JAPAN

"Information and Communications" field

Achievement: Development of the operating system, UNIX

Dr. Dennis M. Ritchie

Born : September 9, 1941 (Age 69)
Distinguished Member of Technical Staff Emeritus, Bell Labs

Dr. Ken L. Thompson

Born : February 4, 1943 (Age 67)
Distinguished Engineer, Google Inc.

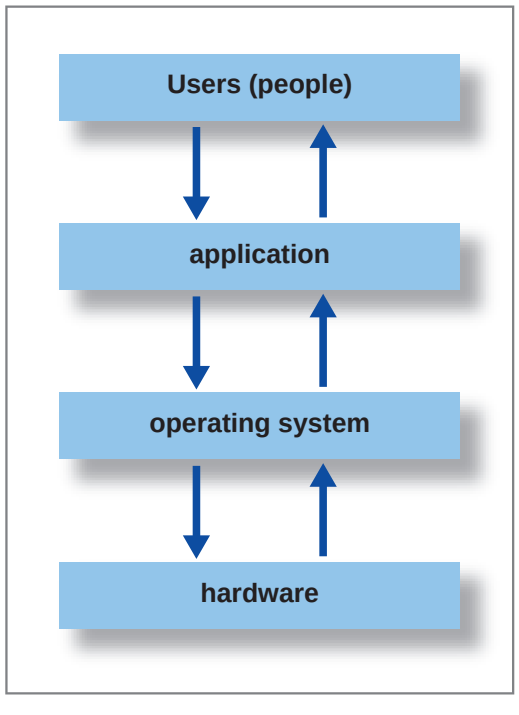
Summary

With present computer systems, basic software called operating systems are used in addition to application software to perform word processor, spreadsheet tasks, and so on. Dr. Dennis Ritchie and Dr. Ken Thompson developed an advanced operating system called UNIX in 1969. The operating systems in those days were increasing in scale but becoming complex and disorderly. With UNIX, stability and high-speed performance could be attained by combining modularized programs. UNIX's superior design concept has been carried on by many computer technicians, and has supported the development of an advanced information society including the Internet.

Operating systems which make user-friendly computers possible

With present computers, multiple software usually functions hierarchically (Figure 1). For example, application software works closest to the user in operating a spreadsheet or in processing photographs. The operating system works in between the application software and hardware (machine). The role of the operating system is to make the hardware which includes the hard disk constituting the computer abstract and present it to the application software. Thanks to it, the application software can simplify such commands as "record data" or "print." In addition, the operating system can execute multiple tasks concurrently and also perform basic tasks such as connecting to the network.

Figure 1 Software hierarchical diagram



The early computers which appeared on the scene in the 1940's did not, in fact, have an operating system. In the 1950's, programs came to be used as tools to simplify hardware usage, which established the concept of an operating system. Then in the 1960's, computer developers were competing to upgrade the operating system functions. In those days, large-scale and high-speed computers were rapidly being developed, and a time sharing system was achieved where one high performance computer was used concurrently by multiple persons. In order to improve the user-friendliness of these computers, the development of an operating system became indispensable.

In the U.S. in 1964, Massachusetts Institute of Technology (MIT), in collaboration with Bell Labs and General Electric (GE), began a joint research project to develop a time sharing operating system called Multics. Multics aimed to use the capacity of high performance computers to the full, in order to achieve an interactive user interface that could be used like a telephone or electricity, which was a breakthrough system back then.

Dr. Ritchie and Dr. Thompson, both of whom were then in their 20's, were among those who participated in the project as researchers of Bell Labs. Dr. Ritchie was developing an efficient programming language for Multics, and Dr. Thompson came up with the idea of a hierarchical filing (document management) system which later became the core technology for UNIX. However, between 1968 and 1969, Bell Labs decided to withdraw from Multics development. The verdict reached by Bell Labs was that Multics, in pursuing ideals, had become too massive and complex, and not much hope could be held for the overall system performance.

In want of making their own operating system

The development of Multics at Bell Labs was discontinued, but Dr. Thompson and his colleagues who were deeply involved in the development carried on independent research. They felt they did not want to lose the convenient user interface which Multics provided at its development stage, and began to search for an alternative system. In particular, Dr. Thompson was very fond of an interactive computer game called "Space Travel" that he programmed himself. Thus, he ported the computer game into an old computer (DEC's PDP-7) which was lying idle at the laboratory . With Dr. Ritchie's help, he gradually added functions in Multics which were thought to be particularly important. Dr. Thompson's filing system which was left in limbo was also ported, and by 1969, it came to have an appearance of a new operating system. In the process, this operating system came to be known among the staff as UNICS. The name was supposedly given to emphasize its compact and single layer (UNIplex) image in contrast to Multics' massive and multilayer (Multiplex) image.

In time, the spelling of UNICS became UNIX, and its superior functions became known to researchers as well. In addition to having a hierarchical filing system that enables a quick search of desired information, because its basic parts were developed by a handful of people, it was a simple yet relatively trouble-free, solid operation system. In 1970, it was ported to a higher performance computer (PDP-11), and Bell Labs' patent department became one of its users.

The next issue which the now highly-evaluated UNIX faced, was the improvement of the programming language. From his experience with Multics, Ritchie felt the need for a "high-level language" programming with a higher abstraction level of commands. Dr. Ritchie along with Dr. Thompson were jointly developing B language, but they completed the improved version, the C language, and in 1973, UNIX was rewritten in the C language. Through this development, it became possible for UNIX to be used in computers around the world. In 1974, both doctors published their long-awaited UNIX article, and UNIX became known worldwide.

Figure 2 UNIX philosophy

(1) Small is beautiful:
Small things have advantages that large things do not have. By separating the programs into small modules as much as possible, they can be used in combinations.

(2) One program with one function:
Programs separated into small modules should each have one definite and reliable function.

(3) More emphasis on portability than efficiency:
Rather than having maximum capabilities on one particular hardware, by maximizing functions on as many computers as possible, the computer environment is enhanced.

(4) Emphasis on data portability:
Even if the program is portable, information cannot be shared. All number data should be stored in ASCII flat files.

(5) Avoid excessive interactivity:
Data flow is disrupted during the time users are interacting. Aim to achieve a moderately interactive interface.

(6) Design all programs as filters:
The basis of software is not to generate data but to process it. The programs should be designed as filters.

An open culture achieved by UNIX

Both UNIX and the C language which were developed by both doctors greatly influenced the information science in later years. In those days, Bell Labs provided free-of-charge UNIX and the source code (number sequence indicating basic commands to the hardware) to universities and research institutes; thus they were used proactively by researchers around the world. UNIX has created an open culture where researchers share ideas among themselves, which in turn, leads to new developments. As bamboo shoots after the rain, design concepts which sprung up one after the other has been handed down as UNIX philosophy. Many improvements have also been made to the C language, and many operating systems today have been written in the C language from the beginning.

In retrospect, many basic technologies in the information field have been conceived with UNIX as the basis. Noteworthy of them is the Internet. University of California, Berkeley developed BSD UNIX, which is the extended version of the Version 6 UNIX functions. From this, Internet protocol (TCP/IP)-mounted UNIX originated, greatly contributing to the realization of the Internet.

At present, there is a license system where certain regulations are applied to UNIX usage. However, "open source," which is a method where the source code is disclosed while protecting the copyright of the software producer, is also under parallel development. Operating systems carrying on the UNIX philosophy are now being used widely from mobile phones to supercomputers.