MUST

Wisdom & Virtue

MIRPUR UNIVERSITY OF SCIENCE AND TECHNOLOGY (MUST), MIRPUR

DEPARTMENT OF SOFTWARE ENGINEERING

Computer Networks

Lecture [15]: Low-Pass Channel with Limited Bandwidth

Engr. Samiullah Khan

(Lecturer)

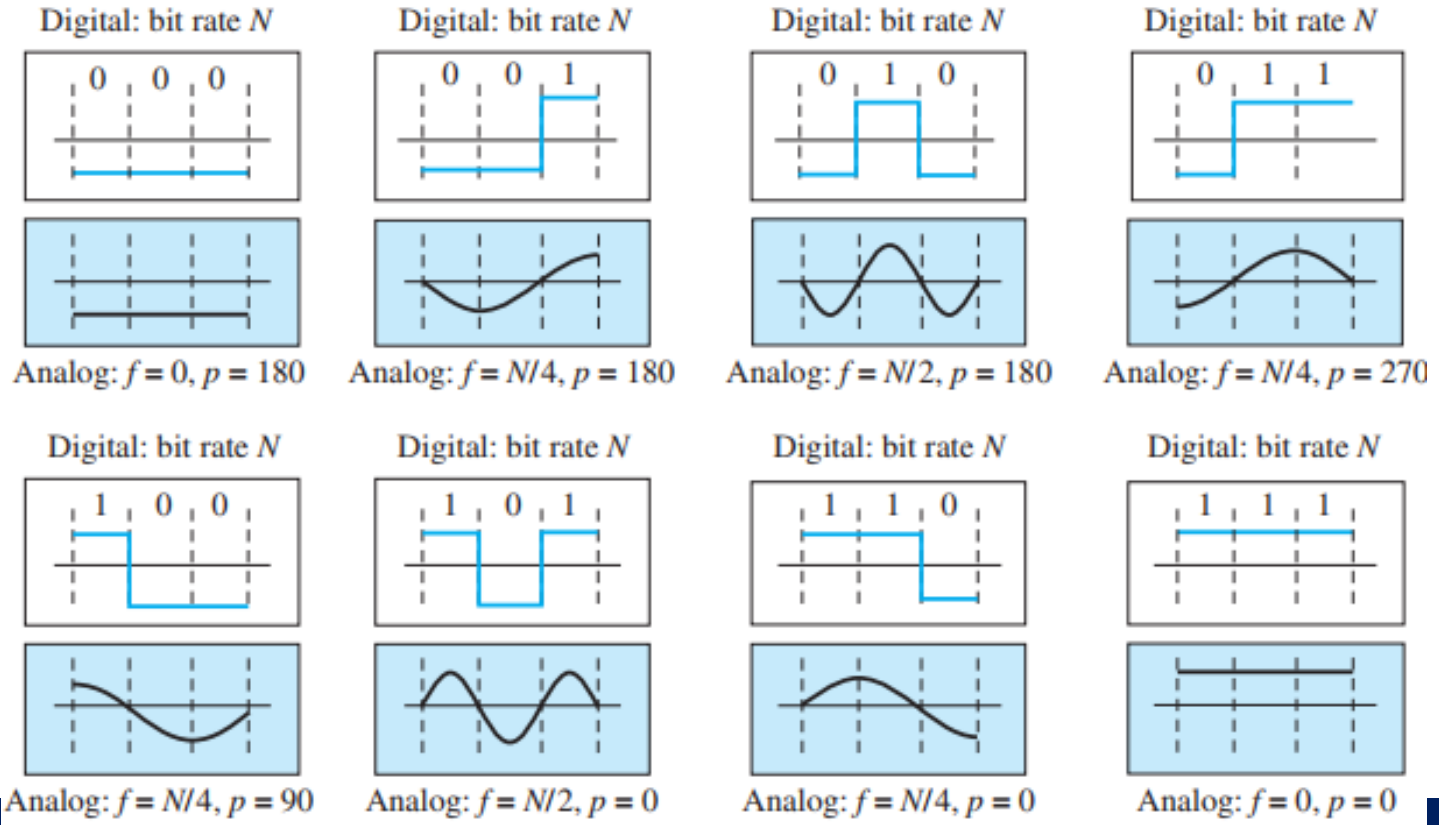
Topics discussed in Today's Lectures

- Low-Pass Channel with Limited Bandwidth
- Broadband Transmission (Using Modulation)
- Attenuation
- Distortion
- Noise

Low-Pass Channel with Limited Bandwidth

- In a low-pass channel with limited bandwidth, we approximate the digital signal with an analog signal
- The level of approximation depends on the bandwidth available

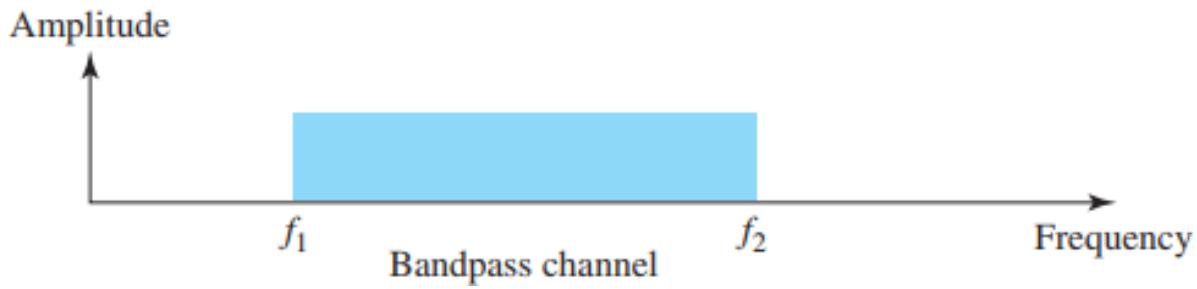
- A digital signal with a 3-bit pattern can be simulated by using analog signals



Broadband Transmission (Using Modulation)

- Broadband transmission (or modulation) means changing the digital signal to an analog signal for transmission
- Modulation allows us to use a bandpass channel—***a channel with a bandwidth that does not start from zero***
- This type of channel is more available than a low-pass channel
- Figure 3.24 shows a bandpass channel

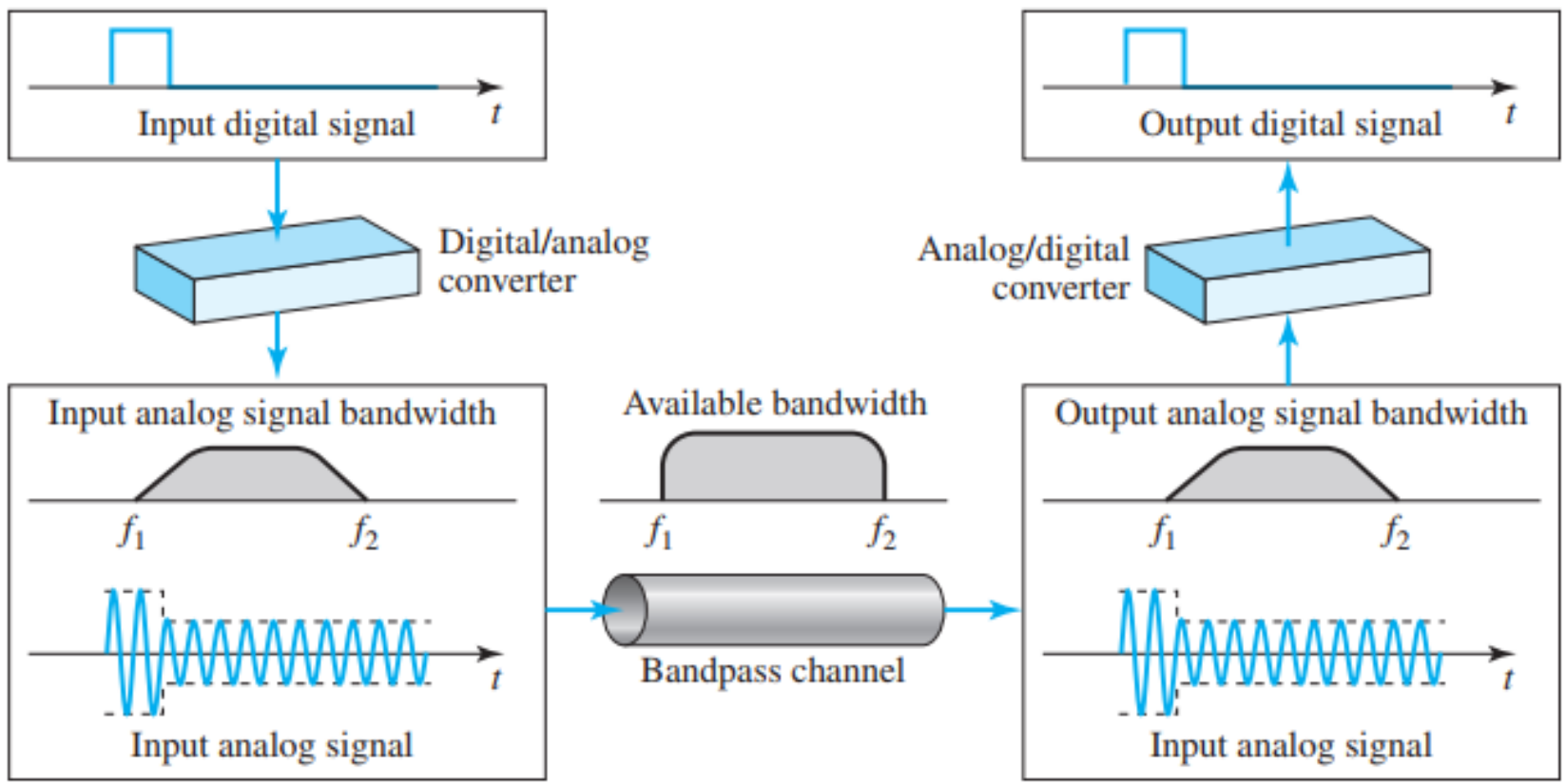
Figure 3.24 *Bandwidth of a bandpass channel*



Broadband Transmission (Using Modulation)

- If the available channel is a bandpass channel, we cannot send the digital signal directly to the channel
- We need to convert digital signal to an analog signal before transmission

Figure 3.25 *Modulation of a digital signal for transmission on a bandpass channel*



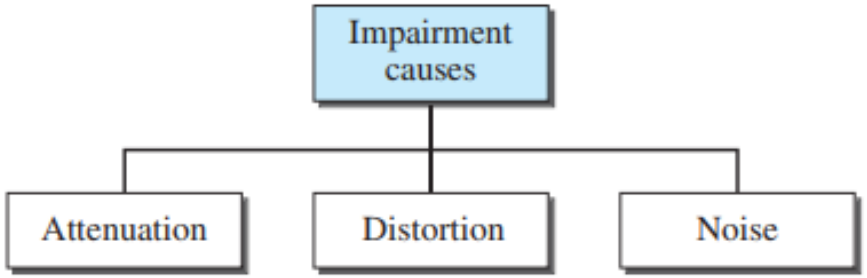
Broadband Transmission (Using Modulation)

- Fig 3.25 shows the modulation of a digital signal
- In fig., a digital signal is converted to composite analog signal
- We have used a single-frequency analog signal (called a carrier)
  - Amplitude of the carrier has been changed to look like the digital signal
  - At the receiver, received-analog signal is converted to digital
  - Result is a replica of what has been sent

Signals Impairment

- Signals travel through transmission media, which (media) are not perfect
- The imperfection causes signal impairment
  - This means that the signal at the beginning of the medium is not the same as the signal at the end of the medium
  - What is sent is not what is received
- Three causes of impairment are attenuation, distortion, and noise

Causes of impairment

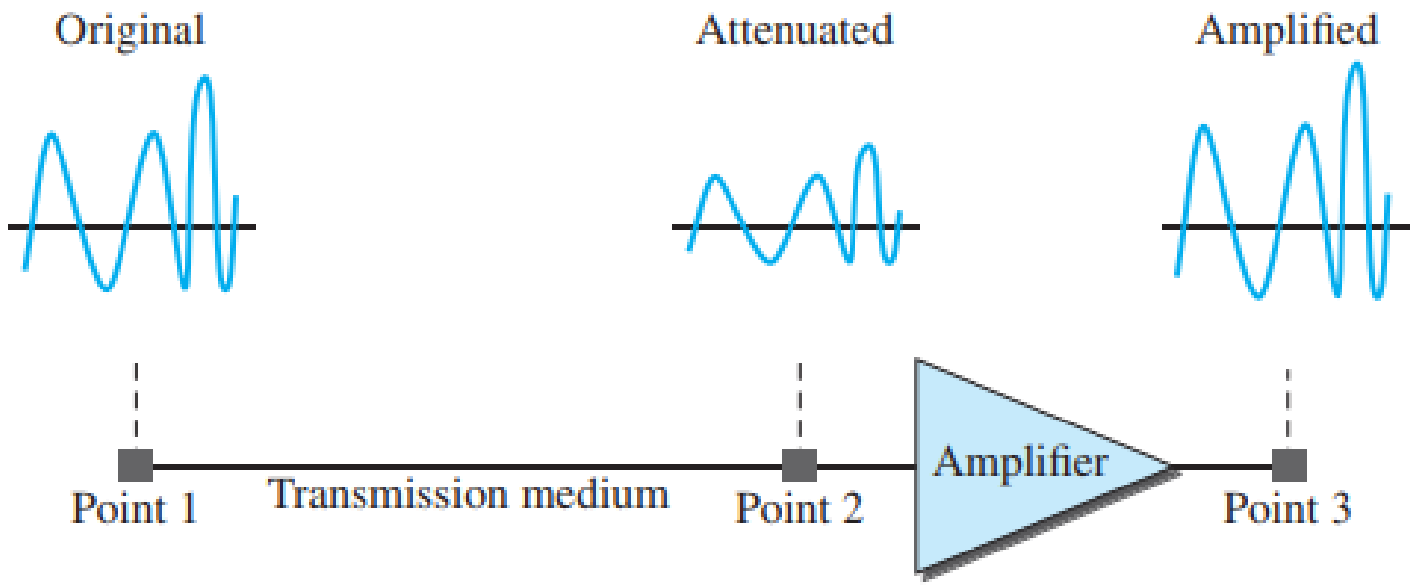


Attenuation

- Attenuation means *a loss of energy*
- When a signal, travels through a medium, it loses some of its energy in overcoming resistance of the medium
- That's why a wire carrying electric signals gets warm, after a while
- Some of the electrical energy in the signal is converted to heat
- To compensate for this loss, amplifiers are used to amplify the signal
- Figure 3.27 shows the effect of attenuation and amplification

Attenuation

Figure 3.27 *Attenuation*



Decibel

- To show that a signal has lost or gained strength, unit used is called decibel
- Decibel (dB) measures the relative strengths of two signals or one signal at two different points
- Decibel is -ve if a signal is attenuated and +ve if a signal is amplified

$$\text{dB} = 10 \log_{10} \frac{P_2}{P_1}$$

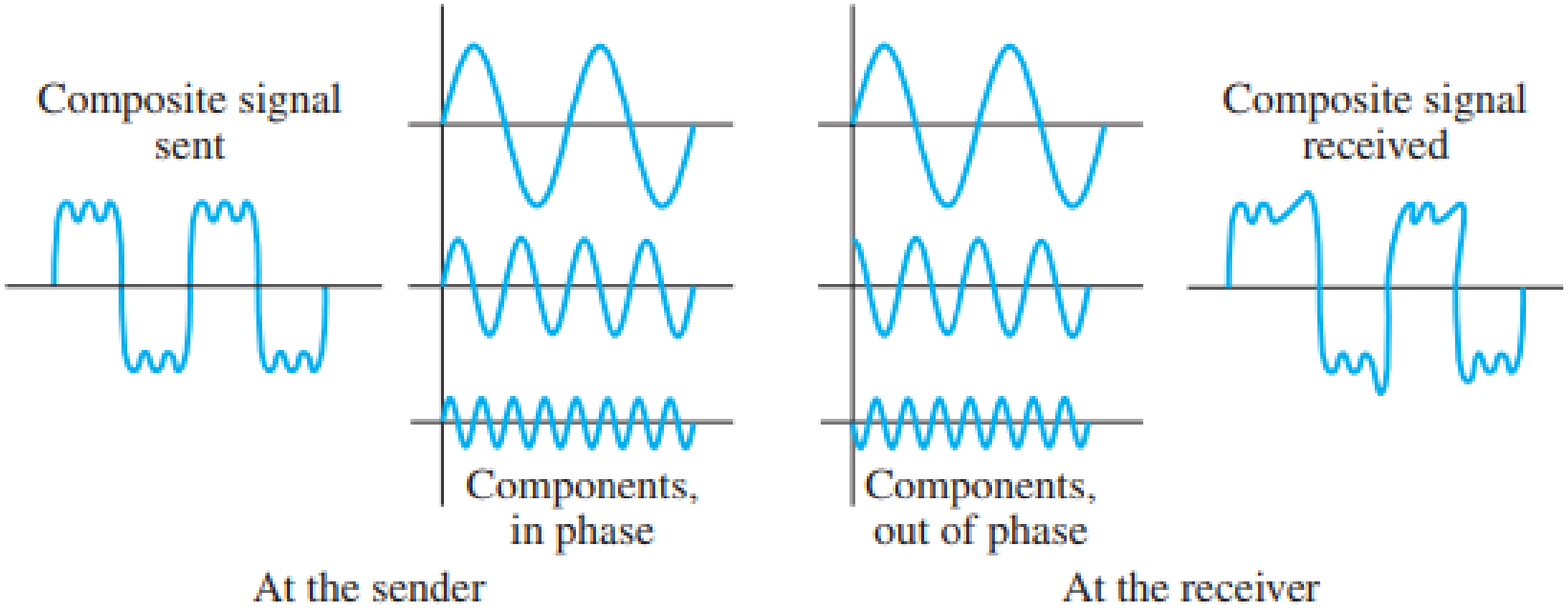
Variables $P1$ and $P2$ are the powers of a signal at points 1 and 2, respectively.

Distortion

- Distortion means that the signal changes its form or shape
- It can occur in a composite signal, made of different frequencies
- Each signal component has its own propagation speed and, therefore, its own delay in arriving at the final destination
- Differences in delay may create a difference in phase
- In other words, signal components at the receiver have phases different from what they had at the sender
- The shape of the composite signal is therefore not the same
- Figure 3.29 shows the effect of distortion on a composite signal.

Distortion

Figure 3.29 *Distortion*

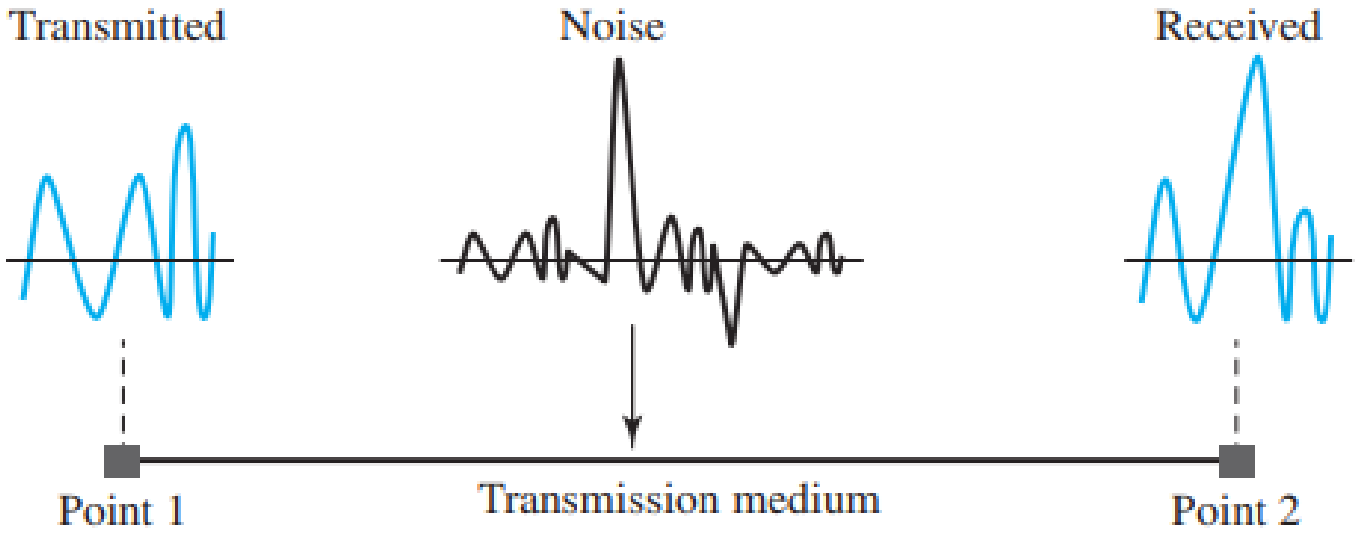


Noise

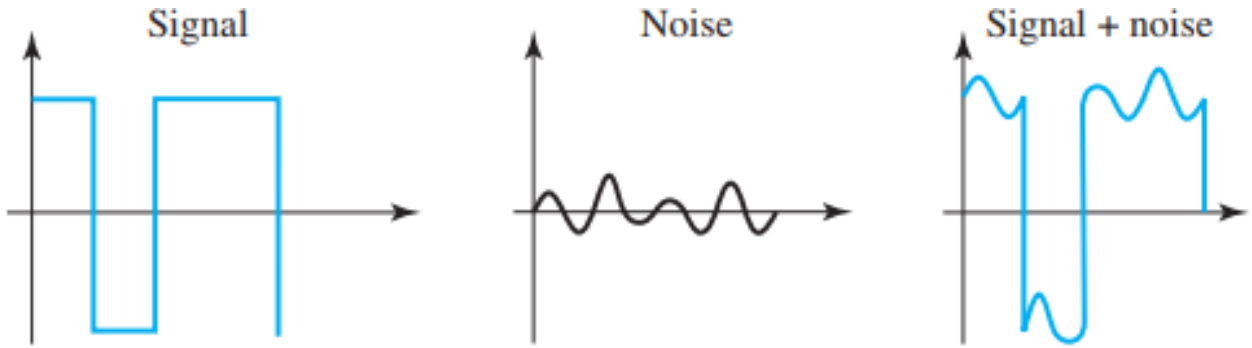
- Several types of noise, such as thermal noise, induced noise, crosstalk, and impulse noise, may corrupt the signal
- **Thermal noise** is the random motion of electrons in a wire, which creates an extra signal not originally sent by the transmitter
- **Induced noise** comes from sources such as motors and appliances
- **Crosstalk** is the effect of one wire on the other
  - One wire acts as a sending antenna and the other as the receiving antenna
- **Impulse noise** is a spike (a signal with high energy in a very short time) that comes from power lines, lightning, and so on
- Figure 3.30 shows the effect of noise on a signal..

Noise

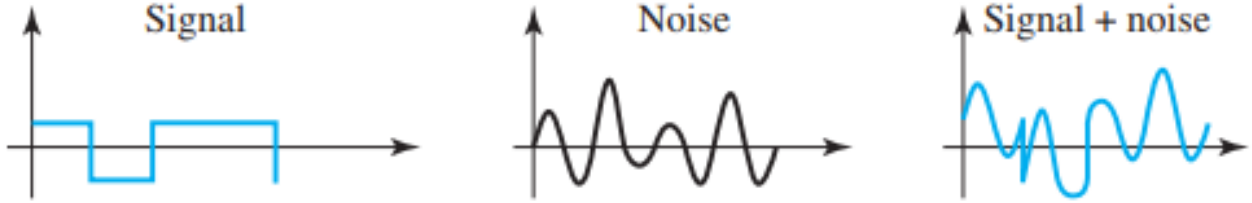
Figure 3.30 *Noise*



Noise



a. High SNR



b. Low SNR

SNR is actually the ratio of what is wanted (signal) to what is not wanted (noise). A high SNR means the signal is less corrupted by noise; a low SNR means the signal is more corrupted by noise.

References

Chapter 3

Data Communication and Networking (5th Edition)
By Behrouz A. Forouzan

THANKS