



# Enterprise Storage Spotlight Report

## New Power-driven, High-end and Modular Enterprise Storage Systems

Game-changing Server Technologies/Advances  
Supercharge IBM's Storage Market Leadership Bid



## About this Enterprise Storage Spotlight Report

On October 12<sup>th</sup> 2004, IBM made its most important and dramatic enterprise storage announcement of this decade. In a major industry game-changing move, IBM not only revealed the expected new generation of high-end enterprise storage systems, named the IBM TotalStorage DS8000 series, but also unexpectedly revealed a compact and powerful new low-cost, modular, enterprise-class storage system. The latter, named the IBM TotalStorage DS6000 series, redefines the important mid-range and small enterprise market segments. Sharing the same operating environment, copy services and management interfaces, these new mid-range and high-end storage systems each support both mainframe and open systems servers on the same SAN, and are completely interoperable, allowing major infrastructure simplification, enhanced business continuity, and improved information lifecycle management for medium and large enterprises. The two systems create a continuum of compatible enterprise storage systems, from a much lower entry price-point, up to massive high-end systems that redefine the top-end of the market.

The DS8000 series and the DS6000 series incorporate a broad-ranging, technology tour de force blend of IBM's advanced Power microprocessors, pSeries server technologies, high-bandwidth interconnects, IBM Virtualization Engine LPAR technology (*DS8000 series only*), dense packaging and cooling skills, and advanced Reliability, Availability and Serviceability (RAS) engineering features. They also share and extend the well-proven, five-year established, ESS storage server microcode base. Each provides major advances over previous IBM ESS systems, and over current main competitors in these two important segments, by large factors. The benefits of IBM's server technology-based enterprise storage approach become clear with these important announcements.

With this DS Family, spearheaded by the new flagship DS8000 series and DS6000 series enterprise-class systems, IBM is now openly and avowedly driving to win the number one position in the overall and enterprise storage systems markets. Under the apposite slogan "The POWER to Breakthrough to Information On Demand", these impressive new Enterprise-Class Storage Systems (ECSS) will have major impact in, and will extend, the ECSS market.

In this Enterprise Storage Spotlight Report, systems and server technology analysts Software Strategies evaluates and assesses the technologies, capabilities and strengths of the new DS8000 and DS6000 systems, and highlights what they mean to customers and competitors. We have extensively researched and published on many of the technologies used in these new systems. These included the POWER Everywhere microprocessor strategy and the POWER5 microprocessor, the POWER5-based i5/iSeries, the IBM Virtualization Engine, the pSeries, zSeries and xSeries server lines, and IBM TotalStorage developments, which we were able to draw on in our research for this Report.

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# 1. Executive Summary

Our principal findings and conclusions from this Enterprise Storage Spotlight Report, briefly summarized here, provide a concise executive overview and summary:

- 1. On Demand Era Demands Storage Improvements:** On Demand's new, optimized business models/processes demand more flexible, responsive storage infrastructures that are better able to support variable demands. Customers are demanding simplified, more manageable, and more cost-effective enterprise storage infrastructures.
- 2. Improving Economy, Storage \$ Growth at Last:** Global economies are growing in 2004, as is the storage market after a three-year decline. The \$5.5B high-end enterprise segment will post a low single-digit rise in 2004. The larger \$8.7B mid-range storage segment will grow at 8-9% for the next several years. With combined \$14.2B customer expenditure in these segments, these are rich prizes for the leading vendors.
- 3. Storage Networks Too Complex:** As enterprises implemented storage networks to better share data, complexity crept in, and multiple SANs with poor or no compatibility were implemented for different server platforms. For On Demand, users now need ways to consolidate and integrate their enterprise storage networks more cost effectively.
- 4. 2 Major New Enterprise-class series of Storage Systems from IBM:** On October 12<sup>th</sup> 2004, IBM made its most important and dramatic enterprise storage announcement of this decade (*overviewed more fully in Section 3*), by announcing not just the one expected, but two all-new enterprise-class storage server systems:
  - **DS6000 series:** The surprise was this ultra-compact, high-density 3U enterprise-class server that scales up to 67.2TB, sets a new price point, and offers mirroring interoperability with its DS8000 big brother, ESS 800 and ESS 750, redefining mid-range enterprise storage with "no compromises" performance, reliability, scalability and copy functionality in a small package. (*The DS6000 series is reviewed in detail in Section 5*)
  - **DS8000 series:** Expected, but impressive in its all-new specifications and advanced capabilities was the DS8000 high-end, enterprise-class storage server, in two models scaling up to a high 192TB, using IBM's leadership POWER5 microprocessors and p570 server engines. The DS8000 introduced the industry's first storage system LPARs, allowing two storage images to be run on one system. The DS8000 offers up to 6 times the scale, large performance increases in 20% less space, at significantly lower cost than IBM's ESS (*Shark*) its predecessor. (*The DS8000 series is reviewed in detail in Section 6*)

The scalability-entry price-positioning of these impressive new enterprise storage systems within the overall new IBM TotalStorage DS Family of disk systems is shown in Figure 1 (*on page 6*). The new systems become available from December 3<sup>rd</sup> 2004, with entry level list prices beginning at \$97,000 for the DS6000 and \$250,000 for the DS8000.

- 5. Creates New Enterprise Storage Continuum:** To date, high-end and mid-range enterprise storage have been worlds apart, with separate product lines, copy service, and management interfaces adding complexity and cost for customers. The DS6000 and DS8000 break down these costly barriers to provide the first continuum of enterprise storage across the mid-range and high-end, with the same functionality, copy services and management software. This is shown in Figure 1 (*on page 6*).
- 6. Allow First Unified Enterprise Storage Infrastructures:** These systems now allow users to eliminate long-standing, costly, dual SAN environments, and deploy one smooth enterprise continuum to support both mainframes and Open Systems on one affordable, common, integrated SAN environment. Major savings from such consolidation are obtainable.
- 7. Systems Complete New DS Family Line:** IBM named a new brand of IBM TotalStorage DS Family last month, adding new low-price point entry-level systems (*DS300 & DS400*) to its successful mid-range (*now DS4000 series*). With this October 2004 addition of the breakthrough DS6000 and DS8000 enterprise-class storage servers, the giant now claims the widest and newest single-vendor disk line-up on the market. (*The DS Family's low and mod-range members are described in Appendix A*)
- 8. Customer Needs Foremost:** In designing the new DS6000 and DS8000, IBM looked hard at, and listened carefully to, what enterprise customers most needed; to better protect data, simplify storage infrastructures, and to manage data efficiently throughout its lifecycle, in the faster On Demand Era. Four main needs were clear:
  - Higher upward scalability with more granular horizontal growth.
  - Unified solution to support heterogeneous servers.
  - Needed range of Quality of Service (*QoS*) options to suit different tiers.
  - Need improved disaster recovery processes.

With the DS6000 and DS8000, in our Report's detailed assessment, the firm has hit these needs squarely on the nose, and raised the competitive game substantially.

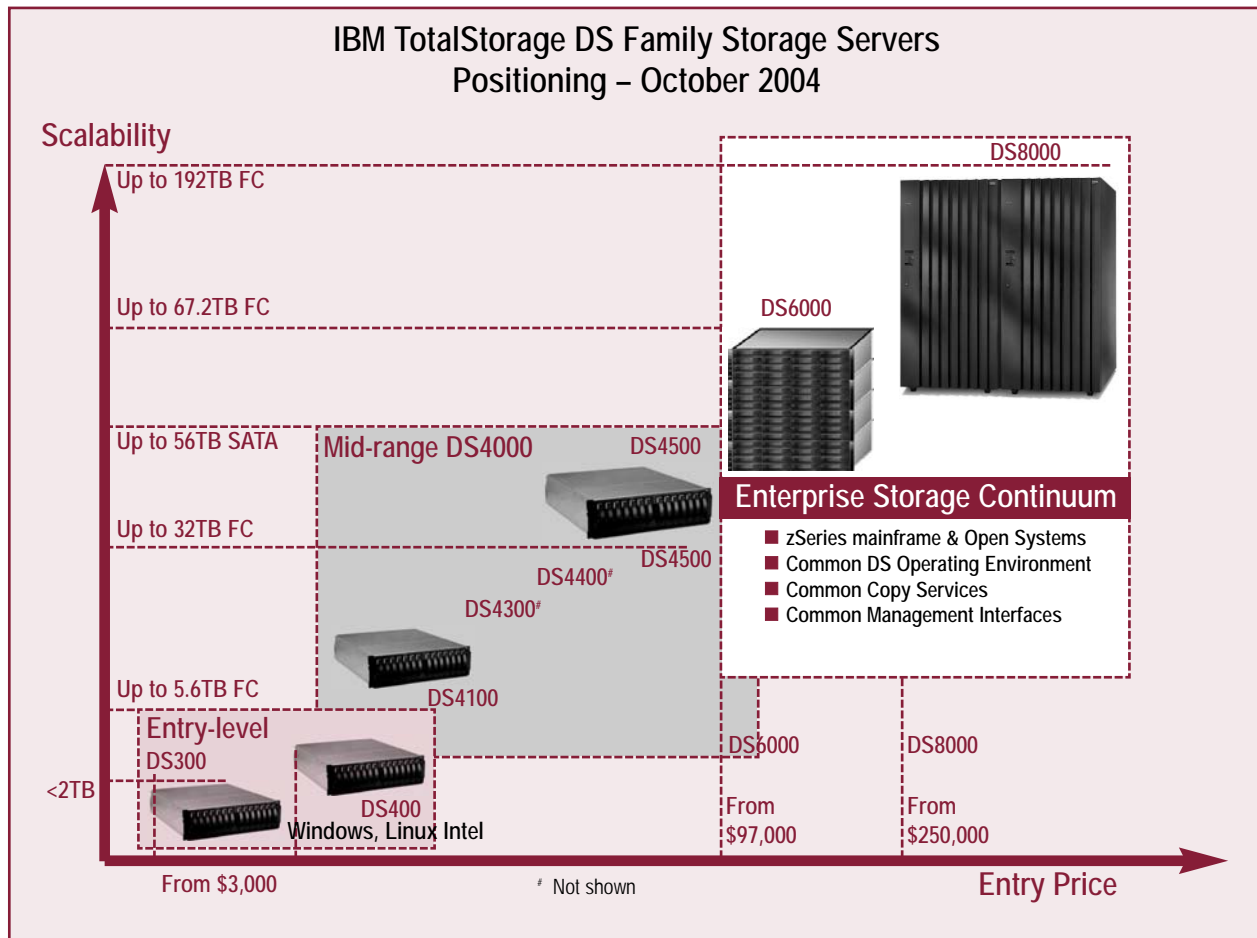


Figure 1: October 2004 – DS6000 & DS8000 Positioning in IBM's TotalStorage DS Family

9. **Balance Tips to Server-based Technology:** Enterprise storage competitors like EMC long used proprietary, specialized storage systems, custom-built end-to-end for the role in hardware and software, and sold at high prices. IBM's new products are its fifth generation of general server-based enterprise storage systems, and heavily leverage IBM's milestone PowerPC/POWER5 microprocessor and server advances. Now these server-based systems have pulled ahead in scalability, performance and price, tipping the balance in IBM's favor. The inflection point towards server-based storage solutions is now truly here!

10. **Mold-breaking DS6000 series Looks a Winner:** With its dramatically smaller form, mid-range prices, but full enterprise-class capabilities, the DS6000 series, will be hugely attractive to customers in at least five common situations, including:

- Mid-sized enterprises without enterprise-class storage today.
- Users with mainframes and Open Systems on separate SANs.
- Users of small-medium IBM ESS and other older competitors' systems.
- z890 mainframe customers.
- Customers needing lower-cost Disaster Recovery/Business Continuance (DR/BC) options.

These are widespread, the DS6000 completely outclasses competition, and we assess is certain to become a major success and sector leader.

11. **DS8000 series Goes for the High Ground:** The DS8000's impressive gains in performance, 6-fold higher scalability, 20% smaller footprint, and competitive pricing (*than the ESS 800*) are market game-changing, and present a formidable IBM challenge to leader EMC and other main competitor HDS.

Prime opportunity “sweet-spots” for IBM with the DS8000 are:

- ESS replacements.
- Booming zSeries market.
- New-name open bid wins from EMC or HDS.
- Storage consolidation for multiple server environments
- High-end pSeries and iSeries.
- IBM Global Services (*IGS*) services-led storage improvement projects.

Most early DS8000 successes will come from these scenarios. Medium-term, IBM expects to engage full battle with HDS and EMC at the high-end, and win, with customers benefiting from this new market option.

- 12. Shared Copy Services Leadership Will Help:** IBM's TotalStorage Resiliency Family products (*described fully in Section 7*) provide common copy services that enable affordable DR/BC and Information Lifecycle Management (*ILM*) solutions across the new DS8000, DS6000 and ESS enterprise storage systems continuum. This unique commonality allows CIOs to extend continuity and ILM strategies more broadly, easily and affordably. This strength will aid IBM's battle towards higher share and ultimate storage leadership.
- 13. IBM's Storage Leadership Push Accelerates:** With these two powerful enterprise-class storage systems, within a new overall disk range, IBM makes no secret of its ambition to recapture the number-one position in both enterprise and overall storage markets. With these new systems, it has formidable product weapons, and extended channels, that are certain to see it gaining share and momentum through 2005 on the first of these goals. The competitors are tough and entrenched, but the IBM offerings are so radical that chances are good. It is likely to take three to four years for IBM to attain its target, and customers will benefit throughout from these innovations and stronger competition.
- 14. Challenges Ahead:** IBM faces entrenched and capable competitors in EMC and HDS, who will not easily relinquish their current positions. EMC's customers are familiar with its copy services and software, and are generally well supported. HDS struck first, by announcing their new TagmaStore USP HE ECSS and SAN virtualization offering a timely month before IBM's announcement, and will, no doubt, be clearing inventory of Lightning 9900 V series at favorable prices. IBM needs to seize the bridgeheads of opportunity that we identify in 10 and 11 above rapidly to gain momentum, and to push the envelope of technology advance briskly. It must also ramp up its Business Partner channels to fully address the mid-market opportunities. These are demanding challenges, and will require consistent execution.
- 15. Larger DS8000 Models in the Wings:** Adding gasoline to the fire it already lit, IBM gave a Statement of Direction (*SoD*) for an even larger, more powerful DS8000 model. Scaling up to 384TB, the SoD 8-way systems will keep IBM at the top of the enterprise storage bragging scale when the top segment of the market requires systems of this power.
- 16. Storage Software Portfolio Supports Aims:** IBM extended its TotalStorage Open Software Family, including the TotalStorage Productivity Center Suite, which will be a good management option for DS6000 and DS8000 customers. These integrated storage management tools now include automated server and storage provisioning that cuts storage staff effort and time to service. These tools ensure customers get the best from their new DS6000 and DS8000 systems, and merit closer review and full consideration. (*Described in Appendix C.*)

These are interesting times in the enterprise storage business! With this announcement, IBM has put a stake in the ground with two new and attractive major offerings that redefine enterprise storage, and will be welcomed warmly by its many customers. Established competitors will be forced to respond – to the benefit of customers. Read the rest of this Report for the detailed findings this Executive Summary is based on.

## 2. Report Introduction and Positioning

### Introduction

Medium and large enterprises have wrestled with the complexities of managing the multiple enterprise storage networks/SANs they deployed to support the complex heterogeneous server environments that they had accumulated during the 1990s. The different storage worlds of the mainframes and open systems, and of high-end and mid-range storage systems, have to date usually required at least two solutions, each with different skill sets, different software for copy and replications services, and different storage management tools.



As more enterprises move into the On Demand era, they need new business models, optimized core business processes, and much more flexible, responsive and adaptive business systems able to better respond more quickly to variable demands, the pressure for simplified and more efficient enterprise infrastructures has mounted considerably.

*...the pressure for simplified and more efficient enterprise storage infrastructures has mounted considerably.*

Simpler enterprise storage infrastructures require increased commonality and standardization, and greater virtualization of enterprise storage resources, across the diverse server platform

mixes in use today. Traumatic world events and frequent natural disasters have highlighted much-increased enterprise needs for more affordable and manageable business continuity storage provision that can span across more of the storage infrastructure and over wider geographical areas. On Demand businesses are generating sharply rising storage installed capacities and usage. Global trends have brought stricter regulatory regimes in many industries and geographic markets. These all demand higher standards of data retention, traceability and accessibility. These compliance rules also impose more stringent demands for increasingly sophisticated ILM. This requires hierarchies of affordable storage solutions for all levels on the storage cost, performance, and frequency of access, spectrums.

## Storage Markets and the Enterprise Segments

Storage is a central part of all IT infrastructures, representing a \$56B total 2003 market, one projected to grow to \$71.4B by 2006 (*IDC forecast*). These researchers found storage services accounted for 40%, disk systems for 39%, storage software for 11%, tape for 6%, and Fiber Channel (*FC*) infrastructure for 4% of this total expenditure in 2003.

- **High-End Enterprise-Class Storage Arrays/Systems (HE ECSS):** Gartner recently (*July 2004*) reported the HE ECSS market segment to have been worth \$5.42B in 2003. Within this concentrated storage segment, EMC held a near 36% share, IBM some 22%, HP and Hitachi around 11% each, and "others" the remaining 20%. This market segment has been declining since 2000, but now some growth is expected from 2004, at low, single-digit percentage rates.
- **Mid-range Storage Arrays/Systems:** The mid-range storage arrays market was reported to have been worth \$8.7B in 2003, and is expected to show a more healthy growth rate of 8-9% over the next three years, and so represents another prime battleground for storage system vendors.

*...high-end enterprise and mid-range storage array/systems markets thus generated revenues of around \$14B in 2003...*

Combined, these high-end enterprise and mid-range storage array/systems markets thus generated revenues of around \$14B in 2003, and, after three years of decline, are again showing revenue growth in 2004. Aggregate revenues conceal

a substantial rate of increase in storage TB volumes shipped, and continuing downward storage price/MB cost curve in all segments, a trend all storage analysts expect to continue.

## IBM TotalStorage

IBM has, for some years, fought aggressively to move back towards the overall storage market leadership that it lost to EMC during the 1990s. Its TotalStorage range of disk, tape, and storage software systems has seen much development and investment over this time, rewarded by climbing market shares. In the high-end enterprise storage system segment, IBM held a near 22% market share (*2003-Gartner*) with its ESS (*Shark*) series of high-end storage systems, battling leader EMC, and tough competitor Hitachi Data Systems (*along with the latter's OEMs, HP and Sun*). It also achieved good success with its mid-range; open systems-targeted, DS4000 series (*formerly FASiT*) FC storage systems, and its extensive tape, storage management and storage virtualization software portfolio.

## Who Should Read This Report?

This Report was written primarily to fulfill the information needs of CIOs, CTOs, Senior Architects and Storage Managers in enterprise IT shops with interests in the planning, purchasing, deployment and operation of ECSS. It will also help IT managers and technical seniors in medium-sized enterprises who are seeking more powerful storage solutions. Services and Systems Integration firms serving enterprise IT customers (*often influential in choice of systems and storage*) will also find our results of value, as will ISVs planning storage platform support for their applications. IT press and media representatives seeking to understand and cover this major IBM storage announcement are our final constituency.

## Terms

This Report covers IBM's new enterprise-class storage systems, often also called enterprise storage arrays, or enterprise storage servers. We use the acronym ECSS (*for singular and plural cases*) to refer to this whole segment of Enterprise-Class Storage Systems or servers in this Report. In part, we adopted this usage to avoid confusion with the IBM product name ESS (*Enterprise Storage Server*). There are two segments in this market, mid-range and high-end, and we refer to these as MR ECSS and HE ECSS, for brevity wherever clear.





## Our Report Research

A large group of EMEA-based systems and storage analysts, including the author, were extensively pre-briefed by the IBM TotalStorage executive and engineering team leaders. We were able to closely question them, and examine the new systems “in the flesh”, at the IBM Montpellier site in southern France, over an intense two-day period, several weeks before the announcement. This provided a primary research source for this Report. We also drew on our previous research on related IBM Systems topics, detailed on page 43. Our focus is on the technology and capability of these new systems, rather than storage market data projection, or detailed competitor feature comparison.

## 3. October 2004 TotalStorage Announcement Overview

### TotalStorage Announcement Set to Change Enterprise Storage Markets

On October 12<sup>th</sup> 2004, IBM made its most important, dramatic enterprise storage announcement of this decade. In a major industry game-changing move, it revealed its expected new generation of high-end storage systems, named the DS8000 series, but also unexpectedly revealed an ultra-compact and low-cost, modular ECSS. Named the DS6000 series, this system redefines this important market segment. We overview the announcement here, and delve more deeply into its significance in the rest of this Report.

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*...compact and low-cost, modular ECSS. Named the DS6000 series, this system redefines this important market segment.*

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### The DS6000 series – Breakthrough Modular ECSS

The big surprise at the TotalStorage Announcement was the unexpected unveiling of a staggeringly compact and capacious new, low-cost, modular, enterprise-class storage system (*MR ECSS*) named the IBM TotalStorage DS6000 that redefines this important and faster growing market segment. The extraordinarily compact and dense DS6000 line is a modular, rack-based system in a 3U form-factor. A base model provides up to 4.7TB physical capacity from just one 3U controller/server module, but the system can scale up to a 67.2TB physical storage capacity, supporting up to 224 HDDs, by the addition of up to 13 3U expansion drawers, each housing 16 HDDs. Thus a full 67.2TB DS6000 system can be housed in one standard 42U 19” rack. The DS6000 series also sets a new low price level for the full enterprise storage capabilities it offers, at under half the price of its closest competitor, as well as offering a far lower entry point. This server technology-based system is an extraordinary engineering feat of high density, small size, low weight, and power consumption reduction. For example, at almost 5.0TB (4.7TB) capacity, a DS6000 occupies some 5% of the space required by a comparable EMC DMX800, is just 10% of the weight, is less than half the price, yet offers superior capabilities. These are dramatic gains. The DS6000 series shares its software code and advanced functions with the DS8000 series, and has copy services interoperability between the DS6000 series, the DS8000 series, ESS 800 and the ESS 750. This enables customers to have a low-cost storage system alternative for secondary, disaster recovery sites. The system is engineered top-to-bottom for easy customer self-installation, configuration, and hot-swap self-repair, with simplified configuration and management interfaces and extensive diagnostic and maintenance support. The DS6000 series also introduces an industry leading 4-year warranty, covering both hardware and software. A DS6000 controller/server unit is shown (*front view*) on the left-hand side of Figure 2 (*on page 10*). We review the DS6000 series fully in Section 5.

### All-new DS8000 High-end ECSS First With Storage System LPARs

IBM revealed, as expected, a completely new generation of High-End ECSS (*HE ECSS*), named the DS8000, of impressive capabilities that considerably lift the bar in the HE ECSS segment. These server-based systems are the industry's first to offer storage system LPAR capability (*Logical Partitioning*), which allows them to run two completely separate and isolated storage images on a single storage system, bringing a new dimension of infrastructure simplification and optimization.

The larger of the two initial models of the DS8000 supports up to 192TB of physical storage capacity, offers a major leap in performance, and many other important advances. These systems use architecture capable of addressing up to an almost unimaginable 96PB, and also offer a roadmap statement of direction (*SoD*) for larger models and a roadmap for further enhancements that will break the 1PB barrier, already well advanced in development. The announced larger model already delivers a striking up to six-fold increase in performance over its predecessor, the IBM ESS 800. The DS8000 also incorporates extraordinary levels of reliability and availability, engineered deeply into the system at every level, from the enormously powerful POWER5 microprocessors and p5 570 server engines used, up through the hardware, microcode and software stack. These are claimed to offer a “greater than five 9s” availability never seen in storage systems before. A DS8000 is shown on the right hand side of Figure 2 (*on page 10*). IBM's confidence in DS8000 reliability is signified by the industry-first 4-year 7\*24 on-site warranty it offers on the systems, which helps further enhance its already favorable TCO. We review the DS8000 series fully in Section 6.

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*IBM's confidence in DS8000 reliability is signified by the industry-first 4-year 7\*24 on-site warranty it offers on the systems...*

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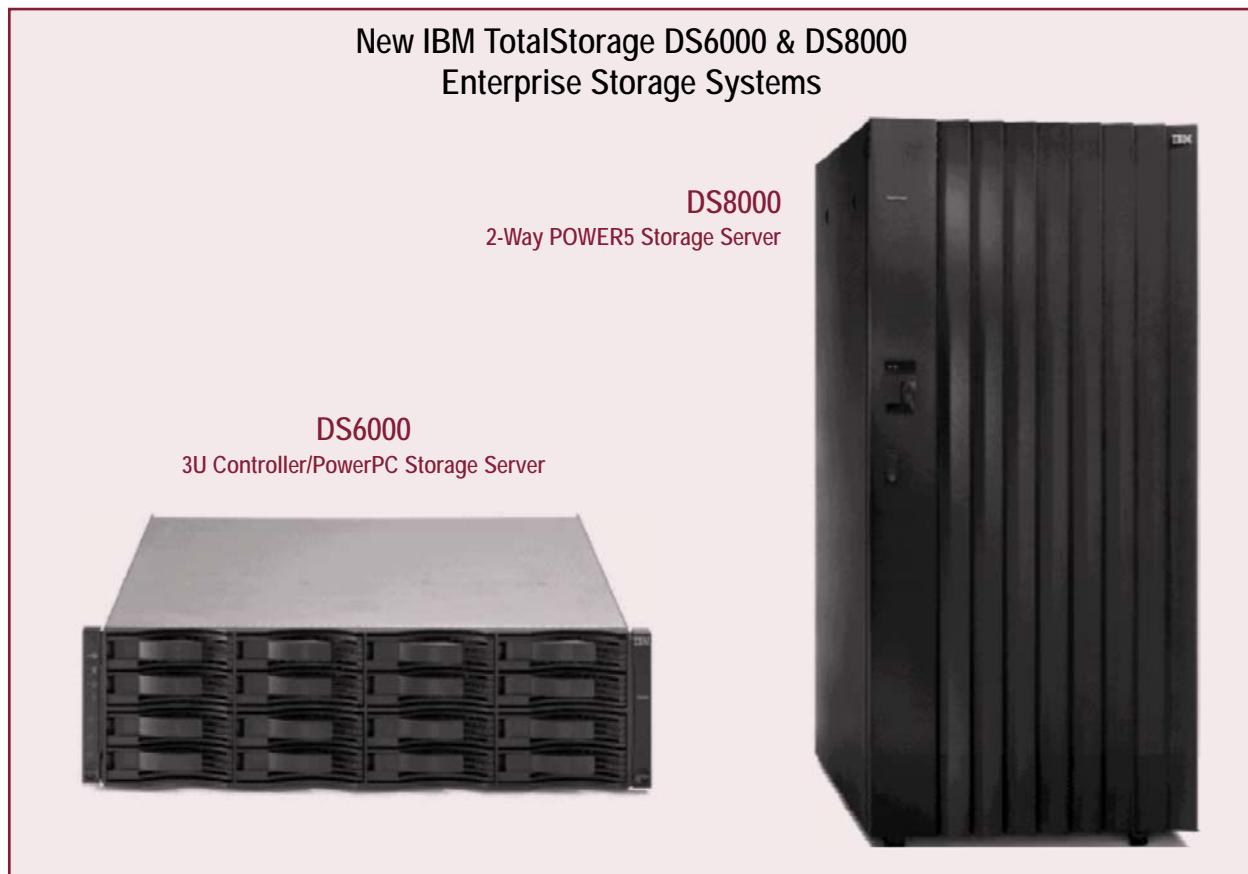


Figure 2: New IBM TotalStorage DS6000 & DS8000 Enterprise Storage Systems

## Common Code Base Brings Common Functionality, Well-proven Platform

Because both of these all-new server technology-based ECSS share most of a common, five-year proven microcode code base Operating Environment from their ESS (*Shark*) predecessors, both systems provide the same copy services, and the same storage management interfaces. This is a hugely important factor, for several reasons. Firstly, it allowed the all-new DS8000 to inherit over 75% of the ESS 800 microcode base that has been extensively refined and made resilient over its five-year life. Secondly, the DS6000 and DS8000 today share 97% common microcode, which enables their common functionality, and also allows IBM to far more easily maintain and develop these systems in parallel in future. Thirdly, this commonality bridges the usual gulf of different and incompatible copy services and management interfaces between mid-range and HE ECSS, which has long demanded duplication of skills and extra costs for customers

*Because the DS6000 runs on the reliable Linux Open Source operating system, IBM was able to port the Operating Environment microcode remarkably quickly...*

running both levels of enterprise storage. Finally, by porting and using this high proportion of common microcode for the DS6000, IBM was able to bring the DS6000 to market many months or years earlier, and at its new low price-point, than if all-new microcode had had to be developed and debugged. The ESS microcode always ran on a subset of AIX, IBM's rock-solid and mature enterprise UNIX operating system, on these server-based HE ECSS. Because the DS6000 runs on the reliable Linux Open Source operating system, IBM was able to port the Operating Environment microcode remarkably quickly and relatively easily.

Such gains are unobtainable with the proprietary, monolithic, custom-built hardware and embedded software architectures used by leading competitors. We discuss server-based versus proprietary design ECSS architectures in Section 4 following.

## Enterprise Storage Continuum

IBM has coined a new term – the enterprise storage continuum – to describe this important new level of common services and management interfaces, across the modular DS6000 from a far lower entry point, up to the high-end DS8000 with its up to six-fold higher performance (*over the ESS 800*). This is well illustrated and portrayed in Figure 3 (*on page 11*), which shows the full current IBM TotalStorage DS Family of disk systems.

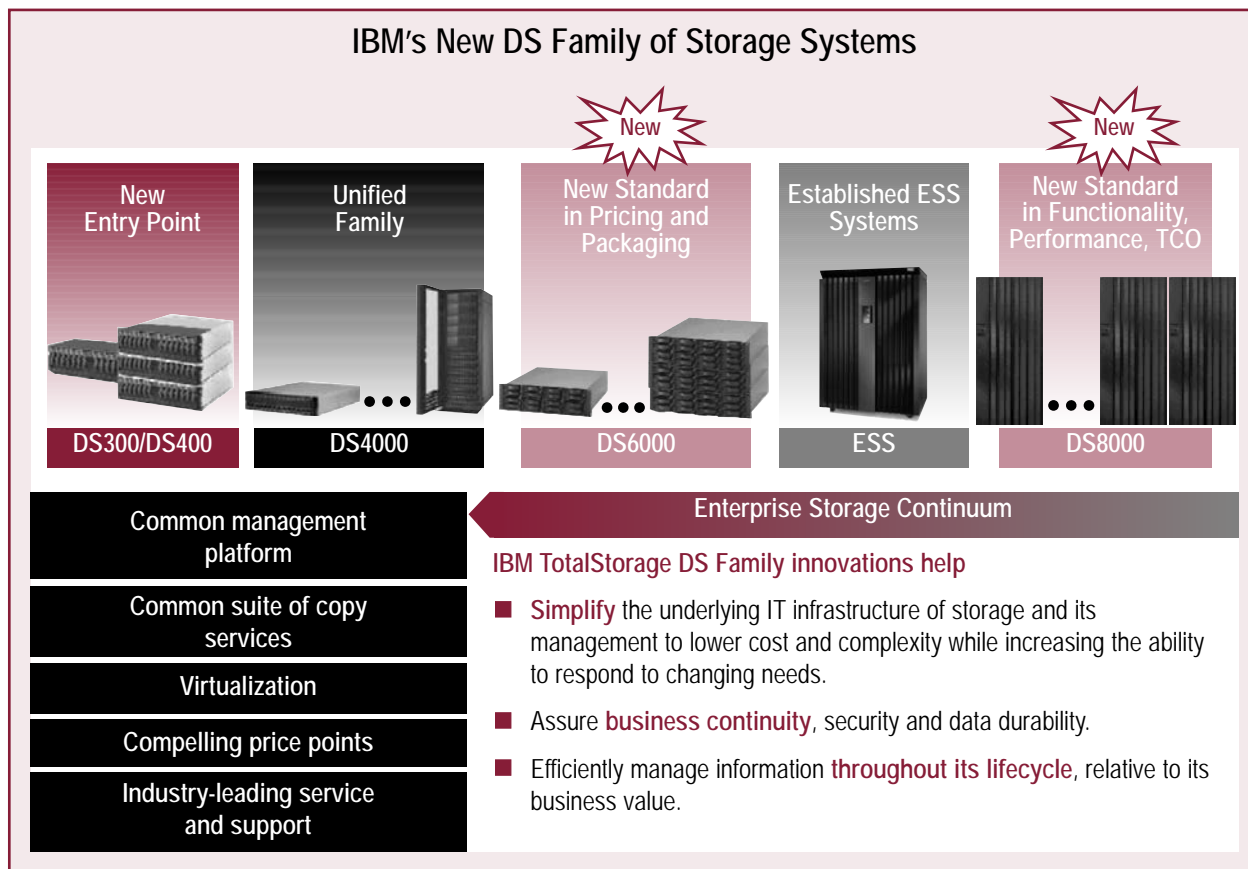


Figure 3: IBM's New DS Family of Storage Systems

The new enterprise-class modular DS6000 and DS8000 high-end ECSS can also each support both mainframe and open systems servers on the same SAN. This allows more customers to make considerable infrastructure simplifications by eliminating the usually separate SANs deployed for mainframes or larger iSeries, and for open systems (*UNIX, Windows and Linux*).

Because the DS6000 and DS8000 are fully interoperable, they can be used together in many configurations, to provide enhanced but affordable business continuity, and to deliver improved ILM for medium and large enterprises. These two complementary systems create a much wider, continuum of compatible ECSS, from a much lower entry price-point, up to massive high-end systems that redefine the top-end of the market.

### IBM DS Family – Rebrands Disk Line

All IBM's disk systems are now branded as the TotalStorage DS Family. This comprises the two new ECSS above, plus IBM's successful mid-range FC storage systems for open systems, now named the DS4000 series (*previously FASiT*), together with new, ultra-competitive entry-level systems named the DS300 (*iSCS*) and DS400 (*FC*), and targeted for workgroup and SMB computing. The positioning of these lines within the DS Family is shown in Figure 2 (*on page 10*).

*Because the DS6000 and DS8000 are fully interoperable, they can be used together in many configurations, to provide enhanced but affordable business continuity, and to deliver improved ILM for medium and large enterprises.*

### Design Goals: Meeting High Priority Important Customer Needs

The broad and universal enterprise needs to better protect data, simplify storage infrastructures, and to manage data efficiently throughout its lifecycle, in the faster-moving On Demand era, were the high-level targets for improvement with these new systems. Enterprise storage customers know and recognize the technology barriers and limitations that, to date, has blocked the path to such desirable improvements. These barriers centre on a lack of sufficient scalability, complex storage management challenges, the current difficulty of optimizing the use of storage resources, and of providing affordable business continuity. Storage customer research, including IBM's, has highlighted the most important advances needed today are for:

- **Much greater vertical scalability as well as granular horizontal growth:** Customers are experiencing high growth rates in storage capacity and need ECSS that can scale up to handle much larger capacities, but without requiring additional storage administration staff headcount. They want this scalability to be contained within a single-system footprint for easier management, and with the highest levels of security and resilience. At the same time, they want the ability to upgrade in smaller increments to meet their changing demands, with the finer granularity more modular systems can offer.
- **Heterogeneous Server Environment Widespread:** Virtually every medium or large enterprise today operates diverse, heterogeneous server environments, and this has spawned a complex web of storage networks and SANs in most such shops. In part, this arose because no single vendor could provide a single-source solution for all these needs when installed. The interoperability of SAN components remains a considerable issue and challenge, and customers feel they are spending far too much time and money managing these multiple diverse storage networks and systems.
- **Need a Range of QoS options:** Whilst core, large-scale, mission-critical enterprise applications will usually require the highest levels of storage QoS (*performance, availability, scalability*), other important workloads may need lower-costs above all, with still acceptable QoS and enterprise-class functionality. Customers want to be able to better optimize their storage environment across all their workloads, to meet both ends of this spectrum of needs, and those that fall in between, cost-effectively and with safe isolation between these storage pools.
- **Disaster recovery processes difficult:** There is far greater awareness of the need for, and desire to provide, more extensive disaster recovery and business continuity, but the process remains difficult, and sometimes too costly. Customers said they needed better ways of getting data to DR/BC sites reliably and affordably, and needed to be able to replicate data across heterogeneous storage systems more easily.

Meeting these demanding customer requirements was the design brief for the new DS6000 and DS8000 systems, and we evaluate how closely they achieve and deliver advances to achieve these goals throughout the rest of this Report.

## Migration Services

IBM provides migration services to consolidate data from customers' existing storage to the DS6000 and DS8000 series. When businesses need to move up from the DS6000 to a larger system, IBM can also provide migration services to migrate customer data to the high-end IBM TotalStorage DS8000. This approach, which often uses on-site portable hardware assists, lets businesses change with their evolving needs without disruptive discontinuities. These services can greatly ease the paths of what we anticipate will be the many customers who will wish to take full advantage of the DS6000 and DS8000 systems capabilities by moving onto the platforms from their older storage systems, both IBM and non-IBM.

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*When businesses need to move up from the DS6000 to a larger system, IBM can also provide migration services to migrate customer data to the high-end IBM TotalStorage DS8000.*

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## Our Analysis

IBM threw off the covers to show a formidable pair of all-new ECSS, for the enterprise mid-range and high-end, that genuinely redefine these segments, threaten competitors' positions, and appear well-set to help propel the giant back to overall storage leadership. There is no doubt that this announcement was IBM's most important enterprise storage move since the original ESS was launched five years ago. These impressive systems are built on server-based technologies that fully leverage IBM's leadership in microprocessor, Linux and UNIX server technology, and system design optimization skills, to set new standards. We examine and evaluate these underlying technologies in Section 4 next. They also create an important new continuum of enterprise storage of common capabilities, which now spans from a much lower entry-point of MR ECSS up to a much higher HE ECSS. This continuum brings major opportunities for customers to simplify their storage infrastructures, improve their

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*IBM threw off the covers to show a formidable pair of all-new ECSS, for the enterprise mid-range and high-end, that genuinely redefine these segments, threaten competitors' positions...*

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business continuity and enhance their information lifecycle management at significantly lower costs, to bring lowered TCO. Customers will now be able to eliminate the dual ECSS environments of enterprise mid-range disk for Open Systems and separate high-end SANs for mainframe systems that have added to storage infrastructure complexity for so long.



## 4. Server Technology-based, Enterprise-class Storage Systems

### Introduction – Architecture/Technology Strategy Matters

ECSS are special-purpose computing systems focused on providing rapid access from host server applications to large amounts of stored data, with high data access and data movement performance goals. High memory bandwidth and large processor memory (*cache*) are thus central requirements. These systems must also be highly-reliable, and be able to support the range of software-based copy services, storage management, and back-up operations required in demanding enterprise storage environments, and to operate in SANs supporting a range of server host types. Two main technology/architectural strategies have been used to address this market:

- **Special-purpose storage computing systems:** These use proprietary architectures, custom-designed and built monolithic hardware, and vendor-unique storage-orientated operating software. The arguments for this approach are that the whole system can be optimized and integrated by its vendor for its ECSS role without compromises. The downsides are the complexity, time to market, high development costs, and the closed and proprietary technology originally employed, and the difficulty of keeping all this advancing at the faster rates of the wider technology/server market. Consequently, these systems commanded high prices to cover their huge development costs. EMC and (*later*) HDS were the principal exponents of this strategy, both successful to date. Several generations of such systems have made increasing use of standardized Common Off The Shelf (*COTS*) parts, prices have fallen sharply since 2000 and more open-standards and interoperability support has been added. The EMC DMX systems and the HDS Lightning 9900V Series are current HE ECSS representatives of this approach. It is often argued these monolithic storage systems use a model similar to the one that drove the IBM mainframe into near-terminal decline in the late 1980s and 1990s, which only a drastic 10-year effort from IBM has now turned into healthy resurgence!

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- **Server-based/server technology-based ECSS:** This architectural approach says that ECSS are best built on general-purpose server computing systems technology. Server hardware and OS developments attract several \$B of R&D expenditure, and drive microprocessor development investments to support the rich \$50B overall server market. Server technology and microprocessor developments have advanced ever more quickly, alongside standardization and commoditization, bringing rapid server performance and price/performance advances. This strategy bases ECSS design on proven, existing server platform and runs standard operating system software. The resulting ECSS thus inherits all the ongoing developments of its server platform and operating system, and the builder focuses storage R&D on the storage microcode/software functionality and physical hardware engineering that turns a server platform into an ECSS. Development costs are lower, new generations with improved performance can also be produced faster, and these factors, plus cheaper standard hardware, allow market-competitive pricing. IBM has been the principal exponent of server-based ECSS with its ESS (*Shark*) systems. The new IBM DS8000 covers the HE ECSS segment using a server-based approach and the new IBM DS6000 addresses the MR ECSS segment using a server technology-based approach.

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*The new IBM DS8000 covers the HE ECSS segment using a server-based approach and the new IBM DS6000 addresses the MR ECSS segment using a server technology-based approach.*

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Arguments have raged throughout as to which approach would ultimately prevail. To date, special-purpose storage systems had generally won the majority of the market, but their high prices have been beaten down by competition from server-based ECSS, and the latter have already won a substantial share, fuelled by competitive pricing and rapidly-advancing capabilities. Performance and scalability bragging rights have swapped and leapfrogged between the three leading vendors with each new generation and refresh.

### Server-based ECSS – The IBM ESS & DS6000/DS8000 Evolution

The advances in scalability of IBM's ECSS, through five rapidly succeeding generations from 1999 to date, is illustrated and commented in Figure 4 (*on page 14*). These systems exploited the rapidly increasing power and capacity of both IBM's Power Architecture PowerPC processors (*and now of the POWER5 microprocessor chip*) and of its complete RS/6000 and pSeries/p5 servers, which we discuss separately below.

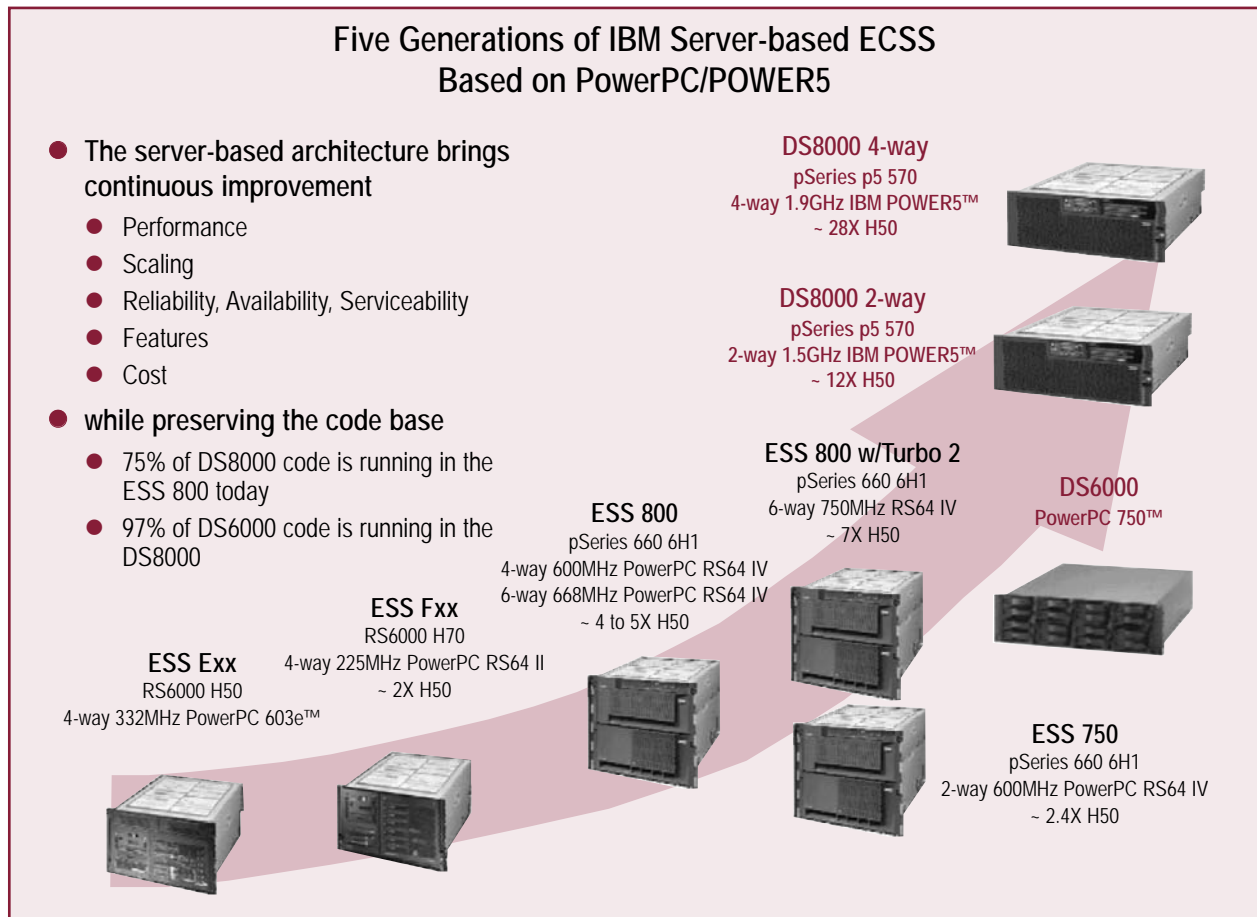


Figure 4: Five Generations of IBM Server-based ECSS Based on PowerPC/POWER5

As can be seen, the new DS8300 high-end model (4-way) employs p5 570 server processing which offers 28-times the scalability of the original RS/6000 H50 server processing used in the original ESS E20. It also represents a dramatic four-fold leap from its immediate predecessor, the IBM ESS 800 Turbo2. This leap reflects the power and performance of the POWER5 processors, and of the p5 570 servers and systems architecture that have blown away every competitor in server markets, and are now set to do the same in the HE ECSS segment with the DS8000. The DS6000 exploits the lower-cost, small footprint, easy to cool, and low power-consuming PowerPC750 64-bit processor, ideally suited to its breakthrough ultra-dense design and significantly lower price point. IBM's storage system microcode base is now robust, mature and well proven, and is shared.

### ECSS Market Now at Inflexion Point – Server-based ECSS Pull Ahead

*We consider IBM's new DS systems are real breakthroughs signaling a major market inflexion point. Now such advanced server-based/server technology-based ECSS can clearly outgun special-purpose, hardware-based ECSSs...*

We consider IBM's new DS systems are real breakthroughs signaling a major market inflexion point. Now such advanced server-based/server technology-based ECSS can clearly outgun special-purpose, hardware-based ECSSs, and can be expected to extend their future lead (with the known advances scheduled in IBM's roadmap for future DS systems, POWER MPUs and pSeries systems). The extraordinary technology and capability of POWER5, the p5 570 server base, and of the PowerPC microprocessor platform,

must be understood to appreciate fully why and how IBM's new DS8000 and DS6000 systems can deliver these breakthrough capabilities.

### IBM's Strategy Succeeded in Servers, Now Transforms ECSS

IBM's Systems & Technology Group (which includes TotalStorage) has pursued a clear, unified strategy for over five years. The strategy was to accelerate and leverage IBM's acknowledged world-leadership in microprocessors and semiconductors, R&D and innovations, its huge stock of patented IPR, and a decades-long strength in optimizing balanced hardware-software systems architectures, and deep software skills.

It used these to deliver leadership commercial performance, much better value, and improved reliability and manageability. The strategy had already been applied to IBM's POWER & PowerPC microprocessors, all its eServer, and now to its ECSS TotalStorage hardware platforms, and to their associated software support.

On top of these long-standing strengths, IBM added an exemplary commitment to open-standards, Linux and autonomic. It has now used all these skills to successfully deliver leadership performance, price/performance and functionality to each of its server system segments, extending real differentiation with each successive generation of these lines to consistently lead the overall server market. In addition, it focused heavily on extending its virtualization leadership, brought hundreds of autonomic computing innovations into its systems (*to make them easier and cheaper to manage*), and widely championed the open-source Linux operating systems platform for lower-software costs.

It was therefore just a matter of time before this combined force, and the advanced technologies flowing from this strategy, were fully deployed to the TotalStorage disk business.

## POWER Everywhere and PowerPC Innovation

IBM's PowerPC microprocessors are now the de-facto industry standard for system builders (*e.g. CISCO, EMC*) embedded systems constructors, and digital consumer products makers (*e.g. Sony, Toshiba, and Samsung*). These markets bring IBM the tens of millions of chip sales each year that support its semiconductor and chip R&D and fabrication facilities, acknowledged as the world leader. With the digital revolution putting microprocessors at the heart of an ever-widening range of systems and products of every level, this scalable, customizable, well-proven and widely supported microprocessor architecture now offers the broadest platform for semiconductor innovation on the market. This ecosystem and these volumes also support the top-end POWER4, POWER4+, and now POWER5 chips used only in IBM's own high-performance eServer and storage systems. These have given each IBM system using them unrivalled performance and differentiated strengths that no competing processor has approached. On March 31<sup>st</sup> 2004, IBM launched a new POWER Everywhere initiative to open and extend the already burgeoning Power ecosystem in which over 1,750 companies are now participating. (*See the Other Related Software Strategies Research Section, on page 43, items 2 & 3 for our full assessment of POWER Everywhere and PowerPC.*)

## POWER5 – Unquestioned 64-bit Champion

The culmination of IBM's five-years-plus long, and over \$1B investment in, high-performance 64-bit Power Architecture-based, high-end system microprocessors is the POWER5 chip, and its associated POWER5 system architecture. Software Strategies has assessed the POWER5 MPU as by far the most powerful, highest-performing 64-bit RISC processor chip available today. This extraordinarily advanced chip packs and integrates almost 276M transistors, 2 processor cores, and cache and distributed switch circuitry on the die, and supports simultaneous multi-threading (*two threads*). With up to 3.0 times the power and performance (*rperf*) of the original POWER4, new POWER5-based IBM i5 and p5 servers have won virtually every industry benchmark over Q2 and Q3 2004. As well as being optimized and designed to provide leadership server performance, scalability up to 64-way systems, huge bandwidth and unique chip-level reliability features, the chip design and system architecture was also, for the first time ever, optimized for its role in the DS8000 ECSS. IBM storage system engineers worked closely with the POWER5 team to add the storage-orientated features and capabilities now fully exploited in the DS8000 systems. 1.9GHz and 1.5GHz versions of the POWER5 are used in the DS8000's p570 server engine discussed below.

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*Software Strategies has assessed the POWER5 MPU as by far the most powerful, highest-performing 64-bit RISC processor chip available today.*

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## IBM eServer p570 Server – DS8000 Engine

The new DS8000 uses the ultra-high performance, POWER5 processor-based IBM eServer p570 Server as its core server platform, and this server can be seen top right in Figure 4 (*on page 14*). These dense, modular servers scale with near linear performance from a 1-way to a 16-way SMP using up to four 4U building blocks. The servers support the IBM Virtualization Engine™ technologies of Dynamic LPAR and Micro-Partitioning, which provides the foundation for the DS8000's industry-first storage systems LPAR. The design of these servers was thus optimized for storage as well as server roles, supports large robust memories and cache, and delivers clear industry-leadership performance at each size point. The POWER5's support for Simultaneous Multi-Threading (*SMT*) contributes substantially to this performance. The p570 fully exploits the unique POWER5 chip self-healing features that include: bit-steering (*bit sparing*); Chipkill™ ECC (*8-bit packet correct*); ECC on processor cache memories; L3 cache line deletes; memory scrubbing; and dynamic processor de-allocation. These combine with the p570's strong systems-level RAS attributes of N+1 power and cooling; hot-plug PCI; in-place service; and First Fault Data Capture, to deliver far the highest server reliability and availability in its class. The same server hardware also powers the iSeries i570 systems, which we fully assessed in previous documents. (*See the Other Related Software Strategies Research Section on page 43, items 1 & 4 for our full assessment of the p570, i570 and POWER5 chip.*)



## Our Analysis

Over the past several years, under the strategy described above, IBM has proven its ability to simultaneously optimize the design of all aspects of chip, system, firmware, and software architecture together. The result has been systems that have regularly delivered world-leadership performance, new levels of price/performance, differentiated functions, more reliability, and better manageability. Much of this innovation is based on the Power Architecture, and feeds back into the PowerPC advances that its whole Power ecosystem benefits from. Many advanced capabilities first pioneered on zSeries mainframes have also been brought directly across into its POWER-based systems,

*Now, with the DS8000 and DS6000 ECSS, the full force of these technologies and innovations have been deployed...*

adding to their strengths. Now, with the DS8000 and DS6000 ECSS, the full force of these technologies and innovations have been deployed to vault these server-based/server-technology-based storage systems into scalability and performance leadership positions in their respective markets.

As analysts, we have closely reviewed IBM's future plans and roadmaps for its PowerPC, POWER5+ POWER6, pSeries and DS series. Having done so, we are certain the giant can now sustain a rapid pace of further advancement to all these elements, which will allow its DS ECSS to maintain the substantial lead they have now seized. Indeed, its advantage is likely to widen further whenever these advances are deployed to subsequent generations of DS systems.

## 5. DS6000 series Creates New, Mid-range, Enterprise-class Segment

### DS6000 series Introduction

The DS6000 series represents a major leap forward in modular but enterprise-class storage systems. These systems are dramatically smaller, far denser, far lower-priced, are modular, offer higher capacities, and are much more expandable than those of competitors. The system's main capabilities are overviewed and portrayed in our summary in Figure 5.

### DS6000 – Enterprise-class Storage for Customers of All Sizes


<p><b>Supports All Server Types:</b> Mainframes, iSeries and Open Systems.</p>	<p><b>All the Capabilities of Enterprise Storage Systems:</b> At half the price. Fraction the size.</p>	<p><b>Highly Scalable:</b> To 67.2TB physical capacity. Up to 224 HDD. Up to 13 expansion units of 16 HDD each.</p>
<p><b>Dense Modular Packaging:</b> Start small. Pay as you grow. Fraction the size, weight, power usage of competitors.</p>		<p><b>Compatible Copy Services:</b> With DS8000, ESS 800 &amp; 750.</p>
<p><b>Excellent Performance:</b> 50% faster than EMC CX700.</p>	<p><b>Common Code Base:</b> 97% common with DS8000. 5-year proven on ESS.</p>	<p><b>Common User interfaces:</b> Between DS6000 and DS8000.</p>
<p><b>Enterprise-class Resilience:</b> Redundant power, cooling, RAID. Autonomic self-healing. 4 paths to each HDD.</p>	<p><b>Advanced Server-based Technologies:</b> Dual clustered PowerPC750 engine. Linux operating system. Calibrated Vector Cooling™.</p>	<p><b>Ultra Competitive vs. EMC DMX800:</b> 4% of size, 10% of weight at 5TB. Lower entry-point. 2X scalability at half the price. DS6000 controller \$86,500 US.</p>
<p><b>Common Management:</b> Same interface as DS8000, ESS. Same CLI, runs same scripts.</p>		<p><b>Easy to Install &amp; Service:</b> Customer self-install/configure. Customer repair/service. Extensive hot-swap. All non-disruptive. 4-year warranty, NBD 9-5 M-F. Upgrades to 24x7 onsite available.</p>

Figure 5: DS 6000 – Enterprise-class Storage for All Sizes of Customer

The systems uniquely offer the same advanced copy and replication services, and the same management interfaces, as their high-end DS8000 storage system family members, and are completely interoperable with both these and their ESS 800 and ESS 750 predecessors. Competitors offer enterprise mid-range storage systems using different architectures, copy services and management interfaces to those of their high-end ECSS forcing customers using both to maintain two sets of tools and two sets of skills, and precluding fluent interoperability across their mid-range and high-end systems.

## DS6000 series Main Highlights

The overall highlights of this new DS6000 series modular ECSS are:

- Designed and priced to provide considerably lower TCO for a highly available, robust storage solution for medium and large enterprises.
- Delivers enterprise-class functionality, with both open systems and mainframe host attachment, in a dense, modular, scalable, rack-mounted form-factor.
- Provides the same advanced copy services and is interoperable with, the DS8000 series and ESS 800 and ESS 750 systems.
- Provides Light Path® Diagnostics and Controls to provide fast and easy identification of components in the event of a failure without needing to use a management server.
- Included with the DS6000 series is the IBM TotalStorage Disk Storage (DS) Storage Manager, offering a Graphical User Interface (GUI) and Express Configuration wizards that provide simplified system configuration and management.
- Uses Predictive Failure Analysis® and autonomic capabilities that enable the system to automatically, and without human intervention, take pre-emptive actions to correct problems before a component failure occurs.
- Physically packaged in modular 3U, 16-disk drive, rack mountable enclosures, the DS6000 can grow with customer storage up to 67.2TB in a single system.

Other highlights are also shown in Figure 5 (*on page 16*).

## DS6000 series Surprise Catches Market Unawares

Unusually, the radical and market-disruptive DS6000 series has been a best-kept secret in the storage industry until its October 12<sup>th</sup> 2004 announcement, with few stories of its game-changing capabilities circulating. Whilst the industry was expecting the long-planned, high-end system announced as the DS8000, and knew it would bring impressive POWER5 processor server-based performance, bandwidth and reliability, along with the industry's first implementation of storage system LPAR, the DS6000 remained quite a surprise. In our assessment, this system will delight thousands of customers requiring affordable enterprise storage at a much lower new price point, in a dramatically smaller, and much more convenient form factor. It will be a hammer blow to the mid-range enterprise storage competitors, including EMC, Hewlett-Packard, and HDS, who now find themselves a full generation, and a gulf in capabilities, behind.

## Leadership Claims

At the announcement, IBM posted strong capability and comparative claims for the DS6000 series. These referenced main rival EMC's entry high-end enterprise system, the modular DMX 800, which is the DS6000's closest competitor, and the CX700, the top model of EMC's mid-range storage line. These bragging points are shown in Figure 6, and are indeed impressive.

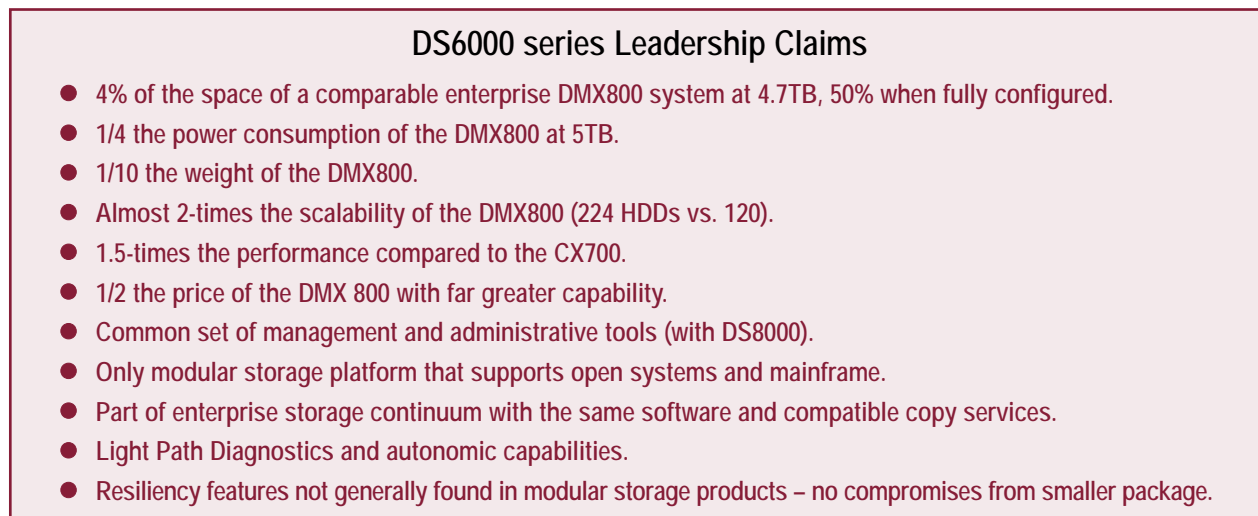


Figure 6: DS6000 Leadership Claims

Server analysts have become accustomed to IBM eServer announcements, each showing similar dramatic advances in performance, price/performance and capabilities derived from the firm's blend of technologies, discussed in Section 4. We have usually found claims such as these to be relatively accurate, if selective, and to precede substantial market share gains or the attainment of segment leadership. A company of IBM's size and position is careful to highlight only claims and comparisons it can fully support with evidence. Here, the strengths of the advances it has made in this system, under its technology-leadership strategy do allow it to fairly do so.

## Scalable, Modular, Ultra-dense MR ECSS Sets New Benchmark

It is easier to appreciate the advance represented by the DS6000 series in size, density and scalability by a visual comparison. Figure 7 shows the DS6000 in the centre compared to the ESS 750 (*its current low-end ESS model*) to the left, and the directly competitive modular EMC DMX800 on the right. The data on this chart speaks for itself.

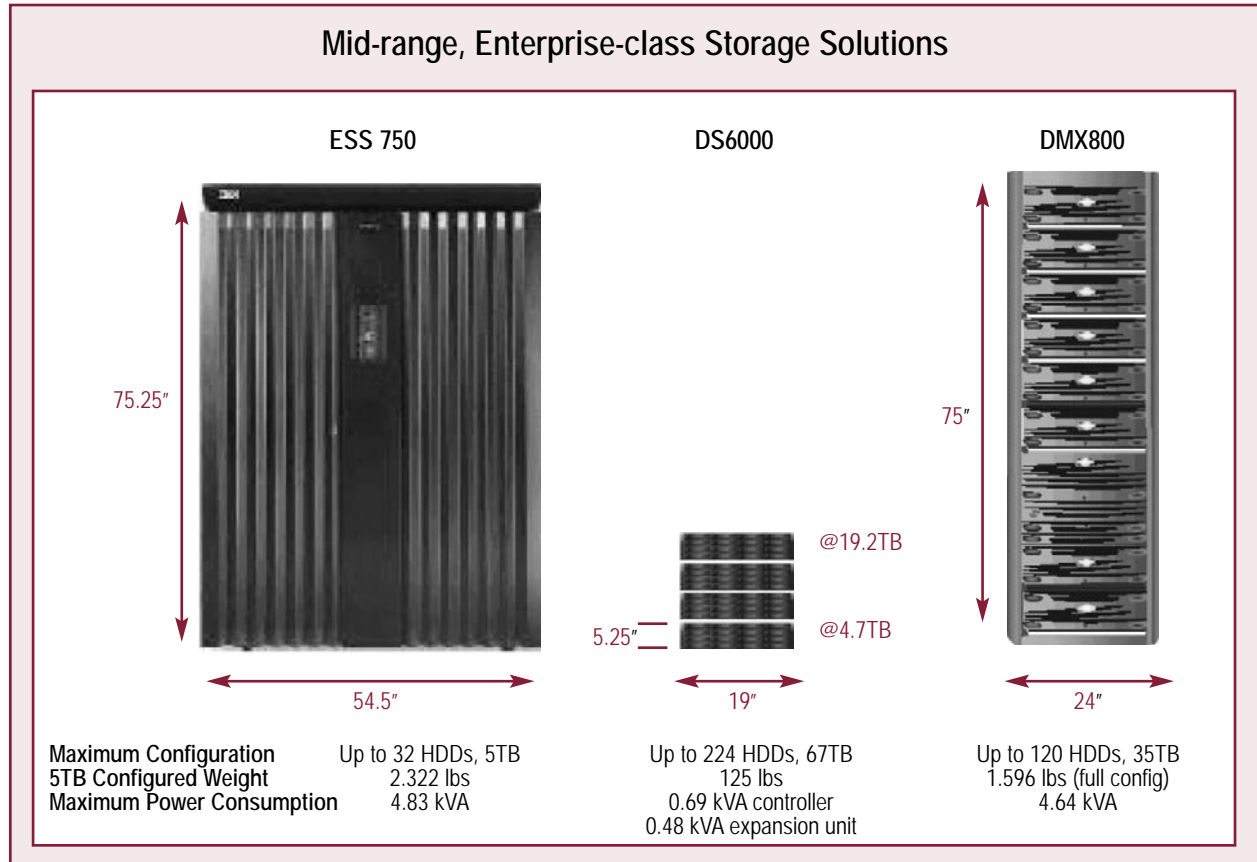


Figure 7: Mid-range, Enterprise-class Storage Solutions

The comparison with the IBM ESS 750 is particularly striking, with a single 3U DS6000 controller/unit providing the same 4.8TB of capacity, superior functional capabilities, and higher performance as the ESS 750 shown left, with just one nineteenth of the weight, using one seventh of the power. Offering almost twice the scalability at half the price of the more competitive EMC DMX800, the DS6000 undoubtedly sets the new benchmark standard. The modular architecture of the DS6000 also allows "pay-as-you-grow" capacity increases in a fine-grained increment (*initially 8 HDDs at general availability, but reducing to only 4 HDDs in 1Q 2005*), which ensures minimum unused capacity. This allows customers to start small, whilst only paying for the enterprise-class storage capacity they actually need and use.

## Server Technology-based Storage Advantages Well Used

How has IBM achieved these major advances for the DS6000? The new server technology-based, MR ECSS fully exploits and incorporates a wide range of its advanced microprocessor, server architecture, dense packaging, autonomic computing, and RAS engineering and advanced management software techniques. The firm has honed and exploited these with great success on its xSeries, pSeries, iSeries and zSeries server systems for several years.

Many of the same techniques of ultra-dense modular design and packaging, thermal and cooling technology (*notably Calibrated Vector Cooling™*), reliability and maintainability employed on its clear world market-leading eServer BladeCenter (*now the industry reference standard for blade server technology*), have also been deployed to the DS6000. Indeed, the detailed construction and packaging of the DS6000 is reminiscent of BladeCenter, in this case with up to 16 HDDs plugged into the system mid-plane from the front, and the controller/server, adapters, power and cooling modules plugged into the mid-plane from the rear of the system. These enable the DS6000 to achieve similar dramatic advances in power, scale, density, ease of installation, and ease of maintenance that characterize these impressive new MR ECSS.

A rear view of the DS6000 Controller unit, shown in Figure 8, illustrates both the high-density of the packaging, but also the customer serviceability and diagnostics (*for example, the Light Path Diagnostics feature that visually indicates failed components*). Symbol marked (*orange*) handles and levers highlight customer hot-swappable components.

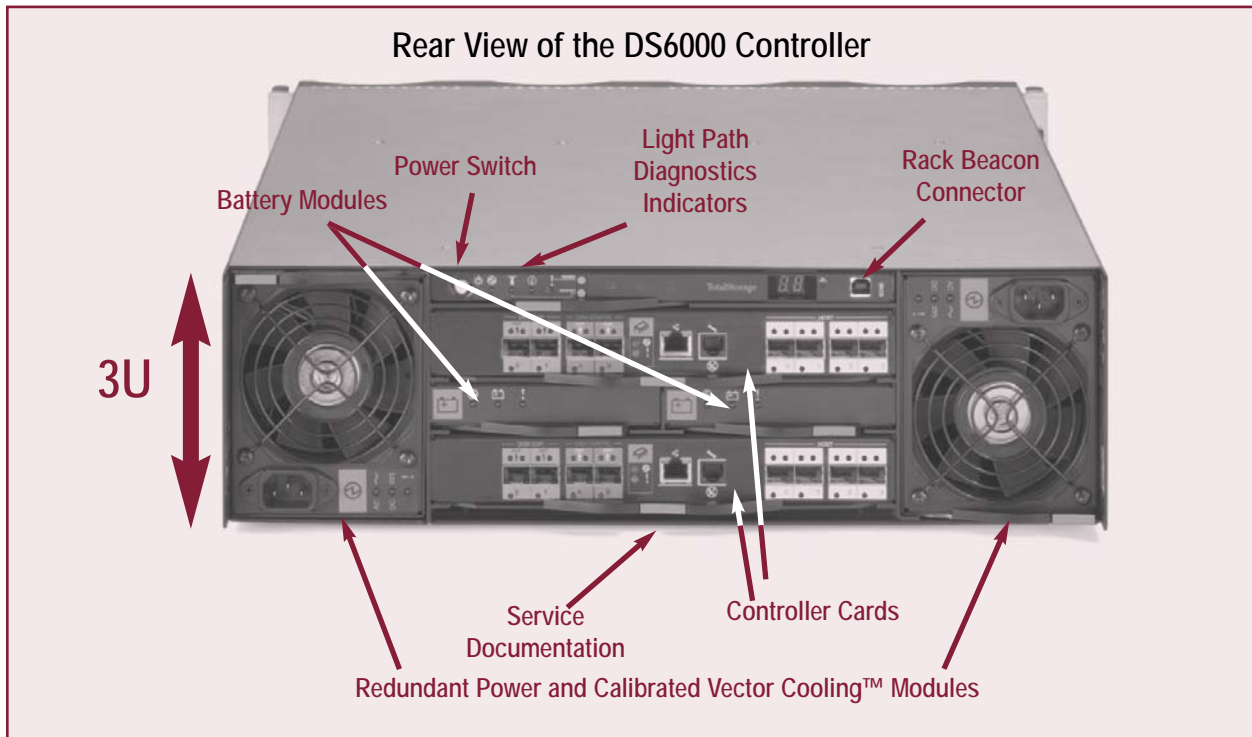


Figure 8: DS6000 Controller – Rear View

The system also exploits the processing power and bandwidth of the PowerPC 64-bit RISC microprocessor family, in this case deploying the PowerPC 750, a physically small and low power-consuming, easy-to-cool microprocessor that powers the DS6000's controller/server. Other PowerPC microprocessors and IBM-designed ASIC chips are also used to power the DS6000's Host Bus and FC Disk Adapters. The DS6000 server/controller runs on the Open Source Linux operating system, amongst the first to do so, which adds to its open standards credentials, using a dual clustered controller/server model that also contributes to its high-reliability. The DS6000 series is an equally major game-changer, and market re-defining achievement in the MR ECSS market as the eServer BladeCenter has already proved itself to be in the server market

## Flexible, High-performance Storage for Medium & Large Enterprises

The DS6000 series, says IBM, was designed to deliver high availability and high performance in this extremely small modular package. The DS6000, along with the DS8000 series, delivers an enterprise storage continuum of systems with shared copy and replication services and common management interfaces, as we discussed in Section 3 and showed in Figure 2 (*on page 10*). The lower-cost DS6000 series provides medium and large businesses a low-cost, enterprise-class storage solution to simplify data management, offer comprehensive data protection and recovery capabilities, and offer easy scalability for both mainframe and open systems storage needs.

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*The lower-cost DS6000 series provides medium and large businesses a low-cost, enterprise-class storage solution...*

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## Easy Installation and Management

The DS6000 series has been designed for straightforward customer installation and configuration. Easy configuration and management is supported by the IBM TotalStorage DS Storage Manager – an intuitive Web-based GUI claimed to provide a straightforward way of configuring the system, managing copy services, and performing the other administration functions. DS Storage Manager incorporates the Interactive Configuration Agent Tool (*/CAT*) which provides an intuitive, Web-based GUI. Express Configuration Wizards in the DS Storage Manager help users configure and manage storage functions easily and quickly. By simplifying storage administration and operations, the DS6000 helps reduce IT labor costs and increase IT staff productivity, helping to yield lower TCO. With the DS6000 series, customers can also fully leverage existing ESS administration skills without retraining, whilst also using the same skills on the new, high-end DS8000.

Storage environment management can be further simplified through the IBM TotalStorage Productivity Center (*TPC*). TPC offers one interface through which administrators can monitor and manage multiple and different members of the IBM TotalStorage DS family, as well as non-IBM disk arrays. More details of this software are given in Appendix C.

## Built on Open Standards – Supports All Main OS Environments

By using an open-standards architecture, the DS6000 series helps businesses unify data and facilitate the flow of information across the enterprise, even in complex, heterogeneous server environments. The use of open standards means businesses can use a variety of server types, operating environments and business applications from a variety of vendors, to best suit their particular requirements.

The DS6000 series supports Linux, UNIX, Microsoft Windows, IBM z/OS, IBM OS/400, IBM i5/OS, IBM AIX, HP-UX and Sun Solaris, as well as other operating systems. The DS6000 and DS8000 enterprise storage continuum now allows businesses to match the appropriate storage solution to both IBM and non-IBM servers.

*The DS6000 series supports Linux, UNIX, Microsoft Windows, IBM z/OS, IBM OS/400, IBM i5/OS, IBM AIX, HP-UX and Sun Solaris, as well as other operating systems.*

When a customer's business is ready to expand storage capacities, the DS6000 series can grow in line. With its modular design, the DS6000 can be scaled from 584GB (*292GB in 1Q 2005*) to 67.2TB of raw physical storage capacity by adding storage expansion enclosures. Each of these contains up to 16

HDDs. Customers can select 73GB, 146GB or 300GB physical capacity discs to construct a system that fits their capacity needs and their budget. These upgrade options help companies protect their IT investments while also accommodating rapid growth.

## DS6000 series Performance

IBM has recently published TotalStorage® DS6000 performance targets (*See Footnote below for basis*) that are summarized in Figure 8A. Although final tuning is still in progress, IBM expects the DS6800 will achieve these targets. These show the initial DS6800 model is expected to outperform the IBM TotalStorage Enterprise Storage Server® (*ESS*) Model 800 and Model 800 with turbo feature for many storage benchmarks.

Benchmark	ESS 800 Turbo Actual	DS6800 Performance Target	% Difference
Open Database <sup>1</sup>	26 Kio/sec	39 Kio/sec	+50.0%
z/OS Database	37 Kio/sec	24 Kio/sec	-35.1%
Maximum Open IOPs	112 Kio/sec	310 Kio/sec	+176.8%
Maximum z/OS IOPs	67 Kio/sec	72 Kio/sec	+7.5%
Sequential Read	540 MB/sec	1.4 GB/sec	+159.3%
Sequential Write (Mirrored in cache)	350 MB/sec	540 GB/sec	+54.3%

<sup>1</sup> IBM Open Database (70/30/50) benchmark.

Figure 8A: DS6800 Performance Targets vs. ESS 800 Turbo Actuals

Given the extraordinarily small size of the DS6800, and its significantly lower cost, it is highly impressive that the DS6800 is expected to post 2.5 times the sequential read, and a 50% higher open database benchmark performance, amongst other gains, compared to the high-end ESS 800 Turbo. In our assessment, these targets highlight the exceptional capability and performance achievements IBM will shortly deliver with this system.

**Footnote:** The above performance information is based on DS6000 estimates and projections made using IBM performance models and preliminary measurements in a controlled environment. Actual performance may vary and will be dependant upon an individual customer's application and implementation. The above performance values are maxima, assuming each machine was optimized to take advantage of its unique features (*for example, was configured with the maximum number of available channels, cache and disk drives*). The DS6800 may be configured with up to 8 x 2Gb fibre channels (*or 2Gb FICON channels for z/OS*) and 224 disk drives.



## High Availability/Resiliency and Serviceability Features

The DS6000 series has four paths to each HDD, uses storage expansion enclosures with redundant FC switches that provide switch access to disks to provide maximum bandwidth and eliminate the bottlenecks of traditional loop-based architectures, and continues to run even if some components fail. The design features redundant RAID controllers, power supplies and fans to help keep data available under a hardware failure. These components are hot swappable, and the system allows non-disruptive upgrades and configuration changes, so customer technicians may make most repairs and upgrades themselves, without disrupting system availability. The system performs end-to-end data checking to assure consistent delivery. The DS6000 also includes Light Path Diagnostics and controls on the enclosure. This Light Emitting Diode (*LED*) visual alert and control system helps identify and repair server component problems quickly and easily. Additional autonomic features, such as Predictive Failure Analysis, prompt pre-emptive action to replace failing HDDs before they actually die. The system also includes intuitive status indicators on front and rear panels, call home, remote management support, and an open standards S-MIS management software interface.

## Disaster Tolerance with Advanced Copy Services

The DS6000 series also features enterprise-class back-up and recovery services. The FlashCopy point-in-time copy function backs up data in the background, giving users nearly instant information access on source and target volumes. The Metro Mirror, Global Mirror, and Global Copy capabilities generate and maintain duplicate copies of data on separate storage systems located locally and at geographically-dispersed locations, to protect data from disasters and support business continuity in the event of power outages or disaster. These capabilities, which are offered on both the DS6000 and DS8000, are discussed separately in Section 7.

Companies can also use a multi-tiered approach for mirroring and back-up functions. For example, the DS6000 series can be used to mirror data from a DS8000 series to save on both the initial and ongoing costs of a secondary disaster recovery site without sacrificing any enterprise-level storage systems benefits.

## Valuable Extra Tier in Information Lifecycle Management (*ILM*) Hierarchy

With its rather lower price point and enterprise-class capabilities, the DS6000 series will help customers improve their ILM from creation to disposal. The overall TotalStorage DS Family enables companies to construct a multi-tiered storage environment to help minimize storage costs, by retaining frequently-accessed or higher-performance storage volumes on higher-performing storage systems, and by archiving less-frequently-accessed information onto less-costly storage volumes. The DS6000 provides an additional new tier in this hierarchy.

## DS6000 Specifications

The “speeds and feeds” for the DS6000 are shown in Figure 9 below.

IBM TotalStorage DS6000 Series Specifications	
Max. Number of Host Ports:	8
Max. Number of Storage Ports:	8
Max. Number of HDD/system:	224 With maximum 13 expansion enclosures per system.
Size of Cache:	2GB cache per controller, 4GB cache per system.
No. of RAID Controllers:	2 per system.
Processor:	PowerPC 750GX 1GHz.
Battery back-up for Cache:	72 hours.
Host Interface:	2Gb/s FC/FICON.
Drive Interface:	2Gb/s FC.
Maximum Physical Storage Capacity:	67.2TB
Disk Sizes:	73GB (15K r.p.m.), 146GB (10K r.p.m.), 300GB (10K r.p.m.)
RAID Levels Supported:	5, 10
Power Supplies and Fans:	2 per enclosure.
Rack Support:	19" rack-mountable.
Form Factor:	3U, 14 enclosures per 42U 19" rack.

Figure 9: DS6000 Series Specification

## DS6000 Pricing

IBM has set the IBM TotalStorage DS6000 Base Controller at a US list price of \$86,500 with 4GB of processor memory (*cache*) standard hardware. The optional IBM TotalStorage DS6000 Expansion Enclosure has a list price of \$6,000. Other DS6000 priced hardware features include 2Gb FC Disk Drive Sets (*of 4 HDD: \$5,100 to \$10,800 per set, equivalent to from \$9,000 to \$17,650 per 1TB physical capacity*), and host connectivity ports. The latter is a one-time FICON attachment license charge (*\$10,000*) for attaching the DS6800 to zSeries. Software-related features include a new required Operating Environment License (*OEL – which is priced from \$4,250 @ 1TB to \$145,000 at 50TB*) and optional advanced function license features including Point-in-Time Copy (*PTC*), Remote Mirror and Copy (*RMC*), and Parallel Access Volumes (*PAV*). The OEL as well as the PTC, RMC and PAV licenses scale through capacity tiers that include 1TB, 5TB, 10TB, 25TB, and 50TB levels.

Purchase costs for three sample systems, with OEL, are given in Figure 10.

DS6000 Systems	Example 1	Example 2	Example 3
Physical Storage Capacity:	4.8TB	9.6TB	48.0TB
System Including:	1* DS6000 Controller. 4* Sets of 4 off 300GB HDD 5TB OEL. Open Systems attached. No other software.	1* DS6000 Controller. 1 DS6000 Expansion Units. 8* Sets of 4 off 300GB HDD. 10TB OEL.	1* DS6000 Controller. 9* DS6000 Expansion Units. 40* Sets of 4 300GB HDD. 50TB OEL.FICON for zSeries. 50TB PAV software.
Purchase Price \$US List:	\$153,442	\$220,892	\$875,992
System Purchase Cost/TB:	\$31,967	\$26,444	\$18,250

Figure 10: DS6000 Example Configurations Purchase Costs (US \$ List)

The DS6000 pricing model also implements many significant improvements over that of the ESS based on customer feedback. These include transaction-based capacity tiers, tiered pricing for advanced functions and OEL, reduced disk drive prices, sub-capacity pricing for advanced functions, and the new four-year warranty. These prices and examples, in our assessment, undoubtedly make the DS6000 fiercely competitive for the enterprise-class functionality it provides.

## Competitive Position

The IBM DS6000 and DS8000 cover a range main competitor EMC supports with its CX500 up to DMX3000 models. In the case of the IBM pair, the systems offer one common user interface, a common management interface and compatible common copy services, whereas, for EMC, two completely different product sets must be used, customer staff must be trained on two systems, and the copy services are incompatible.

*When the DS6000 is compared to the EMC CX700, it offers advantages by supporting all types of server, having a smaller footprint (38% at 5TB), and offering better resilience features.*

When the DS6000 is compared to the EMC CX700, it offers advantages by supporting all types of server, having a smaller footprint (38% at 5TB), and offering better resilience features (4-paths to each drive and Predictive Failure Analysis). It also offers higher performance (e.g. 50% higher read cache I/Os/second), and provides superior copy services.

Relative to EMC's entry high-end enterprise system, the DMX800, the DS6000 scores with a much smaller footprint (4% of space at 4.7TB), a lower entry configuration (minimum 4 drives for the DS6000 in 1Q 2005), higher performance, almost two times the scale, and provides superior copy services.

## IBM Systems and Technology Strategy in Action

Since the eServer announcement in 2000, IBM has clearly articulated and systematically followed a distinctive strategy for its Systems and Technology business, which we detailed and explored fully in Section 4. The DS6000 series is a perfect example of this strategy in action, and has clearly integrated all its strengths, skills and technologies to genuinely redefine the mid-range of enterprise storage.



As server analysts, we have closely observed the string of dramatic innovations made by IBM Systems, using similar blends of skills and technologies to create game-changing winners, each of which has later driven the firm to clear market share leadership in their important sectors, including:

- **Mid- to high-end UNIX servers**, with the POWER4- and POWER5-based pSeries systems, from late 2001 to date.
- **In mid- to high-end, high-function modular Intel-based servers**, with the impressive x440, x445 and x 455 systems from Q2 2002.
- **In blade servers, with the eServer BladeCenter** family from Q4 2002 to date.
- **In zSeries mainframes**, including the z900, z800, z990 and z890, which have seen dramatic technological transformation and advances since 2000, rewarded by market resurgence after earlier years of struggle.

We expect the DS6000 to achieve similar success in the new market segment it has created for itself.

## DS6000 series Future Directions

The DS6000 series roadmap offers many further extensions and advances. These include the use of low-cost Serial ATA drives, which would further improve its already strong economics, and increase capacities for tier-two roles. The addition of dynamic LUN and volume expansion will increase the flexibility of the system, as will on-line data relocation. Support for virtual capacity over-provisioning will allow headroom to be built into storage applications. A space-efficient FlashCopy implementation will improve copy capacity utilization, and a three-site business continuity solution will allow for recovery from the secondary or tertiary site with full data consistency. It would also be open to IBM to up-rate the server/controller and adapter cards with faster PowerPC processors and/or higher port speeds, although these options were not announced. Enhancements to the OE are also certain to continue.

## Our Analysis

The DS6000 series is a striking and attractive advance in modular enterprise-class storage systems. For the first time, it brings full compatibility of copy services and management interfaces to those on its high-end DS8000 (*and ESS*) siblings to provide a smooth continuum of enterprise storage. This now spans from an attractively priced, low entry point, up through the 67.2TB capacity of a single DS6000 and upward to DS8000 high-end systems when needed. The fact that the microcode load on this server technology-based storage system is 97% common with the mostly well-proven code base used on the DS8000 also means that it will be more solid and functional than any completely new code base could deliver.

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*The DS6000 series is a striking and attractive advance in modular enterprise-class storage systems. For the first time, it brings full compatibility of copy services and management interfaces to those on its high-end DS8000 (and ESS) siblings...*

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The DS6000 series will be particularly attractive in a number of widespread storage scenarios, including:

- **Mid-sized Enterprises without Enterprise-class Storage:** All those medium-sized enterprises who have hitherto been unable to enjoy the benefits of high-end ECSS functionality at all. With this much lower-price point, simple self-install, self-configure and self-maintain attributes, and the far more compact packaging and footprint than ever seen before, DS6000 presents a compelling case to move up to this mid-range, enterprise-class storage system from conventional mid-range arrays.
- **Users With Mainframes and Open Systems on Separate SANs:** Medium and larger enterprises currently running separate storage pools and SANs for their mainframe or iSeries platforms, and their UNIX, Windows and Linux systems, can now deploy the DS6000 cost-effectively. With it, they can combine and consolidate their storage into a single pool, under unified management, and with full enterprise-class copy services. Major savings from this simplified infrastructure, more efficient use of storage capacity and reduced storage management effort can be obtained, which makes a good ROI case.
- **Existing Users of ESS and Other, Older ECSS:** The large performance advances, capacity increases, and lower price points of the DS6000, as well as its far smaller footprint and low TCO, will make upgrading to the DS6000 an attractive option. Users of a wide-range of such older ECSS can move up to the DS6000, enjoy a big step forward in performance and capacity, as well as obtaining rapid payback and a high ROI on their investment. IBM's data migration services, which include special hardware assists, can conduct and support such migrations almost seamlessly for the customer without service disruption.
- **z890 Mainframe Customers:** The DS6000 also provides an ideal enterprise storage complement for the new lower-end z890 mainframes, providing full enterprise-class functionality at an entry price point below the \$100,000 barrier. It will enable/encourage many hundreds of smaller mainframe users, previously unable to justify high-end ECSS, to now enjoy their benefits at an affordable price. It will provide a similarly good fit for customers running medium and mainframe-equivalent, larger iSeries systems needing enterprise storage.
- **Ideal DR/BC Option:** Customers requiring business continuity and disaster recovery, who were previously unable to justify the cost of a HE ECSS for their second/disaster/back-up recovery site, can now install DS6000 for this role. With it, they obtain a far lower price point, but can enjoy all the same copy services as on their primary high-end ECSS.

We consider the market will rapidly appreciate the radical advances, the strong benefits it offers, and the business case it argues. From a competitive viewpoint, with the DS6000, IBM has also set a high barrier to competitive emulation or response. Its arrival renders EMC, Hitachi and HP's mid-range storage systems with enterprise aspirations at a substantial disadvantage on functionality and price. It is doubtful that these prime competitors can emulate the density and power of the DS6000 easily or quickly, and thus seems unlikely that they can deliver directly comparable products any time soon. Big Blue is thus likely to maintain this lead for a considerable time. It also has plenty of options to increase performance/functionality of future models by using higher-performing core server/controllers driven by higher-power PowerPC processors, and many other options, when needed.

Competitors can only realistically respond short-term by sharply dropping their mid-range ECSS prices to be nearer to DS6000 pricing, and by accelerating their engineering efforts to try and catch up, which is difficult for the reasons outlined above.

We expect the DS6000 will drive IBM to a number-one market share in its mid-range ECSS marketplace within twelve to eighteen months. Such success will provide substantial help in its wider goal of reaching the coveted number-one position in the overall storage marketplace over the next three or four years.

## 6. DS8000: IBM's New, High-end Enterprise Storage System

### DS8000 Introduction – Setting the New Standard

The DS8000 is the flagship, all new HE ECSS that exploits IBM technology leadership to deliver a new generation of POWER5-driven, p570 server-based, HE ECSS that clearly now set the new standard and benchmark for this market.

We reviewed IBM Systems technology leadership strategy in Section 4, where we assessed its server-based storage systems versus the specialized proprietary storage systems approach of competitors. This is based on Power Architecture, PowerPC, the top-end POWER5 64-bit microprocessors, and the eServer p570 modular, highly-scalable server. These, and many other elements, have now been brought together in the DS8000.

### DS8000 – Setting New Enterprise Storage Standards


<p><b>Dramatic Performance:</b> 6X Increase over ESS 800 base. POWER5-driven.</p>	<p><b>All-New, High-End Enterprise Storage System:</b> New cost/effectiveness level.</p>	<p><b>Breakthrough Scalability:</b> Supports 1.1 to 192TB. Up to 640 HDDs. Architected to exceed 1PB. Field upgradable model-to-model. Linear scalability.</p>
<p><b>Exceptional Consolidation Capability:</b> Industry-first Storage System LPARs. IBM Virtualization Engine™. 2 LPARs per system at initial availability.</p>		<p><b>Server-based Architecture:</b> 1.5 or 1.9GHz. POWER5 chip. p570 Server-based. 2-way and 4-way models. Dual SMP clustered configurations.</p>
<p><b>Common Code Base:</b> 97% common with DS6000. 5-year proven on ESS. 75% common with ESS.</p>		<p><b>Enterprise Resiliency &amp; BC:</b> Dual SMP clustered engines. Mainframe-inspired RAS. Greater than five 9s availability. Global &amp; Metro Mirroring interoperable with DS6000 and ESS. Designed for 7*24 environments.</p>
<p><b>Technology:</b> Leverages IBM advanced technologies. Can adapt to new developments.</p>		<p><b>Flexibility/Extensibility:</b> Near-infinite addressing. Larger models following (SOD).</p>
<p><b>4 Year Warranty:</b> Industry-first. Further cuts TCO. 24*7 on-site.</p>	<p><b>Enhanced Manageability:</b> All new management tools. Interoperable with DS6000.</p>	<p><b>Much Lower Prices:</b> 50-60% below comparable ESS 800. DS8100 list prices beginning at \$250,000.</p>

Figure 11: DS8000 – Setting New Enterprise Storage Standards

As a result, these systems now deliver major advances in HE ECSS scalability, dramatic performance gains, new levels of mainframe-inspired resiliency and availability, the industry's first implementation of storage LPARs, outstanding business continuity capabilities, and much-improved business value and price/performance. These first next-generation systems use an all-new architecture, with all-new hardware and management software. They have been architected so future models can break the 1PB single-system internal storage scalability barrier, and this architecture also provides almost infinitely extended addressing headroom of up to 96PB for future exploitation. The DS8000 provides the high-end of the **enterprise-class storage continuum** IBM has created in the DS family with the DS6000 mid-range ECSS discussed in the previous section.

## DS8000 Highlights Overview

Our summary of the principal capability, functionality, technology, and economic highlights for the DS8000 are consolidated in Figure 11 (*on page 24*), to provide an at-a-glance overview of the system's major features and advances.

It can immediately be seen from this chart that these new systems are a radical new generation of IBM HE ECSS. The DS8000 systems moved the reference standard bar sharply upwards by large multiples on most factors of comparison, when measured against their ESS predecessor comparison point.

## Architecture and Technology

The server-based systems architecture of the DS8000 system is shown in Figure 12 below. At its heart are hugely powerful dual-clustered POWER5 processor-based p570 N-way SMP servers (*discussed in Section 4*). The DS8000 models announced are the DS8000 2-way and 4-way 8100 and 8300 models, which use dual 2-way and dual 4-way clustered p570 server engines respectively.

Each server supports its own volatile and persistent memory, and IBM Virtualization Engine™ technology enables the overall system to support two Storage System LPARs, each serving a different storage image. The DS8000 uses a new higher-bandwidth, fault-tolerant interconnect, supports new four-port 2Gb fiber channel/FICON host bus adapters on the server side, and new switched FC arbitrated loop adapters on the disk side of the array, which are designed to eliminate arbitration overhead and further improve performance.

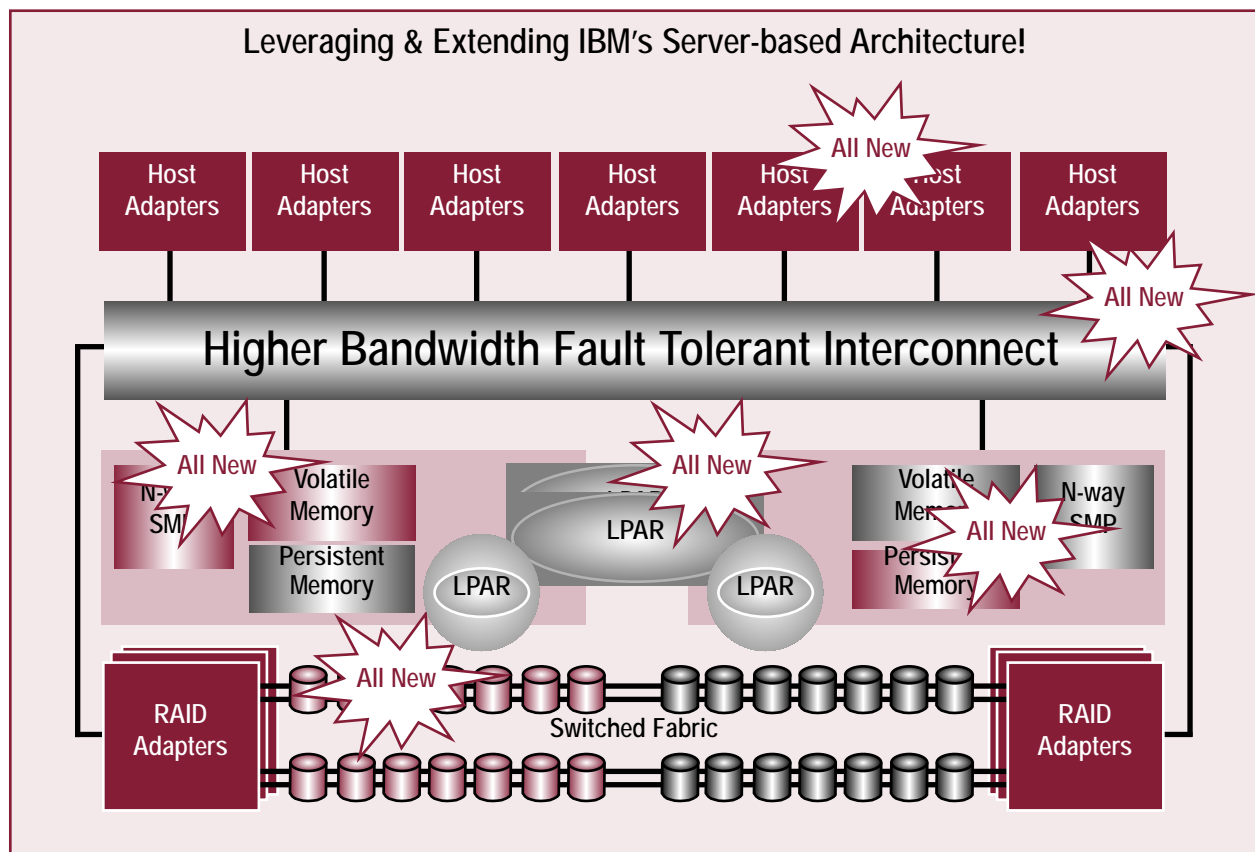


Figure 12: DS8000 – Leveraging & Extending IBM's Server-based Architecture

The DS8000 FICON/FCP 2Gb Host Bus Adapters each provide four 2Gbps FC Ports on a PCI-X, 64-bit, 133MHz. form-factor card. Each port can be configured as either fibre channel or FICON. The DS8000 RAID Device Adapters also each provide four 2Gbps FC Ports, also on a PCI-X, 64-bit, 133MHz. form-factor card. Each Adapter uses PowerPC microprocessors (*PowerPC750 GX 1GHz. on the HBA, PowerPC 750FX 500MHz. on RDA*), plus high-performance IBM data-mover ASIC, and FC protocol engine chipsets.

Cache capacities can scale up to 256GB and IBM has introduced another breakthrough with the announcement of adaptive replacement cache (*ARC*) which can determine the optimum size ratio between the random and sequential lists. It approximates the optimum size ratio, without the need for dual directory structures and tunes the size of the lists based upon the hit ratios. This offers users exceptional performance and cache management efficiency, another step in the firm's avowed commitment to low cost data storage and management.

This high performance design is further reinforced by the fact that IBM has architected cache with only 4K block sizes, which optimizes cache efficiency and performance. Additionally, future versions of the DS8000 will offer the opportunity to set variable write cache sizes, again providing improved efficiency, flexibility and performance. Of course, write cache is mirrored to help maintain high availability by avoiding single points of failure in the cache architecture

The disk side of the array uses a switched FC Arbitrated Loop approach to provide point-to-point links to each drive and adapter, and supports two simultaneous operations per domain, which doubles system bandwidth over traditional FC-AL loop implementations. The subsystem supports the IBM autonomic Predictive Failure Analysis capability that can detect fading HDDs before they fail, allowing timely replacement. No common hardware is used between switch fabrics, avoiding single points of failure. Dual-ported FC HDDs are used. This design provides minimal arbitration delay, high-resiliency and good performance.

## Industry-first Storage System LPARs Introduced

The DS8000 also introduces the industry's first deployment of Storage System LPARs. This initially allows a DS8000 to run two completely separate and isolated storage LPARs (*or storage images*) on a single, logically-partitioned DS8000, as shown in Figure 13.

The system builds this new capability on the well-proven IBM Virtualization Engine™ technologies, including the POWER5 Hypervisor dynamic server logical partitioning and micropartitioning technology that has been so successful on eServer pSeries UNIX and iSeries integrated business system servers for several years. The roots of this technology come from the zSeries mainframe, where dynamic LPAR technology was pioneered and refined over many years. LPAR is now used successfully in many thousands of mainframe, pSeries and iSeries installations.

With the DS8000's first implementation of Storage System LPARs, shown logically in Figure 13 (*on page 26*), a number of important application scenarios can now be concurrently supported on a single DS8000 system. These can include:

- **Supporting two production workloads:** Where the workloads could represent production loads from different operating systems, different applications, or from two organizational or geographical areas.
- **Production and development partitions:** Supporting the live production workload and the development/test storage images for a single, mission-critical application or workload.
- **Production and business intelligence/data mining:** Supporting a live production transactional system and its associated business intelligence/data mining storage images.
- **Business Continuance (BC):** Where the primary storage image and the secondary BC image are held within the same physical array to provide increased resiliency.
- **ILM partitions:** Lower-cost partitions allocated fewer resources, and using slower and cheaper drives can easily create an ILM storage hierarchy within a single DS8000 system, without any impact on the other partition's performance.

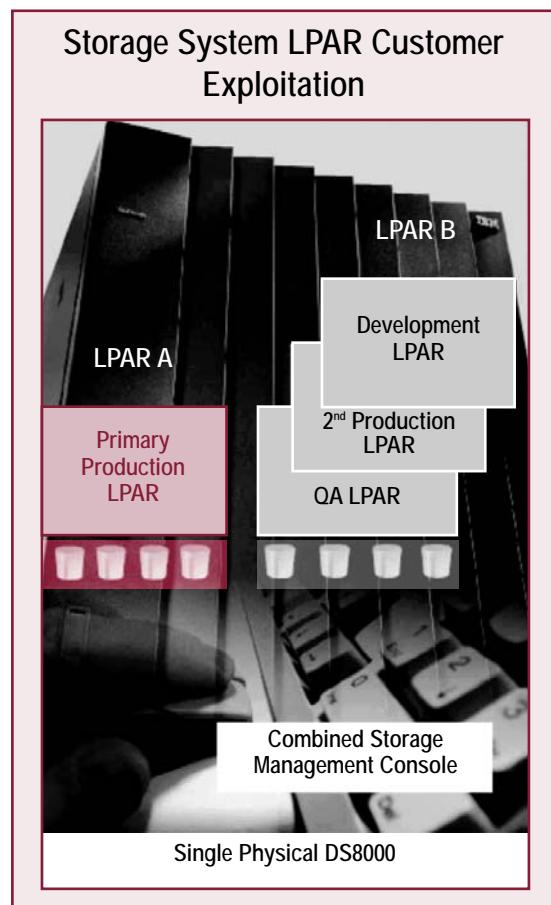


Figure 13: Storage System LPAR Customer Exploitation Example

Because the DS8000 Storage System LPAR implementation offers some flexibility in defining and allocating system resources to each LPAR, specific Service Level Agreements can be delivered for each partition by dedicating it appropriate available system resource levels. The system resources that can be divided between partitions/images are processors, cache, adapters and disks. Each partition can also run its own level of the DS8000 microcode, ideal for testing new microcode releases before production deployment.

The two LPAR capability initially offered is actually also rather more flexible and versatile than may appear. Where a workload and its storage image is only required online for a part of the year or month, that storage image can be staged up on-line from back-up only when needed on-line. Several such workloads/storage images could therefore share on-line time on a single Storage System LPAR. This means, for example, in an enterprise application environment, "LPAR A" may be permanently dedicated to the live production image whose storage must always be on-line 7\*24\*365. "LPAR B", however, could, for different periods, be used to put on-line the associated development image when heavy development work is in progress. LPAR B could then support the application test environment image during the functional and regression testing period, and later a capacity and stress testing image.

## Provides Strong Storage Consolidation Platform

Enterprise customers are seeking every opportunity to simplify, consolidate and render their enterprise storage more manageable. The DS8000 provides a strong enterprise storage consolidation platform, able to handle storage loads previously supported by up to four, six or more previous generation HE ECSS on a single DS8000. This striking reduction in complexity, footprint, management effort, etc., can more easily be visualized by review of the example shown in Figure 14.

*The DS8000 provides a strong enterprise storage consolidation platform, easily able to handle storage loads previously supported by up to four, six or more previous generation HE ECSS on a single DS8000.*

This shows a single 36TB DS8000 (*far right*) can consolidate storage volumes currently resident on four 9TB ESS 800 systems, or four 9TB EMC DMX 1000 systems. The entry single-frame DS8100 2-way Model (*explained below*) can support up to 38.4TB physical capacity, and so can easily four-fold-consolidate either of these older solutions. The DS8100 also has an optional expansion frame that can bring the DS8100 up to a total supported physical capacity of 115TB. In this example, the DS8000 solution uses just under one seventh of the bay-frontage used by the ESS solution, and just under one-third of the bay-frontage of the DMX 1000 solution, occupying only 9.9 sq. ft. of floor space.

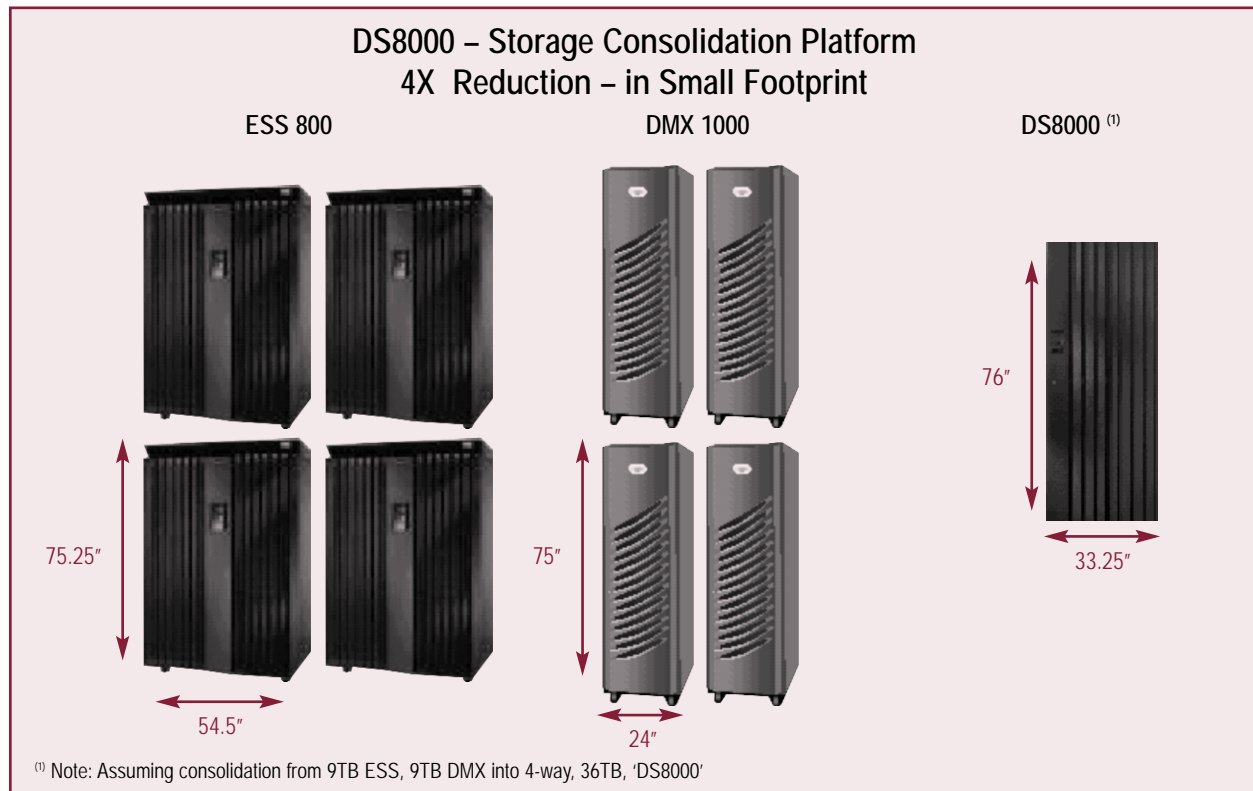


Figure 14: DS8000 – New Storage Consolidation Platform – Four-fold Compression – Small Footprint



With the announced DS8000 models already reaching up to 192TB physical capacity, the scope for even more significant consolidation is quite obvious, highlighting the major gains in density and compactness the DS8000 delivers:

- **Consolidation Enabler:** This introduction of storage LPARs, discussed above, allows the DS8000 to offer a dramatic additional multiplier of consolidation. Because the DS8000 can support two entirely separate storage images, each completely isolated in their Storage System LPARs, storage images that previously required two separate ECSS, such as a production storage image and a development/test image, can now be combined on a single DS8000 system.
- **Major Benefits Already:** This first implementation of storage LPARs on the DS8000 helps customers reduce TCO, fully exploit the investment in a large, high-performance ECSS, simplify storage infrastructure, gain greater flexibility and staff productivity and improve service levels, whilst using less data center floor space. Resources can also be moved dynamically between LPARs to balance the system's two workloads. These are compelling and persuasive real benefits.
- **Much More to Come:** IBM plans to extend, enrich and make this implementation of Storage LPARs substantially more versatile, granular and dynamic in future releases of the OE and customers can expect to see steady and substantial further improvements, as has been the case with server LPAR on eServer.
- **Storage Applications Running in LPARs:** The most compelling direction is the planned enablement of storage-intensive applications to actually run in the Storage LPAR on the DS8000. Candidate applications that would hugely benefit from executing much closer to physical storage on the storage system itself include file systems, storage protocols or interfaces, database acceleration/offload, and back-up/recovery applications. This would not only offload these workloads from costly host servers, but such closer proximity to physical storage will bring large performance gains.

In our view, the introduction of Storage LPARs is major advance in ECSS technology, one that can now already support a valuable range of immediate application scenarios. These can be deployed to simplify storage system infrastructure and consolidate storage images on to half the number of separate systems, improve business continuity, and enhance ILM. Many further developments of this technology are underway and will bring further valuable gains when released.

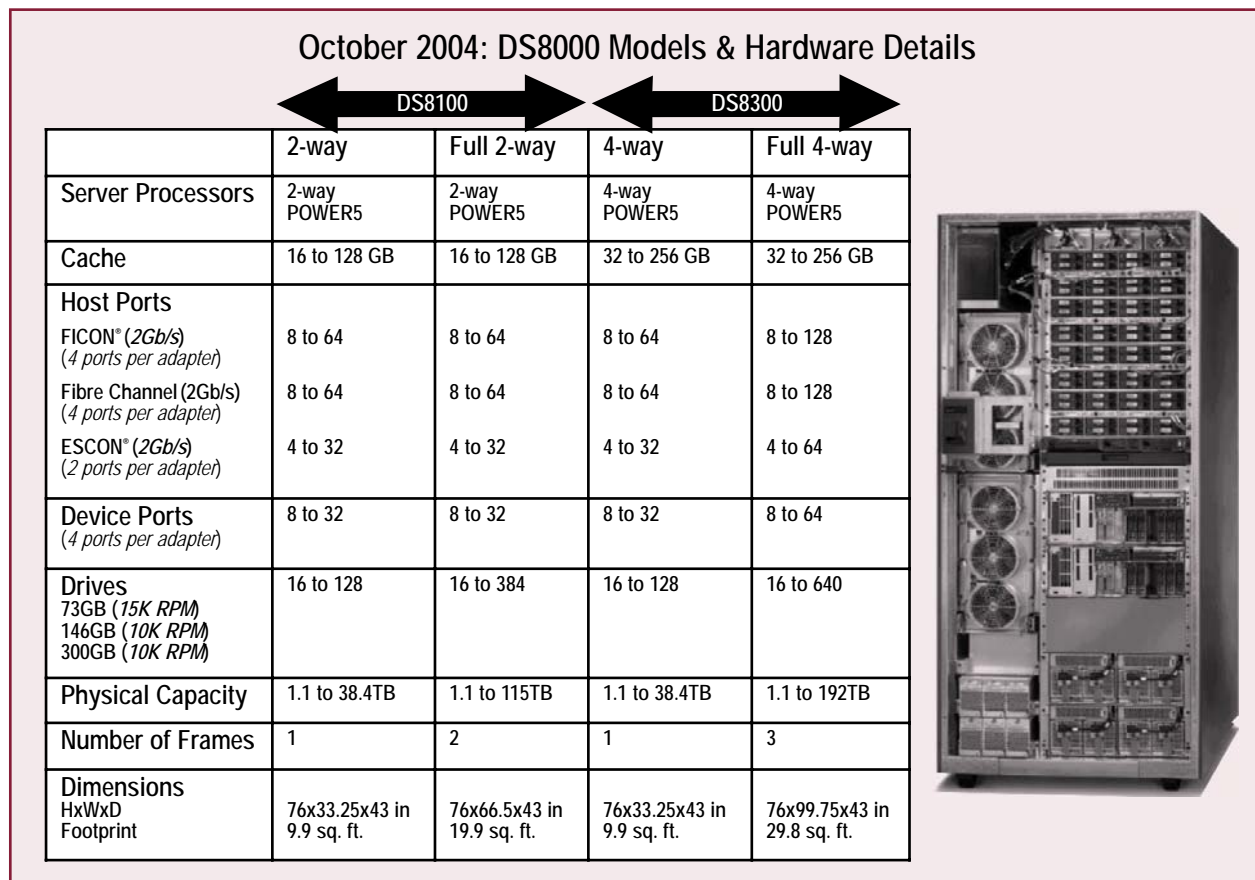


Figure 15: October 2004 – DS8000 Models & Hardware Details

## DS8000: 2-way and 4-way Models Announced – Hardware Overview – Good Scalability, High Capacities

The initially announced DS8000 models (*detailed below*) span from 1.1TB to 192TB of physical capacity with up to 640 HDDs, (*which are of the same three types as for the DS6000*). This range covers a high proportion of the overall HE ECSS market in terms of the size of systems actually sold, and represents a large increase over its ESS predecessor.

*In the announcement, IBM unveiled the first two models of the new DS8000, the 2-way DS8100 and the 4-way DS8300 systems, with entry and full system configurations of each.*

In the announcement, IBM unveiled the first two models of the new DS8000, the 2-way DS8100 and the 4-way DS8300 systems, with entry and full system configurations of each. An overview of the hardware capabilities and capacities of these systems is shown in the table of Figure 15 (*on page 28*), which also shows a door-open view of a DS8000 Base system frame.

- **DS8100:** The DS8100 can scale from 1.1TB to 115.2TB of physical storage across up to 384 HDDs, three specifications of which are offered, and which come in disk sets of 16 HDDs. The system can be configured with up to 128GB of processor cache, and can support up to 64 2Gb FICON or FC host ports, or 32 ESCON ports. Up to 32 device ports are supported. Full DS8100 systems use a DS8100 Base and an Expansion Unit in a two-frame format that has a 19.9 sq. ft. footprint.
- **DS8300:** The DS8300 can scale from 1.1TB to 192TB of physical storage across up to 640 HDDs, three specifications of which are offered, and which come in disk sets of 16 HDDs. These systems can be configured with up to 256GB of processor cache, and can support up to 128 2GB FICON or FC host ports, or 64 ESCON ports. Up to 64 device ports are supported. Full DS8300 systems use a DS8300 Base and two Expansion Units in a three-frame format that has a 29.9 sq. ft. footprint.

The capacities on every main system measure, as can be seen from the table of Figure 15 (*on page 28*), are impressive, and are significantly increased over the ESS. The hardware packaging is illustrated and annotated fully in Figure 16, which shows the front and rear of the DS8000 Base system frame, and the layout of its components in this dense modular packaging that is 20% smaller in footprint than the ESS. Future 8-way models were an announced statement of direction, and these, as well as a 12-way model described as on IBM's product roadmap, are described in Appendix B.

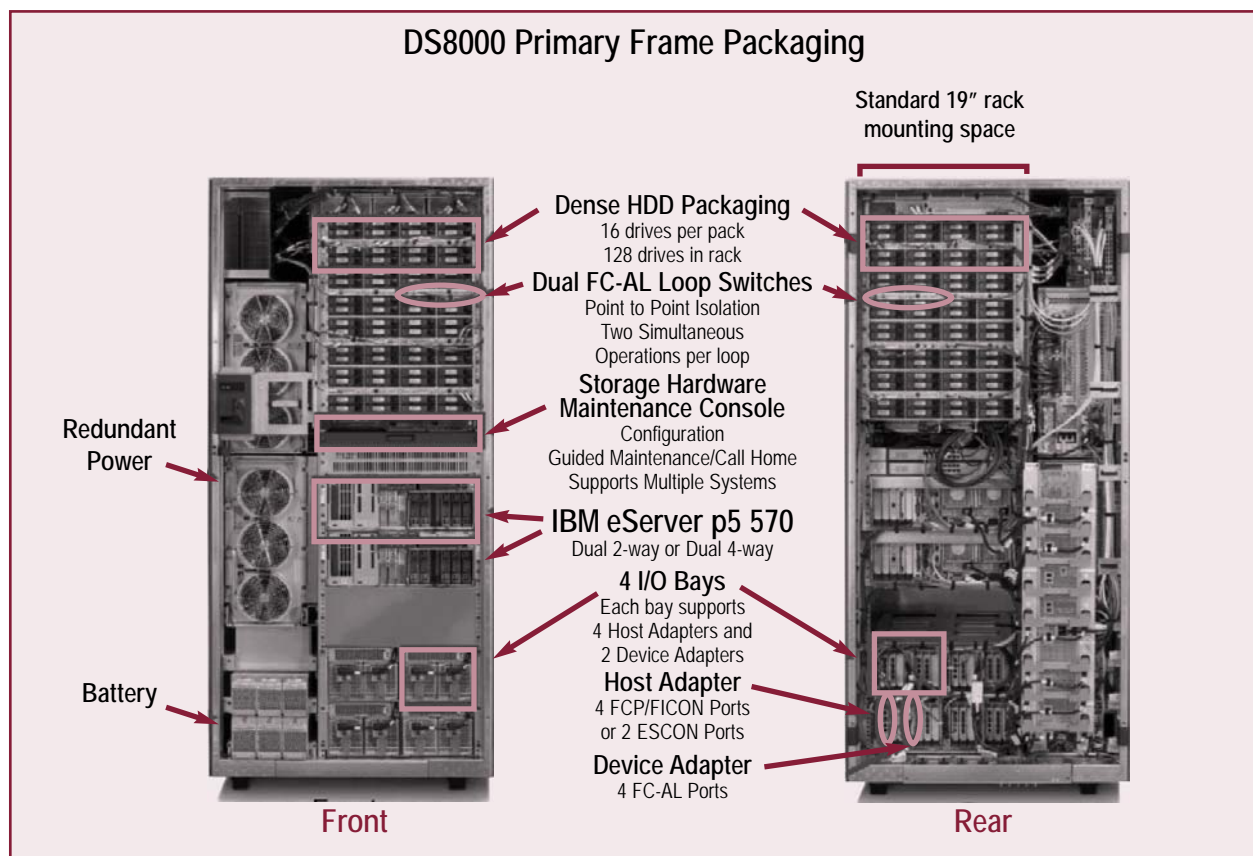


Figure 16: DS8000 Primary Frame Packaging



## DS8000 Performance

IBM has recently published TotalStorage® DS8000 series performance targets (*See Footnote below for basis*) that are summarised in Figure 17. Although final tuning is still in progress, IBM expects the DS8000 series models will achieve these targets.

Benchmark	ESS 800 Turbo Actual	DS8100 Performance Target	DS8300 Performance Target
Open Database <sup>1</sup>	26 Kio/sec	43 Kio/sec	103 Kio/sec
z/OS Database	37 Kio/sec	53 Kio/sec	126 Kio/sec
Maximum Open IOPs	112 Kio/sec	1.7 Mio/sec	3.4 Mio/sec
Maximum z/OS IOPs	67 Kio/sec	99 Kio/sec	236 Kio/sec
Sequential Read	540 MB/sec	2.0 GB/sec	4.0 GB/sec
Sequential Write (Mirrored in cache)	350 MB/sec	1.0 GB/sec	2.0 GB/sec

<sup>1</sup> IBM Open Database (70/30/50) benchmark.

Figure 17: DS8000 Series Performance Targets vs. ESS 800 Turbo

These impressive comparative figures speak for themselves. For example, the DS8300 is expected to outperform the ESS 800 Turbo four-fold on the IBM Open Database benchmark, to deliver almost eight times the Sequential Read performance, and almost six times the Sequential Write performance of the current high-end IBM platform. These are striking advances that highlight the benefits of the server-based architecture of the DS8000 series and of its POWER5 processors.

*With these claimed better performance level and significantly lower prices, IBM has engineered the strongest case possible against EMC...*

EMC has long refused to publish, or allow any DMX owner/user to conduct and publish, standard storage performance benchmarks; a policy it will surely continue in the face of this fiercely competitive attack. It can probably respond by introducing larger DMX models (*"DMX 4000" perhaps*) and other performance upgrade actions, or it can reluctantly reduce

its prices. With these claimed better performance levels and significantly lower prices, IBM has engineered the strongest case possible against EMC, upon whom it is obviously focusing most of its competitive push. The larger DS8300 makes a particularly strong showing over all competitor models presented here, as can be seen in the chart.

## DS8000 Advances Over ESS

For readers familiar with the IBM ESS, another perspective is to consider the specific advances the DS8000 offers over the ESS platform they know and use today. As discussed above, every part of the hardware is completely new, from the microprocessors to the frames, and everything in between. The biggest innovation is the hugely significant addition of support for two Storage System LPARs, which offers the invaluable consolidation opportunities discussed above. Performance, as Figure 17 shows, is very substantially increased in all areas. A new cache algorithm contributes to these performance gains, as does the much larger, up to 256GB-processor memory.

Other notable gains include:

- **Four times the cache:** With up to 256GB of processor memory/cache for high performance at high capacity.
- **Adaptive Replacement Cache:** Offering autonomic and dynamic cache optimization capabilities to further improve performance.
- **Smaller Footprint:** Despite its much increased capacity and power, the DS8000 occupies a 20% smaller footprint than the ESS 800 for a useful reduction in data center space occupancy per system.

**Footnote:** The above performance information is based on DS8000 estimates and projections made using IBM performance models and preliminary measurements in a controlled environment. Actual performance may vary and will be dependant upon an individual customer's application and implementation. The above performance values are maxima, assuming each machine was optimized to take advantage of its unique features (*for example, was configured with the maximum number of available channels, cache and disk drives*). The DS8100 may be configured with up to 64 x 2Gb fibre channels (*or 2Gb FICON channels for z/OS*), 128GB of system memory (*cache*) and 384 disk drives. The DS8300 may be configured with up to 128 x 2Gb fibre channels (*or 2Gb FICON channels for z/OS*), 256GB of system memory (*cache*) and 640 disk drives..

- **Logical Subsystems:** Logical device addressing now increases LSS to 256 from 32, an eight-fold increase or 510 on DS8000 systems with LPARs, 16-fold higher, and supports virtualized assignment of physical capacity to LSS. Up to 64K logical volumes may now be specified, also an eight-fold increase, with up to 128K on LPAR models.
- **Connectivity Extensions:** Up to 128 host ports are now supported on the DS8000, with up to 512 FCP logins per port. It also, for example, supports up to 512 FICON logical paths per logical control unit image and over 130,000 per storage facility image, and up to 256 FICON logical path groups per control unit image. These, and other, connectivity extensions are a considerable advance.
- **Better Administration:** On-line and off-line configuration can now be more easily performed with a Web-based GUI, ease-of-use is improved compared to with ESS Specialist, and the CLI supports control of copy services without any dependencies on GUI-created tasks.
- **Better TCO:** Through better base price/performance, improved and more flexible feature licensing, through support for larger capacity volumes, increased consolidation capability and improved management software, and a 4-year warranty, the DS8000 offers considerable TCO advances over the ESS, and we expect, over the competition as well.

## Extreme Resiliency & Availability

From its specification and platform technology, the ES8000 will set a new resiliency and availability standard. IBM has clearly designed the system to post exceptional availability, and the high durability that will allow a long service life. We have seen extreme field reliability on the POWER4/4+ driven, high-end p690 server across the US installed base, posting whole population averages of over "five 9s" for many months, quite unprecedented for a UNIX server, and deriving from the on-chip POWER architecture resiliency features, and mainframe-inspired construction. These approaches have both again been extended by POWER5 and applied to the DS8000, along with a fully redundant, non-disruptively replaceable everything, non-disruptive software update, with autonomic features that help the systems keep running. These considerations mean the DS8000 will undoubtedly assure an exceptional level of resiliency and represent a real advance. It will be interesting to see what the field resiliency record is after twelve months. IBM's confidence in the reliability of the systems is clearly high, evidenced by its decision to provide an industry-first, full four-year on site, 7\*24 warranty on the system; a valuable benefit to customers.

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*From its specification and platform technology, the ES8000 will set a new resiliency and availability standard. IBM has clearly designed the system to post exceptional availability, and the high durability that will allow a long service life.*

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## Leadership Business Continuance Solutions with Advanced Copy Services

The DS8000 series also features an extended suite of advanced copy services. The FlashCopy point-in-time copy function backs-up data in the background, giving users nearly instant information access on source and target volumes. The Metro and Global Mirror capabilities generate and maintain duplicate copies of data on separate storage systems located locally and at geographically-dispersed locations, to protect data from disasters and support business continuity in the event of power outages or disaster. These capabilities, which are offered on both the DS6000 and DS8000, are discussed separately and more fully in Section 7.

## Full Interoperability with DS6000 & ESS

Companies can also use a multi-tiered approach for mirroring and back-up functions. For example, the DS8000 series can be used to mirror data to another DS8000 series, to a lower-cost DS6000, or to an older ESS system. The Global Mirror function is rated the fastest such long-distance solution. This full interoperability with the new compatible DS6000 allows a wider range of tiered storage solutions to be deployed at a more affordable cost. We previously discussed the use of a common code base between the DS8000 and the DS6000; most of it well-proven code carried forward from the ESS, and thus providing a proven foundation for this interoperability, and for future common advances.

## LUN and Volume Management

Significant improvements have been made in LUN and Volume management for the DS8000, with the addition of non-disruptive deletion of LUNs, allowing the reuse of their capacity, and support for larger LUNs of up to 2TB size. For zSeries, support has been extended to offer 64K cylinders (56.6GB) z/OS volumes, increasing the headroom for larger volumes that may now be needed on growing zSeries workloads.

## DS8000 Pricing Overview

The DS8000 series consists of the DS8100 (2-way), the DS8300 (4-way), and the DS8000 Expansion Unit. The DS8100 and DS8300 base controller US list prices are \$95,000 and \$190,000, and the DS8000 Expansion Unit list price is \$75,000. A DS8300 configured to support storage system LPARs is no extra charge. Priced hardware features include processor memory (*cache*), 2Gb FC Disk Drive Sets, and host connectivity ports. As on the ESS, all software-related advanced features are separately packaged and ordered via the IBM TotalStorage DS Series Function Authorization Model 2244. Priced features of the Model 2244 include a new required OEL and optional advanced function license features including PTC, RMC, PAV and Remote Mirror for z/OS (*RMZ*). The OEL, as well as the PTC, RMC, RMZ and PAV licenses scale with capacity. Supported capacity tiers include 1TB, 5TB, 10TB, 25TB, 50TB and 100TB. For example, the OEL for 1TB, 5TB and 25TB capacity tiers on the DS8000 are \$6,750, \$27,250, and \$87,500 respectively.

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*The DS8000 pricing model also implements six significant improvements over that of the ESS based on customer feedback.*

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price can be fully determined by the capacity being acquired in the current purchase transaction), tiered pricing for advanced functions and OEL, reduced disk drive prices, sub-capacity pricing for advanced functions, and the new four year warranty. These prices, in our assessment, undoubtedly make the DS8000 fiercely competitive for the high-end, enterprise-class functionality it provides.

The DS8000 pricing model also implements six significant improvements over that of the ESS based on customer feedback. These include transaction-based capacity tiers (*which just means*

## DS8000 – Competitive Position

The DS8000's strongest target is EMC's flagship Symmetrix, specifically the DMX 1000, 2000, and 3000 systems. EMC introduced this "Direct Matrix Architecture"-based generation in the first half of 2003, and refreshed it with a DMX-2 speed bump (*by moving up its Channel I/O Directors from 500MHz. PowerPC processors to 1.0GHz. PowerPC processors*) in March 2004. It is therefore unlikely that EMC has any radical new architecture/line-change this early in this generation's lifecycle. As the ECSS market leader and premium price-setter, EMC has the most to lose from the DS8000 assault. IBM's new flagship now out-scales, appears to outperform on a model-by-model basis (*according to its own estimates*), and substantially undercuts the DMX on price at each scale-point.

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*IBM's new flagship now out-scales, appears to outperform on a model-by-model basis (according to its own estimates), and substantially undercuts the DMX on price at each scale-point.*

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introducing larger DMX models (*"DMX 4000" perhaps*) and making other performance upgrade actions, could reduce/discount its prices, or rely on the loyalty of its customer base.

The HDS Lightning 9900™V Series is also a direct DS8000 target. These systems have been longer in the market, were promoted as performance leader, and usually undercut EMC on price. The DS8000 rates well on a like-for-like model basis with Lightning equivalents on capacity, performance and functionality, and can clearly win ground from this contender. HDS also (*last month*) announced the new TagmaStore Universal Storage Platform, which will be resold by Sun Microsystems and Hewlett-Packard. This new class of storage infrastructure system combines internal ECSS capabilities, with the ability to virtualize and manage other external storage servers in a tiered hierarchy. The three TagmaStore USP models announced compare more closely to DS8000 systems, with a higher scale point for the top HDS model. IBM approaches tiered heterogeneous SAN virtualization in a different way, with the SAN Volume Controller, a software image solution that can be installed in an xSeries appliance or as a CISCO switch blade application, to

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*The DS8000 rates well on a like-for-like model basis with Lightning equivalents on capacity, performance and functionality, and can clearly win ground from this contender.*

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perform similar functions. The firm has also said it will focus on putting storage applications on Storage System LPARs, to bring combined server-storage overall performance gains that are yet unquantified, but which should be substantial.

The first opportunity for the DS8000 will be as a replacement and upgrade for existing ESS users, for whom it represents a major advance in every respect, whilst retaining skills and copy services compatibility. It will also now hugely strengthen IBM's hand in open new customer ECSS procurements, with its scalability, performance, first-class value and other more than competitive attributes, and should considerably increase its win rates, which had suffered of late with the aging ESS. Established EMC sites will be a harder sale, as they tend to have entrenched loyalty, although some will welcome the leverage such a contender brings and will now find a migration to IBM considerably more attractive than previously.

## Future Roadmap Developments

An extensive roadmap for the ES8000 was shared with analysts, and this includes hardware enhancements such as:

- **Additional multi-processor models:** IBM's statement of direction indicates plans for additional models in the future. Based on our work with IBM, and their SoD, we expect that next will be an 8-Way model, with linear scalability literally doubling the performance (*and capacity*) of the current Model 8300 (*4-Way*). Beyond that, we would expect, when it's needed, that IBM can introduce a 12-Way model with over 500TB of available capacity. Longer term, it has also outlined the parameters of a future DS8000 that would scale past the 1PB barrier.
- **Higher-performance SMPs:** Scheduled advances in the POWER5 and following POWER5+ processors for the p570 SMP server base of the DS8000 will allow higher-performance versions of the DS8000 models when the former become available in 2005, if needed. This shows the primary advantage of server-based architectures for storage systems, which can exploit leading-edge microprocessor and server rapid advances.
- **4Gb/s FC/FICON Host Adapters:** Doubling the current 2Gb/s adapter port capacities, with similarly effect beneficial on system throughput performance.
- **Higher capacity/speed disk drives:** Which will increase system storage capacity pro-rata.

It also included functional enhancements that will mainly be delivered through developments in the DS8000 OE, and which are expected to include:

- **Extensive Storage System LPAR Extensions:** See below.
- **Additional RAID options:** Support for a wider range of RAID options will be added to support enhanced data protection.
- **On-demand enhancements:** Additional capabilities to further improve support for dynamic on-demand environments.
- **Logical volume over-provisioning:** To allow logical volumes to be over-provisioned for greater headroom.
- **Larger zSeries Volumes:** To support larger enterprise application volume requirements on zSeries.

Storage System LPARs will be steadily and substantially extended (*as they were on eServers*), to move the DS8000 still further ahead in its lead in this central technology. Planned are more granular I/O allocation at the physical array level, to allow more flexible CPU resource allocation between LPARs, and provision of a wider range of partition processing power levels. Virtualization support will be extended to allow virtual I/O between applications, LPARs, and virtual array images, and to provide virtualization of FC and Ethernet ports for application LPARs. The other fundamental development will be the introduction of a growing list of storage-intensive applications that will be made available, tightly integrated with the Storage System LPAR environment, and which will offer significant benefits compared to compute server-resident deployment.

These major further advances are all enabled by DS8000 architecture and its use of server-based platform and virtualization technology. We expect that IBM will maintain a steady pace of introduction of these additional LPAR applications capabilities, which will increasingly differentiate DS8000 systems from their competition. It will use this particularly to extend the commanding lead it has now secured over its main competitors, and to support its drive to the number-one market position in high-end storage.

## Our Analysis

The DS8000 presents an impressive, comprehensive, all-round advance to set a new standard in HE ECSS. It offers dramatic gains in overall, all-round performance aided at high-capacity by up to four-times more cache and up to six-times more scalability in a 20% smaller physical footprint (*all than the ESS base Model 800*) at attractively competitive pricing levels. The technology used is all-new, and centers on the immensely powerful POWER5 microprocessor engines and p570 server-based architecture which puts far more of the action onto this highly-integrated silicon, and uses the high-bandwidth, fault-tolerant, distributed switch architecture interconnect well proven in pSeries and iSeries servers. The design is also claimed to be extensible to use future advanced interconnect technologies envisioned in the POWER6 roadmap.

Most significant is the invaluable addition of Storage System LPARs. Two separate storage images can now be securely run in isolation on the same system, supported by IBM Virtualization Engine™ technology, to bring considerable consolidation opportunities, improved flexibility and better ROI. This initial LPAR implementation will be a principal focus for DS8000 enhancement in future OE releases. These will increase the flexibility and granularity of the LPAR implementation, and more importantly, introduce an increasing number of storage-intense applications running on the storage system in an LPAR in close proximity to the storage, expected to offer major further performance advantages in appropriate applications.

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*The technology used is all-new, and centers on the immensely powerful POWER5 microprocessor engines and p570 server-based architecture...*

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The two initial DS8000 models – the 2-way DS8100 and the 4-way DS8300 – scale up to 192TB. This amply covers a large majority of the market's average initial purchase size range. Their design is modular, using from one to three frames. The systems are designed to scale to over 1PB of internal storage, and the architecture can address up to 96PB, providing ample headroom for years ahead. The architecture is also claimed to scale-up well, with balanced performance gains from the extra resources that come with system size increases. It will exploit the technology advances flowing from POWER and pSeries server advances, whose roadmap is compelling

The systems are also expected to deliver extremely high levels of resiliency, exploiting the in-built, on-chip reliability features intrinsic in the POWER5 chip as their foundation, and engineering the highest levels of reliability, availability, autonomic self-healing and non-disruptive operations into the whole system. It is expected that the DS8000 will post greater than five 9s availability on aggregate when settled into production usage in the field. They therefore provide an ideal storage platform to support large, mission-critical enterprise applications for both traditional OLTP and new-generation e-business On Demand Web applications.

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*Indeed, the clever combination of this impressive high-end system with the ground breaking, low-cost, ultra-dense DS6000 creates a large opportunity.*

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As we discuss in the next section, the DS8000 enjoys the strengthened range of advanced copy services, including the impressive Global Mirror function that it shares with its fellow enterprise continuum member, the DS6000. Indeed, the clever

combination of this impressive high-end system with the ground breaking, low-cost, ultra-dense DS6000 creates a large opportunity. These, we predict, can successfully extend the ECSS market both downwards as well as upwards, and this allows many new consolidated and tiered storage solutions to meet rising business continuity and ILM requirements affordably.

The pricing levels and longer-term costs of ownership appear sharply competitive against leader EMC's, and will help the DS8000 gain share. IBM has implemented a number of important customer-requested improvements in the DS8000 OEL and copy services software licensing models, including new and more flexible sub-capacity licensing models for the Point-in-Time and Metro/Global Mirror services, to better reflect their expected usage levels and encourage wider adoption.

Good market opportunities for the DS8000 include:

- **ESS Replacement:** The early replacement of exiting ESS systems at high-performance, large-application customers, where the advancements it offers present a cast-iron case to such customers to upgrade as fast as possible, for increased scale, better performance and economic advantages.
- **zSeries z990:** The zSeries mainframe is enjoying a widespread market resurgence after its transformation was completed with the high-end z990 and the low-end z890. Fuelled by new platform workloads such as J2EE™, enterprise applications and Linux, mainframe sales have boomed this year, and these sites represent an exceptionally good opportunity to additionally install the highly-complementary DS8000, with its enhanced zSeries support, with much-increased addressing and much-improved LUN management.
- **Competitive Wins:** As discussed under "Competitive Position" above, the DS8000 greatly improves IBM's relative competitive position against the HDS Lightning and USP and EMC DMX systems, and can now take competitive wins from both in open market bid situations.
- **High-end pSeries and iSeries:** Unnoticed by many has been the tremendous success for the pSeries high-end UNIX systems. Well over 4000 p690 top-end systems have been sold and now dominate the high-end UNIX market. These up to 32-way systems are close to mainframe in their robust strengths and the size of workload they are supporting, and an increasing proportion of them now need enterprise-class storage to match. With further expected blockbuster technology gains expected when the POWER5 high-end pSeries (*that will scale up to 64-way*) emerge late in 2004, this opportunity will further expand. An increasing number of larger iSeries, also of near-mainframe class and using the same hardware platform, have also been deployed, and often require enterprise-class storage to match.
- **Services-led Storage Improvement Projects:** IBM Global Services is the world leader in the provision of storage services that have been growing well and account for 40% of the total storage global market. The DS8000 and DS6000 opportunity and IGS skills make a good combination to speed migration, convert competitive wins, and help customers implement new tiered storage architectures for DR/BC and ILM.

Challenges faced by IBM with the DS8000 center on the entrenched strength of EMC within its installed base, the falling market share experienced as the ESS became less competitive, and the timing of this announcement (*which was not great from a short-term sales viewpoint*). Its enterprise storage sales are therefore likely to be weak in Q4 2004, constrained as customers evaluate the DS8000 that becomes available from December 3<sup>rd</sup> 2004, with volume availability and shipments stepping up over the first half of 2005. Another challenge is that although 75% of the DS8000's OE microcode is carried forward from the robust and stable ESS base, 25% is new, and some issues must be expected as this is stress-tested by live production usage. However, we believe that everything possible has been done to minimize this factor, after the earlier ESS issues experience on this.

IBM has also articulated a message about the growing convergence between high-end servers and ECSS. Where these are on a common technology platform, using common capabilities such as LPAR, recombining server and storage systems in a combined enterprise machine would be straightforward. These could share core infrastructure, hugely speed server-storage intercommunication, and achieve significant economies. This direction appears easily feasible from a technology point of view, and could dramatically change the server and storage systems markets in the longer term if implemented.

In any event, these announcements undoubtedly represent an inflexion point in the HE ECSS market, and mark the beginning of IBM's march back towards leadership, with an all-round offering that could hardly be stronger in every major area of comparison.

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## 7. Common Copy Services across the Enterprise Continuum

### Introduction

Deploying ECSS into enterprise environments requires not only powerful ECSS and comprehensive storage OE firmware, but also copy and replication services to enable business continuity, disaster recovery, Storage LPAR staging, and ILM tiered storage hierarchies to be effectively deployed. IBM had already established a sound position with the copy services for its ESS systems, and made further major announcements of the Metro Mirror and Global Mirror offerings earlier in 2004. Now, with the near-term availability of the impressive new DS6000 and DS8000 systems providing a new continuum of enterprise-class storage, covering a much wider span than hitherto possible, and which share the same copy services, many new and more affordable solutions to these requirements can be provisioned.

In this Section, we briefly review and assess the principal copy services now offered uniformly across the DS8000, DS6000 and ESS 800/750.

### Resiliency across DS8000, DS6000 and ESS800/750 – Copy Services Offered

IBM has substantially extended its resiliency copy and replication services for the DS Family with several major developments in 2004. These facilities are now collectively branded as the "IBM TotalStorage Resiliency Family", and include:

- **Metro Mirror:** This synchronous data-mirroring function uses a single handshake protocol that minimizes overhead and speed-of-light penalties. It is intended to support mirroring over metro-area distances of up to 300km. Developments through 2004 now make significantly greater distance achievable for a given response time objective. In one real example, 68km was achieved versus 23km for a previous implementation (*with 4K blocks at 2ms response time*). Metro Mirror can provide real-time remote mirroring for disaster recovery and back-up for IBM z/OS and a variety of UNIX, Microsoft Windows, and other servers, and is supported on the DS8000, DS6000 and ESS 800 and 750 ECSS. Metro Mirror can also support the zSeries GDPS mainframe clustering facility.
- **Global Mirror:** Available from May 2004 as IBM Global Mirror for Enterprise Storage (*previously known as PPRC*), this function provides an impressive real-time, remote-mirroring solution able to support unlimited (*global*) distances. This technology provides global back-up and recovery protection at speeds approaching those achievable at local distances. Global Mirror can operate across up to eight ECSS subsystems (*DS8000, DS6000 or ESS*) and across z/OS mainframes and Open Systems. It can support two-site complete and consistent data mirroring, and currency can be configured to be as low as 3 to 5 seconds behind host I/O. This function is designed to minimize the possibility of any data loss. Global Mirror can provide this real-time, remote mirroring for disaster recovery and back-up for IBM z/OS and for a wide variety of UNIX, Microsoft Windows, and other servers, and is supported on the DS8000, DS6000 and ESS 800 and 750 ECSS. At launch, IBM described Global Mirror as the world's fastest global business continuity technology, with claims that it substantially outpaces similar EMC offerings and therefore offers lower infrastructure costs. The function uses innovations in asynchronous Peer-to-Peer Remote Copy (*PPRC*) technology to speed disk mirroring at distances of more than 300 kilometers with the above low delays. This performance also needs only two FC links per ECSS, where comparable technologies often require four links, reducing infrastructure costs and TCO. An example of Global Mirror utilizing DS8000 and DS6000 systems is shown in Figure 18 (*on page 36*).
- **Global Copy:** This function provides asynchronous global remote copy over unlimited distances, without the overheads of maintaining consistency.
- **FlashCopy:** The TotalStorage FlashCopy® point-in-time copy function is designed to help reduce application downtime by providing near instantaneous internal copies of data. This high-speed, high function, point-in-time copy function supports consistency groups across volumes and storage systems, and operates at dataset level.

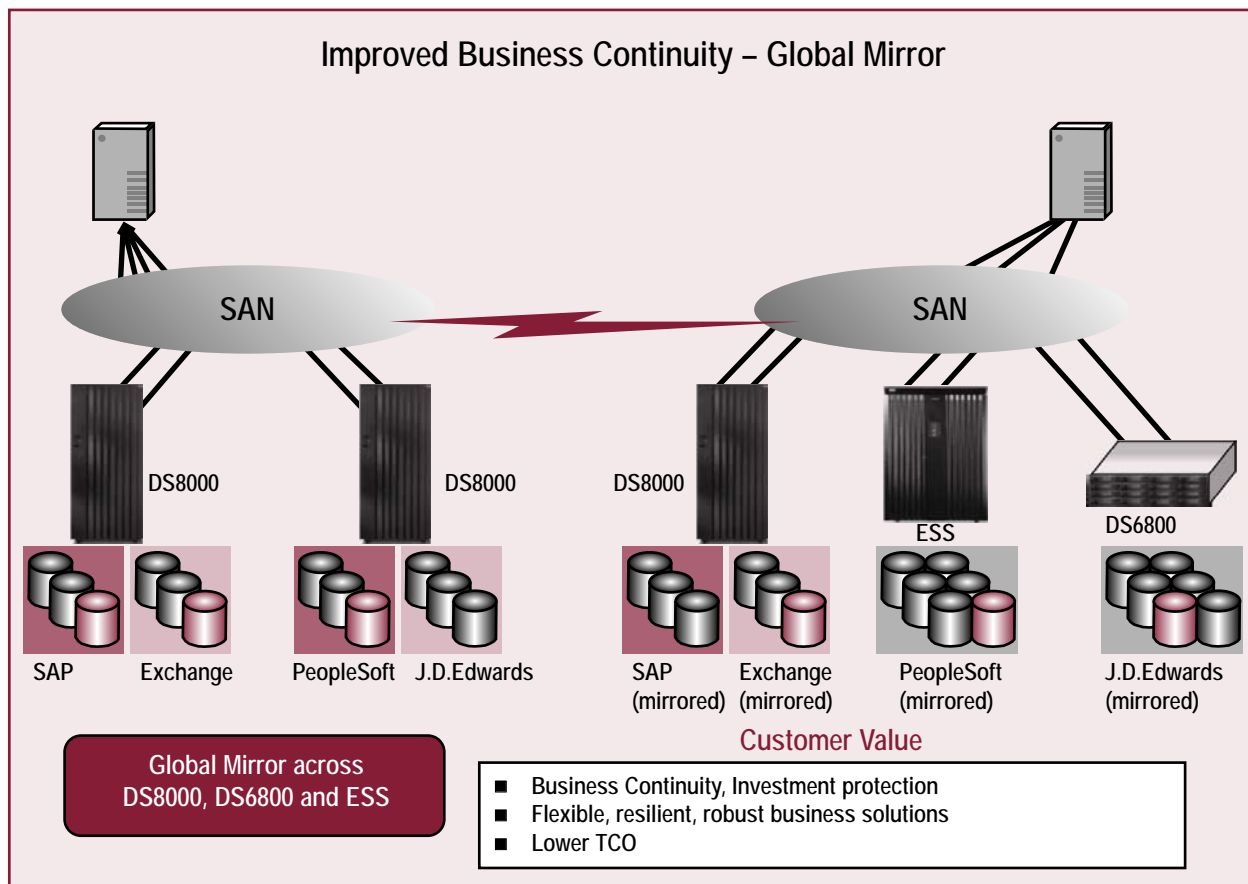


Figure 18: Improved Business Continuity – Global Mirror

- **Global Copy and Global Mirror for DS4000:** Recently-announced advances now provide Global Copy and Global Mirror long-distance remote replication solutions for the mid-range DS4000 storage server family.

This set of copy services covers all requirements for most environments and situations.

## Our Analysis

The portfolio of the IBM TotalStorage Resiliency Family described above provides a set of tools for customers of a wider range of sizes to deploy appropriate and affordable business continuity, disaster recovery and ILM solutions meeting their specific needs.

*The extended enterprise-class storage continuum provided by the DS6000 greatly increases the number of affordable configurations that can benefit from these flexible resiliency services...*

The extended enterprise-class storage continuum provided by the DS6000 greatly increases the number of affordable configurations that can benefit from these flexible resiliency services, and can inter-operate fully with both existing ESS and new DS8000 high-end servers.

It is also encouraging that IBM has now also introduced comparable Global Mirror and Copy services on the midrange DS4000 storage servers, enabling these competitive, mid-range, Open System storage nodes to also be protected in a similar fashion.

With these servers and copy services, CIOs can extend sound and comprehensive business continuity strategies, that have now become a wider business imperative, more broadly and affordably.



# Appendix A: IBM TotalStorage DS Family in Review

## New TotalStorage DS Family Debuts

In September 2004, IBM announced that it had consolidated its disk storage offerings into the new IBM TotalStorage DS Family, now claimed to be the most extensive disk family from a single vendor. By simultaneously adding the new, entry-level systems below to its already fast-growing, existing mid-range disk systems, and now the breakthrough DS6000 and DS8000 enterprise-class systems assessed in this Report, the giant offers small businesses through to the largest enterprises the broadest range to address their diverse disk needs. The DS storage server family focuses on providing common features and design attributes, such as high availability, and high-function storage management software, as well as class-leading performance and pricing in each segment. The whole Family is positioned in Figure 1 on page 6.

The TotalStorage DS Family joins the broader TotalStorage range that is designed to provide overall solutions to simplify customer's overall ("Total") storage infrastructures, improve their business continuity, and their ILM.

## IBM TotalStorage DS300 Entry-level iSCSI Storage Server

The DS300 was introduced in September 2004 as the industry's lowest-priced, entry-level storage server to offer advanced management features, incorporate SCSI drives, and is integrated with servers to deliver disaster recovery and business continuity for mid-size businesses. The DS300 is designed to give mid-size business a simple, reliable and affordable option to transport data through standard Internet protocols, priced under \$3,000.

With the DS300, IBM claimed to have become first amongst tier-one storage vendors to offer a storage server based on the iSCSI storage protocol, which allows customers to create a SAN with their existing Gigabit Ethernet networks. iSCSI brings dramatically lower costs for SAN storage servers, and offers a simple, low-cost way that the advanced storage management techniques currently used by most large organizations can be adopted by mid-sized businesses. iSCSI technology allows IT administrators to deploy existing server and network management skills on these low-cost SANs. The cost-effective DS300 storage server offers reliability and performance features that include Ultra320 SCSI drives, battery back-up cache, and redundant hot-swappable power supplies in a 3U form factor. The DS300 runs Windows and Linux, and has been optimized to provide a low-cost iSCSI workgroup storage server for IBM eServer xSeries and BladeCenter customers. Typical applications include file, print and Web serving, as well as remote boot storage for diskless servers. The physical storage capacity of the DS300 can scale to 2TB. The single-controller model of the DS300 shipped from September 24<sup>th</sup> 2004, with the dual-controller model due to start shipping on December 17<sup>th</sup> 2004.

## IBM TotalStorage DS400 2GB FC Storage Server

With the DS300, IBM also introduced the DS400. This storage server is a 2GB FC storage server in a dense 3U form that can be managed simply with the ServerRAID management software tool included. The combination of IBM's eServer xSeries and BladeCenter rackable systems with this new storage option offers clients a comprehensive solution to help address both workgroup and departmental needs, such as managing databases, e-mail and Web serving. It provides an affordable migration from Direct Attached Storage (DAS) to a SAN. The DS400 also runs Windows and Linux, and has been optimized to provide a low-cost yet capable FC workgroup storage server for IBM eServer<sup>®</sup> xSeries<sup>®</sup> and BladeCenter<sup>™</sup> customers. The product can also leverage existing customer investments in TotalStorage EXP400 enclosures. DS400 physical storage capacity can scale up to 5.8TB. The single-controller model of the DS400 shipped from September 24<sup>th</sup> 2004, with the dual controller model due to start shipping on December 17<sup>th</sup> 2004.

## DS4000 Mid-range Storage Servers Debut with DS4000 Storage Manager V9.1

Also a central part of this new DS family, IBM announced the TotalStorage DS4000 mid-range storage server series (*formerly the IBM TotalStorage FASiT Storage Server series*). Designed to deliver advanced functionality at a breakthrough price for FC storage, the servers include the series' latest storage firmware, named the DS4000 Storage Manager V9.1. This software is a Web-downloadable performance upgrade that provides new, enhanced, remote mirroring and copy functions – called Global Mirror and Global Copy – to help customers mirror data both synchronously and asynchronously. This DS Storage Manager's Enhanced Remote Mirroring feature helps protect information stored on the DS4000 server through real-time data replication, and was made available in September for download on the firm's Web site ([www.ibm.com](http://www.ibm.com)). The DS4000 series has been enhanced to complement the entry and enterprise disk system offerings with support for EXP100 serial ATA expansion units attached to DS4400s. The DS4000 series now includes:

- **IBM TotalStorage DS4100 (formerly FASiT100):** Entry-level, mid-range disk storage server aimed at storage consolidation and near-line application storage needs.
- **IBM TotalStorage DS4300 (formerly FASiT600):** Mid-level storage server providing economical and scalable storage for rapidly-growing application needs for limited access, data reference, and near-line storage.

- **IBM TotalStorage DS4400 (formerly FASi7700):** Superior performance storage server to support growing storage requirements created by e-business applications. Advanced replication services help to enable business continuance solutions.
- **IBM TotalStorage DS4500 (formerly FASi7900):** Enterprise-class, mid-range storage server delivering high disk performance and reliability for demanding, data-intensive applications in all Open Systems computing environments, investment protection, with advanced functions and flexible features. The DS4500 supports up to 32TB of FC disk storage with the EXP700, and advanced replication services to support business continuance and disaster recovery. When coupled with the EXP100, RAID-protected storage solutions of up to 56TB (*SATA*) can be supported to help provide economical and scalable storage for rapidly growing application needs for limited access, data reference, and near-line storage.

Advanced DS4000 series features include:

- Data protection with dual-redundant components, multiple RAID levels, LUN masking and enhanced management options.
- Storage consolidation for SAN, NAS and direct-attach environments.
- Investment protection throughout the DS4000 family of storage systems.
- Support for intermixes of EXP100 and EXP700 enclosures behind the DS4500, DS4400 and DS4300 with Turbo feature. (*Planned available from November 24<sup>th</sup> 2004.*)
- Support for IBM AIX®, Microsoft® Windows® 2000, Windows NT®, Windows Server 2003, Novell™ NetWare™, Sun Solaris, HP-UX, Red Hat Linux, VMWare, and Linux IA64.
- Supports EXP700 or EXP100 drive enclosures to preserve investment in DS4000 storage.
- Scales up to 32TB of FC disk capacity using flexible combinations of 18.2, 36.4, 73.4 and 146.8GB FC drives with the EXP700, or up to 56TB of Serial ATA disk capacity with the EXP100. (*EXPs are expansion enclosures.*)

These complete a mid-range offering that has proved successful and popular in the Open Systems storage market.

## IBM TotalStorage Storage Switch 2006-L10

In September the firm also announced the new TotalStorage Storage Switch, designed to provide new levels of price/performance for first time external SAN users. The 2006-L10 is designed as a cost-effective, enhanced FC loop switch for xSeries storage applications, and is an ideal storage companion for DS400, DS4000 Series and Ultrium 2 tape library deployments. Dell's success with volume network and storage switches has clearly been noticed!

## Express SMB Storage

Select DS300 and DS400 storage server models are included in the over 100 products in the expanding Express Portfolio of solutions for mid-sized businesses. This portfolio offers hardware, middleware, services and financing tailored specifically to the needs of mid-sized businesses. IBM claims each was designed to be acquired, installed and managed quickly, to be cost-effective, and deliver a rapid ROI. Many analysts, including ourselves, rate IBM's SMB strategy as probably the most comprehensive in the industry, with coverage, channels, and offerings that now also include many leading application-based offerings from independent solution providers worldwide, as well as affordable hardware, software, service and financing offerings.

## Our Analysis

The October 2004 announcement of the groundbreaking new enterprise-class DS6000 and DS8000 systems (*assessed in detail in this Report*) completed this now all-new TotalStorage DS Family. This now consists of the competitive, entry-level DS300 (*iSCSI*) and DS400 (*FC*) storage servers for Windows and Linux; the just-revamped, new DS4000 mid-range (*FC and SATA*) storage server series for Open Systems (*assessed in this Appendix*), and the enterprise systems. IBM now has a truly industry-leading, complete, attractive, well-positioned and well-branded disk storage server and management software line-up. This complete range now provides a winning disk platform to power the overall TotalStorage offering, which also includes strong tape, storage management software and storage virtualization solutions, towards its declared goal of overall storage market leadership over the next few years.

In the words of widely-respected executive Rich Lechner, now vice president of IBM Storage Systems, commenting on the new entry-level DS300 and DS400 systems in September: "Today's customers are placing a high emphasis on innovative technology that is easy to use and delivers high value. These new systems deliver a combination of advanced technology at an extremely attractive entry price. Tight integration with our Intel-based servers makes installing and managing a complete system infrastructure with IBM easier than ever."

With strength at every level and in every sector of the disk market, for both SMB and enterprise markets, and its broad go-to-market mix of direct and multiple indirect channels, we rate IBM's probability of success in its ambitious goal as high. To achieve this it must overcome the challenges and issues in this tough and competitive market.

## Appendix B: DS8000 – Statement of Direction for 8-way Model

IBM revealed its intention to introduce other upper-end DS8000 models. It gave a SoD for the DS8000 8-way model, which doubles scalability to 384TB, and adds the immense power of 8-way dual p570 server-based technology. The eight-frame 8-way system is illustrated photographically in Figure B1.

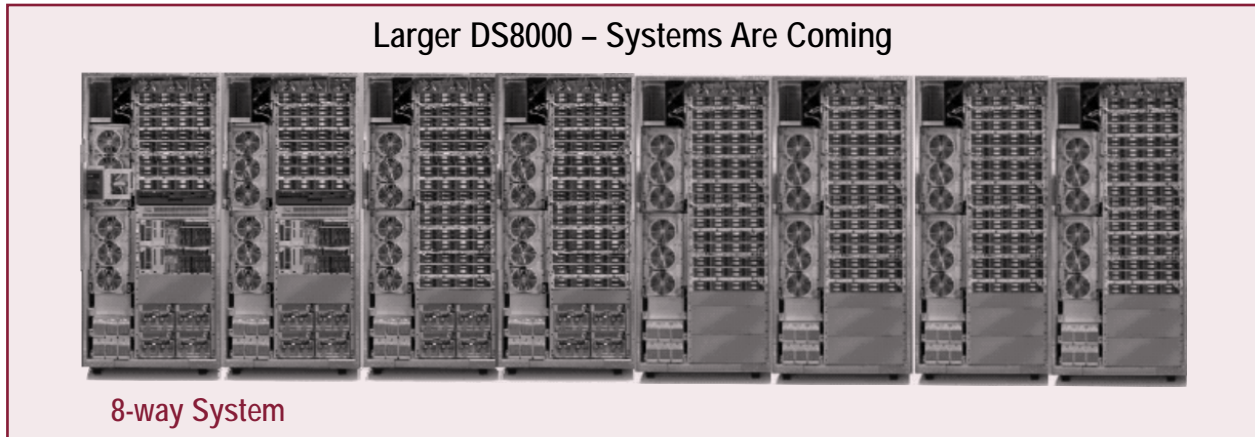
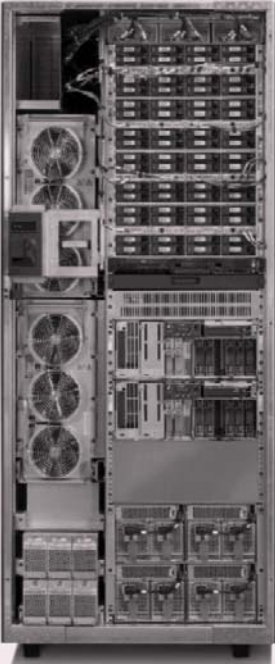


Figure B1: Larger DS8000 Systems Are Coming

The impressive capacities of the DS8000 range, including this SoD 8-way, are shown in Figure B2.

**DS8000 – Future Range Capacities**

	2-way	4-way	8-way*
<b>Server Processors</b>	2-way POWER5	4-way POWER5	8-way POWER5
<b>Cache</b>	16 to 128 GB	32 to 256 GB	64 to 512 GB
<b>Host Ports</b>			
FICON® (2Gb/s) <i>(4 ports per adapter)</i>	8 to 64	8 to 128	up to 256
Fibre Channel (2Gb/s) <i>(4 ports per adapter)</i>	8 to 64	8 to 128	up to 256
ESCON® <i>(2 ports per adapter)</i>	4 to 32	8 to 64	up to 128
<b>Device Ports</b> <i>(2 ports per adapter)</i>	8 to 32	8 to 64	8 to 128
<b>Drives</b> 73GB (15K RPM) 146GB (10K RPM) 300GB (10K RPM)	16 to 384	16 to 640	up to 1280
<b>Physical Capacity</b>	1.2 to 115TB	1.2 to 192TB	384TB
<b>Number of Frames</b>	1 to 2	2 to 3	2 to 8



\* Statement of Direction

Figure B2: DS8000 – Future Range Capacities

### Our Analysis

By issuing this SoD, IBM made it quite clear that the higher-end DS8000 8-way model is well-advanced in test/development, and will be released after initial demands for DS8100 and DS8300 have been met, and/or whenever competitor pressure requires it. This will be reassuring to purchasers of the DS8100 and DS8300, assuring them of a massive upgrade path from model-to-model on the DS8000 platform when they need it. The fact that these large systems are publicly known to be on the way and well-advanced will also preclude competitor out-bragging with any higher scalability claims based on the DS8300.

# Appendix C: IBM TotalStorage Open Software Family

## Managing Open, On Demand Storage Infrastructures

Supporting the IBM TotalStorage hardware range, including the DS6000 and DS8000 covered in this Report, are the revamped, extended and repackaged IBM TotalStorage Open Software Family. Management software is an ever-more important part of total storage solutions, and for readers not familiar with the extensive changes and advances IBM has made in this area over the last year, we include our concise overview of what is offered below. This management software suite provides a full set of capabilities, including storage infrastructure management, Hierarchical Storage Management (*HSM*), archive management, and recovery management. The suite encompasses support for:

**Storage Orchestration:** Automated management and allocation of storage resources to business goals and policies:

- IBM Tivoli® Intelligent ThinkDynamic™ Orchestrator.
- IBM Tivoli Provisioning Manager.

**Storage Infrastructure Management:** Complete integrated storage solutions to help enterprises understand and proactively manage their storage infrastructure:

- IBM TotalStorage Productivity Center offering.
- IBM TotalStorage Productivity Center with Advanced Provisioning.

**Hierarchical Storage Management:** Data storage solutions that can respond quickly to dynamic changes in business:

- IBM Tivoli Storage Manager for Space Management.

**Archive Management:** Solutions to help enterprises archive, retain, and manage data, including e-mail, to help satisfy regulatory, legal, and other business requirements:

- IBM Tivoli Storage Manager.
- IBM Tivoli Storage Manager for Data Retention.

**Recovery Management:** Solutions to quickly, reliably recover enterprise data, using central Web-based management, intelligent back-up and archiving (*with little/no application availability impact*), and automated policy-based data migration copy services:

- IBM Tivoli Storage Manager.

**Storage Virtualization:** Infrastructure software to pool storage assets, optimizing their use more widely, with the ability to modify the storage infrastructure with minimal or no disruption to application services:

- IBM TotalStorage Virtualization.

## IBM TotalStorage Productivity Center Detail

This open-storage infrastructure management tool cuts effort in managing complex storage infrastructures, improves storage capacity utilization and SAN performance, and improves administrative efficiency. It enables a more agile storage infrastructure that can respond to on-demand storage needs. The IBM TotalStorage Productivity Center consists of a GUI ease-of-use interface and the following components:

- IBM Tivoli® Storage Resource Manager.
- IBM Tivoli SAN Manager.
- IBM TotalStorage Multiple Device Manager Performance Manager.

IBM TotalStorage Productivity Center with Advanced Provisioning extends the above with capabilities that allow customers to automate capacity provisioning through automated workflows, and adds the following additional tool:

- IBM Tivoli® Provisioning Manager.

This addition reduces storage management costs through workflow automation, improves availability by reducing the human errors factor and automating best practices, and supports rapid new server and application provisioning, integrating server and storage provisioning through shared workflows and a common tool.



## Our Analysis

This is an advanced set of now well integrated storage management tools, covering all the main requirements. Particularly noteworthy and valuable are the automated provisioning which enables considerable further automation of storage workflows and server/storage provisioning that can dramatically cut both storage staff effort and time to service. These complementary software facilities will help customers get the best from their new DS6000 and DS8000 systems, and merit closer review and full consideration.

## Other Related Software Strategies Research

1. **"New POWER5-based eServer i5 Systems & i5/OS™ – Will Fuel Resurgence of IBM's Evergreen SMB Computing Platform"** Software Strategies Server Spotlight Report, 2<sup>nd</sup> Edition, July 2004, 42 p.p., 23 charts and tables. (*New i5 line hardware and software review.*)
2. **"IBM Stakes Strong Industry Leadership Bid With First Open, Customizable Microprocessor"** Software Strategies White Paper, 2<sup>nd</sup> Edition, May 2004, 40 p.p., 16 charts and Tables. (*In-depth review and assessment of IBM's POWER Everywhere initiative and the Power microprocessor ecosystem.*)
3. **"IBM Microelectronics 2004"** Software Strategies Analyst Overview, 1<sup>st</sup> Edition, May 2004, 12 p.p., 8 charts and Tables. (*Assessment of IBM Microelectronics operation behind the POWER Everywhere initiative.*)
4. **"Technology Fit for Business – IBM's New iSeries – "On Demand" Consolidation Powerhouse for Wider Roles/Markets"** Software Strategies Enterprise Server Spotlight Report, February 2003. 76 p.p., 45 charts and tables (*POWER4-based systems*).
5. **"The IBM p650 Mid-range RISC UNIX Server – Hammer-blow Challenger for UNIX Mid-market Leadership"** Software Strategies Enterprise Server Spotlight Report, December 2002, 8 p.p., 7 charts and tables. (*POWER4+-based systems.*)
6. **"New RISC UNIX Enterprise Server Leader? – The IBM eServer pSeries 690"** Software Strategies Enterprise Server Spotlight Report 2<sup>nd</sup> Edition, May 2002, 39 p.p., 31 charts and tables. (*POWER4 -based systems.*)
7. **"Big Blue Blasts into Bubbling Blade Server Battle – Powerful eServer BladeCenter Looks Set for Technology/Market Leadership"** Software Strategies Enterprise Server Spotlight Report 2<sup>nd</sup> Edition, November 2002, 48 p.p., 21 charts and tables. (*BladeCenter fundamentals.*)

## About Software Strategies

Software Strategies is a specialist analyst firm focused on e-infrastructure platform strategies and issues. Since 1997, we have hosted numerous successful industry events, including our popular Focus Events, and have worked closely with industry leaders, including: IBM; Microsoft; Intel; ICL; Unisys; CA; BMC; Stratus Computers; NetIQ; Misys; Notability Solutions; and many others.

Specialist expertise on mainframes, servers, operating systems and e-infrastructure middleware and enterprise software has been a common thread. Several thousand enterprise IT users have benefited from our authoritative events, presentations, conferences, newsletters, journals, white papers and reports.

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This Enterprise Storage Spotlight Report was researched and written by Ian Bramley, Managing Director of Software Strategies, and this 2<sup>nd</sup> Edition published in November 2004. The views expressed are those of Software Strategies and are based on our proprietary research. Ian founded Software Strategies in 1997, is an experienced enterprise infrastructure analyst, a keynote speaker at many industry events, and has published many reports and papers. He was previously Director of Enterprise Platforms at Butler Group, and Founder/Chairman of the Enterprise NT Management Forum from 1998 to end-2000.

Previously, he held a variety of executive positions with international software vendors over a 25-year industry career.



**Report Basis:**

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