EAST WEST UNIVERSITY

COMPARATIVE ANALYSIS ON VIDEO STREAMING KQI

A Thesis

By

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Submitted in partial fulfillment of the requirements

For the degree of

Master of Science in Telecom Engineering

The undersigned have examined the thesis entitled '**Comparative analysis on video streaming KQI**' presented by **FAISAL MOHSIN**, a candidate for the degree of **Master of Science in Telecom Engineering** and hereby certify that it is worthy of acceptance.

Date	Advisors name

ABSTRACT

Mobile operators are focusing more on end user perception, instead of system KPI. The motivation behind this is the increasing usage trend of smartphone and rapid growth of streaming traffic.2 major streaming KQI ‘Duration to first play’ and ‘Buffering duration’ are discussed here along with field test results from 2 leading operators of Bangladesh. Professional KQI test and analysis tool is used for better verification and comparison. Test is done in both stationary and moving condition. Root cause analysis is done at the end.

ACKNOWLEDGMENTS

I would like to thank my thesis supervisor for giving me the opportunity to do research on this latest topic. My sincere respect to all the teachers from my masters and undergraduate courses, who laid the foundation and taught to connect the dots. Last but not the least, my better half deserves a big thanks - without whose support I wouldn't enroll for this degree, let alone finish in due time.

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CHAPTER I: Introduction

Internet is the driving force of today's economy. Communication, entertainment, media, education, transportation are to name only a few. In has entangled almost every aspect of our daily life. From the top executive up in the corporate ladder to the poor farmer of the rural area, everyone is getting benefitted one way or the other from the blessing of internet.

Usage of internet use has seen a steady growth, starting from its birth. For the last few years usage has grown exponentially. Prime factor of this growth, is the increasing demand of mobile internet (MBB). Increasing use of smartphone is the main reason for the use of MBB. As smartphones are becoming more and more powerful, people are getting introduced to newer services which are also data hungry. Increasing use of MBB has paved the way to newer kind of analytics using big data.

CHAPTER II: Background and Literature Review

For the last 6 years, mobile data traffic is exponentially increasing – but voice traffic remained almost same as shown in Figure 1 [1].

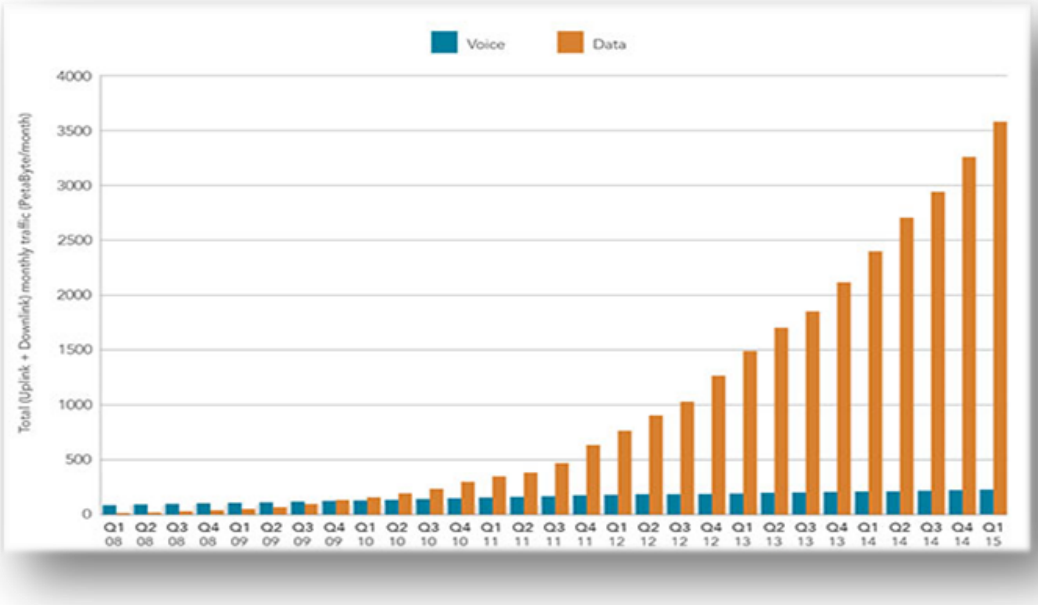

Figure 1 : Exponential growth of data

Even for voice call, people are using various over-the-top applications like viber, whatsapp using internet. Communication has become a lot cheaper over the years. Price of internet packages has been reduced by the mobile operators a lot.

As the overall ecosystem is becoming more and more favorable, people are using high data consuming apps more. Video streaming, virtual reality, augmented reality – these sorts of things are becoming common.

Smartphones are becoming part and parcel of daily life. Recent studies (Figure 2) show the smartphone dependency of young people [2].

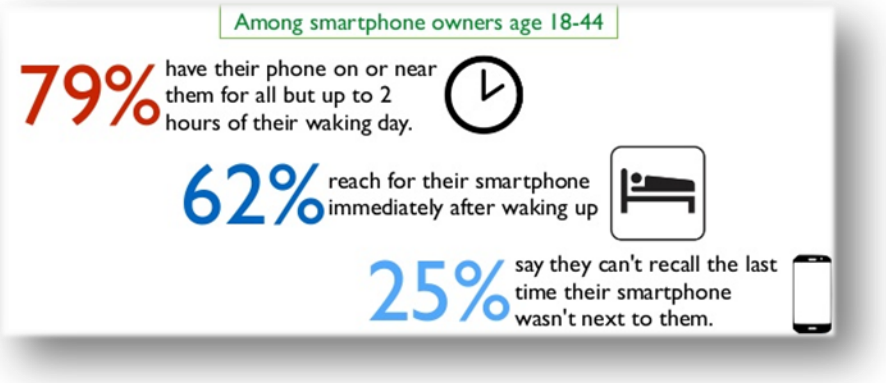

Figure 2 : Smartphone usage pattern

Price of smartphones are also getting cheaper, thus enabling more people to use smartphone. Recent trends of smartphone shipping (Figure 3) shows the linear growth every year [3].

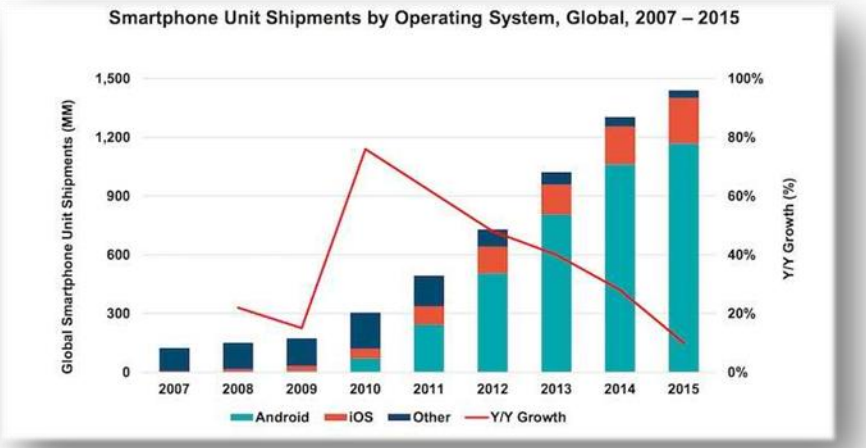

Figure 3 : Smartphone user statistics

As discussed, data usage is increasing exponentially. But not sectors show the same growth. Main surge in data traffic occurred due to increasing demand of online video streaming (Figure 4) [4-5].

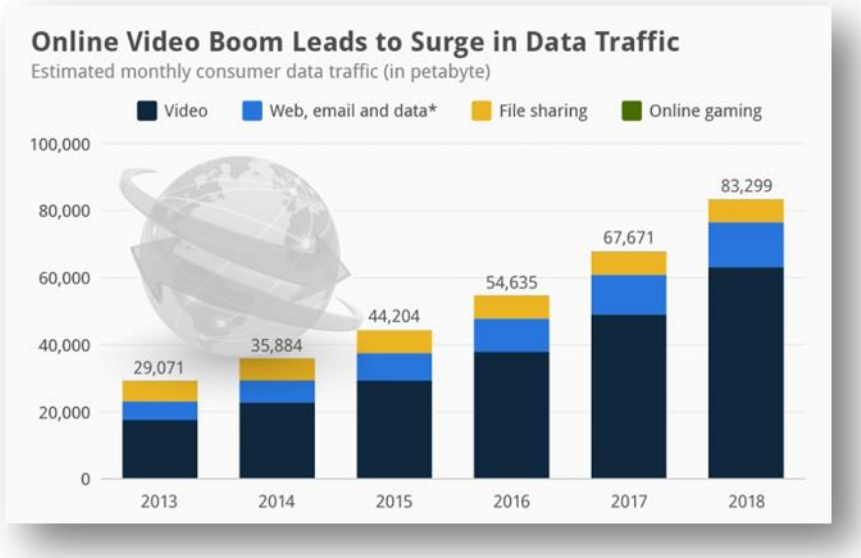

Figure 4 : Data usage segregation

Top 3 video streaming providers are Facebook, Youtube and Netflix.

Figure 5 : Top streaming service providers

Telecom operators mainly focus on the revenue generating part. Smooth video streaming is going to be a key factor in future and depending on the performance, subscribers will switch from one operator to other. So, it is of great importance to check current status and find root cause.

In chapter 3, we showed a methodology to test video streaming user perception and discussed the result in chapter 4. Some root cause and solutions are discussed on chapter 5.

CHAPTER III: METHODOLOGY

Mobile operators G and B (which are 2 top operators of the country) are selected. 2 major KQIs are selected to compare current status of video streaming [8], which are-

-Duration to first play

-Buffering duration

If delay>10s occurs it may hamper user perception seriously, so it is considered as threshold.

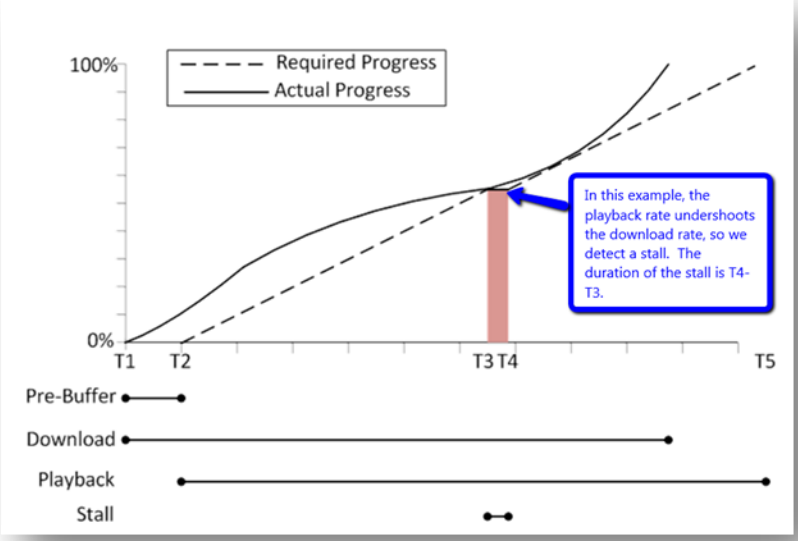

Figure 6 : Illustration of video stalling

If the required progress becomes less than actual progress, buffering occurs in video streaming [6]. An illustrative sample is shown in the figure 6, where playback rate undershoots the download rate and a stall is detected.

For the test of KQI, trial version of commercial software Azenqos [7] is used, which is used by many telecom operators and vendors for benchmarking. Samsung S5 smartphone is used for the testing to minimize lower end handset related issues.

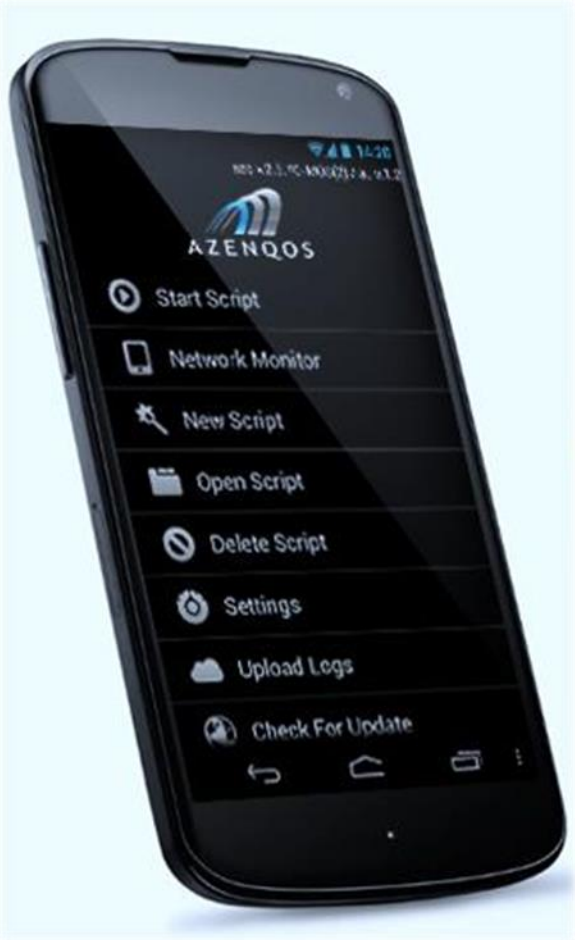

Figure 7 : Test tool - Azenqos

Both stationary and drive test are performed to check the scenario. Details of the tests are:

- Drivetest
  - Operator : G
  - Route: Gulshan-Banani-Kakoli-Zia colony
  - Total video: 18 (3 times)
  - Video timeout: 1min
- Stationary
  - Operator : G and B
  - Location: Basundhara
  - Total video: 20 (3 times)
  - Video timeout: 1min

To correlate the KQI with radio condition and internet performance, 3 KPIs are considered as well. Those are RSCP, Ec/Io and Throughput [9]. Details of these 3 metrics are discussed below:

Received signal code power (RSCP) denotes the power measured by a receiver on a particular physical communication channel. It is used as an indication of signal strength. RSCP > -80dBm is generally considered good coverage.

Ec/Io is the ratio of Received power of the carrier to the all over Noise. It is used to measure quality of Pilot Channel. Ec/Io > -12dB is generally considered good quality. Ec is the carrier energy and Io in the interference from surroundings.

Throughput is a measure of how many units of information a system can process in a given amount of time. It can be measured in bps, kbps, Mbps etc. The threshold depends upon operator strategy and desired service.

CHAPTER IV: RESULTS

Results, findings, discussion of results OR manuscripts. It is best to also reiterate information in your literature review to help substantiate the findings of your research.

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Drivetest findings

Drivetest is conducted for operator G. Below shown the results in terms of RSCP, Ec/Io and Throughput.

RSCP

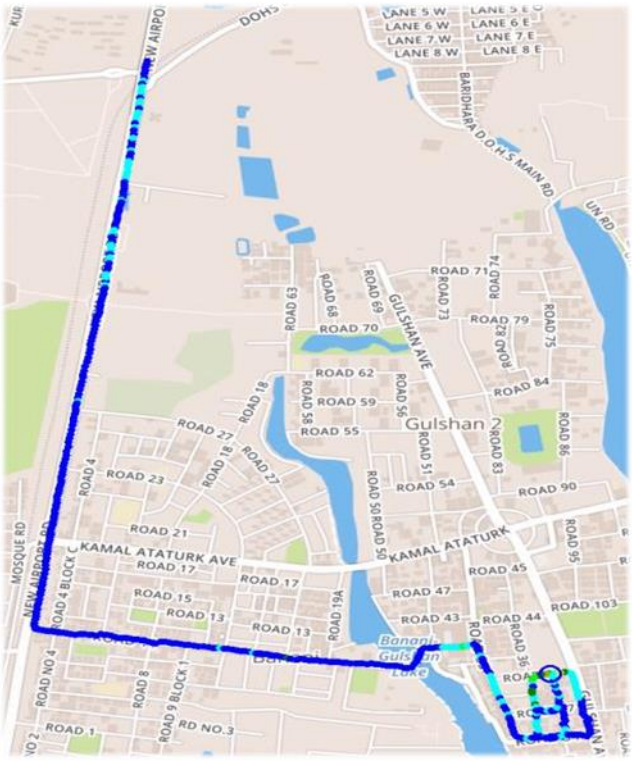
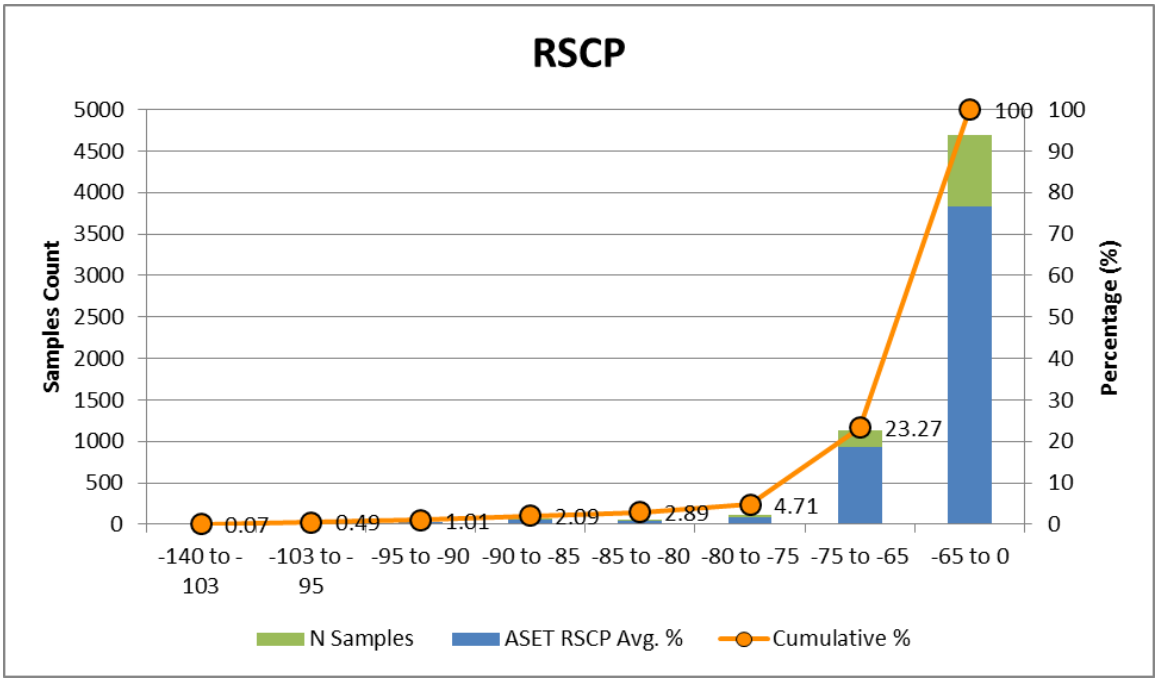


Figure 8 : Drivetest RSCP of operator G

Table 1 : RSCP legend

Range	Percent(%)	N	Color
-140 <= x < -103	0.07	4	
-103 <= x < -95	0.43	26	
-95 <= x < -90	0.52	32	
-90 <= x < -85	1.08	66	
-85 <= x < -80	0.8	49	
-80 <= x < -75	1.82	111	
-75 <= x < -65	18.56	1135	
-65 <= x < 0	76.73	4692	

Table 2 : RSCP distribution of operator G drivetest



Observations:

- In the test route, **RSCP>-80dBm is 97.1%**
- Coverage in the road is very good

Ec/Io

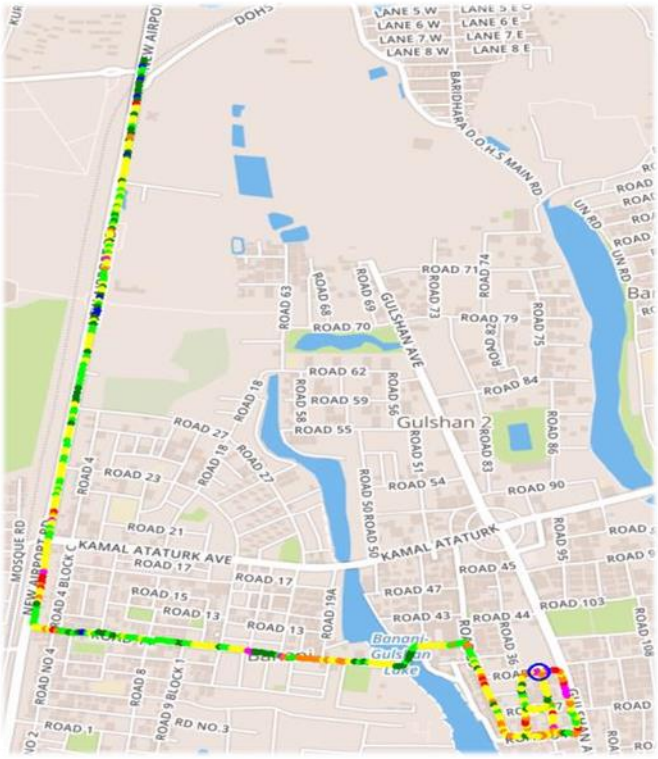
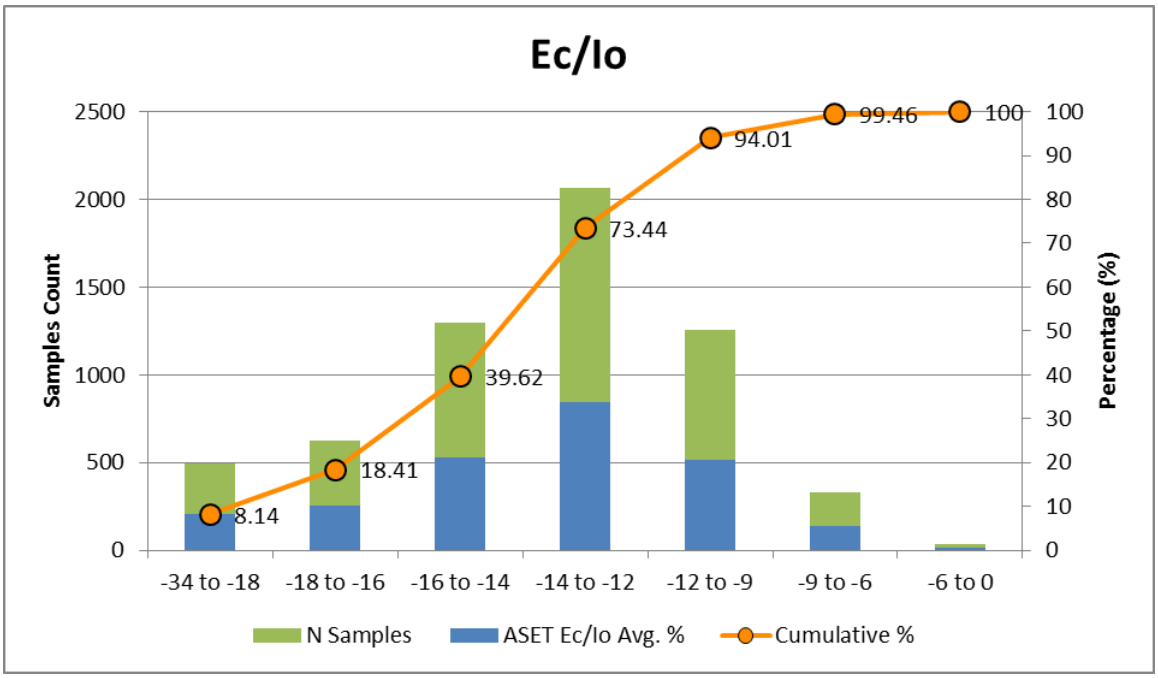


Figure 9 : Drivetest Ec/Io of operator G

Table 3: Ec/Io legend

Range	Percent(%)	N	Color
-34 <= x < -18	8.14	498	
-18 <= x < -16	10.27	628	
-16 <= x < -14	21.21	1297	
-14 <= x < -12	33.82	2068	
-12 <= x < -9	20.57	1258	
-9 <= x < -6	5.45	333	
-6 <= x < 0	0.54	33	

Table 4 : Ec/Io distribution of operator G drivetest



Observations:

- In the test route, **Ec/Io > -12dB is only 26.56%**
- Quality in the road is very poor even with good coverage

Throughput:

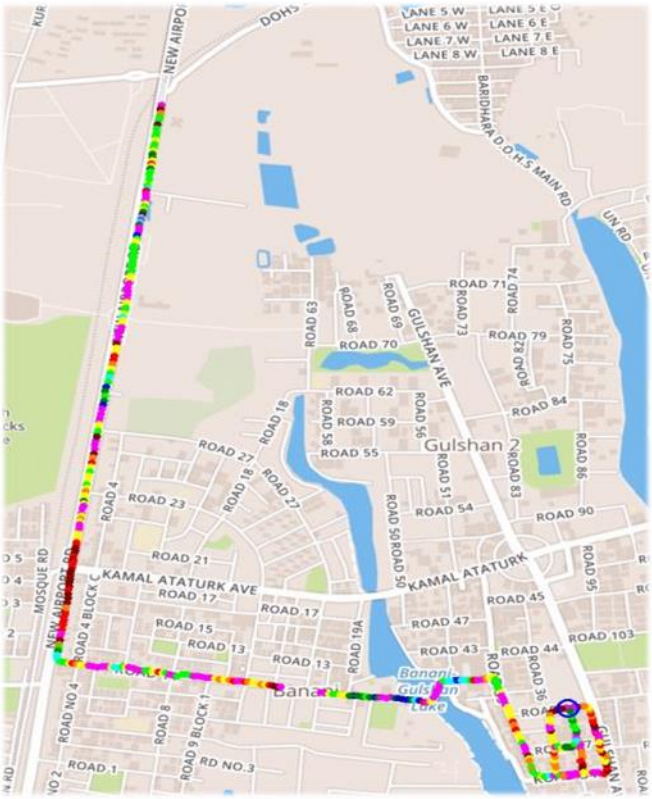
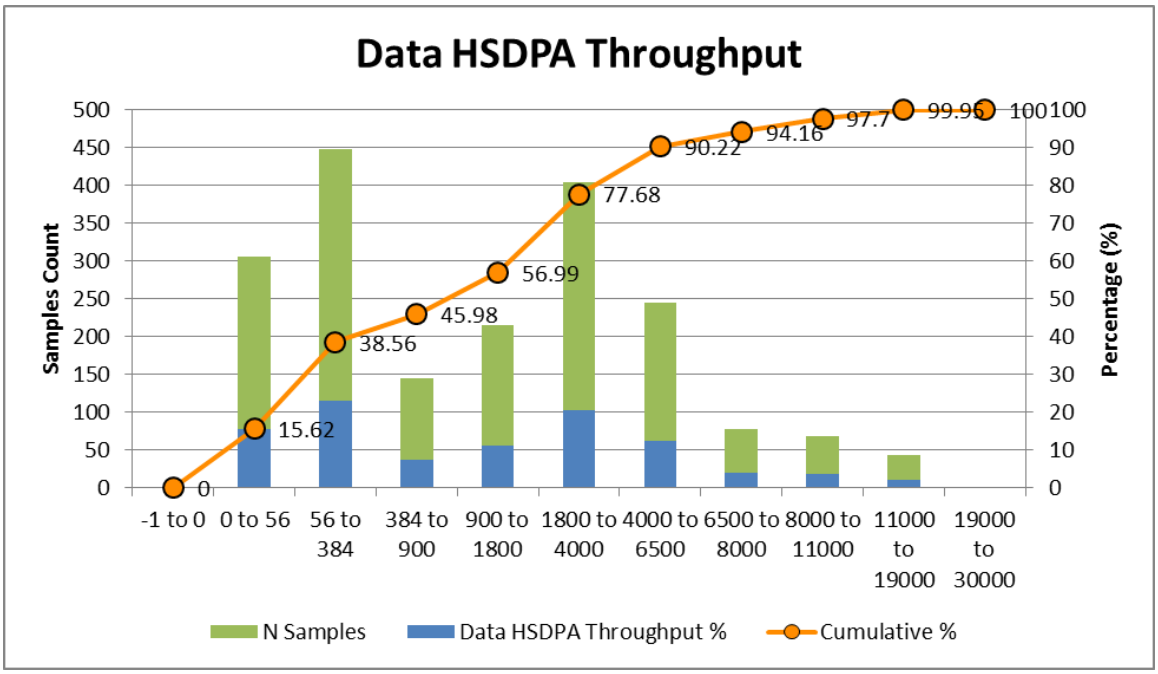


Figure 10 : Drivetest Throughput of operator G

Table 5 : Throughput legend

Range	Percent(%)	N	Color
-1 <= x < 0	0	0	
0 <= x < 56	15.62	305	
56 <= x < 384	22.94	448	
384 <= x < 900	7.42	145	
900 <= x < 1800	11.01	215	
1800 <= x < 4000	20.69	404	
4000 <= x < 6500	12.54	245	
6500 <= x < 8000	3.94	77	
8000 <= x < 11000	3.53	69	
11000 <= x < 19000	2.25	44	
19000 <= x < 30000	0.05	1	

Table 6 : Throughput distribution of operator G drivetest



Observations:

- In the test route, **throughput >384kbps is 61.43%**
- To run smooth YouTube video >384kbps throughput is required
-

KQI results:

After analyzing problem areas it was found,

- YouTube starting delay >10s happened in the positions where videos started with Ec/Io < -12dB (red circles).

- Reasons for poor Ec/Io can be lack of dominant cells, pilot pollution, overshooting and too many users in busy hour.

- Only good coverage is not enough to ensure good QoS

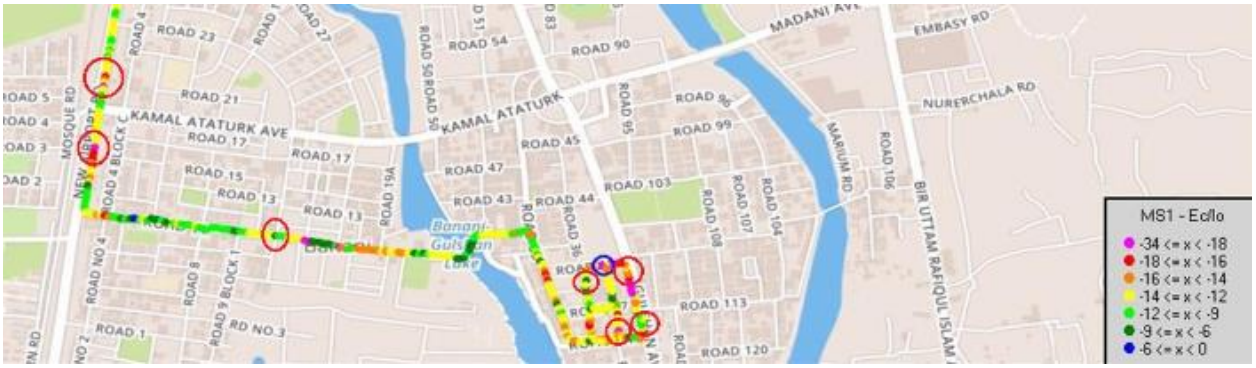


Figure 11 : Buffering points during drivetest

Table 7 : Youtube KQI result of operator G drivetest

	YouTube duration to first play (s)			YouTube buffering duration (s)		
Video_ID	Round1	Round2	Round3	Round1	Round2	Round3
0v-NZ_rJZYA	12.31			11.70		
4YpiDUhTW9I	7.25	4.65	4.42	2.97	12.28	2.82
9E3CaWPS12A	3.59	8.18	25.08	0.79	2.01	1.67
9jIThLkm_w0	2.20	2.70	1.87	2.90	1.90	0.00
ALopaFsaoVI	2.03	3.34	3.34	0.00	0.89	1.87
At-cZwzOco4	6.15			0.63		
BqBxL0Iua_E	4.90	2.39	1.65	0.00	0.89	0.00
ByKov4F3gwE			26.25			1.94
ESLPHPvmdy8	4.74	2.65	4.37	1.82	0.87	0.84
Faawin6qYaI	2.49	3.38	2.05	0.00	0.00	0.00
heVu-pzaUjs	3.84	21.70		0.00	0.00	0.00
jqxENMKaeCU	4.33		11.68	0.00		1.88
Ju8-fAyqkBg	2.61	1.56	2.62	0.00	0.00	1.02
ku6xktfX030	6.10	2.36	3.70	0.00	0.00	0.88
N4zEjT7q4AU	2.72	2.08	1.99	0.71	0.00	0.85
RuQFyDY_GNE	5.96	16.11	5.06	0.00	0.00	0.00
ThfDn-6xB2o	4.53	10.07	2.90	0.00	3.90	0.00
V1Oog7mjh5E	4.82	22.99	2.83	4.88	0.00	2.90

Stationary test findings

Stationary test is conducted for both operator G and B. For the radio condition we checked both RSCP and Ec/Io and prepared scatter plot. Interesting result can be found from the chart which is shared below.

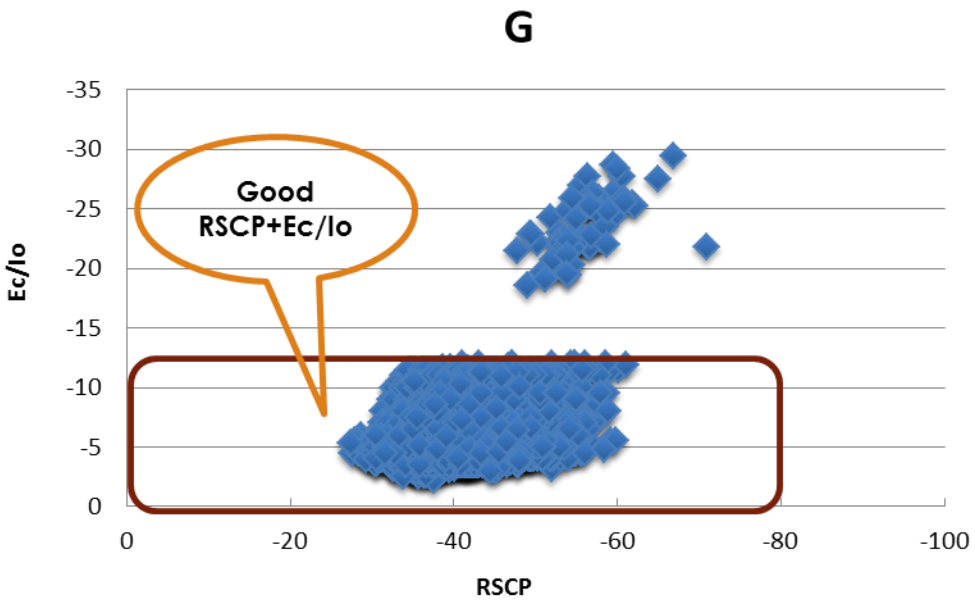


Figure 12 : Stationary test radio condition of operator G

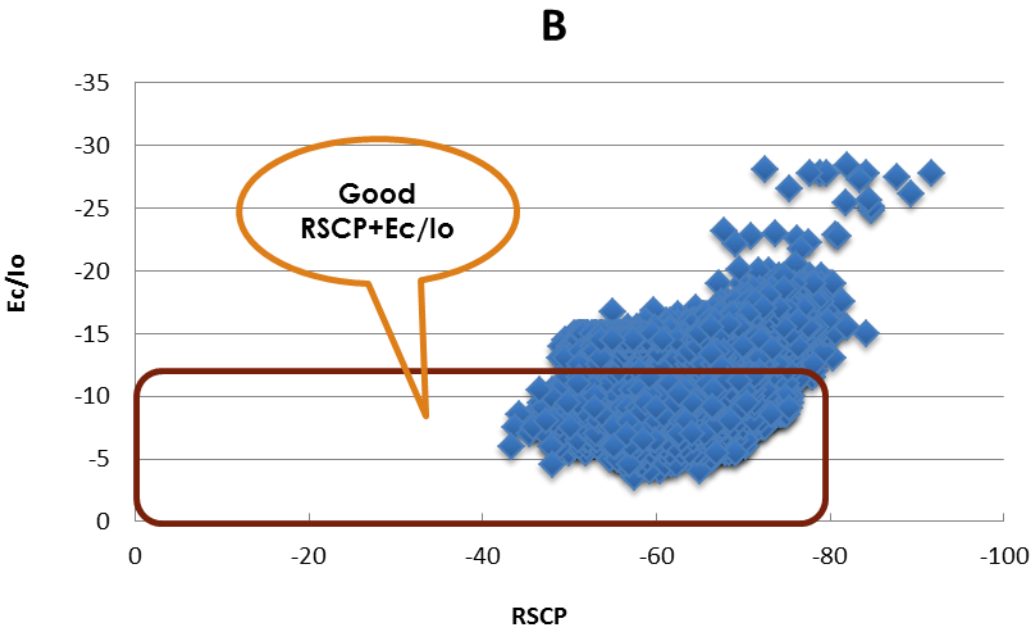


Figure 13 : Stationary test radio condition of operator B

- From coverage analysis, it can be seen G has better coverage (RSCP > - 80dBm) and quality (Ec/Io>-12dB) than B at test location.

- G has some discrete parameter settings for Ec/Io, possibly to reduce soft handover [11].

For this radio condition we found below KQI results:

Table 8 : Youtube KQI result of stationary test for operator G and B

Video_ID	Duration	Views	Avg G	Avg B	Avg G	Avg B
jqxENMKaeCU	1:33:17	94160	2.298	8.602	0.299	2.685
Faawin6qYaI	6:57	4346	2.771	5.919	0.000	1.902
Ju8-fAyqkBg	9:07	3228	1.963	8.767	0.000	7.511
V1Oog7mjh5E	2:08	1578	2.757	9.096	0.000	2.350
ByKov4F3gwE	17:56	1003	2.390	12.658	0.000	1.520
ThfDn-6xB20	4:08	913	5.141	4.648	0.301	7.784
ALopaFsaoVI	9:59	832	3.885	10.170	0.000	3.036
9E3CaWPS12A	13:39	666	2.820	14.934	0.236	4.371
RuQFyDY_GNE	13:30	626	4.002	4.816	0.000	2.025
9jIThLkm_wo	3:10	525	3.286	12.936	0.000	1.608
4YpiDUhTWgI	2:30	427	2.571	3.434	0.000	5.335
N4zEjT7q4AU	1:51	352	3.687	11.136	0.000	2.023
1hkATWGpM1E	6:47	343	4.451	10.429	0.000	4.690
ov-NZ_rJZYA	7:06	266	4.356	4.015	0.000	4.921
ESLPHPvmdy8	0:20	214	2.279	15.584	0.263	5.619
heVu-pzaUjs	6:54	208	4.729		0.652	
At-cZwzOco4	8:09	199	2.218	6.949	0.000	1.787
ku6xktfXo30	9:23	153	3.871	20.816	0.000	2.343
s_H7WKWhELo	2:35:52	134	7.756	16.564	0.000	2.938
BqBxLoIua_E	6:23	88	5.113	2.809	0.000	2.023

- From KQI test, it is clear, almost in all cases G users face low starting and stalling delay than B users.
- 9 out of 20 times B starting delay is >10s, G has 0
- 3 major reasons for this might be
    - In the stationary point Ec/Io of BL lower than G

- G has 10MHz 3G spectrum, hence higher peak throughput. B has 5MHz spectrum

- G has YouTube caching server (Total 9)

It's interesting to observe the effect of caching server [10] on duration to first play.

- In G, initial delay gets reduced in every round gradually.

- In B, no such correlation is observed.

Table 9 : Caching server effect comparison

			G			B		
			Youtube duration to first play (s)			Youtube duration to first play (s)		
Video_ID	Duration	Views	Round1	Round2	Round3	Round1	Round2	Round3
jqxENMKaeCU	1:33:17	94160	2.508	2.488	1.898	8.537	14.582	2.688
Faawin6qYaI	6:57	4346	2.93	3.835	1.549	8.155	6.717	2.885
Ju8-fAyqkBg	9:07	3228	2.654	1.827	1.408		14.87	2.664
V1Oog7mjh5E	2:08	1578	3.251	2.649	2.371	4.547	18.44	4.3
ByKov4F3gwE	17:56	1003	3.13	2.457	1.582	16.231	8.357	13.385
ThfDn-6xB2o	4:08	913	8.539	5.23	1.655	6.156	4.134	3.655
ALopaFsaoVI	9:59	832	5.23	4.324	2.101	10.852	16.633	3.024
gE3CaWPS12A	13:39	666	3.237	3.125	2.099	17.971	20.352	6.478
RuQFyDY_GNE	13:30	626	6.125	3.667	2.213	3.48	5.855	5.114
9jIThLkm_wo	3:10	525	5.392	2.74	1.726	26.197	7.038	5.574
4YpiDUhTW9I	2:30	427	3.295	2.914	1.505	4.355	3.033	2.914
N4zEjT7q4AU	1:51	352	6.516	2.671	1.874	7.119	15.153	
1hkATWGpM1E	6:47	343	7.071	5.056	1.227	13.83	6.206	11.25
ov-NZ_rJZYA	7:06	266	4.824	6.781	1.464	3.518	4.505	4.022
ESLPHPvmdy8	0:20	214	2.988	1.974	1.875	16.556	23.33	6.865
heVu-pzaUjs	6:54	208	5.361	7.342	1.485			
At-cZwzOco4	8:09	199	3.274	1.639	1.74	13.261	3.587	3.999
ku6xktfXo3o	9:23	153	6.274	4.03	1.31	24.515	26.149	11.784
s_H7WKWhELo	2:35:52	134	14.952	4.911	3.405	25.464	15.751	8.477
BqBxLoIua_E	6:23	88	6.853	6.632	1.853	2.641	2.204	3.581

CHAPTER V: CONCLUSION

Comparative study is done on 2 major KQIs. Benchmark is done between 2 biggest operators of Bangladesh. Both drivetest and stationary method is used for testing. Possible root cause affecting delay>10s are:

- Poor Ec/Io can cause higher streaming delay
- Caching server plays a big role
- Soft network side parameter tuning has a significant role
- Total spectrum might also be helpful for reducing delay

In suggestion for solving the issues, for operator G – in roads - optimized azimuth/tilt/cell power should be planned to improve Ec/Io. For oprator B, new sites can be added to improve coverage and quality, proper soft tuning can be done to restrict Ec/Io, Youtube caching server can be deployed and buying new spectrum is an option.

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