CMPT 371 Assignment 1

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Assignment 1: CMPT 371 Complete in groups of one to two students

1) A system uses statistical time division multiplexing, there are 56 channels (56 different signals) being combined into one multiplexed signal. Each channel carries frames with a total length of 1200 bytes. Each frame has a header of 60 bytes. Each channel supports a maximum bit rate of 9.6Mb per second (1KB = 1000 bytes, 1MB = 1000 KB, 1GB = 1000 MB, 1Kb = 1000 bits, 1Mb = 1000 Kb, 1Gb = 1000 Mb). Assume that the average frame rate passing through each channel is 555 frames/s. Assume that the line carrying the multiplexed signals can carry signals at a maximum bit rate of 550 Mb/s.

a) **[3 points]** What is the maximum number of frames per second supported by each channel?

Answer:

Maximum number of frames rate = maximum bit rate / length of frames

= (9.6Mb/s) / (1200 bytes/frame)

notes: 9.6Mb/s = $9.6 \times 1000 \times 1000 = 9.6 \times 10^{6}$Mb/s

= $9.6 \times 10^{6}/(1200 * 8)$ = 1000 frames/s

b) **[3 points]** What the average percentage of the time each channel is used?

Answer:

Average percentage of the time is used = average frame rate / max frame rate

= (555 frames/s) / (1000 frames/s) =0 0.0693 = 55.5%

c) **[3 points]** What fraction of the information being sent is overhead?

Answer:

There are 60 bytes of overhead in each 1200 bytes packet.

d) **[3 points]** What are the average bit rate and the average frame rate summed over all signals?

Answer:

Summed average frame rate = average frame rate of channels ×number of channels

= 555 frames/s × 56 channels = 31080 frames /s

Summed average bit rate = summed average frame rate × length of frame

= 31080 frames/s ×1200 bytes/frame = 3.7296$\times 10^{7}$bytes/s

= 3.7296$\times 10^{7}$bytes/s = 298.368 Mb/s

e) **[4 points]** What is the average data rate summed over all signals? (data only)

Answer:

Average data rate × percent of data = average bit rate

Average data rate = (298.368 Mb/s) /(1140 bytes/1200bytes)

= 298.368 Mb/s/0.95 = 314.072 Mb/s

f) **[3 points]** What percentage of the line's capacity will be utilized?

Answer:

Percentage of utilized = Average data rate / max bit rate of multiplexed

= 314.072 Mb/s / 550 Mb/s = 0.57104 = 57.104%

2) Consider a transmission line with a transmission rate of 360 Mibps (1Mibps = 2^{20} bits per second).

a) **[4 points]** How many users would the line support? Make the following assumptions:

i. Each user has a 15 Mibps connection
ii. The line is shared using synchronous TDM
iii. Assume that 85% of the capacity of the line may be used for user connections.

Answer:

Total user transmission rate = 0.85 * 360 Mibps = 306 Mibps
Number of users = Total user transmission rate/each user
= 306 Mibps/15Mibps = 20.4 users
= 20 users

b) **[4 points]** How many users can the line support? Why? Make the following assumptions

i. Each user has a 15 Mibps connection
ii. Each user's connection is used an average of 34% of the time
iii. The line is shared using synchronous TDM
iv. Assume that 85% of the capacity of the line may be used for user connections.

Answer: Still 20 users. Since TDM is allocated in advance prior to use, it does not affect the results

c) **[4 points]** How many users can the line support? Make the following assumptions

i. Each user has a 15 Mibps connection
ii. Each user's connection is used an average of 34% of the time
iii. The line is shared using statistical TDM
iv. Assume that 85% of the capacity of the line may be used for user connections.

Answer: Each user = 15 Mibps * 0.34 = 5.1 Mibps
Number of users = Total user transmission rate/each user
= 306 Mibps/5.1Mibps = 60 users

d) **[8 points]** Suppose there are 66 users, using 10 Mibps connections at the same time. Each user uses their connection 38% of the time. Find the probability that at any given time, exactly 22 users are transmitting simultaneously. Derive an equation then calculate the requested value (Hint: use the binomial distribution).

Answer: The probability = 66C22 * 0.38^{22} *0.62^{44} = 0.07602

3) **[20 points]** Consider a local network with one router, that router is connected to the internet through its first network card (interface). The router is connected to the local network through a second interface. All hosts on the local network including the router are on the same physical network segment. A proposal has been made to add a HTTP proxy server to a host in the local network. All HTTP traffic will be processed by the proxy server before being sent onto the Internet. HTTP queries would be sent to the internet only if they could not be satisfied from the HTTP cache. The purpose of adding the proxy server is to reduce traffic on the Internet connection.

- The local network supports a bit rate of 900 Mbs.
- The internet connection supports a bit rate of 250 Mbs
- The average traffic on the local network, excluding HTTP traffic, is 320 Mbs.
- The average traffic on the Internet connection, excluding HTTP traffic, is 85 Mbs.
- The average number of internet queries from the network is 135 queries per second
- Each query has an average size of 1.18 Mb.
- If a HTTP proxy server is added the number of queries satisfied by the cache will be 62%

Determine each of the following:

a) HTTP traffic intensity for the local network

Answer: Intensity of HTTP = traffic / data rate = (135*1.18Mbs) / 900 Mbs = 0.177 = 17.7%

b) HTTP traffic intensity for the internet without the proxy server.

Answer: Intensity of HTTP = traffic /data rate = (135*1.18Mbs) / 250 Mbs = 0.6372 = 63.72%

c) The total traffic intensity for the local network without the proxy server.

Answer: Total traffic intensity = (traffic of HTTP + traffic exclude HTTP) / data rate
= (159.3 + 320Mbs) / 900Mbs = 0.53 = 53%

d) The total traffic intensity for the internet connection without the proxy server

Answer: Total traffic intensity = (traffic of HTTP + traffic exclude HTTP) / data rate
= (159.3 + 85Mbs) / 250 Mbs = 0.98 = 98%

e) The total traffic intensity for the internet connection with the proxy server

Answer: Total traffic intensity with proxy = (traffic of HTTP + traffic exclude HTTP)
= (0.38*159.3 + 85Mbs) / 250Mbs = 0.58 = 58%

Is a proxy server needed? Why?
Will the addition of the proxy server solve any problems with traffic intensity your identified? Why?

Answer: The proxy server is needed. It reduces load on the Internet, and fewer copies of the same object are requested. Also, if the requested object is in the cache, it also reduces response time on external access links. Reducing bottlenecks in bandwidth.

HINT: traffic intensity = traffic(Mbs/sec)/data rate(Mbs)

4) Suppose two hosts A and B. Both hosts are part of a packet switched network. A user has a 3 Gb ($3*2^{30}$ bits) file to transfer across the connection. Assume that each link in the packet switched network has a capacity of 900MBps, the propagation delay on each link is 0.0001s, the processing delay at each host is 0.003s, there are no queuing delays, and the packet is transmitted by A and by 9 additional hosts as it travels through the packet switched network to B.

a) **[5 points]** Consider sending the file through the packet switched network as a single packet. Assume that each of the intermediate hosts are store and forward nodes. How long does it take to send the file from A to B?

Answer: Delay = propagation delay*hop + (processing + transmission delay)*hop =
= 0.0001s*10 + (0.003s + 3*2^30 Mb / 900*2^20 bps)*10 = 341.4s

b) **[6 points]** Assume that the file is segmented into packets containing 12000 bits each. Each packet has a header of 200 bits. If a packet is partially full of data the remainder of the data field is filled with zeros before the resulting full size packet is transmitted. How long does it take for the file to be transmitted through the network (assume no queuing delays).

Answer: M = number of packets = 3*2^30 bits / 11800 bits = 272985.2 packets.
so, 272986 packets in total.

transmission delay of one packet = 12000 bits / 900*2^20 bps = 0.000127 s
N = number of transmission = 10

delay = propagation*N + (processing + transmission)*(M + N -1)
= 0.0001*10 + (0.003 + 0.000127)*(272986 +10-1) = 853.66 s

c) **[10 points]** What is the optimal packet size to transmit this file through this network? To find the optimum express the equation as a function of the amount of data in each packet, Ipacket. Then take a derivative with respect to Ipacket to get the general expression. Finally evaluate the expression to find the optimal packet size for the

see picture below

$$d_{end\ to\ end} = \{d_{proc} + (d_{data} + d_{head})\} \times (N_{trans} + (N_{pack} - 1)\} + d_{prop} \times N_{trans}$$

$$= \frac{I_{data}}{R} \times N_{trans} + (N_{trans} + N_{pack} - 1) \times \{d_{proc} + \frac{I_{data}}{R} + \frac{I_{head}}{R}\}$$

$$= \frac{I_{data}}{R} \times N_{trans} + (N_{packet} - 1) \times \{d_{proc} + (\frac{I_{data}}{R} + \frac{I_{head}}{R})\}$$

$$+ (d_{proc} + d_{prop} + \frac{I_{head}}{R}) \times N_{trans}$$

find minimal I_{data}

$$F(x) = \frac{d}{dI_{data}}\left(\frac{I_{data}}{R} \times N_{trans} + (N_{packet} - 1) \times \{\frac{I_{data}}{R} + \frac{I_{head}}{R} + d_{proc}\}\right.$$

$$= \frac{d}{dI_{data}}\left(\frac{I_{data}}{R} \times N_{trans} + \frac{L}{I_{data}} \times \{\frac{I_{data}}{R} + \frac{I_{head}}{R} + d_{proc}\} - \{\frac{I_{data}}{R} + \frac{I_{head}}{R} + d_{proc}\}\right.$$

$$= \frac{d}{dI_{data}}\left(\frac{I_{data}}{R} \times N_{trans} + \frac{L}{R} + \frac{L I_{head}}{I_{data} \cdot R} + \frac{L d_{proc}}{I_{data}} - \frac{I_{data}}{R} - \frac{I_{head}}{R} - d_{proc}\right)$$

remove const $= \frac{d}{dI_{data}}\left[\frac{I_{data}}{R}(N_{trans} - 1) + \frac{L I_{head}}{R I_{head}} + \frac{L d_{proc}}{I_{data}}\right]$

$$F(x) = \left[\frac{(N_{trans} - 1)}{R} - \frac{L[I_{head} + R d_{proc}]}{R I_{data}^2}\right]$$

$$F(x) = 0. \quad \left[\frac{(N_{trans} - 1)}{R} - \frac{L[I_{head} + R d_{proc}]}{R I_{data}^2}\right] = 0.$$

$$\sqrt{\frac{[I_{head} + R d_{proc}] \cdot L}{N_{trans} - 1}} = I_{data}.$$

$\because N_{trans} = 10. \quad I_{head} = 200. \quad L = 3 \times 2^{30}$ bits

$$\therefore I_{data} = \sqrt{\frac{200 + 2.67 \times 10^5 \times 0.003 \times 3 \times 2^{30}}{9}} = 2.67 \times 10^5 \text{ bits}.$$

$$= \frac{\sqrt{200 + 801} \times 3 \times 2^{30}}{9}$$

$$= 5.99 \times 10^6.$$

5) Consider the HTTP protocol. HTTP is the protocol used for sending the contents of web pages between hosts, from a web server to an agent (client like Firefox or explorer). HTTP is also used by agents to make requests to web servers for particular web pages. HTTP communications, both requests and replies travel through TCP connections. The packets sent back and forth between an agent requesting web pages and the web server sending the web page were captured using the packet sniffer Wireshark. All the provided files provide a list of packets that were transmitted when web pages were requested using the chrome browser on a windows 10 machine.

You can download Wireshark and open the pcapng data files supplied with this problem. These files contain a great deal of information about each packet. I will discuss some of the things you can do with Wireshark in the video that will be supplied soon after this assignment is posted. If you try capturing your own packets, please be aware that many license agreements specify you will not capture packets from the application, and using Wireshark may flag you to network admins of the networks you work on as a potential hacker. You do not need to capture any packets to complete this problem. Please use the supplied Wireshark files.

Summary data was captured and is provided for you in the files HTTP2020summary.pcapng and HTTP2020conversation.pcapng. Consider only the HTTP packets in the summary file (ignore the packets labeled TCP). The conversation file contains both the HTTP packets and the TCP packets used to transmit the data sent by the server in response the HTTP requests. Both files include both the initial request for one or more web pages and the responses to those requests.

Based on the information in these files answer each of the following questions. In each case explain how the contents of the files supports the answer you have given.
For parts a), c} support for your answer should include reference to a particular frame or group of frames in the file HTTP2020summary.pcapng, pointing out the useful evidence within the packet or packets.
For parts d), e} support for your answer should include reference to a particular frame or group of frames in the file HTTP2020conversation.pcapng, pointing out the useful evidence within the packet or packets.

a. **[6 points]** What is the difference between a basic HTTP GET request and a conditional HTTP get request? After answering this question provide the following information to illustrate your answer:

   i. Identify by frame number an example packet from the file HTTP2020summary.pcapng for a conditional Get request. Show the line in the file you have selected in your solution. (The line from the list of Wireshark packets)

Answer: The first packet in HTTP2020summary which frame number is 1, is a conditional Get request. If-Modified-Since: Wed, 27 May 2020 16:05:12 GMT\r\n

   ii. Identify by frame number an example packet from the file HTTP2020summary.pcapng for a Get request that is not conditional. Show the line from the file you have selected in your solution and if possible one for a Get that is not conditional.

Answer: The seventh packet in HTTP2020summary which frame number is 7, is not a conditional one. There is not if-modified-since in the header, which means it's not a conditional Get.

iii. Explain briefly how you found the packets and the evidence within the packets tell you if the packet is executing a GET or a conditional GET? Show the evidence you site in your answer

Answer: Looking at the Hypertext Transfer Protocol part, if there is an additional directive called if-modified-since, it's a conditional GET. If there is not, it's a GET.

"If-Modified-Since: Wed, 27 May 2020 16:05:12 GMT\r\n" This is found in frame1, which is a conditional GET.

So, the difference of GET and conditional GET:

There is an if-modified-since directive in the header. If an object has been changed since the date, the server will send the object.

b. **[4 points]** What is different about the responses to a basic HTTP GET command and to a conditional HTTP GET request? What information does each type of response return? Would you expect a different response to the conditional get if the web page had been modified between the two requests? No evidence from packets is required for this

Answer: When a basic HTTP GET is requested:

The object will be returned in the entity body of the response message

When a conditional GET is requested:

If the requested object has not been changed since the last GET request, the server will send a response message showing the object has not been modified. Also, the server will not return the object, so the entity body will be empty.

If the requested object has changed since the last GET request, the server will return the requested object. So, the entity body is not empty.

c. **[4 points]** What was the IP address of the computer running the browser (the agent)? What was the IP address of the web server it queried? Explain why the evidence you used from the file HTTP2020summary.pcapng file to demonstrate the addresses you chose were the addresses of the agent and the server?

Answer: The agent IP: 192.168.1.144

Web server IP: 69.90.66.160

For example, the first packet, frame 1.

	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.1.44	69.90.66.160	HTTP	696	GET /blog/index.php/author/ HTTP/1.1

This line indicates the source and destination IP of the GET message. The agent sends a request to the server. So the agent is the source, and the server is the destination.

d. **[2 points]** For one of the HTTP GET responses shown in file HTTP20202conversation.pcapng how many packets were used to carry the HTTP GET response from the server to the client? How did you determine your answer?

Answer: When we select the Internet protocol version, we can see there is a flag tab says: "Flags: 0x40, Don't fragment". If it has fragment label, it will cut the packet into several pieces. However, if it shows don't fragment, it still have one packet use to carry the HTTP GET response from server to the client.

e. **[4 points]** Were persistent or non-persistent connections used to download the webpage information from the server? Explain why you think so? Were persistent or non-persistent connections used to download the webpage information from the server?

Answer: Persistent connections were used to download the webpage information from the server.

Firstly when we load the HTTP protocol in the “http2020conversation” file, it shows “GET /blog/index.php/author/ HTTP/1.1”. Since it used ‘HTTP 1.1’ protocol, it should be persistent connection. Also, we can notice that there are several packets send in the same connection. For example there are multiple GET messages going through the source port: 49417 and destination port: 80. So it can also conclude that it used the persistent connections.