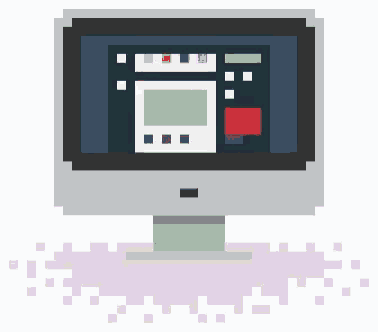
Operating Systems: At the Core of the Computer Experience

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 Operating systems are one of the most important parts of personal computers today. The ease of use of today’s PCs is made possible by the latest advancements in operating systems. Throughout the years, various operating systems have been released, each with its distinct features. Through analyzing the development of operating systems, one can see that operating systems are significant to the user experience of using the computer.

The earliest computers had no operating systems. According to the *Scientific American* magazine, the first operating systems were created for the first electronic computers in the late 1940s, and they were sets of simple routines for input and output, such as a program for storing binary codes read from a punched paper tape into successive memory locations (Denning and Brown, 1984). In the 1950s, only one program could be executed at a time on a computer. Users would arrive at a scheduled time, bringing their program with them on punch cards or tape to load in the computer, and the computer would execute the program until it had completed running or crashed (Per Brinch Hansen, 2011). By 1960, the first time-sharing systems were being designed, which switched the load of the central processing unit, or CPU, between multiple programs at a time, giving the illusion of multitasking (Denning and Brown, 1984). Early operating systems read programs off punched cards or paper tape. The first commercial hard drive was the RAMAC 305 produced by IBM, and it was made in 1956 (Computer History Museum, n.d.), and the first floppy disk was made by a team of IBM engineers led by Alan Shugart in 1971 (Guinness World Records, n.d.). From these humble beginnings, operating systems have gone a long way, and have vastly developed.

 One of the earliest and most popular multi-user operating systems was Unix. Unix was developed by Ken Thompson, Dennis Ritchie, Brian Kernighan, Douglas McIlroy and Joe Ossanna at Bell Labs. It was written in C and assembly language. It was initially designed for use inside the Bell System, the telephone system of the United States, once monopolized by AT&T. Unix was created by software developers for software developers. It was originally meant to be a convenient platform for software developers (Brand, 1984). Commands in Unix are typically executed through a command-line shell, which requires the user to enter textual commands to open files and programs. The output of one command could be fed, or “piped”, into another command. Unix also popularized regular expressions, which are patterns of characters that are used to search for substrings in a string. Later on, various graphical shells for Unix-like operating systems were developed, which allowed users to point and click on onscreen elements using a mouse. The Unix operating system was also the first portable operating system, as almost the entire operating system was written in C, which could be compiled on many platforms. The C programming language was also popularized by Unix and can now be used on many operating systems and platforms. The rise of Unix also spawned the development of GNU/Linux, a free and open-source Unix-like operating system. Richard Stallman announced the GNU (short for GNU’s Not Unix) project in 1983, and Linus Torvalds released the Linux kernel as free and open-source software in 1991. Linux distributions largely consist of GNU free software, leading to the name GNU/Linux to refer to Linux distributions (Stallman, 2021). GNU/Linux distributions are widely used on servers, and Android, the world’s most popular smartphone operating system, is based on the Linux kernel. Additionally, many variants of Unix appeared, such as the Berkeley Software Distribution (BSD), Solaris and Darwin, on which macOS was based. One can see that the release of Unix and GNU/Linux were significant to the modern computer and mobile device experience.

 Throughout the years, Microsoft has also developed various operating systems. One of their earliest operating systems for personal computers was MS-DOS, which stood for Microsoft Disk Operating System. It was the leading operating system of the 1980s (Encyclopedia Britannica editors, 2008). It is distinguished from Unix by its use of drive letters, such as A: or C:, as opposed to mount point names, to identify disks mounted to the system. MS-DOS and software for it was typically booted from floppy disks. MS-DOS was targeted at the Intel 8086 processor. As opposed to Unix, it is a single-user operating system. DOS formed the basis for early versions of Windows, Microsoft’s flagship operating system that had a graphical user interface (GUI). The first version of Windows, Windows 1.0, was released to limited popularity. Windows 3.0 was the first version of Windows to use clickable icons to represent file names. The GUI was comparable to that of early versions of Mac OS. It could also run graphical versions of Microsoft Word, Excel and PowerPoint. Windows 3.1 was an improved version of Windows 3.0 with minor improvements. Windows 95 was the first Windows version that was popularized 32-bit programs. This was succeeded by Windows 98, which improved upon many aspects of Windows 95. Visual Basic 6, last version of the original Visual Basic, a software which allowed users to easily program graphical Windows programs, was made during this time. At the same time, Windows NT, a version of Windows with a different kernel, was also available. Later Windows operating systems would all be based on Windows NT. Windows XP was one of the most iconic releases of Windows NT, with an iconic desktop background of a blue sky and a green hill titled “Bliss”. Windows XP brought many improvements to the media, gaming and browsing experience, and was widely used even after it had become unsupported and had many security vulnerabilities. It was also the first version of Windows to feature the controversial Product Activation feature, a measure intended to prevent piracy of the operating system. Windows Vista, Windows XP’s successor, was badly received, as many people complained about performance issues. Windows 7 was very well received, and addressed many of the issues of Windows Vista, along with many new features for easier multitasking and enjoyment of media. Windows 8 flattened out the design of Windows by shifting to a tablet-like Start screen interface with bright tiles and apps downloaded from Microsoft’s Windows Store (later renamed the Microsoft Store). Additionally, a version of Windows 8 for ARM processors, Windows RT, was developed. Windows 10 emphasized Microsoft’s new “software as a service” model for Windows by continuously providing mandatory updates for the operating system. Windows 11, Windows 10’s successor, had strict hardware requirements, such as the requirement to use 8th-generation or newer Intel or 2nd-generation AMD Ryzen processors, only providing a 64-bit version of the operating system, and requiring the use of a Trusted Platform Module (TPM) 2.0 chip, a security chip which is banned in China in favour of the Trusted Cryptographic Module (TCM) chip. This controversially required many users to purchase new computers to use the new operating system. Windows Phone was also once available as a stripped-down version for smartphones as a competitor to Google’s Android and Apple’s iOS, but it failed to achieve much popularity.

Apple is also a major competitor to Microsoft in the desktop operating system market. Apple’s operating system, macOS (originally called Mac OS, later Mac OS X, then OS X, then macOS), is exclusively made for Apple desktop computers. Classic versions of Mac OS from were made for the Motorola 68000 processor. After Mac OS 7, Apple began to switch to the IBM PowerPC architecture. In 2006, Apple began to switch to Intel processors, and Mac OS X Tiger was the first version of the operating system to support Intel processors. After Steve Jobs was forced out of Apple, he founded his own computer company, NeXT, which made the NeXT computer and the NeXTSTEP operating system. NeXT was later acquired by Apple in 1996, and Mac OS X was based upon many parts of the NeXTSTEP operating system. Apple is also known for producing Logic Pro, a digital audio workstation, and Final Cut Pro, a video editor, for its operating system, both of which are widely used in the creative industry.

On the phone and tablet, there are also many major mobile operating systems. The most popular mobile operating system is Android, by Google. Android phones are made by a variety of manufacturers, who license the Android trademark from Google. Outside of China, the Google Play Store is the main means of downloading or purchasing Android apps. Additionally, Apple develops iOS, which is its operating system for the iPhone. iOS is restricted to installing apps from the App Store, and many have criticized this practice.

In conclusion, operating systems have varied a lot throughout the ages and have been very important to the use of the computer. In the future, more and more new technology will be in operating systems, advancing the digital life of everyone.

Chinese-English Glossary

中英对照

|  |  |
| --- | --- |
| **English** | **中文** |
| Boot | 启动 |
| Command-line interface (CLI) | 命令行界面 |
| Floppy disk | 软盘 |
| Graphical user interface (GUI) | 图形用户界面 |
| Hard drive | 硬盘 |
| Kernel | 内核 |
| Memory  RAM (Random Access Memory)  ROM (Read-Only Memory) | 存储器  随机存储器  只读存储器 |
| Microsoft | 微软 |
| Operating system | 操作系统 |
| Punch cards | 穿孔卡 |
| Punch tape | 穿孔纸带 |
| User experience | 用户体验 |

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