

EMC ControlCenter 5.2 Storage Architecture Terminology

Abstract

This white paper explains the terminology ControlCenter 5.2 uses to describe the logical and physical environment. Terms such as logical device, volume, physical disk, and volume group are described, as well as the platform-specific equivalent terms used by vendors (including EMC). This material applies to all hosts and storage arrays displayed within ControlCenter and StorageScope, and includes both the traditional EMC product line, as well as the CLARiiON CX series and Symmetrix DMX series.

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Introduction

Note: Many EMC software products (for example, ControlCenter and StorageScope) display information about multiple array types. We try to use each vendor's proprietary terminology whenever practical, so as to provide information to the user in a familiar context. However, when storage management applications merge data from a heterogeneous group of arrays or hosts, we must use terms common to the broader environment. This document attempts to describe both the proprietary and the common terms.

Describing the components of a complex, heterogeneous storage environment is a daunting task. Every vendor has their own architecture and their own terminology. In addition there are many common terms used in the industry, often inconsistently and with varying definitions. Because EMC ControlCenter™ has become a focal point for the monitoring and management of a wide range of storage arrays, the burden is on EMC to address this terminology issue and present information in a vendor-neutral manner.

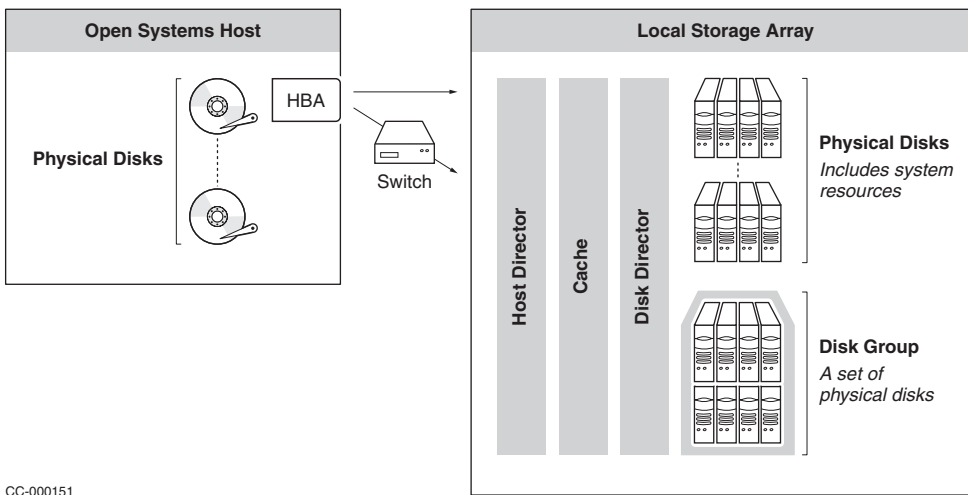
This document consists of the following sections:

- *Physical Architecture*
- *Logical Components*
- *Organization of Logical Components*
- *Replication and Protection*

There are many vendor-specific physical and logical architectures for both hosts and storage arrays. It is not the attempt of this document to explain the particulars of each of these. Rather, we hope to explain storage architecture at a high enough level to avoid discussions of particular implementations. This document describes what all of these architectures have in common. In some cases, this document explains how this kind of terminology is used within ControlCenter.

Physical Architecture

Figure 1 provides a high-level view of a storage environment physical architecture.



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Figure 1. Open Systems Hosts and Storage: Physical Architecture

For the purposes of this discussion, the host has two components: internal physical disks, and a host bus adapter to communicate with external storage.

The storage array will always have physical disks, and some means to control those disks. *Disk director* is the most descriptive and the least proprietary term. Although *cache* is not a required component for the architecture of storage arrays, all vendors have used cache in one form or another to temporarily maintain data. The *host director* is the component that manages host-facing I/O, as well as provides the logical mapping to ports that makes storage available.

Table 1. Physical Terminology

Term	Description
Array cabinet	The physical cabinet used to house the storage array. Some vendors use multiple cabinets, with physical disk expansion.
Array cache	RAM used to store data until it can be destaged to the physical disks or accessed by hosts.
Disk cabinet	A cabinet containing disks. This can be the main cabinet for the storage array, or an additional cabinet.
Disk director	A physical circuit board used to control communication with physical disks in the array. Some arrays, such as the HP StorageWorks EVA, use controllers that perform the actions of both host directors and disk directors.
Disk group	A set of physical disks.
HBA	Host Bus Adapter - A physical board and associated driver installed in a host to support communication with a storage array or switch. Common protocols include Fibre Channel and iSCSI.
Host director	A physical circuit board with drivers, that emulates the expected behavior of a physical disk for a host. Some arrays, such as the HP StorageWorks EVA, use controllers that perform the actions of both host directors and disk directors.
Internal disk	A physical disk internally accessible to the host.

Table 1. Physical Terminology (continued)

Term	Description
Physical disk	A disk drive that plugs into an enclosure slot and communicates with disk controllers. A single physical disk can contain multiple logical devices, or may be one disk of many in the creation of a larger logical device.
Slot	Opening for a physical disk, board, or card. This term should usually be used with a modifier, such as <i>disk slot</i> .
Storage array	A collection of physical disks, with associated directors, cache, and host-facing hardware. Commonly offered in a single cabinet, but not restricted to that format.

Table 2 summarizes the common physical terms and their array-specific usage.

Table 2. Vendor-Specific Physical Terminology

Generic Physical Term	Symmetrix®	CLARiiON®	HP StorageWorks EMA ^a and EVA ^b	Hitachi, Sun, and HP XP	IBM ESS
Array cabinet	Array cabinet and disk cabinet are the same for a Symmetrix array.	DPE (Disk-array Processor Enclosure) - The array contains only one DPE. DPE has 10 disks. DPE2 has 15 disks. DAE2 has 15 disks. SPE (Storage Processor Enclosure) - For larger models; contains no disks.	Controller enclosure	DKC (Disk Controller Unit) - Contains the controller that controls the disks in the DKUs.	Expansion enclosure
Array cache	Cache	Cache (Storage Processor (SP))	Cache (Controller)	Cache	Cache
Disk cabinet	Array cabinet and disk cabinet are the same for a Symmetrix array.	DAE (Disk Array Enclosure) DAE2 - DAE with back-end 2 Gb loop.	Disk enclosure	DKU (Disk Array Unit) - A cabinet full of disks. The array contains zero or more DKUs (the HP XP 128 does not contain any DKUs, only a DKC).	Cage
Disk director	Back-end director	LCC (Link Control Card) - Controls the SP's access to the disks. There are two LCCs, supporting the dual porting of all disks.	Controller The EVA Controller board performs the role of disk director and host director.	Array Control Processors (ACPs) - The back-end processors which transfer data between the disk drives and cache.	Device Adapter (DA)

Table 2. Vendor-Specific Physical Terminology (continued)

Generic Physical Term	Symmetrix®	CLARiiON®	HP StorageWorks EMA^a and EVA^b	Hitachi, Sun, and HP XP	IBM ESS
Disk group	Used by Optimizer.	RAID Group - Group of physical disks. Used as the basis for the creation of LUNs that share a common RAID type.	A group of physical disks on an EVA array. On an EMA array, a disk group is a storage set (RAID group).	Parity group - A set of hard disk drives that have the same capacity and are treated as one group. A parity group contains both user data and parity information, which allows the user data to be accessed in the event that one or more of the drives within the group are not available. Parity group is also called <i>Array Group</i> or <i>RAID group</i> . HDU (Hard Disk Unit) - A collection of physical disks in a canister.	Disk group - Groups of physical disks that make up RAID ranks.
Disk pool	Although currently used by Symmetrix Optimizer, this term does not have a significant place in ControlCenter.				
Host director	Front-end director	Storage Processor (SP) - Contains the ports to which hosts connect to the array.	Array Controller - Contains the ports to which hosts connect to the array.	CHIP - Client Host Interface Processor ports provide host connections.	IBM RISC processors - Contains the ports to which hosts connect to the array.
Internal Disk	Commonly used when describing physical disks within a host.				
Physical disk	Physical disk	Physical disk	Physical disk or physical device	HDD (Hard Disk Drive) - The disk mechanism number has three parts: DKU # (R1, R2, R3, L1, L2, L3), HDU # (0, 1, 2, 3, 4, 5, 6, 7), HDD slot number (0, 1 ... B).	HDD (Hard Disk Drive) DDM (Disk Drive Module)
Storage array	Storage array	Storage array	Storage subsystem	Disk array or subsystem	Storage server

a.EMA - HP StorageWorks Enterprise Modular Arrays with HSG80 controllers

b.EVA - HP StorageWorks Enterprise Virtual Arrays

Logical Components

The description of the storage environment logical architecture is as fraught with confusion and entrenched positions, as the physical view was simplistic and all-encompassing. Over time, virtually all reasonable terms have been pressed into service by every vendor even remotely associated with the field, with the end result being that every voice seems to have a persuasive argument for, and shining example of, the various terms they have decided to use.

While the physical architecture is consistently tied to common denominators such as physical disks and cache, the logical constructions are as flexible and varied as software can produce. Figure 2 shows the basic logical components of the physical architecture.

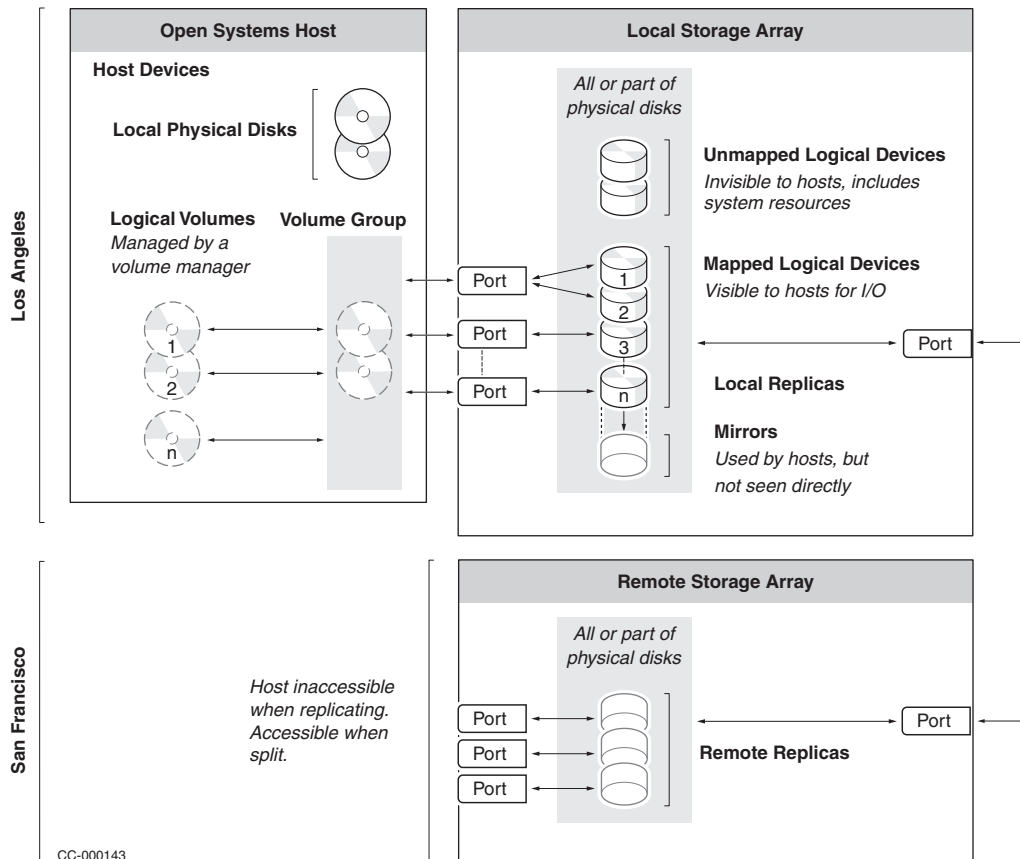


Figure 2. Open Systems Logical Components

The host side has three types of storage volumes:

- *Local volumes* are all or part of internal physical drives. For the most part, this is not significant to us, although they are listed under the ControlCenter Host Devices folder.
- *Logical volumes* are host-based constructs that are associated with logical devices in the storage array or with storage in the internal physical drives. They are created and managed by native or third-party logical volume managers.

- *Host Devices* are devices seen by the host as a path for I/O. This includes all visible physical disks in the host, as well as all logical devices (presented as physical disks) in the storage array that are available to the host. Figure 3 shows the icons used for host devices in the ControlCenter Console.

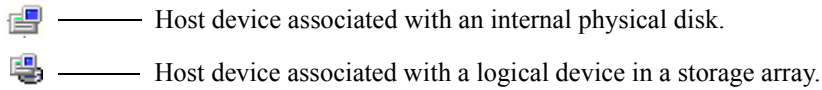


Figure 3. Host Device Icons in the ControlCenter Console

On the array side, host ports present logical devices to hosts.

Table 3 summarizes the terms used for these basic logical components.

Table 3. Logical Component Terminology

Term	Description
Array host port	A combination of logical and physical elements in the storage array used to connect a host with the logical devices that have been mapped to this port.
Host devices	Devices seen by the host as a path for I/O. This includes all visible physical disks in the host, as well as all logical devices (presented as physical disks) in the storage array that are available to the host. Note: ControlCenter displays every host device name for a Windows host starting with "PHYSICALDRIVE".
Local volume	A volume that physically resides on the host, and has no relationship to the storage array. Also known as an <i>internal disk</i> .
Logical device	A logical storage element, configured on the storage array. When mapped to an array host port, logical devices are also referred to as Logical Units, LUs, or LUNs.
Logical volume	A host-based construct that is associated with logical devices in the storage array or with storage in the internal physical drives. They are created and managed by native or third-party logical volume managers.
Logical Volume Manager (LVM)	A native or third-party tool that allows the user to establish and control logical volume storage, usually residing in a storage array.
Logical Unit (LU)	A separately identifiable peripheral managed by a SCSI Device, which is typically accessed by a host port or storage group. Each Logical Unit is addressed by a Logical Unit Number (LUN) that is assigned relative to a SCSI Device.
Logical Unit Number (LUN)	A unique number relative to an array host director port or storage group. The LUN is used to differentiate between peripheral devices (each of which is a Logical Unit) that are accessed through a particular array host director port. Commonly used instead of LU.
Volume	For all vendors this is an identifiable unit of data storage that is logical, but may have a one-to-one mapping to the physical. Frequently used to describe objects on both the host and storage array side. Avoid using this term without a modifier; instead use <i>volume group</i> or <i>logical volume</i> .

Table 4. Vendor-Specific Logical Component Terminology

Generic Logical Component Term	Symmetrix	CLARiiON	HP StorageWorks EMA^a and EVA^b	Hitachi, Sun, and HP XP	IBM ESS
Array host director port	Front-end port	Port	Host port	Port	Port
Logical device	Logical device	Private LUN (not part of a Storage Group) LUN (part of a Storage Group)	Unit (EMA) VirtualDisk (EVA)	Logical Device (LDEV)	Logical device Custom volume

a.EMA - HP StorageWorks Enterprise Modular Arrays with HSG80 controllers

b.EVA - HP StorageWorks Enterprise Virtual Arrays

Organization of Logical Components

Of all the approaches for viewing networked storage, the organization of lower-level components is perhaps the most contentious. Logical components can be organized in limitless ways, and most vendors have developed constructs and terminology that are unique. Still, there are certain common functions that must be addressed to satisfy the basic functionality required by most customers. Not everyone offers a Virtual Snapshot Logical Hyper Drive, but all storage vendors must provide grouping in order to operate on multiple volumes.

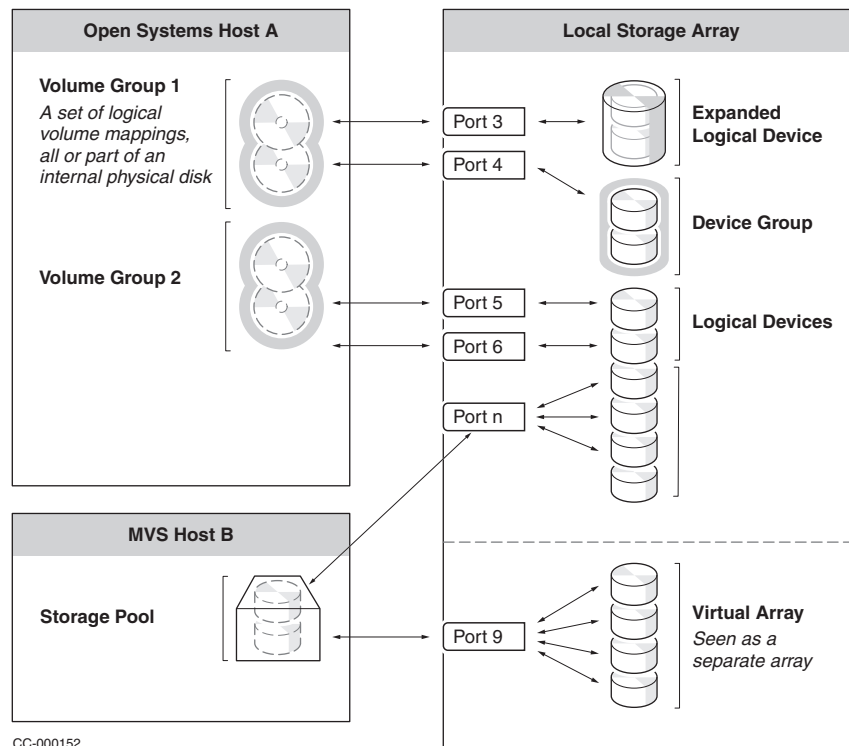


Figure 4. Organization of Logical Components

The host side has the following groupings:

- *Volume groups* are sets of logical volume mappings to local physical disks or storage arrays. They are created and managed by native or third-party logical volume managers. They usually contain logical volumes, but that is not required.
- *Storage pools* are sets of available logical devices that can provide additional storage for a host. Allocated storage can also be added to, or remain in, storage pools for reporting purposes.

On the array side, host facing ports present logical devices to hosts.

- *Expanded logical devices* are collections of logical devices presented to the host as a single logical device.
- *Virtual array* is a set of logical devices presented to the host as a separate array.

Table 5 summarizes the terms used for the organization of the logical components.

Table 5. Organizational Terminology

Term	Description
Expanded logical device	A collection of logical devices that are presented to the host as a single logical device.
Device group	A host-based or array-based set of logical devices. Within ControlCenter, this term refers only to host-based sets of Symmetrix logical devices used by TimeFinder [®] and SRDF [®] .
Device type	Descriptor for the type of logical device. Examples include BCV, RDF2, Unprotected, ConCatSet, and STD.
Virtual array	A LUN masking that presents a subset of LUNs as an entire, separate storage array. When configured in CLARiiON arrays, it is called a Storage Group.
Storage pool	ControlCenter: A ControlCenter-based, user-defined collection of storage elements such as a logical volumes. It allows the user to use storage from the pool and manage application ownership or type, such as storage performance or storage cost. Allocated storage can be added to storage pools for reporting purposes. The term <i>storage pool</i> is used by MVS, Replication Manager, TSM, and CLARiiON, although the implementation and definition details vary between environments.
Logical volume	An identifiable unit of data storage that is logical, but may have a one-to-one mapping to the physical. A physical disk can be divided into several separately identifiable logical volumes, or multiple physical disks can represent a single logical volume.
Volume group	A host-based set of storage allocations from the array or local physical disks. Volume groups contain logical volumes. They are created and managed by native or third-party logical volume managers. On Windows, ControlCenter creates a default volume group named <i>rootdg</i> , which contains all volumes that are not in volume groups managed by a volume manager.

The following table summarizes the generic terms, as well as the vendor-specific terms they are meant to include. Not all table cells have an entry, since a vendor may not have a feature in a particular area, or may have a proprietary feature for which EMC has decided not to create a generic term.

Table 6. Vendor-Specific Organizational Terminology

Generic Organizational Term	Symmetrix	CLARiiON	HP StorageWorks EMA ^a and EVA ^b	Hitachi, Sun, and HP XP	IBM ESS
Control devices	Gatekeeper VCMDB		Command Console LUN	Command Device	
Device group	SYMAPI device group	Storage Group	StorageSet (EMA)	CU (Control Unit) - A logical grouping of LDEVs containing up to 256 LDEVs. Comparable to a SYMAPI Device Group. VDEV (Virtual Device) - A subdivision of parity group and is a logical container of LDEVs on HP XP arrays. One parity group contains one or more VDEVs and one VDEV contains one or more LDEVs. A VDEV in a parity group contains LDEVs of the same capacity and RAID level.	
Disk group	Disk group (<i>used by Optimizer</i>)	RAID group	Disk group (EVA) (<i>Contains one or more parity groups</i>)	RAID group	Disk group
Device type (<i>examples</i>)	STD, BCV, DRV	LUN, Snapshot	Active (when masked), Snapshot	BC, CA, LDEV, LUSE	PPRC, XRC
Expanded logical device	Concatenated meta device Striped meta device	MetaLUN	ConCatSet - Two StorageSets of the same RAID type can be concatenated together to form a ConCatSet. StorageSet Expansion	Logical Unit Size Expansion (LUSE) represents an expanded volume and consists of more than one LDEV. LUSE is used to create virtual logical units that are larger than standard OPEN-x logical units.	
Storage pool	Although this term is used by other vendors, and is normally defined as representing a collection of storage capacity available for use, EMC defines it in terms of ControlCenter, where it is used by the Storage Provisioning Services.				

Table 6. Vendor-Specific Organizational Terminology (continued)

Generic Organizational Term	Symmetrix	CLARiiON	HP StorageWorks EMA^a and EVA^b	Hitachi, Sun, and HP XP	IBM ESS
Virtual array		A LUN masking that presents a subset of LUNs as a separate storage array.	A LUN masking that presents a subset of LUNs as a separate storage array.	A LUN masking that presents a subset of LUNs as a separate storage array.	
Volume group	Not applicable to storage arrays.				

a.EMA - HP StorageWorks Enterprise Modular Arrays with HSG80 controllers

b.EVA - HP StorageWorks Enterprise Virtual Arrays

Note: ControlCenter supports the backup products VERITAS NetBackup and LEGATO NetWorker, which use volume pools and storage pools respectively. These terms are used in some of the ControlCenter dialog boxes, and in the online help system, but only in the context of supporting these third-party applications.

Replication and Protection

There is yet another set of terms that must be covered when discussing storage arrays: replication terminology. What started out years ago as simple tape backup and perhaps mirroring of a disk, has evolved into a complex landscape of data protection and replication configurations. Some, like RAID, have their basis in industry recognized standards, while others like SRDF, are proprietary solutions.

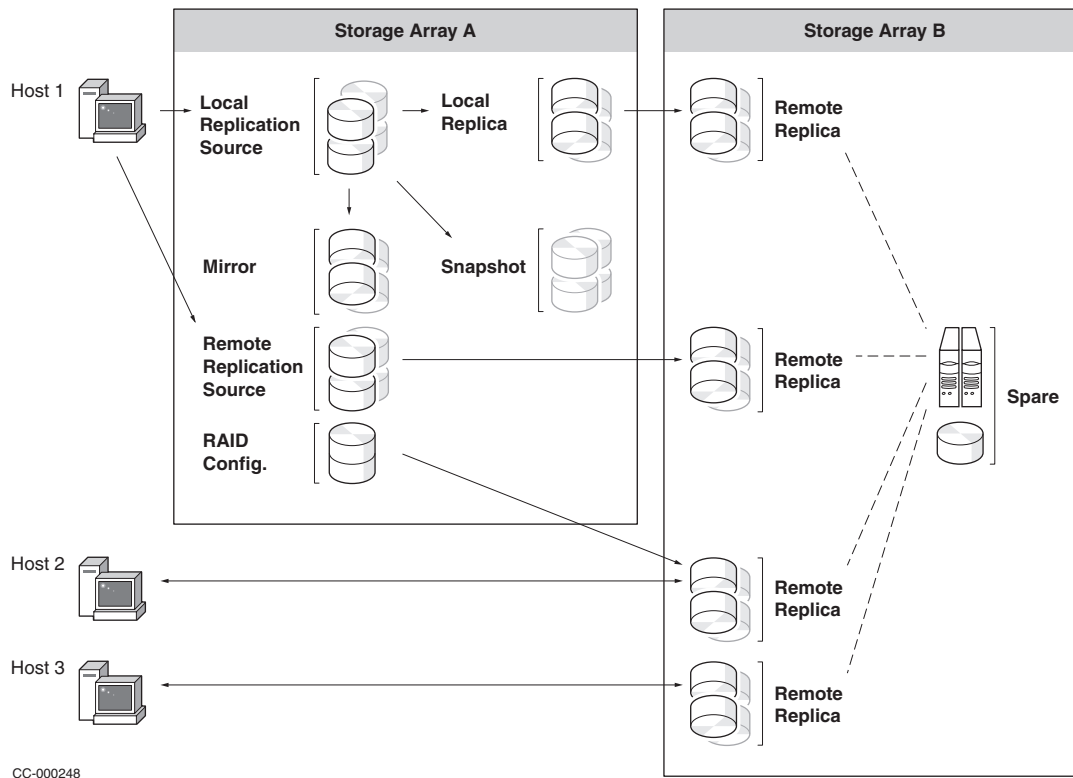


Figure 5. Replication and Protection Components

On the host side, there are no significant changes, since the burden of replication is on the storage array.

The array side has a variety of logical devices, each providing a different type of replication or data protection.

Note: Local replicas can have their own remote replicas, as well as remote replicas having a local replica in the remote array.

Table 7. Replication and Protection Terminology

Term	Description
Local replica	A secondary logical device, in the same array, of the same size as the primary device. It matches all the write operations, but can be separated from the primary device to allow backup and report generation while I/O continues on the primary.
Local replication source	A normal logical device seen by the host, but is also the data source for a local replica.
Mirror	An exact copy of a logical device or physical disk that mirrors the write operations. Used to ensure data availability in case of physical disk failure.
RAID	There are a variety of RAID configurations, both industry-standard and proprietary. The distinctions are not important here, except for RAID-0, which offers no protection.
Remote replica	A secondary logical device, in a remote array, of the same size as the primary device. It matches all the write operations, but can be separated from the primary device to allow backup and report generation while I/O continues on the primary. Critical component in any disaster recover strategy.
Remote replication source	A normal logical device seen by the host, but is also the data source for a remote replica.
Spare	A physical disk or logical device that is available to replace a failed physical disk.
Snapshot	A point-in-time image of the contents of a logical device. It can be the complete contents, or just the changed data from the last snapshot. The operation is the same as a local replica.

Table 8 summarizes the generic terms, as well as the vendor-specific terms they are meant to include. Not all table cells have entries, since a vendor may not have a feature in a particular area, or may have a proprietary feature for which we have decided not to create a generic term.

Table 8. Heterogeneous Device Terminology

Device Category Generic Name	Symmetrix	CLARiiON	HP StorageWorks EMA^a and EVA^b	Hitachi, Sun, and HP XP	IBM ESS
Primary Logical Device					
Primary	Standard	Source LU	Source Unit	BC P-Vol (Primary volume)	(no term)
Unprotected	Unprotected	Individual Disk	Individual Disk (JBOD)	Individual Disk	JBOD
Striped Unprotected	Striped meta (no protection)	RAID 0	RAID Level 0 (stripeset)	N/A	N/A
Mirrored	2-way mirror 3-way mirror 4-way mirror	RAID 1	Mirrorset - Another name for RAID 1. Also called mirrored units or mirrored virtual disks. (EMA) VRAID1 (EVA)	RAID-1+ (HDS) RAID 0/1 (HP)	N/A
Striped mirrored	Striped meta (based on 2-way mirror)	RAID 1/0	RAID Level 0+1 (striped mirrorset)	RAID-1+ (HDS) RAID 0/1 (HP)	N/A
Parity protected	RAID-S RAID-R Parity RAID 3+1 (DMX) Parity RAID 7+1 (DMX) RAID-5 (DMX)	RAID 3 RAID 5	RAID Level 3/5 RAIDset (EMA) VRAID5 (EVA)	RAID-5	RAID
Expanded	Meta	metaLUN (concatenated expansion)	ConcatSet StorageSet Expansion	Expanded LUN LUSE	
Striped Expanded	Striped Meta	metaLUN (striped expansion)			
Replication Device					
Local Replication Source	Standard	Source LU	(no term)	BC P-Vol	(no term)
Local Replica	BCV Clone	Clone LU Swap	Snapshot Unit (EMA) Clone (EVA)	BC S-Vol (Secondary volume)	Dual Copy
Snapshot	TimeFinder Clone (Used to create multiple point-in-time images) VDEV (stores pointers) SAVE (stores VDEV data)	Snapshot Copy LUN (SCLUN). SCLUN is a reference to a frozen-in-time virtual copy (in memory) of a SSLUN. SnapShot Source LUN (SSLUN)	Snapshot unit	BC S-Vol BC P/S-Vol	FlashCopy

Table 8. Heterogeneous Device Terminology (continued)

Device Category Generic Name	Symmetrix	CLARiiON	HP StorageWorks EMA^a and EVA^b	Hitachi, Sun, and HP XP	IBM ESS
Remote Replication Source	SRDF R1	Primary LU Primary Image	Remote Copy Initiator unit	CA P-Vol (Continuous Access Primary volume)	PPRC source
Remote replica	SRDF R2	Secondary LU/ Secondary Image Remote Mirror - One primary image LUN on one array and one secondary image LUN on another array for MirrorView.	Remote Copy Target Unit	CA S-Vol (Continuous Access Secondary volume)	Extended Remote Copy (XRC) target Peer-to-Peer Remote Copy (PPRC) target
System Resources					
Spare	Dynamic Spare	Hot Spare	Spare (single spare) Spareset (set of spares)	Dynamic Spare ^c	Spare
Array Command & Control Devices	Gatekeeper VCMDB Symmetrix File System (SFS) Celerra Control Station volumes SAVE device	Hot spare PSM SnapView cache SnapClone Private MirrorView WIL (Write Intent Log)	Commandconsole LUN	Command Device	
Swap devices	DRV (used by Optimizer)				Workload migration device

- a. EMA - HP StorageWorks Enterprise Modular Arrays with HSG80 controllers
- b. EVA - HP StorageWorks Enterprise Virtual Arrays
- c. ControlCenter does not store or display data about Hitachi spares in each cannister set.

