CPE 400/ECG600 Computer Communication Networks
Homework 1
Due by 2:30pm Wednesday, Sept. 18
(Show all your work and staple your answer sheets together)

Read Chapter 1 Introduction, Chapter 2 Protocols and Architecture, Appendix 2A, Chapter 3 Data Transmission of William Stallings, and Appendix 3A of Data and Computer Communications, 9th edition and complete the following questions.

1. Explain how *tracert* works and the meaning of the parameters. Show the output of *tracert* to one website.

2. Problem 2.5 on pp. 56.

3. Problem 2.6 on pp. 56.

4. Problem 2.7 on pp. 56.

5. Problem 2.13 on pp. 56.

6. Problem 3.6 on pp. 95.

7. Problem 3.8 on pp. 95.

8. Problem 3.13 on pp. 96.

9. Problem 3.20 on pp. 96.

10. (G) Problem 3.21 on pp. 96.

11. Problem 3.23 on pp. 96.

Question pages are attached.

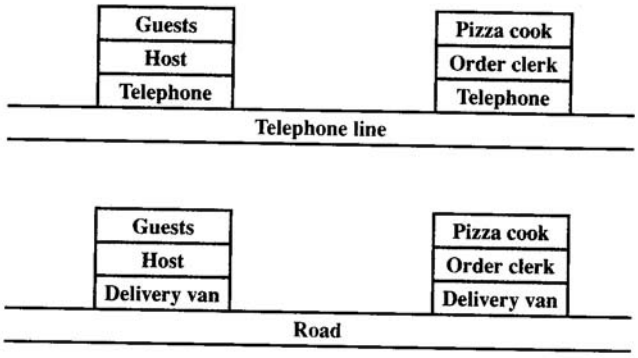

Figure 2.12 Architecture for Problem 2.1

Problems

2.1 Using the layer models in Figure 2.12, describe the ordering and delivery of a pizza, indicating the interactions at each level.

2.2 **a.** The French and Chinese prime ministers need to come to an agreement by telephone, but neither speaks the other's language. Further, neither has on hand a translator that can translate to the language of the other. However, both prime ministers have English translators on their staffs. Draw a diagram similar to Figure 2.12 to depict the situation, and describe the interaction and each level.

b. Now suppose that the Chinese prime minister's translator can translate only into Japanese and that the French prime minister has a German translator available. A translator between German and Japanese is available in Germany. Draw a new diagram that reflects this arrangement and describe the hypothetical phone conversation.

2.3 List the major disadvantages with the layered approach to protocols.

2.4 Two blue armies are each poised on opposite hills preparing to attack a single red army in the valley. The red army can defeat either of the blue armies separately but will fail to defeat both blue armies if they attack simultaneously. The blue armies communicate via an unreliable communications system (a foot soldier). The commander with one of the blue armies would like to attack at noon. His problem is this: If he sends a message to the other blue army, ordering the attack, he cannot be sure it will get through. He could ask for acknowledgment, but that might not get through. Is there a protocol that the two blue armies can use to avoid defeat?

2.5 A broadcast network is one in which a transmission from any one attached station is received by all other attached stations over a shared medium. Examples are a bus-topology local area network, such as Ethernet, and a wireless radio network. Discuss the need or lack of need for a network layer (OSI layer 3) in a broadcast network.

2.6 In Figure 2.2, exactly one protocol data unit (PDU) in layer N is encapsulated in a PDU at layer $(N - 1)$. It is also possible to break one N-level PDU into multiple $(N - 1)$-level PDUs (segmentation) or to group multiple N-level PDUs into one $(N - 1)$-level PDU (blocking).

a. In the case of segmentation, is it necessary that each $(N - 1)$-level segment contain a copy of the N-level header?

b. In the case of blocking, is it necessary that each N-level PDU retain its own header, or can the data be consolidated into a single N-level PDU with a single N-level header?

2.7 A TCP segment consisting of 1500 bits of data and 160 bits of header is sent to the l layer, which appends another 160 bits of header. This is then transmitted through tw networks, each of which uses a 24-bit packet header. The destination network has maximum packet size of 800 bits. How many bits, including headers, are delivered t the network layer protocol at the destination?

2.8 Why is UDP needed? Why can't a user program directly access IP?

2.9 IP, TCP, and UDP all discard a packet that arrives with a checksum error and do no attempt to notify the source. Why?

2.10 Why does the TCP header have a header length field while the UDP header doe not?

2.11 The previous version of the TFTP specification, RFC 783, included the followin statement:

> All packets other than those used for termination are acknowledged individually unless a timeout occurs.

The RFC 1350 specification revises this to say:

> All packets other than duplicate ACK's and those used for termination are acknowledged unless a timeout occurs.

The change was made to fix a problem referred to as the "Sorcerer's Apprentice." Deduce and explain the problem.

2.12 What is the limiting factor in the time required to transfer a file using TFTP?

2.13 A user on a UNIX host wants to transfer a 4000-byte text file to a Microsoft Window host. In order to do this, he transfers the file by means of TFTP, using the netascii trans fer mode. Even though the transfer was reported as being performed successfully, the Windows host reports the resulting file size is 4050 bytes, rather than the original 400 bytes. Does this difference in the file sizes imply an error in the data transfer? Why o why not?

2.14 The TFTP specification (RFC 1350) states that the transfer identifiers (TIDs) chosen for a connection should be randomly chosen, so that the probability that the same number is chosen twice in immediate succession is very low. What would be the prob lem of using the same TIDs twice in immediate succession?

2.15 In order to be able retransmit lost packets, TFTP must keep a copy of the data it sends. How many packets of data must TFTP keep at a time to implement this retransmission mechanism?

2.16 TFTP, like most protocols, will never send an error packet in response to an error packet it receives. Why?

2.17 We have seen that in order to deal with lost packets, TFTP implements a timeout-and- retransmit scheme, by setting a retransmission timer when it transmits a packet to the remote host. Most TFTP implementations set this timer to a fixed value of about 5 seconds. Discuss the advantages and the disadvantages of using a fixed value for the retransmission timer.

2.18 TFTP's timeout-and-retransmission scheme implies that all data packets will eventu ally be received by the destination host. Will these data also be received uncorrupted? Why or why not?

2.19 This chapter mentions the use of Frame Relay as a specific protocol or system used to connect to a wide area network. Each organization will have a certain collection of services available (like Frame Relay) but this is dependent upon provider provision ing, cost and customer premises equipment. What are some of the services available to you in your area?

Note: The following problem concern materials in Appendix H.

gital transmission	intermodulation noise	signaling
rect link	loss	simplex
fective bandwidth	multipoint link	sinusoid
quency	noise	spectrum
quency domain	Nyquist bandwidth	thermal noise
l duplex	peak amplitude	time domain
ndamental frequency	period	transmission
in	periodic signal	unguided media
ded media	point-to-point link	video
f duplex	phase	wavelength
ulse noise	signal	wireless
rlacing	signal-to-noise ratio (SNR)	

Review Questions

3.1. Differentiate between guided media and unguided media.
3.2. Differentiate between an analog and a digital electromagnetic signal.
3.3. What are three important characteristics of a periodic signal?
3.4. How many radians are there in a complete circle of 360 degrees?
3.5. What is the relationship between the wavelength and frequency of a sine wave?
3.6. Define *fundamental frequency*.
3.7. What is the relationship between a signal's spectrum and its bandwidth?
3.8. What is attenuation?
3.9. Define *channel capacity*.
3.10. What key factors affect channel capacity?

Problems

3.1 a. For multipoint configuration, only one device at a time can transmit. Why?
b. There are two methods of enforcing the rule that only one device can transmit. In the centralized method, one station is in control and can either transmit or allow a specified other station to transmit. In the decentralized method, the stations jointly cooperate in taking turns. What do you see as the advantages and disadvantages of the two methods?

3.2 A signal has a fundamental frequency of 1000 Hz. What is its period?

3.3 Express the following in the simplest form you can:
a. $\sin(2\pi ft - \pi) + \sin(2\pi ft + \pi)$
b. $\sin 2\pi ft + \sin(2\pi ft - \pi)$

3.4 Sound may be modeled as sinusoidal functions. Compare the relative frequency and wavelength of musical notes. Use 330 m/s as the speed of sound and the following frequencies for the musical scale.

Note	C	D	E	F	G	A	B	C
Frequency	264	297	330	352	396	440	495	528

3.5 If the solid curve in Figure 3.17 represents $\sin(2\pi t)$, what does the dotted curve represent? That is, the dotted curve can be written in the form $A\sin(2\pi ft + \phi)$; what are A, f, and ϕ?

3.6 Decompose the signal $(1 + 0.1\cos 5t)\cos 100t$ into a linear combination of sinusoidal functions, and find the amplitude, frequency, and phase of each component. *Hint:* Use the identity for $\cos a \cos b$.

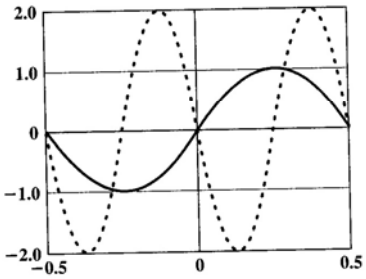

Figure 3.17 Figure for Problem 3.5

3.7 Find the period of the function $f(t) = (10 \cos t)^2$.

3.8 Consider two periodic functions $f_1(t)$ and $f_2(t)$, with periods T_1 and T_2, respectively. Is it always the case that the function $f(t) = f_1(t) + f_2(t)$ is periodic? If so, demonstrate this fact. If not, under what conditions is $f(t)$ periodic?

3.9 Figure 3.4 shows the effect of eliminating higher-harmonic components of a square wave and retaining only a few lower harmonic components. What would the signal look like in the opposite case; that is, retaining all higher harmonics and eliminating a few lower harmonics?

3.10 Figure 3.5b shows the frequency domain function for a single square pulse. The single pulse could represent a digital 1 in a communication system. Note that an infinite number of higher frequencies of decreasing magnitudes is needed to represent the single pulse. What implication does that have for a real digital transmission system?

3.11 IRA is a 7-bit code that allows 128 characters to be defined. In the 1970s, many newspapers received stories from the wire services in a 6-bit code called TTS. This code carried upper- and lower case characters as well as many special characters and formatting commands. The typical TTS character set allowed over 100 characters to be defined. How do you think this could be accomplished?

3.12 For a video signal, what increase in horizontal resolution is possible if a bandwidth of 5 MHz is used? What increase in vertical resolution is possible? Treat the two questions separately; that is, the increased bandwidth is to be used to increase either horizontal or vertical resolution, but not both.

3.13 **a.** Suppose that a digitized TV picture is to be transmitted from a source that uses a matrix of 480 × 500 picture elements (pixels), where each pixel can take on one of 32 intensity values. Assume that 30 pictures are sent per second. (This digital source is roughly equivalent to broadcast TV standards that have been adopted.) Find the source rate R (bps).

b. Assume that the TV picture is to be transmitted over a channel with 4.5-MHz bandwidth and a 35-dB signal-to-noise ratio. Find the capacity of the channel (bps).

c. Discuss how the parameters given in part (a) could be modified to allow transmission of color TV signals without increasing the required value for R.

3.14 Given an amplifier with an effective noise temperature of 10,000 K and a 10-MHz bandwidth, what thermal noise level, in dBW, may we expect at its output?

3.15 What is the channel capacity for a teleprinter channel with a 300-Hz bandwidth and a signal-to-noise ratio of 3 dB, where the noise is white thermal noise?

3.16 A digital signaling system is required to operate at 9600 bps.

a. If a signal element encodes a 4-bit word, what is the minimum required bandwidth of the channel?

b. Repeat part (a) for the case of 8-bit words.

3.17 What is the thermal noise level of a channel with a bandwidth of 10 kHz carrying 1000 watts of power operating at 50°C?

3.18 Given the narrow (usable) audio bandwidth of a telephone transmission facility, a nominal SNR of 56dB (400,000), and a certain level of distortion,

a. What is the theoretical maximum channel capacity (kbps) of traditional telephone lines?

b. What can we say about the actual maximum channel capacity?

3.19 Study the works of Shannon and Nyquist on channel capacity. Each places an upper limit on the bit rate of a channel based on two different approaches. How are the two related?

3.19 Consider a channel with a 1-MHz capacity and an SNR of 63.

a. What is the upper limit to the data rate that the channel can carry?

b. The result of part (a) is the upper limit. However, as a practical matter, better error performance will be achieved at a lower data rate. Assume we choose a data rate of 2/3 the maximum theoretical limit. How many signal levels are needed to achieve this data rate?

3.20 Given the narrow (usable) audio bandwidth of a telephone transmission facility, a nominal SNR_{dB} of 56dB (400,000), and a distortion level of <0.2%,

a. What is the theoretical maximum channel capacity (kbps) of traditional telephone lines?

b. What is the actual maximum channel capacity?

3.21 Given a channel with an intended capacity of 20 Mbps, the bandwidth of the channel is 3 MHz. Assuming white thermal noise, what signal-to-noise ratio is required to achieve this capacity?

3.22 The square wave of Figure 3.7c, with $T = 1$ ms, is passed through a lowpass filter that passes frequencies up to 8 kHz with no attenuation.

a. Find the power in the output waveform.

b. Assuming that at the filter input there is a thermal noise voltage with $N_0 = 0.1\ \mu$Watt/Hz, find the output signal to noise ratio in dB.

3.23 If the received signal level for a particular digital system is −151 dBW and the receiver system effective noise temperature is 1500 K, what is E_b/N_0 for a link transmitting 2400 bps?

3.24 Fill in the missing elements in the following table of approximate power ratios for various dB levels.

Decibels	1	2	3	4	5	6	7	8	9	10
Losses			0.5							0.1
Gains			2						10	

3.25 If an amplifier has a 30-dB voltage gain, what voltage ratio does the gain represent?

3.26 An amplifier has an output of 20 W. What is its output in dBW?