GTU104KM: Enterprise Information Systems

Hardware and Mobile Devices

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2018

Objectives

- After completing this lesson, you will be able to:
  - Identify and briefly describe the functions of the primary components of a computer
  - Give an example of recent innovations in computer processor chips, memory devices, and input/output devices
  - Identify the characteristics of various classes of single-user and multiuser computer system, and discuss the usage of each class of system
  - Identify some of the challenges and trade-offs that must be considered in implementing a data center
  - Define the term “green computing” and identify the primary goals of this program

Anatomy of a Computer

- Hardware components include devices that perform:
  - Input
  - Processing
  - Data storage
  - Output

Anatomy of a Computer

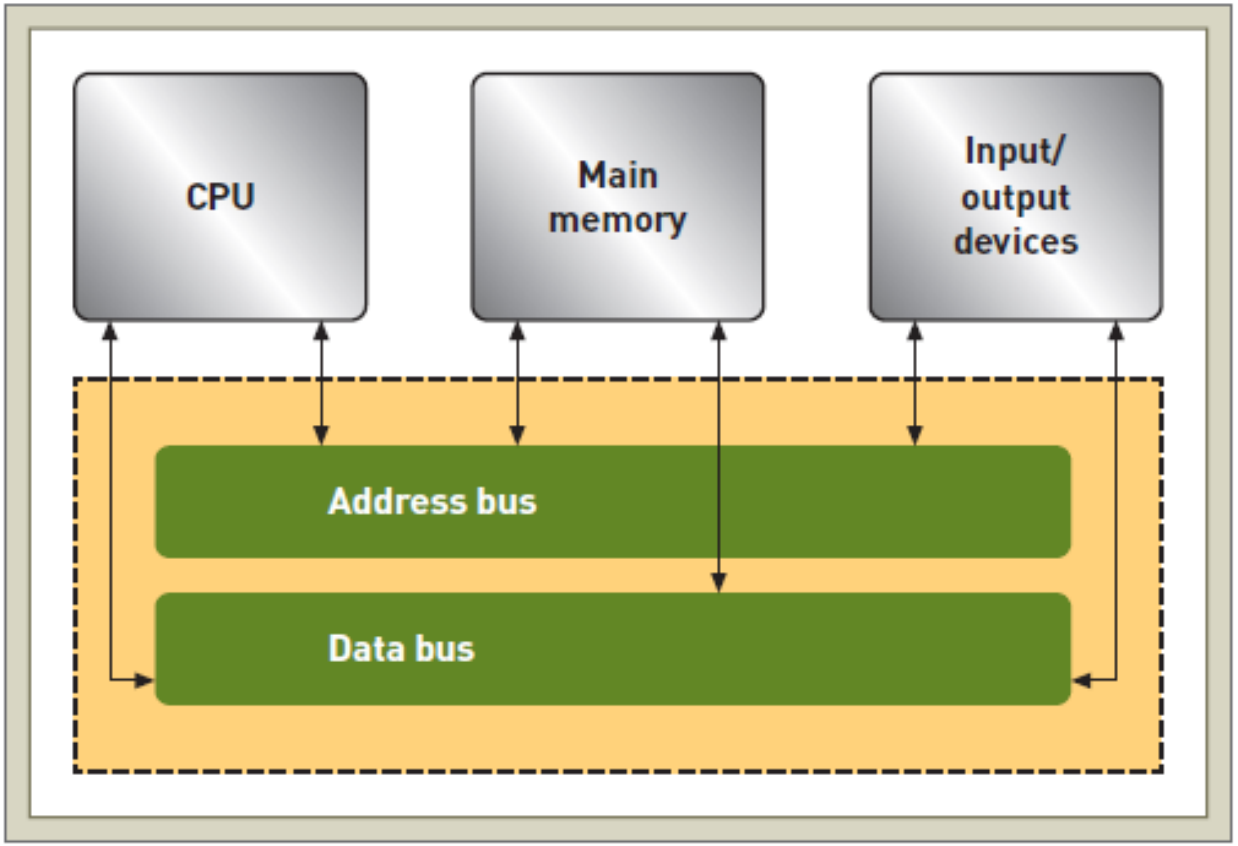


FIGURE 3.1

Basic anatomy of a computer

Computer hardware components include the processor (CPU), memory, address and data bus, and input/output devices.

Processor

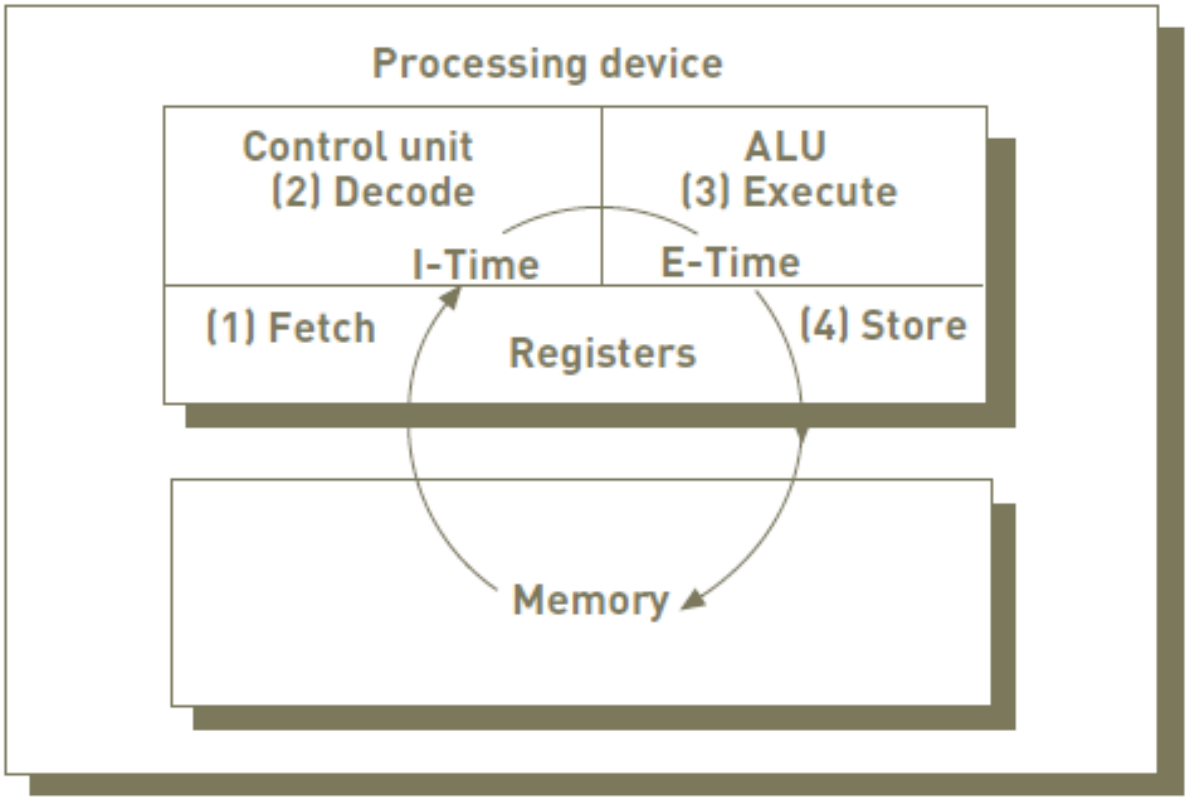
- Central processing unit (CPU) components
  - Arithmetic/logic unit, the control unit, and the register areas
  - Part of the computer that sequences and executes instructions
- Memory
  - Provides the processor with a working storage area to hold program instructions and data
- Input/output devices
  - Provide data and instructions to the computer and receives results from it

Processor

- Completing an instruction involves two phases, which are broken down into four steps:
  - The instruction phase
    - Step 1: fetch instruction
    - Step 2: decode instruction
  - The execution phase
    - Step 3: execute instruction
    - Step 4: store results

Processor

FIGURE 3.2
Execution of an instruction
(1) In the instruction phase, a program's instructions and any necessary data are read into the processor. (2) The instruction is then decoded by the control unit of the CPU so that the central processor can understand what to do. (3) In the execution phase, the arithmetic and logic unit (ALU) component of the CPU does what it is instructed to do, making either an arithmetic computation or a logical comparison. (4) The results are then stored in the registers or in memory. The instruction and execution phases together make up one machine cycle.



Processor

- Clock speed
  - A series of electronic pulses produced at a predetermined rate that affects machine cycle time
  - Often measured in gigahertz (GHz): billions of cycles per second
  - Many of today's computers operate in the 1 to 4 GHz range

Processor Families

- Instruction set architecture (ISA) of a computer
  - Defines the basic set of commands (opcodes) that the processor can execute
- Processor family
  - A set of processors from the same manufacturer that have similar features and capabilities
  - Examples:
    - x86 family
    - Intel Atom
    - ARM

Multiprocessing

- Multiprocessing
  - Involves the simultaneous execution of two or more instructions at the same time
  - One form uses coprocessors
- Coprocessor
  - Speeds processing by executing specific types of instructions while the CPU works on another processing activity
- Multicore processor
  - Has two or more independent processing units, called cores

Parallel Computing

- Parallel computing
  - The simultaneous execution of the same task on multiple processors
- Massively parallel processing systems
  - Systems with thousands of such processors
  - Links hundreds or even thousands of processors to operate at the same time
- Grid computing
  - The use of a collection of computers that work in a coordinated manner to solve a common problem

Manufacturing Processors

- Integrated circuit (IC)
  - A set of electronic circuits on one small piece of semiconductor material
  - Processors and memory chips are examples
- Semiconductor fabrication plant
  - Factory where ICs are manufactured

Manufacturing Processors

TABLE 3.1 Some members of the Intel family of processors

Chip	Family	Product Name	MaxClock Speed (GHz)	Number of Cores	Lithography (Nanometers)
x86	Xeon	E7-2850	2.0	10	32
x86	Core i7	Extreme Edition 980x	3.3	6	32
x86	Core i5	6600	3.9	4	14
x86	Pentium	4 G4400T	2.9	2	14
Atom	x7	Z8700	2.4	4	14
Atom	x5	Z8500	2.2	4	14

Memory

- Main memory
  - Provides the CPU with a working storage area for programs and data
  - Rapidly provides data and instructions to the CPU
- Storage capacity
  - Byte (B): eight bits that together represent a single character of data

Memory

TABLE 3.2 Computer storage units

Name	Abbreviation	Number of Bytes
Byte	B	1
Kilobyte	KB	1,000
Megabyte	MB	$1,000^2$
Gigabyte	GB	$1,000^3$
Terabyte	TB	$1,000^4$
Petabyte	PB	$1,000^5$
Exabyte	EB	$1,000^6$
Zettabyte	ZB	$1,000^7$
Yottabyte	YB	$1,000^8$

Types of Memory

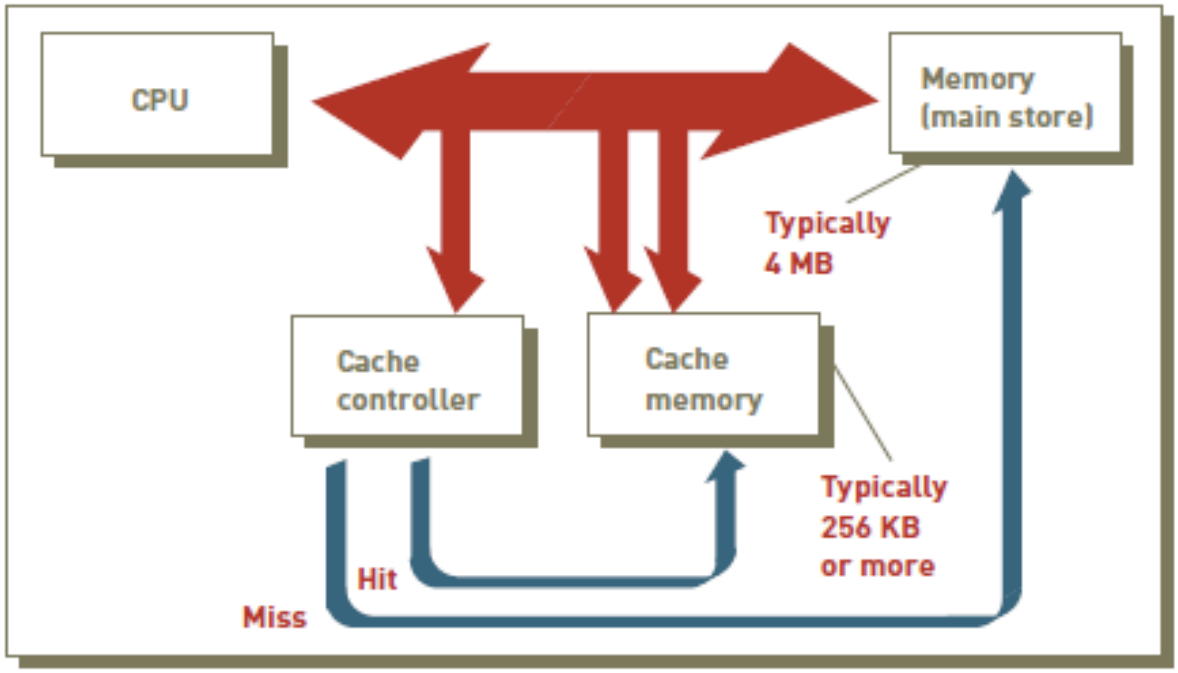
- Random access memory (RAM) is temporary and volatile
- Types of RAM
  - Static random access memory (SRAM) used for high-speed registers and caches
  - Dynamic random access memory (DRAM) used for main memory
  - Double data rate synchronous dynamic random access memory (DDR SDRAM)
- Cache memory: a type of high-speed memory that a processor can access more rapidly than main memory

Types of Memory

FIGURE 3.3

Cache memory

Processors can access this type of high-speed memory faster than main memory. Located on or near the CPU chip, cache memory works with main memory. A cache controller determines how often the data is used, transfers frequently used data to cache memory, and then deletes the data when it goes out of use.



Types of Memory

- Read-only memory (ROM) is nonvolatile
  - It provides permanent storage for data and instructions that do not change
- Types of ROM
  - Programmable read-only memory (PROM)
    - manufactured as blank memory
  - Electrically erasable programmable read-only memory (EEPROM)
    - a special type of PROM that can be erased by exposing it to ultraviolet light.

Secondary Data Storage Devices

- Secondary storage
  - Devices that store large amounts of data, instructions, and information more permanently than allowed with memory
- Advantages over memory
  - Nonvolatility
  - Greater capacity
  - Greater economy

Secondary Data Storage Devices

- Secondary storage is not directly accessible by the CPU
  - Computers usually use input/output channels to access secondary storage and then transfer the desired data to intermediate areas in primary storage
- Most common forms
  - Magnetic
  - Optical
  - Solid state

Magnetic Secondary Storage Devices

- Magnetic tape
  - A type of sequential secondary storage medium
  - Primarily for storing backups of critical organizational data
- Hard disk drive (HDD)
  - A direct access storage device; consists of rapidly rotating disks coated with magnetic material

Magnetic Secondary Storage Devices

- Redundant array of independent/inexpensive disks (RAID)
  - A method of storing data that generates extra bits of data from existing data
- Disk mirroring
  - A process of storing data that provides an exact copy that protects users fully in the event of data loss
- Virtual tape
  - A storage device for less frequently needed data

Optical Secondary Storage Devices

- A form of data storage that uses lasers to read and write data

- Common types of optical storage devices
  - Compact disc read-only memory (CD-ROM)
  - Digital video disc (DVD)
  - Blu-ray high-definition video disk
  - DNA data storage: experimental at this time

Solid State Secondary Storage Devices

- Solid state storage device (SSD)
  - Stores data in memory chips rather than magnetic or optical media
- Advantages
  - Require less power and provide faster access than magnetic data storage devices
  - Have no moving parts, so they are less fragile than hard disk drives
- A universal serial bus (USB) flash drive is a common SSD

Enterprise Storage Options

- Enterprise storage
  - Large secondary storage
- Forms of enterprise storage
  - Attached storage
  - Network-attached storage (NAS)
  - Storage area networks (SANs)
  - Cloud computing storage

Attached Storage

- Includes devices connected directly to a single computer
  - Tape, HDDs including RAID devices, virtual tape, optical devices, and SSDs
- Advantages: simple and cost effective for single users and small groups
- Disadvantages: does not allow systems to share storage, and data backup is difficult

Network-Attached Storage

- Network-attached storage (NAS)
  - A hard disk drive storage device that is set up with its own network address and provides file-based storage services to other devices on the network
- Common applications for NAS
  - Consolidated storage
  - Internet and e-commerce applications
  - Digital media

Storage Area Networks

- Storage Area Networks (SAN)
  - A high-speed, special-purpose network that integrates different types of data storage devices into a single storage system and connects that to computing resources across an entire organization
- SANs can provide capabilities such as:
  - Disk mirroring, data backup and restore, data archiving, data migration from one storage device to another, and sharing data among other devices
- A SAN deals with block input/output
  - Based on subsets of data smaller than a file

Storage Area Networks

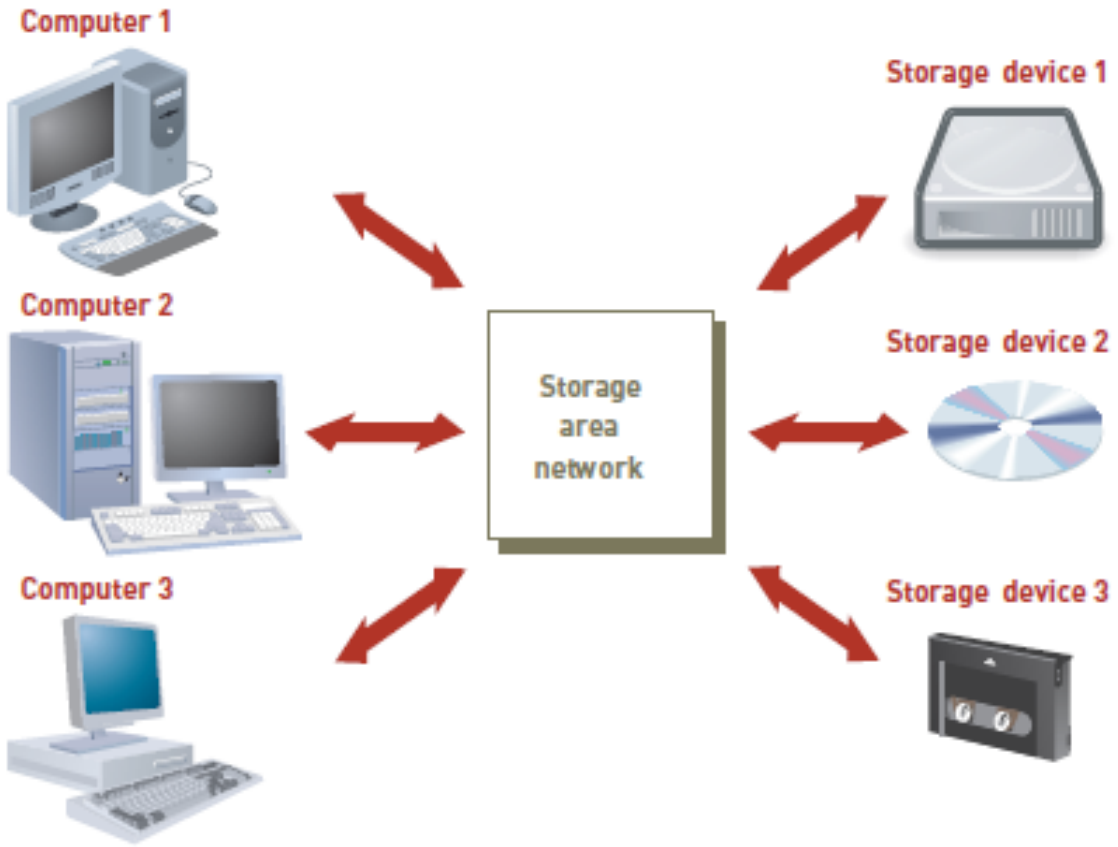


FIGURE 3.7

Storage area network

A SAN provides high-speed connections among data storage devices and computers over a network.

Storage as a Service

- Storage as a Service
  - A data storage model where a data storage service provider rents space to individuals and organizations
  - Rented data storage is accessed via the Internet

- Cloud-based storage services
  - Amazon's Elastic Compute Cloud, Apple iCloud, Dropbox, Google Drive, Microsoft SkyDrive, and Mozy
  - Amazon's Simple Storage Service (Amazon S3) allows subscribers to upload, store, and download data

Input and Output Devices

- Input and output devices:
  - Allow the user to provide data and instructions to the computer and to receive results from it
  - Are part of a computer's user interface
- Organizations should keep their business goals in mind when selecting input and output devices
- Desired characteristics
  - Input devices: allow accurate and rapid entry
  - Output devices: produce timely results
- Specialized functions may be required

Data Entry and Input

- Two-stage process of getting data into the computer system
  - Data entry: converting human-readable data into a machine-readable form
  - Data input: transferring the machine- readable data into the system
- Many companies are using online data entry and input

Source Data Automation

- Capturing and editing data where it is initially created and in a form that can be directly entered into a computer
  - Ensures accuracy and timeliness
- Example: salesperson entering a sales order into the computer at the time and place the order is taken

Input Devices

- Common Personal Computer Input Devices
  - Keyboard and mouse
- Speech-Recognition Technology
- Motion-Sensing Input Devices
- Scanning Devices
- Optical Data Readers
- Magnetic Ink Character Recognition (MICR) Devices

Input Devices

FIGURE 3.9

MICR device

Magnetic ink character recognition technology codes data on the bottom of a check or other form using special magnetic ink, which is readable by people and computers.

Input Devices

- Magnetic Stripe Cards
- Smart Cards
- Contactless Payment Cards
- Point-of-Sale (POS) Devices
- Automated Teller Machine (ATM) Devices
- Bar-Code Scanners
- Radio Frequency Identification (RFID) Devices
- Pen Input Devices
- Touch Screens

Input Devices

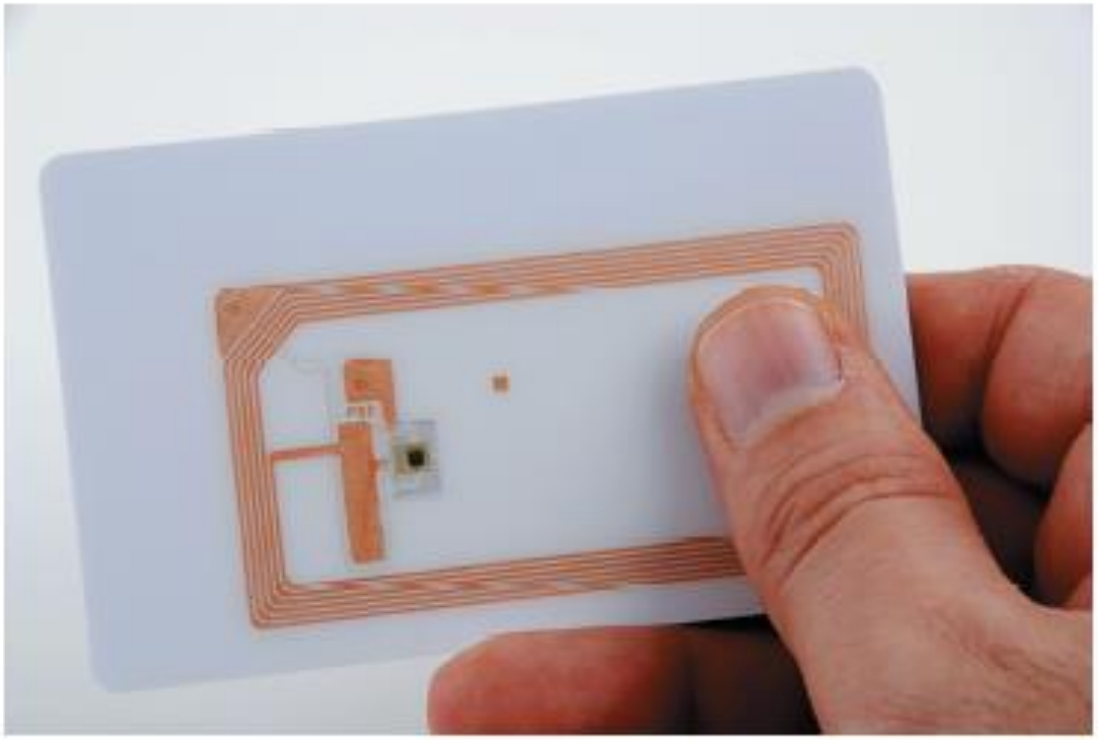


FIGURE 3.10

RFID tag

An RFID tag is small compared with current bar-code labels used to identify items.

Output Devices

- Display Screens
  - Used to show output from the computer

TABLE 3.4 Various types of flat-panel displays

Type	Description	Noteworthy Feature
Liquid crystal display (LCD)	Uses several layers of charged liquid crystals placed between clear plates that are lit from behind by a fluorescent light to create light and images	The viewing angle tends to be worse than that of plasma displays
Light-emitting diode (LED)	An LCD display that uses light-emitting diodes (LEDs) as backlight on the screen rather than a fluorescent lamp	Provides better contrast and lower energy consumption than LCDs
Organic light-emitting diode (OLED)	Functions by exciting organic compounds with electric current to produce bright, sharp images	Does not employ a backlight, which enables improved contrast and lower power consumption than LCD and LED LCD displays
Plasma	Uses electricity to excite gas atoms to light up appropriate phosphors on the screen to emit light and color	Performs well in dark conditions but not as well in well-lit rooms

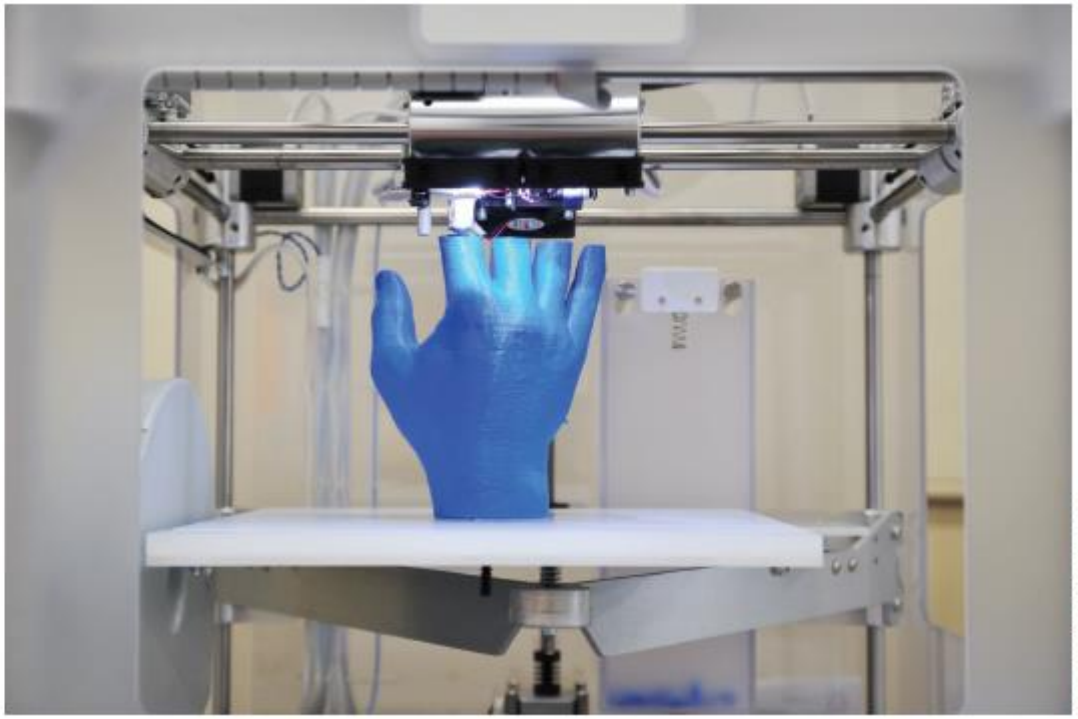
Output Devices

- Printers and Plotters
  - Two main types of printers
    - Laser
    - Inkjet
  - Mobile print solutions enable users to wirelessly send documents, email messages and attachments, presentations, and other documents from any smartphone, tablet, or laptop to any mobile-enabled printer in the world
  - Plotters are used for general design work
    - Blueprints, schematics, and drawings of buildings

Output Devices

- 3D Printers
  - 3D technology takes a three-dimensional model of an object stored on a computer and sends it to a 3D printer to create the object using strands of a plastic filament or synthetic powder
  - Commonly used by aerospace firms, auto manufacturers, and other design-intensive companies
  - Bioprinting
    - Uses 3D printers to build human parts and organs from actual human cells

Output Devices



dreamnikon/iStock/Getty Images

FIGURE 3.11
3D printer
3D print technology is making it possible to print objects ranging from everyday objects to houses.

Output Devices

- Digital Audio Players
  - Device that can store, organize, and play digital music files
  - MP3: a popular format for compressing a sound sequence into a very small file while preserving the original level of sound quality
- E-Book Readers
  - An electronic book (e-book) is the digital media equivalent of a conventional printed book
  - Usually have the capacity to store thousands of books

Computer System Types

- General classification
  - Special-purpose computers
  - General-purpose computers
- Two major groups of general-purpose computers
  - Single-user computers
  - Multiple-user computers

Portable Computers

- Portable computers are small enough to carry easily
- Wearable computers
  - An electronic device capable of storing and processing data that is incorporated into a person's clothing or personal accessories
  - Health tracking wrist bands and smart watches are examples

Portable Computers

- Smartphones
  - Allow users to place calls, download and run apps, send and receive text messages and email, view documents and files, take and send photos and videos, get driving directions via GPS, browse Web sites, and create playlists of digital tunes
- Mobile Computers
  - Laptops are designed for use by mobile users
  - Notebooks and ultrabooks are smaller than laptops
  - Tablet computers are portable, lightweight computers with or without a keyboard

Portable Computers

FIGURE 3.13
Tablet
The Samsung Galaxy Note 10.1 Android tablet has a large touch screen and a quad-core processor.

Thin Clients, Desktops, and Workstations

- A thin client is a low-cost, centrally managed computer with no internal or external attached drives for storage
- Desktop computers are single-user computer systems that are highly versatile
- A nettop computer is an inexpensive desktop computer
  - Smaller, lighter, and consumes much less power than a traditional desktop computer
- Workstations are more powerful than personal computers but still small enough to fit on a desktop

Servers, Mainframes, and Supercomputers

- Server
  - A computer employed by many users to perform a specific task, such as running network or Internet applications
  - Usually has special features that make it more suitable for operating in a multiuser environment
- Scalability: the ability to increase the processing capability
  - Enable the system to handle more users, more data, or more transactions
- Mainframe computer: a large, powerful computer shared by hundreds of concurrent users connected to the machine over a network
- Supercomputers: one of the most powerful computer systems with the fastest processing speed

Servers, Mainframes, and Supercomputers

TABLE **3.7** Five most powerful operational supercomputers (July 2015)

Rank	Name	Manufacturer	Research Center	Location	Number of Cores	Speed (Petaflops)
1	Tianhe-2	NUDT	National University of Defense Technology (NUDT)	China	3.1 million	33.9
2	Titan	Cray	Oak Ridge National Laboratory	United States	0.56 million	17.6
3	Sequoia	IBM	Lawrence Livermore National Laboratory	United States	1.5 million	17.2
4	K	Fujitsu	Riken Advanced Institute for Computational Science	Japan	0.75 million	10.5
5	Mira	IBM	Argonne National Laboratory	United States	0.8 million	8.6

Source: Lendino, Jamie, "China's Tianhe-2 Still the Fastest Supercomputer in the World, but the US Is Catching Up," *Extreme Tech*, July 13, 2015, *www.extremetech.com/extreme/209704-chinas-tianhe-2-still-the-fastest-supercomputer-in-the-world-but-the-us-is-catching-up*.

Server Farms

- Server farm: a room used to house a large number of servers
  - Access to the machines can be controlled and authorized support personnel can more easily manage and maintain the servers
- Virtual server: a method of logically dividing the resources of a single physical server to create multiple logical servers
  - Each logical server acts as its own dedicated machine
- Blade server: a server that houses many individual computer motherboards
  - Include one or more processors, computer memory, computer storage, and computer network connections
  - Share a common power supply and air-cooling source within a single chassis

Server Farms

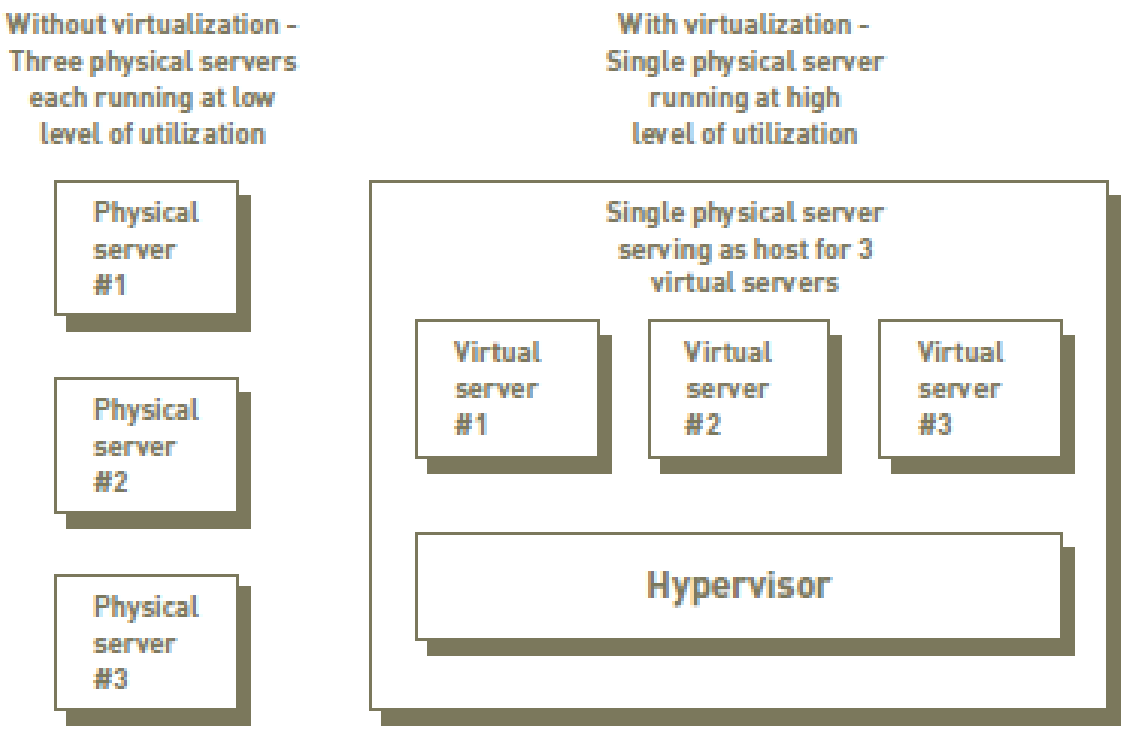


FIGURE 3.14

Virtual server

Virtualization is an approach to improving hardware utilization by logically dividing the resources of a single physical server to create multiple logical servers.

Data Center

- Data center
  - A climate-and-access-controlled building or a set of buildings that houses the computer hardware that delivers an organization's data and information services
- Factors driving growth in data centers:
  - Demand for additional computing capacity
  - Need for additional storage capacity
  - Some organizations are consolidating data centers from many locations down to just a few locations

Data Center

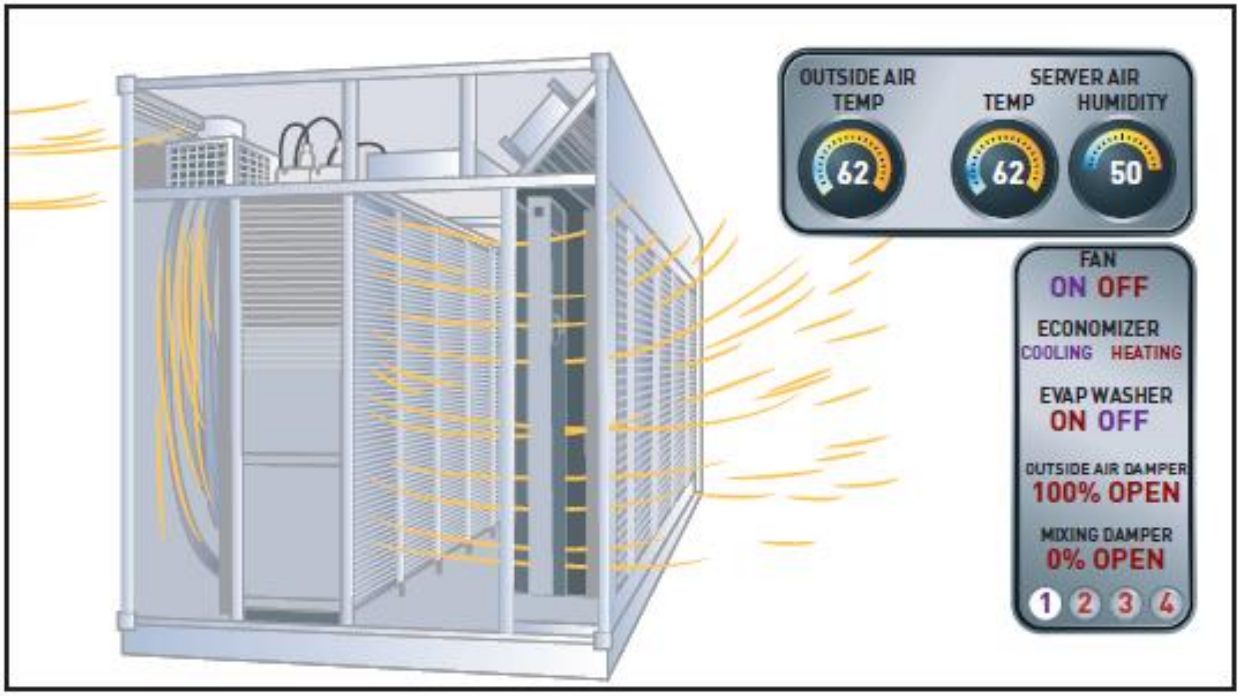


FIGURE 3.15

Modular data center

Microsoft employs a state-of-the-art modular data center.

Source: *www.datacenterknowledge.com/archives/2013/01/31/microsofts-1-billion-roof less-data-center/*

Data Center

- Construction Considerations
  - More efficient operation and reduced energy for processing and cooling
    - Modular design
    - Location: areas with milder climates and lower energy rates and land costs
  - Ability to absorb the impact of a disaster (e.g., hurricane, earthquake, terrorism attack, or war) and quickly restore services

Green Computing

- A program concerned with the efficient and environmentally responsible design, manufacture, operation, and disposal of IS-related products

- Goals
  - Reduce the use of hazardous material
  - Allow companies to lower their power-related costs
  - Enable safe disposal or recycling of equipment

Green Computing

- Electronic Product Environmental Assessment Tool (EPEAT)
  - A system that enables purchasers to evaluate, compare, and select electronic products based on a total of 51 environmental criteria

TABLE 3.8 EPEAT product tiers for computers

Tier	Number of Required Criteria That Must Be Met	Number of Optional Criteria That Must Be Met
Bronze	All 23	None
Silver	All 23	At least 50%
Gold	All 23	At least 75%

Summary

- The computer hardware industry is rapidly changing and highly competitive, creating an environment ripe for technological breakthroughs
- Computer hardware must be carefully selected to meet the evolving needs of the organization and its supporting information systems
- The computer hardware industry and users are implementing green computing designs and products

- Principles of Information Systems, Thirteenth Edition