

## Abstract

The IBM System/360 was a family of mainframe computers designed and developed by IBM. It had a major impact on technology and on the computing field, and it set IBM on the road to dominate the computing field for the next 20 years, up to the arrival of personal computers in the 1980s. The user could start with a low specification member of the family and upgrade over time to a more powerful member of the family. It was the start of an era of computer compatibility, and it set IBM on the road to dominate the computing field. It was a massive \$5 billion gamble by IBM, and it moved the company from its existing product lines to the unknown world of the System/360.

## Key Topics

System/360

Family of computers

Gene Amdahl

Fred Brooks

*The Mythical Man Month*

## 8.1 Introduction

The IBM System/360<sup>1</sup> was a family of mainframe computers designed and developed by IBM. It had a major impact on technology and on the computing field, and it set IBM on the road to dominate the computing field for the next 20 years, up to the arrival of personal computers in the 1980s.

It was the beginning of an era of computer compatibility, where for the first time machines across a product line could work with each other. It meant that IBM customers could start off with a low specification member of the family and upgrade over time to a more powerful member of the family. This allowed the customer to choose the appropriate model to meet its current needs, and then as its needs evolved, it could upgrade to a more powerful member of the family. It was a massive \$5 billion investment (*bet the business gamble*) by Thomas Watson Jr., and it moved IBM from its traditional business and product lines into the unknown with the gamble that the future would be the System/360.

Thomas Watson Jr.<sup>2</sup> announced the System/360 in 1964, and the revolutionary announcement changed business and the world of computing forever. The System/360 replaced all five of IBM's computer product lines with one strictly compatible family. It used a new computer architecture that employed hybrid integrated circuit technology, and it pioneered the 8-bit byte, which remains in use on every computer today.

The System/360 included a multiprogramming disc-based operating system, which was called OS/360. It included free software packages such as compilers for several programming languages, as well as packages for communication network capabilities [Pug:09].

The System/360 was an extremely successful product line for IBM, with orders rapidly exceeding forecasts. Its success vastly exceeded IBM's expectations, with over a thousand orders placed in the first 4 weeks after the announcement. The popularity of the System/360 made it difficult for IBM competitors (such as Burroughs, Honeywell and Sperry Rand) to compete against IBM in the general-purpose computer market.

Monthly rental prices ranged from under \$3000 per month for the most basic system to over \$100,000 per month for a large multisystem. The purchase cost ranged from \$130,000 for a basic system to over \$5 million for a large system. In 1989, 25 years after the announcement of the System/360, products based on the System/360 architecture and its extensions still accounted for over 50% of IBM revenue.

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<sup>1</sup>The number '360' (the number of degrees in a circle) was chosen to represent the ability of each computer to handle all types of applications.

<sup>2</sup>Thomas Watson Jr. later stated, 'The System/360 was the biggest, riskiest decision that I ever made, and I agonised about it for weeks, but deep down I believed that there was nothing that IBM couldn't do'.

## 8.2 Background to the Development of System/360

Thomas Watson Jr., the son of Thomas Watson Sr. (the first president of IBM), became president of IBM in 1952. He recognized that computers would play a key role for business in the years ahead, and he realized that the future of IBM was in the computer business and not in tabulators. It was clear to him that IBM needed to change, and he played a key role in transforming the company to become the world leader in the computer industry.

IBM was already a successful computer company in the 1950s. It introduced its first large computer (the IBM 701) based on vacuum tubes in 1952, the IBM 650 (Magnetic Drum Calculator) in 1954 and the IBM 704 data processing system computer in 1954. It had also played a key role in the development of the computers for the SAGE air defence system in the United States. IBM had become the market leader with a large growth in its revenue and earnings, and it employed over 100,000 people around the world.

However, within IBM there were concerns that the company had reached a plateau, and competitors were launching alternative products to IBM. The origins of the System/360 go back to the late 1950s and Watson's determination to transform IBM in order to position it for future success. IBM was supporting five different product lines by 1959, and it was becoming a major challenge to train staff to service and maintain software to support so many different computer products.

There were major problems with incompatibility between different hardware and software among the different computer vendors, as well as incompatibility among IBM's own products. IBM had an existing product line of several computers, each excellent in its own right, but all with incompatible architectures. It meant that customers who wished to move up from their existing small system to a larger system had to invest in a new system, new printers, new storage devices and new software (often totally rewritten for the new machine).

It was clear to Watson and other senior IBM executives that there was a need to develop a totally cohesive product line so that computers produced at different IBM facilities would be compatible with one another.

IBM set up a corporate wide task group to establish an overall IBM plan for its future products. The task group had the acronym SPREAD (System Programming, Research, Engineering and Design), and it completed its final report in the late 1961. It made a series of recommendations such as that there would be five processors spanning a 200-fold range in performance. IBM made the brave decision in 1962 to replace the company's entire product line of computers and to build a new family of compatible machines.

It would mean that code written for the smallest member of the family would be upwardly compatible with each of the processors in the family. Further, the various peripherals such as printers and storage devices would be compatible across the family. It was an incredibly brave decision, and *Fortune Magazine* later described it as *IBM's five billion dollar gamble*.

### 8.3 The IBM System/360

Thomas Watson announced the new System/360 to the world at a press conference in 1964 and said:

The System/360 represents a sharp departure from concepts of the past in designing and building computers. It is the product of an international effort in IBM's laboratories and plants, and is the first time IBM has redesigned the basic internal architecture of its computers in a decade. The result will be more computer productivity at lower cost than ever before. This is the beginning of a new generation—not only of computers—but of their application in business, science and government.

The IBM System/360 (Fig. 8.1) was a family of small to large computers, and the concept of a *family of computers* was a paradigm shift away from the traditional *one-size-fits-all* philosophy of the computer industry, as up until then, every computer model was designed independently.

The family of computers ranged from minicomputers with 24 KB of memory to supercomputers for US missile defence systems. However, all these computers employed the same user instruction set, and the main difference was that for the larger computers, the more complex machine instructions were implemented with hardware, whereas the smaller machines used microcode.

The System/360 architecture allowed customers to commence with a lower-cost computer model and to then upgrade over time to a larger system to meet their evolving needs. The fact that the same instruction set was employed meant that the time and expense of rewriting software was avoided.



**Fig. 8.1** IBM System/360 (Courtesy of IBM Archives)

**Fig. 8.2** Gene Amdahl  
(Photo courtesy of Perry  
Kivolowitz)



**Fig. 8.3** Fred Brooks  
(Photo courtesy of Dan  
Sears)



Gene Amdahl (Fig. 8.2) was the chief architect for the System/360, and Fred Brooks<sup>3</sup> was the project manager (Fig. 8.3). This family was introduced in 1964, and the IBM chairman, Thomas Watson Jr., called it the most important product announcement in the company's history.

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<sup>3</sup>Fred Brooks wrote an influential paper *The Mythical Man Month* based on his experience as project manager for the System/360 project.

The IBM 360 family of small to large computers offered a choice of five processors and 19 combinations of power, speed and memory. There were 14 models in the family. It was successful in achieving strict compatibility in the family of computers, and the project introduced a number of new industry standards including 8-bit bytes.

A customer could start with a small member of the System/360 family and upgrade over time into a larger computer in the family. This helped to make computers more affordable for businesses, and it stimulated growth in computer use.

It was used extensively in the Apollo program to place man on the moon. The contribution by IBM computers and personnel was essential to the success of the project. IBM invested over \$5 billion in the design and development of the S/360. However, the gamble paid off and it was a very successful product line for IBM.

Gene Amdahl was appointed an IBM fellow in 1965 in recognition of his contribution to IBM, and he was appointed director of IBM's Advanced Computing Systems (ACS) Laboratory in California and given freedom to pursue his own research projects. He later left IBM following disagreements on later computer development and he formed Amdahl Corporation, which later became a major competitor to IBM in the mainframe market.

Fred Brooks was the project manager for the System/360 project, which involved 5000 man-years of effort at IBM. Brooks recorded his experience as project manager in a famous project management book titled *The Mythical Man Month* [Brk:75]. This book which appeared in 1975 considered the challenge of delivering a major project (of which software is a key constituent) on time, on budget and with the right quality. Brooks described it as *my belated answer to Tom Watson's probing question as to why programming is hard to manage*.

For a more detailed account of the System/360 revolution, see the excellent IBM article 'The 360 Revolution' by Chuck Boyer [Boy:04]. For more detailed information on Brooks and Amdahl, see [ORg:13, ORg:15].

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## 8.4 Review Questions

1. Why did IBM decide to retire its existing product line and develop the System/360?
2. What were the main risks in developing the System/360?
3. What were the advantages of developing the System/360?
4. What new industry standards followed from the System/360?
5. What is a family of computers?
6. Describe the contributions of Gene Amdahl to the computing field.
7. Describe the contributions of Fred Brooks to the computing field.

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## 8.5 Summary

The IBM System/360 was a family of small to large computers, and it was a paradigm shift away from the traditional ‘one-size-fits-all’ philosophy of the computer industry, as up until then, every computer model was designed independently.

The family ranged from minicomputers with 24 KB of memory to supercomputers for US missile defence systems. However, all these computers employed the same user instruction set, and the main difference was that for the larger computers, the more complex machine instructions were implemented with hardware, whereas the smaller machines used microcode.

The System/360 architecture allowed customers to commence with a lower-cost computer model and to then upgrade over time to a larger system to meet their evolving needs. The fact that the same instruction set was employed meant that the time and expense of rewriting software was avoided.

Gene Amdahl was the chief architect for the System/360 and Fred Brooks was the project manager. Fred Brooks later wrote an influential project management book, which was concerned with the challenge of delivering a major project (of which software is a key part) on time, on budget and with the right quality.