Surname Name:	Pimenov Gleb
ID:	1820243077
Chapter:	2
Date:	March 20, 2024

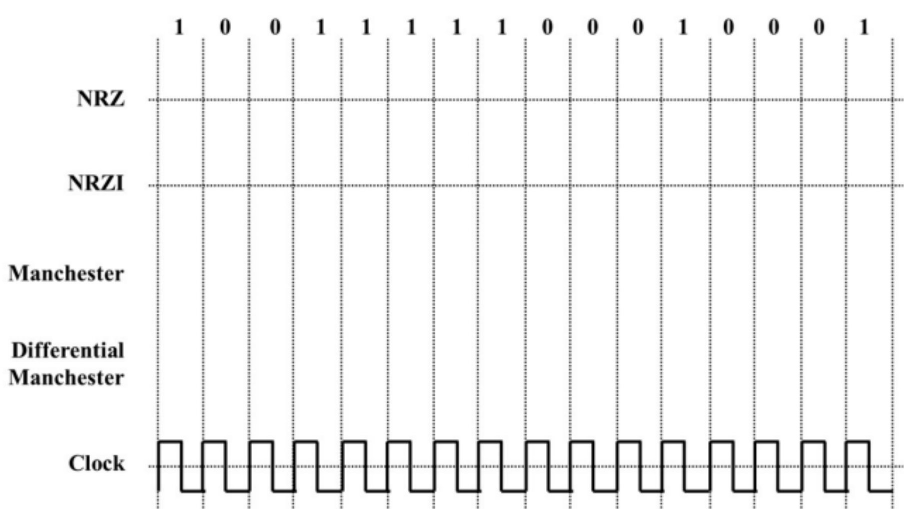
Computer Networks
Assignment Chapter №2

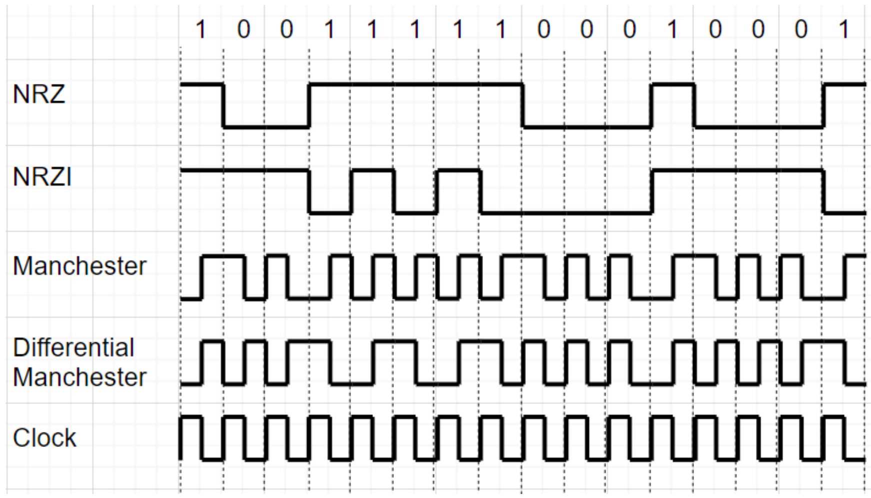
Task 1. *1. A noiseless 4-kHz channel is sampled every 1 msec. What is the maximum data rate? How does the maximum data rate change if the channel is noisy, with a signal-to-noise ratio of 30 dB?*

Solution. a) We can use Nyquist formula for the noiseless channel
Max Bit Rate $= 2 \cdot H \cdot log_2 V$ bps
Where H is the bandwidth, V - number of signal values
As I understand noiseless channel can carry an arbitrarily large amount of information, no matter how often it is selected.
Assume that we have binary channel -> V = 2
Max Bit Rate $= 2 \cdot 4000 \cdot log_2 2 = 8000$ bps
b) We can use Shannon formula for the channel with noise
Max Bit Rate $= H \cdot log_2(1 + \frac{S}{N})$ bps
Where H is the bandwidth, $\frac{S}{N}$ - the signal-to-noise ratio
Also Noise in db $= 10 \cdot log_{10}(\frac{S}{N})$
$\frac{S}{N} = 10^{\frac{30}{10}} = 10^3 = 1000$
Max Bit Rate $= 4000 \cdot log_2(1 + 1000) = 39869$ bps

□

Task 2. *Show the NRZ, NRZI, Manchester, and Differential Manchester encodings for the bit pattern shown in Figure 2-1. Assuming that the 0 in Manchester encoding is encoded as a high-to-low transition and 1 being encoded as a low-to-high transition, and that the signals of NRZI and Differential Manchester start out low*





Solution. □

Task 3. *What are the disadvantages of Manchester Encoding?*

Solution. 1. Manchester encoding requires at least one transition per bit time to ensure synchronization and clock recovery. This means that the signal transitions twice as often as in NRZ encoding, which can lead to higher power consumption and more complex circuitry.
2. Manchester encoding has a maximum modulation rate that is twice that of NRZ encoding. While this can be seen as an advantage in terms of data transmission speed, it also means that the bandwidth requirements are higher, which can be a limiting factor in certain applications.
3. Due to the nature of Manchester encoding, where each bit is represented by a transition, it requires more bandwidth compared to other encoding schemes such as NRZ. This can lead to congestion in communication channels and may not be suitable for applications with limited bandwidth availability.
4. Manchester encoding is considered bandwidth inefficient as it utilizes only 50% of the available bandwidth for data transmission. This is because each bit is represented by a transition, leading to a 50% overhead in terms of bandwidth utilization. In comparison, other encoding schemes like NRZ can achieve higher bandwidth efficiency.

□

Task 4. *A total of four stations perform code division multiple access CDMA communication.*
The chip sequences of the four stations are:
A: (-1 -1 -1 +1 +1 -1 +1 +1)
B: (-1 -1 +1 -1 +1 +1 +1 -1)
C: (-1 +1 -1 +1 +1 +1 -1 -1)
D: (-1 +1 -1 -1 -1 -1 +1 -1)
Station X now receives such a chip sequence:
(-1 +1 -3 +1 -1 -3 +1 +1). Which stations transmitted, and which bits did each one send?

Solution. Assume that every chip sequence equals to one bit.
We have a formula for calculating bits from the received sequences and codes for each sequence of station chips:
$d^* = \frac{\sum Z^*_m \cdot c^*_m}{M}$
Where is d is a bit, * - number of sender (A, B, C or D), $Z^*_m = d^* \cdot c^*_m$, c^*_m - code of * sender, M - count of codes
Now we can calculate what bit send every sender
$d^A = \frac{1-1+3+1-1+3+1+1}{8} = 1$ - A sent "1"bit
$d^B = \frac{1-1-3-1-1-3+1-1}{8} = -1$ - B sent "0"bit

$d^C = \frac{1+1+3+1-1-3-1-1}{8} = 0$ - C sent nothing
$d^D = \frac{1+1+3-1+1+3+1-1}{8} = 1$ - D sent "1"bit
We can verify this by summing up each transmitted sequence.
$A - B + D = (-1-1-1+1+1-1+1+1) + -(-1-1+1-1+1+1+1-1) + (-1+1-1-1-1-1+1-1) = (-1+1-3+1-1-3+1+1) = X$

$\square$