White Paper

NFVI Test Tools

VoerEir Demonstrates Touchstone for Testing NFVI

Touchstone demonstrates packet generation capabilities in tests on Intel® Xeon® Scalable processor servers that saturate two 25 Gbps network interface cards with minimal compute resources and using 64-byte packets.[1]

Today's next-generation data center is a complex, dynamic, and largely virtualized enterprise. Its software-based functions may be spread across servers in multiple physical locations. For all its advantages, virtualization makes the task of analyzing traffic and pinpointing the causes of slowdowns vastly more difficult.

Cloud computing plays an essential role in the next-generation data center, providing the compute resources for network function virtualization infrastructure (NFVI). Without this infrastructure to build on, network function virtualization (NFV) would not be possible. NFVI is today typically based on OpenStack cloud management software and KVM as the hypervisor. Lately also Kubernetes has started to play an important role, either as a container orchestrator on top of OpenStack, or deployed directly on a bare metal server.

OpenStack and Kubernetes utilize APIs and a dashboard to enable organizations to manage compute, storage, and networking resources controlled by these platforms.

Hybrid environments—mixing private cloud, public cloud, and on-premises computing—are common, especially as organizations evolve data centers from legacy to next-generation configurations. These platforms must integrate seamlessly with each other. Complexity is unavoidable in such an environment.

Software in any given NFVI can come from between 15 and 20 open source communities, commercial software and hardware vendors. The number of open source solutions and hardware devices makes solution integration difficult and, because every combination of elements is different, the resulting infrastructures can vary widely in functionality and performance characteristics.

If any single network function does not perform well, the NFVI overall will suffer. If the network operator makes a change to improve the performance of that NF, the change might negatively affect other NFs. The key to ensuring optimal performance is to test the NFVI performance before putting a newly configured or modified network into service.

Such an environment demands developing many key performance indicators (KPIs), and they can be complex to define. Automation of the tests becomes necessary due to the complicated and dynamic environment. Ensuring optimal performance is important because even small amounts of packet loss, as little as 2 packets per million (PPM), can impact VNF or CNF performance.

VoerEir's Touchstone for NVFI Testing and Validation

The foundation for testing these networks is to generate enough packets to stress each software element to learn more about how it reacts and whether it maintains the KPI. VoerEir, an Intel® Network Builders ecosystem member, offers Touchstone, a highly configurable NFVI benchmarking tool. Touchstone is a software-based automated test suite manager for NFVI benchmarking, certification, and validation of performance.

Table of Contents

Touchstone generates and receives high throughput in a virtualized environment, allowing it to send heavy data loads to platform software and hardware components under test to find their limits and determine whether they are adequate for their intended use. Touchstone provides the means to test both OpenStack and Kubernetes configurations, allowing organizations to discern the capabilities of different distributions and to gauge the effects of their unique NFVI configurations on performance.

To demonstrate Touchstone's capabilities, VoerEir and Intel teamed up to test its ability to saturate Intel® Ethernet Network Adapters. The tests revealed that Touchstone can saturate two 25 Gbps network adapters using a dual-socket server based on 2nd generation Intel® Xeon® Scalable processors.

Touchstone performs the testing specifications set by the ETSI NFV Test working group, specifically "ETSI GS NFV-TST 009, Specification of Networking Benchmarks and Measurement Methods for NFVI." This document describes how a benchmark should be measured and how a metric is expressed. Touchstone is capable of testing the 300 key performance indicators (KPIs) that are described in these specifications. Some use cases for Touchstone include measuring:

- L2 vSwitch DPDK performance
- L3 SR-IOV DPDK performance
- vSwitch performance with large routing tables
- vSwitch performance as VxLANs increase
- vSwitch performance for VNF with Kernel IP stack and multi-queue
- Standards based tests using IETF RFC2544

Touchstone comes preloaded with thousands of automated test cases, and features tools for test organizations to create a wide variety of custom tests to find the limits of their cloud environment's functionality, robustness, and stability. It uses a software-based packet generator to saturate network cards, routers, and switches—whether software or hardware-based—to find the maximum throughput those network elements can accept within the NFVI configuration.

Touchstone is highly configurable, allowing infrastructure test managers to develop any number of relevant test configurations for their NFVIs. By adding or subtracting compute nodes, test agents in VMs or containers, and other parameters, network operators can test their virtualized cloud platforms under realistic conditions simulating the load from real NFs, with no scripting needed. Touchstone identifies bottlenecks slowing the flow of data so that network engineers can remediate or remove them. By running subsequent tests on incremental modifications, the infrastructure tester can identify and mitigate the bottlenecks that are relevant for specific infrastructure use cases.

One centralized Touchstone deployment enables benchmarking of multiple cloud environments spanning multiple data centers. It provides support for benchmarking the environments using an advanced test engine developed by VoerEir, and many popular open source test engines including OpenStack Rally, Open Platform for NFV (OPNFV) Yardstick, and Google Perfkit Benchmarker, among many others.[2]

Touchstone provides a wide array of features for environment benchmarking, report management, and enhanced platform awareness (EPA) test suites. Its pre-integrated test cases include test suites for both OpenStack and OPNFV Certification, and with pre-configured test suites to measure more than 200 different NFVI KPIs. Touchstone also comes bundled with a management portal that eases management and allows users to configure Touchstone according to their requirements.

To Touchstone the test organization can connect all of their NFV clouds, such as development labs, staging sites and production sites[3] (see Figure 1). Different teams throughout an organization can use it simultaneously to automate testing. This maximizes collaboration, optimizes lab resource use, and avoids the need for repeated deployments of the tool.

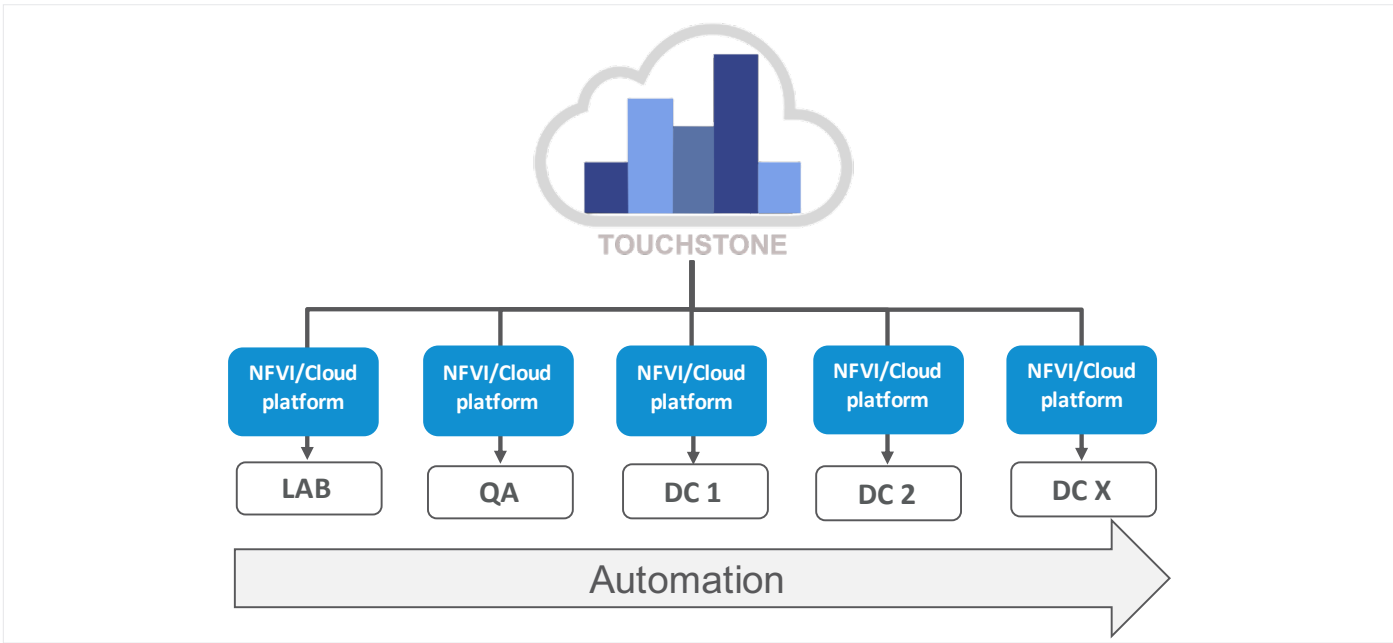

Figure 1. Touchstone can enable testing at various points through the services delivery pipeline.

Intel® Xeon® Scalable Processors for Networking

Intel Xeon Scalable processors are built with the performance needed to deliver flexible and scalable solutions to address multi-cloud, AI, IoT, 5G, analytics and virtual networking workloads. The CPUs feature enhanced hardware-based security and exceptional multi-socket processing performance. With trusted, hardware-enhanced data service delivery, these processors deliver improvements in I/O, memory, storage, and network technologies to harness actionable insights from an increasingly data-fueled world.

The 2nd generation Intel Xeon Gold 6230N used in these tests offers a 27.5 MB cache, 20 cores and 40 threads per socket, and 3.5 GHz max turbo frequency. It also features Intel® Resource Director Technology, which enhances visibility and control over how shared resources such as last-level cache and memory bandwidth are used by applications, virtual machines, and containers.[4]

Touchstone supports any number of configurations, allowing a tremendous range of testing scenarios at various stages of the service delivery process (see Figure 2).

VoerEir also offers a testing service based on Touchstone.

Touchstone Test Setup

VoerEir developed tests to measure the ability of Touchstone to saturate 25 Gbps network adapters (line rate of 50 Gbps) based on a number of receive (RX) and transmit (TX) CPUs. Due to test lab limitations, the tests were configured for only two 25 Gbps network adapters. The tests used 2nd generation Intel Xeon Gold 6230N CPU-based servers at 2.3 GHz.

VoerEir used Touchstone's own traffic generation capabilities to create the traffic for these tests. In order to give Touchstone a serious challenge, VoerEir conducted the tests with 64-byte data packets. Reaching line rate is harder with smaller packets, but preferable for testing as packets per second usually is the bottleneck in a software-based network overlay of an NFVI. The open source Data Plane Development Kit (DPDK) was used to configure the test for optimal packet processing performance. Touchstone was used as both the packet sender and receiver.

To determine the ability of Touchstone to saturate the network adapters and to measure performance, the software was tested under four scenarios:

- **Scenario 1:** One TX CPU, one RX CPU, and one single root I/O virtualization (SR-IOV) virtual function (VF).
- **Scenario 2:** Two TX CPUs, one RX CPU, and one SR-IOV VF.
- **Scenario 3:** Two TX CPUs, two RX CPUs, and one SR-IOV VF.
- **Scenario 4:** Four TX CPUs, two RX CPUs, and two SR-IOV VFs.

Single Queue Test Results[1]
Benchmark tests showed that using a single queue limits the flow of data packets to 22.47 million packets per second (Mpps), short of the traffic needed to saturate a 25 Gbps NIC. The test showed the same throughput result under both scenarios 1 and 2. Adding a second TX CPU without increasing RX CPUs made no difference in throughput to the network adapters under test.[1]

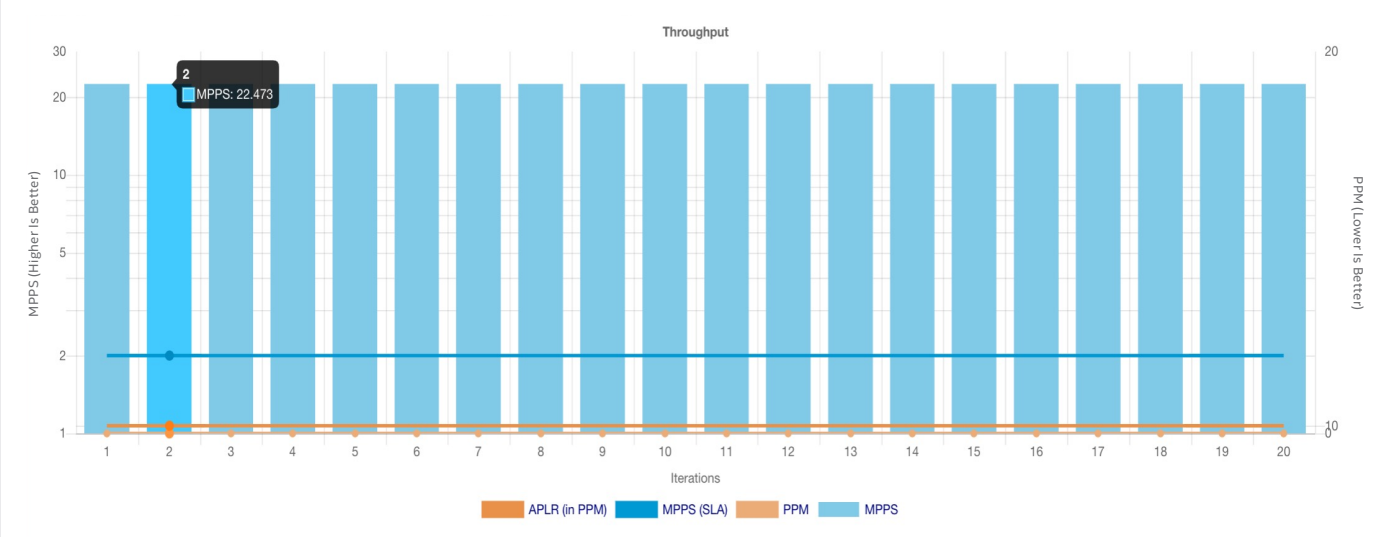

Figure 2. Test results from 1 TX and 1 RX CPUs generating 22 Mpps.

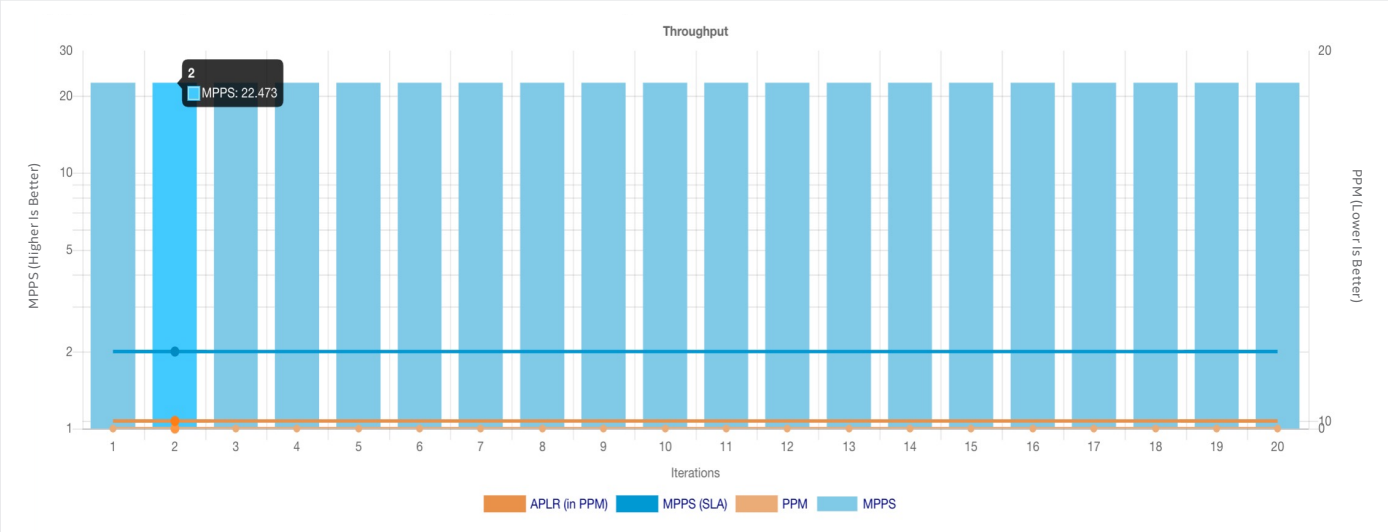

Figure 3. Test results from 2 TX and 1 RX CPUs generating 22 Mpps.

Figure 3 shows the throughput rate using a single CPU and a single VF; even if TX CPUs are doubled, the rate is limited to 22 Mpps.

To identify the bottleneck, another test was executed where two queues were used to generate traffic. In this scenario, TouchStone was able to generate 36.1 Mpps, fully saturating the 25 Gbps NIC with 64-byte packets. This shows that the single RX queue was the limiting factor in the tests described below (Figure 4).

Multiple Queues Saturate 50 Gbps NIC[1]

When VoerEir added more queues to the test, the data throughput rose dramatically. With 4 TX CPUs and 2 RX CPUs marshalled into service, throughput rose to 72.72 Mpps, achieving about 98% of the line rate for 50 Gbps network adapters. Moreover, Touchstone still generates, sends, and receives data at this rate with no packet loss.

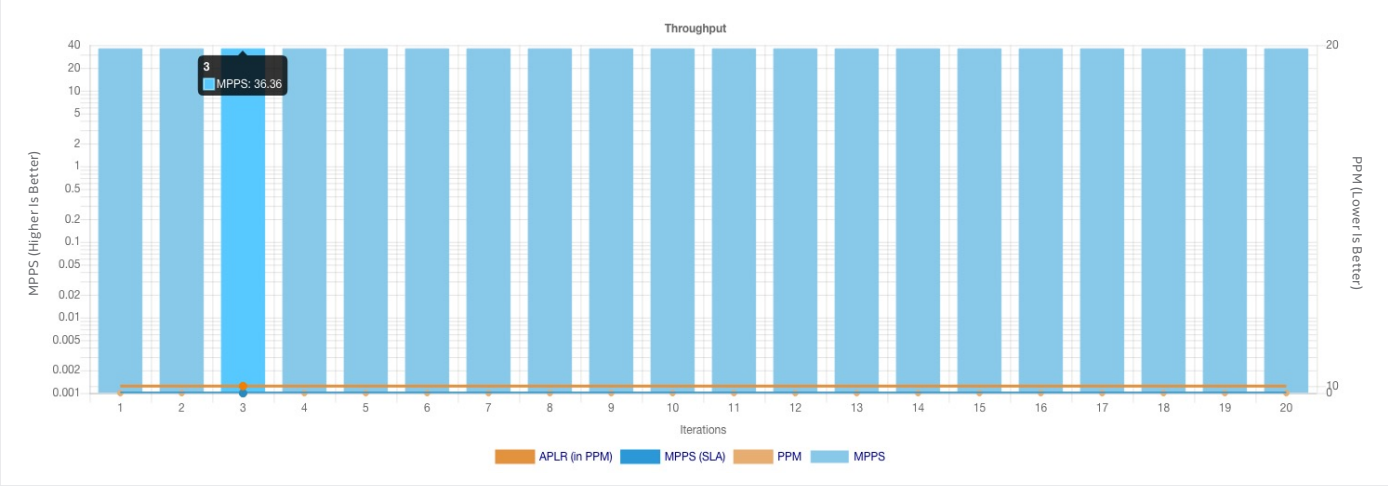

Figure 4. Test results using two TX and two RX queues, generating 36.1 Mpps.

Conclusion

The tests by VoerEir, completed at the Intel Network Builders lab, achieved the dual goals of validating Touchstone's abilities to generate packet traffic to enable NFVI testing, and to identify bottlenecks that choke the flow of data across physical and virtual network components. Using the smallest sized packets, it was able to generate enough data to approach the line rate of 50 Gbps network adapters. This demonstrates significant flexibility and versatility, with a minimal dependence on hardware, making it a compelling choice for organizations testing their NFVIs. The tests also show how the Touchstone packet generator can scale. By adding more queues, the generator's capacity can be extended in a linear fashion.

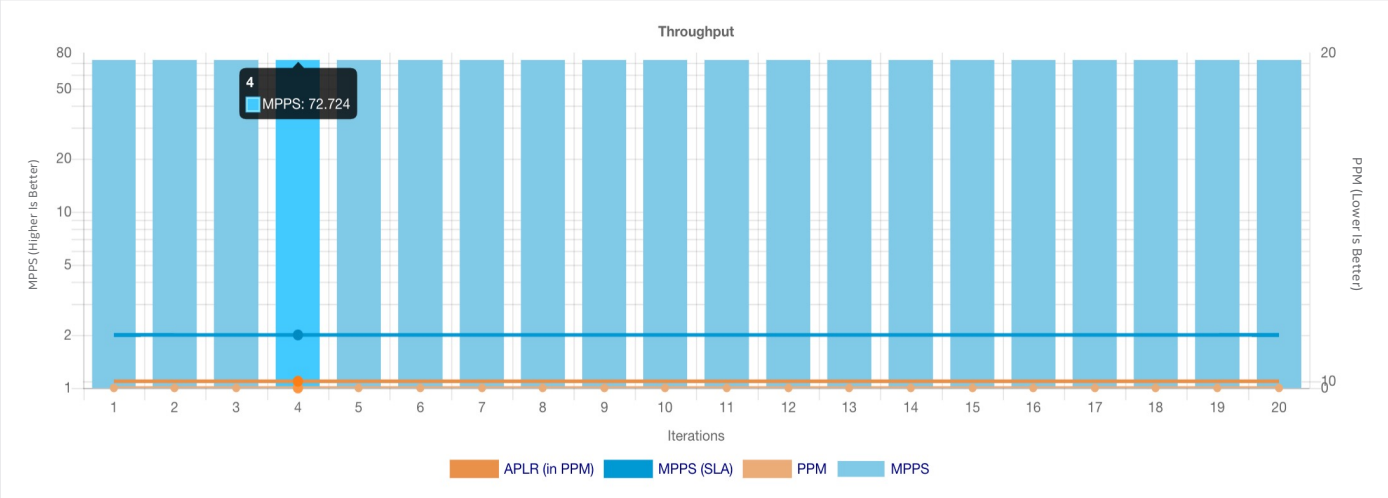

Figure 5. Test results from 4 TX and 2 RX CPUs generating 72 Mpps.

Learn More

VoerEir Touchstone

Jio Whitepaper: Critical NFVI KPIs to Validate (PDF download)

Intel® Network Builders

Intel® Xeon® Scalable processors

Contact

Ashok Kumar, ashok@voereir.com

Abhimanyu Bhatter, abhimanyu@voereir.com

Dheeraj Dang, dang@voereir.com

Notices & Disclaimers

[1] Testing done by VoerEir in November 2020. DUT configuration featured Intel® Xeon® Gold 6230N processor (microcode: 0x500001c) with 20 cores operating at 2.3 GHz. The server featured 385 GB of RAM. Intel® Hyper-Threading Technology was enabled, as was Intel® Turbo Boost Technology 2.0. IRQ balancing and NUMA balancing were disabled. BIOS version was Intel Corporation SE5C620.86B.0D.01.0395.022720191340. Intel® Ethernet Network Adapter XXV710 provided network access. The operating system was Ubuntu Linux version release 18 with kernel 4.15.0-48 generic. Compiler GCC was version 7.4.0. DPDK was version 19.08. The workload was Touchstone v.3.4.

[2] OPNFV and the Cloud Infrastructure Telco Taskforce (CNTT) have recently merged to become Anuket. See https://anuket.io for more.

[3] Video: "A Quick Introduction to Touchstone," https://vimeo.com/365212212

[4] https://ark.Intel.com/content/www/us/en/ark/products/192450/Intel-xeon-gold-6230n-processor-27-5m-cache-2-30-ghz.html

0621/DO/H09/PDF ♻ Please Recycle 347336-001US