Storage System

Does I/O performance matter?

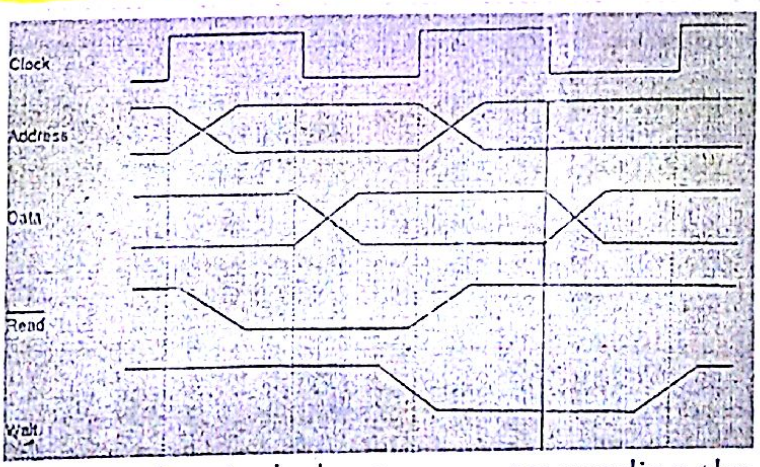
- I/O performance matters because-
  - Response time is important for interactive software.
  - It is expensive to rely on running other processes.
  - Applications such as transaction processing place strict limits on response time.
  - Mobile device and desktop computer are operated by single user thus there are fewer processes.

- Thus I/O performance increasingly limits system performance and effectiveness.

CPU-memory bus Vs I/O bus

- Buses are traditionally classified as CPU-memory buses and I/O buses.
- I/O buses-
  1. I/O buses are lengthy → 2. low speed
  - many types of devices connected to them
  - wide range of data bandwidth depends on different devices
  - follow a bus standard
- CPU-memory buses-
  - are short
  - high speed
  - maximized memory-CPU bandwidth
  - Designer knows all types of devices that connect togather

Typical bus read transaction



- A bus transaction includes two parts: sending the address and receiving or sending the data. In a read transaction the address is first sent down the bus to memory, together with the appropriate control signal (asserting the read signal). The memory responds by returning the data on the bus with appropriate control signal (deasserting the wait signal).

Bus design decision

- Options for designing a bus based on performance versus cost:

Option	High performance	Low cost
Bus width	Separate address and data lines	Multiplex address and data lines
Data width	Wider is faster	Narrower is cheaper
Transfer size	Multiple word has less bus overhead	Single word transfer is simpler
Bus masters	multiple	Single master
Split transaction	yes	No
clocking	Synchronous	Asynchronous

Synchronous Vs Asynchronous bus

- Synchronous bus-
  - includes a clock in the control lines and a fixed protocol for sending address and data relative to the clock.
  - Little or no logic is needed to decide what to do next.
  - Fast and inexpensive.
  - Two major disadvantages are-
    - For clock skew problem they cannot be long in length
    - Every device connected to the bus must run at the same speed.
  - CPU-memory buses are typically synchronous.

- Asynchronous bus-
  - Self timed and handshaking protocols are used between sender and receiver
  - Bus length is flexible
  - Slower than synchronous bus
  - I/O buses are more likely to be asynchronous.

Reliability, availability and dependability

- How does a system failure occur?
  - A programming mistake is a *fault*. The consequence of a *fault* is an error (or latent error) in the software. Upon activation, the error becomes effective. When this effective error produces erroneous data that affect the delivered service, a *failure* occurs.

- Two states of delivered service:
  - Service accomplishment- where the service is delivered as specified.
  - Service interruption- where the delivered service is different from the specified service.

Transition between these two states are caused by failure (from state 1 to state 2) or restorations (from 2 to 1).

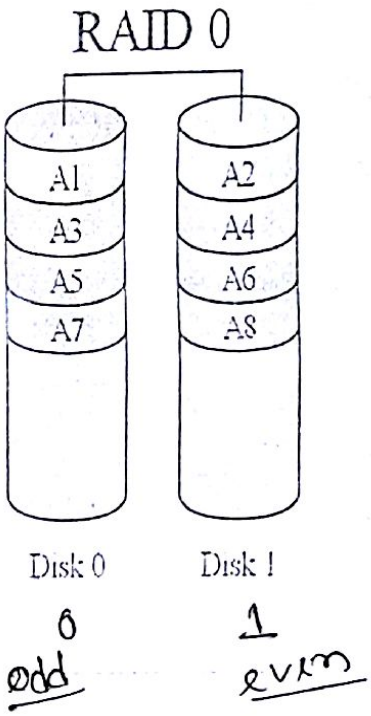
RAID (Redundant Array Of Independent Disks)

- RAID (Redundant Array Of Independent Disks) is a data storage virtualization technology that combines multiple physical disk drive components into a single logical unit for the purpose of data redundancy and performance improvement. Earlier RAID was known as Redundant Array of Inexpensive Disks.

- Common RAID levels:
  - RAID 0 → odd-even
  - RAID 1 → Mirror
  - RAID 5 → Parity
  - RAID 10 → combination of RAID-0 and 1.

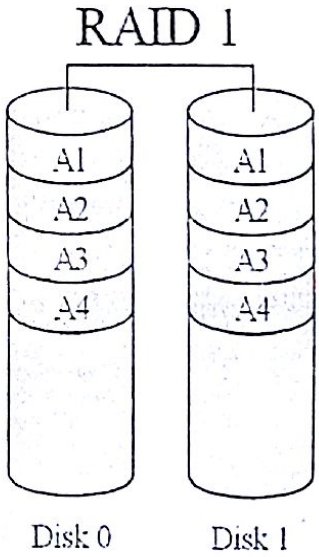
RAID 0

a. It splits data among two or more disks.
b. Provides good performance.
c. Lack of data redundancy means there is no fail over support with this configuration.
d. In the diagram to the right, the odd blocks are written to disk 0 and the even blocks to disk 1 such that A1, A2, A3, A4, ... would be the order of blocks read if read sequentially from the beginning.
e. Used in read only NFS systems and gaming systems.



RAID 1

- RAID1 is 'data mirroring'.
- Two copies of the data are held on two physical disks, and the data is always identical.
- Twice as many disks are required to store the same data when compared to RAID 0
- Array continues to operate so long as at least one drive is functioning.



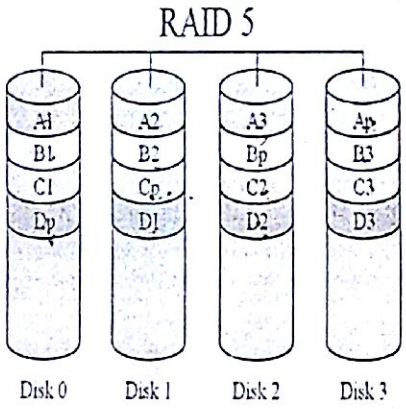
Disk 0 = Disk 2

RAID 5

RAID 5 is an ideal combination of good performance, good fault tolerance and high capacity and storage efficiency.

An arrangement of parity and CRC to help rebuilding drive data in case of disk failures.

"Distributed Parity" is the key word here.



RAID 10

a. Combines RAID 1 and RAID 0.
b. Which means having the pleasure of both - good performance and good failover handling.
c. Also called 'Nested RAID'.