# 計算機作業系統的誕生

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計算機能變得很好用，編譯器（Compiler）及作業系統（Operating System）的發展功不可沒。

作業系統管理計算機或行動裝置的軟體和硬體功能，讓所有應用和程式能順暢運行。桌面運算裝置最常用的作業系統包括微軟（Microsoft）Windows 及蘋果（Apple）macOS。這些作業系統的功能複雜，很多原理歸功於 1960 年代電腦科學家的努力。

1965 年時，貝爾實驗室（Bell Labs）、奇異電子（General Electric）和麻省理工學院（MIT）合作建立一套多使用者（Multi-user）、多工（Multi-processor）、多層次（Multi-level）的作業系統，稱為 MULTICS，主要貢獻者是「分時處理作業系統」之父柯巴托（Fernando José "Corby" Corbató, 1926~2019）。

當時參與計畫的湯普森（Ken Thompson）在 MULTICS 寫了一款電動遊戲程式「星際旅行」（Space Travel）。貝爾實驗室在 1969 年終止參與 MULTICS 的研發。有人開玩笑說，為了能繼續玩這個遊戲，湯普森找來瑞奇（Dennis MacAlistair Ritchie, 1941~2011），發展出一套更有效率的作業系統，稱為 Unix。這套作業系統後來成為主流，廣泛的被各種電腦採用。

在 Thompson 及 Ritchie 獲得圖靈獎（Turing Award）的次年（1984 年），貝爾實驗室的技術期刊《AT&T Bell Laboratories Technical Journal》編輯一期特刊，專門討論 UNIX 系統。1984 年這一期特刊，具有紀念性，成為我的珍藏版。為此特刊撰文的作者都赫赫有名。當中寫 Preface 的 Robert L. Martin 是我在 Bellcore 時的大老闆，而 Robert H. Morris 則為 2010 年 IBM 的全球服務副總裁，他於 2010 年來台灣，頒發 IBM Faculty Award 給我。

近年來，超級電腦業者打破「高速計算」必須透過一部高速運轉的超級電腦來執行計算工作的思維，而作業系統更加重要。

2008 年 4 月克雷公司（Cray Inc）開始與英特爾技（Intel）術合作，用 Xeon 處理器及刀鋒系統設計來打造超級電腦，稱為 Cray CX1。這種蛻變的高速計算，稱為「高階計算」(High-end Computing)。以多部 CPU 進行高階計算，原理是平行理論（Concurrency Theory），早期的主要貢獻者是米爾納（Arthur John Robin Gorell Milner, 1934~2010）。

我於 2014 ～ 2016 年間在科技部督導超級電腦的建置，了解其技術的複雜度，更能體會過去計算機先驅者的貢獻。
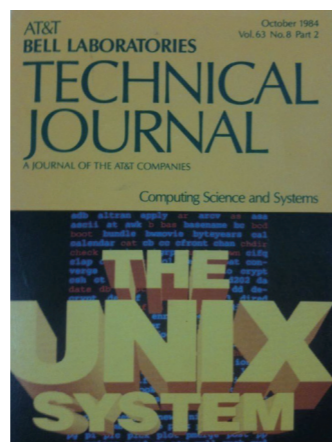


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現為國立陽明交通大學資工系終身講座 教授暨華邦電子講座，曾任科技部次長，為 ACM Fellow、IEEE Fellow、AAAS Fellow 及 IET Fellow。研究興趣為物聯網、行動計算及系統模擬，發展出一套物聯網系統 IoTtalk，廣泛應用於智慧農業、智慧教育、智慧校園等領域／場域。興趣多元，喜好藝術、繪畫、寫作，遨遊於科技與人文間自得其樂，著有 < 閃文集 >、< 大橋驟雨 >。

# The Birth of Computer Operating System

Computers have become more user-friendly and useful to human beings, largely due to the development of compilers and operating systems. An operating system (OS) is a system software that manages hardware resources and software functions of a computer or a mobile device so that all applications and programs can run smoothly. The most widely used operating systems for desktop computers include Microsoft Windows and Apple macOS. These operating systems are composed of many complicated functions, most of which were developed by computer scientists in the 1960s.

In 1965, Bell Labs, General Electric and MIT collaborated on a project to build a multi-user, multi-processor, and multi-level operating system, called MULTICS. The man behind the MULTICS was Fernando José "Corby" Corbató (1926~2019), who is also known as the father of the "time-sharing processing system".

Ken Thompson, who was part of the MULTICS project, developed a video game called Space Travel on the operating system. However, Bell Labs ended its involvement in the project in 1969. Some people jokingly said that in order to continue playing the game, Thompson brought in Ritchie (Dennis MacAlistair Ritchie, 1941-2011) to develop a more efficient operating system called Unix. This operating system later became mainstream and was widely adopted by various computers.

The year after Thompson and Ritchie won the Turing Award, a special issue of the AT&T Bell Labs Technical Journal from 1984 was devoted to UNIX systems. This commemorative special issue holds a special place in my heart. The articles in this special issue were contributed by renowned authors, including Robert L. Martin, who was the author of the Preface and my former boss at Bellcore, and Robert H. Morris, the

Vice President of Global Services at IBM in 2010. He came to Taiwan in 2010 and presented me with the IBM Faculty Award.

In recent years, supercomputer manufacturers have challenged the notion that "high-speed computing" can only be achieved with a high-speed supercomputer, highlighting the importance of the operating system. In April 2008, Cray Inc collaborated with Intel to develop a supercomputer called Cray CX1, which utilized a Xeon processor and blade system design. This new era of high-speed computing is also known as "High-end Computing," and is built on the core concept of Concurrency Theory, to which Arthur John Robin Gorell Milner (1934~2010) made significant contributions in its early stages.

During my tenure as Deputy Minister for the Ministry of Science and Technology from 2014 to 2016, I oversaw the establishment of supercomputers, which gave me a greater appreciation for the complexity of the technology and the invaluable contributions of past computing pioneers.

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