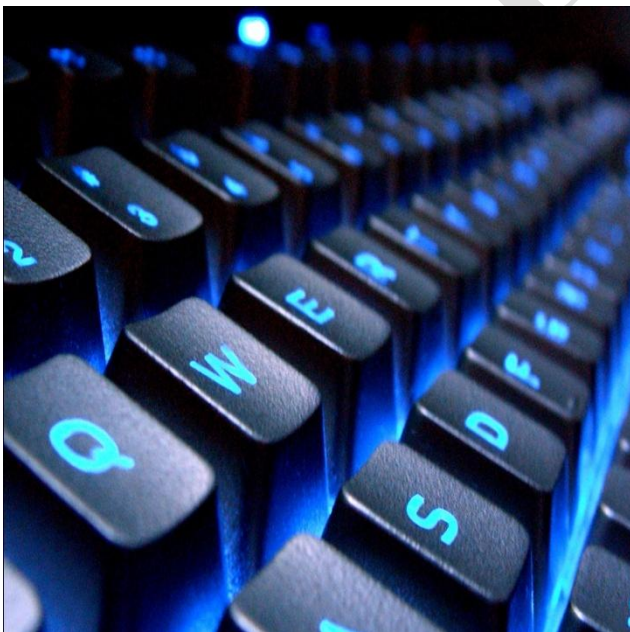




INFORMATION TECHNOLOGY

JOSH JOSEPH KARUKAYIL



By: Josh Joseph Karukayil

Chapter wise analysis of Past Exam papers of IPCC in the subject of INFORMATION TECHNOLOGY

No.	Chapter/Topic Name	M-05	N-05	M-06	N-06	M-07	N-07	M-08	N-08	M-09	N-09	M-10	N-10	M-11	N-11	M-12
1.	INTRODUCTION TO COMPUTERS	9	1	7	16	3	4	3	1	2	4	2	4	10	2	2
2.	INPUT AND OUTPUT DEVICES	1	10	10	5	2	2	1	2		6		4		6	6
3.	SOFTWARE	20	15	20	5	5	7	7	7	7	5	2	7	6	8	14
4.	DBMS	20	18	30	5	12	5	17	7	16	8	13	12	14	10	16
5.	COMPUTER NETWORKS & NETWORK SECURITY	20	19	15	20	7	12	12	16	20	11	16	16	8	12	10
6.	INTERNET & EMERGING TECHNOLOGIES	11	15	5	20	13	11	5	12	5	6	7	8	14	6	4
7.	FLOW CHARTS	10	10	10	10	10	10	10	10	10	10	10	10	4	8	8
8.	DECISION TABLES		5	5	5									4		
9.	NUMBER SYSTEM	5	5	5	5										4	

DECISION TABLES

A decision table is a tabular presentation of program logic. It displays all conditions affecting a particular situation. It gives appropriate action or actions to be taken for each set of conditions.

Decision tables are useful when a computer has to make large number of decisions or if there are a large number of different branches within a program.

Components of a decision table:

Table Heading	Decision Rules Heading
Condition Stub	Condition Entries
Action Stub	Action Entries

Table Heading: The name or number, of the Decision Table, specifying the problem, which is being represented. For complex problems, the decision table is sometimes broken into parts where the Table heading would identify the part of the program being represented.

Condition Stub: The conditions that could exist in the program logic are described.

Action Stub: The action statements or possible outcomes of the system are described.

Decision Rules: These may be one or more decision rules numbered 1,2,3n representing the answers to the Condition Stub and Action Stub described before.

Condition Entry: These represent the possibility of each of the condition stub (answer to each of the condition stub). The condition entry can be 'Y' for Yes or 'N' for No only.

Action Entry: The list relating to the set of action to be performed or taken to a given set of conditions. The action entry can be 'X' for selection action or '-' for unselected action only.

The final decision table would appear as below:

Table Heading ➡	Decision Rule (R1) i.e. a unique combination of 'conditions' and 'actions'	Decision Rule (R2) i.e. a unique combination of 'conditions' and 'actions'	Decision Rule (R3.....)
Condition Stub: ⬇	Condition Entry i.e. if these conditions exist (Yes)/not exist (No)	Condition Entry i.e. if these conditions exist (Yes)/not exist (No)	Condition Entry i.e. if these conditions exist (Yes)/not exist (No)
C1	Yes/No	Yes/No	Yes/No
C2	Yes/No	Yes/No	Yes/No
C3	Yes/No	Yes/No	Yes/No
.....			
Action Stub:	Action Entry i.e.	Action Entry i.e.	Action Entry i.e.

	<i>then following actions result (X)/not result (-)</i>	<i>then following actions result (X)/not result (-)</i>	<i>then following actions result (X)/not result (-)</i>
A1	X / -	X / -	X / -
A2	X / -	X / -	X / -
A3	X / -	X / -	X / -
.....			

Types of Decision Tables:

A. Limited Entry Decision Table: The Condition Stubs and Action Stubs are exhaustively defined. This means that the condition entry may contain either 'Yes' representing existence of condition or 'No' representing non existence of condition. In the same manner the action entry may contain a 'X' representing execution of a particular action or '-' representing that particular action is not to be executed.

Illustration. A company allows credit to its customers if they are from local city and can either provide surety or have good credit worthiness.

Steps:

Identify conditions:

- Local area : Yes/No
- Provide surety : Yes/No
- Good credit worthiness : Yes/No

Identify Actions:

- Refuse Credit
- Grant Credit

 Determine the possible number of rules. If there are N number of conditions, there are 2^N number of possible rules. In the present case there are 23 possibilities. i.e. 8 possibilities

 Draw the table with stubs and required number of entry columns. i.e. column for rules.

 Fill the condition entries using half rule.

 For each column enter the corresponding action or actions to be taken.

 Scrutinise the table to find if any of the rules can be eliminated.

ALLOWING CREDIT FACILITY	DECISION RULES							
	1	2	3	4	5	6	7	8
CONDITIONS:								
C1: LOCAL CITY	Y	Y	Y	Y	N	N	N	N
C2: PROVIDE SURETY	Y	Y	N	N	Y	Y	N	N
C3: GOOD CREDIT WORTHINESS	Y	N	Y	N	Y	N	Y	N
ACTIONS:								
A1: GRANT CREDIT	X	X	X	-	-	-	-	-

A2: REFUSE CREDIT	-	-	-	X	X	X	X	X
-------------------	---	---	---	---	---	---	---	---

If we observe rules 1 & 2, we find that if C1 & C2 are 'y', it is irrelevant whether C3 is 'y' or 'N' as it does not affect action. So rules 1 & 2 can be combined. Alternatively, rules 1 & 3 can be combined in which case C2 becomes irrelevant.

Again, observe rules 5,6,7 & 8. If C1 is 'N', action is always the same and is not affected by C2 & C3.

Above Table:

R1	R2	R3	R4	R5	R6	R7	R8
⏟		↓	↓	⏟			

New Table R1 R2 R3 R4

ALLOW CREDIT FACILITY	DECISION RULES			
	1	2	3	4
CONDITIONS:				
C1: LOCAL CITY	Y	Y	Y	N
C2: PROVIDE SURETY	Y	N	N	-
C3: GOOD CREDIT WORTHINESS	-	Y	N	-
ACTIONS:				
A1: GRANT CREDIT	X	X	-	-
A2: REFUSE CREDIT	-	-	X	X

B. Extended Entry Decision Table: This is second type of decision table. Here, the condition and action stub are generalised. The statements made in the stub portion are incomplete. The condition and action entry are of descriptive type.

Illustration: A life insurance company has the following criterion for deciding whether or not the insurance for a person is to be accepted.

If a person's health is good and the person is aged between 20 and 35 years, lives in a town or city, and is a male, then the premium charged is Rs.20 per thousand and the policy is written for an amount not exceeding Rs.10,00,000. If a person satisfies all the above conditions except that the person is a female, then the premium charged is Rs.25 per thousand and the policy is written for not more than Rs.6,00,000. If the person's health is poor and the person is aged between 20 and 35 years, lives in a village and is a male, then the premium charged is Rs.40 per thousand and the policy is written for not more than Rs.2,00,000. If the person is a female, the premium rate charged and the maximum limit for writing a policy are the same. In all other cases, the person is refused insurance. Prepare a decision table for the above problem.

LIMITED ENTRY DECISION TABLE

POLICY OF INSURANCE COMPANY	DECISION RULES			
	1	2	3	4
CONDITIONS :				
C1: Is health good?	Y	Y	N	E
C2: Is age between 20 and 35 years?	Y	Y	Y	L
C3: Is the person male?	Y	N	--	S
C4: Does the person live in town or city?	Y	Y	N	E
ACTIONS				
A1: Premium Rs.20 per thousand	X	-	-	-
A2: Maximum policy amount Rs.10,00,000	X	-	-	-
A3: Premium Rs.25 per thousand	-	X	-	-
A4: Maximum policy amount Rs.6,00,000	-	X	-	-
A5: Premium Rs.40 per thousand	-	-	X	-
A6: Maximum policy amount Rs.2,00,000	-	-	X	-
A7: Refuse insurance	-	-	-	X

EXTENDED ENTRY DECISION TABLE

POLICY OF INSURANCE COMPANY	DECISION RULES			
	1	2	3	4
CONDITIONS :				
C1: Health	Good	Good	Poor	E
C2: Age	20 to 35	20 to 35	20 to 35	L
C3: Sex	Male	Female	--	S
C4: Place of Residence	Town/city	Town/city	Village	E
ACTIONS				
A1: Premium per thousand	Rs.20	Rs.25	Rs.40	-
A2: Maximum policy amount	Rs.10,00,000	Rs.6,00,000	Rs.2,00,000	-
A3: Insurance Policy	ALLOW	ALLOW	ALLOW	REFUSE

C. Mixed entry decision table: This is third type of decision table. It uses the techniques of both a limited entry decision table and extended entry decision table. While the limited and extended entry forms can be mixed within the table, only one form may be used within a condition statement/entry or an action statement/entry.

Illustration: A wholeseller has three commodities to sell and has three types of customers. The discount is given as per following rules:

- (i) For Govt. orders, 15% discount is given irrespective of the value of the order.

- (ii) For orders of more than Rs.20,000, an agent gets a discount of 20% and the retailer 15% respectively.
- (iii) For orders of value between Rs.10,000 and Rs.20,000, agent gets discount of 15% and the retailer gets 10%.
- (iv) For order of value less than Rs.10,000, the agent and retailer get discount of 10% and 5% respectively.

The above rules do not apply to furniture items. However, in case of furniture items, a flat rate of 10% discount is admissible to all type of customers.

Prepare a mixed entry decision table.

MIXED ENTRY DECISION TABLE

Discount policy	Decision Rules							
	1	2	3	4	5	6	7	8
Conditions								
C1: Order value	Any amount	Any amount	More than Rs.20,000		Between Rs.10,000 & Rs.20,000		Below Rs.10,000	
C2: customer type	Any	Govt.	Agent	Retailer	Agent	Retailer	Agent	Retailer
C3: Product	Furniture	Others	Others	Others	Others	Others	Others	Others
Actions								
Discount								
A1: 5%								X
A2:10%	X					X	X	
A3: 15%		X		X	X			
A4: 20%			X					

Benefits of Decision Tables:

Following are given some of the Benefits of Decision Tables:

- i. Easy to Draw – Decision Tables are easy to draw and modify as compared to flowcharts.
- ii. Compact Documentation – The documentation in the form of decision tables is compact since one decision table may replace few pages of a flowchart
- iii. Simplicity – It is easier to follow a particular path in one column of a decision table than it is to go through several pages of the flowcharts.
- iv. Direct Codification - The decision tables can be directly coded into a program.
- v. Better Analysis – A decision table shows various alternatives and their respective outcomes side by side for better analysis of the problem.

- vi. Modularity – The complex problems would require complex decision tables which can be easily broken down to micro-decision tables.
- vii. Non-technical – No knowledge of computer language or CPU working is necessary for drawing decision tables.

Limitations of Decision Tables

Following are given some of the Limitations of Decision Tables:

- i. All programmers may not be familiar with Decision Tables and therefore flow charts are more common
- ii. Flowcharts can better represent a simple logic of the system rather than a decision table.
- iii. The decision tables do not express the total sequence of the events needed to solve the problem.



INTERNET & EMERGING TECHNOLOGIES

History and Background:

- ✚ The history of the Internet is closely tied to the U.S. Department of Defense.
- ✚ In 1970's, Advanced Research Projects Agency (ARPA) developed a network that has evolved into today's Internet. The network was named as ARPANET.

ARPANET Objectives:

- ✚ The network should continue to function even if one or many of the computers or connections in the network failed.
- ✚ The network should be usable in different hardware and software platforms.
- ✚ The network should be able to reroute its traffic around non-functioning parts of the network.
- ✚ The network should be a network of networks rather than a network of computers.

Internet:

- ✚ It is very difficult to define the term 'Internet'. Internet is a network of computers that offer access to information and people.
- ✚ In some ways, it is like an information service, because it offers e-mail, bulletin boards, etc. through which one can access files and databases around the world.
- ✚ However, Internet is different from an information service because there is no central computer system. There is only a web of connections between thousands of independent systems connected to each other through telephone lines.
- ✚ The internet is not a single network. It is a vast, global network of networks. No single person, group or organisation runs the Internet. These networks communicate with each other on the basis of certain protocols such as TCP/IP. There are tens of thousands of such networks.
- ✚ Many to many, one to many, many to one as well as few to few types of networking is possible.
- ✚ Using telephone network, these computers can communicate with each other. These connections can use the regular dial up telephone lines or dedicated lines to connect to the nearest Internet Service Provider (ISP).
- ✚ A recent but revolutionary development on the Internet is World Wide Web (WWW).

WWW:

- World Wide Web or Web is a component of the Internet that provides access to large amount of information located in different servers. WWW provides many of the services that are available on the Internet.
- The fundamental unit of the Web is the Web page. Web page is a document that contains links to other Web pages, graphics, audio files and other Internet services such as E-mail.
- Web pages reside in servers. These servers run special software that allows users to access web pages and other Internet services. Millions of Web servers are currently connected to the Internet.

A user can directly access any Web page on one of these servers and then follow the links to other pages. This process creates a web of links around the world. That is why it is called WWW.

- Web pages are created by using Hypertext Markup Language (HTML).
- HTML allows the creator of a Web page to specify how text will be displayed and how to link to other web pages, files and Internet services.
- These links are formally known as hypertext links, because they are activated when a user clicks on specific text or image within a web page.

Web Browser

- To view a web page, the user must use special client software known as Web browser.
- The first browser capable of displaying graphics within a web page was Mosaic.
- Some of the popular web pages are Netscape Navigator, Internet Explorer, Fire fox, Opera, etc.



- How web browser displays a web page?
 - Web browser reads a specified web page using HTML commands written in the web page and displays the information.
 - Text positioning, fonts, colors and size are specified through HTML.
 - The browser software interprets (=understand) the HTML commands and displays the information on the user's monitor.
 - It is important to note that different browsers can interpret an HTML command differently and display text differently.
 - For example a web page may contain HTML code stating that text should be emphasized. One browser may emphasize (=highlighting) text by bolding the text and another browser may use Italics.

Search Engine:

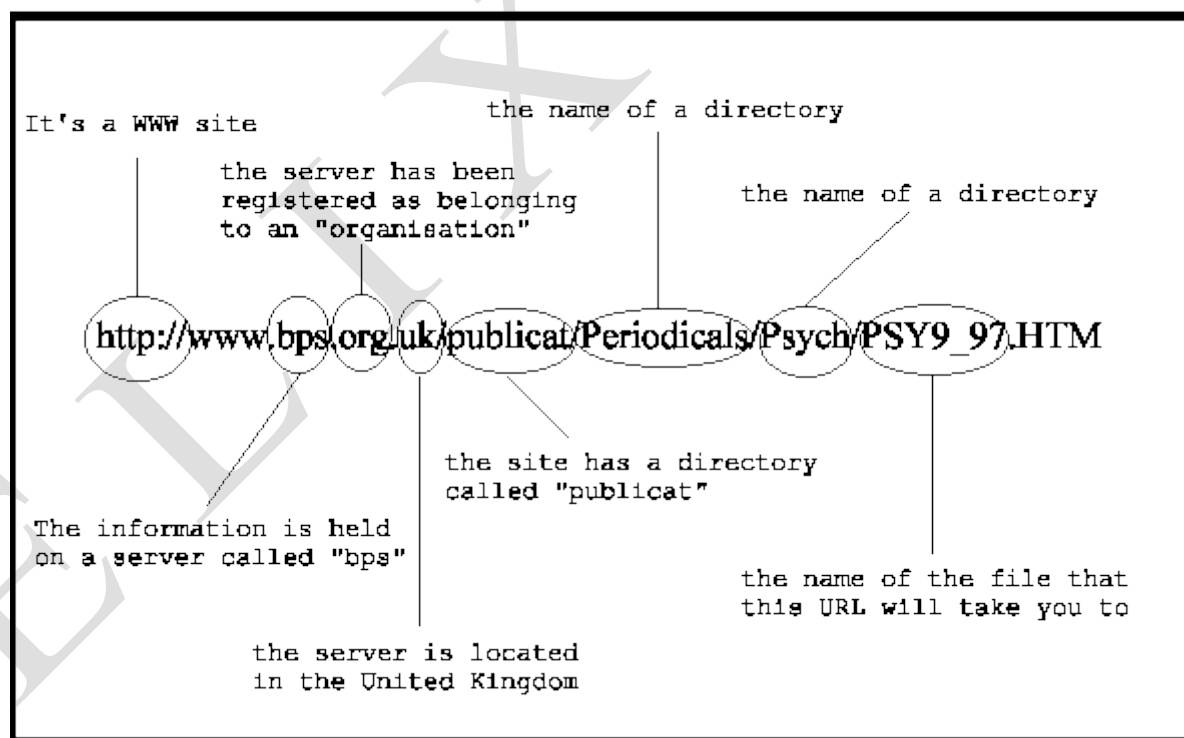
- Internet is a set of computer networks made up of number of smaller networks, using different networking protocols. There is no centralized management who is maintaining internet. Instead, it is a collection of thousands of individual networks and organisations, each of which is run independently.
- There is so much of information on the Internet. But such data is very poorly organised. Thus, it is almost impossible to find the required information or documents.
- One of the popular solutions to such problem is to use search engines. They are also called search tools or web crawlers or spiders.

- Search engines contain massive database of various web sites.
- They do not provide the entire information. But one has to search through them by typing the keywords that describe the required information.
- Some popular search engines:



URL:

- World Wide Web or Web is a component of Internet that provides access to large amount of information located in different servers.
- Information is stored in servers in the form of web pages. Each web page and server must have a unique address so that computer can locate and retrieve the required information.
- The unique identifier for a host computer is called IP address and the unique identifier for a web page is called URL or Uniform Resource Locator. URL is similar to that of postal address.
- A typical URL looks like this:



Web casting or Push Technology:

- Generally Internet runs in pull environment where a user opens a browser application and searches for information.
- There are millions of web pages. So the user should find the required web page and “pull” the required information.

- The web pages are dormant (=lying behind) until they are located and opened by the user. But this process is frustrating and time consuming.
- Another web - based technology is push technology or web casting. It is different from traditional uses of Internet and it eliminates this frustration.
- This technology allows users to receive broadcast information rather than search the web for information.
- The user has to choose from a menu of sources, specifying what kind of information they want to receive. Once selected, the information is automatically forwarded to the user.
- For example, Internet news services deliver the day's activities to the user's desktop.
- Cost of push technology is also cheap because news is delivered along with advertisements.

Benefits of Internet

1. As a network: Organizations can use the Internet to link their offices and employees. Thus Internet can be used as a virtual private network.
2. E-mail: It is an electronic mail system in Internet. Each user will be given a unique address. With this user can communicate with any person in the world. There are different web sites providing this service such as Hotmail.com, Rocketmail.com, P.O.box.com., e-mail.com, yahoo.com, Rediffmail.com, gmail.com, etc.
3. Knowledge base: Internet is a library where companies and establishments provide information about their products and services.
4. Chat rooms: Using Internet Chat SW, user can log on to certain website and communicate with other users. This is an interactive software that allows users to type comment in one window and receive reply in another. Such websites are called Chat rooms.
5. Universities on the web: Various universities have their own websites where they provide information about university, research, papers published by students and professors, etc. They also provide the facility of video conferencing.
6. E-Commerce: E-Commerce refers to the use of internet for business-to-business and business-to-consumer transactions. It is the process of doing business electronically. Visitor to the site can sell or buy any product or service on line.
7. Data Publishing: Data publishing is a new opportunity being provided by Internet. Information can be either forwarded to a specified address or stored in a particular place.

Applications of Internet

Internet's applications are many and depend on the innovation of the user. The common applications of the Internet can be classified into three primary types namely: Communication, Data retrieval and Data publishing.

➤ **Communication:**

- Communication on the Internet can be online or offline.
- When some users connect to a single server at the same time, they can communicate in an "online chat".
- This can be truly "many to many" communication.
- Alternatively, users can send e-mail to each other which can be read by the receiver whenever he/she finds the time. This is off-line communication.
- Users can come together electronically with the help of "usenet" groups. Users can post messages to be read and answered by others at their convenience.

➤ **Data Retrieval:**

- A large number of databases exist on the Internet.
- These databases have been compiled from various sources and put together in a usable form.
- This job can be done by commercially run data providers as well as individuals or groups with special interest in particular areas.
- To retrieve such data, it is sufficient for any user to search several Internet servers.
- This is similar to a search process in a large library.
- Search engines help the users for searching the requisite information.
- Latest information on products, markets, strategies, etc. can be found in a convenient way.

➤ **Data publishing:**

- Data publishing is a new opportunity available on Internet.
- Latest information can be published in a special site or can be posted in a Usenet site or can be forwarded
- to specific addresses. Of course, Internet discourages sending of unsolicited E-mails.

Intrinsic Benefits of Using Internet For Business

Today, Internet is the most advanced and sophisticated means of communication available to mankind. Till now Internet is being used for research and education purposes. But it can also be used for business purposes. Following are some of intrinsic benefits of using internet for business:

- Information on businesses and services is arranged in a proper manner at a common location and is open to any person.
- Access to this information is provided at reasonable costs.
- Immediate feedback can be obtained from consumers or business partners,
- The cost of information delivery to internal and external sources is reduced,
- Employee can easily access required information even from distant locations,
- Latest and updated information can be provided to customers and internal staff in an efficient manner.
- Customized information can be delivered to consumers.

These are only a small sample of number of intrinsic benefits of using internet for business purposes.

E-mail

It is an increasingly utilized technology, which has become the primary means of communication for many organizations and individuals. Electronic mail provides quick, cost-effective transfer of messages to other Email users, worldwide. This is probably one of the fastest and most convenient ways of communication. At present, all Internet subscribers get free E-mail facility. In addition there are many private E-mail service providers.



Advantages:

- i. With each E-mail address, the subscriber gets certain amount of disk space on the Server. This disk space serves as the post box of respective subscriber.
- ii. E-mail can be received even if the receiver's computer is switched off.
- iii. Lot of time, energy and money can be saved by creating a Mailing List of all clients and using it to send common letters/notices/circulars.
- iv. By creating Address book in the computer, one need not remember E-mail addresses.
- v. The chance of delivering the message to a wrong person is very less.
- vi. The message is instantly transferred to the receiver.

vii. One can also send files as attachments with E-mail messages.

Various Features Offered By An E-mail Software:

E-mail software supplied with Internet connection consists of some important and useful features, which are stated below:

- a. Composing messages: With this one can compose messages in an attractive way, using various fonts. It is also possible to spell check the message.
- b. Replying to the mail received: It is possible to reply to any mail by using the "Reply" facility available. This facility can save lost of time in remembering addresses.
- c. Address Book: This is an electronic form of Address Book where the following details can be saved: Name, full name, e-mail address, name of the organisation to which the person belongs, the designation of such person, etc.
- d. Printing of messages: It is possible to print messages received as well as sent.
- e. Offline Editing / Composing / Reading: To read/edit/compose messages it is not necessary to connect to Internet.
- f. Forwarding of messages: It is possible to forward any message received from, say, Mr. A to Mr.B without retyping the message.
- g. Transfer of data files: An important use of E-mail is the ability to send / receive data files to/from a client. This would result in considerable saving of time, energy and money.
- h. Greeting cards: On the Internet, there are several sites which offer free greeting cards for thousands of occasions.

Intranets

- Intranet is a type of information system that facilitates communication within the organisation, among widely dispersed departments, divisions and regional locations.
- It may consist of many inter-linked LANs and also use leased lines in the wide area networks.
- Intranet includes connection through one or more gateway computers to the outside internet.
- On Internet, the users can send e-mail, post documents, update material & chat with other users.
- The main purpose of intranet is to share company information and computing resources among employees.
- Intranet can also be used to facilitate working groups, video conferencing and continuous updating of company database.
- The big difference is that an intranet is faster and more secure than internet.
- Intranet uses TCP/IP, HTTP and other internet protocols and in general looks like a private version of internet.
- However intranet uses passwords, restricting access to certain areas of the network.
- Intranets is the main means of intra-office communication.



Advantages:

- a) Reduced costs - printing, paper, software distribution, mailing, order processing, telephone
- b) Reduced information searching time
- c) Easier, faster access to information

- d) Easier, faster access to remote locations
- e) Sharing and reuse of tools and information – Reduced set – up and update time
- f) Latest, up-to-date information.
- g) Easier access to customers and partners.
- h) Collaborative, group working is possible.
- i) Reduced support costs
- j) Reduced redundant page creation and maintenance – Faster & cheaper creation

Features:

- i. Similar to Internet: Intranet uses TCP / IP, Hypertext Transfer Protocol, and other Internet protocols and it looks like a private version of the Internet.
- ii. Use of Public Network: Companies can send private message through public networks, using special encryption / decryption and other security safeguards.
- iii. User Access Control: Intranet usually has a system of access privileges controlled by passwords, restricting access to certain areas of the network. For example, access to the files such as payroll, sales projections, product development notes and client memos can be restricted to a limited number of people.
- iv. Access to Information: With Intranet, access to all information, applications and data can be made available through the same browser.

Applications of Intranet:

Following are some of the areas where intranet is successfully used:

- a) Helps in Intra office communication: A company's Intranet is the main means of intra-office communication. Updates to business policies and procedures, information on health insurance & other benefits, profiles of various employees, company's organisational structure can be published
- b) Electronic directory: Intranets can provide electronic directory service, so that employees can easily find someone's telephone number and location.
- c) Electronic chatting: Intranet can also provide the facility of white board, an electronic chat space, where employees can "talk" to each other by posting text messages.
- d) Employees can have own web pages: Some employees can have their own home pages on their company's Intranet. Personal web pages allow employees to know each other.
- e) Helps in group decision making: Intranet helps group decision making through Group Ware i.e. software used in group Decision Support System.
- f) Universities and Colleges: Many universities and colleges have their own Intranets for students, faculty and other users.

Extranet

- Extranet is a private network that uses Internet protocol and public telecommunication systems to securely share part of a business's information or operations with suppliers, vendors, partners, customers or other businesses.
- It is part of company's intranet that is extended to users outside the company.
- Simply put, it is the Company's website for its customers and vendors.



Requirements: It requires security and privacy which can be provided through

- a. Firewall server management;
- b. Issuance and use of digital signature certificate or similar means of user authentication;
- c. Encryption of messages;
- d. Use of virtual private networks that pass through the public network.

Uses/Applications: Companies can use Extranet to:

- a) Exchange large volumes of data using EDI.
- b) Share product catalogues exclusively with wholesaler or those “in the trade”.
- c) Collaborate with other companies on joint development efforts.
- d) Jointly develop and use training programs with other companies.
- e) One company can provide access to a group of other companies, such as an online banking application managed by one company on behalf of affiliated banks.
- f) Share news of common interest exclusively with partner companies.

Internet protocol suite

- It is a set of communication protocols that implement the protocol stack on which the Internet and most commercial networks run.
- Sometimes it is called TCP/IP protocol suite.
- The two most important protocols in it are:
 - i. Transmission Control Protocol (TCP) and
 - ii. Internet Protocol (IP)
- Like any other protocol suite internet protocol suite consists of a set of layers.
- Each layer solves a set of problems involving the transmission of data.
- It provides a well defined service to the upper layer protocols based on services from lower layers.
- Upper layers are logically closer to the user and deal with more abstract data.
- The OSI model describes a fixed, 7 layer stack for networking protocols. But TCP/IP consists of only 4 layers.

E-Commerce

- Electronic commerce and its related technologies are the current leading - edge business and finance delivery systems for the 21st century.
- It is the process of doing business electronically. It involves automation of a variety of business-to-business and business-to-customer transactions through reliable and secure connections.
- It strengthens relationships with buyers, makes it easier to attract new customers, improves customer responsiveness and opens new markets on a global scale.
- EC is the application of various communication technologies to provide automatic exchange of business information with internal and external customers, suppliers and financial institutions.
- It helps to cut costs while improving the quality of goods & services and increase the speed of service.



- EC is associated with buying and selling of information, products & services via computer networks.

Definition:

It is not possible to give all inclusive definition for E-Commerce. Following are some of the important definitions of E-Commerce:

- *Electronic Commerce is a composite of technologies, processes and business strategies that foster the instant exchange of information within and between organizations.*
- *Electronic Commerce is the application of various communication technologies to provide the automatic exchange of business information with internal and external customers, suppliers and financial institutions. Examples of these technologies are Electronic Data Interchange (EDI), bar coding, scanning, E-mail, fax, etc.*
- *Electronic Commerce, simply put, is the automation of the business process between buyers and sellers. -IBM Corporation.*
- *Electronic business transactions, without paper documents, using computer and telecommunication networks.*
- Thus, it is clear that there is no single, globally accepted definition of EC. These technologies and services can include - Electronic Data Interchange (EDI), E-mail, Electronic Funds Transfer (EFT), Bulletin Boards (BBs), WWW, Electronic Banking (EB), Push technologies, Internet Telephony, Bar-coding, 2D - Imaging, Electronic Forms, Voice Recognition, security services such as firewalls, encryption, gateway managers and many more.

Impact of E-Commerce on Business Activities:

- E- Commerce is the process of doing business electronically. It involves automation of a variety of business-to-business and business-to-consumer transactions through reliable and secure connections. E-Commerce shows impact on large number of business activities such as:
 - Marketing, sales and sales promotion,
 - Financing and insurance,
 - Commercial transactions: ordering, delivery, payment.
 - Product service and maintenance,
 - Distributed co-operative working,
 - Business administration, (permissions, tax, customs, etc)
 - Transport and logistics,
 - Public procurement,
 - Automatic trading of digital goods,
 - Accounting.

Benefits of E-Commerce application implementation

- EC presents many benefits to individual organizations, consumers and society as a whole. They are:
 - i. Buyers can get the required goods at less cost because more suppliers will compete in an electronically open market.

- ii. It is not necessary to re-enter data. Thus information processing errors, time and overhead costs can be reduced.
- iii. Sellers can participate in on-line bidding. Thus selling costs can be reduced.
- iv. Reduced time to complete business transactions, from delivery to payment.
- v. Creation of new markets as it is easy and cheap to reach potential customers.
- vi. Easy entry into new markets, especially geographically remote markets, for companies of all sizes and locations.
- vii. Better quality and improved variety of goods can be acquired by consumers because of increase in competition and expanded markets.
- viii. Reduced inventories and reduction of risk of obsolete inventories because the demand for goods and services is electronically linked through just-in-time inventory and integrated manufacturing techniques.
- ix. Reduced overhead costs through uniformity, automation and large scale integration of management processes.
- x. Reduced delivery cost, especially for goods that can also be delivered electronically.
- xi. Equal access to markets (i.e. for small-to-medium enterprises and big corporations).
- xii. Reduced use of ecologically damaging materials.
- xiii. Ability to undertake more global programs.
- xiv. Reduced advertising costs.
- xv. Equal access to new markets.
- xvi. Easy access to new markets.

Reasons For Increasing Impact of Internet on E- Commerce:

- Internet has shown dramatic impact on E-Commerce. Following are some reasons for such dramatic impact of internet on E-Commerce:
 - i. Universality: Using internet any business can easily interact with any other business. This was not possible in earlier networking technologies. In those technologies, businesses can interact with only those computers that are connected to the same network.
 - ii. Reach: Internet is every where - large cities, small towns and through out the modern and developing world.
 - iii. Performance: Unlike many other public networks, Internet can handle visual images, audio, and other large electronic objects. It provides different kinds of functions, in addition to handling everyday networking tasks such as electronic mail.
 - iv. Reliability: The design concepts for the Internet came out of U.S. Department of Defense. Hence, Internet technology is highly robust and reliable.
 - v. Cost: Compared to alternative networking technologies, Internet costs are surprisingly low.
 - vi. Readymade: Tens of millions of individuals are already connected to the Internet and business can readily use it.

Because of the above reasons internet is showing dramatic impact on E-Commerce.

Different Types of E-Commerce: E-Commerce can be used in the following 3 distinct areas:

- Customer-to-Business
- Intra-organisational (within a business)
- Inter-organisational (business-to-business)

B2B with reference to E-Commerce:

- B2B is a short form of business-to-business exchange of services, information and/or products from one business to another business.
- B2B electronic commerce (B2B) typically takes the form of automated processes between trading partners and is performed in much higher volumes than B2C applications.
- For example, a company that manufactures tyres can sell them to an automobile manufacturer rather than directly to the consumers. This is a B to B transaction.
- EDI and Intranet are good examples of inter-organisation information systems.



B2B applications: Inter-organisation e-commerce applications include:

- a) **Supplier management:** EC applications help companies to negotiate and transact with suppliers at reduced costs. This helps to reduce purchase order processing costs and cycle times and increase the number of orders processed during a period of time.
- b) **Inventory management:** Electronic applications shorten the order-ship-bill cycle. If majority of business partners are electronically linked, information once sent by fax or mail can now be instantly transmitted. Business can also track their documents. This also helps to reduce inventory levels, improve inventory turnover and eliminate out-of-stock occurrences.
- c) **Distribution management:** Electronic applications facilitate the transmission of documents such as bill of lading, purchase orders and ensures that documents contain more accurate data.
- d) **Channel partners management:** EC applications quickly distribute information about changing operational conditions to trading partners.

B2B standards:

- UN/EDIFACT is one of the most well-known and established B2B standards.
- ANSI ASC X.12 is also a popular standard in the States.
- Rosetta Net is an XML based, emerging B2B standard in the heavy technology industry.

Wallet

- Wallet is an encryption software which holds user's payment information, a digital certificate to identify the user, and shipping information to speed transactions.
- Wallet is a software program and data that is used for on-line purchase transactions.
- It allows several methods of payments (like use of different credit cards) that are defined within the wallet.
- It generally resides on the user's Personal Computer.



Benefits:

- Consumer: The consumer benefits because his or her information is encrypted against piracy and because some wallets will automatically input shipping information at the merchant's site and will give the consumer the option of paying by digital cash or check.
- Seller / Merchants: Merchants benefit by receiving protection against fraud.

Operation:

- When the user (or the consumer) orders for purchase of something, the order is sent to the vendor's server.
- The vendor's server sends back an invoice requesting the consumer to launch the wallet in his computer.
- The user then selects "pay" option in the cyber cash software of vendor's server which sends a message back to the consumers PC that activates the "wallet" software.
- The consumer selects one of the cards defined in the wallet and clicks.
- The transaction includes real-time credit card authorization.

B2C in E-Commerce

- B2C is a short form of business-to-consumer and involves exchange of services, information and/or products from a business to a consumer, as opposed to between one business and another.
- It is a form of electronic commerce in which products or services are sold from a firm directly to the consumer.



Classification of B2C E-Commerce:

1. Direct Sellers: Companies that provide products or services directly to customers are called direct sellers. Following are the 2 types of direct sellers.
 - a) E-tailers: On the basis of order received, the E-tailer ships products directly to the consumer or to a wholesaler or manufacturer for delivery.
 - b) Manufacturers: A manufacturer can sell directly to consumers via Internet. The target is to remove intermediaries, through a process called dis-intermediation and to establish a direct relationship with customers. This is not a new idea because several companies have been utilizing this method for years.
2. Online Intermediaries: Online intermediaries are companies that facilitate transactions between buyers and sellers and receive some percentage. Following are the 2 types of online intermediaries.
 - A. Brokers: A broker is a company that facilitates transactions between buyers and sellers. There are various types of Brokers:
 - i. Buy/Sell Fulfillment: A corporation that helps consumers place buy and sell orders.
 - ii. Virtual Mall: A company that helps consumers to buy from a variety of stores.
 - iii. Metamediary: A firm that offers customers access to a variety of stores and provides them with transaction services, such as financial services.
 - iv. Bounty: An intermediary that offers a fee to locate a person, place, or idea.
 - v. Search Agent: A company that helps consumers to compare different stores.
 - vi. Shopping Facilitator: A company that helps consumers in using online shops easier by providing facilities such as currency conversion, language translation, payment and delivery solutions, etc.

B. Infomediaries:

i. Advertising based models:

- In this system, businesses' sites have ad inventory, which they sell to interested parties.
- Advertisers take a high-traffic approach when attempting to reach a larger audience. These advertisers will be willing to pay a premium for a site that can deliver high numbers, for example advertisements on any web site.
- When advertisers are trying to reach a smaller group of buyers, they take a niche approach.
- These buyers are well-defined, clearly identified, and desirable. This approach focuses on quality, not quantity. For example, customized advertisements in some websites, targeting a particular class of people.

ii. Community based models: In a community based system, companies allow users worldwide to interact with each other on the basis of similar areas of interest. These firms make money by accumulating loyal users and targeting them with advertising.

iii. Fee-Based Models: In a fee-based system, a firm charges a subscription fee to view its content.

Advantages of B2C:

- i. The B2C model can save time and money by doing business electronically.
- ii. This minimizes internal costs created by inefficient and ineffective supply chains and creates reduced end prices for customers.
- iii. Shopping can be faster and more convenient.
- iv. Offerings and prices can change instantaneously.
- v. Call centers can be integrated with the website.
- vi. Broadband telecommunications will enhance buying experience.

Payment Options for B2C E-commerce businesses: Following are different types of online payment options that could be used in B2C E-commerce:

- a) Financial cyber intermediary: An internet based company that facilitates payment between two individuals, online, usually by credit card.
- b) Electronic Cheque: Transferring money from one's checking account to another over the internet.
- c) Electronic Bill Presentment And Payment (EBPP): A Computer system that generates electronic bills and sends them to customers over the internet.
- d) Smart Card: Debit cards that contain information about how much money you have and deduct purchases from that total. These are provided by all banks. Merchandise that is best suited for B2C: B2C can be used for all products in online. Following are the types of merchandise that can be easily sold online by a B2C E-commerce business:

- i. Convenience Goods: Low priced products which are bought frequently.
- ii. Specialty Goods: High priced merchandise that is ordered rarely and usually requires customization.
- iii. Commodity-like Goods: Products that are same where ever they are bought and are highly substituted.
- iv. Digital Goods: Products that can be created and sent electronically. For example, music, images, videos, etc.

Challenges Faced by B2C E-Commerce:

- The two main challenges faced by B2C e-commerce are:
 - a) building traffic and
 - b) sustaining customer loyalty.
- Due to 'winner-take-all' nature of B2C structure, many smaller firms find it difficult to enter a market and remain competitive.
- In addition, online shoppers are very price-sensitive and are easily lured away. So, it is very difficult to acquire and keep new customers.

CRM

- Customer Relationship Management (CRM) includes the methodologies, technology and capabilities that help an enterprise to manage customer relationships.
- The general purpose of CRM is to help organizations in managing their customers in a better way through the introduction of reliable systems, processes and procedures.



Implementation of CRM:

- CRM is a corporate level strategy which focuses on creating and maintaining long lasting relationships with its customers.
- CRM is not technology itself. It is a holistic change in the organization's philosophy which places emphasis on the customer.
- A successful CRM strategy can't be implemented by simply installing and integrating a software package and will not happen over night.
- Changes must occur at all levels including policies and procedures, front office customer service, employee training, marketing, systems and information management, etc.
- All the aspects of business must be reshaped to be customer driven.
- When setting up a CRM, the company has to first identify the key areas relevant to its business. They are:
 - What information it needs to serve its consumers,
 - Customer's past financial history,
 - Effects of the CRM segment,
 - What information is not useful,
- Eliminating unwanted information can be the large aspect of implementing CRM system.
- While designing a CRM structure, a company may keep more extensive information of their primary customers and less extensive details of their low-margin clients.

Requisites of a good CRM Program: To be effective, the CRM process needs to be integrated across marketing, sales and customer service. A good CRM program needs to:

- a) Identify customer success factors.
- b) Create a customer-based culture.
- c) Adopt customer-based measures.
- d) Develop an end-to-end process to serve customers.

- e) Recommend the questions to be asked to help a customer to solve a problem.
- f) Recommend what to tell a customer with some complaint.
- g) Track all aspects of selling to customers.

Architecture of CRM: There are 3 parts of application architecture of CRM

- a. Operational: automation is provided to the basic business processes like marketing, sales, service, etc.
- b. Analytical: helps to analyze customer behavior, implements business intelligence like technology, etc.
- c. Collaborative: ensures contact with customers like phone, email, fax, web, SMS, post, in person, etc.

Operational CRM

- Operational CRM means supporting the front office business processes, which include customer contact like sales, marketing and service.
- Tasks resulting from these processes are forwarded to the employees responsible for them,
- The necessary information for carrying out the tasks is also provided,
- Information to back end applications is provided, and activities with customers is documented for further reference.

Advantages: It provides the following benefits

- i. Delivers personalized and efficient marketing, sales, and service,
- ii. Enables a reverse view of the customer while the organization is interacting with them.
- iii. Sales people and service engineers can access complete history of all customer interaction with the company.

Areas of business: The operational part of CRM typically involves 3 general areas of business:

- a) Sales Force Automation (SFA): SFA automates some of the company's critical sales and sales force management functions. For example, lead/account management, contact management, quote management, forecasting, sales administration, keeping track of customer preferences, buying habits, and demographics, as well as performance management. SFA tools are designed to improve field sales productivity.
- b) Customer Service and Support (CSS): CSS automates some service requests, complaints, product returns and information requests. Traditional internal help desk and traditional inbound call-center support for customer enquiries are now developed as "Customer Interaction Center" (CIC) using multiple channels (Web, phone/fax, face-to-face, kiosk, etc).
- c) Enterprise Marketing Automation (EMA): EMA provides information about the business environment, including competitors, industry trends and macro environmental variables. It is the execution side of campaign lead management. The intention of EMA application is to improve marketing campaign efficiencies. Many call centers use CRM software to store all of their customer's details. When a customer calls, the system can be used to retrieve and store information relevant to the customer. By serving the customer quickly and efficiently, and also keeping all information of a customer in one place, a company aims to make cost savings, and also encourage new customers.

Analytical CRM

In analytical CRM, data gathered within operational CRM and/or other sources are analyzed to segment customers or to identify potential customers to enhance client relationship. Examples of campaigns directed towards customers are:

- a) Acquisition: Cross-sell, up-sell
- b) Retention: Retaining customers who leave due to maturity or attrition.
- c) Information: Providing timely and regular information to customers.

d) Modification: Altering details of transactional nature of the customers' relationship.

Coverage: Analysis is not limited to decision support. But it generally covers the following:

- a) Dashboards, reporting, metrics, performance etc.
- b) Predictive modeling of customer attributes.
- c) Strategy and research.

Analysis of customer data: Analysis of customer data may relate to one or more of the following areas:

- Campaign management and analysis
- Contact channel optimization
- Contact Optimization
- Customer Acquisition / Reactivation / Retention
- Customer Segmentation
- Customer Satisfaction Measurement / Increase
- Sales Coverage Optimization
- Fraud Detection and analysis
- Financial Forecasts
- Pricing Optimization
- Product Development
- Program Evaluation
- Risk Assessment & Management

Data warehouse:

- Data collection and analysis is viewed as a continuous process,
- Generally business decisions are refined over a period of time, based on the feedback from earlier analysis and decisions,
- Therefore, most successful analytical CRM projects take the advantage of a data warehouse to provide suitable data.

Collaborative CRM

- Collaborative CRM facilitates interactions with customers through all channels like personal, letter, fax, phone, web, E-mail and supports co-ordination of employee teams and channels.
- It is a solution that brings people, processes and data together.
- So, companies can better serve and retain their customers.
- The data/activities can be structured, unstructured, conversational, and/or transactional in nature.

Objective: The objectives of collaborative CRM can be broad, including cost reduction and service improvements.

Benefits: Collaborative CRM provides the following benefits

- Enables efficient productive customer interactions across all communication channels.
- Enables web collaboration to reduce customer service costs.
- Integrates call centers enabling multi-channel personal customer interaction.
- Integrates view of the customer while interacting at the transaction level.

In what way a CRM software can improve customer service?

A good CRM program will allow a business to acquire customers, service the customer, increase the value of the customer to the company, retain good customers, and determine which customers can be retained or given a higher level of service. A good CRM program can improve customer service by facilitating communication in several ways:

- a. Product information: It can provide product information, product use information and technical assistance on web sites that are accessible round the clock.
- b. Quality: Identify how each individual customer defines quality and then design a service strategy for each customer based on these individual requirements and expectations.
- c. Sales follow up: Provides a fast mechanism for managing and scheduling follow-up sales calls to assess post-purchase cognitive dissonance, repurchase probabilities, repurchase times and repurchase frequencies.
- d. Tracking points of contact: Provides a mechanism to track all points of contact between a customer and the company and do it in an integrated way.
- e. Identify potential problems: Helps to identify potential problems quickly, before they occur.
- f. Registering complaints: Provides a user-friendly mechanism for registering customer complaints. The complaints that are not registered with the company can't be resolved and are a major source of customer dissatisfaction.
- g. Handling problems & complaints: Provides a fast mechanism for handling problems and complaints (complaints that are resolved quickly can increase customer satisfaction)
- h. Correcting service deficiencies: Provides a fast mechanism for correcting service deficiencies. Helps to correct the problem before other customers experience the same dissatisfaction.
- i. Track customer interests: Uses internet cookies to track customer interests and personalize the product accordingly.
- j. Scheduling maintenance: Provide a fast mechanism for managing and scheduling maintenance, repair, and on-going support. This improves efficiency and effectiveness.
- k. Integration: The CRM can be integrated into other cross-functional systems and thereby provide accounting and production information to customers when they want it.

Technical functionality: A CRM solution is characterized by the following functionality:

- a) Scalability: the ability to be used on a large scale and can be reliably expanded to the necessary scale.
- b) Multiple communication channels: The ability to interface with users via several devices (phone, WAP, internet, etc.)
- c) Workflow: the ability to trigger a process in the back office system, e. g. Email Response, etc.
- d) Assignment: the ability to assign requests (Service Requests, Sales Opportunities) to a person or group.
- e) Database: the centralized storage (in a data warehouse) of all information relevant to customer interaction.
- f) Customer privacy considerations: the data encryption and the destruction of records to ensure that they are not stolen or abused.

Supply Chain Management and Supply Chain Event Management?

Supply Chain Management (SCM) is the process of planning, implementing and controlling the operations of the supply chain with the purpose to satisfy customer requirements in an efficient way. Supply chain management covers all movements and storage of raw materials, work-in-process, and finished goods from point-of-origin to point-of-consumption. According to the Council of Supply Chain Management Professionals (CSCMP) Supply Chain Management encompasses the planning and management of all activities involved in sourcing procurement, conversion and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, Supply Chain Management integrates supply and demand management within and across companies.

Supply Chain Event Management (SCEM) is a consideration of all possible occurring events and factors that can cause a disruption in a supply chain. With SCEM, possible scenarios can be created and solutions can be planned. Some experts distinguish supply chain management and logistics management, while others consider the terms to be interchangeable.

Opportunities Enabled By Supply Chain Management:

Proper implementation of SCM helps to use the following strategic and competitive areas to their full advantage:

- a) **Fulfillment:** It ensures that right quantity of parts for production or products for sale arrive at the right time and it is achieved through efficient communication. It also allows a company to constantly monitor the inventory and ensure that the right quantities are ordered to replace stock.
- b) **Logistics:** Keeping the transportation cost of materials as low as possible along with safe and reliable delivery. Here the SCM enables a company to have constant contact with its distribution team, which could consist of trucks, trains, or any other mode of transportation.
- c) **Production:** SCM ensures smooth functioning of production lines because necessary spare parts and components will be available as and when necessary. As logistics are correctly implemented, production can run smoothly.
- d) **Revenue & profit:** When supply chain is properly managed companies can react to the unforeseen changes in demand and supply in a flexible way. Because of this, a company can produce goods at lower prices and distribute them in a quicker way, thus increasing the overall profit.
- e) **Costs:** Keeping the cost of purchased parts and products at acceptable levels. SCM reduces costs by increasing inventory turnover on the shop floor and in the warehouse, controlling the quality of goods and thus reducing internal and external failure costs.
- f) **Cooperation:** Co-operation among supply chain partners ensures 'mutual success'. Collaborative Planning, Forecasting and Replenishment (CPFR) is a longer-term commitment, joint work on quality and support by the suppliers. This relationship allows a company to have access to current, reliable information, obtain lower inventory levels, cut lead times, enhance product quality, improve forecasting accuracy and ultimately improve customer service and overall profits.

Problems Faced By Supply Chain Management:

- a. **Distribution Network configuration:** Number and location of suppliers, production facilities, distribution centers, warehouses and customers.
- b. **Distribution Strategy:** Centralized versus decentralized, direct shipment, cross docking, pull or push strategies, third party logistics.
- c. **Information:** Integrated systems and processes through the supply chain to share valuable information, including demand signals, forecasts, inventory and transportation.
- d. **Inventory Management:** Quantity and location of inventory including raw materials, work-in-process and finished goods.

Activities Or Functions of SCM:

SCM is a cross functional approach to manage the movement of raw materials into an organisation and movement of finished goods out of the organisation towards the end consumer. Due to outsourcing of several operations:

- the number of companies involved in satisfying consumer demand have increased,
- while reducing management control of daily logistics operations.
- Less control and more supply chain partners led to the creation of supply chain management concepts.
- Several models have been proposed for understanding the activities required to manage material movements across organizational and functional boundaries.

- SCOR is a supply chain management model proposed by the Supply-Chain Council.
- Another model is the SCM Model proposed by the Global Supply Chain Forum (GSCF).

Levels of Activities Involved In SCM:

Supply chain activities can be grouped into strategic, tactical and operational levels of activities.

a) Strategic level:

- Strategic network optimization, including the number, location and size of warehouses, distribution centers and facilities.
- Strategic partnership with suppliers, distributors, and customers, creating communication channels for critical information & operational improvements such as cross docking, direct shipping and third-party logistics.
- Product design coordination, so that new and existing products can be optimally integrated into the supply chain.
- Information Technology infrastructure, to support supply chain operations.
- Where to make, what to make and make or buy decisions.

b) Tactical level:

- Sourcing contracts and other purchasing decisions.
- Production decisions, including contracting, locations, scheduling, and planning process definition.
- Inventory decisions, including quantity, location and quality of inventory.
- Transportation strategy including frequency, routes and contracting.
- Benchmarking of all operations against competitors and implementation of best practices throughout the enterprise.
- Milestone Payments.

c) Operational level:

- Daily production and distribution planning, including all nodes in the supply chain.
- Production scheduling for each manufacturing facility in the supply chain (minute by minute)
- Demand planning and forecasting, coordinating the demand forecast of all customers and sharing the forecast with all suppliers.
- Sourcing planning, including current inventory and forecast demand, in collaboration with all suppliers.
- Inbound operations, including transportation from suppliers and receiving inventory.
- Production operations, including the consumption of materials and flow of finished goods.
- Outbound operations, including all fulfillment activities and transportation to customers.
- Order promising, accounting for all constraints in the supply chain, including all suppliers, manufacturing facilities, distribution centers, and other customers.
- Performance tracking of all activities.



Bullwhip effect in SCM: The Bullwhip Effect or Whiplash Effect is an observed phenomenon in forecast driven distribution channels.

- Forecasting demand: Customer demand is very unstable. So, organisation must forecast demand in order to arrange for inventory and other resources. Forecasts are based on statistics, and they are rarely perfectly accurate. So, Companies generally maintain additional inventory called safety stock.
- Safety stock: Moving up the supply chain from end consumer to raw materials supplier, each supply chain participant has greater observed variation in demand and thus greater is the need for safety stock. During the periods of rising demand, down-stream participants will increase their orders. During the periods of falling demand, orders will fall or stop in order to reduce inventory. Due to this the variations in demand are further amplified.



Forecast driven Vs. demand driven supply chain: Supply chain experts have recognized that the Bullwhip Effect is a problem in forecast driven supply chains. The alternative is to establish a demand driven supply chain which reacts to customer orders. The result is near-perfect visibility of customer demand and inventory movement throughout the supply chain. Better information leads to better inventory positioning and lower costs throughout the supply chain. Barriers to implement a demand driven supply chain include - investments in information technology and creating a corporate culture of flexibility and focus on customer demand.

Factors contributing to the Bullwhip Effect:

- a. Forecast Errors
- b. Lead Time Variability
- c. Batch Ordering
- d. Price Fluctuations
- e. Product Promotions
- f. Inflated Orders
- g. Methods intended to reduce uncertainty, variability, and lead time:
- h. Vendor Managed Inventory (VMI)
- i. Just In Time replenishment (JIT)
- j. Strategic partnership (SP)

Electronic Funds Transfer (EFT):

- EFT stands for "Electronic Funds Transfer".
- It represents the ways the business can receive direct deposit of all payments from financial institutions to the company's bank account.
- Once the user signs up, money comes to him directly and sooner than ever before.
- EFT is fast and safe. It means the money will come to the user's bank account quicker than if he had to wait for the mail, deposit the cheque and wait for the funds to become available.
- The payment mechanism moves money between accounts in a



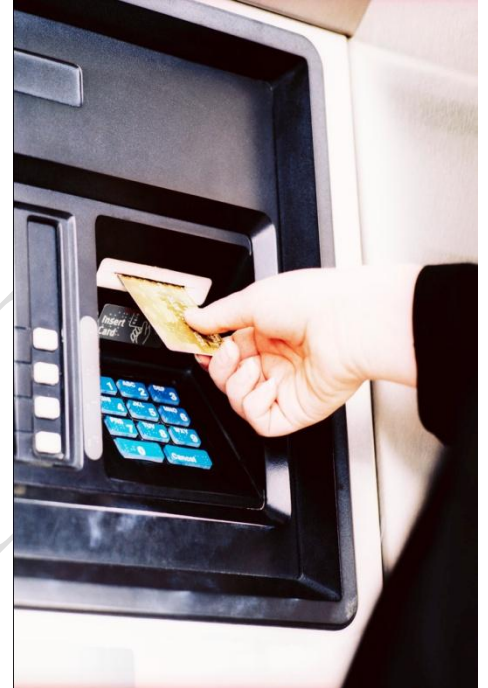
By: Josh Joseph Karukayil

fast, paperless way.

- Some common examples of EFT are Automatic Teller Machine, Point-of-Sale Transactions, Preauthorised
- Transfers and Telephone Transfers.

Automatic Teller Machines (ATMs):

- ATMs are specialised form of Point of Sale Terminals that are designed for unattended use by a customer of a financial institution.
- These ATMs are kept in a public place and are connected to the network of financial institution.
- With the help of these machines consumers can do their banking without the assistance of a teller.
- These machines are activated by inserting a card (ATM/Debit/Credit) which contains user's account number and PIN on a magnetic strip.
- The card holder has to enter the PIN into the ATM which is transmitted to the server in an encrypted form.
- The ATM calls up the server, verifies the customer's account balance, dispenses the cash and generates a transaction slip.
- Even bank personnel will not be able to see the customer's PIN number as it is stored in encrypted form.
- ATM cards can be used to get cash, or to make deposits, pay bills, or transfer funds from one account to another account electronically.



Point-of-Sale (POS) Transactions:

- Some Debit or EFT cards (sometimes referred to as check cards) can be used for shopping that allow the transfer of funds from the consumer's account to the merchant's account.
- To pay for a purchase, the consumer presents an EFT card instead of check or cash.
- Money is taken out of the consumer's account and put into the merchant's account electronically.

Preauthorized Transfers:

- This is a method of automatically depositing to or withdrawing funds from an individual's account, when the account holder authorizes the bank or a third party (such as employer) to do so.
- For example, consumers can authorize direct electronic deposit of wages, social security, or dividend payments to their accounts.
- They can also authorize financial institutions to make regular, ongoing payments of insurance, mortgage, utility or other bills.

Telephone Transfers:

- Consumers can transfer funds from one account to another, for example from savings to current account, or
- They can order payment of specific bills by phone.

Credit Card:

- It is a system of payment in which a small plastic card is issued to the users of the system.
- Those persons who are interested to obtain a credit card must apply to some bank or financial institution.
- A credit card will be issued after verifying the credit worthiness of the applicant.
- A credit limit is sanctioned to each applicant and the applicant can make purchases or draw funds within such credit limit.
- For this service the bank or financial institution collects some service charge.



Manual Credit Card transaction:

- In a credit card transaction, the consumer presents preliminary proof of his ability to pay by presenting his credit card number to the merchant.
- The merchant verifies this with the bank and creates a purchase slip which is endorsed by the consumer.
- The merchant then uses this purchase slip to collect funds from the bank, and
- On the next billing cycle, the consumer receives a statement from the bank with a record of the transaction.

Credit card transaction through internet:

- The same procedure is followed to make purchases over the internet.
- But on the Internet, additional steps must be taken to provide more security to the transactions and for authentication of both buyer and seller.
- Variety of systems are developed for using credit cards over the Internet.
- 2 main distinguishing features of these systems are:
 - i. The level of security they provide for transactions, and
 - ii. The software required on both the customer and business sides of the transaction.
- Credit cards can be handled on line in two different ways:
 - i. Sending unencrypted credit card numbers over the Internet,
 - ii. Encrypting credit card details before any transaction is transmitted.
- **Unencrypted credit card information:**
 - A customer browsing the web might enter a credit card number in an order form and click a submit button to transmit the information to the merchant's web server.
 - Since the data is raw, anyone can intercept the transmission. So, there is no security for this type of transaction.
 - On the other hand an unscrupulous merchant (or someone posing as a merchant) can use such unencrypted numbers for illegal charges.
- **Encrypting credit card details:**
 - Encrypting credit card transactions can also be subdivided according to what is encrypted.
 - If the entire transmission between buyer and merchant is encrypted, the merchant has to decrypt at least the order details to complete the purchase.
 - But sensitive information like credit card numbers will be visible to merchant and he/his employees may misuse such information.
 - To protect against this, a trusted third party can be used to separately handle credit card and order data with a wallet as helper application.
 - Such third party decrypts the credit card information for authorisation of the purchase.

Transaction Using Third Party Verification:

- The market for handling credit card purchases on the Internet is yet to develop as a single way of doing things, or a single standard that allows the software from different vendors to work together.
- Due to lack of interoperability it is likely to slow down both consumer and business acceptance of using credit cards for making purchases on the Internet.
- However, there are 2 significant standards that will make the interoperability of electronic wallet and credit card transactions simpler, both for consumers and businesses.

Secured Electronic Transaction (SET):

- Secured Electronic Transaction Protocol (SET) was first developed by a consortium led by MasterCard & Visa.
- It is a combination of protocols designed for use by other applications (such as Web browsers) and a standard for handling credit card transactions over the Internet.
- It is designed for cardholders, merchants, banks and other card processors.
- SET uses digital certificates to identify all parties involved in a purchase.
- SET also encrypts credit card and purchase information before transmission on the Internet.

Joint Electronic Transaction:

- The second standard is Joint Electronic Payments, led by World Wide Web Consortium and Commerce Net.
- JEPI is an attempt to standardize payment negotiations.
- On the buyer's side, it serves as an interface that enables a Web browser and wallets to use a variety of payment protocols.
- On the merchant's side, it acts between the network and transport layers to pass off the incoming transactions to the proper transport protocol (for e.g. e-mail vs. HTTP) and proper payment protocol (such as SET)
- Multiple protocols will be around for payment, transport and wallets.
- JEPI makes it easier for the buyer to use a single application and a single interface, in a variety of commercial situations.

Electronic Cheques

- An electronic cheque has all the features as a paper cheque.
- It acts as a message to the sender's bank to transfer funds.
- Like a paper cheque, the message is first given to the receiver who, in turn, endorses the cheque and presents it to the bank to obtain funds.
- The electronic cheque can prove to be superior to the paper cheque in one significant aspect. The sender can protect himself against fraud by encoding the account number with the bank's public key. Thus it is not necessary to reveal the account number to the merchant.
- Similar to SET protocol, digital certificates can be used to authenticate the payer, the payer's bank, and the bank account.
- Credit card payments will undoubtedly be popular for commerce on the Internet. However, following 2 systems have been developed to use electronic cheques to pay Web merchants directly:

1. FSTC:

The FSTC is a consortium of banks and clearing houses that has designed an electronic cheque. Designed in the lines of traditional paper cheque, this new cheque is initiated electronically. It uses digital signature for signing and endorsing.

2. Cyber Cash:

This is an extension of wallet for credit cards, and it can be used in the same way to make payments with participating vendors. Cyber Cash will not serve as an intermediate party for processing the cheque. That function will be handled directly by banks.

Extending electronic cheques to existing payment systems:

- Electronic cheque can be delivered either by direct transmission over a network or by e-mail.
- In either case, existing banking channels can clear payments over their networks.
- This has led to a convenient integration of the existing banking infrastructure and the Internet.

Smart Cards:

- Smart cards have an embedded microchip instead of magnetic strip.
- The chip contains all the information a magnetic strip contains but offers the possibility of manipulating the data and executing applications on the card.

Types of smart cards: Three types of smart cards have established themselves.

- a. Contact Cards: Smart cards that need to insert into a reader in order to work, such as a smart card reader or automatic teller machines.
- b. Contactless Cards – Contactless smart cards don't need to be inserted into a reader. Just waving them near a reader is just sufficient for the card to exchange data. This type of cards is used for opening doors.
- c. Combi Cards – Combi cards contain both technologies and allow a wider range of applications.

Electronic purses

- Electronic purse is yet another way to make payments over the internet.
- It is very similar to a pre paid card.
- For E.g. Bank issues a stored value cards to its customers. Customer can then transfer value from their accounts to the cards at an ATM, a personal computer, or a specially equipped telephone.
- The electronic purse card can be used as an ATM card as well as a credit card.
- While making purchases, customers pass their cards through a vendor's point of sale terminal.
- No credit check or signature is needed.
- Validation is done through a Personal Identification Number (PIN Number)
- Once the transaction is complete, funds are deducted directly from the card and transferred to the vendor's terminal.
- Merchants can transfer the value of accumulated transactions to their bank accounts by telephone, as frequently as they choose.



- When the value on a card is spent, consumers can load additional funds from their accounts to the card.

General Management Concern About E-Commerce

From years together computer security is not a big problem. Many companies did not concentrate much on such security aspects. But now computers are accessible even from distant locations. On the other hand there is an increasing trend in the number of hackers. In this scenario, the concept of computer security has become an important consideration.

- a. Loss of paper audit trail: Paper is the prime source of audit trail that can be certified. The electronic certification may not be as reliable as ordinary certification.
- b. Business continuity: As the dependence on electronic means of doing business increases, business continuity becomes an important consideration. If EC system fails to work properly, even ordinary business activities can't be continued effectively.
- c. Exposure of data to third parties: As data is shared and organizations are connected to outside world, the possibility of data exposure to vendors, service providers and trading partners is significantly increased.
- d. Potential legal liability: The inability to complete transactions or meet deadlines or the risk of exposing information of trading partners creates significant legal risks.
- e. Record safeguarding: Electronic information has the same legal and statutory requirements as paper information. Organizations are responsible for safe storage, retention & retrieval of such information.
- f. Segregation of duties: In an electronic environment, the potential for occurrence of fraudulent transactions increases. Therefore, duties of people involved in EC must be appropriately segregated and reviewed.

Challenges in E-Commerce: Before all businesses accept this technology, several challenges should be accepted.

- a. Reliability: For conducting e-commerce the company has to depend upon services of several other organizations. So the company should consider the reliability of such organisations.
- b. Scalability: How can the Internet and individual services be scaled to meet the needs and expectations of all businesses?
- c. Ease of use: The methods developed should be easy to access for all trading partners and customers. We should also consider, whether small businesses are at a disadvantage due to lack of technical sophistication and resources?
- d. Payment methods: What will be an appropriate, safe and reliable payment method for electronic commerce?
- e. Other considerations include the threat of computer viruses and the existence of unprofessional employees. Companies or consumers pass information through e-mail. If it is captured by a third party, great loss occurs to both the parties. Some businesses connect to the internet and they also store important information in the same location. Such businesses are subjected to tampering and their information may be accessed by third parties and may be damaged. For e.g. financial information such as credit card numbers may be stolen and used by unauthorized parties to make illegal purchases, resulting in damage to customers and business.

Tools Available To Protect The Information In Network Against Intrusion Or Misuse

In spite of several risks, internet is the most advanced infrastructure for “anywhere, anytime” electronic communication between businesses, customers, suppliers. Several tools are now available to protect information and systems unauthorized intrusion or misuse:

- a) **Firewalls:** They control the flow of traffic between the Internet and the firm’s internal LANs and systems. They are setup to implement the security policies desired by the organisation. A firewall is a proved, effective means of protecting the firm’s internal resources from unwanted intrusion.
- b) **Encryption:** This allows information to transit the Internet while being protected from interception. There are two basic approaches to encryption:
 - i. Hardware encryption devices are available at a reasonable cost and can support high-speed traffic. If Internet is used to exchange information among branch offices or development collaborators, use of such devices can ensure that all traffic between these offices is secured.
 - ii. Software encryption is typically employed in specific applications. For example, certain electronic mail packages provide encryption and decryption for message security.
- c) **Message authentication:** It makes sure that a message is really from whom it is supposed to be and that it has not been tampered. Regardless of a company’s individual needs, Internet security policies and procedures should always be clearly defined.
- d) **Site blocking:** It is a software-based approach that prohibits access to certain web sites that are deemed to be inappropriate by management. For example, sites that contain objectionable material can be blocked to prevent employees from accessing these sites. Companies can also log activities and determine the amount of time spent on the Internet and identify the sites visited.

Possible legal issues in E-Commerce:

Electronic transactions are used by businesses to issue instructions and to make commitments with external organizations, and many of these transactions are used to form legally binding contracts. For example, a contract is entered into when a buyer electronically issues a purchase order for goods at some fixed price and a seller electronically acknowledges the order. In legal terms, ‘electronic order’ means “offer,” and the electronic acknowledgment means “acceptance,” forming a contract.

Legal issues:

1. **Jurisdictional disputes:**
 - E-commerce throws up several new challenges. The most important issue is that of taxation. For taxation purposes, the first question to be asked is where did the sale take place?
 - In case of E-Commerce there is no physical place of business. So, it is very difficult to determine the country/state/city from where the sale was concluded.
 - Similarly jurisdictional disputes arise in case of indirect taxes.
2. **Tax evasion:** Since there is no paper work and all the interaction between the buyer and the seller is done electronically, there is a possibility that the entire transaction is kept out of books of accounts. So, the transaction may all together escape from the tax net.
3. **Fraud detection:** E-commerce comes to us along with the in-built dangers of cyber crimes and frauds. Detection and Prevention of such frauds is very difficult.
4. **Potential legal liability:** As electronic commerce grows, number of new legal issues may arise. Organizations must be prepared to protect themselves from potential legal liabilities and ensure that their legal rights are protected.
5. **Internet security:**
 - Internet usage can be as secure as a company requires.
 - It is important to use some appropriate tools and procedures to protect information assets.
 - But we should not overreact and incur unnecessary costs and difficulties.
 - Organizations should take proactive role in monitoring electronic transactions and protecting assets.

Mobile Commerce

Mobile Commerce or M-Commerce is about applications and services that are accessible from Internet enabled mobile devices. M-commerce (mobile commerce) is the buying and selling of goods and services through wireless handheld devices such as cellular phones, Personal Digital Assistants (PDAs), etc. It is also known as next generation e-commerce.



Features:

- It involves new technologies, services and business models.
- It is quite different from traditional E-Commerce.
- This technology is based on Wireless Application Protocol (WAP).

Facilities:

- M-commerce enables users to access the Internet without any wired connection.
- Using Bluetooth technology, smart phones are able to offer fax, e-mail, and phone capabilities all in one. Due to this, M-Commerce is being accepted by large number of mobile workforce.
- The content delivery over wireless devices is faster, more secure, and scalable. So, there is a speculation that m-commerce will surpass wire line e-commerce.

Industries affected by M-Commerce: Following are the industries that are affected by M-Commerce.

- a. Financial services: Financial services, which include mobile banking (when customers use their handheld devices to access their accounts and pay their bills) as well as brokerage services, in which stock quotes can be displayed and trading can be done from the same handheld device.
- b. Telecommunications: Service charges, bill payment and account reviews in telecommunications, can all be conducted from a handheld device.
- c. Service/retail: Consumers can place orders and pay for them on the move.
- d. Information services: They include the delivery of financial news, sports updates and traffic updates to individual mobile devices.

Future expectation: In order to exploit the potential market in m-commerce, handset manufacturers such as Nokia, Ericsson, Samsung, and Qualcomm are working with carriers such as 'AT&T Wireless' and 'Sprint' to develop WAP enabled smart phones. Mobile phones or PDAs have some constraints when compared to desktop computers. But they also open the door to a wide range of new applications and services. Companies like IBM are experimenting with speech recognition software as a way to ensure security for M-Commerce transactions.

Bluetooth

Bluetooth is a telecommunications industry specification that describes how mobile phones, computers and Personal Digital Assistants (PDAs) can be easily interconnected using a short range wireless connection. This technology got its name in honour of Harald Bluetooth, king of Denmark in the mid-tenth century.



Usage:

- Using this technology, users can easily exchange

files between computers, cellular phones, pagers, and Personal Digital Assistants over short distances.

- Users can easily synchronize the information in their portable devices with a desktop or notebook computer.
- User can also send or receive a fax, initiate a print-out and in general, have all mobile and fixed computer devices be totally coordinated.

Technical details:

- To get Bluetooth facility, it is required to include a low cost transceiver chip in each device. Actually this transceiver transmits and receives data.
- The transceiver uses a frequency band of 2.45 GHz that is available globally.
- Each device has a unique 48-bit address from the IEEE 802 standard.
- In addition to data, up to 3 voice channels are available.
- Connections can be point-to-point or multipoint.
- The maximum range is 10 meters.
- Data can be exchanged at the rate of 1 Mbps (up to 2 Mbps in the second generation of the technology)
- With frequency hop (=jump) scheme, devices can communicate even in the areas of electromagnetic interference.
- Built-in encryption and verification is provided.

Wi-Fi

- Wi-Fi stands for Wireless Fidelity.
- Wifi (also WiFi, Wi-fi or wifi) is a brand originally licensed by the Wi-Fi Alliance and it is used to describe the underlying technology of Wireless Local Area Networks (WLAN) and it is based on IEEE 802.11 specifications.
- This technology is designed for mobile computing devices such as laptops in LANs.
- But now it is used for variety of other applications, including Internet and VoIP phone access, gaming, and basic connectivity of consumer electronics such as televisions and DVD players.
- Several other standards are in development that allow Wi-Fi to be used by cars in highways in support of an Intelligent Transportation System. It can be used to increase safety, gather statistics and enable mobile commerce.



How it works?

- A person with a Wi-Fi device, such as a computer, telephone, or Personal Digital Assistant (PDA) can connect to the Internet when it is near to access point.
- The region covered by one or several access points is called a hotspot.
- Hotspots can range from a single room to many square miles of overlapping hotspots.

Wi-Fi Certification: WI-FI certification means that it is compatible with other WI-FI CERTIFIED products. In other words the WI-FI CERTIFIED logo means it's a "safe" buy.

Areas where it is used?

1. Wireless technology gives complete freedom to a user to be connected anywhere if the computer is configured with a Wi-Fi CERTIFIED device.
2. Wi-Fi also allows connectivity in peer-to-peer mode which enables devices to connect directly with each other. This is very much useful in consumer electronics and gaming applications.
3. Wi-Fi can be used to create a Wireless mesh network.
4. Many corporations also provide wireless networks to their off-site and telecommuting workers to use at home or in remote locations.
5. Large companies and campuses often use Wi-Fi to connect buildings.
6. Wi-Fi networks are also found in busy public places like coffee shops, hotels, airport lounges and other locations where large crowds gather. This may be the fastest-growing segment of Wi-Fi service.
7. Soon, WI-FI networks will be found in urban areas providing coverage throughout the central city or even highways.

Limitation: When the technology was first commercialized users faced many compatibility problems. The Wi-Fi Alliance began as a community to solve this issue. The Alliance created another brand "Wi-Fi CERTIFIED" to indicate that the products are interoperable with other products displaying the "Wi-Fi CERTIFIED" logo.



DATA STORAGE, RETRIEVAL & DBMS

Number Systems

We use the decimal numbers or the decimal number system for our day-to-day activities. As we all know, in decimal number system there are ten digits 0 to 9. But computers understand only 0s and 1s - the machine language. But using 0s and 1s to program a computer is a thing in the past. Now we can use the decimal numbers, alphabets and special characters like +, -, *, /, ?, etc for programming the computer. Inside the computer, these decimal numbers, alphabets and special characters are converted into 0s and 1s, so that the computer can understand what we are instructing it to do. To understand the working of a computer, the knowledge of binary, octal and hexadecimal number systems is essential.

Decimal Number Systems:

- The base or radix of a number system is defined as the number of digits it uses to represent the numbers in the system.
- Since decimal number system uses 10 digits 0 to 9, its base or radix is 10. The decimal number system is also called base-10 number system.
- The weight of each digit of a decimal number system depends on its relative position within the number. Weight of n^{th} digit from the right is $10^{(n-1)}$. For example 4219 means
 $4*1000+2*100+1*10+9*1$ in other words
 $4*10^3+2*10^2+1*10^1+9*10^0$

Binary Number System

- The base or radix of the binary number system is 2. It uses only 2 digits- 0 and 1.
- Data is represented in a computer system by either the presence or absence of electronic or magnetic signals in its circuitry or media it uses. Thus for electronic circuits, the conduction state(ON) represents ONE and non-conducting state(OFF) represents ZERO.
- The binary symbol 0 or 1 is commonly called a bit, which is a contraction of the term Binary Digit.
- In binary system, all numbers are represented as groups of binary digits(bits), that is 0s and 1s.
- The value of a binary number depends upon the position or place of each digit in a grouping of binary digits. The values are based on the right to left positions of the digits in a binary number, using the power of 2 as position values. For example, consider 10100

$$\begin{aligned} 10100 &= 1*2^4+0*2^3+1*2^2+0*2^1+0*2^0 \\ &= 16+0+4+0+0 \\ &= 20 \end{aligned}$$

Different Coding Schemes

BCD:

- BCD stands for binary Coded Decimal system.
- This is a 6 bit code i.e. each character is expressed in terms of a 6 bit code.

- There will be 64 ways of representing digits, alphabets and special symbols.
- There is no parity bit in this coding scheme.

ASCII:

- ASCII stands for American Standard Code for Information Interchange.
- This code is extensively used in small computers, peripherals, instruments and communication devices.
- It is a seven-bit code and has replaced many of the special codes that were previously used.
- Microcomputers using 8-bit word length use 7 bits to represent the basic code. The 8th bit is used for parity or it may be permanently 1 or 0.
- With 7 bits, up to 128 characters can be coded.
- A letter, digit or special symbol is called a character. It includes upper and lower case alphabets, numbers, punctuation marks, special and control characters.
- Here the first 3 bits are zone bits and the remaining 4 bits represent digit values.

ASCII-8:

- A newer version of ASCII is ASCII-8 code, which is an 8-bit code.
- With 8 bits, the code capacity is extended to 256 characters.

EBCDIC:

- EBCDIC stands for Extended Binary Coded Decimal Interchange Code.
- It is a standard character code for large computers.
- It is a 8-bit code without parity and 9th bit can be used as parity bit.
- Using 8 bits, 256 characters can be coded.
- In ASCII-8 and EBCDIC, the first 4 bits are known as zone bits and the remaining 4 bits represent digit values.

UNICODE:

- Unicode is a worldwide character code standard.
- In this code system, 16-bits(2bytes) are used to represent a single character or symbol.
- Using this system, 65,536 different characters can be represented inside the computer.
- The first 256 codes in Unicode are identical to the 256 codes used by ASCII system.
- The Unicode standard was developed in 1991 by a joint engineering team from Apple Computer Corporation and Xerox Corporation.
- Unicode system is supported by the popular operating systems such as Windows 2000 and OS/2 and also supported by some applications.

Bits, Bytes and Words

- A bit is an abbreviation of binary digits 0 and 1. It is defined as the smallest basic unit of storage in the computer memory that has a value 0 or 1 known as bit.
- A byte is a basic grouping of bits (binary digits) that the computer operates on as a single unit. It consists of 8bits and is used to represent a character by the ASCII and EBCDIC coding systems. The capacity of a computer's primary and secondary storage devices is usually expressed in terms of bytes.
- A word is a grouping of bits (usually larger than a byte) that is transferred as a unit between primary storage and the registers of the ALU and control unit. Thus a computer with a 32-bit word length might have registers with a capacity of 32bits, and transfer data and instructions within CPU in groupings of 32bits.
- The following table shows the multipliers of Byte:

Name	Abbr.	Size
Kilo	K	$2^{10} = 1,024$
Mega	M	$2^{20} = 1,048,576$
Giga	G	$2^{30} = 1,073,741,824$
Tera	T	$2^{40} = 1,099,511,627,776$
Peta	P	$2^{50} = 1,125,899,906,842,624$
Exa	E	$2^{60} = 1,152,921,504,606,846,976$
Zetta	Z	$2^{70} = 1,180,591,620,717,411,303,424$
Yotta	Y	$2^{80} = 1,208,925,819,614,629,174,706,176$

Key:

- A key is a set of one or more columns whose combined values are unique among all occurrences in a given table. A key is the relational means of specifying uniqueness.

Types of Keys:

- Candidate Key:**
 - It is a set of one or more columns whose combined values are unique among all occurrences (i.e. tuples or rows)
 - Since a null value is not guaranteed to be unique, candidate key can't be null.
 - There can be any number of candidate keys in a table.
- Primary Key:**
 - It is a candidate key of the table which the database designer designates as "primary key".
 - Entire data in a database is sorted using this primary key.
 - The primary key may be selected for convenience, comprehension, performance or any other reasons.
 - It must have unique values.
- Alternate Key:**
 - It is a candidate key which is defined as primary key but not currently selected for the purpose is called primary key.
 - It is a function of all candidate keys minus primary key.
- Secondary Key:**
 - Secondary keys can be defined for each table to optimize the data access.
 - A candidate key which is not selected as a primary key is known as Secondary Key.
 - Like the primary key, the secondary key can consist of multiple columns.
 - A table is first sorted on the basis of primary key and then on the basis of secondary key.
 - They help to prevent sequential scans over the table.
- Referential Integrity:**
 - It is a feature provided by Relational Database Management Systems (RDBMS's).
 - It prevents users or applications from entering inconsistent data.

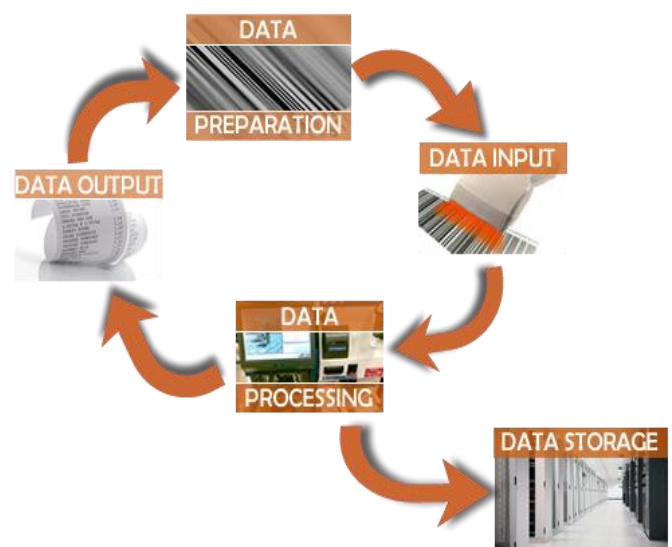
- It is a form of range control in which the value of a field must be similar to the value of some other field in another row of the same or different table.
- Many RDBMS's have various referential integrity rules that are applied when a relationship is created between 2 tables.
- This is very much useful in case of fields that have repeated values.

Data:

- Generally the word “data” is used in singular sense but actually it is the plural form of “datum”. Data can be defined as any fact, observation, assumption or occurrence. Data are compiled to form reports, figures documents etc. Data can be in the form of numbers or alphabetical characters or special symbols (=, + %, Rs. etc.). Some important data definitions are given below:
 - Digit:** A simple numeric character 0, 1, 2.....9 is called digit.
 - Character:** A single alphabetic, numeric or special symbol that is used to represent data. For e.g. 0, 1, 2..... 9, A, B.....Z, a, b,.... z, +, -, %, etc.
 - Data item (field):** A set of characters which are used together to represent a specific data element. For e.g.name item consists of alphabetic characters & amount item consists of numbers.
 - Record:** It consists of a group of data items, related to an object of data processing. For e.g., a payroll record consists of data fields such as name, age, qualification, sex, wage rate etc. (N00)
 - Data file:** It is a group of related records maintained in some pre-arranged order. (N00)
 - Database:** A group of related data files is known as database.
 - Information:** Information is nothing but organised or classified data and it has some additional value to the user. For example, a file containing transactions occurred during a year, in a company, is data for a managing director. If the same file is arranged, processed and financial statements are prepared then it becomes information. Such statements are very much useful for a manager.

Data Processing:

- It is a process of restructuring or reordering of data by people or machines to increase their usefulness and value to the user.
- Data processing can be done in several ways. In olden days it was performed manually with the help of simple tools such as paper, pencil and filing cabinets.
- Afterwards data processing was done electro-mechanically with the help of unit record machines.
- Now it is done electronically with the help of a computer. With the help of computers and peripheral devices sorting, classifying, summarizing and other similar activities can be performed at a very high speed.



Steps in Data Processing:

1. **Preparation of source documents:** The first step is to collect relevant facts and figures and to record them on source documents. For e.g. in a population survey - name, address, age, sex, occupation, etc. are first recorded on survey sheets or some other documents.

2. **Recording / Input Data:** Once data is given as input to a data processing system. The method of giving input will depend upon input media and devices.
3. **Processing of data:** Here, user may classify or sort the given data. For example, in a population survey, we can classify people on the basis of occupation or on the basis of age. We may sort the data in alphabetical order or in any other order. In all data processing, systems following fundamental operations are performed:
 - a) **Classifying:** It involves grouping of like items (=similar items) or transactions. Data are generally classified according to alphabetic or numeric code.
 - b) **Sorting:** Sorting means arrangement of data or transactions in ascending or descending order. Sorting may be done on numeric or alphabetic data. For example, Indian States may be arranged in the descending order of population or on the basis of name.
 - c) **Calculating:** It includes adding, subtracting, multiplying or dividing data to produce useful results. For example – computation of interest on amount etc.
 - d) **Summarizing:** It involves consolidating of data, emphasising main points. Generally, it involves finding out totals, calculating percentages etc.
4. **Information Output (Reporting):** The summarised data becomes information and it is presented to the management in the form of reports. Reporting is the final step of all data processing activities. For e.g. financial statements. Information should be understandable easily and quickly.
5. **Data Storage:** In most of the cases, the results of processing are retained for future use. For example, it may be necessary to compare the latest figures with previous figures. That is why data processing system requires a considerable amount of secondary storage space.

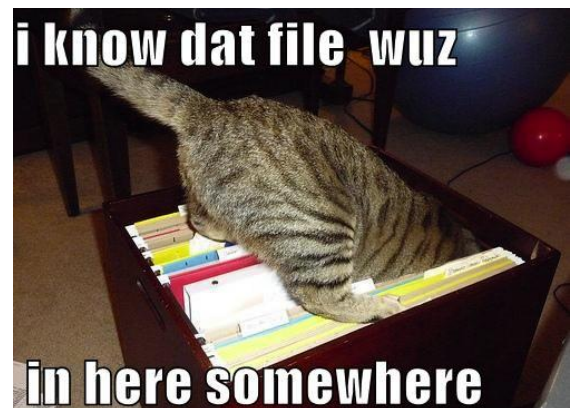
Data Access Methods:

Sequential Access:

- Sequential Access refers to the method in which records are accessed in a sequence i.e. in the order in which they are stored. If a particular record is required to be accessed, all previous records should be passed.
- Under sequential access method, all the records are kept in sequence either in ascending order or in descending order on the basis of key field.
- For E.g.: Magnetic tape devices.

Direct Access:

- In Direct access method (or Random Access Method), access of data is independent of the storage sequence. Individual records can be accessed at random, in no particular order or sequence.
- Under this method, any record can be accessed at random without passing through intervening records.
- For E.g.: Magnetic disk, Optical disk, etc.



File Organization Methods

Serial File Organisation:

- This is the simplest file organization scheme. In this method, records can be arranged one after another in chronological order.
- Serial organization is commonly found in transaction files.
- Sometimes, records in a serially organized file are processed in the order in which they occur.

- In this scheme, a new customer is given the next highest account number that has not been issued. Data about new customer are placed at the end of the existing customer account file.
- When this approach is used, it is easy to distinguish old customers from new ones because old customers have lower account numbers.

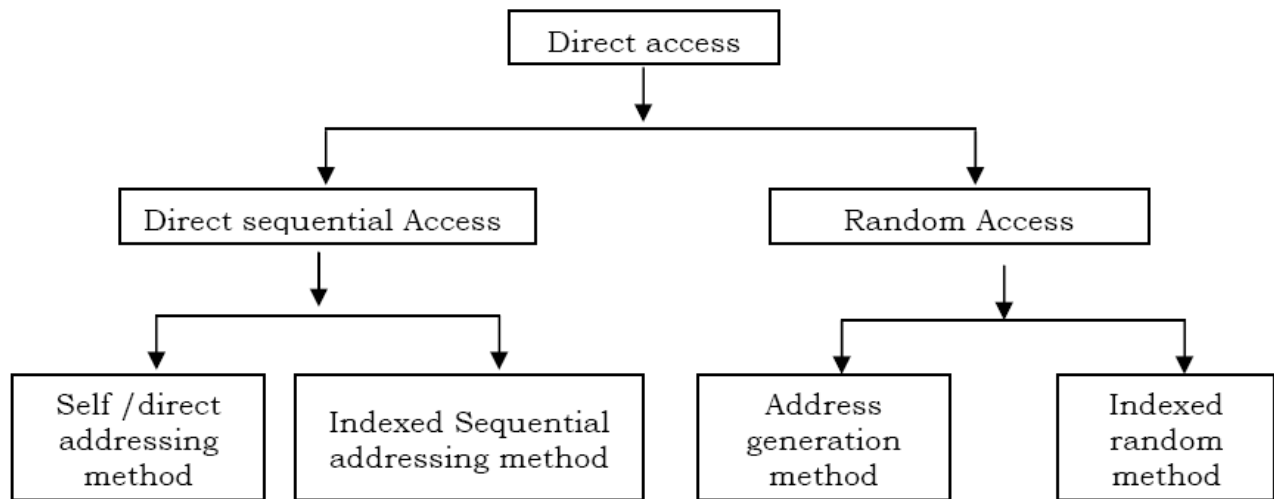


Sequential File Organisation:

- In sequential file organisation, all records are arranged in ascending or descending order by a record key.
- For example, in Payroll master file, records will be arranged in ascending order by employee number.
- To locate an individual record, a sequential search is performed, beginning from the first record. Thus each individual record must be examined until the required record is located.
- Such a search is time consuming. Therefore, sequential file organization can't provide immediate access to individual records.
- Sequential organization is suitable for master files in a normal batch processing environment where all or most of the records are processed.
- Certain storage media, like magnetic tape and paper tape allow sequential file organization only. However, direct access storage devices like floppy disk, CD, DVD etc. allow sequential file organization as well as direct access file organisation.
- Advantages:
 - » Easy to organise, maintain and understand,
 - » For locating a particular record it is sufficient to specify the key field,
 - » Relatively inexpensive media and devices can be used for storage and processing of files.
 - » It is very efficient when the activity ratio is very high i.e. for an application where large numbers of records in a file are to be regularly updated at scheduled intervals. For e.g. applications such as payroll processing.
- Disadvantages:
 - » Inefficient and uneconomical for applications in which the activity ratio is very low.
 - » It is required to read the entire sequential file even to update few records in the file.
 - » Before processing, transactions must be stored and arranged in a sequence.
 - » A batch of transactions must be accumulated before processing begins.
 - » Very soon data becomes obsolete because processing starts only after accumulating a batch of transactions.

Direct Access File Organisation method:

- Direct access file organization allows immediate access to individual records on the file. There are some devices which can provide direct access and are called Direct Access Storage Devices (DASD).
- They can directly reach any required location.
- Discs are the most widely used direct access storage devices.
- Most widely used direct access techniques are shown below:



Direct Sequential Access Methods:

A. Self (Direct) Addressing method:

- Under self (direct) addressing system, a record key is used as its relative address.
- Therefore, we can compute the record's address directly from the record key and the physical address of the first record in the file.
- This method is suitable for fixed length records.
- Suppose we want to store 1,60,000 payroll records in a hard disc with 200 cylinders. The first cylinder carries the first 800 records, 2nd cylinder carries the next 800 records and so on. For processing the file, the read/write heads would move cylinder by cylinder in which records are sequentially arranged.
- For example, ten faces in the first cylinder would carry the first 800 records as below:

F 1,1 1 to 80
 F 1,2 81 to 160
 :
 :
 F 1,10 721 to 800

- Advantage: There is no need to store an index because the data itself is stored in a particular sequence.
- Disadvantages:
 - » This method is highly impractical because files have gaps in the keys and this would leave too many empty sectors.
 - » The records must be of fixed length i.e. not suitable for variable length records.
 - » If some records are deleted, their storage space remains empty.

B. Indexed Sequential File Organisation:

- The indexed sequential file organization or Indexed Sequential Access Method (ISAM) is a hybrid between sequential and direct access file organisations.
- The records within the file are stored sequentially but direct access to individual records is possible through an index. This index is similar to a card catalog in a library.
- This organization permits both sequential as well as random access.
- For direct access of a record, the key is located by the operating system, in the index file and the address so obtained is used accessing the record. For sequential access, the index is not required.
- If it is needed to add additional records, they can be stored in a special overflow area.
- It combines the best features of sequential file organization and directs access.
- Advantage:

- » In this method it is not required to arrange the transactions in a sequence because an index is used to locate the address.
- » If the activity ratio is high it is economical to use sequential processing of records.
- » If the activity ratio is low it efficient to use direct access processing of records.
- Disadvantages:
 - » Relatively expensive.
 - » Requires extra storage space to make subsequent insertions.
 - » Requires extra storage space for storing indexes.
 - » Lot of time is wasted in processing the indexes and in reordering the files periodically.

Random Access Organisation:

- In this method, transactions can be processed in any order and written at any location throughout the file. To access a record, prior records need not be examined first. Generally this method is used by CPU. The CPU can go directly to the desired location using randomising procedure.
- Under randomising procedure records are stored in such a way that there does not exist any relationship between keys of adjacent records. This technique provides for converting the record key number into physical location represented by a disk address through computational procedures.

Factors Which Determine The Best File Organisation

Several factors must be considered in determining the best file organization. These factors are:

- a) **File volatility:** It refers to number of additions and deletions to the file in a given period of time. For Example, payroll file of a construction company, where employees are constantly changing, is a highly volatile file. In such a situation ISAM is not a good choice and other direct access methods would be better. If there are no interrogation requirements, even sequential file organisation would be appropriate.
- b) **File activity:** It is the proportion of master file records that are actually used or accessed in a given period of time. Some times each transaction will be processed immediately and hence, at a time, only one master record is accessed. In such a situation direct access method is best suited. At some other times almost every record in master file is accessed. For example, when weekly payroll is processed, every record in payroll master file is accessed. In such a situation, it is sufficient to arrange the file sequentially.
- c) **File interrogation:** It refers to retrieval of information from a file. If the retrieval of individual records must be fast, to support a real-time operation (such as airline reservation) then some kind of direct access file organization is required. On the other hand, if requirements for data can be delayed then all the individual requests can be processed under batch processing mode. In such a situation, sequential file organisation is best suited.
- d) **File Size:** Large files that require many individual references to records, with immediate responses must be organised under some type of direct access method. In case of small files it may be more efficient to search the entire file sequentially.

Short Comings of Traditional File Processing Systems

Traditional information systems were designed to meet specific information and data processing needs of a particular department such as accounting, sales, purchasing etc. Different files are created to support these functions. Data needed for each user application was stored in independent files. Many of the fields in these files were common. Following are some of the problems of traditional file processing system:

- a) **Data redundancy:** Independent data files used to include lot of duplicate data i.e. same data is recorded and stored in several files. This creates lot of inconsistency among data stored in separate files. This data redundancy causes several problems when data has to be updated.

- b) **Lack of Data Integration:** In file processing system, data produced by each application program is stored in a separate file. So, it is not possible to get integrated data (i.e. data generated from more than one program). Such kind of data is generally requested by managers for their decision making purposes.
- c) **Data Dependence:** In file processing system, major components of a system i.e. organisation of files, their physical location in storage devices, hardware, application software, etc. depend on one another. If changes are made in the format or structure of data or records in a file then changes have to be made in all programs that use such file.
- d) **Other Problems:** In file processing system, data elements such as stock numbers and customer addresses are defined differently by different end users and applications. It is very difficult to develop programs which access such data. In addition, the integrity (i.e. the accuracy and completeness) of data is suspected because there is no control over their use and maintenance.

Database

Introduction: The concepts of database and database management system were developed to solve the problems of file processing systems. A database is an integrated collection of logically related records and file. It consolidates records stored in independent files so that it serves as a common pool of data, to be accessed by different application programs. The data stored in a database is independent of computer programs using it and of secondary storage devices.

Definition: A database is a computer file system that uses a particular file organisation to facilitate rapid updating of individual records, simultaneous updating of related records, easy access to all records by all application programs and rapid access to all stored data which must be brought together for a particular routine report or inquiry or a special purpose report or enquiry. This is the precise definition of database given by "G.M.Scott". Each of the italicized phrases in the definition has a special meaning which helps to define a database.

- a) **Uses particular file organisation:** In a database, records are organized using any of the file organisation techniques available. It helps to establish associations in a database.
- b) **Rapidly updates individual records and simultaneously updates related records:** The database permits the entry of an individual transaction to update all records affected by that transaction simultaneously.
- c) **Easy access to all records by all application programs:** DBMS uses standard data definitions and record formats. With this one application program can access data from another application program. Without a database, each application program can access data from its own file only.
- d) **Rapid access to all stored data:** It provides 'rapid access' to all stored data needed by a "routine report or inquiry". Thus routine reports can be quickly provided after the end of the accounting period or whenever requested during the period because the processing of transactions is kept up to date.
- e) **Special purpose report or enquiry:** In DBMS records are kept continuously up to date. The structures of database files facilitate rapid development of special purpose reports about unanticipated problems.

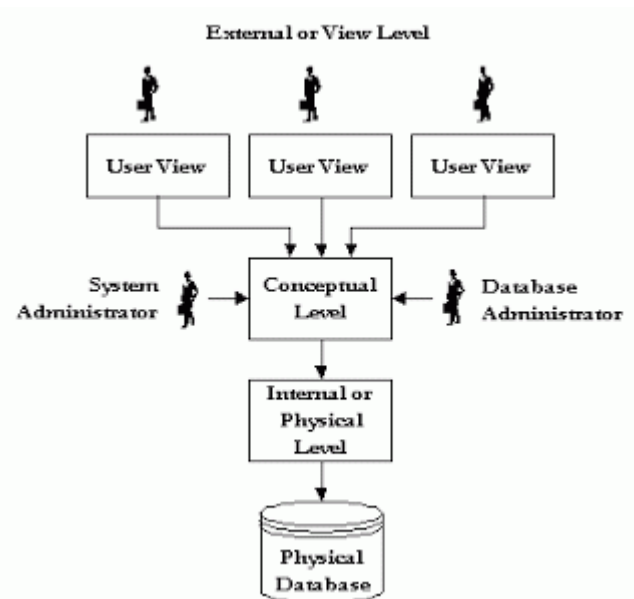
Architecture of Database:

A database follows a three level architecture:

- a) External or user view,
- b) Conceptual or global view,
- c) Physical or internal view.

a) External or user view:

- It is viewed by the chairman or the operation manager or the data entry operator.
- It is at the highest level of database abstraction.
- It includes only those portion of database or application programs which is of concern to the users.
- It is described by means of a scheme, called the external schema.
- It is defined by the users or written by the programmers.
- E.g.: An external view in its Logical Record 1 may indicate employee name, employee address and in its Logical Record 2 may indicate employee name, employee address, employee code and employee salary.



b) Global or conceptual view:

- It is viewed by Data Base Administrator.
- All database entities and relationships among them are included.
- Single view represents the entire database.
- It is defined by the conceptual schema.
- It describes all records, relationships and constraints or boundaries.
- It includes data description to render it independent of the physical representation.
- E.g.: A conceptual view may define employee code as a string of characters, employee address as a string employee code as a key and employee salary as an integer.

c) Physical or internal view:

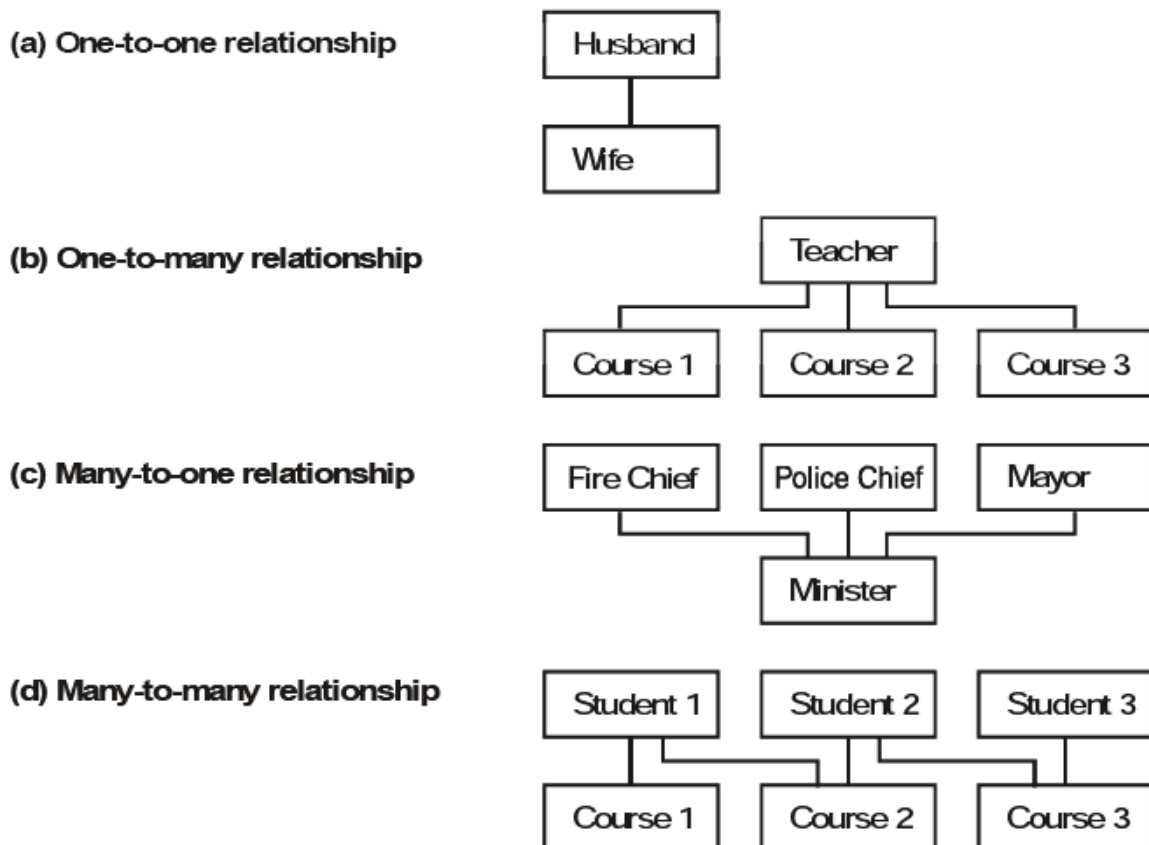
- It is at the lowest level of database abstraction.
- It is closest to the physical storage method.
- It indicates how data will be stored.
- It describes data structure.
- It describes access methods.
- It is expressed by internal schema.
- E.g.: The internal view may define that employee name consists of 30 characters, employee address also consist of 30 characters, employee code consists of 5 characters and employee salary consists of 12 numbers.

Different Kinds of Record

The relationship between data is very important for a database to work. Related data are processed in the database through relationships. There are four types of relationships in databases:

- a) One - One Relationship:** In a one-to-one relationship, one group of data is related to only one other group of data and vice versa. For example, there are 2 files in a database – Customer Record file and Customer Receivables file. Customer Record file consists of following details – Customer number and customer name. On other hand Accounts Receivable file consists of following details - customer's number and balance due by the customer. There is one customer record for each customer and one accounts receivable record for each customer. Then, each customer record is related to one receivables record, and vice versa. Thus, there is a one-to-one relationship between customer records and accounts receivable records.

- b) One- to-Many Relationship:** The second type of relationship is known as one-to-many relationship. In this type, one group of data is related to one or more other groups of data but not vice versa. For example, assume that a database contains customer records and invoice records, each with an invoice date and amount. Each customer can have any number of invoices, but each invoice can be associated with only one customer. Then the relationship between customer records and invoice records is one-to-many.
- c) Many-to-one Relationship:** This is just reverse to One-to-many relationship.
- d) Many-to-Many relationship:** The last type of relationship is many-to-many relationship. In this relationship one or more groups of data are related to one or more other groups and vice versa. For example, assume that a database contains vendor records (each with vendor's name) and inventory records (each with item description, unit price and quantity on hand). Each vendor can supply several inventory items and each item can be supplied by several vendors. Then the relationship between vendor records and inventory records is many-many.



Database Structure

Database structure is the definition of data records in which information is stored, including the number of data fields. The data in a database is organized in such a way that it is easy for people to understand. The database organization is based on one of 3 approaches for arranging data in a database. The three approaches result in three types of databases:

1. Hierarchical databases
2. Network databases and
3. Relational databases.

1. Hierarchical Database

Meaning:

- In a hierarchical database, all relationships between groups of data are one-to-one or one-to many but not “many-to-many”.
- In this database structure, records are logically organised into a hierarchy of relationships and involve an inverted tree like structure.
- The tree consists of hierarchy of nodes and the uppermost tree is called parent.
- Every element can have any number of lower level elements, called children, but every node will have only one parent.

Features:

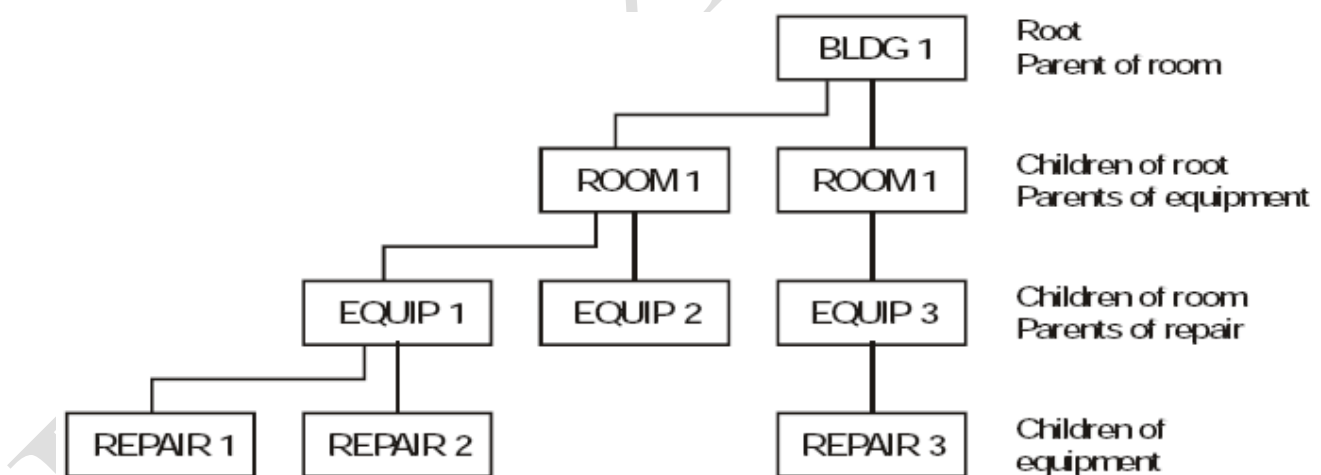
- The hierarchy should be pre-determined and implemented and therefore, they are fixed in structure and are less flexible than other database structures.
- Adhoc queries can't be made by the managers.
- When the parent node is deleted, all the child nodes get automatically deleted.
- If a particular record has to be traced then tracing will start from the root, continues downwards until the requisite record is located.

Advantages:

- It facilitates day to day structured operations because it maximises the speed in case of batch operations.
- Data processing becomes more efficient.
- For most of the users it is simple to understand and can satisfy their information requirements.

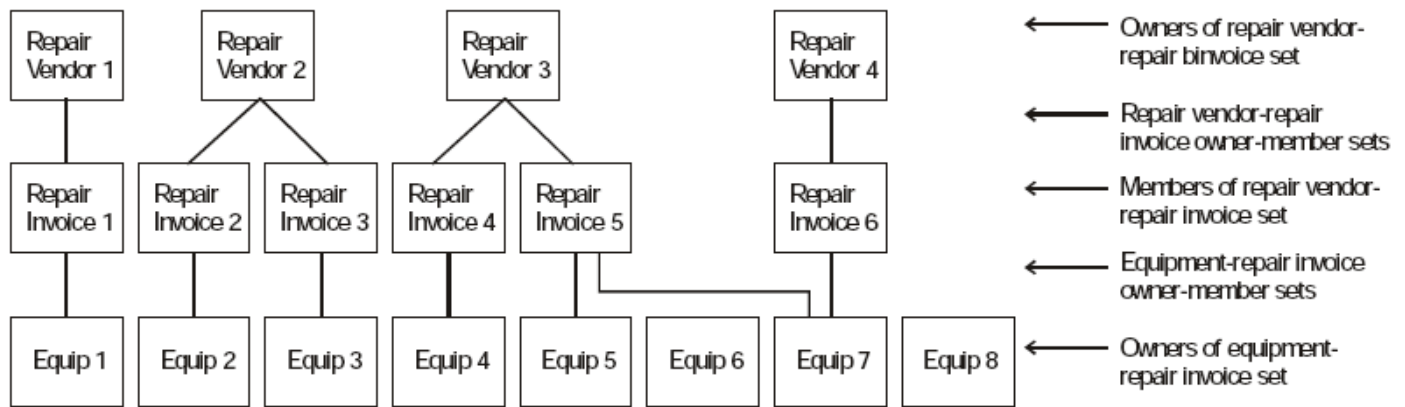
Disadvantages:

- It can't support many-to-many relationships.
- Use of query languages require multiple searches and hence time consuming.
- It is a rigid database structure and new relationships can't be accommodated within the structure.



2. Network Database Structure

- In a network database, all types of relationships are allowed, without any restriction. Thus one-to-one, one-to-many and many-to-many relationships are permitted.
- The below figure shows an example of network database. This database has one many-to-many relationship, which indicates that each vendor can supply many inventory items and each item can be supplied by many vendors. The database also has one one-to-many relationship which indicates that each warehouse can store any number of inventory items but each item can be stored in one warehouse only.



Features:

- It is a modified version of hierarchical database. In network database structure each node may have several parents.
- It is very difficult to develop this type of database structures.
- It is useful for one-to-one and one-to-many record relationships.
- The relationships should be pre-determined.

Advantages:

- It is more flexible than hierarchical database structure.
- They are appropriate to support data with many-to-many relationships.
- Relatively efficient than hierarchical database structure.
- Easy to restructure the information.

Disadvantages:

- As the number of points in the network increases it is very difficult to operate and maintain this structure.
- Less user friendly than hierarchical structure.
- Very difficult to maintain because of its complex nature.
- It is very difficult to add relationships to the existing database.

3. Relational Database Structure

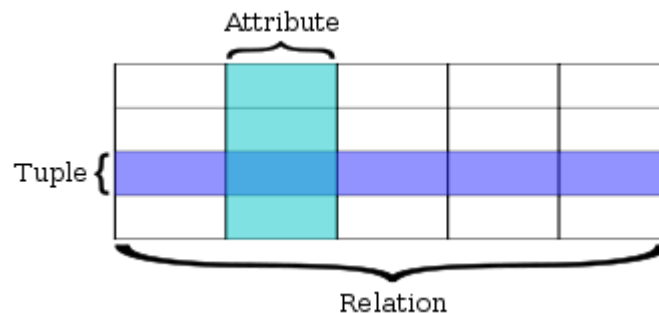
- A relational database organizes data in a different form than that of hierarchical and network databases. In a relational database, data is arranged in tables that have rows and columns. In a relational database, a table is called relation (not to be confused with 'relationship'), a row is called a tuple (which rhymes with couple) and a column is called an attribute. Some relational DBMS's use these terms; others use the terms table, row and column. Still others use file (for relation), record (for tuple) and field (for attribute).
- Relationships in relational databases are different from that of relationships in hierarchical and network databases. A relationship exists between two relations (i.e. tables) because there is a common attribute in the relations. For example, there is a relationship between INVENTORY relation and ORDER relation because the ITEM NUMBER attribute is found in both relations. Similarly, there is a relationship between BILLING relation and ORDER relation because CUST_NUMBER attribute appears in both relations. Any type of relationship i.e. one-to-one, one-to-many and many-to-many can be represented in a relational database.

Advantages:

- Highly flexible to program and retrieve data.
- It is much easier to use.
- Can handle queries in a more efficient way.

Disadvantages:

- Processing efficiency is comparatively low.
- Requires more processing capacity and memory.
- Storage space requirements are high.
- Processing can't be done without establishing the relationships.



Different Types of Database Users

- Naive users:** They are not aware of the presence of the database system supporting the usage.
- Online users:** They communicate with database either directly through online terminal or indirectly through user interface or application programs. Usually they acquire atleast some skill and experience to communicate with the database.
- Application programmers:** They are responsible for developing application programs and user interfaces.
- Data Base Administrator:** He can execute centralized control and is responsible for maintaining the database. He is the most familiar person with the database.

Advantages of Database Management Systems

Companies find number of advantages in using database management system instead using file management systems. Following are important among them:

- Data Sharing:** It is very easy to share between users. Data from the entire company can be used by users who need them. Managers can analyze the data in a more extensive (=wide) manner than in file management system.
- Reduced data redundancy:** A database minimizes duplication of data from file to file. For example in a university database student's name and address may appear in only one record rather than in the files of many departments.
- Data independence:** A database system keeps data separate from the application that uses the data. Thus, changes can be made to data definitions without making changes to every application program that uses the data. Thus program maintenance costs (i.e. cost of upgrading application programs) can be substantially reduced.
- Increased user productivity:** In database environment user with minimum technical knowledge can also generate queries using query languages and can generate reports using report generators. To generate same queries/reports MIS departments take long periods of time. Thus productivity of user also increases.
- Increased application programmer productivity:** Most database management systems offer application program development tools. With the help of these tools a programmers can write program code. These tools can be very powerful and can increase the productivity of programmer substantially.
- Improved Data Integrity:** As data redundancy is minimized, data inconsistency and threat of non integrated data are substantially decreased.

- g) Improved data administration & control:** In database environment the responsibility of protecting the database is placed in the hands of one person or department. It becomes easy to control access to data, privacy of data, updates, deletions of data etc.

Database Languages

DBMS consists of 2 languages, Data Definition Language (DDL) and Data Manipulation Language (DML):

Data Definition Language (DDL): DDL is a link between the logical and physical structure of the database. Here, logical means the way user views data; physical means the way data is physically stored. DDL is used to define the physical characteristics of each record i.e. fields within the record, each field's data type and each field's length and logical name. DDL is also used to specify relationships among records. The primary functions of DDL are:

- a) Describing the schema and sub schema.
- b) Describing the fields in each record.
- c) Describing the data type and name of each field.
- d) Providing data security restrictions.
- e) Providing logical and physical data dependence and
- f) Providing means for associating related records or fields.

Data Manipulation Language (DML): Data Manipulation Language (DML) provides techniques for processing the database such as retrieval, sorting, display, and deletion of records. In summary, the functions of DML are:

- a) To provide techniques for data manipulation such as - deletion, replacement, retrieval, sorting or insertion of data or records.
- b) Enable the user and application programs to process data on logical basis rather than on physical location basis.
- c) Provide for independence of programming languages. DML should support several, high level procedural languages such as COBOL, PL/ 1, C ++ etc.
- d) Allow the user and application programs to be independent of physical data structures and database structure maintenance.
- e) It also helps to use the record relationships.

Structure of DBMS

a) DDL Compiler:

- It converts data definition statements into a set of tables.
- Tables contain meta data (data about data) relating to database.
- It creates a format which can be used by other components of database.

b) Data Manager:

- It is the central software component.
- It is also known as the database control system.
- It converts operations in users' queries to physical file system.

c) File Manager:

- It is responsible for file structure.
- It is responsible for managing the space.
- It is responsible for locating blocks containing required records.
- It is responsible for requesting blocks from disk manager.
- It is responsible for transmitting required records to data manager.

d) Disk Manager:

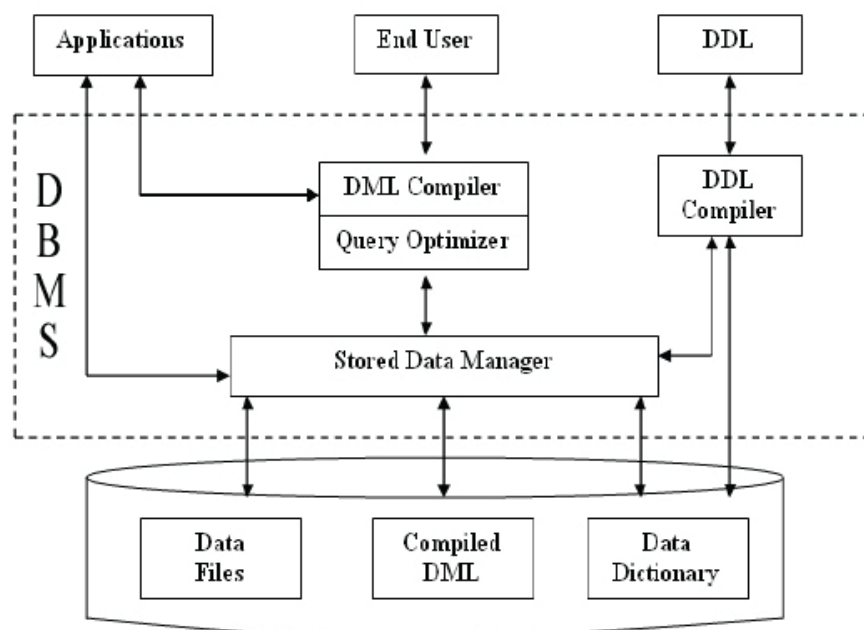
- It is a part of the Operating System.
- It carries out all physical input / output operations.
- It transfers blocks / pages requested by file manager.

e) Query Manager:

- It interprets user's online queries.
- It converts them into an efficient series of operations.
- In a form it is capable of being sent to data manager.
- It uses data dictionary to find structure of relevant portion of database.
- It uses information to modify query.
- It prepares an optimal plan to access database for efficient data retrieval.

f) Data Dictionary:

- It maintains information pertaining to structure and usage of data and meta data.
- It is consulted by database users to learn what each piece of data and various synonyms of data field means.



Database Administrator

- DBA is a database professional who actually creates and maintains the database and also carries out the policies developed by DA. DBA is responsible for defining the internal layout of the database and also for ensuring that the internal layout optimises system performance.
- To design the database, DBA must know the data requirements of users. Then he can decide the schedule, accuracy requirements, frequency of data access, search strategies, physical storage requirements of data, level of security needed, response time requirements, etc. He may also identify the source of data and the person responsible for originating and updating data. The database administrator then converts these requirements into a physical design.
- Following are other functions of a DBA:
 - To assist in the creation and maintenance of database.
 - To carrying out the policies developed by Data Administrator.
 - To look after the technical aspects of database management.
 - Defining internal layout of the database.
 - Designing a system as per the requirement of the organization.
 - Defining the contents of the database.

- Using DDL to define the various data elements and their usage.
- Maintain standards and control access to database is important aspects to be looked after by DBA.
- To ensure proper preparation of documents to help the end user to use the database effectively.
- To perform routine jobs like taking a back up, maintenance and security procedures, scheduling database following a restart and recovery procedure are done in a proper way.
- To ensure conduct of periodic audit to check for identifying and correcting violation of standards, documents and correct errors.
- To incorporate new system to access and control the database.
- To manage all activities relating to the schema controls the validity and access rights for sub-schemas, and preparation of requisite documentation.
- To ensure availability of data for sharing by the entire organisation and to ensure that the database is developed for management purposes.
- To co-ordinate discussions between user groups to determine the contents and format of the database so that data redundancy is kept to minimum.
- To demonstrate the benefits and the database technology to other managers of the organization and to educate them in the uses of DBMS.

Database Environment

Database environment consists of following components:

- a) **The Database files:** These files have data elements stored in database file organisation formats. The database is created in such a way so as to achieve the objectives of speed, multiple access paths, minimum storage, program data independence, etc.
- b) **Database Management System (DBMS):** DBMS is a set of software programs that manages the database files. DBMS accesses the files, updates the records and retrieves the requested data. The DBMS is responsible for data security which is very important in a database environment because database will be accessed by number of users.
- c) **The users:** Users consist of both traditional users (such as accounting personnel) and application programmers who are not traditionally considered as users. Users can directly interact with the database through query languages or indirectly through application programs.
- d) **A host language interface systems:** This is a part of DBMS which communicates with the application programs. It interprets the instructions in high-level language of application programs and tells to the DBMS.
- e) **The application programs:** These programs perform the same functions that they do in a traditional system but they are independent of data files and use standard data definitions. This independence and standardization makes the development process easier and faster.
- f) **A natural language interface systems:** With the help of this language, users can make queries to the database. This language is 'English-like' because instructions of this language are usually in the form of simple commands in English, rather than symbols and equations.
- g) **The data dictionary / directory:** Data dictionary is a centralized depository (collection) of information, in a computerized form, about the data in the database. Data dictionary consists of schema of the database i.e. the name of each item in the database, a description and definition of its attributes along with the names of the programs that use them, and who is responsible for the data etc. These descriptions and definitions are called as "data standards".
- h) **Online access and update terminals:** These may be adjacent (near to) to the computer or even thousands of miles away. They may be dumb terminals, smart terminals or microcomputers.
- i) **The output system or report generator:** This provides routine job reports, documents and special reports.

Data Directory

- Data dictionary is a centralized depository of information, in a computerized form, about the data in the database.
- It is also called Data Directory and contains the schema of the database i.e. the name of each item in the database and a description of its attributes names of the programs that use them, who is responsible for the data; authorization tables that specify users and the data and programs authorized for their use. These descriptions and definitions are covered under data dictionary.
- The data dictionary is helpful in the following ways:
 - a) If a data field is to be altered in any way or eliminated from the database, the dictionary can identify all programs that might require some modifications.
 - b) It also helps to protect the integrity of data in the database.
 - c) It helps programmer to quickly locate blocks of code that can be reused in new applications.
 - d) It also ensures that all design or coding actions performed by an analyst are consistent with the application.
- They inform the user / programmer of what data is available in the database and how it is used.

Different Types of Databases

- a) Operational databases:** These databases contain detailed data needed to support the operations of the entire organisation. They are also called subject area databases or transaction databases or production databases. Examples are - customer database, personnel database, inventory database and other databases containing data generated by business operations.
- b) Management database:** These databases store data and information extracted from selected operational databases and external sources. They consist of summarized data and information which is mostly needed by organisational managers and other end users. Management databases are also called information databases.
- c) Information warehouse databases:** An information warehouse stores data from current and previous years and such information is extracted (=collected) from various operational and management databases of an organisation. An important use of information warehouse databases is to determine the trend.
- d) Distributed Databases:** These databases are generated by local work groups, departments at regional offices, branch offices, manufacturing plants and other work sites.
- e) End User Databases:** These databases consist of a variety of data files developed by end users at their workstations. For example, users may store files generated by word processing packages or spreadsheet or other application packages or E-mails.
- f) External Databases:** Organisations can access data from external, privately owned online databases or data banks, for a fee. Data is available in the form of statistics on economic trends.
- g) Text Databases:** These databases will develop when computers are used to create and store documents electronically. Big corporations and government agencies have developed large text databases containing documents of all kinds.
- h) Image Databases:** The above stated databases consist of data in traditional alphanumeric form. But in image databases a wide variety of images can also be stored electronically. Thousands of pages of business documents, such as customer correspondence, purchase orders, invoices, sales catalogues and service manuals can be scanned and stored as images on a single optical disk.

Database Models

A. Distributed Database Model:

In a centralised system, the computer system and the database are both found at one location. Databases in this system are called centralised databases. If an organisation wants to decentralise its processing, the database or parts of the database must be distributed. There are basically two ways to distribute a database:

- a) **Replicated database:** In this method duplicates of entire database are provided at all sites. This method is recommended if it is necessary for every location to have frequent access to the same data. However, this method is very expensive and it is difficult to maintain consistency. Of course, replication provides some security to the database. If data at one particular location is lost, duplicate will be readily available.
- b) **Partitioned database:** Another means of distributing the database is to partition it. In this method the database is divided into segments that are appropriate for certain locations and those segments are distributed only to those locations. Many organisations with many locations, partition the database hierarchically. For example, detailed data such a payroll and sales data are kept close to their source i.e. local site. Regional and national locations receive summaries of detailed data.

Advantages:

- Distributed database reduce costs for an organisation because they reduce transfer of data between remote sites.
- They can also reduce the response time for filing orders, answering customer requests or providing managers with information.
- Immediate updation of data and faster communication of information within the firm.

Disadvantages:

- Very difficult to control a distributed database system because it increases problems of security and need more computer resources.
- If the distribution of database is not done carefully, many of the advantages of database will be lost.
- Need more computer resources.
- Increases data redundancy.

B. Object Oriented Database:

- File and database structures were unable to meet the changing needs of application programs. When organisations recognized the need for integrated databases, hierarchical, network and subsequently relational data structures emerged.
- Relational database structures are very flexible. But they are best suited to handle character and numeric data.
- The results of many engineering applications such as Computer Aided Design (CAD), Computer Aided Engineering (CAE) are not handled easily by relational systems. Expert Systems, Image Processing Systems, Multimedia Systems, Computer Aided Software Engineering (CASE), Project Management Software, Presentation Graphics Packages produce lot of important information which is not supported by traditional file and database structures. New structures are needed to handle such information.

- Object Oriented Databases are new structures which can handle such information. Object Oriented Data Base (OODB) is a natural extension of OOP. Like other database management systems OODB systems can be either active or passive.
- In an active OODB, every object is described by a set of attributes describing what the object is. The behavior of the object is also included. For example, the object for a CAD design of a new product could include instructions for on-screen display, shrinking, exploding and rotation.
- Object-oriented databases are still evolving, but the goal is to provide a repository of reusable objects that need to be created only once. This can greatly accelerate application development time and reduce application backlogs.

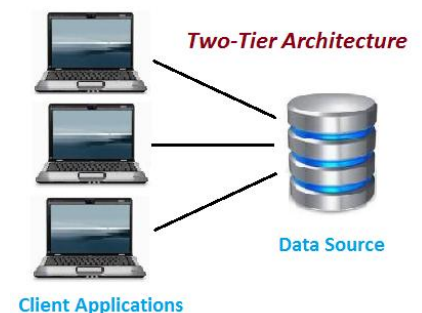
C. Client Server Database:

- It is designed in such a way that one system can connect to another system to ask a question or instruct to perform a job.
- The system that asks the questions and issues the instructions is the client and the system answering the queries and responding to the instructions is the server.
- The client machine contains the user interface logic, business logic and the database logic and the server machine contains the database.
- Both are interconnected through high bandwidth network.
- The user interface program or front end program is called client and back end program is called server.
- Client and server computers can interact in an environment which is based on heterogeneous hardware / software platforms.
- The server does all higher level functions which it alone can do leaving the client to perform lower level functions.
- The system is scaleable i.e. any number of clients may be added or removed and the shared resources may be relocated to a larger and faster server or to multiple servers.



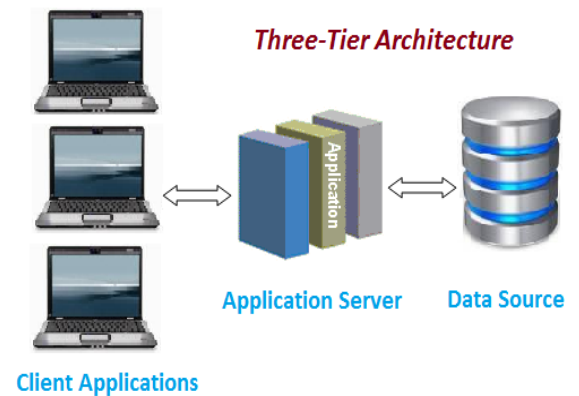
2-tier architecture:

- The above is a 2-tier model which implies a complicated software distribution procedure.
- All the application logic is executed on the personal computers. If a new software is released all such personal computers should be updated which is very costly, time consuming, complicated and error prone.
- At the client end the software first has to be installed and then tested for correct execution.
- Due to this it can't be assured that all clients work on the correct copy of the program.



3-tier & n-tier architecture:

- 3-tier and n-tier client-server database designs try to solve these problems by simply transferring the application logic from the client back to the server.
- It is achieved by inserting an application server tier between the data server tier and the client tier.
- Client tier is responsible for data presentation, receiving user events and controlling the user interface.
- The actual business logic is handled by the application server tier.
- Business objects which implement the business rules, reside in application server tier which forms the central key to solve the 2-tier problems and protects the data from direct access by the clients.
- Data server tier is responsible for data storage.



D. Knowledge Database:

- A database system provides facilities to define, create, modify, delete and read data in a system.
- Historically, the type of data maintained in a database system has been declarative, describing the static aspects of the real world objects and their associations. For e.g. a pay roll file and a personnel file can share data about salary of each and every employee, their positions, names, etc.
- A database system can also be used to maintain procedural data describing the dynamic aspects of the real world objects and their associations. For e.g. a database can contain, several amended versions of enactments in the field of labour laws to facilitate management decisions in pay negotiations.
- When both the declarative and procedural data are stored in a database it is called a knowledge database with more powerful data maintenance.

Structured Query Language and Other Query Language:

- Query languages allow programmers, managers and other users to ask adhoc questions of the database without the aid (=help) of programmers. One form of query language is SQL or Structured Query Language. SQL is a set of about 30 English line commands that has become a standard in the database industry. Many vendors of software now provide SQL along with their database software.
- SQL is used in many database management systems. Managers who understand SQL syntax can use the same set of commands in every database management system. Thus by learning SQL, manager can access data located in many database management systems.
- The basic form of an SQL command is SELECT..... FROM... WHERE.....After SELECT the user lists the fields desired (=wanted) by him. After FROM, the name of the file or group of the records that contains those fields is listed. After WHERE any conditions for the search of the records are listed. For example, user may wish to SELECT all customer names FROM customer records WHERE the state in which the customer lives is Maharashtra. So, the following command will be entered.
SELECT NAME, ADDRESS. CITY STATE, PIN
FROM CUSTOMER
WHERE STATE= 'Maharashtra'

- This gives a list of names and addresses of all customers located in Maharashtra. Some query languages use natural language set of commands. These query languages are structured so that the command used is close to Standard English as possible. For example:

PRINT THE NAMES AND ADDRESSES OF ALL CUSTOMERS WHO LIVE IN MAHARASHTRA.

- On the other hand managers need not learn COBOL, BASIC or other standard programming languages to access the database. It is sufficient to learn SQL.

Program Library Management System Software:

Meaning:

Program library management system is a database of system and application software used by the organisation. It may include:

- a) Application and system software program code,
- b) Job control statements that identify the following which manage the processing:
 - resources used
 - processes to be performed, and
 - processing parameters.



Capabilities / Functions of PLMS:

- a) It provides several functional capabilities to effectively and efficiently manage data center software inventory which include:
 - Application Program Code,
 - System Software Code,
 - Job Control Statements.
- b) It possesses integrity capabilities such that for each source program
 - A modification number is assigned,
 - A version number is assigned,
 - And it is associated with a creation date.
- c) It uses:
 - Password,

- Encryption,
 - Data Compression,
 - Automatic backup
- d) It possesses update capabilities with the facilities of:
- Addition,
 - Modification,
 - Deletion,
 - Re-sequencing library members
- e) It possesses reporting capabilities for being reviewed by management and end users by preparing lists of:
- Additions,
 - Deletions,
 - Modifications,
 - Library catalogue,
 - Library members attributes
- f) It possesses interface capabilities with the:
- Operating System,
 - Job scheduling system,
 - Access control system,
 - Online program management
- g) It controls movement of programs from test to production status.
- h) At last, it changes controls to application programs.

User Interface:

- **Design of user interface:** User interface involves designing of the ways in which users will interact with the system. Following elements should be considered in designing user interface:
 - a) Source documents to capture data.
 - b) Hard copy output reports.
 - c) Screen layout for input of source documents.
 - d) Enquiry screens for database queries.
 - e) Command languages for Decision Support Systems.
 - f) Query languages for the database.
 - g) Graphic display and color or non-monochromatic display.
 - h) Voice output to answer users or answer queries.
 - i) Screen layout manipulation by mouse or light pen.
 - j) Icons for representation of the output.
- **Development of User interface:** User interface design is developed as follows:
 - a) Identifying system users and classifying them into homogeneous groups,
 - b) Understanding the characteristics of the user group. For example, whether the system is handled by novice users or experts,
 - c) Bring out the tasks which the users wish to perform using the system,
 - d) Commencing a preliminary design of the form of interaction that will support these tasks.

Generally, prototyping tools are employed to refine the design aspect with the users.

Backup:

- 'Backup' is a utility program used to make a copy of the contents of database files and log files.



- These additional copies may be used to restore the original files after the event of a data loss. These additional copies are called 'backup files'.
- The database files consists of a database root file, log file, mirror log file and other database files called dbspaces.
- Generally 'backup and recovery' is treated as one topic and 'disaster recovery' as another.

Recovery:

- 'Recovery' is a sequence of tasks performed to restore a database to some point-in-time.
- Recovery is performed when either a hardware or media failure occurs.
- Hardware failure is a physical component failure in the machine such as, disk drive, controller card or power supply.
- Media failure is the result of unexpected database error while processing data.
- Before beginning database recovery, it is always advisable to have a back up copy of the failed database.
- This preserves the existing situation.



Disaster recovery:

- Disaster recovery is the process of regaining access to the data, hardware and software necessary to resume critical business operations after a natural or human induced disaster.
- 'Disaster recovery' is different from database recovery because the operating system and all the related software must be recovered before any database recovery can begin.

Database Files That Make Up A Database

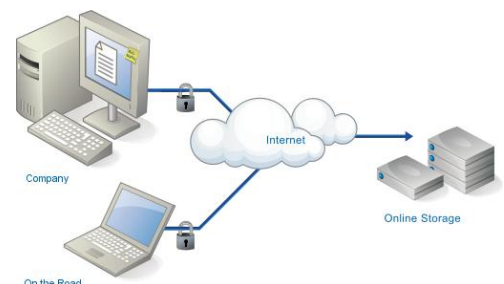
- Databases consist of disk files that store data. When we create a database, a main database file or root file is created. This main database file contains database tables, system tables and indexes. The database files consist of a database root file, log file, mirror log file and other database files called dbspaces.
- A transaction log is a file that records database modifications. Database modifications consist of insertions, updations, deletions, commits, rollbacks and database schema changes. A transaction log is not compulsory, but it is recommended.
- A mirror log is an optional file and has a file extension of .mlg. It is a copy of the transaction log and provides additional security against the loss of data and it is very much useful when the transaction log becomes unusable.

Different Types of Backups

Database backups can be performed while the database is being actively accessed (online) or when the database is shutdown (offline).

a) Online backup:

- Database backup which is performed while the database is being actively accessed is called on-line backup.
- An online database backup can be performed by executing the command-line or from the 'Backup Database' utility.
- The database engine continues recording activity in the transaction log file while the database is being backed up.



By: Josh Joseph Karukayil

- The log file is backed up after the backup utility finishes backing up the database.
- The log file contains all the transactions recorded since the last database backup.

b) Off line backup:

- Performance of backup when the database is shutdown is called offline backup.
- When a database goes through a normal shutdown process i.e. the process is not being cancelled the database engine commits the data to the database files.

c) Live backup:

- A live backup provides a redundant copy of the transaction log for restarting system on a secondary machine when the primary database server machine becomes unusable.
- A live backup is carried out by using the BACKUP utility with the command line option.

d) Full and incremental database backup:

- A database backup can be either full or incremental.
- For a full backup, the database backup utility copies the database and log.
- An incremental backup uses the DBBACKUP utility to copy the transaction log file since the most recent full backup.
- When an incremental backup is performed the mirror log is not backed up.
- When we backup and rename the log files the transaction and mirror log file are renamed and new log files are created.
- We must plan to manually back up the mirror log. Be aware of this when planning out backup and recovery strategy.



Different Steps In Development of A Backup And Recovery Strategy

Following are the steps in the development of a backup and recovery strategy:

- 1. Understand what backup and recovery means to the business:** How long can a business survive without access to the corporate data? Express the answer in terms of minutes, hours or days. If the recovery time is in minutes then database backup and recovery is critical to the business and it is very important to implement some kind of backup and recovery strategy. If recovery time can take hours then we can have more time to perform the tasks. If recovery can be expressed in terms of days then time appears to be less important.
- 2. Management commits time and resources for the project: Management** must commit some financial resources towards the development and implementation of a backup and recovery strategy. The strategy can be basic or quite extensive depending upon the business needs of the company. After developing a backup and recovery strategy, management should be informed of the expected backup and recovery times. Anticipate management countering the timings by preparing alternative solutions. Then, management will decide the best solution.
- 3. Develop, test, time, document, health check, deploy and monitor:** These are the most important phases in the development of a backup and recovery strategy:
 - Create backup and recovery commands. Verify whether these commands produce the desired results.
 - Prepare time estimates for executing backup and recovery commands. Use this information to identify what commands will be executed and when.
 - Document the backup commands and create written procedures for outlining
 - where the backups are kept,
 - identify the naming convention used and the kind of backup performed.
 - Incorporate health checks into the backup procedures to ensure that the database is not corrupt.

- Deployment of backup and recovery consists of setting up of backup procedures on the production server. Provide necessary hardware and any other supporting software to perform these tasks.
 - Monitor backup procedures to avoid unexpected errors. If any changes take place in the process, reflect those changes in the documentation.
4. **Beware of external factors that affect recovery:** External factors that affect database recovery are time, hardware and software. Allow additional recovery time for performing miscellaneous tasks such as entering recovery commands or retrieving and loading tapes. Factors that influence time are size of database files, recovery medium, disk space and unexpected errors. As the backup and recovery strategy develops it is necessary to check the performance of the equipment and software to ensure that it meets our expectations.
 5. **Protect database backups by performing health checks:** Database health checks are run against the database and log files to ensure that they are not corrupt. If the database file is found to be corrupt, we need to recover it from the previous database backup.

Data Warehouse

A data warehouse is a computer database that collects, integrates and stores an organization's data with the aim of producing accurate and timely management information and supporting data analysis. Data warehouse has become a distinct type of computer database during the late 1980's and early 1990's.



Need for data warehouses:

They are developed to meet the growing demand for management information and analysis that could not be met by operational systems. Operational systems were unable to meet this need because of following reasons:

1. The processing load of reporting has reduced the response time of the operational systems,
2. The database designs of operational systems were not optimised for information analysis and reporting,
3. Most organisations had more than one operational system, so company-wide reporting could not be supported from a single system, and
4. To develop reports in operational systems it was required to write specific computer programs which were very slow and expensive.
5. As a result, separate computer databases are built that are specifically designed to support management information and for the purpose of analysis.
6. These data warehouses were able to bring in data from different data sources such as mainframe computers, minicomputers, personal computers and office automation software such as spreadsheets and integrate this information in a single place. This capability is coupled with user-friendly reporting tools.

Various Stages In Development of Data Warehouses

As technology improved and user requirements increased, data warehouses have evolved through several fundamental stages:

- a) **Offline Operational Databases:** Data warehouses in this initial stage are developed by simply copying the database of an operational system to an off-line server. As a result the processing load of reporting does not impact the performance of the operational system.
- b) **Offline data warehouse:** Data warehouses in this stage are updated on a regular time cycle (usually daily, weekly or monthly) from the operational systems and the data is stored in an integrated reporting oriented data structure.
- c) **Real time data warehouse:** Data warehouses at this stage are updated on a transaction or event basis i.e. data warehouse is updated every time an operational system performs a transaction.
- d) **Integrated data warehouse:** Data warehouses at this stage are used to generate activity or transactions that are passed back into the operational systems for use in the daily activity of the organization.

Various Components Of Data Warehouse

The primary components of the majority of data warehouses are:

1. **Data Sources:** Data sources refer to any electronic repository of information that contains data of interest for management use or analysis. This definition covers mainframe databases, client-server databases, PC databases, spreadsheets and any other electronic store of data. Data needs to be passed from these systems to the data warehouse either on a transaction-by-transaction basis (real-time data warehouses) or on a regular cycle, e.g. daily or weekly. (off line data warehouses).
2. **Data Transformation:** The Data Transformation layer receives data from the data sources, cleans it and standardises it and loads it into data repository. Generally this is called "staging of data" because data generally passes through a temporary database while it is being transformed. Transformation of data can be done either manually or through a specific type of software. Regardless of the software used, following activities occur during data transformation:
 - a) Comparing data from different systems to improve data quality (For e.g. Date of birth for a customer may be blank in one system but contain valid data in another system. The data warehouse will retain the date of birth field from the second system)
 - b) Standardising data and codes.
 - c) Integrating data from different systems (e.g. if one system stores orders and another stores customers, then these data elements need to be linked together)
 - d) Performing other functions such as determining change to be made to files to reduce data load times, generating or finding replacement keys for data, etc.
3. **Data Warehouse:** The data warehouse is a relational database organised to hold information in a structure that best supports reporting and analysis. Most data warehouses hold information for at least 1 year. As a result these databases can become very large.
4. **Reporting:** If the data warehouse is to be useful, the data in the data warehouse must be available to the organisation's staff. Several software applications can perform this function or reporting can be custom developed. Examples of different types of reporting tools are:
 - a) Business intelligence tools: These are software applications that simplify the process of development and production of business reports based on data warehouse data.
 - b) Executive information systems: These are software applications that are used to display complex business metrics and information in a graphical way to allow rapid understanding.
 - c) OLAP tools: OLAP tools arrange data into logical multi dimensional structures and users can select the dimension in which he wants to view data.
 - d) Data Mining: Data mining tools allow users to perform detailed mathematical and statistical calculations to detect trends, identify patterns and analyse data.
5. **Metadata:** Metadata or "data about data" is used to inform operators and users of the data warehouse about its status and the nature of information held in the data warehouse. For example, the most

recent data load date, the business meaning of a data item, the number of users that are currently logged in etc.

6. **Operations:** Data warehouse operations consist of loading, manipulating and extracting data from data warehouse. Operations also cover functions like user management, security, capacity management, etc.

Optional components:

In addition, the following components also exist in some data warehouses:

- a) **Dependent data marts:** It is a physical database that receives all its information from the data warehouse. The main purpose is to provide a sub-set of the data warehouse's data for a specific purpose or to a specific sub-group of the organisation.
- b) **Logical data marts:** It is a filtered view of the main data warehouse but does not physically exist as a separate data copy. The main advantage of this approach is that it does not require additional disk space.
- c) **Operational data store:** It is an integrated database of operational data. It contains current or near term data. An ODS may contain 30 to 60 days of information, while a data warehouse typically contains years of data. ODS's are used to provide some near real time reporting which a data warehouse can't provide. This is so because Data Warehouse's loading time and architecture prevents it from providing near real time reporting.

Different Methods of Sorting Data In Data Warehouse

All data warehouses store their data grouped together by subject areas that reflect the general usage of the data (Customer, Product, Finance etc.) The general principle used in the majority of data warehouses is that data is stored at its most elemental level for use in reporting and information analysis. Within this generic intent, there are two primary approaches to organise data in a data warehouse.

1. Dimensional approach:

In this approach, information is stored as "facts" which are numeric or text data that capture specific data about a single transaction or event and "dimensions" which contain reference information that allow each transaction or event to be classified in various ways.

As an example, a sales transaction would be broken up into facts such as the number of products ordered, the price paid and dimensions such as date, customer, product, geographical location and sales person.

Advantages:

- a) The Data Warehouse is easy for business staff with limited information technology experience to understand and use.
- b) As the data is pre-processed into the dimensional form, the Data Warehouse tends to operate very quickly.

Disadvantage:

It is quite difficult to add or change later if the company changes the way in which it does business.

2. Normalisation approach:

In this approach, the data in the data warehouse is stored in third normal form. The main advantage of this approach is that it is quite straightforward to add new information into the database. The primary disadvantage of this approach is that it is very slow to produce information and reports.

Advantages of using data warehouses:

Following are some of the advantages in using a data warehouse:

- a) Enhances end-user access to a wide variety of data.

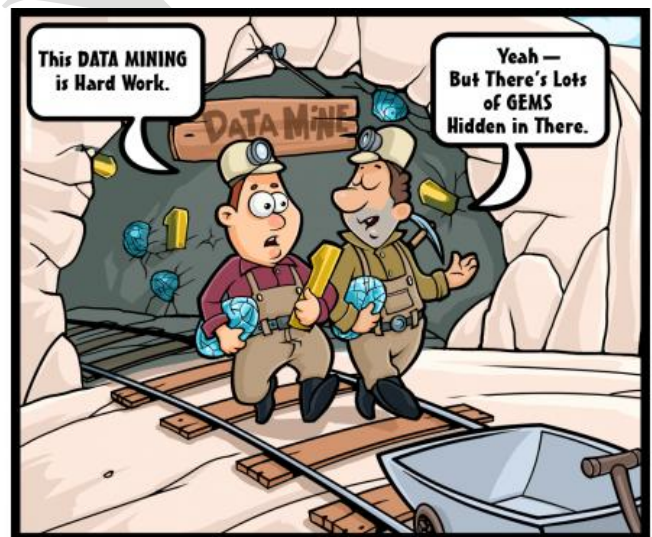
- b) Increases data consistency.
- c) Increases productivity and decreases computing costs.
- d) It is possible to combine data from different sources, in one place.
- e) It provides an infrastructure that could support changes to data and replication of the changed data back into the operational systems.

Concerns in using data warehouses:

- a) Extracting, cleaning and loading data could be time consuming.
- b) Data warehousing project scope might increase.
- c) Compatibility problems with systems already in use e.g. transaction processing system.
- d) Providing training to end-users, who are unable to use data warehouse.
- e) Security could be a major issue, especially if the data warehouse is web accessible.
- f) A data warehouse is a high maintenance system.

Data Mining

- Data mining is concerned with the analysis of data and the use of software techniques for finding patterns and regularities in sets of data.
- Here, a computer software is responsible for finding the patterns by identifying the underlying rules and features in the data.
- The logic behind data mining is that it is possible to strike gold in unexpected places.
- Data mining software extracts patterns that are previously unrecognized or so obvious that no one has noticed them before.
- The analysis process starts with a set of data, uses a methodology to develop an optimal representation of the data during which time knowledge is acquired.
- Once knowledge is acquired this can be extended to larger sets of data basing on the assumption that the larger data set has a structure which is similar to the sample data.
- This process is similar to mining activity where large amounts of low grade materials are sifted through in order to find some valuable thing.

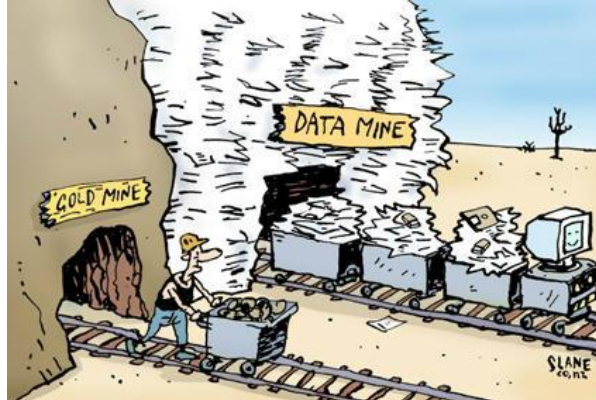


Steps in Data Mining:

The data mining activity starts with raw data and ends with extracted knowledge which is acquired from the following stages:

- a) **Selection:** Selecting or segmenting the data according to some criteria, e.g. all those people who own a car, is the first step in data mining. In this way subsets of data can be determined.
- b) **Preprocessing:** This is the data cleansing stage where certain information is removed which is deemed unnecessary and may slow down the queries. For example, it is unnecessary to study the sex of a patient when studying pregnancy. As data is drawn from several sources, there is a possibility of inconsistency. So, data is reconfigured to ensure consistency. For example sex of a person may be recorded as 'F' or 'M' in some cases and in some other cases it may be recorded as 1 or 0. So, data should be reconfigured to ensure consistency.

- c) **Transformation:** The data is not merely transferred across but transformed in that overlays may added such as the demographic overlays commonly used in market research. The data is made useable and navigable.
- d) **Data mining:** This stage is concerned with the extraction of patterns from the data. A pattern can be defined as a given set of facts (data) F , a language L , and some measure of certainty C . A pattern is a statement S in L that describes relationships among a subset F_s of F with a certainty C such that S is simpler in some sense than the enumeration of all the facts in F_s .
- e) **Interpretation and evaluation:** The patterns identified by the system are interpreted into knowledge which can then be used to support human decision-making e.g. prediction and classification tasks, summarizing the contents of a database or explaining observed phenomena.





COMPUTER NETWORKS AND NETWORK SECURITY

Computer Network:

- A computer network is a collection of computers and terminal devices connected together by a communication system.
- The set of computers may include large-scale computers, medium scale computers, mini computers and micro computers.
- The set of terminals may include dumb terminals, intelligent terminals, workstations and miscellaneous devices such as telephone lines, printers, etc.
- There is no specific definition of a computer network. However, Computer networks increase the reliability of computer resources, facilitate overall system development and also satisfy the primary objective of resource sharing such as device sharing, file sharing, program sharing and program segmentation.

Purpose of networks:

- It allows departments to share hardware devices.
- It allows information to be shared.
- It allows electronic transfer of text.
- It allows decentralization of various data processing functions.
- It facilitates communication between organizations.

Most commonly found networks:

- Local Area Networks (LAN)
- Metropolitan Area Networks (MAN)
- Wide Area Networks (WAN)
- Virtual Private Networks (VPN)

Need And Scope of Computer Networks

Following are some of the ways in which a computer network can be beneficial to a business.

- a) **File Sharing:** File sharing is the most common function provided by networks and consists of grouping all data files together on a server or servers. When all data files in an organization are stored in one place, it is easier for staff to share documents and other data. It also helps to organize the files in a systematic way. Network operating systems also help to restrict access to these files to authorised personnel only.
- b) **Print Sharing:** In a network environment, a single printer can be shared by multiple users. This can reduce the number of printers the organization must purchase, maintain and supply. Network printers are often faster and more capable than those printers which are connected to stand alone computers.
- c) **E-Mail:** Internal or "group e-mail" enables staff in the office to communicate with each other quickly and effectively. Group email applications also provide capabilities for contact management, scheduling and task assignment.
- d) **Fax Sharing:** When a shared modem is connected directly to the network server then it can send/receive fax directly. With this facility users can fax documents directly from their computers without any need for printing them on to paper. Incoming faxes can also be handled by the network

and forwarded directly to users' computers via email. With this facility it is not necessary to print a hard copy of every fax.

- e) Remote Access: Sometimes staff may require access to their email, documents or other data from remote locations. With the help of this facility users can dial into their organization's network via telephone and access all the network resources as if they are in office. With the help of Virtual Private Network (VPN) even the cost of long-distance telephone calls can be avoided.
- f) Shared Databases: This is a subset of file sharing. If the organization maintains an extensive database - for example, a membership, client, grants or financial accounting database - a network is the only effective way to make the database available to multiple users at the same time.
- g) Fault Tolerance: Establishing fault tolerance is a process which ensures that there are several lines of defense against accidental data loss. An example of accidental data loss might be a hard drive failure or someone deleting a file by mistake. In a network it can be prevented by maintaining redundant hardware, tape libraries, UPS, etc.
- h) Internet Access and Security: When computers are connected through a network, they can share a common network connection to the Internet. This facilitates email, document transfer and access to the resources available on the World Wide Web.
- i) Communication and collaboration: A network helps employees to share files, view other people's work and exchange ideas more efficiently. In a big office, one can use e-mail and instant messaging tools to communicate quickly and to store messages for future reference.
- j) Organization: Network scheduling software helps to arrange meetings without constantly checking everyone's schedules. This software usually includes other helpful features such as shared address books, to-do lists, etc.

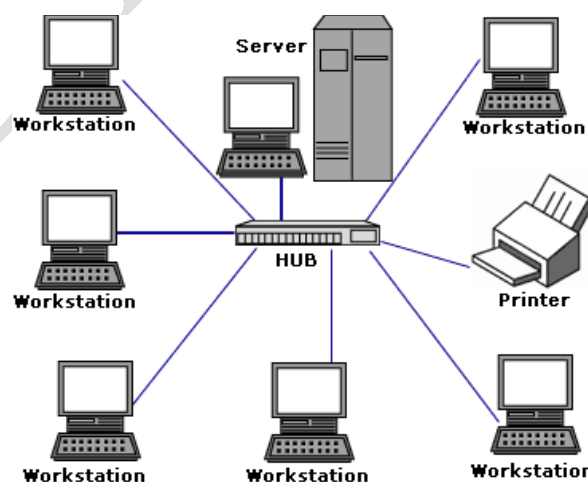
Benefits of Using A Computer Network

- As the business grows, good communication between employees is needed. Organisations can improve efficiency by sharing information such as common files, databases and business application software over a computer network. Following are the benefits of using networks:
 1. Can improve communication: Organisations can improve communication by connecting their computers and working on standardised systems, so that:
 - a) Staff, suppliers and customers can share information and get in touch with each other more easily,
 - b) Information sharing can make the business more efficient – e.g. in a network it is possible to share a file stored in a common database. With this we can avoid the same data being keyed for multiple times, which would waste time and could result in errors.
 - c) Staff can handle the queries in a better way. So, they can deliver better quality of service to their customers.
 2. Reduce costs and improve efficiency: By storing information in one centralised database and streamlining working practices, organisation can reduce costs and improve efficiency. With this:
 - a) Staff can deal with more number of customers at the same time.
 - b) Network administration can be centralised. So, less IT support is required.
 - c) Costs can be reduced by sharing peripherals such as printers, scanners, external discs, tape drives and Internet access.
 3. Reduction in errors: All the staff can work from a single source of information. So, organisations can reduce errors and improve consistency because standard versions of manuals and directories can be made available and data can be backed up from a single point on scheduled basis. This ensures consistency.

Local Area Network (LAN)

- LAN is a digital communication system capable of interconnecting large number of computers, terminals and other peripheral devices within a limited geographical area, typically under 1 km.

- LAN's normally operate within a compact area such as office building or a campus and is owned by the user organisation.
- Major parameters considered in LAN's are the topology, the transmission media and the speed of transmission. Common topologies include Star, Bus and Ring.
- One computer, with large capacity disk drive, can become server to other clients. Software can be stored on this central server and used by the whole group.
- They decentralise the processing from mainframes and mini computers to personal computers.
- Coaxial and twisted pair cables are used for data transmission.
- Communication channels are generally owned and maintained by the user organization. These channels are relatively error free (for e.g. a bit error rate of 1 in 10⁸ bits transmitted.)
- The attached computers may be of different types and perform variety of functions such as data processing, word processing and electronic mail.
- The two main purposes of LAN are to link computers within an organisation so that they can share expensive peripheral devices (for e.g., high speed printers or magnetic disks) and to allow these computers to communicate with each other.
- Characteristic features / Important requirements of LAN:
 - a) **Compatibility:** A local area network must be compatible so that software can be easily written and widely distributed. A LAN operating system must be flexible i.e. it must support large variety of hardware.
 - b) **Internetworking:** It should be possible to interconnect 2 LANs. Bridge acts as a mediator between LANs of similar topology and protocol. Bridging of different LANs together is one of the most important requirements of any network. Users should easily access resources from all workstations on the bridge network in a transparent way i.e. no special commands should be required to cross the bridge.
 - c) **Growth path and Modularity:** Another important feature of a LAN is its modularity. A set of PCs should be easily converted into LAN. It should be able to grow simply by adding additional workstations. For e.g. if more storage is required, one should be able to add another hard disk drive or another server.
 - d) **System reliability & maintenance:** In LAN, all computers are prone to system lockups, power failures and other catastrophes (=disaster, calamity). If the central processing system goes down, all users connected to it will also fail to work. However, a LAN operating system should be powerful enough to withstand such accidents.



Advantages of LAN

In the environment of LAN, users can have their own independent processing stations while sharing expensive computer resources like hard disks, printers and plotters. Because of this advantage many users

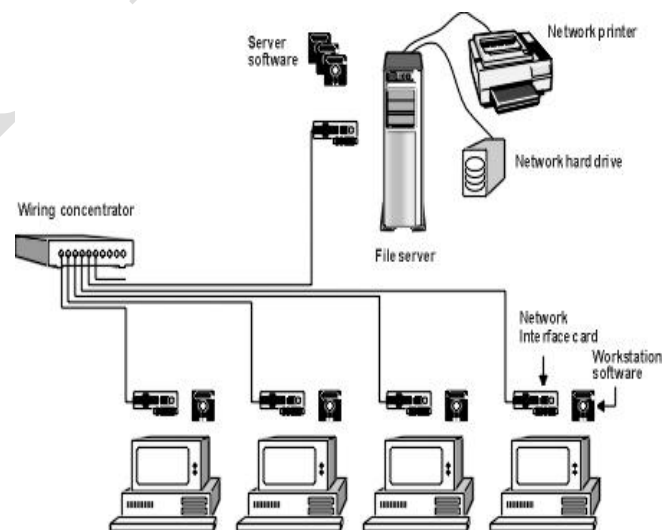
preferred LAN's. But, today, there are several reasons that are making the users to move towards LAN. These include:

- a) **Security:** Security for programs and data can be achieved using servers that are locked physically and logically (i.e. through passwords, etc). Diskless nodes also offer security by not allowing users to download important data on floppies or upload unwanted software or virus.
- b) **Expanded PC usage through inexpensive workstation:** Once LAN is set up, it is very easy and economical to accommodate additional employees through diskless PCs. On the other hand existing PCs can be easily converted into nodes by adding network interface cards.
- c) **Electronic mail and Message Broadcasting:** Electronic mail allows users to communicate easily with other employees. Each user can be assigned a mail-box on the server. Messages to other users can be dropped into the mail-box and read by them when they log into the network. If a particular message has to be communicated to everyone in the office, broadcasting facility can be used.
- d) **Organisational benefits:** Benefits of LANs are numerous. These include reduced costs in computer hardware, software, peripherals and drastic reduction in time and cost of training and retraining man power to use the systems. Managers and executives can communicate with each other more easily and quickly. Further, information flow becomes easier and smoother.
- e) **Data management benefits:** Since data is located centrally on the server, it is easy to manage it and also to maintain back up copies. It is not necessary to transfer files through floppies.
- f) **Software cost and upgradation:** If the organisation wants to purchase licensed software, purchasing a network version can save lot of money. Software upgradation is also easy and cheap.

Components of LAN

A typical local area network has five basic components. They are:

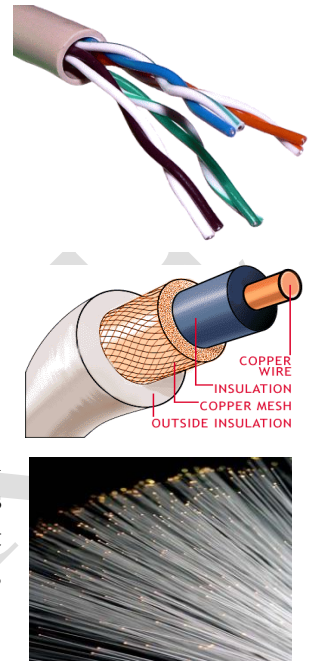
- a) **File Server:** It is a computer system used for the purpose of managing the files, servicing the network printers, handling network communications and other functions. A server may be dedicated or non-dedicated. A server should have huge amount of RAM because it is required to serve the requests of several users. Thus a Pentium system is preferable for better overall performance of the network.
- b) **Network operating system:** It is loaded in the server's hard disk along with system management tools and user utilities. Thus DOS or Windows operating system is no longer valid. However, most DOS/Windows programs can be run as usually.
- c) **Workstations:** Workstations are attached to the server through network interface card and cables. Workstations are normally intelligent systems, such as IBM PC. Dumb terminals that are used in mainframes and mini computers are not supported on LANs because they are not capable of processing on their own. In other words only intelligent terminals are used in LANs. PCs load programs and data from server and do the processing on their own. After processing the files are again stored in the server. Workstation can also be a diskless PC. In such a case operating system is loaded from the file server. In short, a PC + LAN card = Workstation.
- d) **Network interface card:** Every device connected to a LAN needs a Network Interface Card (NIC) to plug into the LAN. For e.g. to connect a PC to Ethernet LAN, it must have Ethernet card.
- e) **Network Cabling:** Once the server, workstations and network interface cards are arranged, network cabling is used to connect everything together. The most popular type of network cables are twisted-pair cables, co-axial and fiber optic cables. It is important that cables and cards should match each other.



Different Kinds of Cables Used In LAN

Following are the most commonly used cables in Local Area Networks:

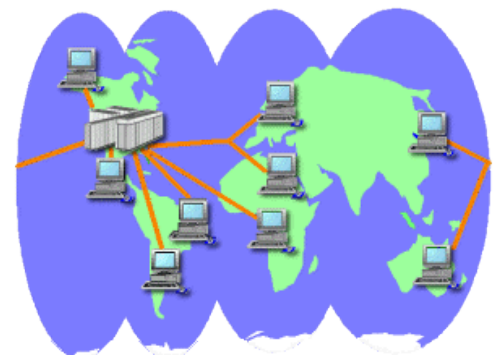
- a) **Twisted – Pair cables:** Twisted-pair wires or cables are similar to cables used for home and office telephone system. Two insulated wires are twisted around each other. It is inexpensive and easy to install. Due to technological improvements, capacity of twisted-pair cables has increased. Now they can handle data communications with speeds up to 10 mbps (= million of bits per second) over limited distances.
- b) **Coaxial Cable:** It is a well established and long-used cabling system for terminals and computers. These cables come in a variety of sizes to suit different purposes. Coaxial cables are commonly used to connect computers and terminals in a local area such as an office, floor, building or campus. This cable is conventionally used for cable television network.
- c) **Fiber Optic Cables:** Fiber optic cables use light as the communication medium. To create the on-and-off bit code needed by computers, light is rapidly turned on and off inside channel. Fiber optic cables are light weight and can handle huge amount of data. They can be installed in environments hostile (=not suitable) to copper wire, such as wet areas or areas subject to electromagnetic interference. Data is more secure in fiber optic networks.



	Difference	Twisted pair	Co-axial	Fiber-optic
1.	Medium of transmission	Copper wire	Copper wire	Glass fiber
2.	Electromagnetic interference	High interference	Moderate interference	No interference at all.
3.	Cost	Inexpensive	Moderate	Expensive
4.	Band width	Low	Moderate	High
5.	Speed	Slow	Moderate	High speed
6.	Maintenance	Easy	Moderate	Difficult

Wide Area Network (WAN)

- WAN is a digital communication system which interconnects different sites, computers and user terminals that are spread over a wide area (a state, a country or even world-wide). It also helps LANs to communicate with each other.
- It covers a wider geographical area with various communication facilities such as long distance telephone lines, satellite transmission and even under-sea cables.
- This type of communication network may be developed to operate nationwide or worldwide.
- It is a commercial data network that provides data communication services for business and government agencies.
- Using WAN, users can send electronic messages, data, graphics, programs, documents and even video information rapidly and economically.
- Examples of WANs are inter-state banking networks, airline reservation systems, etc.



Characteristics of WAN:

- The transmitting and receiving equipments are distributed over wider geographical area.
- The basic components in a common WAN include a host computer which is linked through various inter-connected communication lines to sub-ordinate computers.
- Communication channels between machines are usually furnished (= provided by) by a third party (for e.g. Telephone Company, public data network, satellite carrier, etc.).
- WAN typically operate at lower link speeds (about 1 MBPS)
- Channels are of relatively low capacity.
- Channels are relatively error prone (a bit error rate of 1 in 10⁵ bits transmitted)

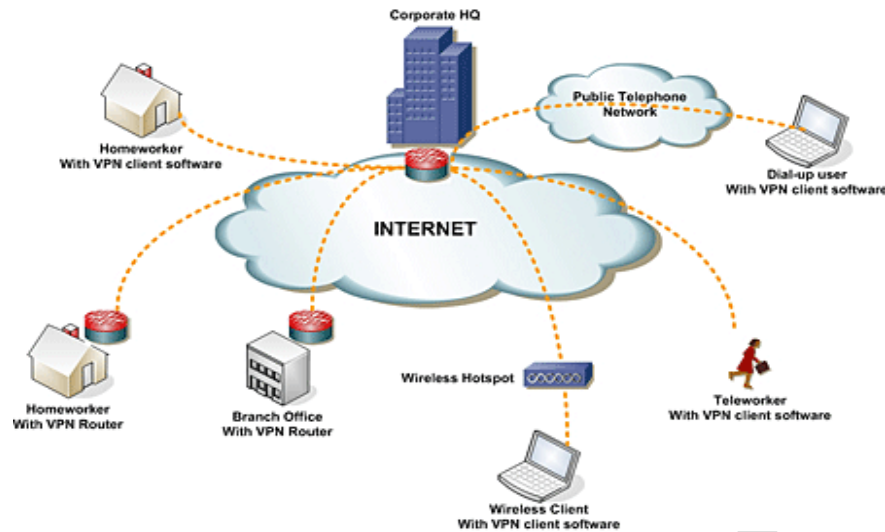
No.	Difference	Local Area Network	Wide Area Network
1.	Spread/Coverage	A LAN is restricted to a limited geographical coverage of few kilometers.	WAN spreads over greater distance and may operate nationwide or even worldwide.
2.	Data transmission errors	Fewer data transmission errors occur in case of LAN because the distance covered is less.	When compared to LAN, error rate is more because the distance covered is more.
3.	Data Transmission speed.	Data transmission speed is much higher in LAN than in WAN. Typical transmission speeds in LAN'S are 1 to 10 MBPS.	In a WAN the data transmission speed ranges from 180 to 9600 Bits per second
4.	How nodes are connected?	In a LAN, computers, terminals and peripheral devices are usually connected with wires and coaxial cables.	But in WAN there may not be direct physical connection between various computers.
5.	Cost of Transmission	The cost to transmit data in a LAN is negligible since the transmission medium is usually owned by the user organisation.	Cost will be high because the transmission medium used is leased lines or public systems such as telephone lines, microwaves and satellite links.
6.	Communication Mode	Communication may take place just by a way of direct cabling.	Communication takes place by way of telecommunication cables, satellites or microwaves.
7.	Security	Security is not that much important because the network runs within the organisation.	Security is very important because the network has to run outside organisation also.

Metropolitan Area Network(MAN)

- A Metropolitan Area Network (MAN) is somewhere between a LAN and a WAN.
- Sometimes MAN refers to a network that connects systems or local area networks within a metropolitan area (roughly 40 kms in length from one point to another).
- MANs are based on fiber optic transmission technology and provide high speed interconnection between sites (10 MBPS or so).
- MAN can support both data and voice.
- Cable television networks are best examples of MANs that distribute television signals.

Virtual Private Network (VPN)

- A VPN is a private network that uses a public network (usually Internet) to connect remote sites or users together. It will not use a dedicated, real-world connection such as leased line. It uses "virtual" connections routed through the Internet from the company's private network to the remote site or employee.



Types of VPN:

Following are the 2 most common types of VPN

1. Remote-access:

- **Meaning:** This is a user-to-LAN connection used by a company that needs to connect to the private network from various remote locations. It is also called as Virtual Private Dial-Up Network (VPDN).
- **Working:** Generally, a company that wishes to set up a large remote-access VPN will outsource it to an Enterprise Service Provider (ESP). The ESP sets up a Network Access Server (NAS) and provides desktop client software to all the computers of remote users. Employees can dial a toll-free number to reach the NAS and use their VPN client software to access the corporate network. They provide secure, encrypted connections between a company's private network and remote users through a third-party service provider.
- **Suitability:** It is suitable for a company with large number of employees spread over wide area. For example a company with hundreds of sales people in the field needs a remote-access VPN.

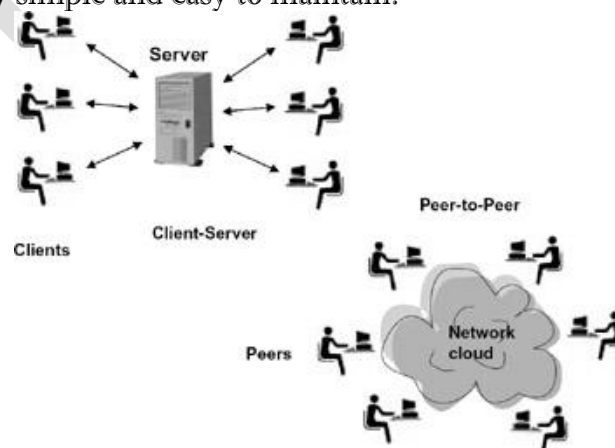
2. Site-to-Site VPN:

- Through the use of dedicated equipment and large-scale encryption, a company can connect multiple fixed sites over a public network such as Internet. Site-to-site VPNs can be one of the following two types:
 - a) **Intranet based:** If a company has one or more remote locations that they wish to join in a single private network, they can create an intranet VPN to connect LAN to LAN.
 - b) **Extranet based:** When a company has a close relationship with another company (for example, a partner, supplier or customer), they can build an extranet VPN that connects LAN to LAN. With this, various companies can work in a shared environment.

Network Architectures

- The terms LAN or WAN indicates the physical area covered by the network. The way in which individual computers (called nodes) on a network interact with other computers depends on how they are organised. The scheme of organizing network is called network architecture. There are only two basic types of architecture:
 - a) **Server-based (Client-Server Model)**

- This type of network consists of certain machines and devices (called servers) that are fully dedicated to provide various services to the other computers (called clients).
 - Server can be either dedicated or non-dedicated.
 - Different types of specialised servers include file, fax, printer, modem, E-mail, database server, etc.
 - The most common type of client server arrangement is a LAN composed of microcomputers connected to a network server. The network serves all clients (users) of the LAN.
 - A client program running on one of the microcomputers can request specific data from the server. The server program retrieves the requested data from its database and returns it to the client.
 - Server can also answer the queries raised by client computers.
 - This way, a LAN permits all the computers connected to it to share hardware, software and data. The most commonly shared resources are disk-storage devices and printers.
 - The architecture is used when there are large numbers of nodes in the network.
- b) Peer to peer:
- In peer-to-peer architecture, there are no dedicated servers. All computers are equal. That is why they are termed as peers.
 - Normally, each of these machines function both as a client and as a server. This arrangement is suitable when:
 - i. there are limited numbers of users (10 or less),
 - ii. users are located in a small area and
 - iii. security is not an important issue.
 - Users can freely access data and programs that reside (=lie) on other computers across the network.
 - d. The network does not depend completely on a particular computer. In a server based system if the server fails, the entire network fails. But in a peer to peer network only that particular computer is affected and other systems continue to function as usually.
 - Linking computers in a peer to peer network is very straight forward because there is no central server to which all the computers have to be connected. The computers can be connected to the network in any convenient manner. This can save lot of time and money.
 - The architecture is very simple and easy to maintain.



Difference Between Peer-to-Peer and Client-Server Architecture

Aspect	Peer-to-Peer	Client Server
Structure	Independent stand-alone systems are interconnected. Each of the system is called a Peer and acts as both server and a client.	Systems with no / limited independence (called Clients) are linked to a Central Computer called Server.
Server	There is no server concept. All	Server is available to provide various

	computers are equal, and are termed as peers.	services to clients.
Working	Any peer can access any other peer on the network for sharing and retrieving data. It does not depend on any particular system.	Client requests specific data from the server. The server program retrieves the requested data and returns it to the client.
Simplicity	It is simple in design and maintenance.	It is complex in design and maintenance.
Security and Control	Does not provide adequate security and control over data and resources.	Provide adequate security and control over data and resources.
Suitability	Suitable for environment with a limited number of users.	Suitable for environment with a large number of users.
Reliability	Network does not depend on a particular computer.	Network totally depends on File Server.

Components of Data Communication System

Following are the 5 basic components found in any data communication network:

1. The sending device,
2. The communications interface devices,
3. The communications channel,
4. The receiving device,
5. Communications software.

Communication Interface Devices

1. Network Interface cards:

- NIC is an adapter that provides a connector to attach network cable to a server or workstation.
- It is a microprocessor based device containing hardware and software which supplies the intelligence to communicate across the network and to perform all communication processing.
- It is a PCB installed in the microcomputer. It may be called as Network card, Network adaptor or NIU.
- The on-board circuitry provides the required protocols and commands.
- An NIC has additional memory for buffering incoming and outgoing data packets. This improves network performance.
- Network interface cards are available in 8 bit or 16 bit bus standards (today even 32 bit)
- But a NIC is required only when networking ability is not already present in the micro computer.



2. Modem:

- Modem is a communication device used to transmit computer data through ordinary telephone lines because computer data is in digital form but telephone lines are analog.
- It is an encoding as well as decoding device used in data transmission. It converts digital computer signal into analog telephone signal (modulation) and converts analog telephone signal into digital computer signal (demodulation).
- The speed of modem is measured in KBPS (Kilo Bits Per Second). Today a 56.6 kbps modem is standard.
- It helps to access remote computers. Thus employees at home can access computer files at office.
- They can also exchange files with other employees and exchange e-mail messages.
- MODEM is required only when a computer network is developed using telephoned lines.
- **Types:** Modems can be categorized according to speed, price and other features. But most commonly, people classify them as internal and external. Internal modems look like sound cards and video cards that fit inside the computer as daughter cards. On the other hand External modems are connected to the serial port of the computer. On the other hand PCMCIA modems are used with laptop computers. They are small - about the size of a visiting card and are quite expensive.



3. Multiplexer:

- It is a form of data transmission in which one communication channel carries several transmissions at the same time.
- Multiplexer is a device that combines large number of low speed transmission lines into high speed line.
- Thus Multiplexer can divide a single communication line between number of terminals.
- Multiplexer can scan each device to collect and transmit data on a single line to the CPU. It can also transmit data from CPU to appropriate terminal linked to the Multiplexer.
- This function may be very complex and on some systems a separate computer processor is devoted to this activity and it is known as "front-end-processor".
- For e.g. telephone lines can carry thousands of our conversations at the same time using multiplexing.
- The extract number of transmissions depends on the type of communication channel and the communication rate.



4. Front-end communication processor:

- These are programmable devices which control the functions of communication system.
- They support the operations of a mainframe computer by performing some functions, which a mainframe computer has to perform by itself.
- It is like a mini computer which sits between the mainframe computer and MODEM.
- These functions include code conversions, editing and verification of data, terminal recognition and control of transmission lines.
- With this, the mainframe computer can devote its time on data processing rather than on data transmission.

5. Protocol Converters:

- Dissimilar devices can't communicate with each other unless a strict set of communication standards are followed. Such standards are commonly known as communication protocols.
- A Protocol is a set of rules required to initiate and maintain communication between sending and receiving device.
- Generally an organisation uses several types of computers, transmission channels, transmission modes and data codes. Protocol converters help to communicate data between such diverse components and computers.
- For example it may be necessary to convert data from ASCII to EBCDIC.
- Protocol conversion can be done by hardware, software or a combination of hardware and software.

6. Hub:

- A hub is a hardware device that provides a common wiring point in a LAN.
- Each node is connected to the hub by means of simple twisted pair wires.
- The hub then provides a connection over a higher speed link to other LANs, the company's WAN, or the Internet.
- Generally it works on half duplex mode.
- A Hub can be either active or passive.



7. Switches:

- These are hardware devices used to direct messages across a network. Switches create temporary point to point links between two nodes on a network and send all data along that link.

8. Repeaters:

- When data is transmitted through several cables, signal gets degraded. To avoid such problems repeaters are used. Repeater boosts or amplifies the signal before passing it through the next section of cable.



9. Bridges:

- The main task of a bridge is to receive and pass data between two LAN's that use similar protocol and topology. In order to transmit this data successfully, bridge magnifies the signal. Thus a bridge acts as a repeater as well as a link.

10. Gateway:

- Gateways are similar to bridges because they are also used to transfer data from one network to another network.

- But Gateways are used to transfer data between 2 networks that use dissimilar protocols and terminals.
- For e.g. several years ago, the sales department of a company installed LAN. Today accounting department wants to install LAN but wants to use latest technology. Now these networks are using 2 different topologies and protocols. Now these 2 different LANs can be connected using a gateway.

11. Routers:

- Routers are used to route data between several nodes in the network.
- Router computers are similar to bridges but can also provide network management utilities to the user.
- It plays a very key role in managing network traffic.
- Their job is to ensure that data arrives at proper destination.
- Generally Routers are not needed for LAN because the network itself can handle its internal traffic.
- Routers come into play when data is sent between different networks.
- Routers examine packets to determine their destination. They take into account the volume of activity on the network and they send the packets to another router – one that is closer to the packet's final destination.
- If one network is out of order, router can route the data through another appropriate route.

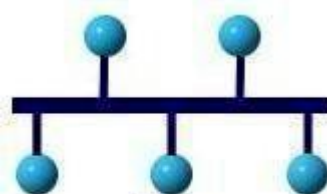


12. Remote Access Devices:

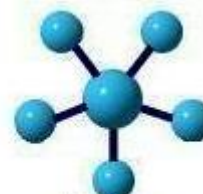
- Remote access devices are modem banks that serve as gateways to the Internet or to private corporate networks. Their function is to properly route all incoming and outgoing connections.

Network Structures or Topology

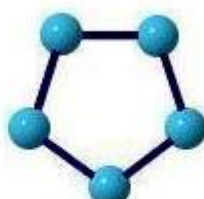
- The geometrical arrangement of computer resources, remote devices, and communication facilities is known as network structure or network topology. A computer network consists of nodes and links. A node is the end point of any branch in a computer. It can be either terminal device, workstation or an interconnecting equipment facility. A link is a communication path between two nodes.
- A network structure determines how one computer in the network can communicate with other computers.
- Following are the most commonly used network topologies:



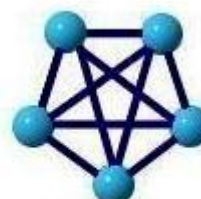
Bus



Star



Ring



Mesh

1. Bus Topology:

- A bus network topology is a network architecture in which a set of clients are connected via a shared communications line, called a bus.
- Bus networks are the simplest way to connect multiple clients, but often have problems when two clients want to transmit at the same time on the same bus.
- This structure is very popular for local area networks.
- In this structure or topology, a single network cable runs in the building or campus and all nodes are linked along with this communication line.
- Two ends of the cable are terminated with terminators.

Advantages:

1. It is a highly reliable in small networks. Any line breakdown does not affect the communication between two computers.
2. Easy to use and understand.
3. Requires least amount of cable to connect the computers together.
4. Less expensive than other cabling arrangements because only a single cable is used.
5. It is easy to extend the network. 2 Cables can be joined together with a connector, making a longer cable.
6. With this more number of computers can be connected to the network.
7. A repeater can also be used to improve the quality of signal.
8. Well suited for temporary or small networks not requiring high speeds (quick setup)

Disadvantages:

1. Heavy traffic can slow down the network. This is so because only one computer can transmit at any time.
2. But networks do not coordinate when information is sent. Computers interrupting each other can use lot of bandwidth.
3. Each new connection weakens the signal. (because the length of cable increases)
4. It is difficult to troubleshoot bus network. It is difficult to find out break or malfunction of a cable and can cause the whole network to stop functioning.
5. If there is a problem with main cable, the entire network goes down.
6. Maintenance costs may be higher in the long run.
7. It is slower than the other topologies.

Suitability: It works best with limited number of nodes.

2. Star Topology:

- This is the most commonly used structure or topology.
- Here communication channels emanate (=come) from centralized computer system. That is, processing nodes in a star network interconnect directly with a central system.
- In its simplest form, a star network consists of one central switch, hub or computer, which acts as a medium to transmit messages.
- Each terminal, small computer or large main frame, can communicate only with the central site and not with other nodes in the network.
- If a node wants to transmit information from one node to another, it can be done by sending the details to the central node, which in turn sends them to the destination.

Advantages:

1. It is easy to add and remove nodes. So, it is easy to expand a star network.
2. A node failure does not bring down the entire network
3. Connection of additional computers does not slow down the communication between any 2 computers.
4. It is easier to diagnose network problems through a central hub.
5. Very Robotic.

Disadvantages:

1. More dependence on central hub. If the central hub fails, the entire network ceases to function.
2. It is costlier than other topologies (more cable is required than bus or ring network).
3. The performance and scalability of the network depends upon the capabilities of the hub. Network size is also limited by the number of connections that a hub can handle.

Suitability: A star network is particularly appropriate for organisations that require centralized database or centralized processing facility.

3. Ring Topology:

- It is another structure used for local area networks.
- It is a decentralised network topology in which number of nodes is arranged around a closed loop cable.
- In this topology, the network cable passes from one node to another until all nodes are connected in the form of a loop or ring.
- There is a direct point-to-point link between two neighboring nodes.
- These links are unidirectional. It ensures that transmission by a node passes the whole ring and comes back to the node that made the transmission.

Advantages:

1. It offers high performance for a small number of workstations.
2. Ring networks can spread over longer distances than other types of networks.
3. It is also easy to expand ring network.
4. It is more reliable since communication between 2 computers is not dependent on a single host computer.
5. Does not require network server to manage the connectivity between the computers
6. Performs better than star topology under heavy network load

Disadvantages:

1. Relatively expensive and difficult to install.
2. Failure of one computer on the network can affect the whole network.
3. It is difficult to trouble shoot a ring network.
4. Adding or removing computers can disturb the network.
5. Addition of computers to the network increases the communication time between 2 computers.

Suitability: Ring networks offer high performance for a small number of workstations. It can also be used for large networks where each station has a similar workload.

4. Mesh Topology:

- Mesh networking is a way to route data, voice and instructions between nodes. It allows for continuous connections and reconfiguration around broken or blocked paths by “hopping” from node to node until the destination is reached.
- In a mesh network structure, the nodes are randomly connected using communication links.
- But in real life network connections, it may be fully connected or connected with only partial links. In a fully inter connected topology, each node is connected by a dedicated point-to-point link to every other node. In partially connected topology, computer nodes are widely scattered.
- When every node is connected to every other node, a mesh network with ‘n’ nodes will have $n*(n-1)/2$ number of links and the number of links coming from every node is (n-1).
- This concept is applicable to wired and wireless networks.
- This architecture is typically used in Wireless mesh networks.

Advantages:

1. This topology is very reliable. If direct link between 2 nodes breaks down, there exists an alternate path.

2. Mesh networks are self-healing. The network can still operate even when a node breaks down or a connection goes bad.
3. Gives the greatest amount of redundancy. Even if one node fails, network traffic can be redirected to another node.
4. It allows the network to isolate and prioritize communications from different computers.

Disadvantages:

1. It is very difficult to diagnose network problems.
2. Adding or replacing a node will disturb the entire network.
3. The cost of installation and maintenance is high (more cable is required than any other topology)

Suitability: Only military organizations, that need high degree of redundancy, use this type of networks.

Difference Between Star and Ring Networks:

No.	Difference	Star Network	Ring Network
1.	Meaning	It is a type of network topology in which all nodes are connected to a central computer/hub through dedicated cables.	It is a type of network topology in which all nodes are connected in the form of a circular chain.
2.	Communication between nodes	The communication takes place between the nodes through the hub/computer only i.e. all communication between terminals must pass through hub/computer.	The communication takes place by each node to receive and check for the message i.e. every node receives message and passes it to the next node.
3.	Break connection in	A broken connection between hub/central computer and node does not affect the rest of the network.	A broken connection between nodes leads to failure of entire network.
4.	Failure of the systems	Failure in the hub/central computer affects all nodes connected to that hub.	Failure in one node does not affect the entire system.
5.	Repeaters	The signal becomes weak when it has to travel long distances. To avoid it, repeaters are required to be used.	Repeaters are not needed. Every computer acts as a repeater.
6.	Adding/removing nodes	It is very easy to add/remove a node from the network.	It is difficult to add/remove a node from the system.

Transmission Modes

1. Serial Transmission:

- Serial Transmission is the most commonly used method of communication.
- In serial transmission bits of each byte are transmitted one after the other along a single path. Then the receiver assembles the incoming bit stream into characters. In serial transmission, the bits of each byte are sent along a single path one after another.
- An example is the serial port (RS-232), used for Mouse or MODEM.
- Serial transmission can occur in any of the two ways - Asynchronous & Synchronous transmission.

Advantages:

1. It is a cheap mode of transferring data.

- It is suitable to transmit data over long distances.

Disadvantage:

- This method is not efficient (i.e. slow) because it transfers data in series.

2. Parallel Transmission:

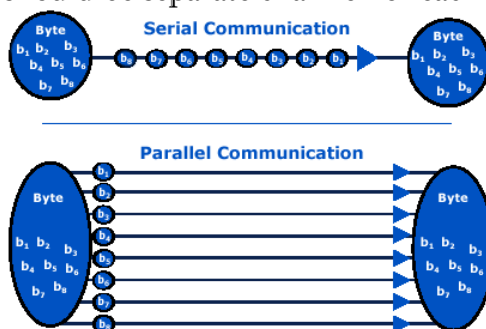
- In parallel transmission all the bits of each byte are transmitted simultaneously i.e. each bit will have a unique channel dedicated to it. For ASCII character we need eight channels. All bits are transmitted together and arrive at the destination together.
- Example – Parallel port being used for printers.

Advantages:

- Data can be transmitted at a very high speed.

Disadvantage:

- As it uses parallel paths, cross talk may occur. So, it is not suitable for transferring data over long distances. To minimise cross talk, cable length should be limited.
- It is costly. (Because, there should be separate channel for each bit)



Difference Between Serial and Parallel Transmission:

No.	Difference	Serial Transmission	Parallel Transmission
1.	Path	The bits of each byte are sent along a single path one after the other.	In parallel transmission, there are separate parallel paths corresponding to each bit of byte.
2.	Data Transmission	Bits in a byte are transmitted one by one.	All character bits are transmitted in parallel, at a time.
3.	Distance	It is used to transfer data over long distances.	It is used to transfer data to limited distances.
4.	Speed	The rate of data transmission is very slow.	The rate of data transmission is very high.
5.	Use	It is used where less volume of data is to be transmitted.	It is used where more volume of data is to be transmitted.
6.	Cost	Economical.	Costly.

3. Synchronous Transmission:

- In this method characters are transmitted as groups, preceded and followed by control characters.
- The transmission and receiving intervals are precisely timed, permitting grouping of bits into identifiable characters.
- In this method data bytes are sent one after the other at regular intervals. The data form a continuous stream of bits spaced at equal intervals, with no space between consecutive bytes.
- This method is mainly used for computers but is also used for human operation of buffered terminals.

Advantages:

- It can transfer data at a very high speed since fewer bits are needed to identify the beginning and ending of the character coding.

Disadvantages:

1. Its main drawback is inaccuracy.
2. This method requires high quality communication channels.
3. It is expensive because the device built has to be smart enough to differentiate actual data and special synchronous characters.

4. Asynchronous Transmission:

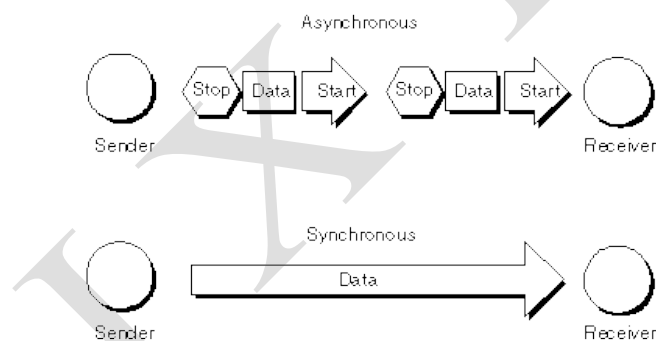
- In this method each character is transmitted separately i.e. one character at a time.
- The character is preceded by a start bit, which tells the receiving device where the character coding begins, and is followed by a stop bit, which tells the receiving device where the character coding ends after which there is an interval of idle time on the channel.
- Then the next character is sent, start bits first, character bits next, stop bits last.
- The start and stop bits (and the interval of time between consecutive characters) allow the receiving and sending computers to synchronise the transmission.
- This is the most common mode world-wide, especially for operation of interactive computer terminals and teletypewriters.

Advantages:

1. Reliable as the start and stop bits ensure that the sender and receiver remain in step with one another.
2. It is less expensive.

Disadvantages:

- This method is not efficient because the extra start and stop bits slow down the data transmission when huge volume of data is to be transmitted.



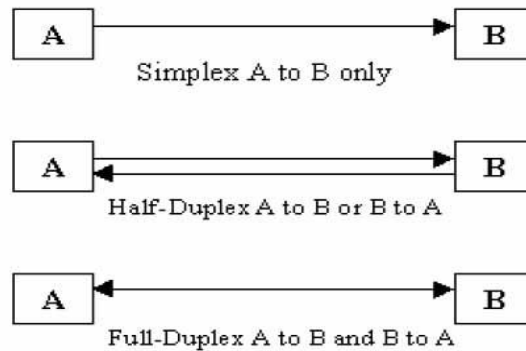
No.	Synchronous	Asynchronous
1.	In this transmission technique, bits are transferred at a fixed rate.	In this method, transmission takes place in the form of words accompanied by start and stop bits.
2.	This allows characters to be sent down the line without start-stop bits.	Transfer the data with start-stop bits.
3.	It allows data to be sent as a multi-word block.	Data transfer takes place in the form of words.
4.	Uses a group of synchronization bits.	No special synchronization bits are used to synchronize the equipments.
5.	Data transfer rate is fast.	The data transfer rate is slow.

Modes of Data Communication

There are three different modes of data communication:

- a) **Simplex:** In this mode data is transmitted in one direction only. The sending station cannot receive data. A terminal connected to such line may send only or receive only.

- b) **Half duplex:** Under this mode, data can be transmitted in both the directions but only one side at a time. Thus every terminal can send and receive data but only one activity at a time. For example, all terminal devices are connected to the CPU in half-duplex mode.
- c) **Full duplex:** A full duplex connection can simultaneously transmit and receive data between two stations. It is the most commonly used communication mode. A full duplex line is faster because it avoids the delay that occur in half-duplex mode (for changing the direction of transmission) Full-duplex transmission uses two separate circuits for communication i.e. one for each direction. It is costlier than half- duplex but easy to use.



Data Transmission Techniques

1. Circuit switching:

- Circuit Switching is the simplest method of data communication. Landline telephone network uses this method to establish connection between two subscribers.
- Circuit switching establishes a physical connection between two devices and the physical path that is established remains open until the end of the session.
- At any point of time only two communication devices can transmit information to each other. These devices could be either telephones or computers.
- Once a circuit is established between two stations, it is exclusively used by the two parties and the dedicated link becomes unavailable to others till the call is terminated by either party.
- This will be the experience of every person using the telephone. We make a call and either we get our destination party or encounter a busy signal.
- A single circuit is used for the entire duration of call.

2. Message switching:

- Message switching is a system which uses computer techniques to transmit, receive, store and retrieve textual information.
- A message is a logical unit of information and can be of any length. In this method, if a station wants to send a message to another station, the destination address is attached to the message and then transmitted to the destination through intermediary nodes.
- The intermediary node receives the message, stores it temporarily, inspects for errors and transmits the message to the next node on the basis of availability of channel. This process goes on till the message reaches its intended destination.
- Organisations with heavy volume of data transmission use this method.
- It causes long delay because the message is stored at the exchange until suitable circuits are available to transmit message.
- For message switching it is not necessary to establish a dedicated path between 2 stations.
- Examples are telegrams, electronic mail, computer files, transaction queries and responses.

3. Packet switching:

- It is a sophisticated technique of maximizing transmission capacity of networks.

- Here the message is broken into transferable units of fixed size called packets. Depending on the availability of channel these packets are routed individually through the network.
- Each packet contains source and destination address, synchronizing error correction and control bits. The packets are routed using these source and destination addresses.
- Passwords and all types of data can be included within the packet.
- Now transmission is done by packets and it is possible that different packets of the same message can be routed across different paths and they will be combined at the destination.
- Transmission cost is by packet and not by message, route or distance.
- This method is currently being used to transmit data in Internet.

Aspect	Circuit Switching	Message Switching	Packet Switching
Dedicated Communication Path or Channel	Required	Not Required	Not Required
Availability of Recipients and Sender at the same time	Required	Not Required	Not Required
Use of source address & destination address to transmit a message	Not Required	Required	Required
Full Message Required at each node for transmission	Yes	Yes	No
Breaking or Division of Data into Packets	No	No	Yes

Communication Channels

A communication channel is the medium that connects the sender and the receiver in data communications network. Common communication channels include telephone lines, fiber optic cables, microwaves, satellite, etc. Different communication channels possess different characteristics that can affect the network's reliability, cost and security. They are:

- Bandwidth:** It refers to a channel's information carrying capacity. Technically bandwidth represents the difference between highest and lowest frequencies that can be used to transmit data. It is usually measured in terms of Bits per Second (BPS). A communication channel with greater bandwidth will be more useful, because it can transmit more information in less time. Higher bandwidth is essential for applications like real-time video, audio, etc.
- Transmission Rate:** It is the data transmission capacity of a telecommunication channel. It depends on the bandwidth. The greater the bandwidth higher will be the transmission rate.
- Transmission Mode:** It is the mode in which data are transmitted over the network. There are 2 modes of data transmission namely synchronous and asynchronous transmission.
- Transmission Direction:** It is the direction in which data is transmitted. It is categorized into 3 ways –Simplex, Half Duplex and Full Duplex.

Types of Communication Services

- Normally, an organization uses one of the common carrier services to carry messages from one station to another station. Following is a brief description of these services:
 - Narrow band service:** Usually, this service is used where data volume is relatively low. The transmission rate range from 45 to 300 bits per second. Example of this are telephone companies' typewriters exchange service (TWX), Telex service.
 - Voice band services:** Voice band services use ordinary telephone lines to send data messages. Transmission rates vary from 300 to 9600 bits per second or higher.
 - Wide band Services:** Wide band services provide data transmission rates from several thousands to several million bits per second (9600 to 256000). These services are limited to high-volume

users. Such services generally use coaxial cable or microwave communication. Space satellites are using this service to transmit data from one part of the world to another part of the world.

- Communication services may be either leased or dialed up.
 - A leased line can be exclusively used by the user. It is used when there are continuing data-transmission needs.
 - The dial-up variety requires the person to dial the computer. This alternative is appropriate when there are periodic data to transmit.

Communication Software

Communication software is a software that manages the flow of data across a network. Following are the important functions of communication software:

- a) Access control:
 - Linking and disconnecting different devices;
 - automatically dialing and answering telephones;
 - restricting access to authorized users;
 - establishing parameters such as speed, mode, and direction of transmission.
- b) Network management:
 - Polling (=checking) devices to see whether they are ready to send or receive data;
 - queuing input and output;
 - determining system priorities;
 - routing messages,
 - logging network activity, use and errors.
- c) Data and file transmission: Controlling the transfer of data, files and messages among various devices.
- d) Error detection and control: Ensuring that data sent is actually data received.
- e) Data security: Protecting data during transmission from unauthorized access.

Communication or Transmission Protocol

- For any network to exist, there must be connections between computers and agreements or what is termed as protocols in communications language. Protocols are software that performs a variety of actions necessary for data transmission between computers.
- Protocols are a set of rules for inter-computer communication that have been agreed upon and implemented by many vendors, users and standard bodies. Ideally, protocols allow heterogeneous computers to talk to each other.
- At the most basic level, protocols define the physical aspects of communication, such as how the system components will be interfaced and at what voltage levels data will be transmitted, etc.
- At higher level, protocols define the way data will be transferred such as the establishment and termination of “sessions” between computers and the synchronisation of those transmissions. At still higher levels, protocols can standardise the way data is encoded and compressed for transmission.
- **Aspects defined by protocols:** A transmission protocol is a set of conventions or rules that must be followed by both the parties to ensure that the information is correctly exchanged. A protocol defines the following 3 aspects of digital communication.
 - a. Syntax: The format of data being exchanged, character set used, type of error correction used, type of encoding scheme being used.
 - b. Semantics: Type and order of messages used to ensure reliable and error free information transfer.
 - c. Timing: Defines data rate selection and correct timing for various events during data transfer.
- Layers:

- Communication protocols are defined in layers.
- The first layer is the physical layer which defines the manner in which nodes in a network are connected to each other.
- Subsequent layers describe how messages are packaged for transmission, how messages are routed through the network, security procedures and the manner in which messages are displayed.
- The number of subsequent layers depends upon the protocol.
- Examples: Several protocols are in common use. For example,
 - X.12 is the standard for Electronic Data Interchange;
 - X.75 is used for interconnection between networks of different countries;
 - XON/XOFF is the de-facto standard for microcomputer data communication;
 - XMODEM is used for uploading and downloading files.
 - TCP/IP – protocol being used in internet.

Open System Interconnection(OSI)

- OSI or the Open System Interconnection has been outlined by International Organization for Standardization (ISO). It facilitates communication of heterogeneous hardware or software platforms with each other.
- Layers: It is defined with the help of following seven layers of functions with their associated controls:
 - a. Layer 1 or Physical Layer is a hardware layer which specifies mechanical features as well as electromagnetic features. Network topology is a part of this layer.
 - b. Layer 2 or Data Link Layer is also a hardware layer which specifies channel access control method and ensures reliable transfer of data through the transmission medium.
 - c. Layer 3 or Network Layer makes a choice of the physical route of transmission of data. It establishes, maintains, terminates, connections between the nodes and ensures proper routing of data.
 - d. Layer 4 or Transport Layer ensures reliable transfer of data between user processes, assembles and disassembles message packets, provides error recovery and flow control. Multiplexing and encryption are undertaken at this layer level.
 - e. Layer 5 or Session Layer establishes, maintains and terminates sessions between user processes. Identification and authentication are undertaken at this layer level.
 - f. Layer 6 or Presentation Layer controls on screen display of data, transforms data to a standard application interface. Encryption, data compression can also be undertaken at this layer level.
 - g. Layer 7 or Application Layer provides user services by file transfer, file sharing, etc. Database concurrency and deadlock situation controls are undertaken at this layer.

Network Protocols

- Network protocols which are essentially software are sets of rules for –
Communicating, timings, sequencing, formatting, and error checking for data transmission providing standards for data communication
- Where they are stored? These rules are embedded or built into the software which reside either in –
 - Computer's memory or
 - Memory of transmission device
- Need for protocols: Different protocols cannot talk to each other. To solve this problem, standard protocols have been developed.
- Functions of Protocols:
 - a. The entire operation of data transmission over a network is broken down into systematic steps. Each step has its own rules or protocols. For example, in OSI model each of the seven layers use

different protocols. Accordingly, steps must be implemented in a consistent order. This order is same for every computer in the network, either receiving or sending data.

- b. At the sending computer, protocols:
 - Breakdown data into packets,
 - Add destination address to the packet,
 - Prepares data for transmission through Network Interface Card (NIC)
- c. At the receiving computer, protocols:
 - Take data packets from the cable,
 - Bring packets into computer through Network Interface Card (NIC)
 - Strip the packets off any transmitting information,
 - Copy data from packet to a buffer for reassembly,
 - Pass the reassembled data to the application.
- Protocol Stack: A protocol stack is a combination of set of protocols. Each layer specifies a different protocol–
 - For handling a function or,
 - As a subsystem of the common process,
 - Each layer has its won set of rules
- For example:
 1. Application Layer initiates or accepts a request from the user.
 2. The Presentation Layer adds formatting, displays and encrypts information to the packet.
 3. The Session Layer adds traffic flow information to determine when the packet should be sent or received.
 4. Transport Layer adds error handling information.
 5. The Network Layer does sequencing and adds address information in the packet.
 6. The data Link Layer adds error checking information and prepares the data for going to the destination.

TCP/IP

- The protocol used on the Internet is called TCP/IP (Transmission Control Protocol/Internet Protocol). TCP/IP protocol consists of 2 parts
 - a. TCP deals with exchange of sequential data.
 - b. IP handles packet switching and is used on the Internet.
- TCI/IP has four layers:
 - a. Application Layer: It directly provides services to the users such as e-mail,
 - b. Transport Layer: It provides end-to-end communication between applications and verifies correct packet arrival.
 - c. Internet Layer: It provides packet routing for error checking, addressing and integrity.
 - d. Network Interface Layer: It provides an interface to the network hardware and device drivers. This is also called as Data Link Layer.
- Steps in transmission of data: TCP/IP creates a packet-switching network. When a message is to be sent over the Internet,
 - a. The TCP protocol breaks it up into small packets.
 - b. A header is given to each packet, which consists of destination address.
 - c. The packets are then sent individually over the Internet.
 - d. The IP protocol guides the packets so that they arrive at proper destination.
 - e. Once the destination is reached, the TCP protocol reassembles the packets into the original message.

Broadband Networks

- **Meaning:**
 - Integrated Services Digital Network (ISDN) is a circuit switched telephone network system, designed to allow digital transmission of voice and data over ordinary telephone copper wires, resulting in better quality and higher speeds.
 - ISDN is a set of protocols for establishing and breaking circuit switched connections and for advanced call features for the user.
- **Types of channel:**
 - a. Bearer channels (B channels): Data and voice are carried by these channels having a bandwidth of 64 kilobits per second.
 - b. Delta channels (D channels): It carries signals and controls. But it can also be used for carrying data.
- **Types of ISDN services:**
 - a. Basic Rate Interface (BRI):
 - It consists of two 64 kbps B channels and one 16 kbps D channel to form a total of 144 kbps.
 - It is suitable for individual users.
 - b. Primary Rate Interface (PRI):
 - It consists of 23 B channels and one 64 kbps D channel to form a total of 1536 kbps.
 - It is suitable for users with higher capacity requirements.
- **Advantages:**
 - a. Multiple channel operation in same cable: ISDN allows multiple digital channels to be operated simultaneously through the same regular phone cable which is meant for analog signals. However, this is possible only if the telephone company's switches can support digital connections.
 - b. Combines different digital sources: With ISDN, it is possible to combine several digital data sources and send the information to the proper destination. In a digital line it is easy to reduce noise and interference even after combining these signals.

Different Traditional Computing Models

1. **Mainframe architecture:**
 - In mainframe architecture, all the intelligence lies in the central host computer (processor)
 - Users can interact with the host computer through dumb terminals.
 - These terminals can capture keystrokes and send that data to the host computer.
 - Centralized, host-based computing model allows users to share a single computer application, database and peripherals.
 - Limitations:
 - a. They do not easily support graphical user interface or
 - b. They don't support access to multiple databases from geographically dispersed sites.
 - c. The cost of these systems will be thousands of times more than PCs. But they don't do thousands of times more work.
2. **Personal Computers & workstations:**
 - With the introduction of PC and its operating system, independent computing workstations became popular. These are stand alone computing models.
 - Advantages:
 - a. They are not connected to the central computer and hence independent.
 - b. In this model, the processing load on central computer is removed.
 - Limitations:

- a. Disconnected personal computers can't share data and expensive resources like disk drives, printers, modems and other peripheral devices.
- b. These problems led to the development of network/file server computing model. It links PCs and workstations together in a Local Area Network. So, they can share data and peripherals.

3. File sharing architecture:

- The original PC networks were based on file sharing architectures. Here the server downloads files from the shared location to the desktop. The requested user's job is then run in the desktop environment.
- In other words the data sent by the server is processed into information by the workstation.
- Limitations:
 - a. The server will send the entire file over the network even though the workstation only requires a few records in the file.
 - b. If Graphic User Interface (GUI) is added to this model then it increases network traffic, decreases response time and limits customer service.
 - c. It is not suitable for multi user applications because of the following reasons: (i) this model does not support data concurrence i.e. simultaneous access to a file by multiple users (ii) when several workstations request and send several files in a LAN, then the overall performance of the network will degrade. It can only satisfy about 12 users simultaneously.
 - d. With the advent of less expensive but more powerful computer hardware the file server architecture has become outdated.

Client Server Model

• Meaning:

- Client server technology is an advancement of the traditional computing models.
- Client/Server (C/S) refers to a computing technology in which the hardware and the software components (i.e., clients and servers) are distributed across a network.
- It is a technology in which the server software accepts requests for data from client software and returns the results to the client. The client processes the data and presents the results to the user.
- Client server technology intelligently divides the processing work between the server and the workstation.
- The server handles all the global tasks while the workstation handles all the local tasks.
- The server only sends those records to the workstation that are needed to satisfy the information request. As a result network traffic is significantly reduced.
- This is a versatile, message based and modular infrastructure.
- It improves usability, flexibility, interoperability and scalability when compared to centralised, mainframe, time sharing computing.
- This is very fast, secure, reliable, efficient, inexpensive and easy to use.
- The use of LANs has made the client/server model even more attractive to organisations.



- **Reasons For Shifting To Client Server Technology**

- Client/server is described as a 'cost-reduction' technology. These technologies include client/server computing, open systems, fourth generation languages and relational databases. Cost reduction is the main reasons for changing to client server technology. These systems also help to improve control, increase data integrity and security, increase performance and better connectivity.
- Following are the main reasons for the adoption of client server technology.
 - a. Improving the Flow of Management Information
 - b. Better Services to End-User Departments.
 - c. Lowering IT costs
 - d. The ability to manage IT costs better
 - e. Direct access to required data
 - f. High flexibility of information processing
 - g. Direct control of the operating system
 - h. Client server technology has been defined as "the provision of information that is required by a user, which is easily accessed despite of the physical location of the data within the organisation".

- **Uses Of Client Server System**

Following are some of the areas where client server technology is currently being used.

- a. Online banking application
- b. Internal call centre application
- c. Applications for end-users that are stored in the server
- d. E-commerce online shopping page.
- e. Intranet applications.
- f. Financial, Inventory applications based on the client server technology
- g. Tele communication based on Internet technologies.

- **Benefits of Client Server System**

Client/server systems bring tremendous benefits to new users, especially the users of mainframe systems. Many businesses are currently in the process of changing or in near future will change from mainframe (or PC) to client / server systems. Following are the benefits of client/server technology:

- a. People in the field of information systems can use client/server computing to make their jobs easier.
- b. Reduce the total cost of ownership.
- c. Increased Productivity i.e. End user productivity & Developer productivity
- d. Takes less people to maintain a client/server application than a mainframe.
- e. The expenses of hardware and network in the client/server environment are less than those in mainframe environment.
- f. Since applications can be easily divided among different users, efficiency will be high.
- g. Reduce the cost of client's computer. The server stores data for the clients. So, it is not necessary for clients to have large amounts of disk space. Therefore, less expensive network computers can be used.
- h. Reduce the cost of purchasing, installing, and upgrading software programs and applications on each client computer. Delivery and maintenance will be done from one central point i.e. server.
- i. The management control over the organisation will be increased.
- j. It is very easy to implement client/server system than any other systems.
- k. Leads to new technology and the move to rapid application development such as object oriented technology.
- l. Long term cost benefits for development and support.

- m. Easy to add new hardware to support new systems such as document imaging and video conferencing which are not feasible under mainframe environment.

- **Characteristics of Client Server Technology:**

There are 10 characteristics that reflect the key features of a client / server system. These ten characteristics are as follows:

- a. Components: Client/server architecture consists of a client process and a server process that can be distinguished from each other.
- b. Separate platforms: The client portion and the server portions can operate on separate computer platforms.
- c. Individual upgradation: Either the client platform or the server platform can be upgraded without upgrading the other platforms.
- d. Concurrent service: The server is able to service multiple clients concurrently. In some client/server systems, clients can access multiple servers.
- e. Networking capability: The client/server system includes some sort of networking capability.
- f. Application logic: A significant portion of the application logic resides at the client end.
- g. Initiation of action: Action is usually initiated at the client end, not at the server end.
- h. GUI: A user-friendly Graphical User Interface (GUI) generally resides at the client end.
- i. SQL: Structured Query Language (SQL) is a common characteristic of majority client/ server systems.
- j. Security: The database server will provide data protection and security.

- **Components of A Client Server Technology:**

Following are the components of C/S technology:

1. Client: (M04 - 1M) Generally clients are the personal computers. They are the “users” of the services offered by the servers. Basically, there are 3 types of clients.
 - a. Non-Graphical User Interface (GUI) clients: They require minimum amount of human interaction. E.g. ATMs, cell phones, fax machines, robots, etc.
 - b. GUI-Clients: They are human interaction models. They involve object/action models like pull-down menus in Windows.
 - c. Object-Oriented User Interface (OOUI) Clients: They have further expanded visual formats, multiple workplaces and object interaction rather than application interaction.
2. Server: Servers are the systems which provide required data to the clients. Servers receive requests from the client and regulate access to shared resources. Following are different types of servers:
 - a. File servers help to share files across a network by maintaining a shared library of documents, data, and images.
 - b. Database servers can execute Structured Query Language (SQL) requests from clients.
 - c. Transaction servers execute a series of SQL commands,
 - d. Web servers allow clients and servers to communicate with a universal language called HTTP.
3. Middleware: The network system implemented within the client/server technology is known as middleware. Middleware is the software needed to allow clients and servers to interact. Middleware allows for communication, directory services, queuing, distributed file sharing and printing. Generally, middleware consists of four layers - Service, Back-end Processing, Network Operating System and Transport Stacks.
4. Fat-client or Fat-server: Fat-client and fat-server are popular terms in computer literature. In a fat-client system, most of the processing takes place in the client. E.g. file server or database server. Fat-servers place more emphasis on the server and try to minimize the processing done by clients. Examples of fat-servers are transaction, GroupWare, and web servers. Fat-clients are also known as “2-Tier” systems and fat-servers are known as “3-Tier” systems.

5. Network hardware: The network hardware is the communication cords and the devices that link the server and the clients. The communication and data flow over the network is managed and maintained by network software.

Various Types Of Servers

1. Database Servers:

- Database Management Systems (DBMS) can be divided into 3 primary components: development tools, user interface, and database engine.
- The database engine does all the selecting, sorting and updating.
- Currently, most DBMS combine the interface and engine on each user's computer.
- Database servers split these two functions, allowing the user interface software to run on each user's
- PC (the client), and running the database engine in a separate machine (the database server) shared by all users.
- This approach can increase database performance as well as overall LAN performance because only selected records are transmitted to the user's PC, not large blocks of files.
- The database engine must handle multiple requests. So, the database server itself is a bottleneck when a large number of requests are pending.
- Database servers offer real potential for remote database access and distributed databases.
- The database server sends only selected database record(s) to the client machine (instead of large blocks of data). So, remote access over relatively slow telephone lines can provide acceptable performance.
- In addition, a client computer can make requests to multiple servers regardless of physical location.

2. Application Servers:

- An application server is a server program that resides in the server (computer) and provides the business logic for the application program.
- The server program is a program that provides its services to the client program.
- Application servers are mainly used in web-based applications that have 3-tier architecture.
- First Tier: Front End - Browser (Thin Client) - a GUI interface lying at the client/workstation.
- Second Tier: Middle Tier - Application Server - set of application programs.
- Third Tier: Back End - Database Server.
- The application server is a second/middle tier of the three-tier architecture. In other words, application servers are now an integral part of 3 three-tier architecture.
- The application server syncs and combines with the web server for processing the request made by the client.
- If we look at the request-response flow, the client's request first goes to the web server, which then sends the required information to the application server. It then sends the response back to the web server after taking an appropriate action. The web server then sends the processed information back to the client.
- Web servers use different approaches or technology for forwarding or receiving back processed information.
- Some of the most common approaches are given below.
 - CGI (Common Gateway Interface): Can be written either in JAVA, C, C++, or Perl.
 - ASP (Active Server Pages): A Microsoft Technology
 - JSP (Java Server Pages): Java Servlets - Sun's Technology
 - Java Script (Server Side): Netscape technology which requires livewire for database connectivity.
- Features of the Application Servers:

- a. Component management: It provides tools to managers for handling all the components and runtime services like session management, synchronous/asynchronous client notifications and executing server business logic.
- b. Fault tolerance: Ability of the application server with no single point of failure, defining policies for recovery and fail-over recovery in case of failure of one object or group of objects.
- c. Load balancing: Capability to send the request to different servers depending on the load and availability of the server.
- d. Transaction Management.
- e. Management Console: Single point graphical management console for remotely monitoring clients and server clusters.
- f. Security: There are security features for applications security.
- Types of application servers:
 - a. Web Information Servers: This type of server employs HTML templates and scripts to generate pages incorporating values from the database in them. These types of servers are stateless servers. Such servers include Netscape Server, HAHT, Allaire, Sybase, and Silver Stream.
 - b. Component Servers: The main purpose of these servers is to provide database access and transaction processing services to software components including DLLs, CORBA, and JavaBeans. First, they provide environment for server-side components. Second, they provide access to database and other services to the component. These types of servers are stateless. Examples include MTS (which provides an interface for DLL), Sybase Jaguar, and IBM Component broker.
 - c. Active Application Server: This type of server supports and provides a rich environment for serverside logic expressed as objects, rules and components. These types of servers are most suitable for dealing with based e-commerce and decision processing.

3. Print Servers:

- Print servers provide shared access to printers.
- Most LAN operating systems provide print service. Print service can run on a file server or on one or more separate print server machines.
- Non-file server print servers can be dedicated to the task of print service.

4. Transaction Servers:

- MTS or Microsoft Transaction Server is an integral part of Windows NT, and is installed by default as part of the operating system in NT 5.
- It is part of the system that is available in the background whenever one of our applications requires it.
- Control and configuration of MTS is via either a snap-in to the Microsoft Management Console, or through the HTML administration pages that are included with MTS.
- This is very similar to the interface provided for Internet Information Server 4, and gives an integrated management function that is useful when building and setting up distributed applications.

5. Internet Servers:

- a. File server:
 - It is one of the simplest servers.
 - It manages requests from clients for files stored in the server's local disk.
 - A central file server permits groups and users to share and access data in multiple ways.
 - Central file servers are backed up regularly and administrators may put disk space quotas for each user or group of users.
- b. Mail server:
 - A mail server is the most efficient way to receive and store electronic mail messages for a group of users.
 - A central mail server can run for 24 hours a day.

- The mail server can also provide a global e-mail directory for all community and users.
 - E.g.: "Eudora" is a powerful cross-platform email client that receives incoming mail messages from and sends outgoing mail messages to a mail server.
- c. DNS server:
- Domain Name Service is an Internet-wide distributed database system that documents and distributes network-specific information, such as the associated IP address for a host name and vice versa. The host that stores this database is a name server.
- d. Gopher server:
- Gopher is an Internet application that uses multiple Gopher servers to locate images, applications, and files stored on various servers on the Internet. For example, "Veronica" is a Gopher application that searches databases of the file contents of worldwide Gopher servers which help to locate Gopher resources.
- e. Web server:
- The World Wide Web (WWW) is a very popular Internet source of information. Web browsers present information to the user in hypertext format.
- f. FTP server:
- File Transfer Protocol (FTP) is an Internet-wide standard for distribution of files from one computer to another. The computer that stores files and makes them available to others is a server. Client software is used to retrieve the files from the server.
- g. News server:
- Usenet News is a world wide discussion system consisting of thousands of news groups organized into hierarchies by subject. Users read and post articles to these newsgroups using client software. The "news" is held for distribution and access on the news server.
- h. Chat server:
- Some organizations choose to run a server that will allow multiple users to have "real-time" discussions, called "chats" on the Internet. Some chat groups are moderated. However, most of them are unmoderated public discussions.
 - Further, most chat servers allow the creation of "private" chat rooms where participants can "meet" for private discussions. "Chat" is a graphical form of an Internet service called IRC, or Internet Relay Chat.
- i. Caching server:
- A caching server is employed when we want to restrict our number of accesses to the Internet.
 - Basically, a caching server sits between the client computer and the server that would normally fulfill a client's request.
 - Once the client's request is sent, it is intercepted by the caching server.
 - The caching server maintains a library of files that have been requested in the recent past by various users on the network. If the requested information is available in it then the caching server will send such information without going to the original Internet source. Storing the frequently used information locally is a good way to reduce overall traffic to and from the Internet.
 - A caching server does not restrict information flow. Instead, it makes a copy of requested information, so that frequently requested items can be served locally, instead of original Internet source.
 - Caching servers can also be connected in a hierarchy so if the local cache does not have the information, it can pass the request to nearby caching servers, that might also contain the desired files.
- j. Proxy server:
- A proxy server is designed to restrict access to information on the Internet.

- If we don't want our users to access certain material then a proxy server can be used to refuse the access to such material.
- A proxy server operates on a list of rules given to it by a System Administrator.
- Some proxy software uses list of specific forbidden sites, while other proxy software examines the content of a page before it is served to the requester. If certain keywords are found in the requested page, access to it is denied by the proxy server.
- Technologically, there's no substantial difference between a caching server and a proxy server. The difference comes in the desired outcome of such servers.
- If we want to reduce the overall amount of traffic between our network and the Internet then a caching server is the best choice.
- On the other hand, if we want to restrict or prohibit the flow of certain types of information to our network, a proxy server will serve that purpose.

Intrusion Detection System

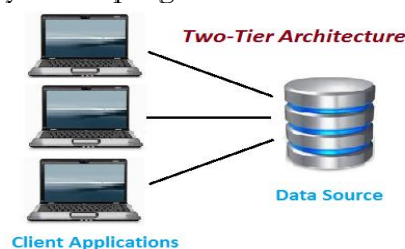
- The goal of intrusion detection system is to monitor the network assets, to detect anomalous behavior and misuse. This concept is there for nearly twenty years. But in recent years there is a dramatic rise in its popularity and it is being incorporated into the overall information security infrastructure. Following are different components of IDS:
 1. Network Intrusion Detection (NID):
 - Network intrusion detection deals with information passing in the wire between hosts.
 - Typically referred to as "packet-sniffers,"
 - Network intrusion detection devices intercept packets traveling in different communication channels. Once captured, the packets are analyzed in a number of different ways.
 - Some NID devices will simply compare the packet with a database consisting of known attacks and malicious packet "fingerprints",
 - While others will look for anomalous (= abnormal) packet activity that might indicate malicious behaviour.
 - In either case, network intrusion detection should be treated as a perimeter defense.
 2. Host-based Intrusion Detection (HID):
 - Host-based intrusion detection systems are designed to monitor, detect and respond to user and system activity and attacks on a given host.
 - Some more robust tools also offer audit policy management and centralization, supply data forensics, statistical analysis and evidentiary support, and in some cases provide some measure of access control.
 - The difference between host-based and network-based intrusion detection is that NID deals with data transmitted from host to host while HID is concerned with what occurs on the hosts themselves.
 - Host-based intrusion detection is best suited to combat (= fight against) internal threats.
 - Majority of computer threats come from within organization. For example, disgruntled employees, corporate spies, etc.
 3. Hybrid Intrusion Detection:
 - Hybrid intrusion detection systems offer management of and alert notification from both network and host-based intrusion detection devices.
 - Hybrid solutions provide the logical complement to NID and HID i.e. Central Intrusion Detection Management.
 4. Network-Node Intrusion Detection (NNID):
 - Network-node intrusion detection was developed to work around the inherent flaws in traditional NID.
 - Network-node pulls the packet-intercepting technology from the wire and puts it on the host.

- With NNID, the "packet-sniffer" is positioned in such a way that it captures packets after they reach their final destination i.e. host.
- The packet is then analyzed just as if it were traveling along the network through a conventional "packet-sniffer."
- In this approach, network-node is simply another module that can attach to the HID agent. The major disadvantage is that it only evaluates packets addressed to the host on which it resides.
- On the other hand, traditional network intrusion detection can monitor packets on an entire subnet.
- "packet-sniffers" are also incapable of viewing a complete subnet when the network uses high-speed communications, encryption or switches since they are essentially "without a sense of smell".
- But NNID can defend the specific hosts against packet-based attacks in these complex environments where conventional NID is ineffective.

Client-Server Architectures

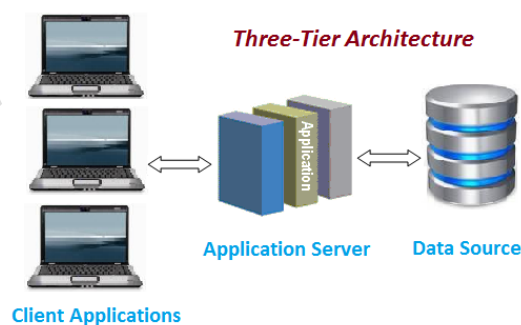
1. 2-tier architecture:

- Meaning:
 - a) With the appearance of LAN, PC's are being connected to servers also.
 - b) Servers are mainly database servers which offer data on the server.
 - c) Thus the application intelligence is implemented on the client.
 - d) Since there are only tiered data-server and client, this is called 2-tier architecture.
 - e) This model is still predominant today,
 - f) This is actually opposite to the terminal based system where the entire intelligence lies on the host system.
- Suitability: 2-tier architecture is suitable in the following situations –
 - a) Tools and middleware implemented in client are –
 - i. Relatively inexpensive and well integrated PC-tools and
 - ii. Good Rapid Application Development (RAD) qualities i.e. simple applications can be produced in a comparatively short time.
 - b) Server side uses relatively expensive tools.
- Limitations:
 - a) Massive applications implemented on PC are expensive to maintain.
 - b) Windows 3.X and Mac systems have tough resource restrictions. For this reason application programmers should be well trained in systems technology, so that they can optimize scarce resources.
 - c) Since the application logic is executed on the PC, in case of a new software release, all personal computers have to be updated. This is very costly, time consuming, complicated and error prone.
 - d) Once the software reaches users desktop it should be installed and then tested for correct execution. Due to distributed character of such a procedure, there is no guarantee that all clients work on the correct copy of the program.



2. 3-tier architecture:

- In 3-tier architecture, application logic is transferred from the client back to the server.
- Tiers: It has the following tiers -
 - a) Client – tier:
 - It is responsible for the presentation of data, receiving user events and controlling the user interface.
 - The actual business logic is moved to application server.
 - Today, Java – applets offer an alternative to traditionally written PC – applications.
 - b) Application – Server – tier:
 - This tier is new, i.e., it is not present in 2-tier architecture.
 - Business – objects that implement the business rules “live” here, and are available to the client-tier. This level is the central key to solve 2-tier problems.
 - It protects the data from direct access by the clients.
 - Furthermore, the term “component” is also found here. Today the term describes visual components on the client-side.
 - Components on the server-side can be defined as configurable objects, which can be put together to form new application processes.
 - c) Data-server-tier:
 - This tier is responsible for data storage:
 - Besides the widespread relational database systems, existing legacy systems databases are also used here.
- Advantages: It solves number of problems that are inherent in 2-tier architecture.
 - a) Clear separation of user-interface-control and data presentation from application-logic: With this separation more clients are able to have access to a wide variety of server applications. The two main advantages for client-application are
 - i. Quicker development
 - ii. Shorter test phase.
 - b) Dynamic load balancing: If bottlenecks occur in terms of performance then the server process can be moved to other servers at runtime.
 - c) Change management:
 - It is easy and faster to exchange components on the server than to provide number of PCs with new program versions.
 - In addition such components require high standard of quality control.



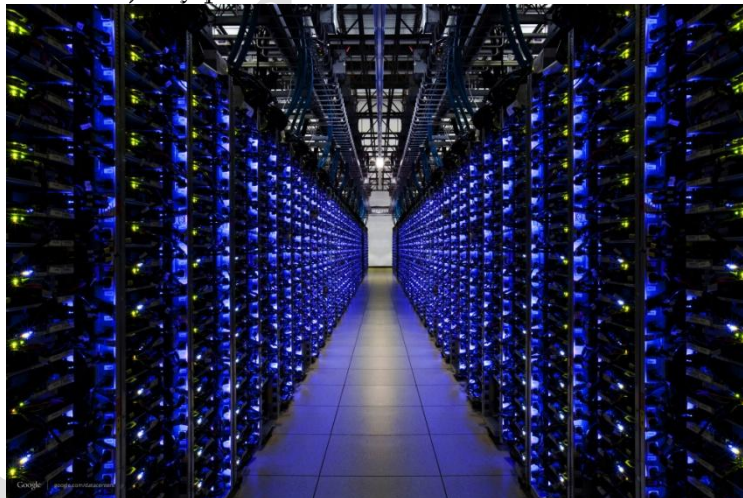
3. Multi tier (n tier) architecture:

- Meaning:
 - The client program has only UI code.
 - The UI code talks to the “middle tier” on which the business and database logic sits. In turn the middle tier talks to the database. If necessary the middle tier can be placed on the same machine as the database.
 - In either case the data “traffic” is highest between database logic and database.
 - So, the network infrastructure that connects the database logic with the database server needs have very high bandwidth i.e. expensive.

- **Advantages of Multi-tier architecture:** The advantages of a multi-tier architecture are:
 - a) Forced separation of UI and business logic.
 - b) Low bandwidth network.
 - c) Business logic sits on a small number of centralised machines.

Data Center

- A data center is a centralized repository (= warehouse) for the storage, management and dissemination (=distribution) of data and information.
- Data center is a highly secure, fault-resistant facilities, hosting customer equipment that connects to telecommunications networks.
- The purpose of a data center is to provide space and bandwidth connectivity for servers in a reliable, secure and scalable environment.
- Data centres are often referred to as Internet hotel, server farm, data farm, data warehouse, corporate data center, Internet Service Provide (ISP) or Wireless Application Service Provider (WASP).
- These facilities can accommodate thousands of servers, switches, routers and racks, storage arrays and other associated telecom equipment.
- This kind of data center may contain a Network Operations Center (NOC), which is a restricted access area, and contains automated systems which constantly monitor server activity, Web traffic, network performance and report even slight irregularities to engineers. Thus engineers can spot potential problem before they happen.
- The primary 'goal' of a data center is to arrange the required state-of-the-art, redundant infrastructure (= additional, more than the required) and systems so as to maximize availability and prevent or mitigate (= minimize) any potential downtime for customers.



- **Different types of Data centers:** Data centers serve variety of needs of different businesses. On this basis, data centers can be classified into following two main categories:
 - a. **Private Data Centre:** A private data center (also called captive or enterprise data center) is managed by the organization's own IT department, and it provides the applications, storage, web-hosting, and e-business functions needed to maintain full operations. If an organisation wants to outsource these IT functions, then it turns in to a public data center.
 - b. **Public data centers:** A public data center (also called internet data centers) provides services ranging from equipment collocation to managing web-hosting. Generally, clients access their data and applications through internet.
- **Different Tiers in Data Center:** Typically, data centers can be classified in tiers, ranging from tier I to tier IV. Tier I being the most basic and inexpensive and tier 4 being the most robust (= very tough) and costly. If the application is more 'mission critical' then more redundancy, robustness and security are required for the data center.

- a) A tier 1 data center:
 - Need not have redundant power and cooling infrastructures.
 - It only needs a lock for security and
 - Can tolerate upto 28.8 hours of downtime per year.
- b) A tier 4 data center:
 - Must have redundant systems for power and cooling, with multiple distribution paths that are active and fault tolerant.
 - Access should be controlled with biometric reader and single person entry ways;
 - Gaseous fire suppression is required;
 - The cabling infrastructure should have a redundant backbone; and
 - The facility must permit no more than 0.4 hours of downtime per year.

Tier 1 or 2 is usually sufficient for enterprise data centers because they serve users within a corporation. Financial data centers are typically tier 3 or 4 because they are critical to our economic stability and therefore must meet the higher standards set by the government.

- **Type of Organization That need Data Center:**

- Any large volume of data that needs to be centralized, monitored and managed centrally needs a data center.
- Of course, a data center is not mandatory for all organizations that have IT. Everything depends on the size and criticality of data.
- Data centers are extremely capital-intensive facilities.
- Commissioning costs amount to millions of dollars and operational costs involved in maintaining redundant connectivity, hardware and human resources, will also be very high.
- Only for few companies it is economical to commission and operate an enterprise data center.
- Majority of small, medium and large enterprises host their online and web-enabled applications with established public data centers because they can use the existing infrastructure services, round-the-clock support and monitoring infrastructure.
- Certain sectors like defence and banks prefer their own infrastructure i.e. private data centers.

- **Features of Data Center :** A data center is a centralized repository (= warehouse) for the storage, management and dissemination (=distribution) of data and information. Data center is a highly secure, fault-resistant facilities, hosting customer equipment that connects to telecommunications networks. Following are the features of data centers:

1. **Size:** The most distinguishing feature of data centers is their size of operations. A financially viable data center could contain several hundreds to several thousands of servers. This would require a minimum area of around 5,000 to 30,000 square meters. Apart from this, the physical structure of the data center should be able to withstand the weight of the servers. Thus, there is a need for high quality construction.
2. **Data Security:** Another critical issue of data centers is the need to provide maximum data security and 100% availability. Data centers should be protected from intruders through access controls and video surveillance (= observation through CCTV cameras, etc). They should be able to withstand natural disasters and calamities like fire, power failures, etc. Disaster Recovery sites must be well maintained.
3. **Availability of Data:** The goal of a data center is to maximize the availability of data and to minimize the downtime. To do this, redundancy should be maintained in case of all important infrastructure such as connectivity, electrical supply, security and surveillance, air conditioning, fire suppression, etc.
4. **Electrical and power systems:** A data center should provide highest power availability with Uninterrupted Power Systems (UPS).

5. Security: Physical security and systems security are critical to operations. Thus, it should provide both types of security measures to ensure the security of equipment and data placed at the data center.
 - a. Physical security: It can be achieved through
 - i. Security guards
 - ii. Proximity card and PIN for door access
 - iii. Biometrics devices
 - iv. 24 x 365 CCTV surveillance and recording
 - b. Data security: Data security within a data center should be maintained at multiple levels.
 - c. Perimeter security: This is to manage both internal and external threats. This consists of firewalls, intrusion detection and content inspections, host security, anti-virus, access control, administrative tools, etc.
 - d. Access management: This is for both applications and operating systems that host these critical applications.
6. System monitoring and support: The data center should provide system monitoring and support so that one can be assured that the servers are being monitored round the clock.
 - a. 24x7x365 hours network monitoring
 - b. Proactive customer notification
 - c. Notification to customers for pre-determined events
 - d. Monitoring of power supply, precision air conditioning system, fire and smoke detection systems, water detection systems, generators and uninterruptible power supply (UPS) systems.
 - e. A data center will be considered as world-class only if there are no shortcuts in providing facilities. Connectivity, electrical supply and security are the three most important requirements of any data center.
7. Storage: In public data centers, data storage runs into multiple terabytes. As the customer requirements differ, data centers usually have hybrid storage and backup infrastructure. Primarily, data center storage can be differentiated into:
 - a. Primary storage (SAN, NAS, DAS)
 - b. Secondary storage (tape libraries)
 - c. Tertiary storage (offline tape storage, such as DAT drives, and magneto-optical drives)Most data centers today operate in hands-off mode i.e. no individual enters the data center unless there is a genuine need. All the storage is operated and managed from remote consoles, located outside the data centers.

- **Various Types Of Services Provided By Data Centers:** Some of the value added services that a data center provides are:
 - a. Database monitoring: This is done through a database agent, which enables the high availability of database through comprehensive automated management.
 - b. Web monitoring:
 - The main objective is to assess and monitor website performance, availability, integrity and the responsiveness from the visitor's point of view.
 - It also reports on HTTP, FTP service status, monitors URL availability, response times, verifies web content accuracy and changes.
 - c. Backup and restore:
 - They provide centralized, multi-system management capabilities.
 - They also provide an integrated management solution for enterprise data storage using specialised backup agents for operating system, database, open files and applications.
 - d. Intrusion detection system (IDS):
 - ID stands for Intrusion Detection, which is the art of detecting inappropriate, incorrect, or anomalous (=irregular, strange) activity.

- The term intrusion is used to describe attacks from the outside. Whereas, misuse is used to describe an attack that originates from the internal network.
- ID systems that operate on a host computer to detect malicious activity on that computer are called host-based ID systems.
- » ID systems that operate on network data flows are called network-based ID systems.
- » The IDS is scalable.
- e. Storage on demand:
 - It provides back-end infrastructure as well as expertise, best practices and proven processes to give robust, easy and cost effective storage strategy.
 - It provides data storage infrastructure that supports access to information at any given moment.
 - It also gives security, reliability and availability needed to meet company demands.
- **Essential Components of Data Centers:** To keep equipment running reliably, even under the worst circumstances, the data center is built with the following support infrastructure:
 1. Network connectivity with various levels of physical (optical fibre and copper) and service (both last mile and international bandwidth) provider redundancy
 2. Dual DG sets and dual UPS
 3. HVAC systems for temperature control
 4. Fire extinguishing systems
 5. Physical security systems - swipe card/ biometric entry systems, CCTV, guards and so on.
 6. Raised flooring
 7. Network equipment
 8. Network management software
 9. Multiple optical fiber connectivity
 10. Network security - segregating the public and private network, installing firewalls and Intrusion Detection Systems (IDS)
- **Disaster Recovery Plans:**
 - Data centers need to be equipped with appropriate disaster recovery systems that minimize downtime for its customers.
 - Downtime can be eliminated by having proper Disaster Recovery (DR) Plans for mission-critical types of organisations.
 - Some of the larger IT organizations, which cannot tolerate too much downtime, will set up their DR site as a hot site.
 - Here, both primary and DR sites are kept in real-time synchronisation.
 - Types of DR sites: Following are the different types of disaster recovery plans
 - a. Cold site: It is an alternative facility which does not consist of any resources or equipment, except air conditioning and raised flooring. Equipment and resources must be installed to duplicate the critical business functions of an organisation. Cold sites may vary depending on the communication facilities.
 - b. Warm site: This is an alternate processing site that is only partially equipped. It can be either shared (sharing servers, equipment) or dedicated (own servers).



They are similar to cold sites with minimal equipment and resources which are required to start critical operations of a business.

- c. Hot site: Hot sites are fully equipped with the required facilities and resources needed to recover business functions that are affected by a disaster. Hot sites may vary in the type of facilities offered (such as data processing, communications or any other critical business functions needing duplication). The location and size of the hot site must be proportional to the equipment and resources needed.

- **Challenges Faced By Organizations In Management Of Data Centers:** Following are challenges faced by organisations in the management of data centers:

- a. Maintaining skilled staff and high infrastructure needed for daily data center operations: A company needs to have staff that is expert in network management, has software and hardware skills. The company has to employ large number of such employees, as they have to work on shift basis.
- b. Maximising uptime and performance: While establishing sufficient redundancy and maintaining water tight security; data centers should maintain maximum uptime and system performance.
- c. Technology selection: The other challenges that enterprise data centers face is technology selection, which is very crucial for their operations. Another problem is compensating for obsolescence.
- d. Resource balancing: The enterprise needs to balance reduced operational budgets, increased demands on existing infrastructure, maximise availability, ensuring round-the-clock monitoring and management, periodic upgrades, etc. That is why even some of the largest enterprises in the world prefer public data centres.

- **Disaster Events**

- Disasters are disruptions which make the entire facility inoperative for a long period of time (usually more than a day).
- There is a potential for significant interruption to normal business processing.
- All disruptions (=disturbances) are not disasters,
- In case of disaster there is a potential for significant interruption to normal business processing,
- Business is associated with natural disasters (=calamity) like earthquake, flood, tornadoes, thunderstorms, fire, etc.
- On the other hand catastrophes are disruptions resulting from disruption of processing facility.

Business Continuity Plan (BCP)

- A Business Continuity Plan (BCP) is a documented description of action, resources and procedures to be followed before, during and after an event, vital functions to business operations are recovered, Operational in an acceptable time frame.

- **Steps in the development of BCP:**

1. Phase 1: Define requirements based on business needs.
This involves risk analysis in critical, vital, sensitive and non critical areas, determining critical time period, applications to be recovered in critical recovery time period and coverage of insurance.
2. Phase 2: Statements of critical resources needed
It involves determination of minimum resources necessary, review of operations between current practices and backup procedures (whether they are adequate to support a business resumption plan).
3. Phase 3: Detailed planning on use of critical resources
This involves:

- a. Identification of most appropriate recovery solutions including information processing and telecommunication recovery,
 - b. Hot sites which are fully configured and ready to operate within several hours.
 - c. Warm sites are partially configured with network connections and selected peripheral equipments but without the main computer.
 - d. Cold sites are ready to receive equipment but do not offer any equipment at the site in advance. It only provides basic environment to operate an information processing facilities.
 - e. Duplicate information processing facilities.
 - f. Reciprocal agreements.
 - g. Preparing a list of alternatives,
 - h. Visits and reviews
4. Phase 4: Define responsibilities of trained personnel
This involves:
- a. Plan preparation
 - b. Provision for requirement of manual process,
 - c. Document revised work flow,
 - d. Plan development,
 - e. Team building,
 - f. Developing general plan.
5. Phase 5: Written documentations and procedures to cover all operations
This involves testing BCP in various phases like –
- a. Pre-test,
 - b. Test,
 - c. Post-test,
 - d. Paper test,
 - e. Preparedness test,
 - f. Review test,
 - g. Review test results
6. Phase 6: Commitment to maintain plan as per the changing needs
This involves Maintenance by BCP Coordinator who has to arrange for
- a. scheduled and unscheduled tests,
 - b. develop a scheduled training,
 - c. maintain records of test,
 - d. training and review,
 - e. update notification directory.

Security Program

- Network security consists of provisions made in an underlying computer network infrastructure, policies adopted by the network administrator to protect the network and the network accessible resources from unauthorized access and the effectiveness of these measures together.
- **Need for security:** The basic objective of providing network security is two fold:
(a) to safeguard assets and (b) to ensure and maintain data integrity.
- **Types of security:** There are two types of systems security
 - a) Physical security is implemented to protect the physical assets of an organization like personnel, hardware, facilities, supplies and documentation.
 - b) Logical security is intended to control (i) malicious and non-malicious threats to physical security and (ii) malicious threats to logical security itself.
- The task of Security Administration in an organization is to conduct a security program which involves the following eight steps:

1. Step 1: Preparing project plan for enforcing security. In a sequence, the components of project plan are:
 - a. outlining the objectives of the review
 - b. determining the scope of the review and tasks to be accomplished,
 - c. assigning tasks to the project team
 - d. preparing resources budget which will be determined by the volume and complexity of the review and
 - e. fixing a target / schedule for task completion.
2. Step 2: Assets identification
Assets which need to be safeguarded are identified and subdivided into Personnel, Hardware, Facilities, Documentation, Supplies, Data, Application Software and System Software.
3. Step 3: Assets valuation
This is a very difficult job. The valuation can differ depending on
 - a. age of assets
 - b. the person doing the valuation,
 - c. the way in which the asset can be lost
 - d. the period for which it is lost and
 - e. how old is the asset.Valuation of assets include valuation of logical assets also. For example, the replacement value of the contents in a hard disk may be several times more than the replacement value of the hard disk itself.
4. Step 4: Threats Identification
 - The source of a threat can be external or internal and the nature of a threat can be non-deliberate (accidental) or deliberate.
 - a. non-deliberate external threat - act of God.
 - b. non-deliberate internal threat – pollution.
 - c. deliberate external threat – hackers
 - d. deliberate internal threat - employees.
 - In other words, the sources of threat are the Nature or acts of God like earthquake, flood, fire, extreme temperatures and electromagnetic radiations followed by other sources like Hardware / Software Suppliers, Competitors, Contractors, Shareholders / Debenture holders, Unions, Governmental Regulations, Environmentalists, Criminals / Hackers, Management, Employees and Unreliable Systems.
5. Step 5: Assessment of probability of occurrence of threats
The fifth step is assessment of the probability of occurrence of threats over a given time period. This exercise is not so difficult if prior period statistical data is available. If prior period data is not available, it has to be extracted from the associated stakeholders like end users (providing the data aspect) and the management (providing the control aspect)
6. Step 6: Exposure analysis
 - It is done in the following order
 - a. identify the controls in the place,
 - b. assess the reliability of the existing controls,
 - c. evaluate the probability that a threat can be successful and
 - d. assess the resulting loss if the threat is successful.
 - For each asset and each threat the expected loss can be estimated as the product of
 - a. the probability of threat occurrence,
 - b. probability of control failure and
 - c. the resulting loss if the threat is successful.
7. Step 7: Controls adjustment
The controls should be adjusted in such a way that the cost of control is lower than the reduction in the expected losses. The reduction in the expected losses is the difference between expected losses with the (i) existing set of controls and (ii) improved set of controls.

8. Step 8: Report generation: Report generation includes
 - a. documenting the findings of the review
 - b. recommending new asset safeguarding techniques
 - c. recommending the existing assets safeguarding mechanisms that should be eliminated / rectified,
 - d. and also recommending the levels of security to be followed for individual end users and systems.

Threats and Vulnerabilities Involved In System Security

- The threats to the security of systems assets can be broadly divided into nine categories. Following are the threats and vulnerabilities involved in system security and the measures to be taken to overcome them:
 1. **Fire:** Use of fire detection and fire avoiding equipment like automatic fire extinguishers.
 2. **Water:** Well designed water protection system.
 3. **Energy variations like voltage fluctuations, circuit breakage, etc.:** Use voltage stabilizers, circuit breakers, etc.
 4. **Structural damages:** Insurance.
 5. **Pollution:** Use dust proof material at the time of construction of computer room and ensure dust free environment.
 6. **Intrusion like physical intrusion and eavesdropping:** Physical access controls, prevention of electromagnetic emission.
 7. **Viruses and Worms:** Use preventive, detective and corrective controls.
 8. **Misuse of software, data & services:** Prepare employee's code of conduct.
 9. **Hackers:** Through robust logical access controls and/or Cyber laws of the land.
- **Abuse of software, Data and Services can arise in any of the following ways:**
 - a. Without any authority, employees may take away the copies of generalized software and proprietary databases of the organization. They may keep it for their own purposes or they may hand it over to competitors,
 - b. Organizations fail to protect the privacy of individuals whose data is stored in databases,
 - c. Employees use system services for their own personal gains and activities.
- **Important Threats:**
 1. **Virus:**
 - A virus is a malicious program that attaches itself to a legitimate program and penetrates into the operating system.
 - A virus is a program that instructs the operating system to append it to other programs and thus propagates to other programs via files containing macros.
 - A virus can replicate itself over and over and the replicated modules can grow independent of the initial virus.
 - Sometimes a virus can be benevolent and it may cause minor disruptions by printing laughing message and sometimes a virus can be malignant and it may delete files or corrupt other programs.
 - Following are the controls to safeguard against the viruses:



- a. **Preventive controls like:**

- i. using only clean and licensed copies of software,
- ii. cutting the use of public domain software / shareware,
- iii. downloading files or software only from reliable websites,
- iv. implementing read-only access to software.
- v. checking new files / software with anti-virus software before installation,
- vi. imparting education and training programs to end users

b. Detective controls like:

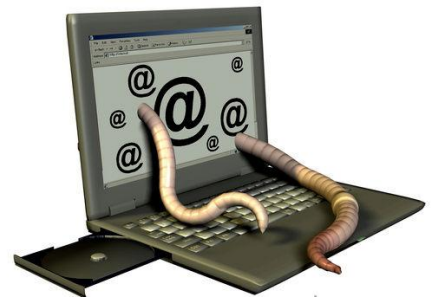
- i. regularly running antivirus software,
- ii. file size comparison to observe whether the size of programs has changed,
- iii. date / time comparisons to detect any unauthorized modifications.

c. Corrective controls like:

- i. maintaining a clean backup,
- ii. having a recovery plan from virus infections,
- iii. regularly running antivirus software (which is useful for both detection & removal of virus)

2. Worms:

- A computer worm is a self-replicating computer program.
- Worms are similar to viruses but they exist as separate and independent programs.
- It uses a network to send copies of itself to other nodes (computer terminals on the network) and it may do so without any user intervention.
- Unlike a virus, worms do not need to attach itself to an existing program.
- Worms may cause harm to the network. For e.g. they may consume bandwidth.
- They exploit security weaknesses / bugs in the operating system to penetrate into other systems.
- Exposures that arise from worms are more difficult to control than that arise from virus.
- Generally anti virus / anti spyware software can prevent the attacks from Worms.



3. Hackers:

- Hackers attempt to gain unauthorized entry into a system by circumventing the access control mechanism of the system. They can do this either with good or bad intention.
- Some hackers may just trespass and read the files without making any changes to them.
- Some hackers may cause destruction by deleting critical files, disrupting / suspending operations, stealing sensitive data and / or programs.
- They can be avoided only through robust logical access controls and / or Cyber Laws of the Land.

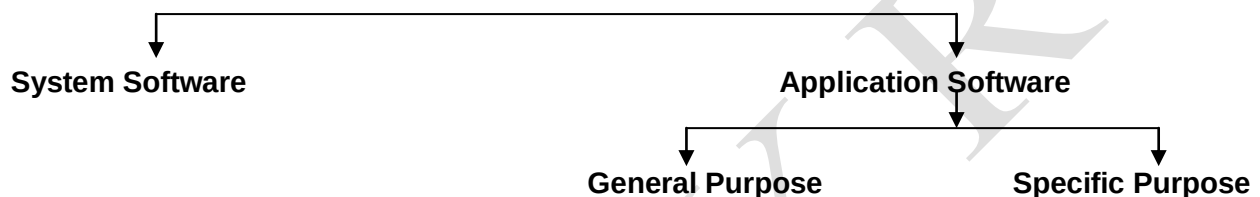




Software

- The term Software is used to describe the instructions that tell the hardware how to perform a task. Without software, hardware cannot do any work. Thus software is the means of controlling hardware.
- In early days of computer, only standard programs supplied by the computer manufacturers were known as software. But now-a-days the term has got much wider meaning. It includes programs developed by the user or procured by him, from an organisation dealing in software.

Types of Software:



System programs or system software: These programs are designed to make the computer easier to use. A system program can't solve a particular problem, but it makes easy to use necessary application programs. An example of system software is an Operating system.

Application programs or application software: These programs are designed for specific computer applications. For example, a programme that prepares payroll for a business is an application program.

Firmware

- Firmware or micro programs refer to a series of special program instructions. In a computer, the most basic operations such as addition, multiplications etc. are carried out by hard wired circuits.
- These fundamental tasks are combined in the form of micro programs to produce high level operations such as move data, make comparisons etc.
- These micro programs are called firmware they deal with very low level machine operations.
- For example, a small program for computing square root can be stored in computer's secondary memory or it can also be embedded into CPU's circuitry. But the later is very expensive. It is economical only if the square root has to be calculated for large number of times.
- Generally simple arithmetic/logical operations (like add, subtract, multiply, divide) are provided in the CPU circuitry so that they can be performed at a very high speed. These operations are repeated for number of times in both business and scientific applications.

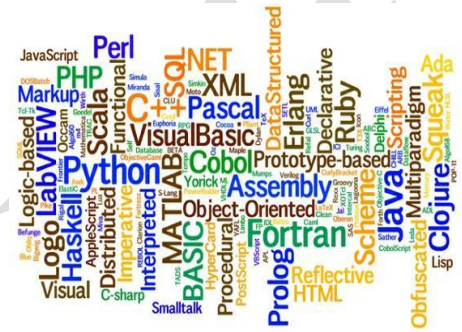
System Software

- These programs are designed to make the computer easy to use. A system program can't solve a particular problem, but it makes easy to use necessary application programs. It consists of programs that control and support the computer system and its data processing applications. Following are different types of system software:
 1. Programming languages
 2. Diagnostic routines

3. Operating systems
 4. Language translators
 5. Utility programs
- **Who will provide such SW?** A wide variety of above software are usually provided by computer manufacturer. But some software is also provided by software companies. Generally these companies charge extra amount for such software. But some manufacturers provide this software without any extra cost.

Programming Language

- Human beings use natural languages such as English and Spanish to communicate with each other.
- Similarly a programming language is used to communicate with computer through a program.
- For each specific task a program must be written so that computer can interpret (=understand) it. A program is developed to direct processing steps of the computer. Every instruction must follow specific rules that form a language.
- Generally programming languages are provided by the manufacturer.



• **Types of Languages:**

1. Machine / 1st Generation Languages

- In the early days of computer, each particular computer model has a unique language, which is based on the internal circuitry of the computer and it is developed and provided by the computer manufacturer.
- The computer manufacturer supplies a manual of codes for various operations which are unique to that computer.
- It is the language of the computer and it is the only language which a computer can understand without any translation.
- **Advantages:**
 1. These programs do not need any translation. Thus translation time can be saved.
 2. The processing speed of programs written in these languages is very high.
 3. It provides great security to programs because program developed by one person is not understandable to other persons.
- **Disadvantages:**
 1. Writing a program in machine language is very difficult and it is also error prone.
 2. Programs written for one computer model cannot be used for other models. That is why this language is also known as machine-oriented language or machine dependent language.
 3. This is a machine oriented language. So, the programmer must know the language for each and every new machine/model.
 4. It is very difficult to make changes to programs.
 5. It is a low level language and is not user friendly.

2. Compiler / 3rd Generation Languages

- Assembler Languages are at the next level to machine languages.
- They are also known as symbolic languages because they employ symbols for both arithmetic and logical operations and such symbols are called mnemonic codes.
- Such standard symbols were supplied by computer manufacturer.
- Programs written in this way are required to be translated into machine level language.
- **Advantages:**
 1. Programs written in assembly language are more efficient than that of machine language.

2. Programming in assembly language is much easier than in machine language.
3. Since assembly language is machine oriented, a programmer can write programs that suit the capabilities of the computer i.e., the program would occupy minimum storage and take less processing time.
4. Flexibility i.e. wherever required, additional instructions can be inserted.

▪ **Disadvantages:**

1. Each type of computer has its own assembly language. So, it is difficult to learn and remember.
2. A program written for one computer will not run on a computer of different manufacturer.
3. To solve a particular program, the programmer has to write large number of statements than a programmer using other high-level programming languages.
4. It is very difficult to write, read and maintain programs in Assembly language than that of high-level languages.

▪ **Where they are used?**

1. Normally assembly languages are not used to write programs for general business applications such as payroll, accounts receivable, billing etc. These languages are used to write system programs and other types of programs in which control or efficiency are important.
2. These languages are used where fast execution is essential.

3. Assembler / 2nd Generation Languages

- Compiler languages are also known as high level languages or procedural languages because they are highly procedure oriented.
- They use plain English like and mathematical expressions. An instruction in these languages is usually called a statement.
- Programs written in third-generation languages have to be translated into machine language using a compiler or interpreter.

▪ **Advantages:**

1. It is easy to learn and write error free programs.
2. Programs written in these languages are much more compact than those written in lower level (machine and assembly) languages.
3. Economical than low level languages.
4. They are very close to human languages.

▪ **Disadvantages:**

1. Programs written in compiler language occupy more storage space and require more processing time than programs written in assembly language.
2. More time is wasted on translation.

- **Where they are used?** Frequently used programs are written in low level languages and rarely used programs are written in high level languages. E.g.: FORTRAN, COBOL, BASIC, PASCAL, C etc.

4. 4th Generation Language

- These are high level, non-procedural languages designed to produce spectacular results with minimum programming effort.
- With 4GLs special purpose queries or “reports can be prepared by the user by himself, in just few minutes.
- 4GL’s include English like instructions, limited mathematical manipulation of data, sorting and selection of records by a given criteria, automatic report formatting etc.
- Types:
 1. Production oriented 4GLs – Used by computer professionals for creating information systems, etc.
 2. User oriented 4GLs – Used by end users to query databases, etc.

▪ **Advantages:**

1. To generate a report or to make an enquiry, minimum training and practice is sufficient.

2. Most of the fourth-generation languages are machine independent i.e. they can be used on any type of computer.
3. Easy to learn and use.
4. Requires few instructions to write a program than a third generation language.
5. Program development is faster than 3rd generation languages.

▪ **Disadvantages:**

1. But 4GLs require more computer storage to perform a particular operation.
2. Large programs with multiple users are better handled by 3GLs or an assembly language.
3. Slow response time.

▪ **Suitability:**

Many 4GLs are used to get information from files and databases. These 4GLs contain a query language, which is used to answer queries from a database. They are used for writing business application programs and not suitable for scientific application programs or system programs.

Object Oriented Languages

- It is a programming language which develops programs using objects. An object is a predefined set of program code that is written and tested. This object will always behave in the same way. So, it can be used in several other applications.
- All programs consist of some specific tasks such as saving data, printing data, retrieving data, calculations etc. In object-oriented programming, an object is written for each specific task and saved in a library so that anyone can use it.
- In this method objects are combined and a small amount of code is sufficient for finishing the program.
- **Advantages:**
 1. Graphical interface, ease of use, faster program development and improved productivity.
 2. Programs are more reliable and contain less number of errors.
 3. Economical than other languages.
 4. New objects can be created or old objects can be modified, reused, copied.
- **Disadvantages:**
 1. Huge amount of initial development costs and huge amount of start-up time.
 2. Programs are slower and use more memory and computer resources than traditional methods. As a result, it requires powerful PCs and workstations.
- E.g.: Some common object-oriented languages are Small talk, C++, Visual Basic and Java.



High Level Languages

- High level languages provide a level above assembly languages.
- Instead of mnemonic codes they use English and mathematical symbols. Thus a programmer can concentrate more on the logic of the problem.
- They enable the programmer to create programs quickly and easily, but the program should be translated into machine language by an interpreter or compiler. A translating program that converts high-level language instructions into machine language is called Compiler.
- They are also called as Procedure oriented languages.

- For example, COBOL (Common Business Oriented Language) is a high level language used for business related problems. On the other hand FORTRAN (Formula Translator) is another high level language used for scientific applications.
- There are two high level languages – procedural languages & Object Oriented languages.
- **Advantages:**
 1. They are machine independent i.e. a program written for one computer can easily work on another computer.
 2. They are easy to learn because they use english like words and common mathematical symbols.
 3. Programs written in high level languages are easy to modify and debug.
 4. Overall cost of development of software packages decreases.
- **Limitations:**
 1. Program written in high level language is required to be translated into machine language with the help of compilers. This requires additional time and storage space.
 2. Since high level languages are machine independent, it is not possible to design programs that suit the capabilities of the computer.

Operating Systems

- Operating System is a Master control program that runs the computer.
- In olden days lot of time used to be wasted in setting up computer and everything was supervised by an operator. Every time the computer is started, the operating system must be compiled / assembled.
- Similarly, several application programs were required to be read into the CPU everyday. Thus lot of time was wasted in setting up the computer.
- This wastage of time can be avoided by maintaining all programs in storage devices. The required program can be recalled into CPU more quickly than in olden days.
- Operating systems optimize the man-machine capabilities. Operating systems are based on the concept of modularity.
- Operating systems are also known as “executive systems” or “Control systems” or “monitor systems”.
- **Functions of an O/S:**
 - a. Schedule jobs: An operating system can determine the sequence in which jobs are to be executed.
 - b. Manage hardware and software resources: Operating system first loads the user’s application programs on to the computer’s primary memory and executes it. It makes various hardware units to perform as per the specifications of the application program.
 - c. Maintain system security: To maintain security, operating system maintains a system of passwords in the organization. To enter into a system the user has to enter his password.
 - d. Enable multiple user resource sharing: OS can handle the scheduling and execution of application programs for many users at the same time. This is called multiprogramming.
 - e. Handle Interrupts: An interrupt is a technique used by the operating system to temporarily suspend the processing of one program in order to execute another program. Interrupts are issued when a program requests an operation or when the program exceeds some predetermined time limit.
 - f. Maintain usage records: OS can record the amount of time used by each user for each system - the CPU, secondary storage, input and output devices.



Files

- A file is a collection of related data, saved on a specific area of a storage medium.
- To use a file the file must have a name. The name is also significant because it indicates the type of data stored in the file. (OSs such as Windows 95 and Windows NT use small icons to identify nature and type of a particular file.)
- For most OSs the file name consist of two parts known as prefix & suffix (extension).
- Prefix is supplied by the user. Suffix is supplied either by user or computer Program being used.
- Generally, prefix is separated from suffix by full stop or slash.
- Below is a list of some typical DOS/Window file names with appropriate suffixes:
NOTE.TXT Text file (.TXT-Text)
LETTER.DOC Document file (.DOC-Document)
MENU.EXE Executable file (.EXE-Executable)

Directories

- A set of files is called Directory. It is like drawer in a filing cabinet. It consists of several files.
- A computer disk can have multiple number of directories. If necessary, a directory can have number of sub-directories.
- The purpose of directories is to partition the computer's disk/storage devices in an organised and meaningful manner.

Graphical User Interface (GUI)

- During 1980, micro computer's operating system was strictly text-based, command driven software. Users were required to issue commands to the operating system.
- Such commands were syntax sensitive. For constructing a command the user must follow the syntax strictly; otherwise an error message is displayed on the screen.
- Today we are using user-friendly, graphics environment called Graphical User Interface or GUI.
- In GUI environment, a unique icon will be given for each command.
- With GUI, the user can issue a command by selecting options from a menu or by positioning cursor over the appropriate icon. Thus user need not memorise and enter commands.
- For example, Microsoft Windows supports GUI.

Different Operating Systems

1. MS/PC-DOS:

- As IBM was about to finalise the PC, it started to negotiate with other computer companies to get a suitable OS for the product.
- Initially IBM made negotiations with Digital Research. Digital Research already owned personal computer operating system called CP/M (Control Program for Micro computer) which was, at that time, the market leader in microcomputer OS's. But it failed.
- In 1980, IBM and Microsoft started negotiations for the production of a suitable PC OS.
- It purchased 86 DOS from Seattle Computer Products. With joint minimum effort, 86 DOS was totally modified and upgraded and a new 16 bit OS called PC-DOS was released.
- In 1981, IBM introduced its PC with PC-DOS as its operating system.
- Microsoft released an almost identical (=similar) version of this OS under the name of MS-DOS.
- MS-DOS was supplied with PC compatible computers & PC-DOS was supplied with IBM PCs.



2. MS Windows:

- The first version of Microsoft Windows OS was launched in 1983, but it was not successful.
- In 1990, it launched windows 3.0 and it became the world's best selling 16-bit GUI OS. By the end of 1996 Microsoft had sold more than 45 million copies.
- The main reason for its success is the overall design and GUI.
- Windows 3.0 enabled true multitasking and also allowed users to use programs written for MS / PC-DOS.
- To work effectively, a PC must have minimum of 4 MB of RAM and a 386 Processor.



3. Window 95:

- Windows 95, a 32 bit OS was released in August 1995. Microsoft took 3 ½ years to develop it.
- It was a gigantic task and was estimated to have taken 75 million hours of testing.
- To run Windows 95 users need a computer with 386DX or higher processor with a minimum of 4 MB of memory (8MB is recommended) along with a hard disk of 50 MB as well as 3.5 inch disk drive or a CDROM drive.
- Windows 95 was designed to have certain critical features over and above what was already supplied by Windows 3.1. These include:
 - a) A 32-bit architecture (=design) which provides for multitasking environment. This allows user to run multiple programs at a time.
 - b) One click access i.e. the user need not double click the mouse to activate an application.
 - c) The user can employ long file names.
 - d) 'Plug and play technology' - enables users to connect various peripheral devices with minimum effort.
 - e) Windows 95 is also network ready. In other words, the OS is designed for easy access to network resources.
 - f) In addition Windows 95 is backward compatible.



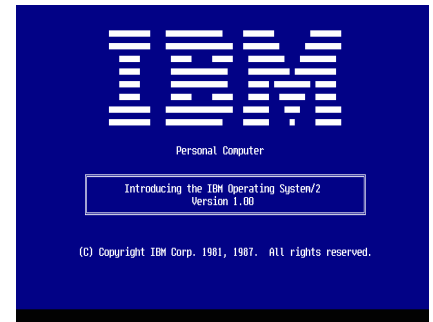
4. Windows NT:

- Unlike Windows 3.0 and Windows 95, Windows New Technology (NT) is a critical OS for network.
- It is a 32 bit OS. It is very much preferred for Intel's more powerful Pentium range of processors.
- Windows NT 4.0 is very much similar in appearance to Windows 95 (Although not exactly same).
- Important features include:
 - a) A stable multitasking environment,
 - b) Enhanced security features,
 - c) Increased memory support,
 - d) Network utilities,
 - e) Windows NT is more expensive than other Windows OSs and & require lot of processing power.



5. OS/2:

- In 1987 IBM and Microsoft announced a new PC OS called OS/2 (Operating System Two). Unfortunately, the original OS/2 was not very successful because it was unable to support many existing PC applications. So users faced compatibility problems.
- The initial failure of OS/2 showed considerable impact on IBM - Microsoft alliance (=group, association). After that IBM and Microsoft began to go in their separate ways.
- Microsoft left OS/2 to IBM and chose to concentrate on MS-DOS and Windows.



MS Windows

- Microsoft Windows is a Graphical User Interface software for IBM PC and its clones, introduced by Microsoft Company.
- The name 'Windows describes how the software functions it runs one or more applications in windows which are rectangular areas displayed on the screen.
- It defines a new platform or standard on which other application software packages are written.
- **Features:**
 - a) Windows is user friendly: Windows employs a graphical user interface. Thus user need not memorise and enter commands through keyboard.
 - b) Windows enables multiple programming.
 - c) Windows enables user to work with large files: Large Data Bases, Spread Sheet files and Wordprocessing documents can be used with windows. Without Windows, a file containing one or two chapters of a book might not fit into available RAM.
 - d) Windows permits information to be passed between applications: With Windows, text in a wordprocessing document can be transferred in seconds to a data base record. These types of information transfers are cumbersome (=bulky, burdensome) and time consuming with MS-DOS.
 - e) Application software packages created for MS-DOS run under windows also.

Interleaving Techniques

- Large centralized systems can support multiple users simultaneously. The user's terminals may have limited processing capacity and actual processing may be entirely done by the large computer that is connected to the terminals. Such types of systems require an operating system which can share the central processor. To do this, the operating system combines (interleave) the processing work of multiple users or applications in such a manner that resources are used efficiently. Commonly used interleaving techniques are:

1. **Multiprogramming:**

- Simultaneous processing of multiple, independent programs by interleaving (=leaving some time gap in between) their execution is called Multi programming. In other words, it is defined as execution of two or more programs at a time, that all reside (=exists) in primary storage.
- It is a facility available in an operating system.
- CPU can execute only one instruction at a time i.e. it cannot execute instructions from two or more programs simultaneously. However, it can execute instructions from one program then from second program then from first again and so on. This type of processing is referred to as "concurrent execution".

- In multiprogramming, storage area is allocated for each program and such areas are called “partitions”.
- Each partition will have some form of storage protection and priority to ensure that a program in one portion will not accidentally write over and destroy the instructions of another partition.
- With the help of this facility, all parts of the system, processor, input and output peripherals can be used concurrently. Thus the entire system can be more effectively.

2. Foreground/Background processing:

- Multiprocessing (or parallel processing) refers to the use of two or more central processing units, linked together, to perform the work simultaneously.
- The available CPU's can execute different instructions of the same program or different instructions of different programs at the same time.
- Using multiprocessing facility many complex operations can be performed at the same time.
- Although parallel processing is not yet widespread, it will be the trend in future.
- Because of the availability of cheaper but more powerful processors, many computer manufacturers are now designing hardware and software systems to do multiprocessing.
- Since several machines can work as a team and operate in parallel, jobs can be processed much more rapidly than on a single machine.
- Since a micro processor is very costly, multiprocessing is very expensive.

3. Multi-tasking:

- Multi-tasking refers to the operating system's ability to execute two or more tasks of a single user concurrently. Most of the operating systems used in micro computers were single-user operating systems. These operating systems allow the user to work on one task at a time. For example, in many single-user operating systems, a word-processing user cannot type a document while another document is being printed out on an attached printer.
- For microcomputers, multi-tasking operating systems provide single users with multiprogramming capabilities.
- This is often accomplished through foreground/background processing. Multitasking operating systems for microcomputers-such as Windows, OS/2, UNIX, XENIX, and Macintosh System 7 - only run on powerful microprocessors. Old machines with less powerful microprocessor typically use single-user operating system.

4. Virtual memory:

- Virtual Memory or Paging is a facility provided by Operating System to a computer System. With the help of this facility, large size software can be loaded on small size RAM.
- Most of today's softwares like WINDOWS, MS Office, etc. require huge amount of RAM.
- Loading of such a large size software into smaller size RAM is possible by the facility called Virtual Memory / Paging.
- As a part of this facility the large size software gets divided into small parts modules. Each module will be smaller than RAM's capacity. These modules are prepared in such a way that each module can perform a set of tasks.
- One by one, the modules are loaded into RAM and perform their task. After one module work is over, the next module is loaded on to RAM overwriting/overlying the first module.
- At the end, it looks as if RAM has suddenly expanded to the size of software and allowed loading of such large software. Thus, Virtual Memory is an illusion and not reality. Hence it is called so.
- The overlaying modules are also called pages. Thus this technique is also known as Paging.
- **Dumping:** It is the other aspect of Virtual Memory. When RAM capacity is insufficient to hold data, a small part of the secondary storage disk space is taken up by RAM, to hold some semi-processed data. This is temporarily copied to the disk and is removed from the disk after

processing. But user feels that RAM capacity has increased to the requirements of the user. This facility also comes under Virtual Memory.

Sub Routines

- A sub-routine is a set of instructions designed to perform a well defined arithmetical or logical operation. Subroutines are particularly useful when it is required to perform the same operation several times in a single program. Detailed instructions are once laid down. Whenever it is needed, a branch instruction will be given.
- After the subroutine is completed, control is returned to the main program.
- These programs are also known as application packages. They are ready made solutions to several problems.
- Subroutine programs may be written by users or may be supplied by manufacturers. By using these subroutines, the work of a programmer is simplified to a great extent.
- **Advantages of sub-routine:**
 1. They help in performing routine but tedious work such as preparation of examination results, income tax calculations, editing of data for input and output, etc.
 2. Storage space is saved as there is no duplication of instructions.
 3. Programming time is reduced because a sub-routine was already tested & proved in another application.
 4. They can be employed many times without wastage of programming effort.
 5. They can be written by a programmer not involved in the main programs.
 6. It is easy to locate faults in programs that are constructed using sub-routines.

Utility Programs

- Utility programs are programs that perform system support tasks.
- These programs are provided by computer manufacturers to perform tasks that are common to all data processing installations.
- Some utility programs may be developed as separate programs and some may be included in application programs.
- Generally following tasks are performed by utility programs:
 1. Sorting the data.
 2. Editing the output data.
 3. Dumping of data to disc or tape.
 4. Tracing the operations of program.
 5. Converting data from one recording medium to another, viz., floppy disk to hard disc, tape to printer, etc.
- **Sort Utility:**
 - It is a utility program used to sort data i.e. arranging the data in a particular order, according to a key filed.
 - For example, we have a file of student records. We could declare “name” as the primary sort key and arrange the file alphabetically on the basis of name field. This is useful to produce student directory.
 - Alternatively we can sort the file by name and then within name, by date-of-birth. Hence, we will declare name as the primary sort key and date-of-birth as the secondary sort key.
 - Examples described here use only one or two sort keys. But many sorting packages can identify 12 or more sort keys and can arrange the records in either ascending or descending order on each declared key.

- Generally sort utilities are found in mainframe and minicomputer environments. (Now these are available even with Microcomputers).
- In case of micro computers, these sort utilities are bundled with application packages. For example, sort routines are commonly found in spreadsheet and database management software.
- **Spooling Software:**
 - Spooling (Simultaneous Peripheral Operation On Line) is a technique used for dynamic job processing. It allows input and output operations to occur simultaneously with processing operations. It refers to procedures followed by the user in order to minimise the high speed CPUs slowing down and waiting whenever direct inputs and outputs take place to the CPU. These procedures are followed by the user both during input and output.
 - During output:
 - » In Spooling during output, whenever output has to be sent from the CPU to the printer, output is re-directed and stored in secondary storage devices. Subsequently, the stored output gets printed.
 - » During first re-direction, the output is sent from CPU to storage device at a very high speed and immediately the CPU gets released for other jobs. For subsequent printing, CPU is not required.
 - During Input:
 - » When data or programs are required to be loaded from tape to RAM, first files are copied or dumped from tapes to Disks and subsequently files are loaded from disk to CPU.
 - » This procedure reduces the CPU's waiting time.
 - Thus the main purpose of spooling software is to compensate for the speed differences between the computer & its peripheral devices.
- **Text Editors:**
 - Text editor is a form of utility program.
 - Text editors are used to create or modify text data in a file.
 - These utilities are widely used by professional programmers for cutting and pasting programs together, changing data files by eliminating certain data fields, changing the order of certain data fields, adding new data fields and changing the format of data.
 - Although text editors closely resemble word processors, they are not same. Word processors are specifically designed to prepare "document" materials such as letters and reports. But text editors are designed to prepare "non-document" instructions in computer programs or data in files.
 - Most word processors contain extensive (=huge number of) capabilities of text formatting and document printing. These capabilities are not found in Text editors.
- **Other Utility Programs:**
 - Some of the commonly used utilities (other than Sort utilities, text editors, spooling software) for microcomputer operating systems are discussed below:
 - a. Disk copy programme: This program is used to copy the entire contents of one diskette to another diskette. It is generally used to make a backup or archive copy of some data or application program.
 - b. File copy programme: This program helps to copy just one file or group of files to another diskette.
 - c. Disk formatting programme: Whenever a diskette is purchased it requires to be divided into tracks and sectors. This process is called formatting and such formatting is done by this program.
 - d. File deletion programme: This program helps to delete a particular file on a diskette.
 - e. File viewing programme: It is used to view the contents of a file on the display screen of the microcomputer.
 - f. Directory programme: This program helps to view the names of data and programme files, which are stored on a disk or diskette. It addition, it gives following additional information: memory occupied by different files, day they were last received and amount of unused storage space left on storage devices.

Diagnostic Routines

- These programs are usually written and provided by the computer manufacturers. They assist in program debugging. They usually trace the processing of the program being debugged.
- They also help to identify the hardware accessories supplied by the manufacturer. They identify the type of processor, BIOS supplied, keyboard attached, type of monitor supplied with the computer manufacturer, etc.
- Using the program, one can find answer to the following questions:
 - What type of processor does the computer use?
 - Is there a math coprocessor in the computer?
 - Who is the BIOS manufacturer?
 - What is the total amount of conventional memory in the computer?
 - What type of keyboard is attached to the computer?
 - What is the display type?
 - Is there any mouse attached to the computer? What type is it and who made it?
- Generally diagnostic routines are treated as a category of utility or service programs.

Language Translators

- A language translator or language processor accepts statements in one language and produces equivalent statements in another language. It reads the statements of source language and converts them into statements of other language. Most computer installations have several language translators, one for each programming language. The three most widely used language translators are:
 - a. **Assembler:**
 - It translates program written in an assembly language into machine language.
 - To develop a program, assembly languages use mnemonic codes and assembler translates such codes into machine language.
 - b. **Interpreter:**
 - Interpreter is translation software that translates, interprets and executes one line at a time.
 - With an interpreter, each statement is translated into machine language just before it is executed.
 - No object module or load module is produced. Generally, program is first developed using interpreter and then using compiler.
 - Programs written in simple languages such as BASIC are more likely to be interpreted than compiled because these programs are often developed on microcomputers.
 - **Advantages:**
 1. They are usually easier and faster to use (i.e. the translation speed is high).
 2. Generally they provide superior error messages to users. When a program contains an error, the interpreter can exactly identify the error because interpreters stop when errors are encountered (=come across). Thus interpreters help programmers to debug their programs. This increases programmer productivity and reduces program development time.
 3. An interpreter requires less storage space in primary memory.
 4. Interpreters are less expensive.
 - **Disadvantages:**
 1. Program statements are required to be translated over and over again.
 2. Interpreters do not provide safety to programs.
 3. Difficult to make changes to programs.

c. **Compiler:**

- Compiler is a translation software which translates the programs written in high level language to machine level language.
- Compilers are used to translate high-level languages such as COBOL, FORTRAN, and Pascal into machine level language.
- A compiler translates the entire program into machine language before the program is executed.
- **Compilation Procedure:**
 - Program is entered into computer system and submitted to the appropriate compiler. For example, a COBOL program is input to a COBOL compiler; a Pascal program to a Pascal compiler.
 - The program submitted for compilation is called source program. The compiler translates the program into machine language, producing an object program.
 - Then, another software program called linkage editor binds the object module of this program to object modules of any sub programs.
 - The resultant program, which is ready for computer execution, is called load program (or load module). Actually the computer executes this load program.
 - Programs can be saved on disk either in source, object or load-module forms.

Application Software

- An application program is a program used to solve a particular application or problem that is unique to a particular organization.
- Examples of such programs are payroll, General accounting, sales statistics, inventory control etc.
- Usually different organizations require different programs for similar application and hence it is difficult to write standardized programs. However, tailor-made application software can be written by software houses on modular design.

General Purpose Software

- This software provides the framework for a great number of business, scientific, and personal applications.
- Spreadsheet, database, Computer-Aided Design (CAD), word processing software etc. fall into this category.
- Most general-purpose softwares are sold as a package.
- The software is accompanied by user-oriented documentation such as reference manuals, keyboard templates, and so on.
- For example, an accountant can use spreadsheet software to create a balance sheet of a company.
- An aeronautical engineer can use CAD software to design an airplane or an airport. A personnel manager can use word processing software to create a letter and so on.
- Number of personal computer-based general-purpose software packages is available in the market.

Word Processor

- Word processor is different from word processing. A word processor is an application software that helps in the production of such documents. In simple words, it is a text editor that allows us to type, edit and save text. The first word processing software was invented by IBM. The intention was to relieve secretaries from time consuming typing task. However, the present day word processor packages offer far more features than just editing words - they provide spell checking, designing and elaborate formatting features. With a word processor, one can easily change the way a document

looks. Thus it is easy to present ideas in a coherent (=good, sound) manner. With a word processor one can:

1. Read and revise a document on screen,
 2. Change the formatting to get the desired visual effect,
 3. Increase productivity by automating,
 4. Improve proof reading,
 5. Produce as many copies as needed,
 6. Save a document and work on it later.
- Some of the popular word processing packages are:
 1. MS – Word
 2. Perfect Writer
 3. Word star
 4. Professional Writer
 5. Word perfect
 6. MultiMate
 7. Lotus Notes
 - As of 1999, the most popular Word processing programs were Microsoft Word which is based on GUI.



Electronic Spreadsheet

- In day to day life, many transactions take place and it is humanly not possible to remember all of them. Hence we record them in a systematic manner for future reference; To help users, electronic spreadsheets are available. Spreadsheet applications are primarily designed to perform mathematical calculations. The Spreadsheet, as the name suggests, is like a large sheet consisting of several rows and columns. In appearance, it looks like a maths note book.
- Besides calculations, spreadsheets can be used for working with data [information]. The latest version of spreadsheet program can serve as powerful data management tool. Using a spreadsheet program, one can not only store lot of data in the worksheet but also make use of different functions to arrange and analyse data in any way he likes.
- Spreadsheet application also comes with powerful Graphic utilities. These utilities help the user to represent the data in a picture format. To achieve this task, these utilities make use of different charts and graphs that will be supplied along with spreadsheet application.
- Currently the leading spreadsheet applications include - Microsoft Excel, Lotus 1-2-3, Quantro Pro. These programs are written in a combination of an assembler and high level languages, which are accessible to managers, accountants and other computer professionals. Even people with no programming experience can use these programs.
- MS-Excel is one of the best spreadsheet applications available; possessing several enhanced spreadsheet features. One can use MS-Excel to make quick and easy financial analysis. One can also analyse data and create presentations with charts. MS-Excel allows user to retrieve data from external data sources and use it in the worksheets. MS-Excel can be used to create web pages with ease and also run queries on data available on the web.

	C 1	C 2	C 3	C 4	B 5	B 6	G 7	G 8
Map	Family ID	Patient ID	Father ID	Mother ID	Sex	Affection Status	SNP1	SNP2
1	1001-1	1001	1	?	?	0	?	3,3
2	1001-2	1001	2	?	?	1	?	1,1
3	1001-3	1001	3	1	2	1	1	1,3
4	1002-1	1002	1	?	?	0	?	3,3
5	1002-2	1002	2	?	?	1	?	1,3
6	1002-3	1002	3	1	2	1	0	3,3
7	1003-1	1003	1	?	?	0	?	3,3
8	1003-2	1003	2	?	?	1	?	1,3
9	1003-3	1003	3	1	2	0	0	1,3
10	1004-1	1004	1	?	?	0	?	3,3
11	1004-2	1004	2	?	?	1	?	1,1
12	1004-3	1004	3	1	2	0	1	1,3
13	1005-1	1005	1	?	?	0	?	1,3
14	1005-2	1005	2	?	?	1	?	1,3

Decision Support System

- DSS's are information processing systems frequently used by accountants, managers and auditors to assist them for decision-making purposes.
- The concept of DSS was developed in 1960's, after studying decision making several in organisations. These studies noted that managers require flexible systems which can respond to adhoc questions.
- Advances in hardware technology, interactive computing design, graphics capabilities and programming languages contributed to this development.
- Today Decision Support Systems are widely used in accounting and auditing.
- **Characteristic features:**
 - a. DSS supports management decision making:** Generally these systems are used by top management for decision making purposes (For example, to decide whether to drop a product line or not, to increase the advertisement expenditure or not). These are also used by operational managers for management planning decisions (For example, to solve scheduling problems). DSS enhances (=increases) the quality of decisions. The system will recommend a particular alternative and the final decision is taken by the user.
 - b. Decision support systems solve unstructured problems:** Problems that do not have easy solutions and problems in which some managerial judgment is necessary are called unstructured problems and such problems can be easily solved by DSS. Generally decision support systems use non-routine data as input. It is difficult to collect such data and sometimes it may require estimates. An important characteristic of many decision support systems is that they allow users to ask what-if questions and to examine the results of these questions.
 - c. Friendly computer interface:** Generally Decision support systems are operated by managers and other decision makers, who are non programmers. So these systems must be easy to use. With the help of non procedural languages, users can easily communicate with the decision support system.
- **Components of Decision Support Systems:**
 - a. Users:** Usually, the user of a DSS is a manager with some unstructured or semi-structured problem. The manager may be at any level of authority in the organisation (e.g. either top level or middle level or bottom level managers). Generally, users do not need computer knowledge to use a decision support system.
 - b. Databases:** Decision support systems include one or more databases. These databases contain both routine and non-routine data from both internal and external sources. The data from external sources include data about operating environment - for example, data about economic conditions, market demand for the organisation's goods or services and industry competition. DSS users may construct additional databases. Some data may come from internal sources. An organisation generates this type of data in the normal course of operations - for example, data from financial and managerial accounting systems. The database may also capture data from other subsystems such as marketing, production and personnel. External data include assumptions about variables such as interest rates, market prices and level of competition.



- c. Planning languages: Two types of planning languages that are commonly used in decision support systems are: (1) general purpose planning language and (2) special purpose planning language.
- d. Model base: The model base is the “brain” of the decision support system because it processes data with the help of data provided by the user and the database. There are many types of model bases, but most of them are custom developed models that do some type of mathematical functions - for example, regression analysis, time series analysis, linear programming and financial computations. The analysis provided by model base is the key for user’s decision.
- Decision support systems are widely used as part of an organisation’s AIS. Many DSS’s are developed inhouse, to solve specific problems. Below are some of the illustrations of these systems.
 - a. Cost Accounting system: Cost structure is very complex in health care industry. It is very difficult to divide costs in the areas of supplies, expensive machinery, technology and a variety of personnel. Cost accounting applications help health care organisations to calculate product costs for individual products or services.
 - b. Capital Budgeting System: Companies require new tools to evaluate high-technology investment decisions. Decision makers need to supplement analytical techniques such as NPV and IRR with decision support systems. For example AutoMan is a DSS, designed to support decisions about investments in automated manufacturing technology, which allow decision makers to consider financial, non financial, quantitative and qualitative factors in their decision-making process. Using this DSS, they can evaluate upto 7 investment alternatives at a time.
 - c. Budget Variance Analysis System: Financial institutions rely heavily on their budgeting systems for controlling costs and evaluating managerial performance. For example, an organisation can use DSS to generate monthly variance reports for each division. With the help of this system one can view, analyse, budget variances. After analysing the variances, organisation can create one-year and five-year budgets.
 - d. General DSS: DDSs use general purpose planning languages that can analyse different types of problems. In a sense these systems act as tools to decision makers. To use this type of systems the user has to input data and answer questions about a specific problem. An example is a program called Expert Choice. This program supports a variety of problems requiring decisions. For example, the system may ask whether cash inflows are important or initial cash outlay is important. The decision maker also makes judgments about such questions. Expert Choice analyzes these judgments and presents the best alternative to the user.

Artificial Intelligence

- Artificial intelligence (AI) is software that tries to imitate aspects of human behavior, such as reasoning, communicating, seeing, and hearing. AI software can use its accumulated knowledge to reason and in some instances learn from experience and thereby modify its subsequent behaviour. Artificial intelligence is manmade and its level of activity depends on the programming capability. It is mechanism that is not subject to human feelings like fatigue, worry, etc.
- **Types of AI:**
 - There are several types of AI, including natural language, voice and visual recognition, robotics, neural networks and expert systems.
 - With the help of Natural language, Voice recognition and Visual recognition computers can interact with users, more easily and naturally. On the other hand Robotics can replace human labour. Both neural networks and expert systems aim to improve decision-making.



Expert Systems

- An expert system (ES) is a computerized information system that allows non-experts to make decisions comparable to that of an expert. Expert systems are used for complex or unstructured tasks that require experience and specialised knowledge.
- **Components:** Expert systems typically contain the following components:
 - a. Knowledge base: This includes data, knowledge, relationships, rules of thumb (heuristics) and decision rules used by experts to solve a particular type of problem. A knowledge base in a computer is equal to the knowledge of an expert or group of experts developed through years of experience in their field.
 - b. Inference engine: This program consists of logic and reasoning mechanism that can simulate (=replicate, reproduce) the expert's logic process and deliver advice. It uses data obtained from both knowledge base and the user to make associations and inferences, form conclusions and recommend a course of action.
 - c. User interface: This program allows the user to design, create, update, use and communicate with the expert system.
 - d. Explanation facility: With the help of this facility user can know the logic being followed by the expert system to arrive at the conclusion.
 - e. Knowledge acquisition facility: Building a knowledge base, known as knowledge engineering, involves both human expert and a knowledge engineer. The knowledge engineer extracts an individual's expertise and uses the knowledge acquisition facility to enter it into knowledge base.
- **Advantages:**
 1. They provide a cost-effective alternative to human experts.
 2. They can outperform a single expert because their knowledge is gained from several experts. They are faster and more consistent and do not get over worked or stressed out.
 3. They produce better-quality and more consistent decisions. Expert systems assist users in identifying problems, which increases the probability of making sound decisions.
 4. They can increase productivity (=i.e. production per unit of time).
 5. They preserve the expertise of an expert, leaving the organisation.
- **Limitations:**
 1. Development can be costly and time-consuming. Some large systems require upto 15 years and millions of dollars to develop.
 2. It is difficult to obtain knowledge from experts because it is very difficult to specify exactly how the decision maker has taken decision.
 3. Designers were unable to program human being's common sense into current systems. If the system faces any situation, which is not programmed to handle, then the system may break down.
- **Examples (For academic interest only):** As technology advances, these problems can be overcome and expert systems will play an important role in accounting information systems. Following are examples of companies that have successfully used expert systems:
 1. IRS analyzes tax returns to determine the returns to be passed to tax fraud investigators.
 2. IBM designs and evaluates internal controls in both new and existing applications.
 3. American Express authorizes credit card purchases to minimize fraud and credit losses. Its Expert System has replaced 700 authorization clerks and saved millions of dollars.

Voice Synthesizers And Voice Recognition Systems

- **Voice Synthesizers:**
 - These are also known as voice-output devices or audio-response units or voice synthesizers.
 - They convert data stored in secondary storage devices into sounds that are understandable to human beings.

- In these systems speed and pitch of voice can be adjusted.
 - This facility is available in many of today's applications such as children education software.
 - Voice output serves as an excellent & important media for communicating information to blind people.
 - In recent years, voice output is becoming very much popular. From the present trend of development of multi-media systems, it seems that voice output will become one of the dominant methods of output.
 - Voice synthesizers can be relatively expensive and can be easily connected to almost every computer.
 - Multimedia systems, which incorporate multi-media presentations and voice output are popular amongst consumers.
 - Voice output is produced in two ways. In the first method the computer will play stored words over a speaker. In the second method, the voice is created with special computer circuitry, a process called Speech synthesis. This circuitry is designed so that it can produce sounds like a human voice.
- **Voice recognition systems:**
 - Voice Recognition Systems (VRS) can provide hands-free interaction between the computer and the user.
 - In other words, users can discard conventional input devices such as keyboard or mouse and access the computer system by simply talking to it.
 - VRS applications were originally designed for physically handicapped people. But due to the rise in RSI (Repetitive Strain Injury) claims and the desire for non-typists voice dictating applications, the demand for VRS technology is increasing.
 - Simple voice command driven applications have proved to be very effective and are extremely well received by inexperienced users. Although there are numerous applications in the market, the technology is still developing.
 - The problem is that people are irregular in their speech. Human conversation is ungrammatical, repetitive and open- ended.
 - Once the technology is perfected, it will revolutionise the use of computers.



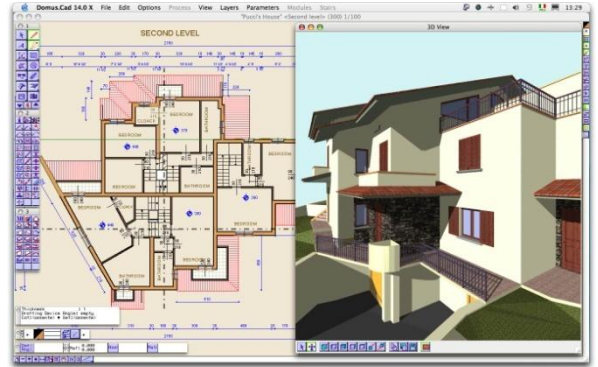
Neural Network

- Neural networks are computing systems, developed to imitate the brain's learning process. Human brain uses massive, parallel network of interconnected neurons. Similarly Neural Networks use interconnected processors that can perform several operations simultaneously.
- Neural networks cannot handle unexpected events very well. But they are very good at recognizing patterns that humans overlook and at discovering emerging trends.
- Like humans, neural networks learn by fine-tuning their accumulated knowledge using the facts in each new case.
- For example, to develop a neural network that can detect fraudulent credit card transactions, it is necessary to give enough examples of both valid and fraudulent transactions until it can reliably differentiate them. Developing a large database of examples is the most difficult and costly part of developing a neural network.

CAD And CAM

- **CAD:**

- **Meaning:** It refers to use of computers in design process.
- **How it helps?** Computer Aided Design or Computer Aided Drafting is helpful in design process in the following way. When designing a product with a computer, engineers create electronic model of the product by describing all the three dimensions of the object. If they want to see the object from a different dimension, they just tell the computer to display another view. If they want to make any changes they need not repeat the task from the beginning as in the case of earlier days. They can just tell the computer, the changes to be made and it will automatically make the changes. Under this system some standard shapes will be stored in secondary storage devices and they can be incorporated (=included) in other designs. This technique is widely used for designing almost anything - Houses, Cars, Buildings, molecules, Space Crafts, etc.



- **CAM:**

- **Meaning:** Manufacturing with computers and robotics is called CAM. For e.g. factories use computerised robotic arms to do physical work, which is hazardous (=dangerous) or highly repetitive.
- **How it helps?** Consider a Power Plant that generates steam for electricity. Here a computer monitors pressure and temperature at hundreds of critical points throughout the plant. If pressure or temperatures in a pipe or tank exceeds specified level, computer can regulate the process.