# 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?

**Nyquist**

**Shannon**

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

**The data-rate in T1 is 1.544 Mbps**

**Shannon**

**In dB**

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.

# 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?

**011110111110011111010**

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)

**10100001 divided by 1001**

**reminder 111**

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

**The 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 would be necessary to make a pass over the frame to compute the CRC before transmitting. This would require each byte to be handled twice— once for checksumming and once for transmitting. Using the trailer cuts the work in half.**

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

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

**(a) Stop-and-wait.**

**send**

**(b) Protocol 5(go-back-n protocol)**

**(c) Protocol 6(selective repeat protocol)**

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.

**2(FLAG) +1(Protocol)+2(Checksum)=5bytes**

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