Component 4: Introduction to Information and Computer Science

Unit 3: Computer Hardware & Architecture

Lecture 1

Unit Objectives

- List the major elements of a computer (motherboard, CPU, I/O devices, memory, secondary storage, buses, expansion cards, ports, etc.).
- Describe how data is stored in memory and in secondary storage.
- Describe how data is represented in binary.
- Describe the function of the CPU.
- Describe how data is input/output from the computer.
- Describe how a computer system works together.
- Introduce specialized architectures and embedded systems used in healthcare settings.

What is a Computer?

- An electronic device that receives input and produces output that is useful to people or devices.
- Made up of hardware and software.
- Executes instructions found in software programs.

What is a Computer? (cont'd)

- Computers understand only binary numbers.
- All input is translated into a binary value.
- Output is generally translated from a binary value to a code understood by users (people).
  - Output is sent from one computer to another in binary format.

Computer Hardware Components

- Computer hardware consists of
  - System components
  - Storage devices
  - Input devices
  - Output devices

System Components

- Motherboard
  - Made up of circuitry, chips, and thousands of thin copper wires.
- Central Processing Unit (CPU)
  - The "brain" of the computer that is responsible for all operations.
  - Has its own memory which serves as a 'work area'.
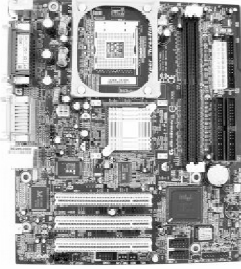 - Modern computers have multiple processors (or cores).

System Components (cont'd)

• A modern motherboard:

Motherboard Ports are…

• Expansion ports on motherboard rear panel:
  – Interface between the computer and an external device.
  – An example is a mouse (PS/2) port, usually colored green.
  – Some expansion ports permit device connection while the computer is running ("hot swappable").

Motherboard Ports are also…

• Expansion cards that plug into motherboard:
  – PCI (peripheral component interface) slots hold expansion cards.
    • An example is a network interface card.
  – PCI standards and architecture provide functionality.
    • Standards needed for interoperability between hardware manufactured by various vendors.
    • PCI Express (PCIe) replaces PCI-X and AGP and is found in modern computer systems.

Motherboard Buses

- Buses
  - Copper wires on a motherboard that connect motherboard devices for communications purposes.
  - A motherboard has a number of buses, but we will focus on its main three buses:
    - Address bus - Destination address for this communication.
    - Control bus – Timing and specific commands.
    - Data bus – Actual data to be acted upon.

Motherboard Buses

- For example, if a device requests data be saved to the hard disk:
  - The "save" command is placed on the control bus .
  - The actual data to be saved is placed on the data bus.
  - The physical address on the HD is placed on the address bus.

What is a Device?

- A computer device is hardware that is not part of the computer case or installed inside the computer.
  - Input devices provide data and control settings to a computer:
    - Key presses (keyboard)
    - Sound (microphone)
    - Movement (mouse)
  - Output devices communicate data processing done by a computer to the world outside the computer:
    - Monitor
    - Printer
    - Headphone
    - Speakers

What is a Device? (cont'd)

- Some devices are standalone pieces of hardware:
  - Computers are devices!
  - Routers manage access to networks
  - Digital cameras
  - Cell phones
  - Handheld equipment
  - Can you think of others?

Device Functionality

- Devices usually connect to the computer via ports but can connect wirelessly as well.
  - Devices can also connect to the computer via expansion cards.
- Devices communicate by sending/receiving electronic signals that are translated to binary (machine language instructions).

Input Devices

- Keyboard
  - Device whose key strokes are usually interpreted by software into some type of symbol or symbols.
  - For example, the capital letter "A," typed into a word processing document, is sent electronically in binary code to the motherboard (as "01000001") and output on the monitor in alphabetic format.
- Mouse
  - Pointing device that functions by detecting motion using an X and Y coordinates system, relative to its point of origin on some type of surface.
- Sound
  - Devices include CD/DVD players, microphones.

Input Devices (cont'd)

- Touchpads – found on most modern laptops. The surface is pressure sensitive and is able to detect (finger) movement and translate this as mouse movement.
- Other common input devices include game joysticks, fingerprint readers, cameras, and bar code readers used in stores.

Input Devices (cont'd)

- Computerized Tomography (CT) Scans
  - "… a diagnostic procedure that uses special x-ray equipment to obtain cross-sectional pictures of the body." [X-ray computed tomography, From Wikipedia, the free encyclopedia, Online: http://en.wikipedia.org/wiki/Computed_tomography, 2010.]

The image displays a Philips 64 slice 'Brilliance' Scanner.

Input Devices (cont'd)

- Positron Emission Tomography (PET) Scans
  - "…a nuclear medicine imaging technique which produces a three-dimensional image or picture of functional processes in the body." [Positron emission tomography, From Wikipedia, the free encyclopedia, Online: http://en.wikipedia.org/wiki/Positron_emission_tomography, 2010]

The image displays the GE Discovery D600 PET/CT System, with 16 slice CT System, built in 2009.

Input Devices (cont'd)

- Ultrasonography
  - Sound waves are utilized to produce an image. The echoes are received as input from a sonographic probe and translated into pixels.
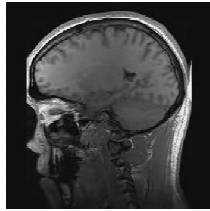
Input Devices (cont'd)

- Magnetic Resonance Imaging (MRI) – a body is placed in a magnetic field and flooded with a radio frequency pulse that produces an image of the body's interior structure.

The image represents the output of an MRI scan of the human head.

Output Devices

- Monitor
  - Display device that can show computer input and output on screen.
- Printer
  - Device that usually produces a paper copy based on an electronic document.
  - Connects to the motherboard via USB, parallel, or other ports, depending on device.
- Flash drive
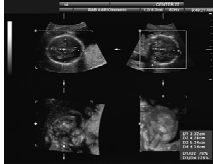 - Secondary storage device that connects to the computer via a USB port.

Output Devices (cont'd)

- Speakers
  - Hardware devices connected to a sound card which is installed on the motherboard.
    - ✓ An onboard speaker does not connect to a 'sound card' since sound card functionality is part of the motherboard's circuitry.
- Sonographic equipment
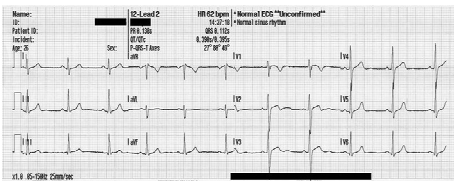 - Produces images based on sound waves received.

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Output Devices (cont'd)

- Electrocardiography (ECG or EKG)
  - An interpretation of the electrical activity of the heart over time captured and externally recorded by skin electrodes.
  - A noninvasive recording produced by an electrocardiographic device.

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Output Devices (cont'd)

- Voice synthesizer
  - Produces sound based on text input.
  - Physicist Stephen Hawking's synthesized 'voice' is known throughout the world although he lost his ability to speak in 1985.
- Other common output devices
  - Projectors, scanners and fax machines.

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