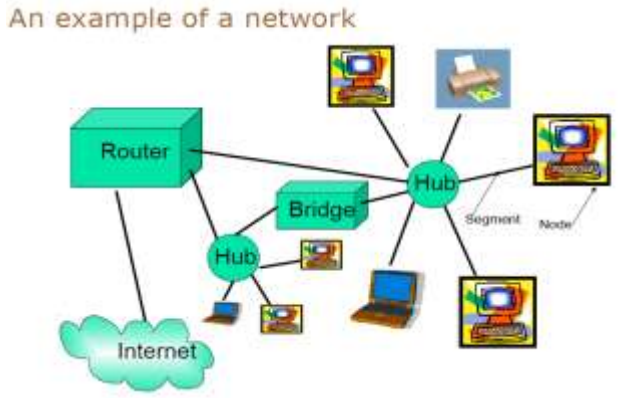
Introduction to Computer Network

What is computer Network?

Computer Network is a collection of computing devices. Devices are connected in various ways in order to communicate and share resources. Usually, the connections between computers in a network are made using physical wires or cables. Sometime connections are wireless, using radio waves or infrared signals. Example, a computer network can consists of a collection of computers, printers and other equipment like router, switch and servers that is connected together so that they can communicate with each other.



Uses/Application of Computer Network

Computer network has a broad range of application. It can be summarized in following points:

1. Business Application
2. Home Application
3. Mobile Users
4. Social Issues

Business Application

Resource sharing: The goal is to make all programs, equipment, and especially data available to anyone on the network without regard to the physical location of the resource or the user. An obvious and widespread example is having a group of office workers share a common printer.

A computer network can provide a powerful communication medium among employees. Virtually every company that has two or more computers now has email (electronic mail), which employees generally use for a great deal of daily communication.

Telephone calls between employees may be carried by the computer network instead of the phone company. This technology is called IP telephony or Voice over IP (VoIP) when Internet technology is used.

Desktop sharing lets remote workers see and interact with a graphical computer screen. This makes it easy for two or more people who work far apart to write a report together.

Many companies is doing business electronically, especially with customers and suppliers. This new model is called e-commerce (electronic commerce) and it has grown rapidly in recent years. Airlines, bookstores, and other retailers have discovered that many customers like the convenience of shopping from home.

Home Application

The biggest reason to buy a home computer was probably for Internet access. Internet access provides home users with connectivity to remote computers. As with companies, home users can access information, communicate with other people, and buy products and services with e-commerce. Access to

remote information comes in many forms. It can be surfing the World Wide Web for information or just for fun. Information available includes the arts, business, cooking, government, health, history, hobbies, recreation, science, sports, travel, and many others.

Mobile Users

Mobile computers, such as laptop and handheld computers are one of the fastest-growing segments of the computer industry. People on the go often want to use their mobile devices to read and send email, tweet, watch movies, download music, play games, or simply to surf the Web for information. They want to do all of the things they do at home and in the office. Naturally, they want to do them from anywhere on land, sea or in the air.

Wireless networks are of great value to fleets of trucks, taxis, delivery vehicles, and repairpersons for keeping in contact with their home base. Perhaps the key driver of mobile, wireless applications is the mobile phone.

Text messaging or texting is tremendously popular. It lets a mobile phone user type a short message that is then delivered by the cellular network to another mobile subscriber. Since mobile phones know their locations, often because they are equipped with GPS (Global Positioning System) receivers, some services are intentionally location dependent. Mobile maps and directions are an obvious candidate as your GPS-enabled phone and car probably have a better idea of where you are than you do.

Social Issues

Social networks, message boards, content sharing sites, and a host of other applications allow people to share their views with like-minded individuals. As long as the subjects are restricted to technical topics or hobbies like gardening, not too many problems will arise. The trouble comes with topics that people actually care about, like politics, religion, or sex. Views that are publicly posted may be deeply offensive to some people. Furthermore, opinions need not be limited to text; high-resolution color photographs and video clips are easily shared over computer networks.

Computer networks make it very easy to communicate. They also make it easy for the people who run the network to snoop on the traffic.

There are multi-person messaging services too, such as the Twitter service that lets people send short text messages called ‘‘tweets’’ to their circle of friends or other willing audiences. The Internet can be used by applications to carry audio (e.g., Internet radio stations) and video (e.g., YouTube). One of the most popular social networking sites is Facebook. It lets people update their personal profiles and shares the updates with other people who they have declared to be their friends.

Advantages and Disadvantages of Computer Network

Advantages

- File Sharing
- Resource Sharing
  - Device sharing(Printers)
- In-expensive setup
  - Sharing Resource reduce Cost
- Flexible Handling
  - Easy For Network Admin to Manage Resource
  - User can login from any Host and access his/her files
- Increased Resource Capacity
  - By Sharing Resource

Disadvantages

- Security Concerns

    - Computer within a Network can be Vulnerable
- Malware (Malicious software)
    - Malicious software (worms, viruses, Trojan Horse, Logic bomb, zombie)
- Lack of Robustness
    - Break down of Central System disrupt the Entire System
- Needs An Efficient Handler
    - Required Technically qualified Candidate to maintain the system

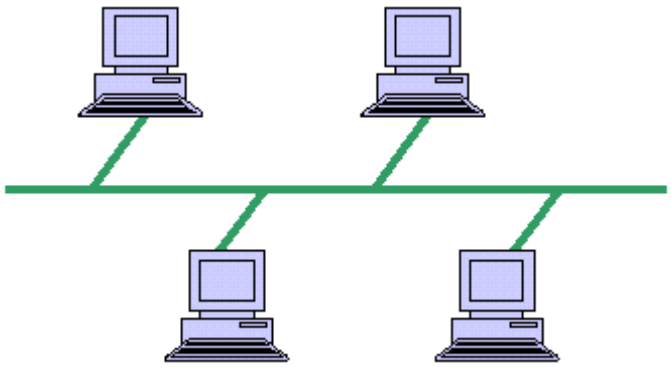
Overview of Network Topologies

Topology - Physical and logical network layout

- Physical – actual layout of the computer cables and other network devices
- Logical – the way in which the network appears to the devices that use it

Bus Topology

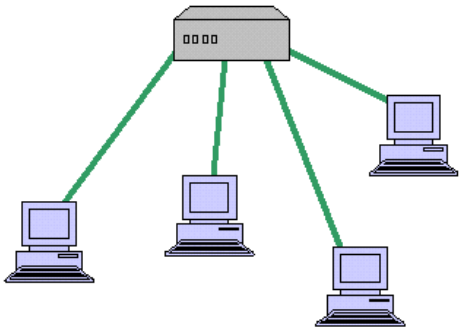
Bus consists of a single linear cable called a trunk.
Data is sent to all computers on the trunk.
Each computer examines EVERY packet on the wire to determine who the packet is for and accepts only messages addressed to them.



Advantages	Disadvantages
Cheap and easy to implement	Network disrupts when computer are added or removed
Require less cable	A break in the cable will affect all the networks

Star Topology

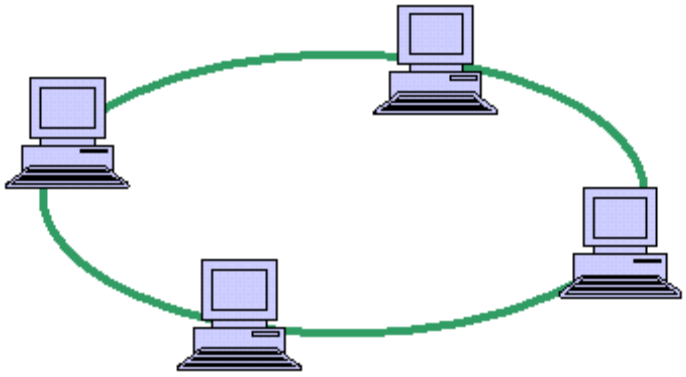
- All computers/devices connect to a central device called hub or switch.
- Each device requires a single cable
- Point-to-point connection between the device and hub.
- Most widely implemented



Advantages	Disadvantages
Easily expanded without disruption to the network	Requires more cable
Cable failure affects only a single user	Centralized device-Single point of failure

Ring Topology

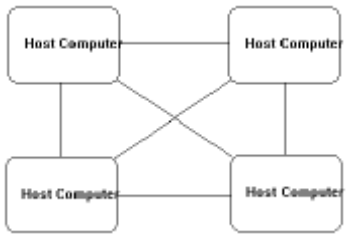
- Computers are connected on a single circle of cable.
- Usually seen in a Token Ring or FDDI (fiber optic) network.



Advantages	Disadvantages
Cable fault are easily located making troubleshooting easier	Expansion to the network can cause network disruption
Easy to install	A single break in the cable can disrupt entire network

Mesh Topology

- Each computer connects to every other.
- High level of redundancy.

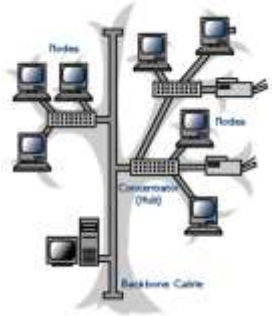


Advantages	Disadvantages
Provide redundant path between devices	Require more cable than the other LAN topologies
Network can be expanded without disruption	Complicated implementation

Tree Topology

• A tree topology (hierarchical topology) can be viewed as a collection of star networks arranged in a hierarchy.

• This tree has individual peripheral nodes which are required to transmit to and receive from one other only and are not required to act as repeaters or regenerators.



Advantages	Disadvantages
Expansion of network is easy	Relies on main bus cable, if it breaks entire system fails
Easy error detection and correction	Slow as number of devices increases
If one segment is affected other are not affected	

Hybrid Topology

• A combination of any two or more network topologies.

• A hybrid topology always accrues when two different basic network topologies are connected.

Overview of Network Types

- **LAN (Local Area Network)**
  A LAN is a network that is used for communicating among computer devices, usually within an office building or home. LAN's enable the sharing of resources such as files or hardware devices that may be needed by multiple users

- **PAN (Personal Area Network)**
  PAN network is a computer network that allows devices to communicate around a single person.The network is structured for a single entity which can be in a small office, a building or apartment. PAN network connects different peripherals such as computers, telephones, video game consoles.

- **CAN(Campus Area Network)**
  It is a type of network built upon connection of various LAN networks within restricted geographical area. It is also known ascorporate network. These are interconnected with high speed Ethernet using optical fiber. The range of CAN varies from 1 km to5 km.

- **MAN (Metropolitan Area Network)**
  A (**MAN**) is a large computer network that usually spans a city or a large campus. A MAN is optimized for a larger geographical area than a LAN, ranging from several blocks of buildings to

entire cities. A MAN might be owned and operated by a single organization, but it usually will be used by many individuals and organizations. Examples of MAN: Telephone company network that provides a high speed DSL to customers and cable TV network.

- **WAN (Wide Area Network)**
  WAN covers a large geographic area such as country, continent or even whole of the world. A WAN is two or more LANs connected together. Multiple LANs can be connected together using devices such as bridges, routers, or gateways, which enable them to share data. The world's most popular WAN is the Internet.

CLIENT SERVER MODEL

A client-server network consists of a number of devices called clients who acquire services from the relatively powerful devices called servers. Client devices are typically PCs or mobile devices with network software applications installed. Server device typically stores files, databases and applications like Web sites. The client-server model can be used on the Internet as well as local area networks (LANs). Examples of client-server systems on the Internet include Web browsers and Web servers, FTP clients and servers, and DNS.

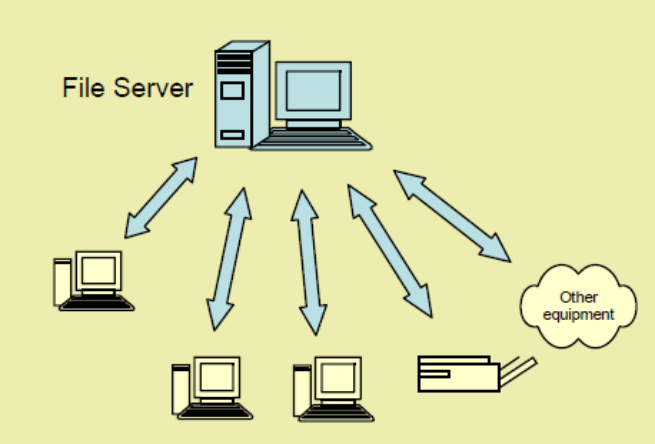


Figure: Client Server model

If we look at the client-server model in detail, we see that two processes (i.e., running programs) are involved, one on the client machine and one on the server machine. Communication takes the form of the client process sending a message over the network to the server process. The client process then waits for a reply message. When the server process gets the request, it performs the requested work or looks up the requested data and sends back a reply. These messages are shown in figure below.

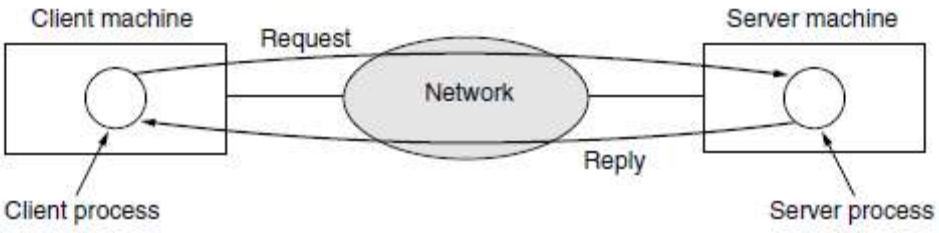


Figure: request and replies in client server model

Client and its function

Thin client– a personal computer that does not have to be very powerful because it only presents the user interface to the user. It is largely used for interaction with processing layers. Example: Increasingly PDA's, Handhelds or Smart phones

Fat client–a typically powerful personal computer capable of independent application processes. Also notebook computer or workstation

Different types of server and function

Database server– a server that hosts one or more databases, (Executing all data manipulation commands at the server)

Transaction server– a server that hosts services which ensure that all database updates for a transaction succeed or fail as a whole. (Crucial in banking contexts –cash machines; online shopping …)

Application server–a server that hosts application logic and services for an information system. (between interface & database)

Messaging or groupware server– a server that hosts services for e-mail, calendaring, and other work group functionality.

Web server– a server that hosts Internet or intranet websites, (sends data (XML) and documents (HTML) to clients)

PEER-TO-PEER NETWORK

P2P is a distributed network architecture, which consists of devices known as peers that share their own resources (disk storage, processing power or network bandwidth) directly, without the need for central server. Peer-to-peer is popular for file sharing on the Internet. Peer-to-peer systems often implement an Application Layer overlay network on top of the native or physical network topology.

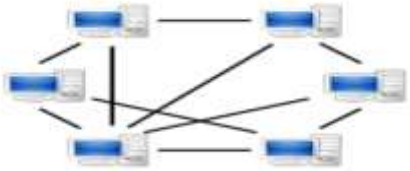


Figure: Peer-to-Peer Network

Peer-to-Peer computing is inspired by the controversial music-sharing service Napster. Instead of Internet information being held in a few central locations, Peer-to-Peer computing makes it theoretically possible to access the files and data residing on every personal computer connected to the Internet.

Problem with Server-Client Model

- **Scalability**

  As the number of users increases, there is a higher demand for computing power, storage space, and bandwidth associated with the server-side
- **Reliability**

  The whole network will depend on the highly loaded server to function properly

Advantage of P2P model

- The system is based on the direct communication between peers
- There is zero reliance on centralized service or resources for operations
- The system can survive extreme changes in network composition
- They thrive in a network with heterogeneous environment
- This model is highly scalable

A **point-to-point connection** is a direct link between two devices such as a computer and a printer. It uses dedicated link between the devices. The entire capacity of the link is used for the transmission between those two devices.

A **multipoint connection** is a link between three or more devices. The networks having multipoint configuration are called Broadcast Networks. In broadcast network, a message or a packet sent by any machine is received by all other machines in a network.

Overview of Protocols and Standards --Assignment

OSI MODEL

The Physical Layer

The physical layer is concerned with transmitting raw bits over a communication channel. The design issues largely deal with mechanical, electrical, and timing interfaces, as well as the physical transmission medium.

The Data Link Layer

The main task of the data link layer is to transform a raw transmission facility into a line that appears free of undetected transmission errors. It break up the input data into **data frames** (typically a few hundred or a few thousand bytes) and transmit the frames sequentially. Another issue that arises in the data link layer (and most of the higher layers as well) is how to keep a fast transmitter from drowning a slow receiver in data (i.e., flow control).

The Network Layer

The network layer controls the operation of the subnet. A key design issue is determining how packets are routed from source to destination. If too many packets are present in the subnet at the same time, they will get in one another's way, forming bottlenecks. Handling congestion is also a responsibility of the network layer, in conjunction with higher layers.

The Transport Layer

The basic function of the transport layer is to accept data from above it, split it up into smaller units if need be, pass these to the network layer, and ensure that the pieces all arrive correctly at the other end. The transport layer also determines what type of service to provide to the session layer, and, ultimately, to the users of the network.

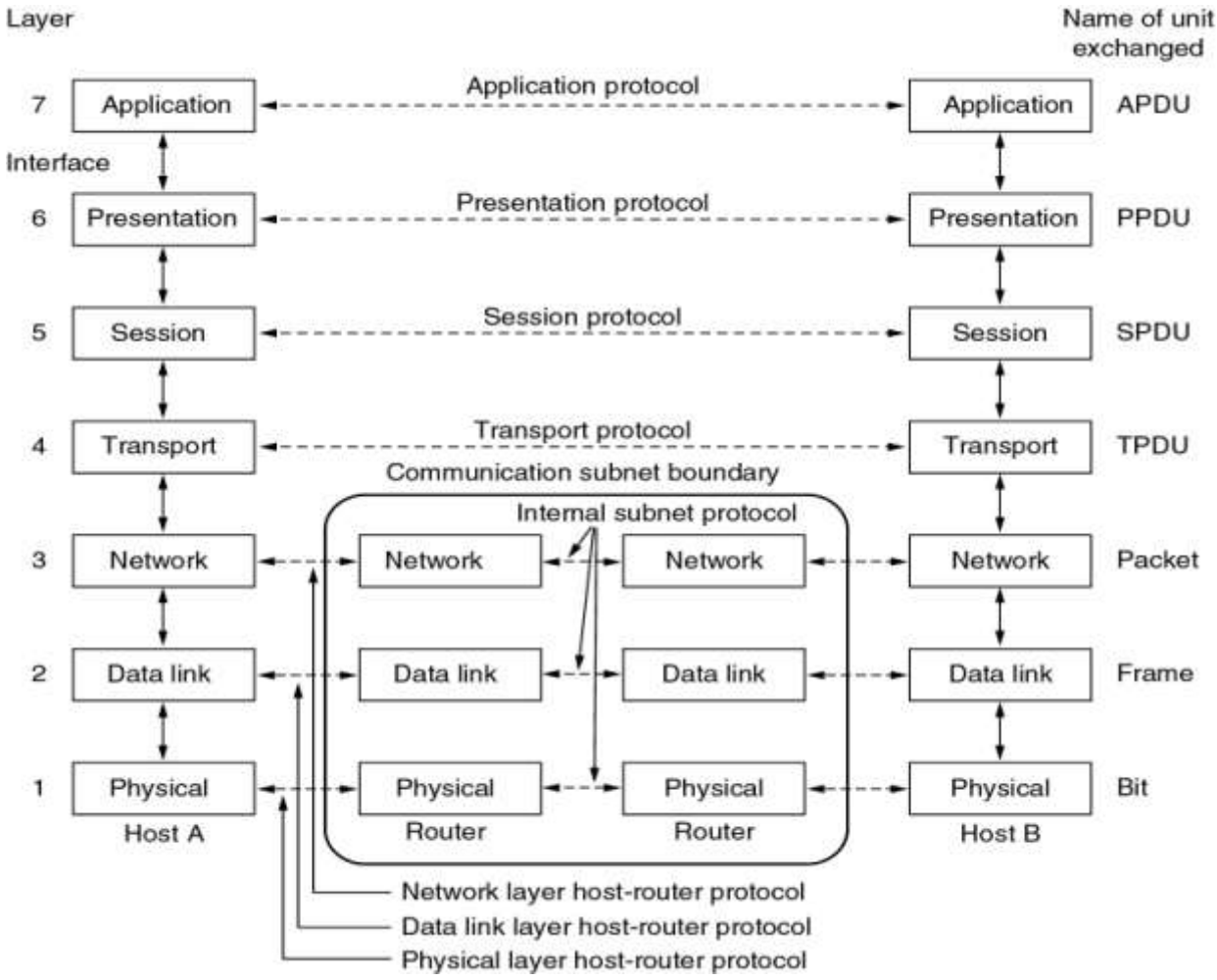


Figure: OSI model

The Session Layer

The session layer allows users on different machines to establish sessions between them. Sessions offer various services, including **dialog control** (keeping track of whose turn it is to transmit), **token management** (preventing two parties from attempting the same critical operation simultaneously), and **synchronization** (check-pointing long transmissions to allow them to pick up from where they left off in the event of a crash and subsequent recovery).

The Presentation Layer

Unlike the lower layers, which are mostly concerned with moving bits around, the presentation layer is concerned with the syntax and semantics of the information transmitted.

The Application Layer

The application layer contains a variety of protocols that are commonly needed by users. One widely used application protocol is **HTTP** (**HyperText Transfer Protocol**), which is the basis for the World Wide Web.

TCP/IP MODEL

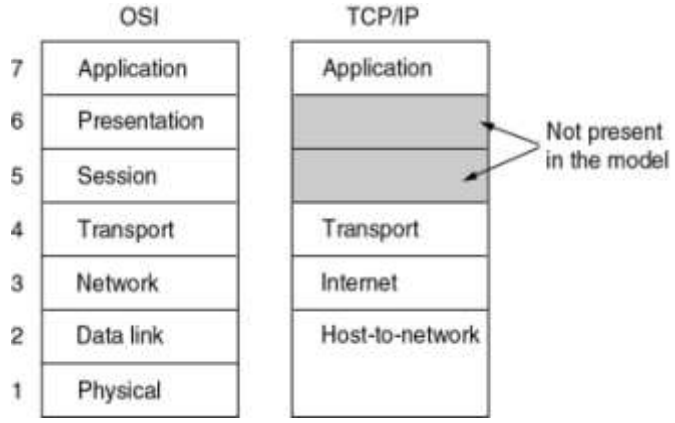


Fig 1.6: OSI and TCP/IP model

There are 4 layers in the TCP/IP model
Layer 4: Application
Layer 3: Transport
Layer 2: Internet
Layer 1: Network access (Host to Network)

The network access layer (Host to Network)

Concerned with all of the issues that an IP packet requires to actually make the physical link.It includes all the details in the OSI physical and data link layers.

- Electrical, mechanical, procedural and functional specifications
- Data rate, Distances, Physical connector

- Frames
- Synchronization, flow control, error control

The Internet Layer

It is concerned with Packet Addressing. It sends source packets from any network and have them arrive at the destination independent of the path and networks they took to get there. Packet may arrive in different order to destination. It is job of higher layer to arrange them. It is also important to avoid congestion while packet routing.

The Transport Layer

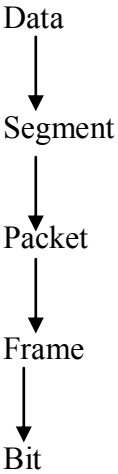
The transport layer deals with the quality-of-service issues of reliability, flow control, and error correction. Two end-to-end transport protocols have been defined here. The first one, **TCP** (**Transmission Control Protocol**), is a reliable connection-oriented protocol that allows a byte stream originating on one machine to be delivered without error on any other machine in the internet. The second protocol in this layer, **UDP** (**User Datagram Protocol**), is an unreliable, connectionless protocol for applications that do not want TCP's sequencing or flow control and wish to provide their own.

The Application Layer

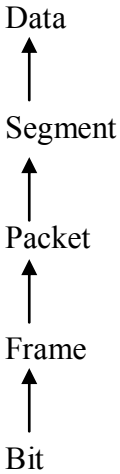
The TCP/IP model does not have session or presentation layers. Instead, applications simply include any session and presentation functions that they require. On top of the transport layer is the application layer. It contains all the higher- level protocols. The early ones included virtual terminal (TELNET), file transfer (FTP), and electronic mail (SMTP).

How header and footer are added and removed as data move from sender computer to receiver computer? How data encapsulation and de-encapsulation occurs in OSI model

Data Encapsulation



Data De-encapsulation



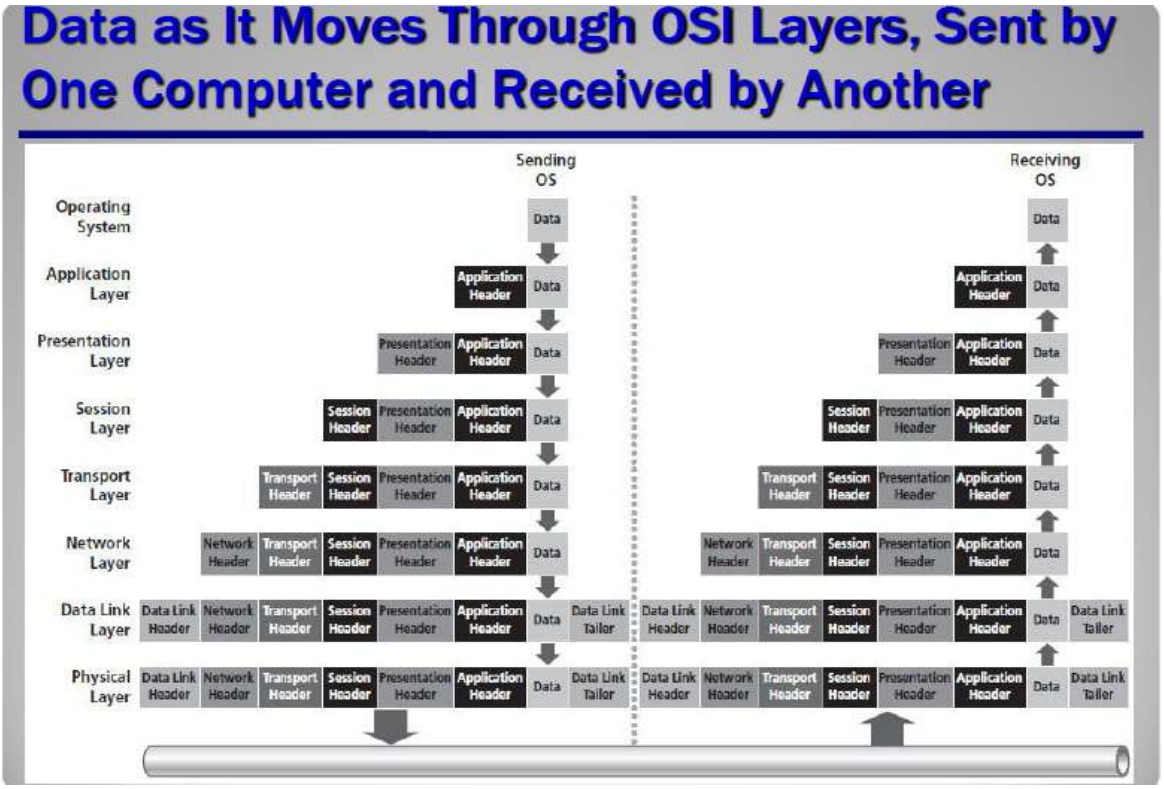


Fig 1.11: Data encapsulation and De-encapsulation

Comparison of OSI and TCP/IP – Assignment

Connection Oriented and Connectionless Services

Layers can offer two different types of service to the layers above them: connection- oriented and connectionless. **Connection-oriented** service is modeled after the telephone system. To talk to someone, you pick up the phone, dial the number, talk, and then hang up. Similarly, to use a connection-oriented network service, the service user first establishes a connection, uses the connection, and then releases the connection. The essential aspect of a connection is that it acts like a tube: the sender pushes objects (bits) in at one end, and the receiver takes them out at the other end. In most cases the order is preserved so that the bits arrive in the order they were sent.

Connectionless service is modeled after the postal system. Each message (letter) carries the full destination address, and each one is routed through the intermediate nodes inside the system independent of all the subsequent messages. There are different names for messages in different contexts; a **packet** is a message at the network layer. When the intermediate nodes receive a message in full before sending it on to the next node, this is called **store-and-forward switching**. The alternative, in which the onward

transmission of a message at a node starts before it is completely received by the node, is called **cut-through switching**. Normally, when two messages are sent to the same destination, the first one sent will be the first one to arrive. However, it is possible that the first one sent can be delayed so that the second one arrives first.

	Service	Example
Connection-oriented	Reliable message stream	Sequence of pages
	Reliable byte stream	Movie download
	Unreliable connection	Voice over IP
Connectionless	Unreliable datagram	Electronic junk mail
	Acknowledged datagram	Text messaging
	Request-reply	Database query

Figure: Six different types of services

Internet and its application

The Internet is a global system of interconnected computer networks. When two or more electronic devices (e.g. computers) are connected so that they can communicate; they become part of a network. The Internet consists of a worldwide interconnection of such networks, belonging to companies, governments and individuals, allowing all of the devices connected to these networks to communicate with each other. On the Internet, communication is possible because all devices use the same "language" or protocol, namely the Internet Protocol (IP). It forms the basis for all other systems of communication on the Internet.

Applications of the Internet

Traditional core applications:

- Email
- News
- Remote Login
- File Transfer

The killer application:

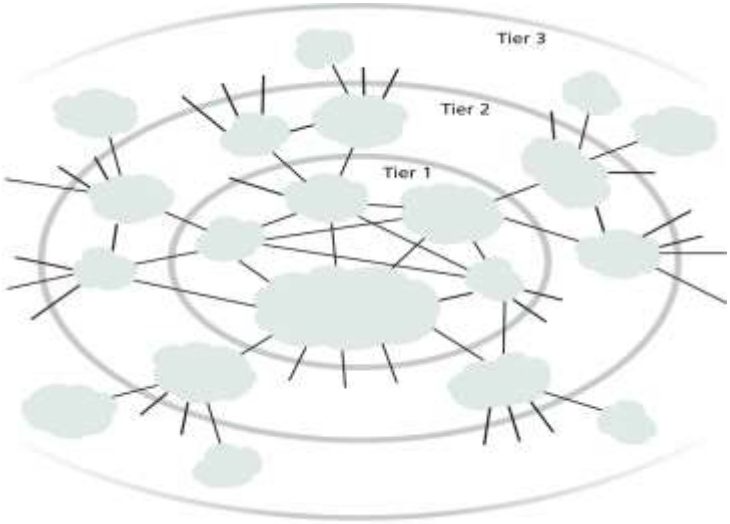
- World-Wide Web (WWW)

New applications:

- Videoconferencing
- Telephony
- P2P applications
- Internet Broadcast

ISP (Internet Service Provider)

- An Internet service provider (ISP) is an organization that provides access to the Internet.
- Access ISPs directly connect clients to the Internet using copper wires, wireless or fiber-optic connections.
- Hosting ISPs are a kind of co-location center that leases server space to smaller businesses and other people.
- Transit ISPs provide large amounts of bandwidth for connecting hosting ISPs to access ISPs
- ISPs
  •Tier1
  •Tier2 and
  •Tier3 ISPs

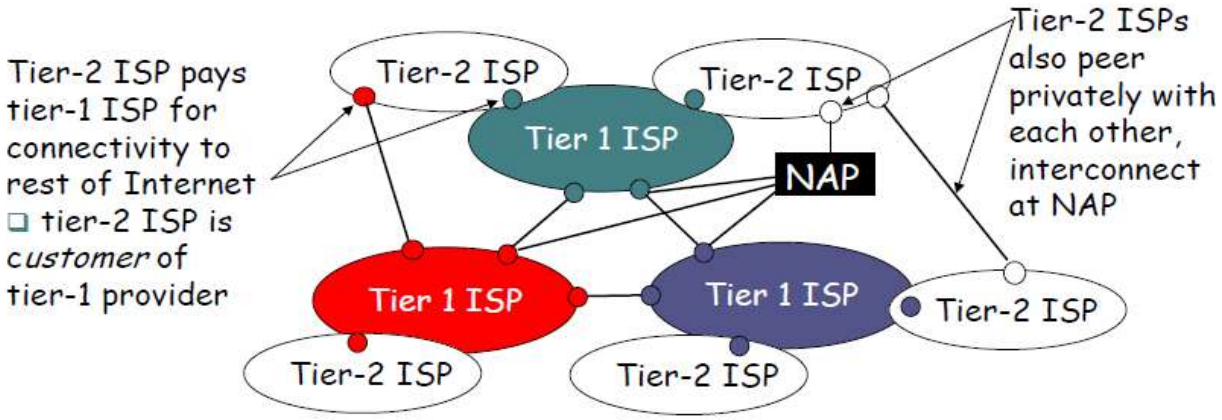


Tier 1 ISPs

- at center: "tier-1" ISPs (e.g., MCI, Sprint, AT&T, Cable and Wireless), national/international coverage
- treat each other as equals

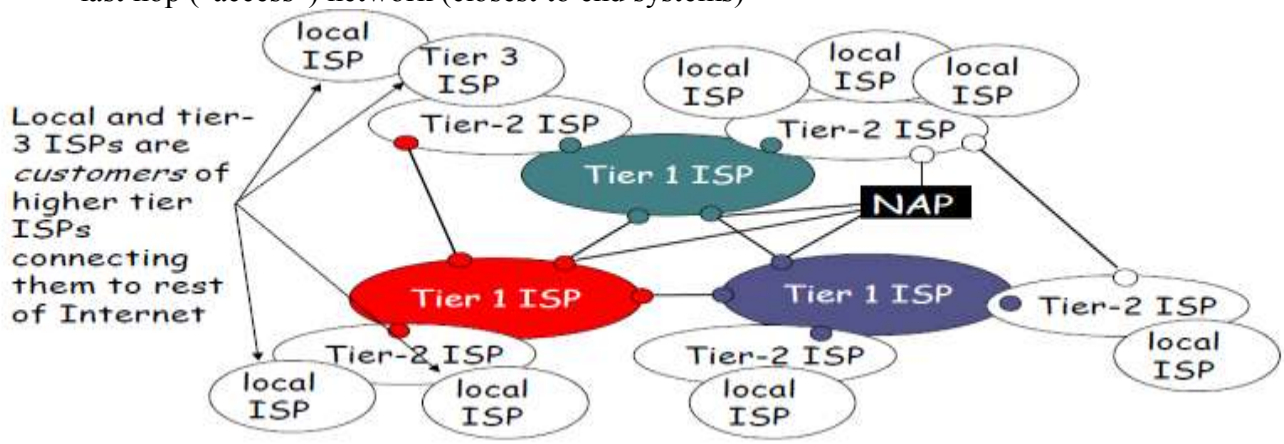
Tier 2 ISPs

- "Tier-2" ISPs: smaller (often regional) ISPs
- Connect to one or more tier-1 ISPs, possibly other tier-2 ISPs



Tier 3 ISPs

- "Tier-3" ISPs and local ISPs
- last hop ("access") network (closest to end systems)



Internet Backbone Networks

- Backbone networks are high speed networks that link an organization's LANs and also provide connections to other backbones, MANs, WANs and the Internet.
- Internet Backbone refers to the principal data routes between large, strategically interconnected networks and core networks on the internet.
- These data routes are hosted by commercial, government, academic and other high capacity network centers.
- Internet Service Provider (ISPs) are example that participate internet backbone exchange of traffic.