



**Report on the Mobile Quality of  
Services  
(July 2019- September 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:

- a) 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

- **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 (HTTP):** 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 the 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 dialled 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:

$$CDR = (Number\ of\ Call\ drops / Total\ number\ of\ attempted\ calls) \times 100$$

- **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(MOS)	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.

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

- **Data Throughput Rate:** To measures the speeds of data uploads or download.

## 4. Regional Benchmark

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

The voice test was performed on a “Double-Ended Call Test”<sup>2</sup> mode using maximum of

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<sup>1</sup>**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.

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

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*<sup>3</sup>(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)<sup>4</sup> 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.

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

<sup>4</sup>SwissQual'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

On July and August, the KPI drive test was conducted for both 3G and 4G network but on September the KPI drive test was conducted only for 4G network

### 6.1 Mobile voice services

#### 6.1.1 Call Drop Rate (CDR)

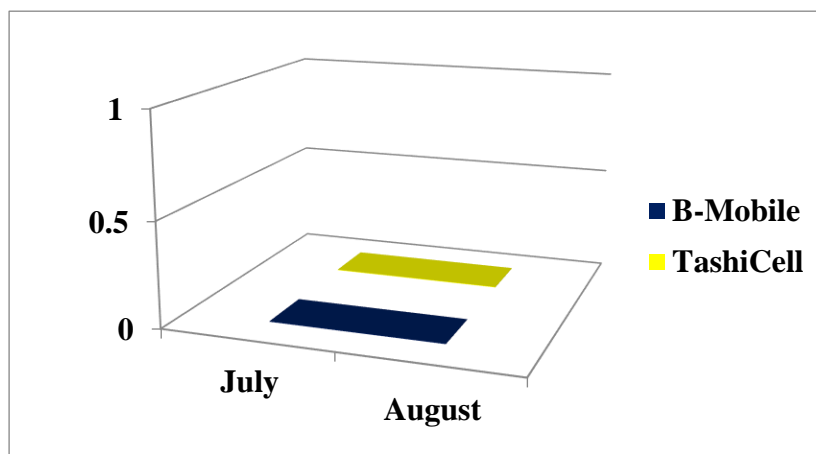
KPI	Regional benchmark
Call drop rate (CDR)	< 2 %

#### a. 3G

The subscribers of both service providers did not experience any call drop issue in the month of July and August 2019 as shown below.

Sl. No	Month	Location	Averaged Call drop Rate	
			B-Mobile	TashiCell
1	July	Thimphu (Motithang)	0	0
2	August	P/ling (Town area)	0	0
Average CDR			0	0

*Table 1: Average monthly CDR*



*Figure 1: Monthly CDR*

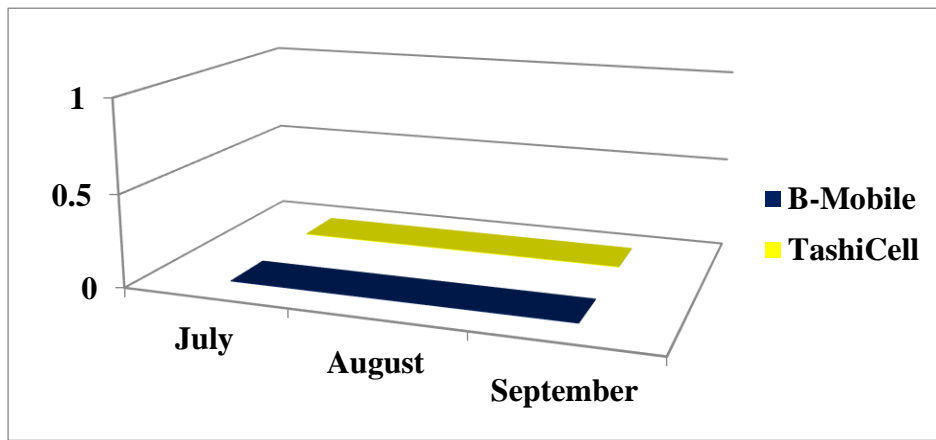


**b. 4G**

The subscribers of both service providers did not experience any call drop issue for 4G network in the month of July and August 2019 as shown below.

Sl.No.	Month	Location	Averaged Call drop Rate	
			B-Mobile	TashiCell
1	July	Thimphu (Motithang)	0	0
2	August	P/ling (Town area)	0	0
3	September	Paro (Olathang and Town)	0	0
<b>Average CDR</b>			<b>0</b>	<b>0</b>

*Table 2: Average monthly CDR*



*Figure 2: Monthly CDR*

**6.1.2 Call Set-up Time (CST)**

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

**a. 3G**

The Call-Set Up Time for both service providers for 3G network exceeded the international benchmark. It took longer time for a caller of both service providers to establish a call as shown below.

Sl. No	Month	Location	Averaged Call Set up Time(s)	
			B-Mobile	TashiCell
1	July	Thimphu (Motithang)	8.34	8.08
2	August	P/ling (Town area)	8.14	8.48
<b>Average CDR</b>			<b>8.24</b>	<b>8.28</b>

*Table 3: Average monthly CST*

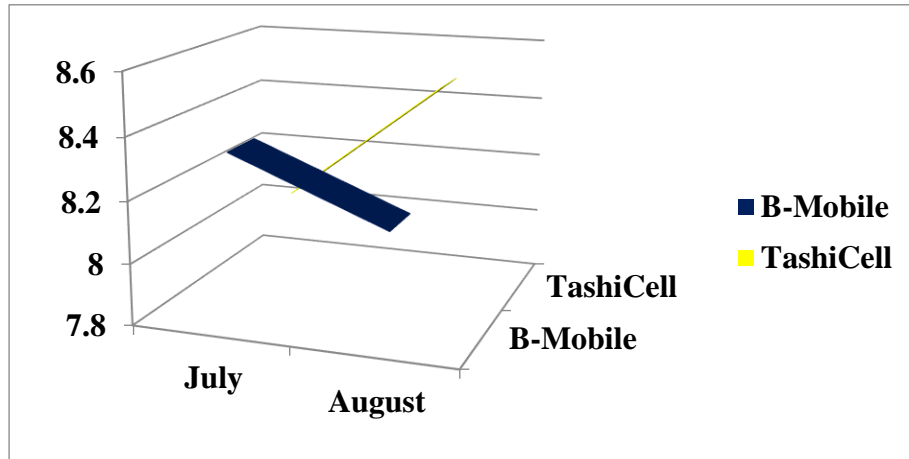


Figure 3: Monthly CST

a. 4G

The Call-Set Up Time for both service providers for 4G network exceeded the international benchmark. It took longer time for a caller of both service providers to establish a call as shown below.

Sl. No	Month	Location	Averaged Call Set up Time(s)	
			B-Mobile	TashiCell
1	July	Thimphu (Motithang)	10.62	9.09
2	August	P/ling(Town area)	9.93	12.12
3	September	Paro (Olathang and Town)	12.29	12.74
Average CST			<b>10.95</b>	<b>11.32</b>

Table 4: Average monthly CST

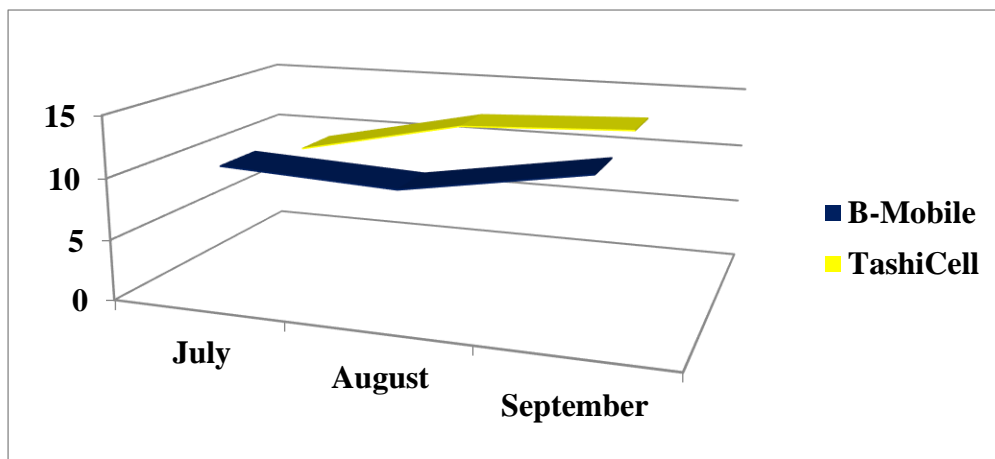


Figure 4 Monthly CST

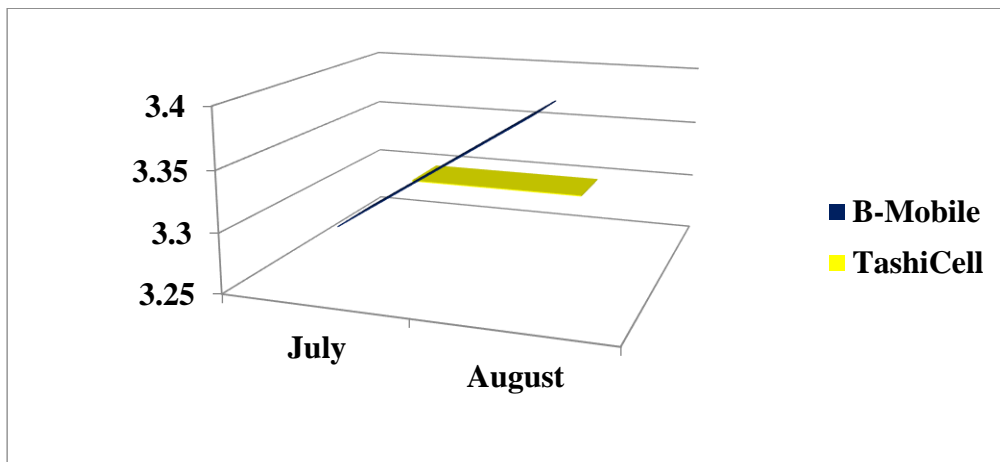
### 6.1.3 Mean Opinion Score (MOS)

#### a. 3G

The average MOS of both mobile service providers are in the range of 3 to 3.5 as shown below:

Sl.No	Month	Location	Mean Opinion Score (s)	
			B-Mobile	TashiCell
1	July	Thimphu (Motithang)	3.3	3.3
2	August	P/ling(Town area)	3.4	3.3
<b>Average CST</b>			<b>3.4</b>	<b>3.3</b>

*Table 5: Monthly Average MOS*



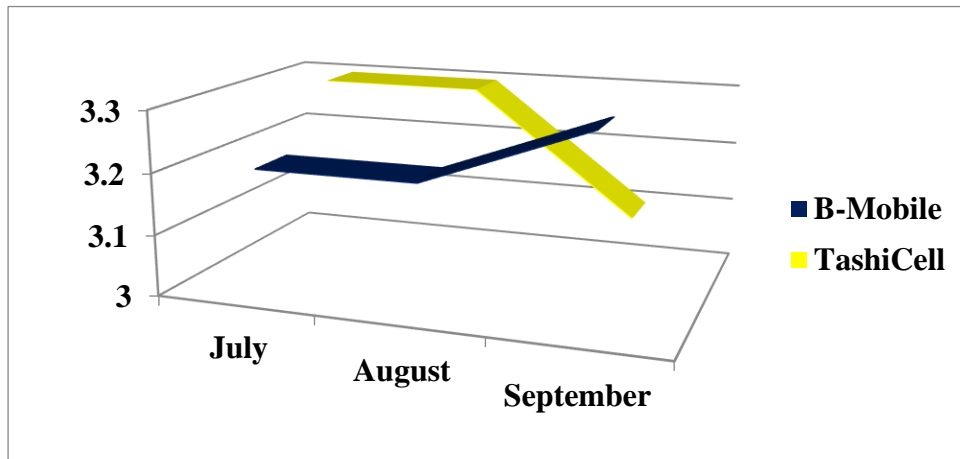
*Figure 5: Monthly MOS*

#### b. 4G

The average MOS of both mobile service providers are in the range of 3 to 3.5 as shown below

Sl.No	Month	Location	Mean Opinion Score (s)	
			B-Mobile	TashiCell
1	July	Thimphu (Motithang)	3.2	3.3
2	August	P/ling(Town area)	3.2	3.3
3	September	Paro (Olathang and Town)	3.3	3.1
<b>Average CST</b>			<b>3.2</b>	<b>3.2</b>

*Table6: Average Monthly MOS*



*Figure 6: Monthly MOS*

## 6.2 Mobile data service

### 6.2.1 Data Completion Rate

#### A. File Transfer Protocol (FTP) Test

##### a. 3G

Both Service Providers have not faced any problem associated while transferring files (FTP), for both up-loading and down loading files using 3G. The average key performance indicators (data completion rate) in these months are 100 percent as shown below:

Sl.No	Month	Location	FTP (DCR in %)	
			Up-load	Down- load
1	July	Thimphu (Motithang)	100	100
2	August	P/ling (Town area)	100	100
<b>Average</b>			100	100

*Table 7: Average DCR of B-Mobile*

Sl.No	Month	Location	FTP (DCR in %)	
			Up-load	Down- load
1	July	Thimphu (Motithang)	100	100
2	August	P/ling (Town area)	100	100
<b>Average</b>			100	100

*Table 8: Average DCR of TashiCell*

**b. 4G**

Both Service Providers have not faced any problem associated while transferring files (FTP), for both up-loading and down loading files using 4G. The average key performance indicators (data completion rate) in these months are 100 percent as shown below:

Sl.No	Month	Location	FTP (DCR in %)	
			Up-load	Down- load
1	July	Thimphu (Motithang)	100	100
2	August	P/ling (Town area)	100	100
3	September	Paro (Olathang and Town)	100	100
<b>Average</b>			<b>100</b>	<b>100</b>

*Table 9: Average DCR of B-Mobile*

Sl.No	Month	Location	HTTP (DCR in %)	
			Up-load	Down- load
1	July	Thimphu (Motithang)	100	100
2	August	P/ling (Town area)	100	100
3	September	Paro (Olathang and Town)	100	100
<b>Average</b>			<b>100</b>	<b>100</b>

*Table 10: Average DCR of TashiCell*

**B. Hyper Text Transfer Protocol (HTTP) tests**

**a. 3G**

During third quarter of 2019, while browsing any websites through mobile phone, both Service Providers have not faced difficulties while getting connected or completing viewing both for up-loading as well as down loading files using 3G.

Sl.No	Month	Location	HTTP (DCR in %)	
			Up-load	Down- load
1	July	Thimphu (Motithang)	100	100
2	August	P/ling (Town area)	100	100
<b>Average</b>			<b>100</b>	<b>100</b>

*Table 11: Average DCR (HTTP) of B-Mobile*

Sl.No	Month	Location	HTTP (DCR in %)	
			Up-load	Down- load
1	July	Thimphu (Motithang)	100	100
2	August	P/ling (Town area)	100	100
<b>Average</b>			<b>100</b>	<b>100</b>

*Table12: Average DCR (HTTP) of TashiCell*

**b. 4G**

During third quarter of 2019, while browsing any websites through mobile phone, the TashiCell users would have faced difficulties, either getting connected or completing viewing.

Sl.No	Month	Location	HTTP (DCR in %)	
			Up-load	Down- load
1	July	Thimphu (Motithang)	100	100
2	August	P/ling (Town area)	100	100
3	September	Paro (Olathang and Town)	100	100
<b>Average</b>			<b>100</b>	<b>100</b>

*Table13: Average DCR (HTTP) of B-Mobile*

Sl.No	Month	Location	HTTP (DCR in %)	
			Up-load	Down- load
1	July	Thimphu (Motithang)	100	100
2	August	P/ling (Town area)	100	100
3	September	Paro (Olathang and Town)	96.9	96.9
<b>Average</b>			<b>98.9</b>	<b>98.9</b>

*Table14: Average DCR (HTTP) of TashiCell*

**6.2.2 Data Throughput (DT)**

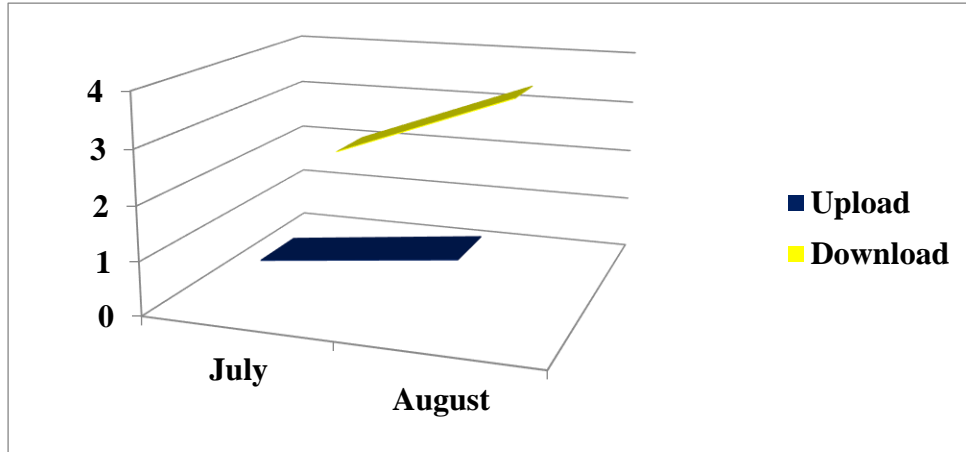
**A. FTP test**

**a. 3G**

KPI	Regional benchmark (Mbps)	
	Up-load	Down-load
Throughput (FTP)	≥ 1.5	≥ 1.5

Sl.No	Month	Location	Average DT (Mbps)	
			Upload	Download
1	July	Thimphu (Motithang)	0.9	2.09
2	August	P/ling (Town area)	1.3	3.4
<b>Average</b>			<b>1.1</b>	<b>2.7</b>

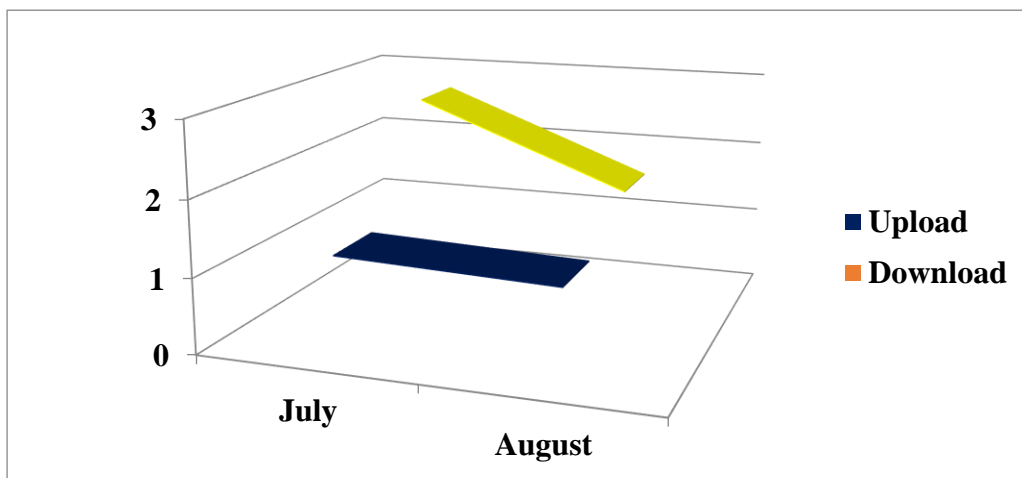
*Table 15: Average DT of B-Mobile*



*Figure 7: Monthly DT of B-Mobile*

Sl.No	Month	Location	Average DT (Mbps)	
			Upload	Download
1	July	Thimphu (Motithang)	1.2	2.7
2	August	P/ling (Town area)	1.1	1.6
<b>Average</b>			<b>1.6</b>	<b>2.2</b>

*Table 16: Average DT of TashiCell*



*Figure 8: Monthly DT of TashiCell*

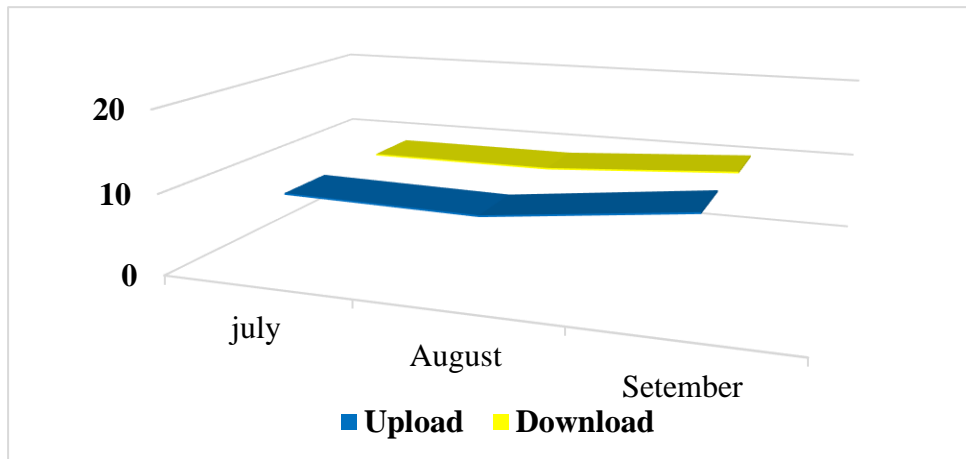
**b. 4G**

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

In general, the users have experienced good Data Throughput in the month of June, July and August 2019. The average DT for both UL and DL are above the regional benchmark.

Sl.No	Month	Location	Average DT (Mbps)	
			Upload	Download
1	July	Thimphu (Motithang)	9.3	8.9
2	August	P/ling (Town area)	8.9	8.9
3	September	Paro (Olathang and Town)	11.6	10.4
Average			<b>9.9</b>	<b>9.4</b>

*Table 17: Average DT of TashiCell*

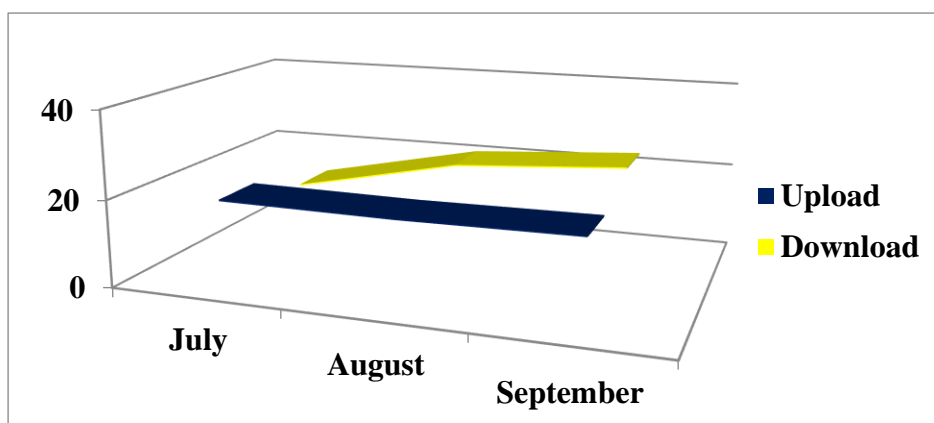


*Figure 9: Monthly DT of TashiCell*

Sl.No	Month	Locations	Average DT (Mbps)	
			Upload	Download
1	July	Thimphu (Motithang)	18.8	12.8
2	August	P/ling (Town area)	18.4	21.1
3	September	Paro (Olathang and Town)	18.75	23.7
Average			<b>18.6</b>	<b>19.2</b>

*Table 18: Average DT of B-Mobile*





*Figure 10: Monthly DT of B-Mobile*

## B. HTTP Test

### a. 3G

KPI	Regional benchmark (Mbps)	
	Up-load	Down-load
Throughput (HTTP)	≥ 1.5	≥ 1.5

In the month of July and August 2019, the users have experienced very good Data Throughput in case of up-load whereas the users have experienced a poor data throughput in case of down-load. The average DT for both UL and DL are above the regional benchmark as shown below

Sl.No	Month	Location	Average DT (Mbps)	
			Upload	Download
1	July	Thimphu (Motithang)	5.9	1.3
2	August	P/ling (Town area)	5.4	1.3
<b>Average</b>			<b>5.7</b>	<b>1.3</b>

*Table 19: Monthly average DT of B-Mobile*

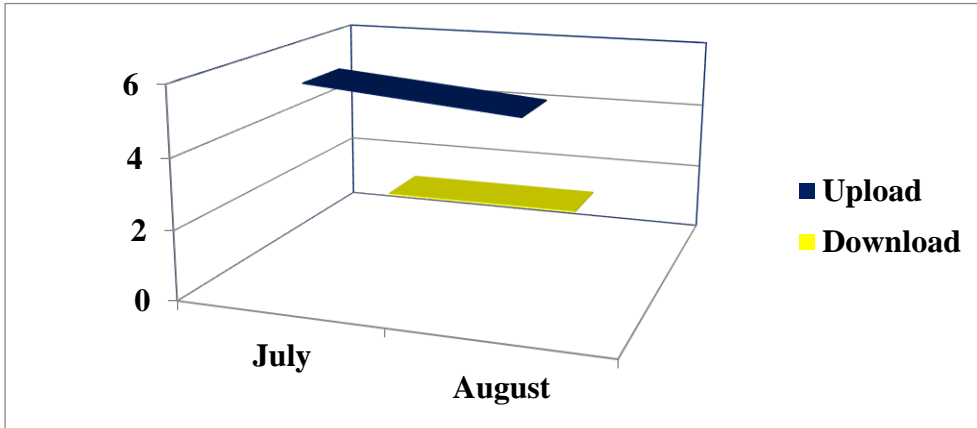


Figure 11: Monthly DT of B-Mobile

Sl.No	Month	Location	Average DT (Mbps)	
			Upload	Download
1	July	Thimphu (Motithang)	2.5	0.6
2	August	P/ling (Town area)	4.1	1.1
<b>Average</b>			<b>3.3</b>	<b>0.9</b>

Table 20: Monthly average DT of TashiCell

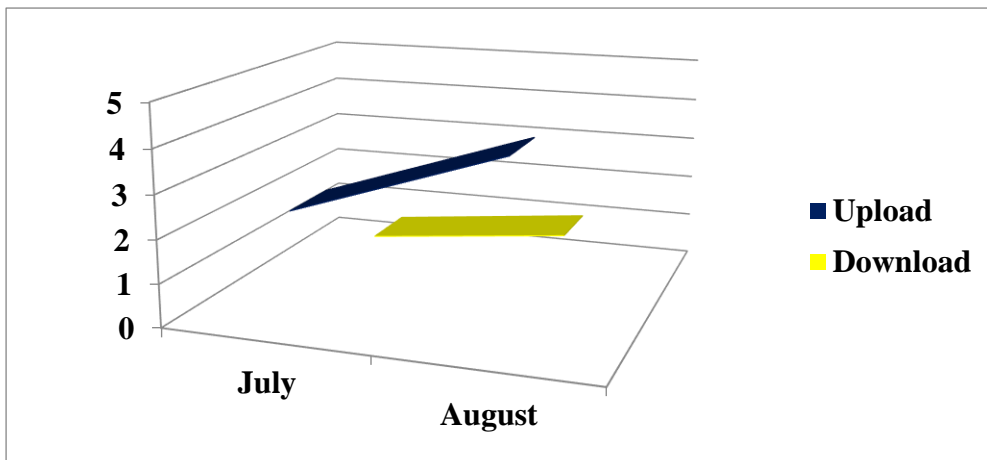


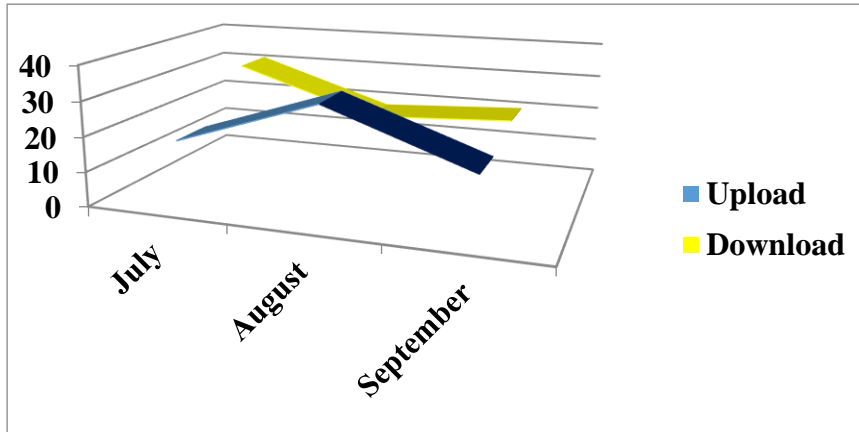
Figure 12: Monthly DT of TashiCell

b. 4G

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

Sl.No	Month	Location	Average DT (Mbps)	
			Upload	Download
1	July	Thimphu (Motithang)	17.7	31.6
2	August	P/ling(Town area)	31.5	18.7
3	September	Paro (Olathang and Town)	16.8	20.8
<b>Average</b>			<b>22</b>	<b>23.7</b>

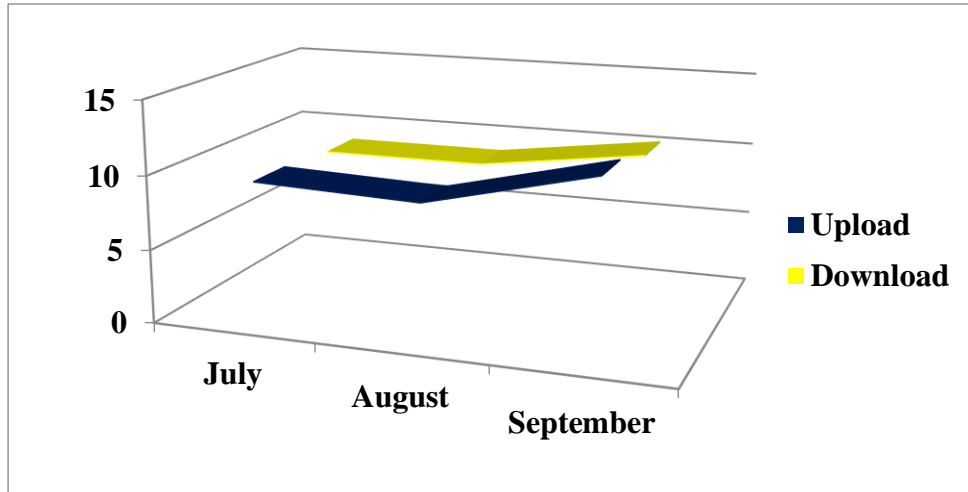
*Table 21: Monthly average DT of B-Mobile*



*Figure 13: Monthly DT of B-Mobile*

Sl.No	Month	Location	Average DT (Mbps)	
			Upload	Download
1	July	Thimphu (Motithang)	9.3	8.9
2	August	P/ling(Town area)	8.9	8.9
3	September	Paro (Olathang and Town)	11.6	10.4
<b>Average</b>			<b>9.9</b>	<b>9.4</b>

*Table 22: Monthly average DT of TashiCell*



*Figure 14: Monthly DT of TashiCell*

## **7. FINDING**

### **a. Voice Service**

- In general, both B-Mobile and TashiCell did not face any Call-Drop issue in the month of July, August and September.
- The Call Set-Up Time for both service providers exceeded the regional benchmark. The Call Set-Up Time was found much higher for the 4G network compared to the 3G network. This is because in the 4G network, when users make a call the voice call must fall-back to either 3G or 2G network.
- The average Mean Opinion Score (MOS) for both B-Mobile and TashiCell clearly indicates the availability of good quality of voice services in Thimphu (Motithang), Phuntsholing (Town) and Paro (Olathang and Town) .

### **b. Data Service**

- The Data Completion Rate (DCR) was excellent for B-mobile for both 3G and 4 G network with 100% completion. In case of T-cell the Data Completion Rate (DCR) was excellent for 3G network with 100% completion and good for 4G network with 98.9% completion.
- The 3G data throughput (HTTP) of B-mobile and TashiCell did not face any difficulties while uploading as the average up-load throughput was found above the regional benchmark. However, both the service providers experienced difficulties while downloading as the average download throughput was found below the regional benchmark.
- The 4G data throughput (HTTP) of B-Mobile was found to be much higher than that of TashiCell. On average, B-Mobile had a DT throughput of 22 Mbps (Up-load) and 23.7Mbps (down-load) when compared to 9.9 Mbps(up-load) and 9.4Mbps(down-load) 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 Phuntsholing, 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