Homework Chapter 2

10195101553 苏建锐

_____

2-1. A noiseless 8-kHz channel is sampled every 1 msec. What is the maximum data rate?

From Nyquist's Theorem we know that the maximum data rate is 2*B log_2V bits/sec.

So the maximum data rate is 16kbps.

2-2. 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?

The sighal‑to‑noise ratio is 20dB, so S/N = 100,

From Shannon's Theorem wo know that the maximum achievable data rate is:

= 3k * log_2(1+100) ≈ 19.95k bits/sec.

2-3. How much bandwidth is there in 0.1 microns of spectrum at a wavelength of 1 micron?

$$because\ f = \frac{c}{\lambda} \Rightarrow \frac{df}{d\lambda}$$
$$= \frac{c}{\lambda^2} \Rightarrow \Delta f$$
$$= \frac{c}{\lambda^2}\Delta \lambda \ \therefore \Delta \lambda$$
$$= 0.1 \times 10^{-6} = 10^{-7}\, m \setminus \therefore \Delta f$$
$$= 30 \times 10^{12}\, Hz = 30THz.$$

2-4. It is desired to send a sequence of computer screen images over an optical fiber. The screen is 1920x1200 pixels, each pixel being 24 bits. There are 50 screen images per second. How much bandwidth is needed?

The Bangwidth = 1920*1200*24*50

=2,764,800,000

The bandwidth is rounded, so the needed bandwidth is 3 Gbps.

2-5. Radio antennas often work best when the diameter of the antenna is equal to the wavelength of the radio wave. Reasonable antennas range from 1 cm to 5 meters in diameter. What frequency range does this cover?

Because f = c˜lambda, and the lambda here is from 1cm to 5 meters, so f ranges from 3*10˜10 to 6*10˜7 bits/sec, that is 30GHz to 60MHz.

2-6. Ten signals, each requiring 4000 Hz, are multiplexed onto a single channel using FDM. What is the minimum bandwidth required for the multiplexed channel? Assume that the guard bands are 400 Hz wide.

10*4000 + 9*400 = 43600Hz = 4.36kHz, so the bandwidth is 4.36kHz.

2-7. Why has the PCM sampling time been set at 125 μsec?

This corresponds to a sampling rate of 8000 samples/sec.   According to the Nyquist theory, this is the sampling frequency needed to capture all the information in 4 kHz channel.

2-8. Compare the maximum data rate of a noiseless 4-kHz channel using

(a) Analog encoding (e.g., QPSK) with 2 bits per sample.

(b) The T1 PCM system.

(a) The maximum data rate is 2*log_2 V = 2*4k*2 = 16kbps.

(b) The maximum data rate is 2B*log_2 V = 2*4k*7 = 56kpbs.

2-9. A CDMA receiver gets the following chips: (-1 +1 -3 +1 -1 -3 +1 +1). Assuming the chip sequences defined in Fig. 2-28(a), which stations transmitted, and which bits did each one send?

We know that:

S=(–1 +1 –3 +1 –1 –3 +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) D=(–1 +1 $^-$1 $^-$1 $^-$1 $^-$1 +1 –1)

A · S=(+1–1+3+1–1+3+1+1)/8=1

B · S=(+1–1–3–1–1–3+1–1)/8=–1

C · S=(+1+1+3+1–1–3–1–1)/8=0

D · S=(+1+1+3–1+1+3+1–1)/8=1

So for station A, B, C, D, they send bits 1, 1, 0, 1 seperately.

2-10. A cable company decides to provide Internet access over cable in a neighborhood consisting of 5000 houses. The company uses a coaxial cable and spectrum allocation allowing 100 Mbps downstream bandwidth per cable. To attract customers, the company decides to guarantee at least 2 Mbps downstream bandwidth to each house at any time. Describe what the cable company needs to do to provide this guarantee.

A 2–Mbit/s downstream bandwidth means 2*5000=10000Mbit/s in total. But we just have 100Mbps per cable.Thus, the cable company will need to spilt uo the existing cable into 100 coaxial cables for 50 houses per cable, and connect each of them directly to a fiber node.