भादूविप्रा
TRAI

TELECOM REGULATORY AUTHORITY OF INDIA

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Independent Drive Test Report

Gujarat, Rajasthan & Haryana 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 performed on Inter-state National Highways, part of Golden Quadrilateral highways undertaken in Gujarat, Rajasthan & Haryana License Service Area (LSA) during the month December-2024 under the supervision of TRAI Regional Office (RO), Jaipur. Details of route covered during the IDT is as given below:

Sl. No	Drive test route	Type of route	Distance covered (KMs)	From date	To date
1	Vapi to Rewari	Highway	1242.64	17-Dec-2024	19-Dec-2024

Table-1: Drive test summary

2.2 Drive test routes

The map provides overview of drive test routes indicating Highway drive as per the legends shown on the map.

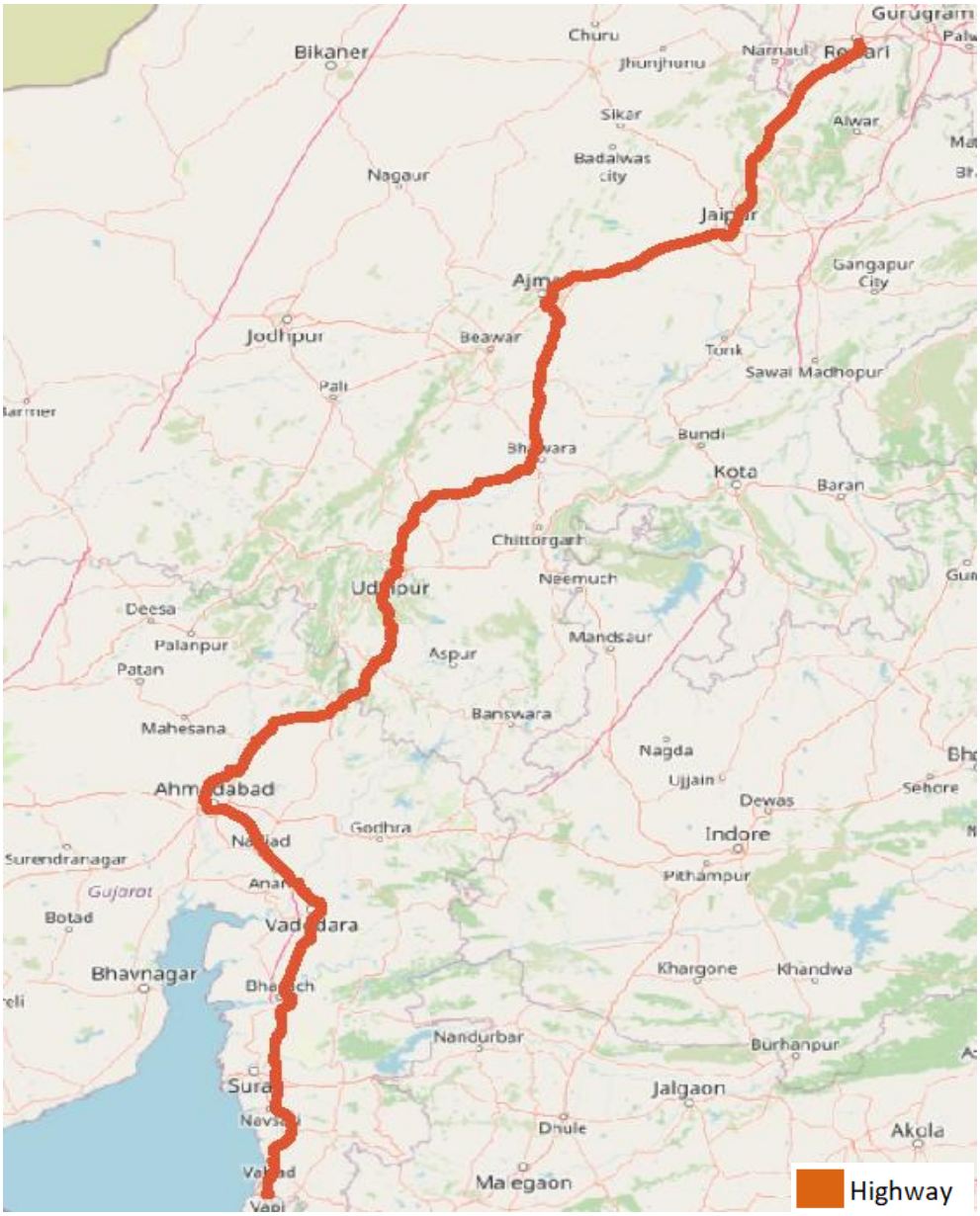

Figure-1: Drive test routes

2.3 Summary of areas covered

a) Highway- Vapi to Rewari inter-state highway via NH48 trunk road, Surat, Vadodara bypass, Ahmedabad –Vadodara expressway, Himatnagar, NH147, NH 58, NH758, NH448, Ajmer bypass, Jaipur and NH248 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	900,1800
2	Bharti Airtel Ltd.	4G	900,1800,2100,2300
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	900,1800
10	Vodafone Idea Ltd.	4G	900,1800,2100,2500

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

QoS Performance Analysis- Gujarat, Rajasthan & Haryana 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 December-2024 covering 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	501	623	645
Call Setup Success Rate %	98.20	81.86	78.45
Drop Call Rate %	1.42	10.78	4.15
Call Setup Time-Average (Second)	4.23	3.72	4.62
Handover Success Rate %	98.62	97.68	98.11

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

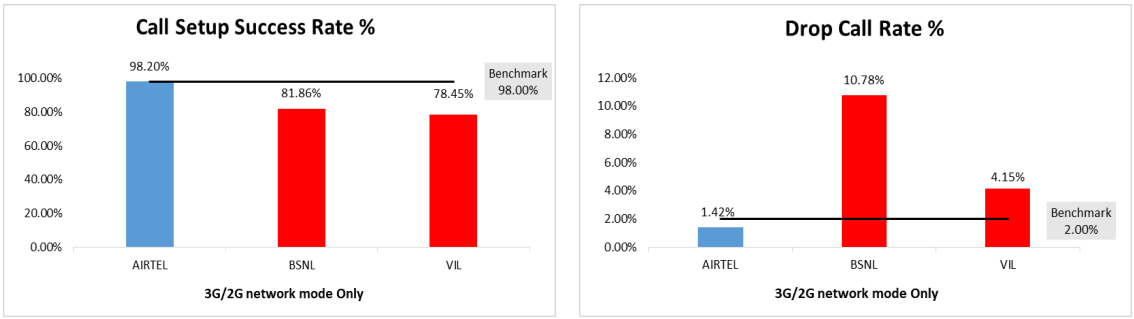

Figure-2: Call setup success rate and drop call rate performance.

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	215	NA
2G	1394	580	1077

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	516	651	523	534
Call Setup Success Rate %	99.42	76.96	99.43	94.01
Drop Call Rate %	0.78	14.17	0.77	2.99
Call Setup Time-Average (Second)	1.66	2.70	1.75	1.40
Handover Success Rate %	99.87	97.61	99.93	99.91

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

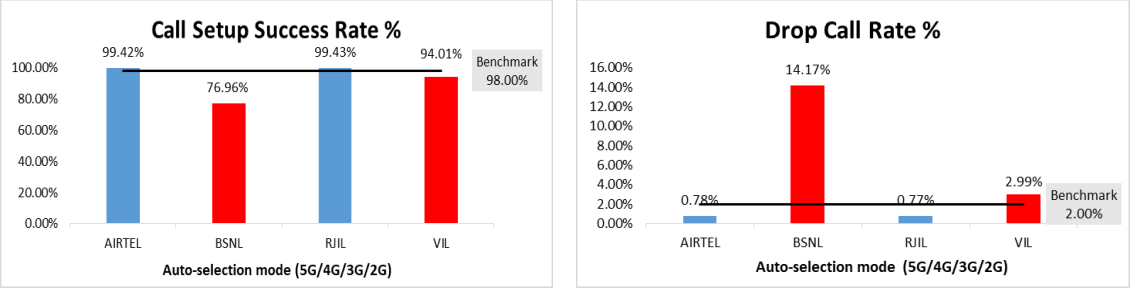

Figure-3: Performance for call setup success rate and drop call rate.

Parameter	Service Provider			
	Mobile-to-Mobile (5G/4G - Open Mode)			
	AIRTEL	BSNL	RJIL	VIL
Call Established (within service provider Network)	499	574	503	508
Number of silence call for >4 Sec	12	32	7	13
Silence Call Rate %	2.40	5.57	1.39	2.56
Number of silence instances for >4 Sec	16	61	8	15
Number of silence instances for >3 Sec	21	74	18	31
Number of silence instances for >2 sec	64	108	63	101
RTP Jitter (4G & 5G) in ms	6.98	15.74	7.68	30.27
Packet loss Rate Downlink %	0.62	6.67	0.55	1.12
Packet loss Rate Uplink %	0.76	7.04	0.74	1.05

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

Note-

- BSNL has latched 34.17% on LTE technology. Count of silence calls, jitter and packets lost have been considered for that duration only (VoLTE calls).

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	709	NA
4G	2715	469	2732	2059
3G	NA	141	NA	NA
2G	0	386	NA	66

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

Note-

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

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

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

Speech Quality (MOS) distribution	Service Provider			
	AIRTEL	BSNL	RJIL	VIL
Total Number of MOS Samples for calls in table-6	6335	4821	6209	6057
Speech Quality (Average MOS Score)	3.94	2.81	3.92	4.38
Number of samples with MOS >=4 to <5(Excellent)	4863	807	4648	5085
Number of samples with MOS >=3 to <4 (Good)	1205	713	1203	478
Number of samples with MOS >=2 to <3 (Fair)	144	2529	225	305
Number of samples with MOS >=1 to <2 (Poor)	123	772	133	189
%age of samples with MOS >=4 to <5 (Excellent)	76.76%	16.74%	74.86%	83.95%
%age of samples with MOS >=3 to <4 (Good)	19.02%	14.79%	19.38%	7.89%
%age of samples with MOS >=2 to <3 (Fair)	2.27%	52.46%	3.62%	5.04%
%age of samples with MOS >=1 to <2 (Poor)	1.94%	16.01%	2.14%	3.12%

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

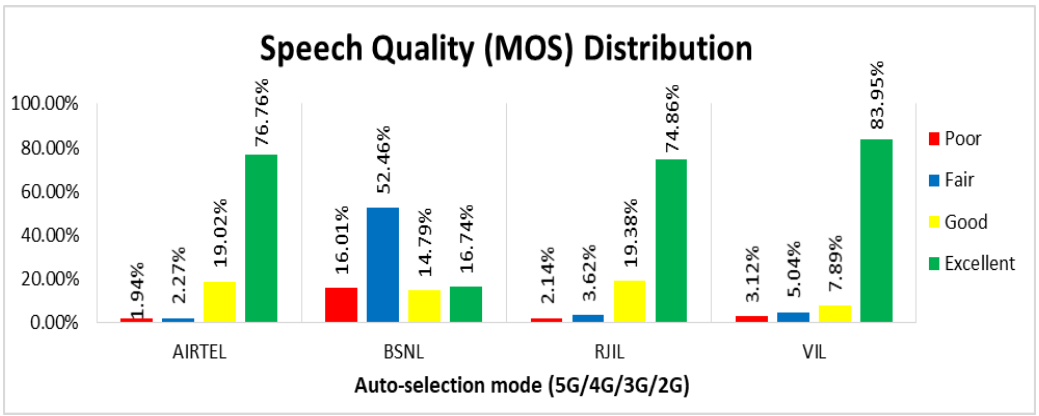

Figure- 4: Distribution of samples in MOS score range.

3.3 Data performance

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

Parameters		Service Provider			
		Auto-selection mode (5G/4G/3G/2G)			
		AIRTEL	BSNL	RJIL	VIL
Download Throughput (Mbits/s)	Average	147.27	6.22	306.50	34.61
	80th Percentile	256.04	9.78	512.12	55.73
	20th Percentile	25.83	0.46	101.51	13.35
Upload Throughput (Mbits/s)	Average	23.70	3.25	31.08	13.32
	80th Percentile	40.73	4.28	54.84	23.38
	20th Percentile	4.32	0.81	6.60	3.32
Latency (ms)	50th Percentile	34.45	54.00	22.50	26.45

Table-9: Summary of data performance in network auto-selection mode.

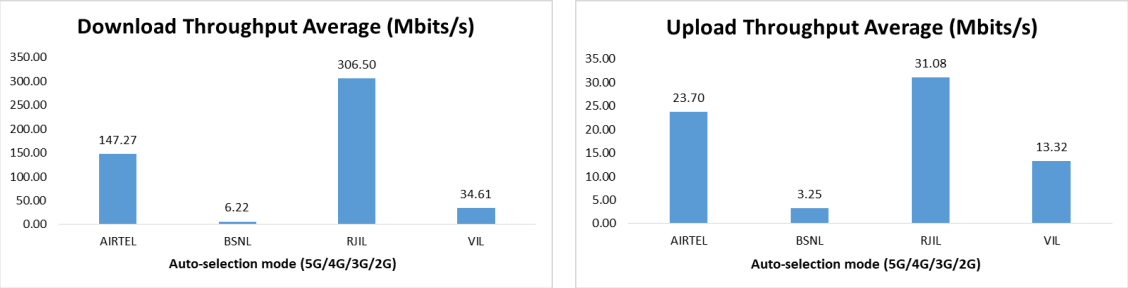

Figure- 5: Download and upload throughput.

Number of unique cell id's covered in Data test- Technology wise				
Technology	Service Provider			
	Auto-selection mode 5G/4G/3G/2G			
	AIRTEL	BSNL	RJIL	VIL
5G	0	NA	1700	NA
4G	2675	485	465	2108
3G	NA	247	NA	NA
2G	5	187	NA	91

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

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

Detailed QoS Performance Analysis

4. Detailed QoS performance analysis

4.1 Overview

This section covers analysis on performance of various categories of drives like Highway for all Telecom service providers, the results of drive tests conducted is shown individually for respective areas.

4.2 Highway

Drive test has been conducted from 17th December 2024 to 19th December 2024 covering Highway routes. (Refer Table-1)

4.2.1 Drive test routes

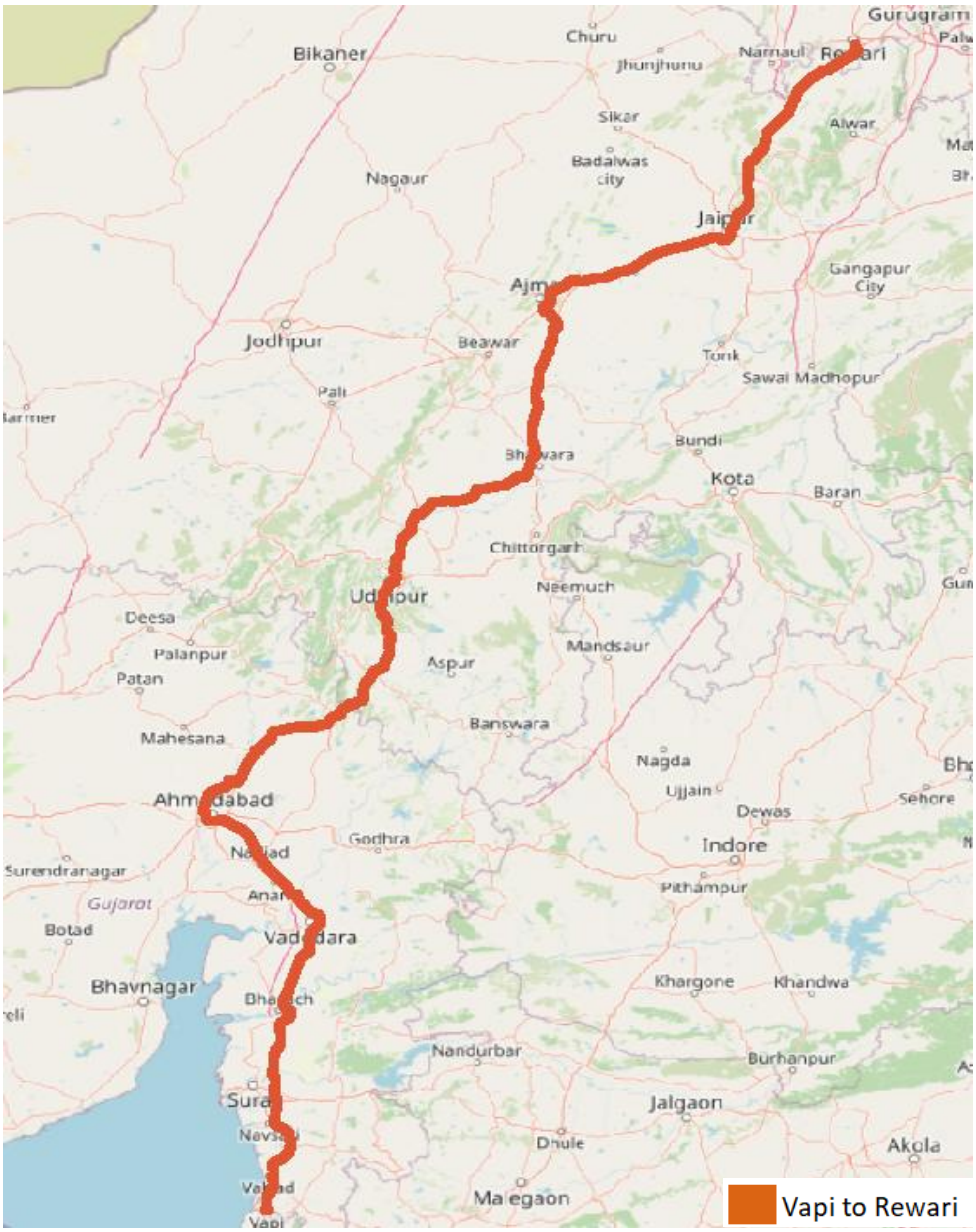

Figure-6: Drive test route highway.

4.2.2 Routes Covered

Vapi to Rewari (Inter-state National Highways, part of Golden Quadrilateral highways) via NH48 trunk road, Surat, Vadodara bypass, Ahmedabad – Vadodara expressway, Himatnagar, NH147, NH 58, NH758, NH448, Ajmer bypass, Jaipur and NH248 etc. Drive test for this route has been conducted from 17th December 2024 to 19th December 2024.

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 the 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	501	623	645
Call Setup Success Rate %	98.20	81.86	78.45
Drop Call Rate %	1.42	10.78	4.15
Call Setup Time-Average (Second)	4.23	3.72	4.62
Handover Success Rate %	98.62	97.68	98.11

Table-11: Summary of voice call performance in 3G/2G network mode only.

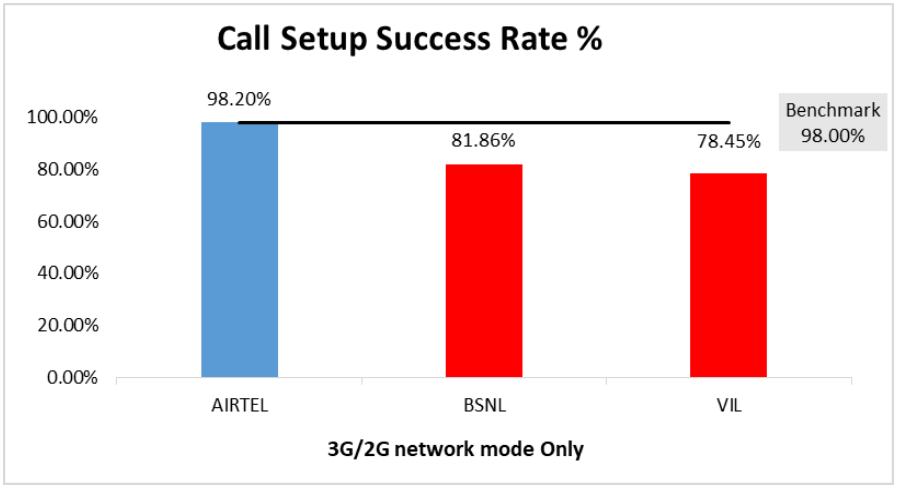

Figure-7: Performance for call setup success rate.

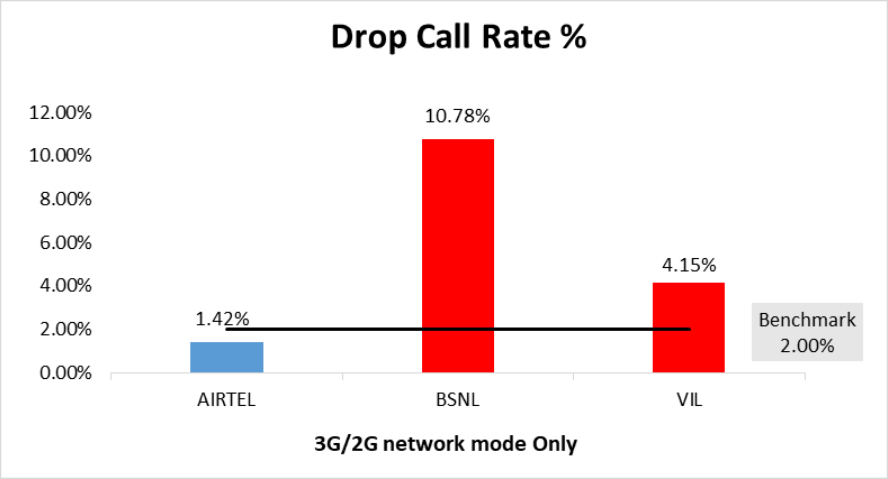

Figure-8: Performance for drop call rate.

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

Technology	Service Provider		
	AIRTEL	**BSNL**	**VIL**
3G	NA	21.00%	NA
2G	99.96%	76.85%	99.47%
Limited Service	0.04%	2.15%	0.53%

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

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

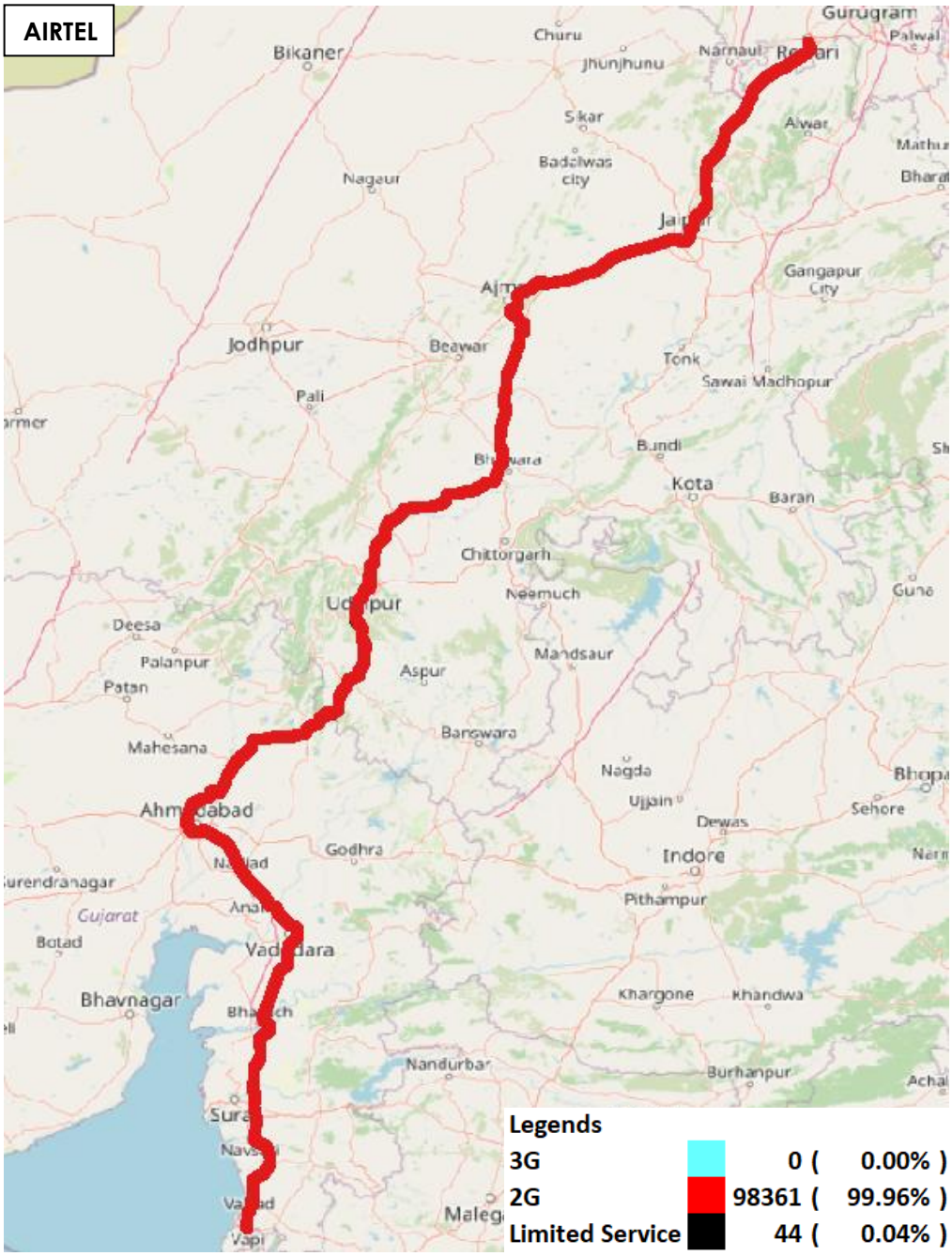

Figure-9: Serving technology plots 3G/2G network mode – AIRTEL.

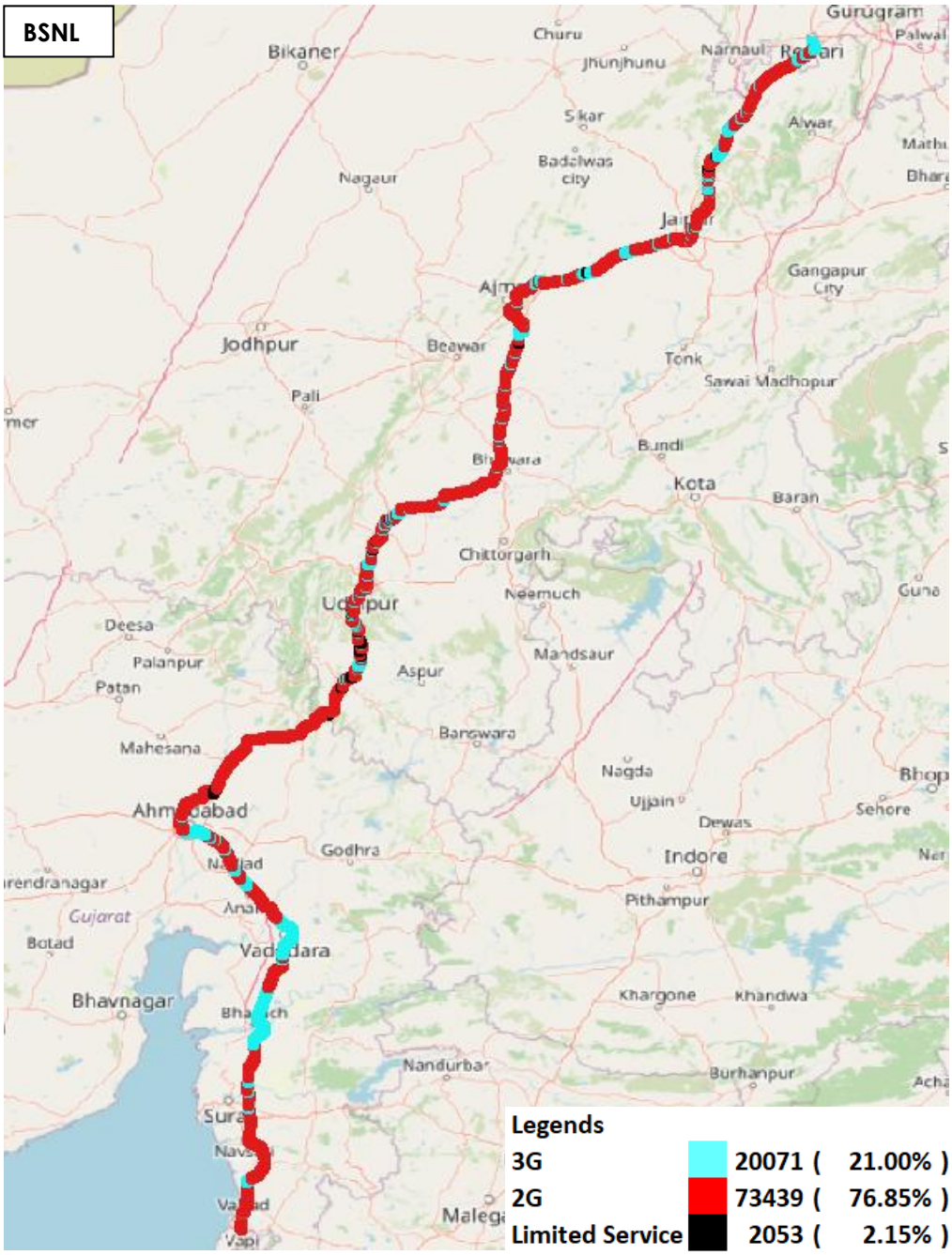

Figure-10: Serving technology plots 3G/2G network mode – BSNL.

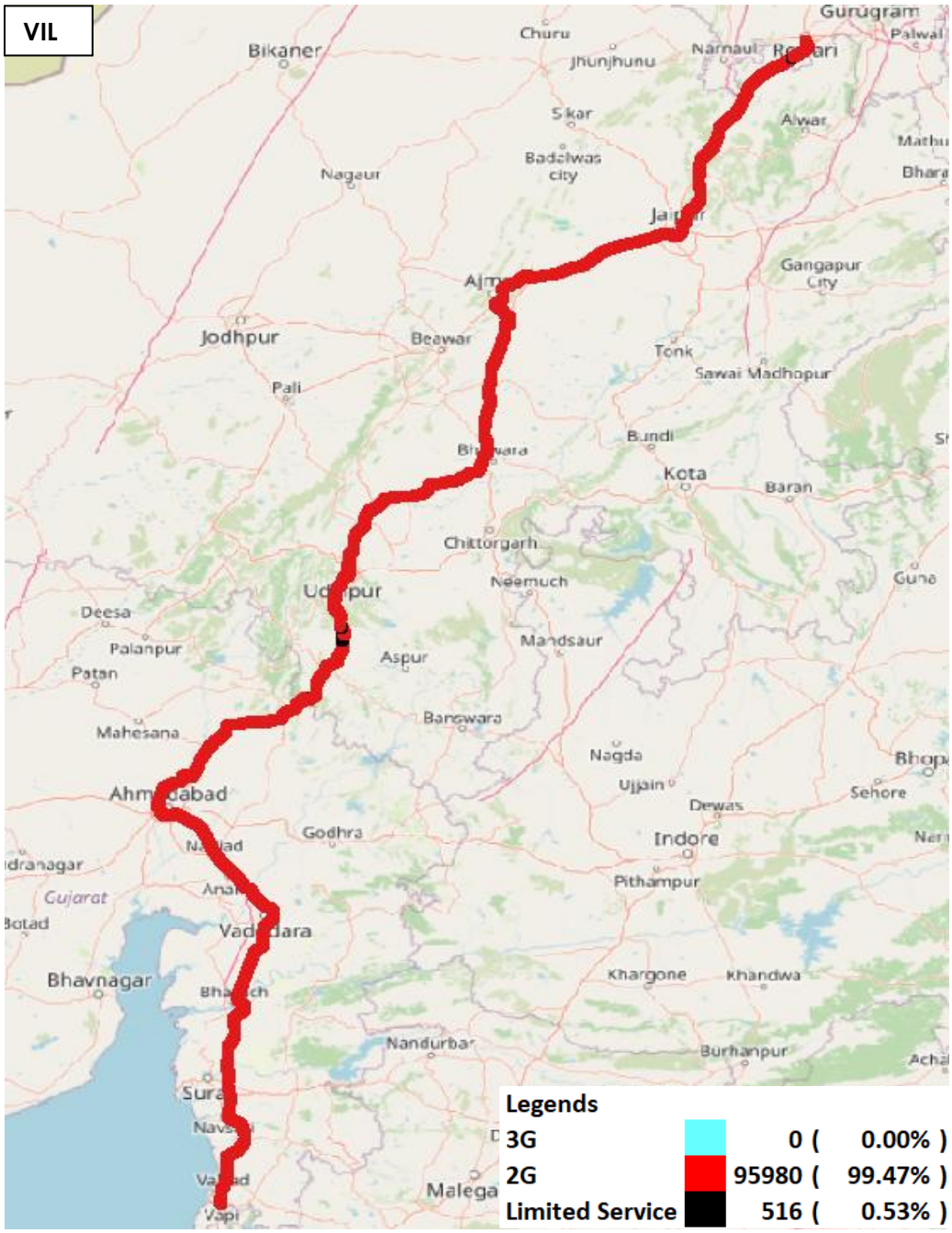

Figure-11: Serving technology plots 3G/2G network mode –VIL.

(c) Network Signal Strength distribution: The following chart represents signal strength distribution for 3G/2G network mode only. (Refer figure-23, 24 & 25 for map view)

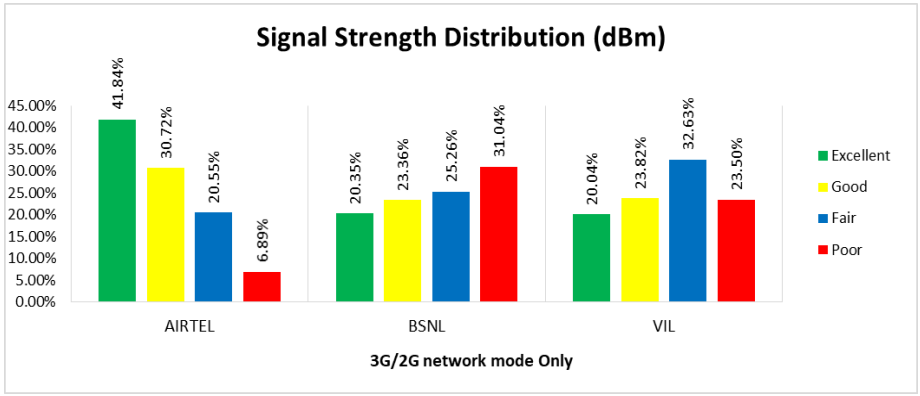

Figure-12: Signal strength distribution 3G/2G network mode only.

Observations:

- Airtel has 42% of samples falling in the excellent signal strength category.
- BSNL has 20% of samples falling in the excellent signal strength category.
- VIL has 20% 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	516	651	523	534
Call Setup Success Rate %	99.42	76.96	99.43	94.01
Drop Call Rate %	0.78	14.17	0.77	2.99
Call Setup Time Average (Second)	1.66	2.70	1.75	1.40
Handover Success Rate %	99.87	97.61	99.93	99.91

Table-13: Summary of voice call performance in network auto-selection mode (5G/4G/3G/2G).

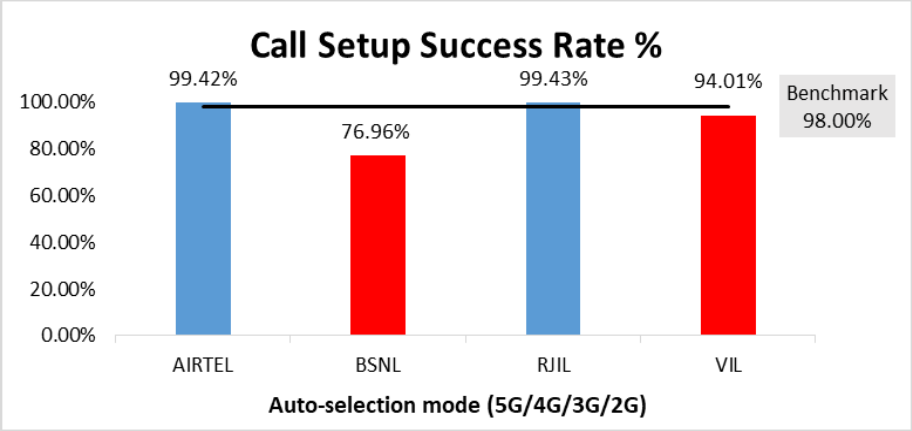

Figure-13: Performance for call setup success rate.

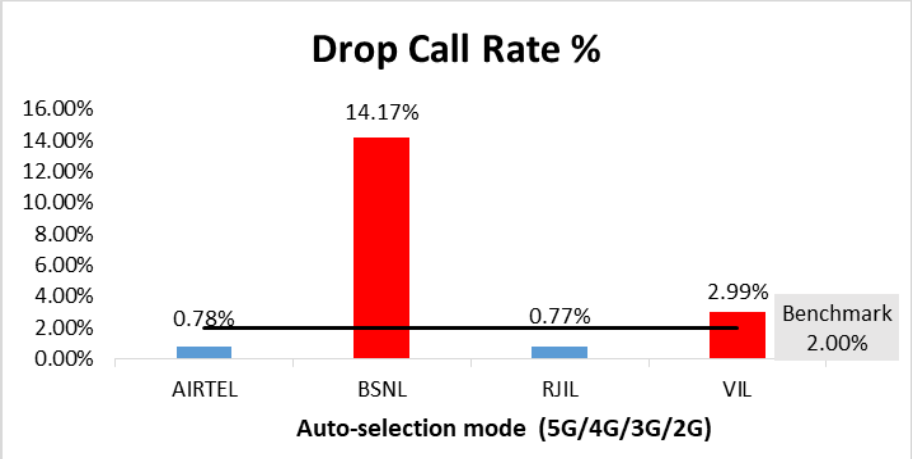

Figure-14: Performance for drop call rate.

Parameter	Service Provider			
	Mobile-to-Mobile (5G/4G - Open Mode)			
	AIRTEL	BSNL	RJIL	VIL
Call Established (within service provider Network)	499	574	503	508
Number of silence call for >4 Sec	12	32	7	13
Silence Call Rate %	2.40	5.57	1.39	2.56
Number of silence instances for >4 Sec	16	61	8	15
Number of silence instances for >3 Sec	21	74	18	31
Number of silence instances for >2 sec	64	108	63	101
RTP Jitter (4G & 5G) in ms	6.98	15.74	7.68	30.27
Packet loss Rate Downlink %	0.62	6.67	0.55	1.12
Packet loss Rate Uplink %	0.76	7.04	0.74	1.05

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

Note-

- BSNL has latched 34.17% on LTE technology. Count of silence calls, jitter and packets lost have been considered for that duration only (VoLTE calls).

(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-53	6335	4821	6209	6057
Speech Quality (Average MOS Score)	3.94	2.81	3.92	4.38
Number of samples with MOS >=4 to <5 (Excellent)	4863	807	4648	5085
Number of samples with MOS >=3 to <4 (Good)	1205	713	1203	478
Number of samples with MOS >=2 to <3 (Fair)	144	2529	225	305
Number of samples with MOS >=1 to <2 (Poor)	123	772	133	189
%age of samples with MOS >=4 to <5 (Excellent)	76.76%	16.74%	74.86%	83.95%
%age of samples with MOS >=3 to <4 (Good)	19.02%	14.79%	19.38%	7.89%
%age of samples with MOS >=2 to <3 (Fair)	2.27%	52.46%	3.62%	5.04%
%age of samples with MOS >=1 to <2 (Poor)	1.94%	16.01%	2.14%	3.12%

Table-15: Summary of speech quality (MOS) samples.

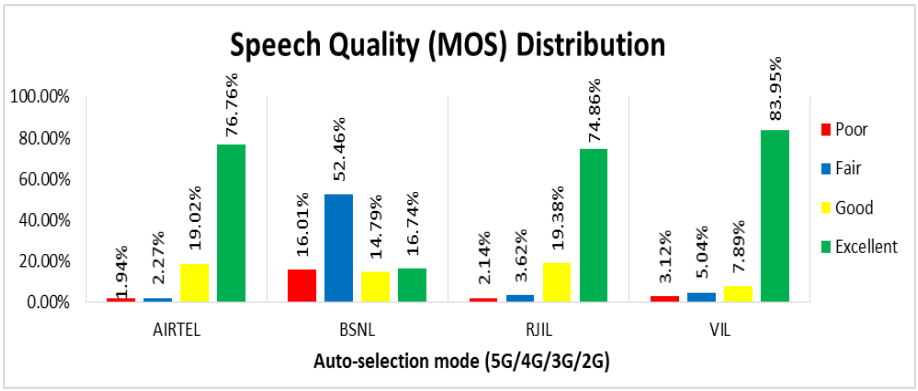

Figure-15: Distribution of samples in MOS score range.

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

Technology	Service Provider			
	AIRTEL	BSNL	RJIL	VIL
5G	2.56%	NA	12.72%	NA
4G	97.36%	33.28%	87.25%	92.96%
3G	NA	12.64%	NA	NA
2G	0.00%	50.63%	NA	6.30%
Limited Service	0.08%	3.45%	0.03%	0.74%

Table-16: 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.

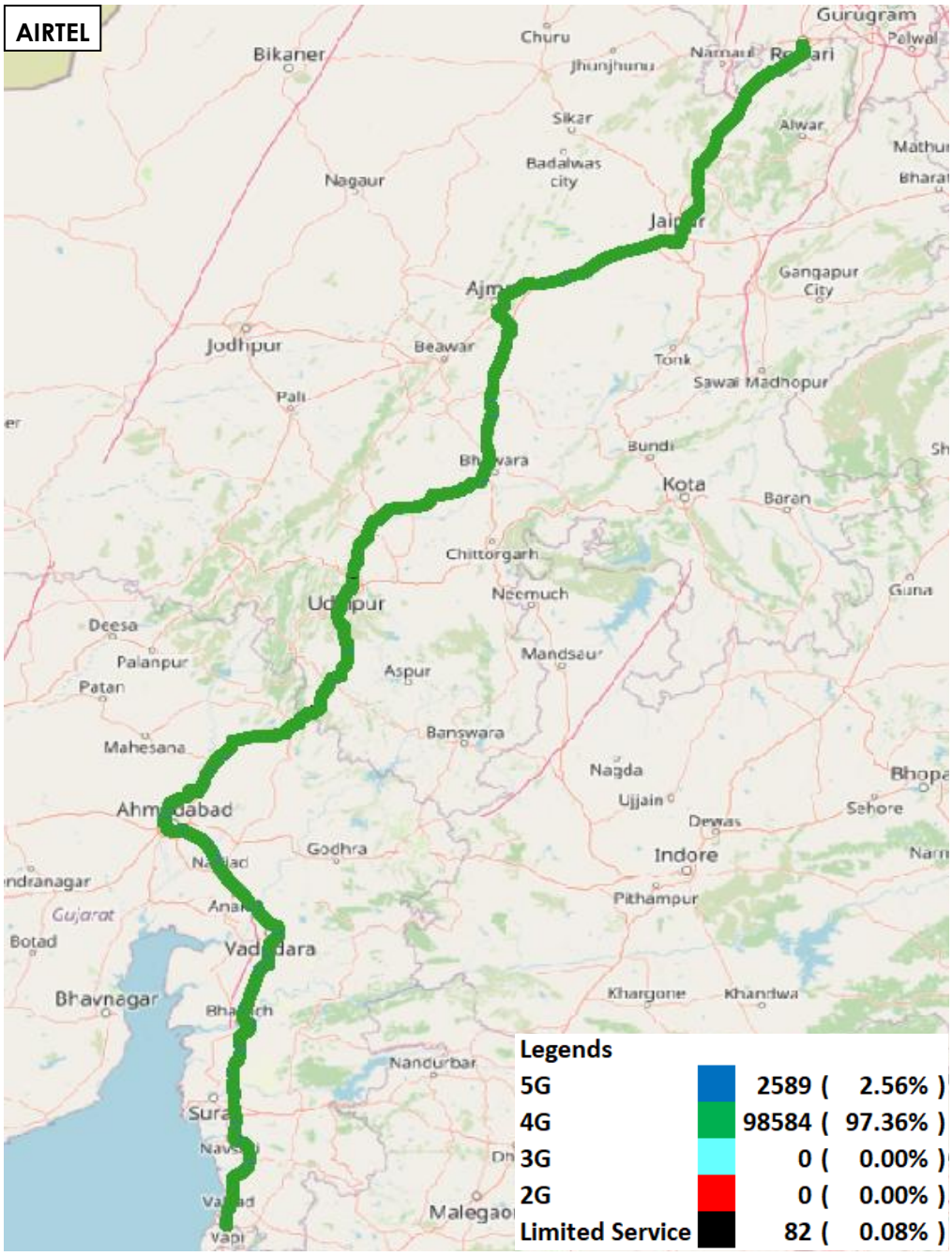

Figure-16: Serving technology plots in auto-selection mode (5G/4G/3G/2G) –AIRTEL.

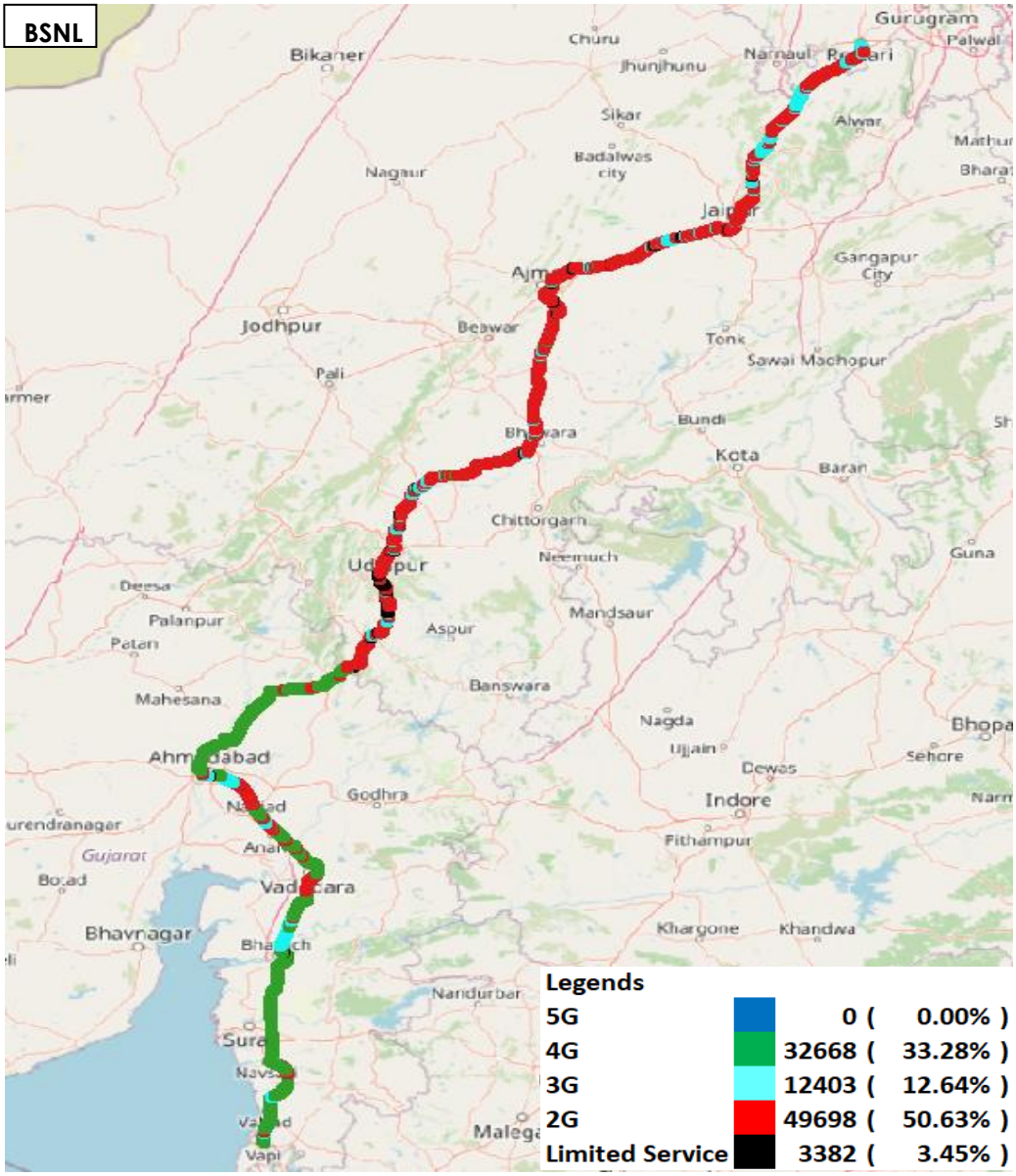

Figure-17: Serving technology plots in auto-selection mode (5G/4G/3G/2G) –BSNL.

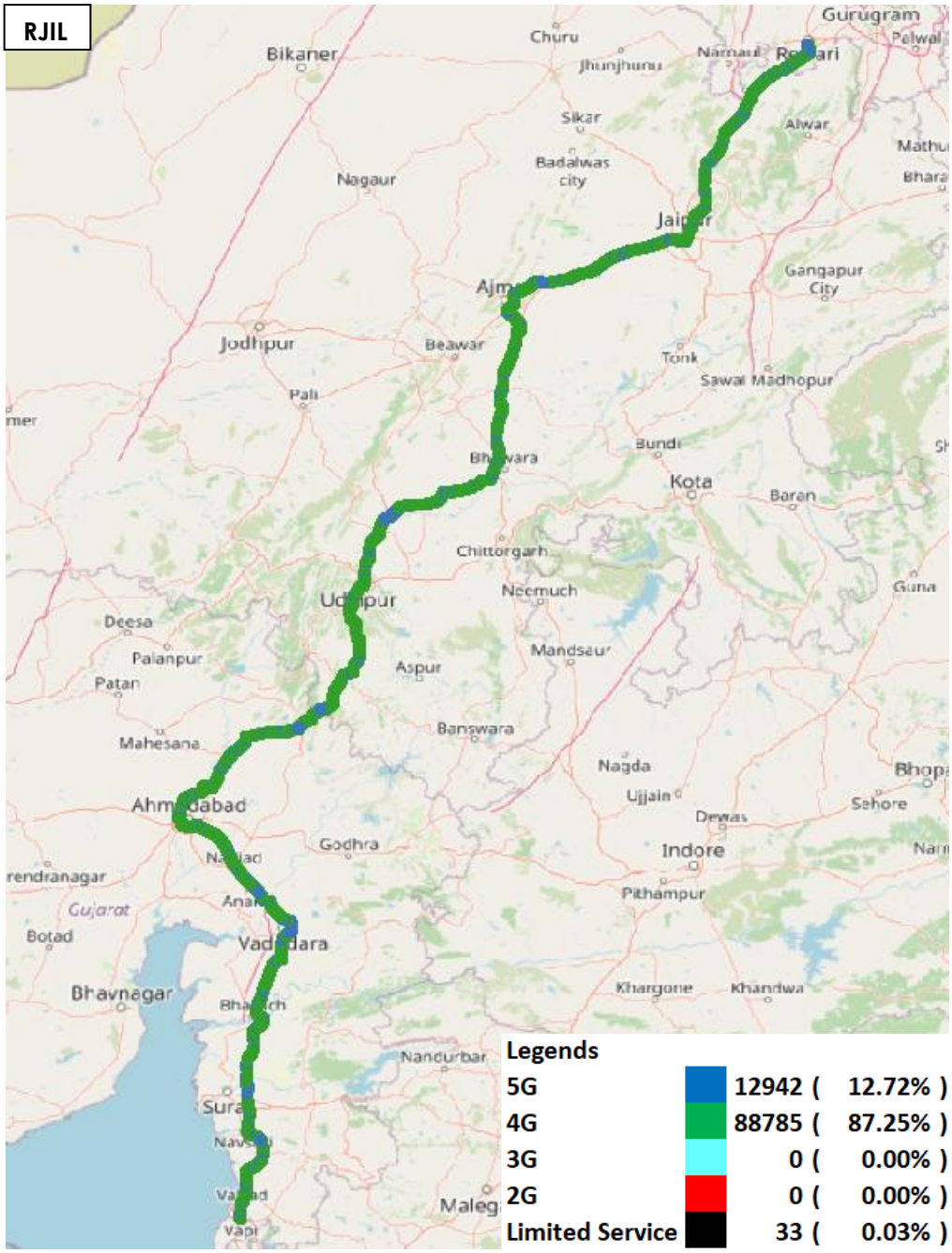

Figure-18: Serving technology plots in auto-selection mode (5G/4G/3G/2G)- RJIL.

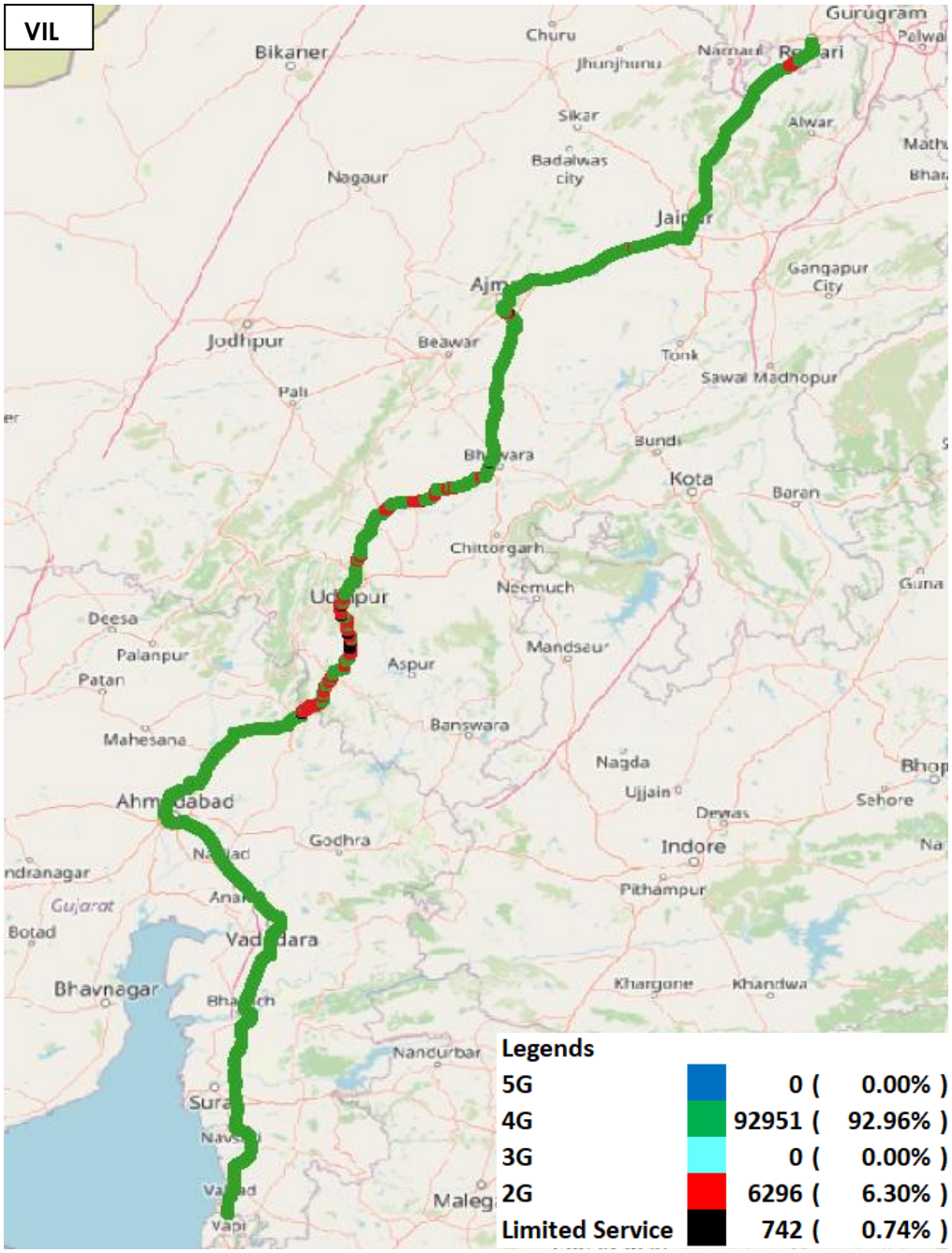

Figure-19: Serving technology plots in auto-selection mode (5G/4G/3G/2G) – VIL.

(g) Network Signal Strength distribution: The following chart provide signal strength distribution for auto-selection mode (5G/4G/3G/2G). (Refer figure-26, 27, 28 & 29 for map view)

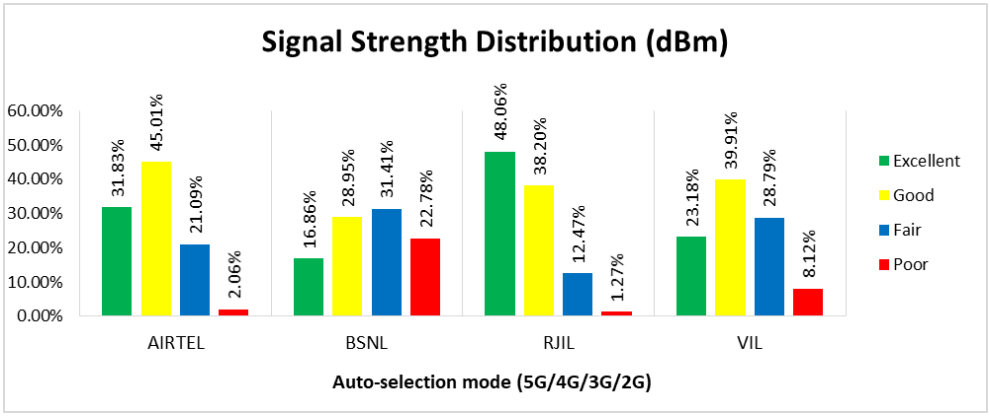

Figure-20: Signal strength distribution auto-selection mode 5G/4G/3G/2G.

Observations:

- Airtel has 32% samples falling in the excellent signal strength category.
- BSNL has 17% samples falling in the excellent signal strength category.
- RJIL has 48% samples falling in the excellent signal strength category.
- VIL has 23% 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	147.27	6.22	306.50	34.61
	80th Percentile	256.04	9.78	512.12	55.73
	20th Percentile	25.83	0.46	101.51	13.35
Upload Throughput (Mbits/s)	Average	23.70	3.25	31.08	13.32
	80th Percentile	40.73	4.28	54.84	23.38
	20th Percentile	4.32	0.81	6.60	3.32
Latency (ms)	50th Percentile	34.45	54.00	22.50	26.45

Table-17: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

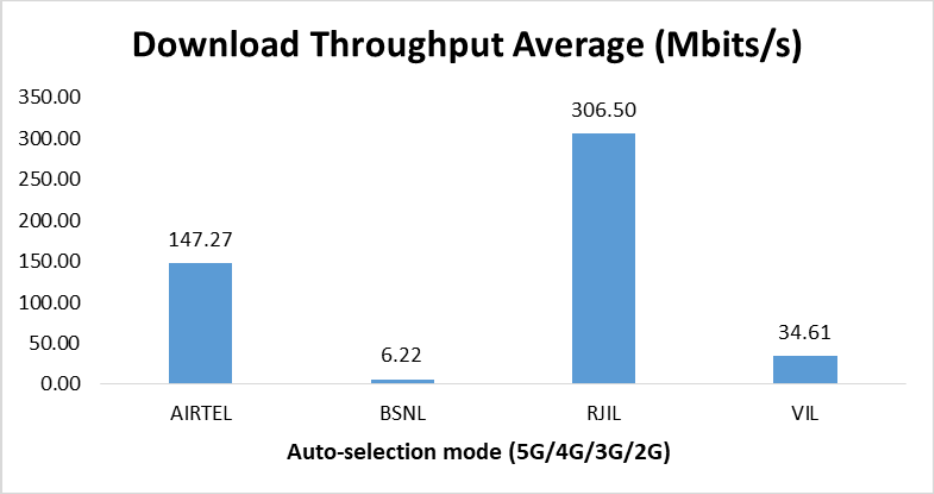

Figure-21: Download throughput.

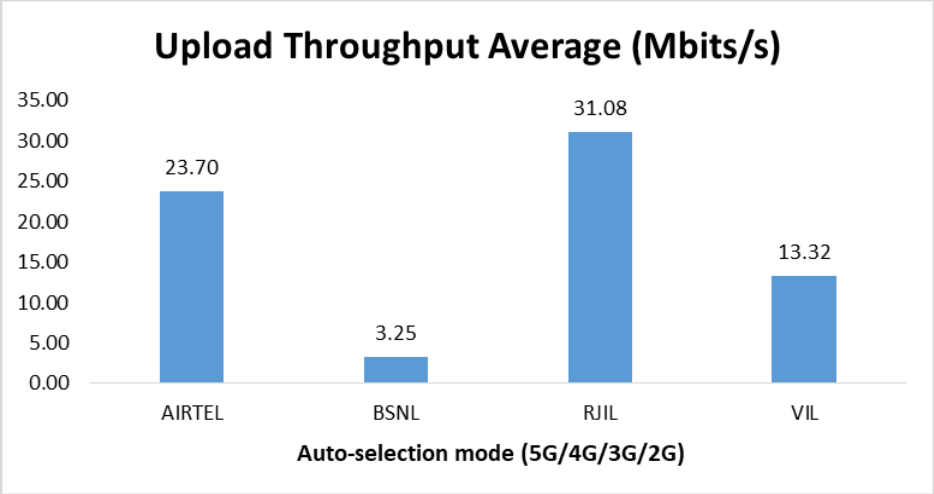

Figure-22: Upload throughput.

5. Voice & Data Key findings

5.1 Overall Voice

1. Call Setup Success Rate:

a) Airtel, BSNL and VIL have 98.20%, 81.86% and 78.45% call setup success rate respectively in 3G/2G network mode. (refer table-3 & 11)

b) Airtel, BSNL, RJIL and VIL have 99.42%, 76.96%, 99.43% and 94.01% call setup success rate respectively in auto-selection mode (5G/4G/3G/2G). (refer table-5 & 13)

2. Call Setup Time:

a) VIL has taken comparatively longer time (4.62 second) to establish the voice call, whereas Airtel and BSNL call setup time is 4.23 & 3.72 seconds respectively in 3G/2G network mode. (refer table-3 & 11)

b) BSNL has taken comparatively longer time (2.70 second) to establish the voice call, whereas RJIL, Airtel and VIL call setup time is 1.75, 1.66 & 1.40 seconds respectively in Auto-selection mode (5G/4G/3G/2G). (refer table-5 & 13)

3. Call Silence/Mute Rate: In packet switched network (4G/5G), BSNL, VIL, Airtel and RJIL have 5.57%, 2.56%, 2.40% & 1.39% silence call rate respectively. Further BSNL has higher RTP packet loss rate in downlink (6.67%) compared to VIL (1.12%), Airtel (0.62%) and RJIL (0.55%). In uplink the RTP packet loss rate is higher for BSNL (7.04%) compared to VIL (1.05%), Airtel (0.76%) and RJIL (0.74%). (refer table-6)

4. Call Drop Rate:

a) Overall BSNL's and VIL's call drop rate 10.78% and 4.15%, respectively higher than QoS benchmark of 2%, while Airtel has 1.42% drop call rate in 3G/2G network mode. (refer table-3 & 11)

b) Overall BSNL's and VIL's call drop rate 14.17% and 2.99% is higher than QoS benchmark of 2%, while RJIL and Airtel have 0.77% and 0.78% drop call rate respectively in Auto-selection mode (5G/4G/3G/2G). (refer table-5 & 13)

5.2 Overall Data

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

a) BSNL (6.22 Mbps) and VIL (34.61 Mbps) both have 4G as top technology providers, have comparatively lower average download data speeds. While Airtel and RJIL have average download speed of 147.27 Mbps and 306.50 Mbps respectively. (refer table-9 &17)

b) BSNL (3.25 Mbps) and VIL (13.32 Mbps) both have 4G as top technology providers, have comparatively lower average upload data speeds. While Airtel and RJIL have average upload speed of 23.70 Mbps and 31.08 Mbps respectively. (refer table- 9 & 17).

5.3 Operator wise Key Findings

1. Airtel:

Voice

- 98.20% call setup success rate and 1.42% call drop rate have been observed in 3G/2G network mode. Performance is well within the benchmark of 98.00% & 2.00% respectively, across the route. (refer table-3 and 11)

- 99.42% call setup success rate and 0.78% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G). Performance is well within the benchmark of 98.00% & 2.00% respectively, across the route. (refer table-5 and 13)

Data

- Airtel has 147.27 Mbps average download throughput & 23.70 Mbps average upload throughput, across the route.(refer table-9 and 17).

- Airtel's latency is 34.45 ms across the measured route, well within the benchmark of 75 ms. (refer table- 9 & 17)

2. BSNL:

Voice

- 81.86% call setup success rate and 10.78% call drop rate have been observed in 3G/2G network mode. Performance is not meeting the benchmark of 98.00% & 2.00% respectively, across the route. (refer table-3 and 11)

- 76.96% call setup success rate and 14.17% call drop rate have been observed in auto-selection mode. Performance is not meeting the benchmark of 98.00% & 2.00% respectively, across the route. (refer table-5 and 13)

Data

- BSNL has 6.22 Mbps average download throughput & 3.25 Mbps average upload throughput across measured routes. (refer table-9 and 17)

- BSNL's latency is 54.00 ms across the measured route, well within the benchmark of 75 ms. (refer table- 9 & 17)

3. RJIL:

Voice

- 99.43% call setup success rate and 0.77% 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, across the route. (refer table-5 and 13)

Data

- RJIL has 306.50 Mbps average download speed & 31.08 Mbps average upload speed across measured routes. (refer table-9 and 17)

- RJIL's latency is 22.50 ms across the measured route, well within the benchmark of 75 ms. (refer table- 9 & 17)

4. VIL:

Voice

- 78.45% call setup success rate and 4.15% call drop rate have been observed in 3G/2G network mode. Performance is not within the benchmark of 98.00% & 2.00% respectively, across the route. (refer table-3 and 11)

- 94.01% call setup success rate and 2.99% call drop rate have been observed in auto-selection mode. Performance is not within the benchmark of 98.00% and 2.00% respectively, across the route. (refer table-5 and 13)

Data

- VIL has 34.61 Mbps average download speed & 13.32 Mbps average upload speed across measured routes. (refer table-9 and 17)

- VIL's latency is 26.45 ms across the measured route, well within the benchmark of 75 ms. (refer table- 9 & 17)

6. Annexure

6.1 Route wise coverage map

6.1.1 Highway

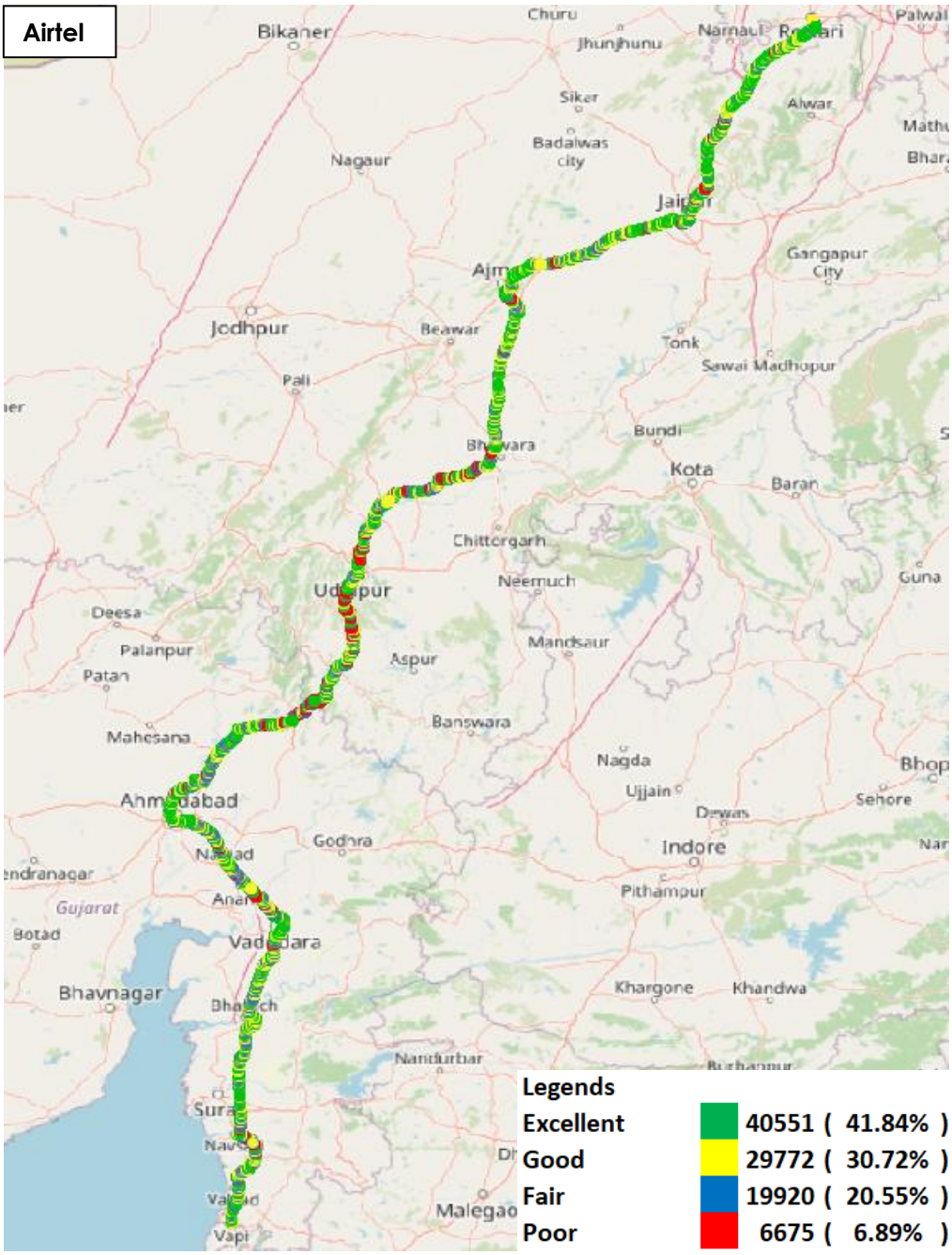

Figure-23: Signal strength 3G/2G network mode – Airtel.

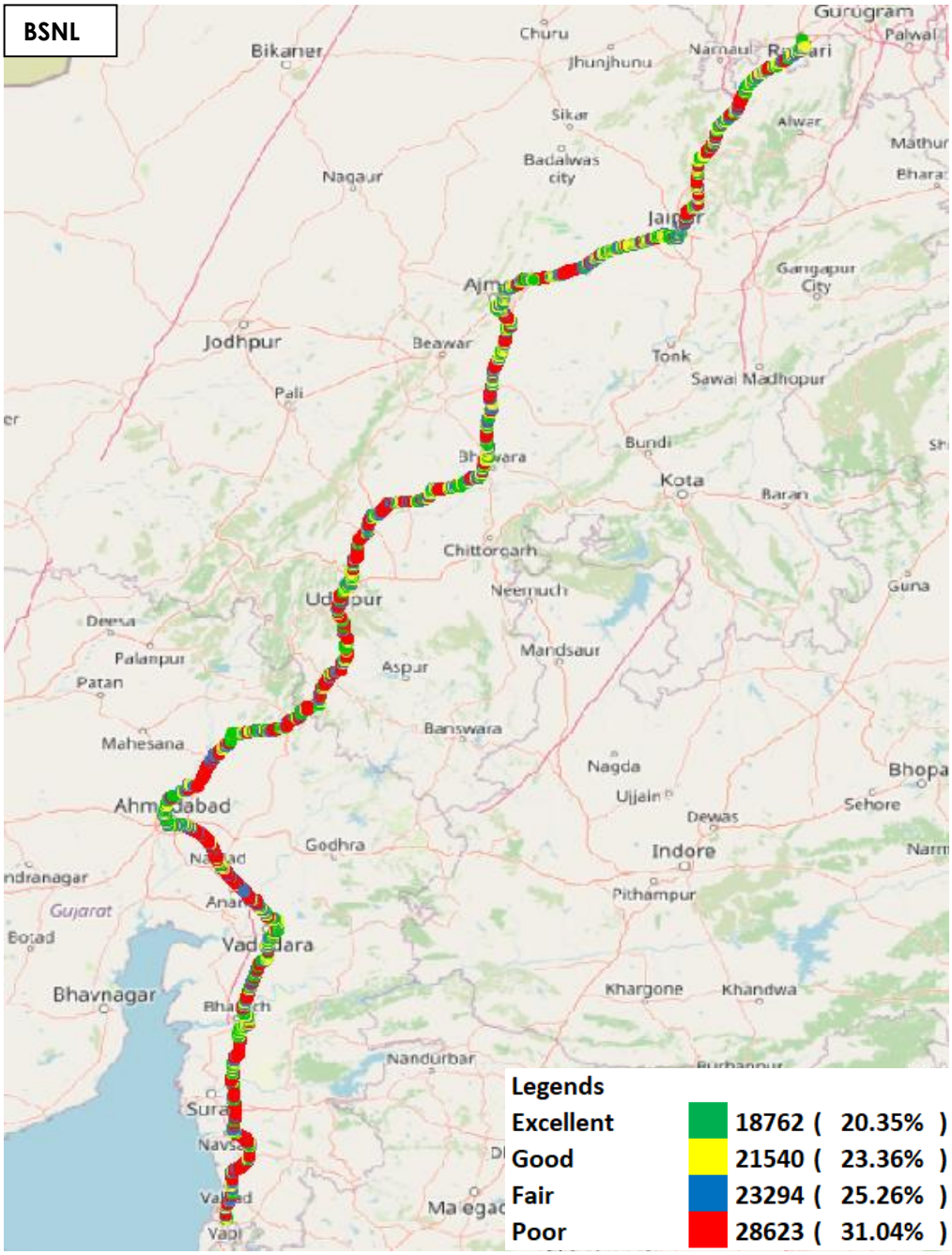

Figure-24: Signal strength 3G/2G network mode – BSNL.

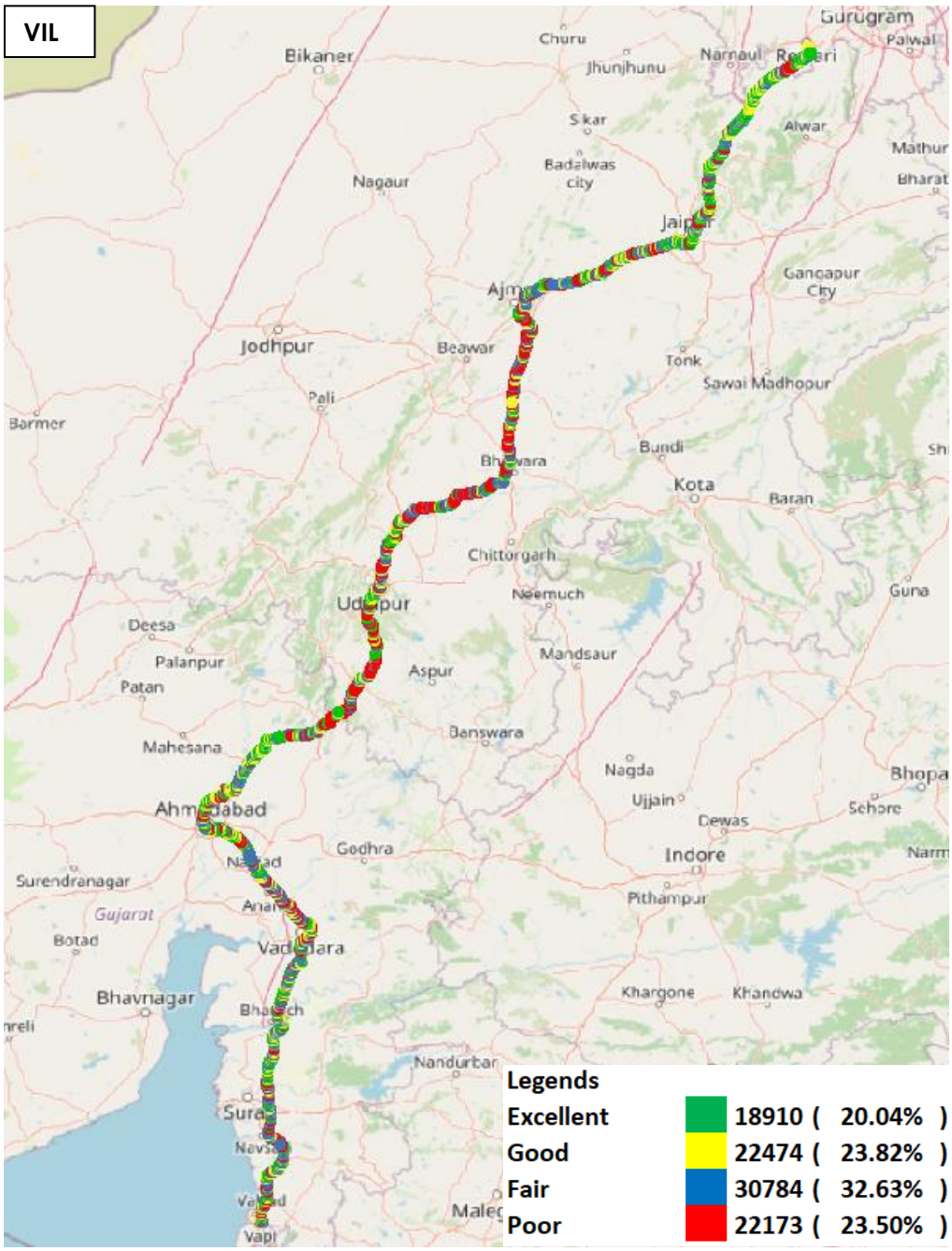

Figure-25: Signal strength 3G/2G network mode – VIL.

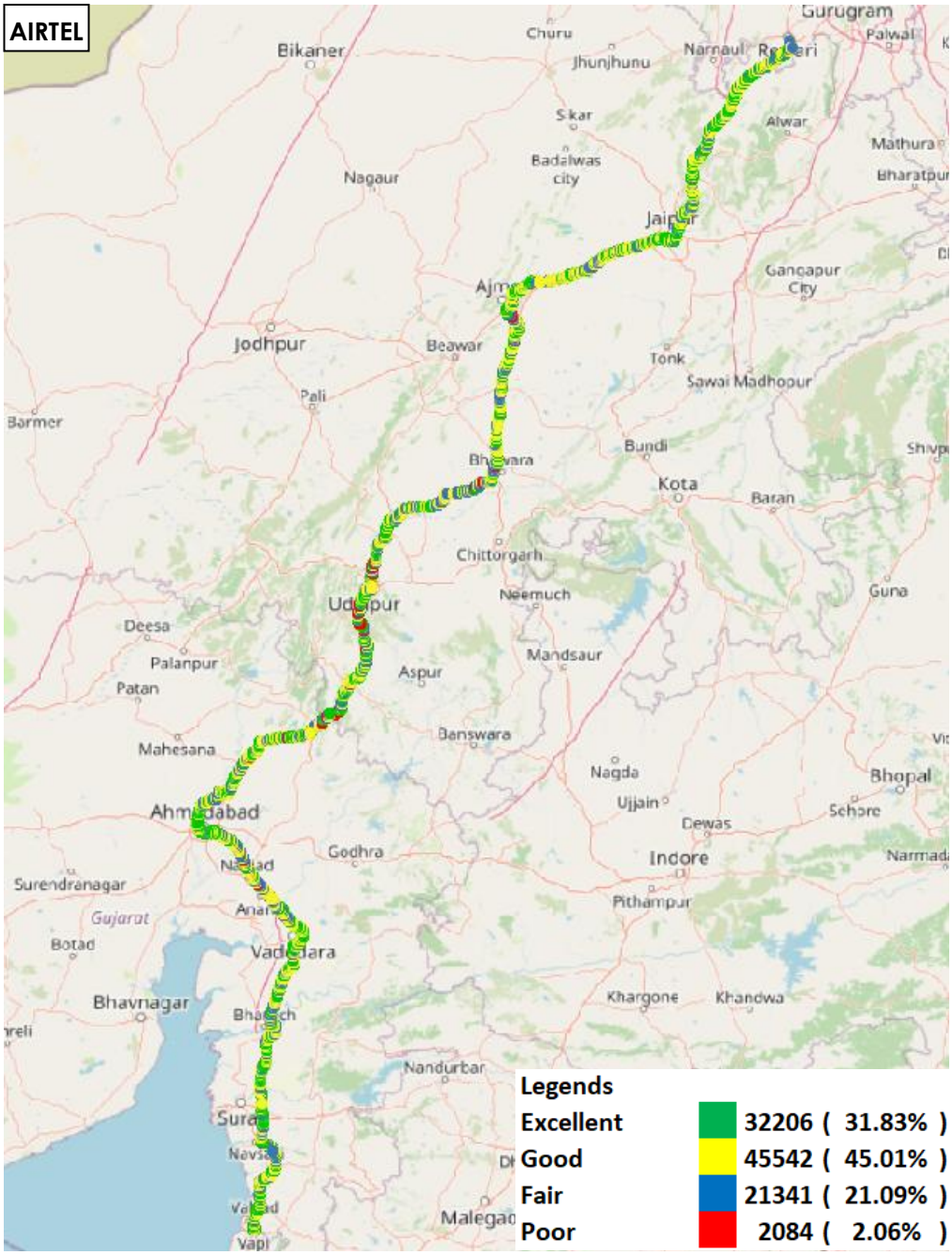

Figure-26: Signal strength auto-selection mode 5G/4G/3G/2G – Airtel.

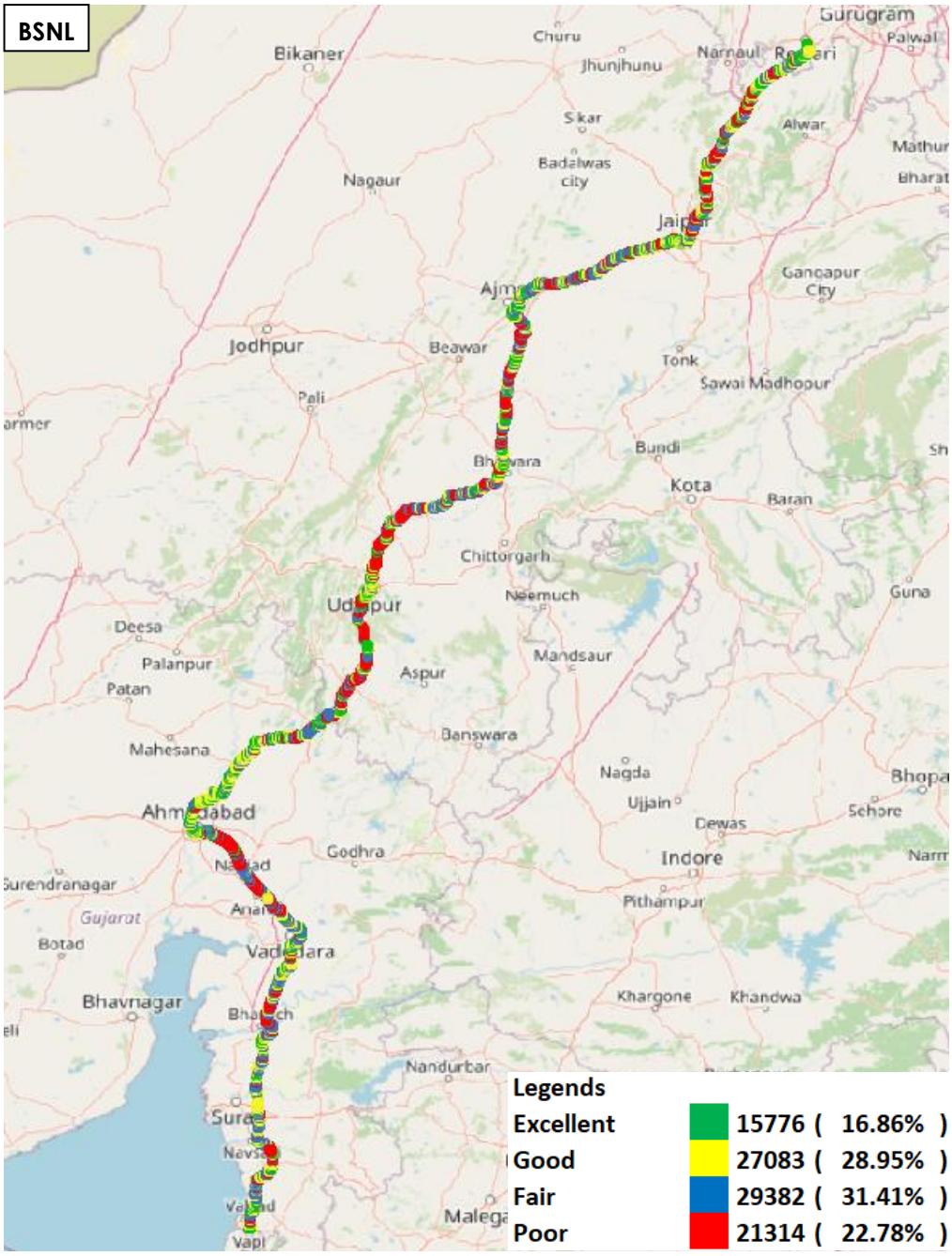

Figure-27: Signal strength auto-selection mode 5G/4G/3G/2G – BSNL.

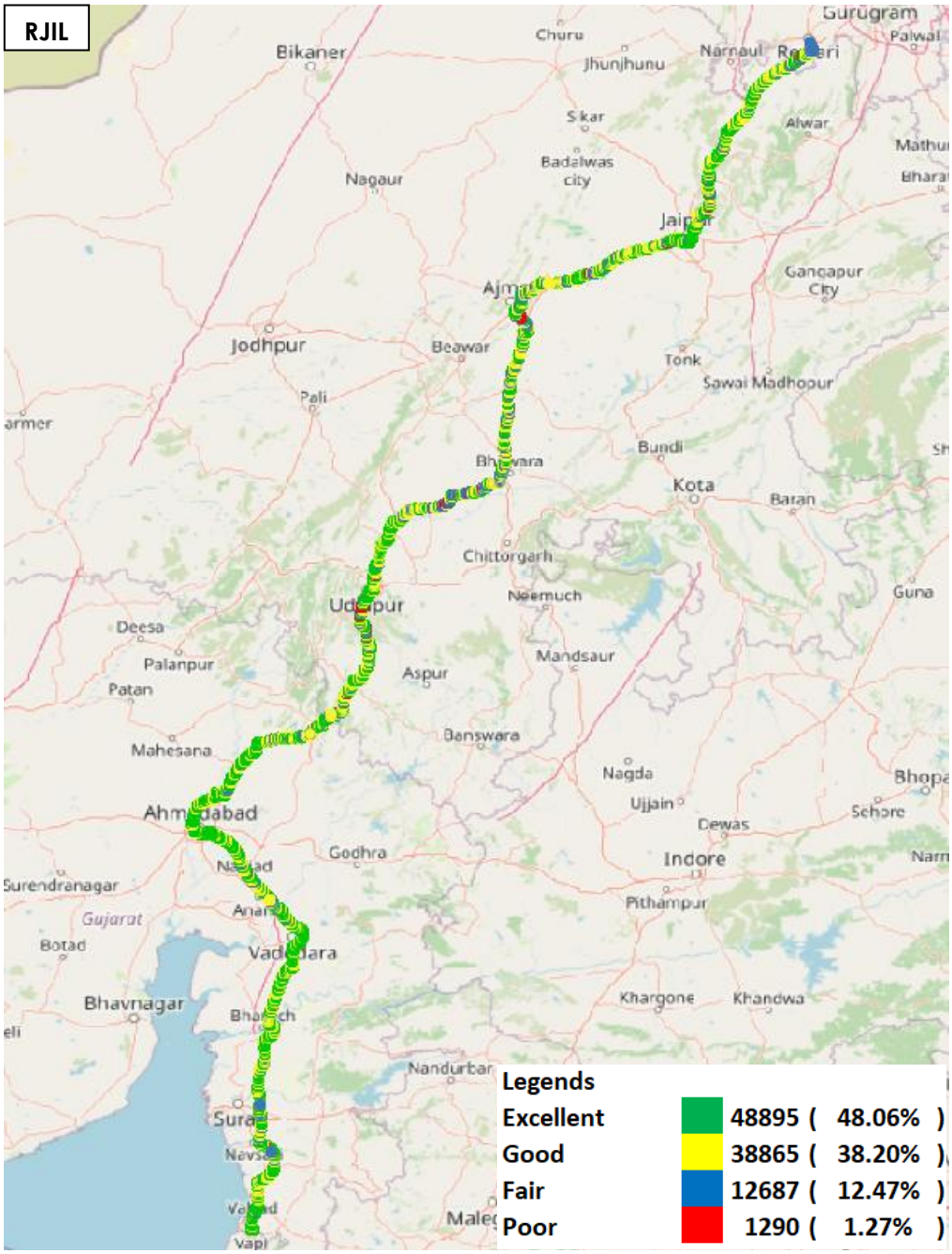

Figure-28: Signal strength auto-selection mode 5G/4G/3G/2G – RJIL.

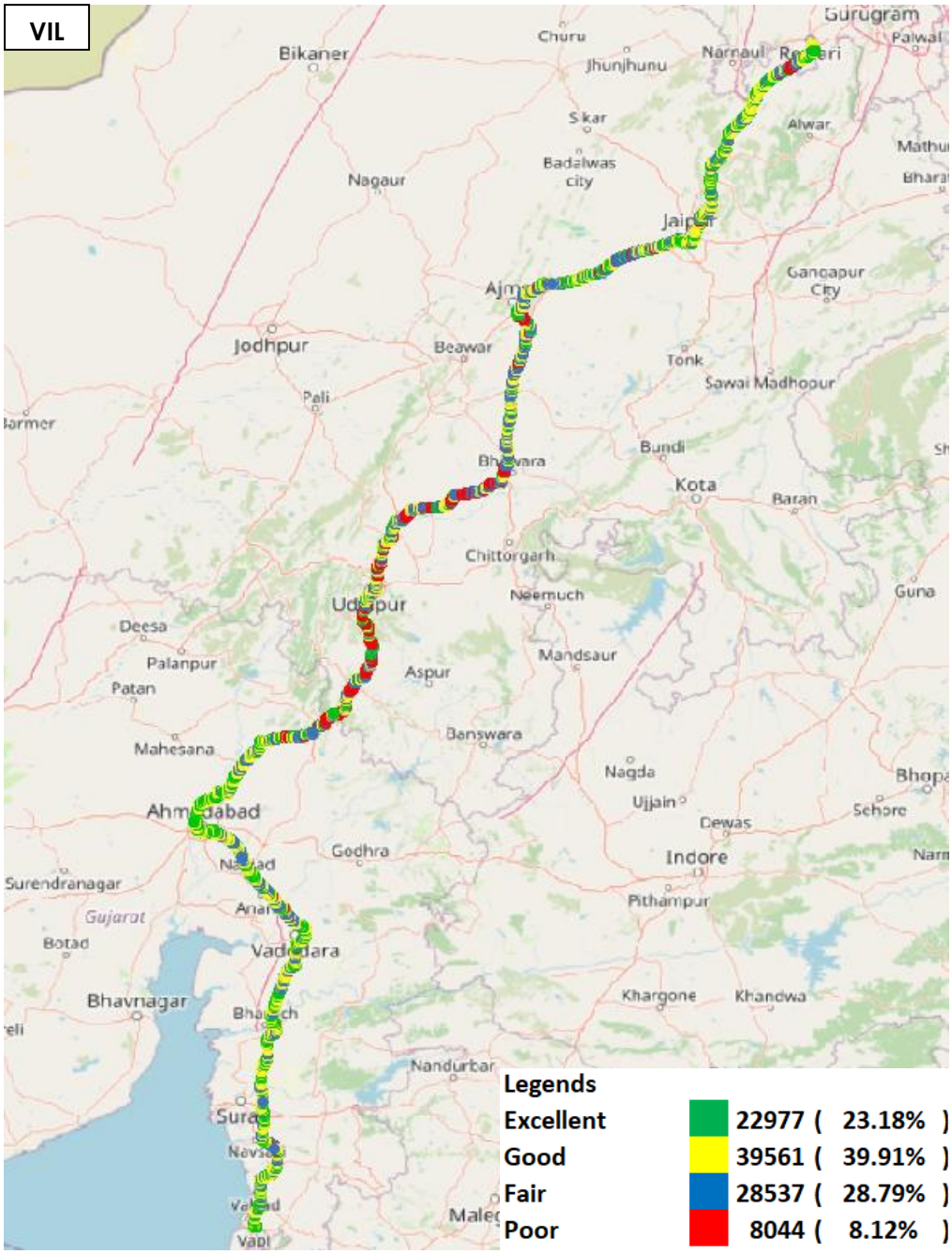

Figure-29: Signal strength auto-selection mode 5G/4G/3G/2G – VIL.

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		180 Sec
Wait/ Guard Time		15 Sec

Table-18: 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 20 sec timeout (only at Hotspot)
Latency		25 count- Dynamic 1000 count- Hotspot Payload- 42 bytes in all drive

Table-19: 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.

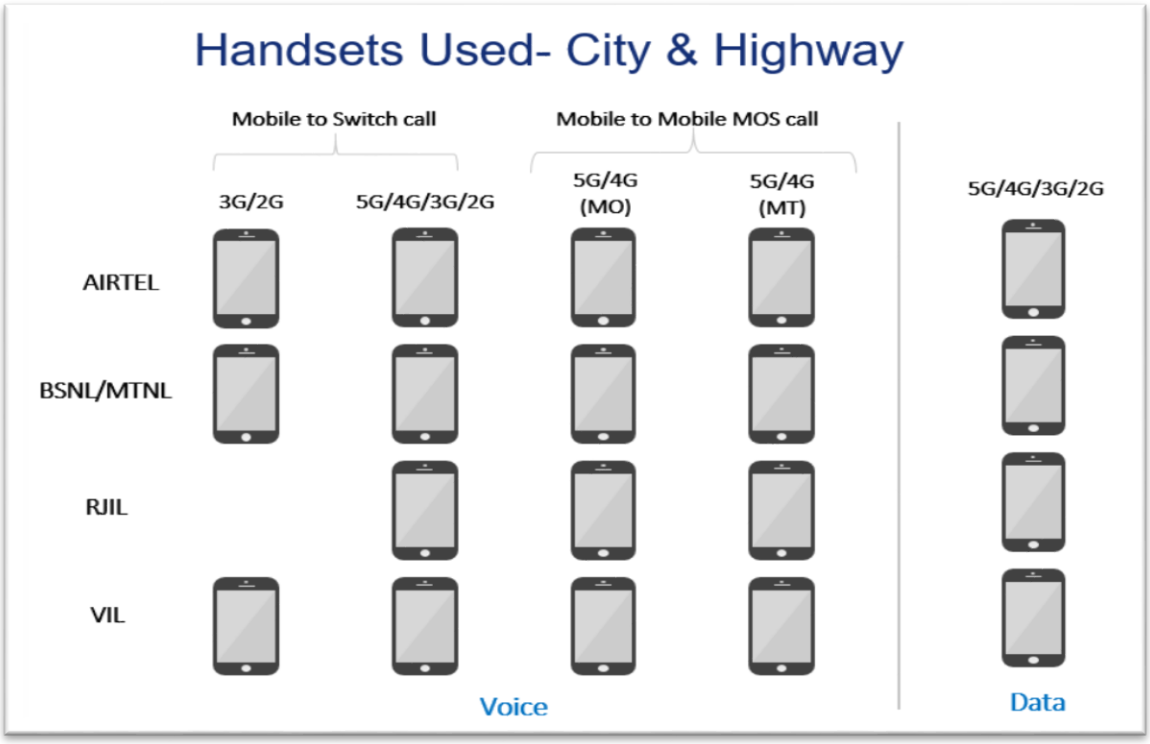

Figure-30: Number of handsets used in city & highway drive

MO: Mobile originating

MT: Mobile terminating

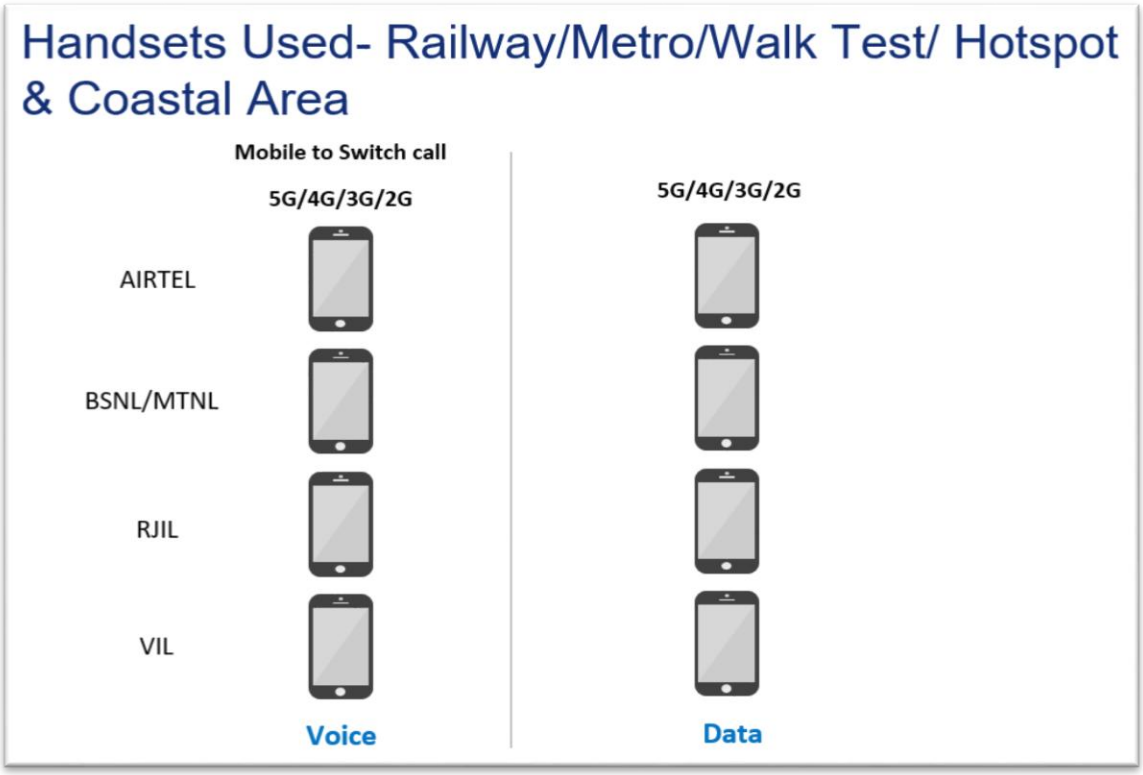

Figure-31: Number of handsets used in railway/metro/walktest/hotspot & coastal area

7.1.2 Drive test Methodology

(a) Dynamic voice testing (on the move)

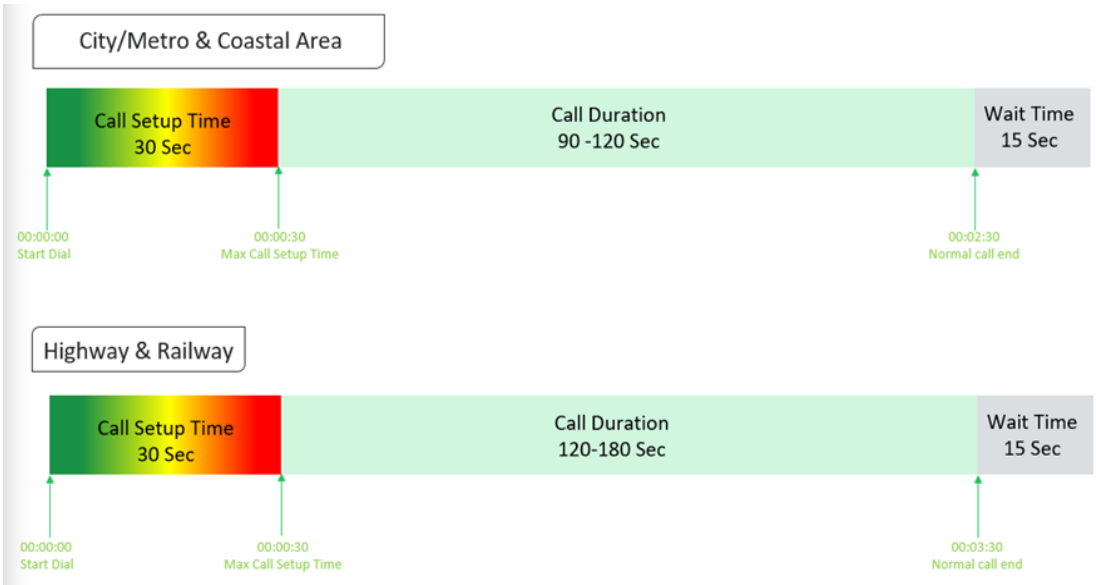

Figure-32: Voice test script for city/railway/metro/highway & coastal area

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

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

(b) Hotspot voice testing

Figure-33: 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

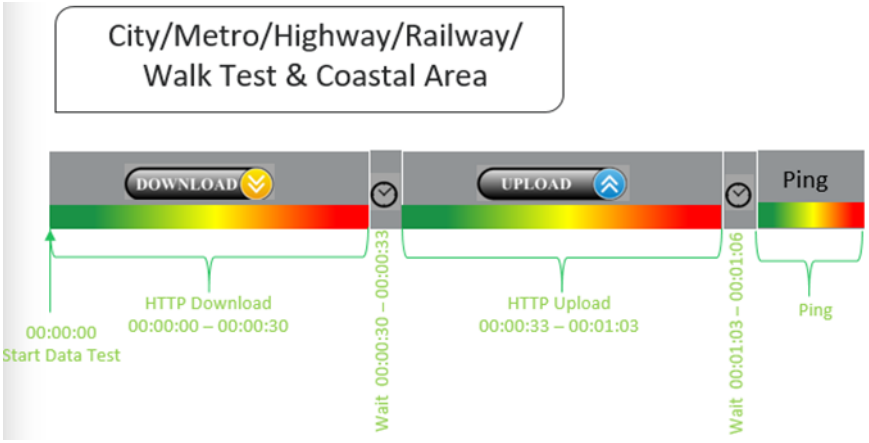

Figure-34: Data test script used in city/metro/railway/highway/walk test & coastal area

(d) Static Data(internet) testing

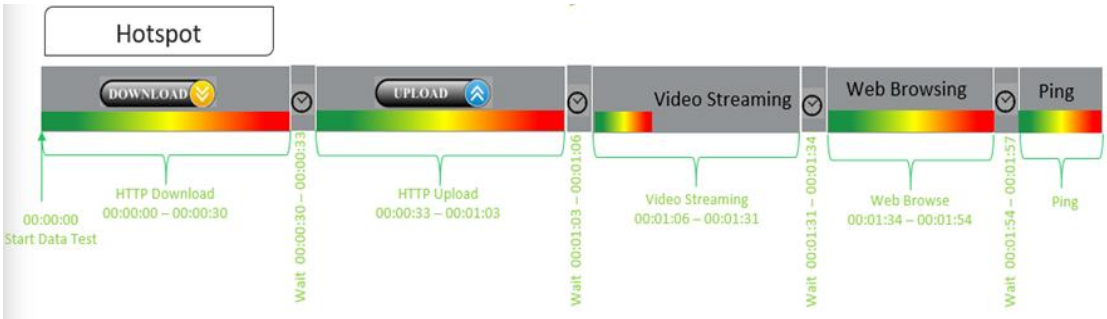

Figure-35: Data test script used at hotspot

- 5 Data iteration done at each hotspot location.
- Min. 5 iteration made during the walk test.
- Web browsing duration mentioned above is for one web site only.
- Only 1 ping iteration (with 1000 Count) done at hotspot location.

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 ≥ 4 sec continuous RTP gap is considered as a Silence Call. Silence call rate = (count of silence call / Total calls established) *100

<table>
<tr><td></td><td>If a call observes multiple silence count >=4 sec in a particular established call it has been taken as one silent event.</td></tr>
<tr><td>Jitter</td><td>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</td></tr>
<tr><td>Downlink Packet Drop Rate</td><td>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)</td></tr>
<tr><td>Uplink Packet Drop Rate</td><td>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).</td></tr>
<tr><td>Signal Strength</td><td>Signal strength is the signal power level received by the wireless user.
<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></td></tr>
</table>

Table-20: Network performance parameter and definition voice

7.2.2 Network Performance Parameters Data tests

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

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

Table-21: Network performance parameter and definition Data