ECEN4533 Quiz #2 30 March 2011 Name Solution

1) A 40 Gbps trunk is carrying Ethernet traffic with an average packet size of 770 bytes, of which 66 bytes are overhead. A network sniffer has been placed on the line to capture some of the traffic statistics. Over a 24 hour period, 8,649,000 measurement have been taken at 0.1 second intervals. The average amount of traffic carried during these time intervals has been measured to be 4.2 Gbps, with a standard deviation = 1.3 Gbps. Call this time series X. You desire to estimate the H parameter, so you form a new time series (call this one Y) of 864,900 points by merging together 10 consecutive non-overlapping points of X to form each point of Y. The average amount of traffic measured using these new points remains 4.2 Gbps, but the standard deviation is now 811 Mbps.

1a [4] **Estimate** the H parameter.

1b [4] The carrier has decided that a 40 Gbps trunk is too large for this amount of traffic, and wishes to use a smaller trunk. What is the minimum size trunk you'd recommend if the carrier is willing to accept overages lasting up to 0.1 seconds with probability 0.001? An overage here is defined to be when the total input traffic exceeds the recommended trunk bandwidth.

1c [4] **Compute** the average time a packet will spend in the switch if this recommended trunk size is used.

1d [4] **Compute** the average number of packets in the switch if this recommended trunk size is used.

1e) [4] Suppose you've a switch with 200 MB of queue buffer space allotted to this particular trunk. What's the average size of an overage this switch can handle? I.E. if there are an average number of packets of average size in the queue, what would be the average excess input rate (where the sum of the traffic bps into the switch exceeds the line speed of 1b) that the switch could handle for an entire 0.1 second interval, and not run out of queue buffer space?

1a) $\sigma^2_{X_{10}} = \dfrac{\sigma^2_{X_1}}{N^{2(1-H)}} \Rightarrow (811M)^2 = \dfrac{(1.3G)^2}{10^{2(1-H)}} \Rightarrow 657.7(10^{15}) = \dfrac{1.69(10^{18})}{10^{2-2H}}$

$\Rightarrow \dfrac{657.7(10^{15})}{1.69(10^{18})} = \dfrac{10^{2H}}{10^2} \Rightarrow 10^{2H} = 38.92 \Rightarrow 2H = 1.590$

$H = .7951$ ANS

1b) $C = 4.2\text{Gbps} + 1.3\text{Gbps}\sqrt{-2\ln(0.001)}$

$= 4.2\text{Gbps} + 1.3\text{Gbps}(3.717) = 9.032\text{Gbps}$ ANS

$\Rightarrow \rho = \dfrac{4.2G}{9.032G} = 0.4650$

Initials__________

1D) $E[K(t)] = \dfrac{\rho^{\frac{1}{2(1-H)}}}{(1-\rho)^{H/(1-H)}} = \dfrac{.4650^{\frac{1}{2(.2049)}}}{.535^{.7951/.2049}}$

$= \dfrac{.4650^{2.441}}{.535^{3.880}} = \dfrac{.1543}{.08831} = \underline{\underline{1.747}}$ ANS

1C) $E[T] = \dfrac{E[K(t)]}{\lambda}$ $\quad \lambda = \dfrac{4.2\,\text{Gbps}}{8\,b/B \;\; 770\,B/\text{packet}} = 681.8\,K\,pps$

$= \dfrac{1.747}{681.8K}$

$= \underline{\underline{2.562\,\mu sec}}$ ANS

1e) $E[K(t)] = E[K_q(t)] + E[\text{server}]$

$1.747 = E[K_q(t)] + .4650 \Rightarrow E[K_q(t)] = 1.282$

$\Rightarrow$ 987.1 B are in the queue, on average

$\Rightarrow$ pretty much 220MB are available to handle on average

In 0.1 sec, $0.1\,sec \times 9.032\,G\,\frac{b}{sec} = 903.2\,Mb$ can be cleared

+

200MB = 1.6Gb storage

2.503 Gb can enter switch in 0.1 second without tossing anything

An average of 25.03Gbps for 0.1 seconds can be handled ANS