# Transmission of Digital Data : Interface and Modems

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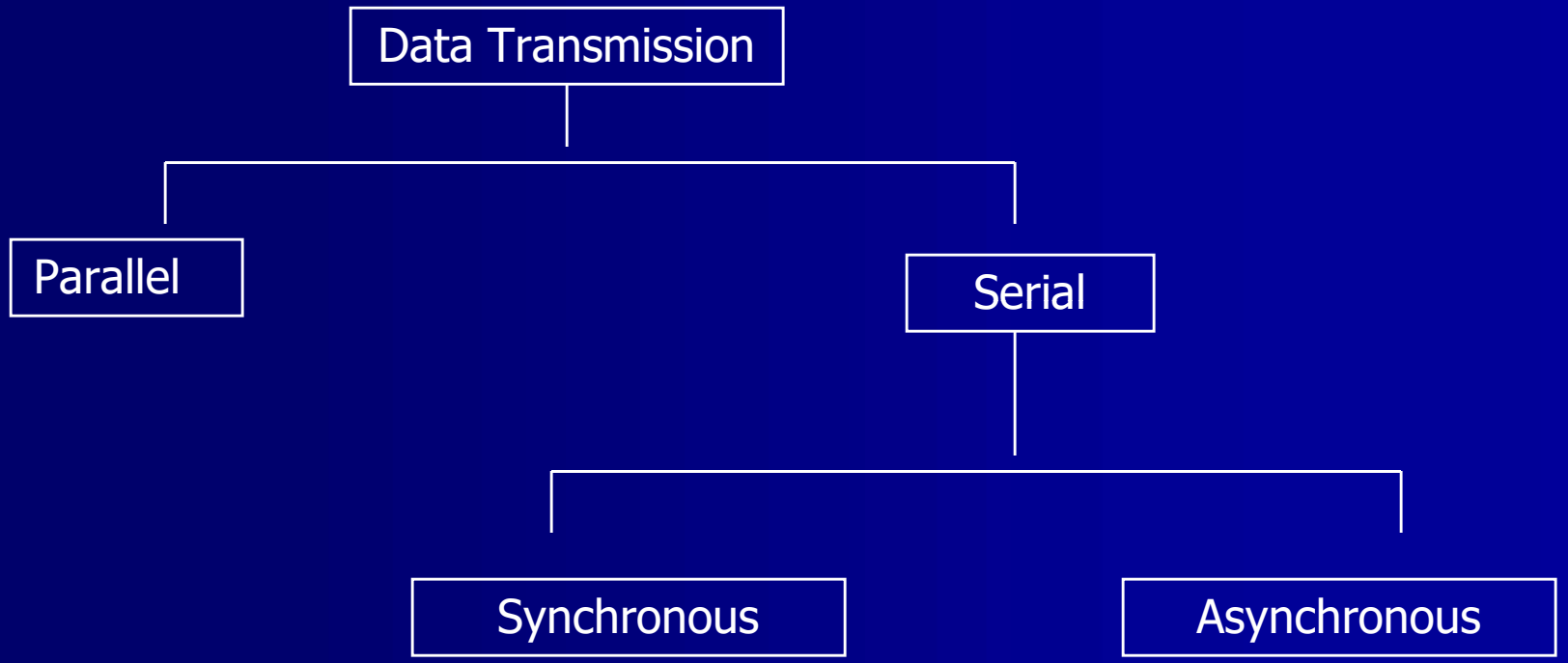
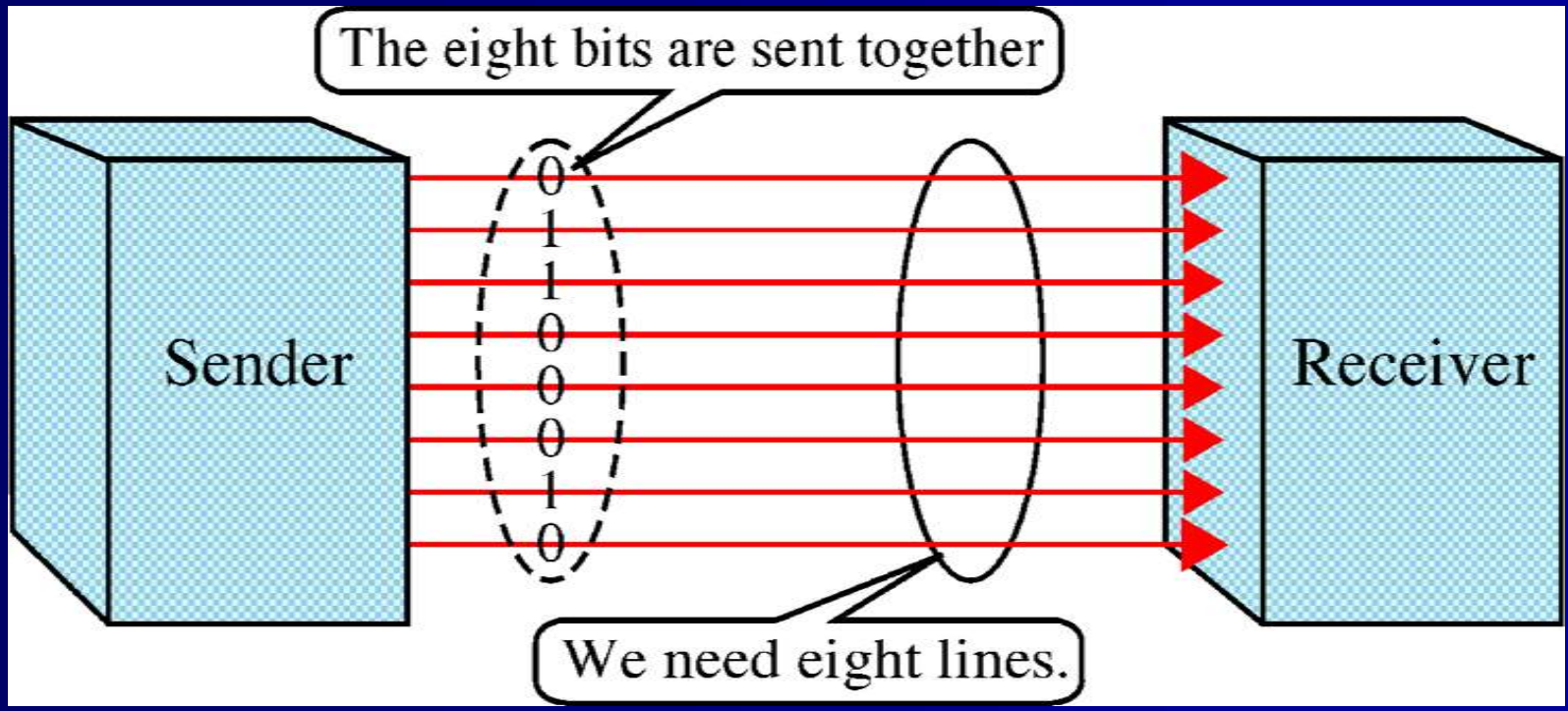
# Digital Data Transmission



# Parallel Transmission

- Groups of *n* bits
- Send one group at one time
- Use *n* wires to send *n* bits
- Advantage
  - Speed
- Disadvantage
  - Cost (*n* wires to transmit *n* bits)
  - Limited to short distances

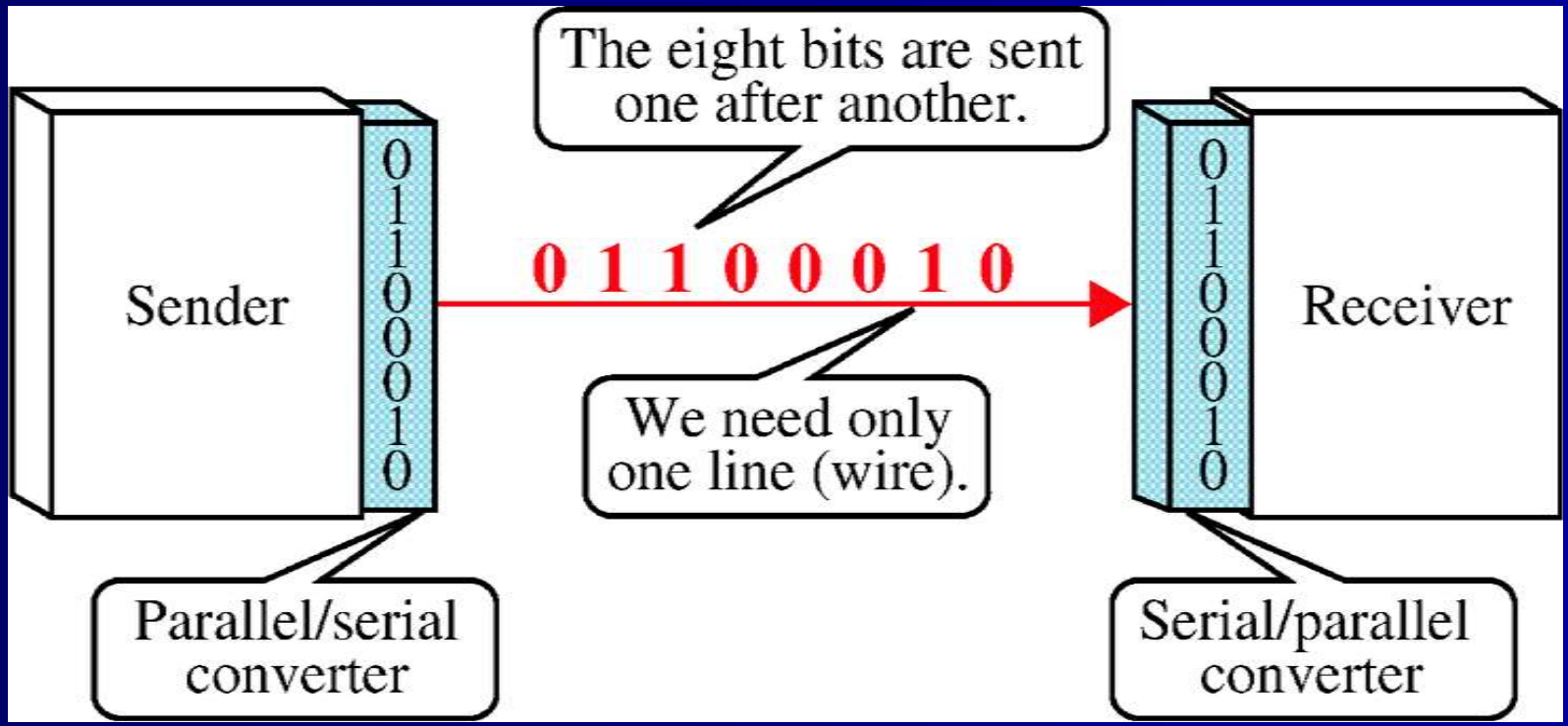
# Parallel Transmission



# Serial Transmission

- One bit at one time
- Requires only one wire
- Requires conversion devices at the interface between
  - The sender and the line (parallel to serial)
  - The line and the receiver (serial to parallel)
- Advantage
  - Low cost

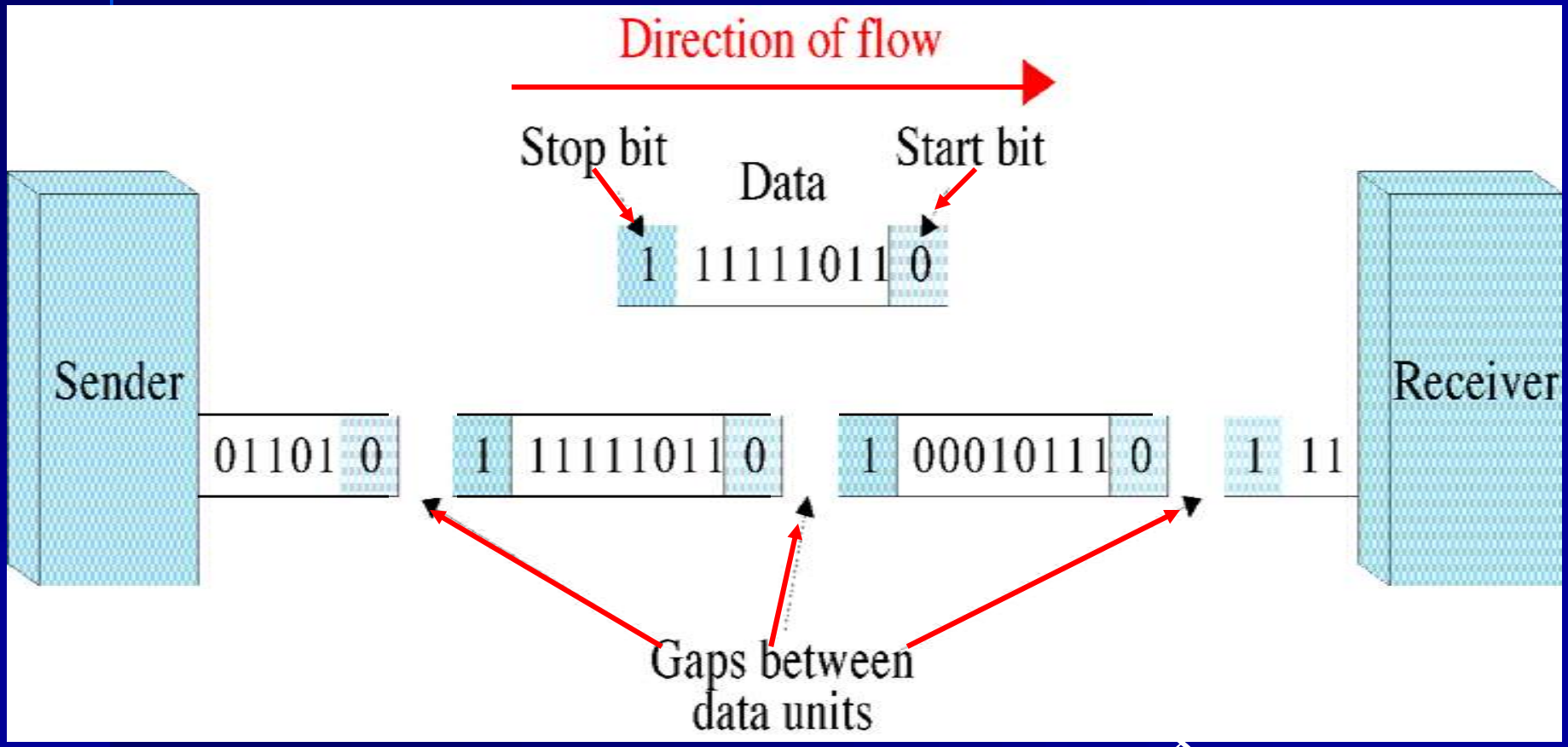
# Serial Transmission



# Serial Transmission (Asynchronous)

- Asynchronous
  - The timing of signal is unimportant
  - Information is retrieved and translated upon pattern
  - Patterns : grouping bit streams into bytes
    - Each group (usually 8) is sent as a unit
  - The sending device sends each group without regard to a timer

# Serial Transmission (Asynchronous)



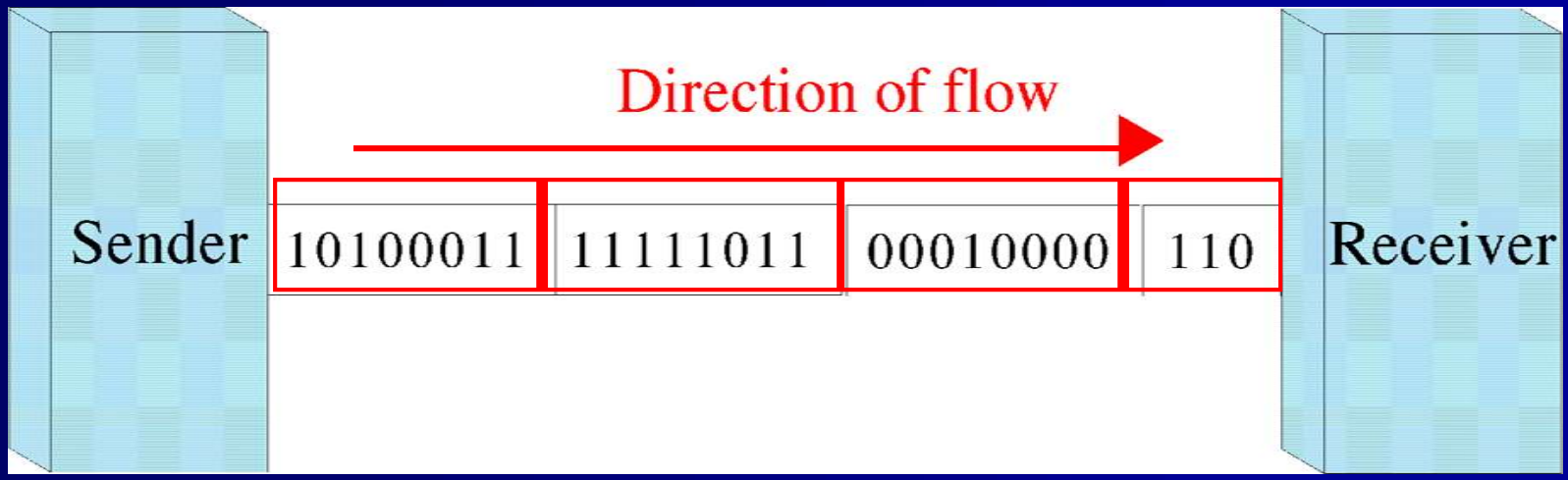
# Serial Transmission (Asynchronous) (cont.)

- Method
  - To alert the receiver :
    - An extra bit (start bit -- 0) is added to the beginning of each byte
    - One or more extra bits are added to the end of the byte
      - Stop bits -- 1
    - A gap (idle channel/streams of stop bits) is added at the end of each byte
    - Thus, start bit + stop bit + gap → alert the receiver the begin and end of each byte

# Serial Transmission (Asynchronous) (cont.)

- Advantage
  - Cheap
  - Effective
- Example:
  - Low speed communication
    - Terminal → computer

# Serial Transmission (Synchronous)

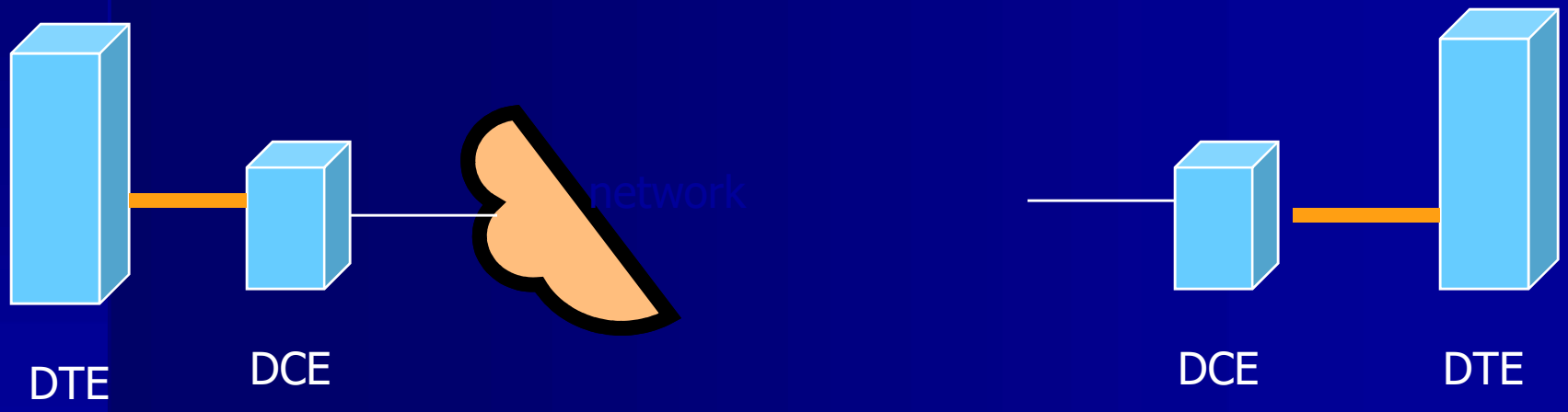


# Serial Transmission (Synchronous)

- Synchronous Transmission
  - Bit streams is combined into longer "frame"
  - A frame may consist of multiple bytes
  - No gap between each byte is added into a transmission link
  - The receiver has to separate the bit stream into bytes for decoding purpose
  - Timing is important in synchronous transmission
  - Byte synchronization is performed at the data link layer
- Advantage
  - Speed
  - → useful for high speed applications

# DTE-DCE Interface

- DTE : Data Terminal Equipment
- DCE : Data Circuit-terminating Equipment



# DTE-DCE Interface

- Sending End
- The DTE
  - generates the data and passes them to a DCE
- The DCE
  - converts the signal to a format appropriate to a transmission medium
  - Sends it onto the network
- Receiving End
  - This process is reversed

# DTE

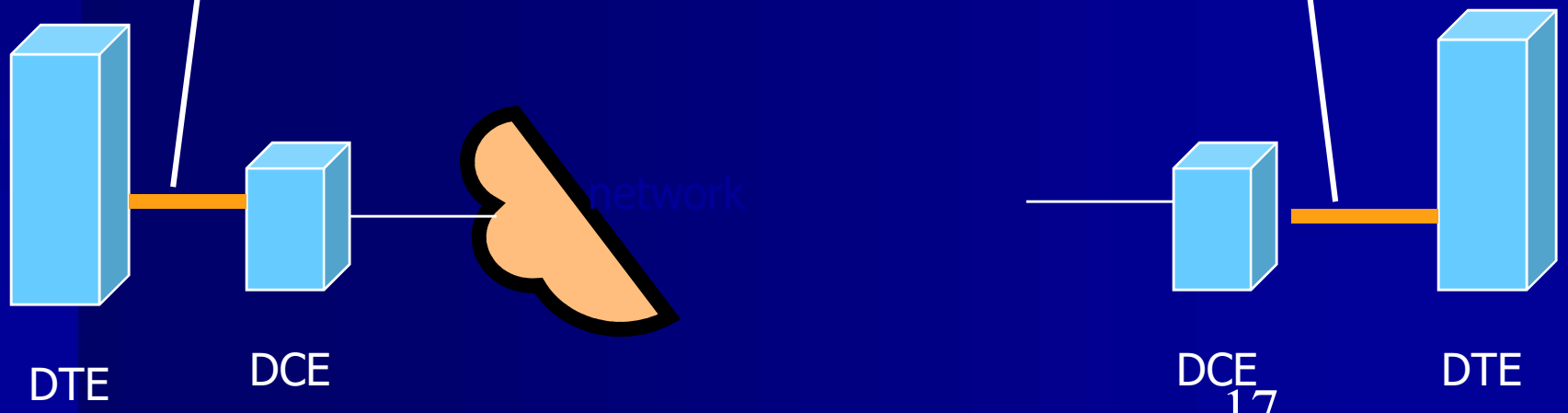
- Includes any unit that functions as a source or a destination for binary data
- At the physical layer, it can be
  - A terminal
  - A computer
  - A printer
  - A fax machine, etc.
- DTEs do not communicate with other DTE directly

# DCE

- Includes any functional units that transmits or receives analog/digital signal through a network
- At the physical layer,  ex. Modems
- Sending and receiving DCEs must use the modulating method (e.g. FSK)

# DTE-DCE Interface Standards

DTE-DCE standards try to define the mechanical, electrical, and functional characteristics of the connection between the DTE and the DCE



Input/output port high speed internal parallel bus of the users terminal and convert it into serial form at much lower speed in the proper format for transmission for modem

when data is ready to sent and then to send data at the proper time and synchronization

I/o Port must be able to take data from the modem at the proper time and synchronization, indicate when it is ready and when errors and then convert data from serial to parallel form for the internal data bus

# EIA

Electronic Industries Association(EIA)

International Telecommunication Union-Telecommunication(ITU-UT)

# EIA-232 Interface

- Previously called RS-232
- Introduced in 1960 for serial communication transmission of data
- Defines the mechanical, electrical, and functional characteristics of the interface between a DTE and a DCE

# EIA-232 Interface

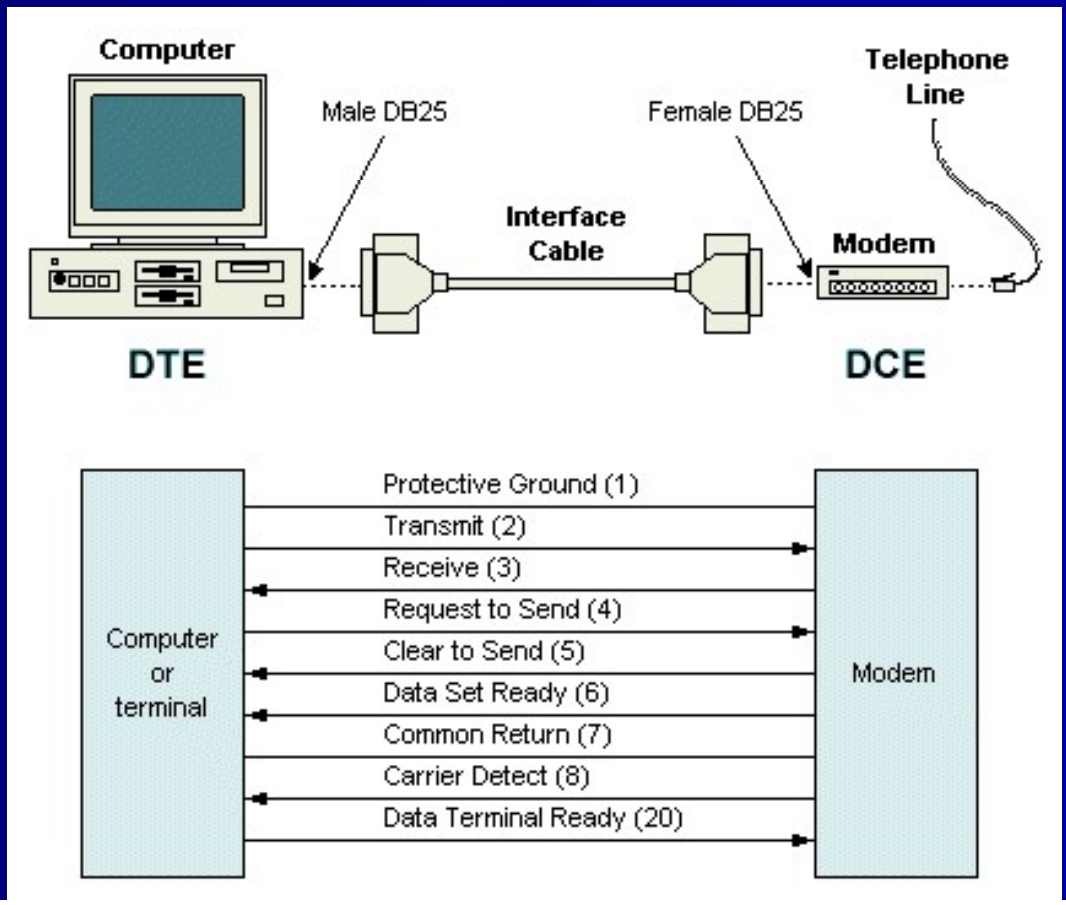
it was commonly used for computer serial communication ports

# EIA-232

- 25-wire cable
  - Male and female DB-25 pin connector attached to either end
  - The cable length not > 15 meters (50 feet)
  - Many of them are not used so  9 pin connection was implemented on most computers

# EIA-232 Interface

Data rate upto 20 kbps



It is full duplex mode

B’ cos Transmit data and Receive data are separate circuits

It uses negative,bipolar logic in which a negative voltage is used to represent a logic 1

positive voltage to represent 0

# EIA-232 : DB-9

- Many of the pins in DB-25 implementation are not necessary
- A 9-pin version of EIA-232 (called DB-9) was developed

# Other Interface Standards

- IEA-449
  - DB-37/DB-9
- RS-423/422
- EIA-530
- Etc.

# CCITT X.21 interface

- To replace EIA 232
- Digital interface between a computer and an ISDN connection
- Connection upto 1 KM length
- data rate upto 10 mbps
- The connector based on ISO 4903 standard
- 15 pins for connecting the circuits

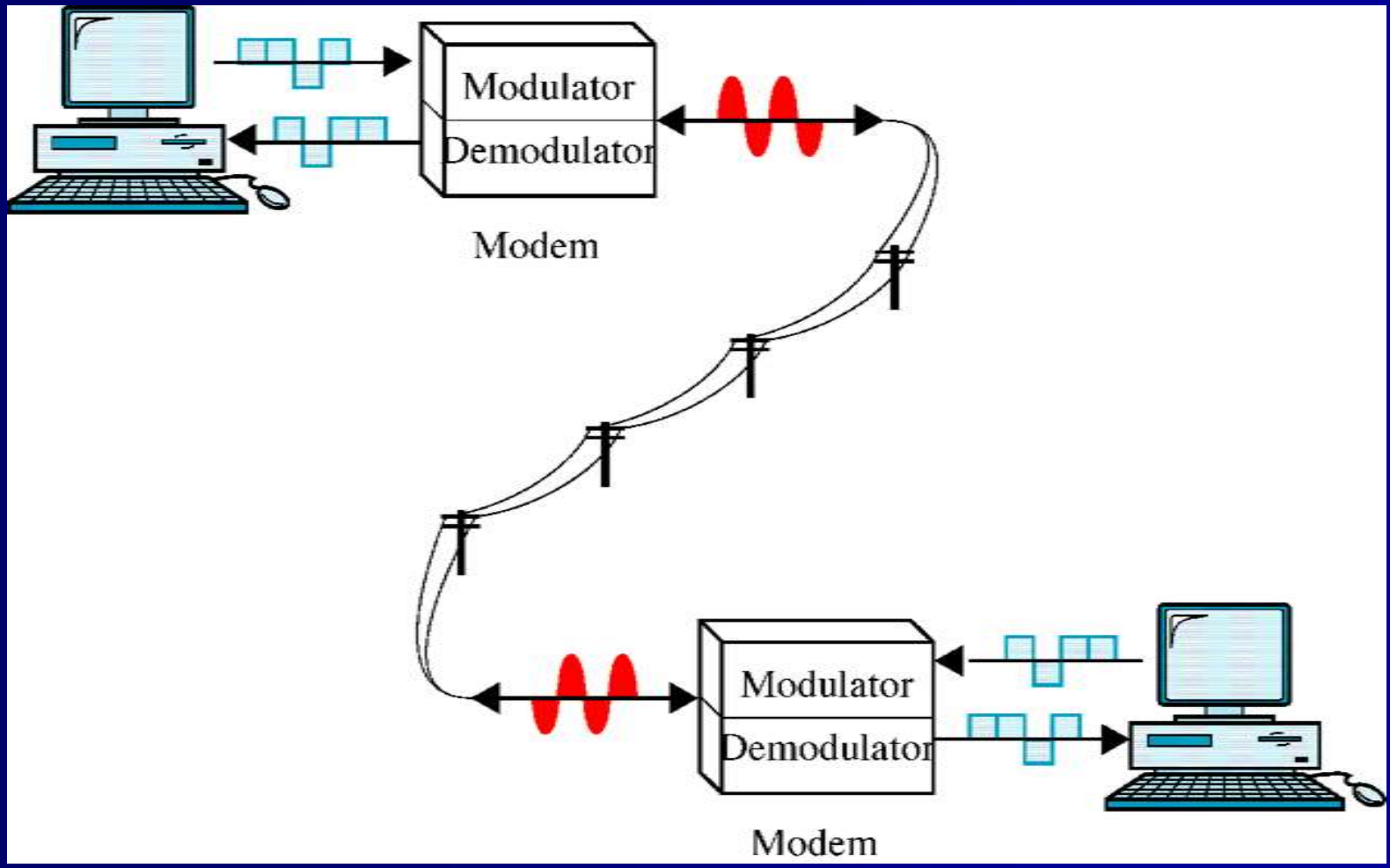
# CCITT X.21 interface

- **Consultative Committee for International Telephony and Telegraphy**
- 4 circuits carry bulk of the interface information
- each four of these is capable of contain many different signals
- The combined total of four circuits much larger than EIA 232

# Modems

- Modulator/demodulator
- Modulator
  - Converts a digital signal into an analog signal using ASK, FSK, PSK or QAM
- Demodulator
  - Converts an analog signal into a digital signal

# Modems


Modulator
Demodulator
Modem
Modulator
Demodulator
Modem

# Modems

- Voice based dial up modems
- Dial a phone number to connect to an ISP
- operated on Analog phone lines
- used same frequency as telephone calls
- maximum data rate upto 56 Kbps
- voice calls interrupt the internet connection

# Modems

- DSL or Cable modems
- Broadband devices
- Digital Subscriber Line
- Wider frequency range
- higher data transfer tah dial up modems
- Voice calls Do not interrupt  INternet connection

# Modems

Cable modems use coaxial cable

DOCSIS(Data Over Cable Service Interface Specification)

which provides an efficient way of transmitting TV,cable Internet ,Digital Phone signals

# Modems

- Modems needed for fiber optic connections
- ITU defined standards are followed by most modems
- Modems are full duplex
- It also supports  fallback for slower connections

# DSL Modems

- Digital Subscriber Line
- Faster than Dial up connection
- xDSL
- x is replaced with A,V,H,or S
- First developed during 1980's

Integrated Services Digital Network

160 KBps signals is transmitted over the local loop using 2B1Q

# DSL Modems

The 160 Kbps divided into Two B channel 64 kbps each

16kbps for D channel

16 kbps for signalling channel

it provide the speed of 64 Kbps and 128 Kbps

# DSL Modems

- High bit rate DSL was developed about 1990
- 1.544 Mbps  speed
- low cost T1 type access
- Symmetric -Upload and Download speed are same

# DSL Modems

- Asymmetric DSL, or ADSL was developed in 1990 s
- Developed for Video on Demand
- Downstream range from 1.5 to 9 Mbps
- upstream rates range from 16 to 640 kbps

# Cable Modems

- Cable Modems has TWO interfaces
- Cable Modem speed 10 or 100 MBPS
- Cable Modem Termination System(CMTS)
- Introduced in 1995
- Standardised called
  - Data Over Cable Services Interface Specification(DOCSIS)
- DOCSIS 1.0 provides Two way data service 27-56 Mbps Dwonstream 3MBps upstream

# Cable Modems

- Voice Over Internet Protocol -DOCSIS 1.1
- DOCSIS 2.0 released in 2002
- upstream 30Mbps

# Radio and Microwave Modems

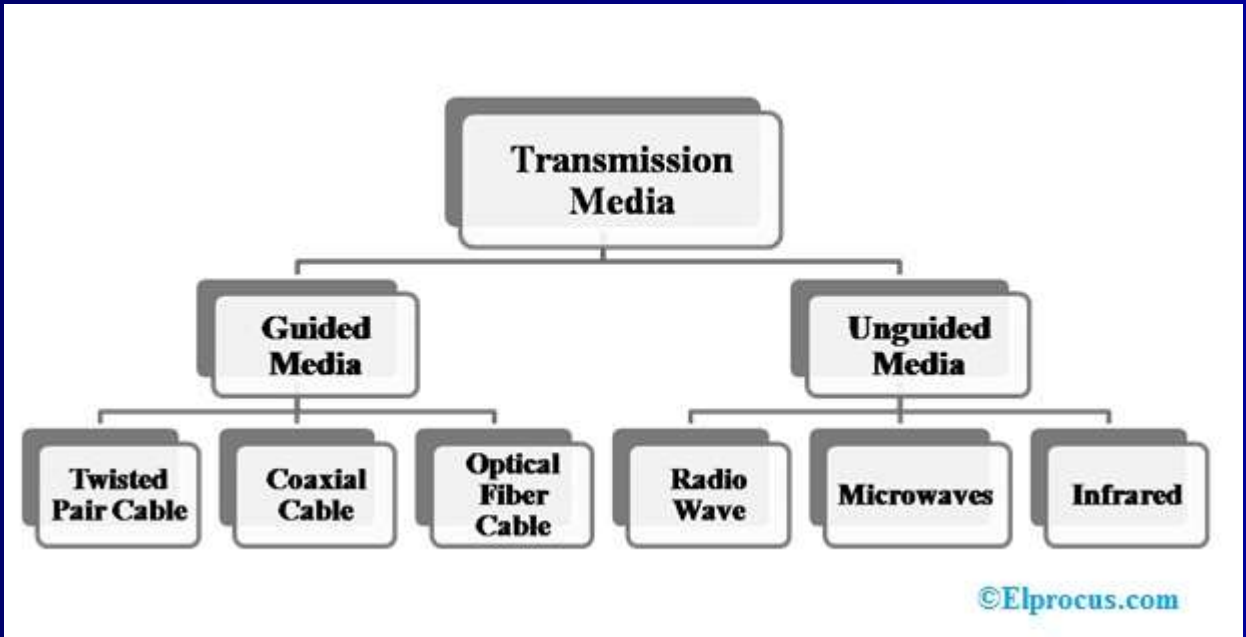
- Digital cable vision and cable INternet services use radio frequency modems
- They transmit information that is modulated onto a carrier frequency to allow many simultaneous wireless communication links
- Half duplex modems

# Mobile Broadband Modems

GPRS (General pAcket Radio Services)
UMTS(Universal Mobile Telecommunication systems
High Speed Packet Access(HSPA)
Evolution Data Optimized(EVDO)
WiMax

# Transmission Media

A transmission medium can be broadly defined as anything that can carry information from a source to a destination



| Guided Media | Unguided Media |
|---|---|
| The signal energy propagates within the guided media | The signal energy propagates through air |
| Guided media is mainly suited for point-to-point communication | Unguided media is mainly used for broadcasting purpose |
| The signal propagates in guided media in the form of voltage, current or photons | The signal propagates in unguided media in the form of electromagnetic waves |

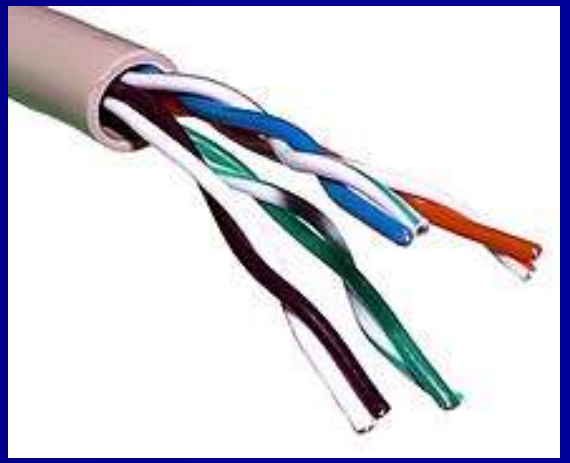
| Guided Media | Unguided Media |
|---|---|
| Examples of guided media are:<br>Twisted pair cables<br>Coaxial cables<br>Optical fibre cables | Examples of unguided media are:<br>Microwave or radio links<br>Infrared |

# Guided Media

1. Twisted Pair
2. Coaxial Cable
3. Fiber Optic Cable

# Twisted Pair

A twisted pair consists of two conductors (normally copper), each with its own plastic insulation, twisted together,



# Twisted Pair

One of the wires is used to carry signals to the receiver, and the other is used only as a ground reference

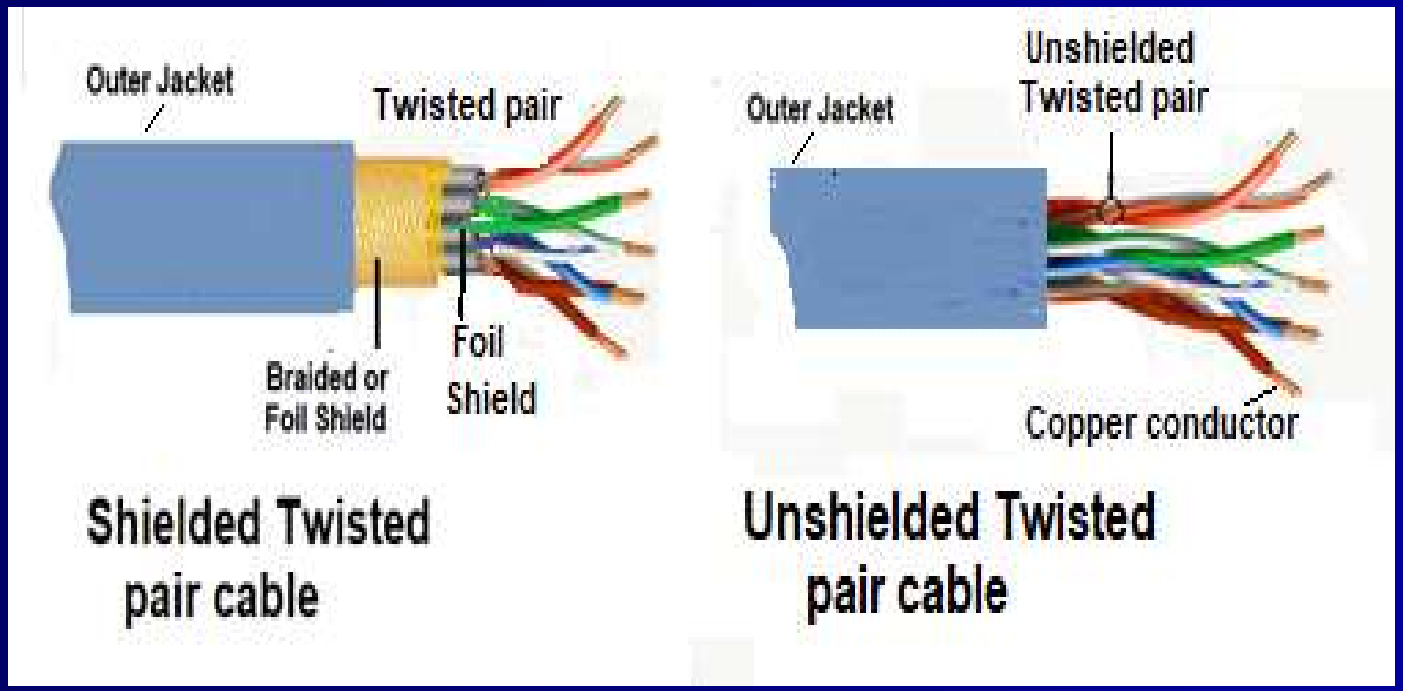
The receiver uses the difference between the two.

# Twisted Pair

If the two wires are parallel, the effect of these unwanted signals is not the same in both wires because they are at different locations relative to the noise or crosstalk sources

This results in a difference at the receiver. By twisting the pairs, a balance is maintained.

Unshielded Versus Shielded Twisted-Pair Cable


Outer Jacket
Twisted pair
Braided or
Foil Shield
Foil
Shield
Shielded Twisted
pair cable
Outer Jacket
Unshielded
Twisted pair
Copper conductor
Unshielded Twisted
pair cable

# Twisted Pair

least expensive for installation and local moves

High Availability

# Disadvantages

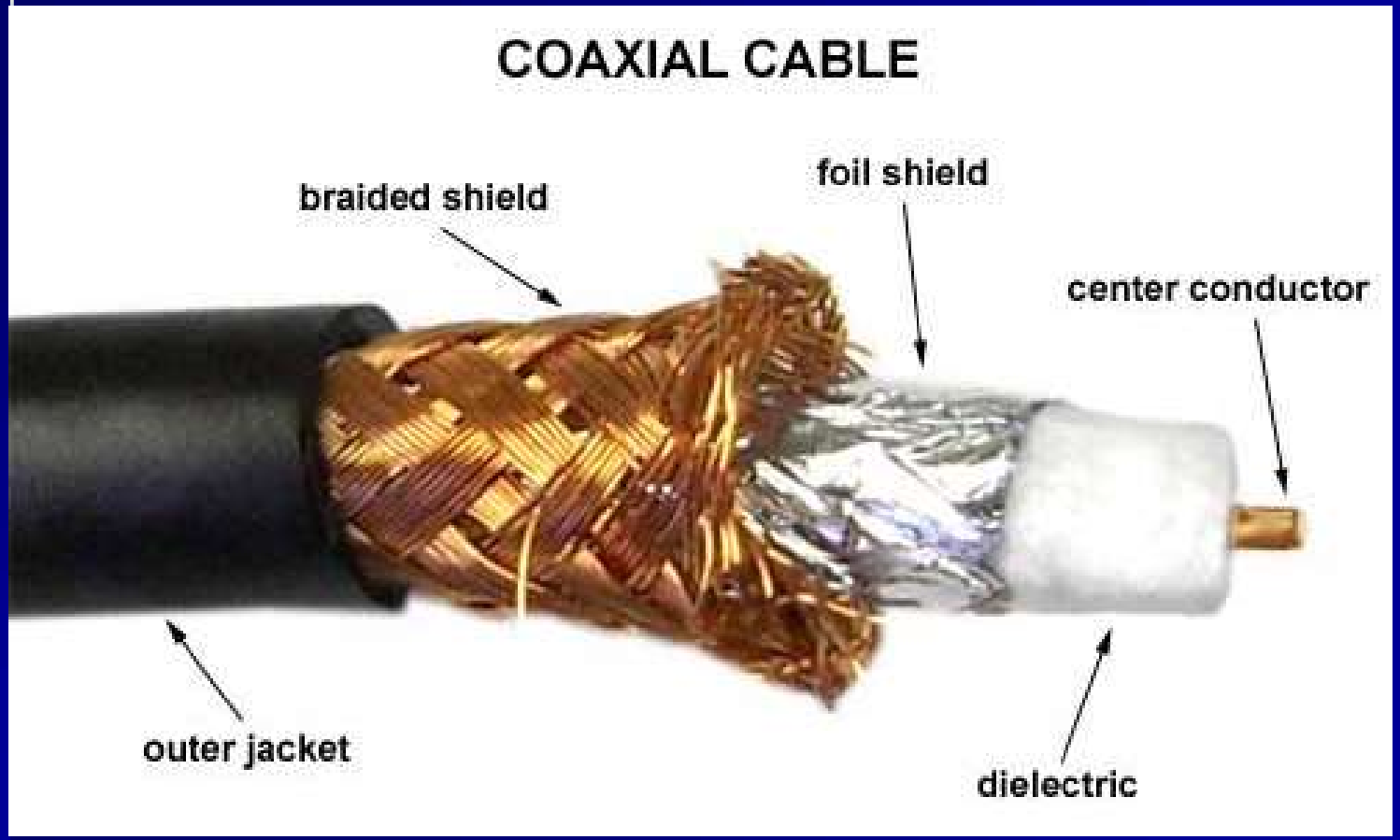
Limited  Frequency spectrum- usable spectrum is 1 MHZ

Limited Data Rates-Maximum data rate is 100 Mbps

repeaters required

High error rate

# Coaxial Cable



# Coaxial Cable

Inner Conductor: Centre is conductor

Typically constructed of either pure copper(in higher end cables)

or copper coated steel or aluminium

The center conductor is responsible for transmitting

The rest of the cable construction is primarily designed to help the center conductor maintain its electrical integrity

# Dielectric Insulator

Its purpose is twofold

1. it act as an insulator between the centre conductor and the outer metallic shielding
2. physically hold the center conductor in the centre cable

A signal loss can occur if the centre conductor strays too close to the outer area of the cable.

Various materials are commonly used

# Braided Shield

Long copper cables tendency to act like antennas

So these can pick up interference

Two Type Interference

electromagnetic interference(EMI)

Radio frequency interference(RFI)

Heavy power lines and cell phone signals causes EMI

# Foil Shield

It is not always present on coaxial cable
protects from RFI
mostly aluminium foil
wrap around inner parts of the cable

# Outer Jacket

Made up of flexible PVC(polyvinyl chloride)
it holds the cable together

# standards

Government ratings
50 ohm RG-8 and RG-11 for thick ethernet
50 ohm RG-58 thin ethernet
75 ohm RG-59 used for cable TV
93 ohm RG-62 ARC net(Attached Resource Computer **NETwork**

# Characteristics of coaxial cable

10 mbps is the transmission rate

Maximum cable length for thinnet is 185 mtr thicknet 500 mtr

flexible and easy to work

less expensive that fiber more than twisted pair

good resistance

# Advantages

- It can use to send both analog and digital signals
- Superior frequency characteristics than twisted pair
- much susceptible to interference and crosstalk than twisted pair
- easy to handle and relatively inexpensive as compared fibre optic cables
- it can be used for longer distances as higher data rates
- excellent noise immunity

# Disadvantages

distance is limited
repeaters needed in every km
number of nodes connections is limited
proper connectors and termination is must

# Application of coaxial cable

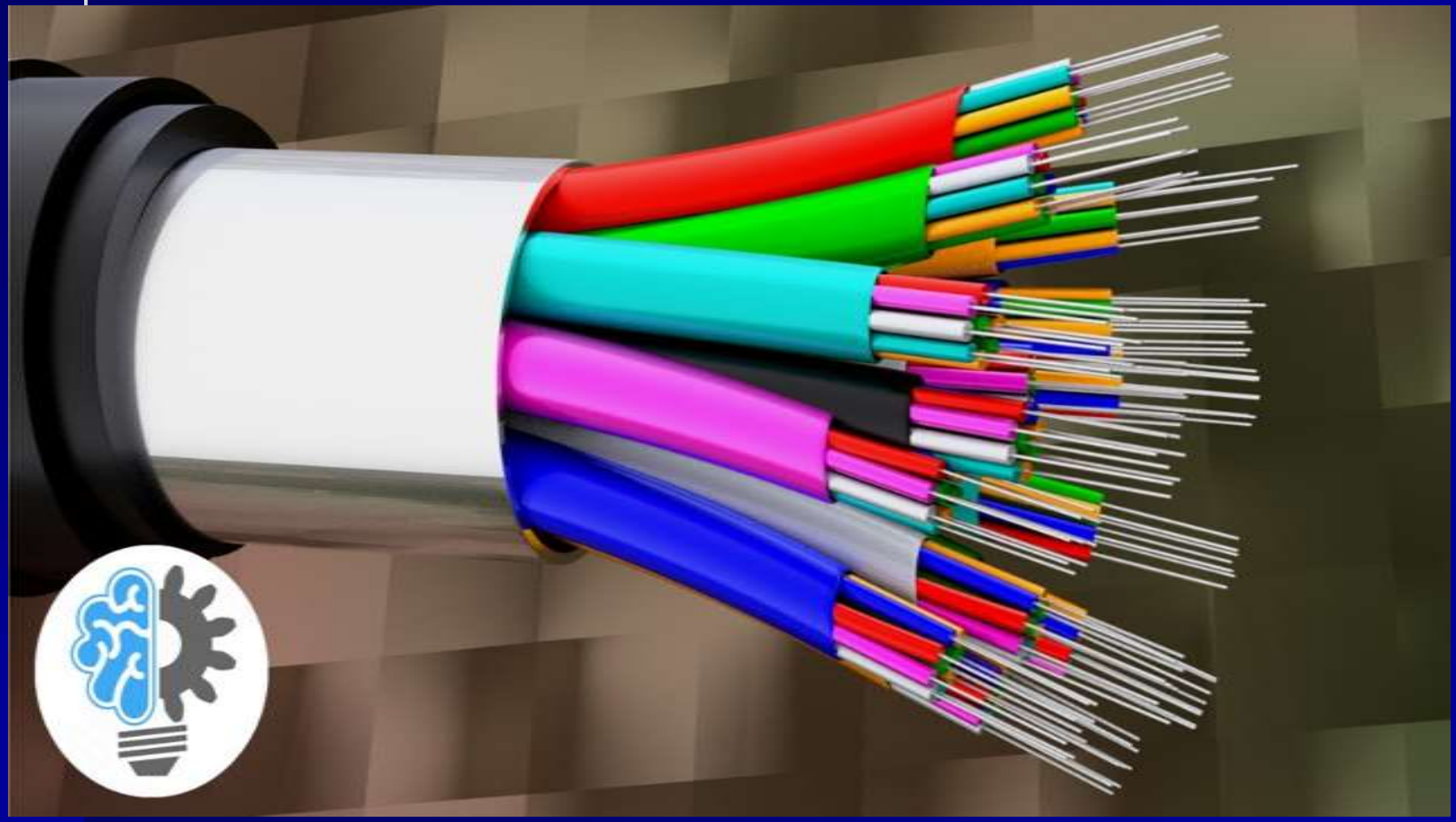
Long distance telephone and television transmission

Television distribution

LAN

Short run system links

# Optical Fibre



# Optical Fibre

It is a cylindrical dielectric waveguide

transmits light along its axis

Light in glass medium can carry more information over long distances than electrical signal  can carry by other wires

Various plastics and glasses are used to construct this medium

# Optical Fibre

Cylindrical shape

3 parts

The core, cladding and outer jacket

The core is innermost section made up o f one or more fibre

Each core surrounded by its own cladding

it has optical properties different from the core

# Optical Fibre

refractive index of the core must be greater than that of the cladding.

The outermost layer one or a bundle of cladded fibres is the jacket

The jacket is composed of plastic and other materials layered to protect against moisture, abrasion,crushing and other environmental dangers

# Optical Fibre

IT works on  the principle of internal reflection

https://www.youtube.com/watch?v=jZOg39v73c4

Light reflects or  refracts depending on the angle at which it strikes the surface

# Optical Fibre

The composition of the glass relative to the core glass determines the fibers ability to reflect light

Three modes

multi mode step-index fibre

multimode graded index

single mode

# Multimode step index

The density of the core remains constant from the center to the edges

fibre will be uniform throughout  the core

A beam of light moves through this constant density in a straight line until it reaches the interface of the core and the cladding

at the interface abrupt change in density

The step index refers to this sudden changes

# multimode graded index

decreases this distortion of the signal through the cable

The index refers to the index of refraction.

This uses varying densities

Density is highest at the centre of the core decreases gradually its lowest at the edge

# Single mode

it uses step index
focused source of light that limits beams to a small range of angles
its density is lower than multimode fibre and smaller diameter

decrease in density results in a critical angle that is close enough 90 degree to make the propagation of beams almost horizontal

# Single mode

in this case propagation of different beams is almost identical and delays are negligible

# Fibre Optic

Two type light source

. LED(Light emitting Diode

ILD(Injection laser diode

LED is less costly,operates over a greater temperature range,longer operational life

# Types of fibre

Plastic core cladding
Glass core with plastic cladding
Glass core and glass cladding

# Plastic core cladding

flexible
more rugged (uneven)than glass
easy to install
better withstand stress
less expensive

Disadvantage
high attenuation, do not propagate light efficiently, short runs

Glass core with plastic cladding(PCS fibre)
plastic clad silica

low attenuation characteristic
less affected by radiation better than SCS
more attractive to military

## Glass core and glass cladding

Best Propagation
easier to terminate than PCS
least rugged
more attenuation when exposed to radiation

# Fibre sizes

7.0 micron core/125 micron cladding-single mode

62.5 micron core/125 micron cladding-multimode

50 micron core/125 micron cladding-multi mode

100 micron core/140 micron cladding

# Characteristics

Transmission rate 100 Mbps
Not affected by the electrical interferences
most expensive cables
supports 2 km
supports voice video and data

# Advantages

- Wide bandwidth
- Low losses
- Immune to crosstalk
- Interference Immune
- Light weight
- Small size
- More strength
- security
- Long distance Transmission
- Environment immune
- Safe and easy installation
- Long term cost

# Disadvantages

High initial cost
Unidirectional light propagation
maintenance and repairing cost
Fragile cannot run at the sharp corners
aligning and joining two fibre cable is not easy

# Unguided media

It uses electromagnetic waves without physical conductor

signals are normally broadcasted through free space  and thus are available to anyone who has a device capable of receiving them.

Spectrum range from 3 khz to 900 THz

# Unguided media

Can travel source to destination several ways

Ground Propagation
Sky propagation
line of sight

# Ground propagation

In this radio waves travel through the lowest portion of the atmosphere

these low frequency signals emanate in all directions from the transmitting antenna and follow the curvature of the planet

Distance depends on the amount of power in the signal.

The greater the power the greater the distance

# Sky Propagation

Radio waves radiate upward into the ionosphere

Then it is reflected back to the earth

This type of transmission allows for greater distances with lower output power

# Line of Sight Propagation

High frequency signals are transmitted in straight lines directly from antenna to antenna

Antennas are directional

facing each other either tall enough or close enough together not to be affected by the curvature of the earth

# Unguided Media

Radio waves
Microwaves
Infrared Waves

# Radio waves

electromagnetic waves ranging in 3 khz and 1 GHz -radio waves

1 and 300 gHZ microwaves

radio waves are easy to generate can travel long distances and cna penetrate building easily

They are omni directional meaning they can travel any direction.

so they can use for multicasting

# Radio waves

disadvantage

The radio waves transmitted by one antenna are susceptible to interference by another antenna

It travels long distance broadcasting

# Radio waves

low and medium frequencies can penetrate walls

advantage
communication is possible in inside or outside
disadvantage
cannot limit into inside or outside

radio wave band is low under 1GHZ
it subdivided into sub bands

# Microwaves

between 1 300 GHZ

it is unidirectional;

when antenna transmits microwaves ,they can narrowly focused

A pair of antennas can be aligned without interfering with another pair aligned antennas

# Characteristics of microwave propagation

- It is line of sight
- High frequency microwaves cannot penetrate walls
- Microwave band is relatively wide
- Use of certain portions of the band requires permission from authorities

# Infrared waves

- 300 GHz to 400 THZ short range communication
- High frequencies can not penetrate walls
- Infrared Data Association (IrDA) establish standards for this type of waves

# Transmission Impairment

Signal at the beginning of the medium is not the same as the signal at the end of the medium

Attenuation

Distortion

noise

# Attenuation

loss of energy

it losses b'cos of overcoming the resistance of the medium

That is why it is getting warm after while

electrical energy in the signal converted into heat

# Distortion

it changes its form or shape

it occur b'cos a composite signal made of different frequencies

# Noise

Several type of noise

thermal noise :random motion of electrons in a wire. it causes extra signal

induced noise:comes from motors and appliance

cross talk:one wire on the another

impulse noise:high energy in short time