EE 5390 Selected Areas in Communication Networks
Assignment 2
Due: February 9, 2022

1. Purchase a 2" 3-ring binder to use as your class portfolio.
2. Download and print the article "Flow monitoring explained: From packet capture to data analysis with NetFlow and IPFIX". Place this article in your 3-ring binder.
3. Read the article referenced in 2.
4. Solve problems P24 and P26 below.
5. Capture flow data with pmacct to a CSV file. Write a python script to load the CSV file into a PANDAS dataframe, print the minimum and maximum number of flow bytes, and plot the histogram of flow bytes; all with PANDAS functions (use v1.4 of PANDAS). I want to see a lot of detail in the histogram so do not use the default number of bins, use many more. ***Hint***: use column='BYTES' as one of the arguments to the hist() function to get it to work correctly. Submit this python script through Blackboard.

from the server to the client, then the server will re-transmit the packet. On average, how many times will the server re-transmit the packet in order for the client to successfully receive the packet?

P22. Consider Figure 1.19(a). Assume that we know the bottleneck link along the path from the server to the client is the first link with rate R_s bits/sec. Suppose we send a pair of packets back to back from the server to the client, and there is no other traffic on this path. Assume each packet of size L bits, and both links have the same propagation delay d_{prop}.

a. What is the packet inter-arrival time at the destination? That is, how much time elapses from when the last bit of the first packet arrives until the last bit of the second packet arrives?

b. Now assume that the second link is the bottleneck link (i.e., $R_c < R_s$). Is it possible that the second packet queues at the input queue of the second link? Explain. Now suppose that the server sends the second packet T seconds after sending the first packet. How large must T be to ensure no queuing before the second link? Explain.

P23. Suppose you would like to urgently deliver 40 terabytes data from Boston to Los Angeles. You have available a 100 Mbps dedicated link for data transfer. Would you prefer to transmit the data via this link or instead use FedEx overnight delivery? Explain.

P24. Suppose two hosts, A and B, are separated by 20,000 kilometers and are connected by a direct link of $R = 2$ Mbps. Suppose the propagation speed over the link is $2.5 \cdot 10^8$ meters/sec.

a. Calculate the bandwidth-delay product, $R \cdot d_{\text{prop}}$.

b. Consider sending a file of 800,000 bits from Host A to Host B. Suppose the file is sent continuously as one large message. What is the maximum number of bits that will be in the link at any given time?

c. Provide an interpretation of the bandwidth-delay product.

d. What is the width (in meters) of a bit in the link? Is it longer than a football field?

e. Derive a general expression for the width of a bit in terms of the propagation speed s, the transmission rate R, and the length of the link m.

P25. Referring to problem P24, suppose we can modify R. For what value of R is the width of a bit as long as the length of the link?

P26. Consider problem P24 but now with a link of $R = 1$ Gbps.

a. Calculate the bandwidth-delay product, $R \cdot d_{\text{prop}}$.

b. Consider sending a file of 800,000 bits from Host A to Host B. Suppose the file is sent continuously as one big message. What is the maximum number of bits that will be in the link at any given time?

c. What is the width (in meters) of a bit in the link?