



Mellanox, HPE, and Micron Demonstrate Next Gen All-Flash Datacenter Storage: Storage Spaces Direct at 1.2 Terabit/sec

Mellanox, HPE and Micron collaborated to break a datacenter speed barrier: the first public demonstration of Windows Server 2016 Datacenter Storage Spaces Direct achieving 1.2 Tb/second on a twelve node cluster. The team leveraged HP ProLiant DL380 Gen9 servers, Micron's NVMe SSDs, and Mellanox's end-to-end RoCE (RDMA over Converged Ethernet) solution to showcase world-class data throughput, sustaining a level of performance between applications and storage that opens new possibilities.

Microsoft Ignite

"High-speed storage in hyper-converged solutions is critical to capitalizing on the performance benefits of NVMe SSDs. Collaborating across networking, software, and storage leaders is an essential part of delivering optimized next-generation solutions. Customers needing the extreme performance of an all NVMe SSD storage tier can leverage this kind of performance for their real-world workloads."

Eric Endebrock
VP of Storage Solutions, Micron

Storage Spaces Evolution

Microsoft continues to deliver on their Software Defined Storage (SDS) features with Windows Server 2016 Datacenter Storage Spaces Direct (S2D) which enables building highly available and scalable storage systems using industry-standard servers with internal drives. This leap forward in Windows Server SDS simplifies the deployment and management of SDS systems and unlocks types of disk devices previously not available in clustered Storage Spaces, including NVMe SSDs and SATA SSDs. It also uses RDMA enabled networking to provide lower storage IO latency and is significantly more CPU efficient.

The Demonstration

Using HPE ProLiant DL380 G9 Servers equipped with Micron 9100 MAX 2.4TB NVMe SSDs and Mellanox ConnectX-4 100Gb/s RoCE adapters connected by Mellanox Spectrum Switch and LinkX cables, and Windows Server 2016 Datacenter, the demonstration highlights the extreme performance and scalability of Storage Spaces Direct. Using a 12 node Storage Spaces Direct and Hyper-V cluster the team demonstrated 1.2Tib/sec of sustained throughput across the entire cluster using DiskSpd VMFleet*. All storage requests were generated from Windows Server 2016 Server Core guest machines running in the Hyper-V cluster, a total of 336 VMs with 28 VMs per node.

* DiskSpd and VM Fleet are available as Open Source at <https://github.com/microsoft/diskspd>. DiskSpd is also available as a binary download from Microsoft at <http://aka.ms/diskspd>

Enabling New Possibilities

Extreme Performance, Extreme Scale

1.2Tb/s opens a new world of options by combining Mellanox 100Gb/s RoCE adapters, Spectrum switch, LinkX cabling with Micron 9100 NVMe SSDs and HP DL380 G9 servers running Microsoft Windows Server Datacenter Storage Spaces Direct. Equip your next data-center with unparalleled capability from class leading performance to extreme scale out capacity – with one of the most capable and flexible hyper-converged infrastructures you can easily handle extremely diverse workloads and manage unfore-casted demand

Better Windows Server 2016 SDS

RDMA, State of the Art Fabrics and the simplicity of Storage Spaces Direct – unlock Windows SDS features to run better and faster than ever. Leverage 100GbE adapters, switches and cables to take full advantage of NVMe SSDs in HP standard servers and better use all the features of Windows Server 2016 SDS (like Scale-out File Server, Clustered Shared Volume File System (CSVFS), Resilient File System (ReFS), Storage Spaces and Failover Clustering)

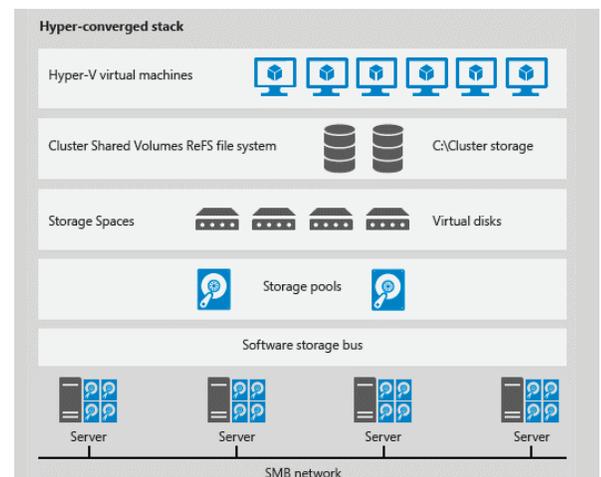


Figure 1. Microsoft's Hyper-converged Solutions Architecture

Stellar Results

With 1.2Tb/sec of sustained storage traffic running across the cluster, each node in the cluster consumed only 25% of available CPU capacity leaving plenty of power to perform additional computer tasks.

Direct Performance and Value

The Storage Spaces Direct stack seamlessly integrates with the Windows Server SDS features you know today including the Scale-Out File Server, Clustered Shared Volume File System (CSVFS), Resilient File System (ReFS), Storage Spaces and Failover Clustering. Micron NVMe SSD technologies eliminate storage bottlenecks. Mellanox end-to-end 100GbE solutions, which include the Spectrum switch, ConnectX-4 adapters and LinkX cables, deliver 100Gib/sec RDMA throughput. Leveraging Microsoft's Windows Server 2016 Datacenter Storage Spaces Direct over HP, Micron and Mellanox products demonstrated the highest Hyper-converged solution performance at the best efficiency.

The Configuration

We used HPE DL380 G9 servers to create our hyper-converged configuration. Each DL380 G9 was equipped with four Micron 9100 MAX 2.4TB NVME SSDs and 2 Mellanox ConnectX-4 100Gb/s RoCE adapters - all connected by a Mellanox Spectrum 100GbE switch and LinkX copper cables. This combination delivered the highest performance, flexibility, and reliability for hyper-converged-based hyper-scale platforms. We assembled the cluster at the Mellanox Sunnyvale, California lab. Mellanox, Microsoft, HP and Micron teams setup and configured the cluster using new Power Shell commands that streamline the process of creating and validating a large hyper-converged cluster. The result is a high performance SDS solution and hyper-converged powerhouse.

CSV FS	IOPS	Reads	Writes	BW (MB/s)	Read
Total	304,428	304,411	17	159,328	159,327
ignite1	26,680	26,678	1	13,734	13,734
ignite10	22,345	22,342	2	11,714	11,714
ignite11	28,452	28,450	2	14,897	14,897
ignite12	26,028	26,028	1	13,646	13,646
ignite2	23,857	23,856	1	12,507	12,507
ignite3	23,257	23,256	1	12,193	12,193
ignite4	29,391	29,390	1	15,409	15,409
ignite5	23,180	23,177	2	12,152	12,152
ignite6	24,177	24,175	2	12,675	12,675
ignite7	24,058	24,056	2	12,612	12,612
ignite8	26,823	26,822	1	14,062	14,062
ignite9	26,182	26,181	1	13,726	13,726

Figure 2. Twelve-Node Cluster Performance

Our joint Windows Server 2016 demonstration simulates application and user workloads using DiskSpd and VM Fleet* across a 12 node cluster using Storage Spaces Direct, Hyper-V, Windows Clustering, local high performance NVMe SSD storage and 100GbE RoCE eliminating complex and costly external shared storage requirements from Windows Server 2016 SDS solutions. The demonstration used DiskSpd to generate 512KiB read requests from each of the 336 Windows Server 2016 Server Core VMs in the cluster, controlled by VM Fleet.

About Mellanox

Mellanox Technologies (NASDAQ: MLNX) is a leading supplier of end-to-end InfiniBand and Ethernet interconnect solutions and services for servers and storage. Mellanox interconnect solutions increase data center efficiency by providing the highest throughput and lowest latency, delivering data faster to applications and unlocking system performance capability. Mellanox offers a choice of fast interconnect products: adapters, switches, software and silicon that accelerate application runtime and maximize business results for a wide range of markets including high performance computing, enterprise data centers, Web 2.0, cloud, storage and financial services. More information is available at www.mellanox.com.

About Micron

Micron Technology is a global leader in the semiconductor industry. For more than 35 years, Micron has dedicated itself to collaborating with customers and partners to engineer technology that drives innovation and transforms what's possible. Micron offers the industry's broadest portfolio of silicon-to-semiconductor solutions—starting with foundational DRAM, NAND, and NOR Flash memory, and extending to SSDs, modules, MCPs, HMCs, and other semiconductor systems. This best-in-class technology powers leading-edge computing, enterprise server and storage, networking, embedded, automotive, industrial, and mobile products. As the only U.S.-based DRAM manufacturer, Micron leverages an expansive global footprint and proven technology leadership to make it easier for customers to try new things and gain competitive advantages in their markets. More information is available at www.micron.com.

About Hewlett Packard Enterprise (HPE)

Hewlett Packard Enterprise Company is a provider of technology solutions. The Company operates through five segments: Enterprise Group, Software, Enterprise Services, Financial Services and Corporate Investments. The Enterprise Group segment provides its customers with the technology infrastructure they need to optimize traditional information technology (IT). The Software segment allows its customers to automate IT operations to simplify, accelerate and secure business processes and drives the analytics that turn raw data into actionable knowledge. The Enterprise Services segment brings all of its solutions together through its consulting and support professionals. The Financial Services segment enables flexible IT consumption models, financial architectures and customized investment solutions for its customers. The Corporate Investments segment includes Hewlett Packard Labs and certain business incubation projects, among others. The Company's customers range from small and medium-sized businesses (SMBs) to large global enterprises. More information is available at www.hpe.com.



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