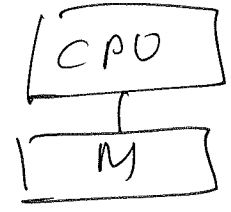


Memory — place to store data.



Considerations

- Capacity: RAM 8GB? 32GB?
- Access Time: How much time to R/W
- Performance: system-level (minimize access time)
- Cost/bit.

Volatile
non
Volatile

Types of Memory — Internal
External

- CPU Registers
 - on the CPU chip
 - stores frequently needed data
 - small capacity (~ few registers)
 - fastest (~ 1 CPU clock cycle or less)

cost?

• Cache Memory

- Sits in between CPU + Main Memory
- Acts as a weigh station for data + instructions
- Capacity ~ 8-30 MB
- Slower than register access
- faster than main memory
- Levels — L1 (Instruction/Data), L2 (Both), L3, ...

1 MB ~ \$20

• ~~Main Mem~~
• Main Memory — RAM

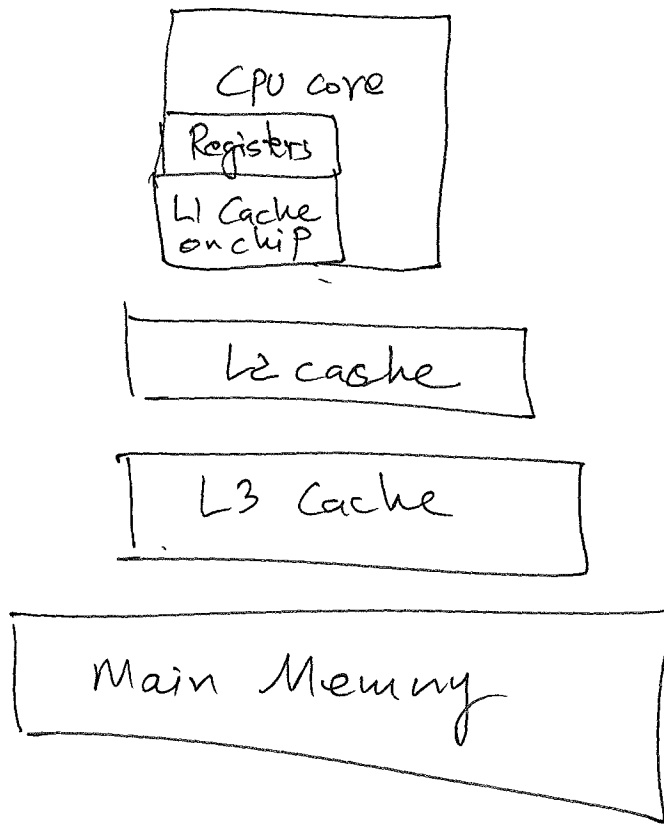
- Primary Memory
- Larger Storage Capacity (8GB - 32GB)
- Slower access time
- Stores data + programs currently in use by CPU

Draw pic on next page

32 GB ~ \$60.00

Memory Technology

- static RAM (SRAM) — used for cache
- Dynamic RAM (DRAM) — used for main memory



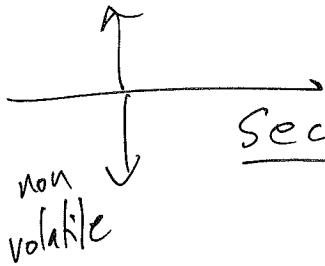
Memory Technology

Static RAM (SRAM) - uses flip-flops
- faster than DRAM
expensive.

Dynamic RAM (DRAM)

- stores data in a capacitor charge
- requires refreshing to maintain charge
- more memory than SRAM

not so
expensive
Volatile

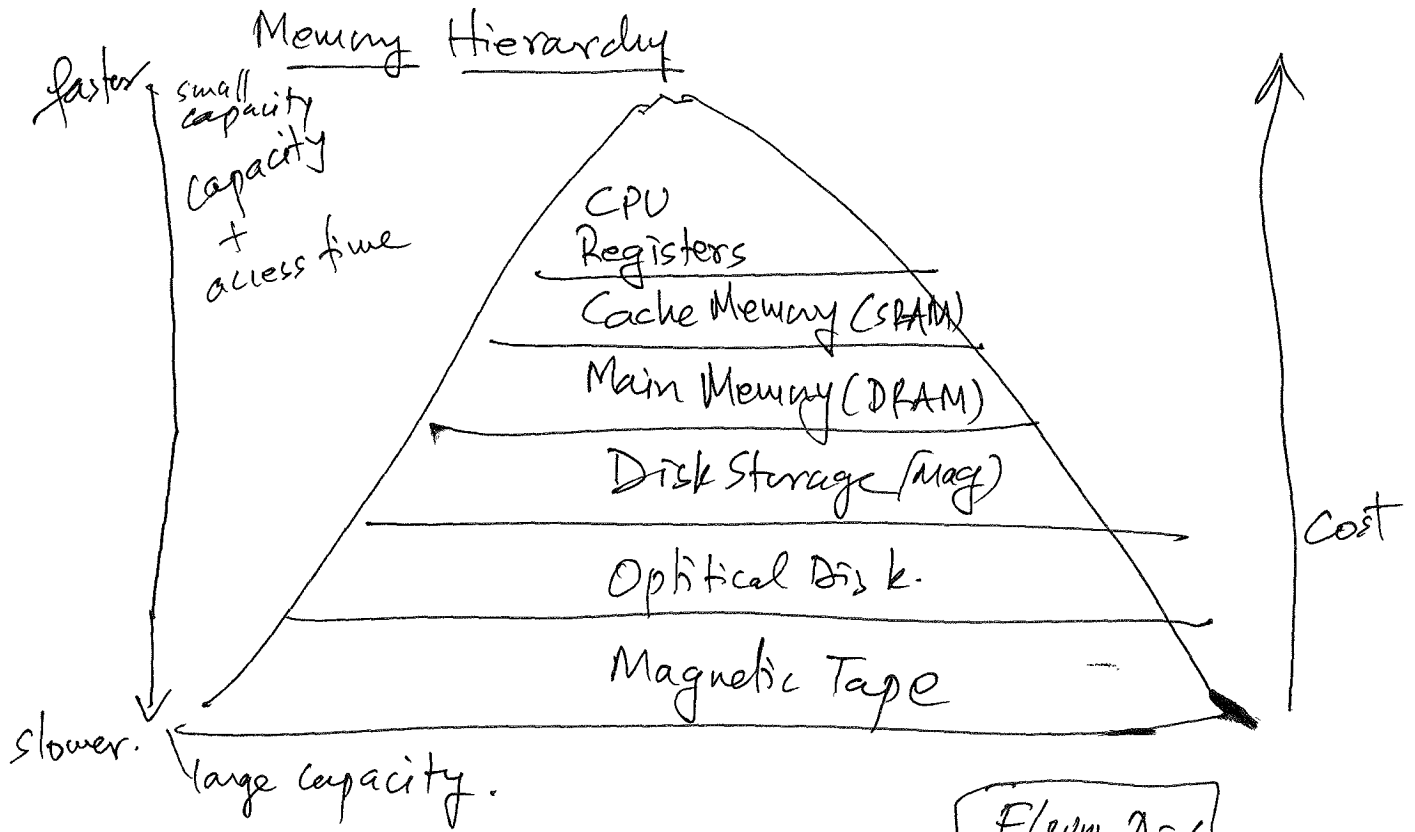


Secondary Storage

- large capacity ~ TB
- stores data + programs not currently used by CPU
- slow access time.

Types

- 1 T portable \$60 - Hand Disks (Magnetic) ^{R/W} (optical) ^{Read Only}
- 10T internal \$200
- used to be \$1 million in 1990!
- 2TB \$200
- 32GB \$6
- Magnetic Tape
- solid state ~~drive~~ (SSD)
- Flash Drives.
- Floppy Disks Gone



example
 32 GB \swarrow Double Data Rate DDR4-3200 $\xrightarrow{\# \text{ Modules}}$ PC4-25600 Non-ECC \$60.00