IT301: Data Communication & Computer Network(DCCN)

Class: B. Tech (CS) Sec A
Semester : V
Teacher: Dr. Amritanjali

Week 4

Syllabus

Module I

- **Data Communications and Networking**: Overview A Communications Model, Data Communications, Data Communication Networking, The Need for Protocol Architecture, A Simple Protocol Architecture, OSI, The TCP/IP Protocol Architecture, Data TransmissionConcepts and Terminology, Analog and Digital Data Transmission, Transmission Impairments, Channel Capacity. (8L)

Module II

- **Transmission Media and Signal Encoding Techniques:** Guided Transmission Media, Wireless Transmission, Wireless Propagation, Line-of-Sight Transmission.Digital Data Digital Signals, Digital Data Analog Signals, Analog Data Digital Signals, Analog Data Analog Signals. (8L)

Module III

- **Digital Data Communication Techniques and Data Link Control:** Asynchronous and Synchronous Transmission, Types of Errors, Error Detection, Error Correction, Line Configurations, Interfacing, Flow Control, Error Control, High-Level Data Link Control (HDLC). (8L)

Module IV

- Multiplexing, Circuit Switching and Packet Switching Multiplexing Frequency Division Multiplexing, Synchronous Time Division Multiplexing, Statistical Time Division Multiplexing, Switching Networks, Circuit-Switching Networks, Circuit-Switching Concepts, Control Signaling, Soft switch Architecture, Packet-Switching Principles, X.25, and Frame Relay. (8L)

Module V

- Asynchronous Transfer Model Protocol Architecture, ATM Logical Connections, ATM Cells, Transmission of ATM Cells, ATM Service Categories, ATM Adaptation Layer. Routing in Switched Networks Routing in Circuit-Switching Networks, Routing in Packet-Switching Networks, Least-Cost Algorithms. (8L)

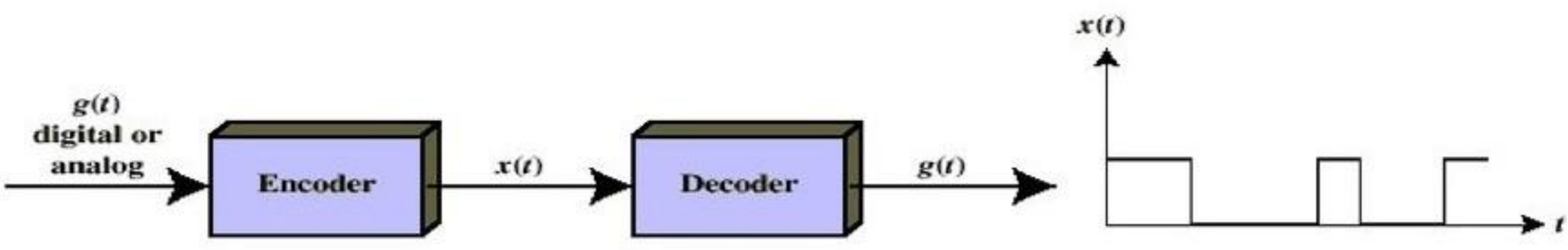
Text Book: Stallings W., Data and Computer Communications, 10th Edn., Pearson Education, PHI, New Delhi, 2014.(T1)

Reference Book: Forouzan B. A., Data Communications and Networking, 5thEdn. TMH, New Delhi, 2017.(R1)

Signal Encoding Techniques

Digital Signaling

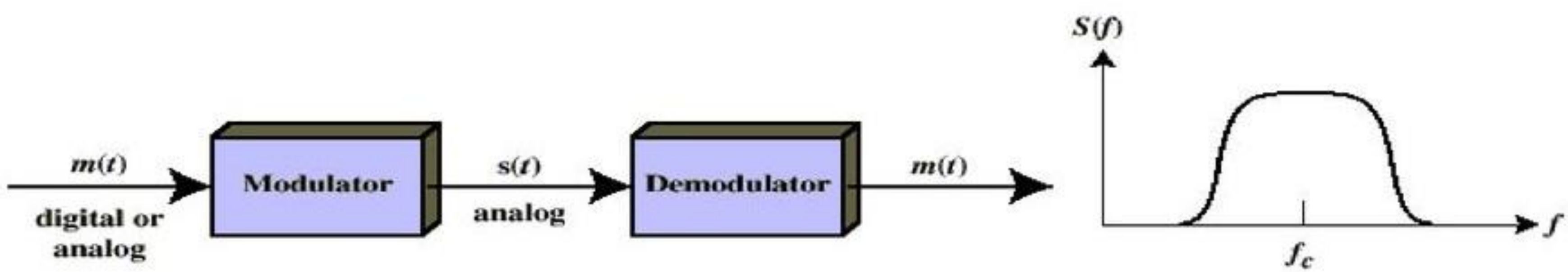
- A digital or analog data source is encoded into a digital signal
- Encoding technique decides the form of output digital signal
- It is chosen to optimize the use of the transmission medium



(a) Encoding onto a digital signal

Analog Signaling

- A carrier signal is used
- Frequency of the carrier signal should be compatible with the transmission medium being used
- Modulator is required to encode the data onto the carrier signal



(b) Modulation onto an analog signal

Signal Encoding

- Digital Data Digital Signal
- Analog Data Digital signal
- Digital Data Analog Signal
- Analog Data Analog Signal

Digital Data Digital Signals

Digital Signal

- A sequence of discrete, discontinuous voltage pulses
- Each pulse is a signal element
- Bits are encoded into signal elements

Unipolar Signaling

- All signal elements have same sign

Bipolar signaling

- Both positive and negative voltage levels are used

Digital Data Digital Signals

Data Rate

- Rate at which binary data is transmitted in bits per second

Bit Duration

- Time taken to transmit a single bit

Modulation Rate

- Rate of change of signal level

Signal Interpretation

- Receiver samples at the middle of bit duration and compares with a threshold value
- Receiver needs to know timing of each bit
- And, the binary value denoted by each signal level

Factors affecting error rate

Bandwidth and Data Rate

Signal to Noise Ratio

Encoding Technique

Desirable Features

- Lack of high frequency components
- Lack of DC Component
- Synchronization mechanism based on the transmitted signal
- Error detection Capability built into encoding scheme
- Signal interference and noise immunity
- Lower signaling rate for a given data rate

Non Return to Zero (NRZ)

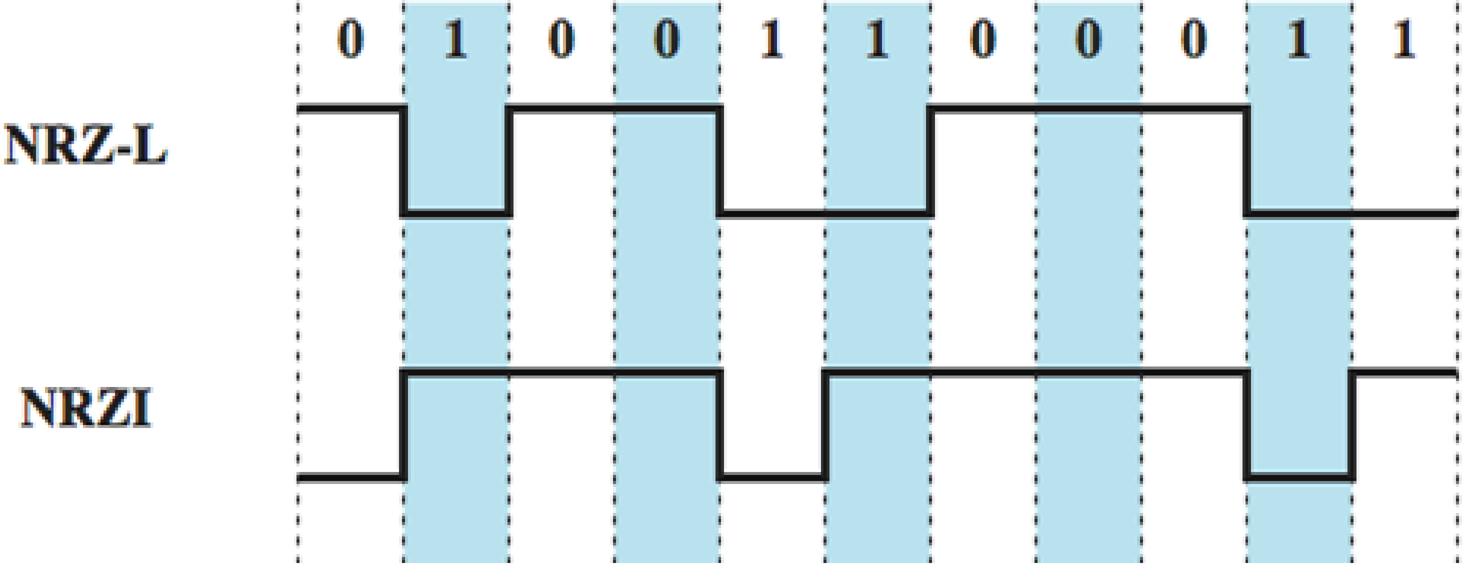
NRZ-L (Non Return to Zero-Level)

- Negative voltage level represents binary value 1
- Positive voltage level represents binary value 0

NRZI (Non Return to Zero, Invert on ones)

- Maintains a constant level for the duration of bit
- Transition at the beginning of bit interval indicates 1
- Absence of transition at the beginning of bit interval indicates 0
- A type of differential encoding technique, more reliable in the presence of noise as compared to multi-level signaling

NRZ Encoding



NRZ Performance

- Easy to implement
- Bandwidth efficient
- Presence of DC component
- Lack of synchronization capability

Multilevel Binary

- Use more than two signal levels

Bipolar AMI (Alternate Mark inversion)

- Binary 0 is represented by no line signal
- Binary 1 is represented by alternate positive and negative pulse

Pseudoternary- Inverse logic is used

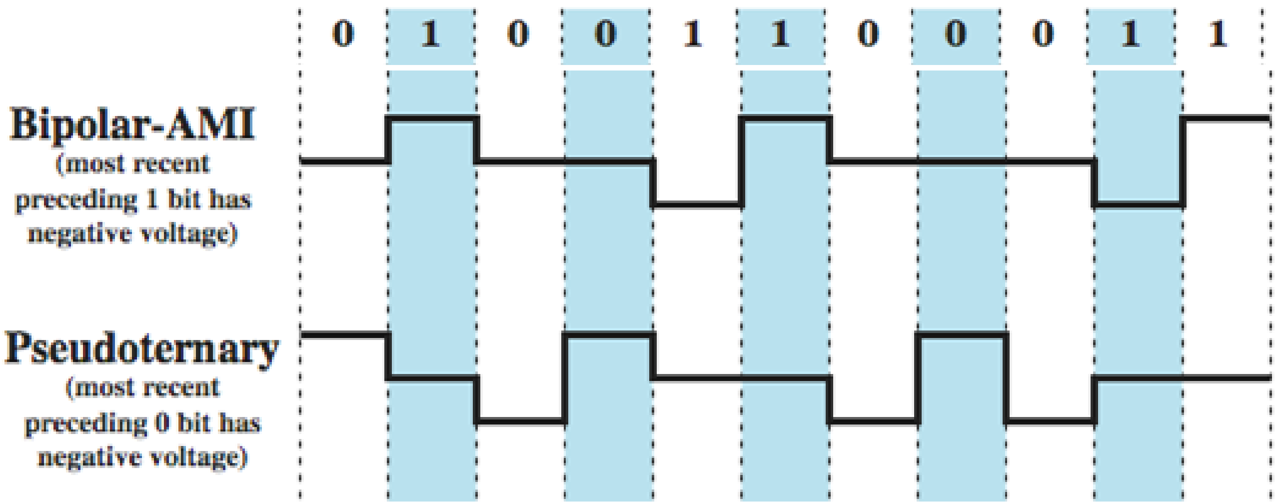
Advantages

- No DC component
- No loss of synchronization for long sequences of 1's
- Error detection capability

Disadvantage

- Not as BW efficient as NRZ

Multilevel Binary Encoding



Biphase

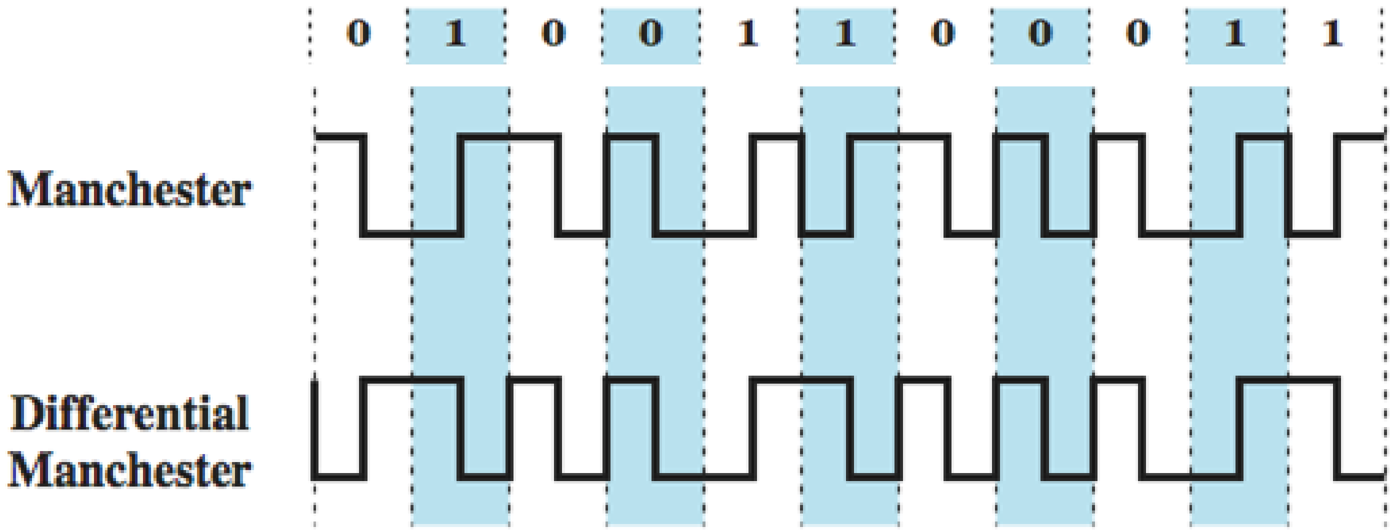
Signal level is checked twice in each bit duration

Manchester

- Transition at the middle of bit duration
- Low to high represents 1
- High to low represents 0

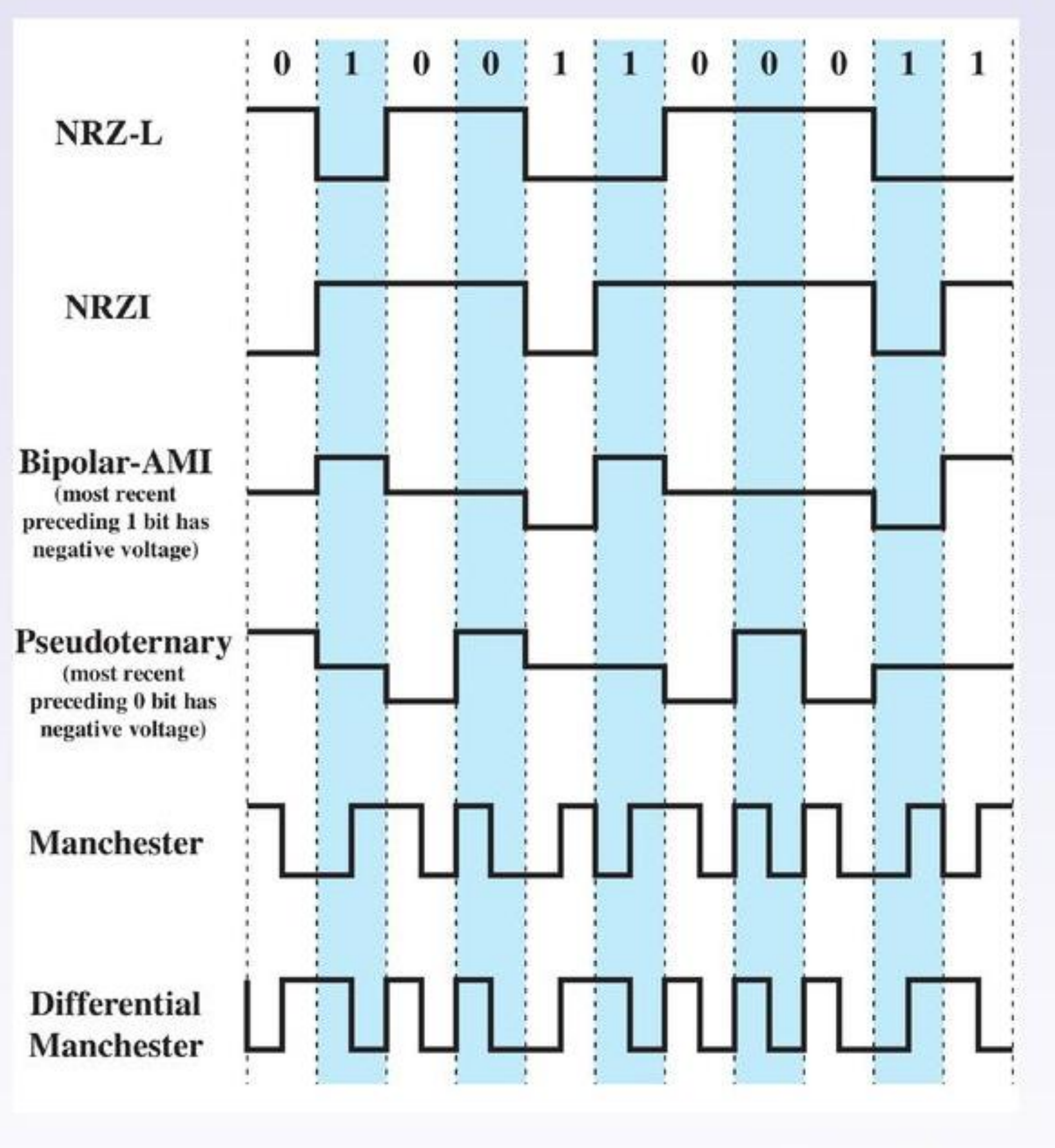
Differential Manchester

- Mid-bit transition for clocking
- Transition at the beginning represents 0
- Absence of transition at the beginning represents 1


0 1 0 0 1 1 0 0 0 1 1
Manchester
Differential Manchester

Performance

- Self clocking codes
- No DC component
- Absence of expected transition can be used for error detection
- Maximum modulation rate is twice that of NRZ


0 1 0 0 1 1 0 0 0 1 1
NRZ-L
NRZI
Bipolar-AMI
(most recent preceding 1 bit has negative voltage)
Pseudoternary
(most recent preceding 0 bit has negative voltage)
Manchester
Differential Manchester

Scrambling Techniques

- Biphase techniques are widely used in LAN applications
- Not suitable for long distance communications
- Scrambling technique are used for modifying the sequence of bits to avoid those sequences that would result in a constant voltage level on the line
- Such sequences are replaced by filling sequences that will provide sufficient transitions
- Ex- B8ZS and HDB3

B8ZS

Bipolar with 8 Zeroes Substitution

- Overcomes the problem of bipolar AMI
  - If an octet of all zeroes occur and if the last voltage pulse preceding this octet was positive pulse, then the octet is encoded as 000+-0-+
  - If an octet of all zeroes occur and if the last voltage pulse preceding this octet was negative pulse, then the octet is encoded as 000-+0+-

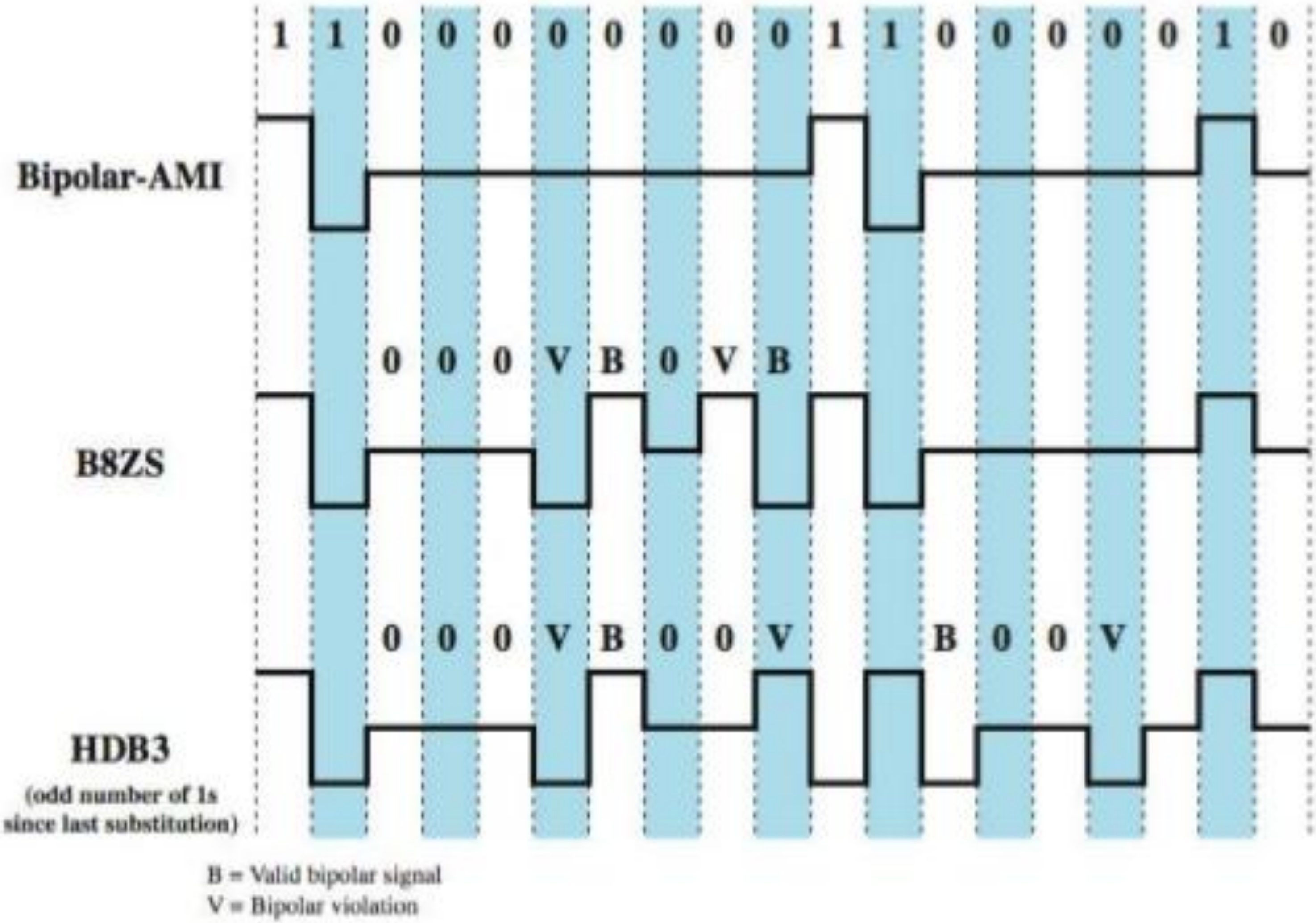
- It forces two code violations of the AMI code, which is unlikely to be caused by noise or other impairments

HDB3

High Density Bipolar 3 Zeroes

- It is also based on AMI encoding
- Replaces strings of four zeroes with sequences containing one or two pulses
- Fourth zero is replaced with a code violation
- Successive violations are of opposite polarity to avoid DC component

Previous Mark Polarity	Number of marks since the last substitution	
	Odd	Even
-	0 0 0 -	+ 0 0 +
+	0 0 0 +	- 0 0 -


1 1 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 1 0
Bipolar-AMI
0 0 0 V B 0 V B
B8ZS
0 0 0 V B 0 0 V B 0 0 V
HDB3
(odd number of 1s since last substitution)
B = Valid bipolar signal
V = Bipolar violation

Performance

- No DC Component
- No long sequence of zero level signals
- No reduction in data rate
- Error detection capability

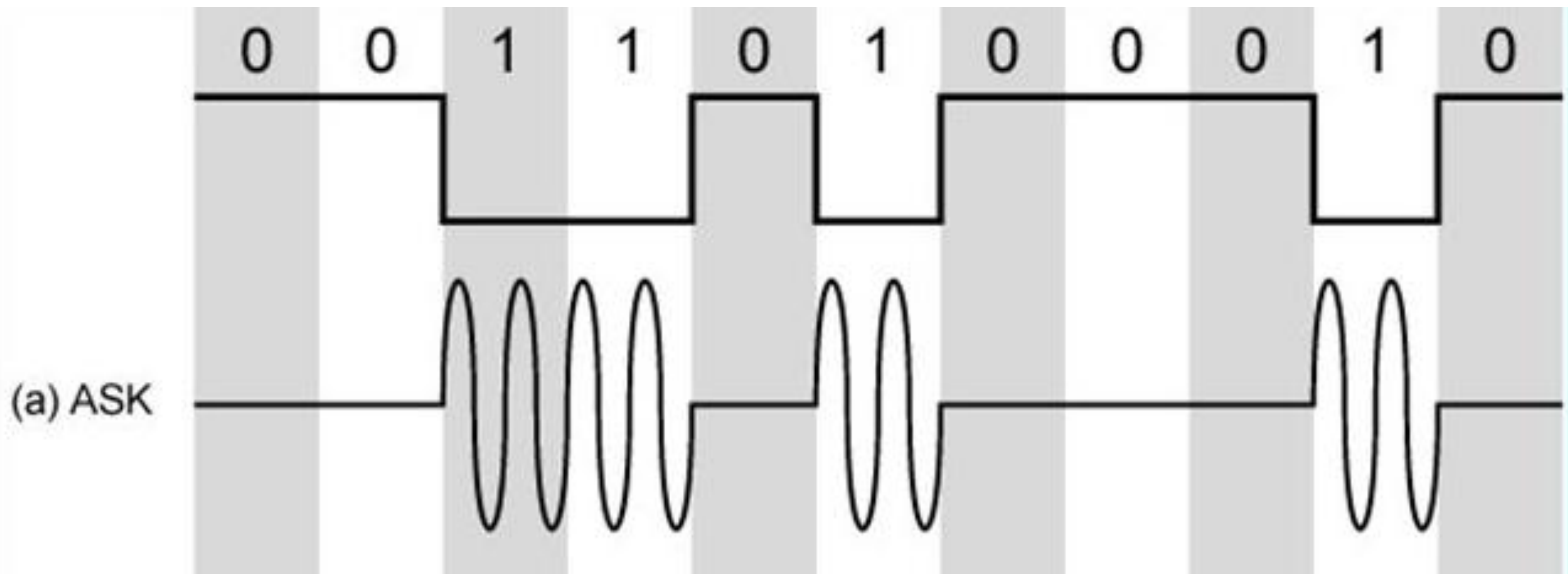
Digital Data Analog Signals

- Carrier signal is modulated using the input digital data
- It involves variation of one or more of the three characteristics of the carrier signal,
- Amplitude, frequency and phase
- Basic encoding or modulation techniques
- Amplitude shift keying (ASK), Frequency shift keying (FSK) and Phase shift keying (PSK)

ASK

- Two different amplitudes of the carrier signal is used to represent the binary values
- Used for transmitting data over optical fibers

$$s(t) = \begin{cases} A\cos(2\pi f_c t) & \text{binary 1} \\ 0 & \text{binary 0} \end{cases}$$


0
0
1
1
0
1
0
0
0
1
0
(a) ASK

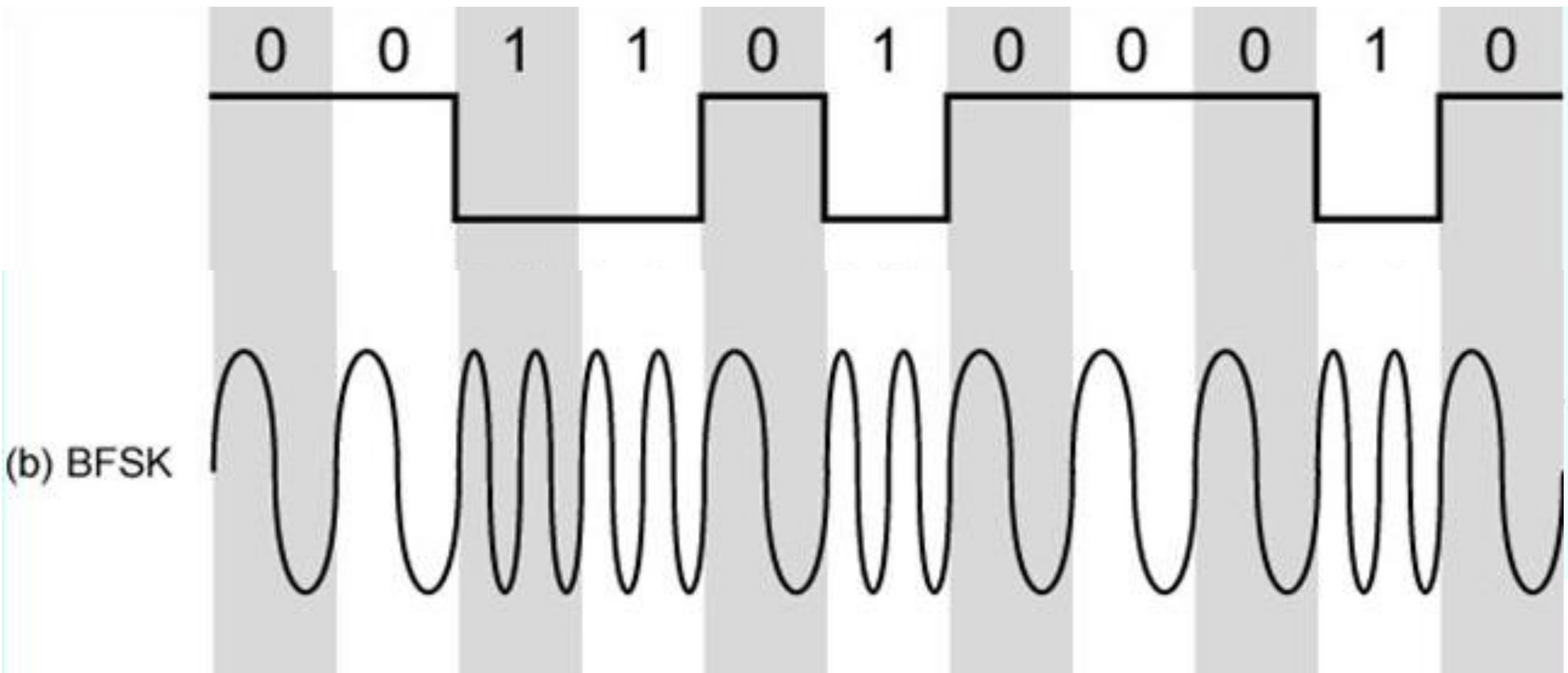
FSK

- Most common form is Binary FSK (BFSK)
- Carrier signals of two different frequencies are used to represent the two binary values

$$s(t) = \begin{cases} A\cos(2\pi f_1 t) & \text{binary } 1 \\ A\cos(2\pi f_2 t) & \text{binary } 0 \end{cases}$$

- f1 and f2 are offset from the carrier frequency by equal and opposite amounts

FSK



FSK

- Less susceptible to noise than ASK
- Used for high frequency radio transmission and in LANs using coaxial cable

MFSK

- More than two frequencies are used
- Bandwidth efficient but more susceptible to error

$$s_i(t) = A \cos 2\pi f_i t \qquad 1 \leq i \leq M$$

- $f_i = f_c + (2i - 1 - M) f_d$
- f_c = the carrier frequency
- f_d = the difference frequency
- M = number of different signal elements = 2^L
- L = number of bits per signal element

- Minimum frequency separation is $2f_d$ and required BW is $2Mf_d$

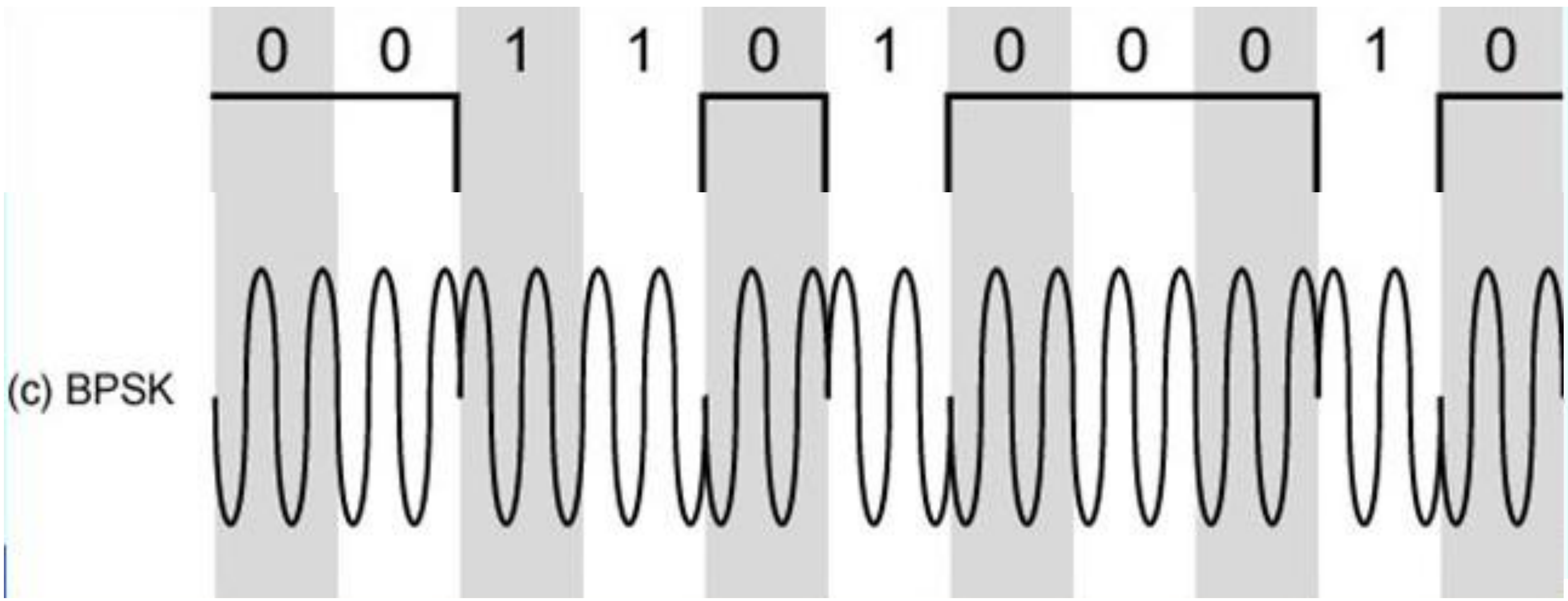
PSK

- Phase of the carrier signal is shifted to represent data
- BPSK

$$s(t) = \begin{cases} A\cos(2\pi f_c t) & \text{binary } 1 \\ A\cos(2\pi f_c t + \pi) & \text{binary } 0 \end{cases}$$

$$= \begin{cases} A\cos(2\pi f_c t) & \text{binary } 1 \\ -A\cos(2\pi f_c t) & \text{binary } 0 \end{cases}$$

PSK



QPSK

- Quadrature Phase Shift Keying (4-level PSK)
- Uses phase shifts in multiple of π/2

$$s(t) = \begin{cases} A\cos\left(2\pi f_c t + \frac{\pi}{4}\right) & 11 \\ A\cos\left(2\pi f_c t + \frac{3\pi}{4}\right) & 01 \\ A\cos\left(2\pi f_c t - \frac{3\pi}{4}\right) & 00 \\ A\cos\left(2\pi f_c t - \frac{\pi}{4}\right) & 10 \end{cases}$$

Transmission Bandwidth for Modulated Analog Signals

For ASK and PSK the bandwidth is given as

$\mathbf{B_T = (1 + r)\,R}$, where

R is the bit rate and r is a constant between 0 and 1.

For multilevel FSK, the bandwidth is given as

$\mathbf{B_T = ((1 + r)M/ \log_2 M)R}$., where

For multilevel PSK, bandwidth can be given as

$\mathbf{B_T = ((1 + r)/ \log_2 M)R}$.