Computer Networks

Homework 3

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Problem 1:

A signal is sampled two times each microsecond, into samples carrying 2 bits of information each. The communication channel has a bandwidth of 20 MHz and a signal to noise ratio of 30 dB.

a) What data rate does the sampling provide?
b) What is the maximum data rate of the channel?

$B = 20\ MHz = 20 * 10^6\ Hz$

$SNR = 30\ dB$

ips (information per sample) = 2b

$L = ips^2 = 4$

a) data rate = $B * ips = 20 * 10^6\ Hz * 2b = 40\ Mbps$
Answer: The sampling provides the data rate of 40 Mbps.

$SNR = 10 * \log_{10}(S/N)$

$\log_{10}(S/N) = SNR / 10$

$S/N = (SNR / 10)^{10} = (30\ dB / 10)^{10} = 59\ 049\ dB$

b) mdr_{NY} (max data rate Nyquist) = $2 * B * \log_2 L = 2 * 20\ 10^6\ Hz * \log_2 4 = 80\ Mbps$
Mdr_{SH} (max data rate Shannon) = $B * \log_2(1+S/N) = 20 * 10^6\ Hz * \log_2(59\ 050) = 95.42\ Mbps$
mdr_{REAL} (real max data rate) <= min $\{mdr_{NY}, mdr_{SH}\} = mdr_{NY} = 80\ Mbps$
Answer: The maximum data rate of the channel is lower or equal to 80 Mbps.

Problem 2:

Given the following bit sequences:

- A: 01101111
- B: 10000111
- FLAG: 01111110
- ESC: 11100000

show the transmitted bit sequence for data = FLAG A B ESC when using:

a) byte count,
b) flag bytes with byte stuffing,
c) flag bytes with bit stuffing.

| data | = 4 B

| data $_{BCount}$ | = | data | + 1B = 5B

a) data $_{BCount}$ = | data $_{BCount}$ | + data =
00000101 01111110 01101111 10000111 11100000

b) data $_{BStuffing}$ = FLAG ESC FLAG A B ESC ESC FLAG =
01111110 11100000 01111110 01101111 10000111 11100000 11100000 01111110

c) data $_{bStuffing}$ = data $_{BStuffing}$ + [0 after every 5 successive 1s] =
01111110 11100000 011111010 01101111 100000111 110100000 11100000 01111110