

Dell™ Systems

Getting Started With RAID



Notes, Notices, and Cautions



NOTE: A NOTE indicates important information that helps you make better use of your computer.



NOTICE: A NOTICE indicates either potential damage to hardware or loss of data and tells you how to avoid the problem.



CAUTION: A CAUTION indicates a potential for property damage, personal injury, or death.

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This document provides basic information about using redundant array of independent disks (RAID) technology. It is a high-level overview that defines RAID, the advantages and disadvantages of various RAID levels, and guidelines to observe when implementing RAID.



NOTE: The information in this document is intended for SCSI, IDE, and software RAID solutions only. It does not address RAID in a Fibre Channel environment.



NOTE: Despite the redundancy that most RAID solutions provide, Dell recommends that you perform a tape backup of your data on a regularly scheduled basis.

This document does not provide procedural information for implementing RAID using a controller. For specific information about setting up and managing RAID arrays, see the documentation that came with your RAID controller.

RAID Defined

RAID is a way of storing data on two or more physical disks for the purpose of redundancy, improved performance, or both. The combined physical disks make up what is called an array, and this array appears on the host system as one disk. For example, if you have physical disk 1 and physical disk 2, those two disks appear to the host system as one disk.



NOTE: Arrays are sometimes called "containers" or "virtual disks."

RAID consists of different levels, which determine how the data is placed in the array. Each RAID level has specific data protection and system performance characteristics. The following are commonly used SCSI RAID levels:

- RAID 0 — striping, good performance, no redundancy
- RAID 1 — mirroring, one-to-one redundancy
- RAID 5 — striping with parity striped across all drives; offers performance and redundancy
- RAID 10 — mirroring and striping; best redundancy and best performance
- RAID 50 — parity striped across all drives in a mirrored set; redundancy and performance

These RAID levels are discussed in more detail later in this document.

You can manage RAID arrays with a RAID controller (hardware RAID) or with software alone (software RAID).

Reasons for RAID

Depending on how you implement RAID (which RAID level you use), the benefits include one or both of the following:

- **Faster performance** — In RAID 0, 10, or 50 arrays, the host system can access multiple disks simultaneously. This improves performance because each disk in an array has to handle only part of the request. For example, in a two-disk array, each disk needs to provide only its part of the requested data.
- **Data protection** — In RAID 1, 10, 5, and 50 arrays, the data is backed up either on an identical disk (mirror) or on multiple disks (parity disks). RAID 10 and 50 also allow the host to access disks simultaneously.

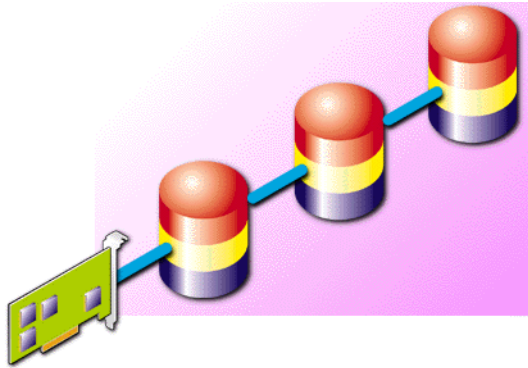
Supported RAID Levels

Dell™ systems that use SCSI RAID controllers support RAID 0, 1, 10, 5, and 50. The following is a brief explanation of those levels.

RAID 0 (Striping)

RAID 0, also known as striping, maps data across the physical drives in an array to create a large virtual disk. The data is divided into consecutive segments or stripes that are written sequentially across the drives in the array. See Figure 1-1. Each stripe has a defined size or depth in blocks. RAID 0 provides improved performance because each drive in the array needs to handle only part of a read or write request. However, because none of the data is mirrored or backed up on parity drives, one drive failure makes the array inaccessible and the data is lost permanently.

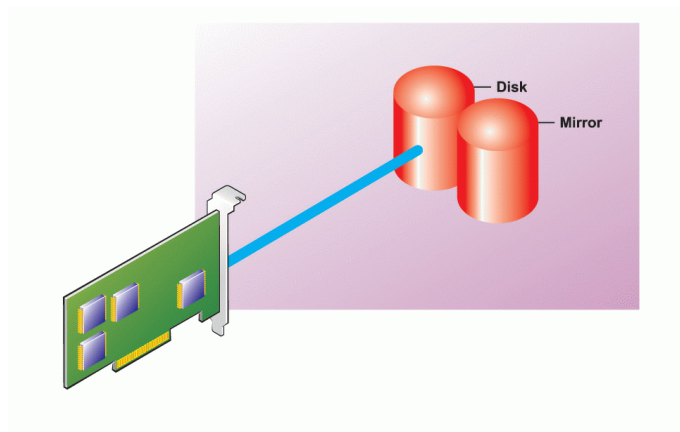
Figure 1-1. RAID 0



RAID 1 (Mirroring)

RAID 1 stores duplicate sets of data on separate drives. See Figure 1-2. This configuration ensures complete redundancy of data. If a disk fails, the mirrored drive takes over and functions as the primary drive.

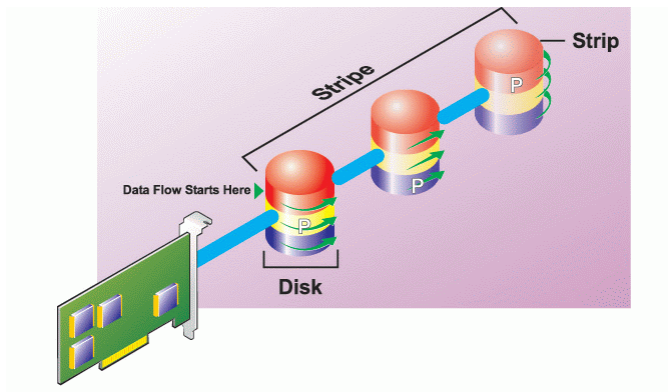
Figure 1-2. RAID 1



RAID 5

RAID 5 maps the data across the drives and stores parity information for each data stripe on different drives in the array. The parity data, labeled **P** in Figure 1-3, is distributed. This lessens the data congestion that occurs if all of the parity data is written to one drive. A RAID 5 array can preserve data if one drive fails. However, if two drives fail, all data in the array is lost.

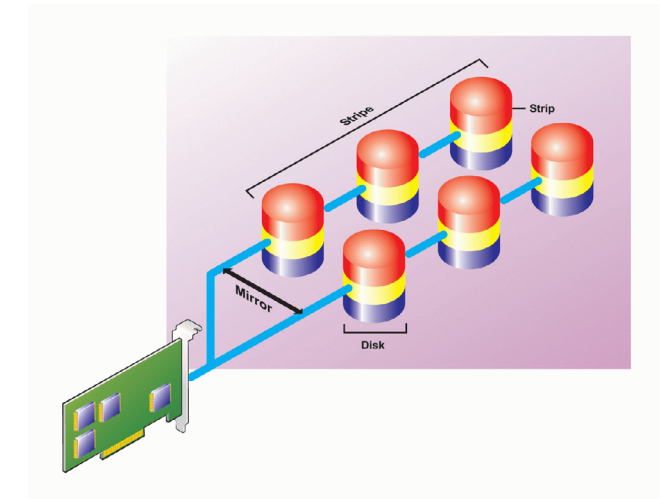
Figure 1-3. RAID 5



RAID 10 (Striping Over Mirrored Sets)

RAID 10 is a variation of RAID 1 that combines data striping and mirroring. RAID 10 is also known as RAID 0+1 or RAID 1+0, depending on how it is configured. In a RAID 0+1 array, data is mapped across mirrored sets of drives. In a RAID 1+0 array, data is mapped across several drives, and this complete array of drives is mirrored by one or more arrays of drives. See Figure 1-4.

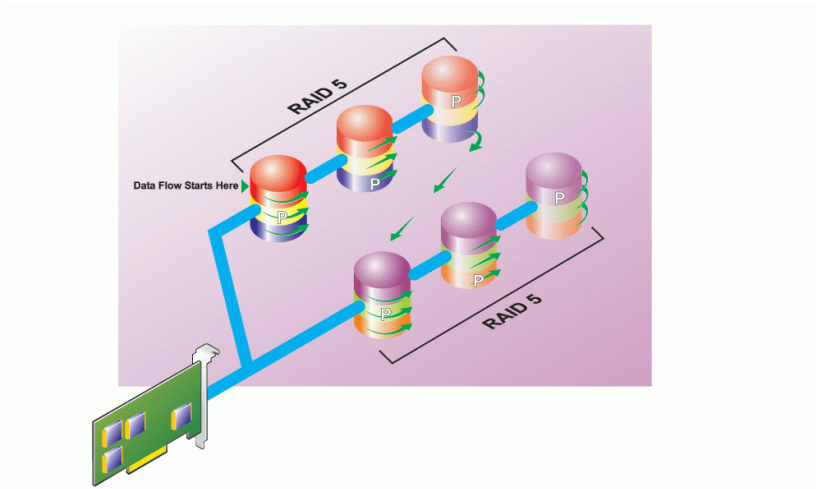
Figure 1-4. RAID 10



RAID 50

RAID 50, which is shown in Figure 1-5, is a variation of RAID 5 that maps data across two RAID 5 arrays. Figure 1-5 indicates how the parity data (labeled **P**) is stored. RAID 50 offers the data protection of RAID 5 and, depending on the size of the data stripes (established when you configure the array), can provide fast throughput.

Figure 1-5. RAID 50



Choosing a RAID Level

The RAID level you should use depends largely on the type of data that you are storing. Table 1-1 provides information about each RAID level.

Table 1-1. RAID Level Overviews

Level	Number of Drives	Advantage	Disadvantage	Best Used When...
0 (Striped)	2–32	Fast	No data protection (redundancy).	Data is not mission critical but needs to be accessed quickly.
1 (Mirrored)	2	Data protection; fast, but not as fast as RAID 0 on write operations. NOTE: Throughput performance depends on the type of operation (read or write) and the number of channels on the controller.	Requires a drive for each mirror.	Data protection is critical and must be protected at any expense.
5 (Striped with parity)	3–32	Good performance because data is striped, and good protection because of backup disks (parity disks).	Redundancy is not as certain as with RAID 1.	Data protection is critical, and performance is secondary.
10 (Striped and mirrored)	2 <i>n</i> , where <i>n</i> is the number of drives and is greater than 1. The maximum value of <i>n</i> is 16.	Faster than RAID 1 or 5; Same data protection as RAID 1.	Requires more drives than RAID 5.	Data protection and performance are equally critical.

Table 1-1. RAID Level Overviews

Level	Number of Drives	Advantage	Disadvantage	Best Used When...
50 (Striped with parity)	6–256	Data striping makes RAID 50 faster than RAID 1 or 5, and it offers the same data parity as RAID 5.	More expensive than RAID 5, but costs less than RAID 10. Also, because the data is striped across two RAID 5 arrays, if two or more drives in one of the arrays fail, the entire RAID 50 array fails.	Data accessibility is most critical, but protection is also important.

Getting Started

This section provides a basic overview of the steps involved to create and configure a RAID array. For more information, see the documents that are referenced.

-  **NOTE:** The required steps may vary, depending on how your system was configured when you received it.
- 1 Install the RAID controller card. See your RAID controller card’s *User’s Guide*.
If the RAID controller card is already installed or the controller is embedded on the system board, continue to the next step.
 - 2 Configure the RAID arrays. See your RAID controller documentation or the *Array Manager User’s Guide*.
 - 3 Install the operating system. See the *Dell OpenManage Server Assistant* CD.

Frequently Asked Questions

The following are common questions asked about RAID. Some answers depend on the capability of your RAID controller. See your RAID controller documentation for information about the features your controller supports.

Can I delete my RAID array and create a new one (the same as the previous array) without losing any data?

Some array controllers allow you to clear and rebuild the array, and the data remains intact as long as the re-created arrays are not initialized after being re-created. Deleting an array on other controllers may delete all data in the array. Make sure that you know the capabilities of your controller before deleting a RAID array.

Do not delete an array unless it is absolutely necessary for recovery purposes. If you delete an array, back up the data in the array before deleting it.

How can I find out what RAID levels are configured on my system?

You can see arrays using Dell OpenManage™ Array Manager software. Right-click an array (shown as a "virtual disk" in Array Manager) and select **Properties** to see what RAID level the array is.

You can make RAID arrays easier to identify by naming them based on the RAID level and the physical disks they contain. For example, you could assign "R5_14" as the name for a RAID 5 array that contains disks 1–4.

Do all drives in a RAID array have to be the same size?

All drives in an array do not have to be the same size. However, all drives in the array default to the smallest drive in the array. For example, if your array contains three 36-GB drives and one 18-GB drive, the maximum capacity of any drive in the array is 18 GB.

To lessen complexity and use drive space efficiently, use only unpartitioned drives of the same size when creating an array.

Can I control external storage with an integrated RAID controller?

For most systems, the integrated controller supports both internal and external storage. See your RAID controller and system documentation for information about what type of storage your RAID controller and system support.

What are OLVE, OLCE, and OLVD?

These acronyms all refer to methods of adding storage space. They are defined as follows:

- Online Capacity Expansion (OLCE) — OLCE is adding a drive to an enclosure and then rescanning the enclosure. The enclosure adds the drive without rebooting the system. This adds disk capacity but does not add it to an array.
- Online Volume Expansion (OLVE) — OLVE adds capacity to an array by adding a drive to the array. For example, if array 1 contains drives 1–3, you can add an existing fourth drive to the array by using the Array Manager software. OLVE is supported only on Microsoft® operating systems.
- Online Virtual Disk (OLVD) — OLVD increases the size of an array by using the remaining disk space. For example, if array 2 has drives 5–8 with a combined capacity of 219 GB, and you are using only 100 GB of that capacity, you can add the remaining 119 GB to the array.



NOTE: These methods can affect performance and manageability. To add storage capacity, Dell recommends creating new arrays, rather than expanding an existing array. However, if you prefer to have all of the data in one array, you should back up the data, reinitialize and reformat the drives, create the array, and then restore the data.

Can I hot swap a drive in a RAID configuration?

If your system supports hot-swappable drives (the ability to replace or insert a drive without powering down the system), you can replace a failed drive in a RAID array with a working drive that is the same size or larger than the other drives in the array. You can also insert spare drives to be configured into arrays or used as hot spares. When you add or replace a drive in an array, the RAID array begins to rebuild using the new drive.



NOTICE: Never pull an active drive from an array unless it is placed in a failed state or prepared for removal. You can prepare a drive for removal by right-clicking on the drive in Array Manager and selecting **Prepare for Removal**.

Can I upgrade controllers without data loss?

In most cases, you can upgrade controllers without losing data because configuration information is kept on the controller and the hard drive. However, some controllers store configuration data only on the controller itself.



NOTICE: Data loss can occur if you initialize a new controller that stores the configuration data differently than the controller it is replacing. Check the documentation that came with your controller for information about where the configuration is stored.

See the *Dell PowerEdge Expandable RAID Controller 3/DC, 3/DCL, 3/QC, and 3/QC Information Update* at support.dell.com for more information about upgrading RAID controllers.

What is the preferred way to configure arrays?

Use Dell OpenManage Array Manager to configure arrays. Array Manager is included on the *Dell OpenManage Systems Management* CD (if shipped with your system).

Can I change the level of a RAID array?

Dell recommends creating new arrays. However, depending on the type of controller used for the array, you might be able to use Array Manager to upgrade the disks to dynamic and change the level of a RAID array. For example, you can go from RAID 1 to RAID 10 or from RAID 5 to RAID 50. This adds data striping to the array. See your *Array Manager User's Guide* for more information.

How do hot spares work?

A hot spare is a drive that is on standby in case another drive fails. Depending on how the array is configured, the drive is either picked up automatically and the array is rebuilt, or you manually select the drive (or insert a new drive in the same slot as the failed drive) and rebuild the array. Most Dell systems ship with the automatic rebuild feature enabled.

How the hot spare works depends on how the array is configured. When a drive fails, the array rebuilds automatically using the hot spare. This is assuming that automatic rebuild is enabled (as it is by default on most Dell systems). If automatic rebuild is disabled, you must manually start the rebuild process.

During a rebuild you may notice degraded performance on the drives.

What is the difference between global and dedicated hot spares?

A dedicated hot spare is assigned to one or more arrays, whereas a global hot spare can be used for any array that is on the same controller as the hot spare. Dell recommends using dedicated hot spares for critical data. Also, dedicated hot spares that reside in the same storage enclosure typically have better performance than global hot spares. This is because a global hot spare is selected randomly and may be in a different enclosure than the failed drive it is replacing.

How do I replace a failed drive?

If you introduce a new drive into the same slot where a bad drive was, the failback is automatic (assuming that automatic rebuild is enabled on the system). In other words, a new drive inserted into the same slot as a previously bad drive acts as a dedicated hot spare for that array.

What is the rebuild rate?

In RAID 1, 5, 10, and 50 arrays, you can rebuild a failed drive by re-creating the data that was stored on the drive before it failed. The rebuild rate is the percentage of the compute cycles dedicated to rebuilding failed drives. A rebuild rate of 100 percent means that the system is totally dedicated to rebuilding the failed drive, while a 0 percent rebuild rate means that the rebuild occurs only when the system is not doing anything else.

What is the best type of caching to implement

There are two types of caching—write-back and write-through. In write-back caching, the RAID controller signals that a data transfer is complete when the controller cache has received all data in the transaction. In write-through caching, the RAID controller signals that a data transfer is complete when the disk subsystem has received all of the data.

Write-back caching is faster, while write-through caching provides more data security. If your RAID controller has a battery backup unit, the controller's cache retains data if there is a power loss, meaning that you can have the performance of write-through caching as well as data security.

When do I need to recondition my battery?

If your RAID controller has a functioning battery, any data in your RAID controller's cache is preserved in the event of a power loss. The battery is fully charged when the controller is first installed in the system. However, you should recondition the battery every six months to ensure that the controller cache is backed up for the maximum period of time. See your Array Manager documentation for information on reconditioning the RAID controller battery.

What are stripe size and width?

Disk striping, which enables data to be written across multiple hard drives, partitions each drive into stripes that can vary in size from 2 KB to 128 KB. The stripes are interleaved, and the combined storage space consists of stripes from each drive.

Stripe width is the number of disks involved in an array where striping is implemented. For example, a four-disk array with disk striping has a stripe width of four. Stripe size is the length of the interleaved data segments that a RAID controller writes across multiple drives.

Disk striping enhances performance because multiple drives are accessed simultaneously, but it does not provide data redundancy.

Is disk spanning the same thing as RAID?

No. Disk spanning combines multiple drives and displays them in the operating system as one drive. For example, four 20-GB hard drives that are spanned appear as one 80-GB drive in the operating system. Disk spanning alone provides no data protection.

How do consistency checks work?

In RAID, a consistency check verifies the correctness of redundant data in an array. For example, in a system with parity, checking consistency means computing the data on one drive and comparing the results to the contents of the parity drive. Some RAID controllers allow you to pause a consistency check and resume it later or to resume the consistency check after the system reboots.

Glossary

Array — A combination of two or more disks that appears to the system as one disk. Arrays are also referred to as *containers* or *virtual disks*.

Disk — A physical hard drive on which data is stored. Also referred to as a *drive*.

Hot spare — An extra, unused disk that is assigned as a backup disk that can take over when a primary disk fails without interrupting the system or requiring user intervention. A global hot spare can be used to replace any failed primary disk, whereas a dedicated hot spare replaces only the disk to which it is assigned.

IDE — Acronym for integrated drive electronics, which is a type of interface between a system and mass storage devices in which the controller is integrated into the disk.

Parity — Redundant information that is associated with a block of information and used to rebuild a disk that has failed. RAID 5 arrays map data and parity intermittently across a set of disks. Within each stripe, the data on one disk is parity data and the data on the other disks is normal data. Therefore, RAID 5 arrays require at least three disks to allow for this parity information. When a disk fails, the Array Manager software uses the parity information in those stripes in conjunction with the data on the other disks to re-create the data on the failed disk.

RAID — Storing data on two or more physical disks for the purpose of redundancy, improved performance, or both. You can implement RAID with a RAID controller (hardware RAID) or without a controller (software RAID). See "RAID Defined" for more information.

SCSI — Acronym for small computer system interface, which is a type of interface between a system and devices such as hard drives, diskette drives, CD drives, printers, scanners, and other peripherals.

Volume — A logical or virtual entity that consists of portions of one or more disks. A volume may be formatted and may have a file system, a drive letter, or both. A volume has a type (dynamic) and a layout (simple, spanned, striped, RAID 5, and RAID 10 or RAID 0+1).

