भादूविप्रा
TRAI

TELECOM REGULATORY AUTHORITY OF INDIA

Independent Drive Test Report

Karnataka LSA

January 2025

Contents

1. Introduction

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

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

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

2. Executive Summary (LSA)

2.1 Drive test details

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

Sl. No	Drive test route	Type of route	Distance covered (KMs)	From date	To date
1	Bengaluru	City	471	15-Jan-2025	17-Jan-2025
2	Bengaluru	Inter Operator Calling	35	18-Jan-2025	18-Jan-2025
3	Bengaluru	Hotspot	9 Locations	20-Jan-2025	20-Jan-2025
4	Bengaluru	Walk Test	13.39	18-Jan-2025	18-Jan-2025

Table-1: Drive test summary

2.2 Drive test routes

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

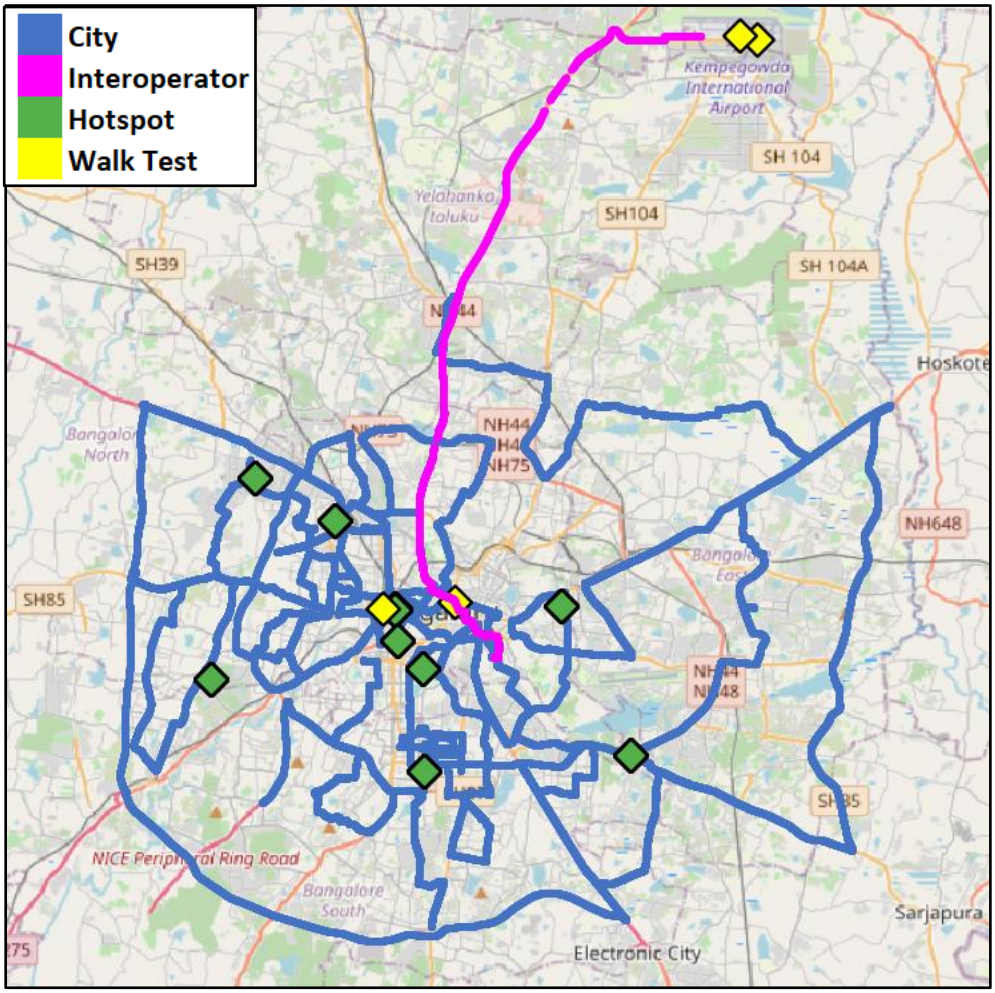


Figure-1: Drive test routes

2.3 Summary of areas covered

a) City- Nearby Ashwath Nagar, Jayantinagara, Kasturi Nagar, Anjanapura, Indiranagar, C V Raman Nagar, Richards Town, Banaswadi, Cleveland Town, Jayanagar East etc.

b) Hotspot-

1. Bangalore University Campus
2. Indiranagar Metro Station
3. ISKCON Temple Rajaji Nagar
4. KR Market
5. Lal-Bagh Botanical Garden
6. LIC Office Jeevan Soudha JP Nagar
7. Majestic Bus Stand
8. Manipal Hospital,Sarjapur Road
9. Peenya Industrial Area

c) Walk Test

1. (Terminal I) Kempegowda International Airport
2. (Terminal II) Kempegowda International Airport
3. Cubbon Park
4. KSR Railway Station

2.4 Telecom service providers detected frequency bands

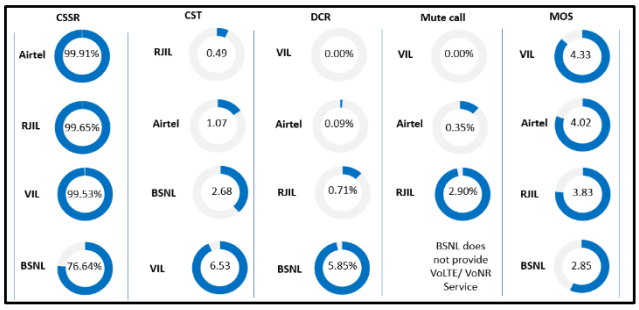
Technologies covered during the IDT and frequency bands in use are summarised in below table

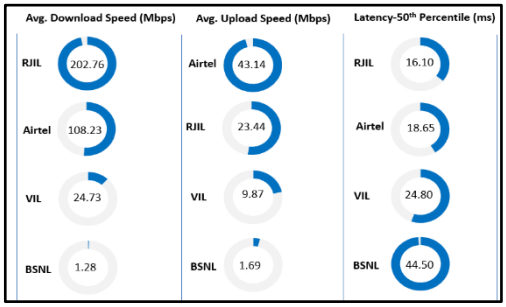
S.no.	Name of TSP	Technology	Frequency Bands (In MHz)
1	Bharti Airtel Ltd.	2G	900
2	Bharti Airtel Ltd.	4G	900,1800,2100,2300
3	Bharti Airtel Ltd.	5G	3500
4	BSNL	2G	900
5	BSNL	3G	2100
6	BSNL	4G	700,2100
7	Reliance JIO Infocomm Ltd.	4G	850,1800,2300
8	Reliance JIO Infocomm Ltd.	5G	700,3500
9	Vodafone Idea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

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

2.5 Performance against key QoS parameters

CSSR: Call setup success rate, **CST:** Call setup time, **DCR:** Drop call rate





Summary-Voice services

Call Setup Success Rate: Airtel, RJIL, VIL & BSNL have 99.91%, 99.65%, 99.53% and 76.64% call setup success rate respectively in Auto-selection mode (5G/4G/3G/2G).

Call Setup Time: VIL has taken comparatively longer time (6.53 seconds) to establish the voice call, whereas RJIL, Airtel and BSNL call setup time is 0.49, 1.07 & 2.68 second respectively in Auto-selection mode (5G/4G/3G/2G).

Call Drop Rate: Overall BSNL's call drop rate (5.85%) is higher (QoS benchmark of 2%), while VIL, Airtel and RJIL have 0.00%, 0.09% and 0.71% respectively in Auto-selection mode (5G/4G/3G/2G).

Call Silence/Mute Rate: In packet switched network (4G/5G), VIL, Airtel and RJIL have 0.00%, 0.35% & 2.90% silence call rate respectively.

Mean Opinion Score (MOS): Quality of speech of VIL (4.33) and Airtel (4.02) is having a MOS score >4, whereas RJIL (3.83) and BSNL (2.85) is having a MOS score <4.

Summary-Data services

Data Download performance (Dynamic): BSNL offers a download speed of 1.28 Mbps while VIL provides 24.73 Mbps, utilizing legacy technologies respectively. In contrast, Airtel and RJIL achieve significantly higher average download speeds of 108.23 Mbps and 202.76 Mbps.

Data Upload performance (Dynamic): BSNL (1.69 Mbps) and VIL (9.87 Mbps), operating on 4G/3G legacy technologies respectively, have comparatively lower upload speeds. In contrast, Airtel and RJIL offer faster speeds of 43.14 Mbps and 23.44 Mbps, respectively.

QoS Performance Analysis- Karnataka 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 January-2025 covering City, Hotspots and walk test. (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	844	858	803
Call Setup Success Rate %	98.93	98.95	98.51
Drop Call Rate %	0.12	1.53	0.51
Call Setup Time-Average (Second)	5.02	3.51	11.40
Handover Success Rate %	98.55	99.66	98.07

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

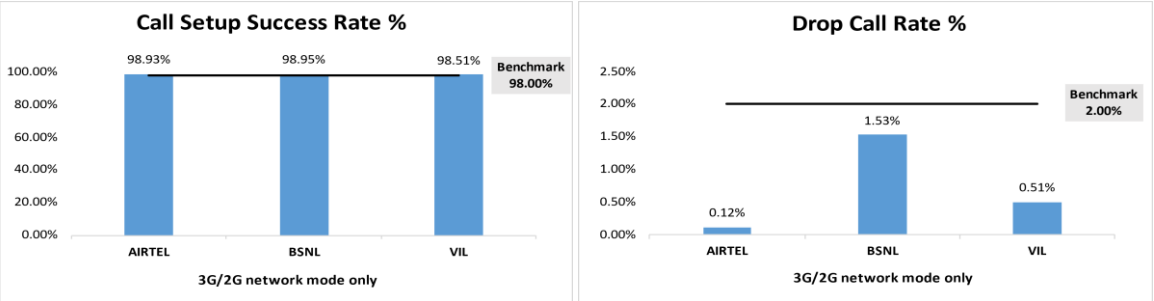


Figure-2: Call setup success rate and drop call rate performance.

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	471	NA
2G	1808	529	1577

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	1117	1250	1136	1072
Call Setup Success Rate %	99.91	76.64	99.65	99.53
Drop Call Rate %	0.09	5.85	0.71	0.00
Call Setup Time-Average (Second)	1.07	2.68	0.49	6.53
Handover Success Rate %	99.98	98.98	99.97	99.72

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

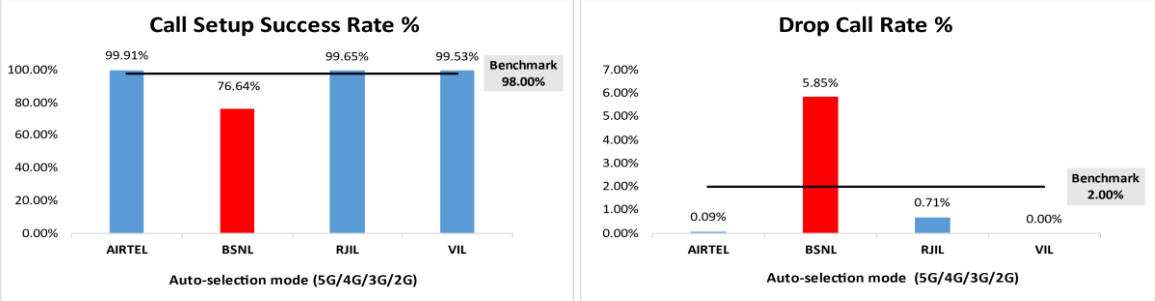


Figure-3: Performance for call setup success rate and drop call rate.

Parameter	Service Provider			
	Mobile-to-Mobile (5G/4G - Open Mode)			
	AIRTEL	BSNL	RJIL	VIL
Call Established (within service provider Network)	854	844	863	809
Number of silence call for >4 Sec	3	NA	25	0
Silence Call Rate %	0.35	NA	2.90	0.00
Number of silence instances for >4 Sec	5	NA	29	0
Number of silence instances for >3 Sec	14	NA	37	0
Number of silence instances for >2 sec	41	NA	65	8
RTP Jitter (4G & 5G) in ms	4.14	NA	14.27	15.38
Packet loss Rate Downlink %	0.38	NA	0.63	0.32
Packet loss Rate Uplink %	0.44	NA	1.08	0.54

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.
- In BSNL, VoLTE services were observed in mobile to switch calls only. All mobile to mobile calls were initiated on 2G/3G only.

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	1948	NA
4G	2816	630	1400	2221
3G	NA	206	NA	NA
2G	0	387	NA	3

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	5086	4264	4977	4741
Speech Quality (Average MOS Score)	4.02	2.85	3.83	4.33
Number of samples with MOS >=4 to <5 (Excellent)	4301	0	3077	3879
Number of samples with MOS >=3 to <4 (Good)	678	2376	1541	723
Number of samples with MOS >=2 to <3 (Fair)	63	1421	234	83
Number of samples with MOS >=1 to <2 (Poor)	44	467	125	56
%age of samples with MOS >=4 to <5 (Excellent)	84.57%	0.00%	61.82%	81.82%
%age of samples with MOS >=3 to <4 (Good)	13.33%	55.72%	30.96%	15.25%
%age of samples with MOS >=2 to <3 (Fair)	1.24%	33.33%	4.70%	1.75%
%age of samples with MOS >=1 to <2 (Poor)	0.87%	10.95%	2.51%	1.18%

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

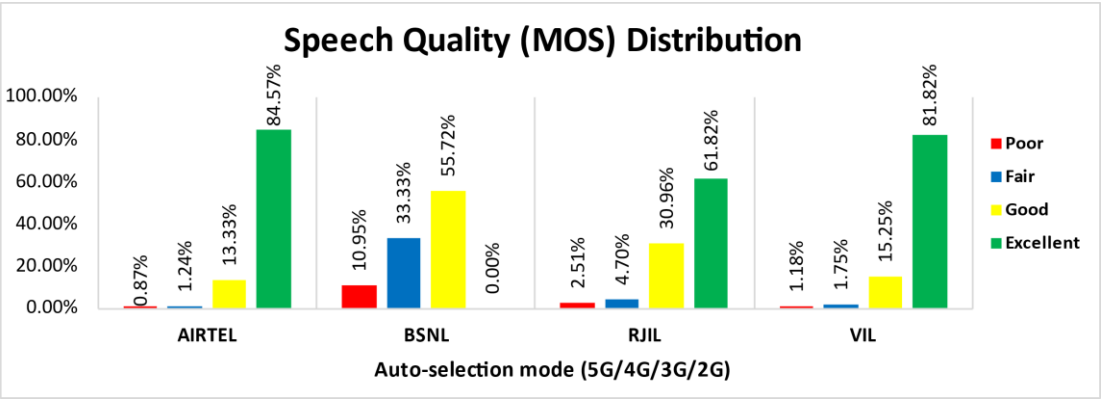


Figure- 4: Distribution of samples in MOS score range.

(d) Inter-service provider voice call performance: To check the performance of inter-service provider call setup success rate, total 55 to 74 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	100.00	NA	100.00	98.36
RJIL	100.00	100.00	NA	100.00
VIL	100.00	100.00	100.00	NA

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

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

Call setup time average (seconds)				
From Service Provider	**To Service Provider**			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
AIRTEL	NA	6.12	1.60	1.86
BSNL	5.00	NA	4.73	5.06
RJIL	1.76	5.71	NA	1.91
VIL	2.14	3.90	1.85	NA

Table-10: Call setup time across service providers.

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

3.3 Data performance

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

Parameters		**Service Provider**			
		Auto-selection mode (5G/4G/3G/2G)			
		AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput (Mbits/s)	**Average**	108.23	1.28	202.76	24.73
	80th Percentile	162.56	1.64	344.41	38.71
	20th Percentile	39.75	0.36	57.69	8.19
Upload Throughput (Mbits/s)	**Average**	43.14	1.69	23.44	9.87
	80th Percentile	71.81	2.33	41.11	15.56
	20th Percentile	11.61	0.83	4.57	5.02
Latency (ms)	**50th Percentile**	18.65	44.50	16.10	24.80

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

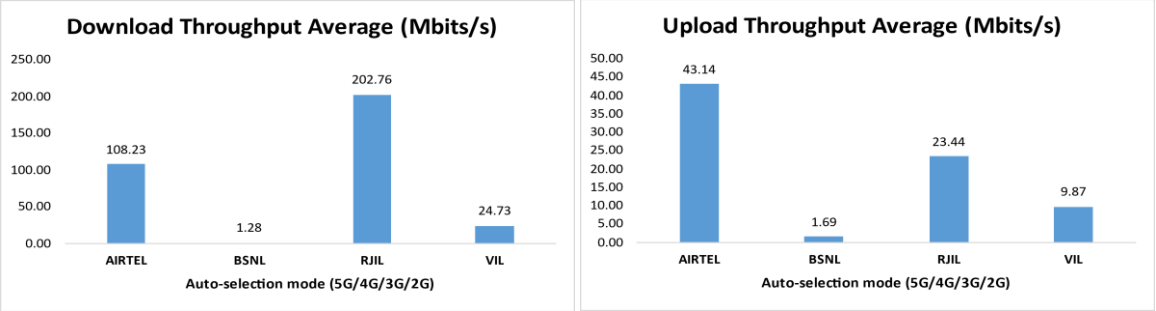


Figure- 5: Download and Upload throughput

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	1867	NA
4G	3045	337	245	2172
3G	NA	653	NA	NA
2G	0	88	NA	14

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.
- 0- No cell Id's were found in respective technology.

Detailed QoS Performance Analysis

4. Detailed QoS performance analysis

4.1 Overview

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

4.2 City

Drive test has been conducted from 15th January 2025 to 17th January 2025 in Bengaluru. (Refer Table-1)

4.2.1 Drive test route

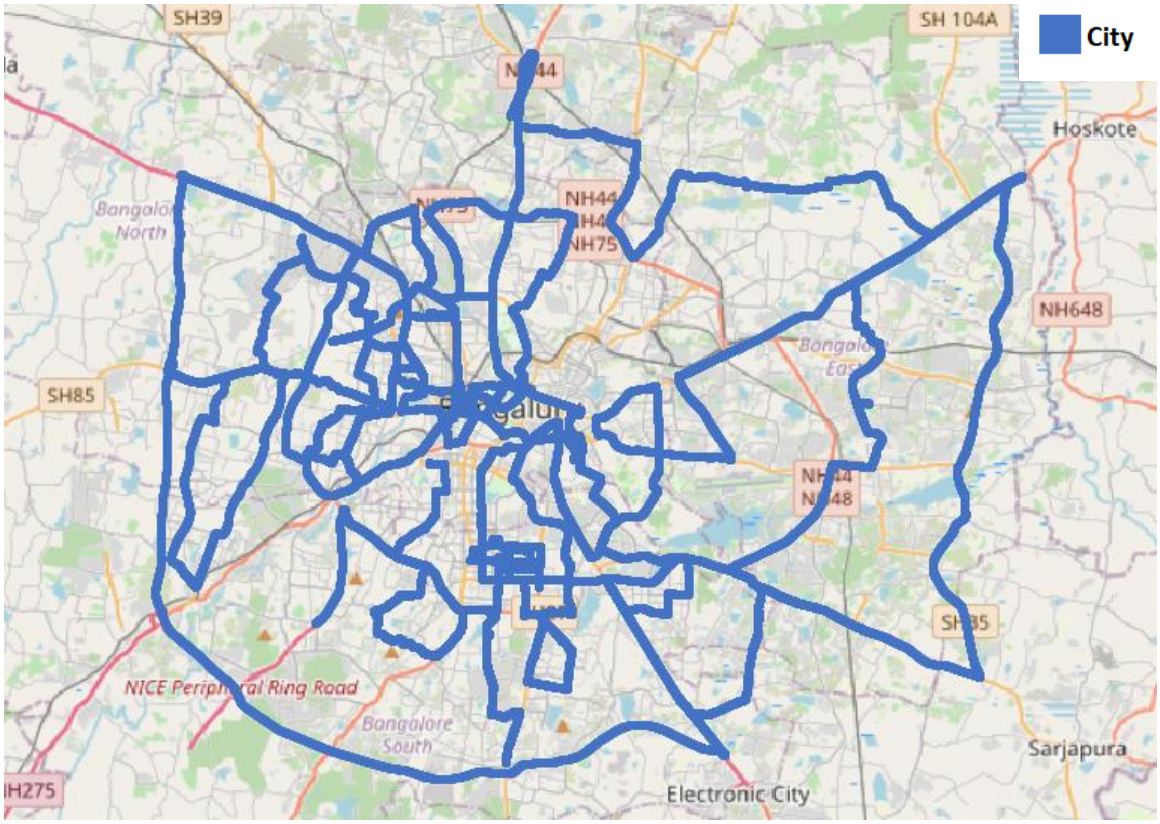


Figure- 6: Drive test routes

4.2.2 Areas covered

Nearby Ashwath Nagar, Jayantinagara, Kasturi Nagar, Anjanapura, Indiranagar, C V Raman Nagar, Richards Town, Banaswadi, Cleveland Town, Jayanagar East etc.

4.2.3 Voice performance

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

Parameters	Service Provider		
	3G/2G network mode only		
	AIRTEL	BSNL	VIL
Call Attempts	844	858	803
Call Setup Success Rate %	98.93	98.95	98.51
Drop Call Rate %	0.12	1.53	0.51
Call Setup Time-Average (Second)	5.02	3.51	11.40
Handover Success Rate %	98.55	99.66	98.07

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

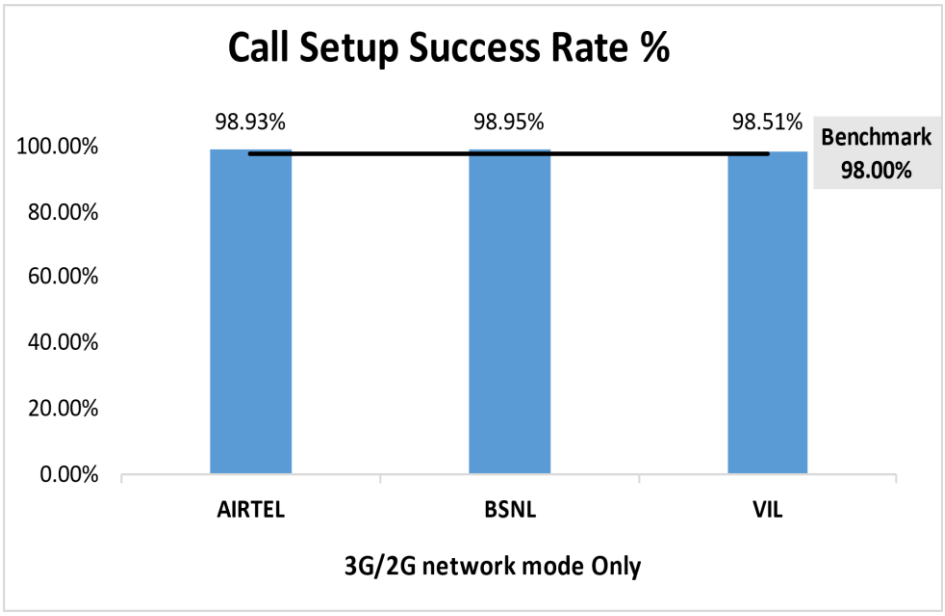


Figure-7: Performance for call setup success rate.

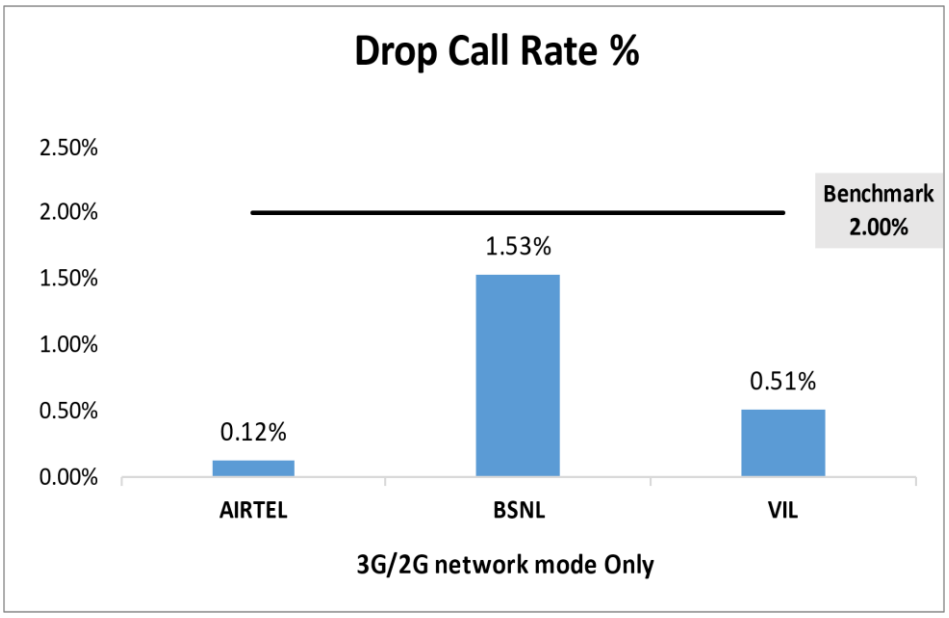


Figure-8: Performance for drop call rate.

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

Technology	Service Provider		
	AIRTEL	BSNL	VIL
3G	NA	61.30%	NA
2G	100.00%	38.69%	99.98%
Limited Service	0.00%	0.00%	0.02%

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

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

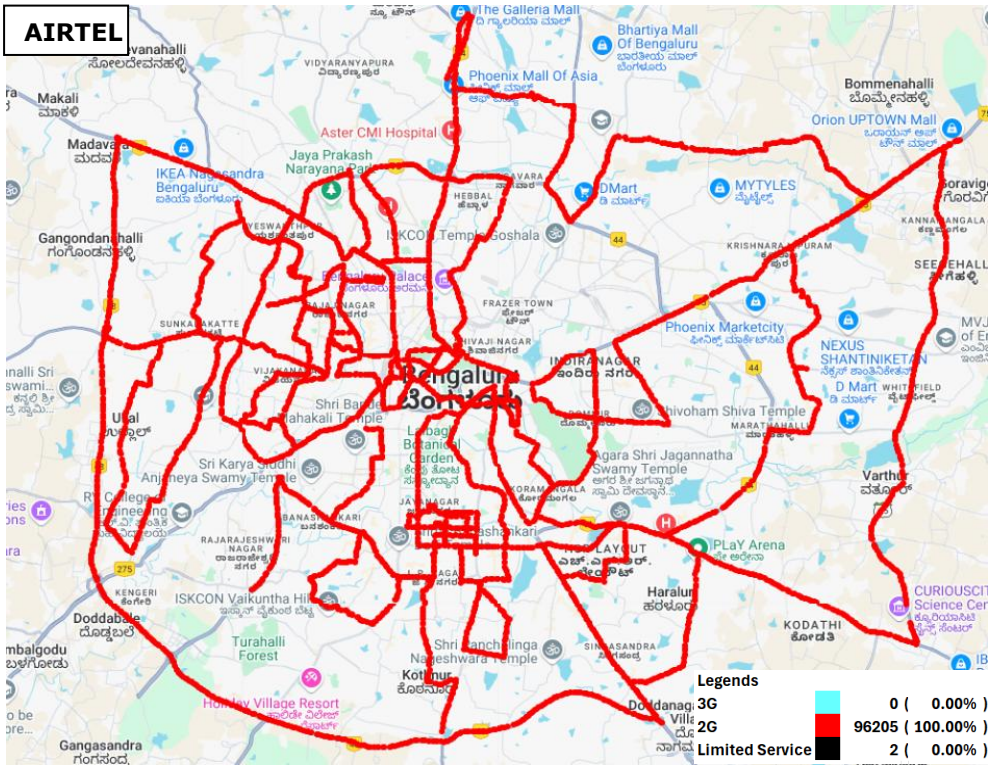


Figure-9: Serving technology plots 3G/2G network mode – AIRTEL.

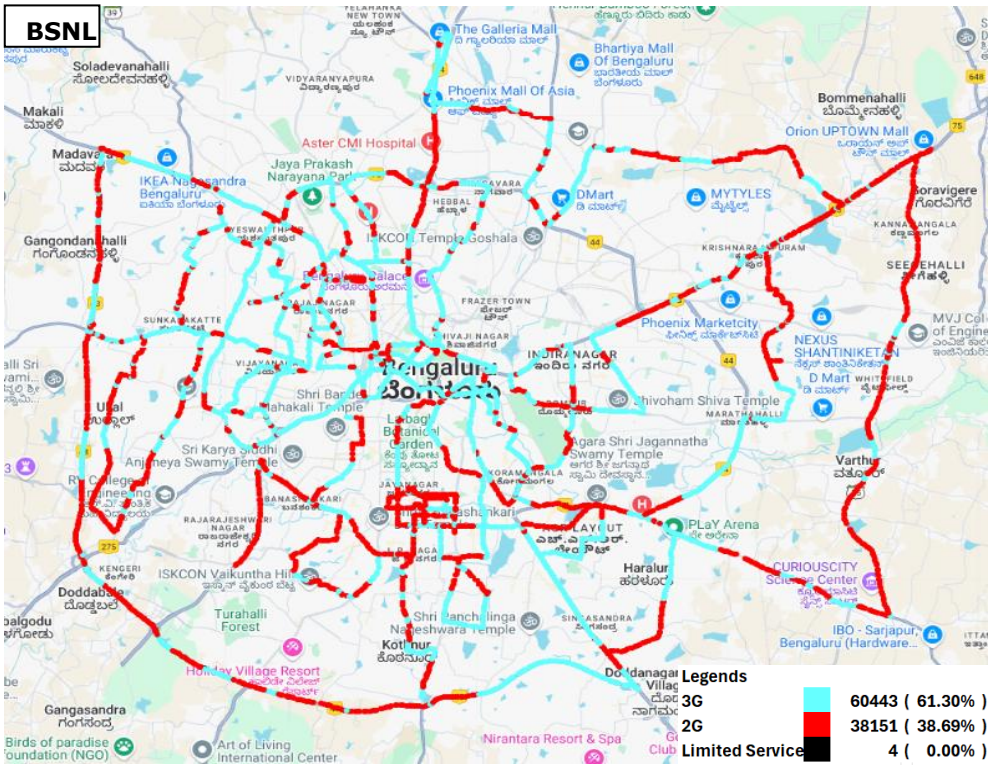


Figure-10: Serving technology plots 3G/2G network mode –BSNL.

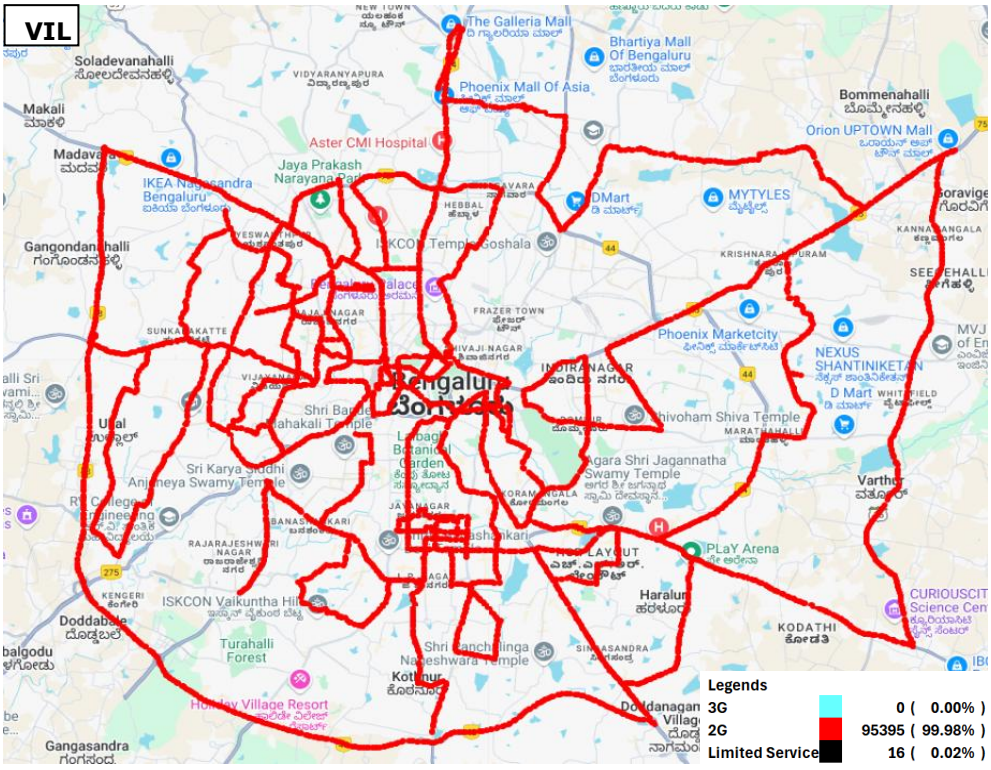


Figure-11: Serving technology plots 3G/2G network mode –VIL.

(c) Network Signal Strength Distribution: The following chart represents signal strength distribution for 3G/2G network mode only. (Refer figure- 25, 26 & 27 for map view)

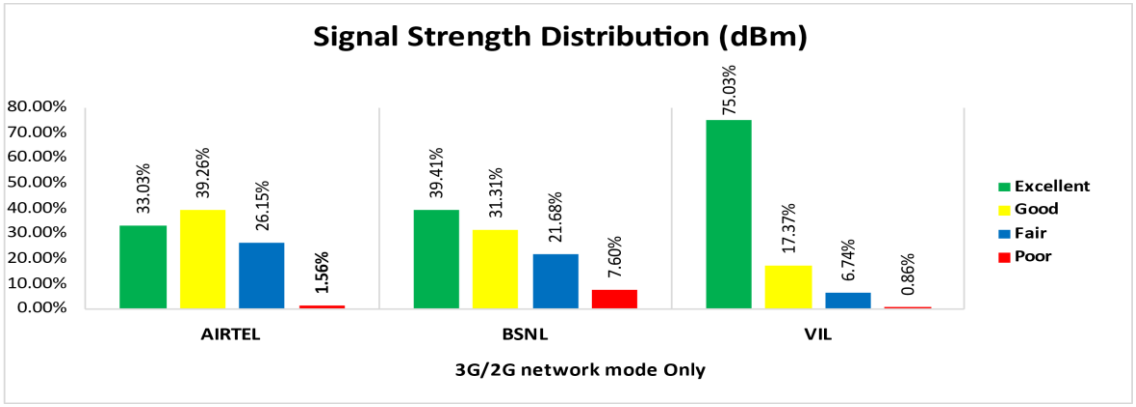


Figure-12: Signal strength distribution 3G/2G network mode only.

Observations:

- Airtel has 33% of samples falling in the excellent signal strength category.
- BSNL has 39% of samples falling in the excellent signal strength category.
- VIL has 75% 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	885	995	901	839
Call Setup Success Rate %	99.89	78.89	99.78	99.40
Drop Call Rate %	0.11	6.75	0.89	0.00
Call Setup Time Average (Second)	1.09	2.55	0.47	8.12
Handover Success Rate %	99.98	98.95	99.96	99.70

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

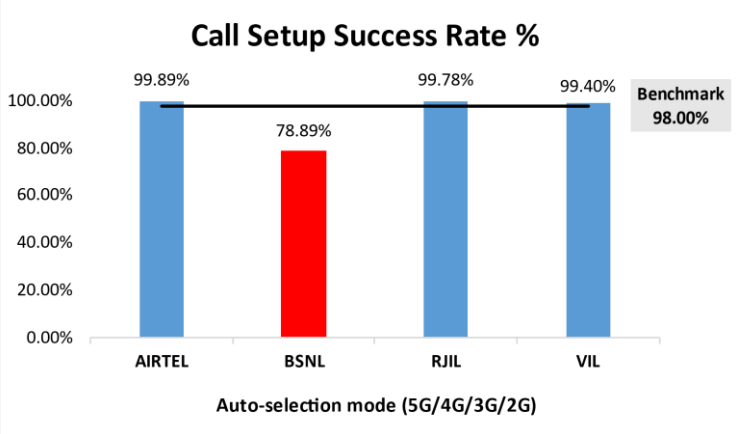


Figure-13: Performance for call setup success rate.

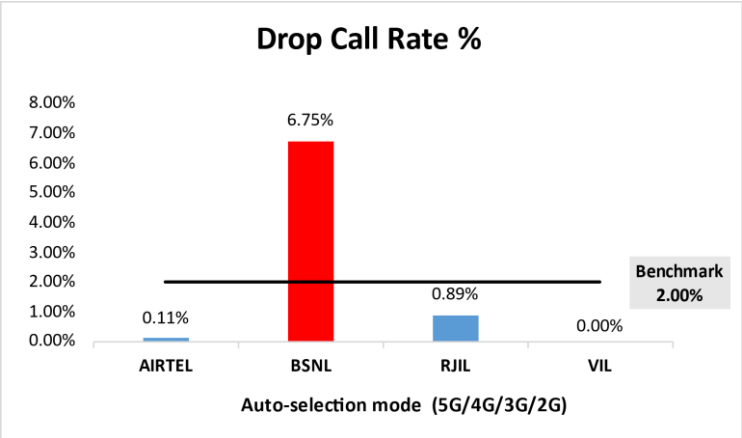


Figure-14: Performance for drop call rate.

Parameter	Service Provider			
	Mobile-to-Mobile (5G/4G - Open Mode)			
	AIRTEL	BSNL	RJIL	VIL
Call Established (within service provider Network)	854	844	863	809
Number of silence call for >4 Sec	3	NA	25	0
Silence Call Rate %	0.35	NA	2.90	0.00
Number of silence instances for >4 Sec	5	NA	29	0
Number of silence instances for >3 Sec	14	NA	37	0
Number of silence instances for >2 sec	41	NA	65	8
RTP Jitter (4G & 5G) in ms	4.14	NA	14.27	15.38
Packet loss Rate Downlink %	0.38	NA	0.63	0.32
Packet loss Rate Uplink %	0.44	NA	1.08	0.54

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.
- In BSNL, VoLTE services were observed in mobile to switch calls only. All mobile to mobile calls were initiated on 2G/3G only.

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

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

Speech Quality (MOS) distribution	Service Provider			
	AIRTEL	BSNL	RJIL	VIL
Total Number of MOS Samples for calls in table-16	5086	4264	4977	4741
Speech Quality (Average MOS Score)	4.02	2.85	3.83	4.33
Number of samples with MOS >=4 to <5 (Excellent)	4301	0	3077	3879
Number of samples with MOS >=3 to <4 (Good)	678	2376	1541	723
Number of samples with MOS >=2 to <3 (Fair)	63	1421	234	83
Number of samples with MOS >=1 to <2 (Poor)	44	467	125	56
%age of samples with MOS >=4 to <5 (Excellent)	84.57%	0.00%	61.82%	81.82%
%age of samples with MOS >=3 to <4 (Good)	13.33%	55.72%	30.96%	15.25%
%age of samples with MOS >=2 to <3 (Fair)	1.24%	33.33%	4.70%	1.75%
%age of samples with MOS >=1 to <2 (Poor)	0.87%	10.95%	2.51%	1.18%

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

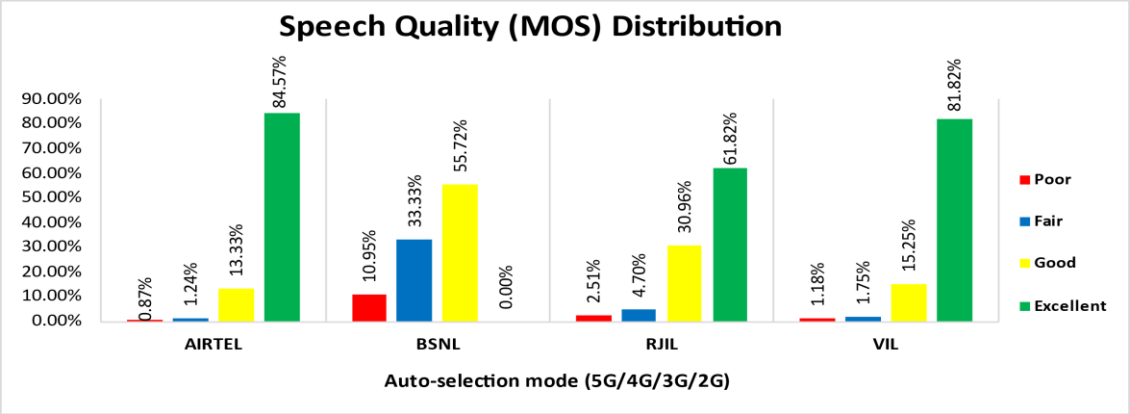


Figure-15: Distribution of samples in MOS score range.

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

Technology	Service Provider			
	AIRTEL	BSNL	RJIL	VIL
5G	15.88%	NA	73.77%	NA
4G	84.12%	54.65%	26.23%	99.89%
3G	NA	22.44%	NA	NA
2G	0.00%	22.06%	NA	0.11%
Limited Service	0.00%	0.85%	0.00%	0.00%

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

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

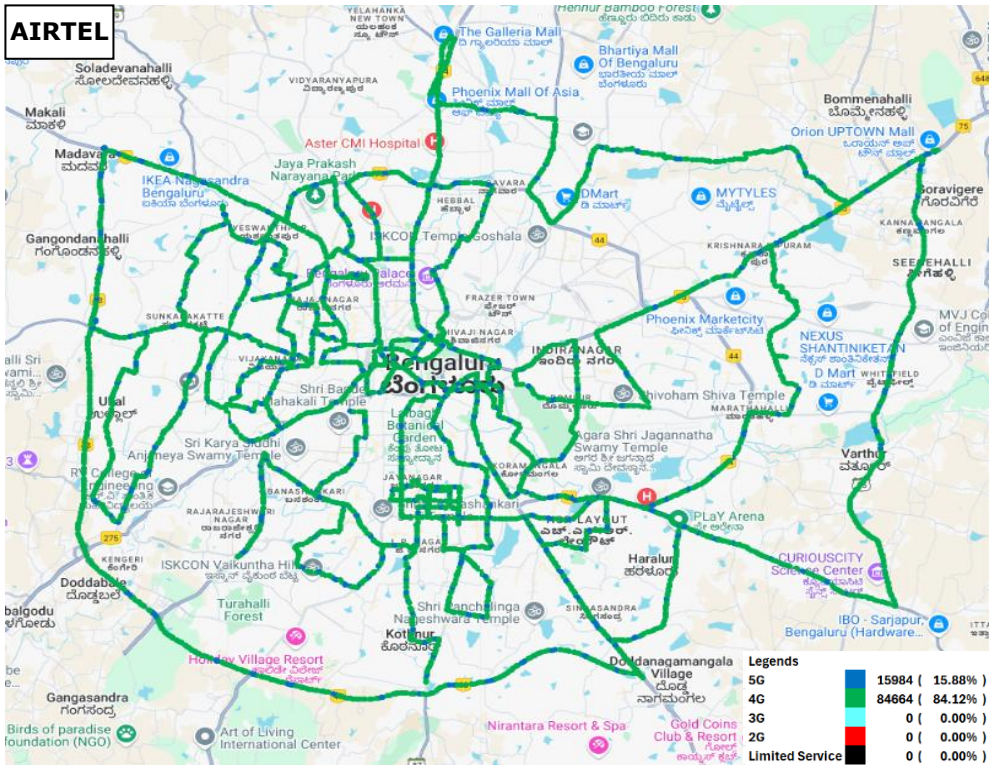


Figure-16: Serving technology plots in auto-selection mode (5G/4G/3G/2G) -AIRTEL.

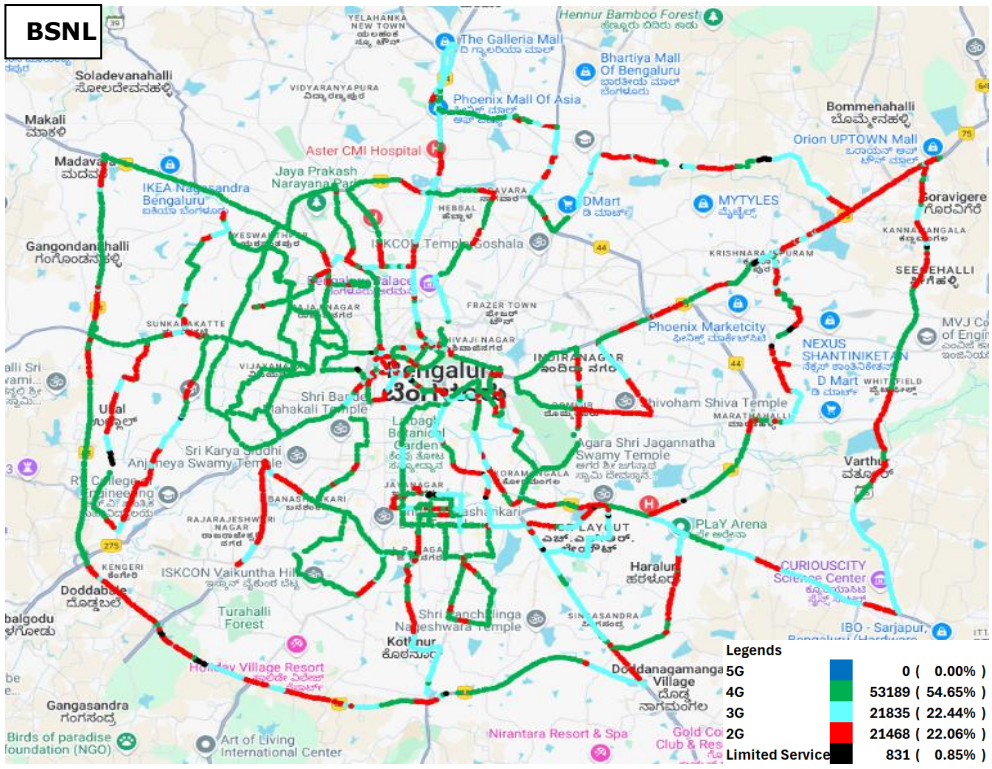


Figure-17: Serving technology plots in auto-selection mode (5G/4G/3G/2G) -BSNL.

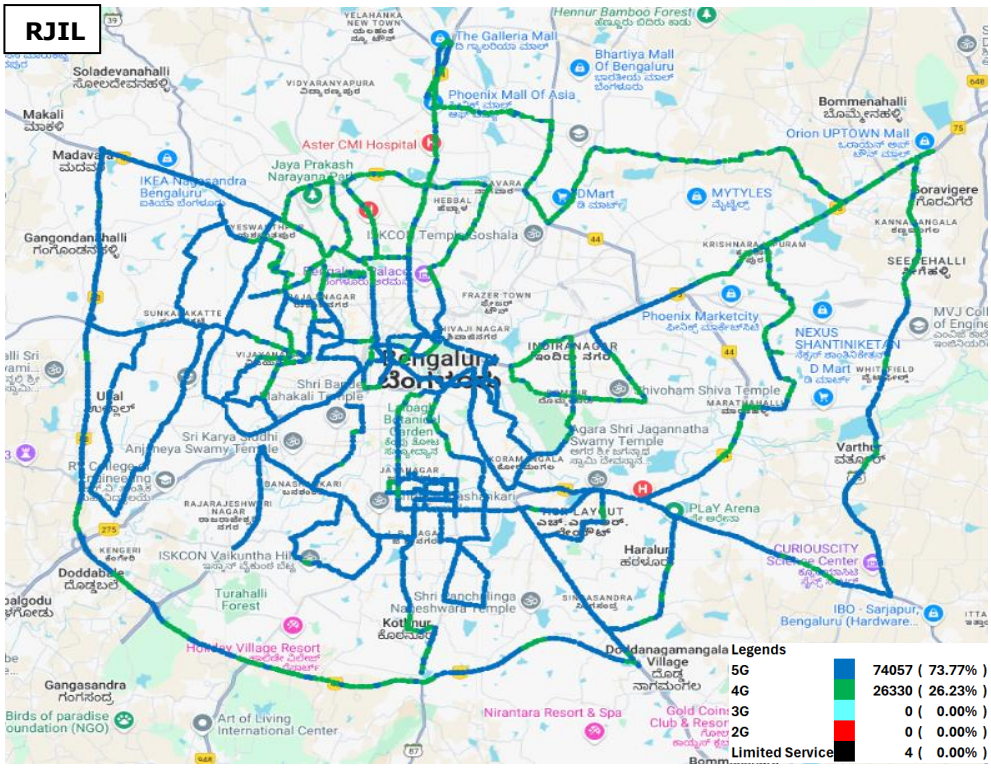


Figure-18: Serving technology plots in auto-selection mode (5G/4G/3G/2G)- RJIL.

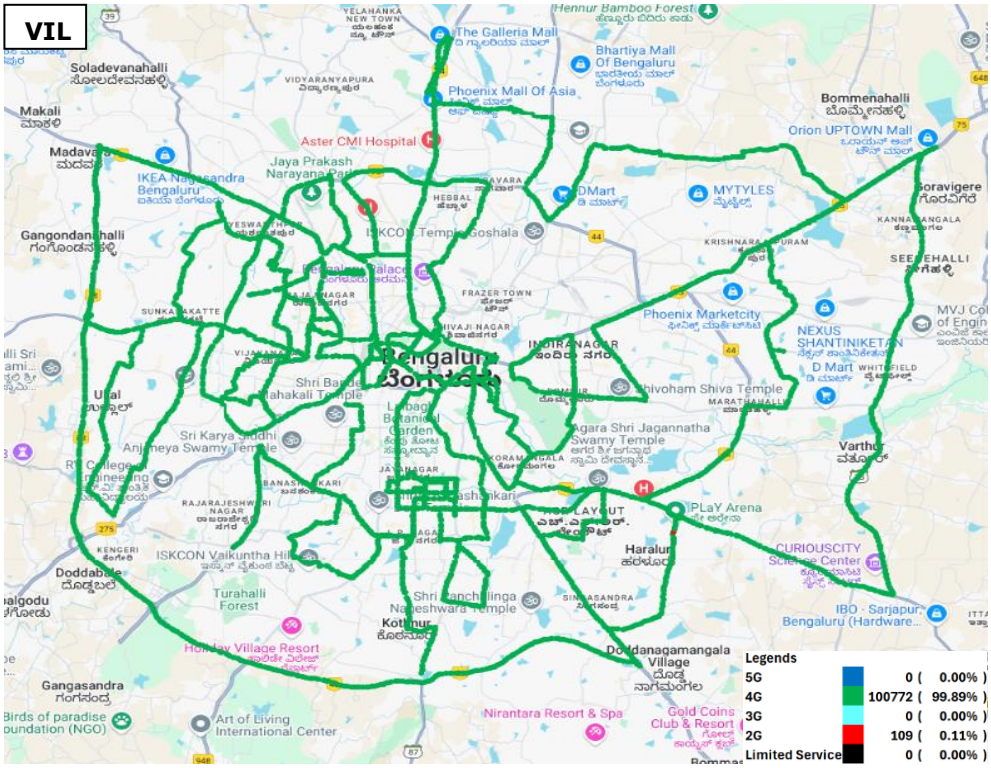


Figure-19: Serving technology plots in auto-selection mode (5G/4G/3G/2G) – VIL.

(g) Network Signal Strength Distribution: The following chart provide signal strength distribution for auto-selection mode (5G/4G/3G/2G). (Refer figure-28, 29, 30 & 31 for map view)

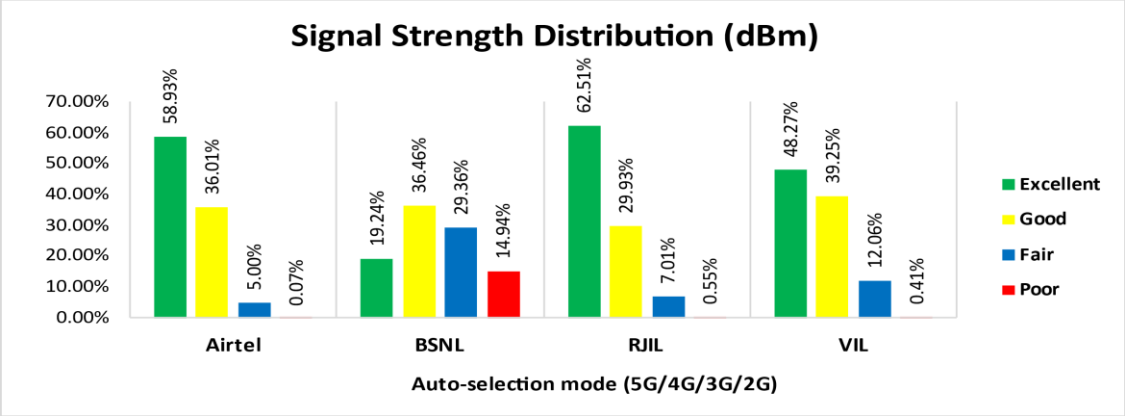


Figure-20: Signal strength distribution auto-selection mode 5G/4G/3G/2G.

Observations:

- Airtel has 59% samples falling in the excellent signal strength category.
- BSNL has 19% samples falling in the excellent signal strength category.
- RJIL has 63% samples falling in the excellent signal strength category.
- VIL has 48% 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	113.62	1.34	229.24	23.53
	80th Percentile	168.54	1.72	359.26	37.12
	20th Percentile	51.64	0.38	92.37	8.14
Upload Throughput (Mbits/s)	Average	45.46	1.65	26.01	9.59
	80th Percentile	73.98	2.20	44.27	14.64
	20th Percentile	15.44	0.82	7.13	5.20
Latency (ms)	50th Percentile	18.65	44.75	13.80	25.05

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

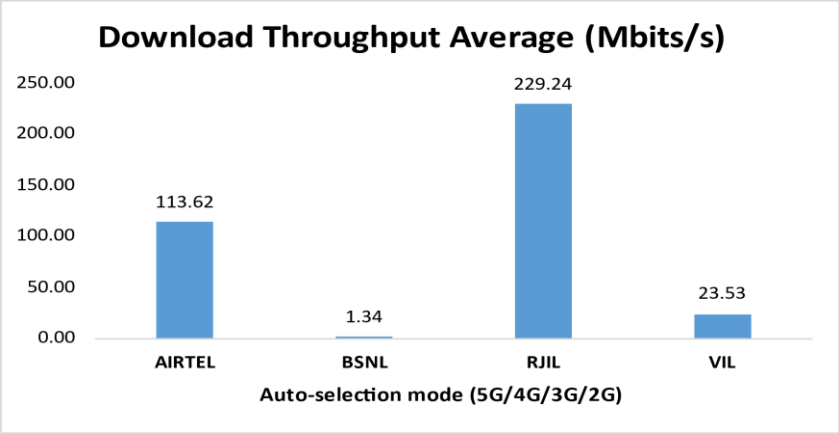


Figure- 21: Download throughput

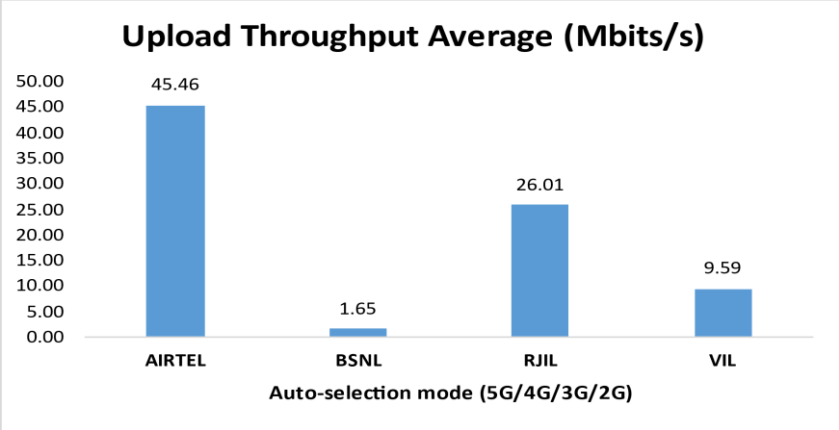


Figure- 22: Upload throughput

4.3 Hotspots

Hotspot testing have been done on 20th January 2025. Nine locations have been tested in the city.

4.3.1 Locations

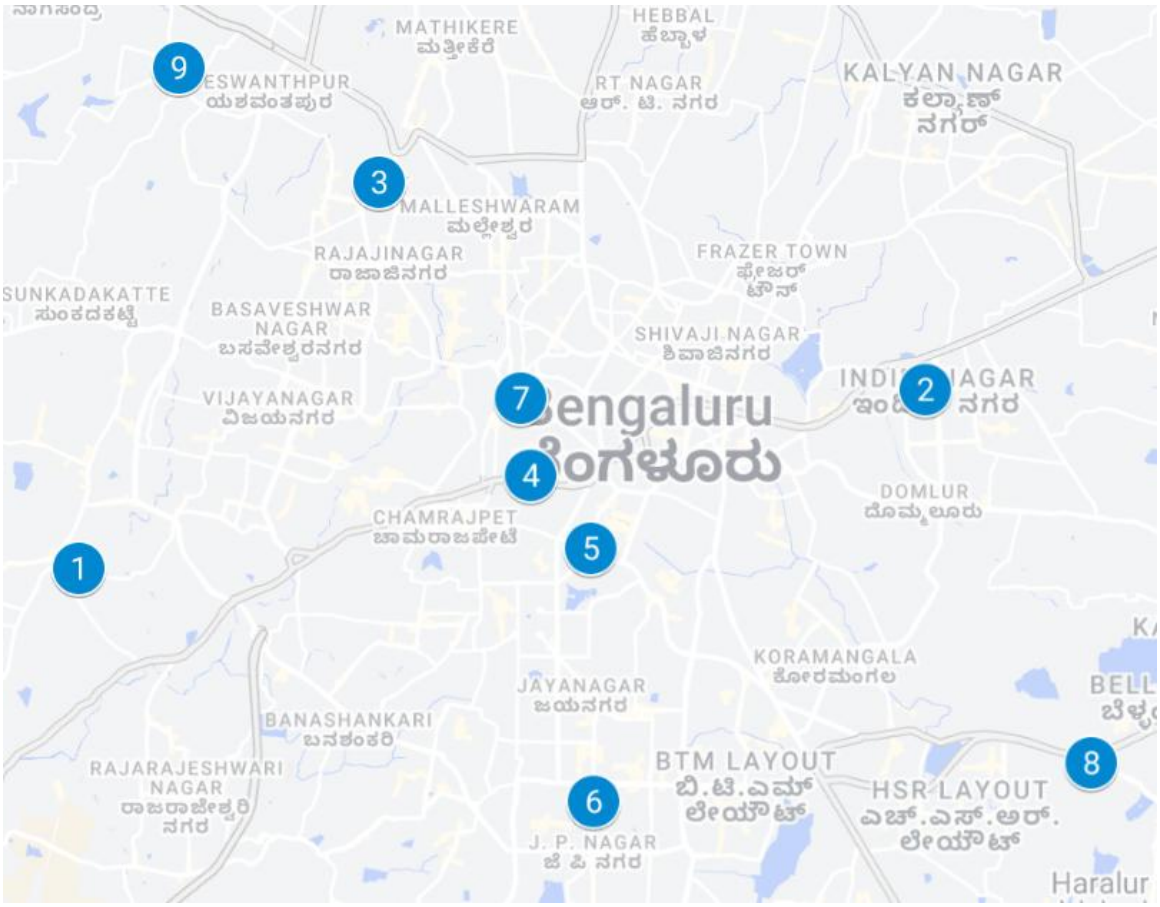


Figure- 23: Hotspot locations

4.3.2 Hotspot covered

1. Banglore University Campus
2. Indiranagar Metro Station
3. ISKCON Temple Rajaji Nagar
4. KR Market
5. Lal-Bagh Botanical Garden
6. LIC Office Jeevan Soudha JP Nagar
7. Majestic Bus Stand
8. Manipal Hospital Sarjapur Road
9. Peenya Industrial Area

4.3.3 Voice performance

Overall Voice Performance				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	90	90	90	90
Call Setup Success Rate %	100.00	93.33	100.00	100.00
Drop Call Rate %	0.00	1.19	0.00	0.00
Call Setup Time-Average (Second)	1.12	2.81	0.41	0.85

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

Bangalore University Campus				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Second)	1.08	0.73	0.44	0.95

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

Indiranagar Metro 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	80.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Second)	1.36	4.30	0.45	0.84

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

ISKCON Temple Rajaji Nagar				
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	70.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Second)	1.05	7.46	0.37	0.90

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

KR Market				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Second)	1.11	3.27	0.42	0.81

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

Lal-Bagh Botanical Garden				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	90.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Second)	1.08	0.91	0.40	0.89

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

LIC Office Jeevan Soudha JP Nagar				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Second)	1.13	0.60	0.41	0.88

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

Majestic 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 (Second)	1.13	4.36	0.42	0.79

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

Manipal Hospital Sarjapur Road				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Second)	1.06	2.33	0.37	0.81

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

Peenya Industrial Area				
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	10.00	0.00	0.00
Call Setup Time-Average (Second)	1.10	2.56	0.40	0.81

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

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

Overall Data Performance				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	122.42	0.98	225.09	30.70
Download Throughput 80th Percentile (Mbit/s)	138.62	1.44	366.20	47.01
Download Throughput 20th Percentile (Mbit/s)	67.70	0.53	83.79	7.49
Download Session Setup Success Rate %	100.00	73.33	88.89	97.78
Upload Throughput Average (Mbits/s)	70.38	1.87	24.84	10.59
Upload Throughput 80th Percentile (Mbit/s)	105.56	2.54	37.11	15.99
Upload Throughput 20th Percentile (Mbit/s)	26.53	1.27	7.02	2.23
Upload Session Setup Success Rate %	100.00	73.33	100.00	97.78
Web Browsing Delay (Second)	2.23	4.47	2.50	8.29
Youtube Initial Buffer Delay (Second)	0.56	2.12	0.69	2.12
Latency (ms) - 50th Percentile	17.90	44.60	19.65	24.33
Jitter (ms)	5.74	74.02	18.01	5.81
Packet Loss Rate%	0.14	17.12	4.54	0.81
Packet Loss Rate- 90th percentile	0.42	43.14	17.22	1.42

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

Bangalore University Campus				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	76.40	0.97	56.18	39.39
Download Session Setup Success Rate %	100.00	80.00	80.00	100.00
Upload Throughput Average (Mbits/s)	74.05	2.26	8.72	13.49
Upload Session Setup Success Rate %	100.00	80.00	100.00	100.00
Web Browsing Delay (Second)	2.32	4.11	2.21	8.76
Youtube Initial Buffer Delay (Second)	0.50	2.19	0.62	1.60
Latency (ms)- 50th Percentile	17.35	43.50	15.30	22.05
Jitter (ms)	4.40	93.68	3.00	1.19
Packet Loss Rate%	0.00	9.00	0.00	0.30

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

Indiranagar Metro Station				
Parameters	**Service Provider**			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	102.59	0.71	130.72	9.84
Download Session Setup Success Rate %	100.00	60.00	100.00	100.00
Upload Throughput Average (Mbits/s)	28.90	1.57	9.11	3.08
Upload Session Setup Success Rate %	100.00	80.00	100.00	100.00
Web Browsing Delay (Second)	2.31	6.23	2.16	9.06
Youtube Initial Buffer Delay (Second)	0.56	2.22	0.64	3.66
Latency (ms) - 50th Percentile	20.48	56.00	22.20	29.55
Jitter (ms)	6.71	43.93	10.16	16.71
Packet Loss Rate%	0.30	27.10	0.10	3.50

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

ISKCON Temple Rajaji Nagar				
Parameters	**Service Provider**			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	242.49	0.01	129.70	11.29
Download Session Setup Success Rate %	100.00	40.00	80.00	100.00
Upload Throughput Average (Mbits/s)	114.08	1.35	4.52	14.61
Upload Session Setup Success Rate %	100.00	60.00	100.00	100.00
Web Browsing Delay (Second)	2.19	-	3.39	8.35
Youtube Initial Buffer Delay (Second)	0.52	-	0.82	1.35
Latency (ms) - 50th Percentile	17.55	71.25	41.20	27.00
Jitter (ms)	3.73	201.16	32.24	3.31
Packet Loss Rate%	0.00	80.58	16.00	0.40

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

Note- Web Browsing and Youtube test were failed at this location for BSNL.

KR Market				
Parameters	**Service Provider**			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	115.05	1.38	248.16	33.24
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	65.32	1.29	24.96	15.75
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.39	4.69	2.39	7.10
Youtube Initial Buffer Delay (Second)	0.62	2.44	0.60	0.80
Latency (ms) - 50th Percentile	30.13	45.00	20.13	20.50
Jitter (ms)	7.83	9.61	15.79	2.90
Packet Loss Rate%	0.50	1.20	0.30	0.30

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

Lal-Bagh Botanical Garden				
Parameters	**Service Provider**			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	55.67	0.87	581.09	2.79
Download Session Setup Success Rate %	100.00	100.00	80.00	100.00
Upload Throughput Average (Mbits/s)	12.86	2.42	72.72	2.28
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.38	3.23	2.30	8.77
Youtube Initial Buffer Delay (Second)	0.68	1.14	0.60	4.62
Latency (ms) - 50th Percentile	18.45	46.15	15.08	22.85
Jitter (ms)	3.29	3.52	3.85	16.66
Packet Loss Rate%	0.00	0.20	0.00	0.60

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

LIC Office Jeevan Soudha JP Nagar				
Parameters	**Service Provider**			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	91.29	0.98	136.33	60.17
Download Session Setup Success Rate %	100.00	80.00	80.00	100.00
Upload Throughput Average (Mbits/s)	101.69	2.22	6.06	0.76
Upload Session Setup Success Rate %	100.00	60.00	100.00	100.00
Web Browsing Delay (Second)	2.14	3.87	3.74	8.29
Youtube Initial Buffer Delay (Second)	0.52	1.68	0.87	2.68
Latency (ms) - 50th Percentile	17.58	33.98	46.70	26.45
Jitter (ms)	7.19	29.02	54.53	2.13
Packet Loss Rate%	0.40	2.00	22.10	0.60

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

Majestic Bus Stand				
Parameters	**Service Provider**			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	77.67	1.60	101.65	30.78
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	44.28	2.42	29.74	14.52
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.25	4.26	2.19	7.44
Youtube Initial Buffer Delay (Second)	0.64	2.89	0.81	0.98
Latency (ms) - 50th Percentile	13.78	35.45	22.73	25.30
Jitter (ms)	6.67	46.85	17.16	2.60
Packet Loss Rate%	0.00	3.30	0.70	0.90

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

Manipal Hospital Sarjapur Road				
Parameters	**Service Provider**			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	73.15	0.96	131.56	23.98
Download Session Setup Success Rate%	100.00	60.00	80.00	80.00
Upload Throughput Average (Mbits/s)	74.39	1.43	33.28	16.18
Upload Session Setup Success Rate %	100.00	60.00	100.00	80.00
Web Browsing Delay (Second)	2.13	4.90	2.21	9.59
Youtube Initial Buffer Delay (Second)	0.49	2.27	0.69	1.71
Latency (ms)- 50th Percentile	17.25	52.50	21.55	22.10
Jitter (ms)	7.86	249.86	20.75	3.30
Packet Loss Rate%	0.10	13.60	1.70	0.60

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

Peenya Industrial Area				
Parameters	**Service Provider**			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	267.44	0.07	559.15	63.50
Download Session Setup Success Rate%	100.00	40.00	80.00	100.00
Upload Throughput Average (Mbits/s)	117.86	0.85	34.48	15.74
Upload Session Setup Success Rate %	100.00	20.00	100.00	100.00
Web Browsing Delay (Second)	1.97	-	1.91	8.12
Youtube Initial Buffer Delay (Second)	0.49	-	0.61	1.70
Latency (ms)- 50th Percentile	17.03	-	13.60	25.55
Jitter (ms)	3.94	-	4.57	3.44
Packet Loss Rate%	0.00	-	0.00	0.10

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

Note- Web Browsing, Youtube and Ping test were failed at this location for BSNL.

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

Overall Data Performance				
Parameters	**Service Provider**			
	Auto-selection mode (4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	49.83	0.86	57.37	16.18
Download Throughput 80th Percentile (Mbit/s)	89.72	1.32	94.35	29.68
Download Throughput 20th Percentile (Mbit/s)	16.94	0.42	13.27	8.39
Download Session Setup Success Rate %	100.00	84.44	91.11	100.00
Upload Throughput Average (Mbits/s)	15.51	1.77	12.29	9.24
Upload Throughput 80th Percentile (Mbit/s)	19.21	2.08	21.46	12.91
Upload Throughput 20th Percentile (Mbit/s)	10.78	1.27	5.79	5.52
Upload Session Setup Success Rate %	100.00	91.11	97.78	100.00

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

Bangalore University Campus				
Parameters	**Service Provider**			
	Auto-Selection Mode (4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	91.26	0.90	55.44	8.47
Download Session Setup Success Rate%	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	21.81	3.06	6.52	6.58
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00

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

Indiranagar Metro Station				
Parameters	**Service Provider**			
	Auto-Selection Mode (4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	86.30	0.90	83.74	27.15
Download Session Setup Success Rate%	100.00	60.00	100.00	100.00
Upload Throughput Average (Mbits/s)	16.75	1.40	21.11	7.92
Upload Session Setup Success Rate %	100.00	80.00	100.00	100.00

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

ISCKON Temple Rajaji Nagar				
Parameters	**Service Provider**			
	Auto-Selection Mode 4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	84.84	0.20	9.73	8.36
Download Session Setup Success Rate%	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	15.29	1.36	1.55	4.55
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00

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

KR Market				
Parameters	**Service Provider**			
	Auto-Selection Mode (4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	13.31	1.06	15.60	31.66
Download Session Setup Success Rate%	100.00	100.00	60.00	100.00
Upload Throughput Average (Mbits/s)	13.75	1.37	4.35	14.16
Upload Session Setup Success Rate %	100.00	100.00	80.00	100.00

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

Lal-Bagh Botanical Garden				
Parameters	**Service Provider**			
	Auto-Selection Mode (4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	19.69	0.60	100.21	11.52
Download Session Setup Success Rate%	100.00	80.00	100.00	100.00
Upload Throughput Average (Mbits/s)	7.00	1.44	9.51	3.61
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00

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

LIC Office Jeevan Soudha JP Nagar				
Parameters	**Service Provider**			
	Auto-Selection Mode (4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	36.15	0.90	83.04	8.44
Download Session Setup Success Rate%	100.00	60.00	100.00	100.00
Upload Throughput Average (Mbits/s)	18.64	1.44	18.38	9.58
Upload Session Setup Success Rate %	100.00	80.00	100.00	100.00

Table-46: Summary of Data performance in network auto-selection mode (4G/3G/2G).

Majestic Bus Stand				
Parameters	**Service Provider**			
	Auto-Selection Mode (4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	29.95	1.18	11.95	32.74
Download Session Setup Success Rate%	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	18.86	1.91	10.33	16.37
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00

Table-47: Summary of Data performance in network auto-selection mode (4G/3G/2G).

Manipal Hospital Sarjapur Road				
Parameters	**Service Provider**			
	Auto-Selection Mode (4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	11.77	0.41	42.30	8.75
Download Session Setup Success Rate%	100.00	60.00	100.00	100.00
Upload Throughput Average (Mbits/s)	10.94	1.69	10.06	10.24
Upload Session Setup Success Rate %	100.00	60.00	100.00	100.00

Table-48: Summary of Data performance in network auto-selection mode (4G/3G/2G).

Peenya Industrial Area				
Parameters	**Service Provider**			
	Auto-Selection Mode (4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	75.19	1.37	124.46	8.50
Download Session Setup Success Rate%	100.00	100.00	60.00	100.00
Upload Throughput Average (Mbits/s)	16.56	2.06	27.23	10.13
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00

Table-49: Summary of Data performance in network auto-selection mode (4G/3G/2G).

4.4 Walk Test

Walk Test has been conducted on 18th January 2025. Four locations have been tested in the city.

4.4.1 Drive test route

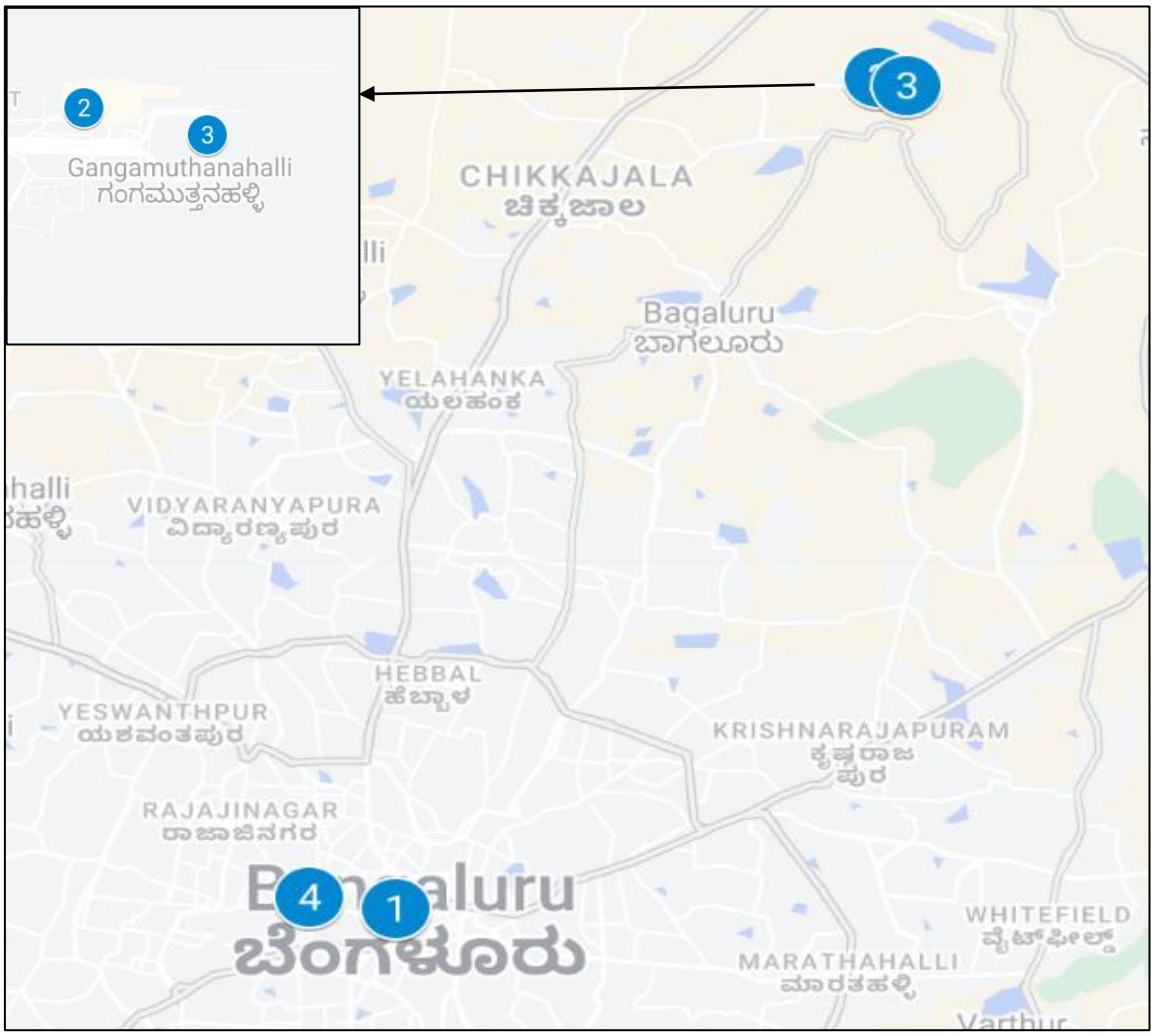


Figure-24: Walk Test locations.

4.4.2 Walk Test Covered

1. (Terminal I) Kempegowda International Airport
2. (Terminal II) Kempegowda International Airport
3. Cubbon Park
4. KSR Railway Station

4.4.3 Voice Performance

(Terminal I) Kempegowda International Airport				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	41	44	42	41
Call Setup Success Rate %	100.00	77.27	95.24	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Second)	0.93	3.33	0.88	0.84

Table-50: Summary of voice call performance in network auto-selection mode (5G/4G/3G/2G).

(Terminal II) Kempegowda International Airport				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	56	74	57	57
Call Setup Success Rate %	100.00	33.78	100.00	100.00
Drop Call Rate %	0.00	8.00	0.00	0.00
Call Setup Time-Average (Second)	0.92	6.48	0.53	0.83

Table-51: Summary of voice call performance in network auto-selection mode (5G/4G/3G/2G).

Cubbon Park				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	20	23	21	20
Call Setup Success Rate %	100.00	60.87	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Second)	1.00	2.31	0.73	0.85

Table-52: Summary of voice call performance in network auto-selection mode (5G/4G/3G/2G).

KSR Railway Station				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	25	24	25	25
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)	1.01	2.04	0.52	0.79

Table-53: Summary of voice call performance in network auto-selection mode (5G/4G/3G/2G).

4.4.4 Data Performance

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

(Terminal I) Kempegowda International Airport				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	32.88	0.71	15.60	27.23
Download Session Setup Success Rate %	100.00	58.18	55.00	100.00
Upload Throughput Average (Mbits/s)	10.26	1.36	3.96	15.33
Upload Session Setup Success Rate %	100.00	58.49	85.00	100.00
Latency (ms) - 50th Percentile	21.15	40.53	34.10	27.20

Table-54: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

(Terminal II) Kempegowda International Airport				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	30.24	0.36	20.69	48.80
Download Session Setup Success Rate %	100.00	10.56	72.88	100.00
Upload Throughput Average (Mbits/s)	8.13	0.49	2.44	14.17
Upload Session Setup Success Rate %	100.00	10.63	89.47	100.00
Latency (ms) - 50th Percentile	20.40	72.00	29.40	20.65

Table-55: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

Cubbon Park				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	228.78	1.42	185.21	20.63
Download Session Setup Success Rate %	100.00	84.62	90.91	100.00
Upload Throughput Average (Mbits/s)	43.55	3.60	11.01	9.29
Upload Session Setup Success Rate %	100.00	88.46	100.00	100.00
Latency (ms) - 50th Percentile	17.75	39.08	20.28	19.60

Table-56: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

KSR Railway Station				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	54.57	1.61	78.13	7.76
Download Session Setup Success Rate %	100.00	51.43	70.37	94.74
Upload Throughput Average (Mbits/s)	34.90	1.79	10.69	0.78
Upload Session Setup Success Rate %	100.00	54.29	92.59	94.74
Latency (ms) - 50th Percentile	22.10	50.00	40.55	28.38

Table-57: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

5. Voice & Data Key findings

5.1 Overall Voice

1. **Call Setup Success Rate:**
   a) Airtel, BSNL and VIL have 98.93%, 98.95% and 98.51% call setup success rate respectively in 3G/2G network mode. (refer table-3)

   b) Airtel, BSNL, RJIL and VIL have 99.91%, 76.64%, 99.65% and 99.53% call setup success rate respectively in auto-selection mode (5G/4G/3G/2G). (refer table-5)

   c) Airtel, RJIL and VIL have 100% call setup success rate while calling on peer service provider's network, while BSNL have block call rate for inter-operator calls. (refer table-9)

2. **Call Setup Time**:
   a) VIL has taken comparatively longer time (11.40 second) to establish the voice call, whereas Airtel and BSNL call setup time is 5.02 & 3.51 seconds respectively in 3G/2G network mode. (refer table-3)

   b) VIL has taken comparatively longer time (6.53 second) to establish the voice call, whereas BSNL, Airtel & RJIL call setup time is 2.68, 1.07 & 0.49 seconds respectively in Auto-selection mode (5G/4G/3G/2G). (refer table-5)

3. **Call Silence/Mute Rate**: In packet switched network (4G/5G), RJIL, Airtel and VIL have 2.90%, 0.35% & 0.00% silence call rate respectively. Further RJIL has higher RTP packet loss rate in downlink (0.63%) compared to Airtel (0.38%) and VIL (0.32%). In uplink the RTP packet loss rate is higher for RJIL (1.08%) compared to VIL (0.54%) and Airtel (0.44%). (refer table-6)

4. **Call Drop Rate**:
   a) Overall BSNL's, VIL's & Airtel's drop call rate 1.53%, 0.51% and 0.12% respectively in 3G/2G network mode. (refer table-3)

   b) Overall BSNL's call drop rate 5.85% is higher than QoS benchmark of 2%, while RJIL, Airtel & VIL have 0.71%, 0.09% and 0.00% drop call rate respectively in Auto-selection mode (5G/4G/3G/2G). (refer table-5)

5.2 Overall Data

1. **Data download and upload performance (Dynamic i.e. while moving):**
   a) BSNL (1.28 Mbps) and VIL (24.73 Mbps) being on 4G as top technology, have comparatively lower data speeds respectively. While Airtel and RJIL have average download speed of 108.23 Mbps and 202.76 Mbps respectively. (refer table-11)

   b) BSNL (1.69 Mbps) and VIL (9.87 Mbps) being on 4G as top technology, have comparatively lower data speeds respectively. While Airtel and RJIL have average upload speed of 43.14 Mbps and 23.44 Mbps respectively. (refer table-11)

2. **Data download and upload performance (static i.e. while stationary):**
   a) At Hotspots, RJIL has better 5G QoS performance comparatively, with average download speed of 225.09 Mbps. (refer table-30)

   b) At Hotspots, Airtel has better 5G QoS performance comparatively, with average upload speed of 70.38 Mbps. (refer table-30)

3. **Data session setup success rate (static i.e. while stationary):**
   a) Airtel, VIL, RJIL and BSNL have 100.00%, 97.78%, 88.89% and 73.33% download session setup success rate respectively. (refer table-30)

   b) Airtel & RJIL have 100.00% while VIL & BSNL have 97.78% and 73.33% upload session setup success rate respectively. (refer table-30)

5.3 Operator wise Key Findings

1. Airtel:

Voice

- 98.93% call setup success rate and 0.12% call drop rate have been observed in 3G/2G network mode. Performance is well within the benchmark of 98.00% & 2.00% respectively for LSA and city drive. (refer table-3 & 13)

- 99.91% call setup success rate and 0.09% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for LSA. Performance is well within the benchmark of 98.00% & 2.00% respectively. (refer table-5)

- 99.89% call setup success rate and 0.11% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for city drive. Performance is well within the benchmark of 98.00% & 2.00% respectively. (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 all 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) for all walk test locations. (refer table-50, 51, 52 & 53)

Data

- Airtel has 108.23 Mbps average download throughput & 43.14 Mbps average upload throughput across measured routes for LSA. (refer table-11)

- Airtel has 113.62 Mbps average download throughput & 45.46 Mbps average upload throughput across measured routes for city drive. (refer table-19)

- Bangalore University Campus, Lal-Bagh Botanical Garden, LIC Office Jeevan Soudha JP Nagar, Majestic Bus Stand and Manipal Hospital Sarjapur road have less download speed (less than 100 Mbps) out of total 9 Hotspots for auto-selection mode (5G/4G/3G/2G). (refer table-31, 35, 36, 37 & 38)

- Lal-Bagh Botanical Garden hotspot has less upload speed (less than 20 Mbps) out of total 9 Hotspots for auto-selection mode (5G/4G/3G/2G). (refer table-35)

- (Terminal I) Kempegowda International Airport, (Terminal II) Kempegowda International Airport and KSR railway station have less download speed (less than 100 Mbps) out of total 4 walk test locations. (refer table-54, 55 & 57)

- (Terminal I) Kempegowda International Airport and (Terminal II) Kempegowda International Airport have less upload speed (less than 20 Mbps) out of 4 walk test locations. (refer table- 54 & 55)

2. BSNL:

Voice

- 98.95% call setup success rate and 1.53% call drop rate have been observed in 3G/2G network mode. Performance is meeting the benchmark of 98.00% & 2.00% respectively for LSA and city drive. (refer table-3 & 13)

- 76.64% 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 the benchmark of 98.00% & 2.00% respectively for LSA. (refer table-5)

- 78.89% call setup success rate and 6.75% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G). Performance is not meeting the benchmark of 98.00% & 2.00% respectively for city drive. (refer table-15)

- 93.33% call setup success rate and 1.19% drop call rate have been observed in auto-selection mode (5G/4G/3G/2G) for all hotspot locations. (refer table-20)

- (Terminal I) Kempegowda International Airport, (Terminal II) Kempegowda International Airport and Cubbon Park have 77.27%, 33.78% and 60.87% call setup success rate respectively for walk test locations. (refer table- 50, 51 & 52)

- At (Terminal II) Kempegowda International Airport 8.00% drop call rate has been observed for walk test locations. (refer table- 51)

Data

- BSNL has 1.28 Mbps average download throughput & 1.69 Mbps average upload throughput across measured routes for LSA. (refer table-11)

- BSNL has 1.34 Mbps average download throughput & 1.65 Mbps average upload throughput across measured routes for city drive. (refer table-19)

- All Hotspots have less download speed (less than 10 Mbps) for auto-selection mode (5G/4G/3G/2G) and auto-selection mode (4G/3G/2G). (refer table-31, 32, 33, 34, 35, 36, 37, 38, 39, 41, 42, 43, 44, 45, 46, 47, 48 & 49)

- Indiranagar Metro Station, ISCKON temple Rajaji Nagar, KR Market, Manipal Hospital Sarjapur road and Peenya Industrial area hotspots have less upload speeds (less than 2 Mbps) for auto-selection mode (5G/4G/3G/2G). (refer table-32, 33, 34, 38 & 39)

- Indiranagar Metro Station, ISCKON temple Rajaji Nagar, KR Market, Lal-Bagh Botanical Garden, LIC Office Jeevan Soudha JP Nagar, Majestic Bus Stand and Manipal Hospital Sarjapur road have less upload speeds (less than 2 Mbps) for auto-selection mode (4G/3G/2G). (refer table-42, 43, 44, 45, 46, 47 & 48)

- (Terminal I) Kempegowda International Airport, (Terminal II) Kempegowda International Airport, Cubbon Park and KSR railway station have less download speed (less than 10 Mbps) out of total 4 walk test locations. (refer table-54, 55, 56 & 57)

- (Terminal I) Kempegowda International Airport, (Terminal II) Kempegowda International Airport and KSR Railway Station have less upload speed (less than 2 Mbps) out of 4 walk test locations. (refer table- 54, 55 & 57)

3. RJIL:

Voice

- 99.65% call setup success rate and 0.71% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G). Performance is well within the benchmark of 98.00% & 2.00% respectively for LSA. (refer table-5)

- 99.78% call setup success rate and 0.89% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G). Performance is well within the benchmark of 98.00% & 2.00% respectively for city 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 all hotspot locations. (refer table-20)

- At (Terminal I) Kempegowda International Airport 95.24% call setup success rate has been observed for auto-selection mode (5G/4G/3G/2G). Performance is not within the benchmark of 98.00% at this walk test location. (refer table-50)

Data

- RJIL has 202.76 Mbps average download speed & 23.44 Mbps average upload speed across measured routes in LSA. (refer table-11)

- RJIL has 229.24 Mbps average download speed & 26.01 Mbps average upload speed across measured routes in city drive. (refer table-19)

- Bangalore University Campus hotspot has less download speed (less than 100 Mbps) out of total 9 Hotspots for auto-selection mode (5G/4G/3G/2G). (refer table-31)

- ISCKON Temple Rajaji Nagar has less download speed (less than 10 Mbps) out of total 9 hotspots for auto-selection mode (4G/3G/2G). (refer table-43)

- Bangalore University Campus, Indiranagar Metro Station, ISCKON Temple Rajaji Nagar & LIC Office Jeevan Soudha JP Nagar have less upload speed (less than 20 Mbps) out of total 9 hotspots. (refer table-31, 32, 33 & 36)

- ISCKON Temple Rajaji Nagar has less upload speed (less than 2 Mbps) out of total 9 hotspots for auto-selection mode (4G/3G/2G). (refer table-43)

- (Terminal I) Kempegowda International Airport, (Terminal II) Kempegowda International Airport and KSR railway station have less download speed (less than 100 Mbps) out of total 4 walk test locations. (refer table-54, 55 & 57)

- (Terminal I) Kempegowda International Airport, (Terminal II) Kempegowda International Airport, Cubbon Park and KSR Railway Station have less upload speed (less than 20 Mbps) out of 4 walk test locations. (refer table- 54, 55, 56 & 57)

4. VIL:

Voice

- 98.51% call setup success rate and 0.51% call drop rate have been observed in 3G/2G network mode. Performance is meeting the benchmark of 98.00% & 2.00% respectively for LSA and city drive. (refer table-3 & 13)

- 99.53% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G). Performance is meeting the benchmark of 98.00% & 2.00% respectively for LSA. (refer table-5)

- 99.40% call setup success rate and 0.00% call drop rate have been observed for auto-selection mode (5G/4G/3G/2G). Performance is meeting the benchmark of 98.00% & 2.00% respectively for city drive. (refer table-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 all hotspot locations. (refer table-20)

- 100.00% call setup success rate and 0.00% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G) for all walk test locations. (refer table-50, 51, 52 & 53)

Data

- VIL has 24.73 Mbps average download speed & 9.87 Mbps average upload speed across measured routes in LSA. (refer table-11)

- VIL has 23.53 Mbps average download speed & 9.59 Mbps average upload speed across measured routes in city drive. (refer table-19)

- Indiranagar Metro Station and Lal-Bagh Botanical Garden hotspots have less download speeds (less than 10 Mbps) out of total 9 hotspots for auto-selection mode (5G/4G/3G/2G). (refer table-32 & 35)
- LIC Office Jeevan Soudha JP Nagar has less upload speed (less than 2 Mbps) out of total 9 hotspots for auto-selection mode (5G/4G/3G/2G). (refer table-36)
- Bangalore University Campus, ISCKON Temple Rajaji Nagar, LIC Office Jeevan Soudha JP Nagar, Manipal Hospital Sarjapur road and Peenya Industrial area have less download speed (less than 10 Mbps) for auto-selection mode (4G/3G/2G) (refer table-41, 43, 46, 48 & 49)
- KSR railway station has less download speed (less than 10 Mbps) and less upload speed (less than 2 Mbps) out of total 4 walk test locations. (refer table-57)

6. Annexure

6.1 Route wise coverage map

6.1.1 City

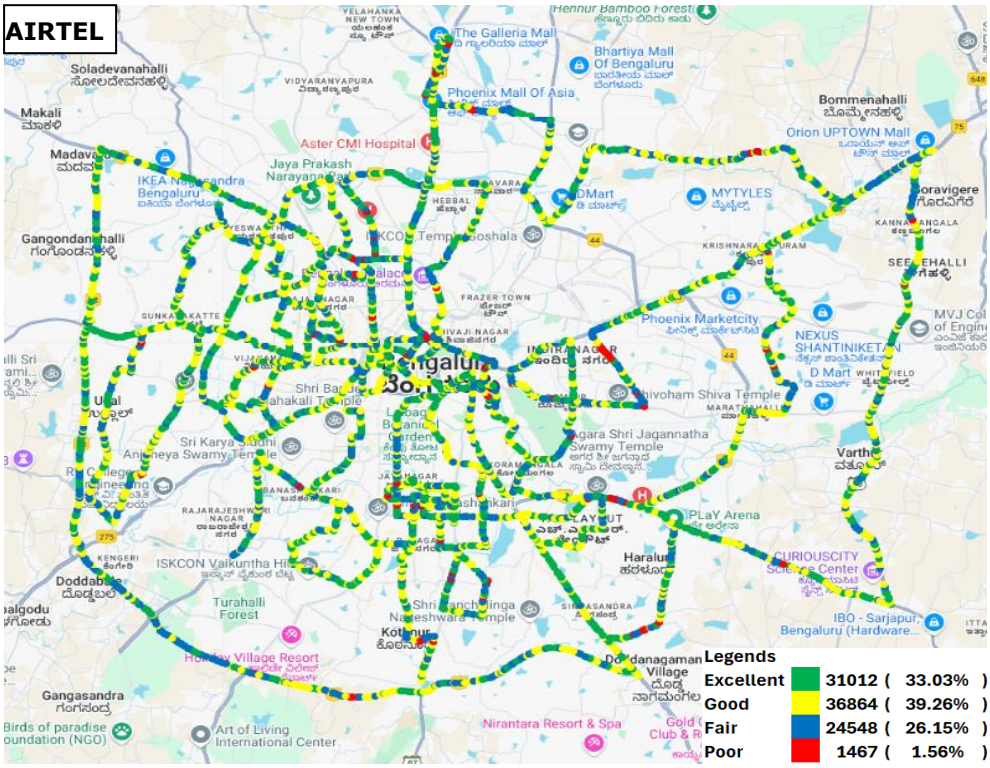


Figure-25: Signal strength 3G/2G network mode – AIRTEL.

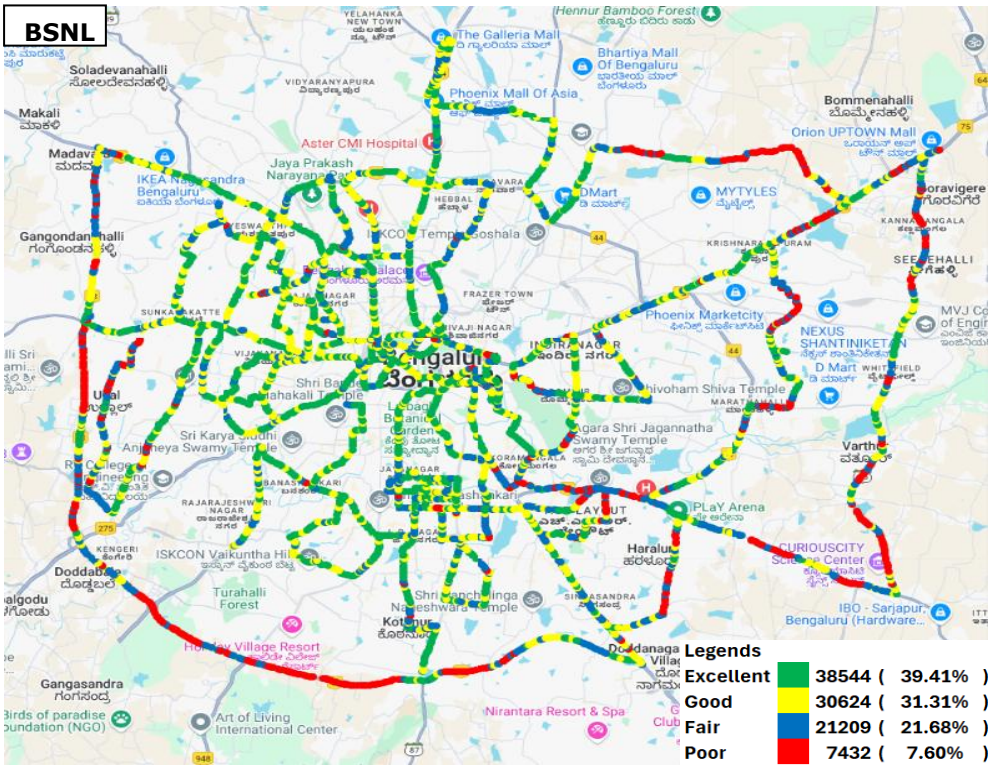


Figure-26: Signal strength 3G/2G network mode – BSNL.

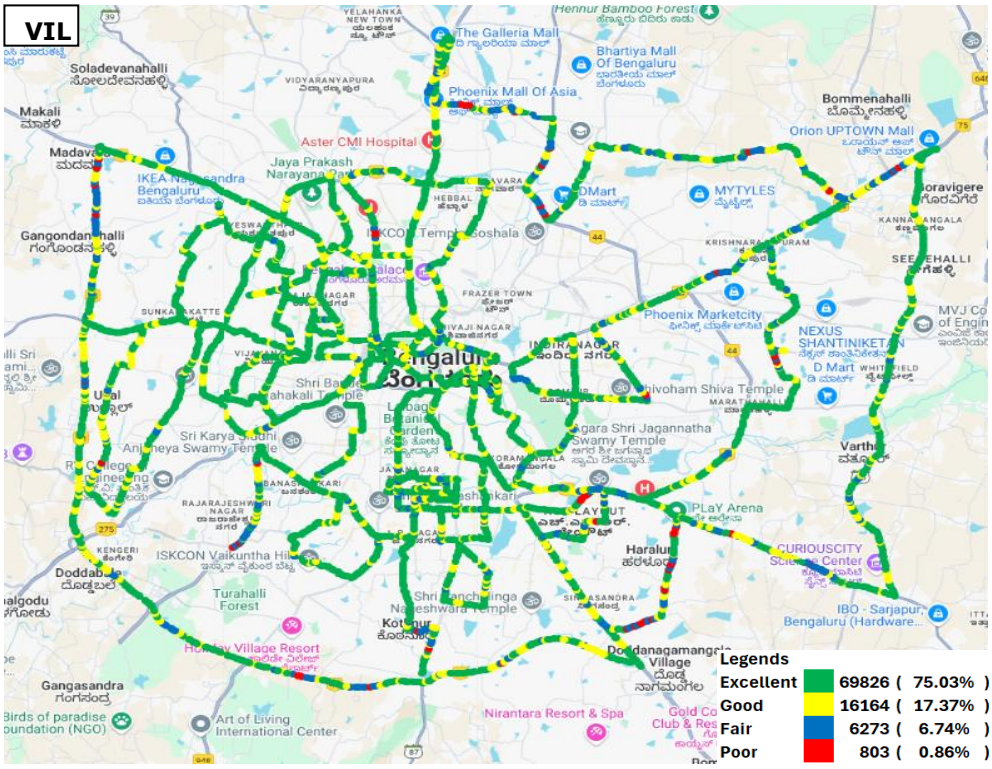


Figure-27: Signal strength 3G/2G network mode – VIL.

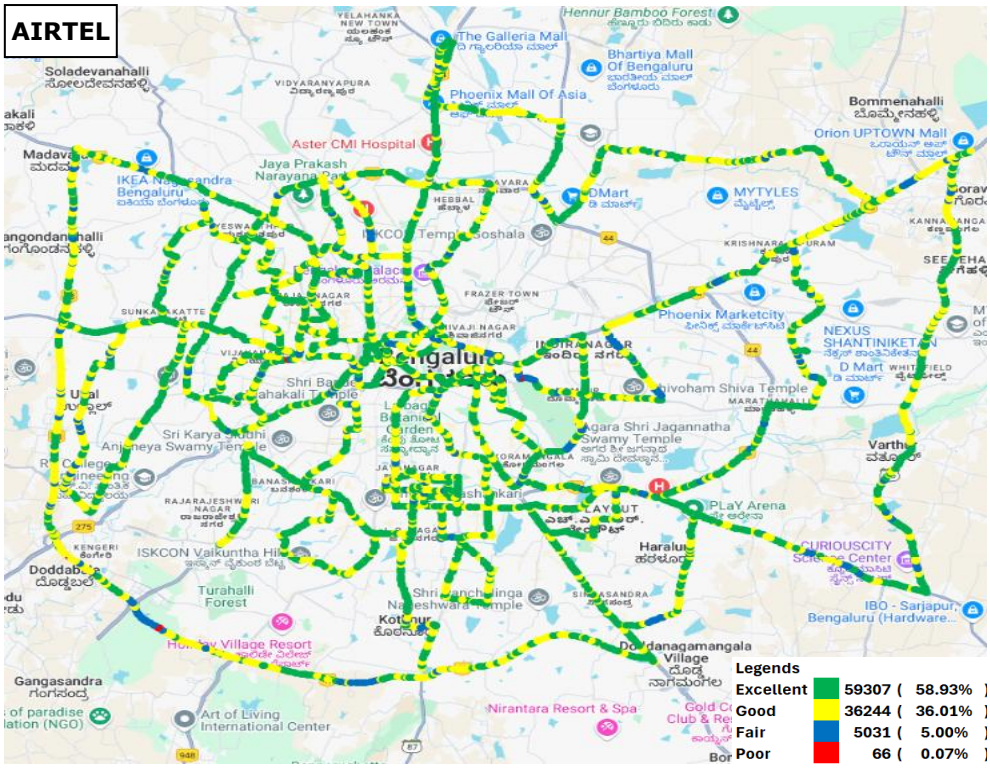


Figure-28: Signal strength auto-selection mode 5G/4G/3G/2G – AIRTEL.

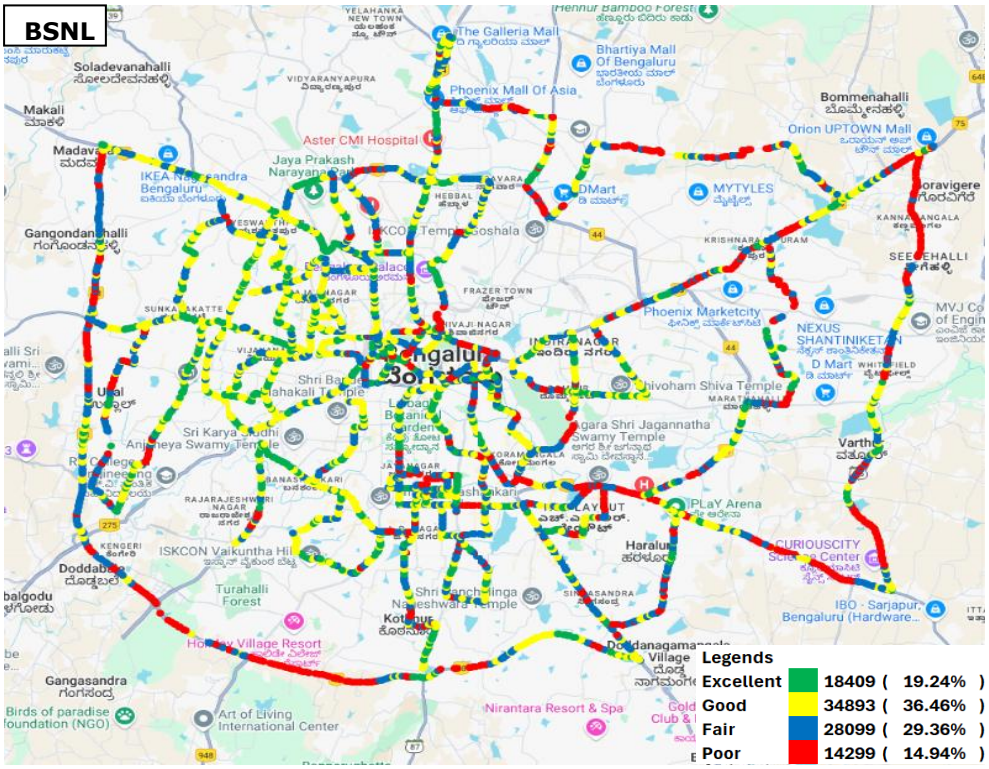


Figure-29: Signal strength auto-selection mode 5G/4G/3G/2G – BSNL.

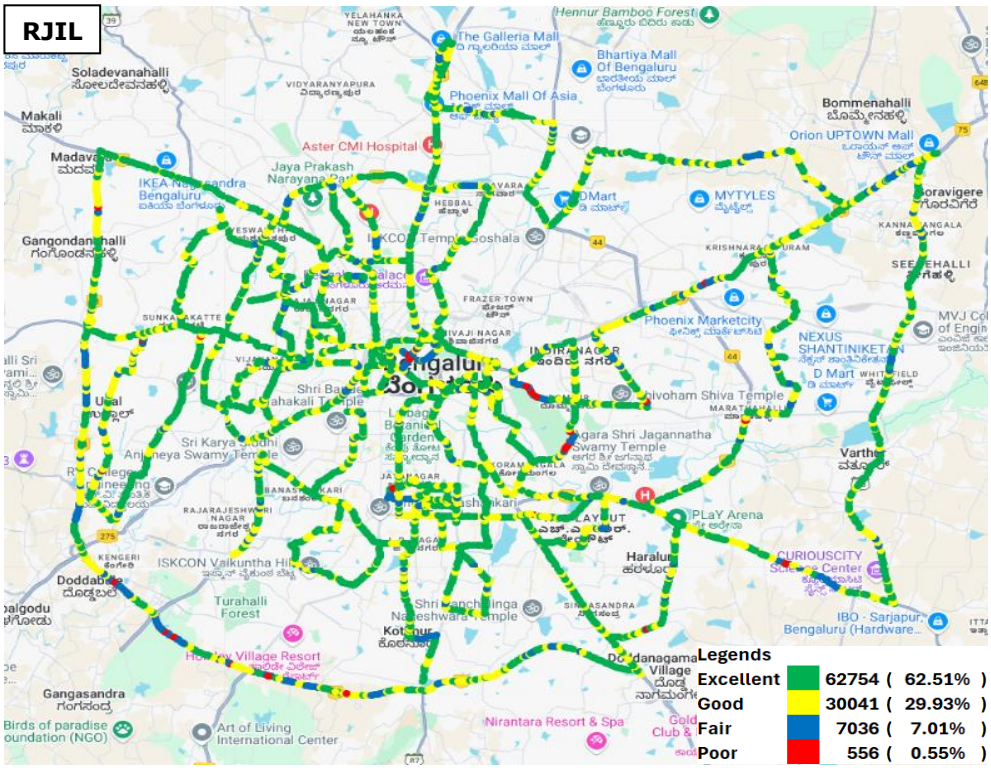


Figure-30: Signal strength auto-selection mode 5G/4G/3G/2G – RJIL.

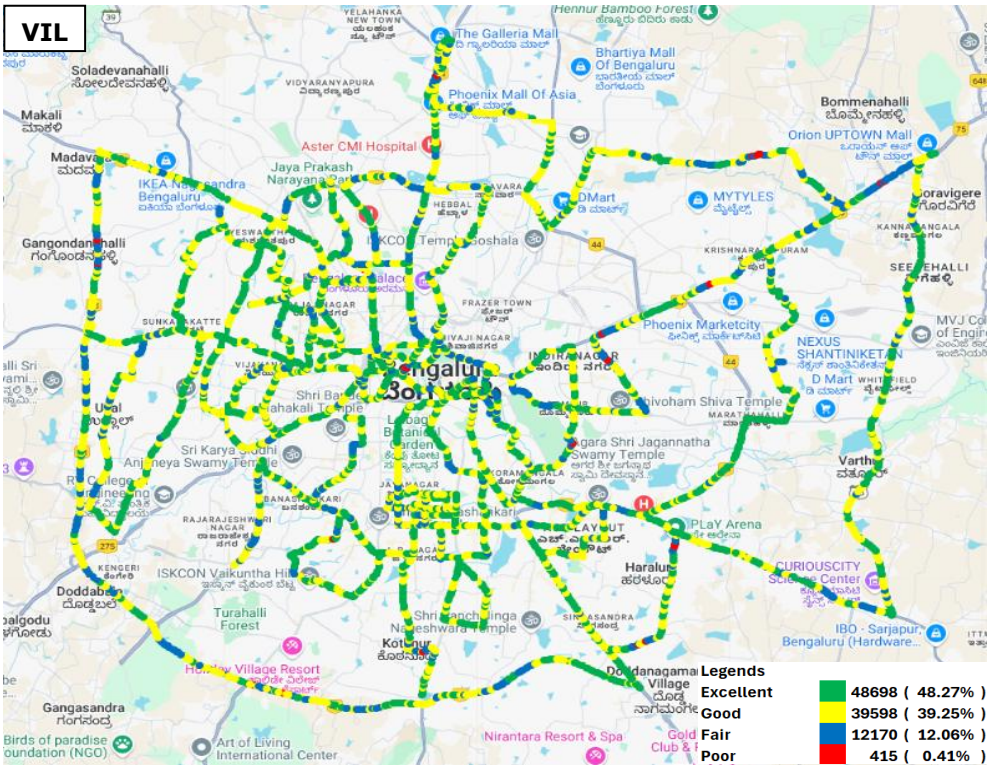


Figure-31: Signal strength auto-selection mode 5G/4G/3G/2G – VIL.

7. Appendix

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

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

7.1 Appendix-I

7.1.1 Drive test setup

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

Table-58: 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.google.co.in, www.amazon.co.in, www.facebook.co.in) 20 sec timeout (only at Hotspot)
Latency		25 count- Dynamic 1000 count- Hotspot Payload- 42 bytes in all drive

Table-59: Data test detail

Note-

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

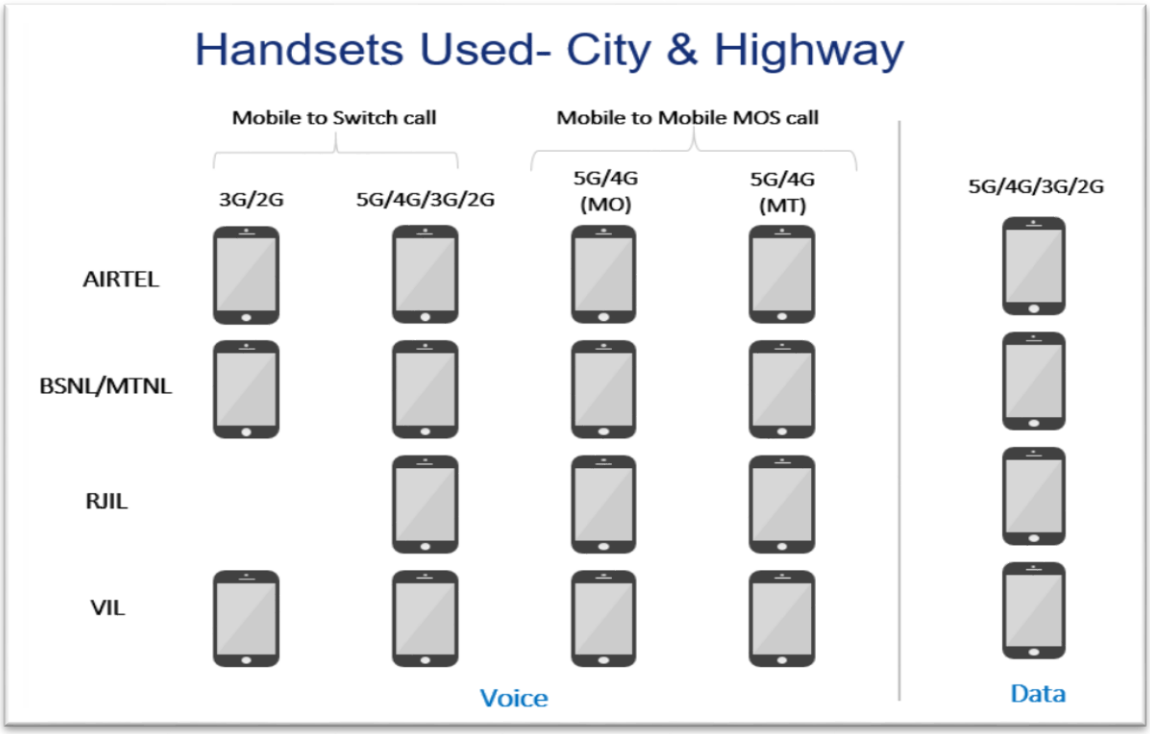


Figure-32: Number of handsets used in city & highway drive

MO: Mobile originating

MT: Mobile terminating

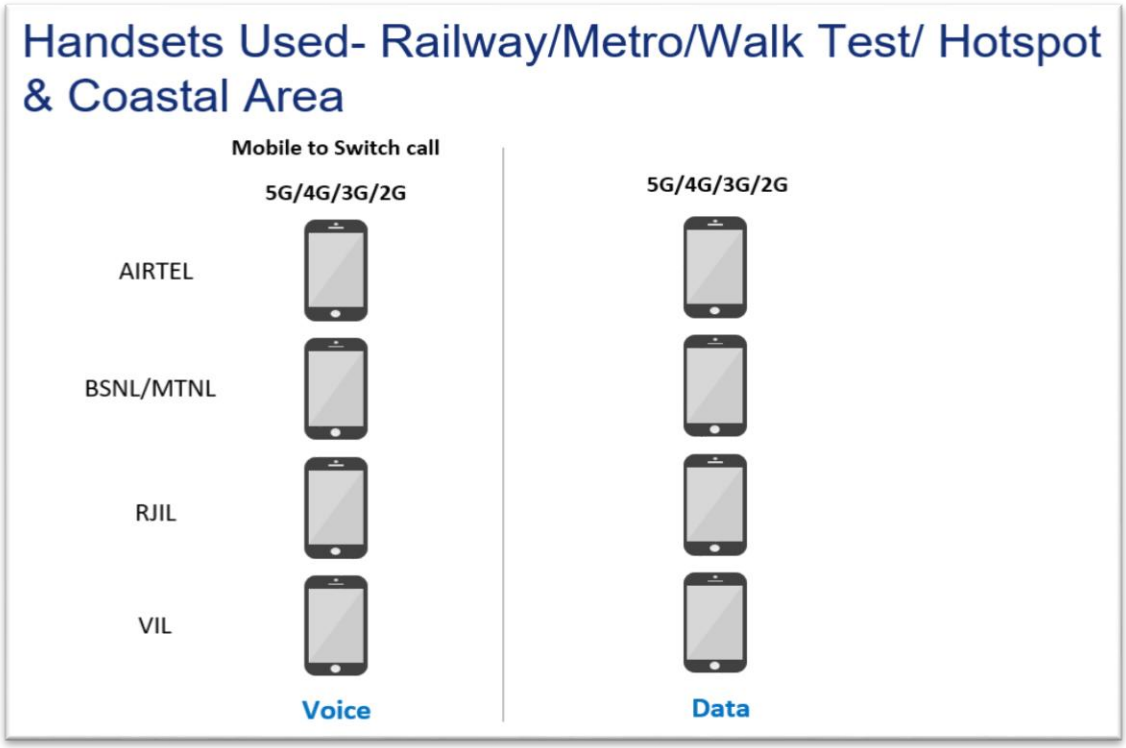


Figure-33: Number of handsets used in railway/metro/walktest/hotspot & coastal area

7.1.2 Drive test Methodology

(a) Dynamic voice testing (on the move)

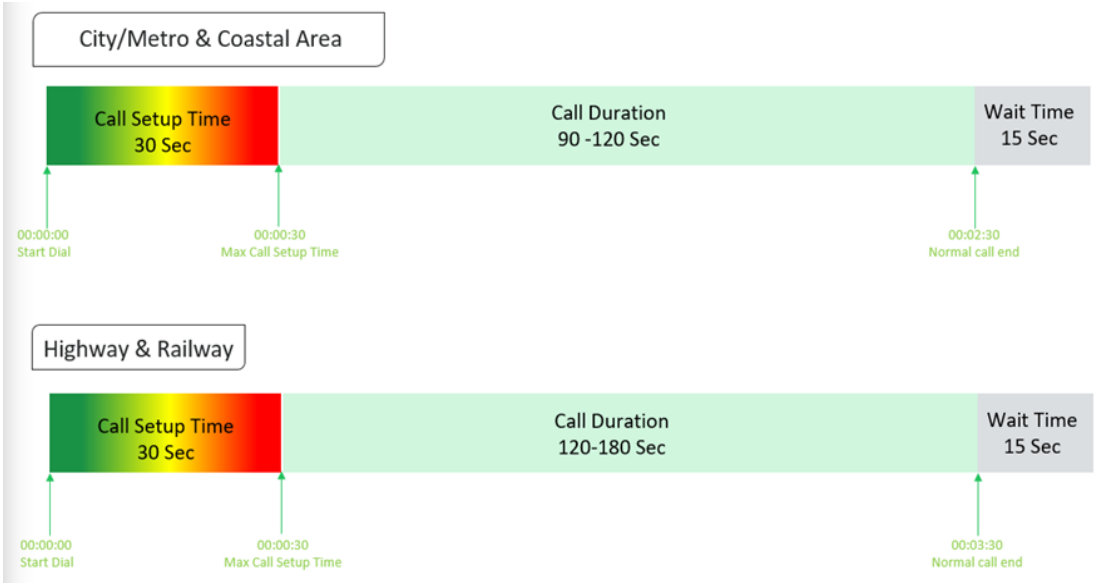


Figure-34: Voice test script for city/railway/metro/highway & coastal area

- 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-35: 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

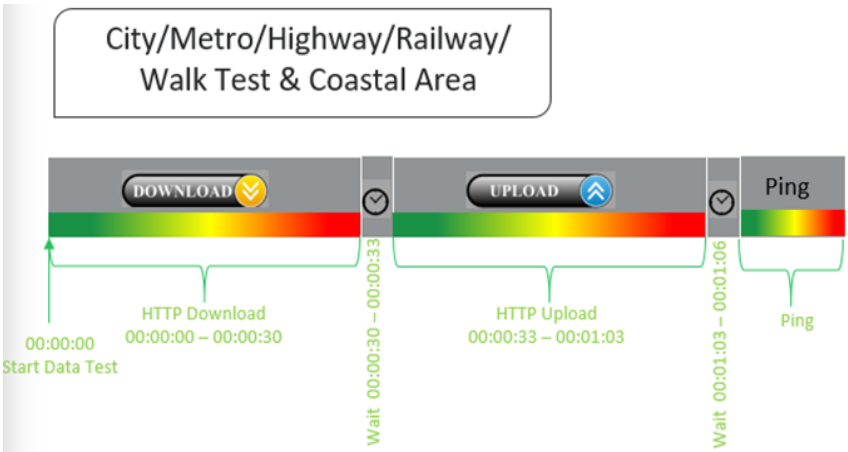


Figure-36: Data test script used in city/metro/railway/highway/walk test & coastal area

(d) Static Data(internet) testing

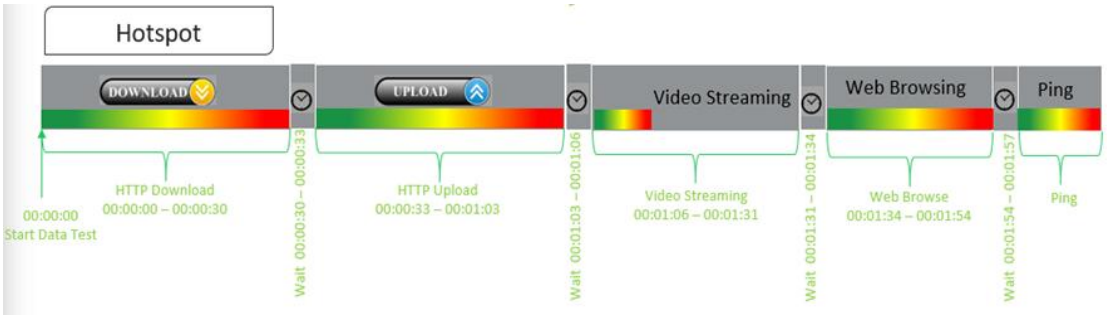


Figure-37: Data test script used at hotspot

- 5 Data iteration done at each hotspot location.
- Min. 5 iteration made during the walk test.
- Web browsing duration mentioned above is for one web site only.
- Only 1 ping iteration (with 1000 Count) done at hotspot location.
- Download & Upload test performed at hotspot in 4G/3G/2G auto-selection also.

7.2 Appendix-II

7.2.1 Network Performance Parameters for Voice calls

Parameter Name	Definition
Call Setup Success Rate	(i) Call Setup Success Rate is defined as the ratio of Established Calls to Call Attempts. 'Established Calls' mean the following events have happened in call setup: (a) Call attempt is made (b) The signaling channel is allocated (c) The call is routed to the outwards path of the terminating network (d) An alert signal is received by caller in the form of ring back tone, busy tone, or an announcement. CSSR = (Total Call Established/ Total Call Attempt) *100 As per QoS Regulation 2024 benchmark value is **>=98%**
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 If a call observes multiple silence count >=4 sec in a particular established call it has been taken as one silent event.

<table>
<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-60: Network performance parameter and definition voice

7.2.2 Network Performance Parameters Data tests

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

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

Table-61: Network performance parameter and definition Data

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

Hardik Rajeshbhai Patel

Digitally signed by Hardik Rajeshbhai Patel
Date: 2025.02.19 18:45:57 +05'30'