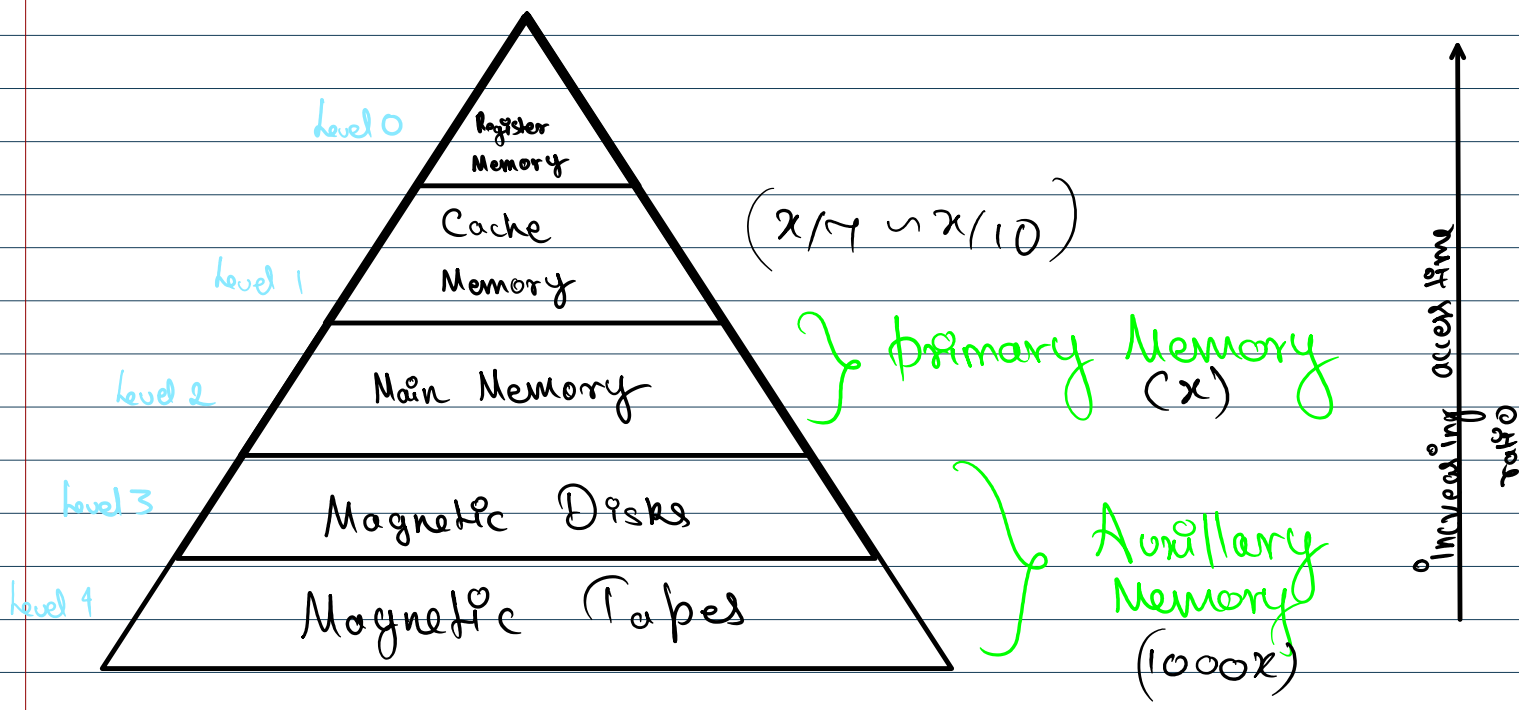
Memory Hierarchy



Main memory occupies central position and it directly communicates with CPU & Auxiliary memory via I/O processor.

Memory Access Methods

Each memory type is a collection of memory locations

To access data from any memory, it is first located and then data is then read from the location

1) Random Access ; Main memories are random access memories, in which each memory has a unique address.
Using unique address any memory location can be reached in same amount of time in any order

2) Sequential Access ; This method allows memory access in sequence or order.

3) Direct Access ; In this mode, information is stored in tracks, with each track having separate read/write head

Main Memory

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Main memory

RAM (Random Access Memory)

(RAM has major share in Main memory)

1. DRAM (Dynamic RAM)
   - → made of transistor & capacitors.
   - → refreshed every 10-100 ms.
   - → slower & cheaper than SRAM
2. SRAM (Static RAM)
   - → has 6-transistor circuits in each cell
   - → retains data until powered off
   - → faster than DRAM
3. NVRAM (Non-Volatile RAM)
   - → Retains data even when turned off
   - → example: flash memory

ROM (Read only Memory)

Non Volatile Storage (permanent storage) (→ Stores bootstrap loader)

1. PROM (Programable ROM)
2. EPROM (Erasable PROM)
3. EEPROM (Electrically Erasable PROM)

Cache Memory

Cache is very special high speed Memory & is used by CPU

This is used to reduce access time of data from memory

Cache copies data from main memory & feeds to the CPU at high speeds

Cache Mapping
- ① Direct Mapping
- ② Associative Mapping
- ③ Set-Associative Mapping

Direct Mapping : (Simplest technique)

Maps each block of main memory into only one possible cache line

Associative Mapping :

In this associative memory is used to store

Content and address memory word

Any block can go into any line of cache

This is considered to be most flexible & fastest mapping form

Set-Associative Mapping :

Enhanced form of direct mapping, where drawbacks of direct mapping is removed

This groups few lines together creating a set

Thus allows cache to have two or more words in main memory for the same index

Combine best of ① & ②

RAID Memory

Raid is a data virtualization technology, in which a set of physical disk is used as one logical disk by the operating system

The data is distributed accross the array of physical drive, This is known as striping

RAID : Redundant Array of Independent Array

Raid has 6 levels

RAID level 0 :

- fast read/write speed
- fails if any drive fails
- Not redundant
- full storage capacity

- User & System datas are distributed across all of the disk in array
- lower data availability than single disk
- Large I/O data transfer capacity is very high
- Small I/O request rate is very high for both read & write

RAID level 1 : (disk mirroring)

- at least two drive contain exact same data
- works even if one drive fails
- high read speed
- slow write than RAID 0
- Capacity of single drive only

- Disk mirroring config. consisting of least two drives

- No Stripping
- Read Speed is improved as either disk can access
- Write performance is same

RAID level 2 :

- No Striping
- Hamming code - parity
- ECC

- Uses striping across disk, with storage error checking & correcting (ECC) info.
- Uses dedicated hamming code parity, a linear form of ECC

RAID level 3 :

- Dedicated parity
- Striping
- min 3 drives

- Uses striping & dedicates one drive for storing parity info
- Embeded ECC info is used to detect error
- Data recovery is accomplished by calculating the exclusive information recorded on other drives

RAID level 4 :

- Uses large stripes which means user can read record from any single drive
- Overlapped I/O can then be used for read operation
- because all write operations are required to

- because all write operations are required to update the parity drive, no I/O overlapping is possible

RAID level 5 :

- Requires min. 3 drives
- stripes data across with "parity"
- works if 1 drive fails
- read is faster
- write is slow (comparatively)
- loss 33% capacity

- Based on parity block level Stripping
- Parity info is stripped across each drive, retains functionality even if one drive fails
- Array's architecture enables read/write to span multiple drives & requires at least 3-disks

RAID level 6 :

- Similar to RAID 5 but parity written to two drives
- min 4 drive
- max. drive failure = 2
- Read faster than Raid 5
- write slower than Raid 5

- Includes second parity scheme across drives in array
- Due to additional parity, stays functional even if two drives fail
- Slowest write performance than RAID