Technical Research Report

PROWESS

How Do Dell™ PowerEdge™ Servers Perform for Networking Workloads at the Edge?

Prowess Consulting conducted a series of benchmarking tests on Dell PowerEdge servers to see how well they deliver edge network performance for communications service providers (CoSPs) and other industries.

Executive Summary

Many industries are in the process of moving workloads to the edge to increase operations, performance, and service. However, operating networks at the edge requires servers that conform to unique size constraints, can withstand extreme conditions, and operate reliably with little intervention.

Prowess evaluated the Dell™ PowerEdge™ XR11 server and the Dell PowerEdge XR12 server to test network performance and input/output operations per second (IOPS).

Through benchmark testing, Prowess found that Dell PowerEdge XR11 and Dell PowerEdge XR12 server clusters delivered these results:

- **Up to 23.4 gigabytes/second (GBps) of data** over Transmission Control Protocol (TCP) on the Dell PowerEdge XR11 server using the iPerf® network benchmarking tool
- **Up to 1.05 megabits/second (Mbps) of data** over User Datagram Protocol (UDP) with **low packet loss** (up to 0.012) for 5,432 data packets per second on both the Dell PowerEdge XR11 and Dell PowerEdge XR12 servers[1]
- **Up to 767,147 (10 percent) more new orders per minute (NOPM)** for Microsoft® SQL Server® workloads with remote direct access memory (RDMA) enabled on both the Dell PowerEdge XR11 and Dell PowerEdge XR12 servers[1]
- **Up to 33x better read/write IOPS** with RDMA enabled on both the Dell PowerEdge XR11 and Dell PowerEdge XR12 servers[1]

This technical research report details the findings of our testing and analysis.

Introduction

Moving networks to the edge—that is, as close to the point of request as possible—provides many benefits to organizations in retail, manufacturing, healthcare, telecommunications, and other industries. When these businesses offer apps and services at the edge, they can reduce application latency, improve operations, and enhance the customer experience. The overall impact can be a game changer. For instance, healthcare companies can deliver patient services at the point of contact more efficiently, customer service teams can react and resolve issues more quickly, and manufacturers can increase agility and efficiency on the factory floor while reducing costs and downtime.

Edge computing isn't new; many processes have relied on localized computing for decades. What is new, however, is the idea of creating edge networks that can integrate with the rest of the business. These networks are becoming ubiquitous. As a result, many organizations are actively seeking ways to modernize and enable their edge networks, both for existing operations and for new initiatives. Some are currently in the process of moving workloads and services out of their core networks and data centers and closer to data-ingestion points. Others are still in the planning phase. No matter where a company is in its journey, however, edge computing—and therefore edge networking—remains key to experiencing continued competitive advantage and revenue generation in new markets.

Investigating Workload Performance on Edge Servers

Operating networks at the edge can provide its own set of challenges, including choosing the right servers. What might be appropriate for data centers might not be the best choice for an edge scenario. For instance, servers at the edge need to be able to withstand potentially harsh conditions, whether on a factory floor or in a remote telecommunications (telco) outpost. These servers also need to be reliable because they might be completely unattended for long periods of time.

Prowess engineers looked at two different rugged rack-mount servers from Dell Technologies to see how they could handle edge workloads:

- Dell PowerEdge XR11, a 1U rack-mount server
- Dell PowerEdge XR12, a 2U version that offers more room for greater storage or add-on cards

We chose Dell Technologies servers because of Dell Technologies' leadership in the industry, including its 5G converged-core portfolio, multi-access edge computing (MEC), and private wireless solutions. Both the Dell PowerEdge XR11 and the Dell PowerEdge XR12 servers are available with a range of Intel® Xeon® Scalable processors to meet a range of edge and telco workload needs.

For this testing project, we opted for servers using 3rd Gen Intel Xeon Gold processors.

Table 1 | Test system configurations

System	Dell™ PowerEdge™ XR11 server (1U) and Dell™ PowerEdge™ XR12 server (2U)
CPU	One Intel® Xeon® Gold 5318N processor
Cores/threads	24/48
Frequency (base/SCT/MCT)	2.1 GHz/3.4 GHz
Storage controller 1 disk	Dell™ Boot Optimized Server Storage (BOSS)-S1 (Embedded) and 2 x Micron® MTFDDAV240TDU, 240 GB
Storage controller 2 disk	PCIe® solid-state drive (SSD) backplane 0 1 x Dell™ Enterprise NVM Express® (NVMe®) P5800x WI U.2, 400 GB 3 x Dell™ Enterprise NVMe® P5500 RI U.2, 1.92 TB
Memory	8 x Micron® 18ASF4G72PDZ-3G2E1, 256 GB, 2,666 megatransfers per second (MT/s) (max 3,200 MT/s)
Network adapter 1	Broadcom® BCM57504 4 x 25G SFP28 PCIe®
Network adapter 2	Broadcom® NetXtreme®-E P425D BCM57504 4x25G SFP28 PCIe®
Operating system	VMware ESXi™ 7.0.3

Prowess Testing

Testing was completed in two phases: one to test network throughput on iPerf, and a second on virtual machines (VMs) on VMware vSAN™ running database workloads.

iPerf®

Prowess tested network performance using iPerf, a benchmarking tool that measures the maximum achievable bandwidth on IP networks. The iPerf tool provides metrics on bandwidth, data loss, and other parameters.

We downloaded and installed iPerf 3 on two Dell PowerEdge servers—one client and one server—running the Ubuntu® 20.04 operating system (OS). We first ran a Transmission Control Protocol (TCP) workload on both servers, then a User Datagram Protocol (UDP) workload, and we captured the results (see Table 1).

TCP and UDP are commonly used network protocols by which devices communicate or send information to each other. Unlike other protocols (such as FTP, SMTP, and HTTP), TCP and UDP protocols are used by devices to communicate over the internet. TCP is typically represented in discrete units called "packets," while UDP units are expressed as "datagrams." The TCP and UDP protocols can be measured in gigabytes or megabits per second, respectively, which are referred to as the "bitrate." UDP also captures "jitter," which is the variation in datagram/packet delay or loss due to poor network performance.

Table 2 | iPerf® network benchmarking results[1]

Dell™ PowerEdge™ XR11 and Dell™ PowerEdge™ XR12 server network performance	
TCP test	
Bandwidth (GB)	25
Interval	10 seconds
TCP transfer (GB)	27.3
TCP bitrate (GBps)	23.5
UDP test	
Datagrams (units of data being transferred)	5,432
Interval	60 seconds
UDP transfer (KB)	7.5
UDP bitrate (Mbps)	1.05
Jitter (lost packets)	0.012

VMs on VMware vSAN™

Prowess then tested performance on multiple VMs to mimic a real-world edge networking scenario. This phase of testing was performed on a Dell PowerEdge XR11 vSAN cluster of three nodes and a Dell PowerEdge XR12 vSAN cluster of three nodes. VMware vSAN is hyperconverged infrastructure (HCI) software that allows organizations to adopt a cloud operating model for speed, agility, and cost savings. It is the storage component of VMware's virtualized technology stack that helps businesses scale from as few as two nodes to as many as 64 nodes in a virtualized cluster using a subscription model.

We ran a Microsoft SQL Server workload on both clusters to measure IOPS using HammerDB. HammerDB is a leading benchmarking and load-testing software solution for popular databases, including SQL Server. We tested the SQL Server workloads with RDMA on and then with RDMA off.

Turning RDMA on enables direct memory access from one computer to another without involving the processor, cache, or OS. Because data is transferred without burdening the CPU, RDMA can provide a faster, more efficient way to move data at lower-latency CPU utilization levels.

This phase of testing followed the same step-by-step procedure:

1. Conduct baseline testing and set up the VM.
2. Deploy the workload.
3. Run the workload three times.
4. Gather, review, and validate the test results.

See the related Methodology Report for a detailed description of each test run.

Results

Because both the Dell PowerEdge XR11 and Dell PowerEdge XR12 servers were nearly identical in configuration, we are providing results for only the Dell PowerEdge XR11 server in this report.

Figure 1 shows that RDMA made a significant difference of up to 10 percent more new orders per minute (NOPM) across three groups of virtual users. NOPM represents database transactions and is used to measure and compare throughput among different databases. In our testing project, we compared the performance between three different sizes of databases.

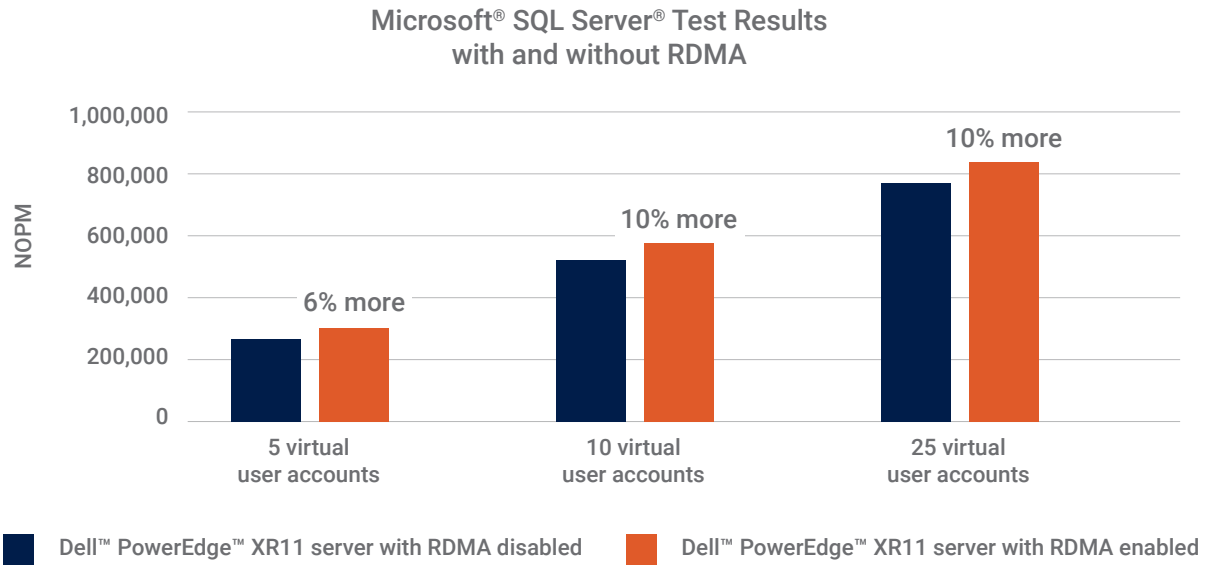

Figure 1 | Microsoft® SQL Server® database workload results on Dell™ PowerEdge™ XR11 server nodes

Figure 2 shows that the Dell PowerEdge XR11 server with RDMA enabled delivered more read IOPS and write IOPS across three different virtual user group sizes. IOPS is the standard unit of measurement for the maximum number of reads and writes to storage. It typically characterizes performance in SSDs or hard disk drives (HDDs), but in this project, it indicates virtual storage area network (VSAN) performance.

Read-heavy workloads indicate how quickly the servers can retrieve information from their disks. Write-heavy workloads show how quickly the servers can commit or save data to the disks. Seeing how each server performed with these different data-intensive workloads helps us understand how they could handle workloads of different block sizes.

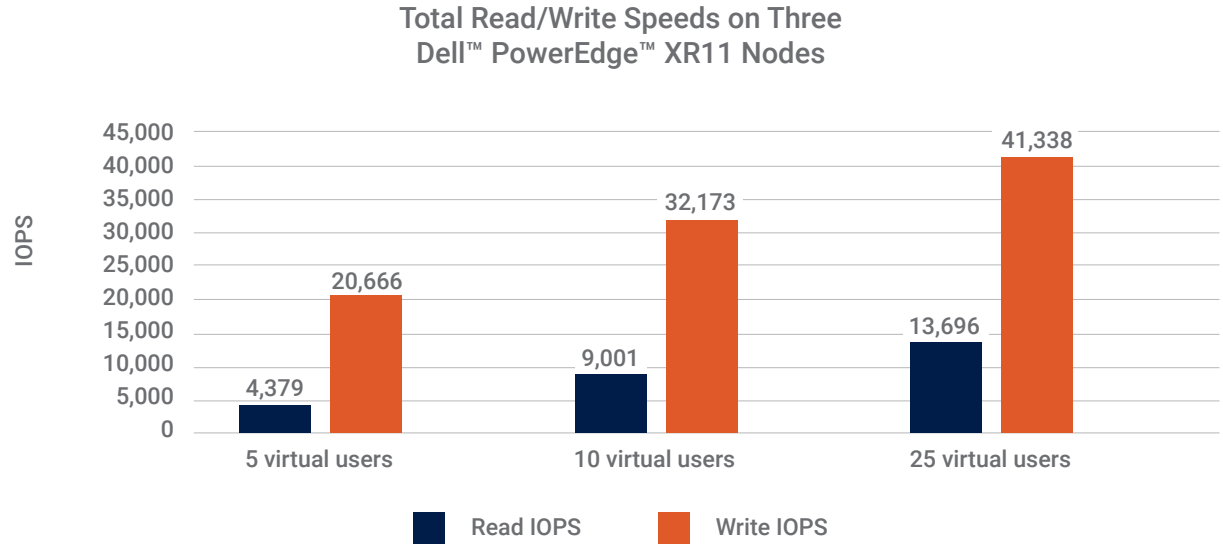

Figure 2 | Read and write IOPS on three Dell™ PowerEdge™ XR11 VMware vSAN™ nodes

Analysis

Overall, the Prowess engineers found that the Dell PowerEdge XR11 and Dell PowerEdge XR12 nodes performed well in both phases of testing. iPerf benchmarking results showed high network throughput for both TCP and UDP workloads, with low jitter. This performance is key for edge deployments that need to process and transfer large amounts of data in a wide variety of use cases, such as databases, digital streaming content, and high-resolution medical images.

The servers also provided high-performance data transfer rates on vSAN clusters. As seen in the HammerDB test results, clusters with RDMA enabled performed better than those with RDMA disabled. RDMA allows systems to bypass the CPU and send data with lower latency and compute overhead. This results in improved storage performance.

Other features of Dell PowerEdge servers help support the needs of businesses in large industries, such as CoSPs. In moving compute infrastructure to the edge, many CoSPs are looking to use new technologies, such as Open RAN (ORAN), that give them more options for deploying network infrastructure to support future growth.

A large, geographically distributed, open-compute deployment can be difficult to set up and manage. Using Dell Technologies™ Bare Metal Orchestrator, CoSPs can automate the deployment and management of hundreds of thousands of servers across wide-ranging geographic locations to support ORAN and 5G deployments. Tools such as Bare Metal Orchestrator can simplify the configuration and provisioning of ORAN technologies, reducing the time it takes to bring network hardware into a workload-ready state.

About Dell™ PowerEdge™ Servers

Dell™ PowerEdge™ XR11 and Dell PowerEdge XR12 servers are designed specifically for use outside of the traditional data center, and we found that they are well-suited for enterprise-level edge deployments. They are designed for compact spaces—such as in remote field cabinets or vehicles, or under counters—making them suitable for telco, manufacturing, and retail scenarios.

These servers' compact size—less than 16 inches deep—creates a layout advantage so that the processor, memory, and PCI cards receive ambient-temperature air. As a result, both servers can continuously operate in extreme temperature environments ranging from –5° to 55° Celsius.

The Dell PowerEdge XR11 and Dell PowerEdge XR12 servers are also designed to withstand vibration and seismic events up to military levels, with features such as 13-gauge steel rack ears, individual PCI card retention, and rugged retention of hard drives and power supplies. The Dell PowerEdge XR12 server provides added protection against dust, with air filtration and a filter that can be serviced without tools.

Dell PowerEdge servers are powered by 3rd Gen Intel® Xeon® Scalable processors, which provide a balanced architecture that delivers built-in acceleration and advanced security capabilities. The processors are optimized for cloud, enterprise, high-performance computing (HPC), network, security, and Internet of Things (IoT) workloads with 8–40 powerful cores and a wide range of frequency, feature, and power levels for optimal performance.

In 2021, VMware updated VMware vSAN™ with RDMA support for clusters configured for RDMA-based networking. Dell PowerEdge servers can be preconfigured with Dell vSAN Ready Nodes that feature validated building blocks that ease deployment and storage scaling.

Dell Technologies is currently testing and demonstrating Dell PowerEdge XR11 and Dell PowerEdge XR12 servers for various real-world usages. In September 2022, Dell launched its Tactical VMware platform in partnership with Tracewell Systems and VMware. The system, based on the Dell PowerEdge XR11 server, runs the VMware® Edge Compute Stack (ECS).

Conclusion

Edge networking will continue to evolve, especially as industries such as manufacturing and telco push to innovate with 5G, IoT, and other edge use cases. Prowess's testing demonstrates that the Dell PowerEdge XR11 and Dell PowerEdge XR12 servers can perform well under these demands. With RDMA enabled, data transfers on virtual networks can be done more efficiently, with fast data movement between servers and storage, and without using the OS or burdening the server's CPU.

Get more information on Dell PowerEdge XR11 and PowerEdge XR12 servers:

- PowerEdge XR11 server
- PowerEdge XR12 server

[1] The Dell™ PowerEdge™ XR11 and Dell PowerEdge XR12 servers delivered nearly identical results.