
EMC ControlCenter 5.2 Storage Allocation Terminology

Abstract

This white paper describes the terminology ControlCenter 5.2 uses to describe storage capacity. Terms such as allocated, free space, available, and database capacity are described, as well as how they apply to components within the host and storage array. 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 used by EMC software.

Configuring storage and making it available to users is a complex multistep process. Storage vendors use different terms to describe the state of the storage at the various stages in the process.

The purpose of this document is to provide consistent vendor-neutral terms for the storage configuration, allocation, and management operations. A parallel document, *Storage Architecture Terminology*, describes the physical and logical components of storage networks and addresses the terms used by other storage vendors.

Figure 1 outlines the storage allocation tasks and associated capacity states defined in this document.

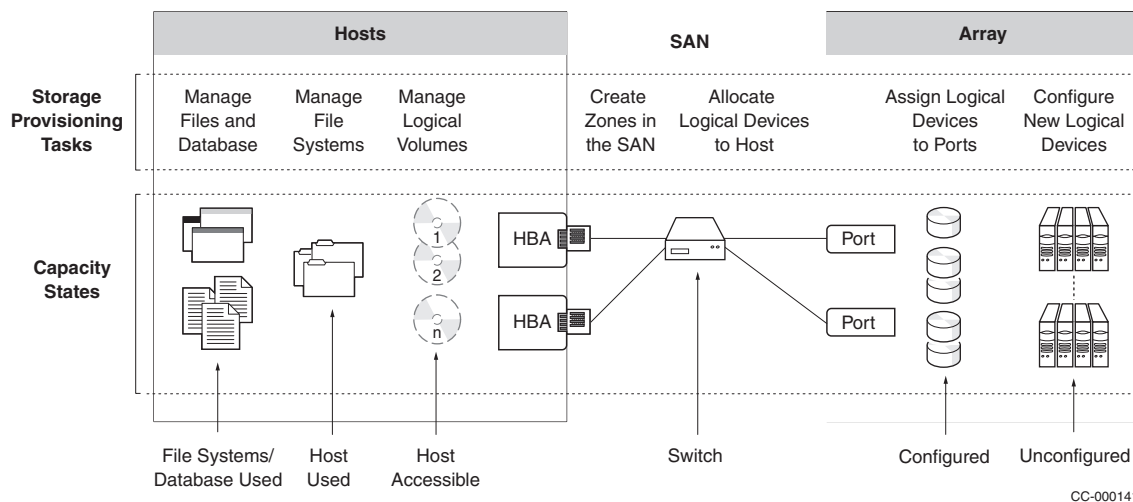


Figure 1. Storage Allocation Terms and Tasks

A few basic terms are commonly used in this document. If you understand what they mean, you are most of the way towards understanding the allocation architecture and process.

Storage States

- **Raw** – The rated capacity of the storage device or array. Commonly used as a synonym for unconfigured. This term also has a secondary definition: The capacity used for I/O, plus any associated protection (mirrors, parity devices).
- **Configured and unconfigured** – The amount of storage capacity configured into a format that can be used by an operating system or internally by the array.
- **Mapped and unmapped** – Logical devices are mapped to the host-facing ports on the storage array. Until they are mapped, logical devices cannot be accessed by hosts. Some arrays, for example, CLARiiON® arrays, use LUN masking to accomplish the same thing.
- **Array-allocated and unallocated** – The amount of configured storage viewed by the array as set aside for use by hosts or the array itself. Some of this storage may not have been used yet by a host, may be invisible to a host because of zoning or use as a replica, or may be used by the array for internal purposes.

- *Host-allocated* – The amount of configured storage available for use by a host. This includes primary storage for I/O, replicas, and mirrors.
- *Accessible and inaccessible* – The amount of storage that can be directly used for I/O by the host. Replica capacity is often not directly usable.

Note: Replicas are considered array-allocated only if the source they are associated with is also allocated. For example, the R2 device of a Symmetrix R1/R2 pair would not be considered allocated if the R1 device was not yet allocated.

Storage Capacity Relationships

Note: Shared devices and multiple hosts (clusters) can result in some storage being counted twice. Consider your configurations when determining capacity. The following definitions and formulas presume a single host.

Three interrelated terms are frequently used when defining how storage capacity is used:

- *Accessible capacity* – The total amount of storage that can be directly used for I/O by the host.
- *Free space capacity* – The amount of storage available, but not yet used, for file systems and databases.
- *Used space capacity* – The amount of storage consumed by file systems and databases.

These terms can be applied to volume groups, physical disks, logical volumes, and hosts. Three formulas can be derived:

- $Accessible = Used + Free$
- $Free = Accessible - Used$
- $Used = Accessible - Free$

EMC ControlCenter Storage Capacity Tools

EMC ControlCenter™ provides a variety of methods for determining , displaying and managing the types of storage capacity discussed in this document:

- *StorageScope* – Helps you assess your current storage environment and determine future storage requirements.
- *EMC ControlCenter Web Console* – Provides a lightweight, web-based, remote access to the ControlCenter Server and storage capacity data.
- *Free Space view* – Displays free space and allocated space for storage arrays related to a selected host or host cluster with options to get detailed information for HBAs, ports, devices, and pools.
- *Properties view* – Provides a detailed description of physical disks, logical devices, logical volumes, and other objects within the Console interface.
- *Storage Provisioning Service* – Allows you to allocate storage from Symmetrix®, CLARiiON, and HP StorageWorks arrays to hosts, file systems, volume groups, and logical volumes.

In addition, SAN Manager™ can be used for masking and zoning operations. Relationship view and Topology view can be used to explore and confirm network connections and zoning configurations.

Physical and Logical Views

This document explains storage capacity in terms of both the physical and logical views.

Figure 2 provides a high-level view of the physical architecture.

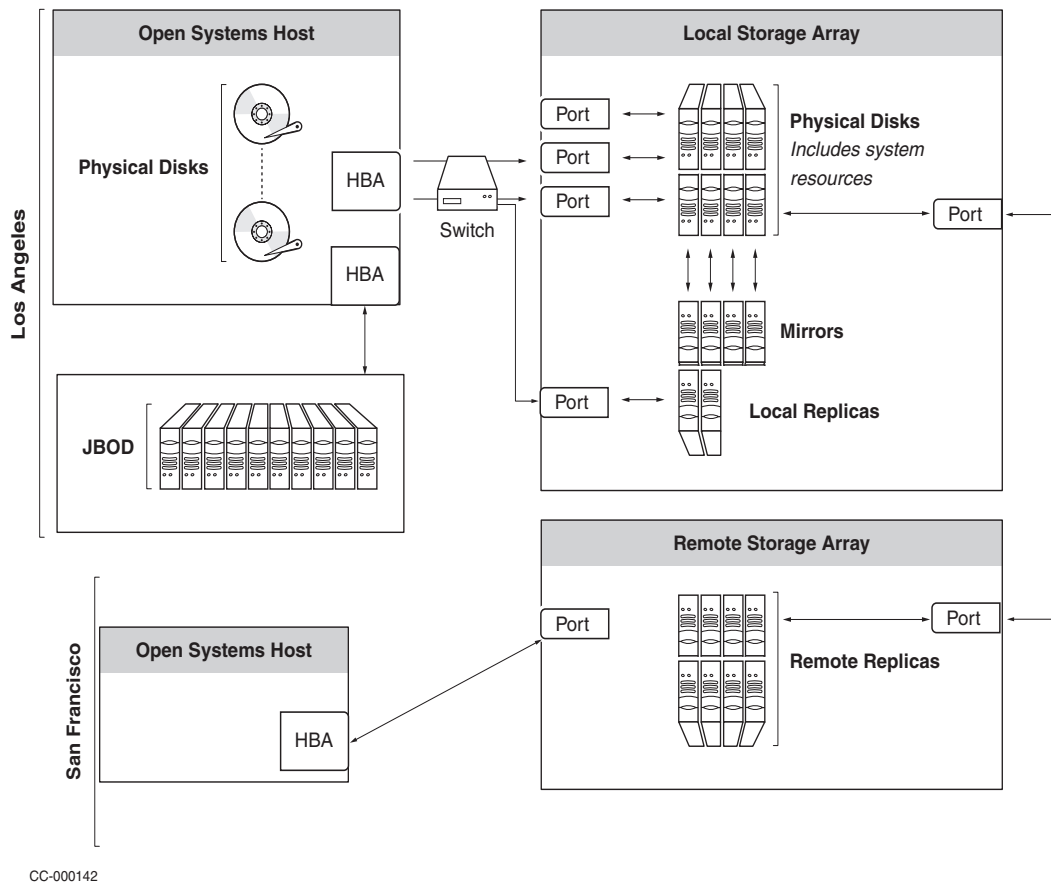


Figure 2. Open Systems Hosts and Storage: Physical Architecture

For storage purposes, the host has two physical components: internal physical disks and JBOD (Just a Bunch of Disks). JBOD capacity is treated as host internal capacity in ControlCenter.

The storage array will always have physical disks, and some means to control those disks. We have chosen to use *host director port* to indicate the network connection point in an array.

Figure 3 provides a high-level view of the logical architecture.

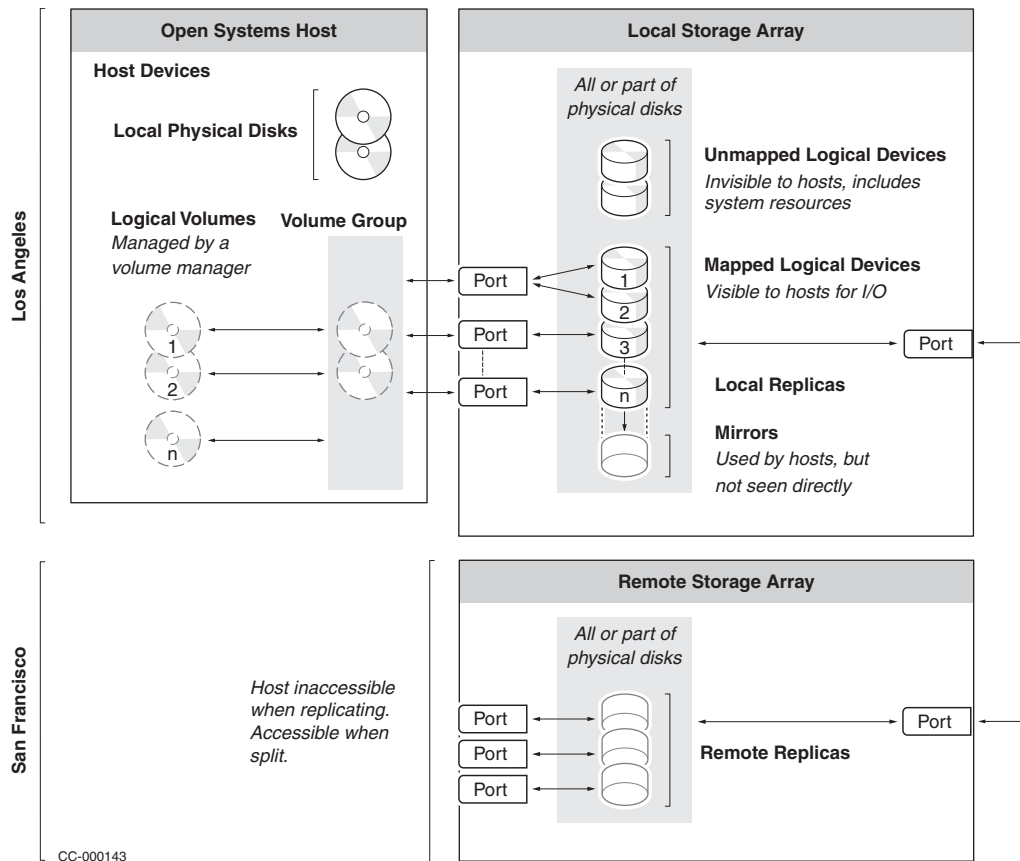


Figure 3. Open Systems Logical Components

The host side has two types of storage volumes:

- *Local physical disks* are all or part of internal physical drives. JBOD capacity is treated as host internal capacity in ControlCenter. For the most part, these two values are not significant to us, although they are listed under the Host Devices folder in ControlCenter.
- *Logical volumes* represent capacity created and managed by native or third-party logical volume managers.

The array side, we have the following logical objects:

- *Ports* are composed of both logical and physical characteristics, so they are also included in the logical view of storage arrays.
- *Logical devices* are logical storage elements configured on the storage array. Once they have been mapped to an array host director port, they are often referred to as LUNs.
- *Mirrors and local replicas* are copies of local logical devices.
- *Remote replicas* are copies of logical devices, but are maintained in remote storage arrays.
- *System resources* are used internally by the array. They can be logical or physical, and may be visible to hosts.

Note: A LUN is a unique number relative to an array host director port. 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. LUNs are included in logical devices. Commonly used instead of LU.

Array Terminology

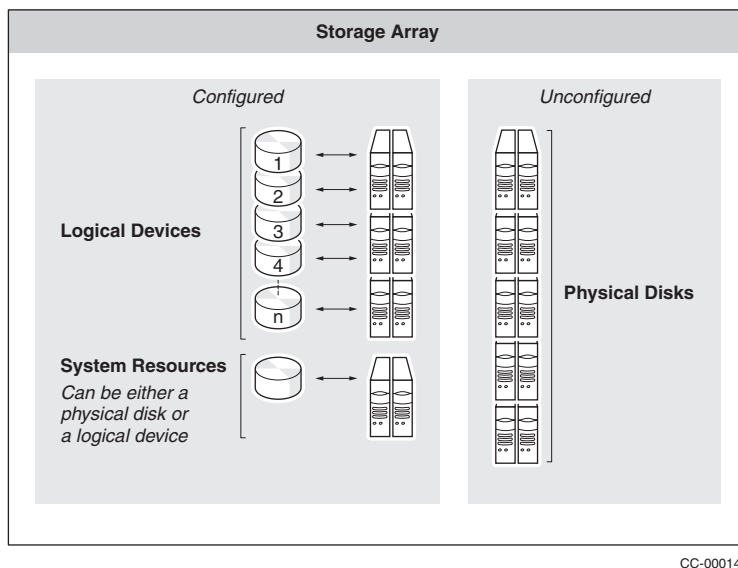
This section describes the terminology used to describe storage capacity from the array perspective.

Configured and Unconfigured Capacity

Configured capacity is the amount of storage capacity that has a defined protection level. This capacity may have been made into logical devices or set aside for system resources.

Unconfigured capacity is the amount of storage not yet configured on the physical disk.

Figure 4 shows a high-level diagram of how these elements can be viewed within a storage array.



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Figure 4. Array Configured and Unconfigured Capacity

Configured capacity is displayed in two forms: raw and primary.

Configured (Raw)

The amount of storage capacity made into logical devices or formatted into groups having a defined protection level (for example RAID groups, or mirroring). The critical characteristic here is that the capacity used for protection levels is included in the overall number. Table 1 summarizes how ControlCenter views configured (raw) capacity for each array type.

Table 1. Array-specific Treatment of Configured (Raw) Capacity

Array Type	Capacity Definition
Symmetrix	Capacity of configured logical devices in the array, including protection capacity.
CLARiiON	Capacity of RAID groups which are bound to at least one LUN.
HDS/HP XP	Total capacity of parity groups. Within an HDS array, configured capacity is measured by the number of LDEVs (logical devices) created. You should note that HDS configuration process is actually two stages, with the first stage used to create RAID configurations out of most or all raw capacity, and the second stage used to create the host-visible logical devices.

Table 1. Array-specific Treatment of Configured (Raw) Capacity (continued)

Array Type	Capacity Definition
IBM ESS	Capacity of the configured disk groups.
StorageWorks (EMA)	Capacity of the StorageSets.

Note: StorageScope includes Symmetrix TimeFinder Clone devices as primary capacity.

Configured (Usable)

The amount of storage capacity of user-visible standard devices that can be used for I/O, but excluding any protection levels. Table 2 summarizes how ControlCenter views configured (usable) capacity for each array type.

Table 2. Array-specific Treatment of Configured (Usable) Capacity

Array Type	Capacity Definition
Symmetrix	Capacity of configured primary devices in the array. This value includes TimeFinder clones, but excludes mirrors, RAID parity, BCV, virtual devices (VDEVs), SRDF R2 and system resources.
CLARiiON	Capacity of RAID groups which are bound to at least one LUN.
HDS/HP XP	Capacity of parity groups. Within an HDS array, configured capacity is measured by the number of LDEVs (logical devices) created. Note that HDS configuration process is actually two stages, with the first stage used to create RAID configurations out of most or all raw capacity, and the second stage used to create the host-visible logical devices.
IBM ESS	Capacity of the configured disk groups.
StorageWorks (EMA)	Capacity of the StorageSets.

Unconfigured Capacity

The amount of storage capacity on disks with no defined protection level. Table 3 summarizes how ControlCenter views array unconfigured capacity for each array type.

Table 3. Array-specific Treatment of Unconfigured Capacity

Array Type	Capacity Definition
Symmetrix	Capacity of disks not configured into logical devices.
CLARiiON	Capacity of unbound disks (Disks not having a RAID group, and RAID groups without a bound LUN).
HDS/HP XP	Capacity of disks not part of a parity group. Will usually be zero for HDS/HP-XP arrays.
IBM ESS	Capacity of disks that are not part of the configured disk groups. This includes the capacity of unconfigured spare disks.
StorageWorks (EMA)	Capacity of storage set not having logical devices and disks having no logical device on partition. This includes capacity reserved for spares.

Note: Ideally, the display of *total capacity* is the sum of unconfigured and configured capacities. However, while unconfigured capacity is always expressed as the *raw* or *rated* capacity of the physical disks, some of that capacity is used in the configuration and array management process, so that when you sum up the component values, the displayed numbers seldom match the original total capacity.

Mapped and Unmapped Capacity

Mapped capacity is the capacity of logical devices that are mapped to an array port or virtual port. Hosts connected to an array connect to the host-facing ports and the LUNs mapped to the ports become available to the hosts. If multiple hosts are connected to the same port, administrators can use zoning or masking to control which LUNs the hosts can access, as shown in Figure 5.

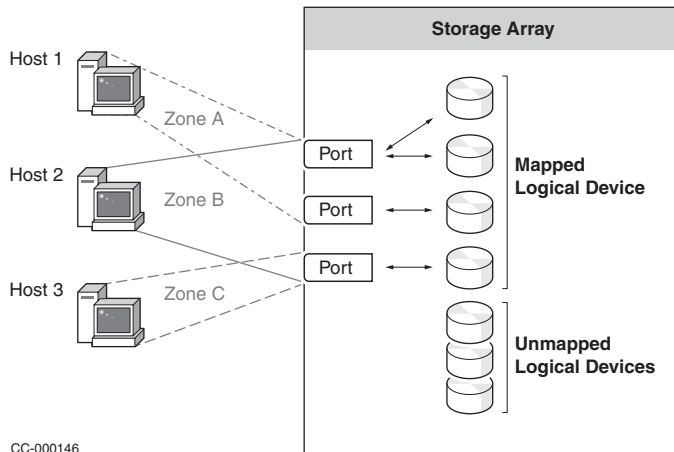


Figure 5. Multiple Hosts and Masking

Always Mapped

After logical devices (portions of a physical disk) are created, they can be defined for use as normal I/O devices. If this is their role, they will be mapped to one or more of the host director ports on the array, so that they will be available to hosts for data storage. The total storage capacity of these mapped devices contains storage that is in use and not in use by hosts. Table 4 summarizes how ControlCenter views mapped devices for each array type.

Table 4. Array-specific Treatment of Mapped Devices

Array Type	Definition of Mapped Device
CLARiiON	Access Logix enabled – the device is part of a Storage Group Access Logix disabled – all devices are considered mapped
All other arrays	Device is associated (mapped) to a host director port or virtual port.

Note: Accessible capacity, from the host perspective, is an important measurement, and is discussed later in the section *Host Accessible Capacity* on page 18.

Temporarily Mapped for Replica Traffic

To ensure data protection, storage arrays may have local replicas and remote replicas. Depending upon the architecture, these replicas can be separated from their primary devices and made available for I/O by various hosts. This assumes an existing mapping to a host director port, at which point they are viewed as ordinary primary devices. The total storage capacity of these temporarily separated devices is short-lived, and should not be considered general storage.

Note: If the replicas are separated from their primary devices when data polling occurs, the storage capacity of the replicas is treated as primary capacity in StorageScope reports.

System Resources (Mapped and Unmapped, but not Directly Used)

The storage array itself often requires either physical disks or logical devices for internal array management functions. This array-dedicated capacity (System Resources) can be mapped to host director ports (Gatekeepers), or unmapped (DRV devices). This category includes the examples shown in Table 5.

Table 5. Array-specific Treatment of System Resource Capacity

Array Type	Capacity Definition
Symmetrix	VCMDB devices, Dynamic spares, Gatekeepers, COVD devices, saved pool devices, RAD devices, SAVE devices, DRV devices (for Optimizer), and SFS (Symmetrix File System) devices. ControlCenter offers a way to keep track of the Symmetrix internally dedicated storage. The DRV, SAVE, and SFS devices can be found within ControlCenter in the Symmetrix System Devices folder. You can also use the filter in Visual Storage to restrict the display to DRV devices, Gatekeeper devices, and VCMDB devices. Another approach is to display the Properties view for all unmapped devices, and then sort by the Parameters or Configuration columns to identify the desired devices. You can then drag just those devices into another Properties view and get the total capacity.
CLARiiON	CPL (Clone Private LUN), PSM (Persistent Storage Manager) LUN, SnapView™ cache LUN, MirrorView™ WIL LUN, private LUNs that are not MetaLUN members, and hot spare LUN.
HDS/HP XP	Reserved and Command Devices.
IBM ESS	System resources are reported as unconfigured or not assigned capacity.
StorageWorks (EMA)	System resources are reported as unconfigured or not assigned capacity.

Unmapped

It is not unusual to create logical devices, but keep them in reserve by not mapping them to host director ports. Unlike some of the other measurements for storage, total unmapped capacity is of great interest to the typical storage administrator.

StorageWorks: Logical devices are mapped when the devices are created, so unmapped devices are not possible. When looking for the unmapped capacity of a StorageWorks EMA array, use the unallocated capacity.

Array Allocated and Unallocated Capacity

Array capacity can be hierarchically organized as shown in Figure 6.

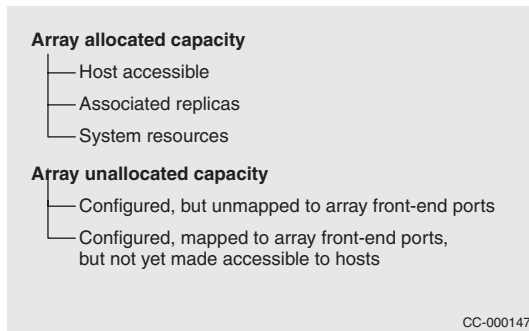


Figure 6. Hierarchy of Array Capacity

Array Allocated Capacity

Array allocated capacity is the amount of storage currently designated for use within a storage array.

Array allocated =

Primary logical devices mapped to host director ports, with access control and LUN masking +

Primary logical devices mapped to host director ports, which are accessible to hosts +

Local replicas associated with the primaries +

Remote replicas associated with primaries external to this array +

System resources (spares, temporary swap devices, array command devices)

Storage may have been allocated within the array, but that does not mean that hosts can see it or use it. Aside from system resources, array allocated storage is divided into two groups: primary mapped devices and associated replicas.

Table 6 summarizes how ControlCenter views array allocated capacity for each array type.

Table 6. Array-specific Treatment of Array Allocated Capacity

Array Type	Capacity Definition
Symmetrix	Primary LUN masked logical devices (includes non-established replica devices) mapped to front-end ports which are access controlled. Primary logical devices (includes non-established replica devices) mapped to front-end ports which are not access controlled. Local replicas (split or established) associated with the primaries. Remote replicas (split or established) associated with local replicas/primaries external to this array. Virtual Devices (VDEV) mapped to front-end ports, with access control and LUN masking. Virtual Devices (VDEV) mapped to front-end ports which are not access controlled. Devices included in SYMAPI device groups and consistency groups. Capacity of system resources.
CLARiiON	Access Logix enabled - LUNs bound to Storage Groups that also contain an HBA. Access Logix disabled - All configured LUNs. Capacity of system resources.

Table 6. Array-specific Treatment of Array Allocated Capacity

Array Type	Capacity Definition
HDS/HP XP	Capacity of devices mapped to ports which are not security enabled. Capacity of devices masked to security enabled ports. Capacity of system resources.
IBM ESS	Primary logical devices mapped to host director ports, with access control and LUN masking. Primary logical devices mapped to host director ports which are not access controlled.
StorageWorks (EMA)	Primary logical devices LUN masked to access controlled ports.

Primary Logical Devices with Access Control and LUN Masking

The first group contains mapped logical devices that have an entry in an access control database, and are LUN masked. For example, Symmetrix uses SAN Manager (Volume Logix) to manage LUN masking. When the ports are connected and zoned, the storage is seen by the host. Table 7 summarizes how ControlCenter views mapped devices for each array type.

Table 7. Array-specific Treatment of LUN Masking

Array Type	LUN Masking Definition
Symmetrix	Device is LUN masked to an HBA.
CLARiiON	Device is part of a CLARiiON Storage Group that also contains at least one HBA.
HDS/HP XP	- The device is LUN masked to an HBA or Host Group. - The LUN group that contains the device is LUN masked to an HBA, Host Group, or virtual port. - The device and the HBA are in a common Storage Domain.
IBM ESS	Device is LUN masked to an HBA.
StorageWorks (EMA)	Device is LUN masked to an HBA.

Note: Some logical devices may be masked or zoned so that a host cannot see them, and some may not be physically connected, but that does not influence the fact that they are considered allocated from the array perspective.

Primary Logical Devices with Direct Connection

Direct-connect devices use one of the common protocols, such as ESCON, SCSI, or Fibre Channel to communicate directly with the host.

Local Replicas Associated with the Primaries

Local replica devices can be BC (business continuance) devices. BC devices require certain states to be directly accessible to a host but are always associated with a host accessible device. Table 8 summarizes how ControlCenter views local replica capacity for each array type.

Table 8. Array-specific Treatment of Local Replica Capacity

Array Type	Capacity Definition
Symmetrix	Local replicas (split or established) associated with the allocated primaries (StorageScope reports all local replicas used by a multihop configuration as part of the local replica capacity). Virtual Devices(VDEV) mapped to front-end ports, with access control and LUN masked. Virtual Devices(VDEV) mapped to front-end ports which are not access controlled.
All other arrays	Not reported.

Remote Replicas Associated with External Primaries

Remote replica devices are associated with an array allocated source device in another array. They also require certain states to be directly accessible to a host (although they can be different hosts). Table 9 summarizes how ControlCenter views remote replica capacity for each array type.

Table 9. Array-specific Treatment of Remote Replica Capacity

Array Type	Capacity Definition
Symmetrix	Remote replicas (split or established) associated with allocated local replicas/primaries external to this array.
All other arrays	Not reported.

Storage Provisioning Service and Possibly Allocated Capacity

When the Storage Provisioning Service is determining what logical devices are available for allocation, it uses a very conservative algorithm to ensure that any ambiguities in the state of device allocation result in that device not being used. This can be an issue when the Symmetrix Device Masking (SDM) Agent retrieves data from the VCM database that may be out of date.

There are three situations when a Symmetrix logical device is considered *possibly allocated* by SPS, and is rejected for use:

- If there are no SDM records for the Symmetrix, ControlCenter assumes that SDM has not run, and that all of the devices mapped to SAN Manager-enabled ports are possibly allocated.
- If a logical device is mapped to a SAN Manager-enabled port and there are some SDM records (but none referencing the port), the logical device is seen as possibly allocated.
- If Volume Control Manager (Volume Logix) is disabled on a Fibre Channel front-end port, and the port is connected into a fabric, then any logical devices associated with that port are marked as possibly allocated

Array Unallocated Capacity

Array unallocated capacity is the amount of configured storage not yet designated for use within a storage array.

Array Unallocated = Unmapped + Mapped, but not assigned to a host

Array unallocated capacity includes:

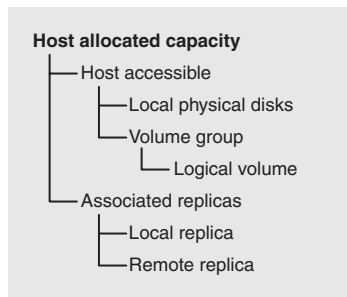
- Logical devices that have been configured, are mapped to array front-end ports, but do not have LUN masking (they are not accessible to hosts)
- Logical devices that have been configured, but are unmapped to array front-end ports

Host Terminology

This section describes storage components and capacity from the host perspective.

Host Allocated Capacity

Host allocated capacity consists of logical devices the host can perform I/O on, plus any associated local or remote replicas not accessible by a host. Note that the remote replica capacity can be spread across multiple arrays. Host allocated capacity can be hierarchically organized as shown in Figure 7.



Note: Shared devices and multiple hosts (clusters) can result in some storage being counted twice. Consider your configurations when determining capacity.

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Figure 7. Hierarchy of Host Terminology

Table 10 summarizes how ControlCenter views host allocated capacity for each array type.

Table 10. Array-specific Treatment of Host Allocated Capacity

Array Type	Host Allocated Definition
Symmetrix	- LUN masked primary logical devices and non-established replica devices mapped to access-controlled front-end ports. - Primary logical devices and non-established replica devices that are mapped to non access-controlled front-end ports which are physically connected to hosts. - Local replicas (split or synchronized) associated with array allocated primary devices. (StorageScope reports all local replicas used by a multihop configuration as part of the local replica capacity.) - Remote replicas (split or synchronized) associated with array allocated local replicas or array allocated primary devices (includes multihop to n levels). - LUN masked VDEVs mapped to accessed-controlled front-end ports. - VDEVs mapped to non access-controlled front-end ports.
CLARiiON	Access Logix enabled – LUNs bound to Storage Groups that also contain an HBA. Access Logix disabled – All configured LUNs on a CLARiiON that is physically connected to a host.
HDS/HP XP	LUN masked devices masked to security-enabled ports. Devices mapped to non security-enabled ports.
IBM ESS	LUN masked primary logical devices mapped to access-controlled host director ports. Primary logical devices mapped to non access-controlled host director ports which are physically connected to hosts.
StorageWorks (EMA)	LUN masked primary logical devices mapped to access-controlled front-end ports.

Host Accessible Capacity

Host accessible capacity is the amount of storage in all the logical volumes that can be seen (addressed and physically connected to) by the host (LUNs). This collection includes volumes that are unprotected, striped unprotected, mirrored, parity protected, striped mirrored, expanded, and striped expanded. On some arrays, such as CLARiiON arrays, snapshots are point-in-time copies and treated as primary capacity. Typically, replicas are not considered primary capacity.

Important: This definition of host accessible capacity assumes a valid physical connection and all hosts connected to the storage arrays are being monitored with ControlCenter agents. If this is not the case, the displayed values may be misleading and require careful analysis.

Once a replica is assigned for use protecting a primary volume, that replica is considered *allocated* to that host. If the replica is separated from the primary, and then temporarily made available for host I/O, it is also considered *accessible*.

Associated replica storage refers to replicas that are mated to host primary volumes, and should not be counted when computing storage capacity for primary I/O.

Local Physical Disk Capacity

Local host device capacity is the capacity provided to a host that does not come from an array, and includes internal disks and JBOD (Just a Bunch of Disks) storage devices.

Logical Volume Capacity

Logical volume capacity is the capacity created and managed by native or third-party logical volume managers.

Local Replicas

Local Replicas are copies (or mirrors) of logical devices or physical disks within the same array as the primary logical device. Examples include Symmetrix BCV, snapshot, and dual-copy.

Important: Local replicas are considered host allocated to the same host that their associated primary is allocated to, regardless of whether they are host accessible to the same or different host, and regardless of whether the primary host is unknown.

Remote Replicas

Remote replicas are copies of logical devices or physical disks in an array external to the primary logical device. Examples include Symmetrix SRDF, XRC (IBM Extended Remote Copy), and secondary volumes.

Important: Remote replicas are considered host allocated to the same host that their associated primary is allocated to, regardless of whether they are host accessible.

Multi-Hop Configurations and StorageScope

When reporting storage capacity in a multi-hop configuration, StorageScope considers all BCV devices in a chain to be local replicas, even though some may be external to the primary array.

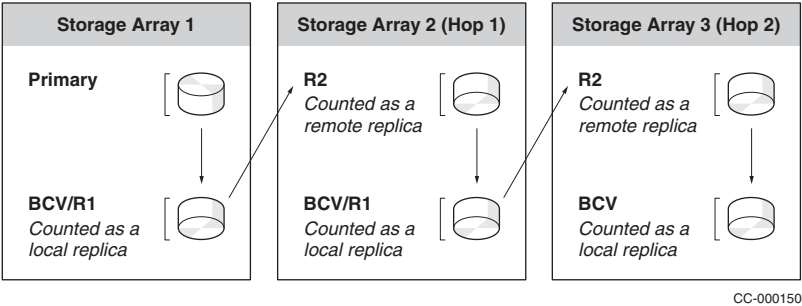


Figure 8. Multi-Hop Configurations and StorageScope

Other Host-Based Storage Terminology

There are many other configurations that reflect capacity. Two of the more common ones are storage pools and connection types.

Storage Pools

A *storage pool* is a ControlCenter-based, user-defined collection of logical devices, and serves as the source of storage capacity for the Storage Provisioning Services. The term *storage pool* is used by MVS, Replication Manager, TSM, and CLARiiON, although the functional definition can be dramatically different between environments.

ControlCenter uses storage pools as the source for storage capacity used by the Storage Provisioning Services.

Capacity within a storage pool may change from array configured capacity, to array mapped capacity, to array allocated capacity, and yet still remain in the same storage pool.

Note: EMC ControlCenter 5.2 does not support the addition of unconfigured capacity into storage pools.

The following types of storage pool capacities are used in the ControlCenter Free Space view and Properties view:

- *Allocated* – Amount of storage in the pool that has been assigned to hosts.
- *Available Mapped* – Amount of storage mapped to array front-end ports, and available for use in new allocations to hosts from the pool.
- *Available Unmapped* – Amount of storage not mapped to array front-end ports, but available for use in new allocations to hosts from the pool.

The following types of storage pool capacities are defined in StorageScope:

- *Pool - Allocated* – Amount of storage in the pool that has been assigned to hosts.
- *Pool - Total* – The total amount of storage (allocated and unallocated) in the storage pool.

Direct Connect and SAN Connected

Host accessible capacity can be either direct connect or SAN connected.

Direct Connect

In a direct connect environment (SCSI, ESCON, or Fibre Channel), logical devices on the array are considered host accessible as soon as they are mapped to a host director (front-end) port. From the host perspective, direct-connect devices also include JBOD units.

SAN Connected

In a SAN implementation, a logical device is considered accessible only when that device has been made visible to a host. In a SAN:

- A logical device must be first mapped to a front-end port on the array
- If volume access control is in use (also known as LUN or device masking), the device must be granted access by a host/WWN using access control software such as ControlCenter SAN Manager or Volume Configuration Management to be host accessible
- If zoning is in use, only those devices that have been zoned to a particular host/WWN are considered host accessible

Only those devices in a SAN that are both mapped and assigned access are considered host accessible.

Measuring How Host Capacity Is Used

Once logical devices are made accessible to a host (become LUNs), various host-based data structures can be created on top of these logical devices. These host-based structures are used to aggregate host volumes into larger addressable space, stripe data across multiple array logical devices, and organize the data stored in them. These structures improve performance and simplify access to the data.

The following figure represents the typical hierarchy of host data structures. Not all of these structures are required. If one layer is not present, lower-level data structures may be created directly on higher structures. For example, databases may be created in files that reside in a file system, but they may also be created directly on the host volumes.

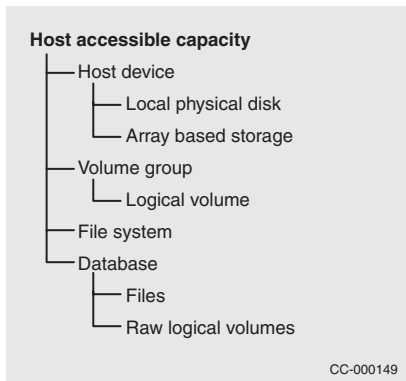


Figure 9. Host Data Structure Hierarchy

Determining when host capacity is used depends on what tasks the users are trying to accomplish. To help the storage administrator determine where free space resides, it may be necessary to display the accessible, used, and free capacity at any given level. The following sections of this glossary describe the accessible and usage states of each of the data structures listed in Figure 9.

Note: An agent is required on each host to collect capacity usage information. When reporting host capacity usage across multiple hosts, servers not reporting usage are assumed to be 100% used.

Local Physical Disks

Local physical disks are all or part of internal physical disks or JBOD units. For the most part, this is not significant to us, although they are listed under the Host Devices folder of ControlCenter.

Volume Group Capacity

A volume group is an allocation of storage that is used to create logical volumes. Volume group capacity is described as follows:

Volume group size – The total storage allocation assigned to a volume group.

Volume group used – The capacity used by the creation of logical volumes within the volume group.

- If host-level mirroring is not in use, then *volume group used* is equal to the sum of all accessible logical volumes in the volume group.
- If host-level mirroring is in use, then *volume group used* will be greater than the sum of all accessible logical volumes in the volume group, because the capacity of the mirrors will be included in *volume group used*.

Volume group free – The space remaining after subtracting volume group used capacity from volume group size.

Logical Volume Capacity

Logical volume capacity is described as follows:

Logical volume size – The capacity of a logical volume.

Logical volume used – The capacity consumed by lower-level data structures such as file systems or capacity consumed by databases and files on raw logical volumes.

Logical volume free – The remaining capacity that can be used for the creation of lower-level data structures.

File System Capacity

File system capacity is described as follows:

File system size – Capacity allocated to a file system.

File system used – Capacity consumed by files and databases within the file system.

File system free – Capacity available to create files or databases.

Database Capacity

Database capacity is described as follows:

Database size – Capacity allocated to database log files and records.

Database used – Capacity used by database log files and records.

Database free – Capacity available for database log files and records.

NAS File Systems

NAS file system capacity is expressed with the following terms:

NAS capacity – The summary amount of storage dedicated exclusively to a NAS file server (such as a Celerra™ Network Server or a Network Appliance file server). In the case of a Celerra Network Server, NAS capacity includes the capacity from all disk arrays connected to the Celerra Network Server. NAS capacity consists of primary, local replica, and remote replica volumes.

NAS file system total capacity – The amount of storage configured as file systems, including both mounted and unmounted file systems.

NAS file system used capacity – The space consumed by files and databases.

Snapshot total capacity – The amount of local replica capacity (for example, BCV or VDEV) configured as business continuance or read-only versions of a file system, commonly used to support backups and report generation.

Snapshot used capacity – Total amount of snapshot capacity allocated to file systems.

CAS Storage Capacity

Centra Content Addressed Storage is expressed with the following terms:

Total Capacity – The total physical capacity of the cluster/node or disk.

System Resources – The capacity that is used by the CentraStar software and is never available for storing data.

Spare Capacity – The capacity that is available on nodes configured as Spare Nodes and that can be made available for storage.

Offline Capacity – The capacity that is temporarily unavailable due to reboots, offline nodes or hardware faults. This capacity will be available as soon as the cause has been solved.

Free Capacity – The capacity that is available for storing data or for self healing operations in case of disk or node failures.

Used Capacity – The capacity that is in use to store data (Protected User Data) plus the overhead capacity required to manage the stored data (Audit & Meta Data).

Heterogeneous Device Terminology

Table 11 summarizes the different types of devices and how they are referred to by storage vendors. Not all types are supported by all vendors.

Table 11. 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 11. 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.