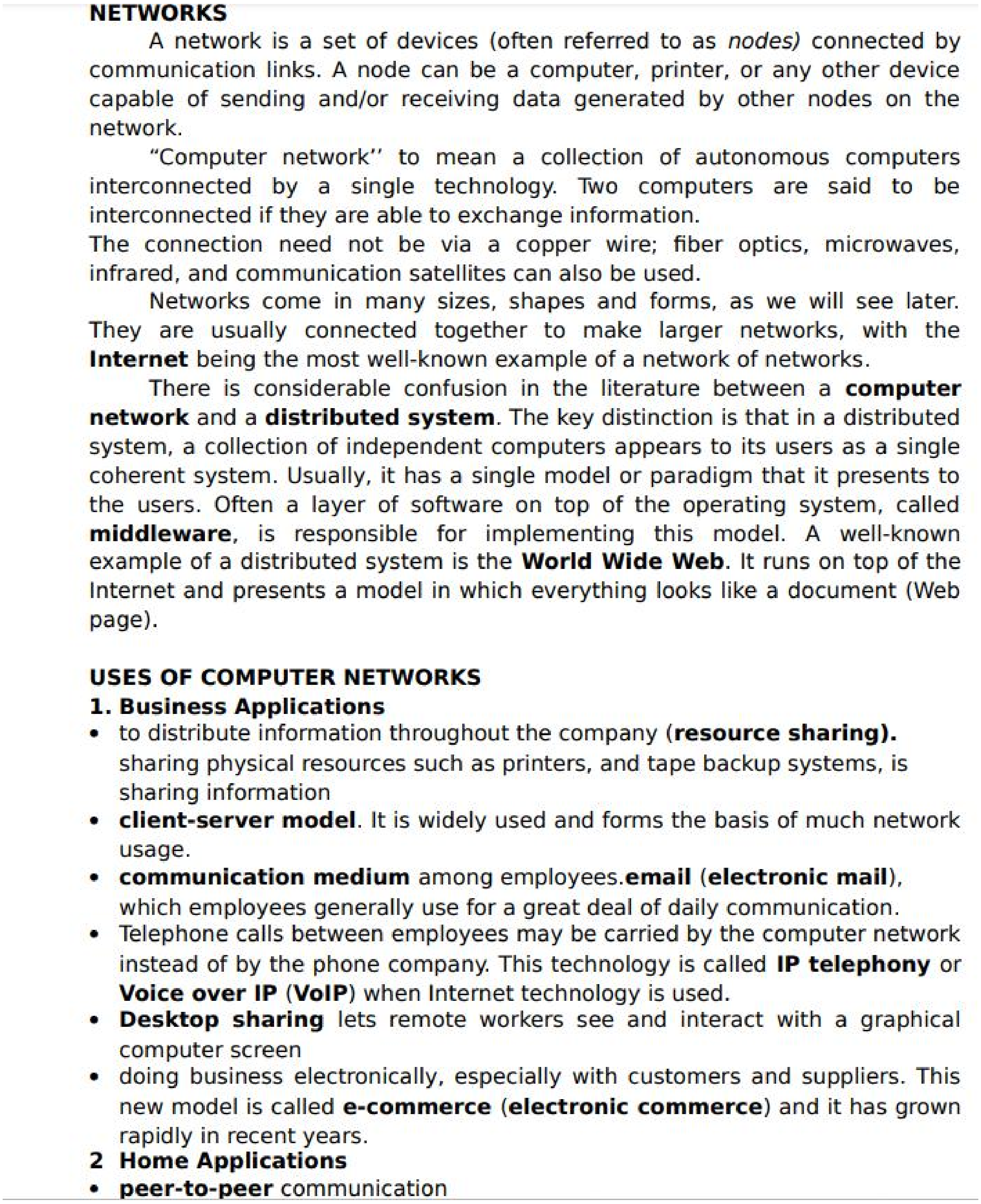


NETWORKS

A network is a set of devices (often referred to as *nodes)* connected by communication links. A node can be a computer, printer, or any other device capable of sending and/or receiving data generated by other nodes on the network.

"Computer network'' to mean a collection of autonomous computers interconnected by a single technology. Two computers are said to be interconnected if they are able to exchange information.
The connection need not be via a copper wire; fiber optics, microwaves, infrared, and communication satellites can also be used.

Networks come in many sizes, shapes and forms, as we will see later. They are usually connected together to make larger networks, with the **Internet** being the most well-known example of a network of networks.

There is considerable confusion in the literature between a **computer network** and a **distributed system**. The key distinction is that in a distributed system, a collection of independent computers appears to its users as a single coherent system. Usually, it has a single model or paradigm that it presents to the users. Often a layer of software on top of the operating system, called **middleware**, is responsible for implementing this model. A well-known example of a distributed system is the **World Wide Web**. It runs on top of the Internet and presents a model in which everything looks like a document (Web page).

USES OF COMPUTER NETWORKS

1. Business Applications

- to distribute information throughout the company (**resource sharing).** sharing physical resources such as printers, and tape backup systems, is sharing information
- **client-server model**. It is widely used and forms the basis of much network usage.
- **communication medium** among employees.**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 by 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
- 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.

2 Home Applications

- **peer-to-peer** communication
- electronic commerce
- entertainment.(game playing,)

3 Mobile Users

- Text messaging or texting
- Smart phones,
- GPS (Global Positioning System)
- m-commerce
- NFC (Near Field Communication)

4 Social Issues

With the good comes the bad, as this new-found freedom brings with it many unsolved social, political, and ethical 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.

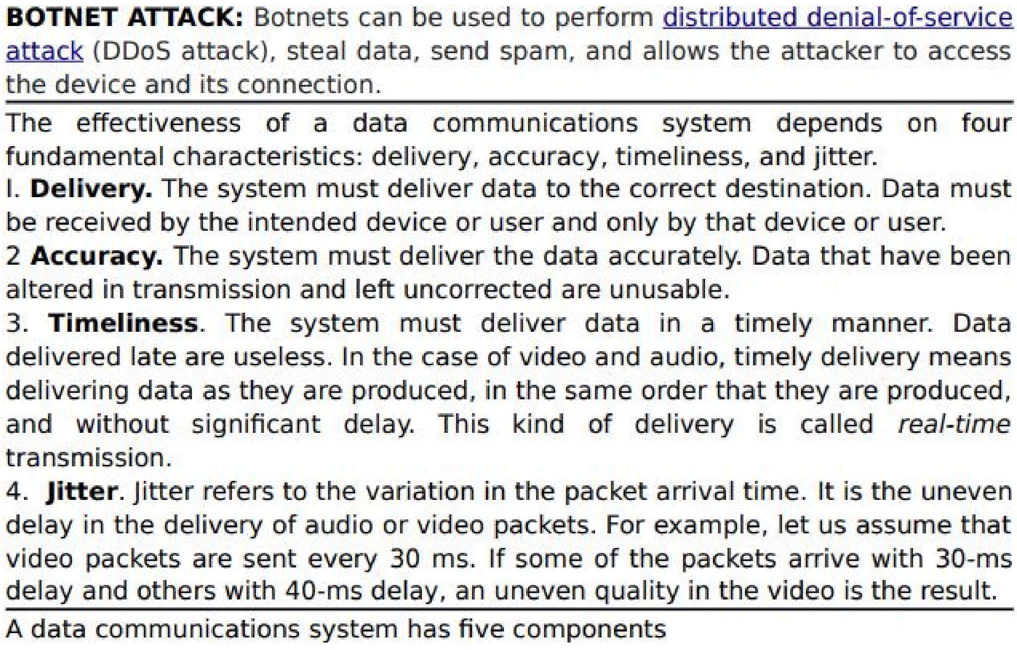
The trouble comes with topics that people actually care about, like politics, religion, or sex. Views that are publicly posted may be deeply offensive to some people. Worse yet, they may not be politically correct. Furthermore, opinions need not be limited to text; high-resolution color photographs and video clips are easily shared over computer networks. Some people take a live-and-let-live view, but others feel that posting certain material (e.g., verbal attacks on particular countries or religions, pornography, etc.) is simply unacceptable and that such content must be censored. Different countries have different and conflicting laws in this area. Thus, the debate rages.

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. This sets up conflicts over issues such as **employee rights versus employer rights**. Many people read and write email at work. Many employers have claimed the right to read and possibly censor employee messages, including messages sent from a home computer outside working hours. Not all employees agree with this, especially the latter part.

Another conflict is centered around government versus citizen's rights.

A new twist with mobile devices is location privacy. As part of the process of providing service to your mobile device the network operators learn where you are at different times of day. This allows them to track your movements. They may know which nightclub you frequent and which medical center you visit.

Phishing ATTACK: ***Phishing*** is a type of social engineering ***attack*** often used to steal user data, including login credentials and credit card numbers. It occurs when an attacker, masquerading as a trusted entity, dupes a victim into opening an email, instant message, or text message.



BOTNET ATTACK: Botnets can be used to perform distributed denial-of-service attack (DDoS attack), steal data, send spam, and allows the attacker to access the device and its connection.

The effectiveness of a data communications system depends on four fundamental characteristics: delivery, accuracy, timeliness, and jitter.

I. **Delivery.** The system must deliver data to the correct destination. Data must be received by the intended device or user and only by that device or user.

2 **Accuracy.** The system must deliver the data accurately. Data that have been altered in transmission and left uncorrected are unusable.

3. **Timeliness**. The system must deliver data in a timely manner. Data delivered late are useless. In the case of video and audio, timely delivery means delivering data as they are produced, in the same order that they are produced, and without significant delay. This kind of delivery is called *real-time* transmission.

4. **Jitter**. Jitter refers to the variation in the packet arrival time. It is the uneven delay in the delivery of audio or video packets. For example, let us assume that video packets are sent every 30 ms. If some of the packets arrive with 30-ms delay and others with 40-ms delay, an uneven quality in the video is the result.

A data communications system has five components

A data communications system has five components

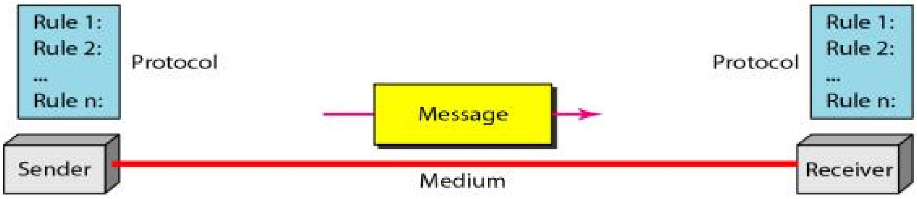
I. **Message**. The message is the information (data) to be communicated. Popular forms of information include text, numbers, pictures, audio, and video.

2 **Sender**. The sender is the device that sends the data message. It can be a computer, workstation, telephone handset, video camera, and so on.

3. **Receiver.** The receiver is the device that receives the message. It can be a computer, workstation, telephone handset, television, and so on.

4. **Transmission medium**. The transmission medium is the physical path by which a message travels from sender to receiver. Some examples of transmission media include twisted-pair wire, coaxial cable, fiber-optic cable, and radio waves.

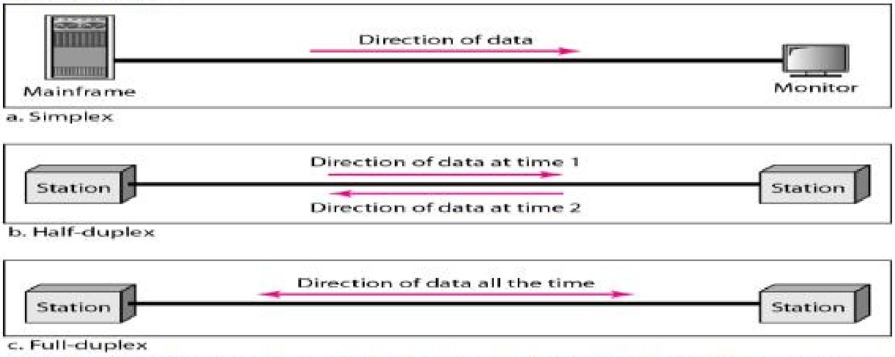
5. **Protocol.** A protocol is a set of rules that govern data communications. It represents an agreement between the communicating devices. Without a protocol, two devices may be connected but not communicating, just as a person speaking French cannot be understood by a person who speaks only Japanese.



Data Representation

Data Flow

Communication between two devices can be simplex, half-duplex, or full-duplex as shown in Figure.



Simplex In simplex mode, the communication is unidirectional, as on a one-way street. Only one of the two devices on a link can transmit; the other can only receive (Figure a). Keyboards and traditional monitors are examples of simplex devices.

Half-Duplex

In half-duplex mode, each station can both transmit and receive, but not at the same time. When one device is sending, the other can only receive, and vice versa (Figure b). Walkie-talkies and CB (citizens band) radios are both half-duplex systems.

Full-Duplex

In full-duplex, both stations can transmit and receive simultaneously (Figure c).

One common example of full-duplex communication is the telephone network. When two people are communicating by a telephone line, both can talk and listen at the same time. The full-duplex mode is used when communication in both directions is required all the time

Types of Network based on size

The types of network are classified based upon the size, the area it covers and its physical architecture. The three primary network categories are LAN, WAN and MAN. Each network differs in their characteristics such as distance, transmission speed, cables and cost.

Basic types

LAN (Local Area Network)

Group of interconnected computers within a small area. (room, building, campus)

Two or more pc's can from a LAN to share files, folders, printers, applications and other devices.

Coaxial or CAT 5 cables are normally used for connections.

Due to short distances, errors and noise are minimum.

Data transfer rate is 10 to 100 mbps.

Example: A computer lab in a school.

MAN (Metropolitan Area Network)

Design to extend over a large area.

Connecting number of LAN's to form larger network, so that resources can be shared.

Networks can be up to 5 to 50 km.

Owned by organization or individual.

Data transfer rate is low compare to LAN.

Example: Organization with different branches located in the city.

WAN (Wide Area Network)

Are country and worldwide network.

Contains multiple LAN's and MAN's.

Distinguished in terms of geographical range.

Uses satellites and microwave relays.

Data transfer rate depends upon the ISP provider and varies over the location.

Best example is the internet.

Other types

WLAN (Wireless LAN)

A LAN that uses high frequency radio waves for communication.

Provides short range connectivity with high speed data transmission.

PAN (Personal Area Network)

Network organized by the individual user for its personal use.

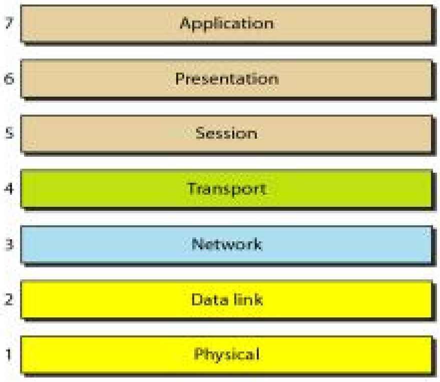
SAN (Storage Area Network)

Connects servers to data storage devices via fiber-optic cables.

E.g.: Used for daily backup of organization or a mirror copy

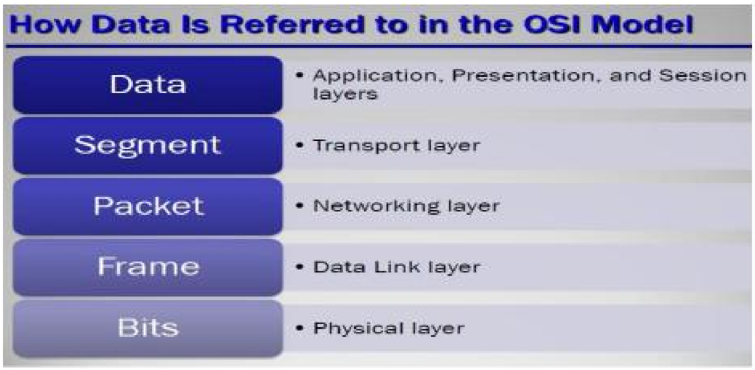
OSI

- OSI stands for Open Systems Interconnection
- Created by International Standards Organization (ISO)
- Was created as a framework and reference model to explain how different networking technologies work together and interact
- It is not a standard that networking protocols must follow
- Each layer has specific functions it is responsible for
- All layers work together in the correct order to move data around a network



7 Application
6 Presentation
5 Session
4 Transport
3 Network
2 Data link
1 Physical

Top to bottom
–All People Seem To Need Data Processing
Bottom to top
–Please Do Not Throw Sausage Pizza Away



How Data Is Referred to in the OSI Model

Data	• Application, Presentation, and Session layers
Segment	• Transport layer
Packet	• Networking layer
Frame	• Data Link layer
Bits	• Physical layer

Physical Layer

- Deals with all aspects of physically moving data from one computer to the next
- Converts data from the upper layers into 1s and 0s for transmission over media
- Defines how data is encoded onto the media to transmit the data
- Defined on this layer: Cable standards, wireless standards, and fiber optic standards.
  Copper wiring, fiber optic cable, radio frequencies, anything that can be used to transmit data is defined on the Physical layer of the OSI Model
- Device example: Hub
- Used to transmit data

Data Link Layer

- Is responsible for moving frames from node to node or computer to computer
- Can move frames from one adjacent computer to another, cannot move frames across routers
- Encapsulation = frame
- Requires MAC address or *physical address*
- Protocols defined include Ethernet Protocol and Point-to-Point Protocol (PPP)
- Device example: Switch
- Two sublayers: Logical Link Control (LLC) and the Media Access Control (MAC)
  - Logical Link Control (LLC)
    - –Data Link layer addressing, flow control, address notification, error control
  - Media Access Control (MAC)
    - –Determines which computer has access to the network media at any given time

- –Determines where one frame ends and the next one starts, called frame synchronization

Network Layer

- Responsible for moving packets (data) from one end of the network to the other, called *end-to-end communications*
- Requires *logical addresses* such as IP addresses
- Device example: Router
- –Routing is the ability of various network devices and their related software to move data packets from source to destination

Transport Layer

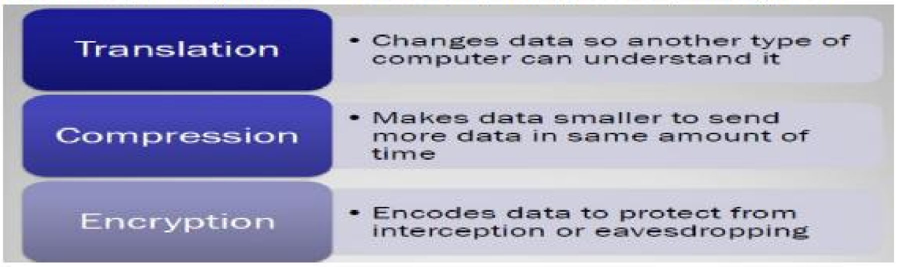
- Takes data from higher levels of OSI Model and breaks it into segments that can be sent to lower-level layers for data transmission
- Conversely, reassembles data segments into data that higher-level protocols and applications can use
- Also puts segments in correct order (called sequencing) so they can be reassembled in correct order at destination
- Concerned with the reliability of the transport of sent data
- May use a *connection-oriented protocol* such as TCP to ensure destination received segments
- May use a *connectionless protocol* such as UDP to send segments without assurance of delivery
- Uses port addressing

Session Layer

- Responsible for managing the dialog between networked devices
- Establishes, manages, and terminates connections
- Provides duplex, half-duplex, or simplex communications between devices
- Provides procedures for establishing checkpoints, adjournment, termination, and restart or recovery procedures

Presentation Layer

- Concerned with how data is presented to the network
- Handles three primary tasks: –Translation , –Compression , –Encryption



Translation
- Changes data so another type of computer can understand it

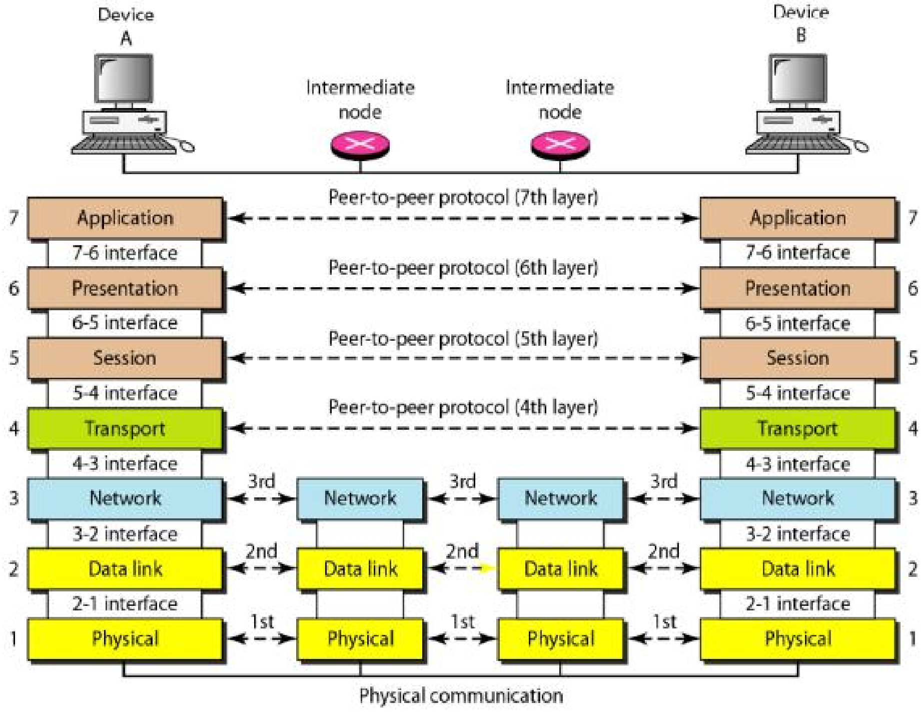
Compression
- Makes data smaller to send more data in same amount of time

Encryption
- Encodes data to protect from interception or eavesdropping

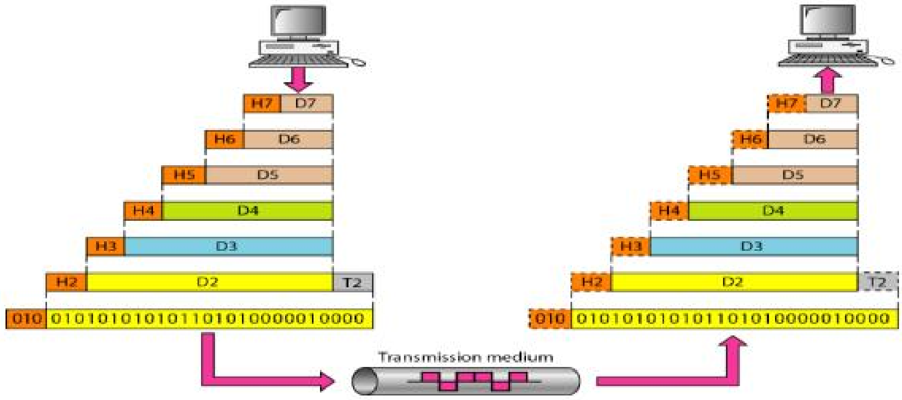
Application Layer

- Contains all services or protocols needed by application software or operating system to communicate on the network
- Examples
  - –Firefox web browser uses HTTP (Hyper-Text Transport Protocol)
  - –E-mail program may use POP3 (Post Office Protocol version 3) to read e-mails and SMTP (Simple Mail Transport Protocol) to send e-mails

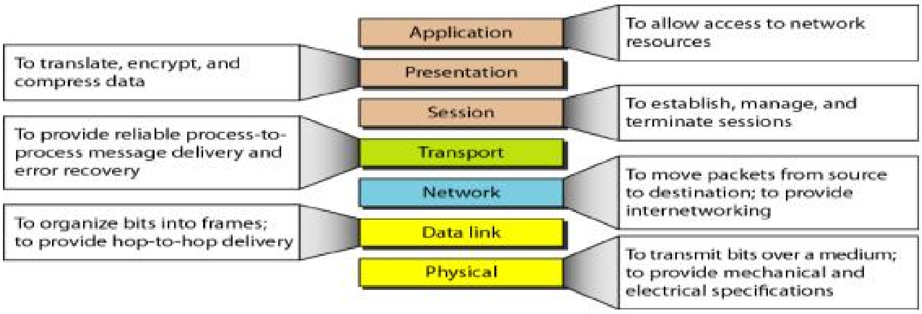
The interaction between layers in the OSI model



An exchange using the OSI model



SUMMARY:



Application: To allow access to network resources

Presentation: To translate, encrypt, and compress data

Session: To establish, manage, and terminate sessions

Transport: To provide reliable process-to-process message delivery and error recovery

Network: To move packets from source to destination; to provide internetworking

Data link: To organize bits into frames; to provide hop-to-hop delivery

Physical: To transmit bits over a medium; to provide mechanical and electrical specifications