**COMP 189: Homework #1**

Assigned Jan 8, 2020

Due Jan 15, 2020

70 points total

*For each problem, show all your work (required for credit). For answers requiring written answers, while no more than five or six sentences are expected, sufficient justification must be given for any position, opinion, or perspective taken.*

**Technical Exercises**

**1. Connectivity (5 pts)**

Using information on the site (<http://www.submarinecablemap.com/>), find the undersea cable that is closest to your hometown. What places in the world does it directly connect?

For me, I’m from Beijing, China, and the closest submarine cable is in Qingdao, China. The Cable in Qingdao consist of two separate cables, EAC-C2C and Trans-Pacific Express (TPE) Cable System. For EAC-C2C, it directly connects to Ajigaura, Japan; Batangas, Philippines; Busan, Korea, Rep.; Cavite, Philippines; Changi North, Singapore; Changi South, Singapore; Chikura, Japan; Chung Hom Kok, Hong Kong, China; Fangshan, Taiwan; Pa Li, Taiwan; Shanghai, China; Shima, Japan; Shindu-Ri, Korea, Rep.; Tanshui, Taiwan; Tseung Kwan O, Hong Kong, China. Additionally, for the Trans-Pacific Express (TPE) Cable System, it directly connects to Chongming, China; Geoje, Korea, Rep.; Maruyama, Japan; Nedonna Beach, OR, United States; Tanshui, Taiwan.

**2. Bandwidth (10 pts)**

Answer the following questions about bandwidth.

1. What is the maximum bandwidth of a wire that can transmit at most 30 bits in 2 seconds? (2 pts)

bandwidth = bits/seconds = 30 bits/2 s = 15 bits/s

1. You can type 6 characters in a second. What is the bandwidth of your hand-keyboard connection? (2 pts)

bandwidth = 6 characters/s

1. You buy a new keyboard which has a weird layout. You type just as fast (hit keys just as quickly), but make a mistake every other letter. To correct a mistake it takes half a second (delete, carefully press the right key). What is the bandwidth of your hand-keyboard connection now? (6 pts)

original speed = 6 characters/s

make 3 corrections for 6 characters

time for 3 corrections = 0.5 seconds \* 3 = 1.5 seconds

6 characters/(1+1.5)seconds = 2.4 characters/s

**3. Broadcasting (25 pts)**

In class we have discussed how the sending data using packets helps with error correction. Packets are also useful when broadcasting information. Broadcasting is when one computer wants to send information to a large number of computers (internet radio, for example, broadcasts the same music feed to an arbitrarily large number of computers).

In the following exercise, you will evaluate two different ways of implementing (called “policies”) a digital broadcast system. Assume that the network of interest consists of four computers, A, B, C, and D, which are physically connected as follows: B - A - C - D. In this problem, computer A wants to send a packet (containing a small file) to all three other computers (B, C, and D). Assume that no packets are lost.

1. Policy 1: computer A must send the data to each computer individually (e.g., it must send the data from A to B, to C, and to D). Compute the number of packets computer A will have to send in order to broadcast the file in this way. (5 pts)

Computer A has to send 3 packets to broadcast the packet to computer B, C, D because computer B, C, D cannot send packet. As a consequence, all packets must be sent by computer A.

1. Policy 2: in this policy, every computer passes the data it receives to its neighbors (e.g., whatever C sees, it immediately sends to A and D). Compute the number of packets computer A will have to send in order to broadcast the file in this way. (5 pts)

Computer A only need to send 1 packet. Computer A send the packet to computer C. After receiving the packet, the computer C will automatically send it to the computers connected to it, and they are computer A and computer D. When the computer A receives the packet sent by computer C, it will send the packet to computer B. Till now, all of these four computers will get the packet. As a consequence, computer A only need to send 1 packet.

1. Use your results from above to explain why policy 2 is the basis for internet broadcasting? (5 pts)

Since all computers automatically send what they receive to other computers connected to them, the first computer will only need to send one data packet, and it will be eventually received by all the computers. It’s extremely applicable for internet. For example, the server of Google in Palo Alto is unable to repeatedly send the same data packet to different computer individually. It will dramatically decrease the efficiency of the server. When the server responds to the first requester, the second requester has to wait for a while. Consequently, the policy 2 is the basis for internet broadcasting.

1. Even the limited example above highlights an inefficiency with policy 2's approach to internet broadcasting. What is it? Give an instance in the example where this issue arises. (10 pts)

The inefficiency is that if one of the receivers lost the data packet, all computers connected to the receivers will not receive the data packet as well. Data packet is a container used for sending content. If a packet was lost, the content was lost either. Take the webpage as an example. Sometimes, when we try to load a webpage, we can only get the text but not the pictures. It happens because the packets which contain the pictures are lost during the transmission. We are only able to see the words but not the format of webpage and pictures.

**4. TCP vs. UDP (30 pts)**

Review the table on this page:

http://www.cyberciti.biz/faq/key-differences-between-tcp-and-udp-protocols

1. Give a detailed example of five packets (collectively comprising a single file) being sent via TCP. Make sure that your example highlights the key aspects of the TCP protocol --- ordering and guaranteed delivery. Like the example given in class, your example should explain the different conceptual steps involved in the generation of the packets, propagation of the data, and reassembly of the packets. *(10 pts)*

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1. Give a detailed example of five packets (collectively comprising a single file) being sent via UDP - with one packet being lost. Make sure that your example highlights the key differences between TCP and UDP --- no ordering and unguaranteed delivery. As for TCP, make sure that your example is detailed and explains the different conceptual steps involved as the packets are moved and processed in the computer network. *(10 pts)*

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1. The UDP internet protocol is typically much faster than the TCP internet protocol (this is why it is used in games and video conferencing, for example) because it does not guarantee packet order or delivery. Why do these compromises make UDP faster? Describe a scenario in which UDP would be faster at transmitting the same information. *(5 pts)*

Since the TCP guarantee the delivery of the information, once we lost one of the packets during the transmission, we have to wait the server to resend it. Furthermore, once the order is wrong, we have to wait for the time needed to correct the order. As a consequence, the time needed by TCP must be much longer than UDP. Considered the advantages of UDP, especially the faster transmission duration, we always use UDP internet protocol in the situation when the newer information can replace the older information. Take the internet-based video game as an example. If we use the TCP internet protocol for the video game, it will result in awful game experience. Once the computer does not receive one of the packets and stops there to wait the resending of the packet, people have to wait for a while to continue playing. It’s unnecessary. Since once the computer receive later packet, people are able to continue their playing by using the later information. UDP internet protocol can do this extremely well. If one of packets was lost during the transmission, the computer just ignores it and use the later information. In this case, the UDP would be much faster than TCP. On the other hand, if the order of packets is interrupted, the computer will use the packet it received first. For example, if the computer receives the packet5 first, it will ignore the packet1,2,3 and 4 it receives later. As a consequence, UDP will be much faster than TCP in these cases.

1. Why is it ok for video conferencing to be built on top of UDP, despite the protocol's limitations? *(5 pts)*

As the needs of video conferencing, the occasional loss of information is acceptable. We just want the conferencing keep consistent. If there are enormous pauses during video conferencing (when lost the information packets), it will negatively affect the efficiency and quality of the video conferencing. As a consequence, it is ok for video conferencing to be built on top of UDP.

**Discussion**

**1. Network structure (5 pts)**

McGill is evaluating internet providers for the campus and is considering two options. The first option involves having all internet delivered by a single cable coming into the library. The second option involves paying for six cables (all still from the same provider) to enter the campus at various points (e.g., the library, Trottier, McConnell, etc...). Both options provide the same, total, bandwidth to McGill. Appealing to features of packet routing already covered in class, make a technical argument for why the second option, despite costing more, is better.

We can consider the advantages of the decentralized internet system. First of all, the decentralized internet system can help an information to be delivered as different packets individually, which will significantly increase the efficiency of information delivery. Additionally, if one of those six cables is unable to make connections, there are still other five cables, even though the bandwidth will be lowered. However, for the first option, if the only one cable in the library is broken, all connections among campus will be unable to use. In summary, the second option is better, despite costing more.