Ch.4 - The System Unit or the Processor
The four hardware components of a computer system

INPUT

SYSTEM UNIT

OUTPUT

PERMANENT STORAGE

3
Let’s open the box!
Inside the System Unit
circuit board - a board with integrated circuits (microchips)

- system board or motherboard
- interface boards or expansion boards

system board or motherboard - a single circuit board with the components which make up the computer’s processor for a microcomputer, including the:
- CPU (Central Processing Unit)
- RAM
- ROM or ROM BIOS
- expansion slots
A Motherboard or System board
Interface board/card (or Expansion board/card)- used to connect peripheral devices (monitor, printer, etc.) to the motherboard (more on this “later”)
Inserting an Interface card or Expansion board into an expansion slot of the motherboard
Integrated Circuits (microchips)
What can they do?

1. **Store bits**: store the data and instructions used for processing
   Example: RAM and ROM chips (later)

2. **Process bits**: process the data and instructions
   Example: CPU (next)
The CPU
The Real Computer

CPU (Central Processing Unit)-
A complex collection of
electronic circuits on one or
more integrated circuits (chips)
which:
1. executes the instructions in a
   software program
2. communicates with other parts
   of the computer system,
especially RAM

The CPU is the computer!
The Intel Pentium PRO CPU
Some of the parts of the CPU

**Arithmetic Logic Unit (ALU)** - area of the CPU responsible for *the actual processing*. Also known as the Data path.

“The CPU’s calculator”

**Control Unit (CU)** - area of the CPU responsible for getting *data and instructions from RAM*
What is in charge of the CPU?

The operating system software!
The “OS”
Windows 95, Macintosh OS, DOS, UNIX, etc.

The operating system manages what programs and data the CPU will be working on.

More Later on Operating Sys.!
A CPU can be:

1. A series of integrated circuits (chips) on one or more circuit boards
   - Mainframe and minicomputers

2. On a single integrated circuit known as a microprocessor

**microprocessor** - a CPU on a single chip

**microcomputer** - a computer with a microprocessor(s) (PC, Macintosh)
The microprocessor (again)
Compatibility
Why can’t I run Windows software on my Macintosh and visa versa?

• **Operating system software** is designed to run on one specific type of CPU or “family of CPUs”

• **Application software** is designed to work with a specific operating system software, thus one specific type of CPU or “family of CPUs”

  More “later”
RAM
Primary Memory

RAM (Random Access Memory)
- integrated circuits (chips) used to temporarily store software (programs, instructions) and data
  • “primary” storage for the CPU
  • electronic switches, storing ON’s and OFF’s
RAM

Temporarily stores for the CPU:

Software
• operating system software
• application software

Data
• data (documents, spreadsheets, etc.)
Inserting RAM onto the motherboard
RAM is **temporary** memory

RAM is **volatile**

- stores ON and OFF bits (software and data) electrically
- when power goes off, everything in RAM is *lost*
RAM Capacity

The amount of RAM determines:

• what software and data the user can work on

• how much software and data the user can work with

“out of memory” error message from the Operating System

The more complex and sophisticated the software, the more instructions that software contains, which means larger software files.
If RAM is temporary where is the data and software stored permanently?

Permanent storage devices such as:

- hard disk drives
- floppy disks
- CD ROM disk
- tape
- cartridge drives

(“later”)
Example: Typing a document in Microsoft Works

In RAM memory

• MS Windows operating system or Macintosh OS
• MS Word
• the document

What the user sees on the screen is being stored in RAM
ROM*
Read Only Memory

ROM (Read Only Memory) - integrated circuits (microchips) that are used to permanently store start-up (boot) instructions and other critical information

Read Only - information which:
• cannot be changed
• cannot be removed
• cannot be appended (added to)

* Today ROM is usually stored using Flash-RAM which is non-volatile RAM.
ROM is sometimes known as **ROM BIOS** (Basic Input Output System software) (also known as CMOS)

ROM permanently contains:

- start-up (boot) instructions
- instructions to do “low level” processing of input and output devices, such as the communications with the keyboard and the monitor
**Firmware** - software program which is stored permanently on a microchip, such as the software on the ROM chip

ROM chips:
Booting up the computer

Booting the computer - starting the computer

Four phase of the boot process:

S.P.I.T.

1. System Start-up
2. Power On Self-Test (POST)
3. Initialization
4. Transfer to the operating system software
1. System Start-up

- Turning on the computer
- Power supply supplies electricity to the computer
- The ROM chip boot instructions (firmware) is now “in charge”
- ROM chip instructions processed by the CPU
2. Power On Self-Test

The ROM chip boot instructions tests the “processor” including:

• checks the CPU
• tests RAM memory and calculates its capacity
• checks other components on the motherboard
3. Initialization

The ROM chip boot instructions checks the “peripheral devices” including:

Input devices
• keyboard, mouse

Output devices
• monitor, printer

Storage devices
• hard disk and floppy drives, CD ROM drive
What is a peripheral device?

A device which is connected to the computer’s processor, including input, output, and storage devices.

(More later)
4. Transfer to an operating system software

- The ROM chip boot instructions are now finished
- The ROM chip wants to give control over to an operating system software
- The ROM chip searches for the operating system (usually on the hard disk drive) and transfers an operating system file (the kernel) into RAM memory
The operating system software is now in charge!

• The operating system file, known as the kernel, is in RAM memory

• The user may now access application programs and data (double click on MS Word)

• The operating system software is in charge

(More later)
Sample Screen of PC during boot-up

ROM BIOS Version 2.10 A05
Copyright BIOSTech Inc. 1996
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0032768 KB
Keyboard . . . Detected
Mouse . . . Detected

Hard Disk Installed WCW AC41500H
Floppy A: Installed
Starting Windows 95

SoundUTIL TSR Version 1.20
Copyright SoundCard Technology 1996-97

IDE CD-ROM device driver version V2.33
(4/20/96)
Copyright Gaijin Electric Co.
1 drive(s) selected
Summary (1 of 2)

CPU
• Is the computer!
• does the processing

RAM
• temporary memory for the CPU
• holds all data and software the CPU needs to work on
• what the user sees on the screen is being stored in RAM
• speed vs. capacity vs. cost
Summary (2 of 2)

ROM

• firmware
• BIOS
• boot instructions
• in charge when the computer is booted

Boot Process (S.P.I.T.)

• System startup
• Power On Self Test (POST)
• Initialization
• Transfer to an operating system