MIS 231

Intro to MIS

Hardware & Software

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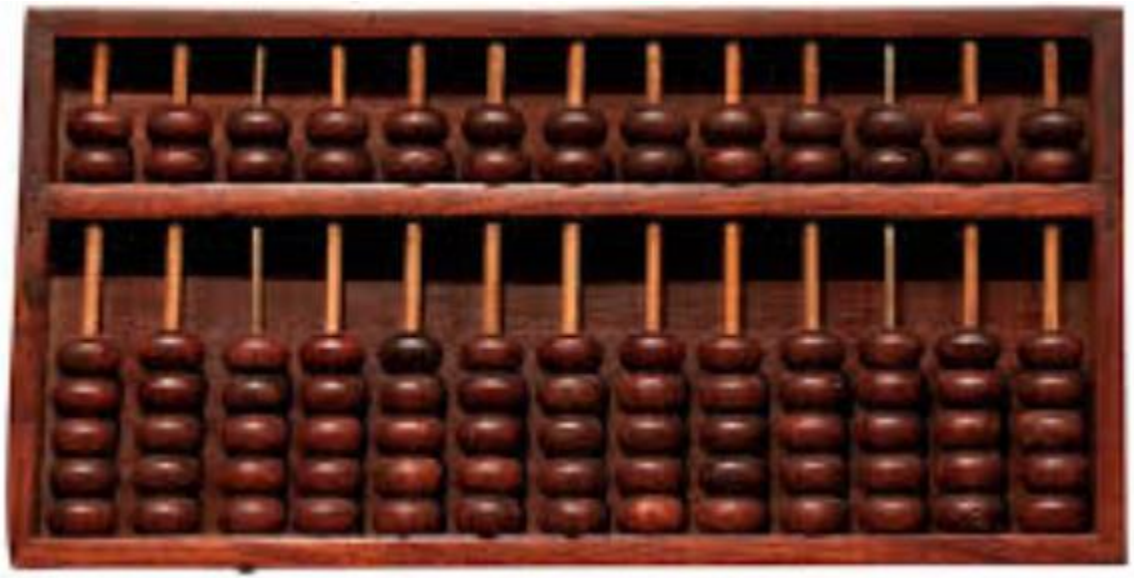
Learning Objectives

- Define a computer system, and describe its components
- Discuss the history of computer hardware and software
- Explain the factors distinguishing the computing power of computers
- Summarize computer operations
- Discuss the types of input, output, and memory devices
- Explain how computers are classified
- Describe the two major types of software
- List the generations of computer languages

Abacus

- Developed by the Chinese around 1200 AD
- Also called a **counting frame**, was in use in China, Russia, and Europe centuries before the adoption of the written Hindu–Arabic numeral system

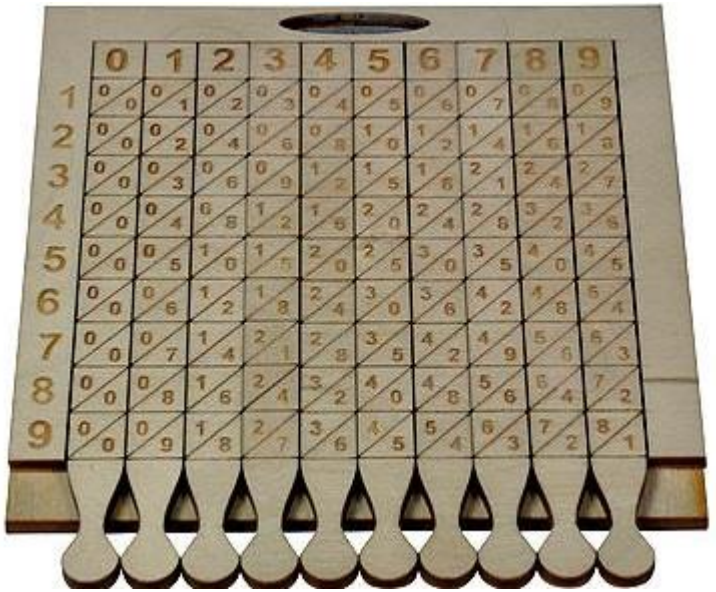


Sector

- Developed by Galileo about 1560
- Also called the military compass and could solve geometry and trigonometry problems also

Napier's Bones

- Developed by Scottish mathematician Jon Napier in 1617
- Also used by Isaac Newton for multiplication and division

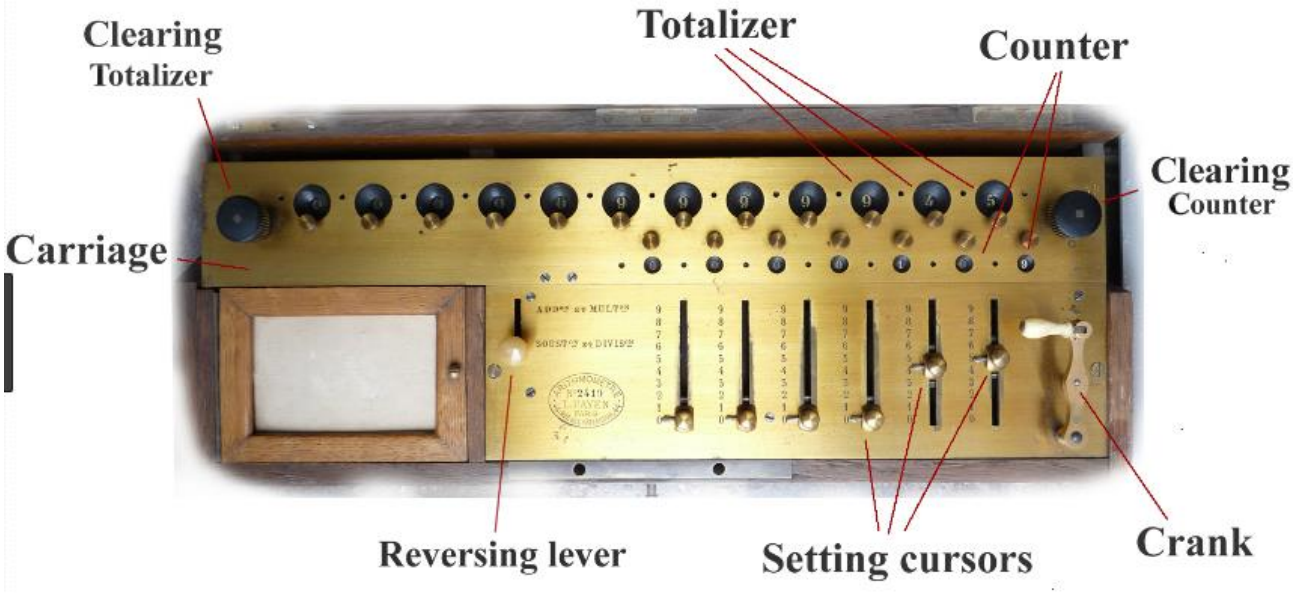


Slide Rule

- Developed by Anglican minister William Oughtred in 1632
- Used logarithms (adding the log of two numbers is the same as multiplying the numbers)

Arithmometer

- First mass produced mechanical calculator patented by Charles Thomas in France in 1820



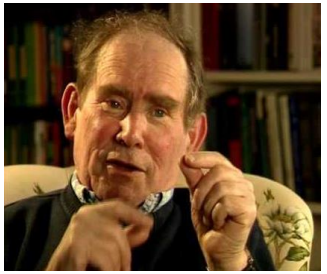
Printing Adding Machine

- Invented by William Burrough's in 1886
- Most popular with business people

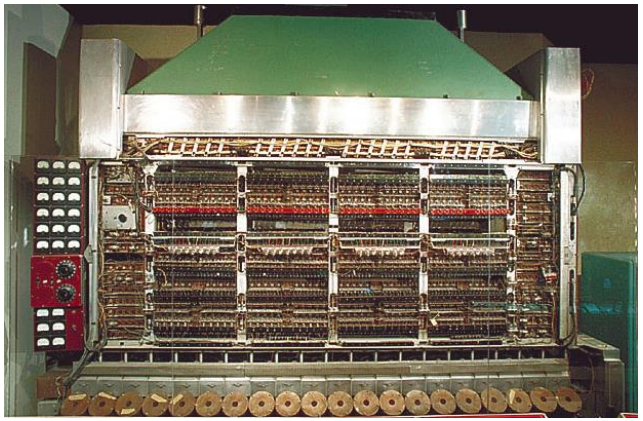
Printing Adding Machine (con't)

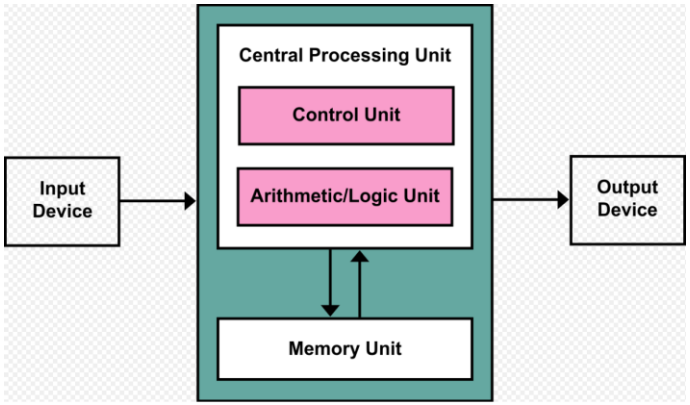
- Portable version about 1930

Von Neumann Machine

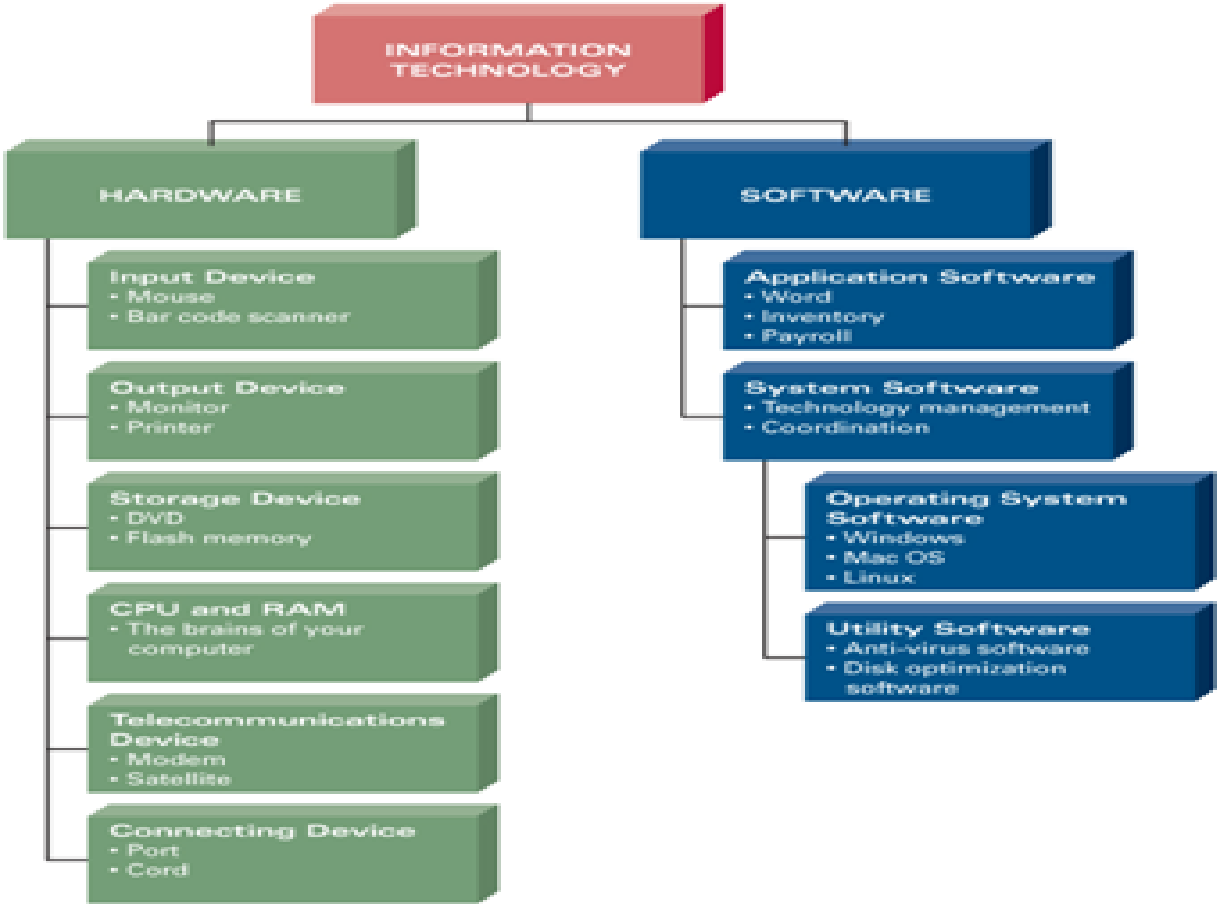


- The **IAS machine** was the first electronic computer to be built at the Institute for Advanced Study (IAS) in NJ in the 1940's
- It is sometimes called the von Neumann machine, since the paper describing its design was John von Neumann, a mathematics professor at both Princeton University





Computer Hardware & Software



- How would you define a computer ?

Thinking…

?

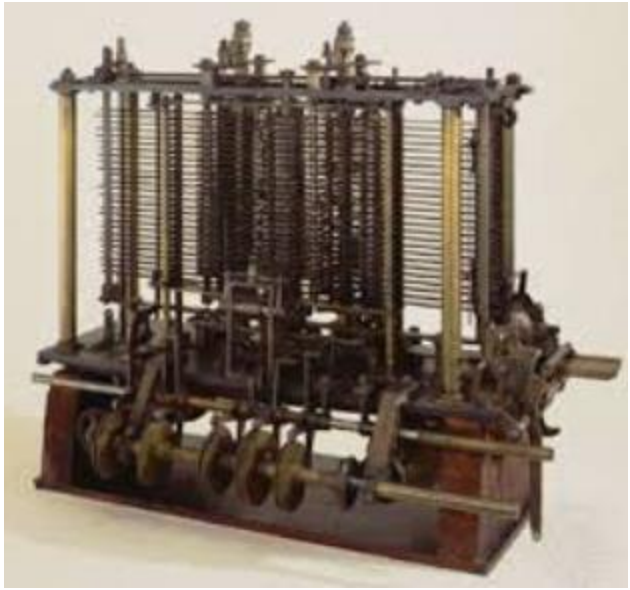
Don’t look ahead !

What is a Computer?

- A device (today, an electronic device) operating under the control of instructions (today, stored in its own memory), that can:
  - Accept data (input)
  - Process the data according to specified rules (process)
  - Produce results (output)
  - Store the results for future use (storage)

Representation of Information by a Computing Agent

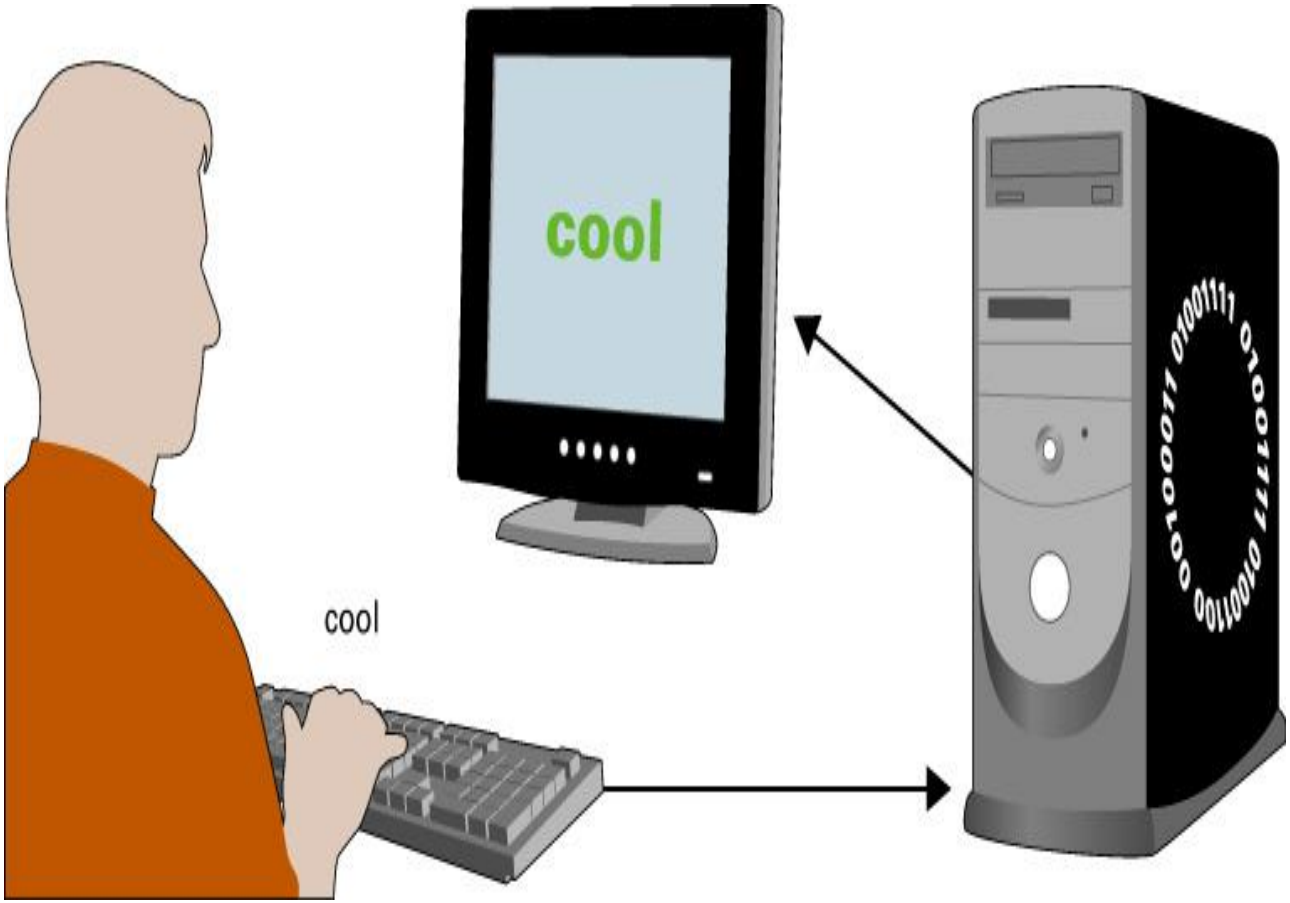
- External Representation [keyboard, monitor, printer]
  - numbers
  - letters
  - signs, decimal points, ...
  - special symbols
  - Images
  - sounds
  - videos



Internal Representation

- A computer cannot store images and sounds directly
- It cannot even store letters and symbols literally
- It can only store numbers
- In fact, it can only store 2 numbers, 0 and 1 → a “bit”

I/O Conversion



Numbers & Symbols

- For a computer to record a number, it must express it in base-2
- Or in other words, convert it from base-10 to base-2 (binary)
- All other symbols, (characters, punctuation marks, etc.) are converted to a base-2 numeric value using a universal encoding scheme -- that encoding scheme is called ASCII

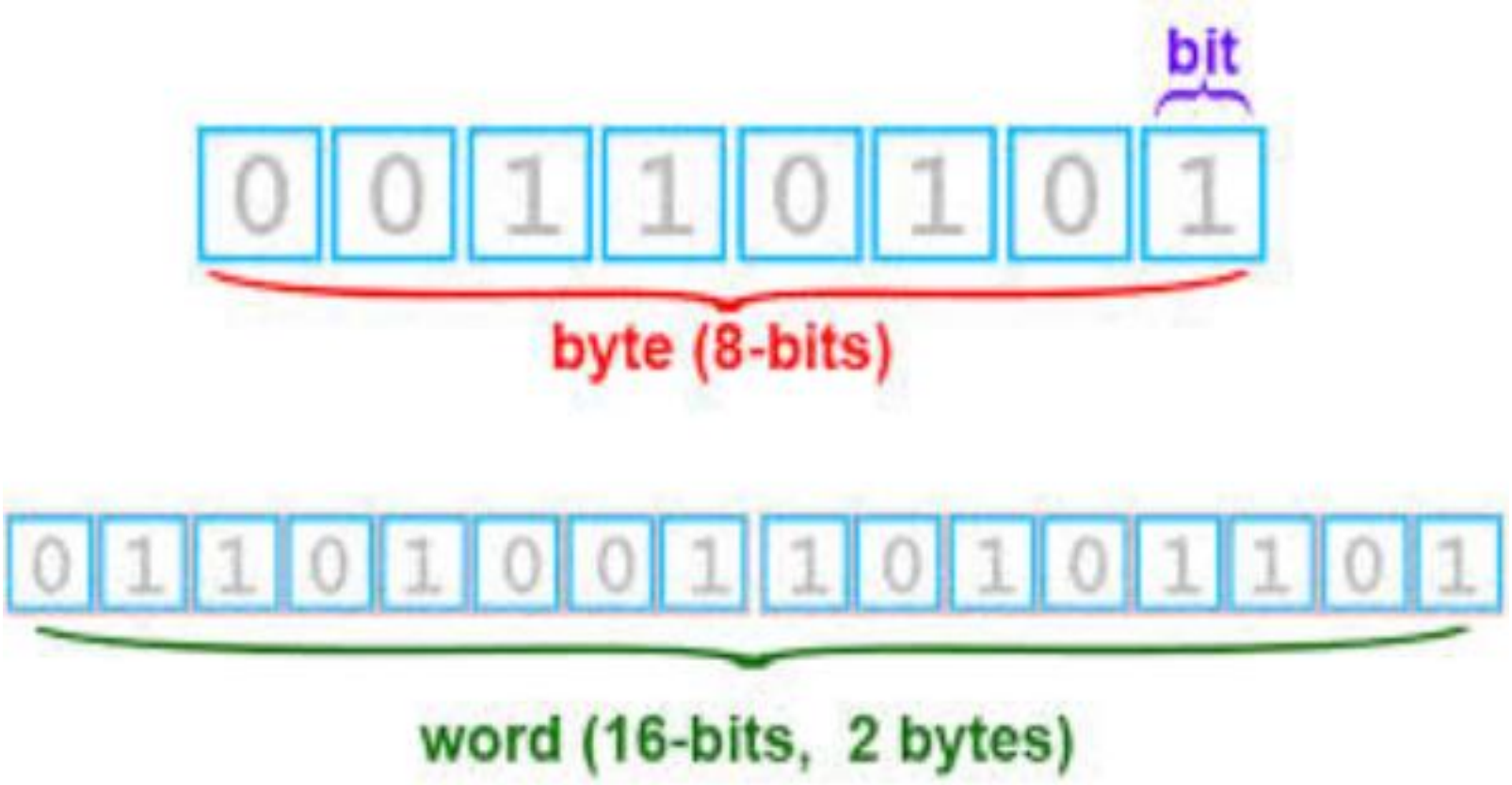
ASCII

- ASCII (ask-ee) Stands for American Standard Code for Information Interchange
- Each symbol or character that you can type from your keyboard is assigned a unique bit pattern called a “byte”:
  - For example, ’A' = 1000001 [decimal 65]
  - And 'a' = 1100001 [decimal 97]
- The original version of ASCII used 7 bits to represent each symbol -- therefore, 128 (2^7) unique symbols could be represented with this encoding scheme

EXTENDED ASCII

- Later, extended ASCII was created, it uses 8-bits to store characters (8 bit bytes) -- therefore, 256 different combinations of 0’s and 1’s could be made
- The extended ASCII character set contains all the original 128 codes plus an additional 128
- It is by far the most commonly-used encoding scheme, now more commonly called UTF-8

CPU Processes a "Word" Each Clock Tick



Decimal	Hex	ASCII	Decimal	Hex	ASCII	Decimal	Hex	ASCII	Decimal	Hex	ASCII
0	00	NUL	32	20	(blank)	64	40	@	96	60	`
1	01	SOH	33	21	!	65	41	A	97	61	a
2	02	STX	34	22	"	66	42	B	98	62	b
3	03	ETX	35	23	#	67	43	C	99	63	c
4	04	EOT	36	24	$	68	44	D	100	64	d
5	05	ENQ	37	25	%	69	45	E	101	65	e
6	06	ACK	38	26	&	70	46	F	102	66	f
7	07	BEL	39	27	'	71	47	G	103	67	g
8	08	BS	40	28	(	72	48	H	104	68	h
9	09	HT	41	29	)	73	49	I	105	69	i
10	0A	LF	42	2A	*	74	4A	J	106	6A	j
11	0B	VT	43	2B	+	75	4B	K	107	6B	k
12	0C	FF	44	2C	,	76	4C	L	108	6C	l
13	0D	CR	45	2D	-	77	4D	M	109	6D	m
14	0E	SO	46	2E	.	78	4E	N	110	6E	n
15	0F	SI	47	2F	/	79	4F	O	111	6F	o
16	10	DLE	48	30	0	80	50	P	112	70	p
17	11	DC1	49	31	1	81	51	Q	113	71	q
18	12	DC2	50	32	2	82	52	R	114	72	r
19	13	DC3	51	33	3	83	53	S	115	73	s
20	14	DC4	52	34	4	84	54	T	116	74	t
21	15	NAK	53	35	5	85	55	U	117	75	u
22	16	SYN	54	36	6	86	56	V	118	76	v
23	17	ETB	55	37	7	87	57	W	119	77	w
24	18	CAN	56	38	8	88	58	X	120	78	x
25	19	EM	57	39	9	89	59	Y	121	79	y
26	1A	SUB	58	3A	:	90	5A	Z	122	7A	z
27	1B	ESC	59	3B	;	91	5B	[	123	7B	{
28	1C	FS	60	3C	<	92	5C	\	124	7C	|
29	1D	GS	61	3D	=	93	5D	]	125	7D	}
30	1E	RS	62	3E	>	94	5E	^	126	7E	~
31	1F	US	63	3F	?	95	5F	_	127	7F	(delete)

UNICODE

- 16 bit bytes
- ASCII is a subset
- Millions of characters
- Represent symbolic languages also (Chinese)
- Used in newer applications: JAVA, PHP & International Web Applications

Representing Numeric Values Internally

- Even though ASCII codes exist for the numbers 0-9, and decimal points, there is a better way to store numeric values than using the ASCII encoding scheme
- This is because using ASCII, 8-bits are used to store each individual symbol, therefore, the largest numeric value you could store in 8 bits is 9
- Using basic binary numbers, the largest number that could be stored in 8 bits is 255

Storing 100 as ASCII

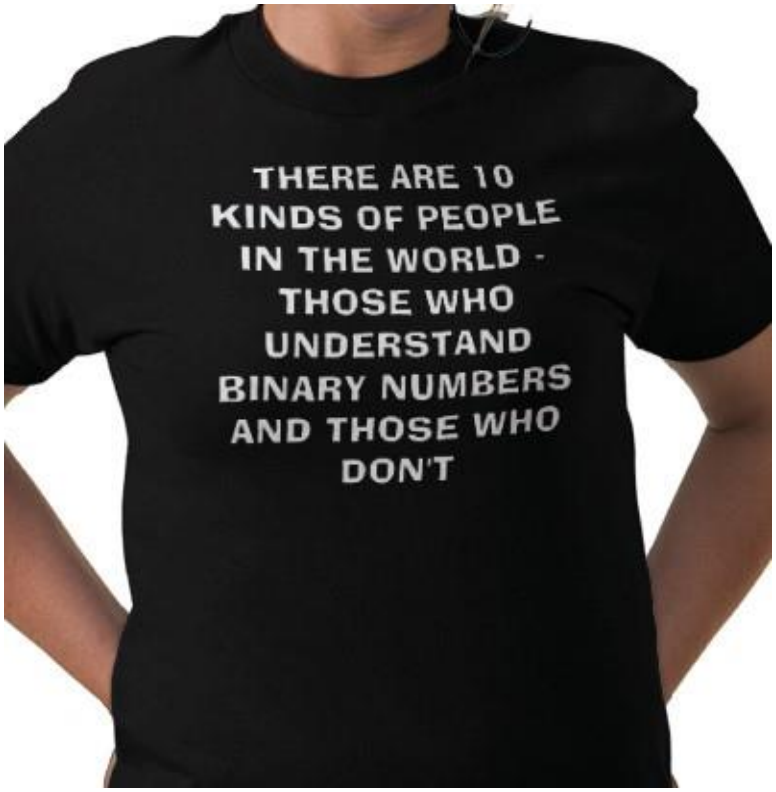
- 8 bits for “1”
- 8 bits for “0”
- 8 bits for “0”

Base for Number Systems

- Base 10 (decimal)
  - first position (rightmost) 10**0 = 1
  - second position 10**1 = 10
  - third position 10**2 = 100
  - 101 = 1*1 + 0*10 + 1*100 (from right side)
- Base 2 (binary)
  - first position (rightmost) 2**0 = 1
  - second position 2**1 = 2
  - third position 2**2 = 4
  - 101 = 1*1 + 0*2 + 1*4 (5 in decimal)

BASE 10 BASE 2 (binary)

BASE 10	BASE 2 (binary)
1	00000001
2	00000010
3	00000011
4	00000100
5	00000101
6	00000110
7	00000111
8	00001000
9	00001001
10	00001010
100	01100100
255	11111111



Converting A Number From Base 2 To Base 10:

TAKE 00000111:

2^7 (128) = 0

2^6 (64) = 0

2^5 (32) = 0

2^4 (16) = 0

2^3 (8) = 0

2^2 (4) = 4

2^1 (2) = 2

2^0 (1) = 1

7

TAKE 11000111:

2^7 (128) = 128

2^6 (64) = 64

2^5 (32) = 0

2^4 (16) = 0

2^3 (8) = 0

2^2 (4) = 4

2^1 (2) = 2

2^0 (1) = 1

= 199

Exercise

- Convert 01101101 to Decimal
- Is it going to be an even or odd number?

Wait….

?

Don’t look ahead, until you have your answer !

TAKE 01101101:

2^7 (128) = 0

2^6 (64) = 64

2^5 (32) = 32

2^4 (16) = 0

2^3 (8) = 8

2^2 (4) = 4

2^1 (2) = 0

2^0 (1) = 1

= 109

Converting From Base 10 To Base 2

- Take a number and subtract the highest power of 2 ($2^?$) that you can without resulting in a negative number
- Keep subtracting the highest $2^?$ Until you get to 0
- Take 45
  - Subtract 2^5 (32) , since 2^6 is 64
  - Get 13
  - Subtract 2^3 (8)
  - Get 5
  - Subtract 2^2 (4)
  - Get 1
  - Subtract 2^0 (1)
  - Get 0
  - Answer: 00101101
- (A “1” in the 5th, 3th, 2nd and 0th positions)

Exercise

- Convert 53 to binary

Wait….

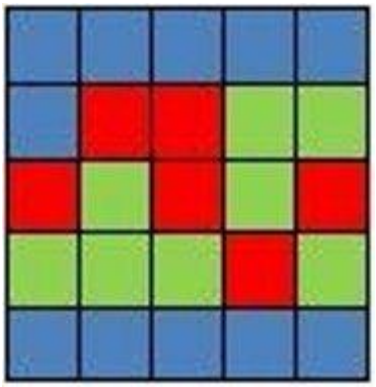
?

Don’t look ahead, until you have your answer !

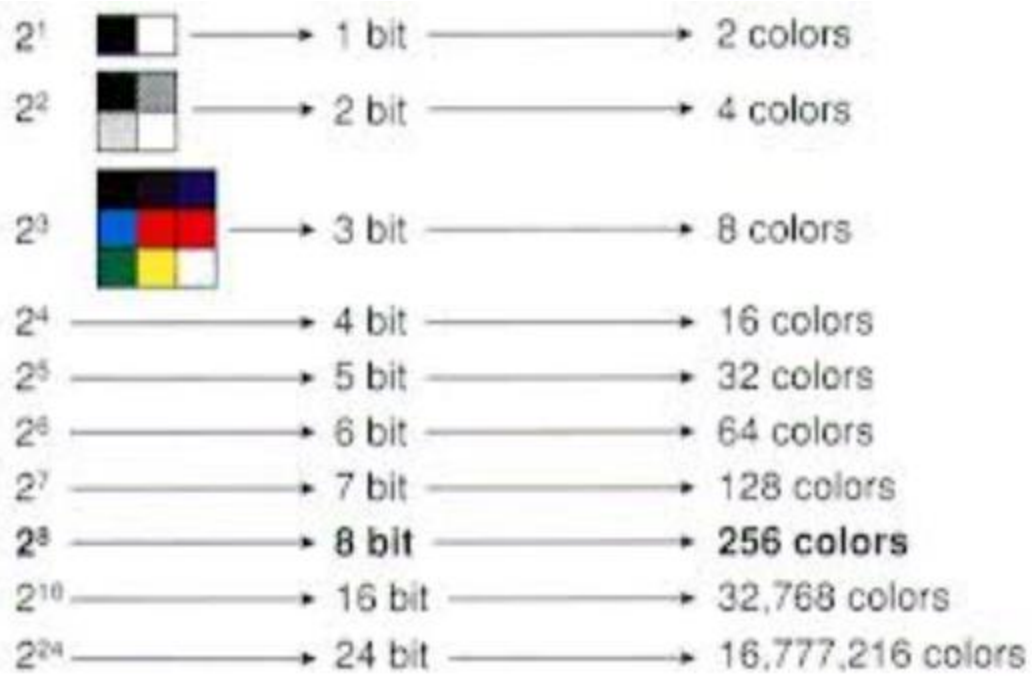
- TAKE 53
  - SUBTRACT 2^5 (32)
  - GET 21
  - SUBTRACT 2^4 (16)
  - GET 5
  - SUBTRACT 2^2 (4)
  - GET 1
  - SUBTRACT 2^0 (1)
  - GET 0
  - ANSWER: 00110101
- (A “1” IN THE 5TH, 4TH, 2ND AND 0TH POSITIONS)

Images, Music, Video Also Stored in Bits

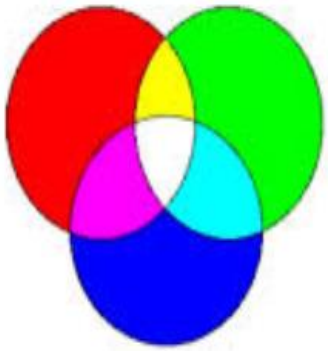
- The **Graphics Interchange Format** (**GIF**) is a bitmap image format that was introduced by CompuServe in 1987
- The format supports up to 8 bits per pixel thus allowing a single image to reference a palette of up to 256 distinct colors; the colors are chosen from the 24-bit RGB color space



Color Representation



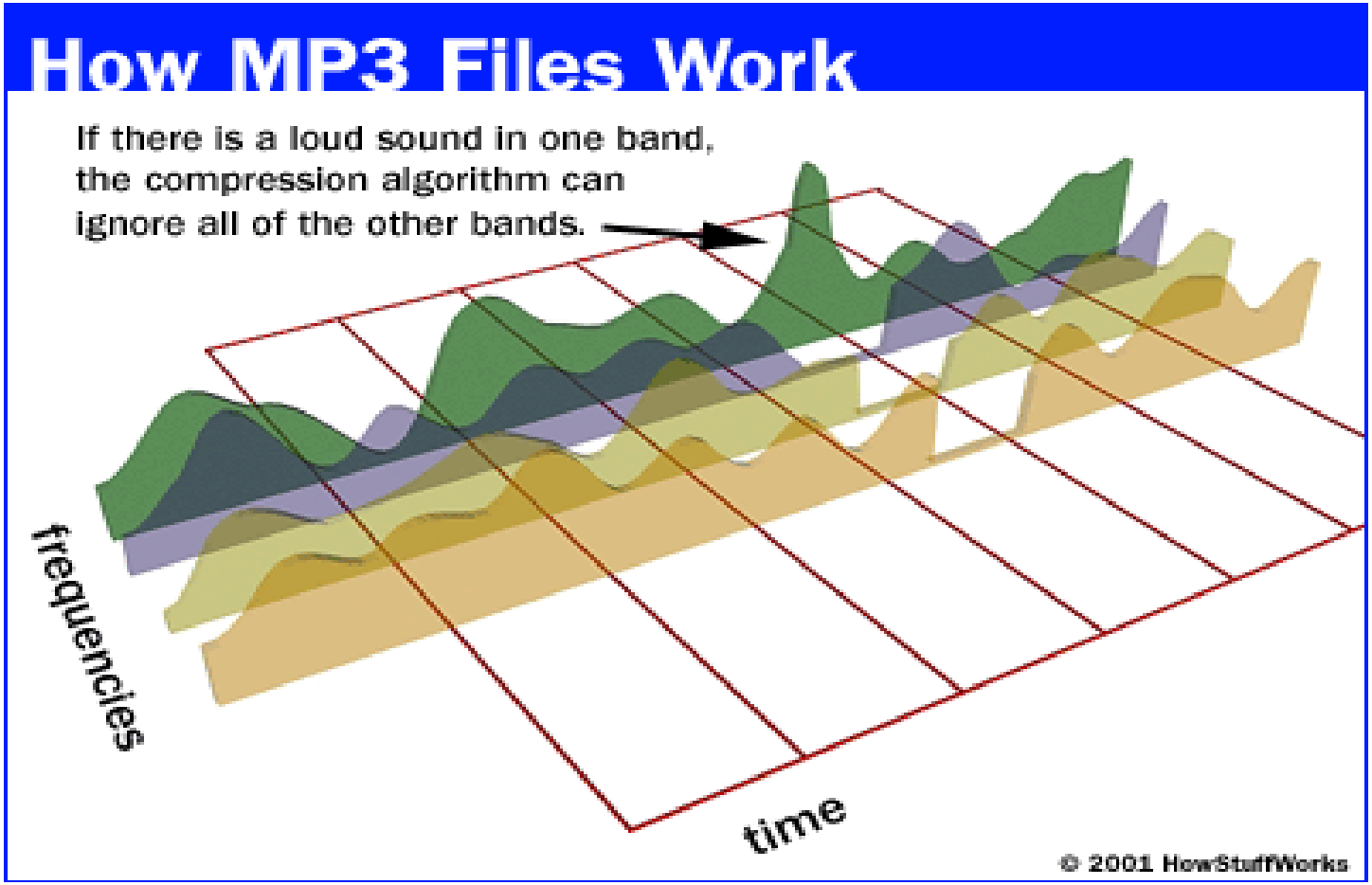
24 bit = 8 bit + 8 bit + 8 bit
red green blue



MP3

- **MPEG-1 or MPEG-2 Audio Layer III**, more commonly referred to as **MP3**, is a patented digital audio encoding format using a form of lossy data compression
- It is a common audio format for consumer audio storage, as well as a de facto standard of digital audio compression for the transfer and playback of music on digital audio players
- An MP3 file that is created using the setting of 128 kbit/s will result in a file that is about 11 times smaller than the CD file created from the original audio source

MP3 (con't)



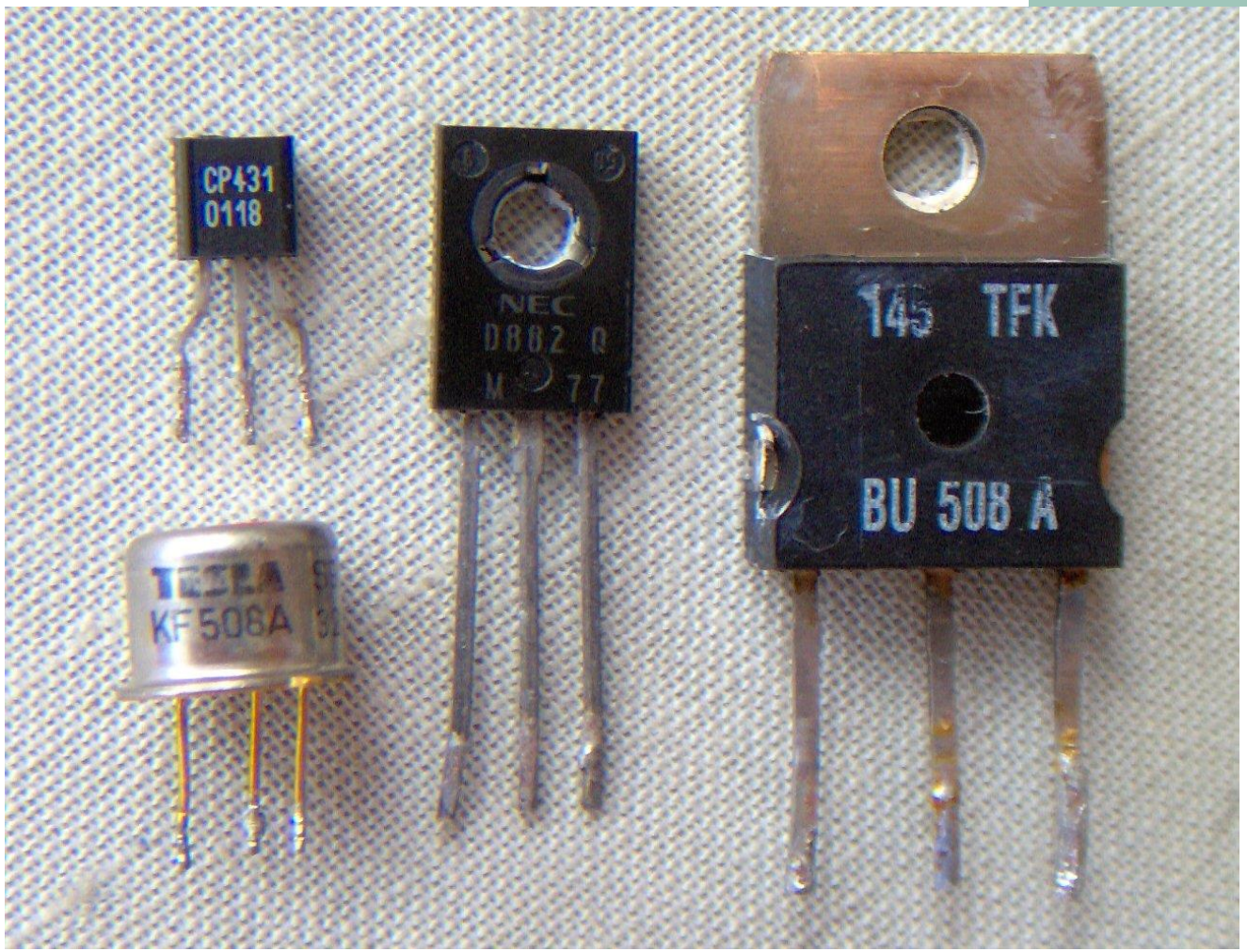
Digital Computers – Binary Devices

- Since computers work with 0's and 1's, they are constructed using devices with two stable states – such as on and off
- The original computers were mechanical
- The first digital computers used vacuum tubes then transistors
- When transistor radios first came out in the 1950's, one was proud to own an advanced transistor radio with five transistors

Changes in Computing

	1950's	1960's	1970's	1980's	1990's	2000's	2010's
Hardware Technology	Vacuum Tubes	Transis tors	Integrated Circuits	LSI	VLSI	ULSI	Nano-systems
Programming Languages	Binary Assembly	Fortran Cobol	Pascal Algol	Ada C Lisp	C++ GUI Java	C# PhP XML	Python, F#
Computing Paradigm	1 user Mainframe	Batch	Time Sharing	Personal Computer	LAN, WEB	.NET, SOA	Mobile
Operating System	none	1 user	multi user	multi user linked	networked	Web, Open source	Cloud, Android, iPhone
Data Base Methods	none	Linear (tapes)	Hier-archical	Relational	Object Oriented	SQL, X Query	SQLJ, OLAP, JDBC
Software Design	pad and pencil	Flow Charts	Structured Design	Data Flow	Object Oriented	RAD, XP, RUP	MDE

Transistors



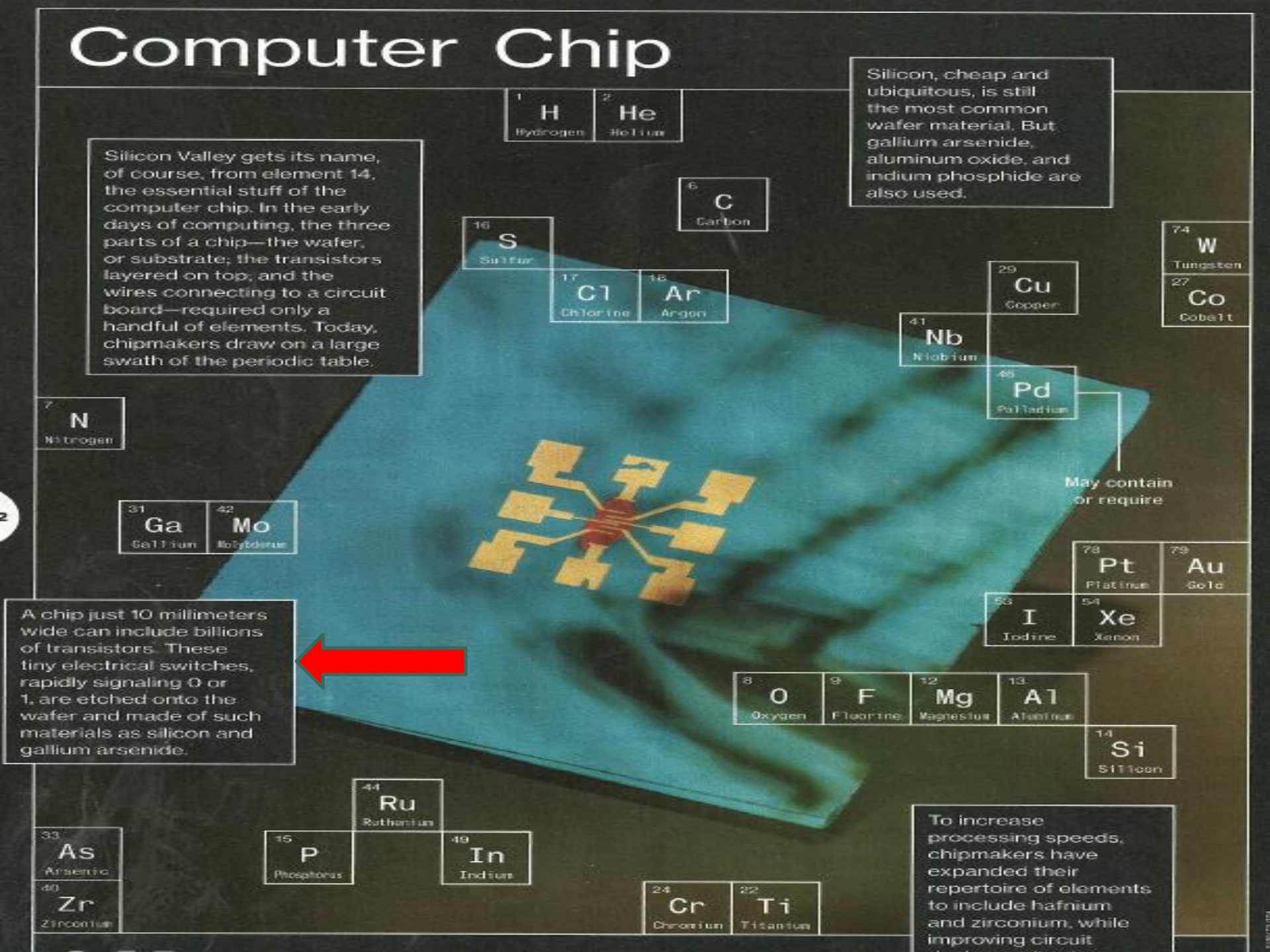
Transistors vs Neurons

- Today one typically owns more transistors then they have neurons in their brain (100 billion)
  - PCs and laptops have about 40 billion transistors
  - A SmartPhone has over 1 billion
  - Modern cars may have billions
  - TVs, and other appliances have millions of transistors each
  - In total the average person may have 100's of billion transistors
- Today for the price of a single gain of rice, one can buy over 100,000 transistors

Computer Chip

Silicon Valley gets its name, of course, from element 14, the essential stuff of the computer chip. In the early days of computing, the three parts of a chip—the wafer, or substrate; the transistors layered on top; and the wires connecting to a circuit board—required only a handful of elements. Today, chipmakers draw on a large swath of the periodic table.

Silicon, cheap and ubiquitous, is still the most common wafer material. But gallium arsenide, aluminum oxide, and indium phosphide are also used.



A chip just 10 millimeters wide can include billions of transistors. These tiny electrical switches, rapidly signaling 0 or 1, are etched onto the wafer and made of such materials as silicon and gallium arsenide.

May contain or require

To increase processing speeds, chipmakers have expanded their repertoire of elements to include hafnium and zirconium, while improving circuit

1 H Hydrogen
2 He Helium
6 C Carbon
16 S Sulfur
17 Cl Chlorine
18 Ar Argon
29 Cu Copper
41 Nb Niobium
46 Pd Palladium
74 W Tungsten
27 Co Cobalt
7 N Nitrogen
31 Ga Gallium
42 Mo Molybdenum
78 Pt Platinum
79 Au Gold
53 I Iodine
54 Xe Xenon
8 O Oxygen
9 F Fluorine
12 Mg Magnesium
13 Al Aluminum
14 Si Silicon
44 Ru Ruthenium
33 As Arsenic
15 P Phosphorus
49 In Indium
40 Zr Zirconium
24 Cr Chromium
22 Ti Titanium

The Power of Computers

- Computers draw their power from three factors that far exceed human capacities
  - Speed
  - Accuracy
  - Storage and retrieval capabilities
- Computer speed is measured as the number of instructions performed per second (MIPS)
  - Millisecond: 1/1,000 of a second
  - Microsecond:1/1,000,000 of a second
  - Nanosecond:1/1,000,000,000 of a second
  - Picosecond:1/1,000,000,000,000 of a second

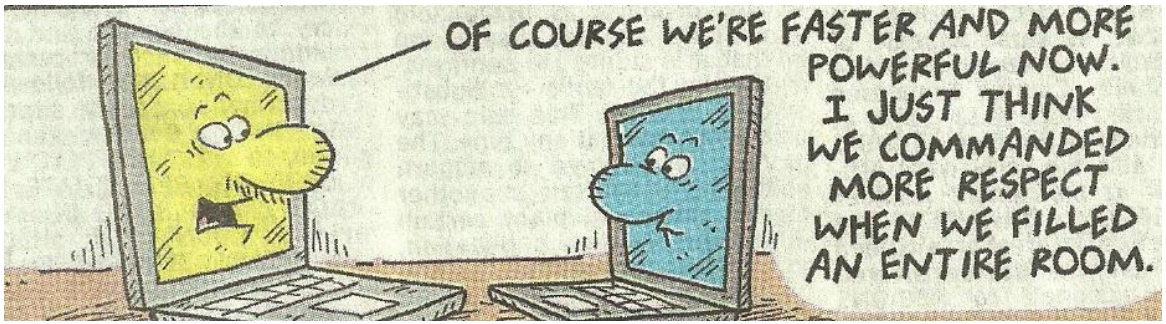
Hardware "Generations"

Generation	Date	Major Technologies	Example
First	1946–1956	Vacuum tube	ENIAC
Second	1957–1963	Transistors	IBM 7094, 1401
Third	1964–1970	Integrated circuits, remote data entry, telecommunications	IBM 360, 370
Fourth	1971–1992	Miniaturization, VSLI, personal computers, optical disks	Cray XMP, Cray II
Fifth	1993–present	Parallel processing, gallium arsenide chips, optical technologies	IBM System zEnterprise EC12

Computational Directions

	Past	Present	Future
Input	Data	Documents	Multimodal Data
Output	Results	Information	Multimedia & Experiences
Processing	Computations	Information Extraction	Experience Processing
Devices	Mainframe	PC's and Internet	Mobile Devices
Applications	Computing	Info and Communication	Insights & Entertainment
User Level	Trained	Knowledge Workers	All Humans
Interaction Mode	Command Line	Windows	Multimodal

Univac (1960 – 1980)



IBM Mainframes (1960 – 1995)

History of IBM mainframes, 1952–present

Market name
700/7000 series
System/360
System/370
System/390
zSeries 900, 800, 990, and 890
System z9
System z10
zEnterprise System (z196, zEC12, z13)

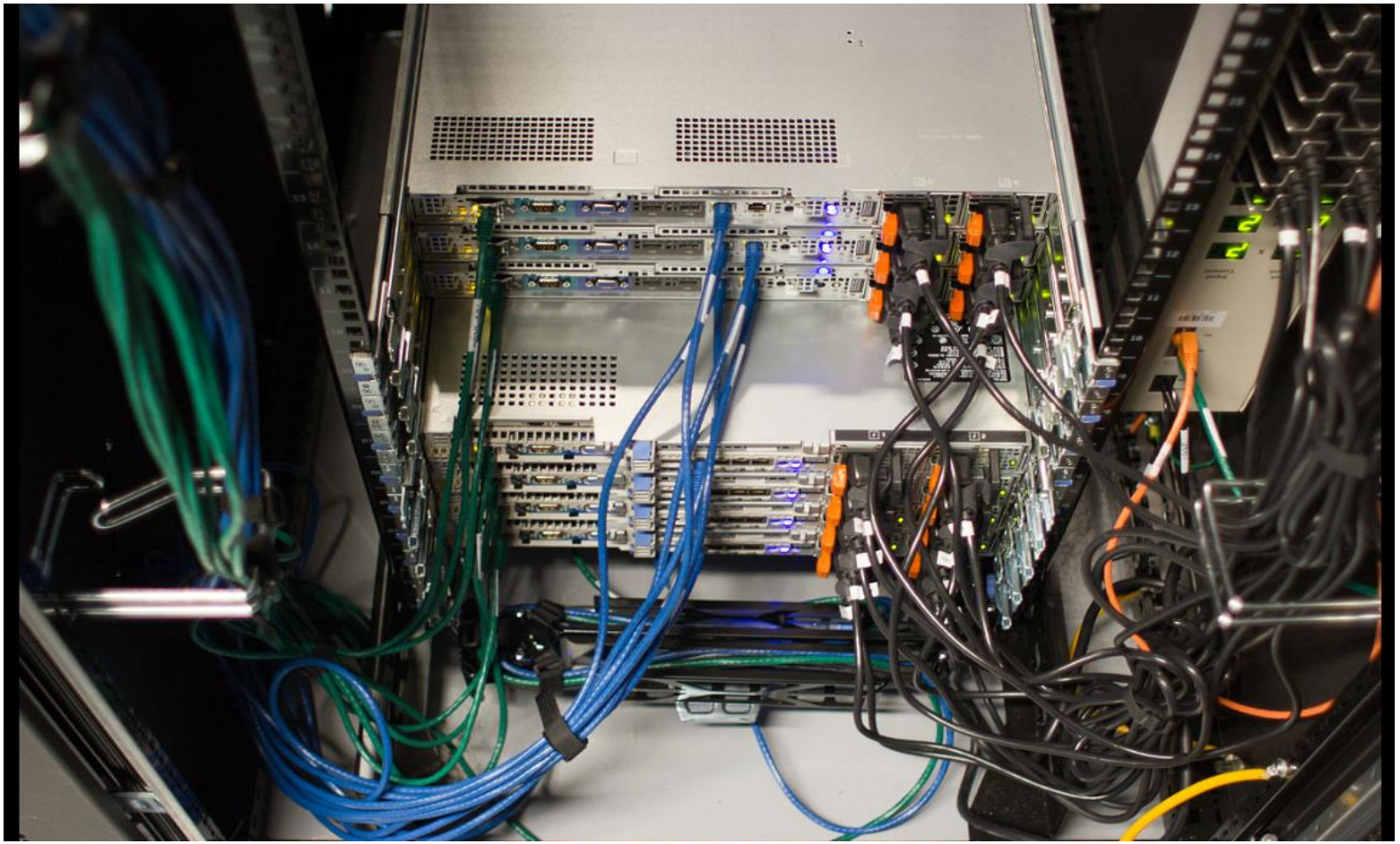
Architecture
System/360
System/370
S/370-XA
ESA/370
ESA/390
z/Architecture

1984 – IBM System 36

1985 – IBM PC XT

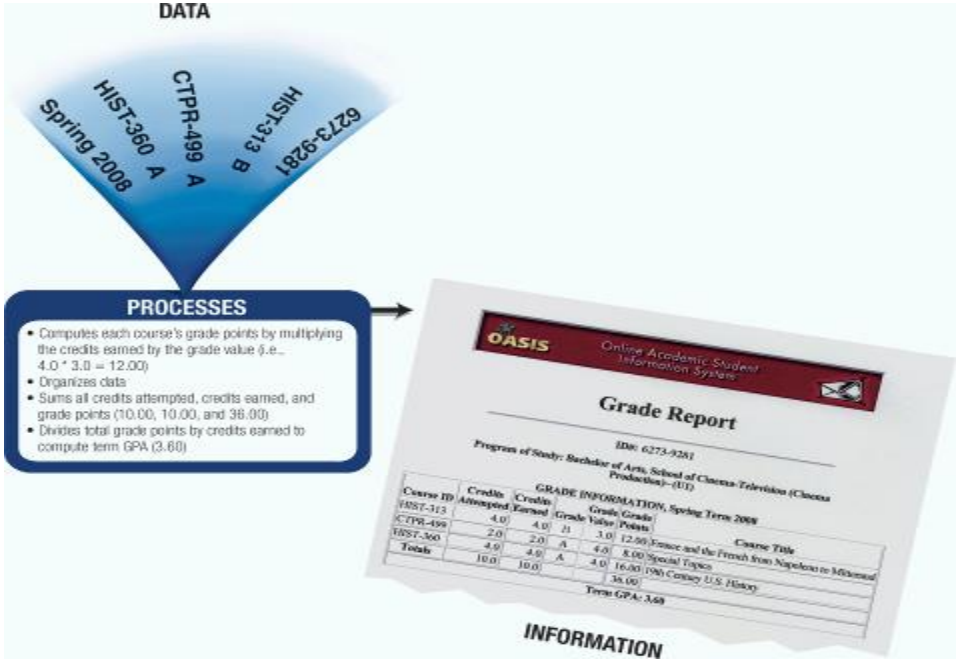
Sun Solaris Blade Server (2000+)

Server Racks



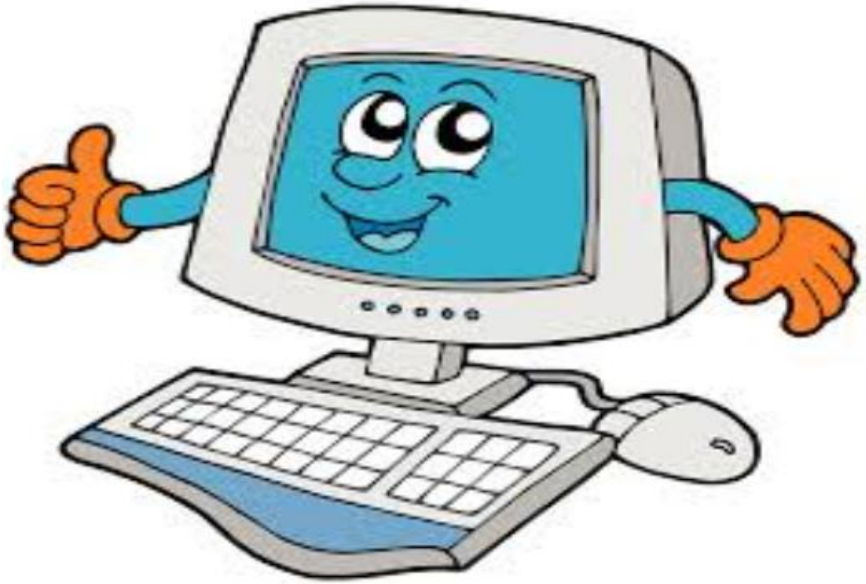
What Does a Computer Do?

- Four basic operations compromise the information processing cycle



INPUT
PROCESS
OUTPUT
STORE

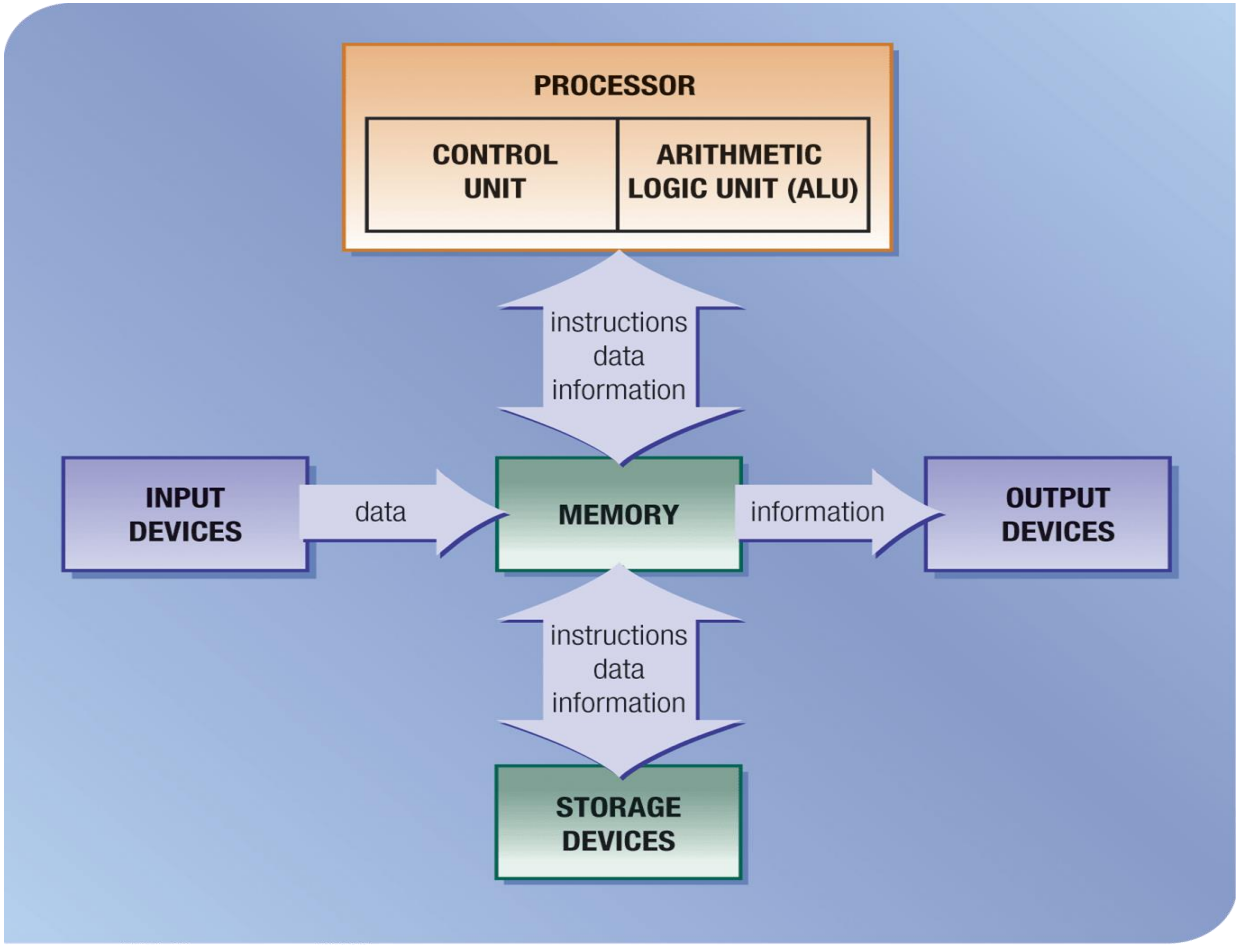
- What are the hardware components of a Computer?



Components of a Computer

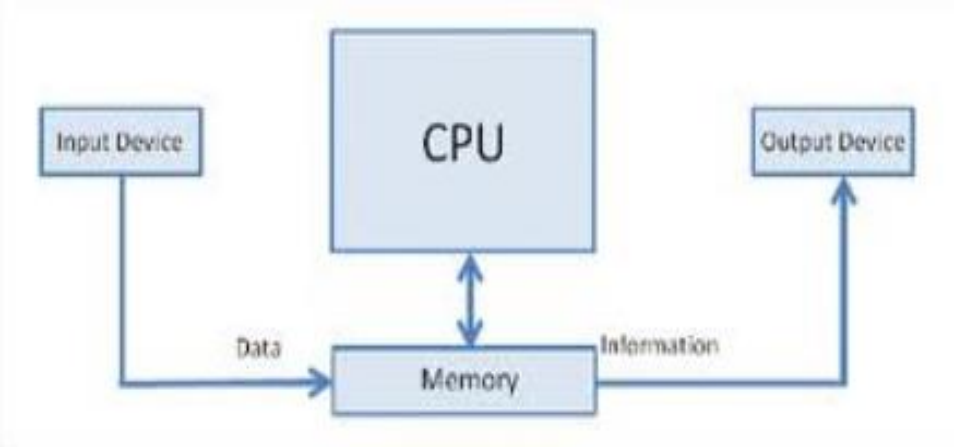
- The six primary components of a computer are input devices, the processor (control unit and arithmetic/logic unit), memory, output devices, storage devices, and communications devices
- The processor, memory, and storage devices are typically housed in a box-like case called the system unit

Components of a Computer (con't)

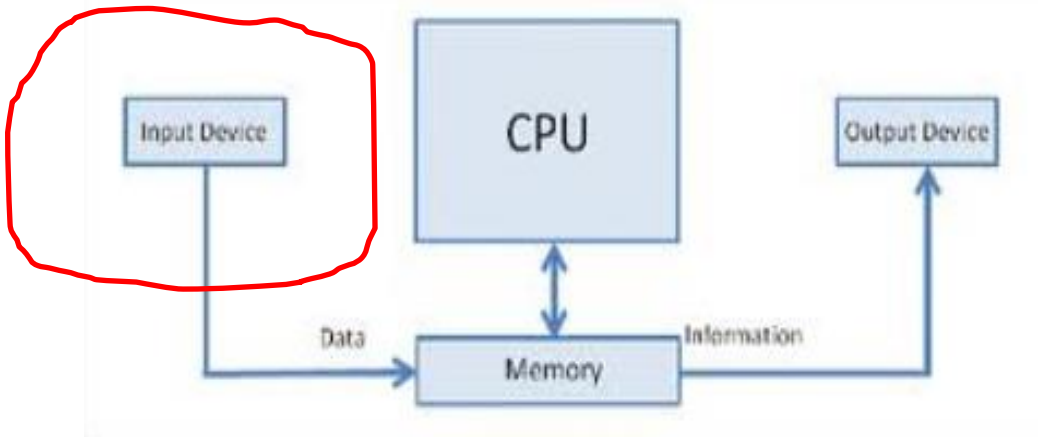


Input Devices

- An input device is any hardware component that allows you to enter data, programs, commands, and user responses into a computer



What are some input devices ?

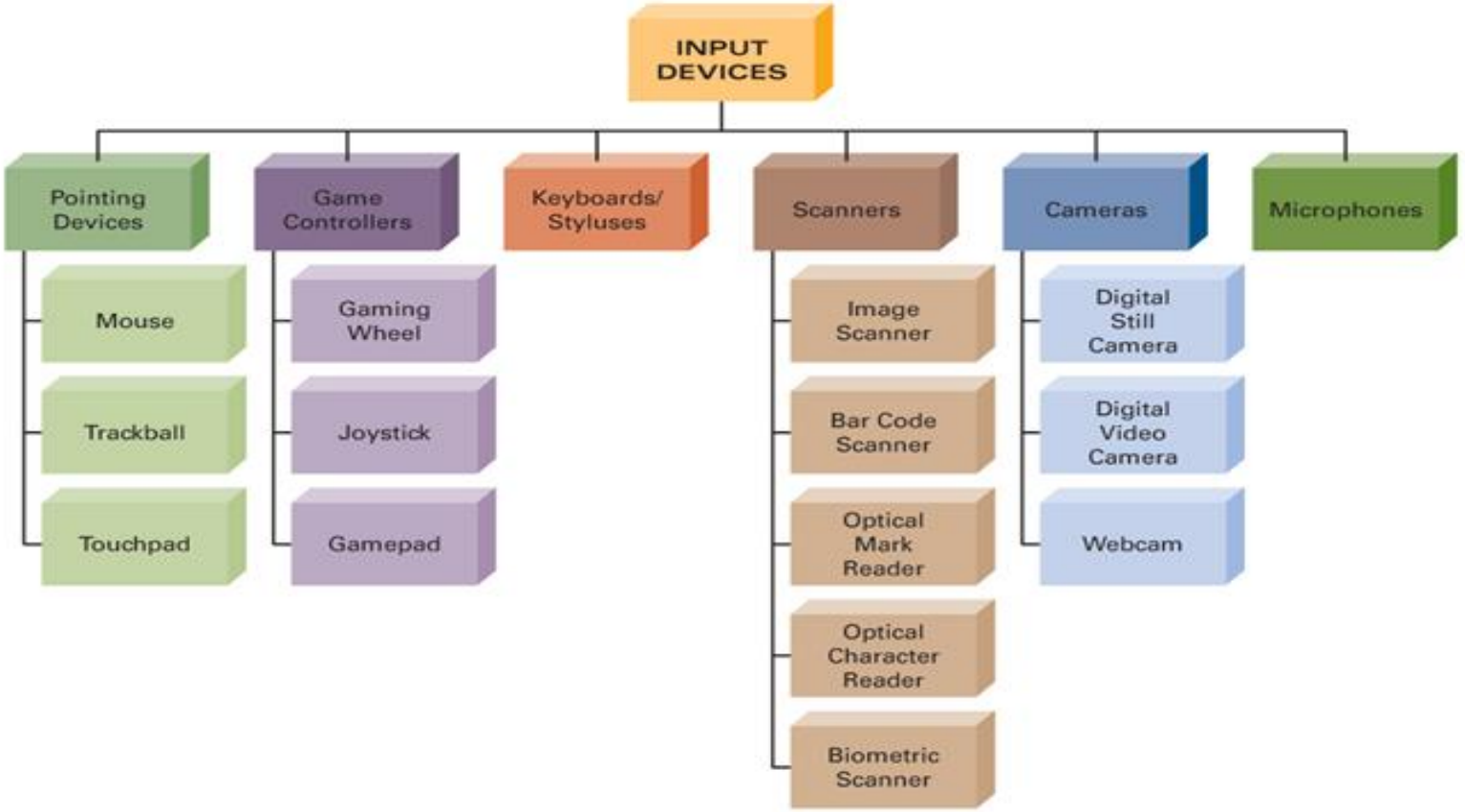


Thinking…

?

Don’t look ahead !

Categories of Input Devices



Common Input Devices

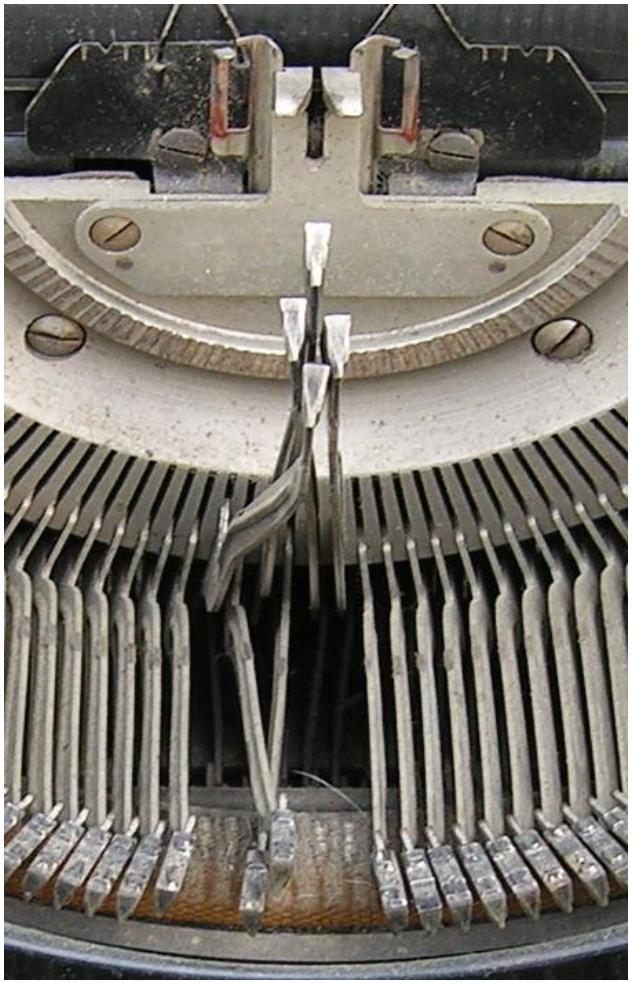
Gamepad

Scanner

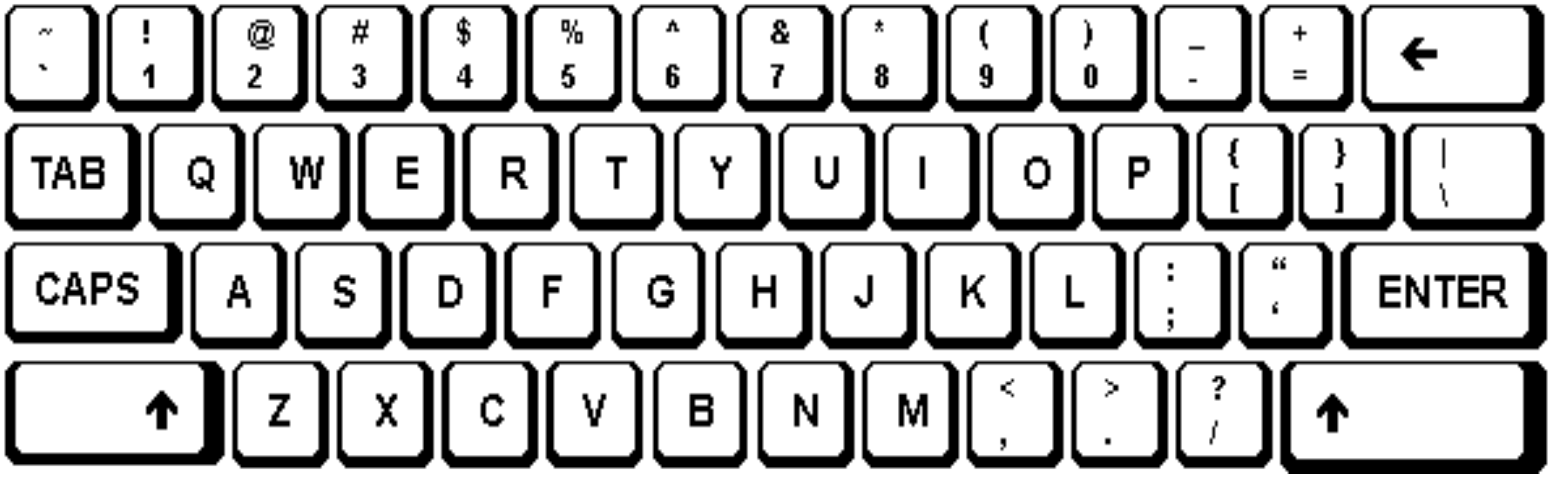
Keyboard

QWERTY Keypad

- Why called QWERTY ?
- 1870s
- Christipher Latham Sholes
- Misconception
  - Designed to slow typist down
- Actually it was designed to prevent jams while typing at speed

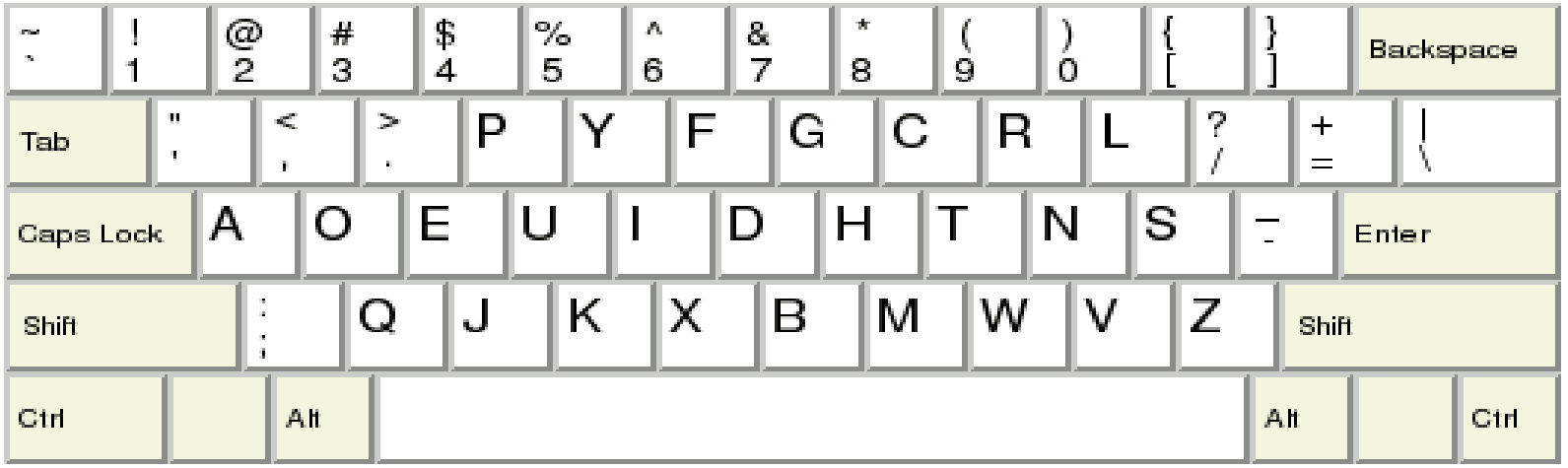


QWERTY Layout



DVORAK Keypad

- 1936 by Dr. August Dvorak
- Use less finger motion
- Increase typing rate & reduce errors
- Supported my all major operating systems
- Not commonly used



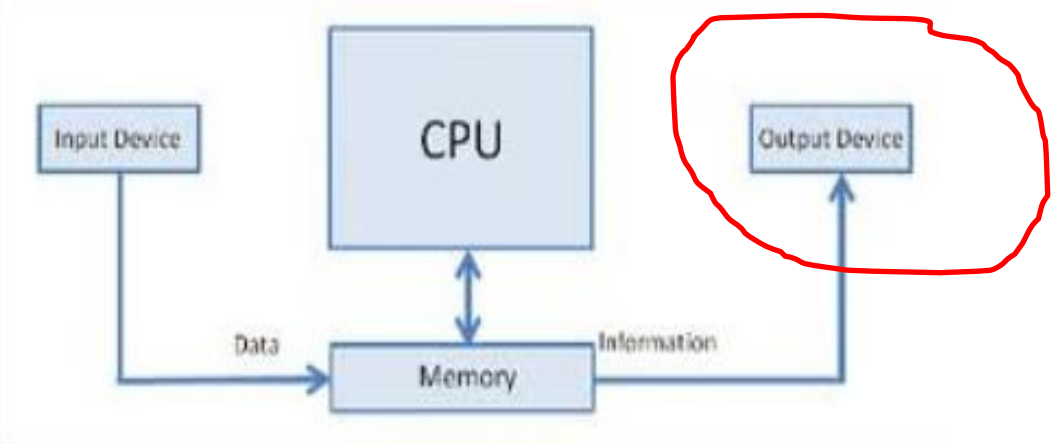
SWYPE


Q W E R T Y U I O P
A S D F G H J K L
CAPs
Z X C V B N M
123
@;(
SWYPE
-TAP
MULTI
-TAP
!
,
TAB
SPACE
?
.

iPhone Keyboard
[dynamic – can change with Ap/Form]

Input via Gestures

What are some output devices ?



Thinking…

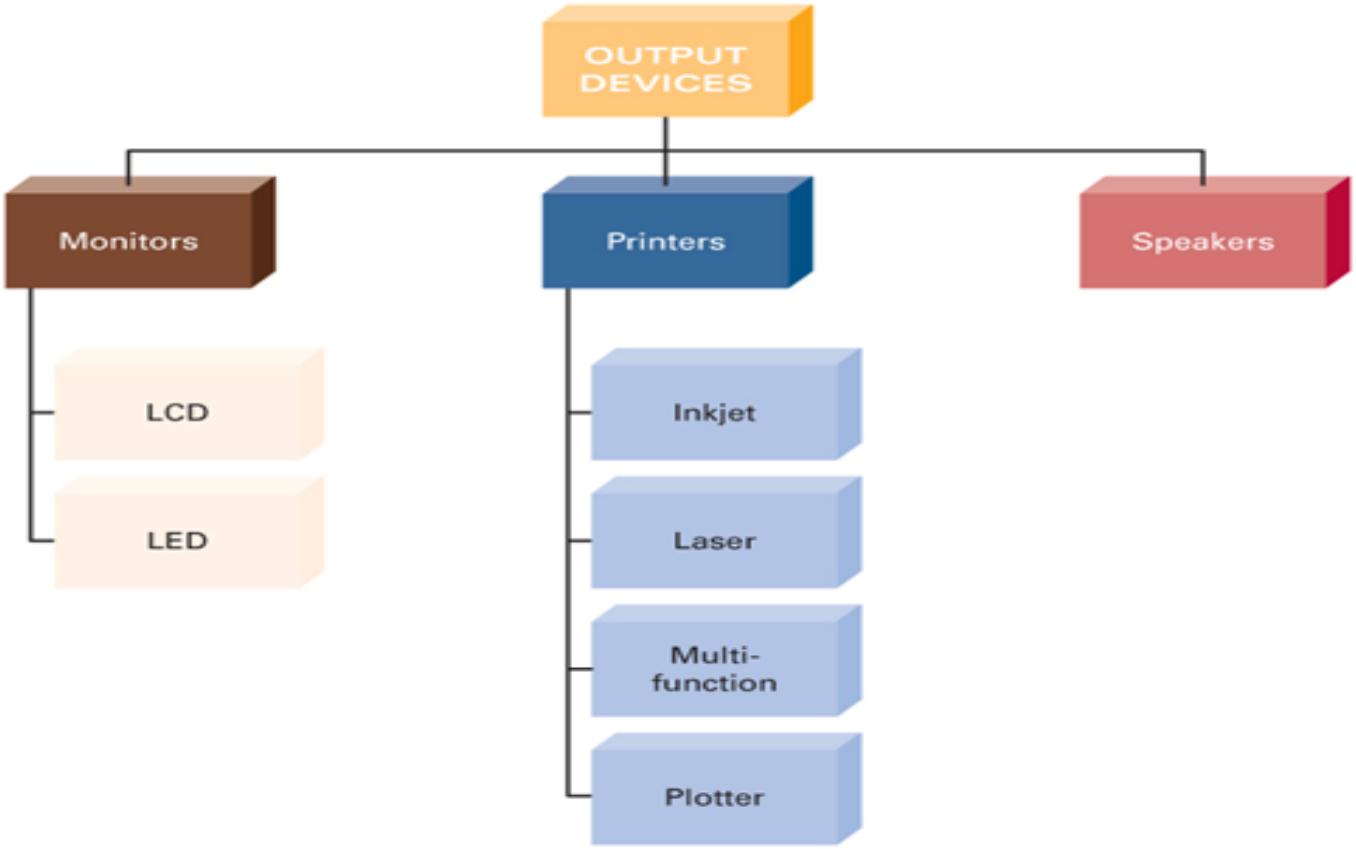
?

Don’t look ahead !

Output Devices

- Output devices make the information resulting from processing available for use
  - An impact printer prints by striking an inked ribbon against the paper
  - Nonimpact printers form characters by means other than striking a ribbon against paper
    - Inkjet
      - Photo printers
    - Laser

Common Output Devices

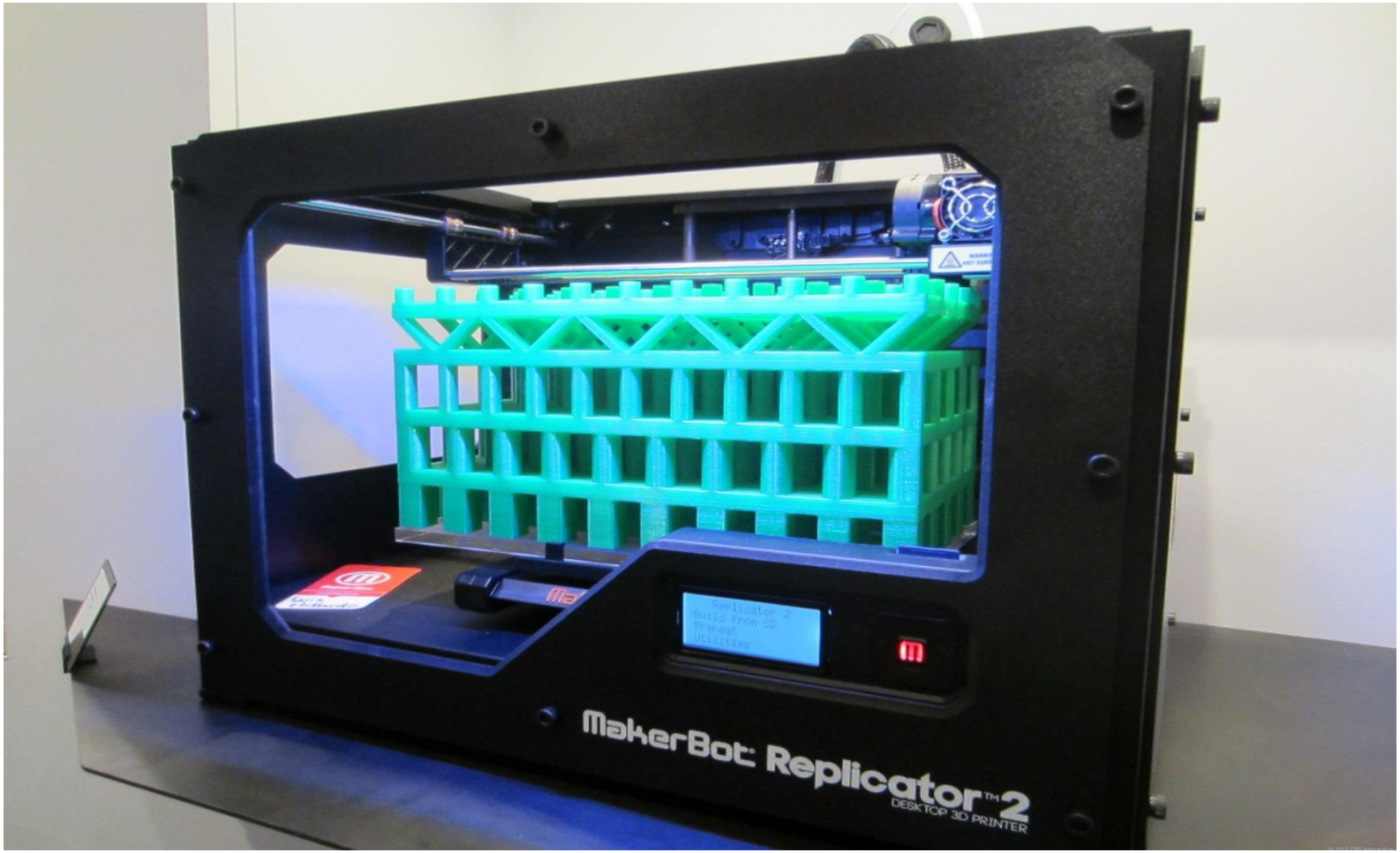


Printers

Multifunction printer

Plotter

3-D Printer



Display Devices

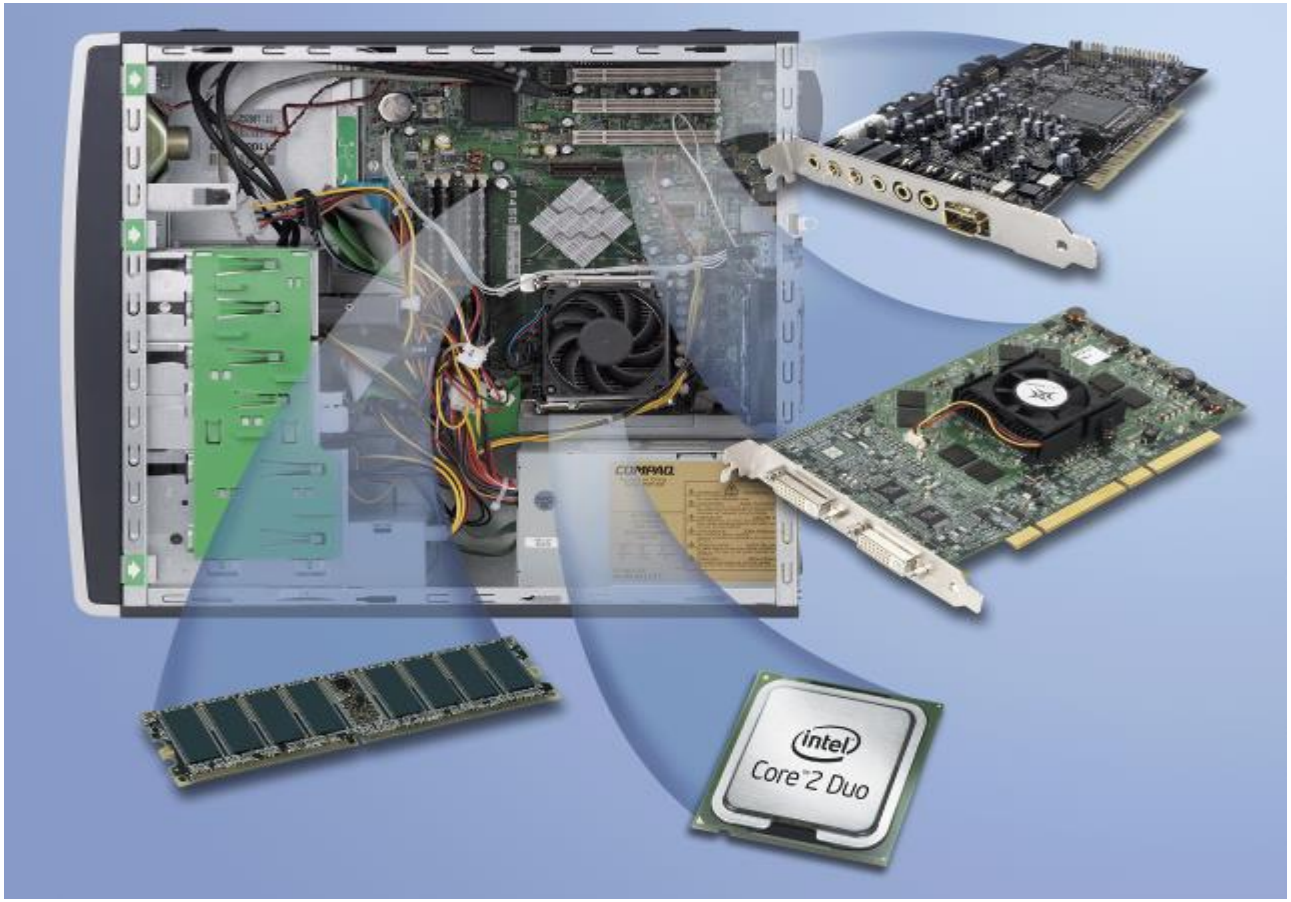
- A display device is an output device that visually conveys text, graphics, and video information
  - Monitor
    - CRT (cathode ray tube)
    - Flat panel monitor
      - LCD (liquid crystal display)
- **Now combined with "input" devices via "touch" screen technology**

Foldable/Rollable Screens

System Unit

- The system unit is a case that contains electronic components of the computer used to process data
  - The processor (CPU) interprets and carries out the basic instructions that operate a computer
    - Arithmetic/logic unit (ALU) & Control Unit
  - Memory (RAM) consists of electronic components that temporarily stores instructions waiting to be executed by the processor, data needed by those instructions, and the results of processed data

System Unit

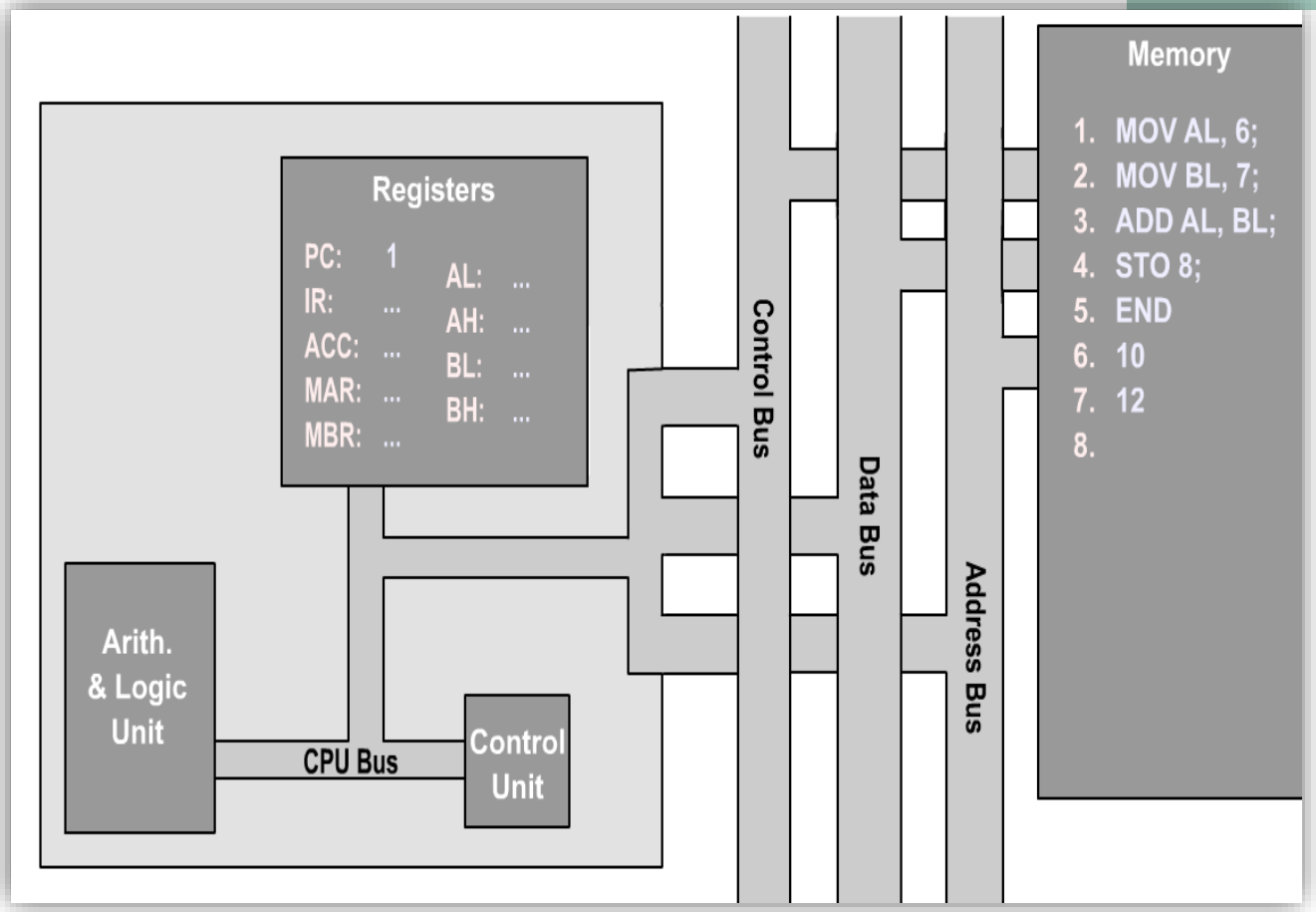


PROCESSOR
- **ALU**
- **CONTROL UNIT**

MEMORY

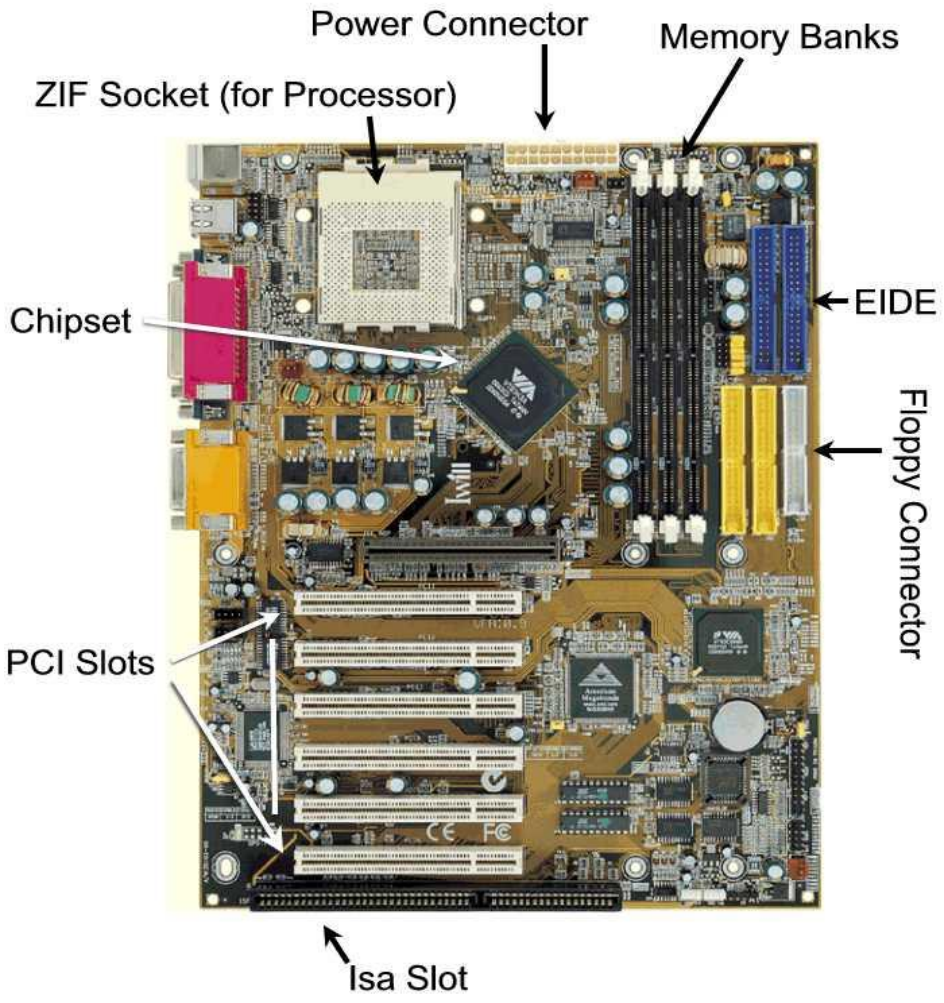
STORAGE

Processor
(ALU, Control Unit, Registers)

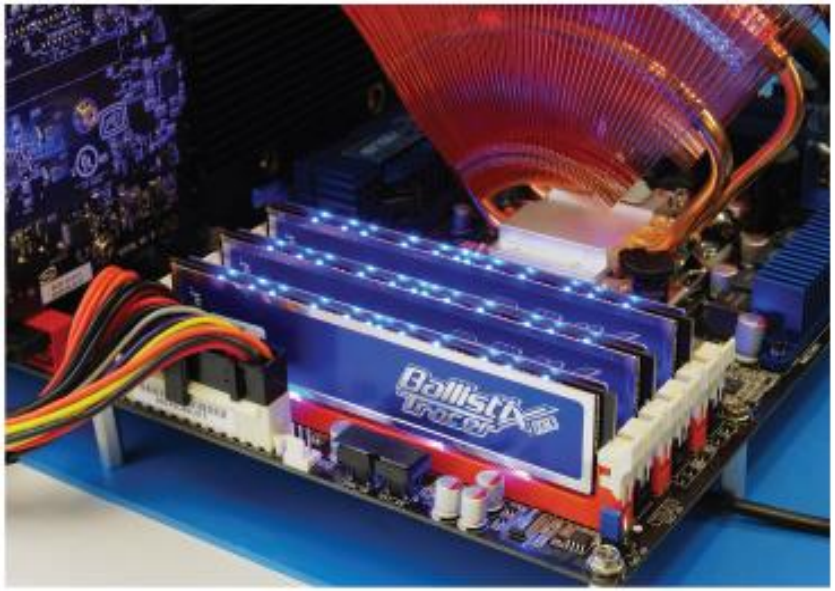


Motherboard

(processor, memory, device controllers & connections)

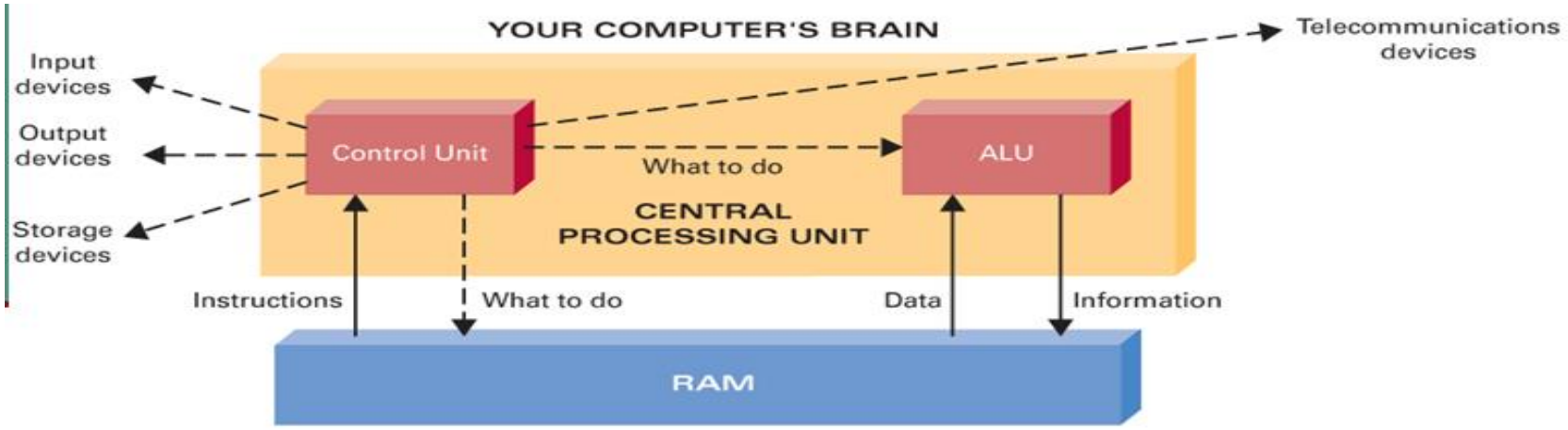


CPU



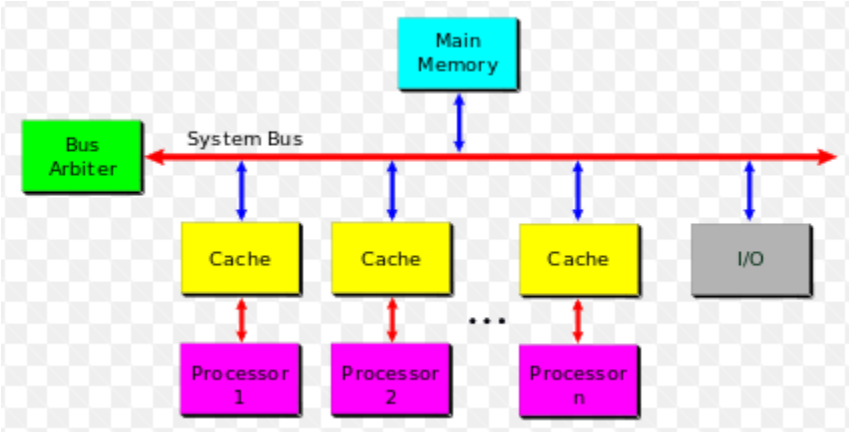
CPU Machine Cycle

1. *Retrieve*: The control unit sends to RAM for the instructions and data it needs
2. *Decode*: CPU gets the instruction out of cache and examines it to see what to do
3. *Execute*: Does what the instruction says to do
4. *Store*: Sends the result of processing to RAM



Multiprocessors

- A **multiprocessor** is a computer system having two or more processing units (multiple processors) each sharing main memory and peripherals, in order to simultaneously process programs



Graphic Cards (parallel processing)

They are important because the CPU should not do complicated mathematical calculations on its own because it slows the computer's central processor

They are being used for gaming, Acrobat, Flash, Photoshop, 3D graphics, parallel computing, virtual reality, AI, etc.

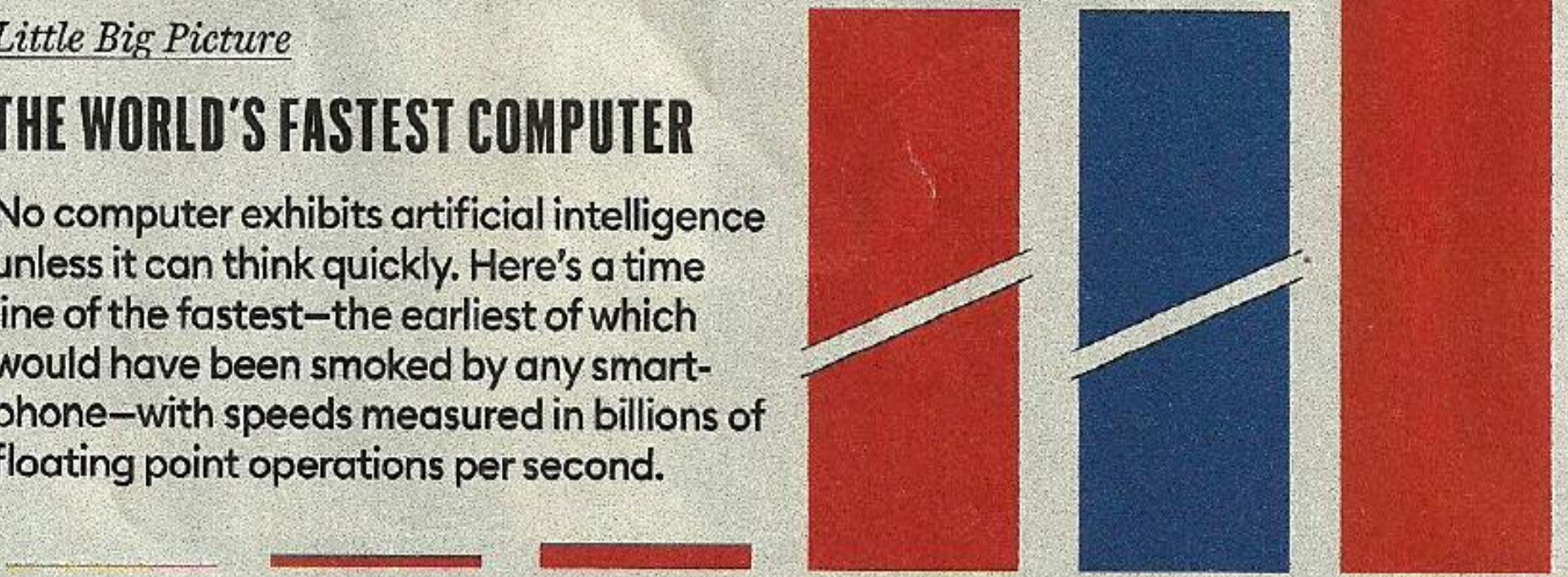
Nvidia's GeForce RTX 2080 TI is a recent most potent GPU

A **GigaFlop** (**or Gflop**) is a billion FLOPS

Little Big Picture

THE WORLD'S FASTEST COMPUTER

No computer exhibits artificial intelligence unless it can think quickly. Here's a time line of the fastest—the earliest of which would have been smoked by any smartphone—with speeds measured in billions of floating point operations per second.



1964	1974	1985	1996		2018
CDC 6600	Star-100	Cray 2	Hitachi SR2201	iPhone 11 Pro	IBM Summit
Control Data	Control Data	Cray	Hitachi	Apple	IBM
(U.S.)	(U.S.)	(U.S.)	(Japan)	(U.S.)	(U.S.)
0.003 GFLOP	0.1 GFLOP	1.9 GFLOP	600 GFLOP	600 GFLOP	149M GFLOP

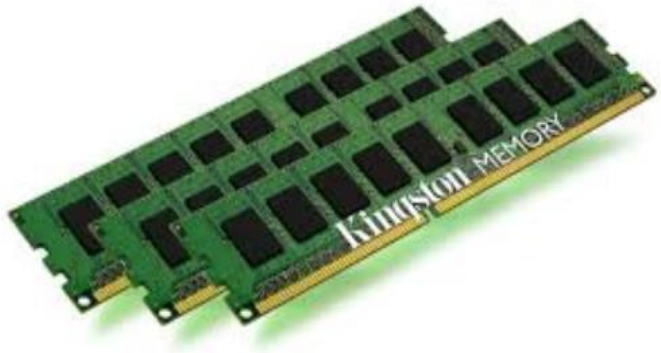
Super Computers

billion	1,000,000,000 (a thousand millions)
trillion	1 with 12 zeros
quadrillion	1 with 15 zeros
quintillion	1 with 18 zeros

- Cray Aurora (2020)
  - Massive multiprocessors (vector processors)
    - Vector processing built into newest computer languages such as R
  - 1 quintillion floating point operations per second – five times faster than the fastest

Storage: Memory and Storage Devices

- Memory
  - RAM – Random Access Memory
  - ROM – Read Only memory
  - Virtual memory
- Storage Devices

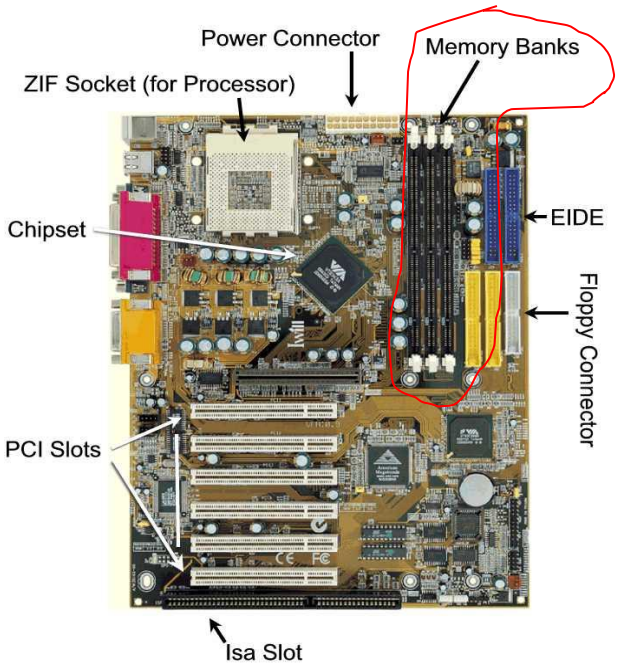


ROM

- Also known as firmware because its programming is fully embedded into the ROM chips
- It is hardware and software
- It is an integrated circuit programmed with specific data when it is manufactured
- It is used mainly when computer is first “booted”

RAM

- Random Access Memory
- It is called main memory or primary memory or just memory
- RAM is temporary meaning that it stores info temporarily
- Once you turn your computer off, or reboot, the information contained in RAM chips is lost



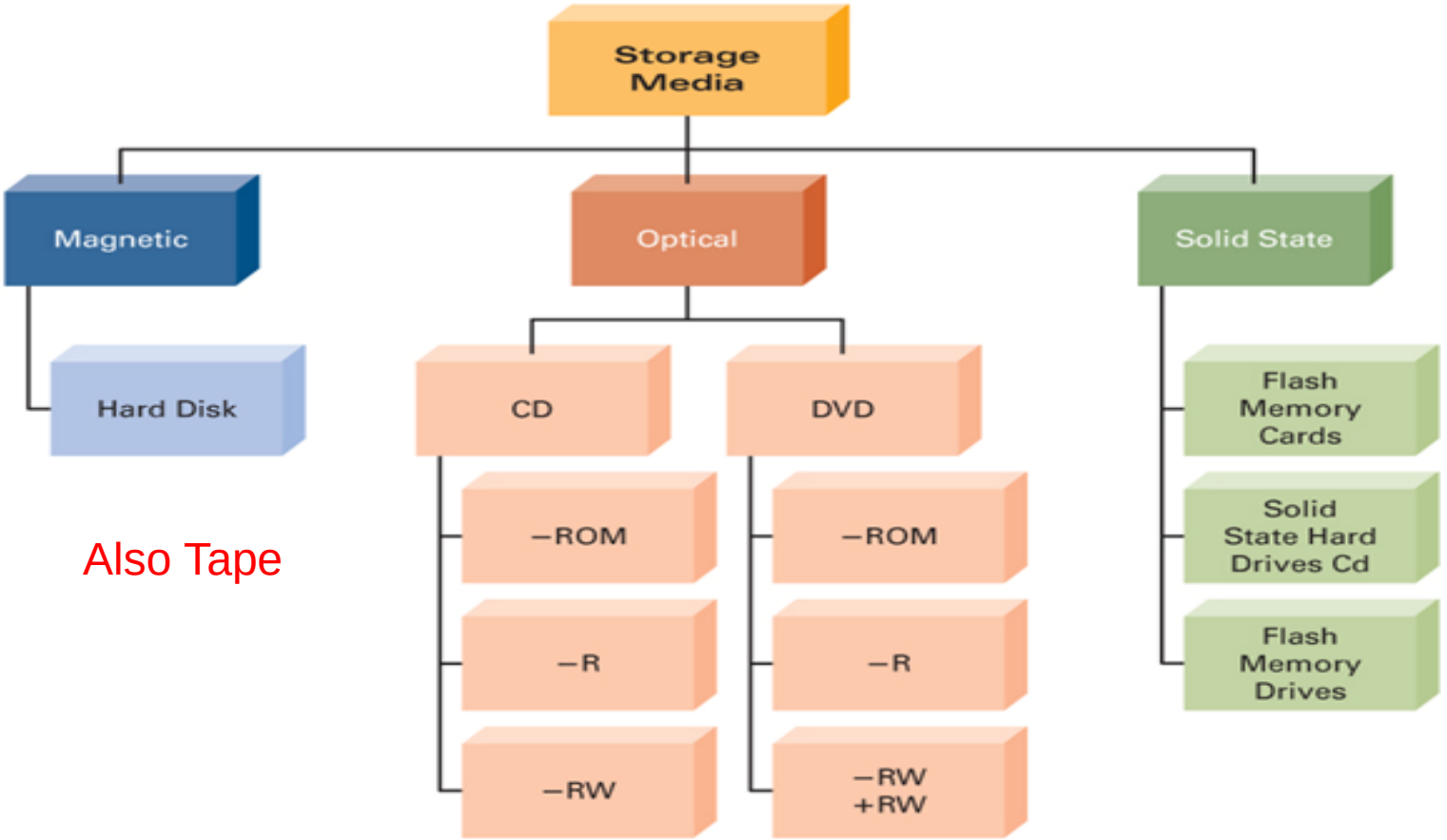
Virtual Memory

- Virtual memory is a space on hardware which your computer uses as a backup when running low on RAM
- It allows one to use a portion of hard drive as though it were RAM
- Virtual memory is slow and inefficient compared to RAM
- Can RAM replace the usage of virtual memory?- YES
  - The usage of Virtual memory can be reduced. Also, when one upgrades RAM, the computer works faster as most the data can be processed through the use of RAM and thus can reduce the use or eliminate the use of Virtual memory

More is better?

- Does adding RAM increase the speed of the computer?
  - More RAM can usually speed up the operations of the computer
  - Because RAM reduces the number of times that the CPU has to access the hard disk drive- an operation that takes longer than reading data from or writing data to RAM
  - More RAM means more memory meaning faster your PC runs

Common Storage Devices



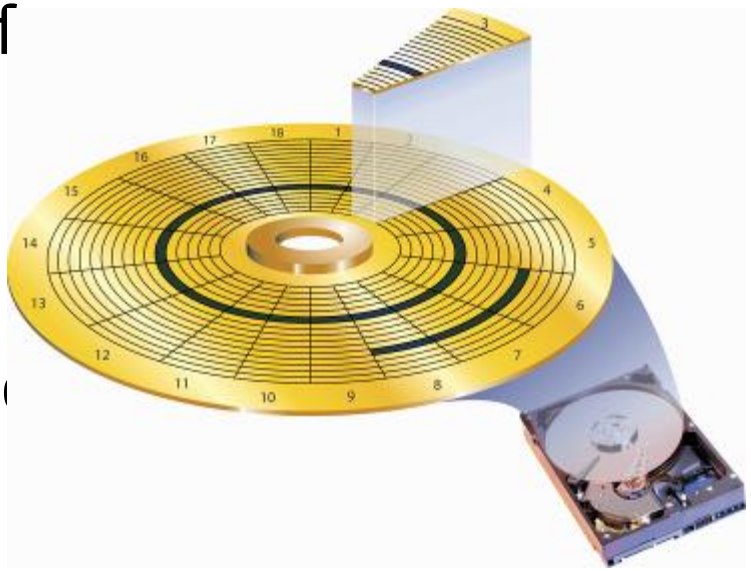
Also Tape

Storage 1980

300 KB

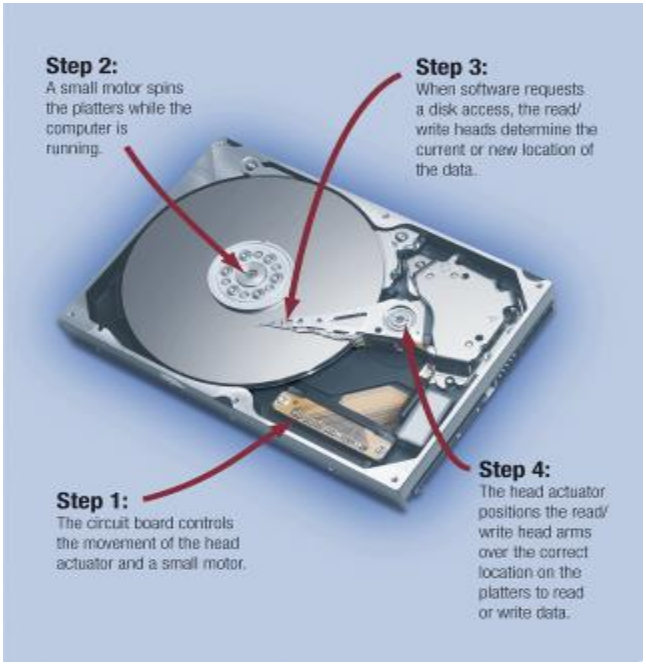
Storage Devices

- A storage device is used to store instructions, data, and information when they are not being used in memory
  - Magnetic disks use magnetic particles to store items on a disk's surf
    - Formatting
    - Track
    - Sectors
    - Portable storage me



Storage Devices

- A hard disk is a storage device that contains one or more inflexible, circular platters that magnetically store data, instructions, and information
  - Head crash
  - Backup



Diskette or Floppy Disk

- A floppy disk is an inexpensive portable storage medium

Optical Disc

- An optical disc is a portable storage medium that consists of a flat, round, portable disc made of metal, plastic, and lacquer that is written and read by a laser

Magnetic Tape

- Tape is a magnetically coated ribbon of plastic housed in a tape cartridge
  - Sequential access
- Tapes stored at 50 deg F can last for 30 years

Magnetic Tape (con't)

- The latest 4.5 inch cartridge tapes can hold about 30 terabytes of data
- Most cloud services companies back up to magnetic tape, one local copy and one remote copy (such as at Iron Mountain)
- Iron Mountain uses 100 million 4.5 in tapes to hold data for its clients, and these are kept all over the world in over 200 warehouse and old mines

Storage Improvements

Date	Capacity	Cost per GB	Density Improvement	Cost Improvement
1956	5MB	$10 million	1	1
1989	4GB	$25,000	6000	400
2009	1 TB (1000 GB, 1000000 MB)	$0.15	100 million	75 million

Storage Measures

- Bit – basic unit of memory [on/off or 0/1]
- Byte – generally 8 or 16 bits [one character]
- Kilobyte (KB) = 1000 bytes [1/2 page of text]
- Megabyte (MB) = 1 million bytes [500 pages]
- Gigabyte (GB) = 1 billion bytes [500 songs]
- Terabyte (TB) = 1 trillion bytes [200 hi-def films]
- And even higher →

Multiples of bytes v · d · e				
SI decimal prefixes		Binary usage	IEC binary prefixes	
Name (Symbol)	Value		Name (Symbol)	Value
kilobyte (kB)	10^3	2^{10}	kibibyte (KiB)	2^{10}
megabyte (MB)	10^6	2^{20}	mebibyte (MiB)	2^{20}
gigabyte (GB)	10^9	2^{30}	gibibyte (GiB)	2^{30}
terabyte (TB)	10^{12}	2^{40}	tebibyte (TiB)	2^{40}
petabyte (PB)	10^{15}	2^{50}	pebibyte (PiB)	2^{50}
exabyte (EB)	10^{18}	2^{60}	exbibyte (EiB)	2^{60}
zettabyte (ZB)	10^{21}	2^{70}	zebibyte (ZiB)	2^{70}
yottabyte (YB)	10^{24}	2^{80}	yobibyte (YiB)	2^{80}
See also: Multiples of bits · Orders of magnitude of data				

Memory Device Capacity

Device	Storage Capacity
Memory stick	1 TB
Hard disk	16 TB
CD-ROM, CD-R, CD-RW	800 MB
DVD-ROM, DVD-R, DVD-RW	4.7 GB or more
Blu-Ray (latest generation optical disc)	Up to 25 GB on a single-layer disc and 50 GB on a dual-layer disc
SD Card	1 TB
SSD (Solid State)	60 TB

What is “raid” ?

Thinking…

?

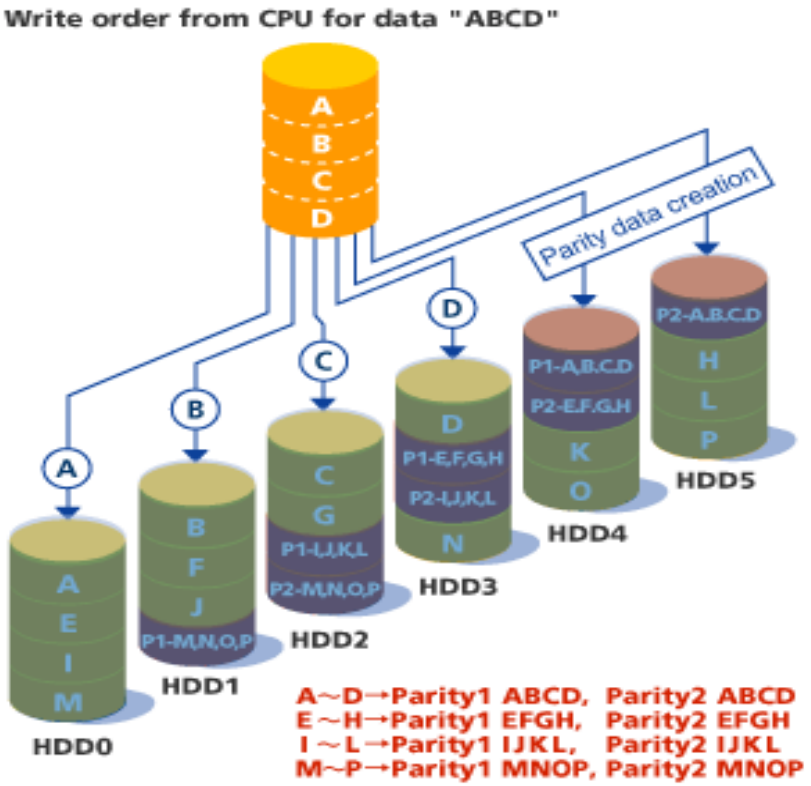
Don’t look ahead !

RAID

- **Redundant Array of Independent Drives** (or **Disks**), also known as **Redundant Array of Inexpensive Drives** (or **Disks**), (**RAID**) is an umbrella term for computer data storage schemes that divide and/or replicate data among multiple hard drives
- RAID is designed to provide increased data reliability and/or increased I/O (input/output) performance
- There are three key concepts in RAID: mirroring, the copying of data to more than one disk; striping, the splitting of data across more than one disk; and error correction, where redundant data is stored to allow problems to be detected and possibly fixed (known as fault tolerance)

RAID 6

- RAID 6 deploys two parity records to different disk drives (double parity) enabling two simultaneous disk drive failures in the same RAID group to be recovered.
- RAID 6 where parity updates are allocated separately across multiple disks, as well as RAID 5, are able to implement multiple write orders at the same time. This feature ensures higher performance when compared to RAID 4 technology.



SAN & NAS

- A **storage area network** (SAN) is an architecture to attach remote computer storage devices (such as disk arrays, tape libraries and optical jukeboxes) to servers in such a way that, to the operating system, the devices appear as locally attached
- By contrast to a SAN, network-attached storage (NAS) uses file-based protocols such as NFS or SMB/CIFS where it is clear that the storage is remote, and computers request a portion of an abstract file rather than a disk block

Flash (solid state) Memory

- **Flash memory** is an electronic (i.e. no moving parts) non-volatile computer storage device that can be electrically erased and reprogrammed
- In addition to being non-volatile, flash memory offers fast read access times, as fast as dynamic RAM, although not as fast as static RAM or ROM
- Its mechanical shock resistance helps explain its popularity over hard disks in portable devices; as does its high durability, being able to withstand high pressure, temperature, and immersion in water

Flash (solid state) Memory (con’t)

- Samsung has started mass production on solid state drives (SSDs) that feature the company's sixth-generation 256GB three-bit vertical NAND memory
- This means the drives come with an industry first 100 layers of NAND cells, a writing speed of 450 microseconds and a reading response time of 45 microseconds

Flash (solid state) Memory (con't)

- So which of the two is the better choice, SSD storage or HDD storage?
- There's no straight-forward answer to this question; each buyer has different needs and you have to evaluate the decision based on those needs, your preferences, and of course budget
- Even though the price of SSDs has been falling, the price per gigabyte advantage is still strongly with HDDs
- Yet, if performance and fast bootup is your primary consideration and money is secondary, then SSD speed is the way to go

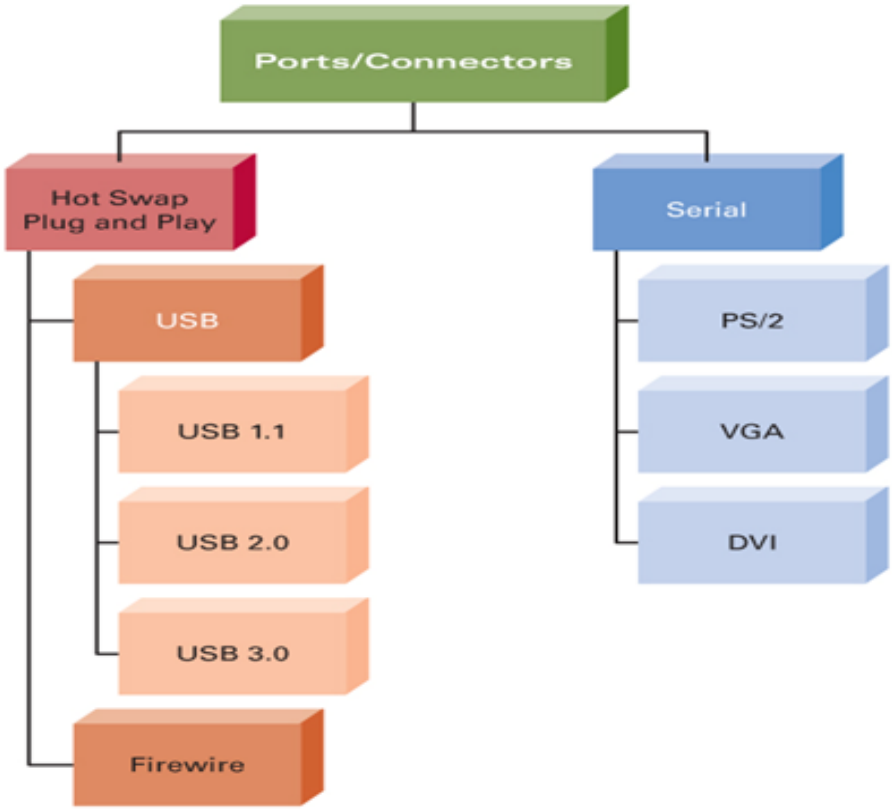
Attribute	SSD (Solid State Drive)	HDD (Hard Disk Drive)
Power Draw / Battery Life	Less power draw, averages 2 – 3 watts, resulting in 30+ minute battery boost ✓	More power draw, averages 6 – 7 watts and therefore uses more battery
Cost	Expensive, roughly $0.20 per gigabyte (based on buying a 1TB drive)	Only around $0.03 per gigabyte, very cheap (buying a 4TB model) ✓
Capacity	Typically not larger than 1TB for notebook size drives; 4TB max for desktops	Typically around 500GB and 2TB maximum for notebook size drives; 10TB max for desktops ✓
Operating System Boot Time	Around 10-13 seconds average bootup time ✓	Around 30-40 seconds average bootup time
Noise	There are no moving parts and as such no sound ✓	Audible clicks and spinning can be heard
Vibration	No vibration as there are no moving parts ✓	The spinning of the platters can sometimes result in vibration
Heat Produced	Lower power draw and no moving parts so little heat is produced ✓	HDD doesn't produce much heat, but it will have a measurable amount more heat than an SSD due to moving parts and higher power draw
Failure Rate	Mean time between failure rate of 2.0 million hours ✓	Mean time between failure rate of 1.5 million hours
File Copy / Write Speed	Generally above 200 MB/s and up to 550 MB/s for cutting edge drives ✓	The range can be anywhere from 50 – 120MB / s
Encryption	Full Disk Encryption (FDE) Supported on some models ✓	Full Disk Encryption (FDE) Supported on some models ✓
File Opening Speed	Up to 30% faster than HDD ✓	Slower than SSD
Magnetism Affected?	An SSD is safe from any effects of magnetism ✓	Magnets can erase data

Tablet Computer

[input, output, processor all in one]

Ports and Connectors

- ***Port*** – place on your system unit, monitor, or keyboard through which information and instructions flow to and from computer
- Connector – the plug on the end of a wire that plugs into your device



Traditional Serial Ports

- ***PS/2 port*** – fits IBM PS/2 connectors (used for keyboards and mice)
- ***Digital Visual Interface (DVI)*** – the newest standard for connecting monitors
- ***Video Graphics Array (VGA)*** **–** an older type of port for monitors

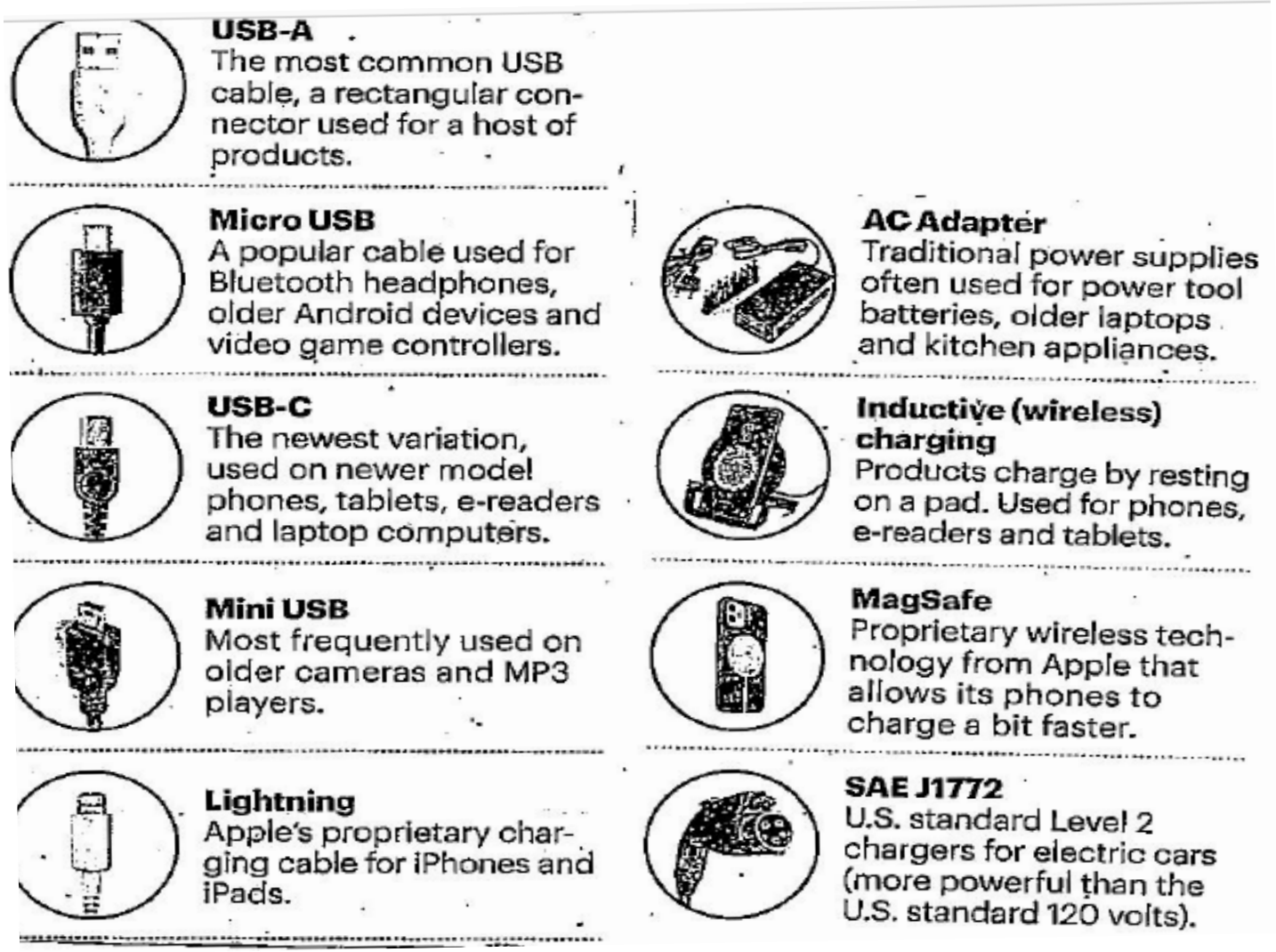
Plug & Play

- Some ports work with plug-and-play and hot-swap ports and devices
  - ***Plug and play*** – operating system feature that finds and installs the driver for the device
  - ***Hot swap*** – operating system feature that allows you to plug or unplug a device while the computer is running

Newer Ports

- ***USB (universal serial bus) port*** – fits small, flat, plug-and-play, hot-swap USB connectors
- ***Firewire port (IEEE1394 or I-Link)*** – fits hot-swap, plug-and-play Firewire connectors

Charging Ports/Cables



USB-A
The most common USB cable, a rectangular connector used for a host of products.

Micro USB
A popular cable used for Bluetooth headphones, older Android devices and video game controllers.

USB-C
The newest variation, used on newer model phones, tablets, e-readers and laptop computers.

Mini USB
Most frequently used on older cameras and MP3 players.

Lightning
Apple's proprietary charging cable for iPhones and iPads.

AC Adapter
Traditional power supplies often used for power tool batteries, older laptops and kitchen appliances.

Inductive (wireless) charging
Products charge by resting on a pad. Used for phones, e-readers and tablets.

MagSafe
Proprietary wireless technology from Apple that allows its phones to charge a bit faster.

SAE J1772
U.S. standard Level 2 chargers for electric cars (more powerful than the U.S. standard 120 volts).

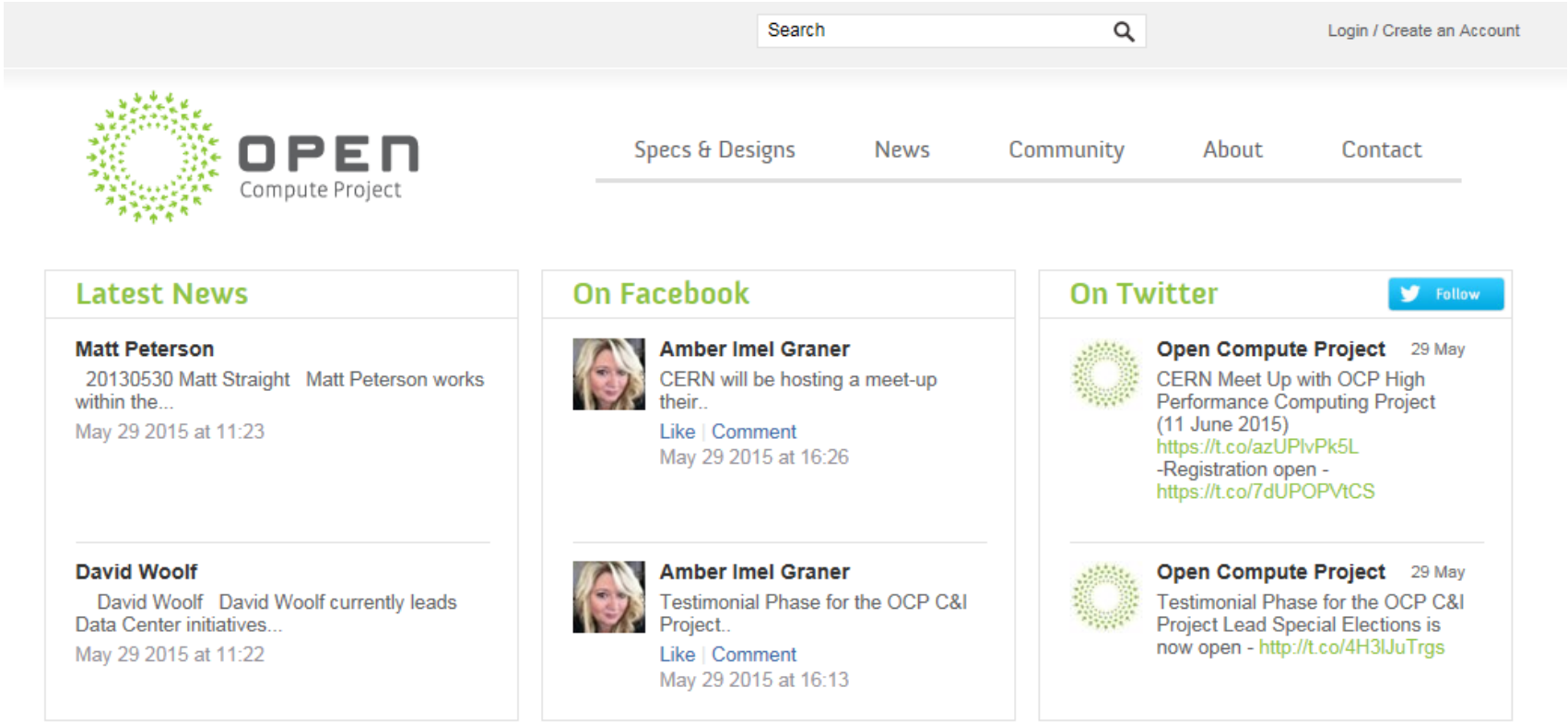
Wireless Connections

- ***Infrared IR or IrDA (infrared data association)*** – uses red light to send and receive information
- ***Bluetooth*** – transmits information as radio waves for a distance of 30 feet
- ***WiFi (wireless fidelity) or IEEE 802.11*** – transmits information as radio waves for a distance of up to several miles

Open Compute Project

- Huge IT companies such as Google and Amazon use millions of servers, but they design and manufacture most of it themselves
- Facebook initiated the “Open Compute Project” about 2010
- The purpose is to lower data center costs by publishing designs for new hardware chips, motherboards, etc.
- This openness reduces the influence (and profitability) of the massive sales teams of the big IT hardware companies such as IBM, HP, Cisco, Oracle-Sun, etc.
- Bank of America runs 80% of its traffic thru open source hardware

http://www.opencompute.org/



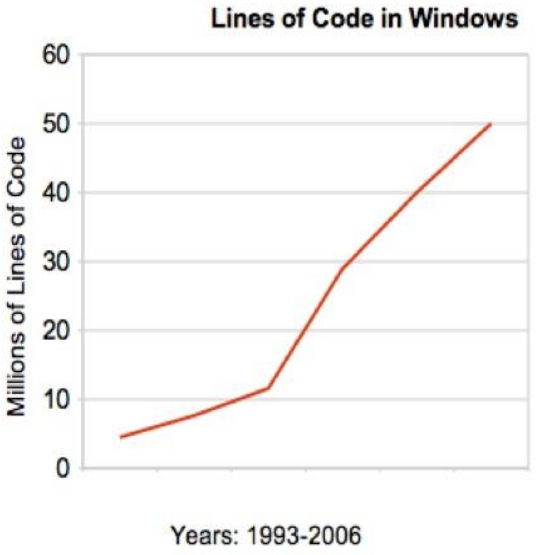
SOFTWARE

Software – Stored Instructions

- **Originally computer instructions were embedded in hardware – only the data was stored in memory**
- **Computer program**. The sequences of instructions for the computer, which comprise ***software***
- **Stored program concept**. Modern hardware architecture in which stored software programs are accessed and their instructions are executed (followed) in the computer's CPU, one after another

Software Cost & Complexity

- As time moves on, more and more of the cost of computers is in the software rather than in the hardware
- As computers and software grows increasing more complex, there are ever increasing possibilities for errors



Types of Software

- **System software**: The class of computer instructions that serve primarily as an intermediary between computer hardware and the user or the application programs; provides important self-regulatory functions for computer systems
- **Application software**: The class of computer instructions that direct a computer system to perform specific processing activities and provide functionality for users

Systems Software

- **System control programs**: Software programs that control the use of the hardware, software, and data resources of a computer system
- **Device drivers** – control devices and translate external representation to internal representation
- **Operating system**: The main system control program, which:
  - **supervises** the overall operations of the computer
  - **allocates** CPU time and main memory to programs
  - **protects** CPU
  - **optimizes** resource utilization
  - and provides an **interface** between the user and the hardware

Device Drivers

Functions of the Operating System

- **Multitasking/ multiprogramming**: The management of two or more tasks, or programs, running concurrently on the computer system (one CPU)
- **Multithreading**: A form of multitasking that runs multiple tasks within a single progam simultaneously
- **Multiprocessing**: simultaneous processing of more than one program by assigning them to different processors (multiple CPUs)

Operating Systems

- Microsoft Windows
  - XP, Vista
  - Win 7
  - Win 8
  - Win 10
- Unix based
  - IBM/AIX
  - Apple/Mac: OS X, iOS
  - Linux (Ubuntu, etc.)
  - Android

Ubuntu 12+

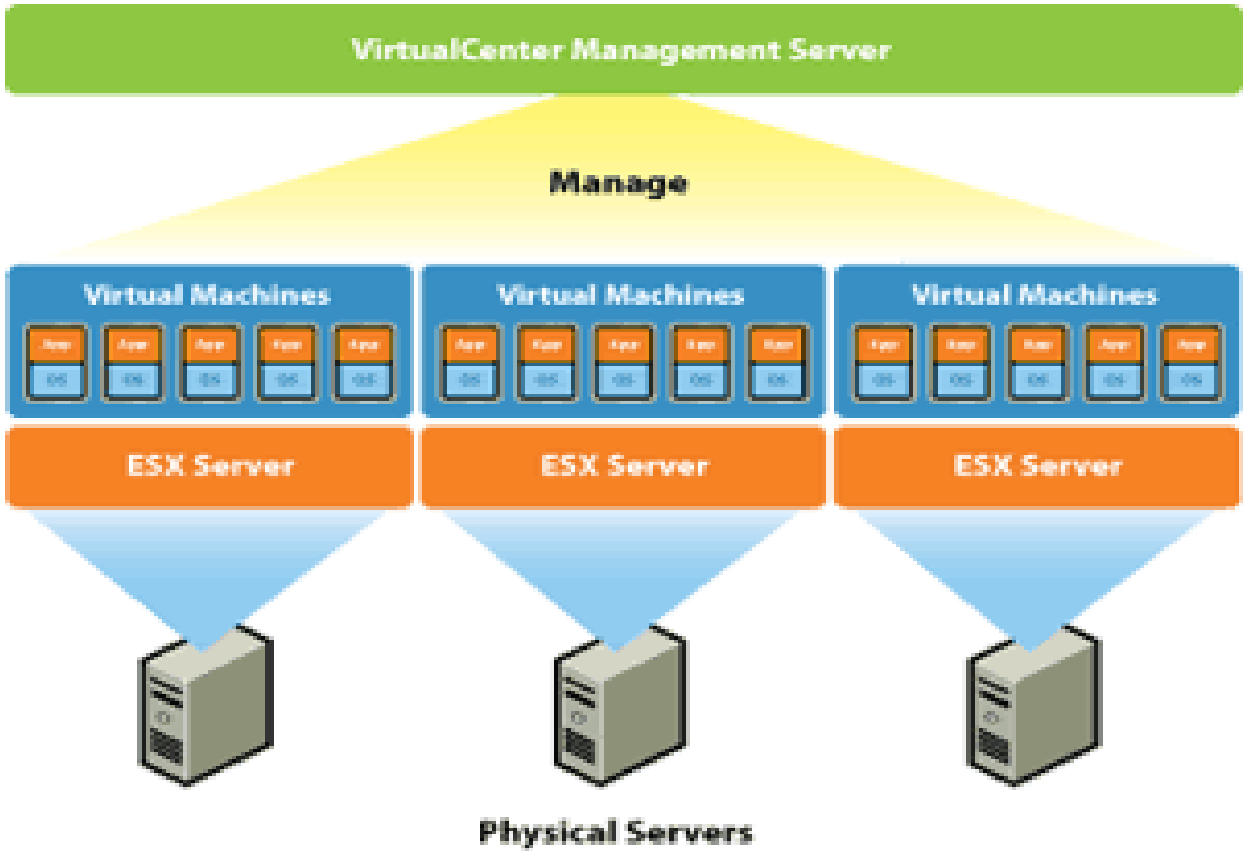
- Better than Windows?

- Free
- Faster
- Safer
- Smaller (2GB vs 18GB)
- Can install with or without Windows

Server Virtualization

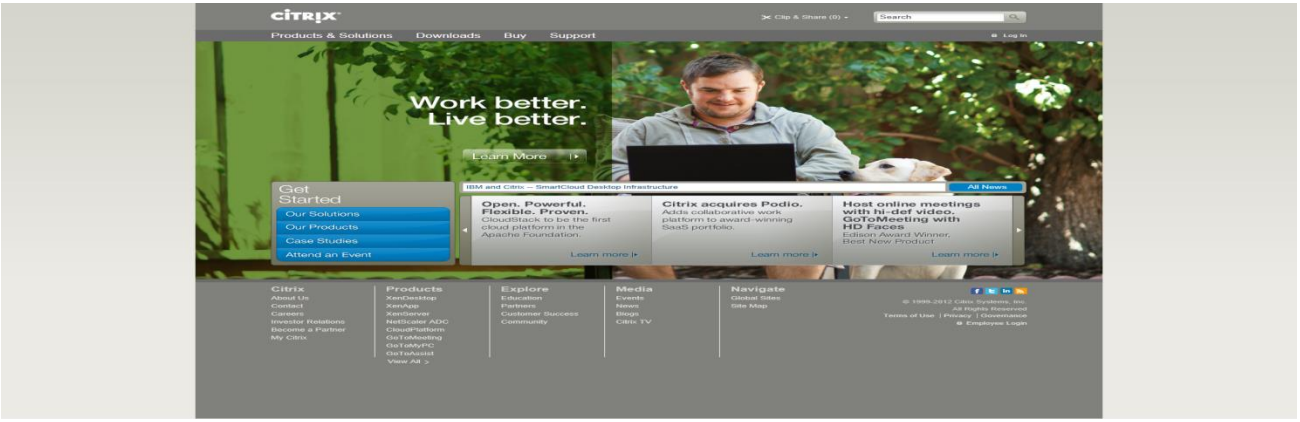
- Virtualization is an abstraction layer that allows multiple virtual machines, with heterogeneous operating systems to run in isolation, side-by-side, on the same physical machine
- Decoupling the physical hardware from the operating system
- VMWare – first commercial use

Virtualization (con't)

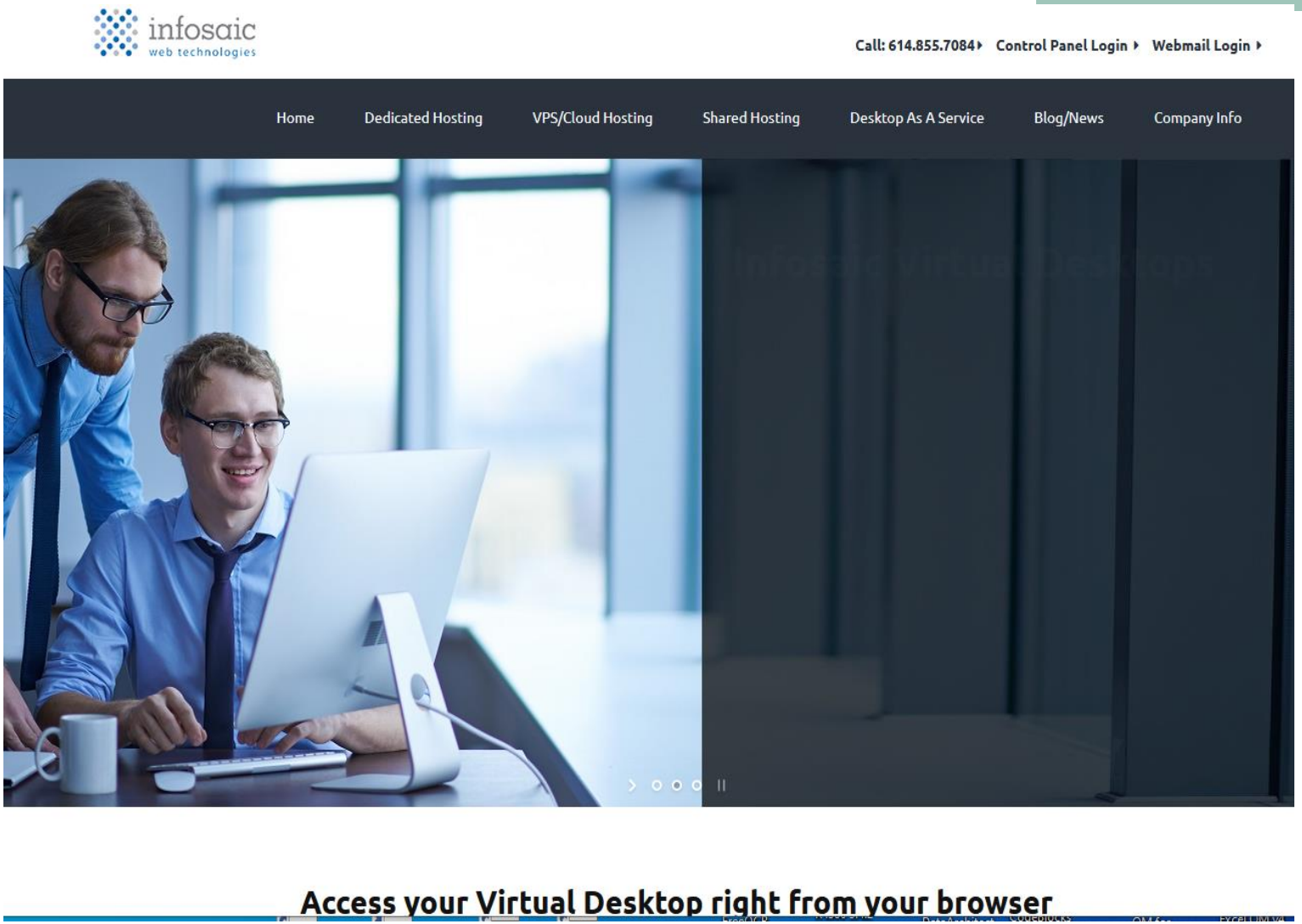


Desktop Virtualization

- **Desktop virtualization** , as a concept, separates a personal computer desktop environment from a physical machine using the client–server model of computing
- Many enterprise-level implementations of this technology store the resulting "virtualized" desktop on a remote central server, instead of on the local storage of a remote client; thus, when users work from their local machine, all of the programs, applications, processes, and data used are kept on the server and run centrally



Desktop as a Service [DAAS]



Application Software

- Application software consists of programs designed to make users more productive and/or assist them with specific job or personal tasks
  - Word processing
  - Spreadsheet
  - Database
  - Presentation graphics
  - Payroll
  - Accounts payable
  - Order entry

Application Software

- **Proprietary application software**. Software that addresses a specific or unique business need for a company ; may be developed in-house or may be commissioned from a software developer
- **Contract software**. Specific software programs developed for a particular company by a vendor
- **Off-the-shelf application software**. Software purchased, leased, or rented from a vendor that develops programs and sell them to many organizations; can be standard customizable

Vertical & Horizontal Market Software

- In order to protect their software from illegal distribution, vendors often rely on **licensing**: individual, site, active users, usage based
- ***Vertical market software* –** application software for a specific industry
  - Patient-scheduling software
  - Restaurant management software
- ***Horizontal market software*** – application software suitable for use in many industries
  - Payroll, inventory, and billing

Software Issues

- Software defects (bugs)
- Alien software (malware)
- Software evaluation and selection
- Software licensing
- Development methodologies
- Software upgrades
- Open source software

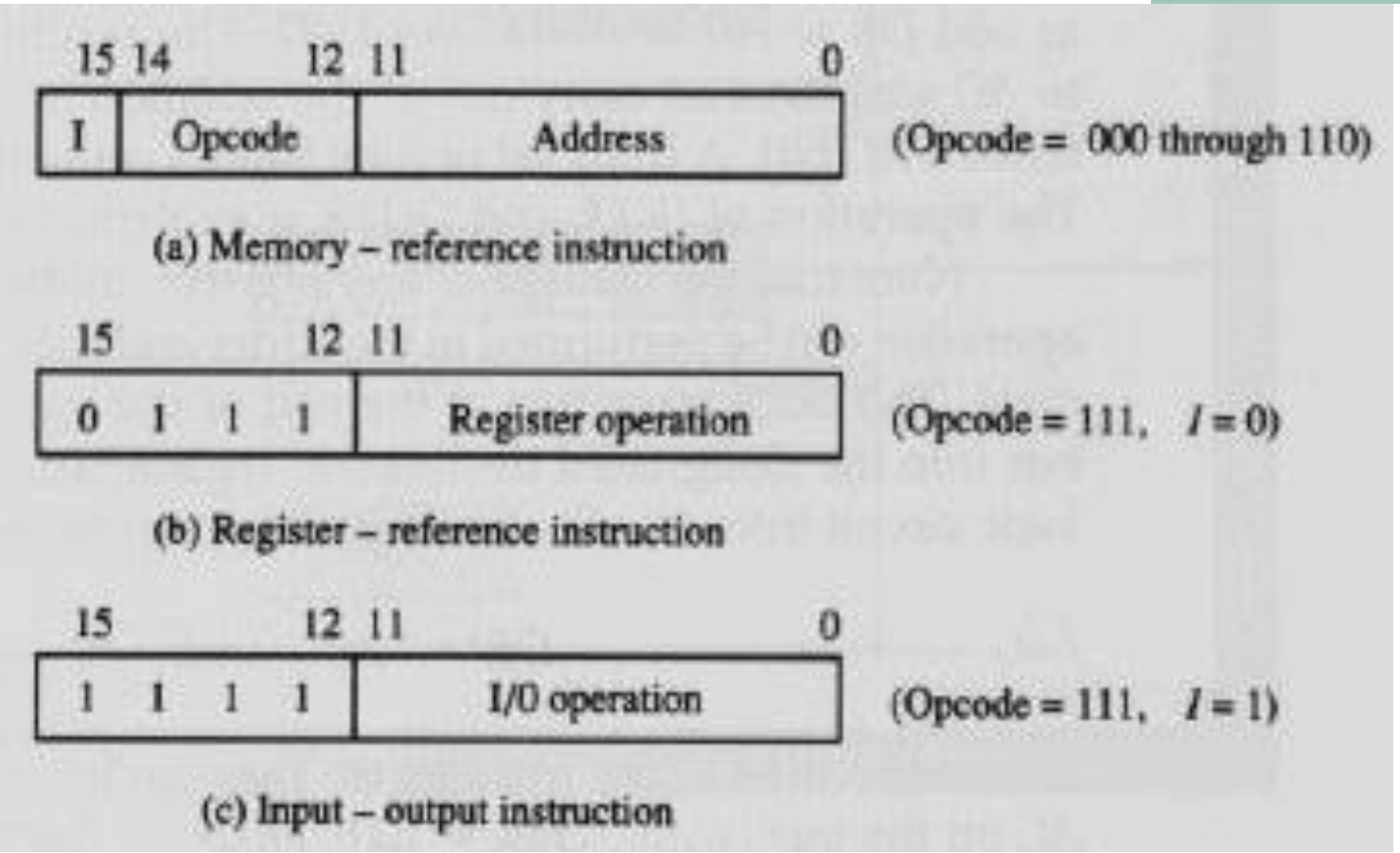
Changes in Computing

	1950's	1960's	1970's	1980's	1990's	2000's	2010's
Hardware Technology	Vacuum Tubes	Transis tors	Integrated Circuits	LSI	VLSI	ULSI	Nano-systems
Programming Languages	Binary Assembly	Fortran Cobol	Pascal Algol	Ada C Lisp	C++ GUI Java	C# PhP XML	Python, F#
Computing Paradigm	1 user Mainframe	Batch	Time Sharing	Personal Computer	LAN, WEB	.NET, SOA	Mobile
Operating System	none	1 user	multi user	multi user linked	networked	Web, Open source	Cloud, Android, iPhone
Data Base Methods	none	Linear (tapes)	Hier-archical	Relational	Object Oriented	SQL, X Query	SQLJ, OLAP, JDBC
Software Design	pad and pencil	Flow Charts	Structured Design	Data Flow	Object Oriented	RAD, XP, RUP	MDE

Programming Languages

- **Machine Language:** The lowest level programming language, composed of binary digits
  - **First-generation language (1GL):** Machine language; the level of programming languages actually understood by CPU:
    - Load (move data from memory to registers and back)
    - Compare (compare data in registers: >, <, =)
    - Jump (specify next instruction to execute)
    - Add (add data in registers)

Basic Compute Instruction Formats



Assembly Language

- **Assembly language:** A lower-level programming language that is slightly more user-friendly than machine language
  - **Second-generation language (2GL):** Assembly language; requires that each statement be translated into machine language through use of on assembler
  - **Assembler:** A system software program that translates an assembly language program into machine language

Early Instruction Set - 4 Bit Op Codes

0000 LOAD X	CON(X) -> R
0001 STORE X	R -> CON(X)
0010 MOVE (X,Y)	CON(X) -> CON(Y)
0011 ADD X	R + CON(X) -> R
0100 INCREMENT X	CON(X) + 1 -> CON(X)
0101 SUBTRACT X	R - CON(X) -> R
0110 COMPARE X	COMPARE X TO R, SET CC
0111 COMPARE (X,Y)	COMPARE CON(X) TO CON(Y)
1000 JUMP X	GET NEXT INSTRUCTION FROM X
1001 JUMPGT X	GET NEXT INSTRUCTION FROM X IF CC GT IS ON
1010 JUMPEQ X	GET NEXT INSTRUCTION FROM X IF CC EQ IS ON
1011 JUMPLT X	GET NEXT INSTRUCTION FROM X IF CC LT IS ON
1100 JUMPNEQ X	GET NEXT INSTRUCTION FROM X IF CC EQ IS OFF
1101 IN X	INPUT INTEGER, PLACE IN X
1110 OUT X	OUTPUT CON(X)
1111 HALT	STOP PROGRAM

Procedural Languages

- **Procedural languages:** User-oriented programming languages, which require programmers to specify step by step how the computer must accomplish a task
  - **Third-generation languages (3GLs):** The first level of higher-level programming languages, which are closer to natural language and therefore easier for programmers to use (COBOL, FORTRAN, Pascal, C)
    - net-salary = salary – taxes - benefits
- **Compiler:** Software program that translates an entire high-level program, called ***source code***, into machine language code, called ***object code*** at once

Nonprocedural Languages

- **Nonprocedural languages:** A type of high-level language that enables user to specify the desired result without having to specify the detailed procedures needed for achieving the result
  - Users specify WHAT they want not HOW to do it
- **Fourth–generation languages (4GLs):** A type of high-level programming languages, which can be used by non-technical users to carry out specific functional tasks
- **Fifth-generation languages**
  - Use artificial intelligence technologies
  - Knowledge-based systems, natural language processing (NLP), visual programming, and a graphical approach to programming
  - Designed to facilitate natural conversations between an individual and the computer

HTML & XML

- **Hypertext markup language (HTML):** The standard markup language used on the Web to create and recognize hypertext documents.
- **Dynamic HTML/HTML5:** lets users interact with the content of richly formatted pages without having to download additional content from the server.
- **Cascading style sheet (CSS):** An enhancement to HTML that adds page layout features to web documents.
- **Extensible markup language (XML):** A markup language designed to improve the functionality of web documents by providing more flexible and adaptable data identification
  - Separates content and format into different files

Object-oriented Programming (OOP) Languages

- **Object- oriented programming (OOP) languages:** Programming language that encapsulate a small amount of data with instructions about what to do with data
- **Methods:** In OOP, the instructions about what to do with encapsulated data objects
- **Encapsulation:** In OOP, the process of creating an object, and protecting its contents
- **Reusability feature:** Feature of object-oriented languages that allows classes created for one purpose to be used (or extended) in a different object-oriented program if desired

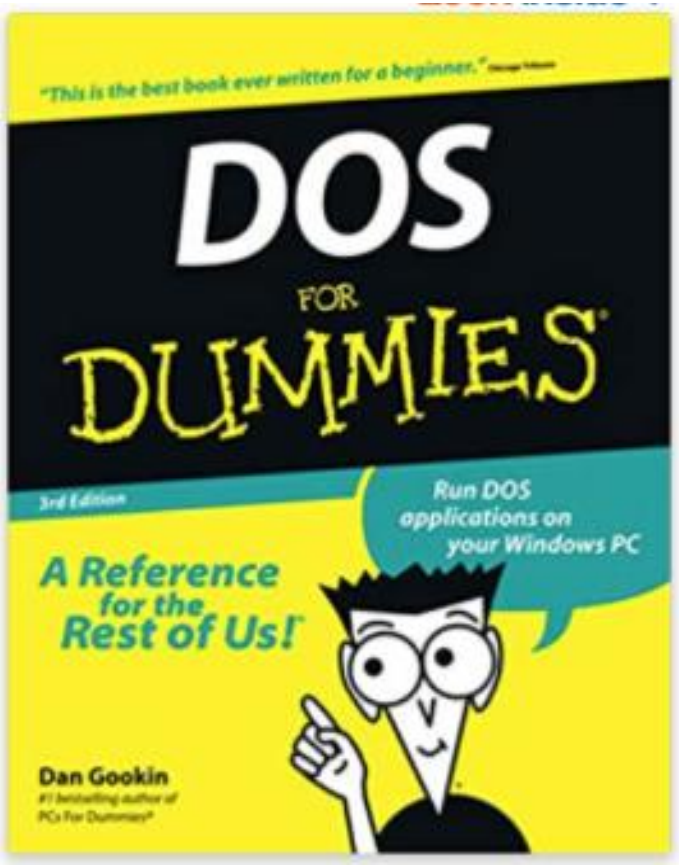
Modern Languages

- **Java –** Full object-oriented programming language
- **JavaScript** - scripting language that is especially suited for web development and is embedded into HTML
- **PHP** - scripting language that is especially suited for web development and runs on a web server, taking PHP code as its input and creating web pages as output
- **R** – language for statistics and data analytics; supports direct vector processing
- Others: C#, Python, Ruby, Objective C

DOS Command Language

- **Dan Gookin** is an author who wrote the first “For Dummies” book
- His first book was *DOS for Dummies* which has sold hundreds of thousands of copies
- *Windows for Dummies*, asserted to be the best-selling computer book of all time, has sold more than 15 million copies
- He later wrote more dummies books and franchised the process inviting in more authors
- **For Dummies books have sold over 350 million copies!**
- See appendix for more on DOS commands

DOS Command Language (con't)



Summary

- A computer can have many definitions
- Major developments in hardware have taken place over the past 60 years
- Computers draw their power from speed, accuracy, and storage and retrieval capabilities
- Computers perform arithmetic, logical, and storage and retrieval operations
- Computers are classified based on cost, amount of speed, and sophistication
- To process data, a computer requires input, output, and memory devices
- Software is all the programs that run a computer system
- Computer languages include machine, assembly, high-level, fourth- and fifth- generation languages

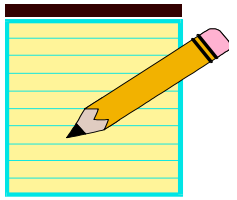
References

- **How Computers Work by Ron White and Timothy Downs**
- **Computers Made Easy: From Dummy To Geek** by James Bernstein
- **Computer Organization and Design: The Hardware/Software Interface (The Morgan Kaufmann Series... by David A. Patterson and John L. Hennessy**
- **Computer Architecture: A Quantitative Approach (The Morgan Kaufmann Series in Computer Architecture and Design)** by John L. Hennessy and David A. Patterson
- **How Computers Work and What to Do When They Don't: A Guide for Users like You! (The Simple Computer Series)** by Matthew R Baker

Homework

- Textbook Chapter 2
- Quiz on this lesson and that chapter
- Lesson appendices: DOS, UNIX, Qubit
- In Windows (see appendix for DOS commands) or MAC UNIX:
  - In DOS command window, create a directory under C:\ with the same name as your CBU username plus “2” (i.e. jdoe2)
  - Create a text file named “add.txt” containing your address and phone numbers and save it in that directory (you can use Wordpad or Notepad)
  - In DOS, create a directory under jdoe2 called “temp”
  - In DOS, move the text file from jdoe2 to temp
  - In DOS, rename the file to “add2.txt”
  - Print the DOS screen (Print-Screen [or ALT Print-Screen] Key), insert it in a Word document, and send that Word document to the instructor in an email
- Optional – Extra Credit - In Unix on student server (sheba.cbu.edu), do the same as above, except use a Unix editor, send the Unix screen of commands
- MAC users will need UNIX commands; click HERE for MAC video
- **Continued ----------→**

Homework (con't)



- Individual technology presentations
- Team Report 1
  - Selection of Industry Area and team name and possibly logo
    - Must be a new business and not an existing business – the focus in this course is the use of IT for a competitive advantage
  - Mission and Vision Statements
  - Specification of Product(s) and/or Service(s) and "value chain"

Appendix

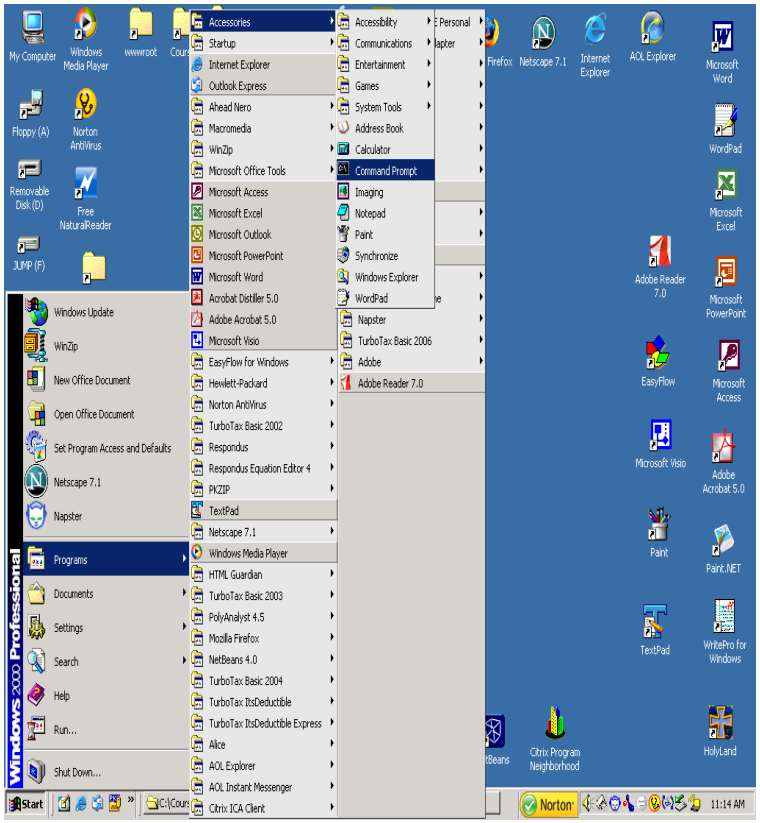
Windows/DOS Command Line

DOS

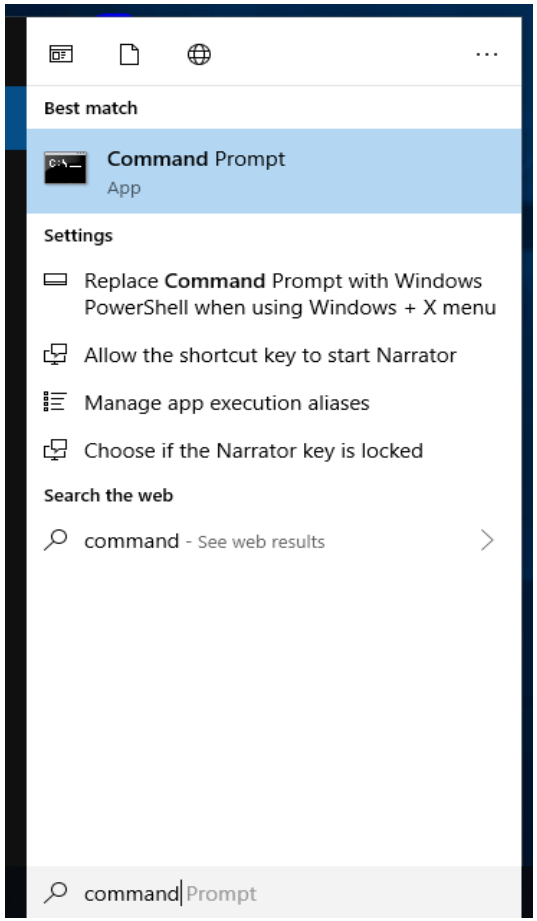
- The roots of the Windows command line lay in DOS, that antique operating system of the 1980s (DOS is gone now)
- Most old DOS programs lost Windows compatibility after the release of Windows 98
- Yet despite Windows' glorious graphical goodness, a wispy memory of text-based computer life still exists
- It's a program called CMD.EXE, and it appears in Windows as the command prompt window
- The command prompt to this day still serves as a useful alternative way to control your computer
- Indeed, there are some things you can do in the command prompt window that in Windows' graphical interface are tedious, slow, or almost impossible
- For Win 10+, there is an enhanced command interface - PowerShell

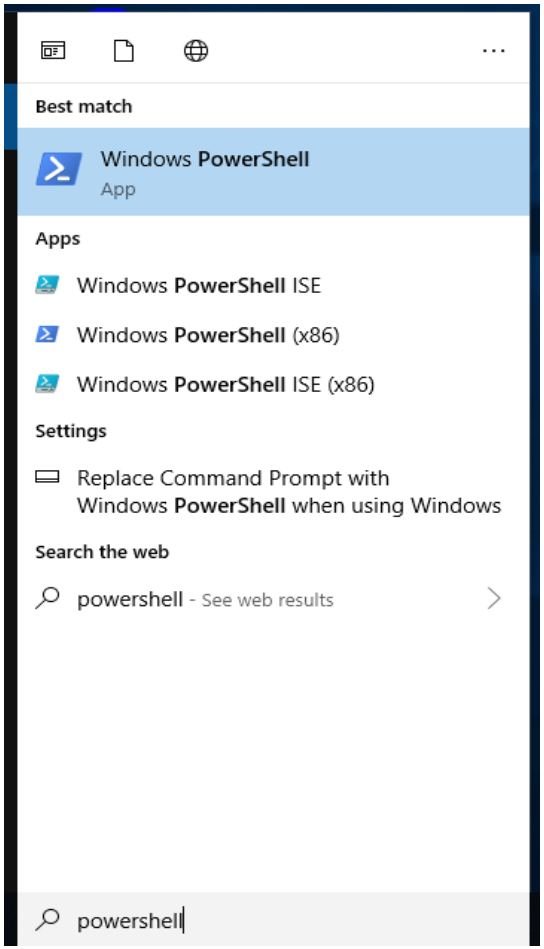
Starting Command Mode

- Text commands, while obscure, are potent. Armed with the right commands and the know-how to use them, you can, even today, fully control any Windows computer from your keyboard alone.
- The command prompt window isn't really text mode, not like the old days. Rather, it emulates text mode.
- In fact, over the years, Microsoft has continued to make the command prompt more and more powerful.
- To begin the command prompt window:
  - Click the Windows Start menu, click All Programs, choose the Accessories submenu, choose Command Prompt, *et voila*, you should be looking at a standard command prompt window.
  - OR select RUN and type in CMD (or powershell in Win 10+)



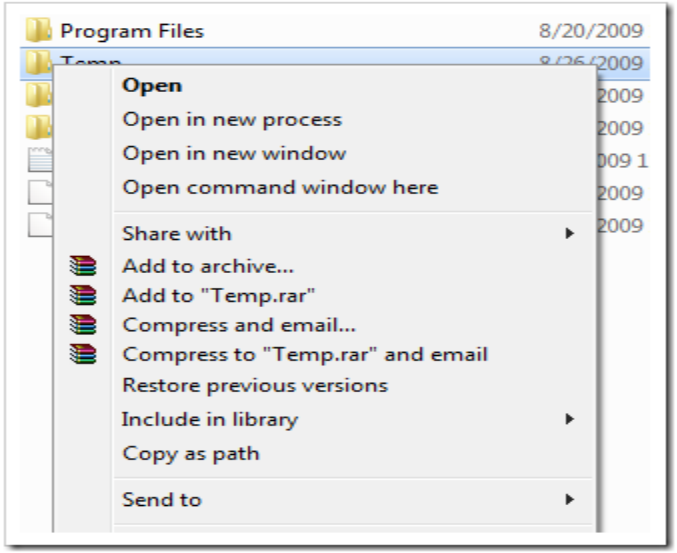
Typing “command” or “powershell” into Search Box [you may have a “run as administrator” option]



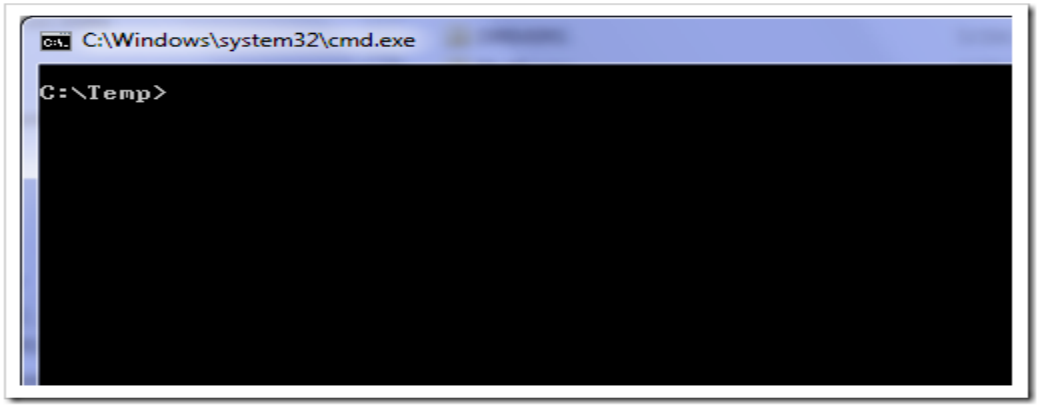


DOS Command Window in Win 7+

In Windows Explorer, simply **hold the Shift key** and right-click the folder you want to set as working directory, choose ***Open Command Window here***.

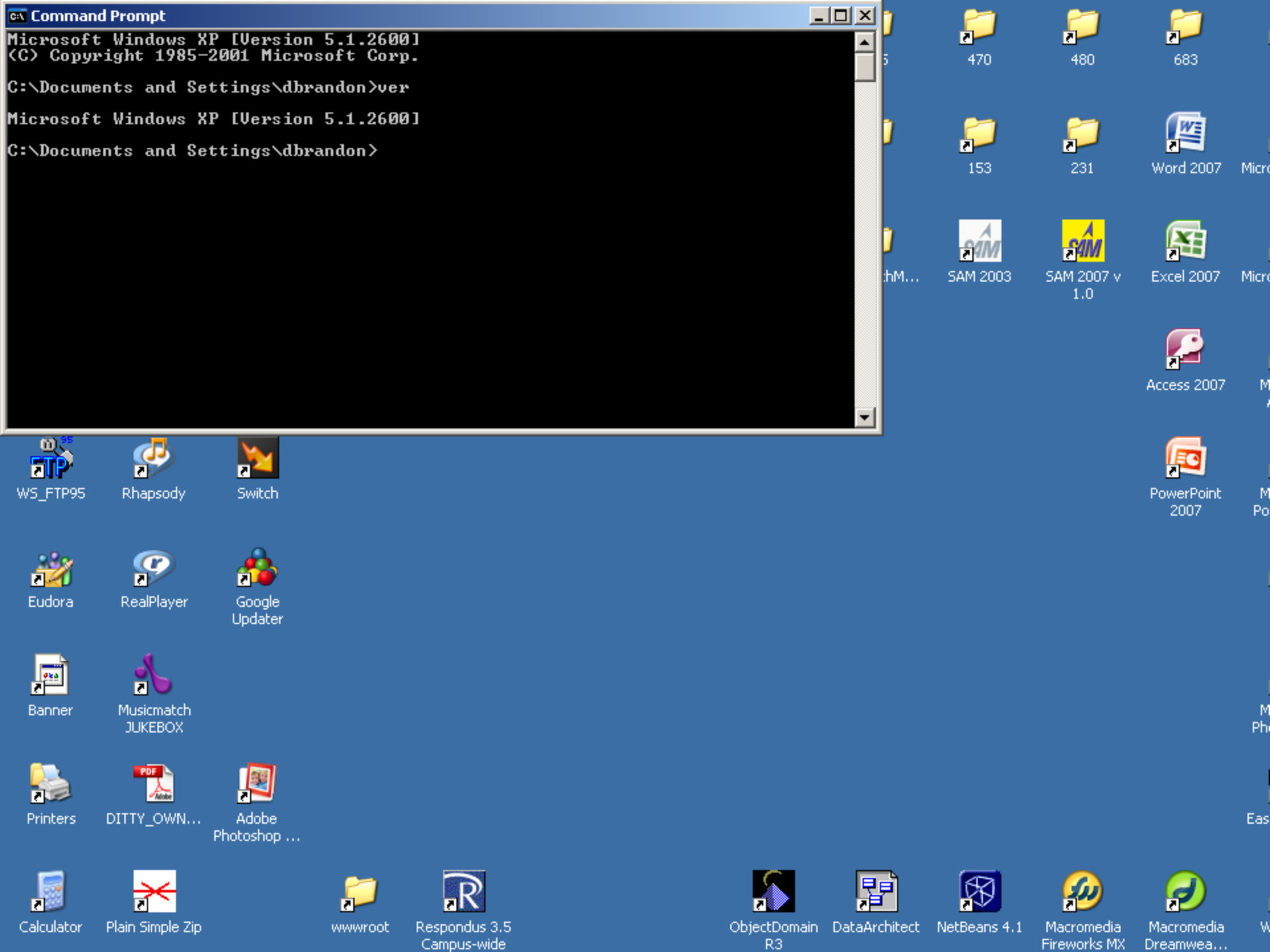


Open powershell here in Win 10+



DOS Command Window (con't)

- The command prompt window emulates the old full-screen text mode of yesteryear in a small window on your screen
- Inside the window you should see 80 columns by 25 rows of text; but you can resize that window
- A command prompt (which begins with C:\) indicates what directory you're currently in; and a blinking cursor shows you where to type your text
- What you type at that prompt are commands
- Type
  - VER
- and press Enter
- You should see text telling you the current version of your operating system


Command Prompt
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.
C:\Documents and Settings\dbrandon>ver
Microsoft Windows XP [Version 5.1.2600]
C:\Documents and Settings\dbrandon>
470
480
683
153
231
Word 2007
SAM 2003
SAM 2007 v 1.0
Excel 2007
Access 2007
PowerPoint 2007
WS_FTP95
Rhapsody
Switch
Eudora
RealPlayer
Google Updater
Banner
Musicmatch JUKEBOX
Printers
DITTY_OWN...
Adobe Photoshop ...
Calculator
Plain Simple Zip
wwwroot
Respondus 3.5 Campus-wide
ObjectDomain R3
DataArchitect
NetBeans 4.1
Macromedia Fireworks MX
Macromedia Dreamwea...

Command Use

- There are many web DOS tutorials available, such as:
  - http://terpconnect.umd.edu/~nsw/ench250/dostutor.htm
- Commands can be typed in uppercase or lowercase. Traditionally, DOS commands are written in ALL CAPS, as we're doing here, but you don't have to type them that way.
- Anything you type is ignored until you press the Enter key. You can use the Backspace key to back up and erase. You can also use the left and right arrow keys to edit text.
- You can quickly summon a previous DOS command by pressing the up arrow key. Pressing the up arrow key repeatedly pages back through the past several commands you've typed at the prompt.
- The Cancel sequence in DOS is Ctrl+C.
- Yes, the error messages are cryptic and useless.
- To finish your DOS session, simply close the window. Or if you want to be completely texty about things, type EXIT to make the command prompt window go bye-bye, just like in the old days.

DOS Command Window

- You can change the row count simply by resizing the window vertically with your mouse. However, the same can't be said for the horizontal axis. To change the command prompt window's column count, you need a DOS command, MODE:
  - MODE CON COLS=90 LINES=30
- The above command sets the number of text columns (COLS) on the CON or "console" (another term for the command prompt window) to 90 and the number of rows or LINES to 30.
- Note, however, that setting the LINES value also affects the command prompt window's ability to scroll back through commands. Normally, the number of lines is set to 300, though the window is sized to show only 25 lines. When you reset the LINES value, the scroll-back buffer will be reset as well, so tread carefully if you think you're going to need to scroll back through your work.
- MODE is one of the most eclectic DOS commands, controlling the operating mode of a variety of devices. To see the current operating statistics for the console, type:
  - MODE CON
- It's also possible to change the command prompt window's text and background colors, something old-time DOS users requested for years. Try this:
  - COLOR 1F
- The above command sets the background color to 1 (blue) and text color to F (bright white). There are 16 color combinations to choose from, as shown below.
  - 0 = Black 1 = Blue 2 = Green 3 = Aqua 4 = Red 5 = Purple 6 = Yellow 7 = White 8 = Gray 9 = Light blue
    A = Light green B = Light aqua C = Light red D = Light purple E = Light yellow F = Bright white
- The order is always background first, then text color -- so COLOR 3B creates an aqua background with light aqua text, COLOR D0 creates a light purple background with black text and so on.

Directories

- To use the command prompt effectively, we first need to review the concept of directories.
- Microsoft made great efforts in the 1990s to change the old nomenclature from "directory" to "folder." For a GUI like Windows, that's OK, but the command prompt uses directories as DOS did.
- The prompt is configured to show you which directory you're currently using -- most of the time. If you're not sure, type
  - CD
- and hit Enter.
- On my computer, the prompt
- C:\Users\Dan>
- indicates that I'm currently using, or *logged to*, the directory Dan, a subdirectory of Users, a subdirectory of the root directory on drive C.
- That means that commands issued affect only the files in the Dan directory, unless you specify an alternate pathname, which we discuss later.

Directories (con’t)

- To refer to or use files in another directory, you have two choices. First, you can change directories by specifying the full pathname to the files. For example:
  - C:\WINDOWS\WEB\WALLPAPER\IMG10.JPG
- Or you can use the CD, change directory, command to log to that specific directory:
  - CD \WINDOWS\WEB\WALLPAPER
- You'll see the command prompt changed to reflect the new location:
  - C:\Windows\web\wallpaper>
- One can type
  - CD \
- To get back o the root directory of the drive (i.e. C:)
- One can type
  - CD ..
- To go back up the directory tree one level
- To make a new directory (under your current directory) named “newdir” use the MKDIR command (or MD command) [RD to remove a directory]:
  - MKDIR newdir

DOS & Unix

- If you're familiar with Unix, you'll note some similarities (and also many differences) between the way it handles directories and how DOS does things.
- First, DOS uses the backslash to separate paths. (DOS can use forward slashes, but their behavior is inconsistent, so it's safest to stick with the backslash.)
- Second, typing CD by itself in DOS does not return you to your home directory; it only shows you where you currently are. In Windows, you must do that manually by entering the pathname as we discussed above, or use this trick:
  - CD %USERPROFILE%
- In Windows, USERPROFILE is an environment variable representing your home directory. When used at the command prompt, environment variables must be enclosed in percent signs so that they expand properly.
- Finally, DOS and Windows handle separate storage devices as unique drive letters. So to use drive D in DOS, you must log to it by typing its drive letter and adding a colon:
  - D:
- Drive D and other drives also have their own file system, which you can navigate by using the CD command. Each drive has a current directory, and to discover what it is, use the CD command followed by the drive letter and a colon:
- CD D:
- The above command reports the current directory on drive D.

Groups of Files

- One can name certain files with a special prefix or suffix -- files with images of one's kids could all start with their names, for example, and files that pertain to a specific event like a birthday or holiday all use the same word as a suffix -- for example, (jonah_filename_birthday).
- That naming system may do nothing in Windows, but in text mode, it allows you to easily gather specific files and treat them as a unit.
- Of course, clever naming isn't enough. To work with groups of files, you also need to know and use DOS's filename *wild cards*. There are two: **?** for single characters and * for a group of characters.
- When you combine the wild cards to represent any character with consistent parts of a filename, you can then manipulate those specific files as a group.
- For example, say one has a folder full of 100 pictures. Some of them have the word "birthday" in the filename. To copy those birthday files to a USB flash drive using drive letter L, one can type the following command:
  - COPY *BIRTHDAY* L:
- The COPY command above automatically plucks out or selects any file with the word BIRTHDAY in it, anywhere in that directory. The * represents any text, that is, any characters, before or after the word BIRTHDAY in the file, so it will select both (jonah_birthday) and (birthday_2006). And the L: represents drive L, the flash drive to which I'm copying the files.

Creating Subdirectories and Moving Files to Them

- Here's another example, typical of digital housekeeping. Say one has a huge directory for a project. It started out small, then grew a bunch of files.
- To keep them organized, one can create separate folders for text, graphics and e-mails.
- Then use the MKDIR command to create new directories, actually subdirectories in the current directory, like so:
  - MKDIR PICS
- The above command creates the subdirectory PICS -- a lot faster than summoning and naming a new folder in Windows.
- The MOVE command is used to move files or folders:

  MOVE filename destination_directory
- To move the image files into the PICS directory, use the following three commands:
  - MOVE *.JPG PICS
    MOVE *.TIF PICS
    MOVE *.PNG PICS
- These three commands empty the current directory of its graphics files, all JPG, TIF and PNG images. The files are moved to the PICS directory, which is a subdirectory of whichever directory I'm currently logged to.

Files

- Say you want to share a file. The environment variable for Windows' Public folder is named, logically, PUBLIC. To copy the movie file SIMON.WMV to that folder, use this command:
  - COPY SIMON.WMV %PUBLIC%
- If SIMON.WMV isn't in the current folder, then you'll have to use CD to log to the proper folder and then issue the command, or stay where you are and specify a pathname to the file, like so:
  - COPY VIDEOS\SIMON.WMV %PUBLIC%\VIDEOS
- Along with MOVE and COPY, DOS sports the ERASE (or DEL) and RENAME (REN) commands, which are used to remove and rename files, alone or in groups.

Copying Whole Directories

- On the macro level, there is the powerful ROBOCOPY utility, which comes standard with Vista and is available for download as part of the **Windows Server 2003 Resource Kit** or the **Windows NT Server 4.0 Resource Kit**.
- No, the ROBO in ROBOCOPY does not stand for *robot*. It stands for *robust*. Just as the old XCOPY DOS command was created to fix many of COPY's shortcomings, ROBOCOPY fixes the shortfalls of XCOPY, and makes it smarter.
- Primarily, ROBOCOPY is a directory-copying (i.e., folder-copying) tool. It can even mirror a directory tree on a network computer, which can help you resume automatically after a network failure. It's a handy tool for any network administrator, as well as anyone who manually backs up his PC.
- The feature set for ROBOCOPY is pretty rich. To get a gander, use the ***/?*** switch to see the full list of options and parameters, or just type ROBOCOPY by itself.
- Now let's take a look at a ROBOCOPY command:
- ROBOCOPY **.** E:\DAN /MIR
- This command directs ROBOCOPY to duplicate, or mirror, the contents of the current directory (abbreviated by the dot) -- and all files and subdirectories in that directory -- to the directory DAN on drive E. All files will be copied. If the operation stops -- it will hang if a file is busy and try it back 1 million times unless you intervene -- you can resume it at any time simply by reissuing the ROBOCOPY command, which will pick up where it left off.
- Speaking of those million attempts, a good switch to employ with ROBOCOPY is /R:1. That sets the number of retries for busy files to one rather than the default 1 million. And that way the mirror process doesn't lag because some network service is accessing a log file.

File Associations

- One place where the command prompt really shows its muscle is with file associations, which Windows handles in only the most cursory way. (Windows makes a guess about which files should be associated with which programs by looking at the filename extension. That's it.)
- To keep track of filename extensions and the programs associated with those extensions, Windows maintains a database (in the Registry). You can use the Registry to fish out various filename extensions and the programs associated with them, or you can use the command prompt, which works better.
- The two commands used for file associations are ASSOC and FTYPE.
- You need two commands because there are two steps to file association:
  - The first step, handled by ASSOC, is to associate a filename extension with a file type.
  - The second step, handled by FTYPE, is to associate the file type to the command that opens the file.
- By itself, the ASSOC command lists every registered filename extension and the type of file it's registered to. The output scrolls by super fast. To get a full list, I recommend printing it or saving to disk and examining the list in Notepad.
- To print the list, type:
  - ASSOC > PRN
- To view it in Notepad:
  - ASSOC > ASSOC.TXT
    NOTEPAD ASSOC.TXT

File Associations (con’)

- Each entry takes the format of
  - .ext=type
- Where ext is the filename extension (complete with period), and type is the name of a file type. For example, to see how JPG files are registered, use this command:
  - ASSOC .JPG
- This command directs ASSOC to output any files associated with the JPG extension. On my screen, I saw this output:
  - .jpg=jpegfile
- Filenames ending in .JPG are associated with the JPEGFILE type.
- As with ASSOC, the output from the FTYPE command is voluminous and scrolls by too quickly to see. You can redirect the output to a file and examine it in Notepad by issuing these two commands:
  - FTYPE > FTYPE.TXT
NOTEPAD FTYPE.TXT
- The format for each line that FTYPE displays works like this:
  - type=command
- where type is an associated file type that the ASSOC command outputs, and command is the command line instructions for opening the given type. Windows opens the file using batch file command line arguments, such as %1 for the filename to open, then %2 through %9 for any additional command-line arguments.
- You may also see various command-line switches specified in the command part of FTYPE's output. (This is how some of those so-called computer geniuses discover "secret" or "hidden" switches.)

File Associations (con’)

- As an example, you can see how Windows treats the JPEGFILE file type:
  - FTYPE JPEGFILE
- On my computer, I see the following command for dealing with JPEGFILE types:
  - %SYSTEMROOT%\SYSTEM32\RUNDLL32.EXE "%PROGRAMFILES%\WINDOWS PHOTO GALLERY\PHOTOVIEWER.DLL", IMAGEVIEW_FULLSCREEN %1
- Remember: Full pathnames are used, so it's really just four items you see altogether. Initially, there's
  - %SYSTEMROOT%\SYSTEM32\RUNDLL32.EXE
- where %SYSTEMROOT% is a variable that expands to represent the location where you've installed Windows on your PC. The RUNDLL32.EXE program runs processes in Windows. In this case, it's running the Windows Photo Gallery Photo Viewer program:
  - "%PROGRAMFILES%\WINDOWS PHOTO GALLERY\PHOTOVIEWER.DLL",
- %PROGRAMFILES% is a variable that expands to equal the location where you've installed programs on your PC. That's followed by the pathname to the PhotoViewer DLL, which must be enclosed in double quotes because it contains spaces.
  - IMAGEVIEW_FULLSCREEN %1
- ImageView_Fullscreen is an option for the PhotoViewer program. It's followed by %1, which represents the name of the JPEG file.

Changing Default File Associations

- You can use the ASSOC and FTYPE combination to change assignments for any type of file. Of course, you'll first need to know the full pathname to the file to run, plus any options required to load a file and properly process the information.
- As an example, here's how you would setup the LOG filename extension to be opened by Notepad:
- ASSOC .LOG=LOGFILE
- This command associates the LOG filename extension with the LOGFILE type. Now you need to direct Windows to use Notepad when it opens LOG files. First, a cheat: See how Notepad is opened for text files, which are the TXTFILE type:
- FTYPE TXTFILE
- You should see something like:
- TXTFILE=%SYSTEMROOT%\SYSTEM32\ NOTEPAD.EXE %1
- Now type:
  - FTYPE LOGFILE=%SYSTEMROOT%\ SYSTEM32\NOTEPAD.EXE %1
- You're using the same command used to open a TXTFILE, but in this case it's a LOG file you're opening. Another way to do this is to associate LOG with TXTFILE:
  - ASSOC .LOG=TXTFILE
- But either way ends up with the same result: Notepad is run and it opens the file.

Printing and Files

- Another thing the command prompt can do that Windows can't is print the contents of a folder, a list of files, their names, sizes and dates. This is actually a function of the DIR command, which lists the contents of a directory:
  - DIR
- In Windows, directory (or folder) information is displayed graphically. You can use the Details mode to see the kind of information that the DIR command displays, but you still can neither print nor easily cut and paste that list within Windows. Yet using the command prompt, it's possible -- providing that you have a printer connected directly to your PC's printer port, also called the LPT1 port. Here's the command:
  - DIR > PRN
- The **>** (greater than) symbol redirects the output of the DIR command to the PRN device, your PC's default printer. Ensure that your printer is attached to the computer and ready to print, then press the Enter key.
- If the page doesn't eject from the printer, then try this useful command:
  - ECHO ^L > PRN
- Note that you create the ^L character by pressing Ctrl+L on the keyboard; don't type the character **^** and then an L, which doesn't work. The ECHO command displays the "Control-L" character, but because the **>** command redirects output, the ^L is "displayed" on the printer, which ejects a page.

Printing and Files (con’t)

- There are two alternatives if you don't have a printer connected directly to your PC's printer port (for instance, if your printer is connected via a USB cable or is on your network). The first is to send the DIR command's output to a file, a file you can later open and print from within Windows. Let's call the file DIRLIST.TXT. When you type:
  - DIR > DIRLIST.TXT
- the above command redirects the DIR command's output to DIRLIST.TXT, which is created in the same directory. You can then use Notepad to print the file by issuing this command:
- NOTEPAD /P DIRLIST.TXT
- The command opens Notepad, loads the file DIRLIST.TXT, prints the file (thanks to the /P switch), then closes Notepad back up. A final command is required to remove the DIRLIST.TXT file:
- DEL DIRLIST.TXT
- There is no confirmation; the file is removed by the DEL command. (Also, it cannot be recovered from the Recycle Bin.)
- The second alternative is available to Windows Vista users only. With Windows Vista, Microsoft added a slew of new DOS commands, including a new filter: CLIP. The CLIP filter is used at the command prompt to send information to the Windows clipboard. Once there, the text generated by the command prompt can be pasted into any Windows application that accepts text.
- So in Vista, the alternative for printing a list of files works like this:
- DIR | CLIP
- The above command uses the pipe character (found above the backslash key on your keyboard) to send the output of the DIR command to the Windows clipboard. You can then use the Ctrl+V, or Paste, command to paste the file listing into any application that accepts text, such as Notepad or Microsoft Word

DOS Command Summary

[http://en.wikipedia.org/wiki/List_of_MS-DOS_commands]

- **COPY**
- **PURPOSE** Creates a copy of a file.
- **SYNTAX** COPY *input output*
- **MOVE**
- **PURPOSE** Moves a file from one location to another.
- **SYNTAX** MOVE *input output*
- **REN**
- **PURPOSE** Renames a file
- **SYNTAX** REN *input output*
- **DIR**
- **PURPOSE** Displays the contents of the current directory.
- **SYNTAX** DIR
- /P causes DOS to pause after filling a complete screen.
- /W causes DOS to list files across the width of the screen.
- **ERASE**
- **PURPOSE** Deletes DOS disk files.
- **SYNTAX** ERASE *file path*
- **MKDIR**
- **PURPOSE** Creates a new disk directory.
- **SYNTAX** MKDIR *directory*
- **RMDIR**
- **PURPOSE** Removes a disk directory.
- **SYNTAX** RMDIR *directory*
- **TYPE**
- **PURPOSE** Display the contents of a file on the screen.
- **SYNTAX** TYPE *file path*

Windows PowerShell

- The Command Prompt is essentially just a legacy environment carried forward in Windows—an environment that copies all of the various DOS commands you would find on an old DOS system
- It is limited, can't access many Windows system administration features, and is more difficult to compose complex scripts with
- PowerShell is a new environment for Windows 10+ system administrators that allows them to use a more modern command-line (Unix like) environment to manage Windows
- PowerShell is more complicated than DOS Command, but much more powerful

PowerShell (con't)

- Many common Command Prompt commands—from ipconfig to cd —work in the PowerShell environment
- This is because PowerShell contains "aliases" that point these old commands at the appropriate new cmdlets, running the new cmdlets when you type the old commands
- As an example, see the commands below:
  - Change a Directory
    - •DOS: cd
    - •PowerShell: Set-Location
  - List Files in a Directory
    - •DOS: dir
    - •PowerShell: Get-ChildItem
  - Rename a File
    - •DOS: rename
    - •PowerShell: Rename-Item
- To see if a DOS command has an alias, you can use the Get-Alias cmdlet
  - For example, typing Get-Alias cd shows you that cd is actually running the Set-Location cmdlet

Basic Unix Commands

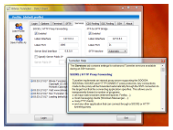
Download the Putty Telnet Client (Unix Terminal Emulator) [www.putty.org]

Install on Desktop

Download PuTTY

PuTTY is an SSH and telnet client, developed originally by Simon Tatham for the Windows platform. PuTTY is open source software that is available with source code and is developed and supported by a group of volunteers.

You can download PuTTY here.

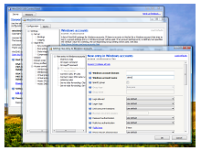


Bitvise Tunnelier

Tunnelier is an SSH and SFTP client for Windows. It is developed and supported professionally by Bitvise. Tunnelier is robust, easy to install, easy to use, and supports all features supported by PuTTY, as well as the following:

- graphical SFTP file transfer;
- single-click Remote Desktop tunneling;
- auto-reconnecting capability;
- dynamic port forwarding through an integrated proxy;
- an FTP-to-SFTP protocol bridge.

Tunnelier is **free for personal use**, as well as for individual commercial use inside organizations. You can download Tunnelier here.



Bitvise WinSSHD

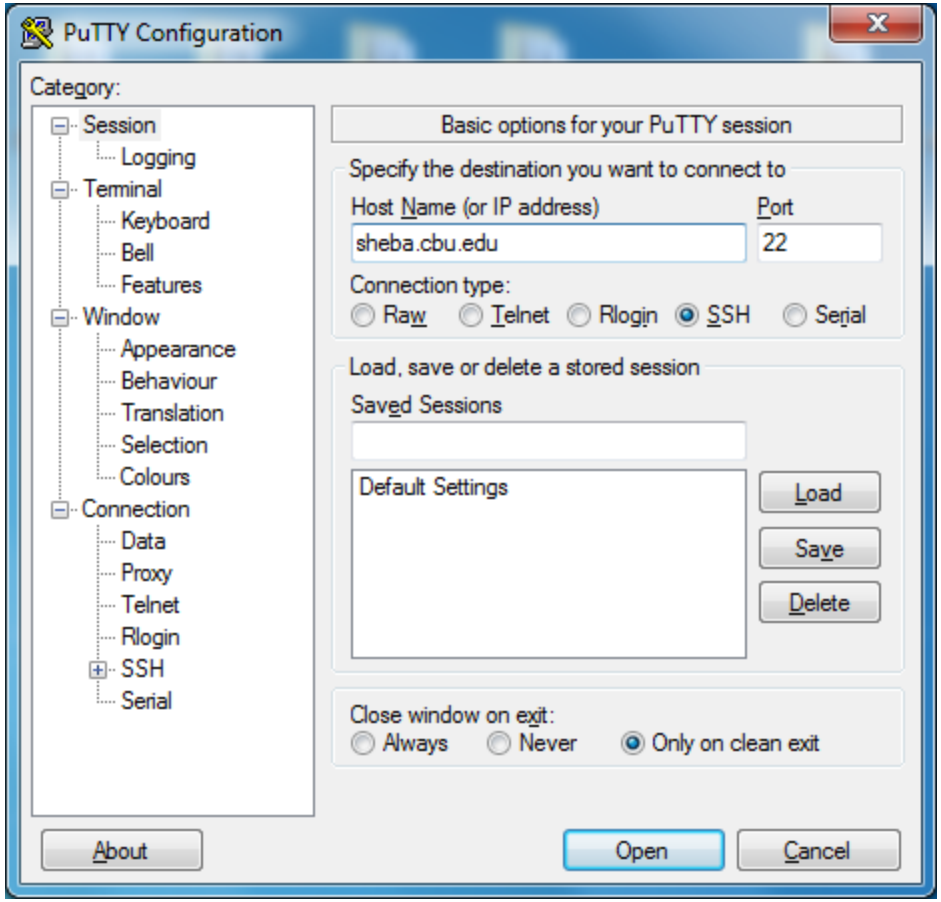
WinSSHD is an SSH, SFTP and SCP server for Windows. It is robust, easy to install, easy to use, and works well with a variety of SSH clients, including Tunnelier, OpenSSH, and PuTTY. WinSSHD is developed and supported professionally by Bitvise.

You can download WinSSHD here.

Putty (con't)

- Putty is one of those single file executables that does not require "installation" nor Administrative privileges
- Students can simply download and save on their "AD" desktop and execute from there
- Another URL below for the download page:
-
- http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html

Log onto Student Server



Common Unix Commands

- **ls** --- lists your files
  ls -l --- lists your files in 'long format', which contains lots of useful information, e.g. the exact size of the file, who owns the file and who has the right to look at it, and when it was last modified.
  ls -a --- lists all files, including the ones whose filenames begin in a dot, which you do not always want to see. There are many more options, for example to list files by size, by date, recursively etc.
- **more *filename*** --- shows the first part of a file, just as much as will fit on one screen. Just hit the space bar to see more or **q** to quit.
- **cat filename** --- lists the contents of a file
- **pico *filename*** --- is an editor that lets you create and edit a file

- **mv *filename1 filename2*** --- moves a file (i.e. gives it a different name, or moves it into a different directory (see below)
- **cp *filename1 filename2*** --- copies a file
- **rm *filename*** --- removes a file. It is wise to use the option rm -i, which will ask you for confirmation before actually deleting anything.
- **diff *filename1 filename2*** --- compares files, and shows where they differ
- **wc *filename*** --- tells you how many lines, words, and characters there are in a file
- **chmod *options filename*** --- lets you change the read, write, and execute permissions on your files. The default is that only you can look at them and change them, but you may sometimes want to change these permissions. For example, **chmod o+r *filename*** will make the file readable for everyone, and **chmod o-r *filename*** will make it unreadable for others again. Note that for someone to be able to actually look at the file the directories it is in need to be at least executable.

- **mkdir *dirname*** **---** make a new directory
- **cd *dirname*** --- change directory. You basically 'go' to another directory, and you will see the files in that directory when you do 'ls'. You always start out in your 'home directory', and you can get back there by typing 'cd' without arguments. 'cd ..' will get you one level up from your current position. You don't have to walk along step by step - you can make big leaps or avoid walking around by specifying pathnames.
- **pwd** --- tells you where you currently are.

Pico Usage

- Original File Creation:
  - pico
    - Type in file contents
  - ^O
  - specify file name (i.e. Hello.java)
  - ^X
- Editing File:
  - pico filename

http://www.cbu.edu/ietc/faq/picofaq.html

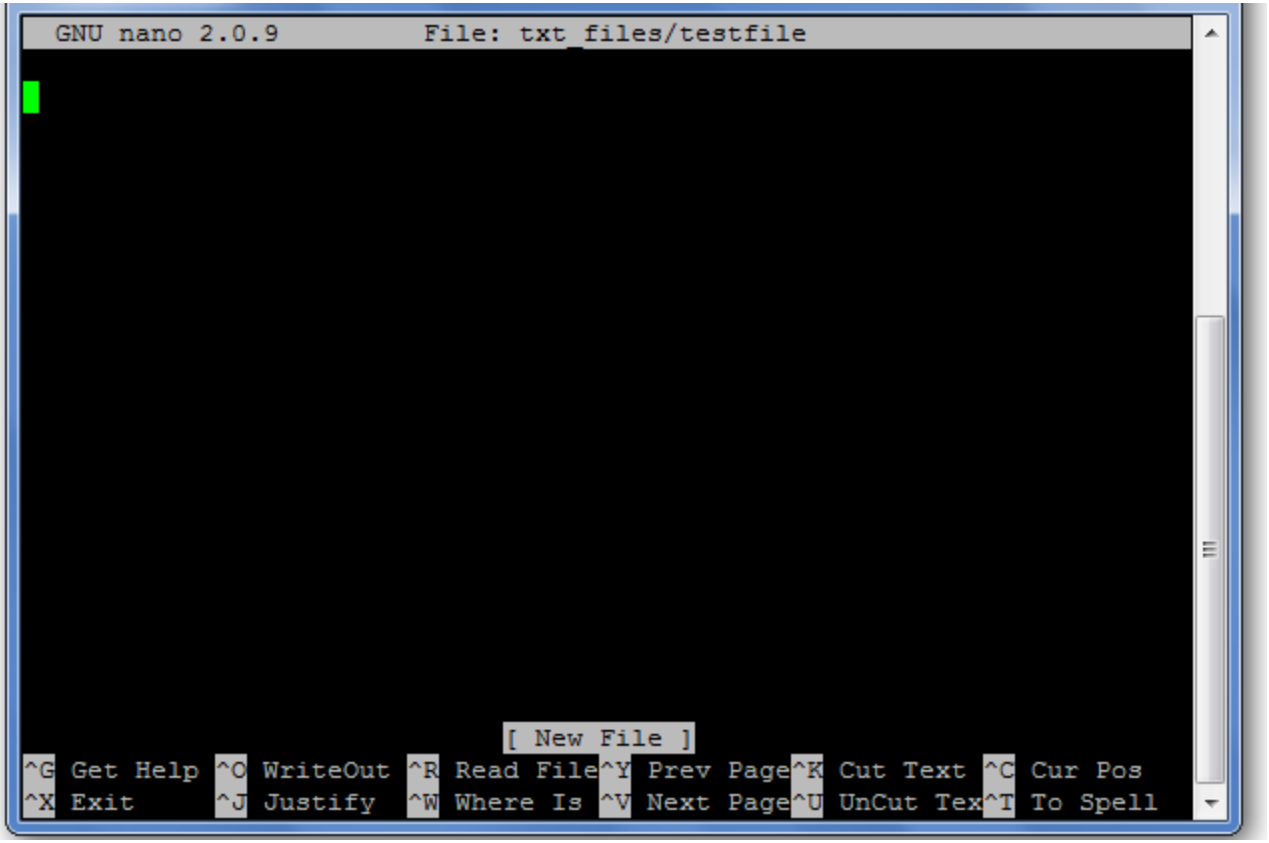
The following functions are available in pico:

Command	Function
^A	move to the beginning of the current line
^B	move Backward a character
^C	report current cursor position
^D	delete the character at the cursor position
^E	move to the End of the current line
^F	move Forward a character
^G	display this help text
^I	insert a tab at the current cursor position
^J	format (justify) the current paragraph
^K	cut selected text
^L	refresh the display
^N	move to the Next line
^O	output the current buffer to a file, saving it
^P	move to the Previous line
^R	insert an external file at the current cursor position
^T	to invoke the spelling checker
^U	uncut (paste) last cut text inserting it at the current cursor position
^V	move forward a page of text
^W	search for (where is) text, neglecting case
^X	exit pico, saving buffer
^Y	move backward a page of text
^^	mark cursor position as beginning of selected text
pico	invokes pico editor mode

Nano Editor

- Nano is a simple text based editor (does not use mouse)
- You can run nano in two ways
- To open nano with an empty buffer, just type in “nano” at the command prompt
- You can also use the following syntax:
  - nano /path/to/filename
- Nano will follow the path and open that file if it exists; if it does not exist, it’ll start a new buffer with that filename in that directory

Nano Editor (con't)



Nano Commands

File Management

Task	Keystroke
Open a file from within **nano**	**Ctrl+r** **NOTE:** tab completion is in effect; also, once this command has been entered, notice the new menu items at the bottom of the screen. For example, **Ctrl+T** will allow you to browse the file system and look for a file to open.
Display the next file buffer	**Alt+>**
Display the previous file buffer	**Alt+<**
Save the current file buffer to disk	**Ctrl+o**
Close the current file buffer	**Ctrl+x** **NOTE:** If the file hasn't been saved yet, you'll be asked if you want to save it. Also, if there's only one file buffer open, closing it will exit from **nano**.

Copy and Paste

Task	Keystroke
Select a region for a cut or paste operation	**Alt+a** **NOTE:** After setting a mark with Alt+a, move the cursor to define the region, you should see it highlighted as you move the cursor. Also, to cancel the definition of the region just enter Alt+a again.
Copy a highlighted region into the clipboard	**Alt+^**
Cut a highlighted region into the clipboard	**Ctrl+k**
Paste the contents of the clipboard at the current cursor position	**Ctrl+u**
Cut from the current cursor position to the end-of-line (EOL)	**Ctrl+k** **NOTE:** This command doesn't require highlighting of the region.

Nano Commands (con't)

Navigating Through Code

Task	Keystroke
Go to beginning of file	**Alt+**
Go to end of file	**Alt+/**
Move forward one screenful	**Ctrl+v**
Move backward one screenful	**Ctrl+y**
Go to a target line number	**Alt+g**
Jump to matching open/close symbol	**Alt+]** **NOTE:** Very useful for finding mismatched brace compiler errors!
Window scrolling	**Alt+=** to scroll down, **Alt+-** to scroll up
Indenting/Outdenting selected blocks	Use **Alt+a** to select a block, then **Alt+}** will indent the selected block, and **Alt+{** will outdent the block.

Search and Replace

Task	Keystroke
Search for a target string	**Ctrl+w** **NOTE:** Once this command has been entered, notice the new menu items at the bottom of the screen, such as toggling the direction of the search (Alt+B) or replacing the search string with a different string (Ctrl+R)
Repeat the last search	**Alt+w**
Toggle direction for next search	**Ctrl+w** followed by **Ctrl+b**
Search and replace	**Alt+r**

UNIX Command Summary

[http://www.math.utah.edu/lab/unix/unix-commands.html]

- cat --- for creating and displaying short files
- chmod --- change permissions
- cd --- change directory
- cp --- for copying files
- date --- display date
- echo --- echo argument
- ftp --- connect to a remote machine to download or upload files
- grep --- search file
- head --- display first part of file
- ls --- see what files you have
- lpr --- standard print command (see also print)
- more --- use to read files
- mkdir --- create directory
- mv --- for moving and renaming files
- ncftp --- especially good for downloading files via anonymous ftp.
- print --- custom print command (see also lpr)
- pwd --- find out what directory you are in
- rm --- remove a file
- rmdir --- remove directory
- rsh --- remote shell
- setenv --- set an environment variable
- sort --- sort file
- tail --- display last part of file
- tar --- create an archive, add or extract files
- telnet --- log in to another machine
- wc --- count characters, words, lines

NETWORKWORLD
FROM IDG

< THE LINUX COMMAND-LINE CHEAT SHEET >

COMMAND	FUNCTION
Getting familiar with your account	
pwd	Displays your current location in the file system
whoami	Displays your username — most useful if you switch users with su and need to be reminded what account you're using currently
ls	Provides a file listing. With **-a**, it also displays files with names starting with a period (e.g., .bashrc). With **-l**, it also displays file permissions, sizes and last updated date/time.
env	Displays your user environment settings (e.g., search path, history size, home directory, etc.)
echo	Repeats the text you provide or displays the value of some variable
history	Lists previously issued commands
passwd	Changes your password. Note that complexity requirements may be enforced.
Examining Files	
cat	Displays the entire contents of a text file.
more	Displays the contents of a text file one screenful at a time. Hit the spacebar to move to each additional chunk.
less	Displays the contents of a text file one screenful at a time, but in a manner that allows you to back up using the **up arrow key**.
file	Identifies files by type (e.g., ASCII text, executable, image, directory)
Managing files	
chmod	Changes file permissions (who can read it, whether it can be executed, etc.)
chown	Changes file owner
cp	Makes a copy of a file.
mv	Moves or renames a file — or does both
rm	Deletes a file or group of files
Creating and editing files	
nano	An easy-to-use text editor that requires you to move around in the file using your arrow keys and provides control sequences to locate text, save your changes, etc.
vi	A more sophisticated editor that allows you to enter commands to find and change text, make global changes, etc.
ex	A text editor designed for programmers and has both a line-oriented and visual mode

Creating and editing files (continued)

touch	Creates a file if it doesn't exist or updates its timestamp if it does
>	Creates files by directing output to them. A single **>** creates a file while **>>** appends to an existing file.
mkdir	Creates a directory
Moving around the file system	
cd	With no arguments, takes you to your home directory. The same thing would happen if you typed **cd $HOME** or **cd ~**
cd ..	Moves up **(toward /)** one directory from your current location
cd <location>	Takes you to the specified location. If the location begins with a **/**, it is taken to be relative to the root directory; otherwise it is taken as being relative to your current location. The **~**character represents your home directory.
Learning about and identifying commands	
man	Displays the manual (help) page for a specified command and (with **-k**) provides a list of commands related to a specified keyword
which	Displays the location of the executable that represents the particular command
apropos	Lists commands associated with a particular topic or keyword
Finding files	
find	Locates files based on criteria provided (file name, type, owner, permissions, size, etc.). Unless provided with a location from which to start the search, find only looks in the current directory.
locate	Locates files using the contents of the **/var/lib/mlocate/mlocate.db** which is updated by the **updatedb** command usually run through cron. No starting location is required.
Viewing running processes	
ps	Shows processes that you are running in your current login session
ps -ef	Shows all processes that are currently running on the system
pstree	Shows running processes in a hierarchical (tree-like) display that demonstrates the relationships between processes (**-h** highlights current process)
Starting, stopping and listing services	
systemctl	The **systemctl** command can start, stop, restart and reload services. Privileged access is required.
service	Lists services and indicates whether they are running

https://images.idgesg.net/assets/2019/04/ie_nw_linux_cheat20sheet_spring202019.pdf

COMMAND	FUNCTION
Killing processes	
kill	Terminates a running process provided you have the authority to do so
killall	Terminates all processes with the provided name
pkill	Terminates a process based on its name
Identifying your OS release	
uname	Displays information on OS release in a single line of text
lsb_release	On Debian-based systems, this command displays information on the OS release including its codename and distributor ID
hostnamectl	Displays information on the system including hostname, chassis type, OS, kernel and architecture
Gauging system performance	
top	Shows running processes along with resource utilization and system performance data. Can show processes for one selected user or all users. Processes can be ordered by various criteria (CPU usage by default)
atop	Similar to top command but more oriented toward system performance than individual processes
free	Shows memory and swap usage — total, used and free
df	Display file system disk space usage
Managing users and groups	
useradd	Adds a new user account to the system. A username is mandatory. Other fields (user description, shell, initial password, etc.) can be specified. Home directory will default to **/home/username**.
userdel	Removes a user account from the system. The **-f** option runs a more forceful removal, deleting the home and other user files even if the user is still logged in.
groupadd	Adds a new user group to the system, updating the **/** etc/group.
groupdel	Removes a user group from the system
Examining network connections	
ip	Displays information on network interfaces
ss	Displays information on sockets. The **-s** option provides summary stats. The **-l** option shows listening sockets. The **-4** or **-6** options restrict output to IPv4 or IPv6 connections.
ping	Check connectivity to another system
Managing security	
visudo	The visudo command allows you to configure privileges that will allow select individuals to run certain commands with superuser authority. The command does this by making changes to the **/etc/sudoers** file.

Managing security (continued)

sudo	The sudo command is used by privileged users (as defined in the /etc/sudoersfile to run commands as root.
su	Switches to another account. This requires that you know the user's password or can use sudo and provide your own password. Using the **-** means that you also pick up the user's environment settings.
who	Shows who is logged into the system
last	Lists last logins for specified user using records from the **/var/log/wtmp** file.
ufw	Manages the firewall on Debian-based systems.
firewall-cmd	Manages the firewall (firewalld) on RHEL and related systems.
iptables	Displays firewall rules.
Setting up and running scheduled processes	
crontab	Sets up and manages scheduled processes. With the **-l** option, cron jobs are listed. With the **-e** option, cron jobs can be set up to run at selected intervals.
anacron	Allows you to run scheduled jobs on a daily basis only. If the system is powered off when a job is supposed to run, it will run when the system boots.
Updating, installing and listing applications	
apt update	On Debian-based systems, updates the list of available packages and their versions, but does not install or upgrade any packages
apt upgrade	On Debian-based systems, installs newer versions of installed packages
apt list	Lists all packages installed on Debian-based system. With — upgradableoption, it shows only those packages for which upgrades are available.
apt install	On Debian-based systems, installs requested package
yum update	On RPM-cased systems, updates all or specified packages
yum list	On RPM-based systems, lists package
yum install	On RPM-based systems, installs requested package
yum list	On RPM-based systems, lists known and installed packages
Shutting down and rebooting	
shutdown	Shuts down the system at the requested time. The **-H** option halts the system while the **-P** powers it down as well.
halt	Shuts down the system at the requested time.
poweroff	Powers down the system at the requested time.

NETWORKWORLD

APPENDIX

Qubit

Google's Sycamore

- In OCT 2019 Google claimed that it's achieved quantum supremacy -- marking a major milestone in computing research and Google's research paper has now been published in the scientific journal *Nature*
- Quantum supremacy is a big deal, because it encapsulates the ability of quantum computers to solve problems that current technology couldn't even begin to attempt
- Google's paper explains how its 53-bit quantum computer -- named Sycamore -- took just 200 seconds to perform a calculation that would have taken the world's fastest supercomputer 10,000 *years*
- In theory, this capability opens a lot of doors to future technologies, such as designing better batteries and medicine, or minimizing emissions from farming chemicals

- It could also help to advance existing technologies such as machine learning
- However, Sycamore's feat has almost no practical use at this stage -- it was designed simply to show that a quantum computer could perform as expected
- Nonetheless, it's an important first step towards a technology that could have a major impact on our lives -- even if that's still some years away
- In an interview with *MIT Technology Review*, Google CEO Sundar Pichai likened the experiment to the first flight by the Wright Brothers
  - "The first plane flew only for 12 seconds, and so there is no practical application of that," he said. "But it showed the possibility that a plane could fly."

Qubit

- In quantum computing, a **qubit** or **quantum bit** (sometimes **qbit**) is a unit of quantum information—the quantum analogue of the classical bit
- A qubit is a two-state quantum-mechanical system, such as the polarization of a single photon: here the two states are vertical polarization and horizontal polarization
- In a classical system, a bit would have to be in one state or the other
- However, quantum mechanics allows the qubit to be in a superposition of both states at the same time, a property that is fundamental to quantum computing

Bit vs Qubit

- The bit is the basic unit of information; it is used to represent information by computers
- Regardless of its physical realization, a bit has two possible states typically thought of as 0 and 1, but more generally—and according to applications—interpretable as true and false
- An analogy to this is a light switch—its off position can be thought of as 0 and its on position as 1
- A qubit has a few similarities to a classical bit, but is overall very different
- There are two possible outcomes for the measurement of a qubit—usually 0 and 1, like a bit; however the state of a qubit can also be a superposition of both
- It is possible to fully encode one bit in one qubit; however, a qubit can hold even more information, e.g. up to two bits using superdense coding
- For a system of n components, a complete description of its state in classical physics requires only n bits, whereas in quantum physics it requires $2^n - 1$ complex numbers

Qubit States

- The two states in which a qubit may be measured are known as basis states (or basis vectors)
- As is the tradition with any sort of quantum states, they are represented by Dirac—or "bra–ket"—notation
- This means that the two computational basis states are conventionally written as $|0\rangle$ and $|1\rangle$
- Pronounced "ket 0" and "ket 1"

Qubit States (con't)

A pure qubit state is a linear superposition of the basis states. This means that the qubit can be represented as a linear combination of $|0\rangle$ and $|1\rangle$:

$$|\psi\rangle = \alpha|0\rangle + \beta|1\rangle,$$

where α and β are probability amplitudes and can in general both be complex numbers.

When we measure this qubit in the standard basis, the probability of outcome $|0\rangle$ is $|\alpha|^2$ and the probability of outcome $|1\rangle$ is $|\beta|^2$. Because the absolute squares of the amplitudes equate to probabilities, it follows that α and β must be constrained by the equation

$$|\alpha|^2 + |\beta|^2 = 1.$$

Qubit States (con't)

It might at first sight seem that there should be four degrees of freedom, as α and β are complex numbers with two degrees of freedom each. However, one degree of freedom is removed by the normalization constraint $|\alpha|^2 + |\beta|^2 = 1$, which can be treated as the equation for a 3-sphere embedded in 4-dimensional space with a radius of 1 (unit sphere). This means, with a suitable change of coordinates, one can eliminate one of the degrees of freedom. One possible choice is that of Hopf coordinates:

$$\alpha = e^{i\psi} \cos\frac{\theta}{2},$$

$$\beta = e^{i(\psi+\phi)} \sin\frac{\theta}{2}.$$

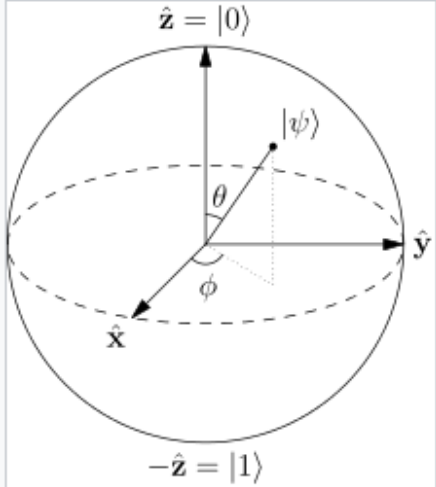
Additionally, for a single qubit the overall phase of the state $e^{i\nu}$ has no physically observable consequences, so we can arbitrarily choose α to be real (or β in the case that α is zero), leaving just two degrees of freedom:

$$\alpha = \cos\frac{\theta}{2},$$

$$\beta = e^{i\phi} \sin\frac{\theta}{2}.$$

Qubit States (con't)

- The possible states for a single qubit can be visualized using a Bloch sphere
- Represented on such a sphere, a classical bit could only be at the "North Pole" or the "South Pole", in the locations where |0⟩ and |1⟩ are respectively
- The rest of the surface of the sphere is inaccessible to a classical bit, but a pure qubit state can be represented by any point on the surface



Bloch sphere representation of a qubit. The probability amplitudes in the text are given by $\alpha = \cos\left(\frac{\theta}{2}\right)$ and $\beta = e^{i\phi}\sin\left(\frac{\theta}{2}\right)$.

Qubit States (con't)

- For example, the pure qubit state

$$\frac{|0\rangle + i|1\rangle}{\sqrt{2}}$$

- would lie on the equator of the sphere, on the positive y axis.
- The surface of the sphere is a two-dimensional space, which represents the state space of the pure qubit states. This state space has two local degrees of freedom.
- It is possible to put the qubit in a mixed state, a statistical combination of different pure states
- Mixed states can be represented by points inside the Bloch sphere
- A mixed qubit state has three degrees of freedom: the angles ϕ and θ, as well as the length r of the vector that represents the mixed state

Qubit Operations

- There are various kinds of physical operations that can be performed on pure qubit states:
  - A quantum logic gate can operate on a qubit: mathematically speaking, the qubit undergoes a unitary transformation - unitary transformations correspond to rotations of the qubit vector in the Bloch sphere
  - Standard basis measurement is an operation in which information is gained about the state of the qubit
    - The result of the measurement will be either $|0\rangle$, with probability $|\alpha|^2$ or $|1\rangle$, with probability $|\beta|^2$
    - Measurement of the state of the qubit alters the values of α and β, for instance, if the result of the measurement is $|0\rangle$, α is changed to 1 (up to phase) and β is changed to 0
    - Note that a measurement of a qubit state entangled with another quantum system transforms a pure state into a mixed state

Entanglement

- An important distinguishing feature between a qubit and a classical bit is that multiple qubits can exhibit quantum entanglement
- Entanglement is a nonlocal property that allows a set of qubits to express higher correlation than is possible in classical systems
- Take, for example, two entangled qubits in the Bell state
- In this state, called an equal superposition, there are equal probabilities of measuring either |00⟩ or |11⟩ , as

$$\left|1/\sqrt{2}\right|^2 = 1/2$$

Entanglement (con't)

- Imagine that these two entangled qubits are separated, with one each given to Alice and Bob
- Alice makes a measurement of her qubit, obtaining—with equal probabilities—either $|0\rangle$ or $|1\rangle$
- Because of the qubits' entanglement, Bob must now get exactly the same measurement as Alice; i.e., if she measures a $|0\rangle$, Bob must measure the same, as $|00\rangle$ is the only state where Alice's qubit is a $|0$
- Entanglement also allows multiple states (such as the Bell state mentioned above) to be acted on simultaneously, unlike classical bits that can only have one value at a time
- Entanglement is a necessary ingredient of any quantum computation that cannot be done efficiently on a classical computer
- Many of the successes of quantum computation and communication, such as quantum teleportation and superdense coding, make use of entanglement, suggesting that entanglement is a resource that is unique to quantum computation

Physical Implementations

Physical support	Name	Information support	$\|0\rangle$	$\|1\rangle$
Photon	Polarization encoding	Polarization of light	Horizontal	Vertical
	Number of photons	Fock state	Vacuum	Single photon state
	Time-bin encoding	Time of arrival	Early	Late
Coherent state of light	Squeezed light	Quadrature	Amplitude-squeezed state	Phase-squeezed state
Electrons	Electronic spin	Spin	Up	Down
	Electron number	Charge	No electron	One electron
Nucleus	Nuclear spin addressed through NMR	Spin	Up	Down
Optical lattices	Atomic spin	Spin	Up	Down
Josephson junction	Superconducting charge qubit	Charge	Uncharged superconducting island (Q=0)	Charged superconducting island (Q=2e, one extra Cooper pair)
	Superconducting flux qubit	Current	Clockwise current	Counterclockwise current
	Superconducting phase qubit	Energy	Ground state	First excited state
Singly charged quantum dot pair	Electron localization	Charge	Electron on left dot	Electron on right dot
Quantum dot	Dot spin	Spin	Down	Up

Computation Usage

- Faster computation, more operations in parallel
- Faster data communications – sending the same number of pulses along the wire or fiber optic cable – but each pulse has more information (a qubit instead of a bit)
  - In 2017 Oak Ridge Lab (ORNL) in TN transferred 1.67 bits per qubit over a fiber optic cable