DELL | EMC CX4 SERIES ARRAYS OVERVIEW

FEATURING ULTRAFLEX TECHNOLOGY

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EXECUTIVE SUMMARY

Dell/EMC CX series storage arrays have built a reputation for performance, ease of use, scalability, flexibility, reliability, and investment protection since their initial launch in 2002. Now in their fourth generation, the new CX4 arrays build on that reputation and are designed to greatly increase performance and capacity from the previous generation. The CX4 series provides impressive flexibility and investment protection with the introduction of new UltraFlex™ technology.

The unique modularity of the UltraFlex technology allows you to use a combination of protocols within a single storage system. The CX4's architecture is based on state-of-the-art I/O interconnect PCI Express technology, enabling it to provide high bandwidth and low latency. In addition, Dell/EMC CX4 arrays are future-ready for new network technologies, allowing you to add them, such as 10Gb/s iSCSI and 8Gb/s Fibre Channel, as they become available. Furthermore, as your requirements change, you can use virtual LUN technology to dynamically move data from one tier of storage to a higher or lower tier within the same CX4 storage system. Dell/EMC storage is designed to maximize the availability of your data while protecting your storage infrastructure investment as your needs change.

INTRODUCTION

This white paper describes the architecture and functionality of the CX4 storage systems with UltraFlex technology. It compares the features and capabilities of the models in the fourth-generation Dell/EMC CX storage system family. It describes the CX4 storage processors (SPs) and subcomponents, and describes and illustrates major system subassemblies and configurations.

This paper also provides an overview of the software capabilities of the CX4 storage system family, including an overview of the CX4 auto-sense speed setting that allows you to use a combination of 2 and 4Gb/s drives. Tiered storage systems are greatly simplified due to this ability to detect and recognize the characteristics of existing drives and new drives as they are added. Furthermore, this paper provides an overview of the Dell/EMC virtual LUN technology that allows you to perform an online transfer of data between different tiers of storage in a CX4 system.

OVERVIEW

CX4 series storage systems are made up of the following modular components:

- A modular 4Gb/s storage processor enclosure (SPE) – Houses the storage processors (SPs), power supplies, blower modules, and I/O modules.
- A 4Gb/s UltraPoint™ disk-array enclosure (DAE) – Houses up to 15 drives. Additional DAEs can be added for a maximum of 120 drives for CX4-120, 240 drives for CX4-240, 480 drives for CX4-480, and 480 or 960 drives for CX4-960.
- Dual standby power supplies (SPS) – Enable proper shutdown of the storage system during power failure by safely moving the data in the write cache to a reserved area in the first five drives.

The following are CX4 features:

- Support for both direct-attach and SAN environments
- Hot-pluggable I/O modules – either 4Gb/s FC or 1Gb/s iSCSI
- Hot-swappable storage processors with up to 16 GB of memory per SP
- RAID level 0, 1, 1/0, 3, 5, and 6, individual disk support, and global hot sparing
- Online upgrade capability
- Five-drive minimum to 960-drive maximum system configuration
- Support for data-in-place upgrades
- Support for Windows, Solaris, Linux, AIX, HP-UX, and VMware Fibre Channel attaches
- Support for Windows, Solaris, Linux, AIX, HP-UX, and VMware iSCSI attaches

DELL/EMC CX4 SERIES ARRAYS OVERVIEW

The CX4 supports the following software:

- FLARE® Operating Environment
- Navisphere® Management Suites - includes Access Logix™ technology and the appropriate Navisphere Agent or Navisphere Server Utility
- Navisphere Analyzer
- Navisphere Quality of Service Manager
- Email Home
- PowerPath® (full-featured or utility kit)
- SnapView™ (snapshots and clones)
- MirrorView™/A and MirrorView/S
- SAN Copy™
- RecoverPoint

CX4 series architecture

The innovative CX4 architecture delivers impressive performance, including high levels of resiliency and availability; tiered-storage flexibility; and powerful, easy-to-use interfaces. CX4's UltraFlex technology provides you with the flexibility of using a combination of FC and iSCSI connections.

Initial tiered storage configurations are simplified due to the CX4's ability to detect the characteristics of drives as they are added. Furthermore, as your requirements change, Dell/EMC CX4 arrays have virtual LUN technology that can help move data from one tier of storage to a higher or lower tier of storage without disrupting the host application.

UltraFlex technology

UltraFlex technology is a breakthrough approach to array connectivity. The CX4's UltraFlex technology delivers a storage system that you can easily customize by populating your I/O slots with the I/O modules that meet your specific needs.

These I/O modules are placed horizontally in the CX4-960, and vertically in the CX4-480, CX4-240, and CX4-120. Figure 1 shows the connectivity of a CX4-960 being expanded by adding an FC I/O module.

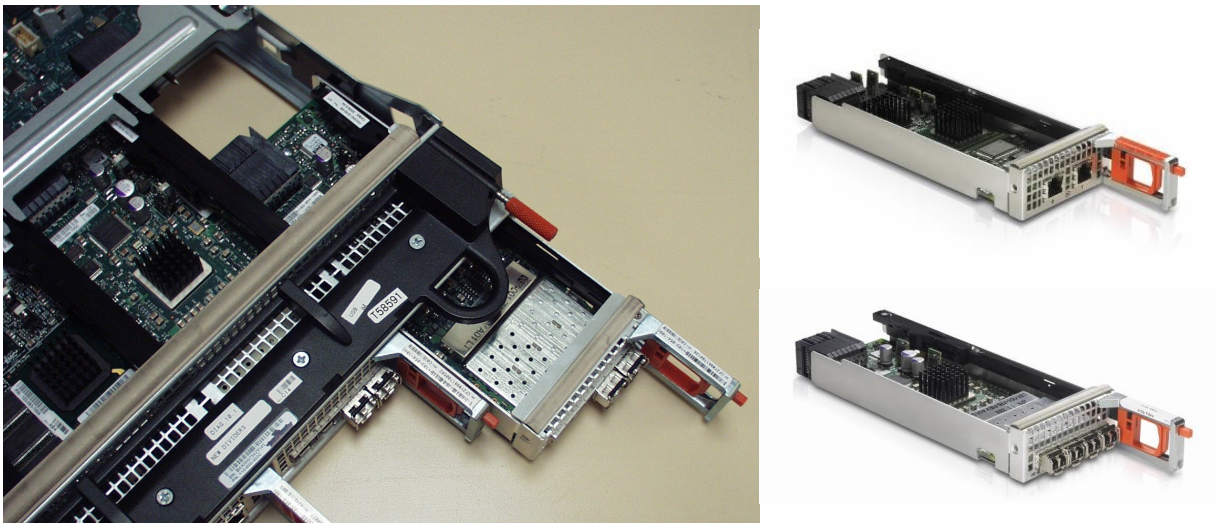


Figure 1. CX4 UltraFlex I/O module addition and iSCSI and Fibre Channel I/O Modules

DELL/EMC CX4 SERIES ARRAYS OVERVIEW

Each model has a base configuration that includes Fibre Channel connectivity, iSCSI connectivity, and additional I/O slots for future connectivity expansion. You can expand this base configuration by adding Fibre Channel and/or iSCSI I/O modules. With this unique architecture, future I/O modules can be added as they are developed. Table 1 lists the base and maximum configurations for the CX4 models.

Table 1. CX4 base and maximum connectivity options

Connectivity	CX4-120	CX4-240	CX4-480	CX4-960
Total I/O slots per array	6	8	10	12
I/O slots populated by base configuration	4	4	6	6
I/O slots available for expansion	2	4	4	6
Front-end 4Gb/s FC ports (Base configuration)	4	4	8	8
Front-end 4Gb/s FC ports (Optimized configuration)[1]	12	12	16	24
Front-end 1Gb/s iSCSI ports (Base configuration)	4	4	4	4
Front-end 1Gb/s iSCSI ports (Optimized configuration)[1]	8	12	12	16
Back-end FC ports (Base configuration)	2	4	8	8
Back-end FC ports (Optimized configuration)[2]	2	4	8	16

[1] The CX4 can be optimized for either maximum Fibre Channel front-end connectivity or maximum iSCSI front-end. It cannot be optimized for both at the same time.
[2] The CX4 can also be optimized for maximum Fibre Channel back-end connectivity.

Where the CX4 series fits into the Dell/EMC storage family

The Dell/EMC CX4 series is the fourth generation of the CX series. The CX4 series continues to expand the reputation and capabilities of Dell/EMC storage systems. It supports 4Gb/s throughput from end to end, and provides high functionality, data integrity, high availability, and expanded flexibility. It also offers excellent price/performance, along with scalable capacity and upgradeability.

Table 2 on page 6 compares the different features for each type of CX4 storage system.

DELL/EMC CX4 SERIES ARRAYS OVERVIEW

Table 2. Side-by-side comparison of the CX4 series

Components/Connectivity	CX4-120	CX4-240	CX4-480	CX4-960
Processor architecture per SP[3]	1 dual-core processor 1.2 GHz	1 dual-core processor 1.6 GHz	1 dual-core processor 2.2 GHz	2 quad-core processors 2.33 GHz
Maximum cache	6GB	8GB	16GB	32GB
Maximum drives	120	240	480	960
Minimum drives	5	5	5	5
Maximum initiators	256	512	512	1024
Maximum H/A hosts	128	256	256	512
Maximum LUNs	1024	1024	4096	4096
Maximum RAID groups	60	120	240	480
Maximum drives per RAID group	16	16	16	16
Maximum LUNs per RAID group	256	256	256	256
SPE form factor	2U	2U	2U	4U
Minimum configuration form factor (SPS + SPE + DAE)	6U	6U	6U	9U
SnapView™ snapshots	512	512	1024	2048
SnapView clones	256	512	1024	2048
MirrorView™/S	128	256	512	512
MirrorView/A	100	100	100	100
SAN Copy™	Yes	Yes	Yes	Yes
146, 300 and 450GB[4] 4Gb/s 15k rpm Fibre Channel	Yes	Yes	Yes	Yes
400GB 4Gb/s 10k rpm Fibre Channel	Yes	Yes	Yes	Yes
1TB 4Gb/s 7.2k and 5.4k rpm SATA-II[5]	Yes	Yes	Yes	Yes
Solid State (Flash) Drive[4]	No	No	Yes	Yes

[3] All models in the CX4 series have two SPs.
[4] 450GB 15k rpm Fibre Channel Hard Drive and Solid State (Flash) Drive expected in fall 2008
[5] 7.2k SATA-II disk drives can be used as the FLARE OS drives for the CX4-120 only.

CX4-960 DETAILS

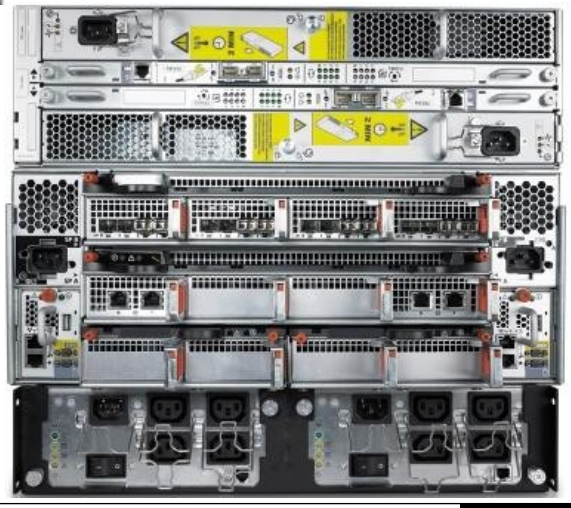
The minimum CX4-960 assembly consists of a single 4U storage processor enclosure (SPE), a 2U standby power supply (SPS), and a 3U 4Gb/s UltraPoint disk-array enclosure (DAE), for a total of 9U. A fully configured CX4-960 consists of the SPE and dual SPS, plus 64 3U DAEs, for a total of 201U.

Each CX4-960 SP contains two 2.33 GHz Quad-Core Intel® Xeon® processors. This dual-storage processor architecture provides the power for enhanced performance, stability, and reliability in the CX4-960 storage system. Each CX4-960 SP has 16 GB of system memory. There is a PCI Express-x8 CMI channel between the storage processors that is used for communication and messaging between the storage processors as well for mirroring data that is written to the portion of memory designated for write cache on the storage system.

The CX4-960 SPE has four 24V blower modules and two 1200-watt power supplies. The power supplies and blower modules are front-serviced vertical field-replaceable units (FRUs).

The CX4-960 SPE uses two 2.4-kilowatt SPSs to maintain power to the storage system during a power loss; this allows a full dump of the write cache to a reserved area on the persistent disk. In the case of the CX4-960, SPS power output connectors are used to power the SPE as well as to power the first DAE on the first back-end loop.

Figure 2: CX4-960 components from the front and rear



CX4-480 DETAILS

The minimum CX4 Model 480 assembly consists of a single 2U storage processor enclosure (SPE), a 1U standby power supply (SPS), and a 3U 4Gb/s UltraPoint disk-array enclosure (DAE), for a total of 6U. A fully configured CX4-480 consists of the SPE and dual SPS, plus 32 3U DAEs, for a total of 99U.

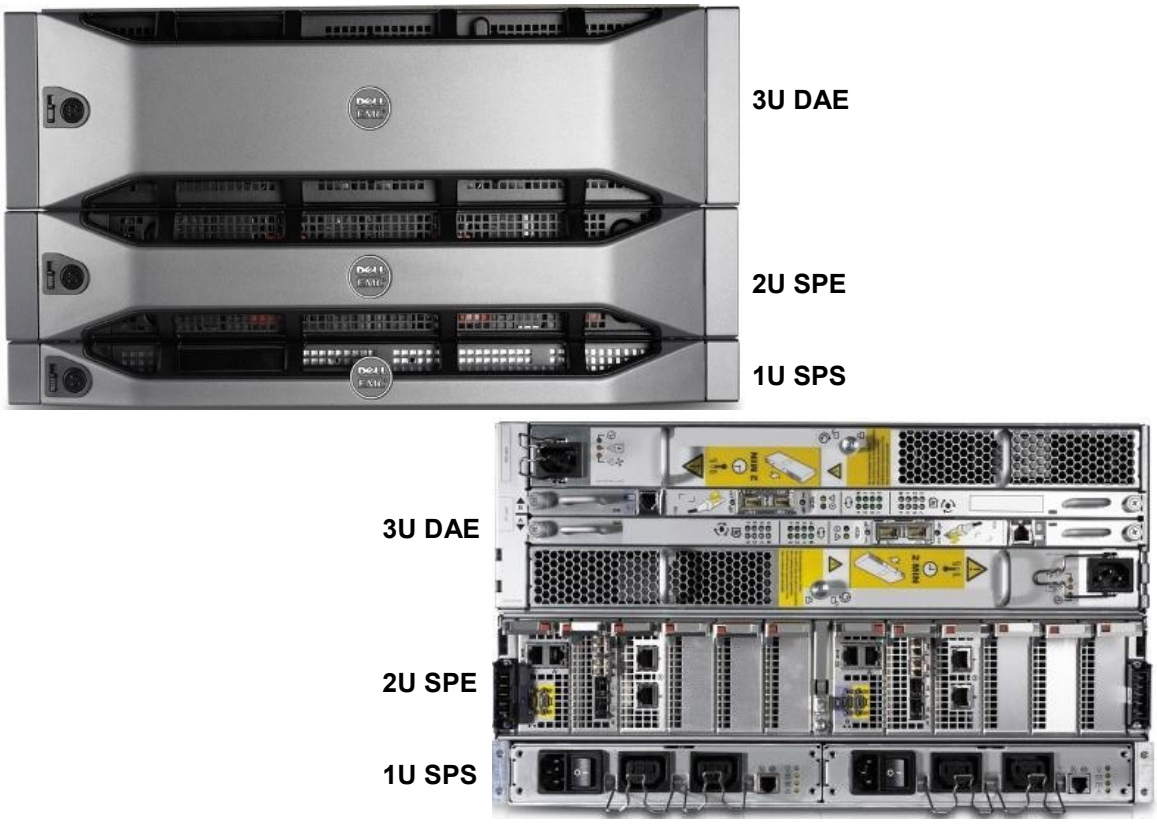
Each CX4 Model 480 SP contains one 2.2 GHz Dual-Core Intel Xeon processor. This dual-storage processor architecture provides the power for enhanced performance, stability, and reliability in the CX4-480 storage system. Each CX4-480 SP has 8 GB of system memory. There is a PCI Express-x4 CMI channel between the storage processors that is used for communication and messaging between the storage processors as well for the mirroring of data that is written to the portion of memory that has been designated for write cache on the storage system.

The CX4-480 SPE uses four 400-watt power supplies supporting N+1 power and N+1 cooling per storage processor. The power supplies contain thermal sensors for Ambient Over-Temperature monitoring. Cooling is achieved through high-speed blowers attached to each power supply module.

A single power supply can power a single storage processor and a single blower can cool a single storage processor. The CX4-480 can run indefinitely with one power supply/blower module faulted or removed on each SP and still maintain high availability.

The CX4-480 SPE uses two 1-kilowatt SPSs to maintain power to the storage system during a power loss to allow for a full dump of the write cache to a reserved area on persistent disk. In the CX-480, both SPS power output connectors are used to power the SPE as well as the first DAE on the first back-end loop.

Figure 3: CX4-480 components from the front and rear



CX4-240 DETAILS

The minimum CX4 Model 240 assembly consists of a single 2U storage processor enclosure (SPE), a 1U standby power supply (SPS), and a 3U 4Gb/s UltraPoint disk-array enclosure (DAE), for a total of 6U. A fully configured CX4-240 consists of the SPE and dual SPS, plus 16 3U DAEs, for a total of 54U.

Each CX4-240 SP contains one 1.6 GHz Dual-Core Intel Xeon processor. This dual-storage processor architecture provides the power for enhanced performance, stability, and reliability in the CX4-240 storage system. Each CX4-240 SP has 4 GB of system memory. There is a PCI Express -x4 CMI channel between the storage processors that is used for communication and messaging between the storage processors as well for the mirroring of data that is written to the portion of memory that has been designated for write cache on the storage system.

The CX4-240 SPE uses four 400-watt power supplies supporting N+1 power and N+1 cooling per storage processor. The power supplies contain thermal sensors for Ambient Over-Temperature monitoring. Cooling is achieved through high-speed blowers attached to each power supply module.

A single power supply can power a single storage processor and a single blower can cool a single storage processor. The CX4-240 can run indefinitely with one power supply/blower module faulted or removed on each SP and still maintain high availability.

The CX4-240 SPE uses two 1-kilowatt SPSs to maintain power to the storage system during a power loss to allow for a full dump of the write cache to a reserved area on persistent disk. In the case of the CX4-240, both SPS power output connectors are used to power the SPE as well as the first DAE on the first back-end loop.

CX4-120 DETAILS

The minimum CX4 Model 120 assembly consists of a single 2U storage processor enclosure (SPE), a 1U standby power supply (SPS), and a 3U 4Gb/s UltraPoint disk-array enclosure (DAE), for a total of 6U. A fully configured CX4-120 consists of the SPE and dual SPS, plus eight 3U DAEs, for a total of 30U .

Each CX4-120 SP contains one 1.2 GHz Dual-Core Intel Xeon processor This dual-storage processor architecture provides the power for enhanced performance, stability, and reliability in the CX4-120 storage system. Each CX4-120 SP has 3 GB of system memory. There is a PCI Express -x4 CMI channel between the storage processors that is used for communication and messaging between the storage processors as well for the mirroring of data that is written to the portion of memory that has been designated for write cache on the storage system.

The CX4-120 SPE uses four 400-watt power supplies supporting N+1 power and N+1 cooling per storage processor. The power supplies contain thermal sensors for Ambient Over-Temperature monitoring. Cooling is achieved through high-speed blowers attached to each power supply module.

A single power supply can power a single storage processor and a single blower can cool a single storage processor. Either storage processor can have a single power supply/blower module fault and still maintain write caching. The CX4-120 can run indefinitely with one power supply/blower module faulted or removed on each SP and still maintain high availability.

The CX4-120 SPE requires one 1-kilowatt SPS to maintain power to the storage system during a power loss to allow for a full dump of the write cache to a reserved area on persistent disk. An additional SPS can be added for further redundancy.

CX4 SERIES 4 Gb/s ULTRAPOINT DAE

The CX4 series has a separate enclosure for the storage processors, while the first DAE contains the drives where the configuration, cache vault, and boot images are stored. The DAE enclosure has room for up to fifteen 2Gb/s or 4Gb/s drives. Drive 0 is at the farthest left side of the enclosure, and drive 14 is at the farthest right side of the enclosure.

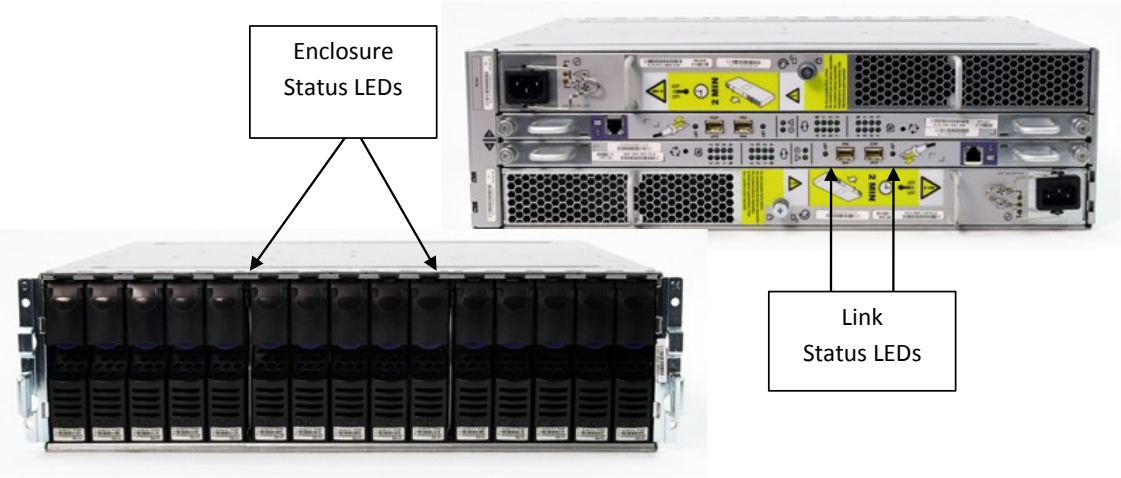


Figure 4. Front and back view of the 4Gb/s UltraPoint DAE

The 4Gb/s UltraPoint DAE has two link control cards (LCCs) that are capable of running at 2 or 4Gb/s. The LED on the left-front of the enclosure indicates fault status. The LED on the right-front of the enclosure has three states of operation: Off, Green, and Blue. Off indicates that the unit is not powered on. Green and Blue indicate that the enclosure and drives are operating at 2 and 4Gb/s, respectively. You can determine the speed at which the enclosure is operating by looking at the LED on the front of the enclosure or the link status on the back of the enclosure.

SOFTWARE ON CX4 SERIES STORAGE SYSTEMS

The CX4 series is designed to focus on intelligent storage management functions that operate in both direct-attach and SAN environments. The CX4 series is capable of incorporating a full range of intelligent storage functions, such as logical unit number (LUN) masking and storage replication applications.

Vault area on CX4 series storage systems

All CX4 series drives have an area reserved for configuration information. Additionally, the first five disks in the first enclosure on the first back-end loop have areas reserved that are used for software images and a write cache dump (the vault area). To support operation of the array, 62 GB on the first five drives and 34 MB on all the other drives is not available to users.

Navisphere Management Suite

You can manage your CX4 storage system with Navisphere Manager, which runs on the storage system and can be accessed anywhere you have network connectivity to the storage processors. With Navisphere Manager, you can manage storage systems on the same subnet as well as manage multiple storage systems in separate storage system domains. Remote management is also supported.

MetaLUNs
With Navisphere Manager, the CX4 storage system can utilize the LUN expansion feature, in which the base LUN is expanded in size to create a metaLUN. The metaLUN is a combination of more than one LUN joined together by either striping or concatenation.

Virtual LUN technology
The virtual LUN technology (LUN migration) feature is managed using either Navisphere Manager or Navisphere CLI (Command Line Interface). This Navisphere software allows the storage administrator to migrate data from a source LUN or metaLUN to another LUN or metaLUN within the storage system, while keeping the source LUN's data online.

LUN migration is useful when:

1. Changing drive types:

- Migrating from 2Gb/s Fibre Channel to 4Gb/s Fibre Channel
- Migrating from 4Gb/s Fibre Channel to 2Gb/s Fibre Channel
- Migrating from SATA-II to Fibre Channel
- Migrating from Fibre Channel to SATA-II

2. Changing performance characteristics:

- Migrating to less utilized disks
- Changing RAID type

During a LUN migration, the storage system copies the data from the source LUN to a destination LUN. After the migration is complete, the destination LUN assumes the identity (World Wide Name and other IDs) of the source LUN and the source LUN is destroyed.

Access Logix (included with Navisphere Management Suites)
Access Logix™ is an easy-to-use Navisphere tool that provides LUN masking between the storage processors and the host's Fibre Channel HBA. Access Logix is enabled from within Navisphere, and provides heterogeneous host connectivity between hosts and the CX4. It provides users with a user-friendly way to define storage groups. Storage groups control which hosts have access to which LUNs.

SnapView snapshots and clones (optional)

SnapView Snapshots

SnapView allows you to create a snapshot of a source LUN on a production server that may be viewed by a secondary server. A snapshot represents a point-in-time copy of the source LUN. During a SnapView session, the production server continues to write to the source LUN and modify data. The snapshot may be used by decision support applications or, using Navisphere CLI, you can write a script for a third-party backup application that uses the snapshot as a backup for the LUN. In the case of a source corruption, contents of the snapshot can be rolled back onto the source LUN. Table 3 shows the SnapView features available on CX4 series storage systems.

Table 3. SnapView snapshots supported on CX4 series storage systems

Feature	CX4-120	CX4-240	CX4-480	CX4-960
Snapshot sessions per source LUN	8	8	8	8
Snapshots per source LUN	8	8	8	8
Snapshots per storage system	512	512	1024	2048
Source LUNs per storage system	128	128	256	512
Reserved LUNs per storage system	128	128	256	512

[6] At least one reserved LUN is required for each source LUN.

SnapView clones

A SnapView clone is a complete copy of a source LUN, equal in size to the source LUN. Once created, this full copy can be fractured from the source LUN and mounted on a different host for processing by backup applications without affecting the production data on the source LUN.

A source LUN can have up to eight clones in a clone group; a clone group consists of all the clones that are created for a particular source LUN. In the case of source corruption, the contents of any clone in the clone group can be reverse-synchronized to the source LUN, thus minimizing downtime. See Table 4 for the clone features available on the CX4 storage systems.

Table 4. SnapView clones supported on CX4 series storage systems

Feature	CX4-120	CX4-240	CX4-480	CX4-960
Clones per source LUN	8	8	8	8
Clone source LUNs	128	256	512	1024
Clone images per storage system (Note: This number does not does not include the source LUN)	256	512	1024	2048

MirrorView/A and MirrorView/S (optional)

MirrorView/A and MirrorView/S are software applications that maintain copies (or mirrors) of LUNs at separate locations. The production image (the one mirrored) is called the primary image; the copy of the image is called the secondary image. MirrorView provides backup for disaster recovery, that is, one image is preserved and is accessible if a serious accident or natural disaster disables the other image. A primary LUN can have up to two mirrors (each mirror must be on a separate storage system) with MirrorView/S and one mirror with MirrorView/A. Additionally, any given storage system can participate in MirrorView connections with up to four other storage systems. Should connectivity be lost between the primary LUN and one or all of its mirrors, a log is kept of the data written to a LUN, so that subsequent synchronizations can be incremental (that is, only the data that changed while the mirror was unreachable is transferred once the mirror regains connectivity). See Table 5 for MirrorView features available on the CX4 storage systems.

Table 5. MirrorView/S and MirrorView/A devices supported on CX4 series storage systems

Feature	CX4-120	CX4-240	CX4-480	CX4-960
MirrorView/S images per storage system (includes primary and secondary images, as well as clone/ source images in the total count)	128	256	512	512
MirrorView/A source LUNs per storage system (total source LUN count shared with source LUNs participating in SnapView sessions and/or participating in an incremental SAN Copy session)	100	100	100	100

SAN Copy (optional)

SAN Copy is a software application that rapidly copies LUNs within a CX4 storage system, or between a CX4 storage system and another storage system. When moving LUNs between storage systems, the CX4 can serve as the source or destination server; in other words SAN Copy can copy a LUN from a CX4 or to a CX4. SAN Copy also provides incremental sessions, which maintain incremental tracking of copies, so that only the data that has changed on the source LUN is copied to the destination LUN. SAN Copy (including incremental) can be used to copy LUNs between a CX4 and number of storage systems, including a Dell/EMC CX3 Series, CX200, CX300, CX400, CX500, CX600, CX700, AX100, AX150, Dell AX4-5, EMC Symmetrix®, and third-party storage systems. See Table 6 for the SAN Copy features available on the CX4 storage systems.

Table 6. SAN Copy devices supported on CX4 series storage systems

Feature	CX4-120	CX4-240	CX4-480	CX4-960
Simultaneous SAN Copy sessions per storage system	8	8	16	16
SAN Copy destinations per storage system	50	50	100	100

PowerPath

PowerPath® is host-resident software that works with Dell/EMC storage systems to deliver intelligent I/O path management. Using PowerPath, administrators can improve the server's ability to manage heavy storage loads through continuous and intelligent I/O balancing; PowerPath automatically configures multiple paths and dynamically tunes for performance as the workload changes. PowerPath also adds to the high-availability capabilities of the Dell/EMC storage systems by automatically detecting and recovering from server-to-storage path failures.

Online Upgrade

Online Upgrade provides a transparent upgrade mechanism for the CX4 product line. This feature, when coupled with PowerPath failover software, allows you to upgrade storage system software, including the core software, without disrupting host access to data. During the online upgrade process, one SP is upgraded and rebooted, while PowerPath or other failover software redirects I/O through the alternate SP. Write cache remains enabled throughout this process to ensure full system performance.

CONCLUSION

The CX4 is the fourth generation of the CX series and continues Dell and EMC's commitment to helping customers maximize their investments in storage technology by helping to ensure that existing resources and capital assets are optimally utilized as customers adopt new technology. The CX4 series with UltraFlex technology is based on a new, breakthrough architecture and extensive technological innovation that delivers remarkable application performance, and new levels of scalability, reliability, flexibility, and affordability. It also introduces new levels of ease of use, making the CX4 easy to install, manage, and scale.

The Dell/EMC CX4 series with UltraFlex technology is a unique combination of a breakthrough architecture design and advanced software capabilities that helps meet the growing IT challenges of today's midsize and large enterprises—scaling system capacity and performance, simplifying management in complex environments, and delivering increasing levels of information availability and protection for critical applications and data.