**Choosing Operating System: Windows, Linux or MAC?**

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**Abstract**

A computer operating system is piece of software which manages all the hardware resources. The operating system acts as a bridge between an application software and the hardware of the computer and interfaces the hardware with the application programs. Since the foundation of the operating system concepts, many industries developed their own operating systems and many more industries are still developing new operating systems. Choosing an operating system demands technical knowledge as well as psychological preferences. This paper presents the technical details of three most powerful and giant operating systems – Windows, Linux and Mac OS and few psychological aspects in choosing an OS among these.

**Introduction**

It sounds nearly impossible to imagine a day without a computer. Computers have become obligatory in our everyday life. Starting from our day planner to the complex control system of space crafts are designed and controlled by the computers. In the early days of the evolution of computers, they were not capable of achieving such complicated tasks. They were developed to perform some specific calculative operations and all the hardware were programmed using machine language which only a few scientists back then were able to do. A single computer could perform only one task. With the advancement of the technology the size of the computers reduced, speed of hardware increased and the concept of operating system originated as an idea to develop a software which could manage the hardware resources and other application software could be written on top of the operating system for performing multiple tasks with a single computer. The first operating system like software were invented during the 1960s [1] and giant computer makers were writing their own operating systems which were able to perform more than one task [1]. Since then various operating systems have been developed but three most popular of them are – Windows, Linux and Mac OS developed by Microsoft, Linus Torvalds and Apple Inc. respectively. All three of these operating systems are presiding the computer industry and choosing an operating system between these requires both technical understanding and psychological preferences.

**Evolution of Operating Systems**

During the mid-1960s FORTRAN language was developed which intellectualized the concept of operating system like programs [1]. In 1965 FORTRAN Monitoring System was developed that dealt with three types of programs [1] and performing more than one task was implemented in this system. Technology began advancing and in 1984 Apple Inc. released MAC System 1 [2] which was the first ever Graphical User Interface (GUI) based operating system. All of the other systems prior to MAC System 1 run on command line interface [2]. In the following year, Microsoft released their GUI version of operating system “Windows 1” [2] which made a successful attempt to familiarize users to control the computer with a mouse by introducing a game called “Reversi” [2]. Over the upcoming years both of the manufacturers came up with new versions of their operating systems which brought changes to their user interface, hardware-software interface enhancement, software support and user experience.

In 1994, a Finnish computer science student and later computer scientist, Linus Torvalds, upon getting frustrated with the licensing issues of then-existing operating systems, developed his own operating system kernel named “Linux” which he made free to use and open source [3]. After the release of Linux it got immense popularity among the programmers across the whole universe and since then the operating system have been developed perpetually by thousands of programmers. At present Linux operating system has not only taken a huge market for computers but Linux is also very popular for writing smart phone operating systems [4].

**Services of an Operating System**

When an average user uses a computer to check e mail or use a spreadsheet software to manage personal accounts s/he might only be interested in the performance of that particular applications software. But there are a number of other issues regarding which the user might be unaware of. Figure 1 shows the organization of the components of a computer’s software system in different layers.

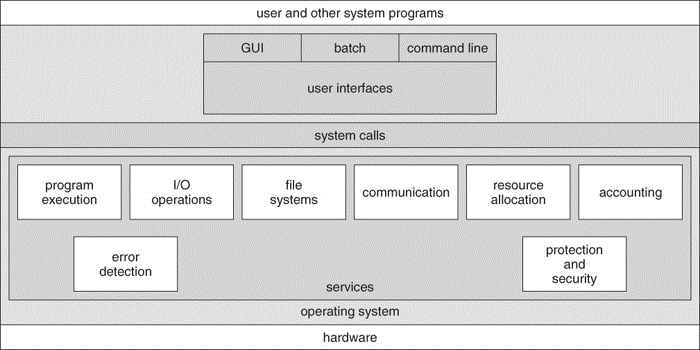


Fig 1: Operating system services [5]

We would like to discuss about some of the features of an operating system and describe how the three operating systems, Windows, Linux and MAC, provide these features.

**Ease of Use**

Windows is so far considered to have the most user friendly interface because of its enormous amount of users worldwide. Windows can be found in almost all the home user computers and in many offices as well. It is most probably the first operating system a person gets introduced to. Architecturally also, Windows has come up with an easy and interactive GUI which creates an impression on the users’ mind.

Apple’s tend towards hiring the best interface designers has resulted in the MAC OS’s intuitive nature of the GUI. The interface is very attractive as well and it reliefs stress among users who use the computer for a prolonged period of time. MAC also has an easy command line interface as well.

Unlike Windows and MAC, Linux was not developed as a GUI based operating system. Linus Torvalds wrote the kernel which has a command line interface. There are GUI based versions of Linux which are developed by third party developers know as distributions or “distros”. As a result, using Linux is not so easy for a general user. Although the GUI based versions are available, the interface is a bit tricky and might not be suitable for mass users.

**Security**

Windows has a relatively open stance towards applications. This has gained Windows its fame and popularity. But at the same time it has made Windows vulnerable to viruses, malwares and hacks [6]. Microsoft is continuously updating Windows security measures. In Microsoft Windows 7 the BitLocker Drive Encryption system has been introduced which encrypts documents, passwords and other necessary data [7]. Windows Firewall also protects the computer from viruses and hackers [7]. Windows 7 also introduced Windows Defender which protects the computer from pop up ads and security threats caused by spyware [7].

Unlike Windows, Linux is less prone to viruses and spywares. First of all, the software support base for Linux is fairly smaller than that of Windows. Secondly, Linux is an open source software which means the system is getting modified and updated very rapidly than Windows. Linux has a very tight security while accessing the files. It requires the user to authorize the execution of any file by entering password which ensures that no malware or viruses can be installed without letting the user know [8]. Moreover, people who use Linux they require deeper knowledge about the operating system than the users of Windows. As a result, users know if any malware is attacking the computer [8]. Due to the fact that number of Linux users is significantly less than Windows, it makes Linux less prone to vulnerabilities [8].

On the other side, MAC is designed specifically of Apple devices which makes the operating system very unique. There is no third-party developer. As a result, MAC has a strong shield around it that protects the OS from malwares and viruses. Along with this, MAC also supports the user acknowledgement while executing any files.

**Reliability**

An apple computer is designed and made from scratch solely by Apple Inc. Apple controls the production line from the beginning to the ending. Every component of the device is tested and assembled to work properly. This makes an Apple device incredibly stable.

Microsoft has been conducting enormous research for developing the Windows operating system. Windows is versatile and can be installed on any machine. Unlike MAC OS, Windows is not a dedicated software for a specific hardware system which leads to unreliability issues due to hardware changes. Windows OS is also very prone to crashes by virus or malware attacks if security measures are not taken very carefully.

Linux, on the other hand, is not a complete operating system [9]. The inventor of Linux developed the kernel only and it was released as open source. It invited the third-party developer to play with the operating system. Thousands of developers from all around the globe started to contribute to the development of the operating system. GUI versions of Linux were being released by different organizations which were known as distributions or distros. Linux is continuously being updated by developers which makes the system stronger day by day.

**Software and Hardware Compatibility**

Microsoft Windows leads the market in compatibility regard. Almost all of the software manufacturers make a Windows version of their software. And there is so many software who only have Windows version. The gaming industry develop their games primarily for Windows platform. Windows has very unique plug and play compatibility that allows versatile kinds of hardware to be interfaced with the operating system.

Linux also have a large but smaller than Windows compatibility feature. The mainstreams software such as word processors, spreadsheets, audio video player and editor, programming environments are available for Linux. The desktop versions of Linux are still developing and the compatibility support will increase in the near future.

Apple’s MAC on the other hand is very compact. It doesn’t support many external software and hardware. Even though many people might think it is a very limited access MAC actually tightly holds itself from external interfacing to increase its security.

**Boot Time**

Windows operating system on a standard hardware has a boot time of 10-15 second, MAC operating system on similar hardware has boot time of 9-15 second and Linux operating system with similar hardware has a boot time of 4-8 second [19, 20].

**Hardware Requirements**

Windows operating system is most widely used so most of the computer manufacturer choose Windows as default operating system for their hardware. So, when a new computer system is bought is will be most probably shipped with Windows. Most hardware on the market are compatible with Windows as long as it meets the requirements. The flexibility with Linux is it can be installed almost on every hardware also it has a minimum system requirement than another operating system. With Linux, a dual boot systems can be made. The Mac OS restricts the hardware to some specific manufacturer selected by apple. So, it can only be installed on computer built by Apple. So, Windows and Linux has more compatibility than MAC OS. The basic system requirement for these three operating system is given on the table. It illustrates the system requirements for most recent versions of MAC OS, Windows and Linux. In case of Linux Ubuntu is chosen as there are a lot of Linux flavors to choose, all of them cannot be compared.

Table-1: Basic system requirements for most recent version of OS [10, 11 12]

|  |  |  |  |
| --- | --- | --- | --- |
| Systems | Windows 10 | Linux (Ubuntu 17.4) | MAC OS Sierra |
| Processor | 1GHz or faster processor or SoC | 700 MHz | 2.4 GHz |
| RAM | 1 GB for 32-bit  2 GB for 64-bit | 512 MB | 2GB |
| Hard Disk Space | 16 GB for 32-bit  20 GB for 64-bit | 5 GB | 8.8GB |
| Graphics Card | DirectX 9 or later with WDDM 1.0 driver | OpenGL 1.4 or higher | OpenGL 3.3 or higher |
| Display (screen resolution) | 800x600 | 1024x768 | 640x480 |

**Architecture and File System**

All the operating system supports 32-bit and 64-bit architecture and they are backward compatible. All of them supports mostly available file system. Linux and MAC OS both follows UNIX like file system. All the files start from root directory and follows subdirectory pattern. Windows system has different local disk and. List of architecture and files system is illustrated in tables below.

Table-2 Architecture Support

|  |  |  |  |
| --- | --- | --- | --- |
| Architecture | Windows | Linux | MAC OS |
| x86 | Supported | Supported | Supported |
| x86-64 | Supported | Supported | Supported |
| PowerPC | Not Supported | Supported | Supported |
| ARM | Supported via Windows NT | Supported | Supported |

Table-3 File System Support

|  |  |  |  |
| --- | --- | --- | --- |
| File System | Windows | Linux | MAC OS |
| FAT, exFAT | Supported | Supported | Supported |
| UDF | Supported | Supported | Supported |
| ISO 9660 | Supported | Supported | Supported |
| HFS+ , HFS | Supported via 3rd-party drivers | Supported | **Supported** |
| ext2, ext3, ext4 | Supported via 3rd-party drivers | **Supported** | Supported via 3rd-party apps |
| NTFS | **Supported** | Supported | Supported Read Only |

\*Bold Ones Indicated Default file system.

**Intelligent Personal Assistant**

Voice-activated digital assistant assists the end user to use the system smoothly. It enables intelligent interaction between machine and user. A user can ask the machine what is the time now, how is the weather outside, what is the top news of a certain journal. These digital assistants are powered by artificial intelligence to identify voice and analyze the spoken sentence to find the exact meaning then reply accordingly. Siri is the name of intelligent personal assistant for MAC OS and Cortana is the name of intelligent personal assistant for Windows, there is no intelligent personal assistant for Linux based OS so far [13]. These intelligent personal assistants can be activated by predefined phrase, or via tap of a button. They can do things for an end user. They can read you the latest email, text someone, make a call but they are not able to reply or do the complex tasks.  None of these intelligent personal assistants passed the Turing test. A machine would pass the Turing test only if it can easily trick a human into conversation as partner like human will only engage thinking as it was human [14].

**Cost of OS and Applications**

Cost of the latest Microsoft Windows 10 is $119.99 USD [15], MAC OS is bundled with apple specific hardware and hardware price is included with total system cost. There is no option to buy MAC OS separately. Ubuntu is free of cost it can be downloaded freely from canonical website and installed without license. A price comparison diagram is presented below to illustrate the big difference in price of these three operating system. A basic office application that includes word processor, spreadsheet etc. prices $42 USD for MAC OS and $110 USD for windows user where in Linux it's totally free [19].

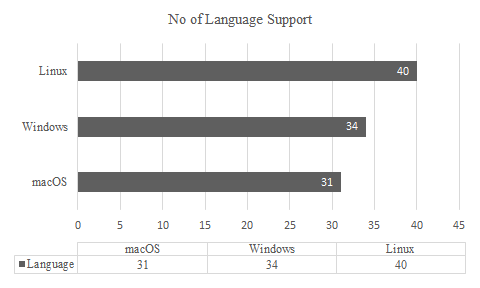


**Software Management**

Software management is the way how an operating system manages its user applications. The most efficient way of managing user application is package manager. All the Linux based operating system uses this package manager concept to manage user application also system application. Package manager like Advanced Packaging Tool (APT), Debian Package Management System (DPKG), yum, pacman is more widely used. These package managers provide an end user to manage new software and installed software. It manages software installation, uninstallation, up gradation, deletion of old software, removal of unnecessary software [18]. It also helps unattended installation process. In windows and mac world there is store concept that manages all the user application. But user can install application out of the store. Out of the store apps are not managed by the app stores. Thus, all the application is not centrally managed. Windows and MAC OS also does not support unattended application installation by default. There are third party application like chocolatey [17] for windows and Homebrew for MAC OS [16] that can do the unattended installation and deletion and remote installation of application.

**Language Support**

The end users always prefer the local Language over the default language. It's easy to understand a system on native language. Primary language of all the three operating system is English. All of them supports most of widely used language like German, Spanish, and French. MAC OS supports total 31 languages [11], windows supports more than MAC OS that is total 34 language [10] and Ubuntu supports maximum number of language that is total 40 languages [12]. Ubuntu is in the process of translating other 200 language.



**Conclusion**

All of the aforementioned operating systems are the three most stable and famous versions of operating systems. Every system has its own strength and weakness. Choosing an operating system among these would require proper analysis of the user. In a nutshell, we can summarize that if a person wants versatility or gaming features he/she should go for a windows or if a person wants to dig deep into the core of the operating system and wants to know how it works he/she should chose Linux. And if someone wants a compact solution with aesthetic features he/she should chose a Mac OS.

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