TELECOM REGULATORY AUTHORITY OF INDIA

Independent Drive Test Report

UP-West LSA

February 2025

Contents

1. Introduction

TRAI Act, 1997 mandates the Authority to ensure the services delivered through various telecommunications networks meet required quality standards prescribed, to protect the interest of the consumers of telecommunication services. TRAI is also responsible for conducting the periodical audit of such services provided by the service providers so as to protect the interest of the consumers of telecommunications service.

Accordingly, TRAI has engaged M/s RedMango Analytics Pvt. Ltd. to undertake assessment of Quality of Service of mobile service through Independent Drive Test (IDT).

In IDT, the performance of all service providers providing service in a Licensed Service Area (LSA) through various technologies (like 2G/ 3G/ 4G/ 5G) for voice and data are measured by conducting drive test. The drive test routes are finalised based on various objective criteria like reported network performance, consumer complaints etc. Methodology adopted for conducting IDT is elaborated in **APPENDIX-I**.

2. Executive Summary (LSA)

2.1 Drive test details

This report covers the findings of the IDT undertaken in UP-West License Service Area (LSA) during the month of February-2025 under the supervision of TRAI Regional Office (RO), Bhopal. Details of route / area covered during the IDT is as given below:

Sl. No	Drive test route	Type of route	Distance covered (KMs)	From date	To date
1	Dehradun	City	227.5	04-Feb-2025	05-Feb-2025
2	Dehradun	Hotspot	9 Locations	06-Feb-2025	07-Feb-2025

Table-1: Drive test summary

2.2 Drive test routes

The map provides overview of drive test routes indicating city drive and hotspots as per the legends shown on the map.
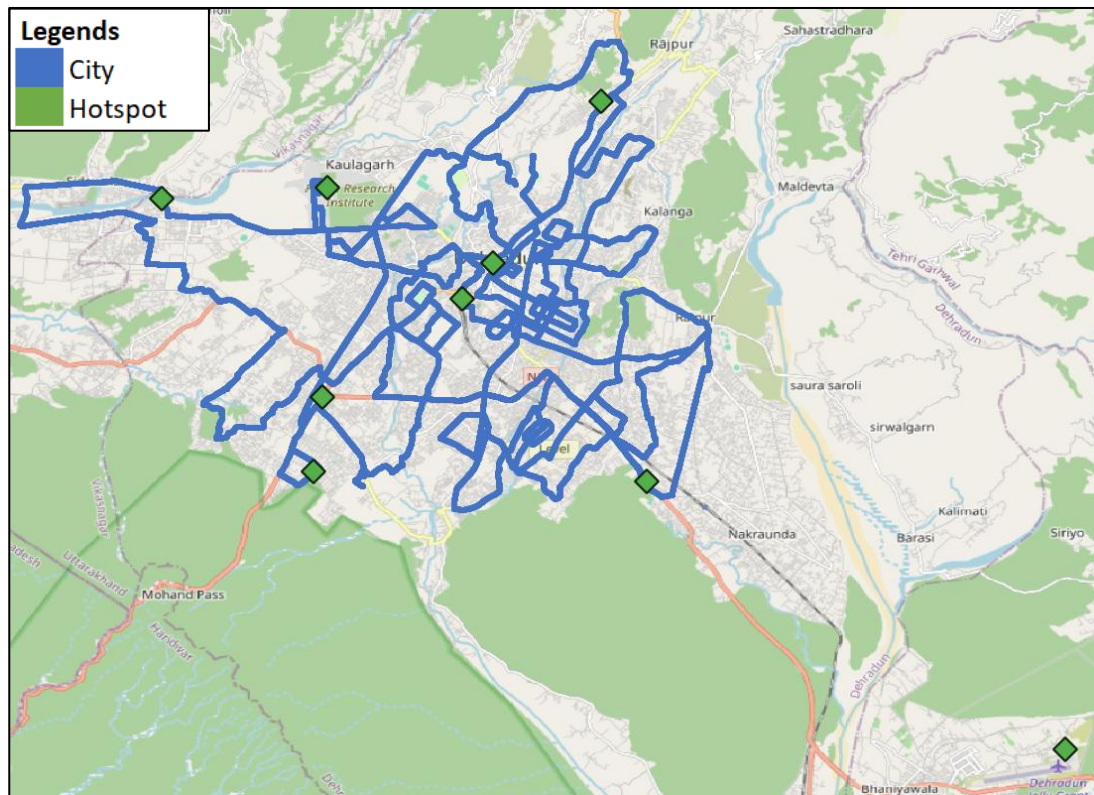
Figure-1: Drive test routes

2.3 Summary of areas covered

a) City- Nearby Subhashnagar, Saharanpur, ISBT Road, Rajpur Mussoorie Road, Raipur Road, Forest Research Institute, Smithnagar and Harbhajwala etc.

b) Hotspot-
1. Dehradun Railway Station
2. Jolly Grant Airport
3. Forest Research Institute (FRI), Dehradun
4. Pacific Mall, Dehradun
5. Mall of Dehradun
6. Uttaranchal University
7. Ghantaghar, Dehradun
8. ISBT, Dehradun
9. Graphic ERA College, Dehradun

## 2.4 Telecom service providers detected frequency bands

Technologies covered during the IDT and frequency bands in use are summarised in below table

S.no.	Name of TSP	Technology	Frequency Bands (In MHz)
1	Bharti Airtel Ltd.	2G	1800
2	Bharti Airtel Ltd.	4G	850, 1800, 2100, 2300
3	Bharti Airtel Ltd.	5G	3500
4	BSNL	2G	900
5	BSNL	3G	2100
6	BSNL	4G	700,2100
7	Reliance JIO Infocomm Ltd.	4G	850,1800,2300
8	Reliance JIO Infocomm Ltd.	5G	700,3500
9	Vodafone Idea Ltd.	2G	900
10	Vodafone Idea Ltd.	4G	900,1800, 2100,2500

Table-2: Telecom service provider (TSP) covered in IDT

2.5 Performance against key QoS parameters

CSSR: Call setup success rate, **CST:** Call setup time, **DCR:** Drop call rate
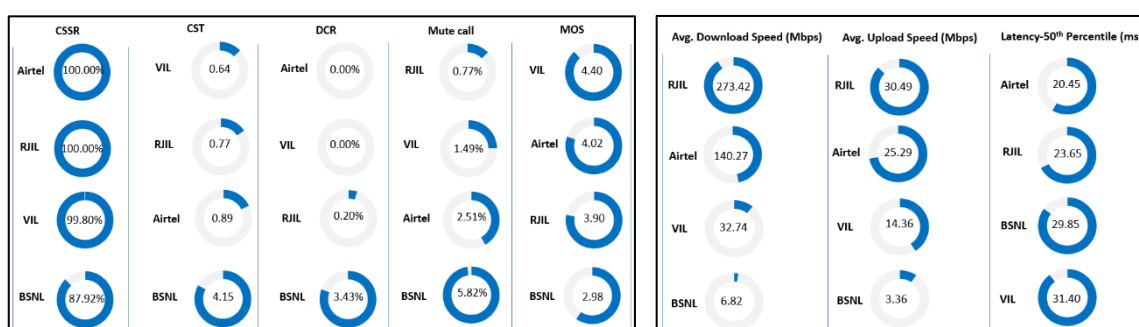
Summary-Voice Service

Call Setup Success Rate: Airtel, BSNL, RJIL and VIL have call setup success rate of 100.00%, 87.92%, 100.00% and 99.80% respectively in Auto-selection mode (5G/4G/3G/2G).

Call Setup Time: Airtel, BSNL, RJIL and VIL have call setup time of 0.89, 4.15, 0.77 & 0.64 seconds respectively in Auto-selection mode (5G/4G/3G/2G).

Drop Call Rate: Airtel, BSNL, RJIL and VIL have drop call rate of 0.00%, 3.43%, 0.20% and 0.00% respectively in Auto selection mode (5G/4G/3G/2G).

Call Silence/Mute Rate: Airtel, BSNL, RJIL and VIL have silence call rate of 2.51%, 5.82%, 0.77% & 1.49% respectively in packet switched network (4G/5G).

Mean Opinion Score (MOS): Airtel, BSNL, RJIL and VIL have MOS score of 4.02, 2.98, 3.90 & 4.40 respectively.

Summary-Data Service

Data Download performance (Dynamic): BSNL and VIL operating on 4G/3G technologies have average download speed of 6.82 Mbps and 32.74 Mbps respectively. Whereas Airtel and RJIL operating on 4G/5G technologies have average download speed of 140.27 Mbps and 273.42 Mbps respectively.

Data Upload performance (Dynamic): BSNL and VIL operating on 4G/3G technology have average upload speed of 3.36 and 14.36 Mbps, respectively. Whereas Airtel and RJIL operating on 4G/5G technology have average upload speed of 25.29 Mbps and 30.49 Mbps respectively.

Data performance - Hotspots (in Mbps):
Airtel- 4G D/L: 3.96   4G U/L: 4.17
      5G D/L: 143.97 5G U/L: 20.83
BSNL- 4G D/L: 5.79   4G U/L: 3.72
RJIL- 4G D/L: 23.67 4G U/L: 4.78
      5G D/L: 251.33 5G U/L: 27.54
VIL-   4G D/L: 21.12 4G U/L: 17.35

Note- "D/L" Download speed, "U/L" Upload speed

QoS Performance Analysis-UP-West LSA

3. QoS performance analysis-LSA level

3.1 Overview

This section provides summary of overall QoS performance of the telecom service provider's network in the LSA by aggregating the results of drive tests conducted in the LSA during the month of February-2025 covering City and Hotspots. (Refer Table 1)

3.2 Voice performance

(a) Voice Call Performance in 3G/2G network mode only: 3G/2G network mode testing has been done to reflect experience for respective users as they have only 3G/2G compatible handsets.

Parameters	Service Provider		
	3G/2G network mode only		
	AIRTEL	BSNL	VIL
Call Attempts	363	396	382
Call Setup Success Rate %	95.87	98.48	99.74
Drop Call Rate %	0.00	1.03	0.00
Call Setup Time-Average (Second)	16.60	2.91	4.67
Handover Success Rate %	98.90	98.56	98.79

Table-3: Summary of voice call performance in 3G/2G network mode only.
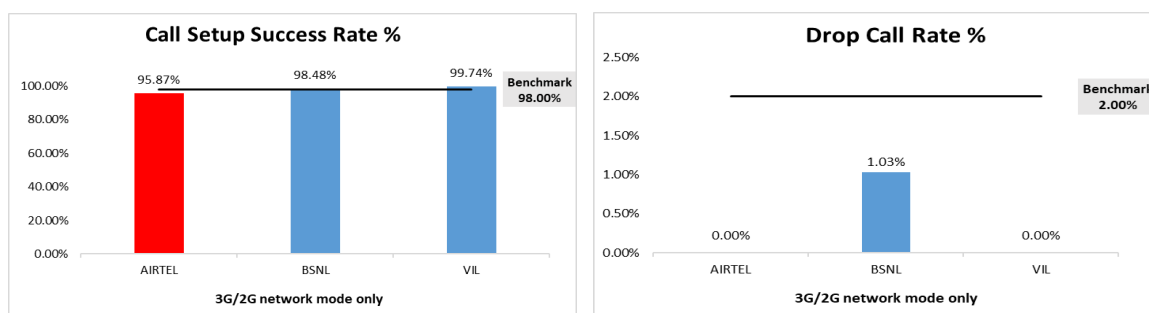
Figure-2: Call setup success rate and drop call rate performance.

Number of unique cell Id's covered in Voice test- Technology wise			
Technology	Service Provider		
	3G/2G network mode only		
	AIRTEL	BSNL	VIL
3G	NA	138	NA
2G	599	205	462

Table-4: Technology wise number of network cell Id's latched during drive test.

> **Note**-
> - RJIL does not have 3G/2G network.
> - NA- Service provider doesn't provide services in respective technology.

(b) Voice Call Performance in auto network selection mode (5G/4G/3G/2G)

Parameters	Service Provider Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Call Attempts	497	530	500	494
Call Setup Success Rate %	100.00	87.92	100.00	99.80
Drop Call Rate %	0.00	3.43	0.20	0.00
Call Setup Time-Average (Second)	0.89	4.15	0.77	0.64
Handover Success Rate %	100.00	100.00	99.76	100.00

Table-5: Summary of voice call performance in network auto-selection mode.
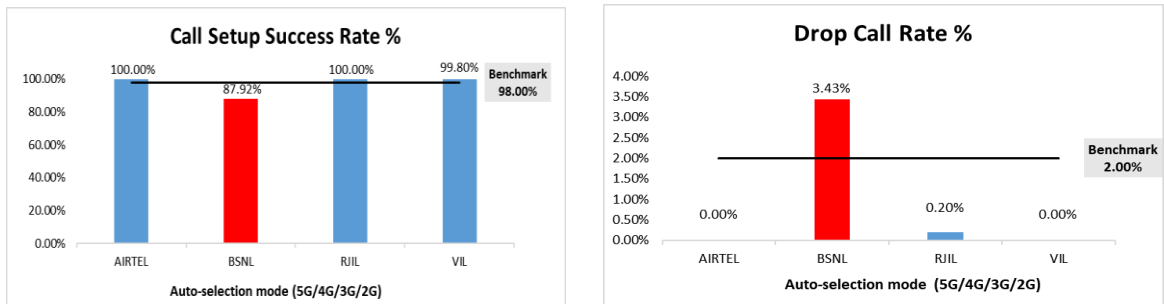
Figure-3: Performance for call setup success rate and drop call rate.

Parameter	Service Provider Mobile-to-Mobile (5G/4G - Open Mode)			
	AIRTEL	BSNL	RJIL	VIL
Call Established (within service provider Network)	399	361	389	402
Number of silence call for >4 Sec	10	21	3	6
Silence Call Rate %	2.51	5.82	0.77	1.49
Number of silence instances for >4 Sec	12	31	3	12
Number of silence instances for >3 Sec	13	46	5	17
Number of silence instances for >2 sec	21	69	15	31
RTP Jitter (4G & 5G) in ms	4.21	11.74	7.75	15.68
Packet loss Rate Downlink %	0.64	5.69	0.28	0.85
Packet loss Rate Uplink %	0.62	5.39	0.66	0.74

Table-6: Summary of silence instances & packet loss rate for mobile to mobile call.

Number of unique cell Id's covered in Voice test- Technology wise				
Technology	Service Provider Auto Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
5G	0	NA	476	NA
4G	995	380	1362	851
3G	NA	27	NA	NA
2G	0	67	NA	0

Table-7: Technology wise number of network cell Id's latched during drive test.

> **Note**-
> - NA- Service provider doesn't provide services in respective technology.
> - 0- No cell Id's were found in respective technology.

(c) Mean Opinion Score (MOS) performance for speech quality:

Mean opinion score indicates quality of speech observed during the drive test across different technologies. This parameter has been calculated for mobile-to-mobile calls made within same operator network in auto mode (5G/4G/3G/2G). As per ITU-T Recommendation P.863.1, MOS score values means: 5-Excellent, 4-Good, 3-Fair, 2-Poor, 1-Bad.

Speech Quality (MOS) distribution	Service Provider			
	AIRTEL	BSNL	RJIL	VIL
Total Number of MOS Samples for calls in table-6	2370	1654	2289	2324
Speech Quality (Average MOS Score)	4.02	2.98	3.90	4.40
Number of samples with MOS >=4 to <5 (Excellent)	1975	393	1614	1934
Number of samples with MOS >=3 to <4 (Good)	347	443	533	299
Number of samples with MOS >=2 to <3 (Fair)	29	484	106	71
Number of samples with MOS >=1 to <2 (Poor)	19	334	36	20
%age of samples with MOS >=4 to <5 (Excellent)	83.33%	23.76%	70.51%	83.22%
%age of samples with MOS >=3 to <4 (Good)	14.64%	26.78%	23.29%	12.87%
%age of samples with MOS >=2 to <3 (Fair)	1.22%	29.26%	4.63%	3.06%
%age of samples with MOS >=1 to <2 (Poor)	0.80%	20.19%	1.57%	0.86%

**Table-8:** Summary of speech quality (MOS) samples.
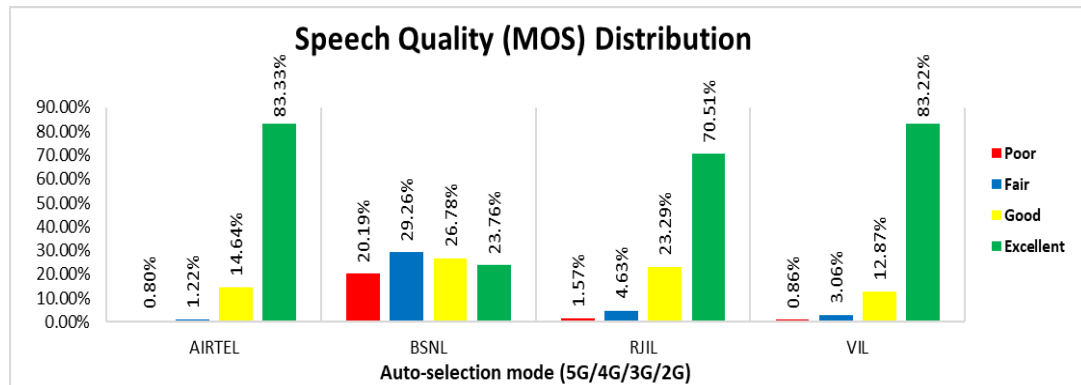
Figure- 4: Distribution of samples in MOS score range.

3.3 Data performance

(a) Data Parameters (Auto-selection mode- 5G/4G/3G/2G)

Parameters		Service Provider			
		Auto-selection mode (5G/4G/3G/2G)			
		AIRTEL	BSNL	RJIL	VIL
Download Throughput (Mbits/s)	Average	140.27	6.82	273.42	32.74
	80th Percentile	237.17	11.05	480.16	49.12
	20th Percentile	0.54	1.31	44.26	15.14
Upload Throughput (Mbits/s)	Average	25.29	3.36	30.49	14.36
	80th Percentile	45.97	3.90	55.79	23.58
	20th Percentile	1.73	1.44	3.76	5.23
Latency (ms)	50th Percentile	20.45	29.85	23.65	31.40

Table-9: Summary of data performance in network auto-selection mode.
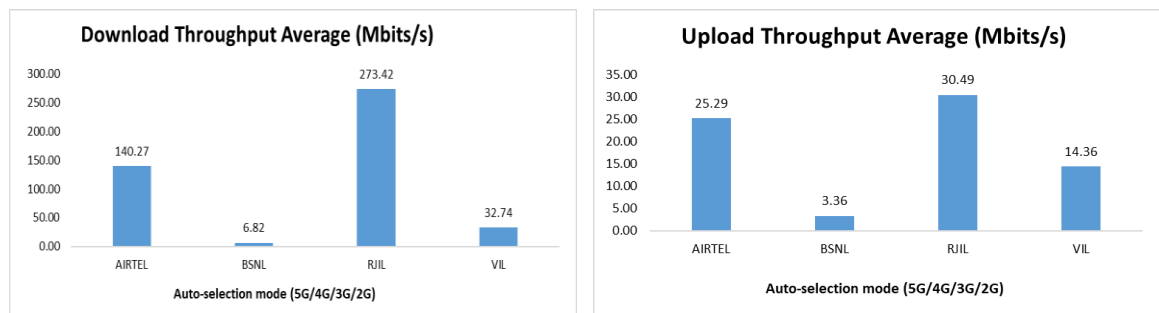
Figure- 5: Download and Upload throughput

Number of unique cell Id's covered in Data test- Technology wise					
Technology		Service Provider			
		Auto-selection mode 5G/4G/3G/2G			
		AIRTEL	BSNL	RJIL	VIL
5G		0	NA	592	NA
4G		1088	298	312	813
3G		NA	60	NA	NA
2G		10	1	NA	0

Table-10: Technology wise number of network cell Id's latched during drive test.

> **Note**-
> - NA**-** Service provider doesn't provide services in respective technology.
> - 0- No cell Id's were found in respective technology.

Detailed QoS Performance Analysis

4. Detailed QoS performance analysis

4.1 Overview

This section covers analysis on performance of various categories of drives like City and Hotspots for all telecom service providers, the results of drive tests conducted is shown individually for respective areas/locations.

4.2 City

Drive test has been conducted from 4th February 2025 to 5th February 2025 in Dehradun. (Refer Table-1)

4.2.1 Drive test route
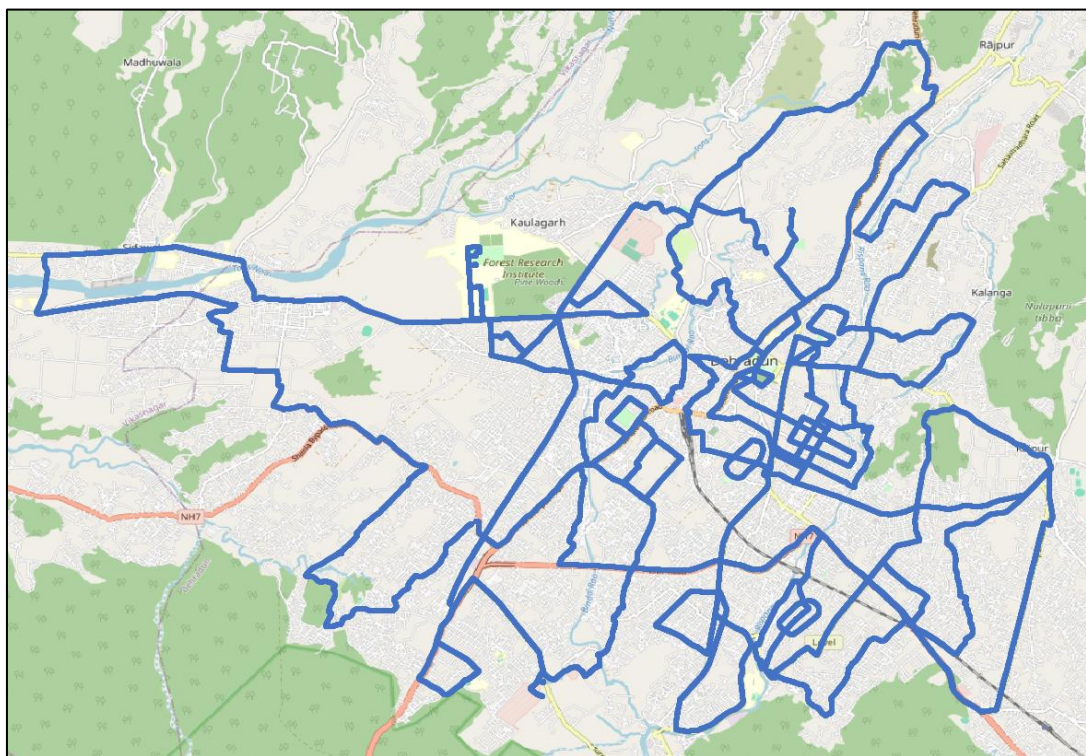
Figure- 6: Drive test routes

4.2.2 Areas covered

Nearby Subhashnagar, Saharanpur, ISBT Road, Rajpur Mussoorie Road, Raipur Road Forest Research Institute, Smithnagar and Harbhajwala etc.

4.2.3 Voice performance

(a) Voice Call Performance in 3G/2G network mode only: 3G/2G network mode testing has been done to reflect experience for respective users as they have only 3G/2G compatible handsets.

| Parameters | Service Provider | | |
	3G/2G network mode only		
	AIRTEL	BSNL	VIL
Call Attempts	363	396	382
Call Setup Success Rate %	95.87	98.48	99.74
Drop Call Rate %	0.00	1.03	0.00
Call Setup Time-Average (Second)	16.60	2.91	4.67
Handover Success Rate %	98.90	98.56	98.79

Table-11: Summary of voice call performance in 3G/2G network mode only**.**
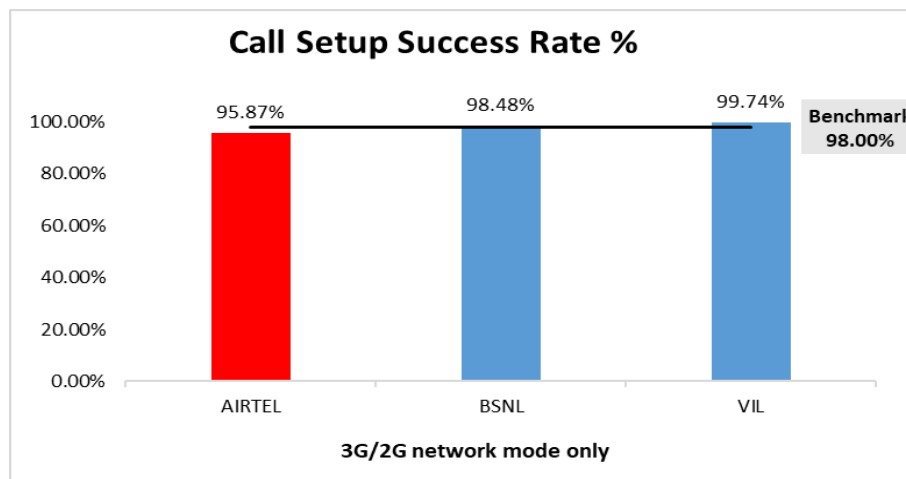
Figure-7: Performance for call setup success rate.
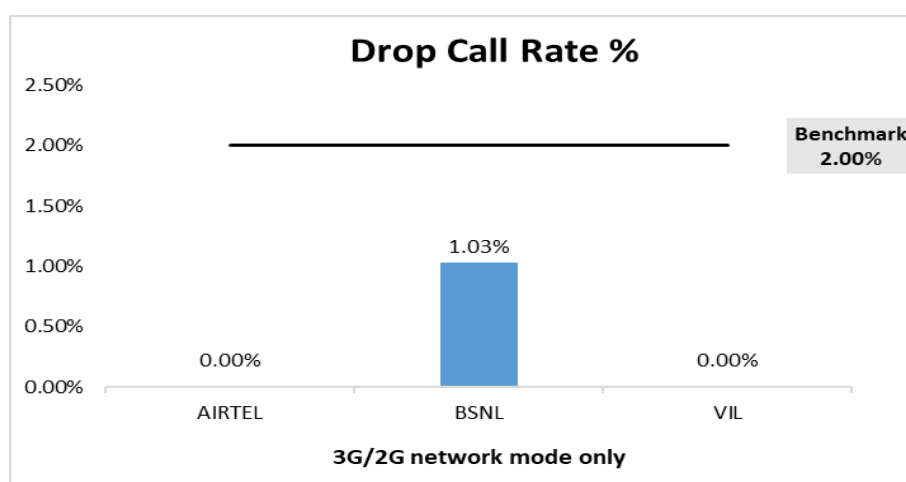
Figure-8: Performance for drop call rate.

(b) Network Technology: This section represent time spent on various network technologies.

Technology	Service Provider		
	AIRTEL	BSNL	VIL
3G	NA	14.61%	NA
2G	99.95%	85.37%	99.95%
Limited Service	0.05%	0.02%	0.05%

Table-12: Time spent on technology during drive test 3G/2G network mode.

Note-
* NA- Service provider doesn't provide services in respective technology.
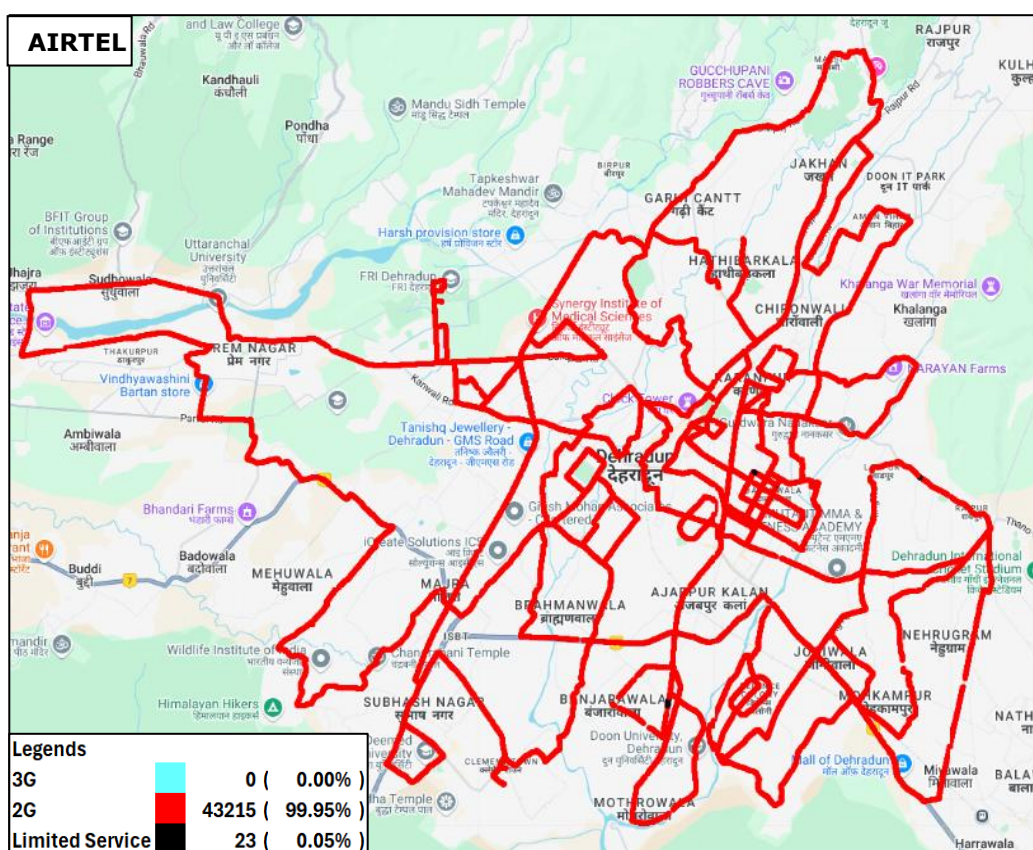
Figure-9: Serving technology plots 3G/2G network mode – AIRTEL.

Legends		
3G		6480 (14.61%)
2G		37851 (85.37%)
Limited Service		9 (0.02%)
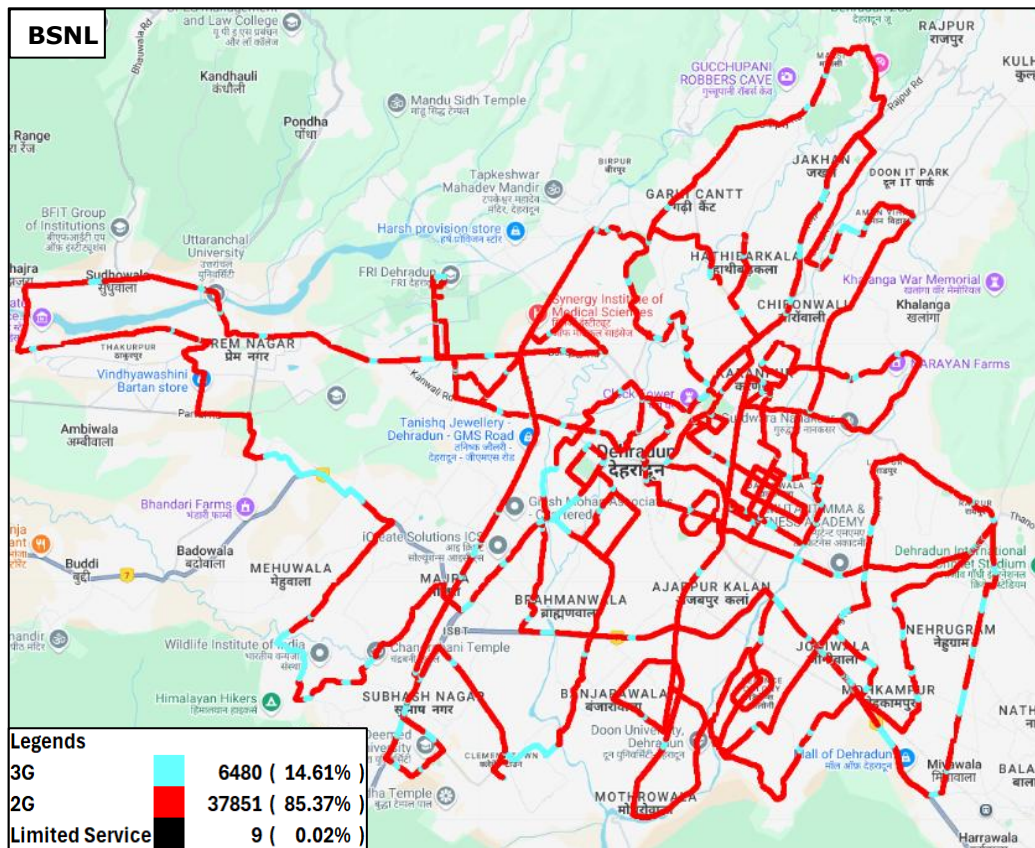
Figure-10: Serving technology plots 3G/2G network mode –BSNL.

Legends		
3G		0 (0.00%)
2G		42379 (99.95%)
Limited Service		20 (0.05%)
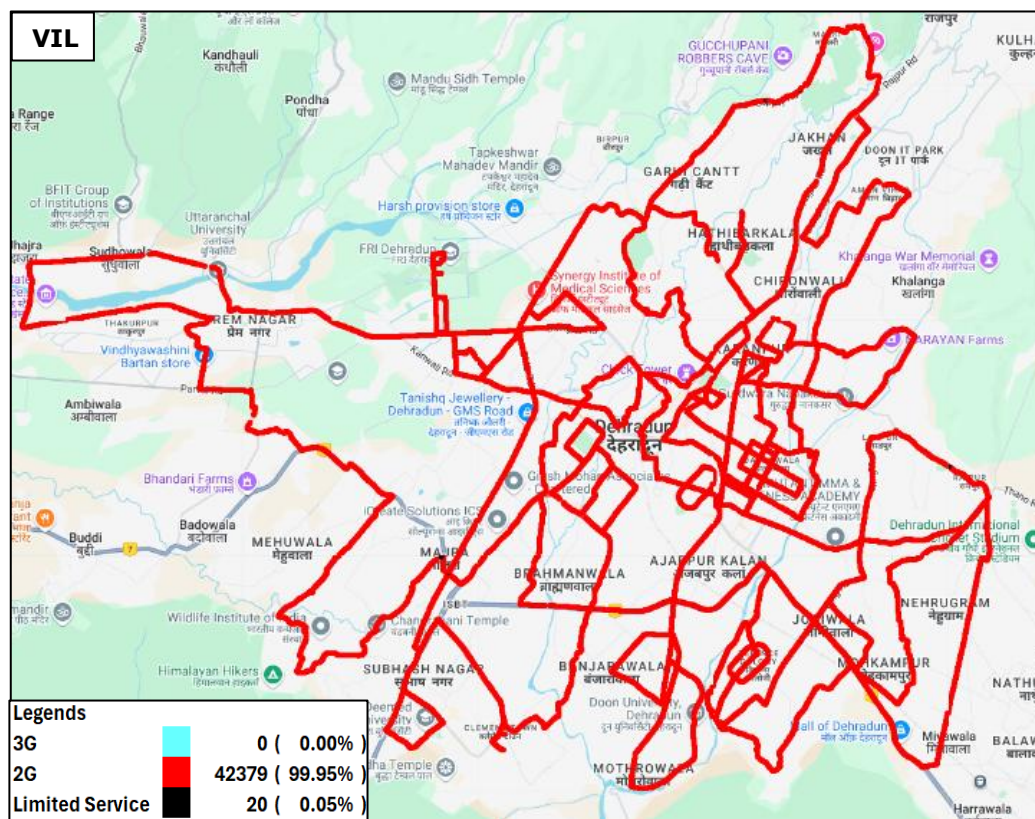
Figure-11: Serving technology plots 3G/2G network mode –VIL.

(c) Network Signal Strength Distribution: The following chart represents signal strength distribution for 3G/2G network mode only. (Refer figure- 24, 25 & 26 for map view)
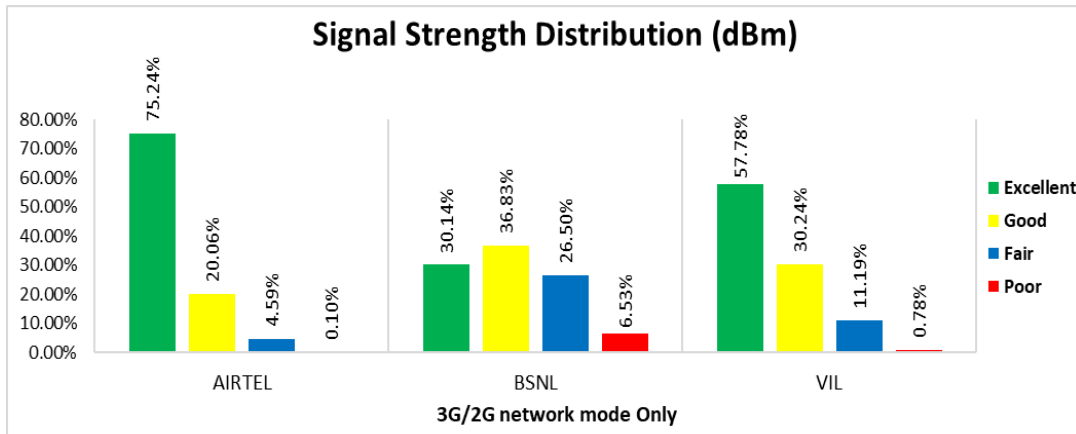
Figure-12: Signal strength distribution 3G/2G network mode only.

Observations:
- Airtel has 75% of samples falling in the excellent signal strength category.
- BSNL has 30% of samples falling in the excellent signal strength category.
- VIL has 58% of samples falling in the excellent signal strength category.

(d) Voice Call Performance in auto network selection mode (5G/4G/3G/2G)

Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Call Attempts	407	440	410	404
Call Setup Success Rate %	100.00	87.05	100.00	99.75
Drop Call Rate %	0.00	4.18	0.24	0.00
Call Setup Time Average (Second)	0.89	4.11	0.78	0.62
Handover Success Rate %	100.00	100.00	99.76	100.00

Table-13: Summary of voice call performance in network auto-selection mode.
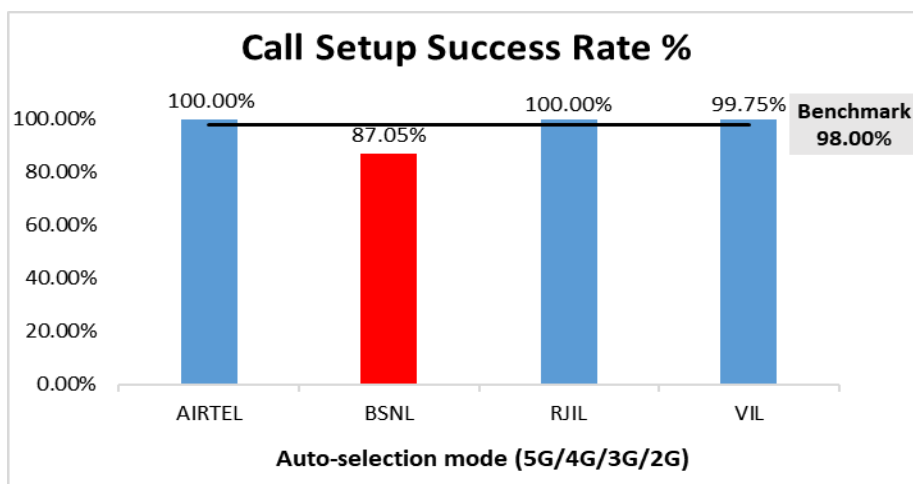
Figure-13: Performance for call setup success rate.
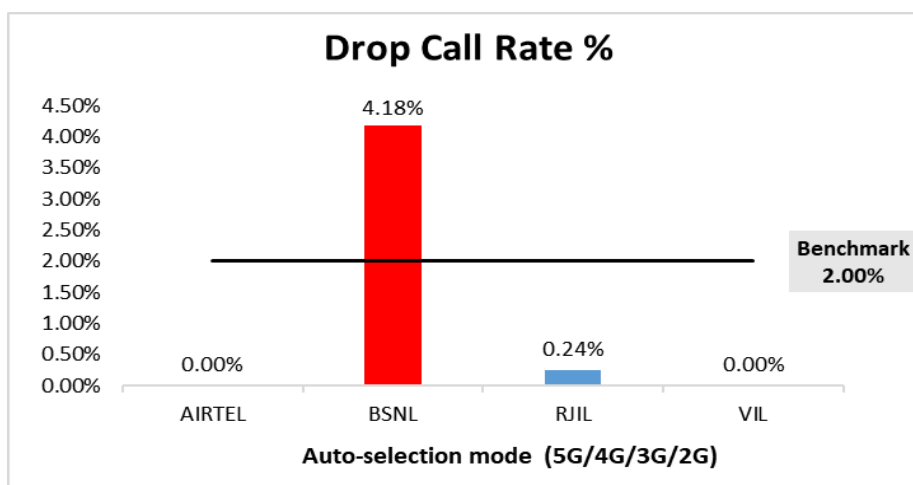

Figure-14: Performance for drop call rate.

Parameter	Service Provider			
	Mobile-to-Mobile (5G/4G - Open Mode)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Established (within service provider Network)	399	361	389	402
Number of silence call for >4 Sec	10	21	3	6
Silence Call Rate %	2.51	5.82	0.77	1.49
Number of silence instances for >4 Sec	12	31	3	12
Number of silence instances for >3 Sec	13	46	5	17
Number of silence instances for >2 sec	21	69	15	31
RTP Jitter (4G & 5G) in ms	4.21	11.74	7.75	15.68
Packet loss Rate Downlink %	0.64	5.69	0.28	0.85
Packet loss Rate Uplink %	0.62	5.39	0.66	0.74

Table-14: Summary of silence instances & packet loss rate for mobile to mobile call.

(e) Mean Opinion Score (MOS) performance for speech quality:

Mean opinion score indicate quality of speech observed during the drive test across different technologies. This parameter has been calculated for mobile to mobile calls made within same operator network in auto mode (5G/4G/3G/2G). As per ITU-T Recommendation P.863.1, MOS score value means: 5-Excellent, 4-Good, 3-Fair, 2-Poor, 1-Bad

Speech Quality (MOS) distribution	Service Provider			
	AIRTEL	BSNL	RJIL	VIL
Total Number of MOS Samples for calls in table-16	2370	1654	2289	2324
Speech Quality (Average MOS Score)	4.02	2.98	3.90	4.40
Number of samples with MOS >=4 to <5 (Excellent)	1975	393	1614	1934
Number of samples with MOS >=3 to <4 (Good)	347	443	533	299
Number of samples with MOS >=2 to <3 (Fair)	29	484	106	71
Number of samples with MOS >=1 to <2 (Poor)	19	334	36	20
%age of samples with MOS >=4 to <5 (Excellent)	83.33%	23.76%	70.51%	83.22%
%age of samples with MOS >=3 to <4 (Good)	14.64%	26.78%	23.29%	12.87%
%age of samples with MOS >=2 to <3 (Fair)	1.22%	29.26%	4.63%	3.06%
%age of samples with MOS >=1 to <2 (Poor)	0.80%	20.19%	1.57%	0.86%

Table-15: Summary of speech quality (MOS) samples
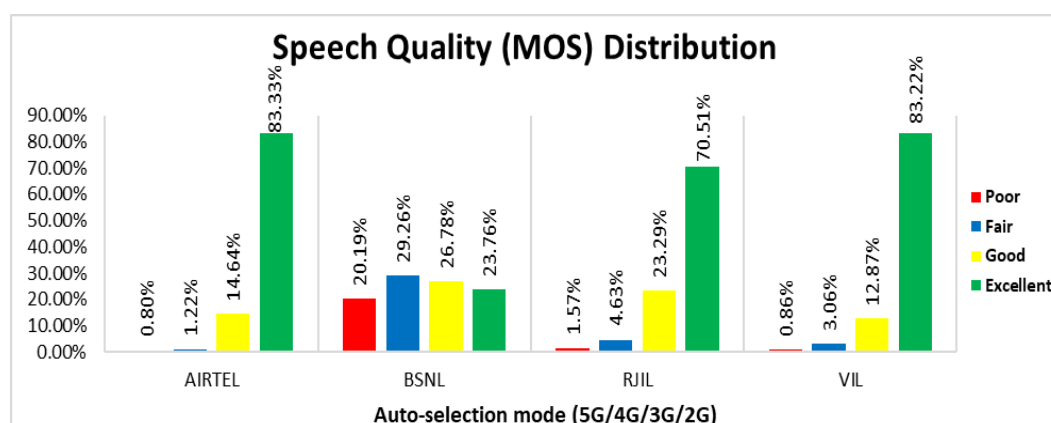
Figure-15: Distribution of samples in MOS score range.

(f) Network Technology: This section represent time spent on various network technologies.

Technology	Service Provider			
	AIRTEL	BSNL	RJIL	VIL
5G	2.65%	NA	19.89%	NA
4G	97.35%	85.13%	80.10%	100.00%
3G	NA	2.92%	NA	NA
2G	0.00%	11.58%	NA	0.00%
Limited Service	0.00%	0.36%	0.01%	0.00%

Table-16: Time spent on technology during drive test.

Figure-16: Serving technology plots in auto-selection mode (5G/4G/3G/2G) -AIRTEL.
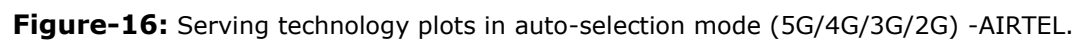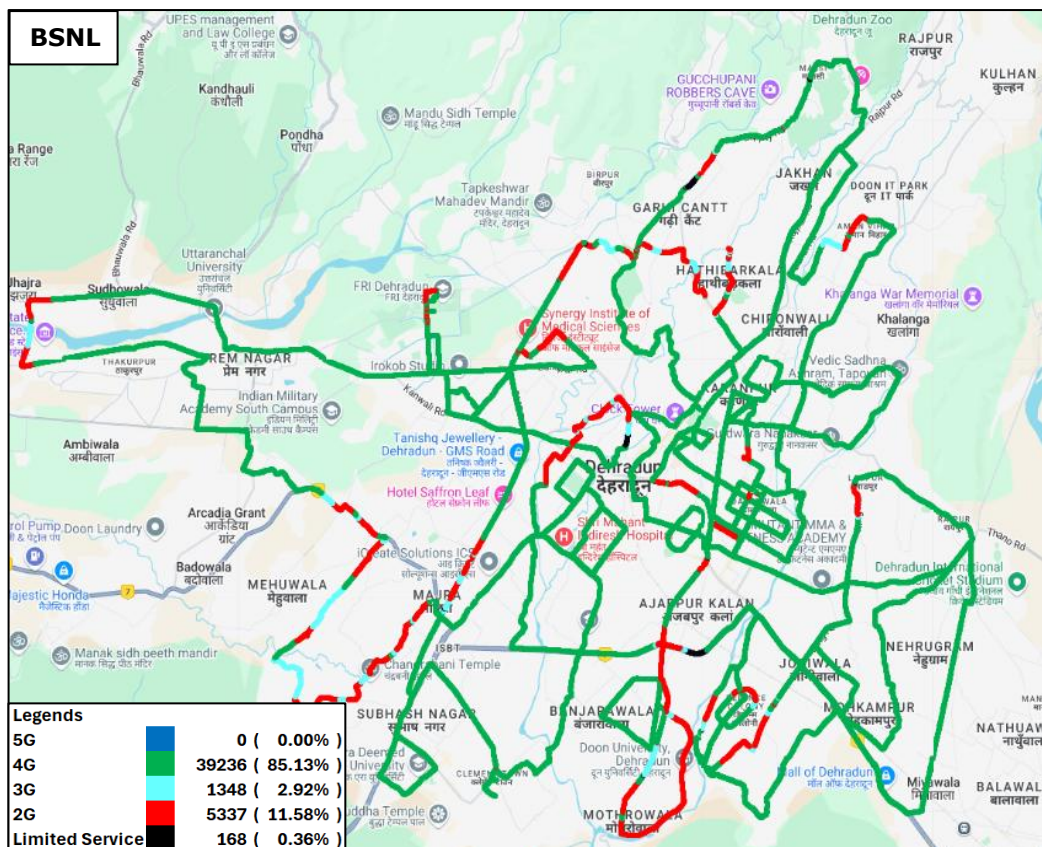
Figure-17: Serving technology plots in auto-selection mode (5G/4G/3G/2G) -BSNL.
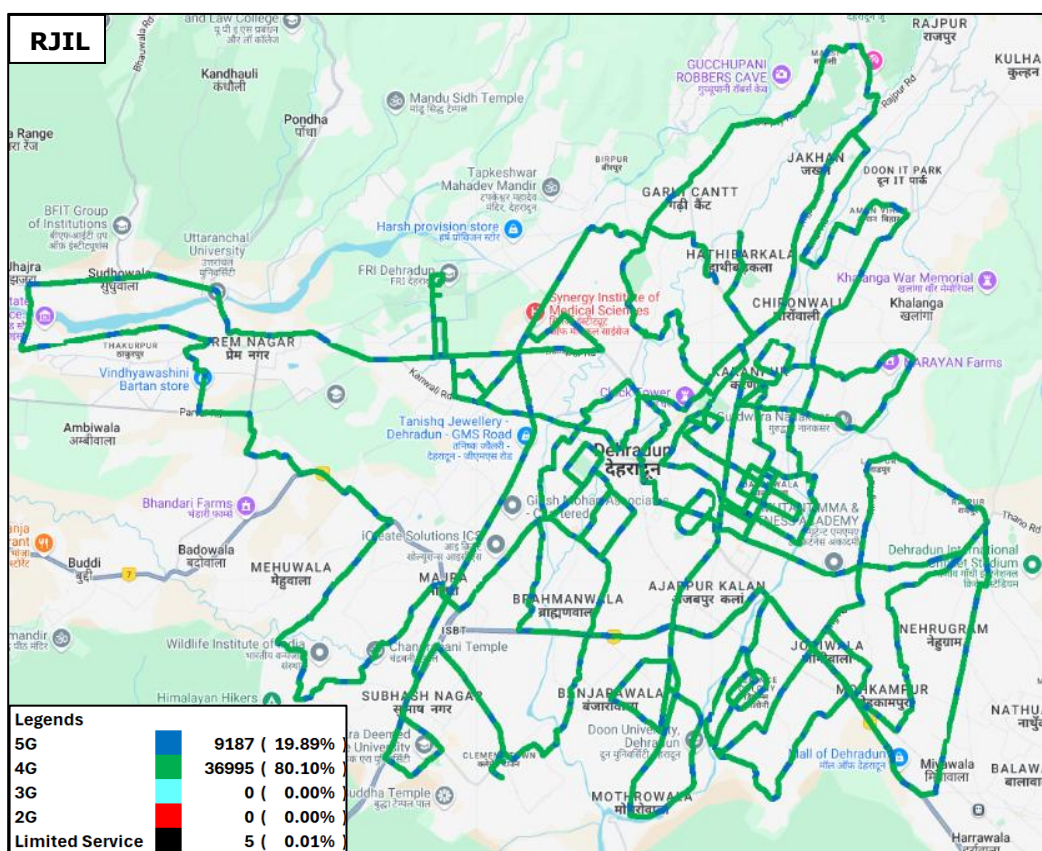
Figure-18: Serving technology plots in auto-selection mode (5G/4G/3G/2G)- RJIL.
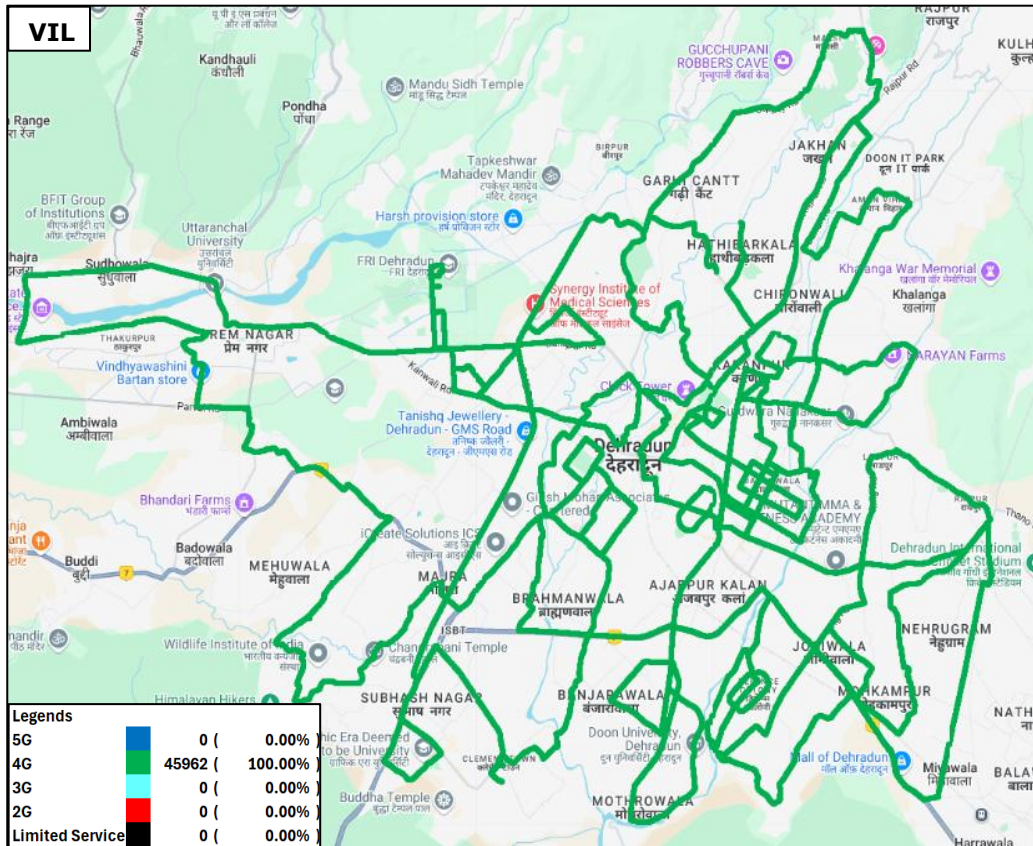
Figure-19: Serving technology plots in auto-selection mode (5G/4G/3G/2G) – VIL.

(g) Network Signal Strength Distribution: The following chart provide signal strength distribution for auto-selection mode (5G/4G/3G/2G). (Refer figure-27, 28, 29 & 30 for map view)
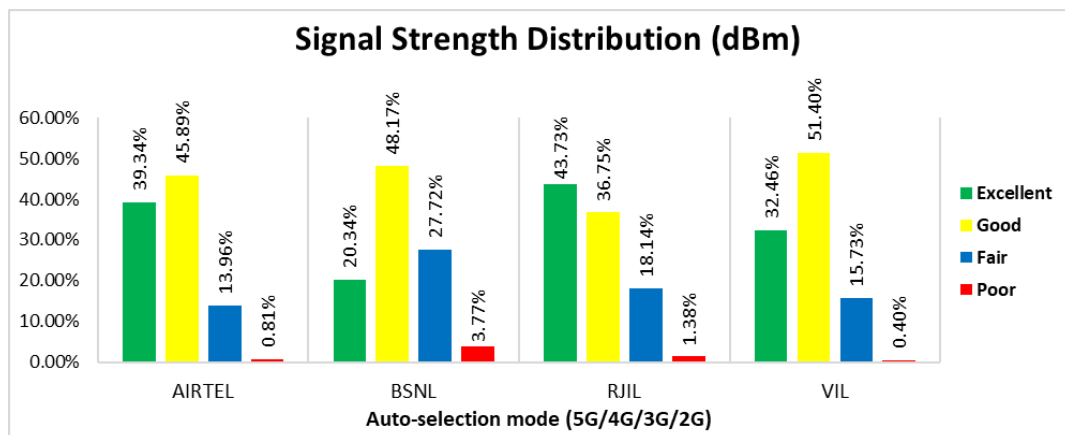
Figure-20: Signal strength distribution auto-selection mode 5G/4G/3G/2G.

Observations:
- Airtel has 39% samples falling in the excellent signal strength category.
- BSNL has 20% samples falling in the excellent signal strength category.
- RJIL has 44% samples falling in the excellent signal strength category.
- VIL has 32% samples falling in the excellent signal strength category.

4.2.4 Data performance

(a) Data Parameters (Auto-selection mode- 5G/4G/3G/2G)

Parameters		Service Provider			
		Auto-selection mode (5G/4G/3G/2G)			
		AIRTEL	BSNL	RJIL	VIL
Download Throughput (Mbits/s)	Average	142.88	6.84	282.48	33.79
	80th Percentile	238.36	11.21	494.59	52.40
	20th Percentile	9.57	1.27	52.53	14.99
Upload Throughput (Mbits/s)	Average	26.16	3.29	31.62	14.55
	80th Percentile	47.97	3.83	57.62	24.29
	20th Percentile	1.84	1.41	4.71	5.39
Latency (ms)	50th Percentile	21.75	32.10	22.50	30.45

Table-17: Summary of Data performance in network auto-selection mode.
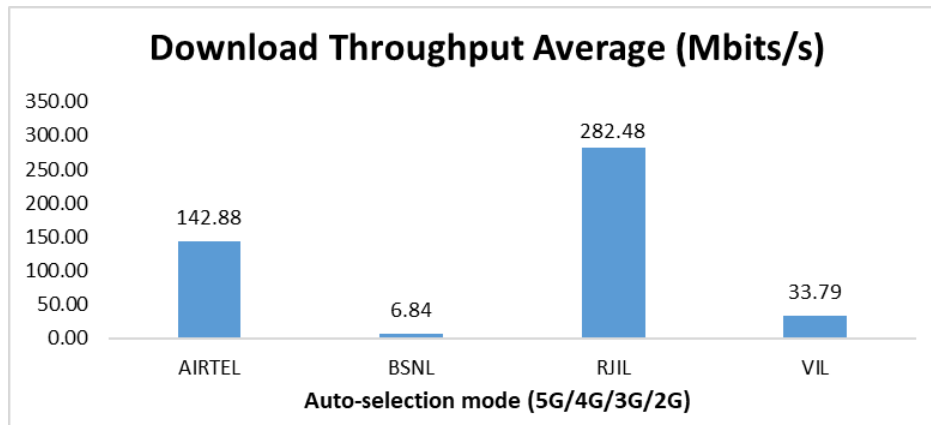
Figure- 21: Download throughput
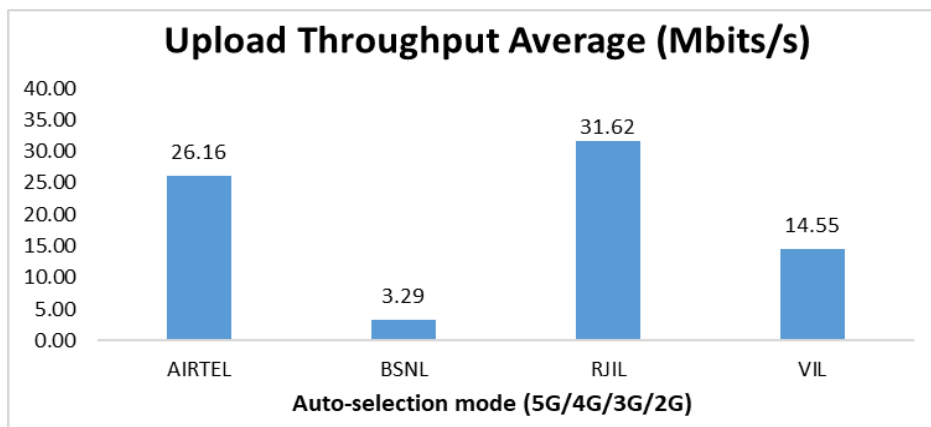
Figure- 22: Upload throughput

4.3 Hotspots

Hotspot testing have been done on 6th February 2025 to 7th February. Nine locations have been tested in the city.

4.3.1 Locations
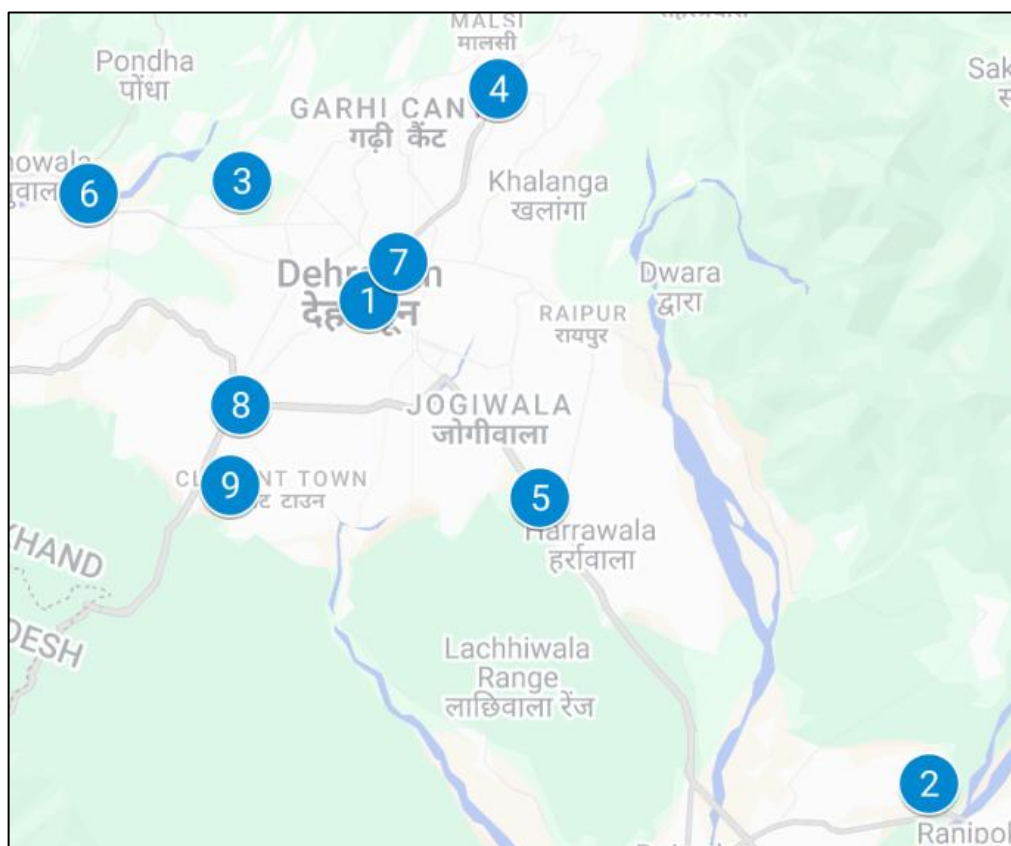
Figure- 23: Hotspot locations

4.3.2 Hotspot covered

1. Dehradun Railway Station
2. Jolly Grant Airport
3. Forest Research Institute (FRI), Dehradun
4. Pacific Mall, Dehradun
5. Mall of Dehradun
6. Uttaranchal University
7. Ghantaghar, Dehradun
8. ISBT, Dehradun
9. Graphic ERA College, Dehradun

4.3.3 Voice performance

Overall Voice Performance				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	90	90	90	90
Call Setup Success Rate %	100.00	92.22	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Second)	0.91	4.35	0.72	0.73

Table-18: Overall summary of voice call performance in network auto-selection mode (5G/4G/3G/2G).

Dehradun Railway Station				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Second)	0.96	3.44	0.62	0.78

Table-19: Summary of voice call performance in network auto-selection mode (5G/4G/3G/2G).

Jolly Grant Airport				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	60.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Second)	0.97	6.09	0.64	0.80

Table-20: Summary of voice call performance in network auto-selection mode (5G/4G/3G/2G).

Forest Research Institute (FRI), Dehradun				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	90.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Second)	0.89	3.00	0.58	0.58

Table-21: Summary of voice call performance in network auto-selection mode (5G/4G/3G/2G).

Pacific Mall, Dehradun				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	90.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Second)	0.86	3.71	0.79	0.59

Table-22: Summary of voice call performance in network auto-selection mode (5G/4G/3G/2G).

Mall of Dehradun				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Second)	0.92	5.92	1.09	0.66

Table-23: Summary of voice call performance in network auto-selection mode (5G/4G/3G/2G).

Uttaranchal University				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Second)	0.94	5.25	0.85	1.44

Table-24: Summary of voice call performance in network auto-selection mode (5G/4G/3G/2G).

Ghantaghar, Dehradun				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Second)	0.86	4.09	0.63	0.61

Table-25: Summary of voice call performance in network auto-selection mode (5G/4G/3G/2G).

ISBT, Dehradun				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	90.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Second)	0.85	5.30	0.66	0.54

Table-26: Summary of voice call performance in network auto-selection mode (5G/4G/3G/2G).

Graphic ERA College, Dehradun				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Second)	0.93	2.98	0.64	0.57

Table-27: Summary of voice call performance in network auto-selection mode (5G/4G/3G/2G).

4.3.4 Data performance (Auto-selection mode 5G/4G/3G/2G)

Overall Data Performance				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	112.20	6.65	184.37	21.57
Download Throughput 80th Percentile (Mbit/s)	232.31	10.73	317.91	25.48
Download Throughput 20th Percentile (Mbit/s)	0.11	1.95	8.08	16.69
Download Session Setup Success Rate %	100.00	95.56	100.00	100.00
Upload Throughput Average (Mbits/s)	16.06	4.03	19.53	12.34
Upload Throughput 80th Percentile (Mbit/s)	33.38	6.41	35.41	20.64
Upload Throughput 20th Percentile (Mbit/s)	1.16	1.65	1.66	4.19
Upload Session Setup Success Rate %	100.00	95.56	100.00	100.00
Web Browsing Delay (Second)	3.93	4.70	3.46	2.53
Youtube Initial Buffer Delay (Second)	2.49	2.49	1.17	0.85
Latency (ms) - 50th Percentile	18.90	28.55	24.80	32.40
Jitter (ms)	6.60	15.94	28.70	3.25
Packet Loss Rate%	0.23	11.50	1.30	0.67
Packet Loss Rate- 90th percentile	0.68	24.14	4.32	0.80

Table-28: Overall summary Data performance in network auto-selection mode (5G/4G/3G/2G).

Dehradun Railway Station				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	227.11	4.05	278.97	18.07
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	33.24	1.67	28.35	4.78
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.17	4.99	2.37	2.43
Youtube Initial Buffer Delay (Second)	0.52	2.68	0.67	0.85
Latency (ms)- 50th Percentile	16.10	30.60	23.63	31.20
Jitter (ms)	3.19	25.28	8.08	2.77
Packet Loss Rate%	0.10	9.10	0.00	0.70

Table-29: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

Jolly Grant Airport				
Parameters	**Service Provider**			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	238.61	0.12	8.03	27.54
Download Session Setup Success Rate %	100.00	60.00	100.00	100.00
Upload Throughput Average (Mbits/s)	29.89	1.40	1.37	16.49
Upload Session Setup Success Rate %	100.00	60.00	100.00	100.00
Web Browsing Delay (Second)	2.09	9.78	5.25	2.73
Youtube Initial Buffer Delay (Second)	0.61	4.66	5.21	0.64
Latency (ms) - 50th Percentile	14.50	90.00	25.50	27.15
Jitter (ms)	7.51	95.32	8.98	4.10
Packet Loss Rate%	0.10	84.30	0.10	0.80

Table-30: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

Forest Research Institute (FRI), Dehradun				
Parameters	**Service Provider**			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	0.53	23.19	32.81	22.92
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	1.89	12.02	2.56	22.09
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	10.16	2.29	2.87	2.47
Youtube Initial Buffer Delay (Second)	7.71	0.71	1.71	0.62
Latency (ms) - 50th Percentile	20.60	25.83	24.00	33.58
Jitter (ms)	4.28	19.73	58.46	2.65
Packet Loss Rate%	0.00	0.30	3.60	0.40

Table-31: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

Pacific Mall, Dehradun				
Parameters	**Service Provider**			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	0.10	3.56	539.16	23.10
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	1.15	2.40	27.09	14.41
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	-	5.80	2.38	2.51
Youtube Initial Buffer Delay (Second)	-	3.40	0.72	0.78
Latency (ms) - 50th Percentile	20.73	28.30	19.28	34.60
Jitter (ms)	4.85	11.31	7.55	2.83
Packet Loss Rate%	0.00	0.10	0.00	0.60

Table-32: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

Note- "-" Web browsing and Youtube test were failed at this location for Airtel.

Mall of Dehradun				
Parameters	Service Provider			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	212.72	2.55	12.06	20.72
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	29.10	1.54	1.98	1.62
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.09	6.45	7.45	2.61
Youtube Initial Buffer Delay (Second)	0.51	4.44	1.18	1.71
Latency (ms) - 50th Percentile	16.70	25.05	22.15	38.40
Jitter (ms)	7.28	7.33	14.26	2.86
Packet Loss Rate%	1.00	0.10	0.30	0.70

Table-33: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

Uttaranchal University				
Parameters	Service Provider			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	0.10	1.43	171.33	29.99
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	0.77	7.90	20.68	3.44
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	-	4.85	2.68	2.44
Youtube Initial Buffer Delay (Second)	-	1.34	0.67	0.74
Latency (ms) - 50th Percentile	23.80	33.15	26.55	33.45
Jitter (ms)	4.79	6.29	8.50	6.32
Packet Loss Rate%	0.10	6.50	0.10	0.70

Table-34: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

Note- "-" Web browsing and Youtube test were failed at this location for Airtel.

Ghantaghar, Dehradun				
Parameters	Service Provider			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	0.53	2.32	279.31	13.98
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	1.90	2.16	35.89	8.43
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	8.50	5.48	2.36	2.53
Youtube Initial Buffer Delay (Second)	9.87	5.88	0.75	0.62
Latency (ms) - 50th Percentile	22.55	28.10	24.45	32.55
Jitter (ms)	15.07	13.70	6.84	2.50
Packet Loss Rate%	0.60	1.10	0.00	0.60

Table-35: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

ISBT, Dehradun				
Parameters	**Service Provider**			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	211.55	10.41	329.93	21.00
Download Session Setup Success Rate%	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	41.80	3.09	54.66	24.59
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.27	2.81	2.58	2.61
Youtube Initial Buffer Delay (Second)	0.60	1.25	0.66	1.00
Latency (ms)- 50th Percentile	19.05	29.55	25.53	32.95
Jitter (ms)	5.00	6.02	13.61	2.45
Packet Loss Rate%	0.00	1.10	0.40	0.80

Table-36: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

Graphic ERA College, Dehradun				
Parameters	**Service Provider**			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	118.59	9.59	7.75	16.82
Download Session Setup Success Rate%	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	4.80	3.00	3.14	15.16
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.29	3.24	5.73	2.41
Youtube Initial Buffer Delay (Second)	1.15	1.40	2.17	0.70
Latency (ms)- 50th Percentile	21.35	29.95	38.20	29.10
Jitter (ms)	7.48	13.15	132.21	2.80
Packet Loss Rate%	0.20	0.90	7.20	0.70

Table-37: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

4.3.5 Data performance (5G Only & 4G Only Download & Upload Speed)

Overall Data Performance					
Parameters		**Service Provider**			
		AIRTEL	**BSNL**	**RJIL**	**VIL**
5G	**Download Throughput Average (Mbits/s)**	143.97	-	251.33	-
	Upload Throughput Average (Mbits/s)	20.38	-	27.54	-
4G	**Download Throughput Average (Mbits/s)**	3.96	5.79	23.67	21.12
	Upload Throughput Average (Mbits/s)	4.17	3.72	4.78	17.35

Table-38: Overall Summary of 5G only & 4G only data download & upload speed.

Note- "-"Respective technology was not observed during the test.

Dehradun Railway Station					
Parameters		**Service Provider**			
		AIRTEL	**BSNL**	**RJIL**	**VIL**
5G	**Download Throughput Average (Mbits/s)**	227.11	-	278.97	-
	Upload Throughput Average (Mbits/s)	33.24	-	28.35	-
4G	**Download Throughput Average (Mbits/s)**	0.10	3.09	23.79	16.56
	Upload Throughput Average (Mbits/s)	0.77	2.60	8.01	8.93

Table-39: Summary of data download & upload speed 5G only & 4G only.

Note- "-"Respective technology was not observed during the test.

Jolly Grant Airport					
Parameters		**Service Provider**			
		AIRTEL	**BSNL**	**RJIL**	**VIL**
5G	**Download Throughput Average (Mbits/s)**	238.61	-	-	-
	Upload Throughput Average (Mbits/s)	29.89	-	-	-
4G	**Download Throughput Average (Mbits/s)**	0.09	0.06	7.45	19.67
	Upload Throughput Average (Mbits/s)	0.77	1.54	2.23	2.76

Table-40: Summary of 5G only & 4G only data download & upload speed.

Note- "-"Respective technology was not observed during the test.

Forest Research Institute (FRI), Dehradun					
Parameters		**Service Provider**			
		AIRTEL	**BSNL**	**RJIL**	**VIL**
5G	**Download Throughput Average (Mbits/s)**	0.53	-	-	-
	Upload Throughput Average (Mbits/s)	1.89	-	-	-
4G	**Download Throughput Average (Mbits/s)**	34.86	9.44	27.58	17.25
	Upload Throughput Average (Mbits/s)	29.86	7.29	3.30	15.37

Table-41: Summary of 5G only & 4G only data download & upload speed.

Note- "-"Respective technology was not observed during the test.

Pacific Mall, Dehradun					
Parameters		**Service Provider**			
		AIRTEL	**BSNL**	**RJIL**	**VIL**
5G	**Download Throughput Average (Mbits/s)**	-	-	539.16	-
	Upload Throughput Average (Mbits/s)	-	-	27.09	-
4G	**Download Throughput Average (Mbits/s)**	0.10	10.40	52.14	22.62
	Upload Throughput Average (Mbits/s)	1.15	2.87	10.79	38.99

Table-42: Summary of 5G only & 4G only data download & upload speed.

Note- "-"Respective technology was not observed during the test.

Mall of Dehradun					
Parameters		**Service Provider**			
		AIRTEL	**BSNL**	**RJIL**	**VIL**
5G	**Download Throughput Average (Mbits/s)**	227.59	-	5.14	-
	Upload Throughput Average (Mbits/s)	29.10	-	3.13	-
4G	**Download Throughput Average (Mbits/s)**	0.10	9.34	5.83	21.10
	Upload Throughput Average (Mbits/s)	1.15	5.31	1.59	4.43

Table-43: Summary of 5G only & 4G only data download & upload speed.

Note- "-"Respective technology was not observed during the test.

Uttaranchal University					
Parameters		**Service Provider**			
		AIRTEL	**BSNL**	**RJIL**	**VIL**
5G	**Download Throughput Average (Mbits/s)**	-	-	171.33	-
	Upload Throughput Average (Mbits/s)	-	-	20.68	-
4G	**Download Throughput Average (Mbits/s)**	0.10	0.16	15.71	47.73
	Upload Throughput Average (Mbits/s)	1.14	2.84	4.15	18.30

Table-44: Summary of 5G only & 4G only data download & upload speed.

Ghantaghar, Dehradun					
Parameters		**Service Provider**			
		AIRTEL	**BSNL**	**RJIL**	**VIL**
5G	Download Throughput Average (Mbits/s)	0.53	-	279.31	-
	Upload Throughput Average (Mbits/s)	1.90	-	35.89	-
4G	Download Throughput Average (Mbits/s)	0.10	3.92	23.88	11.95
	Upload Throughput Average (Mbits/s)	0.77	3.20	4.75	25.26

Table-45: Summary of 5G only & 4G only data download & upload speed.

ISBT, Dehradun					
Parameters		**Service Provider**			
		AIRTEL	**BSNL**	**RJIL**	**VIL**
5G	Download Throughput Average (Mbits/s)	211.55	-	329.93	-
	Upload Throughput Average (Mbits/s)	41.80	-	54.66	-
4G	Download Throughput Average (Mbits/s)	0.10	5.20	34.3	22.09
	Upload Throughput Average (Mbits/s)	1.10	3.10	4.13	25.89

Table-46: Summary of 5G only & 4G only data download & upload speed.

Graphic ERA College, Dehradun					
Parameters		**Service Provider**			
		AIRTEL	**BSNL**	**RJIL**	**VIL**
5G	Download Throughput Average (Mbits/s)	118.59	-	8.19	-
	Upload Throughput Average (Mbits/s)	4.80	-	3.49	-
4G	Download Throughput Average (Mbits/s)	0.10	10.09	22.35	11.14
	Upload Throughput Average (Mbits/s)	0.84	4.19	4.06	16.24

Table-47: Summary of 5G only & 4G only data download & upload speed.

5. Voice & Data Key findings

5.1 Overall Voice

1. **Call Setup Success Rate:**
   a) Airtel, BSNL and VIL have 95.87%, 98.48% and 99.74% call setup success rate respectively in 3G/2G network mode. (refer table-3)

   b) Airtel, BSNL, RJIL and VIL have 100.00%, 87.92%, 100.00% and 99.80% call setup success rate respectively in auto-selection mode (5G/4G/3G/2G). (refer table-5)

2. **Call Setup Time**:
   a) Airtel has taken comparatively longer time (16.60 second) to establish the voice call, whereas BSNL and VIL call setup time is 2.91 & 4.67 seconds respectively in 3G/2G network mode. (refer table-3)

   b) BSNL has taken comparatively longer time (4.15 second) to establish the voice call, whereas Airtel, RJIL and VIL call setup time is 0.89, 0.77 & 0.64 seconds respectively in Auto-selection mode (5G/4G/3G/2G). (refer table-5)

3. **Call Silence/Mute Rate**: In packet switched network (4G/5G), BSNL, Airtel, VIL and RJIL have 5.82%, 2.51%, 1.49% & 0.77% silence call rate respectively. Further BSNL has higher RTP packet loss rate in downlink (5.69%) compared to VIL (0.85%), Airtel (0.64%) and RJIL (0.28%). In uplink the RTP packet loss rate is higher for BSNL (5.39%) compared to VIL (0.74%), RJIL (0.66%) and Airtel (0.62%). (refer table-6)

4. **Drop Call Rate**:
   a) Overall Airtel's, BSNL's & VIL's drop call rate 0.00%, 1.03% and 0.00% respectively in 3G/2G network mode. (refer table-3)

   b) Overall Airtel's, BSNL's, RJIL's & VIL's drop call rate 0.00%, 3.43%, 0.20% and 0.00% in Auto-selection mode (5G/4G/3G/2G). (refer table-5)

5.2 Overall Data

1. **Data download and upload performance (Dynamic i.e. while moving):**
   a) BSNL (6.82 Mbps) and VIL (32.74 Mbps) being on 4G as top technology, have comparatively lower data speeds respectively. While Airtel and RJIL have average download speed of 140.27 Mbps and 273.42 Mbps respectively. (refer table-9)

   b) BSNL (3.36 Mbps) and VIL (14.36 Mbps) being on 4G as top technology, have comparatively lower data speeds respectively. While Airtel and RJIL have average upload speed of 25.29 Mbps and 30.49 Mbps respectively. (refer table-9)

2. **Data download and upload performance (static i.e. while stationary):**
   a) At Hotspots, RJIL has better 5G QoS performance comparatively, with average download speed of 184.37 Mbps. (refer table-28)

b) At Hotspots, RJIL has better 5G QoS performance comparatively, with average upload speed of 19.53 Mbps. (refer table-28)

3. **Data session setup success rate (static i.e. while stationary):**
   a) Airtel, BSNL, RJIL and VIL have 100.00%, 95.56%, 100.00% and 100.00% download session setup success rate respectively. (refer table-28)

   b) Airtel, BSNL, RJIL and VIL have 100.00%, 95.56%, 100.00% and 100.00% upload session setup success rate. (refer table-28)

5.3 Operator wise Key Findings

1. Airtel:
Voice
- 95.87% call setup success rate and 0.00% drop call rate have been observed in 3G/2G network mode. Performance is not within the benchmark of 98.00% of call setup success rate for LSA and city drive. (refer table-3 & 11)

- 100.00% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for LSA & City Drive. Performance is well within the benchmark of 98.00% & 2.00% respectively. (refer table-5 & 13)

- 100.00% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for all hotspot locations. (refer table-18)

Data
- Airtel has 140.27 Mbps average download throughput & 25.29 Mbps average upload throughput for LSA. (refer table-9)

- Airtel has 142.88 Mbps average download throughput & 26.16 Mbps average upload throughput across measured routes for city drive. (refer table-17)

- Forest Research Institute (FRI), Pacific Mall, Uttaranchal University and Ghantaghar have less download speed (less than 100 Mbps) out of total 9 Hotspots for auto-selection mode (5G/4G/3G/2G). (refer table-31, 32, 34 & 35)

- Forest Research Institute (FRI), Pacific Mall, Uttaranchal University, Ghantaghar and Graphic ERA College hotspot has less upload speed (less than 20 Mbps) out of total 9 Hotspots for auto-selection mode (5G/4G/3G/2G). (refer table-31, 32, 34, 35 & 37)

2. BSNL:
Voice
- 98.48% call setup success rate and 1.03% drop call rate have been observed in 3G/2G network mode. Performance is meeting the benchmark of 98.00% & 2.00% respectively for LSA and city drive. (refer table-3 & 11)

- 87.92% call setup success rate and 3.43% drop call rate have been observed in auto-selection mode (5G/4G/3G/2G). Performance is not meeting the benchmark of 98.00% and 2.00% respectively for LSA. (refer table-5)

- 87.05% call setup success rate and 4.18% drop call rate have been observed in auto-selection mode (5G/4G/3G/2G) for city drive. Performance is not meeting the benchmark of 98.00% and 2.00% respectively for city drive. (refer table-13)

- 92.22% call setup success rate and 0.00% drop call rate have been observed in auto-selection mode (5G/4G/3G/2G) for all hotspot locations. (refer table-18)

Data
- BSNL has 6.82 Mbps average download throughput & 3.36 Mbps average upload throughput for LSA. (refer table-9)

- BSNL has 6.84 Mbps average download throughput & 3.29 Mbps average upload throughput across measured routes for city drive. (refer table-17)

- Dehradun Railway Station, Jolly Grant Airport, Pacific Mall, Mall of Dehradun, Uttaranchal University, Ghantaghar, Graphic ERA College Hotspots have less download speed (less than 10 Mbps) for auto-selection mode (5G/4G/3G/2G). (refer table-29, 30, 32, 33, 34, 35 & 37)

- Dehradun Railway Station, Jolly Grant Airport, and Mall of Dehradun hotspots have less upload speeds (less than 2 Mbps) for auto-selection mode (5G/4G/3G/2G). (refer table-29, 30 & 33)

3. RJIL:
Voice
- 100.00% call setup success rate and 0.20% drop call rate have been observed in auto-selection mode (5G/4G/3G/2G). Performance is well within the benchmark of 98.00% & 2.00% respectively for LSA. (refer table-5)

- 100.00% call setup success rate and 0.24% drop call rate have been observed in auto-selection mode (5G/4G/3G/2G). Performance is well within the benchmark of 98.00% & 2.00% respectively for city drive. (refer table-13)

- 100.00% call setup success rate and 0.00% drop call rate have been observed in auto-selection mode (5G/4G/3G/2G) at overall hotspot locations. (refer table-18)

Data
- RJIL has 273.42 Mbps average download speed & 30.49 Mbps average upload speed for LSA. (refer table-9)

- RJIL has 282.48 Mbps average download speed & 31.62 Mbps average upload speed across measured routes in city drive. (refer table-17)

- Jolly Grant Airport, Forest Research Institute (FRI), Mall of Dehradun, and Graphic ERA College hotspot have less download speed (less than 100 Mbps) out of total 9 Hotspots for auto-selection mode (5G/4G/3G/2G). (refer table-30, 31, 33 & 37)

- Jolly Grant Airport, Forest Research Institute (FRI), Mall of Dehradun, and Graphic ERA College hotspot have less upload speed (less than 20 Mbps) out of total 9 Hotspots for auto-selection mode (5G/4G/3G/2G). (refer table-30, 31, 33 & 37)

4. VIL:

Voice

- 99.74% call setup success rate and 0.00% drop call rate have been observed in 3G/2G network mode. Performance is meeting the benchmark of 98.00% & 2.00% respectively for LSA and city drive. (refer table-3 & 11)

- 99.80% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for LSA. Performance is meeting the benchmark of 98.00% & 2.00% respectively. (refer table-5)

- 99.75% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G). Performance is meeting the benchmark of 98.00% & 2.00% respectively for city drive. (refer table-13)

- 100.00% call setup success rate and 0.00% drop call rate have been observed in auto-selection mode (5G/4G/3G/2G) for all hotspot locations. (refer table-18)

Data

- VIL has 32.74 Mbps average download speed & 14.36 Mbps average upload speed for LSA. (refer table-9)

- VIL has 33.79 Mbps average download speed & 14.55 Mbps average upload speed across measured routes in city drive. (refer table-17)

- Mall of Dehradun has less upload speed (less than 2 Mbps) out of total 9 hotspots for auto-selection mode (5G/4G/3G/2G). (refer table-33)

6. Annexure

6.1 Route wise coverage map
6.1.1 City
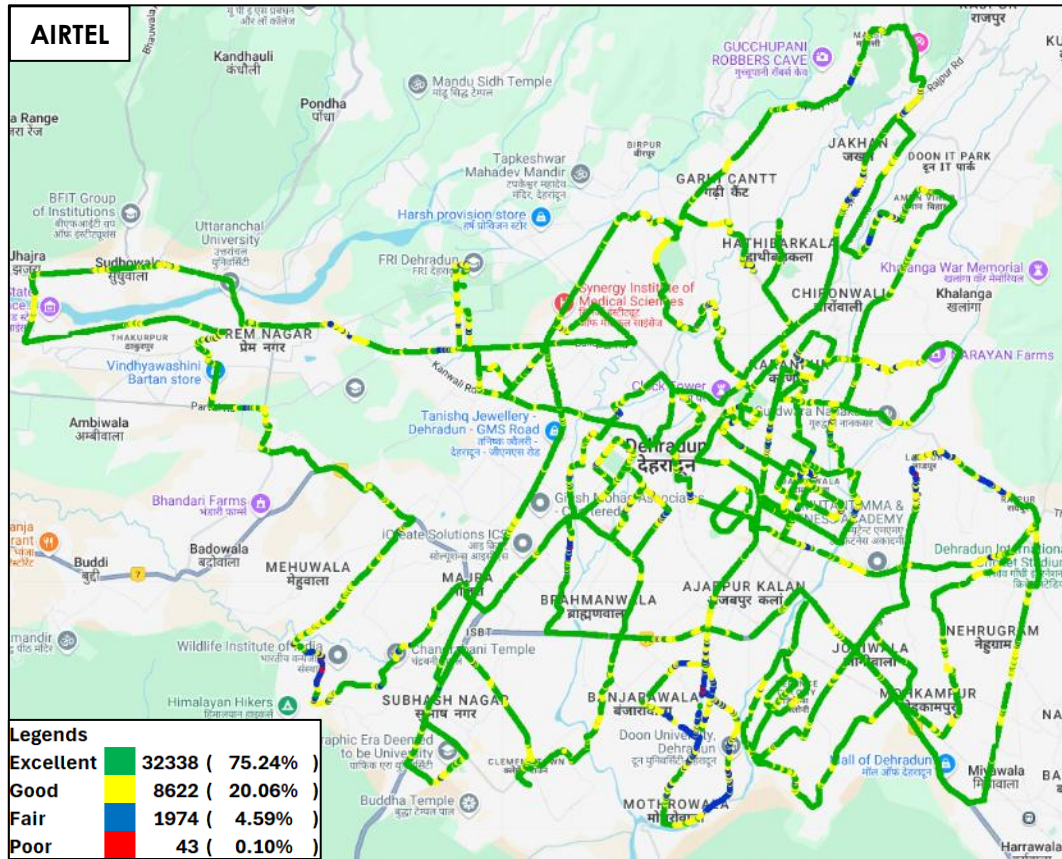
Figure-24: Signal strength 3G/2G network mode – AIRTEL.
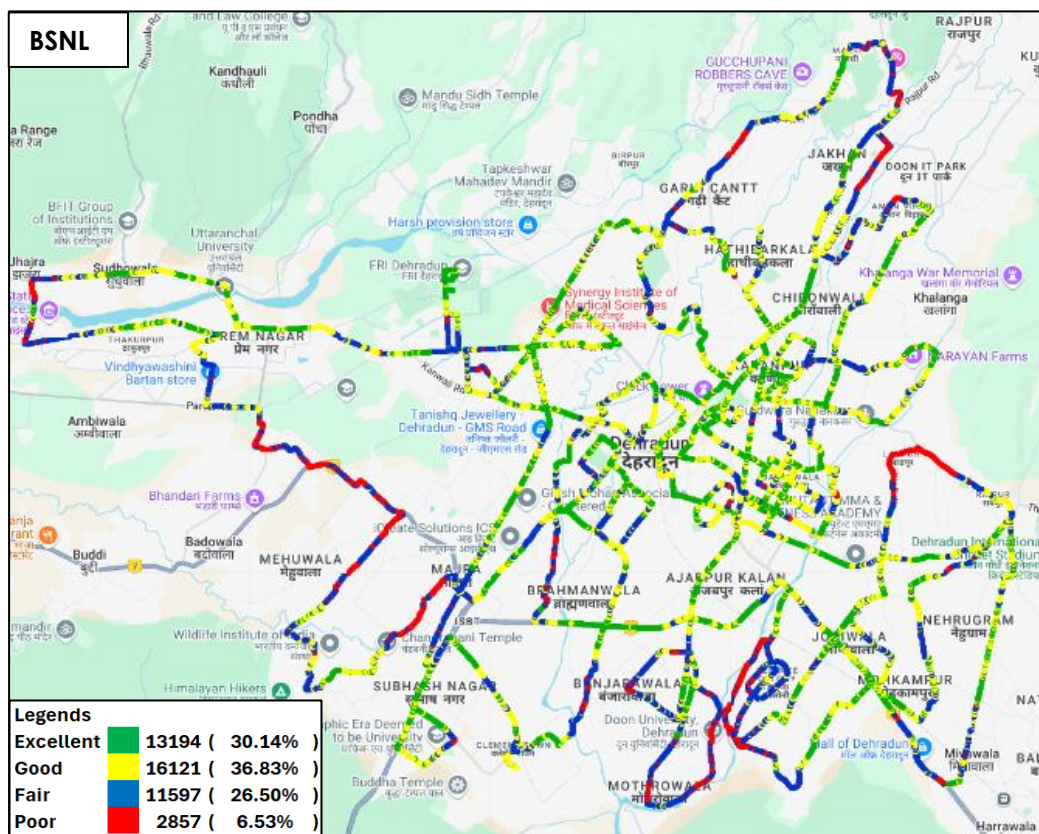
Figure-25: Signal strength 3G/2G network mode – BSNL.
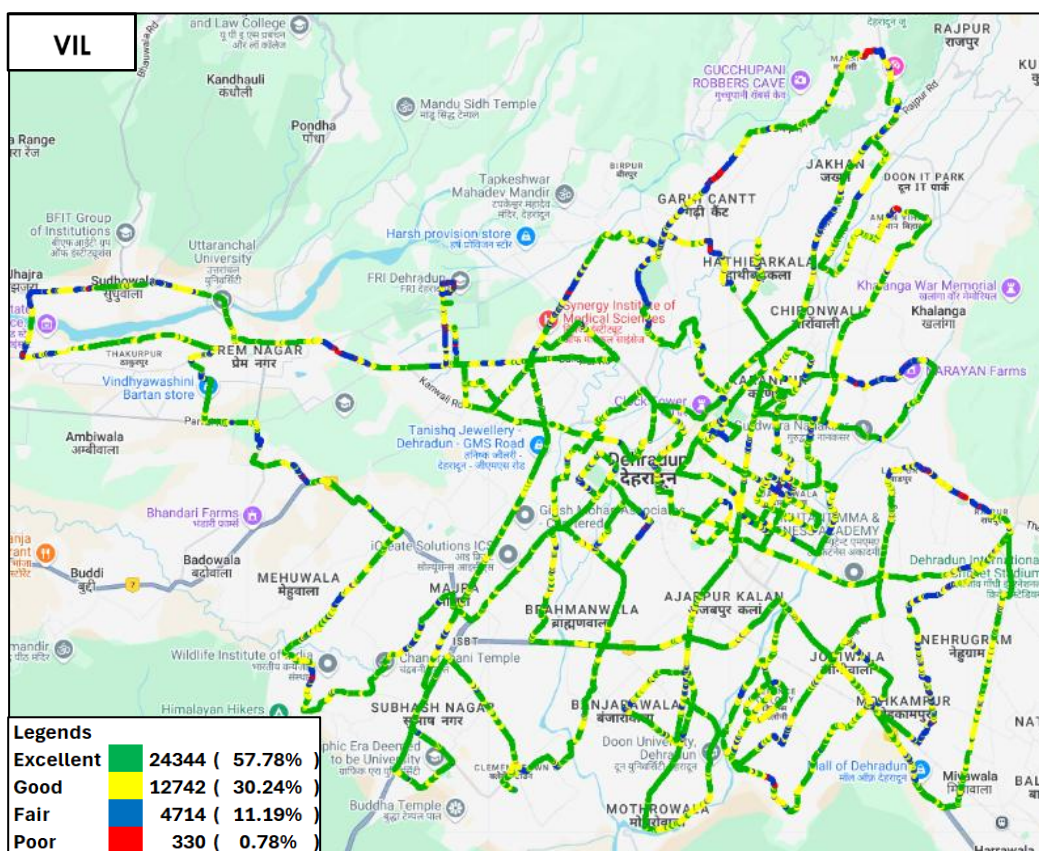
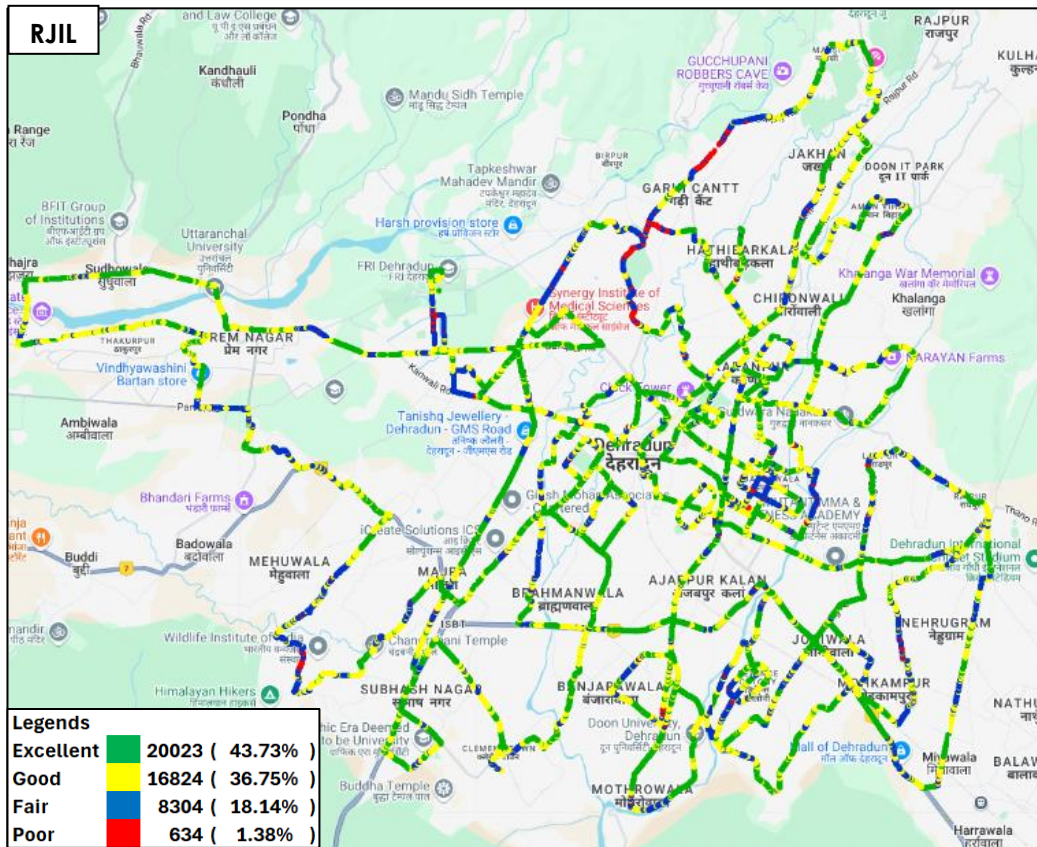**Figure-26:** Signal strength 3G/2G network mode – VIL.
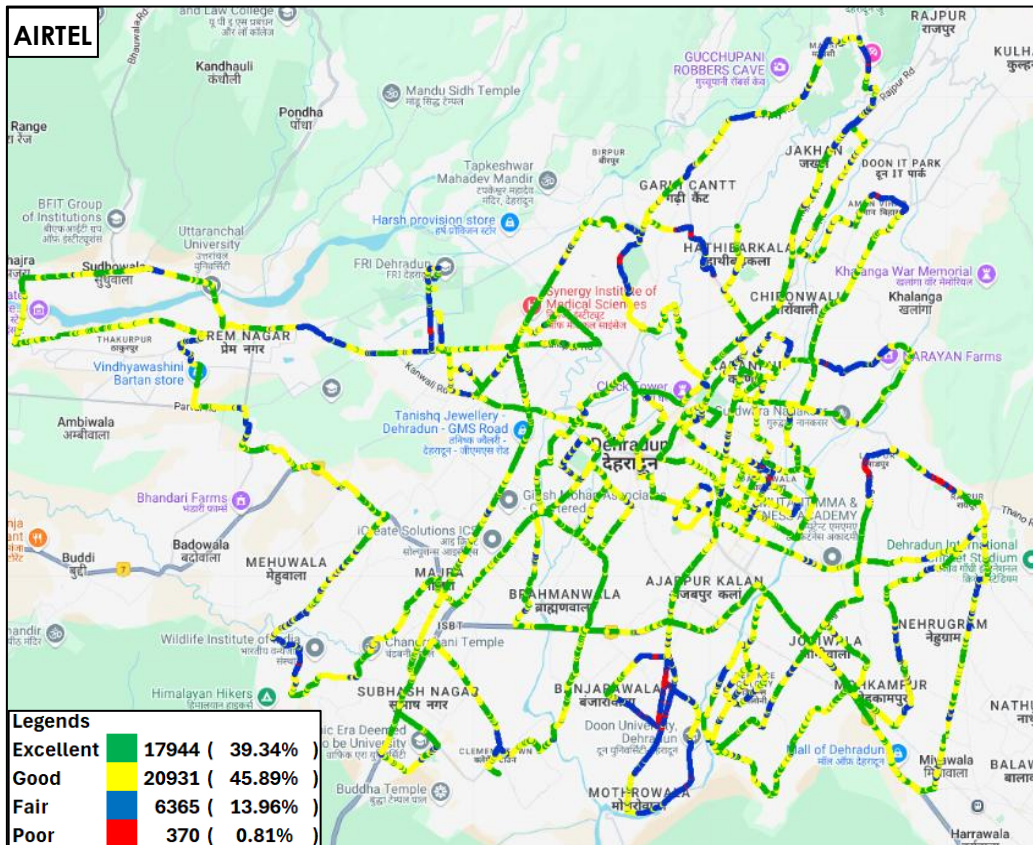
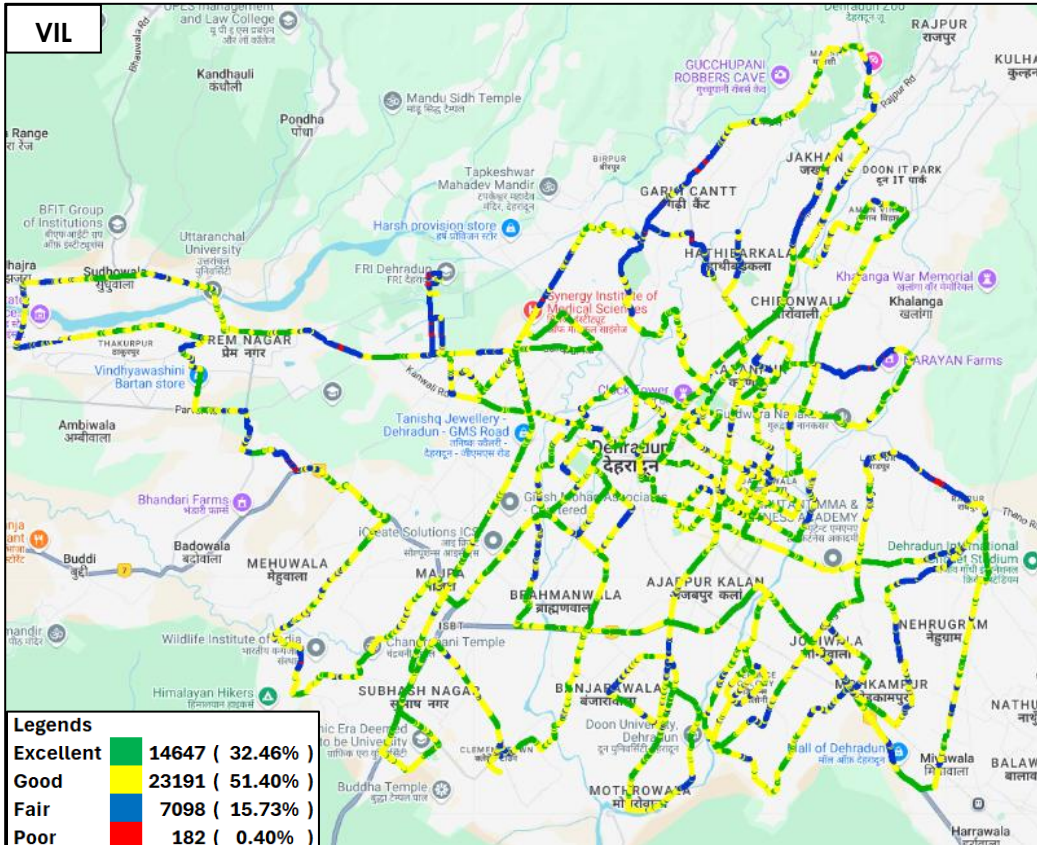**Figure-27:** Signal strength auto-selection mode 5G/4G/3G/2G – AIRTEL.

Legends		
Excellent	17944 (	39.34%)
Good	20931 (	45.89%)
Fair	6365 (	13.96%)
Poor	370 (	0.81%)
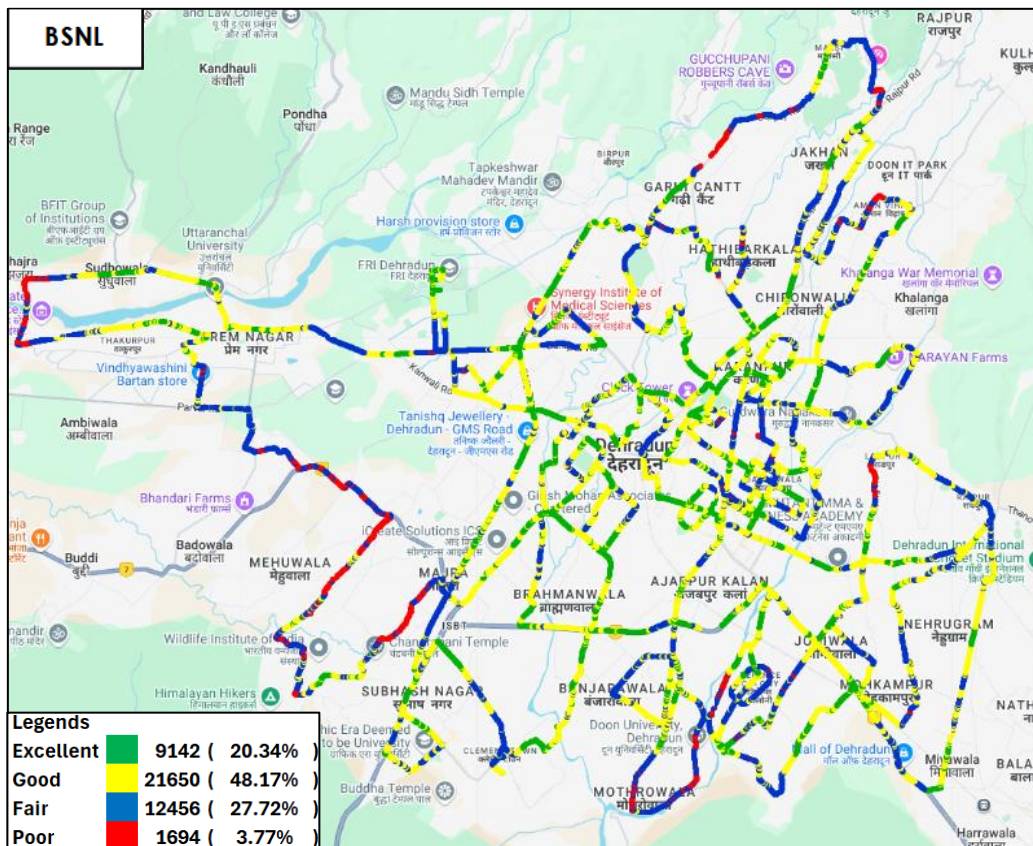
Figure-28: Signal strength auto-selection mode 5G/4G/3G/2G – BSNL.

Legends		
Excellent	9142 (	20.34%)
Good	21650 (	48.17%)
Fair	12456 (	27.72%)
Poor	1694 (	3.77%)

Legends		
Excellent	20023	(43.73%)
Good	16824	(36.75%)
Fair	8304	(18.14%)
Poor	634	(1.38%)

Figure-29: Signal strength auto-selection mode 5G/4G/3G/2G – RJIL.

Legends		
Excellent	14647	(32.46%)
Good	23191	(51.40%)
Fair	7098	(15.73%)
Poor	182	(0.40%)

Figure-30: Signal strength auto-selection mode 5G/4G/3G/2G – VIL.

7. Appendix

The details of the setup used for conducting the drive test and the network or performance parameters captured under different conditions may be seen at Appendix-I. The calculation method of each QoS parameter is given in Appendix-II of the report. The summary of key equipment used in technical setup is as under

- **Device-1**: OnePlus Nord CE3 for 3G/2G CAT-15 Smartphone.
- **Device-2**: Samsung Galaxy S23 for 5G/4G/3G/2G CAT-20 Smartphone
- **Drive test Software**: Azenqos Engineering capable Applications to capture actual user experience.

7.1 Appendix-I
7.1.1 Drive test setup

Voice Call		
Call details	**Technology**	**Detail**
Call Setup Timeout	• 3G/2G auto mode- switch Call • 5G/4G/3G/2G auto mode- switch Call • 5G/4G MOS Call	30 Sec
Call Duration		90 Sec
Wait/ Guard Time		15 Sec

Table-48: Voice test detail

Note-
- There is 15 sec wait time after locking and before starting first call in 3G/2G call.
- 10 calls to be made at each Hotspot location.
- Minimum 10 Calls to be made during the walk test. Call count will be increased based on walk test distance.
- Speech quality (MOS) has been measured only in city drive & highway by making Mobile to Mobile call.
- 180 Sec calls were made only in highway & railway route drive.

Data Test		
Test Type	**Technology**	**Detail**
HTTP/FTP Download	5G/4G/3G/2G Auto Mode	500 MB File- 30 Sec Timeout, (Multithread 3- TCP Connection at a time)
HTTP/FTP Upload		250 MB File- 30 Sec Timeout, (Multithread 3- TCP Connection at a time)
YouTube Streaming		20 Sec Video & 25 sec Timeout (Only at Hotspot)

Web Browsing		3 popular websites (www.google.co.in, www.amazon.in & www.facebook.com) 20 sec timeout (only at Hotspot)
Latency		25 count- Dynamic 1000 count- Hotspot Payload- 42 bytes in all drive

Table-49: Data test detail

Note-
- 5 Data iteration to be done at each hotspot location.
- Minimum 5 iteration to be made during the walk test. Iteration count will be increased based on walk test distance.
- Ping test to be performed only once at hotspot location.
- Youtube & Web browsing test to be performed at static location only.
- All values are taken up to two decimal places with round off.
- Download and upload testing has been done on FTP server for Airtel, BSNL & RJIL. (Airtel, BSNL & RJIL not provided HTTP server)
- VIL download and upload testing is done on HTTP Server.
- Download & Upload test performed at hotspot in 4G/3G/2G auto-selection also.
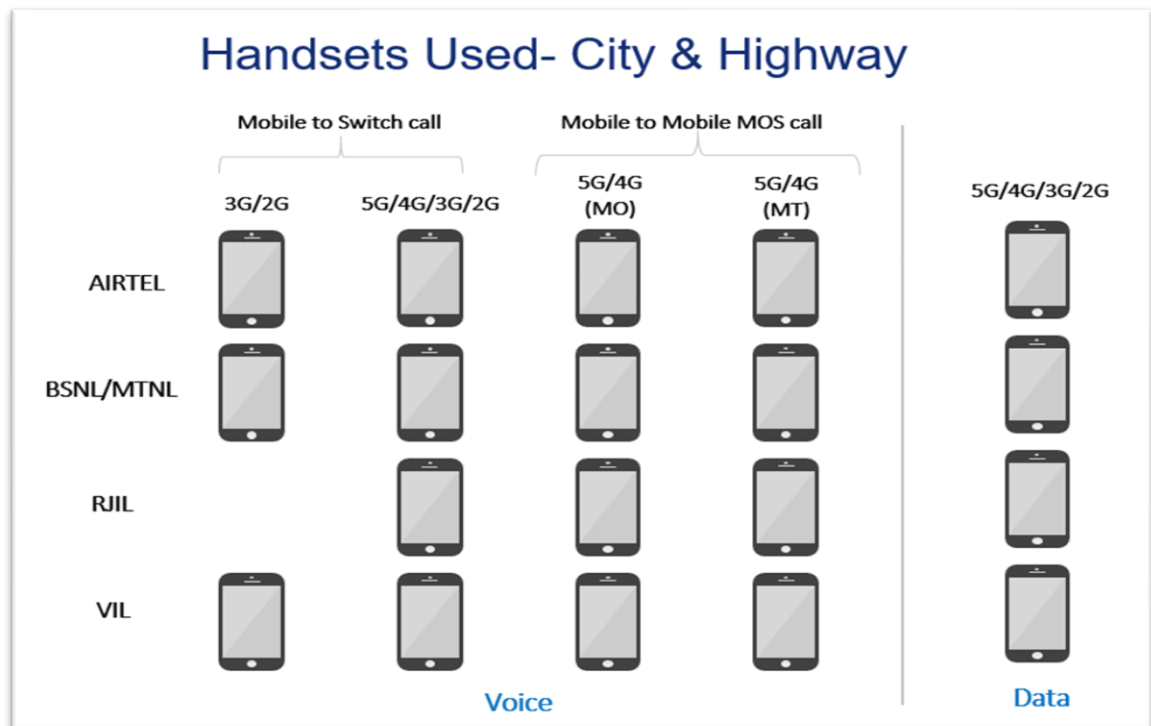
Figure-31: Number of handsets used in city & highway drive

MO: Mobile originating

MT: Mobile terminating
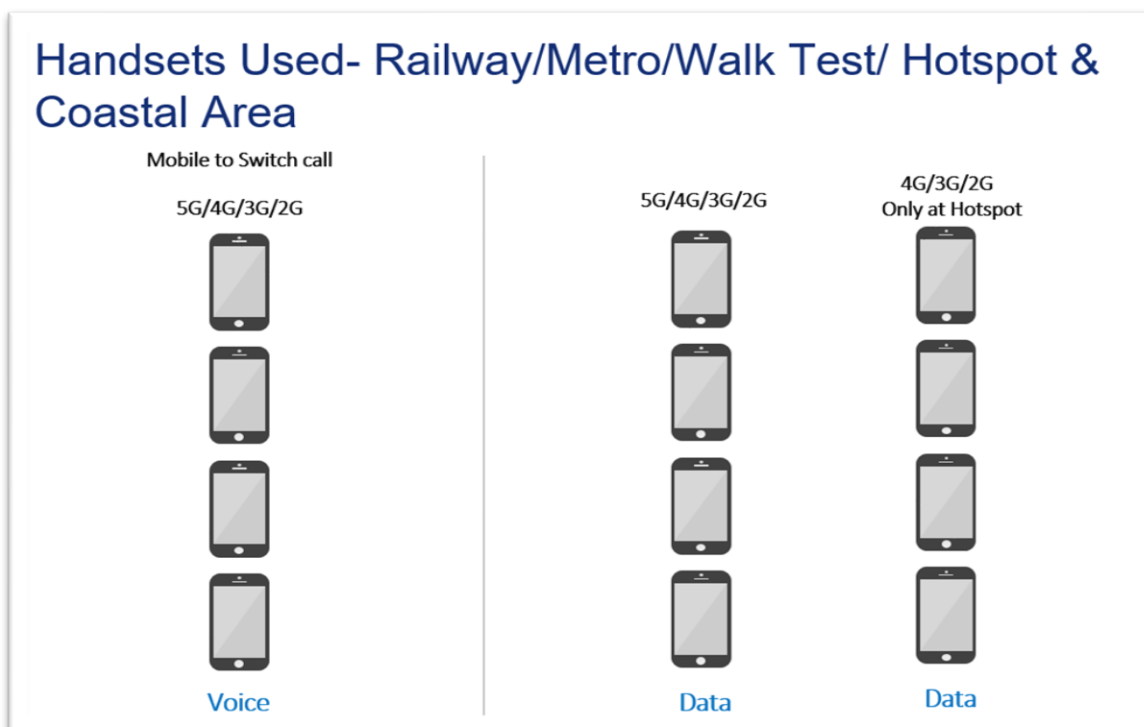
Figure-32: Number of handsets used in railway/metro/walktest/hotspot & coastal area

7.1.2 Drive test Methodology

(a) Dynamic voice testing (on the move)
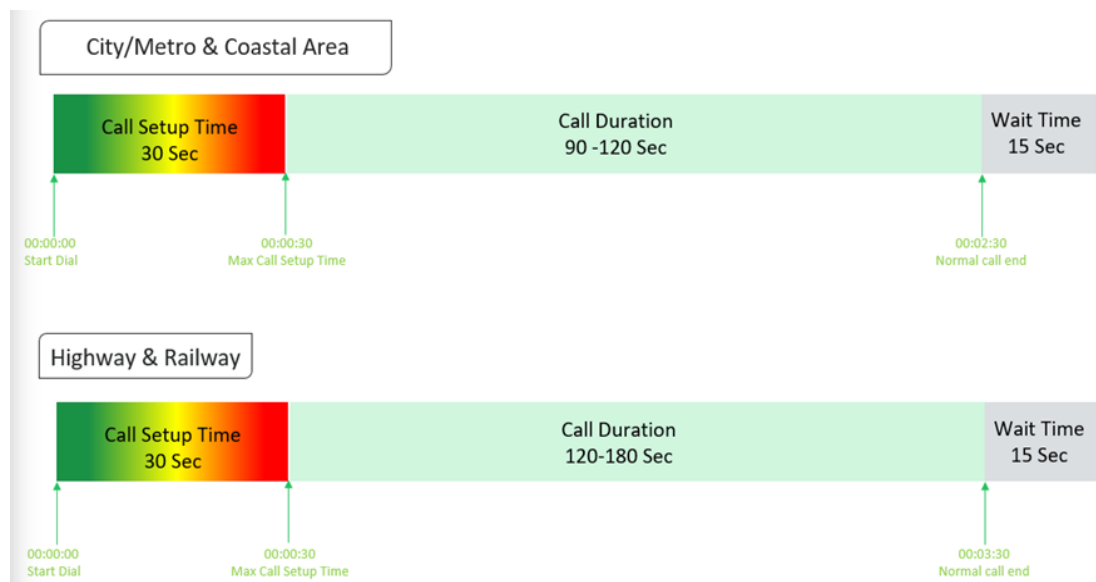
Figure-33: Voice test script for city/railway/metro/highway & coastal area

- 15 sec wait time is applied after locking Radio Access Technology (RAT) to 3G/2G and before starting first call in 3G/2G call.

- Speech quality (MOS) will be measured only City & Highway drive by making Mobile to Mobile calls.

(b) Hotspot voice testing

Figure-34: Voice test script for walktest/hotspot

- 10 calls to be made at each Hotspot location.
- Minimum 10 Calls to be made during the walk test. Call count will be increased based on walk test distance.

(c) Dynamic Data (internet) test
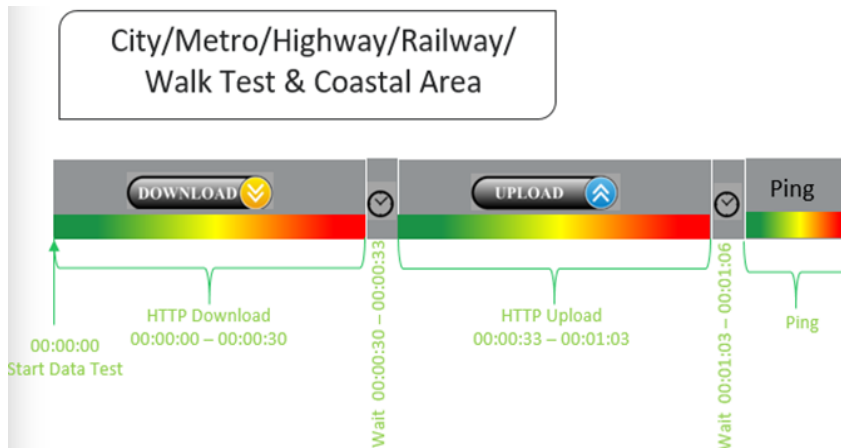
Figure-35: Data test script used in city/metro/railway/highway/walk test & coastal area

(d) Static Data(internet) testing
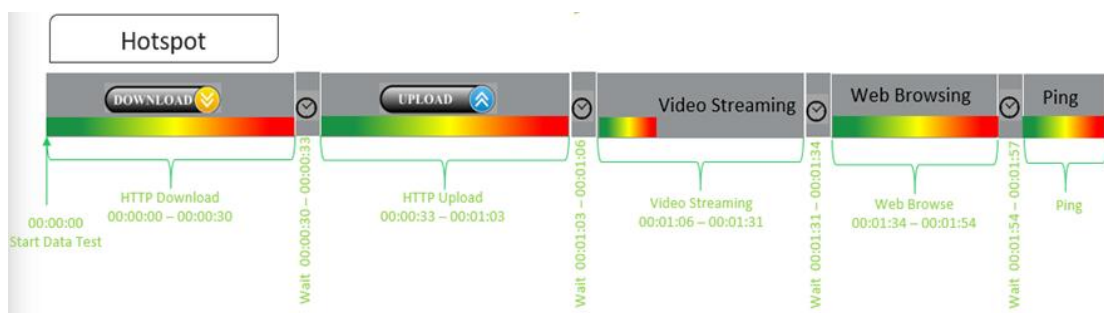
Figure-36: Data test script used at hotspot

- 5 Data iteration done at each hotspot location.
- Min. 5 iteration made during the walk test.
- Web browsing duration mentioned above is for one web site only.

- Only 1 ping iteration (with 1000 Count) done at hotspot location.
- Download & Upload test performed at hotspot in 4G/3G/2G auto-selection also.

7.2 Appendix-II

7.2.1 Network Performance Parameters for Voice calls

Parameter Name	Definition
Call Setup Success Rate	(i) Call Setup Success Rate is defined as the ratio of Established Calls to Call Attempts. 'Established Calls' mean the following events have happened in call setup: (a) Call attempt is made (b) The signaling channel is allocated (c) The call is routed to the outwards path of the terminating network (d) An alert signal is received by caller in the form of ring back tone, busy tone, or an announcement. CSSR = (Total Call Established/ Total Call Attempt) *100 As per QoS Regulation 2024 benchmark value is **>=98%**
Drop Call Rate	Call drop represents the service provider network's ability to maintain a call once it has been successfully established. This parameter shall include both incoming calls and outgoing calls which, once they have been established and have an assigned traffic channel/ bearer, are dropped, or interrupted before their normal completion by the user, the cause of the early termination being within the service provider's network Drop Call Rate = (Total Call Drop/Total Call Established) *100 As per QoS Regulation 2024 benchmark value is **<=2%**
Call Setup Time	Time taken from call initiate to call alerting/ringing. Call Setup Time = T2- T1 T2- Ringing (VoLTE/VoNR) & Alerting (for WCDMA & GSM), T1- Invite (VoLTE/VoNR) & CM Service Request (for WCDMA & GSM)
Voice Quality (MOS)	Voice quality in mobile networks is measured with algorithms based on ITU-T P.863 (POLQA). The grading for Voice quality has been given as: Excellent: $MOS \geq 4$ and < 5 Good : $MOS \geq 3$ and < 4 Fair : $MOS \geq 2$ and < 3 Poor : $MOS \geq 1$ and < 2
Handover Success Rate	Handover Success Rate = Count of successful handovers (All Technology Handover combined) / Total count of Handover Attempt (All Technology Handover combined) *100 Handover type which are considered- 2G Inter & Intra cell, 3G Soft & IRAT, 4G Inter & Intra frequency & SRVCC, 5G Inter & Intra frequency & 5G to 4G handovers.
Silence Call	A call which has ≥ 4 sec continuous RTP gap is considered as a Silence Call. Silence call rate = (count of silence call / Total calls established) *100 If a call observes multiple silence count >=4 sec in a particular established call it has been taken as one silent event.

	The inter arrival jitter is the difference in the relative transit time for two packets. The relative transit time is the difference between a packet's Real-time Transport Protocol (RTP) timestamp and the receiver's clock at the time of arrival, measured in the same units. If Si is the RTP timestamp from packet i, and Ri is the time of arrival in RTP timestamps units for packet i, then for two packets i and j the inter-arrival jitter D can be expressed as: **D(i,j) = (Rj - Ri) - (Sj - Si)** The interarrival jitter is calculated continuously as each data packet i is received from source SSRC_n, using this difference D for that packet and the previous packet i-1 in order of arrival (not necessarily in sequence), according to the formula **J(i) = J(i-1) + (|D(i-1,i)| - J(i-1))/16 or 8**
Jitter	
Downlink Packet Drop Rate	Number of RTP (Real-time Transport Protocol) Packets lost divided by total RTP packet received (against each source_SSRC and sequence number) at call originating handset. This KPI is calculated from MOS call for packet call only (VoNR/VoLTE)
Uplink Packet Drop Rate	Number of RTP (Real-time Transport Protocol) Packets lost divided by total RTP packet received (against each source_SSRC and sequence number) at call terminating handset. This KPI is calculated from MOS call for packet call only (VoNR/VoLTE).
Signal Strength	Signal strength is the signal power level received by the wireless user.

Parameter Name	Technology	Signal Strength (dBm)			
		Excellent	Good	Fair	Poor
Rx Level	GSM	0 to $\geq$ -65	<-65 to $\geq$ -75	<-75 to $\geq$-85	<-85 to min
RSCP	WCDMA	0 to $\geq$ -70	<-70 to $\geq$ -80	<-80 to $\geq$ -90	<-90 to min
RSRP	LTE	0 to $\geq$ -80	<-80 to $\geq$ -95	<-95 to $\geq$-110	<-110 to min
SS_RSRP	NR	0 to $\geq$ -80	<-80 to $\geq$ -95	<-95 to $\geq$-110	<-110 to min

Table-50: Network performance parameter and definition voice

7.2.2 Network Performance Parameters Data tests

Parameter Name	Definition
Download Speed (Mbps)	The download speed is defined as the data transmission rate that is achieved for downloading a test file from a test server to a test device. Download Speed = Total bytes transferred during download / Total time for transfer • 80th percentile (upper range) & 20th percentile (lower range) value has been calculated for download throughput in dynamic drive and Hotspot combine data
Upload Speed (Mbps)	The upload speed is the data transmission rate that is achieved for uploading a test file from a test device to a test server. Upload Speed = Total bytes transferred during upload / Total time for transfer. • 80th percentile (upper range) & 20th percentile (lower range) value has been calculated for upload throughput in dynamic drive and Hotspot combine data.

Download Session Setup Success Rate	(total download session established (successfully connected to server)/ total download session attempt) *100. This KPI has been calculated for Hotspot only.
Upload Session Setup Success Rate	(total upload session established (successfully connected to server)/ total upload session attempt)*100. This KPI need to report for Hotspot only.
Web Page Download Time	Web browsing test is used to measure performance in terms of opening a web/HTTP page. Time taken to open the web page successfully is considered as web browsing delay/web page download time.
Video Streaming Delay	The Video streaming delay is time taken from start of video transfer to First video frame displayed in player.
Latency	Latency is the time it takes for a small data set to be transmitted from a device to a server on the Internet and back to the same device again. The Latency is measured in milliseconds (ms). To calculate the one-way latency we just do half of the round-trip time. 50th percentile of one-way latency has been reported.
Jitter	Measure of variation in time in arrival of packets from a source to destination The consideration of packet delay jitter is considered by standard deviation of Inter Packet Delay Variation. If IPDV is used. By standard deviation is meant the average of standard deviation of IPDV on DL IPDV(i) = D(i) – D(i-1) then Stdvs of IPDV is considered as jitter.
Packet Loss Rate	Number of packets lost out of total packet transferred during test. Packet loss rate = (Total packet lost / Total packet sent) *100 * Packet delay (using ping) >90 ms considered as packet loss and included in packet loss rate. * Packet loss rate is calculated based on ICMP * 90th percentile for Packet loss rate has been reported in overall Hotspot performance summary.

Table-51: Network performance parameter and definition Data

Disclaimer: The observations presented above and, in the reports, represent the performance of the service providers on the area/route under test on the day/time of conducting the drive test and no inference whatsoever may be drawn regarding the quality of the telecom service by the service providers in the whole city/state/licensed service area.