CS50T

By Eng. Rasha Abdeen

Youtube: Coders Camp
https://youtube.com/playlist?list=PLnrlZUDQofUvLtIMvVxZRYYju7ni0Xsxq

Lecture 1 : Hardware

- Binary System
- CPU
- RAM (Random Access Memory)
- Hard Drives
- Flash memory
- Types of Memory and Funneling
- Display Connectors
- USB (Universal Serial Bus)
- Wireless (WIFI – Bluetooth)
- Operating System (OS)

What is Computer Science ?

- A Computer System is divided into two categories: Hardware and Software.

Hardware:

- The physical components of the computer.

Software:

- Software is a set of instructions that tells a computer exactly what to do.

Hardware	Software
It is manufactured.	It is developed and engineered.
Electronic and other materials are used to create hardware.	Created by utilizing a computer language to write instructions.
Hardware typically wears out over time.	The software does not wear out with time. However, it may contain flaws and glitches.
Main categories: • Input devices • Output devices • Storage devices • Processing devices	Mainly divided into : • System software • Programming software • Application software

What is Computer Science ?

- Knowing how to program is only one element of the field.
- Computer science is the study of the theory, design, implementation of any algorithm, and performance of computer software and computer systems, including the study of computing itself.
- **Computer scientists are problem solvers.**

What is Computer Science ?

- Computer science is fundamentally problem solving.
- A computer scientist's goal is to develop list of instructions for solving any problem that might arise.

What is Computer Science ?

Four Main Problem Solving Steps:

1. Understand the Problem.
2. Design a Solution.
3. Implement your Solution.
4. Check your Solution.

What is Computer Science ?

Computational thinking:

- Computational thinking is thinking algorithmically, taking inputs to a problem and carefully going step by step to produce an output.
- We can then present these solutions in a way that a computer, a human, or both, can understand.

Computational thinking

1. Decomposing
2. Pattern Recognition
3. Abstraction
4. Algorithms

Decomposing

The breaking down of a system into smaller parts that are easier to understand, program and maintain.

Pattern Recognition

Find things that similar.

Abstraction

- Focus in what is important and ignore what is not.
- Abstraction is a technique where we can think about a problem more usefully at a higher level as opposed to the lowest level that it is implemented in.

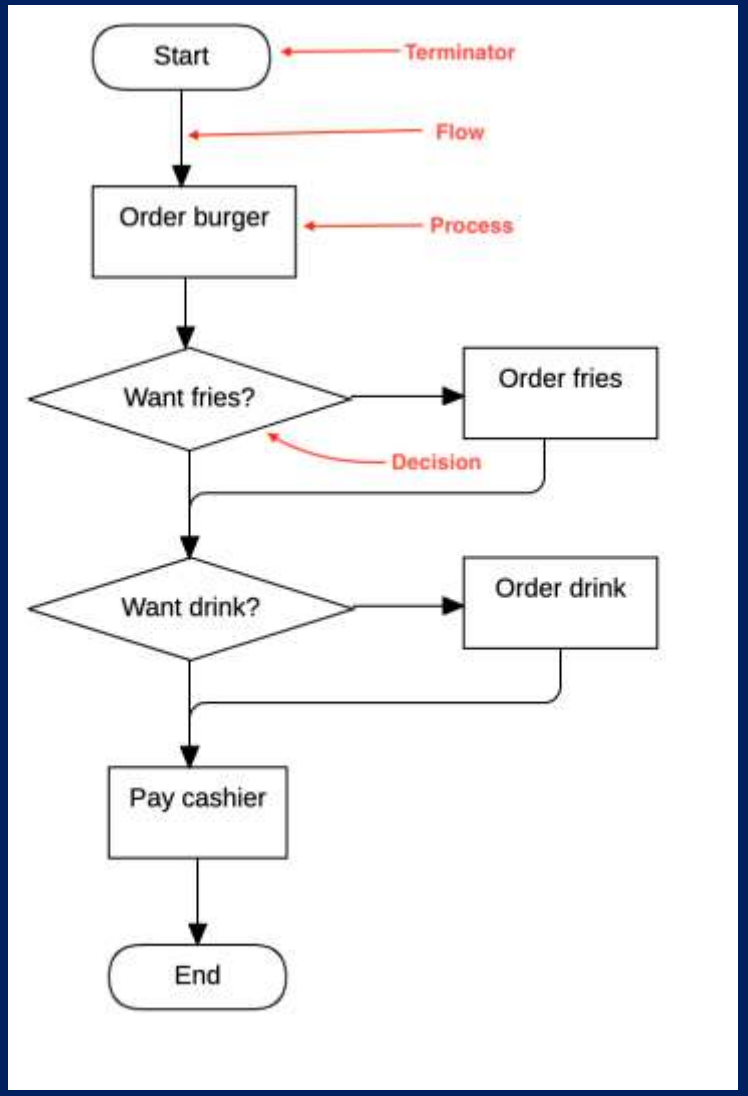
Algorithms

- Write step by step instructions to solve the problem.

Pseudocode

Step 1: Add up the items by type or flavor.
Step 2: Assign the price per each item type.
Step 3: Multiply the number of items by type with its cost per unit.
Step 4: Add the total cost for each type together.
Step 5: Bon Appetit!

Flowchart



Binary System
النظام الثنائي

Binary System

Computer No. System

Base 2 system (0 , 1)

Power of 2

...	2^2	2^1	2^0
...	4	2	1
0	1	1	1
7 =	1*4	1*2	1*1

Decimal System

Human No. System

Base 10 system (0,1,2,3,4,5,6,7,8,9)

Power of 10

...	10^2	10^1	10^0
...	100	10	1
	2	5	5
255 =	2*100	5*10	5*1

11111111 in binary system = 255 in decimal system

Binary System:

Example:

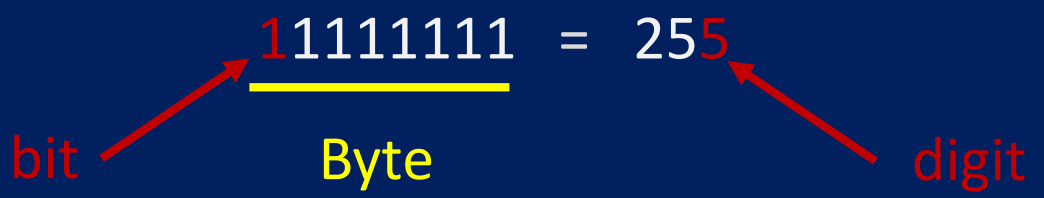
How 11111111 in binary system = 255 in decimal system

1	1	1	1	1	1	1	1
128 +	64 +	32 +	16 +	8 +	4 +	2 +	1

= 255

Binary System:

Example:



- 1 TB (Terabyte) = 1,024 GBs (Gigabytes)
- 1 GB (Gigabyte) = 1,024 MBs (Megabytes)
- 1 MB (Megabyte) = 1,024 KBs (kilobytes)
- 1 KB (Kilobyte)= 1,024 Byte (Byte)
- 1 B (Byte) = 8 b (bits)

Representing Letters

ASCII (American Standard Code for Information Interchange):

- Original ASCII is 7 bits, thus giving 128 characters.

########
0000000 1111111 0111111 1110000 1010101
2^7 = 128

#########
2^8 = 256

####
0000 1234 1024 3240 2568
10^4 = 10000

Representing Letters

ASCII : Original ASCII is 7 bits, thus giving 128 characters.

0	NUL	16	DLE	32	SP	48	0	64	@	80	P	96	`	112	p
1	SOH	17	DC1	33	!	49	1	65	A	81	Q	97	a	113	q
2	STX	18	DC2	34	"	50	2	66	B	82	R	98	b	114	r
3	ETX	19	DC3	35	#	51	3	67	C	83	S	99	c	115	s
4	EOT	20	DC4	36	$	52	4	68	D	84	T	100	d	116	t
5	ENQ	21	NAK	37	%	53	5	69	E	85	U	101	e	117	u
6	ACK	22	SYN	38	&	54	6	70	F	86	V	102	f	118	v
7	BEL	23	ETB	39	'	55	7	71	G	87	W	103	g	119	w
8	BS	24	CAN	40	(	56	8	72	H	88	X	104	h	120	x
9	HT	25	EM	41	)	57	9	73	I	89	Y	105	i	121	y
10	LF	26	SUB	42	*	58	:	74	J	90	Z	106	j	122	z
11	VT	27	ESC	43	+	59	;	75	K	91	[	107	k	123	{
12	FF	28	FS	44	,	60	<	76	L	92	\	108	l	124	|
13	CR	29	GS	45	-	61	=	77	M	93	]	109	m	125	}
14	SO	30	RS	46	.	62	>	78	N	94	^	110	n	126	~
15	SI	31	US	47	/	63	?	79	O	95	_	111	o	127	DEL

Representing Letters

01001000 01001001

72 73

H I

- Programs like notepad, textedit, and MicroSoft Word decide weather to display patterns of bits as letters or words
  - Computers only store 0s and 1s, but the programs interpret those bits in a certain way

Representing Letters

ASCII (American Standard Code for Information Interchange):

- Original ASCII is 7 bits, thus giving 128 characters.
- Extended ASCII is 8 bits, yielding 256 characters

ASCII is Limited!!

Dec	Char	Dec	Char	Dec	Char	Dec	Char
128	Ç	160	á	192	└	224	α
129	ü	161	í	193	┴	225	ß
130	é	162	ó	194	┬	226	Γ
131	â	163	ú	195	├	227	π
132	ä	164	ñ	196	─	228	Σ
133	à	165	Ñ	197	┼	229	σ
134	å	166	ª	198	╞	230	µ
135	ç	167	º	199	╟	231	τ
136	ê	168	¿	200	╚	232	Φ
137	ë	169	⌐	201	╔	233	Θ
138	è	170	¬	202	╩	234	Ω
139	ï	171	½	203	╦	235	δ
140	î	172	¼	204	╠	236	∞
141	ì	173	¡	205	═	237	ø
142	Ä	174	«	206	╬	238	ε
143	Å	175	»	207	╧	239	∩
144	É	176	░	208	╨	240	≡
145	æ	177	▒	209	╤	241	±
146	Æ	178	▓	210	╥	242	≥
147	ô	179	│	211	╙	243	≤
148	ö	180	┤	212	╘	244	⌠
149	ò	181	╡	213	╒	245	⌡
150	û	182	╢	214	╓	246	÷
151	ù	183	╖	215	╫	247	≈
152	ÿ	184	╕	216	╪	248	°
153	Ö	185	╣	217	┘	249	∙
154	Ü	186	║	218	┌	250	·
155	¢	187	╗	219	█	251	√
156	£	188	╝	220	▄	252	ⁿ
157	¥	189	╜	221	▌	253	²
158	₧	190	╛	222	▐	254	■
159	ƒ	191	┐	223	▀	255	

Representing Letters

UNICODE:

- Is a modern standard for text representation that defines each of the letters and symbols commonly used in today's digital and print media.
- Is a bigger set of characters that includes written languages other than English and even emoji! 

UTF-8	Requires 8, 16, 24 or 32 bits (one to four bytes).
Utf-16	Requires either 16 or 32 bits to encode a character.
UTF-32	Always requires 32 bits to encode a character.

- All are still represented by a pattern of bits.

Hardware

Main categories:

1. Processing devices
2. Storage devices
3. Input devices
4. Output devices

Hardware

Motherboard:

- Is the backbone that ties the computer's components together and allows them to talk to each other.
- Without it, none of the computer pieces could interact.
- In 1981, the first motherboard was used in the IBM computer that was originally known as planar.

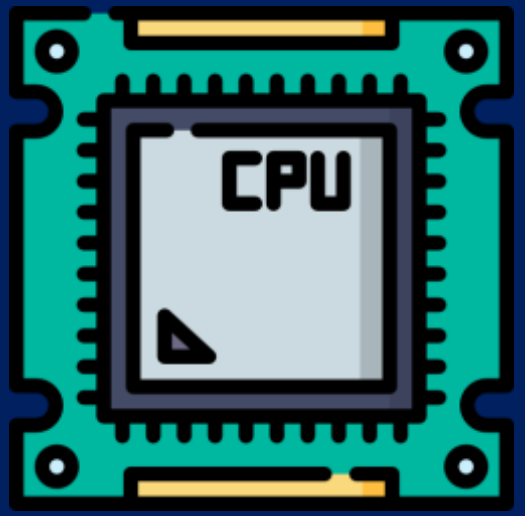
Hardware

1. Processing Devices:

Are the components responsible for the processing of information within the computer system. This includes devices such as:

- CPU
- GPU
- Video Card
- Sound Card

Hardware



1. Processing Devices:

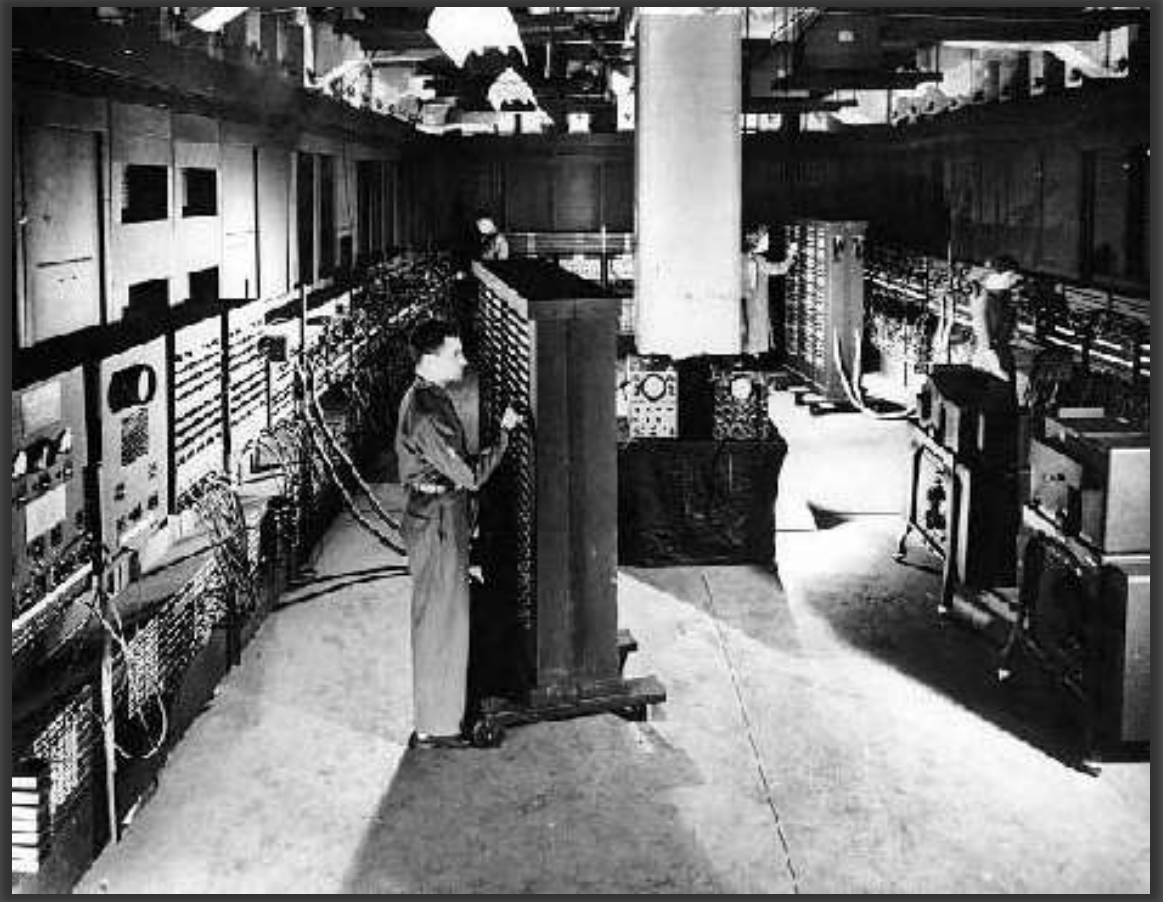
The CPU is the brain of the computer:

- Does all the thinking

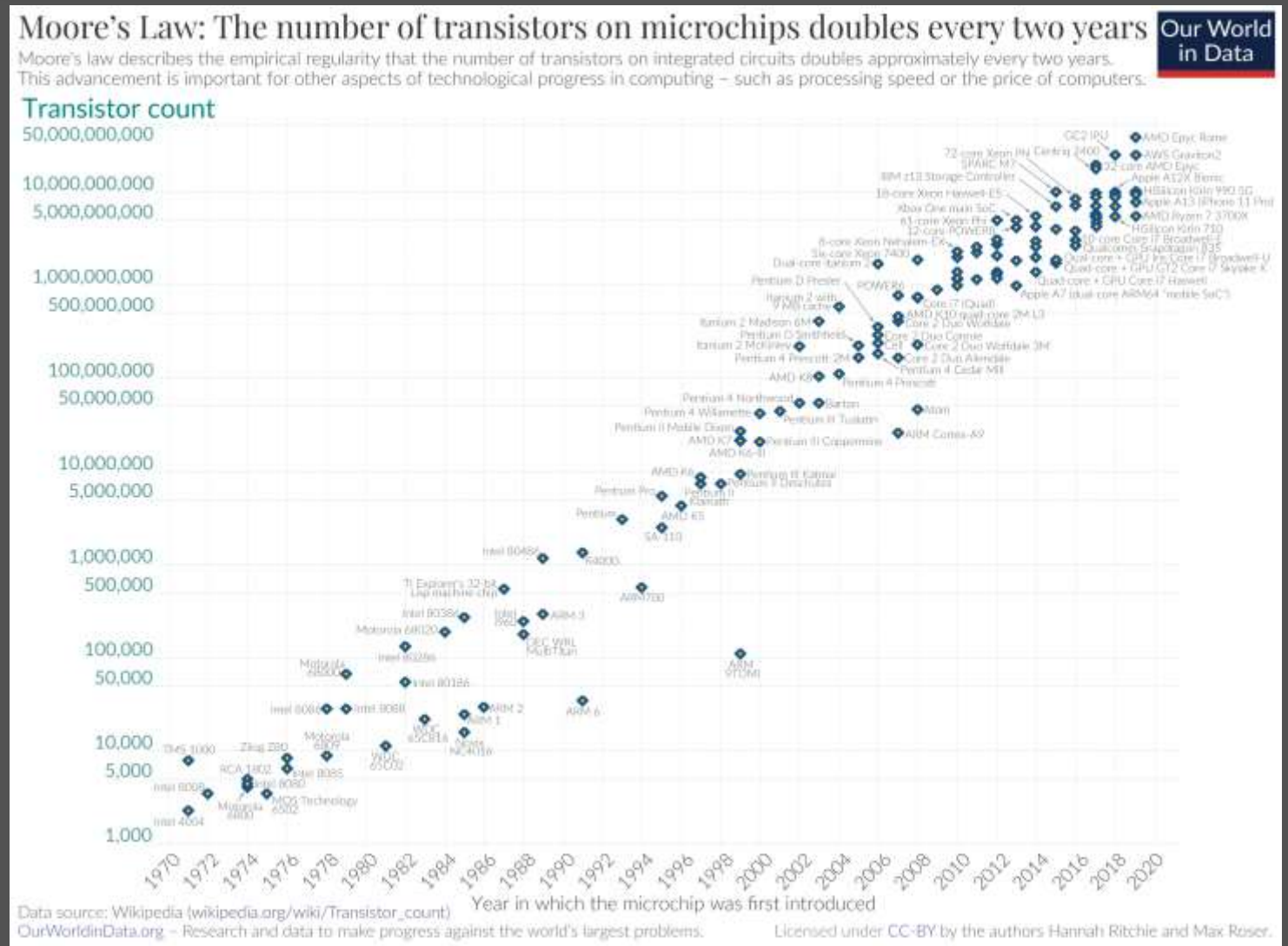
The term “Computer" is derived from the Latin word “Computare" which means to calculate.

ENIAC

Electronic Numerical Integrator and Computer



Moore's law

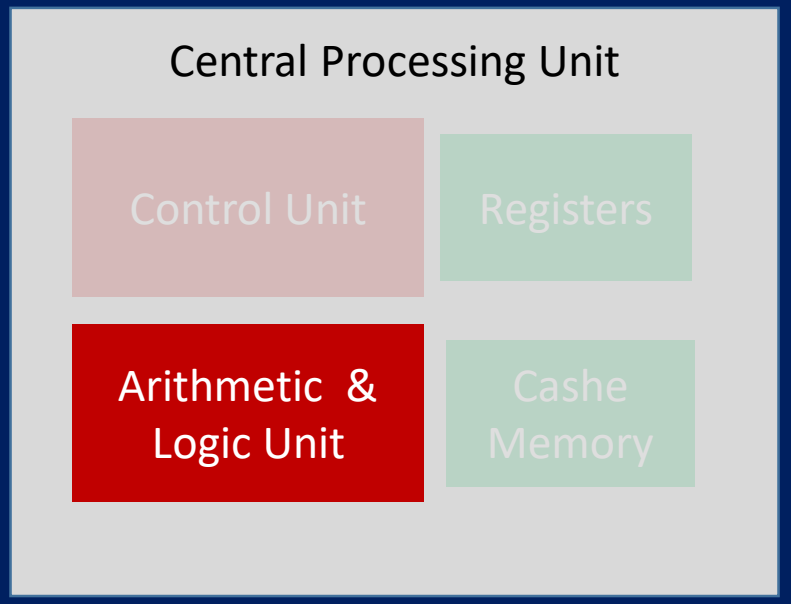


Gordon Earle Moore

Hardware

CPU (Central Processing Unit) (Processor)

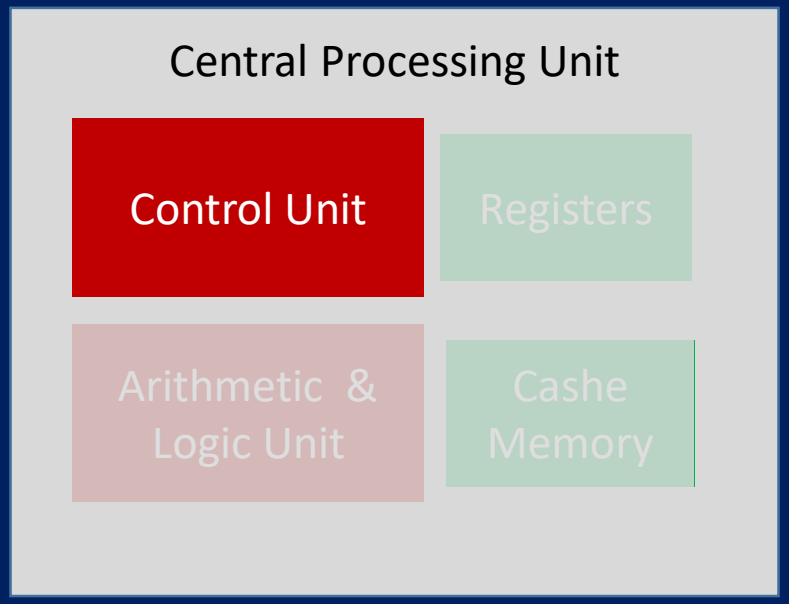
ALU (Arithmetic & Logic Unit):



- Arithmetic functions include addition, subtraction, multiplication ,and division.
- Logical functions mainly include selecting, comparing, and merging the data.
- ALUs can be used for maintaining timers that help run the computer.

Hardware

CPU (Central Processing Unit) (Processor)



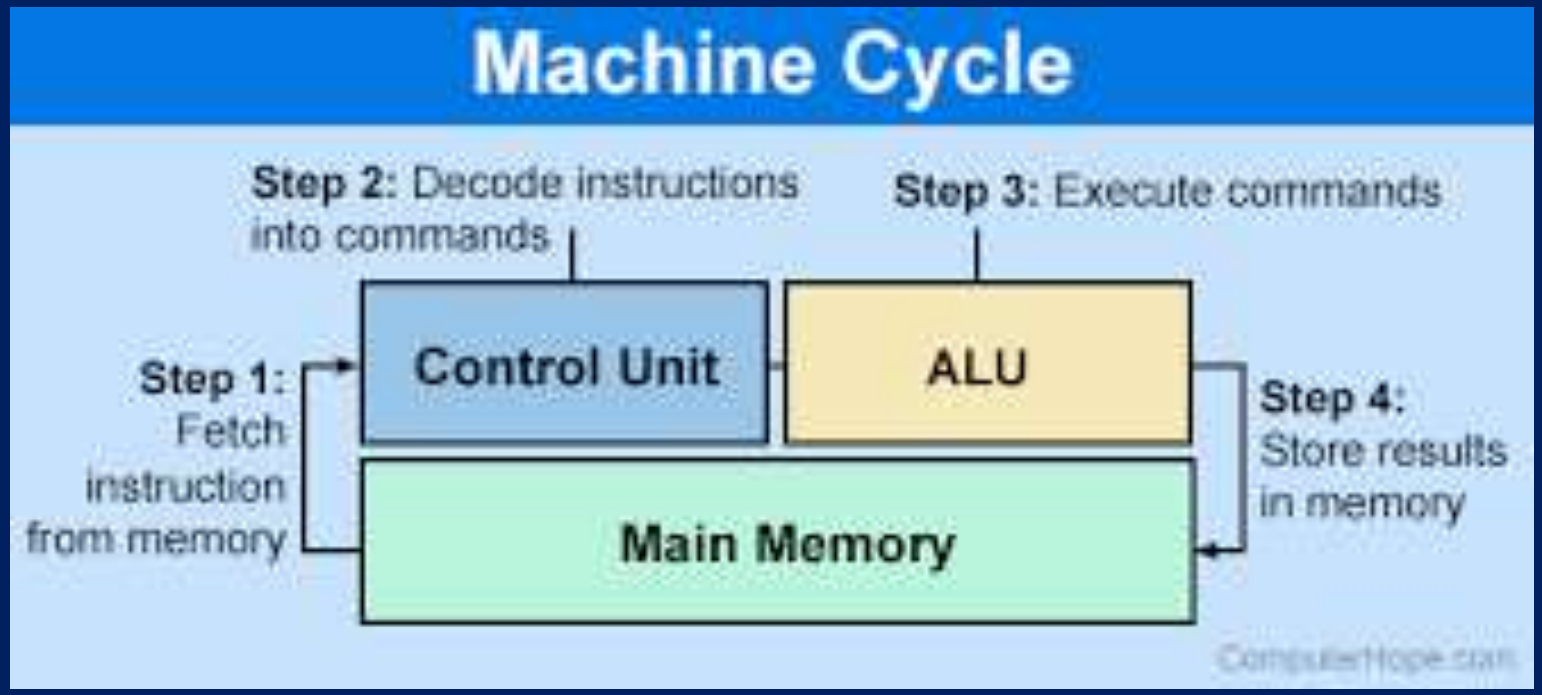
Control Unit:

- It interacts with both the main memory and arithmetic logic unit.
- it issues control signals that control hardware
- it moves data around the system
- it fetches, decodes and executes instructions.

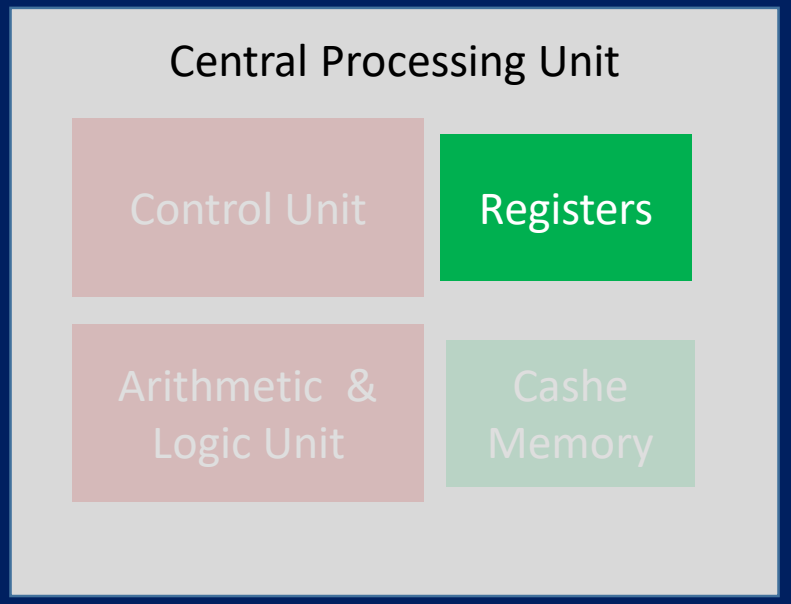
Hardware

Fetch-Decode-Execute Cycle

How the CPU can perform calculations, using a process known as the fetch-decode-execute cycle.



Hardware



CPU (Central Processing Unit) (Processor)

Registers:

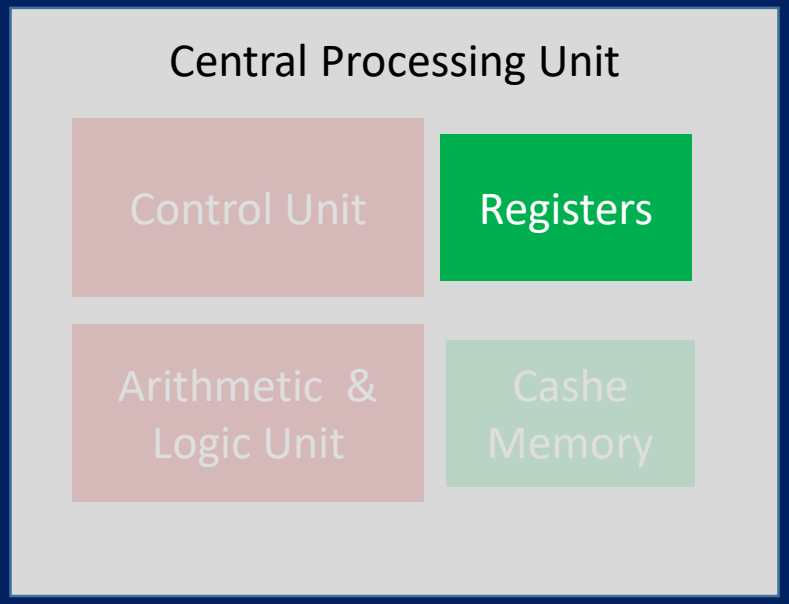
Are small amounts of high-speed memory contained within the CPU. They are used by the processor to store small amounts of data that are needed during processing, such as:

- the address of the next instruction to be executed.
- the current instruction being decoded.
- the results of calculations.

- 1 TB (Terabyte) = 1,024 GBs (Gigabytes)
- 1 GB (Gigabyte) = 1,024 MBs (Megabytes)
- 1 MB (Megabyte) = 1,024 KBs (kilobytes)
- 1 KB (Kilobyte)= 1,024 Byte (Byte)
- 1 B (Byte) = 8 b (bits)

Hardware

CPU (Central Processing Unit) (Processor)

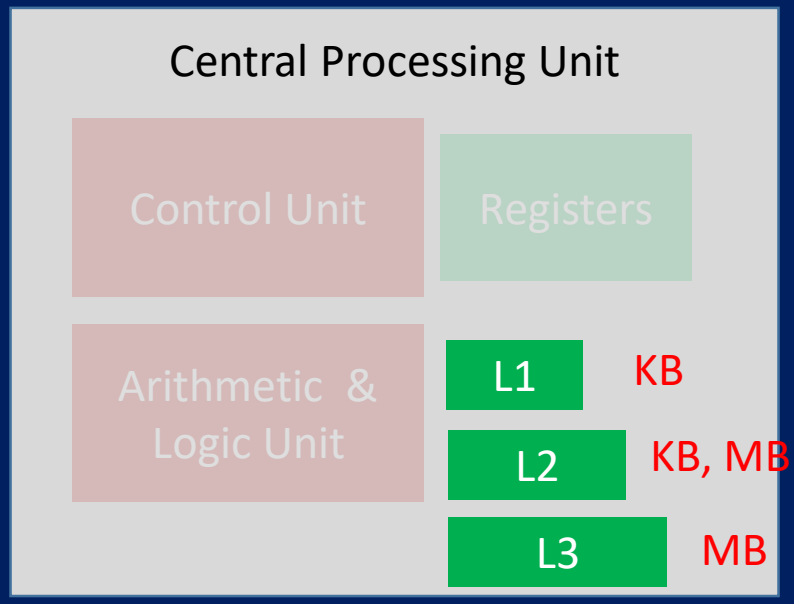


Registers:

Commonly used types of registers

- AC (Accumulator)
- AR (Address Register)
- DR (Data Register)
- IR (Index Registers)
- PC (Program Counter)
- MDR (Memory Data Register)
- MBR (Memory Buffer Register) and more.

Hardware



CPU (Central Processing Unit) (Processor)

Cashe Memory:

Is a special very high-speed memory. It is used to speed up and synchronizing with high-speed CPU.

- L1 (Level one Cash memory).
- L2 (Level 2 Cash Memory).
- L3 (Level 3 Cash Memory).

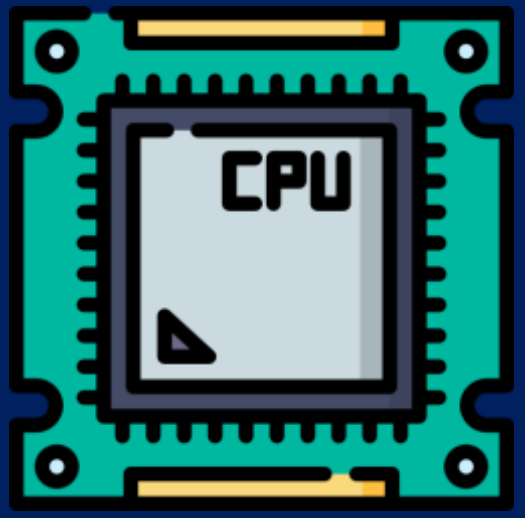
Byte = 8 b (bits)
Kilobyte = 1,024 Byte (Byte)
Megabyte = 1,024 KBs (kilobytes)
Gigabyte = 1,024 MBs (Megabytes)
Terabyte = 1,024 GBs (Gigabytes)

Hardware

1. Processing Devices:

The CPU is the brain of the computer:

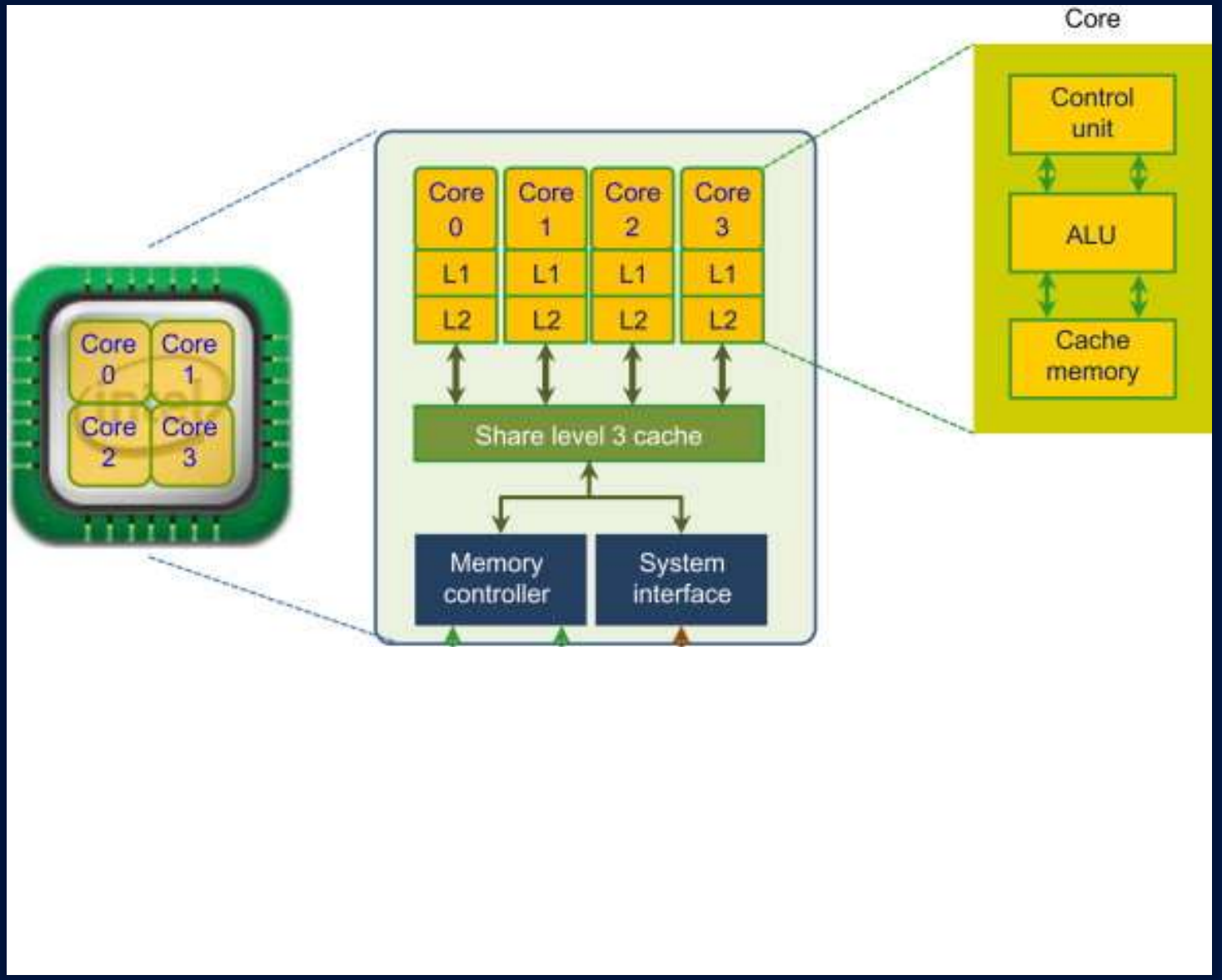
- Does all the thinking
- Performs math in numbers fed to it
- Helps display numbers on a screen
- Adds or deletes numbers
- Cores and Multithreading



Hardware

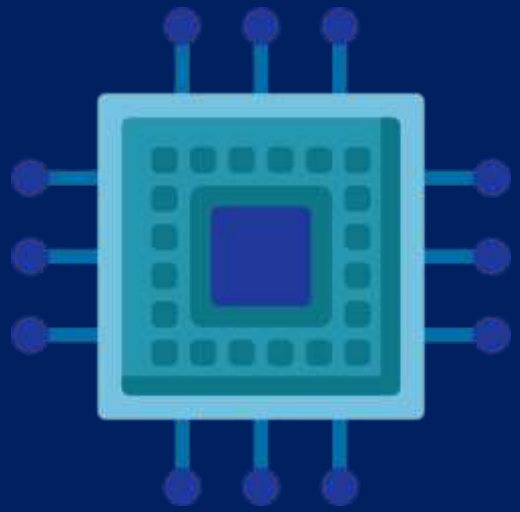
CPU (Central Processing Unit)

Cores:



Hardware

CPU (Central Processing Unit)



Cores:

- 1 core: Don’t expect to be able to open more than one program at a time.
- 2 cores(Dual-core)
- 4 cores(Quad-core)
- 6 cores(hexa-core)
- 8 cores(Octa-core)

Hardware

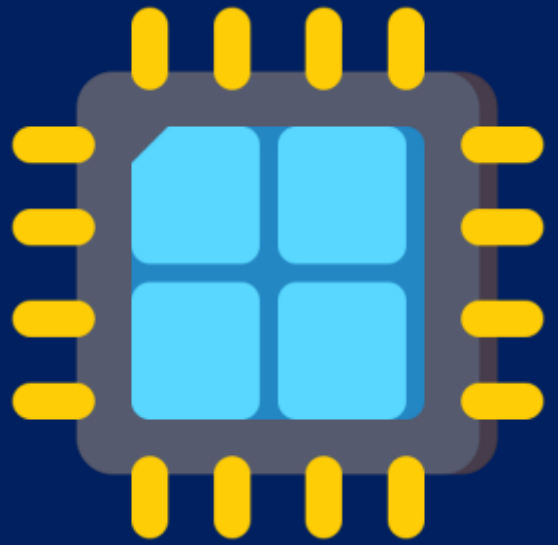
CPU (Central Processing Unit)

Cores:

- 1 core
- 2 cores(Dual-core):
  - You can access email, create and edit documents and spreadsheets
  - Don’t expect to render or edit video without crashing your system
  - you can probably play many games on lower settings, but if you are serious about your gaming, you will want to consider upgrading to a quad-core processor.
- 4 cores(Quad-core)
- 6 cores(hexa-core)
- 8 cores(Octa-core)

Hardware

CPU (Central Processing Unit)

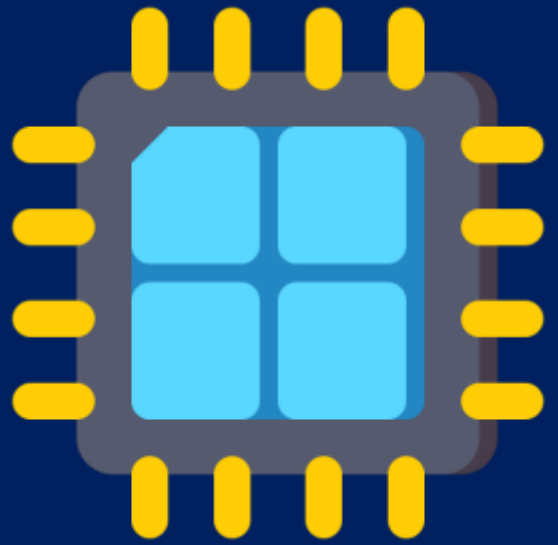


Cores:

- 1 core
- 2 cores(Dual-core)
- 4 cores(Quad-core):
  - Allow you to render video (slowly) or play games (at lower resolutions) in addition to all your regular work or school tasks.
  - Most gamers will be fine here as long as you are not playing the most processor-intensive games and you have a dedicated GPU.
- 6 cores(hexa-core)
- 8 cores(Octa-core)

Hardware

CPU (Central Processing Unit)



Cores:

- 1 core
- 2 cores(Dual-core)
- 4 cores(Quad-core):
  - if you work in video editing, graphic design and 3D rendering, sound editing, or a similar profession, you would be better served by more cores.
  - These industries require applications that use more processing power, along with features like a dedicated GPU, increased storage space, and at least 16GB of RAM.
- 6 cores(hexa-core)
- 8 cores(Octa-core)

Hardware

CPU (Central Processing Unit)

Cores:

- 1 core
- 2 cores(Dual-core)
- 4 cores(Quad-core)
- 6 cores(hexa-core):
  - You can use hexa-core processors for all complex software such as video and audio editing.
  - For more advanced games and programs.
- 8 cores(Octa-core)

Hardware

CPU (Central Processing Unit)

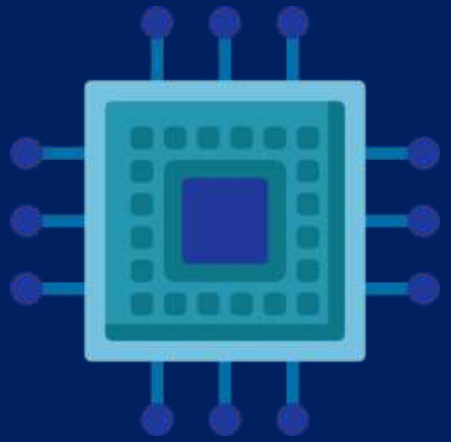
Cores:

- 1 core
- 2 cores(Dual-core)
- 4 cores(Quad-core)
- 6 cores(hexa-core)
- 8 cores(Octa-core):
  - if you’re a pro gamer , a video editor, or an engineer.
  - Video gamers who play, record, and stream intensive games should opt for more cores for as much power as possible.
  - And if you routinely use power-intensive software like VR or AutoCAD, this is your sweet spot.

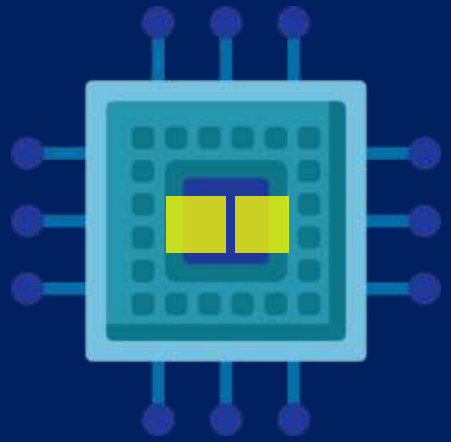
Hardware

CPU (Central Processing Unit)

Cores

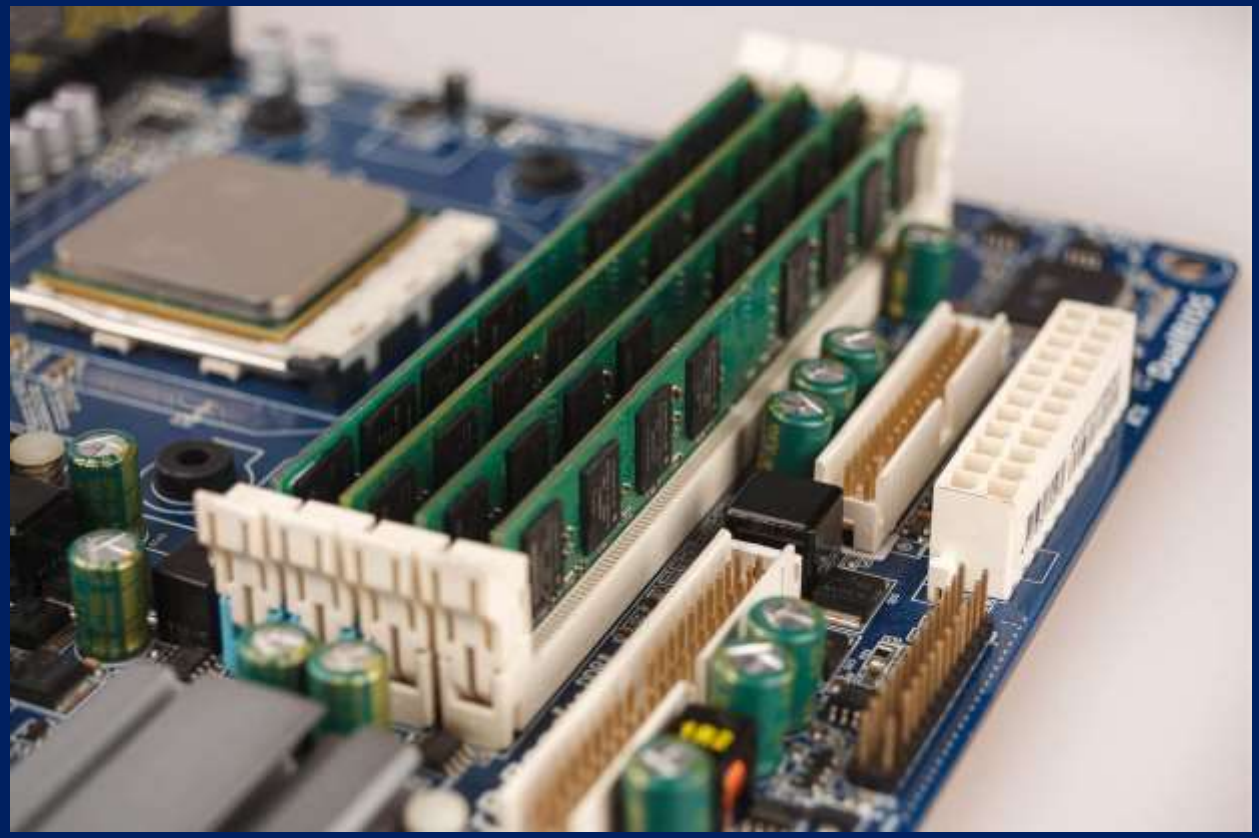


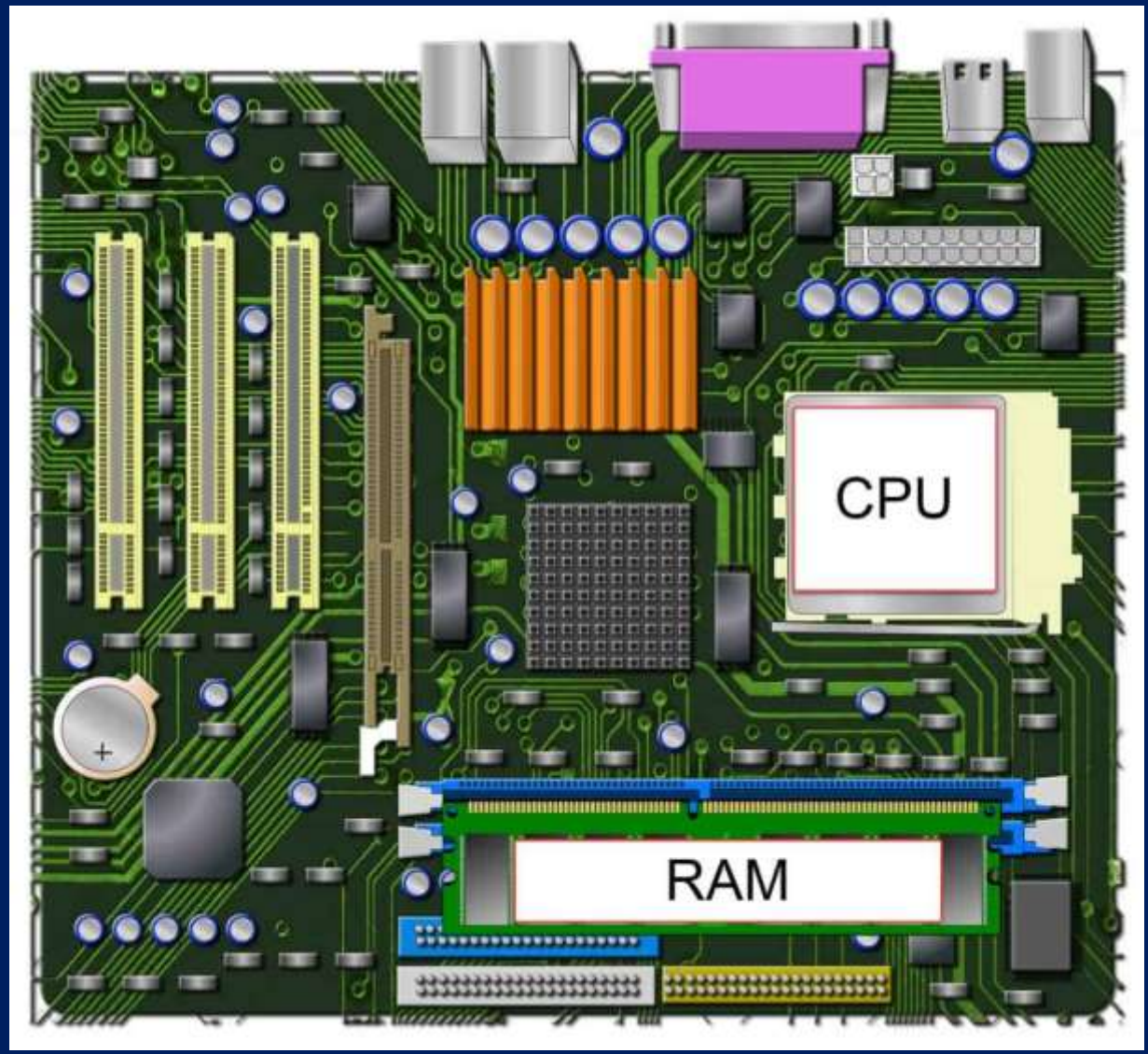
Hyper-Threading



Hardware

RAM (Random Access Memory)





Hardware

RAM (Random Access Memory)

RAM: Circuit board with chips that slides into a slot on the motherboard

- Volatile Memory only stores data when the power is on
- The chips store data
- Files and programs are loaded onto these chips when ran
- Fast memory

Hardware

RAM (Random Access Memory)

RAM: Circuit board with chips that slides into a slot on the motherboard

Capacity: 4 GB
16 GB
32 GB

1 GB = 8,589,934,592 bits

Registers
Cashe memory
RAM

- Byte = 8 b (bits)
- Kilobyte = 1,024 Byte (Byte)
- Megabyte = 1,024 KBs (kilobytes)
- Gigabyte = 1,024 MBs (Megabytes)
- Terabyte = 1,024 GBs (Gigabytes)

Hardware

Hard Drives (HDD):

- When you turn a computer off, you need a place to store data
- A hard disk drive (HDD) stores this information (Nonvolatile)

Hardware

Hard Drives (HDD):

- Inside a HDD, metal platters physically spin around
- Data is stored on these disks
- The reading heads move back and forth reading data from the device
- Power is only needed to read or change the data
- Data is preserved when power is off

Hardware

Hard Drives (HDD):

- RAM may store 1 GB, 2 GB, 4 GB, through 16 GB or so
- HDD stores 256 GB, 1024 GB (AKA terabyte or TB), 2 TB

Hardware

Hard Drives Disadvantages :

- Anytime you have a physical device that moves over a period of time, things go wrong
  - Dropping a HDD can corrupt files
- A hard drive might spin 7200 or 10000 times per minute but still Platters spin slower than how fast electrons move.

Hardware

Main Categories:

1. Processing devices
2. Storage devices
   - Primary Storage device:
     - RAM
   - Secondary Storage Devices:
     - Hard Drive Disk (HDD)
3. Input devices
4. Output devices

Hardware

Flash Memory:

Flash memory is an electronic non-volatile computer memory storage medium that can be electrically erased and reprogrammed.

Solid State Disk (SSD):

- This non-volatile storage media stores data on solid-state flash memory.
- Smaller (3.5 inch width for HDD vs 2.5 inch Width for SSD) Still fits where old HDDs are
- Inside, it looks a lot like RAM.
  No moving particles

Hardware

Flash Memory:

Flash memory is an electronic non-volatile computer memory storage medium that can be electrically erased and reprogrammed.

Solid State Disk (SSD):

- Much faster than HDD
- SSD theoretically don’t last as long as HDD
  - Finite number of writes
- Smaller and faster than (HDDs).
- Noiseless and allow PCs to be thinner and more lightweight.

Hardware

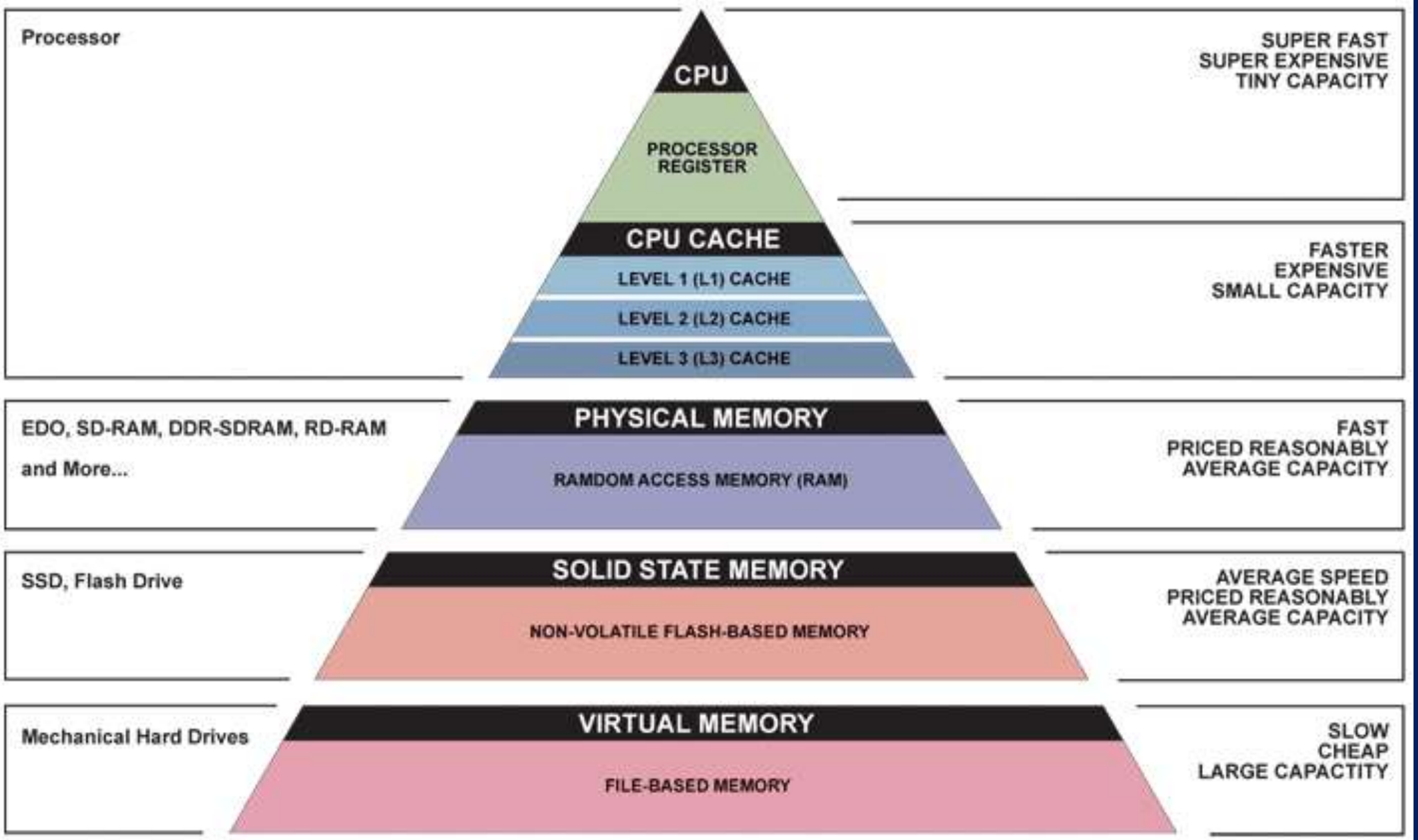
Flash Memory:

- Also exists in the form of USB sticks
- Might store 1 GB, 16 GB, or more
- Portable

Hardware

External SSDs, and HDD

- Exist for more storage Might store 256 GB or more.
- Can be used to share data with others without network usage.



▲ Simplified Computer Memory Hierarchy
Illustration: Ryan J. Leng

Hardware

HDD

SSHD

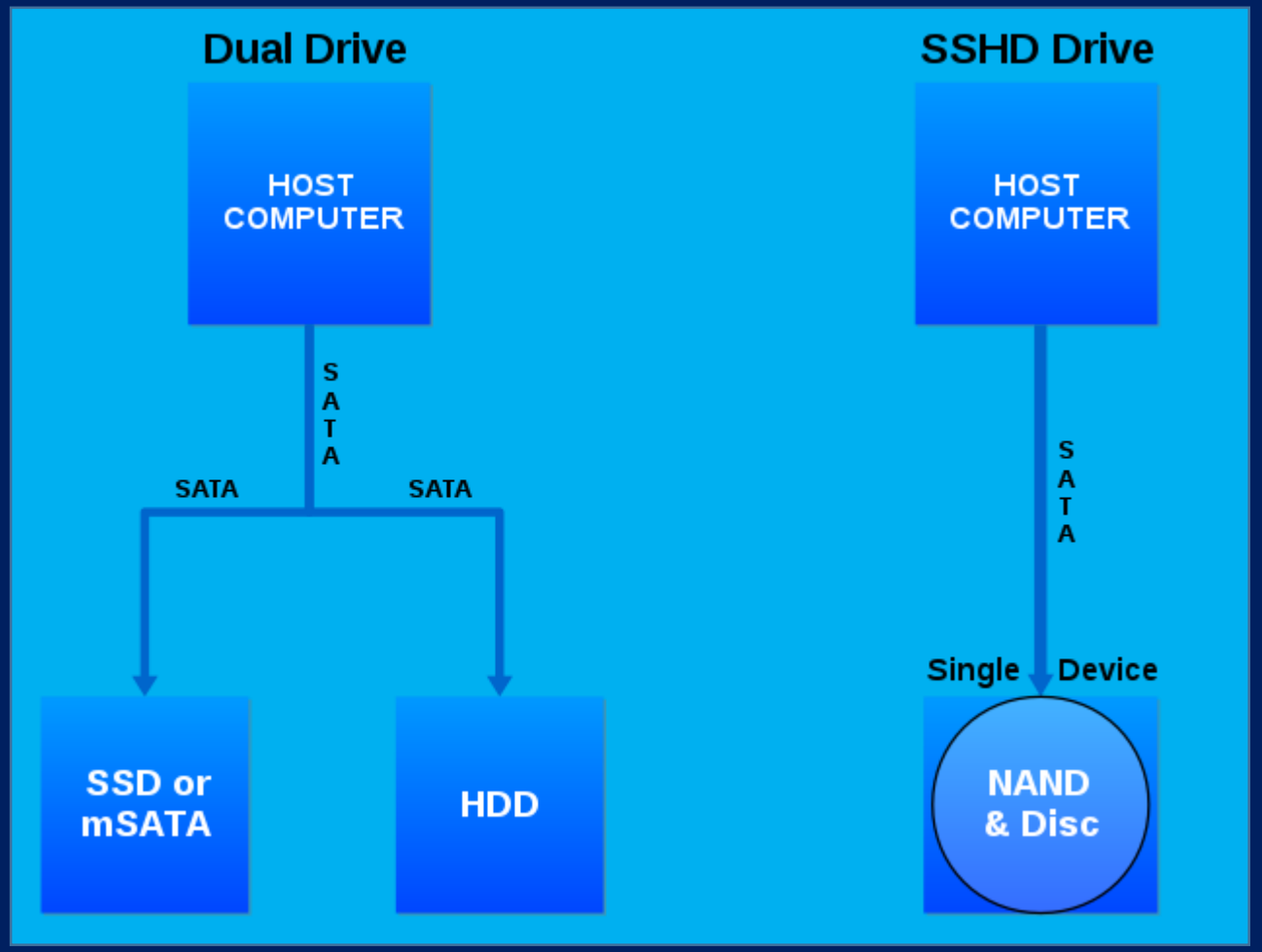
SSD

Hardware

Solid State Hybrid Drives (SSHD):

Some GB of solid state memory and more GB or TB of HDD space.
Stores as much of frequently-needed data on the SSD.
Stores less frequently-needed data on HDD.

Hardware


Dual Drive
HOST COMPUTER
SATA
SATA
SATA
SSD or mSATA
HDD
SSHD Drive
HOST COMPUTER
SATA
Single Device
NAND & Disc

Hardware

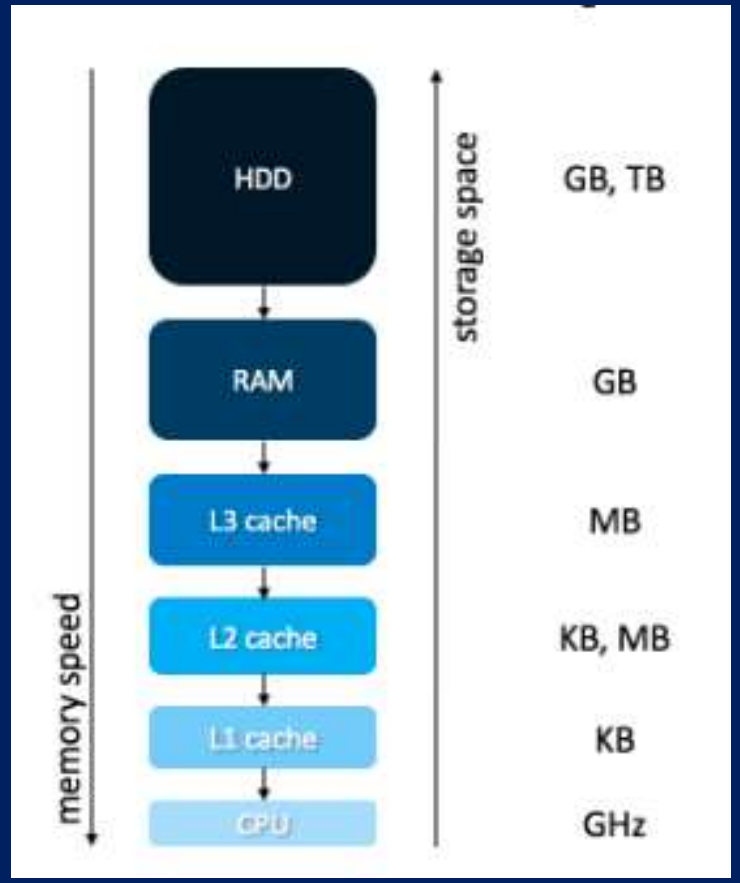
Types of Memory and Funneling:

Data is pushed “down the funnel” to your CPU
From the hard drive, data first goes to the RAM

Hardware

Types of Memory and Funneling:

- Theoretically, the CPU never has to wait for data to crunch.
- Memory at the bottom is more expensive.



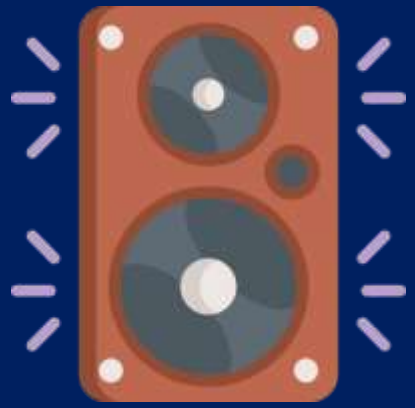
Byte = 8 b (bits)
Kilobyte = 1,024 Byte (Byte)
Megabyte = 1,024 KBs (kilobytes)
Gigabyte = 1,024 MBs (Megabytes)
Terabyte = 1,024 GBs (Gigabytes)

Hardware

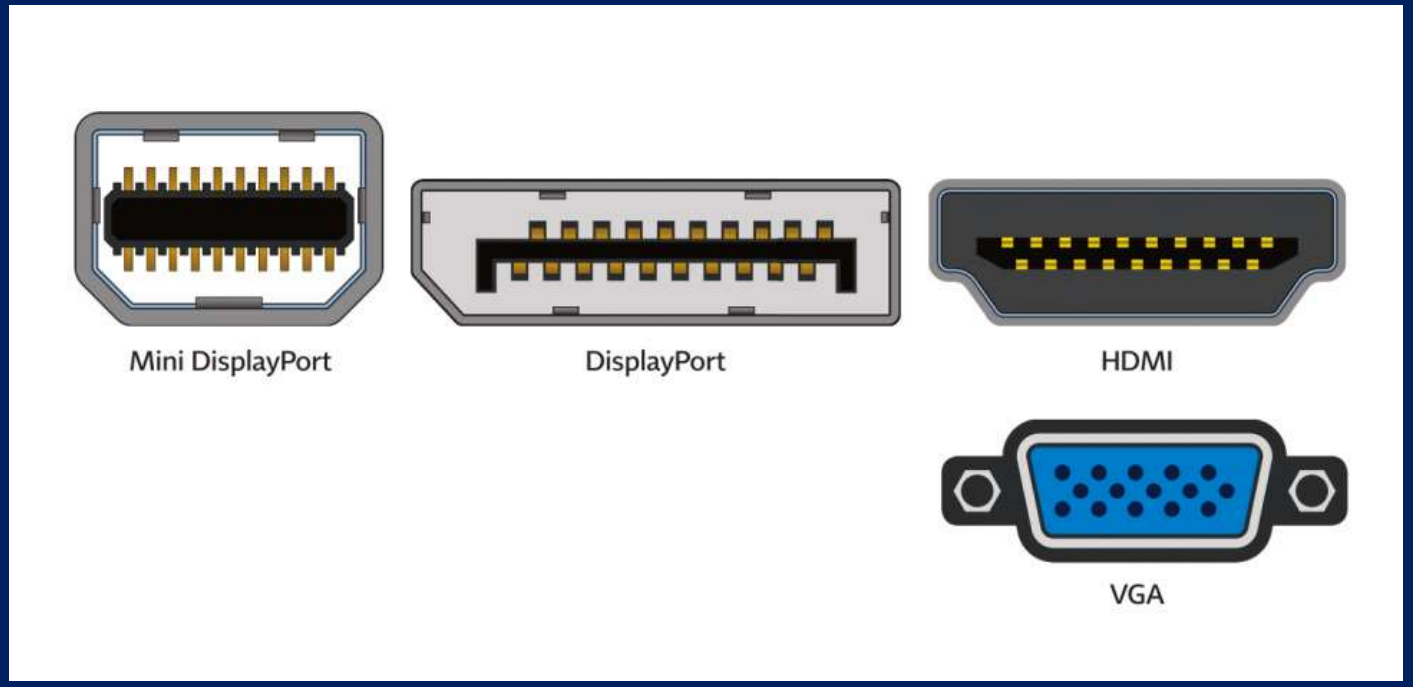
Input, Output Devices:

Hardware

Input, Output Devices:



Hardware



Input, Output Devices:

- Display Connectors:
  - These sockets all connect to monitors or displays
  - Mini DisplayPort are used form monitors
  - HDMI is not only on laptops and computers but also TVs
  - VGA is older, but still commonly uses on projectors

Hardware

Input, Output Devices:

- USB (Universal Serial Bus):
  - USB-A most common
  - USB-B is often used for printers and scanners
  - USB-C is newer and can be plugged in coming from different directions
  - Older USB connections are slower when transferring data
  - 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

Hardware

Wireless:

- WiFi and Bluetooth are wireless technologies that are widely used to send and receive data wirelessly using radio signals.
- Wifi is wireless internet and for high-speed Internet access that connects nearby devices with each other and share the Internet via hotspots.
- 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.

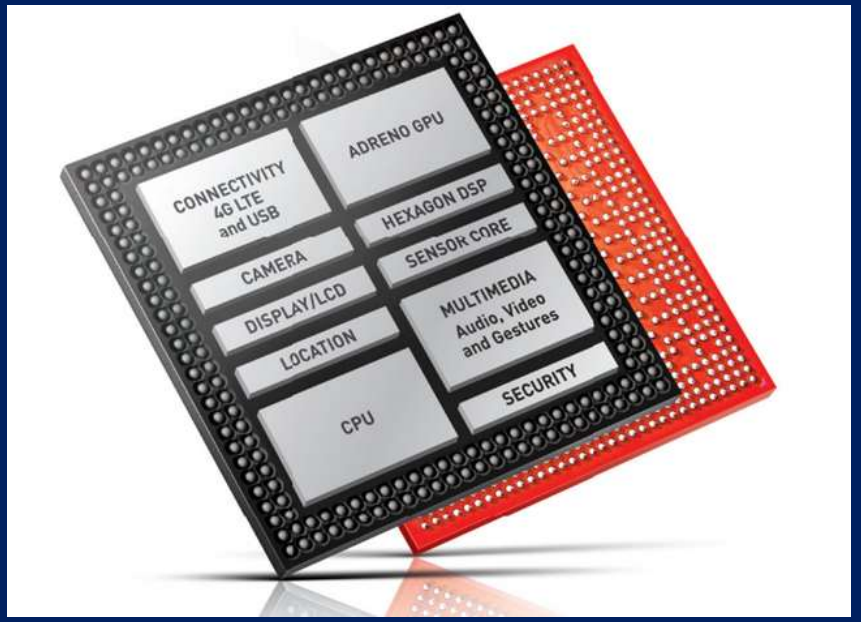
Hardware

System on a Chip (SoC)

A SoC is a complete system on a chip. A `system' includes a microprocessor, memory and peripherals, When a CPU and more are all interconnected at once rather than attached to a motherboard.

- SoCs are found in every consumer product, from modems, mobile phones, DVD players, and televisions.

- The advantage of an SoC is that it is cheaper, smaller, and more energy efficient.
- The disadvantage is that, unlike a full-size computer, they are locked into their configuration.

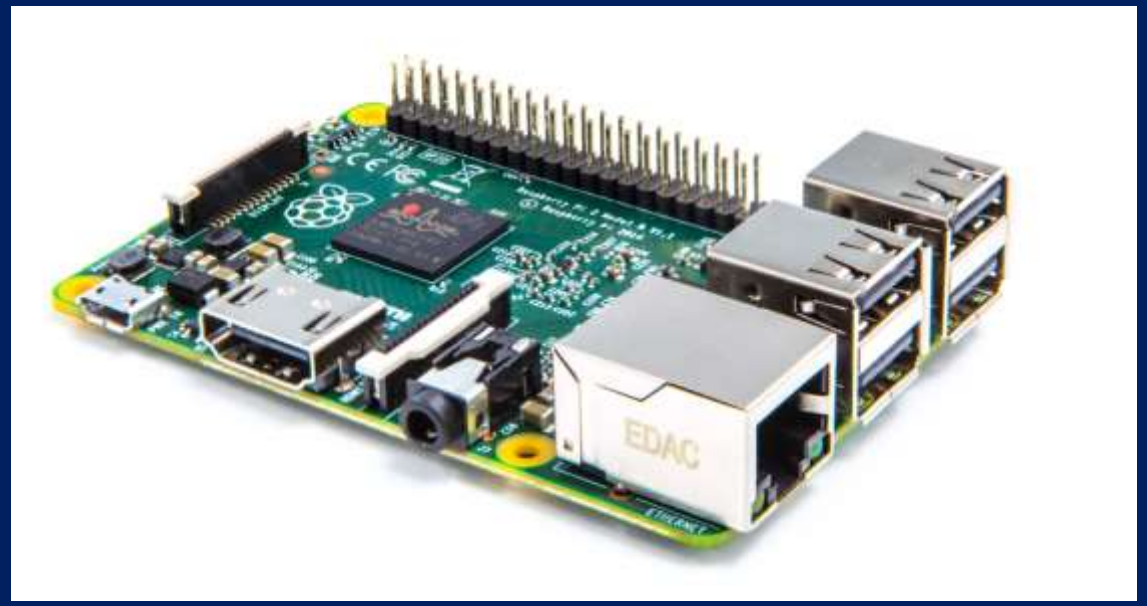


Hardware

Systems on a Chip (SoaC)

When a CPU and more are all interconnected at once rather than attached to a motherboard

- Popular in phones, tables, and game consoles
- Raspberry Pi



Hardware

Operating System (OS):

- Desktop

- Mobile

Hardware

Operating System (OS):

- Installed on HDD or SSD so that it exists persistently without power
- When you hit power on your computer, the OS is loaded into RAM
- Knows how to:
  - Talk to your keyboard and mouse
  - Display info on the screen
  - Move things around in memory
- When an OS doesn't recognize a device, perhaps because it's too new, you can download new device driver from the device manufacturer.
  - Teaches Window, MacOS, or Linux about that new hardware.
  - Future-proofing structure.

THANK YOU
Rasha Abdeen