**Physical Layer**

1. Television channels are 7 MHz wide. How many bits/sec can be sent if 8-level digital signals are used? Assume a noiseless channel. (81%)

If 8-level digital signals are used, this means we need to use 3 bits to represent different levels. According to the Nyquist Bandwidth **C = 2B log2*V*** (*V* is the number of discrete signal or voltage levels), data rate is 2 × 7 × 106 × 3 = 42 Mbps.

1. If a binary signal is sent over a 18-kHz channel whose signal-to-noise ratio is 29 dB, what is the maximum achievable data rate? (62%)

如果按照Shannon Capacity 计算29 = 10 log10(SNR), SNR = 794.328, according to the Shannon Capacity C = Blog2(1+SNR) = 18 × log2(1+ 794.328) = 173.44 kbps.

如果按照Nyquist Bandwidth C =2B = 36kbps.

这里只能取小的那一个，因为Nyquist Bandwidth考虑的Intersymbol interference, the channel is noiseless。所以正确的答案是36kbps.

1. 20 signals, each requiring 2000 Hz, are multiplexed on to a single channel using FDM. How much minimum bandwidth is required for the multiplexed channel? Assume that the guard bands are 500 Hz wide. (83%)

20 × 2000 + 19 × 500 = 49500 Hz.

1. Suppose that A, B, and C are simultaneously transmitting 0 bits, using a CDMA system with the chip sequence of figure following: (66%)

A: (0 0 0 1 1 0 1 1) (−1 −1 −1 +1 +1 −1 +1 +1)

B: (0 0 1 0 1 1 1 0) (−1 −1 +1 −1 +1 +1 +1 −1)

C: (0 1 0 1 1 1 0 0) (−1 +1 −1 +1 +1 +1 −1 −1)

D: (0 1 0 0 0 0 1 0) (−1 +1 −1 −1 −1 −1 +1 −1)

~A: (+1 +1 +1 −1 ­−1 +1 −1 −1)

~B: (+1 +1 −1 +1 −1 −1 −1 +1)

~C: (+1 −1 +1 −1 −1 −1 +1 +1)

(+3 +1 +1 −1 −3 −1 −1 −1)

1. A CDMA receiver gets the following chips: (−1 +1 −3 +1 −1 −3 +1 +1). Assuming the chip sequences defined in figure following, (89%)

A: (0 0 0 1 1 0 1 1) (−1 −1 −1 +1 +1 −1 +1 +1)

B: (0 0 1 0 1 1 1 0) (−1 −1 +1 −1 +1 +1 +1 −1)

C: (0 1 0 1 1 1 0 0) (−1 +1 −1 +1 +1 +1 −1 −1)

D: (0 1 0 0 0 0 1 0) (−1 +1 −1 −1 −1 −1 +1 −1)

which stations transmitted, and which bits did each one send?

A: (−1 +1 −3 +1 −1 −3 +1 +1)•(−1 −1 −1 +1 +1 −1 +1 +1) = 8

B: (−1 +1 −3 +1 −1 −3 +1 +1)•(−1 −1 +1 −1 +1 +1 +1 −1) = −8

C: (−1 +1 −1 +1 +1 +1 −1 −1)• (−1 +1 −3 +1 −1 −3 +1 +1) = 0

D: (−1 +1 −1 −1 −1 −1 +1 −1)• (−1 +1 −3 +1 −1 −3 +1 +1) = 8

Station A transmitted “1”, station B transmitted “0”, and station D transmitted “1”, station C was silent.

1. A signal is transmitted digitally over a 4-kHz noiseless channel with one sample every 125 µsec. How many bits per second are actually sent for each of these encoding methods? (83%)

**C = 2B log2*V*** (*V* is the number of discrete signal or voltage levels)

a．CCITT 2.048Mbps 标准用32 个8 位数据样本组成一个125μsec的基本帧，30 个信道用于传信息，2 个信道用于传控制信号。在每一个4kHz 信道上发送的数据率就是

8×2×4000=64kbps。

b．差分脉码调制（DPCM）是一种压缩传输信息量的方法，它发送的不是每一次抽样的二进制编码值，而是两次抽样的差值的二进制编码。现在相对差值是4 位，所以对应每个4kHz 信道实际发送的比特速率为4×2×4000=32bps。

c．增量调制的基本思想是：当抽样时间间隔*s t* 很短时，模拟数据在两次抽样之间的变化很小，可以选择一个合适的量化值? 作为阶距。把两次抽样的差别近似为不是增加一个?就是减少一个? 。这样只需用1bit 二进制信息就可以表示一次抽样结果，而不会引入很大误差。因此，此时对应每个4kHz 信道实际发送的数据速率为1×2×4000=8kHz。

1. What is the percent overhead on a T1 carrier; that is, what percent of the 1.544 Mbps are not delivered to the end user? How about the E1 carrier? (82%)



从上图可以看出193比特位中有25比特是用于控制，所以结果应该为25/193 = 12.95% ≅ 13%

从教材第155页中，第三段的描述中我们可以看出：Outside North America and Japan, the 2.048 Mbps E1 carrier is used instead of T1. This carrier was 32 8-bit data samples packed into the basic 125-μsec frame. Thirty of the channels are used for information and **up to two are used for signaling**. 所以结果为2×8/(32×8) = 6.25% ≅ 6%

1. A simple telephone system consists of two end offices (本地交换局) and a single toll office (长途交换局) to which each end office is connected by a 1-MHz full-duplex trunk. The average telephone is used to make four calls per 8-hour workday. The mean call duration is 6 min. Ten percent of the calls are long-distance (i.e., pass through the toll office). What is the maximum number of telephones an end office can support? (Assume 4 kHz per circuit.) (83%)

The average telephone is used to make four calls per 8-hour workday. 所以每部电话每小时做0.5 次通话，每次通话6 分钟。因此一部电话每小时占用一条电路3 分钟，一个小时内可以让20 部电话共享一条线路。

Ten percent of the calls are long-distance (i.e., pass through the toll office) 由于只有10%的呼叫是长途，所以200 部电话占用一条完全时间的长途线路。

局间干线频率复用了1000000/4000=250 条线路，每条线路支持200 部电话，因此，一个端局可以支持的电话部数为200\*250=50000。

1. What is the transmission unit for the physical layer? (87%)
2. Bit √
3. Frame
4. Packet
5. Segment
6. A noiseless 2-k Hz channel is sampled every 1 msec. What is the maximum data rate? (85%)
7. 1000 bps
8. 2000 bps
9. 4000 bps
10. Can be infinite √
11. The cable between toll office and the end office of telephone company are known as the (70%)
12. local loop
13. trunk √
14. microware line
15. coaxial cable
16. An T1 channel contains 24 PCM signals, its data rate is (85%)
17. 1.544 Mbps √
18. 2.048 Mbps
19. 64 kbps
20. 100 Mbps
21. An E1 channel contains 32 PCM signals, its data rate is (89%)
22. 1.544 Mbps
23. 2.048 Mbps √
24. 64 kbps
25. 100 Mbps
26. An E1 channel contains 32 PCM time slots, the data rate of each time slot channel is (85%)
27. 1.544 Mbps
28. 2.048 Mbps
29. 64 kbps √ (2.048 Mbps / 32 = 64kbps)
30. 100 Mbps