IBM® System Storage™ DS4700 Express

Technical Paper

Introduction

The midrange open systems storage market reflects the trend that our customers have come to expect: ***More for Less****!* The market wants more performance, more capacity, more functionality, more connectivity, more availability, more data protection, etc., etc., and all for a fraction of the cost they might have paid for the system they are now upgrading.

The DS4700 Express storage system is the latest addition to the DS4000 Series line of storage systems– providing high performance, high storage density, drive intermixing, and fully-featured Storage Manager software.

The purpose of this Whitepaper is to assist IBM personnel and IBM Business Partners with the necessary basic information about this new product in order to understand the capabilities of the DS4700 Express, how it's positioned against our current products and competition, the value propositions detailing how to sell it into our competitive markets, and finally qualifying your potential prospects.

Table of Contents

May 9, 2006

Overview

The DS4700 Express storage system is designed to address many of the requirements our customers have come to expect from the DS4000 Series disk storage products. Two models are available, **model 70** has 4 total host ports, 2 GB of cache and high performance; the **model 72** has 8 total host ports, 4 GB of cache , designed to provide the right processing power when needed. Unless otherwise stated for differentiation, we will continue to refer to both models as 'DS4700 Express' for simplicity.

The DS4700 Express storage system integrates 4 Gb/s Fibre Channel (FC) technology, designed for high-performance FC disk drives, integrated XOR engines, and powerful storage management functionality to help create, robust, high performance solutions targeted squarely at the midrange.

Designed specially for open systems environments, the DS4700 Express storage system's high-speed disk performance enables fast, responsive applications that can help improve transaction rates and customer satisfaction. Its modular "pay-as-you-grow" scalability can help lower acquisition and expansion costs by avoiding over-configuration and enabling optimal just-in-time purchasing. And with online scalability up to 33.6TB of Fibre Channel disk storage with attachment of six EXP810s, the DS4700 Express storage system easily satisfies demanding capacity requirements. Its 4 Gb/s host-side connectivity supports direct-attachment to hosts (DAS) or storage area networks (SANs). The DS4700 Express storage system's high availability helps keep data accessible and can help decrease the risk of downtime-related revenue loss. And its extensive compatibility results are designed to have minimal or no impact on existing infrastructure, helping to provide infrastructure investment protection.

Benefits

Performance – Compared to the DS4300 the DS4700 Express architecture combines faster processors, faster buses, more cache, an integrated drive-side loop switch and 4 Gb Fibre Channel technology to create a system that is designed to excel at both IOPS and bandwidth (MB/s). While certain competitive products may be promoted as 4 Gb, they may only be referring to their host interface, and do nothing to enhance the back-end (drive side) performance.

High Density Controller Enclosure – The 4 Gb enhanced controller enclosure of the DS4700 Express is designed for higher capacity compared to DS4300. The DS4700 Express is an integrated 3U chassis including 2 controllers, dual power, cooling and battery back-up units and up to sixteen (16) 3.5 inch hot-pluggable disk drives. Fibre Channel and SATA disk drives are both supported, as well as mixing those two technologies within the same enclosure. Up to six additional disk drive expansion units, such as the DS4000 EXP810, can be attached to the DS4700 Express for a maximum total of 112 disk drives.

Sensible Cost –Looking at the DS4700 Express model 70 and 72, a key motivation for numerous features was to be cost conscious: higher density controller enclosures, integrating disk drives inside the controllers, greater host connectivity, multiple cache capacity options, etc.

Compatibility – Designed to help extend the backward and forward compatibility of the DS4700 Express. Host ports, for example, were designed with speed auto-negotiation logic, enabling connection to 1, 2, or 4Gb host interfaces, in consideration of possible installed legacy hardware. DS4000 EXP710 2Gb disk drive expansion enclosure can be attached to DS4700 Express, with or without the inclusion of the DS4000 EXP810 4Gb disk drive expansion enclosure.

Connectivity – With 8 host ports for attachment of either hosts or switches, and 4 drive side loops there is double the connectivity and the potential for higher performance when compared with earlier products.

Configurations

The DS4700 Express Storage System is offered in two models, 72 and 70. Because of the high level of integration of this product line, the models may appear quite similar, but can be differentiated in terms of connectivity, standard storage partitions and cache size.

May 9, 2006

| DS4700 Express Model 72 Includes	DS4700 Model 70 Includes
Eight 4 Gb/s host ports	Four 4 Gb/s host ports
Four 4 Gb/s drive ports	Four 4 Gb/s drive ports
4 GB of controller cache	2 GB of controller cache
Integrated XOR engine	Integrated XOR engine
"High" performance	"High" performance
16 integrated disk drive slots	16 integrated disk drive slots
Max of 112 drives (6 additional drive enclosures)	Max of 112 drives (6 additional drive enclosures)*
FC drives	FC drives
DS4000 Storage Manager software	DS4000 Storage Manager software
Partitions (**8** standard w/HVEC order)	Partitions (2 standard w/HVEC order)
FlashCopy	FlashCopy
Volume Copy	Volume Copy
Enhanced Remote Mirroring	Enhanced Remote Mirroring

Mixing 2 Gb and 4 Gb Enclosures

The DS4700 Express supports 4Gb DS4000 EXP810 and 2Gb DS4000 EXP710 disk drive Expansion Enclosures behind the same DS4700 Express; however, it's drive side loops must run at the same speed.

**Mixing 2Gb and 4Gb FC Drives**

One of the benefits of the DS4700 Express is the ability to intermix 2Gb and 4Gb FC disk drives within the same DS4700 Express controller. As is the case when mixing drive modules, however, mixing 2 Gb and 4 Gb FC drives will require the entire 4 Gb/s enclosure to run at 2 Gb/s speed. This includes its internal loops to the drives and external drive loop interfaces. The link speed is set by a switch on the front of the enclosure.

Key Features

Providing end-to-end 4Gb/s Fibre Channel architecture and technology, the DS4700 Express Storage System is a high performance (defined by IOPs or Bandwidth) storage system, as well as providing great functional density at a low cost. Within a single 3U controller enclosure, one could configure up to 4.8TB of raw disk capacity. Featuring dual redundant: RAID controllers, 4GB of controller cache, power supplies, cooling, and storage management software. All of this is possible because the DS4700 Express is designed around 4 Gb technology supporting up to 16 high capacity, hot pluggable disk drives. The enclosure is RoHS compliant, and available with NEBS certification by Q3 of 2006.
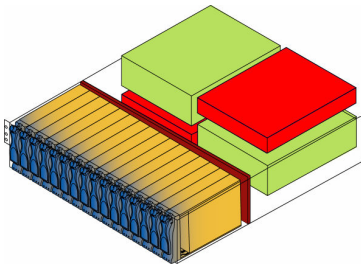
DS4700 Express Control Enclosure
with dual **Controllers**, dual **power and cooling** and up to 16-embedded FC **disk drives**.
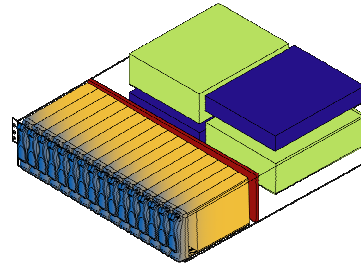

DS4000 EXP810 Expansion Enclosure
with dual **ESMs**, dual **power and cooling** and up to 16-embedded FC **disk drives**.

- The 4.8TB storage maximum for a single 3U enclosure is based on use of 300GB FC disk drives, with up to 16 drives per enclosure, up to a 14% improvement in disk drive modules.

- The DS4700 Express Switched Loop architecture is unique. The DS4700 Express Controllers (as well as the DS4000 EXP810 Expansion Enclosures' 4Gb environmental services modules (ESMs)) are similar to those in the 2Gb DS4000 EXP710 switched Expansion Unit. These Expansion Units have an embedded FC "loop switch" that creates what functions as point-to-point FC communication between the controllers or ESMs and the drives.
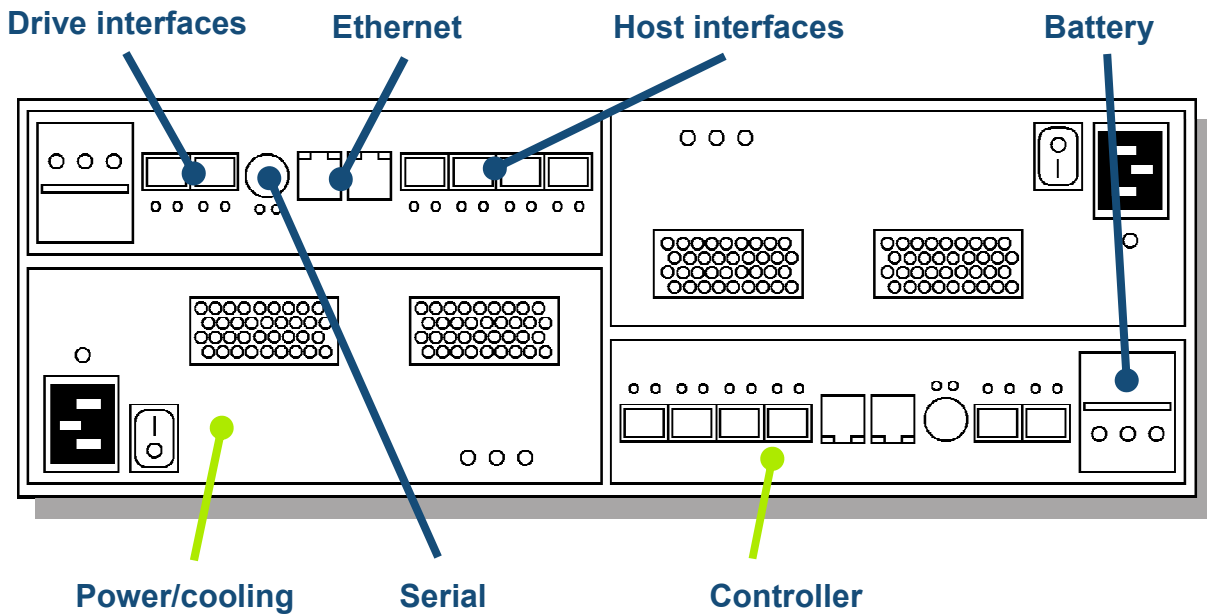
May 9, 2006

Technical Overview

The designs prevalent throughout the DS4700 Express begin with the hardware enclosure packaging. All current enclosures employ the same 3U rack mount chassis. Refer to the block diagram below.

Power/cooling   Controllers

FC Drives
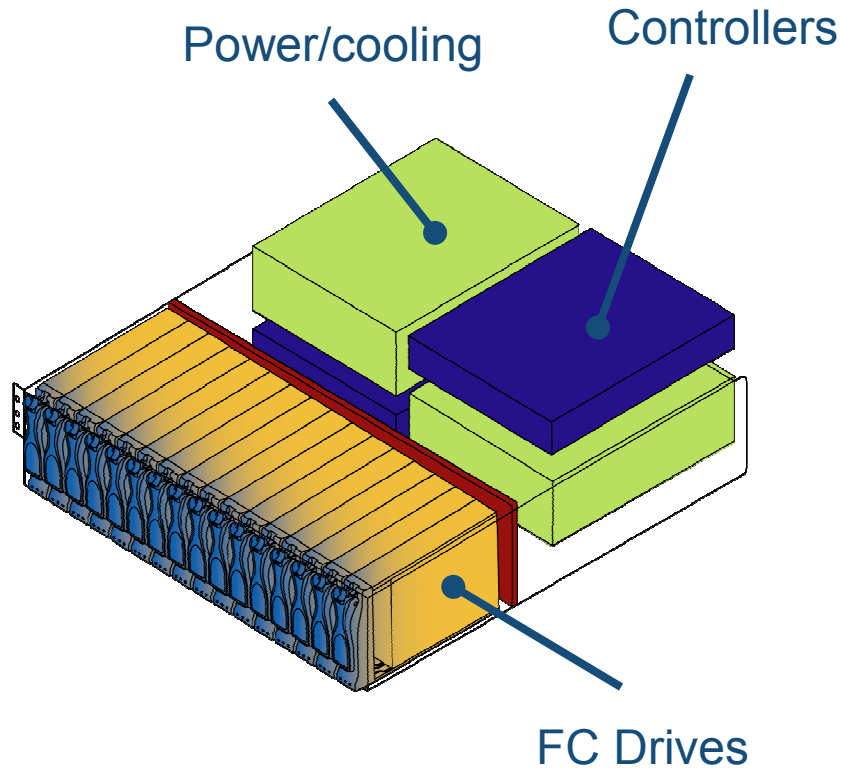
The primary chassis in the DS4700 Express Storage System is the Controller Module. As shown, this rack mount unit has capacity for 16 Fibre Channel Enhanced Disk Drive Modules (E-DDMs). The E-DDMs are easily removable and replaceable, hot, plugging into a proprietary midplane, which is field replaceable also. In the controller module, the drives are recessed behind a functional, decorative bezel

As with the front, the rear of the DS4700 Express is also fully accessible for cabling. In the block diagram above, the controller housing (shown in the deep blue) is mounted adjacent to its companion dedicated power and cooling unit (shown in green). The hot replaceable cache backup battery unit connects separately to the controller.

May 9, 2006

The diagram below displays the components visible from the rear of the DS4700 Express Controller Module:

Drive interfaces   **Ethernet**   **Host interfaces**   **Battery**

Power/cooling   **Serial**   **Controller**

The visual above identifies this unit as a DS4700 Express Model 72, since each of the dual controllers has 4 host interfaces. The equivalent DS4700 Express Model 70 visual would look identical, with the exception that the each controller would have only 2 host ports.

The diagram below is a view of the rear of the DS4000 EXP810 4Gb Expansion Enclosure.

Future use   **Serial**   **Expansion**   **Tray ID**

**Power/cooling**   **ESM**
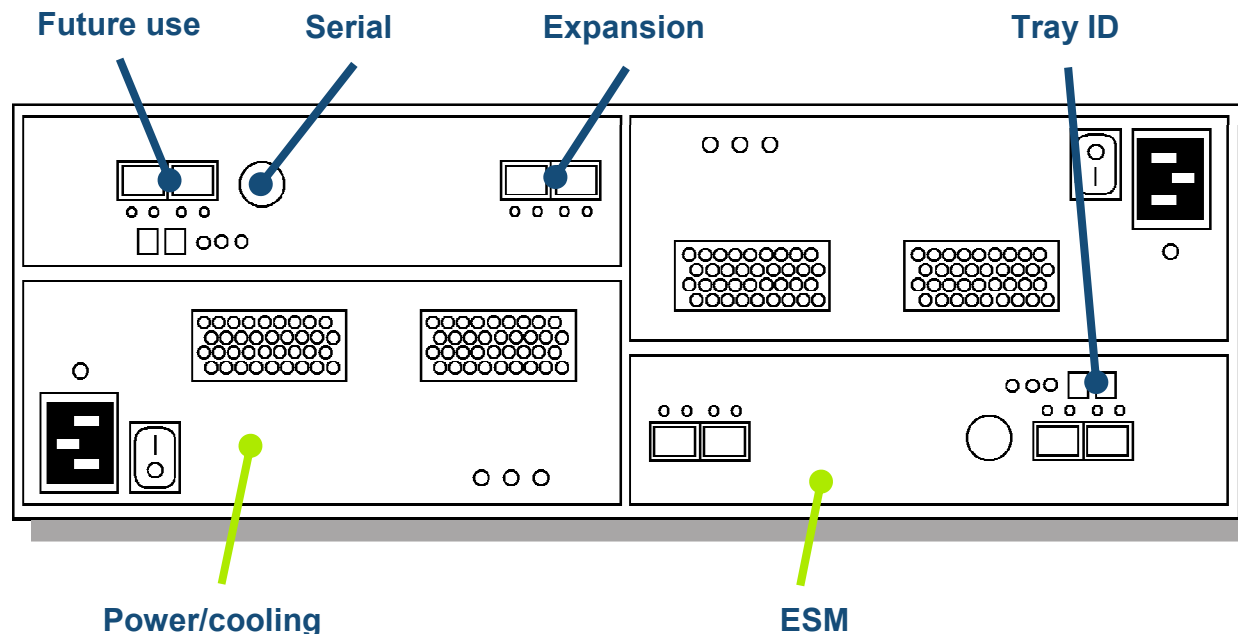
Cabling

The DS4700 Express storage system's four external drive loops are configured as two redundant pairs, with each pair cabling a maximum of three enclosures to the controller module.

The diagram on the right shows a fully configured DS4700 Express storage system with six DS4000 EXP810 Expansion Enclosures.

As noted earlier, the DS4700 Express storage system will support 2Gb disk drive modules

For the highest availability, the DS4700 Express storage system utilizes a "top-down/bottom-up" cabling scheme to ensure access to available expansion units in the unlikely event that a full expansion unit is unavailable.

Most of the other modular storage systems on the market may use a simple daisy chain scheme, where both drive loops run from the controllers, to the first drive enclosure, then to the next, and so on. When cabling this way, one drive enclosure failure may result in access to all enclosures after it to be lost.

EXP810

EXP810

EXP810

EXP810

EXP810

EXP810
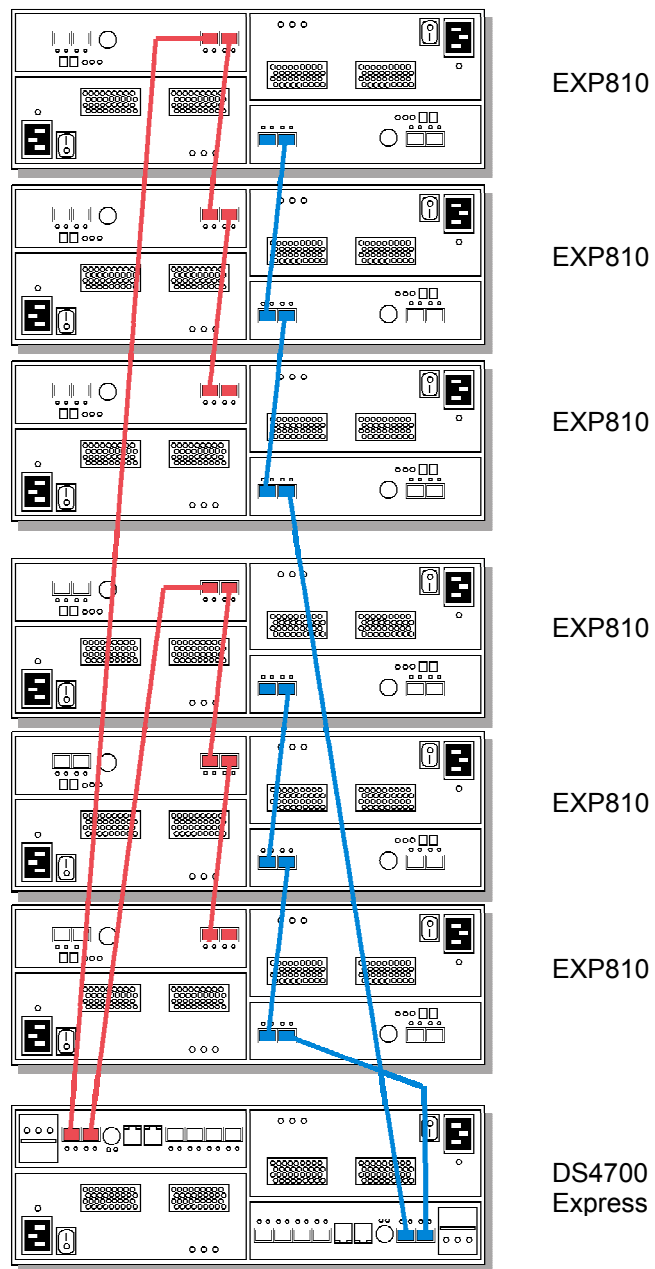
DS4700
Express

DS4700 Express Full Configuration

DS4700 Express Controller Architecture

The DS4700 Express Storage System integrates high-speed, industry-standard components with the robust firmware to deliver enterprise-class functionality and high performance designed to help lower cost .
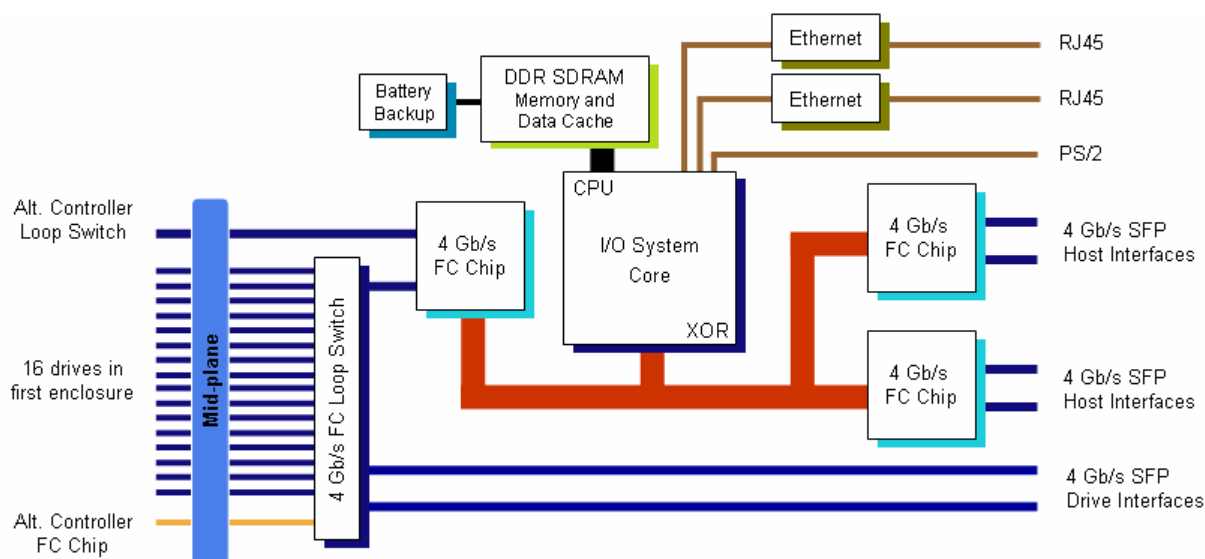
The DS4700 Express takes advantage of a 4Gb/s bus between its core processor and I/O chips. This 64 bit, 133 MHz bus has the "width" to handle vast quantities of large-block I/O (up to 990 MB/s on 512k sequential disk reads), and the "speed" to process large amounts of small-block I/O (44,000 IOPS on 4k random disk reads).

The I/O system core provides built-in hardware XOR for high-speed RAID parity calculations – with a dedicated chip – enabling the DS4700 Express controller to easily handle large amounts of random, small-block I/O and deliver exceptional I/O per second (IOPS) performance to transaction-based applications. And the DS4700 Express takes full advantage of its 4 Gb/s interfaces and high-speed internal buses to provide maximum throughput (MB/s) to bandwidth-intensive applications.

Each DS4700 Express controller has 4Gb/s Fibre Channel host I/O ports (eight per dual-controller Model 72, and four per Model 70) and two 4 Gb/s Fibre Channel drive I/O ports (four drive channels per storage system). With dual-controller configurations, integrated Fibre Channel loop switches connect the drive-side Fibre Channel interface chips in each controller – creating dual drive loop that provide both controllers redundant access to all attached disk drives.

Additionally, each controller has two isolated Ethernet ports – one for out-of-band management over a local or remote network, and one for authorized service personnel troubleshooting and diagnostics.

May 9, 2006

Value Propositions

- The DS4700 Express Storage System represents a combination of a proven design and advanced technology, designed to provide maximum advantage with the lowest risk
    - o High performance, reliability, density, compliance
    - o Designed to help lower direct and indirect costs (space, power, cooling, support, maintenance)
    - o Designed for ease of use (hardware, software and documentation, GUI-driven management, etc.)

- High performance design
    - o IOPS, throughput or bandwidth
    - o Application mixes requiring both IOPs and bandwidth performance

- Scalability to help storage growth at a rate consistent with your needs
    - o Maximum of 112 drives with up to 33.6TB of FC

- Powerful DS4000 Storage Manager
    - o Unmatched configuration flexibility
    - o Online expansion, reconfiguration, maintenance

- DACstore is designed to provide the following benefits:
    - o Creates "data intact" drive portability as drives are not bound to a given enclosure or slot
    - o Individual physical drives can be relocated within a system to help improve channel utilization (performance / availability)
    - o Individual RAID arrays can be migrated to another system
    - o Full systems can be upgraded by simply replacing the controllers

- Designed with high availability features
    - o Redundant components
    - o All data paths may be configured for automatic failover

- Heterogeneous host system support, including multi-pathing failover drivers
    - o Up to 1,024 volumes for large-scale consolidation

- Forward (and backward) compatibility, "data intact" protection with maximum ease of use
    - o Redeploy existing equipment… drives, enclosures, both
    - o Add capacity… drives, enclosures, both
    - o Add infrastructure
    - o Redistribute, Reallocate or upgrade for performance, availability and/or function

- Mix drive types in the same enclosure, may help boost tiered storage performance to an even higher level
    - o Tiered storage requirements can be managed in even a modest system

- Numerous data protection options, without additional requirements or load on your server resources
    - o FlashCopy
    - o Volume Copy

May 9, 2006

- o Synchronous and Asynchronous - Enhanced Remote Mirroring

- High density storage for large or small capacity applications
  - o 4.8TB of FC RAID performance storage with failover, backup (using FlashCopy) in a 3U enclosure

- Compatibility and compliance with interchange, industry, governmental, safety and environmental standards and directives
  - o SMI-S
  - o FCIA, SNIA
  - o UL, FCC, CE, VDE
  - o RoHS, WEEE

- Maximum performance and continuous availability at a price you wouldn't believe

  - o Serving a wide range of storage consolidation and clustering applications.
    The IBM System Storage DS4700 is designed to be an affordable, scalable storage server for storage consolidation and clustering applications. Its modular architecture—which includes Dynamic Capacity Addition, Dynamic Volume Expansion—can support on demand business environments by helping to enable storage to grow as demands increase. Autonomic features such as online firmware upgrades and DS4000 Service Alert also help enhance the system's usability.
- Leveraging DS4000 Series capabilities

  - o The DS4700 is part of the DS4000 Series, which uses common storage management software and expansion enclosures. The DS4700 can be used with the DS4000 EXP810 Expansion Unit utilizing Fibre Channel technology.

  - o This helps address the requirements of various fixed content and data reference applications, which require large amounts of storage capacity but do not have the high utilization and access characteristics satisfied by the DS4000 EXP810

- VolumeCopy
  - o The VolumeCopy feature is designed to provide full replication of one logical volume (source) to another (target) within the DS4700. VolumeCopy is designed to allow read-only access to the source volume during the copy process, and suspend writes to support point-in-time integrity

- Enhanced Remote Mirror
  - o Enhanced Remote Mirror consists of Global Mirror with Asynchronous Write-order Consistency. This is critical for mirroring multi-LUN applications, Global Copy with Asynchronous, and Metro Mirror with Synchronous.

- FlashCopy
  - o The FlashCopy feature is designed to take point-in-time copies of logical volumes, which may be used for file restoration, backups, application testing or data mining.

- Hot-Spares
  - o Multiple DS4700s can use a common pool of hot-spare disk drives as a cost-effective way to help improve availability, even if the DS4700s are attached to

May 9, 2006

different servers. IT administrators can determine the number of drives to allocate as spares.

Positioning

Positioning can be one of the most powerful methods of describing a product… by making a direct or indirect comparison of it with one or more other products or standards that are already known to the prospect. Positioning can be critical because the perception of our product or solution may be strongly influenced by the nature of the comparison

Fact is, the DS4800 is a very successful and highly regarded storage solution in its class today. And the DS4700 Express Storage System can be viewed as the entry point to the DS4800. It's based on comparable 4Gb technology, modular design, rich complement of management and premium feature software, and runs the same firmware.

Below is a high level specification comparison of the 4Gb family members:

Dual-controller system (unless noted)	DS4800	DS4700 Model 72	DS4700 Model 70
Host channels	8	8	4
Native host interface link speed	4 Gb/s	4 Gb/s	4 Gb/s
Supported host interface link speeds	4, 2, 1 Gb/s	4, 2, 1 Gb/s	4, 2, 1 Gb/s
Total host channel bandwidth	3,200 MB/s	3,000 MB/s	1,500 MB/s
Redundant drive channels	Eight 4 Gb/s	Four 4 Gb/s	Four 4 Gb/s
Total drive channel bandwidth	3,200 MB/s	1,500 MB/s	1,500 MB/s
Max drives	224	112	112
Drives supported	FC and SATA	FC	FC
Processor	Intel Xeon 2.4 GHz	Intel xScale 667 MHz	Intel xScale 667 MHz
XOR engine	Dedicated	Integrated	Integrated

Data cache	4, 8, 16 GB	4 GB	2 GB

Will you be asked about how these products compare with the competition, it's always important to address those questions directly, but from a position of strength and without dignifying the competitor or his products. Refer to the section on competition in this document for more suggestions on how to do this.

The chart below is a high level view of DS4700 Model 72 and Model 70 performance, again using DS4800 in comparison.

	DS4800	DS4700 Model 72	DS4700 Model 70
Burst I/O rate – cache reads	575,000 IOPS	120,000 IOPS	120,000 IOPS
Sustained I/O rate – disk reads	85,000 IOPS	44,000 IOPS	44,000 IOPS
Sustained I/O rate – disk writes	22,000 IOPS	9,000 IOPS	9,000 IOPS
Drives in test	224 2Gb FC	112 4Gb FC	Up to 112 4Gb FC
Sustained throughput – disk read	1,600 MB/s	990 MB/s	990 MB/s
Sustained throughput – disk write	1,300 MB/s	850 MB/s	850 MB/s

Note: These are results from initial testing and may differ slightly from the performance of the final released products.

Competition

Parameter	EMC CX500	HP EVA6000	HDS AMS500
Storage Enclosure			
Maximum Drives	15	14	15
Max. Capacity	7.5 TB	4.2 TB	7.5 TB
Interface	2Gb/sec FC-AL, SATA	2Gb/sec FC-AL, Fibre ATA	2Gb/Sec FC, SATA
Drives Supported	146GB 15K FC, 500GB SATA	146GB 15K FC, 250GB FATA	146GB 15K FC, 500GB SATA
Host Interface - Quantity	4	2	4
Host Interface - Type(s)	2Gb/sec FC	2Gb/sec FC	1Gb/2Gb/4/Gb Switched FC
Controller(s) - Processor	Dual Processors	Dual Vraid 0, 1, 5	Dual Controllers
Cache Max. Capacity	4GB	2GB	8GB
Cache Protection	Write Cache Destaging	Battery Backup = 4 days	
Redundant Components	Power	Power	Power
		Controllers	Controllers
		Drives	Drives
		Cooling	Cooling
Hot-Swap Components			Power
			Controllers
			Drives
			Cooling

May 9, 2006

o **Release Phases**

As done with previous products to confine the test cycle and accelerate availability, the DS4700 Express storage system is being release in multiple phases. All three phases will be version 9.16 of DS4000 Storage Manager software (firmware 6.16).

Announce May 9, 2006: Planned Availability May 19, 2006 - (FC)
- Support for Enhanced Disk Drive Modules (E-DDMs) with 2Gb/s and/or 4Gb/s FC drives
- Support for DS4000 EXP810 and DS4000 EXP710 Expansion Enclosure

Preview May 9, 2006: Planned Availability 2Q/3Q06 - (SATA)
- Plan to add support for 3Gb/s SATA II drives, including the intermix of these drives with FC drives in the same DS4700 Express Storage System or DS4000 EXP810 Expansion Enclosure.

2Q/3Q 2006
- Plan to add NEBS level 3 certification

May 9, 2006