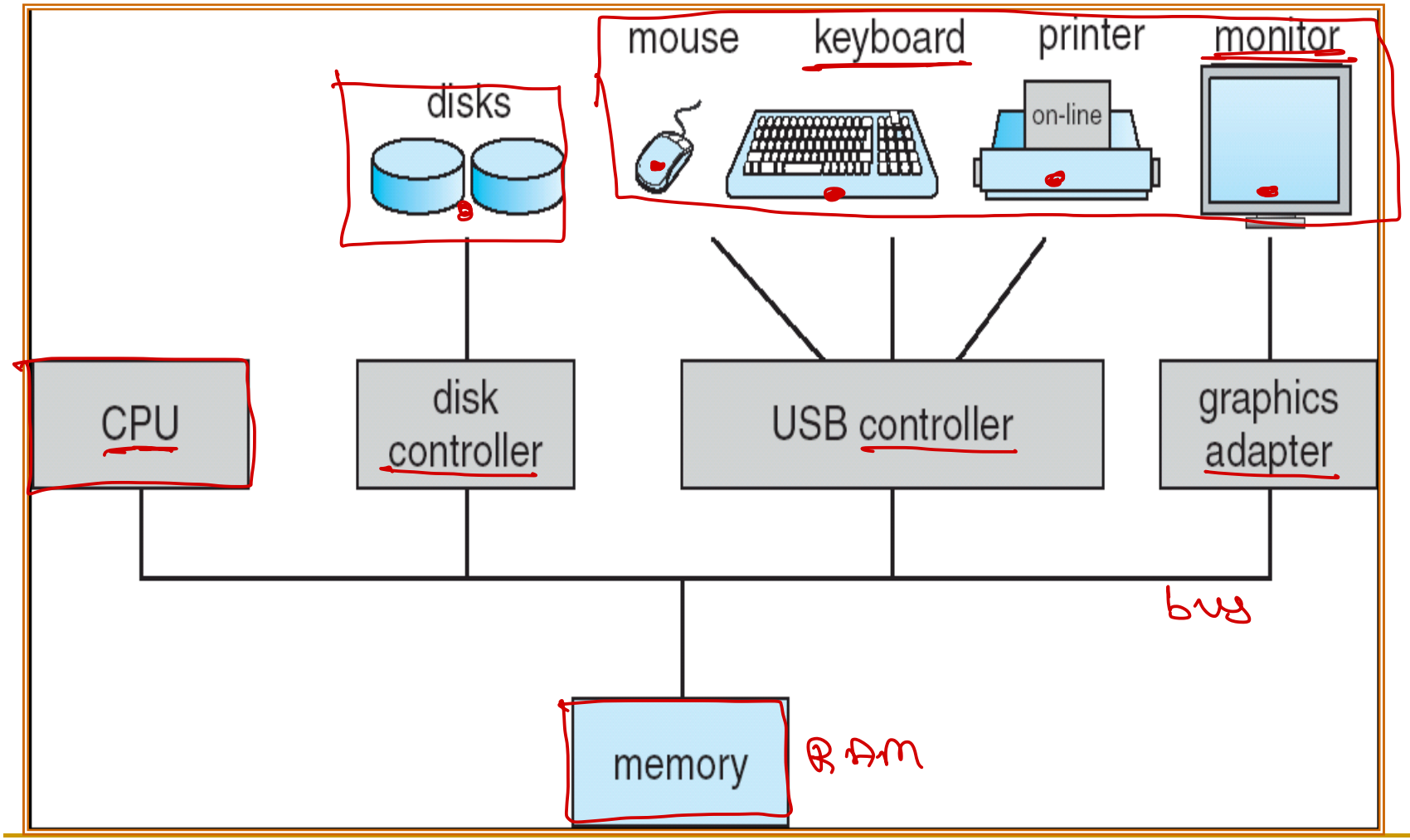
Computer System

Sunbeam Infotech

Computer System Structure



Direct Memory Access Structure

- Used for high-speed I/O devices able to transmit information at close to memory speeds.
- Device controller transfers blocks of data from buffer storage directly to main memory without CPU intervention.
- Only one interrupt is generated per block, rather than the one interrupt per byte.

Memories

Primary
(directly accessible by CPU)

1. CPU registers
2. Cache
3. RAM (main memory)

(Memory)

Secondary
(accessible by CPU via primary memory)

1. hard disk
2. optical disk
3. magnetic tapes.
4. ROM

(Storage)

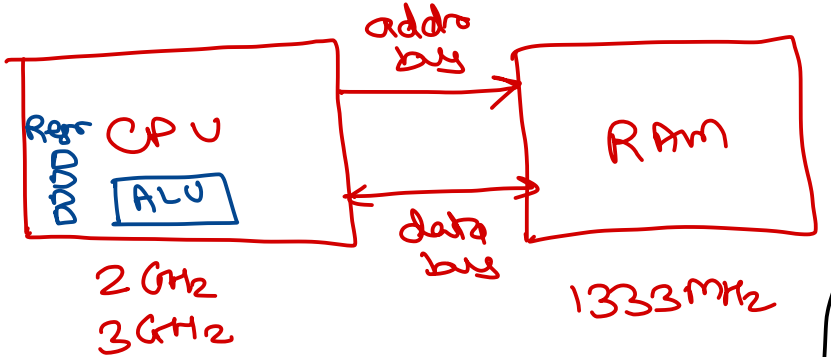
Storage Structure

- Main memory – only large storage media that the CPU can access directly.
- Secondary storage – extension of main memory that provides large nonvolatile storage capacity.
- Magnetic disks – rigid metal or glass platters covered with magnetic recording material
  - Disk surface is logically divided into tracks, which are subdivided into sectors.
  - The disk controller determines the logical interaction between the device and the computer.
- Storage systems organized in hierarchy.
  - Speed, Cost, Volatility

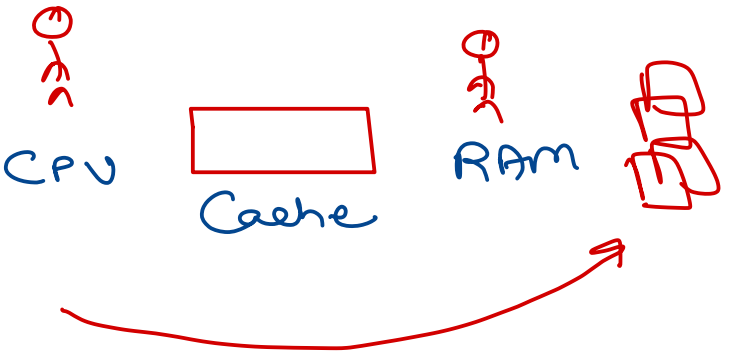
Main Memory

- The main memory and processor registers are directly accessed by the CPU.
- The machine instructions take the addresses from main memory or registers, not the disk.
- In concept of memory mapped I/O, a set of memory addresses are reserved to tie with device registers.
- Even I/O ports are mapped with some addresses.
- The user program or OS writes data on these addresses and then set control register to send the data.
- Access to main memory is slower than the registers.

RAM



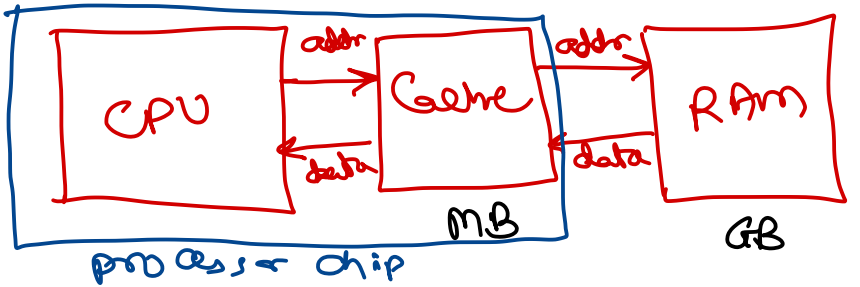
Cache



Cache is high speed associative memory

* search by addr is very fast.
* address → data.
* Least recently accessed data is overwritten.
* Cache always contains recent data only.

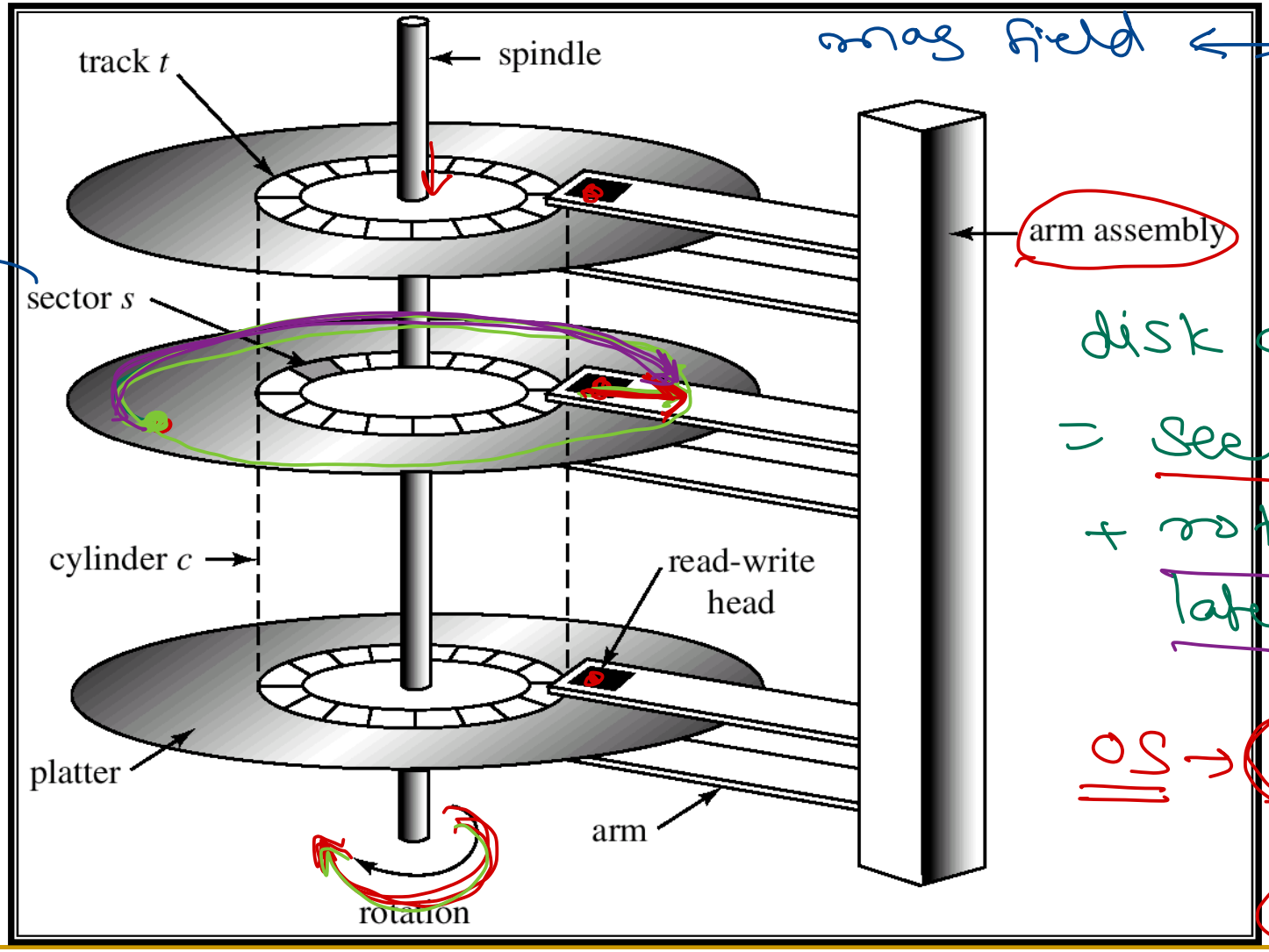
Cache hit
Cache miss



* magnetic dipole
N → S → 1
S → N → 0
* faraday's laws

Magnetic Disks

mag field ↔ current



512 bytes

disk access time
= seek time
+ rotational latency

CHS

OS → LBA → CHS

disk capacity = H * T per head * S per track * 512

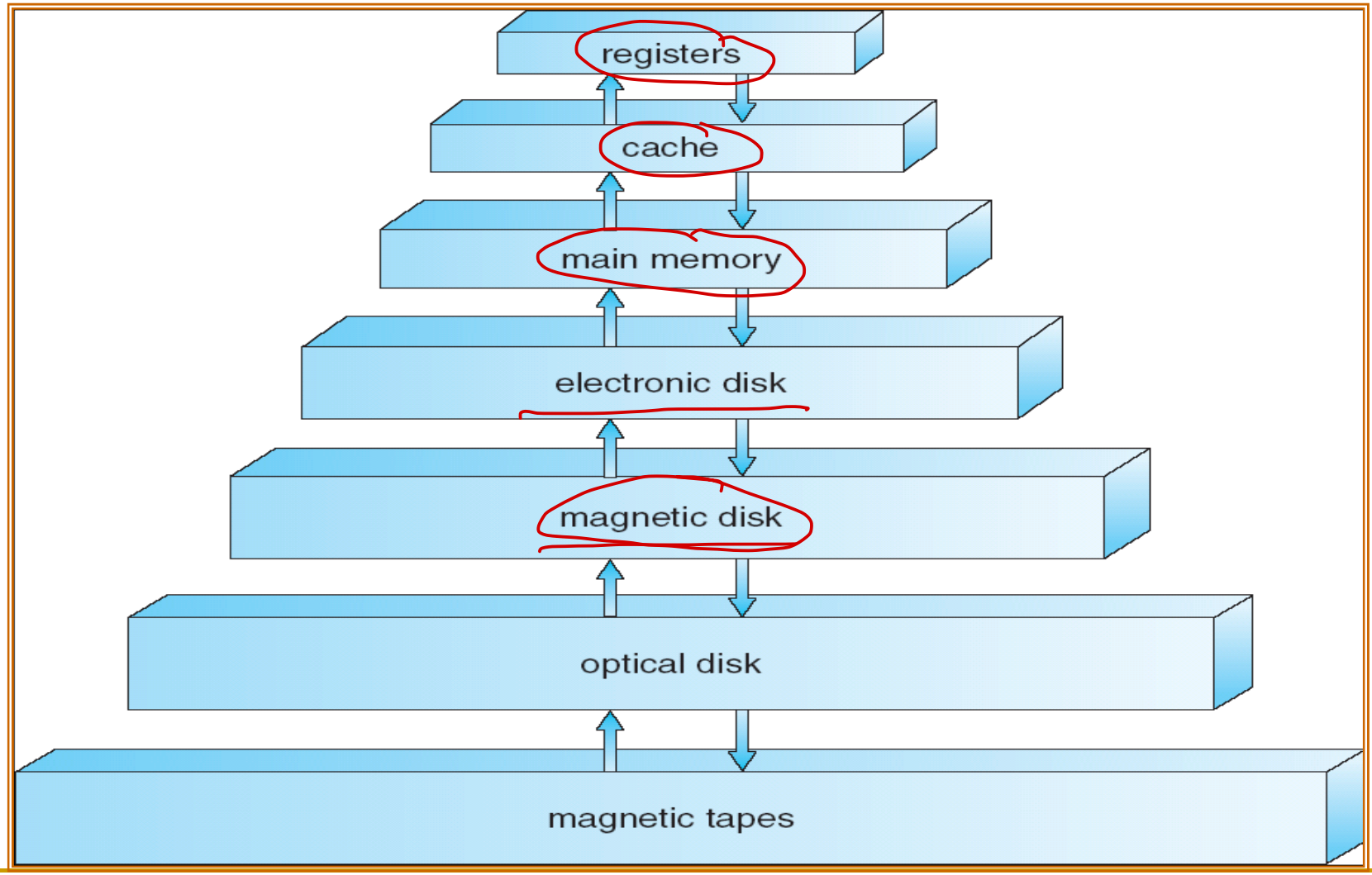
Magnetic Disks

- Magnetic disk speed is based on two factors
  - Transfer rate: data flow rate betⁿ drive and computer
  - Positioning time or Random access time
    - Seek time: move disk arm to desired cylinder
    - Rotation latency: rotate disk head to desired sector
- Drive is attached to computer through I/O bus
- Different types of buses are
  - Enhanced integrated drive electronics (EIDE)
  - Advanced technology attachment (ATA) : (PATA/SATA)
  - Small computer systems interface (SCSI)
- Host controller is connected at computer end of bus connecting to drive and do the I/O.

Performance of Various Levels of Storage

Level	1	2	3	4
Name	registers	cache	main memory	disk storage
Typical size	< 1 KB	> 16 MB	> 16 GB	> 100 GB
Implementation technology	custom memory with multiple ports, CMOS	on-chip or off-chip CMOS SRAM	CMOS DRAM	magnetic disk
Access time (ns)	0.25 – 0.5	0.5 – 25	80 – 250	5,000.000
Bandwidth (MB/sec)	20,000 – 100,000	5000 – 10,000	1000 – 5000	20 – 150
Managed by	compiler	hardware	operating system	operating system
Backed by	cache	main memory	disk	CD or tape

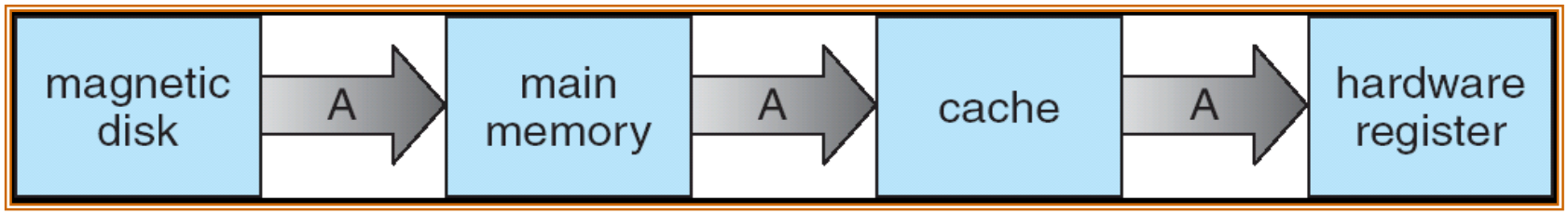
Storage-Device Hierarchy



Caching

- Important principle, performed at many levels in a computer (in hardware, operating system, software)
- Information in use copied from slower to faster storage temporarily
- Faster storage (cache) checked first to determine if information is there
  - If it is, information used directly from the cache (fast)
  - If not, data copied to cache and used there
- Cache smaller than storage being cached
  - Cache management important design problem
  - Cache size and replacement policy

Migration of int A from disk to register



- Multitasking environments must be careful to use most recent value, no matter where it is stored in the storage hierarchy
- Multiprocessor environment must provide cache coherency in hardware such that all CPUs have the most recent value in their cache
- Distributed environment situation even more complex
  - Several copies of a datum can exist

Thank you!

Source: Galvin OS books/slides

Edited by: Nilesh Ghule