Introduction to Data Communication and Computer Networks

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MCA – 1 Sem – I
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Course Content

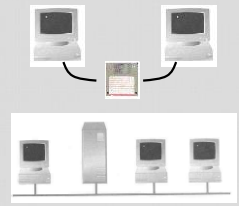
Sr. No.	Topics Details	Weightage in %	No of Sessions
1	Introduction to Data Communication and Computer Networks 1.1 Internet basics and network components. [Transmission Media-Guided, Unguided, Network Devices] 1.2 Various types of Networks (only overview) 1.2.1 Connection Oriented N/ Ws Vs Connectionless N/Ws, 1.2.2 Ethernet- Ethernet standards ZigBee, WiFi, Access Technique -CSMA-CD, Negotiation technique Overview 1.2.3. Wireless Network 1.3 Unified Communication –VOIP Extra Reading: Switching Techniques, CSMA/CA, CSMA/CD, Unified Communication	6	3

What is a Network?

A network consists of 2 or more computers/devices connected together, and they can communicate and share resources (e.g. information)

Why Networking?

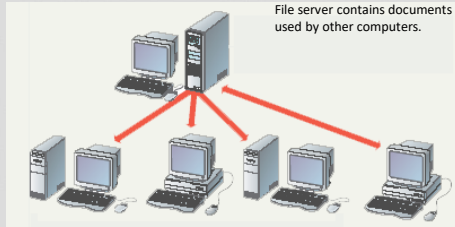
- **Sharing information — i.e. data communication**
  - **Do you prefer these?**
  - **Or this?**



- Simultaneous access to data
  - Data files are shared
    - Access can be limited
  - Shared files stored on a server
  - Software can be shared
    - Site licenses
    - Network versions
    - Application servers

Uses of Network

Sharing Data

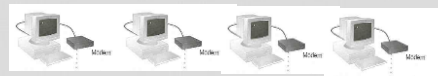


- Sharing of peripheral device
  - Printers and faxes are common shares
  - Reduces the cost per user
  - Devices can be connected to the network
  - Print servers control network printing
    - Manage the print queue

The Uses of a Network

- **Sharing hardware or software**
  - **E.g. print document**

- **Centralize administration and support**
  - **E.g. Internet-based, so everyone can access the same administrative or support application from their PCs**



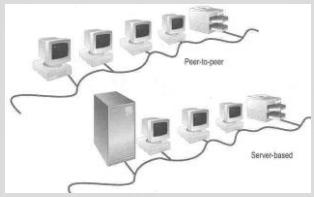
- Personal communication
  - Email
    - Instantaneous communication
  - Conferencing
    - Tele conferencing
    - Videoconferencing
    - Audio-conferencing
    - Data-conferencing
  - Voice over IP
    - Phone communication over network wires

The Uses of a Network

How many kinds of Networks?

- Depending on one's perspective, we can classify networks in different ways
  - Based on transmission media: Wired (UTP, coaxial cables, fiber-optic cables) and Wireless
  - Based on network size: LAN and WAN (and MAN)
  - Based on management method: Peer-to-peer and Client/Server
  - Based on topology (connectivity): Bus, Star, Ring …
    :
    :

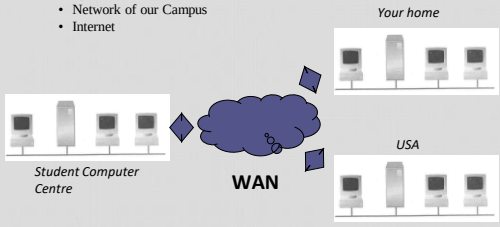
Based on Management Type of Network



LAN and WAN

- Local Area Network (LAN)
  - Small network, short distance
    - A room, a floor, a building
    - Limited by no. of computers and distance covered
    - Usually one kind of technology throughout the LAN
    - Serve a department within an organization
  - Examples:
    - Network inside the Student Computer Room
    - Network inside CF502
    - Network inside your home

- **Wide Area Network (WAN)**
  - A network that uses long-range telecommunication links to connect 2 or more LANs/computers housed in different places far apart.
    - Towns, states, countries
  - Examples:
    - Network of our Campus
    - Internet



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- **Example WAN technologies:**
  - ISDN – **Integrated Service Digital Network**
    - **Basic rate: 192 Kbps Primary rate: 1.544Mbps**
  - T-Carriers — **basically digital phone lines**
    - **T1: 1.544Mbps T3: 28×T1**
  - Frame relay
    - **Each link offers 1.544Mbps or even higher**
  - ATM – **Asynchronous Transfer Mode**
    - **Support B-ISDN: 155Mbps or 622Mbps or higher**
  - SONET – **Synchronous Optical Network**
    - **Basic rate OC1: 51.84Mbps**
    - **Support OC12 and up to OC192 (9953.28Mbps) or even higher in the future**

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- **Example of WAN: Broadband Cable Network**
  - Cable TV services have been extensively developed in most modern cities
  - Cable TV companies try to make use of their coaxial cable installed (that are supposed to carry TV signals) to deliver broadband data services
  - Many cable network wiring has been replaced with hybrid fiber-coax (HFC) — i.e. use of fiber-optic cable to connect to the subscribers' buildings, and then the original coaxial cable to connect to each household

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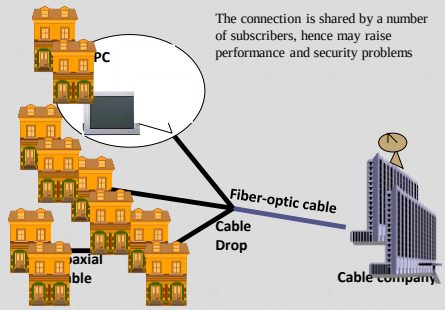

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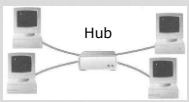
Topology — 3 basic types

- How so many computers are connected together?

Bus Topology

Ring Topology

Star Topology



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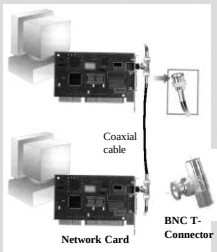
How to construct a network with Bus Topology?

- Bus Topology
  - Simple and low-cost
  - A single cable called a trunk (backbone, segment)
  - Only one computer can send messages at a time
  - Passive topology - computer only listen, do not regenerate data



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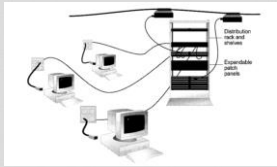
How to construct a network with Star Topology?

- Star Topology

- Each computer has a cable connected to a single point
- More cabling, hence higher cost
- All signals transmission through the hub; if down, entire network down
- Depending on the intelligence of hub, two or more computers may send message at the same time



Star Topology

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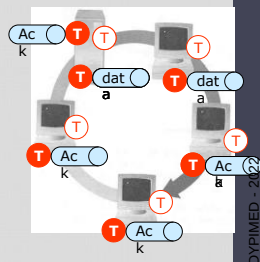
How to construct a network with Ring Topology?

- Ring Topology
  - Every computer serves as a repeater to boost signals
  - Typical way to send data:
    - Token passing
      - only the computer who gets the token can send data
  - Disadvantages
    - Difficult to add computers
    - More expensive
    - If one computer fails, whole network fails



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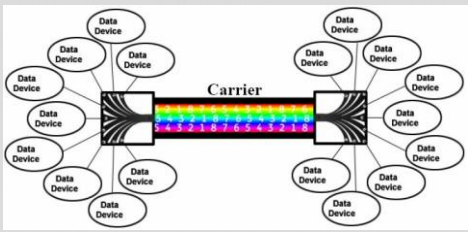
Multiplexing and De-multiplexing (Channelization)



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The Concept of Multiplexing

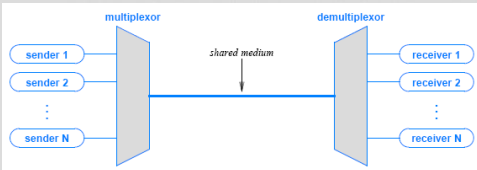

Figure 11.1 The concept of multiplexing in which independent pairs of senders and receivers share a transmission medium.

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11.2 The Concept of Multiplexing

- Multiplexing to refer to the combination of information streams from multiple sources for transmission over a ***shared medium***
  - Multiplexor is a mechanism that implements the concept
- De-multiplexing to refer to the separation of a combination back into separate information streams
  - De-multiplexor to refer to a mechanism that implements the concept
- Figure 11.1 illustrates the concept
  - each sender communicates with a single receiver
  - all pairs share a single transmission medium
  - multiplexor combines information from the senders for transmission in such a way that the de-multiplexor can separate the information for receivers

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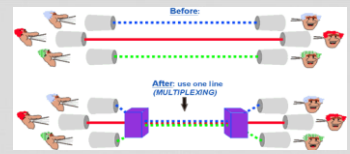
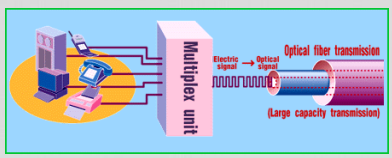
Main purpose is ?





Multiplexing in networks

Sharing the medium?

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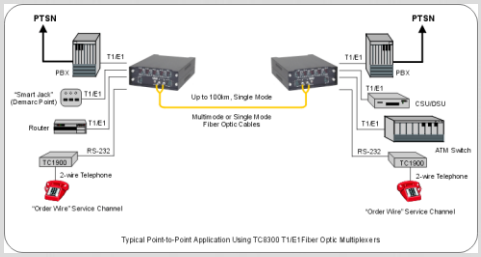

Typical Point-to-Point Application Using TC8300 T1/E1 Fiber Optic Multiplexers

Multiplexer example

The Basic Types of Multiplexing

- There are four basic approaches to multiplexing that each have a set of variations and implementations
  - Frequency Division Multiplexing (FDM)
  - Wavelength Division Multiplexing (WDM)
  - Time Division Multiplexing (TDM)
  - Code Division Multiplexing (CDM)
- TDM and FDM are widely used
- WDM is a form of FDM used for optical fiber
- CDM is a mathematical approach used in cell phone mechanisms

In telecommunications, **frequency-division multiplexing (FDM)** is a technique by which the total bandwidth) is a technique by which the total bandwidth available in a communication medium) is a technique by which the total bandwidth available in a communication medium is divided into a series of non-overlapping frequency) is a technique by which the total bandwidth available in a communication medium is divided into a series of non-overlapping frequency sub-bands, each of which is used to carry a separate signal. This allows a single transmission medium such as the radio spectrum) is a technique by which the total bandwidth available in a communication medium is divided into a series of non-overlapping frequency sub-bands, each of which is used to carry a separate signal. This allows a single transmission medium such as the radio spectrum, a cable or optical fiber to be shared by multiple independent signals. Another use is to carry separate serial bits or segments of a higher rate signal in parallel.

FDM – Frequency Div. Multiplexing

Frequency Division Multiplexing

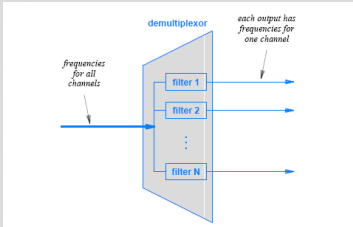

Figure 11.2 Illustration of the basic FDM demultiplexing where a set of filters each selects the frequencies for one channel and suppresses other frequencies.

11.4 Frequency Division Multiplexing

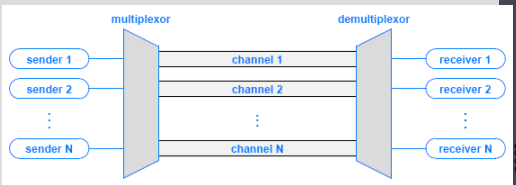

Figure 11.3 The conceptual view of Frequency Division Multiplexing (FDM) as providing a set of independent channels.

Wavelength Division Multiplexing (WDM)

- WDM refers to the application of FDM to optical fiber
  - some sources use the term Dense WDM (DWDM) to emphasize that many wavelengths of light can be employed
- The inputs and outputs of such multiplexing are wavelengths of light
  - denoted by the Greek letter λ, and informally called colors
- When white light passes through a prism
  - colors of the spectrum are spread out
- If a set of colored light beams are each directed into a prism at the correct angle
  - the prism will combine the beams to form a single beam of white light

Wavelength Division Multiplexing

- Prisms form the basis of optical multiplexing and demultiplexing
  - a multiplexor accepts beams of light of various wavelengths and uses a prism to combine them into a single beam
  - a demultiplexor uses a prism to separate the wavelengths.

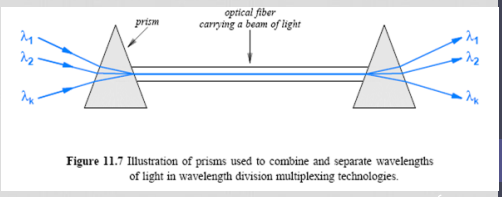

Figure 11.7 Illustration of prisms used to combine and separate wavelengths of light in wavelength division multiplexing technologies.

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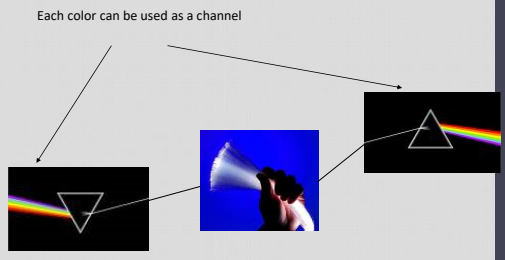

WDM

Today's DWDM systems use 50 GHz or even 25 GHz channel spacing for up to 160 channel operation.

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- **Time-division multiplexing (TDM)**

is a method of transmitting and receiving independent signals over a common signal path by means of synchronized switches at each end of the transmission line so that each signal appears on the line only a fraction of time in an alternating pattern. It is used when the data rate of the transmission medium exceeds that of signal to be transmitted. This form of signal multiplexing is a method of transmitting and receiving independent signals over a common signal path by means of synchronized switches at each end of the transmission line so that each signal appears on the line only a fraction of time in an alternating pattern. It is used when the data rate of the transmission medium exceeds that of signal to be transmitted. This form of signal multiplexing was developed in telecommunications for telegraphy is a method of transmitting and receiving independent signals over a common signal path by means of synchronized switches at each end of the transmission line so that each signal appears on the line only a fraction of time in an alternating pattern. It is used when the data rate of the transmission medium exceeds that of signal to be transmitted. This form of signal multiplexing was developed in telecommunications for telegraphy systems in the late 19th century, but found its most common application in digital telephony in the second half of the 20th century.

TDM

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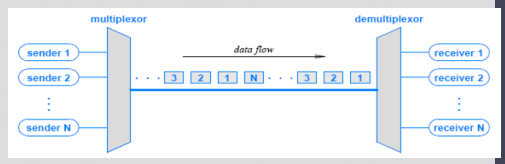
Time Division Multiplexing (TDM)

- TDM assigns time slots to each channel repeatedly
  - multiplexing in time simply means transmitting an item from one source, then transmitting an item from another source, and so on
- Figure 11.8 (below) illustrates the concept



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Synchronous TDM

- TDM is a broad concept that appears in many forms
  - It is widely used throughout the Internet
- Figure 11.8 is a conceptual view, and the details may vary
- Figure shows items being sent in a round-robin fashion
  - Most TDMs work this way
  - Figure shows a slight gap between items
  - Recall from Chapter 9 that no gap occurs between bits if a communication system uses synchronous transmission
  - When TDM is applied to synchronous networks, no gap occurs between items; the result is known as Synchronous TDM
- Figure 11.9 illustrates how synchronous TDM works for a system of four senders

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Code Division Multiplexing (CDM)

- CDM used in parts of the cellular telephone system and for some satellite communication
  - The specific version of CDM used in cell phones is known as Code Division Multi-Access (CDMA)
- CDM does not rely on physical properties
  - such as frequency or time
- CDM relies on an interesting mathematical idea
  - values from orthogonal vector spaces can be combined and separated without interference
- Each sender is assigned a unique binary code C_i
  - that is known as a chip sequence
  - chip sequences are selected to be orthogonal vectors
  - (i.e., the dot product of any two chip sequences is zero)

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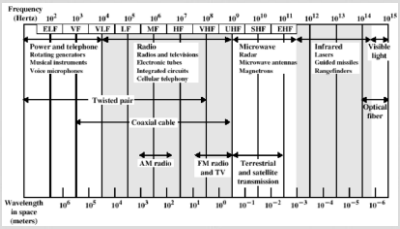
- Conducted or guided media
  - use a conductor such as a wire or a fiber optic cable to move the signal from sender to receiver
- Wireless or unguided media
  - use radio waves of different frequencies and do not need a wire or cable conductor to transmit signals

Classes of Transmission Media

- Bandwidth: All other factors remaining constant, the greater the band-width of a signal, the higher the data rate that can be achieved.
- Transmission impairments. Limit the distance a signal can travel.
- Interference: Competing signals in overlapping frequency bands can distort or wipe out a signal.
- Number of receivers: Each attachment introduces some attenuation and distortion, limiting distance and/or data rate.

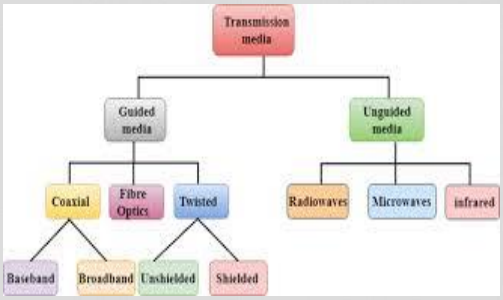
Design Factors for Transmission Media

Electromagnetic Spectrum for Transmission Media



...ve length	Frequency Designations	Transmission Media	Propagation Modes	Representative Applications	Frequency
...m	Extra High Frequency (EHF)	Wave guide		Satellite, Microwave relay, Earth-satellite radar.	100 GHz
...cm	Super High Frequency (SHF)		Line-of-sight radio		10 GHz
...	Ultra High Frequency (UHF)			Wireless comm. service, Cellular, pagers, UHF TV	1 GHz
...n	Very High Frequency (VHF)	Coaxial Cable	Sky wave radio	Mobile, Aeronautical, VHF TV and FM, mobile radio	100 MHz
...0m	High Frequency (HF)			Amateur radio, Civil Defense	10 MHz
...m	Medium High Frequency (MF)		Ground wave radio	AM broadcasting	1 MHz
...km	Low Frequency (LF)	Wire pairs		Aeronautical, Submarine cable, Navigation, Transoceanic radio	100 kHz
...0km	Very Low Frequency (VLF)				10 kHz

Transmission Media

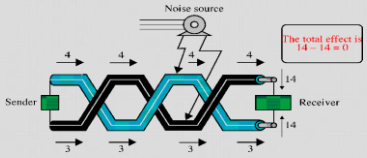


- Transmission capacity depends on the distance and on whether the medium is point-to-point or multipoint
- Examples
  - twisted pair wires
  - coaxial cables
  - optical fiber

Guided Transmission Media

Twisted-Pair Cables

- **If the pair of wires are not twisted, electromagnetic noises from, e.g., motors, will affect the closer wire more than the further one, thereby causing errors**



- **Applications of Twisted-Pair Cables**

✓In telephone lines
✓In DSL lines
✓In LANs (Ethernet)
✓Security Camera's

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- Consists of two insulated copper wires arranged in a regular spiral pattern to minimize the electromagnetic interference between adjacent pairs
- Often used at customer facilities and also over distances to carry voice as well as data communications
- Low frequency transmission medium

Twisted Pair Wires

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- STP (shielded twisted pair)
  - the pair is wrapped with metallic foil or braid to insulate the pair from electromagnetic interference
- UTP (unshielded twisted pair)
  - each wire is insulated with plastic wrap, but the pair is encased in an outer covering

Types of Twisted Pair

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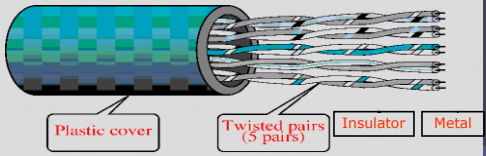
Unshielded Twisted-Pair (UTP)

- **Typically wrapped inside a plastic cover (for mechanical protection)**
- **A sample UTP cable with 5 unshielded twisted pairs of wires**



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Unshielded Twisted Pair:

An unshielded twisted pair is widely used in telecommunication. Following are the categories of the unshielded twisted pair cable:

Category 1: Category 1 is used for telephone lines that have low-speed data.
Category 2: It can support upto 4Mbps.
Category 3: It can support upto 16Mbps.
Category 4: It can support upto 20Mbps. Therefore, it can be used for long-distance communication.
Category 5: It can support upto 200Mbps.

- **Advantages Of Unshielded Twisted Pair:**

It is cheap.
Installation of the unshielded twisted pair is easy.
It can be used for high-speed LAN.

- **Disadvantage:**

This cable can only be used for shorter distances because of attenuation.
Speed is low

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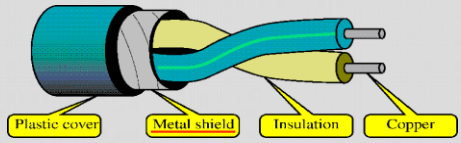
Shielded Twisted-Pair (STP)

- **STP cables are similar to UTP cables, except there is a metal foil or braided-metal-mesh cover that encases each pair of insulated wires**



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Shielded Twisted Pair

A shielded twisted pair is a cable that contains the mesh surrounding the wire that allows the higher transmission rate.

Characteristics Of Shielded Twisted Pair:

✓The cost of the shielded twisted pair cable is not very high and not very low.
✓An installation of STP is easy.
✓It has higher capacity as compared to unshielded twisted pair cable.
✓It has a higher attenuation.
✓It is shielded that provides the higher data transmission rate.

Disadvantages

✓It is more expensive as compared to UTP and coaxial cable.
✓It has a higher attenuation rate.

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- Used for cable television, LANs, telephony
- Has an inner conductor surrounded by a braided mesh
- Both conductors share a common center axial, hence the term "co-axial"
- Coaxial cable is very commonly used transmission media, for example, TV cable wire is usually a coaxial cable.
- The name of the cable is coaxial as it contains two conductors parallel to each other.
- It has a higher frequency as compared to Twisted pair cable.

Coaxial Cable (or Coax)

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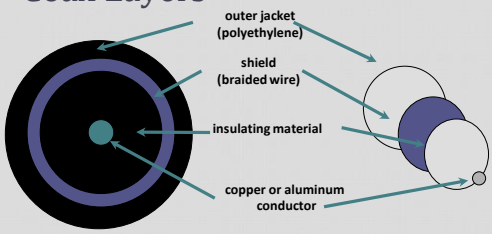
Coax Layers



- The inner conductor of the coaxial cable is made up of copper, and the outer conductor is made up of copper mesh. The middle core is made up of non-conductive cover that separates the inner conductor from the outer conductor.

- The middle core is responsible for the data transferring whereas the copper mesh prevents from the **EMI**(Electromagnetic interference).

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Coaxial cable is of two types:

- **Baseband transmission:** It is defined as the process of transmitting a single signal at high speed.
- **Broadband transmission:** It is defined as the process of transmitting multiple signals simultaneously.

- Higher bandwidth, so the data can be transmitted at high speed
  - 400 to 600Mhz
  - up to 10,800 voice conversations
- It has better shielding as compared to twisted pair cable.
- Can be tapped easily (pros and cons)
- Much less susceptible to interference than twisted pair

Coax Advantages

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- High attenuation rate makes it expensive over long distance
- Bulky
- It is more expensive as compared to twisted pair cable.
- If any fault occurs in the cable causes the failure in the entire network.

Coax Disadvantages

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- Relatively new transmission medium used by telephone companies in place of long-distance trunk lines
- Also used by private companies in implementing local data communications networks
- Require a light source with injection laser diode (ILD) or light-emitting diodes (LED)

Fiber Optic Cable

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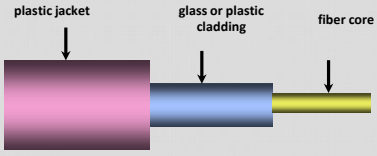
- consists of three concentric sections



Fiber Optic Layers

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- multimode step-index fiber
  - the reflective walls of the fiber move the light pulses to the receiver
- multimode graded-index fiber
  - acts to refract the light toward the center of the fiber by variations in the density
- single mode fiber
  - the light is guided down the center of an extremely narrow core

Fiber Optic Types

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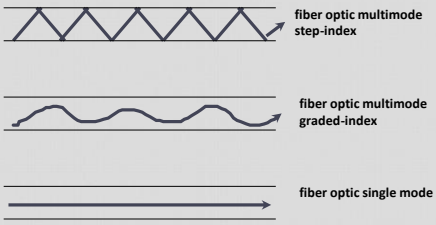

Fiber Optic Signals

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- **Basic elements of Fibre optic cable:**
- **Core:** The optical fibre consists of a narrow strand of glass or plastic known as a core. A core is a light transmission area of the fibre. The more the area of the core, the more light will be transmitted into the fibre.
- **Cladding:** The concentric layer of glass is known as cladding. The main functionality of the cladding is to provide the lower refractive index at the core interface as to cause the reflection within the core so that the light waves are transmitted through the fibre.
- **Jacket:** The protective coating consisting of plastic is known as a jacket. The main purpose of a jacket is to preserve the fibre strength, absorb shock and extra fibre protection.

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- greater capacity (bandwidth of up to 2 Gbps)
- smaller size and lighter weight
- lower attenuation
- immunity to environmental interference
- highly secure due to tap difficulty and lack of signal radiation

Greater Bandwidth: The fibre optic cable provides more bandwidth as compared copper. Therefore, the fibre optic carries more data as compared to copper cable.
Faster speed: Fibre optic cable carries the data in the form of light. This allows the fibre optic cable to carry the signals at a higher speed.
Longer distances: The fibre optic cable carries the data at a longer distance as compared to copper cable.
Better reliability: The fibre optic cable is more reliable than the copper cable as it is immune to any temperature changes while it can cause obstruct in the connectivity of copper cable.
Thinner and Sturdier: Fibre optic cable is thinner and lighter in weight so it can withstand more pull pressure than copper cable.

Fiber Optic Advantages

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- expensive over short distance
- requires highly skilled installers
- adding additional nodes is difficult

Fiber Optic Disadvantages

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- Transmission and Reception are achieved by means of an antenna
- directional
  - transmitting antenna puts out focused beam
  - transmitter and receiver must be aligned
- omnidirectional
  - signal spreads out in all directions
  - can be received by many antennas

Wireless (Unguided Media) Transmission

- Terrestrial microwave
- Satellite microwave
- Broadcast radio
- Infrared

Wireless Examples

- used for long-distance telephone service
- uses radio frequency spectrum, from 2 to 40 Ghz
- parabolic dish transmitter, mounted high
- used by common carriers as well as private networks
- requires unobstructed line of sight between source and receiver
- curvature of the earth requires stations (repeaters) ~30 miles apart

Terrestrial Microwave

- Television distribution
- Long-distance telephone transmission
- Private business networks

Satellite Microwave Applications

- line of sight requirement
- expensive towers and repeaters
- subject to interference such as passing airplanes and rain

Microwave Transmission Disadvantages

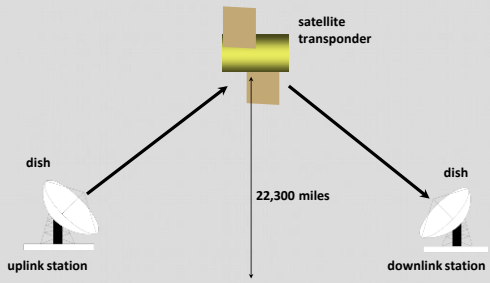
- a microwave relay station in space
- can relay signals over long distances
- geostationary satellites
  - remain above the equator at a height of 22,300 miles (geosynchronous orbit)
  - travel around the earth in exactly the time the earth takes to rotate

Satellite Microwave Transmission

- earth stations communicate by sending signals to the satellite on an uplink
- the satellite then repeats those signals on a downlink
- the broadcast nature of the downlink makes it attractive for services such as the distribution of television programming

Satellite Transmission Links

Satellite Transmission Process



- television distribution
  - a network provides programming from a central location
  - direct broadcast satellite (DBS)
- long-distance telephone transmission
  - high-usage international trunks
- private business networks

Satellite Transmission Applications

- C band: 4(downlink) - 6(uplink) GHz
  - the first to be designated
- Ku band: 12(downlink) -14(uplink) GHz
  - rain interference is the major problem
- Ka band: 19(downlink) - 29(uplink) GHz
  - equipment needed to use the band is still very expensive

Principal Satellite Transmission Bands

Fiber vs Satellite

Table 7.6 A Comparison of Optical Fiber and Satellite Transmission

Characteritic	Optical Fiber	Satellite
Bandwidth	Theoretical limit of 1 terahertz; currently 1–10 GHz	Typical transponder has a bandwidth of 36–72 MHz
Immunity to interference	Immune to electromagnetic interference	Subject to interference from various sources, including microwave
Security	Difficult to tap without detection	Signals must be encrypted for security
Multipoint capability	Primarily a point-to-point medium	Point-to-multipoint communications easily implemented
Flexibility	Difficult to reconfigure to meet changing demand	Easy to reconfigure
Connectivity to customer site	Local loop required	With antenna installed on customer premises, local loop not required

- radio is omnidirectional and microwave is directional
- Radio is a general term often used to encompass frequencies in the range 3 kHz to 300 GHz.
- Mobile telephony occupies several frequency bands just under 1 GHz.

Radio

- Uses transmitters/receivers (transceivers) that modulate noncoherent infrared light.
- Transceivers must be within line of sight of each other (directly or via reflection).
- Unlike microwaves, infrared does not penetrate walls.

Infrared

Advantages and Disadvantages

☺Noise resistance — external light is blocked by outer jacket

☺Less signal attenuation — a signal can run for miles without regeneration (currently, the lowest measured loss is about ~4% or 0.16dB per km)

☺Higher bandwidth — currently, limits on data rates come from the signal generation/reception technology, not the fiber itself

Cost — Optical fibers are expensive

Installation/maintenance — any crack in the core will degrade the signal, and all connections must be perfectly aligned

Preferences

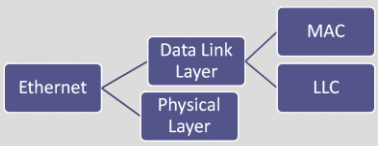
1. Ethernet
2. Wireless LAN
3. X.25
4. ATM
5. Zeegbee

LAN Technologies

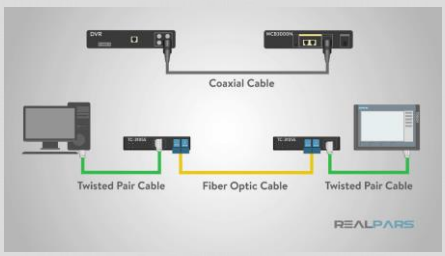
Ethernet (IEEE 802.3)

Ethernet (IEEE 802.3)

In 1983 ethernet was standardized IEEE 802.3 (Institute of Electronics and Electrical Engineers)



Physical Layer



Ethernet

- One of the most widely used wired LAN technology
- Operates in the data link layer and the physical layer
- It was commercially introduced in 1980 and first standardized in 1983 , Family of networking technologies that are defined in the IEEE 802.2 and 802.3 standards.
- Supports data bandwidths of 10, 100,1000, 10000, 40000 and 100,000 Mbps (Gbps).

Ethernet Standards

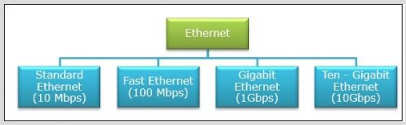
- Define Layer 2 protocol and 1 technology
- Two separate Sub layers of Data link layer to operate , LLC and MAC layer

Initially 3 Mbps baseband coaxial cable (thick Ethernet).

Operational Description

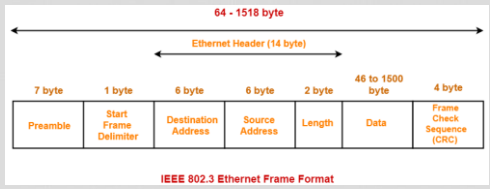
- Ethernet stations sense the channel.
- When the channel is free, the station transmits a frame.
- The stations monitor the 'ether' during the transmission.
- If a collision is detected by any station, the transmission is terminated immediately and a jam signal is sent.
- Upon collision, transmitting stations backoff using a local counter and then retransmit.

Evolution of Ethernet



Ethernet Overview (contd.)

- Ethernet by definition is a broadcast protocol
  - Any signal can be received by all hosts
  - Switching enables individual hosts to communicate
- Network layer packets are transmitted over an Ethernet by encapsulating
- Frame Format



Ethernet Frames

- Preamble is a sequence of 7 bytes, each set to "10101010"
  - Used to synchronize receiver before actual data is sent
- Addresses
  - unique, 48-bit unicast address assigned to each adapter
    - example: **8:0:e4:b1:2**
    - Each manufacturer gets their own address range
  - broadcast: all **1**s
  - multicast: first bit is **1**
- Type field is a demultiplexing key used to determine which higher level protocol the frame should be delivered to
- Body can contain up to 1500 bytes of data

Experiences with Ethernet

- Ethernets work best under light loads
  - Utilization over 30% is considered heavy
    - Network capacity is wasted by collisions
- Most networks are limited to about 200 hosts
  - Specification allows for up to 1024
- Most networks are much shorter
  - 5 to 10 microsecond RTT
- Transport level flow control helps reduce load (number of back to back packets)
- Ethernet is inexpensive, fast and easy to administer!

Ethernet Problems

- Ethernet's peak utilization is pretty low (like Aloha)
- Peak throughput worst with
  - More hosts
    - More collisions needed to identify single sender
  - Smaller packet sizes
    - More frequent arbitration
  - Longer links
    - Collisions take longer to observe, more wasted bandwidth
  - Efficiency is improved by avoiding these conditions

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Why did Ethernet Win?

- There are LOTS of LAN protocols
- **Price**
- Performance
- Availability
- Ease of use
- Scalability

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ZigBee

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Multiple Access

12.88

Access Methods in Network

- Point to Point Protocol (PPP)
- Shared
- Link Access Protocol

➢ **Dedicated Link or Shared Link**

2 devices in a network can be connected by :

- Dedicated link
- Shared link

➢ **Point to Point**

- Access method for connection using dedicated link known as Point to Point access
- Most common protocol for this access is Point-to-Point Protocol (PPP)
- Exp: Internet user makes a connection from his/her home to ISP

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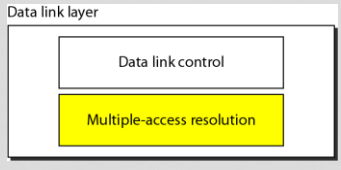
Data link layer divided into two functionality-oriented sublayers



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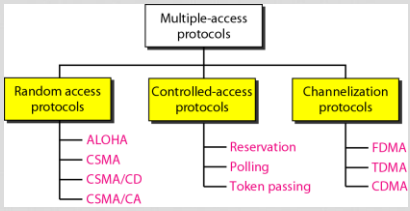
Taxonomy of multiple-access protocols discussed in this chapter



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12-1 RANDOM ACCESS

In random access or contention methods, no station is superior to another station and none is assigned the control over another. No station permits, or does not permit, another station to send. At each instance, a station that has data to send uses a procedure defined by the protocol to make a decision on whether or not to send.

Topics discussed in this section:

ALOHA
Carrier Sense Multiple Access
Carrier Sense Multiple Access with Collision Detection
Carrier Sense Multiple Access with Collision Avoidance

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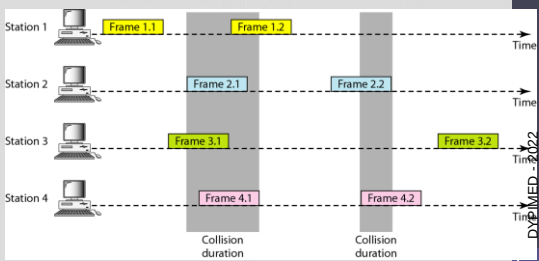
Figure 12.3 Frames in a pure ALOHA network



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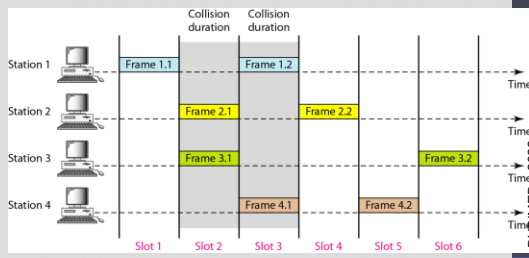
Frames in a slotted ALOHA network



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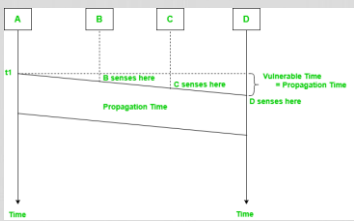
CSMA/CD

This method was developed to decrease the chances of collisions when two or more stations start sending their signals over the datalink layer. Carrier Sense multiple access requires that each station **first check the state of the medium** before sending.



The persistence methods can be applied to help the station take action when the channel is busy/idle.

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Space/time model of the collision in CSMA

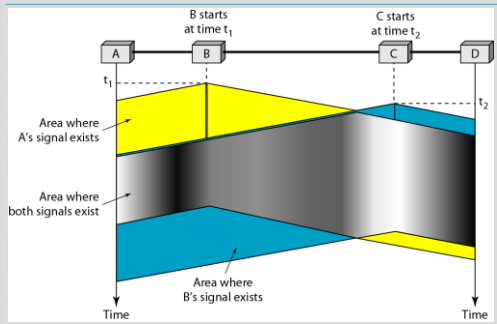

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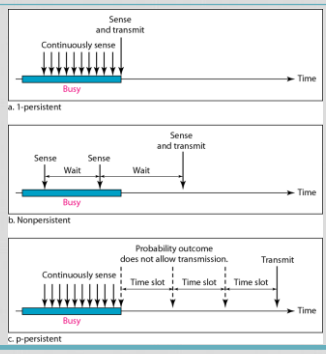
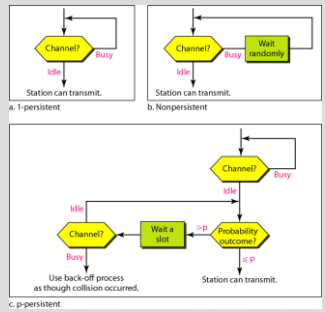
Figure 12.10 Behavior of three persistence methods



Flow diagram for three persistence methods



Collision of the first bit in CSMA/CD

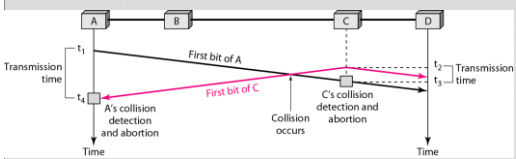
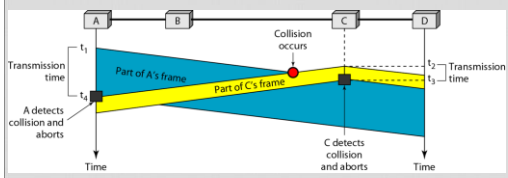
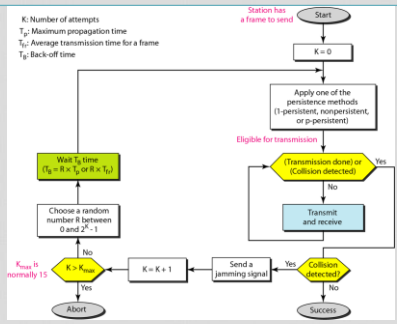


Figure 12.13 Collision and abortion in CSMA/CD

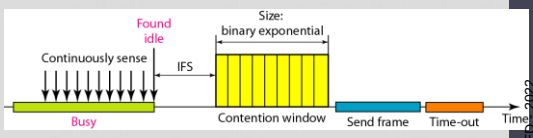


Flow diagram for the CSMA/CD



Carrier Sense Multiple Access with Collision Detection (CSMA/CD) – In this method, a station monitors the medium after it sends a frame to see if the transmission was successful. If successful, the station is finished, if not, the frame is sent again.

Figure 12.16 Timing in CSMA/CA



Inter Frame Space (IFS) – When a station finds the channel busy, it waits for a period of time called IFS time. IFS can also be used to define the priority of a station or a frame. Higher the IFS lower is the priority.

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12.1 103 03

Note

In CSMA/CA, the IFS can also be used to define the priority of a station or a frame.

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12.1 104 04

Note

In CSMA/CA, if the station finds the channel busy, it does not restart the timer of the contention window;
it stops the timer and restarts it when the channel becomes idle.

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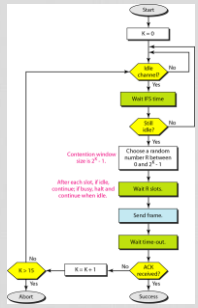
12.1 105 05

Figure 12.17 Flow diagram for CSMA/CA



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Voice over IP (VoIP)

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What's VoIP?

Voice over Internet Protocol (VoIP) is a technology that enables one to make and receive phone calls through the Internet instead of using the traditional analogy PSTN (Public Switched Telephone Network) lines.

VoIP is the ability to make telephone calls and send faxes over IP-based data networks with a suitable quality of service and superior cost/benefit.

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Motivations for VoIP

- Demand for Multimedia communication
- Demand for integration of Voice and Data networks
- Cost Reduction in long distance telephone calls

Other terms frequently encountered and synonymous with VOIP are:
- IP telephony
- Internet telephony
- Voice over broadband
- Broadband telephony
- Broadband phone

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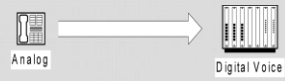
How to VoIP?



Compression to less than 32Kbps

Transfers through Routers, LAN Switches etc, using their Protocols

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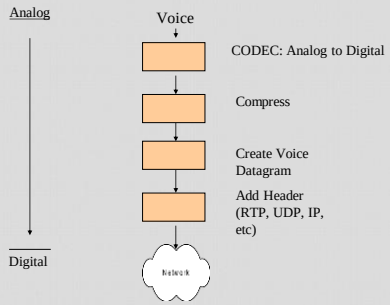
Voice To IP



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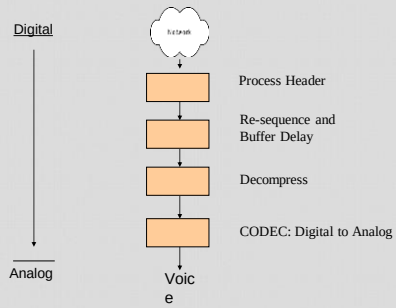
Voice From IP



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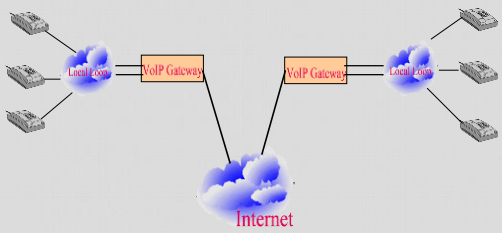
Options

Telephone-to-Telephone



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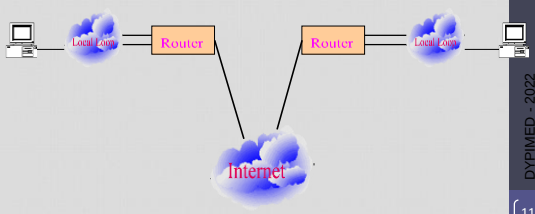
PC-to-PC



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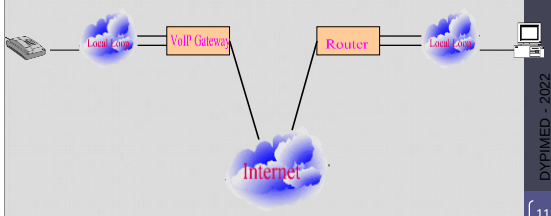
Telephone-to-PC



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Main Issues

- Quality of Voice
- Interoperability
- Security
- Integration with Public Switched Telephone Network(PSTN)
- Scalability

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VoIP Standards

- ITU
  - H.323
- IETF
  - Session Initiation Protocol (SIP)
  - Media Gateway Control (Megaco)
  - Signal Transport (SigTran)

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ANY DOUBTS / QUERIES

THANK YOU

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