Question 1:

The average queuing delay experienced by the 1000 byte packets is 3.66ms. This is assuming that the 2.8 ms delay (the smallest of the 5 delays) has a queuing delay of 0 and subtracting this time from each of the other times. Averaging out these delays gives an average delay of 3.66 ms.

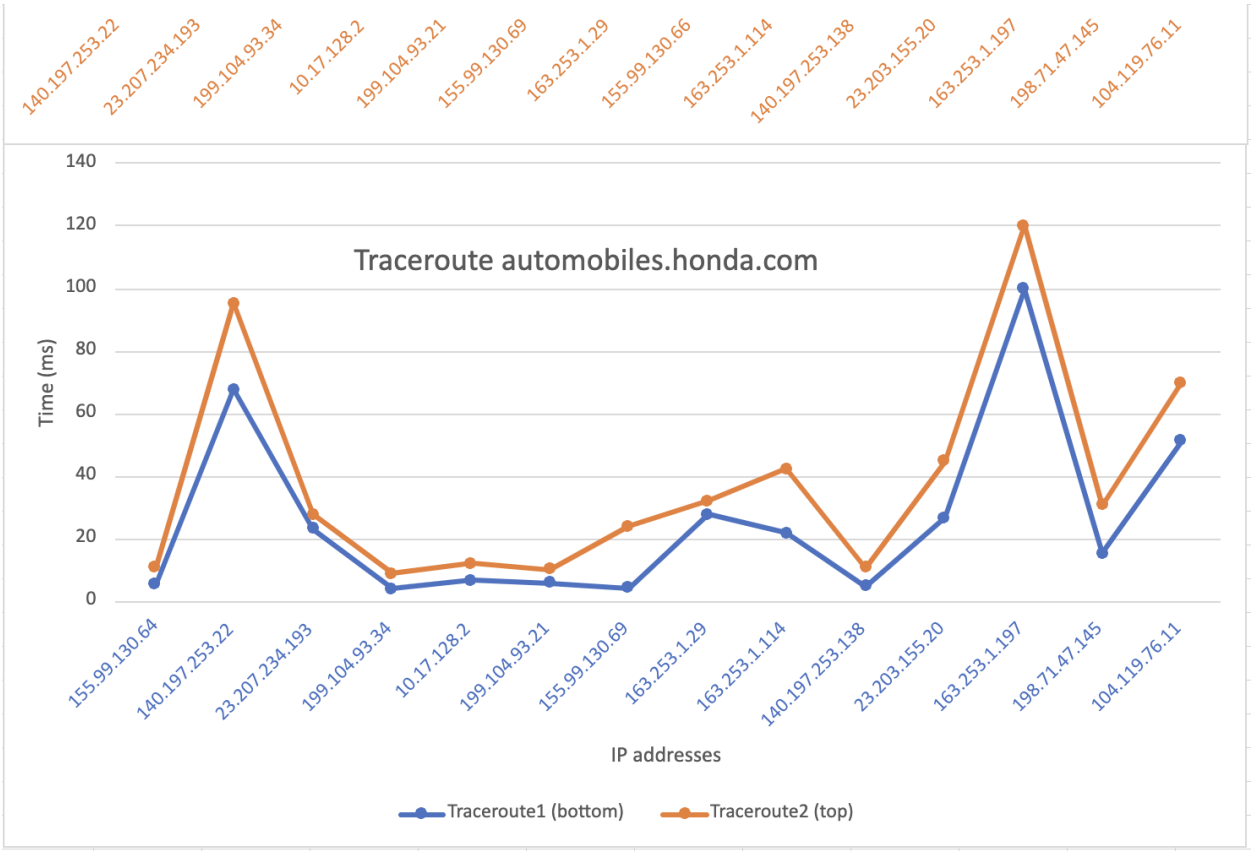
Because it is being assumed that the smallest delay has a queuing delay of 0, it can be assumed that for the 1000 byte packets, the combination of the transmission, propagation, and processing delays is 2.8 and that for the 500 byte packets, the combination of the transmission and propagation delays is 2.4. With this information, for a 600 byte packet it can be assumed it is between 2.4 and 2.8 ms, but closer to 2.4 ms. The transmission delay is the data length divided by the device transmission rate. We know the data length is 600 bytes. We know this device is a router but we do not know its exact device transmission rate. The transmission delay would be equal to:

600 bytes/device transmission rate. Making the assumption that the device transmission rate is 1 gbps, the transmission delay would be 0.6 ms. The device transmission rate being slower than this would result in an even higher amount of the total delay being composed of the transmission delay.

The propagation delay is the distance between nodes divided by something at/CLOSE to the speed of light depending on the medium of travel (wireless, optic cables, copper cables, etc). The propagation delay should be constant and fairly negligible with how fast it is.

The processing delay is the delay in which a device decides what to do with a packet and is in the range of microseconds, so it could be assumed that this delay is also fairly negligible.

Question 2:

a. 

For incomplete data (where we get a response from more than 1 IP address for a given hop, or not all 3 packets received a notification of being dropped) I merely recorded the first IP address. This was done because it seemed that even though they were sent on a different path, the distance was similar because the delay was very similar between the different addresses. I don't think this would be a good solution if this information was actually being used to make some sort of networking decision but for the purposes of this assignment, I think the variance was fairly negligible and made storing information for graphing much more simple.

b. One of the possible causes of an unusually high traceroute delay for one of the 3 values could be a queueing delay, since the 3 packets are not guaranteed to be sent at the exact same time or to the exact same address, one of the packets may end up arriving during a burst in which the traffic intensity exceeds 1, causing a pretty large queuing delay. Another possibility is transmission delay. This would be based on the device's transmission rate and would be constant based on that value. Particularly being an older device with a poor device transmission rate, could increase the overall delay. On its own, this delay wouldn't be too large, but particularly in combination with a queuing delay, it could substantially increase the delay.

Question 3:

The average queuing delay from my pings to the vatican.va was 8.624172. This is subtracting the minimum value of 16.563 which is being assumed is a combination of the propagation, processing and transmission delay