# Introduction to Operating Systems

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# Lesson Plan

▶ Introduction to Operating Systems

▶ Functions of an Operating System

▶ Operating System Classifications

▶ Evolution of Operating Systems

▶ Q&A

▶ Additional Links

▶ Activity

SOUTHERN INSTITUTE OF TECHNOLOGY
TE WHARE WĀNANGA O MURIHIKU

Te Pūkenga

# Introduction to Operating Systems

▶ An Operating System (OS) is a software that manages computer hardware and software resources and provides common services for computer programs.

▶ OS acts as an interface between computer hardware components and the user and other software.
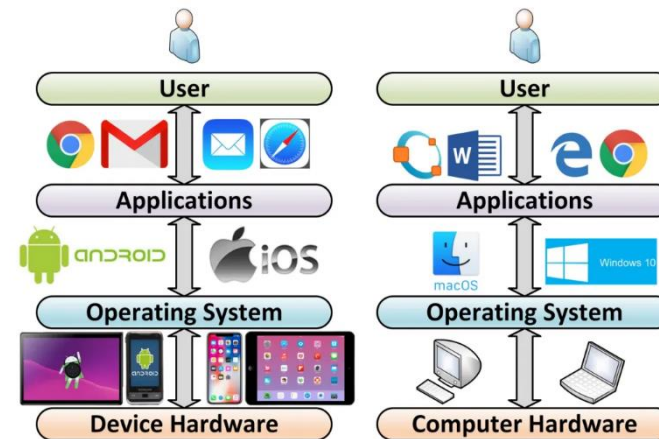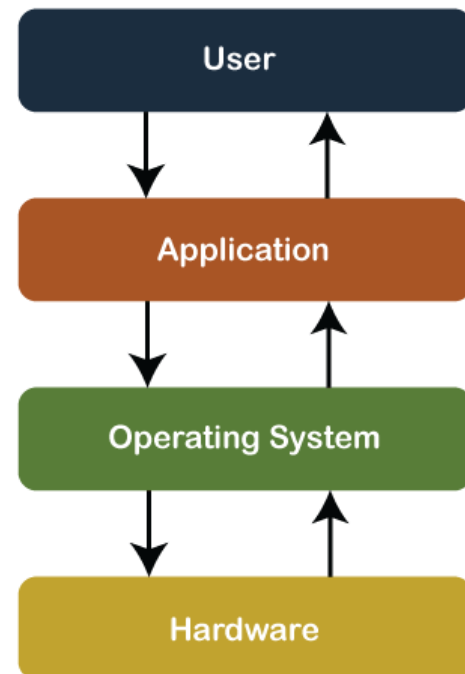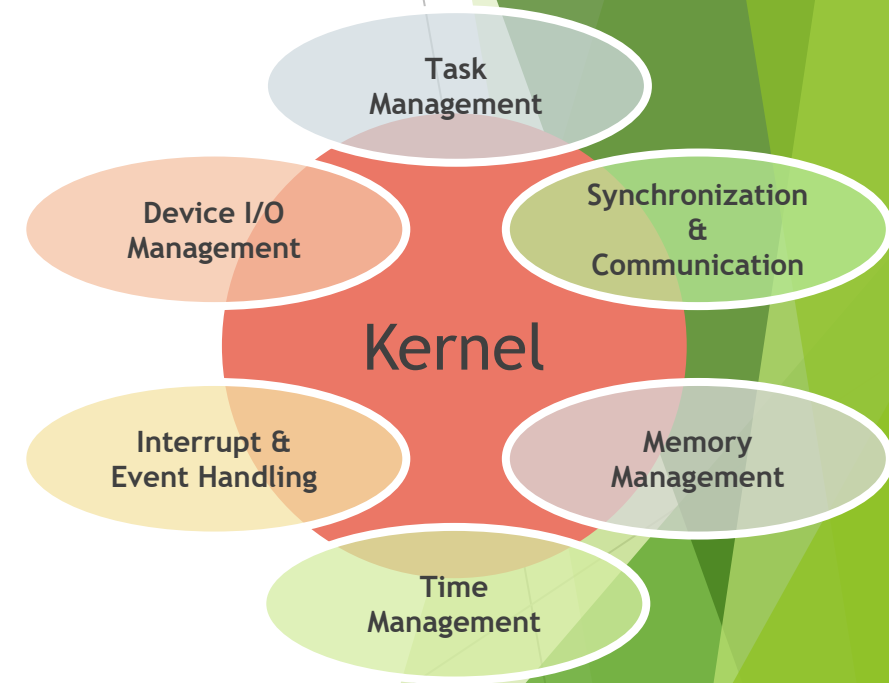
# Introduction to Operating Systems Cont.

▶ There are two main types of Software.

1. System Software

2. Application Software

▶ OS comes under the category of System Software.

▶ OS is the main subtype of System Software.

▶ Every device must have an OS to manage and control its operations.

▶ It's an essential software that runs in the background of a computer system.

▶ What are the remaining software types under System Software???

Device Drivers, Firmware, Programming Language Translators, Utilities
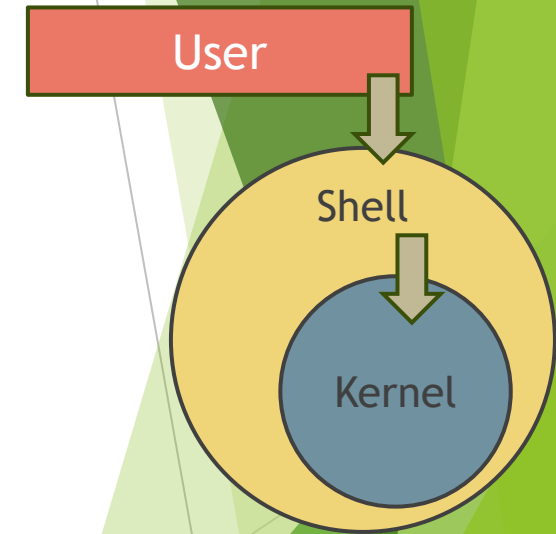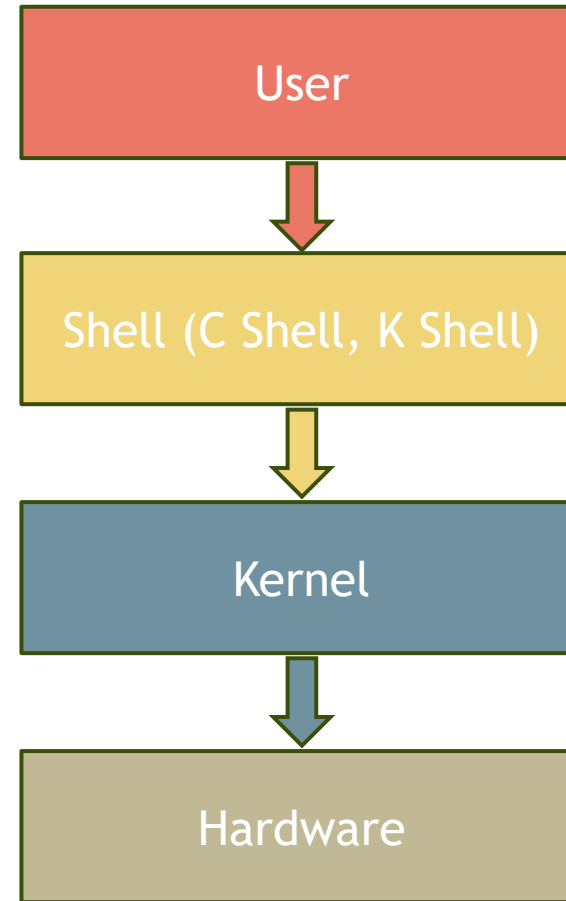
# Introduction to Operating Systems Cont.

**Kernel**

▶ Kernel is the core component of an operating system.

▶ It manages operations of computer hardware and performs tasks such as memory and CPU time management, disk management, task management, etc.

▶ Kernel acts as a bridge between application programs and hardware-level data processing.

▶ Kernel loads first into memory when an operating system is loaded and remains in memory until the operating system is shutdown again.

Task Management

Device I/O Management

Synchronization & Communication

Kernel

Interrupt & Event Handling

Memory Management

Time Management

# Introduction to Operating Systems Cont.

**Shell**

▶ The shell is the outer layer of the operating system that manages the interaction between the user and the OS.

▶ The shell communicates with the operating system by either taking input from the user or a shell script.

▶ A shell script is a sequence of system commands that are stored in a file.

# Introduction to Operating Systems Cont.

**User Mode Vs Kernel Mode**

▶ These are the two modes of an operating system.

▶ When an application program is running the computer is in User Mode. For example, writing a document, reading a PDF, browsing the internet, etc. This mode has limited access to the hardware. So, it is also called less privileged mode, slave mode, or restricted mode.

▶ When the process is in User Mode and requires any hardware resource, that request is sent to the kernel. Then the computer enters Kernel Mode from User Mode which is also called privileged mode or system mode.

▶ This transition is known as "**context switching**".

# Introduction to Operating Systems Cont.

**User Mode Vs Kernel Mode**
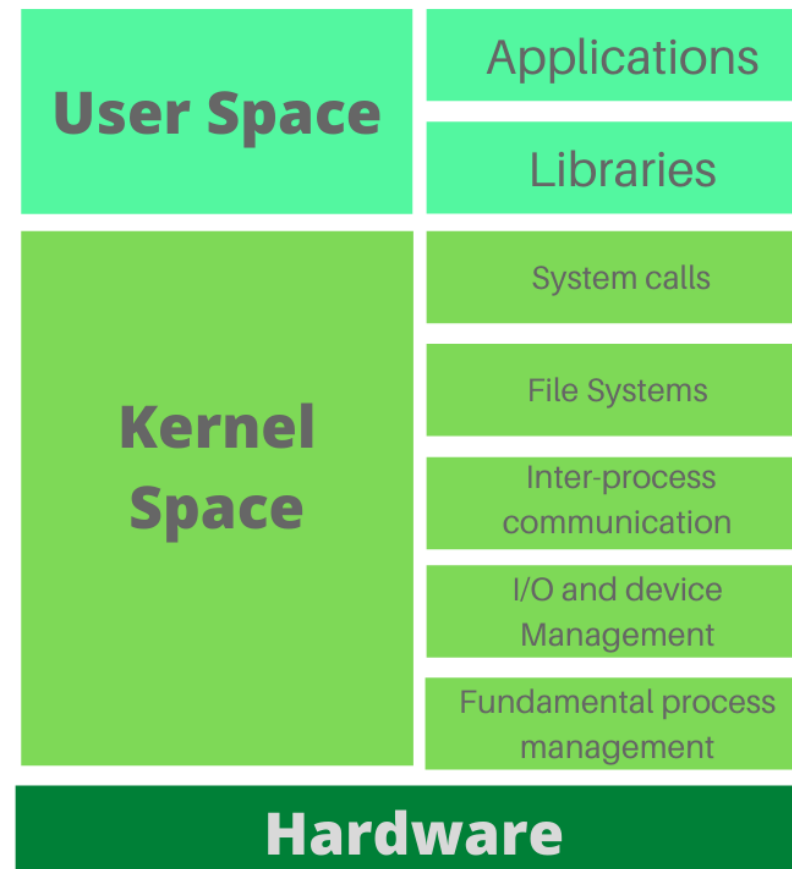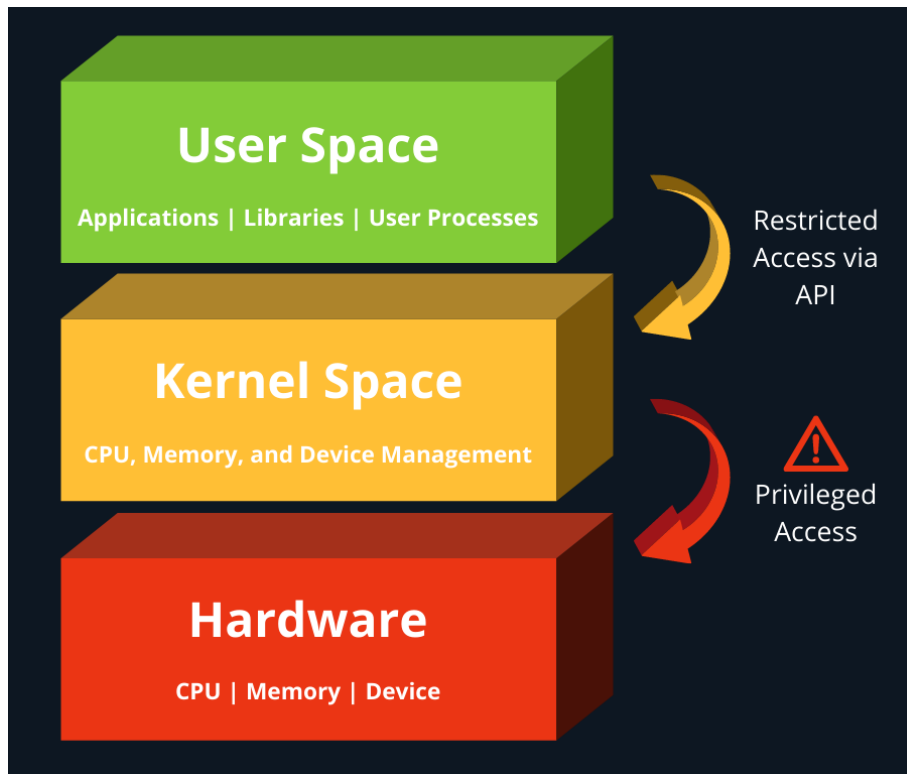
# Functions of an Operating System

- Device Management

- Processor Management

- Memory Management

- Input / Output Management

- Interrupt Handling

- File Management

- Storage Management

- Security Management

- User & Privilege Management

- Human Computer Interface (HCI)

# Functions of an Operating System Cont.

**Device Management**

▶ An Operating System manages device communication using respective drivers.

▶ A device driver is a program that controls the operation of a specific type of device. It provides the interface for the OS that allows interaction with the device.
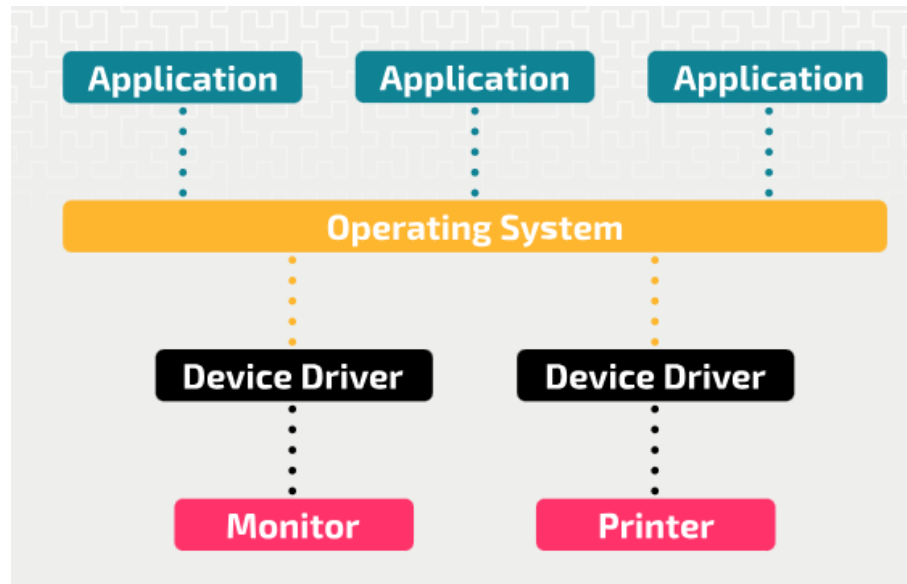
# Functions of an Operating System Cont.

**Device Management Cont.**

▶ The following activities are performed by the operating system for device management.

- Allocates and de-allocates devices to different processes.

- Keeps records of the devices.

- Decides which process can use which device for how much time.

# Functions of an Operating System Cont.

**Processor Management / Scheduling**

▶ The operating system controls the order in which processes have access to the processor and determine the processing time that each process must stay in the processor. This is called process scheduling.

▶ Activities performed by the operating system in processor management.

- Keeping track of the status of processes using a program called Traffic Controller.

- Allocating and de-allocating the processor when it is not required.

# Functions of an Operating System Cont.

**Processor Management / Scheduling  Cont.**

▶ Multiprogramming Vs Multitasking

▶ Executing more than one program in a single processor is called **multi-programming**. Multiprogramming organises the jobs in the main memory to increase CPU utilization.

▶ Running of more than one task simultaneously in the system is called **multi-tasking**. Eg: Typing in a document while the printing process is running. In multitasking, the CPU is assigned to a process for a specified duration called time slice, after this time period, the CPU is switched to another process.

# Functions of an Operating System Cont.

**Memory Management**

▶ The operating system controls the main memory which is also called primary memory.

▶ Main memory is a storage area that can be accessed directly by the CPU. The program(s) that needs to be executed should remain in the main memory.

▶ OS runs a memory manager program that…

- Keeps track of allocated memory portions

- Maps memory to each process

- Controls how much memory to allocate to each process

- Determines when a portion of memory should be available for a process

# Functions of an Operating System Cont.

**Input / Output Management**

- Controlling input and output devices is a main role of an operating system.

- The OS manages I/O devices in many ways...

  - It records which device requires processor time so that the processor can communicate with the device without any conflicts.

  - It prioritises processes based on control signals that the I/O device sends and receives.

  - If an I/O device makes a more critical request than what is currently being executed, the OS can interrupt what is currently being executed and swap to the more important task.

# Functions of an Operating System Cont.

**Interrupt Handling**

▶ An interrupt is a signal that is sent to the processor to request immediate attention. When the processor receives this request, it suspends what it is doing and runs the process associated with the interrupt.

▶ The processor can be interrupted for a number of reasons, including:

- A hardware device has signaled that it has data to process

- A hardware device has completed a task that it was asked to do

- A software process needs a service to be provided or as OS function to be performed

- An allocated amount of time has expired, and action needs to be performed

- A hardware failure has occurred and needs to be addressed

# Functions of an Operating System Cont.

**File Management**

▶ File system is organised in directories for easy navigation and efficient usage.

▶ OS controls file management activities.

- Keeping track of where the files are stored, user access settings, and the status of files, etc.

- Keeping track of information regarding the creation, deletion, transfer, copy, and storage of files in an organised way.

- Maintaining the integrity of the data stored in the files, including the file directory structure, by protecting against unauthorised access.

# Functions of an Operating System Cont.

**Storage Management**

▶ This refers to all non-volatile memory storage device management.

▶ The OS is in charge of keeping track of files and programs which are stored so that they can be accessed quickly when they are requested and transferred into main memory.

▶ This process…

- Improves the performance of the data storage resource and optimises the use of storage devices.

- Assists in storing more data on hardware devices.

- Speed up the data retrieval process and prevents data losses.

# Functions of an Operating System Cont.

**Security Management**

▶ The operating system provides various techniques to ensure the integrity and confidentiality of data.

▶ OS includes security-specific utility software like Firewalls, Anti-Malware, and Software Update checks.

▶ That gives…

- Protection against unauthorised access.

- Protection against interruption by keeping the firewall active.

- Protecting the system memory against malicious access.

- Displaying messages related to system vulnerabilities.

# Functions of an Operating System Cont.

**User & Privilege Management**

▶ Usually, OS provides facilities to manage the different user accounts and control their behaviours on various activities.

▶ Because not all users will get the same opportunity to work with the functionalities given by the OS.

▶ There are different user account types like; Administrator, Backup Operator, Power User, User, etc.

# Functions of an Operating System Cont.

**Human Computer Interface (HCI)**

▶ People don't know the method of communicating with the hardware/devices, so OS gives the option of communicating with the computer with the interfaces.

▶ It defines all the methods of how people interact with the computer system. If the interfaces are difficult to interpret its meaning, then users will find it difficult to understand and use.

▶ HCI focused on interfaces between computers and people.

▶ Earlier days, OS are based on the command line, and modern operating systems are based on graphical nature. Meaning users will feel easy to learn and use the OS functionalities.

▶ There is a high relationship between HCI and User Experience (UX).

# Operating System Classifications

▶ Two main types based on the numbers of users;
1. Single-User OS
2. Multi-User OS

▶ Two main types based on the user interfaces;
1. Command Line Interface (CLI)
2. Graphical User Interface (GUI)

▶ Two main types based on the licensing;
1. Licensed OS (Proprietary OS)
2. Open-Source OS

# Operating System Classifications Cont.

▶ Following are the main types based on the processing method;

1. Batch Processing OS
2. Online or Real-time Processing OS
3. Multi-programming OS
4. Multi-processing OS
5. Multi-tasking OS
6. Multi-threading OS

▶ Following are the main types based on the use;

1. Client OS
2. Network OS & Server OS
3. Embedded OS

# Operating System Classifications Cont.

▶ Types based on the numbers of users:

| SINGLE-USER OPERATING SYSTEMS | MULTI-USER OPERATING SYSTEMS |
|---|---|
| A type of OS that provides facilities to only one user at a time. | A type of OS that provides resources and services to multiple users at a time. |
| Two Types : Single User Single Task OS & Single User Multi-Task OS | Many Types such as Timesharing OS & Distributed OS |
| Eg: Windows, Apple Mac | Eg: UNIX, Linux |

# Operating System Classifications Cont.

▶ Types based on the user interfaces:
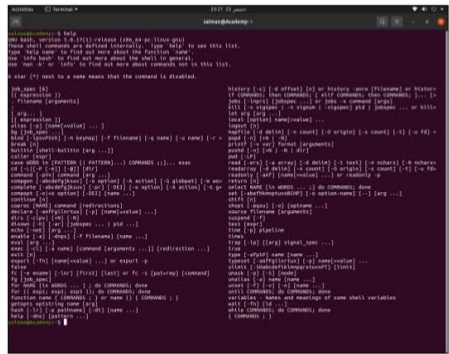
| GRAPHICAL USER INTERFACE | COMMAND LINE INTERFACE |
| --- | --- |
| A type of UI that allows users to interact with electronic devices through graphical icons and visual indications. | An interface for the user to issue commands in the form of lines of text to perform the tasks. |
| Even beginner can easily handle. | User should have a good knowledge of commands. |
| Require more memory. | Doesn't require more memory. |
| Slower compared to CLI. | Faster compared to GUI. |
| Can customise to change the appearance. | Not possible to change the appearance. |
| More flexible. | Not much flexible. |

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# Operating System Classifications Cont.

▶ Types based on the licensing:

| OPEN-SOURCE OS | PROPRIETARY OS |
|---|---|
| Free of charge or lower cost. | Need to pay higher cost. |
| Can get the source code. | Source code is not public. |
| Can modify software. | Cannot modify software. |
| Can install freely. | Require license. |
| Rely on loyal and engaged online user community for support. | Vendor supplies the full support. |

# Operating System Classifications Cont.

▶ Types based on the processing method:

- **Multi-programming OS**

Two or more programs are executed simultaneously in a single processor. This is used in multiuser environments.

- **Multi-processing OS**

Two or more processors use to execute programs simultaneously. Servers are designed to use this concept. UNIX is a multi-processing operating system.

# Operating System Classifications Cont.

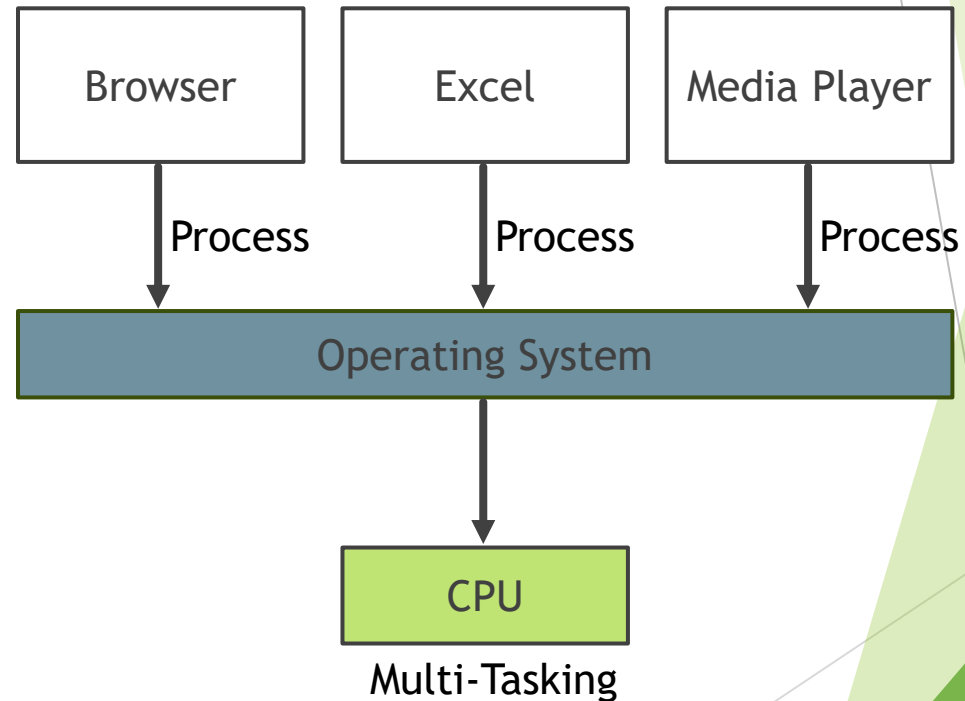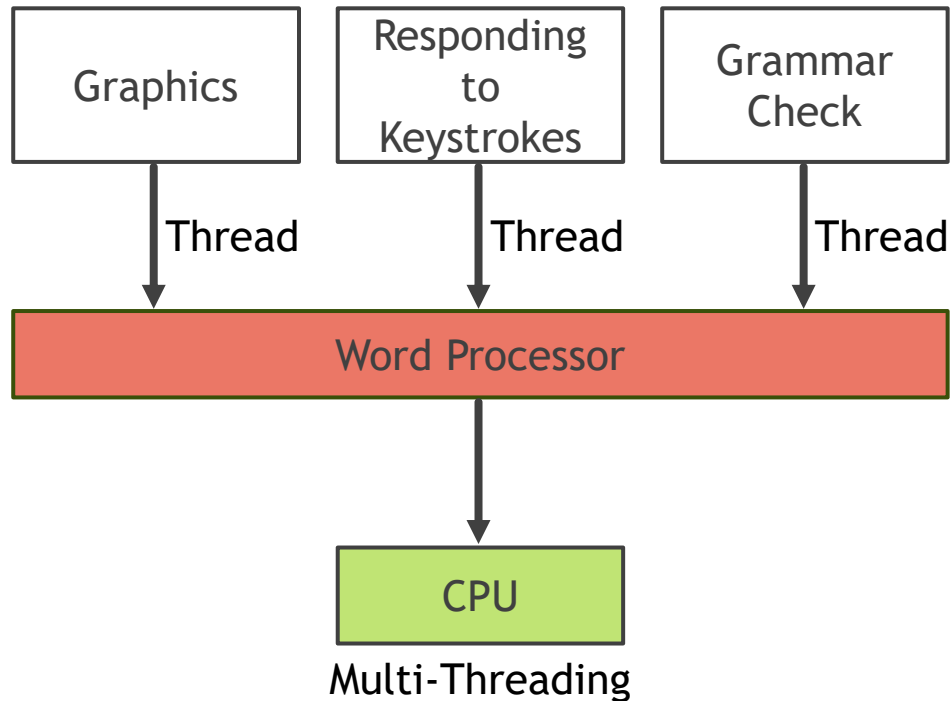▶ Types based on the processing method:

- **Multi-tasking OS**

The capability of running several tasks or programs at the same time in the system. Eg: Listening to music while browsing the internet. Most modern OS like Windows, MacOS, and Linux are multi-tasking operating systems

- **Multi-threading OS**

In multi-threading processes are divided into sub-processes called threads and executes them concurrently. This concept is used in multi-tasking operating systems.

# Operating System Classifications Cont.

▶ Types based on the processing method:



| Graphics | Responding to Keystrokes | Grammar Check |
|----------|--------------------------|---------------|

Thread     Thread     Thread

**Word Processor**

**CPU**

Multi-Threading

| Browser | Excel | Media Player |
|---------|-------|--------------|

Process     Process     Process
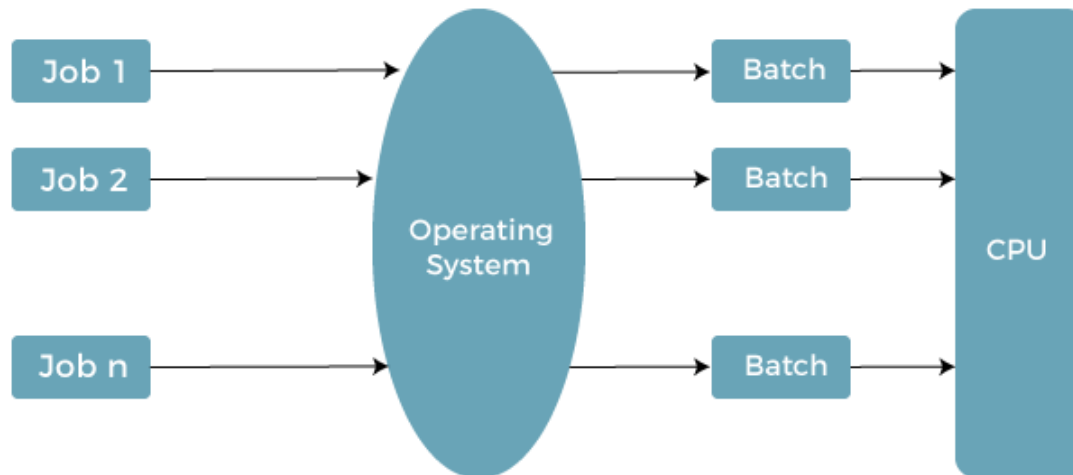
**Operating System**

**CPU**

Multi-Tasking

# Operating System Classifications Cont.

▶ Types based on the processing method:

- **Batch Processing OS**

This type of OS processes large amounts of data in batches. Similar tasks are grouped into batches to process together. Used by organizations that require high-volume data processing such as banks. Eg: IBM's z/OS, Unisys MCP, and Burroughs MCP/BCS

# Operating System Classifications Cont.

▶ Types based on the processing method:

- **Online or Real-time Processing OS**

In these systems, data is accepted and processed in a short time or within a deadline.

Eg : Airline Traffic Control Systems, Command Control Systems etc.

# Operating System Classifications Cont.

▶ Types based on the use:

- **Client OS**

Client operating systems are installed in desktops or other portable devices like laptops, tablets, or smartphones. Suitable for a single-user system. Handles hardware components connected to the device such as printers, monitors, etc. Client OS can request data from network servers if necessary.

- **Network OS & Server OS**

These are more advanced versions of operating systems that run on server computers. Server OS includes facilities to provide several services to client machines and other devices. The key task of the Network OS providing network services and sharing resources to the clients. Eg: Windows Server, MacOS Server

# Operating System Classifications Cont.

▶ Types based on the use:

- **Embedded OS**

These are specialised operating systems designed to perform highly specific tasks of devices. Eg: Smart TV – Embedded OS of the device controls the microprocessor and other associated hardware.

# Evolution of Operating Systems

▶ Let's watch a small clip on this…

▶ https://www.youtube.com/watch?v=e-YI-fjI8Nc

▶ There are popular operating system brands and families such as Windows OS, Linux OS, Mac OS, VMS, OS/400, iOS, Android, etc.

▶ But all of them have initially launched with basic features and matured with their age over the years.

▶ Okey folks, time for a group activity. Find out more useful video resources on the evolution of various OS brands and let's discuss more on them.

# Q&A

▶ Time for your questions and queries …

# Additional Links

- https://learn.microsoft.com/en-us/windows/deployment/windows-autopatch/whats-new/windows-autopatch-whats-new-2023

- https://www.youtube.com/watch?v=wtjPc8nr2iE

- https://www.youtube.com/watch?v=OZowHEjWn0E

- https://www.youtube.com/watch?v=i-RLv4p6AYs

- https://macinfo.us/file-systems-mac-vs-windows-vs-linux/

- https://www.computerworld.com/article/3692451/evolution-of-ios.html#slide10

- https://setapp.com/news/best-features-of-macos-14-sonoma

- https://linuxmint.com/

- https://www.microsoft.com/en-nz/windows/windows-11-specifications#table1

# Activity

▶ Find out more OS options available for networked, distributed, and embedded requirements with their pricing and features offered.

▶ List 3 security options that you use in the current context on your OS.

▶ Explore more about Windows Subsystem for Linux (WSL) and the available distro.

# Thank you!