



# PART I

## *Overview of Data Communications and Networking*

### Overview

#### Network models

#### Protocols and standards

##### Data communications

Components

Data representation

Data Flow

##### Networking

Internet

LANs and WANs

Distribution processing

Criteria

Structure

<b>Chapters</b>		
<i>Chapter 1</i>	<i>Introduction</i>	
<i>Chapter 2</i>	<i>Network Models</i>	

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<b>Chapter 1</b>		
<i><b>Introduction</b></i>		

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# 1.1 Data Communication

**Communication:**

sharing information. Sharing can be local (face to face) or remote (over distance)

**Tele communication:**

(telephone, television, telegraphy) means communication at a distance remote communication. (tele: far)

**Data communication:**

exchange of data between two devices via transmission medium (wire cable)

**Communicating devices**

made up of : H.W( physical equipments )and S.W

# 1.1 Data Communication

*Effectiveness of data communication depends on :*

•**Delivery :**

System must deliver data to **correct destination**. Data must be received by only intended device or user.

•**Accuracy:**

The system must deliver data accurately

•**Timeliness:**

the system must deliver data in a timely manner. Data delivered later are useless.

•**Jitter:**

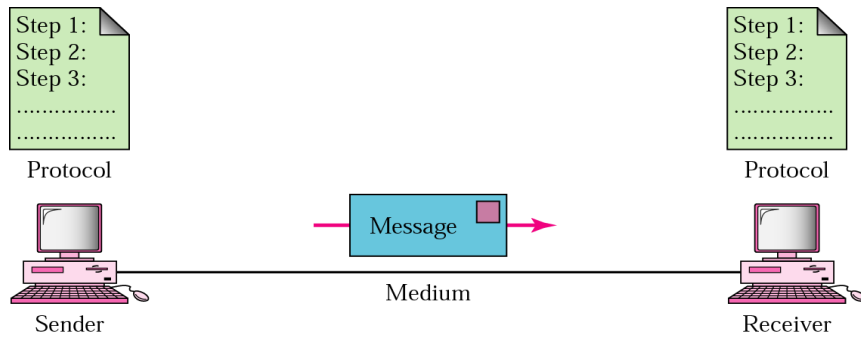
Variation in the packet arrival time. It is the uneven delay in the delivery of audio or video packets.

# 1.1 Data Communication

- Components
- Data Representation
- Direction of Data Flow

## Components

### *Five components of data communication*



**Protocol:** is a set of rules that governs data communications. It represents an **agreement** between the communicating devices. Without a protocol two devices may be connected but not communicating.

## Data representation

Text, numbers, images, audio, and video

**Text:**

- **ASCII:** 7-bit pattern (128 different symbols)
- **Extended ASCII:** 8-bit pattern (with an extra 0 at left from 00000000 to 01111111)
- **Unicode:** 32 bits pattern (65,536,216) symbols, which is definitely enough to represent any symbol in the world.

**Numbers:** represented by bit pattern (binary number)

**Images :** represented by matrix of pixels (picture element), small dot. The size of pixel represent the resolution.

**Audio:** represent sound by continuous (analog) signal

**Video:** can be analog or digital signal

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## Direction of data flow

### Simplex, half duplex and full duplex

**1. Simplex:**  
**communication is unidirectional. (one-way-street). Only one of the two devices on a link can transmit; the other can only receive**

Mainframe

Monitor

**Ex: As Keyboard (only input) and monitors only output)**

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### Direction of data flow

**2. Half duplex:**  
 Each station can both transmit and receive , **but not at the same time.**  
 When one device is sending the other can receive and vice versa. (one-lane road with two direction).

Workstation Direction of data at time 1 Workstation  
Direction of data at time 2

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### Direction of data flow

**3. Full-Duplex:**  
 Both stations can transmit and receive simultaneously. ( telephone network)  
 Like two way street with traffic flowing in both directions at the same time.

Workstation Direction of data all the time Workstation

**Signals going in either direction share the capacity of the link in two ways:**

- Either the link must contain two physically separate transmission paths one for sending and other for receiving.
- Capacity of the channel is divided between signals traveling in both direction

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## 1.2 Networks

*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.*

## 1.2 Networks

### ● Network Criteria

- Performance,
- Reliability and
- security

### ● Physical Structures

- *Type of connection*
- *physical topology*

### ● Categories of Networks


- (LAN, MAN and WAN)

# Network criteria

- 1. Performance:**  
 The performance depends on :
  1. Number of user
  2. Type of transmission media,
  3. Capabilities of connected H.W and the efficiency of software.
  
- 2. Reliability**  
 Measured by frequency of failure, the time it takes to recover from failure, and network's robustness in a catastrophe.
  
- 3. Security:** Protecting data from unauthorized access.

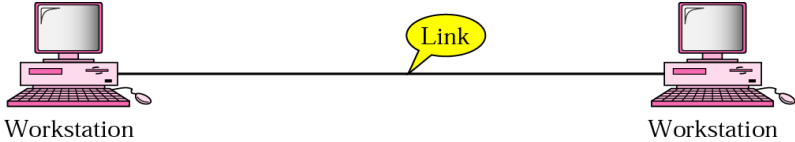
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## Physical Structures: *Type of connection*

- 1. Point -to-point**  
 Dedicated link between two devices. Most of them uses an actual length of wire or cable to connect the two ends but other options ,such as microwave satellite are possible.
 



Workstation
Workstation



Workstation
Workstation

change T.V channel by infrared remote control is point- to -point connection

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## Physical Structures: *Type of connection*

### 2. Multipoint (multidrop) connection:

more than two devices share a single line. The capacity is shared either spatially or temporally.

**Spatially:** Several devices can use link simultaneously

**Temporally:** Users take turns , it is a timeshared

The diagram illustrates a multipoint connection. On the left, a Mainframe computer is connected to a horizontal line labeled 'Link'. Three Workstations are connected to this shared link at different points along the line. Each workstation is represented by a monitor, keyboard, and mouse.

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## Physical Structures :physical topology

- The way in which a network is laid out physically. .
- It is the geometric representation of the relationship of all the links and linking devices (nods) to one another.

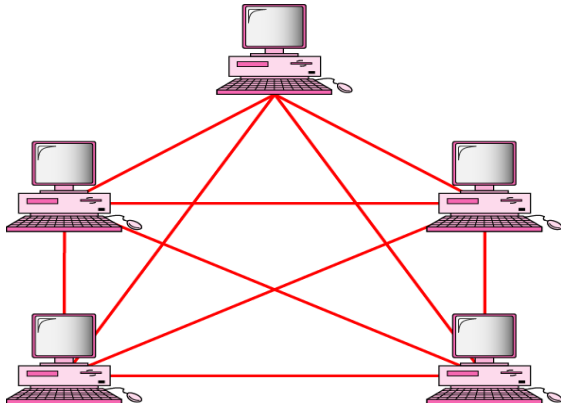
The diagram shows a hierarchical structure. At the top is a box labeled 'Topology'. A vertical line descends from this box and branches into four horizontal lines, each leading to a yellow box representing a different network topology: 'Mesh', 'Star', 'Bus', and 'Ring'.

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**Fully connected mesh topology (for five devices)**

- Every device has a dedicated point-to-point link to every other devices
- Fully connected mesh network has  $n(n-1)/2$  physical connection to link  $n$  devices.
- Every device on the network must have  $n-1$  input/output (I/O) ports



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## Mesh topology

**Advantages:**

- **Privacy or security** (every message travels along a dedicated line, only the intended recipient sees it. Physical boundaries prevents other user from gaining access the message)
- **eliminating the traffic problems** The use of dedicated links guarantees that each connection can carry its own data load; that can occur when links must be shared by multiple devices.
- **A mesh is robust.** If one link becomes unusable, it does not incapacitate the entire system.
- **Fault identification and fault isolation** easy. This enables the network manager to discover the precise location of fault and aids in finding its cause and solution.

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## Mesh topology

### Disadvantages

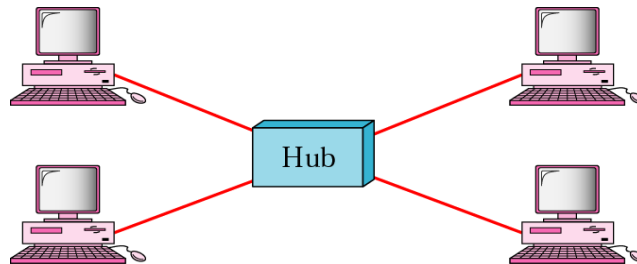
**Related to the amount of cabling devices and the amount of I/O ports required:**

- Every device must be connected to every other device, *installation and reconnection are difficult*
- The sheer bulk of the wiring can be greater than the available space can accommodate.
- The H.W required to connect each link (I/O ports and cable) expensive.

**So a mesh topology is usually implemented in a limited fashion( as a backbone connecting the main computers of a hybrid network that can include several other topology**

## Star topology

- Each device has a dedicated point-to-point link only to a **central controller (hub)**
- Unlike a mesh , a star topology **does not allow direct traffic** between devices, if one device want to send data to another , it send it to the hub, which send it to other device



## Star topology

### Advantages

#### 1. Easy to install and reconfigure and less expensive

- each device need only one link and I/O port to connect it to any other devices.)

#### 2. *Robustness:*

- if one link fails, only that link affected and other links remain active.

#### 3. *identification and fault isolation*

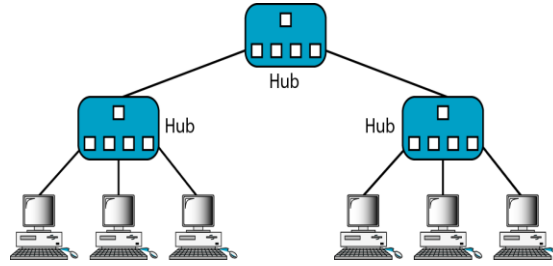
## Star topology

### Disadvantages

- The dependency of the whole topology on one single point, the hub.

***If the hub goes down, the whole system is dead.***

## Tree topology : Is a variation of star



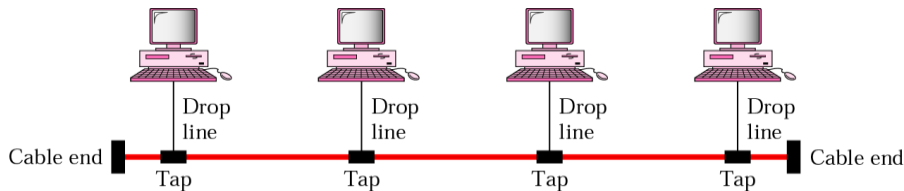
Not every device plugs directly into the central hub. The majority of devices connect to **secondary hub** that in turn is connected to the central hub

**The advantages and disadvantages** of tree topology are generally **the same as those of star**. The addition of secondary hubs bring more advantage:

- Allow more devices to be attached to a single central hub, therefore increase the distance a signal can travel between devices.
- **Example of tree** : Cable TV technology where the main cable from the main office is divided into main branches and each branch divided into smaller branches and so on.

## Bus topology

• **Multipoint connection.** Acts as a backbone to link all the devices in a network.



**There is a limit on the number of taps a bus can support and on the distance between those taps**

As a signal travels along the backbone, some of its energy is transformed into heat, therefore, it becomes weaker and weaker as it has travel farther and farther

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## Bus topology

### Advantages

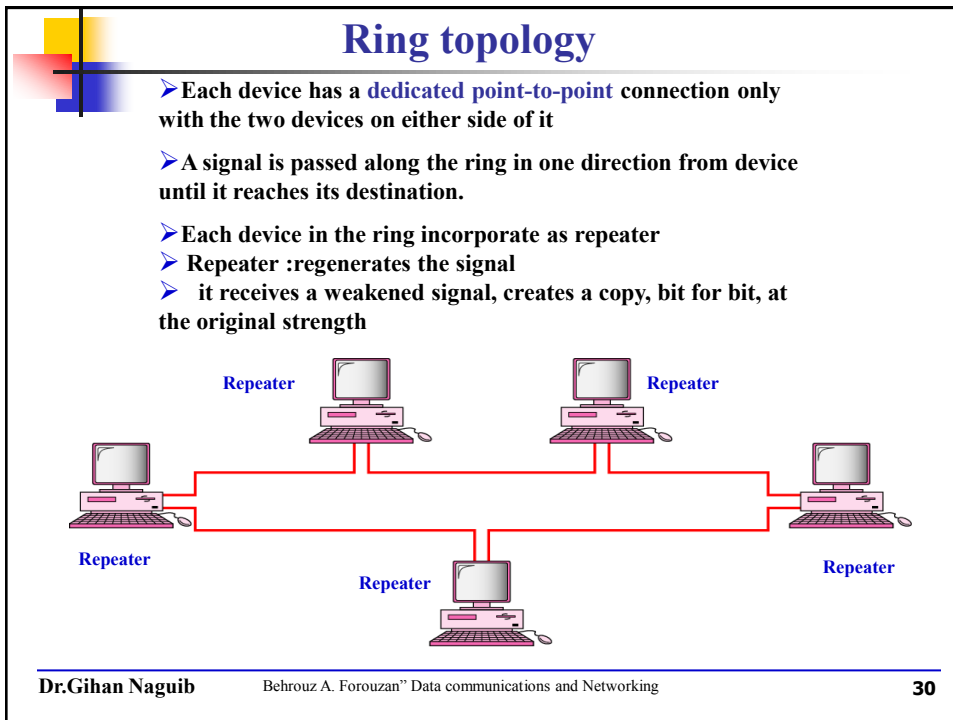
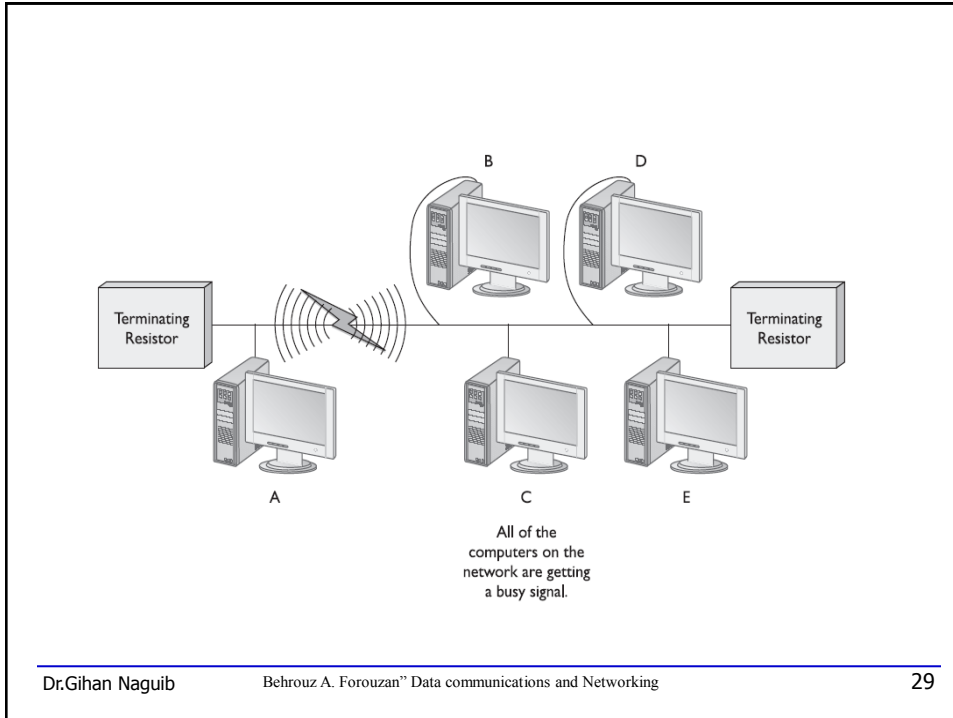
**Easy of insulation, use less cabling than mesh or star**

### Disadvantages

*Include difficult of reconnection and fault isolation*

- 1. Fault**  
A fault in bus cable (break) stops all transmissions even between devices on the same side of the problem. The damaged area reflects signals back the direction of origin, creating noise in both directions
- 2. Reconnection**  
**It can difficult to add new devices (adding more require modification or replacement of the backbone).**

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## Ring topology

### Advantages:

- **Easy to install and reconfigure.**

Each device is linked only to its immediate neighbors. To add or delete a device requires hanging only 2 connections

- **Fault isolation is simplified :**

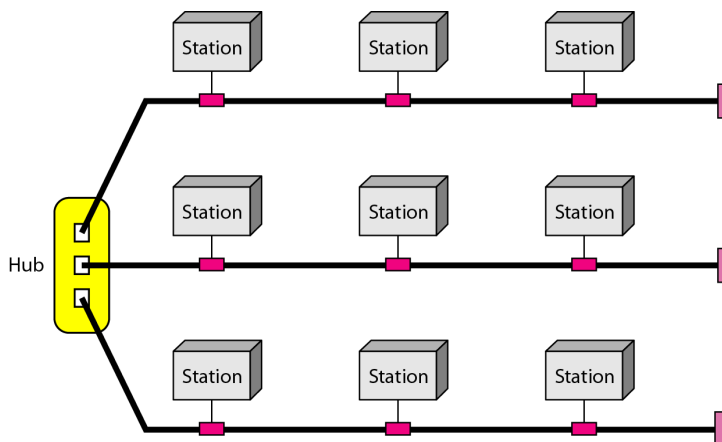
A signal is circulating at all times (token) if one device does not receive a signal within specified period, it can issue an alarm. The alarm alerts the network operator to the problem and its location

### Disadvantages

- **Unidirectional traffic.**

**A break in the ring (such as disabled station) can disable the entire network.** This can be solved by use **dual ring**

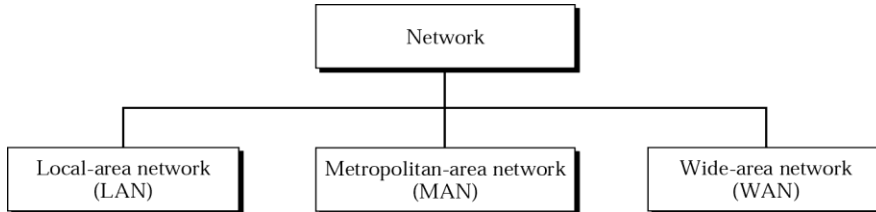
### *A hybrid topology: a star backbone with three bus networks*





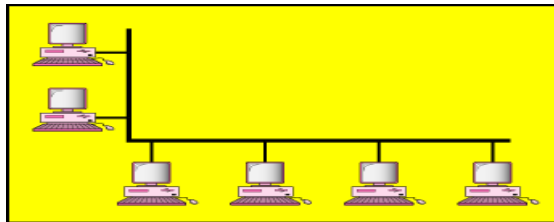
## Networks categories

Network category is determined by its **size, ownership, the distance it cover** and its **physical architecture**.



## Single building LAN

- Used in business environments, links a workgroup of task-related computer.



a. Single-building LAN

*Multiple -building -LAN*

Backbone

b. Multiple-building LAN

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## LAN

- Privately owned and links the devices in a single office, building or campus
- LANs designed to allow resources to be shared between PCs or workstations. The resources may be H.W (e.g. printer) or S.W( applications program) or data.
- In LANs one of the computers has a large capacity drive and becomes a server to other clients.
- S/W stored on server and used as needed by the whole group.
- LAN size determined by licensing restrictions( No of users per copy of S/W)
- LAN use only one type of transmission medium.
- The most common LAN topologies are bus, ring and star.
- Traditionally LAN have data rates in the 4 to 16 Mbps. Today Speed can reach to 100Mbps or 1000MBps(1G).

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## MAN (metropolitan)

- Owned by private company or it may be a service provided by public company ( such as local tel.-company)
- Extended over an entire city.
- May be single network such as a cable television network, or it may be connected number of LANs into a large network so that resources may be shared LAN-TO- LAN.

**Examples:**

- Company can use MAN to connect the LANs in all its offices throughout the city.
- A part of the telephone line network that can provide DSL line to the customer

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## MAN

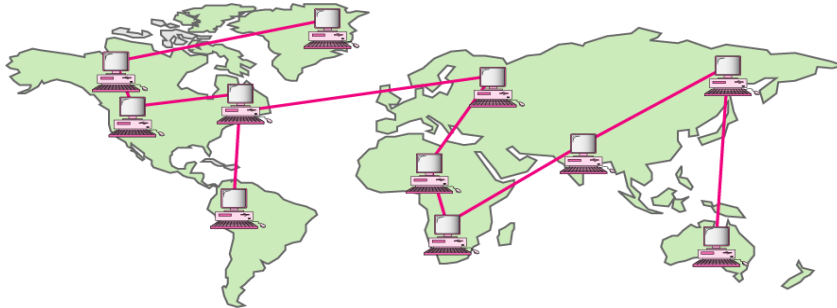
Public city network

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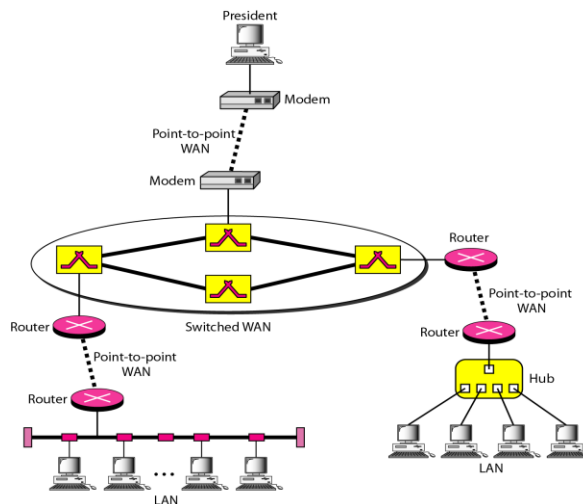
# WAN

- Provides long distance transmission of data, voice , image and video information over large areas ( country or whole world)
- In contrast to LAN, WAN may utilize public or private communication equipments or combination



## Interconnections of networks :internetwork

An internet (small i) is two or more networks that can communicate with each other.



## The Internet

- Internet is a collaboration of more than 100 of 1000 interconnected network.

### Brief History ( self-reading)

- In mid of 1960.:

The Advanced Research Projects Agency (ARPA) in the department of defense was interested in finding a way to connect computers so that the researchers they funded could share their findings, to reduce costs and eliminating duplication of effort.

## Brief history

- In 1967

ARPA presented its ideas for ARPANET, small network of connected computers (mainframe).

- In 1969,

ARPANET was reality. Four nodes at the UNV. Of California,(at los angles and Santa Barba), univ. of utah and SRI (Stand ford Research Institute connected via IMPs computers to form a network. Software called Network Control Protocol (NCP) provided communication between the hosts.

## Brief history

In 1972,

- Protocol to achieve end -to-end delivery of packets, **T**ransmission **C**ontrol **P**rotocol (**TCP**).
- Authorities made decision to split **TCP** into two protocols:
  - **IP**: Internetworking protocol to handle datagram routing and
  - **TCP**: responsible for higher-level-functions such as error detection, segmentation and reassembly.

### Internet today

Made up of many wide and local area networks joined by connecting devices and switching stations. Today most end users use the *services of internet service providers (ISPs)*.

## Protocols and Standards

Protocols

Standards

Standards Organization

## Protocols

Set of rules that governs data communications.

Protocol defines :

- What is communicated?
- How it communicated?
- When it is communicated?

•Key elements of a protocol: **Syntax, semantics and timing**

### •Syntax:

- Structure or format of the data, meaning the order in which they are presented.

Example:

A simple protocol might expect the **first** byte of data to be the address of the sender, the **second** byte to be the address of the receiver and the **reset** of the stream to be the message itself.

## Protocols

### Semantics:

- Refers to the meaning of each section of bits.

### • Example:

does an address identify the route to be taken or the final destination of the message.

### •Timing:

- When data to should be sent?
- How fast they can be sent?

Example:

If a sender produces data at 100Mbps but the receiver can process data at only 1Mbps, transmission will overload the receiver and data will be largely lost.

## Standers

Provide guidelines to manufactures, vendors, government agencies and other service provides to ensure the kind of interconnectivity necessary in today's marketplace and international communication.

Two categories:

1. **De fact:**

Have been adopted as standers through widespread use .Established by manufacturers that define the functionality of a new product or technology

2. **De jure:**

officially recognized body.

## Standers Organization

1. **International Organization for Standardization (ISO)**

- Multinational body
- OSI

2. **International Telecommunication Union Telecommunication standard sector (ITU-T)**

- devoted to the research of standards for telecommunication in general and for phone and data system in particular
- **Data transmission over telephone line Modems standards :V- series( V32, V34,V90)**
- **X-series:** data transmission over public digital network (e-mail)



## Standers Organization

### 3. American National Standards Institute (ANSI)

- completely private, nonprofit corporation

### 4. Institute of Electrical and Electronics Engineers (IEEE)

- International in scope
- In the fields of electrical engineering, electronics and all related branches of engineering
- International standards for computing and communications  
LAN (project 802): IEEE Ethernet 802.3

### 5. Electronic Industries Association (EIA)

- Field of Information Technology (SONET)