Chapter 2

1. If a binary signal is sent over a 3-kHz channel whose signal-to-noise ratio is 20 dB, what is the maximum achievable data rate?

2. What signal-to-noise ratio is needed to put a T1 carrier on a 50-kHz line?

3. Ten signals, each requiring 4000 Hz, are multiplexed on to a signal channel using FDM. How much minimum bandwidth is required for the multiplexed channel? Assume that the guard bands are 400 Hz wide.

Solution

1. $\frac{S}{N_{dB}} = 10\log_{10}\frac{S}{N}$

$\therefore SNR = \frac{S}{N} = 100$

the maximum data rate

$= 2 \times B \times \log_2 V = 6\text{kbps}$

2.

$H \times \log_2(1+\frac{S}{N}) = 1.544 \times 10^6$

where $H = 50\,kH_2 = 5 \times 10^4 H_2$

$\therefore \frac{S}{N} = 2^{31} = 2.1 \times 10^9 \approx 93dB$

3.

the minimum bandwith required is $4000^{10} + 400^9 = 43600\,Hz$

Chapter 3

1. A bit string, 0111101111101111110, needs to be transmitted at the data link layer. What is the string actually transmitted after bit stuffing?

2. What is the remainder obtained by dividing x^7 + x^5+1 by the generator polynomial x^3 +1 ? (注：x^7表示x的7次方，其它表述方式相同)

3 Data link protocols almost always put the CRC in a trailer rather than in a header. Why?

4. Frames of 1000 bits are sent over a 1-Mbps channel using a geostationary satellite whose propagation time from the earth is 270

msec. Acknowledgements are always piggybacked onto data frames. The headers are very short. Three-bit sequence numbers are used. What is the maximum achievable channel utilization for

a) (a) Stop-and-wait.
b) (b) Protocol 5
c) (c) Protocol 6

5. What is the minimum overhead to send an IP packet using PPP? Count only the overhead introduced by PPP itself, not the IP header overhead.

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Solution:

1. The output is

01111011111100111110010

2.
The reminder is x^2+x+1

3.
Because CRC is computed during transmission and appended to the output stream as soon as the last bit goes out onto the wire.
If the CRC were in the Header, it's necessary to make a pass over the frame. This requires each byte to be handled twice.
Using the trailer cuts the work in half

4.
a) k=1, efficiency = $\frac{1}{142}$ = 0.18%

b) k=2, efficiency = $\frac{2}{142}$ = 1.26%

c) k=4, efficiency = $\frac{4}{142}$ = 0.72%

5. At its smallest, each frame has two flag bytes, one protocol byte, and two checksum bytes.
So totally five bytes per frame.