Hardware Layer

AP CSP @ SouthLake Christian Academy

The data we've been discussing so far is stored on physics devices -- the computer's hardware.

Inside a Computer Video

https://youtu.be/HB4I2CgkcCo

CPU

CPU is the computer's central processing unit

- the "brain"
- performs math in numbers fed to it
- helps display numbers on a screen
- adds or deletes numbers

Cores

Back in the old days (pre-2001), CPUs only had 1 *core*.
Nowadays, CPUs are multi-core.

A **core** is the piece of the CPU that actually performs mathematical operations. More cores → more jobs completed at once.


intel

Memory

While the CPU performs calculations, **memory** is where our data is stored.

Registers

registers are the smallest blocks of memory

- fastest type of memory
- very expensive
- accessed by CPU for calculations

RAM

RAM: random access memory

- files, programs, images are stored on these chips
  - stores data when computer is *on*
  - data not preserved when computer is *off*
- fast access times


crucial
by micron

If you have only 8 GB worth of memory, and a software performs best with 16 GB, your program will run very slowly!

HDDs

When your computer turns off, we want our data to not be erased!

- Hard drive disks store data on magnetized particles embedded onto disks
  - a north pole represents `1`, south pole represents `0`
  - dropping harddrive can cause particles to demagnetize
  - exposing to air renders HDDs useless

Slow Motion Video

https://youtu.be/cFRLXvihIU8

SSDs

When your computer turns off, we want our data to not be erased!

- Solid state drives are smaller than HDDs
- No moving plates
  - corruption less likely if dropped
- Much faster than HDDs
- Don't last as long as HDDs

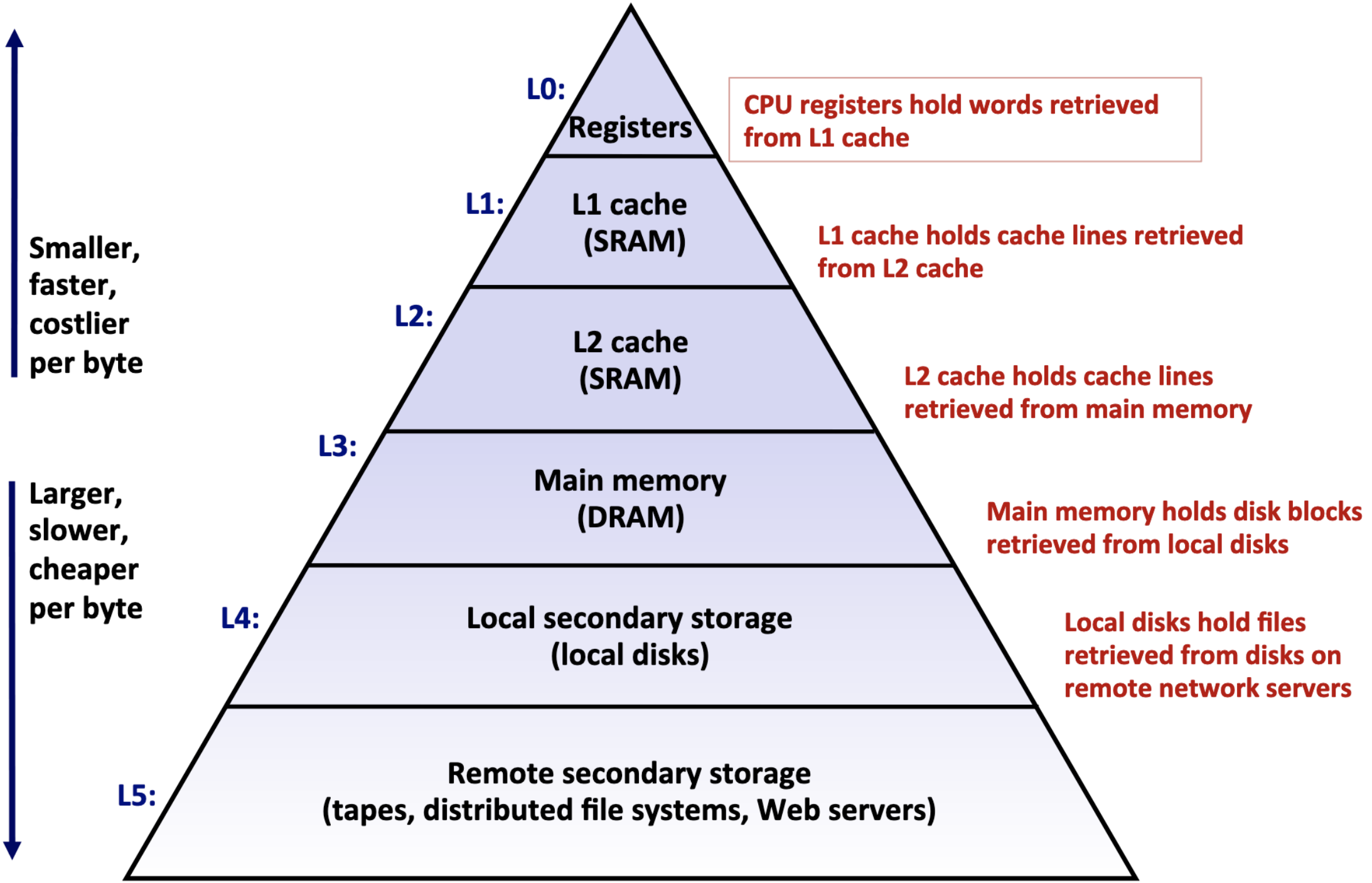
Both SSDs and HDDs are slower than RAM!

Memory Hierarchy

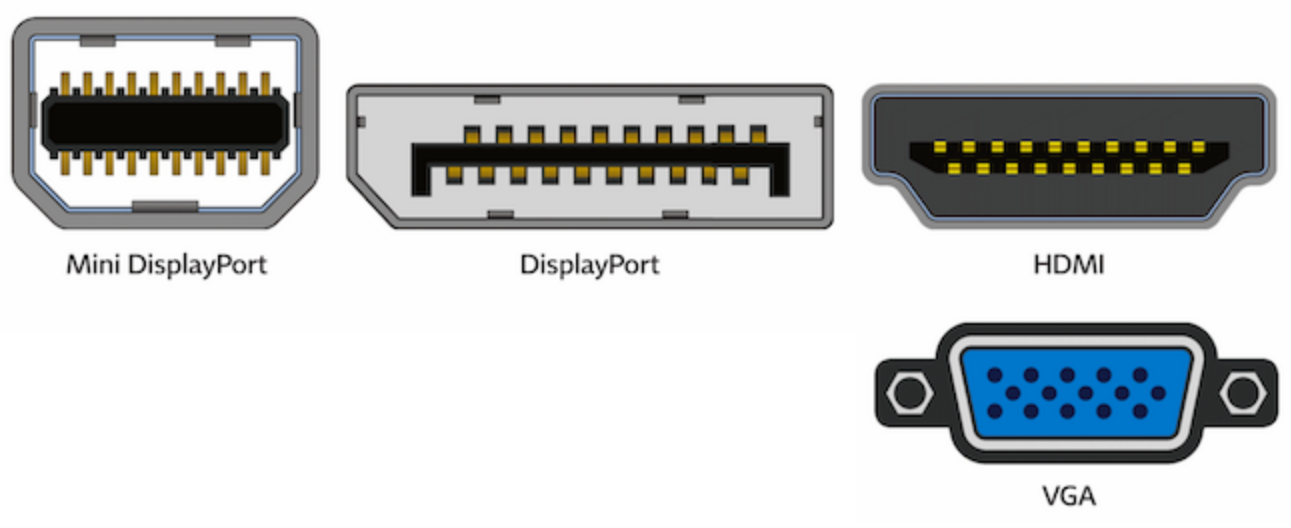
how memory is retrieved from:

- cloud/network storage (ex: Google Drive)
- local storage (ex: HDDs)
- registers

and funneled to CPU


Smaller, faster, costlier per byte
Larger, slower, cheaper per byte
L0:
Registers
CPU registers hold words retrieved from L1 cache
L1:
L1 cache (SRAM)
L1 cache holds cache lines retrieved from L2 cache
L2:
L2 cache (SRAM)
L2 cache holds cache lines retrieved from main memory
L3:
Main memory (DRAM)
Main memory holds disk blocks retrieved from local disks
L4:
Local secondary storage (local disks)
Local disks hold files retrieved from disks on remote network servers
L5:
Remote secondary storage (tapes, distributed file systems, Web servers)

Display Connectors



- Mini DisplayPort → computer displays
- HDMI → computer displays and TVs
- VGA → older computer displays and projectors

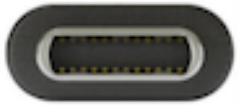
USB

Universal **S**erial **B**us

- Can plug in a whole range of peripheral devices including printers, keyboards, mice, scanners, etc.
- Hard drives can connect via USB
  - Even if a hard drive is fast, if the USB is slow, the transfer of data will be slow

USB A-Type

USB B-Type



USB C-Type

Micro-USB A

Micro-USB B

USB Mini-b (5-pin)

USB Mini-b (4-pin)

USB 3.0 A-Type

USB 3.0 B-Type

USB 3.0 Micro B

WIFI & Bluetooth

- Wifi gives acces to internet
- Bluetooth allows devices such as wireless keyboards and headphones to connect to your computer
  - Limited range
  - This is ok as it is used for you to connect to your own device
- Both use radio waves to transmit data