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RAID

RAID (redundant array of independent disks; originally redundant array of inexpensive disks) is a way of storing the same data in different places on multiple hard disks to protect data in the case of a drive failure. However, not all RAID levels provide redundancy.

RAID use mirroring. Mirroring is the simplest way to give redundant storage. This is a technique that can only be used on two disks unless combined with striping. When data is written to one disk, it is simultaneously written to the other disk, so in a mirrored array the two drives are always an exact copy of each other. If one of the drives fails, service can continue uninterrupted and without data loss as the other drive simply takes over. This method of redundancy doesn't require any fancy calculations so is usually a part of onboard RAID solutions as it's quite cheap to implement. The down side of mirroring is the inefficient use of space. In an array that uses mirroring, half of the total capacity of the disks goes to redundancy.

RAID Controller

A RAID controller can be used as a level of abstraction between the OS and the physical disks, presenting groups of disks as logical units. Using a RAID controller can improve performance and help protect data in case of a crash.

A RAID controller can be used in both hardware- and software-based RAID arrays. In a hardware-based RAID product, a physical controller manages the array. When in the form of a Peripheral Component Interconnect or PCI Express card, the controller can be designed to support drive formats such as SATA and SCSI. A physical RAID controller can also be part of the motherboard.

With software-based RAID, the controller uses the resources of the hardware system. While it performs the same functions as a hardware-based RAID controller, software-based RAID controllers may not enable as much of a performance boost.

If a software-based RAID implementation isn't compatible with a system's boot-up process, and hardware-based RAID controllers are too costly, firmware- or driver-based, RAID is another implementation option.

Parity

Parity is a technique that checks whether data has been lost or written over when it is moved from one place in storage to another or when it is transmitted between computers.

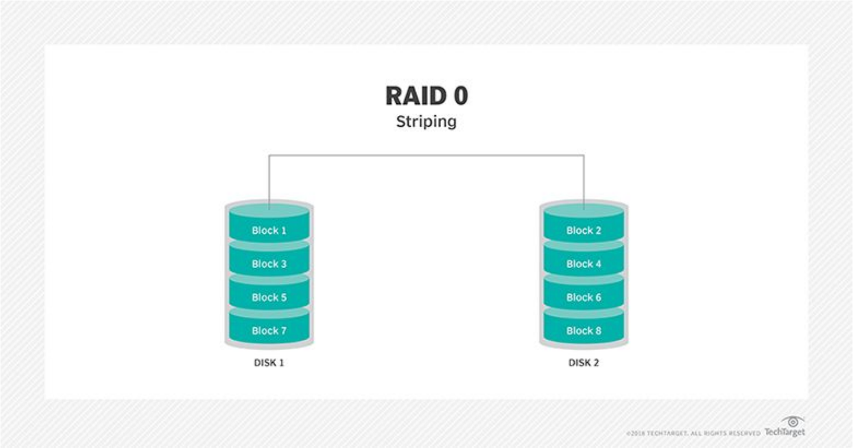
How Parity works?

Because data transmission is not an entirely error-free process, data is not always received in the same way as it was transmitted. A parity bit adds checksums into data that enable the target device to determine whether the data was received correctly.

An additional binary digit, the *parity bit,* is added to a group of bits that are moved together. This bit, sometimes referred to as a *check bit*, is used only to identify whether the moved bits arrived successfully.

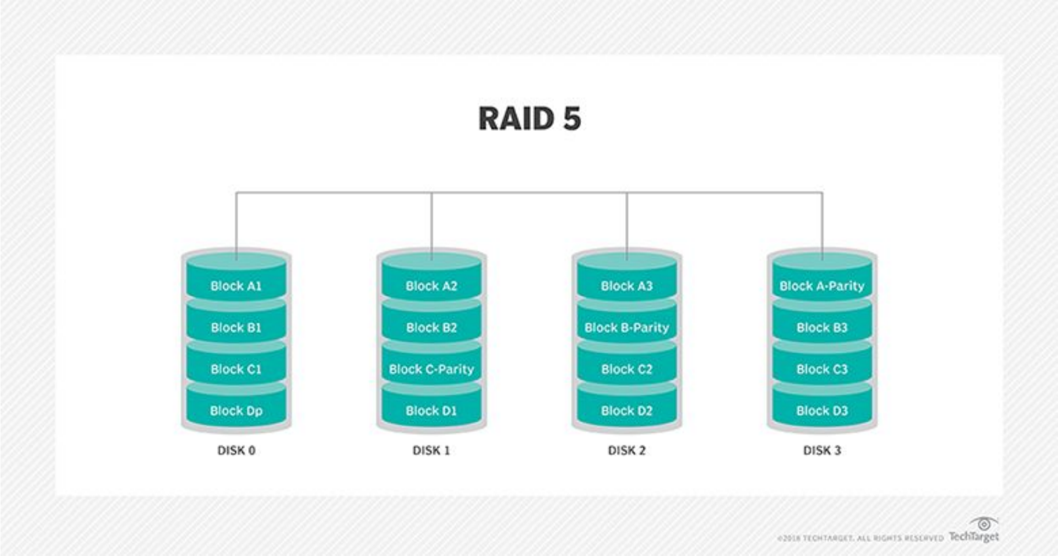
RAID 0

This configuration has striping, but no redundancy of data. It offers the best performance, but no fault tolerance.



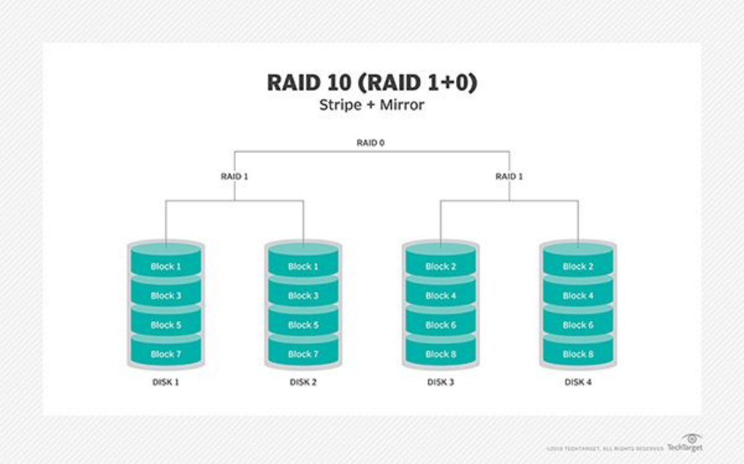
RAID 5

This level is based on block-level striping with parity. The parity information is striped across each drive, allowing the array to function even if one drive were to fail. The array's architecture allows read and write operations to span multiple drives. This results in performance that is usually better than that of a single drive, but not as high as that of a RAID 0 array. RAID 5 requires at least three disks, but it is often recommended to use at least five disks for performance reasons.



RAID 10

RAID 10 (RAID 1+0): Combining RAID 1 and RAID 0, this level is often referred to as RAID 10, which offers higher performance than RAID 1, but at a much higher cost. In RAID 1+0, the data is mirrored and the mirrors are striped.



Data Recovery

RAID works by placing data on multiple disks and allowing input/output (I/O) operations to overlap in a balanced way, improving performance. Because the use of multiple disks increases the mean time between failures (MTBF), storing data redundantly also increases fault tolerance.

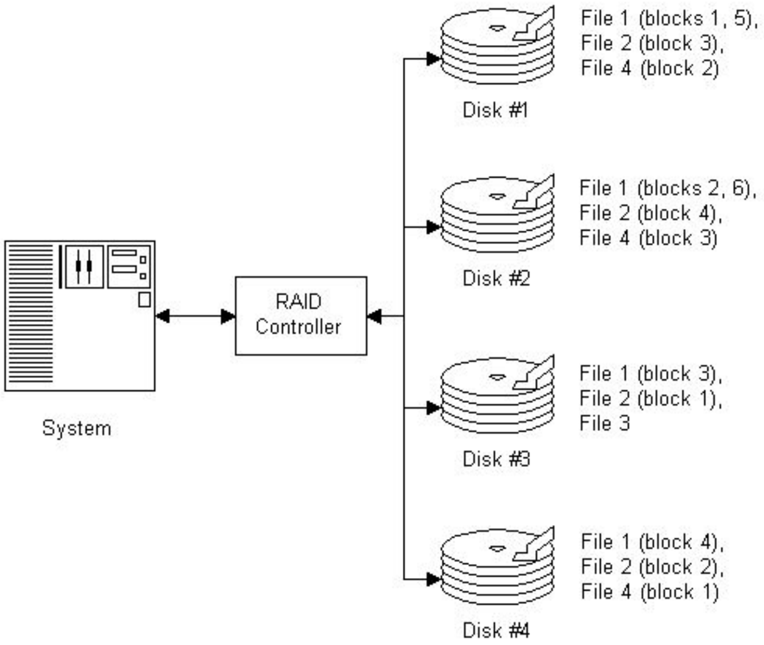
RAID arrays appear to the operating system (OS) as a single logical hard disk. RAID employs the techniques of disk mirroring or disk striping. Mirroring copies identical data onto more than one drive. Striping partitions each drive's storage space into units ranging from a sector (512 bytes) up to several megabytes. The stripes of all the disks are interleaved and addressed in order.

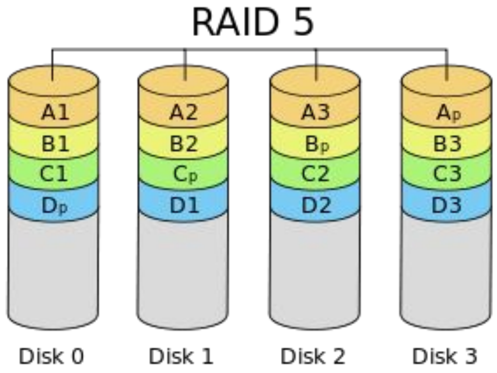
In a single-user system where large records, such as medical or other scientific images, are stored, the stripes are typically set up to be small (perhaps 512 bytes) so that a single record spans all the disks and can be accessed quickly by reading all the disks at the same time.

In a multiuser system, better performance requires that you establish a stripe wide enough to hold the typical or maximum size record. This allows overlapped disk I/O across drives.

Disk mirroring and disk striping can be combined on a RAID array. Mirroring and striping are used together in RAID 01 and RAID 10.

Diagrams


System
RAID Controller
File 1 (blocks 1, 5),
File 2 (block 3),
File 4 (block 2)
Disk #1
File 1 (blocks 2, 6),
File 2 (block 4),
File 4 (block 3)
Disk #2
File 1 (block 3),
File 2 (block 1),
File 3
Disk #3
File 1 (block 4),
File 2 (block 2),
File 4 (block 1)
Disk #4


RAID 5
A1
B1
C1
Dp
A2
B2
Cp
D1
A3
Bp
C2
D2
Ap
B3
C3
D3
Disk 0
Disk 1
Disk 2
Disk 3

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