CS 536 (Park) **Assignment II** **Due: Sep. 24 (Fri.), 2004**

Submission instructions: Please type your answers and submit electronic copies using `turnin` *by 5pm on the due date. You may use any number of word processing software (e.g., Framemaker, Word, LaTeX), but the final output must be in pdf or ps format that uses standard fonts (a practical test is to check if the pdf/ps file prints on a CS Department printer without problem). For experiments and programming assignments that involve output to terminal, please use* `script` *to record the output and submit the output file. Use* `gnuplot` *to plot graphs. Use* `ps2gif` *to convert a eps/ps plot to gif format (e.g., for inclusion in Word).*

PROBLEM 1

Read Sections 2.1–2.5 from P & D.

PROBLEM 2 (20 pts)

"Bandwidth", as used in networking, is an overloaded term. Describe and define the different meanings/usages of the term (at least 5). For each case, provide an example where it comes into play. For example, Nyquist's sampling theorem is one where "bandwidth" appears. So it does in gigabit Ethernet ("bandwidth" 1 Gbps).

PROBLEM 3 (30 pts)

Describe the architectural workings of the iPod + FM transmitter + radio based "digital communication system" for wirelessly sending data bits discussed in class. Your specification should lay down what physical layer transmission scheme was used—assume we have three sets of iPods, FM transmitters, and radios operating concurrently on radio frequencies 88.3 MHz, 88.5 MHz, and 88.7 MHz (of course, only one was used in the experiment)—what coding/framing we used, and if senders and receivers need clocks (if they do why, if not, why not). Your description must be technical, employing the techniques, machinery, and terms studied thus far. Calculate the data rate (bps) that six humans—three senders and three receivers—operating the communication system according to your specification would achieve. Assuming that the "human baud rate" is limited by at most 1 pressing of the pause button per second (those playing computer games may exhibit a faster performance), what other architectural design features (you may not change the 3 sender/3 receiver set-up) may be changed to improve performance, i.e., increase the bit rate? The top three designs with respect to claimed speed will be asked to undergo benchmarking to verify their claims. Benchmarking will be done with one iPod. Those that do come within 10% of their performance spec will be given 10 bonus pts.

PROBLEM 4 (40 pts)

(a) Consider the direct sequence CDMA example for $N = 4$ users, $r = 4$, and chipping codes

$$(1, 1, 1, 1),\ (-1, -1, 1, 1),\ (-1, 1, -1, 1),\ (-1, 1, 1, -1)$$

discussed in class. Assuming that each user wishes to send a single bit—user 1 bit 0, user 2 bit 1, user 3 bit 1, and user 4 bit 0—use the DS-CDMA scheme to compute the (combined) transmission "signal" z. From z, show how each user retrieves, i.e., decodes, his/her bit. Specify how majority voting, formulated in the EXOR 0/1-bit context, manifests itself in the last step of the $1/-1$-bit context, i.e., what step needs to be carried out to determine if the transmitted bit is a 1 (1) or -1 (0).

(b) Suppose z gets corrupted in flight where a noise vector $\varepsilon = (1, 0, 0, -1)$ gets added to yield $z' = z + \varepsilon$. Perform the decoding for each user based on the received signal z'. Are the users able to decode the correct bit value using the procedure employed in (a)? Give a smallest noise vector—the size of a vector is defined as the sum of the absolute values of the components—that causes a decoding failure for at least one user.

(c) Suppose we get greedy and aim to support a 5th user (i.e., $N = 5$) while keeping $r = 4$. Devise a 5th chipping code y^5 such that in the absence of channel noise decoding works correctly for the example bits to be sent (assume the 5th user wishes to send 1). Assuming you have found such a chipping code, how is it possible to transmit five users' data bits simultaneously without using five orthogonal chipping codes? What are the possible limitations of your $N = 5/r = 4$ CDMA system?

PROBLEM 5 $(50 = 40 + 10$ pts)

(a) Extend the client/server application from Assignment I such that any UNIX command—you may ignore command-line arguments—can be requested by the client to be executed on the server and its output returned to the client. The request format should be of the form

process-ID # command #

Your client program is to take as its command-line argument the name of the UNIX command to be executed. Test your program by first running the server application in the background, then executing four copies of the client in the background "simultaneously" with arguments `date`, `ls`, `ps`, and `hostname`, respectively. Use `script` to record your interaction/screen output.

(b) The client/server application is an instance of a *concurrent* server where a server process parses incoming requests, then hands off the actual task to a spawned child process. In an *iterative* server, the task is carried out by the server process itself. What are the pros/cons of an iterative server vis-à-vis a concurrent server? Can the client/server program be implemented as an interative server? Explain.