Fall Term 00-1

TELCOM 2310 – Computer Networks

Homework 3 Solution

Problem 1

Four hops means that five routers are involved. The virtual circuit implementation requires tying up $5 \cdot 8 = 40$ bytes of memory for $1,000$ sec. The datagram implementation requires transmitting $12 \cdot 4 \cdot 200 = 9,600$ bytes of header over and above what the virtual circuit implementation needs. Thus the question comes down to the relative cost of $40,000$ bytes-sec of memory versus 9600 bytes-hop of circuit capacity. If memory is depreciated over $2 \cdot 52 \cdot 40 \cdot 3,600 = 1.5 \cdot 10^7$ sec, a byte-sec costs $6.7 \cdot 10^{-8}$ cents, and 40,000 of them cost just over 2 millicents. If a byte-hop costs 10^{-6} cents, $9,600$ of them cost 9.6 millicents. Therefore, virtual circuits are cheaper for this set of parameters.

Problem 2

2.1– Use an all-path discovery packet to find all possible paths from the source to destination. The packet is replicated by the router over all interfaces, except the one the packet came through. The packet records the routers already visited since it left the source. The routers must also be careful not to circulate the all-path discovery packet undefinitely. They need to detect and discard packets they have already seen (This information is contained in the header of the packet. A router discards a packet when it sees that its name has already been recorded in its header). When the receiver receives all-path discovery packets, it can select two disjoint paths and send those paths back to the source.

2.2– The all-path discovery packet broadcasting eventually terminates. Assuming that at least two disjoint paths exist, the destination discovers those paths and sends them back to the receiver. The algorithm, however, can lead to high overhead due to broadcasting.

Problem 3

3.1– Let the time be slotted in units of T sec. In slot 1, the source router sends the first packet. At the start of slot 2, the second router has received the packet but cannot acknowledge it yet. At the start of slot 3, the third router has received the packet, but it cannot acknowledge it either. This causes all the routers of it to remain hanging. The first acknowledgment can only be sent when the destination host takes the packet from the destination router. Now the acknowledgement begins propagating back. It takes two full transits of the subnet, $2(n-1)T$ sec, before the source router can send the second packet. Thus the throughput is one packet every $2(n-1)T$ sec.

3.2– The protocol exhibits a very poor performance. It forces all routers to operate sequentially. As a result, the throughput decreases rapidly as the number of routers, n, increases.

Problem 4

A datagram subnet allows routers to drop packets whenever they need to. The probability of a router discarding a packet is p. Consider the case of a source host connected to the source router, which is connected to the destination router, and then to the destination host. If either of the routers discards a packet, the source host eventually times out and tries again. Assume that host-router and router-router lines are counted as hops.

4.1– Each packet emitted by the source host makes either 1,2, or 3 hops. The probability that it makes one hop is p. The probability that it makes two hops is $p(1-p)$. The probability that it makes 3 hops is $(1-p)^2$. The mean path length a packet can expect to travel is then the weighted sum of these three probabilities, or

$$p^2 - 3p + 3 \tag{1}$$

Notice that for $p = 0$, the mean is 3 hops and for $p = 1$ the mean is 1 hop.

4.2– With $0 < p < 1$, multiple transmissions may be needed. The mean number of transmissions can be found by realizing that the probability of a successful transmission all the way is $\alpha = (1-p)^2$. The expected number of transmission is just:

$$\alpha + 2\alpha(1-\alpha) + 3\alpha(1-\alpha)^2 + ... = 1/\alpha \tag{2}$$

4.3– The total hops used is just :

$$[1/(1-p)^2] \cdot (p^2 - 3p + 3) \tag{3}$$

The first term denotes the average number of transmission. The second term the average path length a transmission is expected to travel.