

# A History of Operating Systems

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# Abstract

Operating systems are the main piece of software that is run on any computer. An operating system must manage the hardware and software on the computer and with provide a software interface for applications to run on. Operating systems started very primitive with early computers that used punch cards and plug boards to operate. They then moved into a generation of advancement to utilize more of what a computer could do with the advent of multiprogramming and SPOOLING. After that three main branches of operating systems were created with Microsoft, Apple, and the UNIX/Linux families.

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# 1 Introduction

Operating Systems are the most vital piece of software on your personal computer. Every personal computer has some type of operating system. In order to fully understand today's computers and operating systems; you need to understand the history of them and a basic understanding of what they do. Operating systems have come a long way from punch cards and switchboards to command line and all the way to the more high powered Windows, Linux, and Mac OS. All of these modern operating systems have gone through a long evolution that has created what we know today.

## 2 What an Operating System Is

The most important program that runs on a computer is its operating system (sometimes abbreviated as OS). Every general-purpose computer must have an operating system to run other programs. You can think of it as the Master Software of your computer. It enables the computer hardware to communicate and operate with the computer software. Operating systems perform basic tasks, such as recognizing input from the keyboard, sending output to the display screen, keeping track of files and directories on the disk, and controlling peripheral devices such as disk drives and printers.

Operating systems provide a software platform on top of which other programs, called application programs, can run. The application programs must be written to run on top of a particular operating system, however a particular operating system can run on different computers. Your choice of operating system, therefore, determines to a great extent the applications you can run and not necessarily the type of computer you have.

As a user, you normally interact with the operating system through a set of commands. For example, the MS-DOS operating system contains commands such as COPY and RENAME for copying files and changing the names of files, respectively. The commands are accepted and executed by a part of the operating system called the command processor or command line interpreter. Graphical user interfaces allow you to enter commands by pointing and clicking at objects that appear on the screen. For example, dragging-and-dropping a file will move a file from one location to another.

## 3 How an OS Works

An operating system must do two main things in order to be effective. First, it must manage the hardware and software resources like, the processor, memory, and disk space. Second, it must provide a way for the software to work with the hardware. These two elements are only the most fundamental level of what modern operating systems do.

### **3.1 Hardware and Software Management**

Managing the hardware and software is very important on a computer because when programs are running they are constantly competing for system resources, such as attention of the processor, memory, and management of devices. The operating system manages this by getting all the programs to 'play nicely together' along with giving out the resources for the greater good of the system, somewhat like a parent might do for their child or family.

#### **3.1.1 Processor Management**

Processor management is made up of two main components: making sure each process receives enough attention that it works properly, and doing as many process at a time as possible while still having a responsive system. Each unit handled by the operating system is called a process and every process is passed to the processor in an order determined by the operating system.

There are two different ways an operating system can handle processes: single-taking and multi-tasking. Single-tasking is when the processor only deals with one process at a time and juggles the processes by only looking at each of them a short amount of time. Multi-tasking is when the processor is looking at several processes at the same time but only using a portion of the processor for each process.

#### **3.1.2 Memory Management**

Memory management consists of allocating enough memory for each process as to not have the allocation of one process overlap another, and use the different types of memory effectively and efficiently. There are four main types of memory: cache, RAM (Random Access Memory), virtual memory, and disk storage.

Cache is the memory that the processor is directly using, which is swapped frequently and is typically not very large. RAM is all of the memory that all of processes running use, not necessarily the processes being run in the processor at that time. Virtual memory is used the same way as RAM, but it

is on the storage disk. The storage disk is where all of the information that is saved on your computer is stored. The operating system is constantly shuffling data between these four different types of memory, making sure that the data that is needed immediately is accessible and the data that isn't needed isn't wasting space.

### **3.2 Software Interface**

Providing an interface for the software with the hardware is not only important but also a difficult job. The operating system must be able to change if the hardware changes at all in order for it to be used on more than one computer. The API (application program interface) allows this to happen by creating a consistent means in which software is written so that it can talk to the operating system. This allows the operating system to adjust rather than making different software for each piece of hardware and combination of hardware.

API's allow a programmer to use the functions of an operating system without having to keep track of the details involved with the processor's operation of that function. API's are a growing field in computers today because companies are realizing that the more their API is used the more control they have over the market. When a certain company's API starts to become popular, it becomes a standard and everyone is forced to use it.

The user interface is the way that the user is able to interact with the operating system and ultimately the computer's hardware. A command is taken from the user and the operating system translates that into some sort of action that it needs to do. An interface can be either text based or graphically based, GUI (Graphical User Interface). Text based OS's are the majority of all operating systems including most UNIX systems and MS-DOS. GUI has only been around for the last fifteen years or so, since then GUI has become a standard for operating systems like Windows and MacOS.

## **4 Primitive OS's (1950's-1960's)**

Computers have been around since the forties and fifties. These early computers used vacuum tubes and plug boards to operate. With these early computers, the same people designed, built, programmed, operated, and maintained each machine. These machines took up entire rooms that were specially air conditioned just so these huge computers did not overheat. However, they were millions of times slower than any modern day computer.

Another major problem with these computers was that they were nearly impossible to operate. There was no operating system and they had to code their programs in machine language in order for the computer to do anything. An operator would have to sign up for time to use the computer. He would then insert his plug board into the computer and hope that no vacuum tubes burnt out while his process was running, because simple processes would take a few hours to run.

Eventually a system of punch cards was developed in order to make the process somewhat simpler. This system was the first where different people operated the computer than programmed it. In order to run a job on these computers, a programmer must first write his code out on paper. Then, you would have to punch cards with that code. Once you are done with the coding process you would give the cards to the operator and wait for the output. These programs were usually programmed in a language called FORTRAN (FORmula TRANslator), but they also used assembly language to program with.

There were three main operating systems used at this time. The first one was the FORTRAN Monitoring System (FMS). FMS was made in the late 1950's for the IBM 709 by North American Aviation. Another OS for that time was IBSYS, which was developed by IBM in the early 1960's and was also the predecessor for the IBM OS/360 which changed the face of operating systems. The last main operating system was IBM's operating system for the IBM 7094. The IBM 7094 was one of the most common computers at the time and needed this operating system in order to run.

## **5 Multiprogramming OS's (1960's-1980's)**

Up to this time computers were only able to run one job, or program, at a time. This was inefficient and time consuming for the computers. The ability to do more than one job is called multiprogramming. The system separates the memory out into several pieces and lets each one of the pieces be a different job that the computer was running. The ability to do multiprogramming sped the computers up tremendously. In the older system a computer would sit practically idle while computing the I/O (Input/Output), since it does not take much processing

### **5.1 The OS/360 System**

The IBM OS/360 was developed in the mid 60's and was one of the first operating systems that were able to do multiprogramming. With OS/360

computers were able to do more jobs in a day's time, because of the many advancements it took.

OS/360 started a revolution in operating systems. Multiprogramming was not its only advancement from older systems. It also started a technique called spooling (Simultaneous Peripheral Operation On Line). Spooling was like having a queue of jobs. An operator would read the program into the machine and the system would queue it up, so when the computer had an open spot for a job it would bring up the next job.

The other advancement that OS/360 made was that it created an operating system that could create numerical calculations for science and engineering along with word processing for commercial use. Previously there were entirely different machines for each of these functions. In doing this manufactures were able to produce one series of computers rather than one for each of the industries.

## **5.2 The MULTICS System**

IBM's production of the OS/360 spawned all sorts of ideas in programmers around the world. People at MIT, AT&T's Bell Labs, and GE started to envision a giant computer that provided computing power to everyone. They ended up producing a computer called MULTICS (MULTiplexed Information and Computing Service). This machine was designed to support hundred of users at the same time; however it was still much slower than modern day computers.

The MULTICS system ended up not having as much success as was anticipated. Only about eighty companies world-wide bought the systems, but the companies that did buy them were faithful to them. For example, General Motors, Ford, and the U.S. National Security Agency stopped using their MULTICS systems in the late 90's.

The MULTICS system may not have been a huge success however, the design ended up being a huge part of the evolution of computers and operating systems. The design of the MULTICS system was how the internet was modeled, small 'dummy' computers attached to huge servers doing most of the work. MULTICS was also laying the ground work for creating future operating systems. One of the original designers of the system, Ken Thompson, found a small PDP-7 (one of the original micro-computers) that was not being used and started creating what we know as UNIX. This was a small one user version of MULTICS.

## **6 Modern OS's(1980's-Present)**

At this point micro-computers started to become popular, along with the release of the personal computer (PC), plus computers were becoming more widely used in every industry. Once this started happening operating systems broke up into three main branches Microsoft, Apple, and UNIX/Linux. There were many other systems than just these three; however these three play the largest part in the industry today and are the most familiar to most people today. Other systems still play a vital role in certain industries and certain companies.

### **6.1 The Microsoft Family**

In the early 80's IBM developed a PC that they evidently called the IBM PC (IBM was never very creative with their names). They did not want to develop an operating system for their new computer and contacted Bill Gates to license his BASIC (Beginners All-purpose Symbolic Instruction Code) interpreter so that Digital Research, one of the largest OS producers at the time, could use it to develop this new operating system. Digital Research then refused to use the BASIC interpreter. Since IBM had already licensed Bill Gates' software they went back to Gates and he told them he could write an operating system for the new computer, which started the beginning of Microsoft.

#### **6.1.1 DOS**

Gates then went to a local software company, Seattle Computer Products, who had an operating system that would be compatible, DOS (Disk Operating System), and bought it. Gates then presented IBM with the BASIC/DOS package. IBM told Gates a few changes that needed to be made to the system. The revised OS was then labeled MS-DOS (Microsoft-Disk Operating System). This was the beginning of a software revolution.

The IBM PC quickly took over the market of personal computers. Gates then decided to sell MS-DOS to computer manufacturers who sold it bundled with their computers, rather than directly to end users which was opposite of what most software companies were doing at the time. This created a huge market share of Microsoft's operating system since users did not want to buy another OS if they had one already that worked.

MS-DOS was widely used on PC's and became the backbone of the Microsoft family of operating systems. It was used on Intel's processors, 80286, 80386, and 80486, which were very common processors throughout the 80's. The original version of MS-DOS was fairly primitive but eventually added many advanced features.



### **6.1.2 Windows**

In the mid 80's Microsoft decided to build a successor to MS-DOS. They decided that their new operating system should be similar to Apple's Macintosh since it had been so successful (see section 6.2), with its GUI. The new operating system was called Windows and the first version was released in August of 1985. In the first three versions of Windows were actually shells that ran on top of MS-DOS. A shell is an interpreter that passes commands from the user to the actual operating system. Windows started to become a huge success and Microsoft decided to develop it even farther.

In 1995 Microsoft built a stand-alone (not a shell) Windows operating system called Windows 95. Windows 95 only used MS-DOS to boot and to run old programs designed for MS-DOS. Windows 95 also several new developments like right-clicking the mouse, this allowed you to manipulate text and bring up menu options directly with the mouse. Another addition was the Registry. The Registry is where all the system configurations are located. It allowed for multiple system configurations and easy access to those configurations. Windows 95 eventually evolved to Windows 98 and Windows ME (Millennium Edition) by the year 2000.

Windows 95 was developed for the home PC user. Microsoft determined that it should develop an operating system geared more for businesses and the computer industry. They decided to build the new OS from the ground up rather than trying to modify the existing Windows 95 system. Windows NT (New Technology) was released in June of 1996. NT had the look and feel of 95 however it was completely different. It contained advanced networking and security that Windows 95 did not have; however, it did not have the hardware support and multimedia features that Windows 95 had. Windows NT was later developed into Windows 2000.

The next step Microsoft had was to combine the functionality, ease of use, and multimedia support of the Windows 95 line, with the networking, security, and administration of the Windows NT line. They did this when they released Windows XP (Experience) in 2001. Windows XP is currently the most up-to-date version of Windows. It completely integrated features from both of Microsoft's previous lines of operating systems. In addition it supports multiple users, it has a new interface, and it is also updateable from the internet. Today Windows is known for its ease of use and adaptability.

## **6.2 The Apple Family**

In 1976 Steve Jobs and Steve Wozniak started a new computer company, Apple, in Jobs' garage. Jobs and Wozniak met in 1972, while they both were employed at Hewlett Packard. Wozniak enjoyed making computer parts and

Jobs was an excellent marketer. Four years later Jobs convinced Wozniak that they should create a company building computers together.

### **6.2.1 Original Apples**

The Apple I was just a preassembled computer circuit board that they introduced in 1976, which they only sold 50 of. Jobs and Wozniak decided that they should build a whole computer in order to become more successful in the industry.

They developed the Apple II, which was introduced at The West Coast Computer Fair, in 1979. Everyone at the fair was excited about the computer and wanted the company to produce more of them. The Apple II was a huge success and established \$1 million in annual sales.

The company continued its success with the Lisa, named for Jobs' daughter, and the Apple III. None of the computers that Apple shipped had an operating system, but DOS was a popular choice for most users at the time. Jobs and Wozniak knew that this was only the beginning for their company.

### **6.2.2 Macintosh**

During the Super Bowl of 1984, Apple televised a commercial introducing the Macintosh (sometime abbreviated Mac). The commercial used text for George Orwell's book *1984*, then said how the Macintosh was going to revolutionize the world. The Macintosh was then released two days later and was in instant success.

The Mac used a GUI which was introduced with Xerox's PARC operating system in 1978. PARC was not successful; however Jobs saw the style and decided that that was the way the computer industry would be going. The Mac was easy to use and understand making it a milestone in the computer industry. Macs initially appealed mainly to home users, but eventually it caught on in the academic communities. Mac today is known to be one of the most user-friendly and stable operating systems.

When the Macintosh was released the operating system had the name System 1. The Macintosh continued its progress over time and in 1990 released their last "System" operating system with System 7. There were no major changes in all these versions, they mainly upgraded the hardware support and packaged them with their new Macintosh computers.

The first major revision to the Macintosh operating system was in 1997 when they released MacOS 8. The MacOS 8 was more stable than the original operating systems and also had a different basic feel to it. MacOS 8 and MacOS 9 were also very similar with only basic changes between them.

MacOS X was released in 2001 with a completely new look and feel to it. Not only did it have a new look to it, but it also used a UNIX-based core (see section 6.3) making it more reliable and stable than any of the previous Macintosh operating systems. The new OS was not only stable but it was even easier to use, being packaged with new applications and a new interface.

Since MacOS X was released, there have been three major revisions to it. The most current version is MacOS X Panther. Each revision has had increased hardware support and came bundled with new easy to use applications. Over the history of Apple they have created several innovative applications that have changed the way things are done, for example iTunes (an mp3 store/player), QuickTime (a multimedia player), and AppleWorks (an utility suite).

## **6.3 The UNIX/Linux Family**

In 1971, Ken Thompson at AT&T's Bell Labs started creating a stripped down and single user version of MULTICS. Bell Labs distributed this work as UNIX for free. People that received this code started to modify it for their own use. Soon there were many different versions and distributions. Universities, research institutes, government bodies and computer companies all started to use and sell their own versions of UNIX.

### **6.3.1 X/Open**

All through the 80's different vendors started competing over whose version of UNIX was better. There were three main competitors; The University of California at Berkley developed Berkley Software Distribution (BSD), AT&T developed System V, and OSF's (Open Software Foundation) version was OSF/1. All three of these distributions were slightly different, none of them were necessarily better than the other; it all depended on what you wanted to do with them and who you worked for.

None of these competing versions of UNIX would work together with each other, and customers began complaining that all of these versions where trademarked under the name UNIX but none of them where compatible. All of this fighting led to the creation of X/Open. X/Open created the POSIX in 1988 in order to try and standardize the UNIX system. POSIX defined the minimal API's for UNIX, creating somewhat of compatibility.

### **6.3.2 A Single UNIX Specification**

In 1993 AT&T decided that is was done messing with all the UNIX competition and sold UNIX Systems to Novell. Novell was looking for an operating system that could use its NetWare. After dealing with UNIX for

two years, Novell decided that it didn't want to mess with all the competition either. SCO bought UnixWare from Novell and still owns it today.

Finally in 1994 X/Open created the Single UNIX Specification. The Single UNIX Specification separated the UNIX trademark with the actual code, which allowed for multiple versions. In 1995 X/Open created the UNIX 95 brand defining what exactly had to be in UNIX to be apart of the Single UNIX Specification. The UNIX brand was later developed into UNIX 98 and UNIX 03, which united the POSIX specification with the Single UNIX Specification.

### **6.3.3 Linux**

Linus Torvalds was a student at the University of Helsinki, whose hobby was creating a Minix (a small POSIX distribution of UNIX) look-alike. He started working on the system in 1991 and continued until 1994 when he released the first version of the Linux Kernel. The Linux Kernel is the core of all Linux operating systems. Linus released this software as free open source software so that any one could use it and modify it. All Linux systems are developed under the GNU General public license (GPL).

The acronym GNU is self-referring and stands for "GNU's Not UNIX", implying that GNU software was not developed from UNIX code. Software that is licensed under the GPL is distributed for free, can be modified, and can be redistributed under the GPL. So, if you use any code from GNU software in your code you have to distribute that software under the GPL as well. The GNU ensures that there is always free software and free code for people to use.

Linux today has developed into a free alternative to proprietary UNIX and Microsoft operating systems. It has the functionality and usability of modern commercial operating systems. There are several distributions including: Red Hat, Mandrake, Debian, Gentoo, Slackware, SuSE, and many, many more. Today Linux is known for its stability and its high-end performance.

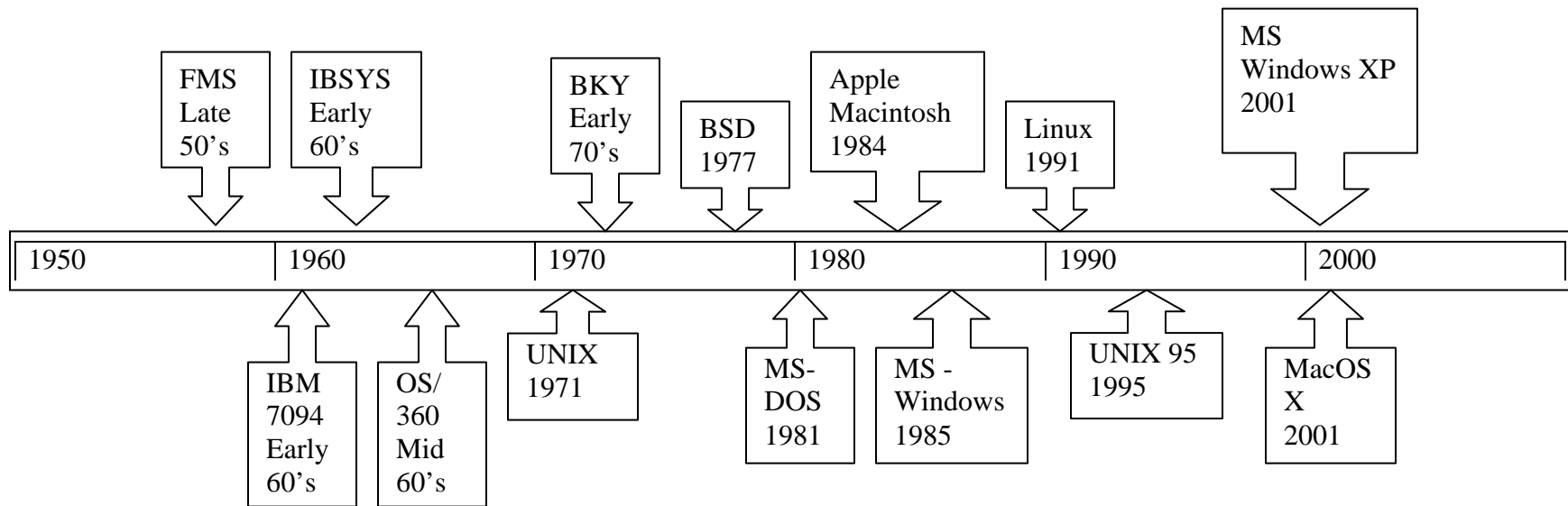
## **7 Conclusion**

Operating systems have had quite an evolution over the last 50 years. Computers started in the 50's with hardly any operating system and used punch cards to operated. They then moved towards the better multiprogramming systems with better task management. After that they moved more toward what we have today with the three major branches of operating systems: Microsoft, Apple, and UNIX/Linux. In this history the hardware limitations have dictated the limitations of the software.

Many people have their own preference for an operating system. People prefer an operating system based on what they are used to and what they need to do. Microsoft Windows is user friendly and diverse, while Apple's MacOS is very easy to use and also very stable, and Linux is very stable and performs well in a business environment.

When choosing what OS is right for you, you need to decide what is important to you and how you are going to use the computer. Some people even choose to use a combination of operating systems with a different OS on each of their computers. All of this could change in the future however. Work is always being done on operating systems and in the future they might not even be what we know them as today, since fifty years ago they were completely different from what they are now.

## Appendix I: Timeline



Note: Early dates are not exact because there was a different release date for every computer system.

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