HITACHI
DATA SYSTEMS

# Hitachi TagmaStore™ Universal Storage Platform

## Architecture Guide

Partner Beyond Technology

# Executive Summary

## Business Challenges and IT Pain Points

Organizations are facing a number of challenges, which, if not addressed, can threaten their very survival. Some of these challenges are external. Competition is no longer from just the familiar, traditional competitors in your industry; it now can come from anywhere in the world, often leveraging products manufactured at much lower cost with acceptable quality, and it may even come in the form a substitute product from a different industry.

Other challenges are internal—getting products to market faster, reducing manufacturing costs, making the supply chain more efficient, increasing worker productivity, streamlining business processes, maintaining customer relationships, integrating acquired companies, and providing a total customer experience. Further internal challenges have emerged more recently, as government and industry regulations have become more widespread and demanding. Any public company (or company that might ever become public) faces financial (Sarbanes-Oxley, for example) and other regulations that require retention of many documents, e-mail messages, etc., for prolonged period of time. Other regulations (such as Basel II) require business continuity processes and system risk mitigation.

These challenges are addressed through a combination of information technology, based on storage systems, and organizational (people) processes. For many organizations, getting information technology aligned with business objectives is painful. One of the pain points lies in "islands of storage management." Most organizations have storage platforms from a number of different vendors in the data center. Each platform requires its own procedures and expertise, has its own set of management tools and software utilities, data replication engines, and business continuity processes. These platform differences often result in islands of storage management, which cause increased complexity and significant operational inefficiencies due to duplication of skills, training, and operational expense. Because these islands of storage management are not integrated, administrators often have to rely on manually prepared spreadsheets to get a view of the overall enterprise storage environment. In fact, such non-interoperable multivendor storage environments prevent IT executives from achieving breakthrough reductions in storage TCO because cost and operational inefficiencies have become ingrained in storage budgets and no vendor to date has offered a unifying solution.

## Meeting Today's Challenges with Hitachi TagmaStore™ Universal Storage Platform

To directly address these challenges, Hitachi Data Systems announced on September 7, 2004, the breakthrough Hitachi TagmaStore™ Universal Storage Platform, built on a combination of revolutionary advances in hardware and software that radically improve storage operations and management efficiency and make true financial benefits possible. The Universal Storage Platform not only extends the Hitachi leadership position in performance and capacity, but for the first time it also enables multivendor storage virtualization and logical partitioning, plus universal vendor-agnostic data replication, all through a simplified "single pane of glass" common storage management approach.

As a foundation for Application Optimized Storage™ solutions from Hitachi Data Systems, the Universal Storage Platform is a powerful enabler that helps you align IT with business objectives. By employing multivendor storage virtualization capabilities of the Universal Storage Platform, you can deploy a tiered storage strategy that answers new archiving regulations for data retention and implement out-of-region data replication to ensure business continuity. You also can extend the life of your current storage and avoid future capital expenditures, which, depending on your configuration and installed base of storage, can result in as much as a 40 percent reduction in TCO.

There is no need for forklift upgrades or major changes in storage management operations. Rather, the Universal Storage Platform approach simply interconnects your multivendor systems and then manages all enterprise data globally, through a single pane of glass. There is no longer a need for manual spreadsheets to reconcile the islands of storage management or wasted costs of duplicated skills, training, and operational expense.

Does employing the Universal Storage Platform to achieve these benefits result in your company getting locked into Hitachi as a vendor? Not really, thanks to its multivendor approach. The benefits far outweigh the risks:

:: New competitive advantage of aligning IT with business goals

:: New revenue streams through new business agility

:: Lower TCO, improved return on investment (ROI), and reduced risk

The Hitachi Data Systems Global Solution Services organization can help you map out a plan to achieve the full benefits of adopting the Universal Storage Platform.

## Universal Storage Platform—Not Just for the Largest Companies

Although it is being deployed by many of the world's largest enterprises, the Universal Storage Platform also fits the plans and budgets of many smaller companies. These companies are facing the same issues as the larger ones, just on a different scale and, of course, with much smaller staffs. Indeed, among the first customers for the Universal Storage Platform, both Pacific Capital Bancorp and University of Utah Health Sciences Center saw it as a way to consolidate, virtualize, and provide advanced functionality (remote replication, for example) to their islands of midrange storage systems and gain significant financial returns.

This architecture guide provides an overview of the Universal Storage Platform, its breakthrough innovations, components, and features, as well as its models and packaging. In addition, this guide addresses how the Universal Storage Platform rises to meet the business continuity/disaster recovery and simplification challenges of the enterprise. It culminates with a case history of financial and operational benefits gained through implementation of the Universal Storage Platform.

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# Introducing the Hitachi TagmaStore™ Universal Storage Platform

## Redefining the Industry Standard, Once Again

With capabilities generations ahead of any competitive offering, the Hitachi TagmaStore™ Universal Storage Platform establishes a new industry category, which IDC calls Networked Storage Controller. It brings into reality the virtualization of both internal and external heterogeneous storage into one pool of storage that is manageable through a single interface. The Universal Storage Platform is wrapped in a comprehensive set of software and services, including application-centric storage area management and simplified and unified data replication across heterogeneous storage systems.

## A New Paradigm for Storage

The Universal Storage Platform empowers IT executives to look at storage deployment and management in a whole different way. By placing the Universal Storage Platform at the apex of their storage infrastructure and attaching existing storage systems directly or through a storage area network (SAN), CIOs can gain significant savings through radical IT efficiencies of scale. These efficiencies can be achieved through "single-pane-of-glass" management for all storage; implementation of data lifecycle management strategies that allocate data to storage devices according to a variety of criteria, including availability, performance, capacity, and cost; or deploying heterogeneous out-of-region data replication to comply with business continuity requirements.

Today, the Universal Storage Platform can move mainframe data to midrange storage systems— an industry first. In the future, the Universal Storage Platform will be able to underpin applications such as Enterprise Content Management by aggregating all sources of information and protocols across the organization and optimizing the placement of content across all tiers of storage.

*Universal Storage Platform helps you to radically increase efficiencies, simplify management, and better align IT and business objectives.*

"Hitachi Data Systems has delivered on a vision for a new approach for simplifying storage management, improving overall storage efficiency, and implementing data lifecycle management. The Hitachi TagmaStore Universal Storage Platform is a combination of the next-generation enterprise-class storage system and a high-end storage virtualization platform, resulting in a new breed of intelligent networked storage."

— *The Hitachi TagmaStore Universal Storage Platform* (7 September 2004)
   Enterprise Strategy Group

Bringing together industry-leading Hitachi, Ltd., hardware, software, and networking technology, the Universal Storage Platform provides the best features in storage technology available today to solve the problems you are facing from both a strategic and tactical perspective.

*Universal Storage Platform maintains a two-generation lead over the competition.*

1. The Universal Storage Platform is a **new industry category that reaches previously unattainable levels of consolidation and virtualization** of up to 32PB of internal and externally attached heterogeneous storage in one pool with a **unique embedded virtualization layer** (illustrated in Figure 1).

   :: Logically partitioned storage resources **maximize application quality of service (QoS)** and facilitate chargeback and utility-like operations.

**Figure 1. The Universal Storage Platform provides a consistent data management and storage services platform for up to 32PB of internal and externally attached heterogeneous storage.**
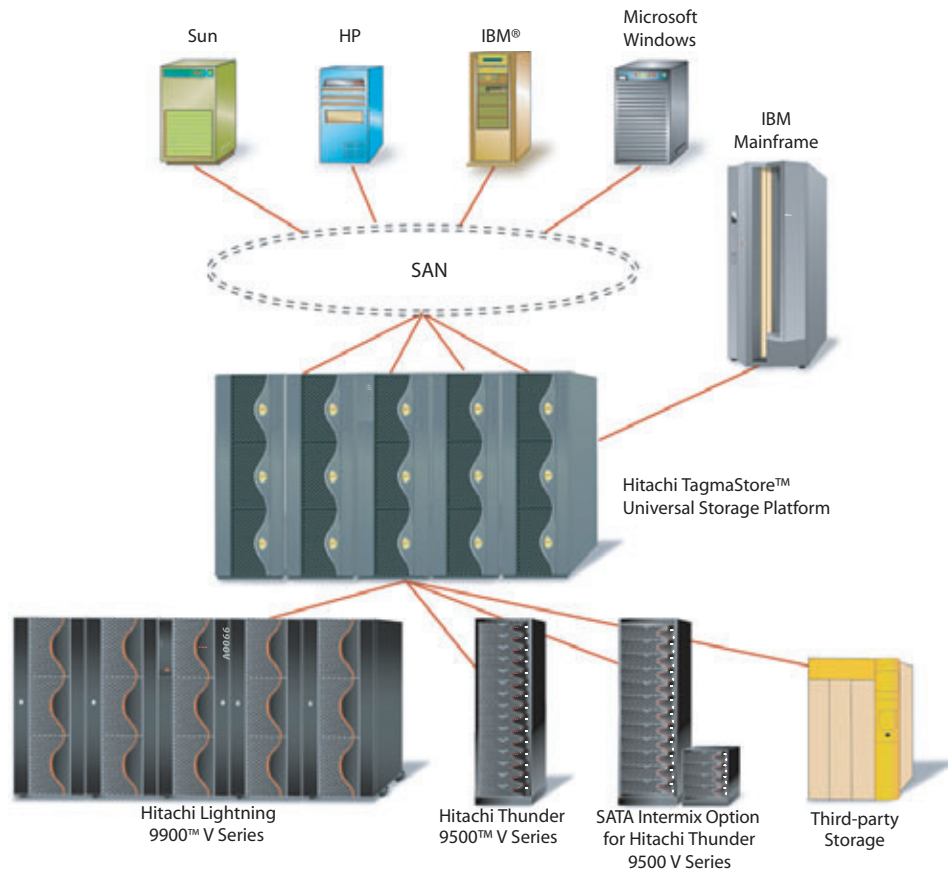


*Advanced software supports storage area management and data replication.*

2. Advanced software supports **application-centric storage area management, simplified heterogeneous data replication,** and the movement of data across tiers of storage to match application requirements.

 :: The Universal Storage Platform provides **unsurpassed high availability** with a sophisticated storage-agnostic remote copy that greatly simplifies business continuity.

 :: The Universal Storage Platform extends the **centralized heterogeneous management** of the Hitachi HiCommand® Storage Area Management Suite with a common set of tools from a single pane of glass.

3. The Universal Storage Platform provides the foundation for a total infrastructure solution powered by **third-generation crossbar switch architecture.**

 :: The mega-scalable crossbar switch architecture delivers an unsurpassed **68GB/sec of cached bandwidth**, and up to 2 million IOPS (input output operations per second), delivering **unmatched performance for all measures of system design.**

 :: Front-end support options include **all major open systems platforms** and IBM® z/OS®-compatible mainframe computers, providing unsurpassed functionality.

 :: The Universal Storage Platform **dramatically increases front-end connectivity** by making available multiple "virtual" Fibre Channel ports, enabling truly **large scale data hyper-consolidation.**

# Universal Storage Platform: Breakthrough Innovation

Several breakthrough hardware innovations from Hitachi, Ltd., enable the Universal Storage Platform to deliver the significant economic and information architecture benefits discussed in this architecture guide.

## Controller-based Virtualization: the Simple and Innovative Hitachi Approach to Storage Virtualization

The objective of storage virtualization is to "melt" groups of heterogeneous storage systems into a common pool of storage resources. This simplifies management, enables increased utilization of storage resources, provides seamless migration across tiers of storage, removes interoperability barriers, and integrates common functionality across this pool of heterogeneous storage.

With the Universal Storage Platform, virtualization is embedded in the Hitachi controller architecture, and it is extended to external storage systems in a way that neither adds complexity nor creates a proprietary lock-in. There are no appliances or application blades in front of the storage, and there is no need to crack the packets and redirect I/O. Additional storage services such as replication and mirroring do not have to impact the core switches and directors. None of that added complexity and resultant latency is needed.

The Universal Storage Platform eclipses all previous attempts at storage virtualization and in dramatic fashion, delivers on a bold vision with immediate business value. Unlike virtualization approaches by other companies, the Hitachi approach does not introduce another layer of complexity between the application server and storage. Further, it does not reside in the Fibre Channel SAN and is not dependent on the SAN for virtualization. Therefore, it is not limited to virtualization of open systems Fibre Channel-based storage. It can support direct-attached Fibre Channel hosts as well as ESCON/FICON-attached mainframes. Mainframe LDEVs can be mapped to lower-cost external ATA or Serial ATA storage.

## Breakthrough Software Innovations

With organizations facing increasingly complex storage infrastructures, the groundbreaking virtualization and universal replication software of the Universal Storage Platform provides centralized management of software suites that enable deployment of many advanced business solutions, including:

:: Business continuity and disaster recovery

:: Consolidation and aggregation

:: Data lifecycle management

:: Corporate governance and compliance

These software suites allow the enterprise to substantially reduce costs and maximize business value.

### Hitachi Universal Volume Manager Software

Through the use of Hitachi Universal Volume Manager software, Hitachi extends its Virtual Storage Ports/Host Storage Domains technology into the first large-scale embedded virtualization layer, enabling up to 32PB of internal and external storage to be aggregated into one common pool and managed by a single set of tools and software. Universal Volume Manager software also allows data replication and migration capabilities across heterogeneous storage systems, while enabling efficient integration and utilization of older storage systems. Combined with Hitachi Volume Migration software (formerly CruiseControl), Universal Volume Manager software enables data lifecycle management across multiple tiers of storage, including the storage of mainframe data on low-cost, SATA-based, midrange storage systems such as the Hitachi Thunder 9500™ V Series systems.

*Controller-based virtualization reduces complexity without impacting performance.*

*32PB of internal and external storage can be aggregated into one common pool.*

### Hitachi Virtual Partition Manager Software

As the first implementation in storage systems of the logical partitioning technology featured in large-scale Hitachi mainframes, Virtual Partition Manager software allocates Universal Storage Platform resources, including ports, cache, and disk (internal and externally attached) into independently managed Private Virtual Storage Machines. Partitions can be dynamically modified to meet application QoS requirements based on changing business and application priorities. With the Universal Storage Platform, you can use Virtual Partition Manager software to create up to 32 Private Virtual Storage Machines. Meanwhile, to the host, each Private Virtual Storage Machine appears as if it were its own storage system and, as such, allows efficient utilization of storage across the platform, enabling chargeback and utility-like operations through a virtual serial number.

### Hitachi Universal Replicator for TagmaStore Universal Storage Platform

Universal Replicator software builds on the success of the asynchronous capabilities of Hitachi TrueCopy™ Remote Replication software and provides a robust business continuity solution that supports both internal and externally attached storage. As it continues to advance the superior Hitachi asynchronous remote replication technology, Universal Replicator software features several industry firsts, including heterogeneous replication, disk-based journaling, protection against link failure, "pull" copying, and multi-data-center support. This ensures enhanced business continuity over any distance and improved IT operations without the need for redundant servers or replication appliances.

### Enhancements to Hitachi Storage Area Management (SAM) Suite Software

With the Hitachi HiCommand® software modules of the Hitachi SAM Suite and the virtualization capabilities of the Universal Storage Platform, administrators finally realize the dream of "single pane" management across the enterprise. Updated versions of HiCommand Storage Services Manager, HiCommand Device Manager, HiCommand Tuning Manager, and the new HiCommand Protection Manager software are available with the Universal Storage Platform. Furthermore, users can standardize on tools such as HiCommand Chargeback software to enable centrally metered storage resource charging and HiCommand Application Modules for optimizing the QoS requirements for Microsoft Exchange, Oracle, Sybase, and File Server applications.

The Hitachi SAM Suite includes heterogeneous HiCommand Application Modules, powered by AppIQ, that are based on open architecture. These modules protect investments by working with almost any storage infrastructure to manage business and application demands. The Hitachi SAM Suite's storage-specific management modules provide granular discovery and control of your Hitachi storage environment, including attached storage systems that are virtualized into the storage pool of the Universal Storage Platform.

### Powered by the Hitachi Universal Star Network™ Massively Parallel Crossbar Switch

To perform as much as 32PB of storage virtualization, move data among storage tiers, and enable heterogeneous replication requires a powerful system with the highest performance in the industry. The Universal Storage Platform delivers with the Hitachi Universal Star Network™ the third generation of patented Hitachi "non-blocking" mega-scalable crossbar switch architecture. The Universal Star Network is a radically enhanced version of the Hi-Star™ architecture in the Hitachi Lightning 9900™ V Series enterprise storage systems, delivering four times the internal processing power and bandwidth of the Lightning 9900 V Series systems, which previously led the competition by a wide margin.

The Universal Star Network is a massively parallel crossbar switch processing engine implemented in industry-leading VLSI silicon chips. It delivers an unsurpassed 68GB/sec of cached bandwidth, and 2 million IOPS while performing 256 concurrent memory operations and supporting 332TB of internal storage capacity. This represents advantages in the 400 percent to 850 percent range compared to other storage products.

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*Ports, cache, and disk can be independently managed in up to 32 Private Virtual Storage Machines.*

*Industry firsts include heterogeneous replication, disk-based journaling, protection against link failure, "pull" copying, and multi-data-center support.*

*AppIQ-powered HiCommand® modules enable application-centric management.*

*A mega-scalable crossbar switch delivers 68GB/sec of cached bandwidth.*

# Universal Storage Platform Models

The Universal Storage Platform is offered in three seamlessly upgradable packages: entry-level model USP100, enhanced model USP600, and high-end model USP1100. Model USP1100 is recommended for users requiring large storage capacities of up to 332TB of raw storage in one system and the ability to virtualize and consolidate up to 32PB of heterogeneous storage in one pool. With the same advanced architecture, model USP100 and model USP600 bridge the gap between standard midrange and advanced-function storage, with capacities up to 74TB and 148TB, respectively. Model USP100 is recommended for users who require advanced-function capabilities of premium storage, yet do not need the actual storage capacity of models UPS600 and USP1100. Table 1 compares key differences of the three new Universal Storage Platform models.

**Table 1. Comparison of the characteristics of the three Universal Storage Platform models.**

| Characteristics | USP1100 High-end Model | USP600 Enhanced Model | USP100 Entry-level Model |
|---|---|---|---|
| Connectivity/Virtualization of External Storage Systems | Yes | Yes | Yes |
| Logical Partitioning | Yes | Yes | Yes |
| Private Virtual Storage Machines | 32 | 32 | 32 |
| Hitachi Universal Star Network™ Crossbar Switch Architecture | Yes | Yes | Yes |
| Maximum Internal Concurrent Bandwidth | 81GB/sec | 40.5GB/sec | 23.5GB/sec |
| Number of Cabinets | 1–5 | 1–2 | 1 |
| Number of Disks | 129–1152 | 64–512 | 5–256 |
| Maximum Internal Raw Capacity | 332TB | 148TB | 74TB |
| Maximum External Raw Capacity | 32PB | 32PB | 32PB |
| Maximum Data Cache Capacity | 128GB | 64GB | 64GB |
| Percentage of Internal Memory Available for Data | 100 | 100 | 100 |
| Maximum Control Memory | 6GB | 6GB | 6GB |
| Maximum Number of LUNs | 16,384 | 16,384 | 16,384 |
| Physical Ports | 0–192 | 0–192 | 0–128 |
| Virtual Ports | Up to 32, 728 | Up to 24,576 | Up to 16,384 |
| Fibre Channel, ESCON, FICON, iSCSI, NAS | Yes | Yes | Yes |
| Nondisruptive Upgrades | Yes | Yes | Yes |
| Hi-Track® "Call Home" Service/Remote Maintenance Tool Support Package | Standard | Standard | Standard |

*From entry-level to the high-end, there is simply no comparison.*

Selecting the right model of the Universal Storage Platform depends on capacity requirements, including expected growth of data, performance, and connectivity requirements, such as external storage support. The Universal Storage Platform offers storage system alternatives that cover a very broad range of scalability, as illustrated in Figure 2.

**Figure 2. Entry-level model USP100 provides for managed growth and open systems exploitation while the enhanced model USP600 and the high-end model USP1100 provide for exploding growth and data hyper-consolidation.**

**Removing the Barriers to Scalability**



Model USP1100 Growth Limit

Model USP600 Growth Limit

Model USP100 Growth Limit

Rapid Business Growth and Consolidations

332.0TB

148.0TB

74.0TB

Managed Growth and Open Exploitation

USP1100

USP600

USP100

Raw Capacity in GB

**Hitachi TagmaStore™ Universal Storage Platform**
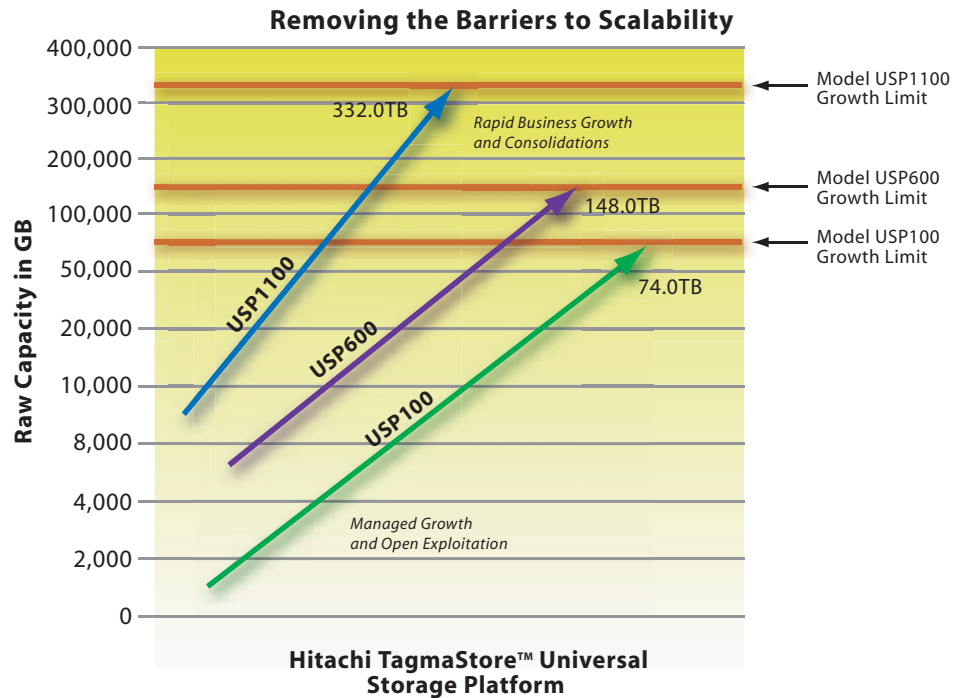
## Answer Challenges with Application Optimized Storage™ Solutions Based on the Universal Storage Platform

The Universal Storage Platform provides the architectural foundation not only for simplification, but also for Application Optimized Storage™ solutions from Hitachi Data Systems, which match business application performance and business continuity/disaster recovery requirements to different classes of storage. The Universal Storage Platform enables enterprises to deploy applications within an Application Optimized Storage solutions framework and fully leverages and adds value to current investments, aligning IT and business objectives. As shown in Figure 3, this is accomplished by leveraging the unique Hitachi approach to storage virtualization and logical partitioning.

*Application Optimized Storage solutions closely align IT and business objectives.*

**Figure 3. Application Optimized Storage solutions—a framework for aligning IT and business objectives.**

| Business Operations | | Services and Best Practices |
|---|---|---|
| Application Services | **Performance, Chargeback, Provisioning, Problem Management** | |
| Content Services | **Archiving, Indexing, Search, Retrieve** | |
| Data Services | **Backup, Migration, Replication, Security** | |
| Storage Services | **Multitier Capacity, Universal Connectivity, Heterogeneous Management** | |

Complete solutions depend on many variables, including hardware design, connectivity infrastructure, and application, storage management, and business continuity software, as well as operators and services, whether outsourced or in house. The Universal Storage Platform is more than just breakthrough hardware and software innovations. It is wrapped in industry-leading software and service solution sets that address the top two business problems facing the enterprise today—business continuity/disaster recovery and simplification—as shown in Table 2.

**Table 2. The Universal Storage Platform comprehensively solves the top two business problems facing the enterprise today.**

| Business Solution | Solution Category | Solution Elements | Storage Challenges Addressed |
|---|---|---|---|
| **Business Continuity/ Disaster Recovery** | System Design | Hitachi Universal Star Network™ massively parallel crossbar switch; redundant, hot-swappable components; global dynamic hot sparing; mirrored write cache with battery backup; Hitachi nondisruptive microcode upgrades; RAID-1+ and RAID-5 for data protection; Hi-Track® "call-home" service/remote maintenance tool | Internal processing power, bandwidth, high transaction rate, fault tolerance |
| | Disk-to-disk Backup<br><br>Application Backup/ Recovery<br><br>Mainframe Tape Replacement<br><br>In-region Local Disaster Recovery<br><br>In-region Metro Disaster Recovery<br><br>Out-of-region Disaster Recovery<br><br>IBM® GDPS™ Support | Remote replication/disaster recovery: Hitachi TrueCopy™ Remote Replication and Hitachi Universal Replicator software; Hitachi Compatible Replication for IBM XRC software; Hitachi ShadowImage™ In-System Replication software; Hitachi Serverless Backup Enabler software; Compatible Mirroring for IBM FlashCopy® software; and Hitachi Dynamic Link Manager™ software | Disaster recovery, data replication, application availability, risk management, service level agreements (SLAs), data protection, performance, QoS |
| | Regulatory Compliance | Message Archive for E-mail, Message Archive for Compliance | Regulatory requirements, document archiving, audit trails, disaster recovery |
| | Services | Risk Analysis Workshop, Hitachi SplitSecond™ Solutions, Remote Copy Planning and Design Services, Continuity Software Services | Total cost of ownership (TCO), return on investment (ROI), risk management, business continuity planning, outsourcing |
| **Simplification** | Common Storage Area Management (SAM) | Hitachi SAM Suite, Hitachi TagmaStore™ Universal Storage Platform external and internal storage virtualization | Explosive data growth; fast-moving technology and business landscape; management of heterogeneous environments; complex and costly management infrastructure; failure to meet application QoS and SLAs |
| | Open and Mainframe: Consolidation, Aggregation, and Virtualization | Hitachi Universal Volume Manager, Hitachi Virtual Partition Manager, and Hitachi Volume Migration (formerly CruiseControl) software; Hitachi Cross-System Copy software (formerly HiCopy); Host Storage Domains | Consolidation, manageability of storage and assets, data growth, integration, migration, and file services |
| | Services | Storage Consolidation Services, External Storage Implementation Service, Storage Economics Strategy Service | TCO, ROI, consulting |

Global Solution Services and Best Practices for the Universal Storage Platform

To ensure that you maximize your investment, Hitachi Data Systems offers a comprehensive suite of technology, storage, education, and professional services and best practices for implementation of Universal Storage Platform and Application Optimized Storage solutions. These are shown in Figure 4.

**Figure 4. Hitachi Data Systems Global Solution Services offerings.**
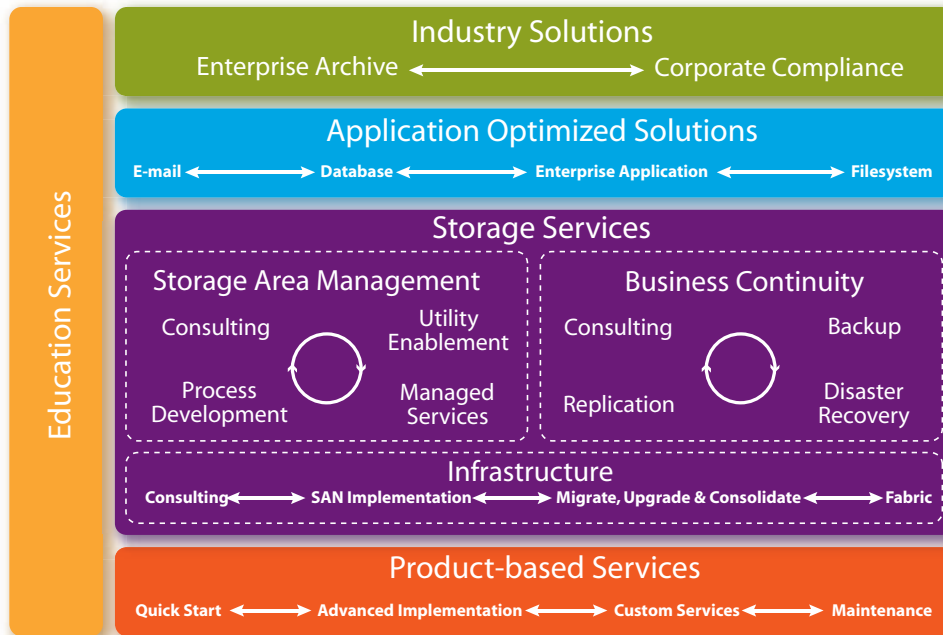


Global Solution Services consultants can help you plan, design, implement, integrate, manage, and optimize storage infrastructure solutions that meet your needs. Areas in which Global Solution Services consultants can assist you include:

**Industry Solutions**—including enterprise content archival solutions that incorporate hardware, software, and professional services to address your business and regulatory compliance requirements

**Application Optimized Solutions**—bridging the gap between business applications and IT's ability to precisely deliver service levels with Global Solution Services strategic consulting, design integration, and robust deployment capabilities

**Storage Services**—applying proven best practices along with appropriate tools and training to help with all stages of your storage infrastructure—from planning to maintenance

**Product-based Services**—providing implementation, simplification, and optimized ROI and TCO for Hitachi Data Systems and select third-party products

**Education Services**—helping you to improve your staff efficacy and efficiency in implementing and supporting multivendor storage solutions

*The Hitachi Data Systems Global Solution Services group offers a comprehensive suite of technology, storage, education, and professional services.*

# Hitachi Controller-based Storage Virtualization

## Storage Virtualization Defined

Virtualization is a technique that has been used for many years to mask complexity, enable new functionality, and drive improvements in performance, connectivity, capacity, and availability. Although the meaning of the phrase varies from speaker to speaker, the Enterprise Strategy Group defines virtualization as "a technology that gathers data location information from physical storage devices, network services, and applications, and then abstracts the locations into logical views for end users." The Storage Networking Industry Association (SNIA) dictionary defines virtualization as "an act of integrating one or more (back-end) services or functions with additional (front-end) functionality for the purpose of providing useful abstractions. Typically, virtualization hides some of the back-end complexity, or adds or integrates new functionality with existing back-end services." Essentially, virtualization is the abstraction of the logical view of storage from the physical layout. The benefit, of course, is ease of management.

The Hitachi TagmaStore™ Universal Storage Platform fulfills this definition and provides simplified management of virtual assets in a way that no other product can match in terms of completeness of vision and ability to execute. Driven by the demand for data hyper-consolidation, Hitachi consolidation and virtualization software has evolved through a number of technology firsts, including LDEV, Host Storage Domains, and finally to the leading-edge approach to storage virtualization employed by the Universal Storage Platform.

*No other vendor can match Hitachi consolidation and virtualization solutions in terms of completeness of vision and ease of execution.*

## Approaches to Storage Virtualization

Storage virtualization, which has been the "Holy Grail" for storage management, first began with host-based software schemes. With the increasing adoption of SANs, many vendors introduced storage virtualization solutions that resided as an appliance or switch blade in the SAN. The industry has also seen some attempts at virtualization[1] via dedicated, add-on appliances or through server- or switch-hosted virtualization software that sits in the data stream between client systems and storage.

### Host-based Virtualization

Storage virtualization in the host has been around for some time. Initially, it amounted to abstracting the application view of a "volume" from the physical target and LUN addressing that was seen by the host interface. A class of software known as volume managers provides this type of virtualization. Additional functions, such as snapshots, mirroring, and replication have been added by the volume manager vendors. Volume managers were originally developed during the direct-attach era and were not necessarily SAN-aware. While some functions like replication could be completed between heterogeneous devices, virtual volumes were generally limited to one type of storage device per volume. The disadvantages of host-based virtualization are that it requires host cycles and is limited to the host in which the volume manager resides. Volume managers are also specific to a host platform, and are often embedded in the host software.

*Host-based virtualization requires host cycles and is limited to the host in which the volume manager resides.*

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[1] For a definitive technical economic discussion of the pros and cons of different approaches to virtualization and the evolution of the Hitachi approach, see the white paper "Hitachi TagmaStore™ Universal Storage Platform: Virtualization without Limits." This paper is authored by Naoya Takahashi, Ph.D., Chief Operating Officer Information & Telecommunication Systems at Hitachi, Ltd., and Hu Yoshida, Vice President and Chief Technology Officer at Hitachi Data Systems, and can be found on the Hitachi Data Systems Web site at: http://www.hds.com/pdf/wp168_tagmastore_virtualization.pdf#view=FitH&pagemode=bookmarks

## Network-based: Appliance-based or Switch-based Virtualization

Over the last four to five years a number of SAN-based virtualization products have been introduced in the market. The arguments for in-band versus out-of-band appliances or intelligent switch blades have waged back and forth with religious fervor. However, instead of reducing complexity they have added another layer of complexity into the core of the storage network. Functionality, which was being accomplished on the edge of the network by storage controllers, was then reinvented for implementation in the core of the SAN. Everyone connected to the SAN feels the resulting latency from the overhead of this functionality.

Intelligence in the SAN is important. However, it can only be useful if it has access to the right information. An appliance or switch blade residing in the core of the network does not have information about the I/O intent of the host application or the placement of data in the storage system. This information is obtained by intercepting and redirecting the I/O, which violates the integrity of the original I/O request. However, this information is directly available to the storage controller, which is the intended recipient of the host I/O. In addition, end-to-end security protocols, such as IPSEC and ESP, do not tolerate proxies (virtualization intelligence) in between the end points (host and storage).

Note that these approaches haven't gained much momentum. These solutions were offered as a panacea to help administrators cope with accelerating storage capacity demand and the increasingly complex storage infrastructure, while also reducing costs. However, the network-based storage virtualization approaches and the products developed and marketed up to now have not satisfied the needs of organizations. They are limited in scalability and robustness, and introduce yet another layer of complexity into the data path, which results in increased network congestion, increased availability exposures, and higher costs.

## Controller-based: "In-the-box" Virtualization

Other vendors introduced in-the-box (storage box) solutions, which present a proprietary pool of blocks that can be assembled into logical units. While in-the-box solutions provide some advantages in ease of configuration, they do not provide a multitier pool of storage, and they introduce new challenges for integrity and QoS. Fragmentation of the data space also adds housekeeping complexity. In-the-box solutions do not work well with applications like databases, which control their own address space. Moreover, other controller-based solutions do not provide heterogeneous vendor support, limiting their virtualization capabilities and "locking-in" customers to that one vendor. None of these approaches, SAN-based appliances/switches or in-the-box solutions, can provide the scalability and flexibility to meet current and future storage growth. As a result, while there have been a plethora of storage virtualization offerings, none of them have earned significant market acceptance.

## The Hitachi Approach: Controller-based External Virtualization

The implementation of storage virtualization by Hitachi, Ltd., in the Universal Storage Platform is through an intelligent controller and combines the strengths of both network-based and controller-based virtualization. The arguments for in-band versus out-of-band solutions, or appliances versus intelligent switch blades, are no longer relevant. While the Universal Storage Platform leverages the connectivity provided by SANs, it also supports direct-attached open systems and mainframe hosts. As an intelligent storage controller, the Universal Storage Platform has direct access to information regarding the origin and destination of I/Os. It is, therefore, optimally positioned to support storage and data virtualization residing on the edge of the network. This approach offloads resource-intensive functions like mirroring and replication to the edge of the network, where they belong. It also avoids adding latency to every I/O that is routed through the network, which occurs with network-based approaches.

While the Universal Storage Platform has increased host connectivity by orders of magnitude with its virtual host ports, it is not a replacement for intelligent switches. Intelligent switches are best suited for routing and management of the SAN. Intelligent switches process routing information and monitor the health and performance of the network, providing valuable services like credit buffer decongestion and virtual SANs for resilience. The Universal Storage Platform works in concert with intelligent switches to ensure availability, QoS, and security of the storage network. Furthermore, the Universal Storage Platform provides the scalable hardware and software solutions to meet current and future storage and data requirements with a simple, evolutionary approach to virtualization that is unlike any other in the industry. The Hitachi controller-based external virtualization approach is compared to host-based and network-based approaches in Figure 5.

*The Hitachi approach offloads resource-intensive functions to the edge of the network.*

**Figure 5. The Hitachi approach to storage virtualization with the Universal Storage Platform: controller-based and at the edge of the network, closest to the data.**



With New Concept
:: Value add for existing storage devices
:: Latest software functions for all devices
:: Latest host connectivity
:: Seamless LUN management and operations
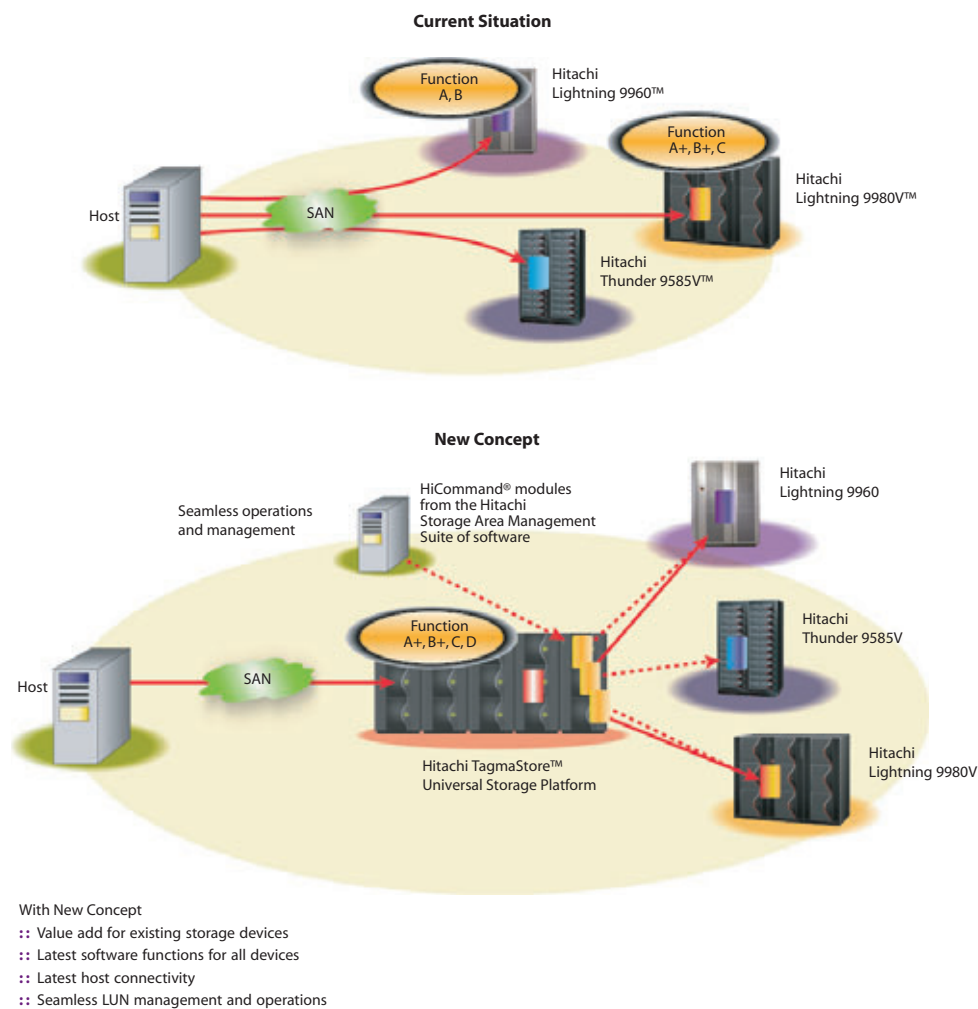
## The Evolution of Virtualization at Hitachi

Recognizing the cost benefits of consolidation during the economic downturn that followed the dot com bust, Hitachi enhanced Lightning family storage with port virtualization. This provided greater connectivity, safe multitenancy, and the ability to prioritize access so that multiple applications or users could share the costs of the same storage resources and still be guaranteed that no one else could see or modify their data. The result was the Hitachi Lightning 9900™ V Series enterprise storage systems, introduced in May 2002, which enabled each physical Fibre Channel port to support up to 128 virtual ports for increased connectivity. Each virtual port could also be assigned its own Host Storage Domain for safe multitenancy. This ensured that users of different virtual storage ports could not access each other's address space even though they shared the same physical storage port. The dual-controller Hitachi Thunder 9500™ V Series modular storage systems were also enhanced with this capability.

Virtual storage ports, available in the Universal Storage Platform as well as the Lightning 9900 V Series and Thunder 9500 V Series storage systems, enable each Fibre Channel physical port to support 128 heterogeneous open systems servers as shown in Figure 6. Each server has its own secure storage partition and bootable LUN 0 through Host Storage Domains. This capability simplifies the storage network infrastructure, eases management, and enables large-scale consolidation, resulting in lower data center TCO.

*Virtual Ports/Host Storage Domains, a step in the evolution of Hitachi controller-based virtualization, offer safe multitenancy for heterogeneous open systems connected to the same physical port.*

**Figure 6. The Universal Storage Platform enables each Fibre Channel port to support 1,024 virtual ports, or up to 32,728 virtual ports in a fully configured model USP1100.**
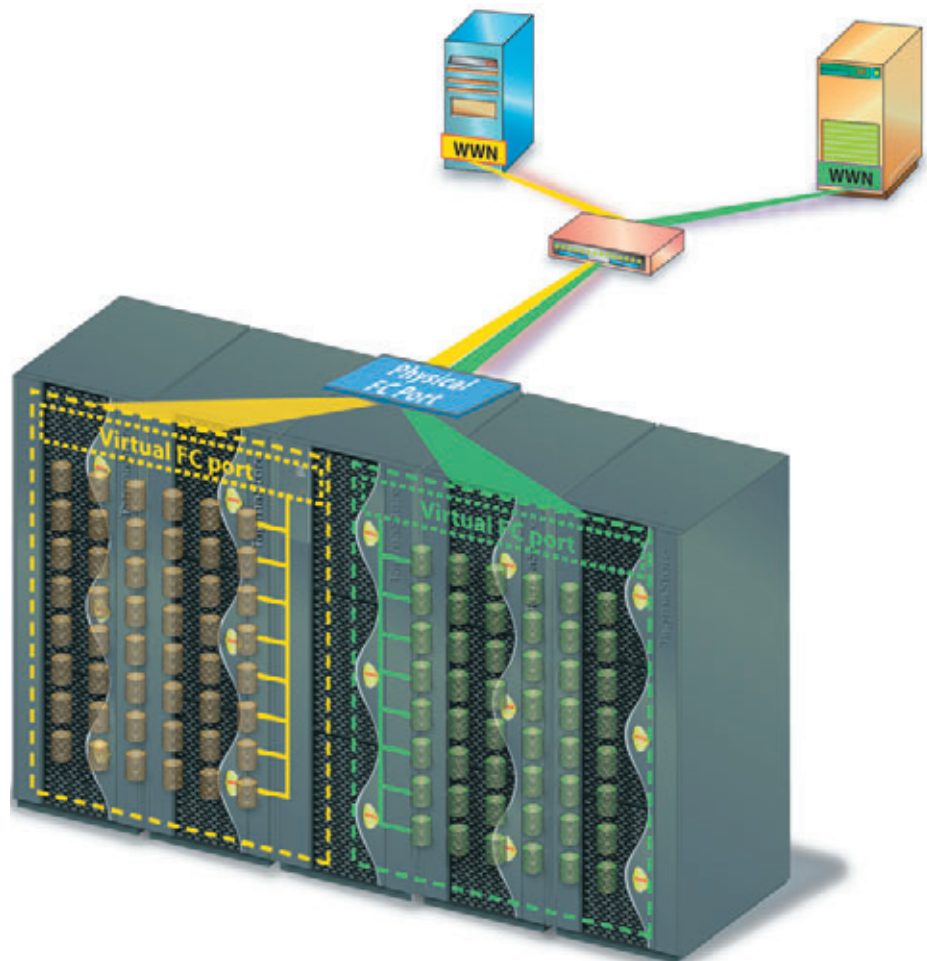
# Hitachi Combines the Strengths of Other Approaches

The Hitachi approach eclipses all previous attempts at storage virtualization, and, in dramatic fashion, delivers on a bold vision that provides immediate business value. Unlike other virtualization approaches, the Hitachi design does not introduce another layer of complexity between the application server and storage. Since it does not reside in the Fibre Channel SAN it is not dependent on the SAN for virtualization. Therefore, it is not limited to virtualization of open systems Fibre Channel-based storage but rather can support direct-attached Fibre Channel hosts as well as ESCON/FICON-attached mainframes.

In direct-attached configurations where SANs have not yet been implemented, open systems and mainframe hosts can attach directly to 192 Fibre Channel ports or 48 FICON ports as a first step toward implementation of a SAN. As the configurations grow, SAN switches and directors can be added for routing efficiency, fanning in to the larger number of virtual ports on the Universal Storage Platform, and fanning out to attach external storage systems. With external storage virtualization, mainframes are no longer limited to high-end storage. Mainframe LDEVs can now be mapped to lower-cost external SATA storage, further reducing TCO.

With the Universal Storage Platform, virtualization is managed in the Hitachi console resident and Universal Storage Platform resident software, and it can now be extended to external storage systems in a way that neither adds complexity nor creates a proprietary lock-in as with competitive virtualization solutions. The applications are connected directly to a cache image in the Universal Storage Platform. There are no appliances or application blades sitting in front of the storage. There is no performance degradation from cracking open network transmission packets, reading them, and then redirecting I/O as is common for fabric-based virtualization approaches. Additional storage services such as replication and mirroring do not have to impact the core switches and directors. None of that added complexity and resultant latency is needed.

Also, unlike in-the-box virtualization approaches, the Hitachi virtualization solution does not require a proprietary data format. The data stays in the format of the external device. If you want to go back to native attachment of the external device for open systems, you do not have to reformat the data. However, going back to native attach means losing all the considerable functionality of the Universal Storage Platform controller. These capabilities include access to a high-speed global cache and advanced software, such as Hitachi ShadowImage™ In-System Replication, Hitachi TrueCopy™ Remote Replication, Hitachi Volume Migration (formerly CruiseControl), Hitachi Universal Replicator, and Hitachi Data Retention Utility (formerly Open LDEV Guard) software.

The virtualization in a Universal Storage Platform extends the innovative Hitachi port-virtualization technology to all enterprise storage assets. The ultimate goal is the abstraction of physical storage systems as Private Virtual Storage Machines, including ports and cache for each client (application, server, or group of users), in order to assure QoS and to shield your organization from the complications of sharing storage. Having virtualization in the storage fabric (as opposed to the network fabric) improves performance through tight integration with physical storage operations (including cache allocation), and creates an optimal balance of economy and functionality. You can have the same confidence in the availability and scalability of the breakthrough virtualization solution as current Hitachi Data Systems customers have in Hitachi high-end storage architecture. In fact, the Hitachi virtualization approach simplifies your environment, rather than adding questions about scalability, a single point of failure, and another layer of complexity.

*The Hitachi design does not introduce another layer of complexity between the application server and storage.*

*With external storage virtualization, mainframes are no longer limited to high-end storage.*

*Logical partitioning assures application QoS and enables a utility storage model.*

## Hitachi Storage Virtualization Enables Many Financial Benefits

All vendors will tell you that their storage solutions reduce TCO and create high ROI. In almost all cases their financial benefits story depends on storage virtualization. There is no doubt that storage virtualization enables data consolidation and simplification and is probably the most important technology in generating real financial returns for storage investments. As you compare Hitachi virtualization and competitive solutions, you will see that no vendor offers a storage virtualization architecture on the scale and scope of the Hitachi solution, and no vendor offers virtualization benefits to all your storage assets. Virtualization is the umbrella concept to keep in mind when evaluating storage hardware, software, and services TCO and ROI. You will quickly see that whatever financial justification area you are looking at, the Hitachi architecture offers significantly more financial return due to the key virtualization enabler.

*Hitachi virtualization offers significant financial return.*

Continued business uncertainty has IT wary and looking to extend the life of and maximize returns on previous investments rather than strike out in new and unproven directions. One of the unintended results of this stance is that IT may see some of the very technologies that could best help them deal with these challenges as too risky. A good example is storage virtualization. IT clearly has to reduce storage complexity to cope with rising volumes of data on multiple tiers and brands of storage. But enterprises hesitate to insert an unproven virtualization platform into the data stream that delivers the lifeblood of the organization. Some even think that virtualization needs to become more mainstream before it can have a real impact on solving the complexity problem. However, effective virtualization has arrived in the Universal Storage Platform.

Whether IT administrators are looking for ways to mask the management complexity of existing networked storage environments or scaling their environments to address dramatic growth, Hitachi storage virtualization technology is the key differentiator. At a time in which technology lifecycles are shorter than capitalization rates, the breakthrough Hitachi virtualization approach enables new functionality to be mapped across older assets to optimize the benefits of simplified common management for multivendor storage. The University of Utah Health Sciences Center in Salt Lake City, Utah, experienced these benefits in their recent implementation of the Universal Storage Platform. Extreme growth and the resulting heightened storage access rate challenged the Center's SAN islands and underutilized storage. The Universal Storage Platform eliminated the waste cost of stranded disk space with increased disk utilization, aligned storage in tiers, and reduced risk of outages. (See "An ROI Case History of Virtual Architecture Justification," in Chapter 7 and Appendix A for more details.)

*The Hitachi virtualization approach extends the life of previous generation storage systems.*

In summary, virtualization provides tremendous flexibility. It:

:: Enables better utilization, allocation, and adjustment of resources (no "islands of storage") efficiently, effectively

:: Frees businesses from being constrained by physical limits of storage

:: Allows businesses to match technology to business requirements, rather than the other way around

# Hitachi TagmaStore™ Universal Storage Platform Is Available in Three Models

## Universal Storage Platform Packaging

The Hitachi TagmaStore™ Universal Storage Platform is available in a one-to-five cabinet configuration depending on capacity, performance, and connectivity needs. Starting with the model USP100 entry-level configuration, you can easily upgrade to the largest configuration by adding power supplies, battery modules, control logic, and additional cabinets with disk modules. An integrated Control/Array Frame serves as both the basic model USP100 and as the control center of models USP600 and USP1100. The control logic modules manage up to four Array Frames that are connected via high-speed Fibre Channel links. A fully configured model USP1100 is contained in five cabinets.

*All models are upgradable and based on common modules.*

### USP1100—High-end Model

:: Maximum internal raw capacity of 332TB and up to 1,152 disk drives with the capability to manage a maximum external raw capacity of 32PB

:: 68GB/sec of cache bandwidth; 13GB/sec of control bandwidth

:: Up to 128GB of Data Cache; 6GB of Control Memory

:: Four crossbar switches; 64 data paths; 192 control paths

:: Up to 192 physical Fibre Channel ports and 32,728 virtual storage ports for open systems and attached storage connectivity

:: Up to 48 FICON, 96 ESCON ports for mainframe connectivity

:: Up to 4 NAS Blades

**Figure 7. Universal Storage Platform model USP1100.**



*The high-end model USP1100 provides up to 332TB internal raw capacity with 1,152 disk drives.*

## USP1100 Control Frame

The Control Frame of model USP1100 contains the Service Processor (SVP), front-end directors, back-end directors, Cache Switch Modules, Data Cache Expansion Modules, Control Memory Modules, Hard Disk Drive Modules, power supplies, battery modules, and cooling fans. An illustration of the Control Frame is shown in Figure 8.

**Figure 8. Universal Storage Platform model USP1100 Control Frame with its major components.**
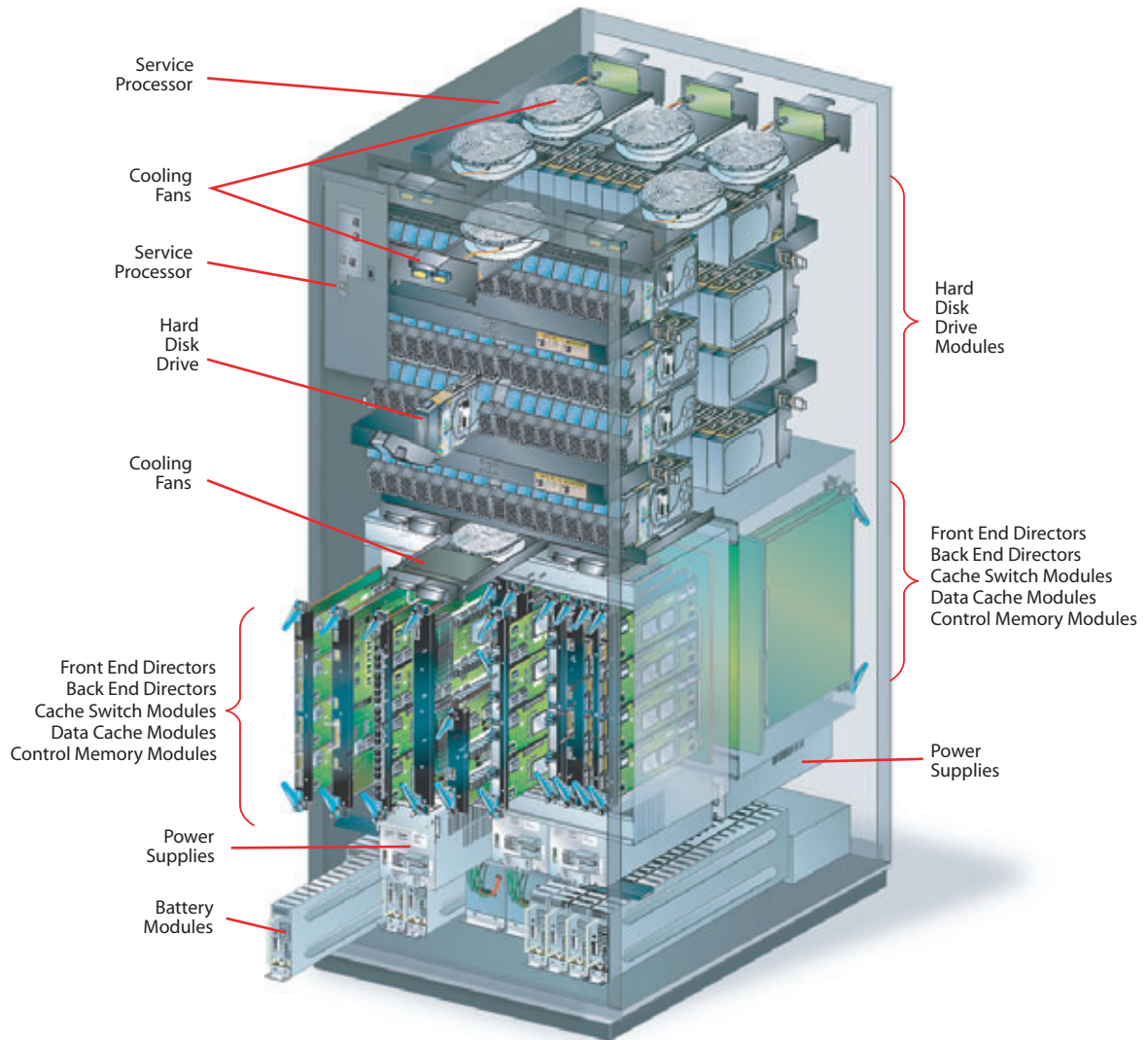
## USP1100 Array Frame

Each array frame of model USP1100 contains the Hard Disk Drive Modules, power supplies, battery modules, and cooling fans, plus communication interfaces to the Control Frame. An Array Frame is shown in Figure 9.

**Figure 9. Universal Storage Platform model USP1100 Array Frame with its major components.**

### USP600—Enhanced Model

:: Maximum internal raw capacity of 148TB and up to 512 disk drives with the capacity to manage a maximum external raw capacity of 32PB

:: 34GB/sec of cache bandwidth; 6.5GB/sec of control bandwidth

:: Up to 64GB of Data Cache; 6GB Control Memory

:: Four crossbar switches; 64 data paths; 192 control paths

:: Up to 192 physical Fibre Channel ports and 24,576 virtual storage ports for open systems and attached storage connectivity

:: Up to 48 FICON, 96 ESCON ports for mainframe connectivity

:: Up to 4 NAS Blades

*The enhanced model USP600 provides up to 148TB internal raw capacity with 512 disk drives.*

**Figure 10. Universal Storage Platform models USP600 and USP100.**
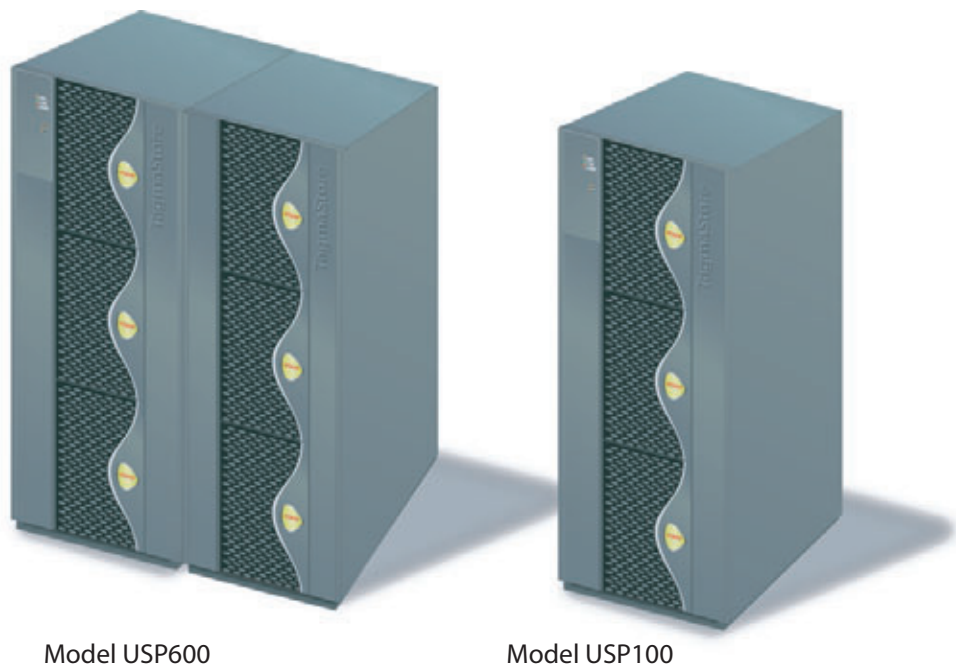


Model USP600                    Model USP100

## USP100—Entry-level Model

::  Maximum internal raw capacity of 74TB and up to 256 disk drives with the capacity to manage a maximum external raw capacity of 32PB

::  17GB/sec of cache bandwidth; 6.5GB/sec of control bandwidth

::  Up to 64GB of Data Cache; 6GB Control Memory

::  Two crossbar switches; 16 data paths; 16 control paths

::  Up to 128 physical Fibre Channel ports and 16,384 virtual storage ports for open systems and attached storage connectivity

::  Up to 32 FICON, 64 ESCON for mainframe connectivity

::  Up to 4 NAS Blades

*The entry-level model USP100 provides up to 74TB internal raw capacity with 256 disk drives.*

Model USP100 is a single-cabinet storage system that can be upgraded by adding as many as four Array Frames. Model USP100 is targeted for IT environments where floor space is a premium and data growth is limited, yet where premium storage functionality, virtualization, and universal replication is required. From the front, model USP100 looks very much like the Control Frame of model USP1100 but with fewer power supplies and battery modules, as shown in Figure 11.

**Figure 11. Universal Storage Platform model USP100 with its major components.**
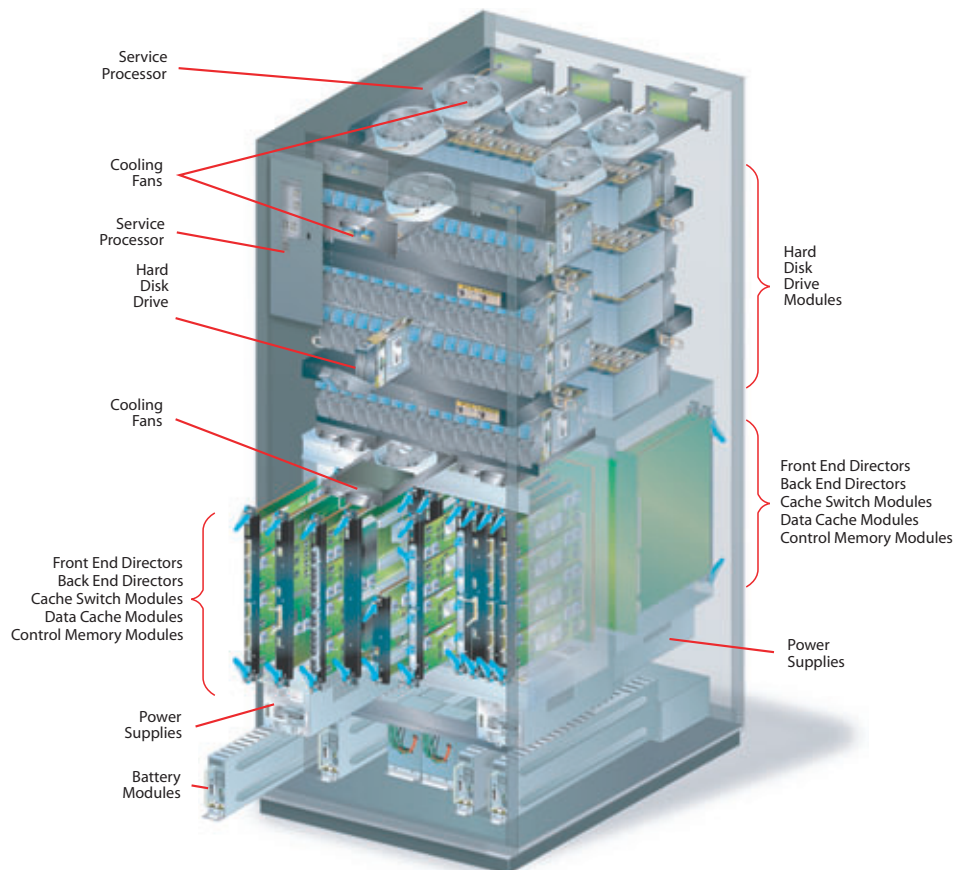
## Power Subsystem of the Universal Storage Platform

The Universal Storage Platform power subsystem consists of redundant power supplies in both Control Frames and Array Frames. The power supplies are both hot-pluggable and hot-swappable, as well as N+1 redundant. This means they can be removed or installed during system operation and that if a power supply fails during operation, the failed power can be dynamically removed without any loss to system operation. The Universal Storage Platform power supply modules are shown in Figure 12.

*All power supplies are both hot-pluggable and hot-swappable.*

**Figure 12. Power supply modules for the Universal Storage Platform.**



Backup
Module

Power Supply
Module
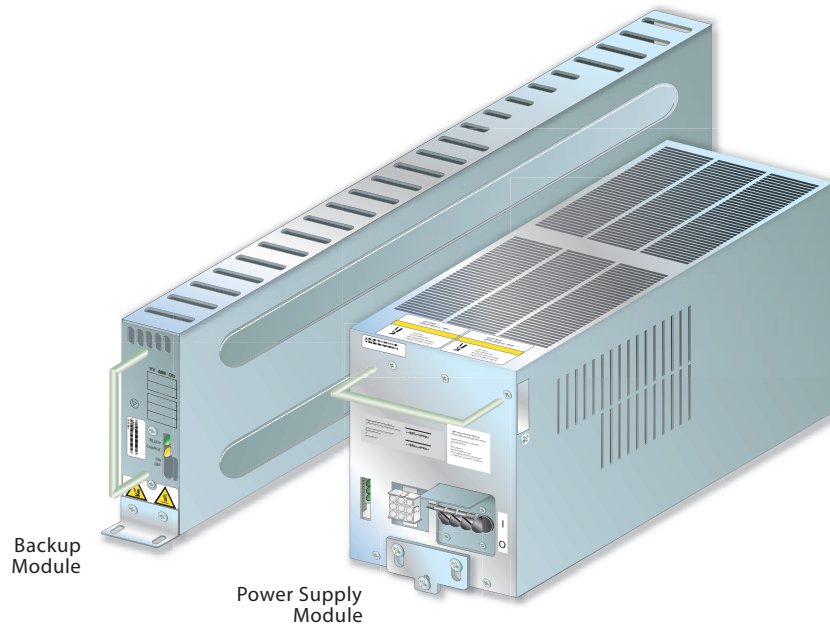
Cables carry 48-volt main system power from the back of the Control Frame and Array Frame where the power is converted to the required voltages. Different AC power cord options allow all Universal Storage Platform models to connect with the different electrical outlet configurations used around the world. This design allows for efficient centralized and consolidated storage, resulting in reduced management costs and lower overall data center TCO.

## The System Monitoring Network of the Universal Storage Platform

*The system monitoring network features failure alerts and "call home" service.*

The Universal Storage Platform is designed with a system-monitoring network. The system-monitoring cables are connected to all cabinets in the Universal Storage Platform, and they report a variety of system parameters, such as component failure, fan speed, power, voltages, and temperature, to ensure trouble-free operation. This network not only provides for efficient predictive maintenance (replacing a component before it fails), but also for the failure alert system to expedite system repair after a component has failed. This information is passed to the Control Frame, where it can be viewed either locally by the Service Processor or remotely across a private LAN on a UNIX or Microsoft Windows NT console. Users can view failure information via SNMP or x/Series SIMs. System status and alerts are also sent to Hitachi Data Systems Customer Support Centers via the Hi-Track® "call-home" service/remote maintenance tool.

# Hitachi TagmaStore™ Universal Storage Platform Components and Features

## An Overview

The Hitachi TagmaStore™ Universal Storage Platform, the most powerful and intelligent enterprise storage system in the industry today, is based on the Hitachi Universal Star Network™, a third-generation implementation of the massively parallel crossbar switch architecture first introduced in the Hitachi Lightning 9900™ Series enterprise storage systems. With this architecture as its engine (see Figure 13), the Universal Storage Platform delivers up to 2 million IOPS, a 500 percent advantage over other storage systems in the market.

*The Universal Storage Platform is the most powerful and intelligent enterprise storage system in the industry today.*

**Figure 13. The Universal Storage Platform is based on a breakthrough VLSI massively parallel crossbar switch architecture.**
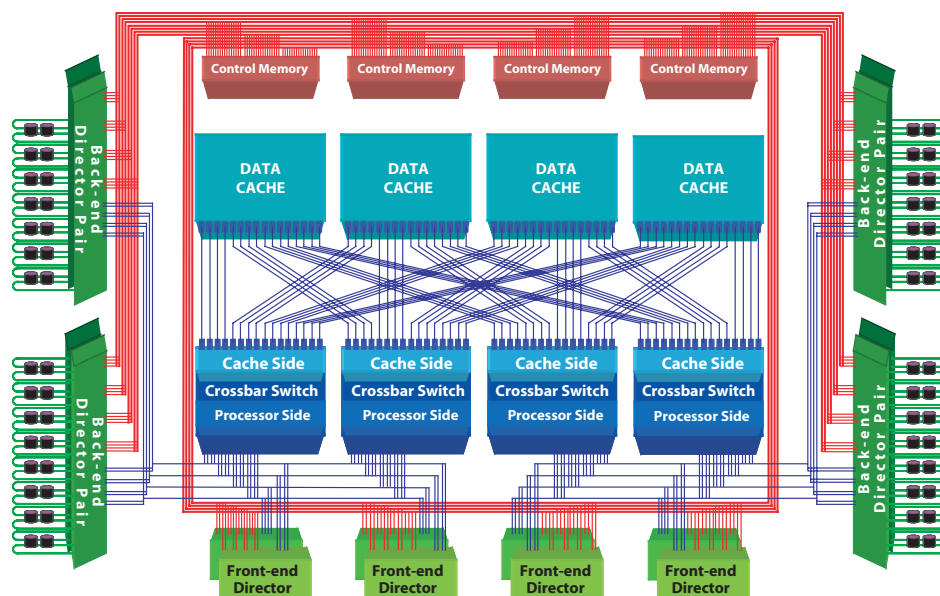


## The Industry's Highest Performance Design

The industry's fastest architecture and the foundation of the Universal Storage Platform supports:

:: New, faster processors and more paths with enhanced symmetric multiprocessing (SMP) design

:: 81GB/sec aggregate cache bandwidth—over five times faster than closest competitor

:: Up to 2 million IOPS—five times greater than closest competitor

:: Up to 128GB of cache with improved algorithms

:: Up to 256 concurrent memory operations

:: Separate data and control paths

:: Up to 32 2Gbit/sec Fibre Channel back-end loops

*Rely on superior performance to manage 32PB of virtualized internal and externally attached storage.*

Heterogeneous Storage Pooling and Choice of Multiprotocol Connectivity

:: Up to 192 connections

:: Fibre Channel for high-performance, mission-critical applications

:: ESCON and FICON for mainframe environments

:: NAS Blades for plug-and-play file sharing

# Hitachi Universal Star Network™ Architecture

The third-generation massively parallel Universal Star Network architecture consists of two separate networks: the Cache–Hierarchical Star Network (C-HSN) and the Control Memory–Hierarchical Star Network (CM-HSN). This architecture allows the Universal Storage Platform to beat the competition by a wide margin when it comes to raw performance. The Universal Storage Platform supports up to 128GB of data cache, all directly addressable. Separate control cache modules (up to 6GB total) are used for system control information storage. Competitive systems use their cache for both data and control information, limiting the amount of usable data cache and creating performance limitations for certain workloads. Performance characteristics of the Universal Star Network architecture are shown in Table 3.

*The Universal Star Network architecture consists of two distinct high-performance networks, separating control and data paths.*

**Table 3. Performance characteristics of the Universal Star Network architecture.**

| Hitachi Universal Star Network™ Crossbar Switch Characteristic | USP1100 High-end Model | USP600 Enhanced Model | USP100 Entry-level Model |
|---|---|---|---|
| Data Cache Bandwidth (GB/sec) | 68 | 34 | 17 |
| Control Cache Bandwidth (GB/sec) | 13 | 6.5 | 6.5 |
| Maximum Cache Bandwidth (GB/sec) | 81 | 40.5 | 23.5 |
| Maximum Control Memory (GB) | 6 | 6 | 6 |
| Maximum Data Cache (GB) | 128 | 64 | 64 |
| Percentage of Internal Memory Available for Data | 100 | 100 | 100 |

Figure 14 is an illustration of the Cache Switch Module, which includes the crossbar switch VLSIs.

**Figure 14. The Cache Switch Module provides fully redundant switched access to cache.**



Crossbar Switch
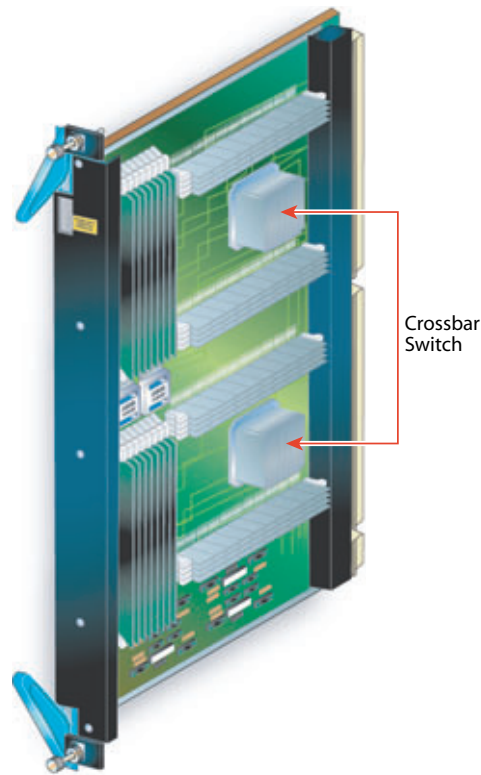
## Cache–Hierarchical Star Network

The Cache–Hierarchical Star Network or C-HSN is the network used for transferring data to and from the main global data cache. The C-HSN can also be broken down into two component networks: the processor paths to the C-HSN and the actual C-HSN.

## Control Memory–Hierarchical Star Network

The internal system control network of the Universal Star Network architecture is the known as Control Memory–Hierarchical Star Network or CM-HSN. This is a point-to-point network that handles the exchange of control information between the processors and control memory. The control memory contains information about the status, location, and configuration of the cache, the data in the cache, and the configuration of the Universal Storage Platform. Two control memory areas are mirrored images of each other. Control data is "data about data" and is sometimes called "metadata." Essentially, control information is handled "out of band" from the data paths, both through a separate memory area and network.

*The CM-HSN exchanges control information between the processors and control memory.*

The CM-HSN is a simpler high-performance network design in that every connection is a point-to-point connection. Only the C-HSN (data paths) uses the crossbar topology for its interconnecting network. The CM-HSN also uses narrower paths than the C-HSN and more of them. Figure 15 shows a close-up view of the CM-HSN topology. As is shown, two control memory areas are mirrored images of each other.

**Figure 15. The CM-HSN handles the exchange of control information between processors and Data Cache memory.**
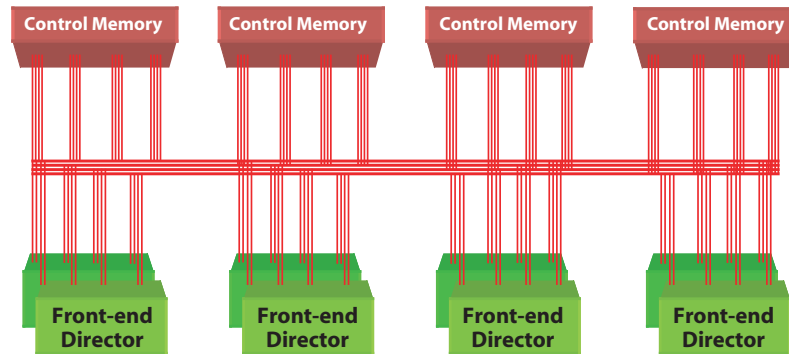


## The Crossbar Switch Provides Non-blocking Switched Access to Cache

At the heart of the Universal Storage Platform architecture are four non-blocking crossbar switches. Together, these four switches use a parallel switch fabric bus. The crossbar switch functions as a combination multiplexer, path arbitrator, and non-blocking network switch. The crossbar switch functions as a multiplexer by supporting 16 paths into the processor side of each switch and 16 paths to the cache modules. All total, there are 64 paths at the processor side of the fabric network and 64 paths to the cache modules from the cache side of the fabric network.

*At the heart of the Universal Star Network are four non-blocking crossbar switches.*

## Advanced Data Cache Algorithms Provide Read-ahead for High-performance Sequential Reads

The Universal Storage Platform has a variety of advanced cache algorithms and software solutions that provide exceptional performance. Read clustering in the Universal Storage Platform is enabled using built-in heuristics to read ahead for every I/O. The heuristics are applied to determine if the data is being accessed sequentially. If so, then the Universal Storage Platform reads ahead, i.e. automatically brings into cache, pages corresponding to that data. Read-ahead helps to ensure that when a client read request is received the requested data will already be stored in the data cache, so the request can be satisfied immediately.

## Hitachi Cache Residency Manager Software Allows Datasets to be Permanently Placed in Data Cache

*Cache Residency Manager software enables data access at memory speed.*

The Hitachi Cache Residency Manager software feature (formerly FlashAccess) allows users to dynamically "lock and unlock" data into cache in real time. Read and write functions are then performed at cache speeds, with no disk latency delay. With the Cache Residency Manager feature, a portion of cache memory can be allocated to specific data. Administrators can add, delete, or change the Cache Residency Manager feature's managed data at any time, quickly and easily.

In IBM mainframe environments defined by the Logical Volume Image (LVI), cache data can be as small as a single track or as large as a full disk volume. For increased configuration flexibility, the Cache Residency Manager feature can be used in conjunction with Hitachi file conversion software to increase the speed of data transfer and, therefore, improve performance of mainframe-to-open-systems data exchange.

# Front-end Design of the Universal Storage Platform

All Universal Storage Platform models support both Fibre Channel for open systems and
ESCON or FICON for IBM z/OS-compatible platforms as shown in Figure 16.

**Figure 16. Universal Storage Platform provides Fibre Channel, ESCON, and FICON
attachment to open systems and mainframe hosts.**
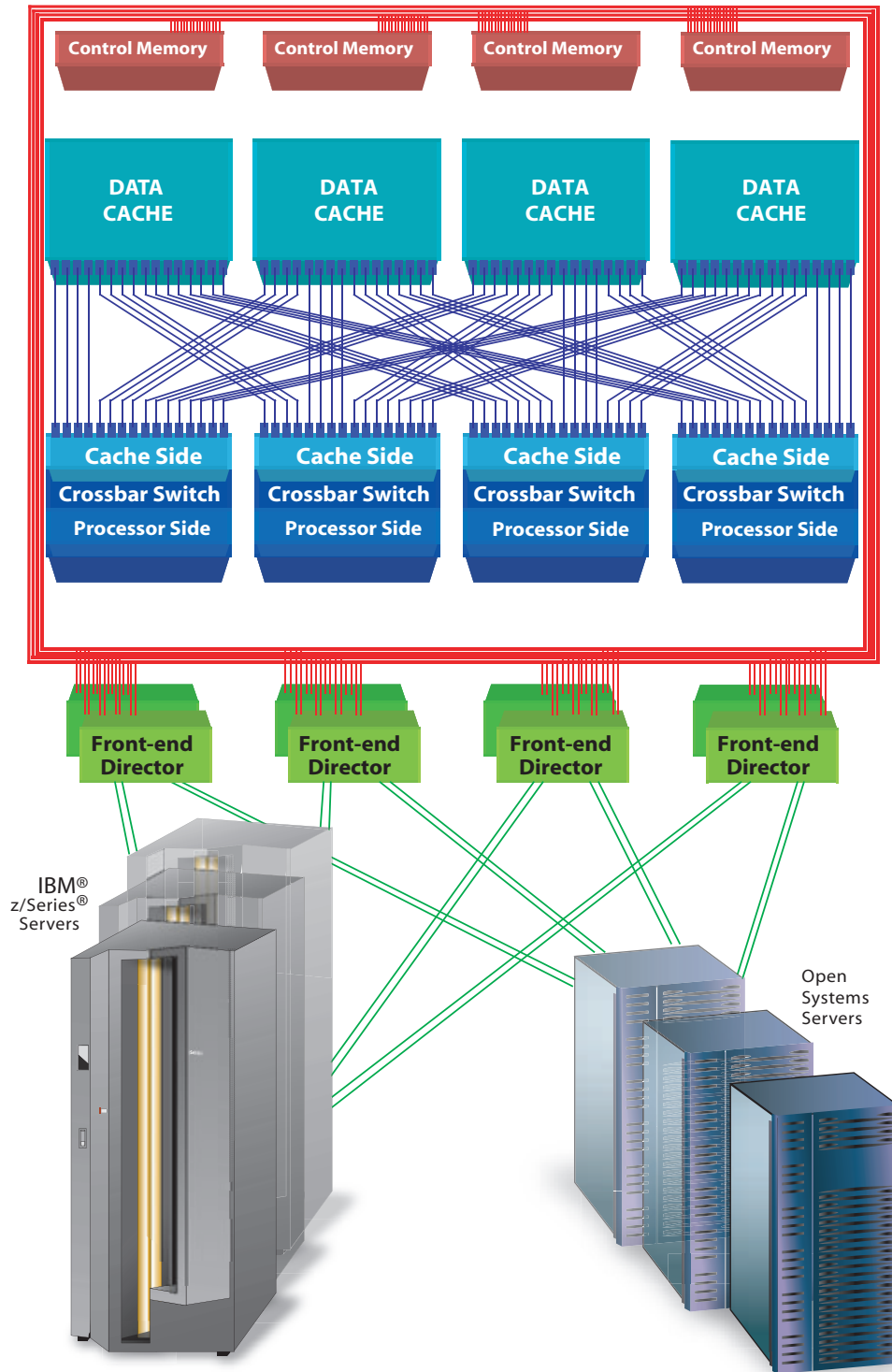
## Connection to Open Systems Hosts

Each Fibre Channel front-end director module has eight interface processors for management of connectivity to open systems hosts and 32 Fibre Channel ports for a total of 192 ports for a fully configured model USP1100. Each Fibre Channel port supports a transfer rate of 2Gbit/sec (gigabits/second) in conformance with the Fibre Channel standard. However, with the industry-leading Universal Storage Platform implementation of "virtual" Fibre Channel ports, each interface card is equivalent to multiple interface cards in competitive systems. The Fibre Channel, ESCON, and FICON front-end director modules are shown in Figure 17.

**Figure 17. Fibre Channel, ESCON, and FICON front-end directors.**



ESCON (8 Ports)

Fibre Channel (16 Ports)

FICON  (4 Ports)

NAS Blade
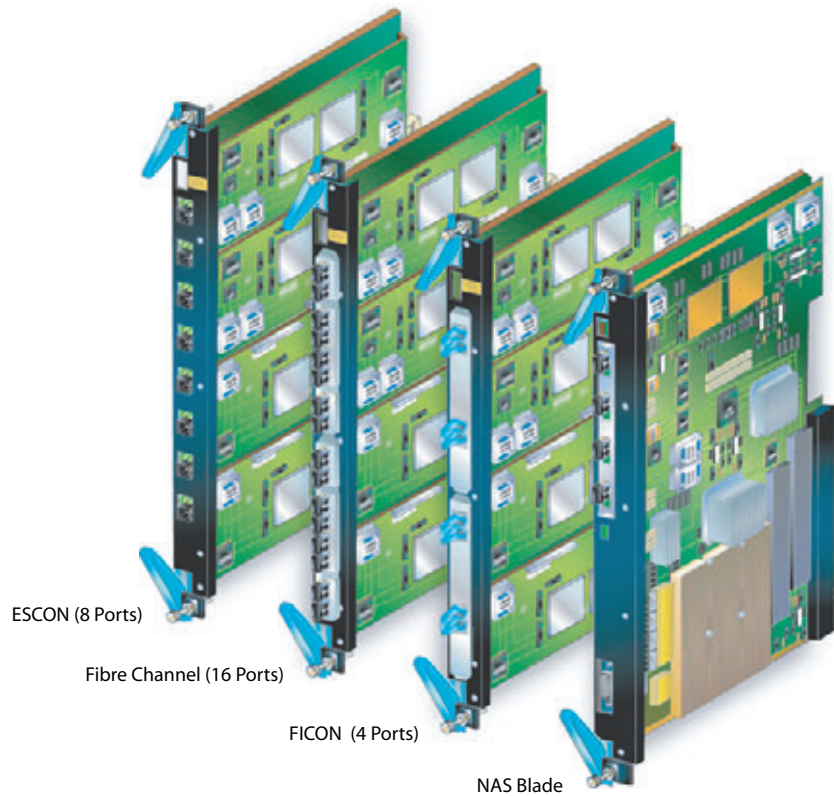
*Universal Storage Platform supports all major open systems hosts.*

The Universal Storage Platform supports all major open systems hosts for unmatched connectivity with direct Fibre Channel host attachments as listed below:

:: Microsoft—Windows NT, Windows 2000, Windows Server 2003

:: Hewlett Packard—HP-UX, Tru64 UNIX, OpenVMS

:: Sun Solaris

:: IBM AIX

:: Novell NetWare

:: Linux (Red Hat, SuSE)

:: SGI IRIX

:: VMWare

## Connection to Mainframe Hosts

For connection to mainframe hosts the Universal Storage Platform supports ESCON and FICON back-end director modules with transfer rates of 17.5 MB/sec and 100 MB/sec, respectively. There are eight ports for each ESCON front-end director module or a total of 96 ESCON host interfaces for a fully configured model USP1100. Similarly, there are four ports for each FICON front-end director module or a total of 48 FICON host interfaces for a fully configured model USP1100. Since a Universal Storage Platform can connect to both mainframes and open systems hosts, hyper-consolidation of the heterogeneous storage into one system provides consistent performance, high availability, and ease of management. This is shown in Figure 18.

**Figure 18. Universal Storage Platform supports both mainframe and open systems hosts.**



Hitachi TagmaStore™
Universal Storage Platform

*Universal Storage Platform supports IBM and compatible mainframes.*

The Universal Storage Platform supports all major mainframe hosts for unmatched connectivity with direct FICON and ESCON host attachments as listed below:

:: IBM OS/390®, MVS/ESA™, MVS/XA™, VM/ESA®, VSE/ESA™, z/OS®, z/OS.e, z/VM®, z/Series® Linux

A summary of the specifications of the Universal Storage Platform front-end director modules is shown in Table 4.

**Table 4. Characteristics of the Universal Storage Platform front-end director modules.**

| Front-end Director Characteristics | USP1100 High-end Model | USP600 Enhanced Model | USP100 Entry-level Model |
|---|---|---|---|
| Cards | 1–6 | 1–6 | 1–4 |
| Fibre Channel Ports | 0–192 | 0–192 | 0–128 |
| Virtual Ports | Up to 32,728 | Up to 24,576 | Up to 16,384 |
| FICON Ports | 0–48 | 0–48 | 0–32 |
| ESCON Ports | 0–96 | 0–96 | 0–64 |
| NAS Blade[2] /Ports | 0–4/0–16 | 0–4/0–16 | 0–4/0–16 |

[2] Each NAS Blade consists of dual NAS servers.

# High-performance, High-capacity Back-end Design of the Universal Storage Platform

## All Fibre Channel Back-end Design

*Each back-end director pair is four times as fast as those of the Lightning 9900 V Series systems.*

Special high-performance back-end high-speed disk drives are available for all models of the Universal Storage Platform. The drives are attached via Fibre Channel Arbitrated Loops (FC-AL). Sixteen FC-AL loops connect to dual ported drives for each back-end director pair. Each back-end director pair for the Universal Storage Platform is about four times as fast as a back-end director pair (known as BED pairs) of the Hitachi Lightning 9900™ V Series enterprise storage systems.

Each FC-AL path is driven with a dedicated high-speed VLSI processor. The diagram of Universal Storage Platform back-end director pair is shown in Figure 19. The Universal Storage Platform uses advanced algorithms for managing performance of back-end director pairs.

**Figure 19. Functional block diagram of an Array Group with FC-AL disks.**
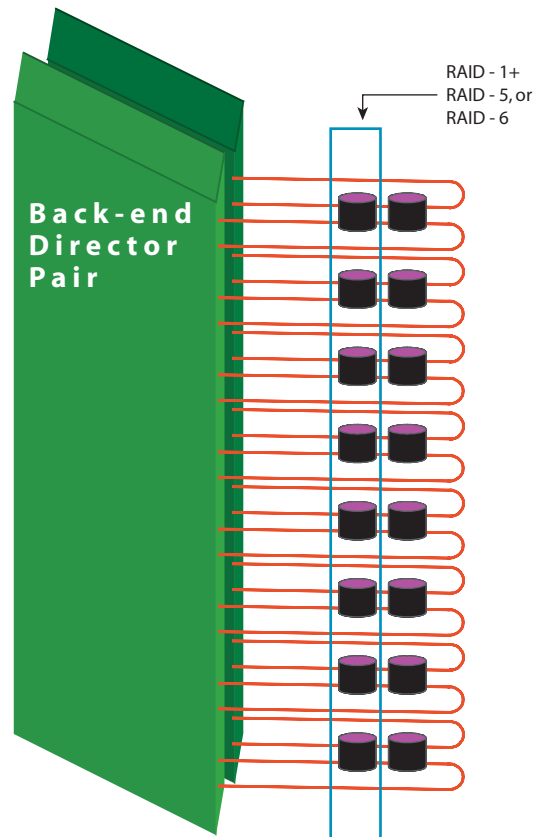


## Flexible back-end configurations

:: 2Gbit/sec Fibre Channel loops for internal disk connections

:: Fibre Channel initiator used for external storage connections

## High-capacity Back-end Design

The back end of the Universal Storage Platform uses dual-ported/dual-active Fibre Channel disk drives. All drives feature Command Tag Queuing, which greatly improves the performance of the Universal Storage Platform back end by offloading much of the seek optimization functions to the disk drives themselves, to allow for more simultaneous back-end I/O operations to occur. The Universal Storage Platform supports an unmatched range of capacities as shown in Table 5.

*Command Tag Queuing greatly improves disk performance.*

**Table 5. System capacities and number of disk drives for various configurations.**

| Configuration | USP1100 High-end Model | USP600 Enhanced Model | USP100 Entry-level Model |
|---|---|---|---|
| Number of Array Frames | 1,2,3, or 4 | 1 or 2 | 0 or 1 |
| Raw System Capacity (Min/Max in TB) | 9.152–332 | 4.741–148 | 0.286–74 |
| Number of Disk Drives (Min/Max) | 129–1152 | 64–512 | 5–256 |
| RAID-5 Usable Capacity Open Systems | 287.8 | 128.8 | 62.4 |
| RAID-5 Usable Capacity IBM® z/OS® Compatible | 270.4 | 117.2 | 58.6 |
| RAID-1+ Usable Capacity Open Systems | 165 | 72.8 | 36.4 |
| RAID-1+ Usable Capacity z/OS Compatible | 143.6 | 63 | 31.6 |

Note: Capacities achieved with 300GB drives, which will be available in Q1CY2005.

## Mix and Match High-density Drives Tailor Capacity and Performance to Application Requirements

All the back-end drives are a low profile, 3.5-inch x 1-inch (height) form factor with 73GB, 146GB, and 300GB (available Q1CY2005) capacities that can be mixed and matched within a system. The drives spin at 10Krpm or 15Krpm and can be configured in a variety of RAID levels to meet the application's performance, availability, and cost requirements.

*Hitachi designs the most advanced RAID controllers in the industry.*

## Advantages of the Universal Storage Platform RAID Implementations

Hitachi designs the most advanced RAID (Redundant Array of Independent Disks) controllers in enterprise storage. These intelligent controllers provide disk-interface and RAID-management circuitry to offload these tasks to dedicated embedded processors. Each Universal Storage Platform back-end director pair supports RAID-1+, RAID-5 (parity RAID), and RAID-6. All user data disks in the system are defined as part of a RAID array of one type or another. The 2D+2D and 4D+4D RAID-1+, the 3D+1P and 7D+1P RAID-5, and the 6D+2P RAID-6 are shown in Figure 20.

**Figure 20. All Universal Storage Platform models support RAID-1+, RAID-5, and/ or RAID-6.**



RAID-1+: (2D + 2D)
with Rotating Copy

RAID-5: (3D + 1P)
Data is striped with parity over RAID members.

RAID-5: (7D + 1P)
Data is striped with parity over RAID members.

RAID-6: (6D + 2P)
Data is striped with parity over RAID members.
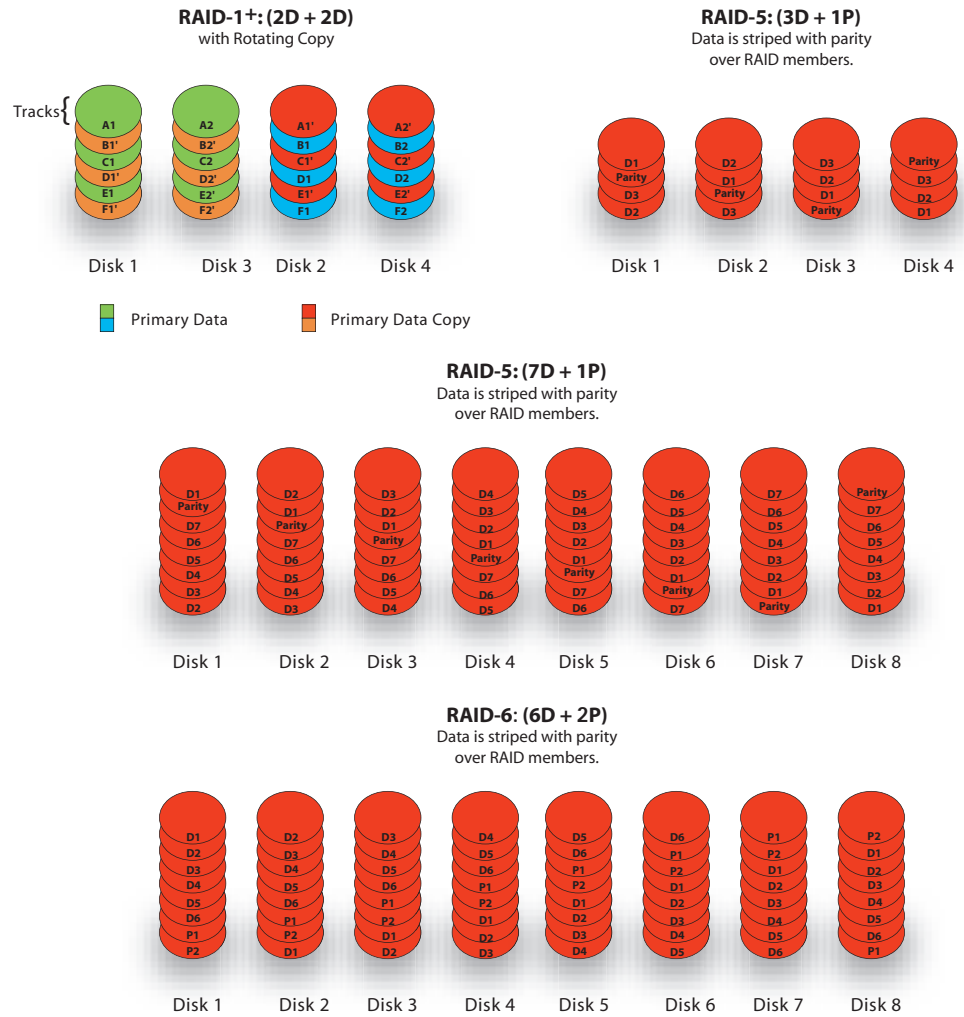
## RAID-1+

For the Universal Storage Platform, RAID-1+ is available in 2 Data + 2 Data and 4 Data + 4 Data disk arrangements in a RAID-1 configuration, but with a twist—a rotating copy. RAID-1 is best for applications characterized by random activity and a high write-to-read ratio.

## RAID-5 Distributed Parity

*Hitachi RAID-5 performance beats RAID-1 performance of some competitors.*

RAID-5 disk arrangements for the Universal Storage Platform consist of four disks (3 Data and 1 Parity) or eight disks (7 Data and 1 Parity). Data is striped across RAID-5 arrays in a fashion similar to RAID-1+, but RAID-5 provides fault resilience by keeping parity information on each stripe of data. If a failure occurs, the contents of that block can be recreated by reading back the other blocks in the stripe along with the parity. Parity information is distributed throughout the array to minimize potential bottlenecks in the event of a need to rebuild data from a failed disk. The overhead of RAID-5 is equivalent to one disk drive, regardless of the size of the array. RAID-5 is best for applications characterized by sequential reads.

### RAID-6 Redundant Distributed Parity

A RAID-6 disk arrangement stripes blocks of data and parity across an array of drives like RAID-5, except that it calculates two redundant sets of parity information for each stripe of data. The goal of this duplication is solely to improve fault tolerance since RAID-6 can recover from the failure of two drives in the array while other single RAID levels can handle at most one fault. As with RAID-5, performance can be adjusted by varying stripe sizes. RAID-6 is good for applications characterized by sequential reads on largest disks.

*RAID-6 provides a fault-tolerant parity disk.*

### RAID Rebuild Capability

In the event of a disk failure, RAID-1+, RAID-5, and RAID-6 arrays can be rapidly and automatically rebuilt using available "hot spare" drives. The Universal Storage Platform also allows logical volumes to be expanded online and for administrators to set the priority of rebuilding based on the daily processing cycle and RAID configuration installed.

*Administrators can set RAID rebuilding priority based on the daily processing cycle.*

### Connecting to External Storage

One of the major benefits of the Universal Storage Platform is its ability to connect to external storage so that existing LUNs in a heterogeneous multivendor environment can be centrally managed using Hitachi storage software. The major financial benefits of this approach are discussed in Chapter 7, and the unique Hitachi approach to virtualization that enables connection to other vendors' storage is discussed in Chapter 2.

As shown in Figure 21, the specific process that allows external storage connectivity is via an ELUN or External LUN. This illustration shows that in a Private Virtual Storage Machine, a LUN recognized by a host and connected to a Universal Storage Platform by being mapped through a physical or target port to a logical device (LDEV) is protected from access by other hosts. An ELUN operates in a manner similar to the Private Virtual Storage Machine of the Universal Storage Platform, but it maps the LDEV through an external port of the Universal Storage Platform to a physical or target port on an external storage system.

This process enables the Universal Storage Platform and virtualization software to manage practically an entire data center from a single pane of glass regardless of the heterogeneous vendor storage present. Current third-party storage systems supported by the Universal Storage Platform are listed in Table 6[3]. In effect, the Hitachi software treats external vendor storage as a Private Virtual Storage Machine and can map LDEVs through to it on a pass-through basis while retaining all the software data protection features of the Universal Storage Platform[4].

*It is finally possible to [virtually] manage an entire data center from a single pane of glass.*

---

[3]  For a list of current and future support for third-party external storage systems, please contact your Hitachi Data Systems representative.

[4]  The external vendor storage will not have the hardware high data availability features of the Universal Storage Platform, but this may suffice for certain applications.

**Figure 21. A host LUN is mapped through an external LUN (ELUN) in the Universal Storage Platform to a LUN in an external storage device.**
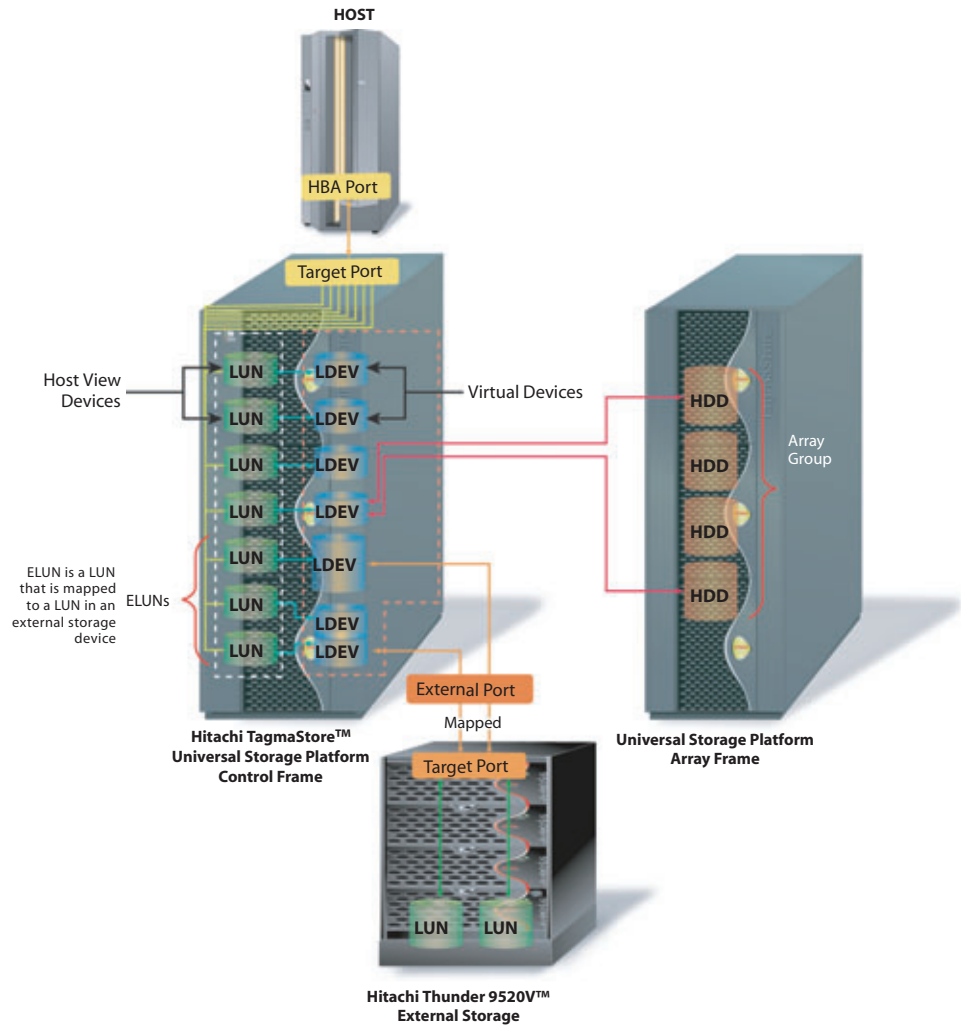


**Table 6. External storage systems currently supported by the Universal Storage Platform.**

| Vendor | Product | |
|---|---|---|
| **Hitachi** | :: Thunder 9200™ (RPQ)<br>:: Thunder 9500™ V Series<br><br>:: 7700E (RPQ)<br>:: HP XP256 (RPQ) | :: Lightning 9900™ Series<br>:: HP XP48/XP512<br>:: Sun StorEdge 9910, 9960<br><br>:: Lightning 9900 V Series<br>:: HP XP128/XP1024<br>:: Sun StorEdge 9970, 9980 |
| **Sun** | :: StorEdge T3B<br>:: StorEdge 6120, 6320 | |
| **IBM** | :: TotalStorage Enterprise Storage Server (Shark) 2105 Series models F20, 750, and 800<br>:: DS4000 (FAStT) Series | |
| **EMC** | :: Symmetrix 3000, 5000, 8000 series<br>:: Symmetrix DMX800, DMX1000, DMX2000, and DMX3000<br>:: CLARiiON CX Series | |

# Business Continuity and Disaster Recovery Solutions

## The Importance of Business Continuity and Disaster Recovery Solutions

Business continuity/disaster recovery is a major problem facing the enterprise today. It is increasingly important for a business to support continued access to global information 24 hours a day, 7 days a week. Careers often depend on the availability of service levels provided by IT to the enterprise. It is more important than ever to have the right data available at the right place and the right time—all the time. Business continuity/disaster recovery depends on many variables, including hardware design, connectivity infrastructure, and application, storage management, and business continuity software, as well as operators and services, whether outsourced or in house. Availability is so important that complete computer systems and networks are modeled by Ph.D.-level experts with elaborate Markov chain models to accurately predict the availability of data when it is needed.

*The benefit of high-availability computing is continuous business operations.*

In computer science, availability refers to the degree to which a system or resource is capable of performing its normal function. Availability is measured in terms of Mean Time Between Failure (MTBF) divided by MTBF plus the Mean Time to Repair (MTTR).

:: AVAILABILITY = MTBF / (MTBF+MTTR)

For example, a server that fails on average once every 5,000 hours and takes an average of two hours to diagnose, replace faulty components, and reboot, would have an availability rating of 5,000/(5,000 + 2) = 99.96%. This would correspond to a Level 3 rating using the Scale of 9s.

The Hitachi TagmaStore™ Universal Storage Platform has been designed to eliminate as many of the factors creating unplanned business continuity/disaster recovery as possible and stands head and shoulders above the competition in this respect. Every factor, from hardened VLSI designs, hardware redundancy, and online replaceable components to software business continuity functions and redundant connectivity, combine toward the objectives of nonstop computing and continuous business operations. (See Table 7.)

In addition, Hitachi has teamed with industry-leading partners for the Universal Storage Platform to provide world-class high-availability software and solutions. These solutions contribute to the fact that customers and analysts alike regard Hitachi storage systems and the Universal Storage Platform in particular as having the highest data availability in the industry.

**Table 7. Hitachi Data Systems focuses on business continuity/disaster recovery solutions.**

| Business Solution | Solution Category | Solution Elements | Storage Challenges Addressed |
|---|---|---|---|
| | System Design | Hitachi Universal Star Network™ massively parallel crossbar switch; redundant, hot-swappable components; global dynamic hot sparing; mirrored write cache with battery backup; Hitachi nondisruptive microcode upgrades; RAID-1+ and RAID-5 for data protection; Hi-Track® "call-home" service/remote maintenance tool | Internal processing power, bandwidth, high transaction rate, fault tolerance |
| **Business Continuity/ Disaster Recovery** | Disk-to-disk Backup<br><br>Application Backup/ Recovery<br><br>Mainframe Tape Replacement<br><br>In-region Local Disaster Recovery<br><br>In-region Metro Disaster Recovery<br><br>Out-of-region Disaster Recovery<br><br>IBM® GDPS™ Support | Remote replication/disaster recovery: Hitachi TrueCopy™ Remote Replication and Hitachi Universal Replicator software; Hitachi Compatible Replication for IBM XRC software; Hitachi ShadowImage™ In-System Replication software; Hitachi Serverless Backup Enabler software; Compatible Mirroring for IBM FlashCopy® software; and Hitachi Dynamic Link Manager™ software | Disaster recovery, data replication, application availability, risk management, SLAs, data protection, performance, QoS |
| | Regulatory Compliance | Message Archive for E-mail, Message Archive for Compliance | Regulatory requirements, document archiving, audit trails, disaster recovery |
| | Services | Risk Analysis Workshop, Hitachi SplitSecond™ Solutions, Remote Copy Planning and Design Services, Continuity Software Services | TCO, ROI, risk management, business continuity planning, outsourcing |

# The Universal Storage Platform Availability Profile Compared to Competitive Products

The Universal Storage Platform was designed with maximum emphasis on high-availability computing for today's most critical enterprises. No other vendor can compare to Hitachi solutions in terms of high data availability and protection.

:: Industry-unique software: Hitachi Universal Replicator for TagmaStore Universal Storage Platform for heterogeneous asynchronous remote replication over any distance

:: Hitachi TrueCopy™ Remote Replication software combined with Hitachi ShadowImage™ In-System Replication software for disaster recovery

:: Hitachi Copy-on-Write Snapshot software (formerly QuickShadow) to provide incremental point-in-time copies without requiring quiescence of databases or applications

:: Hitachi Compatible Replication for IBM® XRC and Compatible Mirroring for IBM FlashCopy® software, coupled with industry-leading support for IBM Geographically Dispersed Parallel Sysplex™ (GDPS™) configurations in mainframe environments

:: Nondisruptive microcode upgrades

:: Redundant, hot-swappable components throughout the system combined with automatic failover architecture

:: Dual data paths and dual control paths connecting every component

:: Active/active dual-ported disk drives instead of single-port drives or active/passive dual-ported drives

:: Mirrored Data Cache for all write data instead of single image cache

:: Hi-Track® "call-home" capability to notify the Hitachi Data Systems support center quickly of any incident that may affect availability

The many advantages in high-availability design that the Universal Storage Platform has over other enterprise storage products are shown in Figure 22.

**Figure 22. The Universal Storage Platform offers higher availability data protection than competitive products.**
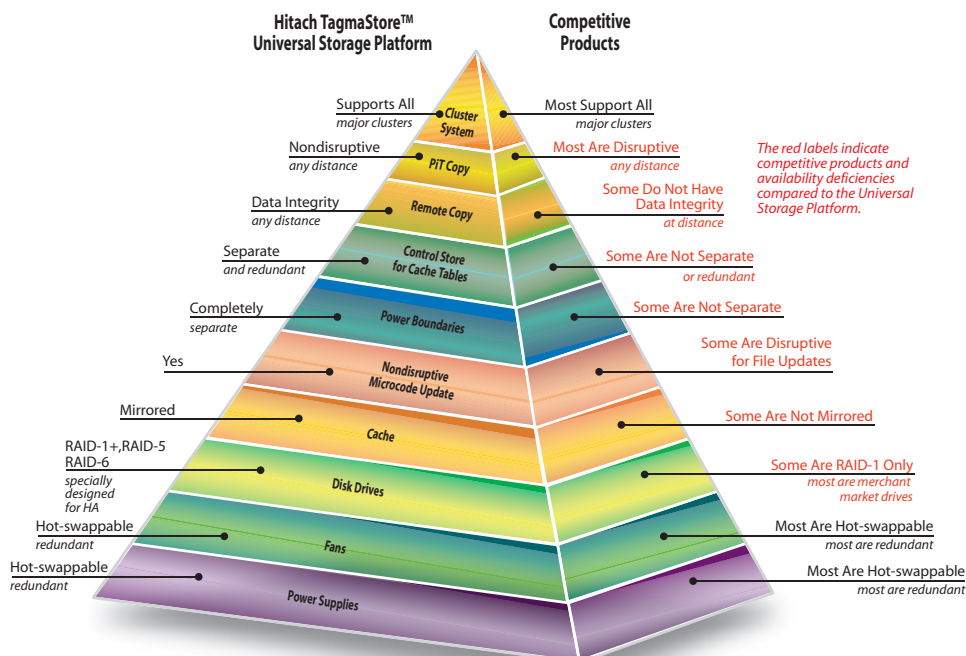
# Business Continuity and Disaster Recovery Software Solutions for the Universal Storage Platform

The Universal Storage Platform delivers an important new capability with Universal Replicator software. In addition, a number of industry-leading Hitachi software tools have been optimized for the Universal Storage Platform. These include TrueCopy Remote Replication software for synchronous replication between Hitachi storage systems, ShadowImage In-System Replication software for fast, nondisruptive local mirroring of mission-critical data and Hitachi Volume Migration software (formerly CruiseControl) for policy-based data lifecycle management across all tiers of storage. As shown in Figure 23, these tools are part of the Hitachi Business Continuity Framework, which combines both local high-availability and remote disaster-recovery capabilities in a centrally managed infrastructure.

*Hitachi business continuity solutions allow central management of both high availability and disaster recovery.*

**Figure 23. Business Continuity Framework.**
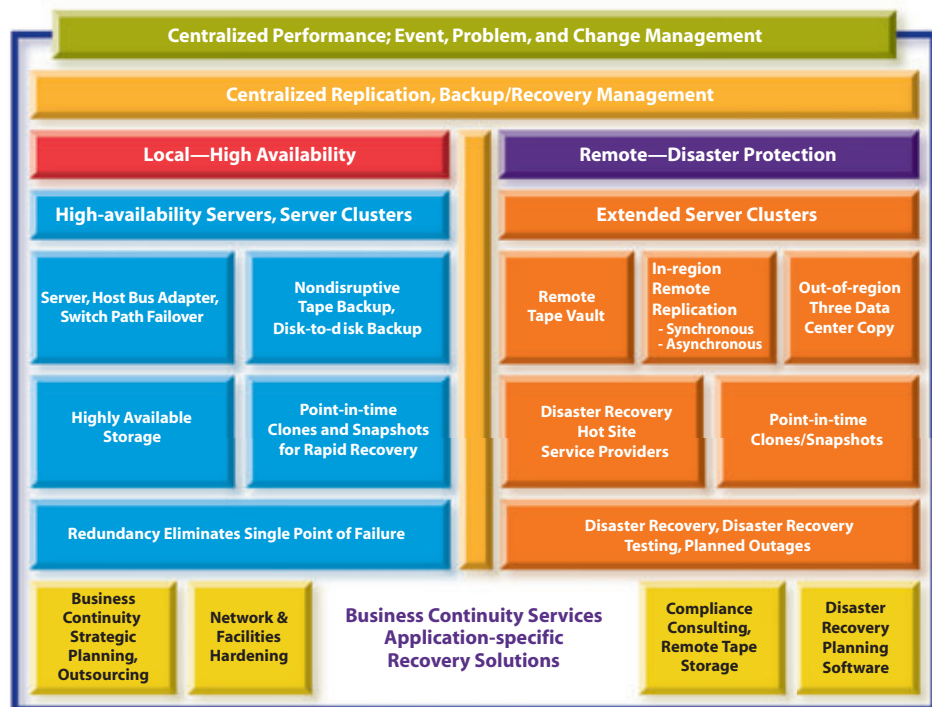


## Data Movement and Data Protection Software

Data movement is the key to business continuity and to cost-effective tiered storage management. Enterprises must have common means of moving data up and down tiers of storage to enable Application Optimized Storage™ solutions for production, test, and archiving environments. And for disaster recovery, organizations must have consistent tools and capabilities for replicating and recovering corporate data.

Hitachi data movement software modules offer a number of important capabilities:

:: Full-volume copy using ShadowImage In-System Replication software

:: Snapshots using Copy-on-Write Snapshot software

:: Efficient, cost-effective asynchronous replication and recovery with Universal Replicator software on the Universal Storage Platform

:: Synchronous and asynchronous replication with TrueCopy Remote Replication software

*Hitachi provides leading-edge tools for replicating and recovering corporate data.*

:: Data movement between storage tiers using Hitachi Cross-System Copy software (formerly HiCopy) or using Volume Migration or ShadowImage In-System Replication software in combination with the virtualization capabilities of the Universal Storage Platform

:: Common access to data movement products through Hitachi HiCommand® Device Manager software, Hitachi Business Continuity Manager software (formerly CopyCentral), and APIs

These products and services can be combined to meet specific business continuity requirements and operational needs.

## Universal Replicator Software for the Universal Storage Platform

For business continuity and related business requirements, the Universal Storage Platform is complemented by a breakthrough capability: Universal Replicator software. Universal Replicator software supports asynchronous real-time replication from one Universal Storage Platform to another for all internal and externally connected disk storage volumes, making it a very powerful solution for total-data-center, multiplatform, multivendor, remote-copy operations. In addition, Universal Replicator software provides a consistent replication approach and enables a common set of procedures, tools, and skills to manage diverse, heterogeneous storage and application environments. The combination of the Universal Storage Platform and the Universal Replicator provides a unique and powerful solution for out-of-region replication requirements.

*Universal Replicator software is a true industry breakthrough that's not likely to be duplicated by others.*

Currently, Universal Replicator software complements all existing platforms and data protection, data movement, and business continuity products from Hitachi Data Systems and selected third-party vendors. Over the near term, Hitachi Data Systems will make these breakthrough capabilities available for management and protection of all major multivendor externally attached heterogeneous storage systems. Thus, the Universal Storage Platform with Universal Replicator software supports the data replication and movement requirements of disparate applications and business processes.

*Universal Replicator software supports all major multivendor systems on your floor.*

Universal Replicator software differs from other solutions in that it pulls the data to the remote site, instead of pushing it from the primary site. The primary storage system writes data to its own journal volumes, but the replication processes that control asynchronous replication initiate on the remote system. This approach reduces resource consumption on the primary storage system and improves production application performance. In effect, Universal Replicator software restores primary site storage to its intended role as a transaction processing resource, not a replication engine.

Universal Replicator software running on the Universal Storage Platform delivers a number of very important technical and financial benefits:

*Universal Replicator software uses disk-based journaling instead of cache.*

**Building on a proven legacy of data integrity and consistency.** Universal Replicator software uses technology proven reliable in both TrueCopy Remote Replication software and Hitachi Compatible Replication software for IBM XRC (formerly Extended Remote Copy or HXRC). Each transmitted record set includes time-stamp (mainframe only) and sequence-number information, enabling the replication engine to verify receipt of all records at the remote site and to arrange them in the correct write order for storage.

**Liberating resources and improving performance.** By using local disk-based journaling and a pull-style remote replication engine, Universal Replicator software releases critical resources that are consumed by other asynchronous replication approaches at the primary site, such as disk storage cache in storage-based solutions, or server memory in host-based software approaches. Universal Replicator software improves cache utilization, lowering costs and improving performance of production transaction applications.

**Improving recovery point objective control and data integrity.** With Universal Replicator software, operations can survive temporary communication problems for longer periods without data loss. Should the replication link fail between sites, Universal Replicator software keeps logging changes in the local journal so that they can be transmitted later, without interruption to the protection process or the application. Data consistency is preserved, and the user can maintain a more current recovery point objective (RPO) during outage situations, compared with existing replication methodologies. In addition, bandwidth requirements are easier to manage in relation to data currency objectives.

*Universal Replicator makes the three data center approach feasible and affordable.*

## An Improved "Three Data Center" Business Continuity Solution with Universal Replicator Software

With its introduction of the Universal Storage Platform, Hitachi Data Systems makes the three data center approach more affordable for a broad range of enterprises and applications. With Universal Storage Platform and combinations of TrueCopy Remote Replication (synchronous capabilities) and Universal Replicator software, three different three data center configurations are enabled: cascade, passthrough (future offering), and multitarget. These data center cascade configurations provide complete data copies at intermediate sites that support server clusters and application failover. Pass-through configurations only store the journal volumes at the intermediate site, reducing storage costs. And, multitarget configurations offer the best protection against local and regional disasters, but at higher cost. Figure 24 illustrates these alternative configurations.

**Figure 24. Enterprises can choose among three alternatives for "three data center" replication configurations, depending on business needs.**
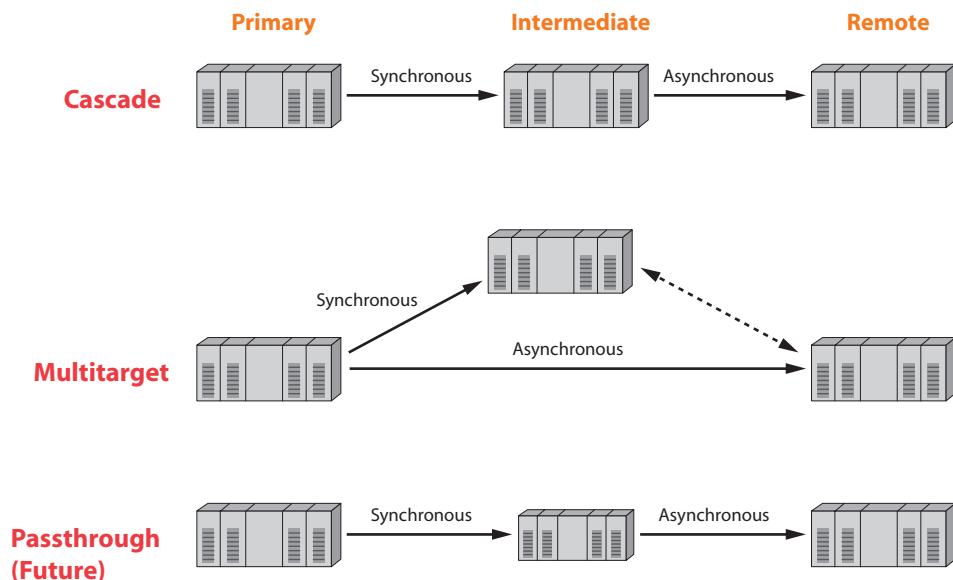
The Universal Storage Platform provides a "no data loss" solution with less complexity, scripting, and overhead than previous solutions. For an example of actual three data center configurations, see the financial services case study in the white paper titled, "Universal Replicator Advanced Technology."[5]

## Enterprise Regulatory Compliance Solutions

Hitachi Data Systems provides comprehensive service solutions throughout the data lifecycle via its Global Solution Services organization. Global Solution Services designs and implements solutions that address current and emerging storage-intensive demands, such as data lifecycle management, which can reduce the pain caused by the runaway growth of all data types. One example is e-mail, which is causing problems for everyone from CEOs and CFOs to e-mail administrators and users faced with "mailbox size limit exceeded" messages. At the same time, tough new regulations are forcing organizations to retain messages and other business documents in a tamperproof, disasterproof form for specified periods and to be able to produce them on demand. Ideally, mainstream storage and existing business continuity practices can be leveraged rather than incurring the expense of managing special-purpose hardware. Figure 25 illustrates the Hitachi Data Systems strategy of policy-based data movement from high-cost, fast-response storage systems to lower cost, slower response storage systems as the frequency of access and the retention value of the data decreases over time.

*The Hitachi Data Systems strategy is to provide automatic policy-based data movement over time in line with access and retention value considerations.*

**Figure 25. Data is moved automatically throughout its lifecycle.**
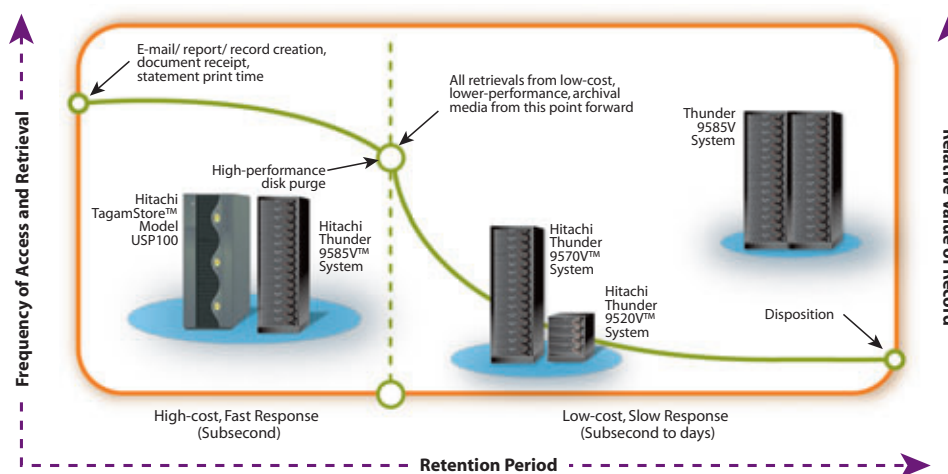
5   The "Hitachi Universal Replicator Advanced Technology" white paper by Christophe Bertrand, Tom Attanese, Roselinda Schulman, and Claus Mikkelsen can be found at http://www.hds.com/pdf/wp_165_universal_replicator.pdf#view=FitH&pagemode=bookmarks
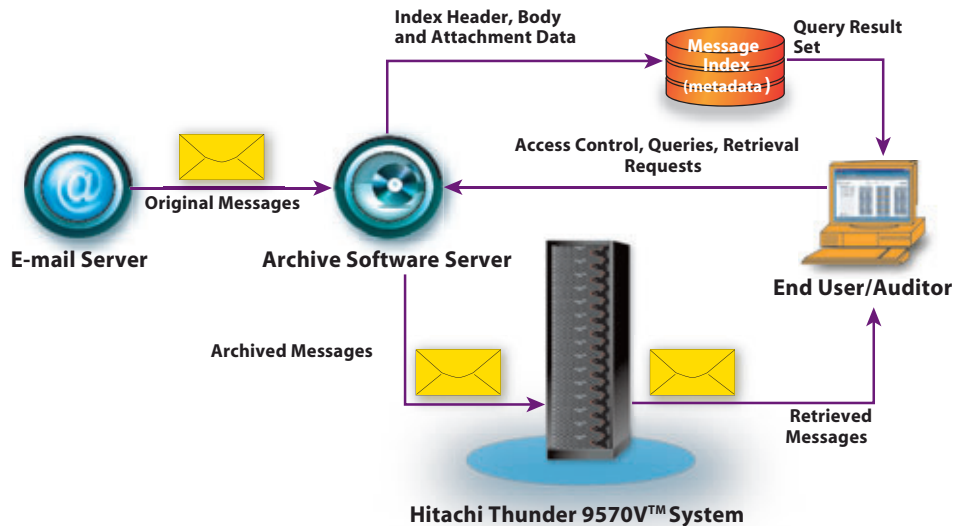
Message Archive for E-mail Solution

The Message Archive for E-mail solution leverages the standard Hitachi archival platform to provide automatic and selective document archiving, along with search and retrieval capabilities and audit trails. Figure 26 illustrates how e-mail archiving works in the data lifecycle.

When data is introduced to the archive, a digital signature is assigned to uniquely identify the object and make sure it has not been tampered with. The object is then indexed and metadata is created to describe the object in the message archive's metadata store. Metadata is information about the data that is used in populating, maintaining, and accessing both the descriptive information that identifies the archive's holdings and the administrative data used to manage the archive. In the Message Archive for E-mail solution, the only metadata needed might be the sender, data and time sent, subject line, and information about any attachments (file name, size). In addition to providing users with a view of archived information, the solution seamlessly integrates into the client interface for Microsoft Outlook and Lotus Notes. Importantly, it eliminates "mailbox limit exceeded" problems, effectively expanding overall storage capacity for your e-mail users.

*The Message Archive for E-mail solution eliminates "mailbox limit exceeded" problems.*

**Figure 26. With the Message Archive for E-mail solution users gain an unlimited mailbox.**



Index Header, Body and Attachment Data

Message Index (metadata)

Query Result Set

Access Control, Queries, Retrieval Requests

Original Messages

**E-mail Server**          **Archive Software Server**

**End User/Auditor**

Archived Messages

Retrieved Messages

**Hitachi Thunder 9570V™ System**

## Message Archive for Compliance Solution

The Message Archive for Compliance solution was developed to help you optimize your e-mail system while providing message indexing, search and retrieval capabilities, audit trails, and policy management to preserve messages for mandatory retention periods. As shown in Figure 27, the Message Archive for Compliance solution enables you to retain an unalterable archive of e-mail and instant messages for the fixed period of time mandated by SEC Rule 17a-4, Sarbanes-Oxley, Basel II, and other regulatory requirements. To do so it leverages Hitachi Data Retention Utility software (formerly Open LDEV Guard) to provide functionality on standard disk hardware. Data Retention Utility tamperproof "write once, read many" (WORM) software is available now on Hitachi Lightning 9900™ V Series enterprise and Thunder 9500™ V Series modular storage systems, as well as the Universal Storage Platform.

**Figure 27. The Message Archive for Compliance solution enables companies to retain an unalterable archive of e-mail and instant messages for the fixed period of time required by Sarbanes-Oxley and other mandates and regulations.**
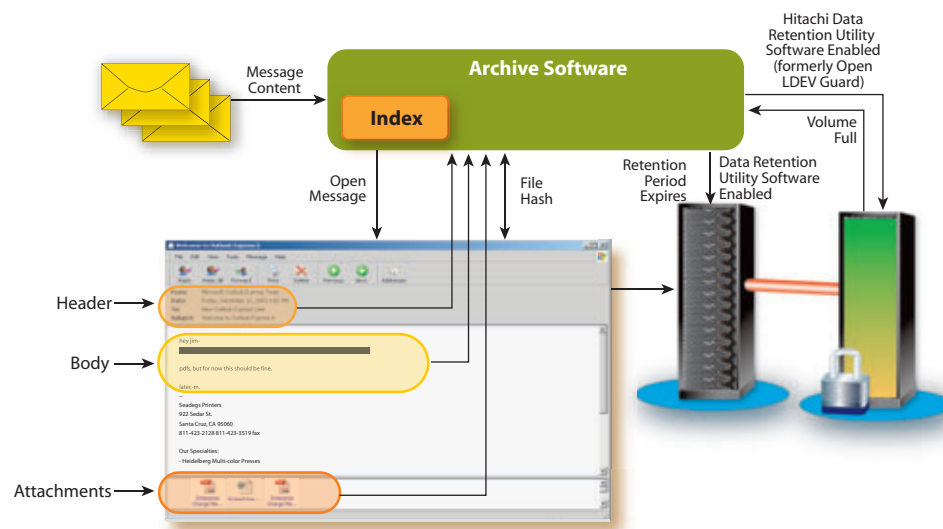
# Business Continuity and Disaster Recovery Services

The Global Solution Services group provides professional services to help keep your data safe, preparing you to maintain business continuity during both planned and unplanned downtime. To keep your critical business operations up, running, and successful, Global Solution Services leverages unique experience acquired in implementing the most effective data protection and disaster recovery solutions for a broad range of demanding businesses. By applying superior data mirroring and replication capabilities, best-of-breed backup, the guaranteed resiliency of Hitachi storage hardware, and proven connectivity architectures, Global Solution Services provides the continuity services that help you minimize downtime and speed recovery in the event of disaster.

## Hitachi SplitSecond™ Solutions for Rapid Recovery

Dramatically diminish backup time while slashing mission-critical application or database-restore time from hours to minutes with SplitSecond Solutions for rapid recovery. Each SplitSecond Solution is designed to address specific application needs of Microsoft Exchange, Microsoft SQL Server, or Oracle with a combination of services, hardware, and software.

### Remote Copy Planning and Design Service

This service assists you with bandwidth decisions and distance data-replication challenges. Using Hitachi Data Systems remote replication best practices, Global Solution Services consultants produce a detailed study of your current workload and recommend the bandwidth necessary to support the remote copy environment. This includes a high-level design for remote replication solutions, as well as a detailed analysis of workload and performance characteristics to help support cost-effective bandwidth decisions.

### Business Continuity Software Services

These services, based on Hitachi products, address your specific technology or education needs for IT enablement, implementation, and education services.

### Tape Backup Service

Hitachi Data Systems helps you simplify the way you manage both copy and centralized backup and recovery processes. In these services, consultants assist you with planning, design, implementation, and evaluation of your backup software, empowering you to seamlessly and effectively deploy, implement, and optimize backup tasks.

### Replication Automation Conversion Services: EMC to Hitachi Storage Systems or IBM PPRC to Hitachi Storage Systems

*Strategically transition your aging systems while extending asset life.*

Global Solution Services professionals will help you determine an exact strategy for migrating data to the Universal Storage Platform or other Hitachi storage systems from EMC, IBM, or other storage vendors. This service is important to align storage system attributes with application requirements within the Application Optimized Storage™ solutions framework from Hitachi Data Systems.

### Business Continuity Environment Evaluation and Planning

Hitachi Data Systems offers several services to assess your environment's risk level and recovery readiness, and to create a strategic technology plan that specifies the appropriate technology, software, and resources you need to create an infrastructure capable of mitigating and recovering from incidents and outages.

# Simplification Solutions

## Driving Complexity and Cost out of Multivendor Storage Environments through Consolidation, Virtualization, and Common Management

Many companies, regardless of size, are struggling to keep up with continuing data growth and to meet SLAs. With infrastructures often featuring storage systems from several vendors, administrators are faced with a myriad of vendor-specific management tools, interfaces, procedures, and policies. These "islands of storage management" stress skilled people, slow productivity, drive up costs, and can lead to errors and downtime. Now, the multiple capabilities of the Hitachi TagmaStore™ Universal Storage Platform offer you choices on how to address these issues.

Just like the previous-generation Hitachi Lightning 9980V™ multi-cabinent enterprise storage system, the Universal Storage Platform is a powerful consolidator, enabling you to take several storage systems off the floor and simplify data and storage management. Now you can go beyond traditional consolidation and use the virtualization and logical partitioning capabilities of the Universal Storage Platform to create a single storage pool and ensure application QoS. Indeed, it is possible to manage data and your storage infrastructure in ways never possible before.

By leveraging the virtualization software of the Universal Storage Platform, you can re-deploy existing storage assets to new roles within a tiered environment as well as extend the advanced software functionality of the Universal Storage Platform to existing systems, including point-in-time replication, remote replication, and data migration. With logical partitioning you can turn the Universal Storage Platform into as many as 32 independently managed Private Virtual Storage Machines, dedicating cache, Fibre Channel ports, and disk capacity (internal and externally attached) to applications or groups of users. You may also choose to combine consolidation with virtualization and logical partitioning and gain additional benefits of simplified operations with consistent procedures and policies across all of your data management functions— backup, business continuity, and disaster recovery, for example—and manage it all from a single common interface.

*The Universal Storage Platform is a powerful consolidator.*

*Virtualization and logical partitioning enable new ways to manage data across the enterprise.*

## Virtualization and Logical Partitioning

The objective of storage virtualization is to "melt" groups of heterogeneous storage systems into a common pool of storage resources. This simplifies management, enables increased utilization of storage resources, provides seamless migration across tiers of storage, removes interoperability barriers, and integrates common functionality across the pool of heterogeneous storage.

Virtualization is embedded in the controller architecture of the Universal Storage Platform, an approach that has been praised by industry analysts as innovative. Indeed, IDC has created a new storage category, the Networked Storage Controller, for systems like the Universal Storage Platform. Unlike virtualization approaches by other companies, the Hitachi approach does not introduce another layer of complexity between the application server and storage. Further, it does not reside in the Fibre Channel SAN and is not dependent on the SAN for virtualization. Therefore, it is not limited to virtualization of open systems Fibre Channel-based storage. It can support direct-attached Fibre Channel hosts as well as ESCON/FICON-attached mainframes. As a result, mainframe LDEVs can be mapped to lower-cost external ATA or Serial ATA storage.

*Industry analysts call the Hitachi virtualization approach "innovative."*

Two software products (introduced in Chapter 1 of this guide), along with a set of complementary services, enable the virtualization and logical partitioning in the Universal Storage Platform:

### Hitachi Universal Volume Manager Software

Universal Volume Manager software enables the virtualization of up to 32PB of internal and external storage, which allows it to be aggregated into one common pool and managed by a single set of tools and software. Once external storage is virtualized, you can use Hitachi battle-tested software to make point-in-time copies within a system, make remote copies acrosss the metropolitan area or the globe, or migrate data across tiers of storage. For example, using Hitachi ShadowImage™ In-System Replication software you can make copies of data volumes from one attached storage system to another. These volumes can then be used for data mining, application development, or backup and recovery.

Further, Universal Volume Manager software, in conjunction with Hitachi Universal Replicator or Hitachi TrueCopy™ Remote Replication software, also allows data replication and migration capabilities across heterogeneous storage systems, while enabling efficient integration and utilization of older storage systems. Combined with Hitachi Volume Migration software (formerly CruiseControl), Universal Volume Manager software enables data lifecycle management across multiple tiers of storage, including the storage of mainframe data on low-cost, SATA-based, midrange storage systems such as the Hitachi Thunder 9500™ V Series systems. For example, in mainframe environments you can replace tape with SATA storage for more reliable and faster backup and recovery, or you can make more frequent point-in-time copies to less costly SATA storage for more up-to-date recovery from application crashes or disasters.

### Hitachi Virtual Partition Manager Software

Virtual Partition Manager software allocates Universal Storage Platform resources, including ports, cache, and disk (internal and externally attached) into independently managed Private Virtual Storage Machines. Partitions can be dynamically modified to meet application QoS requirements based on changing business and application priorities. You can use Virtual Partition Manager software to create up to 32 Private Virtual Storage Machines. Meanwhile, to the host, each Private Virtual Storage Machine appears as if it were its own storage system and, as such, allows efficient utilization of storage across the platform, enabling chargeback and utility-like operations through a virtual serial number.

## Common Storage Management via Hitachi Storage Area Management (SAM) Suite Software

Common storage management is perhaps the most important component of Application Optimized Storage™ solutions from Hitachi Data Systems. Rather than provide end users with disparate interfaces for disparate platforms, essentially resulting in multiple islands of storage management and inaccessible information, Hitachi Data Systems provides you with the same software, the same management interfaces, and the same tool sets to manage all heterogeneous storage systems from a single console. (See Table 8.)

Hitachi ensures this simplification through the Hitachi SAM Suite, which provides HiCommand storage area management modules that are based on an open architecture. Built on the Storage Management Initiative Specification (SMI-S) and Common Information Model (CIM) standards, these HiCommand modules deploy quickly and easily because they use standard agents already resident on servers and storage components. They protect investments and reduce vendor lock-in by working with almost any storage infrastructure you have in your data center.

The storage management tools offered by Hitachi Data Systems to support the Universal Storage Platform are included in the Hitachi SAM Suite, which offers both modules for Hitachi storage-specific and heterogeneous storage area management. The Hitachi SAM Suite provides application-centric capacity and performance management of your entire storage infrastructure. A key component of the Application Optimized Storage initiative, the Hitachi SAM Suite modules tune delivery of storage system performance, availability, recoverability, and functionality attributes to the requirements of your vital business applications.

**Table 8. Manage heterogeneous storage systems from a single console.**

| Business Solution | Solution Category | Solution Elements | Storage Challenges Addressed |
|---|---|---|---|
| | Common Storage Area Management (SAM) | Hitachi SAM Suite, Hitachi TagmaStore™ Universal Storage Platform external and internal storage virtualization | Explosive data growth; fast-moving technology and business landscape; management of heterogeneous environments; complex and costly management infrastructure; failure to meet application QoS and SLAs |
| Simplification | Open and Mainframe: Consolidation, Aggregation, and Virtualization | Hitachi Universal Volume Manager, Hitachi Virtual Partition Manager, and Hitachi Volume Migration (formerly CruiseControl) software; Hitachi Cross-System Copy software (formerly HiCopy); Host Storage Domains | Consolidation, manageability of storage and assets, data growth, integration, migration, and file services |
| | Services | Storage Consolidation Services, External Storage Implementation Service, Storage Economics Strategy Service | TCO, ROI, consulting |

## Hitachi Resource Manager™ Utility Package

The Resource Manager utility package of software provides local resource management for Hitachi storage, with functions such as: executing configuration setting and display, information display, and error monitoring; locking and unlocking of data into cache in real time; optimizing storage capacity usage; streamlining configuration management processes; and ensuring security in SAN environments.

## Hitachi HiCommand® Storage-specific Management

For granular discovery and control of your Hitachi storage environment, including attached storage systems that are virtualized into the storage pool of the Universal Storage Platform, the Hitachi SAM Suite offers Hitachi storage-specific modules. These modules augment and control the management of Hitachi storage systems by providing granular views where standards have not caught up with advanced, industry-leading functionality of Hitachi storage. Storage-specific modules in the Hitachi SAM Suite provide discovery and control of all Hitachi storage elements. The framework for Hitachi storage-specific management is shown in Figure 28.

### Hitachi HiCommand Device Manager Software
Device Manager software provides centralized management of distributed Hitachi environments. It also provides the device interface into Hitachi storage systems for the heterogeneous HiCommand Storage Services Manager software.

### Hitachi HiCommand Tuning Manager Software
Tuning Manager software provides proactive capacity and performance monitoring, reporting, and forecasting of storage resources, including business applications such as Oracle and SQL Server.

*Hitachi SAM Suite helps match application requirements to storage attributes.*

## Hitachi HiCommand Heterogeneous Storage Area Management

Within the Hitachi SAM Suite, HiCommand modules for the management of heterogeneous storage monitor, visually render, and administer your data infrastructure as a whole, including storage from multiple vendors as well as the switches, host bus adapters, servers, and file systems that serve business applications. Hitachi-enhanced storage area management modules deliver focused management for Hitachi storage and SAN environments.

For multivendor storage environments, Hitachi offers HiCommand Application and Business Modules. Clustered around the core management module—HiCommand Storage Services Manager software—business modules satisfy demands for rapid provisioning and accurate chargeback of storage usage. Application modules extend the HiCommand management reach "inside" application objects, better correlating application performance with the storage infrastructure and providing improved storage resource management for even the largest collections of file servers. Powered by AppIQ, these modules protect investments by working with almost any storage infrastructure to manage business and application demands. The framework for Hitachi heterogeneous management software is shown in Figure 28.

### Hitachi HiCommand Storage Services Manager Software
HiCommand Storage Services Manager software acts as the main console for the Hitachi SAM Suite's heterogeneous storage infrastructure management. Depending on your preference, Storage Service Manager software allows storage under its control to be viewed as independent systems, or, when attached to Universal Storage Platform, as part of the virtualized Universal Storage Platform storage pool.

### Hitachi HiCommand Application Modules
Application modules—HiCommand QoS for Oracle, HiCommand QoS for Sybase, and HiCommand QoS for Microsoft Exchange software—identify in real time how storage infrastructure performance, capacity, and availability impact applications. In addition, HiCommand QoS for File Servers software delivers end-to-end management of capacity, performance, and user consumption.

### Hitachi HiCommand Business Modules
Business modules include HiCommand Path Provisioning software, which automates configuration of storage resources to support business applications, and HiCommand Chargeback software, which automatically meters storage resource utilization enterprise-wide, calculates costs, and provides comprehensive reporting.

*Storage Services Manager software provides application-to-disk management.*

**Figure 28. The Hitachi SAM Suite includes heterogeneous HiCommand modules, powered by AppIQ, that are based on open architecture (see blue sections below). These modules protect investments by working with almost any infrastructure to manage business and application demands. It also contains Hitachi storage-specific modules, which provide granular discovery and control of your Hitachi storage environment, including attached storage systems that are virtualized into the storage pool of the Universal Storage Platform (see purple sections below).**
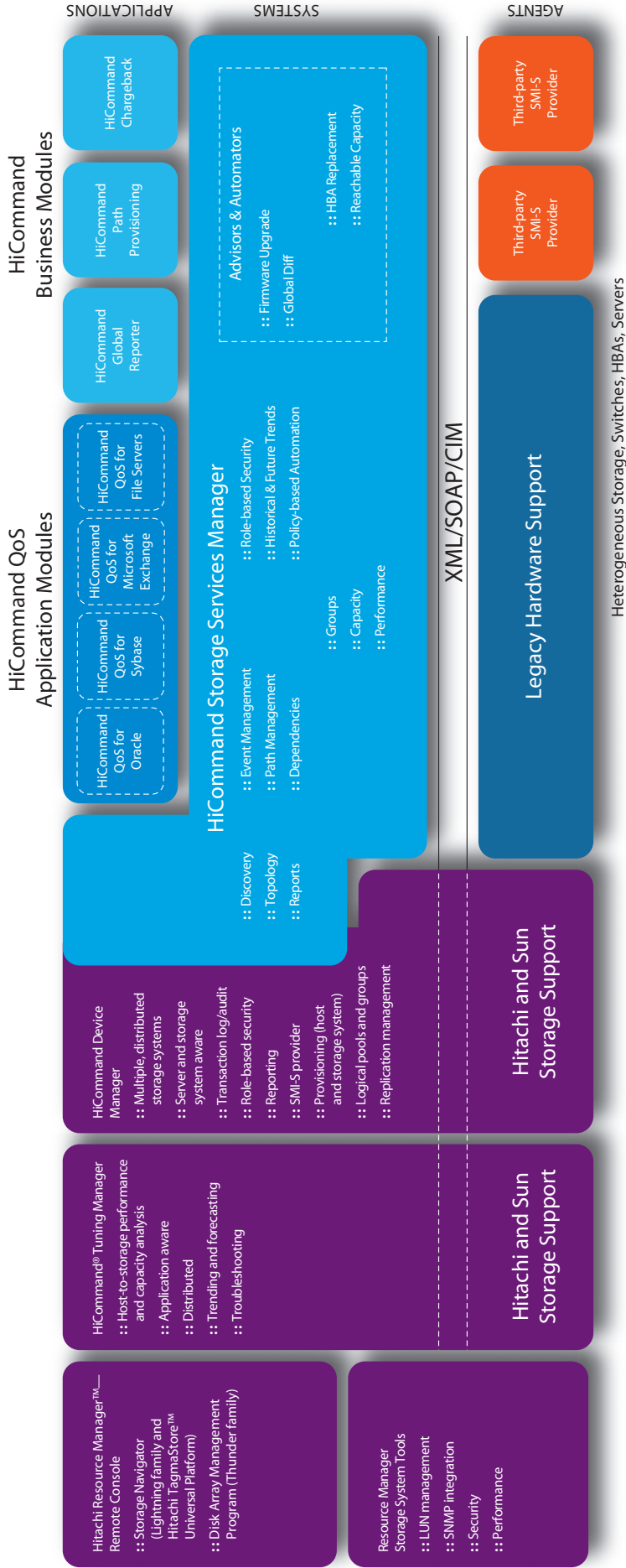
# Storage Management Consulting and Services

The Hitachi Data Systems Global Solution Services group provides professional services to help you manage data from a common console, regardless of where the actual physical storage resides. This allows you to gain significant TCO and ROI advantages while maintaining flexibility in storage management outsourcing and consulting. Global Solution Services leverages unique Hitachi Data Systems experience acquired in implementing the most demanding data and application management solutions for a broad range of businesses.

## External Storage Implementation Service for the Hitachi TagmaStore Universal Storage Platform

The External Storage Implementation Service helps aggregate existing operational storage environments using the groundbreaking virtualization capabilities of the Universal Storage Platform. Global Solution Services consultants apply expertise and proven best practices to help you to plan, design, and implement a tiered storage environment in the manner that best unites your existing operational storage with the Universal Storage Platform. This enables you to maximize the return on both your new and legacy storage investment.

## Storage Consolidation Planning and Design Service

The Storage Consolidation Planning and Design Service helps you consolidate your current storage systems to achieve greater capacity, performance, and scalability. Global Solution Services professionals will help you analyze your existing storage environment, application characteristics, and capacity requirements to determine the best way to proceed. This analysis is then used to create a set of implementation plans that will guide your system transition to a consolidated storage or new SAN environment. The objective of this service is to ensure successful planning and design of your new consolidated storage environment.

## Storage Economics Strategy Service

The Storage Economics Strategy Service helps you better assess, analyze, design, and economically justify the most appropriate storage architecture and management tools to meet your organization's requirements. We help you to objectively consider your current storage environment (host connected or via a network) and make tactical/strategic plans to take advantage of new storage architectures. We employ a workshop approach to rapidly review your business and IT infrastructure, management practices, operational capabilities, and risk areas. Within this workshop and discovery process, we evaluate your storage assets, assess and document your requirements and business drivers, provide a logical design for your storage solution, and provide economic modeling for the resulting design. This assessment provides expert technical and thought leadership that can be used to promote new storage initiatives.

# Competitively Unique Financial Benefits of the Hitachi TagmaStore™ Universal Storage Platform

There is a widespread recognition today of the importance of aligning IT and business for enterprise growth and ultimate survival. With this backdrop, the new Hitachi TagmaStore™ Universal Storage Platform can dramatically change the way you handle storage and produce business benefits not available anywhere else. The emerging discipline of business technology optimization is catalyzing many corporations to maximize the business value of IT by aligning IT with business goals. You can create new revenue streams through newfound IT/business agility while lowering TCO and minimizing risks. This chapter provides a guideline for building a business case for employing the Universal Storage Platform.

*Hitachi offers business benefits not available anywhere else.*

## Building a Business Case for the Universal Storage Platform

It is important start with realistic assumptions about the modern IT enterprise environment and then systematically evaluate all elements of ROI, including hardware, software, and services. It will then be easy to compare the ROI to competitive alternative projections to determine whether an investment in the Universal Storage Platform will provide the best financial return for your enterprise.

*It is important to evaluate all elements of ROI.*

### Start with Realistic Assumptions

Most organizations have storage platforms from a number of different vendors in the data center. Each platform has its own set of management tools, data replication engines, business continuity procedures, and supporting software utilities and management tools. The platform differences often result in "islands of storage management" with significant operational inefficiencies through duplication of skills, training, and operational expense.

Often, a manual approach is required to keep track of and manage these disparate systems and to attempt to provide the storage QoS that business applications demand. In addition, data for a given application cannot easily be moved between the heterogeneous vendor systems to fit the availability and performance requirements of different business applications.

*Most multivendor IT shops suffer from operational inefficiencies.*

This is in sharp contrast to the structured, standardized, and seamless approach possible on the Universal Storage Platform. The Universal Storage Platform with its virtualization capabilities enables common management and procedures that allow the matching of business application requirements to storage attributes to achieve true IT and business agility as ongoing events demand. Aligning IT with business goals and creating new revenue streams while lowering costs and minimizing risks becomes much easier on a Universal Storage Platform. This can be realized because of the Hitachi Data Systems focus on the two key business solutions of Business Continuity/Disaster Recovery and Simplification.

*A standardized seamless approach can foster true IT and business agility.*

### Define and Align Storage Objectives with Business Objectives

Clearly, IT knows that its purpose is to support business objectives. But most vendors push an information lifecycle management approach to storage that is designed simply to achieve operational efficiency in the infrastructure. The opposing view and the one that truly links IT with business objectives, is that storage infrastructure is instrumental in the success of the applications that directly serve business needs and, in turn, drive growth and corporate prosperity.

*Build your business case.*

As shown in Chapter 1, Table 2 can provide you with a road map to help effectively analyze the many financial benefits of the Universal Storage Platform and systematically build your business case. Hitachi Data Systems believes that a careful analysis of the competitively unique features and benefits of Hitachi solutions of will make your decision obvious.

The Universal Storage Platform represents a radical new approach to storage architectures and an equally new set of storage economic factors that can be employed to reduce operating costs (OPEX) and improve the total cost of storage ownership (TCSO). Early analysis of the Universal Storage Platform shows strong payback from a variety of sources, both technical and operational in nature. Hitachi Data Systems consultants, with many years of ROI and economic analysis experience, have determined that the average customer storage infrastructure has US$1 million of storage-related OPEX costs that can be identified and recovered for every 12TB of usable disk capacity. The Universal Storage Platform extends the possibilities to identify and harvest these OPEX costs in a very real manner for most customers. Promoting a new storage architecture with Universal Storage Platform at the core of the strategy can be an effective tool for reducing technical and operational costs. Many of these functional and technical areas are outlined below.

Simply stating that the Universal Storage Platform has TCO benefit is not enough; empirical proof and real-world justifications are often needed for complex sales campaigns. This is where the Storage Economic Strategy Service can be used effectively to discover and prioritize the cost impacts that can be achieved with this new architecture. (See service description at the end of this chapter.)

*A complete systems approach will always generate the best return.*

## A Powerful Mix of Unique Features and Benefits

The Universal Storage Platform is a unique combination of revolutionary advances in hardware, software, and services that creates IT and business benefits not previously thought to be available from storage vendors. The platform not only extends Hitachi leadership in storage system availability, performance, and capacity, but also powers new software virtualization breakthroughs, including logical partitioning, management of externally attached heterogeneous storage systems, and universal storage-agnostic replication. Taken together:

" The Universal Storage Platform represents a new category in the industry as its powerful architecture enables new levels of virtualization and replication not possible in previous generations of enterprise storage. It supports a new operational paradigm capable of delivering a holistic Application Optimized Storage™ approach across an entire enterprise. The result is a new economics framework for information infrastructures, providing organizations with millions of dollars in potential cost savings."

*The Universal Storage Platform maintains Hitachi leadership in the enterprise storage space.*

— Scott Genereux, Senior Vice President of Global Marketing and Channels, Hitachi Data Systems

### Business Continuity Benefits

Economic events from the late 1990s to the present have brought an increased focus on improving business resilience for most enterprises. Events that have sharpened this focus include not only the tragedy of September 11, 2001, but also the maturing of e-commerce, and the trend toward centralized management and consolidation of IT assets. Both enterprises and small- to medium-sized businesses alike find they are increasingly relying on IT infrastructure for revenue generation and competitive advantage, not to mention helping them answer government regulations that mandate disaster tolerance and data protection. All these events have combined to make business continuity the most important storage challenge for many enterprises. This has put business continuity projects "front and center" on the agenda of many businesses, with IT management being asked to document, evaluate, and implement appropriate solutions.

Organizations worldwide are rushing to get their business continuity planning and disaster recovery strategies in order. These forces have caused many organizations to consider a three data center replication model to protect data. Hitachi Universal Replicator software for TagmaStore Universal Storage Platform provides two alternative architectures—Cascade and Multitarget—for implementing the three data center model not available from competitive offerings (see page 40 for a description of Cascade and Multitarget).

Yet, the unspoken truth is that the complexity of any business continuity solution—much less the very advanced three data center variety—brings into question whether it will work in the event of disaster or some other form of outage. Despite the complexity, not to mention the significant investment required, today's increased risks and regulatory scrutiny are prompting companies that have previously decided to bear greater risks to take another look at how to achieve a higher level of data protection.

In addition to supporting two alternative three data center architectures, the Universal Storage Platform can manage heterogeneous disk storage resources for business continuity planning. You can apply consistent procedures, skills, and training across all your storage platforms. Rather than maintaining separate procedures and skills for data replication and recovery on each storage platform, you can apply one powerful and consistent set of replication capabilities and storage management tools to all your disk storage resources. In a disaster recovery scenario, the risks of error are lower when the procedures are consistent across all platforms. It is also easier to ensure when needed, the recovery of critical business applications and data.

## Regulatory Compliance Benefits

Any enterprise doing business in the United States must deal with pending federal, Office of the Comptroller of the Currency (OCC), and Securities and Exchange Commission (SEC) regulations for out-of-region disaster recovery. Similar concerns arise from the Basel II Accord, which will require businesses to provide as much as an 18 percent corporate-wide capital reserve for "operational risk" if appropriate data resiliency measures are not taken. Regulations also apply to health care and other industries, often with an emphasis on protecting privacy as in the UK's Data Protection Act. In all industries, insurance rates can increase dramatically if disaster recovery and business continuity planning processes are not in place.

Beyond the corporate e-mail application's growing share of mission-critical storage needs, retaining e-mail in archival storage is becoming standard practice. Government regulations now recognize that e-mail and attached documents have largely replaced paper-based communications as records of business transactions and corporate behavior. In response, lawmakers and regulatory agencies have imposed new regulations that require the retention and protection of electronic messages and data, and organizations are scrambling to understand and comply with these new and evolving rules. The good news is that an effective tiered storage solution can reduce e-mail server and storage costs, improve e-mail server performance and employee productivity, satisfy regulations, protect valuable company intellectual property, and mitigate the huge and unbudgeted costs of legal discovery involving e-mail that's available only on backup tape.

Most organizations' storage strategies continue to focus on risk avoidance through improved business continuity planning. A proliferation of terrorist threats has also brought risk avoidance to the forefront. Organizations now face increasing threats of wide-area disruption, ranging from frail power grids to terrorism to virulent computer security attacks. The enterprises' reliance on technology concentrates and magnifies exposures to fraud and outages. And since applications are integrated in supply chains and business processes, any problem can easily ripple through an entire operation.

*Recent events have put the spotlight on business continuity.*

*A three data center configuration provides the best combination of protection against disaster.*

*Corporate governance and regulatory compliance are at the forefront of many IT efforts.*

*Advanced Hitachi tiered storage solutions reduce regulatory risk.*

## Storage Area Management Benefits

Managing and optimizing storage to serve the needs of applications may seem difficult. Many organizations have enough trouble just providing an accurate inventory of the storage infrastructure from a set of manually updated spreadsheets. Even organizations with relatively sophisticated storage management software architecture can have their hands full coping with the need to manage this explosion of data, particularly when an uncertain economy has led to caution in IT investment. Yet new regulations demand that an ever-larger amount of data must be replicated or archived for retention and protected in a very structured process. How do you continue to grow when you have to do so much more on flat budgets? A good way to accomplish this is to work smarter, not harder!

*With Hitachi Storage Area Management (SAM) Suite software you work smarter, not harder.*

The Application Optimized Storage framework with the Universal Storage Platform and its surrounding software and services provides a common-sense approach. This framework enables a true business agility advantage by easily matching business application requirements and storage attributes.

## Storage Consolidation Benefits

Even with the complicating factors of terrorism and increased regulation, business efficiency remains the largest IT issue. In today's competitive environment, the savvy enterprise should leverage the inherent value of a business to its fullest. Doing so always means making better use of data for cross-selling, up-selling, unlocking value isolated in individual business units, and increasing agility in addressing new markets.

Consolidation is one way to get organizational data under control while also controlling costs, although the recent high levels of merger and acquisition activities make consolidation problematic, at least at the application level. It's difficult to get the consolidation done even at the storage infrastructure level, much less to the point of finishing consolidated financials fast enough to meet the tight reporting deadlines introduced by the Sarbanes-Oxley Act in the United States.

Sometimes the only way to continue to improve or maintain a competitive edge is by upgrading technology, but that can be problematic when the pace of technological change is faster than your equipment's depreciation schedule. In most organizations, it's very difficult to replace equipment that hasn't yet lived what the Chief Financial Officer would consider a useful life span. In spite of this fast pace, IT solutions must reflect new concerns for integration, effective utilization, manageability, and availability while not forgetting the need for investment protection. All of these business issues drive organizations toward more effective storage consolidation strategies. If anything, it's more important than ever to lower infrastructure and operational costs by reducing the number of systems to manage while at the same time improving overall storage resource utilization. Yet many organizations are finding that they have reached the limits of consolidation with their existing storage systems.

*Unique Hitachi consolidation software extends the useful life of all multivendor storage assets.*

Clearly, Hitachi Data Systems customers are enjoying the benefits that large-scale storage consolidation brings to address many of these problems. But organizations that have already completed some level of consolidation with a competitor's product may find that they lack the scalability to go further on their existing infrastructure. Some storage systems that have room to accommodate additional capacity lack the internal throughput to drive business performance effectively with more data migrated to them.

## Storage Aggregation Benefits

Storage aggregation is what Hitachi Data Systems terms the hyper-consolidation that is available for all heterogeneous storage in the enterprise, and it is not available from any other vendor. Competitive consolidation schemes involve the actual movement of data to the vendor's storage system. To avoid the cost of data migration and the premature retirement of storage systems not yet fully depreciated, a Universal Storage Platform can allow for the attachment and common management of external storage systems. Aggregation therefore is a more comprehensive (hyper) form of consolidation and yet less costly.

With Hitachi SAM Suite software, the external storage systems are presented to the administrator as part of the Universal Storage Platform's own tiered storage pool. This is the definition of storage aggregation. The ability to attach other storage directly to a Universal Storage Platform not only protects an investment in installed storage, but also adds value through extended life for all multivendor external systems. Thus, the attached storage is handled through the same single, common point of management used for internal storage. This leverages the advanced replication and enhanced business continuity tools that a Universal Storage Platform offers.

*Storage aggregation avoids the costs of data migration and the premature retirement of assets.*

One clear benefit of Universal Storage Platform storage aggregation capabilities goes back to the value of consolidation and the difficulty and expense of data migration. With the Universal Storage Platform, data migration can be handled more simply and easily if other storage systems are directly attached and universal replication moves the data to the Universal Storage Platform. At that point, you'd be able to move out the attached storage (if it's older and fully depreciated). Alternatively, you could repurpose it as a lower tier of storage in the shared, virtualized storage pool described in the next section on virtualization.

The simplified data migration capability of the Universal Storage Platform obviously facilitates the matching of different tiers of storage to application requirements over a wide range of business requirements. This makes the notion of attaching storage to a Universal Storage Platform especially attractive. Even older storage systems can act as third- or fourth-tier storage.

*Even older storage systems can act as third- or fourth-tier storage.*

## Storage Virtualization Benefits

An extremely important value of the Universal Storage Platform can be viewed in light of IT administrators looking for ways to mask the management complexity of existing networked storage environments while scaling their environments to meet dramatic growth. At a time in which technology lifecycles are shorter than capitalization rates, the breakthrough Universal Storage Platform virtualization approach enables new functionality to be mapped across older assets to optimize the benefits of simplification for multivendor storage.

Continued business uncertainty has IT still wary and looking to maximize returns on previous investments rather than strike out in new and unproven directions. One of the unintended results of this stance is that IT may see some of the very technologies that could best help them deal with these challenges as too risky. A good example is storage virtualization. IT clearly has to reduce storage complexity to cope with rising volumes of data on multiple tiers and brands of storage. But enterprises hesitate to insert an unproven virtualization platform into the data stream that delivers the lifeblood of the organization. Some even think that virtualization needs to become more mainstream before it can have a real impact on solving the complexity problem. However, effective virtualization has arrived in the Universal Storage Platform.

*Hitachi provides the first true global virtualization solution for the entire enterprise.*

Although the meaning of the phrase varies from speaker to speaker, the Enterprise Strategy Group defines virtualization as "a technology that gathers data location information from physical storage devices, network services, and applications, and then abstracts the locations into logical views for end users." The ideal virtualization in a Universal Storage Platform extends the innovative Hitachi port-virtualization technology to all enterprise storage assets. The ultimate goal is the abstraction of physical storage systems as Private Virtual Storage Machines, including ports and cache for each client (application, server, or group of users), in order to guarantee quality of service and to shield your organization from the complications of sharing storage.

The industry has seen some attempts at virtualization[6] via dedicated, add-on appliances or through server- or switch-hosted virtualization software that sits in the data stream between client systems and storage. However, these approaches haven't gained much momentum. Hitachi Data Systems believes that implementing storage virtualization within the Universal

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[6] For a definitive technical economic discussion of the pros and cons of different approaches to virtualization and the evolution of the Hitachi approach, see the white paper "Hitachi TagmaStore Universal Storage Platform: Virtualization without Limits." This paper is authored by Naoya Takahashi, Ph.D., Chief Operating Officer Information & Telecommunication Systems at Hitachi, Ltd., and Hu Yoshida, Vice President and Chief Technology Officer at Hitachi Data Systems, and can be found on the Hitachi Data Systems Web site at: http://www.hds.com/pdf/wp168_tagmastore_virtualization.pdf#view=FitH&pagemode=bookmarks

Storage Platform controllers would take advantage of the redundancy and scalability that underpin its inherent high availability and massive storage consolidation capabilities. Having virtualization in the storage fabric improves performance through tight integration with physical storage operations (including cache allocation), and creates an optimal balance of economy and functionality. You can have the same confidence in the availability and scalability of the breakthrough virtualization solution as current Hitachi Data Systems customers have in high-end Hitachi storage architecture. In fact, the Hitachi virtualization approach simplifies your environment, rather than adding questions about scalability, a single point of failure, and another layer of complexity.

## Storage Utility Chargeback Benefits

With Universal Storage Platform virtualization and advanced SAM capabilities, any IT organization can accurately provide storage as a utility, whether to enable internal chargeback for storage usage by department to achieve more efficient storage management processes, or to provide storage on a metered basis to a variety of businesses. Logical partitioning of storage, including cache, ports, and capacity has obvious advantages. So does the ability to delegate management permissions to individual administrators for their assigned virtual private storage machines. In addition, it is easy to centrally manage business processes, such as data replication and transferring production processing to a secondary site (either for disaster recovery or nondisruptive maintenance of your primary system), with common tools to make the processes less error prone and more efficient.

## Total Cost of Ownership and Return on Investment Benefits

Although total cost of ownership is an overused phrase in the financial analysis of storage investments, it is clear that one measure of a good investment is to view the total cost of owning storage on an annual basis. Hitachi Data Systems believes that in developing a business case for the Universal Storage Platform, it will become apparent that there are significant lower TCO benefits to be gained from advanced Hitachi software solutions that streamline, automate, and centralize the management of your entire storage investment.

The complete solution can reduce the TCO for enterprise users by as much as 40 percent. Cost reductions can be achieved not only through much-improved administrator productivity, but also by significantly reducing the software licensing costs traditionally associated with maintaining multiple copy and management point products. In the short term, Hitachi Data Systems solutions enable cost efficiencies of your entire heterogeneous infrastructure. In the long term, Hitachi Data Systems expects you to see the advantages of a homogeneous Hitachi storage environment for future growth. The efficiency of a pure Hitachi environment is not marketing puffery, but rather is based on actual data collected over the past three years. This is shown in Figure 29.

**Figure 29. Actual average deployed capacity of Hitachi systems exceeds that of competitive systems by a factor of 2.5X.**



*The Hitachi Data Systems solutions can reduce TCO by as much as 40 percent!*
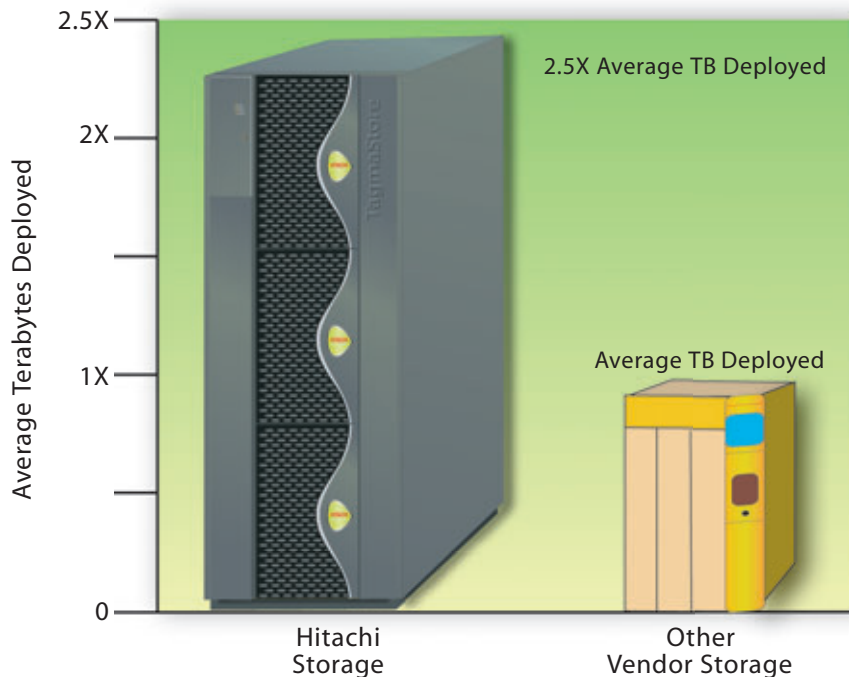
A recent SNIA (Storage Networking Industry Association) survey of customer pain points ranked TCO number one. According to ITCentrix, an independent software and services firm, customers can expect the Universal Storage Platform to deliver significant TCO benefits.

"It's currently too expensive to provide a common management solution for the fragmented data assets of a corporation," said Dave Vellante, CEO of ITCentrix. "Based on our extensive analysis, nothing else compares to this product, which in some configurations will deliver a 160-plus percent internal rate of return on a [US]$3.4 million investment over three years. This changes the dynamics of the storage industry."

Clearly these are major savings to be achieved through the Universal Storage Platform and its ability to aggregate up to 32PB of internal and external storage into a single virtual storage pool, with common functionality and application QoS managed from a single console. The Universal Storage Platform will dramatically reduce management overhead and software-licensing costs, while at the same time extending the latest software advances to older or depreciating storage assets. By adopting this unified management structure, Hitachi removes the need for, and cost of, multiple and overlapping software products.

*The Universal Storage Platform dramatically reduces overhead and software-licensing costs.*

## Storage Economics Strategy Service

Being able to prove the value of a Universal Storage Platform, weighed against your current infrastructure and other alternatives, is perhaps the most practical way to build a business case for purchase. One route, offered by Hitachi Data Systems Global Solution Services, is the Storage Economics Strategy Service. Global Solution Services experts will work with your storage and IT executives to determine the financial returns that a unified enterprise-wide storage infrastructure can accrue by optimizing business applications, simplifying data lifecycle management strategy, and implementing an effective storage area management solution. A unique benefit: unlike the competition, Hitachi takes an approach that avoids the early retirement of existing storage assets before full depreciation.

*The Storage Economics Strategy Service offers a practical way to build a business case for purchase.*

The Storage Economics Strategy Service will graphically demonstrate to executives within your organization the bottom-line impact of spending on any new storage you might acquire plus the ongoing cost of storage ownership. Included are:

:: Assessment of your enterprise storage infrastructure and needs

:: Design of a new multitier, multivendor centrally managed architecture in a collaborative workshop

:: Analysis of ROI for multiple design options and multiple payback elements

:: Justification and quantification of your storage direction in a custom, detailed report

Ultimately, a business case for an appropriately sized Universal Storage Platform investment will cover the comprehensive set of hardware, software, and services that creates an ideal storage infrastructure solution, which:

:: Unifies data and storage services across its own storage and attached storage systems

:: Makes everyone more efficient, enterprise-wide, by optimizing the storage service provided to applications

:: Significantly reduces storage management complexity

:: Reduces operational costs

:: Enables best storage practices

:: Helps align IT practices with business requirements

*Global Solution Services will help you create an ideal storage infrastructure solution.*

## An ROI Case History of Virtual Architecture Justification

University of Utah Health Sciences Center (UUHSC) in Salt Lake City, Utah, had experienced growth and a storage access rate that required a move to a virtualized storage or SAN architecture. UUHSC sought increased disk utilization, reduction in storage management labor, multitiered storage, software capabilities for data redundancy, and elimination of the backup process from production instances of data. Hitachi Data Systems was chosen to supply the solution, which collapsed current SANs and storage (new and old) and virtualized it behind the Universal Storage Platform. Before and after system configurations (Figures 30 and 31) show that the waste cost of stranded disk space was eliminated by the Universal Storage Platform virtual architecture.

**Figure 30. SAN islands and underutilized storage were growing problems at UUHSC before the Universal Storage Platform.**
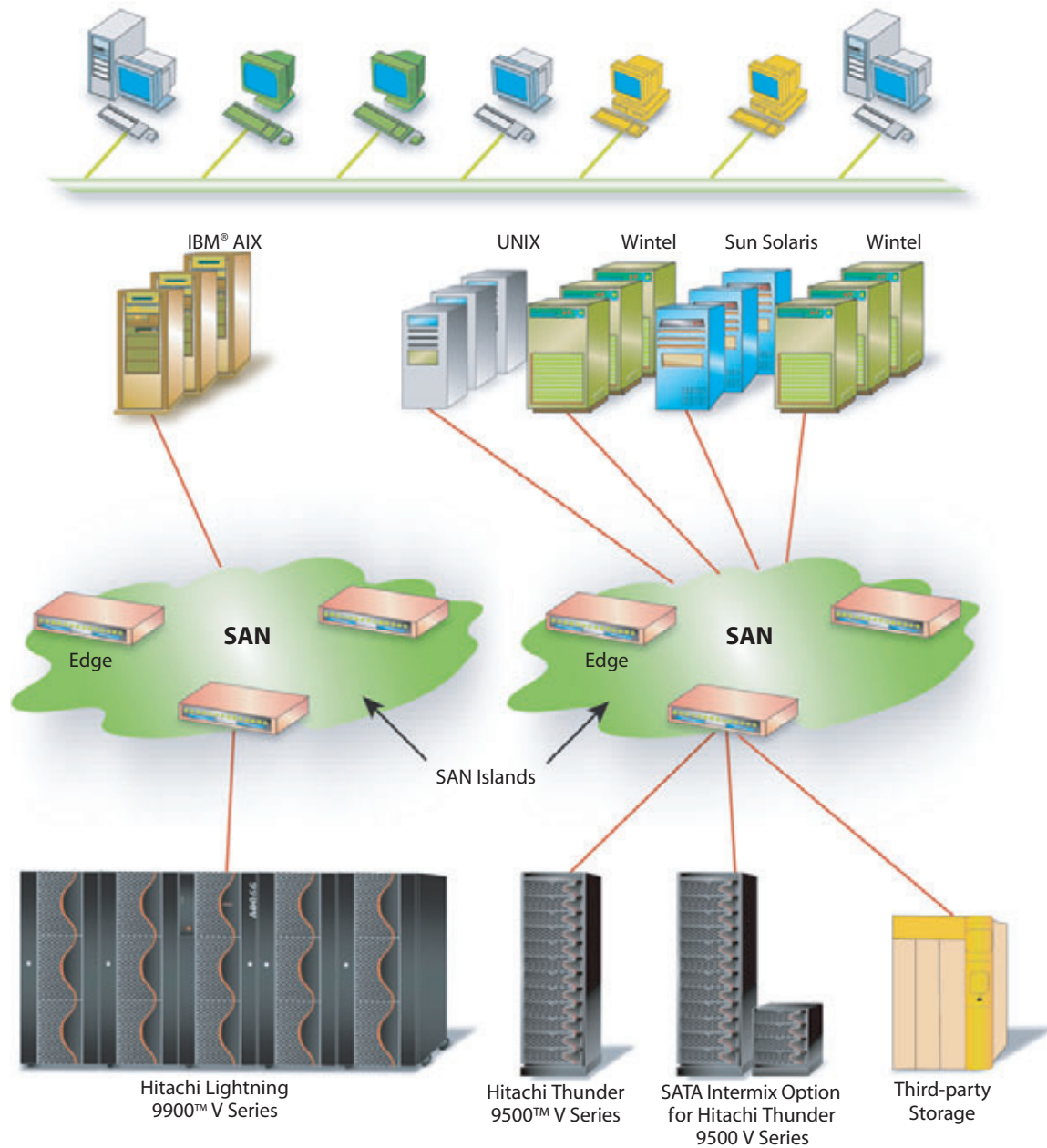


IBM® AIX    UNIX    Wintel    Sun Solaris    Wintel

SAN

Edge

SAN

Edge

SAN Islands

Hitachi Lightning
9900™ V Series

Hitachi Thunder
9500™ V Series

SATA Intermix Option
for Hitachi Thunder
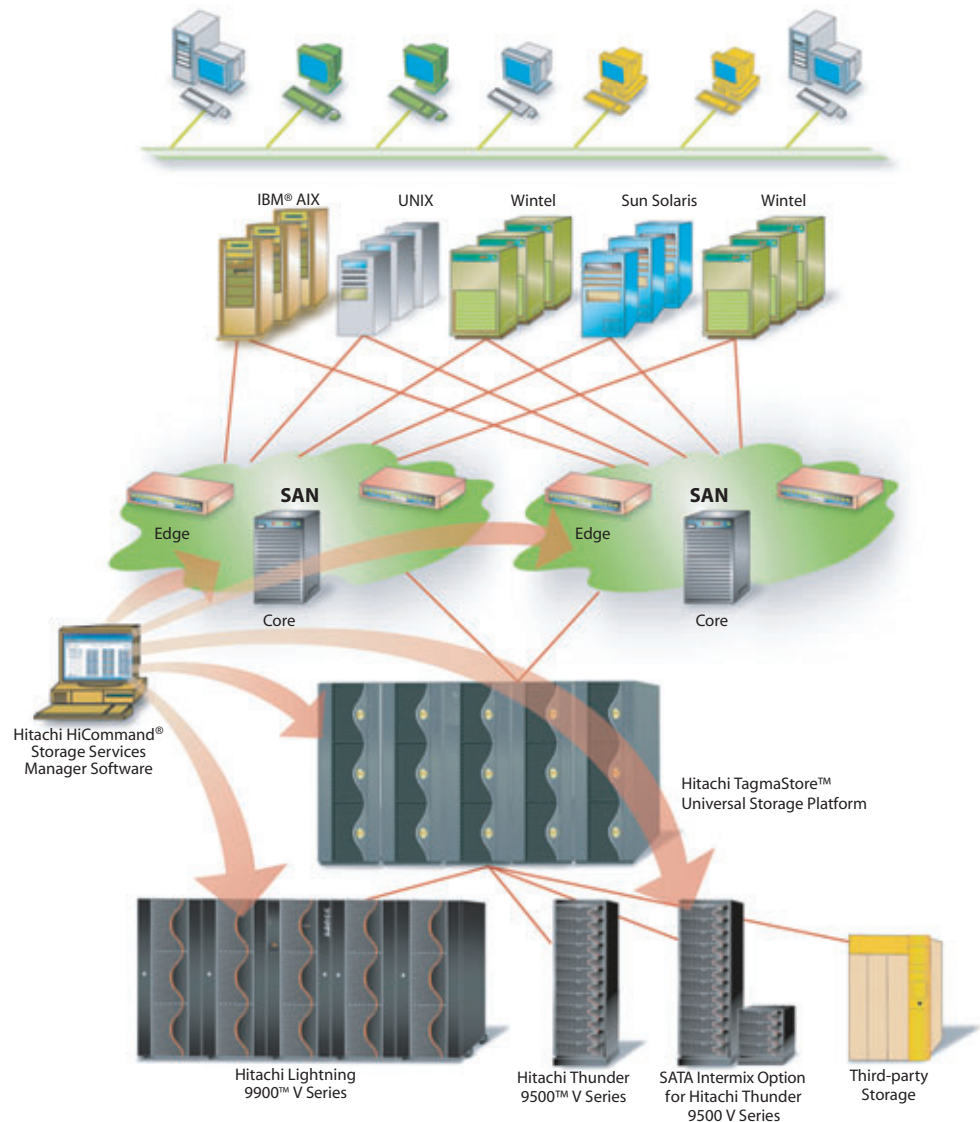9500 V Series

Third-party
Storage

**Figure 31. The Universal Storage Platform not only increased disk utilization but also aligned storage in tiers and reduced the risk of outages.**



Components and economic results of the successful Hitachi Data Systems solution included:

:: Components—10TB Universal Storage Platform (model USP100), 10TB Hitachi Thunder 9585V™ system, 10TB Hitachi Thunder 9520V™ system, Hitachi ShadowImage™ In-System Replication software, Hitachi Universal Volume Manager software, and Hitachi Resource Manager™ utility package. UUHSC plans to pursue Hitachi HiCommand® Storage Service Manager software in the near future.

:: Economic Results—UUHSC's US$705K investment provided a positive 127 percent return on investment, with payback in 14 months. Total three-year savings are estimated over US$1.6 million, with savings accrued from waste reduction, reduced labor for management, hardware and software purchase avoidance, data risk reduction, increased recovery point objective and recovery time objective for backups, disaster protection, and hardware and software maintenance reduction. The projected ROI from this project is shown in Figure 32. Appendix C provides a detailed listing of technical benefits and financial investment projections.

**Figure 32. The Hitachi solution is projected to provide an investment break-even point within 14 months and a ROI of 127 percent.**

### Break Even Analysis
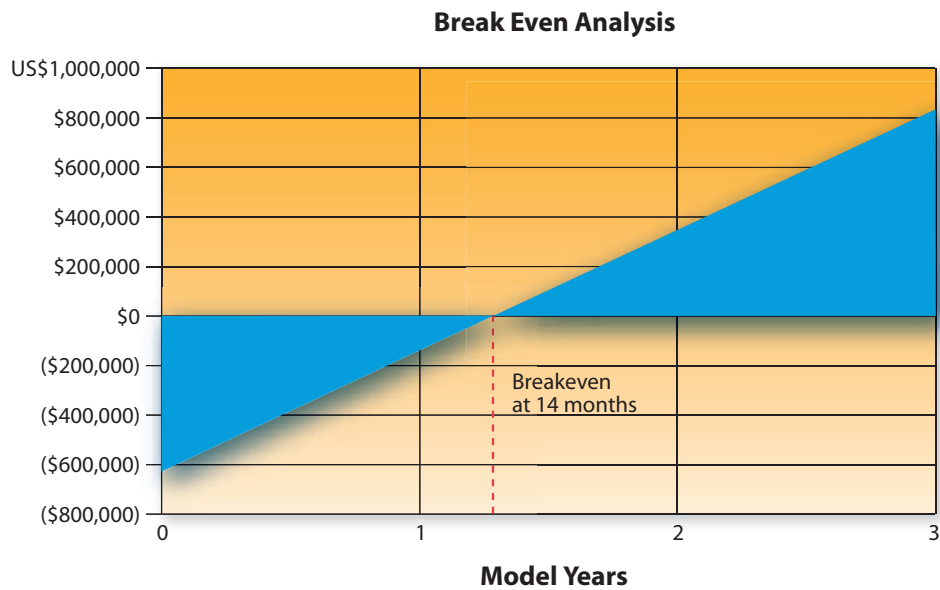


The technical benefits of the Hitachi Data Systems solution, when added to operating expense reduction and economic benefits, provide for a complete rationale for the move to storage virtualization on the Universal Storage Platform. Performance, growth, management, labor, and other limited resources have now been extended. Long-term capabilities with increasing access rates and storage growth rates can be attained within a simplified yet advanced storage architecture. UUHSC is currently developing a storage architecture and catalog of services in order to market IT resources to other departments in the University of Utah system. By offering multiple types of storage solutions at different price points, this new storage architecture will enable the IT group to capture more storage opportunities and lower the overall cost of ownership to the university and individual departments.

# Appendix A: Technical and Economic Benefits of the University of Utah Health Sciences Center (UUHSC) Case History

## Technical Benefits

:: With dramatic improvements in access rates and capacity growth, the Universal Storage Platform ensures that the architecture will no longer be the bottleneck in IT services.

:: Data can be stored on application-appropriate storage resources.

:: Performance is 50 to 100 percent better than that achieved with the previous architecture(s).

:: Increased customer and end-user satisfaction is seen due to improved performance, provisioning time, and utilization reports.

:: Over the years, several outages occurred that could not be avoided with the previous configuration's advanced SAN and storage architecture. With the Universal Storage Platform, this business risk will be reduced.

:: The useful life of older storage devices has been extended, allowing capital expenditure money to be spent on high-end storage capabilities.

:: Tiered storage is now possible, with ease of management and provisioning:

  :: Tier 1 for mission-critical clinical data, operational data, and e-mail; highest performance and protection

  :: Tier 2 for user data and images

  :: Tier 3 for local disk backups, snap copies, and database-development copies

:: Tiers of storage allow for a storage architecture/catalog of services that can be managed to ITIL best practices around operations management (service level agreement or SLA, operating level agreement or OLA)

:: LUN 0 Boot is now possible, so diskless hosts can boot from the SAN.

:: Chargeback methods and usage metrics are now available, by tier, to manage SLAs.

:: Staff can be cross-trained to enable consistent management from a single platform, including administration of heterogeneous disk and fabric elements.

:: The new configuration will drive reduction in planned and unplanned outages.

:: Provisioning and reclamation of SAN disk will be much easier. Stranded disk capacity will be reduced through virtualization and management. All tiers of storage can be presented to all customers.

:: This architecture will enable information lifecycle management or data lifecycle management and several critical initiatives for the record archive.


## Economic Benefits

:: Fewer people are needed to manage, provision, and operate the storage infrastructure; the result is US$320K in labor cost savings.

:: Aggregate utilization improvements reduce total data storage needed by UUHSC; gaining access to stranded data avoids future purchase of 18TB (over three years).

- Removal of three storage frames brings subsequent reduction of hardware, software, maintenance, floor space, and electricity requirements. For example, hardware maintenance for older Hitachi and STK systems has been reduced by US$200K.

- Extending the life of some older assets reduces future capital procurement.

- Removal of older Fibre Channel switches from the collapse of the fabrics also results in fewer hardware maintenance needs.

- Overall availability increases, and the loss potential (billing systems, patient systems) will mark real cost and risk avoidance for UUHSC; risk costs avoided are estimated at a conservative US$118K.

- Performance improvement is sometimes hard to quantify, but it is estimated at US$340K due to faster access.

- SLA and tiered storage are now available for all storage customers.

- The storage footprint is reduced, and electricity and A/C costs have decreased by US$28K.

- Availability has increased, resulting in reduced business impact and SLA penalties and higher customer satisfaction. Forecast risk reduction is US$138K.

## Basis for ROI Calculations

- Capital investment of US$705K

- Total savings of US$1,599,653 over three years

- Internal rate of return of 5.71 percent

- Payback in 14 months

- Return on investment of 127 percent

# Glossary

**Alternate Pathing**
Alternate pathing is a type of middleware that automatically switches the I/O load on a failed primary path to an alternate path on the same host system.

**Availability**
In computer science, availability refers to the degree to which a system or resource is capable of performing its normal function. Availability is measured in terms of Mean Time Between Failure (MTBF) divided by MTBF plus the Mean Time to Repair (MTTR). The availability equation is expressed as follows:

$$\text{AVAILABILITY} = \text{MTBF}/(\text{MTBF}+\text{MTTR}).$$

For example, a server that fails on average once every 5,000 hours and takes an average of two hours to diagnose, replace faulty components, and reboot, would have an availability rating of 5,000/(5,000 + 2) = 99.96%. This would correspond to a Level 3 rating using the Scale of 9s.

**Back End**
In reference to storage systems, the back end includes the controllers, disk drives, and paths to the disk drives.

**Back-end Director**
The back-end director or BED refers to the Hitachi TagmaStore™ Universal Storage Platform modules in the Control Frame that contain a group of processors. These processors perform the physical access of the disk drives across FC-AL groups. In the Hitachi Lightning™ 9900 V Series enterprise storage systems, these modules are known as the Array Control Processors or ACPs.

**Business Continuity**
Business continuity is an "umbrella" term that typically refers to software and services covering both disaster recovery planning and business resumption planning. See also Disaster Recovery.

**Cache–Hierarchical Star Network (C-HSN)**
The Cache–Hierarchical Network or C-HSN is a technical term that is used to describe the paths within the Hitachi Universal Star Network™ architecture that are used for transferring data to and from the main global data cache.

**Common Information Model (CIM)**
This open data model provides for the collection, storage, and analysis of management data for systems, networks, applications, and storage in a common format. CIM is being developed by the Distributed Management Task Force (DMTF) and provides a means for vendors to present management data about their products, independent of their underlying interfaces and data formats.

**Control Frame**
The Control Frame in a Universal Storage Platform contains control modules, interface cards, power supplies, and batteries, in addition to disk drives.

**Control Memory**
Control Memory within the Universal Star Network architecture handles the exchange of control information, such as status, location, and configuration of data between processors and cache memory. Control Memory is independent from data cache.

**Control Memory–Hierarchical Star Network (CM-HSN)**
The Control Memory–Hierarchical Star Network or CM-HSN is a technical term that is used to describe the network used for transfers of data between front-end directors and back-end directors.

**Data Cache**
Data Cache within the Universal Star Network stores data on the way to or from disk to be used by an application. Since there is a separate Control Memory, 100 percent of Data Cache is available for applications.

**Data Duplication**
Data duplication is a class of software that duplicates data as in remote copy or point-in-time (PiT) snapshots. Data duplication is differentiated from data migration in that with data duplication, at the end of the process there are two copies of data and with data migration there is only one.

**Data Migration**
Data migration is a class of software that moves data from one storage device to another. This feature is different from data duplication in that at the end of the process, there is only one copy of data.

**Disaster Recovery**
Disaster recovery is the set of processes for restoring services after a disaster. It also indicates the level of preparedness to respond to an interruption in services by implementing a disaster recovery plan to restore an organization's critical business functions.

**Downtime**
Downtime refers to either a planned or unplanned interruption in system availability. Planned downtime is usually for scheduled system maintenance and unplanned downtime usually includes business interruptions or disasters. See also Disaster Recovery and Availability.

**ESCON**
Enterprise Systems Connection architecture (ESCON) is an IBM mainframe peripheral interface for data exchange. The I/O interface uses ESA/390 logical protocols over a serial interface that configures attached units to a communication fabric.

**Fabric**
In networking terminology, fabric refers to a group of switches that interconnect storage systems and servers to form storage networks that are arranged in such a way as to enhance scalability, availability, and connectivity.

**Failover**
Host, host bus adapter, cable, or controller failover is the routing of all transactions to a second host or controller when the first component fails.

**Fibre Channel**
Fibre Channel is an ANSI standard designed to provide high-speed data transfers among workstations, servers, desktop computers, and peripherals. Fibre Channel makes use of a circuit/packet switched topology capable of providing multiple simultaneous point-to-point connections between devices. Widely deployed in SAN implementations today, Fibre Channel can be deployed in point-to-point, arbitrated loop (FC-AL), or switched topologies.

**Fibre Channel-Arbitrated Loop (FC-AL)**
FC/AL is the most dominant of the three topologies of Fibre Channel. Arbitrated Loops are a cost-effective way of connecting ports in a network without the need for a switch.

**FICON**
The Fibre Connector channel (FICON) is IBM's trademarked channel for zSeries® or zSeries processes in SAN environments.

**Front End**
In reference to storage systems, the front end includes the host adapter boards and directors to transfer data to the host from shared memory.

**Front-end Director**
The front-end director refers to the Universal Storage Platform modules in the Control Frame that contain processors, which perform the physical access of the data between the ESCON, Fibre Channel, and/or FICON host adapter boards and the shared memory modules. In the Lightning 9900 V Series systems, these modules are known as the Client Host Interface Processors or CHIPs.

**High-density Disks (HDDs)**
HDDs are the high-density disks used in the Hitachi Thunder 9500™ V Series modular storage and Lightning 9900 V Series enterprise storage systems, as well as the Universal Storage Platform.

**Hitachi Cache Residency Manager Software (formerly FlashAccess)**
Cache Residency Manager software feature allows specified (usually high-access) data sets to be "pegged" or permanently placed in cache memory so they are not managed by the data movement algorithms of the Hitachi storage system.

**Hitachi Cross-OS File Exchange Software (formerly RapidXchange)**
Cross-OS File Exchange software enables file conversion and exchange of data between zSeries and open systems hosts. Cross-OS File Exchange software also provides file access APIs for open systems.

**Hitachi Cross-System Copy Software (formerly HiCopy)**
Cross-System Copy software provides data replication between Thunder 9500 V Series systems, Lightning 9900 V Series systems, and the Universal Storage Platform.

**Hitachi Data Retention Utility Software (formerly Open LDEV Guard)**
Data Retention Utility software provides tamperproof "write once, read many" (WORM) functionality for disk media on open systems on the Lightning 9900 V Series systems, Thunder 9500 V Series systems, and the Universal Storage Platform.

**Hitachi Dataset Replication Software for IBM® z/OS® (formerly ShadowImage LVD Option)**
Dataset Replication software controls the execution of the ShadowImage function on the Lightning 9900 V Series systems and the Universal Storage Platform.

**Hitachi Dynamic Link Manager™ Path Manager Software**
Dynamic Link Manager path manager software is server-based and enhances RAID systems by providing automatic failover and load balancing on server-to-storage channel-connection failures. Dynamic Link Manager software provides increased reliability and performance. Supported platforms include IBM AIX, Sun Solaris, Red Hat Linux, SuSE Linux, and Microsoft Windows 2000/Windows Server 2003/Windows NT.

**Hitachi Graph-Track™ Performance Monitor Feature**
Graph-Track performance monitor feature monitors hardware performance and supplies complete storage system information via a GUI within the Hitachi Resource Manager™ utility package. This feature is only supported on Lightning 9900 V Series systems and the Universal Storage Platform.

**Hitachi HiCommand® Chargeback Software**
Hitachi HiCommand Chargeback software is a fully integrated chargeback module that employs the rich database of HiCommand Storage Services Manager software to enable association of cost with usage.

**Hitachi HiCommand Device Manager Software**
HiCommand Device Manager software provides a single platform for centrally managing the Thunder 9500 V Series systems, Lightning 9900 V Series systems, and the Universal Storage Platform from Hitachi Data Systems, as well as Sun StorEdge 9900 series and T3 systems.

**Hitachi HiCommand Path Provisioning Software**
HiCommand Path Provisioning software automates the end-to-end provisioning of hosts, SAN switches, and storage systems, which saves time and ensures that mission-critical applications have the storage resources they need to deliver business value.

**Hitachi HiCommand QoS for File Servers Software**
HiCommand QoS for File Servers software seamlessly integrates traditional storage resource management file scanning and reporting capabilities with active SAN management features to deliver end-to-end capacity, performance, and a user-consumption management solution for file servers.

**Hitachi HiCommand QoS for Microsoft Exchange Software**
HiCommand QoS for Microsoft Exchange software extends the integrated SAN management, storage resource management, and storage operations management capabilities of HiCommand software inside Microsoft Exchange, helping ensure the availability and performance of messaging and collaboration applications, more efficient response to help desk calls, and effective planning for disaster recovery.

**Hitachi HiCommand QoS for Oracle Software**
HiCommand QoS for Oracle software extends the integrated SAN management, storage resource management, and storage operations management capabilities of HiCommand software inside Oracle databases, helping ensure the availability and performance of Oracle-based applications, more efficient response to help desk calls, and effective planning for disaster recovery.

**Hitachi HiCommand Storage Services Manager Software**
HiCommand Storage Services Manager software, a comprehensive application-oriented platform for multivendor storage infrastructure management, provides organizations with a single, common repository for discovering and tracking all storage resources.

**Hitachi HiCommand Tuning Manager Software**
HiCommand Tuning Manager software provides intelligent and proactive performance and capacity monitoring, including reporting and forecasting capabilities of Hitachi storage resources.

**Hitachi Lightning 9900™ V Series Enterprise Storage Systems**
The Lightning 9900 V Series of enterprise storage systems was announced in May 2002 (including the Lightning 9980V™ multi-cabinet and Lightning 9970V™ single-cabinet systems). It represents a major advance in enterprise-class storage systems with its second-generation Hi-Star™ internal crossbar switch architecture, which provides for many times more simultaneous transfers to and from the host compared to shared-bus architectures.

**Hitachi Logical Volume Divider Software**
The Logical Volume Divider software is an IBM® zSeries®-compatible product that controls the execution of the Hitachi ShadowImage™ In-System Replication software function of the disk storage on the Lightning 9900 V Series systems and the Universal Storage Platform.

**Hitachi Multiplatform Backup Software (formerly Multiplatform Backup/Restore)**
Multiplatform Backup software provides channel-based backup of open systems volumes using standard mainframe utilities, which leverage current investment in mainframe hardware, software, skills, and procedures. Multiplatform Backup software supplies high-performance, high-bandwidth capabilities.

**Hitachi Resource Manager™ Utility Package**
Resource Manager utility package is a powerful and comprehensive package of device-level management software for Hitachi storage systems.

**Hitachi Server Priority Manager Software (formerly Priority Access)**
Server Priority Manager software allocates bandwidth to meet quality of service (QoS) requirements at the physical port level.

**Hitachi Storage Area Management (SAM) Suite**
The Hitachi SAM Suite provides application-centric capacity and performance management of the entire storage infrastructure. Hitachi SAM Suite solutions tune delivery of storage system performance, availability, recoverability, and functionality attributes to the requirements of vital business applications.

**Hitachi TagmaStore™ Universal Storage Platform**
The Universal Storage Platform is the world's most scalable and high-performance storage system. The Universal Storage Platform is both an enterprise storage system, with 332TB of internal capacity, and a virtualization engine, managing up to 32PB of heterogeneous storage and providing up to 32 Private Virtual Storage Machines through logical partitioning.

**Hitachi Thunder 9500™ V Series Modular Storage Systems**
The Thunder 9500 V Series modular storage systems were announced in December 2002 in both rackmount and deskside packages. This series represents the first modular storage systems with virtual Fibre Channel ports and enterprise-level hardware and software features.

**Hitachi Universal Replicator for TagmaStore Universal Storage Platform**
Unique to the Universal Storage Platform and continuing to advance the superior Hitachi asynchronous remote replication technology, Universal Replicator software features several industry firsts, including heterogeneous replication, disk-based journaling, protection against link failure, "pull" copying, and multi-data-center support. This ensures enhanced business continuity over any distance and improved IT operations. The Universal Replicator software builds on the success of Hitachi TrueCopy™ Remote Replication software, providing a robust asynchronous business continuity solution that supports both internally and externally attached storage.

**Hitachi Universal Star Network™ Architecture**
The Hitachi Universal Star Network architecture refers to the third-generation "non-blocking" crossbar switch architecture within the Universal Storage Platform. This architecture combines two internal networks (the Cache–Hierarchical Star Network and the Control Memory–Hierarchical Star Network). The Universal Star Network contains faster switch components and more paths than previous generations.

**Hitachi Universal Volume Manager Software**
Universal Volume Manager software provides the virtualization of a multitiered storage area network comprising heterogeneous storage systems based on the Universal Storage Platform. It provides a common storage pool and common software tools for storage management, replication, data migration and data lifecycle management across multiple storage systems.

**Hitachi Virtual Partition Manager Software**
Virtual Partition Manager software enables the logical partitioning of ports, cache, and disk (parity groups) on Universal Storage Platform. Each partition, called a Private Virtual Storage Machine, is separately managed and dedicates storage resources for specific servers or applications. Overall system priorities, disk space, and attached storage can be optimized for application QoS based on changing business priorities.

**Hitachi Volume Migration Software (formerly CruiseControl)**
Volume Migration software automatically monitors, analyzes, and moves logical volumes to eliminate "hot spots" within Lightning 9900 V Series systems and provides load balancing to maintain predetermined performance levels. In the Universal Storage Platform, this capability extends to attached storage, enabling data movement in tiered storage environments.

**Hitachi Volume Retention Utility for IBM® z/OS® (formerly LDEV Guard)**
Volume Retention Utility software is available on both the Lightning 9900 V Series systems and the Universal Storage Platform and provides tamperproof, "write once, read many" (WORM) functionality for disk media on mainframes.

**Host Storage Domains**
Host Storage Domains are a collection of LUNs matched to assigned open systems hosts based on World Wide Names or WWNs. Each host has its own secure domain and LUN0 for booting with no threat of exposure to other hosts.

**Hot Site**
A hot site is an alternate facility that has the equipment and resources to recover the business functions affected by the occurrence of a disaster or business interruption. Hot sites may vary in type of facilities offered (such as data processing, communication, or any other critical business functions needing duplication). Location and size of the hot site will be proportional to the equipment and resources needed. Similar terms include backup site, recovery site, recovery center, and alternate processing site. See also Disaster Recovery.

**Hot Spare**
A hot spare is an extra disk or disks that is kept running (hot) but not populated with data until another disk in the storage system fails. If a disk fails in a storage system, the data is mapped by copying (RAID-1) or by rebuilding from parity (RAID-5) at priorities selectable by the user. This feature is supported by the Lightning 9900 V Series systems, Thunder 9500 V Series systems, and the Universal Storage Platform.

**Logical Fibre Channel Port**
The Lightning 9900 V Series and Universal Storage Platform Fibre Channel adapter cards each contain physical Fibre Channel ports. Each physical port can be subdivided into multiple logical or virtual Fibre Channel ports. Each logical Fibre Channel port supports a Host Storage Domain, which is a collection of LUNs matched to assigned hosts based on WWNs. See also Virtual Storage Port and World Wide Names.

**Logical Partition (LPAR)**
LPAR or logical partition, first developed by IBM for its mainframe systems, refers to a system of taking a computer's total resources—processors, memory, and storage—and splitting them into smaller units that each can be run with its own instance of the operating system and applications. The Universal Storage Platform supports logical partitioning of storage resources, including cache, ports, and internal and external capacity.

**Logical Partitioning**
Logical partitioning in the Universal Storage Platform refers to the ability to carve its resources (cache, ports, and internal and external capacity) into up to 32 independently managed Private Virtual Storage Machines. See also LPAR and Private Virtual Storage Machine.

**Logical Unit**
The SCSI term for a logical disk drive.

**Logical Unit Number (LUN)**
Logical unit number, or LUN, is a SCSI term for the field in an identifying message that is used to select a logical unit on a given target.

**Logical Volume**
A logical volume is the storage medium associated with a logical disk drive. A logical volume typically resides on one or more storage devices. A host system sees a logical volume as a physical volume, although it does not correlate directly with a physical disk drive.

**Mean Time Between Failure (MTBF)**
Mean Time Between Failure or MTBF is a commonly used measure of system reliability, usually expressed in hours.

**Mean Time To Repair (MTTR)**
Mean Time To Repair or MTTR includes the time taken to diagnose the failure, replace or repair faulty component(s), and restart the system so it is available to users.

**Message Archive for E-mail**
Message Archive for E-mail is a Hitachi Data Systems data lifecycle solution that archives e-mail messages for security, regulatory, and other reasons.

**Message Archive for Compliance**
The Message Archive for Compliance is a Hitachi Data Systems solution that was developed to help optimize e-mail systems while providing message indexing, search and retrieval capabilities, audit trails, and policy management to preserve messages for mandatory retention periods.

**Mirrored Pair**
A mirrored pair refers to the RAID-1 and RAID-1+ scheme for disk drive organization when two disk units or logical units are both online and contain the same data. The operating system software refers to them as one entity and "reads from either" and "writes to both" when RAID-1 or RAID-1+ is enabled.

**Mirroring**
This term describes the process of writing data to two disk volumes, usually to ensure high availability in case one of the disks fails. Mirroring can be hardware or software based.

**Network Attached Storage (NAS)**
Network-attached storage or NAS servers are a special class of server that allows files to be stored over networks using the UNIX or Microsoft Windows remote file system standards.

**Network Data Management Protocol (NDMP)**
Network Data Management Protocol or NDMP is a standard protocol for network-based backup of network-attached storage. NDMP hides the unique hardware interfaces from third-party backup software that allows this software to execute on any NDMP-compliant system on the network

**Open System**
An open system has characteristics that comply with de facto standards made available throughout the industry, and therefore can be connected to other systems that comply with the same standards.

**Out of Band**
A communication that does not use the same bandwidth that carries data in a system runs out of band.

**Parity**
This data-checking scheme is used in a computer system to ensure the integrity of the data. The RAID implementation uses parity to recreate data if a disk drive fails.

**Path Failover**
See Alternate Pathing.

**Point in Time (PiT) Copy**
A point-in-time or PiT copy is a copy of data that is taken at a specific point in time. PiT copies are used in many ways, including backups and checkpoints.

**Private Virtual Storage Machine**
Created by logically partitioning of the Universal Storage Platform, Private Virtual Storage Machines are seen by storage management software as separate storage entities, each with dedicated internal and external capacity, cache, and ports. Private Virtual Storage Machines can assure application QoS by matching application requirements to the attributes of the partition and its allocated resources.

**Quality of Service (QoS)**
Quality of service or QoS refers to service level agreements (SLAs) between users and the IT organization.

**Radical Efficiency™**
Radical Efficiency refers to the ability of the Universal Storage Platform to dramatically reduce management overhead and software-licensing costs, at the same time extending the latest software advances to older or depreciating storage assets.

**Redundant Array of Independent Disks (RAID)**
Redundant Array of Independent Disks or RAID is a term that refers to disk drive organization schemes that increase reliability of disk storage systems by providing redundancy. Redundancy is provided either through complete duplication of the data (RAID-1, RAID-1+, also known as mirroring) or through construction of parity data for each data stripe in the array (RAID-3, RAID-4, RAID-5, RAID-6). RAID-5 and RAID-6, which distribute parity information across all disks in a storage system, are among the most popular means of providing parity RAID since these schemes avoid the bottlenecks of a single parity disk. Algorithms on the Lightning 9900 V Series systems and Universal Storage Platform enable performance from RAID-5 (and RAID-6 for Universal Storage Platform only) that is competitive with some vendors' RAID-1. Some vendors do not offer RAID-5.

**Remote Copy**
Remote copy refers generically to software or hardware utilities that provide the capability to copy data from one online storage system to remote storage systems without disruption. Synchronous techniques are used for short distances (typically less than 25 miles) and asynchronous techniques over LAN/WAN/MAN are used at any distance.

**Risk Management**
Risk management is the discipline that ensures that an organization does not assume an unacceptable level of risk.

**Service Information Message (SIM)**
Service Information Messages are messages generated by the Lightning 9900 V Series systems, Thunder 9500 V Series systems, and the Universal Storage Platform to identify normal operations.

**Simple Network Management Protocol (SNMP)**
Simple Network Management Protocol or SNMP is a protocol used for communication between simple, server-resident SNMP agents and network administrator management tools running on remote workstations. This feature is supported by the Lightning 9900 V Series systems, Thunder 9500 V Series systems, and the Universal Storage Platform.

**Simple Object Access Protocol (SOAP)**
Simple Object Access Protocol or SOAP is an industry standard supported by Hitachi that provides a standard envelope for a messaging bus that enables simple plug-in of functional modules. This model provides a clear set of information content for management and monitoring of the entire storage and system environment. SOAP goes a long way toward promoting vendor interoperability.

**Small Computer System Interface (SCSI)**
SCSI is an intelligent bus-level interface that defines a standard I/O bus and a set of high-level I/O commands. Currently, many flavors of SCSI are defined by different bus widths and clock speeds. The seven major variations of SCSI are SCSI 1, SCSI 2 (Fast/Narrow), SCSI 2 (Fast/Wide), Ultra SCSI (Fast/Narrow), Ultra SCSI (Fast/Wide; also called SCSI 3), Ultra 2 SCSI (Narrow), Ultra 2 SCSI Wide. See also Fibre Channel.

**Snapshot**
Snapshot is a term that refers to a copy of a file system at a certain point in time. Snapshots are used for backup and recovery, application testing, or data warehousing/data mining applications.

**Storage Area Network (SAN)**
A storage area network or SAN connects storage systems to servers through Fibre Channel or Ethernet switches. Major benefits of SANs include outboard backup, sharing of resources, pooling, and reduced cost of storage management. SANs are also defined as high-speed subnetworks of shared storage devices. SAN architecture works in a way that makes all storage devices available to all servers on a LAN or WAN. See also Fibre Channel.

**Storage Management Initiative Specification (SMI-S)**
The Storage Management Initiative Specification or SMI-S is a standard developed by the
Storage Networking Industry Association (SNIA) designed to make it easier for storage
hardware and management software from different vendors to work together. SMI-S uses the
Common Information Model (CIM) and Web-Based Enterprise Management (WBEM)
specifications to create common models describing storage hardware and software functions.
Vendors then write interfaces that allow their hardware and software to share data with other
vendors' products using these common models. The Hitachi HiCommand Storage Services
Manager software complies with the SMI-S standard, enabling it to manage a broad range of
heterogeneous storage devices.

**Stripe**
In RAID terminology, a stripe is when data is read or written in parallel to or from multiple disks
instead of reading or writing all data to one disk. Striping provides much higher performance
through its parallel design.

**Virtual Storage Port**
Virtual Storage Port, a term for a unique Hitachi feature, refers to virtual Fibre Channel ports
that are logically managed by intelligent Fibre Channel controller cards. Each physical Fibre
Channel port may have multiple Virtual Storage Ports, each supporting a different open systems
server. Each server is assigned a Host Storage Domain each with its own LUN0 and set of logical
unit numbers. Hosts are matched to their assigned HSD based on a unique World Wide Name
identifier. See also World Wide Names.

**Volume**
An IBM ESA/390 term for the information recorded on a single disk unit or recording medium,
volume can also refer, indirectly, to the unit of recording medium itself. On a nonremovable
medium storage device such as a disk drive, the term may also refer, indirectly, to the storage
device that is associated with the volume. When a user stores multiple volumes on a single
storage medium transparent to the program, the volumes are referred to as logical volumes.

**Workload**
I/O workload refers to the pattern of I/Os presented to a storage system or to a disk
drive. Processor workload refers to the pattern of machine instructions presented
to a microprocessor.

**World Wide Names (WWN)**
World Wide Names or WWNs refer to eight-byte identifiers assigned to each product that can
be used as a port on a Fibre Channel network. The WWN is stored in nonvolatile memory and is
frequently stamped on the surface of the product or used as a serial number. It applies to all
HBAs, switches, or storage controller cards that interface to a Fibre Channel network.

**z/OS®**
z/OS is an IBM operating system running on z/Series mainframe computers. It is an evolved
form of OS/390®.

**z/Series®**
z/Series is an IBM hardware platform that supports z/OS, OS/390, VSE, TPF, and Linux on zSeries.
It is an evolved form of the S/390 mainframe family.

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