

UNIT_5

Application Layer

The application layer in the OSI model is the closest layer to the end user which means that the application layer and end user can interact directly with the software application. The application layer programs are based on client and servers.

The Application layer includes the following functions:

- **Identifying communication partners:** The application layer identifies the availability of communication partners for an application with data to transmit.
- **Determining resource availability:** The application layer determines whether sufficient network resources are available for the requested communication.
- **Synchronizing communication:** All the communications occur between the applications requires cooperation which is managed by an application layer.

Services of Application Layers

- **Network Virtual terminal:** An application layer allows a user to log on to a remote host. To do so, the application creates a software emulation of a terminal at the remote host. The user's computer talks to the software terminal, which in turn, talks to the host. The remote host thinks that it is communicating with one of its own terminals, so it allows the user to log on.
- **File Transfer, Access, and Management (FTAM):** An application allows a user to access files in a remote computer, to retrieve files from a computer and to manage files in a remote computer. FTAM defines a hierarchical virtual file in terms of file structure, file attributes and the kind of operations performed on the files and their attributes.
- **Addressing:** To obtain communication between client and server, there is a need for addressing. When a client made a request to the server, the request contains the server address and its own address. The server response to the client request, the request contains the destination address, i.e., client address. To achieve this kind of addressing, DNS is used.
- **Mail Services:** An application layer provides Email forwarding and storage.

- **Directory Services:** An application contains a distributed database that provides access for global information about various objects and services.

Authentication: It authenticates the sender or receiver's message or both.

Network Application Architecture

Application architecture is different from the network architecture. The network architecture is fixed and provides a set of services to applications. The application architecture, on the other hand, is designed by the application developer and defines how the application should be structured over the various end systems.

Application architecture is of two types:

- **Client-server architecture:** An application program running on the local machine sends a request to another application program is known as a client, and a program that serves a request is known as a server. For example, when a web server receives a request from the client host, it responds to the request to the client host.

Characteristics Of Client-server architecture:

- Client-server architecture, clients do not directly communicate with each other. For example, in a web application, two browsers do not directly communicate with each other.
- A server is fixed, well-known address known as IP address because the server is always on while the client can always contact the server by sending a packet to the sender's IP address.

Disadvantage Of Client-server architecture:

It is a single-server based architecture which is incapable of holding all the requests from the clients. For example, a social networking site can become overwhelmed when there is only one server exists.

- **P2P (peer-to-peer) architecture:** It has no dedicated server in a data center. The peers are the computers which are not owned by the service provider. Most of the peers reside in the homes, offices, schools, and universities. The peers

communicate with each other without passing the information through a dedicated server, this architecture is known as peer-to-peer architecture. The applications based on P2P architecture includes file sharing and internet telephony.

Features of P2P architecture

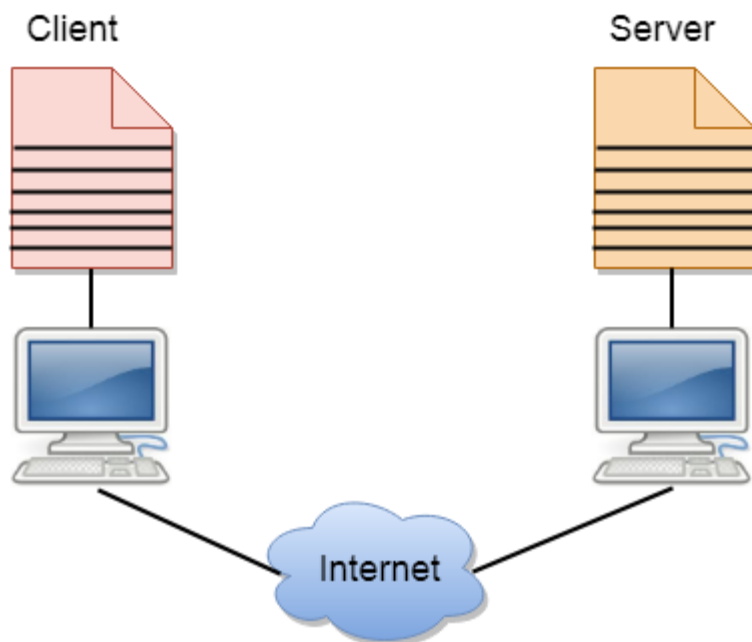
- **Self scalability:** In a file sharing system, although each peer generates a workload by requesting the files, each peer also adds a service capacity by distributing the files to the peer.
- **Cost-effective:** It is cost-effective as it does not require significant server infrastructure and server bandwidth.

Client and Server processes

- A network application consists of a pair of processes that send the messages to each other over a network.
- In P2P file-sharing system, a file is transferred from a process in one peer to a process in another peer. We label one of the two processes as the client and another process as the server.
- With P2P file sharing, the peer which is downloading the file is known as a client, and the peer which is uploading the file is known as a server. However, we have observed in some applications such as P2P file sharing; a process can be both as a client and server. Therefore, we can say that a process can both download and upload the files.
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Client and Server model

- A client and server networking model is a model in which computers such as servers provide the network services to the other computers such as clients to perform a user based tasks. This model is known as client-server networking model.
- The application programs using the client-server model should follow the given below strategies:



- An application program is known as a client program, running on the local machine that requests for a service from an application program known as a server program, running on the remote machine.
- A client program runs only when it requests for a service from the server while the server program runs all time as it does not know when its service is required.
- A server provides a service for many clients not just for a single client. Therefore, we can say that client-server follows the many-to-one relationship. Many clients can use the service of one server.
- Services are required frequently, and many users have a specific client-server application program. For example, the client-server application program allows the user to access the files, send e-mail, and so on. If the services are more customized, then we should have one generic application program that allows the user to access the services available on the remote computer.

Client

A client is a program that runs on the local machine requesting service from the server. A client program is a finite program means that the service started by the user and terminates when the service is completed.

Server

A server is a program that runs on the remote machine providing services to the clients. When the client requests for a service, then the server opens the door for the incoming requests, but it never initiates the service.

A server program is an infinite program means that when it starts, it runs infinitely unless the problem arises. The server waits for the incoming requests from the clients. When the request arrives at the server, then it responds to the request.

Advantages of Client-server networks:

- **Centralized:** Centralized back-up is possible in client-server networks, i.e., all the data is stored in a server.
- **Security:** These networks are more secure as all the shared resources are centrally administered.
- **Performance:** The use of the dedicated server increases the speed of sharing resources. This increases the performance of the overall system.
- **Scalability:** We can increase the number of clients and servers separately, i.e., the new element can be added, or we can add a new node in a network at any time.

Disadvantages of Client-Server network:

- **Traffic Congestion** is a big problem in Client/Server networks. When a large number of clients send requests to the same server may cause the problem of Traffic congestion.
- It does not have a robustness of a network, i.e., when the server is down, then the client requests cannot be met.
- A client/server network is very decisive. Sometimes, regular computer hardware does not serve a certain number of clients. In such situations, specific hardware is required at the server side to complete the work.
- Sometimes the resources exist in the server but may not exist in the client. For example, If the application is web, then we cannot take the print out directly on printers without taking out the print view window on the web.

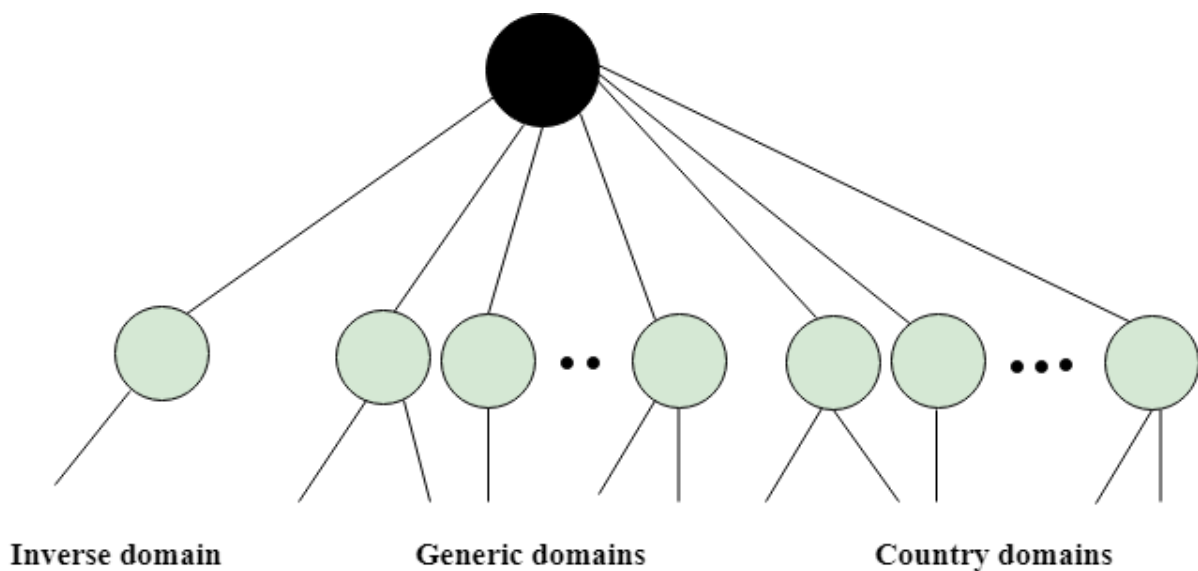
DNS

An application layer protocol defines how the application processes running on different systems, pass the messages to each other.

- DNS stands for Domain Name System.
- DNS is a directory service that provides a mapping between the name of a host on the network and its numerical address.

- DNS is required for the functioning of the internet.
- Each node in a tree has a domain name, and a full domain name is a sequence of symbols specified by dots.
- DNS is a service that translates the domain name into IP addresses. This allows the users of networks to utilize user-friendly names when looking for other hosts instead of remembering the IP addresses.
- For example, suppose the FTP site at EduSoft had an IP address of 132.147.165.50, most people would reach this site by specifying ftp.EduSoft.com. Therefore, the domain name is more reliable than IP address.

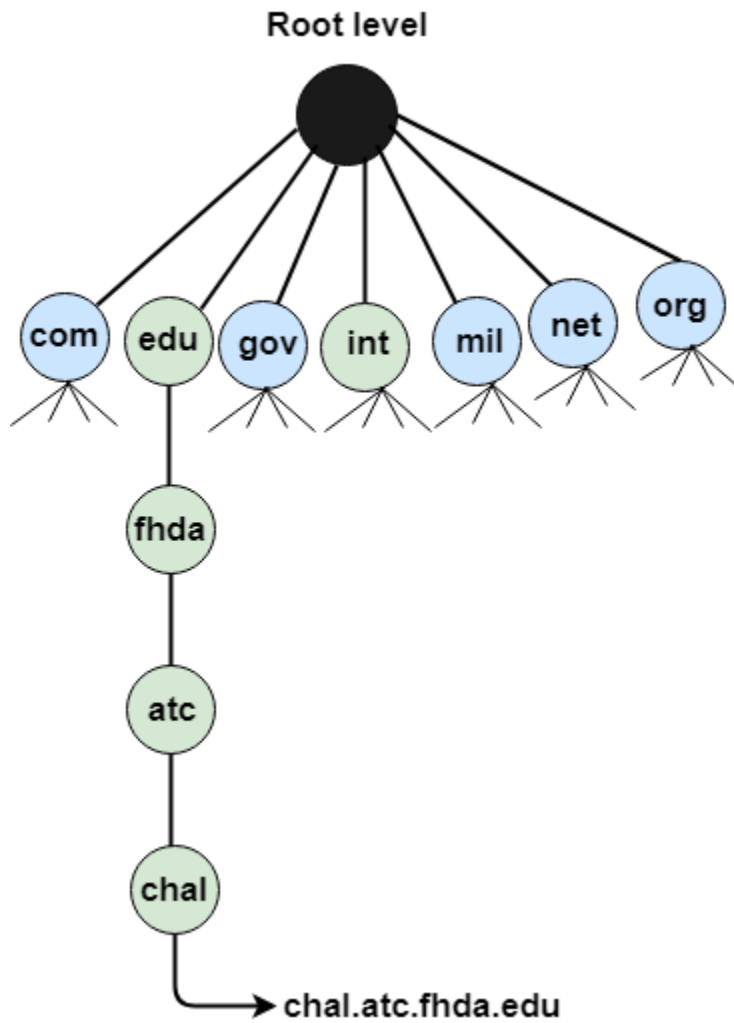
DNS is a TCP/IP protocol used on different platforms. The domain name space is divided into three different sections: generic domains, country domains, and inverse domain.



Generic Domains

- It defines the registered hosts according to their generic behavior.
- Each node in a tree defines the domain name, which is an index to the DNS database.
- It uses three-character labels, and these labels describe the organization type.

Label	Description
aero	Airlines and aerospace companies
biz	Businesses or firms
com	Commercial Organizations
coop	Cooperative business Organizations
edu	Educational institutions
gov	Government institutions
info	Information service providers
int	International Organizations
mil	Military groups
museum	Museum & other nonprofit organizations
name	Personal names
net	Network Support centers
org	Nonprofit Organizations
pro	Professional individual Organizations



Country Domain

The format of country domain is same as a generic domain, but it uses two-character country abbreviations (e.g., us for the United States) in place of three character organizational abbreviations.

Inverse Domain

The inverse domain is used for mapping an address to a name. When the server has received a request from the client, and the server contains the files of only authorized clients. To determine whether the client is on the authorized list or not, it sends a query to the DNS server and ask for mapping an address to the name.

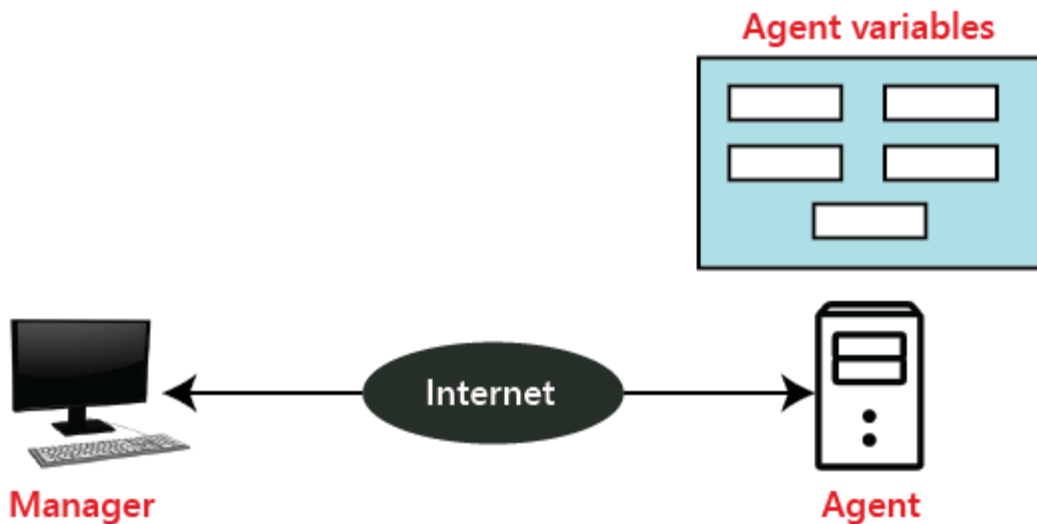
Working of DNS

- DNS is a client/server network communication protocol. DNS clients send requests to the server while DNS servers send responses to the client.
- Client requests contain a name which is converted into an IP address known as a forward DNS lookups while requests containing an IP address which is converted into a name known as reverse DNS lookups.
- DNS implements a distributed database to store the name of all the hosts available on the internet.
- If a client like a web browser sends a request containing a hostname, then a piece of software such as **DNS resolver** sends a request to the DNS server to obtain the IP address of a hostname. If DNS server does not contain the IP address associated with a hostname, then it forwards the request to another DNS server. If IP address has arrived at the resolver, which in turn completes the request over the internet protocol.

SNMP (Simple Network Management Protocol)

SNMP was defined by **IETF (Internet Engineering Task Force)**. It is used to manage the network. It is an internet standard protocol that monitors devices in IP networks and collects and organizes the information (data) of these devices. SNMP is supported by most network devices such as the hub, switch, router, bridge, server, modem, and printer, etc.

The concept of SNMP is based on the manager and agent. A manager is like a host that controls a group of agents, such as routers.



SNMP Manager: It is a computer system that monitors network traffic by the SNMP agent, and it queries these agents, takes answers, and controls them.

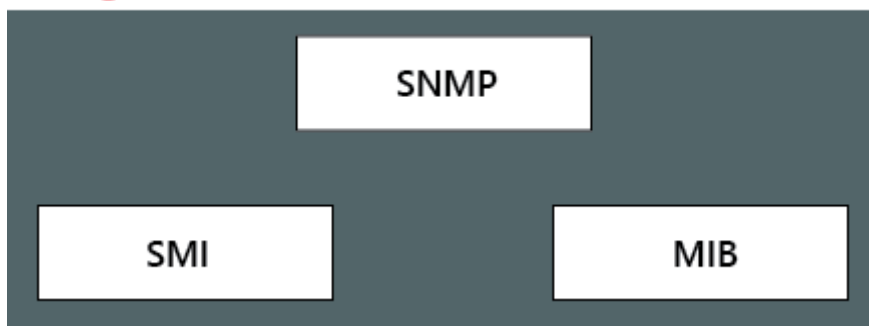
SNMP Agent: It is a software program that is located in a network element. It collects real-time information from the device and passes this information to the SNMP manager.

Management components

It has two components

1. SMI
2. MIB

Management



SNMP: It defines the structure of packets that is shared between a manager and an agent.

SMI (Structure of Management Information): SMI is a network management component that defines the standard rules for the naming object and object type (including range and length) and also shows how to encode objects and values.

MIB (Management Information Base): MIB is the second component of the network management. It is virtual information storage where management information is stored.

SNMP basic operation

- **GetRequest:** The GetRequest operation is used by the SNMP manager to derive one or more values from the SNMP agent.
- **GetNextRequest:** The GetNextRequest is similar to the GetRequest operation, but it is used to get the next value from the SNMP agent.
- **SetRequest:** It is used by the manager to set the value of the agent device.
- **Trap:** This command is used by the SNMP agent to send acknowledgment messages to the SNMP manager.
- **GetBulkRequest:** It is used by the SNMP manager to retrieve the large data from the SNMP agent.

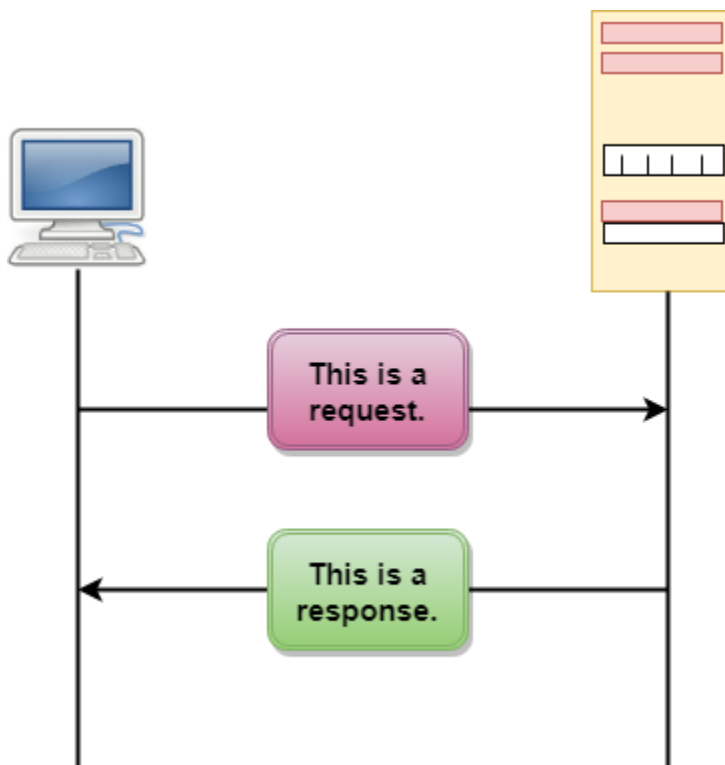
HTTP

- HTTP stands for **HyperText Transfer Protocol**.
- It is a protocol used to access the data on the World Wide Web (www).
- The HTTP protocol can be used to transfer the data in the form of plain text, hypertext, audio, video, and so on.
- This protocol is known as HyperText Transfer Protocol because of its efficiency that allows us to use in a hypertext environment where there are rapid jumps from one document to another document.
- HTTP is similar to the FTP as it also transfers the files from one host to another host. But, HTTP is simpler than FTP as HTTP uses only one connection, i.e., no control connection to transfer the files.
- HTTP is used to carry the data in the form of MIME-like format.
- HTTP is similar to SMTP as the data is transferred between client and server. The HTTP differs from the SMTP in the way the messages are sent from the client to the server and from server to the client. SMTP messages are stored and forwarded while HTTP messages are delivered immediately.

Features of HTTP:

- **Connectionless protocol:** HTTP is a connectionless protocol. HTTP client initiates a request and waits for a response from the server. When the server receives the request, the server processes the request and sends back the response to the HTTP client after which the client disconnects the connection. The connection between client and server exist only during the current request and response time only.
- **Media independent:** HTTP protocol is a media independent as data can be sent as long as both the client and server know how to handle the data content. It is required for both the client and server to specify the content type in MIME-type header.
- **Stateless:** HTTP is a stateless protocol as both the client and server know each other only during the current request. Due to this nature of the protocol, both the client and server do not retain the information between various requests of the web pages.

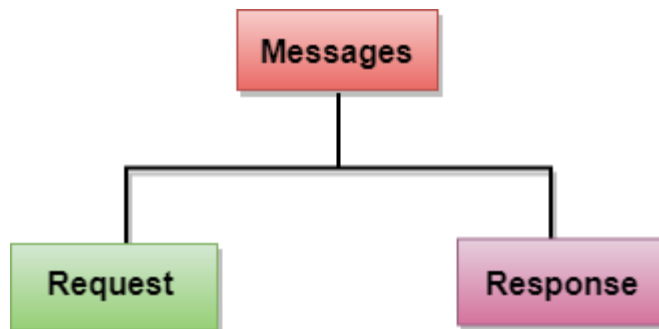
HTTP Transactions



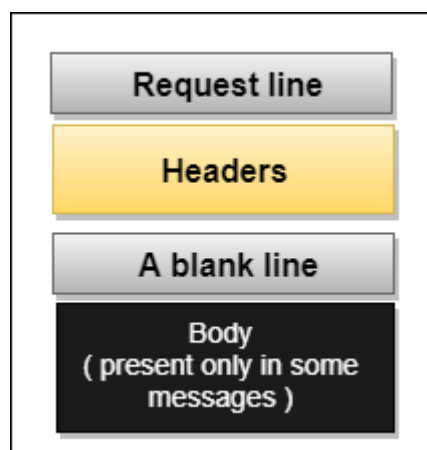
The above figure shows the HTTP transaction between client and server. The client initiates a transaction by sending a request message to the server. The server replies to the request message by sending a response message.

Messages

HTTP messages are of two types: request and response. Both the message types follow the same message format.



Request Message: The request message is sent by the client that consists of a request line, headers, and sometimes a body.



Response Message: The response message is sent by the server to the client that consists of a status line, headers, and sometimes a body.

Uniform Resource Locator (URL)

- A client that wants to access the document in an internet needs an address and to facilitate the access of documents, the HTTP uses the concept of Uniform Resource Locator (URL).
- The Uniform Resource Locator (URL) is a standard way of specifying any kind of information on the internet.
- The URL defines four parts: method, host computer, port, and path.



- **Method:** The method is the protocol used to retrieve the document from a server. For example, HTTP.
- **Host:** The host is the computer where the information is stored, and the computer is given an alias name. Web pages are mainly stored in the computers and the computers are given an alias name that begins with the characters "www". This field is not mandatory.
- **Port:** The URL can also contain the port number of the server, but it's an optional field. If the port number is included, then it must come between the host and path and it should be separated from the host by a colon.
- **Path:** Path is the pathname of the file where the information is stored. The path itself contain slashes that separate the directories from the subdirectories and files.

○ What is E-mail?



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- E-mail is defined as the transmission of messages on the Internet. It is one of the most commonly used features over communications networks that may contain text, files, images, or other attachments. Generally, it is information that is stored on a computer sent through a network to a specified individual or group of individuals.
- Email messages are conveyed through email servers; it uses multiple protocols within the [TCP/IP](#)
- suite. For example, [SMTP is a protocol](#)
- , stands for [simple mail transfer protocol](#)
- and used to send messages whereas other protocols IMAP or POP are used to retrieve messages from a mail server. If you want to login to your mail account, you just need to

enter a valid email address, password, and the mail servers used to send and receive messages.

- Although most of the webmail servers automatically configure your mail account, therefore, you only required to enter your email address and password. However, you may need to manually configure each account if you use an email client like Microsoft Outlook or Apple Mail. In addition, to enter the email address and password, you may also need to enter incoming and outgoing mail servers and the correct port numbers for each one.

Email messages include three components, which are as follows:

- **Message envelope:** It depicts the email's electronic format.
- **Message header:** It contains email subject line and sender/recipient information.
- **Message body:** It comprises images, text, and other file attachments.

The email was developed to support rich text with custom formatting, and the original email standard is only capable of supporting plain text messages. In modern times, email supports [HTML](#)

(Hypertext markup language), which makes it capable of emails to support the same formatting as [websites](#)

. The email that supports HTML can contain links, images, [CSS layouts](#)

, and also can send files or "email attachments" along with messages. Most of the mail servers enable users to send several attachments with each message. The attachments were typically limited to one megabyte in the early days of email. Still, nowadays, many mail servers are able to support email attachments of 20 megabytes or more in size.

In **1971**, as a test e-mail message, Ray Tomlinson sent the first e-mail to himself. This email was contained the text "something like QWERTYUIOP." However, the e-mail message was still transmitted through ARPANET, despite sending the e-mail to himself. Most of the electronic mail was being sent as compared to postal mail till **1996**.

Differences between email and webmail

The term email is commonly used to describe both browser-based electronic mail and non-browser-based electronic mail today. The AOL and Gmail are browser-based electronic mails, whereas Outlook for Office 365 is non-browser-based electronic mail. However, to define email, a difference was earlier made as a non-browser program that needed a dedicated client and email server. The non-browser emails offered some advantages, which are enhanced security, integration with corporate software platforms, and lack of advertisements.

Uses of email

Email can be used in different ways: it can be used to communicate either within an organization or personally, including between two people or a large group of people. Most people get benefit from communicating by email with colleagues or friends or individuals or small groups. It allows you to communicate with others around the world and send and receive images, documents, links, and other attachments. Additionally, it offers benefit users to communicate with the flexibility on their own schedule.

There is another benefit of using email; if you use it to communicate between two people or small groups that will be beneficial to remind participants of approaching due dates and time-sensitive activities and send professional follow-up emails after appointments. Users can also use the email to quickly remind all upcoming events or inform the group of a time change. Furthermore, it can be used by companies or organizations to convey information to large numbers of employees or customers. Mainly, email is used for newsletters, where mailing list subscribers are sent email marketing campaigns directly and promoted content from a company.

Email can also be used to move a latent sale into a completed purchase or turn leads into paying customers. For example, a company may create an email that is used to send emails automatically to online customers who contain products in their shopping cart. This email can help to remind consumers that they have items in their cart and stimulate them to purchase those items before the items run out of stock. Also, emails are used to get reviews by customers after making a purchase. They can survey by including a question to review the quality of service.

History of E-mail

As compared to ARPANet or the Internet, email is much older. The early email was just a small advance, which is known as a file directory in nowadays. It was used to just put a message in other user's directory in the place where they were able to see the message by logging in. For example, the same as leaving a note on someone's desk. Possibly MAILBOX was used at Massachusetts Institute of Technology, which was the first email system of this type from 1965. For sending messages on the same computer, another early program was *SNDMSG*.

Users were only able to send messages to several users of the same computer through email when the internetworking was not beginning. And, the problem became a little more complex when computers began to talk to each other over networks, we required to put a message in an envelope and address it for the destination.

Later in **1972**, **Ray Tomlinson** invented email to remove some difficulties. Tomlinson worked (Like many of the Internet inventors) for Newman and Bolt Beranek as an ARPANET contractor. To denote sending messages from one computer to another, he picked up the @ symbol from the keyboard. Then, it became easy to send a message to another with the help of Internet standards; they were only required to

propose name-of-the-user@name-of-the-computer. One of the first users of the new system was Internet pioneer Jon Postel. Also, describing as a "nice hack," credited goes to Jon Postel.

Although the World Wide Web offers many services, email is the most widely used facility and remains the most important application of the [Internet](#)

. On the international level, over 600 million people use email. There were hundreds of email users by 1974, as ARPANET ultimately encouraged it. Furthermore, email caused a radical shift in Arpa's purpose, as it became the savior of Arpanet.

From there were rapid developments in the field of the email system. A big enhancement was to sort emails; some email folders for his boss were invented by Larry Roberts. To organize an email, John Vittal developed some software in 1976. By 1976 commercial packages began to appear, and email had really taken off. The email had changed people and took them from Arpanet to the Internet. Here was appeared some interesting features that ordinary people all over the world wanted to use.

Some years later, Ray Tomlinson observed about email. As compared to the previous one, any single development is stepping rapidly and nearly followed by the next. I think that all the developments would take a big revolution.

When personal computers came on the scene, the offline reader was one of the first new developments. Then, email users became able to store their email on their own personal computers with the help of offline reader and read it. Also, without actually being connected to the network, they were able to prepare replies like Microsoft Outlook can do today. In parts of the world, this was specifically useful for people where the telephone was expensive as compared to the email system.

Without being connected to a telephone, it was able to prepare a reply with connection charges of many dollars a minute and then get on the network to send it. Also, it was useful as the offline mode allowed for more simple user interfaces. In this modern time of very few standards being connected directly to the host email system often resulted in no capacity for text to wrap around on the screen of the user's computer, and backspace keys and delete keys may not work and other such annoyances. Offline readers helped out more to overcome these kinds of difficulties.

The SMTP (simple mail transfer protocol) was the first important email standard. It was a fairly naïve protocol that is still in use. And, it was made in terms of no attempt to find the person who sent a message that was the right or not what they claimed to be. In the email addresses, fraudulent was very easy and is still available. Later, these basic flaws were used in the protocol by security frauds, worms and viruses, and spammers forging identities. From 2004, some of these problems are still being processed for a solution.

But as developed email system offered some important features that helped out people to understand easily about email. In 1988, Steve Dorner developed Eudora that was one of the first good commercial systems. But it did not appear for a long time after Pegasus mail come. Servers began to appear as a standard when Internet standards POP (Post office protocol) for email began to mature. Each server was a little different before standard post office protocol (POP). POP was an important standard that allowed users to work together.

Individual dialup users were required to charges for an email per-minute in those days. Also, on the Internet, email and email discussion groups were the main uses for most people. There were several issues on a wide variety of subjects; they became USENET as a body of newsgroups.

With the [World Wide Web](#)

(WWW), email became available with a simple user interface that was offered by providers like Hotmail and Yahoo. And, users did not require to pay any charges on these platforms. Now everyone wanted at least one email address as it is much simple and affordable, and the medium was adopted by millions of people.

Internet Service Providers (ISPs) started to connect people with each other all over the world by the **1980s**. Also, by **1993** the use of the Internet was becoming widespread, and the word electronic mail was replaced by email.

Today, email has become a primary platform to communicate with people all over the world. There are continuing updates to the system with so many people using email for communication. Although email has some security issues, there have been laws passed to prevent the spread of junk email over the years.

Advantages of Email

There are many advantages of email, which are as follows:

- **Cost-effective:** Email is a very cost-effective service to communicate with others as there are several email services available to individuals and organizations for free of cost. Once a user is online, it does not include any additional charge for the services.
- Email offers users the benefit of accessing email from anywhere at any time if they have an Internet connection.
- Email offers you an incurable communication process, which enables you to send a response at a convenient time. Also, it offers users a better option to communicate easily regardless of different schedules users.

- **Speed and simplicity:** Email can be composed very easily with the correct information and contacts. Also, minimum lag time, it can be exchanged quickly.
- **Mass sending:** You can send a message easily to large numbers of people through email.
- Email exchanges can be saved for future retrieval, which allows users to keep important conversations or confirmations in their records and can be searched and retrieved when they needed quickly.
- Email provides a simple user interface and enables users to categorize and filter their messages. This can help you recognize unwanted emails like junk and spam mail. Also, users can find specific messages easily when they are needed.
- As compared to traditional posts, emails are delivered extremely fast.
- Email is beneficial for the planet, as it is paperless. It reduces the cost of paper and helps to save the environment by reducing paper usage.
- It also offers a benefit to attaching the original message at the time you reply to an email. This is beneficial when you get hundreds of emails a day, and the recipient knows what you are talking about.
- Furthermore, emails are beneficial for advertising products. As email is a form of communication, organizations or companies can interact with a lot of people and inform them in a short time.

Disadvantages of Email

- **Impersonal:** As compared to other forms of communication, emails are less personal. For example, when you talk to anyone over the phone or meeting face to face is more appropriate for communicating than email.
- **Misunderstandings:** As email includes only text, and there is no tone of voice or body language to provide context. Therefore, misunderstandings can occur easily with email. If someone sends a joke on email, it can be taken seriously. Also, well-meaning information can be quickly typed as rude or aggressive that can impact wrong. Additionally, if someone types with short abbreviations and descriptions to send content on the email, it can easily be misinterpreted.
- **Malicious Use:** As email can be sent by anyone if they have an only email address. Sometimes, an unauthorized person can send you mail, which can be harmful in terms of stealing your personal information. Thus, they can also use email to spread gossip or false information.

- **Accidents Will Happen:** With email, you can make fatal mistakes by clicking the wrong button in a hurry. For instance, instead of sending it to a single person, you can accidentally send sensitive information to a large group of people. Thus, the information can be disclosed, when you have clicked the wrong name in an address list. Therefore, it can be harmful and generate big trouble in the workplace.
- **Spam:** Although in recent days, the features of email have been improved, there are still big issues with unsolicited advertising arriving and spam through email. It can easily become overwhelming and takes time and energy to control.
- **Information Overload:** As it is very easy to send email to many people at a time, which can create information overload. In many modern workplaces, it is a major problem where it is required to move a lot of information and impossible to tell if an email is important. And, email needs organization and upkeep. The bad feeling is one of the other problems with email when you returned from vacation and found hundreds of unopened emails in your inbox.
- **Viruses:** Although there are many ways to travel viruses in the devices, email is one of the common ways to enter viruses and infect devices. Sometimes when you get a mail, it might be the virus come with an attached document. And, the virus can infect the system when you click on the email and open the attached link. Furthermore, an anonymous person or a trusted friend or contact can send infected emails.
- **Pressure to Respond:** If you get emails and you do not answer them, the sender can get annoyed and think you are ignoring them. Thus, this can be a reason to make pressure on your put to keep opening emails and then respond in some way.
- **Time Consuming:** When you get an email and read, write, and respond to emails that can take up vast amounts of time and energy. Many modern workers spend their most time with emails, which may be caused to take more time to complete work.
- **Overlong Messages:** Generally, email is a source of communication with the intention of brief messages. There are some people who write overlong messages that can take much time than required.
- **Insecure:** There are many hackers available that want to gain your important information, so email is a common source to seek sensitive data, such as political, financial, documents, or personal messages. In recent times, there have various high-profile cases occurred that shown how email is insecure about information theft.

Different types of Email

There are many types of email; such are as follows:

- 1.Newsletters
- 2.Lead Nurturing
- 3.Promotional emails:
- 4.Standalone Emails:

Popular email sites

There are some free email website examples include the following:

- AOL
- Zoho
- Gmail
- ProtonMail
- Com
- Microsoft Outlook
- Yahoo Mail

Email is a platform that allows users to communicate with people or groups of people around the world. As email security is more important but consequent, it is not inherently secure.

There are many techniques that can be used by individuals, organizations, and service providers. These techniques provide how to protect sensitive information with email communication and accounts from unauthorized access, loss, or destruction.

Individuals can protect their account with the help of creating strong passwords and changing them frequently. They can use alphabetical, numerical, special symbols to make a strong password that helps to protect your account. Users can also install and run an antivirus and antimalware software on their computer, as well as create spam filters and folders to separate potentially malicious emails and junk mail.

Also, there are some techniques that help organizations to secure email include implementing an email security gateway, training employees on deploying automated email encryption solutions, and proper email usage. By processing and scanning all received emails, email gateways check emails for threats, and analyze that should be allowed into the system or not. A multilayered gateway is a powerful technique since attacks are increasing rapidly and becoming complicated and sophisticated. Some emails that cannot be caught by the gateway, training employees on how to differentiate malicious messages, and properly use email are the best approach, which helps users avoid threatening mails.

For potentially sensitive information, the automated email encryption solutions are used that scans all outgoing messages; it will encrypt the sensitive information before it is sent to the intended recipient. This process helps to send email securely and prevent hackers from gaining access to the secret information, even if they stop it. The only intended recipient can view the original information with permission.

Email service providers can also help to enhance security with the help of accessing control standards and mechanisms and establishing a strong password. Additionally, providers should also offer digital signatures and encryption solutions to secure emails in transit and in users' inboxes. Finally, to protect users from malicious, unrecognized, and untrustworthy messages, service providers should implement firewalls and spam-filtering software applications.

E-mail address breakdown

Let's take an example of krish@koneti.com

to describe the breakdown of an email.

In the email address, before the part of the @ symbol, contains the department of an organization, alias, user, or group. As shown in the above example, **help** is the support department at our company **koneti**.

Next, the @ (at sign) is required for all SMTP (Simple Mail Transfer Protocol) email address that is a divider in the email address, since the first message was sent by Ray Tomlinson.

Finally, users belong to the domain name, javatpoint.com. For the domain, the .com is the top-level domain (TLD).

What is streaming?

The first websites were simple pages of text with maybe an image or two. Today, however, anyone with a fast enough Internet connection can watch high-definition movies or make a video call over the Internet. This is possible because of a technology called streaming.

Streaming is the continuous transmission of audio or video files from a server to a client. In simpler terms, streaming is what happens when consumers watch TV or listen to podcasts on Internet-connected devices. With streaming, the media file being played on the [client device](#) is stored remotely, and is transmitted a few seconds at a time over the Internet.

How does streaming work?

Just like other data that's sent over the Internet, audio and video data is broken down into data packets. Each packet contains a small piece of the file, and an audio or video player in the browser on the client device takes the flow of data packets and interprets them as video or audio.

What is World Wide Web?

World Wide Web, which is also known as a Web, is a collection of websites or web pages stored in web servers and connected to local computers through the internet. These websites contain text pages, digital images, audios, videos, etc. Users can access the content of these sites from any part of the world over the internet using their devices such as computers, laptops, cell phones, etc. The WWW, along with internet, enables the retrieval and display of text and media to your device.



The building blocks of the Web are web pages which are formatted in HTML and connected by links called "hypertext" or hyperlinks and accessed by HTTP. These links are electronic connections that link related pieces of information so that users can access the desired information quickly. Hypertext offers the advantage to select a word or phrase from text and thus to access other pages that provide additional information related to that word or phrase.

A web page is given an online address called a Uniform Resource Locator (URL). A particular collection of web pages that belong to a specific URL is called a website, e.g., *www.facebook.com*, *www.google.com*, etc. So, the World Wide Web is like a huge electronic book whose pages are stored on multiple servers across the world.

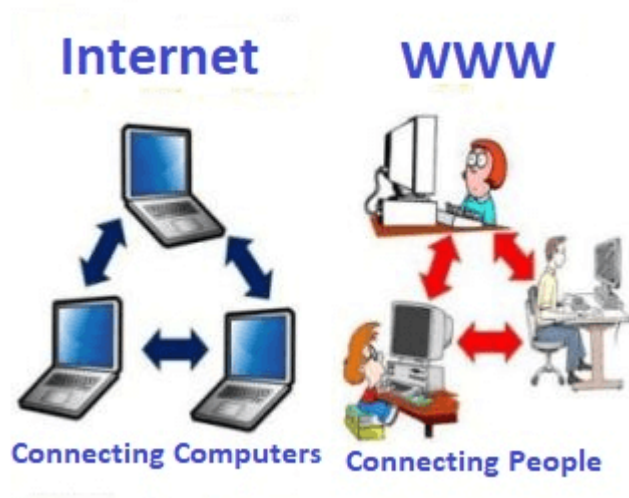
Small websites store all of their WebPages on a single server, but big websites or organizations place their WebPages on different servers in different countries so that when users of a country search their site they could get the information quickly from the nearest server.

So, the web provides a communication platform for users to retrieve and exchange information over the internet. Unlike a book, where we move from one page to another in a sequence, on World Wide Web we follow a web of hypertext links to visit a web page and from that web page to move to other web pages. You need a browser, which is installed on your computer, to access the Web.

Difference between World Wide Web and Internet:

Some people use the terms 'internet' and 'World Wide Web' interchangeably. They think they are the same thing, but it is not so. Internet is entirely different from WWW. It is a worldwide network of devices like computers, laptops, tablets, etc. It enables

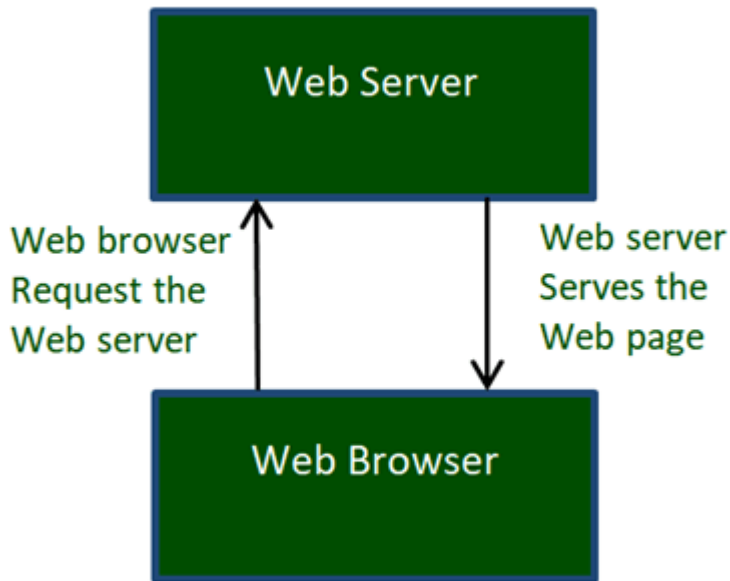
users to send emails to other users and chat with them online. For example, when you send an email or chatting with someone online, you are using the internet.



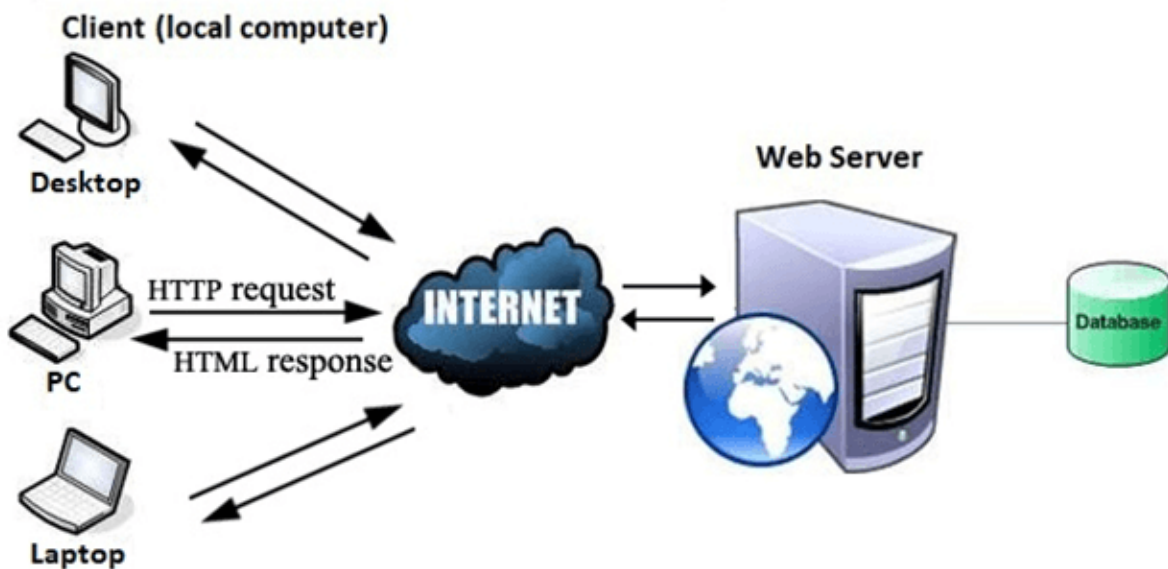
But, when you have opened a website like google.com for information, you are using the World Wide Web; a network of servers over the internet. You request a webpage from your computer using a browser, and the server renders that page to your browser. Your computer is called a client who runs a program (web browser), and asks the other computer (server) for the information it needs.

How the World Wide Web Works?

Now, we have understood that WWW is a collection of websites connected to the internet so that people can search and share information. Now, let us understand how it works!



The Web works as per the internet's basic client-server format as shown in the following image. The servers store and transfer web pages or information to user's computers on the network when requested by the users. A web server is a software program which serves the web pages requested by web users using a browser. The computer of a user who requests documents from a server is known as a client. Browser, which is installed on the user' computer, allows users to view the retrieved documents.



All the websites are stored in web servers. Just as someone lives on rent in a house, a website occupies a space in a server and remains stored in it. The server hosts the website whenever a user requests its WebPages, and the website owner has to pay the hosting price for the same.

The moment you open the browser and type a URL in the address bar or search something on Google, the WWW starts working. There are three main technologies involved in transferring information (web pages) from servers to clients (computers of users). These technologies include Hypertext Markup Language (HTML), Hypertext Transfer Protocol (HTTP) and Web browsers.

MULTIPLEXING AND DEMULTIPLEXING

- **Multiplexing**

- Multiplexing is a process in which multiple data channels are combined into a single data or physical channel at the source.
- Multiplexing divides the physical line (medium) into logical segments called as channels.
- Multiplexing is a technique by which different analog and digital streams of transmission can be simultaneously processed over a shared link.
- Multiplexing divides the high capacity medium into low capacity logical medium which is then shared by different streams.
- Multiplexing also known as MUX.
- The sending of multiple signals or streams of information on a carrier at the same time is known as multiplexing. It is in the form of a single, complex signal

Multiplexing

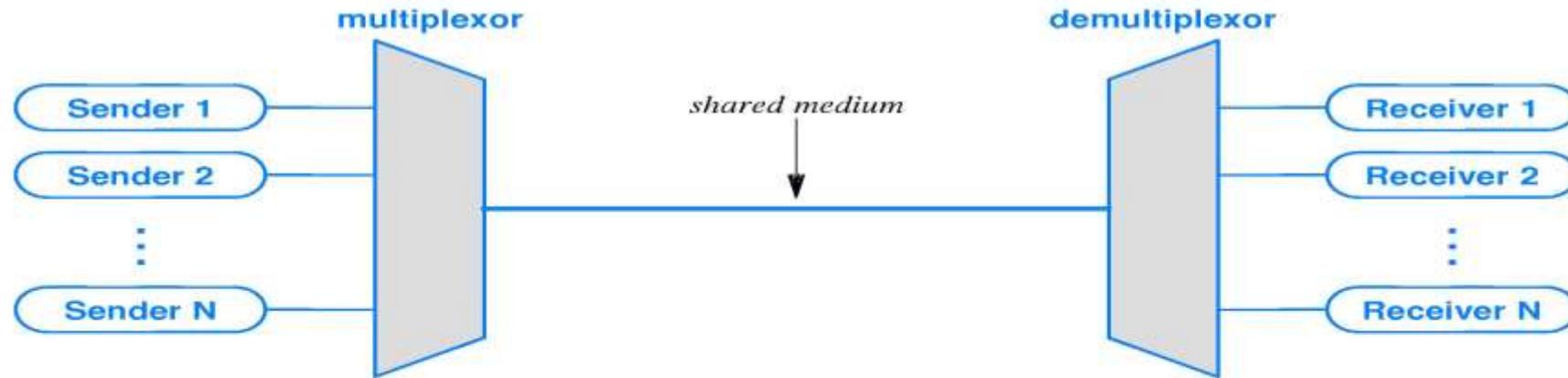


Figure 11.1 The concept of multiplexing in which independent pairs of senders and receivers share a transmission medium.

- The opposite process of multiplexing is called demultiplexing. Technical terms used in Multiplexing:
 - 1. Multiplexer: A device that can combine and transmit several signals over a single line.
 - 2. DeMultiplexer: A device that decode the single line signal into multiple signals.
 - 3. Multilevel: Used when the data rate of the input links are multiples of each other.
 - 4. Multislot: Used when there is a GCD between the data rates. The higher bit rate channels are allocated more slots per frame, and the output frame rate is a multiple of each input link.
 - 5. Pulse Stuffing: Used when there is no GCD between the links. The slowest speed link will be brought up to the speed of the other links by bit insertion, this is called pulse stuffing.

- **Multiplexing are of following forms:**

- 1. Frequency Division Multiplexing (FDM): FDM is an analog multiplexing technique that combines analog signals.
- 2. Time Division Multiplexing (TDM): TDM is a digital multiplexing technique for combining several low-rate digital channels into one high-rate one.
- 3. Wavelength Division Multiplexing (WDM): WDM is an analog multiplexing technique to combine optical signals

Advantages of Multiplexing:

- 1. Simple and easy.
- 2. Large capacities and scalable.
- 3. Inexpensive and signals may have varying speed.

Disadvantages of Multiplexing:

- 1. Complexity.
- 2. Bandwidth is wasted.

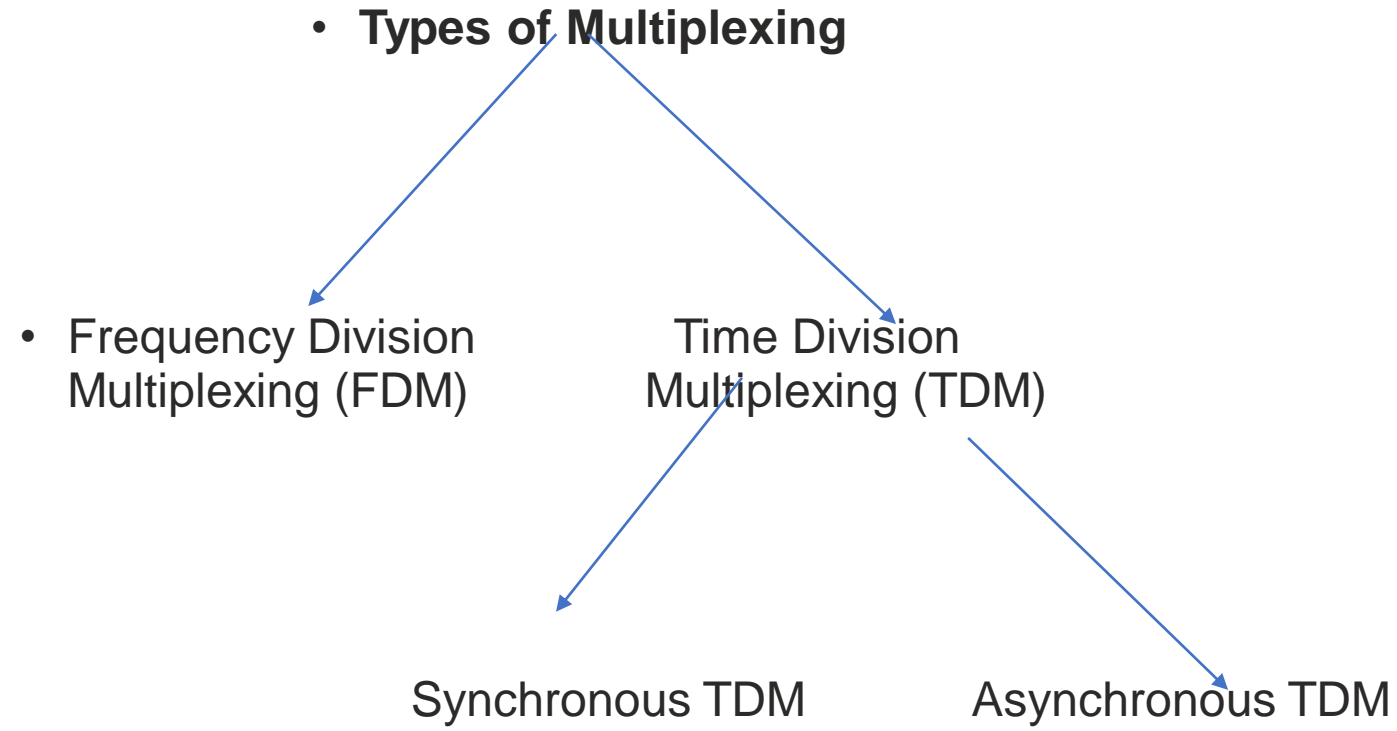
- **Types of Multiplexing**

- Frequency Division Multiplexing (FDM)

- Time Division Multiplexing (TDM)

- Synchronous TDM

- Asynchronous TDM

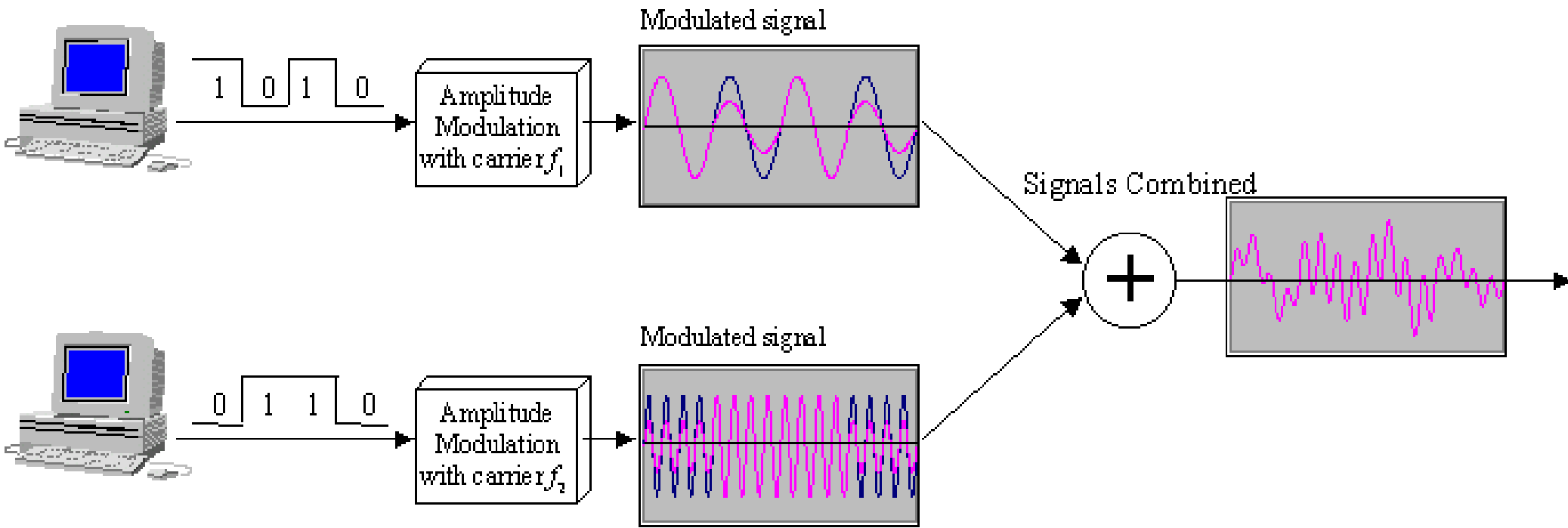


Frequency Division Multiplexing (FDM)

- In FDM, signals generated by each sending device modulate different carrier frequencies
- These modulated signals are then combined into a single composite signal that can be transported by the link.
 - The carrier frequencies have to be different enough to accommodate the modulation and demodulation signals.
- FDM used with analog signals. Perhaps its most common use is in television and radio transmission.
- It accept signals from multiple sources.
- It has a specified bandwidth, the signals are combined into another, more complex signal with large bandwidth.
- MUX extracts and separates the individual components its carries frequencies.

FDM

FDM multiplexing process



Applications of FDM:

- 1. FDM is used for A.M. Radio and Radio broadcasting.
- 2. FDM is used for T.V. broadcasting.

Advantages of FDM:

- 1. Simple and inexpensive.
- 2. All the receivers, cellular telephones, need not to be at the same location
- 3. It is not sensitive to propagation delays.
- 4. It allows maximum transmission link usage.

Disadvantages of FDM:

- 1. In FDM there is need of filters, which are very expensive and complicated to construct and design.
- 2. Analog signal only having limited frequency range.
- 3. Sometimes, it is necessary to use more complex linear amplifiers in FDM systems.

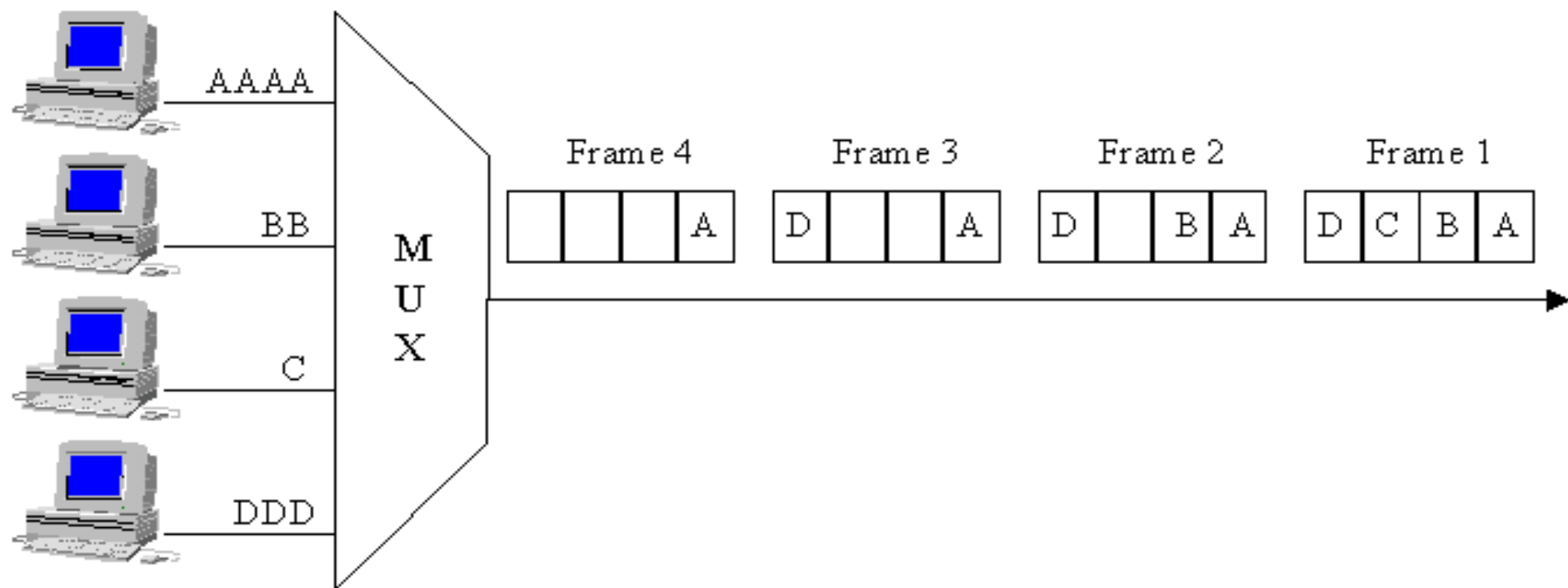
Time Division Multiplexing (TDM)

- In the time-division multiplexing, multiple transmissions can occupy a single link by subdividing them and interleaving the portions.
- TDM can be implemented in two ways i.e.
 1. Synchronous TDM and
 2. Asynchronous TDM.

1.Synchronous TDM:

- The multiplexer allocates exactly the same time slot to each device at all times, whether or not a device has anything to transmit.
- The multiplexer allocates the exactly the same times lot to each transmission devices at all times.
- Time slots are grouped into frames. A frame consists of one complete cycle of time slots.
- Time slot 1, for example, is assigned to device 1 alone and cannot be used by any other device

Synchronous TDM: multiplexing process



Advantages of synchronous TDM:

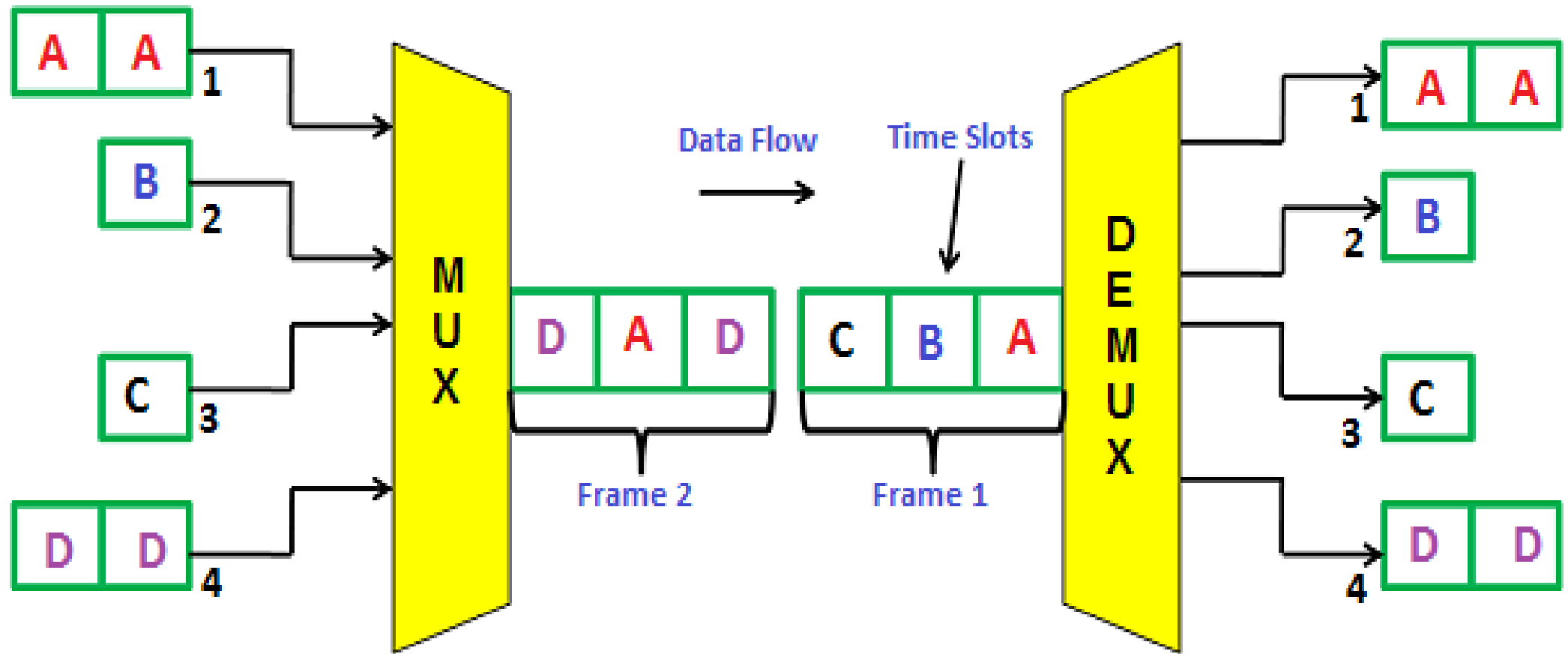
- (i) Relatively simple, and
- (ii) Commonly used with ISDN (Integrated Services Digital Network).

Disadvantages of synchronous TDM:

- (i) Wastage of bandwidth.

Asynchronous TDM:

- In asynchronous TDM, each slot in a frame is not dedicated to the fix device.
- Each slot contains an index of the device to be sent to and a message. Thus, the number of slots in a frame is not necessary to be equal to the number of input devices.
- More than one slot in a frame can be allocated for an input device Asynchronous TDM allows maximization the link.
- It allows a number of lower speed input lines to be multiplexed to a single higher speed line
 - Asynchronous TDM also called as statistical time division multiplexing.
 - In asynchronous TDM, a frame contains a fix number of time slots.
 - Each slot has an index of which device to receive.



Asynchronous TDM

Advantages and Disadvantages of Asynchronous/statistical TDM

Advantages:

- Communication link of low capacity is used.
- The problem of crosstalk is not severe.
- Full available channel bandwidth can be utilized for each channel.
- Intermodulation distortion is absent.

Disadvantages:

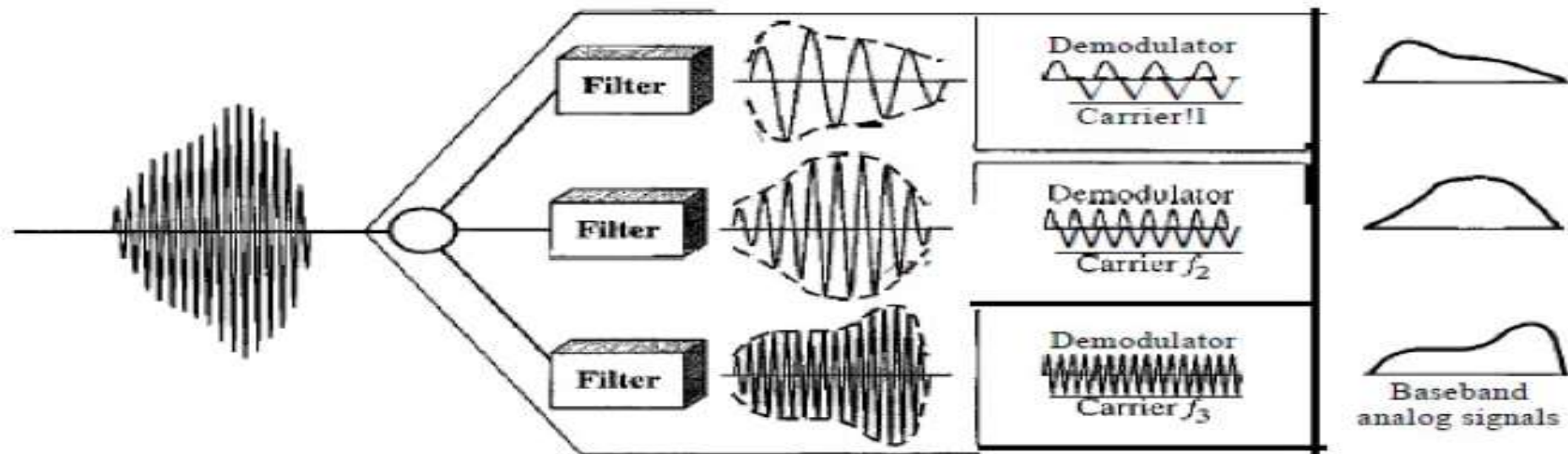
- Frames have different sizes.
- Requires buffers.
- Address information is needed.

Demultiplexing

- Demultiplexing is the process of separating multiplexed data channels at the destination.
- Demultiplex (DEMUX) is the reverse of the multiplex (MUX) process combining multiple unrelated analog or digital signal streams into one signal over a single shared medium, such as a single conductor of copper wire or fiber optic cable.
- Thus, demultiplex is reconverting a signal containing multiple analog or digital signal streams back into the original separate and unrelated signals.
- In demultiplexing process, we use filters to decompose the multiplexed signal into its constituent component signals. Then each signal is passed to an amplitude demodulation process to separate the carrier signal from the message signal. Then, the message signal is sent to the waiting receiver.

For the frequency division demultiplexing (FDM) below:

Figure 6.5 FDM demultiplexing example



Design a filter that can allow the following frequencies (from 5 kHz to 35 kHz)

Sr. No.	TDM	FDM
1.	TDM stands for Time Division Multiplexing.	FDM stands for Frequency Division Multiplexing.
2.	TDM divides a channel by allocating a time period for each channel.	FDM divides the channel into multiple, but smaller frequency ranges to accommodate more users.
3.	TDM provides much better flexibility compared to FDM.	FDM provides much less flexibility compared to TDM.
4.	In FDM spectrum is divided into frequency.	TDM divided into time slot.
5.	FDM is used in 1st generation analog system.	TDM is used in 2nd generation analog system.
6.	Difficult to install.	Easy and simpler to install.
7.	TDM imply partitioning the bandwidth of the channel connecting two nodes into finite set of time slots.	In FDM the signals multiplexed come from different sources/transmitters.
8.	TDM is sensitive to propagation delays.	FDM is not sensitive to propagation delays.