Computer Communication Networks I

Lecture 1

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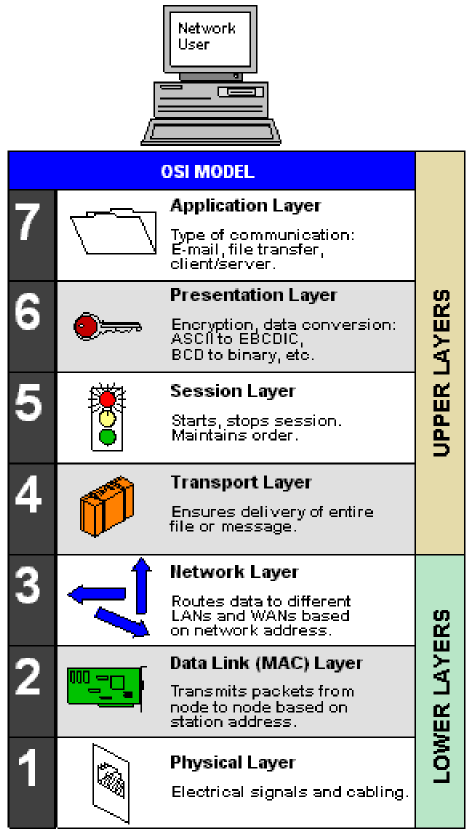
Physical Transmission Fundamentals

- Physical transmission/data communications and the physical layer
- Physical transmission and its relevance to transmission over links; Physical layer services
- Analog and digital communications (why we prefer digital communications)
- Information: Analog and digital forms; digital representation of information; representation accuracy, information bandwidth, sampling rate

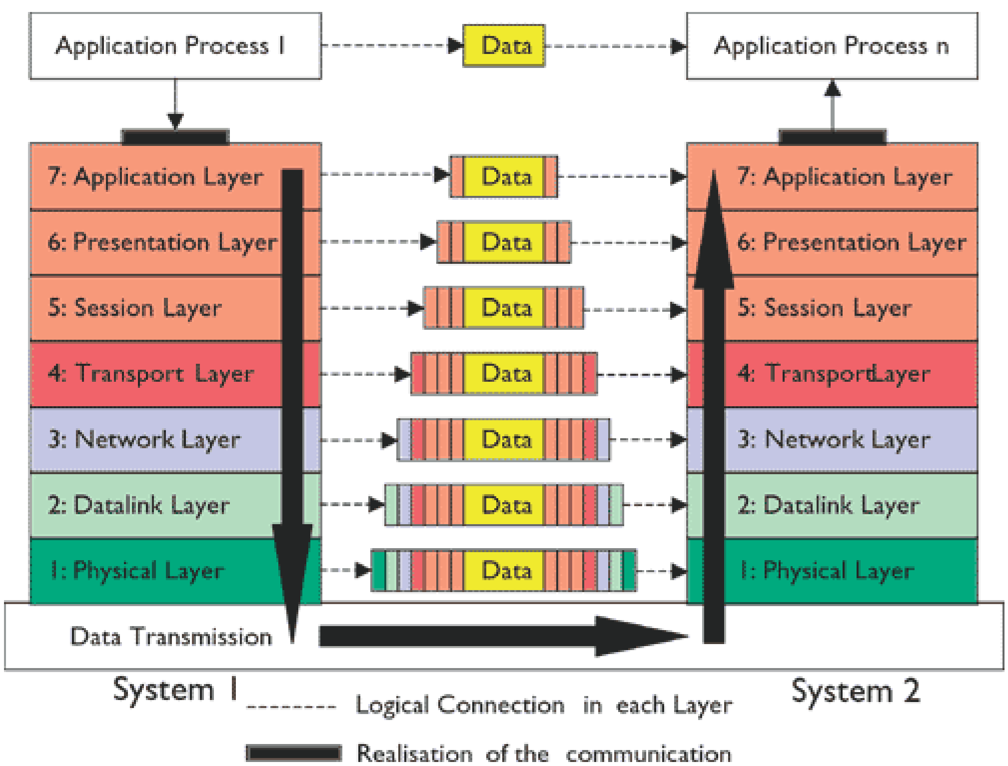
Modern communication systems based on digital transmission can carry all types of information and hence to support many types of application.

Open Systems Interconnection (OSI) Model

The OSI model is a conceptual model that characterizes and standardizes the internal functions of a communication system by partitioning it into abstraction layers.



Network User
OSI MODEL
7
Application Layer
Type of communication: E-mail, file transfer, client/server.
6
Presentation Layer
Encryption, data conversion: ASCII to EBCDIC, BCD to binary, etc.
5
Session Layer
Starts, stops session. Maintains order.
4
Transport Layer
Ensures delivery of entire file or message.
3
Network Layer
Routes data to different LANs and WANs based on network address.
2
Data Link (MAC) Layer
Transmits packets from node to node based on station address.
1
Physical Layer
Electrical signals and cabling.
UPPER LAYERS
LOWER LAYERS



Application Process I
Data
Application Process n
7: Application Layer
6: Presentation Layer
5: Session Layer
4: Transport Layer
3: Network Layer
2: Datalink Layer
1: Physical Layer
Data
Data
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Data
7: Application Layer
6: Presentation Layer
5: Session Layer
4: TransportLayer
3: Network Layer
2: Datalink Layer
1: Physical Layer
Data Transmission
System 1
System 2
-------- Logical Connection in each Layer
Realisation of the communication

Analog and Digital Data

Analog and digital correspond roughly to continuous and discrete. These two terms can be used in three contexts:

Data: Entities that convey meaning.

Analog: Voice and video are continuously varying patterns of intensity

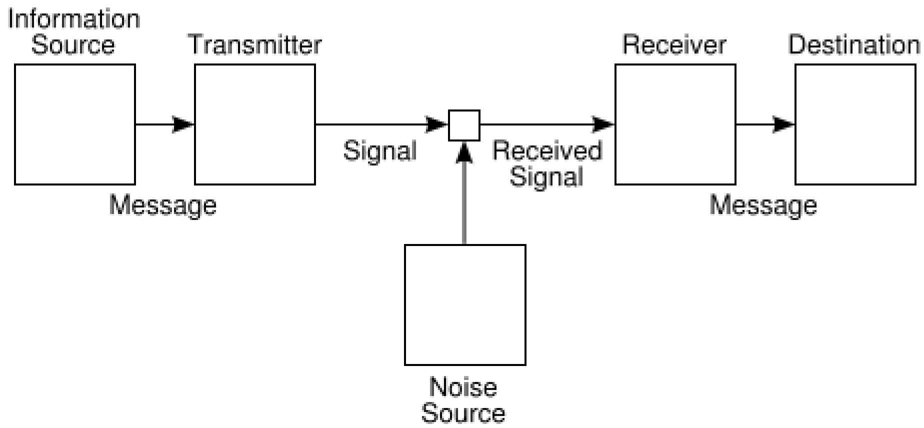
Digital: Take on discrete values (e.g., integers, ASCII text)

Data are propagated from one point to another by means of electrical signals

Digital representation of information

- Applications that run over networks involve transfer of information of various types.
- Some applications involve transfer of blocks of text characters, email for example.
- Others involve the transfer of a stream of information, such as telephony.
- In the case of block-oriented information, one is interested in the number of bits required to represent a block.
- In the case of stream-oriented information, we are interested in the bit rate (number of bits/second) required to represent the information.

Basic Communication System



- An information source that produces a message.
- The transmitter creates a signal (by operating on the message) which can be sent through a channel.
- A channel, which is the medium.
- A receiver, which transforms the signal back into the message intended for delivery.
- A destination, which can be a person or a machine, for whom or which the message is intended.

Block-Oriented Information

- Most common examples of block information are files than contain text, numerical and graphical information.
- The normal forms of these files can contain a fair amount of statistical redundancy.

- Data compression uses such as compress, zip etc. to exploits these redundancies to encode the original information into files that need
    - Fewer bits to transfer
    - Less disk storage space.
- The compression ratio is defined as the ratio of the number of bits in the original file to the number of bits in the compressed file.

Stream Information

- Information such as voice, music or video is produced in a steady stream.
- The first step in digitizing an analog signal is to obtain sample values of the signal every T seconds.
- The bandwidth of a signal is a measure of how fast the signal varies.
- Bandwidth is measured in Hertz. (cycles per second)
- A basic result from signal theory tells that is a signal has a bandwidth W then the minimum sample rate is 2W samples/second. This is the Nyquist sampling theorem.

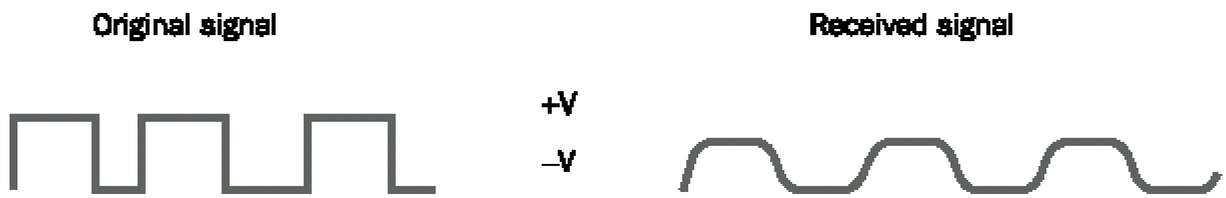
  Example: {sampling rate}
  W = 4 kHz
  2W = 8 kHz
  Sample every 125 microseconds!

Why Digital Communications?

- Digital signaling is:

- Less susceptible to noise and interference
- Suffers more attenuation

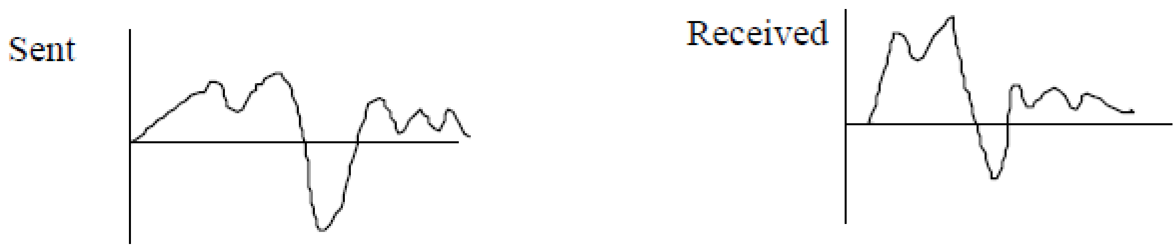
- Attenuation: The reduction or loss of signal strength (power) as it transferred across a system.



Attenuation of a signal

- The strength of the received signal must be strong enough for detection and must be higher than the noise to be received without error.

- Analog transmission: All details must be reproduced accurately.

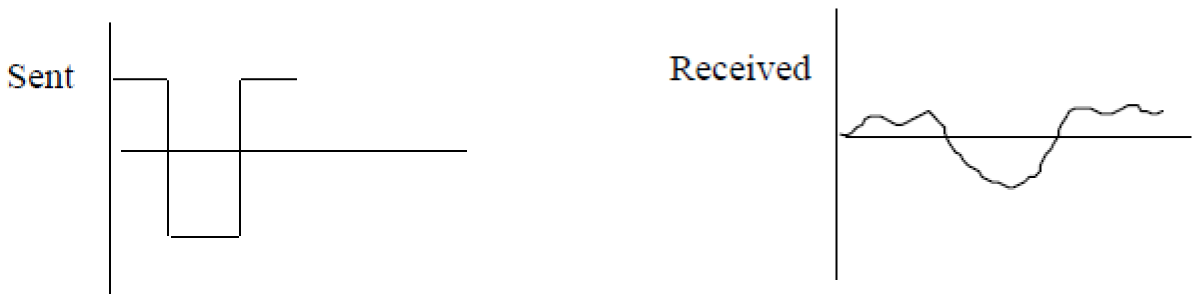


- e.g. AM, FM, TV transmission

- The analog transmission system uses **amplifiers** to boost the energy in the signal.

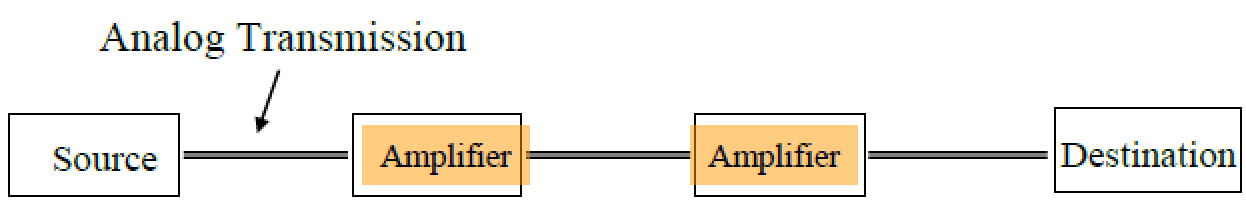
- Amplifiers boost the signal energy; however they also amplify the noise!

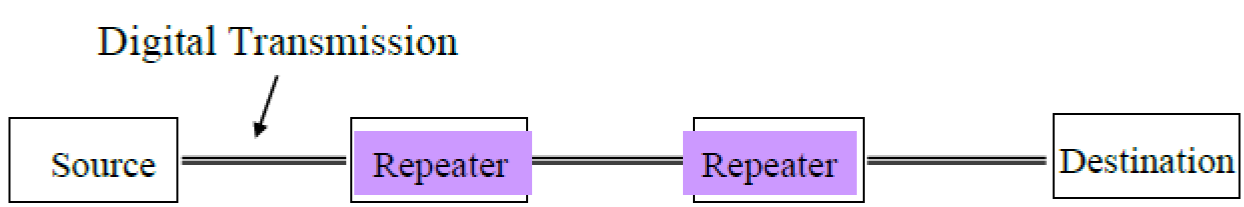
- Digital transmission: only discrete levels need to be reproduced



- e.g digital telephone, CD Audio

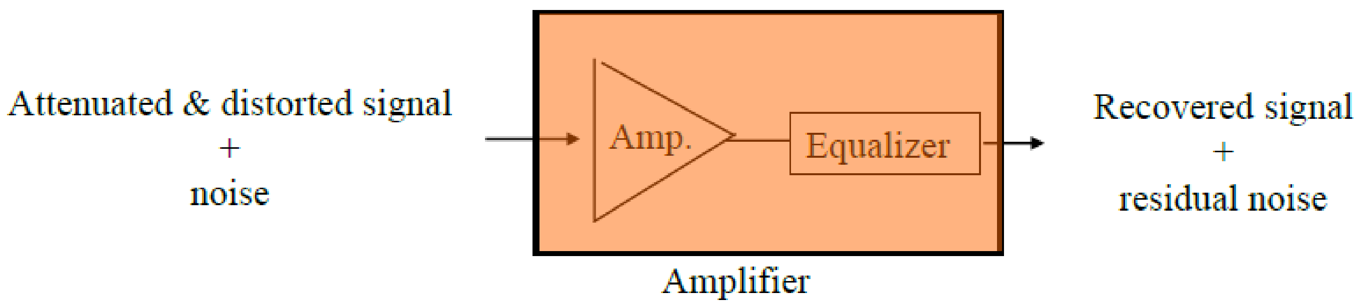
- Digital signals –digital repeaters are used to attain greater distances.
- The digital repeater receives the digital signal, recovers the patterns of 0's and 1's and retransmits a new digital signal.





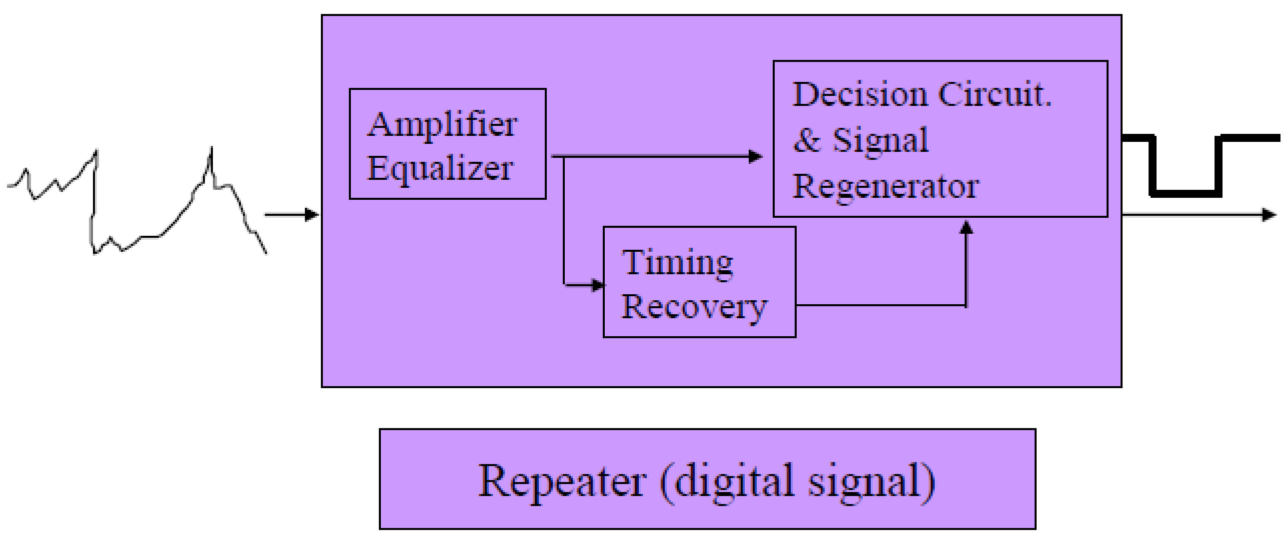
<u>Amplifiers and repeaters</u>

Analog amplifier



- The equalizer tries to eliminate the distortion.

A digital repeater



Advantages of digital transmission are

- Superior cost of digital technology
    - Low cost LSI/VLSI technology

    - Repeaters versus amplifiers costs

- Superior quality

    - Longer distances over lines with lower error rates

- Capacity utilization

    - Economical to build high bandwidth links
    - High degree of multiplexing easier with digital techniques

Basic Properties of a Digital Transmission System

- The purpose of a digital transmission system is to transfer a stream of 0s and 1s from a transmitter to a receiver.

Bit Rate

- Communication engineers are interested in the bit rate or transmission speed (measured in bits/second)

- As the bit rate increases, the amount of information that can flow across the channel per second increases.

- The communication system uses pulses or sinusoidal signals to transmit binary information over the channel.

- How fast bits can be transmitted reliably over a given channel depends on several factors including:

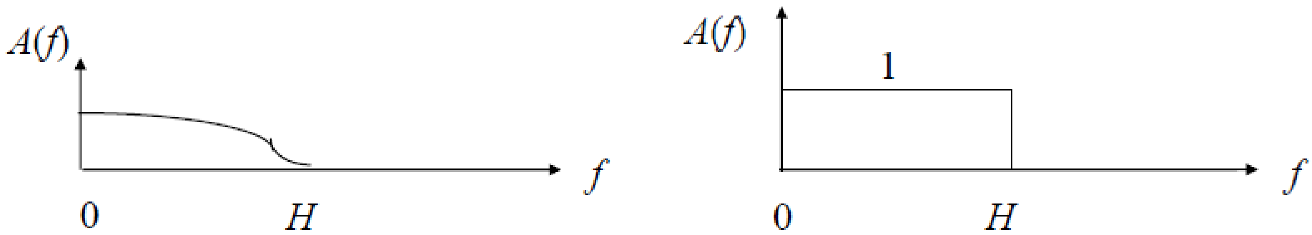
    - The amount of energy put into transmitting each signal

- The distance that the signal has to travel
- The amount of noise that receiver needs to tolerate
- The bandwidth of the transmission channel

Characteristics of the transmission channel

- A transmission channel can be characterized by its effect on input sine signals of different frequencies.
- The ability of a channel to transfer a single frequency f is given by the amplitude response function A(f)
- A(f) is defined as the ratio of the amplitude of the output tone (frequency) divided by the amplitude of the input frequency.
- The **bandwidth of a channel** is defined as the range of frequencies that is passed by a channel.

(a) Lowpass and idealized lowpass channel



(b) Maximum pulse transmission rate is 2*H* pulses/second