**Question 1**

Which Autonomous Systems (ASes) originate these IP addresses?

* [www.google.com](http://www.google.com): AS15169
* [www.mit.edu](http://www.mit.edu): AS16625

Which provider does MIT use to host its public websites?

* Akamai

**Question 2**

For [www.google.com](http://www.google.com)

172.217.6.206

Minrtt observed – 19.661ms Max Distance: 1.9661\*10^6 m

For [www.mit.edu](http://www.mit.edu)

Minrtt observed – 20.163ms. Max distance: 2.163\*10^6m

**Question 3**

AS3 -> AS15169

Approximately where geographically do the packets enter Google’s AS?

**Question 4**

[www.google.com](http://www.google.com)

72.14.212.22: is originated from AS15169

Minrtt: 12.474ms

[www.mit.edu](http://www.mit.edu)

203.46.69.77: is originated from A1221

Minrtt: 4.866ms

In the case of MIT’s CDN provider, what does this reveal about their server deployment strategy? The servers are deployed throughout the world, to limit lookup times.

Based on the RTTs for the last hop on both traceroutes, in which area of the world, roughly, are the servers located? Mit’s rtt indicates that the servers are probably located geographically close to the melborne server from which we ran the commands.

**Question 5**

72.14.212.22

AS3 -> AS15169

203.46.69.77

AS3 -> AS11164 -> AS4637 -> AS1221

**Question 6**

Do your measurements challenge the classical notion of a strictly hierarchical provider/customer Internet? Yes they do. For MIT’s case, the website is hosted by a content delivery network which can own multiple AS’s which is not strictly hierarchical. However, in the case of Google, we simply traverse AS3 to the AS owned by google which implies that AS3 provides transit for google.

**Question 7**

What types of physical links do your packets likely traverse?

I think the physical links used in this case are fiberoptic cables because there’s a relatively quick look up time.

Where is the destination IP address located?

The destination IP address 203.98.227.31 seems to be geographically located at Arenibek, Nauru.

**Question 8**

I am geographically closer to [www.cloudfare.com](http://www.cloudfare.com) than the server in Melbourne is.

**Part 2**

**Question 1**

Avg QoE’s for 1mbps: 15.88, 15.67, 27.71, 23.27, -16.80, -5.43

From my results, I found that the higher the rebuffering seconds, the lower the QoE. From this I could deduce that higher delays caused lower the QoE’s. The QoE was also affected by the smoothness of my curve : the more higher the variations between one bitrate and the next, the higher the penalty which lowered the overall QoE.

Avg QoE’s for 2mbps: 37.51, 38.35, 66.48, 51.74, 11.83, 17.51

Avg QoE’s for 3mbps: 63.70, 64.36, 71.36, 76.04, 36.60, 34.72

When I repeated the same experiment using 2mbps and 3mbps, I found that QoE increased with the rate used. The exact variation wasn’t constant between the traces eg. Verizon seemed to ~double while TMobile didn’t necessarily double.

**Question 2**

*Approach 1*

Replace linear function with a cubic function as defined below

f(buffer\_size) = (buffer\_size – reservoir)\*\*3 + minimum\_bitrate

beween buffer values reservoir <= buffer\_size <= reservoir + cushion

The idea here was to aggressively increase the bitrate chosen with an increase in buffer size. Taken from Test – Train and Valid graphs can be accessed in the folder as well.

**A picture containing screenshot

Description automatically generated**

Generally, the two had the same quality of score – however, cubic has a lower rebuffer penalty but a higher smoothing penalty relative to BBA. The lower rebuffer penalty is because cubic rebuffers significantly less than BBA. However, the aggressive increases and decreases which causes larger variations and thus higher smoothing penalties.

*Approach 2*

Similar to Cubic as described abover, but instead use an quadratic function which is more aggressive than the linear approach but less aggressive than cubic.

A screenshot of a cell phone

Description automatically generated

A picture containing screenshot

Description automatically generated

Just like Cubic, quadratic has a higher smoothing penalty relative to BBA’s linear algorithm. It also has a higher rebuffer penalty compared to BBA’s linear. In comparison with Cubic, Quadratic as a higher rebuffer penalty and a higher smoothing penalty.

*Approach 3*