# Quarterly Report on Frequency Spectrum Monitoring

(January - March 2025)



# Bhutan InfoComm and Media Authority Royal Government of Bhutan

# **Table of Contents**

1. Background	3
2. Monitoring	3
3. Objective of Spectrum Monitoring	4
4. Details of the Equipment used for Fixed and Mobile Spectrum Monitoring	4
a. Fixed Spectrum Monitoring	4
b. Mobile Spectrum Monitoring	4
5. Methodology	5
a. Fixed Spectrum Monitoring	5
b. Mobile Spectrum Monitoring	5
6. Findings	6
i. Fixed Spectrum Monitoring in Thimphu	6
1. Spectrum Occupancy Monitoring for 4G 2300 transmitters	6
2. Spectrum Occupancy Monitoring for 4G 1800 transmitters	6
3. Spectrum Occupancy Monitoring for 3G transmitters	7
ii. Mobile Spectrum Monitoring using the DF equipment	8
7. Follow up	22
Annexure 1	23
Annexure 2	24
Annexure 3	25

## 1. Background

Spectrum monitoring is the practice of maintaining and monitoring the network or devices that use Radio Frequency (RF) signals and frequencies. Due to the growing demands on the radio frequency spectrum, it is critical that spectrum monitoring is consistently carried out and also keep track with advanced techniques in radio communication technology. Spectrum monitoring is carried out mainly to ensure that technical parameters and standards or guidelines for radiocommunication systems are adhered to by the users. In addition spectrum monitoring assists in promoting the efficient utilization of the radio frequency spectrum.

Spectrum Monitoring is closely associated with inspection and compliance that enables the identification and measurement of spectrum usage, interference sources, the verification of proper technical and operation characteristics of radiated signals, and detection and identification of illegal transmitters. The Monitoring further supports the overall spectrum management effort by providing general measurement of channel and band usage, including the channel availability and measure of spectrum occupancy.

The Bhutan InfoComm and Media Authority conducts fixed and mobile spectrum monitoring to ensure that spectrum use complies with the National Radio Rules and Regulations. The monitoring can detect, identify and resolve the unauthorized transmission or interference, verify technical and operational parameters, and to monitor occupancy and field strength.

## 2. Monitoring

To ensure effective and proper utilization of spectrum, to control unauthorized transmission and to ensure compliance of equipment and stations with the the National Radio Rules and Regulation, the Authority has monitored the fixed and mobile spectrum from January to March, 2025 in following places;

SI. No	Monitored Places	Monitored Frequency
1.	Thimphu (Fixed Spectrum Monitoring)	3G Frequencies 860-895 MHz
2.	Sarpang and Tsirang (Mobile Spectrum Monitoring using DF equipment)	2G, 3G, 4G, 5G and FM frequencies
3.	Thimphu (Fixed Spectrum Monitoring)	4G TDD 2300 Frequencies
4.	Thimphu (Fixed Spectrum Monitoring )	4G 1800 Frequencies

## 3. Objective of Spectrum Monitoring

The main objective of the Spectrum measurement monitoring is:

- a. To ensure the authorized spectrum for proper application in conformity with the licensing terms and conditions.
- b. To survey and inspect radio communication systems.
- c. To ensure compliance of transmitters and stations with the National Radio Rules and Regulations.
- d. To detect and identify unauthorized transmission.
- e. To determine the spectrum occupancy, field strength and assessment of channel availability which will be useful for proper spectrum planning and management.

## 4. Details of the Equipment used for Fixed and Mobile Spectrum Monitoring

The details of existing Spectrum monitoring equipment of the Authority are as mentioned below:

#### a. Fixed Spectrum Monitoring

Equipment Make/Model:	LS Telecom FMU308w
Type of the Antenna:	HF/VHF/UHF/SHF omni-directional antenna
Monitoring Receiver:	FMU supports frequency range from 9kHz to 8GHz
Calibration details:	Calibrated on 15-02-2023 and valid up to 2 to 3 years

#### b. Mobile Spectrum Monitoring

Equipment Make/Model:	Narda SignalShark 3310
Type of the Antenna:	HF/VHF/UHF/SHF directional antennas
Spectrum Analyzer/Receiver:	Frequency range for the receiver is from 8KHz to 8GHz
Calibration details:	Calibrated on 23-01-2023 and valid up to 2 to 3 years

## 5. Methodology

The Spectrum measurement monitoring was carried out as mentioned below;

## a. Fixed Spectrum Monitoring

The fixed spectrum monitoring was done with the Fixed Monitoring equipment and LS Observer software for the transmission frequency signals. The Fixed Monitoring equipment is fixed to a particular location and the monitoring is usually done through the scanning of the frequency and obtaining its transmission and reception characteristics.



Figure 1: Fixed Spectrum Monitoring

## b. Mobile Spectrum Monitoring

The Mobile Spectrum Monitoring was carried out using the DF monitoring equipment which was mounted in the roof of the car. These vehicles are passenger cars used to carry equipment and antennas. The antenna array used for DF and monitoring is mounted in an unobtrusive roof-top carrier mounted directly to the luggage rack on the roof of the car. The monitoring and DF equipment is mounted in the luggage area at the rear of the car.



Figure 2: Mobile Spectrum Monitoring

## 6. Findings

# i. Fixed Spectrum Monitoring in Thimphu

#### 1. Spectrum Occupancy Monitoring for 4G 2300 transmitters

- a. The team has carried out the fixed Spectrum Monitoring for 4G transmitter frequencies ranging from 2300 MHz to 2390 MHz.
- b. During the monitoring in Thimphu, we have found out that following frequency are actively operating and occupied the band;

SI.	Frequency Range	Spectrum Occupancy	Remark
1	2300-2310 MHz	Not occupied	Channel is free
2.	2320 MHz	Occupied band is 50%	These Frequencies are actively operated by BTL.
3	2330 MHz	Occupied band is 48%	These Frequencies are actively operated by BTL.
4	2340 MHz	Occupied band is 49%	These Frequencies are actively operated by BTL.
5.	2350 MHz	Occupied band is 45%	These Frequencies are actively operated by BTL.
6.	2360 MHz	Not Occupied	Operation is inactive
7.	2370 MHz	Not Occupied	Operation is inactive.
8.	2380 MHz	Not Occupied	Operation is inactive.
59	2390 MHz	Not Occupied	Operation is active

c. The details of the spectrum occupancy result are attached in **annexure 1**.

- d. No illegal operations were detected so far in the 4G transmitter.
- e. There is no out of band transmission from 4G transmitters. The detailed findings are attached **annexure 1**.
- f. The channels are free in 2300- 2310 Mhz.

#### 2. Spectrum Occupancy Monitoring for 4G 1800 transmitters

- a. The team has carried out the fixed Spectrum Monitoring for 4G transmitter frequencies ranging from 1800 MHz to 1890 MHz.
- b. During the monitoring in Thimphu, we have found out that following frequency are actively operating and occupied the band;

SI.	Frequency Range	Spectrum Occupancy	Remark	
1	1800-1810 MHz	Not occupied	Channel is free	

2.	1820 MHz	Occupied band is 99%	These Frequencies are actively operated by BTL.
3	1830 MHz	Occupied band is 93%	These Frequencies are actively operated by BTL.
4	1840 MHz	Occupied band is 94%	These Frequencies are actively operated by BTL.
5.	1850 MHz	Occupied band is 90%	These Frequencies are actively operated by TICPL.
6.	1860 MHz	Occupied band is 77%	These Frequencies are actively operated by TICPL.
7.	1870 MHz	Occupied band is 65%	These Frequencies are actively operated by TICPL.
8.	1880 MHz	Occupied band is 84%	These frequencies are actively operated by TICPL.
59	1880-1890 MHz	Not Occupied	Channel is free

c. The details of the spectrum occupancy result are attached in **annexure 2.** 

d. No illegal operations were detected so far in the 4G transmitter.

e. There is no out of band transmission from 4G transmitters. The detailed findings are attached **annexure 2**.

f. The channel are free in 1800- 1810 Mhz and 1880 MHz-1890 MHz

#### 3. Spectrum Occupancy Monitoring for 3G transmitters

- a. The team has carried out the fixed Spectrum Monitoring for 3G transmitter frequencies ranging from 860MHz to 899 MHz.
- b. During the monitoring in Thimphu, we have found out that following frequency are actively operating and occupied the band;

SI.	Frequency Range	Spectrum Occupancy	Remark
1	860- 868 MHz	Not occupied	Channel is free
2.	869.00 MHz	Occupied band is 10%	It is a down link Frequencies and actively operated by TIPL.
3.	872.50 MHz	Occupied band is 20%	It is a down link Frequencies and actively operated by TIPL.
4.	877.50 MHz	Occupied Band is 44%	It is a down link Frequencies and actively operated by TIPL.
5.	882.50 MHz	Occupied Band is 57%	It is a down link Frequencies and actively operated by BTL.

6.	887.50 MHz	Occupied Band is 64%	It is a down link Frequencies and actively operated by BTL.
7.	890-899 MHz	Not Occupied	Channel is free

- c. The details of the spectrum occupancy result are attached in **annexure 3**.
- d. No illegal operations were detected so far in the 3G transmitter.
- e. There is no out of band transmission from 3G transmitters. The detailed findings are attached **annexure 3**.
- f. The channel are free in 860-868 MHz and 890 MHz-899 MHz

## ii. Mobile Spectrum Monitoring using the DF equipment

1. The detailed monitoring activities carried out using the DF equipment for triangulation and localization test at **Sarpang** and **Tsirang** are mentioned below:

#### a. Gelephu for 944 MHz for 2G Signal

The monitoring team carried out the DF monitoring by keeping two receiver at different location, one in Gelephu Thromde and another in Gelephu Lodray while doing the triangulation, we could able to detect the location of 2G transmitter for 944 MHz frequency at Longitude (26.89111), Latitude (90.48559) near the Pemathang of Tashi Infocom Private limited tower as shown below:



Figure 1: Triangulation Result



Figure 2: Heat Map for Trigulation

#### b. Jigmeling, Sarpang for 96 MHz Radio Signal

The monitoring team carried out the DF monitoring by keeping the two receiver at different location, one in Bhur and another in Jimeling while doing the doing the triangulation, we could able to detect the location of transmitter for 96 MHz frequency at **Longitude (26.92257)**, **Latitude (90.42106)** near Samtenling and exact location of transmitter is below Samtenling Gewog as shown below:



Figure 3: Triangulation Result



Figure 4: Heat Map Triangulation

#### c. Bhur, Sarpang for 880 MHz frequency of 3G transmitter

The monitoring team carried out the DF monitoring by keeping two receiver at different location, one in Bhur and another in Jimeling while doing the triangulation, we could able to detect the location of 2G transmitter for 880 MHz frequency at **Longitude (26.92054)**, **Latitude (90.42953)** above Bhur top and exact location transmitter below Samtenling of Bhutan Telecom Limited tower as shown below:



Figure 5: Localization Result



Figure 6: Heat Map for Localization

## d. Bhur, Sarpang for 935.3 MHz frequency of 2G transmitter.

The monitoring team carried out the DF monitoring by keeping the two receiver at different location, one in Bhur and another in Jimeling while doing the doing the triangulation, we could able to detect the location of transmitter for 935.3 MHz frequency at **Longitude (26.9155)**, **Latitude (90.42466)** above highway road, Bhur (Saprpang) tower of Bhutan Telecom Limited as shown below:



Figure 7: Triangulation Result



Figure 8: Heat Map for Triangulation

#### e. Shershong, Sarpang for 102.3 MHz frequency of FM transmitter

The monitoring team carried out the DF monitoring by keeping the two receiver at different location, one in Shershong Gewog Center and another in Chuzaygang while doing the doing the triangulation, we could able to detect the location of transmitter for 102 MHz frequency at Longitude (26.85165), Latitude (90.48525) near Hatisar Playground in India and its external signal as shown below:



Figure 9: Triangulation Result



Figure 10: Heat Map for Triangulation

#### f. Sarpang Dzong for 1.87 GHz frequency of 4G transmitter

The monitoring team carried out the DF monitoring by keeping the two receiver at different location, one in Sarpang Dzong and another in Sarpang Town while doing the doing the triangulation, we could able to detect the location of transmitter for 1.87 GHz frequency at **Longitude (26.86994)**, **Latitude (90.271)** near Shompangkha Top as transmitter to is located at Shompangkha top of tower for Tashi Infocom Private limited as shown below:



Figure 11: Triangulation Result



Figure 12: Heat Map for Triangulation

## g. Chuzaygang, Sarpang 885 MHz frequency of 3G transmitter

The monitoring team carried out the DF monitoring by keeping the two receiver at different location, one in Chuzaygang and another in Shershong Gewog Center while doing the triangulation, we could able to detect the location of transmitter for 885 MHz frequency at **Longitude (26.87868)**, **Latitude (90.51083)** Nera Chuzaygang as transmitter to is located at Chuzaygang Top forBhutan Telecom Limited BTS Tower as shown below:



Figure 13: Tringuation Result



Figure 14: Heat Map for Triangulation

. . . . . . . . . . . .

#### h. Sarpang Dzong for 1.84GHz frequency of 4G Transmitter

The monitoring team carried out the DF monitoring by keeping the two receiver at different location, one in Sarpang Dzong and another in Sarpang Town while doing the triangulation, we could able to detect the location of transmitter for 1.84 GHz frequency at **Longitude (26.87352)**, **Latitude (90.26576)** near Sarpang Checkpost as transmitter to is located at above check post, Sarpang for Bhutan Telecom BTS Tower as shown below:



Figure 15: Localization Result



Figure 16: Heat Map for Localization

#### i. Sarpang Town for 875 MHz frequency of 3G transmitter

The monitoring team carried out the DF monitoring by keeping the two receiver at different location, one in Sarpang Dzong and another in Sarpang Town while doing the triangulation, we could able to detect the location of transmitter for 875 MHz frequency at **Longitude (26.87914)**, **Latitude (90.24921)**, above Sarpang Town as transmitter to is located at Jogi Dara for TIPL BTS Tower as shown below:



Figure 17: Triangulation Result



Figure 18: Heat Map for Triangulation

.....

#### j. Damphu, Tsirang for 104.100 MHz frequency of FM transmitter

The monitoring team carried out the DF monitoring by keeping the two receiver at different location, one in Damphu, Tsirang and another in Tsirang monitoring station while doing the triangulation, we could able to detect the location of transmitter for 104.100 MHz frequency at **Longitude (26.97758)**, **Latitude (90.09206)**, near Rangthangling Gewog as transmitter to is located at Top of the Rangthangling transmitter is from Kuzoo FM as shown below:



Figure 19: Triangulation Result



Figure 20: Heat Map for Triangulation

## k. Damphu, Tsirang for 937.5 MHz frequency of 2G transmitter

The monitoring team carried out the DF monitoring by keeping the two receiver at different location, one in Damphu, Tsirang and another in Tsirang Monitoring station while doing the triangulation, we could able to detect the location of transmitter for 937.5 MHz frequency at **Longitude (26.97697), Latitude (90.11555),** near Rangthagling as transmitter to is located at top of the Rangthangling for Bhutan Telecom Limited .BTS Tower as shown below:





Figure 22: Heat Map for Tringulation

#### I. Damphu, Tsirang for 92.00 MHz frequency of FM transmitter

The monitoring team carried out the DF monitoring by keeping the two receiver at different location, one in Damphu, Tsirang and another in Tsirang Monitoring Station while doing the triangulation, we could able to detect the location of transmitter for 92.00 MHz frequency at Longitude (26.96828), Latitude (90.10463), near Rangthangling as the transmitter is located at Top of the Rangthangling for BBS tower as shown below:



Figure 23: Triangulation Result



Figure 24: Heat Map for Tringulation

#### m. Tsirang Monitoring Station for 937.8 MHz frequency of 2G transmitter

The monitoring team carried out the DF monitoring by keeping the two receiver at different location, one in Damphu, Tsirang and another in Tsirang Monitoring station while doing the triangulation, we could able to detect the location of transmitter for 937.5 MHz frequency at **Longitude (26.95609), Latitude (90.1421),** near Mendrelgang as transmitter to is located at Mendrelgang Top, Dupy Dara for Bhutan Telecom Limited BTS Tower as shown below:



Figure 25: Triangulation Result



Figure 26: Heat Map for Trigulation

.....

#### n. Tsirang Monitoring Station for 883 MHz frequency of 3G transmitter

The monitoring team carried out the DF monitoring by keeping the two receiver at different location, one in Damphu, Tsirang and another in Tsirang Monitoring station while doing the triangulation, we could able to detect the location of transmitter for 937.5 MHz frequency at **Longitude (26.95105)**, **Latitude (90.13992)**, near Mendrelgang and exact transmitter location is Top of the Mendrelgang for Bhutan Telecom Limited.BTS Tower as shown below:



Figure 27: Triangulation Result



Figure 28: Heat Map for Trigulation

## 7. Follow up

i. The Authority has to maintain the database for any spectrum signal detected during the monitoring from the outside country.

ii. The authority will continue monitoring the spectrum occupancy for 2G, 3G, 4G and 5G in different places.

iii. The Authority will compare the fixed and mobile spectrum monitoring result with the frequency assigning database to see whether they are operating illegally or not.

vi. The authority will continue monitoring the Fixed Spectrum Monitoring in Thimphu and Tsirang.

v. The Authority has to practise more and periodically (once in a month or two) on DF Monitoring system to find out the accurate bearing and to get more familiar with the DF monitoring system.

iv. The authority will keep the record of external radio signal and transmission location which was obtained from the DF monitoring result.

## Annexure 1

The following are the details of the system generated spectrum occupancy report monitoring for 4G TDD 2300 band (4G) transmitter frequencies ranging from 2300 MHz to 2399 MHz.

## Measurement Receiver Settings

Name:	<b>Re2300 4G March 2025</b>		
Mode:	Frequency Range Freq. Range:	2.30 GHz - 2.39 GHz RBW:	12.50 kHz
Step Width:	12.44 kHz		
Start Time:	3/31/2025 6:55:00 AM		
Stop Time:	3/31/2025 7:55:00 AM		
Duration:	1 Hour 0 Minute 0 Second		

0 dB

Channel Name	Main Frequency	Bandwidth		Occupancy [%]		
Name	Frequency		Max	Avg	Min	
S1	2.31 GHz	10.00 MHz	0	0	0	
S2	2.32 GHz	10.00 MHz	56	50	46	
S3	2.33 GHz	10.00 MHz	53	48	44	
S4	2.34 GHz	10.00 MHz	52	49	43	
S5	2.35 GHz	10.00 MHz	51	45	38	
S6	2.36 GHz	10.00 MHz	0	0	0	
S7	2.37 GHz	10.00 MHz	0	0	0	
S8	2.38 GHz	10.00 MHz	0	0	0	
S9	2.39 GHz	10.00 MHz	0	0	0	

## Annexure 2

The following are the details of the system generated spectrum occupancy report monitoring for 3G frequency range 860-890 MHz from the fixed monitoring equipment.

#### Measurement Receiver Settings

Name:	850 UMTS for 3G March 27, 2025			
Mode:	Frequency Range Freq. Range:	860.00 MHz - 895.00 MHz		
RBW:	25.00 kHz			
Step Width:	24.73 kHz			
Start Time:	3/27/2025 9:05:00 AM			
Stop Time:	3/27/2025 9:45:00 AM			
Duration:	40 Minutes 0 Second			

Attenuation: Auto

Channel Name	Main Frequency	Bandwidth	Occupancy [%]		
			Max	Avg	Min
S1	862.50 MHz	5.00 MHz	0	0	0
S2	867.50 MHz	5.00 MHz	5	1	0
S3	872.50 MHz	5.00 MHz	3	1	0
S4	877.50 MHz	5.00 MHz	52	44	39
85	882.50 MHz	5.00 MHz	63	57	54
S6	887.50 MHz	5.00 MHz	67	64	62
S7	892.50 MHz	5.00 MHz	0	0	0

#### Annexure 3

The following are the details of the system generated spectrum occupancy report monitoring for 4G frequency range 1.80-1.890 GHz from the fixed monitoring equipment.

#### Measurement Receiver Settings

Name:	<b>Re-1800 March 2025</b>				
Mode: 12.50 kHz	Frequency Range Freq. Range:	1.80 GHz - 1.90 GHz RBW:			
Step Width:	12.44 kHz				
Start Time:	3/31/2025 8:10:00 AM				
Stop Time:	3/31/2025 9:25:00 AM				
Duration:	1 Hour 15 Minutes 0 Second				

Attenuation:

0 dB

Occupancy [%] Channel Main Bandwidth Name Frequency Min Max Avg 0 **S**1 1.81 GHz 10.00 MHz 0 0 S2 99 99 98 1.82 GHz 10.00 MHz S3 1.83 GHz 10.00 MHz 96 93 90 S4 1.84 GHz 10.00 MHz 96 94 92 93 90 S5 1.85 GHz 10.00 MHz 86 S6 1.86 GHz 10.00 MHz 83 77 72 59 S7 1.87 GHz 10.00 MHz 73 65 89 79 **S**8 1.88 GHz 10.00 MHz 84 S9 10.00 MHz 0 0 0 1.89 GHz