Inside the Computer System
What’s on the Motherboard?

Processing cycle without pipelining

Instruction 1
Instruction 2 enters fetch phase

Instruction 2

Clock ticks

One processing cycle completed

Instruction 1 completed

- Fetch
- Decode
- Execute
- Store
What’s on the Motherboard?

Processing cycle with pipelining

- Instruction 1
- Instruction 2
- Instruction 3
- Instruction 4

Clock ticks

One processing cycle completed

- Fetch
- Decode
- Execute
- Store
What’s on the Motherboard?

• **Parallel processing**
  - Method where more than one processor performs at the same time—faster processing
  - **Data Dependency**: The CPU needs previous result to process the next instruction
  - **Speculative Execution**: The CPU executes and temporarily stores the next instruction.
  - **Branch Prediction**: CPU predict what will happen next
What’s on the Motherboard?

- **Multi-core processing**
  - Access time reduced
  - Processing time improved
  - Each core handles incoming streams of data or instructions at the same time
  - Two basic types:
    - **Dual core**
    - **Quad core**
What’s on the Motherboard?

- **Chipset**
  - Set of chips that supply the switching circuitry the CPU requires to move data throughout the computer
  - The CPU and the input/output (I/O) bus linked through the chipset
- **PCI** (*Peripheral component interconnect*) Provides a means to communicate with input and output devices
What’s on the Motherboard?

• **Memory**
  - Chips on the motherboard or within the CPU that retain instructions and data

• **Random access memory (RAM)**
  - Temporarily stores data and instructions for the CPU
  - Volatile—contents erased after computer is shut off
  - Allows CPU to access or store data and instructions quickly through RAM’s **memory address** feature
    • Identifies and locates stored data
What’s on the Motherboard?
What’s on the Motherboard?

• **RAM (con’t.)**
  - Comes in the form of memory modules or memory cards
  - **Memory modules (memory cards)**—small circuit boards that hold several RAM chips and fits into special slots on the motherboard
  - Types of RAM:
    - **Dual inline memory modules (DIMM)**—most common today
      - 168-pin connector
      - 64-bit transfer rate
    - **Single inline memory modules (SIMM)**—older technology
      - 72-pin connector
      - 32-bit transfer rate
What’s on the Motherboard?

• **Memory footprint**
  - Amount of RAM the operating system uses while it operates

• **Virtual memory**
  - Section of the hard drive set aside to use when RAM gets full
What’s on the Motherboard?

• **Cache memory**
  o Small unit of ultrafast memory built into or near the processor
  o Used to store frequently or recently accessed program instructions or data
  o Faster than RAM
  o More expensive than RAM
  o Three levels of cache on a system:
    • Level 1 (L1) cache (primary cache) 4-16 KB
    • Level 2 (L2) cache (secondary cache) 512 KB
    • Level 3 (L3) cache
      o Found on some newer microprocessors
      o Primarily used in servers and workstations
What’s on the Motherboard?

- CPU
- Registers
- Motherboard
- Level 3 cache
- Level 2 cache
- Level 1 cache
- RAM
Accessing memory

The CPU looks for instructions/data in the following order:

- Level 1 cache
- Level 2 cache
- Level 3 cache
- Main memory
What’s on the Motherboard?

- **Read-only memory (ROM)**
  - Contains prerecorded instructions to start the computer
  - Nonvolatile—contents stored when CPU power off
    - **Basic input/output system (BIOS)**
      - First code run when the system is powered on
    - **Bootstrap loader**
      - Program—locates and loads the operating system into RAM
    - **Complementary metal-oxide semiconductor (CMOS)**
      - Starts the power-on self-test and verifies other system components are operating correctly
  - **Power-on self-test (POST)**
    - Checks circuitry and RAM, marking defective locations
What’s on the Motherboard?

• ROM (con’t.)
  - Programmable ROM (PROM)
  - Electrically-PROM (EPROM)
  - Electrically erasable PROM (EEPROM)
  - Flash EPROM
What’s on the Outside of the Box?

• **Front panel**
  - **Power switch**
    - Used to turn the computer on
  - **Drive activity light**
    - Advises the user that the hard drive is retrieving data
  - **Power-on light**
    - Shows whether the power is on
What’s on the Outside of the Box?

• **Outside a system unit**
  o **Connector**—physical receptacle used to plug a peripheral device into the computer
    • Example: telephone jack
  o **Port**—electronically defined pathway used to send data into and retrieve data from the computer
    • Example: USB port
What’s on the Outside of the Box?

- FireWire
- PS/2 (keyboard)
- USB
- DVI (LCD monitor)
- FireWire
- Audio jacks
- PS/2 (mouse)
- Ethernet (network)
- S-video (television)
- VGA (monitor)
What’s on the Outside of the Box?

Connectors on a notebook may vary

Right side (15-inch and 17-inch)
- Security port
- USB 2.0
- FireWire 400 (IEEE 1394)
- FireWire 800 (IEEE 1394b)
- Gigabit ethernet
- Dual-link DVI

Left side (15-inch)
- MagSafe port
- USB 2.0
- Audio in
- Audio out
- ExpressCard/34
What’s on the Outside of the Box?

• **USB (universal serial bus) ports**
  - Connects up to 127 peripheral devices
  - **USB 2.0 (high-speed USB)**—fully compatible with USB 1.1 products, cables, and connectors
  - Designed to replace older parallel and serial ports
  - Connects a variety of devices to the computer, including:
    - Keyboards
    - Mice
    - Printers
    - Digital cameras
What’s on the Outside of the Box?

• **USB 2.0**
  - Uses an external bus
  - Supports data transfer rates of 480 Mbps between the computer and the peripheral device
  - Supports **hot swapping**—ability to connect and disconnect devices without shutting down the computer
  - **Plug-and-play (PnP)**—allows computers to automatically detect the device when you plug it in

• **USB hub**
  - Device that plugs into existing USB port
  - Contains four or more additional ports
What’s on the Outside of the Box?

- **FireWire (1394 ports)**
  - Created by Apple in 1995
  - IEEE 1394 Higher Performance Serial Bus, also known as Sony i.Link
  - Offers high-speed connections for dozens of peripheral devices (up to 63)
  - Enables hot swapping and PnP
  - Data transfer rates of FireWire
    - FireWire 400—400 Mbps
    - FireWire 800—800 Mbps
    - FireWire S3200—next generation (expected to transfer data at 3.2 Gbps)
What’s on the Outside of the Box?

• Video connectors
  o VGA (video graphics array)
    • 15-pin male connector—works with standard monitor cables
    • Transmits analog video signals
    • Used for legacy technology cathode ray (CRT) monitors
  o DVI (Digital visual Interface) port—lets LCD monitors use digital signals
  o Onboard video—video circuitry built into the motherboard where the video connector is on the back of the system unit case
What’s on the Outside of the Box?

• **Additional connectors**
  - Telephone
  - Network
  - PC card slot
    - PC card
    - ExpressCard
  - Sound card
  - Game card
  - TV/sound capture board
What’s on the Outside of the Box?

• **Legacy technology**
  o Older technology that is being phased out
  • Examples:
    • Serial ports
    • Parallel ports
    • PS/2 ports
    • SCSI (small computer system interface) ports