MODULE 2
Public Switched Telephone Network (PSTN)




AGENDA

- Introduction to Telecommunications
- Transmission Systems
- Switching Systems
- Signalling Systems

Telecommunications Networks

- A telecoms network permits the transmission of sound, video, computer data, or other information between the telephone or other terminal device (such as a computer or a fax machine) of one party and the telephone or other terminal device of another party by establishing a connection between the telephones or terminal devices of the parties.

Types of Networks

There are basically two types of networks:

- PSTN - carry basic voice communication
- Data Network - carry data at high speed




Public switched (voice) network

- The public switched (voice) network is the total ***analog*** telephone network that allows connectivity over the entire country and much of the world via array of switches and media.
- It provides access to every home and office in the developing world.
- The size of the ***pipeline*** is restricted, and so is the speed or quality of the flow of information.




AGENDA

- **Introduction to Telecommunications**
- Transmission Systems
- Switching Systems
- Signalling Systems

Introduction





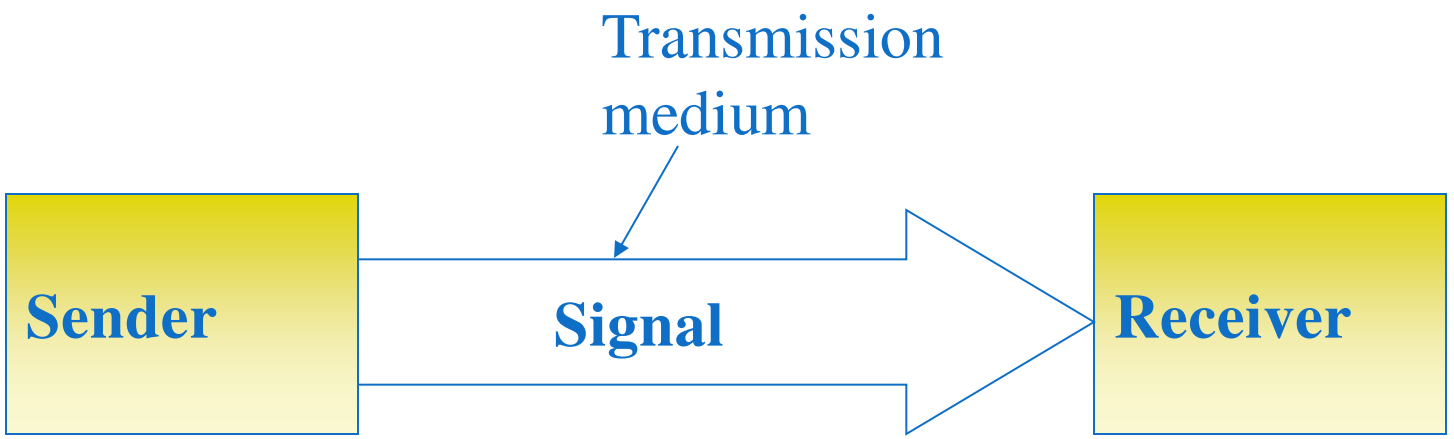
Communications

- Communications is a process that allows information to pass between a sender and one or more receivers.
- Communications is a **human process.**

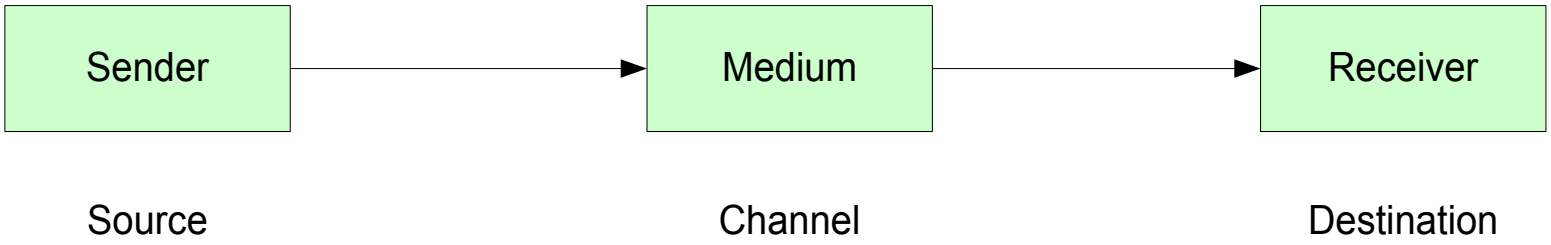
Communications

- Communications
  - The message (data and information) is communicated via the signal
  - The transmission medium “carries” the signal



Basic communications model



- Transport model is a simplistic mode of moving data from one source to one or more destinations through a medium.

Telecommunications

- Telecommunications is the transmission of data, or information, over a distance.
- Telecommunications is the communication by electrical, electromagnetic, or photonic means, over a distance.
- Telecommunications is a more general term and involves the transmission of information or ideas over a distance between humans or machines.

Telecommunications

- Telecommunications is the transmission of data, or information, over a distance.
- Telecommunications is the communication by electrical, electromagnetic, or photonic means, over a distance.
- Telecommunications is a more general term and involves the transmission of information or ideas over a distance between humans or machines.

Telecommunications

- Telecommunications
  - The electronic transmission of signals for communications, including such means as:
    - Telephone
    - Radio
    - Television
- Telecommunication medium
  - Anything that carries an electronic signal and interfaces between a sending device and a receiving device

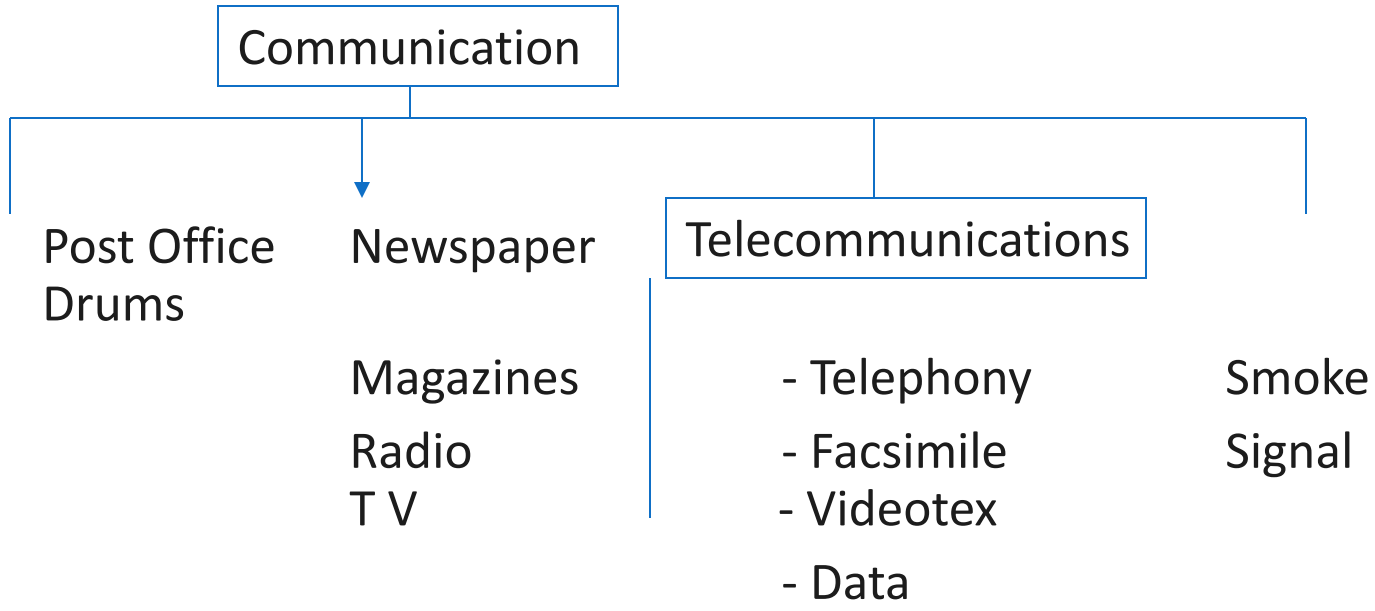




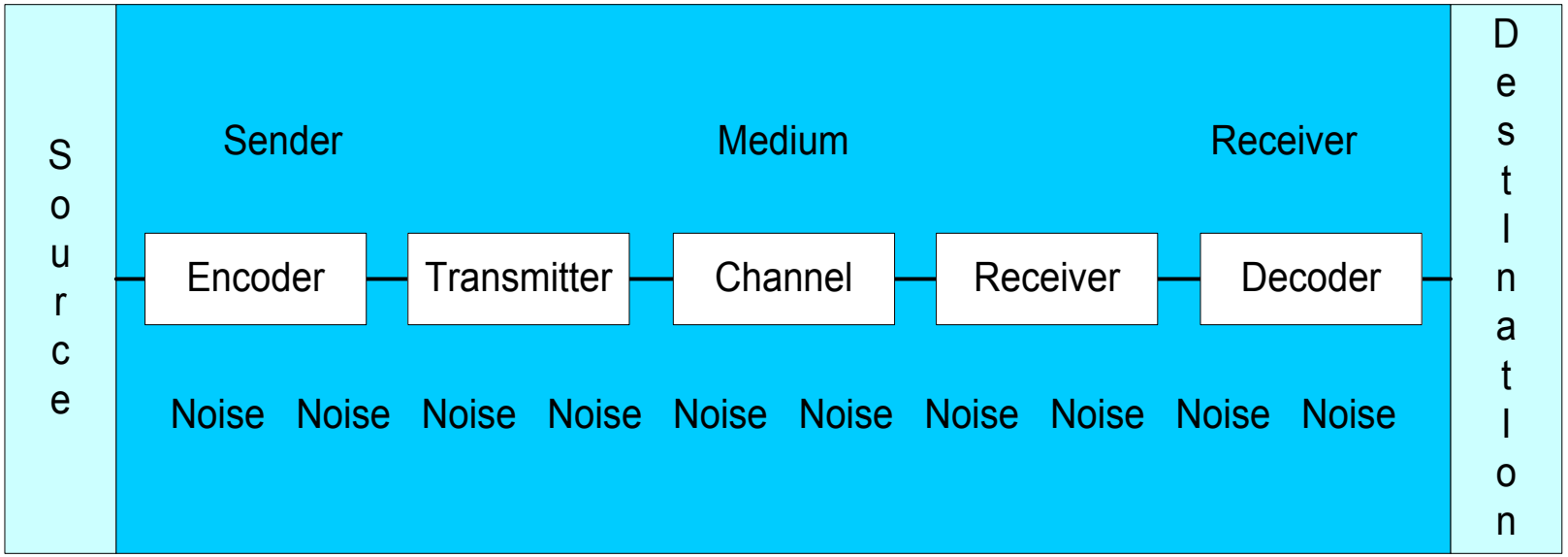
Telecommunication

- Telecommunication's is one of several forms of communication
- "Tele" means "at a distance"



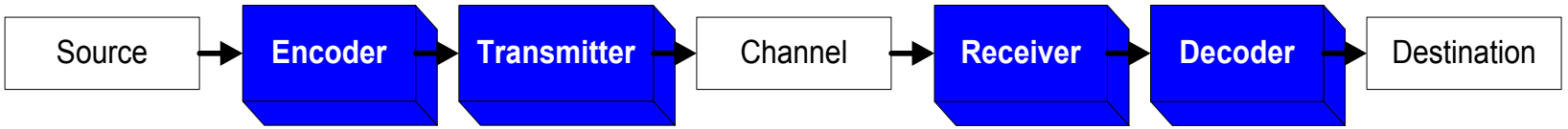
Expanded Telecommunications Model






A Telecommunications Model

- The telecommunications process requires the inclusion of an encoder/decoder and transmitter/receiver.



AFRALTI

Communication

Sender

Transmission medium (air)

Receiver

Signal

Telecommunication

Sender

Transmission medium (wire)

Receiver

Signal




A Communications Model

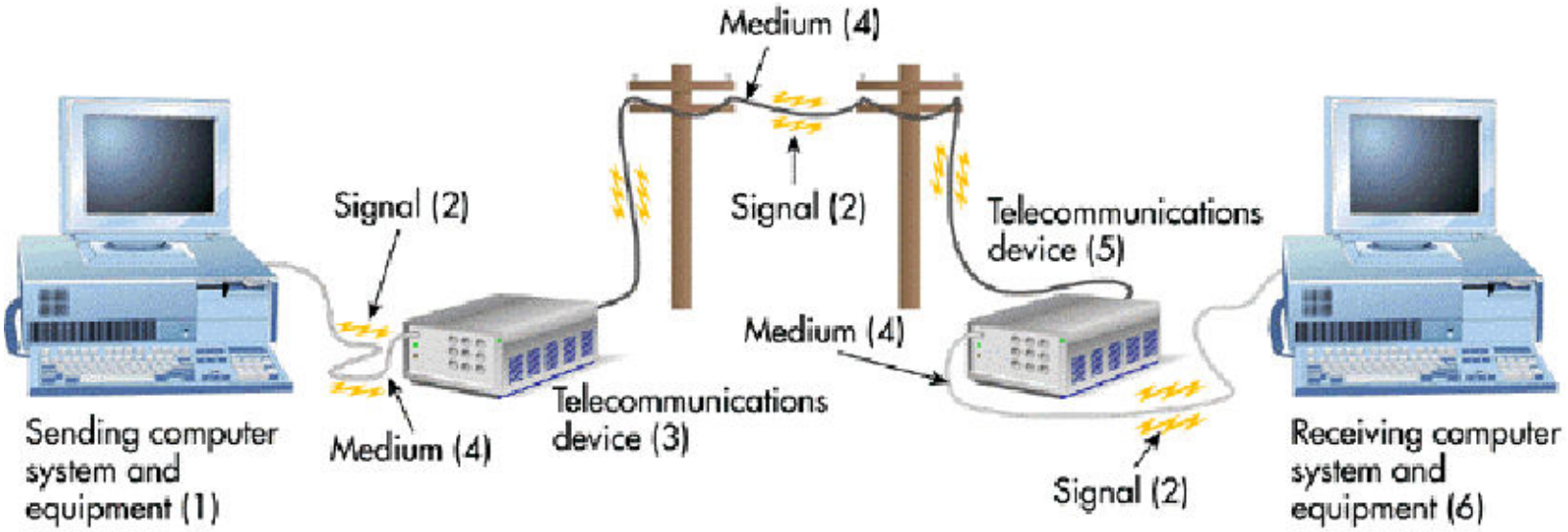
- Source
  - generates data to be transmitted
- Transmitter
  - Converts data into transmittable signals
- Transmission System
  - Carries data
- Receiver
  - Converts received signal into data
- Destination
  - Takes incoming data

Elements of Communication Systems

- Transmitter
  - Modulation
  - Coding
- Channel
  - Attenuation
  - Noise
  - Distortion
  - Interference
- Receiver
  - Detection (Demodulation+Decoding)
  - Filtering (Equalization)

Example: Microphone ----------> Speaker

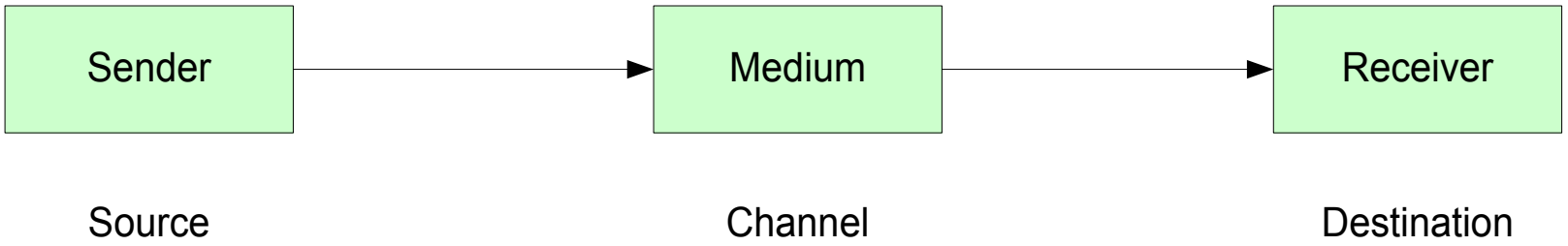
A Telecommunications Model






Medium

- A medium is the means of movement of signals from node to node.
- A medium is any material that is used for propagation or transmission of signals.







Noise

- Noise is any unwanted signal that interferes with the desired signal.




Encoding

- Encoding is the process of placing the signal of interest onto or into a carrier signal.
- Encoding signals onto or into a format for transmission is required *in all cases*.

Decoding

- Decoding of signals is required so the true data can be removed from the envelope they were sent in

Analogue and Digital Technologies

Analogue and Digital

- Original telephone networks designed for voice in analogue format (POTS)
- Analogue signals travel down lines as **electromagnetic waves**
- Speed at which they travel referred to as **frequencies**
- Frequency is the number of times per second that a wave oscillates in a cycle.
- Speed or frequency expressed in **hertz (Hz).**




Analog and Digital

- **Analog** is the process of taking an audio or video signal (the human voice) and translating it into electronic pulses.
- **Digital** on the other hand is breaking the signal into a binary format where the audio or video data is represented by a series of "1"s and "0"s.

Analogue

- Speed divided into
  - Kilohertz (kHz)
  - Megahertz (MHz)
  - Gigahertz (GHz)
- Analogue signal weakens as it travels over distances and fades or weakens
- Also picks up electrical interference or noise or static
- Boosts signal with amplifier but also amplifies noise




Analog voice

- The public switched telephone network is an ***analog*** network developed to handle voice traffic.
- Amplifiers are placed every mile or so to compensate for loss of signal strength due to attenuation.
- Boosting analog signals through repeaters amplifies all parts of the signal, including noise.




Analogue

- Original telephone networks designed for voice in analogue format (POTS)
- Analogue signals travel down lines as **electromagnetic waves**
- Speed at which they travel referred to as **frequencies**
- Frequency is the number of times per second that a wave oscillates in a cycle.
- Speed or frequency expressed in **hertz (Hz).**




Analogue …cont'd

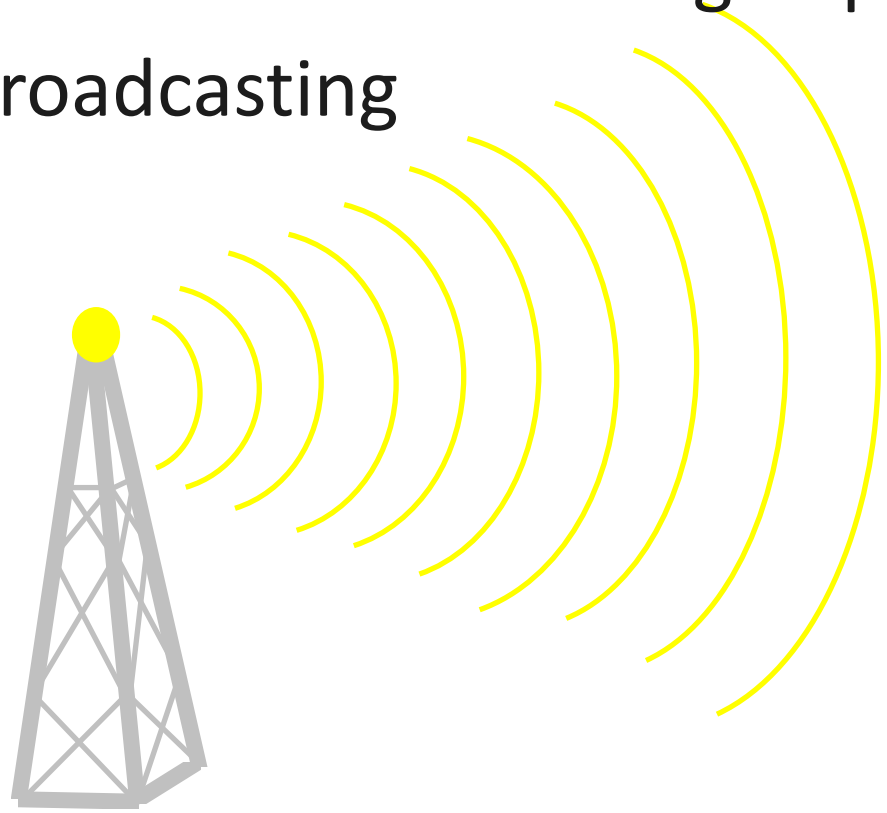
- Speed divided into
  - Kilohertz (kHz)
  - Megahertz (MHz)
  - Gigahertz (GHz)
- Analogue signal weakens as it travels over distances and fades or weakens
- Also picks up electrical interference or noise or static
- Boosts signal with amplifier but also amplifies noise

Information Representation Using Analog Signals

- Information can be represented using analog signals
- Analog signals <u>cannot</u> be manipulated easily
- Analog signals must be digitized for computer processing
  - They must also be presented in binary form for computer processing

Areas of Application

- Old telephone networks
- Most television broadcasting at present
- Radio broadcasting






Digital voice

- A method of avoiding problems caused by amplifying an analog signal is to convert the analog voice signal to a digital form for transmission.
- Digital signals also attenuate over distance, however digital signals are regenerated and amplified instead of just being amplified when required, leaving the noise behind.




Digital voice

- Transmitting voice as data communications instead of an analog signals provides a cleaner signal at the destination.
- Digital voice can be handled the same way as data, with the exception that reception delays are less tolerated for voice than data.




Characteristics of Digital

- Inefficient for increased calling volumes and data
- Digital faster, more capacity, and fewer errors, clear quality
- Digital signals transmitted in binary bits rather than waves – on or off, one or zero
- Impairments can be repaired better than analogue as noise is discarded.





Why Digital ?

Clarity. In most cases, you'll get distortion-free conversations and clearer TV pictures. The nature of digital technology allows it to cram lots of those 1s and 0s together into the same space an analog signal uses. Like your button-rich phone at work or your 200-plus digital channels cable service, that means more features can be crammed into the digital signal. Digital offers better clarity, **but analog gives you richer quality.**

Better Sound Quality

- Digital offers a better quality of sound.
- Digital has stronger battery life than analog, and for the most part, better, more modern features on the phones.

Digital Advantage

- Processing using computer technology
- Programmable services
- Better quality due to being able to reconstruct exact digital patterns at the receiving end
- Faster communication speeds are possible





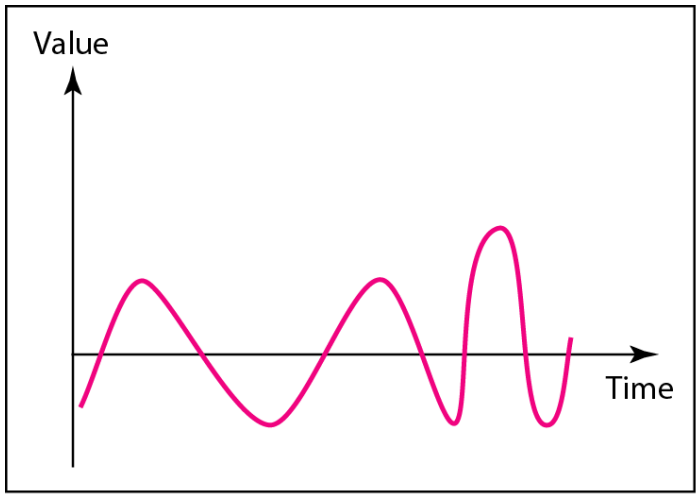



Digital versus analog

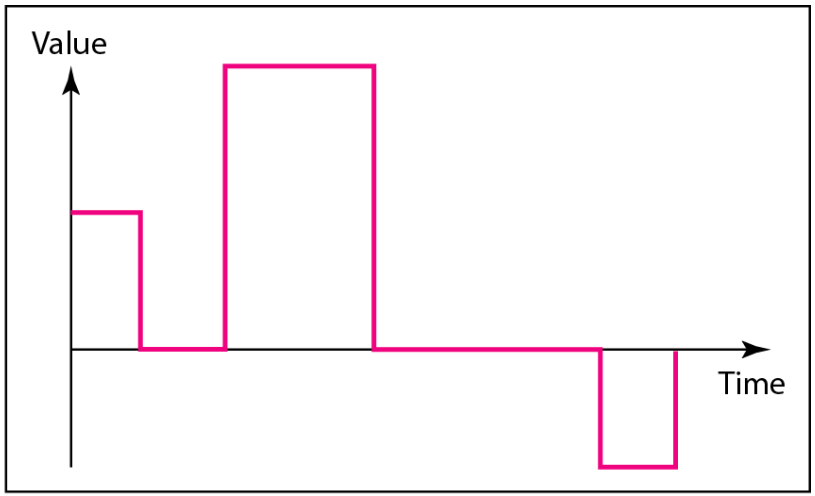
- Digital versus analog can refer to method of input, data storage and transfer, the internal working of an instrument, and the kind of display.

- The digital technology breaks your voice (or television) signal into binary code a series of 1s and 0s transfers it to the other end where another device (phone, modem or TV) takes all the numbers and reassembles them into the original signal.

Comparison of analog and digital signals

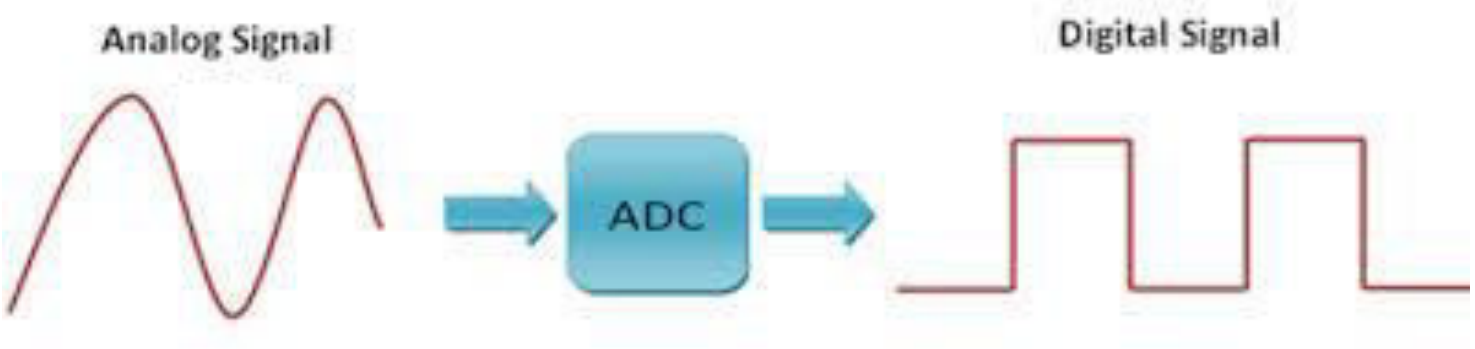


a. Analog signal



b. Digital signal

Analog to Digital Conversion

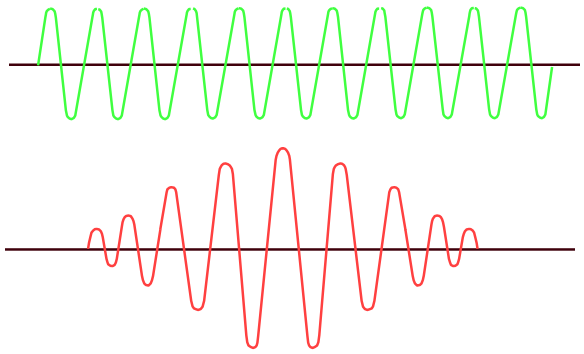


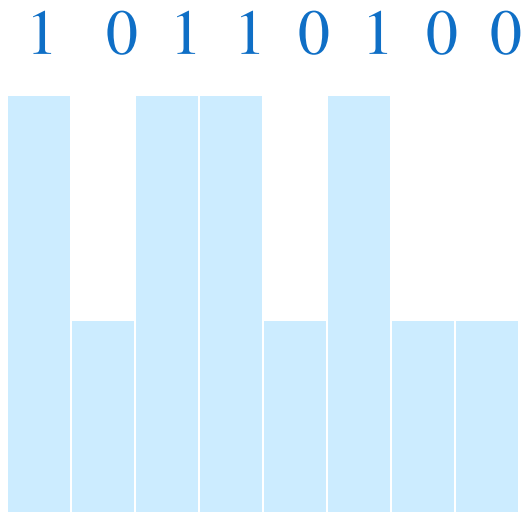



Analog to Digital Conversion

- The equipment at the receiving end of the digital circuit converts the binary numbers back to analog signals, voltage levels, using the same timing as the original sampling device.

Analog to Digital Conversion

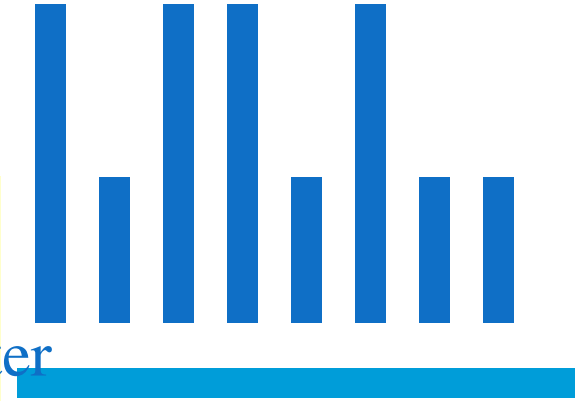




A to D Converters, Digital Signal Processors (DSP) etc.

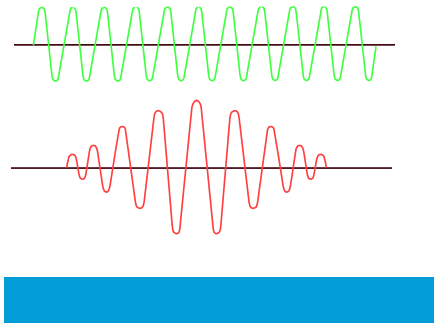
Data Transmission Using Analog Technology

Computer



Digital
0s and 1s

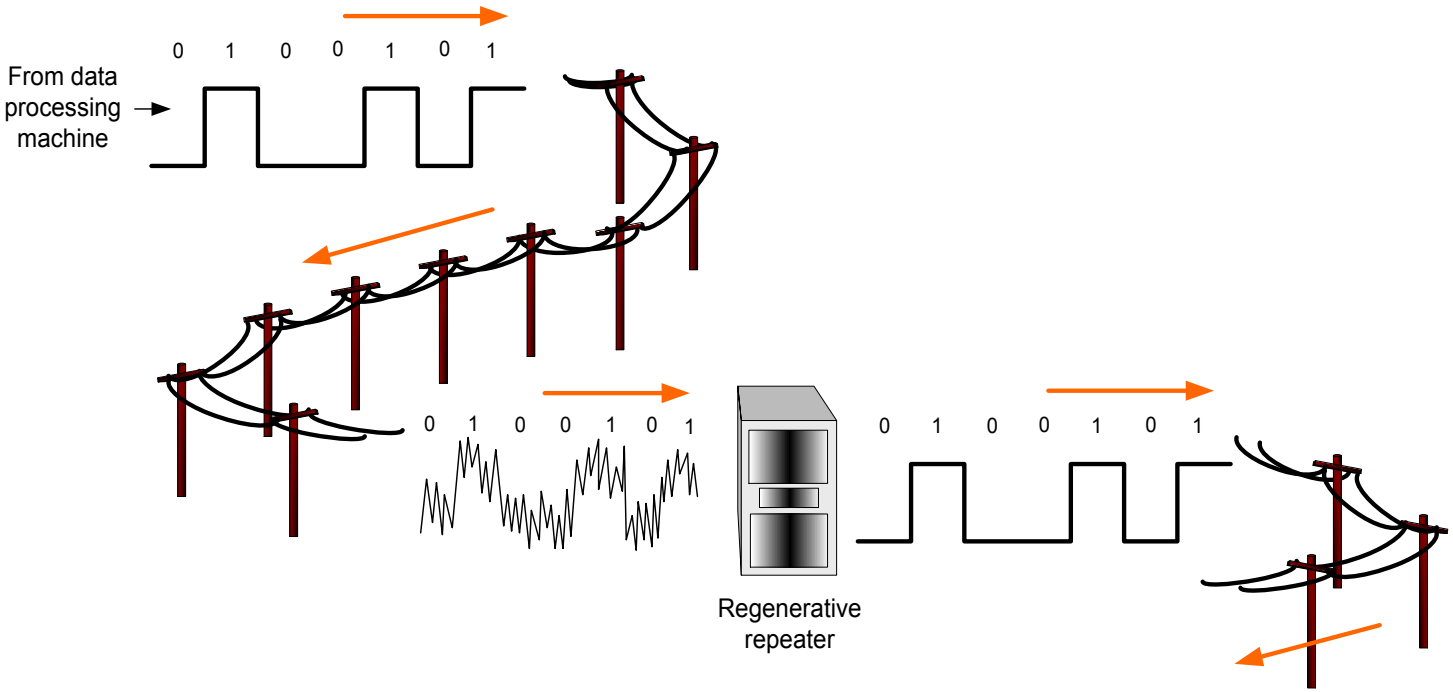
Modem



Analog
0s and 1s

Digital-to-Analog Modulation
and vice versa

Digital Signal Regeneration



Frequency Spectrum and Bandwidth




Frequency

- Frequency is the rate of change with respect to time.
- Change in a short span of time means high frequency.
- Change over a long span of time means low frequency.

Frequency

- Frequency
  - Cycles per second
  - **Hertz** is the unit used for expressing frequency
- Frequency spectrum
  - Defines the bandwidth for different analog communication technologies

Frequency Spectrum Defined

- Available range of frequencies for communication
- Starts from low frequency communication such as voice and progresses to high frequency communication such as satellite communication
- The spectrum spans the entire bandwidth of communicable frequencies

Frequency Spectrum

- Low-end
  - Voice band
- Middle
  - Microwave
- High-end
  - Satellite communication





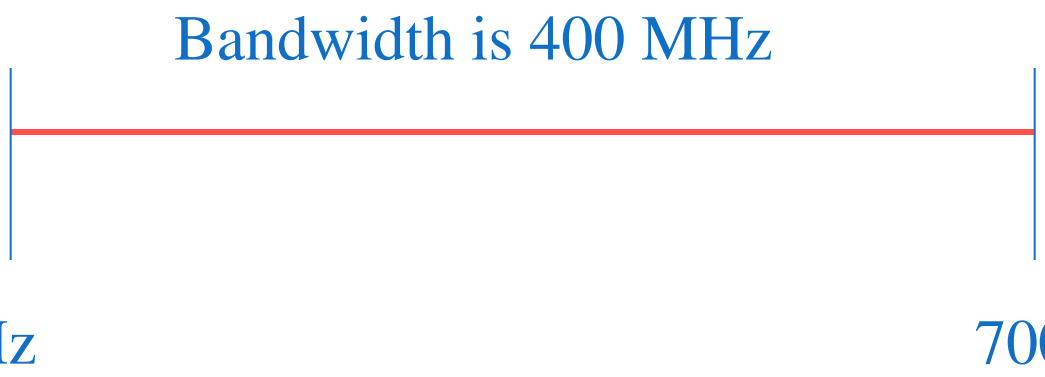
Bandwidth

- Width of the spectrum of frequencies that can be transmitted
  - if spectrum=300 to 3400Hz, bandwidth=3100Hz
- Greater bandwidth leads to greater costs
- Limited bandwidth leads to distortion




Bandwidth Definition

- Bandwidth, in general, represents a range of frequencies







Usage of the Term Bandwidth

- To specify the communication capacity
  - A medium such as a coaxial cable is associated with a bandwidth
- To indicate the bandwidth of a technology
  - Voice grade circuits have a bandwidth of 4 KHz (0-4000 Hz)

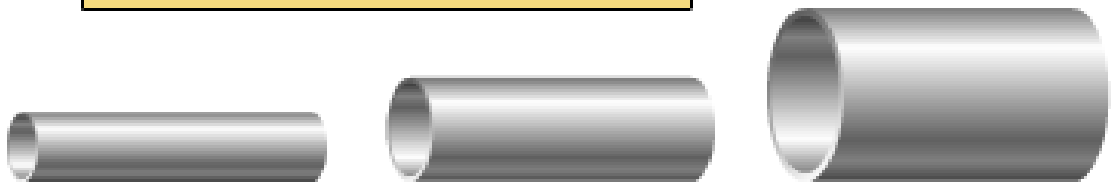



Bandwidth

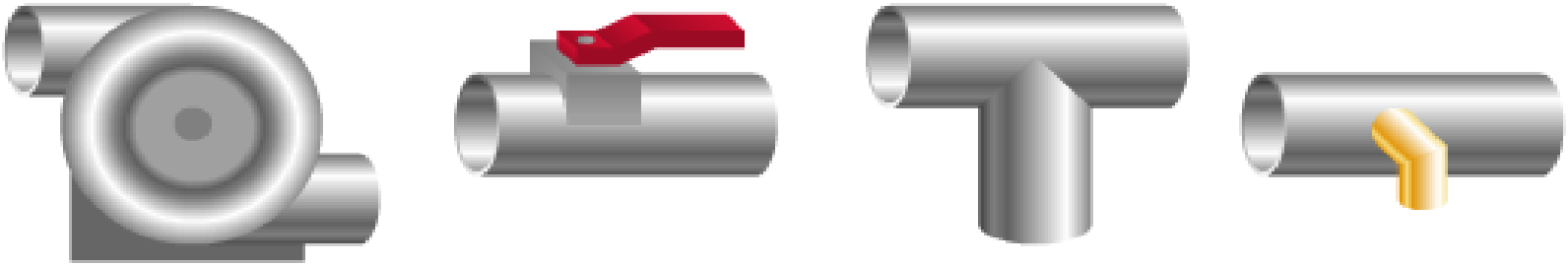
- Bandwidth is the carrying capability of the channel.
- With analog signals, bandwidth is the ability to pass a given spectrum of frequencies
- The greater the bandwidth, the better.
- The range of frequencies of a telephone channel is 0-4000 Hz, so the bandwidth is 4,000 Hz.

Bandwidth Pipe Analogy

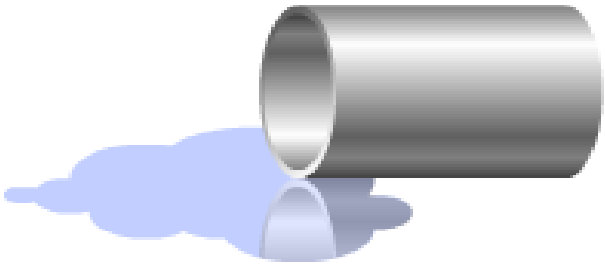
Bandwidth is like pipewidth.

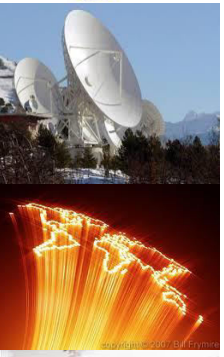


Network devices are like pumps, valves, fittings, and taps.



Packets are like water.





Bandwidth Highway Analogy

Bandwidth is like the number of lanes.

Network devices are like on-ramps, traffic signals, signs, and maps.

Packets are like vehicles.

Bandwidth Measurements

Unit of Bandwidth	Abbreviation	Equivalence
Bits per second	bps	1 bps = fundamental unit of bandwidth
Kilobits per second	kbps	1 kbps = ~1,000 bps = 10^3 bps
Megabits per second	Mbps	1 Mbps = ~1,000,000 bps = 10^6 bps
Gigabits per second	Gbps	1 Gbps = ~1,000,000,000 bps = 10^9 bps
Terabits per second	Tbps	1 Tbps = ~1,000,000,000,000 bps = 10^{12} bps

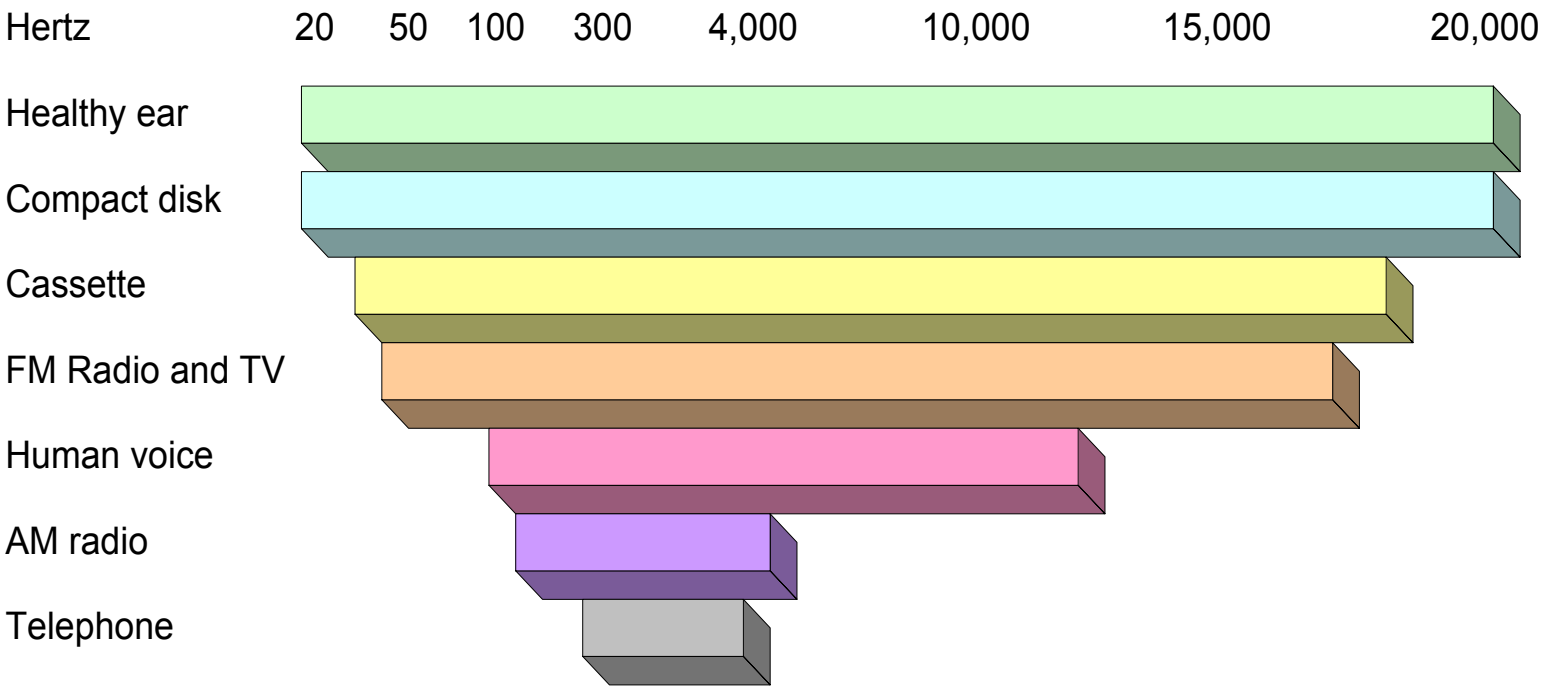
Why Bandwidth is Important

- Bandwidth is limited by physics and technology
- Bandwidth is not free
- Bandwidth requirements are growing at a rapid rate
- Bandwidth is critical to network performance





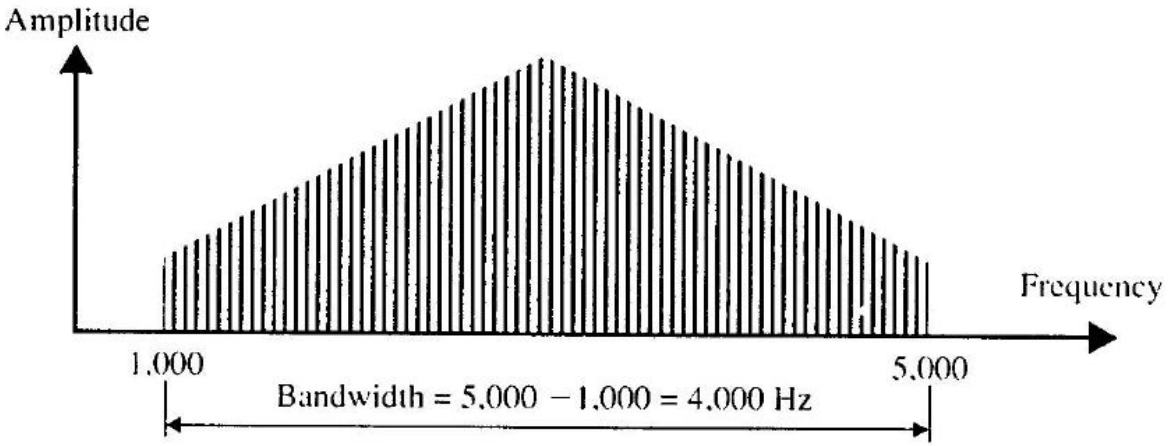
Acoustic Frequency Bandwidth of various devices



Public Switched Telephone Network (PSTN)

Audio Bandwidth

- Bandwidth
  - ***Bandwidth*** is the range of component frequencies. Example:



  - A signal may have infinite number of components.
    - In this case, ***bandwidth*** is defined to be the frequency range over which *x*% (say, 99%) of the energy of the signal lies.

Audio Bandwidth

- Effect of Limited Bandwidth

  - If a network does not have sufficient bandwidth to send all the frequency components of a signal
    - some frequency components are omitted
    - the signal is distorted.

  - If a network has a larger bandwidth to send more frequency components of an audio signal
    - the audio signal is relatively less distorted.



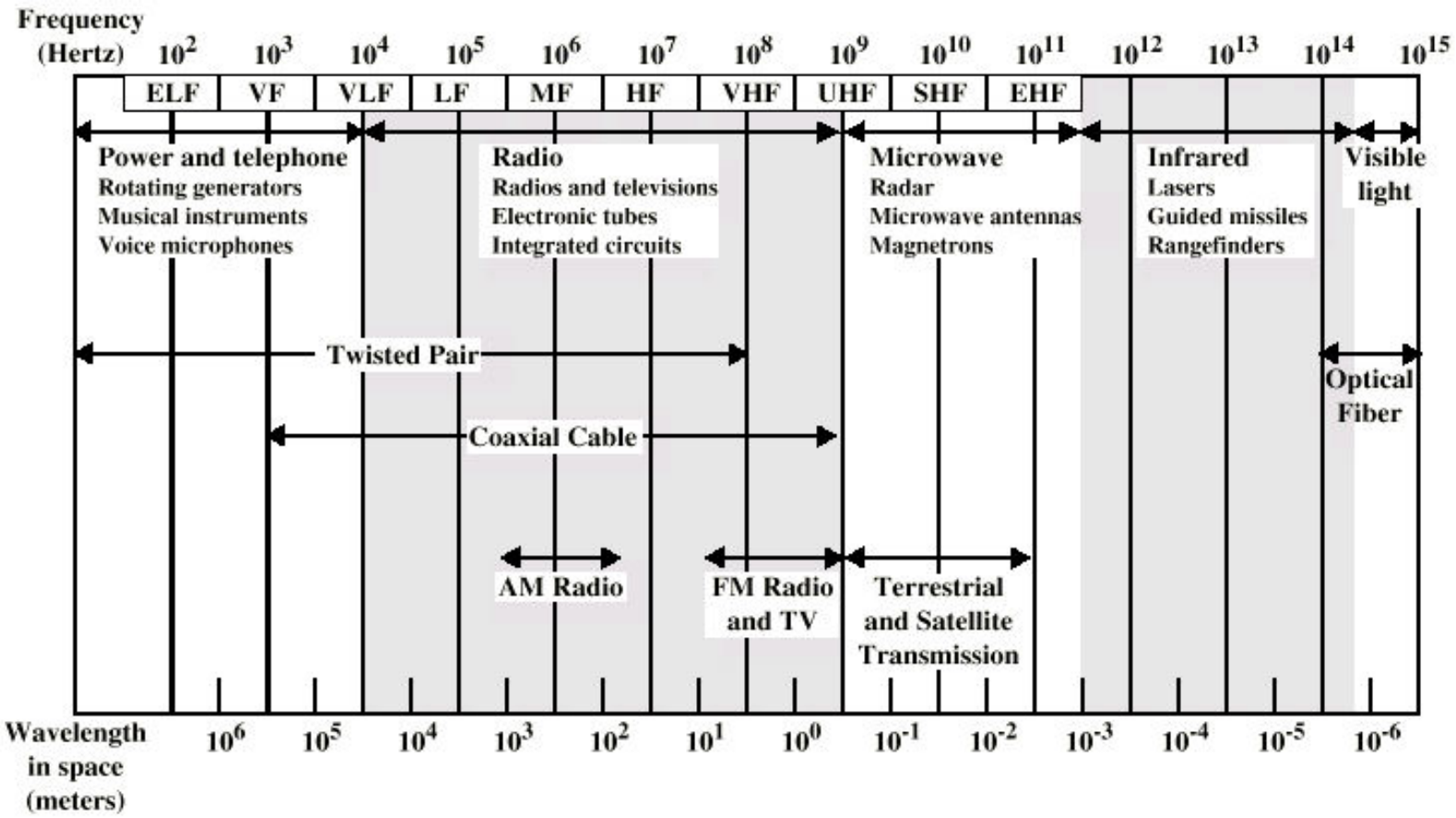





Voice print

- The human voice is made up of a combination of many simile sin waves.
- The voice print is a combination of frequencies from he lowest to the highest that a circuit can carry.

Electromagnetic Spectrum



ELF = Extremely low frequency
VF = Voice frequency
VLF = Very low frequency
LF = Low frequency
MF = Medium frequency
HF = High frequency
VHF = Very high frequency
UHF = Ultrahigh frequency
SHF = Superhigh frequency
EHF = Extremely high frequency

Signal Propagation

- Low frequency
  - Omni-directional
- High frequency (In general)
  - Unidirectional

Communication Capacity

- Bandwidth is indicative of the communication capacity
- Communication speed is proportional to bandwidth
  - Shannon's law
- Units used to represent bandwidth are Hz, bps etc.

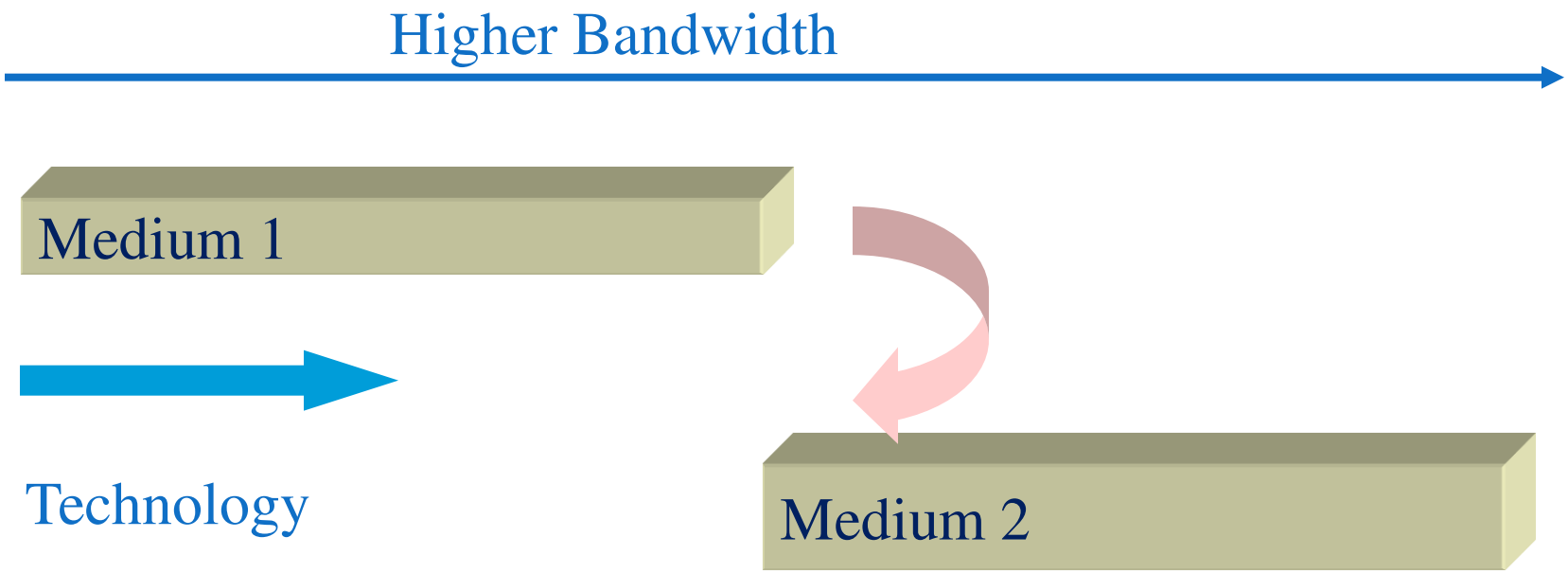




Impact of bandwidth and Technology on Communication Speed

- Bandwidth limitation
  - Use better technology such as data compression used in modems to increase speed of communication.
- Bandwidth and technology limitation
  - Move to higher bandwidth media such as fiber cables.

Speed Dependency on Bandwidth and Technology



Medium 1 example can be shielded twisted pair and medium 2 example can be fiber.





Data Rate and Bandwidth

- Any transmission system has a limited band of frequencies
- This limits the data rate that can be carried

Implication

- Whenever a new technology with higher communication speed is introduced, it is first introduced on a medium of higher bandwidth
  - Example: Optical fiber
- It is then moved to a widely used medium with further advancement of the technology
  - Example: Copper wire








AGENDA

- Introduction to Telecommunications
- **Transmission Systems**
- Switching Systems
- Signalling Systems

Transmission in Telecommunication Systems

Transmission in Telecommunications

- For the transfer of information, we need transport facilities, which employ a variety of transmission techniques.
- Original technique was optimised to handle voice transport in its basic analogue form.
- Digital transport systems can now carry voice, data and video.

Transmission Systems

- Is a means by which information passes from one point to another.
- It comprises both the **transmission medium** and **transmission interface equipment**
- A transmission medium is the medium on which the information is conveyed.

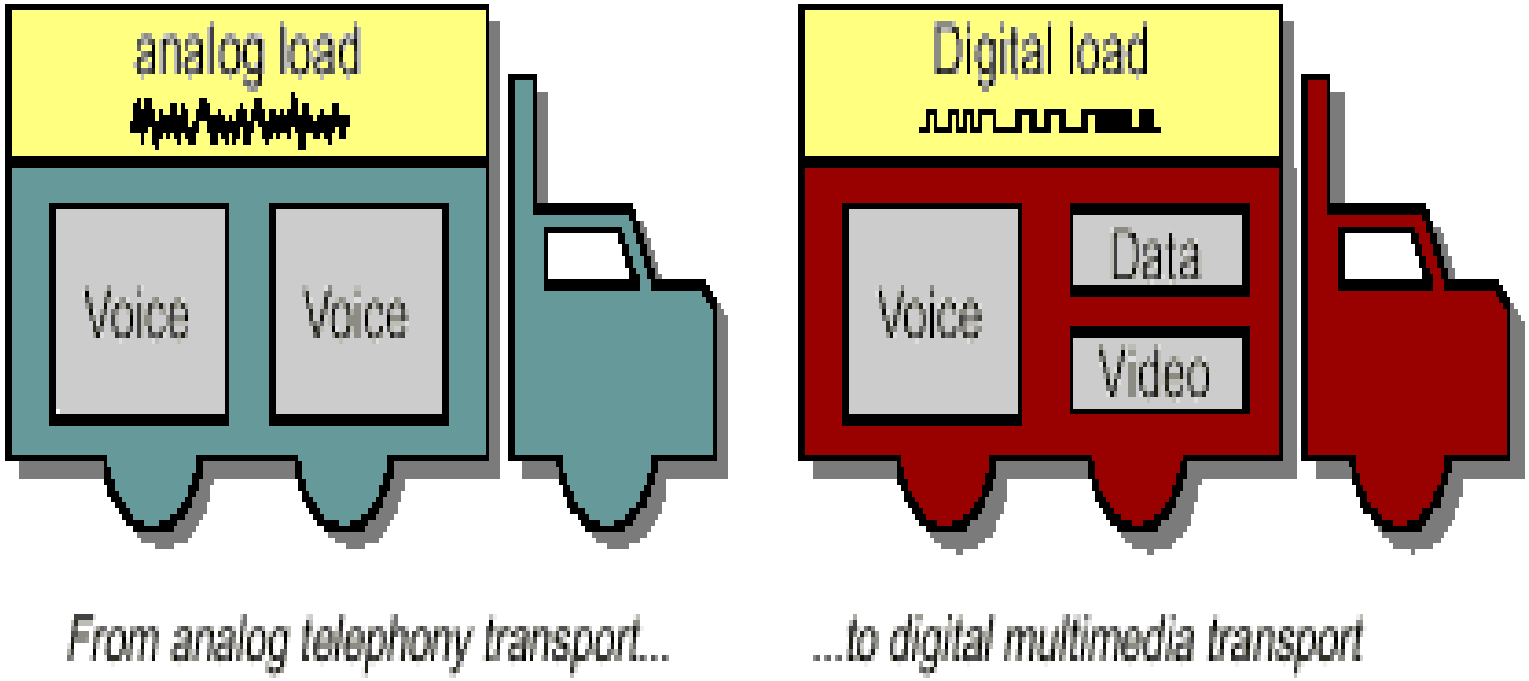


Figure: Transport of information





Transmission in PSTN

- Two forms of transmission exist:
  - Analogue transmission
  - Digital transmission

  In **analogue lines**, the sound is **amplified** at regular intervals. So is the noise.

  In **digital lines**, the signal is **regenerated.** Here, the information is created anew at every regeneration stage.

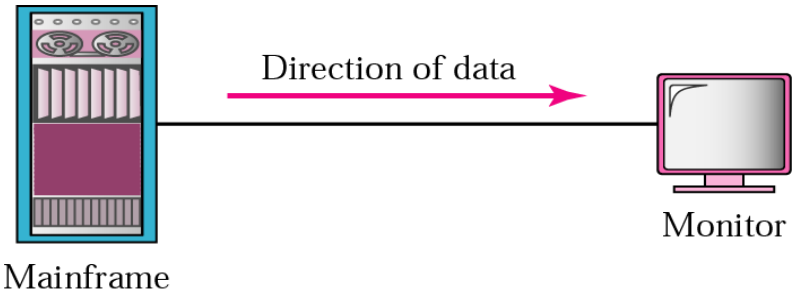
Transmission in PSTN (Cont'd)

Simplex -: Information sent in one direction only. e.g. TV broadcasts.

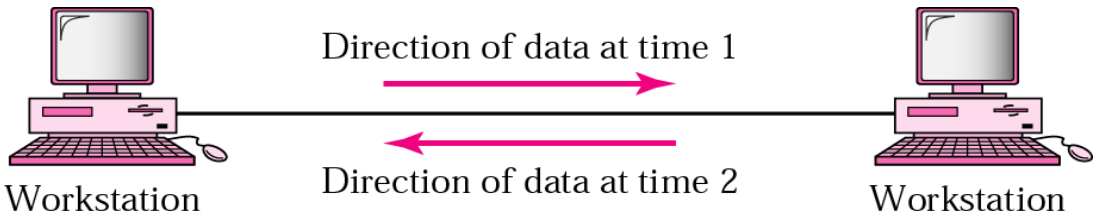
Duplex -: Duplex means that information is sent simultaneously in both directions between two points. E.g. telephony

Asymmetrical transmission: Where the information sent in one direction is greater than in the other direction. e.g. video – on- demand.

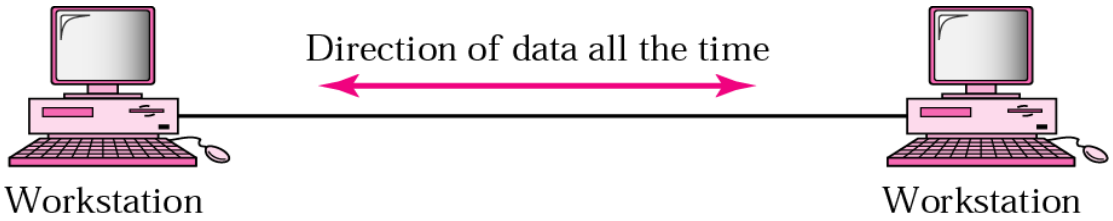
Direction of data flow



Simplex



Half Duplex



Full Duplex

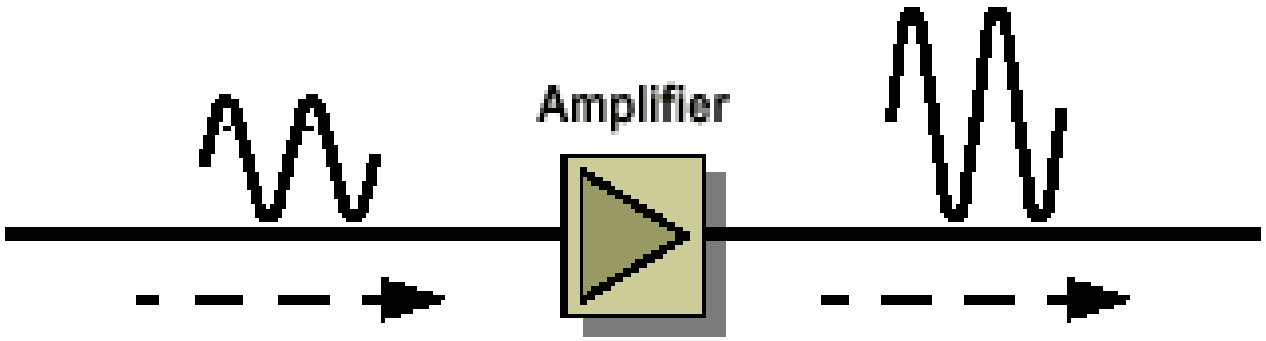


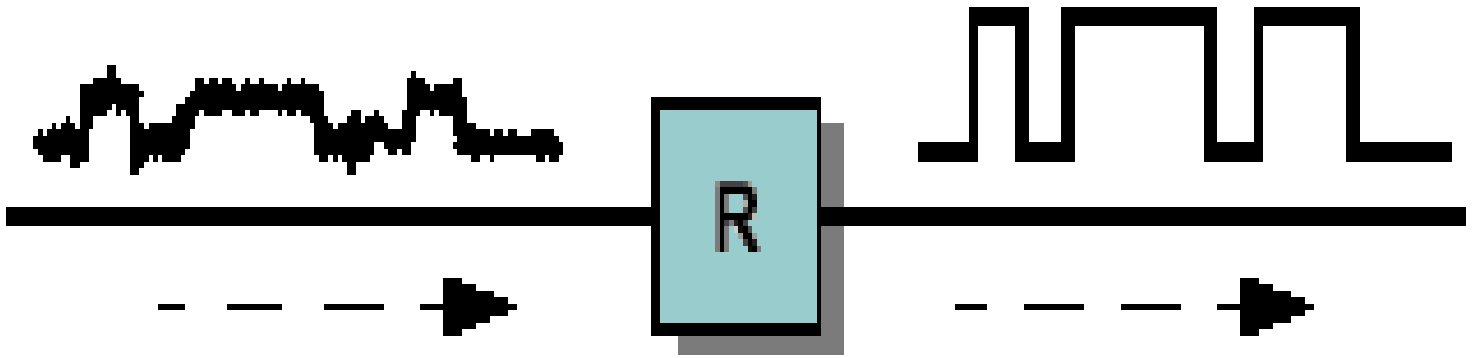


Transmission in PSTN (Cont'd)

Amplification: When the analogue signal becomes weak, repeaters are used to amplify it.

Regeneration: Used when the digital baseband signals need to be "refreshed".


Amplifier


R





Multiplexing and Demultiplexing

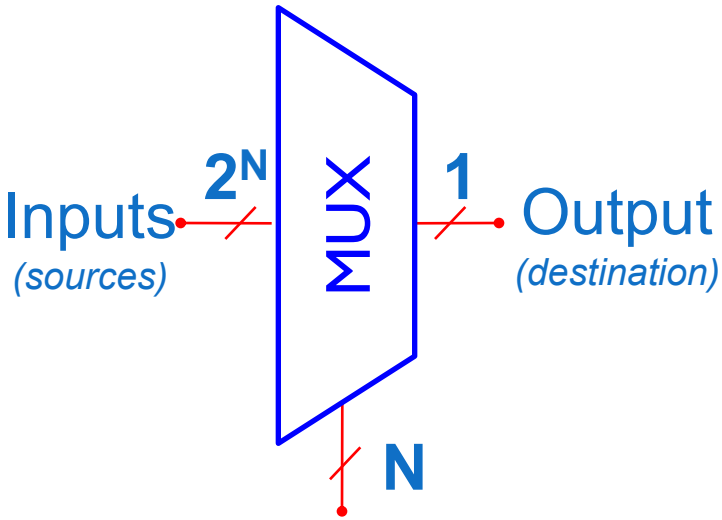
What is a Multiplexer (MUX)?

- A MUX is a digital switch that has multiple inputs (sources) and a single output (destination).
- The select lines determine which input is connected to the output.
- MUX Types
  - → 2-to-1 (1 select line)
  - → 4-to-1 (2 select lines)
  - → 8-to-1 (3 select lines)
  - → 16-to-1 (4 select lines)





Multiplexer
Block Diagram



Typical Application of a MUX





Multiple Sources

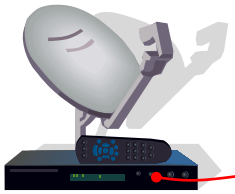
Selector

Single Destination

MP3 Player Docking Station

Laptop Sound Card

Digital Satellite



Digital Cable TV

D0
D1
D2
D3

MUX

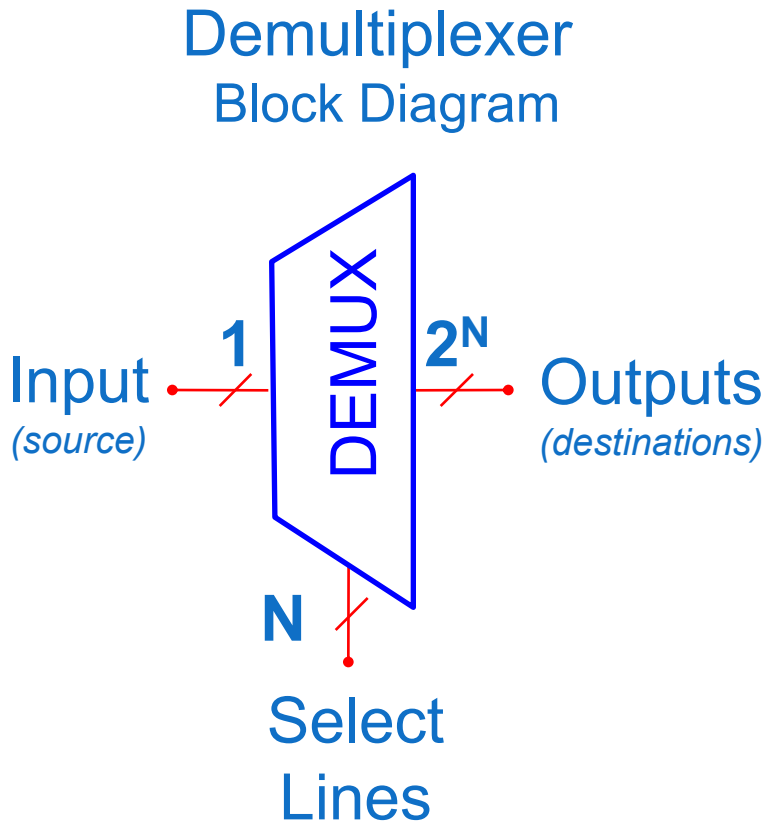
Y

Surround Sound System

B	A	Selected Source
0	0	MP3
0	1	Laptop
1	0	Satellite
1	1	Cable TV

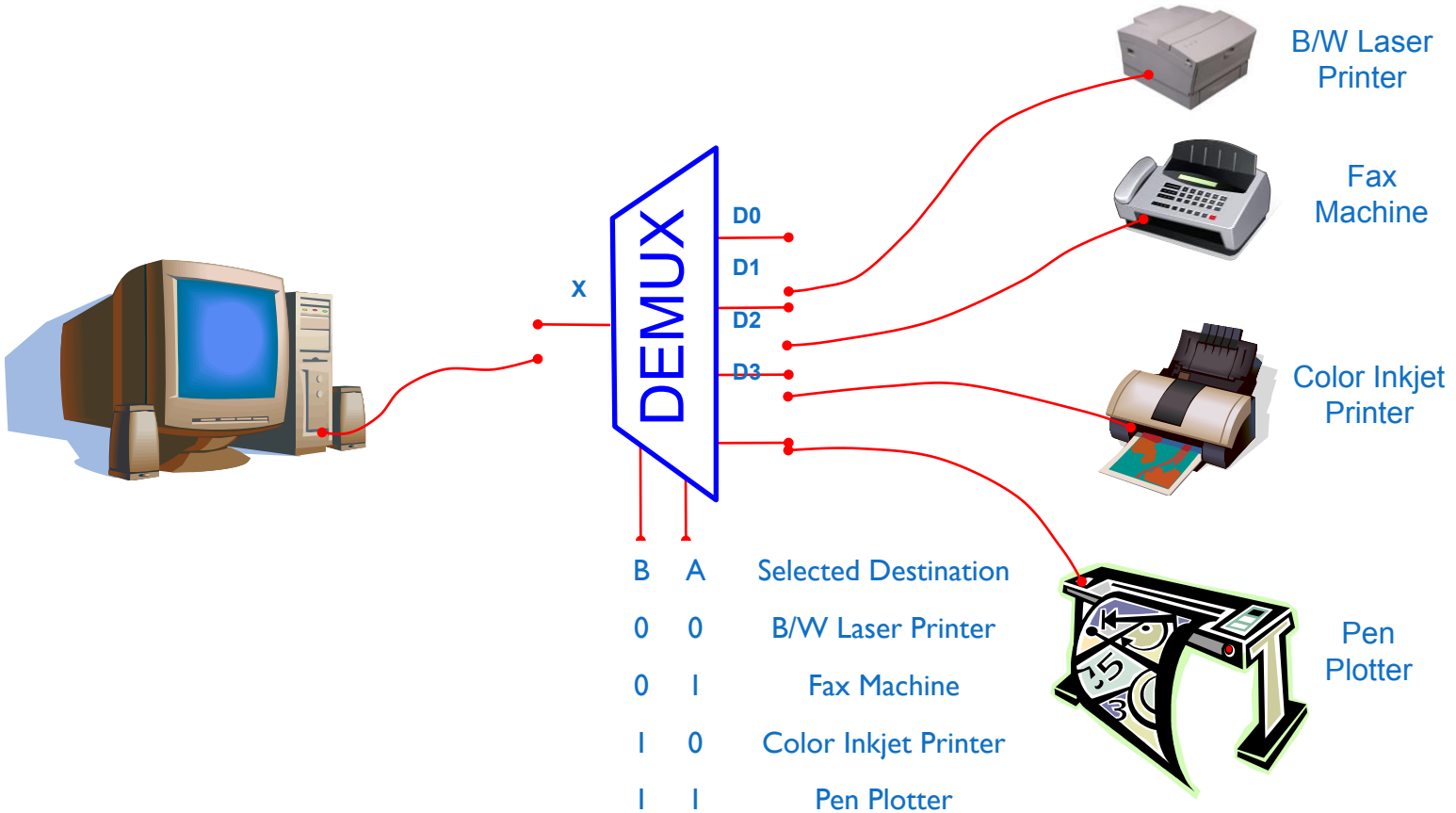
What is a Demultiplexer (DEMUX)?

- A DEMUX is a digital switch with a single input (source) and a multiple outputs (destinations).
- The select lines determine which output the input is connected to.
- DEMUX Types
  - → 1-to-2 (1 select line)
  - → 1-to-4 (2 select lines)
  - → 1-to-8 (3 select lines)
  - → 1-to-16 (4 select lines)



Typical Application of a DEMUX

Single Source | Selector | Multiple Destinations



B	A	Selected Destination
0	0	B/W Laser Printer
0	1	Fax Machine
1	0	Color Inkjet Printer
1	1	Pen Plotter

Transmission in PSTN (Cont'd)

Multiplexing: A technique of transmitting several calls on the same physical connection (such as a wire pair)

There are three types of multiplexing:-

- Frequency division multiplexing (FDM)
- Time division multiplexing (TDM)
- Wavelength division multiplexing (WDM)

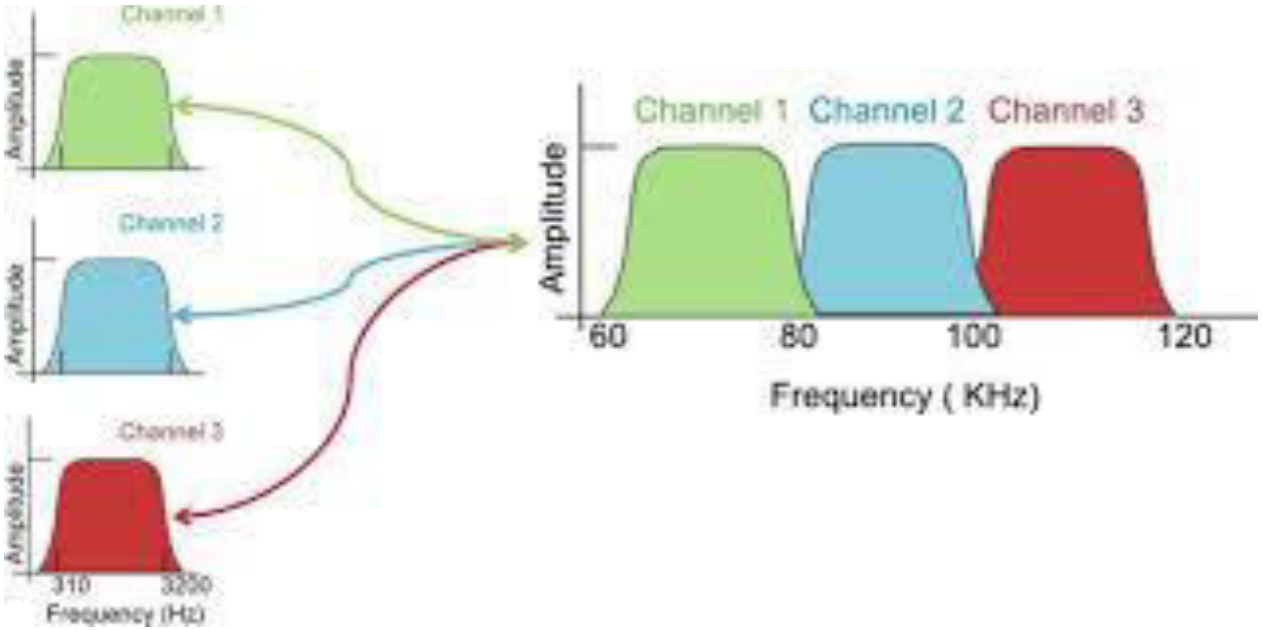


Figure: Frequency division multiplexing, three channels

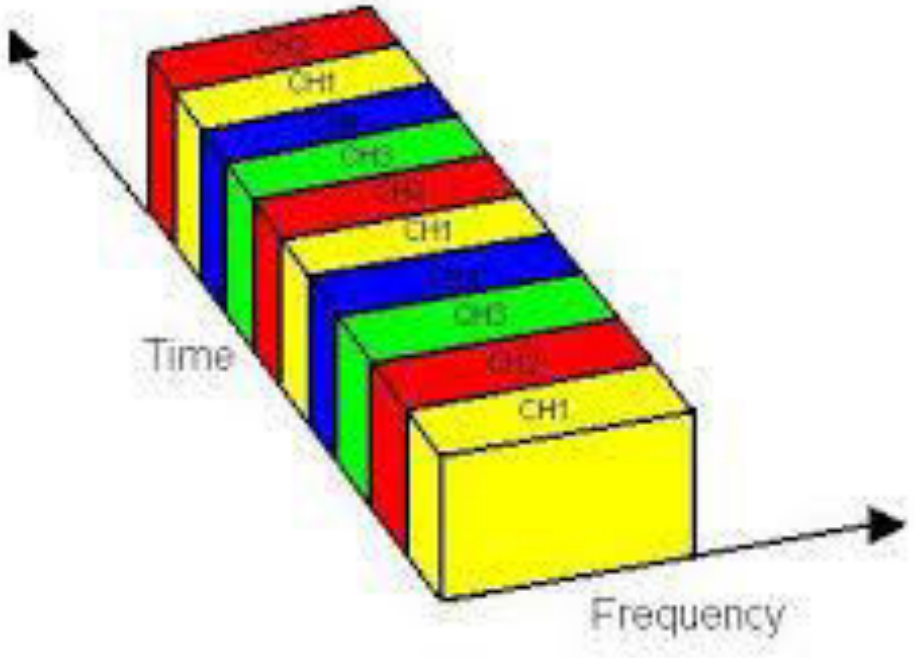


Figure: Time division multiplexing, three channels

Transmission in PSTN (Cont'd)

- Wavelength Division Multiplexing: Enables a number of channels to be sent at different wavelengths in the same fibre, in the same direction or in both directions.

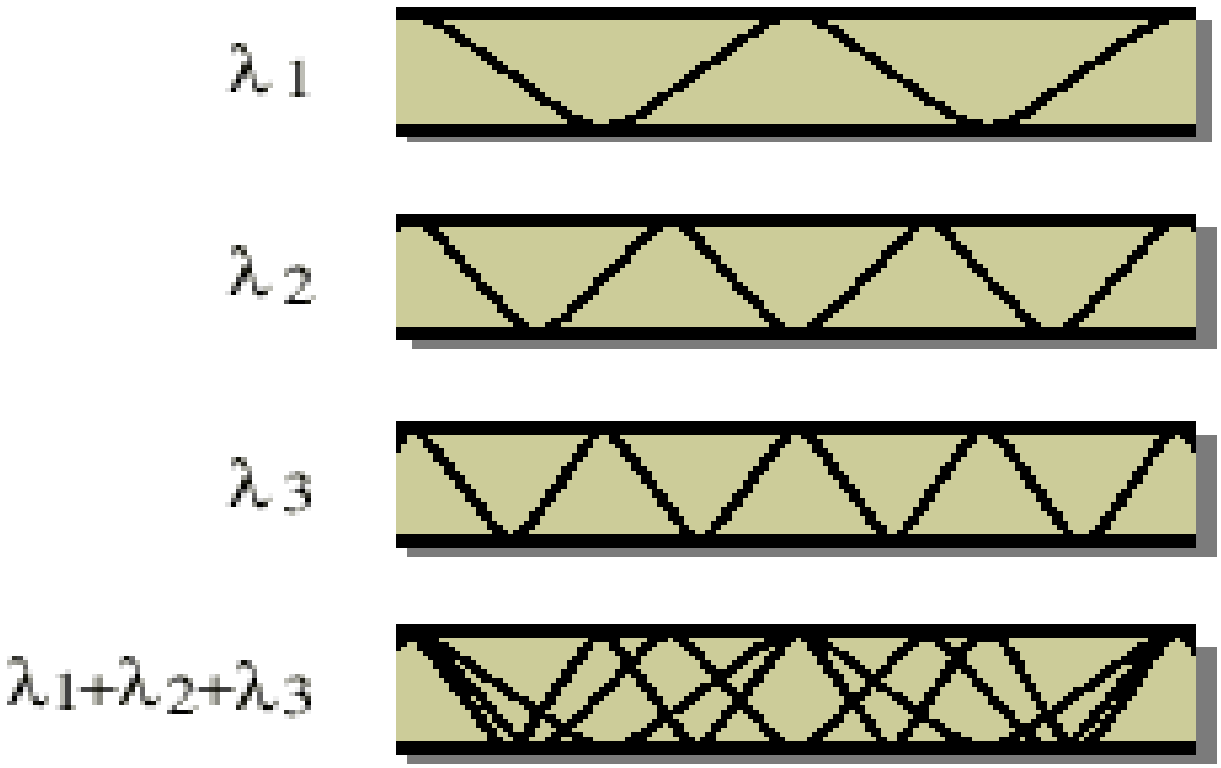


Figure: Wavelength Division Multiplexing

Digital Transmission and Digital Multiplexing

- Digital transmissions transmit sounds in the form of a stream of binary numbers.
- Binary Numbers – numbers represented by”0”and “1”. These numbers are transmitted as a series of electrical pulses along the transmission medium.
- If the transmission medium is fiber optic cable, the numbers are transmitted as a series of light pulses.
- Speech is easily recognizable in the range of 300 to 3400 Hertz.

Digital Transmission and Digital Multiplexing

- Advantages of transmitting sound in digital form include :
  - Possible to transmit a digital signal over any distance with extremely low degradation
  - Digital multiplexing and demultiplexing is a more stable and adaptable process than analogue multiplexing.
  - It permits the use of techniques known as **digital compression** which effectively increase the capacity of a single transmission medium by a factor of 4 or more.




Digital Transmission and Digital Multiplexing (cont'd)

- Enables computers and other digital devices to communicate with each other across the network; and

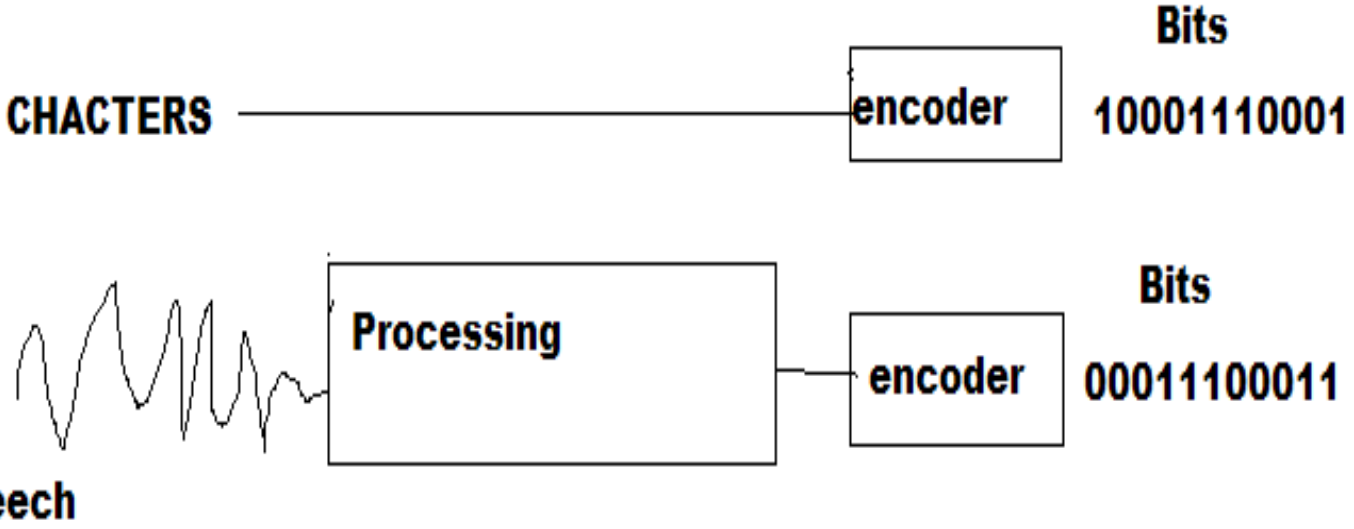
- It permits the use of more sophisticated signalling system

Digital Transmission and Digital Multiplexing (cont'd)

- Capacity of a digital transmission line is expressed by the speed or rate at which it is able to transmit digital information. E.g. a single voice transmission operates at 64 kb/s.
- **Over copper wire** – 2.048kb/s or 2Mb/s. Also known as E1.
- **Over optical wire** – much higher speeds are possible.

The encoding process

- To simplify communication process, information is converted into binary bits so that the communication channel has only **two characters** to choose from i.e. **0 and 1**.
- This is convenient because by appropriate techniques all types of information can be converted into binary format.


CHACTERS
encoder
Bits
10001110001
Processing
encoder
Bits
00011100011
Speech

Modem

- The telephone network can be used for data communication.
- However, since the network is designed for transmitting speech, it can not handle the computers' digital signals directly.
- Conversion of signals to analogue is necessary

Modem Cont'd….

- Modem – **Mo**dulator and **Dem**odulator

- The modulator converts the computer's digital voltage pulses to tone-like signals and the demodulator works in the opposite direction.

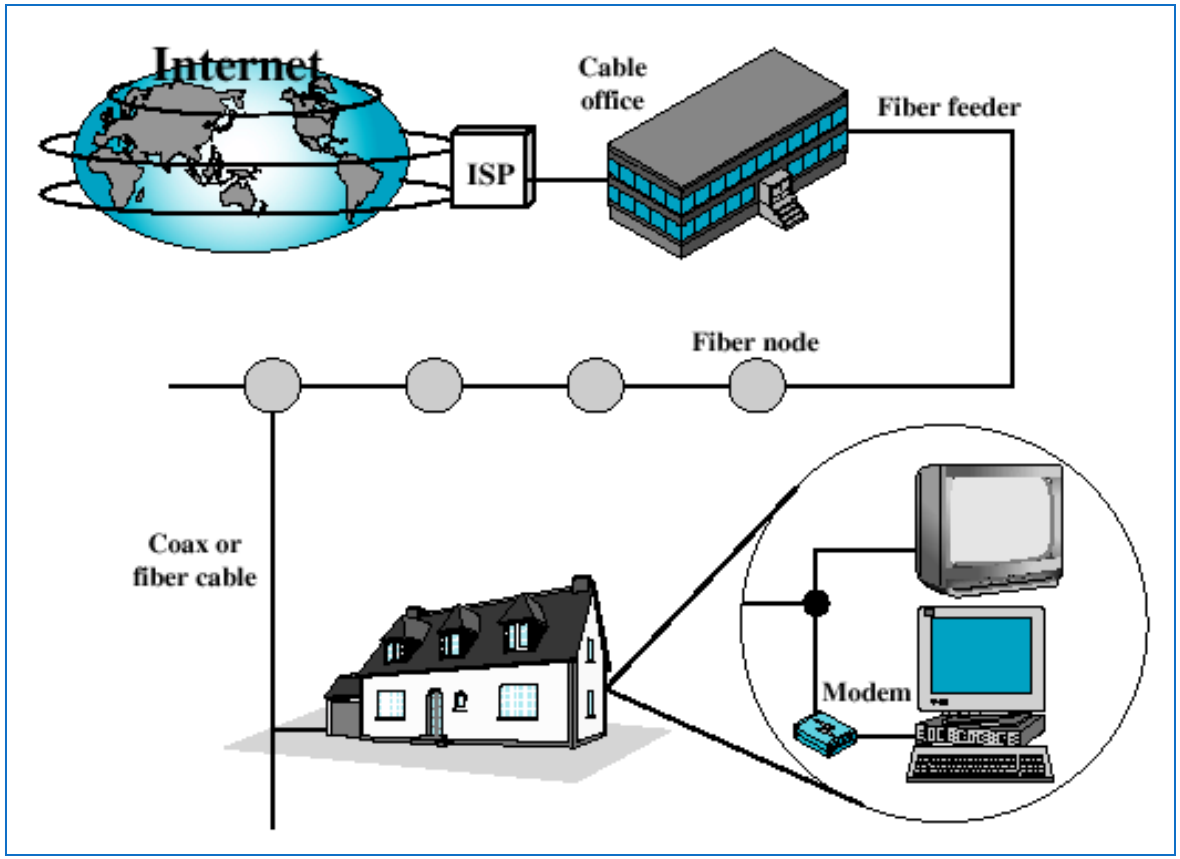
Cable Modems

- Permits Internet access over cable television networks.
- ISP is at or linked by high-speed line to central cable office
- Cables used for television delivery can also be used to deliver data between subscriber and central location
- Upstream and downstream channels are shared among multiple subscribers, time-division multiplexing technique
- Splitter is used to direct TV signals to a TV and the data channel to a cable modem





Cable Modem Layout



Transmission Media





Terminology (1)

- Transmitter
- Receiver
- Medium
  - Guided medium
    - e.g. twisted pair, optical fiber
  - Unguided medium
    - e.g. air, water, vacuum





Terminology (2)

- Direct link
  - No intermediate devices
- Point-to-point
  - Direct link
  - Only 2 devices share link
- Multi-point
  - More than two devices share the link





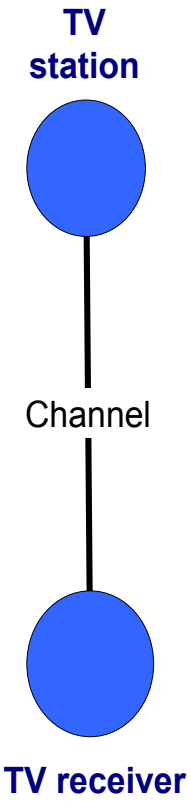
Electromagnetic Signals

- Analog Signal
  - signal intensity varies in a smooth fashion over time. In other words, there are no breaks or discontinuities in the signal
- Digital Signal
  - signal intensity maintains a constant level for some period of time and then changes to another constant level

Channels







- Channels are logical paths for communicating data
- It is not necessarily a pair of wires.
- A channel connects the source to the receiver or destination
- Thought of as a one-way communications path.
- Transmission is usually electrical, but can also be photonic




Circuit verses Channel

- A communications circuit is a path over which a signal can travel.
- **Circuits** are generally thought of as something physical, like wire or radio wave.
- A **channel** is the actual path for the signal and may occupy the total circuit or be a portion of it

Electrical, Electromagnetic and Photonic circuits

- Electrical uses direct or alternating current to carry a signal on a conductive medium.
- Electromagnetic circuits use rapidly varying (high-frequency) current to carry the signal.
- Photonic circuits use light as the data carrier on a transparent media.

Overview Of The Transmission Media

- Guided - wire
- Unguided - wireless
- Characteristics and quality determined by medium and signal
- For guided, the medium is more important
- For unguided, the bandwidth produced by the antenna is more important
- Key concerns are data rate and distance





Design Factors

- Bandwidth
  - Higher bandwidth gives higher data rate
- Transmission impairments
  - Attenuation
- Interference
- Number of receivers
  - In guided media
  - More receivers (multi-point) introduce more attenuation

Transmission

- All transmission must be carried by some medium, whether it be copper, glass, or radio or light waves in space.
- Each medium has a capacity and each has a susceptibility to noise.

Types of Media

- Twisted-pair copper
- Coaxial cable
- Radio
  - Microwave
  - Satellite
  - Omi-directional
- Photonic
  - Fiber optic
  - infrared





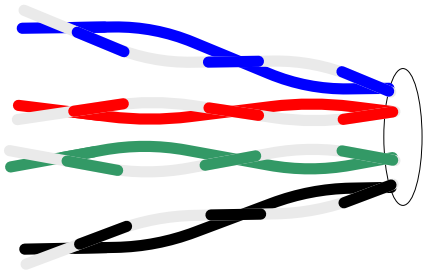


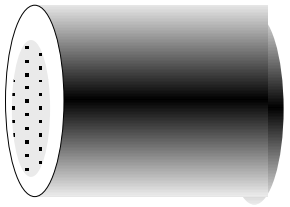


Characteristics of circuit media

Wire

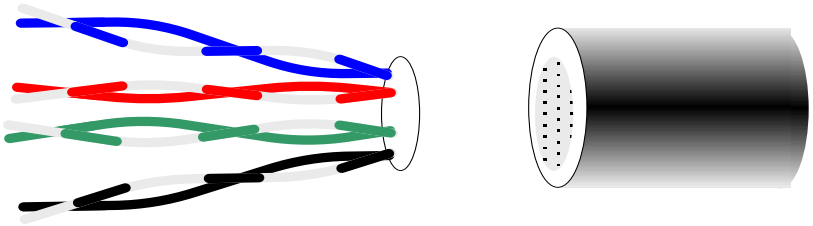
1. 22-26 gauge copper
2. Low bandwidth
3. Used for virtually all local loops
4. Low installation cost
5. Susceptible to noise

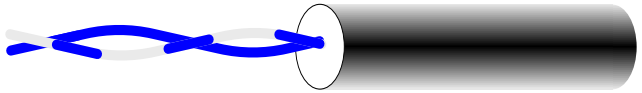




Twisted-pair copper wire

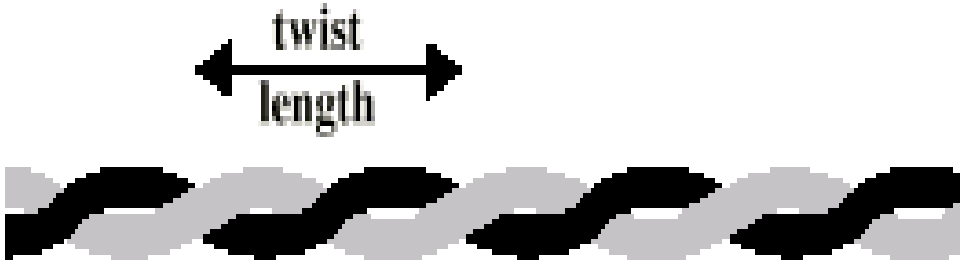
- Twisted-pair copper wire is the most used, lowest cost media.
- A loop formed with a single wire going from the sender to the receiver and back.
- Seen as a pair of wires.





Twisted Pair

—Separately insulated
—Twisted together
—Often "bundled" into cables
—Usually installed in building during construction



(a) Twisted pair




Twisted Pair - Applications

- Most common medium
- Telephone network
  - Between house and local exchange (subscriber loop)
- Within buildings
  - To private branch exchange (PBX)
- For local area networks (LAN)
  - 10Mbps or 100Mbps

Twisted Pair - Pros and Cons

- Cheap
- Easy to work with
- Low data rate
- Short range





Twisted Pair - Transmission Characteristics

- Analog
  - Amplifiers every 5km to 6km
- Digital
  - Use either analog or digital signals
  - repeater every 2km or 3km
- Limited distance
- Limited bandwidth (1MHz)
- Limited data rate (100MHz)
- Susceptible to interference and noise





Unshielded and Shielded TP

- Unshielded Twisted Pair (UTP)
  - Ordinary telephone wire
  - Cheapest
  - Easiest to install
  - Suffers from external EM interference
- Shielded Twisted Pair (STP)
  - Metal braid or sheathing that reduces interference
  - More expensive
  - Harder to handle (thick, heavy)





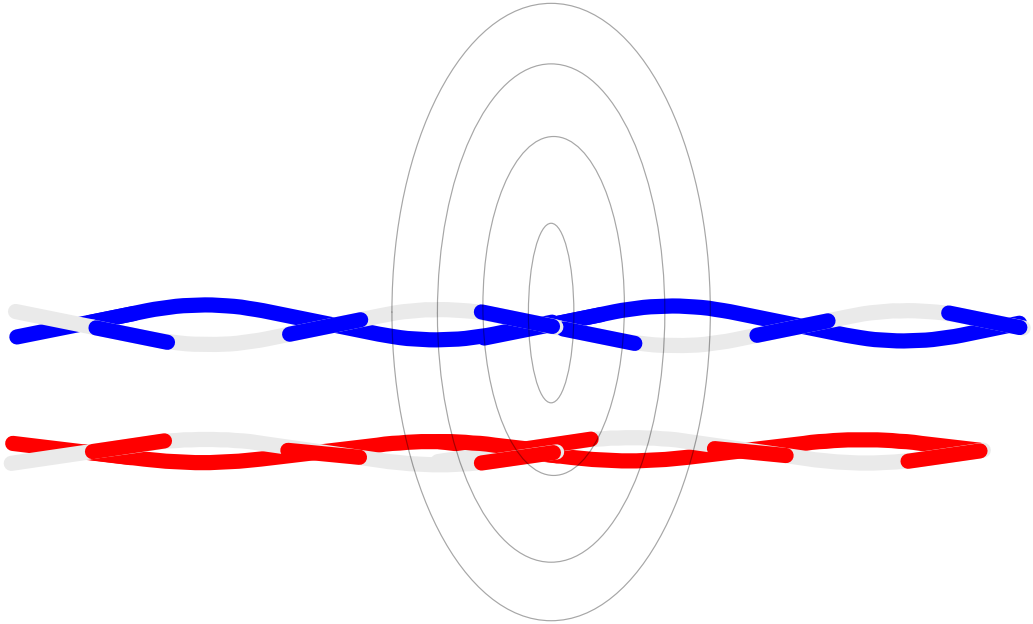
UTP Categories

- Cat 3
  - up to 16MHz
  - Voice grade found in most offices
  - Twist length of 7.5 cm to 10 cm
- Cat 4
  - up to 20 MHz
- Cat 5
  - up to 100MHz
  - Commonly pre-installed in new office buildings
  - Twist length 0.6 cm to 0.85 cm

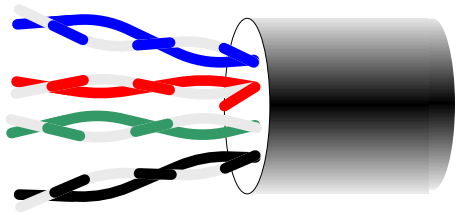



Crosstalk

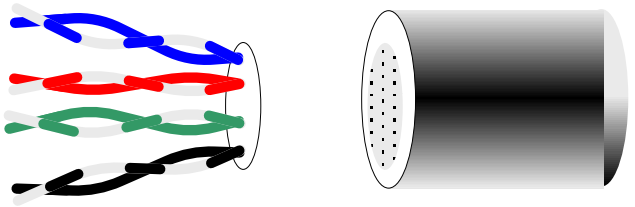
- Crosstalk is the radiation of signals from one circuit to another.



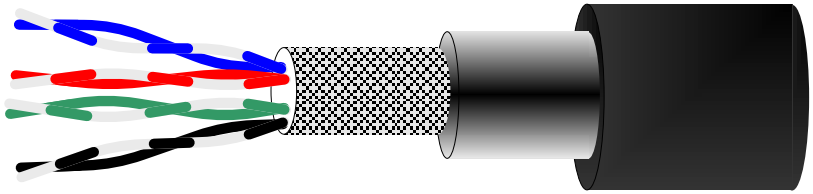
Cable shielding guide



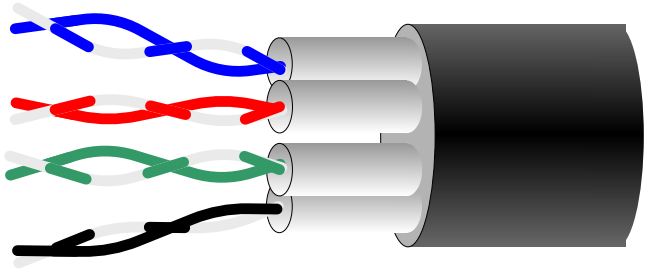
Unshielded



Single Shield



Double Shield -
Foil and Braid



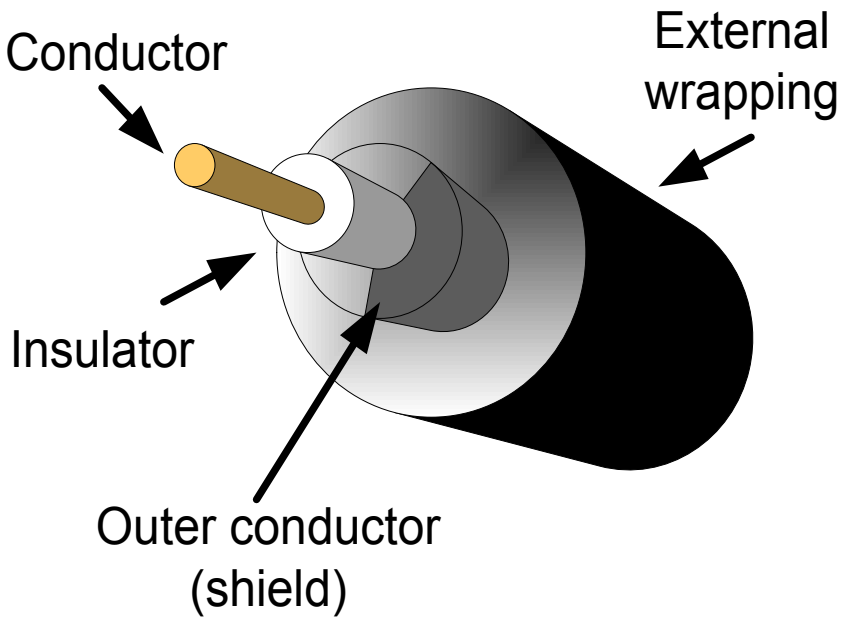
Individually Shielded Pair





Coaxial cable

- Coaxial cable is similar to a pair of copper wires except that one wire is a sheath that encompasses the other wire and shields it from noise.



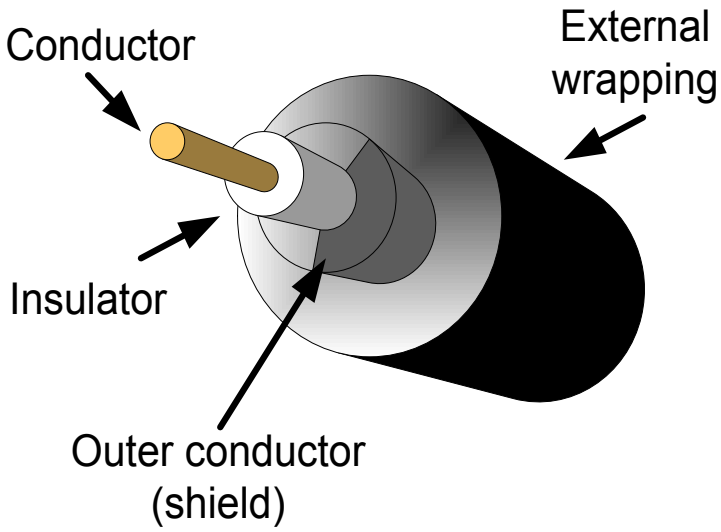
Characteristics of circuit media





Coaxial cable

1. Ground is shielded (immune to interference)
2. Bandwidth of 300MHz, 500 MHz, 750 MHz
3. Up to 10,800 voice conversations
4. Amplifiers every mile
5. 50-100 analog TV channels/cable
6. Cable tapped easily; low to medium security
7. Any analog channel can be digitized with modems with a bandwidth of 27 Mbps.



Impact of Attenuation

- Attenuation is the reduction of signal strength (or voltage) as the signal propagates along the circuit.
- This means the voltage level of the signal is lowered as the signal moves down the wire.
- To keep the signal at acceptable levels, a repeater or amplifier is placed along the circuit to amplify the signal.





Coaxial Cable Applications

- Most versatile medium
- Television distribution
  - Ariel to TV
  - Cable TV
- Long distance telephone transmission
  - Can carry 10,000 voice calls simultaneously
  - Being replaced by fiber optic
- Short distance computer systems links
- Local area networks





Coaxial Cable - Transmission Characteristics

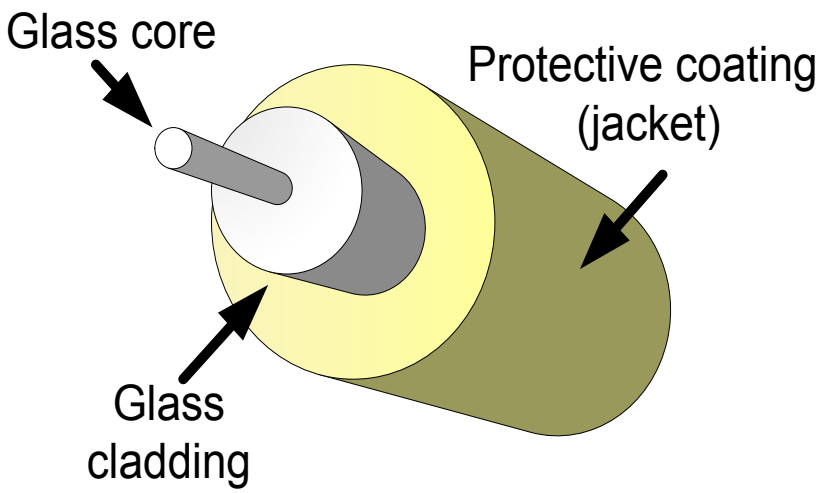
- **Analog**
  - Amplifiers every few km
  - Closer if higher frequency
  - Up to 500MHz
- **Digital**
  - Repeater every 1km
  - Closer for higher data rates

Fiber Optic Cables

1. Made of glass or plastic
2. Difficult to splice
3. Secure
4. Very high speed
5. Unidirectional strand
6. Difficult to split signal
7. Immune to RFI, EMI , crosstalk
8. Most expensive, greatest bandwidth = low cost/bit

Fiber optic cables

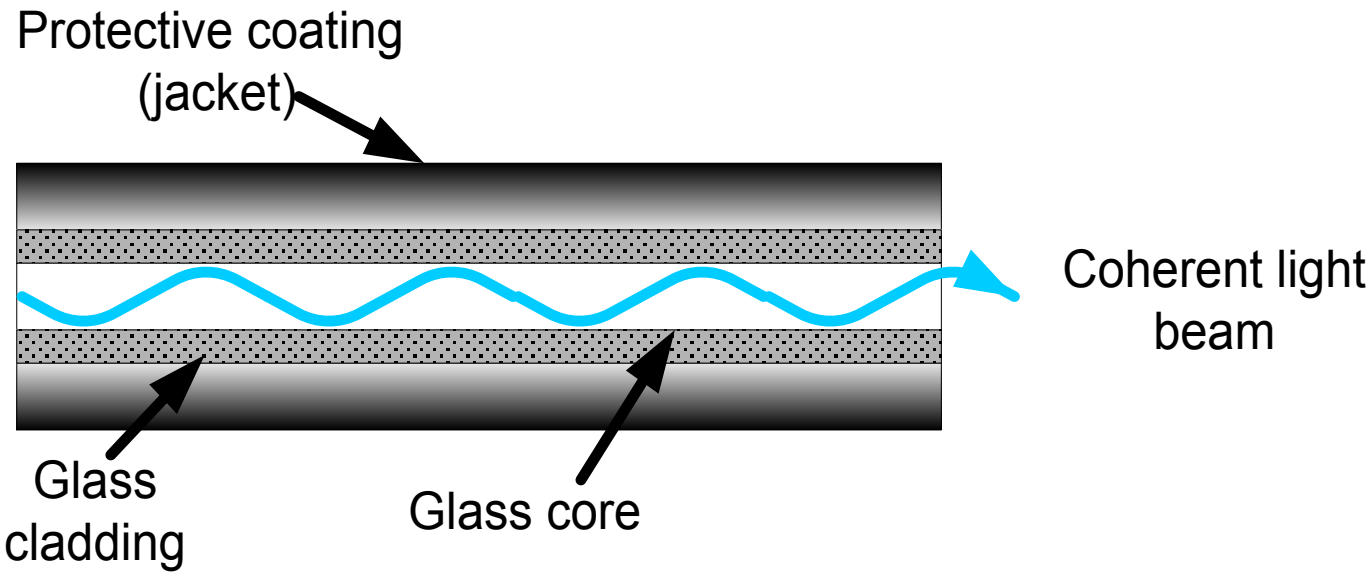
- Fiber optic cables are made up of very small one-way glass stands that have the greatest bandwidth of any media used.
- Circuits often begin and end with some other media.







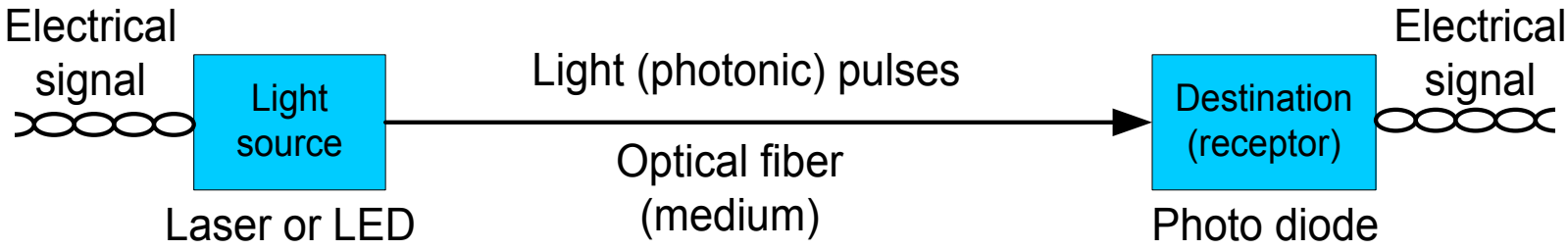
Fiber optic cables






Fiber optic circuits

- Fiber optic circuits use a laser or light-emitting diode (LED) as the source and an optical detector at the receiving end.
- There must be a light-to-electrical signal conversion at each end until optical switching is available.



Optical Fiber - Benefits

- Greater capacity
  - Data rates of hundreds of Gbps
- Smaller size & weight
- Lower attenuation
- Electromagnetic isolation
- Greater repeater spacing
  - 10s of km at least





Optical Fiber - Applications

- Long-haul trunks
- Metropolitan trunks
- Rural exchange trunks
- Subscriber loops
- LANs





Optical Fibre

- Used primarily in urban networks and for long-distance connections, mainly digital transmission
- Enormous transmission capacity (E.g. 2.5 Gbit/s approx. corresponds to 32,000 simultaneous telephone calls at 64Kbit/s).








Optical Media

Optical Fibre

- Used for longer, high bandwidth, point-to-point transmissions required on LAN backbones and on WANs
- Not susceptible to lighting, EMI or RFI
- Does not generate EMI or RFI




Cont'd….

- Has much greater bandwidth capabilities than other media
- Allow greater transmission distances and excellent signal qualities
- More secure than other media
- Costs less than copper for long distance applications




Cont'd….

- No grounding concerns as you have when signalling using electricity
- Light in weight and easily installed
- Has better resistance to environmental factors, like water, than copper
- Lengths of fibre can be spliced together for very long cable runs.





Optical Fibre (cont'd)

The advantages of optical fibre systems include:-

- Very high capacity
- Long repeater spacing
- Small cable dimensions
- Low weight
- Small bending radius
- No crosstalk; and
- Immunity to electromagnetic interface.

Dense Wave Division Multiplexing

- Dense Wave Division Multiplexing (DWDM) is a fiber optic transmission technique that employs multiple light wavelengths to transmit data.
- Allows for the better use of the full bandwidth of a fiber strand.





Hybrid Fiber/Coax (HFC)

- Hybrid Fiber/Coax Service (HFC) makes use of the installed CATV network in the neighborhood and uses fiber for high-speed, high-quality distribution to the neighborhood.





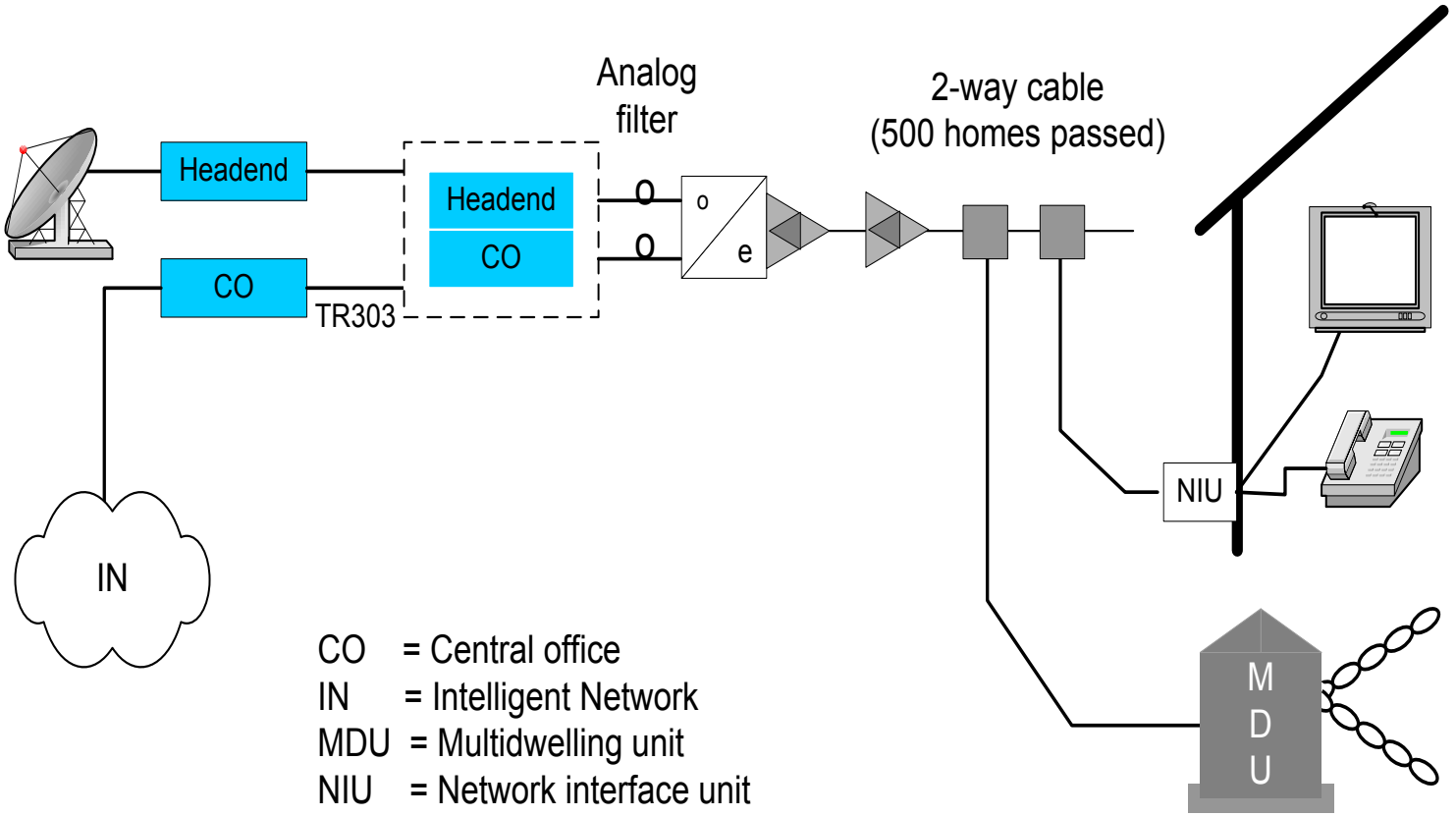




Fiber to the curb

- Fiber to the curb (FTTC) has greater bandwidth and lower noise than HFC, but will be very expensive to run all the way to the premise.

Basic HFC for Video and Voice



Bandwidth and speed of telecommunications media

Circuit Media	Analog Bandwidth (MHz)
Twisted pair	1
Coaxial cable	350, 500, and 750
Microwave radio	30 (1 channel)
Satellite radio	6 (per channel)
Omni-directional radio	0.010 AM, 0.2 FM
Television	6 (per channel)
Telephone channel	0.004

Broadband

- Broadband is high speed or wide bandwidth.
- Generally meaning an analog path that is frequency division multiplexed to create several channels.





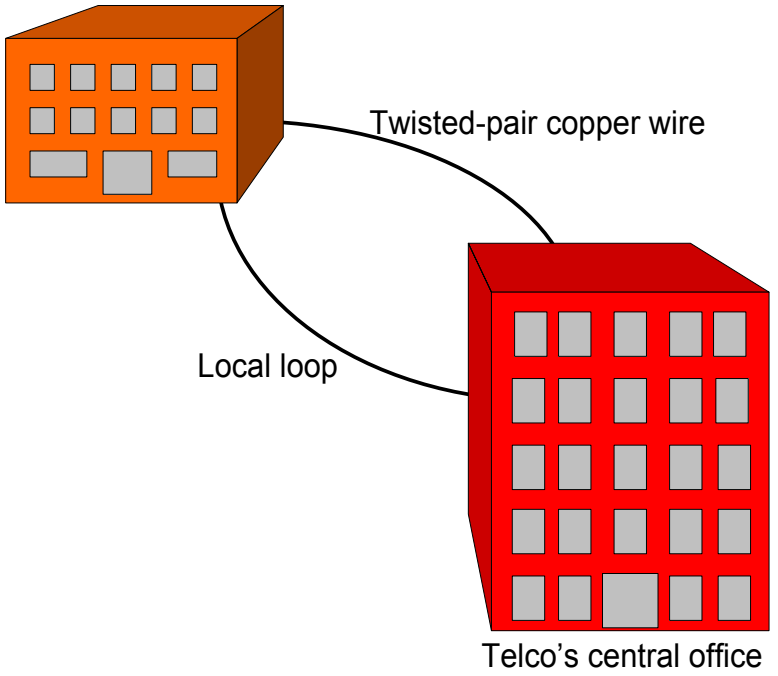
Baseband

- Baseband uses all bandwidth of a circuit as one channel.
- A narrow band, generally not subdivided into channels
- Often describing a digital circuit.

The Local Loop

Local loop

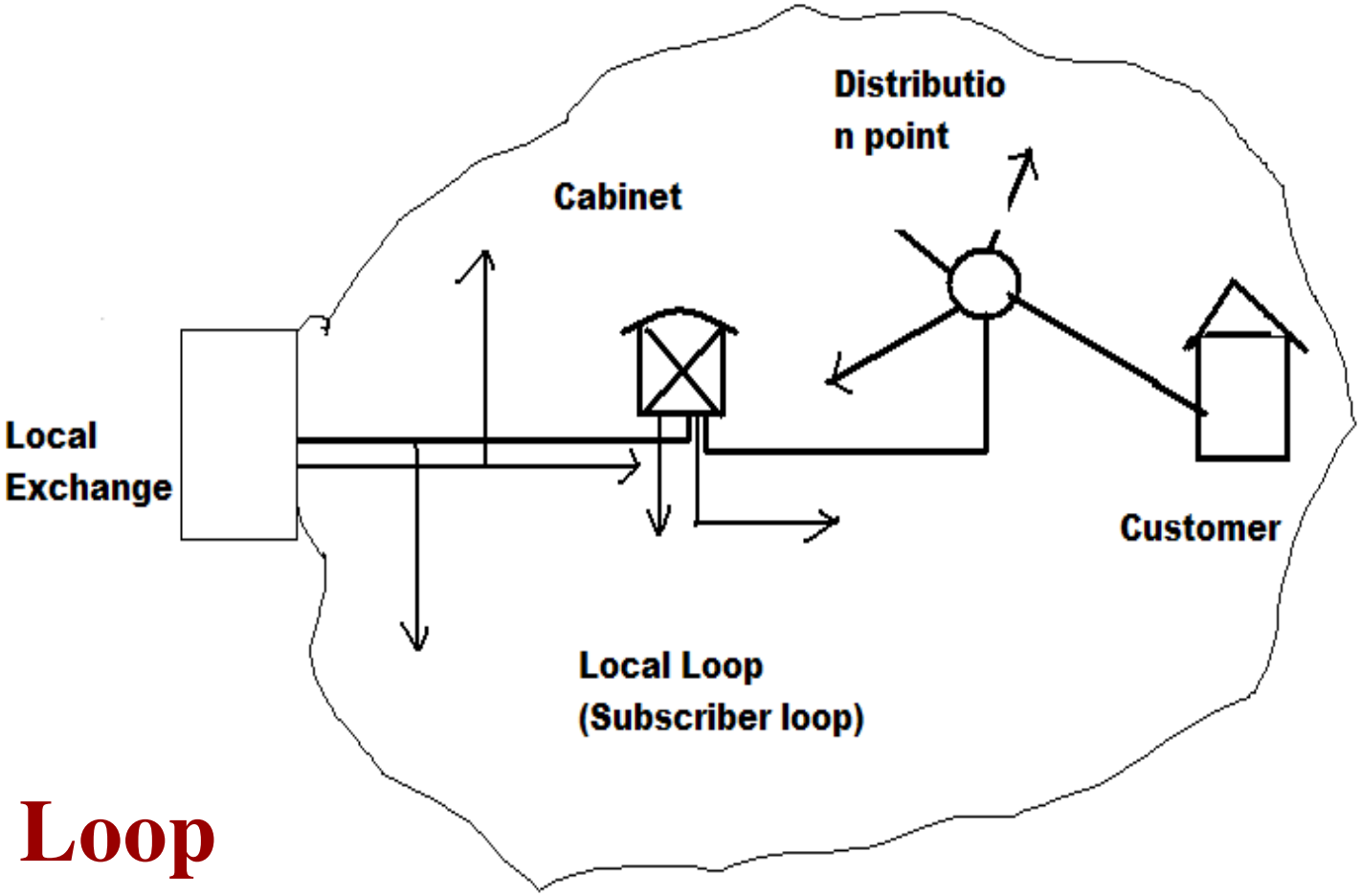
- The local loop is the connection from the telephone instrument to the switching equipment located at the Teleco's central office. This is obvious for a wired phone.
- The term "Teleco" refers to any provider of telephone services.






The Local Loop

- This is a circuit that connects a customer to the telephone network.
- It provides the customer with access to the switching system. It is also referred to as the subscriber loop.


Distributio
n point
Cabinet
Local
Exchange
Customer
Local Loop
(Subscriber loop)

Loop

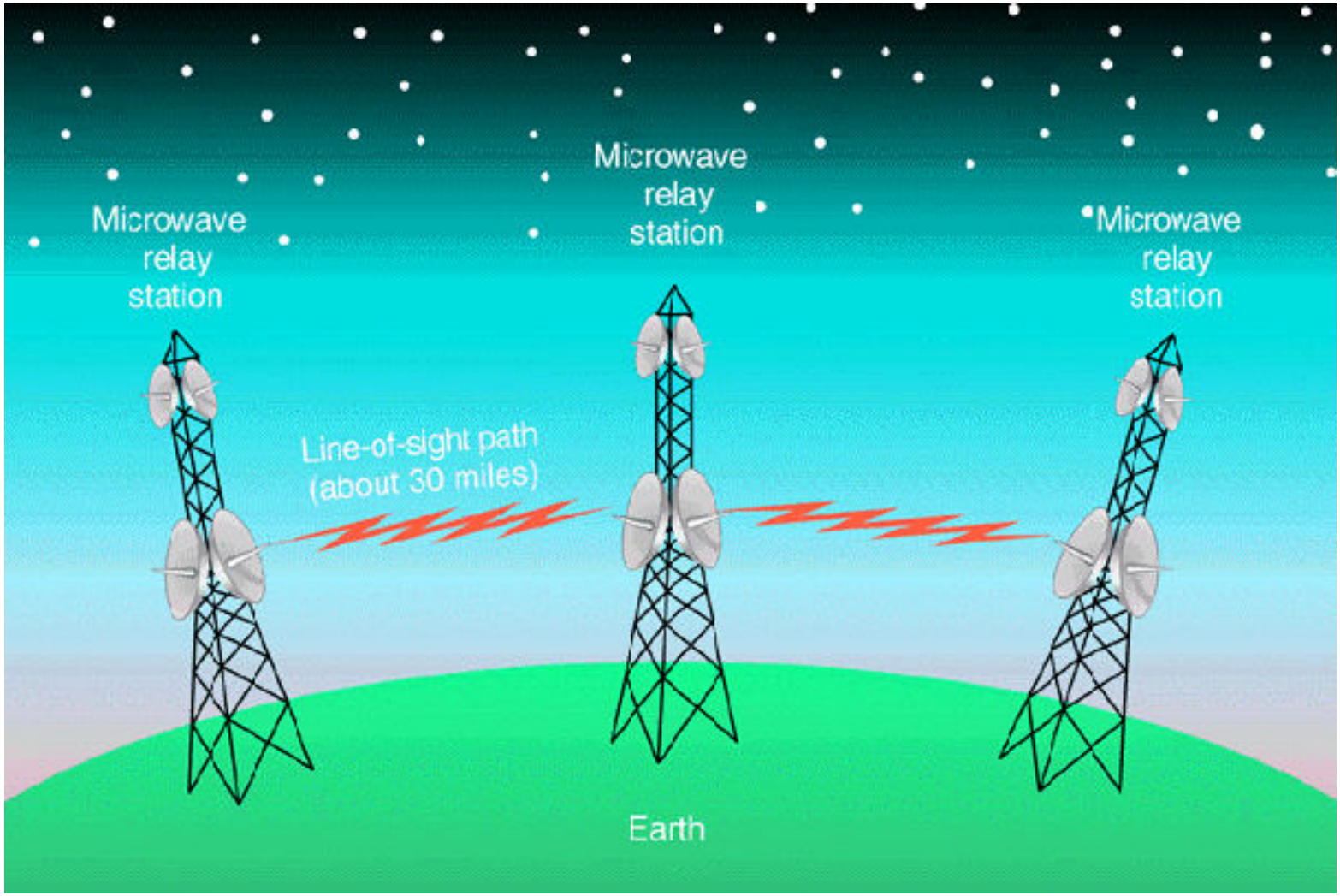
Local loop

- The CPE is connected to the central office by means of the drop wire, distribution cable, and feeder cable which are cross-connected at specific points.)
- The cabinet is a cross-connection point.
- Historically, copper cable was the facility used.
- Today, the facility may also be:
  - Radio links (microwave)
  - Fiber optics.

Wireless Transmission

Microwave Radio Terminal

1. 4-28 GHz voice circuits in a 30-MHz-wide channel
2. Line of sight – 20 to 30 miles between towers
3. Mostly used for analog
4. Subject to interference by rain
5. Must have an FCC license, regulated
6. No right-of-permit required; great for building-to-building within a city

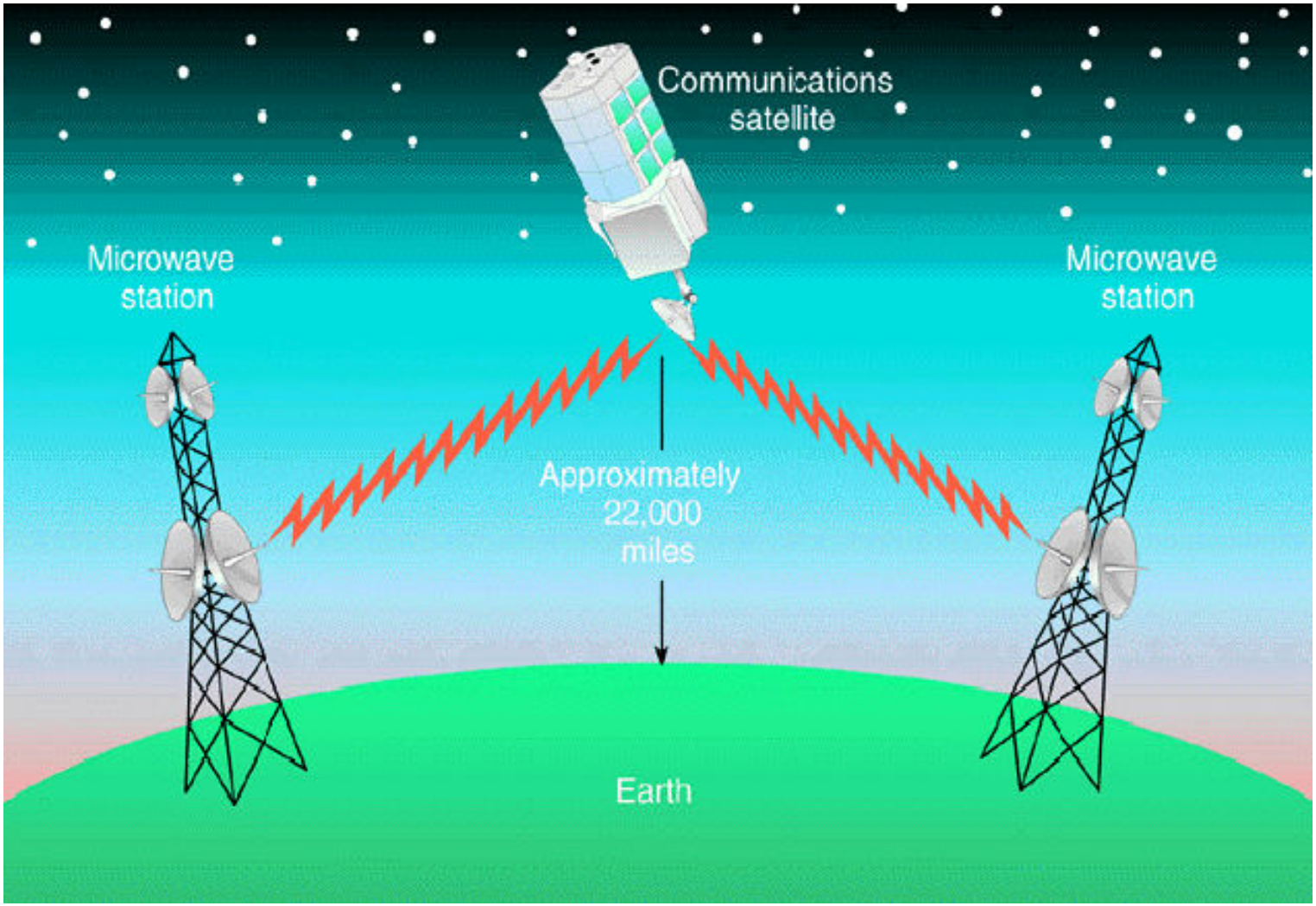

Microwave relay station
Microwave relay station
Microwave relay station
Line-of-sight path (about 30 miles)
Earth

Satellite Radio

- Uplink and downlink each 22,300 miles (geosynchronous orbit)
- Footprint is one-third of earth
- Propagation delay = 44,600 miles/186 mps = .2398 seconds
- Most common carriers have left satellite for terrestrial
- Only security is encryption






Communications satellite
Microwave station
Microwave station
Approximately 22,000 miles
Earth

Omni-directional Radio

- Wireless – replaces wires and cables
- Passes through walls
- Very localized
- Easy to install; easy to move




Infrared (Photonic)

- Limited to within a set of walls (room)
- Omni-directional
- Low speed
- Easy to install; easy to move
- Not secure
- Very localized

Wireless

- Wireless is the driving technology of the 21st century.
- Wireless is the absence of physical channels.
- A wired circuit means the user is tethered to the point of connection.





Wireless

- Fixed wireless is designed to be a point-to-point like and is not designed to be movable.
- Offers the potential of bypassing the expense for new providers of having to install the last mile.
- Potentially faster to install.
- Fixed wireless is a direct replacement for a wired circuit.








Wireless Transmission

- Unguided media
- Transmission and reception via antenna
- Directional
  - Focused beam
  - Careful alignment required
- Omnidirectional
  - Signal spreads in all directions
  - Can be received by many antennae





Cont'd…

Radio waves:

- Large field of applications and offers greater flexibility (for example, cordless telephones).
- Radio can be used locally, inter-continentally and for fixed as well as mobile communication.
- Quality and capacity depend upon many factors including the power of the radio transmitter and its antenna. The radio frequency, etc.





Cont'd….

Radio Spectrum:

- The radio spectrum from 3Khz to 300Ghz, is one range of the electromagnetic spectrum (infrared, visible and ultraviolet light) and x-ray frequencies are other ranges.

Figure: The eight frequency bands of the radio spectrum





Frequencies

- 2GHz to 40GHz
  - Microwave
  - Highly directional
  - Point to point
  - Satellite
- 30MHz to 1GHz
  - Omnidirectional
  - Broadcast radio
- 3×10^{11} to 2×10^{14}
  - Infrared
  - Local

Satellite Communication

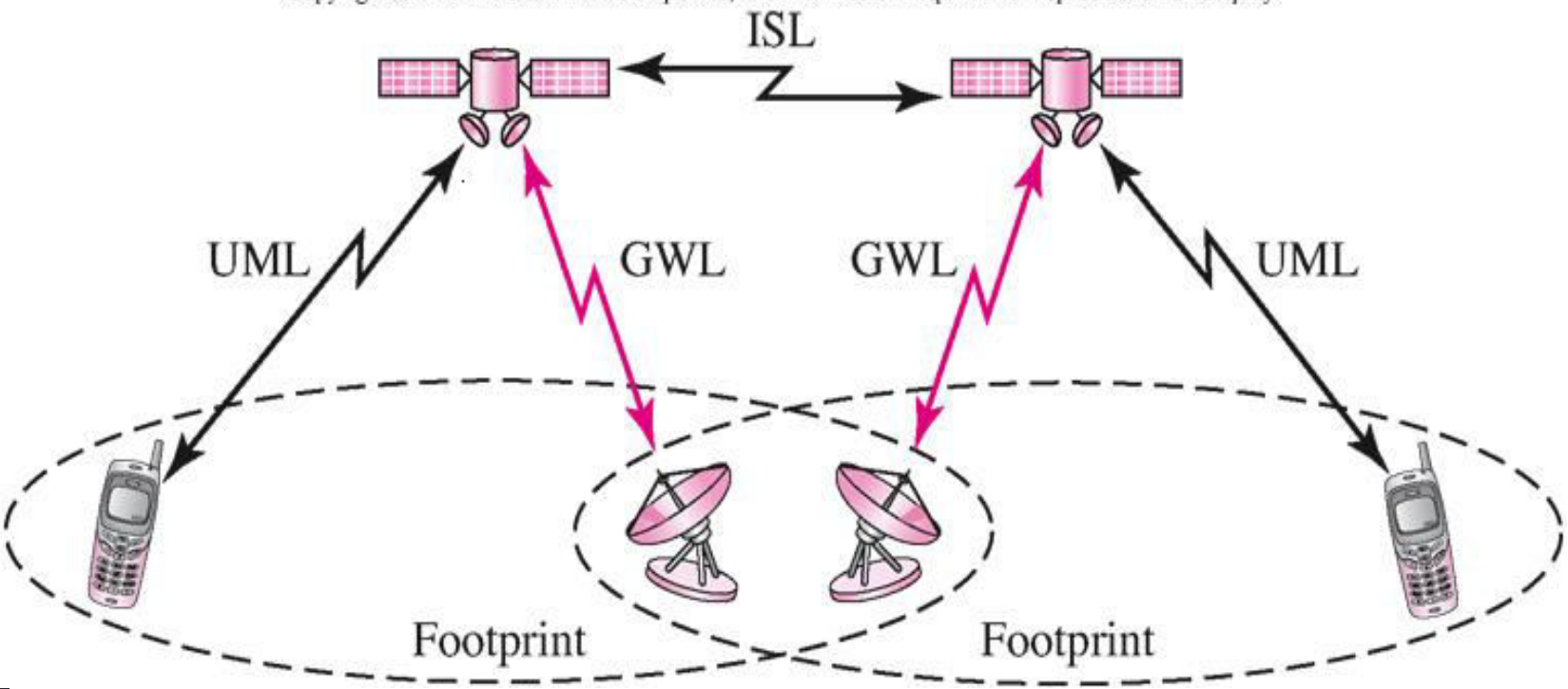



Satellite Communication

- Placed in orbit, 35,800 km, above the earth's surface.
- Used in national as well as international networks
- Transmission properties are excellent
- Major problem – 240ms delay which is trouble some for voice communication

SATELLITE NETWORKS

A satellite network is a combination of nodes, some of which are satellites, that provides communication from one point on the Earth to another. A node in the network can be a satellite, an Earth station, or an end-user terminal or telephone.



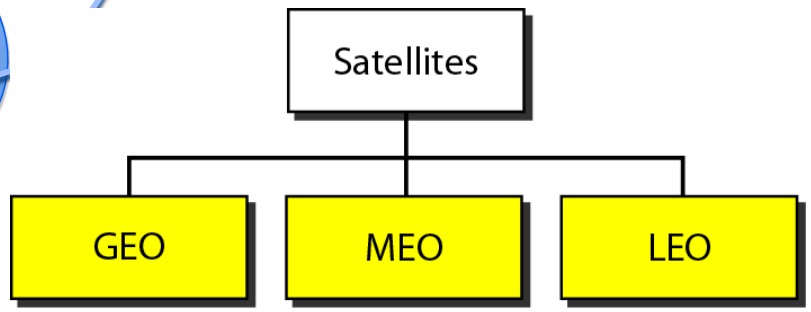
Satellite frequency bands

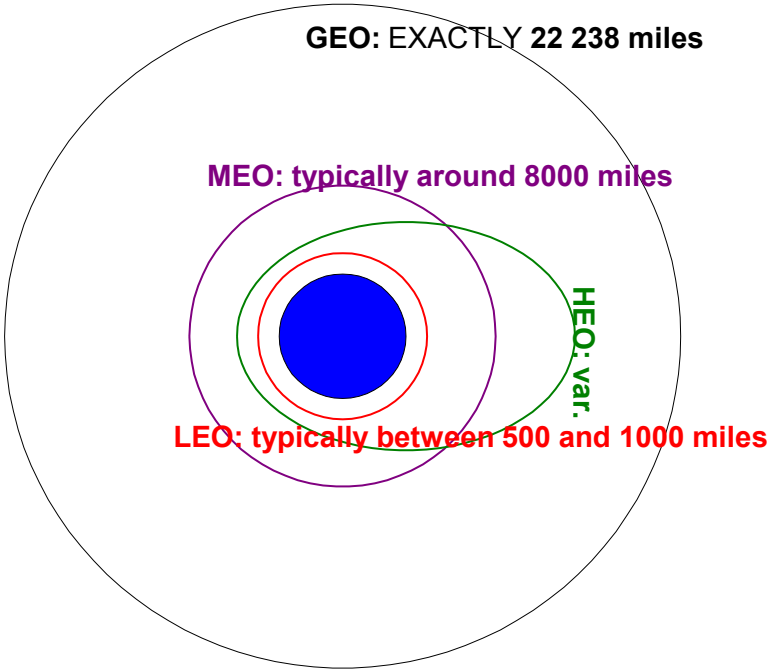
Band	Downlink, GHz	Uplink, GHz	Bandwidth, MHz
L	1.5	1.6	15
S	1.9	2.2	70
C	4.0	6.0	500
Ku	11.0	14.0	500
Ka	20.0	30.0	3500

Sky UK, Eutelsat 28A; Ku band




Satellite categories





- Low Earth Orbit (LEO)
- Medium Earth Orbit (MEO)
- Geosynchronous Orbit (GEO)

Geosynchronous Orbit (GEO) Satellite Systems

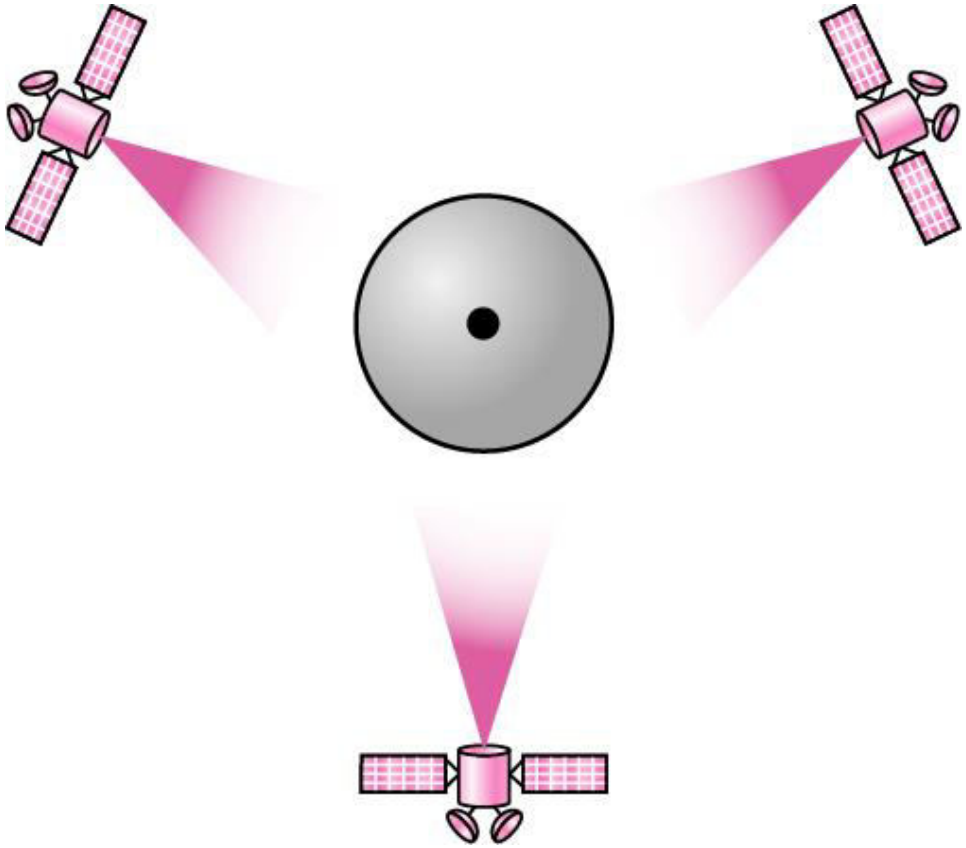
Advantages:

- large area coverage, stay where they are at 35,786km (22,000miles) above the Earth
- satellite rotation is synchronous to earth
- three satellites can cover the whole globe
- low system complexity

Disadvantages:

- long propagation delay (~125 msec)
- high transmission power is required

Satellites in geostationary orbit



Medium Earth Orbit (MEO) Satellite Systems

Advantages:

- slightly longer propagation delays (~40 msec)
- slightly higher transmission power required
- more expensive than LEOs but cheaper than GEOs

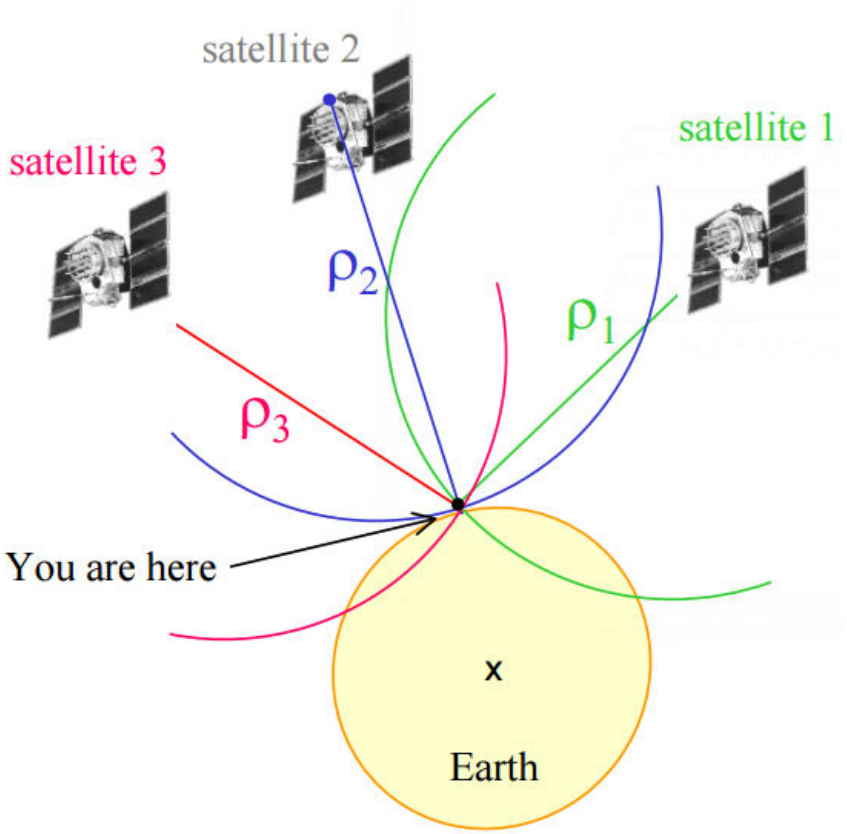
Disadvantages:

- coverage spot greater than a LEO, but still less than a GEO
- still the need to be in rotation to preserve their low altitude 6-8 hours to circle the earth.
- multiple MEO satellites are still needed to cover a region continuously
- handovers and satellite tracking are still needed, hence, high complexity

Global Position System (GPS)

GPS project was started from 1973 by the US Department of Defence

- Orbiting at an altitude about 18,000km
- Consists of 24 satellites in 6 orbits; 32 by June 2014
- At any time, >4 satellites are visible from any point on Earth
- The GPS system concept is based on *time*
- The satellites carry very stable atomic clocks that are synchronized to each other and to ground clocks.
- A GPS receiver monitors multiple satellites and solves equations to determine the exact position of the receiver and its deviation from true time.



If we now our distance from three points, we know exactly where we are. (three circles meet at one signal point)

Application of GPS

- Military forces
- Navigation
- Clock synchronization, CDMA cellular system

Low Earth Orbit (LEO) Satellite Systems

Advantages:

- short propagation delays (10-15 msec)
- low transmission power required
- low price for satellite and equipment

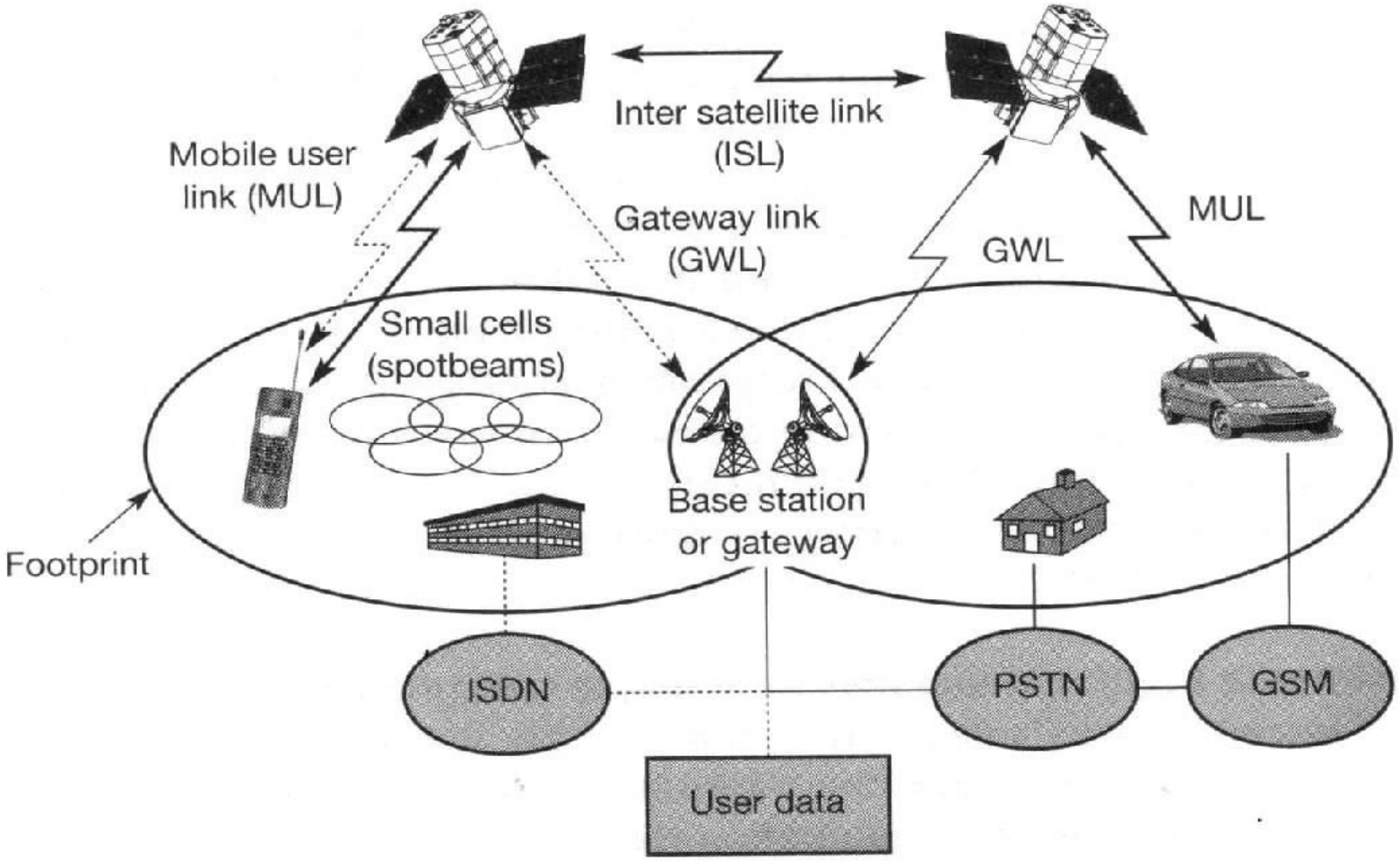
Disadvantages:

- small coverage spot
- they have to be in rotation to preserve their low altitude (90 mins period)
- a network of at least 6 LEO satellites is required to cover a region continuously
- high system complexity due the need for handovers and satellite tracking

Low Earth Orbit (LEO) Satellite Systems

- LEO satellites have polar orbits
- Altitude is between 500-2000 km
- Rotation period of 90-120 min.
- An LEO system has a cellular type of access
- Footprint has a diameter of 8000 km.
- Delay < 20 ms, accept for telephony
- Work together as a network, connected through inter-satellite links (ISLs)

LEO satellite system






Three categories of LEO

- Little LEO, under 1GHz, for low date rate message
- Big LEO: between 1-3 GHz, Globalstar and Iridium system
- Broadband LEO provide communication similar to fibre optic network. Teledesic

Digital Subscriber Line




xDSL

- **ADSL** – Asymmetric Digital Subscriber Line
- **VDSL** – Very High Data Rate DSL (up to 52 Mb/s)
- **HDSL** – High Data Rate DSL (2Mb/s)
- **SDSL** – Single Line DSL
- **RADSL** – Rate Adaptive DSL

Broadband Delivery - ADSL

- ADSL is the technology for normal residential customers
- It is not a line or a modem but a **Network Terminating Equipment.**
- 1.5 to 8 Mb/s to the home
- 16 to 640 Kb/s bothways
- Three information channels – two for data and one for voice.




Broadband Delivery – ADSL

- Transmits an asymmetric data stream, much more going downstream to the subscriber and much less coming back.
- Used in asymmetric transmission like, Fast Internet access, video on demand, remote LAN access, multimedia access, specialized PC services all feature high data rate demands downstream but relatively low data rate demands upstream.

Broadband Delivery – ADSL (cont'd)

- ADSL requires only one pair and delivers up to 2 – 8 Mbps
- For 2Mbps the distance is about 5.5 Km and for 8Mbps it is about 3Km.
- ADSL enables POTS to be delivered over the same copper pair.




Broadband Delivery – RADSL

- This has the same transmission limits as ADSL
- An RADSL device polls the line before transmitting
- Same applications as ADSL – Internet access, VoD, database and LAN access.

Broadband Delivery – HDSL

- This is symmetric
- It is used by Telcos to remote nodes
- It is ideal for PBX connection, interexchange carrier POPs, Internet servers and campus networks
- It may also be used by customers for multimedia delivery.

Broadband Delivery – SDSL

- It is essentially the same as HDSL
- A single wire pair with a maximum range of 2.8 Km
- Ideal for video conferencing or collaborative computing
- Still under development

Broadband Delivery – VDSL

- This is the fastest DSL technology
- Maximum operating distance is 1.5 Km
- This will enable carriers to deliver High Definition TV (HDTV)
- It also supports all ADSL applications.




AGENDA

- Introduction to Telecommunications
- Transmission Systems
- **Switching Systems**
- Signalling Systems




Progression of Technology

- Electromechanical Switches
  - crossbar, step-by-step
- SPC with relays
  - AT&T/Lucent 1A ESS
- SPC with electronic switches
  - AT&T/Lucent 4 ESS
- Digital
  - AT&T/Lucent 5 ESS, Nortel DMSx00

A typical CO…way back

Early Switch Technology

"(snort) Here at the Phone Company we handle eighty four billion calls a year. Serving everyone from presidents and kings to scum of the earth. (snort) We realize that every so often you can't get an operator, for no apparent reason your phone goes out of order [plucks plug out of switchboard], or perhaps you get charged for a call you didn't make. We don't care.

Watch this -- [bangs on a switch panel like a cheap piano] just lost Peoria. (snort) You see, this phone system consists of a multibillion-dollar matrix of space-age technology that is so sophisticated, even we can't handle it. But that's your problem, isn't it ? Next time you complain about your phone service, why don't you try using two Dixie cups with a string. We don't care. We don't have to. (snort) We're the Phone Company."

Lily (Ernestine) Tomlin on Saturday Night Live

Public Switched Telephone Network

A telecom network comprises of the following elements :

- Switching Systems
- Transmission Systems
- Signaling Systems




Subscriber Requirements

Subscribers expect the following from the telephone administration:-

- Reliability
- Ease of access
- Fast call set up
- Good transmission quality
- Low call cost




Responsibility for the Network

Telephone Administration set certain requirements on the network

- Long life for the equipment
- Renewable in stages
- Expandable to cope with increased traffic
- Efficient usage of the equipment
- Simple to repair and maintain
- Space capacity when network faults occur.





Switching in Telephone Networks

Stages in switching development:

- Manual operation of switch boards
- Step-by-step exchanges
- Cross-bar exchanges (Hitachi C400)
- Digital Exchanges.




Definition of Switching

One answer could be:

“to set up a connection between two telephone subscribers so that they can talk to each other”.

The ITU-T defines switching as:

“the establishing, on demand, of an individual connection from a desired inlet to a desired outlet within a set of inlets and outlets for as long as is required for the transfer of information.”

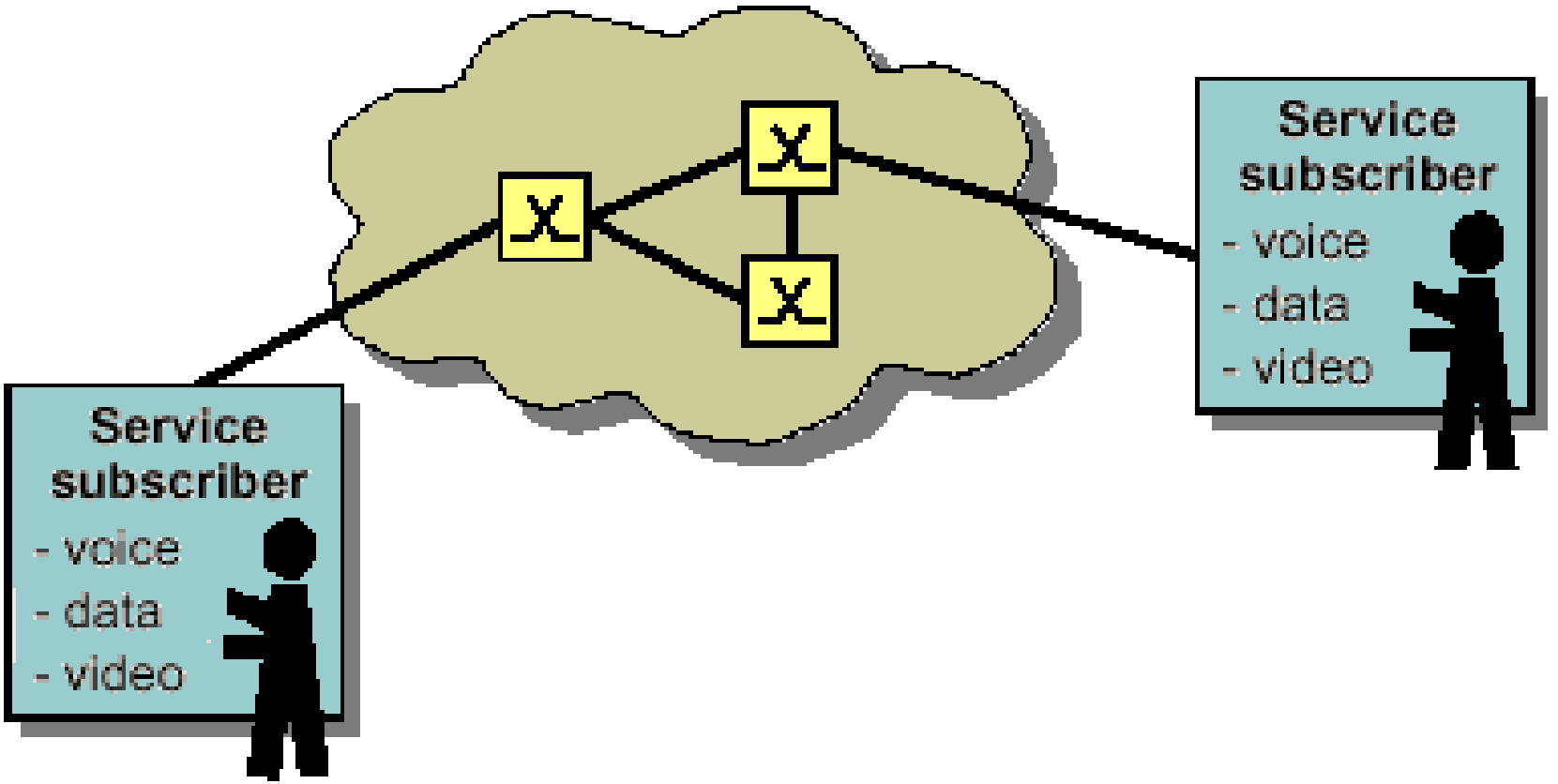


Figure: Switching in the Telecommunications Network




Switching cont'd

- One hundred twenty years ago, switching meant "an operator interconnecting two subscribers with each other".
- Present – day switching equipment must be capable of handling more services than before, including high-quality audio, video of different quality standards, the transfer of large data file.

Switching cont'd

There are two types of switching techniques:

Circuit switching: Developed primarily for voice. Fixed bandwidth connections are assigned to the communicating parties by a call establishment process, and they remain assigned to those parties for the duration of a call.

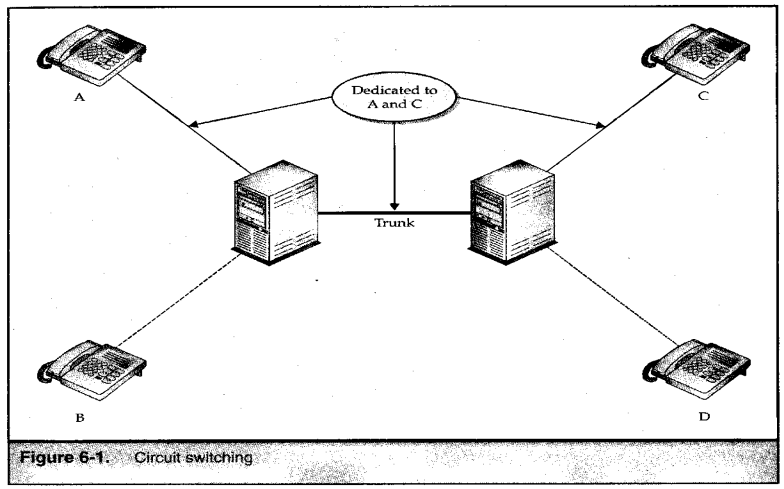


Figure 6-1. Circuit switching

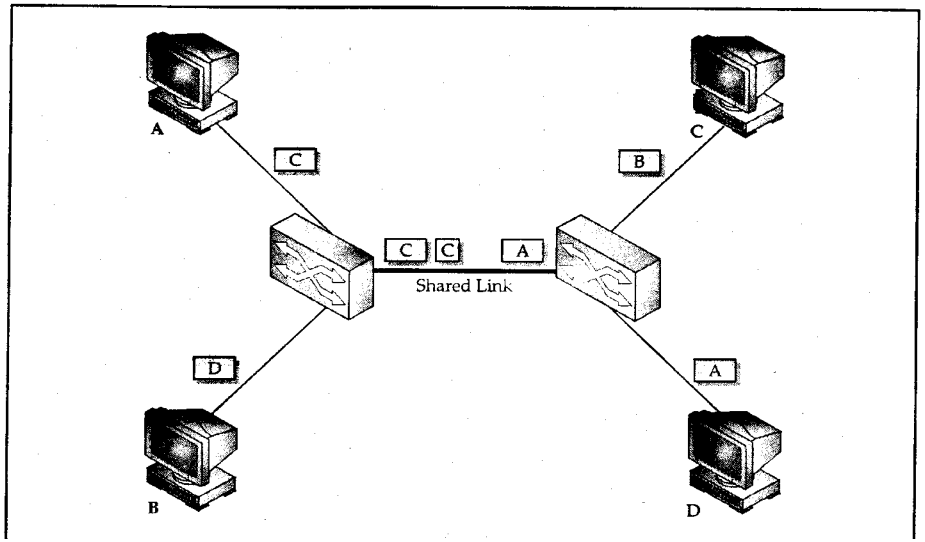
Switching (Cont'd)…





Packet Switching:

Segments long messages into short entities called packets with an upper limit on the packet length. Communicating parties share facilities to get better utilization at a lower cost.






Switching (Cont'd)…

- The distance between the link – station – also called the hop length – is dependent on output power, antenna type and climate as well as frequency.
- The higher the carrier frequency, the shorter the length.

How Did POTS work?

- All switching logic had to be “hard-wired”
- Analog transmission
- Pre-1960’s technology
- In - band signaling

Technology Limitations

- Switching systems were not easily scalable because changes had to be implemented in Hardware
- As systems were upgraded, services were not the same in all areas
- The existing technology was not able to handle the changing needs of callers




Local and Transit Exchange

- Local exchange or End Office is where the subscribers are connected
- A Transit Exchange is a switch where traffic from one local exchange to another local exchange is exchanged in the absence of a direct route between these exchanges.





PBX vs. Centrex




Digital PBX

- An advantage of the PBX is that some systems are entirely digital.
- This permits terminals or computers to be connected to the telephone and communicate with other devices under the control of the PBX without the need for intermediary equipment.

Computer-Telephony Integration (CTI)

- This is the addition of the decision-making ability of a computer to the switching capability of a telephone.
- Simplest form is the PBX routing a call based on the **CallerID** signal while accessing the caller's digital file and linking that to the person responding to the call.





Centrex

- Centrex services are PBX services offered by a common carrier.
- A group of lines and services owned , provided by, and located in the common carrier's CO switch.
- Services may appear as being on a separate facility for customer.





Automatic call distribution

- Automatic call distribution (ACD) and voice mail enhance voice communications.
- ACD gives airlines the ability to place their agents in Nairobi and Mombasa and provide reservation services to all of the nation.




Centrex verses PBX

- In addition to costs, a most powerful feature of Centrex over PBX is that you can configure a single system over multiple locations in a metropolitan area.
- It will look and feel like a single PBX over multiple locations.

Centrex verses PBX considerations

Feature	Centrex	PBX
Initial cost	Low	High
Leasing cost > 500 lines	High	Attractive
Maintenance cost	None	All
Cost to move instruments	High	Low
Local control	Low	High
Selection (least-cost) routing of long-distance calls	None	Option
Software upgrades and costs	None	User responsibility

continued

Centrex verses PBX considerations

Feature	Centrex	PBX
Changes to new equipment	Telco provides	Fixed
Ability to change	Telco decides	Customer decides
Move to ISDN	Telco provides	Customer funds
Insurance	Telco provides	Customer pays
Power consumption and costs	Telco provides	Customer pays
Capacity to grow	High	Low (limited)
Back-up power/processor	Telco provides	Customer responsibility
Housing space	Telco provides	Customer provides
Service mileage charge	None	Customer pays
Reliability (MTBF)	Highest	Medium-to-high





Cost of Centrex

- The cost of Centrex may be higher than for a PBX for a single location.
- With multiple locations, cost effectiveness makes Centrex a competitive alternative.
- A company with multiple locations and using Centrex, will make it appear to their callers that the company is in one location.

Broadband




Broadband - Definitions

- This refers to a network connection that supports a very high bit rate as opposed to Narrowband
- Bandwidth is a measure of capacity. Greater bandwidth allows more information to be communicated in a given time period
- Broadband media services require the transmission of large amounts of information quickly.

Broadband cont'd…

- They are seamless customized on demand creation and delivery of multimedia services to homes, businesses and mobile users
- Broadband media is sometimes called streaming media because the services are delivered in continuous streams
- Broadband content is digitized and accessed using IP, the standard Internet Protocol.




Broadband cont'd…

- Today broadband media services use high speed IP access through DSL
- DSL is a group in increasingly fast technologies which are always on
- Fast Internet access is not fully utilizing the power of broadband, DSL and IP technology.
- Broadband media services will put the consumer in total control by enabling personal, custom, on-demand viewing of entertainment, e-learning, video games and other type of content.

Broadband cont'd…

- Consumers will be able to choose what they want to hear, see or be entertained by and they will no longer have to plan around broadcasting schedules
- Individuals can also create their own content, personalize it and distribute it for viewing on TVs, PCs, remote laptops and mobile phones.







Next Generation Network

- The evolution of the broadband media services network will be characterized by six transitions:
  - From a dial-up network to a data oriented network
  - From connectivity to service creation platforms
  - From copper based to all optical
  - Convergence of fixed networks
  - Convergence of fixed and mobile
  - Transition to IPv6 networks




Next Generation Network

- High speed DSL access multiplexer (DSLAM)
- Broadband access servers
- DSL modem in home/office providing fixed and wireless LAN
- IP network security and authentication producers.




AGENDA

- Introduction to Telecommunications
- Transmission Systems
- Switching Systems
- **Signalling Systems**





Signaling

- (***definition***) The exchange of information between call components required to provide and maintain service
- (***examples***) Dialing digits, providing dial tone, accessing voice mail, sending a call waiting tone, *69, etc.

Functions of Signaling

- Supervisory Signaling
- Address Signaling
- Call Progress Signaling





Supervisory Signaling

- Provides information on line or circuit condition
- “It [signaling] informs a switch whether a circuit (internal to switch) or a trunk (external to switch) is busy or idle; a called party is off-hook or on-hook…”



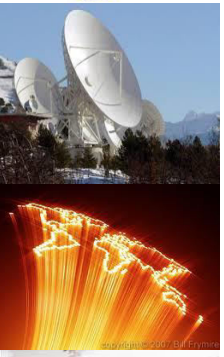


Supervisory Signals (cont'd)…

- Some supervisory signals:
  - Request for service - **off-hook**
  - Ready to receive address - **dial tone**
  - Call alerting - **ringing**
  - Call termination - **on-hook**
  - Request for operator - **hook-switch flash**
  - Called party station ringing - **ring back**
  - Network/called station busy - **busy tone**

Address Signaling

- Directs and routes a telephone call to the called subscriber
- If there is more than one switch involved in the call setup, signaling is required between switches (***inter-register switching***)



AFRALTI

Address Signaling: DTMF Signaling (dual tone multi frequency)

	1209	1366	1477	1633
697	1	2	3	A
770	4	5	6	B
852	7	8	9	C
941	*	0	#	D





Call-Progress Signaling (Audible - Visible)

- Categorized by audio/visual signals sent in a forward and backward direction
- Forward Direction: A signal sent to your phone which tells it to ring





Call-Progress Signaling
(Audible - Visible)

- Backward Signaling:
  - **Ringback** - the distant telephone you are calling is ringing
  - **Busyback** - the called line is busy
  - **ATB** - All trunks are busy (sometimes a voice announcement is used)
  - **Loud Warble** - Telephone is off hook





Signaling Techniques

- In band signaling
- Out-of-band signaling
  - CCS signaling
- E&M signaling
- MF signaling





In - Band Signaling

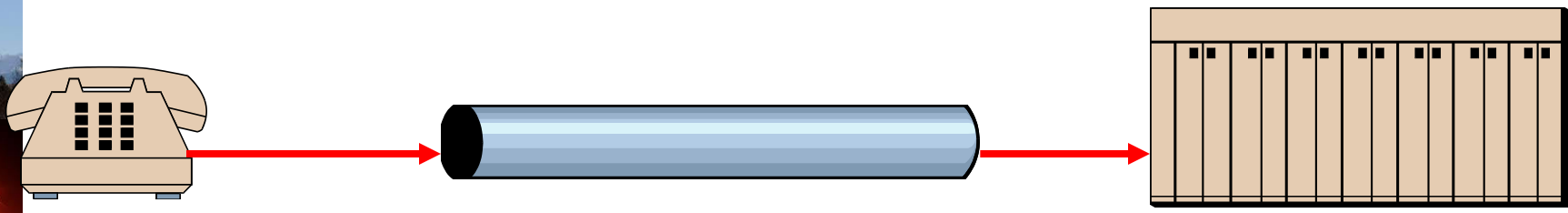
- Signaling path = voice path
- Voice path clogged with signaling
- Busy calls, congestion, and “ring-no-answers” result in 20-35% of incomplete calls
- Slower call setup due to channel sharing

Signaling Techniques

- In-channel signaling







In-band	Out-of-band
•SF Signaling (2600 Hz)	•DC Current (on-/off-hook
•MF Signaling	•Dial pulses (10 pps)
•DTMF Signaling	•20 Hz Ringing voltage

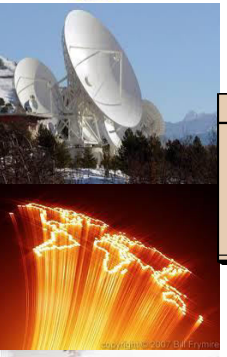




Out - of - Band Signaling

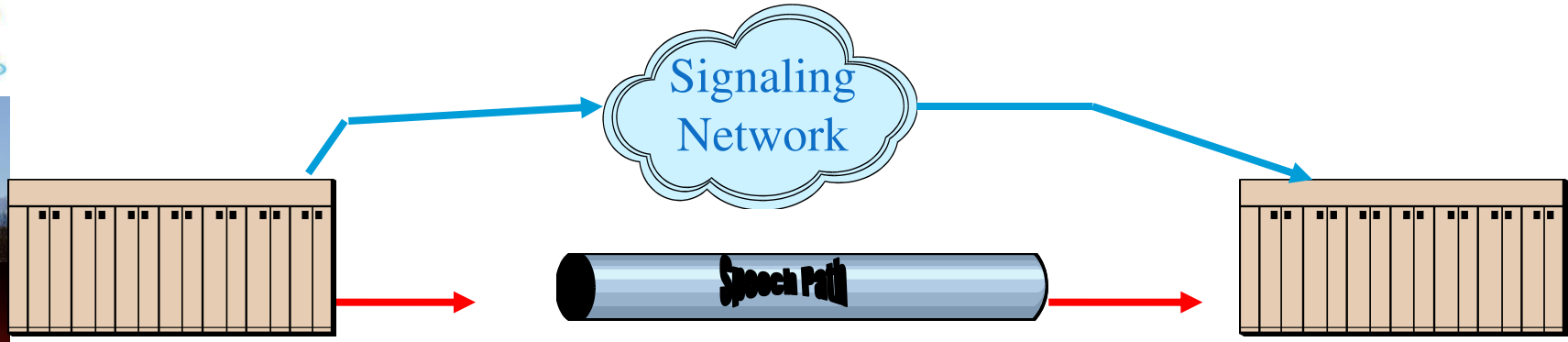
- Signaling path done on a separate channel
- Voice path dedicated only to voice
- Much faster call setup and knockdown
- Led to SS7 and AIN





Signaling Techniques

- Common Channel Signaling (CCS)



Dedicated data link between systems
- Trunk group associated
- Trunk group disassociated





Advantages of CCS

- One signaling path needed per trunk group
- Faster and simpler to transfer information between control processors
- No possibility of interference with speech path
- Signaling can’t be accessed by customer





Advantages of CCS

- Value-added services of a signaling control point
  - Shared processing for small offices
  - Allows centralized decision making (flow management)
  - Permits Advanced Intelligent Network (AIN) services

AFRALTI

Disadvantages of CCS

- CCS links can be a single point of failure
- No inherent testing of speech path by call setup signaling
- CCS response time is critical

Making a Call on the PSTN

Steps:-

1. Calling party sends a signal over the copper wire to the local exchange when the handset is lifted.
2. Local Exchange returns a dial tone
3. The subscriber dials the number of the distant subscriber.
4. The Local Exchange established a connection .
5. If the caller subscriber is in the same exchange – then copper wire. If the called subscriber is in another exchange – trunk transmission medium required.
6. Call is routed by the Exchange
7. For a distant call, detailed signaling information is passed to the next exchange.
8. The call may be passed through several exchanges before reaching the local exchange closest to the called party.
9. If the called party is engaged – signals passed back to the calling party resulting in an “engaged” signal.




Signalling

- A very important element in a telephone network
- Signaling needed for
  - Call setup
  - Call release
  - Charging information
  - CLI
  - Other features





Subscriber Signalling

- This is the signaling between the subscriber and the exchange.
- The signaling type is typically decadic pulses for analogue connection and tone frequency for digital connections




Signalling Systems cont'd…

There are basically two types of signalling systems:

- Channel Associated Signalling (CAS)
- Common Channel Signalling (CCS)




Channel Associated Signaling

- Signaling system used between all types of exchanges.
- Speech and signaling travel the same way through the network.




Channel Associated Signalling

Some variations of CAS are:-

- Signaling is done on the same channel as the speech (in-band).
- The signaling is done on the speech connection, but in another frequency range (out-band).
- The signaling is carried out in time slot 16, where every speech channel has its fixed, allotted and recurring channel for signaling (PCM Signaling).




Channel Associated Signalling

- CAS between exchanges is usually divided into:
  - Line signaling; and
  - Register signaling.
- Line signaling used for monitoring of the line before, during and after the call set-up (e.g. R2)
- Register signaling used when a long chain of exchanges is involved in setting up a call.

Signalling Systems cont'd….

Limitations of Channel – Associated Signalling:

- It is slow
- Signal repertoires are small
- The signal apply to telephony only, and cannot be made to cover new services
- There is no facility for transferring non-call –related information, for example, to aid in the management of the network

Signalling Systems cont'd….

- Signals can only be sent at certain times during the life-cycle of the call
- Signal tones are audible to subscribers, and, therefore annoying
- The signalling capacity allocated to a circuit is always reserved for that circuit, whether or not the circuit is in use and whether or not signals are being sent; its information capacity is, therefore limited.

Signalling Systems cont'd….

- Common Channel Signalling – uses message-based data communication. Signals are sent as messages between the control systems of digital exchanges. CCS is used in fixed as well as mobile telephony, Intelligent networks and data networks.




Signalling Systems cont'd….

Advantages of CCS*:*

It overcomes all the disadvantages of CAS

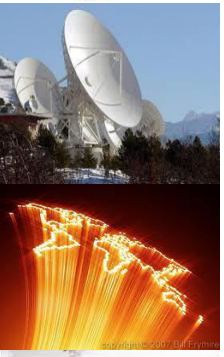
- Being digital, it is extremely fast
- The signal repertoire is potentially vast
- The large repertoire will provide signals for all services and not only for telephony
- Because signalling links are independent of speech paths, signals may be sent at any time.




Signalling Systems cont'd….

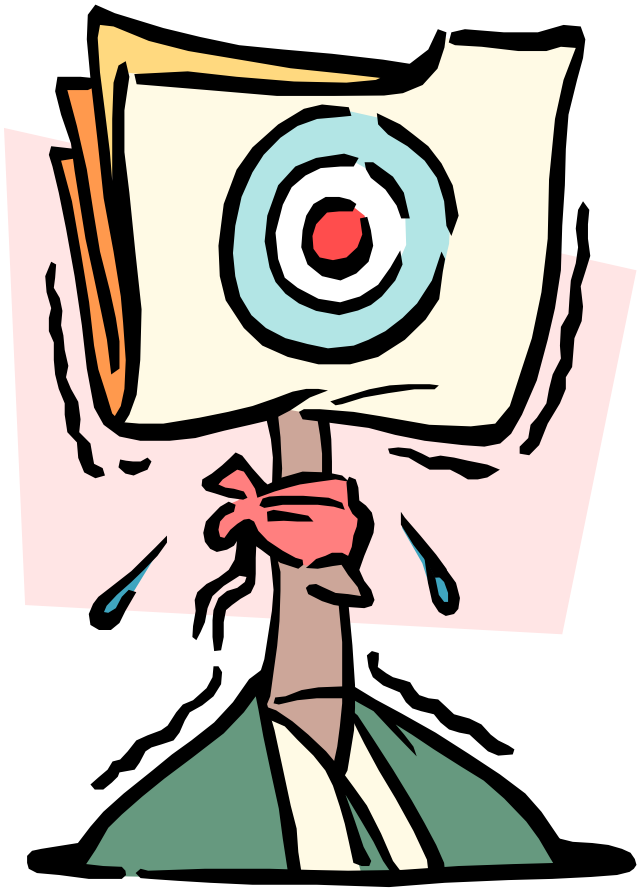
- Network management signals will be facilitated by the fact that they can be made available from the repertoire and by the speed and flexibility of the signalling network.
- Because signals are not transmitted over the speech path, they are inaudible to subscribers.

Questions & Answers



AFRALTI

Q&A



Thank You