For Data Centers

Redundant Array of Independent Disks (RAID)

Combine and control multiple storage devices for better performance and reliability

Application note

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Redundant Array of Independent Disks (RAID)

1. What is Redundant Array of Independent Disks (RAID)?

RAID is a disk configuration technology that contains multiple disk drives as an array and operates using striping and/or mirroring methods to provide better performance, error tolerance and more storage capacity at a moderate cost.
RAID is widely used as a storage solution in servers and storage systems for stability and performance improvement.

2. What are the different operating methods RAID uses?

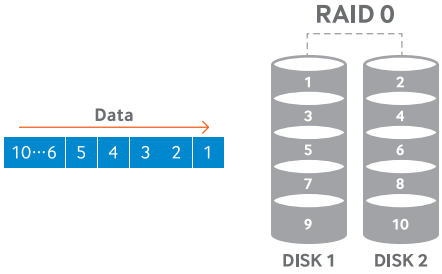
RAID uses the following operating methods :

- Striping : Dividing a body of data into blocks and spreading the data blocks across several partitions on numerous drives. Striping is primarily used to increase performance.
- Mirroring : Replicating data onto two or more disks to provide good fault tolerance. Data mirroring can be performed without data loss or system stoppages if a fault occurs.

According to the disk configuration methods when using striping and mirroring, RAID can be differentiated into the following levels. (Only some levels are described below.)

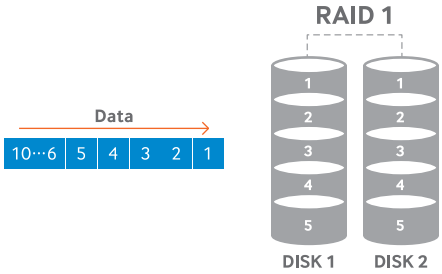
1) RAID 0

RAID 0 writes data to two or more drives alternately to provide the best performance. RAID 0 has a simple design, is easier to implement and has no overheads for parity. However, data is stored on only one disk. So, if one disk fails, data stored within those disks is lost since it does not use parity. For this reason, RAID 0 has very limited usage, like an SSD read cache.



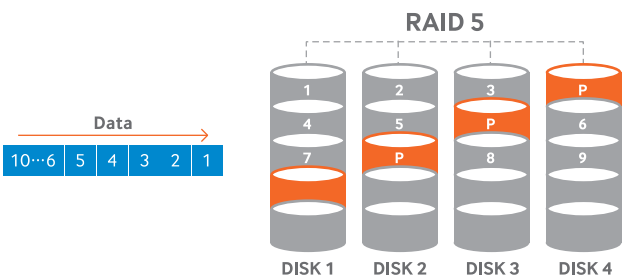
2) RAID 1

RAID 1 provides a redundant, identical copy of a disk, yielding good fault tolerance. Replacement of a faulty disk does not affect any data loss or system stoppages. However, usable capacity is limited by the smallest capacity and the write performance is lower than RAID 0 since it writes data twice. Also, RAID 1 has a large storage overhead and a high cost/capacity ratio.



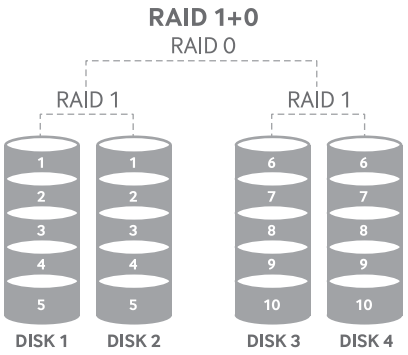
3) RAID 5

RAID 5 uses disk striping with parity across three or more disks. Data redundancy is provided by the parity information. Since data and parity information are arranged on the disk array, two types of information are always on different disks. If one disk fails, just replace it with a new disk and the array rebuilds itself. RAID 5 has a higher read rate and makes good use of capacity. The drawbacks of RAID 5 are slower write rates and slower rebuild times.



4) RAID 10 (1+0)

RAID 10 is a combination of RAID 1 (mirroring) and RAID 0 (striping). RAID 10 uses a striped array of disks, which mirrors identical sets of striped disks. This array level uses at least four disks, and additional disks must be added in even numbers. The data is first placed into mirrored pairs at the lower level. Next, the controller selects a member from each mirrored pair and stripes the data into a new logical volume. Since RAID 10 writes in a random fashion, it performs best with a write-intensive application. The drawback is that RAID 10 is expensive.



3. How do I use the RAID feature?

RAID technology also can be differentiated into software RAID and hardware RAID by a management authority, but it uses the same RAID configuration levels described in the previous chapter.

- Software RAID : Generally, the operating system (OS) manages the RAID group using the CPU resource of the server or storage system. The Linux® OS normally supports software RAID 0, RAID 1, RAID 5, RAID 6 and more, while the Microsoft® Windows® OS supports RAID 0, RAID 1, RAID 5, etc.
- Hardware RAID : Hardware RAID is managed by RAID-supporting Host Bus Adapters (HBAs), and their supportable RAID level is different by specification of the RAID on Chip (RoC) in the HBAs. Since hardware RAID uses the RoC resource, it offloads the CPU in the system.

Most importantly, users should determine their suitable RAID configuration by considering the required storage capacity, performance, cost and mean time between failures (MTBF) of the drives.

Below is a table that describes each RAID's characteristics for reference.

RAID level	Minimum required drives	Fault tolerance*	Random performance	Sequential performance	Storage utilization	Cost
RAID 0	2	None	★★★★	★★★★☆	100%	$
RAID 1	2	★★★★	★★★	★★☆	50%	$
RAID 5	3	★★★	★★★★★(R) ★★(W)	★★☆	67 - 94% (N-1)/N %	$$
RAID 6	4	★★★★	★★★★★(R) ★(W)	★★☆	50 - 88% (N-2)/N %	$$$$
RAID 10/01	4	★★★★	★★★★★	★★★★★	50%	$$$$

* Fault tolerance : Keep in mind that RAID is not a replacement for backups. Backups are essential for any system.

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4. Samsung SSDs for data centers are

Samsung SSD 845DC PRO and 845DC EVO support RAID at any level and are compatible with the most used HBA and RAID controller card products. The table below describes the interoperable HBA and RAID controller card models. The compatibility list will be updated continuously.

Samsung SSD	HBA and RAID controller			
	Manufacturer	Product category		Model
845DC EVO	LSI	HBA	6Gb/s SATA + SAS HBA	LSI SAS 9206-16e LSI SAS 9207-4i4e/8i/8e LSI SAS 9205-8e LSI SAS 9212-4i4e LSI SAS 9201-16e/16i LSI SAS 9200-8e LSI SAS 9211-4i/8i
			12Gb/s SATA + SAS HBA	LSI SAS 9300-4i/4i4e/8i/8e LSI SAS 9311-4i4e (OEM) LSI SAS 9311-8i (OEM)
		RAID controller card (6Gb/s)		MegaRAID SAS 9240-4i/8i MegaRAID SAS 9286(CV)-8e/8eCC MegaRAID SAS 9270-8i MegaRAID SAS 9271-8i/8iCC/4i MegaRAID SAS 9285(CV)-8e MegaRAID SAS 9266-4i/8i MegaRAID SAS 9265-8i MegaRAID SAS 9280-24i4e/16i4e/8e/4i4e MegaRAID SAS 9260-16i/4i MegaRAID SAS 9260DE-8i MegaRAID SAS 9260CV-8i/4i MegaRAID SAS 9261-8i
		RAID controller card (12Gb/s)		MegaRAID SAS 9341-4i/8i MegaRAID SAS 9361-4i/8i
	Intel	RAID controller card (6Gb/s)		Intel® RAID Controller RS2WC080 Intel® RAID Controller RS2WC040 Intel® RAID Controller RS25NB008 Intel® RAID Controller RS2SG244SNGL Intel® RAID Controller RS2WG160 Intel® RAID Controller RS2PI008(DE/SNGL) Intel® RAID Controller RS2BL080 Intel® RAID Controller RS2BL040 Intel® RAID Controller RS2MB044 Intel® RAID Controller RS2VB080 Intel® RAID Controller RS2VB040

Most importantly, to decide which RAID configuration to use, make sure you do your own research so you can make an informed decision on choosing the correct RAID configuration.

※ RAID is not a replacement for backups. Backups are essential for any system.

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