Cisco Reference Configurations for Microsoft SQL Server 2008 R2 Fast Track Data Warehouse 3.0 with EMC VNX5300 Series Storage Systems

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Introduction

Deploying data warehousing solutions that support high capacity and high performance is increasingly essential to business success and competitive advantage. As organizations realize the importance of mining their accumulated data for important business insights, enterprise data warehouses have been growing rapidly, often doubling or tripling in size in a very short time. This massive data growth is often accompanied by increased complexity, both in the management of large volumes of data and in making sure that the data is available for high-performance queries that support essential business decisions.

The reference configurations presented in this document address the common business challenges that IT functions face today, including:

· New application deployments to address business growth and opportunities along with growing demands

· Migration from existing proprietary systems to industry-standard hardware and software

· Hardware refresh demands fueled by growing complexity and response-time requirements

· Consolidation of applications from multiple older servers to fewer, more powerful systems to simplify operations and reduce operating expenses

With Microsoft SQL Server 2008 R2, Microsoft continues to be the value leader, offering comprehensive capabilities to support data warehouse applications. Microsoft has introduced the Microsoft SQL Server Fast Track Data Warehouse program to enable organizations to rapidly deploy predictable enterprise data warehousing infrastructure. Microsoft SQL Server Fast Track 3.0–the third generation of this initiative–is designed to let organizations quickly and reliably deploy a total system solution including server, storage, and connectivity for data warehouses based on Microsoft SQL Server 2008 R2. This approach helps dramatically reduce the burden on end users in (selecting, sizing,

and configuring) a data warehouse.

and testing the right combination of products and technologies while dramatically reducing the risk of failure.

The Microsoft SQL Server Fast Track Data Warehouse 3.0 reference configurations presented in this document are designed, tested, and validated by Cisco, EMC, and Microsoft to provide:

- Architectural guidance for customers, partners, and resellers who are evaluating, planning, or deploying Microsoft SQL Server–based data warehouse solutions
- Performance and capacity guidance for selecting server, storage, and connectivity solutions in which out-of-the box performance and rapid deployments are important
- Lower cost of ownership by using industry-standard hardware and software, eliminating the cost associated with custom performance benchmark testing and proofs of concept

This document introduces a medium-sized enterprise reference configuration and a large enterprise reference configuration, which together are designed to meet a broad range of data warehouse requirements. As of this writing, the reference configurations scale from 8 to 40 terabytes (TB) of recommended user capacity using the compression capabilities available in Microsoft SQL Server 2008 R2.

The reference configurations presented in this document are based on:

- **Cisco UCS™ C-Series Rack-Mount Servers:** Powered by Intel® Xeon® processor 5600 and 7500 Series CPUs, these rack-mount servers are designed to operate both in standalone environments and as part of the Cisco Unified Computing System™ (Cisco UCS).
- **EMC® VNX5300™ Series Storage System:** With industry-leading performance, EMC VNX5300 storage systems offer unified support for block and file usage protocols, a simple and intuitive management interface, five-nines reliability, and built-in features for supporting replication, disaster protection, and automatic storage tiering.
- **Cisco Nexus® 5000 Series Switches:** The Cisco Nexus 5000 Series provides a standards-based unified fabric that carries all I/O modalities including Ethernet and Fibre Channel over a single network, significantly reducing the infrastructure cost.

Cisco and EMC Reference Configurations for Microsoft SQL Server Fast Track Data Warehouse

As a part of the Microsoft SQL Server Fast Track Data Warehouse program, Cisco and EMC partnered with Microsoft and worked jointly to complete a comprehensive qualification process. This approach helps ensure that the complete solution conforms to Microsoft's guidelines for the Microsoft SQL Server Fast Track Data Warehouse program.

Microsoft SQL Server Fast Track Data Warehouse Program
Optimized for common data warehouse, decision support, and business analytics deployments based on Microsoft SQL Server, the Microsoft SQL Server Fast Track

Data Warehouse program allows organizations to deploy tested configurations using proven technologies that offer balanced solution stacks. By following these reference configurations, new projects can be implemented quickly and confidently, avoiding much of the guesswork, planning choices, and difficult decisions involved in traditional approaches. Goals of the program include:

· Accelerated data warehouse projects with pretested and validated hardware and software configurations

· Reduced hardware and maintenance costs as a result of purchasing the right balanced hardware solution that is optimized for data warehouse workloads

· Reduced planning and setup costs as well as less risk as a result of choosing the right scale model, configuring the system correctly, and taking advantage of tuning guidance

Microsoft SQL Server Fast Track Data Warehouse reference configurations help to optimize sequential I/O—critical to data warehouse performance—along with providing a balanced approach to hardware configuration. Most system architectures consider the memory, I/O bandwidth and storage capacity separately when planning a system. Instead, Microsoft SQL Server Fast Track Data Warehouse reference architecture is intended to balance the overall system so that throughput is matched across the various hardware and software components specifically for data warehouse performance. Main considerations for balanced data warehousing application performance include:

· Compute power in terms of available CPU cores

· Main memory for the use of the Microsoft SQL Server cache

· I/O channel throughput between the server and the storage system, including the combined throughput of the host bus adapters (HBAs) and switching hardware

· Storage system throughput for sequential read operations, caching capabilities, data storage capacity, and redundancy

The goal of a Microsoft SQL Server Fast Track Data Warehouse reference configuration is to achieve a cost-effective balance between Microsoft SQL Server data processing capabilities and the capabilities of the underlying hardware components.

Reference Configuration Components

Two reference configurations were designed and tested by Cisco and EMC—a medium-sized enterprise reference configuration and a large enterprise reference configuration—both based on the core components depicted in Figure 1. These reference configurations were intended to balance computing power, storage performance, and capacity, while emphasizing the core values provided by Cisco and EMC. The reference configurations can be deployed as is, or they can be used as starting points for building larger systems. The main components of the reference configurations are described in detail in the sections that follow.

Cisco UCS C-Series Rack-Mount Servers Based on Intel Xeon Processors

Both reference configurations are powered by Cisco UCS C-Series Rack-Mount servers based on Intel Xeon processor 5600 and 7500 series CPUs. Intel Xeon

Figure 1. The Reference Configurations Consist of Cisco UCS C-Series Rack-Mount Servers, Cisco Nexus 5548UP Switches, and EMC VNX5300 Storage Systems
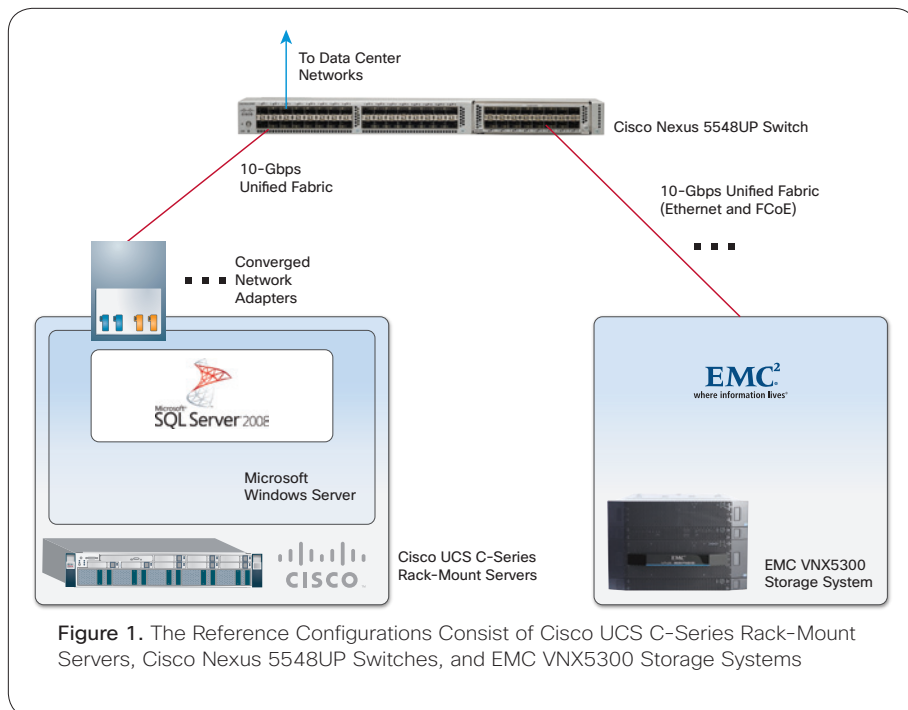
processors at the core of these systems deliver new levels of scalability and performance to support new business intelligence capabilities in Microsoft SQL Server 2008 R2. These advancements help enable large-scale consolidation and virtualization efforts while supporting demanding data-intensive workloads. New features specific to the Intel Xeon processor 7500 series include dynamic reassignment of workloads across processors, interconnect error detection and recovery, and individual virtual machine recovery in virtualized environments. In addition, with Intel Machine Check Architecture Recovery, Intel Xeon processor 7500 series-based servers can automatically detect errors and then work with Microsoft Windows Server 2008 R2 to correct them. In addition, dramatic reductions in total cost of ownership (TCO) are possible with Intel Xeon processors, helping organizations achieve lower costs with automated energy efficiency and consolidation.

Designed to operate both in standalone environments and as part of the Cisco Unified Computing System, the Cisco UCS C-Series Rack-Mount servers enable organizations to deploy systems incrementally—using as many or as few servers as needed—on a schedule that best meets the organization's timing and budget. Many organizations prefer rack-mount servers because of the wide range of I/O options available in the form of PCI adapters. Cisco UCS C-Series servers support a broad range of I/O options, including interfaces supported by Cisco as well as adapters from third parties.

When deployed as part of the Cisco Unified Computing System, these servers can become part of a single converged system whose entire configuration is programmable through Cisco UCS Manager and an XML API. An integral component of Cisco UCS Manager, Cisco UCS service profiles embody the entire system configuration, from firmware revisions and BIOS settings to network profiles.

This automation of system configuration dramatically simplifies and accelerates deployment of enterprise applications such as Microsoft SQL Server, and makes rehosting of the software on larger or smaller servers a point-and-click operation. Moving applications between servers to accommodate larger or smaller workloads is as straightforward as applying a Cisco® service profile to an alternative server and rebooting. Similar to standalone deployments, the Cisco UCS uses a 10-Gbps unified fabric to support both networking and storage access. In contrast to standalone deployments, integration with Cisco UCS enables end-host mode, allowing the data center network to interact with the system as a single server rather than an additional hierarchy of components.

Cisco Nexus 5000 Series Switches

As a part of the unified fabric component of the Cisco Data Center Business Advantage (DCBA) architectural framework, Cisco Nexus 5000 Series Switches deliver a single network technology that supports all I/O in the system. Traditional architectures required separate network switches for handling the server-to-client exchanges, and separate Fibre Channel switches to support I/O traffic. Instead, the unified fabric simplifies the infrastructure by using converged network adapters (CNAs) that each present multiple Ethernet network interface cards (NICs) and Fibre Channel HBAs to the server's PCIe bus. Use of CNAs makes the unified fabric's existence completely transparent to the operating system. Storage administrators can continue to use the same management tools and best practices while storage traffic is physically carried over the system's unified fabric.

There are many advantages to using a unified fabric that supports 10 Gigabit Ethernet and Fibre Channel over Ethernet (FCoE):

- Fewer interface cards need to be purchased, installed, configured, powered, cooled, and managed.
- No Fibre Channel switches are necessary to support the fabric at the rack level.
- The cost of cabling and transceivers is significantly reduced: fiber transceivers are costly, and fiber cabling is fragile. The 10 Gigabit direct-attached copper cabling supported by the Cisco Nexus 5000 Series is inexpensive and reliable.

In the reference configurations described in this document, the unified fabric is extended directly to the EMC VNX5300 storage systems, eliminating the need for any Fibre Channel switching or cabling, further reducing costs. FCoE traffic is carried end to end over the Cisco Nexus 5000 Series low-latency, 10 Gigabit Ethernet and FCoE network. To faithfully support the Fibre Channel model, all FCoE traffic is passed using a lossless priority on the Ethernet network so that no packets containing storage traffic can be lost due to network congestion. The use of FCoE does more than reduce cost: it helps increase performance due to the 10-Gbps speed of the underlying Ethernet network.

EMC VNX5300 Storage System

The EMC VNX5300 storage system is powerful, affordable, and simple, offering reliability, manageability, modular scalability, and performance to address sustained data access bandwidth for demanding data warehouse applications. The system also provides leading array software features to support different types of disk drives, data placement, and auto-tiering. Other software capabilities include virtual

logical unit number (LUN) migration and expansion, rapid point-in-time snapshots, stored data block cloning, remote mirroring support, and other advancements. Whether accessed as block- or file-based storage objects, all data can be managed uniformly in a single EMC Unisphere™ Web-based window. As described in the previous section, EMC VNX5300 storage systems are FCoE enabled, so storage traffic is carried end-to-end over the network using FCoE rather than native Fibre Channel, resulting in significant cost savings.

Reference Configuration Overview and Performance

As a part of the Cisco and EMC collaboration, medium-sized enterprise and large enterprise configurations were defined to meet a range of data warehouse requirements as shown in Table 1. Both configurations connect through a Cisco Nexus 5548UP Switch using different numbers of CNAs as appropriate to the requirements of each reference configuration. Cisco Nexus switches can also be used to connect other IT infrastructure as required in addition to the reference configuration components. Additional details of the configurations are provided in the sections that follow.

Table 1. Medium-Sized Enterprise and Large Enterprise Reference Configurations

Reference Configuration	Server	Processor	Memory	Settings
Medium-sized enterprise	Cisco UCS C250 M2 Extended-Memory Rack-Mount Server	Two Intel Xeon processors X5680 series	192 GB	EMC VNX5300 storage system with 75 SAS disk drives
Large enterprise	Cisco UCS C460 M1 High-Performance Rack-Mount Server	Four Intel Xeon processors X7560 series	256 GB	Two EMC VNX5300 storage systems, each with 75 SAS disk drives

The Microsoft SQL Server Fast Track 3.0 workload consisted of a set of both simple and moderately complex queries representative of modern data warehouse environments. As part of the certification process, these queries executed from 5 to 40 concurrent query streams, running from 30 minutes to 1 hour each. From the results of these tests, both logical scan rates (how quickly data can be read from the buffer cache) and physical scan rates (how quickly data can be read from the physical disk) were determined. Table 2 lists the performance of both the medium-sized enterprise and large enterprise data warehouse reference configurations.

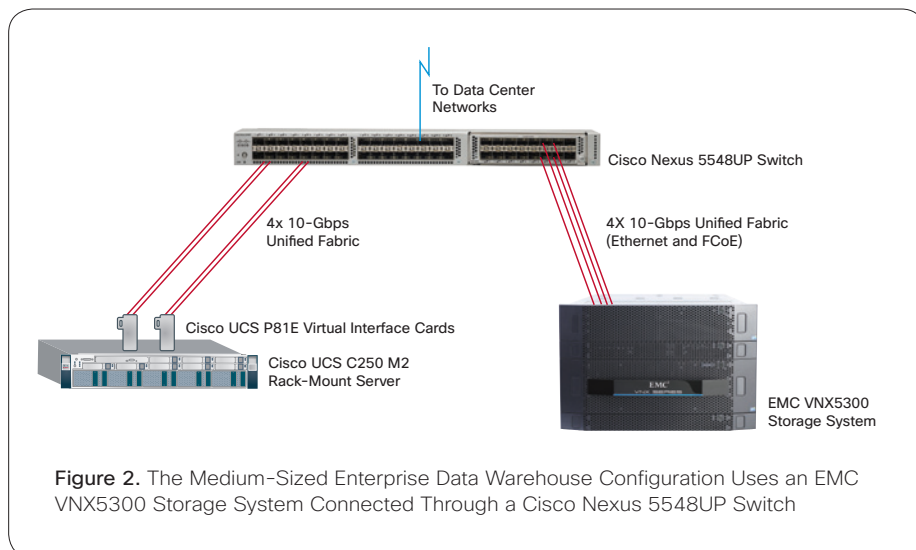**Table 2**. Performance Testing Results for Medium-Sized and Large Enterprise Reference Configurations

Tested Criteria	Medium-Sized Enterprise Reference Configuration	Large Enterprise Reference Configuration
Maximum user data capacity	33 TB	66 TB
Recommended user data capacity	20 TB	40 TB
Benchmark scan rate: Logical	2728 MBps	5577 MBps
Benchmark scan rate: Physical	1985 MBps	3419 MBps
Average Microsoft SQL Server data processing rate	2356 MBps	4498 MBps
Maximum Microsoft SQL Server data processing rate	3600 MBps	6619 MBps

Medium-Sized Enterprise Data Warehouse Reference Configuration

The medium-sized enterprise configuration is intended to meet the performance, capacity, and price requirements of medium-sized to large data warehouse environments.

Configuration Details

Depicted in Figure 2 and detailed in Table 3, the medium enterprise configuration offers considerable ease of use and scalability and provides a usable data capacity

Figure 2. The Medium-Sized Enterprise Data Warehouse Configuration Uses an EMC VNX5300 Storage System Connected Through a Cisco Nexus 5548UP Switch

of 8 to 20 TB. Two Cisco UCS P81E Virtual Interface Cards (VICs) connect the Cisco UCS C250 rack-mount server to the Cisco Nexus 5548UP with four 10-Gbps unified fabric links using FCoE. Four 10-Gbps unified fabric links connect the EMC VNX storage system to the Cisco Nexus 5548UP, also over FCoE. Because the solution uses end-to-end FCoE connections, four full 10-Gbps connections are provided from the server to the EMC VNX5300 storage system.

Table 3. Medium-Sized Enterprise Configuration Details

Server	Cisco UCS C250 M2 Extended-Memory Rack-Mount Server	Processor	Intel Xeon processor X5680 (3.33 GHz, 12-MB Last-level cache, 130 watts [W])
		Memory	96 GB (12 x 8-GB DDR3 1333-MHz RDIMM); up to 384 GB supported
		Internal disk drives	2 Small Form-Factor (SFF) 300-GB 10,000-RPM SAS disk drives
		Converged network adapter (CNA)	2 Cisco UCS P81E VICs
Storage	EMC VNX 5300	Disk drives	75 SFF 300-GB 10,000 -RPM SAS disk drives
		Data protection	RAID 5 for data and temporary database (tempdb) files; RAID 10 for log file
Connectivity		Switch	Cisco Nexus 5548UP Switch
		Protocol	FCoE

EMC VNX5300 Storage Layout

The EMC VNX5300 disk processing enclosure can support up to twenty-five 2.5-inch form-factor disk drives. Additional disk drives can be connected using disk-array enclosures (DAEs) that each provide 25 additional drive slots. One EMC VNX5300 storage system with two installed DAEs is used in this reference configuration. The total storage system, including all the enclosures for the disk drives, occupies nine rack units (9RUs) of rack space. Figure 3 illustrates the data layout for the reference configuration.

Figure 3. The EMC VNX5300 Storage System Is Configured with Two DAEs
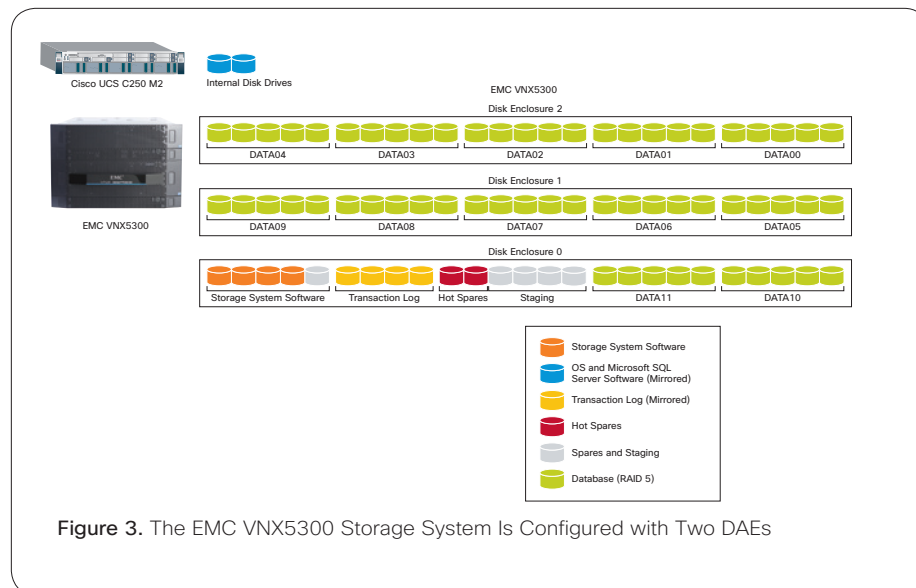
Disk drives in the EMC VNX5300 storage system are configured according to their use in the data warehouse system:

- **Storage system:** Four drives are reserved for the EMC VNX storage system's operating environment, shown as dark orange in the illustration.
- **Transaction log:** Four drives in the form of a 2+2 RAID 10 group are used for the transaction log, shown as dark yellow in the illustration.
- **Data LUNs:** 60 drives are used for database files. These 60 drives are organized into 4+1 RAID 5 sets, known as RAID groups in EMC VNX terminology and colored green in the illustration.
- **Hot spares:** Two drives are reserved as hot spares (colored red in the diagram) and are ready to be automatically switched in to immediately rebuild any of the data drives in any of the RAID 5 groups, reducing the chance of data loss resulting from drive failures in one of the data LUNs.
- **Staging area:** Four drives are used as a staging area, such as for data landing; these are colored gray in the illustration.

Design Considerations

The RAID 5 or parity RAID configuration consists of five data drives protected by distributed parity. In the RAID 5 configuration, each 256-KB chunk of database data stored on one of the data LUNs is striped in 64-KB increments across four of the five drives in each RAID set. On the fifth drive, 64 KB of parity information is computed and stored based on the data on the other four drives.

RAID 5 was chosen as the storage deployment layout for two main reasons:

- Lower cost of data protection compared to RAID 10, with RAID 5 requiring only 20 percent of the total usable capacity for storing parity data
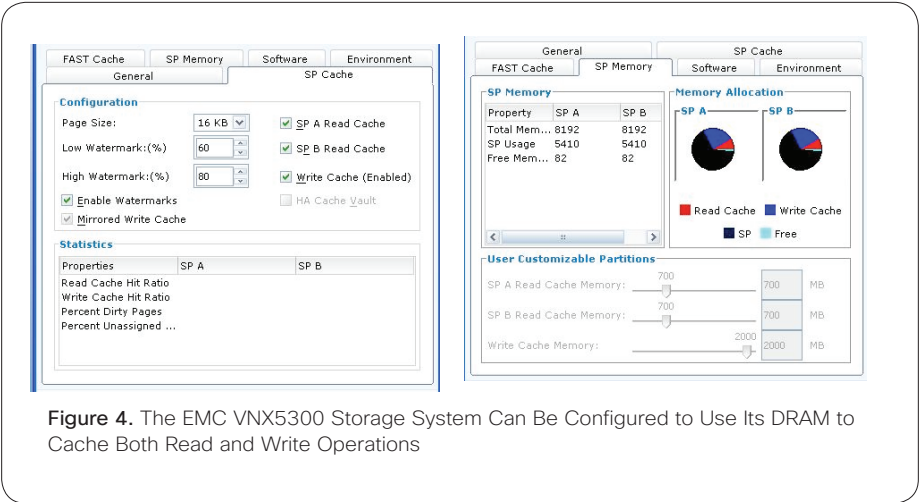- High read performance because all drives contribute to the delivery of data

Figure 4. The EMC VNX5300 Storage System Can Be Configured to Use Its DRAM to Cache Both Read and Write Operations

EMC VNX5300 Storage System Cache Settings

In this reference configuration, 2000 MB of DRAM from the storage processors supports host write caching, and 700 MB supports read-ahead caching. Figure 4 provides a screenshot from the storage management browser window.

Host-Side I/O Device and Multipathing Considerations

The Cisco UCS C250 rack-mount server is configured with two Cisco UCS P81E VICs, with each card providing two 10-Gbps unified fabric links. EMC PowerPath® Version 5.5 for Microsoft Windows 2008 is used as the host-device multipathing management software. Under Microsoft Windows Disk Manager, the EMC PowerPath service presents 14 uniquely identified volumes (12 for data and 1 each for the transaction log and the staging area). Figure 5 provides a screenshot from the EMC PowerPath Management window illustrating the 14 volumes that are presented to the Cisco UCS C250 rack-mount server in the medium-sized enterprise reference configuration.
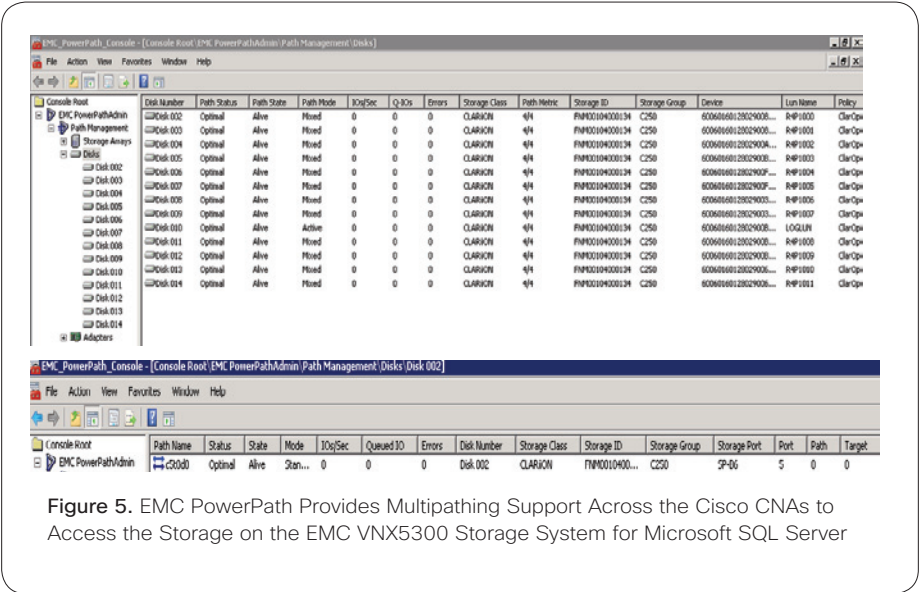

Figure 5. EMC PowerPath Provides Multipathing Support Across the Cisco CNAs to Access the Storage on the EMC VNX5300 Storage System for Microsoft SQL Server

For each of the 12 data drives configured, EMC PowerPath policies select one of the four possible host-to-storage paths as the preferred path (shown as the active path in the Disk 002 path display above). In essence, each of the four host-to-storage paths is assigned 3 of the 12 data LUNs and configured as the primary access I/O channel for those LUNs.

Large Enterprise Data Warehouse Reference Configuration

The large enterprise data warehouse reference configuration is intended to meet the performance, capacity, and price requirements of enterprise-class data warehousing environments, while offering the ease of use of the EMC VNX5300 storage system.

Configuration Details

The large enterprise data warehouse configuration is depicted in Figure 6 and detailed in Table 4. The configuration consists of a Cisco UCS C460 M1 High-Performance Rack-Mount Server equipped with four Intel Xeon processors X7560, 256 GB of memory, and eight QLogic QLE8152 dual-port 10-Gbps CNAs. The storage consists of two EMC VNX5300 storage systems connected through a Cisco Nexus 5548UP Switch.


Figure 6. The Large Enterprise Data Warehouse Configuration Uses Two EMC VNX5300 Storage Systems for End-to-End FCoE Connectivity
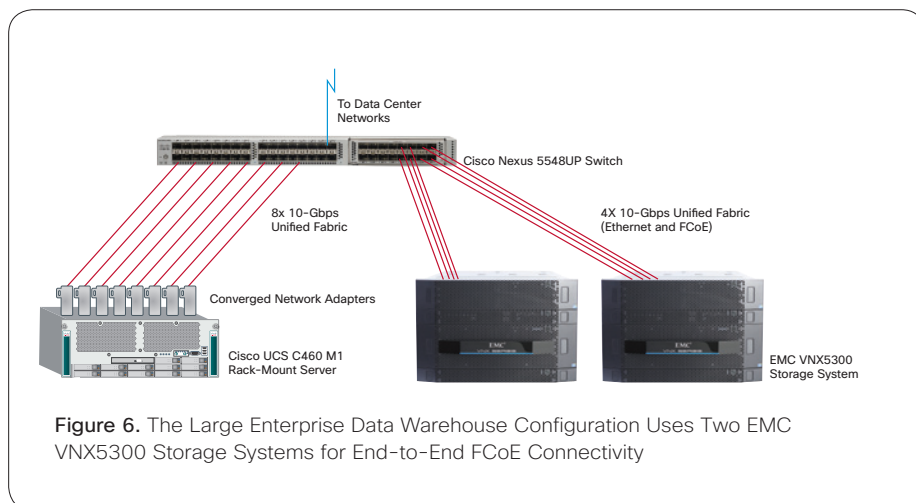
Table 4. Large Data Warehouse Reference Configuration Details

Server	Cisco UCS C460 M1 High-Performance Rack-Mount Server	Processor	4 Intel Xeon processors X7560 (2.26 GHz, 24-MB cache, and 130W)
		Memory	256 GB (32 x 8-GB DDR3 1333-MHz RDIMM); up to 1024 GB supported
		Internal disk drives	2 SFF 300-GB 10,000-RPM SAS disk drives
		CNA	8 QLogic QLE8152 dual-port 10-Gbps CNAs
Storage	Two EMC VNX5300 storage systems	Disk drives	150 SFF 300-GB 10,000-RPM SAS disk drives
		Data protection	RAID 5 for data and tempdb files; RAID 10 for log files
Connectivity		Switch	Cisco Nexus 5548UP
		Protocol	FCoE

Storage Configuration and Layout

Each of the EMC VNX5300 storage systems connected to the Cisco UCS C460 high-performance rack-mount server is configured with 75 drives. The RAID groups and LUN layout are similar in design principles to the medium-sized enterprise reference configuration. This consistent approach allows a deployment that may have been initially sized for a midrange requirement to be expanded and upgraded more readily into a larger enterprise configuration.

With the large enterprise reference configuration, 24 data LUNs are configured as 4+1 RAID 5 groups and are presented to the server for database use. Figure 7 shows the configuration.

Figure 7. Three Disk-Array Enclosures Are Installed in Each of Two EMC VNX5300 Storage Systems in the Large Enterprise Reference Configuration
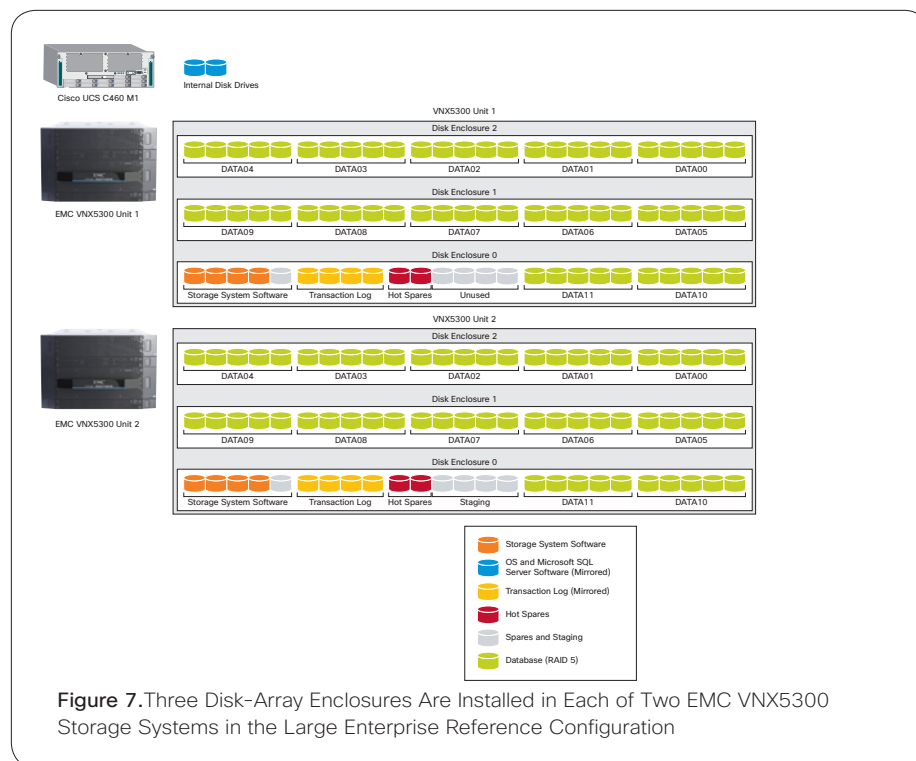
Conclusion

The Microsoft SQL Server Data Warehouse 3.0 reference configurations presented in this document enable rapid deployment of Microsoft SQL Server 2008 R2 enterprise data warehouse implementations. Designed and tested by Cisco, EMC, and Microsoft, these configurations offer proven performance, reliability, and lower TCO for organizations deploying infrastructure for data warehouse applications. Perhaps best of all, these configurations help organizations quickly achieve known, validated, and predictable results rather than undertaking the challenge of designing their own data warehouse implementations..

Combining powerful Intel Xeon processors, Cisco UCS C-Series Rack-Mount Servers, Cisco Nexus 5548UP unified fabric switching, and the innovative EMC VNX5300 storage systems results in configurations that can easily be scaled to accommodate a range of data warehousing workloads. The reduction in the number of switches, the reduced physical size of the server, and the much smaller storage footprint from the 2.5-inch SFF disk drives all contribute to the physical compactness of the complete system. With fewer components, higher effective storage density, and lower energy costs, these reference configurations address the growing concerns of many IT professionals who must support growing data warehouses.

For More Information

To learn more about the Microsoft SQL Server Fast Track Data Warehouse solution, visit http://www.cisco.com/go/microsoft.

Acknowledgments

This document was made possible through the efforts of Raghunath Nambiar and the EMC Partner Engineering team with thanks to Mike Bassett, Girish Kulkarni, Ranganathan Madhanagopal and Rex Backman.

Bill of Materials

Tables 5 and 6 list the bills of materials for the medium-sized enterprise and large enterprise data warehouse reference configurations.

Table 5. Bill of Materials for the Medium-Sized Enterprise Data Warehouse Reference Configuration

Server	Part Number	Quantity
UCS C250 M2 Server w/1PSU	R250-2480805W	1
850 W Power Supply Unit for C-Series 250 M2	R250-PSU2-850W	1
3.33 GHz Xeon X5680 130 W CPU/12 MB cache	A01-X0200	2
16 GB DDR3-1333 MHz RDIMM/PC3-10600/2x8 GB 2R Kit	A02-M316GD5-2	6
LSI 6 G MegaRAID 9261-8i card	R2XX-PL003	1
300 GB 6 Gb SAS 10K rpm SFF HDD	A03-D300GA2	2
Cisco UCS P81E Virtual Interface Card 2-port 10 Gbps	N2XX-ACPCI01	2
Switch		
Nexus 5548 UP Chassis, 32 10 GbE Ports, 2 PS, 2 Fans	N5K-C5548UP-FA	1

10GBASE-CU SFP+ Cable 3 Meter	SFP-H10GB-CU3M	8
Storage	Model Number	Quantity
VNX5300	VNX53D253010F	1
2-Port 10 GbE FCoE Module	VSPMXGFCOOPAS	2
25x2.5" Drive Disk-Array Enclosure	V2-DAE-R-25-A	2
300 GB 2.5" 10K drive (Part VNX53D253010F above includes 8 drives)	VX-2S10-300	67
Unisphere Block and VNX OE VNX5300	UNIB-V53	1
2nd Optional SPS for VNX5300	VNXSPSAS	1

Table 6. Bill of Materials for the Large Enterprise Data Warehouse Reference Configuration

Server	Part Number	Quantity
UCS C460 M1 Rack SVR	R460-4640810	1
850W Power Supply Unit for C-Series C460	RC460-PSU2-850W	4
2.26GHz Xeon X7560 130W CPU/24MB cache	A01-X0200	4
MEMORY RISER BOARD FOR C460 M1	RC460-MRB	4
16GB DDR3-1333MHz RDIMM/PC3-10600/2x8GB 2R Kit	A02-M316GD5-2	16
LSI CONTROLLER 9260-8i	RC460-PL001	1

300GB 6Gb SAS 10K RPM SFF HDD	A03-D300GA2	2
QLogic QLE8152 Dual Port 10 Gb Converged Network Adapter	N2XX-AQPCI03	8
Switch		
Nexus 5548 UP Chassis, 32 10GbE Ports, 2 PS, 2 Fans	N5K-C5548UP-FA	1
10GBASE-CU SFP+ Cable 3 Meter	SFP-H10GB-CU3M	16
Storage	**Model Number**	**Quantity**
VNX5300	VNX53D253010F	2
2-Port 10 GbE FCoE Module	VSPMXGFCOOPAS	4
25x2.5" Drive Disk-Array Enclosure	V2-DAE-R-25-A	4
300 GB 2.5" 10K drive (Part VNX53D253010F above includes 8 drives)	VX-2S10-300	134
Unisphere Block and VNX OE VNX5300	UNIB-V53	2
2nd Optional SPS for VNX5300	VNXSPSAS	2