3: Overcloud BIOS & RAID host variables

Variable	Purpose
bios_config	Dict mapping BIOS configuration options to their required values. See stackhpc.drac role for format.
raid_config	List of RAID virtual disks to configure. See stackhpc.drac role for format.

These variables can be defined in inventory host or group variables files, under ${KAYOBE_CONFIG_PATH}/inventory/host_vars/<host> or ${KAYOBE_CONFIG_PATH}/inventory/group_vars/<group> respectively.

Custom Kolla-ansible Inventories

As an advanced option, it is possible to fully customise the content of the kolla-ansible inventory, at various levels. To facilitate this, kayobe breaks the kolla-ansible inventory into three separate sections.

Top level groups define the roles of hosts, e.g. controller or compute, and it is to these groups that hosts are mapped directly.

Components define groups of services, e.g. nova or ironic, which are mapped to top level groups.

Services define single containers, e.g. nova-compute or ironic-api, which are mapped to components.

The default top level inventory is generated from kolla_overcloud_inventory_top_level_group_map. Kayobe's component- and service-level inventory for kolla-ansible is static, and taken from the kolla-ansible example multinode inventory. The complete inventory is generated by concatenating these inventories.

Each level may be separately overridden by setting the following variables:

Table 4: Custom kolla-ansible inventory variables

Variable	Purpose
kolla_overcloud_inventory_custom_top_level	Overcloud inventory containing a mapping from top level groups to hosts.
kolla_overcloud_inventory_custom_components	Overcloud inventory containing a mapping from components to top level groups.
kolla_overcloud_inventory_custom_services	Overcloud inventory containing a mapping from services to components.
kolla_overcloud_inventory_custom	Full overcloud inventory contents.

Examples

Example 1: Adding Network Hosts

This example walks through the configuration that could be applied to enable the use of separate hosts for neutron network services and load balancing. The control plane consists of three controllers, `controller-[0-2]`, and two network hosts, `network-[0-1]`. All file paths are relative to `${KAYOBE_CONFIG_PATH}`.

First, we must map the hosts to kayobe groups.

Listing 68: `overcloud.yml`

```
overcloud_group_hosts_map:
  controllers:
    - controller-0
    - controller-1
    - controller-2
  network:
    - network-0
    - network-1
```

Next, we must map these groups to kolla-ansible groups.

Listing 69: `kolla.yml`

```
kolla_overcloud_inventory_top_level_group_map:
  control:
    groups:
      - controllers
  network:
    groups:
      - network
```

Finally, we create a group variables file for hosts in the network group, providing the necessary variables for a control plane host.

Listing 70: `inventory/group_vars/network`

```
ansible_user: "{{ kayobe_ansible_user }}"
bootstrap_user: "{{ controller_bootstrap_user }}"
lvm_groups: "{{ controller_lvm_groups }}"
network_interfaces: "{{ controller_network_host_network_interfaces }}"
sysctl_parameters: "{{ controller_sysctl_parameters }}"
users: "{{ controller_users }}"
```

Here we are using the controller-specific values for some of these variables, but they could equally be different.

Example 2: Overriding the Kolla-ansible Inventory

This example shows how to override one or more sections of the kolla-ansible inventory. All file paths are relative to `${KAYOBE_CONFIG_PATH}`.

First, create a file containing the customised inventory section. We'll use the **components** section in this example.

Listing 71: kolla/inventory/overcloud-components.j2

```
[nova]
control

[ironic]
{% if kolla_enable_ironic | bool %}
control
{% endif %}

...
```

Next, we must configure kayobe to use this inventory template.

Listing 72: kolla.yml

```
kolla_overcloud_inventory_custom_components: "{{ lookup('template', kayobe_config_
↪path ~ '/kolla/inventory/overcloud-components.j2') }}"
```

Here we use the `template` lookup plugin to render the Jinja2-formatted inventory template.

1.3.2 Custom Ansible Playbooks

Kayobe supports running custom Ansible playbooks located outside of the kayobe project. This provides a flexible mechanism for customising a control plane. Access to the kayobe variables is possible, ensuring configuration does not need to be repeated.

Kayobe Custom Playbook API

Explicitly allowing users to run custom playbooks with access to the kayobe variables elevates the variable namespace and inventory to become an interface. This raises questions about the stability of this interface, and the guarantees it provides.

The following guidelines apply to the custom playbook API:

- Only variables defined in the kayobe configuration files under `etc/kayobe` are supported.
- The groups defined in `etc/kayobe/inventory/groups` are supported.
- Any change to a supported variable (rename, schema change, default value change, or removal) or supported group (rename or removal) will follow a deprecation period of one release cycle.
- Kayobe's internal roles may not be used.

Note that these are guidelines, and exceptions may be made where appropriate.

Running Custom Ansible Playbooks

Run one or more custom ansible playbooks:

```
(kayobe) $ kayobe playbook run <playbook>[, <playbook>...]
```

Playbooks do not by default have access to the Kayobe playbook group variables, filter plugins, and test plugins, since these are relative to the current playbook's directory. This can be worked around by creating symbolic links to the Kayobe repository from the Kayobe configuration.

Packaging Custom Playbooks With Configuration

The kayobe project encourages its users to manage configuration for a cloud using version control, based on the kayobe-config repository. Storing custom Ansible playbooks in this repository makes a lot of sense, and kayobe has special support for this.

It is recommended to store custom playbooks in `$KAYOBE_CONFIG_PATH/ansible/`. Roles located in `$KAYOBE_CONFIG_PATH/ansible/roles/` will be automatically available to playbooks in this directory.

With this directory layout, the following commands could be used to create symlinks that allow access to Kayobe's filter plugins, group variables and test plugins:

```
cd ${KAYOBE_CONFIG_PATH}/ansible/
ln -s ../../../../kayobe/ansible/filter_plugins/ filter_plugins
ln -s ../../../../kayobe/ansible/group_vars/ group_vars
ln -s ../../../../kayobe/ansible/test_plugins/ test_plugins
```

These symlinks can even be committed to the kayobe-config Git repository.

Ansible Galaxy

Ansible Galaxy provides a means for sharing Ansible roles. Kayobe configuration may provide a Galaxy requirements file that defines roles to be installed from Galaxy. These roles may then be used by custom playbooks.

Galaxy role dependencies may be defined in `$KAYOBE_CONFIG_PATH/ansible/requirements.yml`. These roles will be installed in `$KAYOBE_CONFIG_PATH/ansible/roles/` when bootstrapping the Ansible control host:

```
(kayobe) $ kayobe control host bootstrap
```

And updated when upgrading the Ansible control host:

```
(kayobe) $ kayobe control host upgrade
```

Example

The following example adds a `foo.yml` playbook to a set of kayobe configuration. The playbook uses a Galaxy role, `bar.baz`.

Here is the kayobe configuration repository structure:

```
etc/kayobe/
    ansible/
        foo.yml
        requirements.yml
        roles/
    bifrost.yml
...
```

Here is the playbook, `ansible/foo.yml`:

```
---
- hosts: controllers
  roles:
    - name: bar.baz
```

Here is the Galaxy requirements file, `ansible/requirements.yml`:

```
---
- bar.baz
```

We should first install the Galaxy role dependencies, to download the `bar.baz` role:

```
(kayobe) $ kayobe control host bootstrap
```

Then, to run the `foo.yml` playbook:

```
(kayobe) $ kayobe playbook run $KAYOBE_CONFIG_PATH/ansible/foo.yml
```

1.4 Developer Documentation

1.4.1 Kayobe Development Guide

Vagrant

Kayobe provides a Vagrantfile that can be used to bring up a virtual machine for use as a development environment. The VM is based on the stackhpc/centos-7 CentOS 7 image, and supports the following providers:

- VirtualBox
- VMWare Fusion

The VM is configured with 4GB RAM. It has a single private network in addition to the standard Vagrant NAT network.

Preparation

First, ensure that Vagrant is installed and correctly configured to use the required provider. Also install the following vagrant plugin:

```
vagrant plugin install vagrant-reload
```

If using the VirtualBox provider, install the following vagrant plugin:

```
vagrant plugin install vagrant-vbguest
```

Note: if using Ubuntu 16.04 LTS, you may be unable to install any plugins. To work around this install the upstream version from www.virtualbox.org.

Usage

Later sections in the development guide cover in more detail how to use the development VM in different configurations. These steps cover bringing up and accessing the VM.

Clone the kayobe repository:

```
git clone https://git.openstack.org/openstack/kayobe.git
```

Change the current directory to the kayobe repository:

```
cd kayobe
```

Inspect kayobe's `Vagrantfile`, noting the provisioning steps:

```
less Vagrantfile
```

Bring up a virtual machine:

```
vagrant up
```

Wait for the VM to boot, then SSH in:

```
vagrant ssh
```

Manual Setup

This section provides a set of manual steps to set up a development environment for an OpenStack controller in a virtual machine using Vagrant and Kayobe.

For a more automated and flexible procedure, see *Automated Setup*.

Preparation

Follow the steps in *Vagrant* to prepare your environment for use with Vagrant and bring up a Vagrant VM.

Manual Installation

Sometimes the best way to learn a tool is to ditch the scripts and perform a manual installation.

SSH into the controller VM:

```
vagrant ssh
```

Source the kayobe virtualenv activation script:

```
source kayobe-venv/bin/activate
```

Change the current directory to the Vagrant shared directory:

```
cd /vagrant
```

Source the kayobe environment file:

```
source kayobe-env
```

Bootstrap the kayobe Ansible control host:

```
kayobe control host bootstrap
```

Configure the controller host:

```
kayobe overcloud host configure
```

At this point, container images must be acquired. They can either be built locally or pulled from an image repository if appropriate images are available.

Either build container images:

```
kayobe overcloud container image build
```

Or pull container images:

```
kayobe overcloud container image pull
```

Deploy the control plane services:

```
kayobe overcloud service deploy
```

Source the OpenStack environment file:

```
source ${KOLLA_CONFIG_PATH:-/etc/kolla}/admin-openrc.sh
```

Perform post-deployment configuration:

```
kayobe overcloud post configure
```

Next Steps

The OpenStack control plane should now be active. Try out the following:

- register a user
- create an image
- upload an SSH keypair
- access the horizon dashboard

The cloud is your oyster!

To Do

Create virtual baremetal nodes to be managed by the OpenStack control plane.

Automated Setup

This section provides information on the development tools provided by kayobe to automate the deployment of various development environments.

For a manual procedure, see *Manual Setup*.

Overview

The kayobe development environment automation tooling is built using simple shell scripts. Some minimal configuration can be applied by setting the environment variables in *dev/config.sh*. Control plane configuration is typically provided via the kayobe-config-dev repository, although it is also possible to use your own kayobe configuration. This allows us to build a development environment that is as close to production as possible.

Environments

The following development environments are supported:

- Overcloud (single OpenStack controller)
- Seed hypervisor
- Seed VM

The seed VM environment may be used in an environment already deployed as a seed hypervisor.

Overcloud

Preparation

Clone the kayobe repository:

```
git clone https://git.openstack.org/openstack/kayobe.git
```

Change the current directory to the kayobe repository:

```
cd kayobe
```

Clone the `kayobe-config-dev` repository to `config/src/kayobe-config`:

```
mkdir -p config/src
git clone https://git.openstack.org/openstack/kayobe-config-dev.git config/src/kayobe-
↪config
```

Inspect the kayobe configuration and make any changes necessary for your environment.

If using Vagrant, follow the steps in *Vagrant* to prepare your environment for use with Vagrant and bring up a Vagrant VM.

If not using Vagrant, the default development configuration expects the presence of a bridge interface on the OpenStack controller host to carry control plane traffic. The bridge should be named `breth1` with a single port `eth1`, and an IP address of `192.168.33.3/24`. This can be modified by editing `config/src/kayobe-config/etc/kayobe/inventory/group_vars/controllers/network-interfaces`. Alternatively, this can be added using the following commands:

```
sudo ip l add breth1 type bridge
sudo ip l set breth1 up
sudo ip a add 192.168.33.3/24 dev breth1
sudo ip l add eth1 type dummy
sudo ip l set eth1 up
sudo ip l set eth1 master breth1
```

Usage

If using Vagrant, SSH into the Vagrant VM and change to the shared directory:

```
vagrant ssh
cd /vagrant
```

If not using Vagrant, run the `dev/install-dev.sh` script to install kayobe and its dependencies in a virtual environment:

```
./dev/install-dev.sh
```

Note: This will create an *editable install*. It is also possible to install kayobe in a non-editable way, such that changes will not been seen until you reinstall the package. To do this you can run `./dev/install.sh`.

Run the `dev/overcloud-deploy.sh` script to deploy the OpenStack control plane:

```
./dev/overcloud-deploy.sh
```

Upon successful completion of this script, the control plane will be active.

The control plane can be tested by running the `dev/overcloud-test.sh` script. This will run the `init-runonce` setup script provided by Kolla Ansible that registers images, networks, flavors etc. It will then deploy a virtual server instance, and delete it once it becomes active:

```
./dev/overcloud-test.sh
```

It is possible to test an upgrade by running the `dev/overcloud-upgrade.sh` script:

```
./dev/overcloud-upgrade.sh
```

Seed

These instructions cover deploying the seed services directly rather than in a VM. See *Seed VM* for instructions covering deployment of the seed services in a VM.

Preparation

Clone the kayobe repository:

```
git clone https://git.openstack.org/openstack/kayobe.git
```

Change to the `kayobe` directory:

```
cd kayobe
```

Clone the `kayobe-config-dev` repository to `config/src/kayobe-config`:

```
mkdir -p config/src
git clone https://git.openstack.org/openstack/kayobe-config-dev.git config/src/kayobe-
↪config
```

Inspect the kayobe configuration and make any changes necessary for your environment.

The default development configuration expects the presence of a bridge interface on the seed host to carry provisioning traffic. The bridge should be named `breth1` with a single port `eth1`, and an IP address of `192.168.33.5/24`. This can be modified by editing `config/src/kayobe-config/etc/kayobe/inventory/group_vars/seed/network-interfaces`. Alternatively, this can be added using the following commands:

```
sudo ip l add breth1 type bridge
sudo ip l set breth1 up
sudo ip a add 192.168.33.5/24 dev breth1
sudo ip l add eth1 type dummy
sudo ip l set eth1 up
sudo ip l set eth1 master breth1
```

Usage

Run the `dev/install.sh` script to install kayobe and its dependencies in a virtual environment:

```
./dev/install.sh
```

Run the `dev/seed-deploy.sh` script to deploy the seed services:

```
./dev/seed-deploy.sh
```

Upon successful completion of this script, the seed will be active.

Testing

The seed services may be tested using the Tenks project to create fake bare metal nodes.

Clone the tenks repository:

```
git clone https://git.openstack.org/openstack/tenks.git
```

Edit the Tenks configuration file, `dev/tenks-deploy-config-seed.yml`.

Run the `dev/tenks-deploy.sh` script to deploy Tenks:

```
./dev/tenks-deploy.sh ./tenks
```

Check that Tenks has created a VM called `controller0`:

```
sudo virsh list --all
```

Verify that VirtualBMC is running:

```
~/tenks-venv/bin/vbmc list
```

The machines and networking created by Tenks can be cleaned up via `dev/tenks-teardown.sh`:

```
./dev/tenks-teardown.sh ./tenks
```

Seed Hypervisor

The seed hypervisor development environment is supported for CentOS 7. The system must be either bare metal, or a VM on a system with nested virtualisation enabled.

Preparation

The following commands should be executed on the seed hypervisor.

Clone the kayobe repository:

```
git clone https://git.openstack.org/openstack/kayobe.git
```

Change the current directory to the kayobe repository:

```
cd kayobe
```

Clone the `add-seed-and-hv` branch of the `kayobe-config-dev` repository to `config/src/kayobe-config`:

```
mkdir -p config/src
git clone https://github.com/markgoddard/dev-kayobe-config -b add-seed-and-hv config/
↪src/kayobe-config
```

Inspect the kayobe configuration and make any changes necessary for your environment.

Usage

Run the `dev/install-dev.sh` script to install kayobe and its dependencies in a virtual environment:

```
./dev/install-dev.sh
```

Note: This will create an *editable install*. It is also possible to install kayobe in a non-editable way, such that changes will not been seen until you reinstall the package. To do this you can run `./dev/install.sh`.

Run the `dev/seed-hypervisor-deploy.sh` script to deploy the seed hypervisor:

```
./dev/seed-hypervisor-deploy.sh
```

Upon successful completion of this script, the seed hypervisor will be active.

Seed VM

The seed VM should be deployed on a system configured as a libvirt/KVM hypervisor, using *Seed Hypervisor* or otherwise.

Preparation

The following commands should be executed on the seed hypervisor.

Clone the kayobe repository:

```
git clone https://git.openstack.org/openstack/kayobe.git
```

Change to the `kayobe` directory:

```
cd kayobe
```

Clone the `add-seed-and-hv` branch of the `kayobe-config-dev` repository to `config/src/kayobe-config`:

```
mkdir -p config/src
git clone https://github.com/markgoddard/dev-kayobe-config -b add-seed-and-hv config/
↪src/kayobe-config
```

Inspect the kayobe configuration and make any changes necessary for your environment.

Usage

Run the `dev/install-dev.sh` script to install kayobe and its dependencies in a virtual environment:

```
./dev/install-dev.sh
```

Note: This will create an *editable install*. It is also possible to install kayobe in a non-editable way, such that changes will not been seen until you reinstall the package. To do this you can run `./dev/install.sh`.

Run the `dev/seed-deploy.sh` script to deploy the seed VM:

```
./dev/seed-deploy.sh
```

Upon successful completion of this script, the seed VM will be active. The seed VM may be accessed via SSH as the `stack` user:

```
ssh stack@192.168.33.5
```

It is possible to test an upgrade by running the `dev/seed-upgrade.sh` script:

```
./dev/seed-upgrade.sh
```

Development

Ansible Galaxy

Kayobe uses a number of Ansible roles hosted on Ansible Galaxy. The role dependencies are tracked in `requirements.yml`, and specify required versions. The process for changing a Galaxy role is as follows:

1. If required, develop changes for the role. This may be done outside of Kayobe, or by modifying the role in place during development. If upstream changes to the role have already been made, this step can be skipped.
2. Commit changes to the role, typically via a Github pull request.
3. Request that a tagged release of the role be made, or make one if you have the necessary privileges.
4. Ensure that automatic imports are configured for the role using e.g. a TravisCI webhook notification, or perform a manual import of the role on Ansible Galaxy.
5. Modify the version in `requirements.yml` to match the new release of the role.

Testing

Kayobe has a number of test suites covering different areas of code. Many tests are run in virtual environments using `tox`.

Preparation

System Prerequisites

The following packages should be installed on the development system prior to running kayobe's tests.

- Ubuntu/Debian:

```
sudo apt-get install build-essential python-dev libssl-dev python-pip git
```

- Fedora 21/RHEL7/CentOS7:

```
sudo yum install python-devel openssl-devel python-pip git gcc
```

- Fedora 22 or higher:

```
sudo dnf install python-devel openssl-devel python-pip git gcc
```

- OpenSUSE/SLE 12:

```
sudo zypper install python-devel python-pip libopenssl-devel git
```

Python Prerequisites

If your distro has at least `tox 1.8`, use your system package manager to install the `python-tox` package. Otherwise install this on all distros:

```
sudo pip install -U tox
```

You may need to explicitly upgrade `virtualenv` if you've installed the one from your OS distribution and it is too old (tox will complain). You can upgrade it individually, if you need to:

```
sudo pip install -U virtualenv
```

Running Unit Tests Locally

If you haven't already, the kayobe source code should be pulled directly from git:

```
# from your home or source directory
cd ~
git clone https://git.openstack.org/openstack/kayobe.git
cd kayobe
```

Running Unit and Style Tests

Kayobe defines a number of different tox environments in `tox.ini`. The default environments may be displayed:

```
tox -list
```

To run all default environments:

```
tox
```

To run one or more specific environments, including any of the non-default environments:

```
tox -e <environment>[,<environment>]
```

Environments

The following tox environments are provided:

alint Run Ansible linter.

ansible Run Ansible tests for some ansible roles using Ansible playbooks.

ansible-syntax Run a syntax check for all Ansible files.

docs Build Sphinx documentation.

molecule Run Ansible tests for some Ansible roles using the molecule test framework.

pep8 Run style checks for all shell, python and documentation files.

py27,py34 Run python unit tests for kayobe python module.

Writing Tests

Unit Tests

Unit tests follow the lead of OpenStack, and use `unittest`. One difference is that tests are run using the discovery functionality built into `unittest`, rather than `ostestr`/`stestr`. Unit tests are found in `kayobe/tests/unit/`, and should be added to cover all new python code.

Ansible Role Tests

Two types of test exist for Ansible roles - pure Ansible and molecule tests.

Pure Ansible Role Tests

These tests exist for the `kolla-ansible` role, and are found in `ansible/<role>/tests/*.yml`. The role is exercised using an ansible playbook.

Molecule Role Tests

Molecule is an Ansible role testing framework that allows roles to be tested in isolation, in a stable environment, under multiple scenarios. Kayobe uses Docker engine to provide the test environment, so this must be installed and running on the development system.

Molecule scenarios are found in `ansible/<role>/molecule/<scenario>`, and defined by the config file `ansible/<role>/molecule/<scenario>/molecule.yml` Tests are written in python using the pytest framework, and are found in `ansible/<role>/molecule/<scenario>/tests/test_*.py`.

Molecule tests currently exist for the `kolla-openstack` role, and should be added for all new roles where practical.

Releases

The project creator's guide provides information on release management. As Kayobe is not an official project, it cannot use the official release tooling in the `openstack/releases` repository.

There are various useful files in the `openstack-infra/project-config` repository. In particular, see the `release.sh` and `make_branch.sh` scripts.

Preparing for a release

Synchronise kayobe-config

Ensure that configuration defaults in `kayobe-config` are in sync with those under `etc/kayobe` in `kayobe`. This can be done via:

```
cp -aR kayobe/etc/kayobe/* kayobe-config/etc/kayobe
```

Commit the changes and submit for review.

Synchronise kayobe-config-dev

Ensure that configuration defaults in `kayobe-config-dev` are in sync with those in `kayobe-config`. This requires a little more care, since some configuration options have been changed from the defaults. Choose a method to suit you and be careful not to lose any configuration.

Commit the changes and submit for review.

Add a prelude to release notes

It's possible to add a prelude to the release notes for a particular release using a `prelude` section in a `reno` note.

Creating a release candidate

Prior to cutting a stable branch, the `master` branch should be tagged as a release candidate. This allows the `reno` tool to determine where to stop searching for release notes for the next release. The tag should take the following form: `<release tag>.0rc$n`, where `$n` is the release candidate number.

The `tools/release.sh` script in the `kayobe` repository can be used to tag a release and push it to Gerrit. For example, to tag and release the `kayobe` deliverable release candidate `4.0.0.0rc1` in the Queens series from the base of the `stable/queens` branch:

```
ref=$(git merge-base origin/stable/queens origin/master)
./tools/release.sh kayobe 4.0.0.0rc1 $ref queens
```

Creating a stable branch

Stable branches should be cut for each Kayobe deliverable (`kayobe`, `kayobe-config`, `kayobe-config-dev`).

To create a branch `<new branch>` at commit `<ref>`:

```
cd /path/to/repo
git checkout -b <new branch> <ref>
git review -s
git push gerrit <new branch>
```

After creating the branch, on the new branch:

- update the `.gitreview` file on the new branch, for example: https://review.openstack.org/609735
- update the references to upper-constraints to use the stable branch, For example https://review.openstack.org/#/c/568804.

For the kayobe repo only, on the master branch:

- update the release notes for the new release series: https://review.openstack.org/609742

Creating a release

Prerequisites

Creating a signed tagged release requires a GPG key to be used. There are various resources for how to set this up, including https://help.ubuntu.com/community/GnuPrivacyGuardHowto. Your default Gerrit email should be added to the key, and the key should be trusted ultimately, see https://wiki.openstack.org/wiki/Oslo/ReleaseProcess#Setting_Up_GPG for information.

Tagging a release

Tags should be created for each deliverable (`kayobe`, `kayobe-config`, `kayobe-config-dev`). Currently the same version is used for each.

The `tools/release.sh` script in the `kayobe` repository can be used to tag a release and push it to Gerrit. For example, to tag and release the `kayobe` deliverable version `4.0.0` in the Queens series from the tip of the `stable/queens` branch:

```
./tools/release.sh kayobe 4.0.0 origin/stable/queens queens
```

Post-release activites

An email will be sent to the release-announce mailing list about the new release.

The release notes and documentation are built automatically via a webhook.

How to Contribute

If you would like to contribute to the development of OpenStack, you must follow the steps in this page:

> http://docs.openstack.org/infra/manual/developers.html

If you already have a good understanding of how the system works and your OpenStack accounts are set up, you can skip to the development workflow section of this documentation to learn how changes to OpenStack should be submitted for review via the Gerrit tool:

> http://docs.openstack.org/infra/manual/developers.html#development-workflow

Pull requests submitted through GitHub will be ignored.

Bugs should be filed on StoryBoard, not GitHub:

> https://storyboard.openstack.org/