CSC 4103 - Operating Systems
Spring 2008

LECTURE - XIX

MASS STORAGE AND I/O - II

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RAID Structure

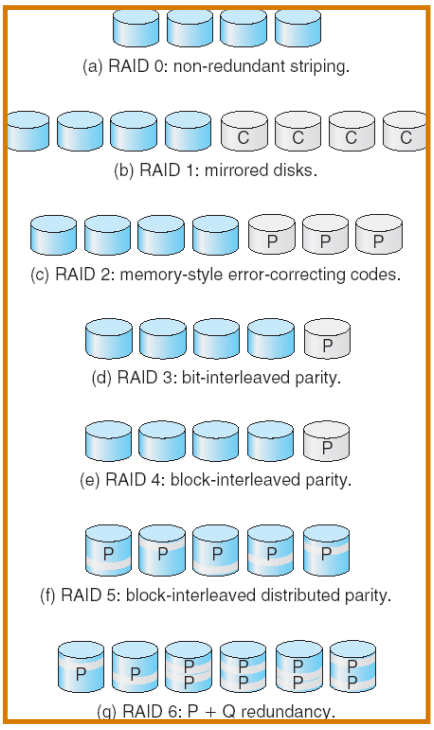
- As disks get cheaper, adding multiple disks to the same system provides increased storage space, as well as increased reliability and performance.
- **RAID: Redundant Array of Inexpensive Disks**
  - multiple disk drives provides **reliability** via **redundancy**.
- RAID is arranged into six different levels.

RAID (cont)

- RAID schemes improve performance and improve the reliability of the storage system by storing redundant data.
  - *Mirroring (shadowing): duplicate each disk*
    - *Simplest but most expensive approach*
  - *Block interleaved parity* uses much less redundancy.

  - Data Striping: splitting each bit (or block) of a file across multiple disks.

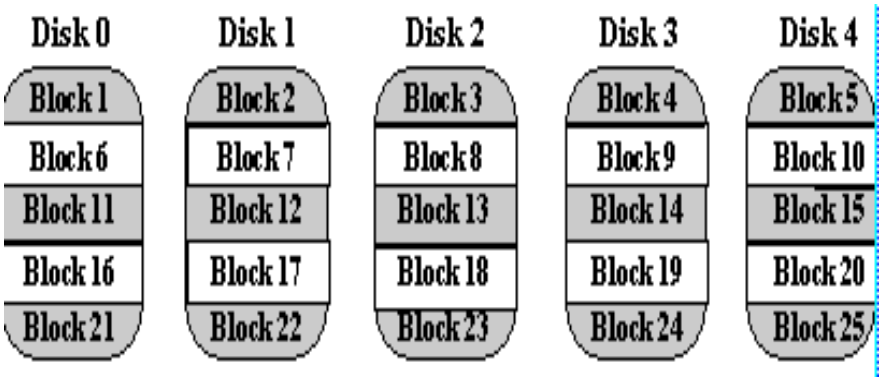
RAID Levels



RAID Level 0

- Data is divided into blocks and is spread in a fixed order among all the disks in the array
- does not provide any fault tolerance
- also known as disk striping
- improves read and write performance via parallel access

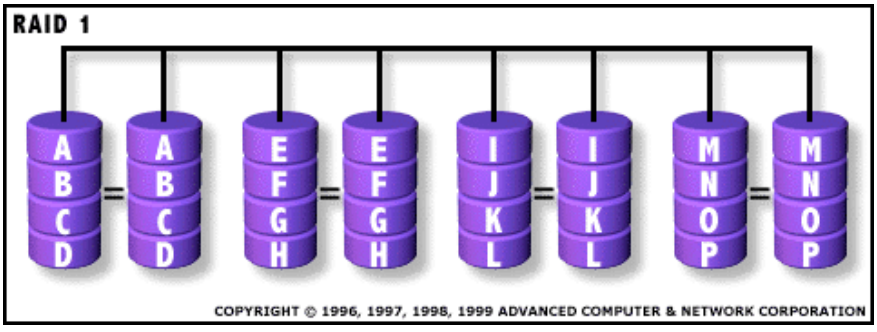
RAID Level 0



RAID Level 1

- All data written to the primary disk is written to the mirror disk
- provides a redundant, identical copy of all data
- provides fault tolerance
- also known as disk mirroring
- also generally improves read performance (but may degrade write performance).

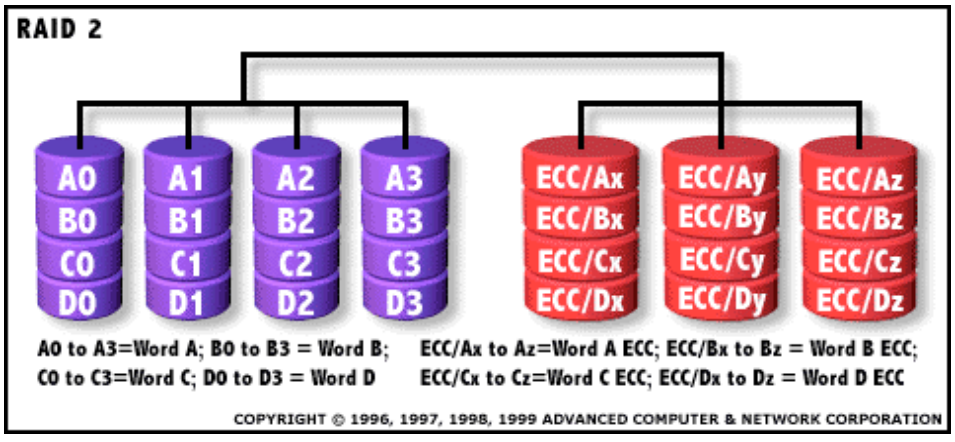
RAID Level 1



RAID Level 2

- uses error correcting algorithm that employs disk-striping strategy that breaks a file into bytes and spreads it across multiple disks
- The error-correction method requires several disks
- provides fault tolerance
- but is not as efficient as other RAID levels

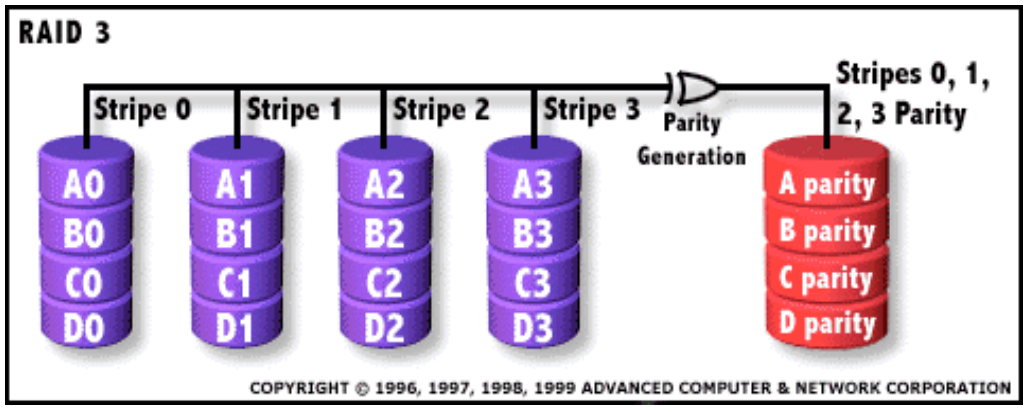
RAID Level 2



RAID Level 3

- similar to RAID level 2, but it requires only one disk for parity data
- suffers from a write bottleneck, because all parity data is written to a single drive
- but provides some read and write performance improvement.

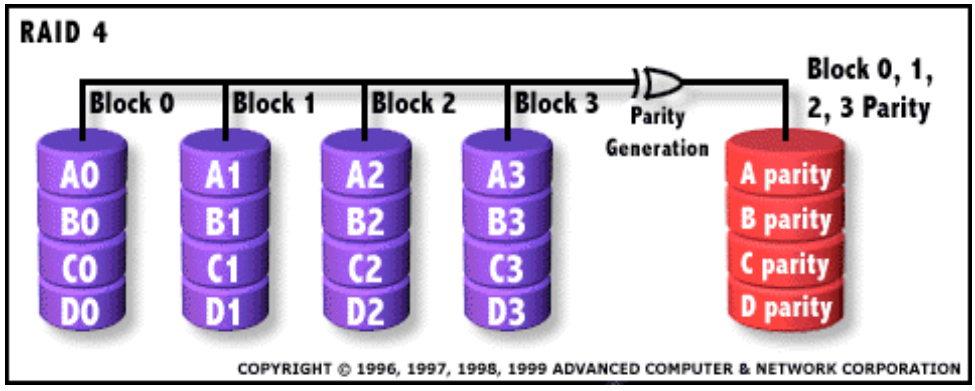
RAID Level 3



RAID Level 4

- similar to RAID level 3, but it employs striped data in much larger blocks or segments
- not as efficient as RAID level 5, because (as in RAID level 3) all parity data is written to a single drive
- so RAID level 4 suffers from a write bottleneck and is not generally used.

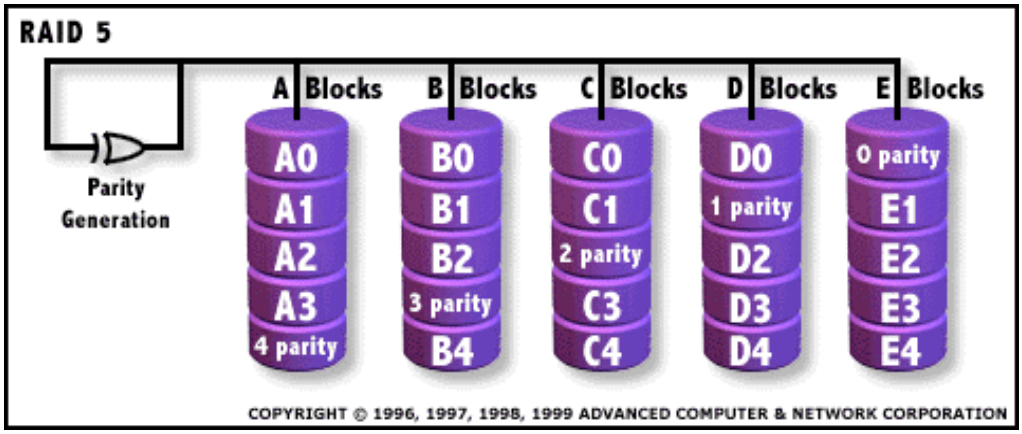
RAID Level 4



RAID Level 5

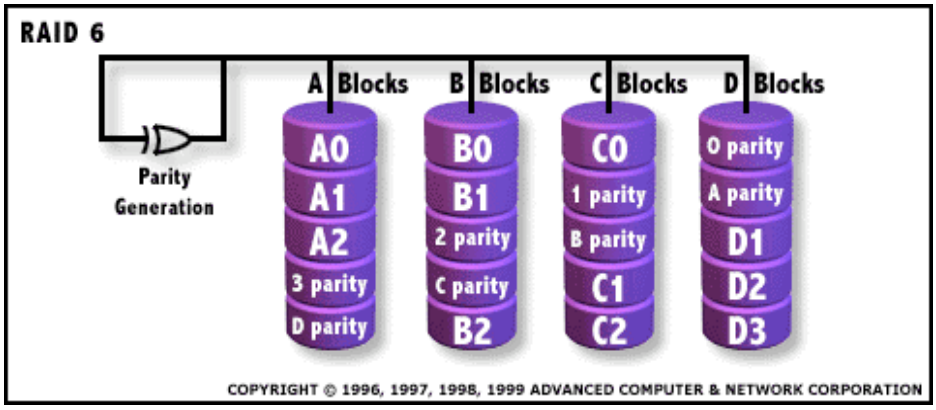
- known as striping with parity
- the most popular RAID level
- similar to level 4 in that it stripes the data in large blocks across all the disks in the array
- It differs in that it writes the parity across all the disks
- The data redundancy is provided by the parity information
- The data and parity information are arranged on the disk array so that the two are always on different disks

RAID Level 5



RAID Level 6

- Similar to RAID 5, but uses dual distributed parity
- more reliability versus less data space



Hierarchical Storage Management (HSM)

- A hierarchical storage system extends the storage hierarchy beyond primary memory and secondary storage to incorporate tertiary storage — usually implemented as a jukebox of tapes or removable disks.
- Usually incorporate tertiary storage by extending the file system.
  - Small and frequently used files remain on disk.
  - Large, old, inactive files are archived to the jukebox.
- HSM is usually found in supercomputing centers and other large installations that have enormous volumes of data.

Hierarchical Storage Management