Dell EMC Ready Stack: VMware vSphere and Red Hat Enterprise Linux for High-Performance Database Applications

June 2019
H17813

Design Guide

Abstract
This design guide describes the architecture and configuration of a converged infrastructure for VMware vSphere and Red Hat Enterprise Linux with Dell EMC PowerEdge servers, XtremIO X2 storage, S-Series switches, and Data Domain protection.

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# Contents

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chapter 1</strong></td>
<td>Introduction</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Ready Stack overview</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Ready Stack key benefits</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Document purpose</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Audience</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>We value your feedback</td>
<td>7</td>
</tr>
<tr>
<td><strong>Chapter 2</strong></td>
<td>Architecture and Components</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Introduction</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Bare-metal versus virtualized infrastructure</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Data center infrastructure requirements</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Ready Stack architecture</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Key components</td>
<td>11</td>
</tr>
<tr>
<td><strong>Chapter 3</strong></td>
<td>Configuration and Specifications</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Introduction</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Recommended components</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Design configuration and specifications</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Ready Stack scaling</td>
<td>21</td>
</tr>
<tr>
<td><strong>Chapter 4</strong></td>
<td>Design</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Compute design</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Network design</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Storage design</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Management design</td>
<td>29</td>
</tr>
<tr>
<td><strong>Chapter 5</strong></td>
<td>References</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Dell EMC documentation</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>ONIE documentation</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>VMware documentation</td>
<td>33</td>
</tr>
</tbody>
</table>
This chapter presents the following topics:

- **Ready Stack overview** ................................................................. 5
- **Ready Stack key benefits** ............................................................ 5
- **Document purpose** ................................................................. 7
- **Audience** .................................................................................... 7
- **We value your feedback** ............................................................ 7
Ready Stack overview

Managing complex data-center-based IT infrastructure can be difficult, and changing the traditional data center infrastructure can significantly affect stability, performance, costs, and upgradability. The Dell EMC Ready Stack certified reference system for VMware and Red Hat Enterprise Linux for high-performance database applications helps organizations meet data center needs for supporting high performance database application workloads. This Ready Stack provides the simplicity of a complete, yet flexible, validated converged infrastructure (CI) that is based on the following components:

- Dell EMC XtremIO X2 storage
- Dell EMC PowerEdge rack servers
- Dell EMC S-Series switches
- VMware vSphere and Red Hat Enterprise Linux
- Dell EMC Data Domain DD6300 protection storage system

This Ready Stack provides:

- The advantage of having one trusted vendor for all CI stack components—compute, storage, networking, virtualization, and data protection
- Design and deployment guidance that incorporates scalability, flexibility, high availability, and best practices

**Note:** This Ready Stack design is database-vendor-agnostic and can apply to various database applications.

Ready Stack key benefits

Key benefits of this Ready Stack are:

- **Resiliency**—The Ready Stack architecture ensures that no single point of failure exists. Redundancy is incorporated in server high-availability features, redundant networking, and multipath storage.

- **Low latency and high throughput**—Each server includes the processing power, memory, and Fibre Channel (FC) and Ethernet network adapters to support the throughput and transactions for high-performance database application workloads.

- **Scalability**—You can configure this Ready Stack to suit your needs for single or multiple databases. The Ready Stack provides flexibility by supporting various options. Based upon database workload requirements, server and storage configurations can be scaled up or out to meet an organization’s requirements for application reliability and service-level agreements.

To scale up:

- Increase memory density.
- Add more processors or processors that have more cores to a server.
- Add drives to the storage brick or bricks.
To scale out:

- Increase server and storage quantity.
- Add network and storage fabrics if additional ports are required.

- **Powerful all-flash storage**—The Dell EMC XtremIO X2 storage array is designed to offer multidimensional scalability. It is optimized for business applications and databases so that DBAs can:
  
  - Meet consistently high performance demands with low latency.
  - Provide a balanced system across all Dell EMC X-Brick blocks for compute power, storage bandwidth, and capacity. Balancing data distribution achieves consistent and predictable database performance by eliminating hot spots.
  - Use inline deduplication to save physical data capacity without affecting database performance.
  - Benefit from in-memory metadata and metadata-aware replication and rich application-integrated copy services.
  - Realize significant management efficiencies
  - Achieve performance that exceeds RAID 10 and provides capacity savings that are better than RAID 5 through a flash-based data protection algorithm.

- **Data protection**—The Dell EMC Data Domain DD6300 is a disk-based inline deduplication system that provides data protection and disaster recovery in the enterprise environment. The DD6300 system includes the Data Domain System Manager (DD System Manager), which provides a UI for performing system operations, and the Data Domain Operating System (DD OS), which provides a command-line interface (CLI).

- **Integrated Dell EMC management**—This Ready Stack includes the following Dell EMC management tools:
  
  - **Dell EMC OpenManage Integration for VMware vCenter (OMIVV)**—A virtual appliance that enables administrators to view physical host details in VMware vSphere.
  - **Dell EMC Integrated Dell Remote Access Controller 9 (iDRAC9)**—An out-of-band (OOB) management tool for Dell EMC PowerEdge rack servers. iDRAC9 has its own HTML5-based UI and can be accessed by using various methods including SSH, RACADM, and the Redfish API. iDRAC9 Group Manager provides a one-to-many console for accessing the details of multiple servers. As needed, administrators can also use Dell EMC OpenManage Enterprise (OME) and OME Modular Edition to manage server content that is accessible through iDRAC9.
  - **Brocade Web Tools**—An embedded UI on Dell EMC Connectrix switches that enables administrators to monitor and manage single or small fabrics, switches, and ports. Web Tools is launched directly from a web browser or from the Brocade Network Advisor.
  - **DD System Manager**—A web-based UI that provides administrators with configurable dashboards to simplify and automate data protection management, monitoring, and reporting.
Document purpose

This Ready Stack design guide describes how high-performance database applications can use Dell EMC compute and Dell EMC Open Networking with XtremIO X2 storage. It provides design principles, best practices, architectural guidance, and sample configurations for compute, networking, storage, and management.

Audience

This guide is for customers, channel partners, and Dell EMC personnel.

We value your feedback

Dell EMC and the authors of this document welcome your feedback. Contact the Dell EMC Solutions team by email or provide your comments by completing our documentation survey.

Authors: Robert Percy, Don Pisinski

Note: The following page of the Ready Stack space on the Dell EMC Communities website provides links to additional documentation for this and other Ready Stack systems:

Ready Stack Info Hub
This chapter presents the following topics:

- **Introduction** ................................................................. 9
- **Bare-metal versus virtualized infrastructure** ....................................... 9
- **Data center infrastructure requirements** .................................................. 9
- **Ready Stack architecture** ..................................................................... 10
- **Key components** ............................................................................... 11
Introduction

Installing, configuring, and running an on-premises CI solution involves multiple processes, including:

- Selecting operating system and virtualization software distributions
- Selecting monitoring and management software
- Allocating and aligning compute, network, and storage resources
- Selecting appropriate server hardware
- Designing the network fabric
- Analyzing sizing and scalability requirements
- Analyzing performance and service-level agreement (SLA) requirements

Complicating these considerations is the need to understand the types of workloads that will run on the cluster and the challenges of managing a system that is designed to accommodate multiple virtualized workloads.

Dell EMC’s customer-centered approach creates rapidly deployable and highly available CI systems that run on enterprise-class hardware. Ready Stack designs include all the hardware, software, resources, and best practices that are needed to run a scalable, highly available CI environment. With this approach, organizations can be operational in a shorter time than is typically possible with homegrown solutions.

Bare-metal versus virtualized infrastructure

A virtual environment provides for dynamic scaling of database resources, enabling more efficient allocation of resources than with physical hosts. This Ready Stack design is based on the following assumptions:

- Two VM-hosted databases will be deployed in your existing virtualized infrastructure.
- The VMs will be configured on an ESXi host that contains production, test, staging, and development databases.
- The virtualization environment will also provide for vSphere vMotion, vSphere DRS, vSphere HA, and vSphere FT.

However, if you will not be using a virtualized infrastructure for some of the databases or management functions, you might want to install them on a bare-metal operating system on a dedicated physical server such as a PowerEdge R740 or R940, especially if your database deployment scales out significantly beyond what we describe in this guide. Consult with your local Dell EMC Sales team to select the appropriate option.

Data center infrastructure requirements

Implementing this Ready Stack requires that the following infrastructure elements be in the existing data center or configured at the time of deployment:

- A Domain Name System (DNS) server on the management network.
• A Network Time Protocol (NTP) server on the management network.
• An Ethernet infrastructure.
• An environment that can support the cooling, floor space, height, power, and weight requirements of the Ready Stack components. Contact your Dell EMC Sales representative for more information about these requirements.

**Ready Stack architecture**

This Ready Stack architecture includes compute servers, data protection, management servers, LAN switches, SAN switches, storage arrays, and OOB switches, as shown in the following figure:

![Ready Stack design architecture](image)

**Figure 1. Ready Stack design architecture**

This design architecture depicts a relatively simple infrastructure stack. Two bare-metal PowerEdge R940 servers host the main production database. The PowerEdge R940 servers provide the computing power to support high-performance database application requirements. Adjacent PowerEdge R740 servers and VMs host additional databases that are related to the main production database but require less computing power.

Your final solution requirements may require more servers or storage, or both, but the basic principles of the architecture would be similar. Consult with your Dell EMC field team on the appropriate sizing for your solution.
Chapter 2: Architecture and Components

Key components

Compute

The Dell EMC portfolio of PowerEdge rack servers is designed to optimize application performance. The servers support intuitive tools to simplify and automate tasks over the entire server life cycle. Every data center and virtual environment has unique requirements, and PowerEdge technology provides the flexibility that is needed to build a scalable vSphere infrastructure.

This Ready Stack supports the following PowerEdge servers:

- **PowerEdge R740/R740xd**—A 2U, 2-socket server workhorse platform that supports up to 24 DIMM slots, thirty-two 2.5 in. drives, and eight PCIe cards and delivers a balance between storage scalability and performance. The versatile R740xd server supports a mix of any drive types to create the optimum configuration of NVMe drives, SSDs, and HDDs for either performance or capacity, or both.

- **PowerEdge R940**—A 3U, 4-socket powerful server platform that supports up to 48 DDR4 DIMM slots (12 of which can be NVDIMMs), up to twenty-four 2.5 in. bays of SAS/SATA (HDD/SSD) drives, and 13 PCI slots. The scalable business architecture of the R940 server maximizes application performance and provides the flexibility to optimize configurations that are based on the application and use case.

Embedded in each PowerEdge server is iDRAC9, which provides secure and remote server access for a multitude of common management functions. iDRAC with Lifecycle Controller operates regardless of the operating system state or the presence of a hypervisor. It also offers a complete set of server management features, including configuration, operating system deployment, firmware updates, health monitoring, and maintenance.

iDRAC9 supports various remote connectivity interfaces and protocols, including IPMI, Redfish, SMASH-CLP, and WS-Man, enabling administrators to securely configure, deploy, manage, monitor, and update the server. The iDRAC9 HTML5 Web UI provides secure connectivity through HTTPS. The iDRAC9 Enterprise license includes Group Manager, which provides a one-to-many console experience. With Group Manager, administrators can view and manage a set of servers rather than visually inspect the servers for faults and manage them manually.

Networking

The Ready Stack architecture network design consists of these functional groups:

- OOB network
- LAN
- SAN

**OOB network**

The key building block of the OOB management network is the Dell EMC S4148T-ON switch, which provides forty-eight 10GBase-T ports and multiple uplink port options. Using two S4148T-ON switches provides redundancy.
LAN
The Dell EMC S5248F-ON switch provides LAN connectivity. This switch provides up to forty-eight 25 GbE ports and six 100 GbE ports. Using two S5248F-ON switches—referred to as top-of-rack (ToR) switches—provides redundancy. Built-in NICs directly connect the ToR switches to the rackmount servers.

SAN
For FC storage traffic, Ready Stack uses Dell EMC Connectrix DS-6620B switches. The DS-6620B switch delivers up to 32 Gb/s FC performance in a 1U form factor and, by default, has twenty-four 32 Gb/s ports enabled. More ports can be added, enabling up to 64 ports per chassis, through Ports on Demand upgrade kits. Brocade Web Tools, the embedded UI on the Connectrix DS-6620B switches, facilitates the monitoring and management of single or small fabrics, switches, and ports.

Storage
The Dell EMC XtremIO X2 all-flash storage array helps realize the promise of a simple, agile, scalable, fully virtualized data center by providing:

- Integrated Copy Data Management (iCDM), which enables the consolidation of primary data and associated copies on the same scale-out all-flash array for high-performance, efficient, and instant application copies
- Multidimensional scalability, enabling scale up within bricks and scale out by adding bricks to the array
- Data reduction, using inline deduplication, compression, XtremIO Virtual Copies (XVC), and thin provisioning
- High performance with consistently low latency for virtualized workloads
- Rich application-integrated copy services
- One hundred percent in-memory metadata for metadata-aware replication
- XtremIO Data Protection (XDP) for protection against SSD failures
- Available data-at-rest encryption
- Simplified management
- Advanced VMware integrations (with vSphere Storage APIs - Array Integration [VAAI], Dell EMC Virtual Storage Integrator [VSI], VMware vRealize, and VMware Site Recovery Manager [SRM])

A dual X-Brick XtremIO X2 cluster storage array with redundant active/active storage controllers provides sufficient capacity, bandwidth, and high availability for the databases in this Ready Stack design. Each FC port in each XtremIO X2 storage controller is connected to a separate FC switch for high bandwidth and high availability.

The XtremIO X2 array is ideally suited for mixed workloads and database applications. XtremIO iCDM natively provides full copy data management capabilities and integrates production copies with nonproduction copies for critical use cases such as dev/test and newer use cases such as on-demand analytics. The XtremIO X2 array achieves a high degree of space efficiency by using in-memory metadata XtremIO Virtual Copies. The inline data deduplication and compression features can yield significant reductions in database size.
X-Brick building blocks

The XtremIO X2 array is based on the X-Brick block, which is shown in the following figure. A highly available, active/active storage component, the X-Brick block contains two independent fault-tolerant storage controllers (nodes) in a compact disk array enclosure (DAE) with 72 SSDs.

![X-Brick block diagram](image)

**Figure 2.** XtremIO X2 X-Brick block

An X-Brick block has no single point of failure, as illustrated in the following figure. Each X-Brick enclosure has two SAS DAE controllers with dual connections to each storage controller. Each XtremIO X2 cluster has two NVRAM components to help archive unwritten data to permanent storage in the event of a power failure. Each XtremIO X2 storage controller and DAE is equipped with dual power supplies that are each powered from two separate electrical power circuits, in accordance with XtremIO X2 installation best practices.

![Component redundancy diagram](image)

**Figure 3.** XtremIO X2 component redundancy

X-Brick blocks can be clustered to create a large scale-out system that grows linearly in IOPS, bandwidth performance, and capacity as more X-Bricks are added. Each X-Brick block can also scale-up capacity with the addition of SSDs.

An XtremIO X2 cluster can have from one to four X-Brick blocks. A cluster of more than one X-Brick block has dual InfiniBand switches for redundancy, and each storage controller is connected to both InfiniBand switches. The InfiniBand switches are also connected to each other to provide increased bandwidth and redundancy.
XtremIO X2 storage management

The XtremIO Management Server (XMS) WebUI provides advanced reporting and analytics, and automated workflow suggestions, reducing administrator time spent on provisioning and performance tuning.

Support for high-performance database applications

XtremIO X2 storage is designed and optimized for databases with features that enable DBAs to focus on databases and not worry about managing the underlying storage. Database management systems, such as Oracle DBMS, SAP, and Microsoft SQL Server, can operate at peak performance on the XtremIO X2 array. The array delivers high performance for diverse workloads such as online transaction processing (OLTP), data warehousing, and hybrid workloads. It also provides outstanding support for applications such as enterprise resource planning (ERP) and customer relationship management (CRM) systems by delivering high IOPS, network throughput, and transactions per second.

Using XtremIO X2 storage for high-performance database applications provides the following benefits:

- **High performance**—The XtremIO X2 array delivers predictable and consistent low-latency performance, often providing submillisecond response times. The array’s high performance preserves initial investment, while its scale-up and scale-out architecture supports year-to-year growth to meet future demands.

- **Agility**—Enterprise applications typically require multiple copies, such as for dev/test, reporting, and online analytics. This can require DBAs and dev/test engineers to spend hours managing database creation and refreshing the environments while often being limited by capacity, performance, and number of copies. The XtremIO X2 iCDM feature enables the creation of instant XtremIO Virtual Copies from production with no performance impact. DBAs can efficiently repurpose these copies for near real-time analytics, dev/test, and other use cases.

- **Protection**—With the XtremIO X2 array, your data is protected by XDP, a proprietary flash-optimized algorithm. XDP provides ultra-low capacity overhead, high levels of data protection in case of double SSD failure, rapid rebuild times, and flash endurance.

In addition, protecting the database is easy with the XtremIO X2 array. In contrast with RAID, XDP requires no design for RAID type, data file capacity, load balancing, and tuning, and XVC provides for easy protection and recovery from any operational or logical corruption. XVC enables the creation of frequent point-in-time copies, according to recovery point objective (RPO) intervals of seconds, minutes, or hours, for use in recovery. Recovery using XVC is instantaneous and does not affect system performance.

Data protection

The Data Domain system is a disk-based inline deduplication appliance and gateway that provides data protection and disaster recovery in the enterprise environment. It provides the following benefits:

- The Data Domain storage system reduces the amount of disk storage, increasing data protection and retention by 10 to 30 times. Because data on disk is available online and onsite for longer retention periods, restoration is fast and reliable.
• For management, the system includes the DD System Manager UI for configuring, managing, and monitoring. Its DD OS also provides a CLI for performing all system operations.

• Dell EMC DD Boost technology optimizes communication between database servers and the Data Domain system. It improves backup performance by reducing the amount of data that is transferred over the network between database servers and the Data Domain system, as well as the amount of data stored by Data Domain.

In this Ready Stack certified reference system, the XtremIO X2 array provides significant data reduction though inline deduplication, compression, and iCDM. The Data Domain 6300 complements and enhances these gains by providing storage-integrated data protection, through its own rich set of data reduction features, to support backup, archive, and data recovery.

Virtualization

VMware vSphere is a complete and robust virtualization platform that uses dynamic resource pools for flexible and reliable virtualization of business-critical applications. It transforms a computer’s physical resources by virtualizing the CPU, RAM, hard disk, and network controller. It also virtualizes graphics processing units (GPUs) for analytics workloads. This transformation creates fully functional VMs that run isolated and encapsulated operating systems and applications.

In this Ready Stack certified reference system, each of the two OLTP databases is running on its own VM, each of which is hosted on ESXi 6.7U1 on a PowerEdge R940 server. Because deploying high-performance databases is possible without the presence of a virtualization environment, running these databases on VMs is not a requirement. For information about bare-metal versus virtualized infrastructure options in this Ready Stack, see Bare-metal versus virtualized infrastructure on page 9.

Operating system

Red Hat Enterprise Linux offers automation capabilities that are designed to limit IT complexity while enhancing workload security and performance for traditional and cloud-native applications. Although this document focuses on Red Hat Enterprise Linux 7.4, you can use other releases of the Red Hat Enterprise Linux operating system if required.

In this Ready Stack, two production database servers are installed on the operating system. XVC Dev and XVC online analytical processing (OLAP) are XVC development and OLAP databases, respectively, that have been repurposed from the respective production databases. The two-server database forms a cluster. Each instance of Red Hat Enterprise Linux is installed as a bare-metal operating system on a PowerEdge R940 server, as shown in the following figure:
This Ready Stack design also includes two XtremIO Virtual Copies of the databases, both of which are installed on a bare-metal instance of Red Hat Enterprise Linux 7.4 that is installed on a PowerEdge R740 server. The XtremIO X2 array uses the XVC databases for database backup snapshots. Although the design shows the server as local to the production servers, you can also use XtremIO X2 storage features to back up the snapshots to a remote location, as needed.
Chapter 3  Configuration and Specifications

This chapter presents the following topics:

- **Introduction** ........................................................................................................... 18
- **Recommended components** ............................................................................. 18
- **Design configuration and specifications** ..................................................... 19
- **Ready Stack scaling** ....................................................................................... 21
Introduction

This chapter provides details about the recommended components for this Ready Stack and component specifications for sample configurations. It also includes information about scaling the Ready Stack.

Recommended components

This Ready Stack uses the latest Dell EMC PowerEdge rack servers, LAN switches, SAN switches, and XtremIO X2 all-flash storage array. It also includes platform management software.

The following table lists the recommended components:

Table 1. Recommended components

<table>
<thead>
<tr>
<th>Platform/category</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server platforms</td>
<td>• 2 x Dell EMC PowerEdge R940 4-socket servers for physical production databases</td>
</tr>
<tr>
<td></td>
<td>• 1 x Dell EMC PowerEdge R740/R740xd 2-socket server for physical XVC databases</td>
</tr>
<tr>
<td>LAN connectivity for Ethernet traffic</td>
<td>• For leaf: 2 x Dell EMC Networking S5248F-ON 10 GbE switches</td>
</tr>
<tr>
<td></td>
<td>• For spine (if needed): 2 x Dell EMC Networking Z9264F-ON switches</td>
</tr>
<tr>
<td>SAN connectivity</td>
<td>2 x Dell EMC Connectrix DS-6620B 32 Gb/s FC switches</td>
</tr>
<tr>
<td>OOB connectivity</td>
<td>2 x Dell EMC Networking S4148T-ON 1 GbE switches</td>
</tr>
<tr>
<td></td>
<td>Note: We recommend using 2 OOB management switches for high availability.</td>
</tr>
<tr>
<td>Storage array</td>
<td>Dell EMC XtremIO X2 dual X-Brick cluster</td>
</tr>
<tr>
<td>Management server platform</td>
<td>2 x VMs hosted on ESXi 6.7U1 (optionally installable on a single PowerEdge R740 or R940)</td>
</tr>
<tr>
<td>Data protection</td>
<td>Dell EMC Data Domain DD6300 deduplication storage system</td>
</tr>
<tr>
<td>Management software</td>
<td>• Dell EMC OpenManage Integration for VMware vCenter (OMIVV)</td>
</tr>
<tr>
<td></td>
<td>• Dell EMC XtremIO Management Server (XMS)</td>
</tr>
<tr>
<td>Virtualization software</td>
<td>VMware vSphere 6.7U1</td>
</tr>
</tbody>
</table>
Design configuration and specifications

**Database servers**

This Ready Stack for high-performance database applications provides flexibility to address both bare-metal and VM database cluster deployments.

Sizing a physical infrastructure for all workloads requires knowledge of all the individual workloads and their compute, memory, storage, and network performance requirements. This guide describes a database implementation with storage resources that can scale significantly as the database expands. For information about applying the described resources and methodologies to a larger-scale implementation, consult your Dell EMC Sales team.

This Ready Stack includes the following servers:

- Two production PowerEdge R940 database servers
- One development PowerEdge R740 database server for XtremIO Virtual Copies
- Optional: One development PowerEdge R940 server using VMware vSphere virtualization

Consider these configuration recommendations when ordering the servers:

- Populate the PCIe slots with the NICs and HBAs (which are used for database public traffic, private interconnect traffic, and SAN traffic) based on the following slot priority recommendations. These recommendations provide for optimal power, bandwidth, and thermal performance of the adapters and the system. Because each PCIe slot is bound to only one CPU, populate the PCIe slots as follows to allow for I/O load balancing across the CPUs:
  - In the PowerEdge R940-based database servers, populate the HBAs in PCIe slots 2 and 5. Populate the NICs in PCIe slots 3 and 6.
  - In the PowerEdge R740-based database server, populate the HBAs in PCIe slots 1 and 7. Populate the NICs in PCIe slot 3 and in the rack Network Daughter Card (rNDC) slot.

- Set the BIOS System Profile to **Performance**.

- To maximize the memory throughput with the CPU sockets, populate the memory DIMMs with at least one DIMM per memory channel across all CPU sockets. The following table shows the recommended capacity and quantity of memory DIMMs for each of the database servers:

**Table 2. Recommended capacity and quantity of database server memory DIMMs**

<table>
<thead>
<tr>
<th>Use case</th>
<th>Server type</th>
<th>Number of CPU sockets</th>
<th>Number of DIMMs per populated channel</th>
<th>Number of DIMMs per populated socket</th>
<th>Capacity per DIMM</th>
<th>Total physical DRAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>OLTP PROD database</td>
<td>R940</td>
<td>4</td>
<td>1</td>
<td>6</td>
<td>64 GB</td>
<td>4 x 1 x 6 x 64 = 1,536 GB</td>
</tr>
<tr>
<td>XVC databases</td>
<td>R740</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>32 GB</td>
<td>2 x 2 x 6 x 32 = 768 GB</td>
</tr>
<tr>
<td>Databases on vSphere VMs</td>
<td>R940</td>
<td>4</td>
<td>2</td>
<td>6</td>
<td>32 GB</td>
<td>4 x 2 x 6 x 32 = 1,536 GB</td>
</tr>
</tbody>
</table>
For more information about tuning the configuration of the Ready Stack components to meet infrastructure requirements, consult your Dell EMC Sales representative.

The following tables list the hardware details of the database servers that are used for physical production databases in this Ready Stack:

### Table 3. Physical components for production database servers

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servers</td>
<td>2 x PowerEdge R940</td>
</tr>
<tr>
<td>Chassis</td>
<td>3U chassis with up to 24 hard drives</td>
</tr>
<tr>
<td>Processors per server</td>
<td>4 x Intel Xeon Gold 6150 18c 2.7 GHz</td>
</tr>
<tr>
<td>Memory per server</td>
<td>1,536 GB (24 x 64 GB QR DDR4 2,666 MT/s LRDIMMs)</td>
</tr>
<tr>
<td>Local disks per server</td>
<td>3 x 1.6 TB SAS 12 Gb/s 2.5 in. SSDs (R1 + 1 hot spare)</td>
</tr>
<tr>
<td>RAID controller</td>
<td>PERC H740P/H730P</td>
</tr>
<tr>
<td>iDRAC</td>
<td>iDRAC9 Enterprise</td>
</tr>
<tr>
<td>rNDC</td>
<td>Broadcom 5720 DP 1 Gb + 57412 DP 10 Gb NetXtreme-E</td>
</tr>
<tr>
<td>Add-on NICs per server</td>
<td>None</td>
</tr>
<tr>
<td>HBAs per server</td>
<td>2 x Emulex LPe31002-M6-D DP 16 Gb/s FC</td>
</tr>
<tr>
<td>Power supplies per server</td>
<td>2 x 1,600 W</td>
</tr>
</tbody>
</table>

### Table 4. Physical components for XVC database server

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server</td>
<td>1 x PowerEdge R740</td>
</tr>
<tr>
<td>Chassis</td>
<td>2U chassis with up to 16 hard drives</td>
</tr>
<tr>
<td>Processors</td>
<td>2 x Intel Xeon Gold 6136 12c 3.0 GHz</td>
</tr>
<tr>
<td>Memory</td>
<td>768 GB (24 x 32 GB DR DDR4 2,666 MT/s RDIMMs)</td>
</tr>
<tr>
<td>Local disks</td>
<td>3 x 1.6 TB SAS 12 Gb/s 2.5 in. SSDs (R1 + 1 hot spare)</td>
</tr>
<tr>
<td>RAID controller</td>
<td>PERC H740P</td>
</tr>
<tr>
<td>iDRAC</td>
<td>iDRAC9 Enterprise</td>
</tr>
<tr>
<td>rNDC</td>
<td>Broadcom 5720 DP 1Gb + 57412 DP 10Gb NetXtreme-E</td>
</tr>
<tr>
<td>Add-on NICs</td>
<td>None</td>
</tr>
<tr>
<td>HBAs</td>
<td>2 x Emulex LPe31002-M6-D DP 16 Gb/s FC</td>
</tr>
<tr>
<td>Power supplies</td>
<td>2 x 1,100 W</td>
</tr>
</tbody>
</table>
Table 5. Physical components for optional VM-hosted database server

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server</td>
<td>1 x PowerEdge R940 server</td>
</tr>
<tr>
<td>Chassis</td>
<td>3U chassis with up to 24 hard drives</td>
</tr>
<tr>
<td>Processors</td>
<td>4 x Intel Xeon Gold 6150 18c 2.7 GHz</td>
</tr>
<tr>
<td>Memory</td>
<td>1,536 GB (48 x 32 GB DR DDR4 2,667 MT/s RDIMMs)</td>
</tr>
<tr>
<td>Local disks</td>
<td>3 x 1.6 TB SAS 12 Gb/s 2.5 in. SSDs (R1 + 1 hot spare)</td>
</tr>
<tr>
<td>RAID controller</td>
<td>PERC H740P</td>
</tr>
<tr>
<td>iDRAC</td>
<td>iDRAC9 Enterprise</td>
</tr>
<tr>
<td>rNDC</td>
<td>Broadcom 5720 DP 1Gb + 57412 DP 10Gb NetXtreme-E</td>
</tr>
<tr>
<td>Add-on NICs</td>
<td>None</td>
</tr>
<tr>
<td>HBAs</td>
<td>2 x Emulex LPe31002-M6-D DP 16 Gb/s FC</td>
</tr>
<tr>
<td>Power supplies</td>
<td>2 x 2,000 W</td>
</tr>
</tbody>
</table>

Ready Stack scaling

If constructing multiple database racked systems or connecting this Ready Stack to other rack-based systems in the data center, you can use Dell EMC Networking Z9264 switches to create a simple yet scalable network, as shown in the following figure. The Z9264 switches serve as the spine switches in the leaf-spine architecture. The Z9264 is a multiline rate switch that supports 10/25/40/50/100 GbE connectivity and can aggregate multiple racks with little or no oversubscription.
When connecting multiple racks by using the 40/100 GbE uplinks from the rack, you can build a fabric that supports multi-terabit clusters. The density of the Z9264 enables flattening of the network tiers, so you can create an equal-cost fabric from any point to any other point in the network.

For large-domain Layer 2 requirements, use extended Virtual Link Trunking (eVLT) on the Z9264, as shown in the following figure. The Virtual Link Trunking (VLT) pair that is formed can scale to hundreds of servers inside multiple racks. Each rack has four 40/100 GbE links to the core network, providing enough bandwidth for all the traffic between each rack.
Figure 6. Multiple compute pods scaled out by using eVLT
This chapter presents the following topics:

- Compute design ................................................................. 25
- Network design ............................................................... 26
- Storage design ................................................................. 27
- Management design ......................................................... 29
Compute design overview

Dell EMC PowerEdge servers are built to accommodate a variety of workload types including high-performance database applications. They are part of a secure and scalable compute platform that is the ideal foundation for on-premises, cloud, analytics, and software-defined data center initiatives. Scaling compute resources with Intel Xeon Scalable processors provides an increase in processing cores and an increase in bandwidth.

The PowerEdge rack server platforms support the Registered DIMM (RDIMM) and Load Reduced DIMM (LRDIMM) memory types. LRDIMM uses an internal buffer to isolate electrical loading from the host memory controller, enabling the use of quad-ranked DIMMs to increase overall memory capacity. For high-performance database configurations, we recommend the following memory resources on the physical servers:

- For each of the two physical production servers:
  1,536 GB (24 x 64 GB QR DDR4 2,666 MT/s LRDIMMs)
- For the physical XVC database server:
  768 GB (24 x 32 GB DR DDR4 2,667 MT/s RDIMMs)
- For the VM-hosted database server:
  1,536 GB (48 x 32 GB DR DDR4 2,667 MT/s RDIMMs)

For information about bare-metal and virtualized infrastructure options in this Ready Stack, see Bare-metal versus virtualized infrastructure on page 9.

You can configure memory in various modes from within the BIOS. To provide an optimized memory performance, the default Optimizer Mode works best for most virtualization use cases. Mirror Mode, Single Rank Spare Mode, and Multi Rank Spare Mode are available for improved reliability and resiliency.

The following table lists the recommended adapters:

<table>
<thead>
<tr>
<th>Adapter</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broadcom 5720 DP 1 Gb + 57412 DP 10 Gb NetXtreme-E rNDC</td>
<td>Virtual workload and host communication</td>
</tr>
<tr>
<td>2 x Emulex LPe31002-M6-D DP 16 Gb/s FC</td>
<td>FC SAN connectivity for PowerEdge servers that connect to XtremIO X2 storage</td>
</tr>
</tbody>
</table>

PowerEdge servers support various BIOS configuration profiles that control the processor, memory, and other options. Dell EMC recommends that you:

- Enable the Performance Optimized virtualization profile.
- Disable the processor’s C States and C1E options to ensure the highest performance in a virtualized environment.
- Enable Intel Hyper-Threading and virtualization features.
The Dell EMC server platforms that are recommended for this Ready Stack for high-performance database applications are:

- **PowerEdge R740 rack server**—The R740 is designed to accelerate application performance. With up to sixteen 2.5 in. drives or eight 3.5 in. drives, the R740 provides the versatility to adapt to virtually any application. Its NVDIMM-N persistent memory can increase database performance by a factor of 10. For specification details, see the [Dell EMC PowerEdge R740 Spec Sheet](#).

- **PowerEdge R940 rack server**—The R940 is designed to power mission-critical applications and high-intensity workloads. With up to 6 TB of memory and 13 PCIe Gen 3 slots, the R940 has the resources to maximize application performance and scale for future demands. Its high-bandwidth quad-socket option is optimized for virtualized environments. For specification details, see the [Dell EMC PowerEdge R940 Spec Sheet](#).

For both PowerEdge server models, Dell EMC OpenManage systems management helps ensure peak efficiency by delivering intelligent, automated management of routine tasks.

### Network design

**Dell EMC Open Networking**

Dell EMC Open Networking disaggregates the hardware from the operating system, giving you the choice of picking the operating system that best fits your unique network infrastructure needs. Open Networking is achieved by using standards-based building blocks that use open source where possible.

The Open Network Install Environment (ONIE), an open-source project within the Open Computer Project, provides an installation environment for bare-metal networking switches. ONIE also provides the option to install different network operating systems on a common set of networking hardware. ONIE is like any operating system boot loader for Windows or Linux and uses the same GRand Unified Bootloader (GRUB) structure that is commonly found in Linux distributions.

In the Dell EMC Networking portfolio, any switch model with an “-ON” suffix, such as the Dell EMC Networking Z9264F-ON and the Dell EMC Networking S5248F-ON switches, has ONIE enabled.

For information about ONIE, see [http://onie.org/](http://onie.org/).

**Network architecture**

The network architecture employs a VLT connection between the two ToR switches. The inherent redundancy of a non-VLT environment requires standby equipment, which increases infrastructure costs and risks. In a VLT environment, all paths are active, adding immediate value and throughput while protecting against hardware failures. VLT technology enables a server or bridge to uplink a physical trunk into more than one Networking S5248F-ON switch by treating the uplink as one logical trunk. A VLT-connected pair of switches acts as a single switch to a connecting bridge or server. Both links from the bridge network can forward and receive traffic.
VLT provides a replacement for Spanning Tree Protocol (STP)-based networks by using multiple active paths to provide both redundancy and full bandwidth utilization. The major benefits of VLT technology are:

- Dual control plane for highly available resilient network services
- Full utilization of the active LAG interfaces
- Active/active design for seamless operations during maintenance events

The Dell EMC Networking S5248F-ON switches each provide six 40/100 GbE uplink ports. The VLT interconnect (VLTi) configuration in this architecture uses two 40/100 GbE ports from each ToR switch to provide a 200 GB data path between the switches.

The following figure illustrates the Networking S5248F-ON VLTi configuration:

![Figure 7. Networking S5248F-ON VLTi configuration](image)

**Storage design**

**Storage design overview**

The XtremIO X2 storage array is designed and optimized for high-performance databases and the DBAs who manage them. Database applications can operate at peak performance on the XtremIO X2 array under heavy workloads.

Running mixed workloads (OLTP and OLAP) on a combination of physical and virtual environments enables you to consolidate all types of databases with submillisecond latencies and strong throughput.

In this Ready Stack, using the XtremIO X2 XMS WebUI, we created the following XtremIO X2 storage volumes for a clustered database implementation:

- Three volumes for the database for cluster level services.
- Four volumes (minimum) for the database data to optimize queuing.
- Two volumes for the database that contains redo files. Used in recovery operations, redo files are preallocated files that store all changes made to the database as they occur.
- One volume for fast recovery. This volume includes redo logs, a control file, archived logs, backup pieces and copies, and flashback logs.
- One volume for the database that contains temp files.
Volume provisioning in XtremIO X2 storage is simple and straightforward. You can create volumes and present them to the database servers with just a few clicks from the XtremIO X2 XMS WebUI.

In the following example, the clustered high-availability database configuration includes a production database running on two R940 servers. In this production database, each of the storage volumes is mapped to each of the R940 servers.

![Clustered Production Database Diagram](image)

**Figure 8. Example of clustered high-availability database configuration**

Under an OLTP workload, the XtremIO X2 array provides advanced inline data reduction methods to reduce the physical data that must be stored. In this scenario, the XtremIO X2 array delivers strong IOPS performance for production workloads, and low average latency for reads and writes. In terms of transactions per minute (TPM), the two-node database can support a large OLTP workload.

Unique inline data reduction capabilities, combined with a simple scalable architecture, enable creation of production database copies at almost zero cost. These data reduction capabilities, which include thin provisioning, compression, and deduplication, are combined with the Virtual Copies that the XtremIO X2 array creates in-memory by using XVC technology without affecting production performance. The Virtual Copies share the same performance capabilities because they use the same paths and access the same physical data.

Using this same clustered database implementation, you can use the XVC feature to create and repurpose production copies. Doing so speeds database provisioning (such as for near real-time analytics, test, or development), with complete space efficiency.

Creating database snapshots in a production environment that is running OLTP and OLAP workloads, and providing submillisecond latencies, does not take up additional physical storage space in the XtremIO X2 array.
Management design

Management infrastructure

The management of this Ready Stack design centers around a new or existing VMware vSphere environment. Additional plug-ins such as Dell EMC OpenManage Integration for VMware vCenter (OMIVV) and iDRAC provide ease of management for the physical PowerEdge servers.

For information about bare-metal and virtualized infrastructure options in this Ready Stack, see Bare-metal versus virtualized infrastructure on page 9.

VMware vCenter Server Appliance

vCenter Server Appliance 6.7 is a preconfigured Linux VM that is optimized for running vCenter Server and its associated services. This Ready Stack design assumes that the two VM-hosted database servers will be deployed in your existing virtualization management infrastructure.

vCenter Server provides management of virtualized hosts and VMs from a single console. It gives administrators visibility into the configuration of the critical components of a virtual infrastructure. vCenter Server enables key capabilities such as vSphere vMotion, vSphere DRS, vSphere HA, and vSphere FT. The open plug-in architecture of vCenter Server supports a broad range of additional capabilities from VMware and its partners. The vCenter Server APIs also enable integration of physical and virtual management tools for maximum flexibility.

Dell EMC OpenManage Integration for VMware vCenter

OMIVV streamlines the management processes in the data center environment by enabling the use of vCenter to manage the entire server infrastructure—both physical and virtual. OMIVV expands data center management with PowerEdge servers in many ways, including:

- Monitoring system-level information
- Producing system alerts
- Rolling out cluster-level BIOS and firmware updates for an ESXi cluster
- Supporting bare-metal deployments

OMIVV provides deep-level details for inventory, monitoring, and alerting of Dell EMC hosts within vCenter, and it recommends or performs vCenter actions based on Dell EMC hardware events.

Proactive HA is a feature of vSphere HA that works with OMIVV. If you are using a vSphere virtualization infrastructure that has multiple hosts (see Bare-metal versus virtualized infrastructure on page 9), the Proactive HA feature safeguards workloads by proactively taking measures based on degradation of redundancy health of supported components in a host. When OMIVV detects a change in the redundancy health status of supported components, through either traps or polling, it sends a health update notification for the component to the vCenter server. Polling runs every hour, and it is available as a fail-safe mechanism to cover the possibility of a trap loss. After assessing the redundancy health status of the supported host components, the OMIVV appliance updates the vCenter server with the health status change.

Deployment templates contain a system profile, hardware profile, hypervisor profile, a combination of system profile and hypervisor profile, or a combination of the hardware
profile and hypervisor profile. The OMIVV deployment wizard uses the template to provision server hardware and deploy hosts within vCenter. Dell EMC recommends using the system profile type for the servers that are described in this Ready Stack certified reference system. For Dell EMC Internal Dual SDM Module (IDSDM) deployment, enable the IDSDM from the BIOS before you deploy a hypervisor with OMIVV.

In this Ready Stack, the management software components run on the two VMs that are hosting the OLTP databases. The following table shows the recommended VM sizing of the management components:

Table 7. Recommended VM sizing of management components

<table>
<thead>
<tr>
<th>Component</th>
<th>Number of VMs</th>
<th>Number of CPU cores</th>
<th>RAM (GB)</th>
<th>Disk space (GB)</th>
<th>Number of NICs</th>
</tr>
</thead>
<tbody>
<tr>
<td>vCenter Server Appliance</td>
<td>1</td>
<td>4</td>
<td>16</td>
<td>290</td>
<td>1</td>
</tr>
<tr>
<td>OMIVV</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td>44</td>
<td>1</td>
</tr>
</tbody>
</table>
This chapter presents the following topics:

**Dell EMC documentation** ................................................................. 32
**ONIE documentation** .................................................................... 32
**VMware documentation** ................................................................. 33
Dell EMC documentation

The following Dell EMC documentation provides relevant information. Access to these documents depends on your login credentials. If you do not have access to a document, contact your Dell EMC representative.

- Best Practices for Running Oracle on Dell EMC XtremIO X2 White Paper
- Brocade Fabric OS Web Tools Administration Guide
- Dell EMC Connectrix DS-6600B Switches Specification Sheet
- Dell EMC Data Domain DD6300 Data Protection (product page)
- Dell EMC Data Domain Deduplication Storage Systems Spec Sheet
- Dell EMC Networking ONIE Quick Start Guide
- Dell EMC Networking Z9264F-ON Series Switch Spec Sheet
- Dell EMC PowerSwitch S-Series 25/40/50/100GbE switches (product page with links to S5000 series spec sheets)
- Dell EMC Ready Solutions for Oracle with Dell EMC XtremIO X2 and Data Domain Validation Guide
- Dell EMC PowerEdge R740 Installation and Service Manual
- Dell EMC PowerEdge R740 Specification Sheet
- Dell EMC PowerEdge R740 and R740xd Technical Guide
- Dell EMC PowerEdge R940 Installation and Service Manual
- Dell EMC PowerEdge R940 Spec Sheet
- Dell EMC PowerEdge R940 Technical Guide
- Dell EMC Virtual Storage Integrator (VSI) for VMware vSphere Client Product Guide
- Dell EMC XtremIO X2 All-Flash Array (product page)
- Dell EMC XtremIO X2 Data At Rest Encryption White Paper
- Dell EMC XtremIO X2 Specifications
- iDRAC9 Knowledge Base
- Integrated Dell Remote Access Controller 9 User Guide
- Introduction to Dell EMC XtremIO X2 Storage Array White Paper
- OpenManage Integration for VMware vCenter Knowledge Base
- S5200F-ON Series Installation Guide

ONIE documentation

For ONIE documentation, see the Open Network Install Environment wiki.
VMware documentation

The following VMware documentation provides additional information:

- [VMware vCenter Server 6.7 Update 1 Release Notes](#)
- [VMware vSphere Documentation](#)