



Report on the Mobile Quality of Services (July 2018- June 2019)

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Bhutan InfoComm and Media Authority
Royal Government of Bhutan

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1. Objective

The main objective of this drive test was to measure the:

- Mobile voice quality in terms of Call Set-up time (CST), Call Drop Rate (CDR) and Call Completion Rate (CCR) and Mean Opinion Score (MSO); and
- b) Data voice quality in terms of Data Completion Rate (DCR) and Data Throughput Rate (DTR)

2. Terminology used in this report

- **Call Set-Up time:** refers to the overall duration of time taken (in seconds) required to establish mobile voice call between users. In other word, it is the time taken (in seconds) to access the radio network by the caller/receiver of the voice service
- **Call Drop Rate:** refers to the fraction of the telephone calls which, due to technical reasons, were cut off before the speaking parties had finished their conversation and before one of them had hung up (dropped calls).
- **Call Completion Rate:** refers to the ratio of successfully completed calls to the total number of attempted calls.
- **Data Completion Rate:** refers to the ratio of successfully completed data (either download or upload) to the total number of attempts made.
- **Data Throughput Rate:** refers to the actual amount of data transmitted or transferred in a period of time.
- **File Transfer Protocol (FTP):** is a standard network protocol used for the transfer of computer files between a client and server on a computer network.
- **Hypertext Transfer Protocol (HTP):** is an application protocol for distributed, collaborative, and hypermedia information systems. HTTP is the foundation of data communication for the World Wide Web.
- **Mean Opinion Score (MOS):** is a numerical measure of quality of human speech at the destination end of the circuit and will determine the voice quality of user experience (QoE) while talking over the phone.

- **Peak Hours:** is a time period determined by Service provider where traffic or number of call attempt is maximum. The peak hours for Bhutan Telecom limited (BTL) is 3 PM to 10 PM while a peak hour for Tashi InfoComm Limited (TICL) is from 6PM to 12 AM.
- **Off – Peak Hours:** is a time period determined by Service provided where the traffic or call attempts is moderate. The Off- peak hours of BTL is from 6 AM to 3 PM and Off-peak hours for TICL is from 6 AM to 6 PM .

3. Parameters used for measuring the QoS

3.1. Mobile Voice Service

The following four parameters were used to determine the Key performance indicator (KPI) of the voice service of the mobile communication network of two service providers.

- **Call set-up time:** To determines the accessibility to the radio network resource. It is measured as shown below:

Call setup time = Time taken by a caller to get connected to the dialed number

- **Call Completion Rate (CCR):** To determine the ability of the network to retain the connectivity for the entire period of the call duration till the call is terminated either by the caller or the receiver. It is measured as the ratio of successfully completed calls to the total number of attempted calls.

CCR = Number of successful calls / total number of attempted calls

- **Call Drop Rate (CDR):** To measures the measures system efficiency. It is measured as shown below:

CDR = (Number of Call drops/ Total number of attempted calls) x 100

- **Mean Opinion Score (MOS):** To measure the quality of experience (QoE). It is expressed as a single number in the range from 1 to 5, where the value of 1 corresponds to the lowest quality experienced by the end-users and 5 as the excellent quality experienced as shown in the table below:

Mean Opinion Score	Quality
5	Excellent
4	Good
3	Fair
2	Poor
1	Bad

3.2 Mobile Data services

The Quality of Service for the mobile data services were measured using the following four parameters.

- **Data Completion Rate (DCR) count:** means the ratio of successfully completed data (either download or upload) to the total number of attempts made.

$$DCR = \text{Number of successful downloads or uploads} / \text{total number of attempts made.}$$

- **Data Throughput Rate:** To measures the speed of data upload or download

4. Regional Benchmark

We have followed the following regional benchmark for this report

Sl. No	Parameters	Regional Benchmark
Mobile Voice Service		
1	Call-Drop Rate	< 2%
2	Call Set-Up Time	< 6.5Sec
Mobile Data Service		
Data Throughput Rate (Mbps)		
3	a. File Transfer Protocol Test(3G)	≥ 1.5
	b. Hyper Text Transfer Protocol Test (3G)	
	c. File Transfer Protocol Test(4G)	≥ 6
	d. Hyper Text Transfer Protocol Test(4G)	

5. Methodology

The real time experience of the quality of mobile services both for voice and data is measured using the mobile network Testing (drive test) equipment of Rohde Schwarz¹ (QualiPocFreerider III). The mobile network testing equipment is manually pre-programmed depending on the type of tests to be carried out. Once the equipment is pre-programmed, it runs the test automatically. The programmed equipment is then placed in a vehicle to carry out the drive test in a pre-selected area.

5.1 Voice Test

¹**Freerider III** is a portable test device for smartphone-based optimization and quality of experience benchmarking of voice, data and video and messaging from a real end-user perspective.

The voice test was performed on a “Double-Ended Call Test”² mode using maximum of each 30 seconds call session to access the network. In the event if the caller is not able to access the network within this time frame, it is considered as failure. This performance test determine the call set-up time.

In addition, once the network work is accessed, the call session is made to run for another 90 seconds and if the call session does not run for 90 seconds, then such call session is considered as a call drop. The results of the combination of these two tests will provide the quality of the voice service.

5.2 Data Test

To test the quality of data service, both the File Transfer Protocol (FTP) and Hyper Text Transfer Protocol (HTTP) tests are performed using an open-source server *speedtest.tele2.net*³(Speed test service). A file with a pre-determined size is downloaded within a given time period to check both the network accessibility and the speed and retention of the network. Each data session is provided a maximum of 30 seconds to access the network and whether the selected file size could be downloaded within the given time frame.

5.3 Computation of data

The data obtained from the drive test are then transferred from the drive test equipment to Swiss Qual’s Network Quality Data Investigator (NQDI)⁴ for post processing of the data collected from the field. The NQDI automatically validates the data and analyzes them to report on both the quality of the voice and data services.

²Double Ended call is a type of test where both the user equipment (A and B) will make a call to each other alternatively.

³The Tele2 Speedtest Service helps to test Internet connection speed including downloading a file via the web browser (HTTP) or downloading and uploading via FTP.

⁴SwissQual’s Network Quality Data Investigator (NQDI Classic) is a post processing system that maximizes the potential of data collected by QualiPoc and Diversity products for network and service optimization and benchmarking.

6. Drive test results

The drive test results from July 2018 to June 2019 are given below:

6.1 Mobile voice services

6.1.1 Call Drop Rate (CDR)

KPI	Regional benchmark
Call drop rate (CDR)	< 2 %

Table 1: Regional benchmark for CDR

However, both the service providers have experience call drop issues during the months of September and December (2018) and February and April (2019) as shown below. During these periods, the mobile users must have experienced mild call drop problem while making calls.

Sl	Month	Location	Averaged Call drop Rate	
			B-Mobile	TashiCell
1	July -18	Norzin Lam	0.0	0.0
2	Aug -18	Motithang	0.0	0.0
3	Sep-18	Olakha	2.8	0.9
4	Oct-18	Changzamtok	1.0	0.0
5	Nov -18	Langjophakha	1.9	0.0
6	Dec -18	Babesa Expressway	2.9	3.0
7	Jan -19	Jungshina	0.0	0.0
8	Feb-19	Babesa	2.6	2.6
9	Mar-19	Changlam	0.0	0.0
10	April -19	Norzin Lam	3.9	3.9
11	May -19	Changzamtok	0.0	0.0
12	June -19	Babesa	0.0	0.0
Average CDR			1.3	0.9

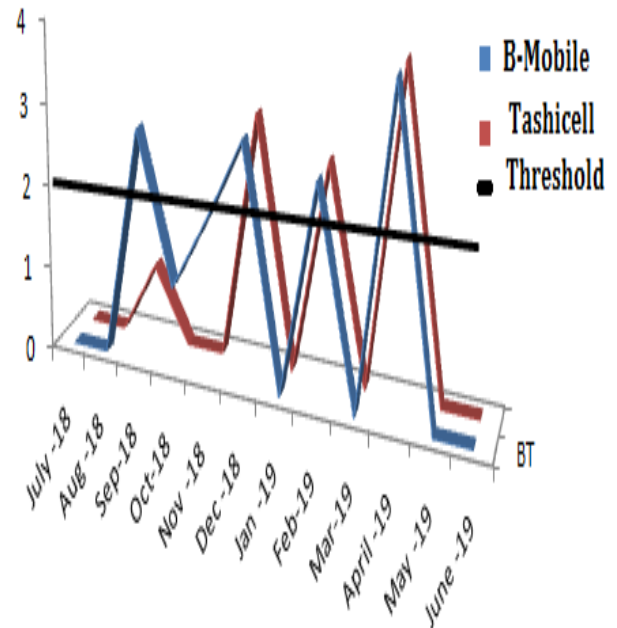


Table 2: Average monthly CDR

6.1.2 Call Set-up Time (CST)

KPI	Regional benchmark
Call set-up time (CST)	< 6.5 sec

Table 3: Regional benchmark for CST

The average monthly call set-up time for the year 2018-2019 is given below:

Sl	Month	Location	Averaged Call Set up Time	
			B-Mobile	TashiCell
1	July -18	Norzin Lam	8.3	9.7
2	Aug -18	Motithang	9.4	9.9
3	Sep-18	Olakha	9.2	12.1
4	Oct-18	Changzamtok	9.5	11.9
5	Nov -18	Langjophakha	9.8	10.1
6	Dec -18	Babesa Expressway	8.9	8.7
7	Jan -19	Jungshina	8.9	8.7
8	Feb-19	Babesa	8.6	9.9
9	Mar-19	Changlam	8.7	9.8
10	April -19	Norzin Lam	9.4	12.0
11	May -19	Changzamtok	9.2	9.9
12	June -19	Babesa	9.4	9.9
Average CST			9.08	10.21

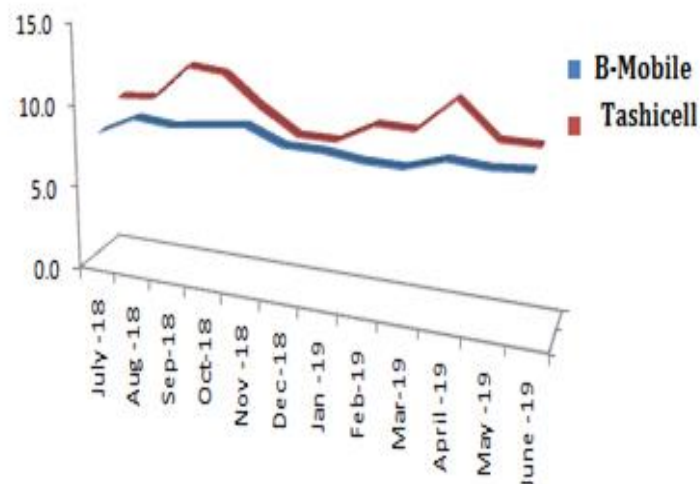


Table 4: Average monthly CST

6.1.3 Mean Opinion Score (MOS)

KPI	Remark
MOS	Satisfactory (much above fair quality of service

Table 5: MOS

The average monthly MSO of both the mobile service providers are in the range of 3.2 to 3.4 as shown below:

Sl	Month	Location	Averaged MOS Score	
			B-Mobile	TashiCell
1	July -18	Norzin Lam	3.4	3.3
2	Aug -18	Motithang	3.3	3.3
3	Sep-18	Olakha	3.3	3.2
4	Oct-18	Changzamtok	3.4	3.8
5	Nov -18	Langjophakha	3.2	3.3
6	Dec -18	Babesa Expressway	3.4	3.4
7	Jan -19	Jungshina	3.3	3.3
8	Feb-19	Babesa	3.4	3.3
9	Mar-19	Changlam	3.25	3.28
10	April -19	Norzin Lam	3.4	3.2
11	May -19	Changzamtok	3.3	2.97
12	June -19	Babesa	3.16	3.28
Average			3.31	3.30

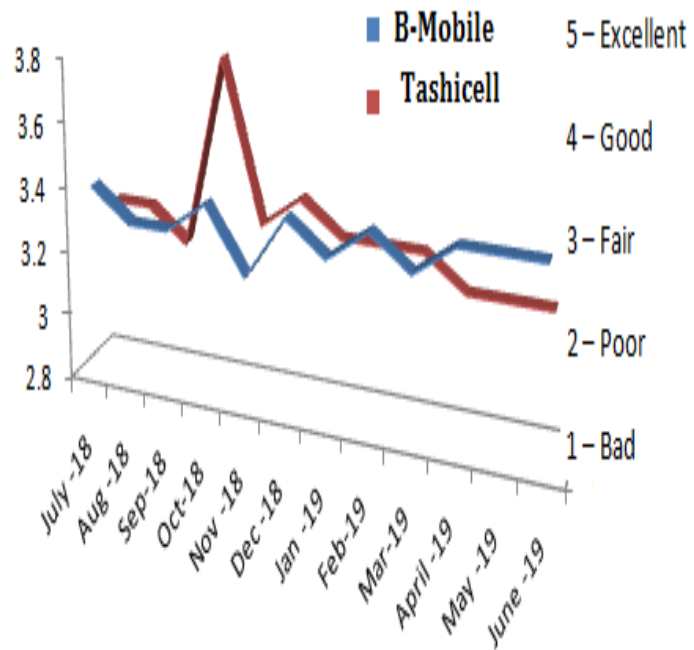


Table 6: Monthly average MOS

6.2 Mobile data service

6.2.1 Data Completion Rate

a. File Transfer Protocol (FTP) Test

During the third quarter of 2018 (July to October), both Service Providers have faced minor problem associated while transferring files (FTP), both for up-loading as well as down loading files. The average key performance indicators (data completion rate) in these months are little less than 100 percent as shown in the Table 7 and 8 below:

Sl	Month	FTP (DCR in %)	
		Up-load	Down- load
1	July -18	100.0	98.5
2	Aug -18	99.3	98.9
3	Sep-18	99.3	99.4
4	Oct-18	100.0	98.3
5	Nov -18	99.4	100.0
6	Dec -18	100.0	100.0
7	Jan -19	100.0	100.0
8	Feb-19	100.0	100.0
9	Mar-19	100.0	100.0
10	April -19	100.0	100.0
11	May -19	100.0	100.0
12	June -19	100.0	100.0
Average		99.8	99.7

Table 7: Average DCR of B-Mobile

Sl	Month	FTP (DCR in %)	
		Up-load	down load
1	July -18	100.0	100.0
2	Aug -18	91.5	100.0
3	Sep-18	99.3	99.7
4	Oct-18	99.8	99.6
5	Nov -18	100.0	99.5
6	Dec -18	100.0	100.0
7	Jan -19	100.0	100.0
8	Feb-19	100.0	100.0
9	Mar-19	100.0	100.0
10	April -19	100.0	100.0
11	May -19	100.0	100.0
12	June -19	100.0	100.0
Average		99.2	99.9

Table 8: Average DCR of TashiCell

However, towards later part of the year and the first half of 2019, the Data completion rate has improved significantly. The mobile users were able to transfer files, either uploading or downloading, without any disruptions.

Over all, the average Data Completion Rate (DCR) indicator for the year 2018-2019 looks quite impressive with slight failure as shown in the table above.

b. Hyper Text Transfer Protocol (HTTP) tests

During second half of 2018, while browsing any websites through mobile phone, the B-Mobile users would have faced difficulties, either getting connected or completing viewing. The average Data Completion Rate for HTTP test in this period shows low completion rate as indicated in the Table 9 below.

However, the scenarios for the TashiCell mobile users were quite different. Besides, February month (2019), the average Data Completion Rate for HTTP test was 100% successful as shown in the Table 10 below.

Sl. No	Month	Average DCR in %
1	July -18	88.5
2	Aug -18	100.0
3	Sep-18	99.7
4	Oct-18	100.0
5	Nov -18	78.9
6	Dec -18	88.5
7	Jan -19	100.0
8	Feb-19	97.4
9	Mar-19	100.0
10	April -19	100.0
11	May -19	100.0
12	June -19	100.0
Average		96.1

Table 9: Average DCR (HTTP) of B-mobile

Sl. No	Month	Average DCR in %
1	July -18	100.0
2	Aug -18	100.0
3	Sep-18	100.0
4	Oct-18	100.0
5	Nov -18	100.0
6	Dec -18	100.0
7	Jan -19	100.0
8	Feb-19	97.4
9	Mar-19	100.0
10	April -19	100.0
11	May -19	100.0
12	June -19	100.0
Average		99.8

Table 10: Average DCR (HTTP) of Tashicell

6.2.2 Data Throughput (DT)

a. FTP test

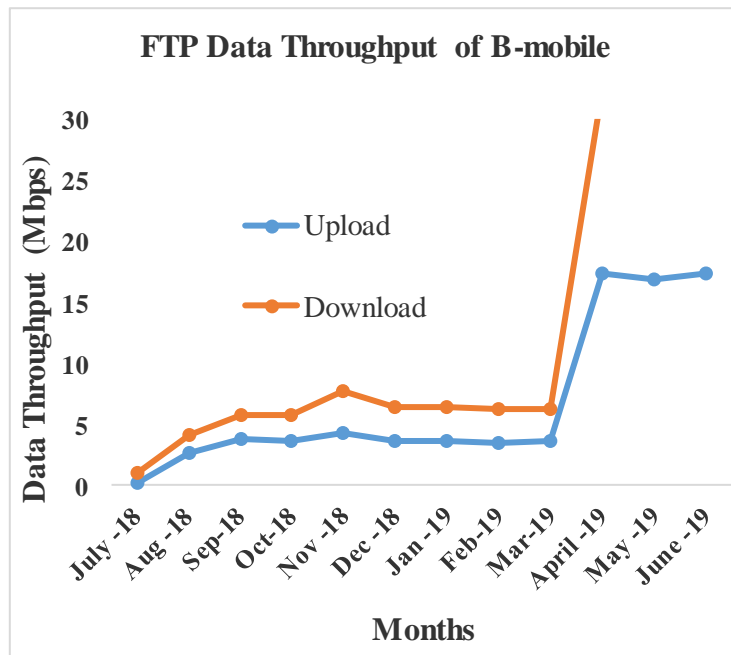
KPI	Regional benchmark (Mbps)	
	Up-load	Down-load
Throughput (FTP)	≥ 6	≥ 6

Table 11: Regional Benchmark for Data Throughput (DT)

In general, the users have only experienced very good Data Throughput in the month of April, May, June 2019 whereas the average DT for both UL and DL are much below the regional benchmark as shown in figures given below

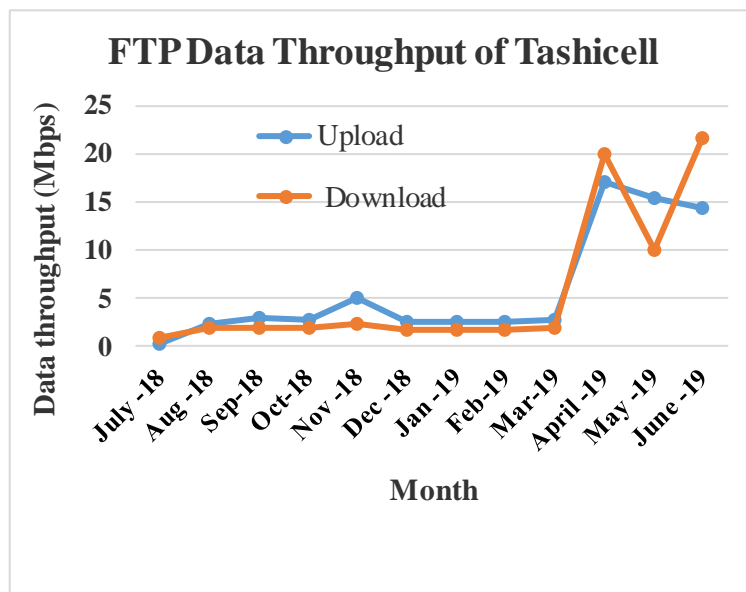
Sl	Month	Location	Average DT (Mbps)	
			UP	DL
1	July - 18 (3G)	Norzin Lam	0.2	0.8
2	Aug - 18	Motithang	2.7	1.4
3	Sep-18	Olakha	3.7	2.0
4	Oct-18	Changzamtok	3.6	2.2
5	Nov - 18	Langjophakha	4.3	3.4
6	Dec -18	Babesa Expressway	3.6	2.8
7	Jan -19	Jungshina	3.6	2.8
8	Feb-19	Babesa	3.5	2.7
9	Mar-19	Changlam	3.6	2.7
10	April - 19	Norzin Lam	17.4	15.1
11	May - 19	Changzamtok	16.84	21.56
12	June - 19	Babesa	17.33	25.15
Average DT			6.70	6.88

Table 12: Average DT of B-Mobile



Sl	Month	Location	Average DT (Mbps)	
			UL	DL
1	July -18	Norzin Lam	0.3	0.8
2	Aug -18	Motithang	2.3	1.9
3	Sep-18	Olakha	2.9	1.9
4	Oct-18	Changzamtok	2.7	1.9
5	Nov -18	Langjophakha	5.0	2.3
6	Dec -18	Babesa Expressway	2.5	1.7
7	Jan -19	Jungshina	2.5	1.7
8	Feb-19	Babesa	2.5	1.7
9	Mar-19	Changlam	2.8	2.0
10	April - 19	Norzin Lam	17.0	20.0
11	May -19	Changzamtok	15.32	9.97
12	June -19	Babesa	14.33	21.53
Average			5.85	5.62

Table 13: Average DT of TashiCell



b. HTTP Test

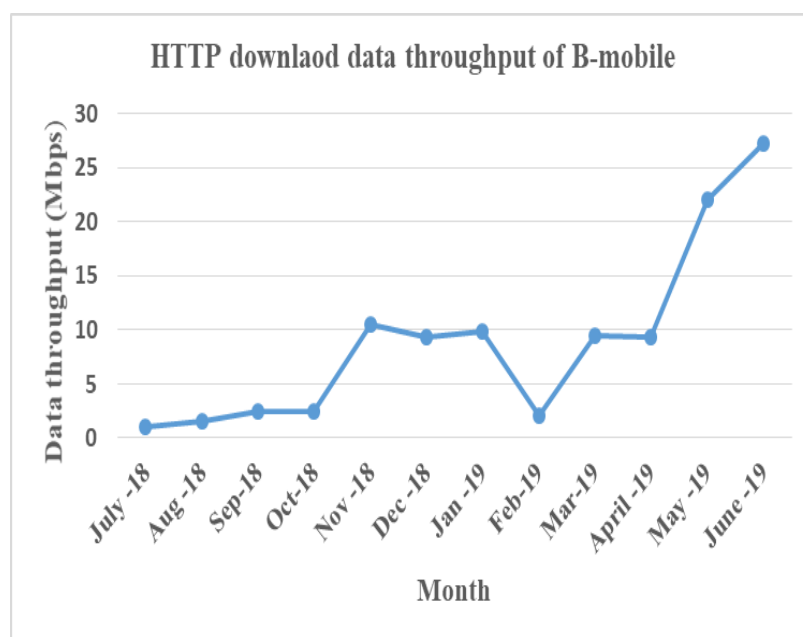
KPI	Regional benchmark (Mbps)
Throughput (HTTP)	≥ 6

Table 14: Regional benchmark for Throughput (HTTP)

Except for few months, the average DT of B-Mobile is much below the regional benchmark, whereas except for the month of February 2019, the DT of TashiCell has always been below the benchmark.

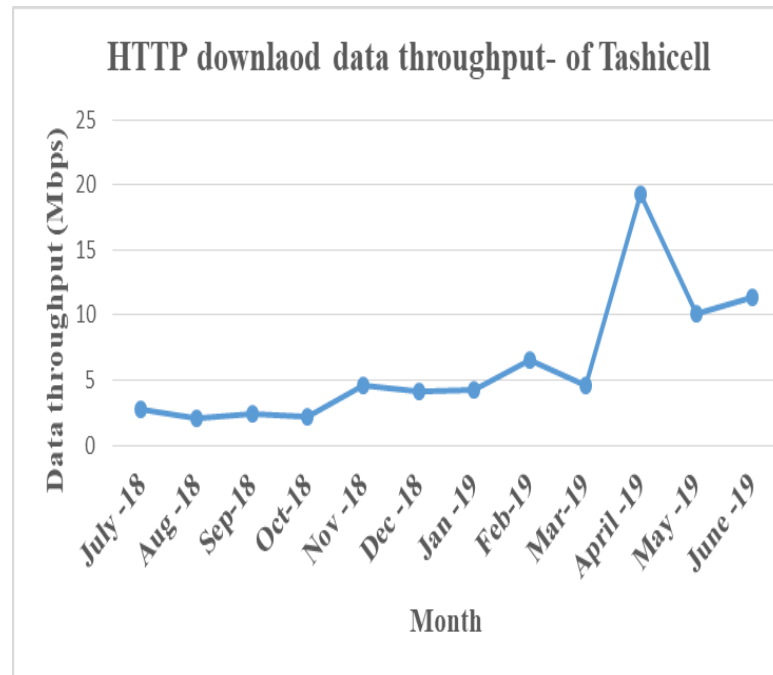
Sl	Month	Location	Average DT (Mbps)
1	July -18	Norzin Lam	1.0
2	Aug -18	Motithang	1.6
3	Sep-18	Olakha	2.5
4	Oct-18	Changzamtok	2.4
5	Nov -18	Langjophakha	10.5
6	Dec -18	Babesa Expressway	9.3
7	Jan -19	Jungshina	9.9
8	Feb-19	Babesa	2.1
9	Mar-19	Changlam	9.5
10	April -19	Norzin Lam	9.3
11	May -19	Changzamtok	22.01
12	June -19	Babesa	27.25
Average			8.95

Table 15: Monthly average DT of B-Mobile



SI	Month	Location	Average DT (Mbps)
1	July -18	Norzin Lam	2.8
2	Aug -18	Motithang	2.1
3	Sep-18	Olakha	2.4
4	Oct-18	Changzamtok	2.2
5	Nov -18	Langjophakha	4.6
6	Dec -18	Babesa Expressway	4.1
7	Jan -19	Jungshina	4.3
8	Feb-19	Babesa	6.5
9	Mar-19	Changlam	4.6
10	April -19	Norzin Lam	19.24
11	May -19	Changzamtok	10.13
12	June -19	Babesa	11.33
Average			5.72

Table 16: Monthly average DT of TashiCell



7. Findings

a. Voice Service

- In general, Both B-Mobile and TashiCell have 100% accessibility and retainability, indicating good performance of mobile voice services under Thim Throm areas.
- The average Mean Opinion Score (MOS) for both B-Mobile and TashiCell clearly indicates the availability of good quality of voice services in Thim Throm areas.
- However, the Call-Setup Time (CST) for both B-Mobile and TashiCell was found to be higher. This is experienced mainly due to voice call fall-back characteristic of 4G network. 4G network is for high-speed data service, not designed for voice service.

In 4G network, when a user make call, the voice call must fall-back from 4G service to either 3G or 2G network for making voice call.

b. Data Service

- The Data Completion Rate (DCR) of B-Mobile and TashiCell were not very impressive during the second half of 2018, especially while transferring files online. However, it improved significantly towards the first half of 2019 with 100% completion rate.
- While browsing websites (HTTP), the DCR of TashiCell was much better than B-Mobile which means network retainability(constant throughput) of Tashicell is better compared B-mobile. Besides, DCR of 97.4% in the month of February 2019, it had
- 100 % completion rate for rest of the months.
- The 4G data throughput of B-Mobile was found to be much higher than that of TashiCell. On average, B-Mobile had a DT throughput of 8.95 Mbps when compared to 5.72 Mbps of Tashicell.

8. Way Forward

Based on the findings of this report, the Authority plans to carry out the following activities:

- Conduct Stakeholders' consultation: to discuss the results of these findings and come out with way forward to improve the key performance indicator to enhance the mobile quality of services.
- Memorandum of Understanding (MoU): Based on the findings, the Authority will sign MoU with the two mobile service providers to improve on their poor key performance indicators.
- Expand the test areas: The Authority also plans to conduct drive test in few selected commercial areas such as Phuentsholing, Gelephu, Samdrup Jongkhar and Nganglam.
- Publish the drive test findings on quarterly basis to facilitate Authority in taking proper regulatory measures for improving the quality of mobile services