

## Part C Explanation

For this part of the assignment, I was tasked with altering the link quality and seeing how the streaming service behaves. In order to do such, I took two additional smartphone traces, over wifi, one right next to the router (good link quality), and one in the bathroom which typically has poor internet connection (poor link quality) for all video service providers. For smartphone 4g cellular traces, I live in the basement of a building, so for improving the link quality, I went out of my building and performed an additional trace for all video service providers.

### **A. A smartphone that connects to a 4G cellular network.**

For this part of the assignment, there were two documents for comparison for each video service provider. The trace of the worse connection should be titled “smartphone\_4g\_<video service provider>\_hostSpecified.pcap”, where <video service provider> is to be replaced by “youtube,” “dailymotion” or “vimeo”. Similarly, the trace of the better connection is titled, “smartphone\_4g\_<video service provider>\_hostSpecified\_close2cell.pcap”, where close2cell refers to the closer proximity to the cell tower.

#### **a. Youtube:**

In an effort to vary the link quality by moving closer to the cell tower, as opposed to the basement to which I call my apartment, I see no noticeable difference between the two traces. Both traces have similar numbers of error packets, and both have similar counts of notably larger packets. The only possible deviation is that the trace that was done closer to the cell tower has more packets of size 1454 bytes. The trace that was done in my apartment has more packets with size 1434 bytes. My prediction is that the number of bytes transmitted in a single packet was lowered to accommodate a slightly reduced quality.

#### **b. DailyMotion:**

This video service was similar to that of youtube, in that the trace done closer to the cellular tower had a greater percentage of packets that had 1454 bytes, while the one in my apartment had a greater number of packets that had 1434 bytes. Once again, my prediction for why this might be would be because of a slightly reduced streaming quality for the video played in my apartment.

Corresponding to this, we also see a slightly greater percentage of TLSv1.2 packets (compared to the whole) in the trace from my apartment than the trace done closer to the cellular tower. A

greater number of packets are needed to send the same information because less information is being transmitted in each packet.

For this video service, I made the shocking finding that the trace done closer to the cellular tower had about 19 retransmission packets, while the trace done at my apartment had only 4.

Overall, the trace done in my apartment required a shockingly less number of total packets, 223 packets, compared to the 370 number of packets at the trace closer to the cellular tower. I'd say that this was largely contributed to the transmission errors that the latter was experiencing.

c. Vimeo:

Once again, in the trace done closer to the cellular tower, we see a greater number of retransmission packets, and thereby overall a greater number of packets.

We observe no overwhelming difference, between the two traces, of the quantity of larger packets. The traces have similar numbers of TCP and TLS1.2 packets. It can be assumed that these traces have similar bit rates and therefore similar streaming quality.

**B. A smartphone that connects to a WiFi network.**

For this part of the assignment, there were three documents for comparison for each video service provider. The trace of the worse connection should be titled "smartphone\_wifi\_<video service provider>\_hostSpecified\_far2Router.pcap", where <video service provider> is to be replaced by "youtube," "dailymotion" or "vimeo". Similarly, the trace of the better connection is titled, "smartphone\_wifi\_<video service provider>\_hostSpecified\_close2Router.pcap". The median distance trace should be titled, "smartphone\_wifi\_<video service provider>\_hostSpecified.pcap".

a. Youtube:

On this video server we note that we observe that there are packets transferred on both TLSv1.2 and TLSv1.3 for all three traces. We also observe that the seemingly weakest link has the greatest percentage (where percentage is taken over the total number of packets) of packets with a size of 1474 bytes (which was typically on TLSv1.3 packets). However, we see that all other packets have a drastically lower size for this trace. While the trace with the seemingly stronger link quality had more packets with sizes in the range of 500-600 bytes.

The pattern of packet sizes for the stronger link seems to suggest that it was strong in the beginning, weak in the middle (also when error packets were sent), and once again strong at the end. While the pattern of the weaker link seems to suggest that it was weak in the beginning and strong at the end.

However, given that both are transmitting the same video and the number of packets exchanged close to the router, as compared to the one far away from the router, is almost double. I can only assume that even though the bit rate is changing in the strong link, the quality of the video is overall better.

b. DailyMotion:

On this video server, we observe that there are notably more error packets (especially compared to the total amount of packets) on the trace done with the device far away than that of the trace that was done closer to the router.

We additionally note that there is a significant difference in the number of “large” sized packets (taken to be greater than 1000 bytes) between that of the trace closer to the router and further from the router. As expected, the trace closer to the router has more large sized packets, most likely meaning that its streaming bit rate is significantly higher than that of the one further away.

Once again, we observe that the trace done closer to the router has almost double the amount of packets than that further away. We can assume that this means that the quality of the video is better for the device closer since a better video quality would entail more data.

c. Vimeo:

Initially, we see that the trace done further from the router has a significantly larger number of error packets. Additionally, if we order by size, we are able to see that the trace done further away has a lesser percentage of packets containing sizes greater than 1000 bytes (and also a lesser percentage of packets with 1474 bytes). This trace, as stated previously also had significantly more error packets, including retransmission packets, meaning that in this set of packets containing more than 1000 bytes (and packets containing 1474 bytes), there are packets that are retransmitted with the same number of bytes. We can understand this to mean that the video closer to the router had a higher quality of stream than the one further away.

We observe that the number of packets transmitted for the trace further away from the router is significantly larger than that of the trace closer to the router. However, this can be attributed to the significant errors that happened within the trace further away.