MONASH UNIVERSITY

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.

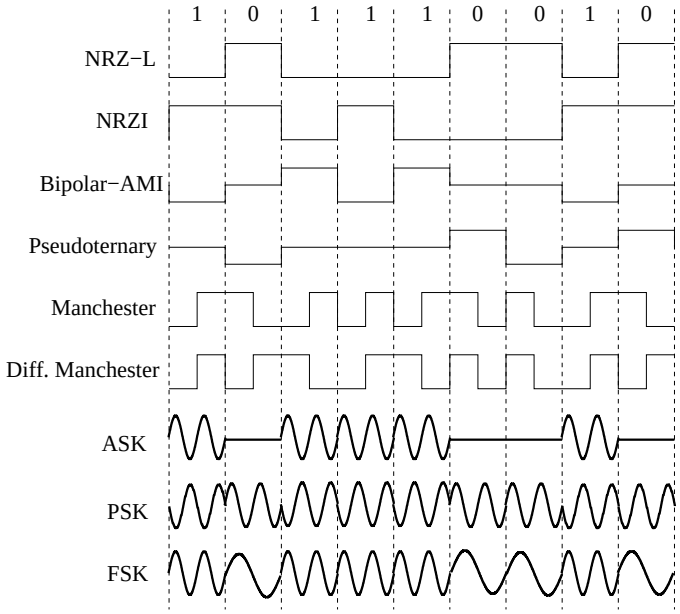
(e) Manchester.

(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:

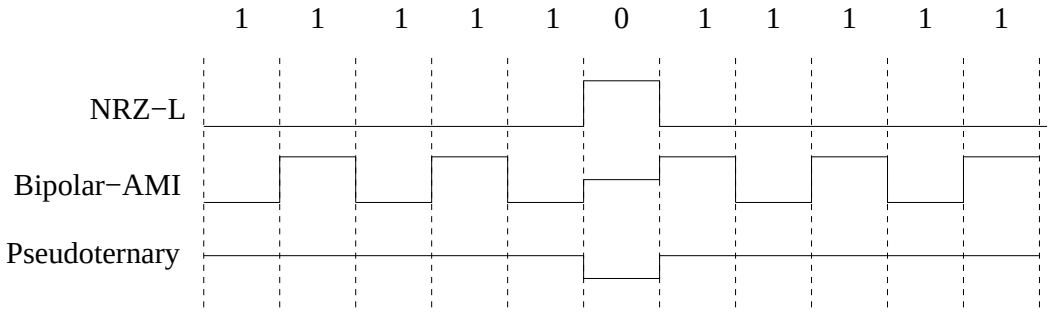
(a) Nonreturn to Zero-Level (NRZ-L).

(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)

$$\begin{aligned}
\textit{Sampling rate} &= 2 \times \textit{highest signal frequency} && (1)\\
&= 2 \times 5,000 && (2)\\
&= 10,000 \textit{ samples/second} && (3)\\
\textit{Bit rate} &= \textit{Sampling rate} \times \textit{Number of bits per sample} && (4)\\
&= 10,000 \times 12 && (5)\\
&= 120,000 \textit{ bps} && (6)\\
&= 120 \textit{ kbps} && (7)
\end{aligned}$$

$$\begin{aligned}
SNR_{db} &= 20\log 2^n + 1.76 && (8)\\
&= 20\log 2^{12} + 1.76 && (9)\\
&= 74.01 \textit{ dB}. && (10)
\end{aligned}$$

OR

$$\begin{aligned}
SNR_{db} &= 6.02n + 1.76 && (11)\\
&= 6.02 \times 12 + 1.76 && (12)\\
&= 74 \textit{ dB}. && (13)
\end{aligned}$$