Introduction To Computer Hardware

In this section of notes you will learn what are the basic parts of a computer and how they work.

High Level View Of A Computer

[Diagram showing the high level view of a computer with blocks labeled Memory, Input, Processor, Output, and Storage, with arrows connecting them to show the flow of information.]
Buses

• Connect the different parts of the computer together

Types Of Buses

• Data buses
  - Are used to transmit information to the different parts of the computer

• Address buses
  - Indicate where the information is supposed to go
Basic Units Of Measurement

Bit
- Binary digit
- Smallest unit of measurement
- Two possible values

Byte
- 8 bits

Word
- The word size of a computer is the number of adjacent bits that can be stored and manipulated as a unit
- 32, 64 for home computers, 128 for faster machines or specialized systems
**Input Devices**

- Used by a person to communicate to a computer.
Example Input Devices

- Keyboard
- Mouse
- etc.

How Keyboard Input Works

The electrical impulse is sent via a wired or wireless connection.

**Keyboard:** A key is pressed.

**Keyboard controller:** based on the electrical impulses it determines which key or combination of keys was pressed.

**Keyboard buffer:** stores the keystrokes.

The keyboard controller transmits an interrupt request.

Operating system
How Keyboard Input Works

Operating system:
Q: Is the key combination a (an operating) system level command e.g., <alt>-<ctrl>-<del>?  

Yes  
Execute operating system instruction

No  
Pass the key combination onto current application

Processor

Memory

Input  
Processor  
Output

Storage
**Processor**

• The brains of a computer

![Brain Image](www.howstuffworks.com)

• A common desktop processor

![Desktop Processor Image](www.howstuffworks.com)

**Small Units Of Measurement (Processor And Memory Speed)**

• Millisecond (ms) – a thousandth of a second (1/1,000 = 10⁻³)
• Microsecond (µs) - a millionth of a second (1/1,000,000 = 10⁻⁶)
• Nanosecond (ns) – a billionth of a second (1/1,000,000,000 = 10⁻⁹)
**Processor Speed**

- Determined by:
  1. Type of processor e.g., Intel: Celeron, Pentium; AMD: Athlon, Opteron
  2. Clock speed
     - 1 Hz = 1 pulse is sent out each second (1 second passes between each pulse)
     - 10 Hz = 10 pulses are sent out each second (0.1 seconds passes between each pulse)
     - 25 MHz = 25 million pulses sent out each second (0.000 000 04 seconds between each pulse or 40 ns between pulses)
     - 3.8 Ghz = 3.8 billion pulses sent out each second (0.26 ns between pulses)

---

**The Processor And The Computer**

Image from Peter Norton's Computing Fundamentals (3rd Edition) by Norton P.
Memory

- The processor has a small amount of memory that is fast but very low in capacity

My To-Do List
1. Do laundry
2. Go grocery shopping
3. Walk the dog
4. Buy gift for gf / bf...

Square root
\[(456789) + \frac{x}{y} + \text{Absolute value}\ (10000 / -50)\]
Memory

• It is used as temporary storage for storing information and instructors that won’t fit in the processor but is needed now

Memory: High-Level View

• Storing information in memory is based on bits (on/off state)

  on  OR  off

• Since bits cannot store enough information bits are combined into bytes
Large Units Of Measurement (Memory, Storage)

- Note: powers of two are used because computer memory and storage are based on the basic unit (bit).
- Kilobyte (KB) – a thousand bytes ($1,024 = 2^{10}$)
- Megabyte (MB) - a million ($1,048,576 = 2^{20}$)
- Gigabyte (GB) – a billion ($1,073,741,824 = 2^{30}$)
  ~ A complete set of encyclopedias requires about 700 MB of storage
  ~ 30 minutes of video (~1/4 of the information stored on a typical DVD)
- Terabyte (TB) – a trillion ($1,099,511,627,776 = 2^{40}$)
  ~ 20 million four-drawer filing cabinets full of text
  ~ 200 DVD’s of information

RAM

- Random Access Memory
- Volatile
  - Used for temporary storage
- Typical ranges 256 MB - 4 GB
**RAM (2)**

- Random access means direct access to any part of memory
- A common form of RAM is DRAM (Dynamic RAM)

![Random access means direct access to any part of memory. A common form of RAM is DRAM (Dynamic RAM).](Picture from Computers in your future by Pfaffenberger B)

**How Does DRAM Work?**

- Acts like a leaky bucket

![How Does DRAM Work?](Image from www.howstuffworks.com)
**How Does DRAM Work?**

- Acts like a leaky bucket

[Image of a diagram showing a transistor, capacitor, and a water faucet representing the leakage.]

**DRAM: A Collection Of Capacitors**

- A capacitor

[Image of a conceptual view of DRAM and an actual DRAM memory module.]
The Word Size Of The Computer Determines The Maximum Amount of RAM

Recall
- $2^{30} \approx 1$ billion
- $2^{31} \approx 2$ billion
- $2^{32} \approx 4$ billion

This means that with a 32 bit computer the maximum amount of memory allowable is 4 billion (4 GB).
**Storage Vs. Memory**

**Memory (e.g., RAM)**
- The information stored is needed now
- Keep the information for a shorter period of time (usually volatile)
- Faster
- More expensive
- Low storage capacity (~1/4 of a DVD for 1 GB)

**Storage (e.g., Hard disk)**
- The information stored is not needed immediately
- The information is retained longer (non-volatile)
- Slower
- Cheaper
- Higher storage capacity (~50 DVD’s for 200 GB)

---

**Categories Of Storage**

1. **Magnetic**
   - Floppy disks
   - Zip disks
   - Hard drives

2. **Optical**
   - CD-ROM
   - DVD

3. **Solid state storage devices**
   - USB Key (a very common form of solid state storage)
1. **Magnetic Drives**

1. **Magnetic Drives: Storage Capacities**

- Floppy disks
  - ~1 MB
- Zip disks
  - 100, 250, 750 MB
- Hard drives
  - ~80 GB – 2 TB
2. **Optical Drives**

- Use lasers to store and retrieve information (CD’s and DVD’s)
- **Categories:**
  - Can only read information off the disc (CD-ROM, DVD-ROM)
  - Can read and also record information to the disk (CD-R, DVD-R, DVD+R)
  - Can read, record and also re-write information multiple times (CD-RW, DVD-RW, DVD+RW)
- **Storage capacities:**
  - CD ~ 700 MB
  - DVD ~ 4 GB (drives with much larger capacities are becoming more common)

---

**Optical Drives: Reading Information**

**CD-ROM, DVD-ROM**

- The disc has already been formatted with a pattern of pits vs. smooth sections.
- Pitted sections don’t reflect light.
- Smooth sections remain reflective.
Optical Drives: Recording And Reading Information

CD-R, DVD-R, DVD+R

- Disk starts out smooth, no pits.
- The recording laser burns a pit into the disk.
- The parts of the disk that’s still smooth are reflective.
- The part of the disk that contains a pit is non-reflective.

Optical Drives: Re-Writing

CD-RW, DVD-RW, DVD+RW
Optical Drives: Re-Writing

CD-RW, DVD-RW, DVD+RW

- The disk already has some information recorded on it.
- As before the smooth parts are reflective and the pitted parts are not.
- To erase the disk the pitted parts are made smooth again

3. Solid State Storage Devices

- Portable but can store a large amount of information (256 MB – 16 GB)
3. **Solid State Storage Devices**

- Require no moving parts but instead uses transistors

- Use a pair of transistors to store each bit of information

**Connected:**

- stores ‘1’
- Connected: stores ‘0’

**Disconnected:**

- Transistor
- Transistor

- An electrical current can be used to connect and disconnect the transistors
- The pair transistors will remain in their current state (connected or disconnected) until an electrical charge is applied.

---

**Output**

- Memory
- Input
- Processor
- Output
- Storage
Output Devices

- Displays information from the computer to a person.

The Most Common Output Device: The Monitor

- Common monitor technologies:
  1. CRT (Cathode Ray Tube)
  2. LCD (Liquid Crystal Display)
  3. Plasma displays
How Images Are Drawn On Monitors

• Images and text are drawn with tiny dots (Pixels: Picture elements)
1. **CRT Monitors**

   • The pixels are drawn with light ‘guns’

   ![CRT Monitor Image](image)

2. **LCD Monitors**

   • Employ a conductive grid for each row and column
   • The meeting of a row and column allows light to be emitted (a pixel can be seen)
2. **Colour LCD Monitors**

- Use three sub pixels:
  - One wire for each row
  - One wire for each sub-pixel
  - One colour filter for each colour (red, blue, green)

3. **Plasma Monitors**

- Sub-pixels are “drawn” by passing an electrical current through a gas.
- Again each pixel is formed by three sub-pixels

Images from [www.howstuffworks.com](http://www.howstuffworks.com)
Relating The Speed Of The Computer To Its Components

Storage: Hard drive

Memory: RAM

Processor
**You Should Now Know**

- What are common units of measurement for the computer
- What are the basic parts of the high level view of a computer
- Example input devices
- The role of the processor in a computer
- What determines processor speed
- What are the characteristics of RAM
- How does DRAM work
- The difference between storage and memory
- What are the different categories of storage devices as well as common examples of each
- How do different storage devices work
- The approximate storage capacity of memory and different storage devices
- How do computer monitors work
- How the different hardware components affects the speed of the system