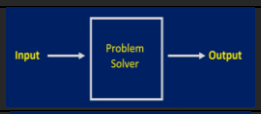
City Kids

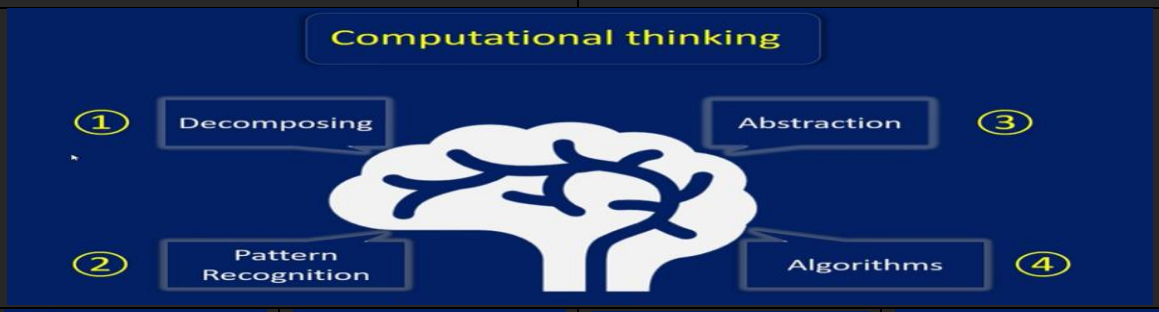
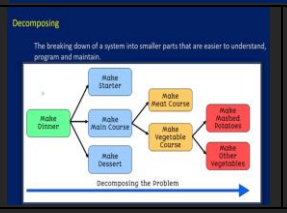
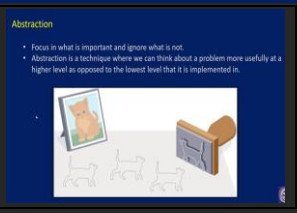
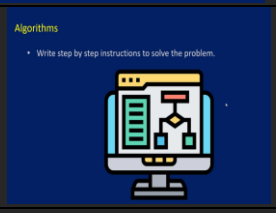
Hardware	
Computational Thinking Binary System CPU Ram (Random Access Memory) Hard Drives Flash memory	Types of Memory and Funneling Display connectors USB (Universal Serial Bus) Wireless (WIFI – Bluetooth) Operating System (OS)

What is Computer Science?	
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.	علوم الكمبيوتر هي دراسة النظرية والتصميم وتنفيذ أي خوارزمية وأداء برامج الكمبيوتر وأنظمة الكمبيوتر، بما في ذلك دراسة الحوسبة نفسها

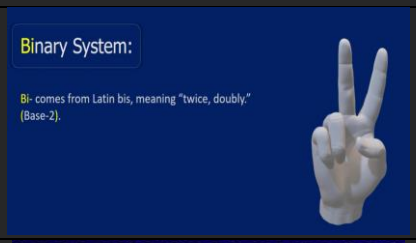
A Computer System is divided into two categories:
ينقسم نظام الكمبيوتر إلى فئتين

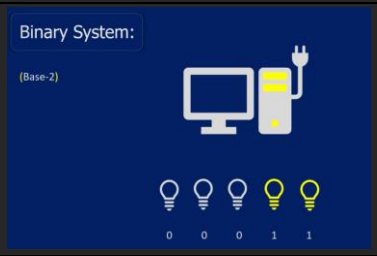
Hardware	Software
The physical component of the computer المكون المادي للكمبيوتر	Software is a set of instructions that tells a computer exactly what to do البرنامج عبارة عن مجموعة من التعليمات التي تخبر الكمبيوتر بما يجب فعله بالضبط
It is manufactured يتم تصنيعه	It is developed and engineered تم تطويره وهندسته
Electronic and other materials are used to create hardware يتم استخدام المواد الإلكترونية وغيرها لإنشاء الأجهزة	Created by utilizing a computer language to write instructions تم إنشاؤها باستخدام لغة الكمبيوتر لكتابة التعليمات
Hardware typically wears out over time عادةً ما تتآكل الأجهزة بمرور الوقت	Software does not wear out with time. However, it may contain flaws and glitches البرمجيات لا تبلى مع مرور الوقت ومع ذلك، فإنه قد يحتوي على عيوب ومواطن الخلل
Main categories: الفئات الرئيسية	Mainly divided into: تنقسم بشكل رئيسي إلى
Input devices أجهزة إدخال Output devices أجهزة اخراج Storage devices أجهزة التخزين Processing devices أجهزة المعالجة	System software برنامج النظام Programming software برامج البرمجة Application software تطبيق البرمجيات

Computer science is fundamentally problem solving. **علوم الكمبيوتر هي في الأساس حل المشكلات**	
A computer scientist's goal is to develop list of instructions for solving any problem that might arise. **هدف عالم الكمبيوتر هو وضع قائمة من التعليمات لحل أي مشكلة قد تنشأ**	

Four Main Problem Solving Steps: **أربع خطوات رئيسية لحل المشكلات**	
Understand the Problem **فهم المشكلة**	**Design a Solution تصميم الحل** (Formulate an algorithm to solve your problem) قم بصياغة خوارزمية لحل مشكلتك
Implement your solution **قم بتنفيذ الحل الخاص بك**	**Check your solution** **تحقق من الحل الخاص بك**
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.**
التفكير الحسابي هو التفكير بطريقة خوارزمية، حيث يأخذ مدخلات للمشكلة ويتحرك بعناية خطوة بخطوة لإنتاج المخرجات	**يمكننا بعد ذلك تقديم هذه الحلول بطريقة يمكن للكمبيوتر أو الإنسان أو كليهما فهمها**
	
			

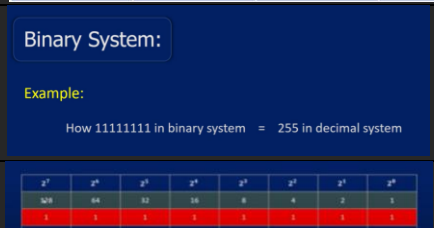
Binary System

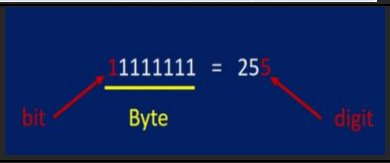


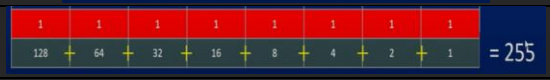


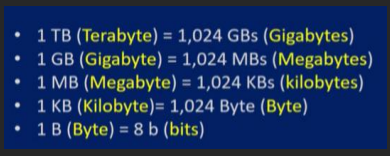
Binary System	Decimal System
Computer No. System	Human No. System
Base 2 system (0 , 1)	Base 10 system (0,1,2,3,4,5,6,7,8,9)
Power of 2	Power of 10

...	2^2	2^1	2^0	...	10^2	10^1	10^0
...	4	2	1	...	100	10	1
0	1	1	1		2	5	5
7 =	1*4	1*2	1*1	255 =	2*100	5*10	5*1









To Do	01001000 01001001 00100000 00111010 00101001

Representing Letters تمثيل الحروف

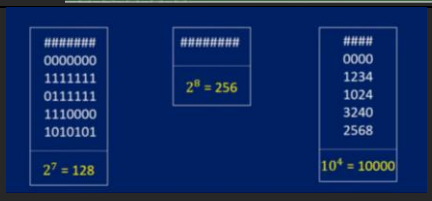
ASCII (American Standard Code for Information Interchange)

(الكود القياسي الأمريكي لتبادل المعلومات)

Original ASCII is 7 bits, thus giving 128 characters

يتكون ASCII الأصلي من 7 بتات، مما يعني 128 حرفًا

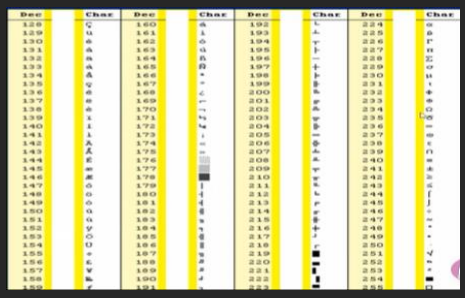
0	NUL	16	DLE	32	SP	48	0	64	@	80	P	96	`	112	p
1	SOH	17	DC1	33	!	49	1	65	A	81	Q	97	a	113	q
2	STX	18	DC2	34	"	50	2	66	B	82	R	98	b	114	r
3	ETX	19	DC3	35	#	51	3	67	C	83	S	99	c	115	s
4	EOT	20	DC4	36	$	52	4	68	D	84	T	100	d	116	t
5	ENQ	21	NAK	37	%	53	5	69	E	85	U	101	e	117	u
6	ACK	22	SYN	38	&	54	6	70	F	86	V	102	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

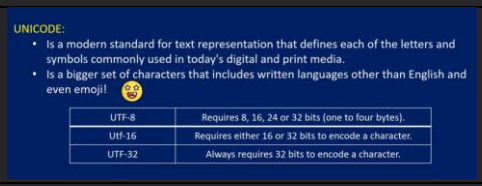


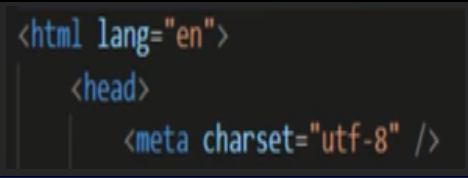
Extended ASCII is 8 bits, yielding 256 characters

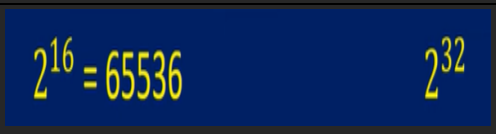
يبلغ طول ASCII الممتد 8 بتات، وينتج 256 حرفًا

ASCII is limited!!

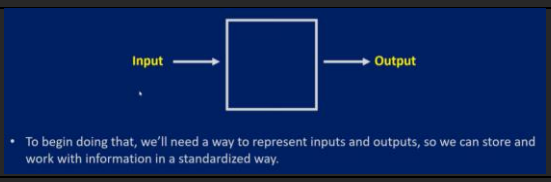




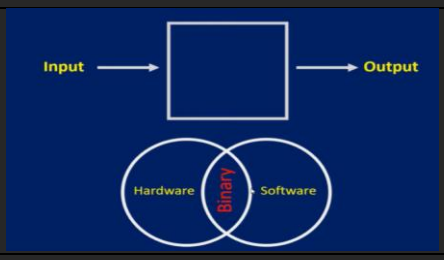




All are still represented by a pattern of bits



Hardware



Main categories:
الفئات الرئيسية

- أجهزة إدخال Input devices
- أجهزة اخراج Output devices
- أجهزة التخزين Storage devices
- أجهزة المعالجة Processing devices

Motherboard

Is the backbone that ties the computer's components together and allows them to talk to each other

هو العمود الفقري الذي يربط مكونات الكمبيوتر ببعضها البعض ويسمح لها بالتحدث مع بعضها البعض

Without it, none of the computer pieces could interact

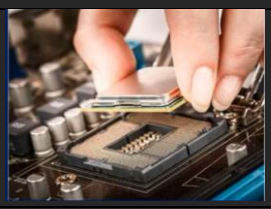
بدونها، لا يمكن لأي من أجزاء الكمبيوتر التفاعل

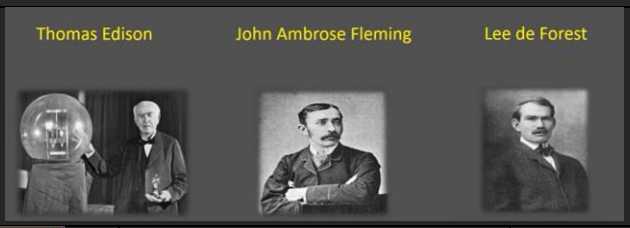
In 1981, the first motherboard was used in the IBM computer that was originally known as planar.

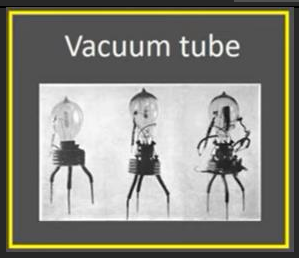
في عام 1981، تم استخدام اللوحة الأم الأولى في كمبيوتر IBM والتي كانت تعرف في الأصل باسمPlanar

Processing Devices

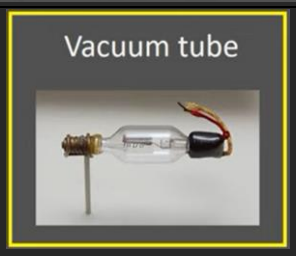
Are the components responsible for the processing of information within the computer system
This includes devices such as:

CPU	GPU	Video Card	Sound Card
Central Processing Unit			
Processor			
			
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 calclate			
			

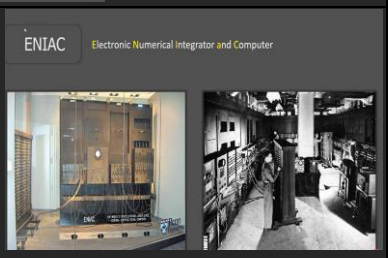




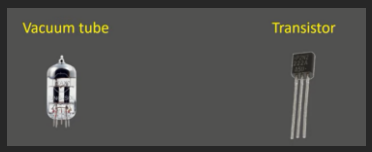
1904

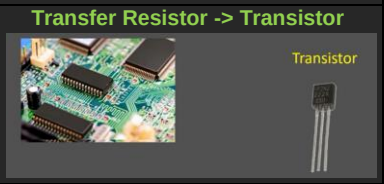


1945



1947



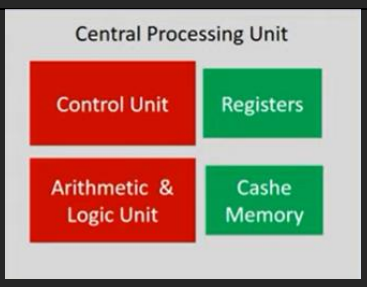


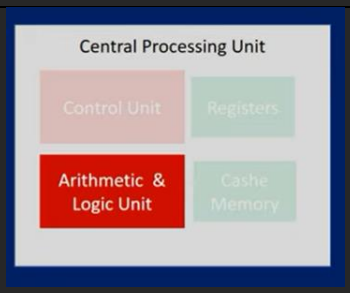
الترانزستور

في عام 1974 ظهرت مقاومة النقل التي أصبحت تعرف اختصاراً باسم الترانزستور

1959 Mo Atalah

عبارة عن دائرة إليكترونية صغيرة الحجم تماثل أقل من رأس الدبوس وتستطيع القيام بالمهام والوظائف التي كان يقوم بها الصمام المفرغ الذي يصل حجمه إلى حجم الإبهام على الأقل، ومن هنا أمكن استخدامه في الحاسب ليقل حجمه إلى حد كبير ومن هنا بدأ أيضاً تطوير الترانزستور ليقل حجمه وتزيد كفاءته بعد ذلك



ALU (Arithmetic & Logic Unit) Arithmetic function 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.	
	

Moore's Law قانون مور

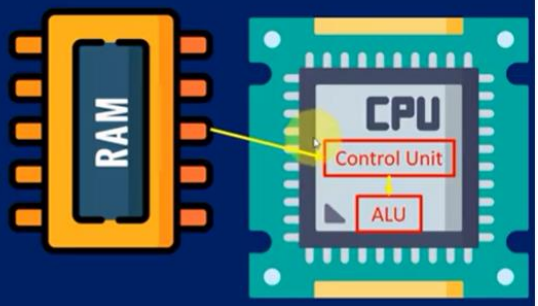
بعد ذلك ، في عام 1965 ، أدلى رجل يُدعى جوردون مور بملاحظة والتي كان من شأنها بعد ذلك أن تصبح شيئًا من نبوءة أو توقع تحقق ذاتها . حيث أشار إلى أنه في غضون فترة زمنية معينة – اعتمادًا على من تسأل ومتى تسأل ، والتي تتراوح في فترة بين 18 و 24 شهرًا – ستسمح التحسينات في عمليات التصنيع التكنولوجية لعدد المكونات المنفصلة على بوصة مربعة (6.5 سنتيمترات مربعة) من رقائق السيليكون بالمضاعفة (أي أن عدد المكونات على كل شريحة سيليكون سيتضاعف كل فترة كالمذكورة في الأعلى) .

رأى أن الشركات التي صممت الرقائق سوف تجد طرقًا جديدة لإنشاء مكونات أصغر ثم تحسين عملية التصنيع بحيث يكون من المنطقي أكثر من الناحية المالية بناء شرائح أكثر قوة

.

Hardware

CPU (Central Processing Unit) (Processor)



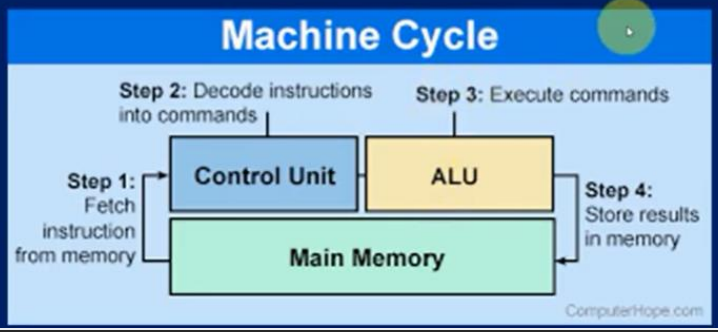
Control Unit:

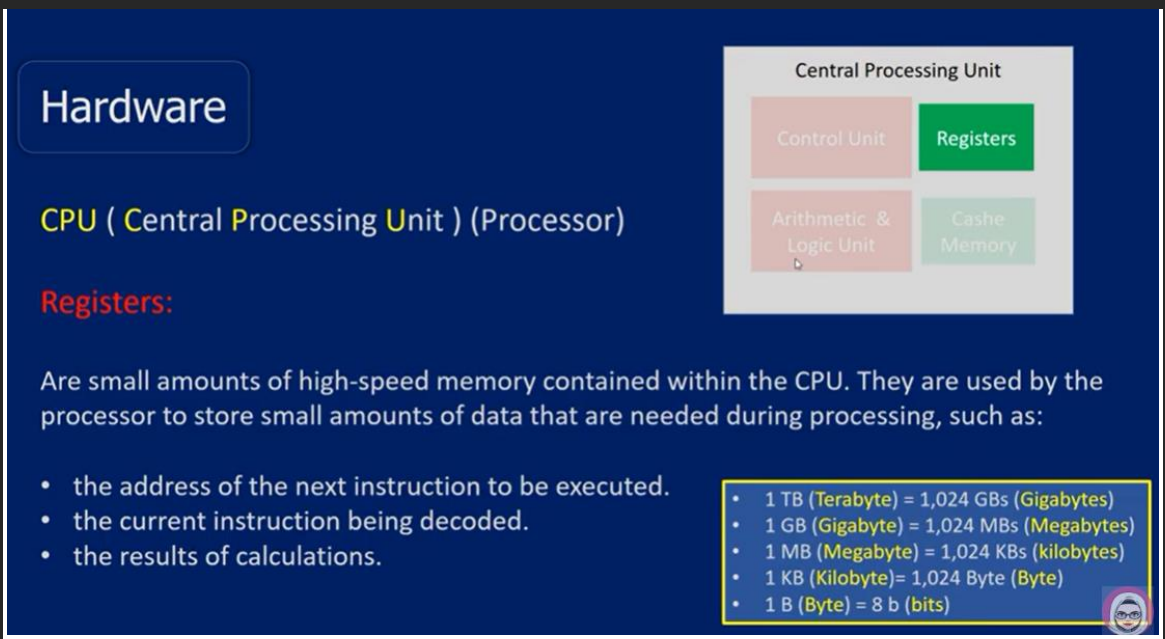
- It interacts with both the main memory and arithmetic logic unit.
- it issues control signals that control hardware
- it moves data around the system
- it fetches, decodes and executes instructions.

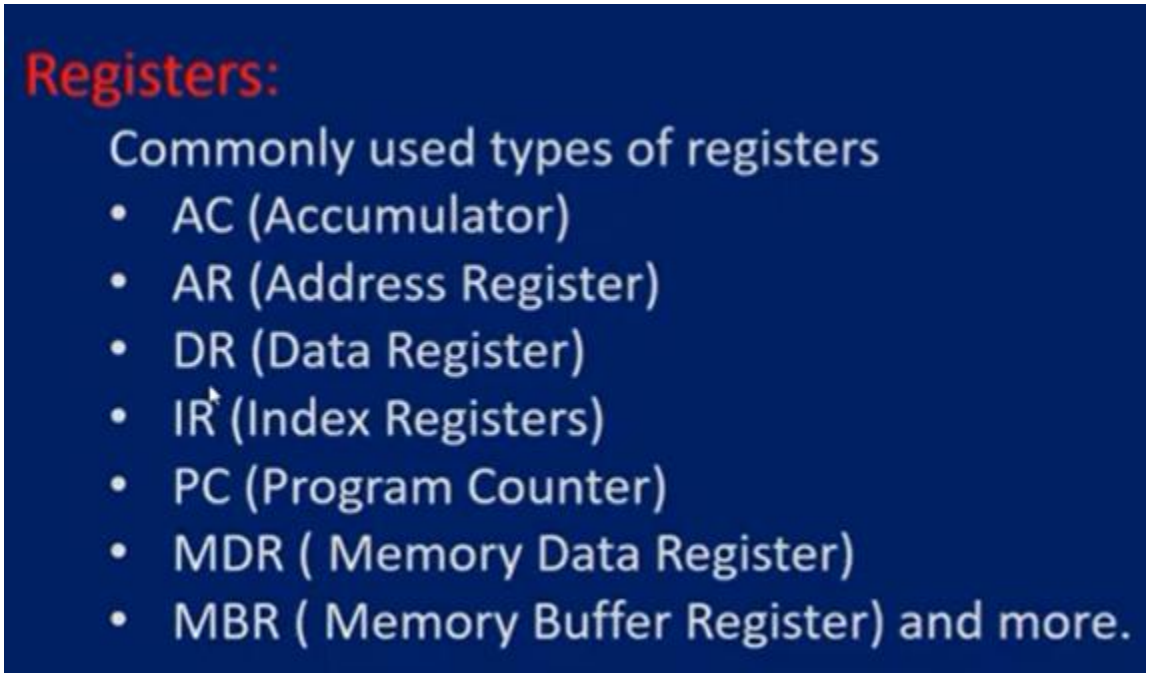
Hardware

Fetch-Decode-Execute Cycle

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





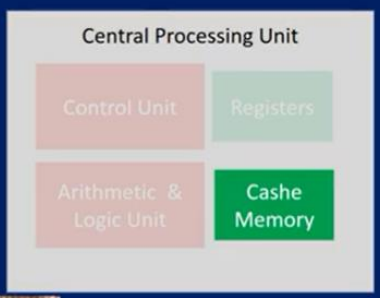


Search for types of register

Hardware

CPU (Central Processing Unit) (Processor)

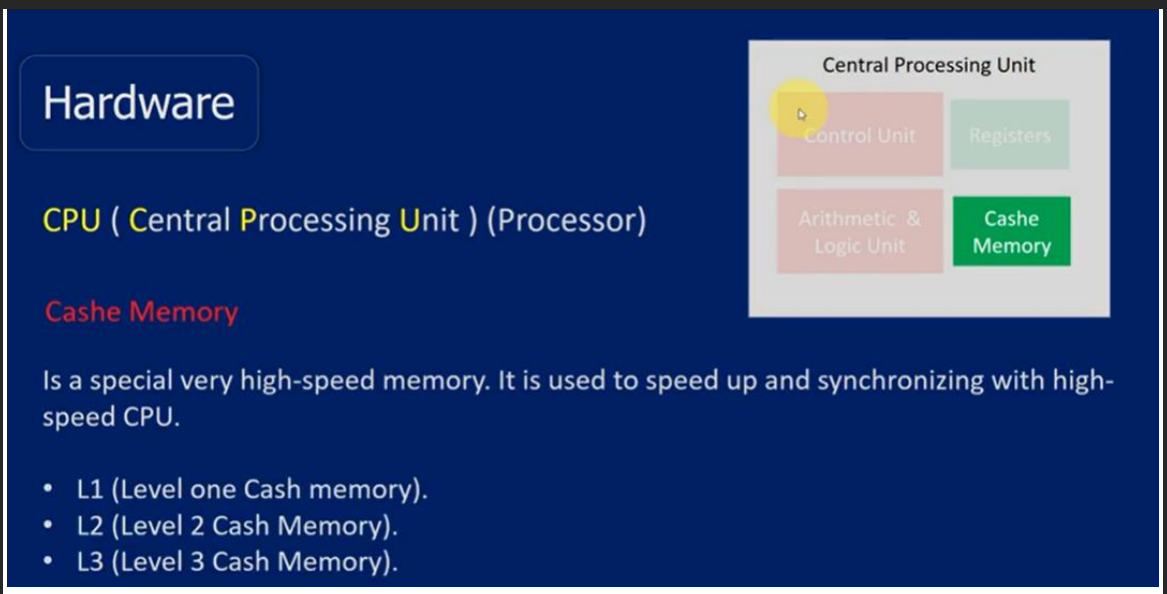
Cashe Memory

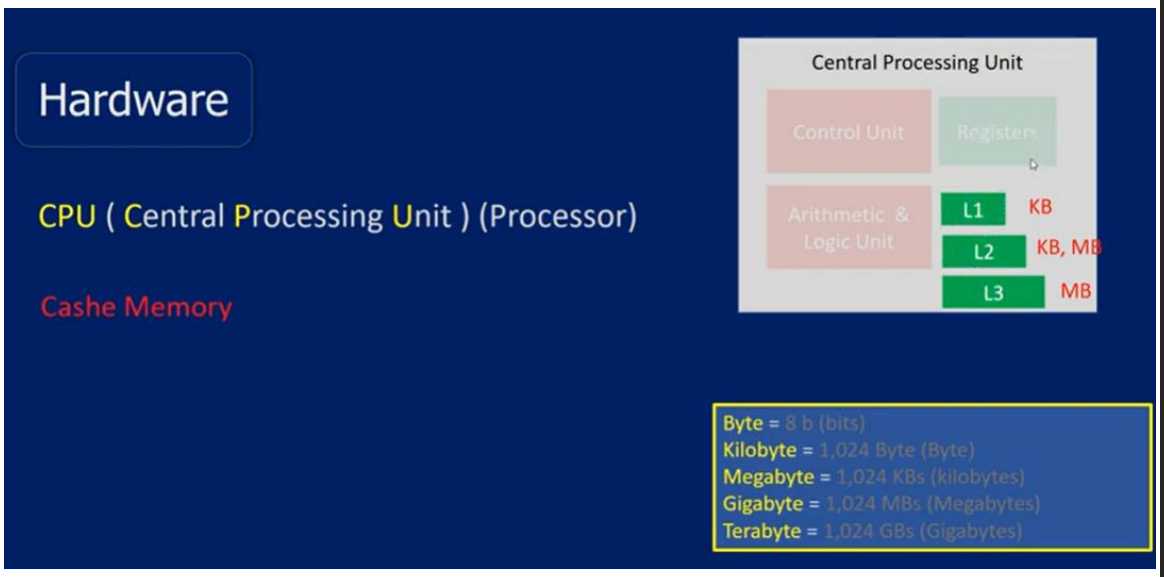


Hardware

CPU (Central Processing Unit) (Processor)

Cashe Memory



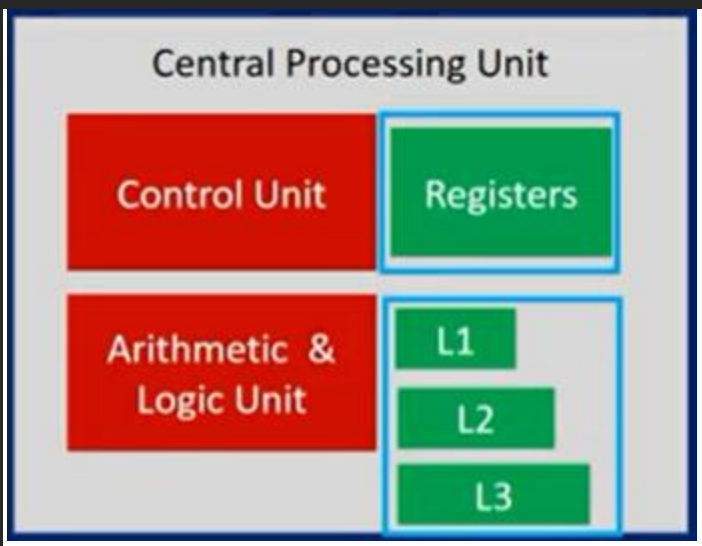


Register faster than L1, L1 faster than L2, L2 faster than L3.

Register is visible by compiler in software, computer can see register and store in register.

L1, L2, L3 are not visible for computer or software, only visible for CPU.

CPU start search in L1 (level 1) if not found the data goes to L2 if not found the data goes to L3 if not found the data goes to RAM.

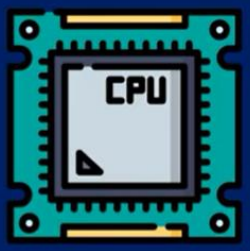


Hardware

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



#8:

1. What is the purpose of the CPU?
   A. To process all the data and instructions.
   B. To turn the computer on.
   C. To create PowerPoint presentations.
   D. To provide power to the computer.

2. What is the job of the control unit?
   A. It carries out calculations
   B. It stores information.
   C. It does nothing.
   D. It controls the input and output of data to make sure that it gets to the right place.

3. Which level of cache is the fastest but has the smallest capacity?
   A. Level 1
   B. Level 2
   C. Level 3

#8:

4. What are registers used for?
   A. To check that students are in school.
   B. To temporarily hold bits of data needed by the CPU.
   C. To make sure that the CPU runs properly.
   D. To make the CPU faster.

5. What does CPU stand for?
   A. Control Processing Unit
   B. Central Processing Unit
   C. Central Power Unit
   D. Center Power Unit

6. Which transfer is faster
   A. data between the cache and the CPU
   B. data between the RAM and cache
   C. data between the RAM and CPU
   D. data between the hard drive and CPU

#8:

7. CPU Cache is located on
   A. The CPU
   B. The RAM
   C. The hard drive
   D. The motherboard

8. Which part of the Fetch-Decode-Execute cycle gets the instruction from the RAM?
   A. Fetch
   B. Decode
   C. Execute

9. Cache memory acts as a buffer between the processor and To start up the computer
   A. the RAM
   B. the hard drive
   C. the motherboard
   D. the user

Boot cast

128	64	32	16	8	4	2	1
0	1	0	0	1	0	0	0
0	64	0	0	8	0	0	0
72							

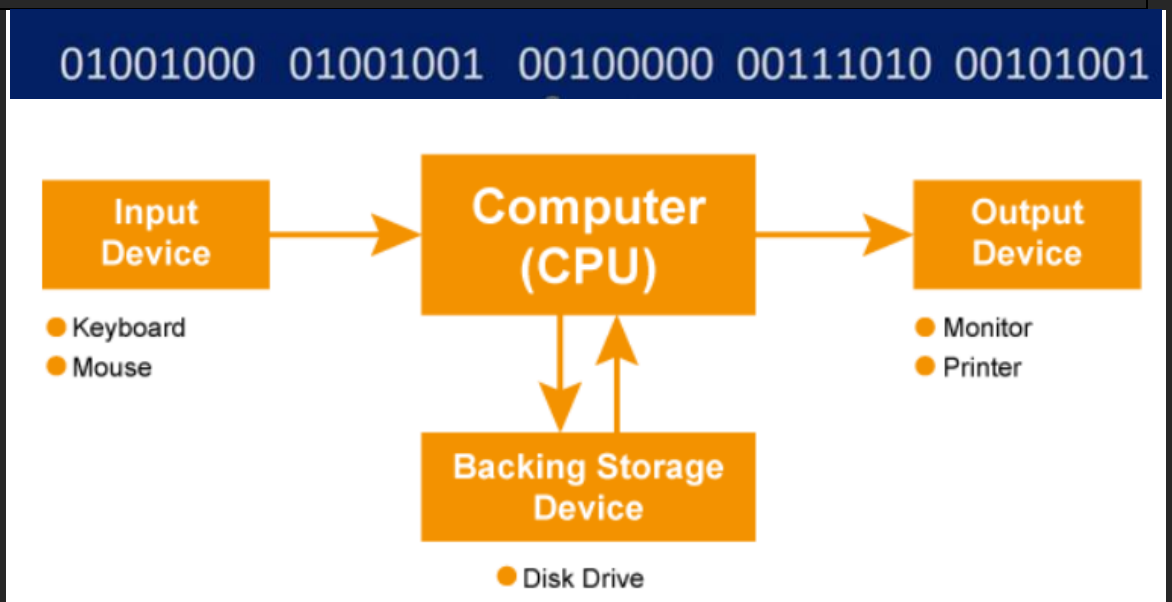
128	64	32	16	8	4	2	1
0	1	0	0	1	0	0	1
0	64	0	0	8	0	0	1
73							

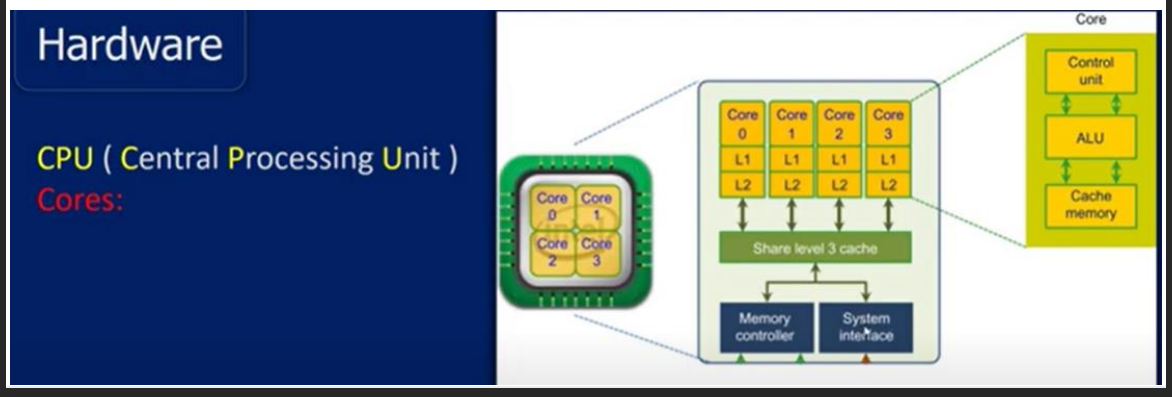
128	64	32	16	8	4	2	1
0	0	1	0	0	0	0	0
0	0	32	0	0	0	0	0
32							

128	64	32	16	8	4	2	1

0	0	1	1	1	0	1	0
0	0	32	16	8	0	2	0
58							

128	64	32	16	8	4	2	1
0	0	1	0	1	0	0	1
0	0	32	0	8	0	0	1
41							





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)

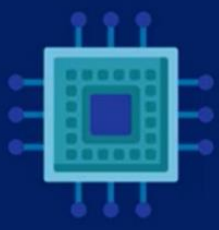
Cores:

- 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.

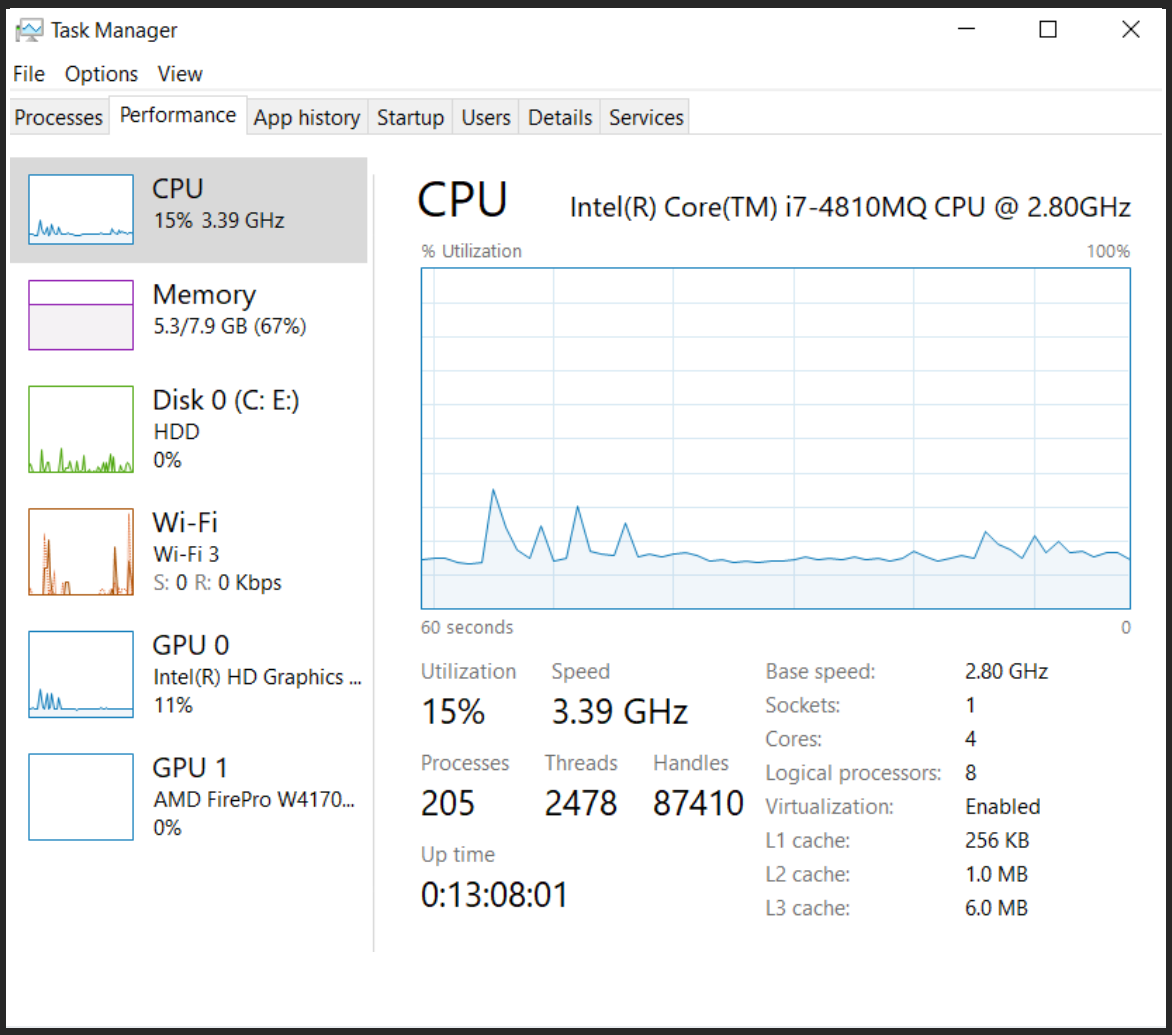
Hardware

CPU (Central Processing Unit)

Cores



Hyper-Threading


Task Manager
File Options View
Processes Performance App history Startup Users Details Services
CPU
15% 3.39 GHz
Memory
5.3/7.9 GB (67%)
Disk 0 (C: E:)
HDD
0%
Wi-Fi
Wi-Fi 3
S: 0 R: 0 Kbps
GPU 0
Intel(R) HD Graphics ...
11%
GPU 1
AMD FirePro W4170...
0%
CPU
Intel(R) Core(TM) i7-4810MQ CPU @ 2.80GHz
% Utilization
100%
60 seconds
0
Utilization
15%
Speed
3.39 GHz
Processes
205
Threads
2478
Handles
87410
Up time
0:13:08:01
Base speed: 2.80 GHz
Sockets: 1
Cores: 4
Logical processors: 8
Virtualization: Enabled
L1 cache: 256 KB
L2 cache: 1.0 MB
L3 cache: 6.0 MB

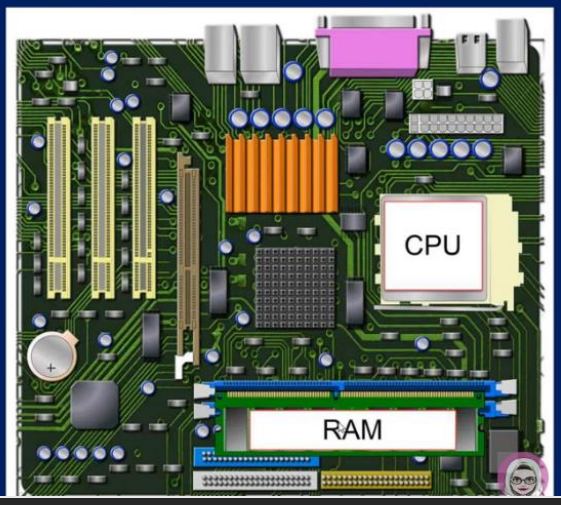
Hardware

Main Categories:

1. Processing devices (CPU).
2. Storage devices
3. Input devices
4. Output devices

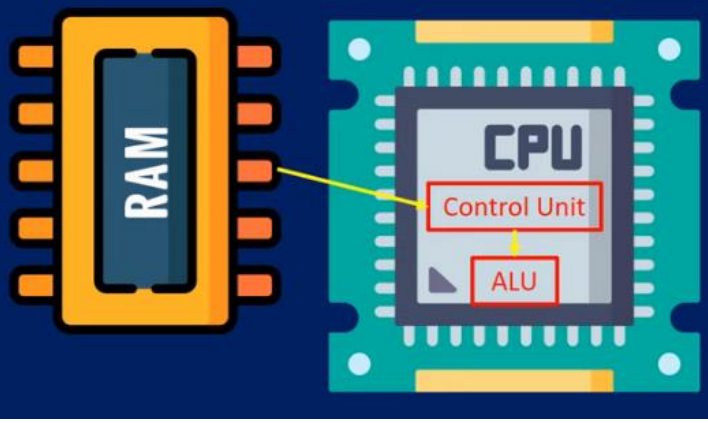
Hardware

RAM (Random Access Memory)



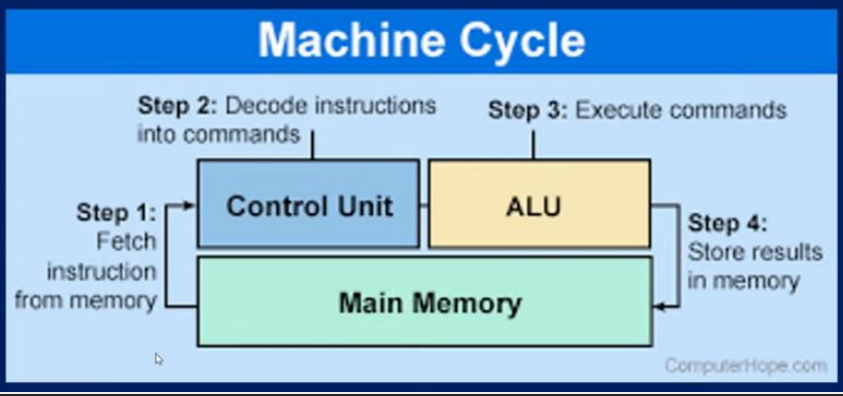
Hardware

CPU (Central Processing Unit) (Processor)



Hardware

CPU (Central Processing Unit) (Processor)



Hardware

RAM (Random Access Memory)

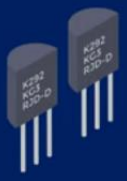
RAM: Circuit board with chips that slides into a slot on the motherboard

- 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)

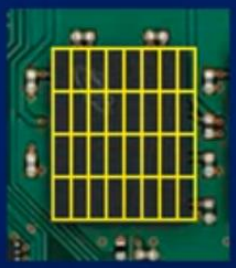
RAM: Circuit board with chips that slides into a slot on the motherboard



Hardware

RAM (Random Access Memory)

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



Hardware

RAM (Random Access Memory)

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

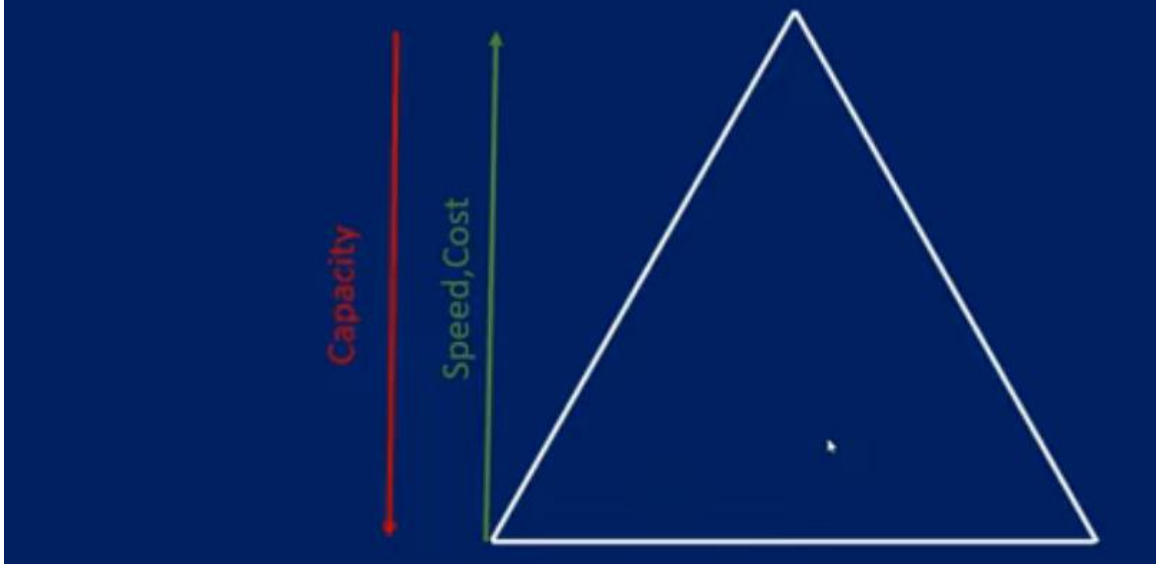
Capacity: 4 GB
16 GB
32 GB

1 GB = 8,589,934,592 bits

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

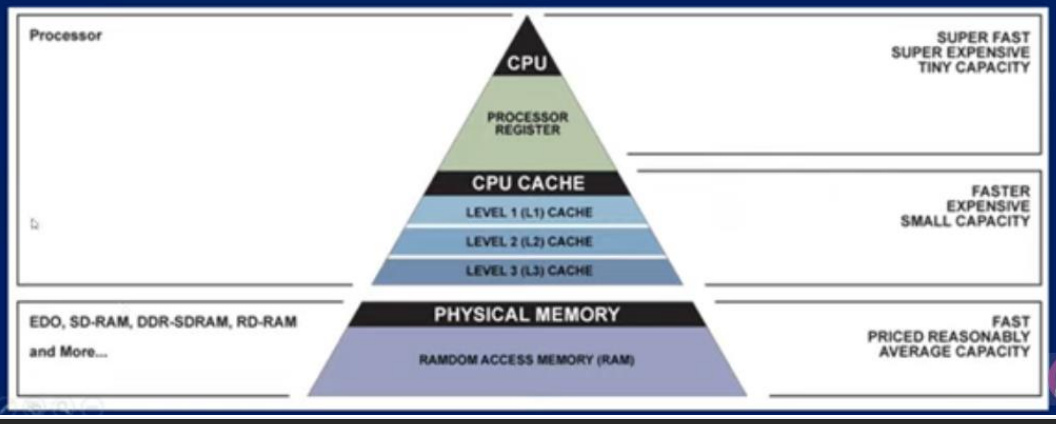
Hardware

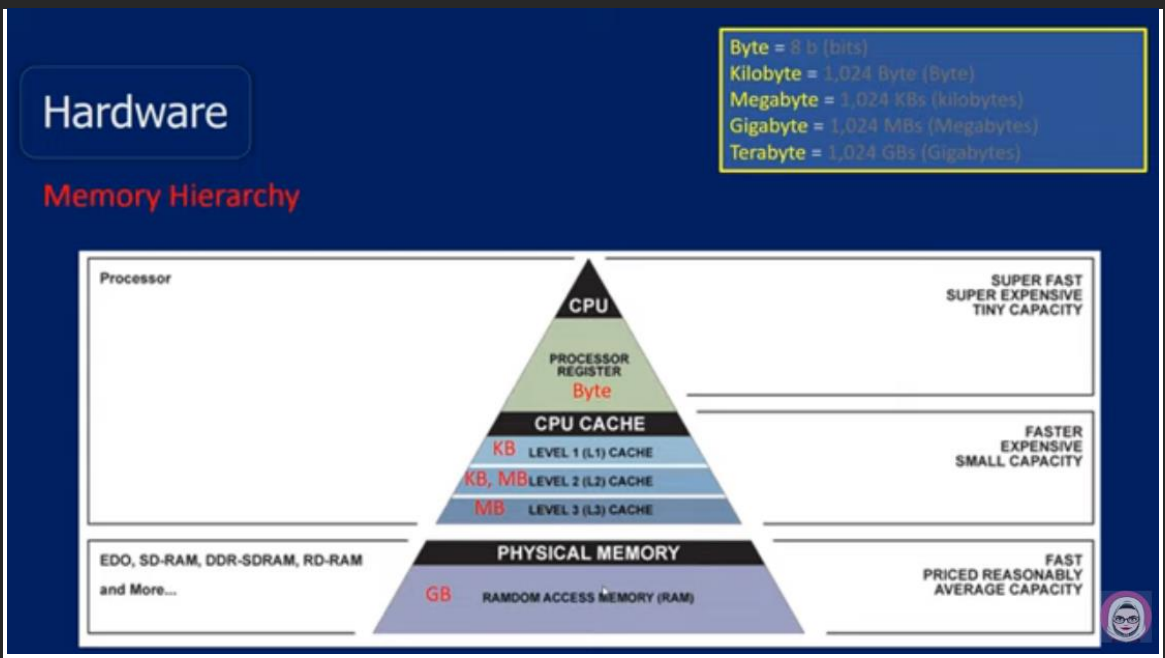
Memory Hierarchy

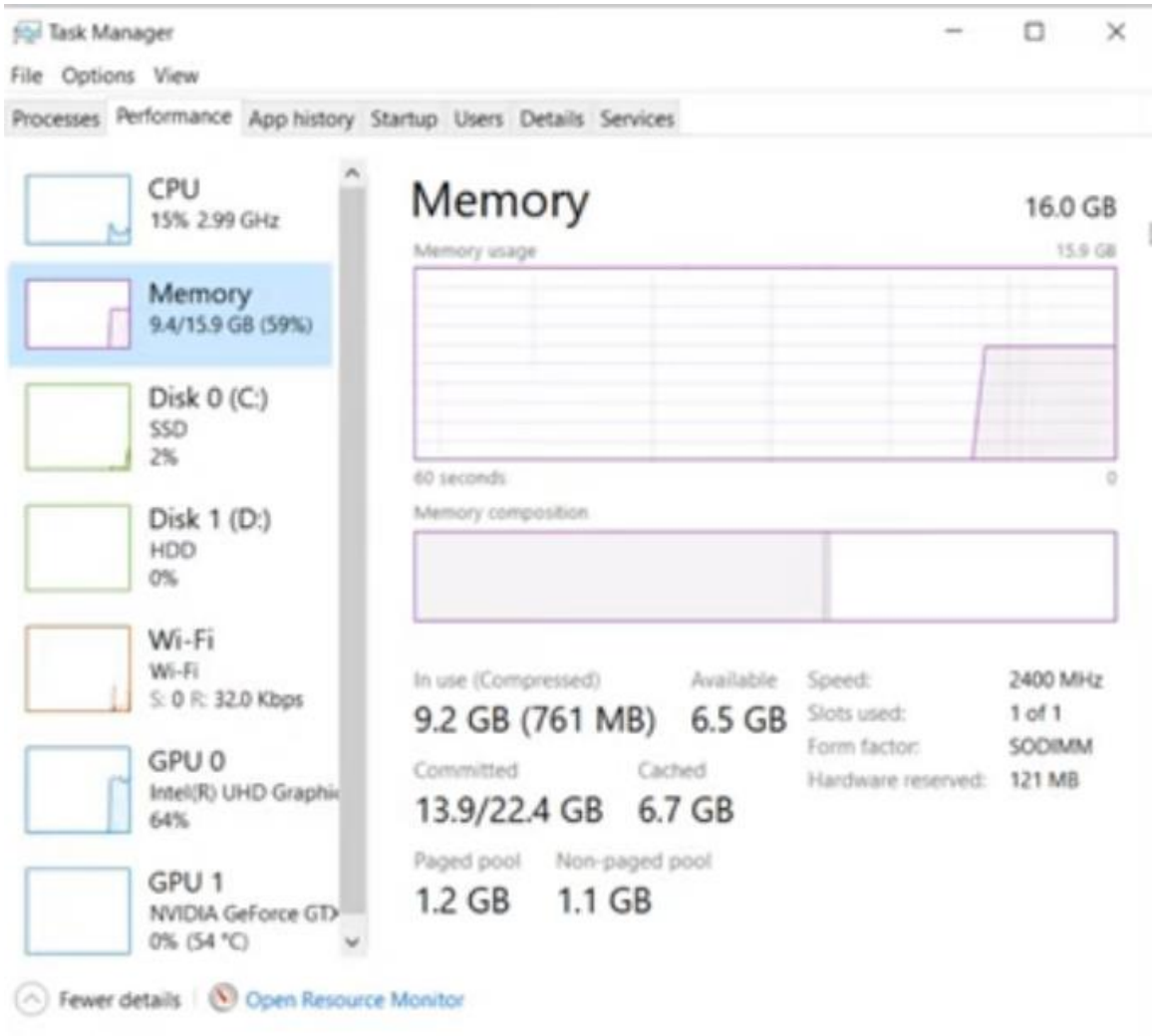


Hardware

Memory Hierarchy




Hardware
Memory Hierarchy
Byte = 8 b (bits)
Kilobyte = 1,024 Byte (Byte)
Megabyte = 1,024 KBs (kilobytes)
Gigabyte = 1,024 MBs (Megabytes)
Terabyte = 1,024 GBs (Gigabytes)
Processor
CPU
PROCESSOR REGISTER
Byte
CPU CACHE
KB LEVEL 1 (L1) CACHE
KB, MB LEVEL 2 (L2) CACHE
MB LEVEL 3 (L3) CACHE
PHYSICAL MEMORY
GB RAMDOM ACCESS MEMORY (RAM)
EDO, SD-RAM, DDR-SDRAM, RD-RAM
and More...
SUPER FAST
SUPER EXPENSIVE
TINY CAPACITY
FASTER
EXPENSIVE
SMALL CAPACITY
FAST
PRICED REASONABLY
AVERAGE CAPACITY


Task Manager
File Options View
Processes Performance App history Startup Users Details Services
CPU
15% 2.99 GHz
Memory
9.4/15.9 GB (59%)
Disk 0 (C:)
SSD
2%
Disk 1 (D:)
HDD
0%
Wi-Fi
Wi-Fi
S: 0 R: 32.0 Kbps
GPU 0
Intel(R) UHD Graphi
64%
GPU 1
NVIDIA GeForce GT
0% (54 °C)
Memory
16.0 GB
Memory usage
15.9 GB
60 seconds
0
Memory composition
In use (Compressed)
9.2 GB (761 MB)
Available
6.5 GB
Committed
13.9/22.4 GB
Cached
6.7 GB
Paged pool
1.2 GB
Non-paged pool
1.1 GB
Speed:
2400 MHz
Slots used:
1 of 1
Form factor:
SODIMM
Hardware reserved:
121 MB
Fewer details
Open Resource Monitor

Hardware

Binary

We use computers everyday

Inside a computer are "0s and 1s"	Computers use the binary number system to represent info

How do computers represent info with just binary?

Consider the decimal number (what we human typically use) 123	The rightmost column is the 1s column The middle, the 10s The leftmost, the 100s
100 | 10 | 1 1 | 2 | 3	**Thus, we have** 100 x 1 + 10 x 2 + 1 x 3 = 100 + 20 + 3 = 123

Inside a computer, the binary 000 would represent 0, just like in our

human world!

However, in this case we are dealing with binary so:	The right most column is the 1s place The middle, the 2s The leftmost, the 4s

4	2	1
0	0	0

In the human world (decimal) we use powers of 10 for place values	$10^0 = 1$, $10^1 = 10$, $10^2 = 100$, $10^3 = 1000$**, etc.**
In the computer world (binary) we use powers of 2 for place values	**$2^0 = 1$, $2^1 = 2$, $2^2 = 4$, $2^3 = 8$, etc.**
The difference between decimal numbers and binary numbers is changing the base	**For the binary number 000, we have** 4 x 0 + 2 x 0 + 1 x 0 = 0 + 0 + 0 = 0**!**

Consider the binary number 001:	

4	2	1
0	0	1

We have 4 x 0 + 2 x 0 + 1 x 1 = 0 + 0 + 1 = 1

How do we represent the decimal number 2 in binary?	We don't need a 4, be we need a 2, and also no 1

4	2	1
0	1	0

This gives us 4 x 0 + 2 x 1 + 1 x 0 = 0 + 2 + 0 = 2

Likewise, the number 3 would be:	As we need a 2 and a 1

4	2	1
0	1	1

Thus, 4 x 0 + 2 x 1 + 1 x 1 = 0 + 2 + 1 = 3

What about 7?	

4	2	1
1	1	1

Which yields 4 x 1 + 2 x 1 + 1 x 1 = 4 + 2 + 1 = 7

What about 8?

We can't count to 8 without another bit (binary digit)

We run into this in the real world too if we need a four-digit number vs a 3-digit number

Start with the 1s, 10s, 100s place and add the 1000s

Here we'll add the next power of 2, 8

8	4	2	1
1	0	0	0

8 x 1 + 4 x 0 + 2 x 0 + 1 x 0 = 8

Even though computers only use binary, they can count as high as humans can!

They do it with a smaller vocabulary, just 1 and 0.

This is because it's easier to represent two states in the physical world.

If you think of one of these bits as being a light bulb:

0 is off

1 is on

Light bulbs just need electricity to turn on or off

Electricity is sufficient to turn a switch on or off

Inside a computer exists these switches called transistors

Modern computers have billions!

Turned off represents 0

Turned on represents 1

Using these transistors we can store values, store data, compute, and do everything we can with computers

David demonstrates how transistors work using light bulbs

So far, all that we can represent is numbers

A decision needs to be made on what pattern of 1s and 0s to represent letters, words, and paragraphs

All computers can store is 0s and 1s

To represent letters, we need a mapping of 0s and 1s to characters

ASCII (American Standard Code for Information Interchange) does this

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

65 -> A, 66 -> B, 67 -> C, etc.

97 -> a, 98 -> b, 99 -> c, etc.

ASCII also has mapping for punctuation symbols

Programs like notepad, TextEdit, and Microsoft Word decide whether 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

For example, if Microsoft word sees a pattern of buts representing the number 65, it will interpret that as "A"

ASCII is limited

Original ASCII is 7 bits, thus giving 128 characters

Extended ASCII is 8 bits, yielding 256 characters

Many symbols are not represented

UNICODE is a bigger set of characters that includes written languages other than English and even emoji!

All are still represented by a pattern of bits

Consider this pattern of bits: 01001000 01001001

16 bits or 2 bytes (1 byte = 8 bits)

Using ASCII, we get the word "HI"

128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
0	1	0	0	1	0	0	0	0	1	0	0	1	0	0	1
1 * 64 + 1 * 8								1 * 64 + 1 * 8 + 1 * 1							
72								73							
H								I							

CPU

If you have heard that your computer has “Intel Inside,” it has an Intel processor in it

The backside of the processor has pins that connect into the motherboard

The motherboard is a circuit board made of silicon

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

CPUs now can have multiple cores

Cores are the devices inside the CPU that can perform mathematical operations, load info from memory, save info to memory, etc.

The more cores, the more tasks a CPU can do at once

CPUs now also support hyper-threading

Where a single core will present itself as multiple cores to a computer's operating system

Systems on a Chip (SoaC) are 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

RAM (Random Access Memory)

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

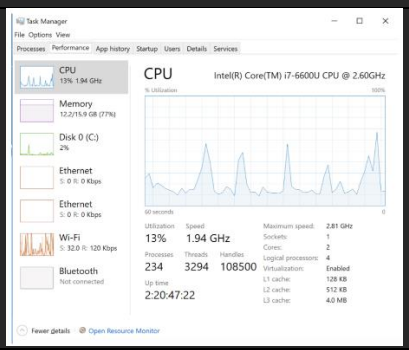
The chips store data: Only stores data when the power is on

Files and programs are loaded onto these chips when ran

Fast memory

You can check your **RAM** and other specs:

Windows Task Manager



CPU chart shows when peak usage occurs

GHz is the number of operations a CPU can perform per second (in billions)

Logical processors in this case is 4, which means both cores support hyper-threading

	1.94 GHz = 1.94 billion operations per second	Each core will do two things at once as if 4 cores exist

Mac System Profiler

Hardware Overview:

Model Name:	MacBook Pro
Model Identifier:	MacBookPro12,1
Processor Name:	Intel Core i7
Processor Speed:	3.1 GHz
Number of Processors:	1
Total Number of Cores:	2
L2 Cache (per Core):	256 KB
L3 Cache:	4 MB
Memory:	16 GB

Hard Drives

When you turn a computer off, you need a place to store data

A hard disk drive (HDD) stores this information

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

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
Uses tiny magnetic particles where north pole orientation represents 1 and south pole orientation represents 0	Power is only needed to read or change the data Data is preserved when power is off

- David shows a video of a HDD running in slowmo
- To store data in a hard drive, RAM sends data and instructions to the HDD
  - The hard drive translates that data into voltage fluctuations
    - Some signals spin the platters, others move the read/write heads
    - Pulses sent to the read/write head turn on a magnet which creates a field that changes the polarity of a tiny portion of the metal platter's surface
    - Power is sent in different directions as to change polarity
  - To read, the particles on the disk use their charge to move the read/write head.
  - Pieces of a file can be spread out around the platters
    - A special file keeps track of data's location
  - Anytime you have a physical device that moves over a period of time, things go wrong
    - Dropping a HDD can corrupt files
  - Platters spin slower than how fast electrons move

Flash Memory

- Solid state disk (SSD)

- Smaller (3.5 inch width for HDD vs 2.5 inch width for SSD)
  - Still fits where old HDDs are
- No moving particles
- Inside, it looks a lot like RAM

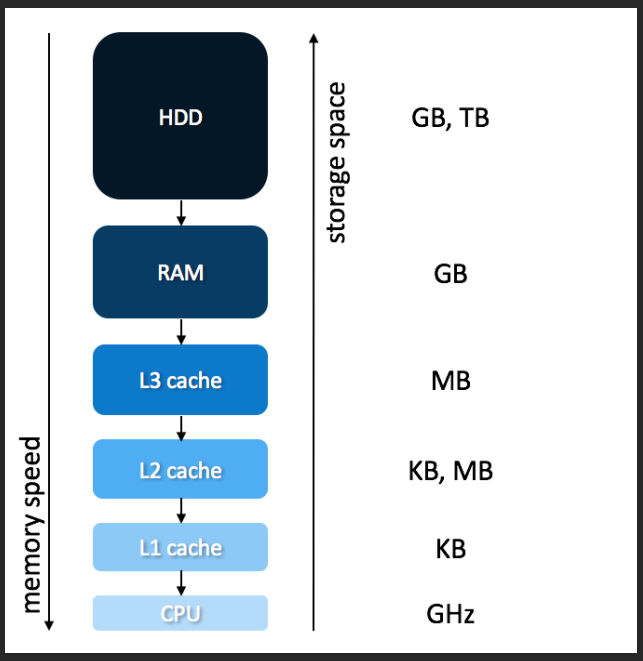
- Much faster than HDD
  - Programs/files load and save more quickly
- SSD theoretically don't last as long as HDD
  - Finite number of writes

- Hybrid Drives
  - 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
- Flash memory also exists in the form of USB sticks
  - Might store 1 GB, 16 GB, or more
  - Portable
- External SSDs exist for more storage
  - Might store 256 GB or more
  - Can be used to share data with others without network usage
- Can also have external HDD

Types of Memory and Funneling

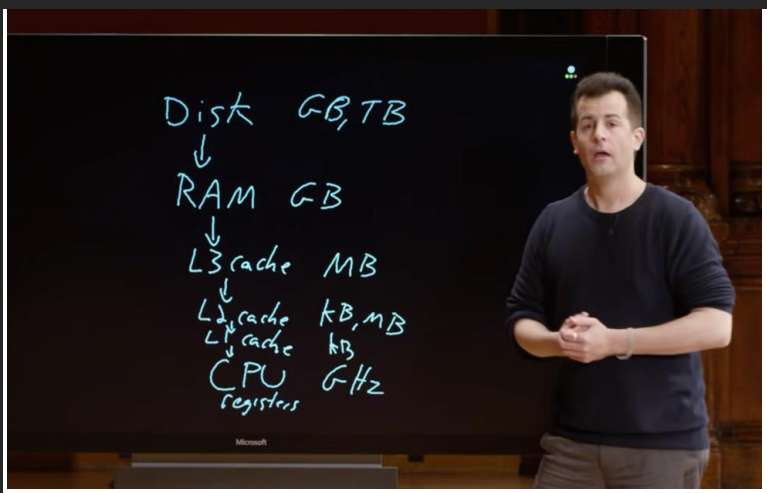
- There is a tradeoff between space, money, and speed of data transfer

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

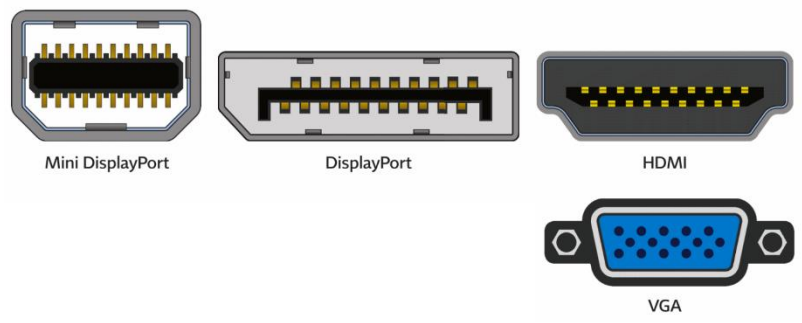


- Theoretically, the CPU never has to wait for data to crunch
- There is a tiny amount of memory (bytes) called registers where numbers are stored for operations.
- Memory at the bottom is more expensive
- Disk is important for the long-term storage

        - RAM is important as it stores programs you use simultaneously
        - L3, L2, L1 cache are on the motherboard
- As an analogy for memory, picture a candy store
    - A customer approaches the counter and requests candy
    - The shop owner then leaves the counter to grab the candy before returning moments later
        - Not super efficient to walk all the way to the store room to grab candy
            - Better to have a cache of memory
    - Instead, the shop owner leaves the counter to ready a cache of candy before the customers arrive
    - When a customer comes, the candy can be distributed quickly
        - Cache memory similarly helps the CPU in this manner
- We can see sizes of cache looking at computer specs like before

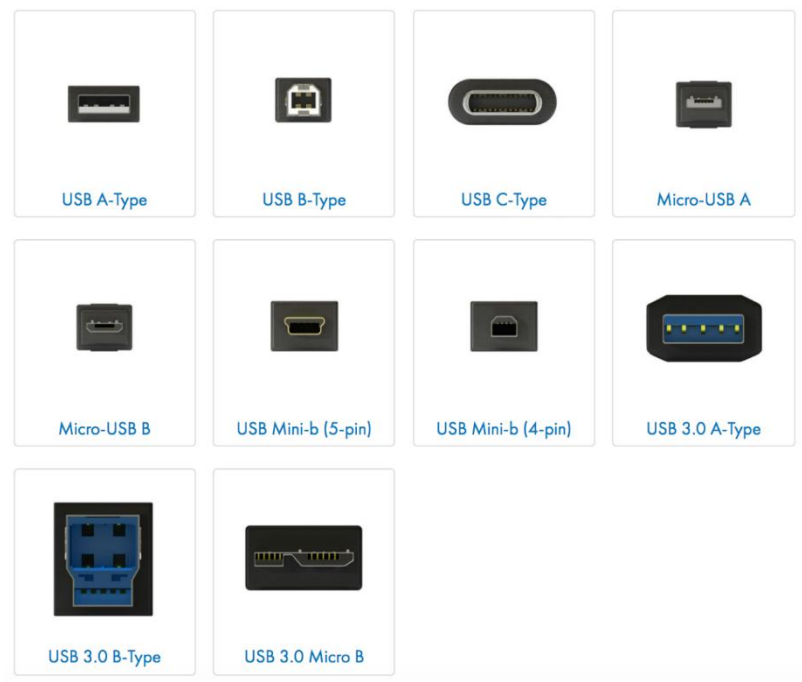


Display Connectors



- **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**

USB (Universal Serial Bus)



- **Can plug in a whole range of peripheral devices including printers, keyboards, mice, scanners, etc.**
- **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**
- **Other variants often exist for phones**
- **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

Wireless

- Wifi is wireless 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

Operating System (OS)

- Software that ensures all devices work and can intercommunicate
- MacOS and Windows are popular OS
- Can be installed by the user, but is typically done so by a manufacturer
    - Installed on HDD or SDD so that it exists persistently without power
- When you hit power on your computer, the OS is loaded into RAM
- Gives you the graphical interface that you see
- Knows how to:
    - Talk to your keyboard and mouse
    - Display info on the screen
    - Move things around in memory
- This is all thanks to device drivers installed with the OS
    - Special software designed to talk to certain model of printer, camera, scanner, etc.
- When an OS doesn't recognize a device, perhaps because it's too new, you can download new device drives from the device manufacturer
    - Teaches Window, MacOS, or Linux about that new hardware
    - Future-proofing structure
- It's this intersection of hardware and software that makes computers powerful!

Looking Underneath the Hood

- David and Colton Ogden look at the exterior of an old ThinkPad computer, examining ports
    - Power bricks convert power from the wall into safe amounts for the computer
- David and Colton examine the inside of an old window desktop, highlighting the motherboard, heatsink, RAM, Hard Drive, etc.

- **David and Colton then look inside a HDD**
  - **Once exposed to air and dust, it’s no longer reliable enough to use**
- **David and Colton then look at a motherboard examining all the ports on it**