CS350 Homework #0 Tim Duffy

1) a. What is the mean number of hits per hour for that web server given the above two observations?

Using the hits per hour, we can calculate how long it took for the server to get 10,000 hits:

- 10,000 hits at 1,000 hits/hour = 10,000 hits in about 10 hours
- 10,000 hits at 2,000 hits/hour = 10,000 hits in about 5 hours

We can then use these number to calculate the mean hits/hour:
(10,000 + 10,000) hits / (10 + 5) hours = 20,000 hits/15 hours **1333.34 hits/hour**

b. Generalize your answer for a set of N observations (each of which is over a fixed number of hits).

Let the set of N observations (hits/hour) = $\{r_1, r_2, r_3 \ldots r_N\}$ where each of which is over a fixed number of hits, X.

Then to calculate the mean hits/hour, we can use this general formula:

$$\textbf{mean} = (X * N) \textbf{ hits} / [(X/r_1) + (X/r_2) + \ldots + (X/r_N)] \textbf{ hours}$$

2) a. Consider a Local Area Network (LAN) rated at 1Gbps (Gbps ~ Giga Bits / Second). Assuming that requests for transmitting traffic through that LAN come in the form of "packets" of *exactly* 1,500 bytes each. What is the capacity of the switch (in terms of packets per second)?

(1,500 bytes/packet) * (8 bits/byte) = 12,000 bits/packet
1 Gbps = (1073741824 bits/sec) * (packet/12000 bits) **89478 packets/sec**

b. With respect to the above LAN, assume that it was measured that during a certain period of time, the number of packets per second going through the LAN is 7,500. What is the utilization of the LAN switch during that period of time?

7500 packets/89478 packets (utilization) **8.38% utilization**

c. Assuming that the average utilization of the switch was as measured in part b, how much traffic (measured in packets per second) must an adversary inject into the switch to cause a denial of service (DoS) attack? You may assume that any utilization above 90% will cause significant degradation in quality to the point that renders the LAN unusable.

DoS occurs when utilization reaches 90% of capacity:
0.9 * 89478 packets/sec 80531 packets/sec

Since there are already 7500 packets/sec already in the network, the adversary must inject an additional (80531 - 7500) **73031 packets/sec** to cause a DoS.'

4) a. What is the capacity of the network between A and B?

The capacity of the network between A and B is **150**.

Each node in the network is a router - it can only distribute the packets it receives. It follows that even though the capacity of a certain link may be great, the traffic that reaches that node is limited by the capacities of the links leading to it.

We can determine the capacity of a network by tracing each path to the end node, and noting the maximum amount of data that can get there. If the traffic flowing into the node is greater than the capacity of the next link, flow is limited to the capacity of that link. If the capacity of the next link is greater than the amount flowing into the node, nothing changes since the nodes cannot somehow produce more traffic to flow in the network.

b. If you have the opportunity to upgrade a single link in the above network, which one would you upgrade? How much higher could the capacity of the network be if you upgrade that one link?

I would upgrade the link with capacity 100 that lies on the shortest path from A to B (the straight line through the middle). By doing so, the capacity of the network would increase to 160, a 6.67% increase in capacity.

5) a. Explain why your friend is mistaken. What would be the real benefit from doubling the speed of the CPU?

Doubling the speed to the CPU would increase the response time slightly but it certainly would not halve it. Most of the time waiting is due to I/O processes. Of the three subsystems described, the least amount of time is spent in the CPU. This shows that increasing CPU speed is probably the least effective subsystem to upgrade.

b. If you have the option of doubling the capacity of one of the subsystems (i.e., halving the amount of time that a request spends in that subsystem), which one would you pick? What is the resulting speedup in the web server performance?

Since most of the time is spent dealing with I/O, if we could halve this amount of time, we would see the greatest increase in response time. With this subsystem upgraded, response time would be 40 ms on the CPU, 125 ms on I/O, and 110 ms on DMA operations. This will decrease response time to 275, a 45.45% decrease

5) a. What is the steady-state utilization of the CPU, if there is only one process in the system?

The steps described occur at a rate of 1 cycle per 8 ms. This equates to:

Total time = 8 ms

μ for the CPU = 3/8 = **0.375 = 37.5%**

b. What is the steady-state utilization of the I/O device, if there is only one process in the system.

μ for I/O = 5/8 = **0.625 = 62.5%**

c. ?
d. ?
e. ?

6) a.?
b. Because 50% of the time is spent in the backend server, it would be best to upgrade this subsystem.

c. If the time spent in the backend server is halved, we will see an increase of:

1 / (1- 0.50(1- 1/2)) = 1/ (1 - 0.25) **= 1.33%**