Analysis of Fujitsu ETERNUS8000 Models 700, 900, 1100, and 2100 Feature/Function

Analyst: Tom Trainer

The purpose of this document is to provide a product analysis of the Fujitsu ETERNUS8000 disk storage system, announced in April 2006. The ETERNUS8000 is an open system storage product and is the successor to the ETERNUS6000, originally delivered to market in November of 2002. The ETERNUS8000 is being sold globally and is supported on five major operating systems: 3 UNIX (SUN, HP, IBM), Windows and Linux (as well as Fujitsu's mainframes in the Japanese markets).

Products and vendors that compete with the ETERNUS8000 include EMC Symmetrix DMX-3, Hitachi Universal Storage Platform, and IBM System Storage DS8000.

HIGHLIGHTS

- A maximum of 128 fibre channel ports that can operate in switched fabric, point-to-point or arbitrated loop modes.
- A maximum of 64 iSCSI Gigabit Ethernet ports.
- Support for failover with server-based failover software.
- Resource sharing and access security with a LUN masking implementation called Host Affinity.
- Centralized web-based management software.
- Support for RAID 0, 1, 5, 6-dual parity, and RAID1+0 with global hot spare disks.
- Online logical volume expansion by adding a physical disk and increasing the RAID group size while redistributing the data.
- RAID group sizes of 4 to 32 disk drives for RAID 1+0 and 4 or 8 for RAID 5.
- Economic storage with 500GB NearLine drives using the ETERNUS Eco-Mode for infrequently accessed data (MAID).
- Block level data protection with error detection codes added to every data block.
- Duplexed write cache with ECC protection.
- Write cache data written to disk if power fails.
- Supports storage controller based Disk Data Encryption
- Optimized controller to controller communication over PCI-Express switch based internal bus
- PCI-Express switched bus used for fast mirroring of write data
- Router based backend for high-speed data transfer
- Redundant fibre channel loops to each disk drive.
- Support for intermix of 36, 73, and 146, 300, and 500GB disk drives.
- Call home feature for proactive maintenance and to minimize response time.
- Hot swappable, and redundant, components
- Octuple (8) active controllers supported.
- Up to 256GB of cache.
- Supports up to 2,760 disk drives
- Maximum raw capacity of 1.380PB
- Support for 4,096 logical volumes.

- Optional point-in-time copy feature called One Point Copy creates snapshot copies.
- Optional features; “Equivalent Copy”; creates clones and mirrors
- Support for remote copy in synchronous or asynchronous mode over fibre channel and iSCSI (iSCSI support with IPsec encryption will be released in December, 2006) remote links with Remote Equivalent Copy. Supports stacked and consistency mode.
- Disk Traffic Control (DTC) performance feature to separate I/O based on sequential or random access.

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OVERVIEW

There are four models of the ETERNUS8000 that vary in capacity, performance, and connectivity. The various models may be used both for direct connect storage and for Storage Area Networks. Heterogeneous server attachment is supported (individual server operating system support is listed in the configuration section of this document).

Fujitsu also offers the ETERNUS4000 storage systems which are mid-tier to entry level enterprise storage platforms that support attachment to open systems. A detailed description of this product is available on the Evaluator Group Knowledgebase www.evaluatorgroup.com.

As an introduction to the ETERNUS8000, Figures 1 and 2, below, illustrate the four models which make up the ETERNUS8000 product line.

Model700

18.7TB

Figure 2. ETERNUS8000 Model 700

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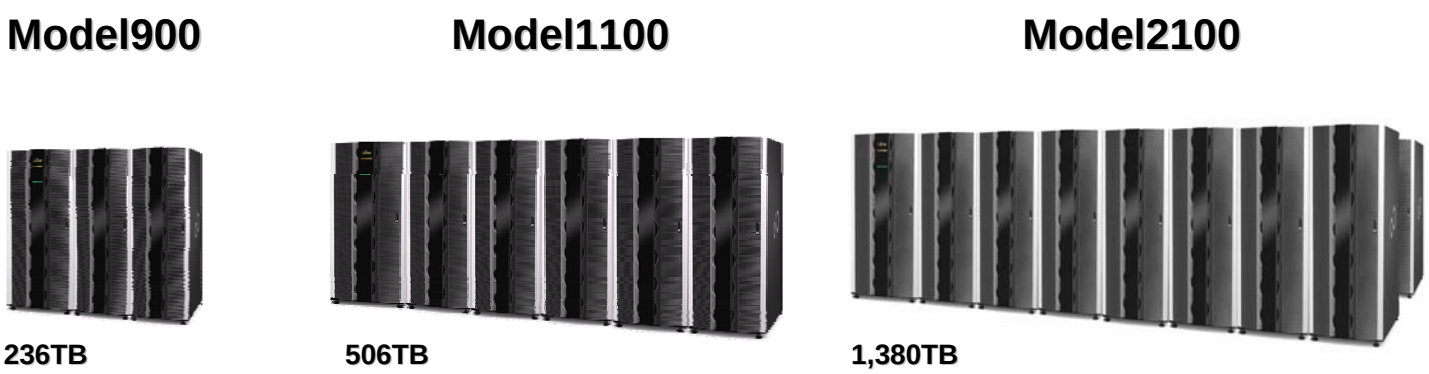

Figure 2. ETERNUS8000 Models 900, 1100, and 2100

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PRODUCT ARCHITECTURE

The ETERNUS8000 uses multiple controllers internally – up to eight (8) active controllers in the largest configurations. Additionally the ETERNUS8000 supports PCI-Express bus architecture in all models and high-speed router based communication (FRT's) for write cache mirroring in Models 900, 1100, and 2100. Moreover, Models 900, 1100, and 2100 support backend routers (BRT's) for high-speed data transfer from the controllers to the Disk Enclosures (DE's).

Evaluator Group Comment: Evaluator Group believes the continued use high-speed routers in the ETERNUS design demonstrates Fujitsu understands the need for internal speed with very large storage configurations.

The Model 700 – sold primarily in the Japanese markets to satisfy lower capacity requirements on Fujitsu mainframes - uses a shared PCI-Express bus architecture for communication between two controllers and for the attachment of the channel adapters and device adapters. In the Model 700 there are four (4) PCI-Express busses running at a rate of 2.5Gbps each. Each of the two (2) controllers in the Model 700 can support a dual core processor environment. Figure 3, below illustrate the maximum configuration and architecture of the ETERNUS8000 Model 700.

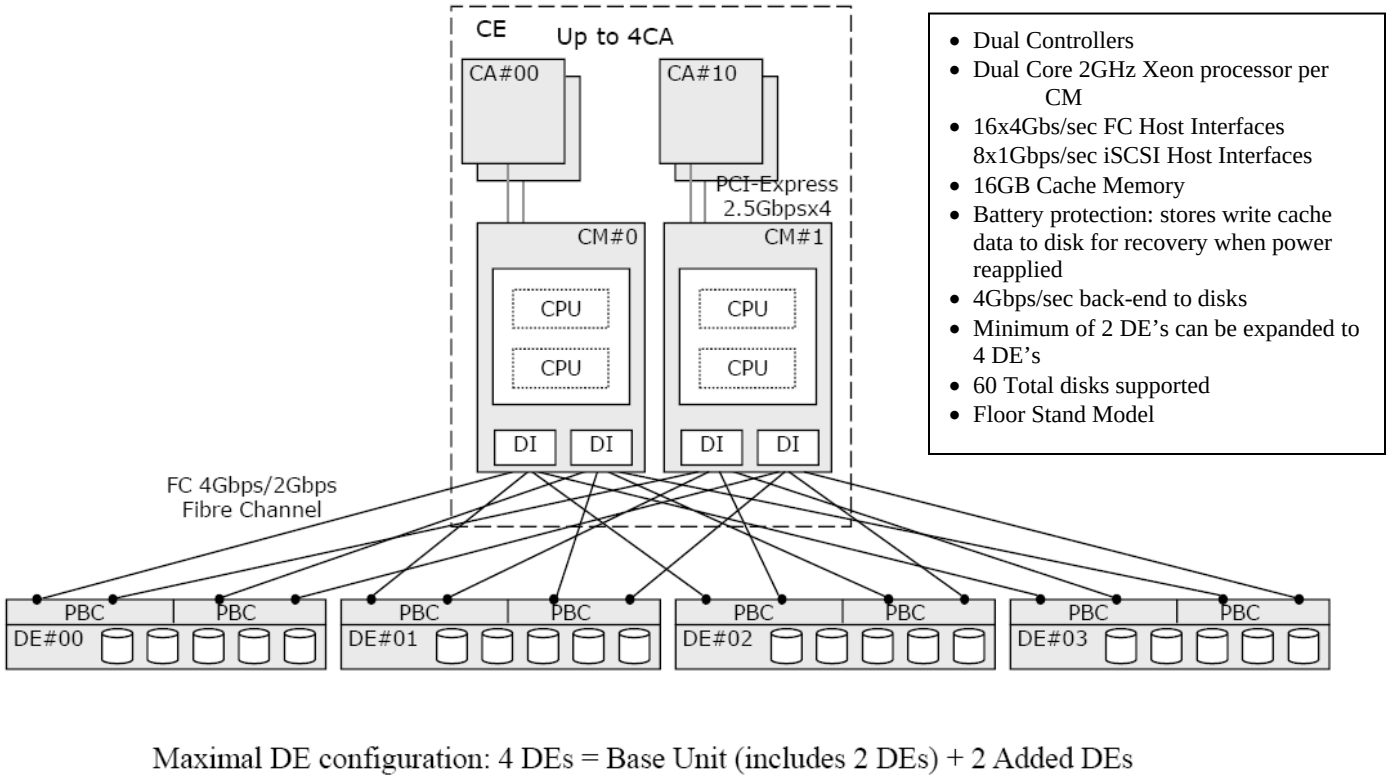

Figure 3. ETERNUS8000 Model 700 Maximum Configuration

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The Model 900 uses a shared PCI-Express bus architecture for communication between up to four (4) controllers and for the attachment of the channel adapters and device adapters. The PCI-Express bus runs at a speed of 2.5Gbps/sec. Additionally the Model 900 employs high-speed routers for rapid communication between controllers when mirroring write cache data. Each of the up to four (4) controllers in the Model 900 supports a dual processor environment. On the backend, the Model 900 employs high-speed FC switches running at 4Gbps/sec between the controllers and the Disk Enclosures (DE's). Figures 4 and 5, below illustrate the minimum and maximum configurations and architecture of the ETERNUS8000 Model 900.

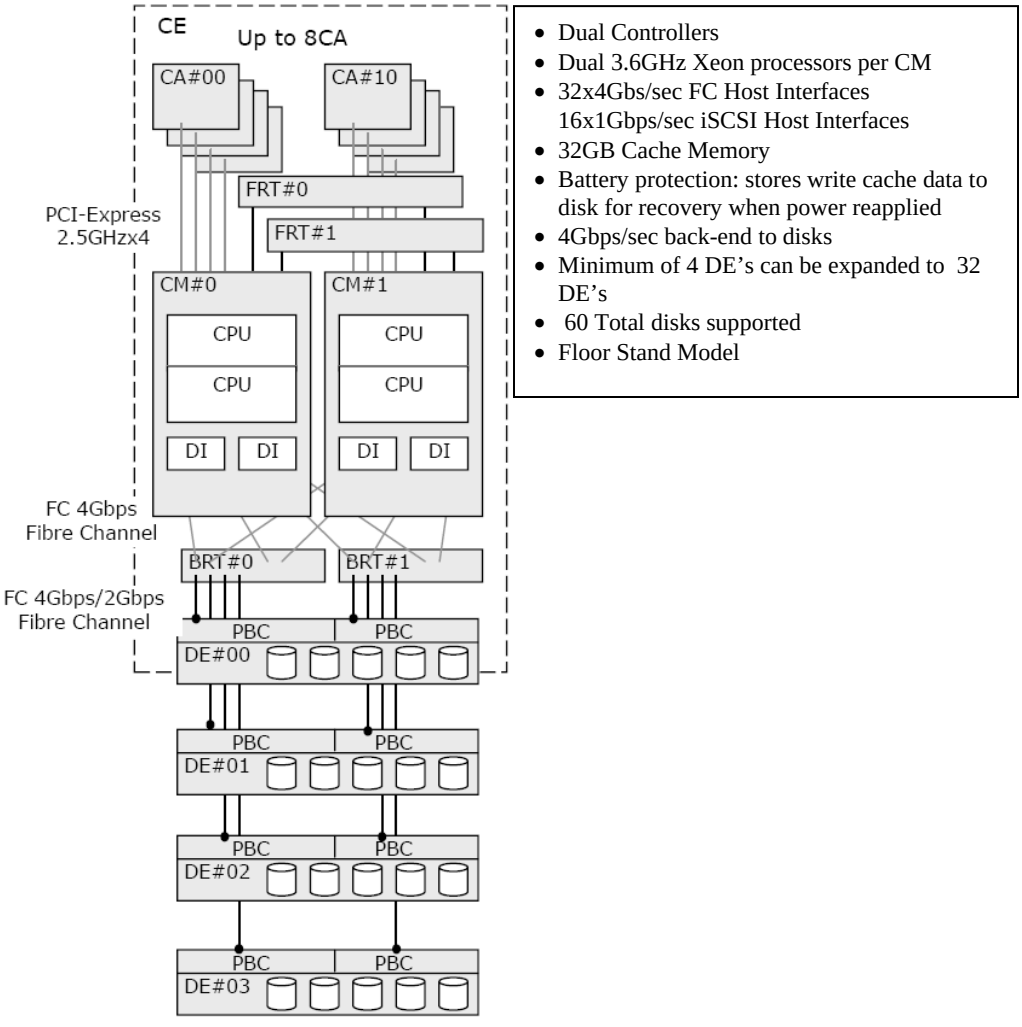

Figure 4. ETERNUS Model 900 Minimum Configuration

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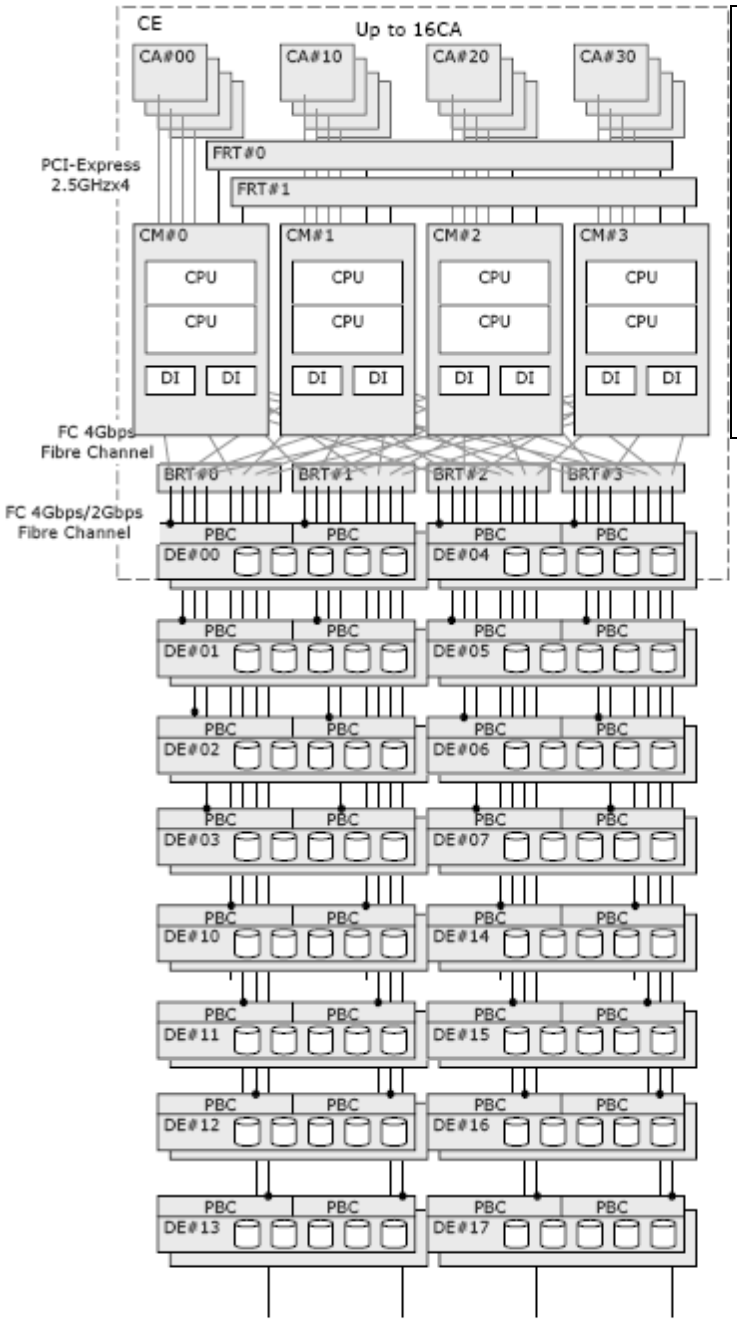

- Quad Controllers
- Dual 3.6GHz processors per CM
- 64x4Gbs/sec FC Host Interfaces
  32x1Gbps/sec iSCSI Host Interfaces
- 64GB Cache Memory
- Battery protection: stores write cache data to disk for recovery when power reapplied
- 4Gbps/sec back-end to disks
- Minimum of 4 DE's can be expanded to 32 DE's
- 480 Total disks supported
- Floor Stand Model

Maximal DE configuration: 32 DEs = Base Unit (includes 4 DEs) + 2 Expansion Rack + 28 Added DEs

Figure 5. ETERNUS Model 900 Maximum Configuration

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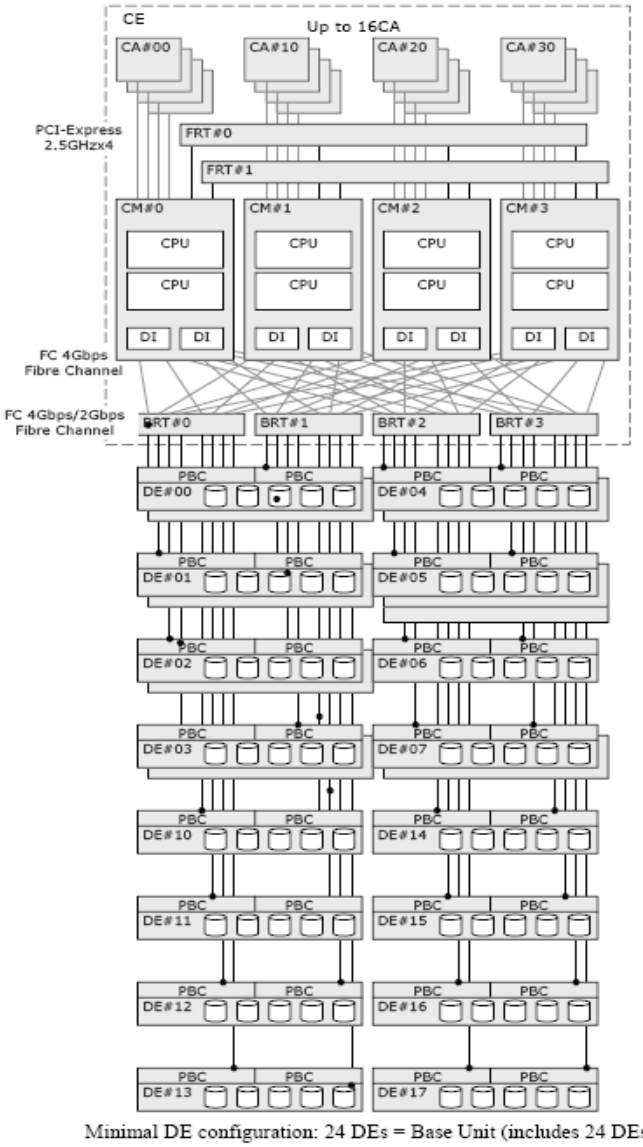
The Model 1100 uses a shared PCI-Express bus architecture for communication between up to four (4) controllers and for the attachment of the channel adapters and device adapters. The PCI-Express bus runs at a speed of 2.5Gbps/sec. Additionally the Model 1100 employs high-speed routers for rapid communication between controllers when mirroring write cache data. Each of the up to four (4) controllers in the Model 1100 supports a dual processor environment. On the backend, the Model 1100 employs high-speed FC switches running at 4Gbps/sec between the controllers and the Disk Enclosures (DE's). Figures 6 and 7, below illustrate the minimum and maximum configurations and architecture of the ETERNUS8000 Model 1100.



Minimal DE configuration: 24 DEs = Base Unit (includes 24 DEs)

- Quad Controllers
- Dual 3.6GHz processors per CM
- 64x4Gbs/sec FC Host Interfaces
  32x1Gbps/sec iSCSI Host Interfaces
- 32GB Cache Memory
- Battery protection: stores write cache data to disk for recovery when power reapplied
- 4Gbps/sec back-end to disks
- Minimum of 24 DE's can be expanded to 68 DE's
- 128 Total disks supported
- Floor Stand Model

Figure 6. ETERNUS Model 1100 Minimum Configuration

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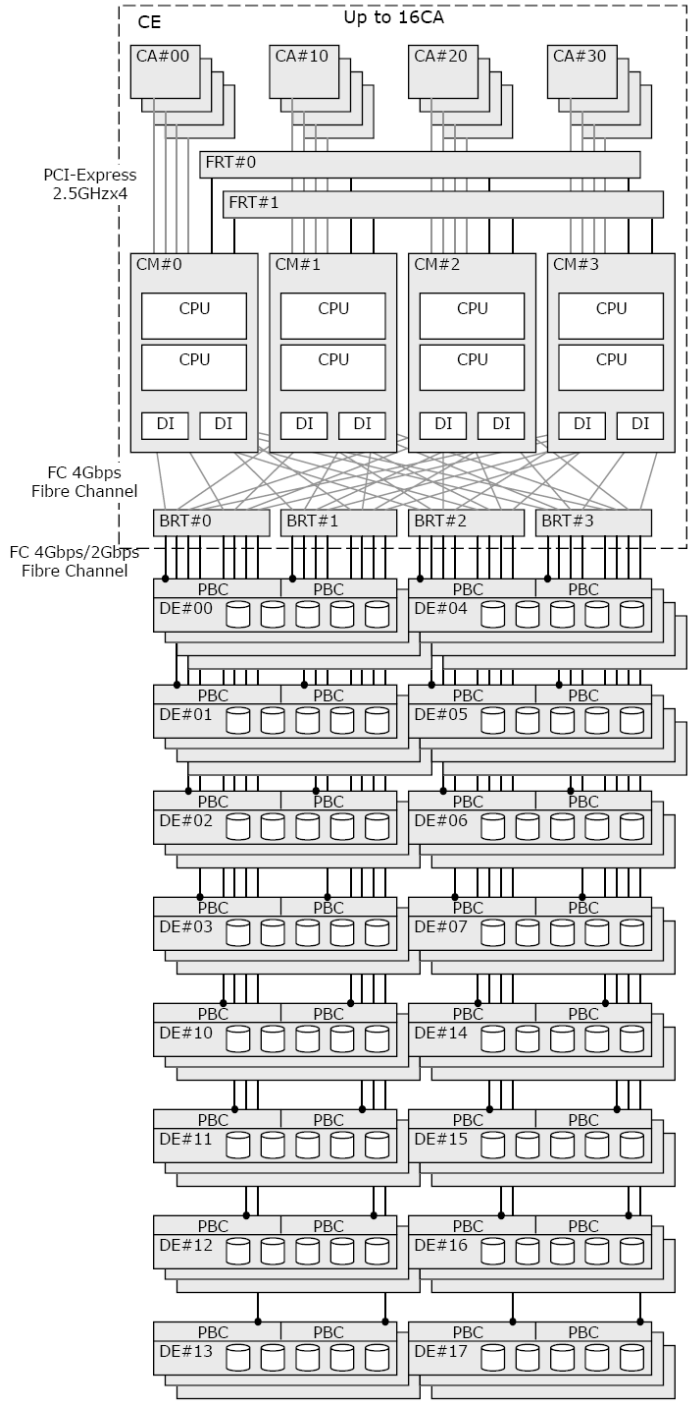

- Quad Controllers
- Dual 3.6GHz processors per CM
- 64x4Gbs/sec FC Host Interfaces
  32x1Gbps/sec iSCSI Host Interfaces
- 128GB Cache Memory
- Battery protection: stores write cache data to disk for recovery when power reapplied
- 4Gbps/sec back-end to disks
- Minimum of 24 DE's can be expanded to 68 DE's
- 1020 Total disks supported
- Floor Stand Model

Maximal DE configuration: 68 DEs= Base Unit (includes 24 DEs) + 3 Expansion Racks + 44 Added DEs

Figure 7. ETERNUS Model 1100 Maximum Configuration

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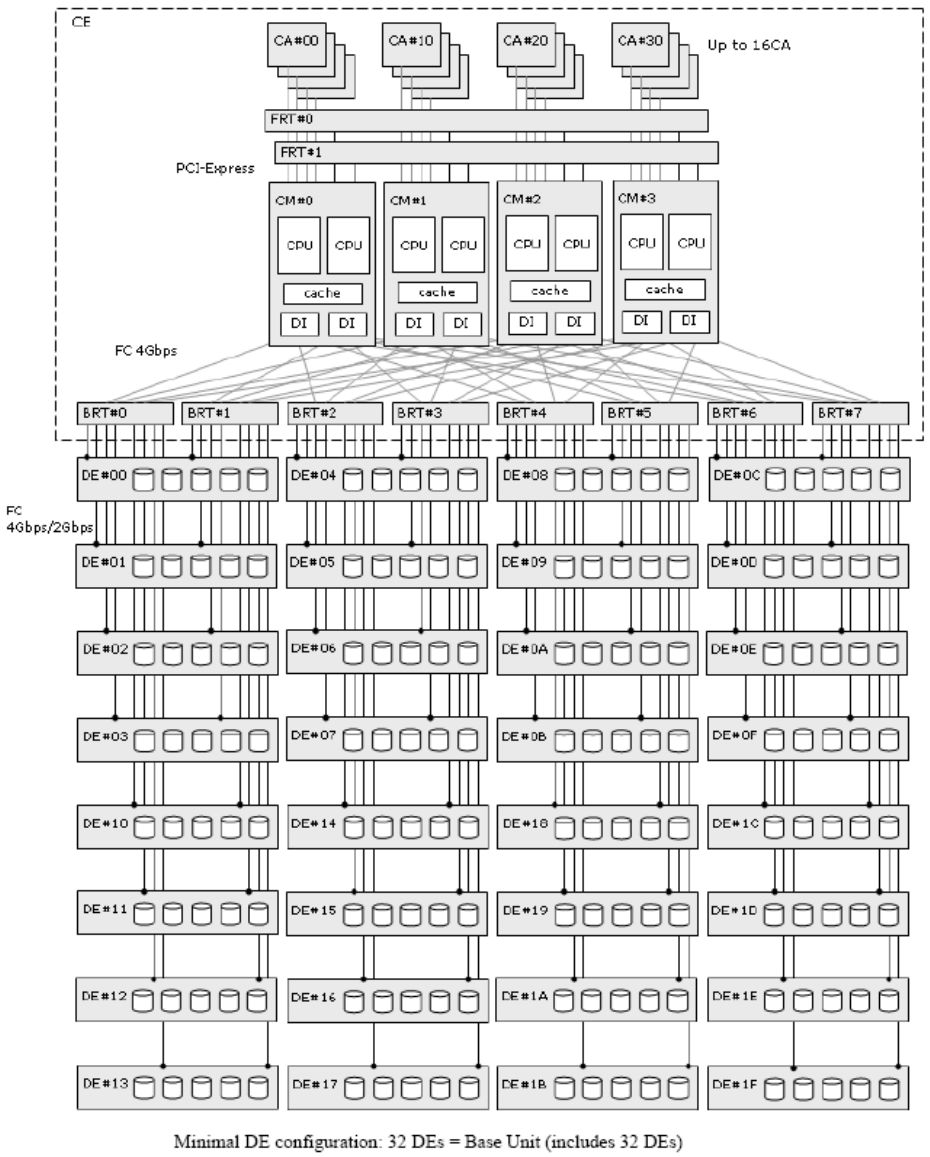
The Model 2100 uses a shared PCI-Express bus architecture for communication between up to eight (8) controllers and for the attachment of the channel adapters and device adapters. The PCI-Express bus runs at a speed of 2.5Gbps/sec. Additionally the Model 2100 employs high-speed FC switches for rapid communication between controllers when mirroring write cache data. Each of the up to eight (8) controllers in the Model 2100 supports a dual processor environment. On the backend, the Model 2100 employs high-speed routers running at 4Gbps/sec between the controllers and the Disk Enclosures (DE's). Figures 8 and 9, below illustrate the minimum and maximum configurations and architecture of the ETERNUS8000 Model 2100.



Minimal DE configuration: 32 DEs = Base Unit (includes 32 DEs)

- Quad Controllers
- Dual 3.6GHz processors per CM
- 64x4Gbs/sec FC Host Interfaces
  32x1Gbps/sec iSCSI Host Interfaces
- 128GB Cache Memory
- Battery protection: stores write cache data to disk for recovery when power reapplied
- 4Gbps/sec back-end to disks
- Minimum of 32 DE's can be expanded to a maximum of 184 DE's
- 2760 Total disks supported
- Floor Stand Model

Figure 8. ETERNUS Model 2100 Minimum Configuration

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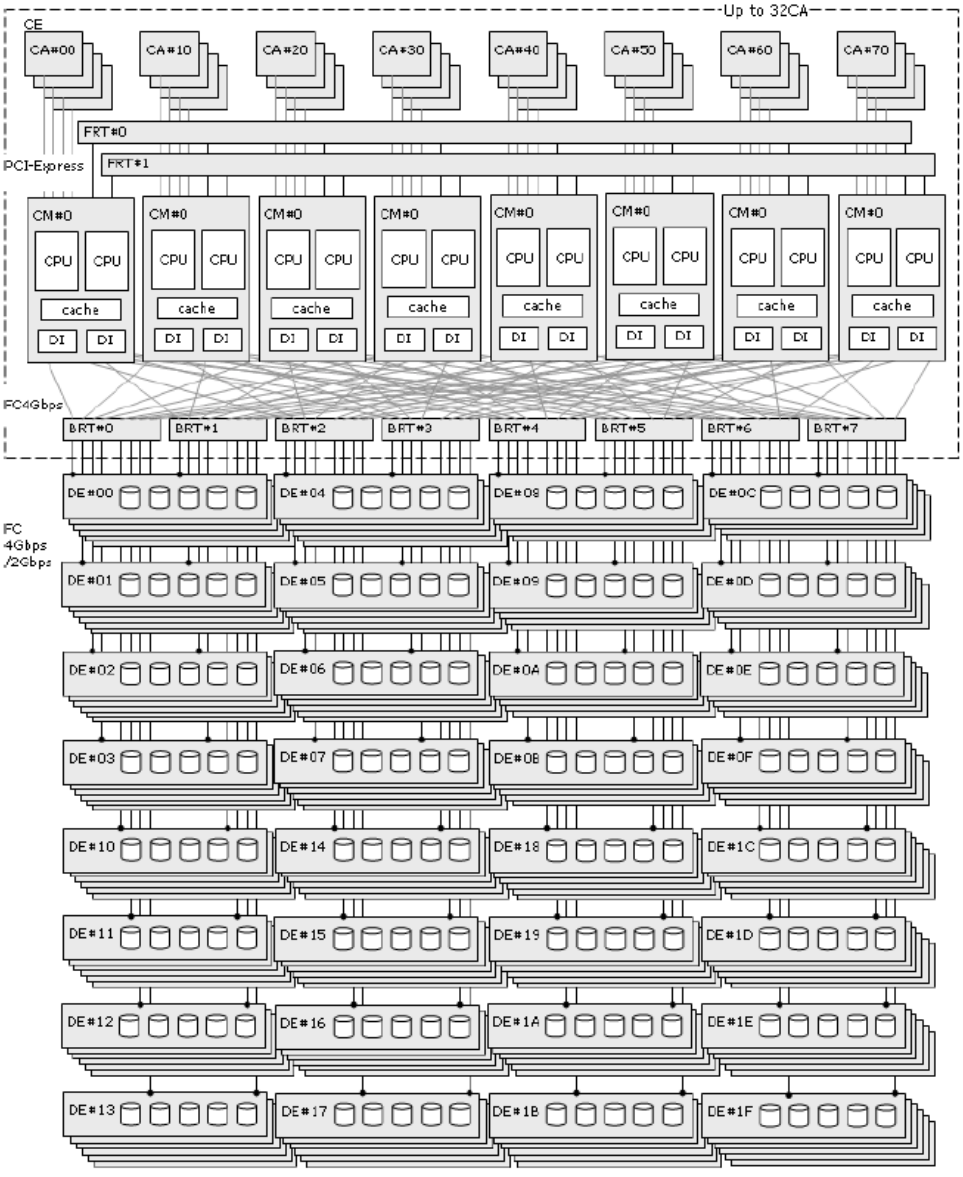

Maximal DE configuration: 184 DEs = Base Unit (includes 40 DEs) + 11 Expansion Racks + 144 Added DEs

Figure 9. ETERNUS Model 2100 Maximum Configuration

- Eight (8) Controllers
- Dual 3.6GHz processors per CM
- 128x4Gbs/sec FC Host Interfaces
  64x1Gbps/sec iSCSI Host Interfaces
- 256GB Cache Memory
- Battery protection: stores write cache data to disk for recovery when power reapplied
- 4Gbps/sec back-end to disks
- Maximum of 184 DE's can be expanded from 32 DE's (i.e. Figure 8)
- 2760 Total disks supported
- Floor Stand Model

As seen from the architectural diagrams, the ETERNUS8000 supports a dual processor environment (3.6 GHz XEON DP processor, except the model 700 which uses dual core processor 2.0GHz XEON LV processor).

Evaluator Group Comment: We believe the use of a dual 3.6GHz processor, coupled with the 4Gbs/sec front and back-end fibre channel interfaces, will provide users with generous bandwidth that more than meets server/application performance requirements.

Channel Adapters

The Channel Adapters (CAs) provide fibre channel and iSCSI interfaces to the host (server) system. They process commands from the host and manage accesses to the cache. The channel adapters plug into a PCI-Express bus on the controller module. Up to 32 Channel Adapter cards can be installed in the largest Model 2100 configurations, supporting up to 128 Fibre Channel connections, or up to 32 iSCSI connections. An intermix of Fibre Channel and iSCSI is supported. For service, an entire controller module must be taken out of operation (a failover to another controller module must be done) before the channel adapter is replaced. After replacement, the controller module can be returned to service.

The channel adapters support fibre channel connectivity at 4Gbps/sec and iSCSI, 1Gb Ethernet, connections.

Table 1, below summarizes channel adapter connectivity.

Interface\Model	Model 700	Model 900	Model 1100	Model 2100
Number of FC 4Gbps Interfaces	16	64	64	128
Number of iSCSI (1Gb)	8	32	32	64

Table 1. ETERNUS8000 Models Host Connectivity

Device Interfaces

Integrated with the controller module, the Device Interface adapters (DIs) connect the disk drives to the controller modules over a fibre channel arbitrated loop interface. A device adapter has up to four fibre channel arbitrated loop ports installed per controller. Dual arbitrated loops are used to connect the dual ported disks so that a single loop failure will not result in loss of access to the disk. There are two dual-loop pairs that interconnect the drive enclosures. Each drive enclosure supports one dual loop pair.

FRT

The Front End Routers (FRT) provide controller to controller interfacing, communications pathing and data transferring pathing between controller caches in support of write cache mirroring operations.

BRT

The Back end Routers provide high-speed fibre channel path switching for data transfer to and from Controller units and disk drives contained within the Disk Enclosures.

RAID Storage Arrays

The Fujitsu storage systems are configured into storage arrays with RAID configurations for data protection. The data in the RAID storage arrays is organized into logical volumes. The logical volumes are made available to servers as LUNs (Logical Unit Numbers). Up to 4,096 logical volumes per storage system may be defined.

The ETERNUS storage system may be configured in different RAID configurations providing different levels of protection and performance. The RAID levels supported are RAID 0, RAID 1 which is essentially mirrored volumes, RAID 1+0 which is data mirrored on multiple disks and then striped – it is supported in configurations from 2+2 to 16+16, RAID 5 which has data distributed on multiple disks (3+1 and 7+1) and rotating parity for protection from disk failure, and RAID 6 (supported in a 6+2 configuration) which offers dual parity disk per RAID group. The disks are organized into groups called RAID groups.

Evaluator Group Comment: Fujitsu's RAID terminology for the Asia-Pacific market is RAID0+1; however their implementation is RAID with mirror then striped (RAID1+0).

The RAID group size, the number of disks in an individual RAID group, can vary but there are limits from Fujitsu of what is supported. The limits are:

- RAID 0 – 2 to 16 drives
- RAID 1 – 1 + 1 (obviously for a mirror)
- RAID 1+0– from 2+2 to 16+16
- RAID 5 – 3+1 and 7+1
- RAID 6 – 6+2

Different capacity drives may be intermixed within in a RAID group. The capacity utilized within a RAID group will be that of the smallest capacity drive within the group. A hot spare can be configured within a loop pair, and a hot spare can be used to replace any failed drive within a RAID group. After a failed drive is replaced, the data will be copied to the replaced drive and the original spare returned to spare status. The ETERNUS manager software (ETERNUSmgr) will allocate one spare disk per loop pair if hot sparing is specified. If different capacity drives are used in the same fibre channel loop, the hot spare must be equal (or greater) to the largest capacity drive.

The ETERNUS Eco-Mode utilizes MAID technology for infrequently accessed data and achieves new scales of cost savings. By allowing RAID groups that are infrequently accessed to be “spinned down” when they are not used customers can realize power savings and reliability gains for their low cost fibre channel drives. Customers will be able to utilize another storage tier within their ETERNUS storage systems.

RAID Configuration

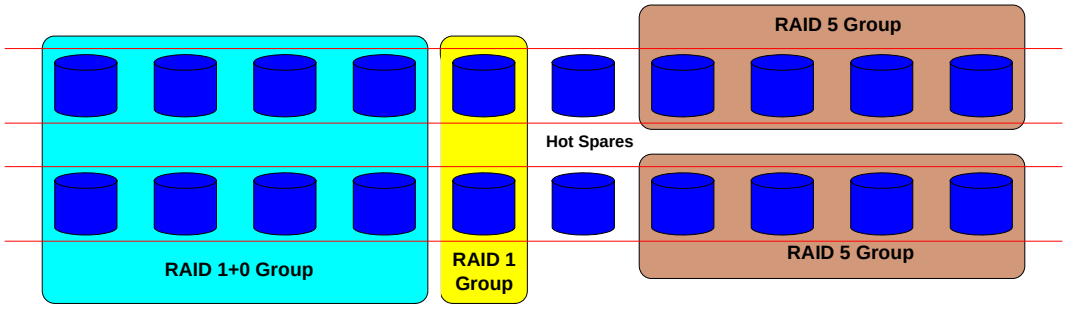

Figure 10. Hot Spare Disk Usage in various RAID Configuration

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Disk Devices

The ETERNUS8000 supports current state-of-the-art 2 and 4Gbps Fibre Channel interface disk drives as well as the new 500 GB NearLine low cost fibre channel disk drive suited for archival and backup purposes, but yet where the archived data may need to be retrieved in a shorter time frame than typically offered by tape media. ***Evaluator Group Comment: Support for a wide range of disk devices coupled with support for very large capacities and up to 128 Fibre Channel connections enables ETERNUS8000 users to deploy the product across a greater number of applications within the enterprise data center.***

The characteristics of the disk devices supported are listed in Table 2, below.

Specification	Drive Type	Drive Type	Drive Type
Max. Capacity (GB)	500GB NearLine	73.4, 146.8, 300	36.7, 73.4, 146.8
Rotational Speed (RPM)	7,200	10,000	15,000
Buffer Size (MB)	16	4	8

Table 2. Disk Drive Characteristics

Disk Data Encryption

ETERNUS provides data encryption and protects critical, security sensitive data from unauthorized access to drives that have been removed from the storage system. The ETERNUS native 128-bit Advanced Encryption Standard (AES encryption) can essentially deliver electronic “data shredding” of sensitive data when drives are removed from the storage system. This type of encryption enables ETERNUS to ensure the highest levels of data security

Mirrored Cache

The controllers each contain cache. Only write data is mirrored from one controller to another controller. With a varying amount of write data, the amount of cache available between the controllers is also variable.

The write data is mirrored between the two controllers over a shared high-speed PCI-Express bus link. The bandwidth of the cache on a controller is not specified by Fujitsu. Table 3, below describes the number of controllers and cache capacities for the ETERNUS models.

Specification \ Model	Model 700	Model 900	Model 1100	Model 2100
Number of Controllers	2	2, 4	4	4, 6,8
Max Cache Size (GB)	8	32	32	256

Table 3. ETERNUS8000 Models Controllers and Cache Mix

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Battery

The ETERNUS8000 protects write data in cache memory that has not yet been written to its intended target drive at the time of a power fault by keeping battery power applied to the cache memory and specific disks (known as “system disks”) long enough so that the write cache data is safely stored on the system disks. Later, after the power fault has been cleared and power has been reapplied to the subsystem, the write data is restored to cache memory from the system disks and the write data is then correctly written to its original target disk drives.

Battery life is specified at three years. The batteries must be replaced if the expiration date has passed. The expiration date can be read through the ETERNUSmgr web-based software.

Host Affinity

Host Affinity is used in open systems for managing server access to specific volumes. Some vendors term this feature LUN Masking, LUN Management, or LUN Mapping. Host Affinity controls the access, which provides a security mechanism at the LUN level. A Host Affinity group is defined as a set of LUNs that are made available to a specific set of servers. The server is identified by the World Wide Name of the host bus adapter. LUNs can be assigned to multiple heterogeneous servers and a duplicate LUN can be used in a different Host Affinity group allowing for some measure of data sharing. The Host Affinity is controlled by the ETERNUSmgr configuration software and is not an extra charge item.

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RELIABILITY, AVAILABILITY, AND SERVICEABILITY

ETERNUS storage systems maintain data integrity and provide data availability via the following mechanisms:

- RAID protection of disk devices
- Redundancy of active components
- Dual power source
- Write cache data de-stage to disk
- Concurrent configuration changes
- Hot spare disk drives
- Concurrent maintenance on components
- Concurrent firmware upgrades
- Parity protection
- ECC (Error Correction Code)
- BlockGUARD

Data Integrity

Data integrity is expected of any storage system and the methods that system vendors employ to ensure data integrity are important for any analysis. Fujitsu has implemented an end-to-end integrity checking mechanism that is called BlockGUARD. BlockGUARD will put an extra eight bytes of information on every 512-byte data block as it enters the system at the channel adapter. These eight bytes are retained with the data as long it is stored within the system. The eight bytes are composed of a four byte cyclical redundancy check (CRC) and four bytes that are the block ID. This information is checked whenever the block is stored on the disk by the device adapter and is also checked when data is retrieved, both at the device adapter and the channel adapter. The BlockGUARD characters are stripped whenever data is sent to the host by the channel adapter.

Data integrity is also a part of the cache function. Data in cache is error-correction code (ECC) protected to be able to detect and correct cache memory errors.

Redundant Power System

The power system is based on redundant power supplies in the modular enclosures with dual line cord inputs. The modular architecture and dual power inputs ensure the greatest amount of power problem isolation. All power system components are replaceable non-disruptively.

Parity

The PCI and PCI-Express busses have parity generating and checking circuitry that verify hardware integrity for data transfers at the time that they are placed onto and taken off of the busses.

Error Checking and Correction (ECC)

The cache memory on each controller module uses ECC to detect all single and double bit errors and correct single bit errors.

BlockGUARD

BlockGUARD is the ETERNUS data protection methodology that protects each and every data block written to disk with Fujitsu's patented parity protection data assurance algorithms.
Evaluator Group Comment: BlockGUARD, using the block code based industry standard T10/DIF (Data Integrity Field) is one of the technologies implemented across the entire ETERNUS product line which enables the high reliability characteristics of this product.

Hot Spares

Using hot spare disks is a configuration option. When chosen, the configurator allocates a spare per loop pair. The operation of handling hot spares is as described in the RAID Storage Array section of this chapter.

RAID 6

With the use of dual parity drives in a RAID 6 configuration, the subsystem is better protected in the event of a double disk failure (two disk drives fail concurrently).

Concurrent Maintenance

A modular architecture is based on modules being able to be taken out of service while others take over the workload. The ETERNUS8000 operates in a mode where some components can be replaced without failing over to another controller while others require a failover to occur for service. Fujitsu states the following components can have concurrent maintenance to provide access assurance.

- Controllers and cache
- Channel Adapters
- Power Supplies
- Cooling Fans
- Disks

Concurrent Firmware Updates

Concurrent firmware updates in a modular architecture is accomplished by copying the firmware to each controller (to flash ROM) and then failing over each controller module individually and then rebooting and enabling with the new firmware loaded. The sequence is performed for each of the controller modules.

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SPECIFICATIONS

Model	Width(cm)	Depth(cm)	Height(cm)	Weight(kg)
700	59.00	99.50	140.00	410
900	74.00	99.50	180.00	2,220
1100	198.0	99.50	180.00	4,230
2100	322.0	99.50	180.00	10,930

Table 4. ETERNUS8000 Physical Specifications

Spec. \ Model	Model 700	Model 900	Model 1100	Model 2100
Power Requirements				
Voltage	AC200-240V	AC200-240V	AC200-240V	AC200-240V
No. of Phases	Single	Single	Single	Single
Frequency	50/50Hz	50/60Hz	50/60Hz	50/60Hz
Max. Power Consumption(Kw)	2.27	16.00	31.20	82.90
Max. Heat Dissipation (KJ/h)	8,000	56,300	109,700	304,500
Environmental Conditions				
Temperature				
Operating	5-35 degrees Centigrade	5-35 degrees Centigrade	5-35 degrees Centigrade	5-34 degrees Centigrade
Non-Operating	0-50 degrees Centigrade	0-50 degrees Centigrade	0-50 degrees Centigrade	0-50 degrees Centigrade
Humidity				
Operating	20-80% RH	20-80%RH	20-80%RH	20-80%RH
Non-Operating	8-80%	8-80%	8-80%	8-80%

Table 5. ETERNUS8000 Electrical and Environmental Specifications

Host Vendors	Supported Servers	Supported Operating Systems
Fujitsu	PRIMEQUEST	Windows Server 2003 for Itanium based Systems, Red Hat Enterprise Linux AS (V.4 for Itanium)
	PRIMEPOWER	Solaris 8 Operating System, Solaris 9 Operating System, Solaris 10 Operating System
	PRIMERGY	Windows 2000 Server, Windows Server 2003, Windows Server 2003 x 64 Editions, Red Hat Enterprise Linux AS v.3, Red Hat Enterprise Linux AS v.4, Red Hat Enterprise Linux ES v.3, Red Hat Enterprise Linux ES v.4, VMware ESX Server 2
	GlobalServer	Mainframe in Japanese market
Sun	Sun Fire, Sun Blade, Sun Enterprise	Solaris 8 Operating System, Solaris 9 Operating System, Solaris 10 Operating System
HP	HP 9000 series	HP-UX 11v2
IBM	pSeries, RS/6000 series	AIX 5.2, AIX 5.3
Others	IA server vendors (various companies)	Windows 2000 Server, Windows Server 2003, Windows Server 2003 x 64 Editions, Red Hat Enterprise Linux AS v.3, Red Hat Enterprise Linux AS v.4, Red Hat Enterprise Linux ES v.3, Red Hat Enterprise Linux ES v.4, SUSE Linux Enterprise Server 8, SUSE LINUX Enterprise Server 9, VMware ESX Server 2

Table 6. ETERNUS8000 Supported Servers and Operating Systems

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CONFIGURATION

There are four (4) models of the ETERNUS8000 and they may be configured in a number of ways.

All Models are of the floor standing cabinet nature. All models are dual controller, or more. The following table gives the logical capacity, cache, and interface options for the specific models.

Model \ Spec	Logical Capacity(TB)(1)	Disk Drives	Max Cache	Host Connections
700 FC Disk NearLine FC Disk	Up to 11.2TB 18.7TB	6 to 60	16GB	4 to 16 FC, 4Gbps/sec 4 to 8 iSCSI, 1Gbps/sec 4 to 8 FC Link(2) 4 to 8 OC Link(2)
900 FC Disk NearLine FC Disk	Up to 110.3TB 184.8TB	20 to 480	64GB	4 or 64 FC, 4Gbps/sec 4 to 32 iSCSI, 1Gbps/sec 4 to 32 FC Link(2) 4 to 32 OC Link(2)
1100 FC Disk NearLine FC Disk	Up to 233.8TB 391.5TB	Max 1020	128GB	16 to 64 FC, 4Gbps/sec 4 to 32 iSCSI, 1Gbps/sec 4 to 32 FC Link(2) 4 to 32 OC Link(2)
2100 FC Disk NearLine FC Disk	Up to 637.5TB 1068.2TB	Max 2760	256GB	16 to 128 FC, 4Gbps/sec 4 to 64, 1Gbps/sec 4 to 64 FC Link(2) 4 to 64 OC Link(2)

Note:

1. ***Logical capacity calculated as 1K byte = 1024 bytes and when formatted as RAID5. Actual user capacities may vary slightly depending upon host environment***
2. ***Connection to Fujitsu mainframes.***

Table 7. ETERNUS8000 Elements of Configurations

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SOFTWARE FEATURES AND FUNCTIONS

The ETERNUS SF software suite includes a number of strong offerings that provide users with feature/functions that leverage the capabilities of the subsystem:

- Advanced Copy Manager (ACM) for replication management
- Storage Cruiser for SAN monitoring and management
- ETERNUSmgr Aid for performance monitoring of ETERNUS resources to identify performance hot spots and assist in load balancing for the ETERNUS system.
-

ETERNUS SF Advanced Copy Manager (ACM)

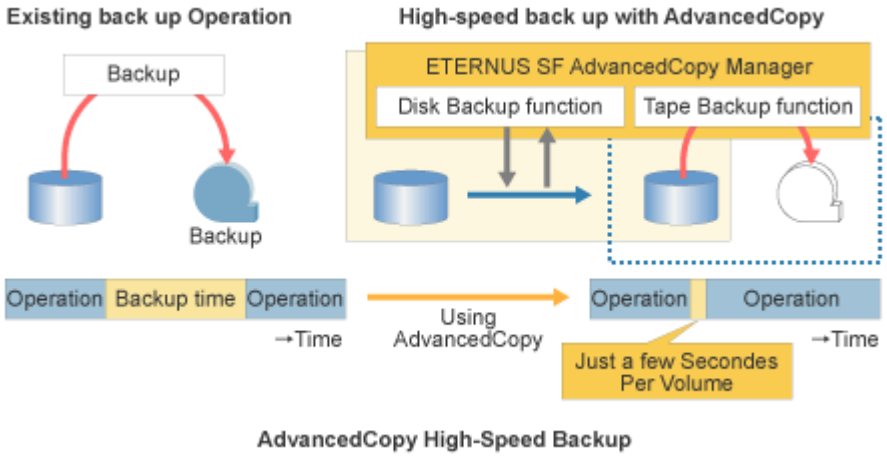

Figure 11. Example; Advanced Copy Manager, ACM

ACM significantly reduces overall backup time (just seconds per volume). ACM uses OPC (One Point Copy) functions described below and can minimize business down time via its integrated disk to disk to tape (D2D2T) type of solution.

- ***ACM Backup in database environments***

ETERNUS SF Advanced Copy Manager does not need to stop the operational database functions of Oracle, Symfoware, SQL Server, DB2 and Exchange Server 2003, while backups are in process.

- ***Differential backup/replication with ACM***

Fujitsu's ETERNUS SF Advanced Copy Manager copies the entire operational volume in order to assure maximum recovery security. The QuickOPC function, only copies differences since the last physical copy. This reduces the amount of data copied as well as the time required for copy. Also, the load on the storage system is lessened, which in turn means less backup effect on your business operations.

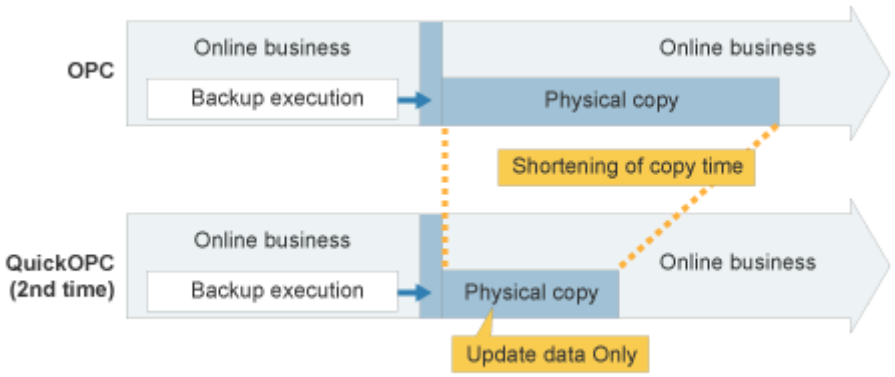

Figure 12. Differential Backup/Replication with ACM

- ***SAN remote copy with ACM***

Copying between storage devices within the SAN and copying to remotely located storage devices via WAN, is possible with ETERNUS SF Advanced Copy Manager. This provides an effective disaster recovery solution whether deploying Fujitsu's storage systems in or between disaster resistant facilities.

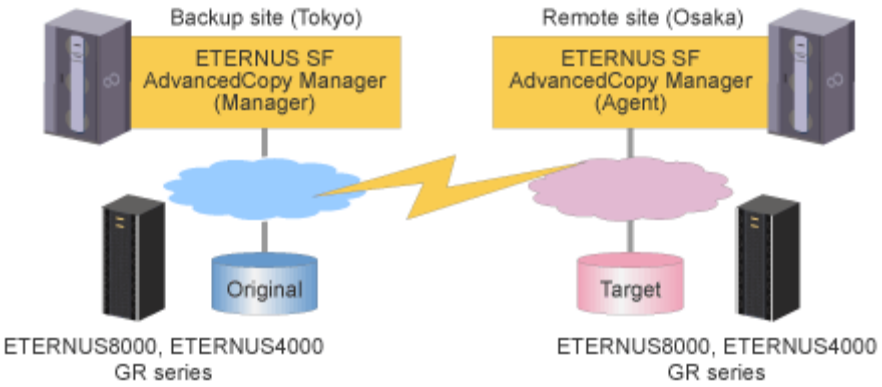

Figure 13. SAN Remote Copy with ACM

Evaluator Group Comment: A well thought out, and routinely executed, back up strategy - leveraging replica copies as part of that strategy - may reduce overall down time and shorten the time to recovery and application restart..

One Point Copy (OPC)

As a data replication function, point-in-time copy has proven to be very valuable to customers and most storage system vendors have implemented some form of point-in-time copy. Fujitsu has termed the implementation for the ETERNUS series, One Point Copy or OPC. The copy is a "clone" copy where an exact original copy is made to another physical area. Entire volumes may be copied. Space for the copy must be reserved previously and be at least the same size. The RAID configuration may be different in the source and target.

The copied volume is available nearly instantly after the OPC initiation. OPC has two copy phases: the logical phase and the physical phase. The logical phase starts after the OPC command is initiated. A bitmap that represents the copy is created in cache memory. That process takes a few seconds and after completion, the copy is available for use. The physical phase then starts which is the process of the storage system copying the data to a new location. During the physical phase, host access to data is available and the following operations could occur (besides reads to the original data) which involve usage of the copy bitmap:

- Read to Target – If the requested block has been previously copied to the target, a normal read is done to the target volume. If the requested block has not been copied, the system will copy the block from the source to the target and then honor the read from the target volume.

- Write to Source – If the requested block has been copied to the target, a normal write operation is done to the source. If the requested block has not been copied yet, the original block is copied to the target and the write is then done to the source.

- Write to Target – If the requested block has been copied to the target, a normal write operation is done. If the block has not been copied, the bitmap is changed to indicate the copy has been done and the normal write is done.

The process of the physical copying persists through a power down or reboot.

There are three speed settings (pacing parameters) to control the amount of storage system resources consumed. The speed settings of low, medium, and high are set by the management software.

One Point Copy consumes cache memory for the bitmap (and the additional data being moved for the copy). To use OPC, at least 1GB of cache for each controller module must be installed.

Up to eight copy sessions may be active on a single LUN with a maximum of 256 sessions within the storage system. The sessions include OPC as well as EC and REC.

On the second time One Point Copy is run, the user can actually execute QuickOPC and dramatically shorten the copy time. The effects of this shortening of the copy time can be realized in the real-time business environment by making copies of data available to applications sooner and this can shorten backup times. Shortening of backup times is especially useful for users with very tight backup windows.

Figure 14, below illustrates OPC and QuickOPC.

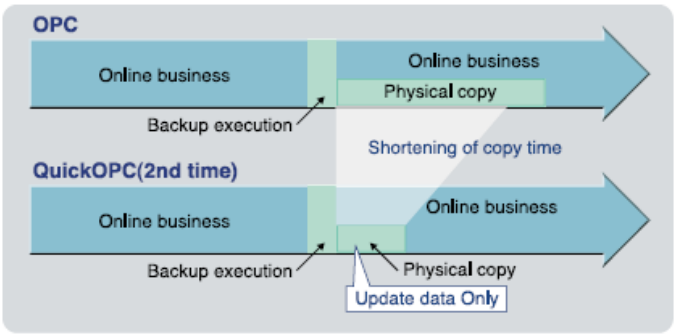

Figure 14. OPC with Secondary QuickOPC

SnapOPC

With the SnapOPC function, only the old version of the updated data is copied to the copy volume. By copying only a portion of the source volume, it minimizes copy volume capacity. This makes it an efficient backup data management solution over multiple generations.

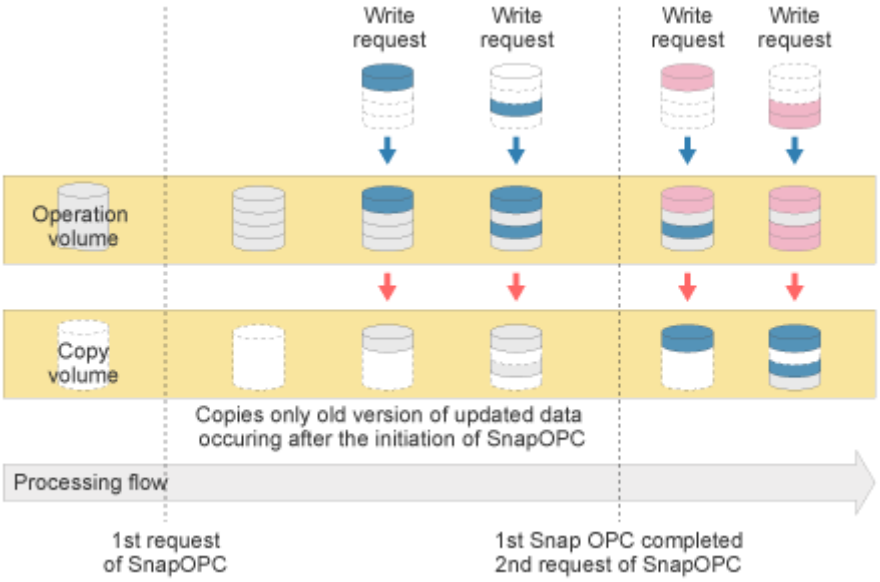

Figure 15. Example of SnapOPC for ETERNUS8000

Equivalent Copy (EC) and Remote Equivalent Copy (REC)

Another data replication function, Equivalent Copy, has been used for both migration of data and as part of a disaster recovery protection strategy. Fujitsu has termed the implementation Equivalent Copy or EC for local copies and Remote Equivalent Copy or REC for remote copies. It is sometimes called a mirror copy as well. The copy is an exact image copy made to another physical area. Entire volumes may be copied as initiated by the Fujitsu management software. Like the One Point Copy feature, space for the copy must be reserved previously and be at least the same size. The RAID configuration may be different in the source and target.

Remote synchronous and asynchronous mirroring options enable business continuity protection. ETERNUS SF EC can improve productivity by providing highly available data mirroring over any distance - and now with the ability to leverage mirroring via iSCSI, REC provides an economical way to provide highly available data storage—from across campus to around the globe—through synchronous or asynchronous data mirroring between ETERNUS arrays. ETERNUS EC is array

based, which means replication is essentially transparent to application performance. With ETERNUS Equivalent Copy user should be able to:

- Maximize data availability and business continuity
  - Maintain an exact byte-for-byte copy of production data in a secure, remote location
  - Failover to secondary sites for rapid disaster recovery
  - Integrate with OPC for secondary site backup operations
- Easily manage Mirrors with ETERNUS Advanced Copy Management
- Choose between synchronous and asynchronous mirroring for ETERNUS systems
  - Today, business continuity and disaster recovery strategies and deployments leverage asynchronous mirroring/replication as the preferred method of replication over long distances. Figure 10, below illustrates the basic example of an asynchronous replication scenario between two ETERNUS8000 storage subsystems.

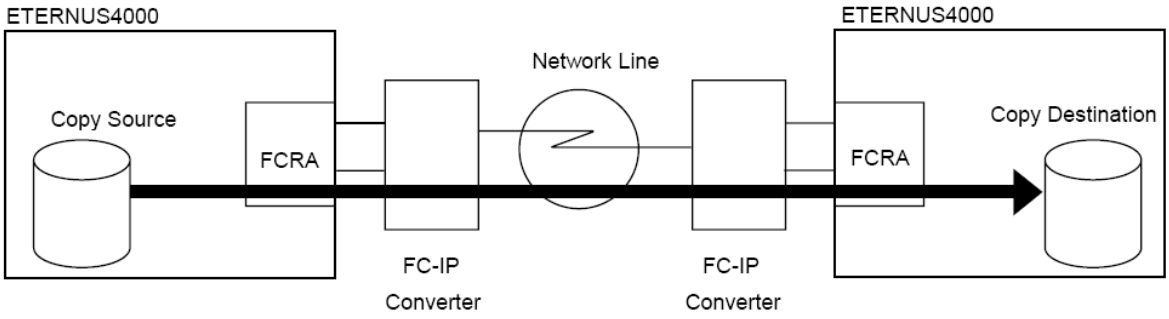

Figure 16. Basic Example of Asynchronous Replication Between Two Subsystems

The copied volume is not available until the initial copy is complete and either a “detach” (split or break in some terminology) or a suspend command has been issued. If suspended, a “resume” may be done which will cause a resynchronization to be done. The resynchronization is the application of incremental updates that have been made to the source volume to the target. The target volume is not available during a resume. If a detach (split, break) has been done, the target volume becomes independent at that time.

The process of the physical copying for the mirror persists through a power down or reboot. As in One Point Copy, Equivalent Copy consumes cache memory for the bitmap (and the additional data being moved for the copy). To use EC, at least 1GB of cache for each controller module must be installed.

While very similar to One Point Copy, the differences are that Equivalent Copy supports the Suspend/Resume function and the mirror volume is not available until the copy is complete.

ETERNUSmpd

The server-based software is used to provide high availability of the ETERNUS storage subsystem via multipathing capabilities and failover to an alternate path in the event of a path failure. The Dynamic Load Balance feature for the software provides load balancing across multiple paths to the storage subsystem.

ETERNUSmgr

Centralized management software for multiple ETERNUS systems for administrative control is provided with the ETERNUSmgr software from Fujitsu. ETERNUSmgr allows status monitoring (including email notifications), configuration, and control of multiple systems from a web browser GUI interface. Currently, ETERNUSmgr runs on Windows and Solaris operating systems.

ETERNUS SF Storage Cruiser

In addition to the SAN management functions (such as configuration specification, and overview of the SAN environment, and error monitoring), Storage Cruiser enhances management functions such as ETERNUS environment support (Direct Attach Storage, and Network Attach Storage) and storage environment visualization (used to manage the relationship between the storage as viewed from the host server and the physical storage.), and allows the whole storage systems configuration and failure conditions to be managed

Figure 17, below illustrates ETERNUS SF Storage Cruiser as it interfaces with the ETERNUS8000:

Analysis of Fujitsu ETERNUS8000
Models 700, 900, 1100, and 2100 Feature/Function

Analyst: Tom Trainer

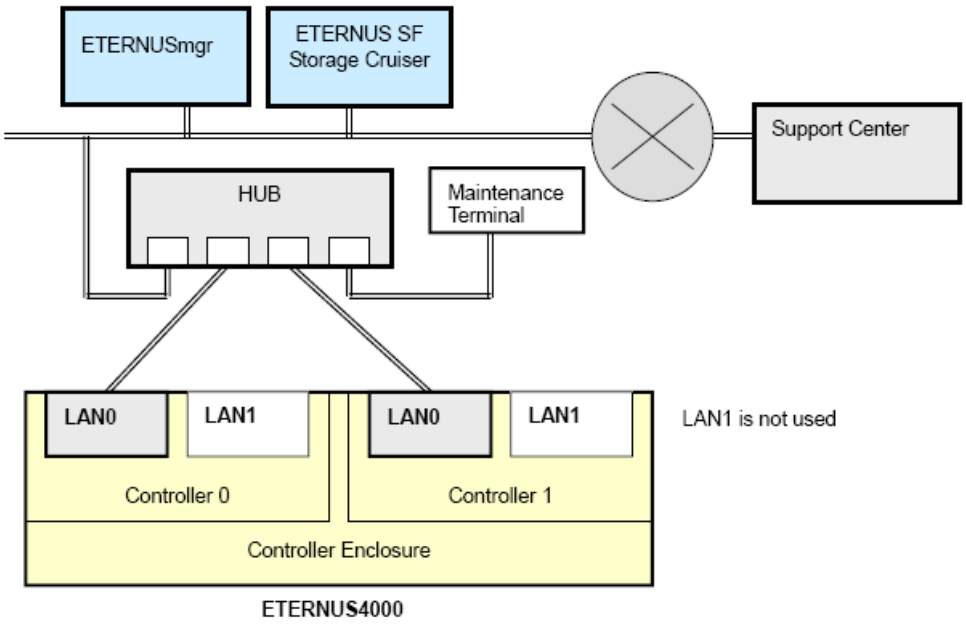

Figure 17. Example of ETERNUS SF Storage Cruiser Interfacing to ETERNUS8000

Analysis of Fujitsu ETERNUS8000
Models 700, 900, 1100, and 2100 Feature/Function
Analyst: Tom Trainer

PERFORMANCE

Performance tests for some models of the ETERNUS8000 have been performed and audited by the Storage Performance Council. The information is available at www.storageperformance.org.
Evaluator Group Comment: Evaluator Group expects that Fujitsu will submit SPC performance test results for the ETERNUS8000 in the near future. Further Evaluator Group expects, based on the architecture of the ETERNUS8000 that the performance results will be excellent and of the standard of enterprise class storage.

Specific performance features of the ETERNUS8000 system include:

- **Disk Traffic Control (DTC)** – DTC is a performance optimization that optimizes the back end disk drive by segmenting sequential and random accesses into separate extents when they both occur simultaneously. The two I/O streams (sequential and random) are processed alternately on a time interval basis to provide optimum usage of the disk drive resource.

- **PCI-Express Bus** – Used in the ETERNUS8000, the dedicated PCI-Express bus provides the high-speed interconnect for controller to controller communications. This high-speed bus is part of the high performance elements that Fujitsu has designed into the ETERNUS family.

- **Overall throughput enhancements** – High performance dual 3.6 GHz XEON processors coupled with 4Gbps/sec front and back-end, and with larger cache sizes the ETERNUS8000 is well positioned for excellent performance in large data block environments such as media streaming and content management.

Analysis of Fujitsu ETERNUS8000
Models 700, 900, 1100, and 2100 Feature/Function

Analyst: Tom Trainer

ANNOUNCEMENT HISTORY

Date	Announcement
April 2006	Announcement of ETERNUS8000 family of storage systems: Models 700, 900, 1100, and 2100

Table 8. ETERNUS8000 Announcement History

Analysis of Fujitsu ETERNUS8000
Models 700, 900, 1100, and 2100 Feature/Function

Analyst: Tom Trainer

Evaluator Group comments:
Evaluator Group's perceived strengths and perceived weaknesses of the product are as follows:

Strengths:

- ***A potential cost effective solution based on price/feature functionality***
- ***Capable of very good open systems performance.***
- ***Well architected to take advantage of 4Gbps/sec SAN and FC disks***
- ***Reliability features designed into the system. Fujitsu well known for stable reliability.***

Perceived Challenges:

- ***Limited advanced software functions compared to some leading solutions.***
- ***Enterprise class API capability to leverage the functionality of the Controllers with applications resident on host servers.***
- ***Multiple models may be somewhat confusing to the customer as which one should be chosen. Clear SE guidance should be provided by Fujitsu***
- ***A major sales push in the United States by an OEM or distributor would greatly improve the volume.***
- ***Fujitsu must do more to market recent wins and volume purchases to current customers and potential prospects. This will assist them in building more market acceptance and momentum for a well architected enterprise class product.***

Summary

With the release of the ETERNUS8000, and growing support of attachment of the ETERNUS line to servers including and other than the Fujitsu server platform, Fujitsu is demonstrating the seriousness of their commitment to providing open storage to a demanding - and rapidly growing market. The ETERNUS systems should fill the need for functional, protected, midrange storage for the open systems market.

The proven valuable features of Point-In-Time copy and remote copy are there – and support of synchronous, asynchronous and consistency mode will position the ETERNUS8000 as a consideration when disaster recovery and business continuance support is required. The performance and competitive cost of the system should be very attractive to customers. Fujitsu continues to supply excellent data integrity features – demonstrating their understanding that this has become an expectation for storage systems in the enterprise open systems storage space.

Analysis of Fujitsu ETERNUS8000
Models 700, 900, 1100, and 2100 Feature/Function

Analyst: Tom Trainer