

## 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?

**Answer:**

根据Nyquist定理:  $2W \cdot \log V = 2 \cdot 3k \cdot \log 2 = 6kb/s$

根据Shannon定理:  $W \cdot \log(1+S/N) = 3k \cdot \log(1+100) = 19.97kb/s$

所以maximum achievable data rate 是 6kb/s

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

**Answer:**

根据香农定理,  $50k \cdot \log(1+S/N) = 1.544M$ , 得出  $S/N = 10^{\log(20^{30.88}-1)} = 92.96dB$

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.

**Answer:**  $4000 \cdot 10 + 400 \cdot 9 = 43600Hz$ , 所以最小带宽是 43600Hz

## Chapter 3

1. A bit string, 011110111110111110, needs to be transmitted at the data link layer. What is the string actually transmitted after bit stuffing?

**Answer:**

The output is 011110111110011111010

3. 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)

**Answer:**

10100001 除以 1001 得到的余数是 111, 所以答案是  $x^2 + x + 1$

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

**Answer:**

CRC 在传输过程中计算, 并在最后一位传送到传输线时追加到输出流中。如果 把 CRC 放在头部, 就需要在传输之前对帧进行一次遍历来计算 CRC。这将要求每个字节被处理两次——一次用于计算校验和, 一次用于传输。使用尾部可以减少一半的工作。

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.

**Answer:**

$$1000/1\text{M} = 1\text{ms}$$

$$1\text{ms}/2 \cdot (1\text{ms} + 270\text{ms}) \cdot 100\% = 0.185\%$$

b) (b) Protocol 5

**Answer:**

$$(2^3 - 1) \cdot 0.18\% = 1.29\%$$

c) (c) Protocol 6

**Answer:**

$$2^2 \cdot 0.18\% = 0.738\%$$

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.

**Answer:**

最小开销是：每帧有 2 个标志字节、1 个协议字节和 2 个校验字节，每帧总共 5 字节开销

=====