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TCP Headers usage for Network Health and Customer Experience

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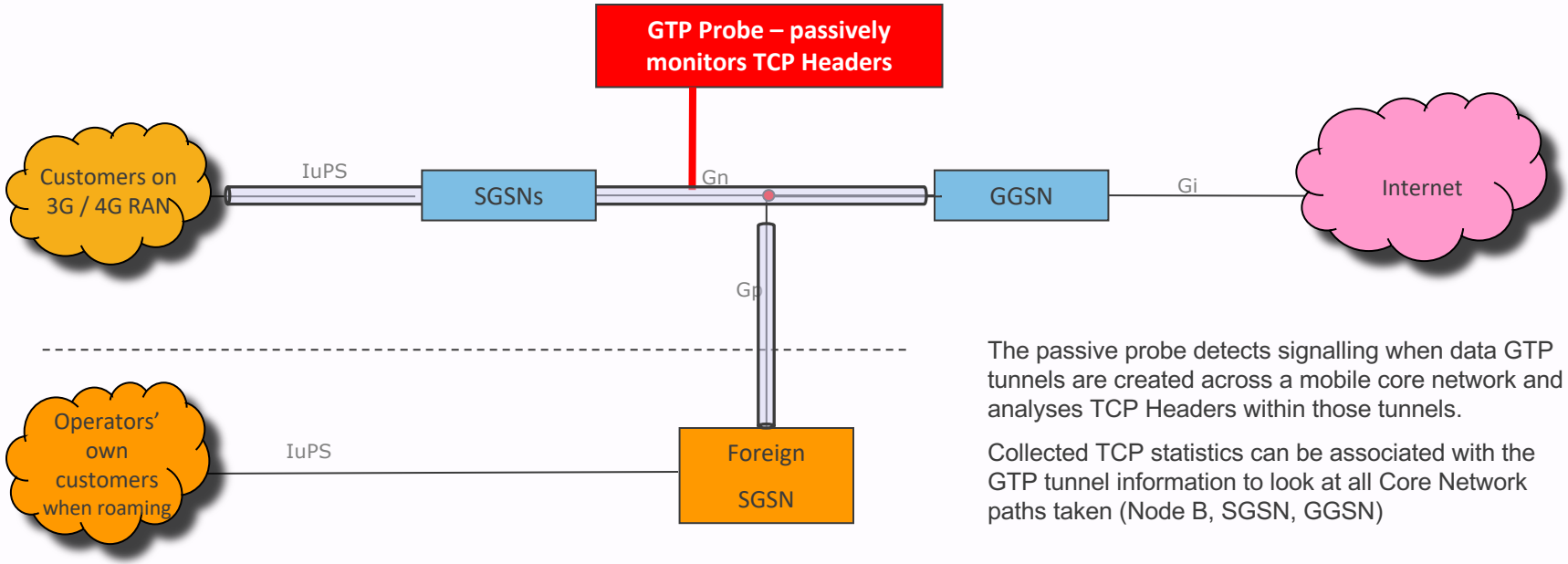
Customer Complaints – User Experience and Fault Diagnosis

History: With the growth in mobile broadband, a solution was needed that could monitor actual user experience - not just performance KPIs from network hardware.

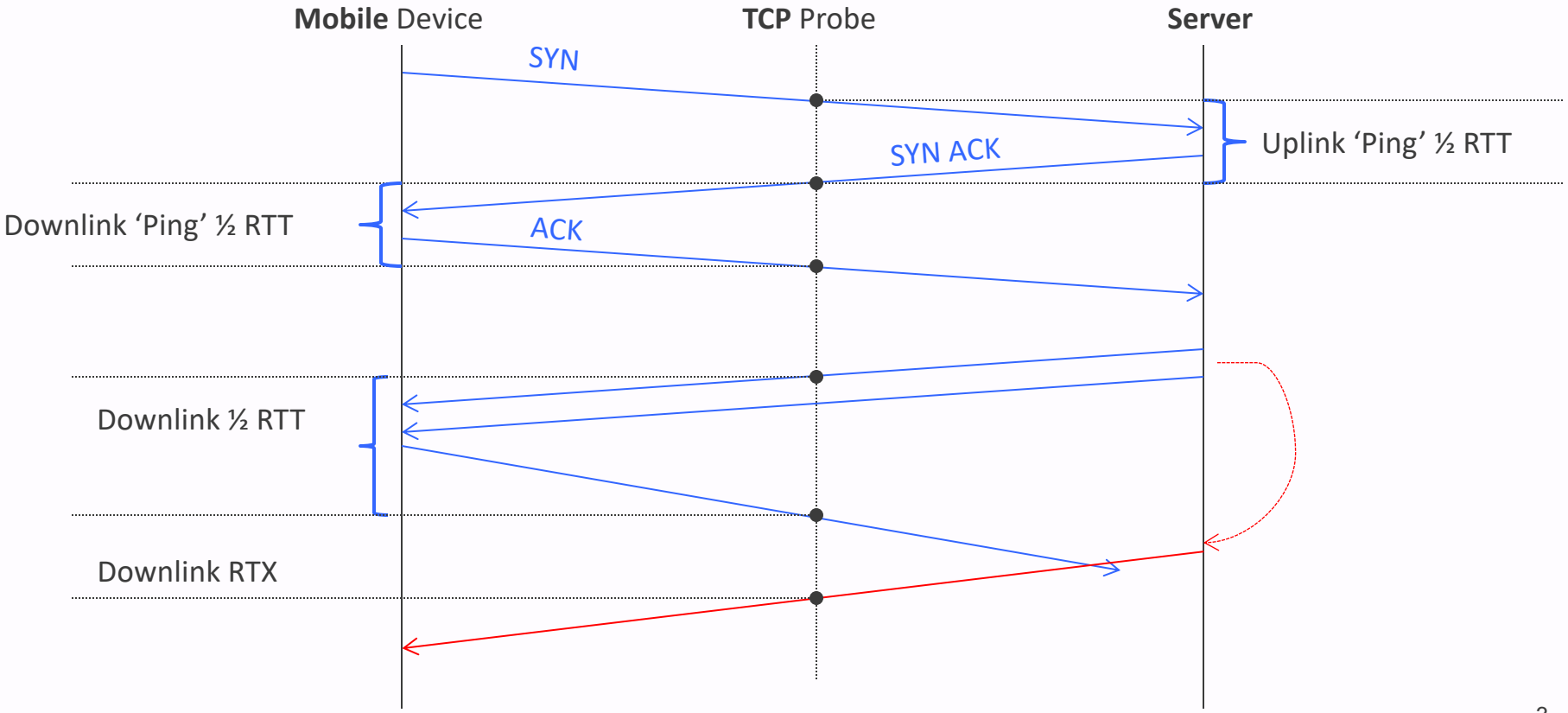
- To assist with customer complaints – identify what parts of network were involved
- To look for tell-tale symptoms in data flow to help network issue diagnosis
- To develop a network method to determine if customers were getting poor data speeds.



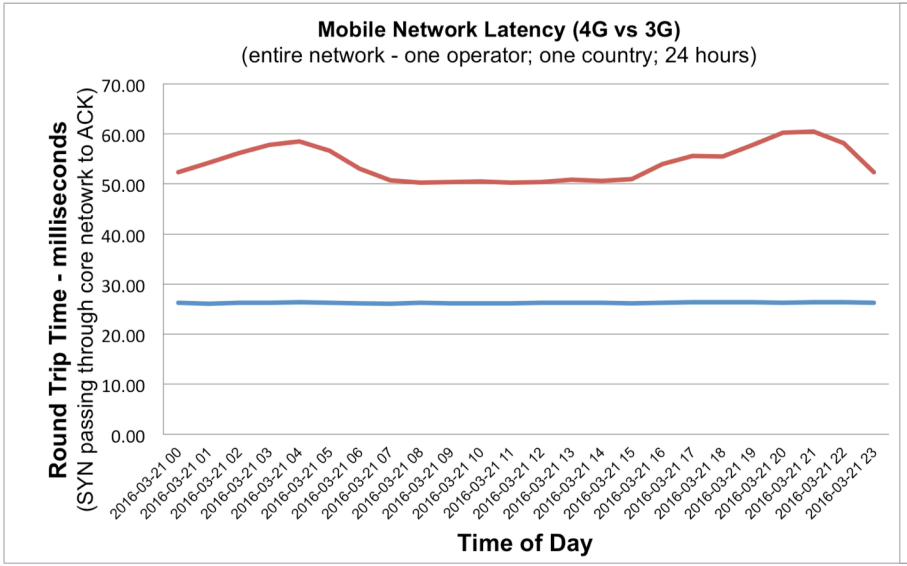
The passive probe detects signalling when data GTP tunnels are created across a mobile core network and analyses TCP Headers within those tunnels.

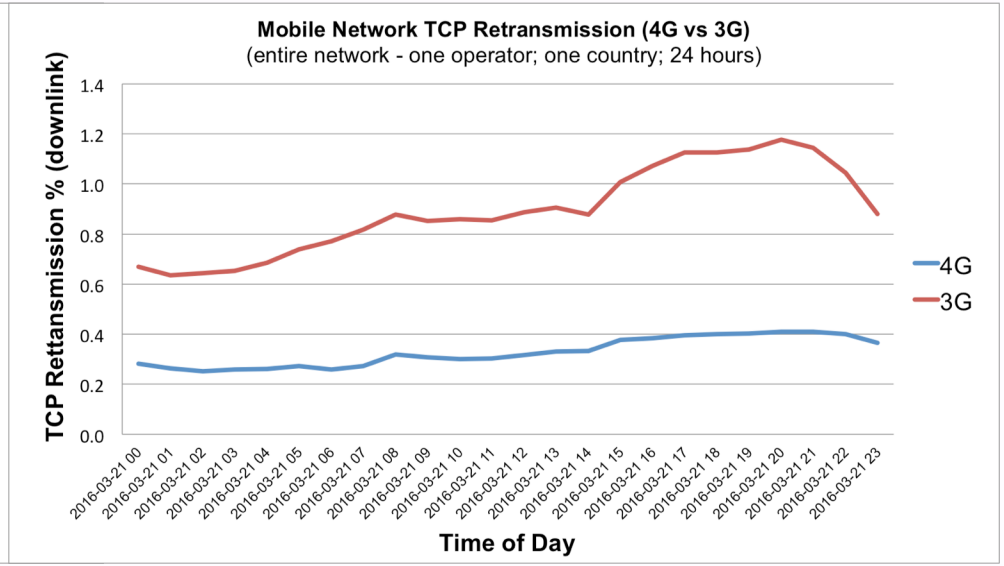
Collected TCP statistics can be associated with the GTP tunnel information to look at all Core Network paths taken (Node B, SGSN, GGSN)

TCP metrics – what's being measured inside GTP tunnels



Overall Network wide view – Latency and Retransmission

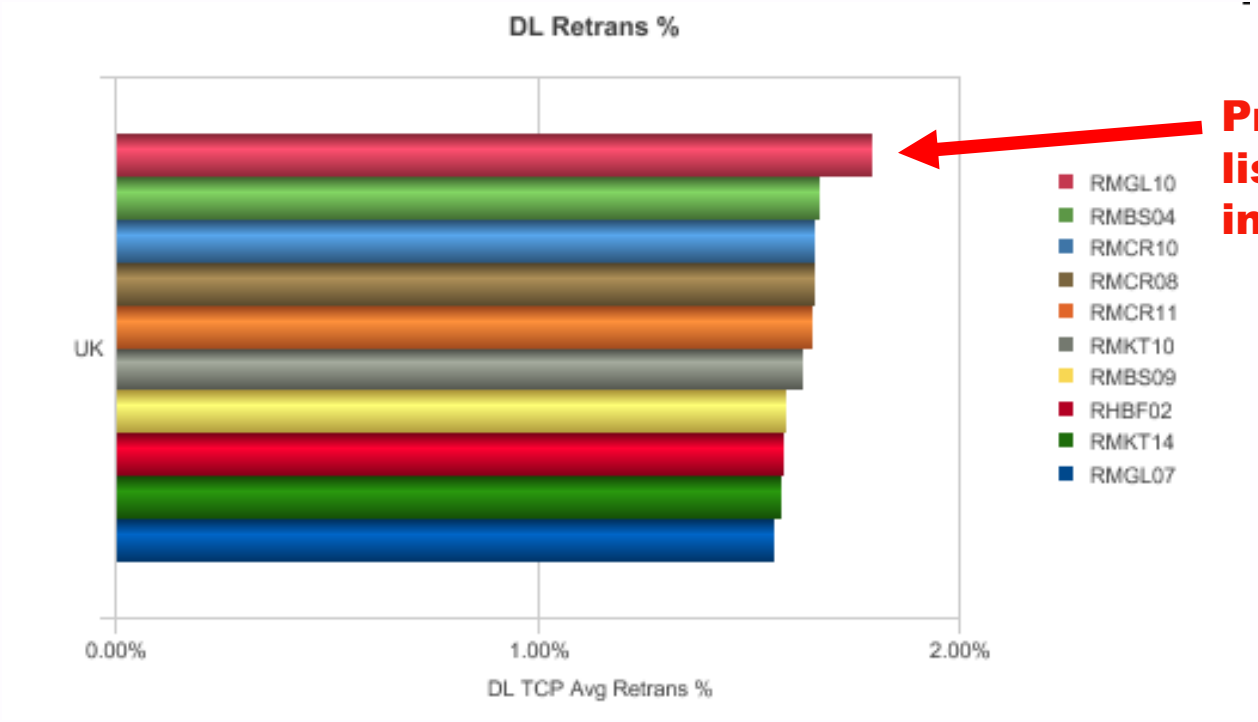




Notes: During peak evening busy-hours overall network congestion rises, with correspondingly higher latency and higher retransmissions. This was most noticeable on the busy 3G network and far less so on 4G which at the time of these results had less traffic. Drilling down by probe and network equipment enabled the easy identification of the most congested network paths. This method of analysis has repeatedly allowed network management teams to isolate network issues that typically do not show in router / network hardware KPIs.

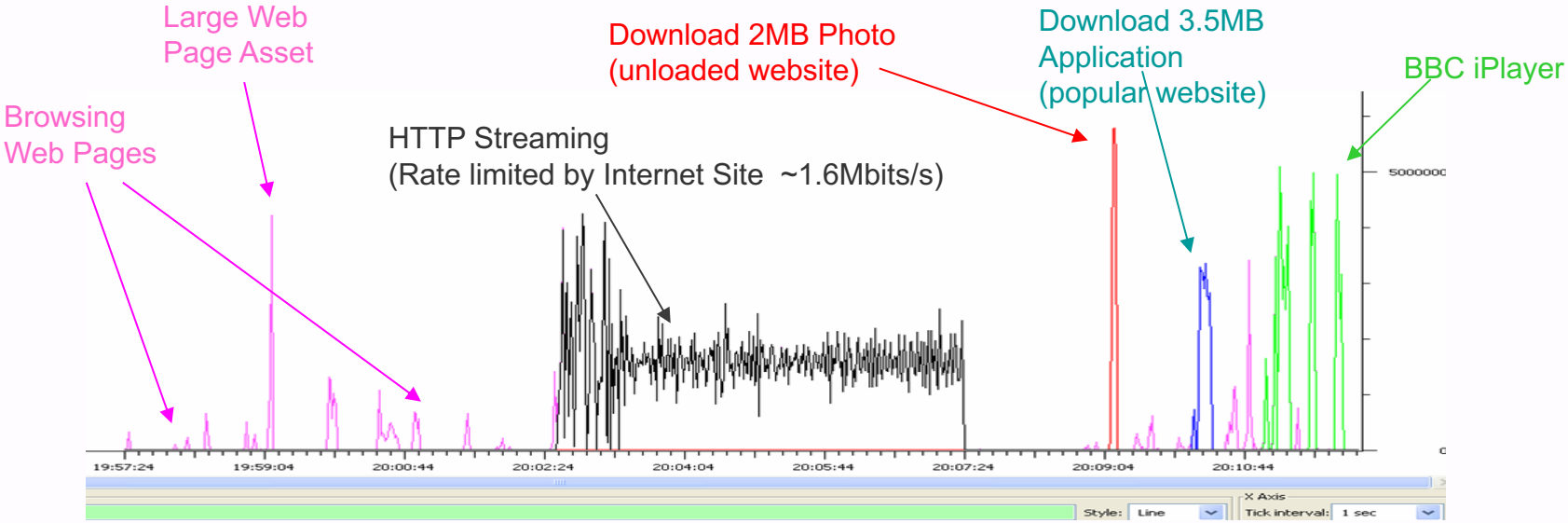
One curiosity is a rise in overnight 3G latency at a time of low data volumes / device inactivity. What's being exposed is a feature of 3G radio technology where devices' radio connectivity modes are more likely to be in various unconnected 'sleep' states (IDLE, PCH, etc), which take significant time to wake up from to receive incoming data. 4G technology changed these connectivity modes to be much quicker to restore back to full-speed connectivity.

Example drill-down – rank which cellsites have worst RTX



Provides a priority list for further investigations

Mobile Broadband: Passive Network Speed Monitoring

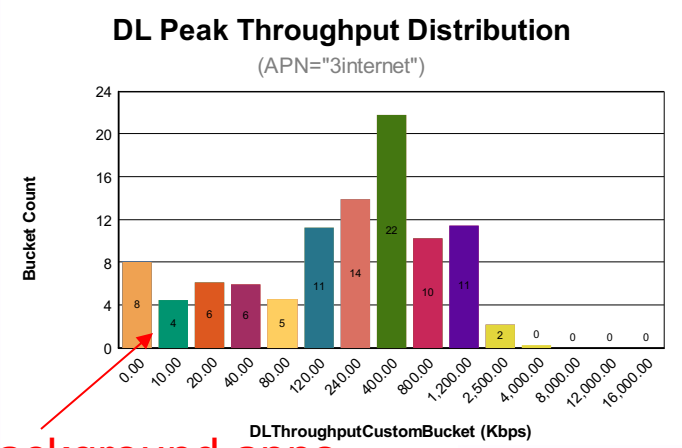


Notes: Above Wireshark graph (PC+ 10+Mbps HSPA dongle) shows the peak speeds achieved during typical user activities (in this case example traces were done some years ago in empty indoor cell in non-busy hours). Few user activities (other than the occasional very large file download) achieve anything close to the available speed. So it is difficult to judge network speeds available to customers from passive measurements as a lot of user activity doesn't fully the utilize the available speed.

Active probes would be counter-productive as the prime interest is for results from the busiest parts of networks and these are precisely the areas where one doesn't want to add more traffic. Instead, to look at customer speed satisfaction using passive monitoring, we sample the observed TCP speeds seen by region (cellsite clusters). A probability distribution functions of these peaks was used to predict where we expected customers to be less satisfied. We correlated this with customer survey results from the customers in those regions.

Peak Speed Probability Distribution

Raw Results

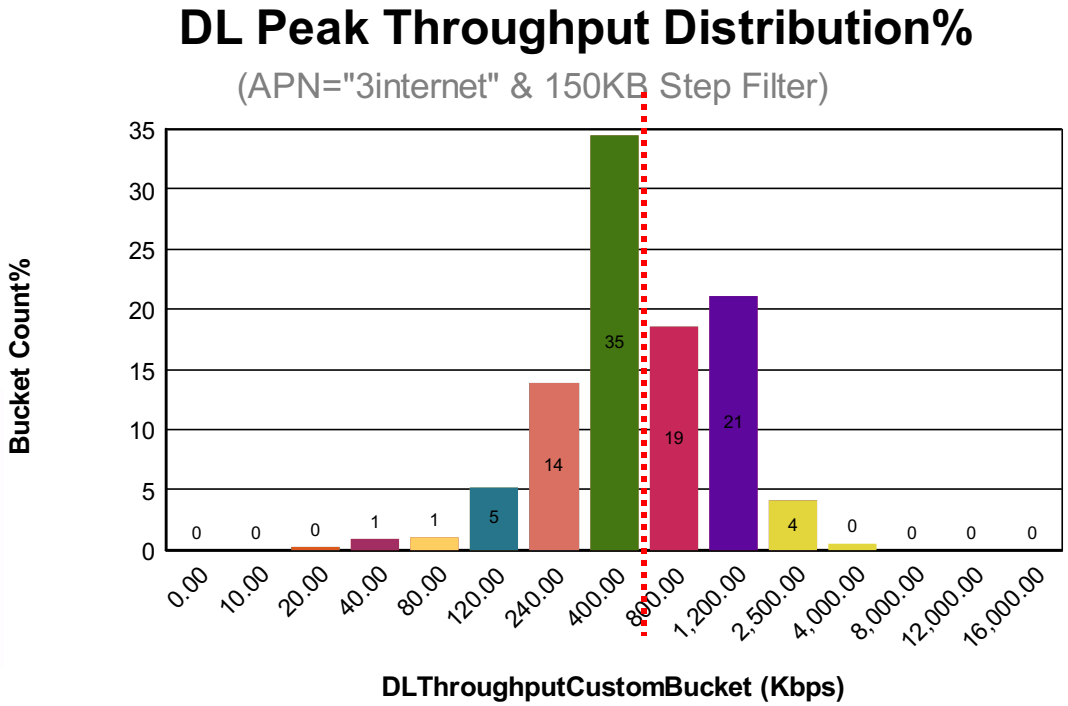


Background apps

Remove samples where less 150kB of data was downloaded

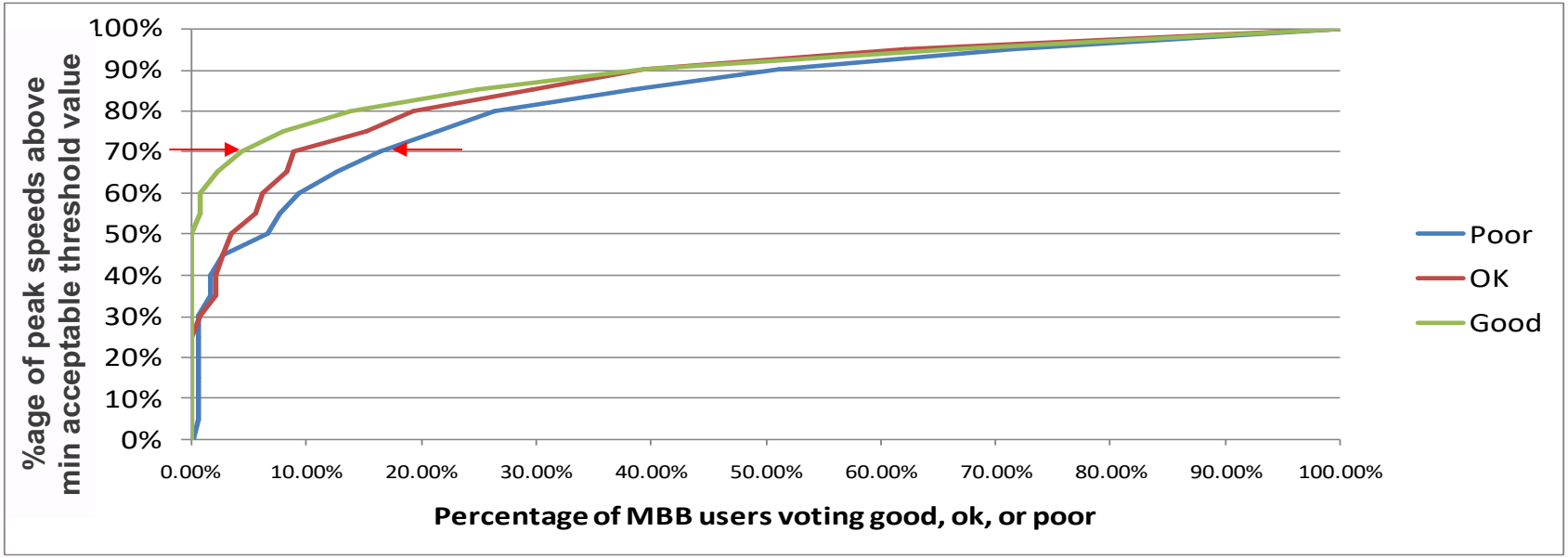
(most popular webpages except Google Search are > 150kB and so will contain enough data to count)

Results filtered to exclude low-level background data activity (e.g. app heart-beats etc)



Regional Survey Scores Distribution.

(Survey ratings: Good = 8,9,10 OK = 6,7 Poor = 1,2,3,4,5)



- The inflexion where opinion changes from most from Good -> Poor is when less than 70-80% of peaks speed fell below a threshold (changes over time – should be tuned by network generation 3G,4G,5G etc).
- The results cannot be used to assess customer activity/behaviour e.g. which customers will have a poor opinion of network performance (also because expectations vary). Instead it helps identify poor network areas. If a customer does happen to complain, it helps with troubleshooting e.g. whether their complaint is likely to relate to network congestion issues.

The end