Enos Documentation

Release 6.0.2

discovery

Aug 03, 2020

Contents:

Hint: The source code is available at https://github.com/BeyondTheClouds/enos

Enos deploys OpenStack and targets reproducible experiments. It allows easy:

- deployment of the system
- customization of the system
- benchmarking of the system
- visualization of various metrics

Enos is developed in the context of the Discovery initiative.

CHAPTER 1

Enos workflow

A typical experiment using Enos is the sequence of several phases:

- `enos up` : Enos will read the configuration file, get machines from the resource provider and will prepare the next phase
- `enos os` : Enos will deploy OpenStack on the machines. This phase rely highly on Kolla deployment.
- `enos init-os` : Enos will bootstrap the OpenStack installation (default quotas, security rules, . . .)
- `enos bench` : Enos will run a list of benchmarks. Enos support Rally and Shaker benchmarks.
- `enos backup` : Enos will backup metrics gathered, logs and configuration files from the experiment.

1.1 Getting Started

1.1.1 Installation

```
$ pip install -U enos
```

You may prefer to go with a virtualenv. Please refer to the virtualenv documentation and the rest of this section for further information.

Then install enos inside a virtualenv (python3.5+ required):

```
$ mkdir my-experiment && cd my-experiment
$ virtualenv -p python3 venv
$ source venv/bin/activate
(venv) $ pip install -U pip
(venv) $ pip install enos
```

Note: The latest *packaged* version of enos will install the latest *stable* version of OpenStack. If you want to install the development version of OpenStack, you should install enos from sources (see *Contribute*).

1.1.2 Configuration

To get started you can get the sample configuration file and edit it:

```
$ enos new > reservation.yaml
$ <editor> reservation.yaml
```

The configuration may vary from one provider to another, please refer to the dedicated *Provider* configuration

Note: If a key is defined several times in the configuration file, only the last occurence will be taken into account. In particular to switch from one provider to another, you can move down the key `provider` and its associated `resources` key.

1.1.3 Deployment

Once your configuration is done, you can launch the deployment :

```
(venv) $ enos deploy
```

The deployment is the combination of the following three phases:

1. Acquire the raw resources that are necessary for the deployment of OpenStack. Enos acquires resources according to the `provider` and `resources` information in the reservation file. One can perform this phase by calling `enos up`.
2. Deploy OpenStack to the resources acquired during the previous phase. Enos uses the resource list provided by the previous phase and combines it with the information specified in the file targeted by the `inventory` key to produce a file that gives a mapping of which OpenStack services have to be deployed to which resources. Enos then calls the Kolla-Ansible tool with this file to deploy the containerized OpenStack services to the right resources. One can perform this phase by calling `enos os`.

   Note: If you don't provide an `inventory` in your current working directory, then Enos uses a default one. You can view it on GitHub at enos/inventories/inventory.sample. Note that the produced file is available at `cwd/current/multinode` (with `cwd` referencing to your current working directory).

   Warning: If you run Enos on macOS, chances are that the BSD version of *docopt* has been installed. Since it is not compatible with Kolla-Ansible, it leads to failures during the second phase of Enos. macOS users should first install the GNU version of *docopt*, and call `enos deploy` or `enos os` with an appropriate PATH environment variable:

   ```
   (venv) $ brew install gnu-docopt
   (venv) $ PATH="/usr/local/opt/gnu-getopt/bin:$PATH" enos deploy
   ```

3. Initialize the freshly deployed OpenStack. Enos initializes OpenStack with the bare necessities, i.e., install a `member` role, download and install a cirros image, install default flavors (m1.tiny, . . . , m1.xlarge) and setup a network (one public/one private). One can perform this phase by calling `enos init`.

1.2 Provider

Enos offers to test different OpenStack deployments over some resources. In the context of Enos, a resource is anything Enos can SSH on and start a Docker daemon. Thus, a resource could be a bare-metal machine, a virtual machine, or a container resource depending on the testbed used for conduction the experiments. To get these resources, Enos relies on a notion of *provider* and already implements the followings:

1.2.1 Static

The static provider reuses already available resources (machines, network) to deploy OpenStack on.

Installation

Refer to the *Getting Started* section to install Enos.

Configuration

The static provider requires already running resources to deploy OpenStack on. Information in the provider description tells Enos where these resources are and how to access to them.

The following shows an example of possible description. It can serve as basis to build your own configuration that will fit your environment.

```
enable_monitoring: false
hosts:
  1: &id002
    address: 192.168.142.245
    alias: enos-0
    keyfile: .vagrant/machines/enos-0/libvirt/private_key
    user: root
  2: &id003
    address: 192.168.142.244
    alias: enos-1
    keyfile: .vagrant/machines/enos-1/libvirt/private_key
    user: root
  3: &id001
    address: 192.168.142.243
    alias: enos-2
    keyfile: .vagrant/machines/enos-2/libvirt/private_key
    user: root
inventory: inventories/inventory.sample
kolla:
  kolla_base_distro: centos
  kolla_install_type: source
  nova_compute_virt_type: qemu
kolla_ref: stable/stein
kolla_repo: https://git.openstack.org/openstack/kolla-ansible
provider:
  networks:
  - cidr: 192.168.142.0/24
    dns: 8.8.8.8
    end: 192.168.142.119
    gateway: 192.168.142.1
```

(continues on next page)

(continued from previous page)

```
    roles:
    - network_interface
    start: 192.168.142.3
  - cidr: 192.168.143.0/24
    dns: 8.8.8.8
    end: 192.168.143.119
    gateway: 192.168.143.1
    roles:
    - neutron_external_interface
    start: 192.168.143.3
  type: static
registry:
  type: none
resources:
  compute:
  - *id001
  control:
  - *id002
  network:
  - *id003
```

Note that the above example is based on running machines given by vagrant and the libvirt provider following this `Vagrantfile`

In the `resources` there must be at least one host entry for each of the following names:

- control
- compute
- network

In the `networks` section of the provider, a network with role *network_interface* must be define. For more information on network roles please refer to the kolla documentation.

1.2.2 Grid'5000

Installation

Connect to a Grid'5000 frontend of your choice. Then, refer to the *Getting Started* section to install Enos.

To access the Grid'5000 API, you must configure python-grid5000. Please refer to the corresponding documentation

If the *virtualenv* module is missing:

```
$ pip install virtualenv --user     # Install virtualenv
$ export PATH=~/.local/bin/:${PATH} # Put it into your path
```

Basic configuration

The provider relies on cluster names to group the wanted resources. For example the following is a valid resources description:

```
enable_monitoring: false
inventory: inventories/inventory.sample
kolla:
```

(continues on next page)

(continued from previous page)

```
  enable_heat: false
  kolla_base_distro: centos
  kolla_install_type: source
kolla_ref: stable/stein
kolla_repo: https://git.openstack.org/openstack/kolla-ansible
provider:
  job_name: enos-jenkins
  type: g5k
  walltime: 02:00:00
registry:
  type: internal
resources:
  paravance:
    compute: 1
    control: 1
    network: 1
```

Deployment

We suggest you to run the deployment from a dedicated node (especially for large deployment). For now the recommended way to do so is to reserve one node prior of your reservation. In the case of an interactive deployment:

```
frontend$ oarsub -I -l 'walltime=2:00:00'
node$ source venv/bin/activate
node$ <edit configuration>
node$ enos deploy
```

Note:

You'll need to configure the access to the Grid'5000 API by setting the following in your `~/.execo.conf.py`:

```
# ~/.execo.conf.py
g5k_configuration = {
    'api_username': "your username",
    'api_verify_ssl_cert': False
}
```

Default provider configuration

The provider comes with the following default options:

```
DEFAULT_CONFIG = {
    'job_name': 'Enos',             # Job name in oarstat/gant
    'walltime': '02:00:00',         # Reservation duration time
    'env_name': 'debian9-x64-nfs',  # Environment to deploy
    'reservation': '',           # Reservation date
    'job_type': 'deploy',           # deploy, besteffort, ...
    'queue': 'default'              # default, production, testing
}
```

They can be overriden in the configuration file.

Advanced Configuration

The following is equivalent to the basic configuration but allows for a finer grained definition of the resources and associated roles.

```
inventory: inventories/inventory.sample
kolla:
  enable_heat: false
  kolla_base_distro: centos
  kolla_install_type: source
kolla_ref: stable/stein
kolla_repo: https://git.openstack.org/openstack/kolla-ansible
provider:
  job_name: enos-jenkins
  resources:
    machines:
    - cluster: paravance
      nodes: 1
      primary_network: int-net
      role: control
      secondary_networks:
      - ext-net
    - cluster: paravance
      nodes: 1
      primary_network: int-net
      role: compute
      secondary_networks:
      - ext-net
    - cluster: paravance
      nodes: 1
      primary_network: int-net
      role: network
      secondary_networks:
      - ext-net
    networks:
    - id: int-net
      role: network_interface
      site: rennes
      type: kavlan
    - id: ext-net
      role: neutron_external_interface
      site: rennes
      type: kavlan
  role_distribution: debug
  type: g5k
  walltime: 02:00:00
registry:
  type: internal
```

Reservation

In order to reserve in advance the ressources needed by your deployment you can set the `reservation` key to the desired sart date. And launch `enos deploy`.

```
# Reserve the 29. February 2020 at 19:00:00 for 14 hours
provider:
```

(continues on next page)

(continued from previous page)

```
  type: g5k
  ...
  reservation: 2020-02-29 19:00:00
  walltime: 14:00:00
  ...
```

EnOS will wait for the job to start. You can keep the process running in the background (e.g using a screen). Alternatively you can stop it (once the reservation is done) and relaunch it later with the exact same configuration file. For this purpose you can leverage the `-f` options of EnOS.

Building an Environment

A personalised environment stored in Grid'5000, containing all the dependencies to install OpenStack in subsequent deployments, may be built directly from command line on-the-fly without and intermediary deploy execution. Run the command `enos build g5k`, changing the default values accordingly (specially the `--cluster` one).

In order to complete the environment construction, after the execution of EnOS on the frontend execute the `tgz-g5k` command following the instructions of the Grid5000 documentation to finish the registration of the new environment.

Once the environment is registered in the database, the name of this environment can be used in the EnOS configuration replacing the default one. For example, let's suppose we want to use a personalised environment named `enos-debian9-x64-openstack`, then the configuration can be set as follows:

```
provider:
  type: g5k
  env_name: enos-debian9-x64-openstack
  ...
```

1.2.3 Vagrant

Installation

To get started with the vagrant provider, you need to install

- Vagrant

You'll also need a virtualization backend. EnOS supports both Virtualbox and Libvirt as shown below.

Then, refer to the *Getting Started* section to install Enos.

Basic Configuration

The provider relies on virtual machine sizes to group the wanted resources. For example the following is a valid configuration

```
enable_monitoring: false
inventory: inventories/inventory.sample
kolla:
  enable_heat: 'no'
  kolla_base_distro: centos
  kolla_install_type: source
  nova_compute_virt_type: qemu
kolla_ref: stable/stein
```

(continues on next page)

(continued from previous page)

```
kolla_repo: https://git.openstack.org/openstack/kolla-ansible
provider:
  backend: virtualbox
  box: generic/debian9
  type: vagrant
registry:
  type: internal
resources:
  extra-large:
    control: 1
  medium:
    compute: 1
    network: 1
```

The list of the sizes may be found here.

By default virtualbox will be used. See below to learn how to change the default virtualbox backend.

Use libvirt as the backend for Vagrant

Declaring your provider options as the following will spin up virtual machines using libvirt. Note that vagrant libvirt must be installed on your system.

```
enable_monitoring: false
inventory: inventories/inventory.sample
kolla:
  enable_heat: 'no'
  kolla_base_distro: centos
  kolla_install_type: source
  nova_compute_virt_type: qemu
kolla_ref: stable/stein
kolla_repo: https://git.openstack.org/openstack/kolla-ansible
provider:
  backend: libvirt
  box: generic/debian9
  type: vagrant
registry:
  type: internal
resources:
  extra-large:
    control: 1
  medium:
    compute: 1
    network: 1
```

Use the advanced syntax

The following is equivalent to the basic configuration but allows for a finer grained definition of the resources and associated roles.

```
enable_monitoring: false
inventory: inventories/inventory.sample
kolla:
  enable_heat: 'no'
```

(continues on next page)

(continued from previous page)

```
  kolla_base_distro: centos
  kolla_install_type: source
kolla_ref: stable/stein
kolla_repo: https://git.openstack.org/openstack/kolla-ansible
provider:
  backend: libvirt
  box: generic/debian9
  resources:
    machines:
    - flavor: extra-large
      networks:
      - network_interface
      - neutron_external_interface
      number: 1
      role: control
    - flavor: medium
      networks:
      - network_interface
      - neutron_external_interface
      number: 1
      role: compute
    - flavor: medium
      networks:
      - network_interface
      - neutron_external_interface
      number: 1
      role: network
  type: vagrant
registry:
  type: internal
```

Default Configuration

```
DEFAULT_CONFIG = {
    'backend': 'virtualbox',
    'box': 'generic/debian9',
    'user': 'root',
}
```

Build a Box

A reference box for Vagrant, containing all the dependencies to install OpenStack in subsequent deployments, may be built directly from command line on-the-fly without an intermediary deploy execution. Run the command `enos build vagrant`, changing the default values accordingly.

In order to complete the box construction, after the execution of EnOS execute the following commands to register a box named `personal/enos-box-openstack`:

```
> vagrant package
> vagrant box add package.box --name personal/enos-box-openstack
```

Once the box is registed in the vagrant catalog, the name of this box can be used in the EnOS configuration replacing the default one. For example:

```
provider:
  type: vagrant
  backend: virtualbox
  box: personal/enos-box-openstack
  ...
```

1.2.4 Virtual Machines on Grid'5000

It is possible to deploy virtual machines on top of bare nodes of Grid'5000. This hybrid approach is useful to take advantage of all resources available in each node. In this way several virtual machines with different roles can be coexist at the same time in a single node depending on the requirements. Actually, in the current implementation machines with different roles will not be colocalized (enoslib limitation) but several those with the same role can coexist. The provisioning of the virtual machines and their deployment is transparent to the user.

Basic configuration

The `vmong5k` provider relies on cluster names to group wanted resources in the same way the Grid'5000 provider does. It also take advantage of the virtual machine sizes of the Vagrant provider to describe resources.

Refer to the *Getting Started* section to install EnOS.

To access the Grid'5000 API, you must configure python-grid5000. Please refer to the corresponding documentation

The following is a valid resource description:

```
enable_monitoring: false
inventory: inventories/inventory.sample
kolla:
  enable_heat: false
  kolla_base_distro: centos
  kolla_install_type: source
kolla_ref: stable/stein
kolla_repo: https://git.openstack.org/openstack/kolla-ansible
provider:
  job_name: enos-jenkins
  type: vmong5k
  walltime: 01:00:00
registry:
  type: internal
resources:
  parapluie:
    compute: 1
    control: 1
  paravance:
    network: 1
```

Deployment

We suggest running the deployment from a dedicated node (specially for large deployments). To reserve a node prior the deployment and launch the deployment you can execute the commands after creating a valid configuration file and setting up the appropriate execution environment for EnOS:

```
frontend> oarsub -I -l 'walltime=2:00:00'
node> enos deploy
```

Default Provider Configuration

The provider comes with the following default options:

```
DEFAULT_CONFIG = {
    'job_name': 'enos-vmong5k',
    'walltime': '02:00:00'
}

DEFAULT_FLAVOUR_BY_ROLE = {
    'control': 'extra-large',
    'network': 'large',
    'compute': 'medium'
}
```

These values be overridden in the configuration file.

Note: Some default values are implicit. They are the defaults from the other providers involved in the deployment and execution.

Advanced Configurations

A configuration equivalent to the basic one presented before shows a finer and more explicit definition of the resources:

```
enable_monitoring: false
inventory: inventories/inventory.sample
kolla:
  enable_heat: false
  kolla_base_distro: centos
  kolla_install_type: source
kolla_ref: stable/stein
kolla_repo: https://git.openstack.org/openstack/kolla-ansible
provider:
  image: /grid5000/virt-images/debian9-x64-base.qcow2
  job_name: enos-jenkins
  resources:
    machines:
    - cluster: parapluie
      flavour: medium
      nodes: 1
      roles:
      - compute
    - cluster: parapluie
      flavour: extra-large
      nodes: 1
      roles:
      - control
    - cluster: paravance
      flavour_desc:
        core: 4
        mem: 4096
      nodes: 1
      roles:
      - network
    networks:
```

(continues on next page)

(continued from previous page)

```
    - network_interface
  type: vmong5k
  walltime: 01:00:00
registry:
  type: internal
```

Other possibilities includes the customization of the topology, networking, etc. These options are described in *Customizations* and *Network Emulation*.

Note: The flavor of the resource can be set by name or using an inline description with `flavour_desc` as is the case of the network in the example.

Build an Image

A personalised image created and stored in Grid'5000, containing all the dependencies to install OpenStack in subsequent deployments, may be built directly from the command line on-the-fly without any intermediary deploy execution. Run the command `enos build vmong5k`, changing the default values accordingly (specially the `--cluster` one).

In order to complete the image construction, after the execution of EnOS, a file with the same name of the virtual machine created during the enactment (for example: `vm-ac28907433b45227ee0d784d24ac91fb-1-0`) is located in the directory configured with the argument `--directory` (default `~/.enos`). Rename this file and placed it in a permanent location visible on Grid'5000 such as `~/public/enos-openstack-image.qcow2`, then the configuration can reuse that image setting the image as follows:

```
provider:
  type: vmong5k
  image: ~/public/enos-openstack-image.qcow2
  ...
```

1.2.5 Openstack

The OpenStack provider allows you to use Enos on an OpenStack cloud. In other words this lets you run OpenStack on OpenStack. In the following, the under-cloud is the underlying OpenStack infrastructure, the over-cloud is the OpenStack configured by Enos.

The over-cloud configured by Enos needs a set of resources to be present on the under-cloud. The first step in the deployment workflow consists in checking or creating such resources. Some resources are mandatory and must be present before the deployment (base image, keypairs, ...), some others can be created or reused during the deployment (private networks). For the latter, you can use the default values set by the provider.

For specific under-clouds (e.g Chameleon), specific providers deriving from the OpenStack provider may be used. They will enforce more default values that fit the under-cloud specificities (e.g specific DNS, base image, ...)

Installation

In addition refer to *Getting Started*, extra dependencies are required. You can install them with

```
pip install enos[openstack]
```

Basic Configuration

The provider relies on flavor names to group the wanted resources. The folliwing gives an idea of the resource description available.

```
provider:
  type: openstack
  <options see below>

resources:
  m1.medium:
    control: 1
    network: 1
  m1.small:
    compute: 10
```

Default provider configuration

The OpenStack provider is shipped with the following default options. These options will be set automatically and thus may be omitted in the configuration file.

```
DEFAULT_CONFIG = {
    "type": "openstack",

    # True if Enos needs to create a dedicated network to work with
    # False means you already have a network, subnet and router to
    # your ext_net configured
    "configure_network": True,

    # Name of the network to use or to create
    # It will be use as external network for the upper-cloud
    "network": {'name': 'enos-network'},

    # Name of the subnet to use or to create
    "subnet": {'name': 'enos-subnet', 'cidr': '10.87.23.0/24'},

    # DNS server to use when creating the network
    "dns_nameservers": ['8.8.8.8', '8.8.4.4'],

    # Floating ips pool
    "allocation_pool": {'start': '10.87.23.10', 'end': '10.87.23.100'},

    # Whether one machine must act as gateway
    # - False means that you can connect directly to all the machines
    # started by Enos
    # - True means that one machine will be assigned a floating ip and used
    # as gateway to the others
    "gateway": True,

    # MANDATORY OPTIONS
    'key_name': None,
    'image': None,
    'user': None
}
```

These options can be overriden in the provider config.

Deployment

Enos will interact with the remote OpenStack APIs. In order to get authenticated you must source your rc file. To use Enos on Openstack there are two distinct cases :

- You have direct access to all your machines. You can set `gateway: False`

Hint: In this case, prior to the Enos deployment, you have probably started a machine to act as a frontend. This machine is in the same network as those used by Enos

---

- You don't have direct access to all your machines. You have to set `gateway: True` in the configuration. EnOS will use a freshly started server as a gateway to access the other nodes.

1.2.6 Chameleon Cloud (KVM)

This provider is an OpenStack based provider where some options are set to fit the folllowing platform :

- https://openstack.tacc.chameleoncloud.org

Basic Configuration

As more default values can be enforced automatically, the following is a valid resources description.

```
enable_monitoring: false
inventory: inventories/inventory.sample
kolla:
  enable_heat: false
  kolla_base_distro: centos
  kolla_install_type: source
kolla_ref: stable/stein
kolla_repo: https://git.openstack.org/openstack/kolla-ansible
provider:
  gateway: true
  key_name: enos_matt
  type: chameleonkvm
registry:
  type: internal
resources:
  m1.medium:
    compute: 1
    control: 1
    network: 1
```

Default provider configuration

The following options will be set automatically and thus may be omitted in the configuration file :

```
DEFAULT_CONFIG = {
    'type': 'chameleonkvm',
    'image': 'CC-Ubuntu16.04',
    'user': 'cc',
    'dns_nameservers': ['129.114.97.1',
                        '129.114.97.2',
```

(continues on next page)

(continued from previous page)

```
                          '129.116.84.203']
}
```

These options can be overriden in the provider config.

1.2.7 Chameleon Cloud (Bare Metal)

This provider is an OpenStack based provider where some options are set to fit the following platforms :

- https://chi.uc.chameleoncloud.org/
- https://chi.tacc.chameleoncloud.org/

The provider interacts with blazar to claim automatically a lease.

Basic Configuration

```
enable_monitoring: false
inventory: inventories/inventory.sample
kolla:
  enable_heat: false
  kolla_base_distro: centos
  kolla_install_type: source
kolla_ref: stable/stein
kolla_repo: https://git.openstack.org/openstack/kolla-ansible
provider:
  gateway: true
  key_name: enos_matt
  type: chameleonbaremetal
registry:
  type: internal
resources:
  compute_haswell:
    compute: 1
    control: 1
    network: 1
```

Note that on Chameleon, they are two groups of machines : compute and storage.

Default provider configuration

The following options will be set automatically and thus may be omitted in the configuration file.

```
DEFAULT_CONFIG = {
    'type': 'chameleonbaremetal',
    # Name os the lease to use
    'lease_name': 'enos-lease',
    # Glance image to use
    'image': 'CC-Ubuntu16.04',
    # User to use to connect to the machines
    # (sudo will be used to configure them)
    'user': 'cc',
    # True iff Enos must configure a network stack for you
    'configure_network': False,
```

(continues on next page)

(continued from previous page)

```
    # Name of the network to use or to create
    'network': {'name': 'sharednet1'},
    # Name of the subnet to use or to create
    'subnet': {'name': 'sharednet1-subnet'},
    # DNS server to use when creating network
    'dns_nameservers': ['130.202.101.6', '130.202.101.37'],
    # Experiment duration
    'walltime': '02:00:00',
}
```

These options can be overriden in the provider config.

Warning: A shared-network is used and may limit the features of the over-cloud (e.g floating ips)

1.2.8 Custom Provider

See *Write a new provider*.

1.3 Enos command line

Once installed Enos give you access to its command line. Please refer to the output of `enos -h`. For a specific command you can use `enos <command> -h`

1.4 Benchmarks

Benchmarks are run by Enos by the mean of a workload description. A workload is a set of scenarios grouped by type. A workload is launched with the following command:

```
(venv) $ enos bench --workload=workload
```

enos will look into the `workload` directory for a file named `run.yml`. This file is the description of the workload to launch. One example is given below:

```
rally:
  enabled: true  # default is true
  args:
    concurrency:
      - 1
      - 2
      - 4
    times:
      - 100
  scenarios:
    - name: boot and list servers
      enabled: true # default is true
      file: nova-boot-list-cc.yml
      args:
        sla_max_avg_duration: 30
        times: 50
```

This will launch all the scenarios described under the scenarios keys with all the possible parameters. The parameters are calculated using the cartesian product of the parameters given under the args keys. Locally defined args (scenario level) shadow globally defined args (top level). The same mechanism is applied to the `enabled` values. The scenario must be parameterized accordingly. The key (rally here) defines the type of benchmark to launch: in the future we may support other type of scenarios.

After running the workload, a backup of the environment can be done through `enos backup`.

1.4.1 Rally

Enos supports natively Rally scenarios. Please refer to the Rally documentation for any further information on this benchmarking tool.

Supported keys :

- `name`: the name of the scenario. Can be any string.
- `file`: must be the path to the scenario file. The path is relative to the `workload` directory
- `enabled`: Whether to run this scenario
- `args`: Any parameters that can be understood by the rally scenario
- `plugin`: must be the path to the plugin. The path is relative to the workload directory

1.4.2 Shaker

Enos supports natively Shaker scenarios. Please refer to the Shaker documentation for any further information on this benchmarking tool.

Supported keys :

- `name`: the name of the scenario. Can be any string.
- `file`: must be the alias of the scenario. Enos don't support custom scenario yet.
- `enabled`: Whether to run this scenario

1.4.3 Osprofiler

Supporting OSProfiler in Rally benchmarks is planned for Q3 2017.

1.5 Customizations

1.5.1 Changing Kolla / Ansible variables

Custom Kolla / Ansible parameters can be put in the configuration file under the key `kolla`. The complete list of Kolla variables can be found here.

For instance, Kolla uses the `openstack_release` parameter to fix the OpenStack version to deploy. So, Enos tells Kolla to deploy the `4.0.0` version with:

```
kolla:
  openstack_release: "4.0.0"
```

Note that the Kolla code varies from one version of OpenStack to another. You should always target a version of Kolla code that support the deployment of the expected OpenStack. To do so, you can change the git repository/reference of Kolla code with:

```
kolla_repo: "https://git.openstack.org/openstack/kolla-ansible"
kolla_ref: "stable/ocata"
```

You can also your own local clone of kolla-ansible with:

```
kolla_repo: "file:///path/to/local/kolla-ansible"
```

Note on the network interfaces:

Providers do their best to configure the network decently. This probably doesn't cover all the possible use cases. But, if you know what interfaces are configured by the provider you can specify a more precise allocation under the `kolla` key. For instance:

```
kolla:
  network_interface: eth1
  neutron_external_interface: eth2
  tunnel_interface: eth3
```

Running from kolla/master

if you want to live on the bleeding edge you can run the latest Kolla code with the latest built kolla images.

```
kolla_repo: "https://git.openstack.org/openstack/kolla-ansible"
kolla_ref: "master"

kolla:
  openstack_release: "master"
```

1.5.2 Changing the topology

Let's assume you want to run the `nova-conductor` in a dedicated node:

1. Add a new node reservation in the configuration file:

```
paravance:
  control: 1
  network: 1
  compute: 1
  conductor-node: 1
```

2. Create an new inventory file in the `inventories` subdirectory (copy paste the sample inventory) and change the group of the conductor service:

```
[nova-conductor:children]
conductor-node
```

3. In the configuration file, points the inventory to use to this new inventory.

4. Launch the deployment as usual, and you'll get the `nova-conductor` on a dedicated node.

1.5.3 Configuration tuning

At some point, Kolla default parameters won't fit your needs. Kolla provides a mechanism to override custom section of configuration files but isn't applicable in our case (at least in the corresponding branch). So we implement a *quick and dirty* way of patching Kolla code to enable custom configuration files to be used (and by extension custom kolla code). See the possible patch declaration in `ansible/group_vars/all.yml`. Patches should be added in the configuration file of the experiment and you can rely on the `{{ cwd }}` key to link patches in your current working directory.

For instance, adding the following in the configuration file tells enos to look into the current working directory for a file called `mariadb_boostrap.yml` that will replace the kolla-ansible mariadb start playbook.

```
patches:
- name: Patch mariadb start
  src: "{{ cwd }}"/mariadb_bootsrap.yml
  dst: kolla/ansible/roles/mariadb/tasks/start.yml
  enabled: "yes"
```

1.5.4 Ansible configuration

By default, Enos loads its own `ansible.cfg`. To use another Ansible configuration file, the `ANSIBLE_CONFIG` environment variable can be used. Further information can be found : see here.

1.5.5 Docker registry mirror configuration

EnOS can deploy a docker registry mirror in different ways. This is controlled by the configuration file.

No Registry mirror

```
registry:
  type: none
```

With the above configuration, EnOS won't deploy any registry mirror. Any docker agent in the deployment will use Docker Hub.

Internal Registry mirror

```
registry:
  type: internal
```

With the above configuration, EnOS deploys a fresh registry that acts as a private docker registry mirroring the official one and cache images close to your deployment resources.

This kind of registry can be made persistent by making sure the underlying storage backend is persitent. Historically, it has been provided on Grid5000 by linking a Ceph Rados Block to the registry backend. Thus you can use the following:

```
registry:
  type: internal
  ceph: true
  ceph_keyring: path to your keyring
```

(continues on next page)

(continued from previous page)

```
  ceph_id: your ceph id
  ceph_rbd: rbd in the form "pool/rbd"
  ceph_mon_host: list of ceph monitor addresses
```

Note: The `reservation.yaml.sample` file provides an example of Ceph configuration that relies on the G5k Ceph of Rennes. The G5k Ceph tutorial will guide you to create your own Rados Block Device.

External Registry mirror

```
registry:
  type: external
  ip: 192.168.142.253
  port: 5000
```

With the above configuration, EnOS will configure all the docker agents to access the registry located at *registry.ip:registry:port*. Note that registry must be an insecure registry.

Note: If you deploy the external registry mirror on the controller node of OpenStack, make sure the port 5000 don't collide with the port of Keystone.

When using EnOS locally, it's a good idea to keep a separated external registry to speed up the deployment.

1.5.6 Single interface deployment

Please refer to this discussion : https://github.com/BeyondTheClouds/enos/issues/227

1.6 Network Emulation

1.6.1 Links description

Enos allows to enforce network emulation in terms of latency and bandwidth limitations.

Network constraints (latency/bandwidth limitations) are enabled by the use of groups of nodes. Resources *must* be described using a `topology` description instead of a `resources` description. The following example will define 4 groups named `grp1`, `grp2`, `grp3` and `grp4` respectively:

```
topology:
  grp1:
    paravance:
      control: 1
      network: 1
  grp[2-4]:
    paravance:
      compute: 1
```

Constraints are then described under the `network_constraints` key in the configuration file:

```
network_constraints:
  enable: true
  default_delay: 25ms
  default_rate: 100mbit
  default_loss: 0.1%
  constraints:
    - src: grp1
      dst: grp[2-4]
      delay: 10ms
      rate: 1gbit
      loss: 0%
      symetric: true
```

To enforce the constraints, you can invoke:

```
enos tc
```

Note that The machines must be available, thus the *up* phase must have been called before.

As a result

- the network delay between every machines of `grp1` and the machines of the other groups will be 20ms (2x10ms: symetric)
- the bandwidth between every machines of `grp1` and the machines of the other groups will be 1 Gbit/s
- the packet loss percentage between every machines of `grp1` and the machines of the other groups will be 0%.
- the network delay between every machines of `grp2` and `grp3` (resp. `grp2` and `grp4`) (resp. `grp3` and `grp4`) will be 50ms
- the bandwidth between every machines of `grp2` and `grp3` (resp. `grp2` and `grp4`) (resp. `grp3` and `grp4`) will be 100Mbit/s
- the packet loss percentage between every machines of `grp2` and `grp3` (resp. `grp2` and `grp4`) (resp. `grp3` and `grp4`) will be 0.1%

1.6.2 Checking the constraints

Invoking

```
enos tc --test
```

will generate various reports to validate the constraints. They are based on `fping` and `flent` latency and bandwidth measurements respectively. The reports will be located in the result directory.

1.6.3 Notes

- `default_delay`, `default_rate`, `default_loss` are mandatory
- To disable the network constraints you can specify `enable: false` under the `network_constraints` key and launch again `enos tc`
- To exclude a group from any tc rule, you can add an optionnal `except` key to the `network_constraints`:

```
network_constraints:
  enable: true
  default_delay: 25ms
  default_rate: 100mbit
  default_loss: 0%
  constraints:
    - src: grp[1-3]
      dst: grp[4-6]
      delay: 10ms
      rate: 1gbit
      symetric: true
  except:
    - grp1
```

1.7 Analysis

1.7.1 Real-time

Setting `enable_monitoring: true` in the configuration file will deploy a monitoring stack composed of:

- Cadvisor and Collectd agents
- InfluxDB for metrics collection
- Graphana for the visualization / exploration

All these services are accessible on their default ports. For instance you'll be able to access grafana dashboards on port `3000` of the node hosting grafana.

Some dashboards are available in this grafana directory.

1.7.2 Post-mortem

TODO

1.7.3 Annotations

Enos embeds an Ansible plugin to add annotations in Grafana. These annotations are marked points which provide rich information about events when hovered over. Enos uses the `ansible.cfg` file that loads the plugin. The plugin can be disabled by editing the line `callback_whitelist = influxdb_events` in the `ansible.cfg`. Note also that the plugin is automaticaly disabled when the monitoring tools are not deployed (i.e. when *enable_monitoring = false* is set in the configuration file).

Once the deployment is finished, a compatible dashboard must be used in Grafana to display annotations. An example of such dashboard is available here.

1.8 Contribute

All contributions are welcome on BeyondTheClouds/enos. For any questions, feature requests, issues please use the GitHub issue tracker.

1.8.1 Install from sources and make them editable

```
$ git clone https://github.com/BeyondTheClouds/enos.git
$ cd enos
$ virtualenv --python=python3 venv
$ source venv/bin/activate
(venv) $ pip install -e .
```

1.8.2 Get tox

```
(venv) $ pip install tox
```

1.8.3 Running the tests

```
(venv) $ tox
```

1.8.4 Running syntax checker

```
(venv) $ tox -e pep8
```

1.8.5 Generate the documentation

```
(venv) $ tox -e docs
```

1.8.6 Other Topics

Write a new provider

The actual implementation gives providers for *Static* resources, *Vagrant*, *Grid'5000* and *Openstack* itself. If you want to support another testbed, then implementing a new provider is easy as 500 lines of Python code.

The new provider should follow the provider.py interface which consists in three methods: `init`, `destroy` and `default_config`. Another good starting point is the simple static implementation.

Init Method

The `init` method provides resources and provisions the environment. To let the provider knows what kind and how many resources should be provided, the method is fed with the `config` object that maps the reservations file. So a provider can access the resource description with:

```
rsc = config['resources']

# Use rsc to book resources ...
```

At the end of the `init`, the provider should return a list of host.py that Enos can SSH on, together with a pool of available IP for OpenStack Network.

Destroy Method

The `destoy` method destroys resources that have been used for the deployment. The provider can rely on the environment variable to get information related to its deployment.

Default Provider Configuration Methods

The `default_config` specifies keys used to configure the provider with a `dict`. A key could be *optional* and so should be provided with a default value, or *required* and so should be set to `None`. The user then can override these keys in the reservation file, under the `provider` key. Keys marked as `None` in the `default_config` are automatically tested for overriding in the reservation file.

Provider Instantiation

Enos automatically instantiates a provider based on the name specified in the `reservation.yaml`. For instance, based on the following reservation file,

```
provider: "my-provider"
```

Enos seeks for a file called `my-provider.py` into `enos/provider` and instantiates its main class. But sometimes, the provider requires extra information for its initialisation. The good place for this information is to put it under the provider key. In this case, the provider name should be accessible throughout the `type` key:

```
provider:
  type: "my-provider"
  extra-var: ...
  ...
```

Then the provider can access `extra-var` with `config['provider']['extra-var']`. Supported extra information is documented into the provider documentation.

1.9 Jenkins

1.9.1 Jobs

We provide here an overview of the jobs that can be runned by our continuous integration server.

1.9.2 Grid5000

Workflow:

- Deploys OpenStack in a standalone mode using the Grid'5000 provider.
- Check if a server can be booted and if Rally can be launched.

Listing 1: Configuration

```
enable_monitoring: true
inventory: inventories/inventory.sample
kolla:
```

(continues on next page)

(continued from previous page)

```
  enable_heat: false
  kolla_base_distro: centos
  kolla_install_type: source
kolla_ref: stable/stein
kolla_repo: https://git.openstack.org/openstack/kolla-ansible
provider:
  job_name: enos-jenkins
  type: g5k
  walltime: 02:00:00
registry:
  type: internal
resources:
  parasilo:
    control: 1
  paravance:
    compute: 1
    network: 1
```

1.9.3 Grid'5000 environment

Workflow:

- Pull all the docker images on the slave
- Save the environment in `/tmp/enos.tar.gz` of the slave.

Listing 2: Configuration

```
enable_monitoring: true
hosts:
  1: &id001
    address: 127.0.0.1
    alias: enos-node
    user: root
inventory: inventories/inventory.sample
kolla:
  enable_heat: 'no'
  kolla_base_distro: centos
  kolla_install_type: source
  node_custom_config: patch/
kolla_ref: stable/stein
kolla_repo: https://git.openstack.org/openstack/kolla-ansible
provider:
  eths:
  - eth1
  - eth2
  network:
    cidr: 192.168.143.0/24
    dns: 8.8.8.8
    end: 192.168.143.119
    extra_ips:
    - 192.168.142.100
    - 192.168.142.101
    - 192.168.142.102
    - 192.168.142.103
    - 192.168.142.104
```

(continues on next page)

(continued from previous page)

```
    gateway: 192.168.143.1
    start: 192.168.143.3
  type: static
registry:
  type: none
resources:
  compute:
  - *id001
  control:
  - *id001
  network:
  - *id001
```

1.9.4 Packaging

Workflow:

- Deploys OpenStack in a standalone mode using the Static provider in a vagrant box.
- Check if a server can be booted and if Rally can be launched.
- Destroy the deployment (leave the images)
- Package the box

Listing 3: Configuration

```
enable_monitoring: false
hosts:
  1: &id001
    address: 127.0.0.1
    alias: enos-node
    user: root
inventory: inventories/inventory.sample
kolla:
  kolla_base_distro: centos
  kolla_install_type: source
  nova_compute_virt_type: qemu
kolla_ref: stable/stein
kolla_repo: https://git.openstack.org/openstack/kolla-ansible
provider:
  networks:
  - cidr: 192.168.143.0/24
    dns: 8.8.8.8
    end: 192.168.143.119
    gateway: 192.168.143.1
    roles:
    - network_interface
    start: 192.168.143.3
  - cidr: 192.168.142.0/24
    dns: 8.8.8.8
    end: 192.168.142.119
    gateway: 192.168.142.1
    roles:
    - neutron_external_interface
    start: 192.168.142.3
```

(continues on next page)

(continued from previous page)

```
  type: static
registry:
  type: none
resources:
  compute:
  - *id001
  control:
  - *id001
  network:
  - *id001
```

1.9.5 Topology

Workflow:

- Deploys nodes using vagrant and apply some network constraints
- Validate those constraints (manually)

Listing 4: Configuration

```
enable_monitoring: false
inventory: inventories/inventory.sample
kolla:
  enable_heat: 'no'
  kolla_base_distro: centos
  kolla_install_type: source
kolla_ref: stable/stein
kolla_repo: https://git.openstack.org/openstack/kolla-ansible
network_constraints:
  default_delay: 10ms
  default_loss: 0
  default_rate: 100mbit
  enable: true
provider:
  type: vagrant
registry:
  type: none
topology:
  grp1:
    extra-large:
      control: 1
  grp2:
    medium:
      compute: 1
      network: 1
```

1.10 Tutorials

This section presents few tutorials. The **'EnOS Tutorial on top of Grid'5000'_** shows you how to deploy,configure, stress and collect metrics of OpenStack on top of Grid'5000 using Enos. The **'OpenStack SDK'_** shows you how to reads Enos environment file to then interact with OpenStack using the OpenStack SDK to create a new OpenStack project with users in it.

1.10.1 EnOS Tutorial on top of Grid'5000

OpenStack[1] has become the *defacto* solution to operate compute, network and storage resources in public and private Clouds. This lab aims at exploring EnOS[2][3] , a holistic framework to conduct evaluations of different OpenStack configurations in an easy and reproducible manner. In particular, EnOS helps you in deploying real OpenStack instances on different types of infrastructure (from virtual environments based on VMs like Vagrant, to real large-scale testbeds composed of bare-metal machines like Grid'5000), stressing it and getting feedback. This lab is composed of two part:

The first part is about getting started with EnOS. More precisely we are going to:

- Deploy and configure OpenStack on Grid'5000 using EnOS.
- Operate this OpenStack to manage IaaS resources (*e.g.*, boot VMs).
- Understand the benchmark mechanisms and run some evaluations.
- Visualize the collected metrics through Grafana.

For those who desire to go further, we propose to use EnOS to investigate OpenStack in WAN networks. In this investigation we will study the impact of a specific feature used in such context, just like a developer would do. To that end, we will:

- Simulate a WAN-wide topology with EnOS by playing with traffic shaping.
- See how EnOS can be used to customize OpenStack (enable/disable features).
- Benchmark the deployed OpenStack and backup metrics.
- Analyze the collected metrics to highlight the impact of features.

1 Requirements and Setup

To follow the lab you'll need :

- A Web browser (*e.g.*, Firefox)
- A Grid'5000 account
- An SSH client (*e.g.*, OpenSSH on Linux/Mac, Putty on Windows)
  - Follow the G5K's recommendations and edit your `~/.ssh/config` file to configure SSH for Grid'5000.
  - Be sure your configure works by typing `ssh rennes.g5k` for instance.

2 Presentation

Note: Since OpenStack deployment can be quite long (~20, 30 minutes) you might be interested in starting its deployment before reading the presentation of OpenStack and EnOS (you can *4 Deploy OpenStack using EnOS* and come back later).

Adrien Lebre gave a lecture regarding Cloud Computing, OpenStack and EnOS. You can find the slides of this lecture here. In the following, we quickly present some information regarding OpenStack, EnOS and the lab we are going to set today.

[1] https://www.openstack.org/
[2] https://hal.inria.fr/hal-01415522v2
[3] https://enos.readthedocs.io/en/stable/

2.1 OpenStack

OpenStack is the *defacto* solution to manage infrastructures (*i.e.*, compute, network, storage resources). To that end, it provides management mechanisms as a modular platform composed of several projects, each of which is in charge of an aspect of the infrastructure management. Among the various projects (30+), here is a selection corresponding to the bare necessities to operate infrastructure:

Nova the compute resource manager (*i.e.*, virtual/bare-metal machines and containers)

Glance the image store

Neutron the network manager for compute resources interconnection

Keystone the authentication/authorization manager

Each project are themselves based on multiple modules. Since OpenStack is designed as a distributed software, each module can be deployed on different physical/virtual machines. For instance, here is a set of modules that compose Nova:

- `nova-api`: in charge of managing users' requests
- `nova-scheduler`: in charge of scheduling compute resources on compute nodes
- `nova-compute`: in charge of the life-cycle of compute resources
- ...

To provide all the features expected by an infrastructure manager, OpenStack's modules need cooperation. For instance, when a user asks nova to boot a VM, the image is fetched from glance, its network interfaces are configured by neutron, supposing keystone authorized the operation. Such cooperation is possible through three communication channels:

REST APIs used for inter-project communications

Message queue (RabbitMQ) used for intra-project communications

Database (MariaDB) used to store project states

From the user viewpoint, OpenStack can be operated by three ways:

- Horizon: the OpenStack service in charge of providing a Web GUI
- The OpenStack CLI
- REST APIs

2.2 EnOS

EnOS is a holistic framework to conduct evaluations of different OpenStack configurations in an easy and reproducible manner. In particular, EnOS helps you in deploying real OpenStack instances on different types of infrastructure (from virtual environments based on VMs like Vagrant, to real large-scale testbeds composed of bare-metal machines like Grid'5000), stressing it and getting feedback.

Many projects exist to deploy OpenStack (e.g. OpenStack-Ansible[4] , OpenStack-Chef[5] , OpenStack Kolla[6] , Kubernetes[7] , Juju[8]). EnOS relies on the Kolla OpenStack project to deploy OpenStack modules as Docker containers.

EnOS' workflow is the following:

[4] https://github.com/openstack/openstack-ansible
[5] https://github.com/openstack/openstack-chef-repo
[6] https://docs.openstack.org/developer/kolla-ansible/
[7] https://github.com/stackanetes/stackanetes
[8] https://jujucharms.com/openstack

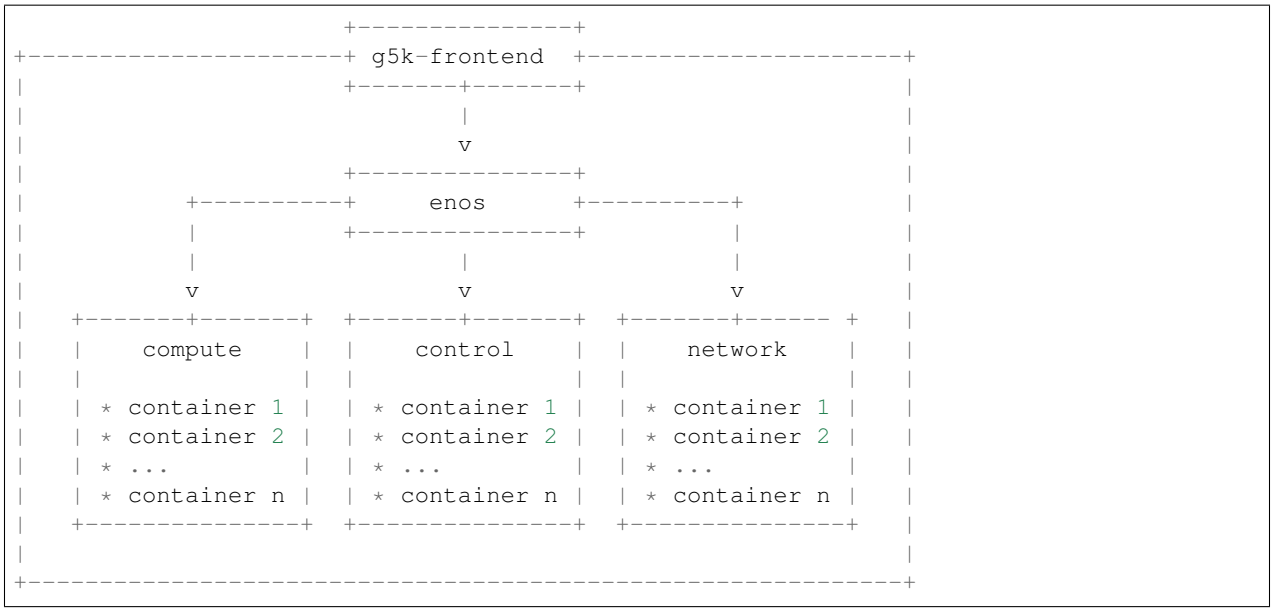
- `enos up`: book, provision and bootstrap testbed resources
  - install dependencies (Docker)
  - install monitoring tools (cAdvisor, collectd, influxdb, grafana)
- `enos deploy`: deploy OpenStack (based on Kolla)
- `enos bench`: benchmark OpenStack
- `enos backup`: backup the collected metrics
- `enos destroy`: release resources

2.3 Topology deployed in this lab

The lab makes use of EnOS to deploy OpenStack on Grid'5000. In particular, we will need four G5K machines for our deployment:

- *enos* node: A machine we will deploy ourselves to run EnOS.
- *control* node: A machine that hosts the control modules, projects' APIs and databases.
- *network* node: A machine that hosts network agents.
- *compute* node: A machine that manages the compute modules where guest VMs live.

Note that while we will deploy the *enos* node ourselves on G5K, but the three other nodes will be deployed automatically by EnOS. The following figure depicts the status of the different components in play during the lab:



As we can see in this figure, EnOS will be in charge of provisioning the *compute*, *control* and *network* nodes. In particular, EnOS will deploy Docker containers inside each nodes, which correspond to OpenStack services. For instance, the *control* node will host the `nova-api` and `nova-scheduler` containers while the *compute* node will host the `nova-compute` and `nova-libvirt` containers to provide VM hypervisor mechanisms.

Note: Note that to deploy on G5K, we need a dedicated node to run EnOS because it is discouraged to run experiments on the frontend. This restriction is meant to avoid disturbing other users that are logged, since the frontend node has limited resources. On a regular deployment, EnOS could be run directly from your laptop.

---

3 Set the *enos* node and install EnOS

The first step is to determine on which cluster you will deploy OpenStack. To that end, you can run `funk` (Find yoUr Nodes on g5K) from any frontend to see the availability on G5K:

```
# laptop:~$
ssh nantes.g5k
# fnantes:~$
funk -w 4:00:00
```

In this example, we check the availability of G5K's clusters for the next four hours (adapt the time regarding your situation). Note that you can adapt the time of your reservation afterward, using the `oarwalltime` command[9] . Find a cluster with at least four nodes available before going further. Once it is done, reach the cluster's site first, and then, get a new machine which we will use as our *enos* node. In this document, we target the parapide cluster, located in the Rennes site:

```
# fnantes:~$
ssh rennes
# frennes:~$ -- Not mandatory, but recommended
tmux
# frennes:~$ -- Let's connect to the enos node
oarsub -I -l "nodes=1,walltime=4:00:00" -p "cluster='parapide'"
```

Here, we get a new machine in interactive mode (*i.e.*, `-I`) for the next four hours from the parapide cluster. If it succeeds you should be directly connected to this node (check your prompt).

Note: Note that we created a `tmux` session in order to be resilient to any network failure during your ssh session. Whenever you want to restore this session, you can connect to the frontend and attach to your tmux session, as follows:

```
# laptop:~$
ssh rennes.g5k
# frennes:~$ -- Stands for "tmux attach"
tmux a
```

Make a directory from where you will install EnOS and run your experiments:

```
# enos:~$
mkdir -p ~/enos-myxp
# enos:~$
cd ~/enos-myxp
```

Then, install EnOS in your working directory (python3.5+ is required):

```
# enos:~/enos-myxp$
virtualenv --python=python3 venv
# (venv) enos:~/enos-myxp$
. venv/bin/activate
# (venv) enos:~/enos-myxp$
pip install "enos[openstack]==6.0.0"
```

Note: Note that EnOS is a Python project. We installed it inside a virtual environment, with `virtualenv`, to avoid any conflict regarding the version of its dependencies. Furthermore, it does not install anything outside the virtual environment which keeps your OS clean. Remember that you have to be in the virtual environment to use EnOS. It

[9] https://www.grid5000.fr/mediawiki/index.php/Advanced_OAR#Changing_the_walltime_of_a_running_job

means that if you open a new terminal, you need to re-enter the venv. For instance, now that EnOS is installed, you can come back as follow:

```
# laptop:~$
ssh rennes.g5k
# frennes:~$
cd ~/enos-myxp
# frennes:~/enos-myxp$
source venv/bin/activate
```

Before going further, check EnOS works by typing `enos --help`:

```
Enos: Monitor and test your OpenStack.
[<args> ...] [-e ENV|--env=ENV]
             [-h|--help] [-v|--version] [-s|--silent|--vv]

General options:
  -e ENV --env=ENV  Path to the environment directory. You should
                    use this option when you want to link to a specific
                    experiment. Not specifying this value will
                    discard the loading of the environment (it
                    makes sense for `up`).
  -h --help         Show this help message.
  -s --silent       Quiet mode.
  -v --version      Show version number.
  -vv               Verbose mode.

Commands:
  new             Print a reservation.yaml example
  up              Get resources and install the docker registry.
  os              Run kolla and install OpenStack.
  init            Initialise OpenStack with the bare necessities.
  bench           Run rally on this OpenStack.
  backup          Backup the environment
  ssh-tunnel      Print configuration for port forwarding with horizon.
  tc              Enforce network constraints
  info            Show information of the actual deployment.
  destroy         Destroy the deployment and optionally the related resources.
  deploy          Shortcut for enos up, then enos os and enos config.
  kolla           Runs arbitrary kolla command on nodes
See 'enos <command> --help' for more information on a specific
command.
```

4 Deploy OpenStack using EnOS

4.1 The EnOS configuration file

To deploy OpenStack, EnOS reads a *configuration file*. This file states the OpenStack resources you want to deploy/measure together with their topology. A configuration could say, "Deploy a basic OpenStack on a single node", or "Put OpenStack control services on ClusterA and compute services on ClusterB", but also "Deploy each OpenStack services on a dedicated node and add WAN network latency between them". So that EnOS can deploy such OpenStack over your testbed and run performance analysis.

The description of the configuration is done in a `reservation.yaml` file. You may generate a new one with `enos new > reservation.yaml`. The configuration file is pretty fat, with a configuration sample for all testbed

supported by EnOS (G5k, Chameleon, Vagrant, . . .).

Use your favorite text editor to open the `reservation.yaml` file, for instance: `vim reservation.yaml`, and edit it to fit your situation – *i.e.*, something like listing *lst:reservation.yaml*. Three parts of this configuration file are interested for a simple use of EnOS:

- `provider` section (l. 5): Defines on which testbed to deploy OpenStack (*i.e.*, G5k, Chameleon, Vagrant, . . .).
- `resources` section (l. 10): Defines the number and role of machines to deploy on the testbed (*e.g.*, book 3 nodes on `paravance` with 1 `control` node, 1 `network` node and 1 `compute` node).
- `kolla` section (l. 36): Defines the OpenStack configuration, for instance:
  - Which OpenStack version to deploy (*e.g.*, `kolla-ref: "stable/stein"`).
  - Which OpenStack project to enable/disable (*e.g.*, `enable_heat: "no"`).

```
1  ---
2  # ############################################### #
3  # Grid'5000 reservation parameters                #
4  # ############################################### #
5  provider:
6    type: g5k
7    job_name: 'enos'
8    walltime: '04:00:00'
9
10 resources:
11   paravance:
12     compute: 1
13     network: 1
14     control: 1
15
16 # ############################################### #
17 # Inventory to use                                #
18 # ############################################### #
19 inventory: inventories/inventory.sample
20
21 # ############################################### #
22 # docker registry parameters
23 # ############################################### #
24 registry:
25   type: internal
26
27
28 # ############################################### #
29 # Enos Customizations                             #
30 # ############################################### #
31 enable_monitoring: yes
32
33 # ############################################### #
34 # Kolla parameters                                #
35 # ############################################### #
36 kolla_repo: "https://git.openstack.org/openstack/kolla-ansible"
37 kolla_ref: "stable/stein"
38
39 # Vars : kolla_repo/ansible/group_vars/all.yml
40 kolla:
41   kolla_base_distro: "centos"
42   kolla_install_type: "source"
43   enable_heat: "yes"
```

The `provider` section tells on which testbed to deploy OpenStack plus its configuration. The configuration may vary from one testbed to another. For instance, Grid'5000 and Chameleon are research testbed were resources have to be booked, thus the configuration includes a `walltime` to define the time of your reservation. Conversely, the Vagrant provider starts VM with VirtualBox on your local machine, and thus doesn't include such a option. Please, refer to the EnOS provider documentation[10] to find the configuration parameters depending on the testbed. For the sake of this lab we are going to use the Grid'5000 provider (*i.e.*, `type: g5k`). Note that a `walltime` of 3 hours is enough for the first part of this workshop. If you plan to stay for the second part you should set 5 hours

The `resources` key contains the description of the desired resources and their topology. Once again, way you describe your topology may vary a little bit depending on the testbed you target. Please, refer to the EnOS provider documentation[10] to find examples of resources description depending on the testbed. Here we declare the G5K cluster we target (*e.g.*, `paravance`), as well as the resources we want to deploy on: a `control`, a `network` and a `compute` node on which will be deployed all the required OpenStack services.

4.2 Deploy OpenStack

EnOS manages all the aspects of an OpenStack deployment by calling `enos deploy`. Concretely, the `deploy` phase first gets resources on your testbed following your configuration description. Then, it provisions these resources with Docker. Finally, it starts each OpenStack services (e.g. Keystone, Nova, Neutron) inside a dedicated Docker container.

Launch the deployment with:

```
# (venv) enos:~/enos-myxp$
enos deploy -f reservation.yaml
```

EnOS is now provisioning three machines on the cluster targeted by the `reservation.yaml`. Once the machines are provisioned, EnOS deploy OpenStack services on them, and you can display information regarding your deployment by typing:

```
# (venv) enos:~/enos-myxp$
enos info
```

In particular, you should see the IP address of the deployed nodes.

While EnOS deploys OpenStack (it takes ~20 to 45 minutes – there are way to speed up your deployment[11]), you can observe EnOS running containers on the control node. For that, you can access to the control node by typing:

```
# (venv) enos:~/enos-myxp$
ssh -l root $(enos info --out json | jq -r '.rsc.control[0].address')
# control:~# -- List the downloaded Docker images
docker images
# control:~# -- List the running Docker containers
docker ps
# control:~# -- Go back to `(venv) enos:~/enos-myxp$`
exit
```

Note: Note that at the end of your session, you can release your reservation by typing:

```
# (venv) enos:~/enos-myxp$
enos destroy --hard
```

[10] https://enos.readthedocs.io/en/stable/provider/index.html
[11] https://enos.readthedocs.io/en/stable/customization/index.html#internal-registry

It will destroy all your deployment and delete your reservation.

5 Play with OpenStack

The last service deployed is the OpenStack dashboard (Horizon). Once the deployment process is finished, Horizon is reachable from G5k. More precisely, Horizon runs in a Docker container on the control node, and listens on port 80. To access Horizon from your own web browser (from your laptop), you can create an SSH tunnel from your laptop to control node, located in G5K. To that end, you first need to get control node's IP address, and then create the tunnel. Open a new terminal and type the following:

1. Find the control node address using EnOS:

```
# (venv) enos:~/enos-myxp$
enos info
# (venv) enos:~/enos-myxp$
enos info --out json | jq -r '.rsc.control[0].address'
```

2. Create the tunnel from your laptop:

```
# laptop:~$ -- `ssh -NL 8000:<g5k-control>:80 <g5k-site>.g5k`, e.g.,
ssh -NL 8000:paravance-14-kavlan-4.nantes.grid5000.fr:80 rennes.g5k
```

Note: This lab has been designed to **run on a cluster where nodes have two network interfaces**. **If you plan to run the lab on a cluster with a single network interface, please run the following script on the network node**. You can check how many network interfaces are associated to a cluster by consulting the G5k Cheatsheet. If you are concerned, connect to the network node as root with:

```
# (venv) enos:~/enos-myxp$
ssh -l root $(enos info --out json | jq -r '.rsc.network[0].address')
```

And execute the following script:

```
#!/usr/bin/env bash

# The network interface
IF=<interface-network-node-(eno|eth)[0-9]>
# This is the list of the vip of $IF
ips=$(ip addr show dev $IF|grep "inet .*/32" | awk '{print $2}')
if [[ ! -z "$ips" ]]
then
  # vip detected
  echo $ips
  docker exec -ti openvswitch_vswitchd ovs-vsctl add-port br-ex $IF && ip addr flush
↪$IF && dhclient -nw br-ex
  for ip in $ips
  do
    ip addr add $ip dev br-ex
  done
else
  echo "nothing to do"
fi
```

Once it is done, you can access Horizon from your web browser through http://localhost:8000 with the following credentials:

- login: `admin`
- password: `demo`

From here, you can reach `Project > Compute > Instances > Launch Instance` and boot a virtual machine given the following information:

- a name (e.g., `horizon-vm`)
- an image (e.g., `cirros`)
- a flavor to limit the resources of your instance (I recommend `tiny`)
- and a network setting (must be `private`)

You should select options by clicking on the arrow on the right of each possibility. When the configuration is OK, the `Launch Instance` button should be enabled. After clicking on it, you should see the instance in the `Active` state in less than a minute.

Now, you have several options to connect to your freshly deployed VM. For instance, by clicking on its name, Horizon provides a virtual console under the `Console` tab. Use the following credentials to access the VM:

- login: `cirros`
- password: `cubswin:)`

While Horizon is helpful to discover OpenStack features, this is not how a real operator administrates OpenStack. A real operator prefers command line interface .

5.1 Unleash the Operator in You

OpenStack provides a command line interface to operate your Cloud. But before using it, you need to set your environment with the OpenStack credentials, so that the command line won't bother you by requiring credentials each time.

Load the OpenStack credentials:

```
# (venv) enos:~/enos-myxp$
. current/admin-openrc
```

You can then check that your environment is correctly set executing the following command that should output something similar to the listing *lst:env-os*:

```
# (venv) enos:~/enos-myxp$
env|fgrep OS_|sort
```

```
OS_AUTH_URL=http://10.24.61.255:35357/v3
OS_IDENTITY_API_VERSION=3
OS_PASSWORD=demo
OS_PROJECT_DOMAIN_ID=default
OS_PROJECT_DOMAIN_NAME=default
OS_PROJECT_NAME=admin
OS_REGION_NAME=RegionOne
OS_TENANT_NAME=admin
OS_USER_DOMAIN_ID=default
OS_USER_DOMAIN_NAME=default
OS_USERNAME=admin
```

All operations to manage OpenStack are done through one single command line, called `openstack`. Doing an `openstack --help` displays the really long list of possibilities provided by this command. The following gives you a selection of the most often used commands to operate your Cloud:

List OpenStack running services `openstack endpoint list`

List images `openstack image list`

List flavors `openstack flavor list`

List networks `openstack network list`

List computes `openstack hypervisor list`

List VMs (running or not) `openstack server list`

Get details on a specific VM `openstack server show <vm-name>`

Start a new VM `openstack server create --image <image-name> --flavor <flavor-name> --nic net-id=<net-id> <vm-name>`

View VMs logs `openstack console log show <vm-name>`

Based on these commands, you can use the CLI to start a new tiny cirros VM called `cli-vm`:

```
# (venv) enos:~/enos-myxp$
openstack server create --image cirros.uec\
                        --flavor m1.tiny\
                        --network private \
                        cli-vm
```

Then, display the information about your VM with the following command:

```
# (venv) enos:~/enos-myxp$
openstack server show cli-vm
```

Note in particular the status of your VM. This status will go from `BUILD`: OpenStack is looking for the best place to boot the VM, to `ACTIVE`: your VM is running. The status could also be `ERROR` if you are experiencing hard times with your infrastructure.

With the previous `openstack server create` command, the VM boots with a private IP. Private IPs are used for communication between VMs, meaning you cannot ping your VM from the lab machine. Network lovers will find a challenge here: try to ping the VM from the lab machine. For the others, you have to manually affect a floating IP to your machine if you want it pingable from the enos node.

```
# (venv) enos:~/enos-myxp$
openstack server add floating ip\
  cli-vm\
  $(openstack floating ip create public -c floating_ip_address -f value)
```

You can ask for the status of your VM and its IPs with:

```
# (venv) enos:~/enos-myxp$
openstack server show cli-vm -c status -c addresses
```

Wait one minute or two the time for the VM to boot, and when the state is `ACTIVE`, you can ping it on its floating IP and SSH on it:

```
# (venv) enos:~/enos-myxp$
ping <floating-ip>
# (venv) enos:~/enos-myxp$
ssh -l cirros <floating-ip>
```

Note: Waiting for the IP to appear and then ping it could be done with a bunch of bash commands, such as in listing *lst:query-ip*.

```
FIXED_IP=$(openstack server show cli-vm -c addresses -f value | sed  -Er 's/
↪private=(10\.0\.0\.[0-9]+).*/\1/g')
FLOATING_IP=$(openstack floating ip list --fixed-ip-address "$FIXED_IP" -f value -c
↪"Floating IP Address" | head -n 1)
COUNT=20
while [[ $COUNT -ne 0 ]] ; do
    ping -c 1 "$FLOATING_IP"
    RC=$?
    if [[ $RC -eq 0 ]] ; then
        COUNT=0
    else
        COUNT=$((COUNT - 1))
        sleep 5
    fi
done


if [[ $RC -ne 0 ]] ; then
    echo "Timeout."; exit 124
fi
```

You can also check that the VM finished to boot by looking at its logs with `openstack console log show cli-vm`. The cirros VM finished to boot when last lines are:

```
=== cirros: current=0.3.4 uptime=16.56 ===
  ____               ____  ____
 / __/ __ ____ ____ / __ \/ __/
/ /__ / // __// __// /_/ /\ \
\___//_//_/  /_/   \____/___/
   http://cirros-cloud.net


login as 'cirros' user. default password: 'cubswin:)'. use 'sudo' for root.
cli-vm login:
```

Before going to the next section, play around with the `openstack` CLI and Horizon. For instance, list all the features offered by Nova with `openstack server --help`. Here are some commands:

1. SSH on `cli-vm` using its name rather than its private IP.

   ```
   # (venv) enos:~/enos-myxp$
   openstack server ssh cli-vm --public --login cirros
   ```

2. Create a snapshot of `cli-vm`.

   ```
   # (venv) enos:~/enos-myxp$
   nova image-create cli-vm cli-vm-snapshot --poll
   ```

3. Delete the `cli-vm`.

   ```
   # (venv) enos:~/enos-myxp$
   openstack server delete cli-vm --wait
   ```

4. Boot a new machine `cli-vm-clone` from the snapshot.

```
# (venv) enos:~/enos-myxp$
openstack server create --image cli-vm-snapshot\
                        --flavor m1.tiny\
                        --network private\
                        --wait\
                        cli-vm-clone
```

6 Stress and Visualize OpenStack Behavior using EnOS

EnOS not only deploys OpenStack according to your configuration, but also instruments it with a *monitoring stack*. The monitoring stack polls performance characteristics of the running services and helps you to understand the behavior of your OpenStack.

Activating the monitoring stack is as simple as setting the `enable_monitoring` to `yes` in your `reservation.yaml`. This key tells EnOS to deploy two monitoring systems. First, cAdvisor[12] , a tool to collect resource usage of running containers. Using cAdvisor, EnOS gives information about the CPU/RAM/Network consumption per cluster/node/service. Second, Collectd[13] , a tool to collect performance data of specific applications. For instance, Collectd enables EnOS to record the number of updates that have been performed on the Nova database.

The rest of this section, first shows how to visualize cAdvisor and Collectd information. Then, it presents tools to stress OpenStack in order to collect interesting information.

6.1 Visualize OpenStack Behavior

A popular tool to visualize information provided by cAdvisor and Collectd (and whatever monitoring system you could use) is Grafana[14] . Grafana is a Web metrics dashboard. A Docker container is in charge of providing this service inside the control node. As a consequence, prior being able to be reachable from your browser, you need to set a tunnel to this service, by typing on your laptop:

```
# laptop:~$ -- `ssh -NL 3000:<g5k-control>:3000 <g5k-site>.g5k`, e.g.,
ssh -NL 3000:paravance-14-kavlan-4.nantes.grid5000.fr:3000 nantes.g5k
```

You can then access Grafana at http://localhost:3000 with the following credentials:

- login: `admin`
- password: `admin`

The Grafana dashboard is highly customizable. For the sake of simplicity, we propose to use our configuration file that you can get with:

```
# laptop:~$
curl -O http://enos.irisa.fr/tp-g5k/grafana_dashboard.json
```

You have then to import this file into Grafana. First, click on the `Grafana logo > + > Import > Upload .json file` and select the `grafana_dashboard.json` file. Next, make names of the right column matching names of the left column by selecting the good item in the list. And finish by clicking on Save & Open. This opens the dashboard with several measures on Nova, Neutron, Keystone, RabbitMQ, ... services. Keep the dashboard open until the end of the lab, you will see consumption variation as we will perform stress tests.

[12] https://github.com/google/cadvisor
[13] https://collectd.org/
[14] https://grafana.com/

6.2 Benchmark OpenStack

Stressing a Cloud manager can be done at two levels: at the *control plane* and at the *data plane*, and so it is for OpenStack. The control plane stresses OpenStack API. That is to say, features we used in the previous section to start a VM, get a floating IP, and all the features listed by `openstack --help`. The data plane stresses the usage of resources provided by an OpenStack feature. For instance, a network data plane testing tool will measure how resources provided by Neutron handle networks communications.

OpenStack comes with dedicated tools that provide workload to stress control and data plane. The one for control plane is called Rally[15] and the one for data plane is called Shaker[16] . And these two are well integrated into EnOS.

EnOS looks inside the `workload` directory for a file named `run.yml`.

```
# (venv) enos:~/enos-myxp$
mkdir -p workload
# (venv) enos:~/enos-myxp$
touch workload/run.yml
```

Edit the file `run.yml` with your favorite editor. An example of such a file is given in listing *lst:run.yml*. The `rally` (l. 2) key specifies the list of `scenarios` (l. 9) to execute (here, only the *8.1 Nova scenario for Rally* – available at `~/enos-myxp/workload/nova-boot-list-cc.yml` – that asks Nova to boot VMs and list them) and their customization.

The customization could be done by using the top level `args` (l. 4). In such case, it applies to any scenario. For instance here, `concurrency` (l. 5) and `times` (l. 7) tells Rally to launch `5` OpenStack client for a total of `10` execution of every scenario. The customization could also be done on a per-scenario basis with the dedicated `args` (l. 12), and thus could be only applies to the specific scenario. For instance here, the `30` value overrides the `sla_max_avg_duration` default value solely in the `boot and list servers` scenario.

```
1  ---
2  rally:
3      enabled: yes
4      args:
5        concurrency:
6          - 5
7        times:
8          - 10
9      scenarios:
10       - name: boot and list servers
11         file: nova-boot-list-cc.yml
12         args:
13           sla_max_avg_duration: 30
14 shaker:
15   enabled: yes
16   scenarios:
17     - name: OpenStack L3 East-West Dense
18       file: openstack/dense_l3_east_west
```

Calling Rally and Shaker from EnOS is done with:

```
# (venv) enos:~/enos-myxp$
enos bench --workload=workload
```

Note: At the same time as enos bench is running, keep an eye on the Grafana dashboard available at http://localhost:

[15] https://rally.readthedocs.io/en/latest/
[16] https://pyshaker.readthedocs.io/en/latest/

3000. At the top left of the page, you can click on the clock icon and tells Grafana to automatically refresh every 5 seconds and only display the last 5 minutes.

Rally and Shaker provide a huge list of scenarios on their respective GitHub[17][18] . Before going further, go through the Rally list and try to add the scenario of your choice into the `run.yml`. Note that you have to download the scenario file in the `workload` directory and then put a new item under the `scenarios` key (l. 9) . The new item should contain, at least, the `name` of the scenario and its `file` path (relative to the `workload` directory).

6.3 Backup your results

Rally and Shaker produce reports on executed scenarios. For instance, Rally produces a report with the full duration, load mean duration, number of iteration and percent of failures, per scenario. These reports, plus data measured by cAdvisor and Collectd, plus logs of every OpenStack services can be backup by EnOS with:

```
# (venv) enos:~/enos-myxp$
enos backup --backup_dir=benchresults
```

The argument `backup_dir` tells where to store backup archives. If you look into this directory, you will see, among others, an archive named `<controler-node>-rally.tar.gz`. Concretely, this archive contains a backup of Rally database with all raw data and the Rally reports. You can extract the Rally report of the *Nova boot and list servers* scenario with the following command and then open it in your favorite browser:

```
# (venv) enos:~/enos-myxp$
tar --file benchresults/*-rally.tar.gz\
    --get $(tar --file benchresults/*-rally.tar.gz\
                --list | grep "root/rally_home/report-nova-boot-list-cc.yml-.*.html")
```

For those interested in playing with deploying applications on top of OpenStack, you can jump to another workshop involving Heat: the OpenStack Orchestration service here.

7 Add Traffic Shaping

EnOS allows to enforce network emulation in terms of latency, bandwidth limitation and packet loss.

7.1 Define Network Constraints

Network constraints (latency/bandwidth limitations) are enabled by the use of groups of nodes. Resources must be described using a `topology` description instead of a `resources` description. For instance, listings *lst:topos-g5k* defines two groups named `grp1` and `grp2`.

```
topology:
  grp1:
    paravance:
      control: 1
      network: 1
  grp2:
    paravance:
      compute: 1
```

Constraints are then described under the `network_constraints` key in the `reservation.yaml` file:

[17] https://github.com/openstack/rally/tree/master/rally/plugins/openstack/scenarios
[18] https://github.com/openstack/shaker/tree/master/shaker/scenarios/openstack

```
network_constraints:
  enable: true
  default_delay: 25ms
  default_rate: 100mbit
  default_loss: 0.1%
  constraints:
    - src: grp1
      dst: grp2
      delay: 50ms
      rate: 1gbit
      loss: 0%
      symmetric: true
```

Copy your `reservation.yaml` file as `reservation-topo.yaml` with `cp reservation.yaml reservation-topo.yaml` and edit it to include the topology and network constraints definition. An example of such file is given in *8.2 Configuration file with a topology and network constraints*.

Since our topology is now defined by groups, we need to re-run `enos deploy -f reservation-topo.yaml` (which should be faster than the first time). And then enforce these constraints with `enos tc`, which results in:

- Default network delay is 50ms.
- Default bandwidth is 100Mbit/s.
- Default packet loss percentage is 0.1%.
- Network delay between machines of `grp1` and `grp2` is 100ms (2x50ms: symmetric).
- Bandwidth between machines of `grp1` and `grp2` is 1 Gbit/s.
- Packet loss percentage between machines of `grp1` and `grp2` is 0%.

Note: Invoking `enos tc --test` generates various reports that validate the correct enforcement of the constraints. They are based on `fping` and `flent` latency and bandwidth measurements respectively. The report is located in the `~/enos-myxp/current/_tmp_enos_/<g5k-(control|network|compute)>.out`.

7.2 Run Dataplane Benchmarks with and without DVR

Run the Shaker `dense_l3_east_west` scenario with

```
# (venv) enos:~/enos-myxp$
enos bench --workload=workload
```

Note: If you look carefully, you will see that execution of Nova boot and list fails because of a SLA violation. You can try to customize listing *lst:run.yml* to make the test pass.

In this scenario Shaker launches pairs of instances on the same compute node. Instances are connected to different tenant networks connected to one router. The traffic goes from one network to the other (L3 east-west). Get the Shaker report with `enos backup` and analyze it. You will remark that network communications between two VMs co-located on the same compute are 100ms RTT. This is because packet are routed by Neutron service that is inside `grp1` and VMs are inside the `grp2`.

Now, reconfigure Neutron to use DVR[19] . DVR will push Neutron agent directly on the compute of `grp2`. With EnOS,

[19] https://wiki.openstack.org/wiki/Neutron/DVR

you should do so by updating the `reservation.yaml` and add `enable_neutron_dvr: "yes"` under the `kolla` key. Then, tell EnOS to reconfigure Neutron.

```
# (venv) enos:~/enos-myxp$
enos os --tags=neutron --reconfigure
```

And finally, re-execute the `dense_l3_east_west` scenario.

```
# (venv) enos:~/enos-myxp$
enos bench --workload=workload
```

Compare this result with the previous one. You see that you no more pay the cost of WAN latency.

This experiment shows the importance of activating DVR in a WAN context, and how you can easily see that using EnOS. Do not hesitate to take a look at the complete list of Shaker scenarios on their GitHub[18] and continue to have fun with EnOS.

8 Appendix

8.1 Nova scenario for Rally

```
{% set image_name = image_name or "cirros.uec" %}
{% set flavor_name = flavor_name or "m1.tiny" %}
{% set sla_max_avg_duration = sla_max_avg_duration or 60 %}
{% set sla_max_failure = sla_max_failure or 0 %}
{% set sla_max_seconds = sla_max_seconds or 60 %}
---
  NovaServers.boot_and_list_server:
    -
      args:
        flavor:
          name: {{flavor_name}}
        image:
          name: {{image_name}}
        detailed: true
        auto_assign_nic: true
      runner:
        concurrency: {{concurrency}}
        times: {{times}}
        type: "constant"
      context:
        users:
          tenants: 1
          users_per_tenant: 1
        network:
          start_cidr: "10.2.0.0/24"
          networks_per_tenant: 1
        quotas:
          neutron:
            network: -1
            port: -1
          nova:
            instances: -1
            cores: -1
            ram: -1
      sla:
```

(continues on next page)

(continued from previous page)

```
        max_avg_duration: {{sla_max_avg_duration}}
        max_seconds_per_iteration: {{sla_max_seconds}}
        failure_rate:
          max: {{sla_max_failure}}
```

8.2 Configuration file with a topology and network constraints

```
---
# ################################################ #
# Grid'5000 reservation parameters                 #
# ################################################ #
provider:
  type: g5k
  job_name: 'enos'
  walltime: '04:00:00'

topology:
  grp1:
    paravance:
      control: 1
      network: 1
  grp2:
    paravance:
      compute: 1

network_constraints:
  enable: true
  default_delay: 25ms
  default_rate: 100mbit
  default_loss: 0.1%
  constraints:
    - src: grp1
      dst: grp2
      delay: 50ms
      rate: 1gbit
      loss: 0%
      symmetric: true

# ################################################ #
# Inventory to use                                 #
# ################################################ #
inventory: inventories/inventory.sample

# ################################################ #
# docker registry parameters
# ################################################ #
registry:
  type: internal
  ceph: true
  ceph_keyring: /home/discovery/.ceph/ceph.client.discovery.keyring
  ceph_id: discovery
  ceph_rbd: discovery_kolla_registry/datas
  ceph_mon_host:
    - ceph0.rennes.grid5000.fr
```

(continues on next page)

(continued from previous page)

```
    - ceph1.rennes.grid5000.fr
    - ceph2.rennes.grid5000.fr

# ########################################### #
# Enos Customizations                         #
# ########################################### #
enable_monitoring: yes

# ########################################### #
# Kolla parameters                            #
# ########################################### #
kolla_repo: "https://git.openstack.org/openstack/kolla-ansible"
kolla_ref: "stable/stein"

# Vars : kolla_repo/ansible/group_vars/all.yml
kolla:
  kolla_base_distro: "centos"
  kolla_install_type: "source"
  enable_heat: "yes"
```

1.10.2 OpenStack SDK

The python OpenStack SDK is a library that exposed the OpenStack API to the developers. The following use information provided by Enos to connect to OpenStack and then programmatically create a project, users and networks. It assumes Enos has already deployed an OpenStack and your are in the virtual environment if you have created one.

First install the OpenStack SDK.

```
(venv) $ pip install python-openstacksdk
```

Then asks enos where is your `admin-openrc`, source it and check everything is OK.

```
(venv) $ source $(enos info --out json|jq -r '.resultdir')/admin-openrc
(vnev) $ env|fgrep OS|sort
OS_AUTH_PLUGIN=password
OS_AUTH_URL=http://10.24.189.255:35357/v3
OS_IDENTITY_API_VERSION=3
OS_INTERFACE=internal
OS_PASSWORD=demo
OS_PROJECT_DOMAIN_NAME=Default
OS_PROJECT_NAME=admin
OS_REGION_NAME=RegionOne
OS_TENANT_NAME=admin
OS_USER_DOMAIN_NAME=Default
OS_USERNAME=admin
```

And that's it!

Now, you can execute the following `openstacksdk.py` file that reads `OS_*` variables from you environment to instantiate the `cloud` REST client. Executes it with `python openstacksdk.py`.

```
#!/usr/bin/env python
# -*- coding: utf-8 -*-
import logging
import os
```

(continues on next page)

(continued from previous page)

```
import openstack


logging.basicConfig(level=logging.INFO)
LOG   = logging.getLogger(__name__)


def make_cloud():
    """Connects to OpenStack cloud using environment variables

    Returns:
        An new openstack.connection.Connection

    Refs:
        - https://docs.openstack.org/openstacksdk/latest/user/connection.html
    """
    LOG.info("New admin authentication on %s" % os.environ['OS_AUTH_URL'])
    return openstack.connect(cloud='envvars')


def make_account(identity, users):
    """Create a new project an put `users` in it.

    Create a new project if it doesn't exists and put
    users `users` in it. Then assigne member and heat roles
    to these users in the newly created project.

    Args:
        identity: Proxy for identity aka keystone [1]
        users: A list of users name to create and put into the project,
            users can access OpenStack with the password "demo".

    Returns:
        The newly created project [2]

    Refs:
        [1] https://docs.openstack.org/openstacksdk/latest/user/proxies/identity_v3.
↪html
        [2] https://docs.openstack.org/openstacksdk/latest/user/resources/identity/v3/
↪project.html#openstack.identity.v3.project.Project
    """
    # Compute project name from users name
    project_name = "project-%s" % '-'.join(u for u in users)

    # Test if the project exists and create it if need be
    project = identity.find_project(project_name)
    if not project:
        project = identity.create_project(
            name=project_name,
            description="Project of %s." % ', '.join(u for u in users))
        LOG.info("Created a new project %s" % project)

    for user_name in users:
        # Test if user exists and create it if need be
        user = identity.find_user(user_name)
        if not user:
```

(continues on next page)

(continued from previous page)

```
            user = identity.create_user(
                name=user_name, password="demo")
        LOG.info("Created a new user %s with password demo" % user)

        # Assign user to member and heat_stack_owner role in newly
        # created project.
        for r in ["member", "heat_stack_owner"]:
            role = identity.find_role(r)

            # The `heat_stack_owner` role only exists if heat is deployed
            if role:
                identity.assign_project_role_to_user(project, user, role)
                LOG.info("Assigne role %s to user %s in project %s"
                         % (role, user, project))

    return project


def make_private_net(net, project):
    """Create a new private network only visible by members of `project`.

    Args:
        net: Proxy for network aka neutron [1]
        project: An OpenStack project [2]

    Returns:
        The subnet of the newly created private network [3]

    Refs:
        [1] https://docs.openstack.org/openstacksdk/latest/user/proxies/network.html
        [2] https://docs.openstack.org/openstacksdk/latest/user/resources/identity/v3/
↪project.html#openstack.identity.v3.project.Project
        [3] https://docs.openstack.org/openstacksdk/latest/user/resources/network/v2/
↪subnet.html#openstack.network.v2.subnet.Subnet
    """
    # Test if the private network exists and create it if need be
    # https://docs.openstack.org/openstacksdk/latest/user/resources/network/v2/
↪network.html#openstack.network.v2.network.Network
    private_net = net.find_network("private", project_id=project.id)
    if not private_net:
        private_net = net.create_network(
            name="private",
            project_id=project.id,
            provider_network_type="vxlan")
        LOG.info("Created a new private network %s" % private_net)

    # Test if the subntet exists and create it if need be
    # https://docs.openstack.org/openstacksdk/latest/user/resources/network/v2/subnet.
↪html#openstack.network.v2.subnet.Subnet
    private_snet = net.find_subnet("private-subnet", network_id=private_net.id)
    if not private_snet:
        private_snet = net.create_subnet(
            name="private-subnet",
            network_id=private_net.id,
            project_id=project.id,
            ip_version=4,
            is_dhcp_enable=True,
```

(continues on next page)

(continued from previous page)

```
            cidr="10.0.0.0/24",
            gateway_ip="10.0.0.1",
            allocation_pools=[{"start": "10.0.0.2", "end": "10.0.0.254"}],
            # dns.watch
            dns_nameservers=["84.200.69.80", "84.200.70.40"])
        LOG.info("Created a new private subnet %s" % private_snet)

    return private_snet


def make_router(net, project, priv_snet):
    """Make a router for communications between private and public net.

    Enos comes with a public network setup in a KaVLAN. This function
    makes a router between the public network and a `priv_sunet`.
    Args:
        net: Proxy for network aka neutron [1]
        project: An OpenStack project [2]
        priv_snet: The subnet of private network to put in the router [3]

    Refs:
        [1] https://docs.openstack.org/openstacksdk/latest/user/proxies/network.html
        [2] https://docs.openstack.org/openstacksdk/latest/user/resources/identity/v3/
↪project.html#openstack.identity.v3.project.Project
        [3] https://docs.openstack.org/openstacksdk/latest/user/resources/network/v2/
↪subnet.html#openstack.network.v2.subnet.Subnet
    """
    # Get the public net from Enos
    public_net  = net.find_network("public", ignore_missing=False)
    public_snet = net.find_subnet("public-subnet", ignore_missing=False)

    # Test if the router exists and create it if need be
    # https://docs.openstack.org/openstacksdk/latest/user/resources/network/v2/router.
↪html#openstack.network.v2.router.Router
    router = net.find_router("router", project_id=project.id)
    if not router:
        router = net.create_router(
            name="router",
            project_id=project.id,
            # Add public gateway
            external_gateway_info={
                'network_id': public_net.id,
                'enable_snat': True,
                'external_fixed_ips': [{'subnet_id': public_snet.id,}]
            })
        LOG.info("Created a new router %s" % router)

        # Add private interface
        res = net.add_interface_to_router(router, subnet_id=priv_snet.id)
        LOG.info("Added private interface %s to router" % res)


def make_sec_group_rule(net, project):
    """Enable every kind of communication (icmp, http, ssh) in `project`.

    Args:
        net: Proxy for network aka neutron [1]
```

(continues on next page)

(continued from previous page)

```
        project: An OpenStack project [2]

    Refs:
        [1] https://docs.openstack.org/openstacksdk/latest/user/proxies/network.html
        [2] https://docs.openstack.org/openstacksdk/latest/user/resources/identity/v3/
↪project.html#openstack.identity.v3.project.Project
    """
    # Delete default security group rules
    sgrs = [sgr for sgr in net.security_group_rules()
                if sgr.project_id == project.id]
    for sgr in sgrs:
        net.delete_security_group_rule(sgr)
        LOG.info("Delete sgr %s" % sgr)

    # Find the sec group for this project
    sg_default = net.find_security_group("default", project_id=project.id)

    # Let all traffic goes in/out
    protocols = ["icmp", "udp", "tcp"]
    directions = ["ingress", "egress"]
    crit = [(p, d) for p in protocols for d in directions]

    for (p, d) in crit:
        sgr = net.create_security_group_rule(
            direction=d,
            ether_type="IPv4",
            port_range_min=None if p == "icmp" else 1,
            port_range_max=None if p == "icmp" else 65535,
            project_id=project.id,
            protocol=p,
            remote_ip_prefix="0.0.0.0/0",
            security_group_id=sg_default.id)

        LOG.info("Created a new sgr %s" % sgr)


cloud = make_cloud()
project = make_account(cloud.identity, [
    "Leonardo", "Michelangelo", "Donatello", "Raphael"])
priv_snet = make_private_net(cloud.network, project)
make_router(cloud.network, project, priv_snet)
make_sec_group_rule(cloud.network, project)
```

CHAPTER 2

Why Enos ?

https://en.wikipedia.org/wiki/Enos_(chimpanzee)

CHAPTER 3

License

CHAPTER 4

Indices and tables

- genindex
- modindex
- search