



Technical Report

# NetApp EF540 Reference Configuration for Microsoft SQL Server 2012 Fast Track Data Warehouse with Cisco UCS C220 M3 Server

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## Executive Summary

This technical report describes a Microsoft SQL Server 2012 Fast Track Data Warehouse (FTDW) reference configuration that was built with a Cisco UCS<sup>®</sup> C220 M3 Server (1U) and a NetApp EF540 flash array (2U), and the performance results of the 3U solution.

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# 1 Introduction

Data-driven businesses rely on their data warehouses, a central component of business intelligence (BI) solutions to provide real-time access and analysis for business critical information. Accelerated overall data growth is increasing the need to consolidate data from multiple sources including: databases, unstructured content, customer resource management (CRM), enterprise content management (ECM), supply chain management (SCM) and more. Furthermore, IT management faces an increased demand for analytic capabilities growing numbers of users, including database analysts, Line-of-Business Managers, and Executive Management, and now with the advent of self-service BI capabilities in database platforms like Microsoft SQL Server, growing numbers of end-users. Since the decisions made with the help from these BI solutions directly affect time-to-market, revenue, productivity, and customer satisfaction, it is critical they operate at maximum potential.

The complex interaction of the different components of BI solutions, and the disparate and usually unwieldy data sources that ultimately underlie them has always made their design, deployment, and management challenging. The increased requirements for capacity, performance, and uptime have only exacerbated this challenge

Since a data warehouse lies at the core of every BI solution, the performance of this database component can make or break the success of the overall solution. Microsoft developed the SQL Server Fast Track Data Warehouse (FTDW) program to address the challenges that customers face in designing balanced architectures for data warehouses built on Microsoft SQL Server. A balanced data warehouse architecture means a workload-specific configuration—that is, online analytical processing (OLAP) rather than online transaction processing (OLTP)—and a cost-effective solution design that avoids bottlenecks and delivers predictable performance.

To achieve high performance, organizations typically had to over-provision storage capacity, deploying partially filled disks that allow the array to meet the needed I/O performance but wasted data center space and power. [SQL Server 2012 FTDW](#), the fourth generation of the program, now includes support for solid state storage to enable designs that meet performance requirements without over-provisioning and maximizing return on investment from high performance applications. However, as buyers consider solid state storage systems, they are often challenged to find an offering that is also enterprise proven and highly reliable.

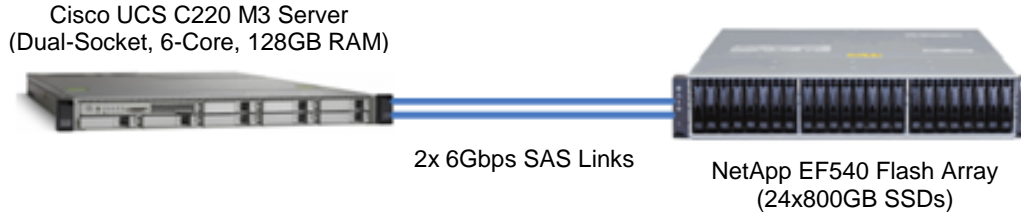
NetApp's Data Management Solutions for Data Warehouses provide high-availability, data protection, increased storage utilization, workload management, and instantaneous modular scaling. Increasingly, corporations are looking for ways to drive greater speed and responsiveness from the applications that control their key business operations – especially database systems. The NetApp EF540 is an all-flash storage array that brings together extreme performance and enterprise-grade reliability to create a system optimized for latency-sensitive workloads. Building on a heritage of performance leadership, the EF540's core architecture has been proven in the world's most demanding and complex computing environments. Its field-proven design is the culmination of 20-years of industry knowledge focused on designing enterprise-class storage. Leveraging experience from over 650,000 systems shipped, the fully-redundant EF540 flash array is architected to provide the highest levels of reliability, availability and data protection.

The reference configuration described in this technical report was built with a [Cisco UCS C220 M3 Rack Server](#) (1U) and [NetApp EF540 flash array](#) (2U). The 3U reference configuration is capable of delivering a rated CSI throughput of 5.6 GBps.

## 2 FTDW Reference Architecture Design and Implementation

Figure 1 shows the hardware components of the FTDW reference architecture. The design calls for a Cisco UCS C220 M3 server directly attached to a NetApp EF540 flash array with two 6-Gbps SAS links.

Figure 1 Reference Architecture with a Cisco UCS C220 M3 Server and NetApp EF540 Flash Array



### 2.1 Cisco C220 M3 Server

The Cisco UCS C220 M3 Server is a one-rack unit (1RU) server powered by the Intel® Xeon® processor E5-2600 product family, up to 512 GB of RAM, eight internal drives, and two 1 Gigabit Ethernet LAN interfaces built into the motherboard, delivering outstanding levels of density and performance in a compact package.

The Cisco UCS C220 M3 server under test was configured with dual-socket hex-core CPUs, for a total of 12 cores. The server was equipped with 128 GB of RAM. Table 1 shows the server configuration details.

Table 1 Cisco C220 M3 Server Configuration

Component	Description
Processor	Dual-socket hex-core Intel Xeon E5-2667 at 2.90 GHz (12 cores total)
Memory	128 GB
Host bus adapter (HBA)	LSI SAS 9207-8e 6 Gbps (dual-channel with 4 lanes per channel for a total of 48 Gbps bandwidth)
Internal disk	A pair of 500-GB 10,000-rpm SAS HDDs configured in RAID 1 for OS
Operating system	Microsoft Windows Server 2008 R2 Enterprise
Database software	Microsoft SQL Server 2012 Enterprise Edition SP1
Multipathing software	NetApp E-Series MPIO

The Cisco UCS C220 M3 server has two PCIe slots. The LSI SAS HBA was installed in the PCIe #2 slot. The PCIe #1 slot is reserved for a Cisco® Virtual Interface Card (VIC) or an additional SAS HBA card. If the second SAS HBA card is used, customers can expect to gain higher throughput than tested and a higher level of redundancy in connectivity between the server and storage.

### 2.2 Microsoft SQL Server 2012 Enterprise

Microsoft SQL Server 2012 Enterprise SP1 was installed, and SQL Server 2012 was installed following the FTDW Reference Guide.

## Startup Options

- **-E** must be added to the startup options to increase the contiguous extents in database files and to enable large transfer sizes in sequential disk access.
- **-T1117** should also be added to the startup options to ensure even growth of all files in a file group if autogrow is enabled.

## SQL Maximum Memory

For SQL Server 2012, no more than 92 percent of total server RAM should be allocated to SQL Server. Therefore 90 percent of 128 GB, or 115 GB, was allocated to SQL Server.

## MAXDOP

MAXDOP, or *maximum degree of parallelism*, is a tuning option that controls how many SQL schedulers a SQL query can use per query step. After consulting a Microsoft FTDW reference architecture expert, we set MAXDOP to 12 for this reference configuration.

## 2.3 NetApp EF540 Flash Array

The NetApp EF540 is an all-flash storage array that brings together extreme performance and enterprise-grade reliability to create a system that is optimized for database-driven applications where responsiveness is critical.

Building on a heritage of performance leadership, the EF540 core architecture has been proven in the world's most demanding and complex computing environments. The fully redundant EF540 supports dual-active controllers and 24 solid state drives in a 2U shelf, and it runs on the enterprise-proven SANtricity software platform. SANtricity software allows storage administrators to achieve maximum performance and utilization of their EF540s through extensive configuration flexibility, custom performance tuning, online administration, and complete control over data placement. Table 2 shows the storage array configuration details.

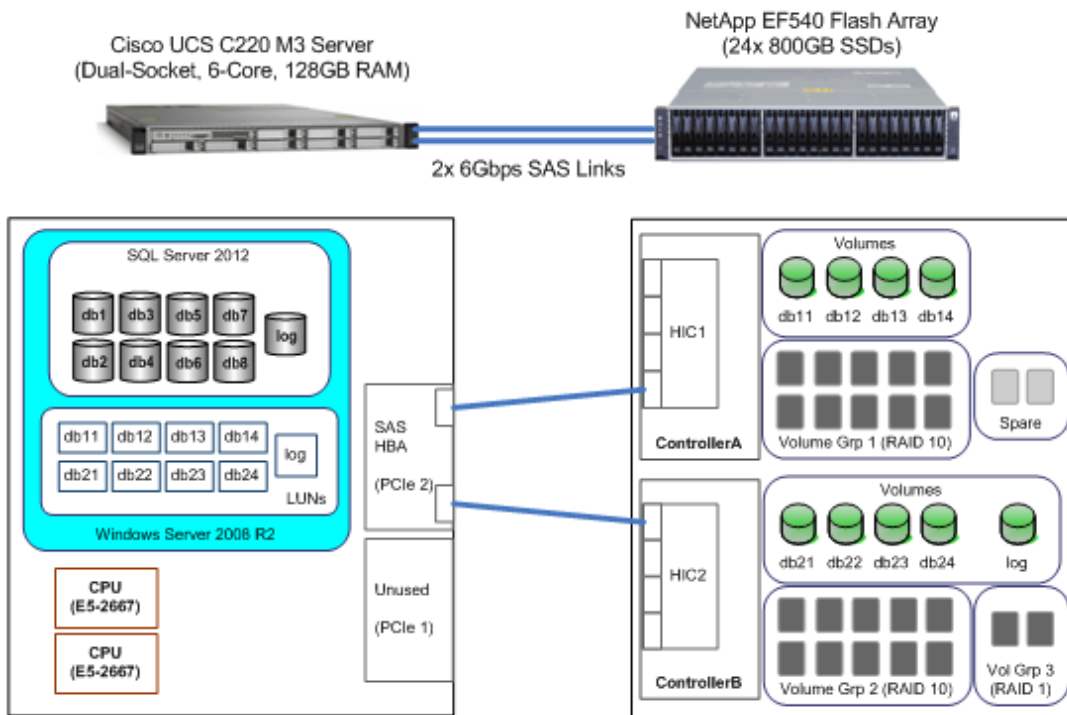
Table 2 NetApp EF540 Flash Array Configuration

Component	Description
OS version	SANtricity 10.84
Disk	24x 2.5-in. SSD 800 GB
Memory	24 GB
I/O interface	8x 6-Gbps SAS
High availability (HA)	Dual active-active controllers with automated I/O path failover

## 2.4 Database and Storage Layout

Figure 2 shows the detailed storage layout and database layout for the reference configuration. Of the 24 SSDs, two RAID 10 volume groups were created for SQL Server databases, with 10 SSDs per RAID group. A third volume group (RAID 1) was created with 2 SSDs for transaction log files. The remaining 2 SSDs were configured as global hot spares.

Figure 2 Storage Layout and Database Layout Details

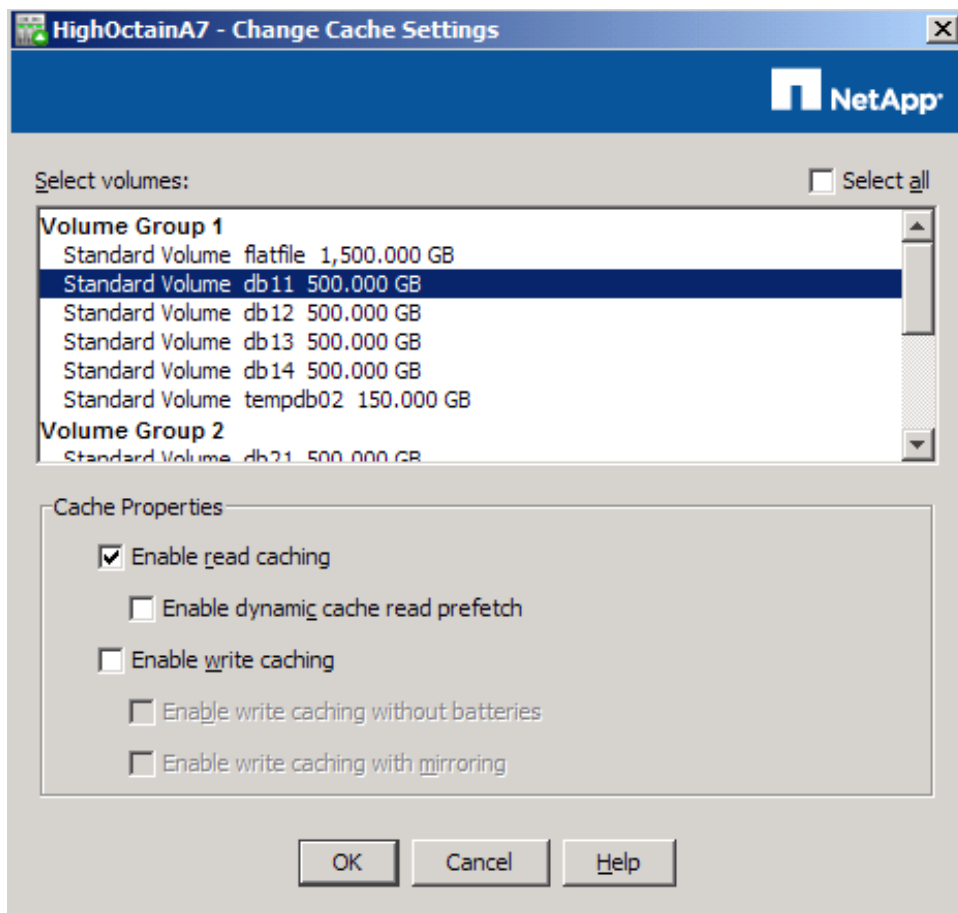


The EF540 storage array cache was configured as follows:

- Read caching: Enabled
- Dynamic cache read prefetch: Not enabled
- Write caching: Not enabled

Figure 3 shows an example of the cache properties.

Figure 3 Configuration of Cache Properties



### 3 FTDW Reference Configuration Validation

After the FTDW reference architecture was designed and implemented, a set of disk I/O tests and a set of SQL query tests, as defined by the SQL Server 2012 FTDW program, were executed to validate the reference configuration. Table 3 summarizes the important performance metrics and results.

Table 3 Performance Results for the Reference Configuration

Metric	Result
FTDW rated database capacity	15 TB
Maximum user data capacity	19 TB
FTDW rated I/O throughput	2327 MBps
Peak I/O throughput	3147 MBps
Benchmark scan rate – logical	2615 MBps
Benchmark scan rate – physical	2039 MBps
FTDW rated CSI throughput	5768 MBps
Peak CSI throughput	7446 MBps

## 4 Bill of Materials

Table 4 shows the bill of materials for this reference configuration, including both server and storage components.

Table 4 Bill of Materials for the Reference Configuration

Part Number	Description	Quantity
UCSC-C220-M3S	UCS C220 M3 SFF w/o CPU, mem, HDD, PCIe, PSU, w/rail kit	1
UCS-CPU-E5-2667	2.90-GHz E5-2667/130W 6C/15-MB cache/DDR3 1600 MHz	2
UCS-MR-1X082RY-A	8-GB DDR3-1600-MHz RDIMM/PC3-12800/dual rank/1.35v16	16
A03-D500GC3	500-GB 6 Gb SATA 7200 rpm SFF hot plug/drive	2
UCSC-RAID-ROM55	Embedded RAID 0/1/10/5, 8 ports SAS/SATA	1
UCSC-PSU-650W	650W power supply for C-Series rack servers	2
CAB-N5K6A-NA	Power cord, 200/240V 6A North America	2
UCSC-CMA1	Reversible cable management arm for C220	1
N20-BBLKD	HDD slot blanking panel for 2.5 inch	6
UCSC-HS-C220M3	Heat sink for UCS C220 M3 rack server	2
UCSC-RAIL1	Rail kit for C220, C22, C24 rack servers	1
H5-25427-00	SAS 9207-8e HBA – dual-port Gen 3 PCI Express 6-Gbps SATA/SAS (third-party order to LSI)	1
EF540-24X800-R6	EF540, 24x800GB SSD, Base,	1
X-54736-00-R6	HIC, E5400, E5500, SAS, 4-port, 6 GB	2
X-52197-00-R6	Power cord, in-cabinet, 2m, C14-C13, E-Series	1

## 5 Conclusion

As organizations expand their Business Intelligence and analytics efforts to encompass structured data, unstructured data, OLTP, OLAP and more, technologies that can provide breadth of features combined with pure speed become increasingly important. IT needs to ensure and bolster reliability, availability and serviceability while continually improving performance for BI and analytics. Converged systems or reference architectures that include and have been optimized for these features across compute, network, storage and applications are the drivers in organizational decision processes surrounding BI and analytics. Understanding the options for the storage decision as part of the converged system is paramount to success. Storage solutions, like all-flash arrays, provide advanced feature sets combined with performance that scale, manage and protect data warehouse investments.

NetApp and Cisco have teamed up to provide the best-in-class platform for a SQL Server 2012 based enterprise data warehouse application. With the all-flash array EF540 as the basis of our joint solution with Cisco, NetApp builds on our core performance heritage of NetApp E-Series storage systems. NetApp's performance heritage has been tested and proven in the world's most demanding environments including high-performance computing, supercomputer, database, video production, modeling & simulation and now data warehouse. For more information, please visit ([URL](#))



## 6 Acknowledgments

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## References

The following references were used in this technical report:

- SQL Server 2012 FTDW Reference Architecture Guide:  
<http://msdn.microsoft.com/en-us/library/hh918452.aspx>
- Columnstore Indexes:  
<http://msdn.microsoft.com/en-us/library/gg492088.aspx>
- Cisco UCS C220 M3 Server:  
[www.cisco.com/en/US/prod/collateral/ps10265/ps10493/C220M3\\_SFF\\_SpecSheet.pdf](http://www.cisco.com/en/US/prod/collateral/ps10265/ps10493/C220M3_SFF_SpecSheet.pdf)
- NetApp EF540 Flash Array:  
[www.netapp.com/us/products/storage-systems/flash-ef540/ef540-tech-specs.aspx](http://www.netapp.com/us/products/storage-systems/flash-ef540/ef540-tech-specs.aspx)

## Version History

Version	Date	Document Version History
Version 1.0	April 5, 2013	First draft created.
Version 1.1	April 24, 2013	Added Cisco server information and BOM, and EF540 information.
Version 1.2	April 30, 2013	Added storage BOM, and other editing.
Version 1.3	April 30, 2013	Editorial review completed.
Version 1.4	May 1, 2013	Incorporated Microsoft comments.
Version 1.5	June 24, 2013	Updated BOM; and Cisco corpedit markup.

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