Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
Analysts: Russ Fellows, John Webster

In June of 2009, Fujitsu announced the introduction and availability of the ETERNUS DX60 and DX80. These rack mounted ETERNUS models are the entry-level models of the ETERNUS family of disk storage systems. The new ETERNUS DX90 system was announced on January 27th 2010, and adds to the entry level ETERNUS DX lineup.

Products and vendors that compete with the ETERNUS DX60/DX80/DX90 include the EMC AX4; Hitachi Data Systems SMS 100; Hewlett Packard's (HP) MSA2000; along with IBM's DS3000 and NetApp's FAS2000 series.

HIGHLIGHTS

- Low profile, 2U enclosure supporting one or two controllers
- Multiple host interface choices on systems
  - Fibre Channel interfaces at 4 Gbit/s (8 Gbit/s on DX80/DX90)
  - 3 Gbit/s SAS interfaces (DX60 and DX80)
  - 1 Gbit/s iSCSI interfaces (DX60 and DX80)
- Support for intermix of performance and capacity drives
  - Enterprise-class Solid State Drives: DX80/DX90 only
  - 15k rpm high-performance SAS drives
  - 7.2k rpm large-capacity Nearline SAS drives
- Reduced power consumption for infrequently accessed data (MAID technology)
- Multiple advanced data protection software options
  - Multiple point in time copy options
  - Local mirroring (DX60 and DX80) and remote replication on DX90 for disaster recovery
- Choice of management software
  - Embedded web GUI and CLI for basic management
  - Centralized web-based management software
  - SAN management option
- HA design with multiple reliability features
  - Call home feature for proactive maintenance
  - Hot swappable, redundant components
  - Cache Protector utilizes capacitor to provide unlimited time protection for cached data
  - Mirrored write cache with ECC protection for high availability
- Advanced Controller Features
  - Support for RAID 0, 1, 1+0, 5, 5+0 and 6 with global hot spare disks
  - Controller based data encryption available per LUN
  - Non-disruptive logical volume expansion
  - RAID Migration allows movement of data on active RAID volumes
  - Support for failover and load balancing with server-based failover software
  - Host Affinity providing LUN masking and access security
  - Data Block Guard, provides data integrity via error detection codes added to every data block
- Option for two (2) or three (3) year maintenance with next business day (NBD) included; uplifted maintenance is available

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
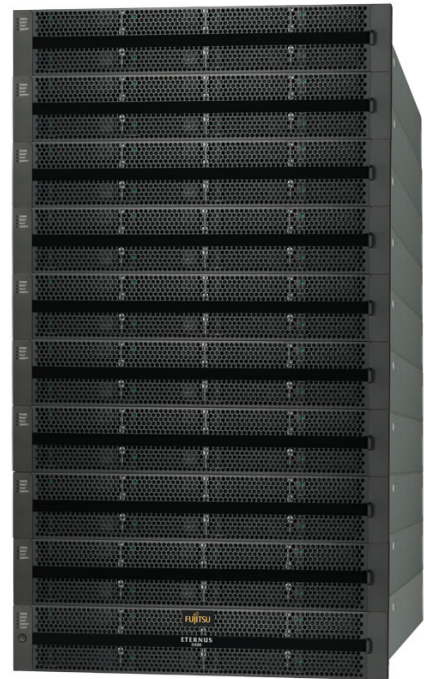**Analysts: Russ Fellows, John Webster**

OVERVIEW

The ETERNUS DX60/DX80/DX90 are the entry-level series of the Fujitsu ETERNUS family of disk storage systems designed for SMB and distributed environments requiring high reliability, availability and serviceability features. The entire entry level ETERNUS DX systems utilize a 2U enclosure for the base unit and support for additional expansion enclosures. The system enclosure houses one or two controllers, with up to twelve - 3.5 inch disk drives.

The ETERNUS DX60 and DX80 support direct connectivity via SAS, iSCSI or FC, along with SAN connectivity using FC or iSCSI connectivity. Currently, the DX90 supports 8Gbit/d FC connections only. Heterogeneous server attachment is supported, with specific operating systems support listed in Table 4.
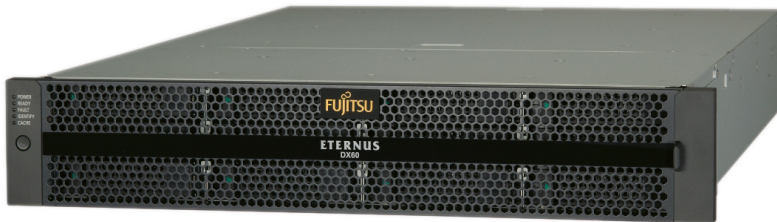
DX60 Single Chassis   DX80/DX90 Full Configuration
Figure 1: ETERNUS DX60, DX80 and DX90 Product Line

The ETERNUS DX series is an update to previous ETERNUS 2000 and FibreCAT SX systems. Packaging includes up to 12 drives in a 2U enclosure, drive spin down for idle disks and Fujitsu's Raid on Chip (ROC) technology for controller operations. A single chip RAID controller minimizes the size and number of components and power requirements.

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
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Evaluator Group Comments: The small form factor and lower power consumption are appealing both in the SMB environments, and larger enterprises where size, power and cooling requirements are important. Support for drive spin down and high capacity Nearline SAS drives allow further opportunity to reduce power consumption.

Model Comparison

		Model DX60	**Model DX80**	**Model DX90**
Form Factor		Rack Mount (2U base configuration)		
Number of Controllers		1 or 2		
RAID Levels		0, 1, 1+0, 5,5+0, 6		
Maximum Disk Drives		24	120	120
Disk Drive Types	3.5" Enterprise SSD	N/A	100 GB, 200 GB	
	3.5" 15k rpm SAS	300 GB, 450 GB, 600 GB		
	2.5" 10k rpm SAS	146 GB, 300 GB		N/A
	3.5" 7.2k SAS nearline	1 GB, 2 TB		
Total Physical Capacity	Enterprise SSD	N/A	1.8 TB (max 9 drives)	1.8 TB (max 9 drives)
	SAS	14.4 TB	72.0 TB	72.0 TB
	Nearline SAS	48.0 TB	240.0 TB	240.0 TB
Maximum Volumes / RAID group		128	128	128
Max Number of Connected Hosts		64	128	256
Max Hosts per port (Host Affinity groups)		16	32	32
Maximum number of snapshots		512	1,024	1,024
Maximum Logical Volumes		512	1,024	1,024
Maximum LUN Size		32 TB (concatenated) or 8 TB (regular LUN)		
Number of Host Interfaces		2 or 4 per system (2 per controller)		4 or 8 (4 / controller)
Host Interfaces / Controller	FC	2 @ 4 Gbit/s	2 @ 4 or 8 Gbit/s	4 @ 8 Gbit/s
	iSCSI	2 @ 3 Gbit/s		N/A
	SAS	2 @ 1 Gbit/s		N/A
Cache Capacity		1 GB / controller	2 GB / controller	2 GB / controller
Drive Interface		SAS (4X @ 3 Gbit/s)		
Dimensions (W x D x H)		18.98" x 25.98" x 3.64" (2U) Mínimum Config		
Additional Drive Enclosures		Max 1	Max 9	Max 9

[1]Calculated as 1k byte = 1,000 bytes and includes system disk capacity
[2]Calculated as 1k byte = 1,024 bytes and when formatted as RAID5. User capacity depends on system environment

Table 1: Model Comparison

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
Analysts: Russ Fellows, John Webster

PRODUCT ARCHITECTURE

The modular, rack mounted ETERNUS DX starts with the Controller Enclosure (CE). The CE contains redundant fans, power supplies and expansion connectivity through SAS expanders. The minimum configuration for the DX60, DX80 and DX90 is contained within a single CE. This 2U CE contains one or two controllers and from 2 to 12 drives. Up to two connections per controller or four total connections are supported on DX60 and DX80 models, with four or eight FC connections on the DX90.
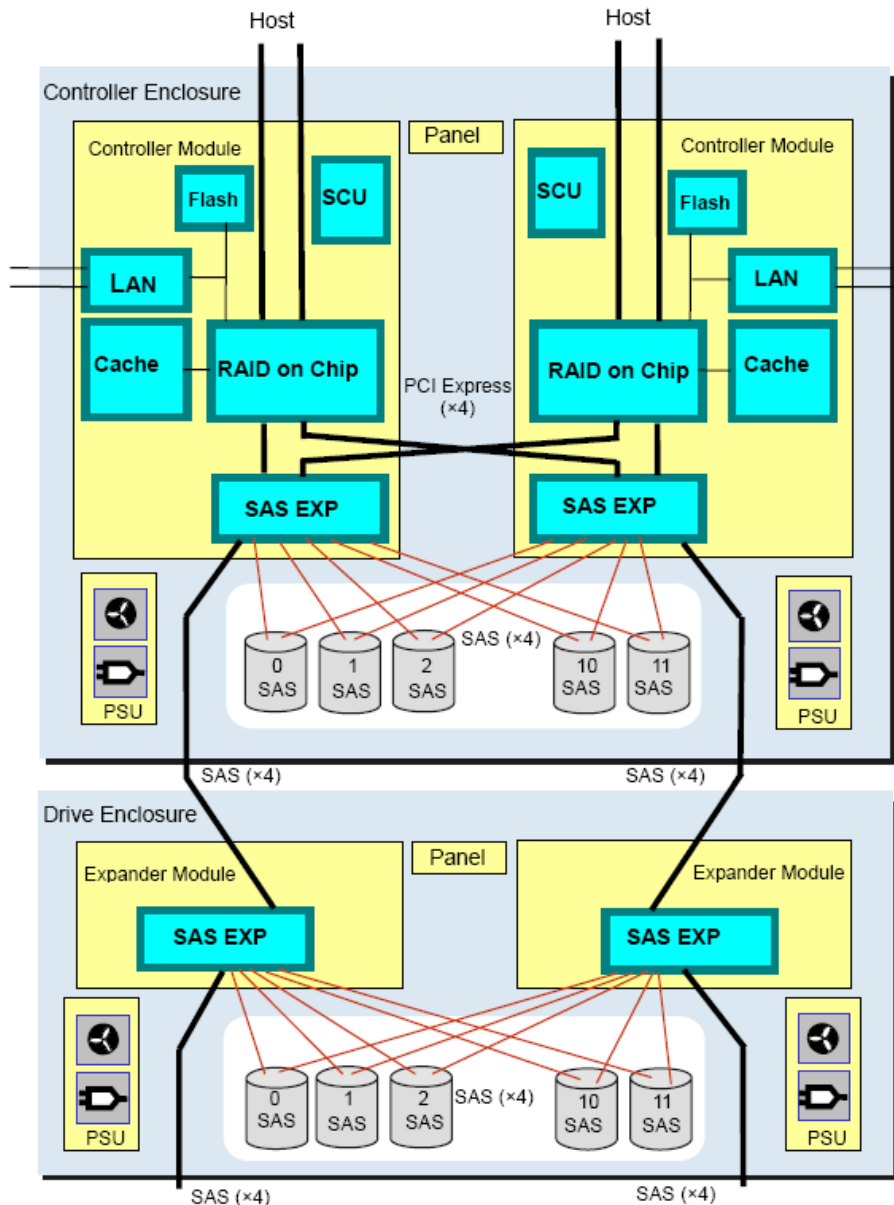

Figure 2: ETERNUS DX60, DX80, and DX90 Architecture, dual controller (source: Fujitsu)

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
Analysts: Russ Fellows, John Webster

When configured with two controllers and connected according to recommendations, the ETERNUS DX60, DX80 and DX90 design provides fault tolerant high availability. The cache is utilized for reads, writes, and controller based copy functions, with the amount being model dependent. Each controller includes cache, with write mirroring between the controllers cache for HA operation.

Cache is utilized for multiple purposes; including data protection functions such as Fujitsu's array based mirroring and point in time copy data protection software. The operation of these optional features is covered in the Software Architecture section of this document.

The function of the battery backup unit that was used for cache protection in prior models has been replaced by a capacitor, known as the Cache Protector, (also referred to as the System Capacitor Unit or SCU) and flash memory. The capacitor provides multiple benefits over batteries, including a shorter recharge time, and a 5+ year lifespan. The SCU is capable of providing power to the control module for sufficient time to save the cache data to the onboard non-volatile flash memory in the event of a power failure. There is no time limit as to how long the cache memory data can reside in flash. Each controller contains a flash and capacitor unit to retain data.

EGI Comment: Fujitsu's new design to preserve cache data is a good change from previous ETERNUS 2000 systems. Capacitors typically do not require special disposal and have a longer lifespan than batteries. Additionally, capacitors are not subject to reduced performance over time, as is the case with batteries. The use of flash storage also adds to the reliability of the system. The new design allows data to be maintained in cache without power for an unlimited amount of time. In SMB environments where the ETERNUS DX60/DX80/DX90 is likely to reside, extended power outages are more likely to occur than larger data centers. Thus, these enhancements should serve customers well.

Each enclosure, including both the base and expansion units house twelve disk slots. Each RAID group should utilize the same capacity and speed drive. Examples would be 15k speed drives or Nearline 7.2k disk drives. Mixed capacity drives are supported in a RAID group, although each disk will only utilize the capacity of the smallest disk in the RAID group.

- A maximum ETERNUS DX60 configuration utilizes one Base Enclosure and one Device Enclosure
- A maximum ETERNUS DX80/DX90 configuration consists of one Base Enclosure and nine Device Enclosures

Each Expansion Enclosure, also known as Drive Enclosure (DE), is 2U and includes dual SAS Expanders, redundant power supply units, redundant fans and 12 disk slots.

Controllers

The Controller Module (CM), housed in the controller enclosure, contains host interface ports, drive interface ports, cache memory, a System Capacitor Unit (SCU), flash memory, RAID control processors, RAID control firmware and Ethernet ports used for management. The ETERNUS DX60/DX80/DX90 design incorporates a controller chip, known as RAID on a Chip (ROC). A SAS Expander provides connectivity from the controllers to the backend disk drives over 3 Gbit/s SAS channels, and provides connectivity from the base enclosure to optional expansion enclosures. The ROC's provide highly integrated array controller processing in conjunction with the CPU and memory as depicted in Figure 2.

The DX60/DX80 systems support multiple host connection types as outline previously in Table 1. Currently, the DX90 only supports FC host connections.

RAID Groups

Fujitsu supports several different RAID group configurations for non SSD disk devices. The configurations are shown below in Table 2. The maximum number of RAID groups is dependent upon the number of disk drives in the system, and the configuration guidelines provided below. Fully configured DX80/DX90 systems may support up to 60 RAID groups (for RAID 0 and 1), to as few as 24 RAID groups for RAID 6.

The Fujitsu ETERNUS DX systems utilize RAID groups as the first unit of grouping and data protection. Host accessible volumes or LUN's are created by aggregating or splitting up RAID groups. Logical volumes are made available to servers as LUNs (Logical Unit Numbers), with a maximum of 128 LUNs per RAID group. LUNs may also span across multiple RAID groups.

The RAID group size and the number of disks in an RAID group can vary within the limitations for support by Fujitsu. Listed below in Table 2 are the officially supported RAID configurations.

RAID	Non SSD Drives / RAID Group		Recommended Drives Configuration (Grouping)
	DX60	**DX80 / DX90**	
RAID0	2 – 16		—
RAID1	2		2(1D+1M)
RAID1+0	4 – 24	4 – 32	4(2D+2M), 6(3D+3M), 8(4D+4M), 10(5D+5M)
RAID5	3 – 16		3(2D+1P), 4(3D+1P), 5(4D+1P), 6(5D+1P)
RAID5+0	(3 – 12) x 2	(3 – 16) x 2	3(2D+1P)x2, 4(3D+1P)x2, 5(4D+1P)x2, 6(5D+1P)x2
RAID6	5 – 16		5(3D+2P), 6(4D+2P), 7(5D+2P)

Table 2: Supported Non Enterprise SSD RAID Groups and Recommended Configurations

The ETERNUS DX systems support multiple RAID levels and disk combinations, providing different levels of protection and performance. The RAID levels supported include: RAID 0, RAID 1, RAID 1+0 (data is mirrored on multiple disks and then striped across 4 to 32 disks), RAID 5 with rotating distributed parity on multiple disks, RAID 5+0 (which combines block striping of RAID 0 with RAID 5 rotating parity) and RAID 6 which offers dual parity per RAID group.

A maximum of 5 Enterprise SSD's are supported with one controller, and 9 Enterprise SSD's are supported with 2 controllers on the DX80/DX90. Only one SSD RAID group is supported per controller, (1 group for a single controller, 2 groups for a dual controller). Only three RAID group configurations are supported with Enterprise SSD: RAID 1, RAID 1+0 and RAID 5.

Hot Spare

The ETERNUS DX has two types of hot spare disk drives: Global hot spare and dedicated hot spares. As the name implies, global spares that may be used by any RAID group with access to the hot spare and dedicated hot spare disk drives are reserved for the use of specific RAID groups. The hot spares along with the

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
Analysts: Russ Fellows, John Webster

Redundant Copy feature allows rebuilding to start automatically when a disk drive fails, or before failure, if a high drive error rate is detected. After replacing a failed drive, the data is copied to the replaced drive and the original spare returned to spare status. If using different capacity drives in the system, the hot spare must be equal to or greater than the largest capacity drive.

When invoking hot sparing, a hot spare disk with the same capacity as the failed disk will be used first; if one does not exist, the largest capacity hot spare disk will be used. There is no limit to the number of hot spares that may be defined for the system.

An additional feature is the ability to use a Nearline 7.2 K drive in place of a 15K SAS drive when both drives are installed together and a 15K hot spare is not available.

Evaluator Group Comment: The ability to utilize any drive as a spare provides administrators with the option to maintain high availability for a RAID group by sacrificing performance. In many cases, availability is more important than performance. This allows administrators the ability to choose to maintain a redundant system or maintain performance. Providing choice is an excellent design by Fujitsu.

Disk Drives

The ETERNUS DX60 and DX90 supports two drive types, with the ETERNUS DX80 supporting three types. The disk drive types correspond to different workloads, IO centric for SSD, mixed performance capacity for enterprise 15k rpm drives, and capacity centric for the nearline 7.2k rpm drives. Enterprise SSD drives are supported on both the ETERNUS DX80 and ETERNUS DX90. The primary form factor is 3.5", with 2.5" drives supported on the ETERNUS DX60 and ETERNUS DX80.

All drives utilize a Serial Attached SCSI (SAS) 3 Gbit/s interface with dual ports for high availability. Fujitsu, along with many other vendors has chosen to drop support for 10K RPM disk drives, due to falling demand for this drive class by customers, and the subsequent drop in supply from disk manufacturers.

The characteristics of the disk devices supported are listed in Table 3, below.

Drive Specification	Enterprise SSD	Enterprise	Enterprise 2.5"	Nearline
Max Number	9 in dual DX80 / DX90	120	120	120
Capacity (GB)	100 GB, 200 GB	300 GB, 450 GB	146 GB, 300 GB	750 GB, 1 TB
Rotational Speed (RPM)	N/A	15K	10k	7.2K
Interface	Dual ported SAS @ 3 Gbit/s	Dual ported SAS @ 3 Gbit/s	Dual ported SAS @ 3 Gbit/s	Dual ported SAS @ 3 Gbit/s

Table 3: Supported Disk Drive Characteristics

Evaluator Group Comment: Fujitsu has recently announced support for SSD drives on the ETERNUS DX 80 and ETERNUS DX90 systems. As a result, flash based SSD drives are becoming a requirement even in the entry-level disk array market. Fujitsu is one of the few vendors offering SSD drives in this

price class, which provides users with more choices when configuring for performance and capacity centric applications.

MAID - Eco-mode

Fujitsu utilizes Massive Array of Idle Disks (MAID) technology for infrequently accessed data in order to reduce power and cooling requirements. This feature is referred to as 'ETERNUS Eco-mode. By allowing RAID groups that are infrequently accessed to spin down when they are not used, the total power consumption may be reduced.

The Eco-mode feature controls the disk drive rotation within a RAID group, affecting all drives that form a RAID group. This feature is managed through the web-based manager for the ETERNUS DX60, DX80 and DX90 systems, known as ETERNUS GUI. Eco-mode is disabled when system activity requires access to the RAID group, including for data protection operations, mirror copying, RAID group rebuild operations and other system required activity.

Eco-mode utilizes a setting, in conjunction with RAID group activity to determine if a RAID group should be spun down. If there is no activity, and the setting indicates the group should be spun down, then Eco-mode takes effect. If either of these two conditions is not meet, then the group will remain spinning. Eco-mode uses time frames for a specific RAID group. The following time frames may be enabled for a RAID group:

- Everyday - The mode is enabled every day from the specified start time to the specified end time.
- Every week - The mode is enabled every day from the specified start time to the specified end time.
- Specific day – The day or date of the month, along with start, and number of days is specified
- Specific week – A day of the week within the month, along with the start and ending day of the week and the starting and ending time are specified
- Last Access Time – A specific amount of time has elapsed since a RAID group was last accessed, this may be set to 10, 20, 30, 40, 50 or 60 minutes (default is 30 minutes)

Evaluator Group Comments: The lower power consumption of Eco-mode provides a somewhat unique feature in this market segment. Currently only one other tier1 vendor supports drive spin down in an entry-level system. Power requirements are becoming and increasing concern for IT managers, and having the ability to power down inactive volumes provides a significant advantage to ETERNUS DX60, DX80 and DX90 customers.

LUN Management

Fujitsu refers to their LUN masking and LUN management features as 'Host Affinity.' LUN access or Host Affinity is controlled by the ETERNUS GUI configuration software, which is included with the system. Host Affinity controls LUN 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 servers, with one LUN used in different Host Affinity groups allowing for multi-host data access for cluster or other configurations using host software to coordinate data sharing.

The maximum number of LUNs per RAID group is 128. The maximum number of LUNs per storage system is 512 for ETERNUS DX60 and 1,024 for ETERNUS DX80/DX90. A LUN may be comprised of one or more RAID groups, or a partial RAID group.

Virtual / Thin Provisioning

Fujitsu does **not** support virtual capacity of volumes, which is sometimes known as "Thin Provisioning" or "Virtual Provisioning." Thin provisioning is available in the higher end ETERNUS DX400 and DX8000 systems. However, Fujitsu does support expansion of a LUN through "Logical Device Expansion" or LDE.

Evaluator Group Comments: The lack of Thin Provisioning may be seen as a significant issue. While it certainly has become a checklist item, in practice Thin Provisioning is often not as effective as vendors have led customers to believe. However, the lack of this feature may lead to greater disk capacity usage for some applications, in particular virtual server environments.

RAID Migration

The support for on-line RAID Migration effectively copies data from one RAID group to another, new RAID group. The target RAID group must be as large as or larger than the source group. There are few restrictions to RAID Migration, allowing administrators to re architect data layout to support changing requirements.

LUN Expansion

Fujitsu refers to LUN expansion as Logical Device Expansion. The capacity of an existing RAID group can be dynamically extended by adding extra disk drives. This feature supports changing the RAID level, or adding capacity to an existing RAID group, within the specified limits of Table 3.

LUN Concatenation

LUN concatenation allows several volumes to be aggregated together to provide a larger volume. Capacity for the concatenated LUN may be taken from unused areas in an existing RAID group, or the unmapped capacity in another RAID group. LUN concatenation creates a new volume with the obtained area, and concatenates the original volume and the new volumes together into a larger capacity volume.

LUN concatenation may be used both for expanding an existing volume and when creating a new volume. Up to 16 volumes may be concatenated, and concatenation is supported with different RAID levels. Maximum volume capacity after the concatenation is 32 (TB).

Data Encryption

The ETERNUS DX60, DX80 and DX90 systems support encryption of data on the disk drives. Fujitsu utilizes a proprietary method of encryption, which is not compatible with AES encryption. Encryption may be enabled on a per LUN basis. Encryption occurs in the cache using the CPU, and is then transferred to disk.

Encryption can impact performance, although the amount of degradation is not specified. Once a volume is marked for encryption, the data cannot be unencrypted in place. Clones or mirrors within the system are not supported between encrypted and unencrypted volumes, thereby preserving the integrity of encrypted data.

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
Analysts: Russ Fellows, John Webster

Evaluator Group Comments: Encryption of data is important for some environments. While the key management and encryption capabilities may not meet all the regulatory compliance requirements imposed on a business, the encryption capabilities integrated into the ETERNUS DX60, DX80 and DX90 provide an easy to use method of protecting data. In practice, most small businesses disk storage encryption needs will be met by Fujitsu's Data Encryption feature.

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
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RAS FEATURES

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
- Capacitor protected cache with flash memory termed CacheProtector
- Controller based data integrity checking with Fujitsu Data Block Guard
- Activities supported with multiple controllers active, non degraded
- Configuration changes
- Adding, removing or changing hot spare disk drives
- Changes supported while the system is active with a single controller:
- Maintenance on controllers
- Firmware upgrades
- Data Encryption

Point to Point Disk Connectivity

The connectivity to from the controllers to the disk devices is through SAS connections. Each enclosure connects to another via a 4X SAS connector, and is then connected to a SAS expander, with a direct connection to each drive. Similar to switched FC connectivity, there is a direct connection to each drive, thereby removing any impact of a faulty connection or drive on the overall system.

Data Block Guard

Fujitsu has implemented integrity checking of data within the controller via a mechanism referred to as Data Block Guard. This feature is also available on the ETERNUS DX400 and ETERNUS DX8000 systems. Data Block Guard adds an extra eight bytes of information on every 512-byte data block as it enters the system at the ROC. 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 disk and is also checked when data is retrieved by the array controller. The Data Block Guard information is stripped whenever data is sent to the host by the controller (also known as Channel Adapter by Fujitsu).

Error Checking and Correction (ECC)

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 double bit, or any odd number of bits of cache memory errors.

**Evaluator Group Comment: Many vendors provide ECC data protection, however Fujitsu adds an extra layer of data protection with Data Block Guard in this market segment. Currently only enterprise class monolithic systems provide both levels of data integrity checking. This is another feature that sets the DX apart in the entry-level space. Data integrity is just as important to small businesses as to large businesses.**

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
Analysts: Russ Fellows, John Webster

Redundant Copy

All disks are monitored for hard and soft errors. When a disk is identified for preventive replacement (before hard failure), the redundant copy function builds the identified disk's data from the other disks in the RAID group to a hot spare. After the drive rebuild is complete, the drive identified is removed from the RAID group to ensure integrity of the RAID group.

Mirrored Cache

Each controller contains cache, with write data mirrored between controllers over an internal bus link. This feature, together with Cache Protection ensures that all data is protected from errors by non-volatile storage.

Cache Protector

The ETERNUS DX60, DX80 and DX90 systems utilize a capacitor known as the System Capacitor Unit (SCU) in case of a power failure to provide power while saving write data in the controller's cache memory. As detailed on page 5, the SCU and flash memory configuration provides protection of cache data for an unlimited amount of time.

Evaluator Group Comment: SCU and Flash memory feature provides a unique combination that delivers unlimited protection time for power loss scenarios. The amount of time data is protected is even more important in entry-level systems due to the potential amount of time a system may be down before the situation is recognized.

Redundant Power System

The power system is based on redundant power supplies in the modular enclosures with dual line cord inputs. All power system components are replaceable non-disruptively.

RAID 6

With the use of dual parity drives in a RAID 6 configuration, the RAID group provides better protection and reduced overhead than many alternative RAID configurations. A RAID 6 group provides protection against a double disk failure, while minimizing the overhead associated with a RAID 50 or similar configuration.

Evaluator Group Comment: Protection against double disk failures is an important consideration with the new generation of high capacity disk drives. As disk capacities grow, the rebuild time also grows, thereby increasing the possibility of a double disk failure prior to data reconstruction. This issue is particularly important for high capacity drives over 500 GB. Due to the lengthy rebuild times, protection against double disk failures is an important consideration for all disk drive types.

Firmware Updates

Firmware updates may be accomplished non-disruptively on the ETERUNUS DX storage systems via the common approach of failing over LUN's to the secondary controller, updating firmware, then failing LUN's to the other controller and updating firmware on that controller.

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
Analysts: Russ Fellows, John Webster

Concurrent Maintenance

A modular architecture is based on modules being able to be taken out of service while others take over the workload. The ETERNUS DX storage systems operate 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 are FRU's (Field replaceable units) and may be replaced while providing data access.

- Array Controller, contains - Controllers, cache and channel adapters
- Power Supplies with integrated cooling fans
- Disk drives

Remote Call Home (limited availability)

The ETERNUS DX system supports remote call home with several remote support features including:

- Send Communication Log
- Automatic sending of system Log
- Manual system log sending

Evaluator Group Comment: The Remote Call Home feature is important to businesses of all sizes. Having remote call home allows small IT shops with limited expertise the ability to deliver high availability with the assistance of Fujitsu support. This feature is limited by geography, so check for local availability.

Management Session Encryption

ETERNUS DX supports the use of SSL/SSH, protocols for encrypting data and sending encrypted data on the network. This prevents malicious accesses with unauthorized access via Web browsers or CLIs.

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
Analysts: Russ Fellows, John Webster

PERFORMANCE

Performance is an important aspect of any system. The current ETERNUS DX80 has performed well in benchmarks, posting one of the best scores in its category on the Storage Performance Council (SPC) benchmarks. The new ETERNUS DX90 has not had official benchmark results submitted to the SPC at this time, although results are expected to match or exceed those of the DX80.

Specifically, the Fujitsu ETERNUS DX80 performed the SPC-1 benchmark for transaction processing workload and received the highest performance metric of any system in the entry-level class. Additionally, the DX80 system had a better dollar per performance number, and a higher number of transactions per disk drive than any other system in its category. The cost per performance numbers and cost per disk drive I/O operation outperformed nearly all other systems in any category.

The current SPC benchmark is not designed to provide an advantage for systems that utilize a mixed configuration of tiered storage using, Enterprise SSD and spinning media. Thus, although the ETERNUS DX80 and ETERNUS DX90 support Enterprise SSD media, there are no current industry standard benchmarks that are able to provide quantifiable performance improvements for these or other systems utilizing Enterprise SSD media.

Evaluator Group Comments: The ETERNUS DX80 is currently the highest performing system in the entry-level category, and just as importantly achieved that metric with one of the lowest cost configurations. Customers looking for a high performing system under 100 drives should strongly consider the ETERNUS DX 60, DX80 and DX90 systems.

Fujitsu submitted benchmark results for both SPC-1 (transaction processing) and SPC-2 (throughput) benchmarks for the ETERNUS DX80 in late 2009 and early 2010. The results of 19,493 SPC-1 operations and 1,357 MB/s for SPC-2 are individually and collectively the best of any currently tested entry-level system. The overall performance levels are industry leading in their class, as are the price performance levels.

For the SPC-1 benchmark, Fujitsu attained nearly 300 SPC-1 IO operations per disk drive, which surpasses nearly all other systems in any class. The results achieved show the ETERNUS DX80 is able to achieve a higher total number of transactions for the system and per each disk drive at a lower total cost per than other comparable systems. This demonstrates that in addition to the excellent feature set, the ETERNUS performs very well in transaction-oriented environments, typical of MS SQL Server or MS Exchange.

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
Analysts: Russ Fellows, John Webster

CONNECTIVITY OPTIONS

The Fujitsu ETERNUS DX60/DX80/DX90 series supports fibre host connections, and ETERNUS DX60/DX80 supports iSCSI or SAS Host connections.

Evaluator Group Comments: By offering three interface choices, Fujitsu is providing customers the opportunity to choose the best option, for their environment. SAS connectivity is often the best option for direct connectivity. iSCSI offers a low cost SAN option, with some performance limitation, while FC connectivity offers the best performance and connectivity options, along with the highest total connectivity price.

The following table lists supported servers and operating systems for Fibre Channel host interface:

Host Vendor	Supported Servers	Supported Operating Systems
Fujitsu	PRIMEQUEST	Windows Server 2003 for Itanium based Systems, Windows Server 2008 for Itanium based Systems, Red Hat Enterprise Linux AS (V.4 for Itanium), Red Hat Enterprise Linux 5 (for Intel Itanium), SUSE Linux Enterprise Server 9/10 for Itanium Processor
	SPARC Enterprise	Solaris 10 Operating System
	PRIMEPOWER	Solaris 8, 9 and 10 Operating Systems
	PRIMERGY	Windows 2000 Server, Windows Server 2003, Windows Server 2003 R2, Windows Server 2003 x64 Editions, Windows Server 2003 R2 x64 Editions, Windows Storage Server 2003 R2, Windows Server 2008, Red Hat Enterprise Linux AS/ES v.4, Red Hat Enterprise Linux 5, SUSE Linux Enterprise Server 9/10, VMware ESX 3.5 or later, VMware Infrastructure 4.0, VMware vSphere 4
Sun	SPARC Enterprise	Solaris 10 Operating System
	Sun Fire	Solaris 8, Solaris 9 and Solaris 10 Operating System
HP	HP 9000	HP-UX 11i v2, HP-UX 11i v3
	HP Integrity	Windows Server 2003 for Itanium based Systems
IBM	pSeries, RS/6000	AIX V6.1; AIX 5L V5.3
Others	Other IA64 servers	Windows Server 2003 for Itanium based Systems, Red Hat Enterprise Linux AS(v.4 for Itanium), Red Hat Enterprise Linux 5 (for Itanium), SUSE Linux Enterprise Server 9/10
	Other Industry Standard Servers	X86 Solaris 10 Operating System, Windows 2000 Server, Windows Server 2003/2003 R2/2003 x64/2003 R2 x64 Editions, Windows Server 2008, RHEL AS/ES v.4, RHEL 5, SUSE Linux Enterprise Server 9/10, VMware Infrastructure 4.0

Table 4: ETERNUS DX60/DX80/DX90 Supported Servers and Operating Systems – Fibre Channel

Evaluator Group Comment: Always check with vendor for the latest supported configurations.

Evaluator Group

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
Analysts: Russ Fellows, John Webster

Multi-Path IO

Fujitsu provides a multi pathing driver, referred to generically as MPD for the operating platforms supported by the ETERNUS line. For each platform there is a specific driver package known as ETERNUSmpd.

The ETERNUS supports either a fixed path access on a per LUN basis, or dynamic multi-path access on a per LUN basis. This feature is different than active/active controllers, and different still from multi-path I/O. The ETERNUS DX DX60/DX80/DX90 permits asymmetric LUN access. This is a mode which Fujitsu refers to as "Assigned CM."

The ETERNUS DX systems assign a controller module (CM) to a specific LUN. The path(s) connecting to the controller normally used will have an active status, while the path(s) connecting to other controllers will have standby status.

Paths connected to the assigned CM are in active status, while paths connected to the non-assigned CM are in standby status. Load-balancing is performed on the paths in active status (called active paths). Paths in standby status (called standby paths) are normally not used for access.

Thus, the ETERNUS DX60/DX80/DX90 provides active/active controller use with multi-pathing, and asymmetric access to a LUN through a specific array controller (or control module - CM). The diagram below illustrates the configuration for AIX, although this is also the case for other OS environments. Figure 3 below illustrates asymmetric access.
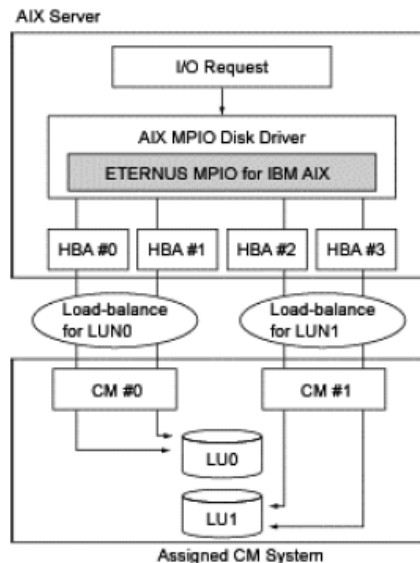

Figure 3: Asymmetric MPIO Access for ETERNUS DX60, DX80 and DX90 (Source: Fujitsu)

Solaris

Fujitsu provides a device driver for Solaris platforms supporting Solaris MPxIO, utilizing Fujitsu's multi-path driver, or MPD.

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
Analysts: Russ Fellows, John Webster

Windows

Fujitsu provides a device driver for Windows platforms supporting Windows MPIO, utilizing Fujitsu's multi-path driver, or MPD.

Linux

Fujitsu provides a device driver for Linux platforms supporting MPIO utilizing Linux MD and multi-pathing.

IBM AIX

For the AIX platform, Fujitsu's MPD is an interface to AIX's native multi-pathing I/O capabilities. The ETERNUS MPIO for AIX is an IBM Path Control Module (PCM) that utilizes AIX's native multi pathing capabilities, through the MPIO interface. ETERNUS systems utilizing this software may be accessed as an MPIO device by AIX. This allows active/active asymmetric logical unit access via AIX.

ETERNUS MPIO for IBM AIX performs load-balancing over the usable paths to improve the access performance.

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
Analysts: Russ Fellows, John Webster

SOFTWARE FEATURES AND FUNCTIONS

The ETERNUS SF software suite includes a number of offerings that provide options for system and SAN management, data protection and disaster recovery, backup and local replication.

Disk Traffic Control (DTC)

DTC is a performance optimization feature 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.

VSS Interface

On MS Windows platforms, a VSS provider is available in order to utilize ETERNUS D60, DX80 and DX90 systems as VSS hardware provider. This provides Windows applications with a consistent point in time copy by allowing application or OS data to be quiesced prior to initiating a point in time copy.

Storage Management

SMI-S Interface

The SNIA along with the DTMF have created a set of storage management interface specifications, known as "SMI-S" interface. Fujitsu ETERNUS DX60, DX80 and DX90 systems support and are certified to be interoperable with SMI-S version 1.2 frameworks. The ETERNUS DX systems have an SMI-S provider that may be used by applications to manage the system.

ETERNUS Web GUI / CLI

The embedded ETERNUS web graphical user interface and command line interface are delivered with each ETERNUS DX60/DX80/DX90 system. The interface is included within the controller, and bundled with each system. This provides basic management, without the need for a separate application.

ETERNUS SF Express (Included)

Fujitsu's ETERNUS SF Express is a new GUI application that provides web-based device management. The application supports all entry-level ETERNUS DX60, DX80 and DX90. The SF Express application supplements the ETERNUS web GUI and includes support for health monitoring, historical performance information and setup and management for a limited number of Advanced Copy features. The base license supports up to 8 copy operations, with more available when a Local Copy License for snapshots and clones is purchased. A Remote Copy license allows storage-based replication between two ETERNUS DX90 systems for disaster recovery.

The ETERNUS SF Express is a client server application that requires installation on a Windows Server 2008 for the manager, with the client portion supported on Windows client systems.

ETERNUS SF Storage Cruiser (Optional)

Storage Cruiser is a SAN management application that provides configuration, specification, and monitoring of a SAN environment, which includes ETERNUS SF Storage Cruiser, and ETERNUSmgr aid. ETERNUS Storage Cruiser is often referred to as ESC by Fujitsu. Storage Cruiser may be used to manage the relationship between the storage as viewed from the host server and the physical storage,

allowing the whole storage system's configuration and failure conditions to be managed. It will manage the ETERNUS family and supports other selected vendors products.

ETERNUS SF AdvancedCopy Manager (Optional)

The ETERNUS SF AdvancedCopy Manager (known as ACM) provides control and management of data protection for backup and replication. The ACM upgrade adds support for up to 1,024 copies over the base support for 8 copies included with all systems. ACM provides management for Equivalent Copy (EC), One-Point Copy (OPC+), differential backup/replication (QuickOPC) and SnapOPC+. Also supported is Remote Copy (storage-based replication) for the ETERNUS DX90 system.

A feature on the ETERNUS DX60, DX80 and DX90 is the ability to calculate and display the amount of power used by the system for tracking and management of power usage.

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
Analysts: Russ Fellows, John Webster

DATA PROTECTION SOFTWARE

Local Point In Time Copy

Fujitsu has termed their point in time copy feature for the ETERNUS series, One Point Copy (OPC). There is local mirroring (Equivalent Copy), along with three different versions of One Point Copy:

- One Point Copy
- Quick OPC
- Snap OPC+

	Equivalent Copy	One Point Copy (OPC)		
		One Point Copy	QuickOPC	SnapOPC+
Copy Type	Mirror	Clone	Clone	PIT
Architecture	Full Copy	Bit Map	Bit Map	Bit Map
Max # Copies	Maximum concurrent EC, OPC QOPC or SnapOPC copies by model: Model DX60 = 512 ; Model DX80, DX90 = 1,024 (32 sessions per volume)			
Re-sync	Yes	No	Yes	No
Potential Data Exposure	Synchronous—none	Exposure back to time OPC activated	Exposure back to time QuickOPC activated	Exposure back to time when snap was taken
Availability for Restore	Mirror available after completion of initial mirror	Available for restore, or replace volume after copy	Available for restore, or able to replace volume immediately	Available for restore only after command completes
DR, Fail-over Capability	Yes On Mirror suspend or break	Yes Able to replace volume after copy complete	Yes Able to replace volume as soon as command completes	No Not for DR or fail-over, depends on source data
Default Action	Mirror. Copy is a true mirror until it is split	Copy when command issued (background)	Copy when command issued (background)	Copy on Write
Additional Capacity	100%	100%	100%	Changes only
Access to Copy	R/W after split	R/W immediate	R/W immediate	R/O
Performance Impact after copy	N/A	Minimal	Minimal	Yes
Performance Impact during copy	N/A	Minimal	Minimal	Yes

Table 5: Fujitsu ETERNUS DX60, DX80 and DX90 Data Protection Options

The base system includes a license for up to 8 point in time copies. A local copy license for snapshots and clones or the AdvancedCopy Manager (ACM) license must be purchased in order to access more features.   In addition to local point in time copy operations, a remote copy (or remote replication) option is available on ETERNUS DX90 systems, however remote copy is not available on DX60 or DX80 systems.

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
Analysts: Russ Fellows, John Webster

One Point Copy (OPC)

The copy is a "clone" copy where an exact original copy is made to another physical area. Entire volumes may be copied using OPC.

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 the copy location and this happens in the background. During the physical phase, host access to data is available. The copied volume is available almost instantly after OPC initiates, upon completion of the logical phase.

There are three speed settings (pacing parameters) to control the amount of storage system resources consumed for the copy operation. The speed or priority settings are controlled via the management software, ETERNUS GUI. The three speed options are *low*, *high and automatic*. The automatic setting changes the priority dynamically in response to the system workload.

QuickOPC

After One Point Copy has been run, an administrator may execute a QuickOPC operation which shortens the copy time. The design leverages the use of a bitmap, which tracks changed blocks for the volume. This function will only copy changes from the source volume since the last One Point Copy operation occurred.

SnapOPC+

SnapOPC+ operates similar to other Copy on Write point in time copy operations. Rather than copying the new data to the copy volume, the old data is copied to the duplicate volume. Space is saved by only saving the original blocks of data, when new data is written to the SnapOPC volume. By copying only a portion of the source volume, it minimizes copy volume capacity.

Equivalent Copy (EC)

Fujitsu local mirroring and replication product is known as Equivalent Copy (EC). The mirror is an exact image copy made to another physical area. Entire volumes may be copied as initiated by the Fujitsu management software.

The mirror volume must be a local volume, thus the ETERNUS DX60, DX80 and DX90 support local, in system mirroring only. 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.

The copied volume is not available until the initial copy is complete and either a "detach" (split or break) or a "suspend" command has been issued. If suspended, a "resume" may be issued 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" 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.

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
Analysts: Russ Fellows, John Webster

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.

EC also support a reverse function that allows high-speed restore of data from the destination to the source. EC Reverse calculates the changed blocks, and copies back only the delta's to the source.

Evaluator Group Comment: The variety of Data Protection options available on the ETERNUS DX60, DX80 and DX90 systems allows them to compete against other, larger and more expensive systems. In comparison to other entry-level products targeted at the SMB space, data protection features surpass most competitors.

Cascade Copy

A cascaded copy is a method to support creating a copy of a copy. Cascade Copy is not supported with a snapshot SnapOPC+ as the source.

VSS Interface (Optional)

The ETERNUS DX60, DX80 and DX90 now support the Microsoft VSS (Volume Snapshot Service) interface. This allows the ETERNUS DX systems to function as a hardware provider for the VSS feature when used in a Microsoft Windows Server environment.

Data Pool for SnapOPC+

The copy destination for SnapOPC+ is a region known as SDV's and SDP's (Snap Data Volumes and Snap Data Pools). Only one SDP region may be used, which supports up to 64 TB of space. Multiple SDV regions may be used, with a 2 TB space limitation.

Remote Replication (optional)

Remote Advanced Copy

Fujitsu's remote replication for the ETERNUS series is known generically as Remote Copy, across the ETERNUS product line. For the entry level ETERNUS line, the remote replication feature is only available on the DX90 system and is known as Remote Copy. Remote Copy is supported on the ETERNUS DX90, DX400 and DX8000 series, although replication for the ETERNUS DX90 is only supported to another ETERNUS DX90 system. Fujitsu's Remote Copy product supports both synchronous and asynchronous remote replication.

A specific "RemoteCopy" license is required in order to utilize storage-based replication. A "Local Copy" license is available on the DX60 and DX80 to provide snapshots and clones within the system. Remote Copy is essentially storage-based replication, and thus mirror splits are used for failover operations. The type of split along with the recovery type may both be specified as Automatic or Manual for remote copy with Remote Copy.

The establishment of Remote Copy replication pairs, and replication type is managed through the Fujitsu ETERNUS SF Express software or with the ETERNUS SF ACM interface for application integration copies.

Evaluator Group

Fujitsu ETERNUS SF Remote Copy provides the following features:

- Synchronous and asynchronous storage based replication
- Maintains an exact byte-for-byte copy of production data in a remote location
- Write order consistency is supported for both Synchronous and Asynchronous replication
- Consistency groups are supported
- Failover to secondary sites for disaster recovery
- Integration with OPC for secondary site backup operations
- Management of replication pairs using ETERNUS SF AdvancedCopy Manager

Remote replication is supported over FC connections, utilizing the FCP protocol, which requires an FCIP converter to support long distance replication over TCP/IP links. An example is shown below in Figure 4.
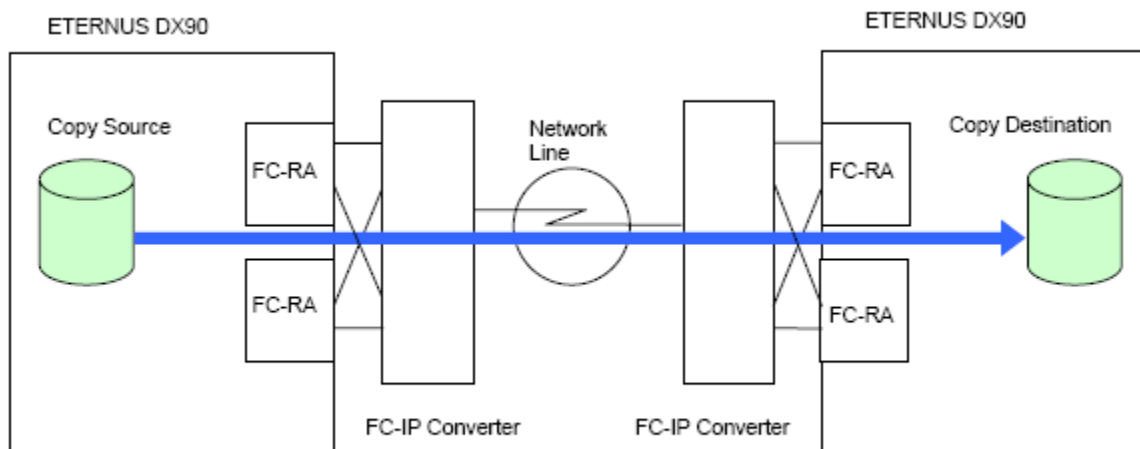
Extended Remote Advanced Copy Connection (via FC-RA)

Figure 4: Example of Replication Between Two Subsystems (Source: Fujitsu)

Additionally, async mode has two sub-modes, the "Stack" mode and the "Consistency" modes of operation. Remote Copy supports up to 16 ETERNUS DX90 systems, with a limit of 4 systems when using asynchronous consistency mode.

Remote Copy Synchronous Mode

In synchronous mode, Remote Copy functions similar to other synchronous replication functions. All write operations are sent to the remote side before a write acknowledgement occurs. Write order fidelity is preserved with synchronous mode of operation.

Remote Copy Asynchronous Stack Mode

When REC operates in this mode, only a record of which data blocks are modified are tracked. The actual transfer of data may be performed separately. This mode is designed to create backup copies and provide DR capability. A large amount of untransferred data may exist between the local and remote volumes.

Another feature of this mode is that write order consistency is not maintained, as only modifications are tracked, not the order in which they occur. For this reason, this mode is not recommended for application failover capabilities.

Remote Copy Asynchronous Consistency Mode

When Remote Copy operates in this mode, write order consistency is maintained. This is critical in order to provide application consistency between two systems. Environments that are looking to provide business continuity, by allowing failover to a remote site should utilize consistency mode.

Remote Copy Copy Groups

A copy group is a group of copy pairs, consisting of a source logical volume and a destination logical volume. The operation mode (sync or async) along with the sub-type for async are specified. The amount of buffer space may also be established with ETERNUS SF Express manager.

Remote Copy Replication States

Users may start replication, suspend, reverse or cancel replication. Remote copy operations may be in one of several states:

- Active (replication is occurring)
- Suspended (replication is paused)
- Reversed (After failover to the remote site, replication must be reversed)

Management of Remote Copy

In order to manage replication, a user may utilize ETERNUS SF Express, which provides basic management of snapshots and replication pairs. However, for full featured management, they may instead choose to purchase the optional Advanced Copy Manager (ACM) software, which can also provide application integration and coordination. This is the same software utilized on the higher end ETERNUS DX400 and DX8000 series systems.

ES/OL *Evaluator Series On-Line™*	Storage Systems Product Analysis	March, 2010 Page 25 of 30

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
Analysts: Russ Fellows, John Webster

Provided below is a summary of the different Remote Copy modes, and their limitations.

	Remote Copy **Synchronous**	Remote Copy **Asynchronous**	
		Stack Mode	**Consistency Mode**
Copy Type	Remote Mirror	Remote Copy	Remote Mirror
Max # Copy Operations	16	16	4 sets
Write Performance Impact	Yes, amount of time for remote side acknowledge	Minimal	Minimal to moderate, depends on line speed
Potential Data Exposure	Synchronous—none	Back to time since last flush	Back to PIT of data replicated on remote site
Availability for Restore	Mirror available after completion of initial mirror	Available for restore, or replace volume after copy	Available for restore, or able to replace volume immediately
DR Capability	Yes On Mirror suspend or break	Yes	Yes On Mirror suspend or break
HA Failover Capability	Yes	No	Yes – with some limits
Access to Copy	R/W after split	R/W immediate	R/W immediate
Cache Utilized	N/A	Minimal	Used as a transfer buffer

Table 6: Fujitsu ETERNUS DX90 Remote Copy Options

Evaluator Group Comment: The inclusion of remote replication through the Remote Copy feature provides customers with a strong enhancement to a product in this price range. Fujitsu understands that many smaller organizations are looking to provide high availability operations beyond simple disaster recovery. Remote replication is a critical component of this, and Remote Copy provides most of the features found in many competing mid-range systems. Although the presence of remote replication is not unique for an entry-level product, this feature is still rare in this price category.

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
Analysts: Russ Fellows, John Webster

TECHNICAL SPECIFICATIONS

Power Requirements		Model DX60	Model DX80	Model DX90
Voltage		AC100-120V, AC200-240V		
No. of Phases		Single		
Frequency		50/60Hz		
Max. Power Consumption (W)		782W (100-120V) 776W (AC200-240V)	3,750W (AC100-120V) 3,740W (AC200-240V)	3,760W (AC100-120V) 3,740W (AC200-240V)
Max. Heat Dissipation (kJ/h)		2,816 (AC100-120V) 2,794 (AC200-240V)	13,500 (AC100-120V) 13,464 (AC200-240V)	13,536 (AC100-120V) 13,464 (AC200-240V)
Max Weight		154.32 lbs	771.6 lbs	771.6 lbs
Environmental Conditions				
Temperature	Operating	5° - 40°C		
	Non-Operating	0° - 50°C		
Humidity	Operating	20 – 80% RH		
	Non-Operating	8 – 80% RH		

Table 7: ETERNUS DX60, DX80 and DX90 Power and Environmental Specifications

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
Analysts: Russ Fellows, John Webster

ANNOUNCEMENT HISTORY

Date	Announcement
January, 2010	Announcement of new DX90, new features and drives for all DX systems
October, 2009	Additional interfaces for DX80, system enhancements for DX60 and DX80
June, 2009	Announcements of ETERNUS DX storage systems – Model DX60, DX80
May 2007	Announcement of ETERNUS2000 series

Table 8: ETERNUS Entry-Level Announcement History

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
Analysts: Russ Fellows, John Webster

EVALUATOR GROUP COMMENTS

The ETERNUS DX series represent the continuing evolution of the ETERNUS series. The entry-level ETERNUS DX60, DX80 and DX90 systems continue to refine and enhance Fujitsu's ETERNUS line.

The included management application, ETERNUS GUI device manager, and the newly available ETERNUS SF Express provide management for multiple ETERNUS systems. The addition of ETERNUS SF Storage Cruiser permits administrators to configure and manage small SAN deployment of ETERNUS DX systems.

The expected features in this category are all present, including multiple RAID levels, RAID level migration, data protection through point in copy and high availability. In addition, Fujitsu adds many features not seen in other entry-level systems such as support for Enterprise SSD, and remote replication for the ETERNUS DX90 system. Other features such as block guard, MAID, drive spin-down and encryption are also unusual additions in this category. Overall, the features, performance and cost of the system provide an attractive offering for customers. Fujitsu continues to supply excellent data integrity features – demonstrating their understanding that this has become an expectation for storage systems across the spectrum, including the entry-level space.

Strengths:

Fujitsu's updated ETERNUS DX line continues the solid, well architected heritage of its predecessor ETERNUS 2000 and FibreCat SX systems. The features offered are on par with that of most major competitors, and add several industry-leading features such as the capacitor-flash cache protection feature, drive spin-down, and disk encryption are all unique, valuable features. The inclusion of multiple RAID levels, including RAID 6, along with good performance and expandability, an excellent choice of data protection options coupled with the industries best in class warranty provide a compelling package.

One of the most notable features and new enhancements are the improved management with ETERNUS Express SF, and the remote replication capability on the ETERNUS DX90. Both of these are significant enhancements to an already solid product line.

A continuing note of strength for the ETERNUS DX60, DX80 and DX90 is the wide range of heterogeneous support. By comparison, many entry-level offerings from system vendors support a limited set of hardware and OS environments.

The Eco-mode feature leverages the idea of spinning down inactive disks, an innovation known as MAID, pioneered by Copan Systems. Fujitsu is one of the first vendors to embrace this idea and incorporate it into their mainstream storage array products. Although the settings are cursory and operate at the RAID group, the capability to selectively spin down drives is an advantage for many deployment scenarios where near-line access capabilities are required, and power and cooling costs are a concern.

Additionally, the ETERNUS DX line offers a wide variety of RAID configuration choices, including RAID-6, which is often the best option for large capacity drives. Wide choices in supported RAID

Analysis of Fujitsu ETERNUS DX60, DX80 and DX90
Analysts: Russ Fellows, John Webster

configurations allow administrators the ability to optimize storage for their business use. The capacity expansion of a RAID group is also a feature where Fujitsu surpasses many competing arrays.

Data protection is a critical aspect of storage for large and small deployments. The wide variety of controller based data protection options allow administrators and users to configure the system to provide data protection that best matches their business needs. The variety of features offered with OPC, QuickOPC, SnapOPC+ and EC, combined with support for Cascaded Copy provides a significantly greater number of alternatives then most competing systems.

The performance of the ETERNUS DX80 is best in class, and hard to match for either performance, or price for performance metrics. As a result, the Fujitsu DX series should perform well for any environment where an entry-level system is required. The recent addition of support for SSD drives can provide an additional performance advantage for some application workloads. Fujitsu is one of the industry leaders in offering SSD drives in an entry level system.

Since the initial release of the predecessor ETERNUS, Fujitsu has continued to enhance its platform and server based software features. The ETERNUS DX family is an excellent choice for departments requiring a flexible, reliable array with a wide variety of data protection options and an extended warranty.

The ETERNUS DX systems are perhaps the best products in their class with the least amount of recognition. The DX60, DX80 and DX90 systems easily compete with the EMC AX4, Hitachi SMS, HP MSA, IBM DS3000 and the NetApp FAS2000 systems. In some cases, these systems are also able to compete with the low-end midrange systems from their competitors due to the excellent features and performance. Customers who do not require advanced application integration capabilities, or capacity beyond approximately 200 TB should consider the ETERNUS DX60, DX80 and DX90 systems.

Perceived Challenges:

There are only a few issues that may be of concern for potential ETERNUS DX customers. It is important to note that the lack of a feature is not in itself a problem. Features are only important if it is an actual requirement for your environment.

The only significant feature which the ETERNUS DX series lacks, is thin provisioning. However, thin provisioning is not effective in all cases and thus may not be an issue in some environments. Buyers should evaluate the potential impact of not having this feature. Many competing systems do offer this feature currently.

Also, Fujitsu and many other vendors limit connectivity choices on a per model basis in this segment. Fujitsu is not alone in forcing users to choose the I/O interface at the time of purchase. This practice was common at the midrange and entry-level, but is no longer true in the midrange category. In one or two cases, Fujitsu's competitors are now beginning to offer multiple connection types on entry-level products. This issue may be a consideration for some buyers who may want to change their storage connectivity prior to the end of life of the storage array.

Prior to the introduction of SF Express, system management choices were limited between simplistic embedded GUI, or the SAN management application ETERNUS SF Storage Cruiser. Fujitsu is clearly moving toward SF Express as the primary storage management application for the DX 60, 80 and 90 systems. However, this process is not yet complete, and other management tools are required in some cases. It is expected that Fujitsu will improve this situation in the near future.

With the addition of SF Express, management choices are now roughly on par with the competing HP MSA and IBM DS3000, the EMC AX4 and HDS SMS. Fujitsu does not currently offer an SRM management package, although, SRM products are generally outside of the price range for SMB and small enterprise deployments. The options should be sufficient for small enterprise or SMB deployments. Moreover, in part due to the options available for managing the Fujitsu ETERNUS DX 60, 80 and 90 systems, the choices are more involved than with other platforms providing a single option. Choice is good, but does require more planning on the part of the purchaser.

Overall, the ETERNUS DX is an excellent choice for buyers seeking leading features, high reliability and a best in class, price-performance storage system.