

Overview of Operating Systems

**CISC 3320 — CUNY Brooklyn College
Lecture Notes**



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Definition of an Operating System

What is an **Operating System (OS)**?



Definition of an Operating System

The video at <https://www.youtube.com/watch?v=RhHMgkUdhdk> defines an Operating System in one way:



<https://www.youtube.com/watch?v=RhHMgkUdhdk>



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Definition of an Operating System

Follow-up questions:

1. What is the definition of OS that the video mentions?
2. How do programs communicate with the OS (e.g., to request services or info?)
3. What are some famous computer operating system brand names?
4. Where are OSs usually installed (besides on computers and phones?)
5. Can you think of additional definitions of OS?



Definition of an Operating System

Several More Definitions of an OS:

- "A program that manages a computer's resources, especially the allocation of those resources among other programs." — [Encyclopedia Britannica](#)
- "An interface between a computer user and computer hardware." — [Tutorials Point](#)
- "Software that controls the operation of a computer and directs the processing of programs." — [Merriam-Webster](#)
- Another idea: A program that operates from a device's launch to its shutdown.



Reasons for Studying Operating Systems

Why do we study operating systems? Why wouldn't learning programming be sufficient?

- At any point during your career, you might be asked to analyze or modify the functionality of an operating system.
- You can make your programs work more efficiently by understanding how an operating system executes them.
- The algorithmic approaches that operating systems use to solve various problems may inspire your own programming practice.



Software Types

To understand how operating systems relate to other programs, we should first learn what software types exist.

1. **System software** is a collection of programs that sit on top of, control, and manage hardware. It provides services to other applications. System software includes:
 - i. The **operating system**, and
 - ii. **Utility software**, which is not as essential as the OS but helps in analyzing the computer's behavior, debugging errors, and optimizing its operation.



Software Types

2. **Application software** (or **user application software**) includes any applications that let users complete daily tasks. Application software depends on and cannot operate without the services of the system software.

Note, however, that it is sometimes hard to tell whether a piece of software is system software or application software, and there are big debates and even court case decisions on this question. Example: in the [U.S. vs. Microsoft Corp.](#) case, the debate is whether a browser is counted as system software or not.



Software Types

Examples of software included in the **operating system**:

- **Kernel** = a core that includes instructions for the OS's basic functionality.
- **Drivers** = each one provides services for and controls a specific type of hardware device.
- **User Interface** = a means by which a user can interact with the computer: either graphically by clicking on the screen or textually by typing instructions into a terminal/command-line utility.



Software Types

Examples of software included in **utility software**:

- **Text editors** = provide access to view or edit code and files.
- **Debuggers** = help the programmer detect bugs and analyze a program's execution at any stage.
- **Antivirus programs** = search for virus-like patterns in executables and remove possible threats to the device's operation.
- **File management programs** = allow viewing properties of, organizing, and deleting files.



Software Types

Examples of programs included in **application software**:

- **Office productivity apps:** [Microsoft Office](#), [LibreOffice](#), [Google's G Suite](#), etc.
- **Gaming apps:** [Minecraft](#), [Gold Miner](#), [Bertie the Brain](#), etc.
- **Music apps:** [Spotify](#), [Pandora](#), [YouTube Music](#), etc.
- **Video conference apps:** [Zoom](#), [Skype](#), [Blackboard Collaborate](#), [Microsoft Teams](#), etc.
- **Emails transfer apps:** [Gmail](#), [Yahoo!](#), [Thunderbird](#), [Outlook](#), etc.



Software Types

Any questions so far?



Operating System Brand Examples

Laptops/Desktops:

- Windows
- Mac OS
- Chrome OS
- Linux/UNIX

Phones/Tablets/Smart Watches:

- Android
- iOS

Every electronic device or appliance contains an operating system, no matter how simple its functionality is.



Types of Operating Systems

We can categorize OSs into types based on their functionality patterns:



https://www.youtube.com/watch?v=MR2ntdZW__A



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Types of Operating Systems

Another video:



<https://www.youtube.com/watch?v=SH64-xkxF5w>



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Types of Operating Systems

Follow-up questions:

1. What are some OS types mentioned in the videos?
2. Give an example of one of the mentioned OS types.
3. What type of OS should be used in medical or military conditions?
4. What type of OS should be used when sharing resources is wanted?



Types of Operating Systems

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Any questions so far?



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Hardware

Since the Operating System interacts directly with **hardware**, let's briefly recall some important hardware components that we will frequently mention during our course:



<https://www.youtube.com/watch?v=HB4I2CgkcCo>



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Hardware

Hardware components that every computer has are:

1. The **motherboard** is a board-shaped structure located inside a computer and is its most critical part: a computer cannot do calculations or remember short-term information without the elements located on it. Components on the motherboard include:
 - i. The **CPU** (Central Processing Unit) is the brain of the computer that performs calculations. A device might have several CPUs.



Hardware

1. ii. **RAM** (Random-Access Memory) is the short-term memory of a computer. This memory has a limited size and is volatile (will be erased when the computer shuts down.)
- iii. **ROM** (Read-Only Memory) stores a small program called **BIOS** that runs when the computer “boots” (turns on or restarts.) ROM is non-volatile, and cannot be deleted since it is "read-only".
- iv. **Cache** is a temporary storage of data located between the CPU and RAM. Accessing cache is faster than accessing RAM in most cases.



Hardware

1. v. **Buses** allow different components to communicate with each other. Buses include wires, optical fibers, and any software that makes them operate.
vi. Every computer also has a **power unit** that feeds electricity to the computer's clock.
2. The **Storage** (also **Secondary Storage**) component of the computer permanently stores data (until you decide to delete it.)
 - i. **Hard disk drives** have higher storage capacity, are cheap, but are slower.
 - ii. **Solid-state drives** are faster and use less power but are more expensive.



Hardware

2. iii. Given that both hard disk drives and solid-state drives are situated inside the computer, we could also resort to **external storage** devices, such as portable hard disk or solid-state drives, or such transportable plug-and-play devices as a **USB flash drive** and an **optical disc** (CD, DVD, Blu-ray, etc.)



External Hard Drive. [Harke](#), [CC BY-SA 3.0](#), via Wikimedia Commons.



USB Flash Drive. [Evan-Amos](#), Public domain, via Wikimedia Commons.



Optical Compact Disk (CD). [Original uploader: Sakurambo](#), [CC BY-SA 2.5](#), via Wikimedia Commons.

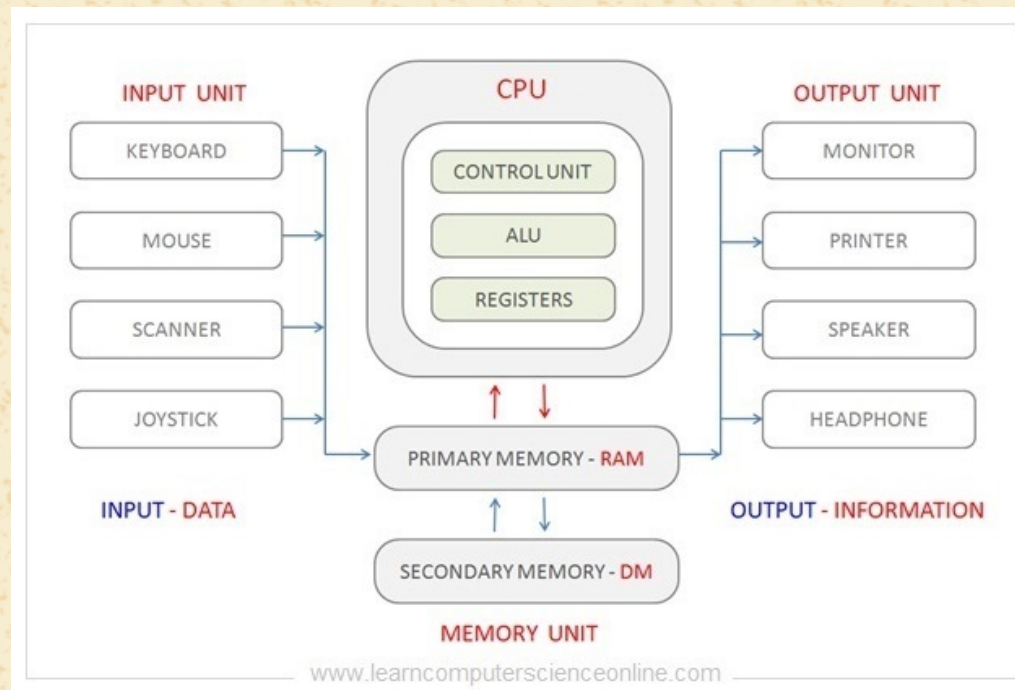


Hardware

3. Since computations are mostly useless if they are not communicated to the outside world, a computer uses **input & and output devices**:
- i. **Input device** examples: the keyboard, mouse (or touchpad), joystick, camera, and microphone.
 - Include devices that transmit user's data into the computer.
 - ii. **Output device** examples: the monitor, speakers, printer, and Braille embosser.
 - Consist of devices that let the computer deliver data to the user.



Hardware



Taken from <https://www.learncomputerscienceonline.com/introduction-to-computer-system/>.



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Hardware

In the Computer Architecture course, we learned that input/output (i/o) operations can be handled in several ways, including:

1. **Program-Controlled i/o**: the computer constantly inquires about whether an i/o event happened, and the CPUs handle i/o events, from start to finish.
2. **Interrupt-Based i/o**: the computer continues performing its tasks until an i/o-related interrupt occurs. CPUs handle the i/o event. After the event is handled, the computer continues with its tasks.



Hardware

3. **Direct Memory Access (DMA) i/o:** A device called a **DMA controller** that is separate from the CPU takes care of all the i/o instructions (besides handling interrupts) instead of the CPU.
4. **I/O Processors:** Smart i/o processor(s) resembling small CPUs control channel paths connected to i/o devices and handle entire i/o events, including interrupts.



Hardware

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Any questions so far?



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Security & Protection

To ensure that the device functions correctly and benignly, and to avoid the corruption of data, the operating system must reinforce security & protection measures.

Security is the ability of the computer to protect data from malicious actions, usually from outside.

An example of a security measure is to prevent an unauthorized user from accessing the data of a legit user, to which the unauthorized one has no access permissions.



Security & Protection

Protection is the ability of the computer to protect data from malicious actions, either advertent or unintentional, usually from the inside.

An example of a protection measure is to prevent the data of Program A to be overwritten by Program B due to miscalculations of memory and variable sizes.

We will elaborate on security & protection in one or two lectures at the end of the course.



Privileges

Some of the services that a program requests from the operating systems require special permission levels.

For instance, installing new utilities (programs) on a Windows or Linux device requires administrator permission.

The operating system maintains lists (or matrices) of activities or access types allowed by various users. These tasks are divided into groups, called **privilege rings**, a method that protects the computer and its data from corruption or malfunction.



Privileges



Privilege rings: from the most privileged to the least.

Taken from https://www.researchgate.net/figure/The-x86-privilege-level-architecture_fig1_235953591.



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Privileges

Any questions so far?



Overview of Operating Systems: Sources

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