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.

  - Data Striping: splitting each bit (or block) of a file across multiple disks.
  - Mirroring (shadowing): duplicate each disk
    - Simplest but most expensive approach
  - Block interleaved parity uses much less redundancy.

RAID Levels

- RAID Level 0 - block level
  - 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 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 2

- uses memory-style error correcting code (ECC) that employs disk-stripping strategy that breaks a file into bits and spreads it across multiple disks
- The error-correction method requires three extra disks for four data disks
- provides fault tolerance (Hamming Code [7,3])
  - can both detect & recover from single bit failures
  - can detect but not correct double bit failures
- but is not as efficient as other RAID levels
- Now, all disks have similar error correction code

RAID Level 3

- similar to RAID level 2, but it requires only one disk for parity for 4 data disks
- byte-level striping
- suffers from a write bottleneck, because all parity data is written to a single drive
- but provides some read and write performance improvement.
- RAID 2 & 3 cannot serve multiple requests simultaneously
**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.
- RAID level 4 suffers from a write bottleneck (due to parity disk) and is not generally used.

**RAID Level 5**

- Known as striping with parity.
- The most popular RAID level, replaced RAID 3 & 4.
- 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 6**

- Stores extra redundant info to recover from multiple disk failures.
- Would need 2 additional disks for each 4 data disks - more reliability versus less data space.
- Uses Reed-Solomon error correcting code.
RAID (0+1) and (1+0)

- Combination of RAID 0 & 1
- Better performance & reliability, but doubles the disk storage requirement

Any Questions?

Hmm.

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