



IT1105 – Information Systems and Technology

BIT – 1ST YEAR – SEMESTER 1
University of Colombo School of Computing

Student Manual

Lesson 2:
Hardware and Software of CBIS

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Duration: 6 hrs

Instructional Objectives

Students will be able to:

- Identify the role of the CPU and memory in a computer system
- Identify secondary storage devices
- Identify different input/output devices and their use
- Describe how application software can support personal, workgroup and enterprise business objectives
- Describe the pros and cons of proprietary (bespoke) software and off-the- shelf software
- Identify the basic role of system software
- Identify key issues and trends of software that have an impact on organisations and individuals

2: Hardware and software of a CBIS

2.1 Overview of Hardware of a Computer System

A computer system, is a collection of several hardware components that performs the basic system functions of input, processing, output, storage and control.

The hardware components of a computer system include input and output devices, the CPU, and primary and secondary storage devices. The selection of these hardware components depends on organisational goals and IS objectives.

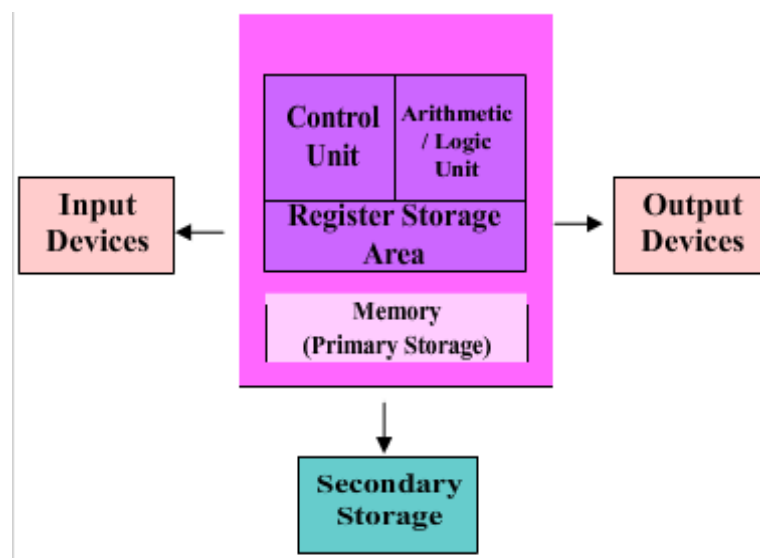


Figure 2.1: Computer System Components

2.1.1 The Central Processing Unit (CPU)

The CPU consists of several components. They are as follows;

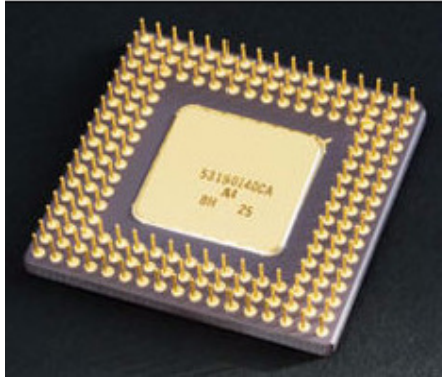


Figure 2.2: Central Processing Unit

1. Arithmetic/Logic unit

Arithmetic/Logic Unit performs arithmetic operations and logical operations. As you know, arithmetic operations such as addition, subtraction, multiplication, and division are fundamental to all mathematical operations. Logical operations are comparisons. That is, the ALU compares two pieces of data to see whether one is equal to (=), greater than (>), or less than (<) the other.

2. Control unit

The control unit directs the movement of data and instructions between the main memory and the ALU. It also carries out the controlling of input and output devices and passing of data to the ALU for computation.

3. Registers

Registers store very small amounts of data and instructions for short periods of time. Essentially, the registers hold the data and instructions that the CPU is currently working with and they can be thought of as being the CPU's workspace.

Efficient processing and timely output is important to an organisation. Let's consider some factors which affect the processing speed of a processor.

When selecting a CPU, organizations must balance the benefits of speed with cost. CPUs with faster clock speeds and machine cycle times are usually more expensive than slower ones.

2.1.2 Main Memory

Main memory is located close to the CPU, but not on the CPU chip itself. Main memory provides you with working storage your computer needs to process applications.

Types of Main (Primary) Memory

There are several forms of primary memory. They include Random Access Memory, Read Only Memory and cache memory.

Random Access Memory (RAM)

Whenever the computer wants to work with data or instructions, they are first loaded in to RAM where they are held temporarily until the computer needs them. Therefore, the storage of data and instructions inside RAM is temporary and data and information which have been stored will disappear from RAM as soon as the computer is switched off.



Figure 2.3: Random Access Memory

Read Only Memory (ROM)

Data and instructions stored in the ROM will not be lost on failure of power supply and therefore, ROM is known as non-volatile memory.

Unlike RAM, ROM can only be read by the CPU and cannot be erased or overwritten. It provides permanent storage for data and instructions that do not change such as the data from the computer manufacturer

Cache Memory

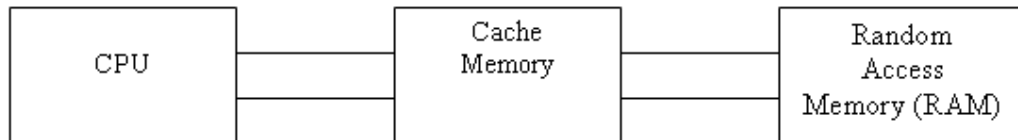


Figure 2.4: Cache Memory

Cache Memory is accessed much faster than conventional RAM, it is used to store programs or data currently being executed or temporary data frequently used by the CPU (as shown in figure 2.4).

2.1.3 Secondary Storage

Organizations need to store large amounts of data and instructions more permanently than allowed by the main memory. Secondary storage can be used for this purpose. It is also called the permanent storage. There are different types of secondary storage mediums such as magnetic discs and tapes. We discuss these in detail in the following sub-sections.

Compared to Memory, secondary storage is non-volatile (i.e. data is not lost when electrical power is switched off) and less expensive. The disadvantage is, it is much slower than the memory. When selecting a secondary storage media and devices, it is important to consider the access method, capacity and portability. Secondary storage media with faster access methods are generally more expensive than slower media. Lets consider what is meant by access method.

Access Methods

There are two methods of accessing data in the storage. They are, sequential and direct access methods.

Sequential access – This means that data must be accessed in the order in which it is stored. For example, product data stored sequentially may be stored by product number ranging from 10 to 30 in a secondary storage device. If you want to retrieve information on product number 25, you have to read and discard data relating to product numbers from 10 to 24.

Direct Access – According to this method data can be accessed directly, without the need to bypass other data in the sequence. If you consider the earlier example, you can directly access information relating to product number 25. Therefore, this access method is much faster than sequential access.

2.1.3.1 Magnetic Tape



Figure 2.5: Magnetic Tape

Magnetic tape is a thin plastic tape on which data can be represented with magnetized spots. Although this is an old technology, it remains popular because it is the cheapest storage medium and can handle enormous amount of data. The downside is that it is the slowest for retrieval of data, because all the data are placed on the tape sequentially.

2.1.3.2 Magnetic Disks

Magnetic disks come in a variety of styles and are extremely popular because they allow much more rapid access to data compared with magnetic tape.

Hard Disks

A modern personal computer may have several gigabytes of storage capacity in its internal hard drive. Data access is very fast. For these reasons, hard disk drives are extremely popular and common.



Figure 2.6: Hard Disk

Optical Disks



Figure 2.7: Optical Disk

An Optical Disk is a removable disk on which data is written and read through the use of a laser beam. Few types of optical technologies are used in computers such as Compact Disk Read -Only Memory (CD-ROM) and Write Once Read Many Disk (WORM)

2.1.3.3 USB flash drives

These devices are typically removable and rewritable, and physically much smaller than an optical disc. Commonly used as a portable storage medium.

USB flash drives are often used for the same purposes for which floppy disks or CD-ROMs were used, i.e., for storage, back-up and transfer of computer files. However, they are smaller, faster and some have more capacity.



Figure 2.8: USB flash drives

2.1.4 Input Devices

Input devices allow users to enter data and information to the computer system. When selecting input devices it is important to balance the speed and functions performed by the input devices with their cost, control and complexity. Input devices vary from capturing specific types of data to more general purpose input devices. Following are some examples.

Keyboard

The keyboard is also referred to as the primary input device of the computer system. The keyboard has a similar layout to the typewriter, but has some additional keys that provide additional functionality than a typewriter, such as Insert key, Enter key, Home key, etc. Keyboards come in different shapes and sizes and may differ in the number of additional keys.



Figure 2.9: Keyboard**Pointing devices**

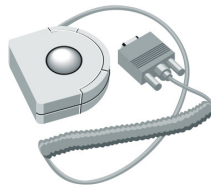
Although keyboards are still the mostly widely used input devices to enter text into a computer system, pointing devices are a better alternative for issuing commands and responding to prompts displayed on the monitor. They work with the operating systems Graphical User Interface (GUI) that presents you with icons, menus, windows, bars and so on for your selection. Pointing devices use one of the most natural gestures of humans i.e. the act of pointing. Mouse, trackballs, joysticks, touch screens are some of the most frequently used pointing devices.

Mouse

The mouse is the second most common input device. A ball underneath rolls as the mouse moves across the mouse pad.

**Figure 2.10:** Mouse**Trackball**

Trackball is a movable ball, on top of a stationary device, that is rotated with the fingers or palm of the hand. Advantages of trackballs are that, it does not need as much desk space as a mouse, and it is not as tiring since less motion is needed.

**Figure 2.11:** Trackball**Joystick**

A joystick is a pointing device that consists of a vertical handle like a gearshift lever mounted on a base with one or two buttons. Joysticks are commonly used in video games to control the cursor motion. A joystick gives a more natural feeling of control for motion in games, especially those in which one is mimicking flying a plane or spaceship.

**Figure 2.12:** Joystick

Voice/Speech Recognition Systems

These devices can recognize human voices. These tools use microphones and special software to record and convert the sound of the human voice into digital signals.

Speech recognition systems can be used on the factory floor to allow equipment operators to give basic commands to machines while they are using their hands to perform other operations. Voice-recognition is also used in security systems to allow only authorized personnel into restricted areas. Since speech is the easiest, most natural means of communication, speech recognition promises to be the easiest method for data entry, word processing and conversational computing.



Figure 2.13: Voice/Speech Recognition System

Digital Cameras

Digital cameras look very similar to regular cameras but record and store images or video in digital form. After taking a picture, the images are electronically stored in the camera. Most often the image file is compressed and stored on the digital memory card to allow a large number of photographs to be taken. Then images stored on the card can be downloaded to the computer with the help of a cable which is connected from the camera to a port on the computer.



Figure 2.14: Digital Cameras

Terminals

Terminals are input devices that perform data entry and data input at the same time. Data entry and input is through the keyboard and mouse. A terminal is connected to a complete computer system by telephone lines or cables. They are inexpensive and easy to use.

Point-of-Sale (POS) devices are terminals used in retail operations to enter sales information into the computer system.



Figure 2.15: Point-of-Sale Device

Magnetic Ink Character Recognition (MICR) Devices

Magnetic Ink Character Recognition (MICR) devices are used to read the data that is placed at the bottom of a check or other form using a special magnetic ink. Humans as well as computers can read this data. This technology is used by banks.

Light Pens

The light pen is a light-sensitive stylus, or a pen like device connected to the computer. The user can bring the pen to the desired point on the screen. When the pen touches the screen, it sends the information available at the location to the computer. Using the pen input device it is possible to activate a command or cause the computer to perform a task, enter handwritten notes and draw objects and figures.

These can be used to activate commands and place drawings on the screen.

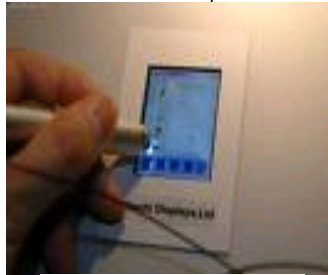


Figure 2.16: Light Pens

Touch-Sensitive Screens

Touch screen is a video display screen that receives input from the touch of a finger or stylus. These screens can act as input as well as output devices. Examples are Automatic Teller Machines (ATMs) in banks and information kiosks.



Figure 2.17: Touch-Sensitive Screen

Scanning Devices

Scanners generally convert text, drawings and photographs into digital form that can be stored in a computer and then manipulated. Sometimes these scanners are called image scanners or graphics scanners.

In retail operations barcode scanners are usually connected to POS devices.



Figure 2.18: Scanner

There are some basic criteria to be considered when purchasing scanners. Resolution and color depth are the most important, as they directly affect the quality of scans.



Figure 2.19: Scanning devices

2.1.5 Output Devices

Output from a computer system may be used by the decision makers at all levels of an organization. Output can take two basic forms. It can be either printed on paper or any other permanent media. Also it can be displayed on a screen or output by other non-permanent means. This is called a softcopy such as a copy on the USB flash drive. Sometimes the output from one computer can be an input to another computer. The form of output might be visual, audio or digital.

Visual Display Unit (VDU)/Monitors

The display monitor is a TV-screen like device on which output from the computer is displayed. A pixel is a dot of color on a photo image or a point of light on a display screen. It can be in on or off mode. The quality of a screen is often measured by the number of horizontal and vertical pixels used to create it. A monitor's ability to display color is a function of the quality of the monitor, the amount of RAM in the computer system and the monitor's graphics adapter card.



Figure 2.20: Monitor (CRT)



Figure 2.21: Monitor (LCD)

Many old monitors use a cathode ray tube (CRT) which are large in size. Liquid Crystal Display (LCD) screens which are flat, is used in laptops, many palm top devices etc. LCD displays are considered as a good solution especially if there is lack of desk space for a large CRT monitor. They are flat screens with good color, but are quite expensive. These screens are much easier on human eye compared to the CRT monitors.

Printers and Plotters:

Printers

The job of a printer is to put on paper what you see on your monitor. How easy and how successfully it is done depends on the choice of your printer. Selection of a printer is based on many parameters such as cost, speed, type of paper used, quality or resolution, size, type of cable connection etc. There are different types of printers. The less expensive but a noisy version is a Dot matrix printer whereas expensive ones are inkjet and laser printers. Laser printers are capable of producing high quality printouts and their biggest advantage is that they are noiseless.



Figure 2.22: Printer

Plotters

A plotter consists of a device that can move paper both backwards and forwards. On the top of the device one or more pens are able to move horizontally across the paper. A plotter is a specialized output device designed to produce high-quality graphics. Plotters are especially useful for creating maps and architectural drawings.



Figure 2.23: Plotter

Computer Output Microfilm Devices

Companies use computer output microfilm devices to place data from the computer directly onto microfilm for future use.

2.2 **Application Software**

2.2.1 Overview of Application Software

The primary function of **application software** is to apply power of the computer to give individuals, workgroups and the enterprise the ability to solve problems and perform specific tasks. The computer uses one or more application programs to perform a particular task. The application programs interact with systems software, and the systems software then directs the computer hardware to take necessary actions.

2.2.2 Types of Application Software

Application Software gives organizations the ability to solve problems and perform specific activities and tasks. Application software can be categorized as proprietary (bespoke) and off-the-shelf (packaged) software.

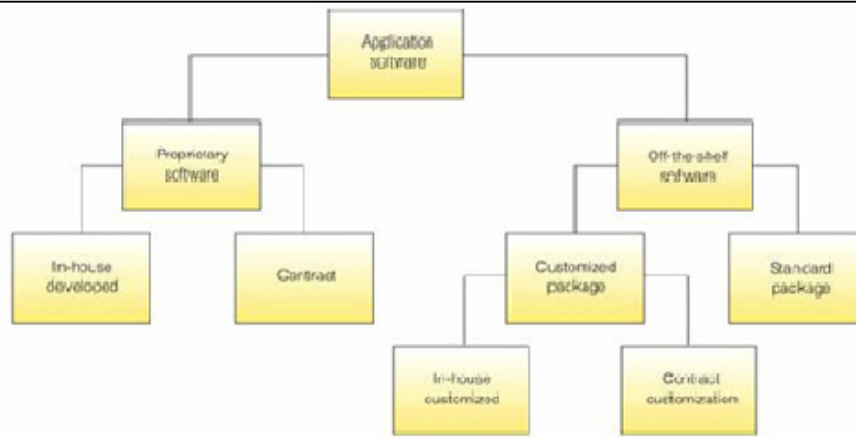


Figure 2.24: Application Software Types

1. Proprietary software – Proprietary application software solves a unique or specific problem. Normally the software is developed and owned by the company or organization that will use the software. In some cases if there are not adequate resources within the company, the development of software may be outsourced to another company based on a contract.

Advantages of proprietary application software are,

- software usually meets the user requirements
- provides flexibility in making modifications
- offers more control over the results.

Disadvantages of proprietary application software are,

- can take a long time and significant resources to develop (costly)
- has more risk concerning the features and performance
- outsourcing of application development also can cause problems as the organization have to rely on another organization for development. Therefore, it is important to select a reputed, financially stable company as the outsourcing organization.

2. Off-the-shelf software – Application software already developed and available in the market is known as off-the-shelf software. These applications are not written for a specific company only. They provide standard functions. Some of the factors to be considered when selecting off-the-shelf software are,

- will the software run on the Operating System (OS) and hardware that have been selected?
- does the software meet the essential business requirements that have been defined?
- is the software manufacturer financially stable and reliable?
- does the total cost of purchasing, installing and maintaining the software compare favourably to the expected business benefits?

Off-the-shelf application software may be purchased, leased, or rented from a software company. Off-the-shelf application software can be customized to a certain extent to better fit company specific needs.

Advantages of Off-the-shelf application software are,

- lower initial cost
- lower risk that the software will fail
- higher quality, usually well tested

Disadvantages of Off-the-shelf application software are,

- may pay for features never used
- may lack important features the organization requires
- may not match current business processes of the organization

2.2.3 Functions of Application Software

2.2.3.1 Personnel Application Software

There are thousands of computer applications which help the individuals at schools, home and work. Some of these are the general-purpose programs (Example: Spreadsheet, Database, Project management, Financial management). There are thousands of other personal computer applications to perform specialized tasks (Example: To help to do the taxes, get medical advice) available under this category.

Examples of personnel application software: MS Office Suite

Word Processing

These types of software has transformed the process of writing. In most of the personal computers word processing applications are installed. With the help of these applications it is possible to create, edit, check spelling, create tables, insert formulas, create graphics, and printing documents (letters, memos, reports) by electronically processing your text data (words, phrases, sentences).

Word processing programs can be used with a team or group of people collaborating on a project.

Examples: MS Word, Lotus WordPro, Corel WordPerfect

Spreadsheet Analysis

Useful for business analysis, planning and modelling. People use spreadsheets to prepare budgets, forecast profits, summarize and analyse data. When numbers and calculations are involved spreadsheet is a good approach to use. Developing a spreadsheet involves designing its format and developing the relationships (formulas) that will be used in the work sheet. The spreadsheet performs necessary calculations based on the formulas defined and displays results immediately. Graphics, limited database capabilities, statistical analysis, built-in business functions, optimization are some of the important features in spread sheets. Optimization allows the spreadsheet to maximise or minimize a quantity subject to certain constraints.

Example: A small furniture manufacturer might want to maximise the profits of his organisation. Using an optimization feature such as Solver, he is able to determine number of chairs and tables needed to produce with labour and material constraints in order to maximize profits.

Examples: MS Excel, LOTUS 1-2-3

Database Applications

Database applications are used to store, manipulate and retrieve data. These are appropriate when it is needed to manipulate large amount of data and produce reports and documents. Manipulating involves merging, editing and sorting data. Database applications can be used to keep a track of a CD collection, tax records and expenses. In business, a database can be used for various operations.

Example: MS Access, DBASE

Graphics Program

Graphics program can be use to develop presentations, illustrations and drawings. Graphics packages can also help you convert numeric data into graphic displays such as line charts, bar charts, pie charts and many other types.

Graphics programs are useful when developing advertising brochures, announcements and full-color presentations.

Graphics are not only easier to comprehend, and communicate than numerical data, multiple colour and multiple media displays but also can more easily emphasize key points, and important trends in the data.

Example: MS PowerPoint, Lotus Freelance, Corel Presentations

Personal Information Managers

Personal information managers (PIM) help individuals. Groups and organizations store useful information such as a list of tasks to complete or a list of names and addresses. They provide an appointment calendar and a place to take notes. The information in a PIM can be linked.

PIM allow people to schedule and coordinate group meetings. When a computer or handheld device is connected to a network, the PIM data can be uploaded and coordinated with the calendar and schedule of others using the same PIM software on the network.

Most PIMs now include the ability to access the World Wide Web and provide e-mail capability. PIM is a popular software application for Personal Digital Assistants (PDA) handheld devices.

Examples: Lotus Organizer, Microsoft Outlook

Online Information Services

Online Information Services allow to connect a personal computer to the outside world through phone lines, cable, satellite or power lines in some cases. By the online information services it is possible to get investment information, make travel plans, check news from around the world, get prices and features for most consumer items, learn about companies, send e-mails to friends and family, find details about degree programs offered by colleges and universities around the world and search for job openings.

Other Personal Application Software

There is personal application software which is used for special purposes.

Example: TurboTax – This is a popular tax preparation program
Software packages for training and distance education
Computer-aided design (CAD) software used to design and develop buildings, electrical systems and plumbing systems

2.2.3.2 Workgroup Application Software

This category of software is designed to support groupwork, whether the group members are within the same location or spread around the world. Groupware is a category of general-purpose application software that combines a variety of software features and functions to facilitate collaboration.

Examples: Lotus Notes, MS Exchange, Novell

Groupware supports collaboration through electronic mail, discussion groups and databases, scheduling, task management and so on.

Collaborative capabilities are also being included in other software products to give them groupware features. An example is MS Office Software Suite. MS Word keeps track of who made revisions to each document, Excel tracks all changes made to a spreadsheet, and Outlook lets you keep track of tasks you delegate to other team members.

2.2.3.3 Enterprise Application Software

Enterprise application programs aim to benefit an entire organization by improving cooperation and interaction between all departments such as product planning, purchasing, manufacturing, sales and customer service.

Many organizations are moving to integrated enterprise software that supports supply chain management (movement of raw materials from suppliers through shipment of finished goods to customers).

Examples include Enterprise Resource Planning (ERP) software.

ERP software is a set of integrated programs that manage a company's critical business operations. The scope of an ERP system may vary from vendor to vendor. However, most ERP systems provide integrated software to support manufacturing and finance. In addition to these core business processes, some ERP systems may be capable of supporting additional business functions such as human resources, sales, and distribution. ERP software is developed based on best practices used in different industries. Some ERP software focus on manufacturing organizations where some other ERP software maybe developed for the service sector.

Some ERP software provide support for global operations. This means, support for languages, legal entities, and currencies is included.

Although previously ERP systems were largely used by global corporations, these applications are becoming popular even among SMEs (Small to Medium Enterprises). ERP software can either be purchased off-the-shelf or developed according to specific requirements. In some cases where ERP applications are purchased from a vendor, they are customized according to the requirements of the customer. However, this can be a very expensive process.

Benefits of ERP systems include elimination of inefficient systems, improved data access for decision making, facilitate the adoption of improved work processes and enable the implementation of supply chain management. Supply chain management (SCM) is a cross-functional interenterprise system that uses information technology to help support and manage the links between some of a company's key business processes and those of its suppliers, customers, and business partners. The goal of SCM is to create a fast, efficient, and low-cost network of business relationships of the supply chain to get a company's concepts to market (figure 2.25).

Drawbacks of ERP systems include high implementation costs and employee resistance to change due to changes in the business process.

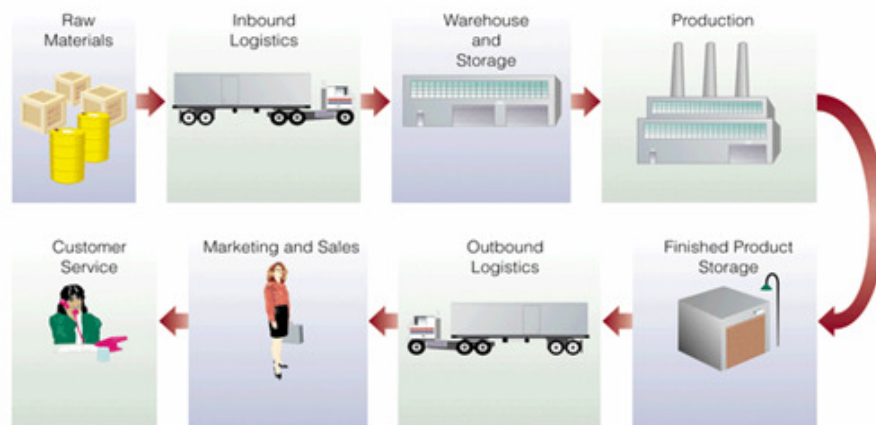


Figure 2.25: Integrated Software to support Supply Chain Management

2.2.3.4 Application Software for Decision Support and Specialized Purposes

Specialized application software for information, decision support and other purposes is available in every industry. Applications of specialized purposes include expert systems as well as other artificial intelligence applications.

Example: Sophisticated decision support software is now being used to increase the cure rate for cancer by analyzing about 100 different scans of the cancer tumor to create a 3-D view of the tumor.

2.3 Basic Role of System Software in CBIS

Systems software is the set of programs designed to coordinate the activities and functions of the hardware and various programs throughout the computer system. A particular systems software package is designed for a specific CPU design and class of hardware.

Different types of system software include operating systems and utility programs. Examples of operating systems are MS Windows, Linux and Unix.

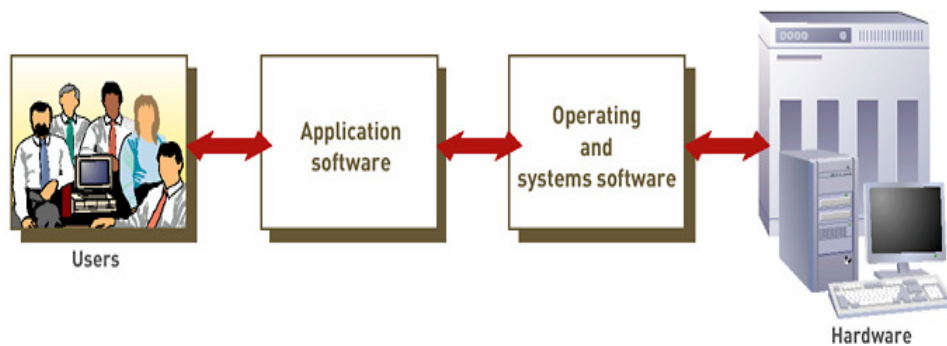


Figure 2.26: Systems Software as an Interface between application software and hardware

2.4 Software Issues and Trends

Software is an increasingly critical component in today's computer systems. Regardless of the approaches to acquiring software, it is important to be aware of current trends in the industry which enable better decision making.

In the following sub-sections we discuss some of the software issues and trends.

2.4.1 Software Bugs

A **software bug** is a flaw in a computer program that causes it to produce incorrect or inappropriate results. Some software bugs are obvious and cause the program to terminate unexpectedly while some are subtler and allow errors to creep into work.

As humans design hardware and software bugs can be expected. Software bugs become an issue for customers when off-the-shelf software is purchased.

Software companies try to release the software as soon as they finish the production without waiting until all the bugs are identified and removed. Typically software companies make money by correcting the bugs in the software and introducing it as an upgraded version.

Bugs can be avoided by delaying the purchasing of latest software releases until the bugs have been identified and removed. Furthermore, customers can be informed of these bugs by connecting to software manufacturers web sites. By doing so, customers can avoid them.

2.4.2 Copyright and Licenses

Most computer software products are protected using **Copyright** or **Licensing** provisions. Copyright law gives the owner of a work certain rights over it, and makes it illegal for others to use the work as though they were its owner. Originally copyright came into being in the 18th century to ensure that authors were properly remunerated for their work. Its concepts originate in the protection of written works, and it can be helpful to remember that computer software and its associated materials are treated by the law as species of literary work. Software vendors earn money through licenses. A license is a permission given by the copyright owner to another person (known as the licensee). The copyright owner agrees to permit the licensee to take actions that would otherwise be prohibited by law, such as copying, adapting and/or distributing the work. The licensee will agree to take these actions within the boundaries set by the license — perhaps only creating and distributing a certain number of copies, or paying a royalty on each copy distributed. Software manufacturers are developing new approaches to licensing their software to lock in a steady, predictable stream of revenue from their customers. Some of these new approaches include usage-based licensing where software fees are charged based on the actual usage of the manufacturer's products. Similar to utility billing users are charged according to the usage.

2.4.3 Open Source Software

Open-source software is software that is freely available to anyone in a form that can be easily modified. The Open Source Initiative (OSI) is a non profit corporation dedicated to the development and promotion of open-source software (see www.opensource.org for further information).

Users can download the source code and build the software themselves or the software developers can make executable versions available along with the source.

Development of open source software is a collaborative effort. With the help of the Internet, users around the world communicate (via email) with each other to download and submit new software. Major changes of the software can occur within a small time period. Open source software is associated with many popular Internet services including e-mail and web.

Examples of Open Source Software :

Sendmail : a program that delivers email to most systems on the Internet.

Apache: a popular web server

Linux, Free BSD: operating systems

Perl: programming language used to develop Internet application software.

Although customers may question the reliability of open source software, open source software can be reliable than commercial software due to the following reasons.

- By keeping a program's source code readily available, users can fix any problems they discover.
- As the source code is available to thousands of users around the world, the chances of bugs being discovered and fixed before it does any damage is much greater than traditional software packages.

However, finding support for open source software can be a problem. This can be done through the Internet where open source community is operating (through Internet forums).

Many companies are emerging to support and service such software for a fee.

Example: RedHat for Linux

C2Net for Apache

2.4.4 Software Upgrades

Popular software products are regularly upgraded and sold to customers. Although in some cases the upgraded version may provide valuable enhancements, in other cases it may provide less additional capabilities to the customer. Therefore, the customer may find it difficult to decide whether to purchase the new software. This decision becomes complex if the customer has already invested heavily on existing software and in cases where the software vendor/manufacturer decides to terminate providing support services for the old version.

Normally software upgrades are less costly than the original purchase price.

2.4.5 Global Software Support

Although large global companies have little trouble in selling software products throughout the world, providing adequate support for their customers in all locations can be problematic. Many of the software vendors overcome this problem by appointing third party distributors. In these cases although the end customer may negotiate licensing arrangements with the software vendor, the third party distributor often provide distribution, support and invoicing services.