White Paper

Cloud Service Providers, Telecommunications Companies, Data Center Operators

VoerEir Uses Touchstone to Maximize NFV Network Performance

Using Touchstone benchmark software, VoerEir configures Intel® Ethernet E810 Network Adapter queues to maximize NFV throughput

Network functions virtualization (NFV) is thriving in telco networks thanks, in part, to the ability to transition from costly network functions based on dedicated hardware to providing the same capabilities on commercial off-the-shelf (COTS) servers with no performance sacrifices.

But network functions are becoming increasingly sophisticated, handling larger datasets and more complex algorithms. Simultaneously, the nature of network traffic is evolving, with an increase in low-latency application requirements such as real-time communications, artificial intelligence, and private 5G networks.

To address these challenges, communications service providers (CoSPs) are turning to advanced processors that offer increased core counts, higher clock speeds, and onboard accelerators. These processors are designed to handle the demanding computational requirements of modern network functions, enabling them to deliver the performance levels necessary to deliver the throughput needed by next generation network functions in open and closed ecosystems.

They are also turning to Ethernet network adapters with features like hardware offload, advanced data queuing, RDMA/RoCE, OVS, DPDK acceleration and SR-IOV to significantly contribute to communications service providers' efforts to operate more efficiently. These features can reduce CPU utilization, improve network performance, and enable new network functions, ultimately helping CoSPs deliver high-quality services to their customers.

To help guide CoSPs in their server decision making, VoerEir AB, an Intel® Industry Solution Builders' Network Builders Community member and Intel® Partner Alliance Member tier partner, worked with Intel to benchmark NFV networking performance using its benchmarking tool, Touchstone. The company developed a test environment using Data Plane Development Kit (DPDK), Intel® Ethernet Network Adapter E810-CQDA2 and servers powered by 4th Gen Intel® Xeon® Scalable processors.

Touchstone Provides NFV Benchmarking

The benchmarking for the tests utilized VoerEir's Touchstone software, which the company designed to serve as an invaluable tool for NFVI benchmarking, certification, and validation.

Touchstone is designed to be a comprehensive test suite manager and comes equipped with an extensive array of automated test cases and pre-packaged tools that empower users to seamlessly evaluate the performance, functionality, robustness, security and stability of their virtualized environments.

The software includes support for multiple data centers and cloud environments and has a proprietary advanced test engine that is tailored for Kubernetes and OpenStack environments, empowering users to evaluate and optimize all of their cloud environments.

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Touchstone boasts the capability to leverage various open-source test engines, such as Kubernetes Kube-Hunter, Kubernetes Litmus, OpenStack Rally, OpenStack Tempest, and others. This versatility ensures users have access to a wide range of options for benchmarking their environments.

With an extensive range of features for environment benchmarking, report management, and Enhanced Platform Aware (EPA) test suites, Touchstone is a complete solution for cloud environment benchmarking, certification, and validation.

Touchstone supports a wide range of benchmarks including performance testing, robustness testing, API testing, Chaos testing and functional testing. Touchstone supports monitoring the resource and power consumption of any Kubernetes environment while it is being benchmarked, to enable correlation and comparison of various Kubernetes platforms. Touchstone also supports stand-alone monitoring, while the environment is loaded with proprietary network functions.

Tests Use Intel Networking, CPU Products

Three Intel-developed technologies were used in the tests:

- 4th Gen Intel Xeon Scalable processors represent a significant leap forward in performance and efficiency, offering compelling advantages for NFV deployments. This processor features a large cache size, delivering exceptional computational power for demanding network functions. Beyond raw performance, the 4th Gen Intel Xeon Scalable processor excels in optimizing resource utilization through enhanced memory and I/O capabilities that ensure swift data transfer and access that is critical for low-latency applications and handling large datasets. These combined attributes allow service providers to consolidate more network functions onto fewer servers, reducing operational costs and increasing overall system efficiency.
- The Intel Ethernet Network Adapter E810-CQDA2 is a high-performance, cloud-ready network adapter designed to optimize cloud and communication services. With features like DDP, PTP, SR-IOV and the Ethernet port configuration tool, it offers reduced latency, synchronized clocks, efficient VM resource allocation, and simplified network management.
- Data Plane Development Kit (DPDK) consists of libraries to accelerate packet processing workloads running on Intel® Architecture Processors. DPDK can significantly accelerate network application performance due to its efficient run-to-completion model and optimized libraries that ensure all necessary resources are allocated upfront.

Test Set Up

The goal of the tests was to show the resources needed to efficiently saturate a single 100 GbE port. The test set up[i] was designed to simulate high network throughput applications as seen in core network applications in NFV. Figure 1 shows two 4th Gen Intel Xeon Scalable processor-based servers with the exact same configuration that were connected to each other at 100Gbps using Intel® Ethernet E810 Network Adapter and a 400 GbE switch. One of the servers under test (SUT), designated ZSP13, acted as the packet transmitter. Touchstone facilitated the packet generation using Data Plane Performance Demonstrator (DPPD) Packet Processing Execution engine (PROX). PROX is a DPDK-based packet generation and measurement application that is used for a wide range of use cases.

Packets generated by PROX on the ZSP13 were transmitted through the switch to the other server, designated ZSP04, server where Touchstone made the packet journey calculations to show throughput.

The test was focused on generating small sized, 64-byte Ethernet frames, a particularly challenging use case involving small packets, which challenge maximum packets per second and balancing that against required throughput. The tests used DPPD-PRoX software and measuring network performance for near 0% packet loss (<10 PPM) per RFC-2544. Because the packet headers take the same time to process regardless of packet length, it's harder to reach the theoretical line rate in a test of only 64-byte packets before experiencing packet losses.

These tests measured the impact of 4th Gen Intel Xeon Scalable Processor features such as support for ultra-fast DDR4 memory and expanded PCIe 4.0 input/output connections. In addition, the processors' support the Intel® Ultra Path Interconnect (Intel® UPI) point-to-point processor interconnect that delivers a transfer rate of 16GT/s. The tests show this performance helps in efficient data packet processing with packet loss within the permissible limit.

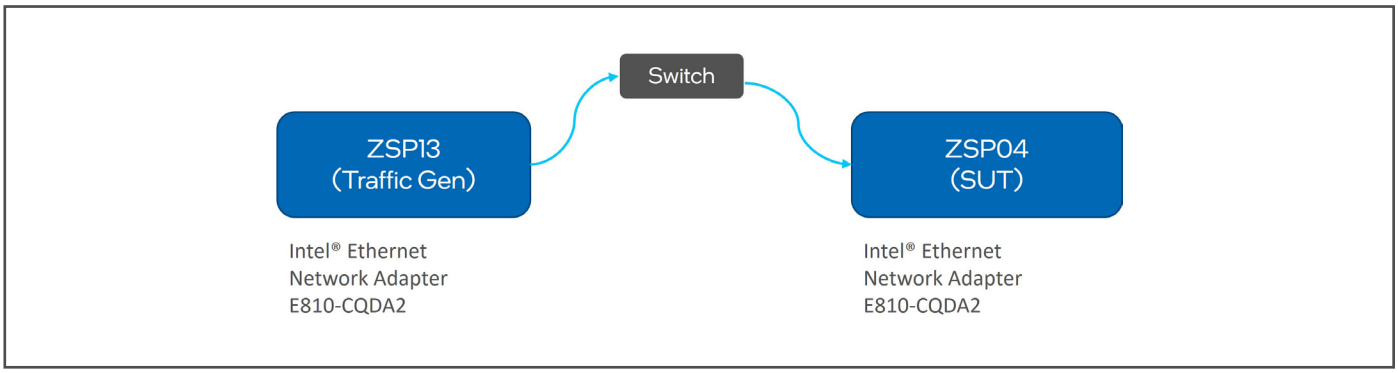

Figure 1. Server and switch configuration.

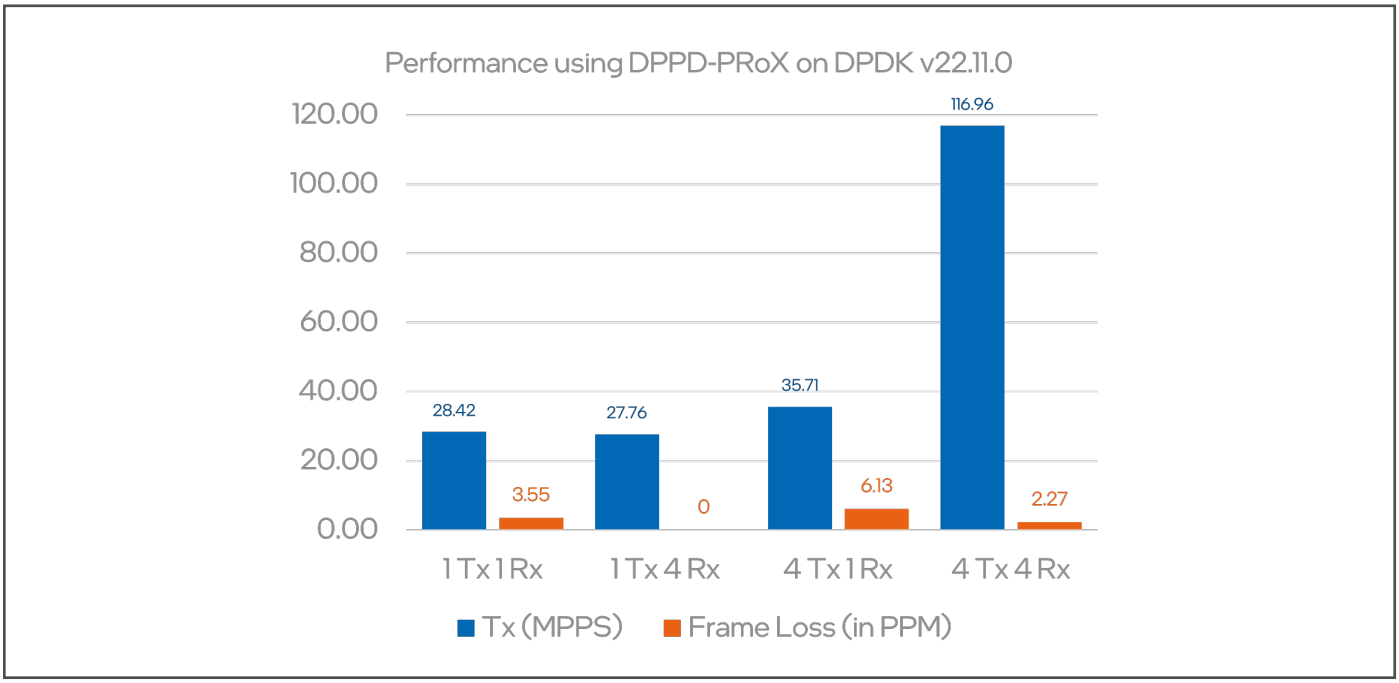

Figure 2. Network throughput in millions of packets per second and packets lost per million packets sent for various adapter queue configurations (higher is better).

This performance leads to higher throughput and predictable network behavior for maintaining consistent application performance and user experience. A no-loss environment leads to more stable and reliable network connections, reducing the risk of dropped connections and interruptions. It also reduces the need for retransmissions, saving bandwidth and lowering operational costs.

For high performance connections between the servers, each SUT made use of Intel Ethernet Network Adapter E810-CQDA2 network adapters operating at 100Gbps. The test team measured network throughput using different numbers of the queues from the network adapter with each queue bound to its own core using SR-IOV. This configuration eliminated the impact of context switching by the operating system which increases latency and decreases throughput.

Test Results

The test results in Figures 2 and 3 show how the test team was able to configure the queues to maximize performance even in the worst-case scenario of transmitting only small packets.

Using just one transmission (TX) and one receiving (RX) queue, the server was able to generate 28.42 million packets per second (19.09 Gbps) within the acceptable packet loss limit. Adding three more RX queues reduced the throughput slightly to 27.76 Mpps (18.65 Gbps) showing the generation side (single TX queue) gets bottlenecked.

By increasing the queue count to four TX and one RX the results show that the throughput improved to 35.71 Mpps (24Gbps), albeit only nominal packet loss of 6.13 PPM is observed which is under permissible limit. It's only when four TX and four RX queues were tested that throughput maxed to 116.96 Mpps (78.59 Gbps). It was observed that increasing the TX and RX queues further doesn't improve the performance.

The optimal performance of 116.96 Mpps achieved in these tests is effectively generated using just four queues. This allows the remaining resources to be efficiently allocated to other computational tasks.

	Tx (MPPS)	Rx (MPPS)	Loss (PPM)
1 Queue Tx 1 Queue Rx	28.42	28.42	3.55
1 Queue Tx 4 Queue Rx	27.76	27.76	0.00
4 Queue Tx 1 Queue Rx	35.71	35.71	6.13
4 Queue Tx 4 Queue Rx	116.96	116.96	2.27

Figure 3. The table showing details of test results that are graphed in Figure 2.

Conclusion

Higher network throughput is critical for achieving optimal performance of core network applications in NFV environments. This can improve the performance of applications that require high data transfer rates, such as file transfers or backups. Using Touchstone for benchmarking and a 4th Gen Xeon Scalable Processor-based server connected with Intel Ethernet Network Adapter E810-CQDA2 adapters, the test team was able to deliver NFV networking performance that fills a 100GbE network pipeline using just a few cores.

Learn More

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VoerEir Touchstone

Data Plane Development Kit

4th Gen Intel® Xeon® Scalable Processor

Intel® Ethernet Products

Intel® Industry Solution Builders' Network Builders Community

[i] SUT Configuration for ZSP13 AND ZSP04: 1-node, 2x Intel® Xeon® Platinum 8470N processor with 52 cores and 104 threads. Total DDR4 memory was 256 GB (8 slots/ 32GB/ 4800 MHz); microcode 0x2b000181; Intel® Hyper-Threading Technology was enabled; Intel® Turbo Boost Technology was enabled. BIOS version: AMI LLC 3A11.uh. Application storage is Intel® SSDPE2KX010T8; Network controller: Intel® Ethernet Network Adapter E810-CQDA2 operating at 100 Gbps. Software: OS was Ubuntu 20.04; kernel was Linux 5.4.0-155-generic. Benchmark/workload software: PRoX (Commit ID: 02425932); Compiler was GCC 9.4.0; Libraries were DPDK 22.11.0. Other software: ICE driver 1.11.14, iavf driver 3.2.3-k and ICE firmware 4.10. Test conducted by VoerEir AB on Oct. 13, 2023.

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