Homework 2 (EECS 333) Introduction to Communication Networks

Prof. Dongning Guo

Due in class on April 6, 2007 (Friday)

Reading assignment
Sections 3.4–3.7 in Leon-Garcia/Widjaja.

Teaching Assistant’s Office Hours
The Teaching Assistant’s office hours are Wednesdays 4–5 pm and Thursdays 3:30–4:30 pm in L445.

Class Notes
Class notes will be posted before class on the course website.

Problem 1 Transmission Overhead
Problem 2.19 in Leon-Garcia.

Problem 2 CD vs. MP3
Problem 3.6 in Leon-Garcia.

Problem 3 Analog Repeater
Problem 3.11 in Leon-Garcia.
(This problem illustrates one disadvantage of an analog communication system compared to a digital system. In a digital system, the signal can be repeated without adding any additional noise.)

Problem 4 The Internet Protocol Stack
1. What are the layers of the Internet protocol stack?
2. What are the principal responsibilities of each of these layers?
4. Which layer(s) in the Internet protocol stack does a router process?

Problem 5 Rate vs. Bandwidth
Consider a communication channel with a bandwidth of $W$ Hz using binary signaling (i.e., an alphabet of size 2).
(a) Using Nyquist’s theorem, give the maximum data rate as a function of $W$.
(b) The noise power in a received signal often increases linearly with the bandwidth. Suppose that the noise power for a channel with bandwidth of $W$ Hz is given by $N_0W$ (so that $N_0$ gives the noise power per
unit bandwidth). Assuming that the received power $P = 100N_0$, plot the maximum data rate as a function of $W$ using Shannon’s formula.

(c) What is the limiting value of the answers in (a) and (b) as $W \to \infty$? Why are they different?

Problem 6  Network Protocols

Design and describe an application-level protocol to be used between an automatic teller machine (ATM) and a bank’s centralized computer. Your protocol should allow a user’s card and password to be verified, the account balance to be queried, and an account withdrawal to be made. Your protocol entities should be able to handle the all-too-common case in which there is not enough money in the account to cover the withdrawal.

Specify your protocol by listing the messages exchanged and the actions taken by the automatic teller machine or the bank’s centralized computer on transmission and receipt of messages. Sketch the operation of your protocol for the case of a simple withdrawal with no errors, using a diagram similar to that in Figure 1. Explicitly state the assumptions made by your protocol about the underlying end-to-end transport service.

![Figure 1: A human protocol and a computer network protocol.](image)

[Note: Figure 1 does not completely describe the actions taken by the client or the server. You may need describe them at the appropriate places on the time line. In addition, for the “withdrawal” service, you may assume the service is successful if the account has enough balance, or it is declined if the balance is low.]

Problem 7  SMTP Protocol

In this problem you will have a “conversation” with a remote machine using the SMTP protocol. Pay attention to the messages you send and the messages returned to you.

Telnet is a popular application-layer protocol used for remote login. It runs over TCP and is designed to work between any pair of hosts. You should be able to find the $telnet$ program in most Windows and Unix machines. On a Windows machine, click “start-run”, input “cmd” and then “telnet”.

Send the teaching assistant an email using Telnet by following the instructions:

```
open www.eecs.northwestern.edu 25
helo northwestern.edu
mail from: your-net-id
rcpt to: recipient-email-address
data
```
My name is your-name. This is my answer to problem 8 in ECE 333 homework 2.

quit

Make sure to try out the procedure to your own email address before you send to the teaching assistant! The email address to use is jun-luo@northwestern.edu. Make sure to include your name in the email. You lose points if the teaching assistant receives zero or multiple emails from you.

Answer (on paper, not in the email): What does 25 stand for in open www.eecs.northwestern.edu 25? What about not using a number? What about using 80 instead? You need a little familiarity with computers - which is not covered in this course.

In case you have problem opening a connection with the remote machine, consider using a machine in one of the EECS labs or logging on one of the Unix/Linux machines in the EECS department.