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
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.
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
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

Digital signal

Analog signal
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*.
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

Diagram showing the connection between a computer, modem, and telephone line through an interface cable.
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

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<thead>
<tr>
<th>Feature</th>
<th>Analog Characteristics</th>
<th>Digital Characteristics</th>
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</thead>
<tbody>
<tr>
<td><strong>Signal</strong></td>
<td>Continuously variable, in both amplitude and frequency</td>
<td>Discrete signal, represented as either changes in voltage or changes in light levels</td>
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<tr>
<td><strong>Traffic measurement</strong></td>
<td>Hz (for example, a telephone channel is 4KHz)</td>
<td>Bits per second (for example, a T-1 line carries 1.544Mbps, and an E-1 line transports 2.048Mbps)</td>
</tr>
<tr>
<td><strong>Bandwidth</strong></td>
<td>Low bandwidth (4KHz), which means low data transmission rates (up to 33.6Kbps) because of limited channel bandwidth</td>
<td>High bandwidth that can support high-speed data and emerging applications that involve video and multimedia</td>
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<tr>
<td><strong>Network capacity</strong></td>
<td>Low; one conversation per telephone channel</td>
<td>High; multiplexers enable multiple conversations to share a communications channel and hence to achieve greater transmission efficiencies</td>
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<td>Network manageability</td>
<td>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</td>
<td>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</td>
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<tr>
<td>Power requirement</td>
<td>High because the signal contains a wide range of frequencies and amplitudes</td>
<td>Low because only two discrete signals—the one and the zero—need to be transmitted</td>
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<td>Security</td>
<td>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</td>
<td>Good; encryption can be used</td>
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<td>Error rates</td>
<td>High; $10^{-5}$ bits (that is, 1 in 100,000 bits) is guaranteed to have an error</td>
<td>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</td>
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