



TELECOM REGULATORY AUTHORITY OF INDIA

Independent Drive Test Report

UP West LSA

December 2024

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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 December, 2024 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)/ Locations	From date	To date
1	Aligarh	City	183.0	16-Dec-2024	17-Dec-2024
2	Aligarh	City (Inter-operator calling)	21.0	17-Dec-2024	17-Dec-2024
3	Aligarh	Hotspot	7 Locations	18-Dec-2024	18-Dec-2024
4	Aligarh & Mathura	Walk Test	7.3	18-Dec-2024	19-Dec-2024
5	Meerut City Junction to Dehradun	Railway	242.0	20-Dec-2024	20-Dec-2024

Table-1: Drive test summary

2.2 Drive test routes

The map provides overview of drive test routes indicating city drive, inter-operator call test, hotspots, walk test and railway as per the legends shown on the map.

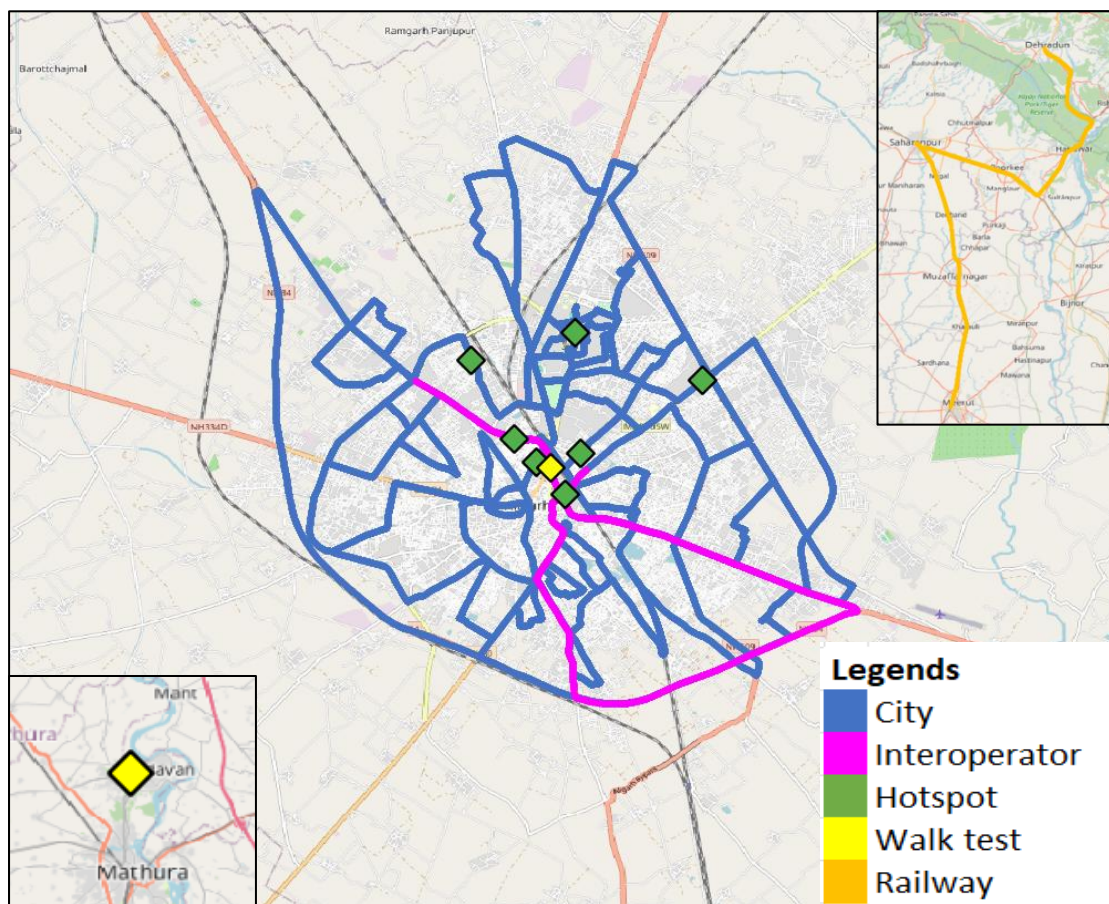


Figure-1: Drive test routes

2.3 Summary of areas covered

a) City- Aligarh fort, Jamalpuri, Dhorra, Quarsi, Ahmad nagar, Dhanipur, Naurangabad, Sasni gate, Shah jamal, Sarsaul etc.

b) Hotspot-

1. Aligarh Muslim University
2. Centre Point
3. Pt. Deen Dayal Hospital
4. Dharma Samaj College
5. ITI Aligarh
6. Malkhan Singh District Hospital
7. Aligarh Masoodabad Bus Stand

c) Walk Test-

1. Aligarh Junction
2. Shri Bankey Bihari Road

d) Railway-

1. Meerut City Junction to Dehradun Railway Station (Vande Bharat)

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

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 December-2024 covering city, hotspot, walk test and railway. (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	378	391	451
Call Setup Success Rate %	98.68	97.19	99.78
Drop Call Rate %	1.61	0.79	5.11
Call Setup Time-Average (Second)	6.42	2.93	4.14
Handover Success Rate %	98.93	99.95	99.24

Table-3: Summary of voice call performance in 3G/2G network mode only.

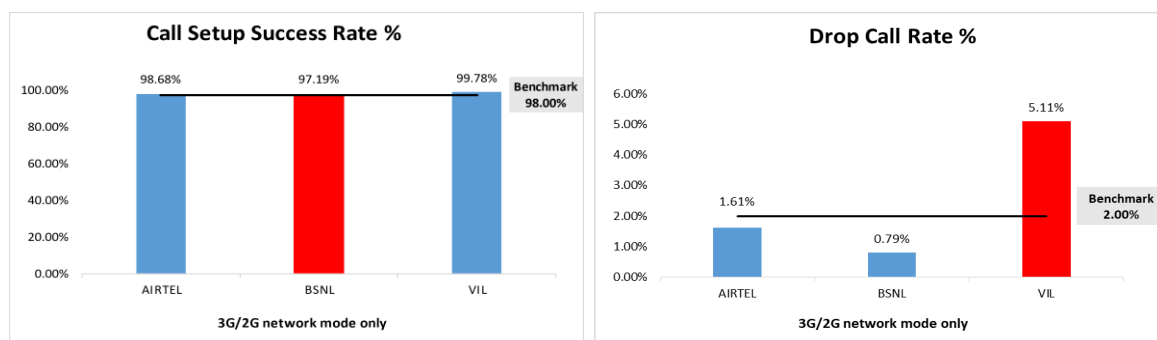


Figure-2: Call setup success rate and drop call rate performance.

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	49	NA
2G	475	84	331

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	607	665	623	609
Call Setup Success Rate %	97.69	90.23	97.27	98.03
Drop Call Rate %	0.17	5.50	0.50	0.17
Call Setup Time-Average (Second)	1.07	3.27	0.78	0.77
Handover Success Rate %	99.94	99.86	99.80	99.92

Table-5: Summary of voice call performance in network auto-selection mode.

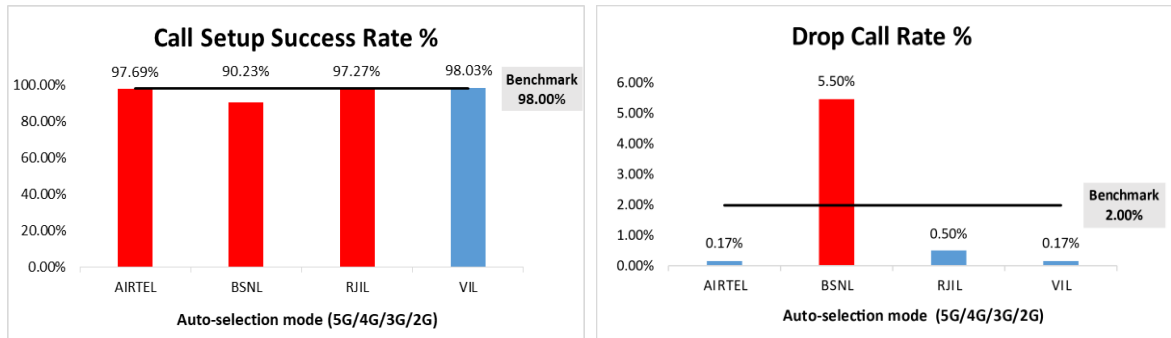


Figure-3: Performance for call setup success rate and drop call rate.

Parameter	Service Provider			
	Mobile-to-Mobile (5G/4G - Open Mode)			
	AIRTEL	BSNL	RJIL	VIL
Call Established (within service provider Network)	390	402	396	395
Number of silence call for >4 Sec	3	13	0	0
Silence Call Rate %	0.77	3.23	0.00	0.00
Number of silence instances for >4 Sec	3	15	0	0
Number of silence instances for >3 Sec	3	21	3	3
Number of silence instances for >2 sec	7	32	11	14
RTP Jitter (4G & 5G) in ms	3.10	13.55	6.83	15.75
Packet loss Rate Downlink %	0.27	9.65	0.14	0.40
Packet loss Rate Uplink %	0.21	5.66	0.24	0.30

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	538	NA
4G	1782	272	2031	1135
3G	NA	68	NA	NA
2G	1	183	NA	30

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

Note-

- NA- Service provider doesn't provide services on 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	2329	2034	2257	2306
Speech Quality (Average MOS Score)	4.02	2.79	3.93	4.45
Number of samples with MOS ≥ 4 to < 5 (Excellent)	1967	342	1647	1982
Number of samples with MOS ≥ 3 to < 4 (Good)	314	487	511	270
Number of samples with MOS ≥ 2 to < 3 (Fair)	32	758	81	46
Number of samples with MOS ≥ 1 to < 2 (Poor)	16	447	18	8
%age of samples with MOS ≥ 4 to < 5 (Excellent)	84.46%	16.81%	72.97%	85.95%
%age of samples with MOS ≥ 3 to < 4 (Good)	13.48%	23.94%	22.64%	11.71%
%age of samples with MOS ≥ 2 to < 3 (Fair)	1.37%	37.27%	3.59%	1.99%
%age of samples with MOS ≥ 1 to < 2 (Poor)	0.69%	21.98%	0.80%	0.35%

Table-8: Summary of speech quality (MOS) samples.

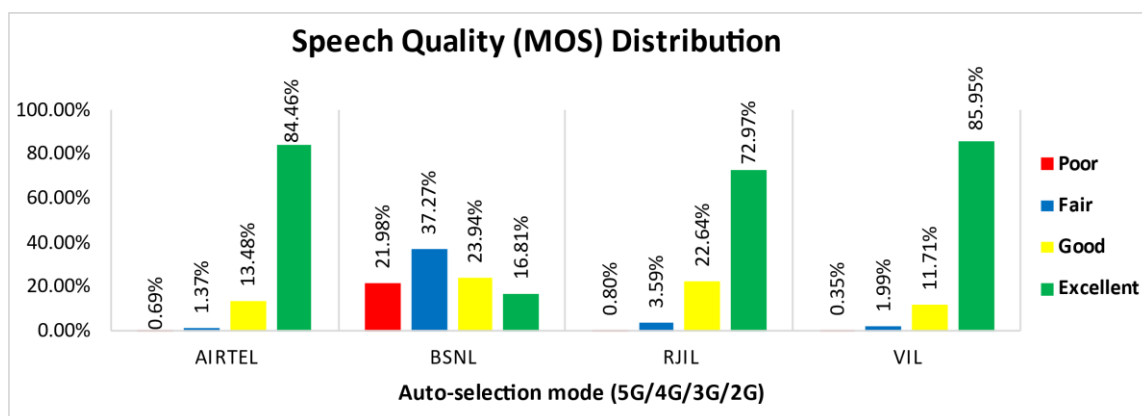


Figure- 4: Distribution of samples in MOS score range.

(d) Inter-service provider voice call performance:

To check the performance of inter-service provider call setup success rate, total 62 to 88 inter operator calls were attempted. The Call setup success rate and call setup time observation are as below.

Call setup success rate %				
From Service Provider	To Service Provider			
	AIRTEL	BSNL	RJIL	VIL
AIRTEL	NA	100.00	100.00	100.00
BSNL	98.61	NA	95.45	98.53
RJIL	100.00	96.77	NA	98.86
VIL	100.00	100.00	100.00	NA

Table-9: Call setup success rate across service providers.

Note-

- NA-Only Inter-operator calls were measured during test.

Call setup time average (seconds)				
From Service Provider	To Service Provider			
	AIRTEL	BSNL	RJIL	VIL
AIRTEL	NA	3.74	2.78	1.77
BSNL	3.09	NA	4.04	3.13
RJIL	2.11	5.40	NA	1.78
VIL	2.15	3.55	2.39	NA

Table-10: Call setup time across service providers.

Note-

- NA- Only inter-operator calls were measured during test.

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	165.91	7.29	260.08	36.37
	80th Percentile	253.00	13.07	441.46	57.88
	20th Percentile	49.66	0.79	89.54	13.57
Upload Throughput (Mbits/s)	Average	30.94	3.57	34.07	15.77
	80th Percentile	50.00	5.46	56.41	26.46
	20th Percentile	8.62	1.27	9.33	5.40
Latency (ms)	50th percentile	20.15	33.65	20.10	32.35

Table-11: Summary of data performance in network auto-selection mode.

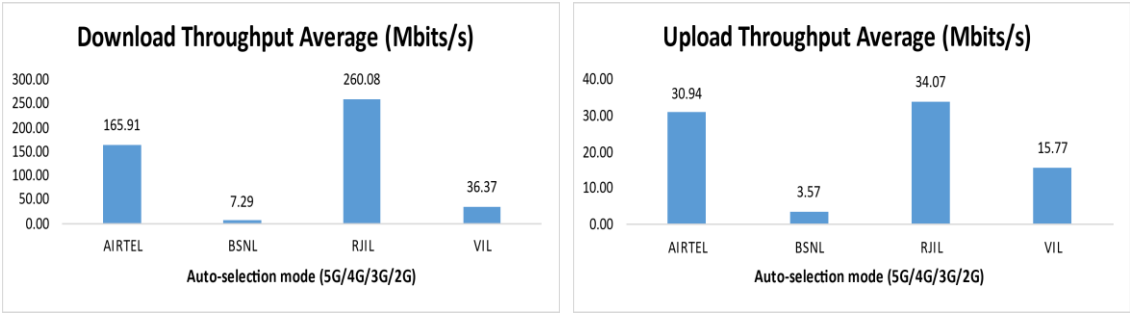


Figure- 5: Download and upload throughput.

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	888	NA
4G	1419	351	293	1143
3G	NA	93	NA	NA
2G	1	36	NA	9

Table-12: Technology wise number of network cell id's latched during drive test.

Note-
<ul style="list-style-type: none">• 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, hotspots, walk test and Railway for all telecom service providers, the results of drive tests conducted are shown individually for respective areas/locations.

4.2 City

Drive test has been conducted from 16th to 17th December 2024 in Aligarh. (Refer Table-1)

4.2.1 Drive test route

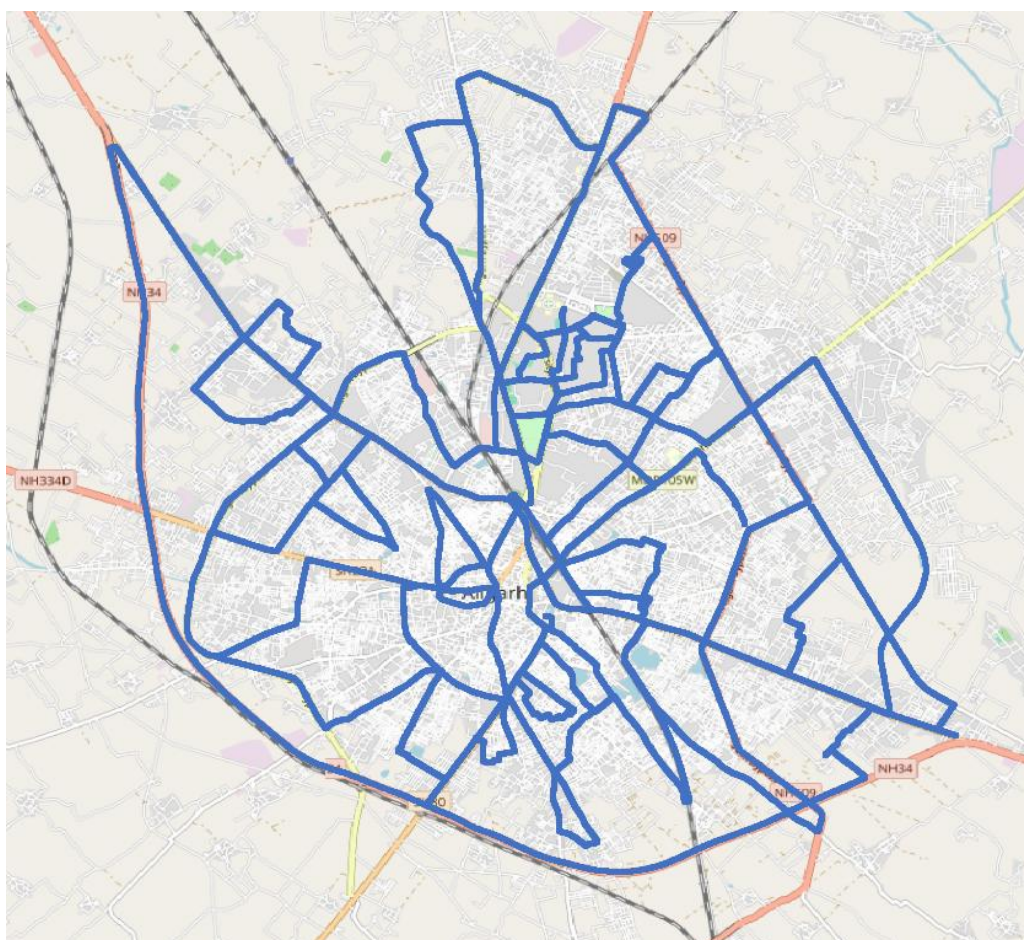


Figure- 6: Drive test routes

4.2.2 Areas covered

Aligarh fort, Jamalpuri, Dhorra, Quarsi, Ahmed nagar, Dhanipur, Naurangabad, Sasni gate, Shah jamal, Sarsaul 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	378	391	451
Call Setup Success Rate %	98.68	97.19	99.78
Drop Call Rate %	1.61	0.79	5.11
Call Setup Time-Average (Second)	6.42	2.93	4.14
Handover Success Rate %	98.93	99.95	99.24

Table-13: Summary of voice call performance in 3G/2G network mode only.

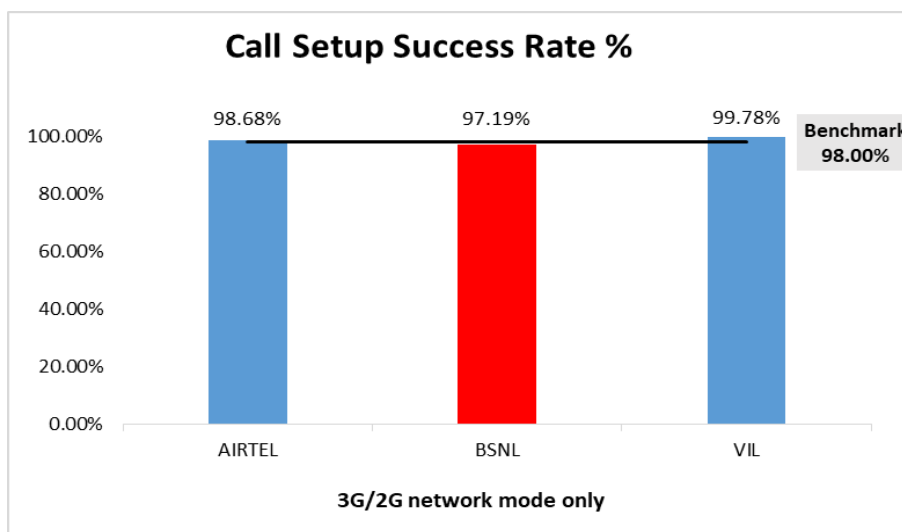


Figure-7: Performance for call setup success rate.

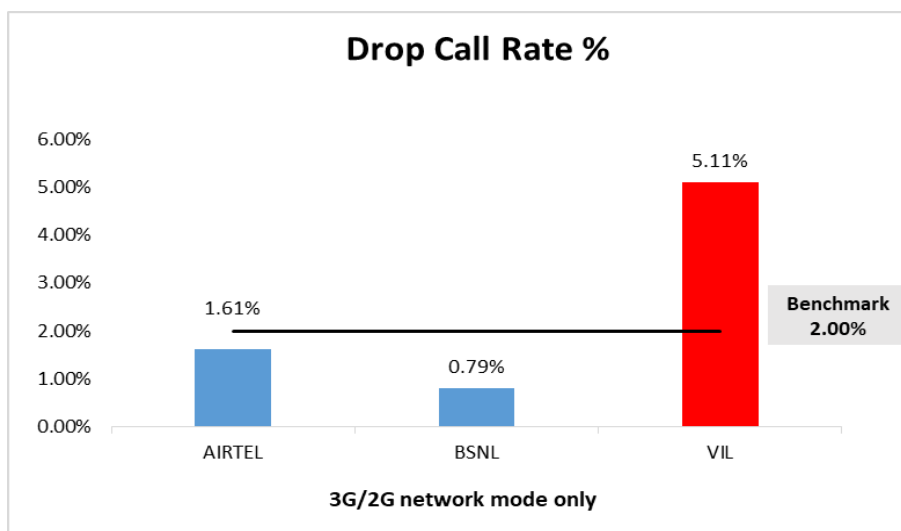


Figure-8: Performance for drop call rate.

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

Technology	Service Provider		
	AIRTEL	BSNL	VIL
3G	NA	65.79%	NA
2G	100.00%	34.21%	99.98%
Limited Service	0.00%	0.00%	0.02%

Table-14: Time spent on technology during drive test 3G/2G network mode only.

Note-

- NA- Service provider doesn't provide services in respective technology.

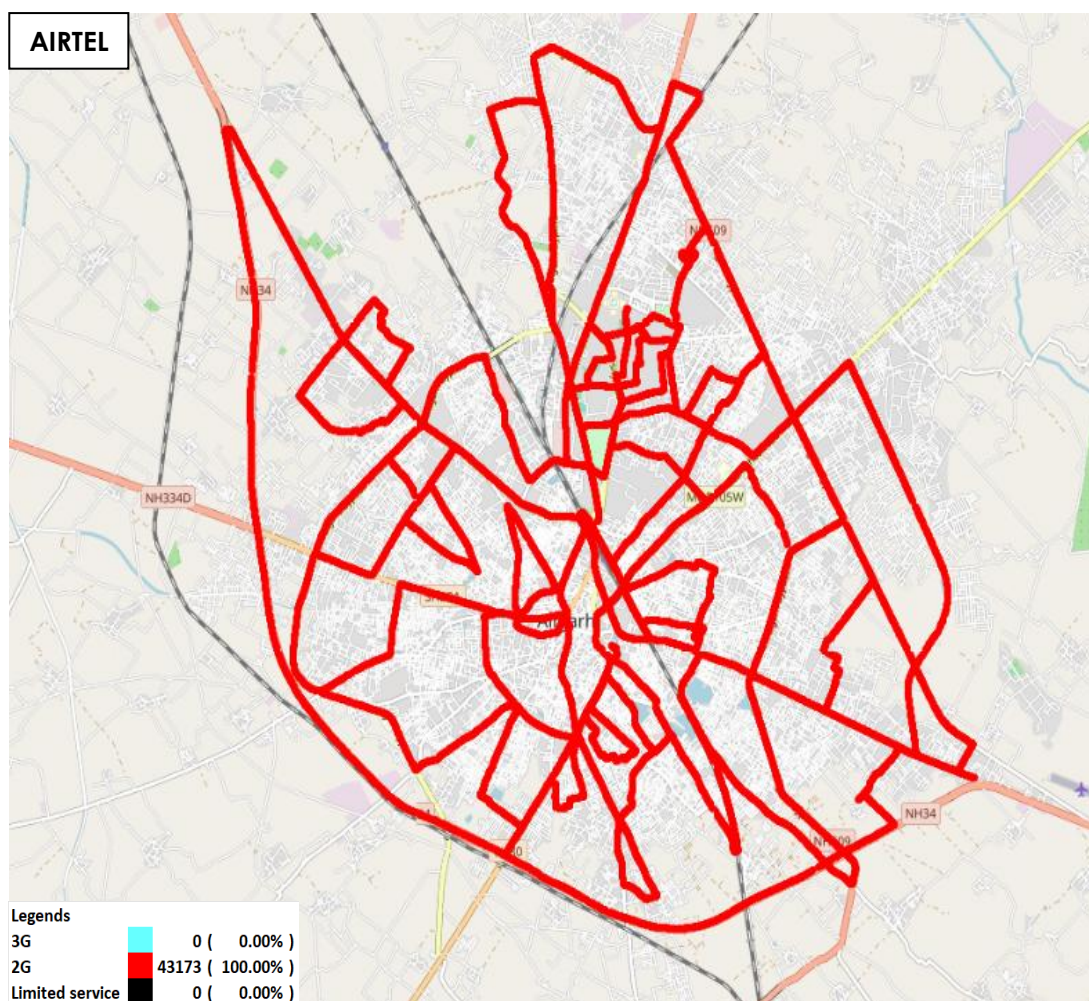


Figure-9: Serving technology plots 3G/2G network mode – AIRTEL.

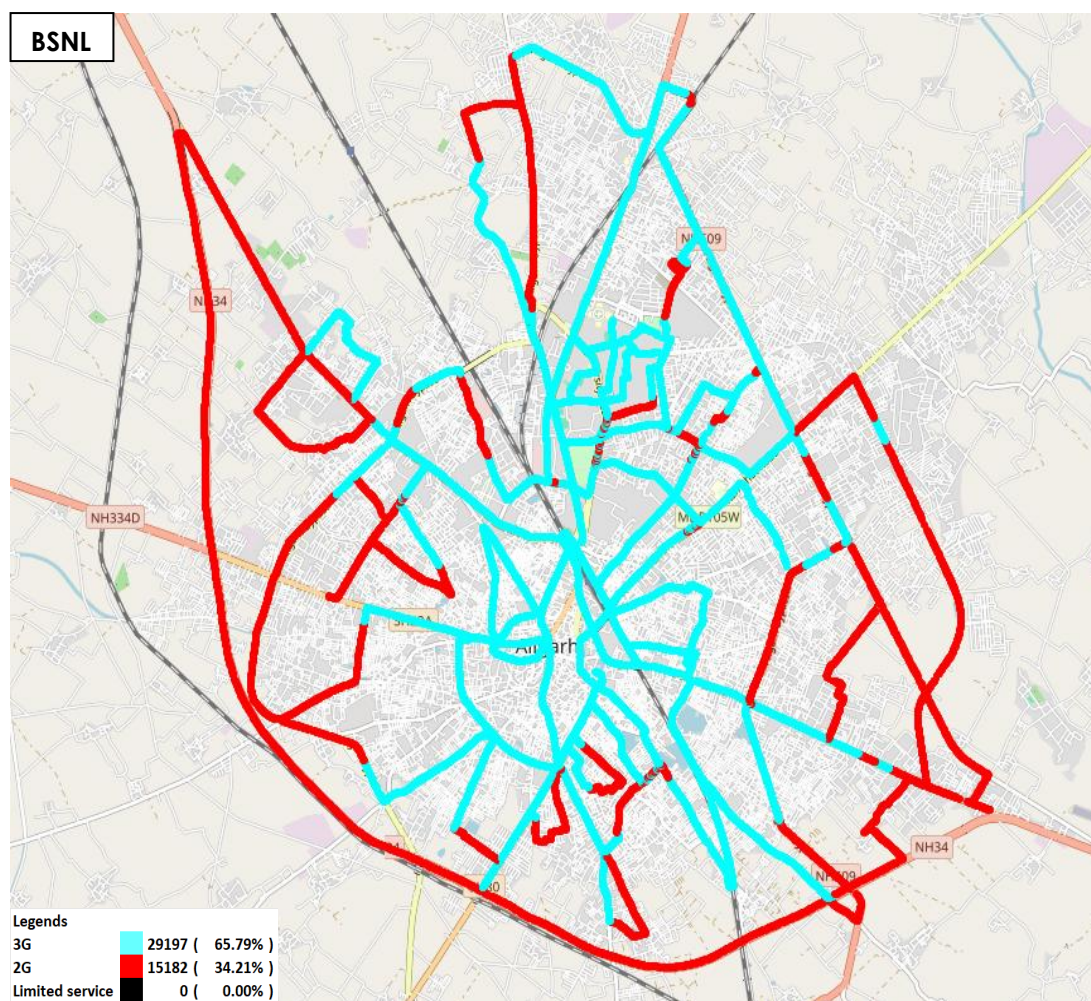


Figure-10: Serving technology plots 3G/2G network mode –BSNL.

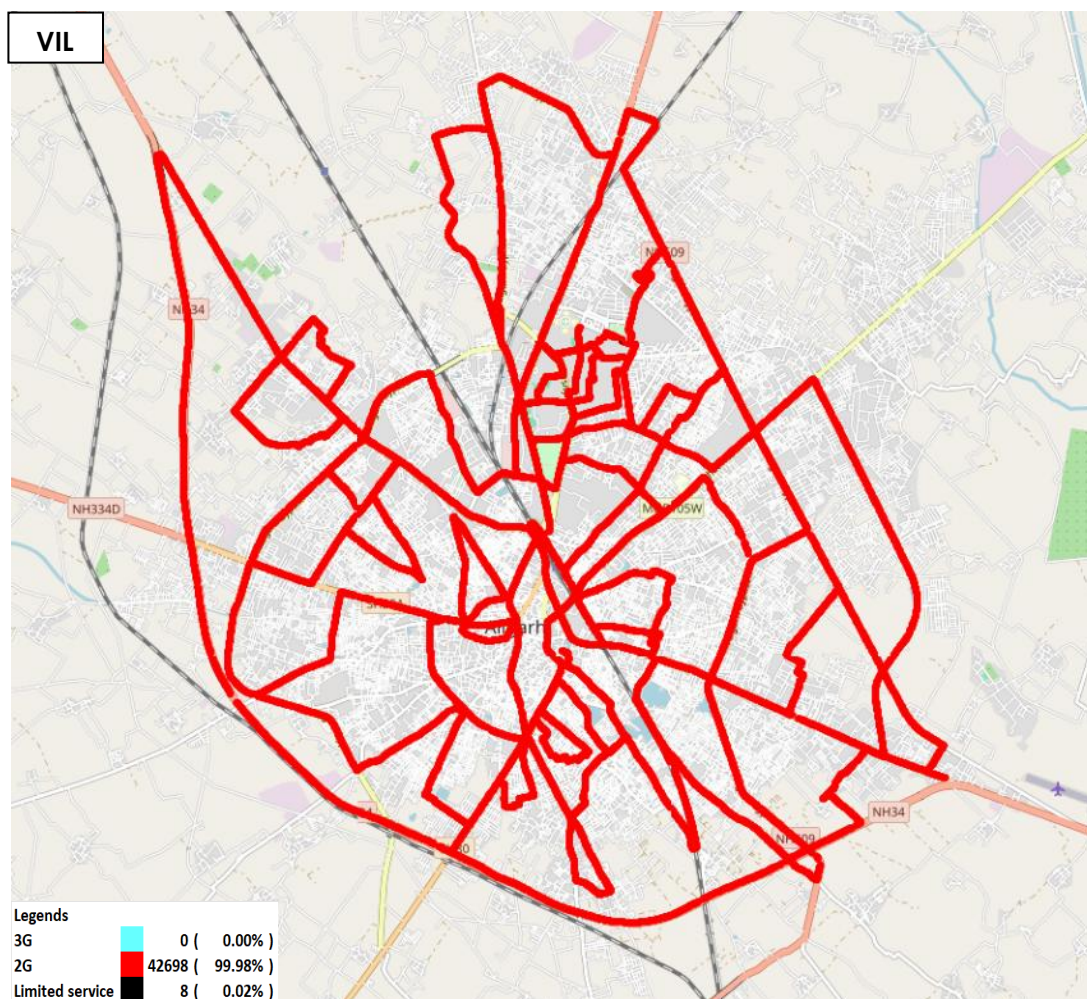


Figure-11: Serving technology plots 3G/2G network mode –VIL.

(c) Network Signal Strength distribution: The following chart represents signal strength distribution for 3G/2G network mode only. (Refer figure-35,36 & 37 for map view).

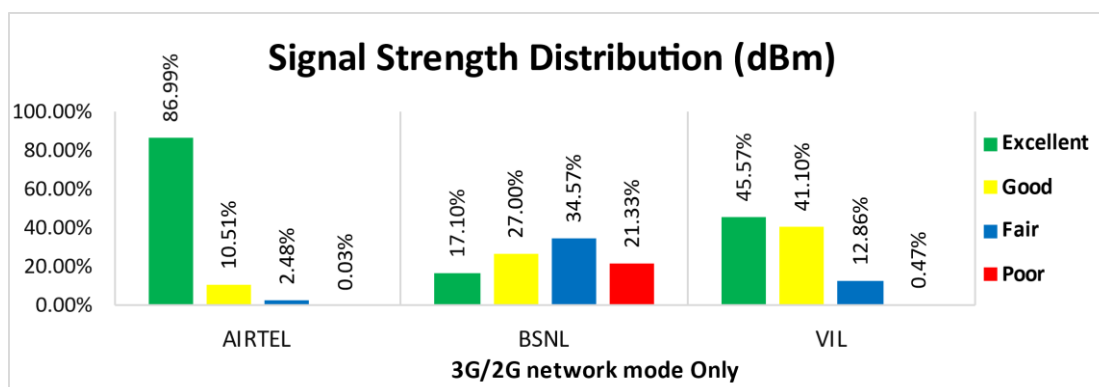


Figure-12: Signal strength distribution 3G/2G network mode only.

Observations:

- Airtel has 87% of samples falling in the excellent signal strength category.
- BSNL has 17% of samples falling in the excellent signal strength category.
- VIL has 46% 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	401	425	412	403
Call Setup Success Rate %	100.00	92.47	99.76	100.00
Drop Call Rate %	0.00	2.29	0.24	0.00
Call Setup Time Average (Second)	0.91	3.35	0.70	0.67
Handover Success Rate %	99.95	99.78	99.79	99.93

Table-15: Summary of voice call performance in network auto-selection mode (5G/4G/3G/2G)

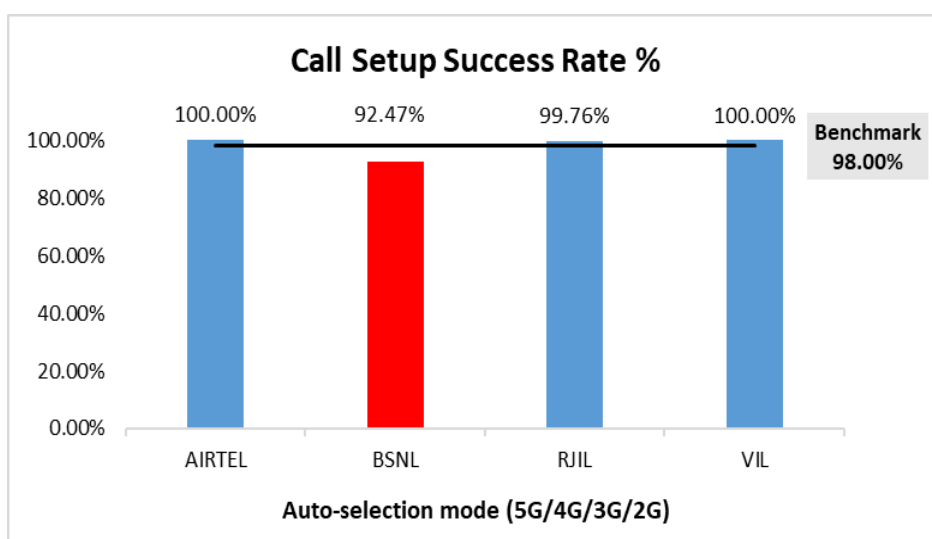


Figure-13: Performance for call setup success rate.

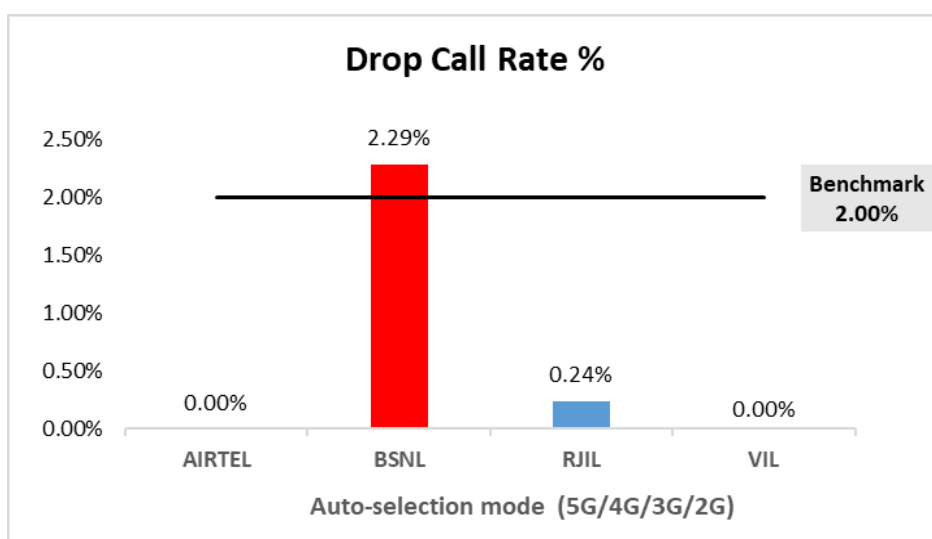


Figure-14: Performance for drop call rate.

Parameter	Service Provider			
	Mobile-to-Mobile (5G/4G - Open Mode)			
	AIRTEL	BSNL	RJIL	VIL
Call Established (within service provider Network)	390	402	396	395
Number of silence call for >4 Sec	3	13	0	0
Silence Call Rate %	0.77	3.23	0.00	0.00
Number of silence instances for >4 Sec	3	15	0	0
Number of silence instances for >3 Sec	3	21	3	3
Number of silence instances for >2 sec	7	32	11	14
RTP Jitter (4G & 5G) in ms	3.10	13.55	6.83	15.75
Packet loss Rate Downlink %	0.27	9.65	0.14	0.40
Packet loss Rate Uplink %	0.21	5.66	0.24	0.30

Table-16: 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 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-16	2329	2034	2257	2306
Speech Quality (Average MOS Score)	4.02	2.79	3.93	4.45
Number of samples with MOS ≥ 4 to < 5 (Excellent)	1967	342	1647	1982
Number of samples with MOS ≥ 3 to < 4 (Good)	314	487	511	270
Number of samples with MOS ≥ 2 to < 3 (Fair)	32	758	81	46
Number of samples with MOS ≥ 1 to < 2 (Poor)	16	447	18	8
%age of samples with MOS ≥ 4 to < 5 (Excellent)	84.46%	16.81%	72.97%	85.95%
%age of samples with MOS ≥ 3 to < 4 (Good)	13.48%	23.94%	22.64%	11.71%
%age of samples with MOS ≥ 2 to < 3 (Fair)	1.37%	37.27%	3.59%	1.99%
%age of samples with MOS ≥ 1 to < 2 (Poor)	0.69%	21.98%	0.80%	0.35%

Table-17: Summary of speech quality (MOS) samples.

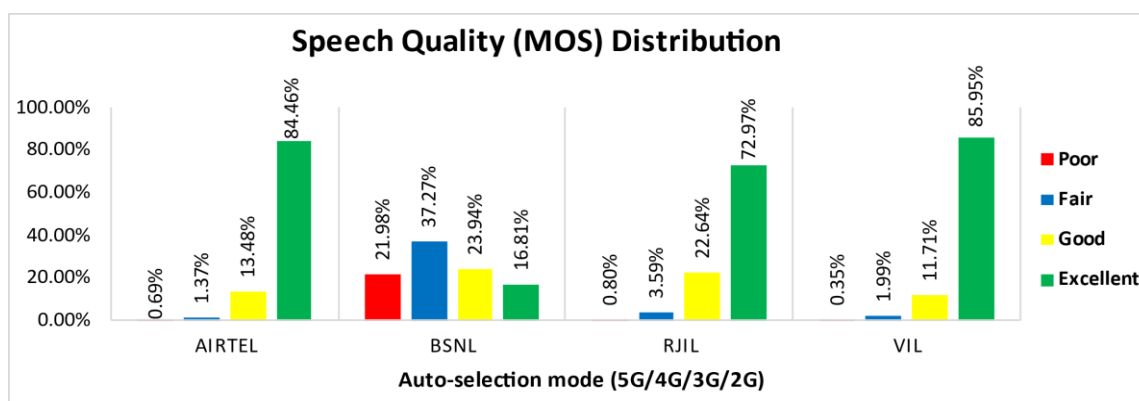


Figure-15: Distribution of samples in MOS score range.

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

Technology	Service Provider			
	AIRTEL	BSNL	RJIL	VIL
5G	1.46%	NA	18.21%	NA
4G	98.54%	65.81%	81.78%	100.00%
3G	NA	11.70%	NA	NA
2G	0.00%	22.29%	NA	0.00%
Limited Service	0.00%	0.20%	0.01%	0.00%

Table-18: Time spent on technology during drive test.

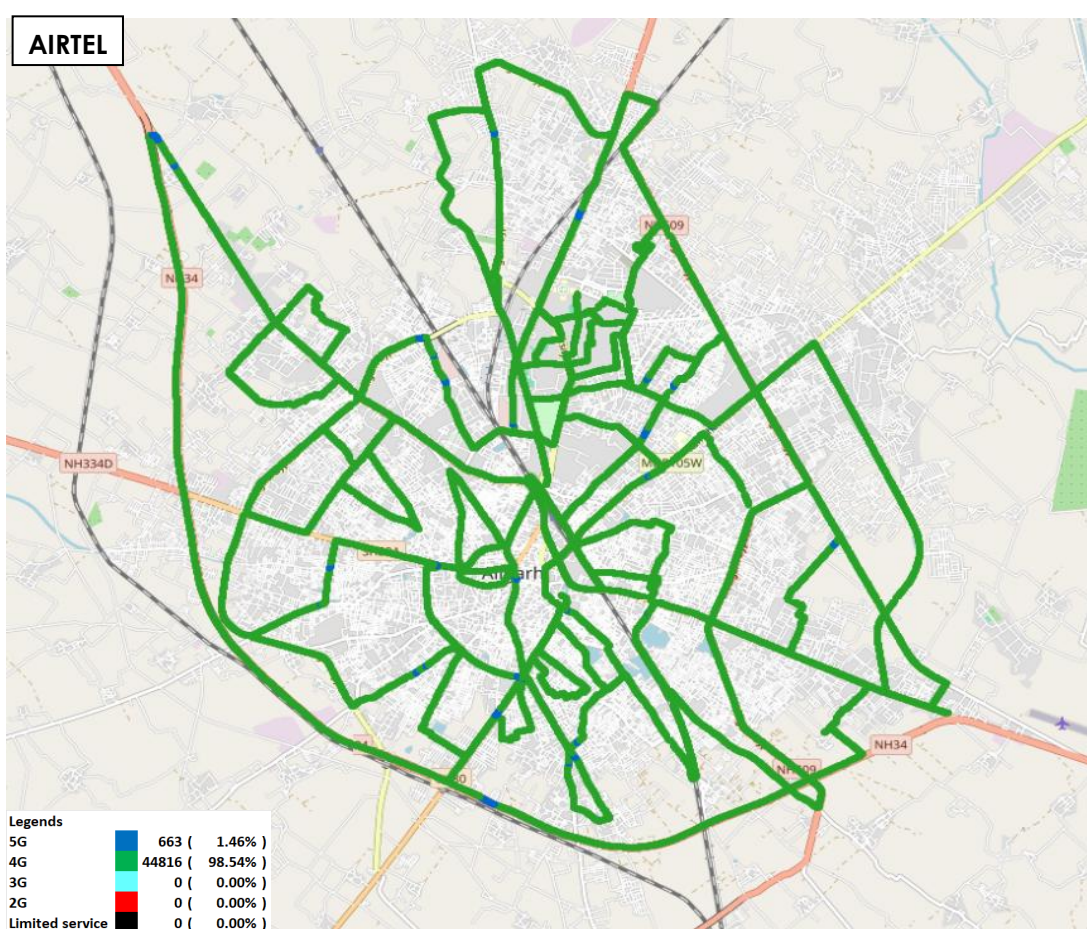


Figure-16: Serving technology plots in auto-selection mode (5G/4G/3G/2G) -AIRTEL.

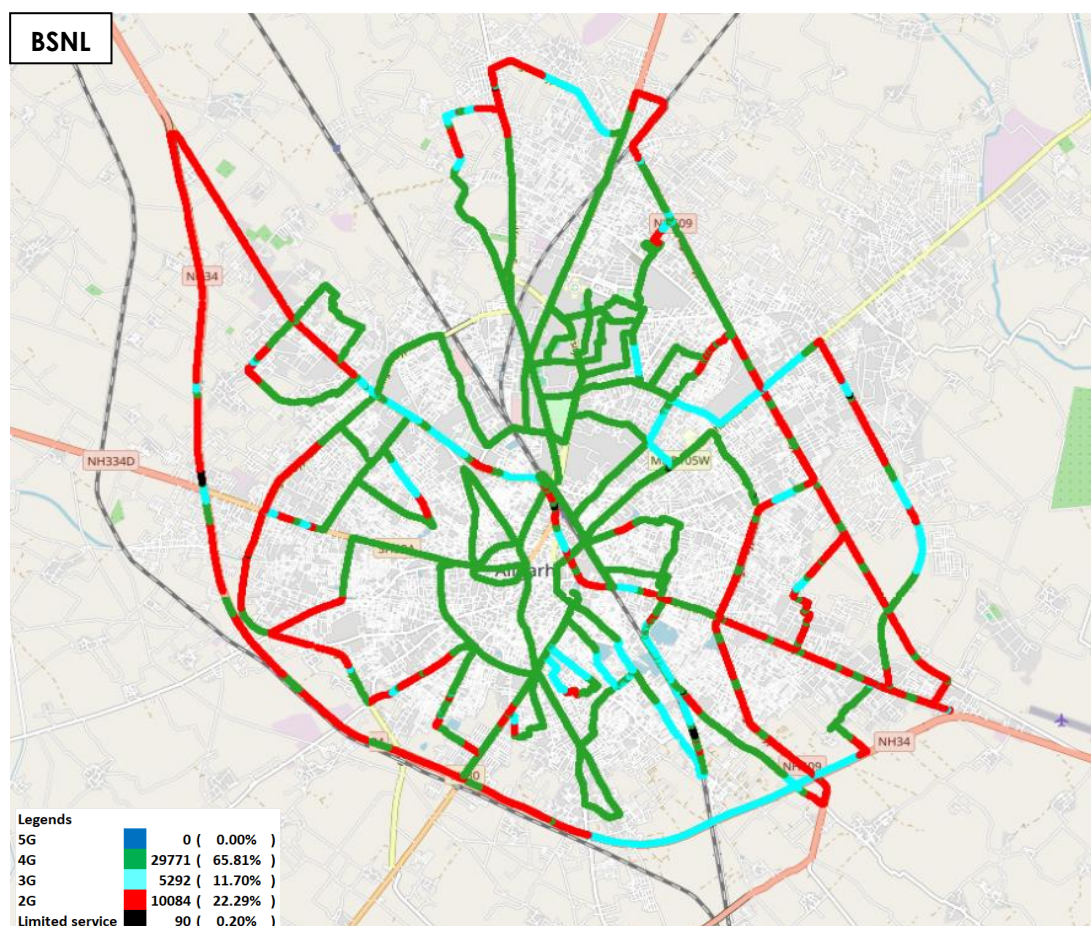


Figure-17: Serving technology plots in auto-selection mode (5G/4G/3G/2G)-BSNL.

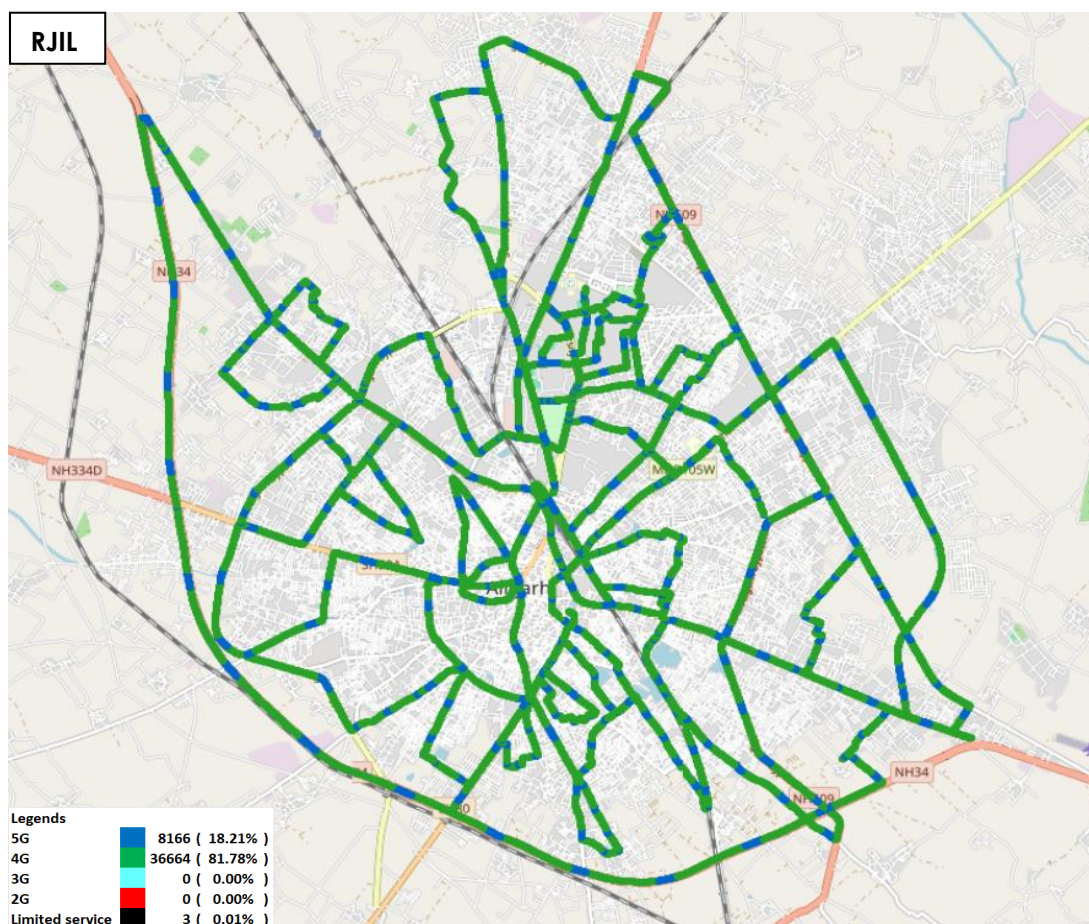


Figure-18: Serving technology plots in auto-selection mode (5G/4G/3G/2G)- RJIL.

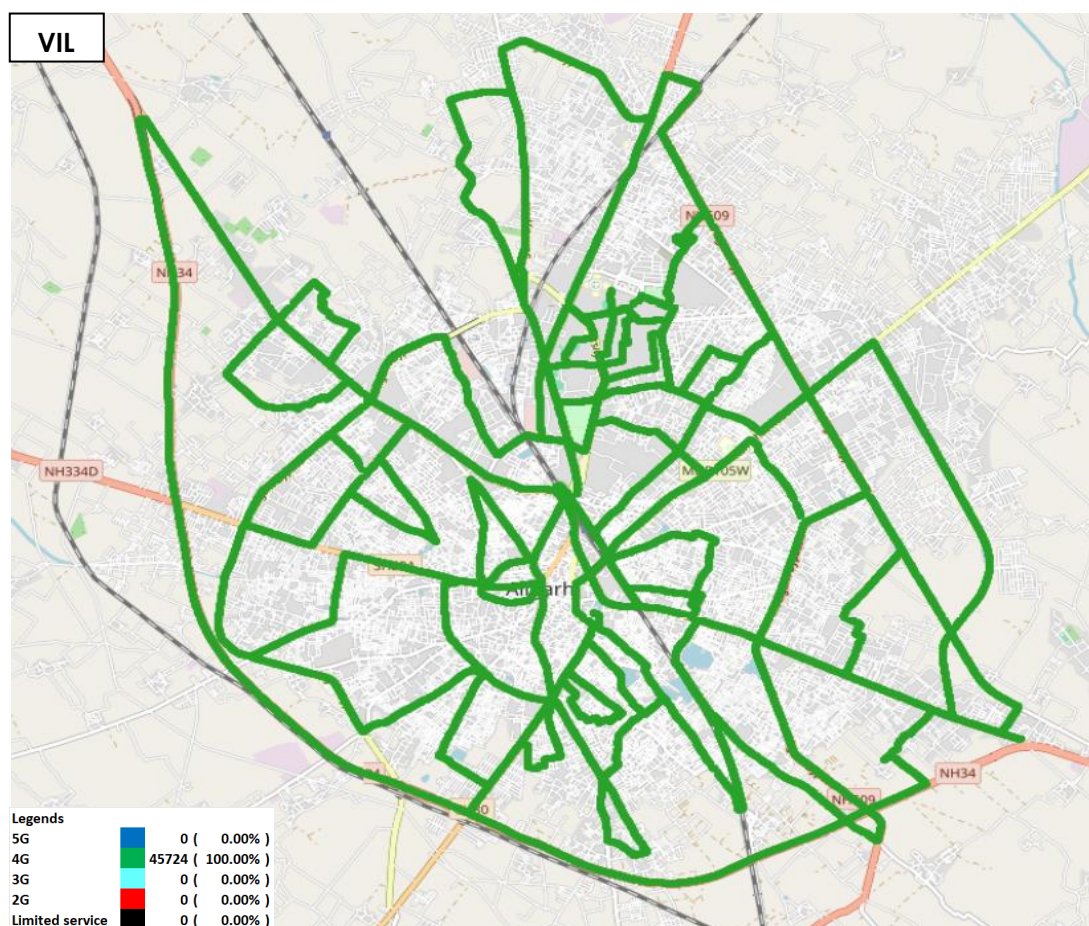


Figure-19: Serving technology plots in auto-selection mode (5G/4G/3G/2G) – VIL.

(g) Network Signal Strength distribution: The following chart provide signal strength distribution for auto-selection mode (5G/4G/3G/2G). (Refer figure-38, 39, 40 & 41 for map view)

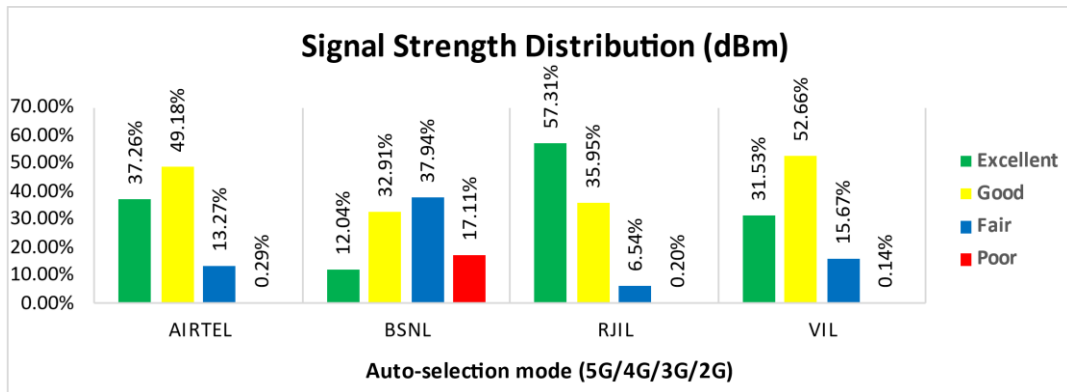


Figure-20: Signal strength distribution auto-selection mode 5G/4G/3G/2G.

Observations:

- Airtel has 37% samples falling in the excellent signal strength category.
- BSNL has 12% samples falling in the excellent signal strength category.
- RJIL has 57% 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	198.47	6.52	305.22	40.89
	80th Percentile	286.36	10.90	481.24	62.27
	20th Percentile	92.74	0.84	141.85	16.70
Upload Throughput (Mbits/s)	Average	35.13	3.00	38.59	17.03
	80th Percentile	53.08	3.76	62.76	27.50
	20th Percentile	15.47	1.24	14.16	6.99
Latency (ms)	50th percentile	18.18	38.98	18.95	31.05

Table-19: Summary of Data performance in network auto-selection mode.

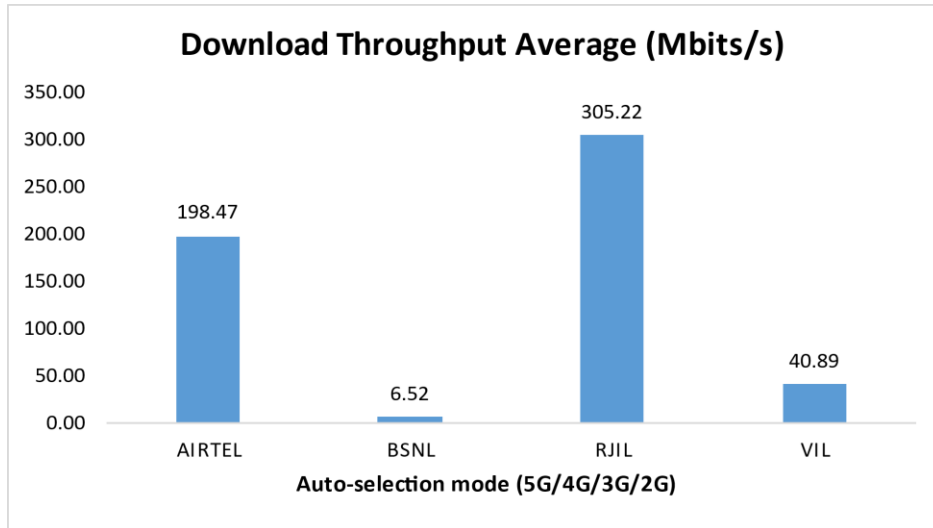


Figure- 21: Download throughput.

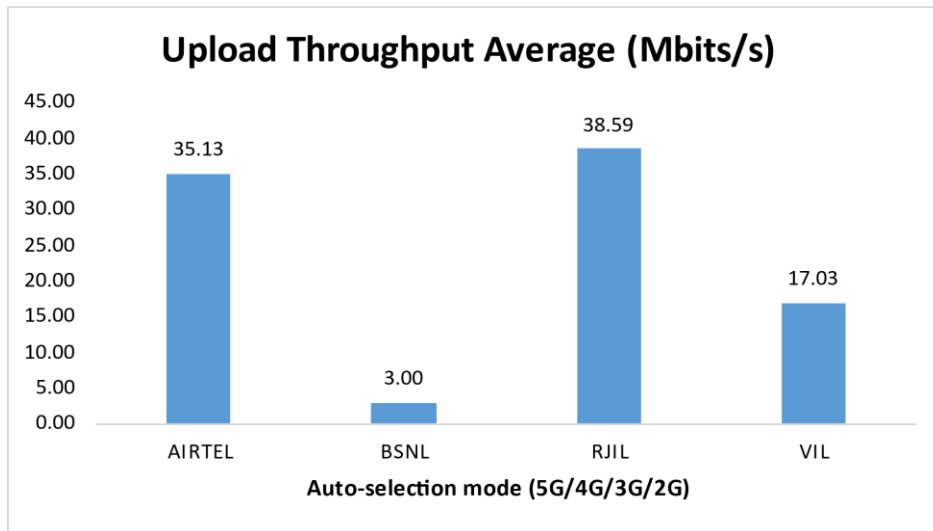


Figure- 22: Upload throughput.

4.3 Hotspots

Hotspot testing has been done on 18th December 2024. Seven locations have been tested in the city.

4.3.1 Locations

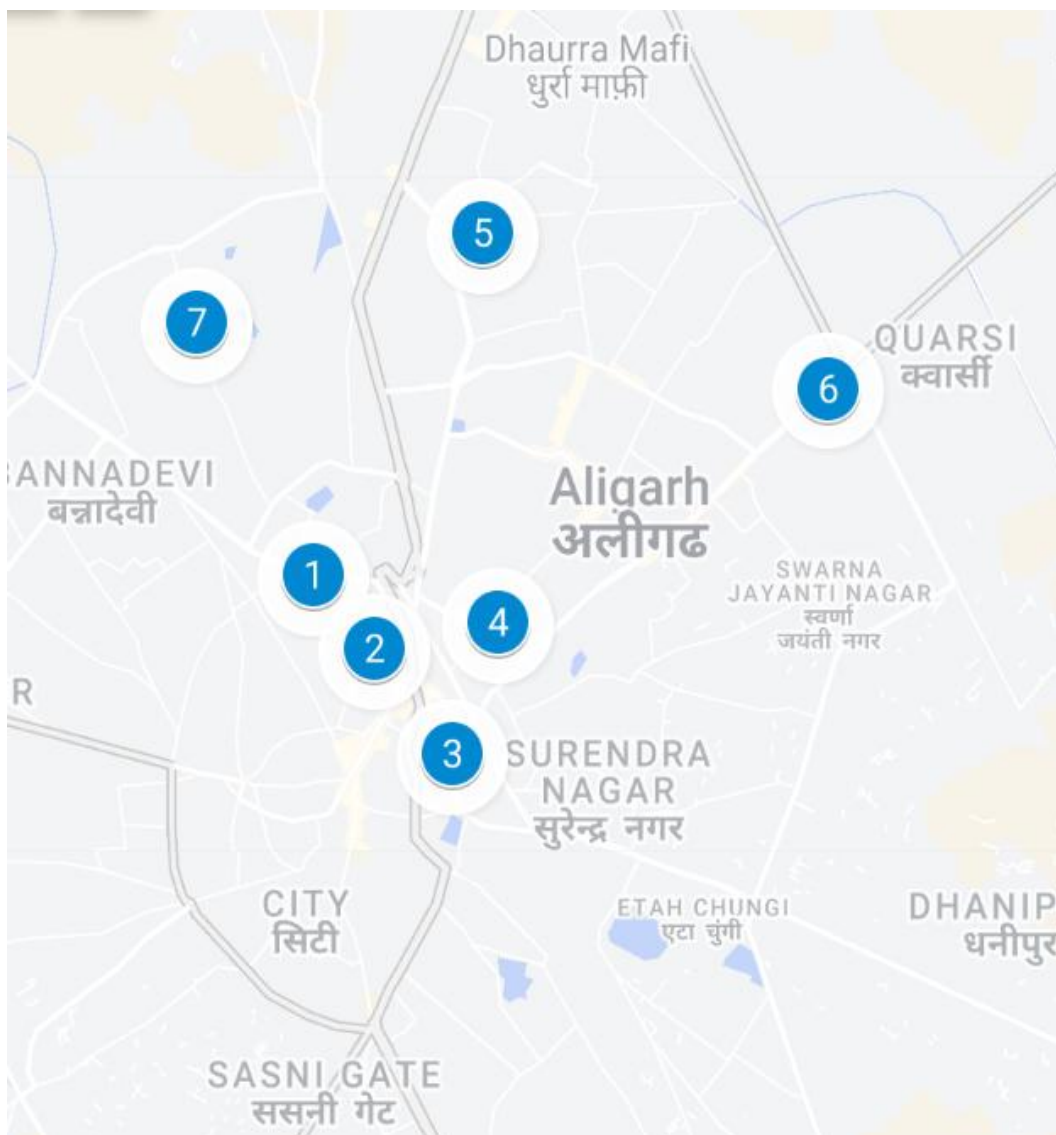


Figure- 23: Hotspot locations

4.3.2 Hotspot covered

1. Aligarh Muslim University
2. Centre Point
3. Pt. Deen Dayal Hospital
4. Dharma samaj college
5. ITI Aligarh
6. Malkhan Singh District Hospital
7. Aligarh Masoodabad Bus Stand

4.3.3 Voice performance

Overall Voice Performance				
Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Call Attempt	70	70	70	70
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 (Sec)	0.92	2.16	0.65	0.65

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

Aligarh Muslim 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 (Sec)	0.94	2.36	0.64	0.68

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

Centre Point				
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 (Sec)	0.85	2.14	0.65	0.65

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

Pt. Deen Dayal Hospital				
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 (Sec)	1.13	2.08	0.65	0.71

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

Dharma Samaj College				
Parameters	Service Provider			
	Auto 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 (Sec)	0.90	2.10	0.78	0.62

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

ITI Aligarh				
Parameters	Service Provider			
	Auto 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 (Sec)	0.84	2.12	0.60	0.59

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

Malkhan Singh District Hospital				
Parameters	Service Provider			
	Auto 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 (Sec)	0.85	2.05	0.62	0.67

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

Aligarh Masoodabad Bus Stand				
Parameters	Service Provider			
	Auto 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 (Sec)	0.93	2.24	0.59	0.61

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

4.3.4 Data performance

Overall Data Performance				
Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	149.33	13.57	243.38	34.21
Download Throughput 80th Percentile (Mbit/s)	227.14	18.45	391.84	65.77
Download Throughput 20th Percentile (Mbit/s)	62.80	8.04	143.39	11.62
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	45.60	6.34	37.64	20.59
Upload Throughput 80th Percentile (Mbit/s)	65.92	7.06	52.79	37.40
Upload Throughput 20th Percentile (Mbit/s)	14.73	3.61	17.86	5.20
Upload Session Setup Success Rate %	100.00	100.00	97.14	100.00
Web Browsing Delay (Second)	2.43	3.03	2.20	2.43
Youtube Initial Buffer Delay (Second)	0.58	1.67	0.74	0.82
Latency (ms)- 50th percentile	22.50	31.05	20.15	32.85
Jitter (ms)	11.50	3.98	26.06	4.24
Packet Loss Rate %	1.06	0.29	1.16	0.61

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

Aligarh Muslim University				
Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	42.71	15.06	102.32	12.67
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	9.82	6.91	3.30	4.47
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.38	2.53	2.42	2.39
Youtube Initial Buffer Delay (Second)	0.83	0.84	1.19	0.96
Latency (ms)- 50th percentile	28.53	31.73	23.40	31.35
Jitter (ms)	17.93	4.85	93.87	4.04
Packet Loss Rate %	2.10	0.40	5.20	0.50

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

Centre Point				
Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	155.06	20.71	147.88	62.02
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	46.20	6.70	62.15	36.70
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.87	2.72	2.29	2.51
Youtube Initial Buffer Delay (Second)	0.55	0.87	0.63	0.70
Latency (ms)- 50th percentile	21.83	30.50	22.73	33.60
Jitter (ms)	10.97	3.46	10.79	3.50
Packet Loss Rate %	0.70	0.10	0.50	1.10

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

Pt. Deen Dayal Hospital				
Parameters	Service Provider			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	131.28	6.07	504.19	21.99
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	14.83	3.68	46.99	12.48
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.21	3.21	2.20	2.36
Youtube Initial Buffer Delay (Second)	0.54	1.23	0.57	0.80
Latency (ms)- 50th percentile	21.15	33.00	18.43	33.93
Jitter (ms)	16.19	4.85	11.56	4.09
Packet Loss Rate %	0.50	0.50	0.30	0.50

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

Dharma Samaj College				
Parameters	Service Provider			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	39.45	12.11	213.09	52.69
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	41.61	3.34	42.52	16.70
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	3.21	4.17	2.23	2.32
Youtube Initial Buffer Delay (Second)	0.66	4.48	0.65	0.95
Latency (ms)- 50th percentile	21.10	27.48	21.70	36.95
Jitter (ms)	17.87	1.93	25.68	6.38
Packet Loss Rate %	3.80	0.00	1.10	0.30

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

ITI Aligarh				
Parameters	Service Provider			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	161.23	17.04	373.53	68.84
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	34.99	14.05	51.03	27.05
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.13	2.56	2.11	2.63
Youtube Initial Buffer Delay (Second)	0.49	1.16	0.57	0.67
Latency (ms)- 50th percentile	22.65	32.00	18.28	33.50
Jitter (ms)	8.16	3.69	7.09	3.88
Packet Loss Rate %	0.30	0.20	0.00	1.10

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

Malkhan Singh District Hospital				
Parameters	Service Provider			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	288.24	10.51	203.54	8.99
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	107.40	5.58	17.85	5.58
Upload Session Setup Success Rate %	100.00	100.00	80.00	100.00
Web Browsing Delay (Second)	2.17	3.47	2.09	2.52
Youtube Initial Buffer Delay (Second)	0.46	2.18	1.11	1.00
Latency (ms)- 50th percentile	21.33	33.85	18.15	30.65
Jitter (ms)	4.27	4.81	26.93	4.85
Packet Loss Rate %	0.00	0.30	1.00	0.20

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

Aligarh Masoodabad Bus Stand				
Parameters	Service Provider			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	227.33	13.49	159.10	12.27
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	64.36	4.11	35.68	41.17
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.06	2.58	2.11	2.31
Youtube Initial Buffer Delay (Second)	0.48	0.87	0.56	0.67
Latency (ms)- 50th percentile	22.70	29.50	19.13	30.38
Jitter (ms)	5.31	4.26	7.34	2.94
Packet Loss Rate %	0.00	0.50	0.00	0.60

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

4.4 Walk Test

Walk test testing has been done on 18th & 19th December 2024. Two locations have been tested in Aligarh & Mathura.

4.4.1 Walk test location map

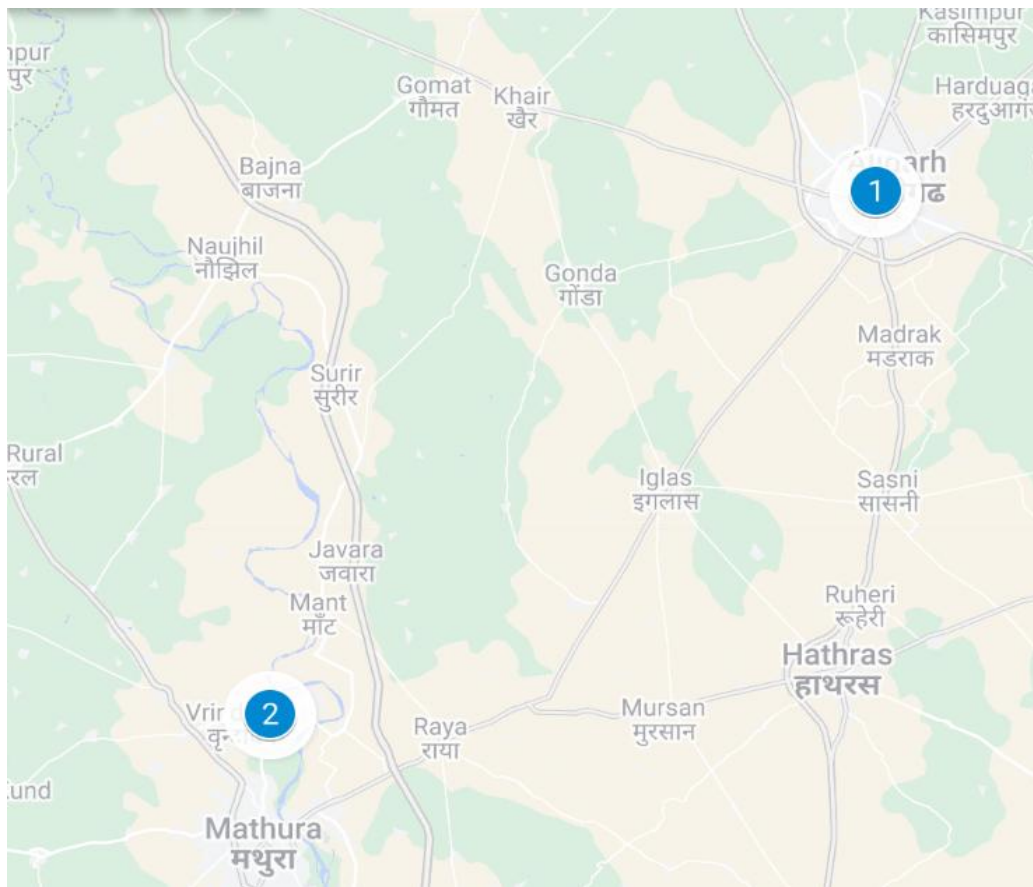


Figure- 24: Walk Test locations.

4.4.2 Walk Test covered

1. Aligarh Junction.
2. Shri Bankey Bihari Road

4.4.3 Voice performance

Aligarh Junction				
Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Call Attempt	18	18	18	18
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)	0.90	2.14	0.68	0.58

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

Shri Bankey Bihari Road				
Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Call Attempt	43	43	44	42
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	2.57	0.65	0.65

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

4.4.4 Data performance

Aligarh Junction				
Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	101.95	7.14	55.46	49.66
Download Session Setup Success Rate %	100.00	80.00	100.00	100.00
Upload Throughput Average (Mbits/s)	17.17	5.83	13.23	24.93
Upload Session Setup Success Rate %	100.00	95.00	100.00	100.00
Latency (ms)- 50th percentile	19.48	31.58	19.05	28.45

Table-38: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

Shri Bankey Bihari Road				
Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	164.40	11.12	197.78	29.02
Download Session Setup Success Rate %	100.00	98.04	100.00	100.00
Upload Throughput Average (Mbits/s)	36.75	6.64	36.99	16.16
Upload Session Setup Success Rate %	100.00	96.08	100.00	100.00
Latency (ms)- 50th percentile	17.75	33.95	20.70	33.40

Table-39: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G)

4.5 Railways

Drive test has been conducted on 20th December 2024 covering one railway route- Meerut to Dehradun through Vande Bharat train. (refer table-1)

4.5.1 Drive test route

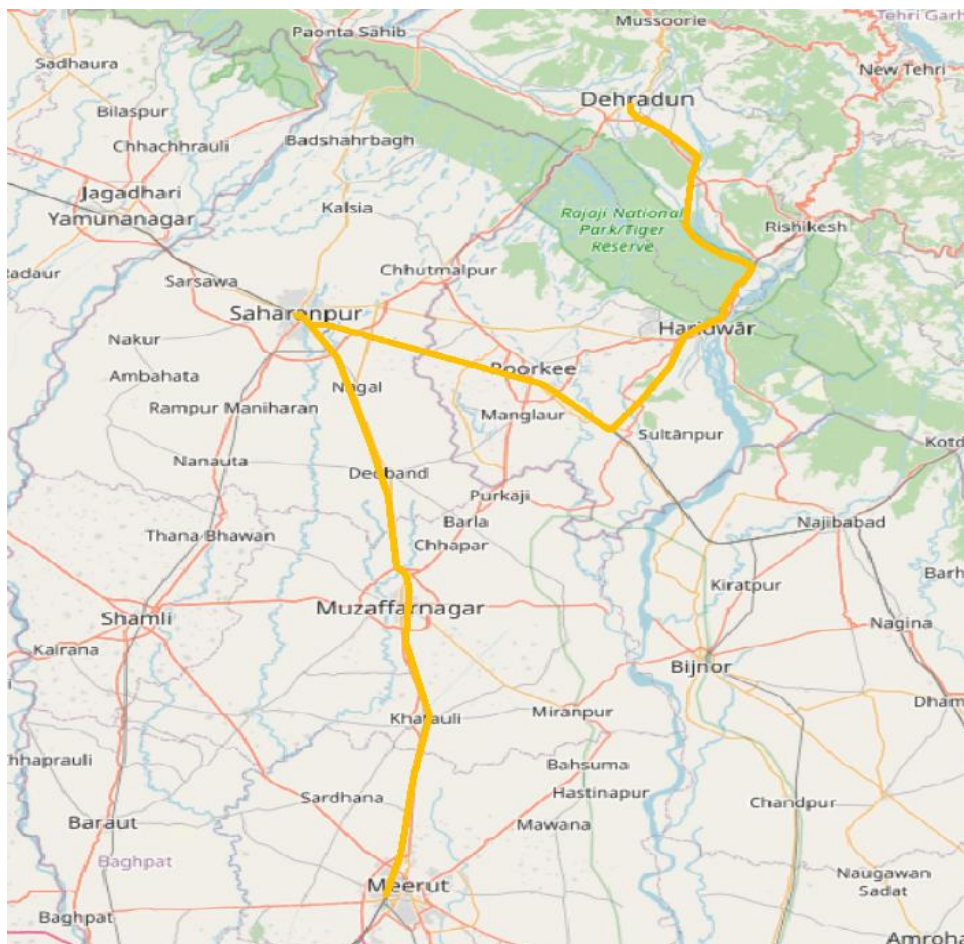


Figure-25: Drive test railway route.

4.5.2 Route Covered

- Meerut city junction to Dehradun railway station (Vande Bharat)

4.5.3 Voice performance

(a) 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	75	109	79	76
Call Setup Success Rate %	81.33	69.72	79.75	84.21
Drop Call Rate %	1.64	31.58	3.17	1.56
Call Setup Time-Average (Second)	2.49	4.85	1.54	1.61
Handover Success Rate %	100.00	99.51	99.84	99.76

Table-40: Summary of voice call performance in network auto-selection mode (5G/4G/3G/2G)

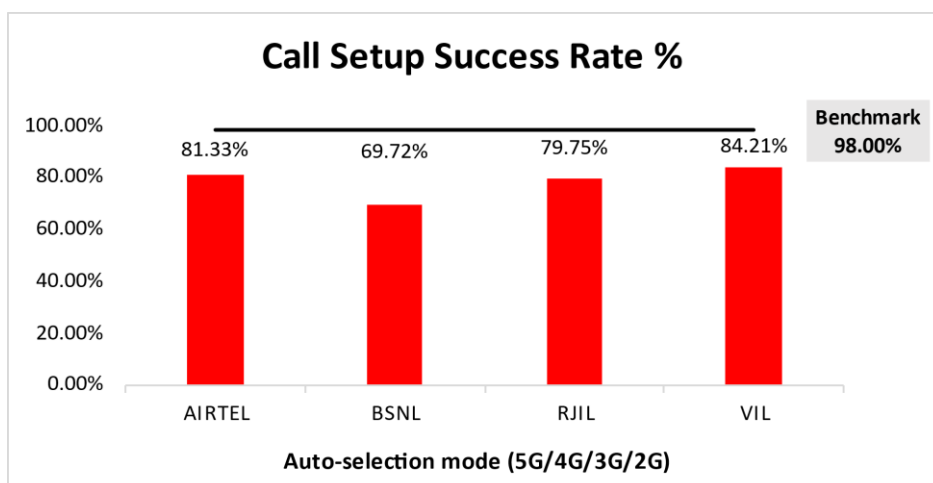


Figure-26: Performance for call setup success rate .

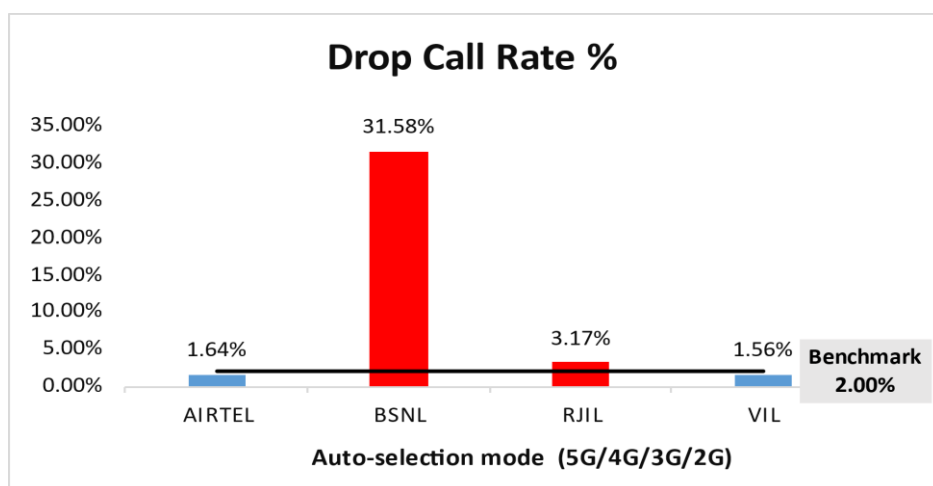


Figure-27: Performance for drop call rate.

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

Technology	Service Provider			
	AIRTEL	BSNL	RJIL	VIL
5G	0.36%	NA	5.48%	NA
4G	96.62%	20.47%	89.64%	88.60%
3G	NA	13.78%	NA	NA
2G	0.00%	59.71%	NA	9.60%
Limited service	3.03%	6.05%	4.89%	1.79%

Table-41: Time spent on technology during drive test.

Note-

- NA- Service provider doesn't provide services in respective technology.

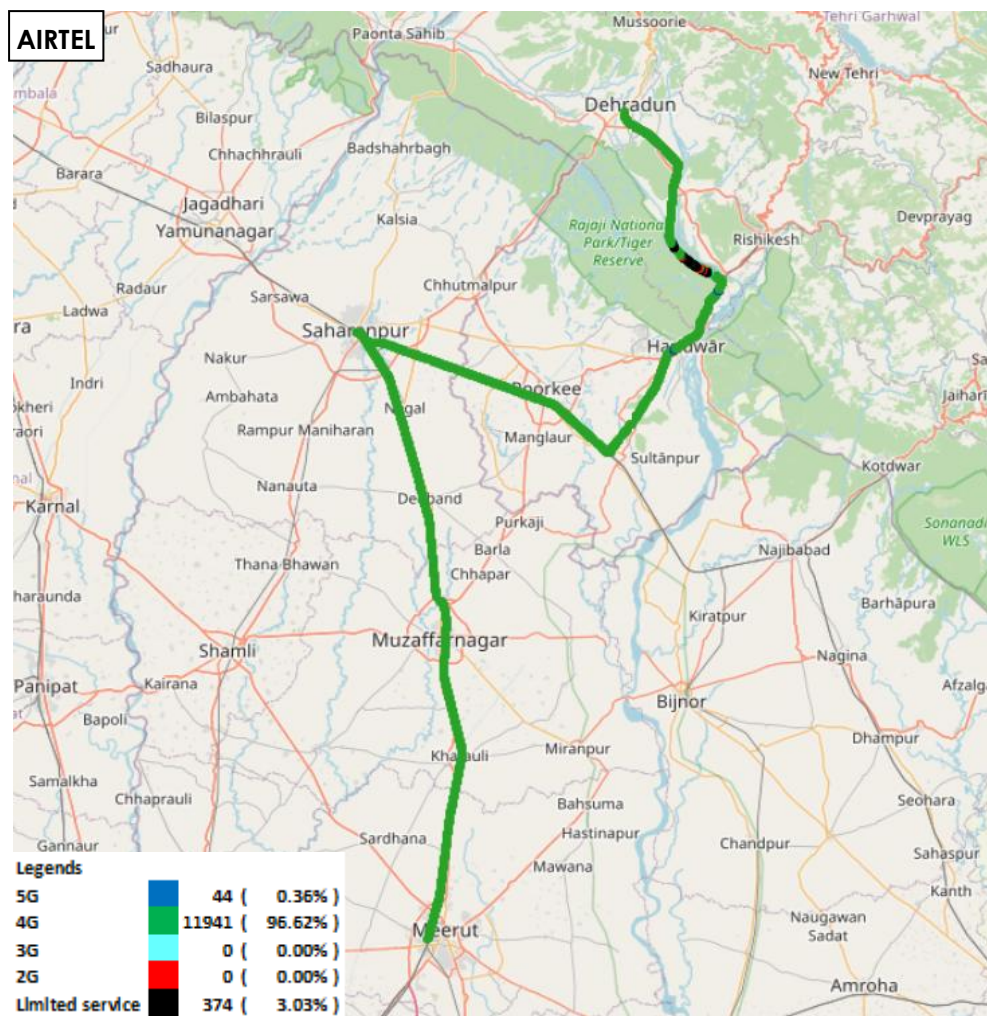


Figure-28: Serving technology plots auto-selection mode 5G/4G/3G/2G -AIRTEL.

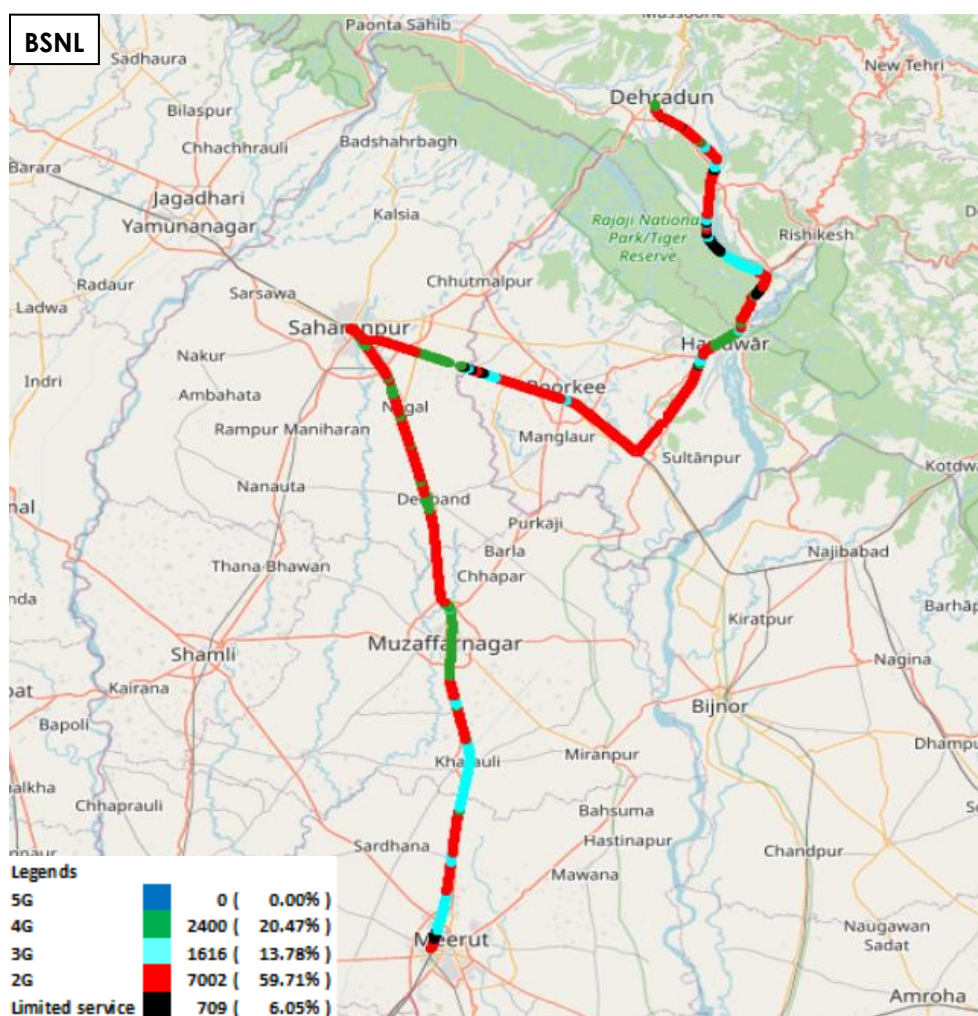


Figure-29: Serving technology plots auto-selection mode 5G/4G/3G/2G -BSNL.

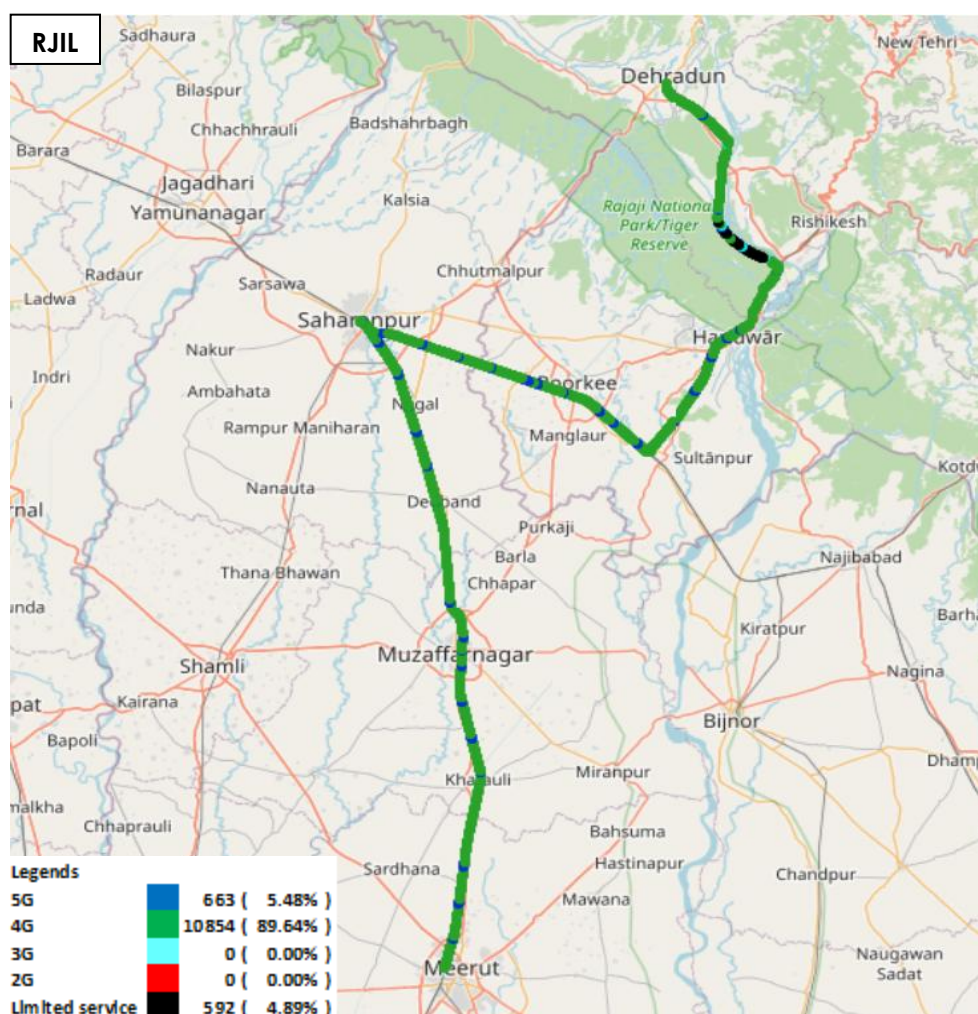


Figure-30: Serving technology plots auto-selection mode 5G/4G/3G/2G –RJIL.

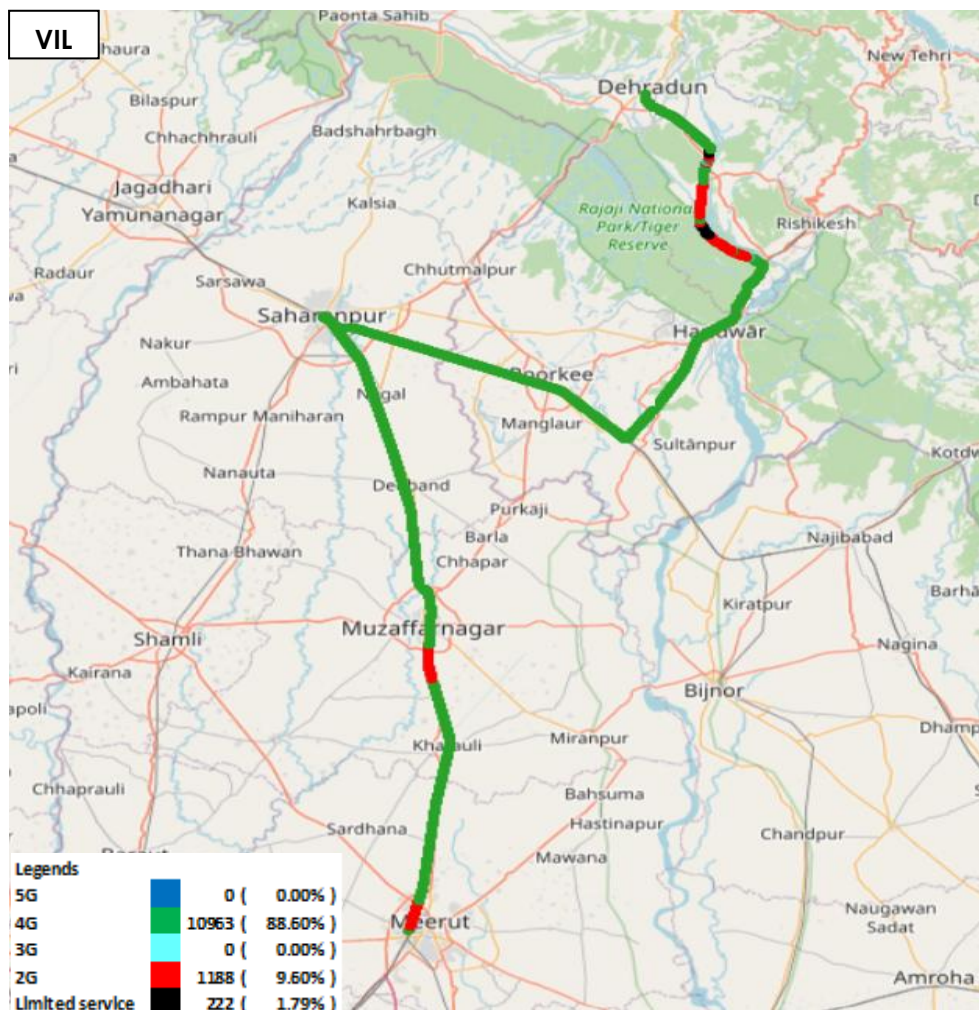


Figure-31: Serving technology plots auto-selection mode 5G/4G/3G/2G – VIL.

(c) Network Signal Strength distribution: The following chart provide signal strength distribution for auto-selection mode(5G/4G/3G/2G) (Refer figure-42, 43, 44 & 45 for map view).

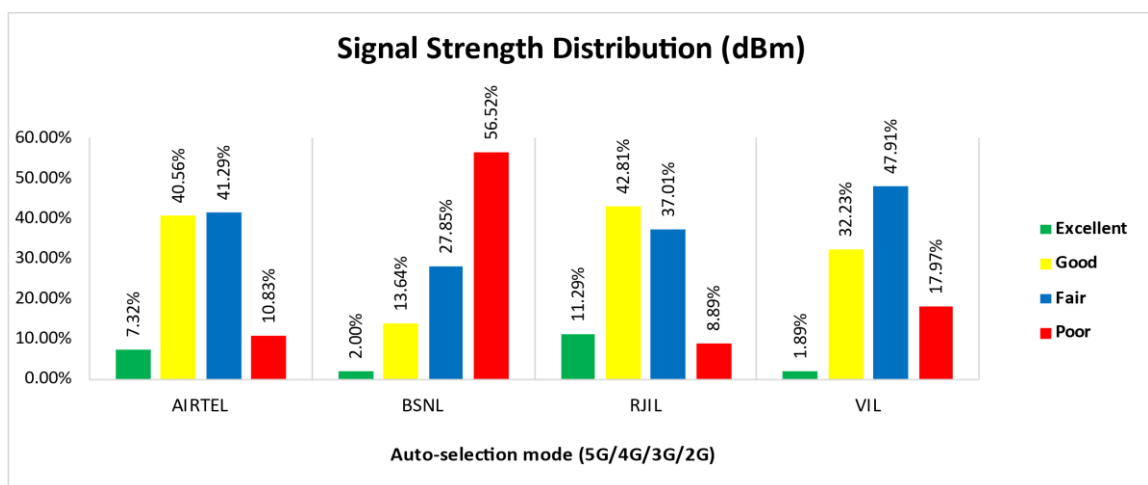


Figure-32: Signal strength distribution for auto-selection mode 5G/4G/3G/2G.

4.5.4 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	50.63	6.09	102.14	18.59
	80th Percentile	95.05	12.20	184.93	26.81
	20th Percentile	2.84	0.26	5.94	5.43
Upload Throughput (Mbits/s)	Average	9.83	2.84	15.96	7.26
	80th Percentile	16.39	4.94	28.56	11.50
	20th Percentile	1.60	0.49	2.19	1.89
Latency (ms)	50th percentile	24.70	33.00	27.85	46.45

Table-42: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G)).

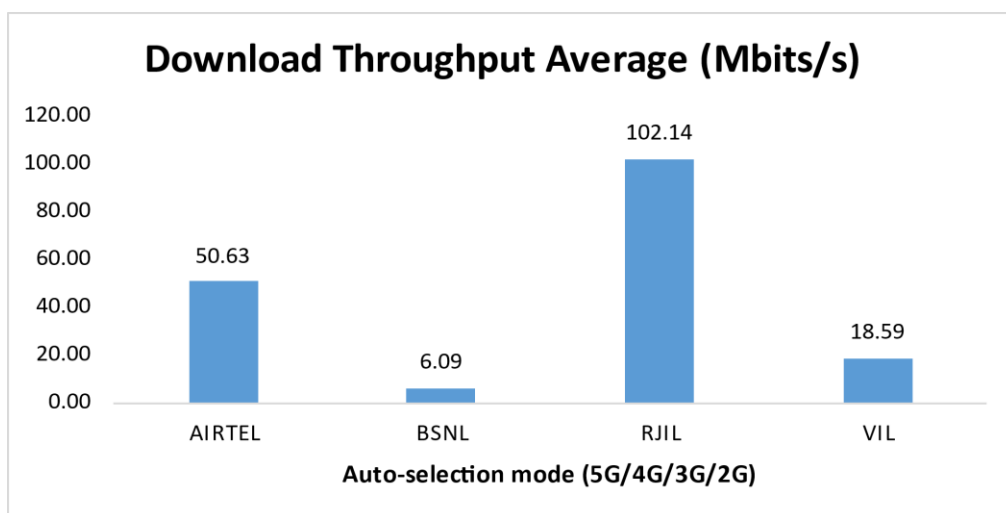


Figure-33: Download throughput.

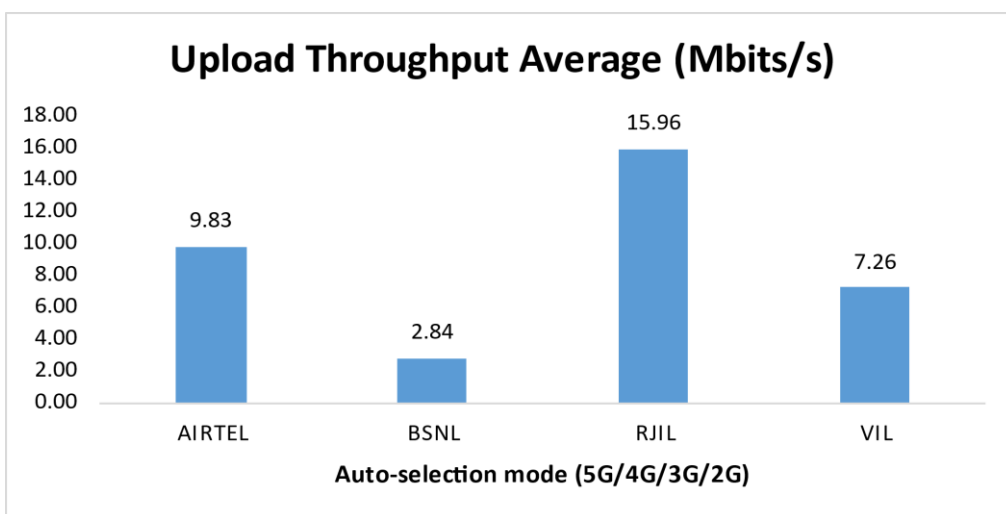


Figure-34: Upload throughput.

5. Voice & Data Key findings

5.1 Overall Voice

1. Call Setup Success Rate:

- a) Airtel, BSNL and VIL have 98.68%, 97.19% and 99.78% call setup success rate respectively in 3G/2G network mode. (refer table-3)
- b) Airtel, BSNL, RJIL and VIL have 97.69%, 90.23%, 97.27% and 98.03% call setup success rate respectively in Auto-selection mode (5G/4G/3G/2G). (refer table -5)
- c) Airtel and VIL have 100% call setup success rate while calling on peer service provider's network, while remaining service providers have block call rate for inter-operator calls. (refer table-9)

2. Call Setup time:

- a) Airtel has taken comparatively longer time (6.42 second) to establish the voice call, whereas VIL and BSNL call setup time is 2.93 & 4.14 seconds respectively in 3G/2G network mode. (refer table-3)
- b) BSNL has taken longer time (3.27 second) to establish the voice call, whereas Airtel, RJIL and VIL call setup time is 1.07, 0.78 & 0.77 seconds respectively in Auto-selection mode (5G/4G/3G/2G). (refer table-5)

3. Call Silence/Mute Rate:

- a) In packet switched network (4G/5G), BSNL, Airtel, RJIL & VIL have 3.23%, 0.77%, 0.00% & 0.00% silence call rate respectively. Further BSNL has higher RTP packet loss rate in downlink (9.65%) compared to VIL (0.40), Airtel (0.27%) & RJIL (0.14). In uplink the RTP packet loss rate is higher for BSNL (5.66%) compared to VIL (0.30%), RJIL (0.24%) & Airtel (0.21%). (refer table-6)

4. Call Drop Rate:

- a) Airtel, BSNL and VIL have 1.61%, 0.79% & 5.11% drop call rate respectively in 3G/2G network mode. (refer table-3)
- b) Overall BSNL's call drop rate (5.50%) is higher (QoS benchmark of 2%), while Airtel, RJIL & VIL have 0.17%, 0.50% and 0.17% drop call rate respectively 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 (7.29 Mbps) and VIL (36.37 Mbps) being on 3G & 4G as top technology respectively, have comparatively lower download speeds. While RJIL and Airtel have average download speed of 260.08 Mbps and 165.91 Mbps respectively. (refer table-11)
- b) BSNL (3.57 Mbps) and VIL (15.77 Mbps) being on 3G & 4G as top technology respectively, have comparatively lower upload speeds. While RJIL and Airtel have average upload speed of 34.07 Mbps and 30.94 Mbps respectively. (refer table-11)

2. Data download and upload performance (static i.e. while stationary):

- a) RJIL's 5G QoS performance shows higher download speed of 243.38 Mbps while Airtel, BSNL and VIL have download speed of 149.33 Mbps, 13.57 Mbps and 34.21 Mbps respectively in overall hotspot locations. (refer table-28)
- b) Airtel's 5G QoS performance shows higher upload speed of 45.60 Mbps while BSNL, RJIL and VIL have upload speed of 6.34 Mbps, 37.64 Mbps and 20.59 Mbps in overall hotspot locations. (refer table-28)

3. Data session setup success rate (static i.e. while stationary):

- a) All TSPs have 100% download session setup success rate in overall hotspot locations. (refer table-28)
- b) Airtel, BSNL, VIL have 100.00% while RJIL have 97.14% upload session setup success rate in overall hotspot locations. (refer table-28)

5.3 Operator wise Key Findings**1. Airtel:****Voice**

- In the 3G/2G network mode, a call setup success rate of 98.68% was observed, and the call drop rate of 1.61% is within the benchmark of 98% and 2% for LSA. (refer table-3 & 13)
- 97.69% call setup success rate and 0.17% drop call rate have been observed for the auto-selection mode (5G/4G/3G/2G) for LSA. (refer table-5).
- 100.00% call setup success rate and 0.00% drop call rate observed for auto-selection mode during city drive. (refer table-15)
- 100.00% call setup success rate and 0.00% drop call rate observed for auto-selection mode during hotspots and walk test. (refer table-20,36 and 37)
- 81.33% call setup success rate and 1.64% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for railway drive. (refer table-40)

Data

- Airtel has an average download throughput of 165.91 Mbps and an average upload throughput of 30.94 Mbps across measured routes for LSA. (refer table-11)
- Airtel has an average download throughput of 198.47 Mbps and an average upload throughput of 35.13 Mbps across the measured routes during the city drive. (refer table-19)
- Aligarh Muslim University and Dharma Samaj College hotspots experience lower download speeds, registering less than 100 Mbps out of total of 7 hotspots. (refer tables-29 and 32)

- Aligarh Muslim University and Pt. Deen Dayal Hospital hotspots experience lower upload speeds, registering less than 20 Mbps out of total of 7 hotspots. (refer tables-29 and 31)
- Airtel has an average download throughput of 50.63 Mbps and an average upload throughput of 9.83 Mbps across the measured route during the railway drive. (refer table-42)
- Airtel has an average download throughput of 101.95 Mbps and 164.40 Mbps and an average upload throughput of 17.17 Mbps and 36.75 Mbps in Aligarh junction and Shri Bankey Bihari Road Walk test respectively. (refer table-38 and 39)

2. BSNL:

Voice

- 97.19% call setup success rate and 0.79% call drop rate have been observed in 3G/2G network mode for LSA and city drive. (refer table -3 and 13)
- 90.23% call setup success rate and 5.50% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G). Performance is not meeting the benchmark of 98% and 2.00% for LSA. (refer to table -5)
- 92.47% call setup success rate and 2.29% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G). Performance is not meeting the benchmark of 98% and 2.00% for city drive. (refer to table -15)
- 100% call setup success rate and 0% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G) in hotspots and walk test. (refer table - 20, 36 and 37)
- 69.72% call setup success rate and 31.58% call drop 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 railway drive. (refer table - 40)

Data

- BSNL has 7.29 Mbps average download throughput & 3.57 Mbps average upload throughput across measured routes for LSA. (refer table -11)
- BSNL has 6.52 Mbps average download throughput & 3.00 Mbps average upload throughput across measured routes for city drive. (refer table -19)
- Pt. Deen Dayal Hospital hotspot location experience lower download speed, registering less than 10 Mbps out of total 7 hotspots. (refer table -31)
- BSNL has an average download throughput of 7.14 Mbps and 11.12 Mbps and an average upload throughput of 5.83 Mbps and 6.64 Mbps in Aligarh junction and Shri Bankey Bihari Road Walk test respectively. (refer table-38 and 39)

- BSNL has 6.09 Mbps average download throughput & 2.84 Mbps average upload throughput across measured route in railway drive. (refer table -42)

3. RJIL:

Voice

- 97.27% call setup success rate and 0.50% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G). Call setup success rate is not meeting the benchmark of 98.00% for LSA. (refer table-5)
- 99.76% call setup success rate and 0.24% call drop 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. (refer table-15)
- 100.00% call setup success rate and 0.00% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G) in hotspots & walk tests. (refer table-20, 36 and 37)
- 79.75% call setup success rate and 3.17% call drop 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 in railway drive. (refer table -40)

Data

- RJIL has 260.08 Mbps average download speed & 34.07 Mbps average upload speed across measured routes in LSA. (refer table -11)
- RJIL has 305.22 Mbps average download speed & 38.59 Mbps average upload speed across measured routes in city drive. (refer table-19)
- Aligarh Muslim University and Malkhan Singh District Hospital hotspots experience lower upload speeds, registering less than 20 Mbps out of total of 7 hotspots. (refer tables-29 and 34)
- RJIL has an average download throughput of 55.46 Mbps and 197.78 Mbps and an average upload throughput of 13.23 Mbps and 36.99 Mbps in Aligarh junction and Shri Bankey Bihari Walk test respectively. (refer table-38 and 39)
- RJIL has 102.14 Mbps average download speed & 15.96 Mbps average upload speed across measured route in railway drive. (refer table-42)

4. VIL:

Voice

- 99.78% call setup success rate and 5.11% call drop rate have been observed in 3G/2G network mode. Call drop rate is not meeting the benchmark of 2.00% for LSA. (refer table -3 &13)

- 98.03% call setup success rate and 0.17% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for LSA. (refer table -5).
- 100.00% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for city drive, hotspots and walk test. (refer table -15, 20, 36 and 37).
- 84.21% call setup success rate and 1.56% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for railway drive. (refer table -40)

Data

- VIL has 36.37 Mbps average download speed & 15.77 Mbps average upload speed across measured routes for LSA. (refer table -11)
- VIL has 40.89 Mbps average download speed & 17.03 Mbps average upload speed across measured routes in city drive. (refer table -19)
- Malkhan Singh District Hospital hotspot location has less than 10 Mbps download speed out of total 7 hotspots. (refer table - 34)
- VIL has an average download throughput of 49.66 Mbps and 29.02 Mbps and an average upload throughput of 24.93 Mbps and 16.16 Mbps in Aligarh junction and Shri Bankey Bihari Road Walk test respectively. (refer table-38 and 39)
- VIL has 18.59 Mbps average download speed & 7.26 Mbps average upload speed across measured routes in railway drive. (refer table -42)

6. Annexure

6.1 Route wise coverage map

6.1.1 City

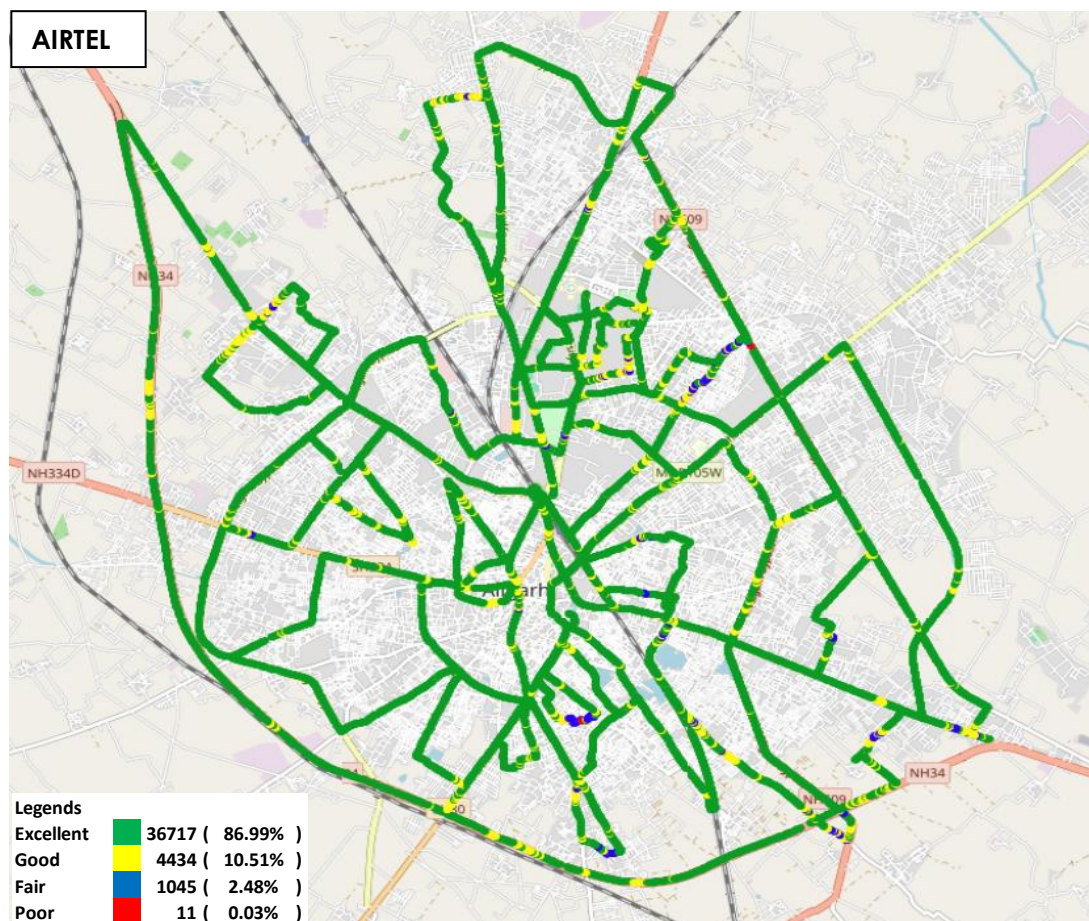


Figure-35: Signal strength 3G/2G network mode – AIRTEL.

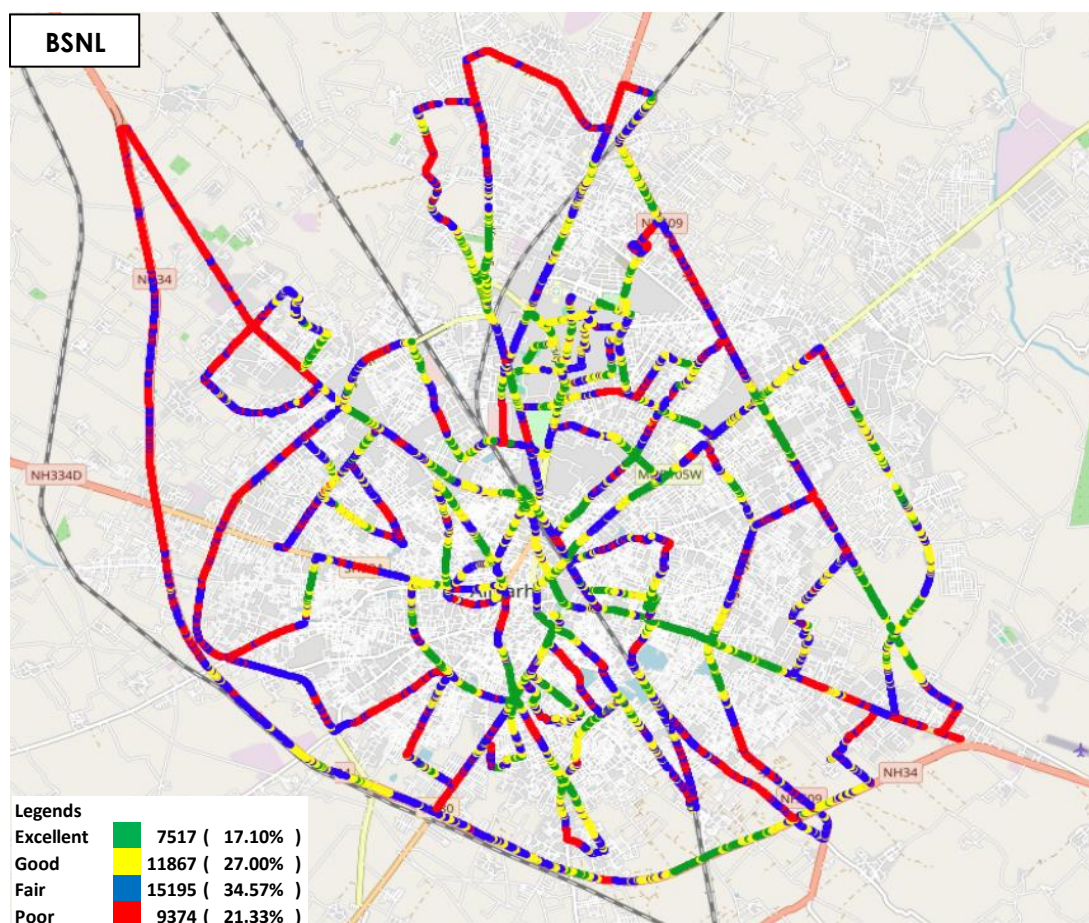


Figure-36: Signal strength 3G/2G network mode – BSNL.

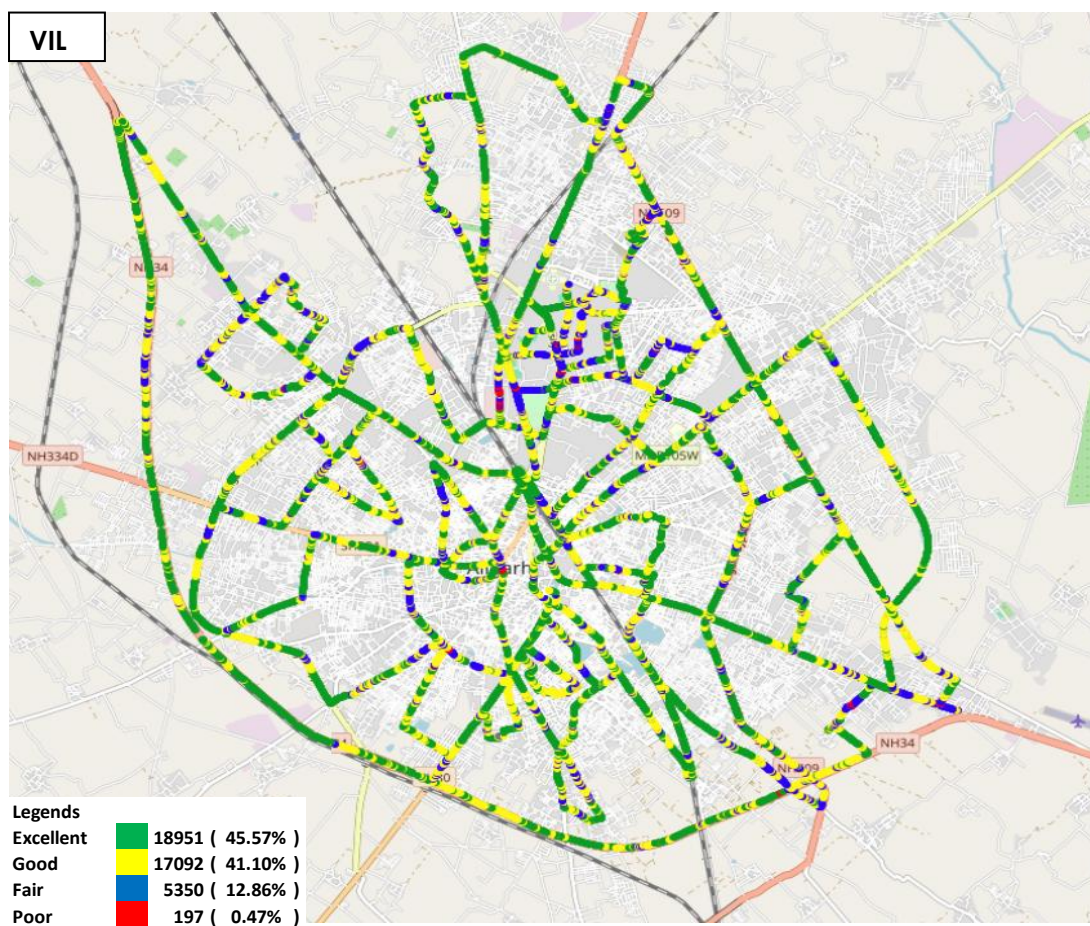


Figure-37: Signal strength 3G/2G network mode – VIL.

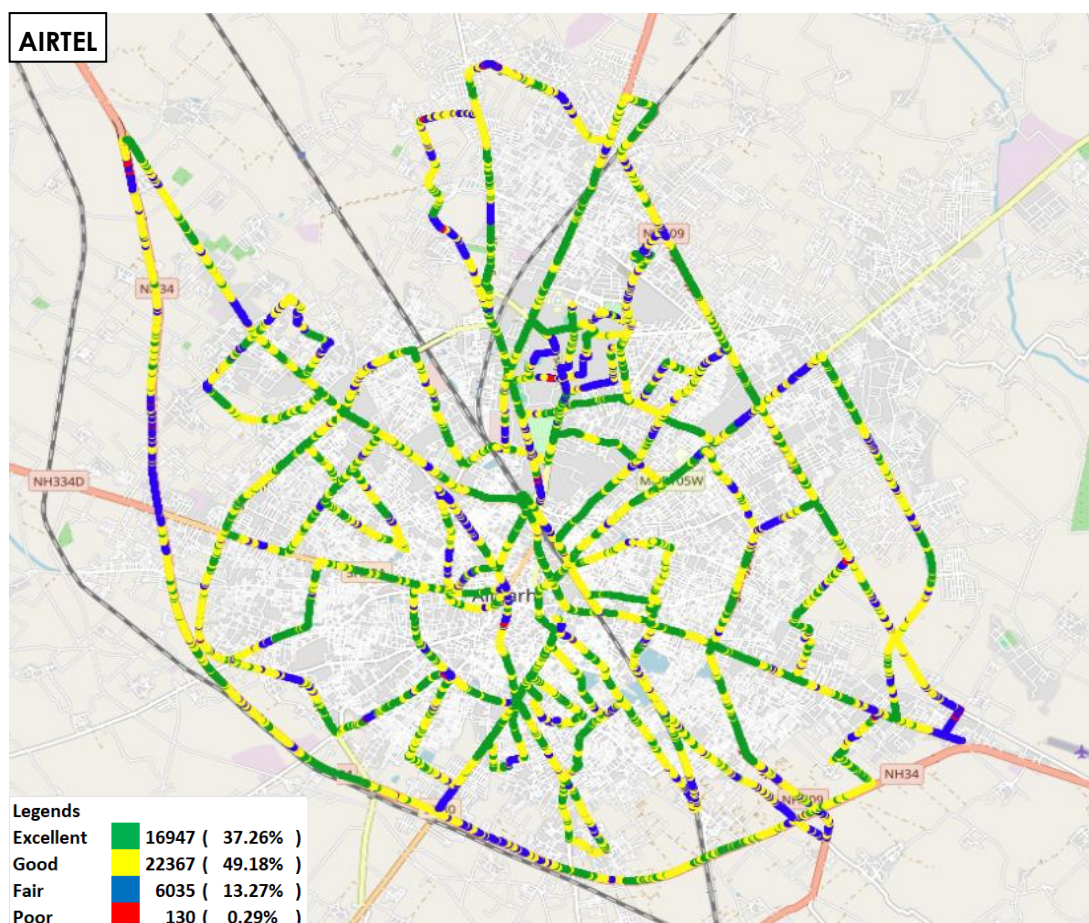


Figure-38: Signal strength auto-selection mode 5G/4G/3G/2G – AIRTEL.

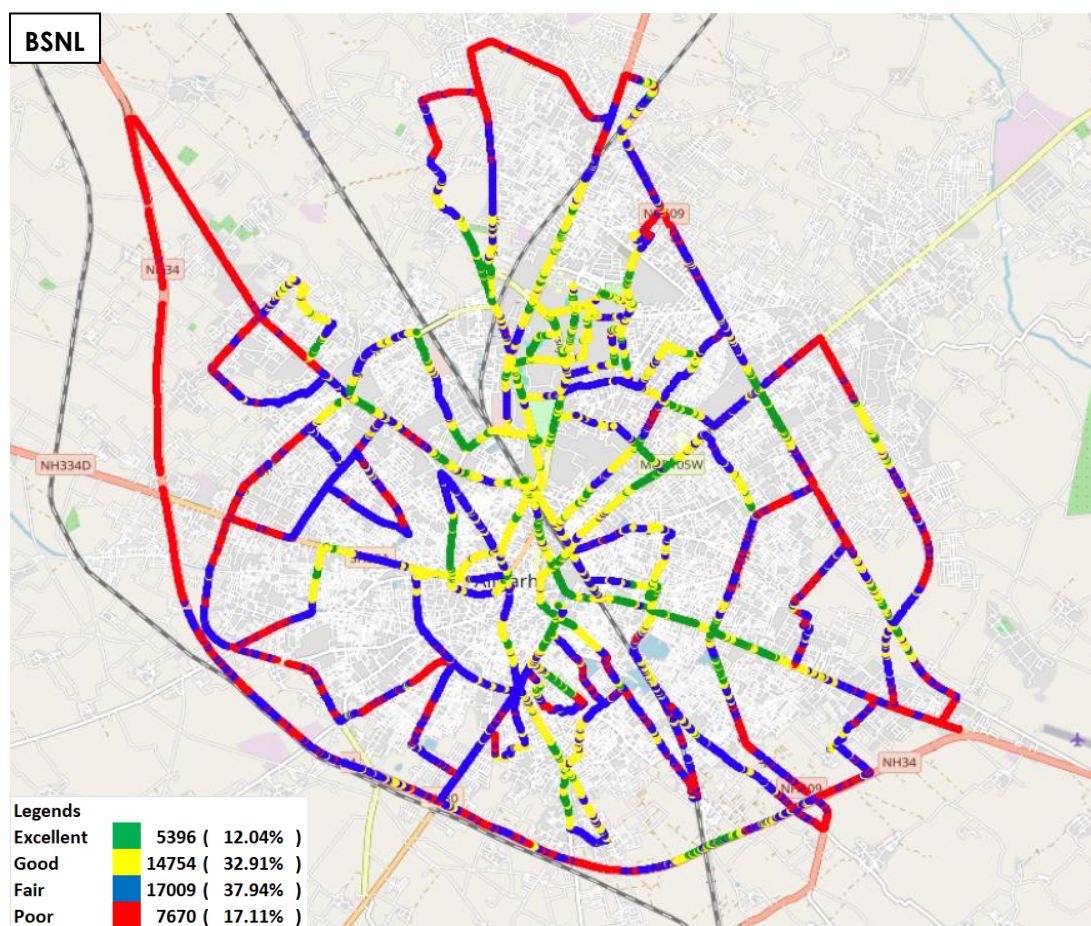


Figure-39: Signal strength auto-selection mode 5G/4G/3G/2G – BSNL.

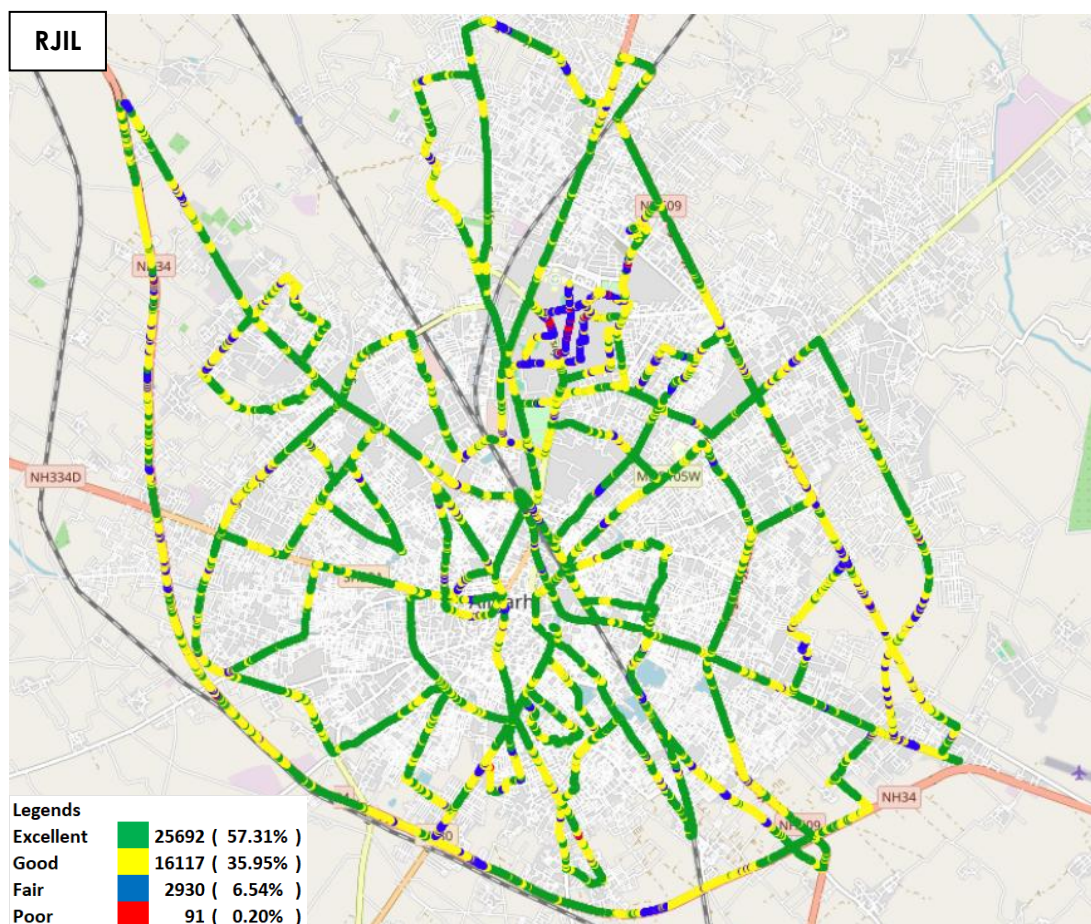


Figure-40: Signal strength auto-selection mode 5G/4G/3G/2G – RJIL.

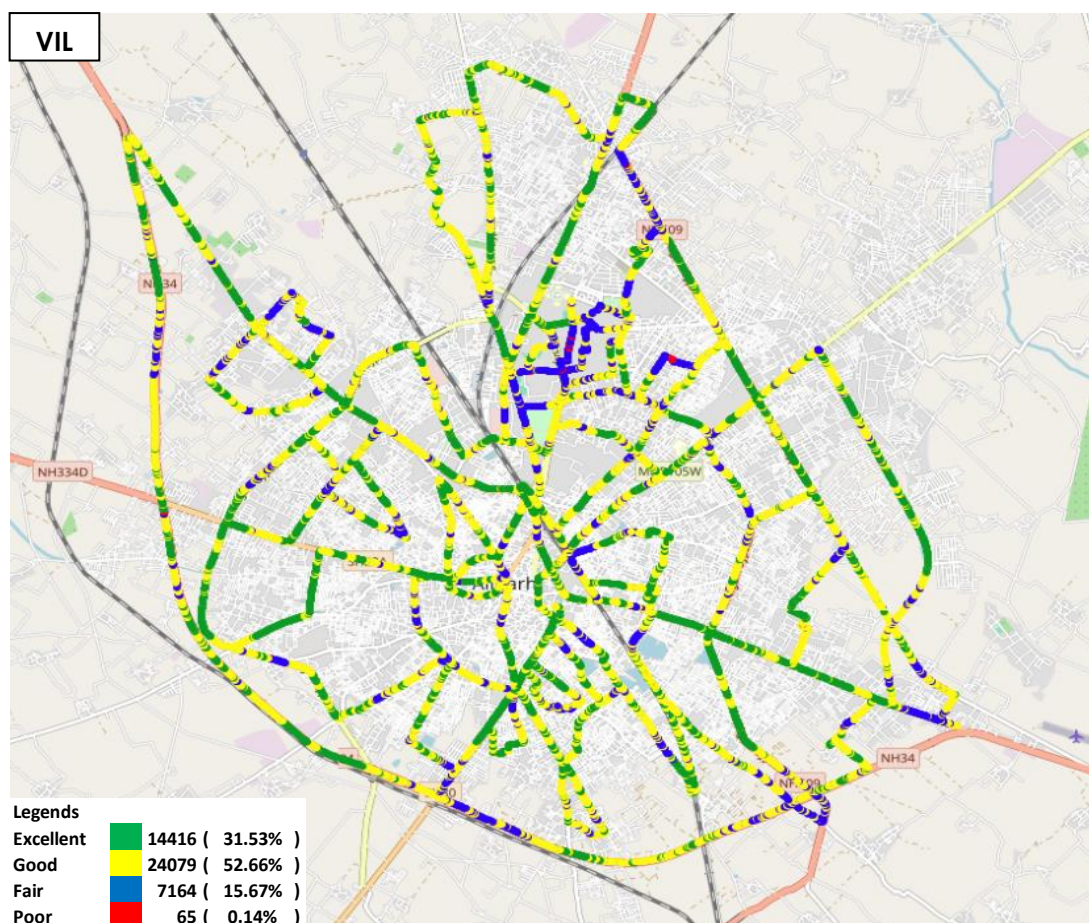


Figure-41: Signal strength auto-selection mode 5G/4G/3G/2G – VIL.

6.1.2 Railway Route

i) Meerut city junction railway route to Dehradun

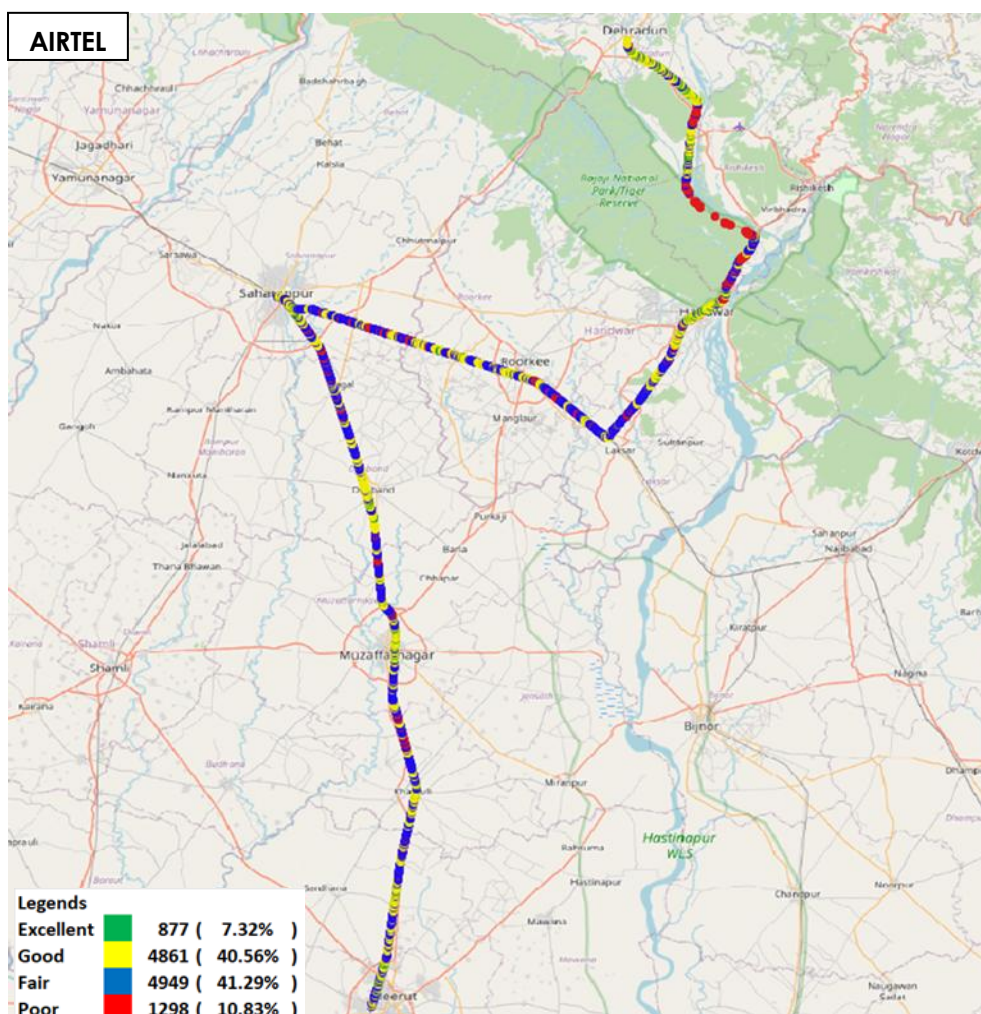


Figure-42: Signal strength auto-selection mode 5G/4G/3G/2G – AIRTEL.

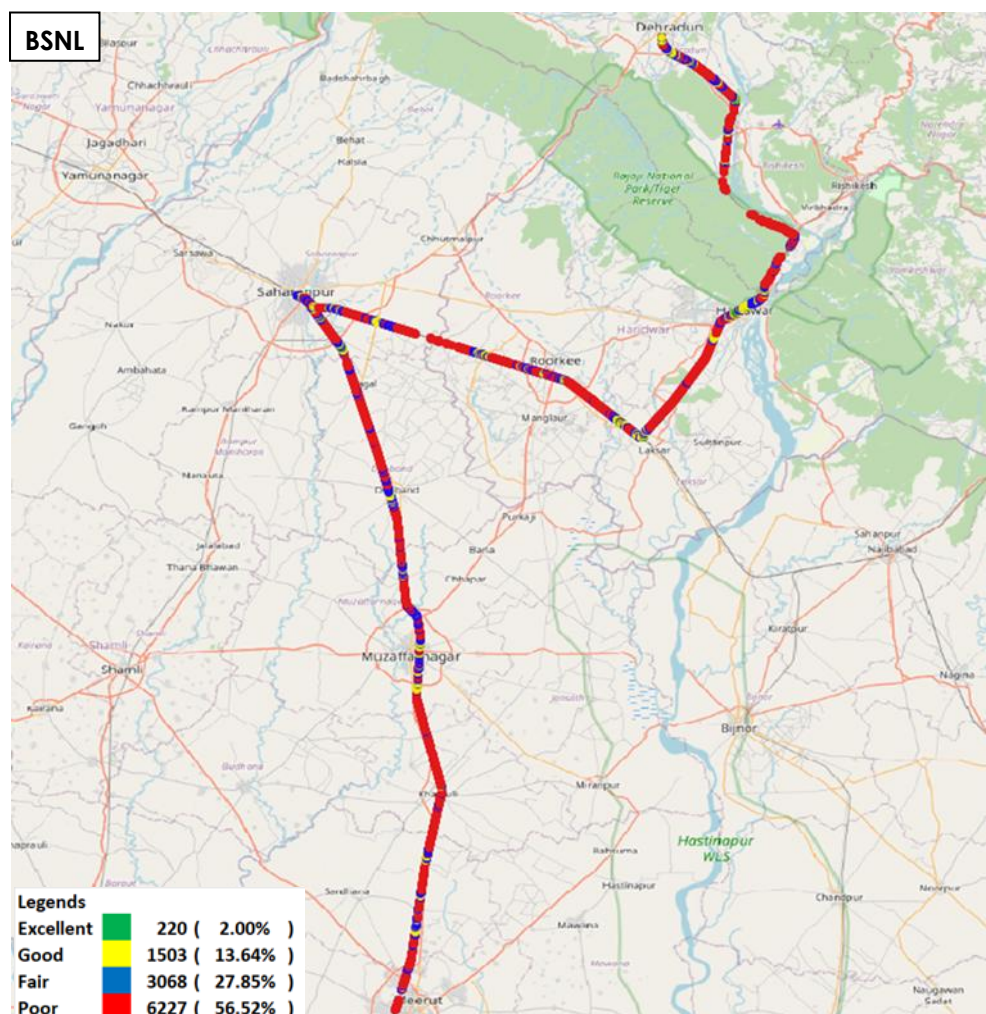


Figure-43: Signal strength auto-selection mode 5G/4G/3G/2G – BSNL.

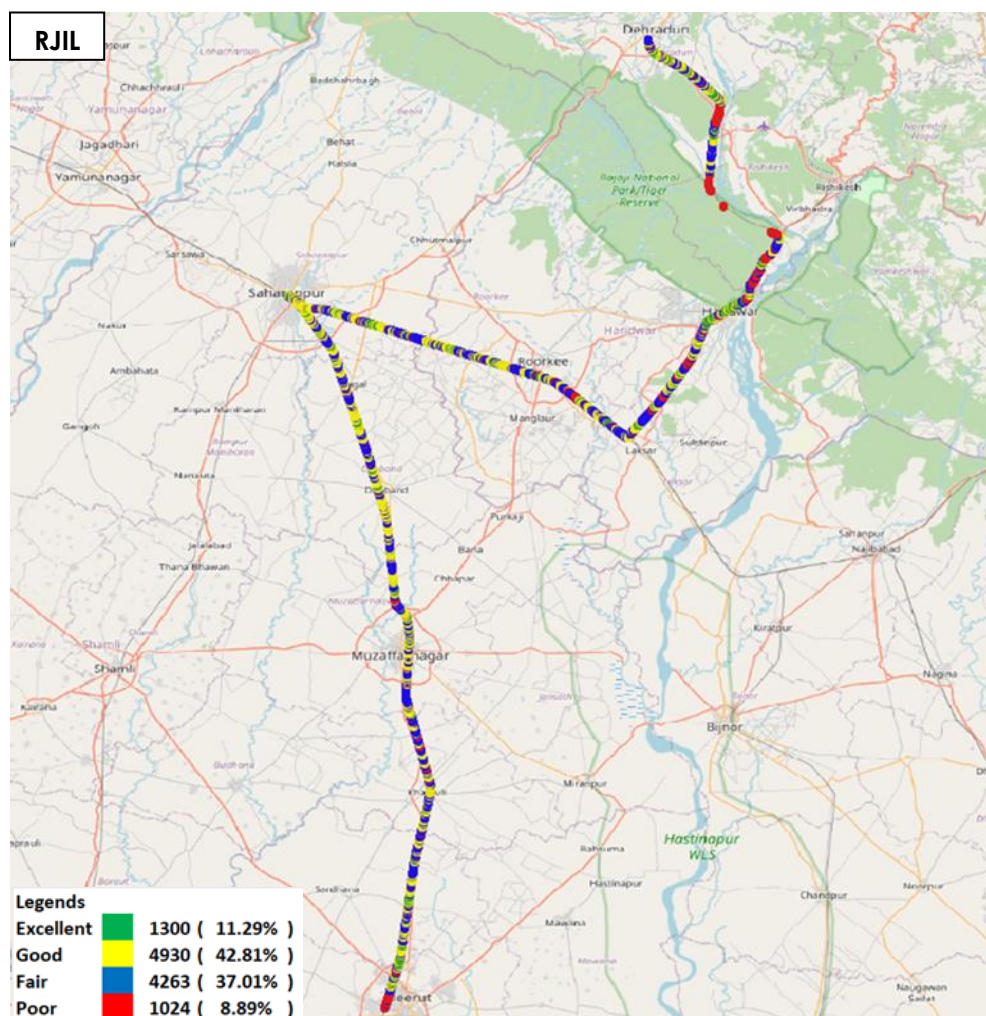


Figure-44: Signal strength auto-selection mode 5G/4G/3G/2G – RJIL.

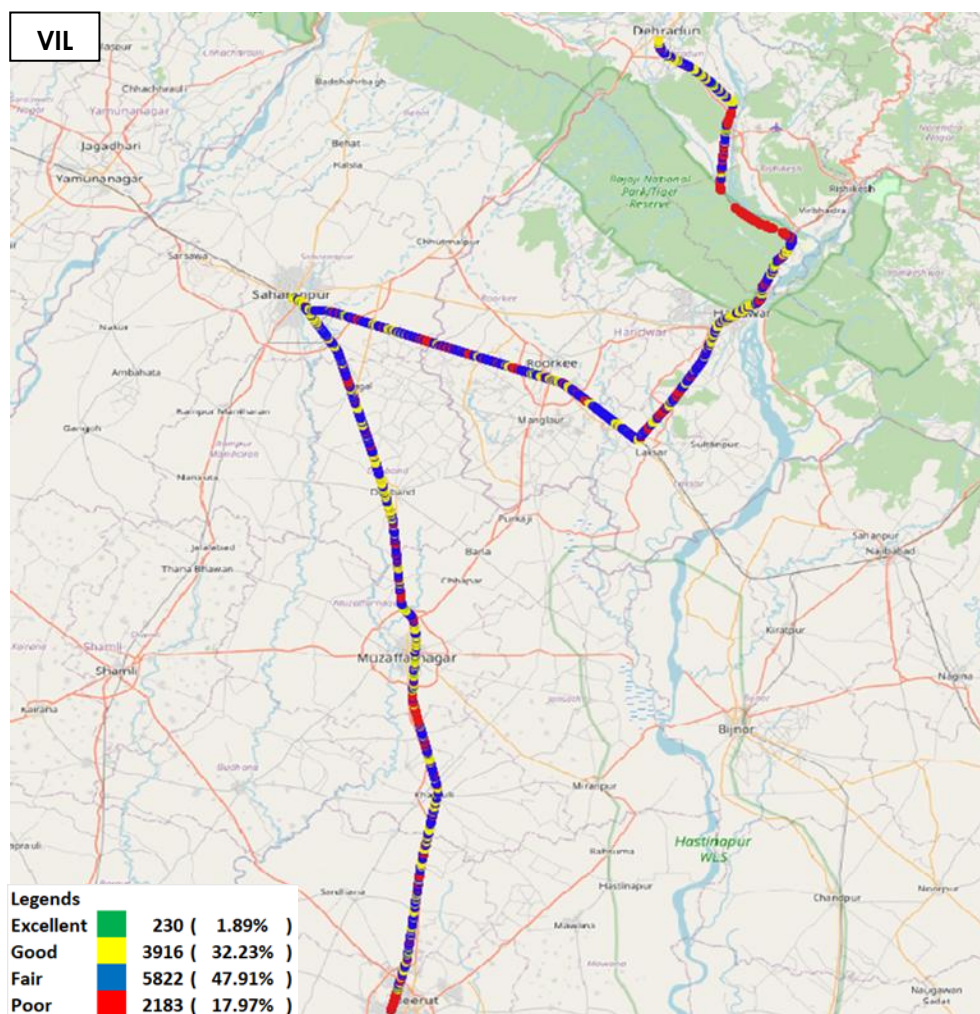


Figure-45: Signal strength auto-selection mode 5G/4G/3G/2G – VIL.

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	<ul style="list-style-type: none"> • 3G/2G auto mode- switch Call • 5G/4G/3G/2G auto mode- switch Call • 5G/4G MOS Call 	30 Sec
Call Duration		90 Sec /180 Sec
Wait/ Guard Time		15 Sec

Table-43: Voice test detail.

Note-

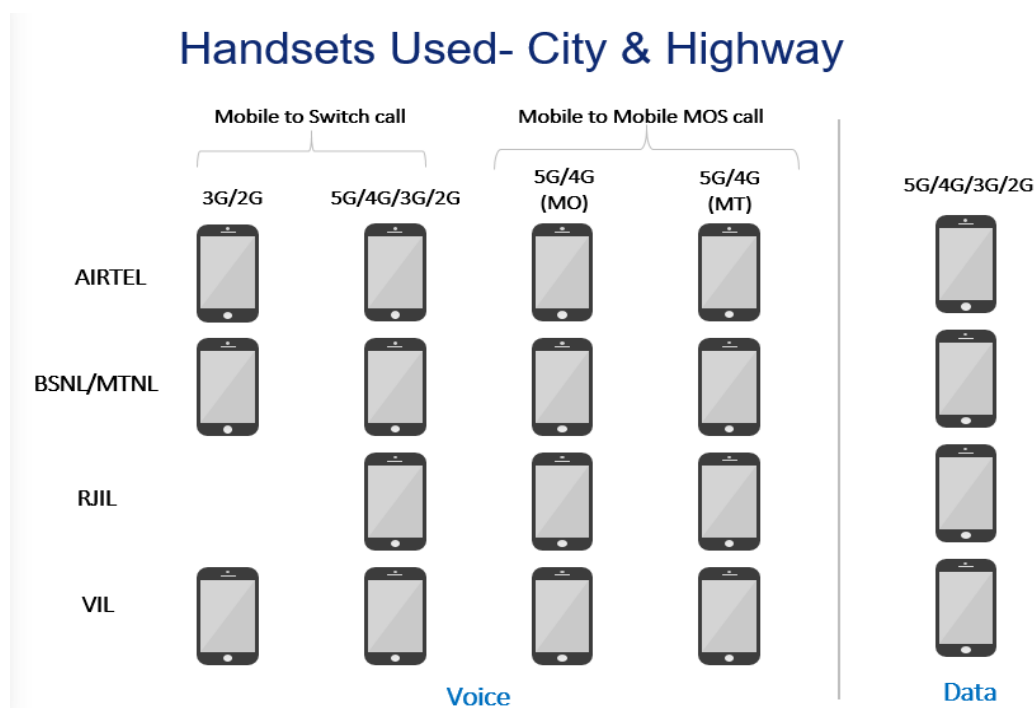
- There is 15 sec wait time after locking and before starting first call in 3G/2G call.
- 10 calls to be made at each Hotspot location.
- Minimum 10 Calls to be made during the walk test. Call count will be increased based on walk test distance.
- Speech quality (MOS) has been measured only in city drive & highway by making Mobile to Mobile call.
- 90 Sec call were made for city drive, hotspot and walk test.
- 180 Sec calls were made only in railway route drive.
- 5G/4G/3G/2G auto mode MOS call were made in BSNL as BSNL don't have VoNR network availability.

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

Table-44: Data test detail**Note-**

- 5 Data iteration done at each hotspot location.
- Minimum 5 iteration 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.

**Figure-46:** Number of handsets used in city & highway drive.

MO: Mobile originating

MT: Mobile terminating

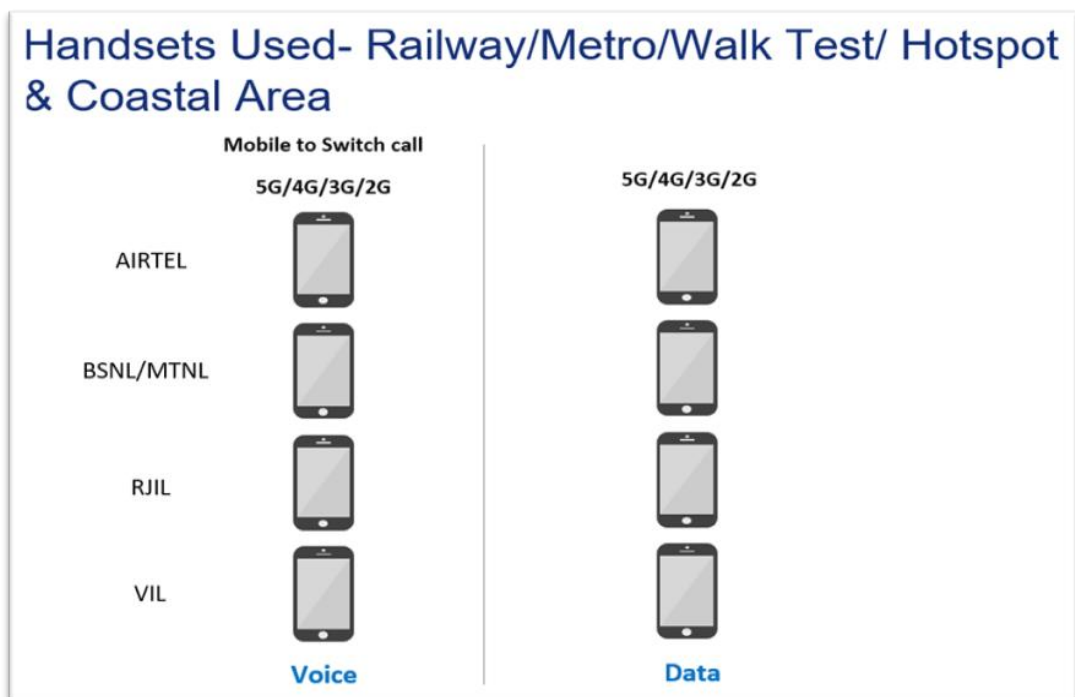


Figure-47: Number of handsets used in railway/metro/walktest/hotspot & coastal area.

7.1.2 Drive test Methodology

(a) Dynamic voice testing (on the move)

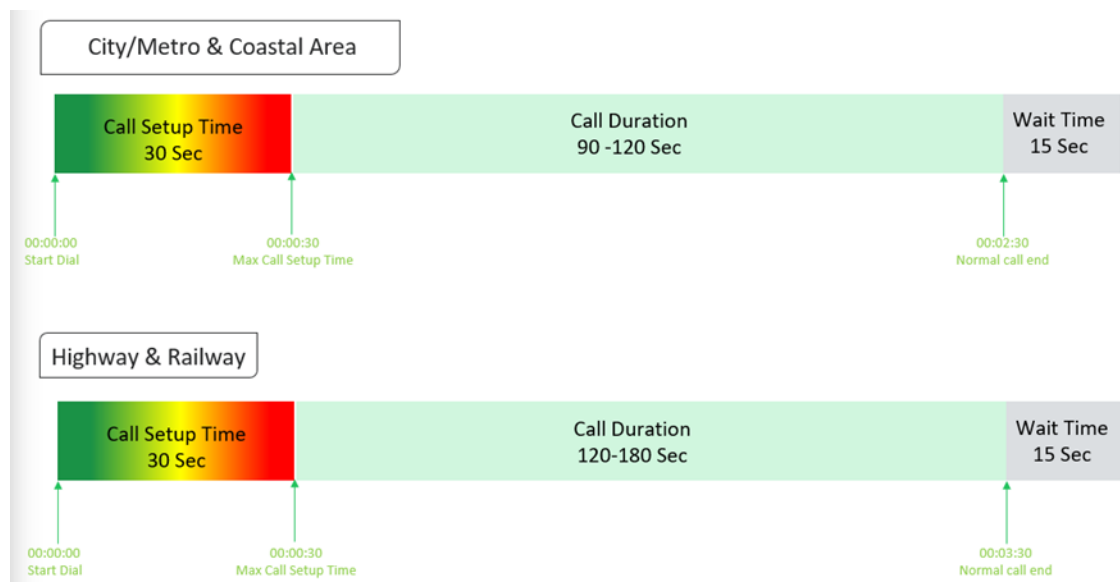


Figure-48: Voice test script for city/railway/metro/highway & coastal area.

- 15 sec wait time is applied after locking 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-49: 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

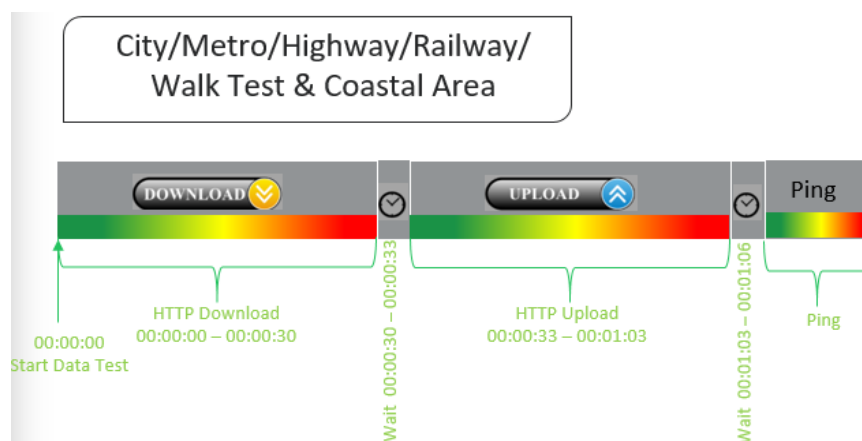


Figure-50: Data test script used in city/metro/railway/highway/Walk test & coastal area.

d) Static Data(internet) testing

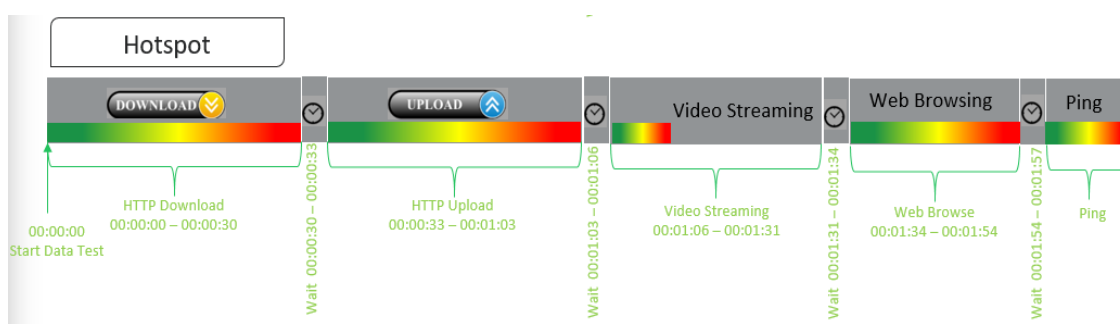


Figure-51: Data test script used at hotspot/walk test.

- 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) to be done at hotspot location.

7.2 Appendix-II

7.2.1 Network Performance Parameters for Voice call

Parameter Name	Definition
Call Setup Success Rate	<p>(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:</p> <ol style="list-style-type: none"> Call attempt is made The signaling channel is allocated The call is routed to the outwards path of the terminating network An alert signal is received by caller in the form of ring back tone, busy tone, or an announcement. <p>CSSR = (Total Call Established/ Total Call Attempt) *100</p> <p>As per QoS Regulation 2024 benchmark value is >=98%</p>
Call Drop Rate	<p>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</p> <p>Call Drop Rate = (Total Call Drop/Total Call Established) *100</p> <p>As per QoS Regulation 2024 benchmark value is <=2%</p>
Call Setup Time	<p>Time taken from call initiate to call alerting/ringing.</p> <p>Call Setup Time = T2- T1</p> <p>T2- Ringing (VoLTE/VoNR) & Alerting (for WCDMA & GSM), T1- Invite (VoLTE/VoNR) & CM Service Request (for WCDMA & GSM)</p>
Voice Quality (MOS)	<p>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:</p> <p>Excellent: MOS ≥ 4 and < 5 Good : MOS ≥ 3 and < 4 Fair : MOS ≥ 2 and < 3 Poor : MOS ≥ 1 and < 2</p>
Handover Success Rate	<p>Handover Success Rate = Count of successful handovers (All Technology Handover combined) / Total count of Handover Attempt (All Technology Handover combined) *100</p> <p>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.</p>
Silence Call	<p>A call which has ≥ 4 sec continuous RTP gap is considered as a Silence Call.</p> <p>Silence call rate = (count of silence call / Total calls established) *100</p> <p>If a call observes multiple silence count ≥ 4 sec in a particular established call it has been taken as one silent event.</p>

Jitter	<p>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 S_i is the RTP timestamp from packet i, and R_i 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:</p> $D(i,j) = (R_j - R_i) - (S_j - S_i)$ <p>The interarrival jitter will be 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</p> $J(i) = J(i-1) + (D(i-1,i) - J(i-1))/16 \text{ or } 8$																																		
Downlink Packet Drop Rate	<p>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 will be calculated from MOS call for packet call only (VoNR/VoLTE)</p>																																		
Uplink Packet Drop Rate	<p>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 will be calculated from MOS call for packet call only (VoNR/VoLTE).</p>																																		
Signal Strength	<p>Signal strength is the signal power level received by the wireless user.</p> <table><tr><th rowspan="2">Parameter Name</th><th rowspan="2">Technology</th><th colspan="4">Signal Strength (dBm)</th></tr><tr><th>Excellent</th><th>Good</th><th>Fair</th><th>Poor</th></tr><tr><td>Rx Level</td><td>GSM</td><td>0 to ≥ -65</td><td><-65 to ≥ -75</td><td><-75 to ≥ -85</td><td><-85 to min</td></tr><tr><td>RSCP</td><td>WCDMA</td><td>0 to ≥ -70</td><td><-70 to ≥ -80</td><td><-80 to ≥ -90</td><td><-90 to min</td></tr><tr><td>RSRP</td><td>LTE</td><td>0 to ≥ -80</td><td><-80 to ≥ -95</td><td><-95 to ≥ -110</td><td><-110 to min</td></tr><tr><td>SS_RSRP</td><td>NR</td><td>0 to ≥ -80</td><td><-80 to ≥ -95</td><td><-95 to ≥ -110</td><td><-110 to min</td></tr></table>	Parameter Name	Technology	Signal Strength (dBm)				Excellent	Good	Fair	Poor	Rx Level	GSM	0 to ≥ -65	<-65 to ≥ -75	<-75 to ≥ -85	<-85 to min	RSCP	WCDMA	0 to ≥ -70	<-70 to ≥ -80	<-80 to ≥ -90	<-90 to min	RSRP	LTE	0 to ≥ -80	<-80 to ≥ -95	<-95 to ≥ -110	<-110 to min	SS_RSRP	NR	0 to ≥ -80	<-80 to ≥ -95	<-95 to ≥ -110	<-110 to min
Parameter Name	Technology			Signal Strength (dBm)																															
		Excellent	Good	Fair	Poor																														
Rx Level	GSM	0 to ≥ -65	<-65 to ≥ -75	<-75 to ≥ -85	<-85 to min																														
RSCP	WCDMA	0 to ≥ -70	<-70 to ≥ -80	<-80 to ≥ -90	<-90 to min																														
RSRP	LTE	0 to ≥ -80	<-80 to ≥ -95	<-95 to ≥ -110	<-110 to min																														
SS_RSRP	NR	0 to ≥ -80	<-80 to ≥ -95	<-95 to ≥ -110	<-110 to min																														

Table-45: Network performance parameter and definition voice

7.2.2 Network Performance Parameters Data tests

Parameter Name	Definition
Download Speed (Mbps)	<p>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.</p> <p>Download Speed= Total bytes transferred during download/Total time for transfer.</p> <ul style="list-style-type: none"> 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)	<p>The upload speed is the data transmission rate that is achieved for uploading a test file from a test device to a test server.</p> <p>Upload Speed= Total bytes transferred during upload/Total time for transfer.</p> <ul style="list-style-type: none"> 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. 50 th 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

Table-46: Network performance parameter and definition Data