Yardstick Overview

Release draft (dc64b51)

OPNFV

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CONTENTS

CHAPTER

ONE

INTRODUCTION

Welcome to Yardstick's documentation !

Yardstick is an OPNFV Project.

The project's goal is to verify infrastructure compliance, from the perspective of a Virtual Network Function (*VNF*).

The Project's scope is the development of a test framework, *Yardstick*, test cases and test stimuli to enable Network Function Virtualization Infrastructure (*NFVI*) verification. The Project also includes a sample *VNF*, the Virtual Traffic Classifier (*VTC*) and its experimental framework, *ApexLake* !

Yardstick is used in OPNFV for verifying the OPNFV infrastructure and some of the OPNFV features. The *Yardstick* framework is deployed in several OPNFV community labs. It is *installer*, *infrastructure* and *application* independent.

See also:

Pharos for information on OPNFV community labs and this Presentation for an overview of *Yardstick*

1.1 About This Document

This document consists of the following chapters:

- Chapter Methodology describes the methodology implemented by the Yardstick Project for *NFVI* verification.
- Chapter Virtual Traffic Classifier provides information on the *VTC*.
- Chapter Apexlake Installation Guide provides instructions to install the experimental framework *ApexLake* and chapter Apexlake API Interface Definition explains how this framework is integrated in *Yardstick*.
- Chapter Yardstick Installation provides instructions to install *Yardstick*.
- Chapter Yardstick Test Cases includes a list of available Yardstick test cases.

1.2 Contact Yardstick

Feedback? Contact us

CHAPTER

TWO

METHODOLOGY

2.1 Abstract

This chapter describes the methodology implemented by the Yardstick project for verifying the *NFVI* from the perspective of a *VNF*.

2.2 ETSI-NFV

The document ETSI GS NFV-TST001, "Pre-deployment Testing; Report on Validation of NFV Environments and Services", recommends methods for pre-deployment testing of the functional components of an NFV environment.

The Yardstick project implements the methodology described in chapter 6, "Pre- deployment validation of NFV infrastructure".

The methodology consists in decomposing the typical *VNF* work-load performance metrics into a number of characteristics/performance vectors, which each can be represented by distinct test-cases.

The methodology includes five steps:

- ***Step1:*** **Define Infrastruture - the Hardware, Software and corresponding** configuration target for validation; the OPNFV infrastructure, in OPNFV community labs.
- ***Step2:*** **Identify *VNF* type - the application for which the** infrastructure is to be validated, and its requirements on the underlying infrastructure.
- ***Step3:*** **Select test cases - depending on the workload that represents the** application for which the infrastruture is to be validated, the relevant test cases amongst the list of available Yardstick test cases.
- ***Step4:*** **Execute tests - define the duration and number of iterations for the** selected test cases, tests runs are automated via OPNFV Jenkins Jobs.
- *Step5:* Collect results - using the common API for result collection.

See also:

Yardsticktst for material on alignment ETSI TST001 and Yardstick.

2.3 Metrics

The metrics, as defined by ETSI GS NFV-TST001, are shown in *Table1*, *Table2* and *Table3*.

In OPNFV Brahmaputra release, generic test cases covering aspects of the listed metrics are available; further OPNFV releases will provide extended testing of these metrics. The view of available Yardstick test cases cross ETSI definitions in *Table1*, *Table2* and *Table3* is shown in *Table4*. It shall be noticed that the Yardstick test cases are examples, the test duration and number of iterations are configurable, as are the System Under Test (SUT) and the attributes (or, in Yardstick nomemclature, the scenario options). **Table 1 - Performance/Speed Metrics**

Category	Performance/Speed
Compute	• Latency for random memory access • Latency for cache read/write operations • Processing speed (instructions per second) • Throughput for random memory access (bytes per second)
Network	• Throughput per NFVI node (frames/byte per second) • Throughput provided to a VM (frames/byte per second) • Latency per traffic flow • Latency between VMs • Latency between NFVI nodes • Packet delay variation (jitter) between VMs • Packet delay variation (jitter) between NFVI nodes
Storage	• Sequential read/write IOPS • Random read/write IOPS • Latency for storage read/write operations • Throughput for storage read/write operations

Table 2 - Capacity/Scale Metrics

Category	Capacity/Scale
Compute	• Number of cores and threads- Available memory size • Cache size • Processor utilization (max, average, standard deviation) • Memory utilization (max, average, standard deviation) • Cache utilization (max, average, standard deviation)
Network	• Number of connections • Number of frames sent/received • Maximum throughput between VMs (frames/byte per second) • Maximum throughput between NFVI nodes (frames/byte per second) • Network utilization (max, average, standard deviation) • Number of traffic flows
Storage	• Storage/Disk size • Capacity allocation (block-based, object-based) • Block size • Maximum sequential read/write IOPS • Maximum random read/write IOPS • Disk utilization (max, average, standard deviation)

Table 3 - Availability/Reliability Metrics

Category	Availability/Reliability
Compute	• Processor availability (Error free processing time) • Memory availability (Error free memory time) • Processor mean-time-to-failure • Memory mean-time-to-failure • Number of processing faults per second
Network	• NIC availability (Error free connection time) • Link availability (Error free transmission time) • NIC mean-time-to-failure • Network timeout duration due to link failure • Frame loss rate
Storage	• Disk availability (Error free disk access time) • Disk mean-time-to-failure • Number of failed storage read/write operations per second

Table 4 - Yardstick Generic Test Cases

Category	Performance/Speed	Capacity/Scale	Availability/Reliability
Compute	TC003 [1] TC004 [1] TC014 TC024	TC003 [1] TC004 [1] TC010 TC012	TC013 [1] TC015 [1]
Network	TC002 TC011	TC001 TC008 TC009	TC016 [1] TC018 [1]
Storage	TC005	TC005	TC017 [1]

Note: The description in this OPNFV document is intended as a reference for users to understand the scope of the Yardstick Project and the deliverables of the Yardstick framework. For complete description of the methodology, refer to the ETSI document.

[1] To be included in future deliveries.

CHAPTER

THREE

ARCHITECTURE

3.1 Overview

Apart from a testing framework Yardstick also comes with default configured test cases, test suites and test sample cases. These can be picked and chosen from, and also modified to fit specific use cases.

Included is documentation describing how to install Yardstick on to different deployment configurations, see Yardstick Installation, how to run individual test cases and test suites and how to design new test cases, see NFV test design.

Yardstick is mainly written in Python, and test configurations are made in YAML. Documentation is written in reStructuredText format, i.e. .rst files.

The Yardstick environment is mainly intended to be installed via a container framework, but it is also possible to install Yardstick directly as well, see Yardstick Installation.

The Yardstick framework can be installed either on bare metal or on virtualized deployments see *Virtual and bare metal deployments*. Yardstick supports bare metal environments to be able to test things that are not possible to test on virtualized environments.

Typical test execution is done by deploying one or several *VM*:s on to the *NFVI* invoking the tests from there, see *Test execution flow*.

Yardstick can be run on its own on top of a deployed *NFVI*, which is mainly how it is run inside the OPNFV community labs in regular daily and weekly OPNFV builds. It can also run in parallel to a deployed *VNF*.

All of the tools used by and included in Yardstick are open source, also the tools developed by the Yardstick project.

3.2 Virtual and bare metal deployments

Yardstick tests can be deployed either on virtualized or on bare metal (*BM*) environments. For some type of tests a virtualized system under test (*SUT*) may not be suitable.

A *BM* deployment means that the OpenStack controllers and computes run on *BM*, directly on top of dedicated HW, i.e. non-virtualized. Hence, a virtualized deployment means that the OpenStack controllers and computes run virtualized, as *VM*:s.

The Cloud system installer is a separate function, but that too can run either virtualized or *BM*.

The most common practice on the different Yardstick PODs is to have *BM* Cloud deployments, with the installer running virtualized on the POD's jump server. The virtualized deployment practice is more common in smaller test design environments.

The Yardstick logic normally runs outside the *SUT*, on a separate server, either as *BM* or deployed within a separate Yardstick container.

Yardstick must have access privileges to the OpenStack *SUT* to be able to set up the *SUT* environment and to (optionally) deploy any images into the *SUT* to execute the tests scenarios from.

Yardstick tests are run as if run as a *VNF*, as one or several compute *VM*:s. Hence, the software maintained by and deployed by Yardstick on the *SUT* to execute the tests from is always run virtualized.

3.3 Concepts

Below is a list of common Yardstick concepts and a short description of each.

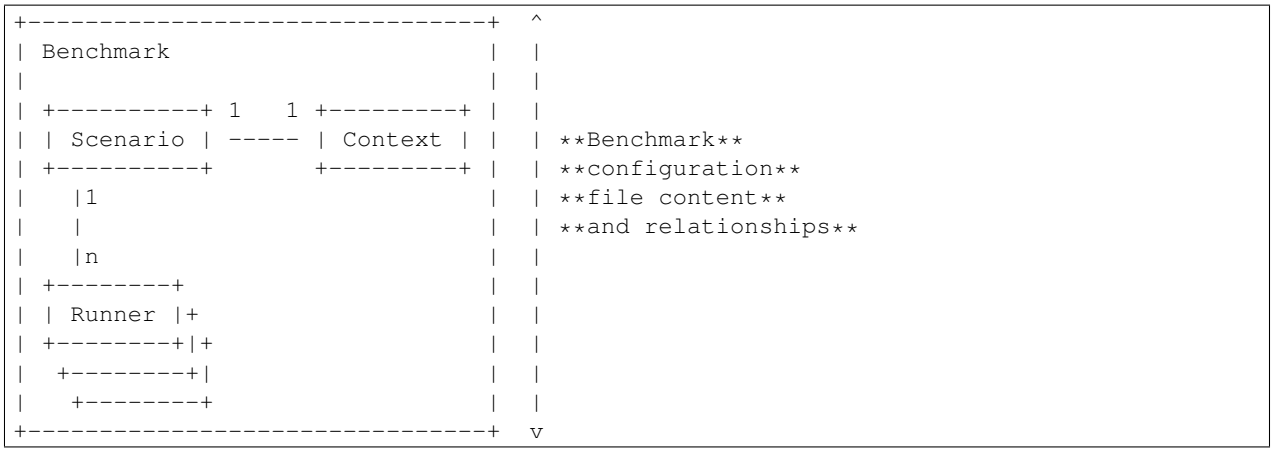
Benchmark configuration file - Describes a single test case in YAML format.

Context - The set of Cloud resources used by a scenario, such as user names, image names, affinity rules and network configurations. A context is converted into a simplified Heat template, which is used to deploy onto the Openstack environment.

Runner - Logic that determines how a test scenario is run and reported, for example the number of test iterations, input value stepping and test duration. Predefined runner types exist for re-usage, see *Runner types*.

Scenario - The overall test management of the runners.

SLA - Relates to what result boundary a test case must meet to pass. For example a latency limit, amount or ratio of lost packets and so on. Action based on *SLA* can be configured, either just to log (monitor) or to stop further testing (assert). The *SLA* criteria is set in the benchmark configuration file and evaluated by the runner.



3.3.1 Runner types

There exists several predefined runner types to choose between when designing a test scenario:

Arithmetic: Every test run arithmetically steps the specified input value(s) in the test scenario, adding a value to the previous input value. It is also possible to combine several input values for the same test case in different combinations.

Snippet of an Arithmetic runner configuration:

```
runner:
    type: Arithmetic
    iterators:
    -
      name: stride
      start: 64
      stop: 128
      step: 64
```

Duration: The test runs for a specific period of time before completed.

Snippet of a Duration runner configuration:

```
runner:
  type: Duration
  duration: 30
```

Sequence: The test changes a specified input value to the scenario. The input values to the sequence are specified in a list in the benchmark configuration file.

Snippet of a Sequence runner configuration:

```
runner:
  type: Sequence
  scenario_option_name: packetsize
  sequence:
  - 100
  - 200
  - 250
```

Iteration: Tests are run a specified number of times before completed.

Snippet of an Iteration runner configuration:

```
runner:
  type: Iteration
  iterations: 2
```

3.4 Test execution flow

As described earlier the Yardstick engine and central logic should be run on a computer from outside the *SUT*, on where the actual testing is executed. This is where the benchmark configuration YAML-file is parsed when invoking the Yardstick task shell command. For instance in the continuous integration activities of a POD Yardstick typically runs on the combined jump and Jenkins server of the respective POD.

The benchmark configuration YAML-file (the test case) is parsed by the Yardstick task shell command. Its context part is then converted into a Heat template and deployed into the stack (in OpenStack) of the *SUT*. This includes for instance *VM* deployment, network, and authentication configuration. Once the context is up an running on Openstack it is orchestrated by a Yardstick runner to run the tests of the *SUT*.

The Yardstick runner(s) is also created when the Yardstick task command is parsed. A runner runs in its own Yardstick subprocess executing commands remotely into a (context) *VM* using SSH, for example invoking ping from inside the deployed *VM* acting as the *VNF* application. While the test runs the output of the SSH commands is collected by the runner and written as JSON records to a file that is output into either a file (/tmp/yardstick.out by default), or in the case of running in a POD into a database instead.

When a test case is finished everything is cleaned out on the *SUT* to prepare for the next test case. A manually aborted test case is also cleaned out.

3.5 Yardstick Directory structure

yardstick/ - Yardstick main directory.

***ci/* - Used for continuous integration of Yardstick at different PODs and** with support for different installers.

***docs/* - All documentation is stored here, such as configuration guides,** user guides and Yardstick descriptions.

etc/ - Used for test cases requiring specific POD configurations.

***samples/* - VNF test case samples are stored here. These are only samples,** and not run during VNF verification.

***tests/* - Here both Yardstick internal tests (*functional/* and *unit/*) as** well as the test cases run to verify the VNFs (*opnfv/*) are stored. Also configurations of what to run daily and weekly at the different PODs is located here.

***tools/* - Various tools to run Yardstick. Currently contains how to** create the yardstick-trusty-server image with the different tools that are needed from within the image.

vTC/ - Contains the files for running the virtual Traffic Classifier tests.

***yardstick/* - Contains the internals of Yardstick: Runners, CLI parsing,** authentication keys, plotting tools, database and so on.

CHAPTER

FOUR

VIRTUAL TRAFFIC CLASSIFIER

4.1 Abstract

This chapter provides an overview of the virtual Traffic Classifier, a contribution to OPNFV Yardstick from the EU Project TNOVA. Additional documentation is available in TNOVAresults.

4.2 Overview

The virtual Traffic Classifier (*VTC*) *VNF*, comprises of a Virtual Network Function Component (*VNFC*). The *VNFC* contains both the Traffic Inspection module, and the Traffic forwarding module, needed to run the *VNF*. The exploitation of Deep Packet Inspection (*DPI*) methods for traffic classification is built around two basic assumptions:

- third parties unaffiliated with either source or recipient are able to

inspect each IP packet's payload

- the classifier knows the relevant syntax of each application's packet

payloads (protocol signatures, data patterns, etc.).

The proposed *DPI* based approach will only use an indicative, small number of the initial packets from each flow in order to identify the content and not inspect each packet.

In this respect it follows the Packet Based per Flow State (term:*PBFS*). This method uses a table to track each session based on the 5-tuples (src address, dest address, src port,dest port, transport protocol) that is maintained for each flow.

4.3 Concepts

- *Traffic Inspection*: The process of packet analysis and application

identification of network traffic that passes through the *VTC*.

- *Traffic Forwarding*: The process of packet forwarding from an incoming

network interface to a pre-defined outgoing network interface.

- *Traffic Rule Application*: The process of packet tagging, based on a

predefined set of rules. Packet tagging may include e.g. Type of Service (*ToS*) field modification.

4.4 Architecture

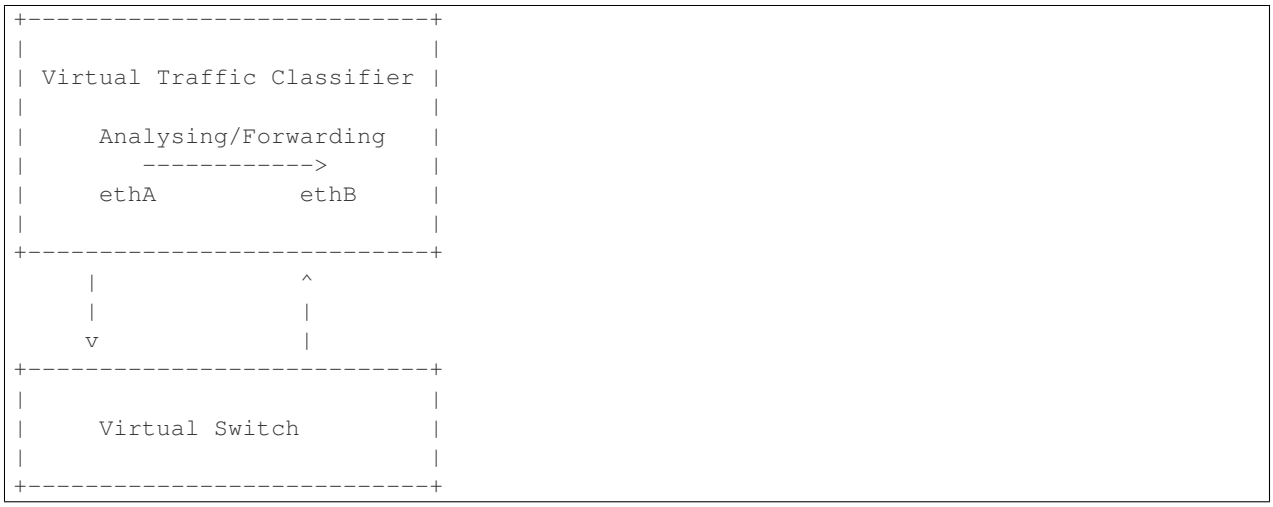
The Traffic Inspection module is the most computationally intensive component of the *VNF*. It implements filtering and packet matching algorithms in order to support the enhanced traffic forwarding capability of the *VNF*. The component supports a flow table (exploiting hashing algorithms for fast indexing of flows) and an inspection engine for traffic classification.

The implementation used for these experiments exploits the nDPI library. The packet capturing mechanism is implemented using libpcap. When the *DPI* engine identifies a new flow, the flow register is updated with the appropriate information and transmitted across the Traffic Forwarding module, which then applies any required policy updates.

The Traffic Forwarding moudle is responsible for routing and packet forwarding. It accepts incoming network traffic, consults the flow table for classification information for each incoming flow and then applies pre-defined policies marking e.g. *ToS*/Differentiated Services Code Point (*DSCP*) multimedia traffic for Quality of Service (*QoS*) enablement on the forwarded traffic. It is assumed that the traffic is forwarded using the default policy until it is identified and new policies are enforced.

The expected response delay is considered to be negligible, as only a small number of packets are required to identify each flow.

4.5 Graphical Overview



4.6 Install

run the build.sh with root privileges

4.7 Run

sudo ./pfbridge -a eth1 -b eth2

4.8 Development Environment

Ubuntu 14.04

CHAPTER

FIVE

APEXLAKE INSTALLATION GUIDE

5.1 Abstract

ApexLake is a framework that provides automatic execution of experiments and related data collection to enable a user validate infrastructure from the perspective of a Virtual Network Function (*VNF*).

In the context of Yardstick, a virtual Traffic Classifier (*VTC*) network function is utilized.

5.1.1 Framework Hardware Dependencies

In order to run the framework there are some hardware related dependencies for ApexLake.

The framework needs to be installed on the same physical node where DPDK-pktgen is installed.

The installation requires the physical node hosting the packet generator must have 2 NICs which are DPDK compatible.

The 2 NICs will be connected to the switch where the OpenStack VM network is managed.

The switch used must support multicast traffic and *IGMP* snooping. Further details about the configuration are provided at the following here.

The corresponding ports to which the cables are connected need to be configured as VLAN trunks using two of the VLAN IDs available for Neutron. Note the VLAN IDs used as they will be required in later configuration steps.

5.1.2 Framework Software Dependencies

Before starting the framework, a number of dependencies must first be installed. The following describes the set of instructions to be executed via the Linux shell in order to install and configure the required dependencies.

1. Install Dependencies.

To support the framework dependencies the following packages must be installed. The example provided is based on Ubuntu and needs to be executed in root mode.

```
apt-get install python-dev
apt-get install python-pip
apt-get install python-mock
apt-get install tcpreplay
apt-get install libpcap-dev
```

2. Install the Framework on the Target System.

After entering the Apexlake directory, run the following command.

```
python setup.py install
```

3. Source OpenStack openrc file.

```
source openrc
```

4. Create Two Networks based on VLANs in Neutron.

To enable network communications between the packet generator and the compute node, two networks must be created via Neutron and mapped to the VLAN IDs that were previously used in the configuration of the physical switch. The following shows the typical set of commands required to configure Neutron correctly.

```
VLAN_1=2025
VLAN_2=2021
neutron net-create apexlake_inbound_network \
        --provider:network_type vlan \
        --provider:segmentation_id $VLAN_1 \
        --provider:physical_network physnet1

neutron subnet-create apexlake_inbound_network \
        192.168.0.0/24 --name apexlake_inbound_subnet

neutron net-create apexlake_outbound_network \
        --provider:network_type vlan \
        --provider:physical_network physnet1

neutron net-create apexlake_inbound_network \
        --provider:network_type vlan \
        --provider:segmentation_id $VLAN_2 \
        --provider:physical_network physnet1

neutron subnet-create apexlake_outbound_network 192.168.1.0/24 \
        --name apexlake_outbound_subnet
```

5. Configure the Test Cases

The VLAN tags must also be included in the test case Yardstick yaml file as parameters for the following test cases:

- Yardstick Test Case Description TC006
- Yardstick Test Case Description TC007
- Yardstick Test Case Description TC020
- Yardstick Test Case Description TC021

Install and Configure DPDK Pktgen

Execution of the framework is based on DPDK Pktgen. If DPDK Pktgen has not installed, it is necessary to download, install, compile and configure it. The user can create a directory and download the dpdk packet generator source code:

```
cd experimental_framework/libraries
mkdir dpdk_pktgen
git clone https://github.com/pktgen/Pktgen-DPDK.git
```

For instructions on the installation and configuration of DPDK and DPDK Pktgen please follow the official DPDK Pktgen README file. Once the installation is completed, it is necessary to load the DPDK kernel driver, as follow:

```
insmod uio
insmod DPDK_DIR/x86_64-native-linuxapp-gcc/kmod/igb_uio.ko
```

It is necessary to set the configuration file to support the desired Pktgen configuration. A description of the required configuration parameters and supporting examples is provided in the following:

```
[PacketGen]
packet_generator = dpdk_pktgen

# This is the directory where the packet generator is installed
# (if the user previously installed dpdk-pktgen,
# it is required to provide the director where it is installed).
pktgen_directory = /home/user/software/dpdk_pktgen/dpdk/examples/pktgen/

# This is the directory where DPDK is installed
dpdk_directory = /home/user/apexlake/experimental_framework/libraries/Pktgen-DPDK/dpdk/

# Name of the dpdk-pktgen program that starts the packet generator
program_name = app/app/x86_64-native-linuxapp-gcc/pktgen

# DPDK coremask (see DPDK-Pktgen readme)
coremask = 1f

# DPDK memory channels (see DPDK-Pktgen readme)
memory_channels = 3

# Name of the interface of the pktgen to be used to send traffic (vlan_sender)
name_if_1 = p1p1

# Name of the interface of the pktgen to be used to receive traffic (vlan_receiver)
name_if_2 = p1p2

# PCI bus address correspondent to if_1
bus_slot_nic_1 = 01:00.0

# PCI bus address correspondent to if_2
bus_slot_nic_2 = 01:00.1
```

To find the parameters related to names of the NICs and the addresses of the PCI buses the user may find it useful to run the *DPDK* tool nic_bind as follows:

```
DPDK_DIR/tools/dpdk_nic_bind.py --status
```

Lists the NICs available on the system, and shows the available drivers and bus addresses for each interface. Please make sure to select NICs which are *DPDK* compatible.

Installation and Configuration of smcroute

The user is required to install smcroute which is used by the framework to support multicast communications.

The following is the list of commands required to download and install smroute.

```
cd ~
git clone https://github.com/troglobit/smcroute.git
cd smcroute
sed -i 's/aclocal-1.11/aclocal/g' ./autogen.sh
sed -i 's/automake-1.11/automake/g' ./autogen.sh
./autogen.sh
./configure
make
sudo make install
cd ..
```

It is also requires the creation a configuration file using the following command:

SMCROUTE_NIC=(name of the nic)

where name of the nic is the name used previously for the variable “name_if_2”. For example:

```
SMCROUTE_NIC=p1p2
```

Then create the smcroute configuration file /etc/smcroute.conf

```
echo mgroup from $SMCROUTE_NIC group 224.192.16.1 > /etc/smcroute.conf
```

At the end of this procedure it will be necessary to perform the following actions to add the user to the sudoers:

```
adduser USERNAME sudo
echo "user ALL=(ALL) NOPASSWD: ALL" >> /etc/sudoers
```

Experiment using SR-IOV Configuration on the Compute Node

To enable *SR-IOV* interfaces on the physical NIC of the compute node, a compatible NIC is required. NIC configuration depends on model and vendor. After proper configuration to support *SR-IOV*, a proper configuration of OpenStack is required. For further information, please refer to the SRIOV configuration guide

CHAPTER

SIX

APEXLAKE API INTERFACE DEFINITION

6.1 Abstract

The API interface provided by the framework to enable the execution of test cases is defined as follows.

6.2 init

static init()

Initializes the Framework

Returns None

6.3 execute_framework

static execute_framework (test_cases,

iterations,

heat_template,

heat_template_parameters,

deployment_configuration,

openstack_credentials)

Executes the framework according the specified inputs

Parameters

- **test_cases**

  Test cases to be run with the workload (dict() of dict())

  Example: test_case = dict()

  test_case['name'] = 'module.Class'

  test_case['params'] = dict()

  test_case['params']['throughput'] = '1'

  test_case['params']['vlan_sender'] = '1000'

  test_case['params']['vlan_receiver'] = '1001'

test_cases = [test_case]

- **iterations** Number of test cycles to be executed (int)
- **heat_template** (string) File name of the heat template corresponding to the workload to be deployed. It contains the parameters to be evaluated in the form of #parameter_name. (See heat_templates/vTC.yaml as example).
- **heat_template_parameters** (dict) Parameters to be provided as input to the heat template. See http://docs.openstack.org/developer/heat/ template_guide/hot_guide.html section "Template input parameters" for further info.
- **deployment_configuration** (dict[string] = list(strings))) Dictionary of parameters representing the deployment configuration of the workload.

  The key is a string corresponding to the name of the parameter, the value is a list of strings representing the value to be assumed by a specific param. The parameters are user defined: they have to correspond to the place holders (#parameter_name) specified in the heat template.

Returns dict() containing results

CHAPTER

SEVEN

YARDSTICK INSTALLATION

7.1 Abstract

Yardstick currently supports installation on Ubuntu 14.04 or by using a Docker image. Detailed steps about installing Yardstick using both of these options can be found below.

To use Yardstick you should have access to an OpenStack environment, with at least Nova, Neutron, Glance, Keystone and Heat installed.

The steps needed to run Yardstick are:

1. Install Yardstick and create the test configuration .yaml file.
2. Build a guest image and load the image into the OpenStack environment.
3. Create a Neutron external network and load OpenStack environment variables.
4. Run the test case.

7.2 Installing Yardstick on Ubuntu 14.04

7.2.1 Installing Yardstick framework

Install dependencies:

```
sudo apt-get install python-virtualenv python-dev
sudo apt-get install libffi-dev libssl-dev git
```

Create a python virtual environment, source it and update setuptools:

```
virtualenv ~/yardstick_venv
source ~/yardstick_venv/bin/activate
easy_install -U setuptools
```

Download source code and install python dependencies:

```
git clone https://gerrit.opnfv.org/gerrit/yardstick
cd yardstick
python setup.py install
```

There is also a YouTube video, showing the above steps:

7.2.2 Installing extra tools

yardstick-plot

Yardstick has an internal plotting tool `yardstick-plot`, which can be installed using the following command:

```
python setup.py develop easy_install yardstick[plot]
```

7.2.3 Building a guest image

Yardstick has a tool for building an Ubuntu Cloud Server image containing all the required tools to run test cases supported by Yardstick. It is necessary to have sudo rights to use this tool.

This image can be built using the following command while in the directory where Yardstick is installed (`~/yardstick` if the framework is installed by following the commands above):

```
sudo ./tools/yardstick-img-modify tools/ubuntu-server-cloudimg-modify.sh
```

Warning: the script will create files by default in: `/tmp/workspace/yardstick` and the files will be owned by root!

The created image can be added to OpenStack using the `glance image-create` or via the OpenStack Dashboard.

Example command:

```
glance --os-image-api-version 1 image-create \
--name yardstick-trusty-server --is-public true \
--disk-format qcow2 --container-format bare \
--file /tmp/workspace/yardstick/yardstick-trusty-server.img
```

7.3 Installing Yardstick using Docker

Yardstick has two Docker images, first one (**Yardstick-framework**) serves as a replacement for installing the Yardstick framework in a virtual environment (for example as done in *Installing Yardstick framework*), while the other image is mostly for CI purposes (**Yardstick-CI**).

7.3.1 Yardstick-framework image

Download the source code:

```
git clone https://gerrit.opnfv.org/gerrit/yardstick
```

Build the Docker image and tag it as *yardstick-framework*:

```
cd yardstick
docker build -t yardstick-framework .
```

Run the Docker instance:

```
docker run --name yardstick_instance -i -t yardstick-framework
```

To build a guest image for Yardstick, see *Building a guest image*.

7.3.2 Yardstick-CI image

Pull the Yardstick-CI Docker image from Docker hub:

```
docker pull opnfv/yardstick-ci
```

Run the Docker image:

```
docker run \
 --privileged=true \
  --rm \
  -t \
  -e "INSTALLER_TYPE=${INSTALLER_TYPE}" \
  -e "INSTALLER_IP=${INSTALLER_IP}" \
  opnfv/yardstick-ci \
  run_benchmarks
```

Where `${INSTALLER_TYPE}` can be fuel, foreman or compass and `${INSTALLER_IP}` is the installer master node IP address (i.e. 10.20.0.2 is default for fuel).

Basic steps performed by the **Yardstick-CI** container:

1. clone yardstick and releng repos
2. setup OS credentials (releng scripts)
3. install yardstick and dependencies
4. build yardstick cloud image and upload it to glance
5. upload cirros-0.3.3 cloud image to glance
6. run yardstick test scenarios
7. cleanup

7.4 OpenStack parameters and credentials

7.4.1 Yardstick-flavor

Most of the sample test cases in Yardstick are using an OpenStack flavor called *yardstick-flavor* which deviates from the OpenStack standard m1.tiny flavor by the disk size - instead of 1GB it has 3GB. Other parameters are the same as in m1.tiny.

7.4.2 Environment variables

Before running Yardstick it is necessary to export OpenStack environment variables from the OpenStack *openrc* file (using the `source` command) and export the external network name `export EXTERNAL_NETWORK="external-network-name"`, the default name for the external network is `net04_ext`.

Credential environment variables in the *openrc* file have to include at least:

- OS_AUTH_URL
- OS_USERNAME
- OS_PASSWORD

- OS_TENANT_NAME

7.4.3 Yardstick default key pair

Yardstick uses a SSH key pair to connect to the guest image. This key pair can be found in the `resources/files` directory. To run the `ping-hot.yaml` test sample, this key pair needs to be imported to the OpenStack environment.

7.5 Examples and verifying the install

It is recommended to verify that Yardstick was installed successfully by executing some simple commands and test samples. Below is an example invocation of yardstick help command and ping.py test sample:

```
yardstick -h
yardstick task start samples/ping.yaml
```

Each testing tool supported by Yardstick has a sample configuration file. These configuration files can be found in the **samples** directory.

Example invocation of `yardstick-plot` tool:

```
yardstick-plot -i /tmp/yardstick.out -o /tmp/plots/
```

Default location for the output is `/tmp/yardstick.out`.

More info about the tool can be found by executing:

```
yardstick-plot -h
```

CHAPTER

EIGHT

NFV TEST DESIGN

This chapter mainly describes how to add new *VNF* test cases to Yardstick.

The relevant use cases will probably be either to reuse an existing test case in a new test suite combination, or to make minor modifications to existing YAML files, or to create new YAML files, or to create completely new test cases and also new test types.

8.1 General

- Reuse what already exists as much as possible.
- Adhere to the architecture of the existing design, such as using scenarios, runners and so on.
- Make sure any new code has enough test coverage. If the coverage is not good enough the build system will complain, see *VNF test case design* for more details.
- There should be no dependencies between different test scenarios. Scenarios should be possible to combine and run without dependencies between them, otherwise it will not be possible to keep the testing modular, neither be possible to run them each as single scenarios. It will in practice be harder to include and exclude test cases in any desirable order in all different test suites. Any exception should be documented in a test scenario that depends on another scenario.
- Any modifications made to the system under test by a test scenario should be cleaned up after the test is completed or aborted.
- Additions and changes should be documented. Remember not only pure coders/designers could be interested in getting a deeper understanding of Yardstick.

8.2 VNF test case design

This chapter describes how to add a new test case type. For more limited changes the scope of the test design would be reduced.

8.2.1 Scenario configuration

A new test scenario should be defined in a separate benchmark configuration YAML file. Typically such includes Yardstick *VM* deployment configurations, *VM* affinity rules, which images to run where, *VM* image login credentials, test duration, optional test passing boundaries (*SLA*) and network configuration. Depending on the nature of a new test type also other or new parameters may be valid to add.

VNF scenario example from *ping.yaml*:

```
---
# Sample benchmark task config file
# measure network latency using ping

schema: "yardstick:task:0.1"

scenarios:
-
  type: Ping
  options:
    packetsize: 200
  host: athena.demo
  target: ares.demo

  runner:
    type: Duration
    duration: 60
    interval: 1

  sla:
    max_rtt: 10
    action: monitor

context:
  name: demo
  image: cirros-0.3.3
  flavor: m1.tiny
  user: cirros

  placement_groups:
    pgrp1:
      policy: "availability"

  servers:
    athena:
      floating_ip: true
      placement: "pgrp1"
    ares:
      placement: "pgrp1"

  networks:
    test:
      cidr: '10.0.1.0/24'
```

8.2.2 Test case coding

An actual *VNF* test case is realized by a test scenario Python file, or files. The test class name should be the same as the test type name. Typical class definitions are the init() and run() methods. Additional support methods can also be added to the class. Also a (simple) _test() design method can be added to the respective file.

A comment field describing the different valid input parameters in the above YAML file should also be included, such as possible dependencies parameter value boundaries and parameter defaults.

The Yardstick internal unit tests are located under *yardstick/tests/unit/*. The unit tests are run at each Gerrit commit to verify correct behavior and code coverage. They are also run when Yardstick is deployed onto an environment/POD. At each new commit up to a total of 10 new lines of uncovered code is accepted, otherwise the commit will be refused.

Example of *VNF* test case from *ping.py*:

```
class Ping(base.Scenario):
    """Execute ping between two hosts

Parameters
    packetsize - number of data bytes to send
        type:    int
        unit:    bytes
        default: 56
    """
 .
 .
 .
 def __init__(self, scenario_cfg, context_cfg):
     <Initialize test case, variables to use in run() method and so on>
 .
 .
 .
 def run(self, result):
     <Run the test, evaluate results and produce output>
 .
 .
 .
```

Example of internal test method of *VNF* test code from *ping.py*:

```
def _test():
    """internal test function"""
     <Create the context and run test case>
```

Snippet of unit test code from *test_ping.py*:

```
import mock
import unittest

from yardstick.benchmark.scenarios.networking import ping

class PingTestCase(unittest.TestCase):

    def setUp(self):
        self.ctx = {
            'host': {
                'ip': '172.16.0.137',
                'user': 'cirros',
                'key_filename': "mykey.key"
            },
            "target": {
                "ipaddr": "10.229.17.105",
            }
        }

    @mock.patch('yardstick.benchmark.scenarios.networking.ping.ssh')
    def test_ping_successful_no_sla(self, mock_ssh):

        args = {
            'options': {'packetsize': 200},
            }
        result = {}

        p = ping.Ping(args, self.ctx)
```

```
        mock_ssh.SSH().execute.return_value = (0, '100', '')
        p.run(result)
        self.assertEqual(result, {'rtt': 100.0})
.
.
.

def main():
    unittest.main()

if __name__ == '__main__':
    main()
```

The vTC part of Yardstick complies to its own testing and coverage rules, see Virtual Traffic Classifier.

8.2.3 The Yardstick VNF test image

The Yardstick test/guest *VM* image, deployed onto the system under test and where tests are executed from, must contain all the necessary tools for all supported test cases (such as ping, perf, lmbench and so on). Hence, any required packages in this dedicated Yardstick Ubuntu image should be added to the script that builds it. See more information in *Building a guest image*.

8.2.4 VNF test case output

Yardstick *VNF* test results are each output in JSON format. These are by default dispatched to the file */tmp/yardstick.out*, which is overwritten by each new test scenario. This is practical when doing test design and local test verification, but not when releasing test scenarios for public use and evaluation. For this purpose test output can be dispatched to either a Yardstick internal *InfluxDB* database, and visualized by *Grafana*, or to the official OPNFV *MongoDB* database which uses *Bitergia* as visualization tool.

InfluxDB is populated by the log dispatcher using an http line protocol specified by InfluxDB.

Set the *DISPATCHER_TYPE* parameter to chose where to dispatch all test result output. It can be set to either *file*, *influxdb* or *http*. Default is *file*.

Examples of which log dispatcher parameters to set:

```
To file:
  DISPATCHER_TYPE=file
  DISPATCHER_FILE_NAME="/tmp/yardstick.out"

To OPNFV MongoDB/Bitergia:
  DISPATCHER_TYPE=http
  DISPATCHER_HTTP_TARGET=http://130.211.154.108

To Yardstick InfluxDB/Grafana:
  DISPATCHER_TYPE=influxdb
  DISPATCHER_INFLUXDB_TARGET=http://10.118.36.90
```

8.2.5 Before doing Gerrit commit

The script *run_tests.sh* in the top Yardstick directory must be run cleanly through before doing a commit into Gerrit.

8.2.6 Continuous integration with Yardstick

Yardstick is part of daily and weekly continuous integration (CI) loops at different OPNFV PODs. The POD integration is kept together via the OPNFV Releng project, which uses Jenkins as the main tool for this activity.

The daily and weekly test suites have different timing constraints to align to. Hence, Yardstick *VNF* test suite time boundaries should be kept in mind when doing new test design or when doing modifications to existing test cases or test suite configurations.

The daily test suites contain tests that are relatively fast to execute, and provide enough results to have an enough certainty level that the complete OPNFV *NFVI* deployment is not broken.

The weekly tests suites can run for longer than the daily test suites. Test cases that need to run for longer and/or with more iterations and/or granularity are included here, and run as complements to the daily test suites.

For the OPNFV R2 release a complete daily Yardstick test suite at a POD must complete in approximately 3 hours, while a weekly test suite at a POD may run for up to 24 hours until completion.

It should also be noted that since CI PODs can run either virtual or *BM* the test suite for the respective POD must be planned and configured with test scenarios suitable for the respective type of deployment.

It is possible to set a precondition statement in the test scenario if there are certain requirements.

Example of a precondition configuration:

```
precondition:
  installer_type: compass
  deploy_scenarios: os-nosdn
```

For further details on modifying test suites please consult the project.

8.2.7 Test case documentation

Each test case should be described in a separate file in reStructuredText format. There is a template for this in the *docs* directory to guide you. These documents must also be added to the build scripts to hint to the OPNFV build system to generate appropriate html and pdf files out of them.

CHAPTER

NINE

YARDSTICK TEST CASES

9.1 Abstract

This chapter lists available Yardstick test cases. Yardstick test cases are divided in two main categories:

- *Generic NFVI Test Cases* - Test Cases developed to realize the methodology

described in Methodology

- *OPNFV Feature Test Cases* - Test Cases developed to verify one or more

aspect of a feature delivered by an OPNFV Project, including the test cases developed for the *VTC*.

9.2 Generic NFVI Test Case Descriptions

9.2.1 Yardstick Test Case Description TC001

Network Performance	
test case id	OPNFV_YARDSTICK_TC001_NW PERF
metric	Number of flows and throughput
test purpose	To evaluate the IaaS network performance with regards to flows and throughput, such as if and how different amounts of flows matter for the throughput between hosts on different compute blades. Typically e.g. the performance of a vSwitch depends on the number of flows running through it. Also performance of other equipment or entities can depend on the number of flows or the packet sizes used. The purpose is also to be able to spot trends. Test results, graphs ans similar shall be stored for comparison reasons and product evolution understanding between different OPNFV versions and/or configurations.
configuration	file: opnfv_yardstick_tc001.yaml Packet size: 60 bytes Number of ports: 10, 50, 100, 500 and 1000, where each runs for 20 seconds. The whole sequence is run twice. The client and server are distributed on different HW. For SLA max_ppm is set to 1000. The amount of configured ports map to between 110 up to 1001000 flows, respectively.
test tool	pktgen (Pktgen is not always part of a Linux distribution, hence it needs to be installed. It is part of the Yardstick Docker image. As an example see the /yardstick/tools/ directory for how to generate a Linux image with pktgen included.)
references	pktgen ETSI-NFV-TST001
applicability	Test can be configured with different packet sizes, amount of flows and test duration. Default values exist. **SLA (optional): max_ppm: The number of packets per million** packets sent that are acceptable to loose, not received.
pre-test conditions	The test case image needs to be installed into Glance with pktgen included in it. No POD specific requirements have been identified.
test sequence	description and expected result
step 1	The hosts are installed, as server and client. pktgen is invoked and logs are produced and stored. Result: Logs are stored.
test verdict	Fails only if SLA is not passed, or if there is a test case execution problem.

9.2.2 Yardstick Test Case Description TC002

Network Latency	
test case id	OPNFV_YARDSTICK_TC002_NW LATENCY
metric	RTT, Round Trip Time
test purpose	To do a basic verification that network latency is within acceptable boundaries when packets travel between hosts located on same or different compute blades. The purpose is also to be able to spot trends. Test results, graphs and similar shall be stored for comparison reasons and product evolution understanding between different OPNFV versions and/or configurations.
configuration	file: opnfv_yardstick_tc002.yaml Packet size 100 bytes. Total test duration 600 seconds. One ping each 10 seconds. SLA RTT is set to maximum 10 ms.
test tool	ping Ping is normally part of any Linux distribution, hence it doesn't need to be installed. It is also part of the Yardstick Docker image. (For example also a Cirros image can be downloaded from cirros-image, it includes ping)
references	Ping man page ETSI-NFV-TST001
applicability	Test case can be configured with different packet sizes, burst sizes, ping intervals and test duration. SLA is optional. The SLA in this test case serves as an example. Considerably lower RTT is expected, and also normal to achieve in balanced L2 environments. However, to cover most configurations, both bare metal and fully virtualized ones, this value should be possible to achieve and acceptable for black box testing. Many real time applications start to suffer badly if the RTT time is higher than this. Some may suffer bad also close to this RTT, while others may not suffer at all. It is a compromise that may have to be tuned for different configuration purposes.
pre-test conditions	The test case image needs to be installed into Glance with ping included in it. No POD specific requirements have been identified.
test sequence	description and expected result
step 1	The hosts are installed, as server and client. Ping is invoked and logs are produced and stored. Result: Logs are stored.
test verdict	Test should not PASS if any RTT is above the optional SLA value, or if there is a test case execution problem.

9.2.3 Yardstick Test Case Description TC005

Storage Performance	
test case id	OPNFV_YARDSTICK_TC005_Storage Performance
metric	IOPS, throughput and latency
test purpose	To evaluate the IaaS storage performance with regards to IOPS, throughput and latency. The purpose is also to be able to spot trends. Test results, graphs and similar shall be stored for comparison reasons and product evolution understanding between different OPNFV versions and/or configurations.
configuration	file: opnfv_yardstick_tc005.yaml IO types: read, write, randwrite, randread, rw IO block size: 4KB, 64KB, 1024KB, where each runs for 30 seconds(10 for ramp time, 20 for runtime). For SLA minimum read/write iops is set to 100, minimum read/write throughput is set to 400 KB/s, and maximum read/write latency is set to 20000 usec.
test tool	fio (fio is not always part of a Linux distribution, hence it needs to be installed. As an example see the /yardstick/tools/ directory for how to generate a Linux image with fio included.)
references	fio ETSI-NFV-TST001
applicability	Test can be configured with different read/write types, IO block size, IO depth, ramp time (runtime required for stable results) and test duration. Default values exist.
pre-test conditions	The test case image needs to be installed into Glance with fio included in it. No POD specific requirements have been identified.
test sequence	description and expected result
step 1	The host is installed and fio is invoked and logs are produced and stored. Result: Logs are stored.
test verdict	Fails only if SLA is not passed, or if there is a test case execution problem.

9.2.4 Yardstick Test Case Description TC008

Packet Loss Extended Test	
test case id	OPNFV_YARDSTICK_TC008_NW PERF, Packet loss Extended Test
metric	Number of flows, packet size and throughput
test purpose	To evaluate the IaaS network performance with regards to flows and throughput, such as if and how different amounts of packet sizes and flows matter for the throughput between VMs on different compute blades. Typically e.g. the performance of a vSwitch depends on the number of flows running through it. Also performance of other equipment or entities can depend on the number of flows or the packet sizes used. The purpose is also to be able to spot trends. Test results, graphs ans similar shall be stored for comparison reasons and product evolution understanding between different OPNFV versions and/or configurations.
configuration	file: opnfv_yardstick_tc008.yaml Packet size: 64, 128, 256, 512, 1024, 1280 and 1518 bytes. Number of ports: 1, 10, 50, 100, 500 and 1000. The amount of configured ports map from 2 up to 1001000 flows, respectively. Each packet_size/port_amount combination is run ten times, for 20 seconds each. Then the next packet_size/port_amount combination is run, and so on. The client and server are distributed on different HW. For SLA max_ppm is set to 1000.
test tool	pktgen (Pktgen is not always part of a Linux distribution, hence it needs to be installed. It is part of the Yardstick Docker image. As an example see the /yardstick/tools/ directory for how to generate a Linux image with pktgen included.)
references	pktgen ETSI-NFV-TST001
applicability	Test can be configured with different packet sizes, amount of flows and test duration. Default values exist. SLA (optional): max_ppm: The number of packets per million packets sent that are acceptable to loose, not received.
pre-test conditions	The test case image needs to be installed into Glance with pktgen included in it. No POD specific requirements have been identified.
test sequence	description and expected result
step 1	The hosts are installed, as server and client. pktgen is invoked and logs are produced and stored. Result: Logs are stored.
test verdict	Fails only if SLA is not passed, or if there is a test case execution problem.

9.2.5 Yardstick Test Case Description TC009

Packet Loss	
test case id	OPNFV_YARDSTICK_TC009_NW PERF, Packet loss
metric	Number of flows, packets lost and throughput
test purpose	To evaluate the IaaS network performance with regards to flows and throughput, such as if and how different amounts of flows matter for the throughput between VMs on different compute blades. Typically e.g. the performance of a vSwitch depends on the number of flows running through it. Also performance of other equipment or entities can depend on the number of flows or the packet sizes used. The purpose is also to be able to spot trends. Test results, graphs ans similar shall be stored for comparison reasons and product evolution understanding between different OPNFV versions and/or configurations.
configuration	file: opnfv_yardstick_tc009.yaml Packet size: 64 bytes Number of ports: 1, 10, 50, 100, 500 and 1000. The amount of configured ports map from 2 up to 1001000 flows, respectively. Each port amount is run ten times, for 20 seconds each. Then the next port_amount is run, and so on. The client and server are distributed on different HW. For SLA max_ppm is set to 1000.
test tool	pktgen (Pktgen is not always part of a Linux distribution, hence it needs to be installed. It is part of the Yardstick Docker image. As an example see the /yardstick/tools/ directory for how to generate a Linux image with pktgen included.)
references	pktgen ETSI-NFV-TST001
applicability	Test can be configured with different packet sizes, amount of flows and test duration. Default values exist. SLA (optional): max_ppm: The number of packets per million packets sent that are acceptable to loose, not received.
pre-test conditions	The test case image needs to be installed into Glance with pktgen included in it. No POD specific requirements have been identified.
test sequence	description and expected result
step 1	The hosts are installed, as server and client. pktgen is invoked and logs are produced and stored. Result: logs are stored.
test verdict	Fails only if SLA is not passed, or if there is a test case execution problem.

9.2.6 Yardstick Test Case Description TC010

Memory Latency	
test case id	OPNFV_YARDSTICK_TC010_Memory Latency
metric	Latency in nanoseconds
test purpose	Measure the memory read latency for varying memory sizes and strides. Whole memory hierarchy is measured including all levels of cache.
configuration	File: opnfv_yardstick_tc010.yaml • SLA (max_latency): 30 nanoseconds • Stride - 128 bytes • Stop size - 64 megabytes • Iterations: 10 - test is run 10 times iteratively. • Interval: 1 - there is 1 second delay between each iteration.
test tool	Lmbench Lmbench is a suite of operating system microbenchmarks. This test uses lat_mem_rd tool from that suite. Lmbench is not always part of a Linux distribution, hence it needs to be installed in the test image
references	man-pages McVoy, Larry W.,and Carl Staelin. "lmbench: Portable Tools for Performance Analysis." USENIX annual technical conference 1996.
applicability	Test can be configured with different: • strides; • stop_size; • iterations and intervals. There are default values for each above-mentioned option. SLA (optional) : max_latency: The maximum memory latency that is accepted.
pre-test conditions	The test case image needs to be installed into Glance with Lmbench included in the image. No POD specific requirements have been identified.
test sequence	description and expected result
step 1	The host is installed as client. Lmbench's lat_mem_rd tool is invoked and logs are produced and stored. Result: logs are stored.
test verdict	Test fails if the measured memory latency is above the SLA value or if there is a test case execution problem.

9.2.7 Yardstick Test Case Description TC011

Packet delay variation between VMs	
test case id	OPNFV_YARDSTICK_TC011_Packet delay variation between VMs
metric	jitter: packet delay variation (ms)
test purpose	Measure the packet delay variation sending the packets from one VM to the other.
configuration	File: opnfv_yardstick_tc011.yaml • options: protocol: udp # The protocol used by iperf3 tools bandwidth: 20m # It will send the given number of packets without pausing • runner: duration: 30 # Total test duration 30 seconds. • SLA (optional): jitter: 10 (ms) # The maximum amount of jitter that is accepted.
test tool	iperf3 iPerf3 is a tool for active measurements of the maximum achievable bandwidth on IP networks. It supports tuning of various parameters related to timing, buffers and protocols. The UDP protocols can be used to measure jitter delay. (iperf3 is not always part of a Linux distribution, hence it needs to be installed. It is part of the Yardstick Docker image. As an example see the /yardstick/tools/ directory for how to generate a Linux image with pktgen included.)
references	iperf3 ETSI-NFV-TST001
applicability	Test can be configured with different • **bandwidth: Test case can be configured with different** bandwidth • duration: The test duration can be configured • **jitter: SLA is optional. The SLA in this test case** serves as an example.
pre-test conditions	The test case image needs to be installed into Glance with iperf3 included in the image. No POD specific requirements have been identified.
test sequence	description and expected result
step 1	The hosts are installed, as server and client. iperf3 is invoked and logs are produced and stored. Result: Logs are stored.
test verdict	Test should not PASS if any jitter is above the optional SLA value, or if there is a test case execution problem.

9.2.8 Yardstick Test Case Description TC012

Memory Bandwidth	
test case id	OPNFV_YARDSTICK_TC012_Memory Bandwidth
metric	Megabyte per second (MBps)
test purpose	Measure the rate at which data can be read from and written to the memory (this includes all levels of memory).
configuration	File: opnfv_yardstick_tc012.yaml • SLA (optional): 15000 (MBps) min_bw: The minimum amount of memory bandwidth that is accepted. • Size: 10 240 kB - test allocates twice that size (20 480kB) zeros it and then measures the time it takes to copy from one side to another. • Benchmark: rdwr - measures the time to read data into memory and then write data to the same location. • Warmup: 0 - the number of iterations to perform before taking actual measurements. • Iterations: 10 - test is run 10 times iteratively. • Interval: 1 - there is 1 second delay between each iteration.
test tool	Lmbench Lmbench is a suite of operating system microbenchmarks. This test uses bw_mem tool from that suite. Lmbench is not always part of a Linux distribution, hence it needs to be installed in the test image.
references	man-pages McVoy, Larry W., and Carl Staelin. "lmbench: Portable Tools for Performance Analysis." USENIX annual technical conference. 1996.
applicability	Test can be configured with different: • memory sizes; • memory operations (such as rd, wr, rdwr, cp, frd, fwr, fcp, bzero, bcopy); • number of warmup iterations; • iterations and intervals. There are default values for each above-mentioned option.
pre-test conditions	The test case image needs to be installed into Glance with Lmbench included in the image. No POD specific requirements have been identified.
test sequence	description and expected result
step 1	The host is installed as client. Lmbench's bw_mem tool is invoked and logs are produced and stored. Result: logs are stored.
test verdict	Test fails if the measured memory bandwidth is below the SLA value or if there is a test case execution problem.

9.2.9 Yardstick Test Case Description TC014

Processing speed	
test case id	OPNFV_YARDSTICK_TC014_Processing speed
metric	score of single cpu running, score of parallel running
test purpose	To evaluate the IaaS processing speed with regards to score of single cpu running and parallel running The purpose is also to be able to spot trends. Test results, graphs and similar shall be stored for comparison reasons and product evolution understanding between different OPNFV versions and/or configurations.
configuration	file: opnfv_yardstick_tc014.yaml run_mode: Run unixbench in quiet mode or verbose mode test_type: dhry2reg, whetstone and so on For SLA with single_score and parallel_score, both can be set by user, default is NA
test tool	unixbench (unixbench is not always part of a Linux distribution, hence it needs to be installed. As an example see the /yardstick/tools/ directory for how to generate a Linux image with unixbench included.)
references	unixbench ETSI-NFV-TST001
applicability	Test can be configured with different test types, dhry2reg, whetstone and so on.
pre-test conditions	The test case image needs to be installed into Glance with unixbench included in it. No POD specific requirements have been identified.
test sequence	description and expected result
step 1	The hosts are installed, as a client. unixbench is invoked and logs are produced and stored. Result: Logs are stored.
test verdict	Fails only if SLA is not passed, or if there is a test case execution problem.

9.2.10 Yardstick Test Case Description TC024

CPU Load	
test case id	OPNFV_YARDSTICK_TC024_CPU Load
metric	CPU load
test purpose	To evaluate the CPU load performance of the IaaS. This test case should be run in parallel to other Yardstick test cases and not run as a stand-alone test case. The purpose is also to be able to spot trends. Test results, graphs ans similar shall be stored for comparison reasons and product evolution understanding between different OPNFV versions and/or configurations.
configuration	file: cpuload.yaml (in the 'samples' directory) There is are no additional configurations to be set for this TC.
test tool	mpstat (mpstat is not always part of a Linux distribution, hence it needs to be installed. It is part of the Yardstick Glance image. However, if mpstat is not present the TC instead uses /proc/stats as source to produce "mpstat" output.
references	man-pages
applicability	Run in background with other test cases.
pre-test conditions	The test case image needs to be installed into Glance with mpstat included in it. No POD specific requirements have been identified.
test sequence	description and expected result
step 1	The host is installed. The related TC, or TCs, is invoked and mpstat logs are produced and stored. Result: Stored logs
test verdict	None. CPU load results are fetched and stored.

9.2.11 Yardstick Test Case Description TC037

Latency, CPU Load, Throughput, Packet Loss	
test case id	OPNFV_YARDSTICK_TC037_Latency,CPU Load,Throughput,Packet Loss
metric	Number of flows, latency, throughput, CPU load, packet loss
test purpose	To evaluate the IaaS network performance with regards to flows and throughput, such as if and how different amounts of flows matter for the throughput between hosts on different compute blades. Typically e.g. the performance of a vSwitch depends on the number of flows running through it. Also performance of other equipment or entities can depend on the number of flows or the packet sizes used. The purpose is also to be able to spot trends. Test results, graphs ans similar shall be stored for comparison reasons and product evolution understanding between different OPNFV versions and/or configurations.
configuration	file: opnfv_yardstick_tc037.yaml Packet size: 64 bytes Number of ports: 1, 10, 50, 100, 300, 500, 750 and 1000. The amount configured ports map from 2 up to 1001000 flows, respectively. Each port amount is run two times, for 20 seconds each. Then the next port_amount is run, and so on. During the test CPU load on both client and server, and the network latency between the client and server are measured. The client and server are distributed on different HW. For SLA max_ppm is set to 1000.
test tool	pktgen (Pktgen is not always part of a Linux distribution, hence it needs to be installed. It is part of the Yardstick Glance image. As an example see the /yardstick/tools/ directory for how to generate a Linux image with pktgen included.) ping Ping is normally part of any Linux distribution, hence it doesn't need to be installed. It is also part of the Yardstick Glance image. (For example also a cirros image can be downloaded, it includes ping) mpstat (Mpstat is not always part of a Linux distribution, hence it needs to be installed. It is part of the Yardstick Glance image.
references	Ping and Mpstat man pages pktgen ETSI-NFV-TST001
applicability	Test can be configured with different packet sizes, amount of flows and test duration. Default values exist. SLA (optional): max_ppm: The number of packets per million packets sent that are acceptable to loose, not received.
pre-test conditions	The test case image needs to be installed into Glance with pktgen included in it. No POD specific requirements have been identified.
test sequence	description and expected result
step 1	The hosts are installed, as server and client. pktgen is invoked and logs are produced and stored. Result: Logs are stored.
test verdict	Fails only if SLA is not passed, or if there is a test case execution problem.

9.2.12 Yardstick Test Case Description TC038

Latency, CPU Load, Throughput, Packet Loss (Extended measurements)	
test case id	OPNFV_YARDSTICK_TC038_Latency,CPU Load,Throughput,Packet Loss
metric	Number of flows, latency, throughput, CPU load, packet loss
test purpose	To evaluate the IaaS network performance with regards to flows and throughput, such as if and how different amounts of flows matter for the throughput between hosts on different compute blades. Typically e.g. the performance of a vSwitch depends on the number of flows running through it. Also performance of other equipment or entities can depend on the number of flows or the packet sizes used. The purpose is also to be able to spot trends. Test results, graphs ans similar shall be stored for comparison reasons and product evolution understanding between different OPNFV versions and/or configurations.
configuration	file: opnfv_yardstick_tc038.yaml Packet size: 64 bytes Number of ports: 1, 10, 50, 100, 300, 500, 750 and 1000. The amount configured ports map from 2 up to 1001000 flows, respectively. Each port amount is run ten times, for 20 seconds each. Then the next port_amount is run, and so on. During the test CPU load on both client and server, and the network latency between the client and server are measured. The client and server are distributed on different HW. For SLA max_ppm is set to 1000.
test tool	pktgen (Pktgen is not always part of a Linux distribution, hence it needs to be installed. It is part of the Yardstick Glance image. As an example see the /yardstick/tools/ directory for how to generate a Linux image with pktgen included.) ping Ping is normally part of any Linux distribution, hence it doesn't need to be installed. It is also part of the Yardstick Glance image. (For example also a cirros image can be downloaded, it includes ping) mpstat (Mpstat is not always part of a Linux distribution, hence it needs to be installed. It is part of the Yardstick Glance image.
references	Ping and Mpstat man pages pktgen ETSI-NFV-TST001
applicability	Test can be configured with different packet sizes, amount of flows and test duration. Default values exist. SLA (optional): max_ppm: The number of packets per million packets sent that are acceptable to loose, not received.
pre-test conditions	The test case image needs to be installed into Glance with pktgen included in it. No POD specific requirements have been identified.
test sequence	description and expected result
step 1	The hosts are installed, as server and client. pktgen is invoked and logs are produced and stored. Result: Logs are stored.
test verdict	Fails only if SLA is not passed, or if there is a test case execution problem.

9.3 OPNFV Feature Test Cases

9.3.1 H A

Yardstick Test Case Description TC019

Control Node Openstack Service High Availability	
test case id	OPNFV_YARDSTICK_TC019_HA: Control node Openstack service down
test purpose	This test case will verify the high availability of the service provided by OpenStack (like nova-api, neutron-server) on control node.
test method	This test case kills the processes of a specific Openstack service on a selected control node, then checks whether the request of the related Openstack command is OK and the killed processes are recovered.
attackers	In this test case, an attacker called "kill-process" is needed. This attacker includes three parameters: 1) fault_type: which is used for finding the attacker's scripts. It should be always set to "kill-process" in this test case. 2) process_name: which is the process name of the specified OpenStack service. If there are multiple processes use the same name on the host, all of them are killed by this attacker. 3) host: which is the name of a control node being attacked. e.g. -fault_type: "kill-process" -process_name: "nova-api" -host: node1
monitors	In this test case, two kinds of monitor are needed: 1. the "openstack-cmd" monitor constantly request a specific Openstack command, which needs two parameters: 1) monitor_type: which is used for finding the monitor class and related scritps. It should be always set to "openstack-cmd" for this monitor. 2) command_name: which is the command name used for request 2. the "process" monitor check whether a process is running on a specific node, which needs three parameters: 1) monitor_type: which used for finding the monitor class and related scritps. It should be always set to "process" for this monitor. 2) process_name: which is the process name for monitor 3) host: which is the name of the node runing the process e.g. monitor1: -monitor_type: "openstack-cmd" -command_name: "nova image-list" monitor2: -monitor_type: "process" -process_name: "nova-api" -host: node1
metrics	In this test case, there are two metrics: 1)service_outage_time: which indicates the maximum outage time (seconds) of the specified Openstack command request. 2)process_recover_time: which indicates the maximun time (seconds) from the process being killed to recovered
test tool	Developed by the project. Please see folder: "yardstick/benchmark/scenarios/availability/ha_tools"
references	ETSI NFV REL001
configuration	This test case needs two configuration files: 1) test case file: opnfv_yardstick_tc019.yaml -Attackers: see above "attackers" discription -waiting_time: which is the time

Yardstick Test Case Description TC025

OpenStack Controller Node abnormally shutdown High Availability	
test case id	OPNFV_YARDSTICK_TC025_HA: OpenStack Controller Node abnormally shutdown
test purpose	This test case will verify the high availability of controller node. When one of the controller node abnormally shutdown, the service provided by it should be OK.
test method	This test case shutdowns a specified controller node with some fault injection tools, then checks whether all services provided by the controller node are OK with some monitor tools.
attackers	In this test case, an attacker called "host-shutdown" is needed. This attacker includes two parameters: 1) fault_type: which is used for finding the attacker's scripts. It should be always set to "host-shutdown" in this test case. 2) host: the name of a controller node being attacked. e.g. -fault_type: "host-shutdown" -host: node1
monitors	In this test case, one kind of monitor are needed: 1. the "openstack-cmd" monitor constantly request a specific Openstack command, which needs two parameters 1) monitor_type: which is used for finding the monitor class and related scritps. It should be always set to "openstack-cmd" for this monitor. 2) command_name: which is the command name used for request There are four instance of the "openstack-cmd" monitor: monitor1: -monitor_type: "openstack-cmd" -api_name: "nova image-list" monitor2: -monitor_type: "openstack-cmd" -api_name: "neutron router-list" monitor3: -monitor_type: "openstack-cmd" -api_name: "heat stack-list" monitor4: -monitor_type: "openstack-cmd" -api_name: "cinder list"
metrics	In this test case, there is one metric: 1)service_outage_time: which indicates the maximum outage time (seconds) of the specified Openstack command request.
test tool	Developed by the project. Please see folder: "yardstick/benchmark/scenarios/availability/ha_tools"
references	ETSI NFV REL001
configuration	This test case needs two configuration files: 1) test case file: opnfv_yardstick_tc019.yaml -Attackers: see above "attackers" discription -waiting_time: which is the time (seconds) from the process being killed to stoping monitors the monitors -Monitors: see above "monitors" discription -SLA: see above "metrics" discription 2)POD file: pod.yaml The POD configuration should record on pod.yaml first. the "host" item in this test case will use the node name in the pod.yaml.
test sequence	description and expected result
step 1	start monitors: each monitor will run with independently process Result: The monitor info will be collected.
step 2	do attacker: connect the host through SSH, and then execute shutdown script on the host Result: The host will be shutdown.
step 3	stop monitors after a period of time specified by "waiting_time"

9.3.2 IPv6

Yardstick Test Case Description TC027

IPv6 connectivity between nodes on the tenant network	
test case id	OPNFV_YARDSTICK_TC027_IPv6 connectivity
metric	RTT, Round Trip Time
test purpose	To do a basic verification that IPv6 connectivity is within acceptable boundaries when ipv6 packets travel between hosts located on same or different compute blades. The purpose is also to be able to spot trends. Test results, graphs and similar shall be stored for comparison reasons and product evolution understanding between different OPNFV versions and/or configurations.
configuration	file: opnfv_yardstick_tc027.yaml Packet size 56 bytes. SLA RTT is set to maximum 10 ms.
test tool	ping6 Ping6 is normally part of Linux distribution, hence it doesn't need to be installed.
references	ipv6 ETSI-NFV-TST001
applicability	Test case can be configured with different run step you can run setup, run benchmakr, teardown independently SLA is optional. The SLA in this test case serves as an example. Considerably lower RTT is expected.
pre-test conditions	The test case image needs to be installed into Glance with ping6 included in it. No POD specific requirements have been identified.
test sequence	description and expected result
step 1	The hosts are installed, as server and client. Ping is invoked and logs are produced and stored. Result: Logs are stored.
test verdict	Test should not PASS if any RTT is above the optional SLA value, or if there is a test case execution problem.

9.3.3 KVM

Yardstick Test Case Description TC028

KVM Latency measurements	
test case id	OPNFV_YARDSTICK_TC028_KVM Latency measurements
metric	min, avg and max latency
test purpose	To evaluate the IaaS KVM virtualization capability with regards to min, avg and max latency. The purpose is also to be able to spot trends. Test results, graphs and similar shall be stored for comparison reasons and product evolution understanding between different OPNFV versions and/or configurations.
configuration	file: samples/cyclictest-node-context.yaml
test tool	Cyclictest (Cyclictest is not always part of a Linux distribution, hence it needs to be installed. As an example see the /yardstick/tools/ directory for how to generate a Linux image with cyclictest included.)
references	Cyclictest
applicability	This test case is mainly for kvm4nfv project CI verify. Upgrade host linux kernel, boot a gust vm update it's linux kernel, and then run the cyclictest to test the new kernel is work well.
pre-test conditions	The test kernel rpm, test sequence scripts and test guest image need put the right folders as specified in the test case yaml file. The test guest image needs with cyclictest included in it. No POD specific requirements have been identified.
test sequence	description and expected result
step 1	The host and guest os kernel is upgraded. Cyclictest is invoked and logs are produced and stored. Result: Logs are stored.
test verdict	Fails only if SLA is not passed, or if there is a test case execution problem.

9.3.4 Parser

Yardstick Test Case Description TC040

Verify Parser Yang-to-Tosca	
test case id	OPNFV_YARDSTICK_TC040 Verify Parser Yang-to-Tosca
metric	1. tosca file which is converted from yang file by Parser 2. result whether the output is same with expected outcome
test purpose	To verify the function of Yang-to-Tosca in Parser.
configuration	file: opnfv_yardstick_tc040.yaml yangfile: the path of the yangfile which you want to convert toscafile: the path of the toscafile which is your expected outcome.
test tool	Parser (Parser is not part of a Linux distribution, hence it needs to be installed. As an example see the /yardstick/benchmark/scenarios/parser/parser_setup.sh for how to install it manual. Of course, it will be installed and uninstalled automatically when you run this test case by yardstick)
references	Parser
applicability	Test can be configured with different path of yangfile and toscafile to fit your real environment to verify Parser
pre-test conditions	No POD specific requirements have been identified. it can be run without VM
test sequence	description and expected result
step 1	parser is installed without VM, running Yang-to-Tosca module to convert yang file to tosca file, validating output against expected outcome. Result: Logs are stored.
test verdict	Fails only if output is different with expected outcome or if there is a test case execution problem.

9.3.5 virtual Traffic Classifier

Yardstick Test Case Description TC006

Network Performance	
test case id	OPNFV_YARDSTICK_TC006_Virtual Traffic Classifier Data Plane Throughput Benchmarking Test.
metric	Throughput
test purpose	To measure the throughput supported by the virtual Traffic Classifier according to the RFC2544 methodology for a user-defined set of vTC deployment configurations.
configuration	file: file: opnfv_yardstick_tc006.yaml **packet_size: size of the packets to be used during the** throughput calculation. Allowe values: [64, 128, 256, 512, 1024, 1280, 1518] **vnic_type: type of VNIC to be used.** **Allowed values are:** • normal: for default OvS port configuration • direct: for SR-IOV port configuration Default value: None **vtc_flavor: OpenStack flavor to be used for the vTC** Default available values are: m1.small, m1.medium, and m1.large, but the user can create his/her own flavor and give it as input Default value: None **vlan_sender: vlan tag of the network on which the vTC will** receive traffic (VLAN Network 1). Allowed values: range (1, 4096) **vlan_receiver: vlan tag of the network on which the vTC** will send traffic back to the packet generator (VLAN Network 2). Allowed values: range (1, 4096) **default_net_name: neutron name of the defaul network that** is used for access to the internet from the vTC (vNIC 1). **default_subnet_name: subnet name for vNIC1** (information available through Neutron). **vlan_net_1_name: Neutron Name for VLAN Network 1** (information available through Neutron). **vlan_subnet_1_name: Subnet Neutron name for VLAN Network 1** (information available through Neutron). **vlan_net_2_name: Neutron Name for VLAN Network 2** (information available through Neutron). **vlan_subnet_2_name: Subnet Neutron name for VLAN Network 2** (information available through Neutron).
test tool	DPDK pktgen DPDK Pktgen is not part of a Linux distribution, hence it needs to be installed by the user.
references	DPDK Pktgen: DPDKpktgen ETSI-NFV-TST001 RFC 2544: rfc2544
applicability	Test can be configured with different flavors, vNIC type and packet sizes. Default values exist as specified above.
	The vNIC type and flavor MUST be specified by the user.
pre-test	The vTC has been successfully instantiated and configured. The user has correctly assigned the values to the

Yardstick Test Case Description TC007

Network Performance	
test case id	**OPNFV_YARDSTICK_TC007_Virtual Traffic Classifier Data Plane** Throughput Benchmarking Test in Presence of Noisy neighbours
metric	Throughput
test purpose	To measure the throughput supported by the virtual Traffic Classifier according to the RFC2544 methodology for a user-defined set of vTC deployment configurations in the presence of noisy neighbours.
configuration	file: opnfv_yardstick_tc007.yaml **packet_size: size of the packets to be used during the** throughput calculation. Allowe values: [64, 128, 256, 512, 1024, 1280, 1518] **vnic_type: type of VNIC to be used.** **Allowed values are:** • normal: for default OvS port configuration • direct: for SR-IOV port configuration **vtc_flavor: OpenStack flavor to be used for the vTC** Default available values are: m1.small, m1.medium, and m1.large, but the user can create his/her own flavor and give it as input **num_of_neighbours: Number of noisy neighbours (VMs) to be** instantiated during the experiment. Allowed values: range (1, 10) **amount_of_ram: RAM to be used by each neighbor.** **Allowed values: ['250M', '1G', '2G', '3G', '4G', '5G',** '6G', '7G', '8G', '9G', '10G'] Deault value: 256M **number_of_cores: Number of noisy neighbours (VMs) to be** instantiated during the experiment. Allowed values: range (1, 10) Default value: 1 **vlan_sender: vlan tag of the network on which the vTC will** receive traffic (VLAN Network 1). Allowed values: range (1, 4096) **vlan_receiver: vlan tag of the network on which the vTC** will send traffic back to the packet generator (VLAN Network 2). Allowed values: range (1, 4096) **default_net_name: neutron name of the defaul network that** is used for access to the internet from the vTC (vNIC 1). **default_subnet_name: subnet name for vNIC1** (information available through Neutron). **vlan_net_1_name: Neutron Name for VLAN Network 1** (information available through Neutron). **vlan_subnet_1_name: Subnet Neutron name for VLAN Network 1** (information available through Neutron). **vlan_net_2_name: Neutron Name for VLAN Network 2** (information available through Neutron). **vlan_subnet_2_name: Subnet Neutron name for VLAN Network 2** (information available through Neutron)
test tool	DPDK pktgen DPDK Pktgen is not part of a Linux distribution, hence

Yardstick Test Case Description TC020

Network Performance	
test case id	OPNFV_YARDSTICK_TC0020_Virtual Traffic Classifier Instantiation Test
metric	Failure
test purpose	To verify that a newly instantiated vTC is 'alive' and functional and its instantiation is correctly supported by the infrastructure.
configuration	file: opnfv_yardstick_tc020.yaml **vnic_type: type of VNIC to be used.** **Allowed values are:** • normal: for default OvS port configuration • direct: for SR-IOV port configuration Default value: None **vtc_flavor: OpenStack flavor to be used for the vTC** Default available values are: m1.small, m1.medium, and m1.large, but the user can create his/her own flavor and give it as input Default value: None **vlan_sender: vlan tag of the network on which the vTC will** receive traffic (VLAN Network 1). Allowed values: range (1, 4096) **vlan_receiver: vlan tag of the network on which the vTC** will send traffic back to the packet generator (VLAN Network 2). Allowed values: range (1, 4096) **default_net_name: neutron name of the defaul network that** is used for access to the internet from the vTC (vNIC 1). **default_subnet_name: subnet name for vNIC1** (information available through Neutron). **vlan_net_1_name: Neutron Name for VLAN Network 1** (information available through Neutron). **vlan_subnet_1_name: Subnet Neutron name for VLAN Network 1** (information available through Neutron). **vlan_net_2_name: Neutron Name for VLAN Network 2** (information available through Neutron). **vlan_subnet_2_name: Subnet Neutron name for VLAN Network 2** (information available through Neutron).
test tool	DPDK pktgen DPDK Pktgen is not part of a Linux distribution, hence it needs to be installed by the user.
references	DPDKpktgen ETSI-NFV-TST001 rfc2544
applicability	Test can be configured with different flavors, vNIC type and packet sizes. Default values exist as specified above. The vNIC type and flavor MUST be specified by the user.
pre-test	The vTC has been successfully instantiated and configured. The user has correctly assigned the values to the deployment configuration parameters.
	• **Multicast traffic MUST be enabled on the network.** The Data network switches need to be configured in order to manage multicast traffic. Installation and configuration of smcroute

Yardstick Test Case Description TC021

Network Performance	
test case id	OPNFV_YARDSTICK_TC0021_Virtual Traffic Classifier Instantiation Test in Presence of Noisy Neighbours
metric	Failure
test purpose	To verify that a newly instantiated vTC is 'alive' and functional and its instantiation is correctly supported by the infrastructure in the presence of noisy neighbours.
configuration	file: opnfv_yardstick_tc021.yaml **vnic_type: type of VNIC to be used.** **Allowed values are:** • normal: for default OvS port configuration • direct: for SR-IOV port configuration Default value: None **vtc_flavor: OpenStack flavor to be used for the vTC** Default available values are: m1.small, m1.medium, and m1.large, but the user can create his/her own flavor and give it as input Default value: None **num_of_neighbours: Number of noisy neighbours (VMs) to be** instantiated during the experiment. Allowed values: range (1, 10) **amount_of_ram: RAM to be used by each neighbor.** **Allowed values: ['250M', '1G', '2G', '3G', '4G', '5G',** '6G', '7G', '8G', '9G', '10G'] Deault value: 256M **number_of_cores: Number of noisy neighbours (VMs) to be** instantiated during the experiment. Allowed values: range (1, 10) Default value: 1 **vlan_sender: vlan tag of the network on which the vTC will** receive traffic (VLAN Network 1). Allowed values: range (1, 4096) **vlan_receiver: vlan tag of the network on which the vTC** will send traffic back to the packet generator (VLAN Network 2). Allowed values: range (1, 4096) **default_net_name: neutron name of the defaul network that** is used for access to the internet from the vTC (vNIC 1). **default_subnet_name: subnet name for vNIC1** (information available through Neutron). **vlan_net_1_name: Neutron Name for VLAN Network 1** (information available through Neutron). **vlan_subnet_1_name: Subnet Neutron name for VLAN Network 1** (information available through Neutron). **vlan_net_2_name: Neutron Name for VLAN Network 2** (information available through Neutron). **vlan_subnet_2_name: Subnet Neutron name for VLAN Network 2** (information available through Neutron).
test tool	DPDK pktgen DPDK Pktgen is not part of a Linux distribution, hence it needs to be installed by the user.
references	DPDK Pktgen: DPDK Pktgen: DPDKpktgen ETSI-NFV-TST001 RFC 2544: rfc2544
applicability	Test can be configured with different flavors, vNIC type

9.4 Templates

9.4.1 Yardstick Test Case Description TCXXX

test case slogan e.g. Network Latency	
test case id	e.g. OPNFV_YARDSTICK_TC001_NW Latency
metric	what will be measured, e.g. latency
test purpose	describe what is the purpose of the test case
configuration	what .yaml file to use, state SLA if applicable, state test duration, list and describe the scenario options used in this TC and also list the options using default values.
test tool	e.g. ping
references	e.g. RFCxxx, ETSI-NFVyyy
applicability	describe variations of the test case which can be performend, e.g. run the test for different packet sizes
pre-test conditions	describe configuration in the tool(s) used to perform the measurements (e.g. fio, pktgen), POD-specific configuration required to enable running the test
test sequence	description and expected result
step 1	use this to describe tests that require sveveral steps e.g collect logs. Result: what happens in this step e.g. logs collected
step 2	remove interface Result: interface down.
step N	what is done in step N Result: what happens
test verdict	expected behavior, or SLA, pass/fail criteria

9.4.2 Task Template Syntax

Basic template syntax

A nice feature of the input task format used in Yardstick is that it supports the template syntax based on Jinja2. This turns out to be extremely useful when, say, you have a fixed structure of your task but you want to parameterize this task in some way. For example, imagine your input task file (task.yaml) runs a set of Ping scenarios:

```
# Sample benchmark task config file
# measure network latency using ping
schema: "yardstick:task:0.1"

scenarios:
-
  type: Ping
  options:
    packetsize: 200
  host: athena.demo
  target: ares.demo

  runner:
    type: Duration
    duration: 60
    interval: 1

  sla:
```

```
    max_rtt: 10
    action: monitor

context:
    ...
```

Let's say you want to run the same set of scenarios with the same runner/ context/sla, but you want to try another packetsize to compare the performance. The most elegant solution is then to turn the packetsize name into a template variable:

```
# Sample benchmark task config file
# measure network latency using ping

schema: "yardstick:task:0.1"
scenarios:
-
  type: Ping
  options:
    packetsize: {{packetsize}}
  host: athena.demo
  target: ares.demo

  runner:
    type: Duration
    duration: 60
    interval: 1

  sla:
    max_rtt: 10
    action: monitor

context:
    ...
```

and then pass the argument value for {{packetsize}} when starting a task with this configuration file. Yardstick provides you with different ways to do that:

1.Pass the argument values directly in the command-line interface (with either a JSON or YAML dictionary):

```
yardstick task start samples/ping-template.yaml
--task-args'{"packetsize":"200"}'
```

2.Refer to a file that specifies the argument values (JSON/YAML):

```
yardstick task start samples/ping-template.yaml --task-args-file args.yaml
```

Using the default values

Note that the Jinja2 template syntax allows you to set the default values for your parameters. With default values set, your task file will work even if you don't parameterize it explicitly while starting a task. The default values should be set using the {% set ... %} clause (task.yaml). For example:

```
# Sample benchmark task config file
# measure network latency using ping
schema: "yardstick:task:0.1"
{% set packetsize = packetsize or "100" %}
scenarios:
-
```

```
  type: Ping
  options:
  packetsize: {{packetsize}}
  host: athena.demo
  target: ares.demo

  runner:
    type: Duration
    duration: 60
    interval: 1
  ...
```

If you don't pass the value for {{packetsize}} while starting a task, the default one will be used.

Advanced templates

Yardstick makes it possible to use all the power of Jinja2 template syntax, including the mechanism of built-in functions. As an example, let us make up a task file that will do a block storage performance test. The input task file (fio-template.yaml) below uses the Jinja2 for-endfor construct to accomplish that:

```
#Test block sizes of 4KB, 8KB, 64KB, 1MB
#Test 5 workloads: read, write, randwrite, randread, rw
schema: "yardstick:task:0.1"

 scenarios:
{% for bs in ['4k', '8k', '64k', '1024k' ] %}
  {% for rw in ['read', 'write', 'randwrite', 'randread', 'rw' ] %}
-
  type: Fio
  options:
    filename: /home/ubuntu/data.raw
    bs: {{bs}}
    rw: {{rw}}
    ramp_time: 10
  host: fio.demo
  runner:
    type: Duration
    duration: 60
    interval: 60

  {% endfor %}
{% endfor %}
context
    ...
```

CHAPTER

TEN

GLOSSARY

API Application Programming Interface

BM Bare Metal

DPDK Data Plane Development Kit

DPI Deep Packet Inspection

DSCP Differentiated Services Code Point

IGMP Internet Group Management Protocol

IOPS Input/Output Operations Per Second

NFVI Network Function Virtualization Infrastructure

NIC Network Interface Controller

PBFS Packet Based per Flow State

QoS Quality of Service

SLA Service Level Agreement

SR-IOV Single Root IO Virtualization

SUT System Under Test

ToS Type of Service

VLAN Virtual LAN

VM Virtual Machine

VNF Virtual Network Function

VNFC Virtual Network Function Component

VTC Virtual Traffic Classifier

CHAPTER

ELEVEN

REFERENCES

11.1 OPNFV

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- DPDKpktgen: https://github.com/Pktgen/Pktgen-DPDK/
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- fio: http://www.bluestop.org/fio/HOWTO.txt
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- Lmbench man-pages: http://manpages.ubuntu.com/manpages/trusty/lat_mem_rd.8.html
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11.3 Research

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- ETSI NFV: http://www.etsi.org/technologies-clusters/technologies/nfv
- ETSI GS-NFV TST 001: https://docbox.etsi.org/ISG/NFV/Open/Drafts/TST001_-_Pre-deployment_Validation/
- RFC2544: https://www.ietf.org/rfc/rfc2544.txt

11.5 Tools

- https://docs.influxdata.com/influxdb/v0.9/write_protocols/line.html