



School of Computer Science and Software Engineering

CSE3020 Network Technology Semester 2, 2003

Tutorial 3 - Week 4

Question T3.1 - What is the difference between bit rate and baud rate? Give an example where both are the same. Give an example where they are different.

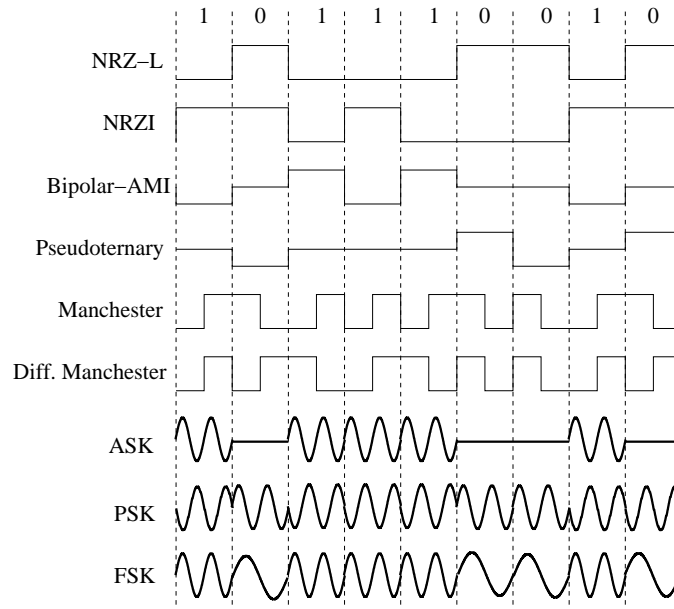
- *Bit rate: Baud rate \times number of bits per signal element. (Number of bits per second).*
- *Baud rate: number of signal elements per second.*
- *Same: 2-level signalling. e.g. Binary code, FSK, ASK, 2-PSK, etc...*
- *Different: 4-level signalling. e.g. 4-PSK, 4-QAM.*

Question T3.2 - Calculate the bit rate for the given baud rate and type of modulation:

- (a) *2000 baud, FSK. (2000 bps)*
- (b) *4000 baud, ASK. (4000 bps)*
- (c) *6000 baud, 2-PSK. (6000 bps)*
- (d) *3000 baud, 4-PSK. (6000 bps)*
- (e) *2000 baud, 8-PSK. (6000 bps)*
- (f) *2000 baud, 4-QAM. (4000 bps)*
- (g) *1500 baud, 16-QAM. (6000 bps)*
- (h) *6000 baud, 64-QAM. (36000 bps)*

Question T3.3 - What is the difference between encoding and modulation? For the bit stream 101110010, sketch the waveforms for each of the following schemes:

- (a) Nonreturn to Zero-Level (NRZ-L).
- (b) Nonreturn to Zero Inverted (NRZI).
- (c) Bipolar-AMI.
- (d) Pseudoternary.
- (e) Manchester.
- (f) Differential Manchester.
- (g) Amplitude Shift Keying (ASK).
- (h) Phase Shift Keying (PSK).
- (i) Frequency Shift Keying (FSK).



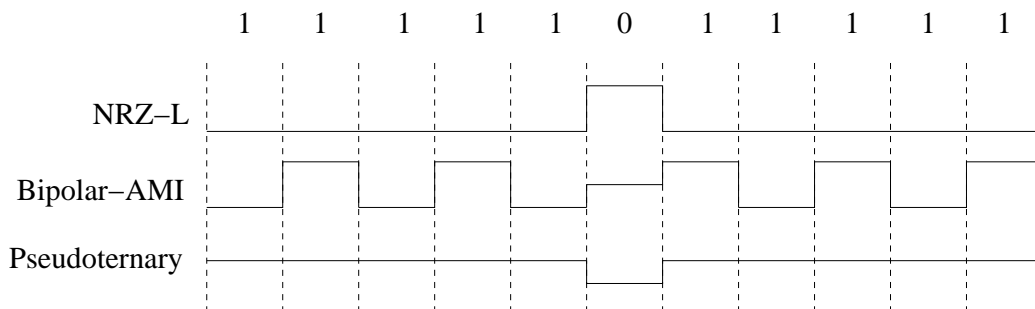
Assume that the signal level for the preceding bit for NRZI was low; the most recent preceding 1 bit (AMI) was a positive voltage; and the most recent preceding 0 bit (pseudoternary) was a positive voltage.

Question T3.4 - Consider a stream of binary data consisting of 5 consecutive of 1s followed by a zero followed by 5 consecutive of 1s, with the same assumptions as **Question T3.3**. Draw the waveforms for each of the following encoding schemes:

- (a) Nonreturn to Zero-Level (NRZ-L).
- (b) Bipolar-AMI.
- (c) Pseudoternary.

Does each of these schemes have a synchronization problem? If yes, explain your answer.

All schemes have a synchronization problem...



Question T3.5 - This question relates to Pulse Code Modulation (PCM).

- (a) What is digitization?
- (b) Using diagrams, explain the steps that take an analogue signal to PCM digital code.
- (c) How does the sampling rate affect the re-construction of the original analogue signal at the receiver?
- (d) How does the number of bits allocated for each sample affect the transmitted digital signal?
- (e) What is the sampling rate if a signal highest frequency component is 5,000 Hz? What is the bit rate assuming 12 bits per sample? What is the signal-to-noise ratio?

(a) *Digitization : conversion of analog data into digital data.*

(b) *Stallings page 149-150 and lecture slides.*

(c) *To ensure the re-construction of the original signal, sampling rate must be at least twice the highest frequency of the original signal. A sampling rate of twice the frequency of x Hz means that the signal must be sampled every 1/2x seconds.*

(d) *The greater the number of bits per sample:*

- *the higher the bit rate,*
- *lower quantizing error or noise, better SNR,*
- *better quality of the transmitted signal.*

(e)

$$\text{Sampling rate} = 2 \times \text{highest signal frequency} \quad (1)$$

$$= 2 \times 5,000 \quad (2)$$

$$= 10,000 \text{ samples/second} \quad (3)$$

$$\text{Bit rate} = \text{Sampling rate} \times \text{Number of bits per sample} \quad (4)$$

$$= 10,000 \times 12 \quad (5)$$

$$= 120,000 \text{ bps} \quad (6)$$

$$= 120 \text{ kbps} \quad (7)$$

$$\text{SNR}_{db} = 20 \log 2^n + 1.76 \quad (8)$$

$$= 20 \log 2^{12} + 1.76 \quad (9)$$

$$= 74.01 \text{ dB.} \quad (10)$$

OR

$$\text{SNR}_{db} = 6.02n + 1.76 \quad (11)$$

$$= 6.02 \times 12 + 1.76 \quad (12)$$

$$= 74 \text{ dB.} \quad (13)$$