Algorithms in the Real World
Assignment #5 Due Date: 21 November 00

Problem 1: (10pt) One of the reasons why modems are limited in speed to 56 kbps is that the least significant bit in every sixth 8-bit sample is "stolen" to indicate whether the call is still in session. For this reason, only 7 bits in every 8-bit sample carry data. (Another reason has to do with the non-linear quantization of analog signals in the phone system, but for this problem we will ignore that effect.) A straightforward way to increase the data transmission rate would be to determine which samples were losing a bit, and to then send only 7 bits of data in each of those samples, but 8 in all of the others. This would give a transmission rate of $8000 * 8 * (63/64) = 63$ kpbs. To liven things up, suppose that within each set of six consecutive samples (where no two sets overlap), we choose one sample at random and then choose a value for the least significant bit of that byte at random. Now it's not possible to determine in advance which bytes are going to lose a bit. Using error-correcting codes, design a protocol that achieves a throughput rate greater than 56 kpbs. More credit will be given for higher throughput rates.

Problem 2: (10pt)
In the scribe notes we used Shannon's limit to derive an upper bound on the rate at which data can be transmitted over the telephone system. The bound was based on the "quantization noise" that was introduced by sampling. DSL systems achieve much higher throughput rates, however. These systems must also quantize the voltage values that are carried over the same pair of copper wires. Suppose that a DSL system also takes 8-bit samples of the voltage and that the quantization error is distributed uniformly and randomly. Why doesn't the same upper bound hold for DSL? What technology change has the telephone company made to improve the throughput?

Problem 3: (10pt)
The ethernet protocol was designed at a time when a host would have difficulty saturating a 10 mbps channel by itself. Today an inexpensive personal computer can easily saturate a 10 mbps channel, and perhaps even a 100 mpbs channel. Describe a scenario in which a single host transmitting a very large file is able to dominate an ethernet channel, preventing a large number of other hosts from gaining access to the channel. Assume that all of the hosts are running the same standard ethernet protocol.

Problem 4: (10pt)
Construct a scenario in which a distance-vector routing algorithm suffers from the count-to-infinity problem even though both the split horizon and reverse poisoning mechanisms are used.

Problem 5: (5pt)
The webmaster of a large and popular web site wants to improve the site's reliability by buying Internet connectivity from two different Internet Service Providers (ISPs). Each of the ISPs arrange for the telephone company to provision a T3 line (45 mpbs) into the facility where the web servers are located. Assuming that the webmaster has been assigned a block of IP addresses and an autonomous system number, how should the web site be configured so that it will stay on-line even if one of the T3 lines goes down?

Problem 6: (10pt)
One of the network engineers at a major backbone has accidentally misconfigured a router running BGP by assigning it the wrong autonomous system (AS) number. Apart from this problem the router is working correctly. But it is appending the wrong AS number to the end of every route that it advertises. Discuss the potential consequences of this mistake.