#216117

July 2016

Commissioned by
Spirent Communications

HPE NFV System

Helion OpenStack Carrier-Grade Performance & Reliability
Powered by Wind River Titanium Cloud

EXECUTIVE SUMMARY

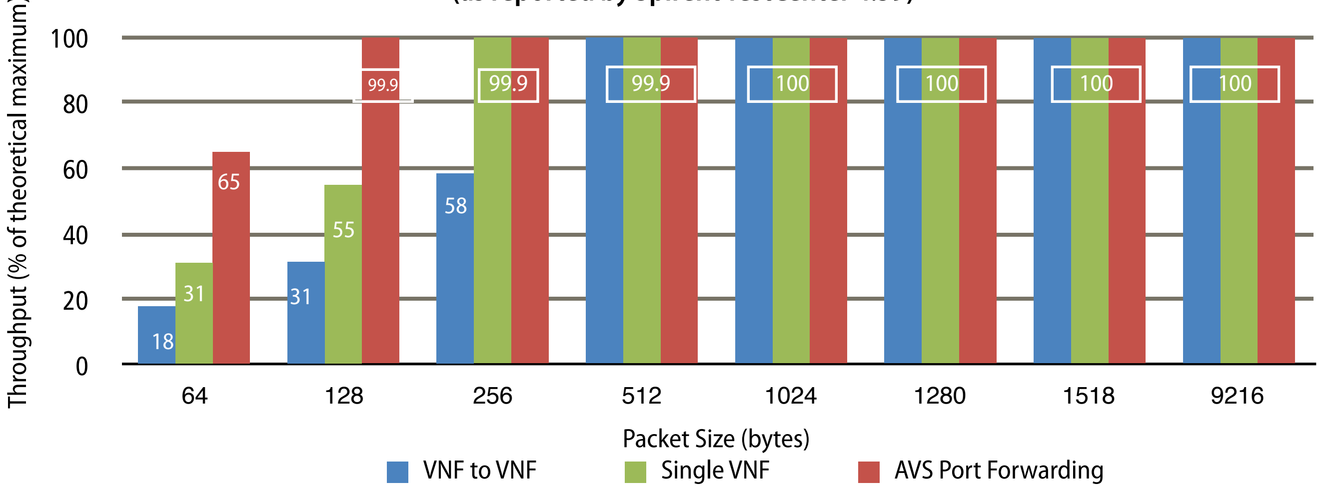
NFVI performance is the basis for and key enabler of NFV deployment. Key components of NFVI that impact the performance are VIM, virtual switch, virtual compute, virtual storage and virtual network node. Benchmarking the performance of NFVI platforms provides insights into what type of performance service providers can achieve from VNFs hosted on the NFVI platform and the capacity of the NFVI platform in compliance with service level agreements (SLAs) for the VNFs.

Spirent Communications commissioned Tolly to evaluate the performance and reliability of the Hewlett Packard Enterprise (HPE) Helion OpenStack Carrier Grade (HCG) network functions virtualization (NFV) solution powered by Wind River Titanium Cloud. Tolly evaluated the solution performance in various virtual switch configurations and benchmarked recovery time in a variety of scenarios including VM Live migration, LAG failure, compute and controller failures. The solution delivered high-throughput, consistent performance and effective responses to failure scenarios.

THE BOTTOM LINE

1. Line-rate 10GbE forwarding performance for AVS (virtual switch) at frame size 256 bytes and above
2. Line-rate one and two VNF forwarding performance at frame size 512 and above
3. Forwarding performance consistent across 10 test runs with zero variance for frame sizes above 256-bytes and variance less than 0.5% for frame sizes 256-bytes and smaller
4. Consistent, low latency averaging under 50 microseconds for all packet sizes tested
5. Robust fault detection and recovery

Layer 2 10GbE Forwarding Performance
Various NFV Configurations
(as reported by Spirent TestCenter 4.59)



Notes: Two physical 10GbE ports from Spirent TestCenter into compute system. One Wind River Linux version 6 guest with a Layer 2 DPDK forwarding application was the Virtual Network Function (VNF). Each VNF VM used 3 cores. Each VM had two virtual 10GbE ports. One core was used for each virtual port. The 3rd core (the management core) was used for the Linux core of the VM. The management core was shared among all VMs. AVS used 2 cores.

Source: Tolly, April 2016 Figure 1

Tests focused on establishing the performance baseline and fault tolerance characteristics of the HPE Helion carrier-grade infrastructure to support network function virtualization (NFV) virtual machines.

The HPE accelerated virtual switch (AVS) provides the core networking function to and between any and all NFV VMs deployed on the HPE Helion. The AVS was allocated two cores.

Performance

Layer 2 10GbE Forwarding

L2 network performance was benchmarked using two physical 10GbE Spirent TestCenter interfaces. Benchmarks were run in three scenarios: 1) AVS port forwarding (no VNF VM), 2) Single VNF, and 3) VNF-to-VNF. (The VNFs were L2 forwarding systems developed by Wind River that ran on three virtual cores.) See Figure 5 for diagrams of the various performance configurations. See Test Setup & Methodology section for additional details of all tests.

In port forwarding tests (traffic only in and out of AVS), the Helion AVS delivered 99.9 or 100% throughput at packet sizes of 128-bytes and larger and 65% with 64-byte packets. See Figure 1 for forwarding results for all configurations.

With single VNF tests, throughput remained 99.% or 100% at 256-bytes and higher and 512-bytes and higher with VNF-to-VNF.

Layer 2 10GbE Forwarding Consistency

Given the elastic nature of virtualized environments, it is important to understand how consistent performance will be over time. To that end, Tolly engineers ran the single VNF configuration discussed above a total of ten times and compared the results across all runs.

The Helion environment delivered very consistent results. In fact, at frame sizes of 512-bytes and higher there was no variance across the runs. At the smaller sizes, the maximum variance in results was 0.46% with 256-byte packets. See Figure 2.

HPE & Wind River

HPE NFV System

Helion OpenStack Carrier-Grade Performance & Reliability Powered by Wind River Titanium Cloud

Tested April-May 2016

Layer 2 10GbE Latency

Understanding latency (delay) characteristics through the VNF is important as high latency can degrade many network functions. Tolly engineers measured the latency in the single VNF configuration and confirmed average latency of under 50 microseconds across all packet sizes tested.

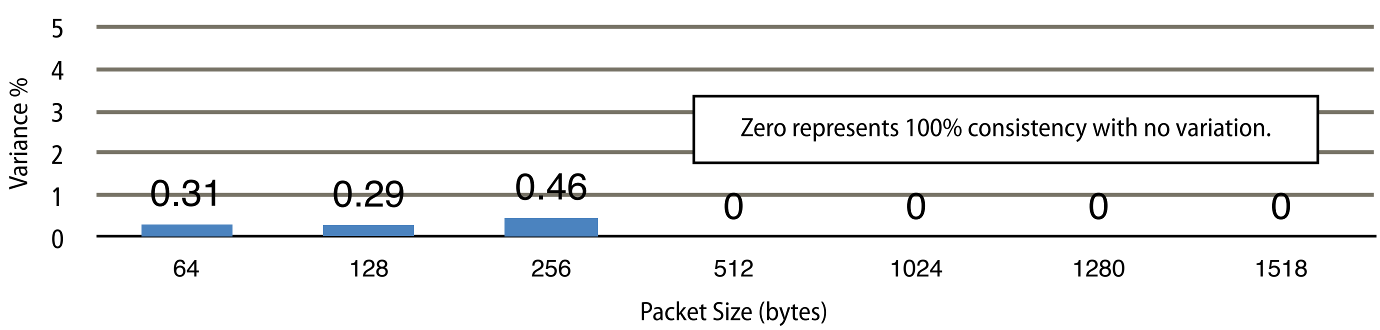
Here, too, the results were very consistent with 99% of all results under this value. See Figure 3 and Table 1 for details of latency results distribution.

Layer 2 10GbE Forwarding Performance Consistency

Single VM VNF Configuration

(as reported by Spirent TestCenter 4.59 & HPE Helion OpenStack Carrier Grade Controller Logs)

Lower numbers are better



Note: Chart depicts range or span of throughput results across 10 runs that measured % of theoretical line rate. Calculated as (max - avg)/avg.

Source: Tolly, April 2016

Figure 2

10GbE Layer 2 Latency
Single VNF Configuration
(as reported by Spirent TestCenter 4.59)

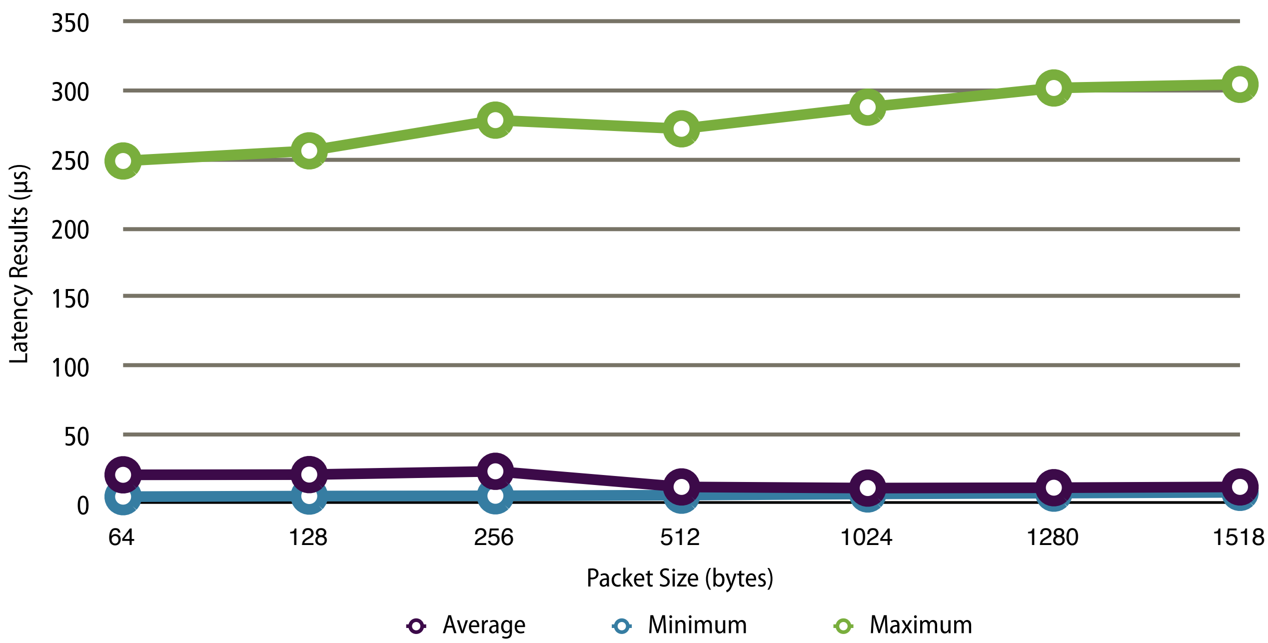


Figure 3

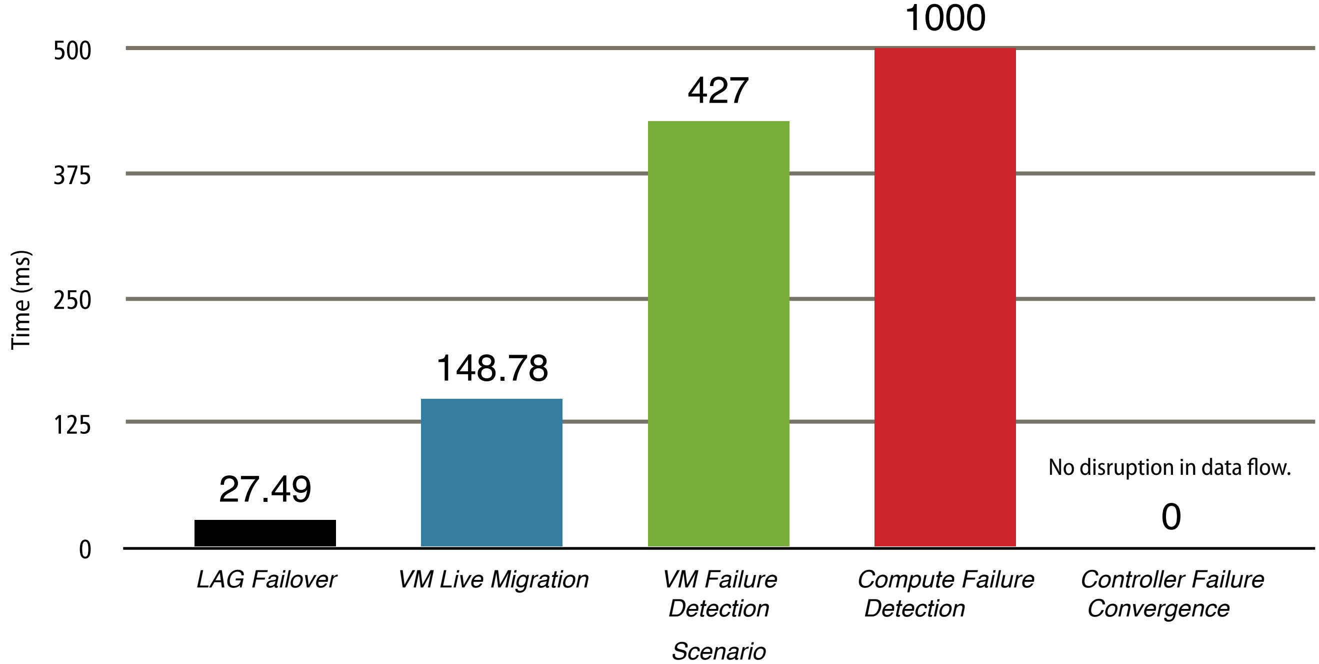
Packet Size (bytes)	Latency Distribution by Various Ranges (Percentage of the Total Packets)							
	<50µs	50-75µs	75-100µs	100-150µs	150-200µs	200-300µs	300-400µs	>400µs
64	99.42%	0.09%	0.1%	0.21%	0.18%	0.01%	0%	0%
128	99.43%	0.08%	0.1%	0.19%	0.18%	0.01%	0%	0%
256	99.37%	0.1%	0.1%	0.2%	0.2%	0.01%	0%	0%
512	99.41%	0.1%	0.1%	0.2%	0.16%	0.01%	0%	0%
1024	99.31%	0.1%	0.1%	0.21%	0.19%	0.06%	0%	0%
1280	99.29%	0.1%	0.1%	0.21%	0.19%	0.07%	0%	0%
1518	99.26%	0.1%	0.1%	0.22%	0.18%	0.1%	0%	0%

Note: Traffic profile was 80% of line-rate for 256, 512, 1024, 1280 and 1518 byte frame sizes. 44% line-rate for 128-byte, 25% of line-rate for 64-byte.

Source: Tolly, April 2016

Table 1

Carrier-Grade Fault Detection Scenarios
Single VNF Configuration
(as reported by Spirent TestCenter 4.59)



Note: Zero for the controller failure scenario indicates "hitless" failover with no measurable down time.

Source: Tolly, May 2016

Figure 4

Carrier Grade Fault Detection

Fault detection and recovery is mandatory in carrier-grade systems. Tolly engineers deliberately created specific failure situations in the HPE Helion environment and measured the time required to recover and, where appropriate, the impact on traffic traversing the environment at the moment of failure. All failure situations were detected and recovered. See Figure 4 for summary.

Link Aggregation Group (LAG) Failover

A LAG group consisting of two 10GbE interfaces was configured between the AVS and a VNF. When one link was removed, the traffic converged in 27ms.

VM Live Migration

When this function was triggered in the HPE Helion controller GUI, traffic converged on the newly-migrated VM in under 150ms.

VM Failure Detection

Engineers manually created a fault that caused the VM to fail and noted that the HP Helion controller detected this in 427ms.

Compute Failure

Engineer's used HPE's iLO to power off the physical compute server. HPE Helion detected this failure in 1 second and moved the affected VM to a backup compute resource.

Controller Failure

With a primary and a backup HP Helion controller in place, engineers turned the active controller off. The backup controller took over immediately for a "hitless" failover and no traffic was lost (thus, the zero for recovery time in Figure 4).

Test Setup & Methodology

One HPE DL360 Gen9 server with dual Intel Xeon E5-2640 v3 @2.6GHz eight-core processors, 128GB RAM, dual HPE Ethernet 10Gb 2-port 560SFP+ Adapter network cards was used as the hardware compute server in the Network Functions Virtualization (NFV) platform. The HPE Helion OpenStack Carrier Grade, version 2.0 patch 3 was used as the software. Spirent TestCenter N4U with test module MX-10G and software TestCenter version 4.59 was used as the test tool. See Table 2.

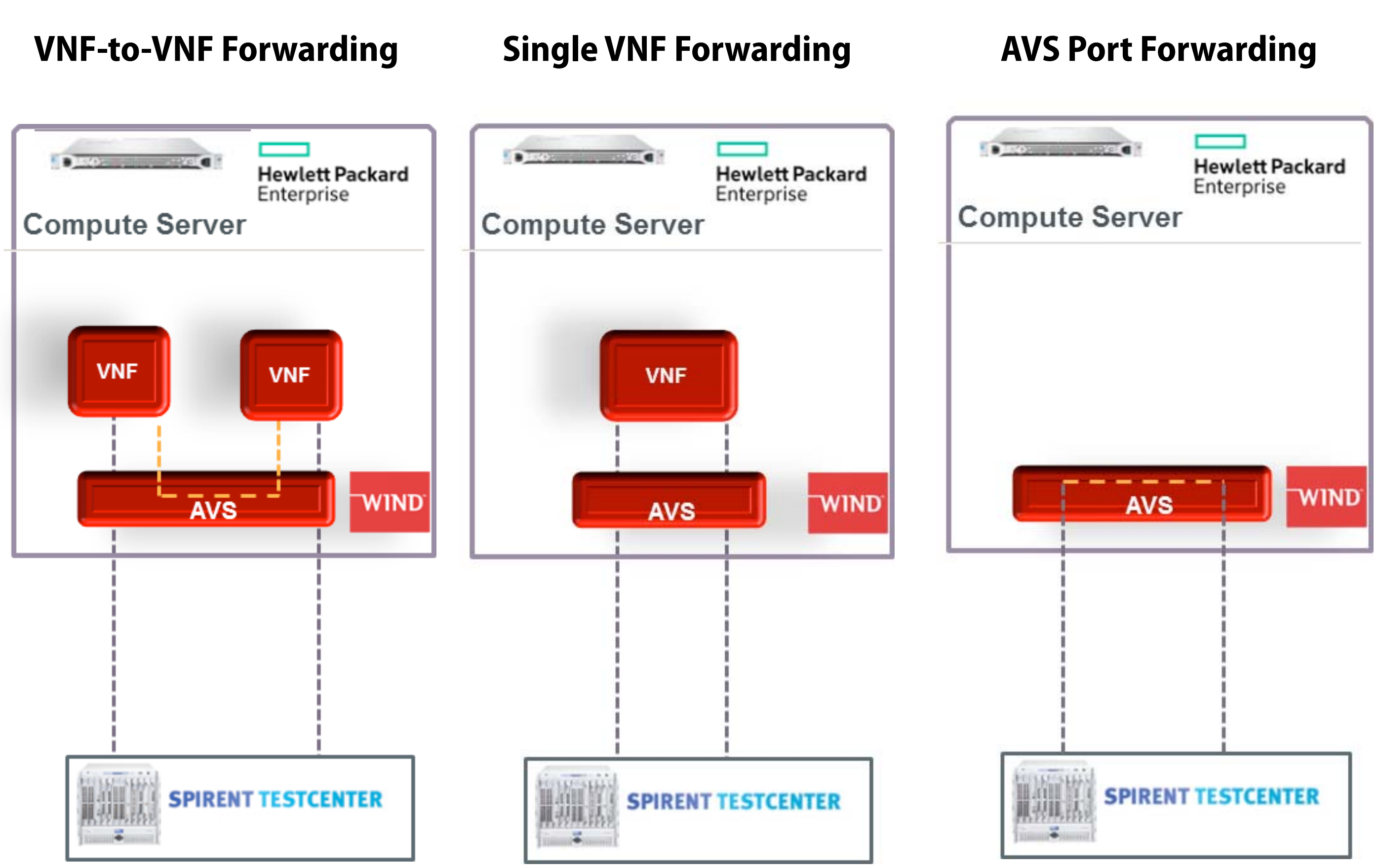
Wind River Linux version 6 guest VMs (each with a Layer 2 DPDK forwarding application) were used as the Virtual Network Functions (VNFs). Each VM used 3 cores. Each VM had two virtual 10GbE ports. One core was used for each virtual port. The 3rd core (the management core) was used for the Linux core of the VM. The management core was shared among all VMs.

Performance Benchmarking

Forwarding Performance Benchmarking

Engineers evaluated the Layer 2 forwarding performance in three scenarios: 1) AVS Port Forwarding; 2) Single VNF Forwarding; 3). VNF to VNF Forwarding. See Figure 5.

40 IP addresses were used for one Spirent TestCenter port. 50 IP address were used for the other Spirent TestCenter port. The



Source: Tolly, May 2016

Figure 5

RFC2544 throughput test wizard was used for the test. The frame loss threshold was set as 0.001%.

Forwarding Performance Consistency

The single VNF test from the Forwarding Performance Benchmarking tests was used to run 10 iterations. Variance % was calculated by (max - avg)/avg.

Latency Distribution

The single VNF test from the Forwarding Performance Benchmarking tests was used to evaluate the latency. For each packet size, 80% of the throughput results we got from the forwarding performance test was used. For 64-byte frame size, 25% line-rate was used; for 128-byte frame size, 44% lien-rate was used; for 256-, 512-, 1024-, 1280- and 1518-byte frame sizes, 80% line-rate was used.

Carrier Grade Fault Detection

The single VNF test from the Forwarding Performance Benchmarking tests was used for all Carrier Grade Fault Detection tests.

LAG Failover

Two 10GbE links from the AVS of the SUT were configured as one Link Aggregation Group (LAG). Engineers removed one active link to evaluate the traffic convergence time.

VM Live Migration

Engineers manually triggered the VM live migration in the HPE Helion OpenStack Carrier Grade controller's GUI-based management console and evaluated the traffic convergence time.

VM Failure

Engineers manually inserted a critical fault and used the log of the HPE Hellion OpenStack Carrier Grade controller to evaluate the elapsed time required for the SUT to detect the failure.

Compute Failure

Engineers used HPE's iLO to turn the physical compute server off. The HPE Helion OpenStack Carrier Grade platform detected the failure and migrated the VNF to the other compute. From the log, the SUT required 1 second to detect the failure.

Controller Failure

There were two HPE Helion OpenStack Carrier Grade controllers (one active and one backup). Engineers turned the active controller off. The backup controller became active. There was no frame loss for the test traffic.

Solution Under Test

HPE Helion OpenStack Carrier Grade	2.0 patch3

Source: Tolly, April 2016

Table 2

About Tolly

The Tolly Group companies have been delivering world-class IT services for more than 25 years. Tolly is a leading global provider of third-party validation services for vendors of IT products, components and services.

You can reach the company by E-mail at sales@tolly.com, or by telephone at +1 561.391.5610.

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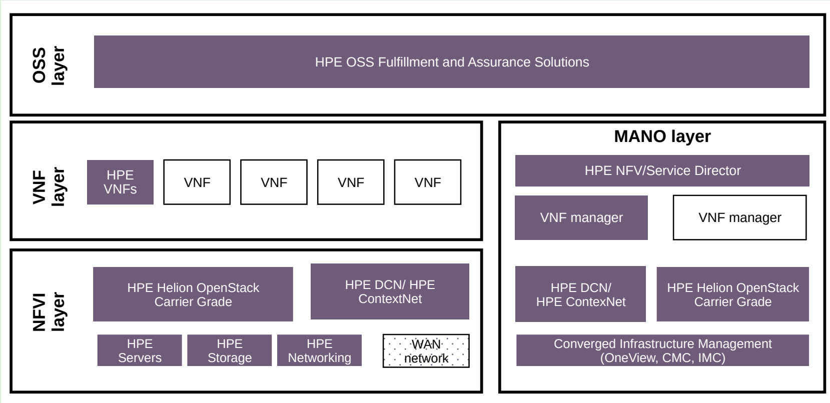
HPE OpenNFV Foundation Architecture



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