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Windows, Linux and Mac Operating system Booting Process: a Comparative Study

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Abstract

This paper presents a comparative study of Booting Paradigm of Windows, Linux and Mac, the three popular operating systems. Booting process is the essential and first step perform by the OS after this process execution all other processes can get the chance to execute , so we may say that booting is the first process because of which all other OS processes can execute. This experimental study gives an overview on the similarity and difference in Booting Process. As every operating system have to initially do the booting and as every OS providing different feature of each others, the paper is highlighting those micro and essential similarities and differences having by the operating systems during the Booting Process.

Keywords: Booting, Cold booting, Worm booting, Linux Booting, Windows Booting, Mac Booting.

1. Introduction

Booting Process is the first step gets happened in the computer system when you switch on the computer. In computing, **booting** is the initial set of operations that a computer system performs when electrical power to the CPU is switched on. The process begins when a computer is turned on for the first time or is re-energized after being turned off, and ends when the computer is ready to perform its normal operations.
Booting includes four main steps in computer including power On and secondly it load the initial instructions from the ROM memory next it detect the operating system in the Hard-disk and finding other hardware attached to computer Finally it start the certain essential computer application as per the default setting done by the operating system or by the computer user
The most general types of computer booting are Cold Booting and Warm Booting , The Cold Booting is the booting when the computer since to be off over a period of time. In which all the primary memory and internal setting completely cleared.

In Worm Booting the computer get restart without shutdown the system, in which the system application and memory just get cleared and then reloading the operating system in primary memory. With the above two booting types we also have some other flavor in the computer booting like Sleep, Hibernate.
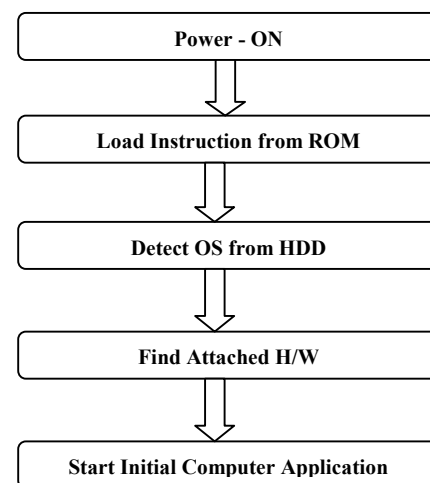

Figure 1: Computer Booting Steps

2. Operating system overview:

Operating system is the program which operates all other program in the computer system. Whenever we want to interact with the computers we must have an operating system on it.
The operating system was developed for the better computer usage and providing better platform to the users application. According to the betterment and demands of the user the operating systems are get grow right from simple operating system like Command oriented (DOS), and Some GUI based Operating system Like Windows , Linux, Mac. The mention operating system are also create the differences according to their features like Number of user can work on the operating system at a simultaneously

(Single-user or Multi-user, Multi-processing, Multi-programming, Network, Distributed, Real Time)

2.1 Windows

The most popular operating system now a day in all over the world. The operating system comes in very different format like single user, multi-user, network operating system etc. Windows was developed by Microsoft Corporation in 1980s. The first GUI operating system developed by Microsoft was Windows 3.0 in 1989. The organization also developed on command based and most popular operating system named as MS-DOS (Microsoft-Disk Operating System) in 1981. Windows XP was the most popular and widely using operating system till date, because of user-friendliness and easy to operate the operating system still   use by most of the people in the word. The latest version of Windows in market is Windows 8 launched commercially in Oct 2012.

2.1.1 Booting in Windows

The booting process in windows is very easy just like its user friendly features. There are four basic steps are there in Windows operating system while booting. The first process starting when you turn on your computer is BIOS i.e., Basic Input Output System.
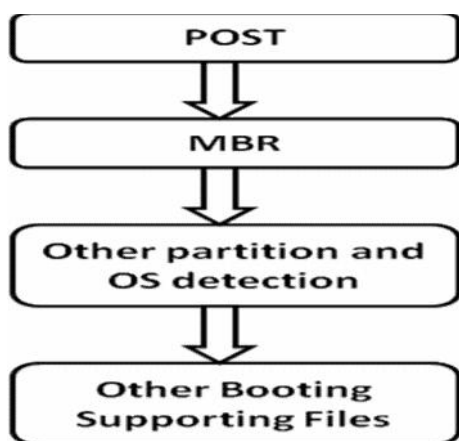

Figure 2:- windows booting Steps

Step 01: In First step POST stands for Power On Self-Test, which is initially inventory step and very critical step, where hardware configuration and detection has been perform, by looking and listen the errors and diagnosis reports e.g. Error codes, beeps codes, numeric codes

Step 02: Now BIOS will look for the Booting Priority, like from where the computer will get the operating system e.g. from hard-disk, floppy disk, or network. This record in booting process is called MBR (Master Boot Record).

Which stored on first sector of the hard disk from where the operating system start it's loading in Primary memory. It also provide the Booting partition information

Step 03: Now the BIOS knows the MBR and Booting Partition where the operating system loads the small system software called KERNEL into main memory. Finding NTLDR (NT Loader) who will load the partitions in the computer system and try to identifying other partition other than primary partitions. In same step boot.inf file check the partitions for other Operating system existence, where the user will select the operating system loading into memory

Step 04: Other important booting support file line win.sys, NTOSKERNEL.exe, HAL.DLL, system.ini, win.ini, sysedit.exe, config.exe, autoexec.BAT, MSCONFIG.exe these file are help in different system software installation for which the application oriented environment has to get implemented and Microsoft Corporation developed some standard configuration done while booting the system.

2.2 Linux

Linux is free open source operating system allowing the free distribution and licensed by GNU (General Public license. Any developer can try to modify the system codes as long as he/she will not going to sale the code. Linux is the first multitasking and platform portable operating system.   The main benefit of the Linux operating system is its free to use and its open source operating system which make it user level modifying operating system which make more user oriented than windows operating system. The Linux also provide the inbuilt utilities like system drivers, antivirus, reliability feature which make them more non-stop works on the client server environment without having reboot of the system. Now days the Linux operating system used as one of the most secure and anti threats operating system which is the one of the best protection mechanism providing operating system.

2.2.1 Booting in Linux

The booting process in Linux is quite different than windows except the BIOS and MBR features. There are four basic steps in Linux operating system while booting. The first process starting when you turn on your computer is BIOS i.e., Basic Input Output System.
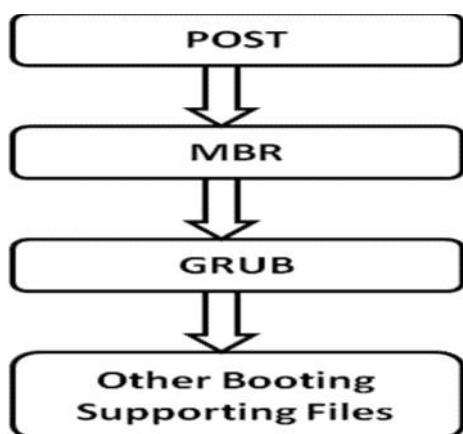
Figure 3 :- Linux Booting Steps

Step01: In First step POST stands for Power On Self-Test, which is initially inventory step and very critical step, where hardware configuration and detection has been perform, by looking and listen the errors and diagnosis reports e.g. Error codes, beeps codes, numeric codes. Will take care of identifying the Master boot record for the initializing the booting process.

Step02: Now BIOS will look for the Booting Priority, like from where the computer will get the operating system e.g. from hard-disk, floppy disk, or network. This record in booting process is called MBR (Master Boot Record). Which stored on first sector of the hard disk from where the operating system start it's loading in Primary memory. Some time it may stores in some ware else like floppy, bootable Compact disk (CD), or flash drive. It also provide the Booting partition information from where the operating system starts its loading on the computer.

Step03: after getting the idea about the primary partition the first bootstrap loader load into the memory is **GRUB (Grand Unified Boot Loader) or LiLo (Linux Loader) which try to load the** operating system feature form the supporting resources the initial loading file is **initrd (Initial RAM-DISK)** which take care to create the ram-disk initialization for the keep ready the RAM disk for the loading the operating system from the sources. one of the most important function of the GRUB is load the Kernel into the memory during the booting by loading LinuxRC which stands for Linux Run Command for initializing the basic hardware for necessary during the booting process during this configuration nest phase is un-mount the initrd un-mounting so that the basic information is stored in the RamDisk and now the real disk can be use by the operating system for further. The finally the Grub complete is part by initializing the file system mounting though INIT root directory by mounting the initial file system for further activity of loading other supporting file of Linux operating system .

Step04: Other important booting support file like **/sbin//init, /etc/inittb, /etc/rc.local, /runlevel**
These file are help in different system software installation for which the application oriented environment has to get implemented, which help to create the GUI or Console base environment for the user to use the operating system.

2.3 Mac

Mac operating system was developed by the apple in 1984 by the Apple Inc. The Apple Inc. Produce proprietary hardware and software for better integration of the OS and the hardware s increase the fastest and smoothest way to handle and use of operating system by the end-users. Macintosh computers used the Motorola PowerPC Chip set with an advanced architecture enhanced for graphics and multimedia interface and usability. Since 2005 the Apple Mac line of computers are Intel-based, but the Mac OS is only licensed to run on an Apple Mac which is the first multitasking operating system. The preferred file system for Mac OS X is HFS, HFS+, a robust file system that includes support for file permissions, but it also supports other file systems.
Macintosh OSs was strictly GUI environments, with no command-line option. Mac OS X, with its UNIX origins, gives you the option of a character-based interface Apple Computers is the only manufacturer of Macintosh computers. Mac Operating system is Hardware oriented which has its own keyboard and mouse where mouse is only has one button as left and right click button like normal mouse use in other operating system. As compare to the other operating systems the MAC operating system is expensive because it's not only OS but also it's an entire (Specific) system expected to purchase by the consumer to run the MAC operating system. Mac OS X Tiger 10.4, the newest version of the operating system apple released in the year 2006 and then apple introduced the latest version of OS X version of Mac was Snow Leopard (10.6) in the year 2010.

2.3.1 Booting in Mac

One of the most unique feature of the Mac operating system booting process is it does not support the BIOS instead of having the BIOS it support the firmware utility call BootROM When the power to a Macintosh computer is turned on, the BootROM firmware is activated. BootROM (which is part of the computer's hardware) has two primary responsibilities: it initializes system hardware and it selects an operating system to run.
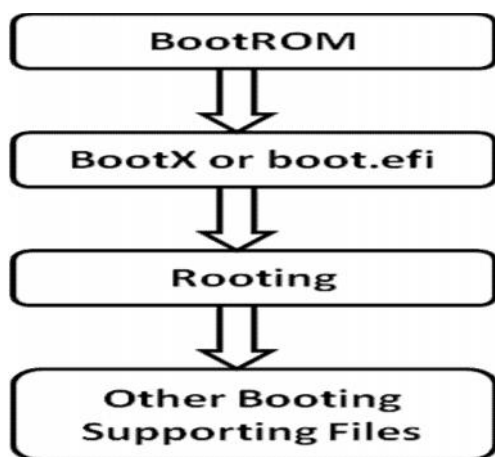
Figure 4: Mac Booting Steps

Step01: BootROM work on two function for Mac system to help it carry out the boot process : First is POST (Power-On Self Test), where it initializes hardware interfaces and verifies the   sufficient availability of the memory and   EFI which verifying the basic hardware initialization and selects which operating system suppose to use.

If there are multiple installations of OS X are available, BootROM check the previous booting process and choose the one that was last selected by the Startup Disk System Preference process. The user can override this choice while the computer boots, which causes EFI to display a screen for choosing the boot volume.

Step02: Once BootROM is finished and an OS X partition has been selected, control passes to the boot.efi boot loader.

The fundamental job of the boot loader is load the kernel into the memory. If full-disk encryption is enabled, the boot loader is responsible for drawing the login UI and prompting for the user's password, which needed to access the encrypted disk to boot from it. The boot loader can be found in the /System/Library/CoreServices directory on the root partition, in a file named boot.efi.

Step03: Once the kernel and all drivers necessary for booting are loaded, the boot loader starts the kernel's initialization procedure. At this point, enough drivers are loaded for the kernel to find the root device.

The kernel initializes the Mach and BSD data structures and then initializes the I/O Kit. The I/O Kit links the loaded drivers into the kernel, using the device tree to determine which drivers to link As used here, the term "root" refers to mounting a partition as the root, or top-level, file system. Boot≠Root is a technology that allows the system to boot from a partition other than the root partition. Boot≠Root uses a helper partition to store the files needed to boot, such as the kernel cache.

Step04: now the mandatory file are get loaded during the booting process now the turn on for the supporting and the system software who also have equal importance in the operating system for make operating system workable like the mach_init and init processes have been replaced by "launchd" . "launchd" is now the root system process. "launchd" then also replace and handle Various system script including /etc/rc, Run starts up items, Prepare the system for the user, Coordinate the launching of system daemons in an orderly manner. "launchd" frees up memory and other resources associated with the daemon. "launchd" starts SystemStarter, "loginwindow" is a program that controls several aspects of user sessions and coordinates the display of the login window and the authentication users.

3. Comparative chart of Windows, Linux and Mac Booting Process

OS ⟶ Features ⟶	Windows	Linux	Mac
BIOS	Yes	Yes	No
POST	Yes	Yes	Yes
Boot Loader	NLTDR	GRUB or LiLo	BootX or boot.efi
Kernel	NTOSKERNEL	INIT , initrd	mach_init , launchd
Supporting Files	win.sys, HAL.DLL, system.ini,sysedit.exe,config.exe, autoexec.BAT, MSCONFIG.exe	/sbin//init, /etc/inittb /etc/rc.local , /runlevel	mkextcache, launchd, loginwindow , /System/Library/CoreServices

Table 1 :- Comparative Chart of Booting Features of Different Operating System

4. Future Scope

This experiment also give the motivation to the comparative study of other operating systems like android, Solaris, server operating system where advance features of the operating system also include the new and advance

steps in the booting process than the existing step which this experiment covered.

5. Conclusion

In the paper we compare the booting aspects with respect to the different operating system scenario such as windows, Linux and Mac operating system. The experiments give the idea about the booting process difference and similarities in these operating system. The experiment give the conclusion that every Operating system (Considered in this research paper) has same POST step common and first step the operating system must processed during the booting process. This experiment also shows the Mac is the only operating system which does not support any BIOS kind mechanism while booting, it has its own mechanism such as BootROM where it has its operating system boot loader called BootX or Boot.efi . This experiment also gives the idea about the different boot loader and kernel used by the operating system during the booting process of individual.

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