Computer Fundamentals

Lecture # 3:

Essential Components of a Computer

Today's Aim

- Components of a computer system
- Role of different Hardware components
- Role of Software
- Firmware

Components of a computer system

- Hardware
- Software
- Firmware

Components of a Computer

- Hardware
  - The physical components of a computer
    - keyboard
    - mouse
    - monitor
    - speakers
- Software
  - The programs that run on a computer
    - Word-processor
    - Calculator
    - Spread-sheets
- Firmware
  - Programs permanently stored in computer ROM

Computer Hardware

- Each Hardware component of a computer falls in one of these four categories
  - Processor
  - Memory
  - Input/Output
  - Storage
  - Buses (Bundles of wires)

Computer Hardware

- Processor
  - It is the brain of a computer
  - It reads instructions and executes them one at a time
  - Multi-core processors can execute multiple instructions
  - Components like video cards (Graphics card) GPU (Graphics processing unit) may have their own dedicated processor to decrease the burden the over-head on the main processor (on the motherboard)

Computer Hardware

- Processor (continued)
  - The overall performance of a computer is greatly dependent on the processor's speed
- Memory
  - It serves as a temporary store-room for the programs being run. e.g., when a game is started, it is first loaded into Memory
  - ANALOGY: Books are kept in the shelf, while the one to be studied is placed on the table

Computer Hardware

- Memory (continued)
  - RAM serves as the ‘Main Memory’ for the system
  - The OS reserves a portion of RAM for itself
  - Every subsequent program is given a share in RAM
  - Devices like video cards have their own dedicated memory to share burden with RAM

Computer Hardware

- Cache
  - Moving data from RAM is very much time consuming because RAM is very slow
  - Hence cache is used; much faster
  - CPU first looks in the cache, if the required instructions aren’t present there, it fetches it from RAM and saves a copy in the cache as well for future use

Computer Hardware

- Cache (continued)
  - Cache is found;
    - Built into the CPU (L1 cache)
    - External cache on the CPU (L2 cache)
    - Cache on the motherboard (L3 cache) (in high-end systems like Xeon Servers)
    - Also found on Hard drives and Network cards etc.
  - Duties …
    - L1 cache holds the most recently used instructions
    - L2 cache holds the possibly upcoming instructions
    - L3 cache holds a number of possibly required instructions

Computer Hardware

- Input Devices
  - Through which computer takes input from the user e.g., Mouse, Keyboard, microphone, camera etc.
  - Trackballs, trackpads, pens and touch screens are variants of mouse
  - In addition Game controllers, Bar Code Readers and Optical character Recognition (OCR) are other input devices

Computer Hardware

- Output Devices
  - Used by the computer to give the results to the outside world
  - Examples include monitor, printer, speakers, headphones etc.

Computer Hardware

- Storage Devices
  - Store the data permanently so that it isn't lost by removing power
  - Examples:
    - Magnetic Storage Devices include Floppy Disks and Hard Disks
    - Optical Media include CD-ROMs, DVD-ROMs and now Blue-Ray

Computer Hardware

- Bus
  - A bundle of wires running between different components of a computer, providing a means of transferring data and the control signals
  - Two types
    - Internal (system) bus: resides on the motherboard and connects CPU to the devices that reside on the motherboard
    - External (expansion) bus: connects external devices, such as mouse, modem, keyboard, printer etc. to the CPU/motherboard

Computer Hardware

- Bus (continued)
  - The **system bus** has two parts;
    - Data Bus
      - Connects CPU, RAM and other devices on the motherboard
      - Number of wires affects the number of bits that can be carried at a time, normally 16-bit, 32-bit and 64-bit buses are available
      - Like CPU, bus has its own clock-speed, normally 100MHz or 133 MHz. 800 MHz in high computers
    - Address Bus
      - Connects only the RAM and CPU, used for addressing

Computer Hardware

- Bus Standards
  - ISA (Industry Standard Architecture)
    - 16-bit, mid-1980s, used in modems and input devices
  - Local Bus
    - Invented for interfacing faster devices
    - Used in system as well as expansion buses
  - PCI (Peripheral Component Interconnect)
    - A type of Local Bus designed by Intel to integrate audio, video and graphics

Computer Hardware

- Bus Standards (continued)
  - AGP (Accelerated Graphics Port)
    - Based on a special architecture that allows the video card to access the RAM directly
    - Not supported by old PCs
  - USB (Universal Serial Bus)
    - Hot swappable
    - Supports up to 127 devices connected in a daisy chain or a hub layout

Computer Hardware

- IEEE 1394 (Fire Wire)
  - First found only on Macintosh, now present in IBM compatible PCs as well
  - Used to connect video devices like cameras and video cameras, also used for digital TV connection
- PC Card Bus
  - Hot swappable, used mostly with laptops
  - Used in Wi-Fi cards, network cards & external Modems
  - The most recent version is called CardBus and is used as an external extension of an internal PCI Bus

Computer Hardware

Performance Specifications of Common Buses			
Bus Type	**Width (bits)**	**Transfer Rate**	**Hot Swappable**
AGP 8	32	2.1 GHz	No
FireWire	32	400 MHz	Yes
ISA	16	8.33 MHz	No
PC Card	32	33 MHz	Yes
PCI	32	33 MHz	No
USB 2.0	32	480 MHz	Yes

Software

- Set of instructions that tell the processor what steps to take; in which sequence
- Software brings the machine to life
- Discussed in detail in a later chapter

Firmware

- Firmware is a set of very basic instructions to guide the computer through the initial steps on startup
- Burnt permanently into the system
- BIOS (Basic Input Output System) is an example