TELECOM REGULATORY AUTHORITY OF INDIA

Independent Drive Test Report

UP East LSA

December 2024

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 East License Service Area (LSA) during the month of 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	Lucknow	City	349.0	9-Dec-2024	11-Dec-2024
2	Lucknow	City (Inter-operator calling)	21.2	11-Dec-2024	11-Dec-2024
3	Lucknow	Hotspot	10 Locations	12-Dec-2024	12-Dec-2024
4	Lucknow	Walk Test	5.5	12-Dec-2024	12-Dec-2024
5	Fatehpur to Varanasi	Highway	248.0	13-Dec-2024	13-Dec-2024

Table-1: Drive test summary.

2.2 Drive test routes
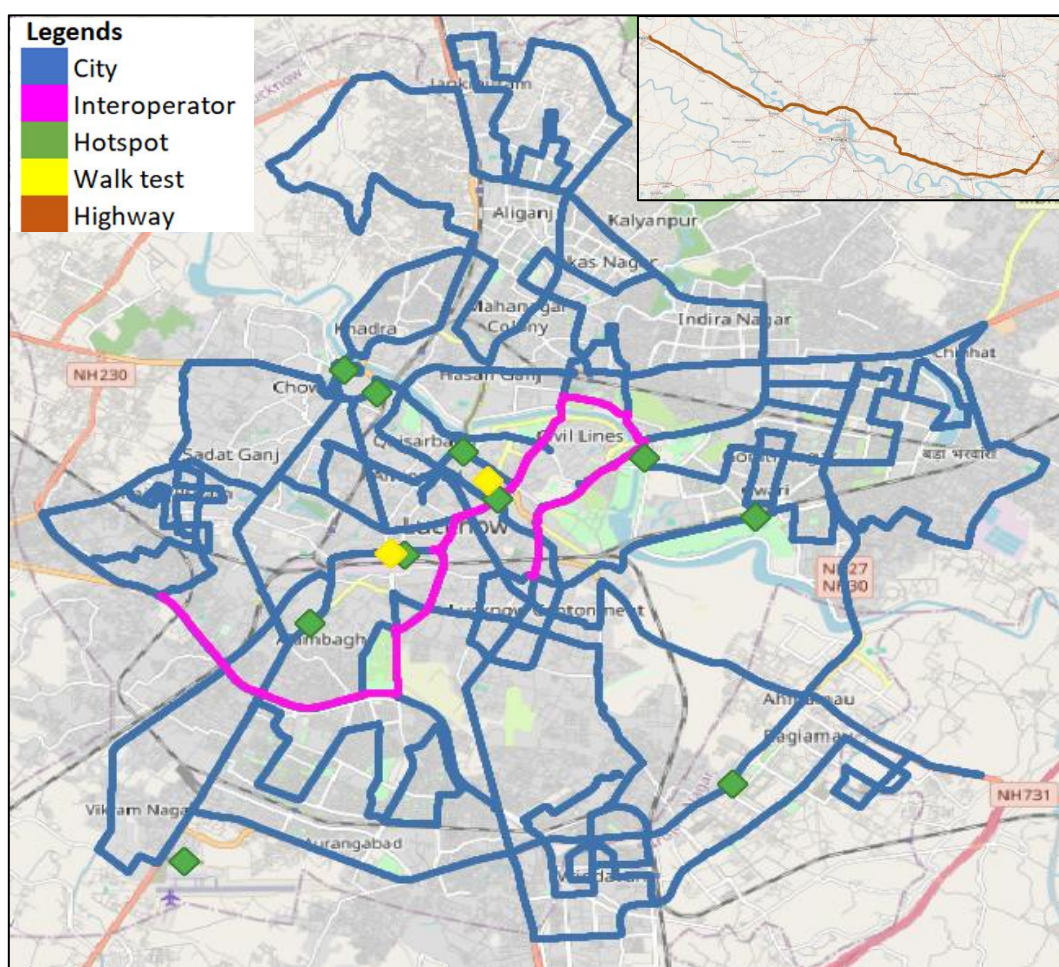
Figure-1: Drive test routes.

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

2.3 Summary of areas covered

a) City- Jankpuram, Vikas Nagar, Vijay Khand, Arya Nagar, Vikram Nagar, Gomti Nagar, Lucknow Cantonment, Ganeshganj and Moti nagar etc.

b) Hotspot
1. Alambagh Bus Stand
2. Charbagh Railway Station
3. Gomti River Front
4. Hazratganj Market
5. Imam Bada
6. Janeshwar Mishra Park
7. King George's Medical University
8. Lucknow Airport
9. Lulu Mall
10. Vidhan Sabha

c) Walk Test
1. Hazratganj Market
2. Lucknow Junction

d) Highway
1. Fatehpur to Varanasi Via Khaga, Soraon, Gopalganj & Bhainsa etc.

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	900
2	Bharti Airtel Ltd.	4G	900,1800,2300
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 East 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 December-2024 covering city, hotspot, walk test and highway. (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	651	686	653
Call Setup Success Rate %	99.85	96.94	98.47
Drop Call Rate %	0.00	4.81	0.47
Call Setup Time-Average (Second)	4.37	2.86	4.77
Handover Success Rate %	99.53	99.96	97.75

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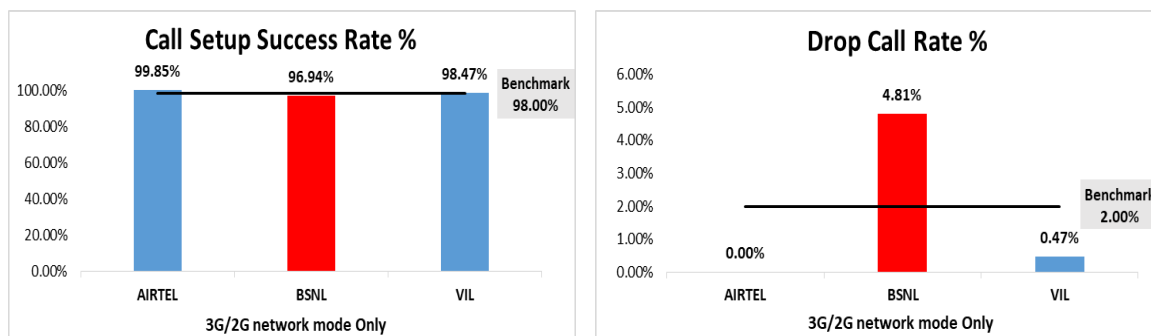
Figure-2: Call setup success rate and drop call rate performance.

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	467	NA
2G	1196	63	939

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	823	872	838	823
Call Setup Success Rate %	100.00	92.20	100.00	99.27
Drop Call Rate %	0.00	5.85	0.12	0.12
Call Setup Time-Average (Second)	1.20	3.59	0.69	1.89
Handover Success Rate %	99.93	99.56	99.94	100.00

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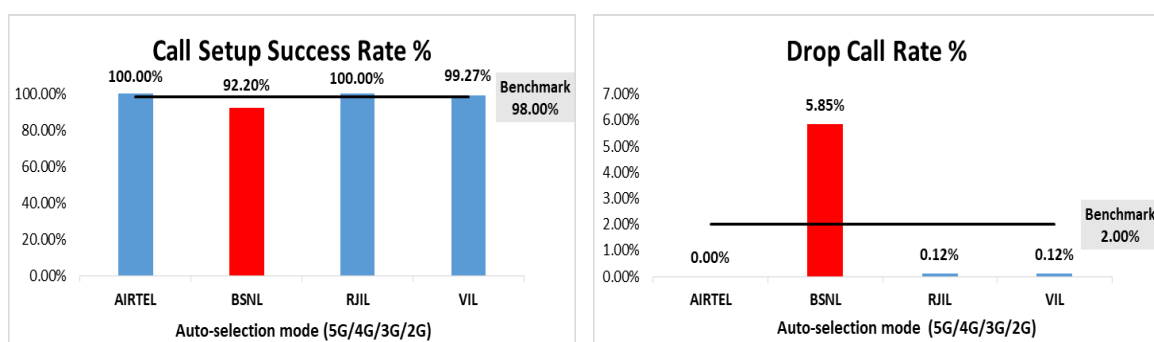
Figure-3: Performance for call setup success rate and drop call rate.

Parameter	Service Provider			
	Mobile-to-Mobile (5G/4G - Open Mode)			
	AIRTEL	BSNL	RJIL	VIL
Call Established (within service provider Network)	661	693	671	668
Number of silence call for >4 Sec	9	NA	2	14
Silence Call Rate %	1.36	NA	0.30	2.10
Number of silence instances for >4 Sec	9	NA	2	22
Number of silence instances for >3 Sec	16	NA	2	40
Number of silence instances for >2 sec	52	NA	10	118
RTP Jitter (4G & 5G) in ms	5.21	NA	7.10	13.68
Packet loss Rate Downlink %	1.08	NA	0.09	1.02
Packet loss Rate Uplink %	0.99	NA	0.22	1.15

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

> **Note-**
> - NA- Due to unavailability of packet switched (VoLTE & 5G) network in BSNL silence instances are not captured.

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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	850	NA
4G	2593	228	2994	1602
3G	NA	364	NA	NA
2G	0	299	NA	6

**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.

(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	4523	3580	4498	4515
Speech Quality (Average MOS Score)	3.94	2.55	3.93	4.28
Number of samples with MOS >=4 to <5 (Excellent)	3578	0	3257	3578
Number of samples with MOS >=3 to <4 (Good)	737	577	1020	583
Number of samples with MOS >=2 to <3 (Fair)	78	2560	193	180
Number of samples with MOS >=1 to <2 (Poor)	130	443	28	174
%age of samples with MOS >=4 to <5 (Excellent)	79.11%	0.00%	72.41%	79.25%
%age of samples with MOS >=3 to <4 (Good)	16.29%	16.12%	22.68%	12.91%
%age of samples with MOS >=2 to <3 (Fair)	1.72%	71.51%	4.29%	3.99%
%age of samples with MOS >=1 to <2 (Poor)	2.87%	12.37%	0.62%	3.85%

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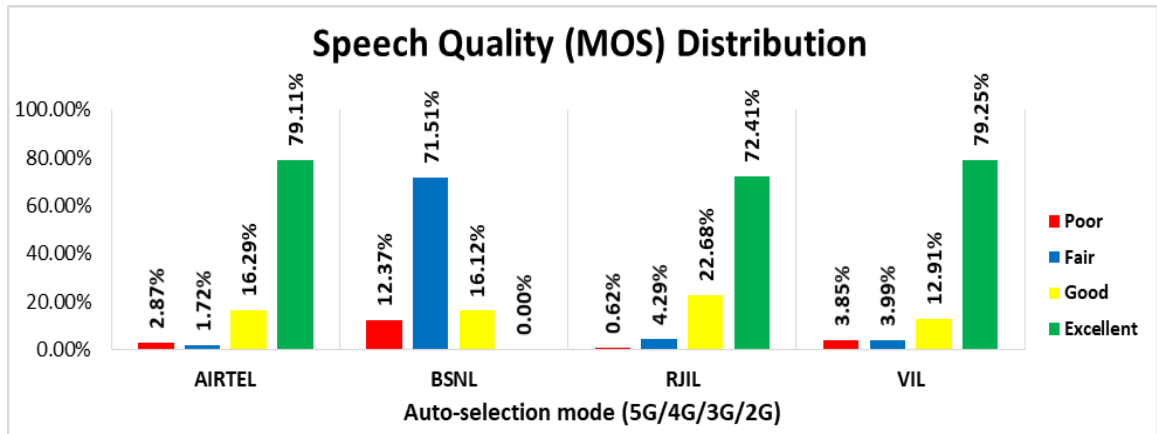
Figure- 4: Distribution of samples in MOS score range.

(d) Inter-service provider voice call performance: To check the performance of inter-service provider call setup success rate, total 75 to 92 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	98.68	NA	95.00	96.05
RJIL	100.00	96.20	NA	100.00
VIL	100.00	93.33	98.91	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	4.88	1.98	1.79
BSNL	4.33	NA	4.35	4.28
RJIL	2.10	4.75	NA	1.64
VIL	2.06	3.64	2.02	NA

Table-10: Call setup time across service providers.

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

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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	129.46	5.01	321.41	41.73
	80th Percentile	213.21	7.67	509.51	69.97
	20th Percentile	24.59	0.99	123.44	8.77
Upload Throughput (Mbits/s)	Average	28.44	4.06	40.80	15.38
	80th Percentile	51.54	6.69	68.65	25.80
	20th Percentile	5.03	1.64	11.46	5.16
Latency (ms)	50th Percentile	41.10	37.55	21.45	28.35

Table-11: Summary of data performance in network auto-selection mode.
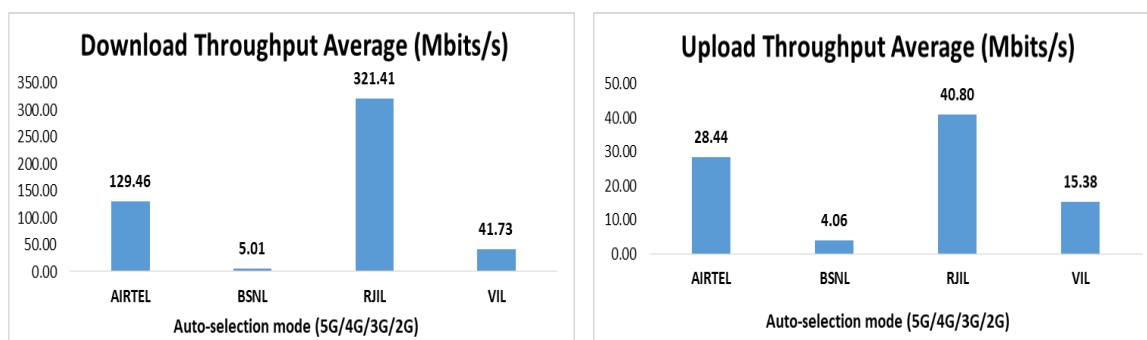
Figure- 5: Download and upload throughput.

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	1346	NA
4G		2857	448	259	1536
3G		NA	216	NA	NA
2G		0	29	NA	36

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

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

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Detailed QoS Performance Analysis

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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 highway 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 9th to 11th December 2024 in Lucknow. (Refer Table-1)

4.2.1 Drive test route
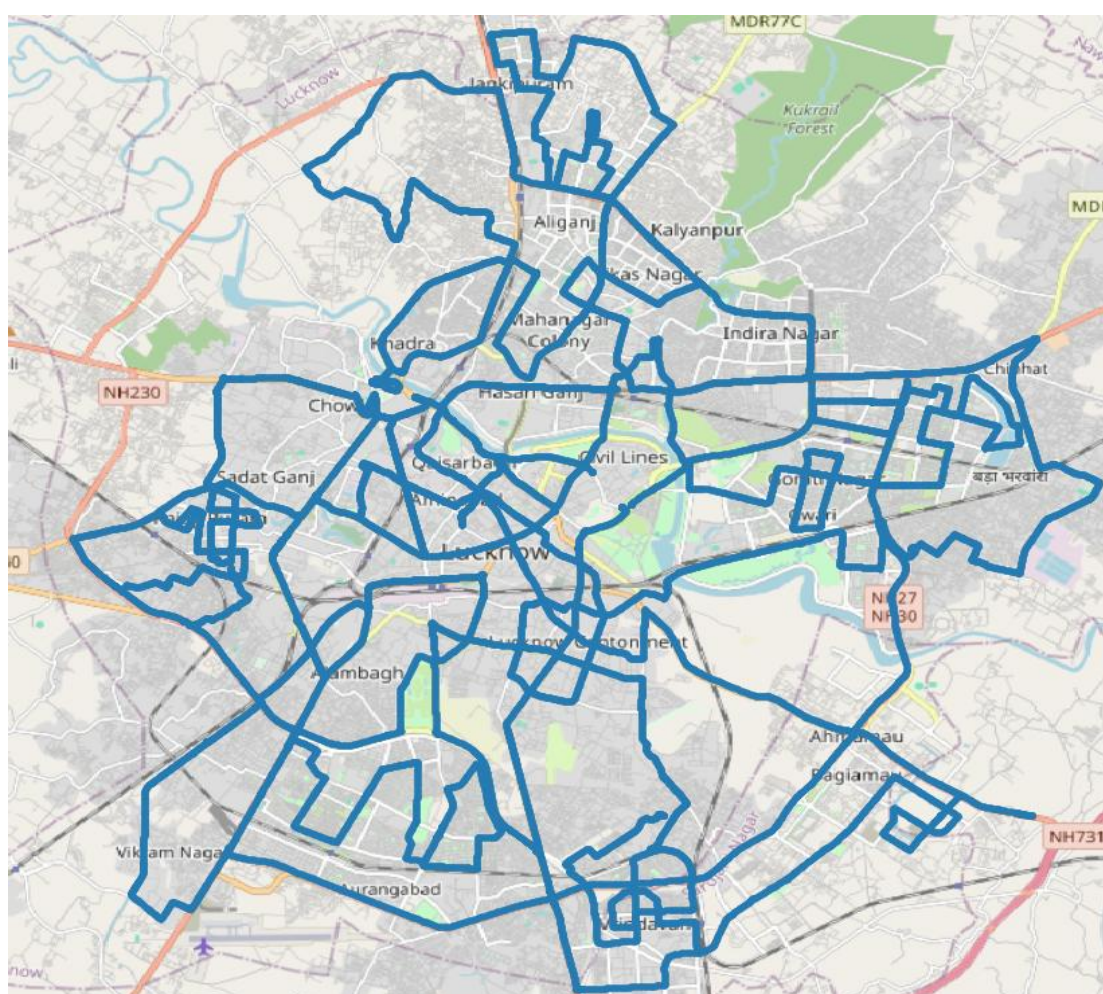
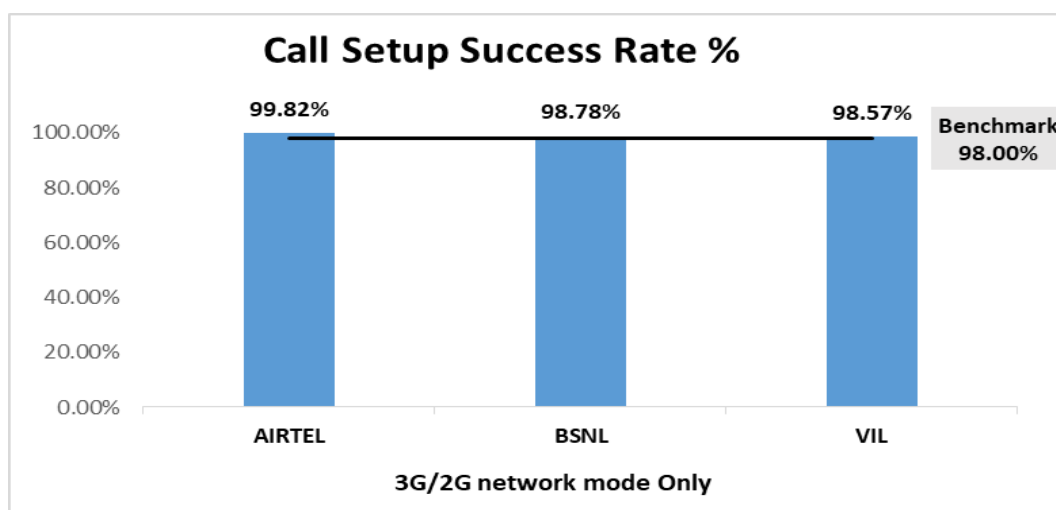
Figure- 6: Drive test routes.

4.2.2 Areas covered

Jankpuram, Vikas Nagar, Vijay Khand, Arya Nagar, Vikram Nagar, Gomti Nagar, Lucknow Cantonment, Ganeshganj and Moti nagar etc.
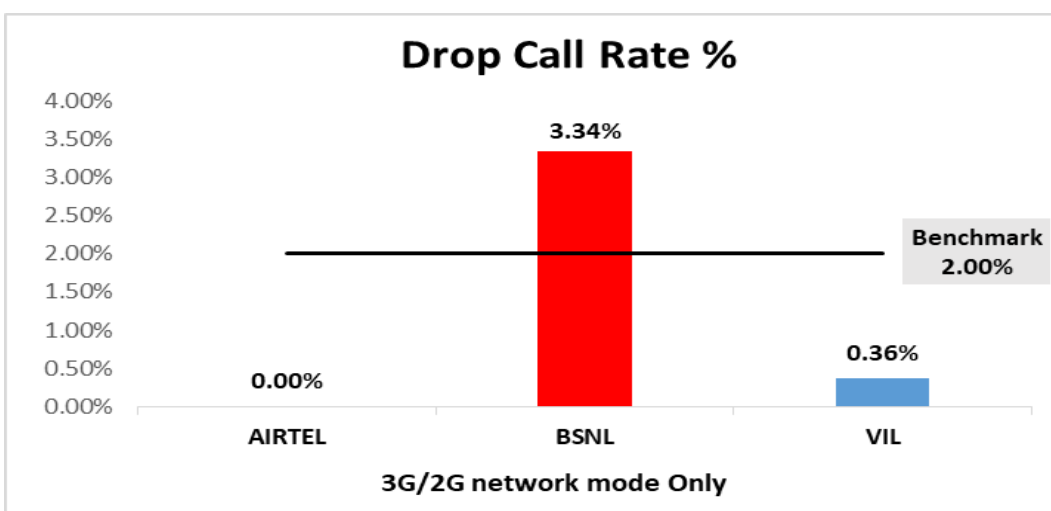
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4.2.3 Voice performance

(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	560	576	561
Call Setup Success Rate %	99.82	98.78	98.57
Drop Call Rate %	0.00	3.34	0.36
Call Setup Time-Average (Second)	4.34	2.80	4.69
Handover Success Rate %	99.70	99.98	97.23

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.

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

Technology	Service Provider		
	AIRTEL	**BSNL**	**VIL**
3G	NA	95.21%	NA
2G	100.00%	4.79%	99.99%
Limited Service	0.00%	0.00%	0.01%

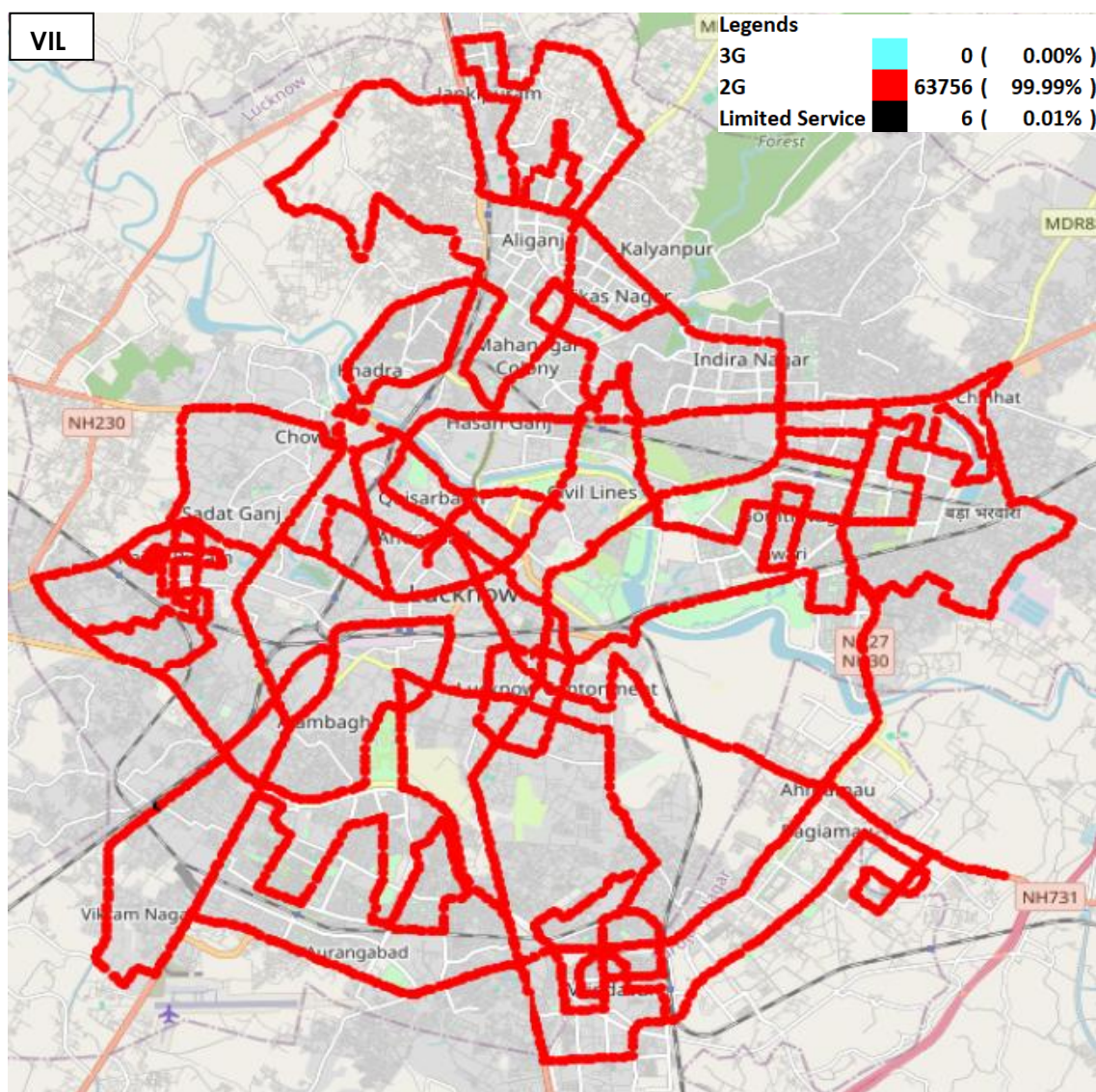**Table-14:** Time spent on technology during drive test 3G/2G network mode only.
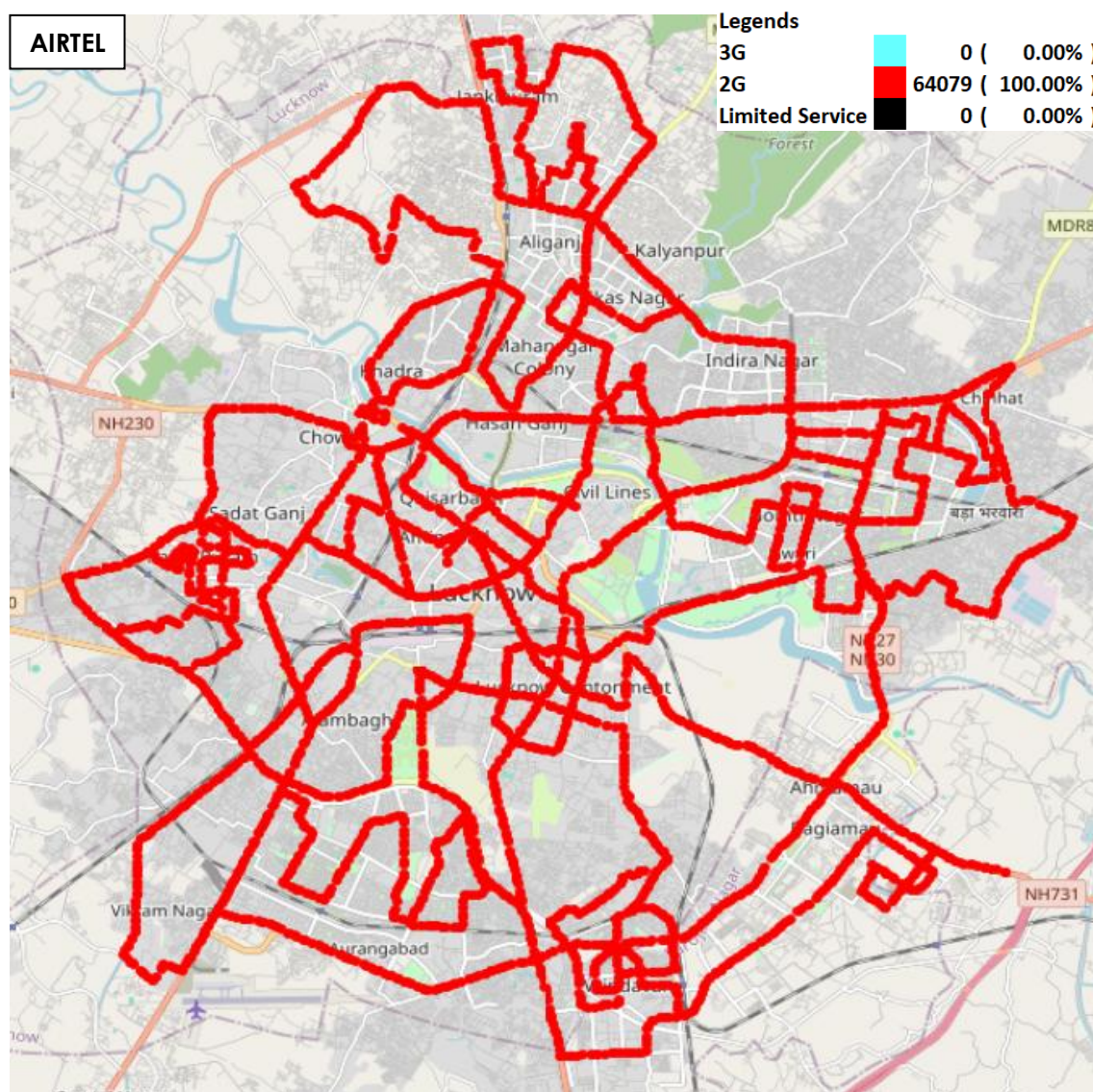
Figure-9: Serving technology plots 3G/2G network mode – AIRTEL.
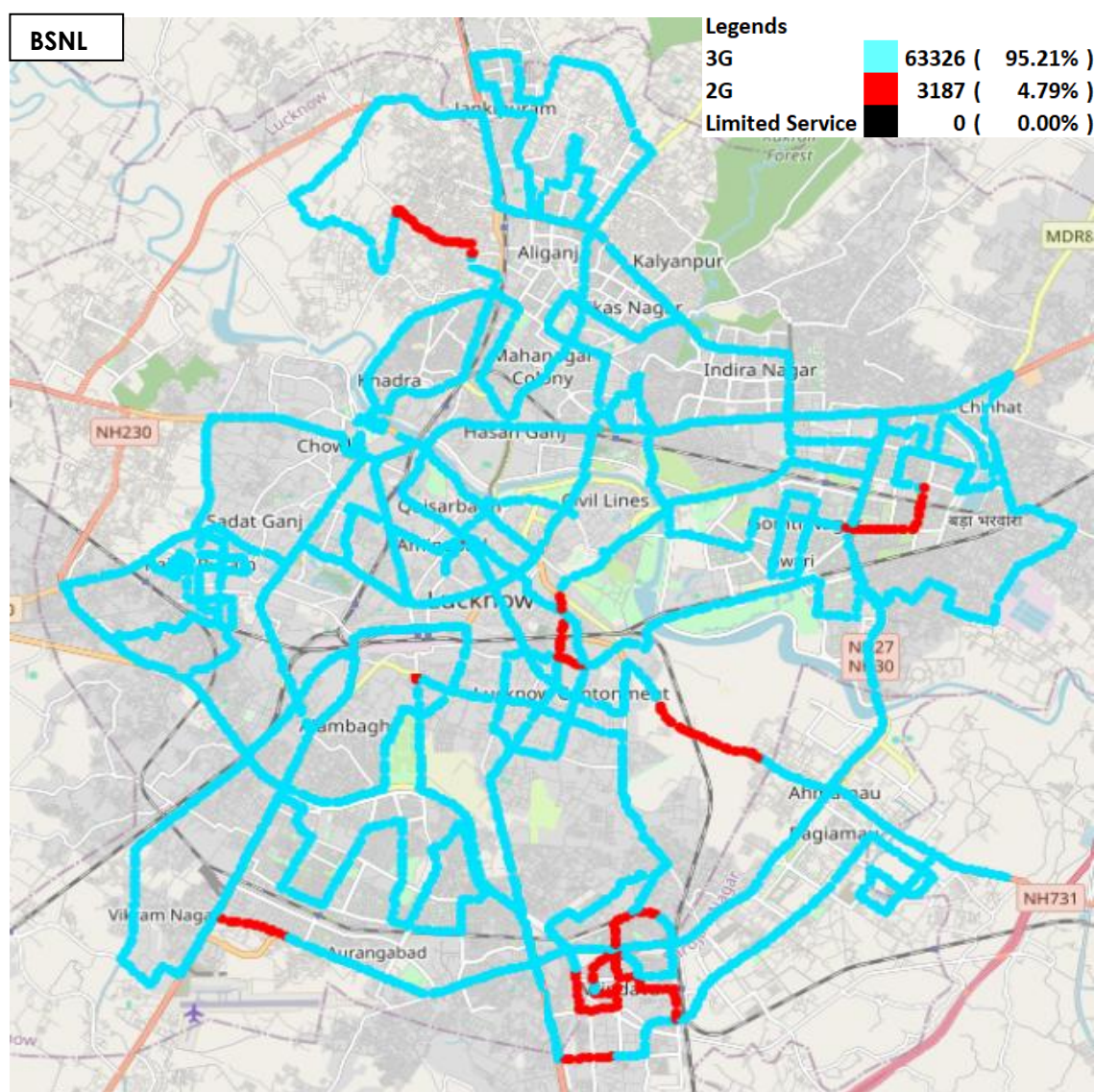
Figure-10: Serving technology plots 3G/2G network mode – BSNL.

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

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(c) Network Signal Strength distribution: The following chart represents signal strength distribution for 3G/2G network mode only. (refer figure-42, 43 & 44 for map view)
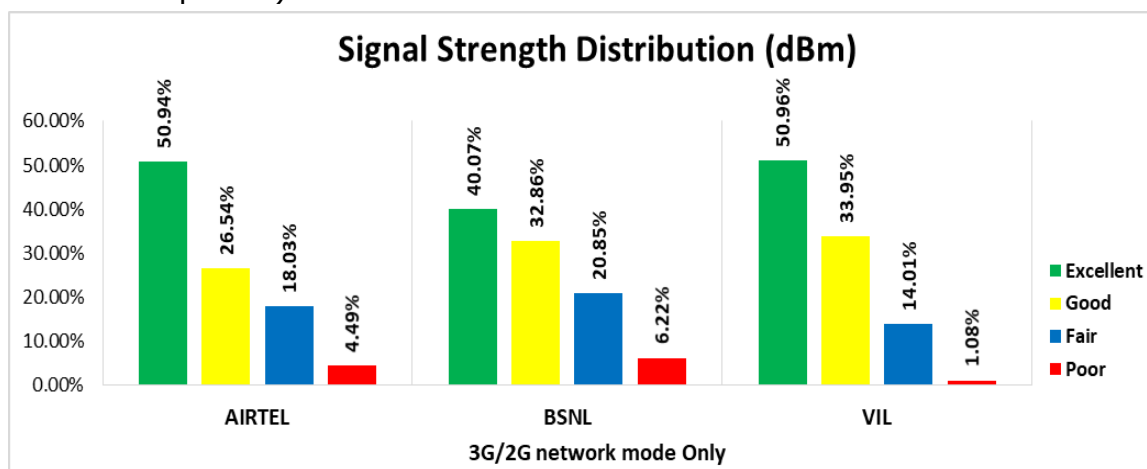
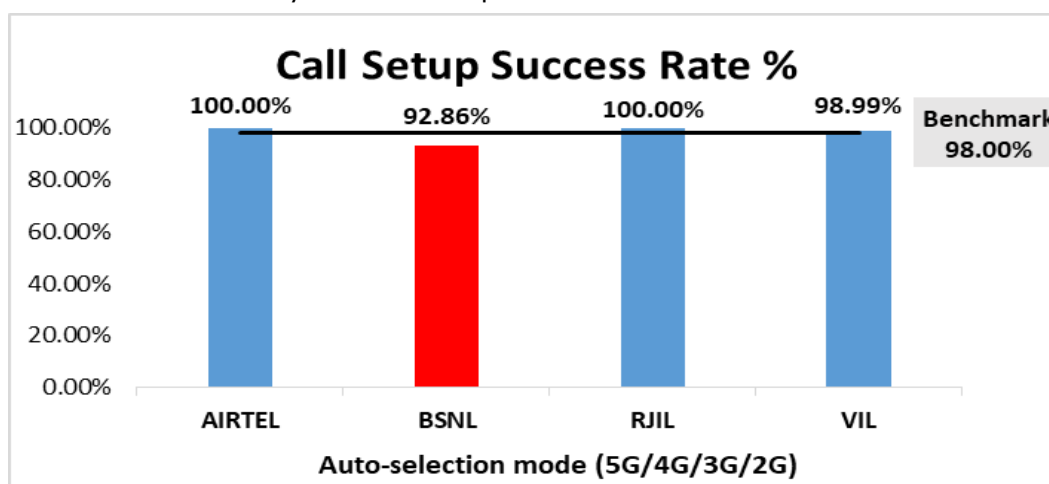**Figure-12:** Signal strength distribution 3G/2G network mode only.

Observations:

- Airtel has 51% of samples falling in the excellent signal strength category.
- BSNL has 40% of samples falling in the excellent signal strength category.
- VIL has 51% of samples falling in the excellent signal strength category.

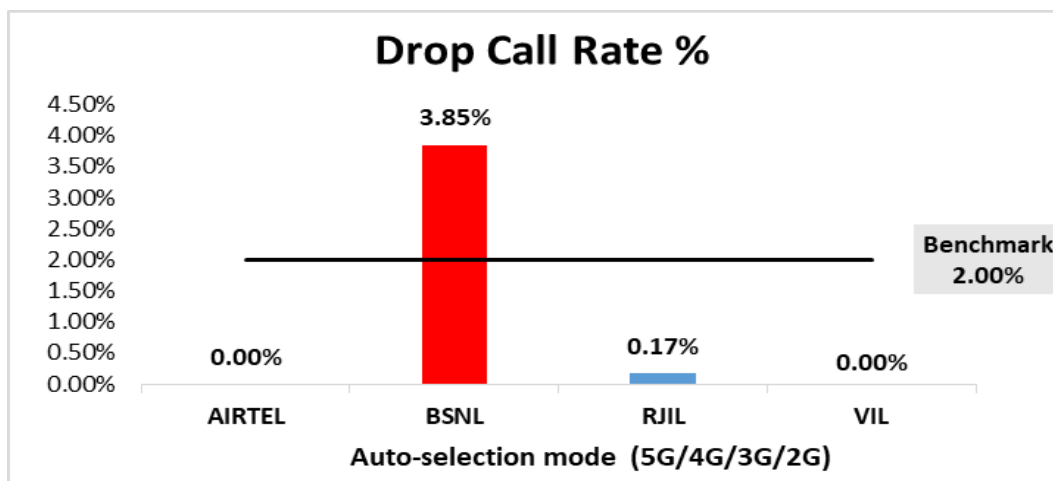**(d) Voice Call Performance in auto network selection mode (5G/4G/3G/2G)**

Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Call Attempts	587	616	600	593
Call Setup Success Rate %	100.00	92.86	100.00	98.99
Drop Call Rate %	0.00	3.85	0.17	0.00
Call Setup Time Average (Second)	1.21	3.50	0.69	0.72
Handover Success Rate %	99.91	99.48	99.91	100.00

Table-15: Summary of voice call performance in network auto-selection mode.

Figure-13: Performance for call setup success rate.

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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)	571	596	579	578
Number of silence call for >4 Sec	9	NA	1	6
Silence Call Rate %	1.58	NA	0.17	1.04
Number of silence instances for >4 Sec	9	NA	1	7
Number of silence instances for >3 Sec	16	NA	1	20
Number of silence instances for >2 sec	40	NA	5	54
RTP Jitter (4G & 5G) in ms	5.23	NA	6.92	14.64
Packet loss Rate Downlink %	0.95	NA	0.07	0.88
Packet loss Rate Uplink %	1.00	NA	0.13	1.04

Table-16: Summary of silence instances & packet loss rate for mobile to mobile call.

> **Note-**
> - NA- Due to unavailability of packet switched (VoLTE & 5G) network in BSNL silence instances are not captured.

(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	3387	2643	3351	3372
Speech Quality (Average MOS Score)	3.95	2.42	3.95	4.35
Number of samples with MOS >=4 to <5 (Excellent)	2708	0	2473	2747
Number of samples with MOS >=3 to <4 (Good)	544	0	740	451
Number of samples with MOS >=2 to <3 (Fair)	49	2293	121	113
Number of samples with MOS >=1 to <2 (Poor)	86	350	17	61
%age of samples with MOS >=4 to <5 (Excellent)	79.95%	0.00%	73.80%	81.47%
%age of samples with MOS >=3 to <4 (Good)	16.06%	0.00%	22.08%	13.37%
%age of samples with MOS >=2 to <3 (Fair)	1.45%	86.76%	3.61%	3.35%
%age of samples with MOS >=1 to <2 (Poor)	2.54%	13.24%	0.51%	1.81%

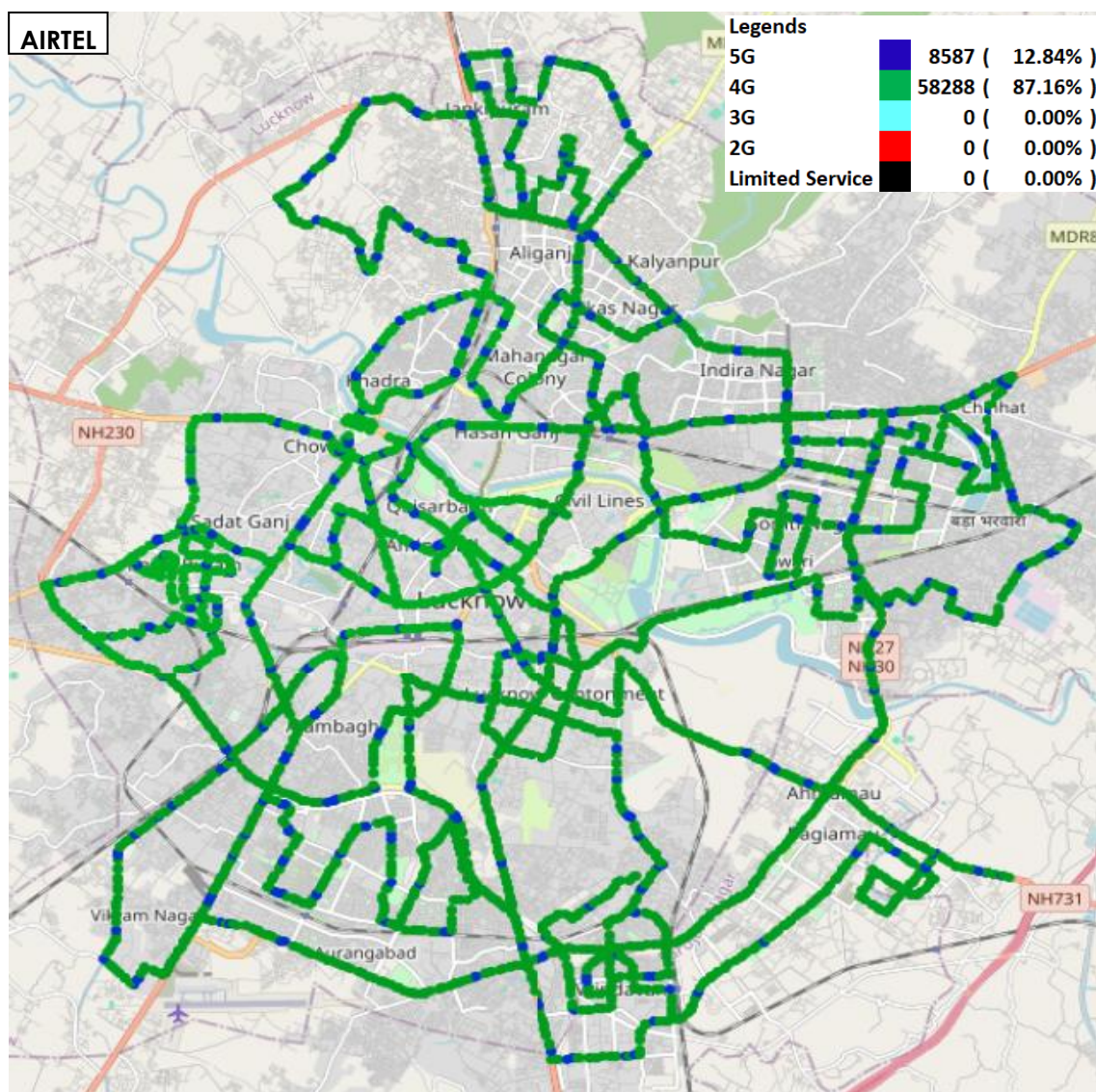**Table-17:** Summary of speech quality (MOS) samples.
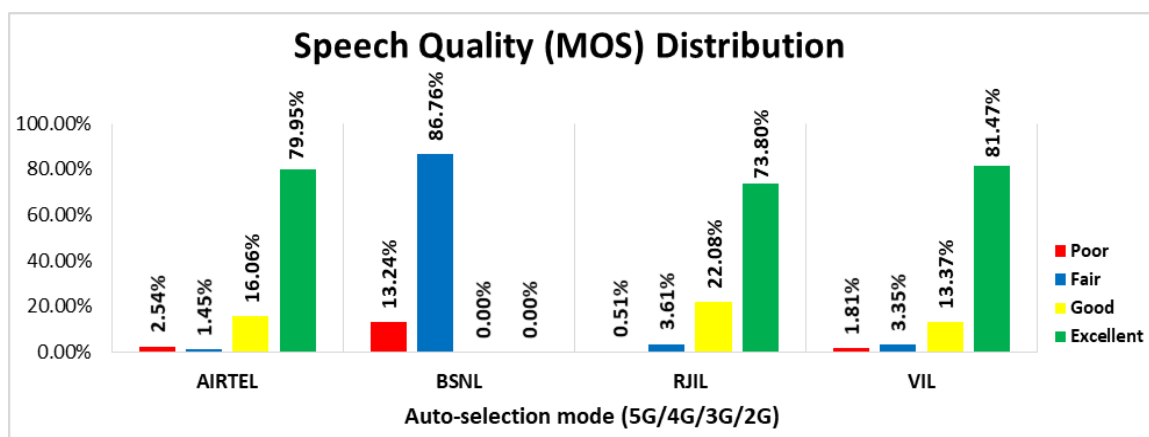
Figure-15: Distribution of samples in MOS score range.

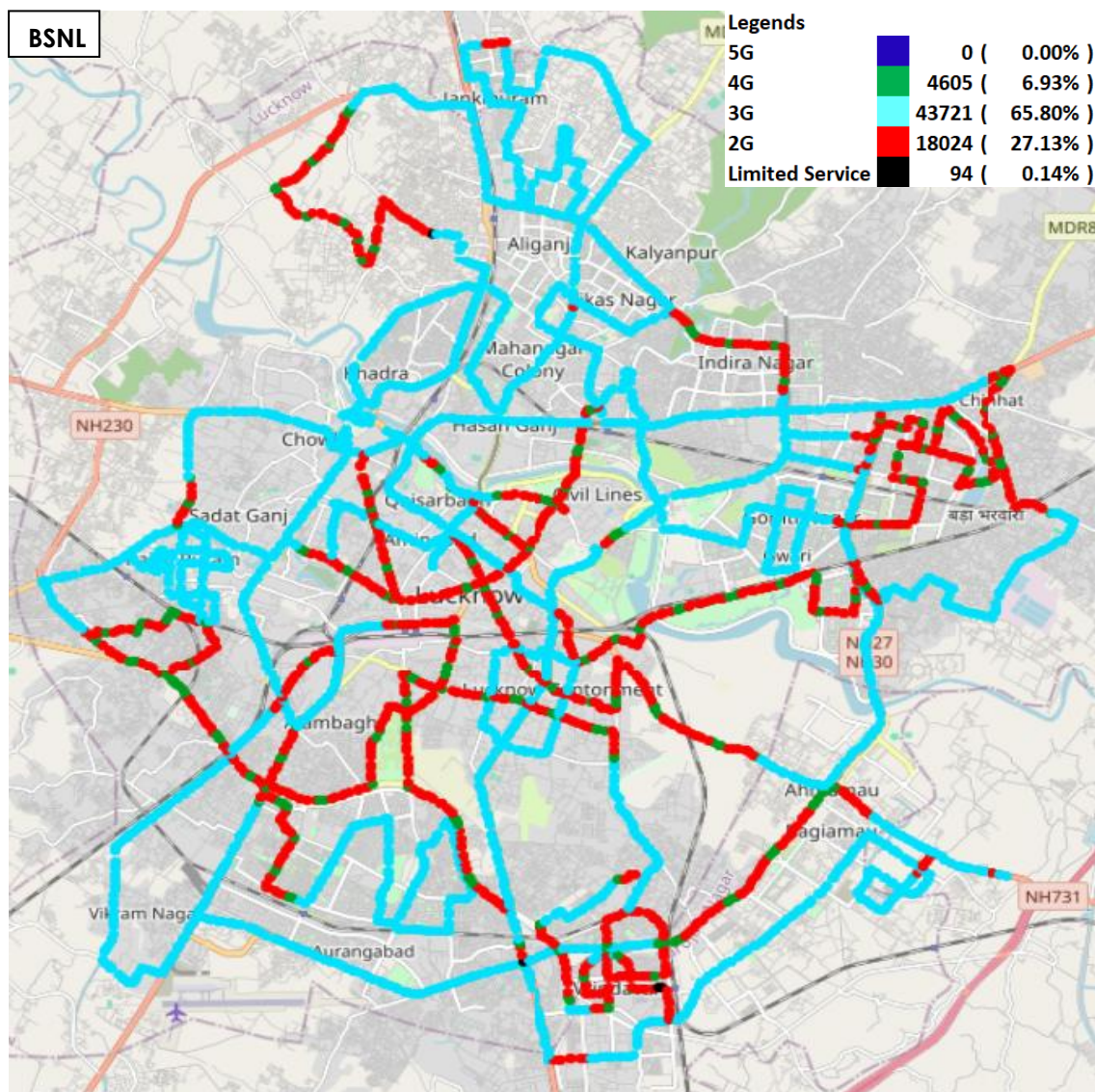**(f) Network Technology:** This section represents time spent on various network technologies.

Technology	Service Provider			
	AIRTEL	BSNL	RJIL	VIL
5G	12.84%	NA	18.67%	NA
4G	87.16%	6.93%	81.33%	99.99%
3G	NA	65.80%	NA	NA
2G	0.00%	27.13%	NA	0.01%
Limited Service	0.00%	0.14%	0.00%	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.

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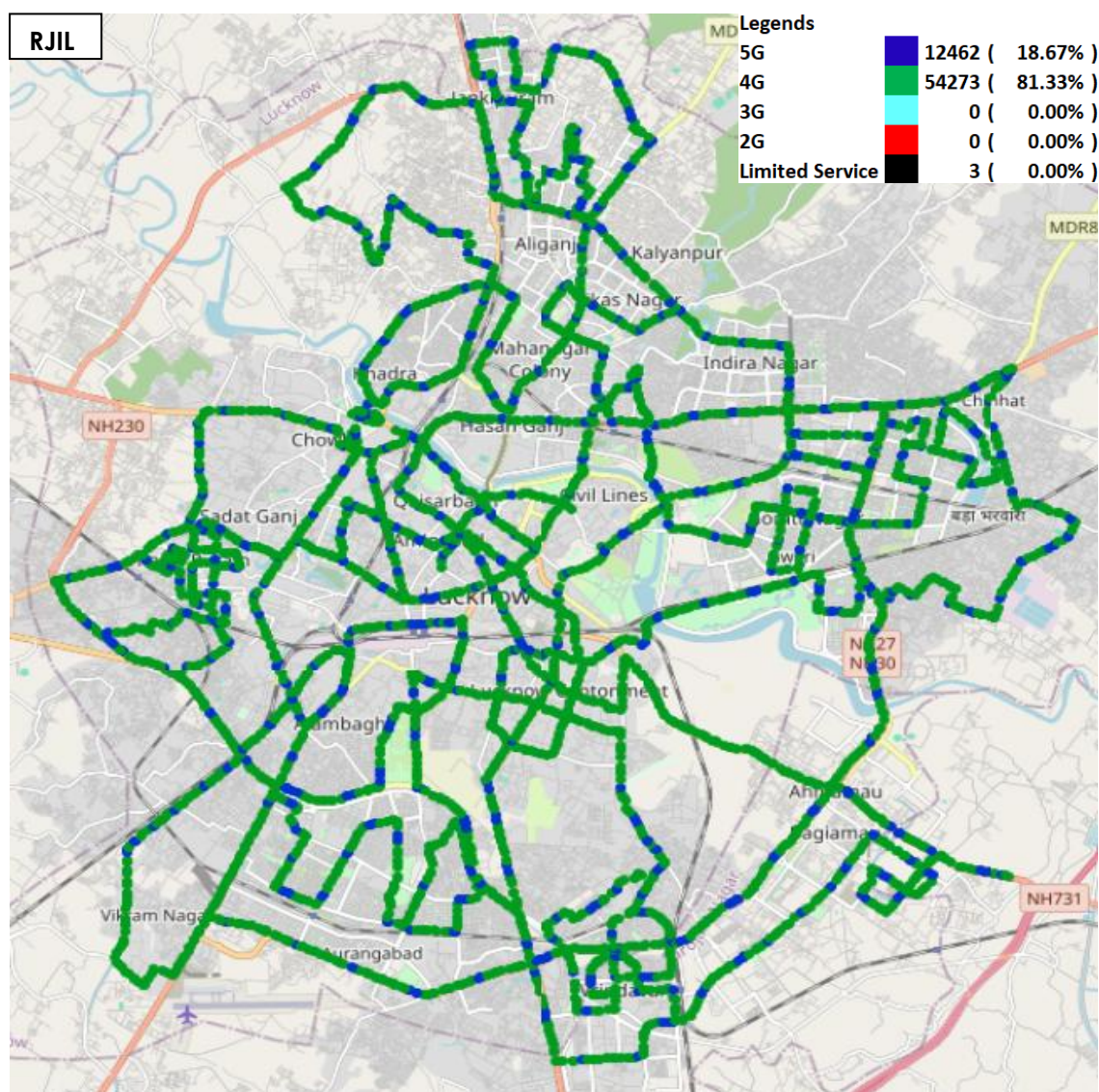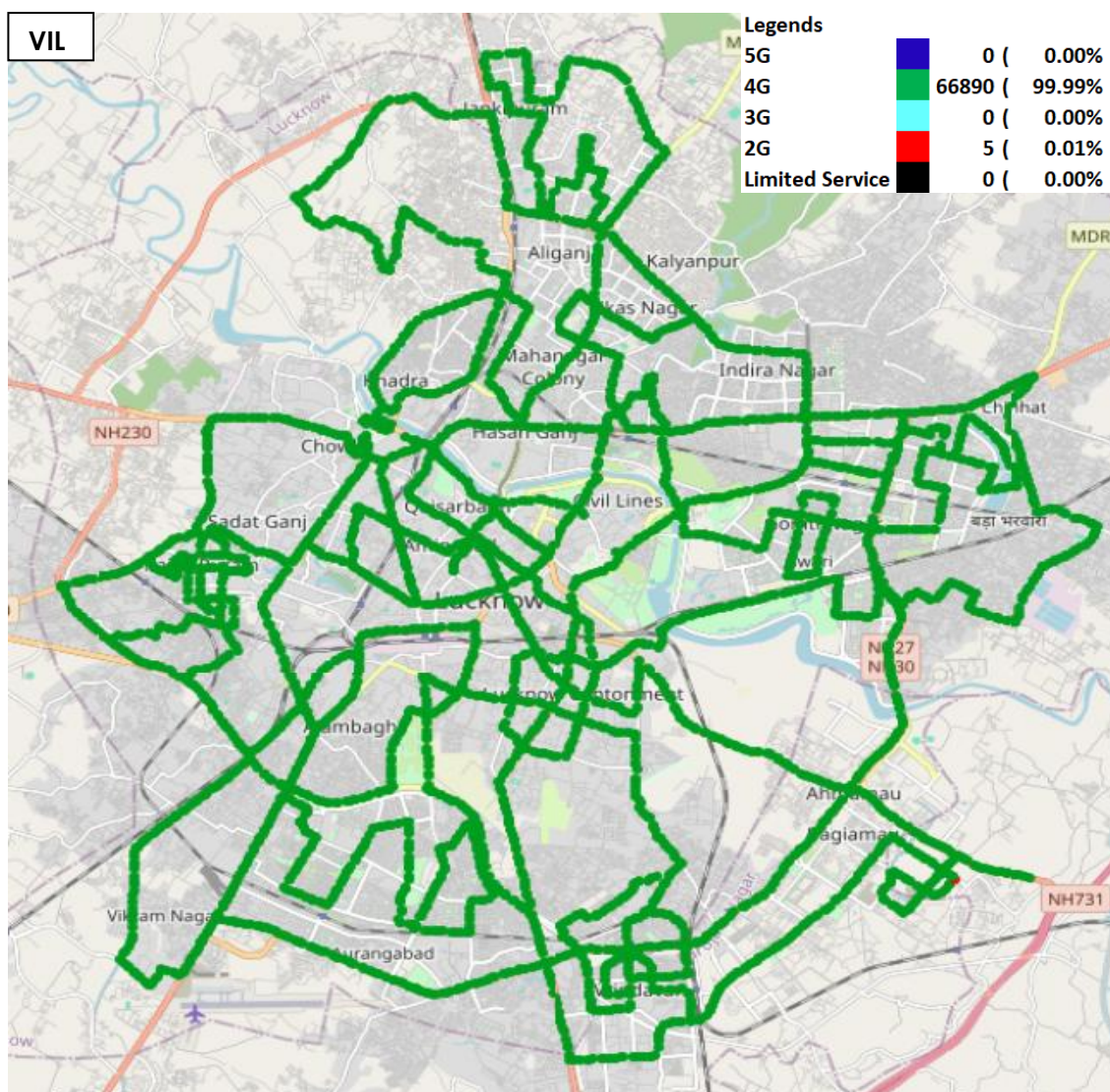
Figure-17: Serving technology plots in auto-selection mode (5G/4G/3G/2G) –BSNL.

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.

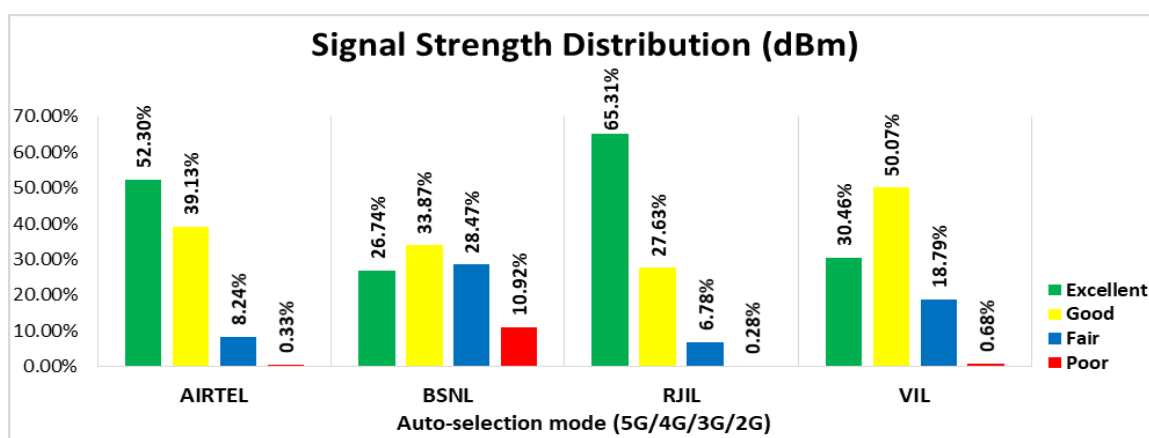**(g) Network Signal Strength distribution:** The following chart provide signal strength distribution for auto-selection mode (5G/4G/3G/2G). (refer figure-45, 46, 47 & 48 for map view)
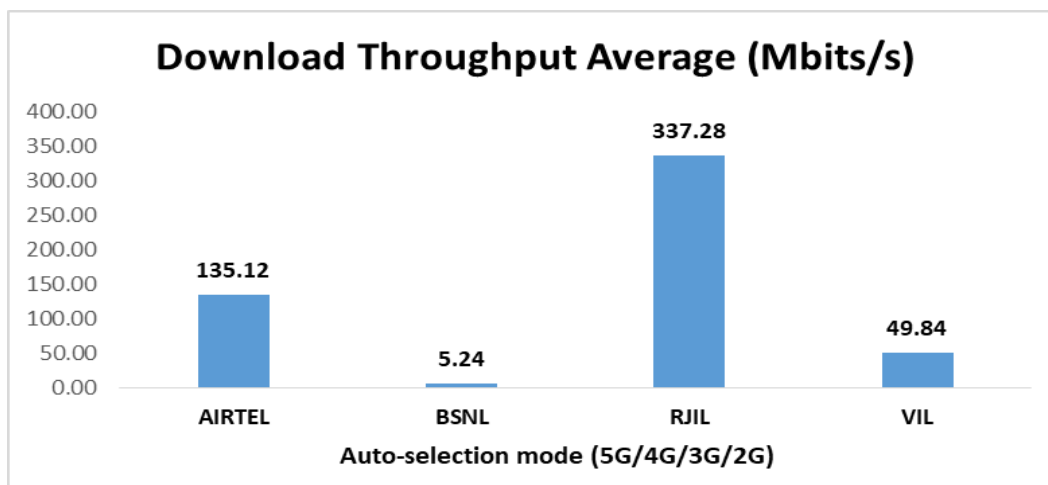

Figure-20: Signal strength distribution auto-selection mode 5G/4G/3G/2G.
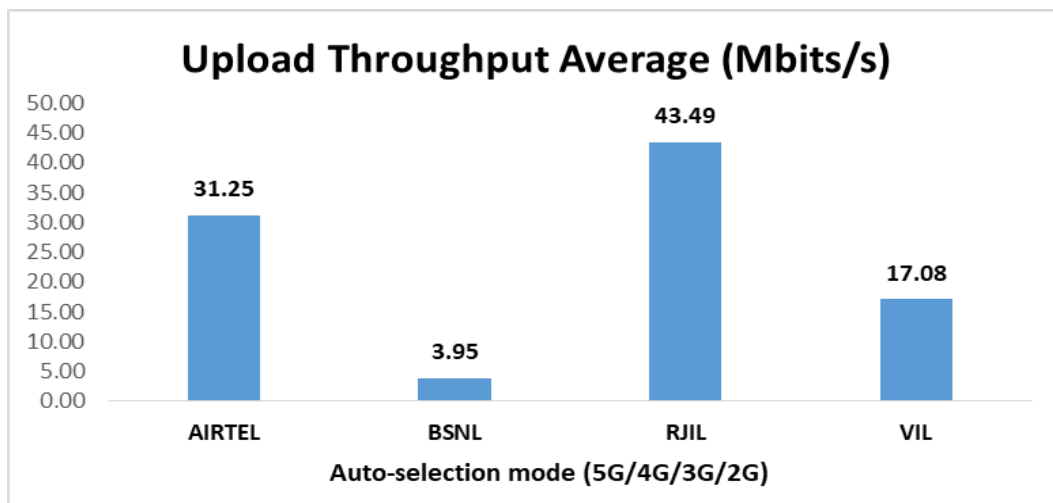
Observations:

- Airtel has 52% of samples falling in the excellent signal strength category.
- BSNL has 27% of samples falling in the excellent signal strength category.
- RJIL has 65% of samples falling in the excellent signal strength category.
- VIL has 30% of 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	135.12	5.24	337.28	49.84
	80th Percentile	216.18	7.78	523.71	77.53
	20th Percentile	20.77	1.28	138.20	21.61
Upload Throughput (Mbits/s)	Average	31.25	3.95	43.49	17.08
	80th Percentile	55.54	5.77	71.72	28.33
	20th Percentile	6.49	1.76	14.21	5.93
Latency (ms)	50th Percentile	41.05	44.25	21.05	27.20

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

Figure- 21: Download throughput.

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Figure- 22: Upload throughput.

4.3 Hotspots

Hotspot testing has been done on 12th December 2024. Ten locations have been tested in the city.

4.3.1 Locations
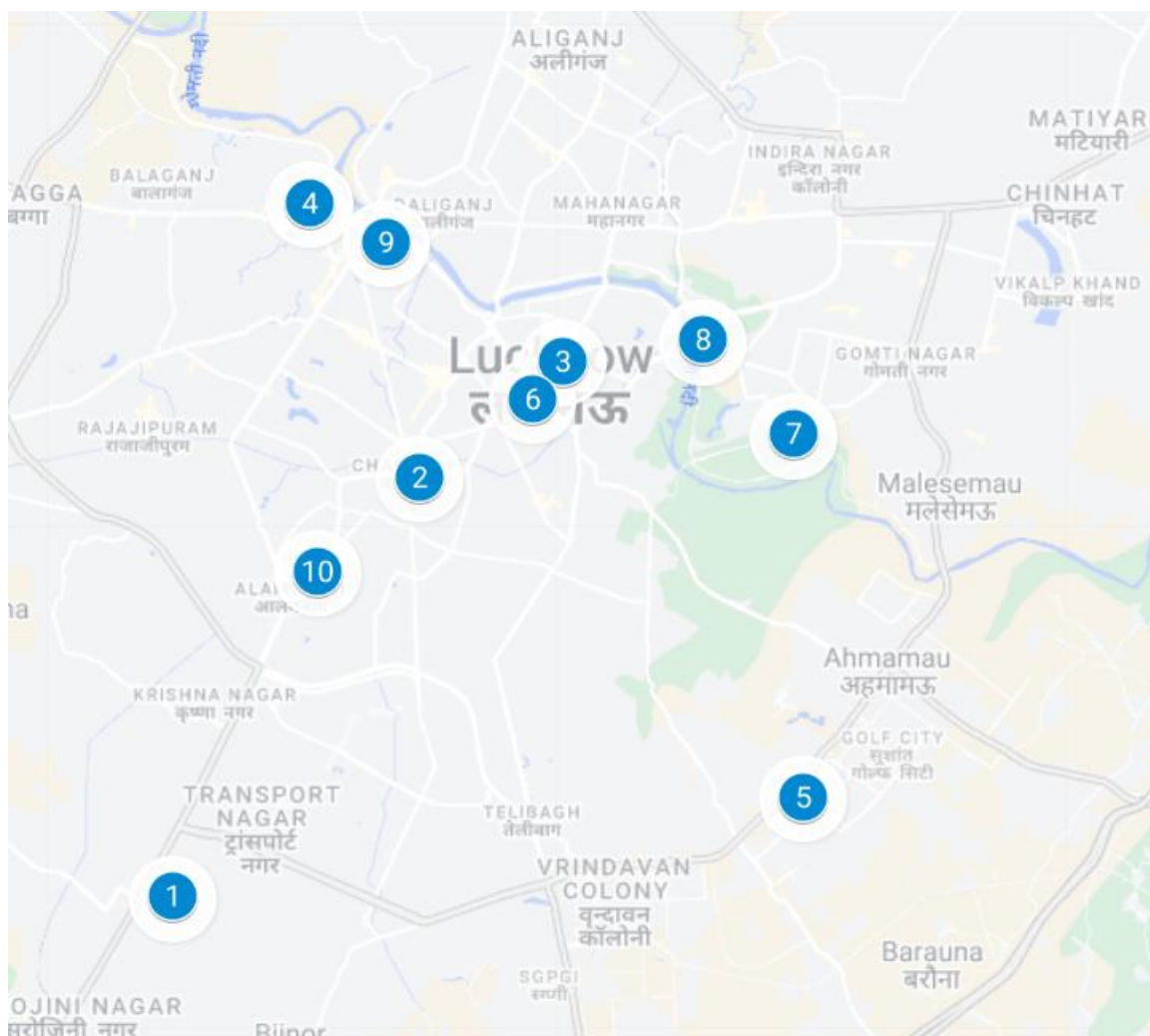
Figure- 23: Hotspot locations

4.3.2 Hotspot covered

1. Alambagh Bus Stand
2. Charbagh Railway Station
3. Gomti River Front
4. Hazratganj Market
5. Imam Bada
6. Janeshwar Mishra Park
7. King George's Medical University
8. Lucknow Airport
9. Lulu Mall
10. Vidhan Sabha

4.3.3 Voice performance

Overall Voice Performance				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	100	100	100	100
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 (Sec)	1.19	3.72	0.61	2.92

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

Alambagh Bus Stand				
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)	1.17	4.24	0.64	0.65

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

Charbagh 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	30.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Sec)	1.18	4.51	0.56	21.54

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

Gomti River Front				
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 (Sec)	1.22	5.23	0.56	0.60

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

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Hazratganj Market			
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	80.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Sec)	1.17	3.28	0.58	0.61

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

Imam Bada			
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)	1.17	2.86	0.55	0.59

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

Janeshwar Mishra Park			
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)	1.30	2.62	0.60	0.69

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

King George's Medical University			
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)	1.15	6.96	0.59	0.54

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

Lucknow Airport			
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)	1.15	4.07	0.63	0.63

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

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Lulu Mall				
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)	1.13	1.90	0.75	0.60

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

Vidhan Sabha				
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)	1.28	2.15	0.61	2.73

Table-30: 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)	167.75	6.89	308.93	40.54
Download Throughput 80th Percentile (Mbit/s)	297.39	12.37	564.76	56.08
Download Throughput 20th Percentile (Mbit/s)	38.00	1.87	35.25	20.96
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	38.46	7.87	47.27	17.61
Upload Throughput 80th Percentile (Mbit/s)	61.81	14.06	75.34	24.86
Upload Throughput 20th Percentile (Mbit/s)	18.13	1.45	18.39	10.28
Upload Session Setup Success Rate %	100.00	98.00	100.00	100.00
Web Browsing Delay (Second)	3.08	4.24	2.34	9.46
Youtube Initial Buffer Delay (Second)	1.03	2.02	0.77	1.77
Latency (ms)- 50th Percentile	40.70	32.60	21.60	29.40
Jitter (ms)	6.01	6.31	19.16	3.82
Packet Loss Rate%	0.86	2.33	1.42	1.34

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

Alambagh Bus Stand				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	373.27	15.58	238.29	20.46
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	68.56	14.32	25.52	20.97
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	3.02	2.66	2.57	9.02
Youtube Initial Buffer Delay (Second)	0.72	1.19	0.57	1.69
Latency (ms)- 50th Percentile	39.73	30.10	22.35	32.75
Jitter (ms)	3.85	4.16	49.15	5.50
Packet Loss Rate%	0.00	0.10	1.80	0.90

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

Charbagh Railway Station				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	0.00	0.00	364.12	35.18
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	30.12	0.00	98.81	17.14
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.99	5.00	2.18	7.30
Youtube Initial Buffer Delay (Second)	0.94	1.43	0.57	0.86
Latency (ms)- 50th Percentile	57.00	30.25	20.60	29.15
Jitter (ms)	4.27	5.96	8.44	1.90
Packet Loss Rate%	0.20	1.10	0.10	0.60

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

> **Note-**
> - Airtel and BSNL Download sessions were failed after server connection.
> - BSNL Upload sessions were failed after server connection.

Gomti River Front				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	367.35	10.31	578.65	36.95
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	61.88	9.68	58.91	10.10
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.06	3.07	1.98	6.98
Youtube Initial Buffer Delay (Second)	1.30	1.18	0.55	1.68
Latency (ms)- 50th Percentile	36.65	31.60	21.80	28.15
Jitter (ms)	2.32	4.16	7.56	3.82
Packet Loss Rate%	0.00	1.50	0.00	2.50

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

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Hazratganj Market				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	24.53	6.56	350.46	26.56
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	15.51	11.10	17.60	16.16
Upload Session Setup Success Rate %	100.00	80.00	100.00	100.00
Web Browsing Delay (Second)	2.73	5.08	2.40	8.74
Youtube Initial Buffer Delay (Second)	0.74	1.23	0.54	1.72
Latency (ms)- 50th Percentile	57.50	28.78	22.78	33.65
Jitter (ms)	4.42	3.99	50.25	4.36
Packet Loss Rate%	0.40	0.00	2.00	0.60

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

Imam Bada				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	219.47	12.86	221.62	65.05
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	37.89	13.54	32.42	16.90
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	3.20	2.71	2.15	8.00
Youtube Initial Buffer Delay (Second)	0.74	1.19	0.51	1.69
Latency (ms)- 50th Percentile	37.35	33.10	19.90	28.10
Jitter (ms)	6.27	4.78	7.15	2.20
Packet Loss Rate%	0.00	2.30	0.10	0.60

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

Janeshwar Mishra Park				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	229.30	3.07	99.89	28.98
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	19.54	0.56	8.58	6.34
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.10	5.93	2.19	9.47
Youtube Initial Buffer Delay (Second)	1.42	3.49	0.83	0.61
Latency (ms)- 50th Percentile	42.70	32.65	21.03	24.00
Jitter (ms)	8.38	9.58	8.96	3.49
Packet Loss Rate%	0.00	7.10	0.10	1.50

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

King George's Medical University				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	87.27	2.53	552.11	4.98
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	35.51	2.35	69.10	34.65
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.52	6.30	2.25	11.85
Youtube Initial Buffer Delay (Second)	0.91	3.29	0.50	1.94
Latency (ms)- 50th Percentile	43.05	34.10	20.25	31.85
Jitter (ms)	5.74	9.34	6.78	2.43
Packet Loss Rate%	0.30	0.30	0.00	3.90

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

Lucknow Airport				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	47.19	2.90	29.37	42.24
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	41.91	14.20	39.45	25.41
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	4.25	2.51	2.44	12.58
Youtube Initial Buffer Delay (Second)	1.16	1.08	0.61	5.19
Latency (ms)- 50th Percentile	36.45	30.40	20.93	28.15
Jitter (ms)	2.43	4.47	6.80	3.07
Packet Loss Rate%	0.20	0.80	0.00	0.70

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

Lulu Mall				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	262.22	1.06	17.96	46.76
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	64.91	2.19	26.78	17.64
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	5.44	6.96	2.99	11.22
Youtube Initial Buffer Delay (Second)	1.15	4.36	2.49	1.68
Latency (ms)- 50th Percentile	38.25	36.10	29.28	25.70
Jitter (ms)	4.70	9.76	40.58	8.46
Packet Loss Rate%	0.00	10.00	10.10	0.60

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

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Vidhan Sabha				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	66.89	14.09	636.85	98.28
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	8.74	11.41	95.54	10.76
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.52	2.76	2.30	10.24
Youtube Initial Buffer Delay (Second)	1.22	1.25	0.54	0.59
Latency (ms)- 50th Percentile	44.05	30.60	20.98	32.25
Jitter (ms)	17.70	7.36	6.52	2.87
Packet Loss Rate%	7.50	0.10	0.00	1.50

Table-41: Summary of Data performance in network auto- selection mode (5G/4G/3G/2G).

4.4 Walk Test

Walk test testing has been done on 12th December 2024. Two locations have been tested in the city.

4.4.1 Walk test location map
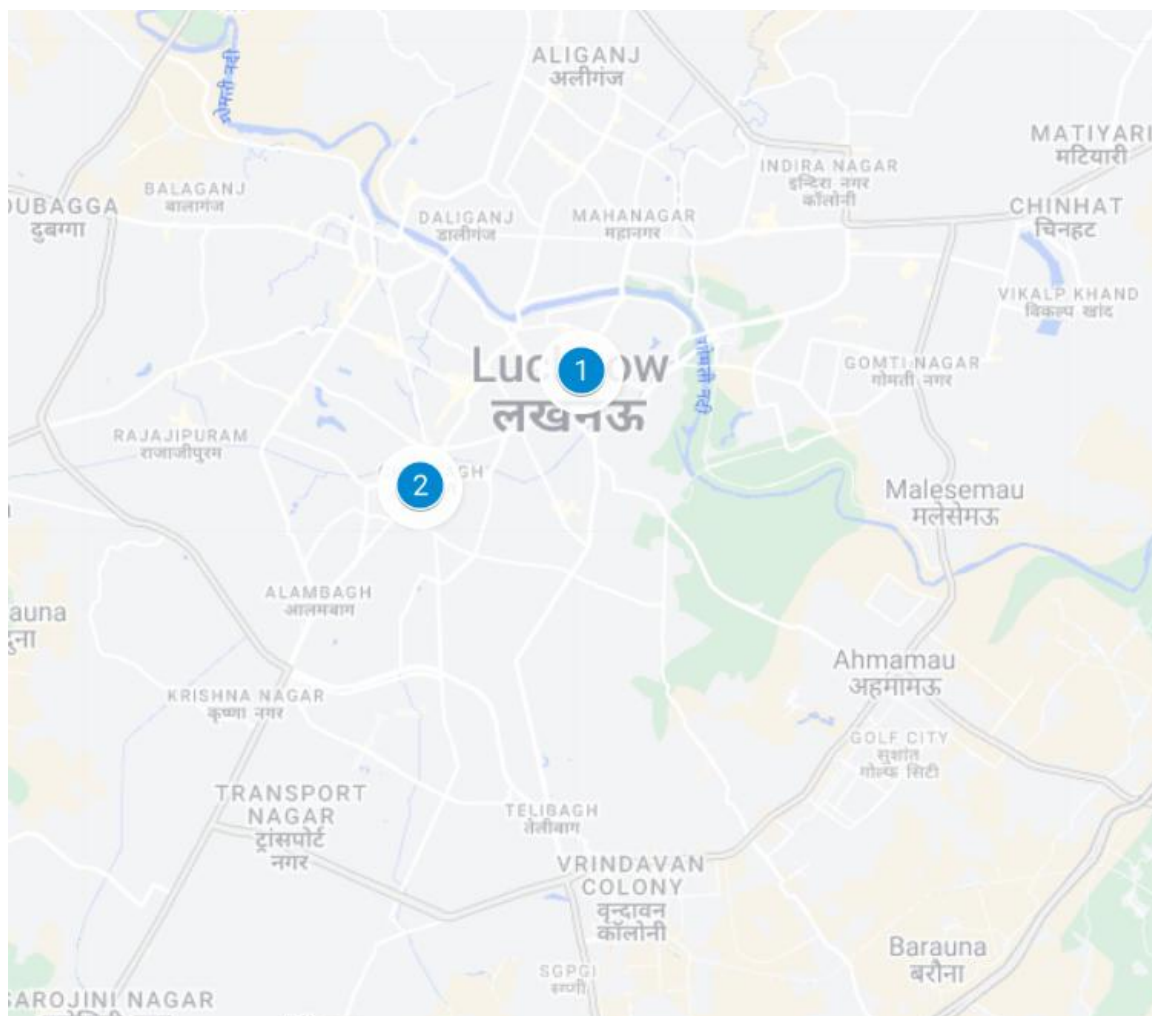
Figure- 24: Walk Test locations.

4.4.2 Walk Test covered

1. Hazratganj Market
2. Lucknow Junction

4.4.3 Voice performance

Hazratganj Market				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	22	22	23	19
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)	1.16	4.19	0.59	21.66

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

Lucknow Junction				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	19	20	19	16
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)	1.19	4.33	0.66	21.55

Table-43: Summary of voice call performance in network auto-selection mode (5G/4G/3G/2G).

4.4.4 Data performance

Hazratganj Market				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	227.94	7.01	319.91	44.25
Download Session Setup Success Rate %	96.67	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	36.35	2.31	47.00	21.42
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Latency (ms)- 50th Percentile	36.55	61.75	20.50	32.05

Table-44: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

Lucknow Junction				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	233.88	2.97	360.76	35.24
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	46.53	10.52	59.27	20.43
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Latency (ms)- 50th Percentile	37.53	34.65	20.75	31.60

Table-45: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

4.5 Highway

Drive test has been conducted on 13th December 2024 covering Highway routes. (refer Table-1)

4.5.1 Drive test route

Figure-25: Drive test route highway

4.5.2 Routes Covered

Fatehpur to Varanasi Via Khaga, Soraon, Gopalganj & Bhainsa, which has covered NH19. Drive test for this route has been conducted on 13th December 2024.

4.5.3 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	91	110	92
Call Setup Success Rate %	100.00	87.27	97.83
Drop Call Rate %	0.00	13.54	1.11
Call Setup Time-Average (Second)	4.59	3.18	5.22
Handover Success Rate %	98.85	99.87	99.47

Table-46: Summary of voice call performance in 3G/2G network mode only.
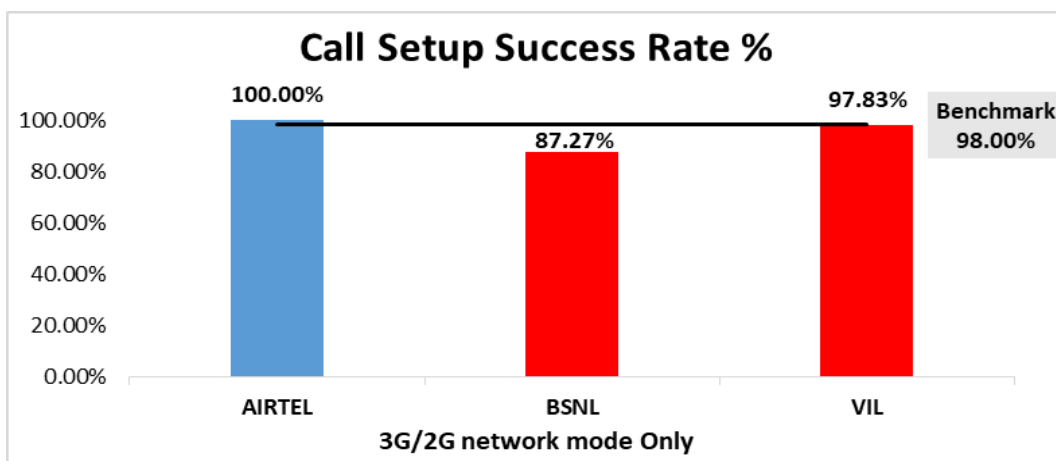
Figure-26: Performance for call setup success rate.
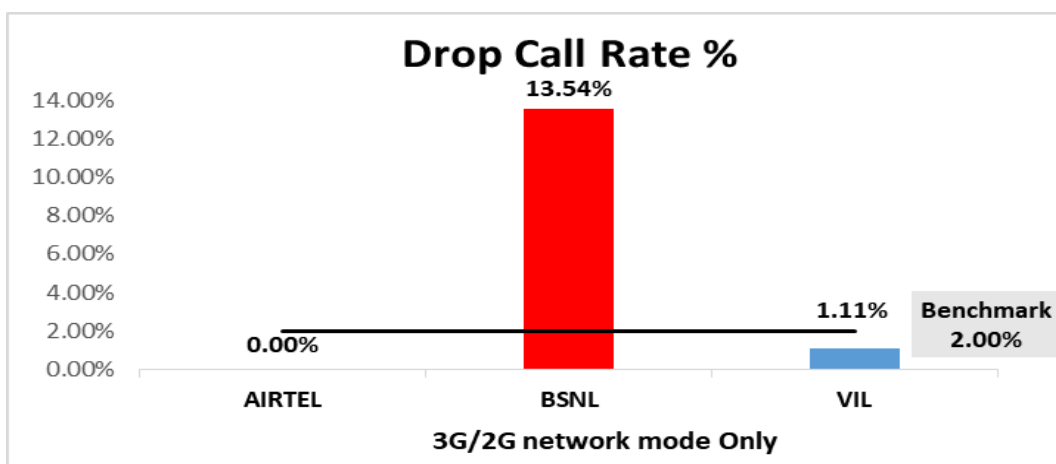
Figure-27: Performance for drop call rate.

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

Technology	Service Provider		
	AIRTEL	**BSNL**	**VIL**
3G	NA	85.35%	NA
2G	100.00%	14.65%	100.00%
Limited Service	0.00%	0.00%	0.00%

Table-47: Time spent on technology during drive test 3G/2G network mode only.

> Note-
> • NA- Service provider doesn't provide services in respective technology.
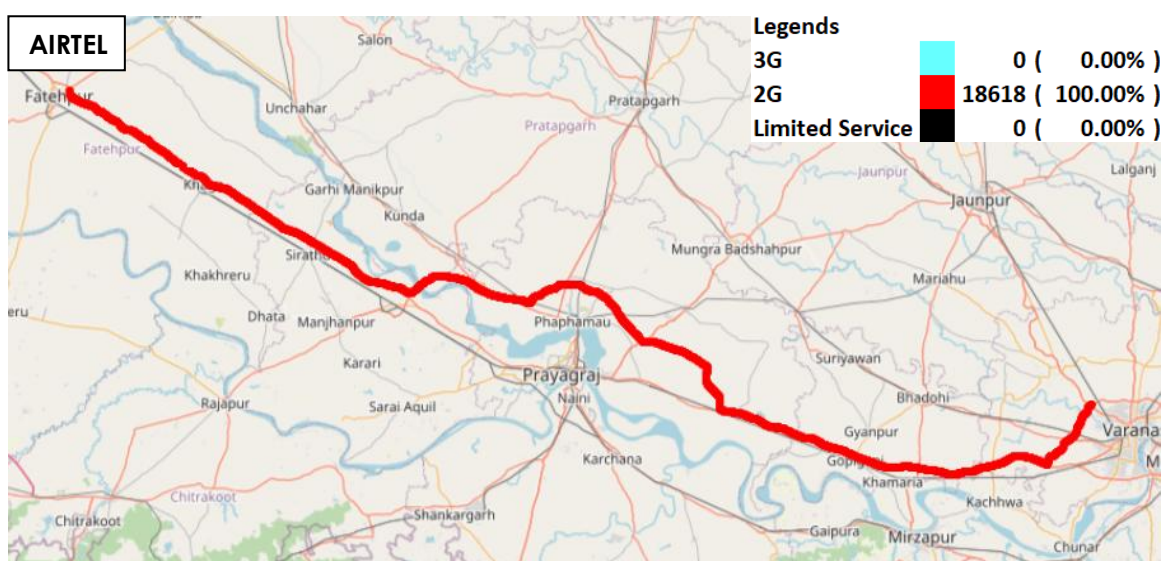
Figure-28: Serving technology plots 3G/2G network mode – AIRTEL.
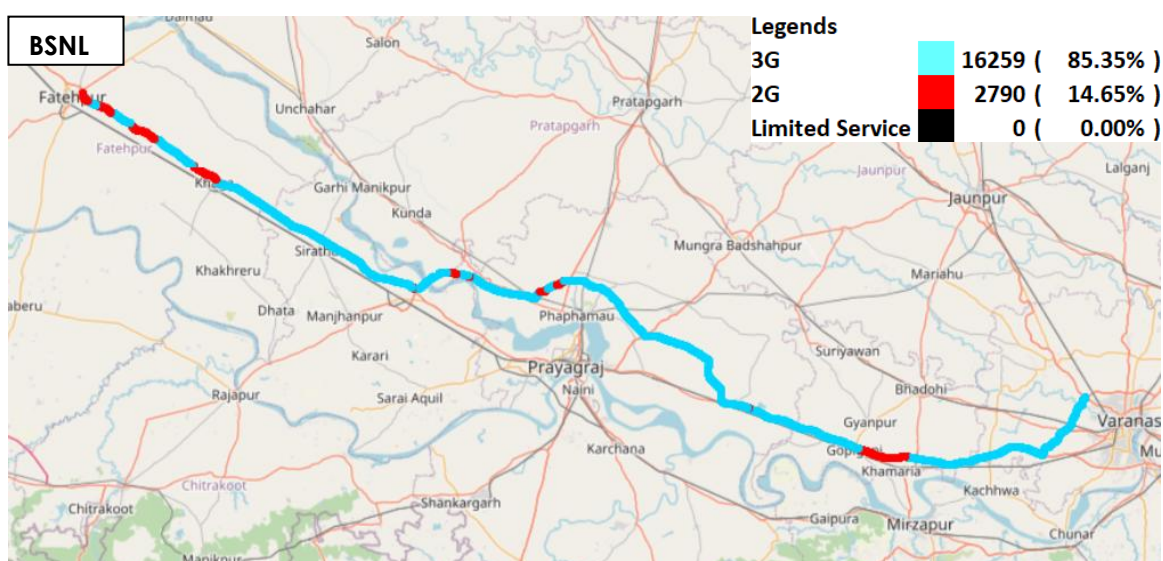
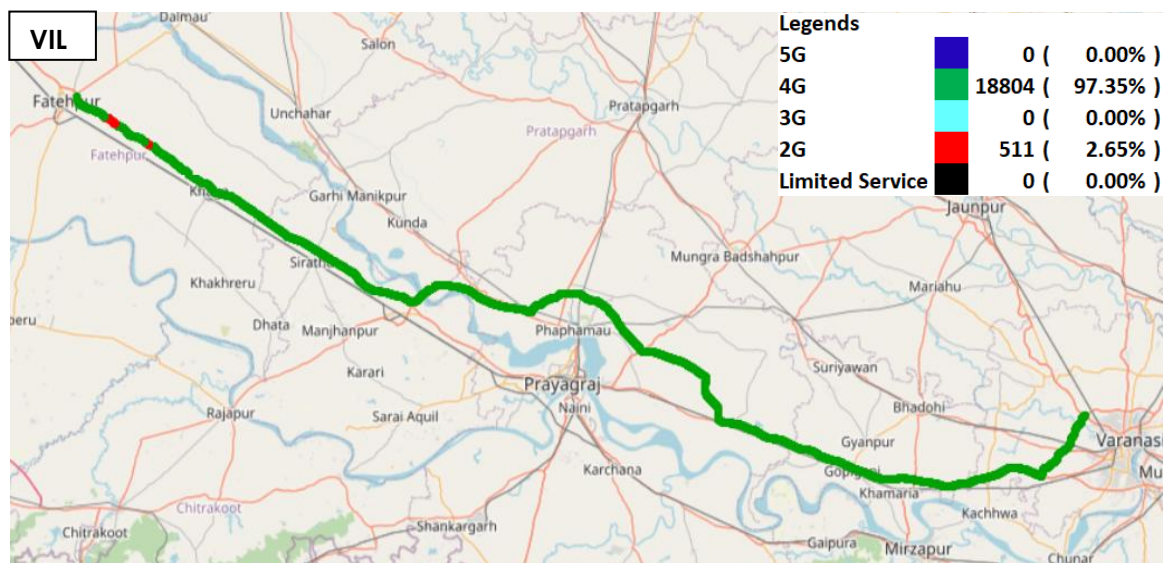**Figure-29:** Serving technology plots 3G/2G network mode – BSNL.

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Generated from eOffice by VIRENDRA SINGH RAJPUT , SRO (VSR) - QoS-I, SENIOR RESEARCH OFFICER, TRAI on 17/02/2025 12:39 pm
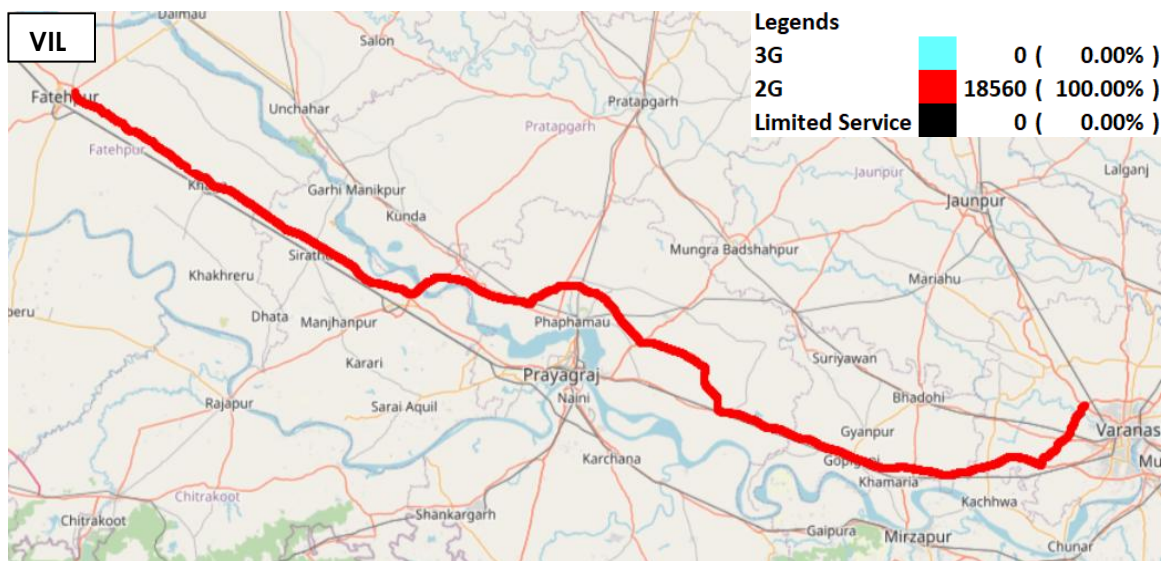
Figure-30: Serving technology plots 3G/2G network mode –VIL.

(c) Network Signal Strength distribution: The following chart represents signal strength distribution for 3G/2G network mode only. (refer figure-49, 50 & 51 for map view)
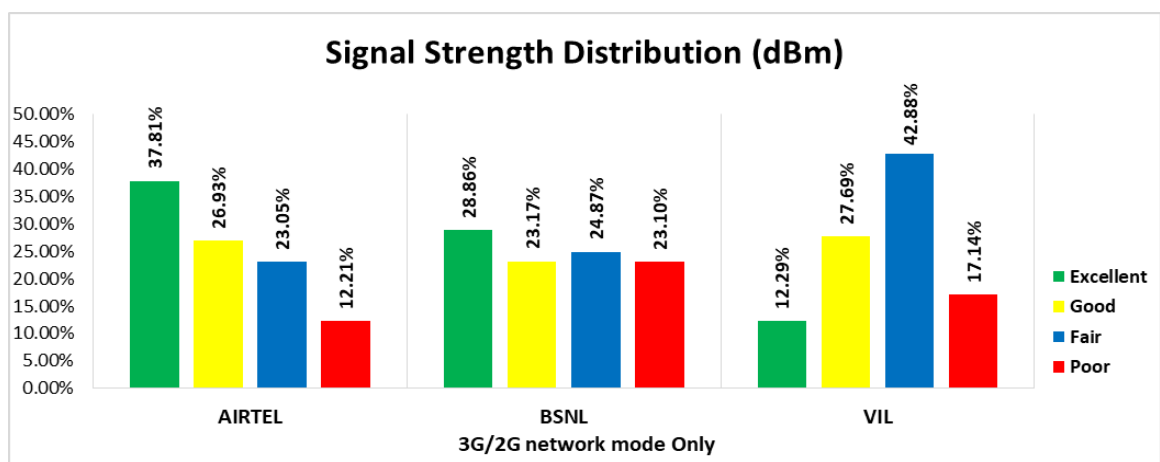
Figure-31: Signal strength distribution 3G/2G network mode only.

Observations:

- Airtel has 38% of samples falling in the excellent signal strength category.
- BSNL has 29% of samples falling in the excellent signal strength category.
- VIL has 12% of samples falling in the excellent signal strength category.

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## (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	95	114	96	95
Call Setup Success Rate %	100.00	89.47	100.00	100.00
Drop Call Rate %	0.00	24.51	0.00	1.05
Call Setup Time Average (Second)	1.18	3.76	0.79	0.75
Handover Success Rate %	100.00	99.73	100.00	100.00

Table-48: Summary of voice call performance in network auto-selection mode (5G/4G/3G/2G).
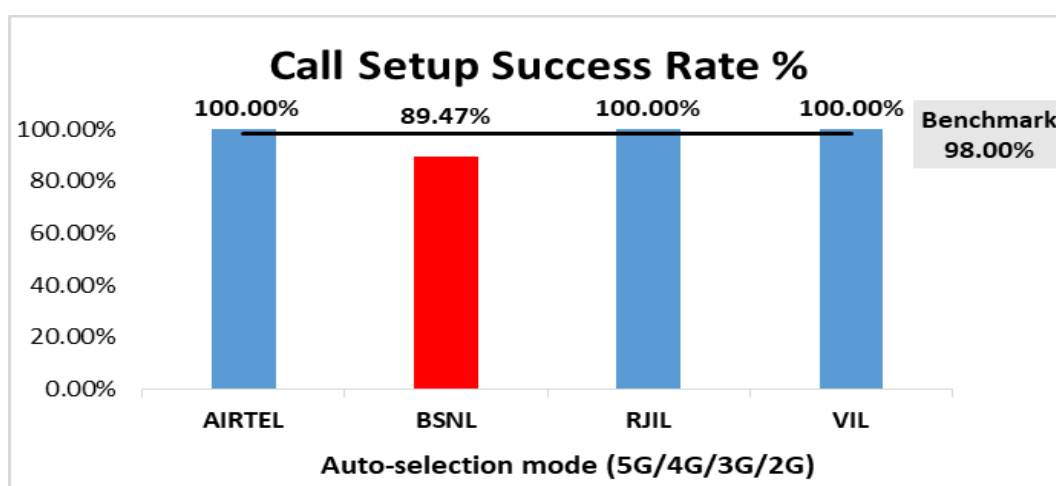
Figure-32: Performance for call setup success rate.
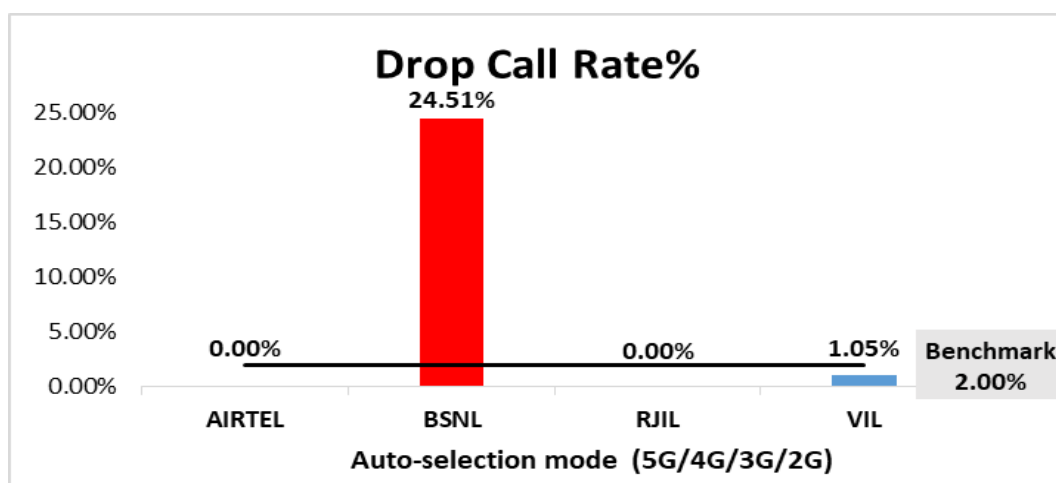
Figure-33: Performance for drop call rate.

Parameter	Service Provider Mobile-to-Mobile (5G/4G - Open Mode)			
	AIRTEL	BSNL	RJIL	VIL
Call Established (within service provider Network)	90	97	92	90
Number of silence call for >4 Sec	0	NA	1	8
Silence Call Rate %	0.00	NA	1.09	8.89
Number of silence instances for >4 Sec	0	NA	1	15
Number of silence instances for >3 Sec	0	NA	1	20
Number of silence instances for >2 sec	12	NA	5	64
RTP Jitter (4G & 5G) in ms	5.18	NA	7.71	10.51
Packet loss Rate Downlink %	1.95	NA	0.21	1.96
Packet loss Rate Uplink %	0.88	NA	0.78	1.86

Table-49: Summary of silence instances & packet loss rate for mobile to mobile call.

> **Note-**
> * NA- Due to unavailability of packet switched (VoLTE & 5G) network in BSNL silence instances are not captured.

(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-49	1136	937	1147	1143
Speech Quality (Average MOS Score)	3.90	2.94	3.88	4.07
Number of samples with MOS >=4 to <5 (Excellent)	870	0	784	831
Number of samples with MOS >=3 to <4 (Good)	193	577	280	132
Number of samples with MOS >=2 to <3 (Fair)	29	267	72	67
Number of samples with MOS >=1 to <2 (Poor)	44	93	11	113
%age of samples with MOS >=4 to <5 (Excellent)	76.58%	0.00%	68.35%	72.70%
%age of samples with MOS >=3 to <4 (Good)	16.99%	61.58%	24.41%	11.55%
%age of samples with MOS >=2 to <3 (Fair)	2.55%	28.50%	6.28%	5.86%
%age of samples with MOS >=1 to <2 (Poor)	3.87%	9.93%	0.96%	9.89%

Table-50: Summary of speech quality (MOS) samples.
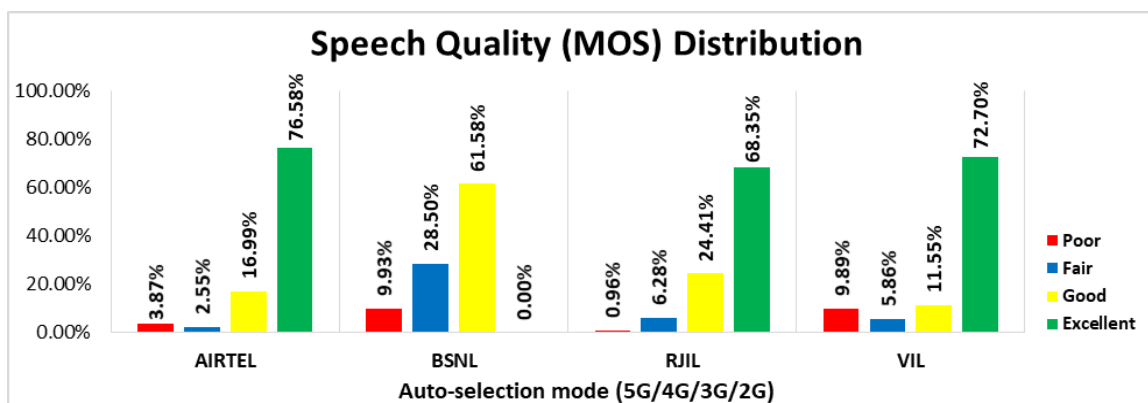
Figure-34: Distribution of samples in MOS score range.

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

Technology	Service Provider			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
5G	4.78%	NA	9.60%	NA
4G	95.22%	1.47%	90.40%	97.35%
3G	NA	71.58%	NA	NA
2G	0.00%	26.51%	NA	2.65%
Limited Service	0.00%	0.45%	0.00%	0.00%

Table-51: Time spent on technology during drive test.

Note-
- RJIL does not have 3G/2G network.
- NA- Service provider doesn't provide services in respective technology.
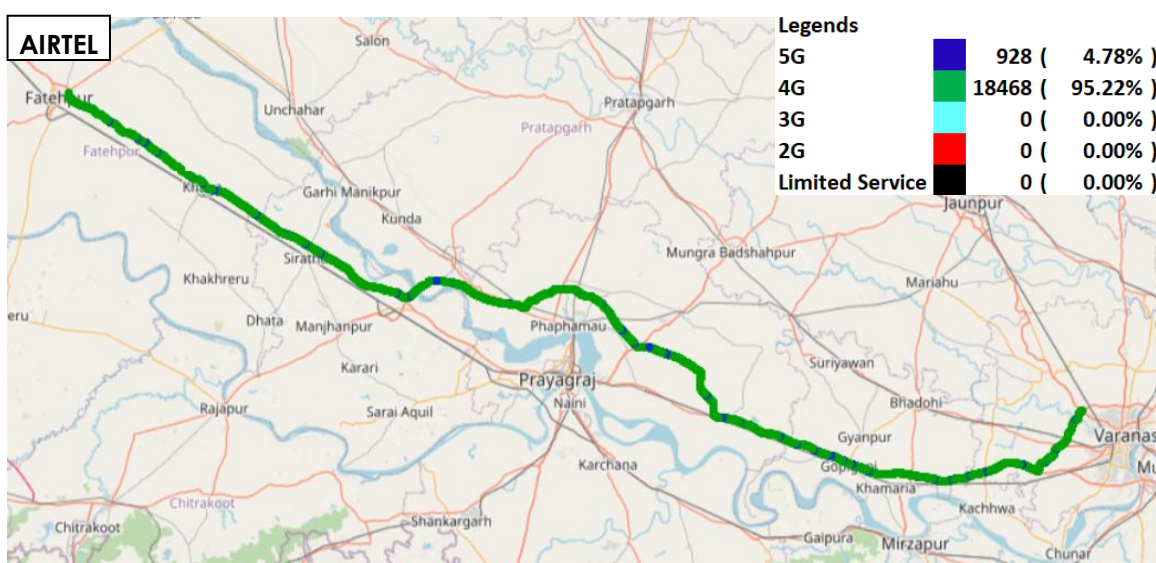
Figure-35: Serving technology plots in auto-selection mode (5G/4G/3G/2G) –AIRTEL.
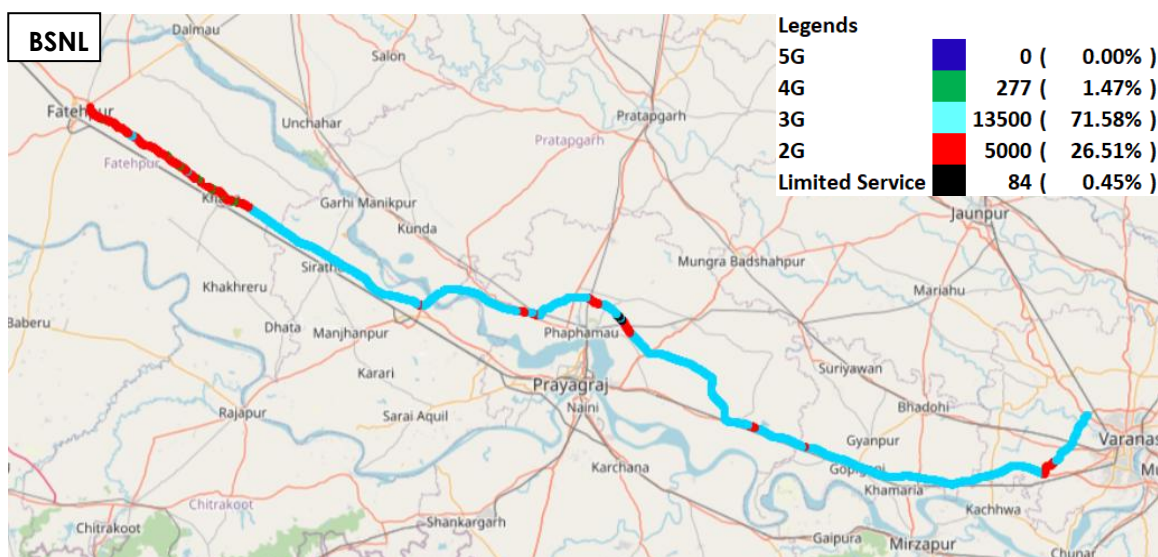
Figure-36: Serving technology plots in auto-selection mode (5G/4G/3G/2G) –BSNL.
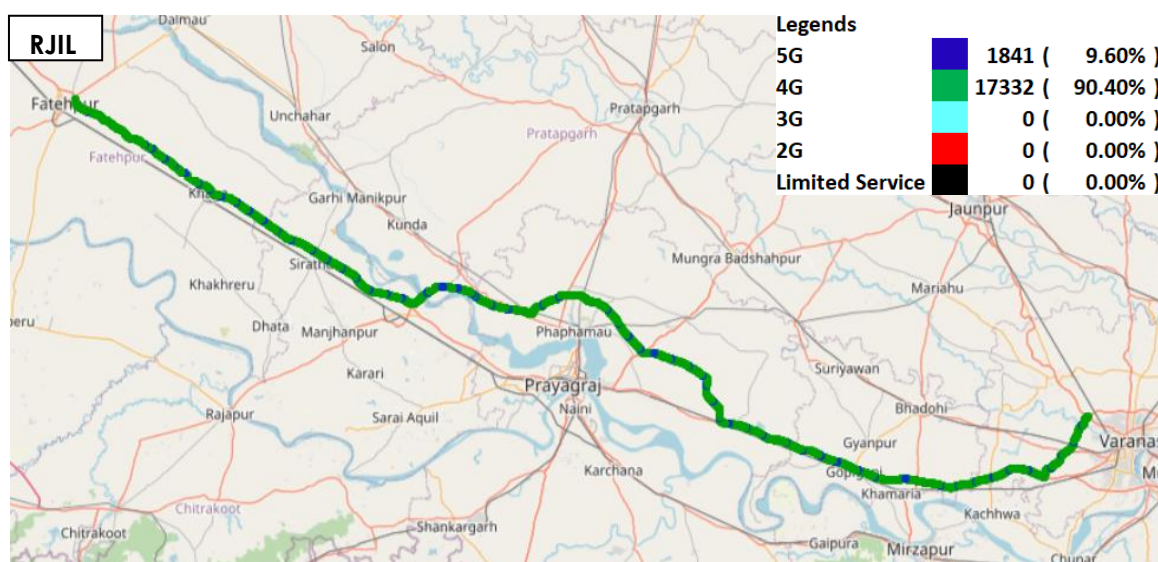
Figure-37: Serving technology plots in auto-selection mode (5G/4G/3G/2G)- RJIL.

Figure-38: 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-52, 53, 54 & 55 for map view).
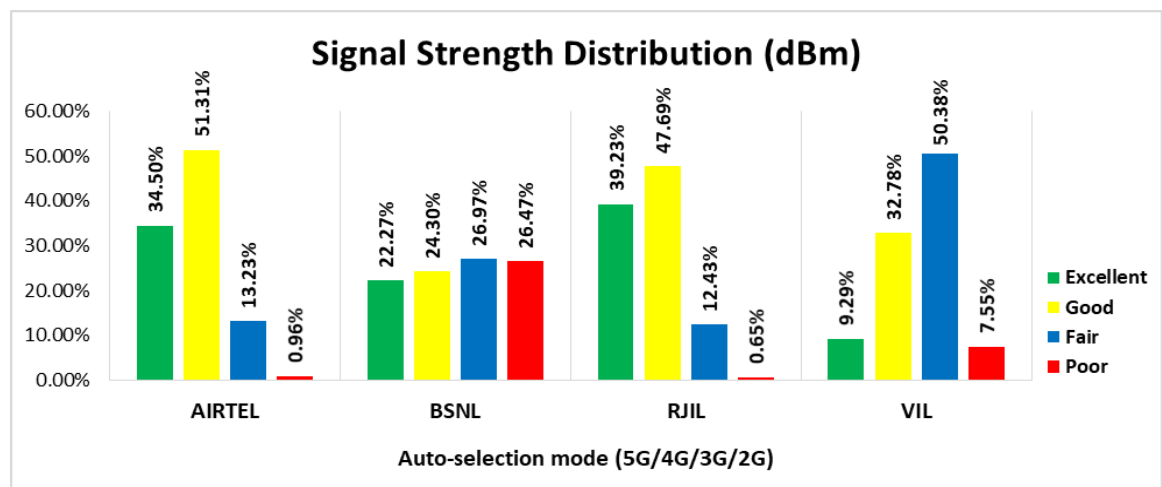
Figure-39: Signal strength distribution auto-selection mode 5G/4G/3G/2G

Observations:

- Airtel has 35% of samples falling in the excellent signal strength category.
- BSNL has 22% of samples falling in the excellent signal strength category.
- RJIL has 39% of samples falling in the excellent signal strength category.
- VIL has 9% of samples falling in the excellent signal strength category.

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	76.56	3.46	264.99	9.84
	80th Percentile	127.82	4.67	457.43	8.70
	20th Percentile	22.74	0.26	75.88	7.48
Upload Throughput (Mbits/s)	Average	13.18	2.70	26.77	6.36
	80th Percentile	22.30	2.64	46.32	9.98
	20th Percentile	2.91	0.85	5.94	2.01
Latency (ms)	50th Percentile	47.73	77.00	22.90	30.10

Table-52: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).
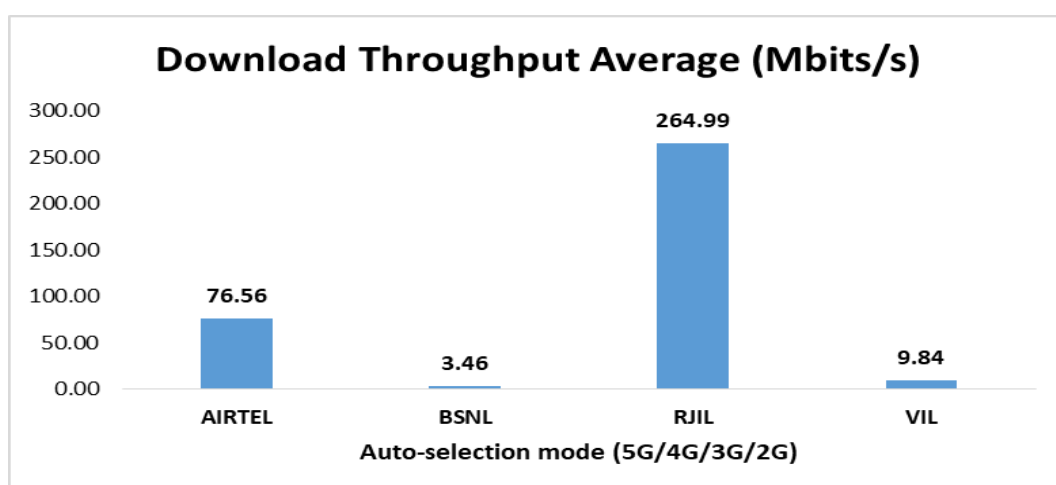
Figure-40: Download throughput
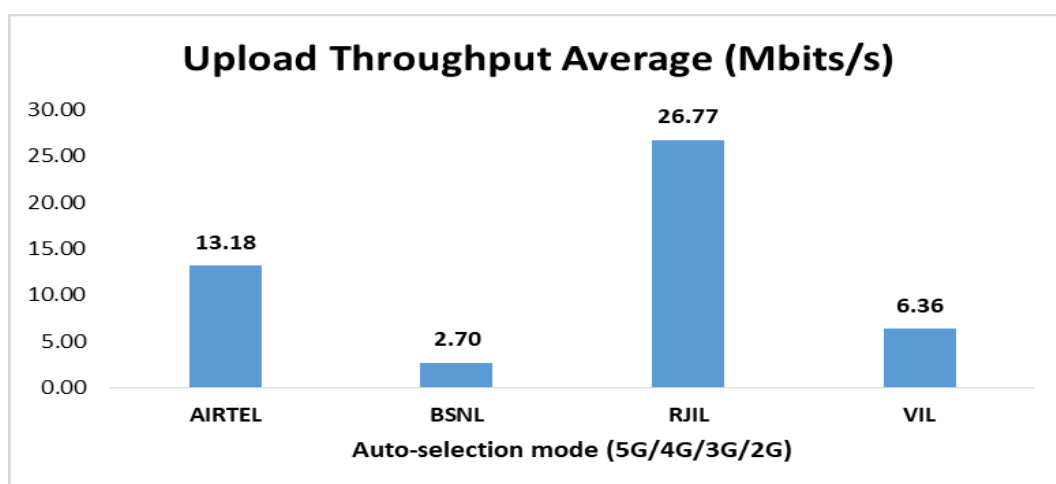
Figure-41: Upload throughput

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5. Voice & Data Key findings

5.1 Overall Voice

1. Call Setup Success Rate:

a) Airtel, BSNL and VIL have 99.85%, 96.94% and 98.47% call setup success rate respectively in 3G/2G network mode. (Refer table-3)

b) Airtel, BSNL, RJIL and VIL have 100.00%, 92.20%, 100.00% and 99.27% call setup success rate respectively in Auto-selection mode (5G/4G/3G/2G).(refer table-5)

c) Airtel has 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) VIL has taken comparatively longer time (4.77 second) to establish the voice call, whereas Airtel and BSNL call setup time is 4.37 & 2.86 seconds respectively in 3G/2G network mode.(refer table-3)

b) BSNL has taken longer time (3.59 second) to establish the voice call, whereas Airtel, RJIL and VIL call setup time is 1.20, 0.69 & 1.89 seconds respectively in Auto-selection mode (5G/4G/3G/2G).(refer table-5)

3. Call Drop Rate:

a) Overall BSNL call drop rate (4.81%) is higher (QoS benchmark of 2%), while Airtel and VIL have 0.00% & 0.47% drop call rate respectively in 3G/2G network mode. (refer table-3)

b) Overall BSNL call drop rate (5.85%) is higher (QoS benchmark of 2%), while Airtel, RJIL and VIL have 0.00%, 0.12% and 0.12% drop call rate respectively in Auto-selection mode (5G/4G/3G/2G). (refer table-5)

4. Call Silence/Mute Rate: In packet switched network (4G/5G), VIL, Airtel and RJIL have 2.10%, 1.36% & 0.30% silence call rate respectively. Further Airtel has higher RTP packet loss rate in downlink (1.08%) compared to VIL (1.02%) and RJIL (0.09%). In uplink the RTP packet loss rate is higher for VIL (1.15%) compared to Airtel (0.99%) and RJIL (0.22%). (Refer table-6)

5.2 Overall Data

1. Data download and upload performance (Dynamic i.e. while moving) :

a) BSNL (5.01 Mbps) and VIL (41.73 Mbps) being on 3G & 4G as top technology respectively, have comparatively lower download speeds. While RJIL and Airtel have average download speed of 321.41 Mbps and 129.46 Mbps respectively (refer table-11)

b) BSNL (4.06 Mbps) and VIL (15.38 Mbps) being on 3G & 4G as top technology respectively, have comparatively lower upload speeds. While RJIL and Airtel have average upload speed of 40.80 Mbps and 28.44 Mbps respectively.(refer table-11)

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

a) RJIL has higher 5G QoS performance shows an average download speed of 308.93 Mbps overall hotspot locations. (refer table-31)

b) RJIL has higher 5G QoS performance shows an average upload speed of 47.27 Mbps overall hotspot locations. (Refer table-31)

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

a) All operators have 100.00% download session setup success rate and Airtel, RJIL, BSNL and VIL have 100.00%, 98.00%, 100.00% and 100.00% upload session setup success rate respectively. (Refer table-31)

5.3 Operator wise Key Findings

1. Airtel:

Voice

- Call setup success rate 99.85% and call drop rate 0.00% have been observed in the 3G/2G network mode respectively. Performance is well within the benchmark of 98.00% & 2.00% in LSA. (refer table-3)

- 100.00% call setup success rate and 0.00% drop call rate have been observed for the auto-selection mode (5G/4G/3G/2G) for LSA and city drive. (refer table-5 & 15)

- 99.82% call setup success rate and 0.00% call drop rate have been observed in 3G/2G network mode in city drive. (refer table -13)

- 100.00% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) during hotspot locations and highway drive. (refer table -20 & 48)

- 100.00% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) during walk test drive. (refer table -42 & 43)

Data

- Airtel has average download throughput of 129.46 Mbps and average upload throughput of 28.44 Mbps across measured routes for LSA. (refer table-11)

- Airtel has average download throughput of 135.12 Mbps and average upload throughput of 31.25 Mbps across the measured routes during the city drive. (refer table -19)

- Charbagh Railway Station, Hazratganj Market, King George's Medical University, Lucknow Airport and Vidhan Sabha hotspot locations have download speed less than 100 Mbps out of 10 hotspot locations. (refer to table 33, 35, 38, 39 and 41)

- Hazratganj Market, Janeshwar Mishra Park and Vidhan Sabha hotspot locations have upload speed less than 20 Mbps out of 10 hotspot locations. (refer table 35, 37 and 41)

- Hazratganj Market has average download throughput of 227.94 Mbps and average upload throughput of 36.35 Mbps and Lucknow Junction has average download throughput of 233.88 Mbps and average upload throughput of 46.53 Mbps during walk test. (refer table 44 and 45)

- Airtel has average download throughput of 76.56 Mbps and average upload throughput of 13.18 Mbps across the measured routes during the highway drive. (refer table -52)

2. BSNL:

Voice

- 96.94% call setup success rate and 4.81% call drop rate have been observed in 3G/2G network mode for LSA. (refer table -3)

- 92.20% call setup success rate and 5.85% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G). Performance is not meeting benchmark of 98.00% & 2.00% for LSA. (refer table -5)

- 98.78% call setup success rate and 3.34% call drop rate have been observed in 3G/2G network mode for city drive. (refer table -13)

- 92.86% call setup success rate and 3.85% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G) for city drive. (refer table -15)

- 90.00% call setup success rate and 0.00% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G) for overall hotspot locations.(refer table -20)

- 100.00% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) during Hazratganj Market walk test location drive. (refer table -42)

- 90.00% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) during Lucknow Junction walk test location drive. (refer table -43)

- 87.27% call setup success rate and 13.54% call drop rate have been observed in 3G/2G network mode which is not meeting the benchmark of 98.00% & 2.00% for highway drive. (refer table -46)

- 89.47% call setup success rate and 24.51% call drop rate have been observed in auto-selection network mode (5G/4G/3G/2G), which is not meeting the benchmark of 98.00% & 2.00% for highway drive. (refer table -48)

Data

- BSNL has 5.01 Mbps average download throughput & 4.06 Mbps average upload throughput across measured routes for LSA. (refer table -11)

- BSNL has 5.24 Mbps average download throughput & 3.95 Mbps average upload throughput across measured routes for city drive. (refer table -19)

- Charbagh Railway Station, Hazratganj Market, Janeshwar Mishra Park, King George's Medical University, Lucknow Airport and Lulu Mall hotspot locations have download speed less than 10 Mbps. (refer table -33, 35, 37, 38, 39 & 40)

- Charbagh Railway Station and Janeshwar Mishra Park hotspot locations have upload speed less than 2 Mbps. (refer table-33 & 37)
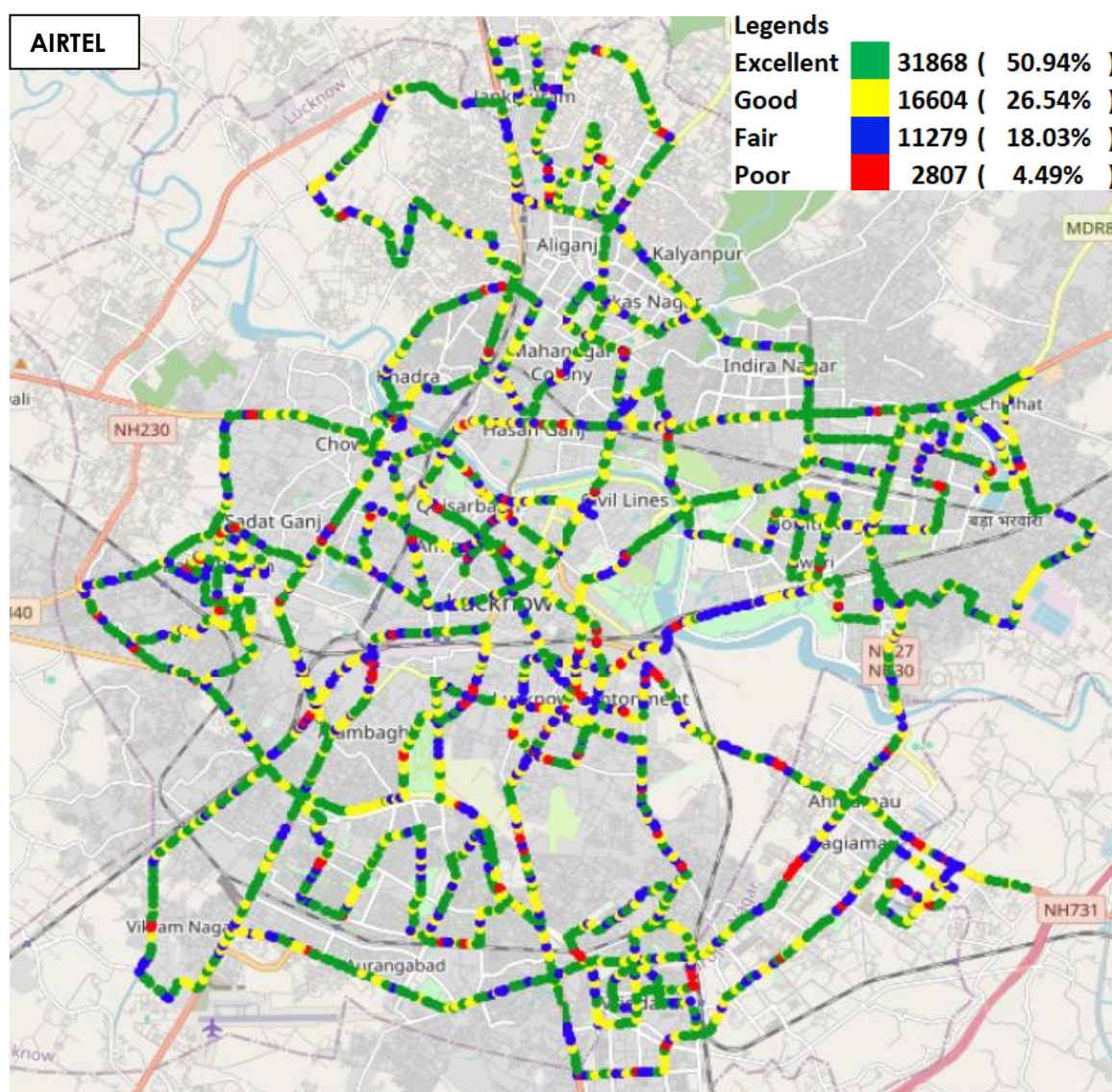
- Hazratganj Market has average download throughput of 7.01 Mbps and average upload throughput of 2.31 Mbps and Lucknow Junction has average download throughput of 2.97 Mbps and average upload throughput of 10.52 Mbps during walk test. (refer table 44 and 45)

- BSNL has 3.46 Mbps average download throughput & 2.70 Mbps average upload throughput across measured routes for highway drive. (refer table -52)

3. RJIL:

Voice

- 100.00% call setup success rate and 0.12% drop call rate have been observed for the auto-selection mode for LSA. (refer table-5)

- 100.00% call setup success rate and 0.17% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G) for city drive. (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) for overall hotspot locations and highway drive. (refer table -20 & 48)

- 100.00% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) during walk test drive. (refer table -42 & 43)

Data

- RJIL has 321.41 Mbps average download speed & 40.80 Mbps average upload speed across measured routes for LSA. (refer table -11)

- RJIL has 337.28 Mbps average download speed & 43.49 Mbps average upload speed across measured routes for city drive. (refer table -19)
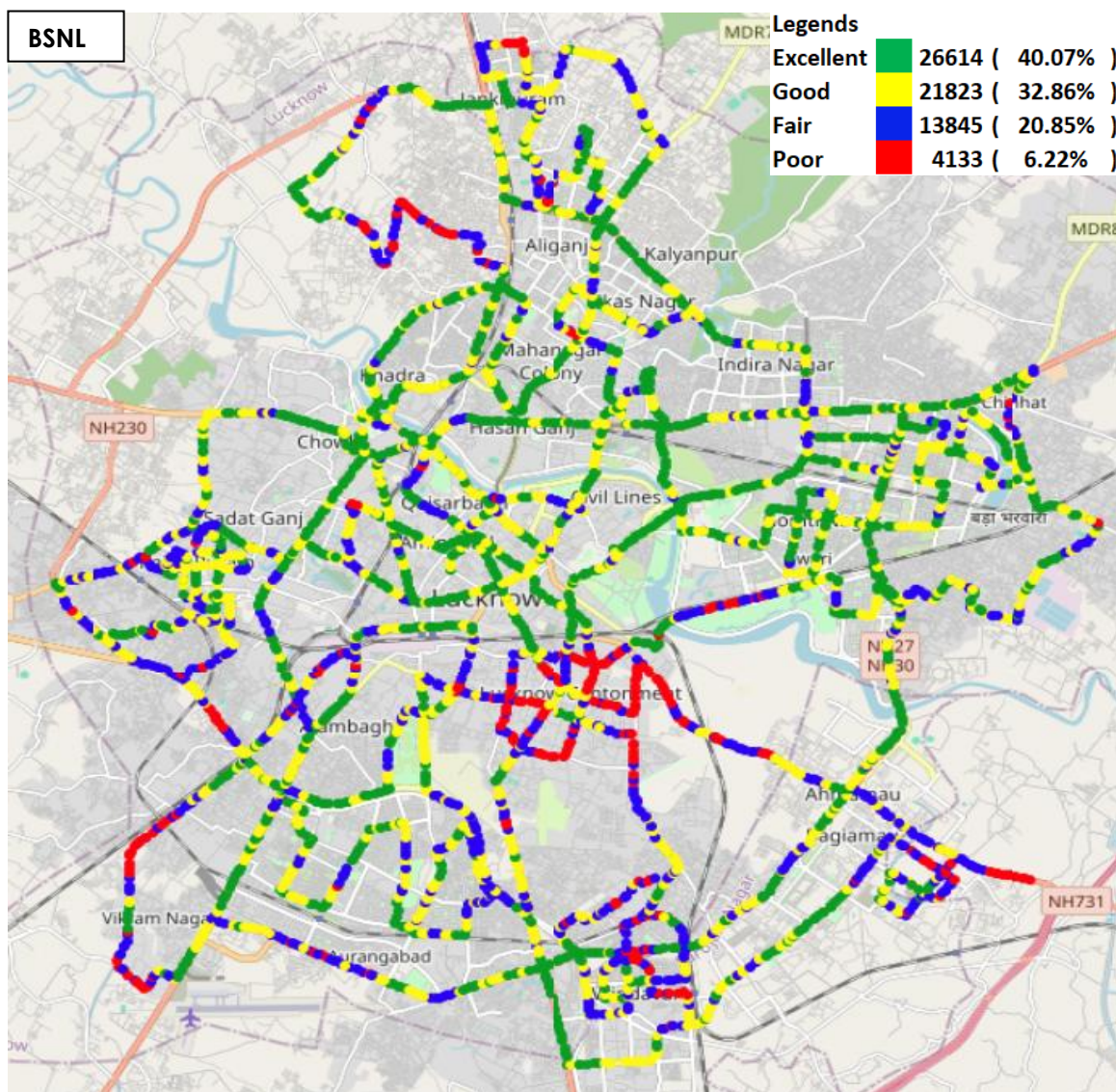
- Janeshwar Mishra Park, Lucknow Airport and Lulu Mall hotspot locations have less download speed (less than 100 Mbps). (refer table – 37, 39 & 40)

- Hazratganj Market and Janeshwar Mishra Park hotspot locations have less upload speed (less than 20 Mbps). (refer table- 35 & 37)

- Hazratganj Market has average download throughput of 319.91 Mbps and average upload throughput of 47.00 Mbps and Lucknow Junction has average download throughput of 360.76 Mbps and average upload throughput of 59.27 Mbps during walk test. (refer table 44 and 45)

- RJIL has 264.99 Mbps average download speed & 26.77 Mbps average upload speed across measured routes for highway drive. (refer table -52)

4. VIL:

Voice
- 98.47% call setup success rate and 0.47% call drop rate have been observed in 3G/2G network mode for LSA. (refer table -3)

- 99.27% call setup success rate and 0.12% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for LSA. (refer table -5)

- 98.57% call setup success rate and 0.36% call drop rate have been observed in 3G/2G network mode for city drive. (refer table -13)

- 98.99% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for city drive. (refer table -15)

- 100.00% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for overall hotspot locations. (refer table -20)

- 97.83% call setup success rate and 1.11% drop call rate have been observed for 3G/2G network mode across highway route. (refer table -46)

- 100.00% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) during walk test drive. (refer table -42 & 43)

- 100.00% call setup success rate and 1.05% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for highway drive. (refer table -48)

Data
- VIL has 41.73 Mbps average download speed & 15.38 Mbps average upload speed across measured routes for LSA. (refer table -11)

- VIL has 49.84 Mbps average download speed & 17.08 Mbps average upload speed across measured routes for city drive. (refer table -19)

- King George's Medical University hotspot location has less than 10 Mbps download speed. (refer table - 38)

- Hazratganj Market has average download throughput of 44.25 Mbps and average upload throughput of 21.42 Mbps and Lucknow Junction has average download throughput of 35.24 Mbps and average upload throughput of 20.43 Mbps during walk test. (refer table 44 and 45)

- VIL has 9.84 Mbps average download speed & 6.36 Mbps average upload speed across measured routes for highway drive. (refer table -52)

6. Annexure

6.1 Route wise coverage map

6.1.1 City

Figure-42: Signal strength 3G/2G network mode – AIRTEL.

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Figure-43: Signal strength 3G/2G network mode – BSNL.
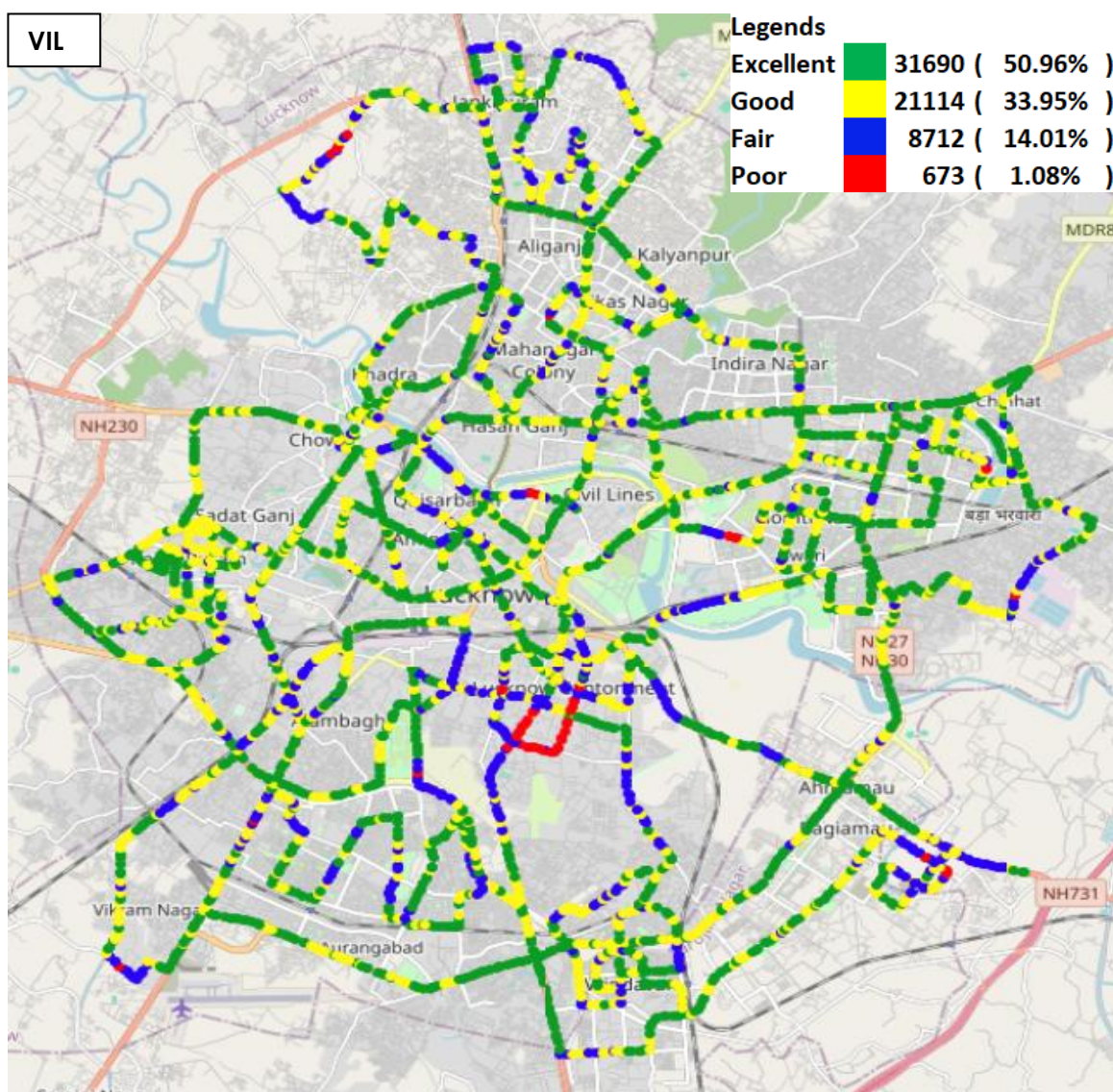
Figure-44: Signal strength 3G/2G network mode – VIL.
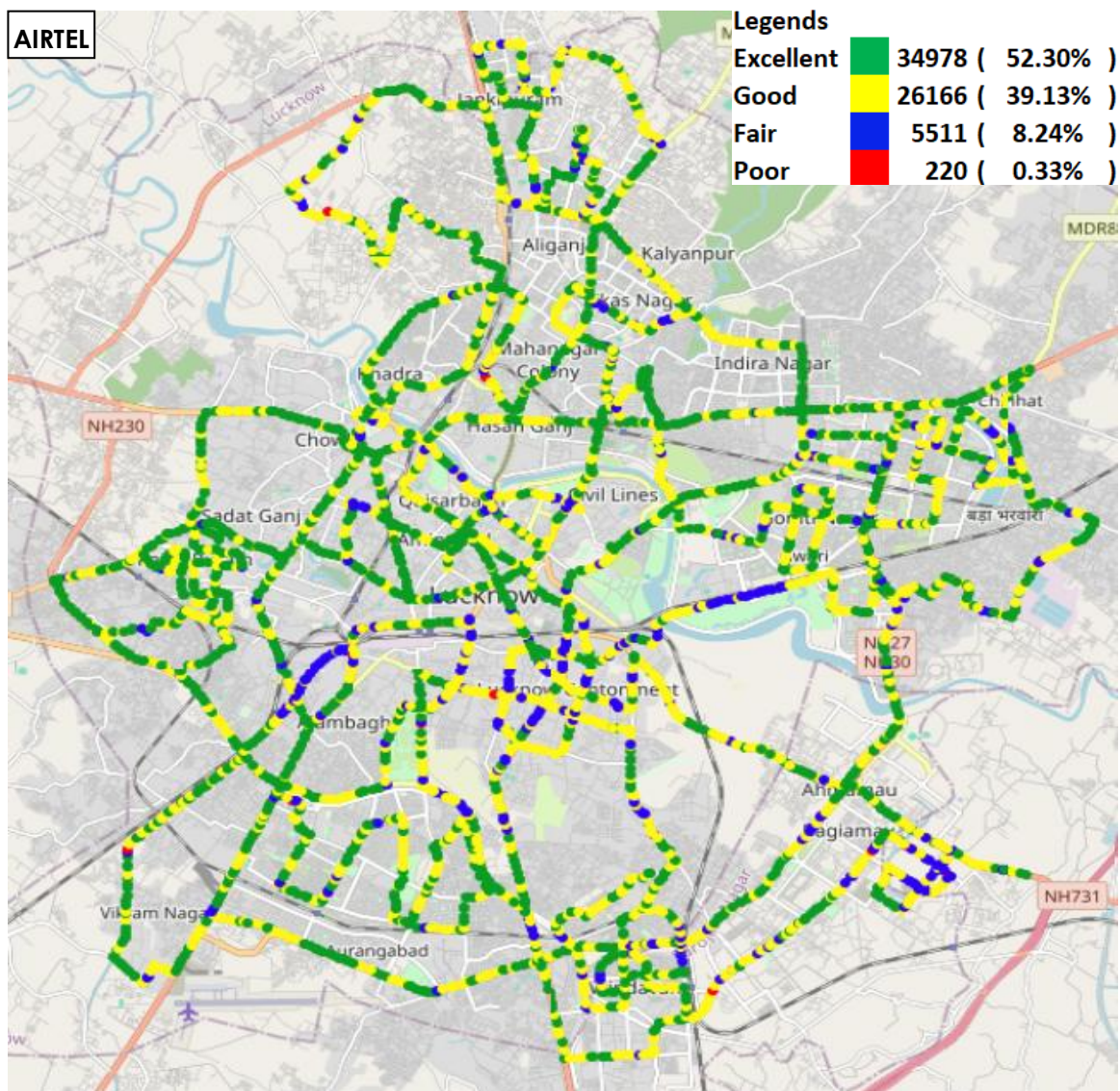
Figure-45: Signal strength auto-selection mode 5G/4G/3G/2G – AIRTEL.

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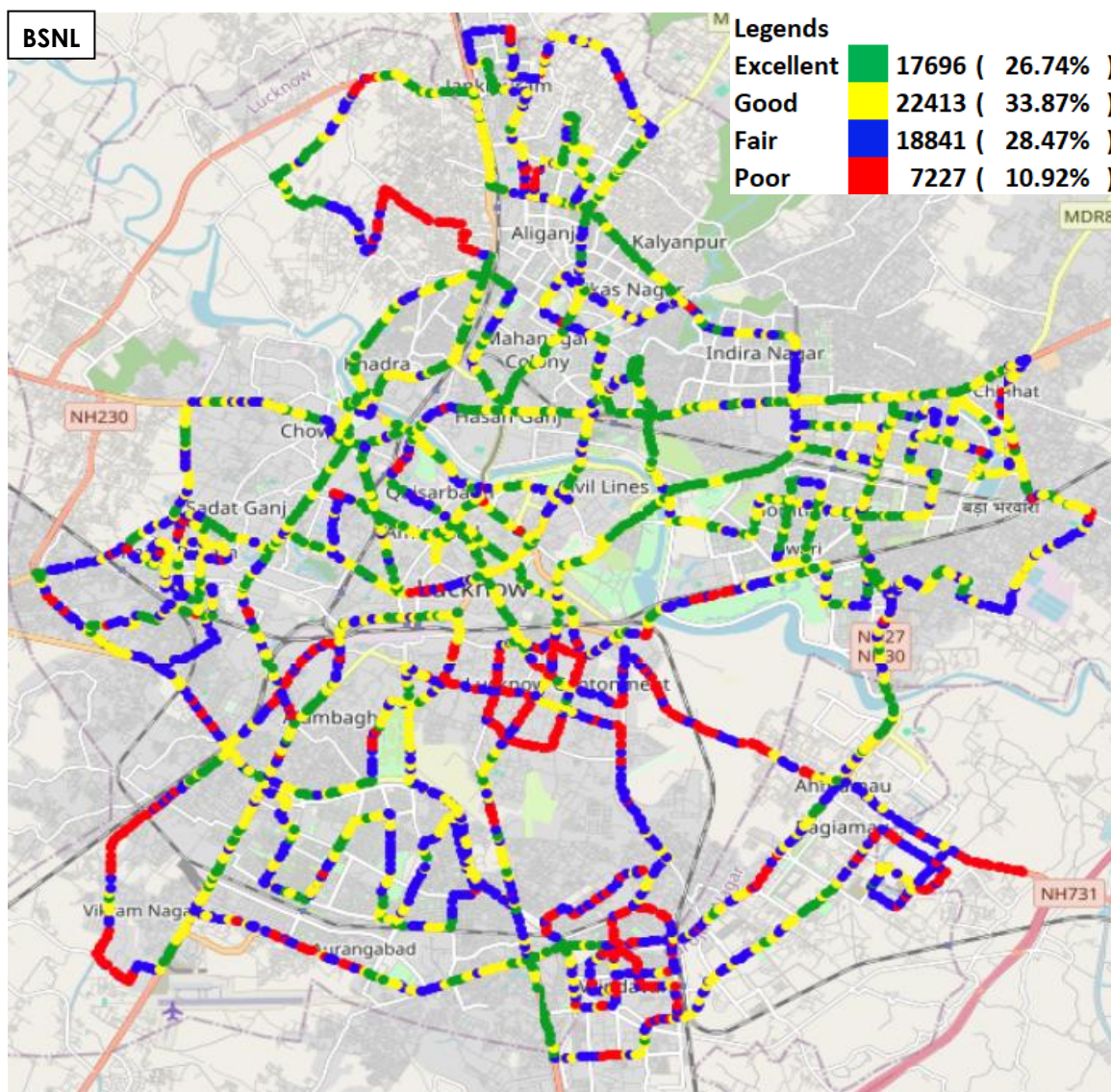
Figure-46: Signal strength auto-selection mode 5G/4G/3G/2G – BSNL.
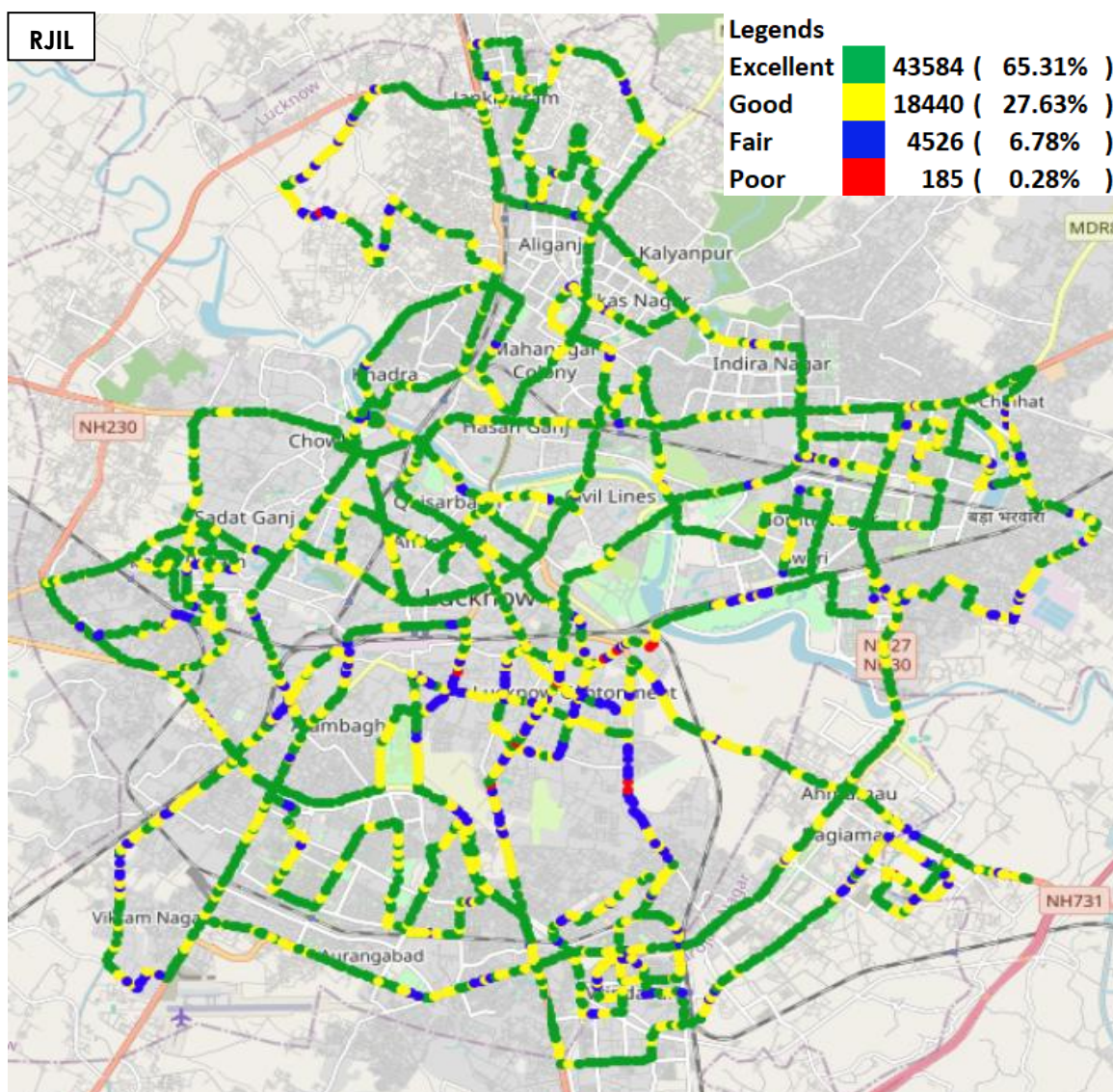
Figure-47: Signal strength auto-selection mode 5G/4G/3G/2G – RJIL.

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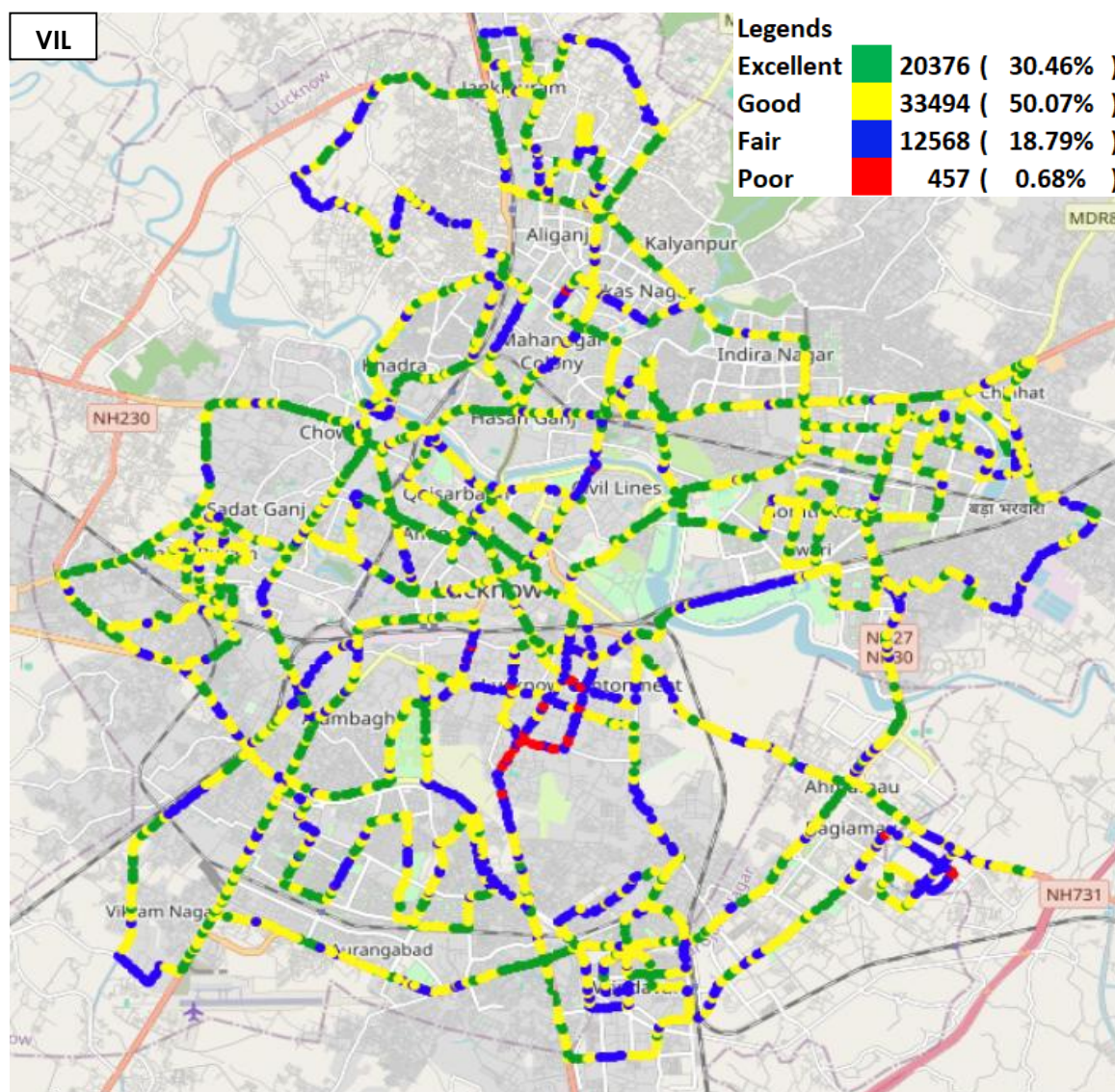
Figure-48: Signal strength auto-selection mode 5G/4G/3G/2G – VIL.

6.1.2 Highway Route

i) Fatehpur to Varanasi
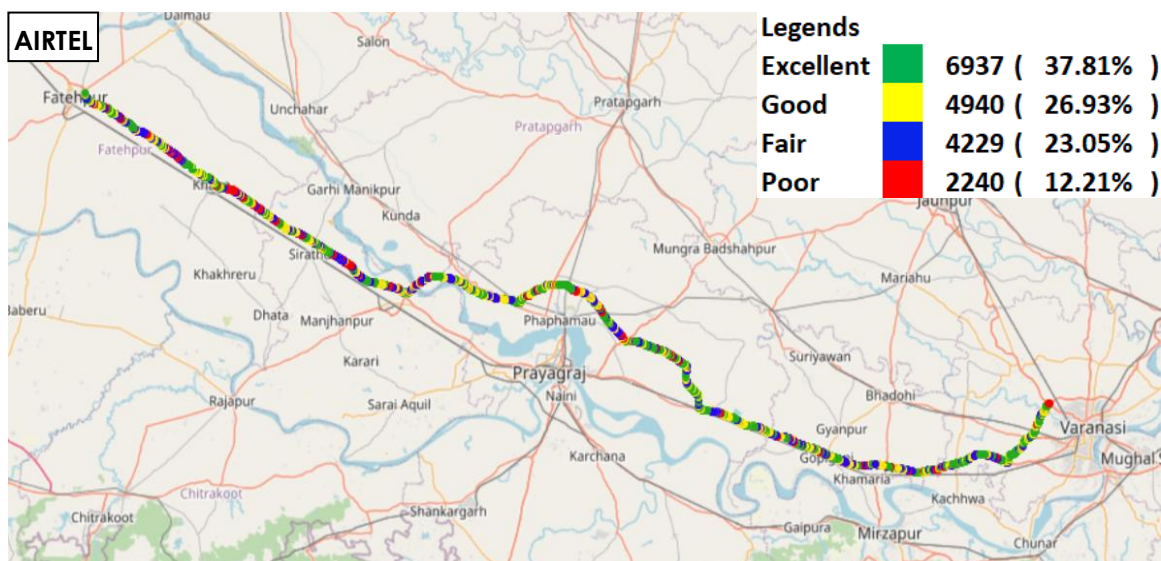
Figure-49: Signal strength 3G/2G network mode – AIRTEL.
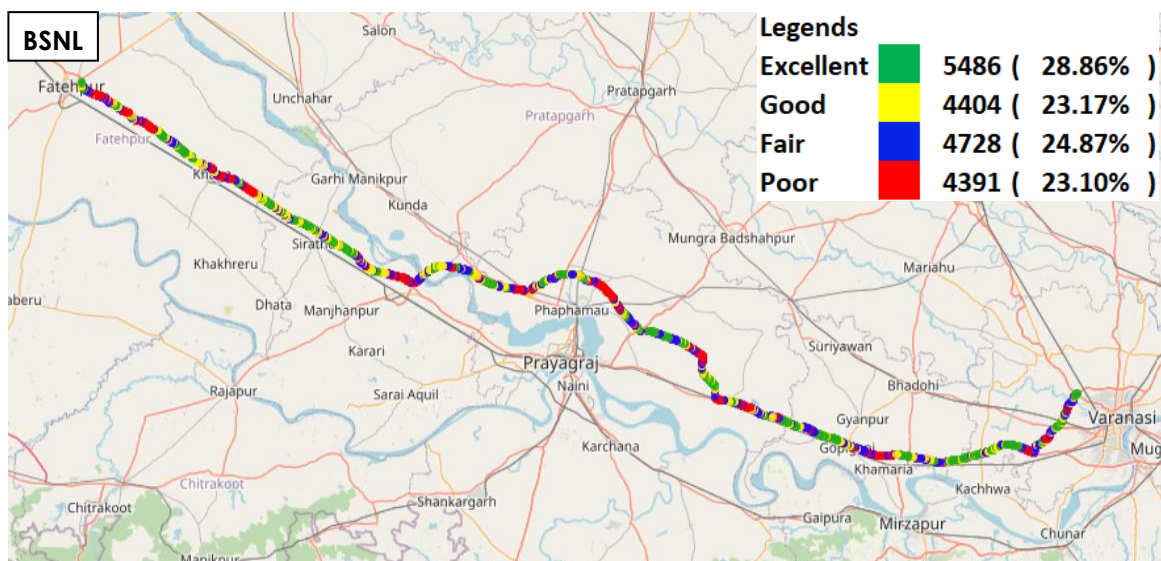
Figure-50: Signal strength 3G/2G network mode – BSNL.
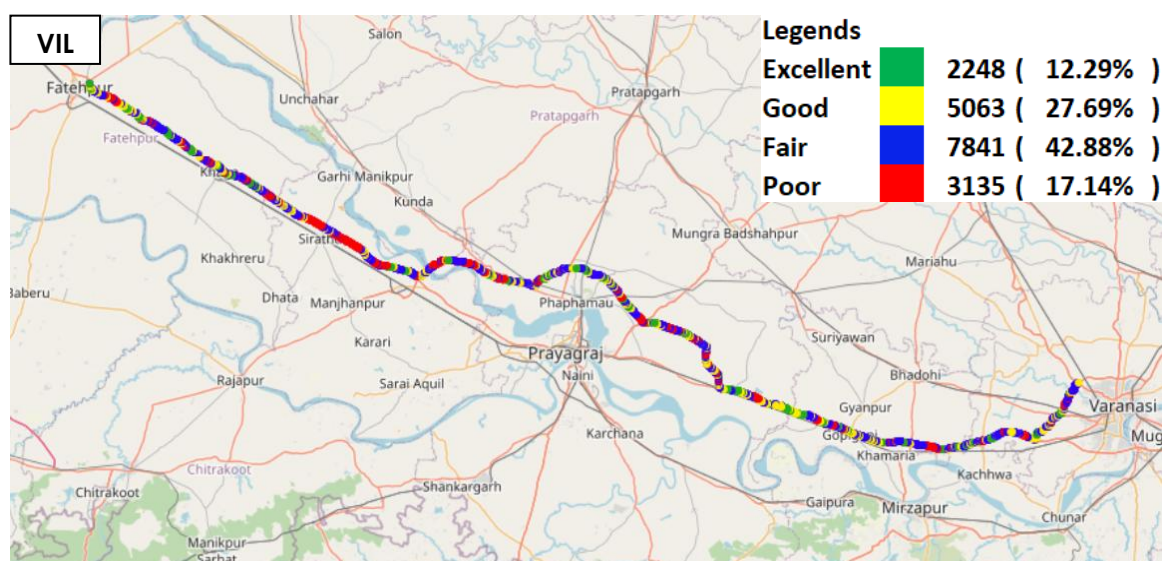
Figure-51: Signal strength 3G/2G network mode – VIL.
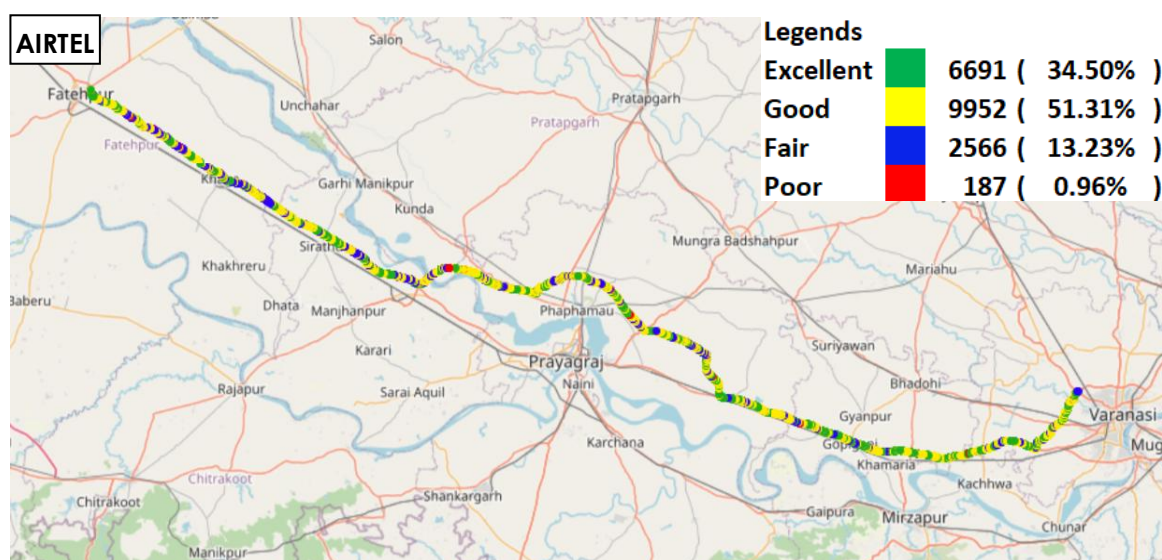
Figure-52: Signal strength auto-selection mode 5G/4G/3G/2G – AIRTEL.

Figure-53: Signal strength auto-selection mode 5G/4G/3G/2G – BSNL.
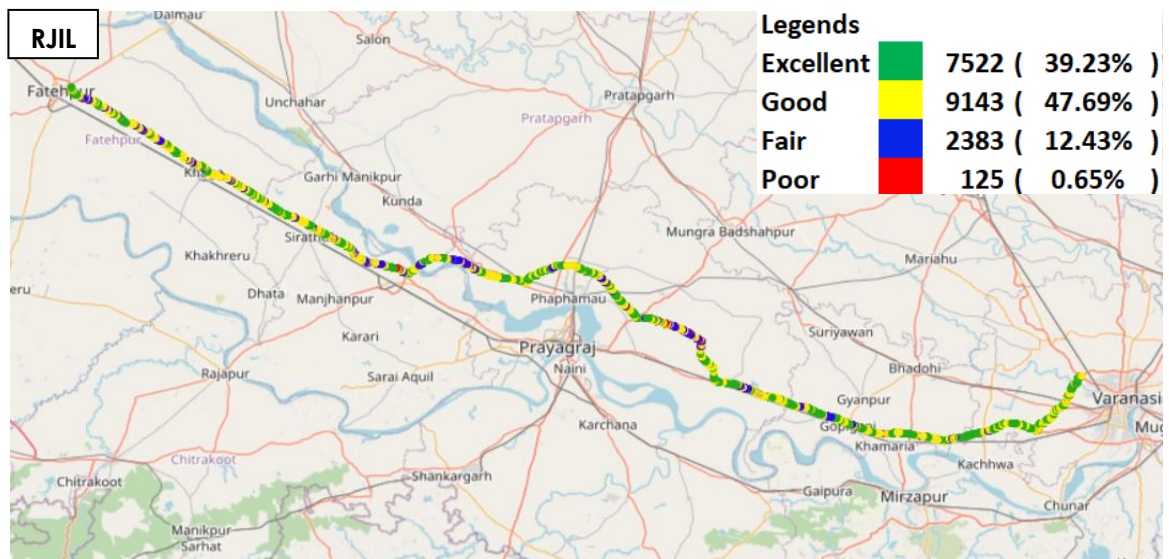
Figure-54: Signal strength auto-selection mode 5G/4G/3G/2G – RJIL.
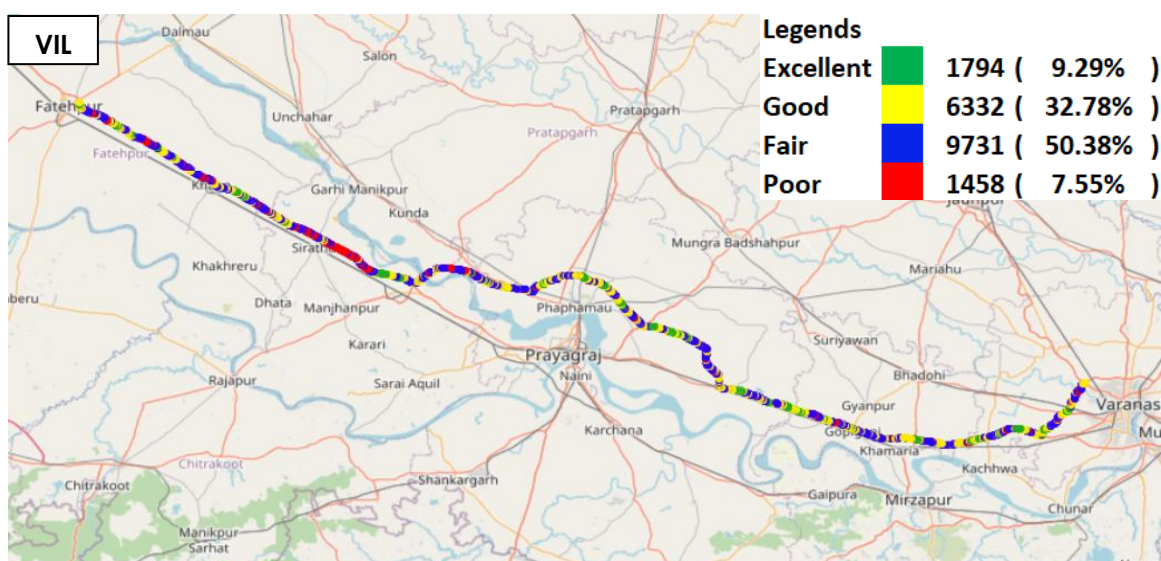
Figure-55: Signal strength auto-selection mode 5G/4G/3G/2G – VIL.

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/180 Sec
Wait/ Guard Time		15 Sec

Table-53: 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.
> - 5G/4G/3G/2G auto mode MOS call were made in BSNL as BSNL don't have VoLTE & 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 popular websites (www.amazon.in, www.facebook.com, www.google.co.in) 20 sec timeout (only at Hotspot)
Latency		25 count- Dynamic 1000 count- Hotspot Payload- 42 bytes in all drive

Table-54: 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.
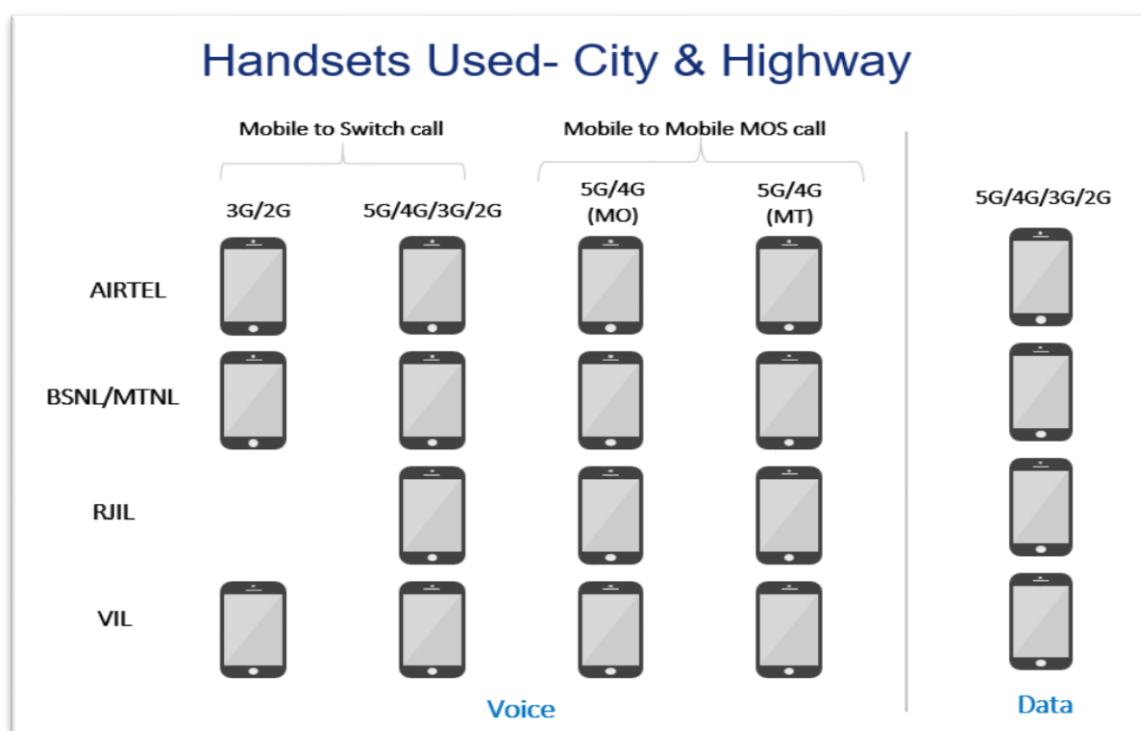
Figure-56: Number of handsets used in city & highway drive
MO: Mobile originating
MT: Mobile terminating
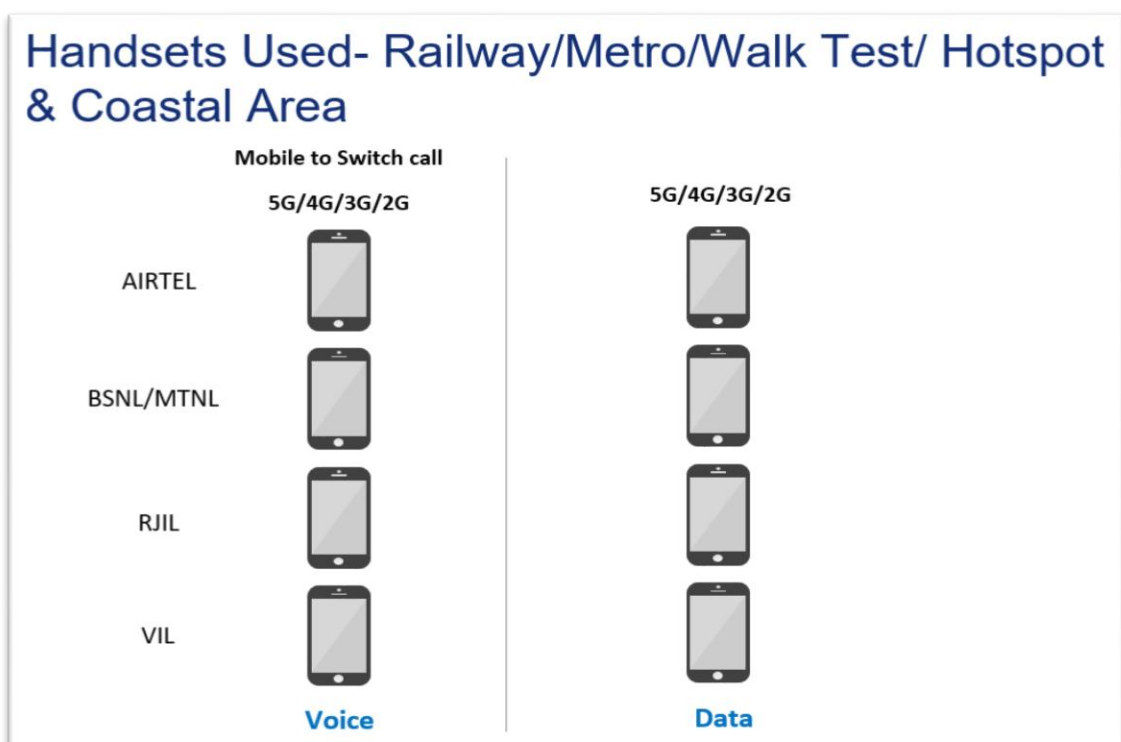
Figure-57: Number of handsets used in railway/metro/walktest/hotspot & coastal area

7.1.2 Drive test Methodology

(a) Dynamic voice testing (on the move)
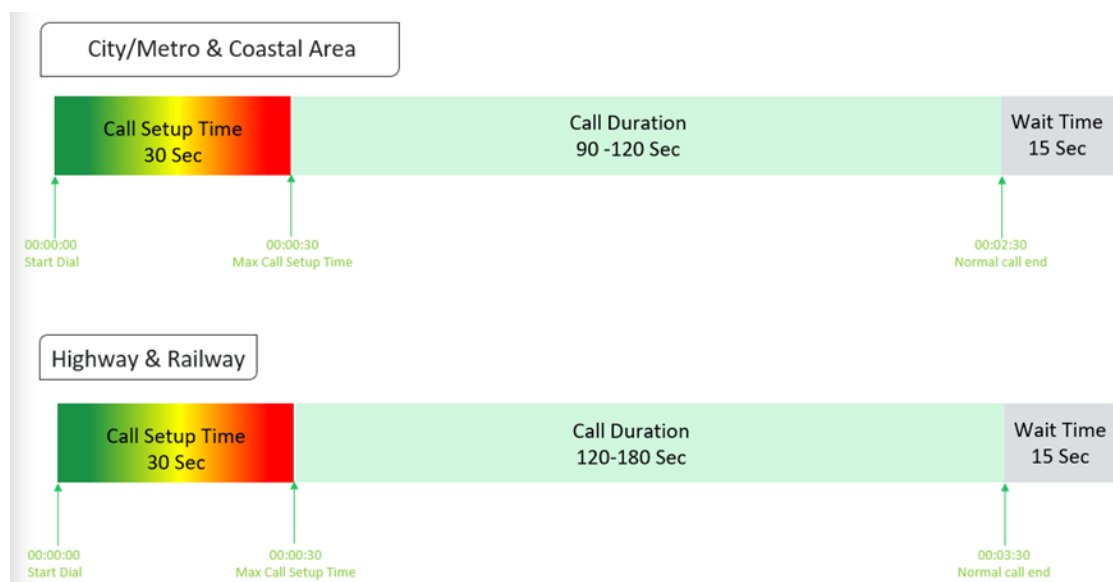
Figure-58: Voice test script for city/railway/metro/highway & coastal area

- 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.

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(b) Hotspot voice testing

Figure-59: Voice test script for walktest/hotspot

- 10 calls 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
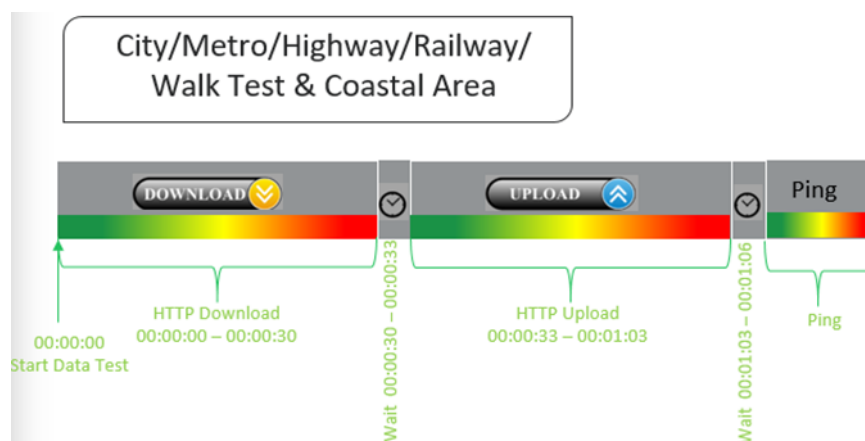
Figure-60: Data test script used in city/metro/railway/highway/walk test & coastal area

(d) Static Data(internet) testing
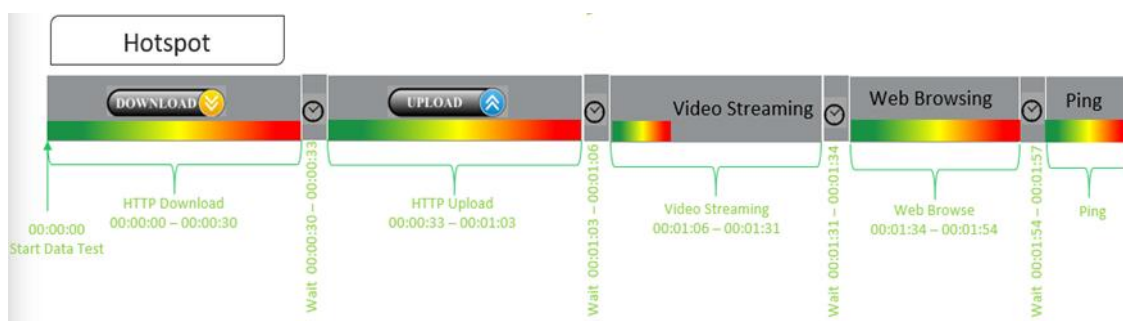
Figure-61: Data test script used at hotspot

- 5 Data iteration done at each hotspot location.
- Min. 5 iteration made during the walk test.

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- Web browsing duration mentioned above is for one web site only.
- Only 1 ping iteration (with 1000 Count) done at hotspot location.

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%**
Call Drop 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 Call Drop 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 $\geq$ 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.

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Jitter	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**
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-55: 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.

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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

Table-56: Network performance parameter and definition Data