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19.2.2024
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CSC138
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SECTION 4
Course ID: 110586
Class Number: 32640

HOMEWORK 1

I have each question above the answer I provide. Spaces have been added for formatting purposes.

CSC/CPE138 Computer Networking Fundamentals SPRING2024

Homework 1

Due: Tuesday 11:59 PM, February 20, 2024

1. (15 points) Consider a packet switching architecture.
   a. Concisely describe the difference between transmission and propagation delay.
   b. How would the queuing delay be affected if the arrival of packet rate increases?
   c. After observing the delays of network communication, you found that the propagation delay is higher and requires immediate attention. What will you do reduce propagation delay?

2. (10 points) Suppose we have an application that requires transmission of data continuously

Homework #1
Answers

1. Packet Switching

1a. Transmission is the delay of being passed through the gate to the propagation lane which is the highway that the packet travels to reach it's destination.

1b. The arrival of packet rate increase would increase the length of the queue. If you wanted to trap a certain message, I'd imagine you could overwhelm the queue upon arrival of target message, then quickly sift through the queue to find what you want. Sort of like clog pipe just as object gets dropped in it, then worm (up) through it to find the temporarily blocked message. Once the message is found, unblock the pipe, allow it to pass the gate and propagate.

1c. Short answer: shorten the distance between the objects, but if the object needs to travel that distance, then we must work toward improving the logic behind it's transmission.

NUMBER 2

2. (10 points) Suppose we have an application that requires transmission of data continuously at a steady rate (e.g., N-bits are sent every T time units, where T is small and fixed) for a long time.

   a. Which network type would be more appropriate for this application: circuit-switched or packet-switched? Justify your answer.
   b. Now, consider a circuit-switched network that has a 1500 Mbps link capacity where each user requires a bandwidth of 100 Mbps when transmitting, but are only active 10 percent of the time. What is the maximum number of users that can be supported? Justify your answer.

2a. For a application that REQUIRES a constant transmission, like a vital healthcare system, we would likely want a circuit based system, because it would maintain constant connection without dropping packets. This would limit the number of users on the network but that's irrelevant if we have a dedicated system for a singular vital individual.

2b.

$$\text{Formula}:$$
$$\text{each user can have } 100 \text{ MBPS}$$
$$\text{each user} = .1 \text{ of their allotted speed}$$
$$\text{that means each user spends } 100 * .1 = 10 \text{ MBPS}$$
$$\text{We have } 1500 \text{ MBPS available}$$
$$\frac{1500}{10} = 15 * 10^1 \text{ users}$$
$$\text{We can support } 150 \text{ users}.$$

NUMBER 3

3. (15 points) Consider a packet-switched network that has a 150 Mbps link capacity where each user requires a bandwidth of 10 Mbps when transmitting but are only active 1 percent of the time. Also, assume that there are 29 packet switching users.

   a. Calculate the probability that exactly one user (i.e., any one of the 29 users) is transmitting at a given time, while the remaining are not. Using binomial distribution, show the formula for the calculation and the final result to 6 decimal places. Note that it may be easier to write a program to find the final value.
   b. Now, calculate the summative probability that any up to 15 of the 29 users (i.e., 0, 1, 2, 3, …, 14, or 15 users) are transmitting at the same time, while the remaining users are not. Using binomial distribution, show the formula for the calculation and the final result to 6 decimal places. Note that it may be easier to write a program to find the final value.
   c. What is the probability to 6 decimal places that more than 15 of the 29 users are transmitting at the same time? What does this mean about the number of users supported under packet switching versus circuit switching for this scenario?

3a. Okay, so we want to find the likelihood of a single user transmitting at any given time.

$$\binom{N}{K} * P^k * (1-p)^{(n-k)}$$

$$\frac{(n!)}{(k!(n-k)!)} * P^k * (1-p)^{(n-k)}$$

$$\frac{(29!)}{(1!(29-1)!)} = (29)$$

$$.01^1 = P^k$$

$$(1-.01)^{29} - 1 = .99^{28}$$

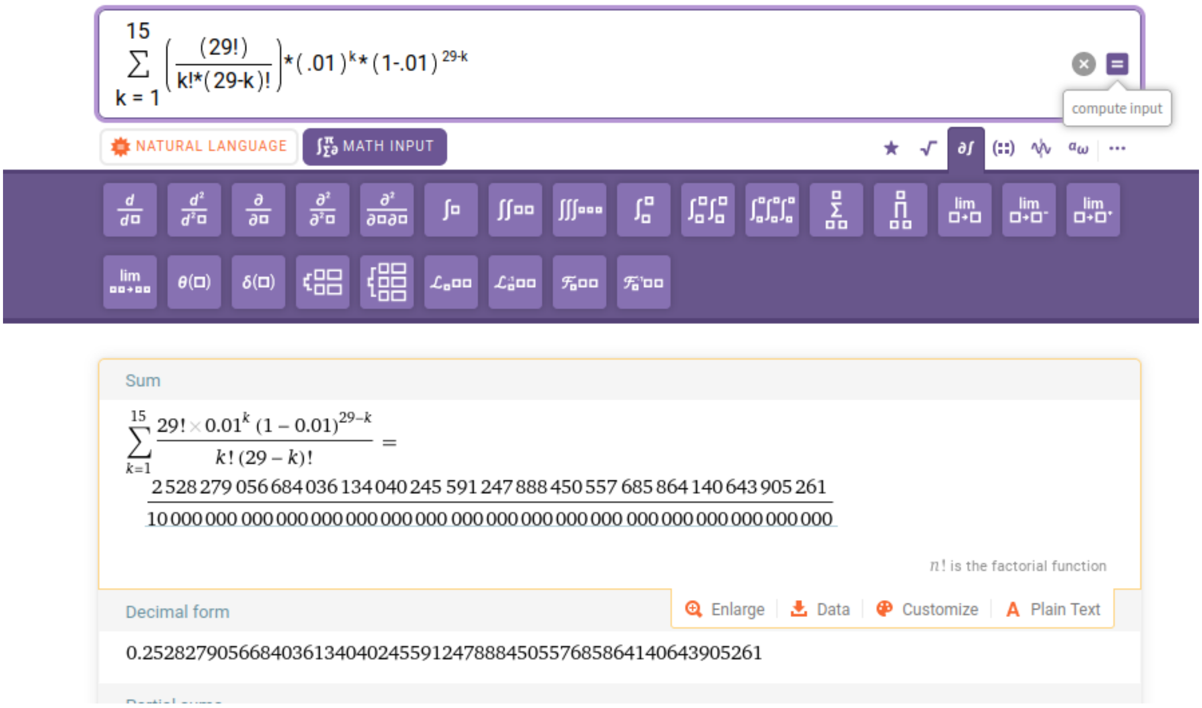
$$(29) * .01^1 * .99^{28} = .270933$$

3b. Now we calculate the summative chance 15 users might be transmitting at the same time.

$$\sum_{k=0}^{k=15} : \binom{29}{K} * .01^{k} * (1-p)^{(29-k)}$$

$$\sum_{0}^{15} k : \frac{(29!)}{(k!(29-k)!)} * .01^{k} * (1-p)^{(29-k)}$$

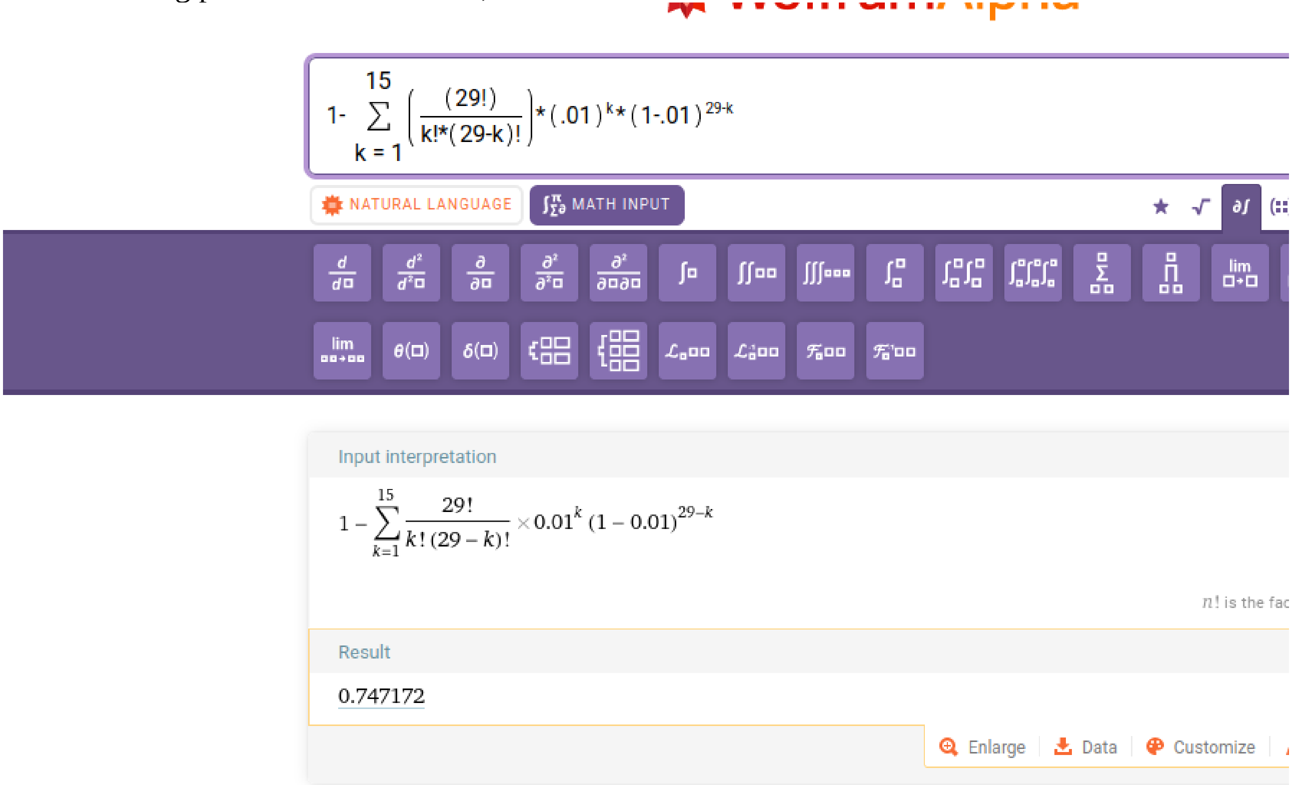
Where p = .01



Round to six places:

.252828% probability Final answer

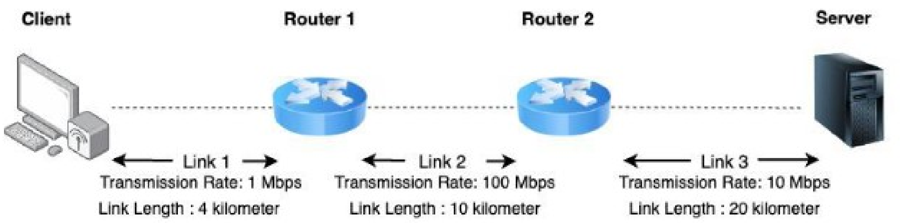
3c. greater than fifteen encompasses 14 summed possibilities, so it’s going to be a larger number. The remaining possibilities are 15-29, or 1-.25828 =



Final Answer: .747172% probability

NUMBER 4

4. (30 points) Consider the following network:



You may assume a packet length of 10 Kilobyte and ignore queueing and processing delays. Use a propagation speed of 3×10^8 m/sec in the following calculations.

a. Assuming no other traffic in the network, what is the throughput for the file transfer.
b. Calculate the transmission and propagation delays on Link 1.
c. Calculate the transmission and propagation delays on Link 2.
d. Calculate the transmission and propagation delays on Link 3.
e. Assuming the processing and queueing delays are negligible (i.e., 0), calculate the end-to-end delay from the left host (when begin transmitting first bit of a packet) to the right host (when the last bit of that packet is received).
f. For Link 2, determine the distance at which the transmission delay d_{trans} equals the propagation delay d_{prop}.

4a. Here, we discover the throughput is defined by the slowest transmission rate, Link1, which is 1mbps.
4b.

$$Link\,1: Transmission\,delay \wedge Propagation\,delay$$

$$\left(\frac{length}{rate}\right) = Transmission\,delay$$

$$\frac{length}{pspeed} = Propagation\,delay$$

$$\frac{(10\,kb)}{(1\,mbps)} = .1\,s$$

$$the\,bytes\,cancel\,leaving\,us\,with\,.1\,for\,transmission$$

$$\frac{(4\,km)}{(3\,x\,10^8\,m)} = 1.33333333 \times 10 - 5$$

$$Now\,we\,add\,¿\,discover\,total\,delay..1 + 1.33333333 \times 10 - 5 = 0.100013333$$

4c. We are going to do the exact same thing, so I will reuse the formula.

$$Link\ 2 : Transmission\ delay \wedge Propagation\ delay$$
$$\left(\frac{scale}{rate}\right) = Transmission\ delay$$
$$\frac{length}{pspeed} = Propagation\ delay$$
$$\frac{(10\ kb)}{(100\ mbps)} = .0001\ s$$
$$the\ bytes\ cancel\ leaving\ us\ with\ .0001\ s\ for\ transmission$$
$$\frac{(10\ km)}{(3\ x 10^8\ m)} = 3.\bar{3} \times 10 - 5$$
$$Now\ we\ add, discover\ total\ delay.$$
$$.001\ s + 1.\bar{3} * 10^{-5}$$
$$x = .0001\bar{3}\ s$$

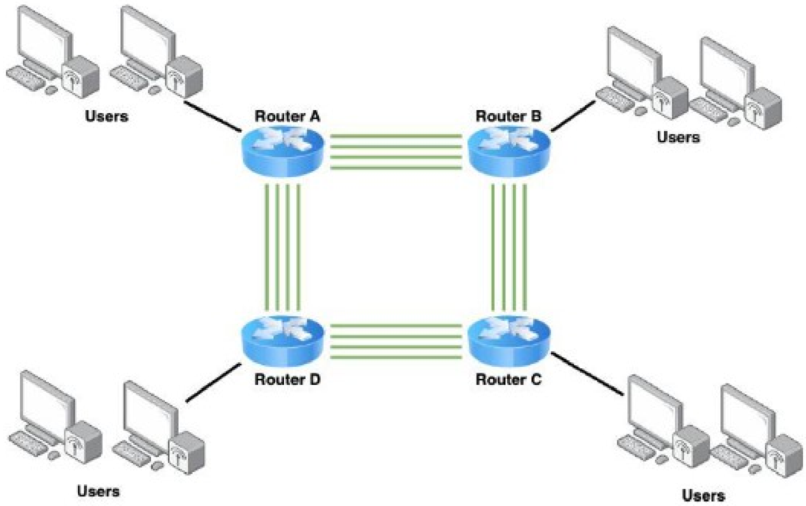
4d. We are going to do the exact same thing, so I will reuse the formula.

$$Link\ 3 : Transmission\ delay \wedge Propagation\ delay$$
$$\frac{scale}{rate} = Transmission\ delay$$
$$\frac{length}{pspeed} = Propagation\ delay$$
$$\frac{(10\ kbps)}{(10\ mbps)} = .001\ s$$
$$the\ bytes\ cancel\ leaving\ us\ with\ .001\ s\ for\ transmission$$
$$\frac{(20\ km)}{(3\ x 10^8\ m)} = 6.\bar{6} \times 10 - 5$$
$$Now\ we\ add, discover\ total\ delay.$$
$$.0001\ s + 6.\bar{6} * 10^{-5}$$
$$x = .00106\bar{6}\ s$$

4e. End to end is simply adding the numbers together, so we get approximately 0.101203333, rounded, all because of the slow rate that exists within link1.
4f. For this, we set up a proportional equation and discover the answer is 30,000 km.

NUMBER 5

5. (15 points) Consider the following circuit-switched network where there are 4 links (green lines) available between each router:



   a. Determine the maximum number of simultaneous connections supported at any one time in this network.

5a. Maximum number of simultaneous connections supported in the network:
Each router has 4 links available. If we assume each link can support one simultaneous connection, then the maximum number of simultaneous connections in the network is 4 (since there are 4 links per router and there are 4 routers in total).

5b. Maximum number of simultaneous connections from router A to router C:
Router A has 4 links available. Router C also has 4 links available. Therefore, the maximum number of simultaneous connections from router A to router C is determined by the router with fewer available links, which is 4.

5c. Simultaneous connections for scenario with 4 users at router A and 4 users at router B:
Router A has 4 links available. Router B also has 4 links available. Router C has 4 links available. Router D also has 4 links available. However, since each router has only 4 links, it's not possible to make 8 simultaneous connections in this network. The maximum number of simultaneous connections that can be made is limited by the number of links available at each router, which is 4.

NUMBER 6

6. (5 points) Suppose that you have 20 terabytes (note that bytes, not bits, are used here) of data on a drive that you need delivered within 24 hours, but preferably faster. If your company has a dedicated 1 Gbps link available to transfer this data, would it be better to use FedEx overnight delivery (will be delivered in 24 hours, but no earlier) or transmit the data on your dedicated link if these are your only options? Show calculations to justify your answer.

$$Time\,taken\,transfer = \frac{(Total\,data)}{(Transfer\,rate)}$$

$$\frac{(20480\,gigabytes)}{(1\,Gbps)}$$

$$(20480\ gigabyts)/(1\,Gbps) = 20480\,seconds$$

There are 3600 * 24 seconds in a day, therefore I'd use the dedicated link.

NUMBER 7

data on your dedicated link if these are your only options? Show calculations to justify your answer.

7. (5 points) Networked systems are organized into protocol layers. Briefly identify and describe four advantages of protocol layers.

8. (5 points) Suppose that you have a multiplexer (mux) with 5 different inputs at the following bit-rates: (A) 20 Kbps, (B) 8 Kbps, (C) 12 Kbps, (D) 8 Kbps, and (E) 4 Kbps.

Here are four protocol layer approaches and their advantages:

From our lectures

Internet application: File transfer protocol, SMTP, HTTP, Rfc

Transport: Transfer control protocol, UDP, data safety, guarantees reliable transport

Network: IP, routing protocols, port designation, priority, allows packets to be interconected.

Physical: ethernet, fiber, wifi, bluetooth etc.

In a broad sense:

Protocol layers allow for the separation of different functions and services into distinct layers, making it easier to understand, maintain, and update the system. Each layer can be developed and modified independently without affecting other layers.

NUMBER 8

8. (5 points) Suppose that you have a multiplexer (mux) with 5 different inputs at the following bit-rates: (A) 20 Kbps, (B) 8 Kbps, (C) 12 Kbps, (D) 8 Kbps, and (E) 4 Kbps. Using a fixed slot size in the frame, how would you organize a single synchronous TDM link receiving the output of the mux? That is, how many time slots are needed? Draw a diagram of a single frame, labeling each slot appropriately.

9. (5 Points) You are a network engineer at XYZ company and monitor network performance. On the weekend, you observe heavy traffic usage over the internet, and suspect DDOS

20	8	12	8	4

To organize a single synchronous TDM link receiving the output of the mux with 5 different inputs at the specified bit-rates, we need to allocate time slots in the frame for each input based on its bit-rate. Since the total capacity of the TDM link should accommodate the highest bit-rate input, we need to calculate the total capacity and then divide it into time slots. Total capacity of the TDM link = Sum of bit-rates of all inputs = 20 Kbps + 8 Kbps + 12 Kbps + 8 Kbps + 4 Kbps = 52 Kbps If we use a fixed slot size in the frame, the number of time slots needed would be determined by the frame duration required to transmit all inputs. For example, if we use a frame duration of 1 second: Number of time slots = Total capacity / Frame duration = 52 Kbps / 1 second = 52 slots Therefore, we would need 52 time slots in the frame.

NUMBER 9

link receiving the output of the mux? That is, how many time slots are needed? Draw a diagram of a single frame, labeling each slot appropriately.

9. (5 Points) You are a network engineer at XYZ company and monitor network performance. On the weekend, you observe heavy traffic usage over the internet, and suspect DDOS attack. What tool would you use to investigate the packets to investigate the network. What level of packet information can this tool provide?

Note: Maximum points will not exceed 100. You will include your student ID, name, section and

9a. Drawing from our lab, we could use wireshark. Although there are other programs available that would or could accomplish the same thing. You can capture loads of data like source and destination locationBurp might be able to do it as well.