Project Name: Satellite and weather information for disaster resilience in Africa

Employer: African Centre of Meteorological Applications for Development (ACMAD)

Technical Write up – High performance computing (HPC) system for the African Centre of Meteorological Applications for Development (ACMAD)

Dear Sirs,

In this digital economy, organizations like ACMAD Niger are looking to technology as a competitive differentiator in driving higher engagement with customers, enabling new business models and staying ahead of the competition. Chief Information Officers (CIOs) are at the core of the transformation agenda, balancing between operational efficiency and forward-thinking projects. In both instances, servers are the bedrock of the modern software-defined data center and the key to building a flexible, efficient and cloud-enabled infrastructure.

Some of the business challenges and requirements that you may be facing in transforming your data center include:

- Your data center requires a faster, denser database solution with software-defined storage nodes
- You need to accelerate application performance with faster response times to ensure customer satisfaction and drive the success of your business
- You need to expand concurrent users without increasing the datacenter footprint
- Your SQL servers require NVMe and NVDIMM capability
- You have an increasing demand for faster application performance and platform expandability to accommodate growth
- You are experiencing continued challenges with operational factors and capital cost containment
- Your traditional deployment predominates, although you have an increasing interest in cloud deployment models (public, hybrid, and private cloud)

The Dell EMC PowerEdge R640 and R740 can provide your business a competitive edge by lowering operating costs in the traditional environment, while simultaneously increasing operational velocity in the new application environment. It helps meet the reliability, cost, and security requirements of traditional workloads and also helps meet the agility, flexibility, and fluidity requirements of applications driven by today's digital economy. PowerEdge R640 provides you with a secure, efficient and scalable IT infrastructure that helps drive your workloads and business forward.

The PowerEdge R640 is the ideal dual-socket, 1U platform for dense scale-out data center computing. With up to 8 NVMe drives, 1.5TB of memory and the ability to mix 2.5" and 3.5" drives, the PowerEdge R640 can easily adapt to your application demands. PowerEdge R640 combines density, performance and scalability to optimize application performance and data center density.

In the proposal that follows, we will tell you more about the offered HPC cluster solution from Dell EMC PowerEdge R640 server and how it provides a scalable business architecture, intelligent automation and integrated security for your workloads from traditional applications and virtualization to cloud-native workloads.

Intertech Group will partner with you every step of the way as you acquire, deploy, and manage your infrastructure. Additionally, SAWIDRA Niger will benefit from the full breadth of Intertech Group expertise, experience, and services capabilities that together help you leverage the full value of your information

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1 Business Needs and Requirements

The overall objective of the SAWIDRA project of which this acquisition will be a part is as follows: to improve the core capacities of the specialized national and regional climate centres (RCCs) to meet the needs of DRM agencies and socio-economic sectors for effective use of weather and climate services and community-focused and real-time early warning systems (EWS).

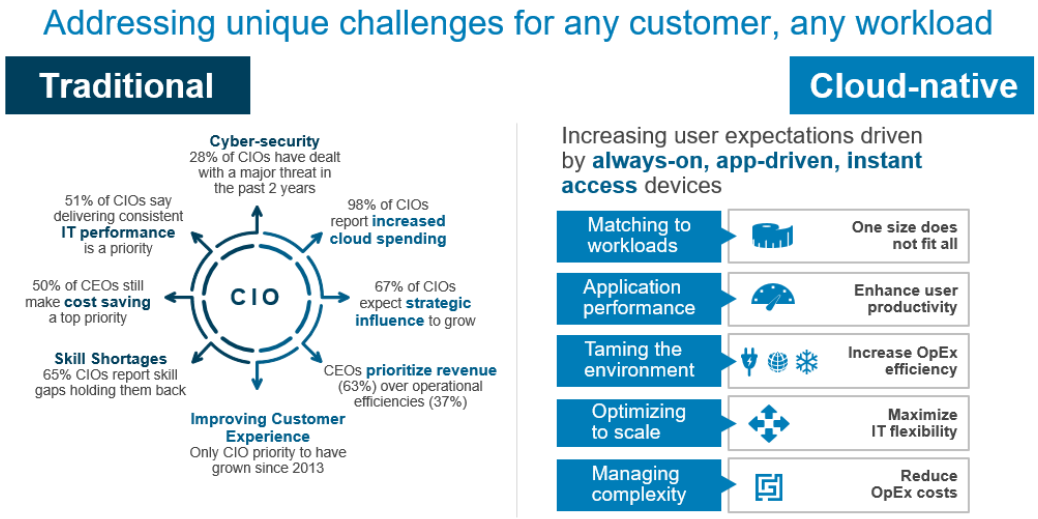
The specific objective is to improve the forecast and weather information production capacity of regional climate centers and national meteorological services in order to allow them to provide the proper inputs to the DRM agencies for their issuing of early warnings.

The approach is to have one continental SAWIDRA project and four regional projects, one each in East, West, Central and Southern Africa. The continental project is implemented by ACMAD and will benefit all African regions and coordinates activities with continental and regional stakeholders. The regional projects seek to improve regional and national capacities in using improved weather prediction modeling and use the output of these models as input into early warning systems, in close cooperation with disaster risk management agencies.

ACMAD runs the continental model at a relatively coarse resolution (less than or equal to 9km horizontal resolution) with data assimilation of both polar orbiting satellite data and appropriate in situ data and generates initial conditions for the Regional Implementation Centres (RICs) to use to drive their model at relatively high resolution (~3km horizontal resolution), i.e. convective permitting scales.

As part of the SAWIDRA project, to support the Regional Climate Centers (RCCs) and National Meteorological Services in Africa to improve the quality of their forecasts at regional and national levels, ACMAD proposes to operate a Numerical Weather Prediction WRF model , limited area, non-hydrostatic, with 6km horizontal resolution, 41 vertical levels, over a domain covering Africa for 5 days forecast in less than 3 hours of integration.

It is in this regard that this Technical Specification is developed for the supply, delivery, installation and commissioning of a High Performance Computing system (HPC).

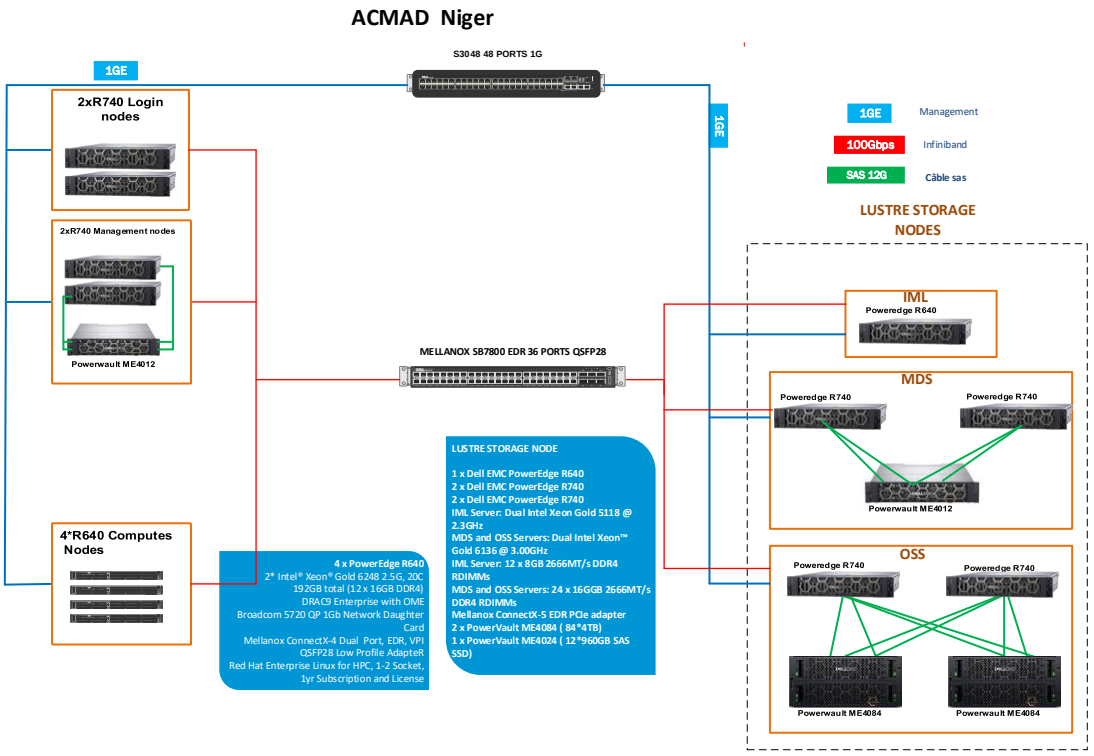


Dell EMC PowerEdge R640 provides your business a competitive edge in lowering operating costs in the traditional environment, while simultaneously increasing operational velocity in the new application environment. It helps meet the reliability, cost, and security requirements of

traditional workloads and also helps meet the agility, flexibility, and fluidity requirements of applications driven by today's digital economy.

In the proposal that follows, we will detail how the Dell EMC PowerEdge R640 provides ACMAD NIGER with an affordable, accessible solution and a flexible design that can help you advance your business processing and decision support for your digital transformation initiatives.

2 Target Architecture



3 Solution environment

Distribution in the rack:

energetic rack consumption

This power is too high for one rack, so we distribute on two cabinets:

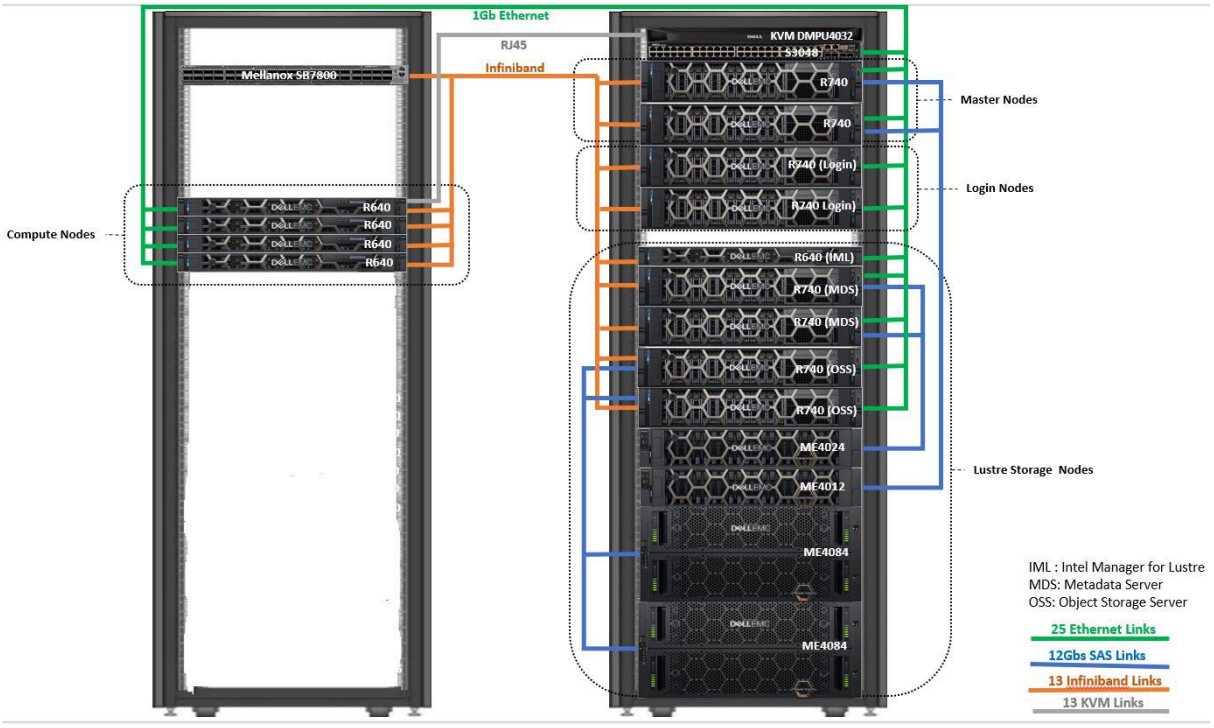
Rack 1

- ✓ 4 computes R640 nodes.
- ✓ Mellanox SB7800, EDR IB2, Managed,36 QSFP28

Rack 2

- ✓ 2 login nodes R740
- ✓ 2 master nodes R740 (ME4112)
- ✓ 1 IML PowerEdge R640
- ✓ 1 Metadata server (2xPoweredge R740 + ME4024)
- ✓ 1 Server Storage Object (2xPoweredge R740 + 2xME4084)
- ✓ S3048

Rack layout schema



4 Performance calculation

Customer's Request

The aggregates nominal peak performance of all compute node to achieve **12 TFlops** and the systems must achieve at least **60% (7.2 TFlops)** of the nominal peak performance, when running the HPL benchmark across all node.

Performance per CPU:

CPU Gold 6248

Peak = 20 Cores X 32 Flops X 2,5 Ghz = 1600 Giga-Flops = 1,6 Tera-Flops

Number of servers for 12 TF:

12 TF / 1,6 TF = 7.5 CPU Gold 6248

Increase to 8 CPU Gold 6248 is 12.8 TF peak

4 R640 with 2 CPU G6248

Raw Performance = 20 Cores X 32 Flops X 2,5 GHz X 8 CPU = **12.8 TF**

Results

After benchmark, we obtain **9,03203TF** with **70.56%** eff.

This is a good result depending on the server setup and the temperature

5 Solution Description

Intertech Group offers a solution based on 5 blocks:

1. Compute nodes
2. Master nodes
3. Login nodes
4. Lustre Storage nodes
5. Switches
6. Software
7. Other accessories

COMPUTES NODES 4 *R640

R640

2* Intel® Xeon® Gold 6248 2.5G, 20C/40T, 10.4GT/s, 27.5M Cache,

192GB total (12 x 16GB DDR4-2666 DIMM/slots)

1* 480GB SSD SATA read intensive 6Gbps 512 2.

DRAC9 Enterprise with OME Server Configuration Management

PERC H330 RAID Controller, Minicard

Broadcom 5720 QP 1Gb Network Daughter Card

2* Mellanox ConnectX-5 Single Port EDR VPI QSFP28 Infiniband Adapter, PCIe Full Height

Dual, Hot-plug, Redundant Power Supply (1+1), 750W

Red Hat Enterprise Linux for HPC, 1-2 Socket, 1yr Subscription and License

1 year

MASTER / SCHEDULER 2*R740

R740

2* Intel Xeon Gold 6134 3.2G, 8C/16T, 10.4GT/s, 24.75M Cache,

192GB Total (12 x 16GB DDR4-2666 DIMM/slots)

2TB 7.2K RPM NLSAS 12Gbps 512n 2.5in Hot-plug Hard Driv

DRAC9 Enterprise with OME Server Configuration Management

PERC H330+ RAID Controller, Adapter, Full Heigh

QLogic 57800 2x10Gb DA/SFP+ + 2x1Gb BT Network Daughter Card + SR Optic

2* Mellanox ConnectX-5 Single Port EDR VPI QSFP28 Infiniband Adapter, PCIe Full Height

SAS 12Gbps HBA External Controller

Dual, Hot-plug, Redundant Power Supply (1+1), 750W

Red Hat Enterprise Linux, 1-2 Socket, 1yr Subscription and License

1 year

+ ME4 (1.8TB *6)

LOGIN 2*R740

R740

2* Intel Xeon Gold 6134 3.2G, 8C/16T, 10.4GT/s, 24.75M Cache,

96GB Total (12 x 8GB DDR4-2666 DIMM/slots)

2TB 7.2K RPM NLSAS 12Gbps 512n 2.5in Hot-plug Hard Driv

DRAC9 Enterprise with OME Server Configuration Management

PERC H330+ RAID Controller, Adapter, Full Heigh

QLogic 57800 2x10Gb DA/SFP+ + 2x1Gb BT Network Daughter Card + SR Optic

2* Mellanox ConnectX-5 Single Port EDR VPI QSFP28 Infiniband Adapter, PCIe Full Height

Dual, Hot-plug, Redundant Power Supply (1+1), 750W

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1 year

STORAGE NODE IML +METADA SERVERS + OBJECT STORAGE SERVERS

IML server model	1 x Dell EMC PowerEdge R640
Metadata Servers (MDS)	2 x Dell EMC PowerEdge R740
Object Storage Servers (OSS)	2 x Dell EMC PowerEdge R740
Processor	IML Server: Dual Intel Xeon Gold 5118 @ 2.3GHz
	MDS and OSS Servers: Dual Intel Xeon™ Gold 6136 @ 3.00GHz
Memory	IML Server: 12 x 8GB 2666MT/s DDR4 RDIMMs
	MDS and OSS Servers: 24 x 16GiB 2666MT/s DDR4 RDIMMs
InfiniBand HCA	Mellanox ConnectX-5 EDR PCIe adapter
External storage controller	2 x Dell 12Gbps SAS HBAs (on each MDS)
	2 x Dell 12Gbps SAS HBAs (on each OSS)
Object Storage Enclosure	2 x PowerVault ME4084 enclosures fully populated with a total of 84 drives de 4TB
Metadata Storage Enclosure	1 x PowerVault ME4024 enclosure with 12*960GB SAS SSD

RAID controllers	Duplex RAID controllers in the ME4084 and ME4024 enclosures
Lustre File system	Lustre v.2.10.4

Red Hat Enterprise Linux, 1-2 Socket, 1yr Subscription and License

1 year

Mellanox SB7800, EDR IB2, Managed,36 QSFP28 ports,1U,2xPSU, Ports to PSU airflow +
use 25 ports. Provide 25 cables 3M (for expansion)

S3048-ON, 48x 1GbE, 4x SFP+ 10GbE ports, Stacking, IO to PSU air, 1x AC PSU, DNOS 9
Software, Rights to use L3 on OS9, S3048-ON

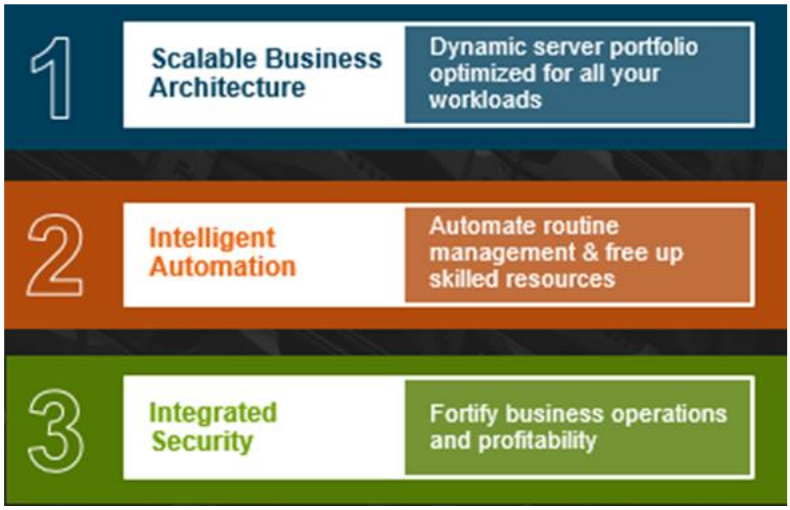
25 C2G - Cat6 Ethernet (RJ-45) UTP - blue - 3m (for expansion)

Dell EMC PowerEdge servers provide a scalable business architecture, intelligent automation and integrated security for your workloads from traditional applications and virtualization to cloud-native workloads. PowerEdge servers also incorporate the embedded efficiencies of OpenManage systems management that enable IT experts to focus more time on strategic business objectives and spend less time on routine IT tasks. With open standards-based, x86 platforms, the PowerEdge portfolio of Rack server infrastructure can help you quickly scale from the data center to the cloud.

The PowerEdge R640 is a dual-socket, 1U platform for dense scale-out data center computing. The PowerEdge R640 combines density, performance and scalability to optimize application performance and data center density.

The PowerEdge R640 enables you to:

- Adapt and scale your dynamic business needs by leveraging Scalable Business Architecture
- Free up skilled resources and focus on core business with Intelligent Automation
- Protect your customers and your business robustly with Integrated Security



5.1.1 Maximize application performance and density

The scalable business architecture of the PowerEdge R640 is designed to maximize application performance and provide the flexibility to optimize configurations based on the application and use case. With the PowerEdge R640 you can create an NVMe cache pool and use either 2.5” or 3.5” drives for data storage. Combined with up

to 24 DIMM's, 12 of which can be NVDIMM's, you have the resources to create the optimum configuration to maximize application performance with the optimum configuration in only a 1U chassis.

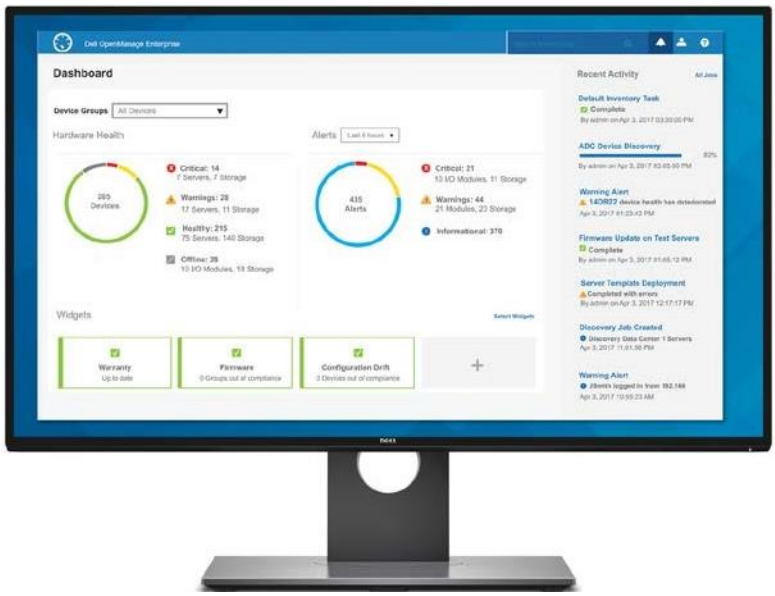
- Simplify deployments and speed deployments with Dell EMC ready nodes for ScaleIO and VSAN.
- Maximize storage performance with up to 8 NVMe drives or 12 2.5" drives.
- Scale compute resources with Intel Xeon SP delivering a 27% increase in processing cores and 50% increase in bandwidth over previous generation Xeon processors.

5.1.2 Automate maintenance with Dell EMC OpenManage

The Dell EMC OpenManage portfolio helps deliver peak efficiency for PowerEdge servers, delivering intelligent, automated management of routine tasks. Combined with unique agent-free management capabilities, the R640 is simply managed, freeing up time for high profile projects.

OpenManage Enterprise simplifies, centralizes and automates the full span of server lifecycle management activities – discovery, configuration, deployment, updates, and remediation – within a single console that manages PowerEdge rack platforms. OpenManage Enterprise assists in standardizing and supporting your IT management policies and practices.

At Dell EMC, our mandate to IT professionals is clear: Make infrastructure management simple, centralized and automated to enable you to work on IT management tasks that drive more value for your business and for your customers.



OpenManage Enterprise Systems Management

Benefits for the next-generation OpenManage Enterprise systems management console are listed as following:

- Simplify management with the New OpenManage Enterprise console, with customized reporting and automatic discovery.
- Take advantage of QuickSync 2 capabilities and gain access to your servers easily through your phone or tablet.

- Reduce the time and effort required to manage small and large scale IT environments.
- Provide a single management layer for managing PowerEdge rack platforms.
- Deploy as a virtual appliance supporting ESXi, Hyper-V and KVM environments.
- Optimize IT operations and requires minimal training through use of an intuitive dashboard and elastic search engine.
- Integrate with OpenManage Mobile enabling anytime, anywhere notification of data center.

5.1.3 Guard your data center with built in security

Every PowerEdge server is designed as part of a cyber-resilient architecture, integrating security into the full server lifecycle. The R640 leverages new security features built-into every new PowerEdge server strengthening protection so you can reliably and securely deliver accurate data to your customers no matter where they are. By considering each aspect of system security, from design to retirement, Dell EMC ensures trust and delivers a worry-free, secure infrastructure without compromise.

- Rely on a secure component supply chain to ensure protection from factory to the data center Quick Sync 2 for secure, wireless management in the data center.
- Maintain data safety with cryptographically signed firmware packages and Secure Boot.
- Prevent unauthorized or malicious change with Server Lockdown.
- Wipe all data from storage media including hard drives, SSDs and system memory quickly and securely with System Erase.

5.1.4 PowerEdge R640 Features and Technical Specifications

PowerEdge R640	
Processor	Up to two Intel Xeon Scalable Processors, up to 28 cores per processor
Memory	24 DDR4 DIMM slots, Supports RDIMM /LRDIMM, speeds up to 2666MT/s, 1.5TB max Up to 12 NVDIMM, 192 GB Max Supports registered ECC DDR4 DIMMs only
Storage controllers	Internal controllers: PERC H330, H730p, H740p, HBA330, Software RAID (SWRAID) S140 Boot Optimized Storage Subsystem: HWRAID 2 x M.2 SSDs 120GB, 240 GB External PERC (RAID): H840 External HBAs (non-RAID): 12 Gbps SAS HBA
Drive bays	Front drive bays: Up to 10 x 2.5” SAS/SATA (HDD/SSD) with up to 8 NVMe SSD max 58TB or up to 4 x 3.5 SAS/SATA HDD max 40TB Rear drive bays: Up to 2 x 2.5” SAS/SATA (HDD/SSD), NVMe SSD max 12TB Optional DVD-ROM, DVD+RW
Power supplies	Titanium 750W, Platinum 495W, 750W, 1100W, and 1600W 48VDC 1100W, 380HVDC 1100W, 240HVDC 750W Hot plug power supplies with full redundancy option
Dimensions	Form factor: Rack (1U) Chassis depth: 705.05 mm
Embedded management	IPMI 2.0 compliant iDRAC9 with Lifecycle Controller (Express, Enterprise)

	Quick Sync 2 wireless module optional	
Bezel	Optional LCD bezel or security bezel	
OpenManage Software	OpenManage Enterprise OpenManage Essentials OpenManage Mobile OpenManage Power Center	
Integrations and connections	Integrations: Microsoft System Center, VMware vCenter, BMC Software Connections: Nagios & Nagios XI, Oracle Enterprise Manager, HP Operations Manager, IBM Tivoli Netcool/OMNIbus, IBM Tivoli Network Manager, CA Network and Systems Management	
Security	TPM 1.2/2.0 optional Cryptographically signed firmware Secure Boot System Lockdown Secure erase	
I/O & Ports	Network daughter card options 4 x 1GE or 2 x 10GE + 2 x 1GE or 4 x 10GE or 2 x 25GE Front ports: Video, 1 x USB 2.0, available USB 3.0, dedicated IDRAC Direct USB Rear ports: Video, serial, 2 x USB 3.0, dedicated iDRAC network port Video card: VGA, NVIDIA NVS310 available as PCIe card Up to 3 x Gen3 slots, all x16	
Supported operating systems	Canonical Ubuntu LTS Citrix XenServer Microsoft Windows Server with Hyper-V Red Hat Enterprise Linux SUSE Linux Enterprise Server VMware ESXi	For specifications and interoperability details see Dell.com/OSsupport.
OEM-ready version available	From bezel to BIOS to packaging, your servers can look and feel as if they were designed and built by you. For more available information, visit Dell.com/OEM.	
Recommended support	Dell ProSupport Plus for critical systems or Dell ProSupport for premium hardware and software support for your PowerEdge solution. Consulting and deployment offerings are also available. Contact your Dell representative today for more information. Availability and terms of Dell Services vary by region. For more information, visit Dell.com/ServiceDescriptions.	

6 Solution Benefits

Dell EMC brings industry-leading expertise in system design, storage and virtualization together to form a common platform. Only Dell EMC can deliver a consistent and scalable design for any workload, from traditional applications to cloud workloads and converged platforms. Build your vision with a scalable system architecture, intelligent automation and integrated security. Dell EMC PowerEdge servers deliver a worry-free infrastructure that is secure and scalable with no compromises.

Dell EMC can deliver PowerEdge technology at any level of integration – from a best-in-breed platform, to a pre-integrated full turnkey hybrid cloud implementation or any step in-between. Combining PowerEdge server infrastructure with Dell EMC Services and Financial Solutions allows you to transform your data center faster, more affordably and with less risk.

The Dell EMC PowerEdge R640 server provides the ideal combination for dense scale out data center computing and storage in a 1U/2S platform. The PowerEdge R640 enables optimization of application performance, price-performance or performance per watt per U of rack space in most data center environments.

- **Scalable business architecture**: On-demand capacity and performance to meet every core challenge
  - Optimized performance – with no compromises
  - Integrated workload 'boost button'
  - Unlimited scalability to adapt to all workload demands
  - Essential support across the entire system lifecycle with Dell EMC Parts
- **Intelligent automation**: Enhanced server room efficiency with no more amber light patrols
  - Remote deployment in minutes
  - Embedded Support Assist for proactive response
  - Reduced IT administrator involvement by up to 90%
- **Integrated security**: Robust and reliable built-in security throughout the IT lifecycle
  - Security embedded into hardware and firmware
  - Built-in protection from delivery to deployment and updates

6.1.1 New Design Features

- **Improved airflow**: A new streamlined front profile moves air efficiently, optimizing power for application performance.
- **Deliver an intuitive user experience**: Server configuration and monitoring is now possible via a handheld smart device using the Quick Sync feature.
- **Be eco-friendly**: The implementation of hemmed edges as a structural element eliminates the use of paint on our servers, thus helping to further reduce environmental impact.

6.1.2 Product Advantages

- Up to 12 2.5" drives or up 4 x 3.5"
- Up to 8 NVMe PCIe drives, 2X more than R630
- 27% more processing cores and 50% more bandwidth with Xeon SP vs Xeon E5 v4
- Embedded SupportAssist for faster, automated issue diagnosis and remediation
- Cryptographically signed firmware packages and Secure Boot ensures data safety

- Security lockdown that protects your server configuration and firmware (BIOS, iDRAC, & RAID) from malicious changes

6.1.3 PowerEdge R640 Solution Benefits

6.1.3.1 Modernize your data center with a scalable business architecture

A scalable business architecture will help you adapt to your changing business realities and can be fine-tuned to address your specific workloads from traditional infrastructure to software defined, cloud-enabled data centers. As the compute and storage engine for leading solutions like ScaleIO, Microsoft Azure, VMware vSAN, Nutanix and Microsoft Storage Spaces Direct, PowerEdge provides a proven platform for your new technology requirements.

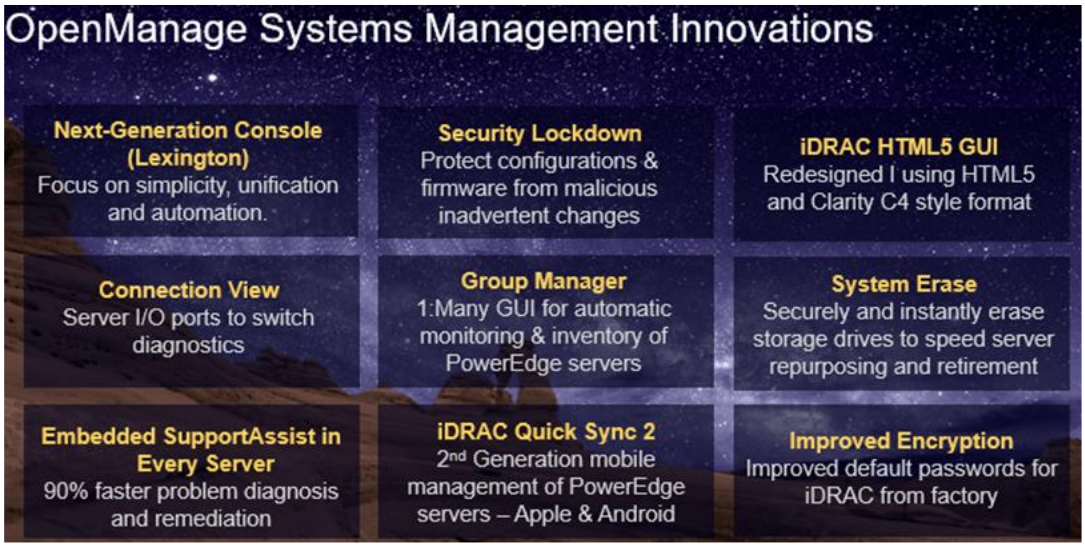
With innovative performance enhancements and new technologies, the latest PowerEdge servers offer Multi-Vector Cooling, enhanced memory speeds, and larger, faster NVMe storage options that all act to increase data center density, performance, and power optimization. Further refinements such as BIOS tuning to match specific workloads provide additional performance gains where every second counts. Additionally, for the first time, PowerEdge now offers a state of the art liquid cooling system available in select platforms.

- Increase application performance and response time: With 19X more Non-Volatile Memory Express (NVMe) low latency storage than the prior generation, Dell EMC leads the industry in driving industry standards in NVMe via Express Flash.
- Get results from PowerEdge faster: One-click BIOS tuning enables quick-and-easy deployment of many processing-intensive workloads.
- Access to right data at the right time: With enhanced storage capacity and flexibility, customers can tailor their storage configurations to their application needs, this is especially critical in a software-defined-storage (SDS) environment.
- Increased GPUs: The ability to support GPUs with storage-dense configurations in certain solutions.
- Support FPGA: The ability of supporting FPGA can be configured in different ways to address the performance needs of unique workloads.
- Broad support for 25Gb networking and remote direct memory access (RDMA).

6.1.3.2 Empower IT with simplicity and intelligent automation

Fast data access, rapid remediation and evolving customer demands require smarter and easier methods to automate repetitive IT management tasks. The OpenManage systems management portfolio simplifies and automates server lifecycle management, assisting your IT staff in building a highly efficient and reliable infrastructure. The agent-free integrated Dell Remote Access Controller (iDRAC), embedded within each PowerEdge server, automates server deployment, configuration, updates and maintenance procedures while the Chassis Management Controller (CMC) efficiently manages servers, storage and networking within PowerEdge modular infrastructure. OpenManage Enterprise, our next-generation console, and the OpenManage Essentials console provide comprehensive management for tower, rack and modular infrastructure in environments of any size.

By adding OpenManage Mobile, you will have at-the-server control and anytime, anywhere access to monitor and manage PowerEdge servers using Android and iOS handheld devices. The simplicity and intelligent automation capabilities of OpenManage are also employed in our integrations for Microsoft System Center and VMware vCenter. ProSupport Plus and SupportAssist, our embedded, automated proactive and predictive support technology, allows you to resolve issues with up to 90% less IT effort.



- Unify the server management experience and provide full data center monitoring: OpenManage Enterprise is a new virtualized enterprise system management console with application plug-ins, an easy-to-use interface and customizable reporting.
- Speed troubleshooting and maximize server uptime: The enhanced iDRAC 9 provides up to 4 times improved performance over the prior generation.
- Enable faster remediation: PowerEdge servers with iDRAC parts replacement capability and ProSupport Plus with Support Assist can reduce time to resolve parts failure by 91%, using up to 21 fewer steps to resolution.
- Improve power efficiency and compute density: Automatic multi-vector cooling enables more GPUs and SSDs in a single configuration increasing up to 50% more users per server, lowering cost per user while delivering a faster response time.
- Connection view: Enables viewing and diagnosing server connections up to the network switch to resolve issues quickly and save money.
- OpenManage PowerCenter: Monitors and enhances power all the way to the virtual machine.

6.1.3.3 Safeguard data with integrated security

Dell EMC provides a comprehensive, cyber-resilient architecture with security embedded into every server to protect your data. Integrating security across hardware and firmware helps minimize potential vulnerabilities and prevent data loss. With a built-in chain of trust to help ensure that only properly signed firmware updates are applied as well as support for secure management protocols such as the iDRAC RESTful API, security is embedded into every PowerEdge server. Once in use, System Lockdown can protect system configuration and firmware from malicious attacks or unauthorized changes. To perform approved updates, OpenManage tools first check file dependencies and sequences, then deploy the correct system updates to help ensure ongoing server availability and integrity. When a PowerEdge server is retired or redeployed, System Erase can ensure data is safely erased from local storage devices (HDD, SSD, NVMe drives).

6.1.3.4 Integrated security protects your business and fortifies business operations and profitability

- Every PowerEdge Server is designed on a Cyber Resilient Architecture (CRA).
- Dell EMC is a trusted partner with end-to-end server ecosystem and lifecycle security.
- Secure manageability protocols save costs in downtime and remediation.

- Prevent unauthorized or inadvertent changes: System Lockdown, an industry-first feature, prevents configuration changes that create security vulnerabilities and expose sensitive data.
- Secure data center through a cyber-resilient architecture: Features such as SecureBoot, BIOS Recovery capabilities, signed firmware and iDRAC RESTful API (compliant with Redfish standards) provide enhanced protection against attacks.
- Ensure privacy: System Erase quickly and securely erases user data from drives or wipes all non-volatile media when a server is retired.

6.1.3.5 Expert Advice On-hand

A modern infrastructure requires reliable IT support and lifecycle services to ensure new technologies are quickly deployed and optimized continuously. Dell EMC can help accelerate your IT and business transformation with our world-class cloud, big data, and technology expertise and services. Our 31,000+ Dell EMC Services experts and 28,000+ services partner professionals, in more than 165 countries around the world, stand ready to serve you.

ProSupport Plus improves the performance and stability of critical systems and workloads with automated technology. You can count on ProDeploy Enterprise Suite experts to lead deployments from basic hardware installations through planning, configuration and complex integrations.

6.1.3.6 Build your modern data center foundation today with Dell EMC PowerEdge

Whether you are operating a global organization or midsized or small company, Dell EMC helps you adjust your solution to deliver the compute, storage and network performance needed to accelerate traditional, software-defined, and cloud workloads in your data center. Talk to your Dell EMC representative about igniting innovation in your data center with PowerEdge servers today.

6.2 Bright cluster

Intertech Group has chosen Bright Cluster Manager to provide infrastructure management technology for its HPC Systems, which enable small and medium-sized enterprises to accelerate their science, engineering and analytics.

Dell EMC HPC Systems are future-ready, flexible solutions that are pre-tested and pre-validated to ensure that they deliver the right research and business outcomes. The Dell EMC Validated Solutions portfolio speeds deployment and simplifies operations and management of solutions for virtualization, OpenStack cloud, big data and analytics, high-performance computing and more, incorporating best-in-class building blocks from Dell EMC and its partners.

Bright technology is included in the Dell EMC HPC Climate System, the Dell EMC HPC for Manufacturing and the Dell EMC System for Research.

Bright cluster offers many benefits like:

- Graphic interface
- Expandable to 10,000 nodes
- Integrated with Dell servers (iDrac)
- Integrated with Lustre
- Integrate with Open manage

6.3 Lustre

The Dell EMC Ready Solution for HPC Lustre Storage is designed for academic and industry users who need to deploy a fully supported, easy-to-use, high-throughput, scaleout, and cost-effective parallel file system storage solution. The Ready Solution uses community edition Lustre maintained by Whamcloud and is a scale-out storage appliance that can provide high performance and high availability. Using an intelligent, extensive, and intuitive management interface—the Integrated Manager for Lustre (IML)—greatly simplifies deploying, managing, and monitoring the hardware and file system components. The solution is easy to scale in capacity, performance, or both, thereby providing a convenient path for future growth. The Ready Solution for HPC Lustre Storage delivers a superior combination of performance, reliability, density, ease of use, and cost-effectiveness. The solution also uses the 14th generation of enterprise Dell EMC PowerEdge servers and the high-density Dell EMC PowerVault ME storage line, which comes with improved capacity, density, performance, simplicity, and features compared to other Dell EMC entry-level storage systems. The solution comes with full hardware and software support from Dell EMC and Whamcloud.

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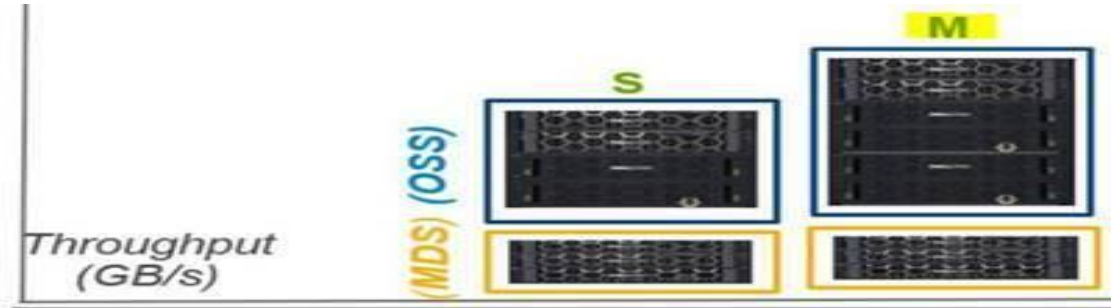
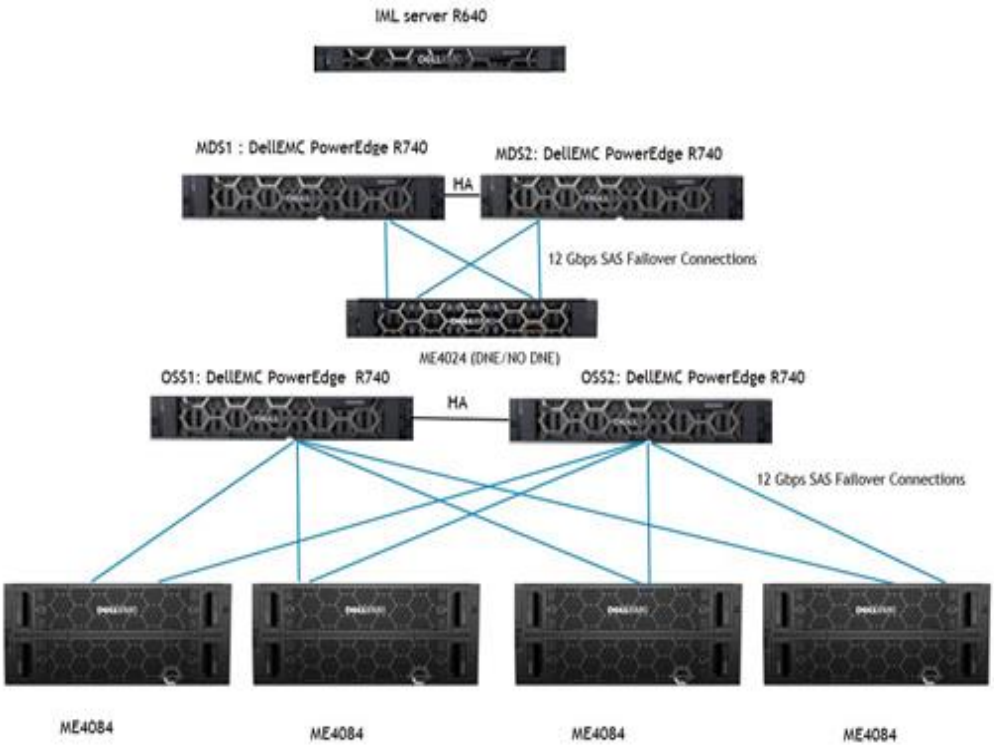


Total U	18U	23U
[1] Estimated Lustre Usable Space 4TB/8TB/10TB/12TB (7.2 K RPM NL SAS HDD)	231 TiB 461 TiB 576 TiB 691 TiB	461 TiB 922 TiB 1152 TiB 1383 TiB
Peak Read Performance[4]	≈ 5.6 GB/s	≈ 11.3 GB/s
Peak Write Performance[4]	≈ 5.3 GB/s	≈ 10.6 GB/s
[2] Sustained Performance[4]	≈ 5 GB/s	≈ 10 GB/s



6.4 Business Outcomes

6.4.1.1 Modernized Cloud-enabled Infrastructure

The potential to transform your infrastructure for modern workloads and the cloud is an exciting challenge, but can be impeded with complexity. Dell EMC enables you to easily scale your business, and simplify how to build your cloud foundation, with a no compromise, scalable system architecture that can be optimized and tuned for your specific workloads. The PowerEdge Server cloud-enabled infrastructure is thoughtfully designed to speed your deployment and increase performance.

6.4.1.2 Empower You to Control Your IT Lifecycle

You want to minimize the time spent on routine maintenance tasks, and instead deliver new initiatives that will grow your firm's business. The less you have to think about your servers, the better. Intelligent Automation frees IT from routine management tasks and improves time to resolution when an issue occurs. The Dell EMC approach to automation and intelligent management means you will spend less time on routine maintenance and be able to invest more time on bigger priorities.

6.4.1.3 Surround Your Business with Security

You want immediate access to your data no matter where it is in this cloud-connected world, so IT professionals must ensure reliable, robust, and secure access to that information. Dell EMC provides a comprehensive cyber-resilient server. Integrated Security embedded into hardware and firmware creates cyber resilient servers. Integrated Security performs the following functions:

- Protect servers with a deep layer of defense securing firmware, configurations and boot.
- Detect quickly if a breach occurs in BIOS or within a configuration.
- Recover to a trusted configuration, BIOS or golden image. Dell EMC enables a secure data center foundation.

7 Solution Summary

7.1 Hardware

Hardware includes the physical components of your information infrastructure solution, and provides capabilities for storage, connectivity, availability, and scalability.

7.1.1 Dell EMC PowerEdge R640

The PowerEdge R640 is a dual-socket, 1U platform for dense scale-out data center computing. The R640 combines density, performance and scalability to optimize application performance and data center density.

7.1.1.1 Maximize application performance and density

The scalable business architecture of the R640 is designed to maximize application performance and provide the flexibility to optimize configurations based on the application and use case. With the R640 you can create an NVMe cache pool and use either 2.5” or 3.5” drives for data storage. Combined with up to 24 DIMM’s, 12 of which can be NVDIMM’s, you have the resources to maximize application performance with the optimum configuration in only a 1U chassis.

- Simplify deployments and speed deployments with Dell EMC ready nodes for ScaleIO and VSAN.
- Maximize storage performance with up to 10 NVMe drives or 12 2.5” drives.
- Scale compute resources with Intel Xeon SP delivering a 27% increase in processing cores and 50% increase in bandwidth over previous generation Xeon processors.

7.1.1.2 Automate maintenance with Dell EMC OpenManage

The Dell EMC OpenManage portfolio helps deliver peak efficiency for PowerEdge servers, delivering intelligent, automated management of routine tasks. Combined with unique agent-free management capabilities, the R640 is simply managed, freeing up time for high profile projects.

- Simplify management with the New OpenManage Enterprise console, with customized reporting and automatic discovery.
- Take advantage of QuickSync 2 capabilities and gain access to your servers easily through your phone or tablet.

7.1.1.3 Guard your data center with built in security

Every PowerEdge server is designed as part of a cyber-resilient architecture, integrating security into the full server lifecycle. The R640 leverages new security features built-into every new PowerEdge server strengthening protection so you can reliably and securely deliver accurate data to your customers no matter where they are. By considering each aspect of system security, from design to retirement, Dell EMC ensures trust and delivers a worry-free, secure infrastructure without compromise.

- Rely on a secure component supply chain to ensure protection from factory to the data center Quick Sync 2 for secure, wireless management in the data center.
- Maintain data safety with cryptographically signed firmware packages and Secure Boot.
- Prevent unauthorized or malicious change with Server Lockdown.
- Wipe all data from storage media including hard drives, SSD’s and system memory quickly and securely with System Erase.

7.1.1.4 Technical specifications

PowerEdge R640	
Processor	Up to two Intel Xeon Scalable processors, up to 28 cores per processor
Memory	24 DDR4 DIMM slots, Supports RDIMM /LRDIMM, speeds up to 2666MT/s, 1.5TB max Up to 12 NVDIMM, 192 GB Max Supports registered ECC DDR4 DIMMs only
Storage controllers	Internal controllers: PERC H330, H730p, H740p, Software RAID (SWRAID) S140 Boot Optimized Storage Subsystem: HWRAID 2 x M.2 SSDs 120GB, 240 GB External PERC (RAID): H840 12Gbps SAS HBAs (non-RAID): External- 12Gbps SAS HBA (non-RAID), Internal-HBA330 (non-RAID)
Drive bays	Front drive bays: Up to 10 x 2.5" SAS/SATA (HDD/SSD) with up to 8 NVMe SSD max 76.8TB or up to 10 NVMe drives max 64TB, or up to 4 x 3.5" SAS/SATA HDD max 48TB Rear drive bays: Up to 2 x 2.5" SAS/SATA (HDD/SSD), NVMe SSD max 15.36TB Optional DVD-ROM, DVD+RW
Power supplies	Titanium 750W, Platinum 495W, 750W, 1100W, and 1600W 48VDC 1100W, 380HVDC 1100W, 240HVDC 750W Hot plug power supplies with full redundancy option
Dimensions	Form factor: Rack (1U) Max depth: 757.75mm – For the 8 x 2.5" front bay drive configuration. 808.51mm – For the 4 x 3.5" or 10 x2.5" front bay drive configurations (plus up to 2 rear drives).
Embedded management	IPMI 2.0 compliant iDRAC9 with Lifecycle Controller (Express, Enterprise) Quick Sync 2 wireless module optional
Bezel	Optional LCD bezel or security bezel
OpenManage Software	OpenManage Enterprise OpenManage Essentials OpenManage Mobile OpenManage Power Center
Integrations and connections	Integrations: Microsoft System Center, VMware vCenter, BMC Software Connections: Nagios & Nagios XI, Oracle Enterprise Manager, HP Operations Manager, IBM Tivoli Netcool/OMNIbus, IBM Tivoli Network Manager, CA Network and Systems Management
Security	TPM 1.2/2.0 optional Cryptographically signed firmware Secure Boot System Lockdown Secure erase

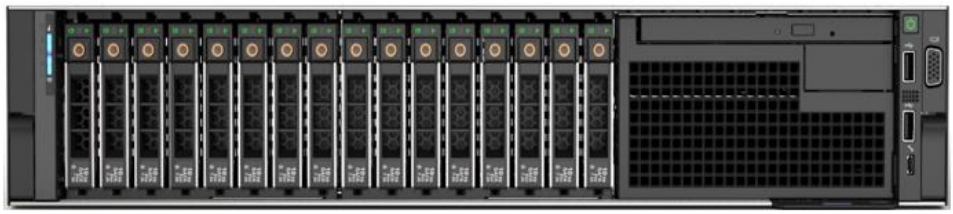
I/O & Ports	Network daughter card options 4 x 1GE or 2 x 10GE + 2 x 1GE or 4 x 10GE or 2 x 25GE Front ports: Video, 1 x USB 2.0, available USB 3.0, dedicated IDRAC Direct USB Rear ports: Video, serial, 2 x USB 3.0, dedicated iDRAC network port Video card: VGA, NVIDIA NVS310 available as PCIe card Up to 3 x Gen3 slots, all x16	
Accelerator options	Up to 1 Intel Arria 10 GX FPGA See Dell.com/GPU for latest information.	
Supported operating systems	Canonical Ubuntu LTS Citrix XenServer Microsoft Windows Server with Hyper-V Red Hat Enterprise Linux SUSE Linux Enterprise Server VMware ESXi	For specifications and interoperability details see Dell.com/OSsupport.
OEM-ready version available	From bezel to BIOS to packaging, your servers can look and feel as if they were designed and built by you. For more available information, visit Dell.com/OEM.	
Recommended support	Dell ProSupport Plus for critical systems or Dell ProSupport for premium hardware and software support for your PowerEdge solution. Consulting and deployment offerings are also available. Contact your Dell representative today for more information. Availability and terms of Dell Services vary by region. For more information, visit Dell.com/ServiceDescriptions.	

7.1.2 Dell EMC PowerEdge R740 Server

The Dell EMC PowerEdge R740 server builds a scalable infrastructure with software-defined storage tightly integrated with VMware vSphere. VMware vSAN solutions from Dell EMC provide a hyper-converged architecture built on PowerEdge servers. It provides simple and flexible storage for growing virtual environments.

- Flexibility: Meet changing demands on storage with agile software-defined solutions.
- The right service levels: Precisely match your workload requirements for performance, data protection and availability.
- Efficiency: Streamline management and operational costs while leveraging server economics and a pay-as-you-grow approach.

The Dell EMC PowerEdge R740 server leverages Graphics Processing Unit (GPU) accelerators and coprocessors to accelerate and scale performance of the most demanding applications with a broad set of offerings from Dell EMC. It can maximize your application performance and bring you the perfect balance of accelerator cards, storage and compute resources in a 2U, 2-socket platform. With up to three 300W accelerator cards or six 150W cards, the PowerEdge R740 has the versatility to adapt to virtually any application and provides the optimum platform for Virtualization Desktop Infrastructure (VDI) deployments. The PowerEdge R740 offers up to 16 x 2.5” or 8 x 3.5” drives and integrated Dell Remote Access Controller (iDRAC9), so you can scale to meet demands and simplify the entire IT lifecycle. Ideal workloads include: VDI; Private cloud; Virtualization and AI/Machine learning.



The PowerEdge R740 is a general-purpose workhorse, optimized for workload acceleration. With the PowerEdge R740 you can transform your data center for VDI, artificial intelligence and software-defined storage (SDS).

The PowerEdge R740 server is easy to deploy from planning, to basic hardware installations, to complex integrations. ProDeploy Enterprise Suite can save you time and reduce cost in implementing and maintaining new systems. ProSupport Plus will improve the performance and stability of critical systems and workloads with automated, proactive and predictive measures. Dell OpenManage portfolio and Dell Active System Manager will achieve dramatic improvements in IT productivity and agility. The PowerEdge R740 can help you:

- Simplify and accelerate VMware vSAN deployments with validated, pre-bundled and tailored Ready Nodes
- Scale compute resources with Intel Xeon Scalable Processor, delivering a 27% increase in processing cores and a 50% increase in bandwidth
- Scale your VDI deployments with 3 double-width GPUs, supporting up to 50% more users
- Free up storage space using internal M.2 SSDs optimized for boot

7.1.3 Highlights

- Highly optimized air flow design which enabling tremendous configuration flexibility and industry leading energy efficiency
- Out of band management architecture facilitating rapid bare metal deployment and remediation regardless of OS state
- Superior acceleration with up to 3 double-wide GPUs or up to 6 single-wide
- Embedded SupportAssist reducing troubleshooting and downtime with embedded diagnostics and automated case creation

7.2 Dell EMC PowerVault ME4 Series Storage

Enterprise-class features in our most affordable entry level SAN/DAS storage array

7.2.1 Purpose-built for SAN/DAS

The affordable, simple, and fast Dell EMC PowerVault ME4 Series SAN/DAS Storage Series is optimized to run a variety of mixed workload applications – physical and virtual – for small businesses.

Whether you need to consolidate your block storage, support the demands of data intensive applications, take advantage of intelligent data management, or optimize your virtual environments, the ME4 Series has been designed to meet your growing business needs. The flexibility of the ME4 Series lets you decide the protocol, supports a wide range of mixed drive types (including SED), scales to 4PB raw, is highly aligned with Dell

PowerEdge Servers, and is delivered to you with all-inclusive software – everything you'll need to store, manage, and protect your data.

7.2.2 Powerful entry storage architecture

Based on the family of Intel processors, Dell EMC PowerVault ME4 Series storage implements a block architecture with VMware virtualization integration and concurrent support for native iSCSI, Fiber channel, and SAS protocols. Each system leverages dual storage processors (single storage processor systems are available) and a full 12Gb SAS back-end. Additional storage capacity is added via Disk Array Enclosures (DAEs) while Distributed RAID (ADAPT) delivers faster drive re-build times. And all ME4 Series arrays are managed by an integrated HTML5 web-based GUI.

7.2.3 PowerVault ME4 Series Base System and Expansion Models

The two non-dense ME4 base arrays start at 2U and the dense ME4 array starts at 5U. Both models include dual controllers with Dual-core Intel Xeon processors, 8GB per controller and 4x10Gb iSCSI, 4x12Gb SAS, and 4x16Gb FC network connections (auto-negotiation supported on iSCSI and FC).

ME4012 SAN/DAS Array
(12 drive) 3.5" drive slots, 2U

ME4024 SAN/DAS ARRAY
(24 drive) 2.5" drive slots, 2U

ME4084 SAN/DAS ARRAY
(84 drive) 2.5" drive slots,5U

Optional ME4 Series expansion enclosures let you scale up to 336 drives or 4PB. PowerVault ME412 and ME424 expansion enclosures can only be used with either ME4012 or ME4024 base arrays.

The ME484 dense expansion enclosure (also available as JBOD) is supported behind any ME4 base array. All array and expansion enclosure models support a mix of SSD, 15K, 10K and 7.2K drives (including FIPS-certified SEDs).

ME412 Expansion Enclosure
(12 drive) 3.5" drive slots, 2U

ME424 Expansion Enclosure
(24 drive) 2.5" drive slots, 2U

ME484 Expansion Enclosure
(84 drive) 3.5" drive slots, 5U

7.2.4 Dell EMC PowerVault ME4 Series Technical Specifications

PowerVault ME4 Series Features and Specifications	
Chassis Overview	
Chassis format	All-in-one (single/dual controllers, internal drive bays, networking) with expansion options
Rack size	2U or 5U
Controllers	2 hot-swappable per chassis (dual active) Single/dual controller support for 2U Dual controller only support for 5U
Processor	Intel 2-core, 2.2GHz

Internal storage	**ME4012:** 12 x 3.5” drive bays (2.5” drive carriers supported) **ME4024:** 24 x 2.5” drive bays **ME4084:** 84x 3.5” drive bays (2.5” drive carriers supported)
System memory	8GB per controller
Expansion Capacity	
Expansion enclosures	**ME412:** 12 x 3.5” drive bays (12Gb SAS) **ME424:** 24 x 2.5” drive bays (12Gb SAS) **ME484:** 84 x 3.5” drive bays (12Gb SAS) Also available as JBOD
Min/Max drive count	**ME4012:** 2/264 **ME4024:** 2/276 **ME4084:** 28/336
Max raw capacity	**ME4012:** 3.1PB (with ME484 expansion) **ME4024:** 3PB (with ME484 expansion) **ME4084:** 4PB
NAS Support	Supported with NX Series Windows NAS appliance
Storage media	SAS and NL-SAS drives; different drive types, transfer rates, rotational speeds can be mixed in the same system: • NLSAS (7.2K 3.5”): 4TB, 8TB, 10TB, 12TB, 12TB SED • NLSAS (7.2K 2.5”): 2TB, 2TB SED • SAS (10K 2.5”): 1.2TB, 1.8TB, 2.4TB, 2.4TB SED • SAS (15K 2.5”): 900GB, 900GB SED • SSD: 480GB, 960GB, 1.92TB, 1.92TB SED • SDD and HDD: FIPS-certified SEDs
Network and Expansion I/O	
Host interface	FC, iSCSI, SAS (supports simultaneous multiprotocol FC/iSCSI)
Max 16Gb FC ports	8 per array (support auto-negotiate to 8Gb)
Max 10Gb iSCSI ports	8 SFP+ or BaseT ports per array (BaseT only support auto negotiate to 1Gb)
Max 12Gb SAS ports	8 12Gb SAS ports
Max multi-protocol ports	4 ports 16Gb FC SFP+ 4 ports 10Gb iSCSI SFP+
Max management ports	2 per array (1Gb BASE-T)
Disk expansion protocol	12Gb SAS
Disk interface expansion ports	2 12Gb SAS (wide-Port) per array (1 port per controller) Up to 9 2U expansion enclosures per 2U base array Up to 3 5U expansion enclosures per 2U base array Up to 3 5U expansion enclosures per 5U base array

Functional	
Array configurations	All-flash, hybrid or all HDD arrays
Storage format	Native SAN or DAS
Data Optimization	
Auto-tiering	Up to 3 primary (media-based) tiers (2 level tiering supported)
RAID support	RAID 0, 1, 5, 6, 10, 50 or Adapt; any combination of RAID levels can exist in single array
Adapt	Distributed erasure coding that reduces rebuild times when drive failures occur
Thin provisioning	Active by default on all volumes, operates at full performance across all features
Snapshots	1024 maximum snapshots per array
Data Mobility and Migration	
Replication	Replicates with other ME4 Series Arrays Asynchronous block via FC or iSCSI Target/source relationships may be one-to-many or many-to-one
Volume copy	Copy complete standalone volumes
Data Protection, Disaster Recovery, Security	
Business continuity	VMware Site Recovery Manager
Data-at-rest encryption	Self-encrypting drives (SEDs) in SSD or HDD formats Full Disk Encryption (FCE) based on AES-256 Drives certified to FIPS 140-2 Level 2
Key manager	Internal controller key management
Management	
Management	ME Storage Manager (MESM) HTML5 GUI, CLI
VMware vCenter	Support VMware vCenter plugin to manage the ME4 arrays through vCenter.
Scripting	CLI Microsoft PowerShell API
Supported host OS	Windows 2016 and 2012 R2 RHEL 6.9 and 7.4 SLES 12.3 VMware 6.7, 6.5 and 6.0
Virtualization integration	VMware vSphere (ESXi) vCenter; SRM Microsoft Hyper-V
Physical Base System	
Rack size	ME4012 (2U), ME4024 (2U), ME4084 (5U)

Base system height	**ME4012:** 8.79 cm (3.46 inches) **ME4024:** 8.79 cm (3.46 inches) **ME4084:** 22.23 cm (8.75 inches)
Base system width	**ME4012:** 48.30 cm (19.01 inches) **ME4024:** 48.30 cm (19.01 inches) **ME4084:** 48.30 cm (19.01 inches)
Base system depth	ME4012: 60.29 cm (23.74 inches) ME4024: 60.29 cm (23.74 inches) ME4084: 97.47 cm (38.31 inches)
Weight (max configuration)	ME4012: 32.00 kg (71.00 lbs) ME4024: 30.00 kg (66.00 lbs) ME4084: 135.00 kg (298.00 lbs)
Weight (empty)	ME4012: 4.80 kg (10.56 lbs) without drives ME4024: 4.80 kg (10.56 lbs) without drives ME4084: 64.00 kg (141.00 lbs) without drives

Physical Expansion Enclosure

Rack size	ME412 (2U), ME424 (2U), ME484 (5U)
Expansion height	ME412: 8.79 cm (3.46 inches) ME424: 8.79 cm (3.46 inches) ME484: 22.23 cm (8.75 inches)
Expansion width	ME412: 48.30 cm (19.01 inches) ME424: 48.30 cm (19.01 inches) ME484: 48.30 cm (19.01 inches)
Expansion depth	ME412: 60.29 cm (23.74 inches) ME424: 60.29 cm (23.74 inches) ME484: 97.47 cm (38.31 inches)
Weight (max configuration)	ME412: 28.00 kg (62.00 lbs) ME424: 25.00 kg (55.00 lbs) ME484: 130.00 kg (287.00 lbs)
Weight (empty)	ME412: 4.80 kg (10.56 lbs) without drives ME424: 4.80 kg (10.56 lbs) without drives ME484: 64.00 kg (141.00 lbs) without drives

Base System Power

Power/wattage	ME4012: 580W ME4024: 580W ME4084: 2200W

Heat dissipation	ME4012: 1980 BTU ME4024: 1980 BTU ME4084: 7507 BTU
Voltage	ME4012: 100-240 VAC ME4024: 100-240 VAC ME4084: 200-240 VAC
Frequency	50/60 Hz
Amperage	ME4012: 7.6-3.0A (x2) ME4024: 7.6-3.0A (x2) ME4084: 11.07-9.23A (x2)

Expansion Power

Power/wattage	ME412: 580W ME424: 580W ME484: 2200W
Heat dissipation	ME412: 1980 BTU ME424: 1980 BTU ME484: 7507 BTU
Voltage	ME412: 100-240 VAC ME424: 100-240 VAC ME484: 200-240 VAC
Frequency	50/60 Hz
Amperage	ME412: 7.6-3.0A (x2) ME424: 7.6-3.0A (x2) ME484: 11.07-9.23A(x2)

Environmental Operating Conditions

Operating temperature	41 - 95°F (5 - 35°C)
Non-operating temperature	-40 - 149°F (-40 - 65°C)
Operating humidity ranges (non-condensing)	10% to 80% with 29°C (84.2°F) maximum dew point
Non-operating humidity (non- condensing)	5% to 95% with 33°C (91°F) maximum dew point

World-class Services Options

Support & Deployment Services	• ProDeploy or ProDeploy Plus gets systems out of the box and into production – fast. • ProSupport or ProSupport Plus offers comprehensive proactive support to improve performance and stability. • Intelligent Data Mobility gives you a faster, easier way to migrate data.
System sizing	Dell EMC Midrange Sizer Tool

OEM-Ready

From bezel to BIOS to packaging, your storage arrays can look and feel as if they were designed and built by you. For more information, visit Dell.com/OEM.

7.2.5 Dell EMC Networking S3048-ON

7.2.5.1 High density 1000BASE-T switch

The Dell EMC Networking S3048-ON 1000BASE-T Top-of-Rack (ToR) switch is the industry's first 1GbE enterprise switching platform to deliver both an industry hardened OS and support for open networking, providing freedom to run third-party operating systems (OS) such as Cumulus Linux.

This open networking platform is built for high-performance, software-defined data centers and provides the features to run traditional workloads and the flexibility to deploy new workloads such as Hadoop, SDS and Big Data. The S3048-ON offers the flexibility to run OS options optimized for diverse deployment needs on a common hardware platform and architecture.

The S3048-ON features a non-blocking switching architecture coupled with OS9.X software, delivering line-rate L2/L3 features for maximized network performance. The S3048-ON design provides (48) 1000BASE-T ports that support 10MbE/100MbE/1GbE and four 10GbE SFP+ uplinks. Each 10GbE interface can be used as uplinks to the network spine/core, as stack ports to connect up to six units in a stacked configuration, or a combination of both, depending on network architecture and uplink/stack bandwidth requirements.

The S3048-ON incorporates multiple architectural features that optimize data center network flexibility, efficiency and availability. including:

- I/O panel to PSU airflow or PSU to I/O panel airflow for hot/cold aisle environments
- Redundant, hot-swappable power supplies and fans with color coded touch points for ease of identification/removal.
- Dell ReadyRails for efficient installation of the switch into data center cabinets.

The S3048-ON also supports Dell EMC Networking's Embedded Open Automation Framework, which provides advanced network automation and virtualization capabilities for virtual data center environments. Embedded Open Automation Framework is a suite of network management apps that can be used together or independently to provide a network that is flexible, available and manageable while helping to reduce operational expenses.

7.2.5.2 Key applications

- High-density 1000BASE-T ToR server aggregation in high-performance data centers environments
- Active Fabric designs with the S- or Z-Series core switch to create a two tier, 1/10/40GbE data center network architecture

- Enterprise, Web 2.0 and cloud service providers' data center networks for ToR applications
- High-performance SDN/OpenFlow 1.3 enabled with ability to inter-operate with industry standard OpenFlow controllers

7.2.5.3 Key features

- Scalable L2 and L3 Ethernet switching with QoS and a full complement of standards-based IPv4 and IPv6 features, including OSPF, BGP and PBR (Policy Based Routing) support
- Four SFP+ 10GbE ports for maximum flexibility and investment protection
- I/O panel to PSU airflow or PSU to I/O panel airflow
- Redundant, hot-swappable power supplies and fans
- Supports ONIE for zero-touch installation of alternate network operating systems
- Open Networking offers choice of OS, such as Dell EMC Networking OS9.X and OS10.X, for inherent stability and feature richness, or the flexibility of a third-party OS (such as Cumulus Linux)
- VRF-lite enables sharing of networking infrastructure and provides L3 traffic isolation across tenants (including support for multicast and IPv6 routing)
- Enhanced automation capabilities (puppet agent, REST API extensions)
- Supports jumbo frames for high-end performance in virtualized environments and IP storage/server communication
- Increase VM Mobility region by stretching L2 VLAN within or across two DCs with unique VLT capabilities like Routed VLT, VLT Proxy Gateway
- User port stacking support for up to six units managed as one logical device
- Embedded Open Automation Framework adds VM awareness automated configuration and provisioning capabilities to simplify the management of virtual network environments

Dell Networking S3048-ON	
Physical	48 line-rate 1000BASE-T ports 4 line-rate 10GbE SFP+ ports 1 RJ45 console/management port with RS232 signaling Size: 1 RU, 1.71"h x 17.09" w x 12.6" d (4.4 h x 43.4 w x 32.0 cm d) Weight: 12.8 lbs (5.84 kg) with 1 power supply, 14.8 lbs (6.74kg) with 2 power supplies ISO 7779 A-weighted sound pressure level: <36 dBA at 78.8°F (26°C) Power supply: 90–264 VAC 50/60 Hz 1) AC forward airflow 2) AC reverse airflow Max. thermal output: 290 BTU/h Max. current draw per system: <1A at 100/120V VAC <0.5A at 200/240VAC Max. power consumption: 87W Typ. power consumption: 65 Watts Max. operating specifications: Operating temperature: 32° to 113°F (0° to 45°C) Operating humidity: 5 to 85% (RH), non-condensing Operating altitude: 0ft to 10,000ft above sea level

	Max. non-operating specifications: Storage temperature: –40° to 158°F (–40° to 70°C) Storage humidity: 5 to 95% (RH), non-condensing
Redundancy	Hot swappable redundant power supplies Hot swappable redundant fans User port stacking up to 6 units
Performance	MAC addresses: up to 80k IPv4 routes: 16K IPv6 routes: 8K (shared CAM space with IPv4) Switch fabric capacity: 260Gbps (full-duplex) 130 Gbps (half-duplex) Forwarding capacity: 131 Mpps Link aggregation: 16 links per group, 128 groups per stack Queues per port: 8 queues Layer 2 VLANs: 4K MSTP : 64 instances VRF-lite: 64 instances Line-rate Layer 2 switching: all protocols, including IPv4 and IPv6 Line-rate Layer 3 routing: IPv4 and IPv6 IPv4 host table size up to 40k max IPv6 host table size 8K IPv4 Multicast table size 8K LAG load balancing: based on Layer 2, IPv4 or IPv6 headers Latency 3.7 µsec for 1000BASE-T, ~1.8 µsec for SFP+ Packet buffer memory: 4MB CPU memory: 2GB
IEE Compliance	802.1AB LLDP 802.1D Bridging, STP 802.1p L2 Prioritization 802.1Q VLAN Tagging, Double VLAN Tagging, GVRP 802.1s MSTP 802.1w RSTP 802.1X Network Access Control 802.3ab Gigabit Ethernet (1000BASE-T) 802.3ac Frame Extensions for VLAN Tagging 802.3ad Link Aggregation with LACP 802.3ae 10 Gigabit Ethernet (10GBASE-X) on optical ports 802.3u Fast Ethernet (100BASE-TX) on mgmt ports 802.3x Flow Control 802.3z Gigabit Ethernet (1000BASE-X) ANSI/TIA-1057 LLDP-MED Force10 PVST+ MTU 12,000 bytes

RFC and I-D compliance	**General Internet protocols** 768 UDP 793 TCP 854 Telnet 959 FTP **General IPv4 protocols** 791 IPv4 792 ICMP 826 ARP 1027 Proxy ARP 1035 DNS (client) 1042 Ethernet Transmission 1305 NTPv3 1519 CIDR 1542 BOOTP (relay) 1812 Requirements for IPv4 Routers 1918 Address Allocation for Private Internets 2474 Diffserv Field in IPv4 and Ipv6 Headers 2596 Assured Forwarding PHB Group 3164 BSD Syslog 3195 Reliable Delivery for Syslog 3246 Expedited Assured Forwarding 4364 VRF-lite (IPv4 VRF with OSPF, BGP, IS-IS, and v4 multicast) 5798 VRRP **General IPv6 protocols** 1981 Path MTU Discovery Features 2460 Internet Protocol, Version 6 (IPv6) Specification 2464 Transmission of IPv6 Packets over Ethernet Networks 2710 Multicast Listener Discovery (MLD) for IPv6 2711 IPv6 Router Alert Option 3810 Multicast Listener Discovery Version 2 (MLDv2) for IPv6 4007 IPv6 Scoped Address Architecture 4213 Basic Transition Mechanisms for IPv6 Hosts and Routers 4291 IPv6 Addressing Architecture 4443 ICMP for IPv6 4861 Neighbor Discovery for IPv6 4862 IPv6 Stateless Address Autoconfiguration 5095 Deprecation of Type 0 Routing Headers in IPv6 IPv6 Management support (telnet, FTP, TACACS, RADIUS, SSH, NTP) VRF-Lite (IPv6 VRF with OSPFv3, BGPv6, and IS-IS) **RIP**

1058 RIPv1 2453 RIPv2

OSPF (v2/v3)

1587 NSSA 4552 Authentication/

2154 OSPF Digital Signatures Confidentiality for

2328 OSPFv2 OSPFv3

2370 Opaque LSA 5340 OSPF for IPv6

IS-IS

5301 Dynamic hostname exchange mechanism for IS-IS

5302 Domain-wide prefix distribution with two-level IS-IS

5303 Three way handshake for IS-IS point-to-point adjacencies

5308 IS-IS for IPv6

BGP

1997 Communities

2385 MD5

2545 BGP-4 Multiprotocol Extensions for IPv6

Inter-Domain Routing

2439 Route Flap Damping

2796 Route Reflection

2842 Capabilities

2858 Multiprotocol Extensions

2918 Route Refresh

3065 Confederations

4360 Extended Communities

4893 4-byte ASN

5396 4-byte ASN representations

draft-ietf-idr-bgp4-20 BGPv4

draft-michaelson-4byte-as-representation-05

4-byte ASN Representation (partial)

draft-ietf-idr-add-paths-04.txt ADD PATH

Multicast

1112 IGMPv1

2236 IGMPv2

3376 IGMPv3

MSDP

draft-ietf-pim-sm-v2-new-05

PIM-SMw

Network management

1155 SMIv1

1157 SNMPv1

1212 Concise MIB Definitions

1215 SNMP Traps

1493 Bridges MIB

1850 OSPFv2 MIB

1901 Community-Based SNMPv2

2011 IP MIB

2096 IP Forwarding Table MIB

2578 SMIv2

2579 Textual Conventions for SMIv2

2580 Conformance Statements for SMIv2

2618 RADIUS Authentication MIB

2665 Ethernet-Like Interfaces MIB

2674 Extended Bridge MIB

2787 VRRP MIB

2819 RMON MIB (groups 1, 2, 3, 9)

2863 Interfaces MIB

3273 RMON High Capacity MIB

3410 SNMPv3

3411 SNMPv3 Management Framework

3412 Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)

3413 SNMP Applications

3414 User-based Security Model (USM) for SNMPv3

3415 VACM for SNMP

3416 SNMPv2

3417 Transport mappings for SNMP

3418 SNMP MIB

3434 RMON High Capacity Alarm MIB

3584 Coexistance between SNMP v1, v2 and v3

4022 IP MIB

4087 IP Tunnel MIB

4113 UDP MIB

4133 Entity MIB

4292 MIB for IP

4293 MIB for IPv6 Textual Conventions

4502 RMONv2 (groups 1,2,3,9)

5060 PIM MIB

ANSI/TIA-1057 LLDP-MED MIB

Dell_ITA.Rev_1_1 MIB

draft-grant-tacacs-02 TACACS+

draft-ietf-idr-bgp4-mib-06 BGP MIBv1

IEEE 802.1AB LLDP MIB

IEEE 802.1AB LLDP DOT1 MIB

IEEE 802.1AB LLDP DOT3 MIB

sFlow.org sFlowv5

sFlow.org sFlowv5 MIB (version 1.3)

FORCE10-BGP4-V2-MIB Force10 BGP MIB (draft-ietf-idr-bgp4-mibv2-05)

FORCE10-IF-EXTENSION-MIB

	FORCE10-LINKAGG-MIB FORCE10-COPY-CONFIG-MIB FORCE10-PRODUCTS-MIB FORCE10-SS-CHASSIS-MIB FORCE10-SMI FORCE10-TC-MIB FORCE10-TRAP-ALARM-MIB FORCE10-FORWARDINGPLANE-STATS-MIB 3376 IGMPv3 MSDP draft-ietf-pim-sm-v2-new-05 PIM-SMw
Regulatory compliance	**Safety** UL/CSA 60950-1, Second Edition EN 60950-1, Second Edition IEC 60950-1, Second Edition Including All National Deviations and Group Differences EN 60825-1 Safety of Laser Products Part 1: Equipment Classification Requirements and User's Guide EN 60825-2 Safety of Laser Products Part 2: Safety of Optical Fibre Communication Systems FDA Regulation 21 CFR 1040.10 and 1040.11 **Emissions** Australia/New Zealand: AS/NZS CISPR 22: 2006, Class A Canada: ICES-003, Issue-4, Class A Europe: EN 55022: 2006+A1:2007 (CISPR 22: 2006), Class A Japan: VCCI V3/2009 Class A USA: FCC CFR 47 Part 15, Subpart B:2011, Class A **Immunity** EN 300 386 V1.4.1:2008 EMC for Network Equipment EN 55024: 1998 + A1: 2001 + A2: 2003 EN 61000-3-2: Harmonic Current Emissions EN 61000-3-3: Voltage Fluctuations and Flicker EN 61000-4-2: ESD EN 61000-4-3: Radiated Immunity EN 61000-4-4: EFT EN 61000-4-5: Surge EN 61000-4-6: Low Frequency Conducted Immunity **RoHS** All S Series components are EU RoHS compliant. **Certifications** Available with US Trade Agreements Act (TAA) compliance USGv6 Host and Router Certified on Dell Networking OS 9.5 and greater

	IPv6 Ready for both Host and Router UCR DoD APL (core and distribution ALSAN switch) **Warranty** 1 year return to depot