1. “Fast” Ethernet operates 10* faster (100Mbps) than regular ethernet. Explain why the following changes were made.

(a) Encoding changed to 4B/5B.

(c) CAT-5 cable has more twists.

Solution:

(a) Manchester encoding is only 50% efficient, requiring 2 signal changes per bit. 4B/5B is 80% efficient, allowing for better line utilization

(c) This reduces interference (noise) on the cable, increasing the effective bandwidth of the cable.

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?

Solution:

A signal-to-noise ratio of 20 dB means S/N=100. Since log 2 101 is about 6.658, the Shannon limit is about 19.975 kbps. The Nyquist limit is 6 kbps. The bottleneck is therefore the Nyquist limit, giving a maximum channel capacity of 6 kbps.

3. What are the advantages of fiber optics over copper as a transmission medium? Is there any downside of using fiber optics over copper?

Solution:

Fiber has many advantages over copper. It can handle much higher bandwidth than copper. It is not affected by power surges, electromagnetic interference, power failures, or corrosive chemicals in the air. It does not leak light and is quite difficult to tap. Finally, it is thin and lightweight, resulting in much lower installation costs. There are some downsides of using fiber over copper. First, it can be damaged easily by being bent too much. Second, optical communication is unidirectional, thus requiring either two fibers or two frequency bands on one fiber for two-way communication. Finally, fiber interfaces cost more than electrical interfaces.

4. Is the Nyquist theorem true for high-quality single-mode optical fiber or only for copper wire?

Solution:

The Nyquist theorem is a property of mathematics and has nothing to do with technology. It says that if you have a function whose Fourier spectrum does not contain any sines or cosines above f, by sampling the function at a frequency of 2f you capture all the information there is. Thus, the Nyquist theorem is true for all media.

5. What is the minimum bandwidth needed to achieve a data rate of B bits/sec if the signal is transmitted using NRZ, MLT-3, and Manchester encoding? Explain your answer..

Solution:

In NRZ, the data rate=signal rate, so the signal rate is B bps. So, the minimum bandwidth need to achieve B bits/sec data rate is B/2 Hz.
In Manchester encoding, the data rate=1/2 * signal rate, so the signal rate is 2B bps. So, the minimum bandwidth need to achieve B bits/sec data rate is B Hz.

6. Is an oil pipeline a simplex system, a half-duplex system, a full-duplex system, or none of the above? What about a river or a walkie-talkie-style communication?

Solution:

Oil pipeline is a half-duplex system because oil can flow in either direction but not both ways at once. A river is a simplex system while a walkie-talkie-style communication is a half-duplex system.

7. A modem constellation diagram similar to Fig. 2-23 has data points at the following coordinates: (1, 1), (1, -1), (-1, 1), and (-1, -1). How many bps can a modem with these parameters achieve at 1200 symbols/second?

Solution:

There are 4 legal values per symbol, so the bit rate is twice(log2 (4)) the symbol rate.
At 1200 symbol, the data rate is 2400 bps.

8. What is the difference, if any, between the demodulator part of a modem and the coder part of a codec? (After all, both convert analog signals to digital ones)

Solution:

The demodulator part of a modem accepts a modulated sine wave and generates a digital signal while the coder part of a codec accepts an arbitrary analog signal and generates a digital signal from it.

9. What is the available user bandwidth in an OC-12c connection?

Solution:

An STS-12c frame has twelve STS-1 frames with 3 columns overhead for each STS-1 frame. Thus, the STS-12c payload = 90 * 12 * 9 – 3 * 12 * 9 = 9396 bytes. We subtract 1 column of POH so that at the end we have: 9396 – 1*9 = 9387 bytes sent every 125 µs. That translates into a user bandwidth of: 600.768 Mbps.

10. Suppose that A, B, and C are simultaneously transmitting 0 bits, using a CDMA system with the chip sequences of Fig. 2-28(a). What is the resulting chip sequence?

Solution:

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)

resulting chip sequence = (-1) * A + (-1) * B + (-1) * C

= (+3 +1 +1 -1 -3 -1 -1 +1)