Principles of Communication (BEC-28)

Unit-4

Pulse Modulation and Digital Transmission of Analog Signal

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Content of Unit-IV

Pulse Modulation and Digital Transmission of Analog Signal: Sampling Theorem and its applications, Concept of Pulse Amplitude Modulation, Pulse width modulation and pulse position modulation, PCM, Pulse Time Modulation, TDM and FDM. Line Coding, Quantizer, Quantization Noise, Compounding multiplexer.

Pulse Code Modulation(PCM)

- The pulse code modulator technique samples the input signal x(t) at a sampling frequency.

- This sampled variable amplitude pulse is then digitalized by the analog to digital converter. Figure.(1) shows the PCM generator.

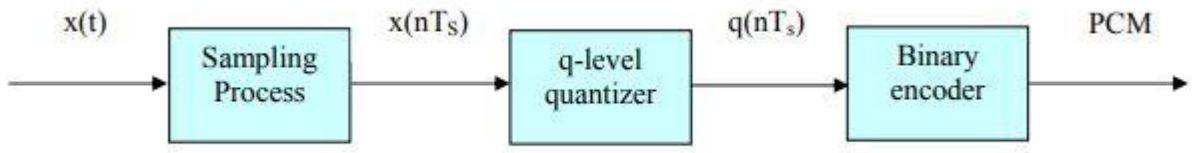


Figure.(1): PCM modulator

In the PCM generator, the signal is first passed through sampler which is sampled at a rate of (fs) where:

$$fs \geq 2fm$$

- The output of the sampler x(nTs) which is discrete in time is fed to a q -level quantizer. The quantizer compares the input x(nTs) with it's fixed levels. It assigns any one of the digital level to x(nTs) that results in minimum distortion or error.

Pulse Code Modulation(PCM)

- The error is called quantization error, thus the output of the quantizer is a digital level called q(nTs).
- The quantized signal level q(nTs) is binary encode. The encoder converts the input signal to v digits binary wo

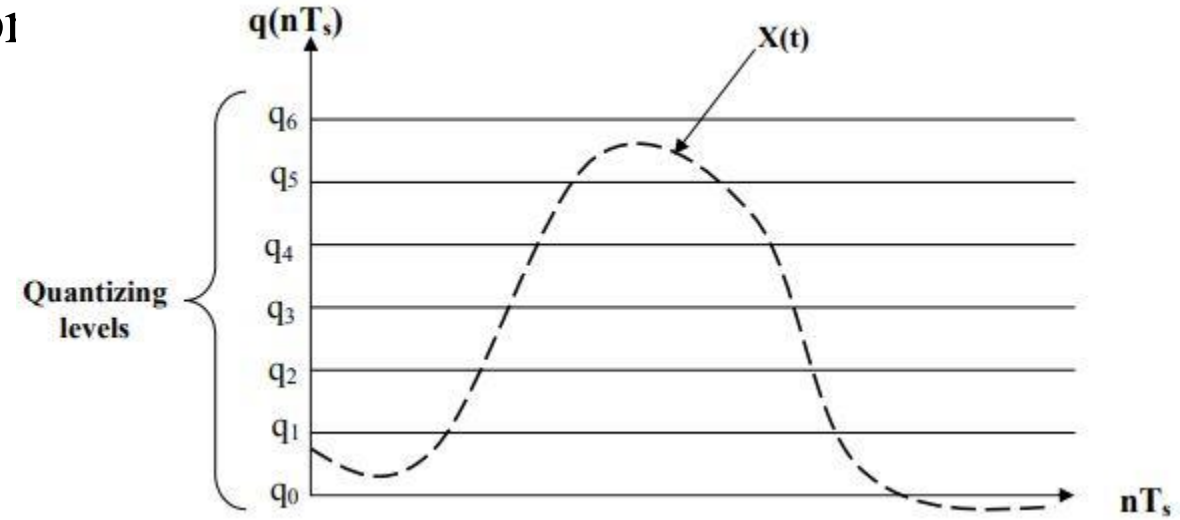


Figure.(2) A sampled signal and the quantized levels

- The receiver starts by reshaping the received pulses, removes the noise and then converts the binary bits to analog. The received samples are then filtered by a low pass filter; the cut off frequency is at fc.

i.e. , fc= fm

Pulse Code Modulation(PCM)

- It is impossible to reconstruct the original signal x(t) because of the permanent quantization error introduced during quantization at the transmitter.

- The quantization error can be reduced by the increasing quantization levels. This corresponds to the increase of bits per sample(more information).

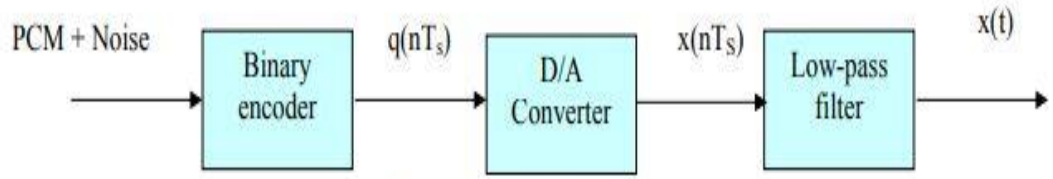


Figure.(3): PCM demodulator

- The choice of the parameter for the number of quantization levels must be acceptable with the quantization noise (quantization error).

Pulse Code Modulation(PCM)

- Figure.(4) shows the reconstructed signal.

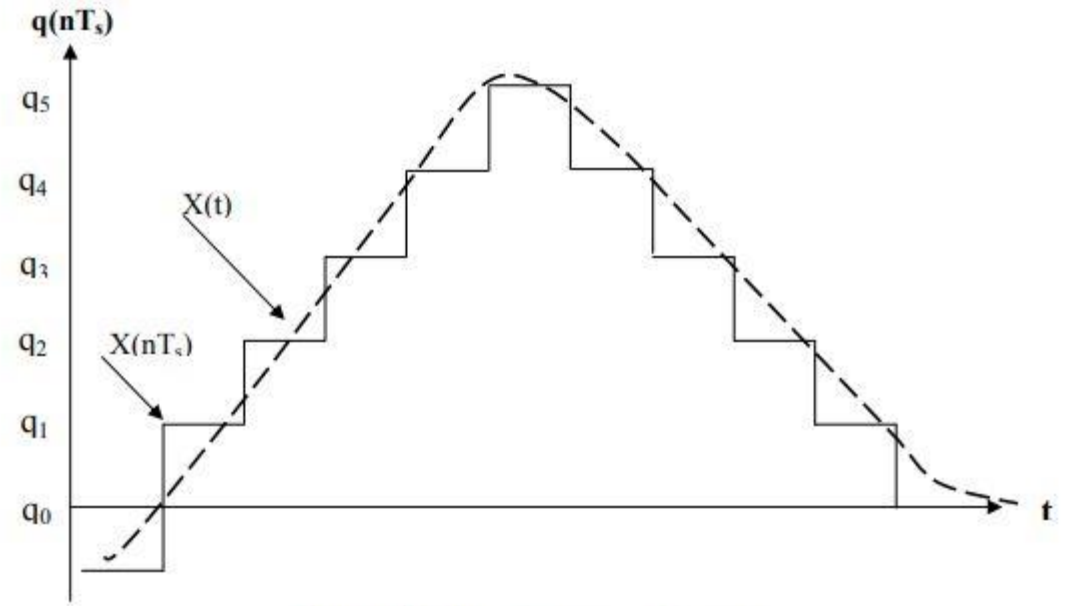


Figure.(4):The reconstructed signal

Signaling rate in PCM

Let the quantizer use 'v' number of binary digits to represent each level. Then the number of levels that can be represented by v digits will be :

$$Q=2^{v}$$

Pulse Code Modulation(PCM)

- The number of bits per second is also called signaling rate of PCM and is denoted by **'r'**:

Signaling rate (r)= vf_s

Example

- If the number of binary bits = 3 and the sampling rate is 2 sample/sec find the signaling rate, number of quantization levels?

Solution:

$f_s=2, \quad v=3$

signaling rate(r) = $v\, f_s$

$=3*2$

$=6$ bits/sec

Number of quantization(q)=2^v

$=2^3$

$=8$ levels

Multiplexing

- Multiplexing refers to the **combination of information streams from multiple sources** for **transmission over a shared medium .**
- Multiplexor is a mechanism that implements the concept. It permits hundreds or even thousands of signals to be combined and transmitted over a single medium. De-multiplexing refers to the separation of a combination, back into separate information streams .

Principle used

- Each sender communicates with a single receiver
- All pairs share a single transmission medium
- Multiplexor combines information from the senders for transmission in such a way that the de multiplexer can separate the information for receivers.
- Cost savings obtained using single channel to send Multiple signals.

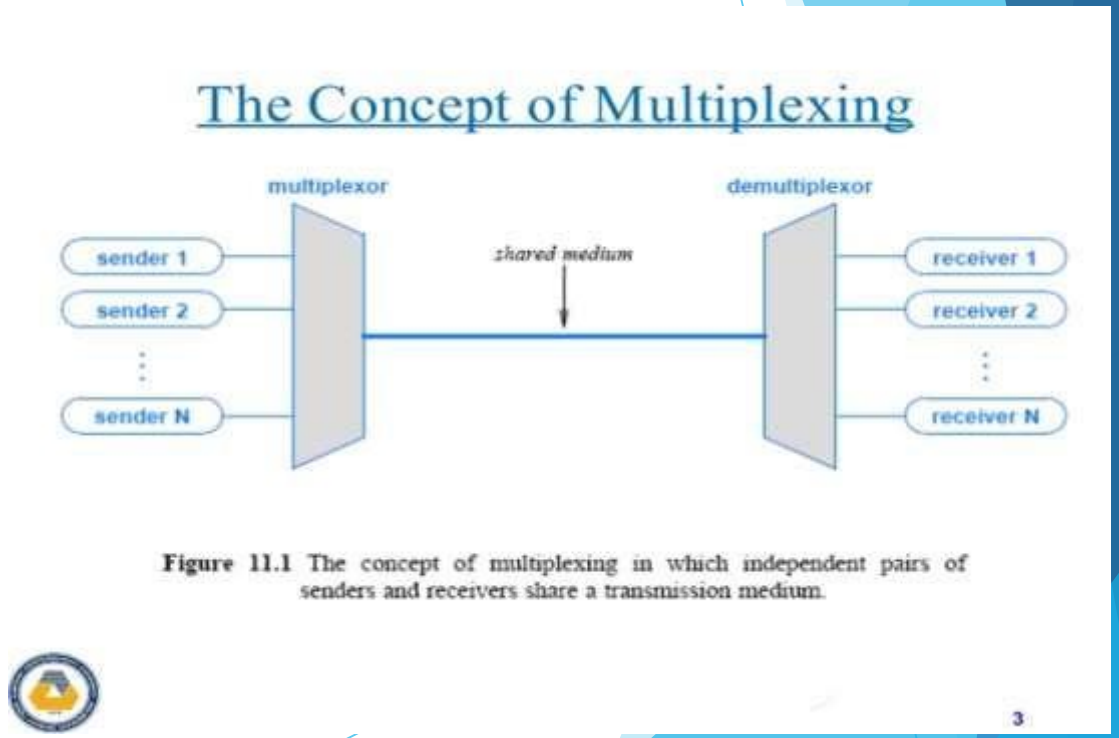
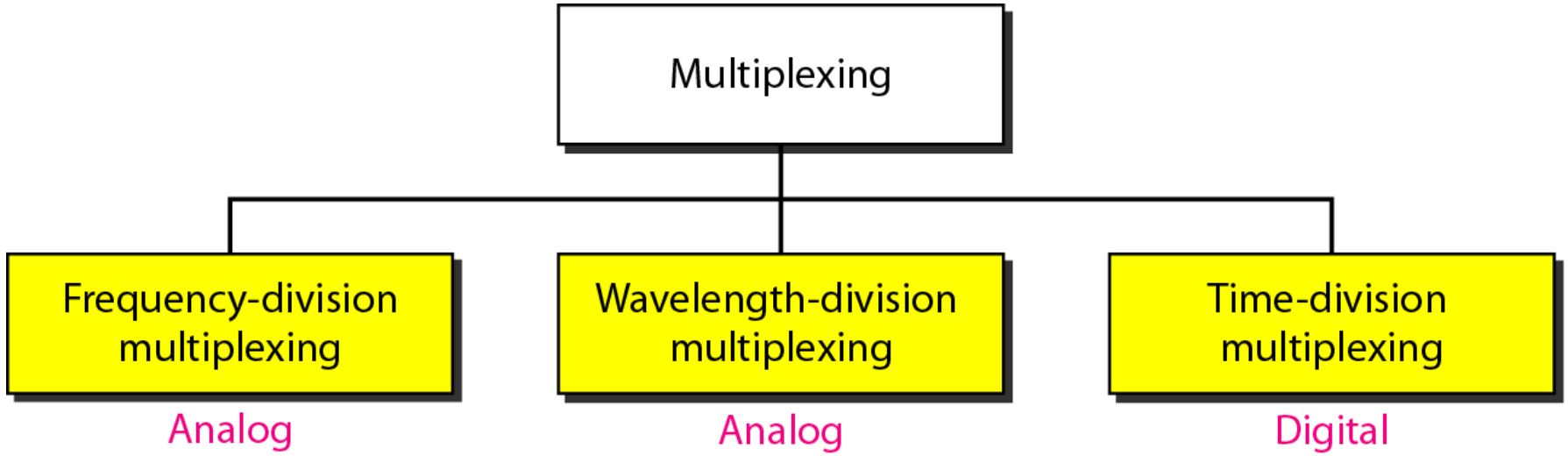


Figure 11.1 The concept of multiplexing in which independent pairs of senders and receivers share a transmission medium.

Four basic types of multiplexing

- Frequency Division Multiplexing (FDM)
- Wavelength Division Multiplexing (WDM)
- Time Division Multiplexing (TDM) •
  Code Division Multiplexing (CDM)




Thank You