Trends in computers driven by Moore's Law

$ price

<table>
<thead>
<tr>
<th>Year</th>
<th>Mainframes</th>
<th>Minicomputers</th>
<th>Workstations</th>
<th>Personal computers</th>
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<td>2000</td>
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Notes:
- UNIX
- Linux
- PC clones
- XT clones
- AT clones
- PCjr boxes
- Lisa computers
- vx730 minicomputer
- vx750 minicomputer
- vx780 minicomputer


Price: $2,560,000, $1,280,000, $640,000, $320,000, $160,000, $80,000, $40,000, $20,000, $10,000, $5,000, $2,500, $1,250, $625, $39, $2.50, $1.25, $0.625
respect for the individual, customer service, and excellence.[138]

1962: SABRE
Two IBM 7090 mainframes formed the backbone of the SABRE reservation system for American Airlines. As the first airline reservation system to work live over phone lines, SABRE linked high speed computers and data communications to handle seat inventory and passenger records.[139]

1964: IBM System/360
In the most important product announcement in company history to date, IBM introduces the IBM System/360: a new concept in computers which creates a "family" of small to large computers, incorporating IBM Solid Logic Technology (SLT) microelectronics and using the same programming instructions. The concept of a compatible "family" of computers transforms the industry.[140]

1964: Word processing
IBM introduces the IBM Magnetic Tape Selectric Typewriter, a product which pioneered the application of magnetic recording devices to typewriting, and gave rise to desktop word processing. Referred to then as "power typing," the feature of revising stored text improved office efficiency by allowing typists to type at "rough draft" speed without the pressure of worrying about mistakes.[141]

1964: New corporate headquarters
IBM moves its corporate headquarters from New York City to Armonk, New York.[142]

1965: Gemini space flights
A 59-pound onboard IBM guidance computer is used on all Gemini space flights, including the first spaceship rendezvous. IBM scientists complete the most precise computation of the Moon's orbit and develop a fabrication technique to connect hundreds of circuits on a silicon wafer.[143]

1965: New York World's Fair
The IBM Pavilion at the New York World's Fair closes, having hosted more than 10 million visitors during its two-year existence.[144]

1966: Dynamic Random-Access Memory (DRAM)
IBM invents one-transistor DRAM cells which permit major increases in memory capacity. DRAM chips become the mainstay of modern computer memory systems: the "crude oil" of the information age is born.[145]

1966: IBM System/4 Pi
IBM ships its first System/4Pi computer, designed to meet U.S. Department of Defense and NASA requirements. More than 9000 units of the 4Pi systems are delivered by the 1980s for use in the air, sea, and space.[146]

1966: IBM Information Management System (IMS)
IBM designed the Information Management System (IMS) with Rockwell and Caterpillar starting in 1966 for the Apollo program, where it was used to inventory the very large bill of materials (BOM) for the Saturn V moon rocket and Apollo space vehicle.

1967: Fractal geometry
IBM researcher Benoit Mandelbrot conceives fractal geometry – the concept that seemingly irregular shapes can have identical structure at all scales. This new geometry makes it possible to mathematically describe the kinds of irregularities existing in nature. The concept greatly impacts the fields of engineering, economics, metallurgy, art, health sciences, and
computer graphics and animation.[147]

1968: IBM Customer Information Control System (CICS)
IBM introduces the CICS transaction monitor. CICS remains to this day the industry's most popular transactions monitor.[148]

1969: Antitrust, the Unbundling of software and services
IBM's dominant market share in the mid-1960s led to antitrust inquiries by the U.S. Department of Justice, which filed a complaint for the case U.S. v. IBM in the United States District Court for the Southern District of New York, on January 17, 1969. The suit alleged that IBM violated the Section 2 of the Sherman Act by monopolizing or attempting to monopolize the general purpose electronic digital computer system market, specifically computers designed primarily for business. The case dragged out for 13 years, turning into a resource-sapping war of attrition. In 1982, the Justice Department finally concluded that the case was "without merit" and dropped it, but having to operate under the pall of antitrust litigation significantly impacted IBM's business decisions and operations during all of the 1970s and a good portion of the 1980s.

In 1969 IBM "unbundled" software and services from hardware sales. Until this time customers did not pay for software or services separately from the very high price for leasing the hardware. Software was provided at no additional charge, generally in source code form. Services (systems engineering, education and training, system installation) were provided free of charge at the discretion of the IBM Branch office. This practice existed throughout the industry. Quoting from the abstract to a widely read IEEE paper on the topic:

"Many people believe that one pivotal event in the growth of the business software products market was IBM's decision, in 1969, to price its software and services separately from its hardware."

At the time, the unbundling of services was perhaps the most contentious point, involving antitrust issues that had recently been widely debated in the press and the courts. However, IBM's unbundling of software had long-term impact. After the unbundling, IBM software was divided into two main categories: System Control Programming (SCP), which remained free to customers, and Program Products (PP), which were charged for. This transformed the customer's value proposition for computer solutions, giving a significant monetary value to something that had hitherto essentially been free. This helped enable the creation of a software industry.

Similarly, IBM services were divided into two categories: general information, which remained free and provided at the discretion of IBM, and on-the-job assistance and training of customer personnel, which were subject to a separate charge and were open to non-IBM customers. This decision vastly expanded the market for independent computing services companies.

Key events

1969: Antitrust
The United States government launches what would become a 13-year-long antitrust suit against IBM. The suit becomes a draining war of attrition, and is eventually dropped in
1982, after IBM's share of the mainframe market declined from 70% to 62%.

**1969: Unbundling**
IBM adopts a new marketing policy that charges separately for most systems engineering activities, future computer programs, and customer education courses. This "unbundling" gives rise to a multibillion-dollar software and services industry.

**1969: Magnetic stripe cards**
The American National Standards Institute makes the IBM-developed magnetic stripe technology a national standard, jump starting the credit card industry. Two years later, the International Organization for Standardization adopts the IBM design, making it a world standard.

**1969: First moon landing**
IBM personnel and computers help NASA land the first men on the Moon.

### 1970–1974: The challenges of success
The Golden Decade of the 1960s was a hard act to follow, and the 1970s got off to a troubling start when CEO Thomas J. Watson Jr. suffered a heart attack and retired in 1971. For the first time since 1914 – nearly six decades – IBM would not have a Watson at the helm. Moreover, after just one leadership change over those nearly 60 years, IBM would endure two in two years. T. Vincent Learson, an IBM executive, succeeded Watson as CEO, then quickly retired upon reaching the mandatory retirement age of 60 in 1973. Following Learson in the CEO office was Frank T. Cary, a 25-year IBMer who had earned his stripes running the fabulously successful data processing division in the 1960s.

During Cary's tenure as CEO, the company continued to dominate in hardware. The IBM System/370 was introduced in 1970 as IBM's new mainframe. The S/370 did not prove as technologically revolutionary as its predecessor, the System/360. From a revenue perspective, it more than sustained the cash cow status of the 360. A less successful effort to replicate the 360 mainframe revolution was the Future Systems project. Between 1971 and 1975, IBM investigated the feasibility of a new revolutionary line of products designed to make obsolete all existing products in order to re-establish its technical supremacy. This effort was terminated by IBM's top management in 1975. But by then it had consumed most of the high-level technical planning and design resources, thus jeopardizing progress of the existing product lines (although some elements of FS were later incorporated into actual products). Other IBM innovations during the early 1970s included the IBM 3340 disk unit – introduced in 1973 and known as "Winchester" after IBM's internal project name — was an advanced storage technology which more than doubled the information density on disk surfaces. Winchester technology was adopted by the industry and used for the next two decades.

Some 1970s-era IBM technologies emerged to become familiar facets of everyday life. IBM developed magnetic stripe technology in the 1960s, and it became a credit card industry standard in 1971. The IBM-invented floppy disk, also introduced in 1971, became the standard for storing personal computer data during the first decades of the PC era. IBM Research scientist Edgar 'Ted' Codd wrote a seminal paper describing the relational database — an invention that Forbes magazine described as one of the most important innovations of the 20th century. The IBM Portable Computer, 50 lbs.
and $9000 of personal mobility, was introduced in 1975 and presaged – at least in function if not size or price or units sold – the Personal Computer of the 1980s. IBM's 3660 supermarket checkout station, introduced in 1973, used holographic technology to scan product prices from the now-ubiquitous UPC bar code, which itself was based a 1952 IBM patent that became a grocery industry standard. Also in 1973, bank customers began making withdrawals, transfers and other account inquiries via the IBM 3614 Consumer Transaction Facility, an early form of today's Automatic Teller Machines.

IBM had an innovator's role in pervasive technologies that were less visible as well. In 1974, IBM announced Systems Network Architecture (SNA), a networking protocol for computing systems. SNA is a uniform set of rules and procedures for computer communications to free computer users from the technical complexities of communicating through local, national, and international computer networks. SNA became the most widely used system for data processing until more open architecture standards were approved in the 1990s.

In 1975, IBM researcher Benoit Mandelbrot conceived fractal geometry—a new geometrical concept that made it possible to describe mathematically the kinds of irregularities existing in nature. Fractals had a great impact on engineering, economics, metallurgy, art and health sciences, and are integral to the field of computer graphics and animation.

A less successful business endeavor for IBM was its entry into the office copier market in 1970. The company was immediately sued by Xerox Corporation for patent infringement. Although Xerox held the patents for the use of selenium as a photoconductor, IBM researchers perfected the use of organic photoconductors which avoided the Xerox patents. The litigation lasted until the late 1970s and was ultimately settled. Despite this victory, IBM never gained traction in the copier market, and withdrew from the marketplace in the 1980s. Organic photoconductors are now widely used in copiers.

Throughout this period, IBM was litigating the massive anti-trust suit filed by the Justice Department in 1969. But in a related bit of case law, the landmark Honeywell v. Sperry Rand U.S. federal court case was concluded in April 1973. The 1964 patent for the ENIAC, the world's first general-purpose electronic digital computer, was found both invalid and unenforceable for a variety of reasons thus putting the invention of the electronic digital computer into the public domain. Further, IBM was ruled to have created a monopoly via its 1956 patent-sharing agreement with Sperry-Rand.

Key events

1970: Relational databases
IBM introduces relational databases which call for information stored within a computer to be arranged in easy-to-interpret tables to access and manage large amounts of data. Today, nearly all database structures are based on the IBM concept of relational databases.

1970: Office copiers
IBM introduces its first of three models of xerographic copiers. These machines mark the first commercial use of organic photoconductors which since grew to become the dominant technology.

1971: Speech recognition
IBM achieves its first operational application of speech recognition, which enables engineers servicing equipment to talk to and receive spoken answers from a computer that can recognize about 5,000 words. Today, IBM's ViaVoice recognition technology has a
vocabulary of 64,000 words and a 260,000-word back-up dictionary.[160]

1971: Floppy disk
IBM introduces the floppy disk. Convenient and highly portable, the floppy becomes a personal computer industry standard for storing data.[161]

1973: Winchester storage technology
The IBM 3340 disk unit—known as "Winchester" after IBM's internal project name—is introduced, an advanced technology which more than doubled the information density on disk surfaces. It featured a smaller, lighter read/write head that was designed to ride on an air film only 18 millionths of an inch thick. Winchester technology was adopted by the industry and used for the next two decades.[162]

1973: Nobel Prize
Dr. Leo Esaki, an IBM Fellow who joined the company in 1960, shares the 1973 Nobel Prize in physics for his 1958 discovery of the phenomenon of electron tunneling. His discovery of the semiconductor junction called the Esaki diode finds wide use in electronics applications. More importantly, his work in the field of semiconductors lays a foundation for further exploration in the electronic transport of solids.[163]

1974: SNA
IBM announces Systems Network Architecture (SNA), a networking protocol for computing systems. SNA is a uniform set of rules and procedures for computer communications to free computer users from the technical complexities of communicating through local, national, and international computer networks. SNA becomes the most widely used system for data processing until more open architecture standards were approved in the 1990s.[164]


President of IBM John R. Opel became CEO in 1981.[165] His company was one of the world's largest and had a 62% share of the mainframe computer market that year.[154] Its share of the overall computer market, however, had declined from 60% in 1970 to 32% in 1980.[166] Perhaps distracted by the long-running antitrust lawsuit, the "Colossus of Armonk" completely missed the fast-growing minicomputer market during the 1970s.[167][168][169] and was behind rivals such as Wang, Hewlett-Packard (HP), and Control Data in other areas.[166]

In 1979 BusinessWeek asked, "Is IBM just another stodgy, mature company?" By 1981 its stock price had declined by 22%. IBM's earnings for the first half the year grew by 5.3%—one third of the inflation rate—while those of minicomputer maker Digital Equipment Corporation (DEC) grew by more than 35%. The company began selling minicomputers, but in January 1982 the Justice Department ended the antitrust suit because, The New York Times reported, the government "recognized what computer experts and securities analysts had long since concluded: I.B.M. no longer dominates the computer business".[154][171]

IBM wished to avoid the same outcome with the new personal computer industry.[169] The company opened its first retail store in November 1980,[172] and a team led by Don Estridge at the IBM Entry Systems Division in Boca Raton built the IBM PC, launched on August 12, 1981. IBM immediately became more of a presence in the consumer marketplace, thanks
A **Fortran** program is made of a collection of program units like a main program, modules, and external subprograms or procedures.

Each program contains one main program and may or may not contain other program units. The syntax of the main program is as follows –

```fortran
program program_name
  implicit none

  ! type declaration statements
  ! executable statements

end program program_name
```

**A Simple Program in Fortran**

Let’s write a program that adds two numbers and prints the result –

```fortran
program addNumbers

  ! This simple program adds two numbers
  implicit none

  ! Type declarations
  real :: a, b, result

  ! Executable statements
  a = 12.0
  b = 15.0
  result = a + b
  print *, 'The total is ', result

end program addNumbers
```
When you compile and execute the above program, it produces the following result –

| The total is 27.0000000 |

Please note that –

- All Fortran programs start with the keyword `program` and end with the keyword `end program`, followed by the name of the program.
- The `implicit none` statement allows the compiler to check that all your variable types are declared properly. You must always use `implicit none` at the start of every program.
- Comments in Fortran are started with the exclamation mark (!), as all characters after this (except in a character string) are ignored by the compiler.
- The `print *` command displays data on the screen.
- Indentation of code lines is a good practice for keeping a program readable.
- Fortran allows both uppercase and lowercase letters. Fortran is case-insensitive, except for string literals.

**Basics**

The **basic character set** of Fortran contains –

- the letters A ... Z and a ... z
- the digits 0 ... 9
- the underscore (_) character
- the special characters = : + blank - * / ( ) [ ] , . $ ' ! " % & ; < > ?

**Tokens** are made of characters in the basic character set. A token could be a keyword, an identifier, a constant, a string literal, or a symbol.

Program statements are made of tokens.

**Identifier**

An identifier is a name used to identify a variable, procedure, or any other user-defined item. A name in Fortran must follow the following rules –

- It cannot be longer than 31 characters.
- It must be composed of alphanumeric characters (all the letters of the alphabet, and the digits 0 to 9) and underscores (_).
• First character of a name must be a letter.

• Names are case-insensitive

Keywords

Keywords are special words, reserved for the language. These reserved words cannot be used as identifiers or names.

The following table lists the Fortran keywords –

<table>
<thead>
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<th>The non-I/O keywords</th>
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<td>end interface</td>
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<td>end type</td>
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**The I/O related keywords**

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<tbody>
<tr>
<td>open</td>
<td>print</td>
<td>read</td>
<td>rewind</td>
<td>Write</td>
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From [https://www.tutorialspoint.com/fortran/fortran_basic_syntax.htm](https://www.tutorialspoint.com/fortran/fortran_basic_syntax.htm)