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### COMPARATIVE WITH RECENT TRENDS, DESIGN, AND FUNCTIONALITIES OF VARIOUS OPERATING SYSTEMS

Amer Abu-Jassar <sup>1</sup>,  
Omar Jamal Khalaf <sup>2</sup>

<sup>1</sup>Faculty of Information Technology, Department of Computer Science, Ajloun National  
University, Ajloun, Jordan

<sup>2</sup>Amman Arab University, Master of Computer Science

#### ABSTRACT:

The article compares and contrasts three widely used operating systems: Macintosh, Linux, and Windows. The fundamentals of storage and data management, architecture, protection, adaptability, and other subjects are the main areas of attention when examining them. In this study, these subjects are contrasted. An overview of the key subjects and the numerous parallels and discrepancies in the fundamental usage of operating systems are provided by this research study. This research focuses on the fundamental advantages and disadvantages of each operating system. Each type of operating system has a unique set of variations in its architecture and makeup.

**Key words:** Operating Systems, Windows 10, MacOS, Linux, Virtualization, Cloud Integrating, Artificial Intelligence

#### INTRODUCTION

The present research aims to perform a thorough contrast of the most recent features, design concepts, and trends among different operating systems (OS). Operating systems are becoming more and more important in determining program compatibility, machine relationships and customer experiences due to the quick advancement of technology. The objective of this study is to investigate and assess the unique characteristics, user experiences, security protocols, performance enhancements, and interoperability frameworks that are present in modern operating systems. At the same time, various methods and approaches can be used here, both for OS development and for their analysis [1]-[23].

This research looks at OS trends on several platforms, including Windows 10, macOS, Linux kernels, Android operating system, & iOS, in an effort to determine the similarities, variations, advantages, and disadvantages of each system. Furthermore, the study will explore cutting-edge operating system developments and technologies, such as virtualization, cloud integrating, artificial intelligence (AI), and Connectivity of Things (IoT) compatibility. This investigation aims to provide information on the current state of operating systems, assisting architects, users, as well as legislators in making knowledgeable choices regarding OS choices, development, and usage in a variety of computing circumstances.

#### Operating systems as a research object

The operating system is a piece of software that controls and facilitates the operation of a computer by acting as an interface among the user's computer and the hardware. It is a group of programs that facilitates the management of physical assets and offers standard functions for computer applications. It is among the computer's most important components. Process

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development, processing nation, process coordination, process interaction and preventative maintenance are an operational system's five main functions. Operating systems (OS) are necessary for applications to function and the machines itself need an OS to preserve system security and create a GUI/CLI foundation for the ability to get to and use the computer performing tasks. Many software operations, such the cost-effective distribution of processing time, mass storage, printing, etc., rely on the operating system (OS), but hardware operations, like memory allocation system operations, the both input and output of memory, etc., also require the OS. This essay examines three distinct operating system types – Linux, Windows, and Macintosh – as well as all of their unique characteristics and components. We compare them according to a number of criteria, including the way they start up, how the user experience works, how system resources are handled, how files and devices are managed, how secure they are, how versatile and efficient they are, how reliable they are, how much they cost, and more. To aid in comprehension, an organized comparison of the three operating systems is provided after each feature. The four primary different kinds of operating systems can be divided into four categories: multi-user, single-user managing multiple tasks, single-user operating systems (RTOS), and single-user operating systems ( OS ) [24]. Industrial systems, equipment, and scientific equipment are all controlled by RTOS. An RTOS usually comes in a "sealed box" ready to be used, meaning it has very minimal user interface capabilities and no end-user services [25]. These kinds of systems are fantastic at allocating resources so that work may be done quickly.

Systems intended for a single user and one task are called single-user, multi-task systems. It is mostly applied to portable electronics. Single-user multitasking allows one person to carry out many tasks or run multiple programs simultaneously. This is the OS type which is most frequently utilized in laptops and desktop computers. This kind of operating system includes Windows and Mac OS [25]. A software package with multiple users enables an equitable simultaneously usage of resources by several users. It ensures that there are enough resources so that none of the users who are currently active will have any issues. Operating systems with multiple users include UNIX, the VMS, and supercomputer OS.

Linux OS is a widely used system for operating that is primarily utilized in massively parallel computers along with information centers, but it is also employed for personal usage throughout the globe. Its many security and OS adaptability benefits have caused it to supplant Mac and Windows OS. Many distributions (distros) operate on this kernel, and anyone can use and alter the system as they see fit [26].

The first release of Microsoft's operating system, Windows, was released on November 20, 1985 [27]. Its foundation is the Disk Operating System (DOS), which is renowned for having command-line capabilities and a dark screen.

Windows 95's launching marked the beginning of Windows' market dominance. This was due to the fact that Windows 95 was the initial operating system to have DOS in the center and the Graphical User Interface (GUI) in the upper right corner. For someone who doesn't use computers, this was truly revolutionary. In 1984, Apple began developing the Mac operating system through Apple Inc. [28]. The Motorola PowerPC Chip, which is equipped with a sophisticated improved design for audiovisual interface and visuals and practicality. Mac OSs were only GUI-based settings, lacking a command-line option. Since the year 2005, the although the Macintosh line of computers is Intel-based, OS may only be used on Apple Macs, which are the first operating

system with several tasks. Because of its UNIX roots, Mac OS X offers us the choice of a character-based interface. The only company that makes Macintosh computers is Apple Computers.

When transferring a computer from one Windows PC to another, it is more effective when transferring files and software from a previous Mac to the new one. Preinstalled on Apple's Mac operating system are a number of potent efficiency and multimedia applications. Because of its UNIX roots, Mac OS X offers us the choice of a character-based interface.

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**Booting process OS**

Linux.

It is the initial action that happens when we turn on a computer or the process of starting a computer. Either hardware (by pressing the start button) or software (by issuing commands) may accomplish it.

There are 6 phases in the booting process. First, the fundamental input/output system runs the Master Boot Record (MBR). Next, the MBR launches the Grand Unified Bootloader (GRUB). Then GRUB starts executing the kernel. The kernel then starts to run /sbin and /init. Subsequently, Init initiates the execution of runlevel programs, which originate from /etc /rc.d /rc\*.d, as illustrated in Figure 1 [29].

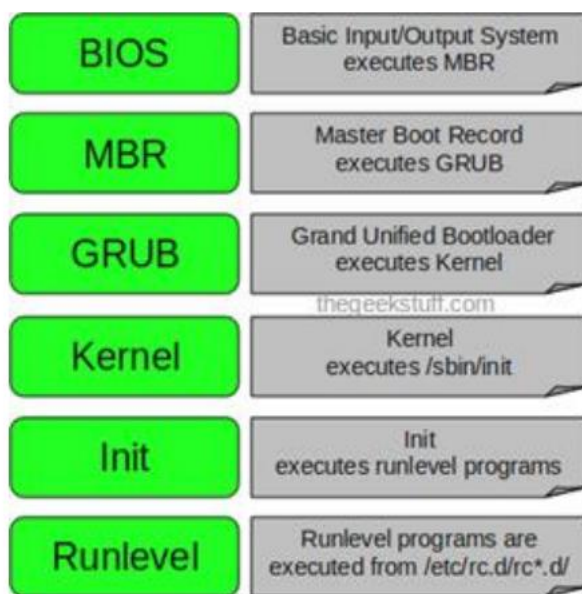


Fig. 1. BOOTING PROCESS OF LINUX OS

Windows.

The cold boot is the first stage of the launching process that happens when the computer has been switched on. The computer runs a Power On Self Test (POST) when it is turned on.

We search the bootable storage device for MBR. The MBR is now used to identify the boot sector and BOOTMGR. BOOTMGR reads the BCD file stored in the boot subdirectory on the working component and looks for the active partition. After drivers have been downloaded by the winloader and configured to launch at boot, the Windows kernel gains control. Figure 2 below depicts the method in detail [30, 31].

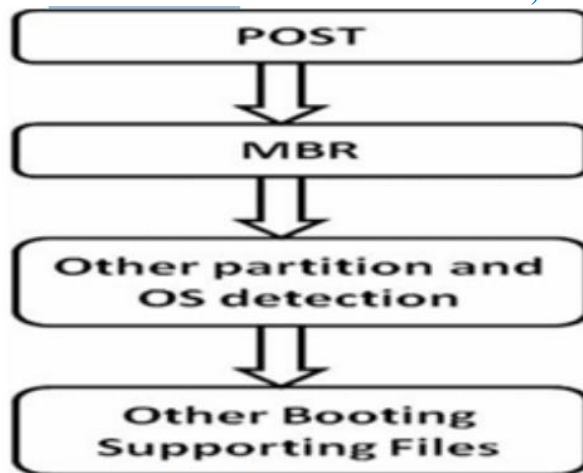


Fig. 2. BOOTING PROCESS OF WINDOWS OS

### OS Comparative Analysis

Comparing the latest styles, layouts, and features of different the operating systems exposes unique features and improvements in every operating system. Windows keeps emphasizing its configurable UI, and the addition of Fluent Design components improves the overall customer experience. Microsoft's efficiency is emphasized by its focus upon performance maximizing efficiency, which includes lower resource use and shorter booting times. Windows has powerful safety functions like Secure Boot & Windows Defender antivirus to protect user information. Like iOS, macOS maintains its straightforward and user-friendly interface, but the macOS Big Sur update brings enhanced control center functionalities and a more upscale appearance.

Easy to use and providing data privacy measures such as Gatekeeper and The FileVault program, macOS is optimized for Apple's goods and efficiently manages resources. Various Linux versions offer various user interfaces (UIs), ranging from feature-rich desktop programs like KDE and GNOME to simple designs.

Linux offers robust security measures including frequent patching and efficient authorization control since the application itself is freely accessible. Android prioritizes customization and adaptability. App security is guaranteed by Google Play Protect, and UI consistency is driven by fundamental Design standards [31].

While maintaining a high degree of performance and simplified user interface across devices, iOS is supported by stringent security measures such as App Store approval processes and biometric identification. Each type of operating system provides unique benefits in terms of effectiveness, safety, and seamless integration, all of those being signs of the technology industry's ongoing innovation and commitment to user-centered principles for design.

### CONCLUSION

As a result, the operating system serves as a conduit between users and the hardware of their computers. We examined Linux, Windows, and Mac OS operating systems based on certain aspects in this study. Our comparison shows that none of them are inferior. Everybody has benefits and drawbacks of their own. Our goal is to provide people with an overview so they may select an operating system based on what best suits their needs.

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