System Storage™

Information Infrastructure
DS5000
Enterprise Solution
for Global Business

Control Unrelenting Change

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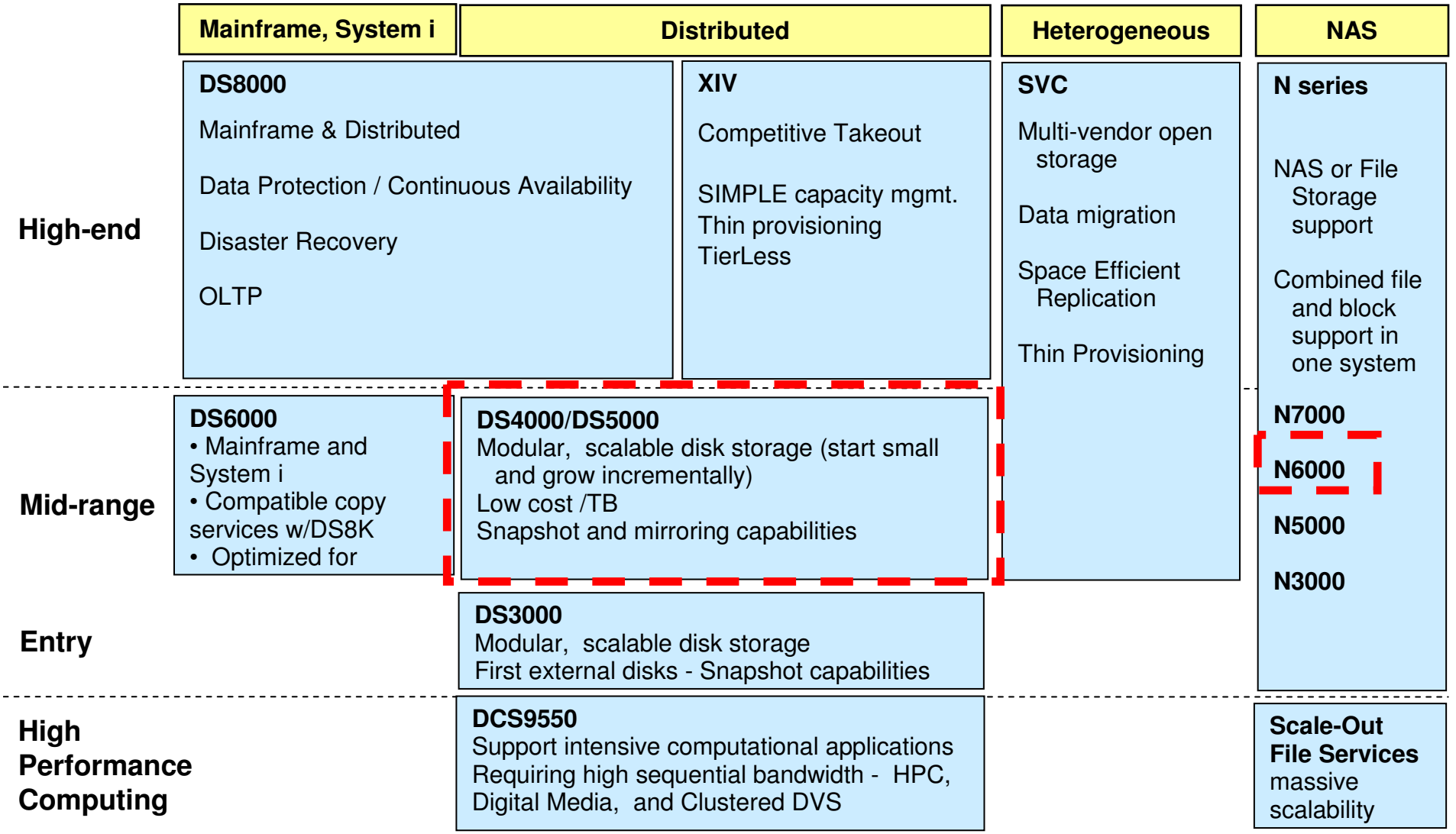
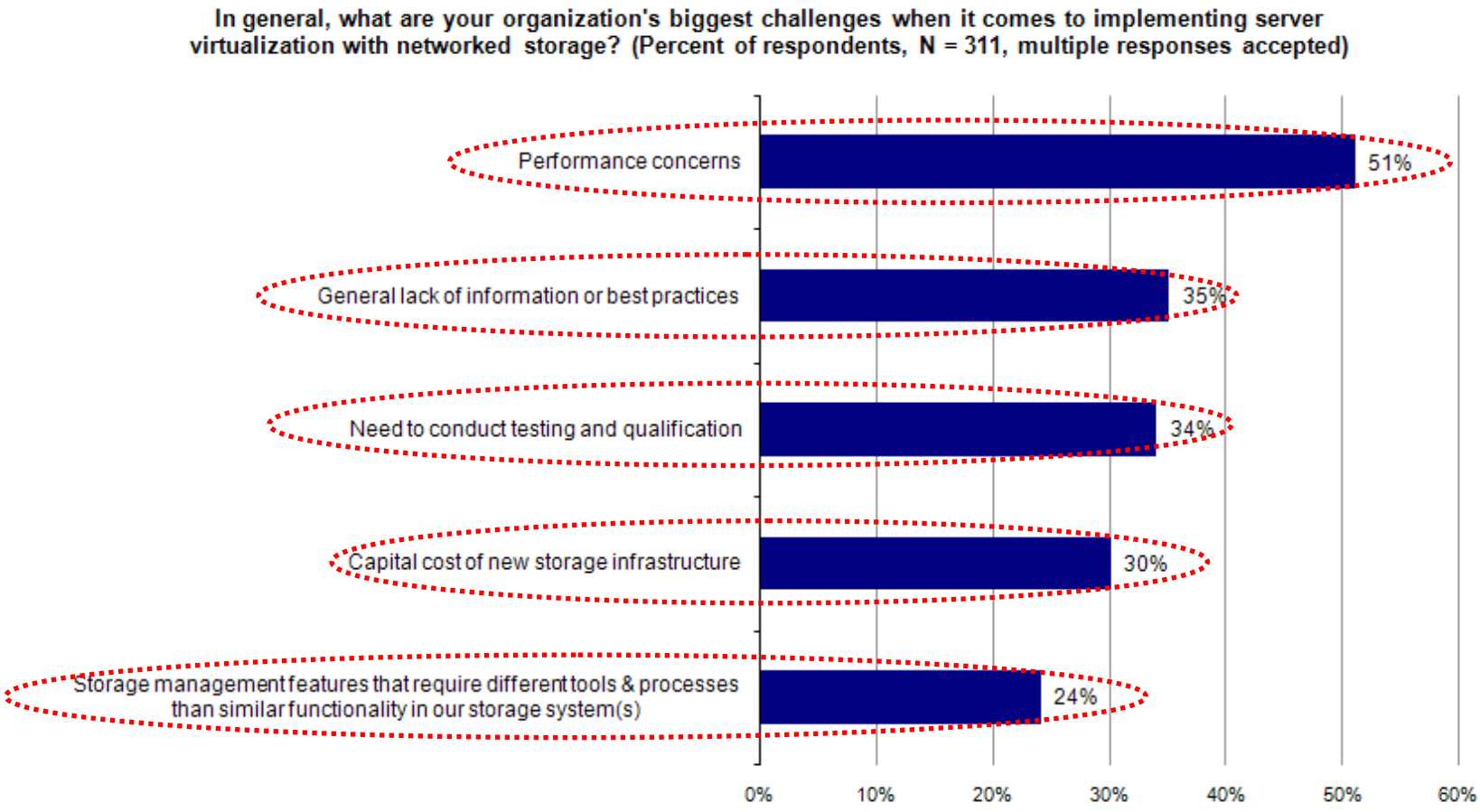
Enterprise Disk Family Positioning



IT Optimization:
DS5000 delivers Bullet Proof Performances for Networked Storage

FIGURE 1. SERVER VIRTUALIZATION AND NETWORKED STORAGE CHALLENGES



Enterprise Strategy Group December, 2007

DS5000 Expands IBM's Midrange Offerings

Performance / Scalability

DS3000

- FC (4 ports), SAS (2 or 6), iSCSI (4) connectivity
- Up to 48 SAS/SATA drives
- Partitions, FlashCopy and VolumeCopy

DS4000

- FC connectivity (4 or 8)
- Up to 224 FC/SATA drives
- Partitions, FlashCopy, VolumeCopy and ERM

DS5000

- FC connectivity (up to 16)
- Up to 448 FC/SATA drives
- Partitions, FlashCopy, VolumeCopy and ERM
- RAID 6

DS5000 Models

DS5300 (1818-53A)

- 8 or 16 4 Gbps FC interfaces
- 8 GB or 16 GB of data cache
- High performance option

DS5100 (1818-51A)

- 8 4 Gbps FC interfaces
- 8 GB of data cache

- Sixteen 4 Gbps FC drive interfaces
- Up to 256 FC/SATA drives in EXP5000 expansion units
  - FC: 146.8 GB, 300 GB, 450 GB (15K 4 Gbps FC DDM)
  - SATA: 750 GB, 1,000 GB (7.2K SATA DDM)
- Partitions: 8, 16, 32, 128, 256 or 512
- FlashCopy (up to 16 per base), VolumeCopy, ERM (up to 128)
- Warranty: 1 year, 24/7, 4 hour response

http://www-03.ibm.com/systems/storage/disk/ds4000/pdf/interop-matrix.pdf

DS5000 Value Proposition for Global Business

- **DS5000 is an EVOLUTION on the heritage of DS4000 disk storage family, which has sold in excess of 87,000 units and 511 peta bytes**
  - **Designed for Business Continuity and High Availability**
  - **Ready for challenges of IT Optimization**
    - **Consolidation, Virtualization, Extended Services, Adaptability**
  - **Ready to exceed business critical applications Service Level Agreements both now and in the future**
  - **Design for longer lifecycle with high investment protection**

DS5000, your major storage component for your Information Infrastructure

DS500
Thinking Beyond Today

Real-world performance
Sustainable, scalable,
balanced, responsive

Interface adaptability
4 Gbps FC, 8 Gbps FC,

10 Gbps iSCSI, Infiniband *

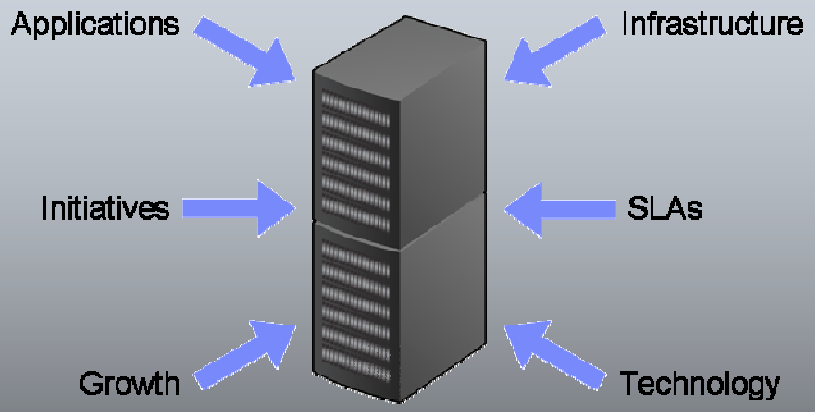
Continuous and reliable access to Information
Online administration, active-active redundancy, advanced diagnostics

Application integration
Certification, solutions, meet SLAs

Green efficiency
Do more with less

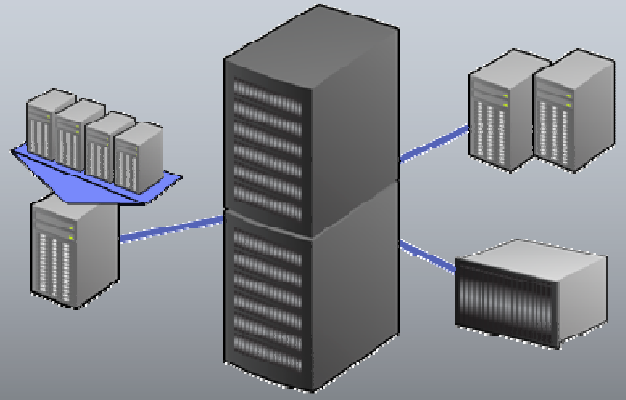
IT Optimization
Chaotic Demands On Today's Storage

Change Creates Risk



- Technology driving infrastructure evolution
- Must maintain SLAs through relentless growth
- Virtualization and "Green" initiatives

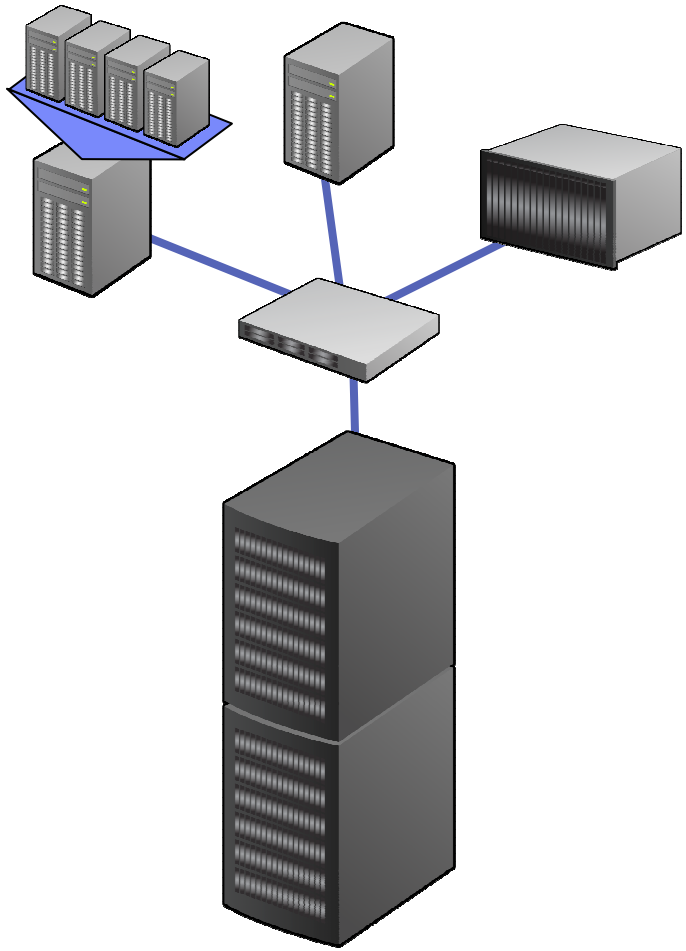
Consolidation Virtualization



- Multiple servers with varying demands create mixed, concurrent workloads
- Individual servers want the performance of a dedicated storage
- Continuous availability is a must

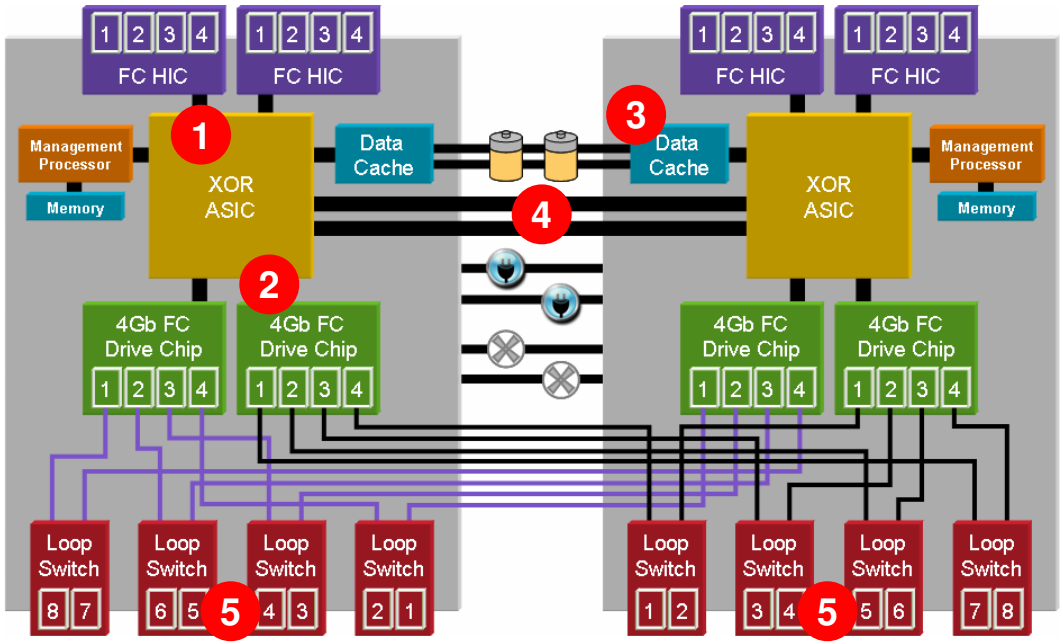
Customer Benefits: IT Optimization
Designed For The Rigors of Consolidation

- Balanced performance excels at mixed IOPS and MB/s workloads
- Sustainable performance handles concurrent workloads
- Configuration flexibility supports custom LUN tuning
- Architected to provide the highest reliability and availability



Next-Generation DS5000 Controller Delivers Real-World Performance

Designed for high-speed, low-latency, real-world performance

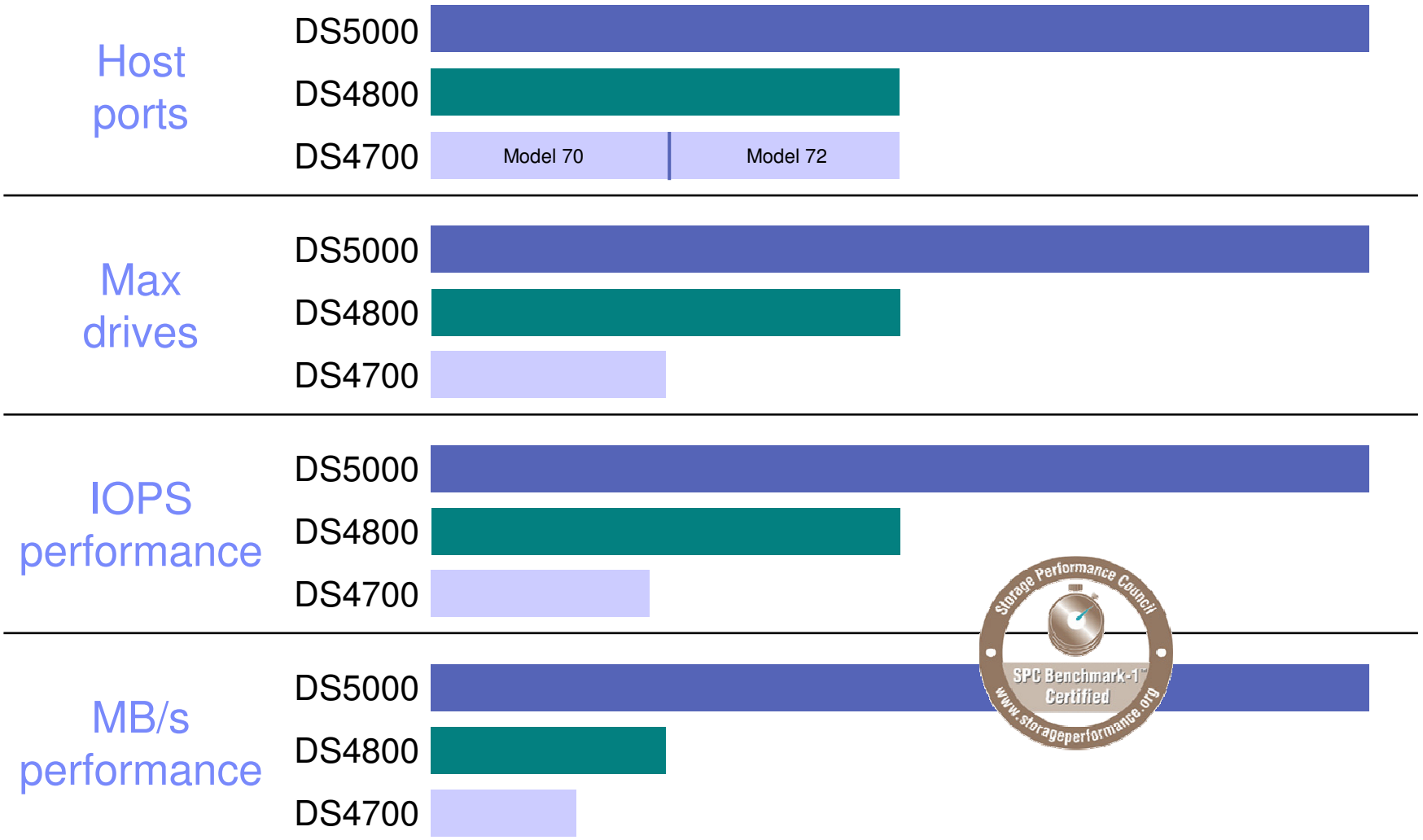


1. Custom ASIC with built-in hardware-assist for RAID 5/6 parity calculations
2. Multiple 2 GB/s PCI-E xX8 busses between ASIC and external interfaces
3. Dedicated data cache with dynamic read/write allocation
4. Dedicated 2 GB/s PCI-Ex X8 cache mirroring buses
5. Sixteen backend drive channels

DS5000 / DS4800 – Key Improvements

	DS5000	DS4800
Host interfaces	Eight or Sixteen 4 Gbps FC (8 Gbps FC, 10 Gb iSCSI – future)	Eight 4 Gbps FC
Max drives	256 (448 – future)	224
Data cache	8 or 16 GB (32 GB – future)	4, 8 or 16 GB
Cache protection	Battery-backed and destaged to disk	Battery backed
Cache mirroring	Dedicated PCI-Express busses	Across backend drive loops
Internal bandwidth (single controller)	4 GB/s on dual PCI-Express busses	1 GB/s on single PCI-X buss
Cache bandwidth (ASIC to Cache)	17 GB/s	3.2 GB/s

Customer Benefits: More Scalability, More Flexibility

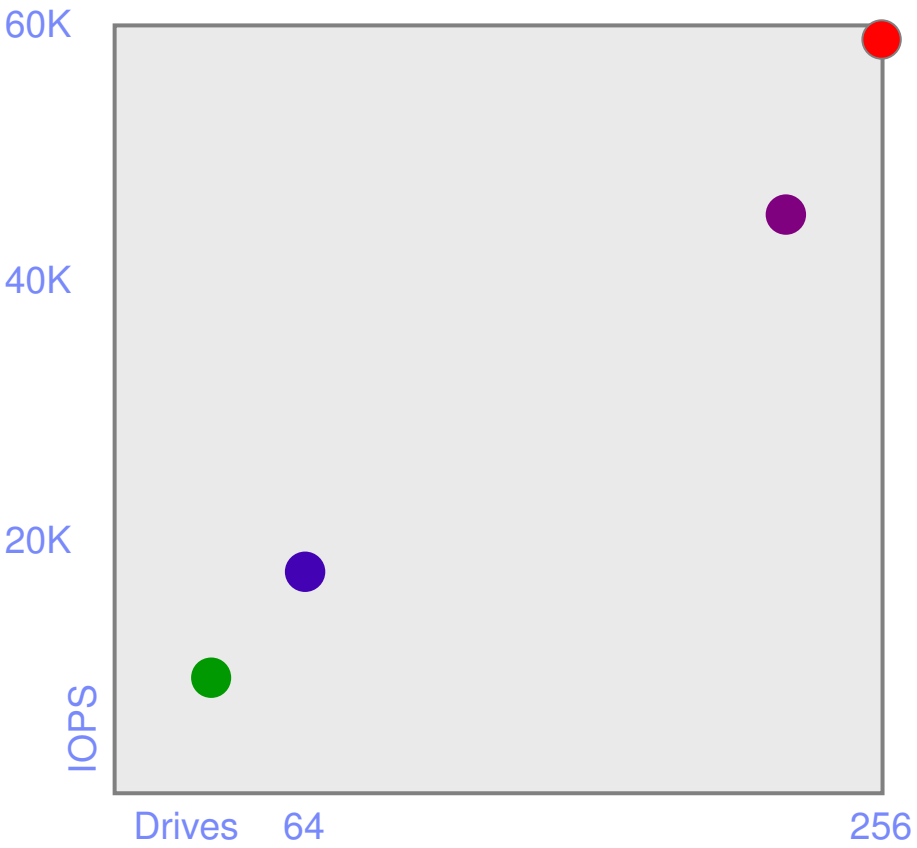


DS5000 / DS4800 Performance Comparison

	DS5300 (256 drives)	**DS4800** (224 drives)
Burst I/O rate cache reads	~ 700,000 IOPS	575,000 IOPS
Sustained I/O rate disk reads	~ 98,000 IOPS	86,000 IOPS
Sustained I/O rate disk writes	~ 25,000 IOPS	22,000 IOPs
Burst throughput cache read	6,400 MB/s	1,700 MB/s
Sustained throughput disk read	6,400 MB/s	1,600 MB/s
Sustained throughput disk write	5,300 MB/s	1,300 MB/s

* Based on performance testing by LSI. DS5000 performance numbers are preliminary estimates and not committed.
Actual results based on testing are to be determined. All numbers were done using RAID 5 using switched drive modules and FC drives.

SPC-1 IOPS Performance



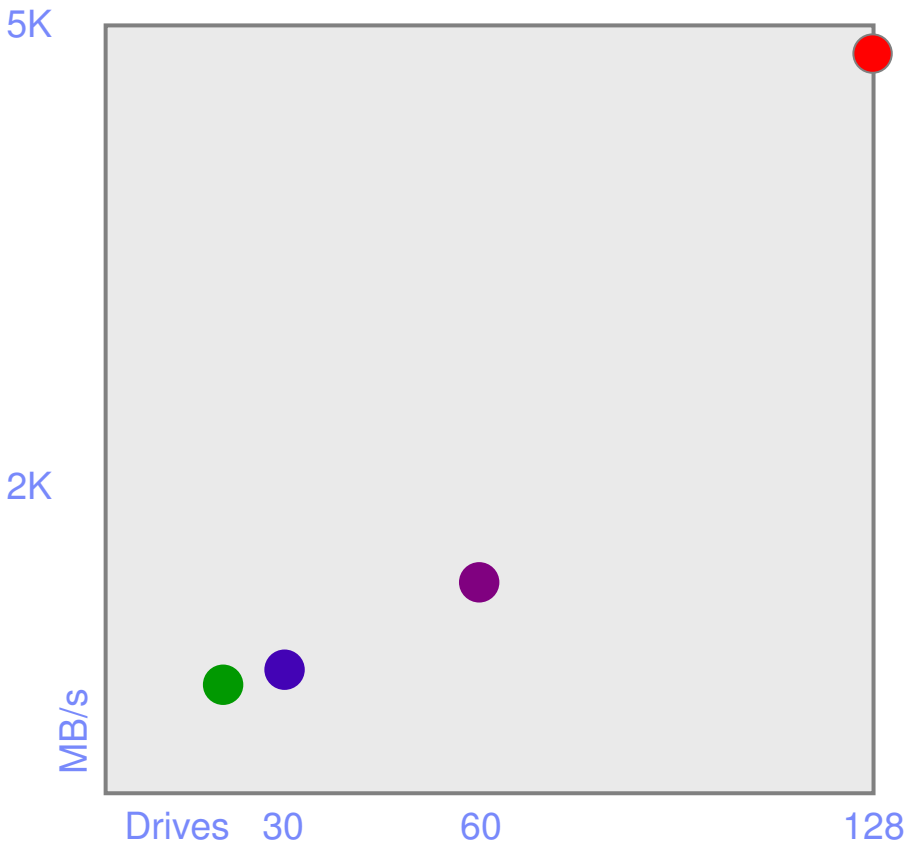
- DS5000 *Results released on SPC*
  @ 256 drives (~ 6 ms)
- DS4800
  45,015 SPC-1 IOPS
  @ 224 drives (~ 15 ms)
- DS4700
  17,195 SPC-1 IOPS
  @ 64 drives (~ 26 ms)
- DS3400
  9,000 SPC-1 IOPS
  @ 32 drives (~ 10 ms)

DS5000 *vs. DS4800*

14% drive increase
30% performance gain
60% response time decrease

Response time at 100% workload. Max allowed is 30 ms.

SPC-2 MB/s Performance



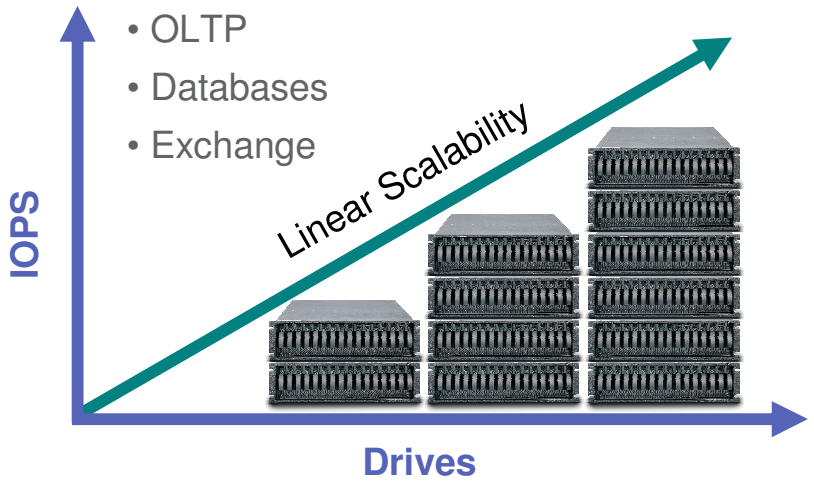
- DS5000 *Results released on SPC*
  @ 128 drives
- DS4800
  1,381 SPC-2 MB/s
  @ 60 drives
- DS4700
  823 SPC-2 MB/s
  @ 30 drives
- DS3400
  731 SPC-2 MB/s
  @ 20 drives

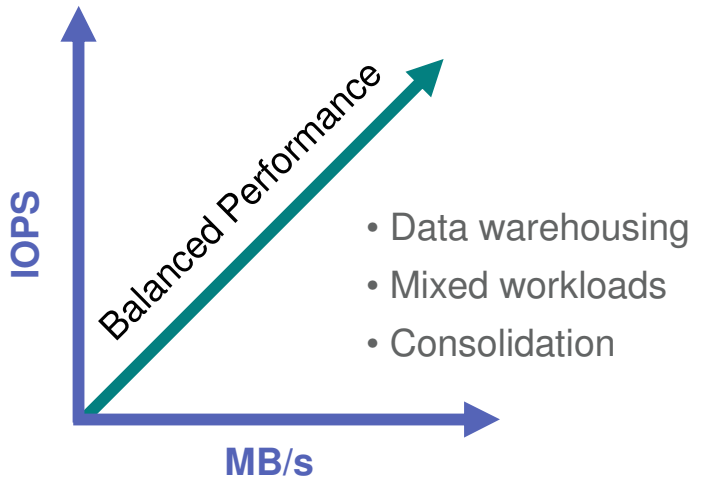
DS5000 *vs. DS4800* 3.5X throughput increase

Customer Benefits:
Sustainable High Performance To Meet SLAs

Efficient disk IOPS that scale linearly

Balanced performance excels at IOPS and MB/s





Maintains high performance through increased utilization

Customer Benefits: **High Availability**
Reliability, Availability, Serviceability, Usability

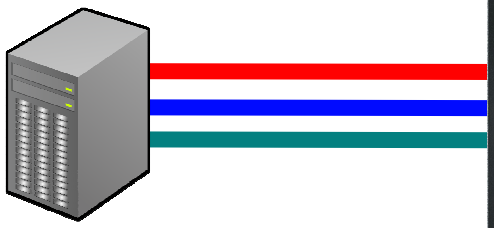
Designed to ensure continuous data access

- Fully-redundant active-active I/O path from host to drives with automated failover
- Proactive drive health monitoring identifies problem drives before they cause problems
- Media scan with automated parity correction
- Internal data integrity verification on SATA II drives
- Hardware-assist RAID 6
- Embedded loop switches for enable advanced diagnostics
- Dedicated data cache
  - Battery backed, mirrored, destaged to disk on power loss
- Global Hot Spares
  - “Unlimited” number, health check, rebuild options
- Extensive diagnostic data capture and statistics collection
- Optional RAID parity verification before returning read request
- Intuitive administration interface maintains simplicity without sacrificing configurability

Customer Benefits: **LIFECYCLE LONGEVITY**

Control Unrelenting Changes with Unparalleled Adaptability

Change interfaces to match evolving infrastructure



- 4 Gbps FC
- 8 Gbps FC *
- 10 Gbps iSCSI *

Scalable performance to match growth, maintain SLAs

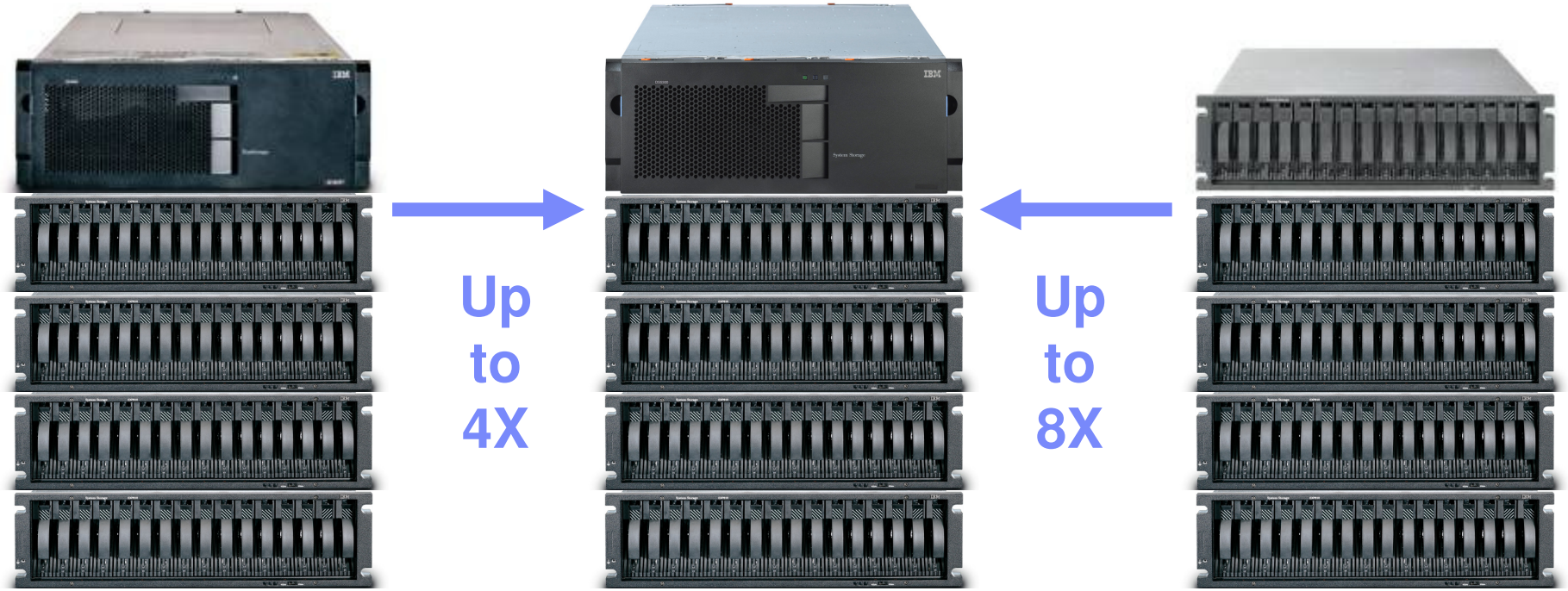
- Linear
- Sustainable
- Balanced

Dynamically expand/reconfigure to match new requirements

* 2009 feature

Customer Benefits:
Investment Protection With A Performance Boost

DS4800 **DS5000** **DS4700**



Up to 4X

Up to 8X

EXP810 drive trays only

Customer Benefits

Control Unrelenting Change Through Adaptability

Adaptability creates lifecycle longevity, increases return on investment (ROI)

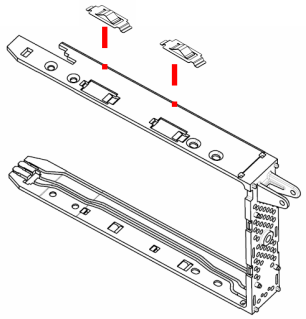
Extend beyond the normal three-year lifecycle

Eliminate the expense of migrating data to a new system

Amortize acquisition costs over extended periods of time

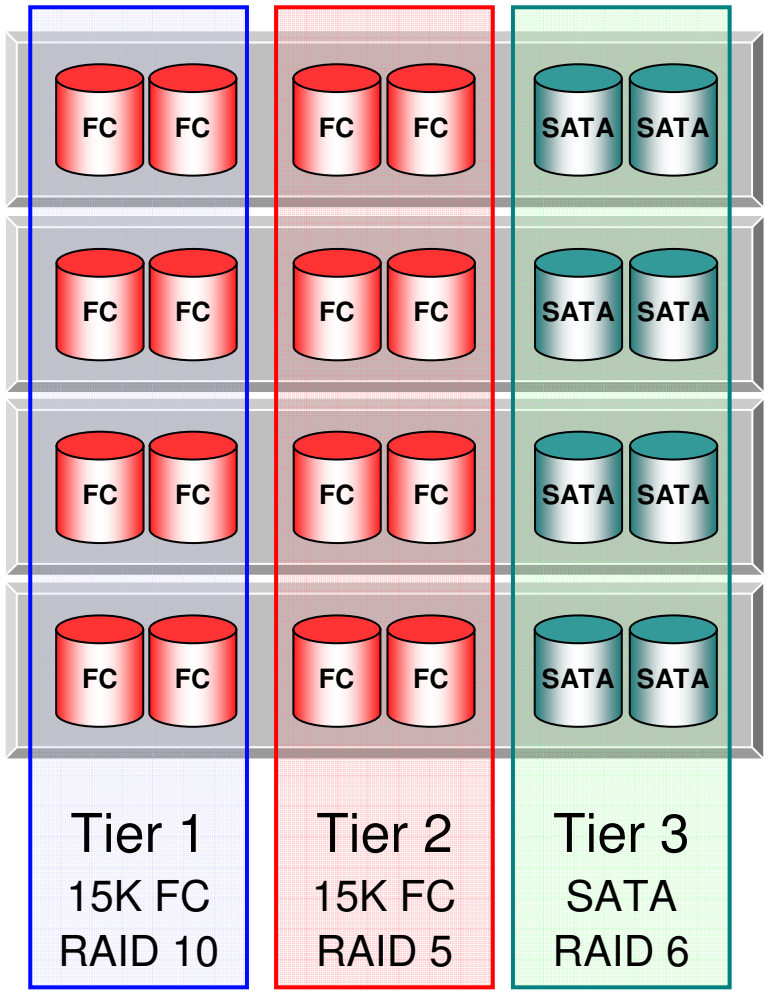
Customer Benefits :
Configuration Efficiencies Lower Environmental Costs

- Drive carrier designed to eliminate rotational vibration issues
- Supports intermixing FC and SATA drives in single enclosure



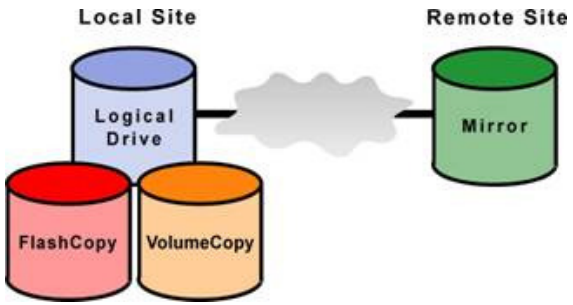
Enclosure-based tiers

- Tier 1 – OLTP, ERP, Email
- Tier 2 – Engineering; Development
- Tier 3 – Archives, backups, user files



Customer Benefits:
More Value out of your Information

The right data at the right time on the right media with Multiple Data Replication Offerings



- FlashCopy
  - Designed to create a point-in-time image
  - Ideal uses: backup source, restoration point, checkpoint
- VolumeCopy
  - Designed to create a complete physical copy (clone)
  - Ideal uses: data mining / analysis, PiT archive
- Remote Mirroring
  - Designed to create a continuously updated copy at a remote location
  - Ideal use: disaster recovery

DS5000 Release Roadmap

Initial Release

- 4 Gbps FC interfaces
- 256 drives
- 8/16 GB data cache
- FlashCopy
- VolumeCopy
- Remote Mirroring

SVC-Enabled

- Space-efficient virtual disks
  - "Thin provisioning"
- Storage virtualization
- Non-disruptive data migration
- FlashCopy
  - Incremental
  - Cascade
- Remote mirroring

2009 Releases

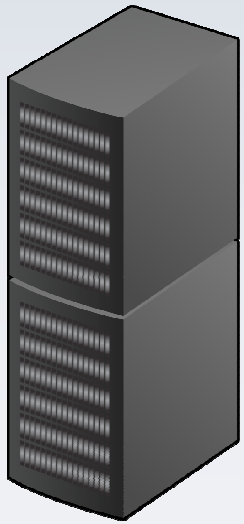
- 8 Gbps FC interfaces
- 10 Gbps iSCSI interfaces
- FC/iSCSI interface mix
- 448 drives
- 8/16/32 GB data cache
- Full Disk Encryption
- Solid State Disk (SSD)

DS5000 will be your choice for Key Applications

Virtualization *Databases* *Email* *ERP*



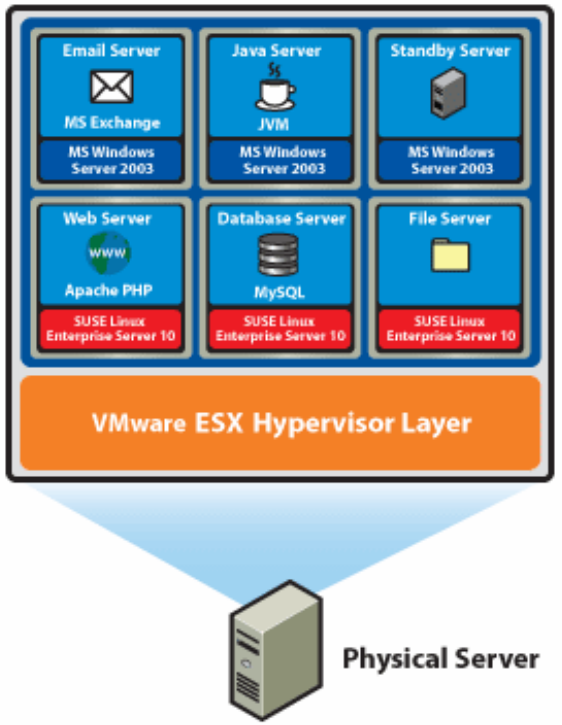

- Performance
- Scalability
- Availability
- Reliability



- Manageability
- Certifications
- Integrations
- Solutions

DS5000 For vmware

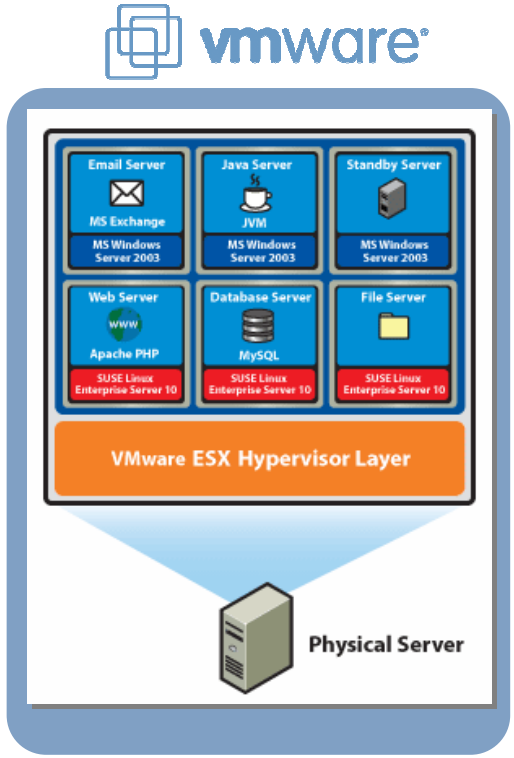
- Block-level shared storage supports complete VMware portfolio
  - VMotion, High Availability, DRS, SRM
- Scalable performance handles concurrent, mixed workloads
  - Validated by VMware benchmark
- Configuration flexibility and tiered storage supports custom LUN tuning for applications with different class of service



Demonstrates sustained balanced performance for all applications running on VMware

DS5000 Mixed-Workload Performance

- **Concurrently delivers**
  - Email – **17,512 Exchange mailboxes**
  - Database – **9,162 IOPS**
  - Data Warehouse – **884 MBPS**
  - Web Server – **4,551 IOPS**
  - Backup Job – **425 MBPS**
- **Time is Money**
  - **Email response time ≤ 16 ms,** under 20 ms max recommended by MS
  - **Database** response time **≤ 5ms**
- **First** concurrent mixed-workload **storage test** for a **virtual environment**
- Complimentary with outstanding **System X3850 VMmark test 13.16@9 tiles**
- **Headroom for** remote data replication and **other features**
- Support of Vmware Site Recovery Manager



WebSphere. software

Exchange Server 2007

Microsoft SQL Server 2008

Powered by Microsoft Office SharePoint Server 2007

Java Sun Microsystems

ORACLE

Apache

Demonstrates sustained balanced performance for concurrent applications running on VMware

High Availability and Disaster Recovery Solutions

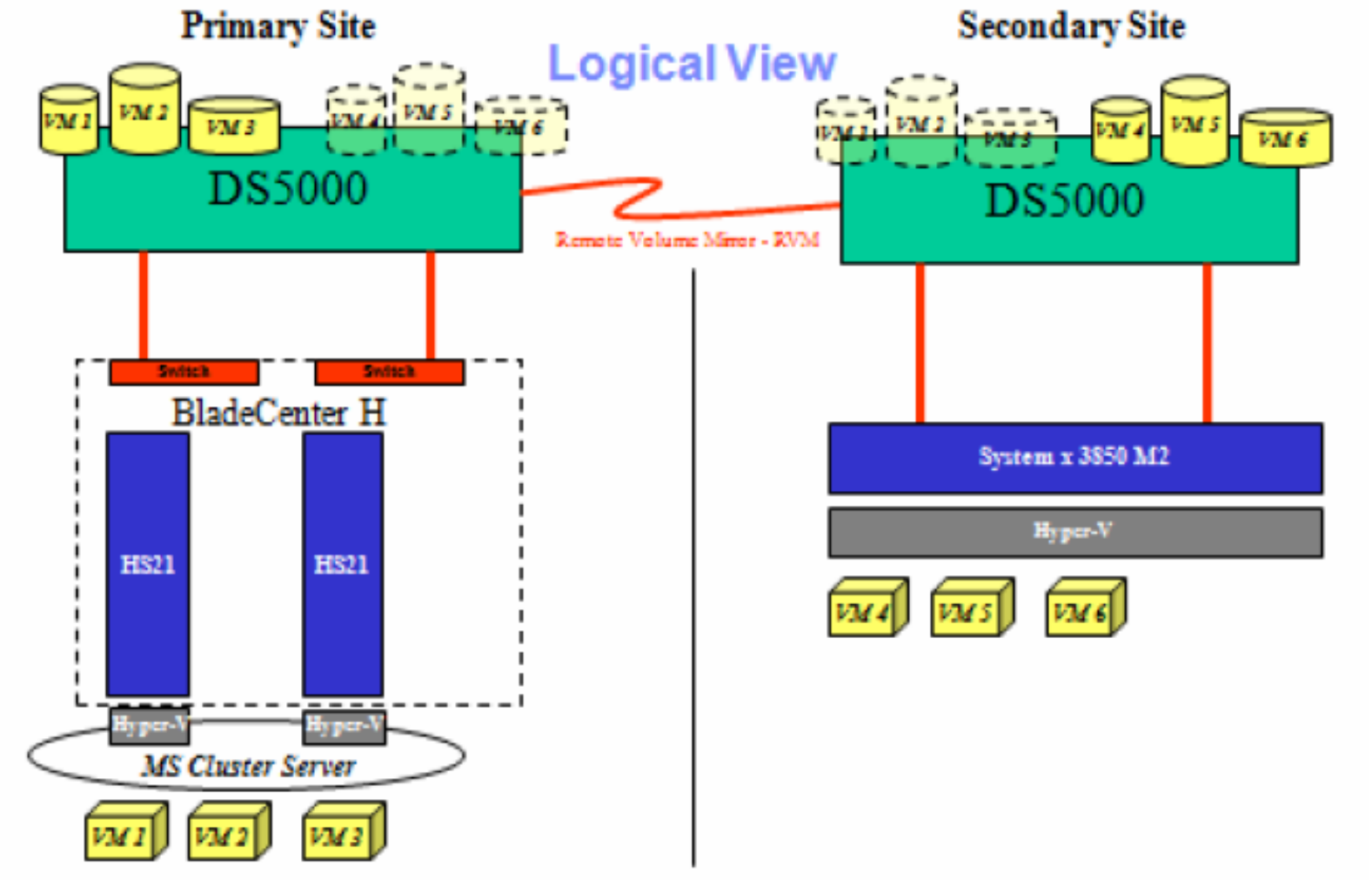
with Microsoft Virtualization Hyper-V on the IBM System DS5000, IBM

- ***Windows Server 2008 and Hyper-V with MSCS failover cluster support provides efficient high availability***
- ***Quick migration of Hyper-V guest machines between IBM HS21XM Blades with automatic fail-over***
- ***Optimized disaster recovery with the flexibility of virtualization and efficiency of the IBM BladeCenter, System x 3850 M2 and the DS5000 modular storage system***
- ***Reliable replication of data between sites with the IBM DS5000 and Remote Volume Mirroring***
- ***A robust, yet easy to manage & configure HA/DR scenario***

Microsoft GOLD CERTIFIED Partner

IBM DS5000

Virtualized High Availability and Disaster Recovery Solutions Microsoft Hyper-V on the IBM System Storage DS5000



DS5000 For ORACLE

- Balanced, scalable performance that's equally adept at supporting growing OLTP and OLAP requirements
  - Validated by the Oracle ORION tests:
  - + 31% IOPS / + 269% MBPS than DS4800
- IBM storage is deployed throughout Oracle labs and participates in early compatibility testing
- Multiple partitions and drive intermix support the data lifecycle management capabilities in Oracle 10g and the enhancements in 11g
- FlashCopy and VolumeCopy **offload production databases** for enhanced performance and facilitated testing / development
- Enhanced Remote Mirroring enables **affordable disaster recovery** in Oracle deployments
- Scaleable and reliable **data warehouses** of almost **half-a-Petabyte**

ORACLE E-BUSINESS SUITE

SAP

PeopleSoft

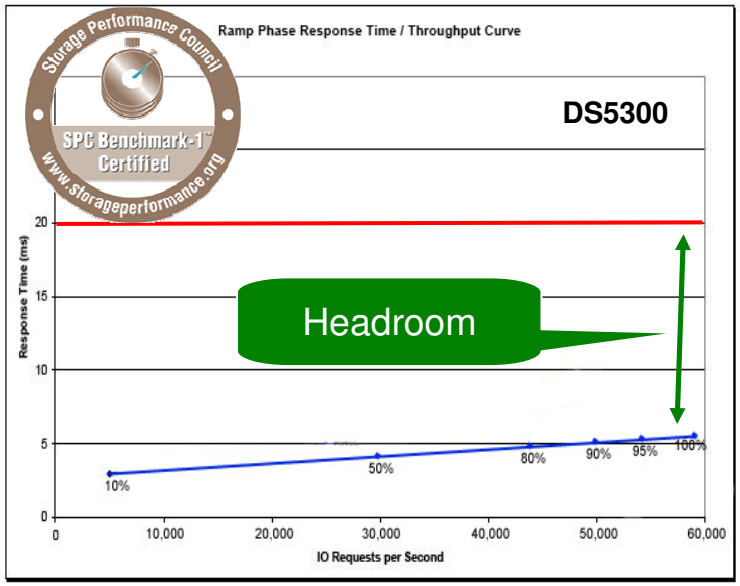
JDEDWARDS

SIEBEL

Demonstrates outstanding balanced and scalable performance for all applications running on Oracle

DS5000 For Microsoft

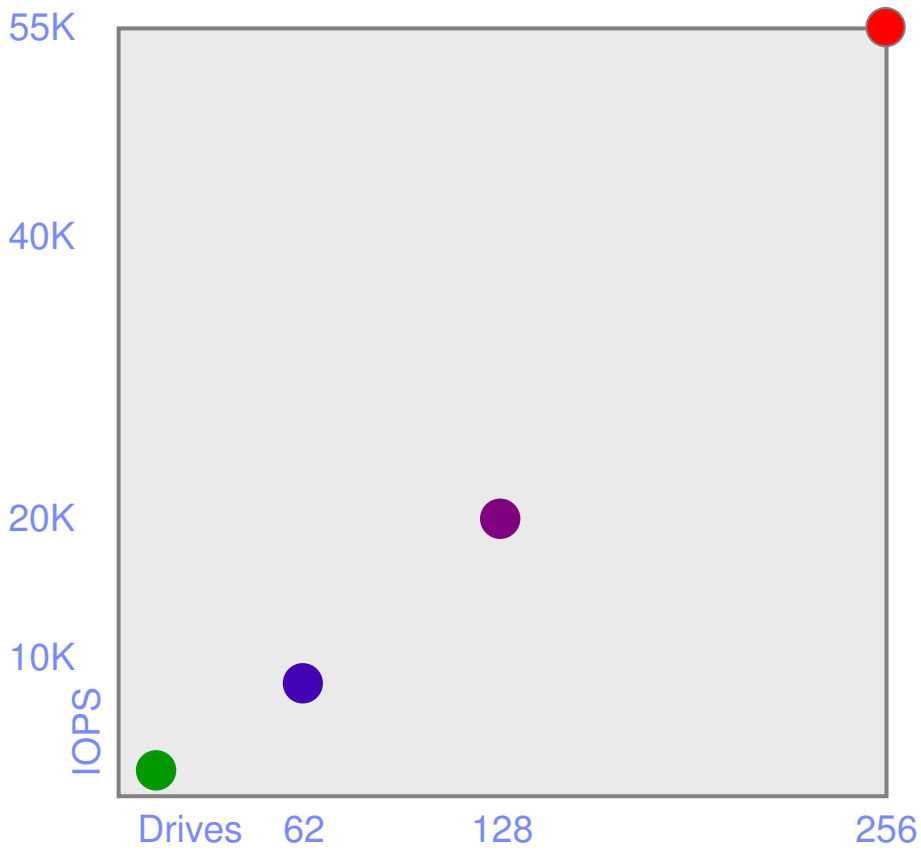
- Exceeds Microsoft's response time requirements for Exchange and SQL Server
  - Validated JetStress, SPC-1, SPC-2
  - Delivers 55,000 Exchange mailboxes
  - Very heavy profile - .48 IOPS per user
  - 400 MB mailbox size
- Seamless integration with Microsoft DPM for fast application restore
- Linear scalability and seamless adaptability as your future changes
- Supports online backup and single mailbox recovery



Exchange Server 2007

Demonstrates sustainable performance and near-continuous protection for Exchange and SQL

Exchange ESRP

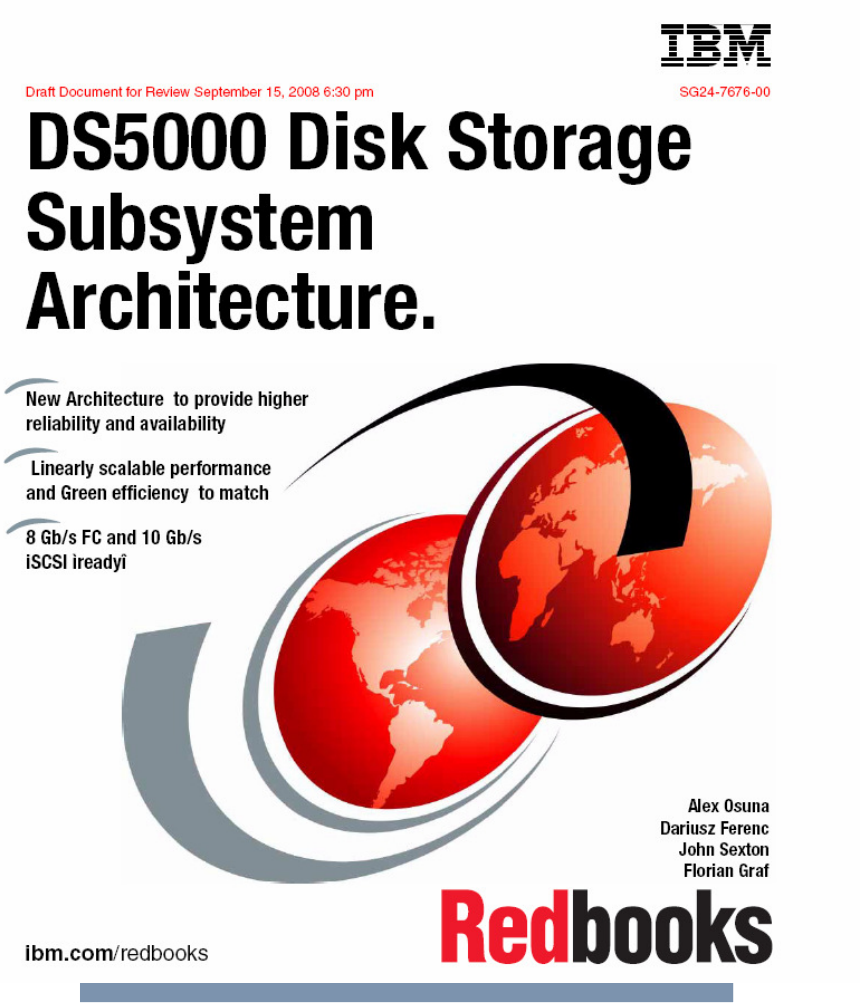


- DS5000 *Results released on MS*
  55,000 mailboxes
  @ 256 drives; 0.48 profile
- DS4800
  20,000 mailboxes
  @ 128 drives; 0.45 profile
- DS4700
  8,000 mailboxes
  @ 62 drives; 0.5 profile
- DS3200
  2,000 mailboxes
  @ 12 drives; 0.6 profile

DS5000 *vs. DS4800*	2X the drives 3.8X the mailboxes

IBM Redbook – DS5000 architecture, Implementation, Usage

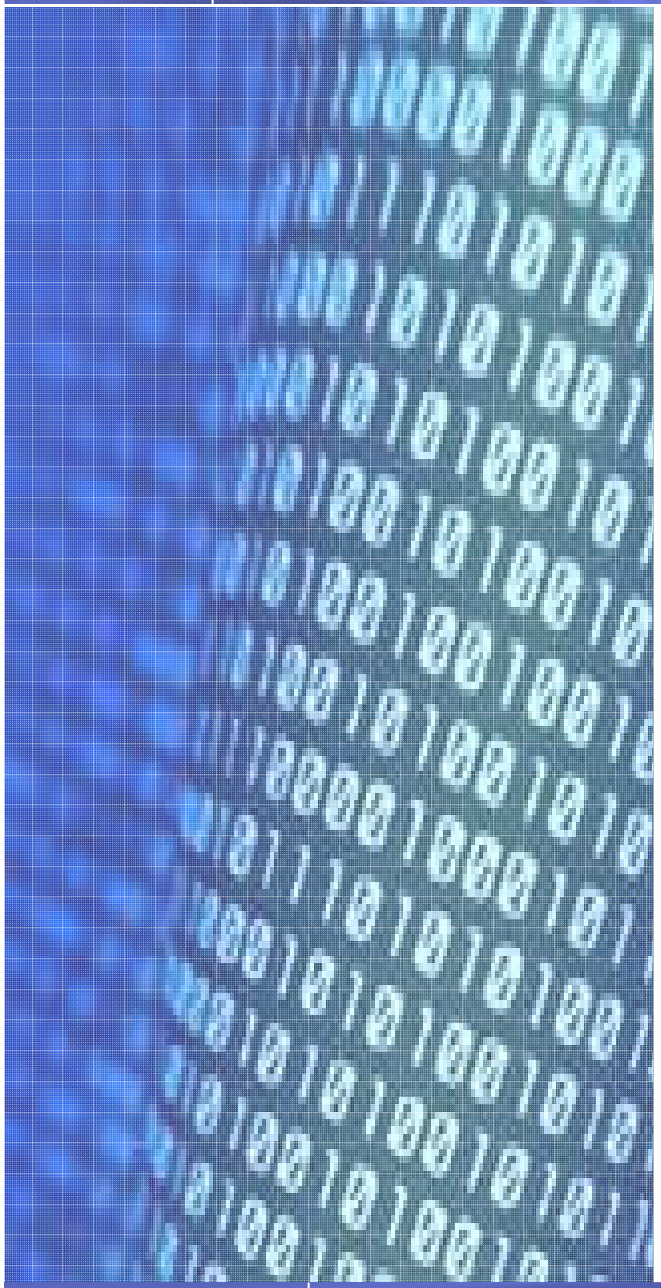
- Written for **customers**, **business partners** and technical professionals
- Best practices for **planning, deployment and maintenance of DS5000**
  - **Hints and tips** for the physical installation, cabling and zoning **using Storage Manager**
  - Performance and tuning of various components and features with **numerous recommendations**
- Large number of technical publications to assist you in deploying DS5000 in different applications environment:
  - **Design, Best practices, Configuration, Performances Tuning, …**



https://www.redbooks.ibm.com/Redbooks.nsf/RedbookAbstracts/sg246434.html?OpenDocument

Why choosing DS5000 ?

1. Built-in future proofing minimizes technology risk, extends useful life
   - 8 Gb FC / 10 Gb iSCSI “ready”
   - Seamless adapts to changing business and technology needs
2. Scalable performance to match growing mixed workload environment
   - Continues to meet SLAs through relentless growth
   - Linear scaling performance for Oracle, SAP, SQL Server, Exchange
   - Designed for the diverse and concurrent workloads created by VMware
3. Optimized ROI and TCO
   - Spend less on your storage and the power to run it
   - Designed for mixed worklaods and multiple services
4. Significant compatibility and integration with IBM servers
   - IBM eServer™, xSeries® and pSeries® servers (e.g. HACMP™)
5. Complete solutions from one vendor with full IBM support ecosystem
   - Servers, storage, applications, integration and installation can be acquired from a single vendor. No finger pointing if things go wrong.
   - One stop shop for Servers, Tape, Disk, SAN and Applications



DS5000 – Thinking Beyond Today

- Protecting your storage investment against the risks of dynamic change and growth
- Designed for the rigors of consolidation / virtualization
- Providing high-performance applications continuous and reliable access to information

THANK YOU
FOR YOUR ATTENTION

DS5000 – Key Features

- Flexible interface cards support evolving infrastructures
  - Initial release supports sixteen 4 Gbps FC interfaces
  - Future offerings include 8 Gbps FC and 10 Gbps iSCSI
- 7th-generation architecture delivers sustainable performance, multi-dimensional scalability and unparalleled flexibility
- Balanced performance and linear IOPS scalability supports workloads from transaction-heavy to bandwidth-intensive
- Scalability to 448 FC/SATA drives supports large configurations
  - Initial release supports up to 256 drives
- Fully redundant components, automated I/O path failover and online administration ensures your data is always accessible
- Multiple replication options provide additional data protection and the means to improve data utilization

Industry-Standard, Vendor-Neutral, Benchmarks

The Storage Performance Council (SPC) is a non-profit corporation founded to **define**, **standardize**, and promote storage subsystem benchmarks as well as to disseminate **objective**, **verifiable** performance data to the computer industry and its customers.

SPC Benchmarks Are Relevant To Email & Databases

- SPC Benchmark 1 (SPC-1)
  - "SPC-1 consists of a single workload designed to demonstrate the performance of a storage subsystem while performing the typical functions of business critical applications. Those applications are characterized by predominately random I/O operations and require both queries as well as update operations. Examples of those types of applications include OLTP, database operations, and mail server implementations"
  - SPC members have declared *I/Os can't exceed a 30ms latency ceiling* or they are too slow to be considered real world
    - Response-Time-Throughput-Curves, created during testing, help define latencies under increasing workloads
    - Many application companies, such as MS Exchange, have established *real world latency ceilings at 20ms or less*.
  - As storage system capacities increase it becomes critical latencies decrease in order to support numerous apps and large data sets

SPC Benchmarks Are Relevant To Video & Databases

- SPC Benchmark 2 (SPC-2)
  - SPC-2 consists of three distinct workloads designed to demonstrate the performance of a storage subsystem during the execution of business critical applications that require the large-scale, sequential movement of data. Those applications are characterized predominately by large I/Os organized into one or more concurrent sequential patterns. A description of each of the three SPC-2 workloads is listed below as well as examples of applications characterized by each workload.
    - **Large File Processing:** Applications in a wide range of fields, which require simple sequential process of one or more large files such as scientific computing and large-scale financial processing.
    - **Large Database Queries:** Applications that involve scans or joins of large relational tables, such as those performed for data mining or business intelligence.
    - **Video on Demand:** Applications that provide individualized video entertainment to a community of subscribers by drawing from a digital film library.