# COMPUTER COMPONENTS

## EGCO342 INFORMATION TECHNOLOGY IN DAILY LIFE

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# Understanding Your Computer

- Computer is a data processing device.

- Performs four major functions:

  - **Input**: Gathers data, allows users to input data.

  - **Process**: Manipulates, calculates, or organizes data into information.

  - **Output**: Displays data and information for user.

  - **Storage**: Saves data and information for later use.

# Bits and Bytes

- The language of computers
    - Bit (**BI**nary digi**T**): 0 or 1
    - Byte = 8 bits
- See 'b' = bit, 'B' = Byte
- Each letter, number, or character is a unique combination of 8 bits of 0s and 1s

# ASCII

## (American Standard Code for Information Interchange)

### Decimal - Binary - Octal - Hex – ASCII
### Conversion Chart

| Decimal | Binary | Octal | Hex | ASCII | Decimal | Binary | Octal | Hex | ASCII | Decimal | Binary | Octal | Hex | ASCII | Decimal | Binary | Octal | Hex | ASCII |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 00000000 | 000 | 00 | NUL | 32 | 00100000 | 040 | 20 | SP | 64 | 01000000 | 100 | 40 | @ | 96 | 01100000 | 140 | 60 | ` |
| 1 | 00000001 | 001 | 01 | SOH | 33 | 00100001 | 041 | 21 | ! | 65 | 01000001 | 101 | 41 | A | 97 | 01100001 | 141 | 61 | a |
| 2 | 00000010 | 002 | 02 | STX | 34 | 00100010 | 042 | 22 | " | 66 | 01000010 | 102 | 42 | B | 98 | 01100010 | 142 | 62 | b |
| 3 | 00000011 | 003 | 03 | ETX | 35 | 00100011 | 043 | 23 | # | 67 | 01000011 | 103 | 43 | C | 99 | 01100011 | 143 | 63 | c |
| 4 | 00000100 | 004 | 04 | EOT | 36 | 00100100 | 044 | 24 | $ | 68 | 01000100 | 104 | 44 | D | 100 | 01100100 | 144 | 64 | d |
| 5 | 00000101 | 005 | 05 | ENQ | 37 | 00100101 | 045 | 25 | % | 69 | 01000101 | 105 | 45 | E | 101 | 01100101 | 145 | 65 | e |
| 6 | 00000110 | 006 | 06 | ACK | 38 | 00100110 | 046 | 26 | & | 70 | 01000110 | 106 | 46 | F | 102 | 01100110 | 146 | 66 | f |
| 7 | 00000111 | 007 | 07 | BEL | 39 | 00100111 | 047 | 27 | ' | 71 | 01000111 | 107 | 47 | G | 103 | 01100111 | 147 | 67 | g |
| 8 | 00001000 | 010 | 08 | BS | 40 | 00101000 | 050 | 28 | ( | 72 | 01001000 | 110 | 48 | H | 104 | 01101000 | 150 | 68 | h |
| 9 | 00001001 | 011 | 09 | HT | 41 | 00101001 | 051 | 29 | ) | 73 | 01001001 | 111 | 49 | I | 105 | 01101001 | 151 | 69 | i |
| 10 | 00001010 | 012 | 0A | LF | 42 | 00101010 | 052 | 2A | * | 74 | 01001010 | 112 | 4A | J | 106 | 01101010 | 152 | 6A | j |
| 11 | 00001011 | 013 | 0B | VT | 43 | 00101011 | 053 | 2B | + | 75 | 01001011 | 113 | 4B | K | 107 | 01101011 | 153 | 6B | k |
| 12 | 00001100 | 014 | 0C | FF | 44 | 00101100 | 054 | 2C | , | 76 | 01001100 | 114 | 4C | L | 108 | 01101100 | 154 | 6C | l |
| 13 | 00001101 | 015 | 0D | CR | 45 | 00101101 | 055 | 2D | - | 77 | 01001101 | 115 | 4D | M | 109 | 01101101 | 155 | 6D | m |
| 14 | 00001110 | 016 | 0E | SO | 46 | 00101110 | 056 | 2E | . | 78 | 01001110 | 116 | 4E | N | 110 | 01101110 | 156 | 6E | n |
| 15 | 00001111 | 017 | 0F | SI | 47 | 00101111 | 057 | 2F | / | 79 | 01001111 | 117 | 4F | O | 111 | 01101111 | 157 | 6F | o |
| 16 | 00010000 | 020 | 10 | DLE | 48 | 00110000 | 060 | 30 | 0 | 80 | 01010000 | 120 | 50 | P | 112 | 01110000 | 160 | 70 | p |
| 17 | 00010001 | 021 | 11 | DC1 | 49 | 00110001 | 061 | 31 | 1 | 81 | 01010001 | 121 | 51 | Q | 113 | 01110001 | 161 | 71 | q |
| 18 | 00010010 | 022 | 12 | DC2 | 50 | 00110010 | 062 | 32 | 2 | 82 | 01010010 | 122 | 52 | R | 114 | 01110010 | 162 | 72 | r |
| 19 | 00010011 | 023 | 13 | DC3 | 51 | 00110011 | 063 | 33 | 3 | 83 | 01010011 | 123 | 53 | S | 115 | 01110011 | 163 | 73 | s |
| 20 | 00010100 | 024 | 14 | DC4 | 52 | 00110100 | 064 | 34 | 4 | 84 | 01010100 | 124 | 54 | T | 116 | 01110100 | 164 | 74 | t |
| 21 | 00010101 | 025 | 15 | NAK | 53 | 00110101 | 065 | 35 | 5 | 85 | 01010101 | 125 | 55 | U | 117 | 01110101 | 165 | 75 | u |
| 22 | 00010110 | 026 | 16 | SYN | 54 | 00110110 | 066 | 36 | 6 | 86 | 01010110 | 126 | 56 | V | 118 | 01110110 | 166 | 76 | v |
| 23 | 00010111 | 027 | 17 | ETB | 55 | 00110111 | 067 | 37 | 7 | 87 | 01010111 | 127 | 57 | W | 119 | 01110111 | 167 | 77 | w |
| 24 | 00011000 | 030 | 18 | CAN | 56 | 00111000 | 070 | 38 | 8 | 88 | 01011000 | 130 | 58 | X | 120 | 01111000 | 170 | 78 | x |
| 25 | 00011001 | 031 | 19 | EM | 57 | 00111001 | 071 | 39 | 9 | 89 | 01011001 | 131 | 59 | Y | 121 | 01111001 | 171 | 79 | y |
| 26 | 00011010 | 032 | 1A | SUB | 58 | 00111010 | 072 | 3A | : | 90 | 01011010 | 132 | 5A | Z | 122 | 01111010 | 172 | 7A | z |
| 27 | 00011011 | 033 | 1B | ESC | 59 | 00111011 | 073 | 3B | ; | 91 | 01011011 | 133 | 5B | [ | 123 | 01111011 | 173 | 7B | { |
| 28 | 00011100 | 034 | 1C | FS | 60 | 00111100 | 074 | 3C | < | 92 | 01011100 | 134 | 5C | \ | 124 | 01111100 | 174 | 7C | | |
| 29 | 00011101 | 035 | 1D | GS | 61 | 00111101 | 075 | 3D | = | 93 | 01011101 | 135 | 5D | ] | 125 | 01111101 | 175 | 7D | } |
| 30 | 00011110 | 036 | 1E | RS | 62 | 00111110 | 076 | 3E | > | 94 | 01011110 | 136 | 5E | ^ | 126 | 01111110 | 176 | 7E | ~ |
| 31 | 00011111 | 037 | 1F | US | 63 | 00111111 | 077 | 3F | ? | 95 | 01011111 | 137 | 5F | _ | 127 | 01111111 | 177 | 7F | DEL |

# How Much Is a Byte

| Name | Abbreviation | Number of Bytes |
|------|--------------|-----------------|
| Byte | B | 1 byte |
| Kilobyte | KB | 1,024 bytes ($2^{10}$) |
| Megabyte | MB | 1,048,576 bytes ($2^{20}$ bytes) |
| Gigabyte | GB | 1,073,741,824 bytes ($2^{30}$ bytes) |
| Terabyte | TB | 1,099,511,627,776 bytes ($2^{40}$ bytes) |
| Petabyte | PB | 1,125,899,906,842,62 bytes ($2^{50}$ bytes) |
| Exabyte | EB | 1,152,921,504,606,846,976 bytes ($2^{60}$ bytes) |
| Zettabyte | ZB | 1,180,591,620,717,411,303,424 bytes ($2^{70}$ bytes) |

# How Computer Works



Instruction

Compute

CPU

Store Data

Get More Instruction

Get Data
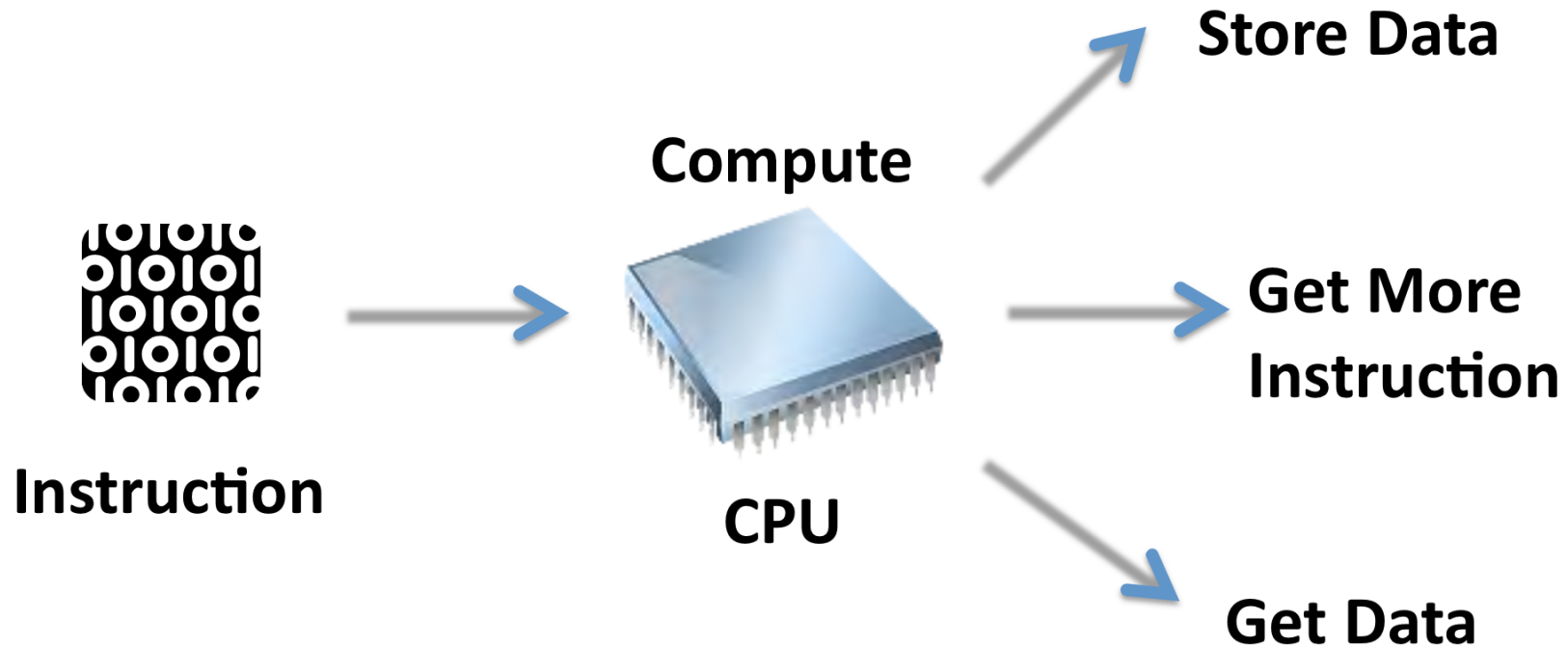
# Know Your Computer (1)
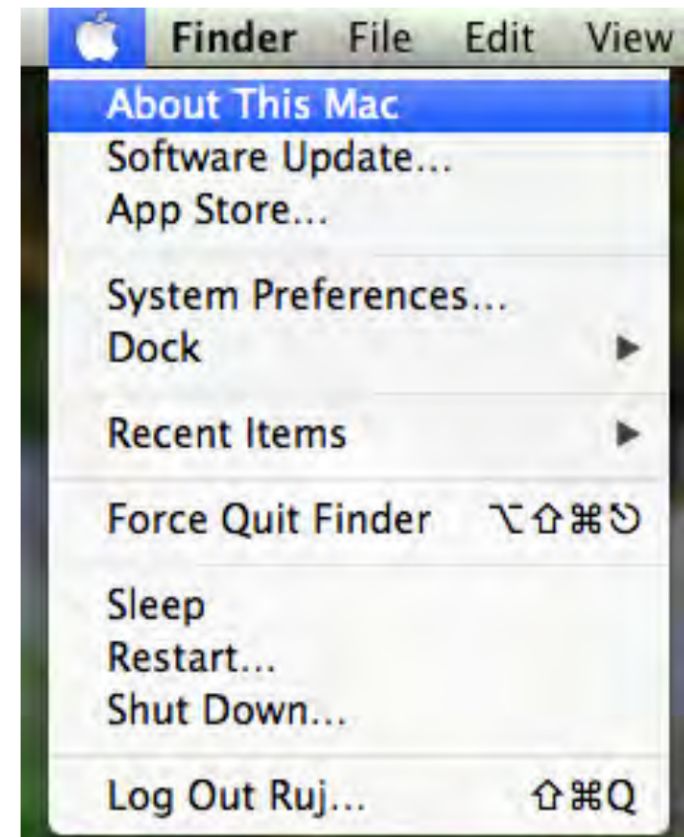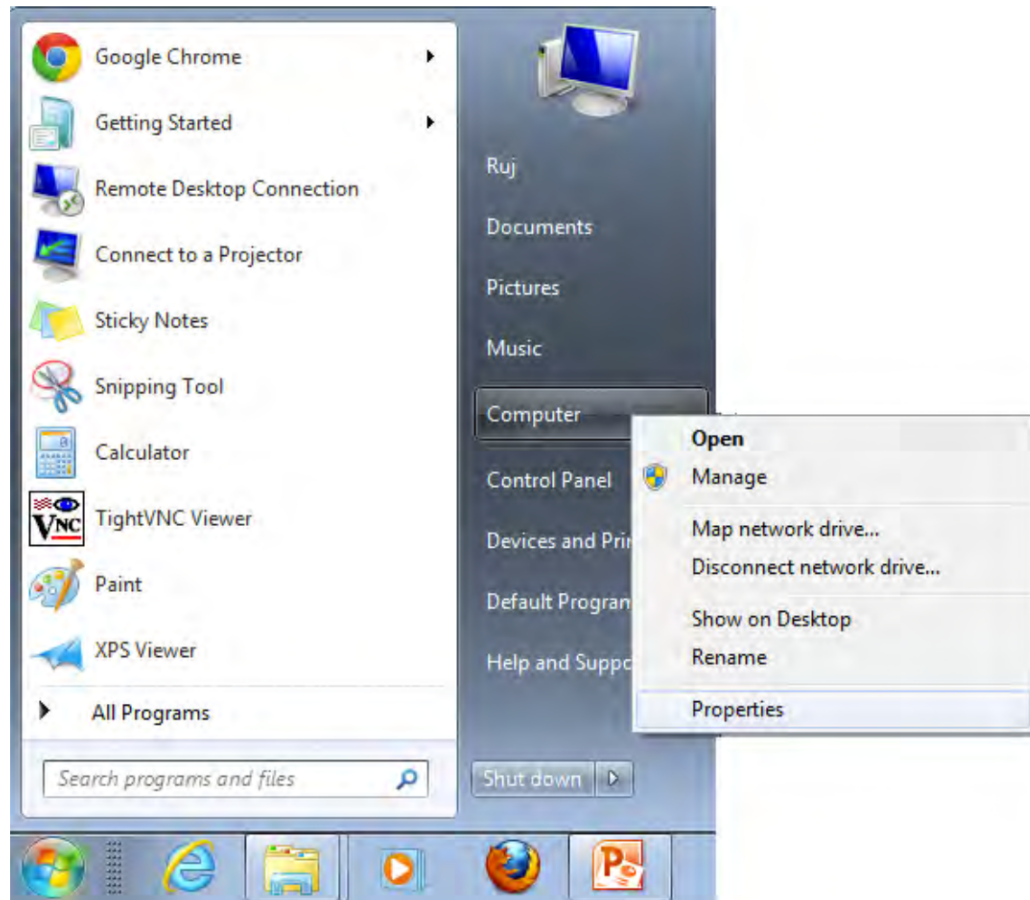
# Know Your Computer (2)

Click for more detail
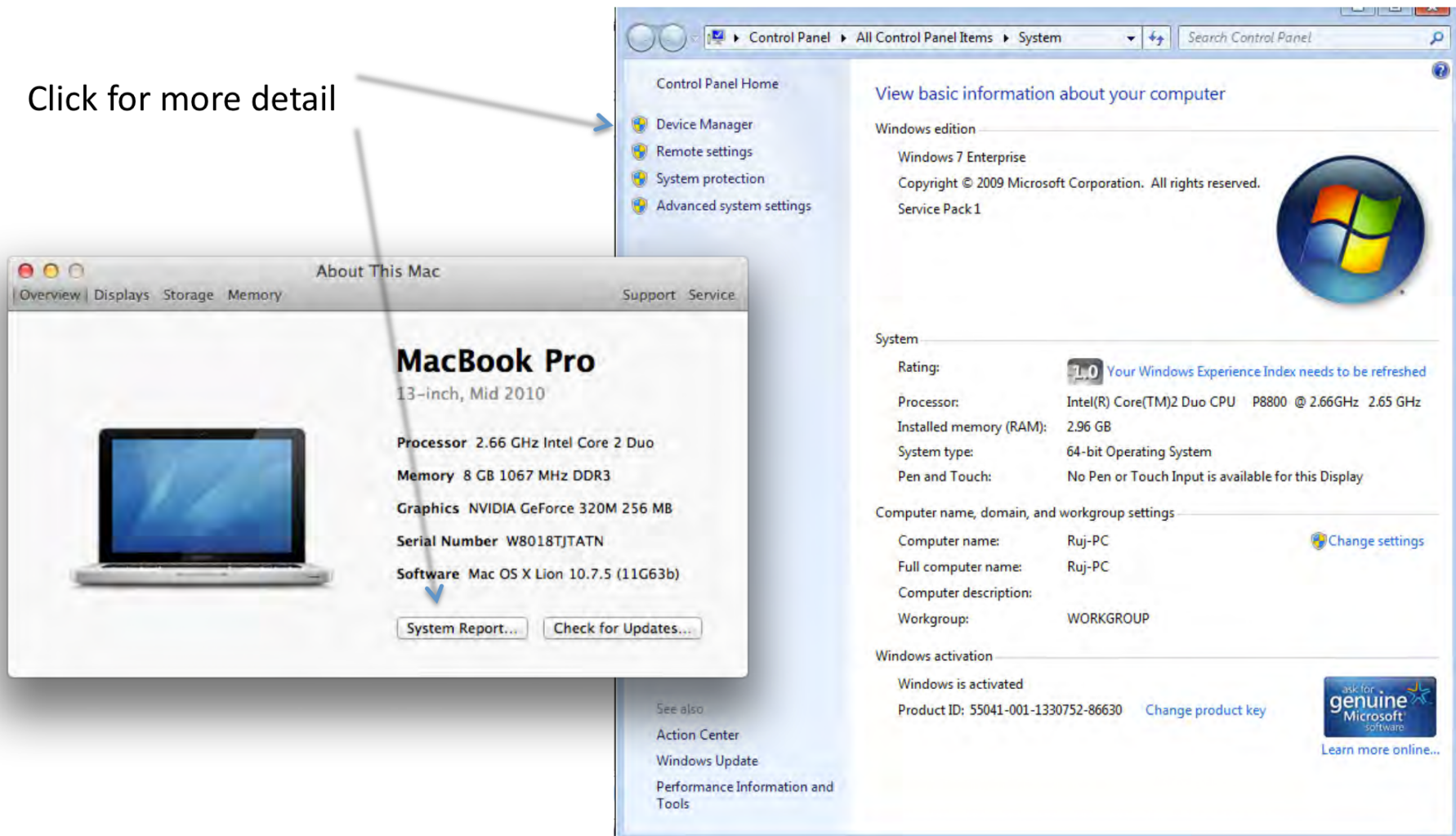
# Know Your Computer (3)

# Know Your Computer (4)

# Computer Box

**EXPANSION CARD**
Used to connect peripheral devices or add new capabilities to a computer system.

**EXPANSION SLOTS**
Connect expansion cards to the mother-board to add addi-tional capabilities.

**MOTHERBOARD**
Connects all compo-nents of the computer system; the PC's main circuit board.

**CPU**
Performs the calculations and does the comparisons needed for processing, and controls the other parts of the computer system.

**POWER SUPPLY**
Converts standard electrical power into a form the computer can use.

**FAN**
Cools the CPU and other important components.

**HARD DRIVE**
Stores data and programs; the principal storage device for most PCs.

**STORAGE BAYS**
Hold storage devices, such as the floppy, DVD, and hard drives shown here.

**DVD DRIVE**
Accesses data stored on CDs or DVDs.

**FLOPPY DRIVE**
Accesses data stored on floppy disks.

**MEMORY (RAM) MODULES**
Store data temporarily while you are working with it.

**MEMORY SLOTS**
Connect memory modules to the motherboard.

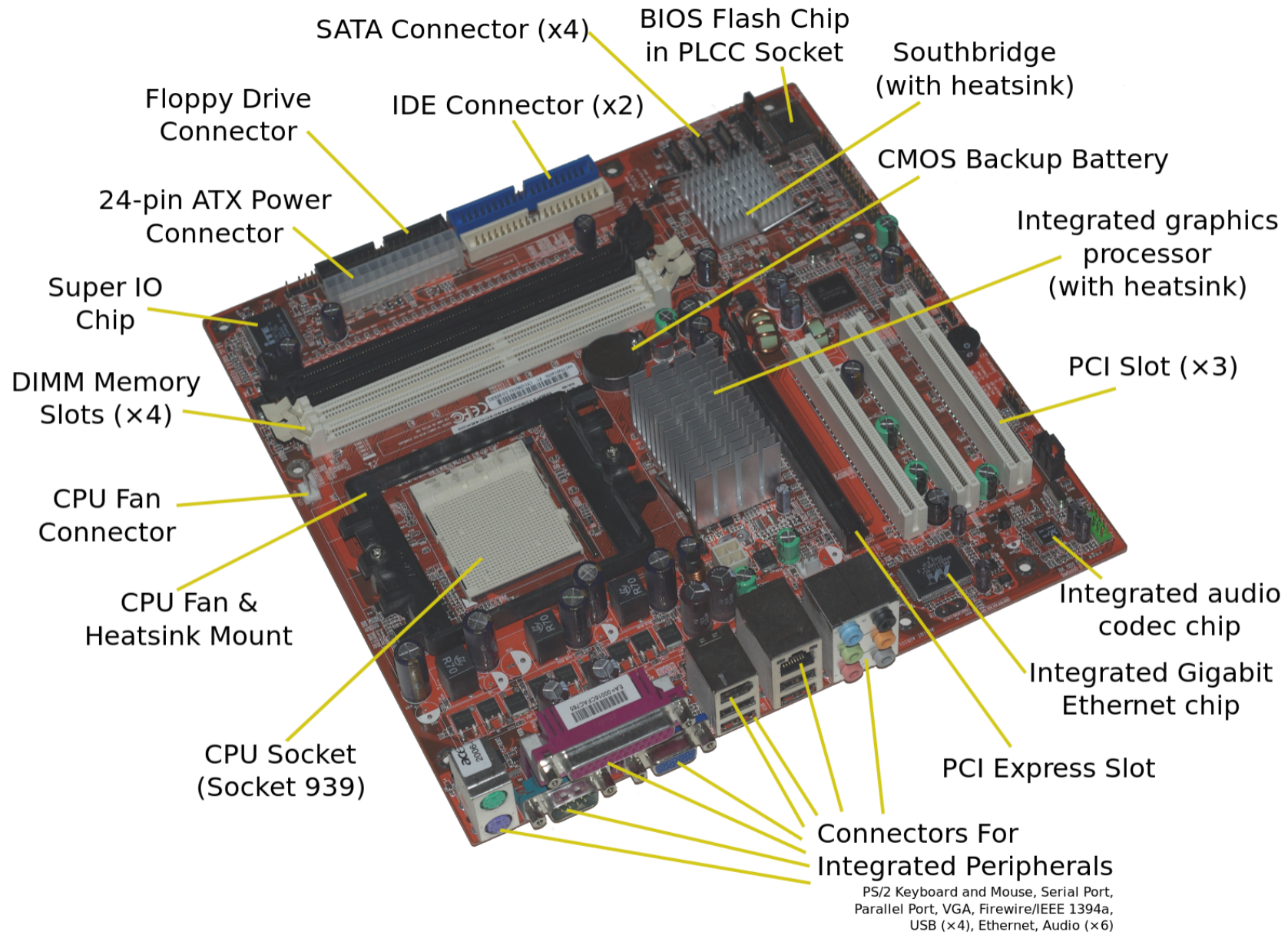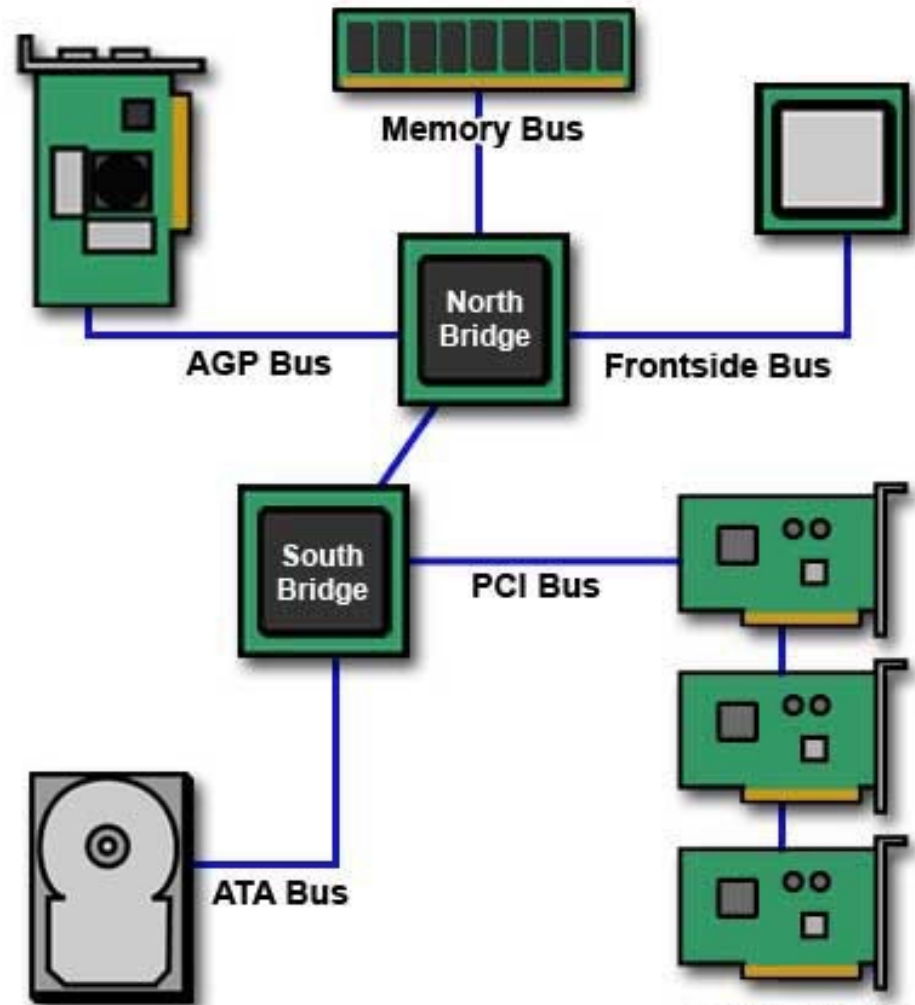# Motherboard (1)

- Motherboard or Mainboard is the central part of a computer.

- Everything connects to the mother board.

- Famous brands: Asus, Gigabyte, MSI, ASRock and etc.

# Motherboard (2)



SATA Connector (x4)

BIOS Flash Chip
in PLCC Socket

Southbridge
(with heatsink)

Floppy Drive
Connector

IDE Connector (x2)

CMOS Backup Battery

24-pin ATX Power
Connector

Integrated graphics
processor
(with heatsink)

Super IO
Chip

PCI Slot (×3)

DIMM Memory
Slots (×4)

CPU Fan
Connector

CPU Fan &
Heatsink Mount

Integrated audio
codec chip

Integrated Gigabit
Ethernet chip

CPU Socket
(Socket 939)

PCI Express Slot

Connectors For
Integrated Peripherals

PS/2 Keyboard and Mouse, Serial Port,
Parallel Port, VGA, Firewire/IEEE 1394a,
USB (×4), Ethernet, Audio (×6)

# Motherboard (3)



Memory Bus

AGP Bus

North Bridge

Frontside Bus

South Bridge

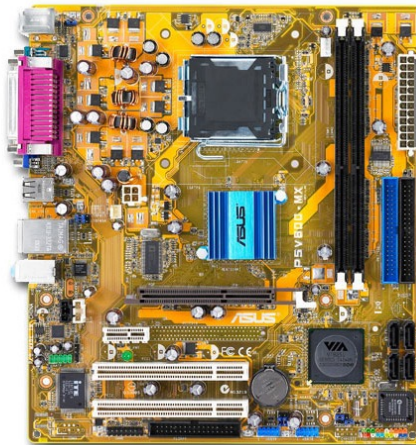PCI Bus

ATA Bus

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# Form Factor

The form factor is the specification of a motherboard – the dimensions, power supply type, location of mounting holes, number of ports on the back panel, etc.



Standard-ATX

Micro-ATX

Mini-ITX

Nano-ITX

Pico-ITX

# Central Processing Unit (CPU)

- Central Processing Unit (CPU)
- Does the most of processing for a computer
- Also called a processor or a microprocessor
- Dual-core, Quad-core CPU
  - Pack 2/4 CPUs in one chip (Like having 2/4 computers)
- Often made by Intel or AMD
  - AMD is backing out from desktop and notebook
  - ARM is majority for mobile device (Phone, Pad). Now coming into desktop and notebook market.

# CPU Names and Terminologies

- CPU Names
  - Intel Core i3, i5, i7
  - Intel Xenon
  - AMD Opteron
  - ARM
- Terminologies
  - Number of Cores
  - Number of Threads
  - Clock Speed
  - Cache
  - Turbo Boost.

# Intel Core i3, i5, and i7

| Model | Core i3 | Core i5 | Core i7 |
|---|---|---|---|
| Number of cores | 2 | 4 | 4 |
| Hyper-threading | Yes | No | Yes |
| Turbo boost | No | Yes | Yes |
| K model | No | Yes | Yes |

# How the CPU Works (1)

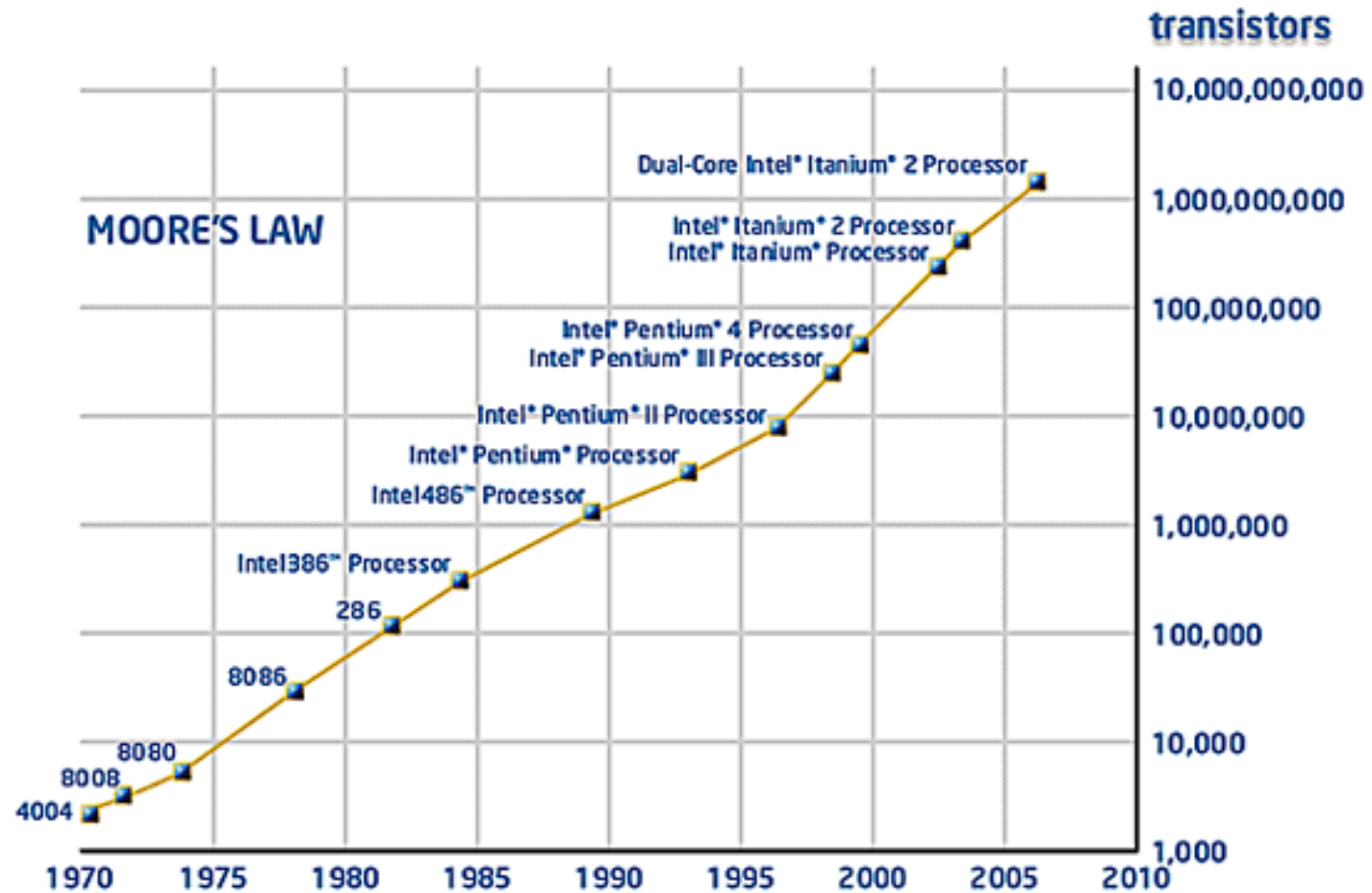- CPU: Consists of a variety of circuitry and components packaged together
  - Transistor: Key element of the microprocessor
  - Made of semi-conductor material that acts like a switch controlling the flow of electrons inside a chip
- Today's CPUs contain hundreds of millions of transistors; the number doubles about every two years (Moore's Law)
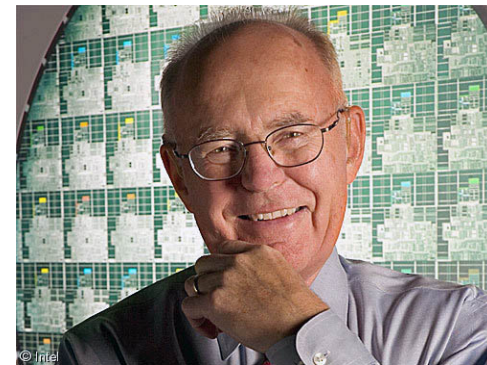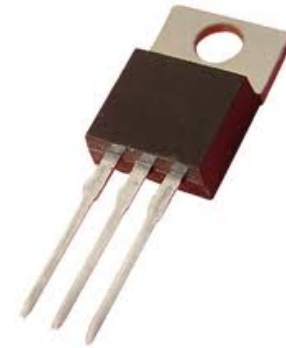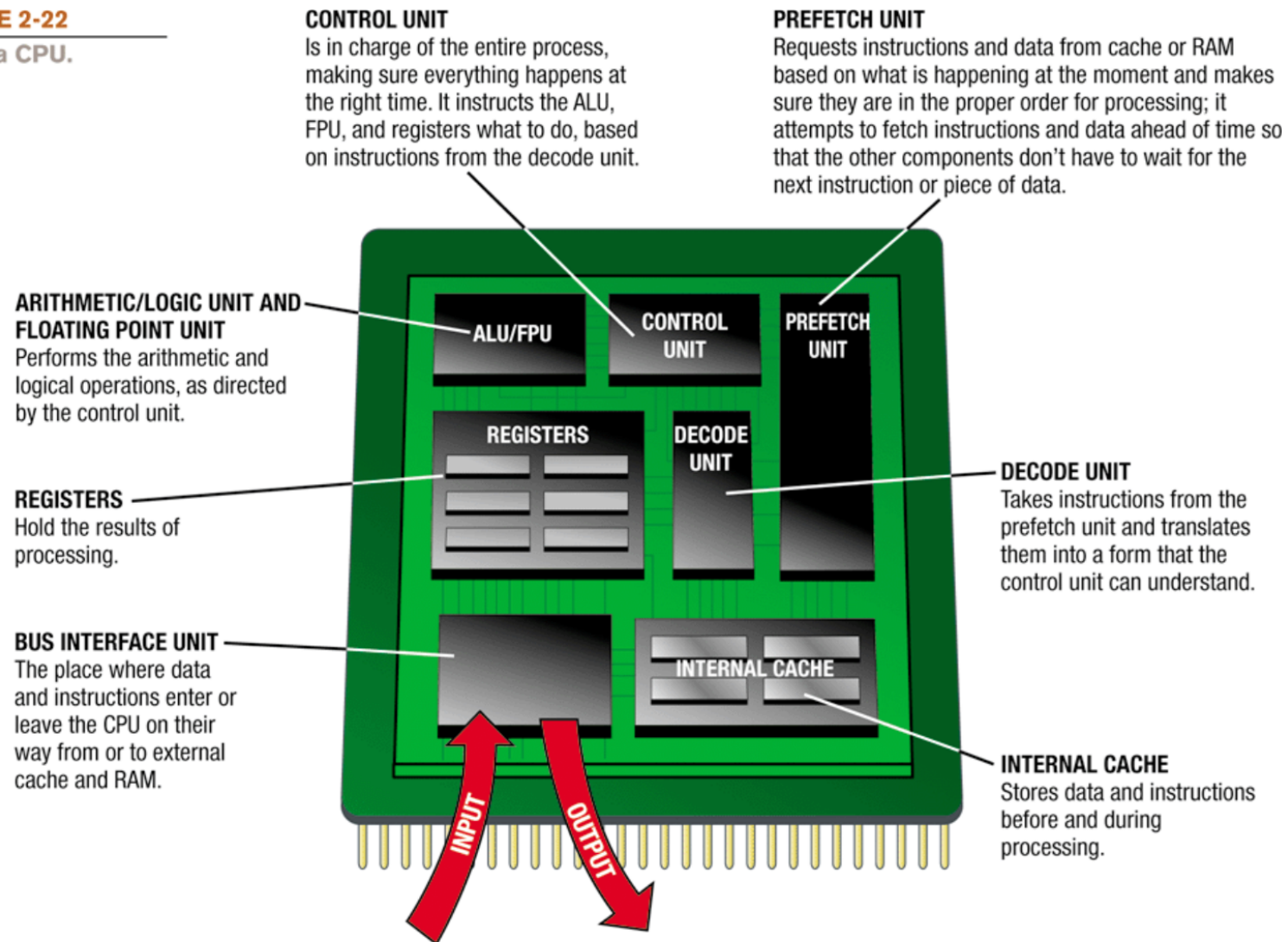




Gordon Moore
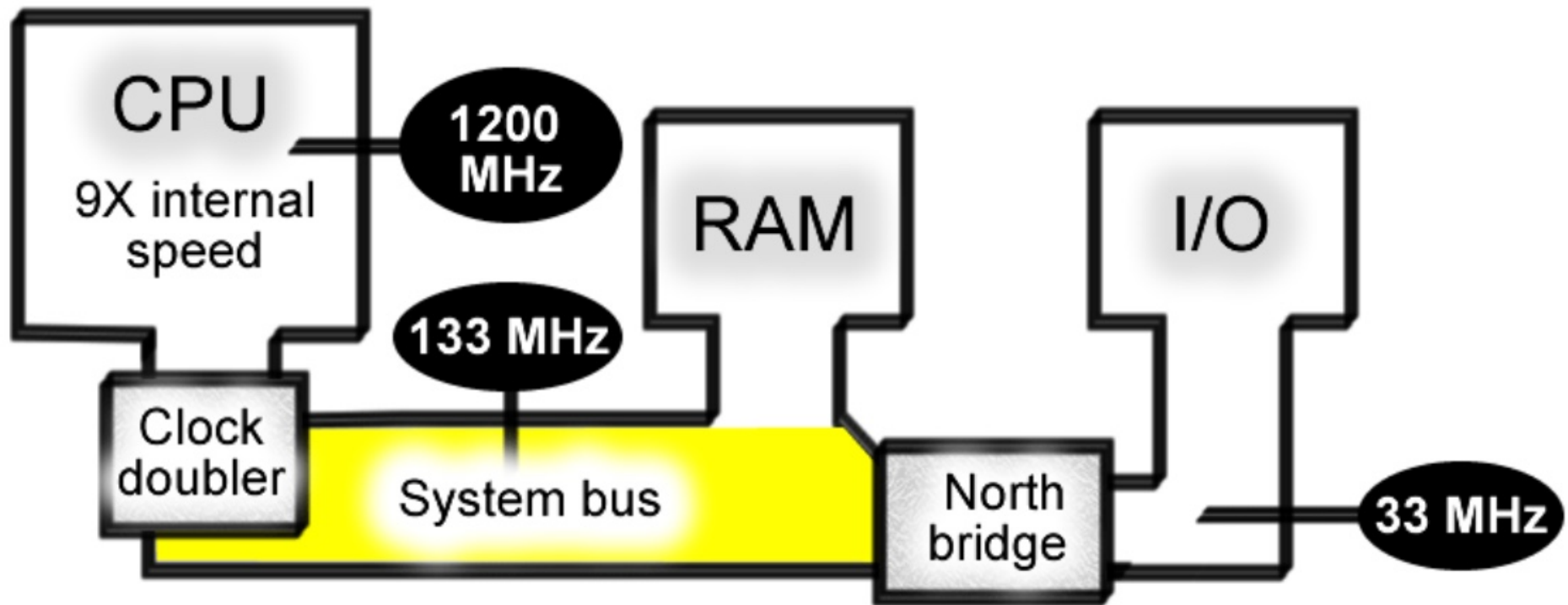Co-Founder of Intel

# How the CPU Works (2)

# Typical CPU Components



**FIGURE 2-22**
Inside a CPU.

**CONTROL UNIT**
Is in charge of the entire process, making sure everything happens at the right time. It instructs the ALU, FPU, and registers what to do, based on instructions from the decode unit.

**PREFETCH UNIT**
Requests instructions and data from cache or RAM based on what is happening at the moment and makes sure they are in the proper order for processing; it attempts to fetch instructions and data ahead of time so that the other components don't have to wait for the next instruction or piece of data.

**ARITHMETIC/LOGIC UNIT AND FLOATING POINT UNIT**
Performs the arithmetic and logical operations, as directed by the control unit.

**REGISTERS**
Hold the results of processing.

**BUS INTERFACE UNIT**
The place where data and instructions enter or leave the CPU on their way from or to external cache and RAM.

**DECODE UNIT**
Takes instructions from the prefetch unit and translates them into a form that the control unit can understand.

**INTERNAL CACHE**
Stores data and instructions before and during processing.

ALU/FPU

CONTROL UNIT

PREFETCH UNIT

REGISTERS

DECODE UNIT

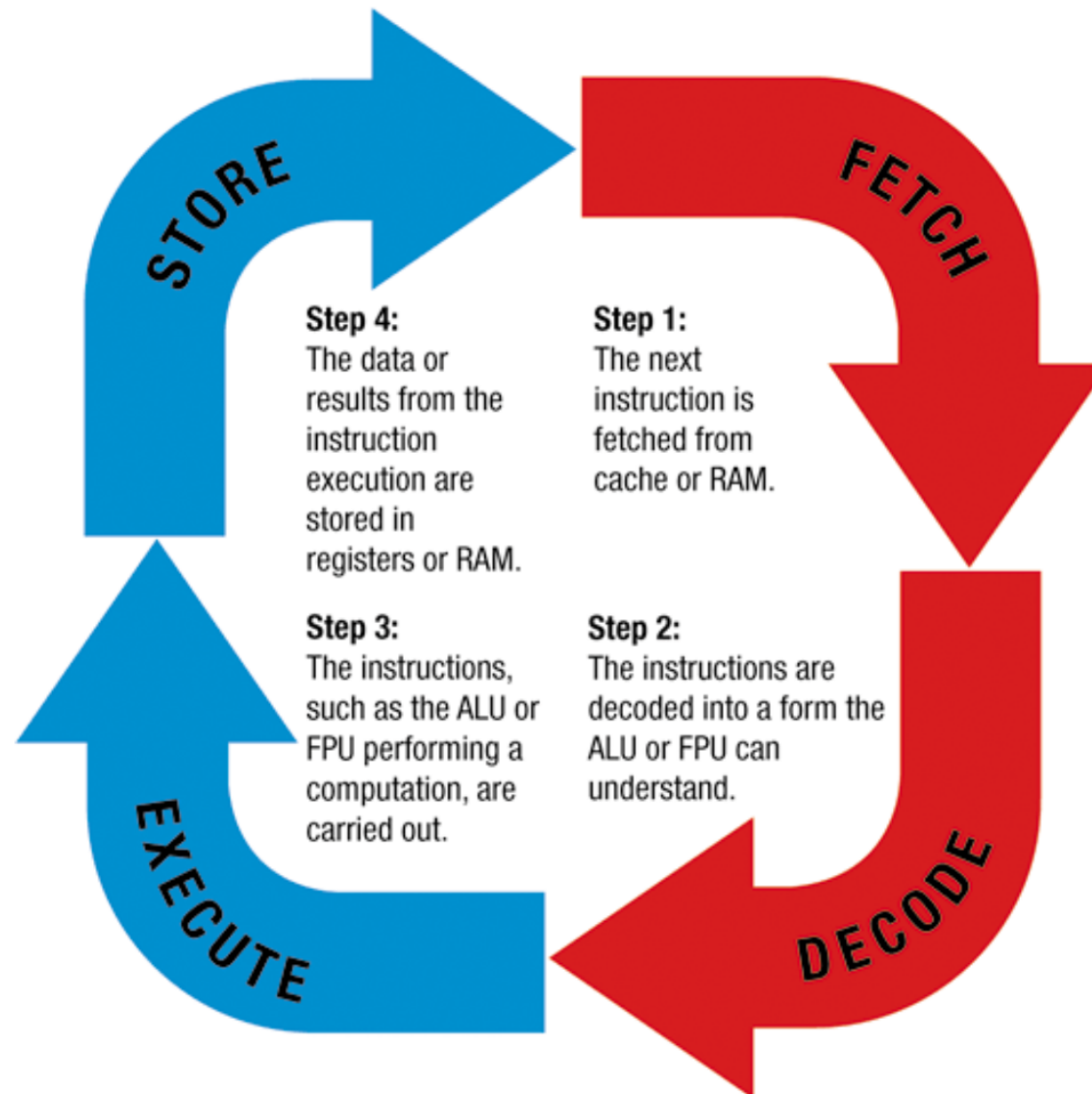INTERNAL CACHE

INPUT

OUTPUT

# Clock Speed

- A computer's system clock resides on the mother board.

- It sends out a signal to all other computer components in sync.

- Every action in the computer is timed by these clock cycles and takes a certain number of cycle to perform.
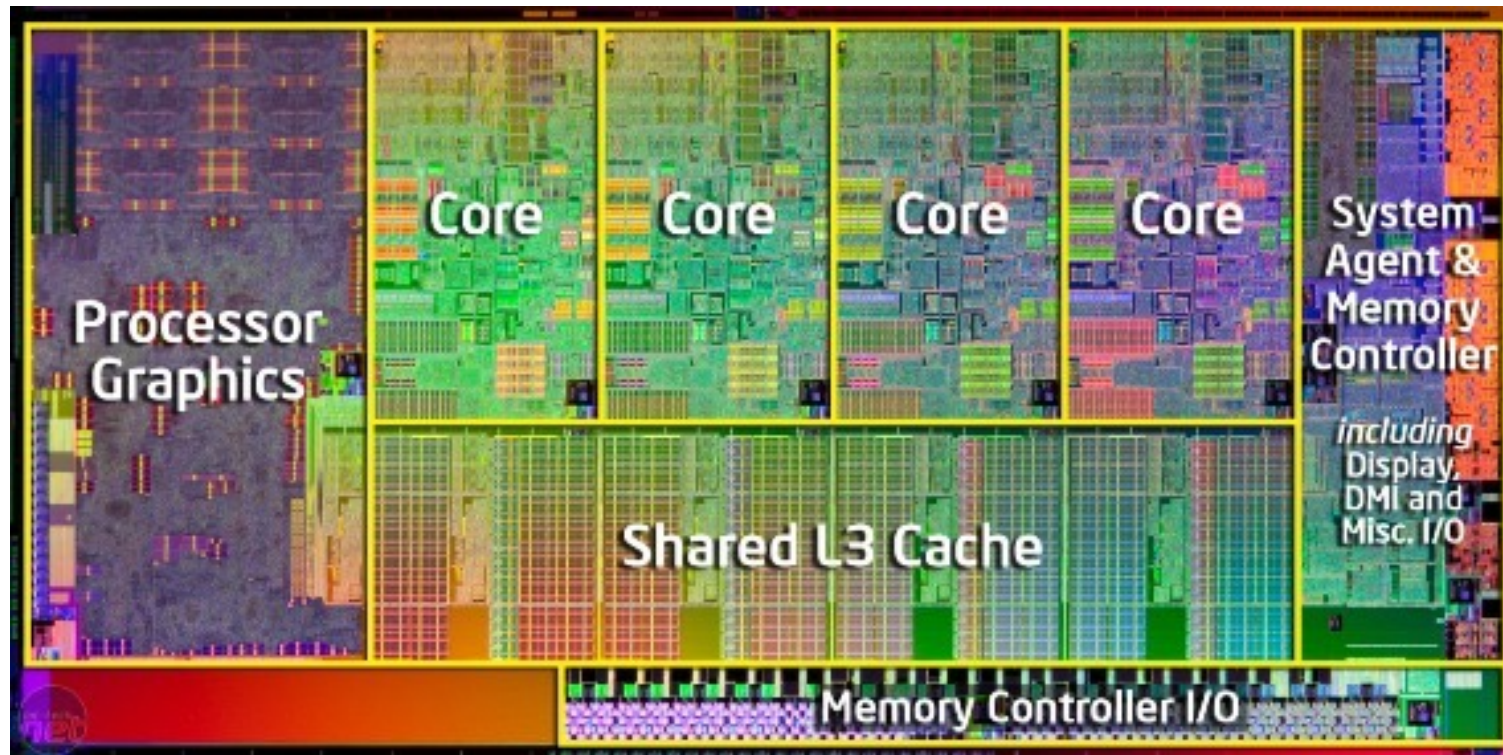
# The System Clock and the Machine Cycle (1)



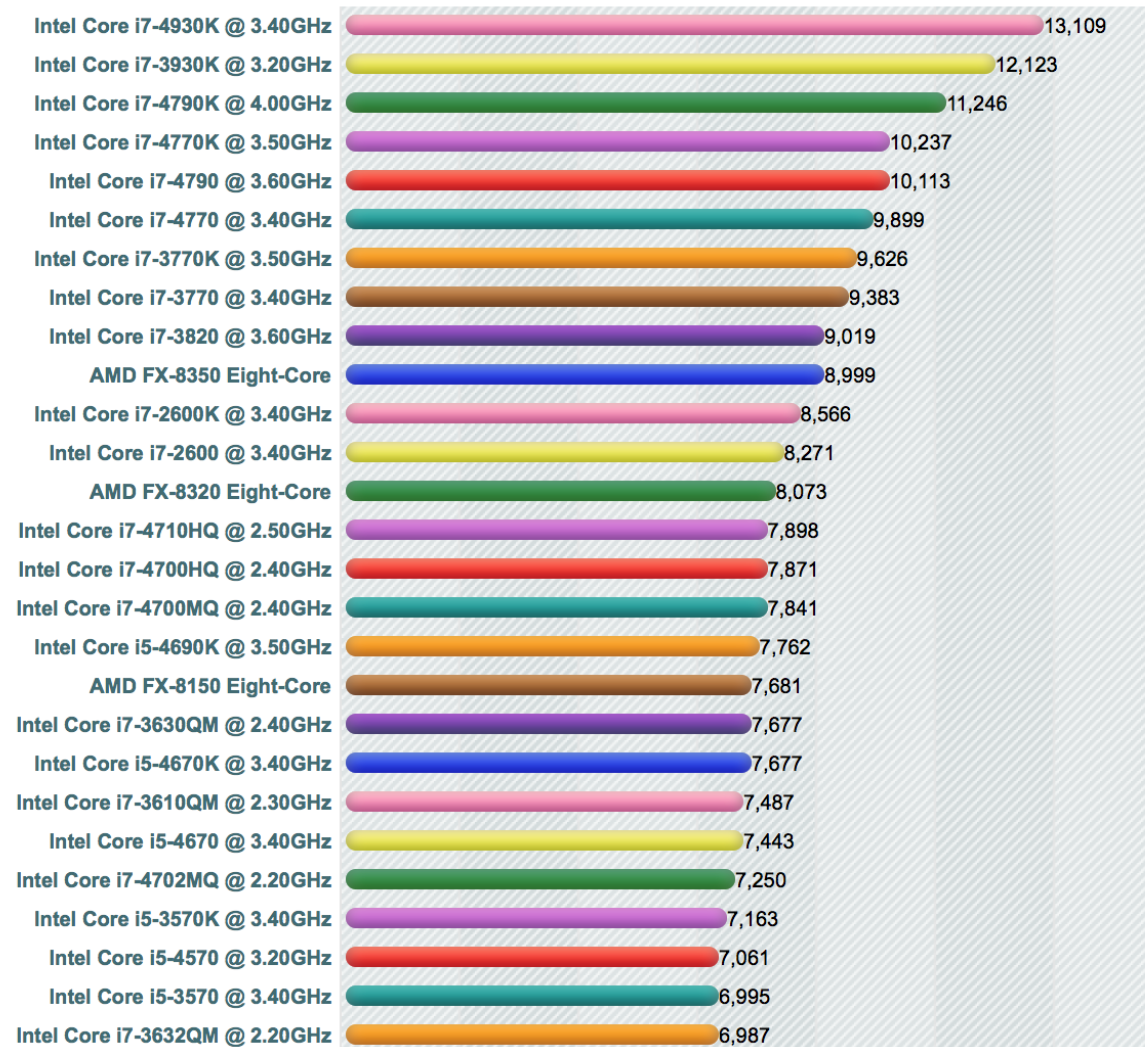The bus system for a Pentium III processor.

# The System Clock and the Machine Cycle (2)



**STORE**

**FETCH**

**EXECUTE**

**DECODE**

**Step 4:**
The data or results from the instruction execution are stored in registers or RAM.

**Step 1:**
The next instruction is fetched from cache or RAM.

**Step 3:**
The instructions, such as the ALU or FPU performing a computation, are carried out.

**Step 2:**
The instructions are decoded into a form the ALU or FPU can understand.

# Inside CPU

# Performance

| CPU | Score |
|-----|------:|
| Intel Core i7-4930K @ 3.40GHz | 13,109 |
| Intel Core i7-3930K @ 3.20GHz | 12,123 |
| Intel Core i7-4790K @ 4.00GHz | 11,246 |
| Intel Core i7-4770K @ 3.50GHz | 10,237 |
| Intel Core i7-4790 @ 3.60GHz | 10,113 |
| Intel Core i7-4770 @ 3.40GHz | 9,899 |
| Intel Core i7-3770K @ 3.50GHz | 9,626 |
| Intel Core i7-3770 @ 3.40GHz | 9,383 |
| Intel Core i7-3820 @ 3.60GHz | 9,019 |
| AMD FX-8350 Eight-Core | 8,999 |
| Intel Core i7-2600K @ 3.40GHz | 8,566 |
| Intel Core i7-2600 @ 3.40GHz | 8,271 |
| AMD FX-8320 Eight-Core | 8,073 |
| Intel Core i7-4710HQ @ 2.50GHz | 7,898 |
| Intel Core i7-4700HQ @ 2.40GHz | 7,871 |
| Intel Core i7-4700MQ @ 2.40GHz | 7,841 |
| Intel Core i5-4690K @ 3.50GHz | 7,762 |
| AMD FX-8150 Eight-Core | 7,681 |
| Intel Core i7-3630QM @ 2.40GHz | 7,677 |
| Intel Core i5-4670K @ 3.40GHz | 7,677 |
| Intel Core i7-3610QM @ 2.30GHz | 7,487 |
| Intel Core i5-4670 @ 3.40GHz | 7,443 |
| Intel Core i7-4702MQ @ 2.20GHz | 7,250 |
| Intel Core i5-3570K @ 3.40GHz | 7,163 |
| Intel Core i5-4570 @ 3.20GHz | 7,061 |
| Intel Core i5-3570 @ 3.40GHz | 6,995 |
| Intel Core i7-3632QM @ 2.20GHz | 6,987 |

* https://www.cpubenchmark.net/common_cpus.html

# 32 bits and 64 bits

- It's the size of number a processor can process or address.

- 32 bits limit 4,294,967,296

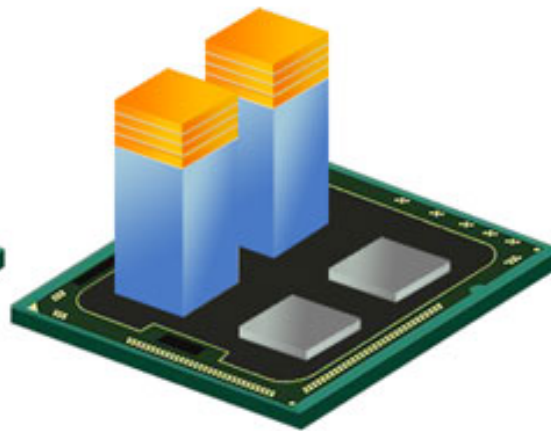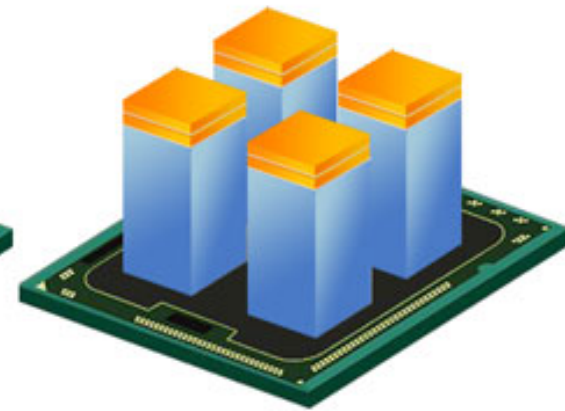- 64 bits limit $1.84467441 \times 10^{19}$
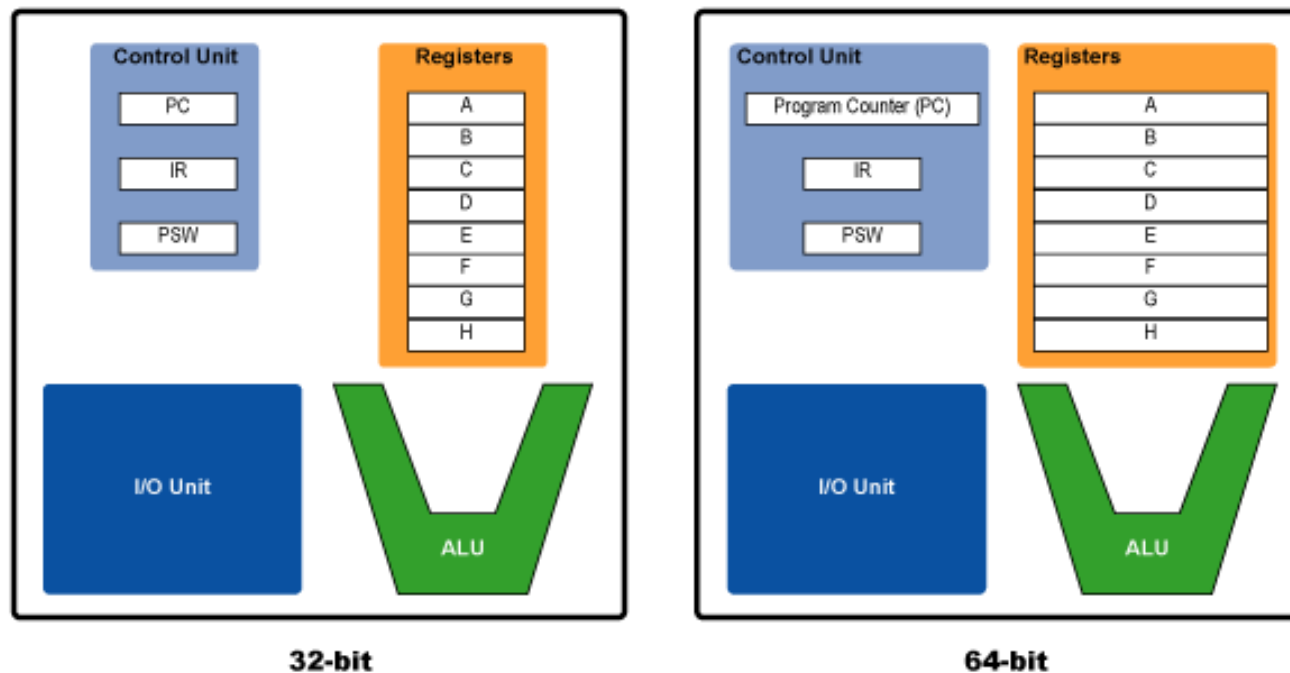
# Core/Thread

- More core = more work can be done at the same time.
- More thread = more work can be done at the same time (but with slight limitation)
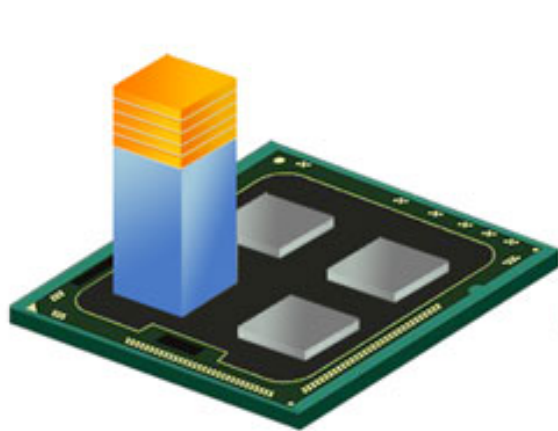


Single-Threaded Workload < TDP
*Near zero power for inactive cores*

Lightly-Threaded Workload < TDP

Highly Threaded Workload < TDP

Multithreading in one core

# Cache

- Faster memory inside CPU.

- Bigger usually better.

- L1, L2, L3 Cache

  - L1>L2>L3>RAM

- CPU Cache, Disk Cache, Web Cache, and Other Cache

# Expansion Slots

- Expand functionality of the computer.

- Graphic Card -> Better graphic or more display

- Sound Card -> Better sound

- Network Card -> More/Faster network connections

- Controller Card -> Control Robot and etc.

- Many type

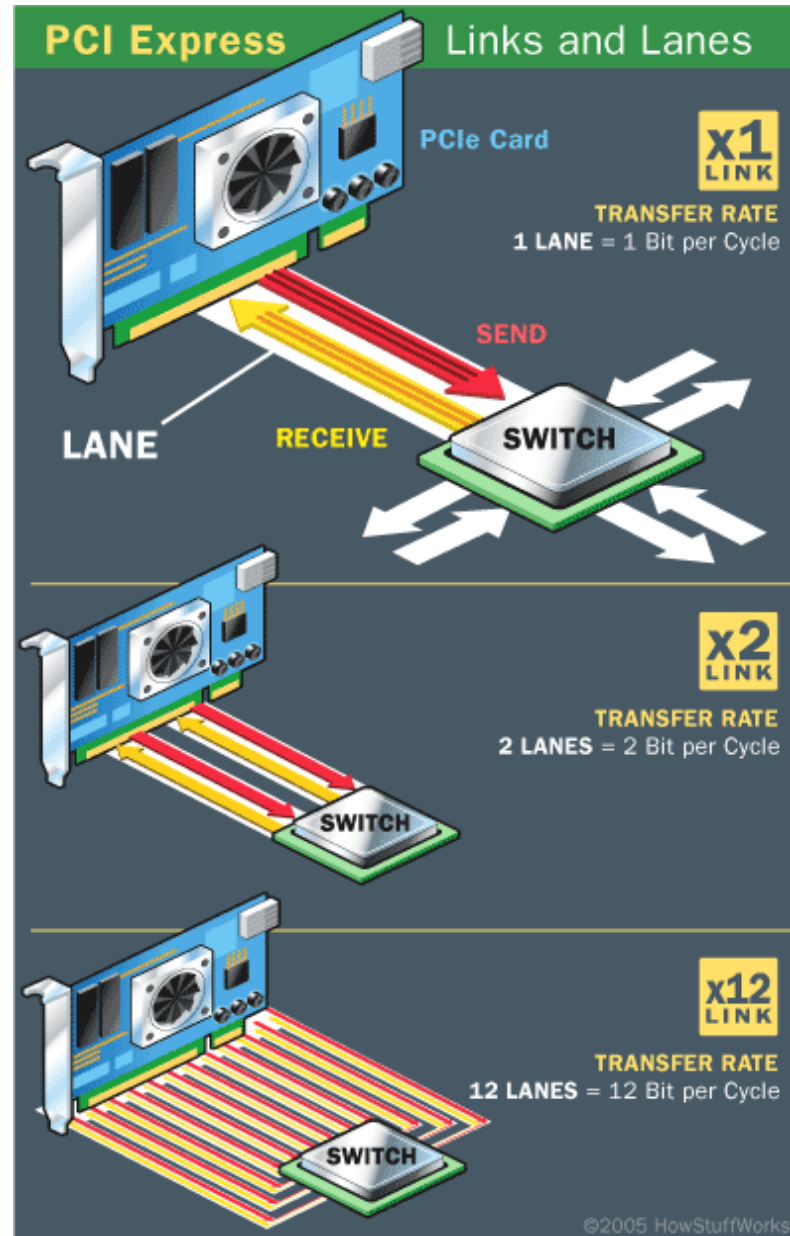    - ISA, EISA, PCI, PCIe (PCI-E)

- Current trend = PCIe (PCI Express)

# PCI Express

- A single PCI Express lane can handle 200 MB of traffic in each direction per second.
- A x16 can handle 6.4 GB of data per second in each direction.
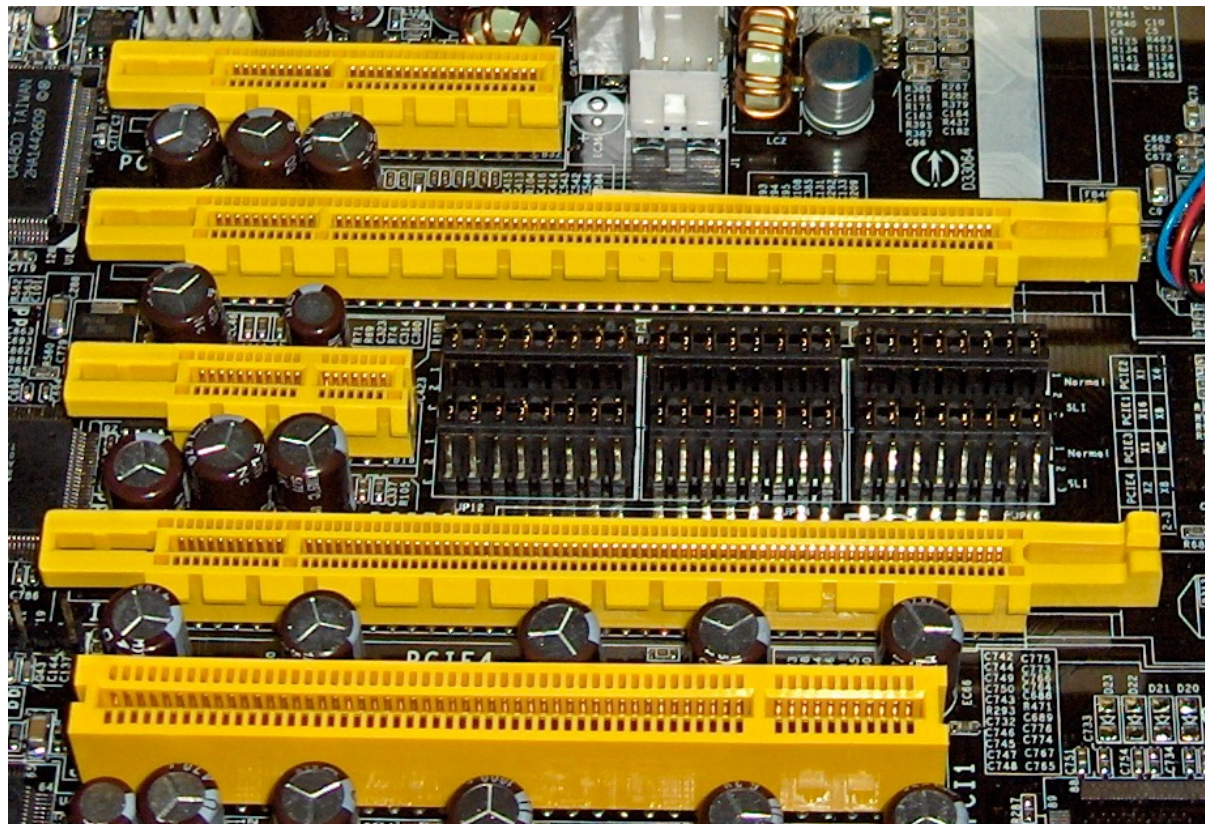


From top to bottom: PCI Express ×4 PCI Express ×16 PCI Express ×1 PCI Express ×16 Legacy PCI (32-bit)
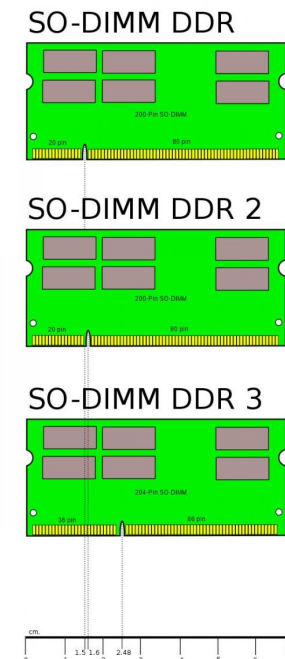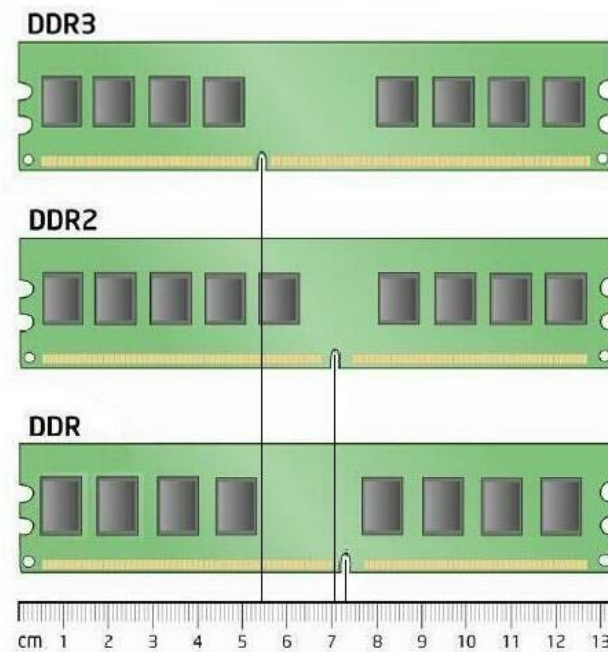
# PCI Express Links and Lanes

# Memory (1)

- Short term memory to help working
- Must be supported by motherboard and CPU
  - Double Data Rate Synchronous Dynamic Random-Access Memory (DDR SDRAM) is a class of memory integrated circuits used in computers.
  - Small Outline Dual In-line Memory Module (SODIMM) is a type of computer memory. SODIMM is often used in systems that have limited space, such as notebooks, small footprint PCs (such as those with a Mini-ITX motherboard)
- More is better. (current good spot is 8 GB)

# Memory (2)

| DDR SDRAM Standard | Bus clock (MHz) | Internal rate (MHz) | Prefetch (min burst) | Transfer Rate (MT/s) | Voltage | DIMM pins | SO-DIMM pins | MicroDIMM pins |
|---|---|---|---|---|---|---|---|---|
| DDR | 100–200 | 100–200 | 2n | 200–400 | 2.5/2.6 | 184 | 200 | 172 |
| DDR2 | 200–533⅓ | 100–266⅔ | 4n | 400–1066⅔ | 1.8 | 240 | 200 | 214 |
| DDR3 | 400–1066⅔ | 100–266⅔ | 8n | 800–2133⅓ | 1.5 | 240 | 204 | 214 |
| DDR4 | 1066⅔–2133⅓ | 100–266⅔ | 8n | 2133⅓–4266⅔ | 1.05/1.2 | 288 | 256 | — |

# Hard Drive / Hard Disk (1)

- Permanent Storage for your computer

- Talk more next time. (Data In and Data Out)

- The bigger size the better (TB>GB>MB)

- Two types
  - Solid State Drive (SSD)
    - Expensive
    - Durable
    - Fast
  - Spinning Disk
    - Cheap
    - Not so durable
    - Slower

# Hard Drive / Hard Disk (2)

- Spin Speed
  - More is faster
  - More is expensive
- Interface
- SATA (Serial ATA)
  - SATA1, SATA2, SATA3
  - Faster
- IDE (Integrated Drive Electronics) or PATA (Parallel-ATA)
  - Older + Slower

# Network

- Detail later.
- For now there are 3 speeds
  - 10 Mb/s, 100 Mb/s and 1000 Mb/s
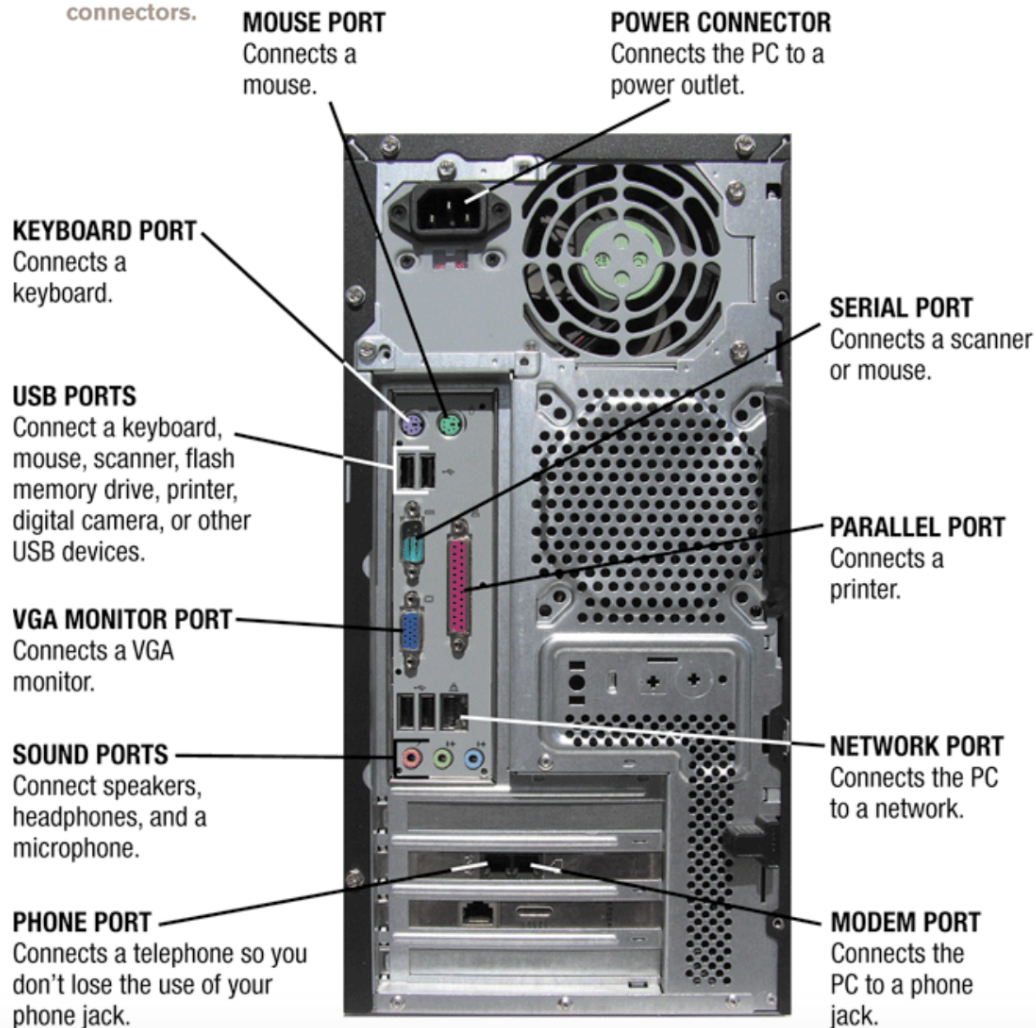- No big difference with network card brand.

# Graphics Card

- Additional card can be add to improve display quality.

- **Nvidia** and **ATi** are main players
  - They make chips then other companies use their chips to make a graphic card.

# Ports and Connectors



**FIGURE 2-17**
Typical ports found on the back of a desktop PC and examples of connectors.

**MOUSE PORT**
Connects a mouse.

**POWER CONNECTOR**
Connects the PC to a power outlet.

**KEYBOARD PORT**
Connects a keyboard.

**SERIAL PORT**
Connects a scanner or mouse.

**USB PORTS**
Connect a keyboard, mouse, scanner, flash memory drive, printer, digital camera, or other USB devices.

**PARALLEL PORT**
Connects a printer.

**VGA MONITOR PORT**
Connects a VGA monitor.

**SOUND PORTS**
Connect speakers, headphones, and a microphone.

**NETWORK PORT**
Connects the PC to a network.

**PHONE PORT**
Connects a telephone so you don't lose the use of your phone jack.

**MODEM PORT**
Connects the PC to a phone jack.

**CONNECTORS**

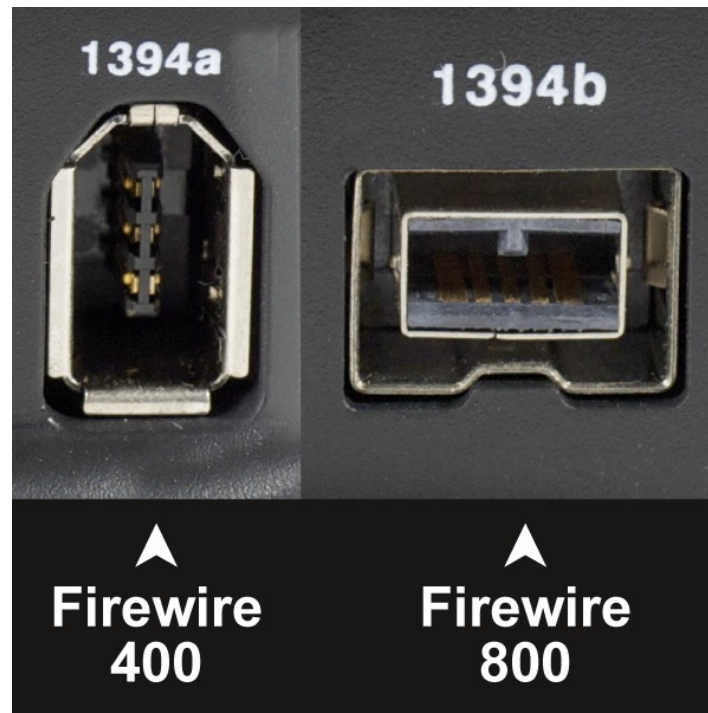| | |
|---|---|
| | USB |
| | FireWire |
| | PS/2 (for mouse or keyboard) |
| | Serial (DB-9) |
| | Monitor (VGA) |
| | Parallel |
| | Telephone (for modem and telephone) |
| | Network (RJ-45) |

# USB (Universal Serial Bus)

- Universal Serial Bus

- USB 1 – 12 Mb/s or 1.5 Mb/s

- USB 2 (High Speed USB) – 480 Mb/s

- USB 3 (Super Speed USB) – 5 Gb/s
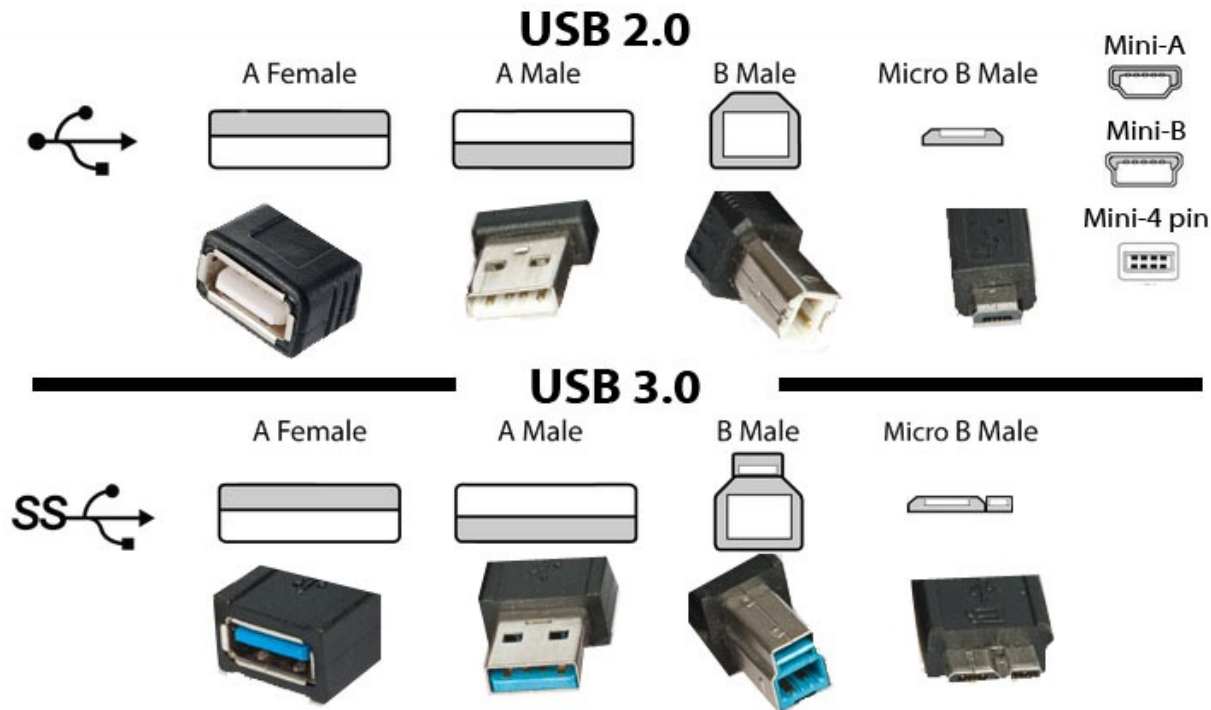
# FireWire / IEEE 1394

- Initiated by Apple
- 400 - 3200 Mbps
- Could not compete with USB in low-end market

# Thunderbolt

- Intel Product
- Marketed by Apple
- Speed: 10 Gbps
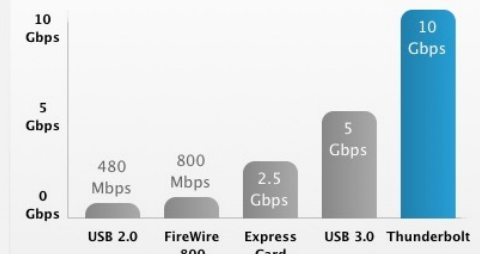- Transfer both data and display
- Compatible with Mini Display



Thunderbolt pairs Intel's PCI Express interconnect with DisplayPort on the same connector.

The new standard delivers bidirectional support for data speeds up to 10Gbps

AppleInsider.com

High-Speed I/O Performance

| | USB 2.0 | FireWire 800 | Express Card | USB 3.0 | Thunderbolt |
|---|---|---|---|---|---|
| | 480 Mbps | 800 Mbps | 2.5 Gbps | 5 Gbps | 10 Gbps |

# VGA (Video Graphics Array)

- First introduced with the IBM PS/2 line of computers in 1987.

- Most common monitor connection.

- Analog Signal (Easy to get noise)
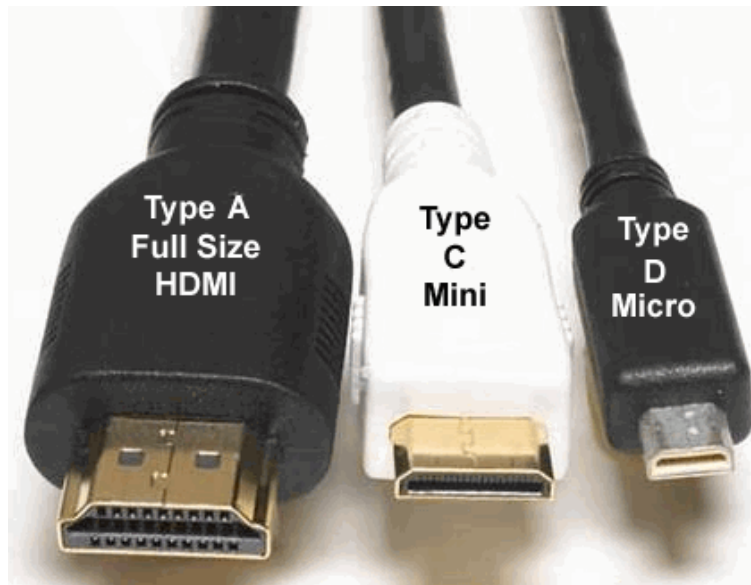
- Display only.

# DVI (Digital Visual Interface)

- Common among new monitors.

- Digital Signal (Only some supports Analog)

- Display only
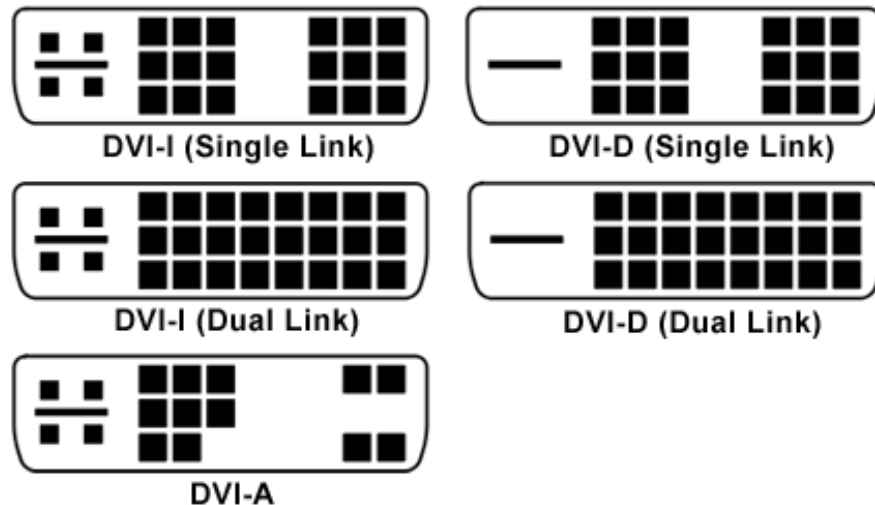
# HDMI (High-Definition Multimedia Interface)

- Found on all new TV

- Display and Sound

- New version includes network data

# Power Supply / UPS

- Need enough power (watt) to run
- Check here …
    - http://powersupplycalculator.net
- UPS (Uninterruptible Power Supply)
    - Form Factor - Tower or Rack-Mount
    - Power Factor (PF)
    - Watt = VA x PF

# Fans, Heat Sinks, and Other Cooling Components

- Heat: A continuing problem for CPU and computer manufacturers.

- Cooling costs more than computing.

- Fans: Used on most PCs

- Heat sinks: Small components typically made out of aluminium with fins that help to dissipate heat

- Water cooling systems: Cool the PC with liquid-filed tubes

# Fans, Heat Sinks, and Other Cooling Components



Fans on the back of the system unit

Fan on top of the CPU

Water cooling tubes
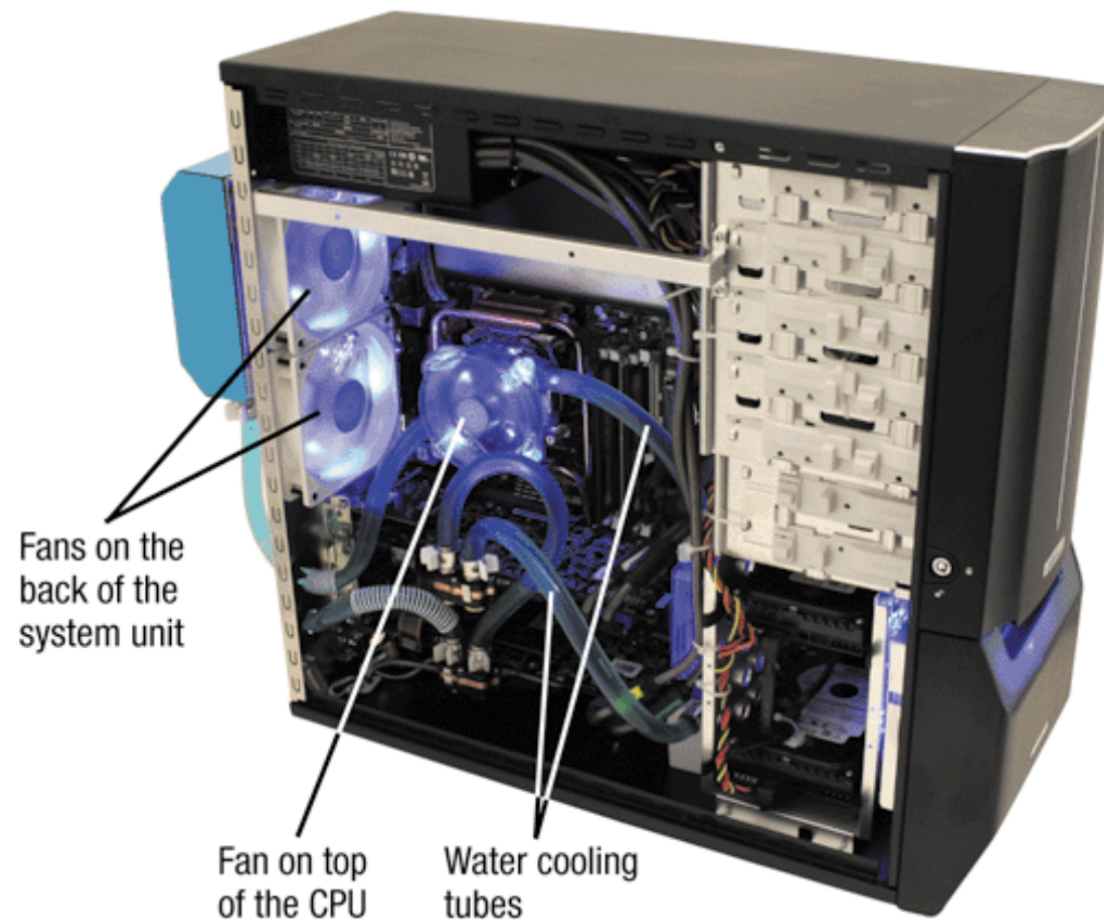
**FANS AND WATER COOLING SYSTEMS**
These cooling methods and heat sinks are used with computers today.

# Want Faster Computer

- Better Hard Disk
  - SSD / Faster
- Better RAM
  - More / Faster
- Better Graphic Card
  - Only when you play 3D game.
- Better CPU
  - If you have money to spare. Not so important

# Assignment 1

- ให้นักศึกษาแต่ละกลุ่มลองหาข้อมูลของคอมพิวเตอร์ของคุณว่ามีคุณสมบัติอย่างไรบ้าง
  - CPU
  - Memory
  - Hard Disk
  - Video Card
  - Operating System
  - Ports
- หาข้อมูลดังกล่าวมา 2 เครื่องและลองเปรียบเทียบกันว่าถ้านำทั้ง 2 เครื่องมาประมวลผลทางคณิตศาสตร์ (อย่างเช่นโปรแกรม MatLab หรือ Mathematica) เครื่องใดควรจะทำงานได้มีประสิทธิภาพมากกว่ากัน
- ตอบคำถามดังกล่าวในเว็บไซต์ของรายวิชา EGCO342