

Management Information Systems

Information Systems: Computer Hardware

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(Adapted from Introduction to IS, Rainer and Turban)

OUTLINE

Introduction
The Central Processing Unit
Computer Memory
Computer Hierarchy
Input and Output Technologies
Innovations in Hardware Utilization
Strategic Hardware Issues

OBJECTIVES

- Identify the major hardware components of a computer system.
- Describe the design and functioning of the central processing unit.
- Discuss the relationships between microprocessor component designs and performance.
- Describe the main types of primary and secondary storage.

OBJECTIVES (continued)

- Distinguish between primary and secondary storage along the dimensions of speed, cost, and capacity.
- Define enterprise storage and describe the various types of enterprise storage.
- Describe the hierarchy of computers according to power and their respective roles.
- Differentiate among the various types of input and output technologies and their uses.
- Discuss the innovations in hardware utilization.
- Discuss strategic issues that link hardware design to business strategy.

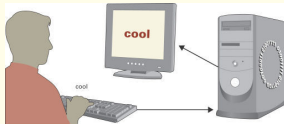
Basic computer architecture

Bits and bytes

- Computers process and store data using tiny on-off switches
- Sequences of on/off $\Leftrightarrow$ strings of bits (0's and 1's)

Information representation and conversion

- We represent and process data differently from computers
- Data we want computers to deal with have to be represented as 0's and 1's, converted back and forth



Basic computer architecture

Examples of information representation

- Numbers

42 $\Leftrightarrow$ 00101010

- Text

IT $\Leftrightarrow$ 01001010 01010100

- Pictures

.gif, .jpeg, .bmp,...

- Audio

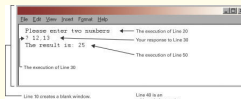
Basic computer architecture

Algorithms, programs and languages

- All computers work by performing structured sequences of instructions called **programs**
- Special languages used to write programs are called **programming languages** (examples?)
- A step-by-step blueprint for getting a computer to do something is called an **algorithm**

```
10 CLS
20 PRINT "Please enter two numbers"
30 INPUT A, B
40 C = A + B
50 PRINT "The result is:", C
60 STOP
```

Ask the user for two numbers
Add the numbers
Display the result



Hardware consists of:

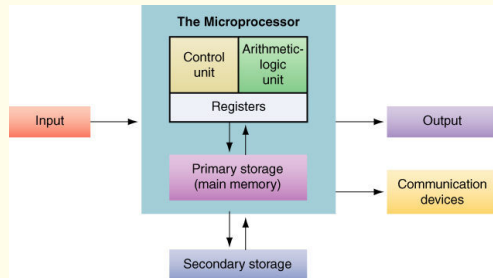
Hardware refers to the physical equipment used for the input, processing, output and storage activities of a computer system.

- Central processing unit (CPU)
- Primary storage
- Secondary storage
- Input technologies
- Output technologies
- Communication technologies

The Central Processing Unit

- **Central processing unit (CPU)** performs the actual computation or "number crunching" inside any computer.
- Microprocessor
 - made up of millions of microscopic transistors embedded in a circuit on a silicon chip.
- Control unit
- Arithmetic-logic unit (ALU)
- Registers

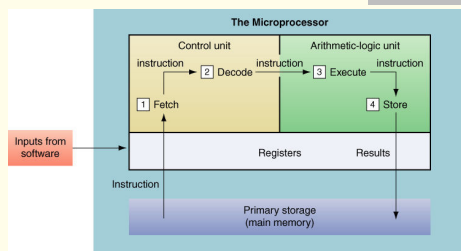
Central Processing Unit (CPU) (continued)



How the CPU Works

- Binary form
- Machine instruction cycle
- Clock speed
- Word length
- Bus width
- Line width

How the CPU Works (continued)

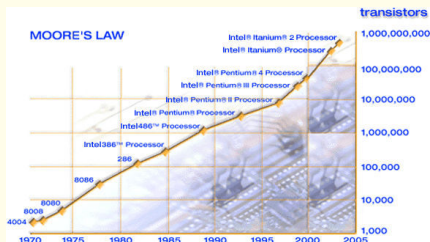


See this [view](#) from Intel of how a chip works

Moore's Law

Advances in Microprocessor Design

Moore's Law: microprocessor complexity would double every two years.



Moore's Law and Implications

- # of transistors on a chip doubles periodically (every 18 months)
- Combined with pricing trends,

Computer Memory

Two basic categories of computer memory:

- Primary Storage
 - stores small amounts of data and information that will be immediately used by the CPU.
- Secondary Storage
 - stores much larger amounts of data and information (an entire software program, for example) for extended periods of time.

Hierarchy of Storage Capacity

- Kilobyte (KB)
 - approximately one thousand (1024) bytes.
- Megabyte (MB)
 - approximately one million bytes
- Gigabyte (GB)
 - Approximately one billion bytes.
- Terabyte (TB)
 - Approximately one billion bytes.
- Petabyte (PB)
 - One thousand terabytes
- Exabyte (EB)
 - One thousand petabytes
- Zettabyte (ZB)
 - one thousand exabytes.

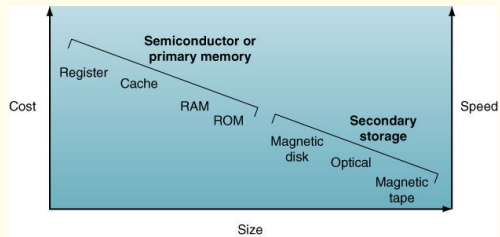
Primary Storage

- **Primary storage** or **main memory** stores three types of information for very brief periods of time:
 - Data to be processed by the CPU;
 - Instructions for the CPU as to how to process the data;
 - Operating system programs that manage various aspects of the computer's operation.
- Primary storage takes place in chips mounted on the computer's main circuit board, called the **motherboard**.

Main Types of Primary Storage

- Registers
 - registers are part of the CPU with the least capacity, storing extremely limited amounts of instructions and data only immediately before and after processing.
- Random access memory (RAM)
 - The part of primary storage that holds a software program and small amounts of data when they are brought from secondary storage.
- Cache memory
 - A type of primary storage where the computer can temporarily store blocks of data used more often.
- Read-only memory (ROM)
 - Type of primary storage where certain critical instructions are safeguarded; the storage is nonvolatile and retains the instructions when the power to the computer is turned off.

Primary versus Secondary Memory

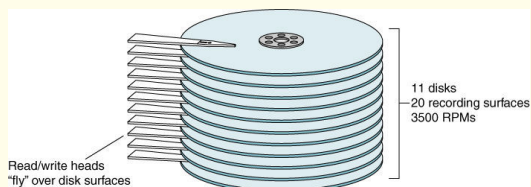


Secondary Storage

Memory capacity that can store very large amounts of data for extended periods of time.

- Magnetic tape
 - sequential access
- Magnetic disks
 - direct access
- Optical Storage Devices
- Flash Memory Devices
- Enterprise Storage System

Hard Drive (Magnetic Disks)



Optical Storage Devices

- **Optical storage devices:** A form of secondary storage in which a laser reads the surface of a reflective plastic platter.
 - Compact Disk, Read-Only Memory (CD-ROM)
 - Digital Video Disk (DVD)

Flash Memory Devices

- Flash memory
 - non-volatile memory that can be erased and reprogrammed
- Flash memory devices
 - electronic storage devices with no moving parts
- Thumb drive

Enterprise Storage Systems

- **Enterprise storage system:** An independent, external system with intelligence that includes two or more storage devices.
- Three types of enterprise storage:
 - Redundant Arrays of Independent Disks (RAID)
 - An enterprise storage system that links groups of standard hard drives to a specialized microcontroller that coordinates the drives so they appear as a single logical drive.
 - Storage Area Network (SAN)
 - An enterprise storage system architecture for building special, dedicated networks that allow rapid and reliable access to storage devices by multiple servers.
 - Network Attached Storage (NAS)
 - device is a special-purpose server that provides file storage to users who access the device over a network; plug-and-play

Computer Hierarchy

- Supercomputers
- Mainframe Computers
- Midrange Computers
- Workstations
- Notebooks and Desktop Computers
- Ultra-mobile PCs
- Computing devices

Input and Output Technologies

- **Input technologies** allow people and other technologies to put data into a computer. The two main types of input devices are:
 - **human data-entry** devices include keyboards, mouse, trackball, joystick, touchscreen, stylus and voice recognition;
 - **source-data automation** devices input data with minimal human intervention (e.g. barcode reader).
 - Speed up data collection;
 - Reduce errors;
 - Gather data at the source of a transaction or other event.

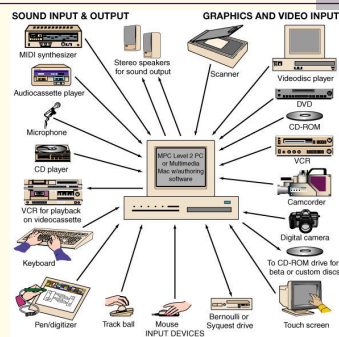
Input and Output Technologies (continued)

- **Output** generated by a computer can be transmitted to the user over several output devices and media, which include:
 - Monitors
 - Printers
 - Plotters
 - Voice

Multimedia Technology

- **Multimedia technology** is the computer-based integration of text, sound, still images, animation and digitized motion video.
- Merges capabilities of computers with televisions, VCRs, CD players, DVD players, video and audio recording equipment, music and gaming technologies.

Multimedia Authoring System



Innovations in Hardware Utilization

- **Server Farms**
 - massive data centers that contain thousands of networked computer servers.
- **Virtualization**
 - using software to create partitions on a single server so that multiple applications can run on a single server
- **Grid computing**
 - involves applying the resources of many computers in a network to a single problem at the same time.

Innovations in Hardware Utilization (Continued)

- Utility computing
 - (also called subscription computing and on-demand computing) is when a service provider makes computing resources and infrastructure management available to a customer as needed for a charge based on specific usage rather than a flat rate.
- Edge Computing
 - process where parts of Web content and processing are located close to the user to decrease response time and lower processing costs.
- Autonomic Computing
 - systems that manage themselves without direct human intervention.
- Nanotechnology ([slides](#))
 - refers to the creation of materials, devices and systems at a scale of 1 to 100 nanometers (billionths of a meter).

TG1.7 Strategic Hardware Issues

- How do organizations keep up with the rapid price and performance advancements in hardware?
- How often should an organization upgrade its computers and storage systems?
- Will upgrades increase personal and organizational productivity?
- How can organizations measure such increase?
- How do organizations manage telecommuting?

Secondary Storage

Type	Advantages	Disadvantages	Application
<i>Magnetic Storage Devices</i>			
Magnetic tape	Lowest cost per unit stored.	Sequential access means slow retrieval speeds.	Corporate data archiving.
Hard drive	Relatively high capacity and fast retrieval speed.	Fragile; high cost per unit stored.	Personal computers through mainframes.
RAID	High capacity; designed for fault tolerance and reduced risk of data loss; low cost per unit stored.	Expensive, semipermanent installation.	Corporate data storage that requires frequent, rapid access.
SAN	High capacity; designed for large amounts of enterprise data.	Expensive.	Corporate data storage that requires frequent, rapid access.
NAS	High capacity; designed for large amounts of enterprise data.	Expensive.	Corporate data storage that requires frequent, rapid access.
Memory cards	Portable; easy to use; less failure-prone than hard drives.	Expensive.	Personal and laptop computers.
Thumb drives	Extremely portable and easy to use.	Relatively expensive.	Consumer electronic devices; moving files from portable devices to desktop computers.
<i>Optical Storage Devices</i>			
CD-ROM	Moderate capacity; moderate cost per unit stored; high durability.	Slower retrieval speeds than hard drives; only certain types can be rewritten.	Personal computers through corporate data storage.
DVD	Moderate capacity; moderate cost per unit stored.	Slower retrieval speeds than hard drives.	Personal computers through corporate data storage.

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Input Devices

Input Device	Description
<i>Human Data Entry Devices</i>	
Keyboards	Most common input device (for text and numerical data).
Mouse	Handheld device used to point cursor at point on screen, such as an icon; user clicks button on mouse instructing computer to take some action.
Optical mouse	Mouse is not connected to computer by a cable; mouse uses camera chip to take images of surface it passes over, comparing successive images to determine its position.
Trackball	User rotates a ball built into top of device to move cursor (rather than moving entire device such as a mouse).
Pointing stick	Small button-like device; cursor moves in the direction of the pressure you place on the stick.
Touchpad	User moves cursor by sliding finger across a sensitized pad and then can tap pad when cursor is in desired position to instruct computer to take action (also called <i>glide-and-tap pad</i>).
Graphics tablet	A device that can be used in place of, or in conjunction with, a mouse or trackball; has a flat surface for drawing and a pen or stylus that is programmed to work with the tablet.
Joystick	Joystick moves cursor to desired place on screen; commonly used in workstations that display dynamic graphics and in video games.
Touch screen	Users instruct computer to take some action by touching a particular part of the screen; commonly used in information kiosks such as ATM machines.
Stylus	Pen-style device that allows user either to touch parts of a predetermined menu of options or to handwrite information into the computer (as with some PDAs); works with touch-sensitive screens.
Digital pen	Mobile device that digitally captures everything you write; built-in screen confirms what you write has been saved; also captures sketches, figures, etc.; on-board flash memory can store up to 50 pages.
Web camera (Webcam)	A real-time video camera whose images can be accessed via the Web or instant messaging.
Voice recognition	Converts voice wave sounds into digital input for computer; critical technology for physically challenged people who cannot use other input devices.

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Source-Data Automation Input Devices

Automated teller machine	A device that includes source-data automation input in the form of a magnetic stripe reader; human input via a keyboard; and output via a monitor, printer, and cash dispenser.
Magnetic stripe reader	A device that reads data from a magnetic stripe, usually on the back of a plastic card (for example, credit or debit cards).
Point-of-sale terminals	Computerized cash registers that also may incorporate touchscreen technology and barcode scanners (see below) to input data such as item sold and price.
Barcode scanners	Devices scan black-and-white barcode lines printed on merchandise labels.
Optical mark reader	Scanner for detecting presence of dark marks on predetermined grid, such as multiple-choice test answer sheets.

Magnetic ink character reader	Read magnetic ink printed on checks, which identify the bank, checking account, and check number.
Optical character recognition	Software that converts text into digital form for input into computer.
Sensors	Collect data directly from the environment and input data directly into computer; examples include your car's airbag activation sensor and radio frequency identification tags.
Cameras	Digital cameras capture images and convert them into digital files.
Retinal scanning displays	Projects an image, pixel by pixel, directly onto a viewer's retina; used with mobile devices; see Microvision's (<i>mvis.com</i>) Nomad and Xybernaut's (<i>xybernaut.com</i>) Poma.
Radio frequency identification (RFID)	Uses active or passive tags (transmitters) to wirelessly transmit product information to electronic readers.

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Output Devices

Output Device	Description
Monitors	
Cathode ray tubes	Video screens on which an electron beam illuminates pixels on display screen.
Liquid crystal display (LCDs)	Flat displays that have liquid crystals between two polarizers to form characters and images on a backlit screen.
Organic light-emitting diodes (OLEDs)	Displays that are brighter, thinner, lighter, cheaper, and faster and take less power to run than LCDs.
Retinal scanning displays	Project image directly onto a viewer's retina; used in medicine, air traffic control, and controlling industrial machines.
Printers	
Laser	Use laser beams to write information on photosensitive drums; produce high-resolution text and graphics.
Inkjet	Shoot fine streams of colored ink onto paper; usually less expensive to buy than laser printers, but can be more expensive to operate; can offer resolution quality equal to laser printers.
Plotters	Use computer-directed pens for creating high-quality images, blueprints, schematics, drawing of new products, and so on.
Voice Output	A speaker/headset, which can output sounds of any type; voice output is a software function that uses this equipment.

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