Evaluation of Broadcom 57414 NetXtreme-E Dual-Port 10/25Gb Ethernet PCIe Adapters in a VMware Dell EMC 14G Server Environment

Broadcom 57414 NetXtreme-E dual-port 10/25Gb Ethernet Adapters offer the performance and bandwidth needed to support high virtual machine density on Dell EMC PowerEdge 14G Servers.

Executive Summary

Dell PowerEdge 14G Servers offer advanced hardware such as Non-Volatile Memory Express (NVMe) and Non-Volatile Dual In-Line Memory Modules (NVDIMM), which push Virtual Machine (VM) density and performance to new heights. 25GbE adapters have become necessary to support the network bandwidth generated, as there is a limit to how many VMs and how much workload can be supported on 10GbE.

When increasing VM density, it is important that performance not be compromised as more VMs are added. It is also important that VMs can be migrated in a timely manner to a backup server for routine maintenance. Lastly improved bandwidth is a must for more advanced workloads like Server Message Block (SMB) 3.

Dell commissioned Demartek to evaluate the benefits of upgrading from 10GbE to 25GbE adapters. We compared the Dell EMC PowerEdge R740xd servers running VMware with Broadcom 57414 NetXtreme-E Dual-Port 10/25Gb Ethernet Adapters operating at 10GbE against the same servers with the same adapters operating at a full 25GbE. iSCSI was used to provide the storage for the tests. Three scenarios were tested, which included a mixed workload environment, a VM migration, and a movie delivery via file copy on SMB 3.1.1.

We found that 25GbE allowed for a higher VM density without performance degradation, faster VM migration, and faster file copy.

Key Findings

> 8 VMs was the limit where two ports of 10GbE did not suffer performance degradation. **However, two ports of 25GbE doubled the VMs to 16 with virtually no performance degradation**.

> **Two ports of 25GbE doubled the maximum VM density**, supporting 16 VMs while keeping overall performance per VM within 12% of the 10GbE 8 VM scores.

> When 16 VM mixed workload tests were performed, there was a **25% overall reduction in latency** and a **31% overall increase in work performed** when moving from two ports of 10GbE to two ports of 25GbE.

> 25GbE supported **45% faster VM migration** than 10GbE.

> 25GbE supported **38% faster movie delivery** via file copy than 10GbE.

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Dell EMC PowerEdge R740xd 14G Servers

The Dell EMC PowerEdge R740xd is a scalable 2U, 2-socket platform which supports:

> Up to two Intel® Xeon® Scalable processors with up to 28 cores per processor, totaling 56 processing cores

> 24 DDR4 2666 MT/s DIMM slots with up to 3 TB of available memory

> 12 NVDIMM capable slots, with up to 192GB of available NVDIMM

> 10.5 GT/s Ultra Path Interconnect (UPI)

> Intel C620 Chipset

> Up to 8 PCIe 3.0 slots, including up to 4 x16 slots

> Up to 24 NVMe compatible 2.5-inch drive bays with up to 144TB of storage

> 80PLUS Titanium or Platinum power supplies

Broadcom 57414 NetXtreme-E Dual-Port 10/25Gb Ethernet PCIe Adapters

The Broadcom 57414 NetXtreme-E Dual-Port 10/25Gb Ethernet PCIe adapter delivers high packet rate and low latency in a PCIe Gen3x8 interface. Features include:

> Remote Direct Memory Access (RDMA) over Converged Ethernet (RoCE) v1 and v2

> SR-IOV support

> Internet Small Computer System Interface (iSCSI) boot

> Network Partitioning (NPAR) 1.0

> CL74 and CL91 Forward Error Correction (FEC)

> Auto-negotiation (AutoNeg) network speeds of 10Gbps and 25Gbps

> Institute of Electrical and Electronics Engineers (IEEE) and Converged Enhanced Ethernet (CEE) Data Center Bridging (DCB) protocols

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Mixed Workload VMware Environments

Environment

VMs were deployed on the server in groups of four. Each group of four had one VM performing each of the following moderate to heavy enterprise workloads:

> DVDStore

> Fileserver Simulation on Iometer

> Exchange Jetstress

> Webserver Simulation on Iometer

16 VMs were deployed on iSCSI datastores on a Dell EMC PowerEdge R740xd running the Broadcom 57414 NetXtreme-E Dual-Port 10/25Gb Ethernet PCIe Adapters at 25Gbps. The workloads were run on 16 VMs. Then the adapters were reconfigured to run at 10Gbps.

The workloads were run on 16 VMs at 10Gbps. Then the workloads were repeated with 12 VMs and 8 VMs at 10Gbps.

The workloads were configured to run for 2 hours each. One workload was started every 30 seconds until all workloads were running.

Performance

Results from different workloads cannot be averaged to give meaningful results, so for each of the four workloads, the performance of only the VMs executing that workload were averaged. These per VM averages are discussed here.

Obtaining an aggregate overall "score" for each environment is problematic in a mixed workload environment, so instead the percent increase in work performed was found for each workload, and this was averaged across the workloads to give us the overall percent performance change between tests. The overall performance of 16 VMs on two ports of 25GbE was found to have lower, but similar performance per VM as 8 VMs on 10GbE. On average the per VM performance on 25GbE was only 12% lower while double the VMs were run on the host.

DVDStore Average Workload VM Operations Per Minute
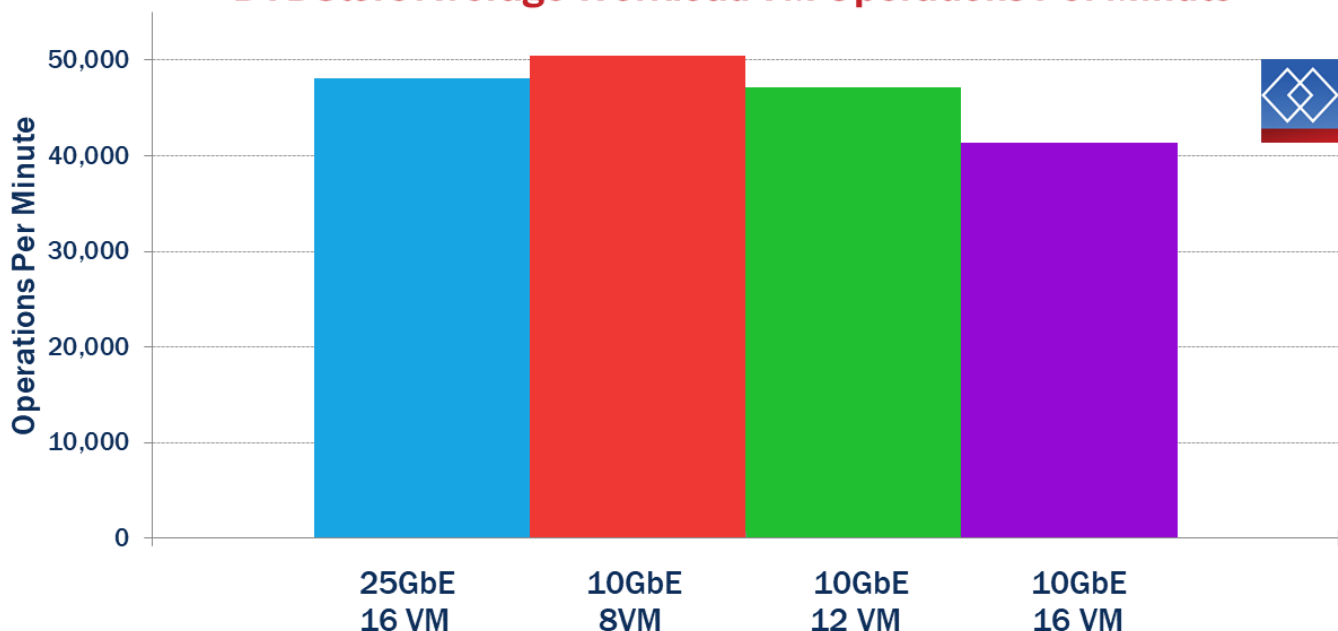
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## Fileserver Average Workload VM Throughput
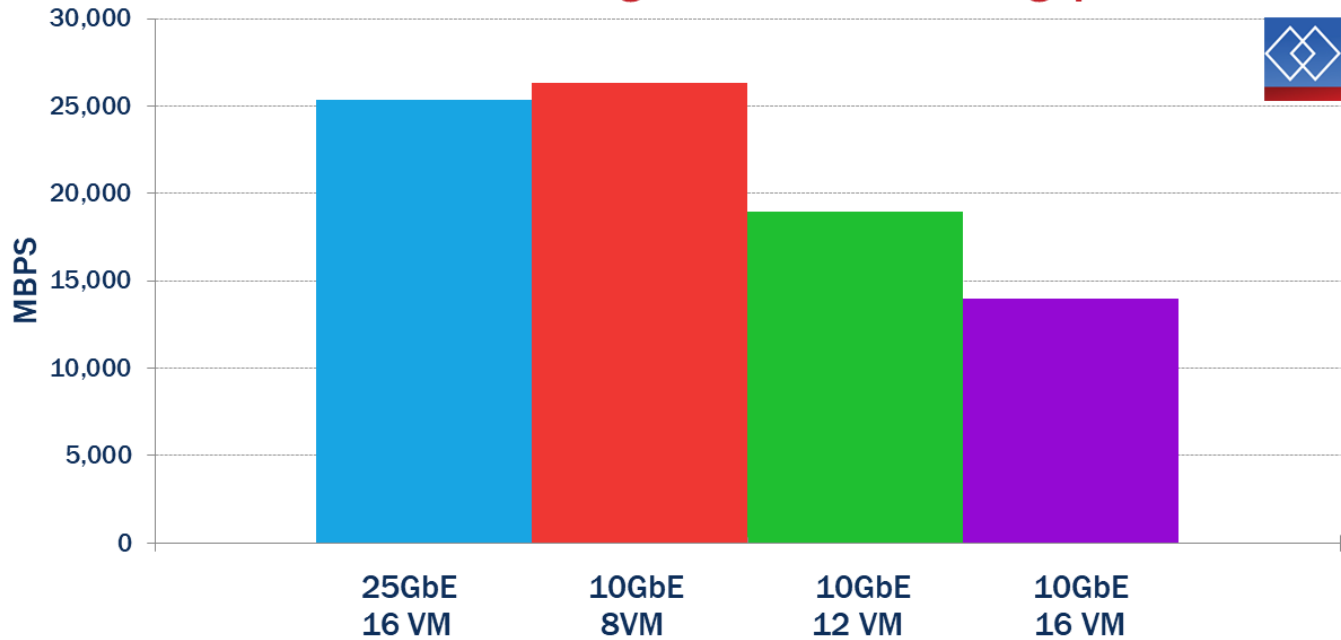
When the number of VMs running on 10GbE was increased to 12, the overall per VM performance of 16 VMs on 25GbE was 14% higher than 12 VMs on 10GbE. *Further increasing the number of VMs running on 10GbE to 16VMs lead to significant performance degradation*. The overall per VM performance of the 25GbE was **31% higher** when compared to 16VM 10GbE performance.

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When evaluating the performance of mixed workloads, we sometimes find that the performance of one workload will increase at the expense of another. The Jetstress workload is just such a workload and it had a performance increase when the number of VMs running on 10GbE increased from 12 to 16, however, *all the other workloads suffered when the number of VMs was increased, causing an overall performance decrease*.

Jetstress Average Workload VM IOPS
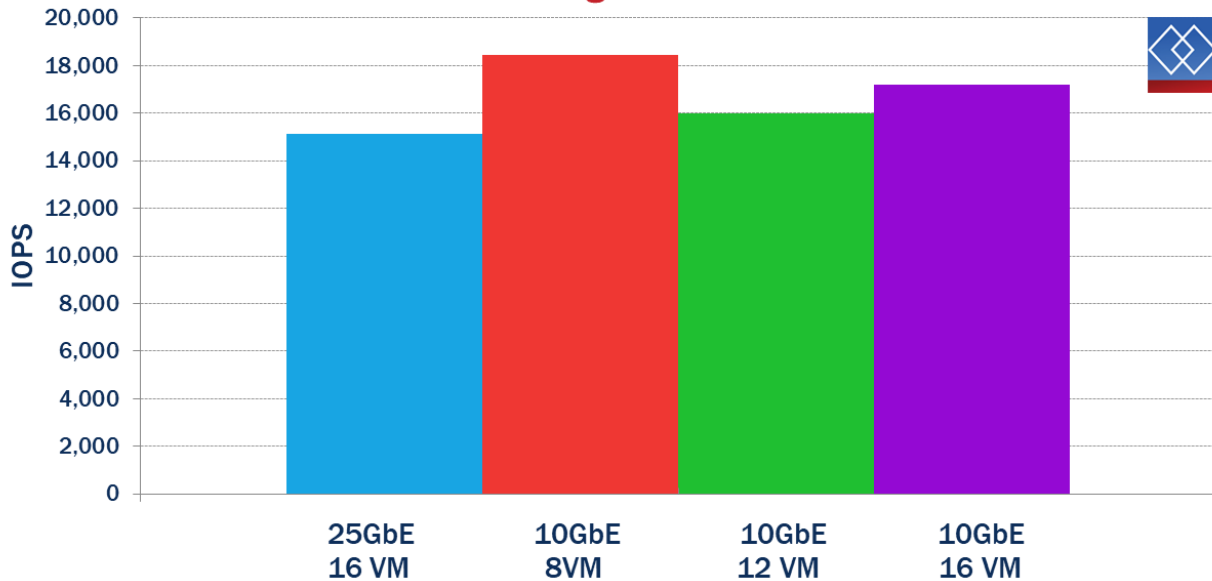
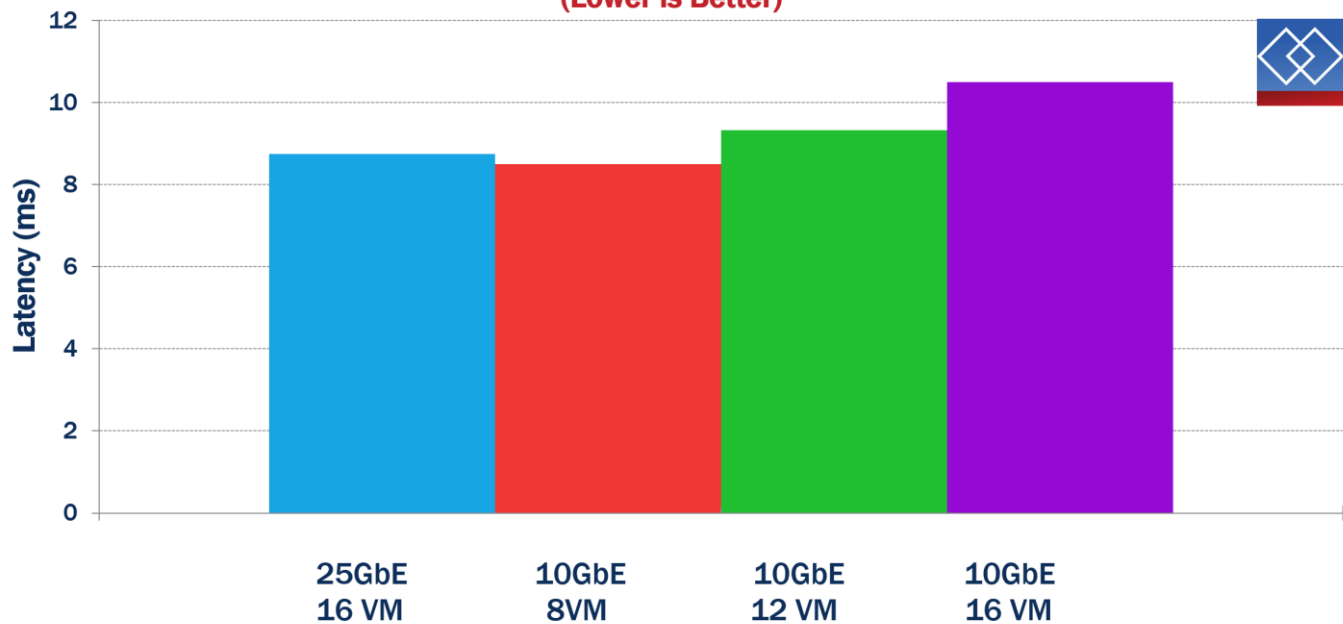**Webserver Average Workload VM IOPS**
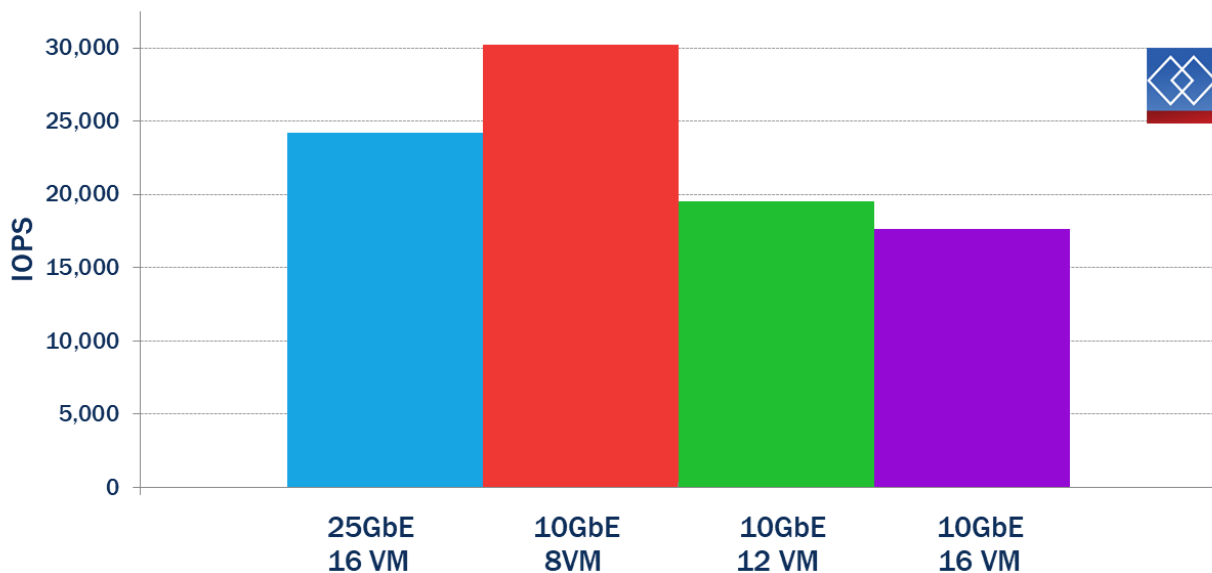
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Latency

Latency overall followed the same pattern with *performance degrading as more VMs were added to the 10GbE tests*. While the latency for the 8 VM 10GbE test was similar to and in some cases lower than the latency for the 16VM 25GbE test, as the number of VMs was increased, so did latency.

All 10GbE workloads run with 12 or more VMs had higher latencies on 10GbE than the latency for the 16 VM 25GbE workload. Only latencies for small block workloads are shown here as comparing large block latencies is not generally useful.

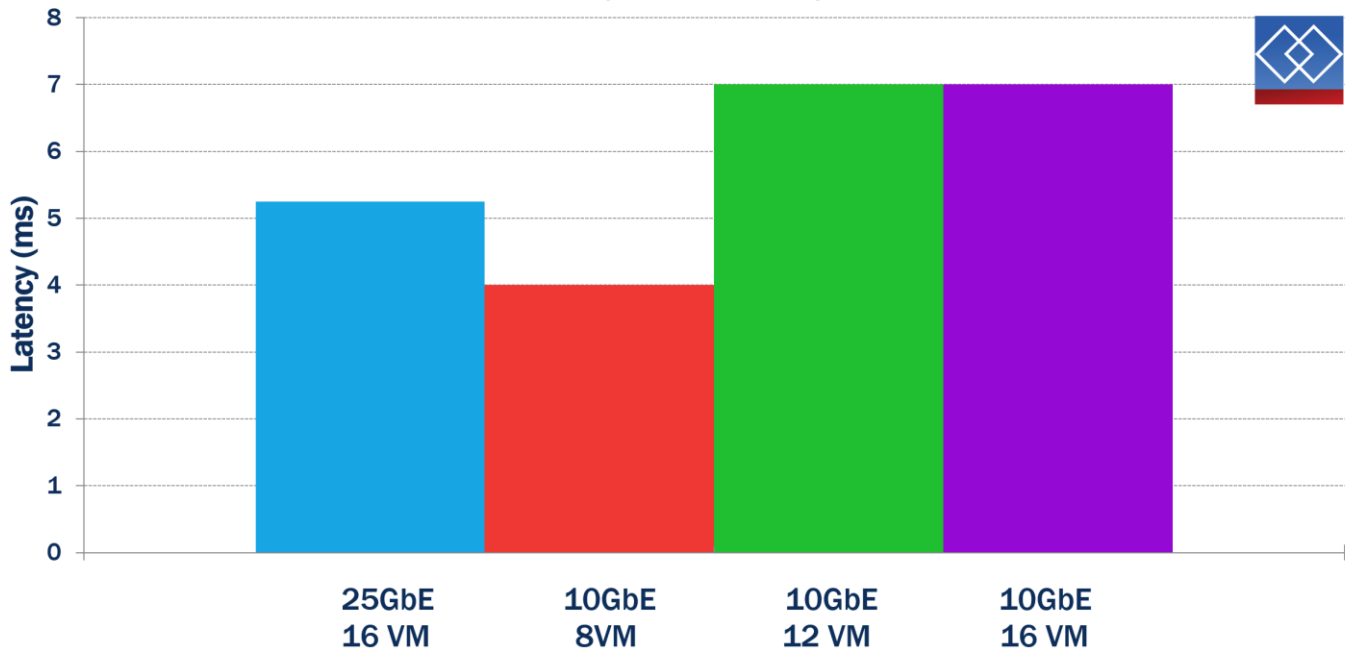DVDStore Average Latency as Measured at VM (Lower is Better)

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Jetstress Average Latency as Measured at VM
(Lower is Better)
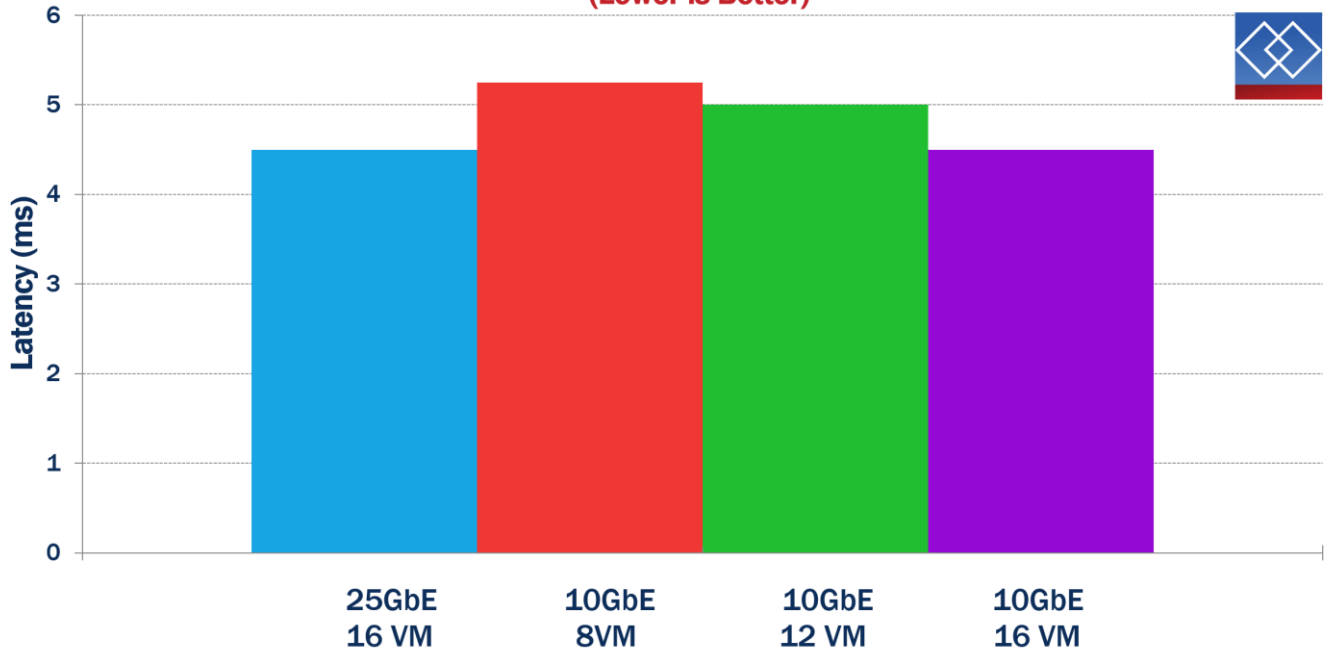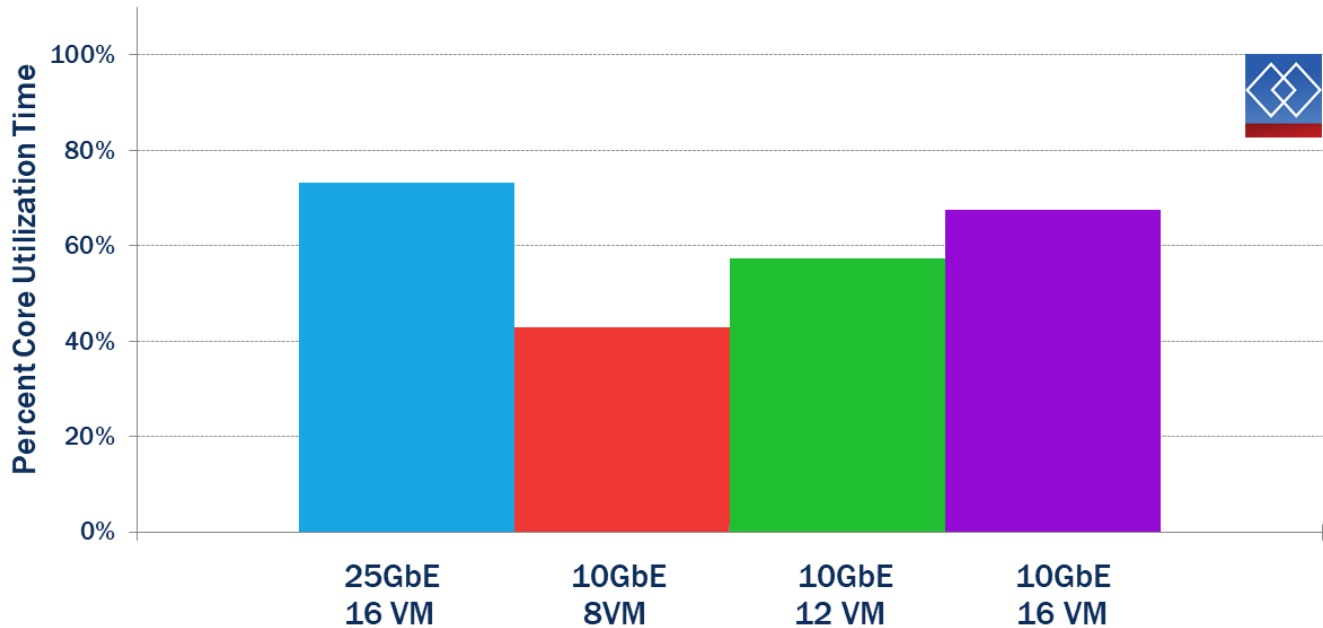

Webserver Average Latency as Measured at VM
(Lower is Better)

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Demartek

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Host Processor Utilization

While running on 10GbE, our server resources were underutilized. Even with 16 VMs running on 10GbE, the *lack of bandwidth at 10GbE limited processor* *utilization*. In order to preserve performance at 10GbE VM density must decrease and consequently the server is not fully utilized.

Average Host Processor Utilization - Mixed Workload Test

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VM Migration

Environment

Two Dell EMC PowerEdge R740xd's were configured with shared iSCSI storage. 15 VMs from the mixed workload test server were migrated to the secondary backup server and then migrated back to the original server a total of three times, making three round trips, or six migrations total. The migrations were run once with the Broadcom 57414 NetXtreme-E Dual-Port 10/25Gb Ethernet PCIe Adapters set to run at 25GbE, and once with the adapters set to run at 10GbE. The migration was compute only. Testlimit was run in each VM to simulate typical memory usage and keep memory utilization consistent for all tests.

Performance

The first migration in each direction took longer than the rest. After the first migration, results were stable. If the first migration in each direction is dismissed as an outlier due to the datacenter not reaching a steady state, the results are found to be very stable. Migrating the VMs with 10GbE took on average 86 seconds, and migrating the VMs with 25GbE took on average 47 seconds. On average, the 25GbE migration was **45% faster**.

Time to Complete 15 VM Migration
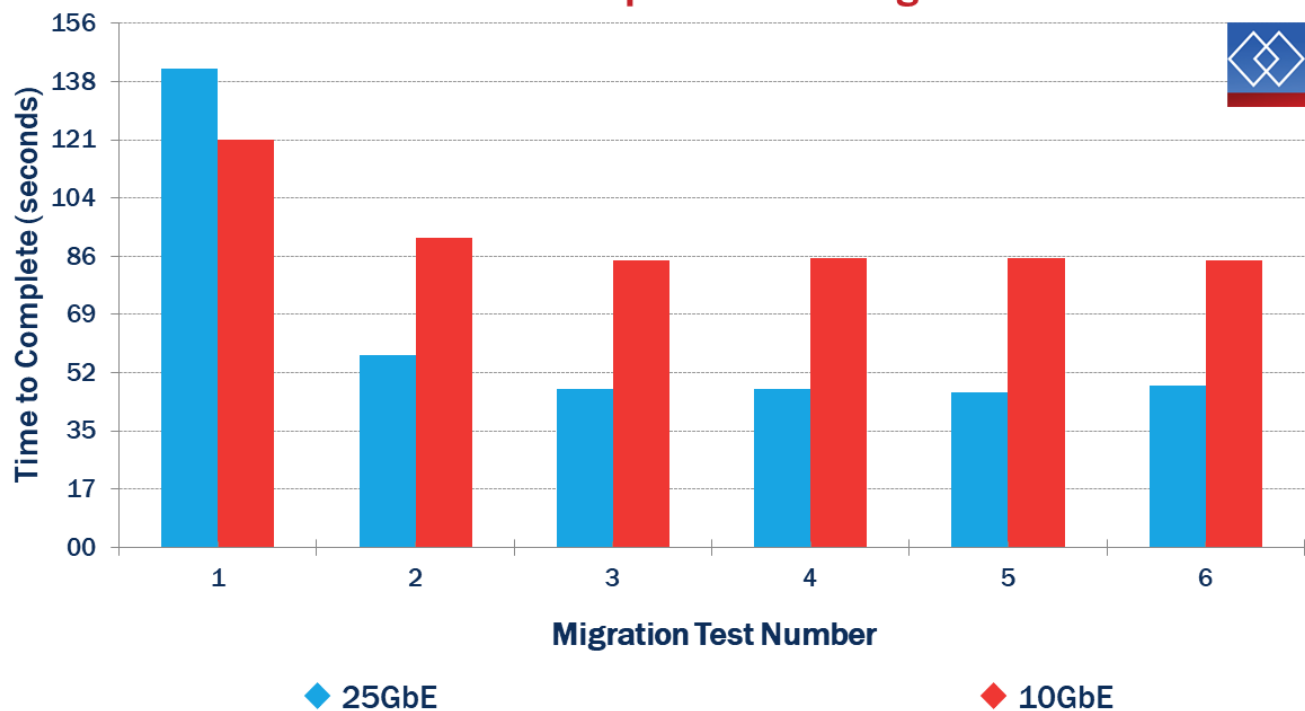
◆ 25GbE   ◆ 10GbE

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Movie Delivery over SMB 3.1.1

Environment

Two Dell EMC PowerEdge R740xd's were configured with ESXi. The first hosted two movie server VMs, with their movie files stored on iSCSI storage. The second hosted two movie client VMs. Powershell scripts were configured on the clients. Each client connected to SMB shares on the movie servers and downloaded movie content to RAM. Two new processes to retrieve movie files were spawned on each movie client every 20 seconds until a total of 40 processes were spawned in seven minutes. Each process copied between 45-50 movie files. The number and size of movie files was static for each process. The movie files had sizes ranging between 1-2GB. The same processes and same number of file copies were initiated for each test, keeping the size of the total dataset to be copied consistent between tests. Tests were run three times with the Broadcom 57414 NetXtreme-E Dual-Port 10/25Gb Ethernet PCIe Adapters set to run at 25GbE. Then the adapters were set to run at 10GbE and three more tests were performed. The median run for each adapter speed was chosen for comparison.

Performance

After ramp-up completed, the 25GbE was able to sustain higher bandwidth, which enabled 25GbE to complete the test faster.

The 25GbE achieved an average throughput of 3,321 MBPS, while the 10GbE achieved an average bandwidth of 2,053 MBPS.

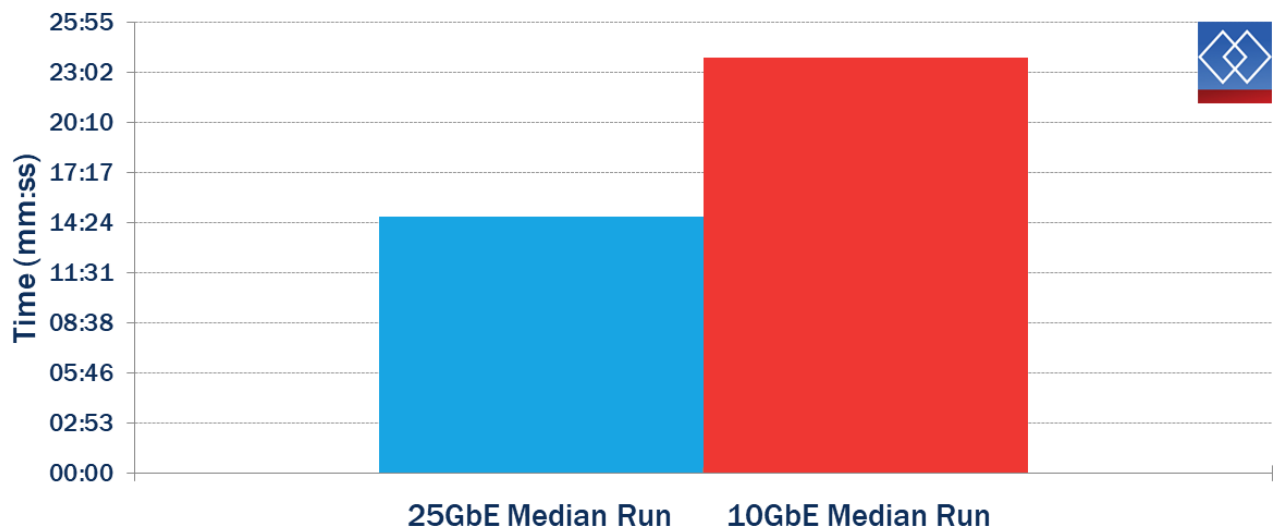**Total Throughput Received at Client VMs - SMB 3.1.1 Movie Delivery Workload**
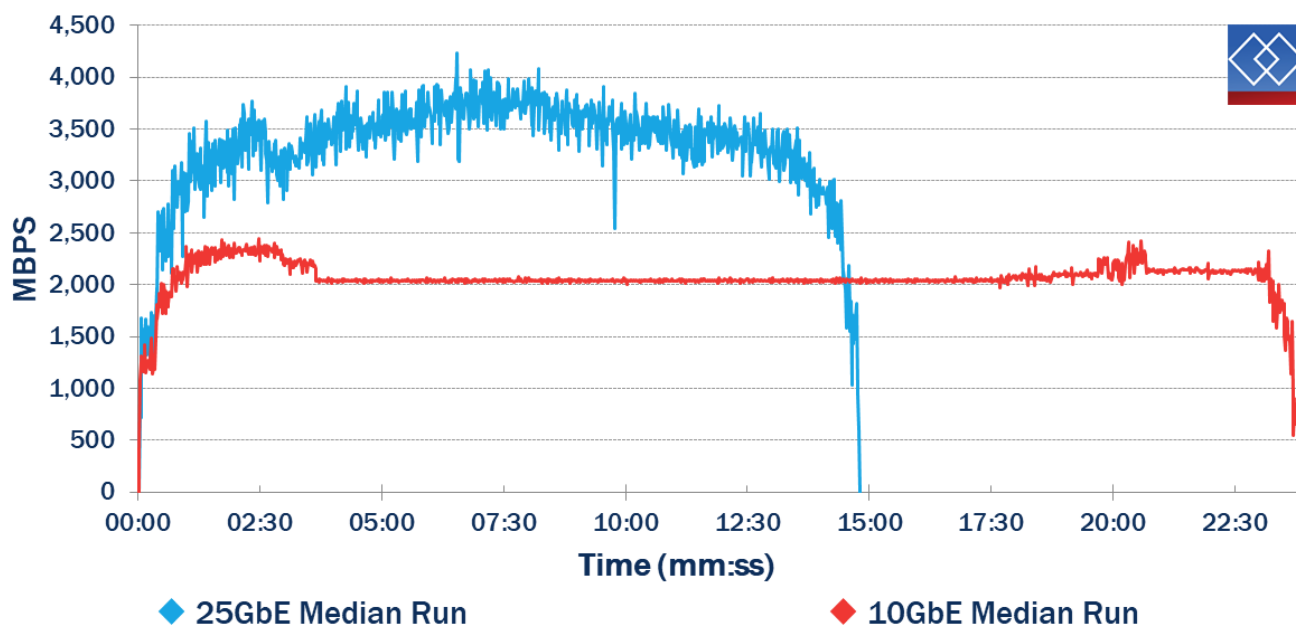
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Average Total Bandwidth - SMB 3.1.1 Movie Delivery Workload
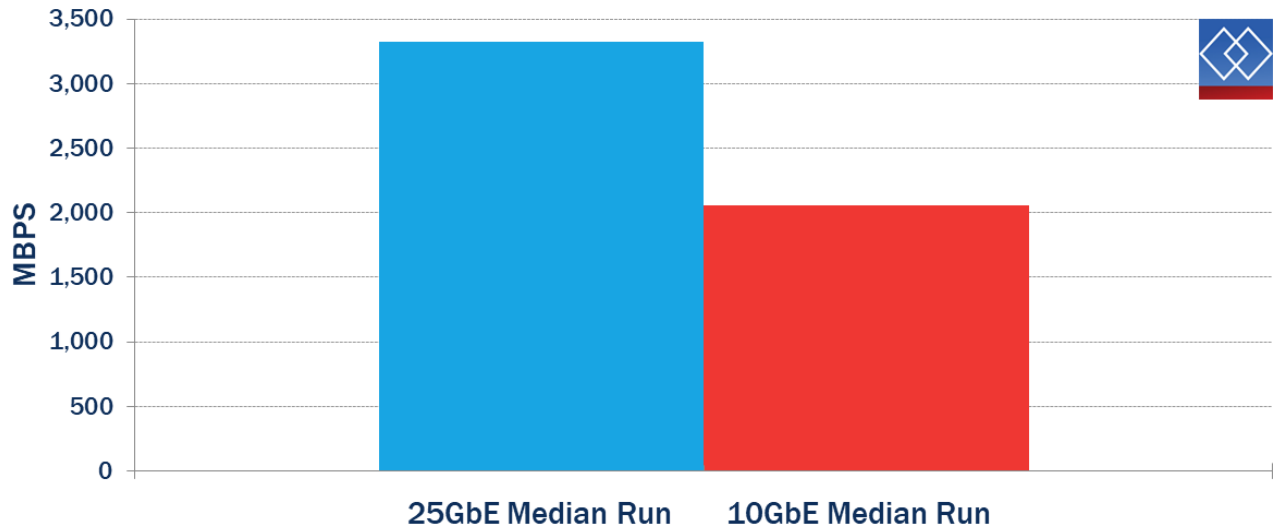
Time To Complete Movie Delivery- SMB 3.1.1 Movie Delivery Workload


Both the 25GbE and 10GbE had the same amount of work to do, but the 25GbE was able to complete the work faster. 25GbE completed the work in 14 minutes and 46 seconds, while 10GbE completed the work in 23 minutes and 53 seconds. 25GbE completed the movie delivery **38% faster**.

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Test Environment
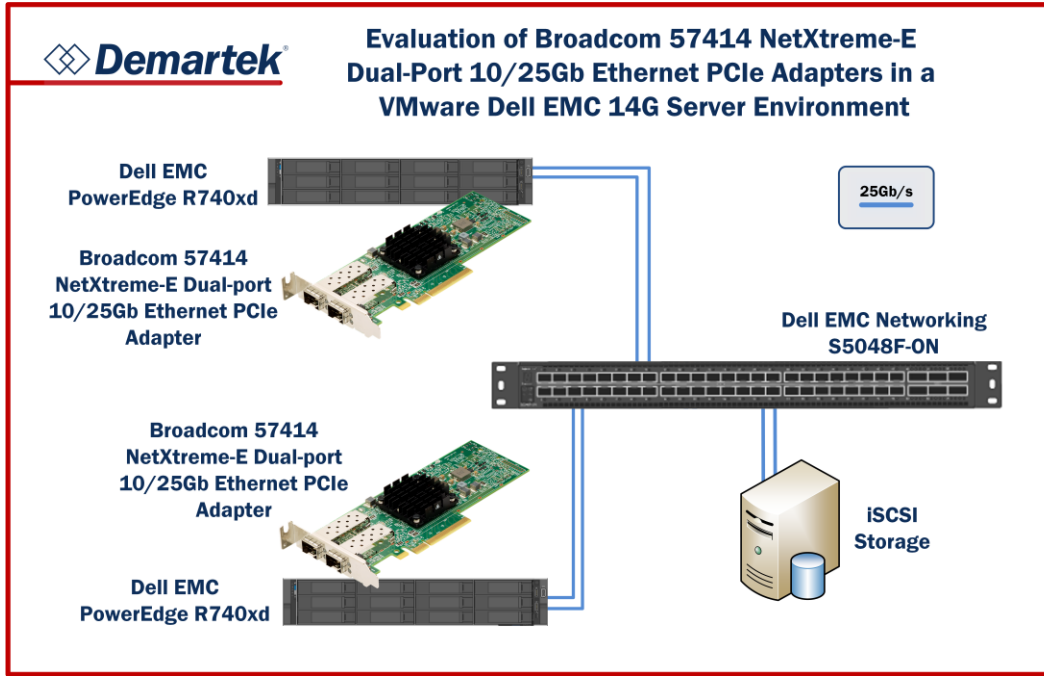
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Servers – Dell PowerEdge R740xd

> 2x Intel Xeon Gold 6130, 2.1GHz, 32 total cores, 64 total threads

> 192 GB DDR4, 2400 MHz

> VMware vSphere 6.7 A01

Ethernet Adapters

> Broadcom 57414 NetXtreme-E Dual-Port 10/25Gb Ethernet PCIe Adapter

Ethernet Switch

> Dell EMC Networking S5048F-ON

VMs

All VMs are stored on the iSCSI storage target and have Microsoft Windows Server 2016 installed

DVDStore

> 4 CPU

> 32 GB Memory.

> 40GB OS virtual disk, 100GB database virtual disk, 30 GB Log disk

> DVDStore was run with a ramp rate of 10, run time f 120, database size of 50GB, 8 threads, and 50 percent newcustomers

Fileserver

> 4 CPU

> 16GB Memory

> 40 GB OS virtual disk

> 2x Virtual Function SR-IOV to connect to iSCSI storage

> 3 iSCSI LUNs

> Iometer was run with 285 workers split between 3 LUN storage targets, running

512KiB, 80% Read, 100% Random, 70 ms transfer delay, burst length of 1 I/O, for 2 hours

Jetstress

> 4 CPU

> 16 GB Memory

> 40GB OS virtual disk, 120 GB database virtual disk, 10GB log virtual disk

> Jetstress was run with 500 mailboxes, 1 IOPS/mailbox, 200MB mailbox size, thread count of 4, for 2 hours, with one database copy

Webserver

> 4 CPU

> 4 GB Memory

> 40GB OS virtual disk, 120GB data virtual disk

> Iometer was run with 4 workers, each connecting to the same data virtual disk, with 512B, 100% Read, 100% random, burst length of 1 I/O, for 2 hours

Movie Server

> 14 CPU

> 87 GB Memory

> 40GB OS virtual disk

> 2x Virtual Function SR-IOV to connect to iSCSI Storage

> 3 iSCSI LUNs

Movie Client

> 4 CPU

> 87 GB Memory

> 40 GB OS virtual disk

> 60 GB RAMdisk

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Summary and Conclusion

Combining the Dell EMC PowerEdge R740xd with the Broadcom 57414 NetXtreme-E Dual-Port 10/25Gb Ethernet PCIe Adapters running at 25GbE increases VM density and performance, reduces VM migration time, and increases the performance of SMB 3.1.1 workloads such as movie delivery. Upgrading to 25GbE adapters is essential to get full performance out of these servers.

> 8 VMs was the limit where two ports of 10GbE did not suffer from performance degradation. **However, two ports of 25GbE supported 16VMs with little performance degradation**.

> When a 16 VM mixed workload test was performed, there was a **25% overall reduction in latency** and a **31% overall increase in work performed** when moving from two ports of 10GbE to two ports of 25GbE.

> 25GbE supported **45% faster VM migration** than 10GbE.

> 25GbE supported **38% faster movie delivery** via file copy than 10GbE.