Other RAID Levels

Levels 2 through 5 do not fully duplicate data

- Redundancy is provided by:
  - Error correcting information or
  - Parity

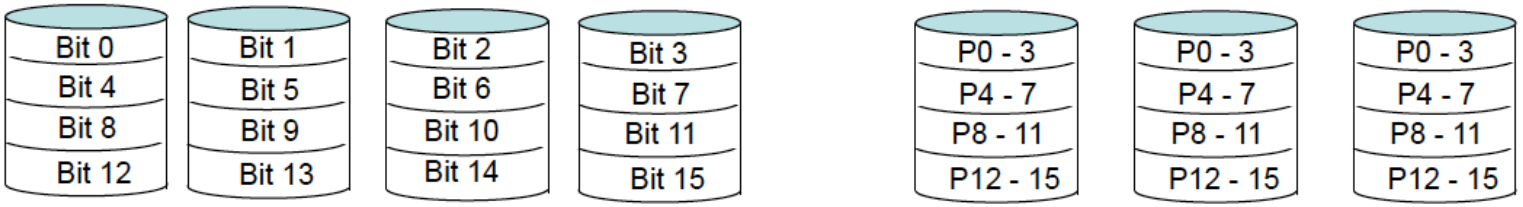
Levels 2 and 3 employ parallel access

- All disks in the array are accessed at the same time
- Heads on each disk move in unison
- Heads on each disk are at the same relative position

Levels 4 and 5 use independent access

- They differ in how the parity is distributed
- Spindles are not synchronized

RAID2



Each access involves all disks

- Parity disks must be written along with data

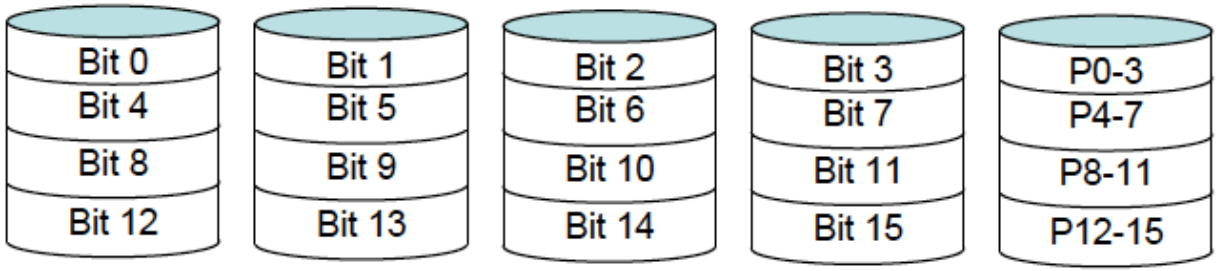
Employs Hamming code for error correction

- Uses almost as much overhead as level 1
- # of parity disks is function of data disks
- For example: 3 error disks for 4 data disks

Nibble, byte or bit level striping

Not used commercially

RAID3

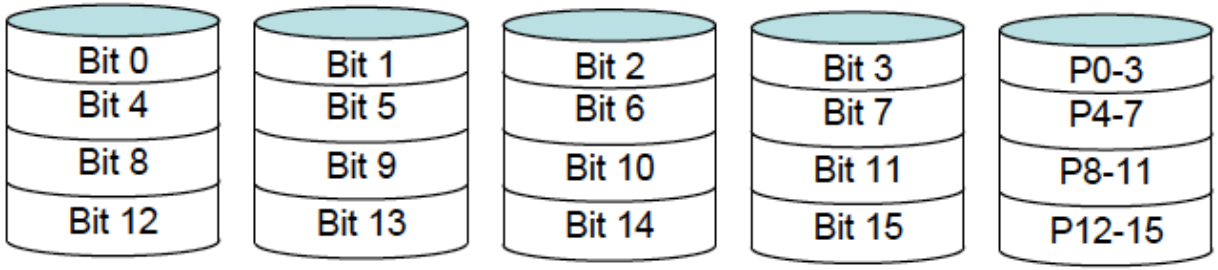


Uses a single parity drive

- Parity based on simple XOR function
- Parity disks must be written along with data
- Parity drive creates a bottleneck
- Parity only used to reconstruct data
- Failures often involve just one disk

All strips within the same “row” constitute a stripe

RAID3 Example



Suppose drive containing bit3 fails:

P0-3 = bit0 ^ bit1 ^ bit2 ^ bit3 (^ denotes XOR operator)

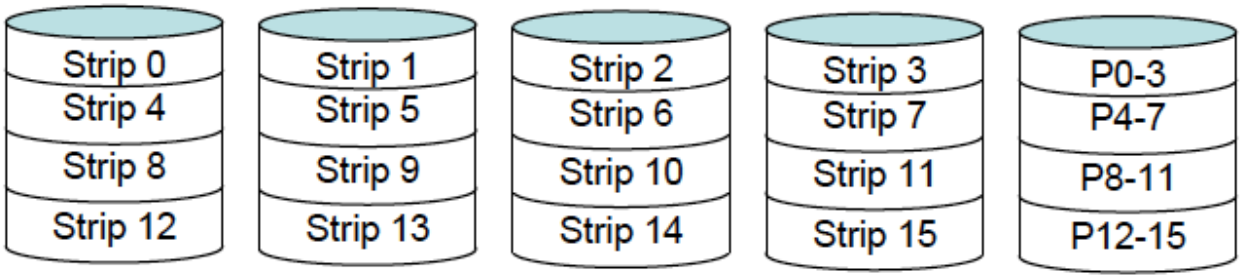
bit3 ^ P0-3 ^ P0-3 = bit0 ^ bit1 ^ bit2 ^ bit3 ^ bit3 ^ P0-3

bit3 = bit0 ^ bit1 ^ bit2 ^ P0-3

So bit3 can be reconstructed from the parity and remaining data disks (entire contents of failed disk can be reconstructed this way)

Writes or reads map to one stripe at a time

RAID4

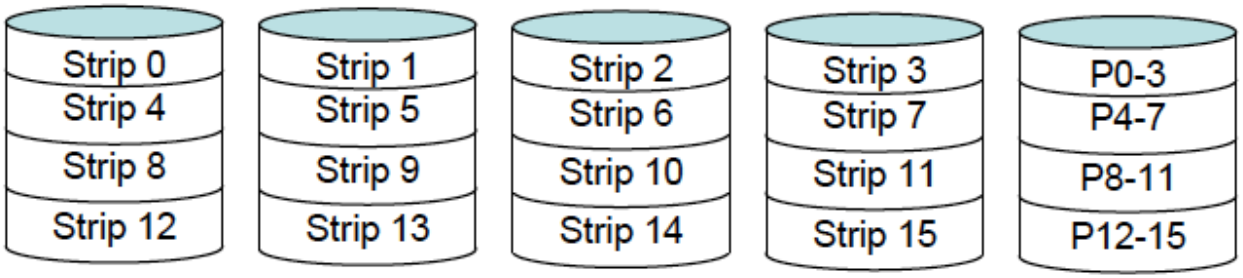


RAID4 uses block level striping (unlike RAID3 strips)
Access heads move independently (unlike RAID 3)

Example: strip0 contains bits 0 – 1023
strip1 contains bits 1024 – 2047, etc.

First bit of P0-3 = XOR of bits 0, 1024, 2048, etc.
(bitwise XOR of data strips)

RAID4



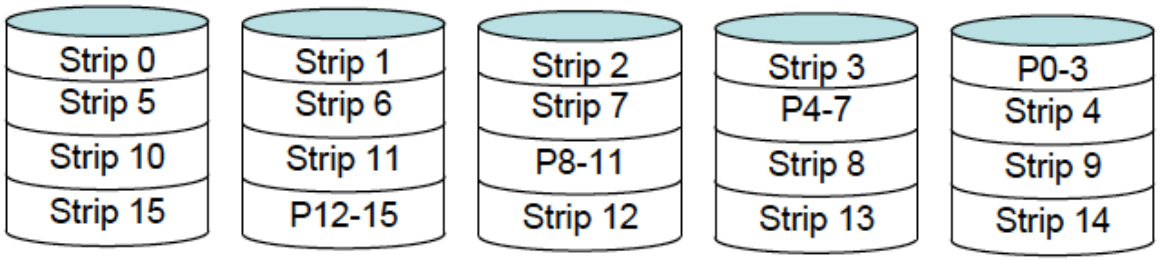
Parity disk must be written if any of the data strips are written

With parity on only one disk, the parity disk is a bottleneck

Tolerates at most one failing disk at a time

If a second disk fails before a replacement occurs, the system is inoperable

RAID5



Uses block-interleaved distributed parity

Different stripes can be updated in parallel (no bottleneck)

- Parity and data blocks are on separate drives

Most popular system

- good reliability
- good performance

RAID5 can only tolerate one failing disk at a time

Failed disk must be replaced before a second disk fails