DELL™ AX4-5 Application Performance

A Comparison of Entry-level Storage Platforms

Abstract

This paper compares the performance of the Dell AX4-5 with the performance of similarly configured IBM® DS3400 and IBM DS3300 storage systems using the same application loads and test criteria.

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EXECUTIVE SUMMARY

This paper compares the performance of the Dell AX4-5 storage system to its nearest competitors. All the compared systems are similarly sized and configured. All effort was made to configure the systems to perform optimally for their task.

The comparison is made using three production workloads that entry-level storage systems are typically employed in. The workloads are:

- On-Line-Transaction Processing (OLTP)
- Microsoft Exchange 2003
- Backup-to-Disk

The OLTP workload simulates the storage system's usage in database system used for transaction-oriented application such as sales ordering, inventory control, or electronic banking. This test shows the number of transactions per minute the storage system can maintain with a two second transaction response time.

The Microsoft Exchange 2003 workload simulates the storage system's usage of that Microsoft messaging and collaboration services application for small and medium organizations. This test shows the number of exchange users the storage system can maintain, if each user executes one I/O per second.

The Backup-to-Disk workload simulates the storage system's usage in a backup process that does not use tape, but disk-based storage. The storage system copies or clones files, data, databases or servers to create an archival duplicate of the source material. This test shows the number of MB/sec of throughput the storage system can maintain.

These three workloads together highlight a storage systems fundamental performance characteristics in: random small-block I/O (OLTP and MS Exchange), and sequential large-block I/O. The following graphs show the relative performance of the AX4-5 and its nearest competitors.

The charts show the AX4-5 outperforms these competitors in both the small-block random I/O tests and the large-block sequential I/O tests across OLTP, MS Exchange and Backup-to-Disk workloads.

FIGURE 1. OLTP Workload Performance Summary

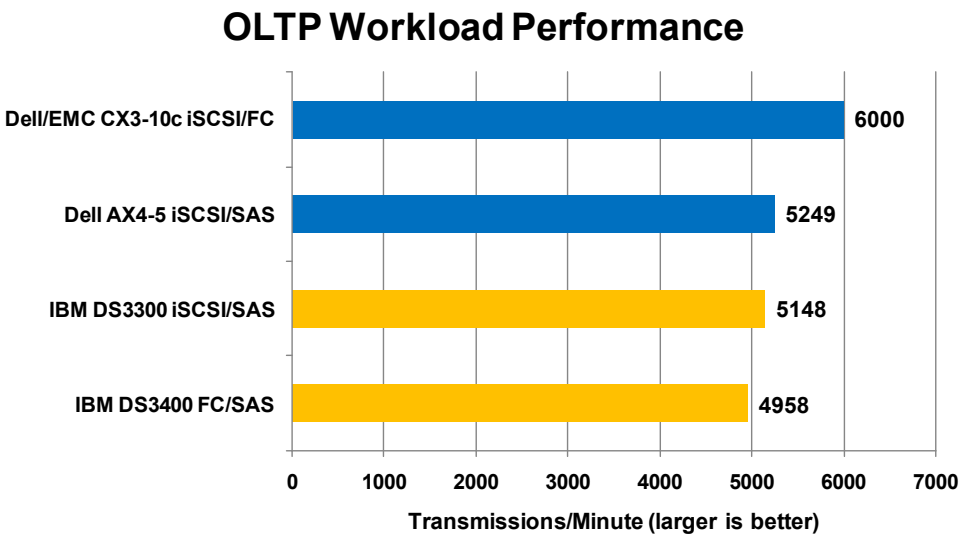


FIGURE 2. Microsoft Exchange Workload Performance Summary

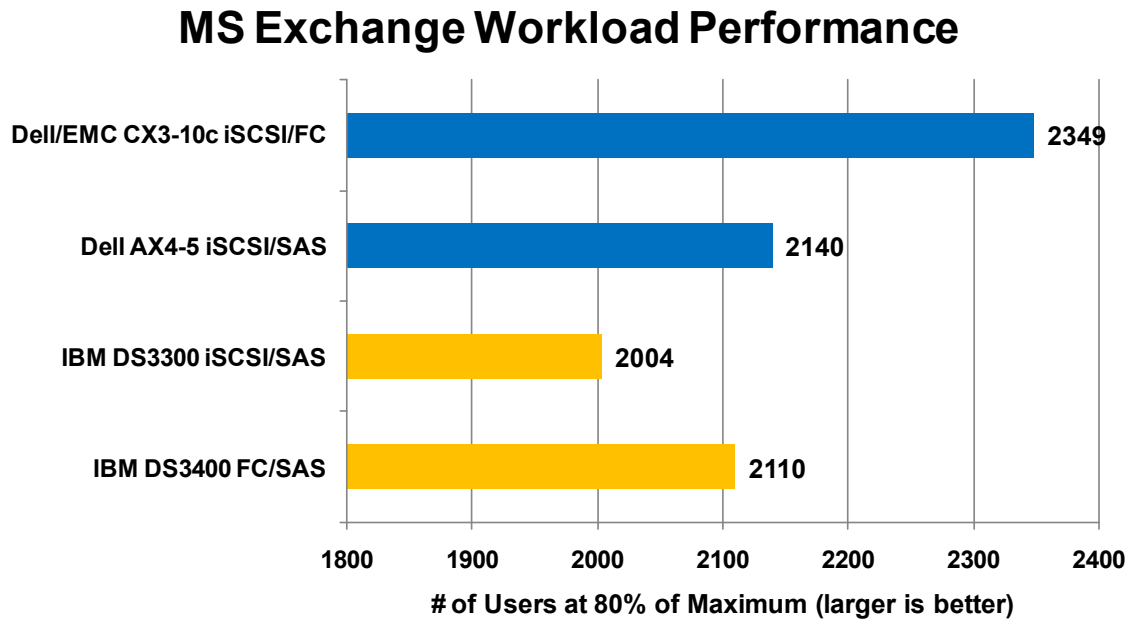
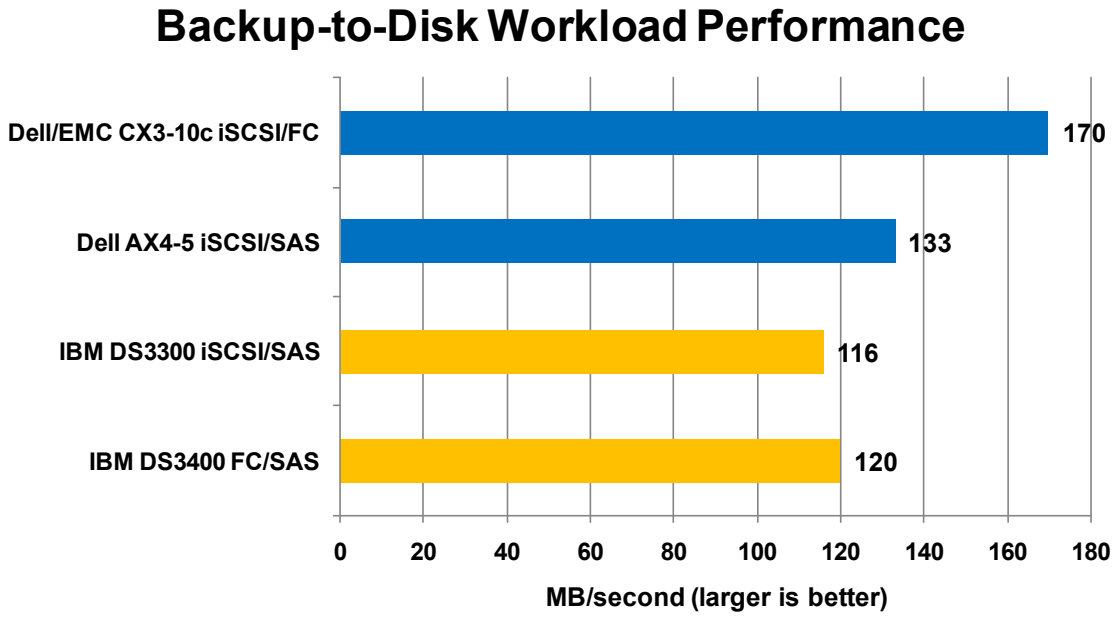


FIGURE 3. Backup-to-Disk Workload Performance Summary



INTRODUCTION

This paper takes a workload approach to comparing the performance of entry-level storage systems.

The workload approach simulates a storage system's performance in a production environment. We believe this is a better way of comparing storage system performance than simpler benchmarks. It avoids the 'synthetic' and possibly misleading results of benchmark programs. For example, benchmarks typically only exercise one aspect of a system, such as front-end ports. Or they may generate unnatural, extremely high throughput or bandwidth that would normally set-off alarms in a production environment.

The workload approach exercises both the front-end ports, the backend interface to the hard drives, and generates more natural I/O patterns. It generates I/O appropriate to the system's configuration, typically determined by the number of hard drives. In addition, it sustains the workload over a long period of time to determine the longer-term behavior of the storage system's hardware and software.

Our comparison focuses on three production-inspired workloads that are representative of the environments used by entry-level storage systems:

- OLTP
- Microsoft Exchange 2003
- Backup-to-Disk

The OLTP workload simulates the small-block random I/O Pattern generated by concurrent users characteristic of this workload. The workload has the following transactions:

- Database Reads: 21 random small-block reads
- Database Writes: 9 random small-block writes
- Logging: 1 simulated aggregated log sequential write
- Checkpoints: 2 simulated checkpoints equivalent to host cache size.

The OLTP workload generates randomly distributed reads and writes over 50 percent of each logical volume of the database. Users have an average 10 second wait time between transactions.

Metrics for this test include Transactions Per Minute (TPM) and Transaction Response Time. The number of simulated users is incremented during the test until the storage system saturates.

The Microsoft Exchange 2003 workload simulates the small-block random I/O patterns characteristic of MS Exchange and Microsoft's LoadSim applications. The workload consists of small-block random reads and writes in at ratio of 2:1.

The Exchange workload generates randomly distributed reads and writes to 50 percent of the configured storage using concurrent threads. Within each thread, a subsequent random read or write is started as soon as the previous I/O completes. This creates one parallel I/O per thread.

The metrics for this test is I/Os Per Second (IOPS) and Exchange Users. The IOPS throughput is determined first. It is used to calculate the number of Exchange users the target array supports assuming the storage system is configured to run at 80 percent of its MS Exchange IOPS rating with the average Exchange user performing one I/O per second.

The Backup-to-Disk workload simulates the large-block sequential I/O pattern characteristic of the disk-to-disk copy that occurs during a backup. The simulation generates a concurrent, large-block, sequential I/O write pattern with parallel threads of sequential writes. One thread is allocated per logical volume.

The metric for this is Megabytes per Second (MB/sec) throughput.

For the testing, every effort was made to configure each storage system to obtain optimal performance for the workload and provide as fair a comparison as possible. For example, all tests were executed with the same number and type of servers and the servers were monitored to ensure they were not adversely affecting the test.

Details on the methodology for creating the workloads can be found in the *CLARiiON Performance Engineering Testing Methodology Engineering White Paper* (available on request). Adaptations made to the methodology are described in the *CLARiiON CX3 Application Performance: A Comparison of Midrange Storage Platforms Technology Concepts and Business Considerations White Paper* available on EMC's PowerLink.

The workloads and their metrics described above are the basis for comparison between the Dell AX4-5 and its nearest competition. The competition storage systems are:

- IBM DS3300
- IBM DS3400

Each storage system's performance in the three workloads is compared to the AX4-5. In addition, the performance of the Dell/EMC CX3-10c in these workloads is shown as a reference. Where appropriate, factors affecting the performance of each storage system are called out

This white paper begins with an overview of each of the storage systems tested and then discusses the performance of each array in comparison to the AX4-5.

AUDIENCE

This whitepaper is for Dell sales representatives, and customers, including customer storage architects and administrators. It is intended to provide a useful comparison for evaluating, acquiring, managing, operating, and designing entry-level networked storage environments. While Dell believes that the workloads assessed here are representative of real production environments, the specifics of your production environment may be different in a variety of ways.

AX4-5 OVERVIEW

The Dell AX4-5 is a SAS hard drive storage system with either a Fibre Channel or an iSCSI front-end.

The AX4-5 is designed to bring the benefits of storage consolidation to small businesses and to the smaller dispersed data centers of larger organizations. The AX4-5 is available with Fibre Channel or iSCSI network connectivity. It can be purchased in single or redundant dual controller models. It can be configured with from 4 to 60 Serial Attach SCSI (SAS) or SATA hard drives in capacities ranging from 146GB to 1TB (interface dependent). The AX4-5 has been designed to be customer maintainable with a simplified Navisphere Graphical User Interface (GUI). The storage system comes bundled with PowerPath and several integrated applications. The AX4-5 is compatible with optional replication software, such as SnapView, MirrorView, SAN Copy and others.

Table 1 below summarizes the AX4-5 features.

Test Configuration

The following describes the AX4-5i configuration for the workload tests: 15 x 146GB 15K rpm SAS hard drives in RAID 5 (4+1) LUNs with an iSCSI interface to hosts. Configuration details are listed in the appendix. Table 2 below summarizes the performance results for the AX4-5.

TABLE 1. Dell AX4-5 Overview

DELL AX4-5		
Controllers	Number	2 (Active/Active)
	Host Ports and Type	2x 4 Gb/s Fibre Channel
		2x 1 Gb/s iSCSI
	Memory/Controller	1GB
	Max. Cache/Controller	1GB
Hard Disks	Min. (Fully Populated Single Enclosure)	12
	Max.	60 w/ 4x SAS Disk Expansion Chassis
	Disk Interconnect	SAS
	Drive Size(s)/Max. Raw Capacity	15K rpm: 146GB, 300GB. 10K rpm: 400GB. 7.2K rpm (SATA): 750GB, 1TB.
	Max. Single System Capacity	45TB
Configuration	Max. Drives/Array	60
	Max. RAID Groups	30
	Max. Drives/RAID Group	16
	Logical Units (LUN)/Array (RAID Group)	512
	Arrays (RAID Groups)/ Storage system	128
	RAID Levels Available	5, 1/0, 3

TABLE 2. Dell AX4-5 Application Performance

DELL AX4-5 iSCSI	
Application Workload	AX4-5-5i 15 SAS Hard Disks with iSCSI
OLTP (transmissions/min)	5249
MS Exchange (# Users)	2140
Backup-to-Disk (MB/sec)	133

IBM DS3300 OVERVIEW

The IBM DS3300 is an iSCSI-based, SAS hard drive storage system.

The DS3300 is designed for small to mid-sized businesses. The DS3300 is available only with iSCSI network connectivity. It can be purchased in single or redundant dual controller models. It can be configured with from 12 to 48 Serial Attach SCSI (SAS) or SATA hard drives in capacities ranging from 36GB to 750GB (interface dependent). The DS3300 has been designed to be customer maintainable with the DS3000 Storage Manager Graphical User Interface (GUI). The storage system comes bundled with several integrated applications. The DS3300 is compatible with IBM layered products such as FlashCopy, VolumeCopy, and others. Table 3 summarizes the IBM DS3300 features.

Test Configuration

The DS3300 was configured for the Workload tests with 15x 146GB 15K rpm Seagate SAS hard drives in three RAID 5 (4+1) groups. Note that this configuration required an EX3000 expansion unit. Configuration details are listed in Appendix A. The DS3300 tested has the optional 1GB of cache installed. Configuration details are listed in the appendix.

Performance Comparison

The Dell AX4-5 performed better than the DS3300 in all three tests. The table below shows the performance comparison details. Table 4 below summarizes the performance results for the IBM DS3300.

TABLE 3. IBM DS3300 Overview

IBM DS3300		
Controllers	Number	2 (Active/Active)
	Host Ports and Type	1 Gb/s iSCSI 2/Controller
	Memory/Controller	144MB
	Max. Cache/Controller	512MB (1GB optional)
Hard Disks	Min. (Fully Populated Single Enclosure)	12
	Max.	48 w/ 3x EXP3000 expansion units.
	Disk Interconnect	SAS
	Drive Size(s)/Max. Raw Capacity	15K rpm: 36GB, 73GB, 146GB, 300GB. 10K rpm: 73GB, 146GB, 300GB, 400GB. 7.2K rpm: 500GB, 750GB
Configuration	Max. Drives/Array (RAID Group)	30
	Max. Arrays (RAID Groups)	45
	Logical Units (LUN)/Array (RAID Group)	256
	Arrays (RAID Groups)/ Storage system	256
	RAID Levels Available	0, 1, 3, 5, 1/0

TABLE 4. IBM DS3300 Performance Comparison

IBM DS3300 PERFORMANCE COMPARISON			
Application Workload	Dell AX4-5 15 SAS Hard Disks with iSCSI	IBM DS3300 15 SAS Hard Disks with iSCSI	Dell AX4-5 Advantage
OLTP (transmissions /min)	5249	5148	2%
MS Exchange (# Users) 80% of Max.	2140	2004	6%
Backup-to-Disk (MB/sec)	133	116	13%

IBM DS3400 OVERVIEW

The IBM DS3400 is a Fibre Channel-based, SAS hard drive storage system.

The DS3400 is designed for small to mid-sized businesses. The DS3400 is available with Fibre Channel network connectivity. It can be purchased in single or redundant dual controller models. It can be configured with from 12 to 48 Serial Attach SCSI (SAS) or SATA hard drives in capacities ranging from 36GB to 750GB (interface dependent). The DS3400 has been designed to be customer maintainable with the DS3000 Storage Manager Graphical User Interface (GUI). The storage system comes bundled with several integrated applications. The DS3400 is compatible with IBM layered products such as FlashCopy, VolumeCopy, and others. Table 5 summarizes the DS34000 features.

Test Configuration

The DS3400 was configured for the Workload tests with 15x 146GB 15K rpm Seagate SAS hard drives in three RAID 5 (4+1) groups. The DS3400 tested has the optional 1GB of cache installed. Configuration details are listed in the appendix.

Performance Comparison

The Dell AX4-5 performed better than the IBM DS3400 in all three tests. This is despite the DS3400 having the advantage of a Fibre Channel front-end, versus iSCSI. Table 6 below summarizes the performance results for the IBM DS3400.

TABLE 5. IBM DS3400 Overview

IBM DS3400		
Controllers	Number	2
	Host Ports and Type	4 Gb/s Fibre Channel
	Memory/Controller	144MB
	Max. Cache/Controller	512MB (1GB optional)
Hard Disks	Min. (Fully Populated Single Enclosure)	12
	Max.	48 w/ 3x EXP3000 expansion units.
	Disk Interconnect	SAS
	Drive Size(s)/Max. Raw Capacity	15K rpm: 36GB, 73GB, 146GB, 300GB. 10K rpm: 73GB, 146GB, 300GB, 400GB. 7.2K rpm: 500GB, 750GB
Configuration	Max. Drives/Array (RAID Group)	30
	Max. Arrays (RAID Groups)	45
	Logical Units (LUN)/Array (RAID Group)	256
	Arrays (RAID Groups)/ Storage system	256
	RAID Levels Available	0, 1, 3, 5, 1/0

TABLE 6. IBM DS3400 Performance Comparison

IBM DS3400 PERFORMANCE COMPARISON			
Application Workload	Dell AX4-5 15 SAS Hard Disks with iSCSI	IBM DS3400 15 SAS Hard Disks with Fibre Channel	Dell AX4-5 Advantage
OLTP (transmissions /min)	5249	4958	6%
MS Exchange (# Users) 80% of Max.	2140	2110	1%
Backup-to-Disk (MB/sec)	133	120	10%

CONCLUSION

The workloads used in this comparison paper may not be identical to your workload. However, they do represent production environments. And, they can be used to compare the relative performance of the Dell AX4-5 with similar storage systems under conditions of different I/O patterns.

The following table summarizes the performance of the Dell AX4-5 in three workload-based tests against its closest competition:

TABLE 7. Workload Performance Comparison Summary

APPLICATION WORKLOAD	DELL AX4-5 ISCSI	IBM DS3300 ISCSI	IBM DS3400 FC
OLTP (transmits/min)	5249	5148	4958
MS Exchange (# Users 80% of Max.)	2140	2004	2110
Backup-to-Disk (MB/sec)	133	116	120

These tests show the Dell AX4-5 is a superior competitor in OLTP, MS Exchange, and Backup-to-disk production environments.

REFERENCES

EMC CLARiiON Performance Engineering Testing Methodology Engineering White Paper, November 4, 2003

CLARiiON CX3 Application Performance: A Comparison of Midrange Storage Platforms Technology Concepts and Business Considerations White, July 2007. http://www.emc.com/collateral/hardware/white-papers/h2904-emc-clariion-cx3-appl-perf-wp.pdf

APPENDIX A:
STORAGE SYSTEM CONFIGURATION SETTINGS

TABLE 8. Dell AX4-5 Workload Configurations

DELL AX4-5 CONFIGURATIONS			
Settings	**OLTP**	**MS Exchange**	**Backup-to-Disk**
Total Cache	1023 Blocks	1023 Blocks	1023 Blocks
System Memory	1GB/SP	1GB/SP	1GB/SP
Read Cache	75MB	75MB	75MB
Write Cache	356MB	356MB	356MB
Cache Page Size	2KB	4KB	16KB
Prefetch	Enabled	Enabled	Enabled
I/O Size Multiplier	4x	4x	4x
Max. Prefetch	2MB	2MB	2MB
Mirrored Write Cache	Enabled	Enabled	Enabled
Cache Write Aside	1MB	1MB	1MB
Watermark High	50	50	50
Watermark Low	30	30	30
Stripe Element Size	64K	64K	64K
Sniff Verify	Yes	Yes	Yes

TABLE 9. IBM DS3300 Workload Configurations

IBM DS3300 CONFIGURATION			
Settings	**OLTP**	**MS Exchange**	**Backup-to-Disk**
Total Cache	1GB	1GB	1GB
System Memory	288MB	288MB	288MB
Read Cache	N/A	N/A	N/A
Write Cache	N/A	N/A	N/A
Cache Page Size	4KB	4KB	4KB
Prefetch	Enabled	Enabled	Enabled
I/O Size Multiplier	N/A	N/A	N/A
Max. Prefetch	N/A	N/A	N/A
Read Cache Prefetch	N/A	N/A	N/A
Write Cache Prefetch	N/A	N/A	N/A
Mirrored Write Cache	Yes	Yes	Yes
Cache Write Aside	N/A	N/A	N/A
Watermark High	80%	80%	80%
Watermark Low	80%	80%	80%
Stripe Element Size	128KB	128KB	128KB
Sniff Verify	Yes	Yes	Yes

TABLE 10. IBM DS3400 Workload Configurations

IBM DS3400 CONFIGURATION			
Settings	**OLTP**	**MS Exchange**	**Backup-to-Disk**
Total Cache	1GB	1GB	1GB
System Memory	288MB	288MB	288MB
Read Cache	N/A	N/A	N/A
Write Cache	N/A	N/A	N/A
Cache Page Size	4KB	4KB	4KB
Prefetch	Enabled	Enabled	Enabled
I/O Size Multiplier	N/A	N/A	N/A
Max. Prefetch	N/A	N/A	N/A
Read Cache Prefetch	N/A	N/A	N/A
Write Cache Prefetch	N/A	N/A	N/A
Mirrored Write Cache	Yes	Yes	Yes
Cache Write Aside	N/A	N/A	N/A
Watermark High	80%	80%	80%
Watermark Low	80%	80%	80%
Stripe Element Size	128KB	128KB	128KB
Sniff Verify	Yes	Yes	Yes

TABLE 11. Dell/EMC CX3-10c Feature Summary

The application performance results for the Dell/EMC CX3-10c are provided for comparison. Below is a feature summary for the array.

DELL/EMC CX3-10c		
Controllers	Number	2 (Active/Passive)
	Host Ports and Type	2x 4 Gb/s Fibre Channel
		2x 1 Gb/s iSCSI
	Memory/Controller	1GB
	Max. Cache/Controller	1GB
Hard Disks	Min. (Fully Populated Single Enclosure)	15
	Max.	60 w/ 4x DAEs
	Disk Interconnect	Fibre Channel
	Drive Size(s)/Max. Raw Capacity	15K rpm: 73GB, 146GB. 10K rpm: 73GB, 146GB, 300 GB 2-Gb/s 7.2K rpm (SATA): 500GB, 750GB, 1TB.
	Max. Single System Capacity	45TB
Configuration	Max. Drives/Array	60
	Max. RAID Groups	30
	Max. Drives/RAID Group	16
	Arrays (RAID Groups)/ Storage system	128
	RAID Levels Available	0, 1, 5, 1/0, 3, 6