

Operating system

1 DEFINITION

Behold the enigmatic enabler of all computing- the operating system! This software acts as a conduit between the user and hardware, deftly juggling functions such as file and process management. A pantheon of operating systems exists, from the ubiquitous Microsoft and Linux to the sleek IOS, as evidenced by the figure below.



These operating systems have some functions such as they help in **booting**, in which they control the startup process by preparing the kernel or loading the necessary services or systems. For example, in booting, the bootloader in the Windows boot manager helps load the operating system kernel in memory and start executing it. Also, operating systems organize the applications on the computer and plan a space for the applications on the computer, which is called **memory management**. For example, in memory management, there are many memory allocation algorithms that help in the memory management process.

The operating systems are also designed to protect the user from cyber attacks by implementing guidelines and measures such as user authentication, access control, and other security measures (**security**). Examples of security include firewalls, file permissions, and various security algorithms. Not only that, these OSs also allocate space for computer processes like storing and sharing information, which is called **process management**.

The OS also controls the user computer drives and split disks, which is called **disk/drive management**; they deal with file systems and file storage; and they provide some functions on disks like formatting and maintenance disks.

- **Windows** : Is one of the OS which is very popular established by Microsoft. This OS provides many features like it gives a GUI that helps the user to communicate with his computer by using icons, menus , and others. It also provides the user the ability to open and run more than one application or file at one time and as I discussed before, it also controls system resources to make the system works effectively and efficiently.

- **MacOS** : Also, this one is very popular but it is used in Macintosh computers (developed by Apple). This OS has similar the same features to Windows, but this one is focuses more on security by providing the best security features to protect user's information from threats and unauthorized access. Additionally, this one provides more advanced features than Windows such as Time machine (automated tasks) and spotlight (more advanced file search) and others to improve the performance.
- **Linux**: This OS is known for its flexibility and security. It also like the same OSs provides GUI , command line interface and others. It also shines in embedded systems, powering devices such as routers and switches, smart TVs, and (IoT) devices.

It just mentioned the most popular OSs in computer and there are many OSs used. Each OS has its own features, user interface, and design, but they are nearly similar to each other in allocating system resources.

Sources: (Types of operating systems (with OS functions and examples)Types of Operating Systems (With OS Functions and Examples) [1]

2 EVOLUTION

These operating systems have changed a lot in the past few years, and they faced many changes to become what they are now.

Early computers were not that bad, but they were limited in how many programs they could execute because, in early computers, there was no operating system, and they were dependent on punch cards and punched tape, which were inputs for early systems in 1950. This system was effective because, at that time, there were no programming languages.

After that, mainframe computers with vacuum tubes and transistors were replaced by another system, magnetic tape. This system worked with a combination of magnetic tapes and drives, which increased efficiency, but it is not as efficient as the operating systems of today. These mainframe devices required a dedicated climate-controlled room as well as operators.

General Motors Reserve Division released an early version of the operating system, the GM-NAA I/O, for the IBM 704 mainframe in 1956. GM-NAA I/O was more developed, but IBM 704 was more popular because of the song "Daisy Bell", made by IBM 704, and this became an iconic and precursor to the later things. Integrated circuits helped reduce the cost of computers, and people started buying these computers, which led to the era of home computers. As microcomputers of the 1970s gave way to home computers of the 1980s, here is where operating systems came in and played an important role in personal computing.

After that, in the 1970s and 1980s, operating systems for personal computers became diverse. However, PCs such as Altair and Xerox Alto were not commercially successful, but they contributed to the future generation of PCs and operating systems like the "Trinity" of Apple, Tandy, and Commodore in 1977.

Each one had its own individual operating system. The Tandy TRS-80 ran TRSDOS (Tandy Radio Shack Disk Operating System), but the TRS-80 Model III used NewDos/80, which is a third-party OS built by Apparat. It's worth noting that these operating systems are not the same as Apple DOS or MS-DOS, which debuted later in 1981.

Then Apple came to try their first operating system with the Lisa PC, which was a PC that had a GUI and mouse but was not designed for gaming. In 1984, Apple introduced their first operating system, which is Mac OS System 1 for Macintosh computers. Apple kept developing their software until their last version of classic OS, which is Mac OS 9.2.2, and Kodiak speculations first surfaced for Mac OS X.

On the other hand, Microsoft also introduced their first operating system, which is Windows 1.01, in 1985. They should have launched their operating system before 1985, but because of the modifications made by IBM and Microsoft, they launched it in 1985. They issued updated versions on a regular basis, while VGA and PS/2 capabilities were not added until 1987. It was not well accepted, as were many early operating systems. That all changed with Windows 3.1, which became a success.

In the late 1970s and early 1980s, there were various operating systems and companies on the market, but Microsoft and Apple were the leaders in the field, and they demonstrated the market. And from 1980 onwards, along with the development of networking, networking protocols, and GUIs, they made it easy to interact with operating systems and, in turn, with the hardware.

Sources: (Field, Complete history of the operating system 2022) [2]

3 BENEFITS OF OPERATING SYSTEMS

As we discussed before, operating systems concept and their evolution, these operating systems have an important role in our computers, such as providing security by setting a password to protect the user's data from any security breaches and avoiding any unauthorized access to the user's programs or data.

They also monitor all the system's health to troubleshoot any problems and help increase the performance of the system. They also keep an eye on the system to ensure there are no errors and to prevent malfunctioning computer systems. Also, these operating systems provide a friendly user interface to make it easier to users to communicate with computer system by making command line interfaces, graphical user interfaces. The user interface enables the user to do tasks, start applications and others.

Operating systems provide memory management by controlling the main memory which is a quick storage device that the CPU may access immediately. It assigns memory to a process when it asks it and deallocates memory when the process terminates or performs an I/O activity. They also manage the file system (File management) by keep tracking of where the information stored, files user access and file status.

Sources: (Libretexts, 2.1: Function of the operating system 2021) [3] , (Understanding operating systems - University of Wollongong) [4]

4 MEMORY MANAGEMENT IN AN OPERATING SYSTEM

In this section, I will discuss one of the most important functions that the OSs do which is memory management that consists of controlling and managing the memory that is in the computer. It works to allocate memory resources, enhance memory usage and other functions. It also helps to secure the memory from unauthorized access. It also prevents one process from corrupting the memory used to another process. Finally, it provides the efficiency to divide the memory resources into the processes.

I will discuss some concepts that related to the memory management in the operating system:

- Static and dynamic loading:

Loading the process into main memory is done by the help of loader. Loading have two different types:

- 1- Static loading -> Means that loading the program into fixed address. This types requires more memory space.
- 2- Dynamic loading -> Means that the program must be in physical memory for the process to run. This means the size of the process limited to the size of physical memory. This type provides memory utilization. Also, in this type, a routine is not loaded until it is called which means that this provide an advantage which is the unused routine is never loaded.

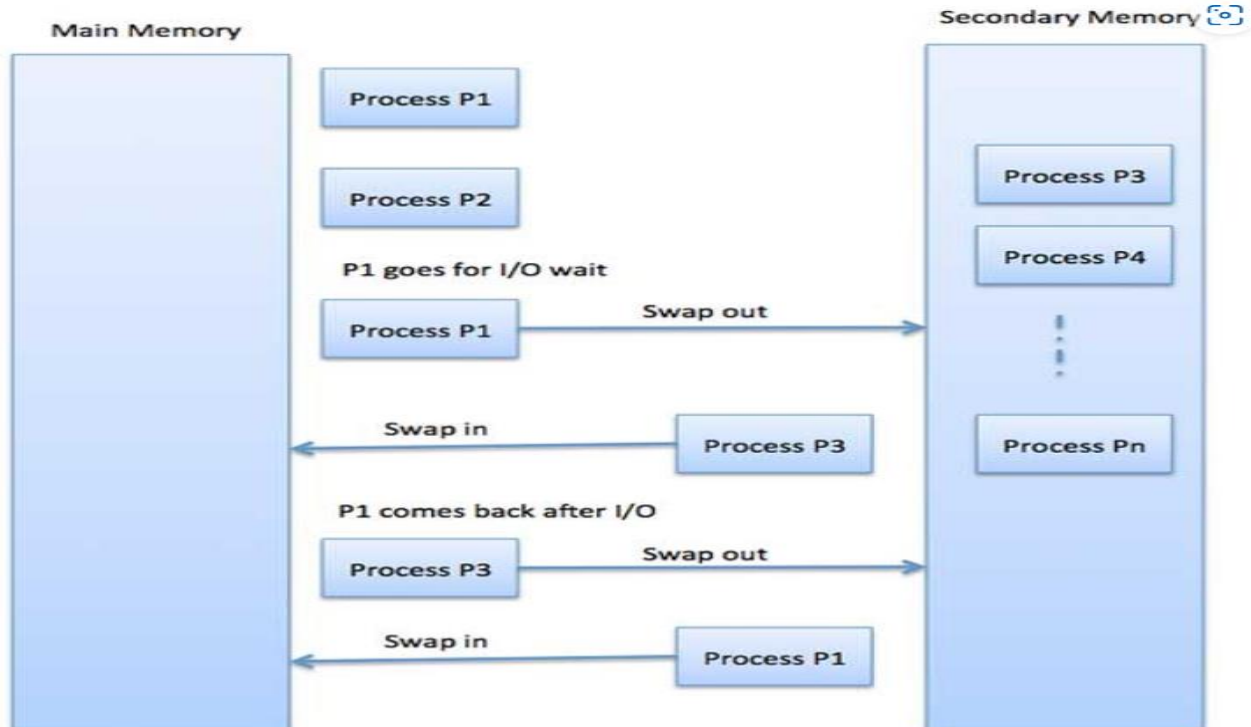
- Static and dynamic linking

First thing, the linker is a program that get one or more object files from the compiler and combines them within a single executable file.

- 1- Static linking -> In static linking, the linker used all the important and necessary programs into a single executable file. In this type, there is no runtime dependency. Some operating systems used this type.
- 2- Dynamic linking -> this type is very similar to dynamic loading. There is new concept called Stub which is a small piece of code, and it is useful to check if the routine is already on the memory or not on the memory. Because if the routine is not on the memory, the program loads the routine into memory. In this type , Stub is implemented for each library routine reference.

- Swapping

Swapping is very important role which moves the process can be moved from the main memory to the secondary memory such as disk and make the available memory from moving the process is available to other processes. After time, the system back the process from the secondary memory to the main memory. Swapping is considered a technique for memory compaction because by using swapping, we can multiple and big processes in parallel as shown in the figure below. These processes may take a time because you must consider the time for each process such as : time for moving the process from main to secondary memory, and time to back the process to the main memory.



- Memory allocation

Inside the main memory, there are partitions which are low memory and high memory. Low memory is used to reside the operating system. On the other hand, high memory is used to hold the user processes.

OSs use two memory allocation mechanisms which are: single partition allocation and multiple partition allocation. Single partition allocation relocation register scheme is used to protect the user processes (from each other) and operating system (modify the operating system data and code). Relocation register include smallest values of physical address, whereas limit register includes range of logical addresses.

On the other hand, multiple partition allocations mean that divide the main memory into fixed size partitions, and each partition includes one process. When the partition is on free, the process is selected from the queue and load it to the free partition. The partition become available for another process when the recent process terminates.

- Fragmentation

It is a problem that happens after the processes can't be allocated to a memory blocks because of their small size and the remain blocks we be still unused. There are two types of fragmentation:

- 1- External fragmentation -> The free memory block but the process can't assign to the free memory because these memory blocks are not contiguous.
- 2- Internal fragmentation -> The memory blocks are assigned to the process more than their requested size.

In conclusion, the fragmentation causes waste of memory, but there are many techniques to reduce the external fragmentation. For example, we can reduce the external fragmentation by using compaction or shuffle memory contents to make all the free memory in one block.

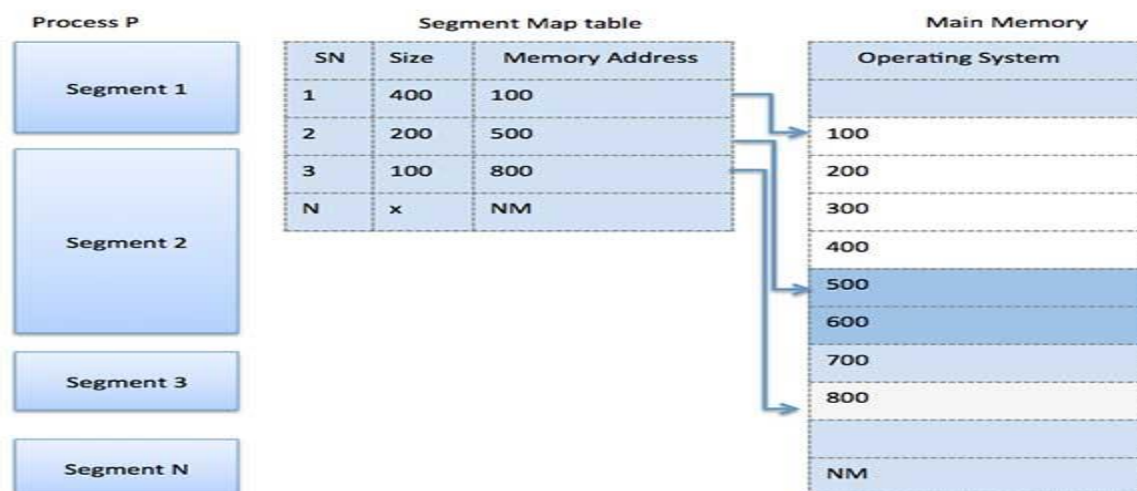
- Paging

The computer may address more additional memory than the amount physically installed on the system, which called virtual memory. Paging is a technique used to implement and get benefits from the virtual memory. It is also a memory management that calculates the need of contiguous allocation of physical memory and considered as an efficient memory management. Paging is useful to reduce the external fragmentation but is still suffering from the internal fragmentation. On the other hand, paging is not recommended to use when you have a computer that have small RAM because it requires more memory space.

- Segmentation

It is a technique that manages the memory by dividing each job into several segments of different sizes. Also, each segment has different logical address space of the program. Segmentation works similar to paging but the difference is that here (segmentation) there is segments and in paging there are pages.

The OS maintains a segment map table for every process and lost of memory blocks as shown in the figure below:



Sources: (Operating system - memory management) [5] , (Memory management in operating system 2023) [6]

5 JOB SCHEDULING

It is the process that distributes the system resources to manage the execution programs. The scheduler determines which job is executed at what time, which one must wait, and the CPU needed to achieve the job. The goal of job scheduling is to check if all the jobs are achieved and completed.

There are many parameters that the job scheduling uses to determine which job to run including: job priority, job dependency, execution time, resource availability, operator prompt dependency, and other parameters. Also, long term scheduling, medium term scheduling, and short term scheduling are the three types of job scheduling that organizations must use to manage their environment.

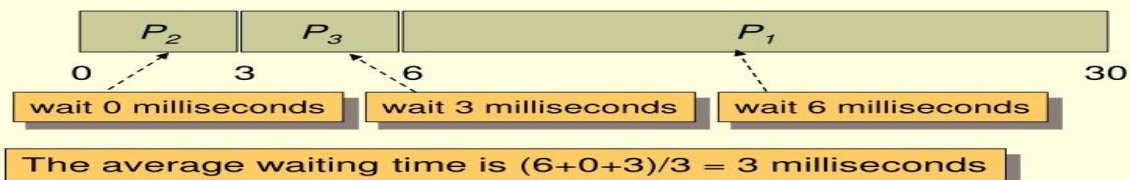
In addition, there are multiple job scheduling algorithms that contribute to which processes should be assigned to CPU. I will mention three algorithms that are commonly used:

- **FCFS**

Abbreviation of first come first serve, it is one of the common algorithms that picks the oldest job in the queue and sends the job for processing. The mean processing time for the jobs is considered long. As shown in the figure below the work of this algorithm.

Scheduling Algorithms – First-Come, First-Served Scheduling (4/33)

- If the process arrive in the order P_2 , P_3 , P_1 , the results will be as follows:



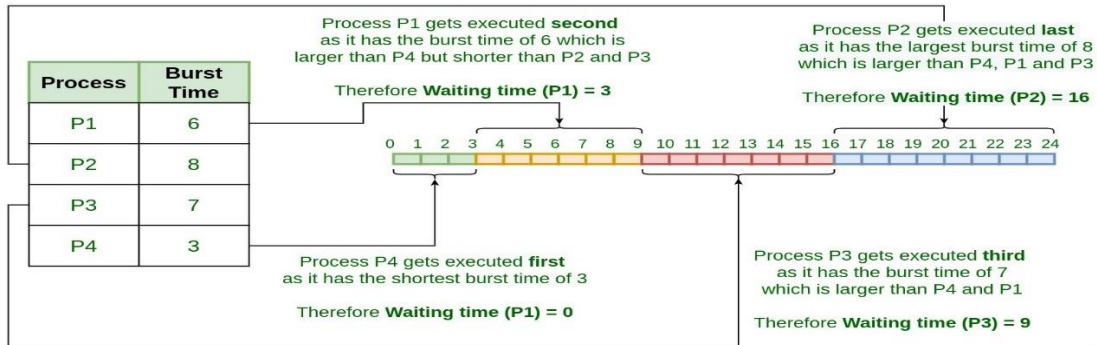
- The average waiting time under an FCFS policy is generally **not minimal** and **may vary substantially**.

The disadvantage of this algorithm is negatively affects the CPU by resulting in lower CPU utilization because, in some cases, some tiny jobs may wait a long time to go into processing.

- **SJF**

Abbreviation of shortest job first which is an algorithm that picks the job that requires less time processing and allocates the job to the CPU, and this method connects the length of the next CPU burst with each process. It helps in minimizing time waiting but on the other hand, it needs accurate knowledge of job length. As shown in the figure below, it shows how this algorithm works.

Shortest Job First (SJF) Scheduling Algorithm

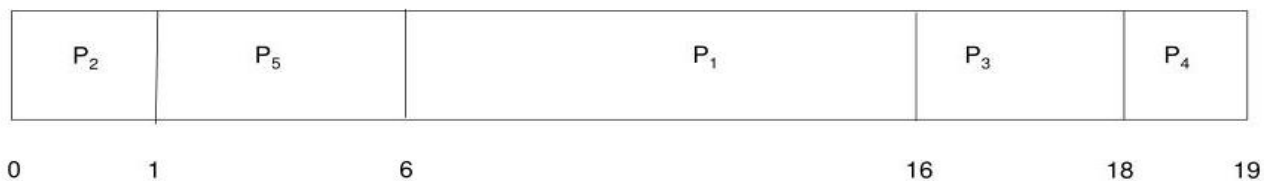


- **Priority scheduling**

In this algorithm, it focuses on the priority of the jobs which means that the highest job priority will be executed first. The priority of the job represents as an integer and the smallest number means highest priority. On the other hand, this algorithm has disadvantage which is that longer jobs may experience starvation. As shown in the figure below, it shows the work of this algorithm.

Process	Burst Time	Priority
P_1	10	3
P_2	1	1
P_3	2	4
P_4	1	5
P_5	5	2

Priority scheduling Gantt Chart



$$\text{Average waiting time} = (6+0+16+18+1) / 5 = 8.2 \text{ msec}$$



Source: (Job scheduling | technology glossary definitions | G2) [7]

6 RESOURCE MANAGEMENT IN OS

In simple words, resource management in the OS is the process that **controls and allocates the computer's resources**. For example, a computer's resources are CPU time, memory, disk space, and processes that are running on the computer.

The aim of resource management is to **optimize the system's efficacy and reliability** by guaranteeing proficient access to the abundant resources for each process. A plethora of algorithms and techniques are employed to manage resources adeptly, thereby enhancing the system's performance. These include scheduling algorithms for allocating CPU time to multiple processes, memory management algorithms for regulating the memory space for various applications, and input/output scheduling algorithms to govern input-output devices like printers.

The orchestration of resources assumes a pivotal function in the operating system's stability, enabling a multiplicity of programs and operations to run concurrently without colliding or compromising the system's integrity. Moreover, it scrutinizes the system's proficiency, ascertaining its capacity to handle an immense workload without succumbing to overexertion or languishing in lethargy.

So, resource management is very important and useful to check the effective utilization of resources, enhancement of performance, stability of the system, and fair allocation among processes.

Sources: (What is resource management in an operating system?) [8]

7 DIFFERENT OPERATING SYSTEMS SECURITY

As we know, there are multiple platforms of operating systems in our time, but the popular operating systems are: Windows, MacOS, and Linux. Their popularity didn't come out of nowhere. Windows, MacOS and Linux have their popularity because of their important features that help the users to easily interface with the computer. One of these features is security. Security is important to secure the user's data from unauthorized access. Each operating system has its own architecture and security features.



In this section, we will describe the security features for each of the most popular operating systems for personal computer:

- **Windows**

Windows is the most famous operating system on the earth. For higher security, Windows provides multifactor authentication technologies such as: BIN, PIN, and fingerprint recognition.

On the other hand, Windows is not considered the most secure OS in the world because of many reasons such as: the large numbers of consumers and large numbers of personal computers that use Windows, which makes the hackers always aimed for this operating system. And from recent research, Windows PCs have faced more malware than MacOS and Linux PCs.

Therefore, Windows provides more updates on their security through pushing Windows defenders updates and provides measures against ransomware. Windows security divides into seven sections which are: Virus & threat protection, Account protection, Firewall & network protection, App & browser control, Device security, Device performance & health, and Family options. It provides users the ability to scan for viruses in the most common places that viruses are likely to hide and checks all the files and programs on the hard disk. Also, there is the Windows Defender Offline scan, which shuts down your computer and investigates it for malicious viruses that other scans are difficult to detect.

Windows also has all the security elements that you need to protect your device such as antivirus scans, ransomware protection, firewall, and Windows defenders which is good to defend PCs.

- **MacOS**

It is considered the best option when it comes to the security because of many reasons such as: when comparing to Windows, MacOS has less users than Windows which makes the hackers always targets the Windows users not Mac users, and the other reason is that Mac provides security features that prevent any viruses and malwares or any kind of attacks. MacOS always uses Xprotect to check the malware, and if any malware is defined, it will be removed. Apple is always updates Xprotect to continuously monitor the new versions of malware and overcome them.

Another security feature which is Gatekeeper that helps when the user installed applications, Gatekeeper will check if the application installed is verified by Apple or has a malicious code. If the application is risky, the Gatekeeper will stop the installation of the application.

Also, MacOS gives the ability to users to add some extra security layers and features such as MacOS firewall, iCloud-private-relay (almost a VPN), and password protections by monitoring your passwords and changing them continuously.

- **Linux**

It is an OS that is considered very strong in security, and it is known for its robust security features, but it requires more configuration and management to ensure the best security. One of the best features in Linux is user management which is a critical component of Linux security. From user management, you can restrict access to essential files and data by creating distinct user accounts. During installation, Linux provides a root account by default. The root account has full access to all system files and settings and should be used carefully. Another security features are firewall, clamAV, SSH and encryption.

ClamAV is a software that is used to detect and scan viruses in the system and remove them from the system. Encryption is a necessary tool for protecting data on a Linux system. Even if an attacker obtains access to the computer, encryption helps you to secure important data from unwanted access. LUKS and GnuPG are two encryption mechanisms available in Linux.

Linux as we know, is an open source which leads the vulnerability to be reviewed and patched because in Linux, there are various developers to review and patch. Also, Linux provides continuous updates which makes Linux more secure over time.

Sources: (kumaresh, Operating system security 2020)[9], (Haslam & Editor, 16 MAC security tips to keep your mac safe 2023)[10], (5 useful linux security features and tools for beginners)[11]

8 FEATURES OF FUTURE OPERATING SYSTEMS

With the big development of technologies and tools these days, it is hard to predict what are the features of future operating systems will look like and what are the changes that will happen to the operating systems to meet the future user's needs. In this section, I will show some potential features that will be implemented in the future of operating systems.

If we talk about the future, we should mention **AI and its capabilities** to help the operating systems in the future. AI can be used and implemented in the operating system to enhance the work of future OSes such as by using user's data and behavior of users, AI can provide **automated tasks** (like : they can schedule appointments) . OSes also can provide **user recommendations** features by using AI algorithms to evaluate user data and behavior and recommend to users some actions (like : from their history, AI can recommend content, application, etc). Finally, OSes can give the users the ability to use **their natural language** to interact with their computers (this can be done by using advanced algorithms).

On the other hand, using AI in OSes means using the user's data, which can be an ethical issue and possibly expose the data to hacking. So , future OSes must provide the best **security** to save their user's data. For example, future OSes can provide security features such as **firmware updates, strong encryption algorithms** that protect the data from any hacker while it is in the data storage or when it transfers over networks. Also, I think that in the future, OSes will make a way (using protocols or technology) to get authorized access to data stored in the device. By using AI in OSes, it can **define some security threats and risks** that will happen on the system which gives an advantage to solve these issues earlier. All these security features will be in the future OSes to get better security than OSes these days.

Additionally, OSes in the future can do the **device synchronization** feature on multiple platforms which means that the user can do the task on device and complete the task on a different device, for example, if the user write a report on his computer, he can continue writing the report using different devices such as laptop or mobile phone. This feature can be done by using real time syncing data which updates the data in all the devices connected if any changes happened.

Also, OSes can implement additional features which is use **Cloud platforms** to get adaptable storage and also provide user experience by making the user easy gets and access the data or application in the cloud from any device (anywhere).

Sources: (Rosini, Ai and the future of Operating Systems 2016)[12], (The operating system of the future will cater to your every need 2018)[13]

9 BENEFITS OF FEATURES OSES TO MEET THE DEVELOPMENT OF FUTURE NEEDS.

The features discussed in the last section will help the future OSES to enhance their work and achieve future needs for example, some features mentioned before helped in many things such as some of them will develop user experience, some of them will provide productivity, and so on.

The features that are related to the AI and its capabilities (for example of these features: automated tasks and user recommendations) in OSES will improve the user experience. And in the future, OSES will need and implement more machine learning algorithms and techniques to do complex tasks for users to achieve the best user experience. Also, AI in OSES will help in management the memory and provides the best security.

Additionally, related with security features in OSES (such as encryption algorithms, authentication technologies, and others) will help in user satisfaction and experience by not making his data such as financial data or personal data under the danger and stop any attacks that will face him. Also, by using more secure features in the future OSES, it will improve the user productivity by making the user use his computer or phone and use his applications without fear of stealing his data.

By using device synchronization feature in OSES, it will improve the productivity by enabling the user to access his data and applications from another device such as laptop or mobile, etc. Additionally, in the future, OSES will need Cloud services to meet future needs and to meet the large amount of data from AI algorithms, IOT devices and other future technologies. Also, Cloud services will give the best security to secure user's data.

Sources: (Kommadi, Ai Operating System 2020) [14]

10 FUNCTIONALITY, INTERFACE DESIGN AND PROCESSES OF A RANGE OF OPERATING SYSTEMS.

In this section, I will evaluate some operating systems including Windows, Apple, Android, and Linux by focusing on their functionality, interface design and process. Each of the evaluations will come from sources and some evaluations will come from my opinion.

- Windows

As we know Windows has multiple versions such as Windows 10 and 11 and so on. Windows in general is a great operating system specifically in **functionality** because it provides high functionality including manage the resource allocations such as CPU, RAM, and others. Also, it performs several tasks such as: opening applications, access the internet, and printing documents. Additionally, Windows has wide compatibility by making it highly compatible with a wide range of hardware and software devices, allowing users to use a variety of devices with this operating system. It allows multitasking and includes

security features like the most important security feature which is Windows defender. On the last version, they develop some features such as: gaming capabilities and performance of the system.

It also provides and offers a new and user-friendly layout known as the "Windows Start Menu." Which makes it very easier for users to access applications, files, settings, and so on. Their interface is also designed to touch screens, mouse, and keyboard setups. Windows is very powerful in interface design because they provide a user-friendly interface and an interface that is very familiar to the users so that they can use it easier. Additionally, in their last version, they made a new feature which creates virtual desktops.

Finally, Windows is a very powerful OS in process management, also as we know about Windows, it has the ability to use multitasking and the user can run multiple programs and applications smoothly without any crashing on the system. Also, it always informed the user of the system activities by sending notifications to users. They also develop power management.

In the end, Windows OS has functionalities more than I mentioned above. They keep updating their OS to develop the performance of their OS by updating the functionalities, user interface and processes.

- Android

It is one of the most OSs used in mobile phones, because it has and provides multiple features and customization services. For example, Android enables multitasking and provides ecosystem applications that are in their Google store. Additionally, multi touch, optimized graphics, widgets, and automations are some of the features that this OS provides.

Behold, the user interface is fully malleable, the users can metamorphose their interface through widgets, applications, or icons. Nevertheless, since this OS is ubiquitous across myriad manufacturers, it may induce a deleterious user experience. The OS UI is composed of four distinct constituents: status bar, Application bar, the content area, and bottom navigation bar.

As the Windows OS, Android is the same as Windows in terms of multitasking by making the user use multiple applications smoothly. Additionally, this OS provides background process to enable efficient utilization of system resources. On the other hand, the openness of this OS may lead to effect the performance of multiple devices and it may cause some security issues.

Android is using Google assistant. It is an Ai based voice assistant that provides multiple features such as voice commands, and merges with multiple applications services. This service helps the user in using this OS easily and provides user experience.

- IOS

It is also one of the most OS used in the mobile phones, this OS focuses on the security features as discussed before to prevent any unwanted access that threatens the user files and information. This OS provides a refined user experience with a common interface across all devices. Additionally, it provides many important features such as: multitasking, and icloud feature which is one of the useful features in IOS that provides internet based data storage. This feature is implemented in all the Apple devices. In my opinion, cloud feature is very important and useful feature because it avoids the user data from any hacking through encryption (highly encrypted) and it also provides backup for users, to help the user not lose his data and information.

This OS has an amazing user interface and its user interface design, which is very simple, intuitive and easy to use for old users and new users with a unified visual aesthetic and layout. Their interface is very easy to make the users find their applications and files easily without taking time to find them.

It also enforces rigorous background process orchestration, elevating system resilience and battery longevity. It furnishes a regulated arena, guaranteeing uniform execution on all gadgets. Nevertheless, this methodology constrains particular personalization alternatives and confines entry to the file structure.

As discussed before, Windows OS used Google assistant, on the other hand, this OS uses Siri AI based voice assistant. Siri merged with the ecosystem of Apple and applications. It is very helpful to users such as it can do various tasks: sending messages, calls, put reminders. All these benefits help in enhance the user experience and make reputation in the marketplace.

Source : (Agarwal, Android operating system : Introduction, features & its applications 2021)[15], (iPhone OS (IOS) graphic user interface (GUI) - more function view: Iphone OS (IOS) graphic user interface (GUI) - standby mode: How to design an interface mockup for iPhone application: Iphone Gui)[16], (Ios introduction: Ios tutorial)[17]

11 THE ROLE OF DIFFERENT OPERATING SYSTEMS IN MEETING THE NEEDS OF FUTURE TECHNOLOGIES AND THE IMPLICATIONS ON SECURITY

As I discussed before, the importance of implementing modern technologies (AI and IOT) in OSs to achieve the future needs. Implementing technology like AI will need advanced devices, computing skills, and additionally strong recourse (like: memory ,CPU, RAM management) management to improve the performance of the device to implement modern technologies like AI and IOT.

Also, one of the functions of OSs is to give drivers. In AI implementation, **developed drivers** are very important to get various benefits such as (enhance performance of computing skills and get better utilization of hardware resources). Additionally, we all know that the AI needs some accelerators like Tensor processing unit to do mathematical tasks correctly and efficient. The objective of OSs in this case is to provide **interfaces ,or libraries to access these accelerators** without mistakes. By providing interfaces to these accelerators, the AI computations will increase and become more efficient.

AI models, techniques, and approaches include multiple processes. What I mean is that there are many computations that will happen and perform in one time to increase the speed of the execution of AI model. The work of OSs here is to **support multiple process in one time** by implementing many mechanisms like process scheduling which giving the AI applications an advantage. Finally, OSs can do many tasks in AI applications such as : **ensure that the interfaces, frameworks , or libraries** are ready and available to execute the AI applications, they also **give required system resources** like CPU,RAM to execute and get an efficient AI computation.

On the other hand, AI and its applications and systems are not well protected and may face multiple hacking, data breaches, and many other cyberattacks. In this case, OSs should use the strongest security features to protect from all these threats and data breaches. I discussed before some security features of multiple OSs such as : encryptions, authentications, and monitoring tools and others to protect data.

About IOT , their devices (IOT devices) are popular in limited resources (low power processor, limited memory and many choices of connection). OSs provide IOT environments that are light and efficient, for example: they provide **real time operating systems (RTOS)** which is very helpful in IOT because IOT devices need real time capabilities or critical processes. Additionally, they include scheduling methods, task management, and interruption handling to guarantee that IoT-related operations are completed on schedule and reliably. Finally, OSs have many additional benefits for IOT such as they provide **connectivity protocols, devices management, and cloud services**. All these features in my opinion will meet future needs.

On the other hand, IOT has many disadvantages such as : few security features, and wide range of deployment. So, must OSs provide strong security and security features to successfully implement the modern technology. For example, they must implement encryption, access control and other security features.

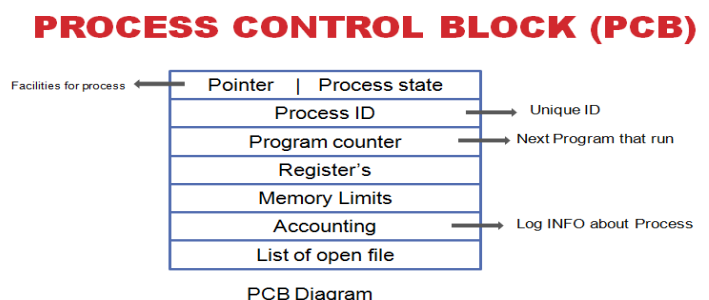
Sources: (Ai and the future of operating systems - content.iospress.com)[18], (IOT operating systems - javatpoint)[19]

12 WINDOWS AND LINUX OPERATING SYSTEMS WHEN REPRESENT PROCESSES AND THREADS

After all this journey, we must know what operating systems are, the importance of them and how they work. In this section, I will focus on the process and thread of Windows and Linux operating systems. First, in simple words process refers to the running file. Each process has specific memory (its own memory), and system resources.

In operating systems, when the process is created, the operating system implements various operations such as: it gives the process identification which is called (PID). Additionally, OSs enable several programming, they need to monitor these processes. In Windows, they provide datastructure called Process Control Block (PCB). In this data structure , it contains several information about the process such as: memory, security, and resource related to the process . When the process is established, the OS allocates memory for process's process control block. As shown in the figure, it shows the PCB information that related to the process.

On the other hand, Linux provides task struct structure, which is nearly the same as the function of PCB in Windows. It contains the same information about processes as shown in the figure. Also, when the process is established, the OS allocates memory for process's task struct.



In addition, threads refer to a single execution path, which is considered a small process that the OS may plan and run alongside other threads. Threads are offer the same memory and resources as the program as which created them. Also, the OS can creates and manage them to work together which give more efficiency work within single program.

In Windows, it uses Threads Control Block (TCB) to represent threads by showing information about the thread such as stack space, register set and program counter. When the thread is established, the OS allocates memory for the threads control block , and it is linked with a parent process.

On the other hand, in Linux, they performed lightweight process (LWP), such that each thread in the process is represented by its own task_struct struct which is the same as processes. The difference is LWP in the same process, they share the same memory and resources.

Let's talk more about threads, when the thread is established, the OS allocates to him many resources like (program counters, register values, and others). Additionally, threads need kernel support to control their running and synchronization. When we compare between process and thread, the difference is the level of resources allocation. When a process is established, an additional instance of the program with its own memory space and resources starts up, resulting in increased overhead. Threads, on the other hand, use the same memory space and resources the inside a process, leading to fewer overheads and improved thread communication.

Sources: (Thread in operating system 2023)[20], (Thread in operating system 2023)[21], (Process table and process control block (PCB) 2023)[22]

13 WINDOWS AND LINUX COMPRESSION RELATED TO THE COMMAND

There are some concepts that are taken to compare between Windows and Linux in relation to how commands are executed such as (command syntax / terminals and others). I will compare them by using five terms (terminal, syntax, file system, modifying files, and package managers) as shown in the table below. Note: there are many terms to talk about but I used this only five terms because I think these five are the most important terms.

Terms	Windows	Linux
Terminal	This OS uses command prompt (which can be accessed through searching in the menu tab) and also in the last versions of Windows, they provide Windows PowerShell which is command line interface.	This OS uses Terminal which provides access to the Bash shell. Bash Shell is the default shell in Linux. You can access the terminal in Linux by entering the applications menu.
Syntax	Use verb – noun structure to represents commands. (for example: “copy” -> means copy file)	Spaces divide commands and options, and options are usually followed by a hyphen. (for example: “ls” means listing file or directories)
File system	Drivers letters (C: , and others) are deployed in file system to show the storage devices	In this OS, the file system in hierarchy starts from the root ('/'). Also, directories are divided by using ('/')

Modifying files	Copy and move commands are the commands used to manipulate files. "the file path included driver letter and backslashes to sperate between directories"	In this OS, Cp and mv are used to manipulate files. "file path use '/' to separate between directories "
Package Manager	Depended on third party packages managers.	Use many managers like APT for Ubuntu, and YUM. DNF for red hat distributions

14 REFERENCES

- Types of operating systems (with OS functions and examples)*Types of Operating Systems (With OS Functions and Examples) (no date) *Types of Operating Systems (With OS Functions and Examples)*. Available at: <https://www.indeed.com/career-advice/career-development/types-of-operating-systems> (Accessed: 17 June 2023). [1]
- Field, C. (2022) *Complete history of the operating system*. Available at: <https://history-computer.com/complete-history-of-the-operating-system/> (Accessed: 17 June 2023). [2]
- Libretexts (2021) *2.1: Function of the operating system, Engineering LibreTexts*. Available at: https://eng.libretexts.org/Courses/Delta_College/Operating_System%3A_The_Basics/02%3A_Operating_System_Overview/2.01%3A_Function_of_the_Operating_System (Accessed: 17 June 2023). [3]
- Understanding operating systems - University of Wollongong* (no date) *UOW*. Available at: <https://www.uow.edu.au/student/learning-co-op/technology-and-software/operating-systems/> (Accessed: 17 June 2023).[4]
- Operating system - memory management* (no date) *Online Courses and eBooks Library*. Available at: https://www.tutorialspoint.com/operating_system/os_memory_management.htm (Accessed: 17 June 2023). [5]
- Memory management in operating system* (2023) *GeeksforGeeks*. Available at: <https://www.geeksforgeeks.org/memory-management-in-operating-system/> (Accessed: 17 June 2023). [6]
- Job scheduling | technology glossary definitions | G2* (no date) *G2*. Available at: <https://www.g2.com/glossary/job-scheduling-definition> (Accessed: 17 June 2023). [7]
- What is resource management in an operating system?* (no date) *Quora*. Available at: <https://www.quora.com/What-is-resource-management-in-an-operating-system> (Accessed: 17 June 2023).[8]
- kumaresh, S. (2020) *Operating system security, Medium*. Available at: <https://medium.com/beyondx/operating-system-security-ea23a46c3615> (Accessed: 17 June 2023). [9]
- Haslam, K. and Editor (2023) *16 MAC security tips to keep your mac safe, Macworld*. Available at: <https://www.macworld.com/article/668710/how-secure-mac.html> (Accessed: 17 June 2023).[10]

5 useful linux security features and tools for beginners (no date) *Online Courses and eBooks Library*. Available at: <https://www.tutorialspoint.com/5-useful-linux-security-features-and-tools-for-beginners> (Accessed: 17 June 2023). [11]

Rosini, R. (2016) *Ai and the future of Operating Systems*, *Medium*. Available at: <https://rodolfofor.medium.com/the-future-of-operating-systems-and-weaveos-e4c9bc3f23d7> (Accessed: 17 June 2023).[12]

The operating system of the future will cater to your every need (2018) *Quartz*. Available at: <https://qz.com/1420040/to-win-the-future-disrupt-the-operating-system> (Accessed: 17 June 2023).[13]

Kommadi, B. (2020) *Ai Operating System*, *Medium*. Available at: <https://medium.datadriveninvestor.com/ai-operating-system-7809e7fc4e49> (Accessed: 17 June 2023).[14]

Agarwal, T. (2021) *Android operating system : Introduction, features & its applications*, *ElProCus*. Available at: <https://www.elprocus.com/what-is-android-introduction-features-applications/> (Accessed: 17 June 2023). [15]

IPhone OS (IOS) graphic user interface (GUI) - more function view: Iphone OS (IOS) graphic user interface (GUI) - standby mode: How to design an interface mockup for iPhone application: Iphone Gui (no date) <https://www.conceptdraw.com>. Available at: <https://www.conceptdraw.com/examples/iphone-gui> (Accessed: 17 June 2023). [16]

Ios introduction: Ios tutorial (no date) *Intellipaat Blog*. Available at: <https://intellipaat.com/blog/tutorial/ios-tutorial/ios-introduction/?US> (Accessed: 17 June 2023).[17]

(No date) *Ai and the future of operating systems - content.iospress.com*. Available at: <https://content.iospress.com/download/information-services-and-use/isu794?id=information-services-and-use%2Fisu794> (Accessed: 17 June 2023).[18]

IOT operating systems - javatpoint (no date) www.javatpoint.com. Available at: <https://www.javatpoint.com/iot-operating-systems> (Accessed: 17 June 2023).[19]

Thread in operating system (2023) *GeeksforGeeks*. Available at: <https://www.geeksforgeeks.org/thread-in-operating-system/> (Accessed: 17 June 2023).[20]

Thread in operating system (2023a) *GeeksforGeeks*. Available at: <https://www.geeksforgeeks.org/thread-in-operating-system/> (Accessed: 17 June 2023).[21]

Process table and process control block (PCB) (2023) *GeeksforGeeks*. Available at: <https://www.geeksforgeeks.org/process-table-and-process-control-block-pcb/> (Accessed: 17 June 2023). [22]