CN1047 INTRODUCTION TO COMPUTER NETWORKING

CHAPTER 3
OSI MODEL – PHYSICAL LAYER

Physical Layer

- Concern with transmission of raw bits over a communication channel.
- It deals with specifications of network connectors, type of transmission media and voltage level used for 0 bit and 1 bit.

Types of Media

Communications media has 2 classes :

1) **Conducting media**
2) **Radiating media**

Types of Media

1) Conducting media

- Referred as bounded media
- Use cables to carry data
- Twisted-wire pair, coaxial cable and fiber optic.

Types of Media

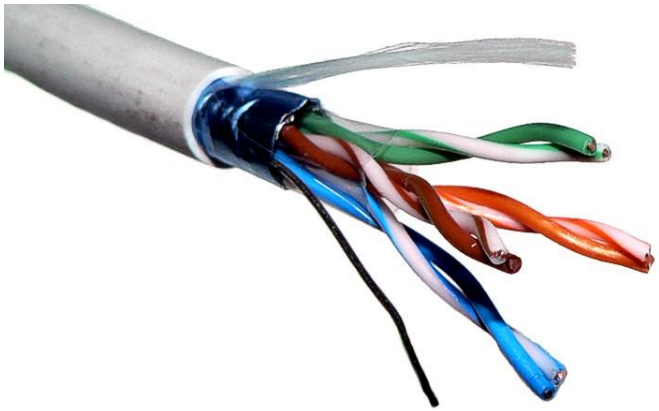
2) Radiating media

- Referred as unbounded media.
- A message in an unbounded medium radiates forever in all directions but will be weaker if further it goes.
- Radio broadcast, microwave radio broadcast, satellite and infrared transmission.

Conducting Media

Twisted Pair

- A pair of wires are twisted together.
- Twisted pair is the ordinary copper wire that connects home and many business computers to the telephone company.
- Telephone system will carries most of the data consists heavily of twisted-wire pair.



Conducting Media

Two types of Twisted Pair

1. Shielded Twisted Pair (UTP)
2. Unshielded Twisted Pair (UTP)

Conducting Media

Shielded Twisted Pair (STP) vs Unshielded Twister Pair (UTP)

- **STP cables are shielded while UTP cables are unshielded**
- **STP cables are more immune to interference and noise than UTP cables**
- **STP cables are better at maximizing bandwidth compared to UTP cables**
- **STP cables cost more per meter compared to UTP cables**
- **STP cables are heavier per meter compared to UTP cables**
- **UTP cables are more prevalent in SOHO networks while STP is used in more high-end applications**

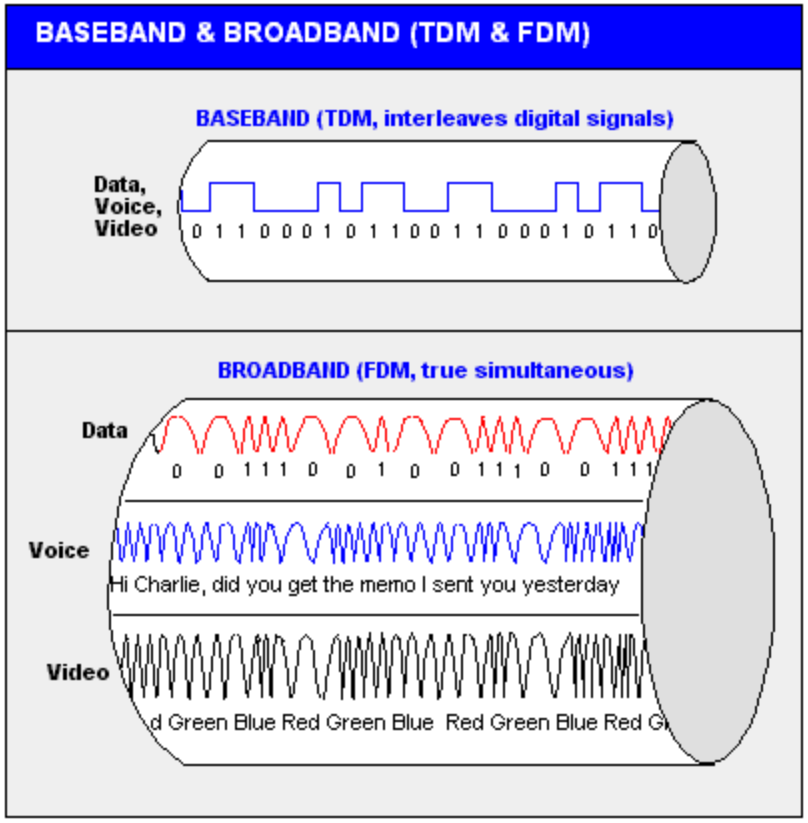
Conducting Media

Coaxial Cable

- Coaxial cable offer much faster data transmission, it is used for underground and underwater lines.
- It is not susceptible to noise or electrical interference and can transmit data over long distance.
- Coaxial cable can carry up to 10000 voice grade channel.

Conducting Media

Coaxial Cable



Conducting Media

Coaxial can be used in 2 ways:

1) Digital baseband transmission - Baseband is a data only digital transmission at high-speed on a single shared channel.

2) Broadband transmission - Use high-frequency carrier waves and analog transmission. Broadband transmission can simultaneously transmit data using a number of different frequency (allows transmit data at high speed and low speed, voice and video signal) on a single cable.

Conducting Media

Fiber Optic

- Fiber optic consist of a core of glass or plastic which carries the signal.
- Optical fibers are widely used in fiber-optic communications, which permits transmission over longer distances and at higher bandwidths (data rates) than other forms of communication.
- Transmission techniques involves the use of lasers to generate the signal.

Conducting Media

Fiber Optic

Advantages:

a) Large data capacity (30 000 simultaneous calls).
b) High speed transmission (1 Gbps)
c) High secure
d) Very low transmission error rate.

Radiating Media

Radio Transmission

- Its frequency is between 10 kHz to 1GHz.
- It is simple to install and has high attenuation.
- These waves are used for multicast communications.

Radiating Media

Microwave Transmission

- It travels at high frequency than the radio waves. It requires the sender to be inside of the receiver. It operates in a system with a low gigahertz range. It is mostly used for unicast communication.
- There are 2 types of Microwave Transmission :
  - Terrestrial Microwave
  - Satellite Microwave

Radiating Media

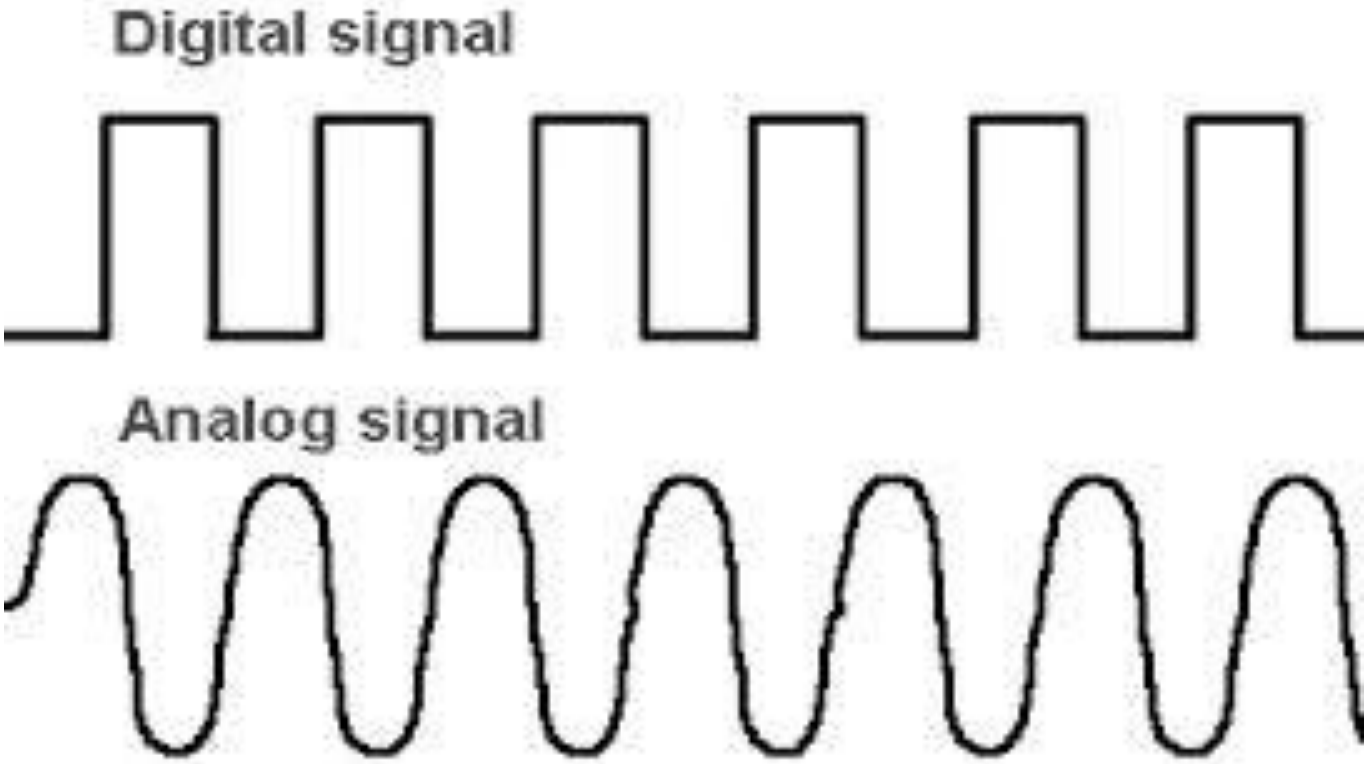
Radio waves vs. Microwaves

- **Radio waves** in general have long distance communication capabilities, but **microwaves** do not have these abilities.
- **Radio waves** are mostly used in the communication field whereas **microwaves** are used in industries and astronomy.

Analogue vs Digital Transmission

- **Transmission means electromagnetic signals which are capable on a variety of transmission media.**
- **To convey information determines the efficiency and reliability of the transmission.**
- **Analog and Digital in data communication has 3 context :**
  1) **Information**
  2) **Signaling**
  3) **Transmission**

Analogue vs Digital Transmission



Analogue Transmission

- **Analog transmission is a method of conveying voice, data, image, signal, or video information.**
- **It uses a continuous signal varying in amplitude, phase, or another property that is in proportion to a specific characteristic of a variable.**

Analogue Transmission

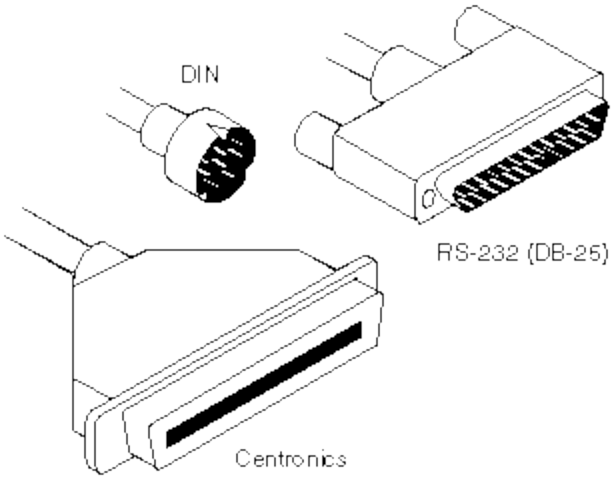
- Analog transmission takes on continuous values or some interval.
- Most information collected by sensor (temperature and pressure) are continuous-valued.
- Analog signal will varying electromagnetic wave that may be transmitted over variety of media, depending on frequency.
- Example: Voice and video

RS-232C Interface

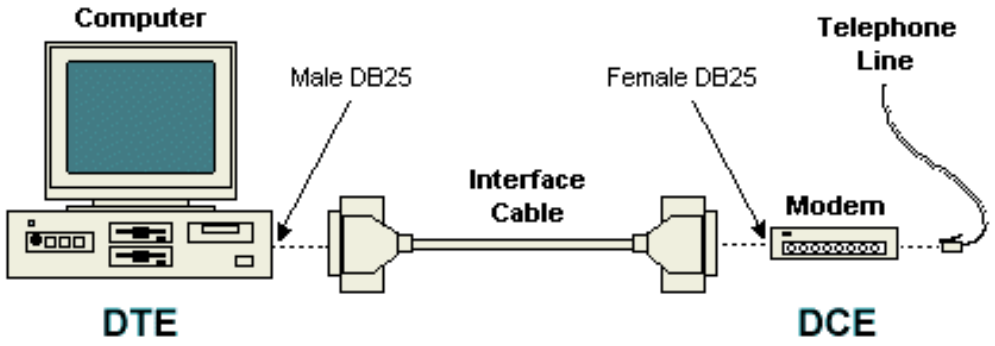
- Short for *recommended standard-232C,* a standard interface approved by the Electronic Industries Alliance (EIA) for connecting serial devices.
- In 1987, the EIA released a new version of the standard and changed the name to *EIA-232-D.*
- And in 1991, the EIA teamed up with Telecommunications Industry association (TIA) and issued a new version of the standard called *EIA/TIA-232-E.*
- Many people, however, still refer to the standard as *RS-232C,* or just *RS-232.*

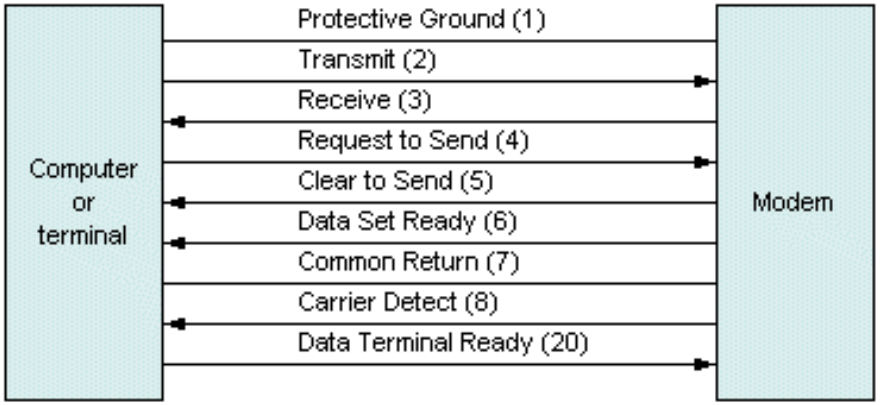
RS-232C Interface

- **Almost all modems conform to the EIA-232 standard and most personal computers have an EIA-232 *port* for connecting a modem or other device.**
- **The EIA-232 standard supports two types of connectors -- a 25-pin D-type connector (DB-25) and a 9-pin D-type connector (DB-9).**
- **The type of serial communications used by PCs requires only 9 pins so either type of connector will work equally well.**



RS-232C Interface





Digital Transmission

- **Digital transmission is on discrete values.**
- **Digital signal is a sequence of voltage pulses that may be transmitted over a wire medium.**
- **Example : text and integers**

X.21 Interface

- This interface specifies physical, electrical and procedural interface between the host and network for digital transmission.
- X.21 interface
  - Digital connection to a digital public telephone network
- X.21bis interface
  - Terminal to packet switch network via analog line

Analog vs. Digital

Feature	Analog Characteristics	Digital Characteristics
Signal	Continuously variable, in both amplitude and frequency	Discrete signal, represented as either changes in voltage or changes in light levels
Traffic measurement	Hz (for example, a telephone channel is 4KHz)	Bits per second (for example, a T-1 line carries 1.544Mbps, and an E-1 line transports 2.048Mbps)
Bandwidth	Low bandwidth (4KHz), which means low data transmission rates (up to 33.6Kbps) because of limited channel bandwidth	High bandwidth that can support high-speed data and emerging applications that involve video and multimedia
Network capacity	Low; one conversation per telephone channel	High; multiplexers enable multiple conversations to share a communications channel and hence to achieve greater transmission efficiencies

Analog vs. Digital

Feature	Analog Characteristics	Digital Characteristics
Network manageability	Poor; a lot of labor is needed for network maintenance and control because dumb analog devices do not provide management information streams that allow the device to be remotely managed	Good; smart devices produce alerts, alarms, traffic statistics, and performance measurements, and technicians at a network control center (NCC) or network operations center (NOC) can remotely monitor and manage the various network elements
Power requirement	High because the signal contains a wide range of frequencies and amplitudes	Low because only two discrete signals—the one and the zero—need to be transmitted
Security	Poor; when you tap into an analog circuit, you hear the voice stream in its native form, and it is difficult to detect an intrusion	Good; encryption can be used

Analog vs. Digital

Feature	Analog Characteristics	Digital Characteristics
Error rates	High; 10^{-5} bits (that is, 1 in 100,000 bits) is guaranteed to have an error	Low; with twisted-pair, 10^{-7} (that, is 1 in 10 million bits per second) will have an error, with satellite, 10^{-9} (that is, 1 in 1 billion per second) will have an error, and with fiber, 10^{-11} (that is only 1 in 10 trillion bits per second) will have an error