Chapter 2

1. What does a data communication mean? What are the key elements of the communication model?

   The five components of a data communication system are the **Source, Transmitter, Transmittion System, Receiver, Destination**.

2. List the major disadvantages with the layered approach to protocols?

   Perhaps the major disadvantage is the processing and data overhead. There is processing overhead because as many as seven modules (OSI model) are invoked to move data from the application through the communications software. There is data overhead because of the appending of multiple headers to the data. Another possible disadvantage is that there must be at least one protocol standard per layer. With so many layers, it takes a long time to develop and promulgate the standards.

3. IP, TCP and UDP all discard a packet that arrives with a checksum error and don’t attempt to notify the source. Why?

   In the case of IP and UDP, these are unreliable protocols that do not guarantee delivery, so they do not notify the source. TCP does guarantee delivery. However, the technique that is used is a timeout. If the source does not receive an acknowledgment to data within a given period of time, the source retransmits.

4. Name the network layer that performs the following functions:

   a. Has a local address that was built in by the LAN adapter card manufacturer. **Data-Link Layer**

   b. Puts out and receives signals through an external port (connector). **Physical**

   c. Provides standard services to various computer programs. **Application**

   d. It uses a hierarchical address assigned by the local network manager. **IP or Network**

   e. Responsible for end-to-end connections across a multi-node switched network or router network. **Transport (TCP or UDP)**
5. Assume that a computer sends a frame at the transport layer to another computer and the destination port address is not running. According to what you read from chapter 2, what will happen to that process?

Most protocols issue a special error message that is sent back to the source in this case.

6. What is the difference between Flow control in Transport and Data link layer?

Like the data link layer, the transport layer is responsible for flow control. However, flow control at this layer is performed end to end rather than access across a single link, so it’s more complex in transport layer than data link layer.

7. Why do we need the error control in transport and data link layer?

To use it in the Mechanism for error correction, detection and retransmission.

8. Why does the TCP header have a header length field while the UDP header doesn’t?

UDP has a fixed-sized header. The header in TCP is of variable length.
Chapter 3

1. Determine the possible bit rate and the number of levels over a channel for these cases?
   a. B = 2.4K Hz, noiseless channel with L = 16.
   b. B = 2.4K Hz, SNR = 20 dB.
   c. B = 3.0K Hz, SNR = 40 db.

   Sol:
   a. \[ N = 2B \log_2 L = 2 \times 2.4K \times \log_2 16 = 19.2 \text{Kbps} \]
   b. \[ \text{SNR}_{\text{db}} = 10 \log_{10} SNR \quad \text{so SNR} = 100 \]
      \[ C = B \log_2 (1 + SNR) = 2.4k \log_2 (1 + 100) = 16 \text{Kbps} \]
      \[ N = 2B \log_2 L \]
      \[ 16K = 2 \times 2.4 \times \log_2 L \quad L = 11 \text{ level} \]
   c. \[ \text{SNR}_{\text{db}} = 10 \log_{10} SNR \quad \text{so SNR} = 10000 \]
      \[ C = B \log_2 (1 + SNR) = 3k \log_2 (1 + 1000) = 39.86 \text{Kbps} \]
      \[ N = 2B \log_2 L \]
      \[ 39.8K = 2 \times 3 \times \log_2 L \quad L = 100 \text{ level} \]

2. A signal goes from routers A, through B and C, and finally arrives at D. The signal loses 2 dB from A to B, again 5 dB from B to C, and loses 3 dB from C to D. What is the total gain or loss from A to D?

   \[ \text{SNR}_{\text{db}} = -2 + 5 - 3 = 0 \text{db} \]
   \[ \text{SNR} = 1 \]

3. We were hired to study the design of a 100K bps modem. How many signal levels would we need, assuming an available bandwidth of 40k Hz?

   \[ N = 2B \log_2 L \]
   \[ 100K = 2 \times 40k \times \log_2 L \quad L = 3 \text{ level} \]

4. What is the channel capacity for a device channel with a 300 Hz bandwidth and SNR is 3 dB?

   \[ \text{SNR}_{\text{db}} = 10 \log_{10} SNR \quad \text{so} \quad \text{SNR} = 2 \]
   \[ C = B \log_2 (1 + SNR) \]
   \[ = 300 \times \log_2 (1 + 2) = 475.49 \text{ bps} \]
5. Given a channel with capacity of 100M bps and a bandwidth of 3M Hz. What is the signal to noise ratio required to achieve this capacity?

\[ C = \frac{B}{\log_2 (1 + SNR)} \]

100M = 3M * \log_2 (1 + SNR)

\[ SNR = 1.08 \times 10^{10}. \]

SNR = 100.33 db

6. We want to design a 56kbps modem. What is the minimum number of signaling levels we need? Assume that a telephone channel has a bandwidth of 3K Hz.

\[ N = 2^{\log_2 L} \]

56K = 2 * 3K * \log_2 L

L = 646 level

7. What is the Capacity (bits/sec) if the bandwidth is 2,400 bps and each symbol has 8 states (levels)?

\[ N = 2^{\log_2 L} \]

= 2 * 2400 * \log_2 8

= 14.4Kbps

8. An image is 1024 x 768 pixels with 3 bytes/pixel. Assume the image is uncompressed.
   a. How long does it take to transmit it over a 56 kbps modem channel?
   b. How long does it take to transmit it over a 1-Mbps cable modem?
   c. How long does it take to transmit it over a 10-Mbps Ethernet? Over 100-Mbps Ethernet?

Size of the Image = 1024 x 768 x 3 bytes
= 2359296 bytes
= 18874368 bits

The time it takes to transfer the image over:

a) 56 kbps line is:

56,000 bits = 1 second.
2359296 * 8 bits = (2359296 x 1 x 8)/56,000 seconds
= 337 seconds.
= 5.61 minutes

b) 1 Mbps Cable modem:

1000,000 bits = 1 second.
18874368 bits = 18874368/1000000 = 18.8 seconds

c) 10 Mbps Ethernet:

10,000,000 bits = 1 second
18874368 bits = 18874368/10000000 = 1.88 seconds

d) 100 Mbps Ethernet

100,000,000 bits = 1 second
18874368 bits = 18874368/100000000 = 0.18 seconds

9. If a binary signal is sent over a 3K Hz channel whose signal-to-noise ratio is 20 dB, what is the maximum achievable data rate?

SNRdb = 10log_{10} SNR so SNR=100
C = B log_2 (1 + SNR)
= 3K* log_2 (1 + 100)
= 23Kbps

10. Assume that you are an Internet Provider and want to provide a customer by ADSL service, and you need to install a switch near his home. Given that it is a noiseless channel with bandwidth of 4K Hz and bit rate of 128K bps.
(a) Determine the maximum distance between the home and the switch in order to get a propagation time of 0.5 μsec. (*Propagation time of cable is 2.4 \times 10^8*

Propagation time = distance / propagation speed.
0.5us = distance/2.4*10^8
Distance = 120m.
11. Suppose there is a 10Mbps microwave link between a geostationary satellite and its base station on Earth. Every minute the satellite takes a digital photo and sends it to the base station. Assume propagation speed of 2.4×10^8 meters/sec, and the space between the satellite and its base station is 36000 Km.
   a. What is the propagation delay of the link?
   b. What is the bandwidth-delay product?
   c. Let x denote the size of the photo. What is the minimum value of x for the microwave link to be continuously transmitting?

   a. Propagation time= distance / propagation speed.
      \[=\frac{36\times10^3 K}{(2.4\times10^8)}\]
      =150ms

   b. Bw delay product = tp*BW
      =10M*150ms
      = 150Kbit

   c. Transmission time =1minutes=60s
      =message size/BW
      =x/10M
      \[x=6\times10^7\text{ bit.}\]

12. Calculate the P₂ for the following system shown in figure below.

   \[Db=15-35+10=-10\text{db}\]

   \[-10=10\log_{10} SNR\]

   \[SNR =0.1 =P_1/P_2 =4\text{mw}/P_2\]

   \[P_2 = 4\text{mw}/0.1=40\text{mw.}\]