CSCE 4753 Computer Networks Homework #1

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40 points
7 questions with multiple parts

Instructions

- Type your work, print it to a *single* PDF, and upload it to Blackboard before the due date and time. It is strongly suggested to use the given document.
- Show all of your work. Without proper justification and details of steps, correct answers alone may not carry full credit.
- -2 points if you do not insert your name and ID at the top of the document.
- -5 points if it is not typed or legible. On this homework, you may scan it with something like the app CamScanner but just make sure it is a legible PDF.
- -5 points if it is not a PDF file.
- -5 points if it is not a single PDF file. Submit one PDF file. Do not submit zip files containing one or more files.
- -5 points if you present the worked problems out of order. In other words, please present the problems in the order assigned, 1, 2, 3, …

1. Consider sending a file of *F* bits over a path of *Q* links. Each link transmits at *R* bits per second (bps). The network is lightly loaded so that there are no queueing delays. When a form of packet switching is used, the *F* bits are broken up into packets, each packet with *L* bits, of which *h* bits of it are header. Propagation delay is negligible. Let $F = 1x10^6$, $Q = 35$, $R = 1$ Mbps, $L = 1000$, and $h = 40$.

1.a. (5 pts.) Suppose that the network is a circuit-switched network. Further, suppose that the transmission rate of the circuit between the source and destination is *R* bps. Assuming $t_s = 250$ milliseconds set-up time and *h* bits of header appended to the entire file, how long does it take to send the file?

Time to send = Transmission + Setup time
Transmission time = $\frac{F+h}{R} = \frac{1x10^6+40}{1{,}000{,}000} = 1.00004$s
Setup time = .250s
Time to send = 1.00004 + .250 = <u>1.25004s</u>

1.b. (5 pts.) Suppose the network is a packet-switched store-and-forward datagram network and a connectionless service is used. How long does it take to send the file?

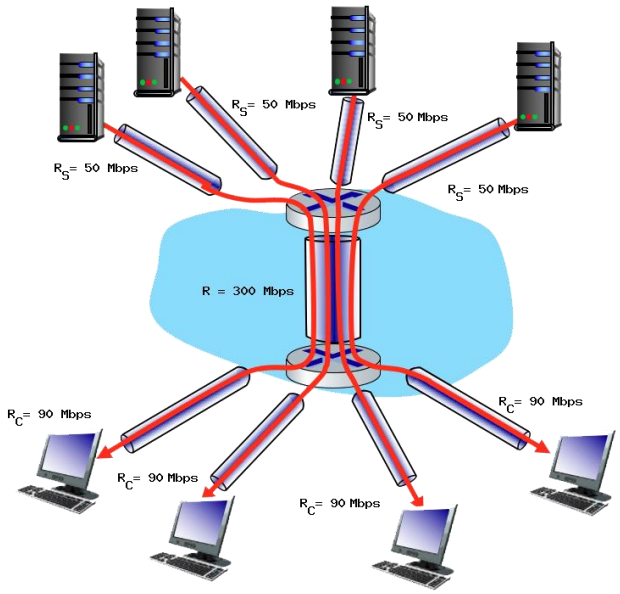
Number of packets $N = \frac{1{,}000{,}000\ File\ Bits}{960\ File\ bits\ per\ packet} = 1042$ packets
Time to send = Transmission Time = $\boldsymbol{T_{first\ packet} + T_{rest\ of\ packets} = \frac{L}{R}(N-1) + \frac{L}{R} * Q = \frac{1000bits}{1Mbps}(1041) + \frac{1000\ bits}{1Mbps}(35)}$ **= 1.041 + .035 = <u>1.076s</u>**

1.c. (2 pts.) Suppose the network is a packet-switched virtual circuit network. Denote the VC set-up time by $t_s = 500$ milliseconds. How long does it take to send the file from source to destination?

Time to send = Transmission Time + Setup Time = 1.076 + .500 = <u>1.576s</u>

2. Consider the scenario shown below, with four different servers connected to four different clients over four three-hop paths. The four pairs share a common middle hop with a transmission capacity of R = 300 Mbps. The four links from the servers to the shared link have a transmission capacity of $R_S = 50$ Mbps. Each of the four links from the

shared middle link to a client has a transmission capacity of R_C = 90 Mbps.



2.a (2 pts.) What is the maximum achievable end-end throughput (an integer value, in Mbps) for each of four client-to-server pairs, assuming that the middle link is fairly shared (divides its transmission rate equally) and all servers are trying to send at their maximum rate? Please write the answer with brief explanation.

50Mbps, as all data in the client-to-server pair must pass through the bottleneck of Rs, which limits the entire end-end throughput.

2.b (2 pts.) Assuming that the servers are all sending at their maximum rate possible, what are the link utilizations for the server links (with transmission capacity R_S)? Enter your answer in a decimal form of 1.00 (if the utilization is 1) or 0.xx (if the utilization is less than 1, rounded to the closest xx). Please write the answer with brief explanation.

1.00, since the max rate of the server links is 50Mbps, and the end-to-end throughput is 50Mbps, 50/50 = 1. This is because Rs is the bottleneck, so it will be utilizing 100% of it's bandwidth.

2.c (2 pts.) Assuming that the servers are all sending at their maximum rate possible, what are the link utilizations of the client links (with transmission capacity R_C)? Enter your answer in a decimal form of 1.00 (if the utilization is 1) or 0.xx (if the utilization is less than 1, rounded to the closest xx). Please write the answer with brief explanation.

Utilization = End-to-End Throughput / Rc = 50/90 = 0.56 because the client link isn't utilizing its full bandwidth as the server link is the bottleneck at 50Mbps. So, the client link is only using 50Mbps out of its available 90Mbps.

3. (3 pts.) List the three layers a router must implement to operate.
Network
Link
Physical

4. (1 pt.) What is the title of RFC 968?
'Twas the Night Before Start-up'

5. (4 pts.) List both the connection-oriented and connectionless transport protocols used in the Internet. Identify at least two differences between them.
TCP (Connection-oriented) and UDP (Connectionless)
TCP offers reliable transport, flow control, congestion control.
UDP does not provide those and is an unreliable data transfer.

6. Suppose two hosts, A and B, are separated by 5000 kilometers and are connected by a direct link of R = 500 Mbps. Assume the propagation speed over the link is 2.0×10^8 meters/second.

6.a. (2 pts.) Calculate the propagation delay t_{prop}.

Tprop = distance / speed = 5,000,000m / 200,000,000m/s = .025s

6.b. (2 pts) How many bits are in transit between hosts A and B?

Bits in transit = R * Tprop = 500,000,000Mbps * .025s = 12,500,000 bits

7. Suppose users share a 1-Gbps link. Also, suppose each user requires 200 Mbps when transmitting, but each user only transmits 40 percent of the time.

7.a. (5 pts.) When circuit switching is used, how many users can be supported?

Num Users = $\frac{R}{R/Person}$ **= 1Gbps / 200 Mbps = 5 users**

7.b. (5 pts.) For the remainder of this problem, suppose packet switching is used. What is the maximum number of users that can be supported if the required blocking probability is strictly less than 0.05 **and** what is the blocking probability with the determined maximum number of users?

$\boldsymbol{\Sigma\, i\ = 6, N\ choose\ (N, i) * p(1-p)^{N-i}}$ **where N is the max number of support users, p = .4 the probability a user is transporting at one time, and the summation is the blocking probability. Plugging into this equation, N = 8 Maximum Users is the highest N possible before the blocking probability becomes larger than 0.05.**

The End.