

NI: A Benchmark Suite for NfvInsight

ABSTRACT

NFV is attracting more and more interest in both industry and academia. It is promising to reduce cost for network operators and accelerate innovation by replacing traditional hardware-base appliance with virtualized functions deploying in cloud computing environment. NFV testing environment deploying involves multiple layers in the software stack including VNF image packaging, virtualization management, network configuration, forwarding rule installation, and performance metric measurement. According to our survey, it takes averagely 1-2 human-month to set up a testing environment. Motivated by the time taking process of deployment, we decided to develop a easy-to-use NFV benchmark named NfvInsight. The benchmark has three key features: 1) Representative NFs 2) One-click running 3) Plenty metrics for measurement. NI include 5 VNF covering half of the NFV use cases, and provide typical NF chaining policies. NI leverages Kubernetes and Docker to do infrastructure management, and OVS to control data flow.

Keywords

Network Function Virtualization;

1. INTRODUCTION

Network function virtualization (NFV) has become a hot topic, both in industry and academia. Since the publication of NFV Introductory White Paper [1] of ETSI in 2012, a lot of works have been emerged in this field. Modification works of NFV were done on the whole software stack (or maybe both SW and HW stack?). There are de facto industrial NFV platform OPNFV [1] as well as advanced NF allocation frameworks like OpenNF [5], CoMb [12] and E2 [9]. Also, there are works like OpenBox [3] and Netbricks [10] to rewrite or modify the NFs.

However, a suite of easy-to-use NFV benchmark is not yet existed. It is unavoidable to experience a time consuming process finding both open source software and proper chaining policies. According to our observation, most NFs used in papers are different open source implementations linked in different kinds of NF chain policies. So that, there is not yet a general baseline for

measurement and comparison. Furthermore, the workload generator and network traffic trace used are also different, and real-world traces need to be provided to test different NF chains.

We also did a survey among top conference researchers who have experiences setting up NFV environment. In our survey, we found that the deploying time varies much due to the scale. In average, it takes around 1 month to build up a NF cluster having less than 10 VM instances. But when the scale of instances increase to over 50, the build up process can take 3-4 months or more. One of our respondent said that they were still keeping on iterating and improving their testbed constantly.

There are more complains pointing out their pain points: 1) Automate the setting up and testing process. 2) Configure and stabilize NFs (?). 3) Write rules to set up topology and enforce flow control.

In this paper, we develop a suite of NF benchmarks, which is supposed to have the following characteristics: 1) Representing typical NFs 2) Easy to use 3) Plenty metrics for measurement.

According to our research and observation, the representative of an NFV benchmark should be satisfied in three aspects: **1) Representative NFs.** For the demand of representative NFs, we referred to the NFV Introductory White Paper [1], which defined ten scenario of NFV use cases. In the first version of our benchmark, the open source implementation of NFs we collected covers half of the ten use cases. Table 2 lists the basic information of NFs used in our benchmark. **2) Representative NF chains.** However, not only single NFs should be typical, but also the NF chains. We referred to ETSI standard documents of SFC (Service Function Chaining) [2] for the typical use case of service chains in the scenarios of both enterprise user and datacenter. We also consulted our industrial partners for real world chaining policies. The typical NF chains our benchmark provides are listed in Table ?? **3) Proper workload generator.** Since each NF chain serves at different network level, only one workload generator is not enough to test all the scenarios. So we select different clients

for each chain.

The goal of the ‘easy to use’ design is to achieve one-week setting up as well as one-click test running, no matter the scale of the testing environment. To finish a test, users only need to touch one configuration file and execute one single command. In the end, the measurement report will be output to a file. To implement our design, we leverage Docker and Kubernetes to pack NFs in docker, manage the images, and do allocation automatically. We use OVS to do switching and packet force forwarding. Pre-written scripts and Openflow rules are written to implement chaining and flow control.

In our benchmark, we provide the most concerned metrics for measurement, that is latency and throughput. We measure latency in the granularity of per-packet and per-NF, and output cumulative distribution of latency in the measurement report.

2. BACKGROUND AND MOTIVATION

2.1 Network Function Virtualization

NFV involves multi-layers in the whole software stack, The concept of NFV chain

2.2 A Survey of NFV Testing Environment Deploying

To get first-hand information about researchers’ experience on NFV testing environment deploying, we did a survey among top conference authors dedicated in the field of NFV. We delivered the survey to sixteen people who are the first authors of their papers and we finally collected eight responses.

In the first place, we asked for the number of types of VNF they used, and the source of VNF, chaining policy and workload generator. Averagely, six types of VNF are used in one paper. Most of the VNF are open source implementations, though three of our respondents have written their own VNF. The chaining policies are all find in papers or public policies. And for the workload generator, half of them directly used open source software, and half of them wrote by themselves.

Another question we concerned most is the time they spent on deploying a NFV testing environment. To more precisely measure the labor time, we use the metric of man-month which indicates the number of months used if the work is done by one person. We also asked for the scale of physical servers and VM instances, as well as the virtualization technology they used. The result is shown in Table 1.

From the responses, we can see the average time to deploy a testing environment for NFV is around 1-2 months for a cluster not in very large scale. It can be quite fast for a experienced person, as the responder No.1, who used less than half a month setting up a cluster including 4 physical servers and 11-20 VMs. How-

	Man-Month Used	# of Servers	# of VMs	Virtualization Technology
1	<0.5	4	11-20	KVM
2	0.5-1	2	1-5	Hyper-V
3	0.5-1	4	1-7	Container
4	0.5-1	4	6-10	KVM
5	1-2	4	6-10	Container, KVM and other
6	4	10	100	KVM
7	3 & broken into pieces	24	72	KVM
8	Constantly Iterating	4	1-5	Xen

Table 1: The result of our survey reflects the relationship between labor consuming and the scale of the testing environment.

ever, for the others, the deploying process can be time taking and painful. Take respondent No.6 and No.7 as examples, they built their test environment in quite large scale, and it results in much longer setting up time.

NFV setting up involves multi-layers in the whole software stack, which includes virtualization, cluster management, network virtualization, and NF configuration, so that any point can become a bottleneck, especially for a green hand. Take respondent No.8 as an example, Most problems they encountered are related to the hypervisor they used. And respondent No.7 said they changed from Xen to KVM with Openstack and things got much better. We asked the authors for their most painful experiences, and we summarize the reasons making the setting up time so long as the following:

- Automating the process of setting up the testbed.
- Setting up the datapath (interfaces, DPDK, routing tables, etc).
- Installing proper rules in OpenFlow-enabled switches to enforce chaining.
- Figure out appropriate workload to test different types of VNFs.
- Figuring out how to determine that NFs were done starting up and ready to forward packets.

One of our responder pointed out that:

If there is a system that will take as input key parameters (e.g., number of nodes, topology, VM images, choice of hypervisor) and then automatically generates a ready to go set up, that will be of a huge value!

This suggestion firms our intention to publish an NFV benchmark which provides typical NF services and workload generator, automatically run the test according to

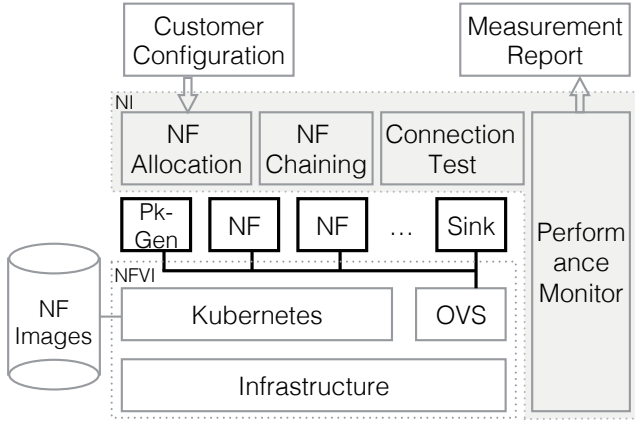


Figure 1: An overview of our benchmark design.

user configurations, and reports the measurement results in the end.

3. BENCHMARK DESCRIPTION

3.1 Overview

According to our research and survey, we found that a suite of easy-to-use NFV benchmark is indeed. First, for all these researches, a universally used baseline is lacked for comparison experiments. So, a selected suite of representative VNF with widely accepted chaining policy and proper workload generator is needed. Second, a well-designed benchmark with a bunch of pre-written scripts to automate the deployment process can effectively save time. Since NFV involves multi-layers in the whole software stack, the automation process includes VNF image packaging, NF allocation, networking config, forwarding rules installation, connection testing, and metrics measurement.

The goal of our work is to provide a benchmark suite with the following three characteristics: 1) Representing typical NFs 2) Easy to use 3) Plenty metrics for measurement.

Representative NF
K8s+ovs
measurement

3.2 NF

Most prevalent NFV use cases.

We select NFs which needs no modification of the kernel.

config NF to work in the way as demanded
Clearwater[2]

3.3 Design

To achieve the demand of easy to use, users are supposed to run only one command to start the test, and touch only two files, which are the configuration file and

Category	NF
IMS	Clearwater
IDS	Snort
NAT	iptables
L4 Load Balancer	Haproxy
L7 Cache	Squid

Table 2: NFs included in our benchmark.

the measurement report. The process to use the benchmark includes five steps:

- Step1 Pre-install
- Step2 Build images
- Step3 Write config file
- Step4 One click running
- Step5 Get the report

Figure 3 shows

Kubernetes is an open-source system for automating deployment, scaling, and management of containerized applications.

Connection test

4. IMPLEMENTATION

5. EVALUATION

6. RELATED WORKS

7. CONCLUSIONS

8. ACKNOWLEDGMENTS

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