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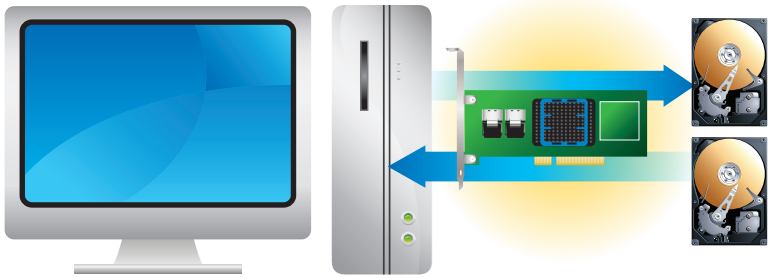
RAID and RAID Controllers

What is a Controller Card?

A controller card is a device that sits between the host system and the storage system, and allows the two systems to communicate with each other.



There are two types of controller cards: Host Bus Adapters (HBAs), and RAID controller cards.

1. **An HBA** is an expansion card that plugs into a slot (such as PCI-e) on the computer system's motherboard and provides fast, reliable non-RAID I/O between the host and the storage devices. HBAs can reliably connect hundreds or even thousands of hard disk drives (HDDs), tape, and solid state drives (SSDs) to the host, making them ideal for cost-sensitive tape backup solutions or high-performance SSD environments.

2. **A RAID controller card** is similar to an HBA, but can also add redundancy (RAID), optimize performance, reduce latency, or even make smart decisions on whether to store data on an HDD or an SSD cache, depending on user needs. Since these additional tasks consume power and processing speed, RAID controllers are typically more expensive than HBAs and handle fewer devices.

Controller	Features
HBA	Low cost, high connectivity, limited functionality, best performance
RAID	Intelligent data management, redundant logical configuration support, broadest functionality, optimized performance, cache backup

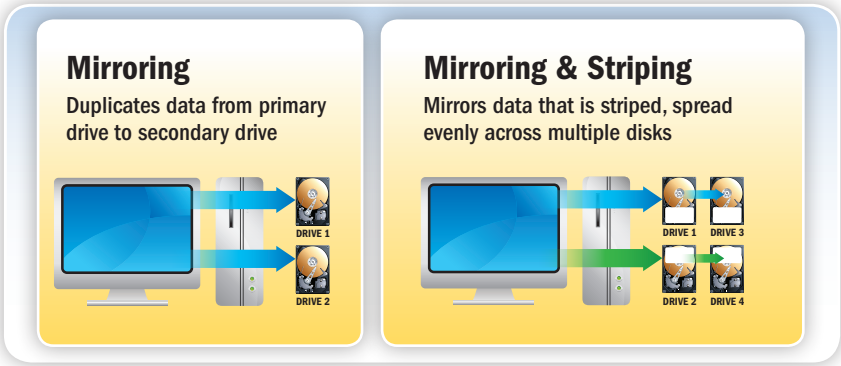
HBAs vs. RAID Controllers

What is RAID and Why do Your Customers Need it?

RAID (Redundant Array of Inexpensive Disks) is a data storage structure that allows a data center to combine two or more physical storage devices (HDDs, SSDs, or both) into a logical unit that is seen by the attached system as a single drive.

There are two basic RAID configurations:

1. Striping (RAID 0) writes some data to one drive and some data to another, minimizing read and write access times and improving I/O performance.
2. Mirroring (RAID 1) copies all information from one drive directly to another, preventing loss of data in the event of a drive failure.



RAID can be hardware-based or software-based.

Hardware RAID resides on a PCI-X or PCIe controller card, or on a motherboard-integrated RAID-on-Chip (ROC).

- **Primary benefit:** Offloads RAID tasks from the host system, yielding better performance than software RAID. Controller cards can be easily swapped out for replacement and upgrades. Data can be backed up to prevent loss in a power failure.
- **Primary drawback:** More expensive than software RAID.

Software RAID runs entirely on the CPU of the host computer system.

- **Primary benefit:** Lower cost due to lack of RAID-dedicated hardware.
- **Primary drawback:** Lower RAID performance as CPU also powers the operating system and applications. No data backup.

Levels of RAID

RAID Level	Description	Benefit
RAID 0	Spreads data evenly over multiple drives to enhance performance. Because there is no redundancy scheme, it does not provide data protection.	Highest performance
RAID 1	Provides data protection by duplicating all data from a primary drive onto a secondary drive.	Highest data protection
RAID 1E	Combines data striping from RAID 0 with data mirroring from RAID 1 to extend RAID 1 data availability across an odd number of disks.	Highest data protection for an odd number of disks
RAID 5	Combines data striping (for enhanced performance) with distributed parity (for data protection) to provide a recovery path in case of failure.	Best cost/performance balance for multi-drive environments
RAID 5EE	Data striping with distributed parity with hotspare integrated into the array.	The cost/performance balance of RAID 5 without setting aside a dedicated hotspare disk
RAID 6	Provides double redundancy and the ability to sustain two drive failures. Data is striped across at least 4 physical drives. A second parity scheme is used to store and recover data.	Highest fault tolerance with the ability to survive two disk failures
RAID 10	Combines RAID 0 (data striping) and RAID 1 (disk mirroring).	Highest performance with highest data protection
RAID 50	Combines multiple RAID 5 sets with data striping (RAID 0) to increase capacity and performance without adding disks to each RAID 5 array.	Increased capacity and performance for multi-array RAID 5 environments
RAID 60	Combines multiple RAID 6 sets with data striping (RAID 0) to increase capacity and performance without adding disks to each RAID 6 array.	Highest fault tolerance with the highest data protection

Figure 4. RAID Levels

Glossary

Connector: A plug or socket that links devices together.

Copyback Hot Spare: When a failed drive is replaced, data is automatically copied from the hot spare back to the replaced drive.

Dual Drive Failure Protection (RAID 6, 60): Provides double redundancy and the ability to sustain two drive failures. Data is striped across at least 4 physical drives. A second parity scheme is used to store and recover data.

Fault Tolerance: The ability of a system to continue to perform its functions even when one or more of its hard disk drives have failed.

Hard Disk Drive (HDD): A motorized mechanical device that stores data on rotating magnetic platters. HDDs are typically slower than flash memory.

Host Bus Adapter (HBA): A hardware component that connects the computer (the host) to storage devices.

Hot Space (RAID 5EE): Provides the protection of RAID 5 and adds a hot spare disk to the array. This extra drive enhances RAID 5 performance with higher IOPs.

Hot Spare: A spare hard drive which will automatically be used to replace a failed member of a redundant disk array.

Hot Swap: The ability to replace a failed member of a redundant disk array without bringing down the server or interrupting transactions that involve the other devices.

I/O: Input/Output. The transfer of data to or from a computer and to or from a peripheral device, such as HDD and SDDs. Every transfer is an output from one device and an input into another.

IOPs: Input/Output operations per second.

Mirroring (RAID 1): Provides data protection by duplicating all data from a primary drive onto a secondary drive.

Parity: A form of data protection used by RAID 5 to re-create the data of a failed drive.

Port: The outlet on the RAID controller that connects the controller to the disk drive.

Port expander: Hardware that allows multiple disk drives to be connected to a single RAID controller port.

SAS: Serial Attached SCSI (see SCSI below). The latest generation of the SCSI interface, it combines the reliability and stability of SCSI with higher performance and scalability, making it more expensive than SATA options.

SATA: Serial ATA. The most common interface for disk drives, SATA offers significantly higher transfer speeds than parallel ATA (PATA). SATA storage is low cost and high capacity.

SCSI: (Pronounced “scuzzy”). Small Computer System Interface. SCSI is the industry standard interface for connecting and transferring data between computers and peripheral devices, including disk drives.

Solid State Drive (SSD): A data storage device that uses non-moving flash memory instead of the rotating platters of a hard disk drive to store data. SSDs typically outperform HDDs.

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