



EMC CLARiiON CX4 Series

The CLARiiON CX4 series is a scalable, dual controller system with varying amounts of cache, processor cores, disk drives and interfaces. As a storage system, the CLARiiON has had a long and successful run with earlier generations from Data General and multiple generations from EMC. The underlying design has been incrementally changed with continued improvements and features. The CX4 Series is another incremental generation of CLARiiON.

The CLARiiON CX4 series is the mid-tier storage solution offered by EMC. The CLARiiON family includes an entry level array system called the AX4. The high-end storage systems offered by EMC are in the Symmetrix/VMAX family.

HIGHLIGHTS

- Tiered storage support with Fully Automated Storage Tiering (FAST)
 - Flash drives to create a tier 0 for ultra-high performance requirements, Fibre channel disks for high performance tier 1, SATA disks for tier 2 storage
 - FAST Cache which uses flash drives as cache extension
- Unified storage administration across CLARiiON and Celerra with Unisphere
- Support for intermix of drives: SSD, fibre channel, and SATA
- Support for RAID 0, 1, 5, 6 and RAID1+0 with global hot spare disks and can coexist in the same system
- Four models where the model number is also the maximum number of drives supported
 - Model 120, Model 240, Model 480 and Model 960
 - All models support both Fibre channel (4 Gbps) and iSCSI (1 Gbps) host connectivity
- UltraFlex technology is the architecture developed to accommodate different I/O connectivity
 - Currently supports iSCSI connectivity
 - Currently supports Fibre channel connectivity
 - Slot designed to be able to accommodate future technologies
- Reduced power consumption for infrequently accessed data (MAID)
 - Policy based administration of SATA drive spin-down
- Adaptive cooling to dynamically adjust cooling and airflow within the array
- Virtual provisioning capabilities

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OVERVIEW

The EMC CX4 Series are multi-platform, enterprise class, modular storage arrays designed and manufactured by the CLARiiON division of EMC. This series is the fourth generation of the CX CLARiiON family.



Figure 1: EMC CLARiiON CX4 Product Line

With the CX-4, EMC introduced to the CLARiiON family a number of features designed to address availability, scalability, environmental efficiency and investment protection. EMC introduced solid-state disk (SSD) technology on their high-end Symmetrix DMX Series early in 2008. The CX4 was the first midrange storage array to incorporate SSD capabilities. The SSD storage utilized for both systems utilize flash technology designed for high speed storage requirements.

UltraFlex™ technology is EMC's new approach to flexible array connectivity. The modular connectivity design, in conjunction with FLARE OE—the CLARiiON operating environment controlling firmware, allows for the combination of fibre and iSCSI host attachment on the front end as well as for implementation of new I/O technologies as they become available.



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EMC CX4 Model Comparison

Feature / Function	Model 120	Model 240	Model 480	Model 960
Form Factor	Rack Mount			
Number of Controllers	2 (HA)			
RAID Levels	0, 1, 5, 6, 1+0			
Maximum Disk Drives	120	240	480	960*
Minimum Disk Drives	5			
Drive Sizes Supported	15k rpm Fibre channel 4 Gb/s: 146GB, 300GB, 450GB, 600GB 10k rpm Fibre channel 4 Gb/s: 450GB, 600GB 7200 and 5400 rpm SATA-II 3 Gb/s: 1TB, 2TB			
Solid State Flash Drives	73GB, 200GB, 400GB			
System Memory	6 GB	8 GB	16 GB	32 GB
Useable Cache Capacity	600 MB	1.254 GB	4.5 GB	10.764 GB
Maximum SAN Connections	128	256	480	960
I/O Slots	6	8	10	12
Min/Max iSCSI ports	4/8	4/12	4/12	4/16
Min/Max Fibre channel ports	4/12	4/12	8/16	8/24
Host Interface	Fibre channel, 4Gb/s, 8Gb/s; iSCSI, 1Gb/s, 10Gb/s; UltraFlex™ technology			
Maximum Logical Volumes	1024	2048	4096	4096
Maximum LUN per RAID Group	256			
Maximum Number RAID Groups	60	120	240	480
Maximum Drives per RAID Group	16			
Minimum Configuration	Model 120: 1 Standby Power Supply (SPS) in 1U Models 240, 480: 2 SPS in 1U			2 SPS in 2U SPE 4U DAE 3U Total 9U
	Service Processor Enclosure (SPE) 2U			
	Disk Array Enclosure (DAE) 3U			
	Total 6U			
Maximum Configuration	SPS 1U SPE 2U DAE 8x3U = 24U Total 27U 1 frame	SPS 1U SPE 2U DAE 16x3U = 48U Total 51U 1 frame	SPS 1U SPE 2U DAE 32x3U = 96U Total 99U 3 frames	SPS 2U SPE 4U DAE 64x3U = 192U Total 198U 6 frames
Disk Array Enclosure (DAE)	Up to 15 drives			

Table 1: Model Comparison

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PRODUCT ARCHITECTURE

The CLARiiON CX4 Series models all consist of the following modular components:

- One or two standby power supplies (SPS) housed in one enclosure
- One storage processor enclosure (SPE)
- At least one Fibre channel disk-array enclosure (DAE) with a minimum of five disk drives.
- All components can be housed in the EMC CLARiiON 40U rack or any standard 19-inch rack

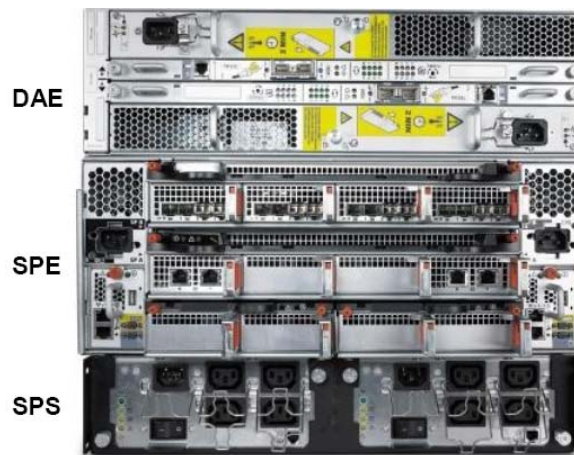


Figure 2: Back View of CX4 960

Storage Processor Enclosure

The SPE components include Storage Processors (SP) which are the central processing units (CPU) for the system, power supplies, blower modules, I/O modules and management modules. There are two storage processors, SP A and SP B, in each model of the CX4 Series and the SP is considered the control center of the system. Model 960 has four cooling modules and two power supplies; the other three models have four power supply/system cooling modules which are referred to as power/cooling modules. Two modules are associated with each SP (two for SP A and two for SP B).

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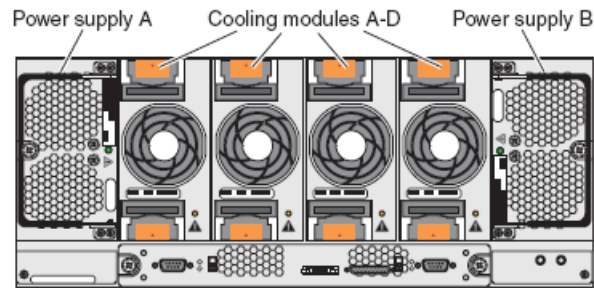


Figure 3: SPE Model 960 front, without bezel (Source: EMC)

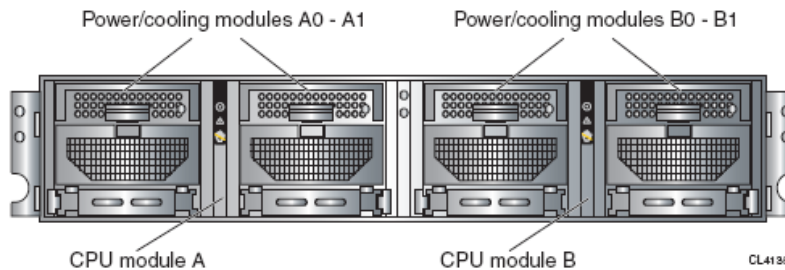


Figure 4: SPE Model 120/240/480 front, without bezel (Source: EMC)

Each SP consists of one CPU module with the model-determined CPU size and system memory, the I/O module carrier with the appropriate number of base and UltraFlex I/O module slots, and one management module. The SP senses the speed of the incoming host I/O and sets the speed of its front-end ports to the lowest speed it senses. The speed of the DAE determines the speed of the back-end ports through which they are connected to the SPs.

	Model 120	Model 240	Model 480	Model 960
Processor Architecture per SP	1 dual-core 1.2 GHz processor	1 dual-core 1.6 GHz processor	1 dual-core 2.2 GHz processor	1 quad-core 2.3 GHz processor
Physical Memory per SP	3 GB	4 GB	8 GB	16 GB
Max Cache	600 MB	1.264 GB	4.5 GB	10.764 GB
Max Write Cache	600 MB	1.264 GB	4.5 GB	10.764 GB
Rack Units	2U	2U	2U	4U
Base I/O slots	2	2	3	3
Expansion I/O slots	1	2	2	3

Table 2: Architecture Comparison per SP

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The I/O module types currently available for the CX4 are enumerated in the following table. Each SP must have the same type of I/O connectivity module or card in the corresponding slot.

Model	I/O Module (Card)
120, 240, 480	<ul style="list-style-type: none"> 4Gb Fibre channel module with two FC back-end ports for disk connection and two front-end ports for server I/O 8Gb FC module with four front-end ports for server I/O 1Gb iSCSI module with two 10/100-gigabit Ethernet ports for server I/O 10Gb iSCSI module with two optical ports for server I/O
960	<ul style="list-style-type: none"> The above module types 4 Gb FC module with four FC back-end ports for disk connections

Table 3: CX4 Current Connectivity Options

Evaluator Group Comments: *Planning connection types is critical in respect to the requirement of having the same type of I/O module in the same SP slot, i.e. if SP A slot A0 has an FC module with two FC back-end ports for disk connection and two FC front-end ports for server I/O, SP B slot A0 must also have the same module. This supports high availability and is the only way the system can be configured.*

The management module has two GbE Ethernet LAN ports, one for management and one for service. The management port is used for managing the storage processor with the Unisphere or Navisphere software, while the service port is for the use of EMC Service if access is needed to the SP. The management module also has one port for serial communication and one port for sensing the SPS.

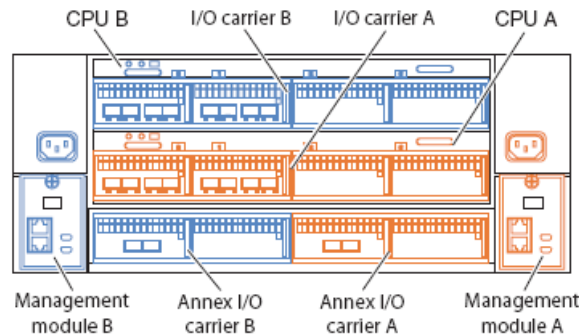


Figure 5: Model 960 back (Source: EMC)

The system memory is double data rate, dual in-line memory module (DDR-II DIMM) memory.

The power supplies, cooling modules, management modules and the SFP modules which plug into the FC front-end port connectors in the FC I/O modules are field replaceable units and can be replaced while the system is operating. EMC service must be contacted to replace a failed CPU board, CPU memory module or an I/O module.



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Evaluator Group Comments: *The restriction requiring EMC service to be contacted in order to replace UltraFlex I/O connectors' reduces the effectiveness of the I/O connectors. Given that these are FRU's, and configuration requirements already dictate configuring I/O connectors in mirrored pairs between the two controllers, many customers may incorrectly assume that they could change failed modules themselves. As it stands, this requirement is an unnecessary burden on IT departments.*

Disk-Array Enclosures

Disk-array enclosures, also known as DAE UltraPoint, use a Fibre channel Arbitrated Loop (FC-AL) as the interconnect interface. A disk enclosure connects to another DAE or an SPE and is managed by storage-system software. The minimum number of drives for a system is five. These drives are considered the vault drives and provide the space for cache data to be written in the event of a power failure. The enclosure can contain up to 15 hard disk drives. A DAE can include either Fibre channel drives or SATA drives. FC and SATA enclosures can be mixed within a storage system but not within the same DAE. Each DAE also includes two power/cooling modules. Any unoccupied disk module slot has a filler module to maintain air flow. The maximum number of DAE that can be supported on Model 120, 240, 480 and 960 are 8, 16, 32 and 64 respectively.

The FC-AL link control cards, drive modules, power supply/system cooling modules and filler modules are field replaceable units and can be replaced while the system is operating.

The non-SSD drives supported on the CX4 range from 146 GB, 15K rpm performance drives to 2 TB, 5.4K rpm SATA drives.

Listed Capacity / Formatted Cap	Disk Speed	Drive Type	Available Formatted GB	
			Disks 1-5 (vault disks)	Other disks
146 GB / 135 GB	15K RPM	4 Gb FC	71.68 GB per disk	133.647 GB per disk
300 GB / 272 GB	15K RPM	4 Gb FC	206.404 GB per disk	268.37 GB per disk
450 GB / 408 GB	15K RPM	4 Gb FC	342 GB per disk	374 GB per disk
450 GB / 408 GB	10K RPM	4 Gb FC	342 GB per disk	374 GB per disk
600 GB / 545 GB	10K RPM	4 Gb FC	479 GB per disk	531 GB per disk
600 GB / 545 GB	15K RPM	4 Gb FC	479 GB per disk	531 GB per disk
1 TB / 931.5 GB	5.4 RPM	SATA	Not supported as vault disk	917.1492 GB per disk
1 TB / 931.5 GB	7.2K RPM	SATA	Not supported as vault disk	917.149 GB per disk
2 TB / 1,852 GB	5.4K RPM	SATA	Not supported as vault disk	1,818.09 GB per disk

Table 4: Disks available for CX4

All CX4 series drives have a 34 MB area reserved for configuration information. Additionally, the first five disks in the first enclosure each have a reserve area of 62 GB that are used for software images and a write cache dump area (the vault area).



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Flash Drives

EMC's utilizes solid state disk (SSD) drives utilizing flash storage technology. Flash drives will allow users to define a new higher speed access, persistent tier of storage. The use of this type of storage is suited for applications with high transaction rates and those requiring the fastest possible retrieval and storage of data.

EMC's flash drives are the STEC manufactured Zeus IOPS, dual ported FC drives.

Evaluator Group Comment: *The use of solid state technology to provide persistent high speed access to data has been around for decades. Until recently, deployments of solid state storage (aka SSD) has been based upon the use of dynamic random access memory (DRAM) along with techniques to de-stage data to disks in the event of power failure. Specifically, the new drives utilize Single-Level Cell (SLC) NAND EEPROM flash technology.*

Historically, SSD is excellent for random reads while its write performance cannot match hard disk drives and will depend upon the SSD implementation of caching to mitigate the slowness of the writes.

However, with the growth of Flash NAND storage technologies, flash storage's use and deployments have risen. There are specific cost and power advantages comparing Flash NAND SSD's to more typical DRAM SSD storage. However, there are also issues with the "wearing-out" of Flash NAND storage. Consideration must be given to understand the impact of write-erase operations. NAND flash, typically used in storage devices, wears out at a predictable rate from write-erase operations. Effective use of "wear-leveling" strategies can improve the life expectancy of the drives.

Standby Power Supplies

The standby power supplies (SPSs) are positioned at the base of the CX4. EMC best practices should be followed for redundant connectivity and availability. Note that MODEL 120 comes standard with one SPS and the EMC 40U rack provides the back up power.

	Model 120	Model 240	Model 480	Model 960
Number of SPS	1 with 1 optional	2	2	2
Power	1 kilowatt	1 kilowatt	1 kilowatt	2.4 kilowatt
Rack Units	1U	1U	1U	2U

Table 5: SPS Comparison

The SPSs allow write caching to continue during a power failure. If an SPS is not fully charged, it will disable the write cache. Each SPS rear panel has one AC inlet power connector with the power switch, AC outlets for the SPE and the first DAE, and one phone-jack type connector for connection to an SP. An SPS can be replaced while the storage system is powered up.

LEDs located on the back of the SPS provide a visual check of the status of the battery, i.e. Online, Battery On, Replace Battery and SPS Fault.



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FLARE Operating Environment (OE)

FLARE is EMC's proprietary CLARiiON Operating Environment (Supervisor) firmware. The CX4 supports non-disruptive upgrades for both firmware and hardware.

With update 28 (FLARE version 28), the operating environment is a 64-bit based real-time operating system embedded in firmware. The following new or enhanced features are supported:

- 64 bit based OE for enhanced memory and I/O address space support
- Support for Dual Core and Quad Core Intel Xeon processors
- Flash SSD drive support
- The ability to intermix iSCSI and FC networks attachments simultaneously using UltraFlex I/O modules
- Virtual provisioning support
- Support for RecoverPoint (added with FLARE version 26)

Evaluator Group Comments: The move to 64 bit will help EMC eliminate many of the size limitations of previous systems, such as LUN sizes, and cache sizes. EMC claims the ability to address up to 1 TB of memory; however, the current memory configuration of CX4 models do not approach 1 TB.

Additionally, EMC claims increased performance of “up to 2.5 times the performance of 32 bit single processor environments depending upon workload.” The claims derive partially from EMC updating single and dual core processors in the CX3 to dual and quad core respectively. These claims are unsubstantiated by any published benchmarks.

Finally, EMC claims “non-disruptive upgrades for both firmware and hardware” due to the use of UltraFlex and the 64 bit FLARE firmware. However, as documented, EMC does not support the interchange of UltraFlex modules by non-EMC service personnel. As a result, the real-world availability results made by EMC for the CX4 may be questioned.

EMC integrated RecoverPoint integration points into the FLARE OE. RecoverPoint installations will support local as well as remote data replication with both CX3 and CX4 based CLARiiON systems utilizing the appropriate version of FLARE.



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RAS FEATURES

Reliability, availability and serviceability

The CX4 Series storage systems maintain data integrity and provide data availability via the following mechanisms:

- Hot swappable SP with up to 16 GB of memory per SP
- Mirrored write cache
- RAID protection levels 0, 1, 3, 5, 6 1+0
- Hot pluggable I/O modules, both 4 & 8Gb/s FC and 1 & 10Gb/s iSCSI
- Hot spares and proactive hot sparing
- Redundant SPs configured with UltraFlex I/O modules
- Battery backup and cache vault
- Redundant power supplies
- Redundant cooling modules
- Online upgrades
- Support for data-in-place upgrades
- Virtual LUN technology to dynamically move data from one tier of storage to a higher or lower tier within the same CX4

Variable speed fans

The variable speed fans provide for environmental savings, especially when used in conjunction with the disk drive “spin down” feature available for seldom used disks. The variable speed fans also provide for more consistent temperature control which is important for storage systems. The EMC Power Reporter is supported in the CX4 product line and is a useful tool for monitoring power usage and calculating environmental costs.

Redundant write cache

The CX4 cache has dual write cache that enhances data integrity and also provides for higher performance for mirroring and data replication. The cache also has battery backup and is de-staged to the vault drives to provide persistence.



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CONNECTIVITY OPTIONS

The following operating systems are supported for Fibre channel: Windows, Solaris, Linux, AIX, HP-UX and VMware. The following operating systems are supported for iSCSI host interface: Windows, Solaris, Linux, AIX, HP-UX and VMware. The list of supported operating system versions and releases, and supported servers is quite extensive. Customers should consult EMC directly to verify their supported levels.

Each CX4 comes with both a base number of Fibre channel connections AND 4 base iSCSI connections. The maximum connections available on the Model 960 must have the expansion I/O optional feature included. The expansion I/O optional feature includes both hardware, to be able to connect the maximum number of drives, and software, presumably a feature for the FLARE-OE.

Connectivity	Model 120	Model 240	Model 480	Model 960
Total I/O Slots per Array	6	8	10	12
I/O Slots Populated by Base Config	4	4	6	6
I/O Slots Available for Expansion	2	4	4	6
Base Config Front-end FC Ports	4	4	8	8
Max Front-end FC Ports	12	12	16	24
Base Config Front-end iSCSI	4	4	4	4
Max Front-end 1 Gb/s iSCSI Ports	8	12	12	16
Max Front-end 10 Gb/s iSCSI Ports	4	4	8	8
Base Back-end FC Ports	2	4	8	8
Max Back-end FC Ports	2	4	8	16

Table 6: Base and Maximum Connectivity Options

Evaluator Group Comment: Note that in order to support the full number drives offered on the model 960, back-end connectivity must be increased at the expense of front-end connectivity.



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TECHNICAL SPECIFICATIONS

Processor Chassis	Model 120	Model 240	Model 480	Model 960
AC Voltage +/- 10%	100 – 240 VAC			240 VAC
Frequency	47 – 63 Hz			
Power Consumption (max)	340 VA (260W)	350 VA (270W)	355 VA (290W)	755 VA (730W)
Heat Dissipation (max)	890 Btu/hour	930 Btu/hour	990 Btu/hour	2500 Btu/hour
DAE Chassis				
AC Voltage +/- 10%	100 – 240 VAC			
Frequency	47 – 63 Hz			
Power Consumption (max)	440 VA (425 W)			
Heat Dissipation (max)	1450 Btu/hour			

Table 7: CX4 Power Requirements

Processor Chassis	Model 120	Model 240	Model 480	Model 960
Height	5.25 inches / 13.34 cm (3U)		10.5 inches / 26.67 cm. (6U)	
Width	17.5 inches / 44.45 cm			
Depth	24.25 inches / 61.6 cm		29.9 inches / 75.9 cm	
Weight	99.5 pounds / 45.4 kg (max)		235 pounds / 106.6 kg (max)	
DAE Chassis				
Height	5.25 inches / 13.34 cm (3U)			
Weight	17.72 inches / 45.0 cm			
Depth	14.00 inches / 35.56 cm			
Weight	68 pounds / 30.9kg (max)			
CLARiiON 40U Rack				
Height	75.0 inches / 190.8 cm			
Weight	24.0 inches / 61/1 cm			
Depth	39.0 inches / 99.2 cm			
Weight	Empty: 380 pounds / 173 kg			

Table 8: Approximate Dimensions



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SOFTWARE FEATURES AND FUNCTIONS

The EMC's CX4 product derives the majority of its features through software. Many features are built into the FLARE firmware and offered as part of the base offering of the CLARiiON product. Additionally, many other features are optional, extra charge items. Still other items such as Unisphere or Navisphere manager are required extra charge items.

Virtual (thin) Provisioning

The CX4 product line supports thin provisioning. Additionally, monitoring and threshold enforcement to prevent abuse of "runaway" consumption of storage are included. Availability of this feature occurred in October 2008.

Evaluator Group Comment: Thin provisioning for enterprise storage allows for more effective storage utilization. However, the issue is how the storage system, storage administrator, application and end users manage the issue of running out of storage if that over-commit leads to real allocation problems. This complicates the entire process and should be kept in mind at all times. The fact that many applications could be allocating storage from a single provisioning pool could have serious consequences to many applications should the free storage pool become depleted.

The virtual provisioning feature added to the CX4 is nearly identical to the virtual provisioning added to EMC Celerra systems in 2006. For a full description and analysis of the issues and benefits of EMC's virtual provisioning, readers should refer to [Evaluator Group's EMC DART OS analysis document](#).

Access Logix (included with Navisphere Management Suites) – provides secure, shared or selective access control to the EMC CLARiiON family of storage systems. LUN Masking capability is the core of the Access Logix software. LUN Masking is the ability to each LUN to specify what host, or combination of hosts, may have access to that LUN.

CLARalert (standard) – provides constant system monitoring, call-home notification and remote diagnostics.

Fully Automated Storage Tiering (FAST) (optional, extra cost) – The FAST function is a combination of host utility software and embedded software that provides tiering within the CX4. The tiering is between the different classes of disk that may be configured in the CLARiiON – Enterprise Flash Drives (SSDs), fibre channel disks, and SATA disks. The tiering is using policies to control placement of data to provide the tradeoff between the cost of the different classes of storage devices and the different performance characteristics. The Virtual LUN migration feature, which has been a feature of CLARiiON for several years is used to migrate LUNs between tiers. The controls or criteria for movement are set up by the storage administrator by the FAST utility software running on a Windows server. The software uses the data from the Navisphere Analyzer to determine what LUNs should be moved. The FAST embedded software on the CLARiiON will process the control file created by the storage administrator to do the LUN management and movement of data.

EMC has added a more granular capability to the FAST movement of data to move blocks at the sub-LUN level. This capability identifies "hot spots" and only moves blocks in that area.

Evaluator Group Comment: This is another refinement on the internal tiering that is more sophisticated in understanding data usage at the block level rather than a gross LUN level. This is

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being done with no hints or interaction from the operating system or applications. Certainly that would be a better architecture but that is not possible in an open systems environment with a general purpose storage system. The drawback is the involvement of the storage administrator. The human element may not be as effective as a completely heuristic system. The indirection overhead for splitting of data in a LUN would be more than offset by the value of not moving blocks within a LUN that are not highly active.

An additional feature added to FAST is the FAST Cache which allows Enterprise Flash Disks to be used as an extension to the system cache. This feature can provide a very large read/write cache in the CLARiiON to optimize specific workloads.

MetaLUN (standard) – Enables users to spread a LUN across a number of physical disk drives within a RAID group and benefit from higher performance gained through parallelism of data spread (striped) across a greater number of drives.

MirrorView (optional) – MirrorView/Asynchronous (MirrorView/A) and MirrorView/Synchronous (MirrorView/S) are software applications that maintain copies (mirrors) of LUNs at separate locations. The production image is called the primary image and the copy of the image is called the secondary image. MirrorView/S replicates data continuously for maximum availability and MirrorView/A replicates data independent of the application I/O ensuring recoverability and extending distance.

Unisphere (optional – extra cost) - EMC has announced a unified management strategy for storage administration that is targeted to be available in the third quarter of 2010. Unisphere is a play on Unified and Navisphere. Currently, the initial target for Unisphere is to provide a single management tool for managing SAN and NAS with the CLARiiON and Celerra storage systems and the RecoverPoint software. The management tool uses Adobe Flex to provide a common view and management experience for block and file systems and functions. Unisphere can see the entire environments where the support storage systems or software exist. From the highly customizable user interface, simple, intuitive management for the systems can be performed. The user interface creates a dashboard for managing the systems and features. There are some capabilities that provide significant advantages over prior management software (Navisphere in the case of CLARiiON). One is that there are hyperlinks for items in the dashboard views that maintain a contextual view of the administration for the underlying system. Another is the ability to do a context-based launch into online support.

Unisphere is integrated with VMware vSphere to be aware of the virtual machines and provide storage system management. Additional awareness for management of applications controlling storage such as Exchange are built into Unisphere.

Evaluator Group Comment: *This new management tool answers many of the criticisms of customers where each different storage system had its own management software and “style.” This is a big step for EMC in simplifying administration. The features look very advanced and should help new customers that are not already used to existing tools. Existing customers should find the new tools to be much easier to use. While Unisphere does not make storage management less complex, it does make the tools much better. To make storage management less complex, there would need to be more self-tuning and automation that may be beyond the capabilities of almost all current storage systems.*



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Until Unisphere is available, the standard management tools for CLARiiON remain Navisphere.

Navisphere Manager (required, extra cost)

The Navisphere Software Suite, which provides device management for CLARiiON and is part of the EMC ControlCenter family, is the framework for managing the entire CLARiiON family of arrays. EMC implemented the industry standard Storage Management Initiative (SMI-S) open storage management interface for CLARiiON in 2000, and has included it in Navisphere Manager, Navisphere Analyzer and Navisphere Agent. The Navisphere suite of software provides the following:

- Manages simultaneous FC and iSCSI connectivity
- Manages single or multiple CLARiiON arrays
- Management of device and performance via a browser-based GUI
- Control for the system-based SnapView and MirrorView operations
- Event notification of status changes
- Collects and displays performance statistics, configuration information and any upgrade enhancements

The Navisphere Manager also includes the optional, extra cost ControlCenter Open Integration Components. The Open Integration Components provide discovery and monitoring for any resource managed by ControlCenter/Open Edition. Open Integration Components provide the following:

- The ability to map from the host logical object (database, file system) to the storage system
- CLARiiON, Symmetrix and other third-party storage systems are supported
- ControlCenter provides a common language between Das, system administrators and storage administrators
- The ability to view a topology map that represents the physical configuration of the storage network. It can display the connectivity topology from the host, through the storage network components, to the multi-vendor storage systems. The topology can be viewed from the host, Fibre channel switch and storage system or expanded to show the actual physical port connectivity.
- Alerting capabilities are provided for EMC storage (CLARiiON, Symmetrix) and selected third-party storage systems, hosts, databases and backup applications.

Navisphere Analyzer (included with Navisphere suite) – Analyzer is a web-based tool that allows an administrator to graphically examine the performance characteristics of the logical and physical entities that make up CLARiiON storage systems. Analyzer supports immediate (real-time) data display as well as the display of previously logged data.

Navisphere Quality of Service Manager (included with Navisphere suite) – NQM is a software product that enables the dynamic allocation of storage system resources to meet application service-level requirements. It provides the ability to prioritize applications and set specific performance targets to get the service needed for specialized applications. NQM can also monitor storage-system performance on an application-by-application basis providing a logical view of application performance on the storage system itself. All NQM performance data gathered is presented with various charts that can be used for application performance analysis and trending.

Online Upgrade (standard) – performs the online upgrade of storage software and FLARE operating system.



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PowerPath (standard) – PowerPath is server resident software that provides dynamic path failover and load balancing. PowerPath offers common HBA driver support across both CLARiiON and Symmetrix storage systems. PowerPath has the ability to support iSCSI along with Fibre channel NICs and adapters.

RecoverPoint/SE (optional) – RecoverPoint/SE is the CLARiiON specific product designed for continuous data protection and for replication. The RecoverPoint family is based on the replication software developed by Kashya Corporation which EMC acquired in 2006. The base RecoverPoint/SE license can be upgraded at an unspecified cost to the user to support a heterogeneous any-to-any replication environment (RecoverPoint). This software supports asynchronous replication with consistency groups.

RecoverPoint/SE supports synchronous local copy (within the same CLARiiON system) and asynchronous remote copy (to another CLARiiON either in the same location or at a separate location over distance). A RecoverPoint/SE system consists of the following components: at least one RecoverPoint appliance (RPA); RecoverPoint software installed on the RPA; RecoverPoint enabler for the CLARiiON array-based write splitter; RecoverPoint host agent software; and RecoverPoint storage replication adapter for VMware Site Recovery Manager is necessary.

RecoverPoint/SE is a scaled down (Standard Edition) version of RecoverPoint, designed specifically for CLARiiON systems which supports write-splitting technologies on Windows hosts and CLARiiON CX3 and CX4 arrays. RecoverPoint/SE supports a maximum of one array for continuous data protection and two systems for continuous remote replication. The maximum protected capacity is 16TB. Also, the SE edition does not support fabric connectivity. RecoverPoint is the family product that has an expanded capability for CDP and CRR.

RecoverPoint/SE replicates data by intercepting the application writes through the use of write-splitting modules. The write-splitting module can be installed on a Microsoft Windows server or on the CX4 array where it runs in each SP. The CLARiiON array-based splitter runs in each storage processor of the CX4 array and will “split” or mirror all writes to the CLARiiON by sending one copy to the original target and the other copy to the RecoverPoint appliance.

Replication Manager Family – EMC Replication Manager simplifies management and automation of the entire information replication process from the application layer to the array for CLARiiON SnapView, SAN Copy, RecoverPoint and other EMC replication software. Replication Manager allows point-in-time copies of application data from discovery, configuration and scheduling to a wizard-driven process for recover operations.

RepliStor (optional) – EMC RepliStor provides real time data replication for the Windows server environment. RepliStor operates over both local area network connections and wide area network connections, and can be administered across domains from any RepliStor client in the network. RepliStor consists of the following components: RepliStor client, RepliStor server, RepliStor driver, RepliStor Control service, RepliStor installation program, SNMP Agent Expansion dynamic link library and Performance Monitor DLL.

SAN Copy (optional) – SAN Copy is a CLARiiON-based LUN replication that moves LUNs/Volumes between current and legacy EMC CLARiiON, Symmetrix, and third party storage systems. SAN Copy is managed via ControlCenter Navisphere. It will support both local and remote distances. LUNs may be copied within and between CLARiiON arrays, between CLARiiON and Symmetrix (8000 and DMX), and between CLARiiON and qualified non-EMC storage including HDS, HPQ, IBM and Sun StorEdge. A CLARiiON system acts as a “Copy



EMC CLARiiON CX4 Series

Manager” and communicates through World Wide Names. The Copy Manager uses SnapView Snapshot and/or SnapView Clone, TimeFinder BCV or an idle production LUN as its source.

SnapView Snapshot – SnapView snapshot is a system based PIT (point-in-time) copy that can capture up to eight point-in-time images of a LUN and retain the images independent of changes to the original data.

SnapView Clone – SnapView clone is a complete copy of a source LUN. While the clone is part of the clone group and not split, any server write requests made to the source LUN are simultaneously copied to the clone.

Virtual LUN (standard) – Enables users to dynamically and non-disruptively move data from one LUN to another across RAID ranks and drive types.

The following table compares the SnapView and MirrorView data protection options.

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	SnapView Clone	SnapView Snapshot	MirrorView/ Asynchronous	MirrorView/ Synchronous
Copy Type	Clone	PIT	Continuous PIT / Mirror	Continuous PIT / Mirror
Architecture	Full Copy	Bit Map	Full Copy	Full Copy
Max # Copies				
Model 120	256	512	100	128
Model 240	512	512	100	256
Model 480	1024	1024	100	512
Model 960	2048	2048	100	512
Re-sync	Yes	No	Yes	Yes
Potential Data Exposure	Synchronous – None	Exposure is back to time snap was taken	Exposure is back to when consistent PIT completed	Synchronous – None
Availability for Restore	Mirror available after completion of initial mirror	Available for restore only after command completes	Either automatic or manual depending on established policies	Either automatic or manual depending on established policies
DR, Fail-over Capability	Yes, on mirror split	Rollback only	Yes, after mirrored image is promoted to primary image	Yes, after mirrored image is promoted to primary image
Default Action	Copy when command issued	Copy on Write	Consistency Group controlled	Copy is a true mirror until split
Additional Capacity	100%	Changes only	100%	100%
Access to Copy	R/W after split	R/O	R/W after promotion to primary image	R/W after promotion to primary image
Writeable	Yes	No	Yes	Yes
Performance Impact	Some impact	Moderate Impact	Minimal	Some impact depending on workload and distance

Table 9: EMC CLARiiON CX4 Data Protection Options



EMC CLARiiON CX4 Series

EVALUATOR GROUP COMMENTS

EMC continues to be one of the main vendors supplying mid-tier storage systems. The CLARiiON CX4 series is another generation in the long line of CLARiiON storage systems. The CX4 has many features and capabilities that customers require in their block storage environments.

The CLARiiON CX4 focuses on the number and speed of I/O connectivity, while increasing memory size and processing capabilities. The increase in the number of drives supported, along with increasing disk capacities now pushes the total capacity for a CX4-960 system up to levels seen only on the very largest of data-center class systems.

The capability to configure flash drives (Solid State Disk) in the CX4 adds another capability for customers with demanding application requirements. Evaluator Group has always maintained that there is some data that must be accessed as fast as possible regardless of the perceived \$/GB price tag. Now that EMC has both CX4 and DMX/VMAX flash drive capability, the other major storage vendors will have pressure to follow suit quickly.

The separation of CPU and I/O modules utilizing the FLARE 64 bit Operating Environment and UltraFlex firmware allows for maximum flexibility for non-disruptive maintenance as well as upgrades. This allows users to accommodate future enhancements in performance, function, and connectivity.

The CLARiiON CX4 with its wide range of performance and scalability encourages users to evaluate the product line as to what it can do to fit business requirements and not view it solely from a speeds, feeds, and technology standpoint. This makes it easier to satisfy business requirements from a storage capability standpoint.

Strengths:

- **Modular architecture:** As discussed previously, the CX4 architecture is highly modular and supports hot-swappable hardware upgrades as well as non-disruptive firmware.
- **Highly scalable with support for nearly 1 PB of storage.**
- **Virtual (thin) provisioning:** The entire CX4 product line supports Virtual (thin) storage provisioning. A provisioning storage pool can be configured and through policy specification, applications may be enabled to use this pool for their storage requirements. The Virtual Provisioning support provides excellent reporting and management for the storage pool.
- **Integration with VMware:** EMC has worked to tie VMware Site Recovery Manager (SRM) with RecoverPoint HA and MirrorView/S to enhance recovery capabilities.
- **Enhanced CLARiiON data replication with integration of RecoverPoint/SE write splitter, eliminating a SANtap or other write splitter requirement.**
- **Flash (SSD) drive support for applications requiring high transaction rates**
- **Fully Automated Storage Tiering (FAST) support for automated tiering within the CX4 across storage devices of different type.**
- **Unisphere potential as a single management interface across multiple storage system types (all from EMC).**

Perceived Challenges:



EMC CLARiiON CX4 Series

Overall, the fourth generation CLARiiON CX4 line-up is a solid product with few issues or missing features. It compares well to competing systems in most regards.

Perhaps the largest issue looming is that of lack of published benchmarks for EMC systems in general. NetApp has taken it upon themselves to publish benchmark results for NetApp and EMC systems in several situations. The results showed that while EMC performed adequately, they were not the superior performing systems in those benchmarks, particularly with snapshots (SnapView) enabled.

There are advantages to the EMC implementation of SnapView snapshots compared to alternatives, particularly with regard to space management. However, the disadvantages arise in terms of performance penalties with writes.

A few other minor issues include:

- **Feature and function delivery:** The CX4 announcements have come with some significant features and functions that were not yet available at announcement time. EMC has assured potential customers that the CX4 architecture provides the capability for upgrades without impacting application availability. The capability to provide upgrades on time and non-disruptively will provide EMC the opportunity to demonstrate the flexibility of the CX4 architecture. The availability of the announced features being in the future can frustrate customers and create a freeze on ordering.
- **Availability Architecture:** EMC has claimed that the architecture of the CX4 product is capable of non-disruptive upgrades and enhancements. Potential customers are rightly skeptical of these claims and it will need to be proven over time that the CX4 can deliver what is promised.

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