

Hardware and Mobile Devices

Information Technology Infrastructure

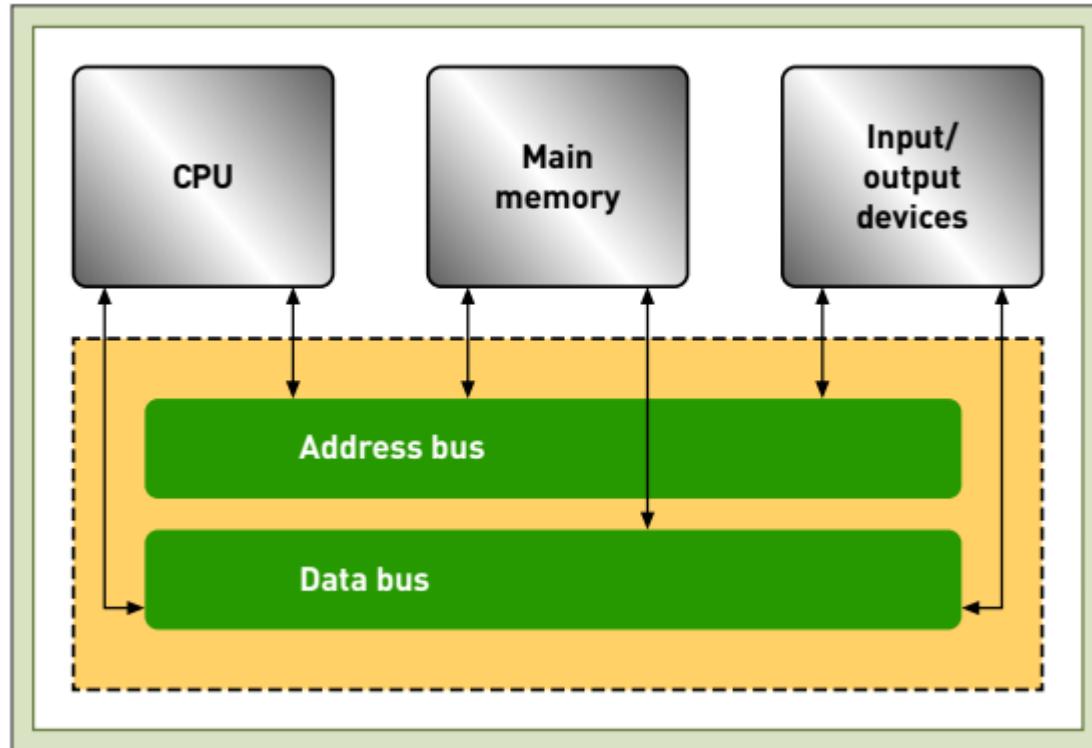
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Learning Outcomes

- Understand the anatomy and characteristics of computers and mobile devices
- Understand the environment of thin clients, desktops, and workstations
- Understand the differences between servers, mainframes, and supercomputers
- Understand the concept of server farms, virtualization, data center, and green computing

Hardware

Computer Anatomy



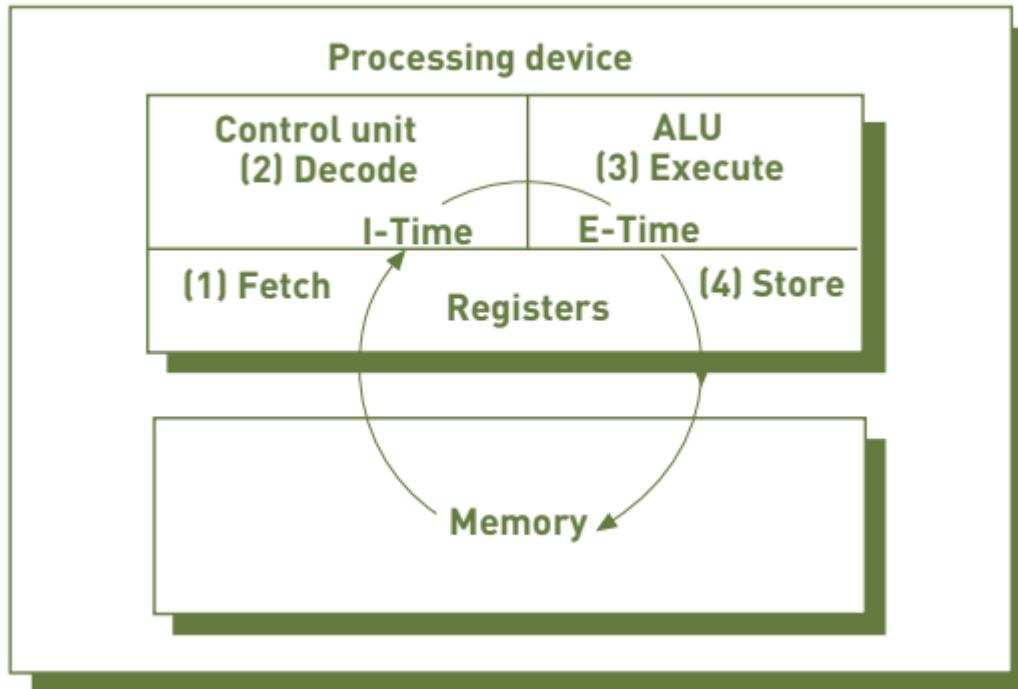
Computer system hardware components include devices that perform input, processing, data storage, and output.

These include the processor, memory, and input/output devices

Processor

- The central processing unit (CPU) or simply processor is the part of a computer that sequences and executes instructions.
- Memory provides the processor with a working storage area to hold program instructions and data.
 - Rapidly provides data/instructions to processor.
- Input/output devices provide data and instructions to the computer and receive results from it.
 - Data and instructions move between components over the bus, a set of electronic circuits.

Execution of an Instruction



Instruction phase: fetch and decode instructions

Execution phase: execute instruction and store results

- (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 Terminology

- Clock speed: A series of electronic pulses produced at a predetermined rate that affects machine cycle time.
- Gigahertz (GHz): A unit of frequency that is equal to one billion cycles per second; a measure of clock speed.
- Instruction Set Architecture (ISA): A basic set of commands (opcodes) that the processor can execute.

Processor Families

- A set of processors from the manufacturer that have similar features and capabilities.
 - x86: Intel, AMD, and VIA processors
 - Intel Atom: Lightweight x86 processors
 - ARM: Snapdragon, Mac M-series, mobile processors
- ARM is based on Reduced Instruction Set Processing (RISC), hence efficient

Multiprocessing

- **multiprocessing:** The simultaneous execution of two or more instructions at the same time.
- **coprocessor:** The part of the computer that speeds processing by executing specific types of instructions while the CPU works on another processing activity.
- **multicore processor:** A microprocessor that has two or more independent processing units, called cores, which are capable of sequencing and executing instructions.

Parallel Computing

- **Parallel computing:** The simultaneous execution of the same task on multiple processors to obtain results faster.
- **Massively parallel processing system:** A system that speeds processing by linking hundreds or thousands of processors to operate at the same time, or in parallel, with each processor having its own bus, memory, disks, copy of the operating system, and applications.
- **Grid computing:** The use of a collection of computers, that work in a coordinated manner to solve a common problem.



IBM Sequoia supercomputer
with over 1.5 million processing
cores that allow it to process
over 17 quadrillion
computations per second.

Processor Manufacturing

- Processors are manufactured in an integrated circuit (IC),
- Intel, Samsung, and, STMicroelectronics design and manufacture their chips in their own fab/foundry plants.
- Qualcomm, Nvidia, and AMD are examples of fabless manufacturers; outsource their manufacturing to foundry companies who fabricate the design.
 - Samsung and TSMC

Memory

- Main memory: The component of a computer that provides the CPU with a working storage area for program instructions and data.
- byte (B): Eight bits that together represent a single character of data.

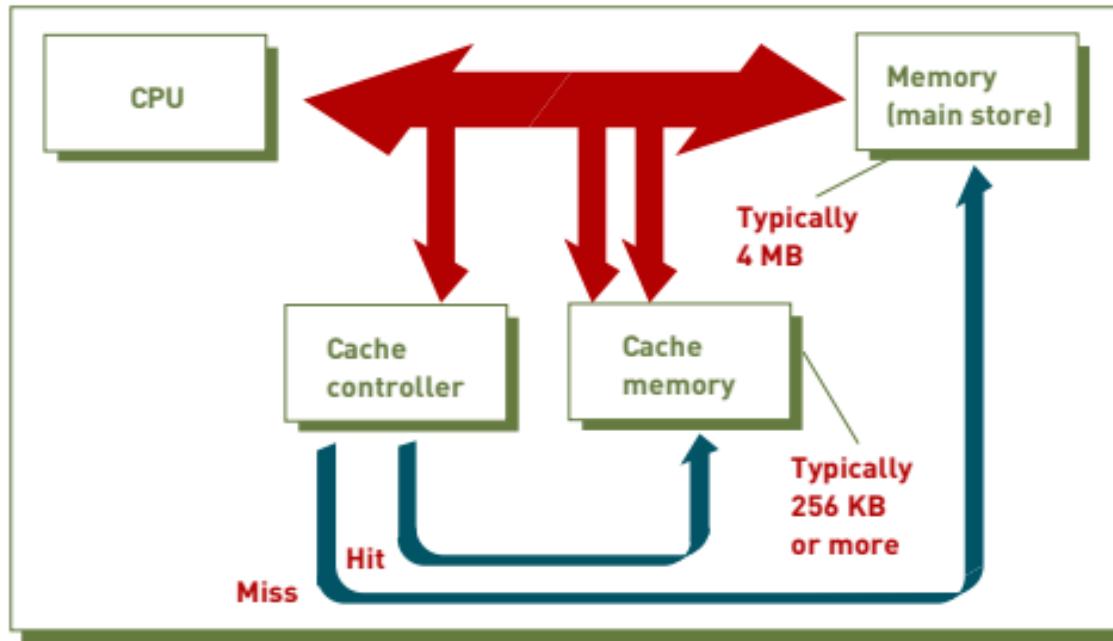
Memory Types

- Random access memory (RAM): a form of memory in which instructions or data can be temporarily stored.
- Cache memory: A type of high-speed memory that a processor access more rapidly than main memory.
- Read-only memory (ROM): non-volatile form of memory.
 - Programmable read-only memory (PROM)
 - Electrically erasable programmable read-only memory (EEPROM)

Random Access Memory

- Static random access memory (SRAM) is byte-addressable storage used for high-speed registers and caches;
- Dynamic random access memory (DRAM) is byte-addressable storage used for the main memory in a computer;
 - Double data rate synchronous dynamic random access memory (DDR SDRAM) doubles the rate at which data are moved in and out of main memory.

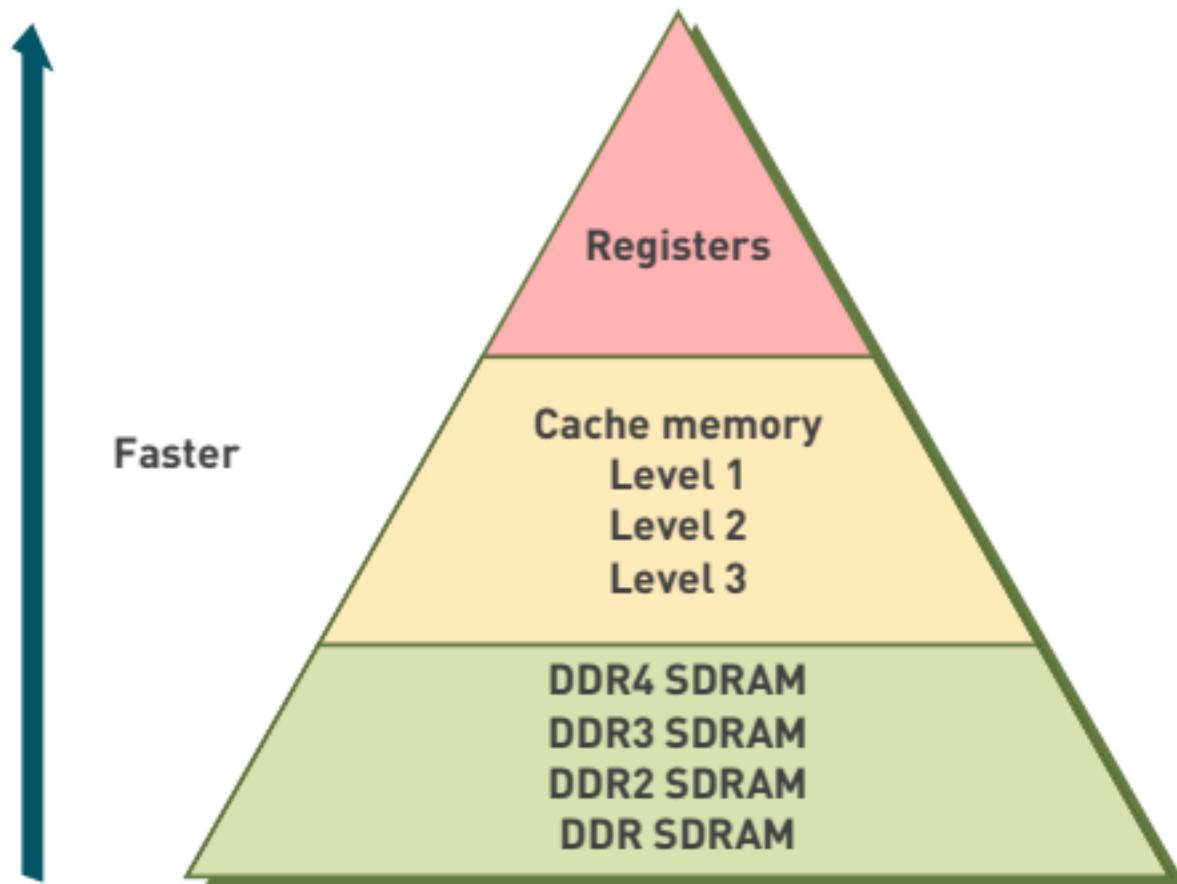
Cache Memory



Cache memory:
A type of high-speed memory that a processor access more rapidly than main memory.

The level 1 (L1) cache is on the CPU chip. The level 2 (L2) cache memory can be accessed by the CPU over a high-speed dedicated interface. The latest processors go a step further, placing the L2 cache directly on the CPU chip itself and providing high-speed support for a tertiary level 3 (L3) external cache

Storage Speed



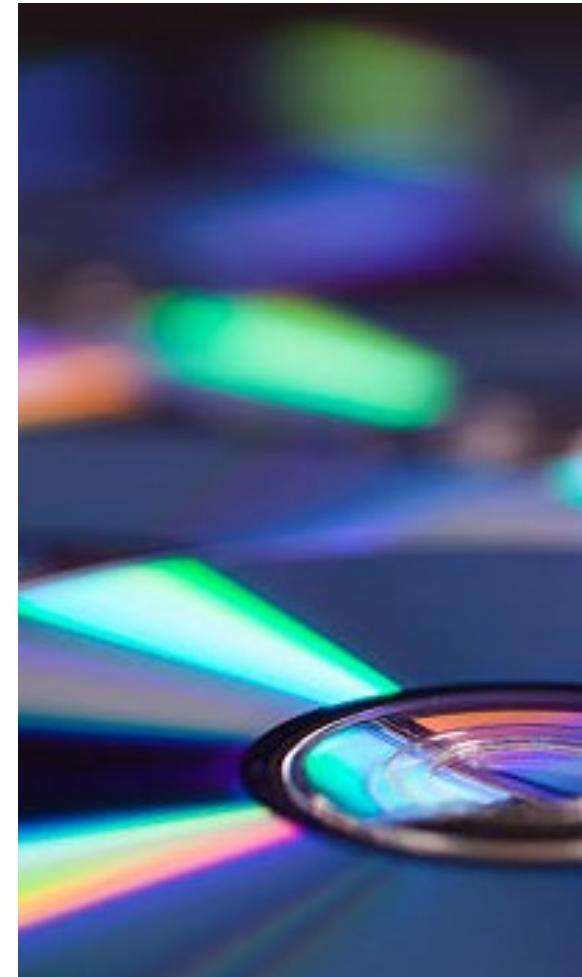
Secondary Data Storage

- A device that stores large amounts of data, instructions, and information more permanently than allowed with main memory.
 - Magnetic tape: now used primarily for storing backups of critical organizational data in the event of a disaster.
 - Hard disk drive (HDD): A direct access storage device to store and retrieve data from rapidly rotating disks coated with magnetic material.

Redundant array of independent/inexpensive disks (RAID): A method of storing data that generates extra bits of data from existing data, allowing the system to create a “reconstruction map” so that if a hard drive fails, the system can rebuild lost data.

Optical Data Storage

- Uses special lasers to read and write data.
 - Lasers record data by physically burning pits in the disc medium
- Compact disc read-only memory (CD-ROM): A form of optical disc on which data cannot be modified once it has been recorded.
- Digital video disc (DVD): A disc storage that looks like a CD but that can store more data and access it more quickly.



Solid State Storage

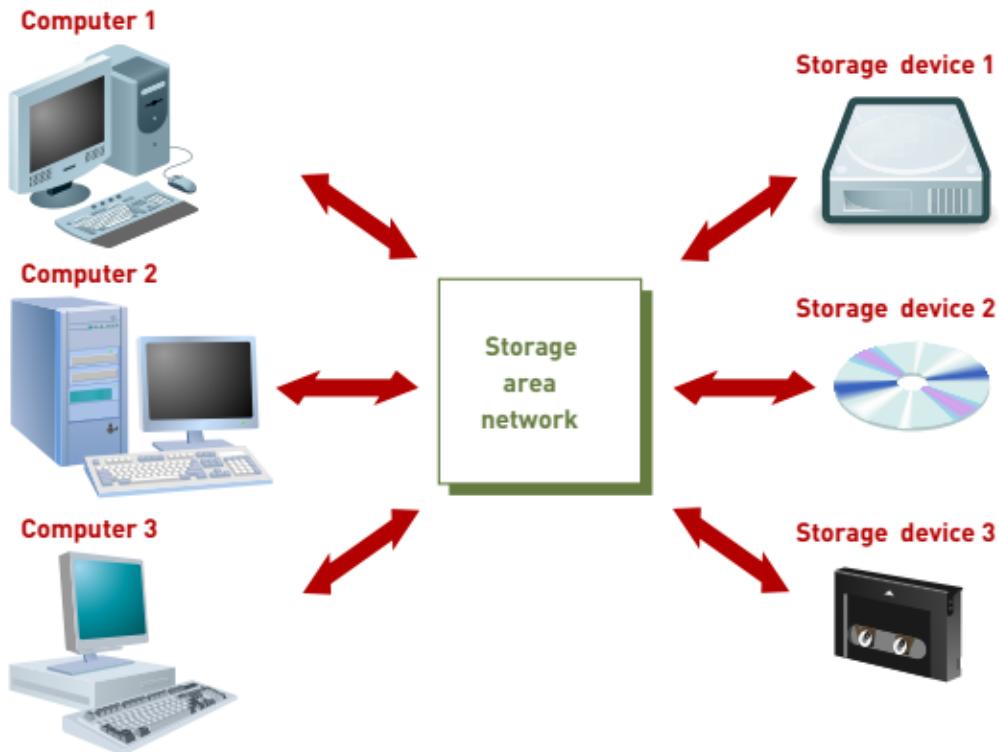
- A storage device that stores data in memory chips rather than on hard disk drives or optical media.
- A universal serial bus (USB) flash drive is one example of a commonly used SSD.



Enterprise Storage Options

- 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.
- Storage as a service: A data storage model where a data storage service provider rents space to individuals and organizations.
 - Google Drive, One Drive, etc.

Storage Area Network (SAN)



Storage area network (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.

Input and Output Devices

- Gateways to the computer systems; used to provide data and instructions to the computer and receive results from it.
- Input and output devices are part of a computer's user interface; includes hardware devices and software that allow users interact with a computer system.

Data Entry and Input

- **Data entry:** Converting human-readable data into a machine-readable form.
- **Data input:** Transferring machine-readable data into the system.
- General types of data, including text, audio, images, and video for personal computers.

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Input Devices

- Common Input Devices, keyboard and mouse
- Speech-Recognition Technology
- Motion-Sensing Input Devices
- Scanning Devices
- Optical Data Readers
- Magnetic Ink Character Recognition (MICR) Devices
- Magnetic Stripe Cards
- Touch Screens
- Chip Cards
- Smart Cards
- Contactless Payment Cards
- Point-of-Sale Devices
- Automated Teller Machine (ATM) Devices
- Bar-Code Scanners
- Radio Frequency Identification (RFID) Devices
- Pen Input Devices

Output Devices

- Display Screens
 - LCD, LED, CRT, OLED, Plasma
 - Computer graphics card: a component of a computer that takes binary data from the CPU and translates into an image.
 - Graphics processing unit (GPU): a powerful processing chip that renders images on the screen display.
- Printers, Plotters, 3D Printer
- Digital Audio Player
- E-Book Readers

Discussion

- Should you purchase a computer with an x86 processor, an Intel Atom processor, or an ARM processor? What are the pros and cons of each type of processor? Will you want a multicore processor? Why or why not?
- What sort of main memory and cache memory should you seek?
- What sort of secondary storage devices would most economically meet your needs?
- Which input and output devices would be most useful to you?

Mobile Devices

Portable Computers

- Computers that are small enough to carry easily
 - Wearable computers, smartphones, laptops, notebooks, ultrabooks, smartwatch, and tablets.
- **Wearable computer:** An electronic device capable of storing and processing data that is incorporated into a person's clothing or personal accessories.

Smartphones

- A portable computer to place calls, download and run apps, access the Internet, view documents and files, take and send photos and videos, get driving directions via GPS, and create a playlist of digital tunes.
- Smartphones employ a combination chipset called a “System on a Chip (SoC),” which includes processor cores, RAM and ROM memory, interface controllers, and voltage regulators

Portable Computers

- **Laptop:** A personal computer designed for use by mobile users, being small and light enough to sit comfortably on a user's lap.
- **Tablet:** A portable, lightweight computer with no keyboard that allows you to roam the office or home, carrying the device like a clipboard.



Thin Clients, Desktops, and Workstations

- Nonportable single-user computers include thin client computers, desktop computers, nettop, and workstations.
- Thin client: A low-cost, centrally managed computer with no internal or external attached drives for data storage.
 - The Chromebook, which runs the Chrome OS operating system, is a highly portable device, is widely used in many schools, and is an example of a thin client.

Thin Clients, Desktops, and Workstations (2)

- **Desktop computer:** A nonportable computer that fits on a desktop and provides sufficient computing power, memory, and storage for most business computing tasks.
- **Nettop:** A very small, inexpensive desktop computer for Internet access, email, accessing web-based applications, document processing, and audio/video playback.
- **Workstations:** A more powerful personal computer used for mathematical computing, computer-assisted design, and other high-end processing 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.
 - Offer great scalability, to increase the processing capability of a computer system so that it can handle more users, more data, or more transactions of a period.

Servers, Mainframes, and Supercomputers (2)

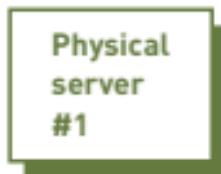
- Mainframe computer: A large, powerful computer often shared by hundreds of concurrent users connected to the machine over a network.
- Supercomputers: The most powerful computer systems with the fastest processing speeds.

Server Farms

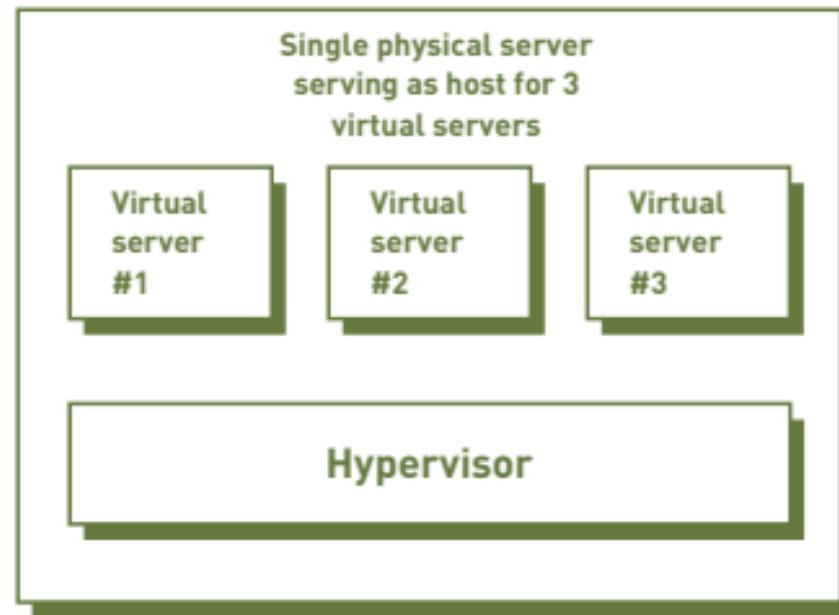
- A facility that houses a large number of servers in the same room, where access to the machines can be controlled and authorized support personnel can more easily manage and maintain the servers.
- Virtual server: A method of logically dividing the resources of a single physical server to create multiple logical servers, each acting as its own dedicated machine.

Virtualization

Without virtualization -
Three physical servers
each running at low
level of utilization



With virtualization -
Single physical server
running at high
level of utilization



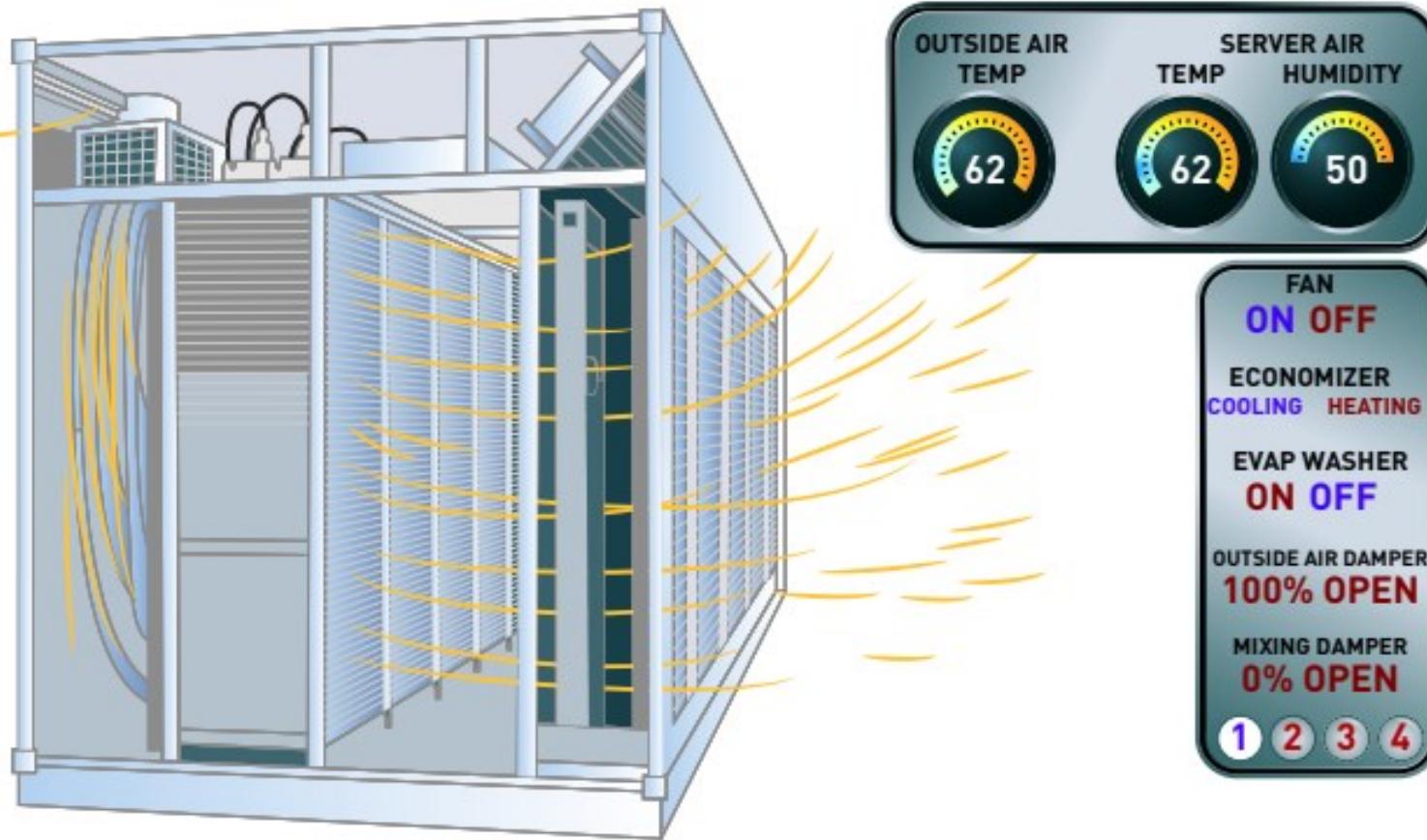
Virtualization

- **Container:** A way for software developers and hardware managers to package applications and software components into a well-defined, compact envelope that can be used to more easily manage it, including moving it across various hosts.
- **Blade server:** A server that houses many individual computer motherboards that include one or more processors, computer memory, computer storage, and computer network connections.

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.

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Green Computing

- A program concerned with the efficient and environmentally responsible design, manufacture, operation, and disposal of IS-related products.
- Electronic Product Environmental Assessment Tool (EPEAT)
 - A system that enables purchasers to evaluate, compare, and select electronic products based on a set of environmental criteria.

Discussion

- In what ways is a move toward green computing consistent with your organization's mission of developing renewable energy sources?
- One green computing proposal is to consolidate the three data centers into one. Discuss the pros and cons of this approach.
- Identify two additional tactics the organization might take to accelerate its move toward green computing?
- Identify the pros and cons or any issues associated with your proposed tactics

Questions?