

Information Technology for Retail

GIRDHAR JOSHI

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1

Introduction to Information Technology

Learning Objectives

- To recapitulate history of computers
- To differentiate between computers of various generations
- To appreciate revolution in digital computing with the invention of microcomputer
- To define basic computer hardware architecture
- To know various types of software
- To understand various generations of programming languages and tools

Information technology is much more than just computers. Today, it is the convergence of hardware, software, telecommunication, data, networks, multimedia, images, Internet, applications, and people. These all revolve round one object—computer. But computers were not the same what we see today.

BRIEF HISTORY OF COMPUTERS

Computers have come a long way since Charles Babbage, a mathematician, designed his mechanical device in 1835. He called his machine Analytical Engine. Babbage drew his inspiration from the centuries-old abacus that was used for counting numbers. Babbage's machine could only perform very simple arithmetical calculations. He replaced the abacus beads with mechanical gears, which were similar to the arithmetic logic unit of modern computers. There were lots of developments by scientists world wide. During World War II, there were many developments in the digital arena. The electronic circuits, relays, capacitors, and vacuum tubes replaced the mechanical parts. The architecture designed by John von Neumann was most suitable for digital computing. Even today, most contemporary computers use this architecture. But the most noticeable development and improvement over Charles' machine was the invention of ENIAC (Electronic Numerical Integrator and Computer) in 1945 by John Mauchly and J. Presper at the University of Pennsylvania. It was the first electronic general-purpose machine and was 1000 times faster than other contemporary computers.



Fig. 1.1 Mainframe computer 'baby'

Later EDVAC (Electronic Discrete Variable Automatic Computer) was designed by John von Neumann. With the end of the War, the US Army sold to John Von Neumann the technology that was the basis of modern computers and most mainframes and minicomputers were developed around that architecture. In the real sense of the term, we can call this as the first generation of computers.

The first generation of computers, called the *mainframe*, came out in 1952 (Fig. 1.1). This time, IBM launched its first 'mainframe' IBM701. This machine was huge, weighed around 30 tons, had 18,000 vacuum tubes to operate them, and hardly fitted into a room of 400 square feet. It used the 'machine-level language', which was later known as 'first-generation computer language', and could only understand 0's and 1's as the programming language. (The programming language is an instruction code to the computer that gets translated into the binary numbers, i.e. 0 and 1.) Programming and operating this computer was a strenuous job. It took hundreds and thousands of days to write a small program for simple calculations.

The decade 1960–70 was the period of minicomputers. In 1960, Digital Equipment Corporation developed a computer with keyboard and monitor that was commercially available. Thus came the turn of the second generation of computers, which were called *minicomputers*. These were called so because of their smaller size as compared to the mainframe. In 1969, Data General launched 'Nova', which was the first 16-bit minicomputer (Fig. 1.2). These computers offered relatively more features and were easy to program, use, and maintain.



Fig. 1.2 DG's Nova minicomputer

The programming language had also evolved from the first generation of machine language to the second generation, called 'assembly language', which was converted into machine language by a converter in the computer.

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PC—THE PERSONAL COMPUTER

With the invention of a microprocessor by Ted Hoff and F. Foggin at Intel Corporation in the early 1970s, computer technology underwent a sea change. Very large-scale integrated (VLSI) circuits technology was behind this revolution. The third-generation computers came into the picture, which were called *microcomputers*, because they used microprocessors. These computers were extremely small, had much more processing speed, and could store information in magnetic disks called *floppy disks*. Thus, the PC was born. These computers were called personal computers because now any individual person could buy and own one of his/her own. The mainframes and minicomputers were only bought and owned by the government agencies such as defence or large corporations.

In 1971, Intel Corporation released the first microprocessor '4004', which was made for a Japanese calculator company. Later in 1975, Intel 8080 was used to build MITS Altair, the personal computer (Fig. 1.3). This was the first time that Paul Allen and his friend, Bill Gates, developed a BASIC interpreter for Altair and later they formed Microsoft. It was only in August 1981 when IBM released its first PC and used the Intel 8088 microprocessor, which had a speed of 4.77 MHz. This computer was developed on a memory chip that could store 1024 bits of data, which is equal to 1 kilobyte.

Almost at the same time, floppy disks were introduced. These were the first-generation floppy diskettes of 8" size. IBM (then known as International Business Machines) standardized the configuration of the personal computer (Fig. 1.4). The following components were made compulsory in any PC:

- Central processing unit (having a microprocessor and a memory chip)
- Monitor



Fig 1.3 MITS Altair 8800



Fig. 1.4 IBM's first PC 5150 with two floppy drives



Fig. 1.5 Modern-day personal computer: really personal!

- Keyboard
- Floppy drive
- Speaker

The journey of personal computer started with Intel Corporation introducing the tiny microprocessor or integrated chip (IC) by the code name ‘8088’. The technology was improved continuously. The size became shorter and the speed and efficiency doubled and quadrupled with every new release (Fig. 1.5). It is said that if the automobile industry had made the progress like the computers did, we would have a car

of size of match box with a speed of a jet within forty years. Table 1.1 shows a tentative time of introduction of the chip and its speed.

The fast evolution of microcomputers was because of the invention of the microchip called integrated circuits (ICs). In this technology, the computer logic is ‘burnt into’ the layers of the microprocessor (Fig. 1.6). A chip of a size of our thumbnail can hold enough logic to run the computer programs we have in our computers. The pace of the evolution of computers was always followed by the development in the field of peripheral devices. Peripheral devices are the various input, output and storage equipment, such as mouse, monitor, printer, and hard disk. Monitors evolved from monochromes to high-resolution coloured to liquid crystal display (LCD) and

Table 1.1 Evolution of microprocessors

<i>Year</i>	<i>Chip</i>	<i>Computers Built around the Chip</i>	<i>Word-length*</i>	<i>Clock Speed*</i>
1981	i8086, i8088	IBM PC	8 bit	8–10 MHz
1983	i8088	IBM PC-XT (Hard disk was added.)	8 bit	8–12 MHz
1983	Motorola-68000	Apple Macintosh, GUI, Mouse Driven	16 bit	
1984	i80286	IBM PC-AT (Advanced Technology)	16 bit	12–16 MHz
1986	i80386	IBM PC-386	32 bit	16–32 MHz
1990	i80484	IBM PC-486	32 bit	32–64 MHz
1996	Pentium I	Pentium	32 bit	64–200 MHz
1998–00	Pentium II/MMX/III	Pentium II/MMX (multimedia extensions)/P-III	32 bit	233–450 MHz
2003	AMD-Athlon	AMD microprocessor based	64 bit	450–1200 MHz
2004	Pentium IV	Pentium IV	64 bit	1200–2800 MHz
2006	Duo Core	Pentium Duo Core	64 bit	2800+ MHz

* We will discuss word-length and clock speed later in this chapter.



Fig. 1.6 Microprocessor—microchip

thin film transistor (TFT). Similarly, introduction of graphic user interface (GUI) based operating system software came along with a mouse. The headache of memorizing DOS commands was gone. Printers evolved from the ubiquitous dot matrix printers to ink-jet and laser jets. In the same way, the hard disks available in 1988 had a 10 MB (megabyte) capacity. Today, we buy a PC with 160 GB (160000 MB) space. This development has been phenomenal by all accounts.

BASIC COMPUTER ARCHITECTURE

In this section, we will discuss the basic components of a computer system.

Input-Process-Output

These devices, made mandatory by IBM, form a complete computer and are ingredients of input, output, and processing system of a computer. Figure 1.7 explains the basic input and output devices. We can add the latest devices in the subsequent diagram.

The central processing unit (CPU) consists of three main components—arithmetic logic unit (ALU), control unit, and primary storage unit.

The *arithmetic logic unit* (ALU) performs all arithmetical and logical calculations in the computer. It can add, subtract, multiply, and divide numbers. Also, it can understand logical calculations and negative numbers. The *control unit* controls and coordinates between various parts and components of a computer. These parts are all input and output devices, storage units, and other internal units of a computer. We will now briefly discuss primary storage system in a computer.

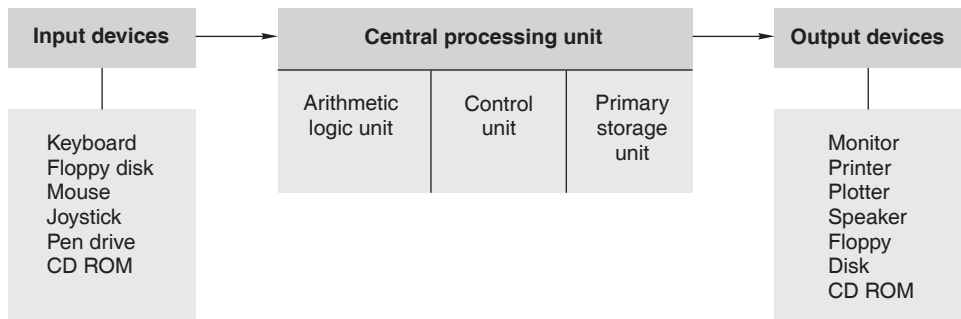


Fig. 1.7 Basic computer architecture and peripheral devices

Primary Storage Unit

Storage of the operating system program during operation and data related to that operation is done in the primary storage area. This is also known as *memory of the computer system*. There are two types of memory systems in a computer—ROM and RAM.

Read-only Memory (ROM)

It is a permanent memory and the retrieval is sequential in nature, i.e. the system can access the second block of memory data only after reading the first block. The data or information in this memory is fused in the chip and stores information about the computer, called BIOS (basic input/output system). You must have noticed some information being displayed on the screen of your computer when your computer boots on. This information comes from the ROM part of the memory.

Random-access Memory (RAM)

It is a temporary memory. This is called ‘random’ because it can be accessed and retrieved randomly from any location in the memory area. This memory is used to store data or application when the system is working. For example, after starting the computer, it retrieves the operating system files from the hard disk, brings it in the RAM area and executes the commands. In the same way, if you are working on a spreadsheet like Excel, your Excel application, which was stored and dormant in the hard disk, comes in the RAM and you start working on it. The data that you enter in the Excel worksheet remains in this volatile memory until you click the *Save* button and permanently write it on the disk. If you have not saved your work and the computer accidentally switches off, the work done will be lost.

Data Storage System

The unit of measurement of memory is *byte*. Every piece of information in the form of a word, a symbol, an image, or a character in computer is stored and processed in the form of binary digits. A binary digit is called a *bit* and is represented by either 0 or 1. All types of data are represented by 0’s and 1’s. Eight bits form one byte or character. Look at the following conversion table:

8 bits	=	1 byte
1024 bytes	=	1 kilobyte (KB)
1024 kilobytes	=	1 megabyte (MB)

1024 megabyte = 1 gigabyte (GB)
 1024 gigabyte = 1 terabyte (TB)

Computer Speed

As memory is measured in bits and bytes, computer speed is measured in word-length. It is the number of bits a computer processes at a time. If a computer has a word-length of 16 bits, it can process 16 bits or 2 bytes at a time. As we have seen in Table 1.1, a Pentium computer has a 32-bit word-length, i.e. it can process up to 4 bytes at a time. The chip speed is guided and affected by the 'clock' speed of the computer. This is an internal speed and measured in megahertz (MHz). The megahertz speed is many millions of cycles per second. If a computer has a clock speed of 2600 MHz, it means it can perform 2600 million cycles per second.

COMPUTER HARDWARE

A computer system is built of mainly two major components, hardware and software. We can see, touch, and feel hardware. It is a tangible part of the computer, whereas the software is intangible and stays in coded form either in the hard disk drive, or in the memory of the computer.

Hardware Components

Hardware consists of the following components.

Cabinet It is a box that houses the main components of the computer such as motherboard, microprocessor, memory chips, hard disk, floppy disk drive, and the CD-ROM drive.

Monitor It is also known as visual display unit (VDU). Monitors come with cathode-ray tube (CRT) technology, in which a beam of electrons is thrown on the inner surface of the tube to form characters and images. Now, the new-generation monitors are LCD and TFT.

Keyboard It is an input device. Computer keyboard has all numerals and alphabets of the English language. Besides, it has some special-purpose keys and function keys, which need no elaborate discussion here.

Mouse It is also an input device and is a must for running Windows (or GUI) applications.

Motherboard This is the main board inside the computer box that accommodates the main microprocessor, memory chips (RAM and ROM), and input-output unit for connecting with the peripheral devices.

Hard Disk It is a storage device. It stores data permanently in the computer and the information is retrieved through the software interface, either for system or application (which is discussed in the next section).

Floppy Disk or CD-ROM Before CD-ROMs were invented, putting a floppy disk was mandatory to load programs and take outputs in the data form. Now, the CD-ROMs have taken this space.

Power Supply Unit switch mode power supply (SMPS) is the power supply unit in the cabinet box that supplies power to different parts of the computer.

Memory Chips or SIM Cards These are plugged on the motherboard. One can add memory chips as required and support by the motherboard.

SOFTWARE

Software is a set of instructions to the computer to perform a certain task and that resides in the computer in the coded form as binary digits of 0 and 1. Windows, Word, Excel, SAP, Tally, Unix, Linux, Visual Basic, and Oracle Forms are all examples of software. Software is an important part of a computer system. You can compare software with the blood and life of a person, which makes the person alive. W.S. Jawadekar (2004) defines software as ‘a set of instructions to acquire inputs and manipulate them to produce the desired output in terms of functions and performance as determined by the user of the software.’ It also includes a set of documents such as the software manual, meant for the users to understand the software system. Today’s software comprises the source code, executables, design documents, operations and system manuals, and installation and implementation manuals.

Software can be broadly classified into two categories—system software and application software.

System Software

System software manages computer resources, such as the file system, other hardware peripherals, and communication links. Various operating systems, browsers, utilities, compilers, and device drivers are examples of system software. As the computer technology evolved from mainframes to minicomputers, to microcomputers, software systems also went through major metamorphosis. Initially, the mainframe did not have an operating system at all. Then, Unix was introduced and became a very popular operating system for mainframes and minicomputers.

Operating Systems (OS)

The basic function of operating systems is to manage the computers' internal and external resources, such as files and peripherals devices. It helps in creating directories and folders as well as copying, deleting, and moving files from a physical storage to another. Operating systems offer various utilities to configure the computer as per your environmental settings, such as date formats, numbering system, and memory management. This also helps in adding new programs and removing unwanted programs from the computer. The various devices attached with a computer are linked through drivers, which are commensurate with the computer's operating system.

With the invention of microcomputers, disk operating system was introduced. IBM developed the first disk operating system (DOS) for its personal computers, which was known as PC-DOS. IBM outsourced the development of PC-DOS to Bill Gates and his friend, Paul Allen. Since IBM did not buy the proprietary rights (which is known as the biggest blunder a company ever made in the modern business history), Bill Gates re-launched the DOS under the banner of Microsoft. It was renamed as Microsoft-DOS or MS-DOS as commonly called. IBM sold PC-DOS preloaded in the desktop computers for some time and finally stopped selling it. MS-DOS supports IBM PC standards and is a 16-bit operating system, i.e. it can address data in chunks of 16-bits at a time. The maximum application size it can handle in the memory is 640 KB and it can run only one program at a time (as opposed to multitasking in Windows).

Windows overcame the constraints in DOS. Microsoft launched the second generation of disk operating system in 1995, which was completely based on GUI and was named *Windows 95*. This was a true 32-bit operating system with more capabilities, such as fax, e-mail, scheduling, and Internet browsing. Though Apple Macintosh, which was launched in 1976, already had an operating system that was full GUI, it was popular only with Mac users. Macintosh systems were mainly used for publishing work. Windows family of operating systems, viz. *Windows 95*, *Windows 98*, *Windows XP*, (Fig. 1.8), and *Windows 2003*, became popular for modern personal computers.

Windows 98, *Windows 2000*, *Windows ME* (Millennium Edition), *Windows XP* (eXPerience), and *Windows Vista* are the subsequent versions of Windows that were launched with some modifications and improvements from the earlier version. Windows can handle files of sizes more than 640 KB because of its capability to use extended memory. Windows has great functionality to perform multitasking, i.e. it can perform several programs at the same time. You may minimize a program and then run another, and yet another. This functionality is available to users only with Windows (Fig. 1.9).



Fig. 1.8 A typical Windows XP desktop screen

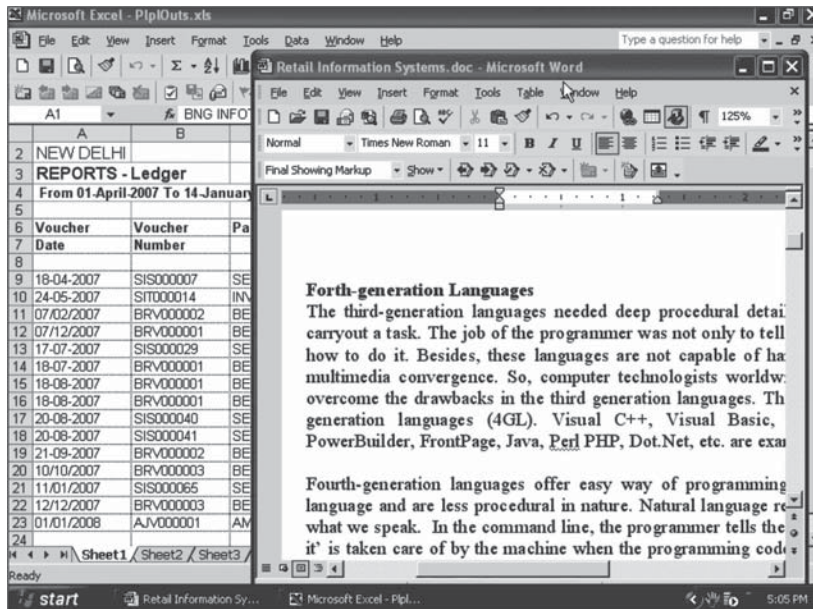


Fig. 1.9 Windows' multitasking capability—working on two documents together



Fig. 1.10 Linux operating system: GUI

Microsoft had a monopoly on the PC operating systems market, until *Linux* was launched at the turn of the century. Linux kernel was developed by Linus Torvalds in 1991. The kernel is the core of the software, around which developers can build tools and utilities. Linux supports open-source technology and is a freeware, that is, nobody legally owns rights over it. Open-source concept propagates non-proprietary rights on the product and allows developments, addition and improvement in the software by any user, mentor, or developer of the system. It can be redistributed along with the improved source code. The source code of Linux is available and one can create additional tools around this OS (Fig. 1.10). One of the many advantages offered by Linux is that it can run on major processors developed by the corporations, such as Intel, Motorola, SPARK, Alpha, and Mips.

Use and development of Linux is supported by Sun Microsystems and IBM, in particular, and Oracle, HP, and other, in general, to champion the cause of open-source technology and also to counter the monopoly of Windows in the market. Initially faced with some hitches, now Linux is gaining acceptance and is quite popular for web-based applications. It is a popular operating system for I Servers. (Also see Case Study at the end of the chapter.)

Network Operating Systems

As Microsoft had a monopoly on the PC disk operating system, Novell Corp had a monopoly on the network operating systems (NOS). *Novell Netware* was a very popular, strong, sturdy, and secure network operating system. It offered capability to network diskless nodes with dedicated Novell servers. Microsoft introduced Windows-NT as the operating system for the networks. Windows NT gave flexibility and an ease of a graphic user interface (mouse compatibility) and was secure enough for local networks. *Windows 2000* integrated capability of Windows NT for secure networking. It can work on PCs, laptops, and servers. As Laudon (2002, p. 177) puts it: ‘Windows 2000 can support software written for Windows and it can provide mainframe-like computing power for new applications with massive memory and file managements. It can even support multiprocessing with multiple CPUs.’ Like Unix, Linux also supports single machines and multiple servers under networks.

Unix and Xenix were operating systems for mainframes and minicomputers. Unix was developed by Bell Laboratories in 1969 primarily to make it run over network. This was made to offer functionalities like multitasking, interactive, and multi-user. Unix is still regarded as a secure and robust operating system that runs on large networks and high-end servers. But with increase in the popularity and power of personal computers, development on Unix and Xenix stopped in the nineties of the last century.

Application Software

Application software is a program created to perform certain tasks for the end users. Some of these tasks are maintaining a fee register in a school, keeping transaction records of an account-holder in a bank, creating bills at the point-of-sales location, managing inventory in a warehouse, playing a music or movie file, creating a database system allowing users to construct database structure, and developing a programming language that further facilitates creation of software by a programmer.

All kinds of software that are used to manage, run and monitor businesses and process data come under application software category. The word processors, database management software, spreadsheet software, compressing-decompressing software, media players, and software that can play a movie file are all examples of application software. It is assumed that students are aware of the basic office management tools such as word processors, spreadsheets, and Internet browsers. Therefore, detailed study of these applications is not a part of this text. Under application software, we will discuss retail application software in Chapters 7, 10, and 11.

PROGRAMMING LANGUAGES AND TOOLS

As we have discussed earlier, for the first and second generations of computers, programming was done using either machine or assembly languages. These languages were used by scientists and engineers for scientific applications. They themselves were users and creators of the programs. The programs were mainly for numerical calculations using scientific formulae and arithmetical rules and logic. It was a time-consuming and cumbersome job to write programs using these low-level languages. Slowly, the languages evolved to higher levels, popularly known as third-generation (3GL) and fourth-generation languages (4GL).

Third-Generation Languages

In these languages, one can write software for both microcomputers and mainframe computers. The main third-generation languages are C, COBOL, FORTRAN, BASIC, and Pascal, which were developed and became popular in development of the system, database and application programming. *System programming* is the development of tools, compilers, utilities, and operating systems. DOS, Windows, Internet browsers, and Linux are all examples of operating systems. *Database programming* is the development of applications around the database management systems, such as FoxPro, Access, and Oracle. *Application programming* is development of applications to perform a certain task and capture, manipulate and retrieve data from databases. Development of websites and business software packages (such as Tally, RetailPro, SAP, and MS-Office) are examples of application programming. These programming languages are much easier than the assembly languages since these come with a compiler, which converts the normal English-like phrases into binary language that the machines understand.

Fourth-Generation Languages

The third-generation languages needed deep procedural details and step-by-step instruction to carry out a task. The job of the programmer was not only to tell the computer what to do but also how to do it. Besides, these languages are not capable of handling GUI and multimedia convergence. So, computer technologists worldwide developed more languages to overcome the drawbacks of the third-generation languages. These languages were called fourth-generation languages (4GL). Visual, C++, Visual Basic, Oracle Developer Tools, SQL, PowerBuilder, FrontPage, Java, CGI-Perl, PHP, and Dot.Net are examples of 4GL.

```

'-----
' Procedure : LastDay
' DateTime  : 19-Oct-2006
' Developer : Sunil
' Purpose   : Return Last Date of Month and Year
' Modify History :
' Date      Dr/Cr      Developer      Details
'-----
Public Function fniLastDay(p_intMonth As Integer, p_intYear As Integer) As
Integer
On Error GoTo ErrorHandler

Select Case p_intMonth
Case 1, 3, 5, 7, 8, 10, 12
LastDay = 31
Case 2
If p_intYear Mod 4 = 0 Then
LastDay = 29
Else
LastDay = 28
End If
Case 4, 6, 9, 11
LastDay = 30
End Select
Exit Function
ErrorHandler:
Err.Raise Err.Number, Err.Source, Err.Description
End Function

```

Fig. 1.11 Sample programming in 4GL

Fourth-generation languages offer an easy way of programming (Figures 1.11 and 1.12). They resemble natural English language and are less procedural in nature. (Natural language refers to the language very close to what we speak.) In the command line, the programmer tells the computer what to do. 'How to do it' is taken care of by the machine when the programming codes are compiled and assembled by the specialized tools provided in the language kit.

The reason of 4GLs becoming popular was their ease in writing programs. The lines of codes (LoC) that need to be written to create a function in different languages reduce sharply as the languages evolved.

```

SELECT item_name FROM itemtable WHERE item_name LIKE 'shirt%';
SELECT customer_name FROM transactiontable WHERE amount = 10000 AND
staxamount=500;

```

Fig. 1.12 Query written in a structured query language (4GL)

Table 1.2 Programming languages in descending order of complexities

Assembly	320
C	128
Fortran	105
C++	56
Java	55
Visual Basic	35
Other 4GL	20
Code Generators	15

Source: Jawadekar, W.S. 2005

Table 1.2 shows how lines of codes per function point drop sharply. (The function point is a measure of the complexity of the software.)

MODERN BUSINESSES AND INFORMATION TECHNOLOGY

After understanding the basic computer architecture and terminology, let us discuss information systems and information technology in respect of modern businesses.

Indian society was largely an agrarian society for centuries. After India's independence in 1947, the government tried to establish industries across the country. It was only after 1960 that India started its steps to move from an agricultural to an industrial society. But worldwide, highly industrialized countries, such as the USA, moved from an industrial society to a service society. The emphasis was on services and the service industry is a knowledge-based industry. From the year 1990 onwards, India has ushered in a knowledge society from an agricultural society and a half-baked industrial society. The use of computers is increasing rapidly, especially with availability of the Internet and high-quality telecommunication network. The way information technology has penetrated society, it has become indispensable. Why do information systems play such big roles within the organizations and affect people in all walks of life? The answer is the ever-increasing power and sharply declining costs of computer-technology products. As Laudon (2002) puts: 'Computing power, which has been doubling every 18 months, has improved the performance of microprocessors over 25,000 times since their invention 30 years ago. With powerful, easy-to-use software, the computer can crunch numbers, analyse vast pools of data, or simulate complex physical and logical processes with animated drawings, sound, and even tactile feedback.'

The Internet, which is the network of the networks, has changed the world. It has not only been instrumental in transforming world economies but also has shaken the basic fabric of social interaction. It has changed the way we shop, the way we socialize, the way we study, the way we bank, make payments, the way scholars conduct research. It has also changed the way a father writes a letter to his daughter, and the way we looked at our old family album.

We would not be doing business the way we did a decade back. E-commerce has opened new avenues in business. Organizations cannot ignore the impact. The dot.com burst in 2000 was a necessary shake-up for unprofitable businesses that had built their foundation on faulty revenue models. Now, businesses are taking care of this aspect. E-commerce has emerged as an enabler of the existing business systems and is adding revenues and facilitating business operations on click of a mouse.

Information technology influences every aspect of life and is going to have a big impact on commerce and industry. Therefore, our progress depends on what our system will be able to do. The market share of a company will depend upon what its technology can support. The modern organizations will have to be prepared for it.

SUMMARY

The journey of modern computing started with the invention of the digital computers in 1950s. The microcomputer revolution started in 1980s after the invention of the microprocessor in early 1970. Very large-scale integrated (VLSI) circuits technology was behind this revolution. Computers have the same architecture of input-process-output. Data is entered in computers through various input devices; it is processed in the CPU having an ALU, a control unit, and memory units. The output is sent to devices such as monitor, printer. Computers consist of various hardware components (such as CPU, input and output devices, and peripherals) and software components.

Broadly, software is classified into system software and application software. System software consists of various operating systems, drivers, compilers, assemblers. DOS, Windows, Unix, Linux, and OS/2 are examples of operating systems. The Internet browsers and modem drivers are utilities under the same category. Computer programming languages, database management software, business application packages, and retail EPOS software are examples of application software. With the invention and evolution of new generation of computer hardware, programming languages also evolved. As the programming languages became rich in functionalities and delivery, it became easier for a programmer to write a piece of software using them. Today,

languages and tools of fourth generation and beyond are available, with which even a not-so-technical person can try to build programs.

CONCEPT REVIEW QUESTIONS

1. Define the basic architecture of a computer system.
2. What are the core components of a modern personal computer?
3. Write a brief note on evolution of computers.
4. Define 4GL with suitable examples.
5. What are the basic functions of operating systems?
6. What is multitasking?

CRITICAL THINKING QUESTIONS

1. 'It was only personal computer that brought about the computer revolution.' Analyse this statement with practical examples.
2. 'It was not the hardware that forced software development but it was the software that had a catalytic effect on the hardware growth.' Do you agree? Fortify your answer with examples.

PROJECTS

1. Visit a retail store in your neighbourhood and prepare a report on the use of IT at the store.
2. Your organization is implementing retail software. You, as a head of the implementing team, have to decide about the operating system. Your liking is for Linux. Build a business case so that your CEO is convinced.

SELECT REFERENCES

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CASE STUDY

Haldia Dock Complex: Laying its Own Linux

Linux is gaining ground in almost all spheres of computing, from small desktop configurations to high-end cluster design for mission-critical work environments. And almost every organization that has an implemented Linux swears by its power and stability.

The Company

The Haldia Dock Complex (HDC) has a uniquely designed Linux installation with an active-active cluster set-up, which is considered as one of the best of its kind. This has ensured efficiency and cost-effectiveness. The HDC, situated in the Bay of Bengal, is one of the most active ports in the eastern front of the country. It manages day-to-day operations on Linux for heavy-duty work applications. It is one of the uniquely designed Linux installations and presently one of the best active-active clusters.

Initial Groundwork

The officials at HDC were keen on modernizing their IT and administrative network infrastructure. At the same time, they were studying the cost-effectiveness of implementing a solution to handle the overall load balancing that was required at the complex.

This set-up involved several major players, including (a) IBM, which supplied the machines and its custom DB2 software in addition to other hardware infrastructure, (b) NIC, which was the overall governing council body (unless NIC sanctioned the project, it couldn't take off, and (c) Officials from Haldia complex and Red Hat India, who configured and implemented the active-active cluster.

Unlike earlier organizations that had proprietary systems in their infrastructure, HDC was a fresh set-up. Without much ado, almost every one agreed to go in for Linux from the very beginning.

The project was based on Red Hat Enterprise Linux cluster suite using DB2, a SAN switch (for shared storage), WAS (Web Application Sphere) from IBM, and DRS (Disaster Recovery Site) about 8 km away from the main installed base to provide redundancy, all connected over a fibre-optic channel network.

Active-active clustering

In this type of application environment there are two servers simultaneously accessing data. If one server shut downs, the other picks up the load of running all services. These servers access different partitions. So, in a typical cluster manager environment, the user can simply spread the application services across the two servers in any way that seems appropriate. The applications are processed faster as both the servers share the total load. This is called active-active clustering, since both servers are simultaneously active.

The Fine Art of Cluster Management

Every organization has different needs depending on the work environment. It is up to the system engineers to design and implement robust and scalable solutions taking into account the future needs of the organization. So, when designing a high-availability configuration, the first task is to identify whether the customer's applications will be supported by the planned system. The Haldia complex wanted a Unix-like, sturdy architecture, which ensured stability. At the same time, the system needed to be cost-effective and free of licencing fees. To meet

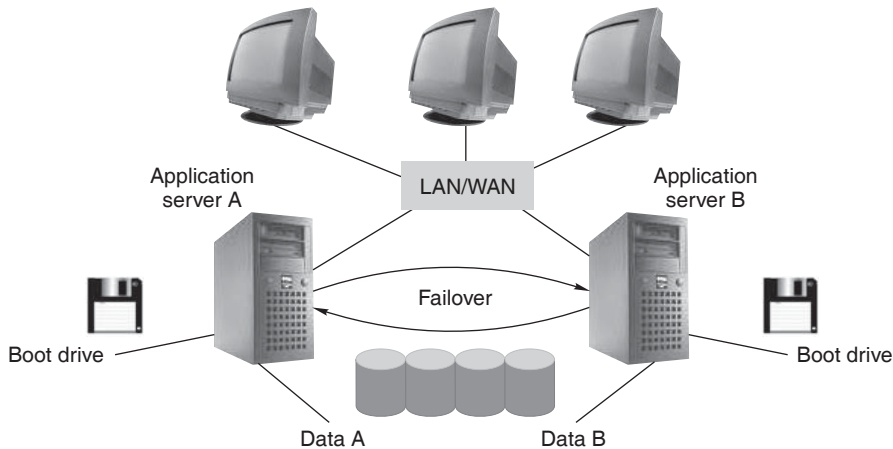


Fig. 1.13 Basic cluster manager operations

these criteria, the experts on the project had to carefully design and implement a smart maintenance and support strategy.

Sandeep Khuperkar, technical specialist, Red Hat India, one of the main architects responsible for the active-active cluster set-up at HDC, agrees, 'we at Red Hat saw the overall design plan and recommended Linux as the de-facto platform for the mission-critical applications. This decision was based on the compatibility and configurability of the OS with other software and hardware such as IBM's DB2 and WAS server applications in sync with the DRS'.

The HDC set-up for the active-active cluster involves one pair of cluster for the database, three servers for WAS and one for the database. The NIC had developed application for the HDC active-active cluster, which is being used by the finance, marine, payroll and human resource departments. At HDC, Red Hat Enterprise Linux forms the basic platform the entire server set-up, with multiple instances running on active-active cluster accessing their own respective DB (database) partitions on external storage (Fig. 1.13).

In the set-up depicted in Fig. 1.14, the cluster manager configuration developed by Red Hat through the SAN switch comprises pair of server connected to an external storage array of devices. The cluster manager software at the HDC is used to control access to storage partitions, so that only one instance of DB2 can access a particular partition at a time. In the event that one of the servers shuts down or fails, the other server will detect the event and will automatically start to run the applications that were previously running on the failed server. This migration of the application from the failed server to the remaining server is called fail-over.

Each server will then operate in the same manner, as if it were a single stand-alone system, running applications and accessing data on its allocated storage partitions. But at the HDC, multiple servers have been used to streamline the steady, demanding flow of data. This typical layout is often referred to as scale-out computing. In addition to their connection to the shared storage array, the two servers are interconnected using a network or serial interface so that

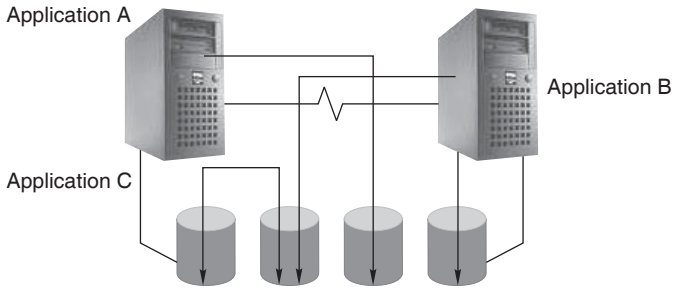


Fig. 1.14 Active-active configuration: multiple applications distributed across both servers. (If either shuts down or fails, the other takes over the total application load. Servers access different partitions.)

they can communicate with each other. So, in this case, there are two nodes: Node 1 and Node 2.

In case a particular application instance fails on Node 1, it is invoked at Node 2, thereby giving continuity of data access to users. As soon as Node 1 is rectified, the application instance that was earlier relocated to Node 2 is relocated back to Node 1.

Sandeep Khuperkar points out, ‘this is very important as scalability needs to be enhanced without any breakdown in the service. So the entire application must be designed for fail-over and maintenance.’

Cluster communication

Cluster manager configuration comprises two server systems connected to a shared external storage array. Typically in most environments, the two servers are connected by LAN or RS-232 serial cables. Cluster manager software uses these connections for heart beating between the servers. Each server heart beats with other with regular short messages to check that if it is operating correctly. If the heart beats do not receive an acknowledgement, then the server will use this as an indication that the remote server has failed.

The HDC is a very high-rate active-active cluster and there are various applications being developed and ported on the system. As a result, the design had to consider compatibility with other operating systems and high-end performance. Therefore, it is natural that the cluster must be able to work with the most common database and applications (interconnectivity) and must be easy to deploy and use with custom applications.

On this aspect, Sandeep adds, ‘we have tested the cluster successfully and it has worked quite efficiently. Looking at the mission-critical applications required at HDC, the cluster management suite (Red Hat) was configured to use multiple instances of DB2 running on several nodes’.

How does one monitor the network effectively? Sandeep explains, 'the enterprise suite has a very good GUI, which helps the system administrator to check the status and monitor the nodes on the cluster'.

So, what's new?

Ask any expert or user of Linux and opinion will invariably be, 'it's a very strong, stable, robust OS with scope for further enhancements and future requirements'. And what do the people at the site had to say? Abhijit Das, Deputy Secretary, HDC, says, 'we are completely satisfied with the active-active cluster set-up and have found the Red Hat application suite to be perfectly stable for our heavy-duty work'.

Questions:

1. What was the major activity at the Haldia Dock complex?
2. Which activities carried out at HDC were LAN establishing and which ones indicated towards an operating system change?
3. Which part of the operations was most critical and why?

Source: Adapted from Nilesh Kakade, *Linux For You*, December 2003, www.lfymag.com.
