भादूविप्रा
TRAI

TELECOM REGULATORY AUTHORITY OF INDIA

Independent Drive Test Report

Tamil Nadu LSA

November 2024

Contents

1. Introduction

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

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

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

2. Executive Summary (LSA)

2.1 Drive test details

This report covers the findings of the IDT undertaken in Tamil Nadu License Service Area (LSA) during the month November, 2024 under the supervision of TRAI Regional Office (RO), Hyderabad. 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	Chennai	City	337.5	19-Nov-2024	21-Nov-2024
2	Chennai	City (Inter-operator calling)	15	22-Nov-2024	22-Nov-2024
3	Chennai	Hotspot	8 Locations	22-Nov-2024	22-Nov-2024

Table-1: Drive test summary

2.2 Drive test routes

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

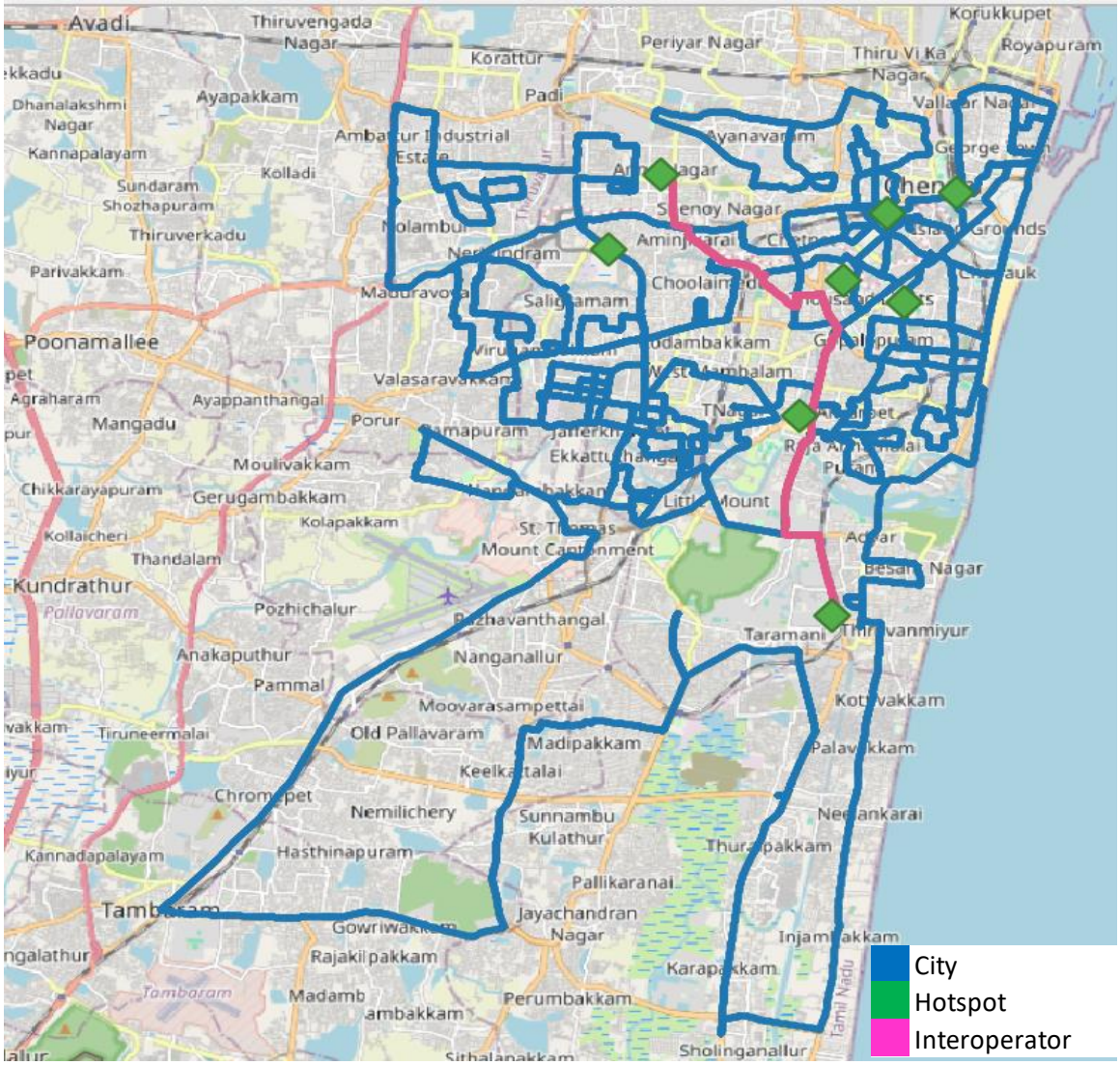


Figure-1: Drive test routes

2.3 Summary of areas covered

a) City- Nearby Neelankarai, Tambaram, Old Pallavaram, St. Thomas Mount Cantonment, Maduravoyal, Arumbakkam, Choolai, George Town, Nungambakkam, Chepauk, Kodambakkam, Besan Nagar , Karapakkam etc.

b) Hotspot-

1. Anna Nagar Tower Park
2. Apollo Hospital Greams Road Teynampet
3. Central Railway Station Circle
4. CMRL Headquarters Nandanam
5. Egmore Railway Station Entrance
6. Express Avenue Mall

7. Koyambedu Bus Stand
8. Tidel Park(IT Park)

2.4 Telecom service providers detected frequency bands

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

S.no.	Name of TSP	Technology	Frequency Bands (In MHz)
1	Bharti Airtel Ltd.	2G	1800
2	Bharti Airtel Ltd.	4G	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
10	Vodafone Idea Ltd.	4G	900,1800,2100

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

QoS Performance Analysis- Tamil Nadu 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 November-2024 covering city and hotspots. (Refer Table 1)

3.2 Voice performance

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

Parameters	Service Provider		
	3G/2G network mode only		
	AIRTEL	BSNL	VIL
Call Attempts	700	730	694
Call Setup Success Rate %	99.71	96.85	99.57
Drop Call Rate%	0.00	4.10	0.29
Call Setup Time-Average (Second)	2.88	2.73	3.20
Handover Success Rate %	99.18	99.54	98.99

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

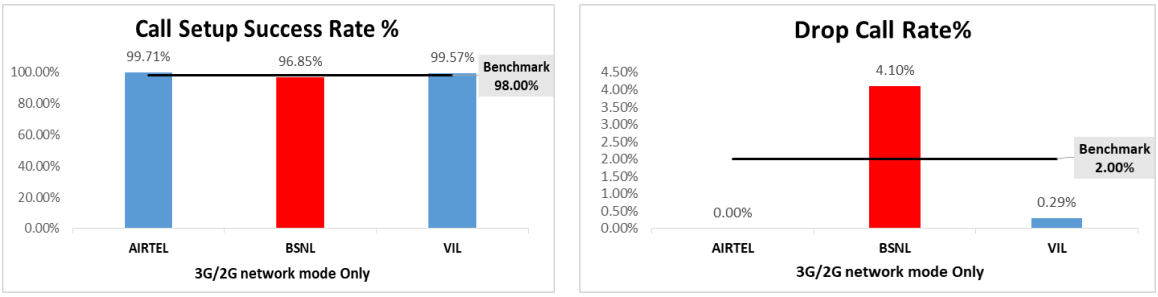


Figure-2: Call setup success rate and drop call rate performance

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	419	NA
2G	1352	178	1305

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	806	799	814	802
Call Setup Success Rate %	100.00	97.00	99.88	100.00
Drop Call Rate%	0.00	2.19	1.11	0.00
Call Setup Time-Average (Second)	0.41	4.34	0.72	1.64
Handover Success Rate %	100.00	99.51	99.93	100.00

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

Parameter	Service Provider			
	Mobile-to-Mobile (5G/4G - Open Mode)			
	AIRTEL	BSNL	RJIL	VIL
Call Established (within service provider Network)	696	695	683	699
Number of silence call for >4 Sec	3	NA	4	6
Silence Call Rate %	0.43	NA	0.59	0.86
Number of silence instances for >4 Sec	5	NA	5	7
Number of silence instances for >3 Sec	6	NA	7	12
Number of silence instances for >2 sec	6	NA	14	43
RTP Jitter (4G & 5G) in ms	3.58	NA	10.45	17.30
Packet loss Rate Downlink %	0.16	NA	0.20	0.48
Packet loss Rate Uplink %	0.17	NA	0.34	0.49

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

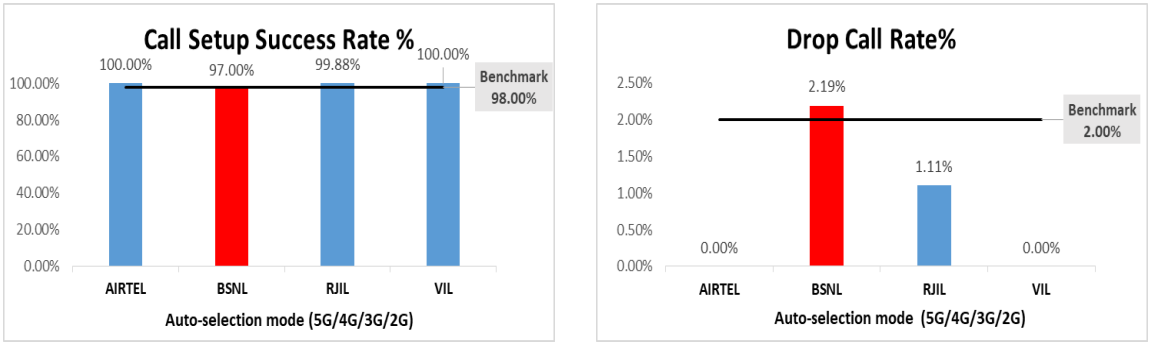


Figure-3: Performance for call setup success rate and drop call rate

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	1197	NA
4G	1797	273	1652	1969
3G	NA	280	NA	NA
2G	0	522	NA	0

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

Note-
- NA- Service provider doesn't provide services in respective technology.
- 0- No calls 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	4166	3579	4001	4150
Speech Quality (Average MOS Score)	4.06	2.90	3.96	4.55
Number of samples with MOS >=4 to <5 (Excellent)	3715	0	2988	3744
Number of samples with MOS >=3 to <4(Good)	413	2022	897	326
Number of samples with MOS >=2 to <3 (Fair)	26	1281	89	46
Number of samples with MOS >=1 to <2 (Poor)	12	276	27	34
%age of samples with MOS >=4 to <5 (Excellent)	89.17%	0.00%	74.68%	90.22%
%age of samples with MOS >=3 to <4(Good)	9.91%	56.50%	22.42%	7.86%
%age of samples with MOS >=2 to <3 (Fair)	0.62%	35.79%	2.22%	1.11%
%age of samples with MOS >=1 to <2 (Poor)	0.29%	7.71%	0.67%	0.82%

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

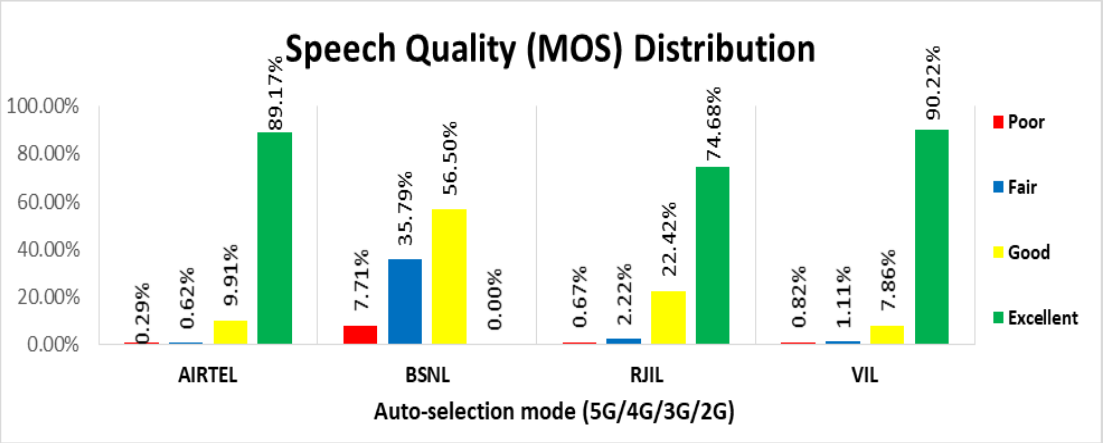


Figure- 4: Distribution of samples in MOS score range

(d) Inter-service provider voice call performance: To check the performance of inter-service provider call setup success rate, total 49 to 75 inter operator calls were attempted. The Call setup success rate and call setup time observation is 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	98.15	93.55
RJIL	100.00	98.39	NA	98.67
VIL	100.00	98.44	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	4.69	1.92	2.04
BSNL	5.07	NA	5.09	5.53
RJIL	1.90	5.42	NA	1.96
VIL	2.17	4.91	2.54	NA

Table-10: Call setup time across service providers

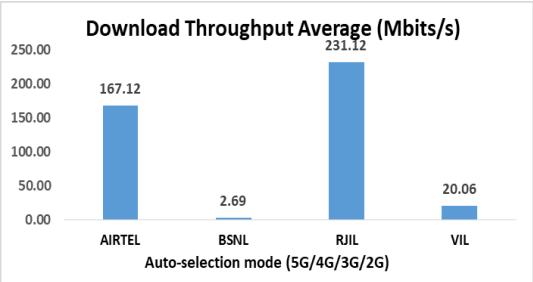
Note-
- NA- Only inter-operator calls were measured during test

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	167.12	2.69	231.12	20.06
	80th Percentile	246.42	4.56	330.42	31.79
	20th Percentile	90.81	0.33	106.81	9.09
Upload Throughput (Mbits/s)	Average	42.12	3.32	29.06	12.58
	80th Percentile	67.66	4.45	45.95	15.90
	20th Percentile	13.33	1.24	10.34	8.92
Ping (ms)	Average	19.59	143.35	46.54	34.74

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



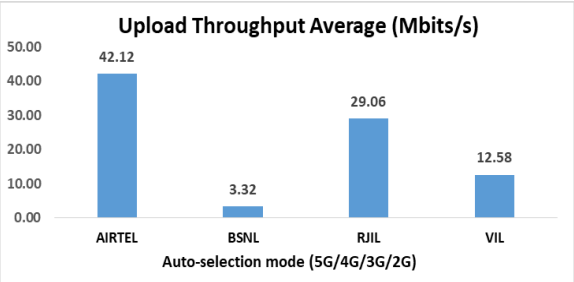


Figure- 5: Download and upload throughput

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	1354	NA
4G	1808	472	158	2008
3G	NA	195	NA	NA
2G	0	48	NA	3

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.

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 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 19th November 2024 to 21st November 2024 in Chennai. (Refer Table-1)

4.2.1 Drive test route

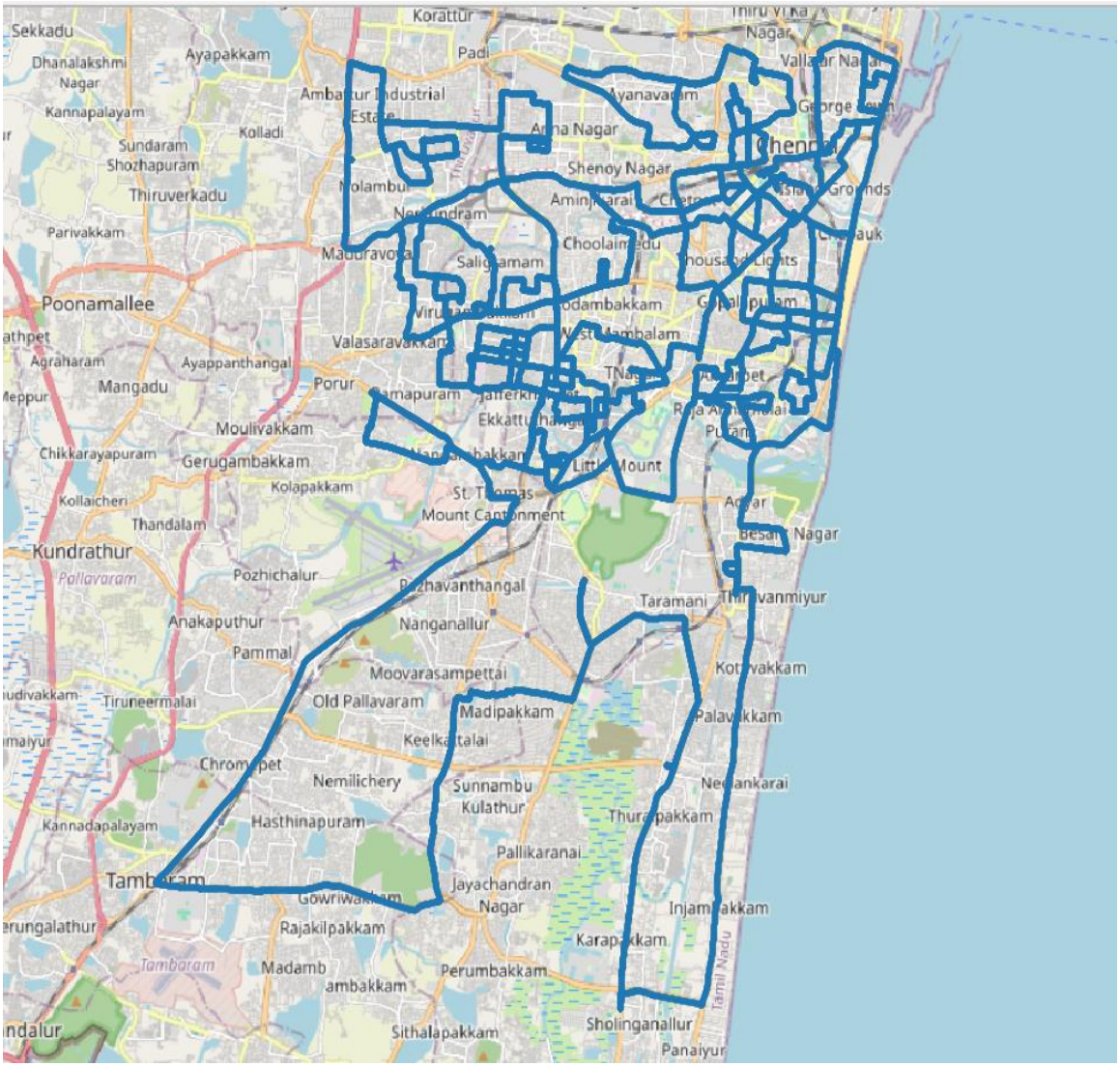


Figure- 6: Drive test routes

4.2.2 Areas covered

Nearby Neelankarai, Tambaram, Old Pallavaram, St. Thomas Mount Cantonment, Maduravoyal, Arumbakkam, Choolai, George Town, Nungambakkam, Chepauk, Kodambakkam, Besan Nagar , Karapakkam 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	700	730	694
Call Setup Success Rate %	99.71	96.85	99.57
Drop Call Rate%	0.00	4.10	0.29
Call Setup Time-Average (Second)	2.88	2.73	3.20
Handover Success Rate %	99.18	99.54	98.99

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

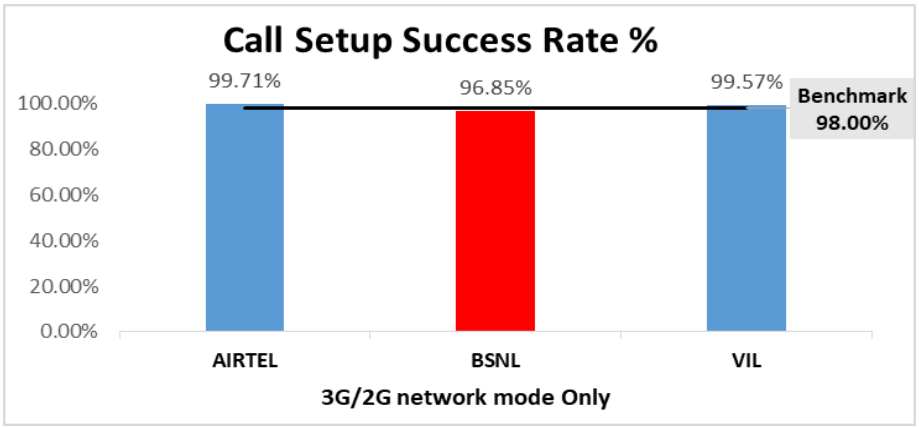


Figure-7: Performance for call setup success rate

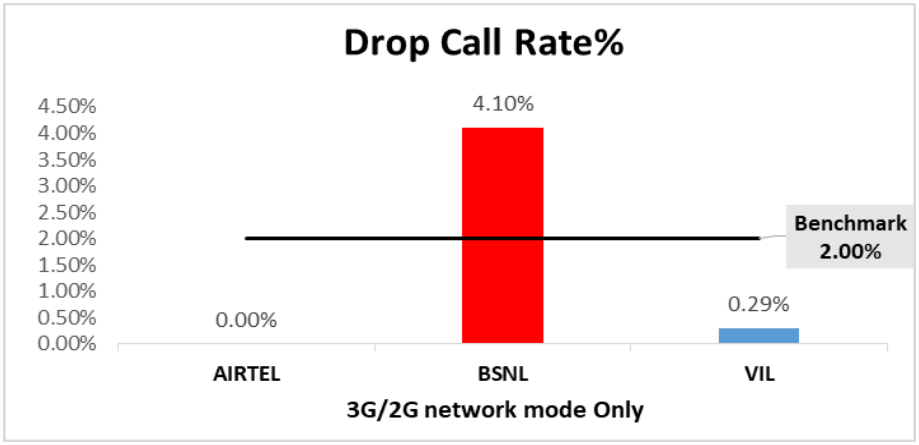


Figure-8: Performance for drop call rate

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

Technology	Service Provider		
	AIRTEL	BSNL	VIL
3G	NA	88.07%	NA
2G	100.00%	11.93%	99.99%
Limited service	0.00%	0.00%	0.01%

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

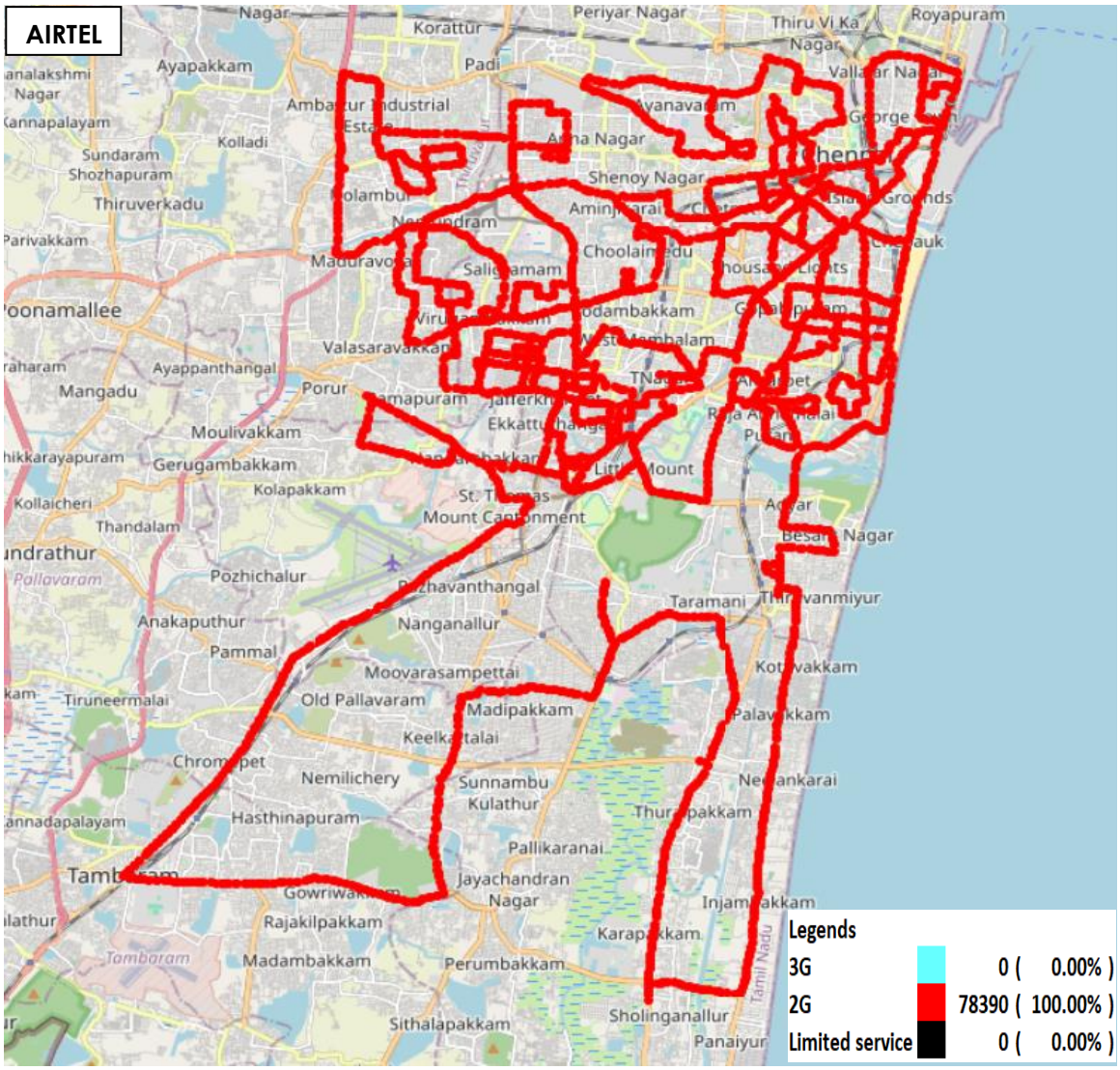


Figure-9: Serving technology plots 3G/2G network mode - AIRTEL

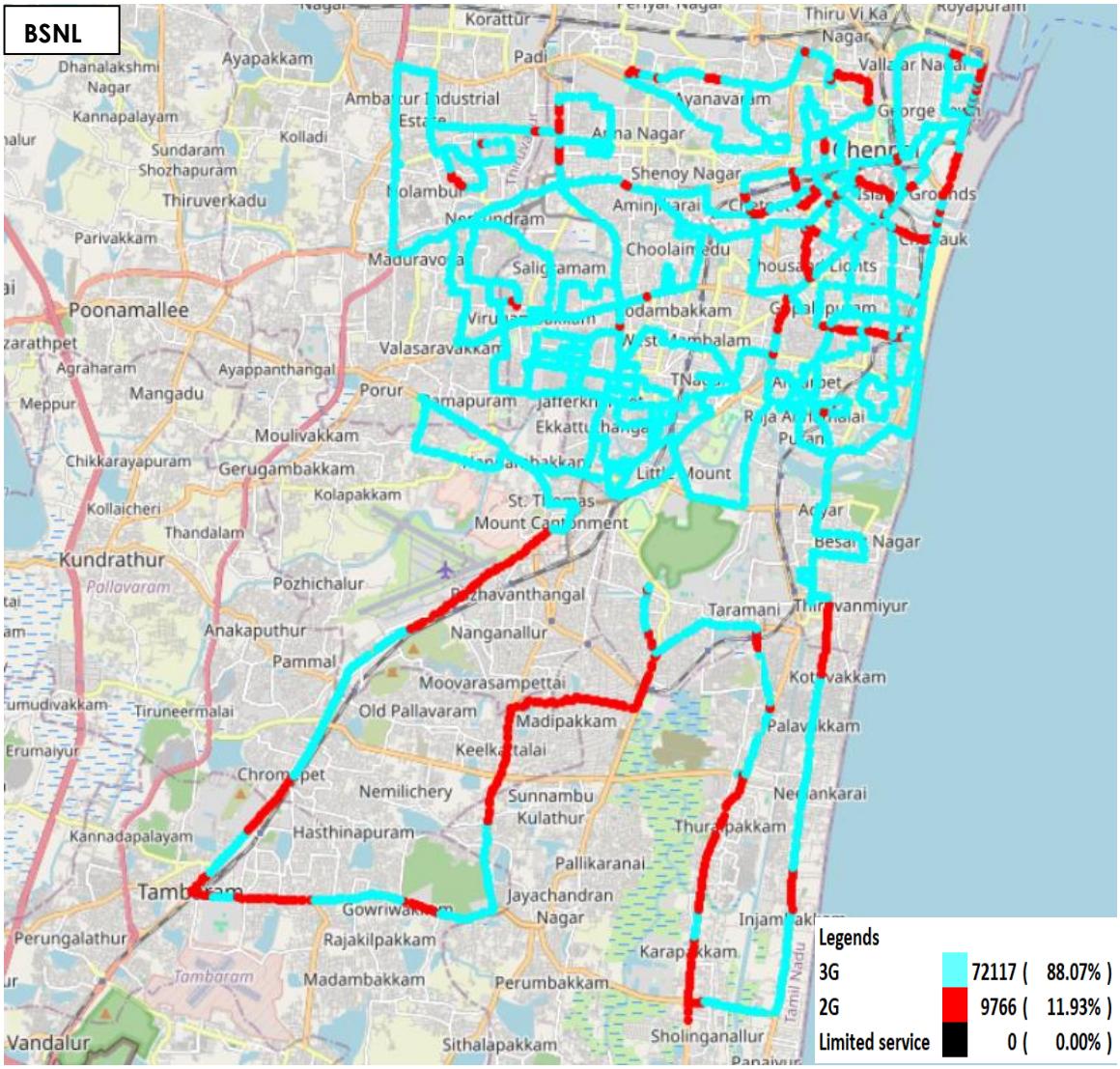


Figure-10: Serving technology plots 3G/2G network mode - BSNL

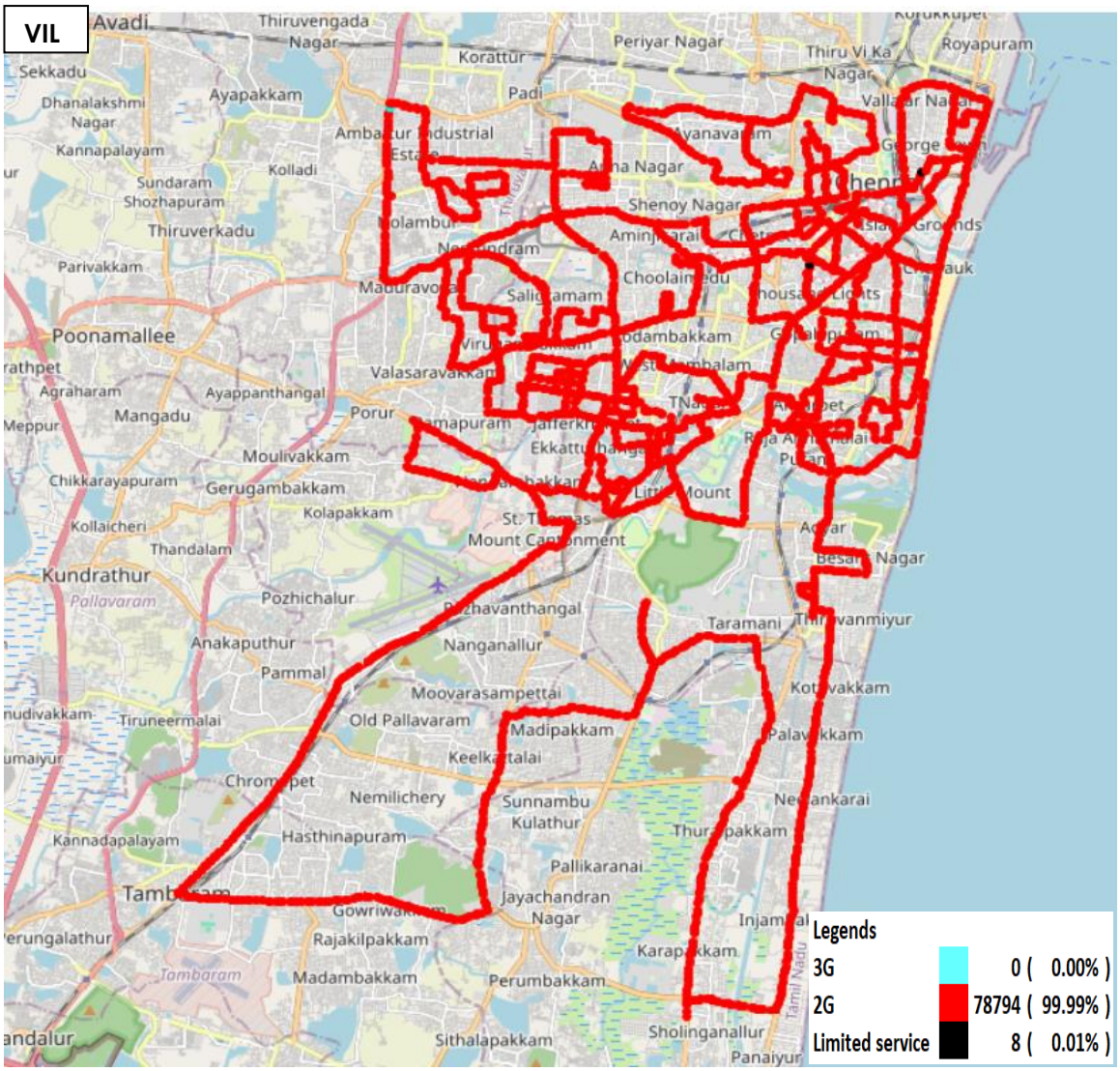


Figure-11: Serving technology plots 3G/2G network mode –VIL

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

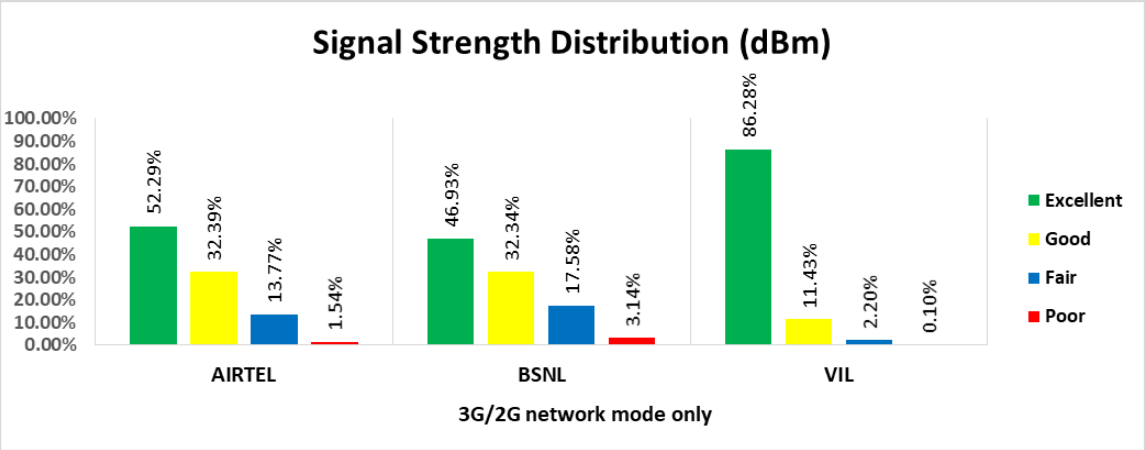


Figure-12: Signal strength distribution 3G/2G network mode only

Observations:

- Airtel has 52% of samples falling in the excellent signal strength category.
- BSNL has 47% of samples falling in the excellent signal strength category.
- VIL has 86% 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	726	719	734	722
Call Setup Success Rate %	100.00	96.94	99.86	100.00
Drop Call Rate%	0.00	2.44	1.23	0.00
Call Setup Time Average (Second)	0.41	4.36	0.73	1.62
Handover Success Rate %	100.00	99.58	99.93	100.00

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

Parameter	Service Provider			
	Mobile-to-Mobile (5G/4G - Open Mode)			
	AIRTEL	BSNL	RJIL	VIL
Call Established (within service provider Network)	696	695	683	699
Number of silence call for >4 Sec	3	NA	4	6
Silence Call Rate %	0.43	NA	0.59	0.86
Number of silence instances for >4 Sec	5	NA	5	7
Number of silence instances for >3 Sec	6	NA	7	12
Number of silence instances for >2 sec	6	NA	14	43
RTP Jitter (4G & 5G) in ms	3.58	NA	10.45	17.30
Packet loss Rate Downlink %	0.16	NA	0.20	0.48
Packet loss Rate Uplink %	0.17	NA	0.34	0.49

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

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

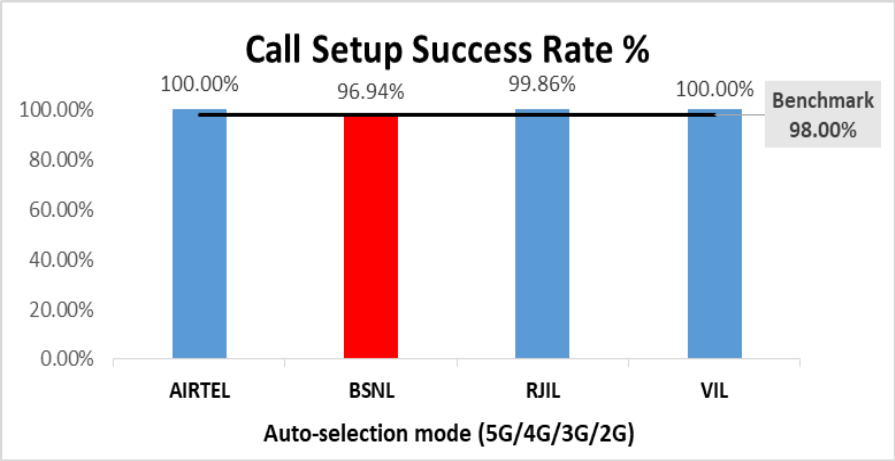


Figure-13: Performance for call setup success rate

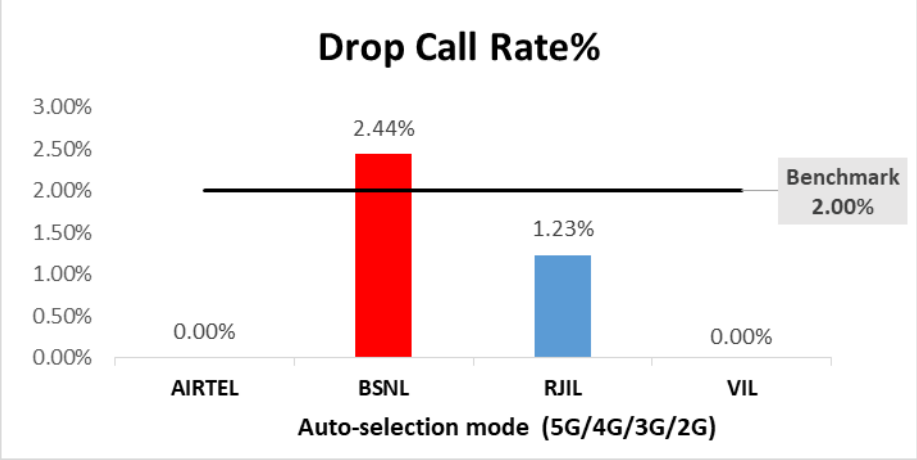


Figure-14: Performance for drop call rate

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

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

Speech Quality (MOS) distribution	Service Provider			
	AIRTEL	BSNL	RJIL	VIL
Total Number of MOS Samples for calls in table-16	4166	3579	4001	4150
Speech Quality (Average MOS Score)	4.06	2.90	3.96	4.55
Number of samples with MOS >=4 to <5 (Excellent)	3715	0	2988	3744
Number of samples with MOS >=3 to <4 (Good)	413	2022	897	326
Number of samples with MOS >=2 to <3 (Fair)	26	1281	89	46
Number of samples with MOS >=1 to <2 (Poor)	12	276	27	34
%age of samples with MOS >=4 to <5 (Excellent)	89.17%	0.00%	74.68%	90.22%
%age of samples with MOS >=3 to <4 (Good)	9.91%	56.50%	22.42%	7.86%
%age of samples with MOS >=2 to <3 (Fair)	0.62%	35.79%	2.22%	1.11%
%age of samples with MOS >=1 to <2 (Poor)	0.29%	7.71%	0.67%	0.82%

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

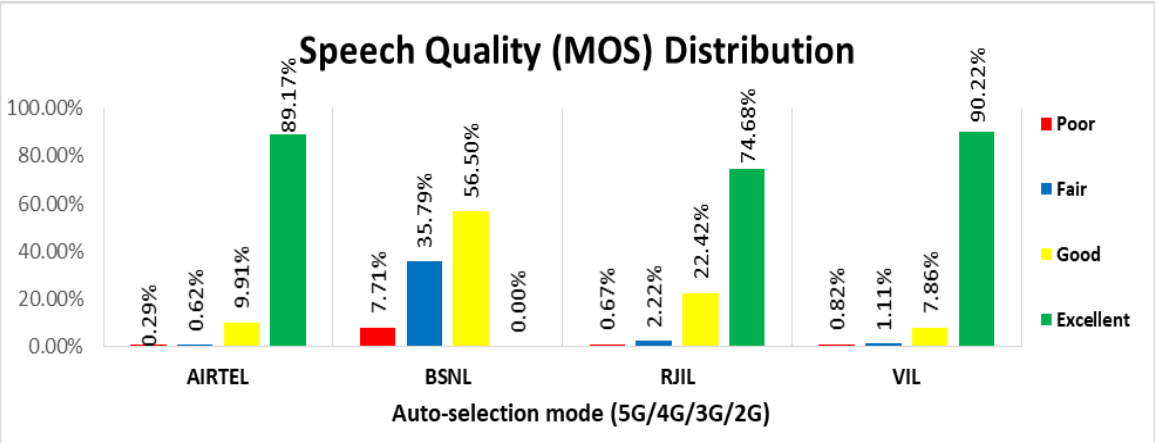


Figure-15: Distribution of samples in MOS score range

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

Technology	Service Provider			
	AIRTEL	BSNL	RJIL	VIL
5G	3.98%	NA	46.95%	NA
4G	96.02%	7.81%	53.05%	100.00%
3G	NA	47.74%	NA	NA
2G	0.00%	44.15%	NA	0.00%
Limited Service	0.00%	0.31%	0.00%	0.00%

Table-18: Time spent on technology during drive test

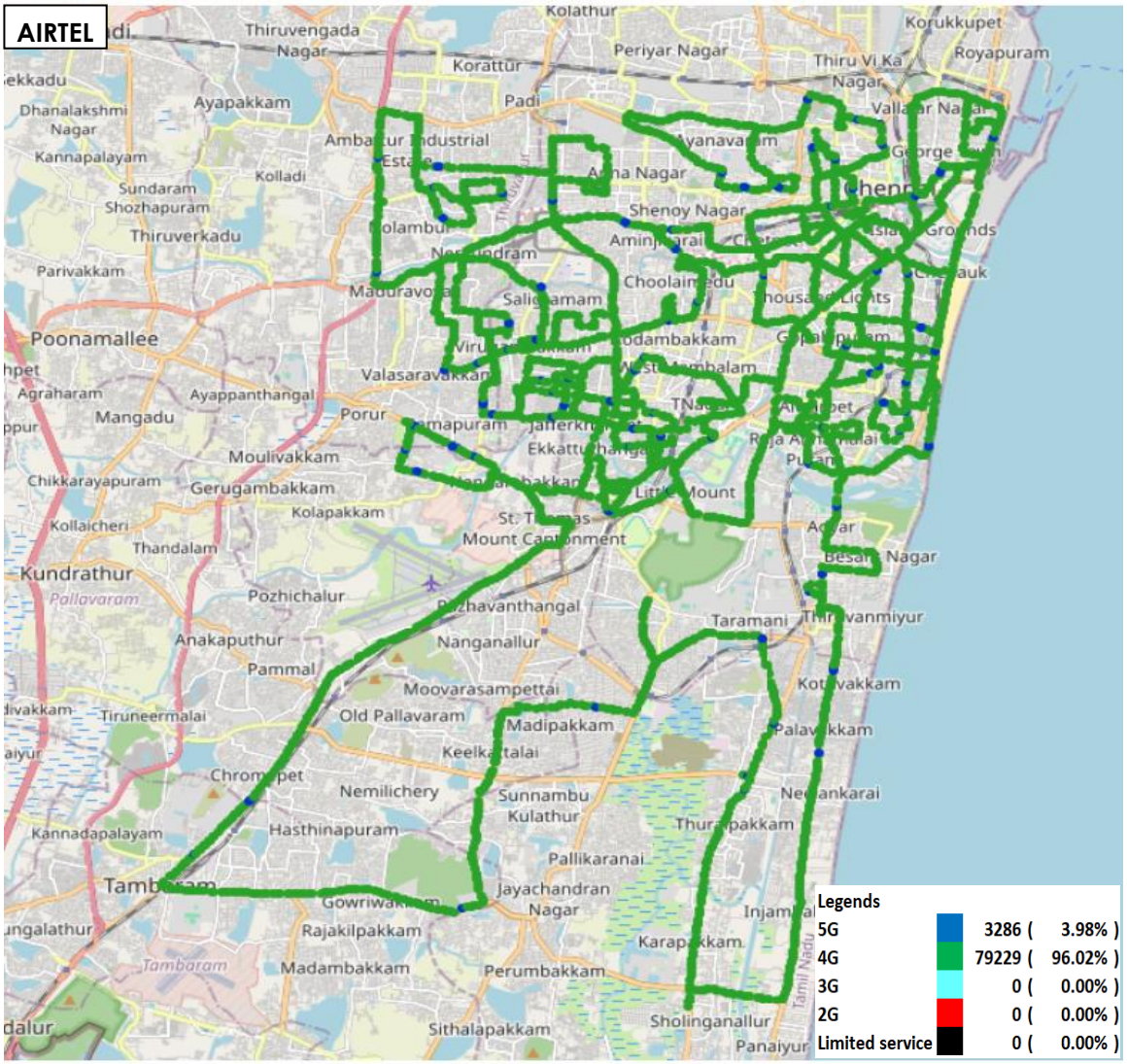


Figure-16: Serving technology plots in auto-selection mode (5G/4G/3G/2G) -AIRTEL

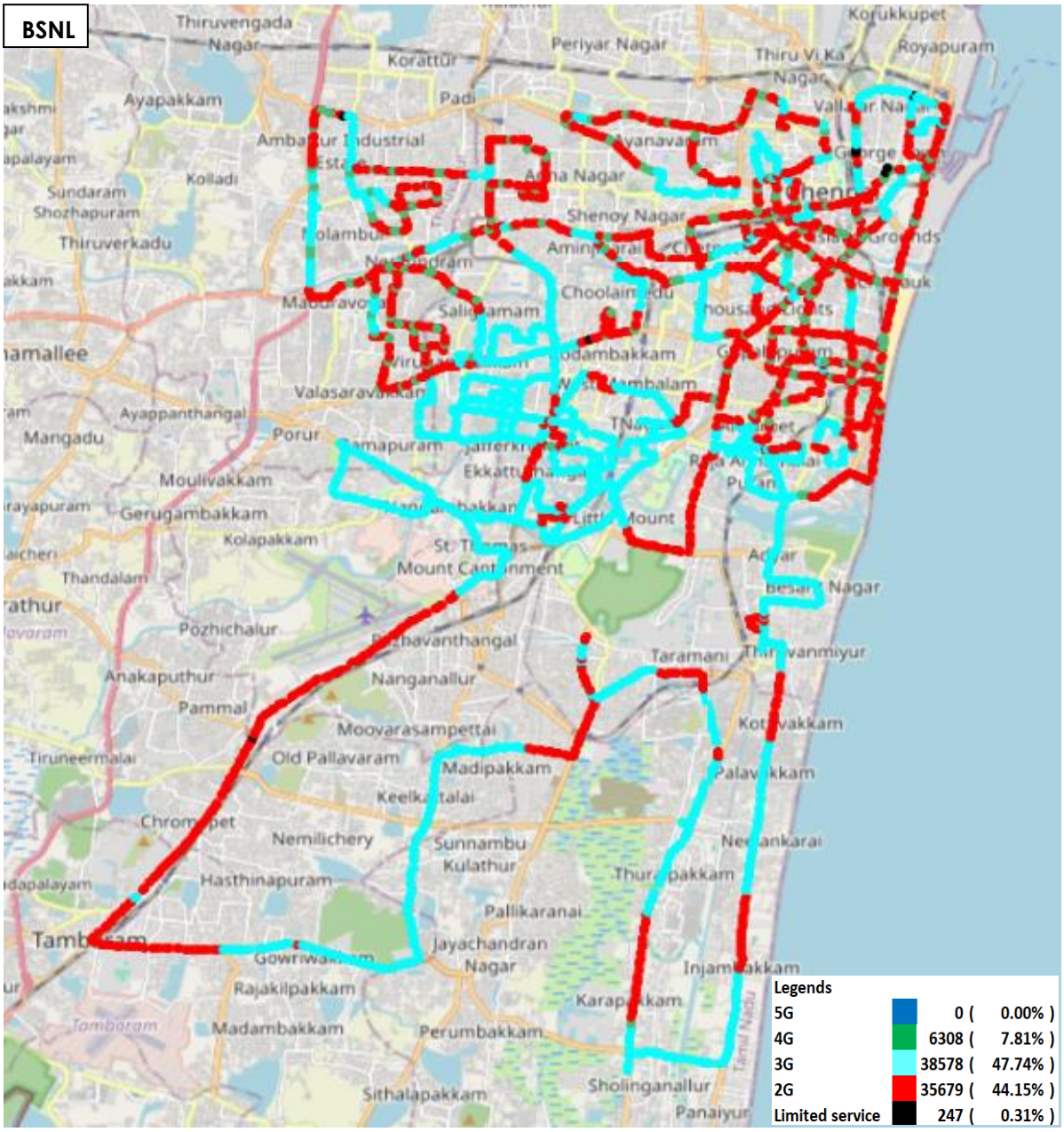


Figure-17: Serving technology plots in auto-selection mode (5G/4G/3G/2G) -BSNL

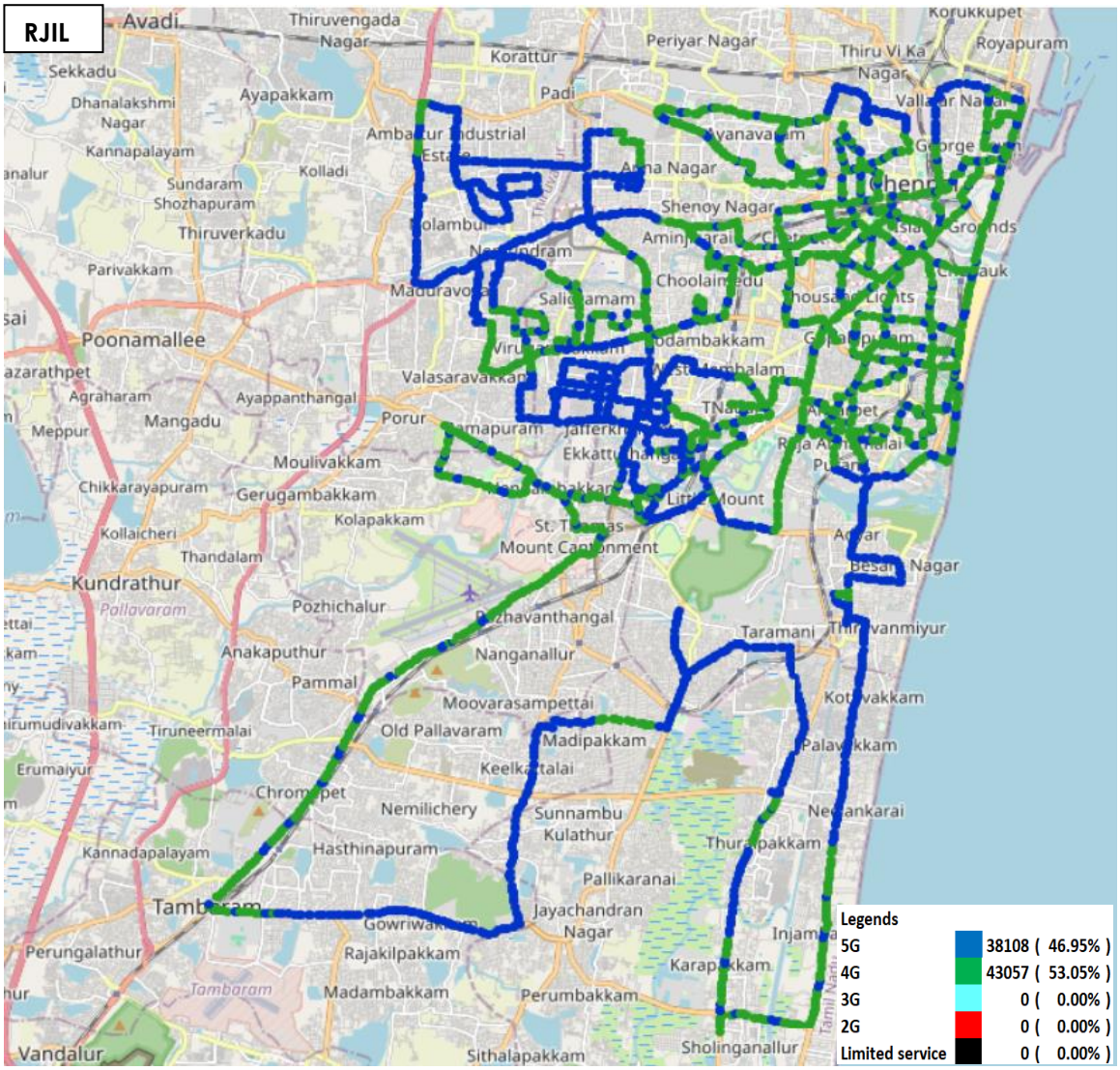


Figure-18: Serving technology plots in auto-selection mode (5G/4G/3G/2G)- RJIL

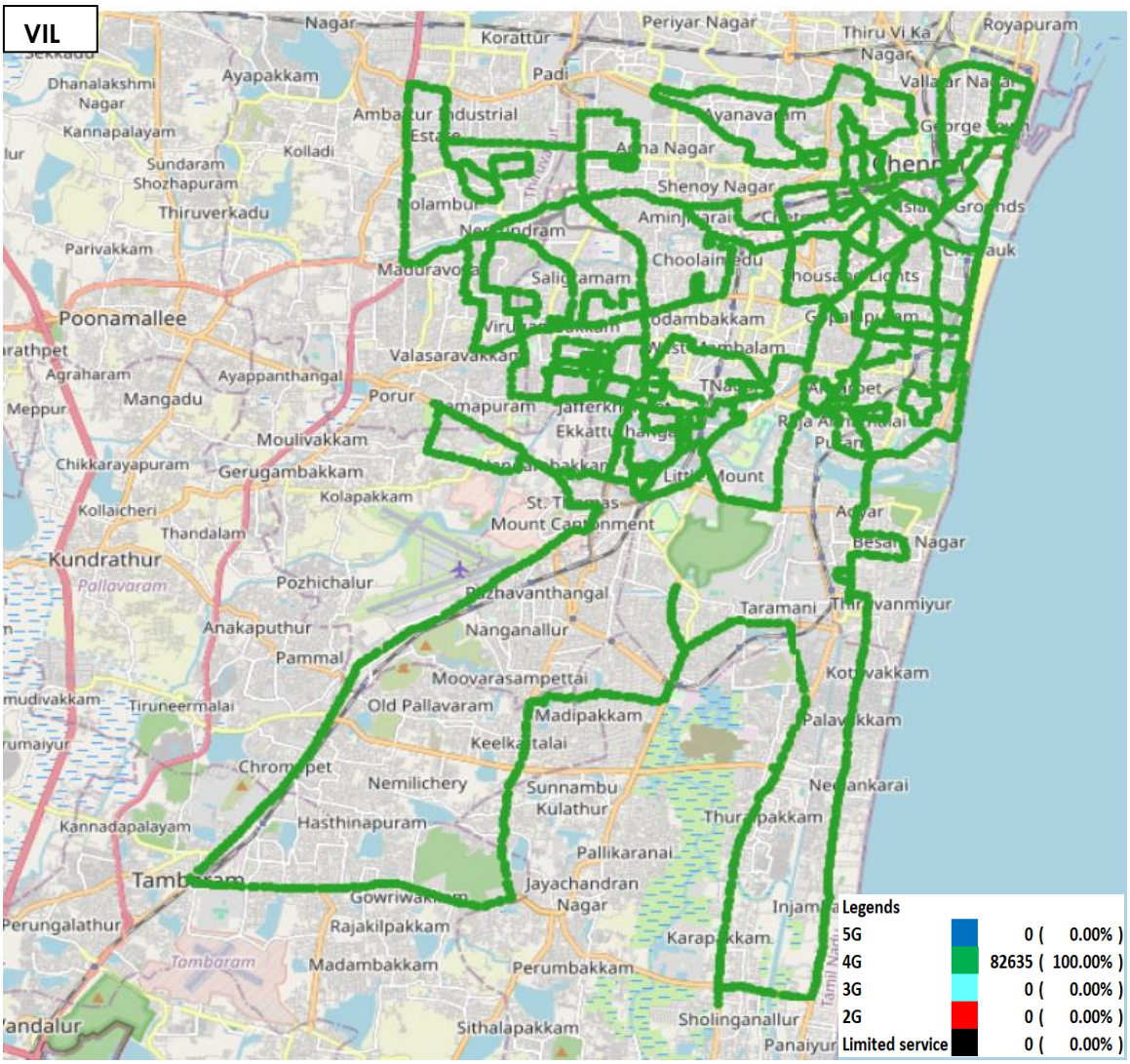


Figure-19: Serving technology plots in auto-selection mode (5G/4G/3G/2G) – VIL

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

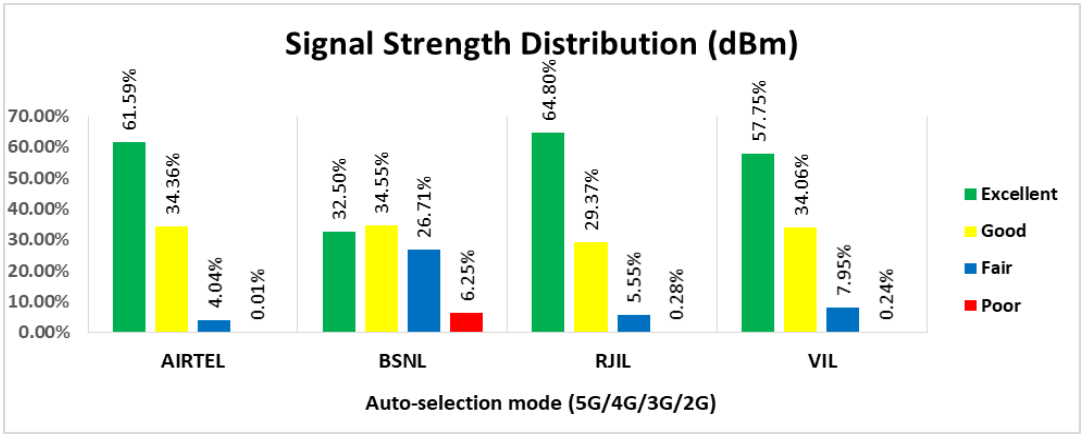


Figure-20: Signal strength distribution auto-selection mode 5G/4G/3G/2G

Observations:

- Airtel has 62% samples falling in the excellent signal strength category.
- BSNL has 33% samples falling in the excellent signal strength category.
- RJIL has 65% samples falling in the excellent signal strength category.
- VIL has 58% 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	166.16	2.51	228.08	20.19
	80th Percentile	245.73	4.33	325.44	31.76
	20th Percentile	89.95	0.31	106.04	9.33
Upload Throughput (Mbits/s)	Average	41.28	3.18	29.02	12.52
	80th Percentile	66.98	4.27	46.13	15.90
	20th Percentile	12.81	1.24	10.84	8.74
Ping (ms)	Average	19.34	198.24	58.29	38.66

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

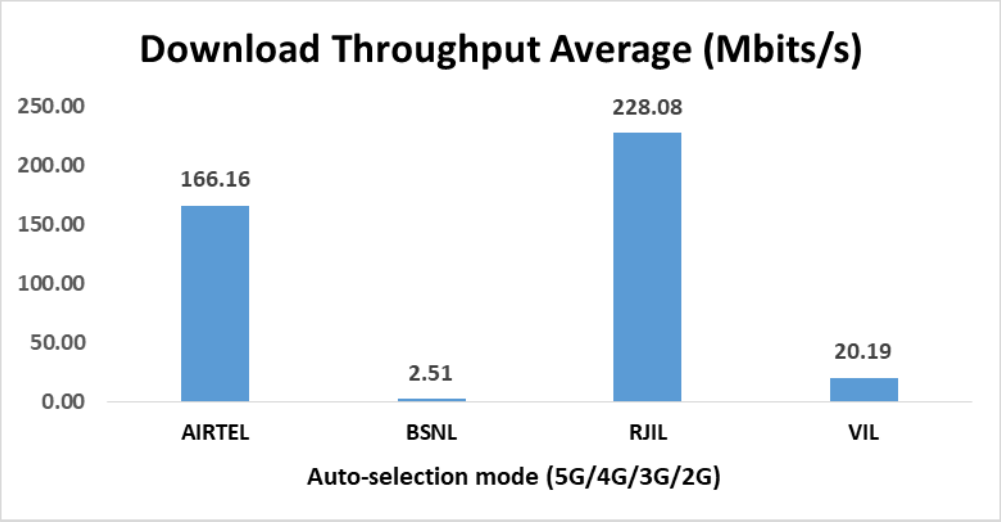


Figure- 21: Download throughput

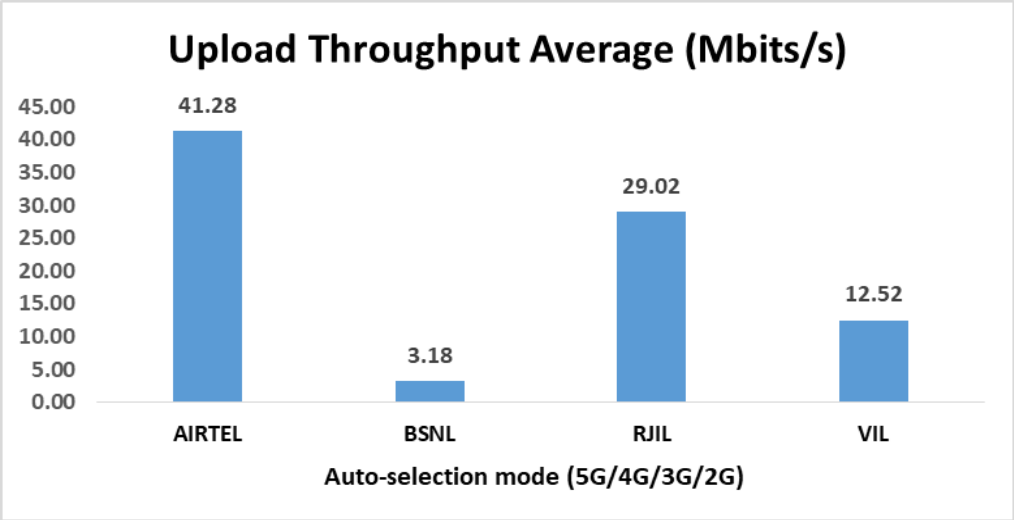


Figure- 22: Upload throughput

4.3 Hotspots

Hotspot testing have been done on 22th November 2024. Eight locations has been tested in the city.

4.3.1 Locations

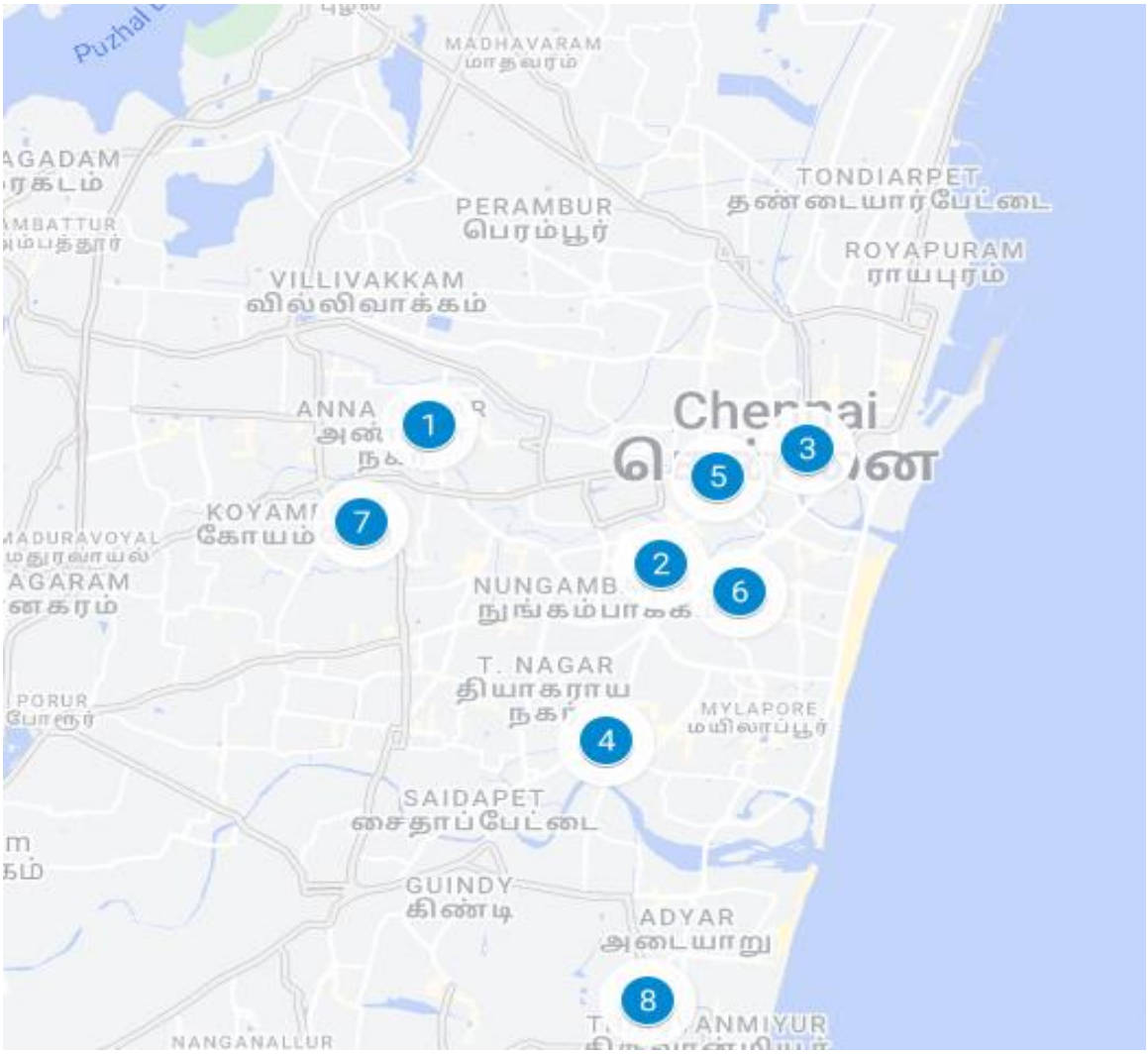


Figure- 23: Hotspot locations

4.3.2 Hotspot covered

1. Anna Nagar Tower Park
2. Apollo Hospital Greams Road Teynampet
3. Central Railway Station Circle
4. CMRL Headquarters Nandanam
5. Egmore Railway Station Entrance
6. Express Avenue Mall
7. Koyambedu Bus Stand
8. Tidel Park (IT Park)

4.3.3 Voice performance

Overall Voice Performance				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	80	80	80	80
Call Setup Success Rate %	100.00	97.50	100.00	100.00
Drop Call Rate%	0.00	0.00	0.00	0.00
Call Setup Time-Average (Sec)	0.43	4.12	0.65	1.75

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

Anna Nagar Tower Park				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate%	0.00	0.00	0.00	0.00
Call Setup Time-Average (Sec)	0.47	6.41	0.61	1.57

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

Apollo Hospital Greams Road Teynampet				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate%	0.00	0.00	0.00	0.00
Call Setup Time-Average (Sec)	0.35	5.91	0.66	1.77

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

Central Railway Station Circle				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate%	0.00	0.00	0.00	0.00
Call Setup Time-Average (Sec)	0.64	1.81	0.61	1.92

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

CMRL Headquarters Nandanam				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	90.00	100.00	100.00
Drop Call Rate%	0.00	0.00	0.00	0.00
Call Setup Time-Average (Sec)	0.37	2.10	0.72	1.75

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

Egmore Railway Station Entrance				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate%	0.00	0.00	0.00	0.00
Call Setup Time-Average (Sec)	0.36	3.09	0.65	1.78

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

Express Avenue Mall				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate%	0.00	0.00	0.00	0.00
Call Setup Time-Average (Sec)	0.36	2.72	0.66	1.59

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

Koyambedu Bus stand				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate%	0.00	0.00	0.00	0.00
Call Setup Time-Average (Sec)	0.44	7.13	0.64	1.59

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

Tidel Park (IT Park)				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	90.00	100.00	100.00
Drop Call Rate%	0.00	0.00	0.00	0.00
Call Setup Time-Average (Sec)	0.46	3.54	0.64	2.06

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

4.3.4 Data performance

Overall Data Performance				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	195.60	6.00	288.59	17.18
Download Throughput 80th Percentile (Mbit/s)	261.51	10.06	375.52	34.03
Download Throughput 20th Percentile (Mbit/s)	110.19	0.91	125.55	3.02
Download Session Setup Success Rate %	100.00	95.00	100.00	100.00
Upload Throughput Average (Mbits/s)	66.79	5.96	29.93	13.81
Upload Throughput 80th Percentile (Mbit/s)	95.75	8.66	42.20	16.00
Upload Throughput 20th Percentile (Mbit/s)	46.39	1.23	8.58	10.39
Upload Session Setup Success Rate %	100.00	95.00	100.00	100.00
Web Browsing Delay (Second)	1.86	4.71	1.91	2.64
Youtube Initial Buffer Delay (Second)	0.55	2.21	0.62	0.80
Ping (ms)	20.49	26.79	19.50	24.14
Jitter (ms)	6.06	12.16	8.99	5.61
Packet Loss Rate-Ping %	0.15	6.71	0.29	1.14

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

Anna Nagar Tower Park				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	267.54	0.77	315.12	2.82
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	50.89	1.61	7.36	12.28
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	1.87	10.75	1.81	3.31
Youtube Initial Buffer Delay (Second)	0.52	4.42	0.63	0.91
Ping (ms)	20.29	30.19	17.6	26.58
Jitter (ms)	3.81	11.30	6.47	6.57
Packet Loss Rate-Ping %	0.00	11.81	0.00	4.50

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

Apollo Hospital Greams Road Teynampet				
Parameters	**Service Provider**			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	232.59	12.34	458.98	29.43
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	39.19	9.34	70.98	11.86
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.00	2.24	1.79	2.30
Youtube Initial Buffer Delay (Second)	0.51	0.77	0.55	0.68
Ping (ms)	21.46	27.72	15.01	23.80
Jitter (ms)	2.83	6.47	6.01	3.65
Packet Loss Rate-Ping %	0.00	2.80	0.00	0.40

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

Central Railway Station				
Parameters	**Service Provider**			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	236.96	11.33	312.37	12.64
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	73.31	7.77	29.68	13.13
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	1.88	1.86	1.67	2.88
Youtube Initial Buffer Delay (Second)	0.69	1.17	0.68	0.86
Ping (ms)	21.19	24.70	18.78	24.06
Jitter (ms)	6.70	8.67	13.76	5.44
Packet Loss Rate-Ping %	0.10	1.00	0.20	0.70

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

CMRL Headquarters Nandanam				
Parameters	**Service Provider**			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	249.01	3.35	94.31	8.55
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	98.43	2.08	9.38	18.02
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	1.77	4.34	1.86	2.67
Youtube Initial Buffer Delay (Second)	0.56	2.75	0.61	0.69
Ping (ms)	20.67	28.47	23.10	23.87
Jitter (ms)	2.87	12.81	9.36	3.47
Packet Loss Rate-Ping %	0.00	1.20	0.20	0.80

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

Egmore Railway Station Entrance				
Parameters	Service Provider			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	101.93	4.15	304.53	4.33
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	58.05	1.66	36.12	15.91
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	1.90	4.89	1.97	2.85
Youtube Initial Buffer Delay (Second)	0.50	1.47	0.55	0.82
Ping (ms)	20.01	15.18	15.74	23.57
Jitter (ms)	2.75	10.06	5.20	3.25
Packet Loss Rate-Ping %	0.00	0.30	0.10	0.30

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

Express Avenue Mall				
Parameters	Service Provider			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	244.05	11.19	460.80	37.80
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	101.36	21.04	39.51	15.85
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.04	2.91	1.88	2.43
Youtube Initial Buffer Delay (Second)	0.50	0.85	0.55	0.64
Ping (ms)	18.07	22.39	15.99	23.56
Jitter (ms)	2.39	4.02	6.56	3.68
Packet Loss Rate-Ping %	0.00	2.40	0.00	0.80

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

Koyambedu Bus Stand				
Parameters	Service Provider			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	118.29	1.03	250.55	31.41
Download Session Setup Success Rate %	100.00	80.00	100.00	100.00
Upload Throughput Average (Mbits/s)	45.72	1.08	40.16	13.91
Upload Session Setup Success Rate %	100.00	80.00	100.00	100.00
Web Browsing Delay (Second)	1.74	8.11	1.88	2.58
Youtube Initial Buffer Delay (Second)	0.56	-	0.59	0.82
Ping (ms)	20.54	25.55	15.95	23.55
Jitter (ms)	2.60	17.69	6.46	14.57
Packet Loss Rate-Ping %	0.00	0.80	0.00	0.90

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

Tidel Park (IT Park)				
Parameters	**Service Provider**			
	Auto-Selection Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	114.43	2.06	112.04	10.47
Download Session Setup Success Rate%	100.00	80.00	100.00	100.00
Upload Throughput Average (Mbits/s)	67.35	1.21	6.24	9.51
Upload Session Setup Success Rate %	100.00	80.00	100.00	100.00
Web Browsing Delay (Second)	1.73	8.73	2.42	2.13
Youtube Initial Buffer Delay (Second)	0.59	8.18	0.85	0.94
Ping (ms)	21.66	46.14	33.84	24.26
Jitter (ms)	24.52	31.58	18.13	4.32
Packet Loss Rate-Ping %	1.10	33.40	1.80	0.70

Table-37: 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 99.71%, 99.85% and 99.57 call setup success rate respectively in 3G/2G network mode.

   b) Airtel, BSNL, RJIL and VIL have 100.00%, 97.00%, 99.88% and 100.00% call setup success rate respectively in Auto-selection mode (5G/4G/3G/2G).

   c) Airtel have 100% call setup success rate while calling on peer service provider's network, while remaining service providers have block call rate for inter-operator calls.

2. **Call Setup time**:
   a) VIL has taken comparatively longer time (3.20 second) to establish the voice call, whereas Airtel and BSNL call setup time is 2.88 & 2.73 seconds respectively in 3G/2G network mode.

   b) BSNL has taken comparatively longer time (4.34 second) to establish the voice call, whereas VIL, RJIL and Airtel call setup time is 1.64, 0.72 & 0.41 seconds respectively in Auto-selection mode (5G/4G/3G/2G).

3. **Call Silence/Mute Rate**: In packet switched network (4G/5G), VIL, RJIL and Airtel have 0.86%, 0.59% & 0.43% silence call rate respectively. Further VIL has higher RTP packet loss rate in downlink (0.48%) compared to RJIL (0.20%) and Airtel (0.16%). In uplink the RTP packet loss rate is higher for VIL (0.49%) compared to RJIL (0.34%) and Airtel (0.17%).

4. **Call Drop Rate**:
   a) Airtel, BSNL and VIL have 0.00%, 4.10% and 0.29% drop call rate respectively in 3G/2G network mode.

b) Overall BSNL's call drop rate (2.19%) is higher (QoS benchmark of 2%), while RJIL, Airtel and VIL have 1.11%, 0.00% and 0.00% drop call rate respectively in Auto-selection mode (5G/4G/3G/2G).

5.2 Overall Data

1. **Data download and upload performance (Dynamic i.e. while moving) :**
   a) BSNL (2.69 Mbps) and VIL (20.06 Mbps) being on 3G & 4G as top technology respectively, have comparatively lower data speeds. While Airtel and RJIL have average download speed of 167.12 Mbps and 231.12 Mbps respectively.

   b) BSNL (3.32 Mbps) and VIL (12.58 Mbps) being on 3G & 4G as top technology respectively, have comparatively lower data speeds. While Airtel and RJIL have average upload speed of 42.12 Mbps and 29.06 Mbps respectively.

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 288.59 Mbps.

   b) At Hotspot, Airtel has better 5G QoS performance comparatively, with average upload speed of 66.79 Mbps.

3. **Data session setup success rate (static i.e. while stationary):**
   a) Airtel, RJIL, VIL have 100% download and upload session setup success rate & BSNL has 95% download & upload session setup success rate.

5.3 Operator wise Key Findings

1. **Airtel:**

Voice

- 99.71% call setup success rate and 0.00% call drop rate have been observed in 3G/2G network mode. Performance is well within the benchmark of 98.00% & 2.00% respectively. (refer Table-3 and Table- 13)

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

Data

- Airtel has 167.12 Mbps average download throughput & 42.12 Mbps average upload throughput across measured routes for LSA (refer Table-11)

- Airtel has 166.16 Mbps average download throughput & 41.28 Mbps average upload throughput across measured routes for city drive (refer Table- 19)

2. BSNL:

Voice

- 96.85% call setup success rate and 4.10% call drop rate have been observed in 3G/2G network mode. Performance is not meeting the benchmark of 98.00% & 2.00% respectively. (refer Table-3 and Table-13)

- 97.00% call setup success rate and 2.19% 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)

- 96.94% call setup success rate and 2.44% 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. (refer Table-15)

- 97.50% call setup success rate has been observed in auto-selection mode (5G/4G/3G/2G). Performance is not meeting the benchmark of 98.00% for Hotspots. (refer Table-20)

Data

- BSNL has 2.69 Mbps average download throughput & 3.32 Mbps average upload throughput across measured routes for LSA (refer Table-11)

- BSNL has 2.51 Mbps average download throughput & 3.18 Mbps average upload throughput across measured routes for city drive (refer Table-19)

- All Hotspots have less download speed (less than 15 Mbps).(refer Table -30, 31, 32, 33, 34, 35, 36 & 37).

- Anna Nagar Tower Park, CMRL Headquarters Nandanam, Egmore Railway Station Entrance, Koyambedu Bus Stand and Tidel Park (IT Park) hotspots have less upload speeds (less than 5 Mbps).(refer Table -30, 33, 34, 36 and 37)

3. RJIL:

Voice

- 99.88% call setup success rate and 1.11% 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)

- 99.86% call setup success rate and 1.23% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G). Performance is well within the benchmark of 98.00% & 2.00% respectively for City. (refer Table-15)

Data

- RJIL has 231.12 Mbps average download speed & 29.06 Mbps average upload speed across measured routes in LSA. (refer Table-11)

- RJIL has 228.08 Mbps average download speed & 29.02 Mbps average upload speed across measured routes in city drive. (refer Table-19)

- CMRL Headquarters Nandanam hotspot has less download speed (less than 100 Mbps) out of total 8 hotspots. (refer Table- 33)

- Anna Nagar Tower Park, CMRL Headquarters Nandanam, Tidel Park (IT Park) hotspots have less upload speed (less than 10 Mbps) out of total 8 hotspots. (refer Table- 30, 33 & 37)

4. VIL:

Voice

- 99.57% call setup success rate and 0.29% call drop rate have been observed in 3G/2G network mode. Performance is well within the benchmark of 98.00% & 2.00% respectively. (refer Table-3 and Table- 13)

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

Data

- VIL has 20.06 Mbps average download speed & 12.58 Mbps average upload speed across measured routes in LSA. (refer Table-11)

- VIL has 20.19 Mbps average download speed & 12.52 Mbps average upload speed across measured routes in city drive. (refer Table-19)

- Anna Nagar Tower Park, Central Railway Station Circle, CMRL Headquarters Nandanam, Egmore Railway Station Entrance and Tidel Park (IT park) hotspots have less download speeds (less than 15 Mbps) out of total 8 hotspots. (refer Table- 30, 32, 33, 34 & 37)

6. Annexure

6.1 Route wise coverage map

6.1.1 City

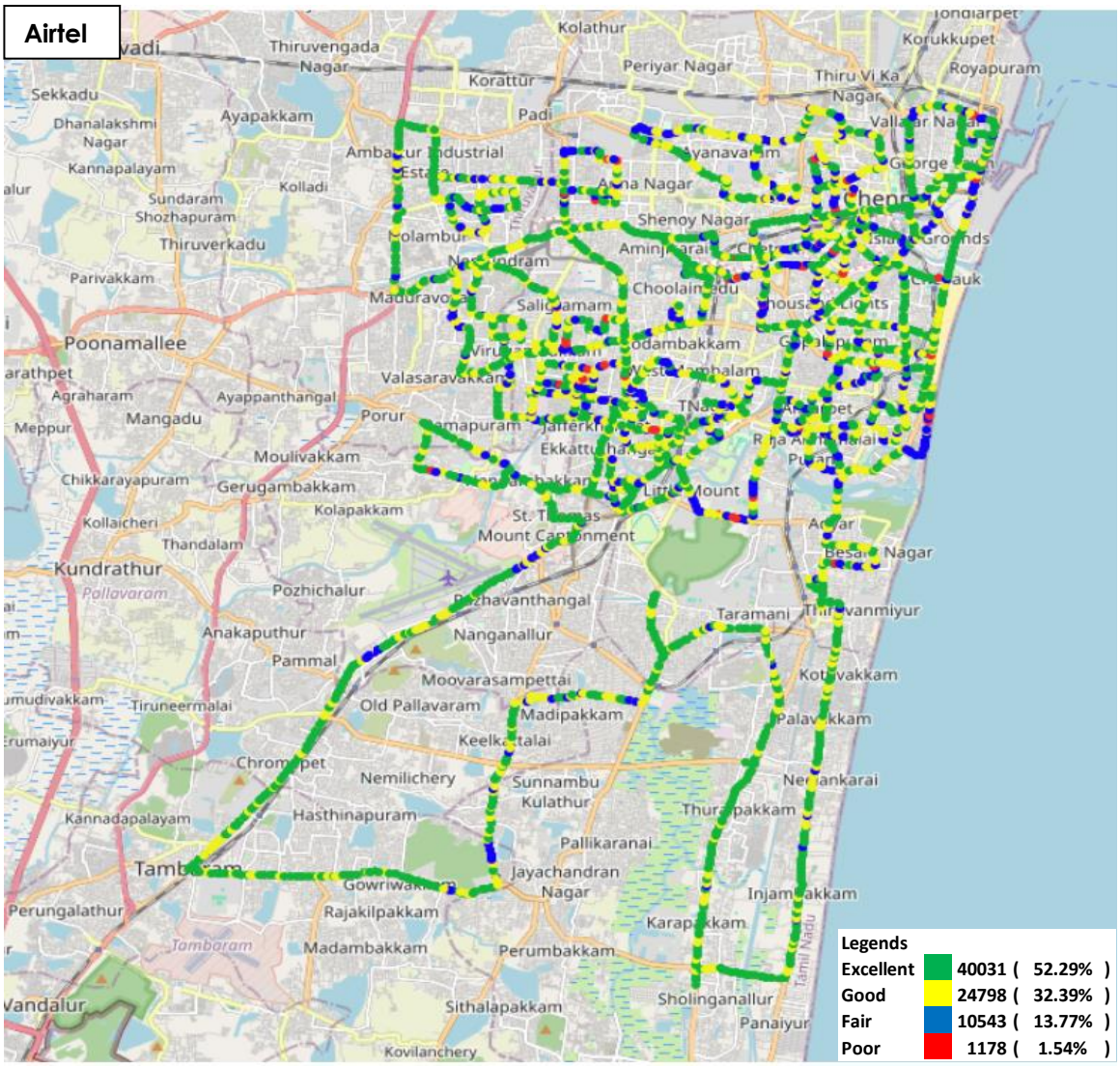


Figure-24: Signal strength 3G/2G network mode – AIRTEL

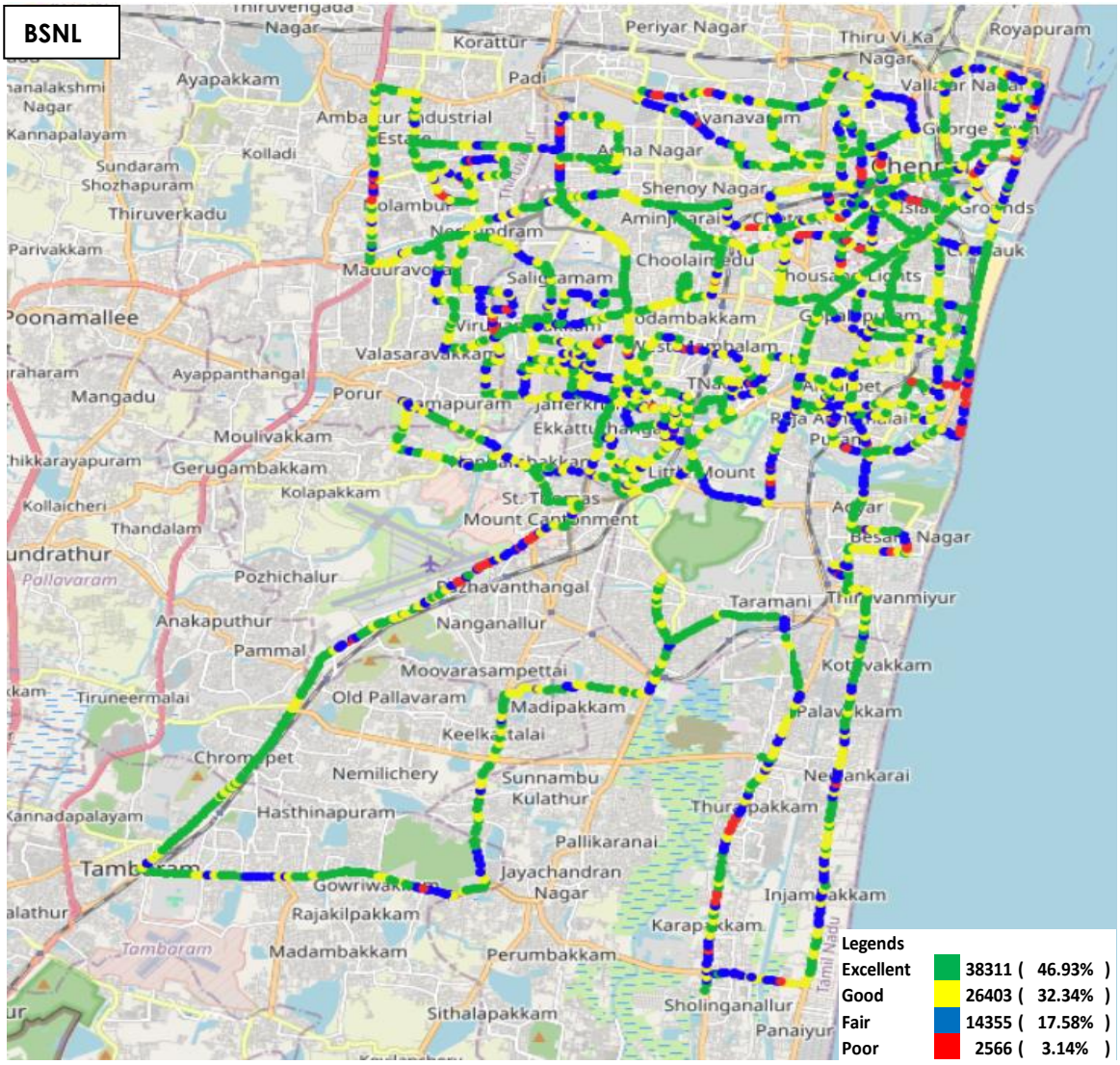


Figure-25: Signal strength 3G/2G network mode – BSNL

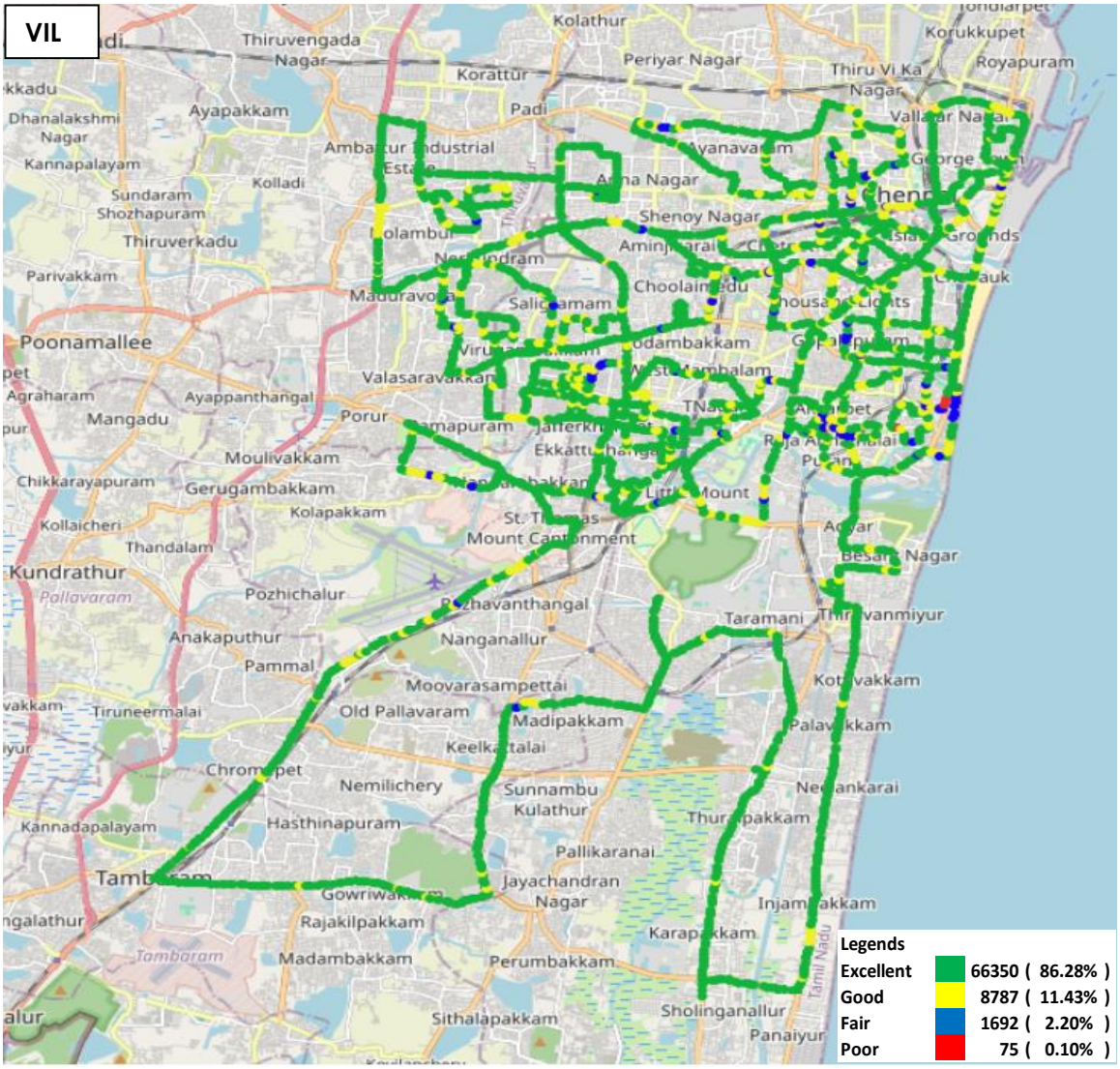


Figure-26: Signal strength 3G/2G network mode – VIL

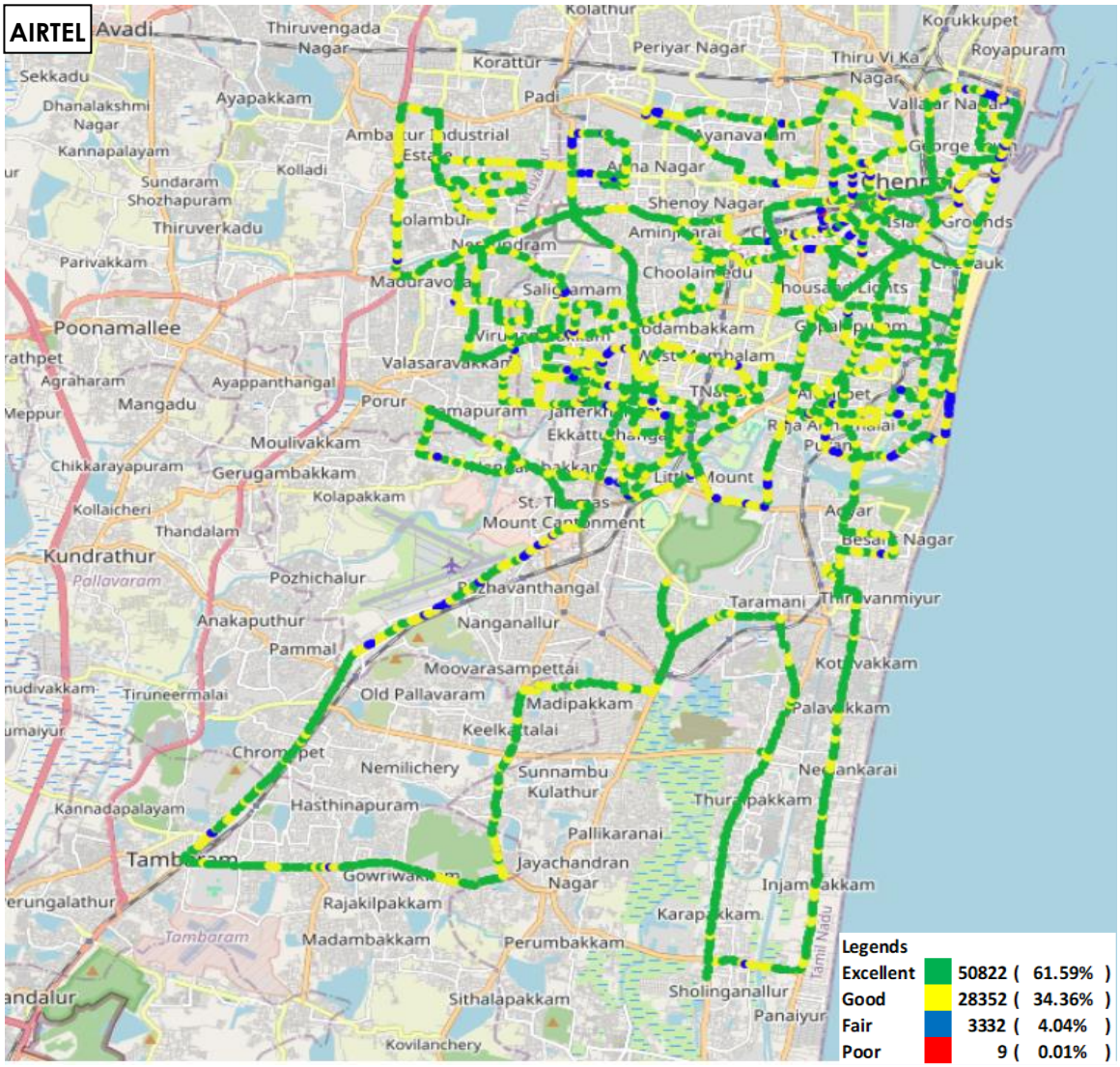


Figure-27: Signal strength auto-selection mode 5G/4G/3G/2G - Airtel

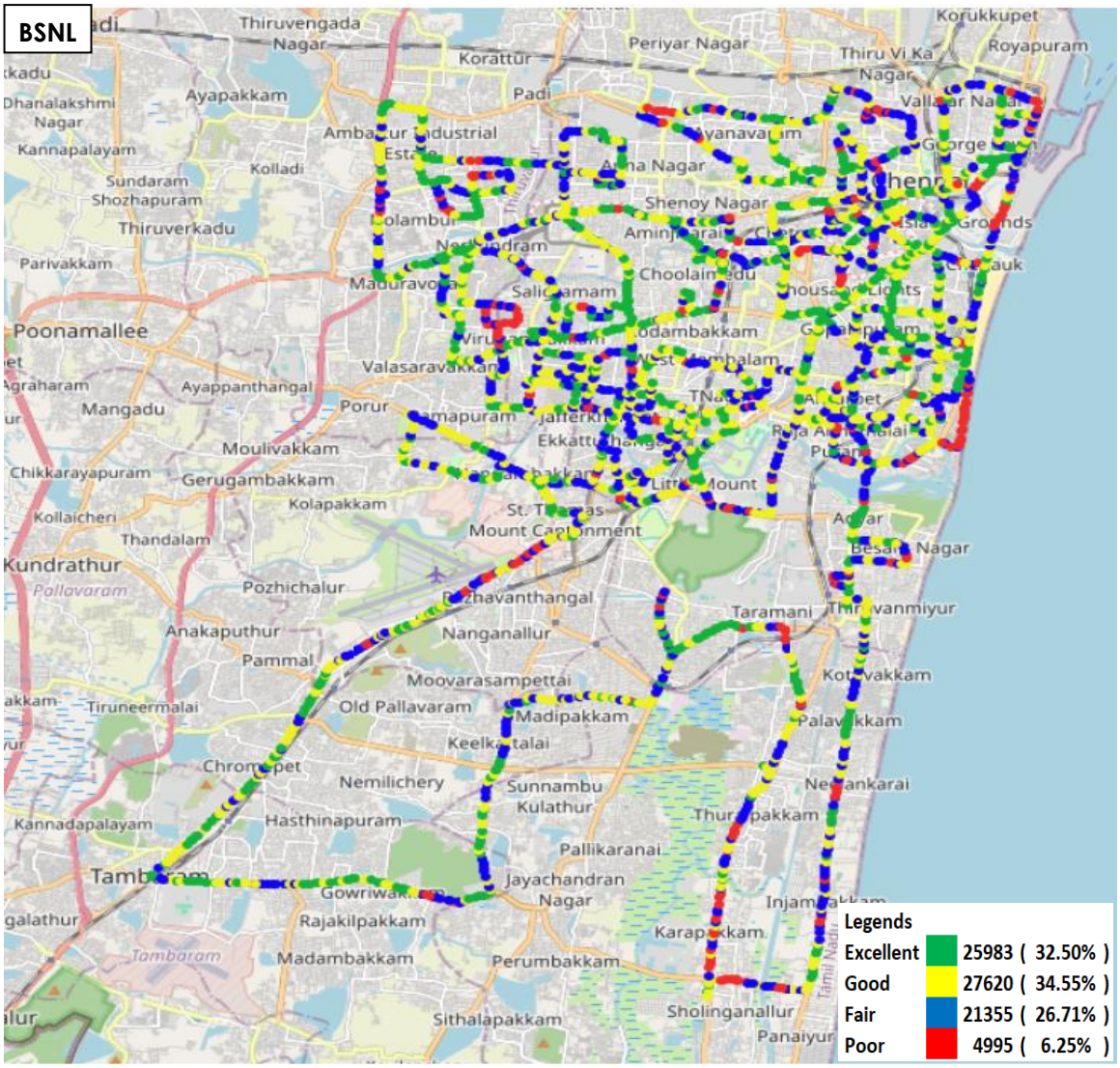


Figure-28: Signal strength auto-selection mode 5G/4G/3G/2G - BSNL

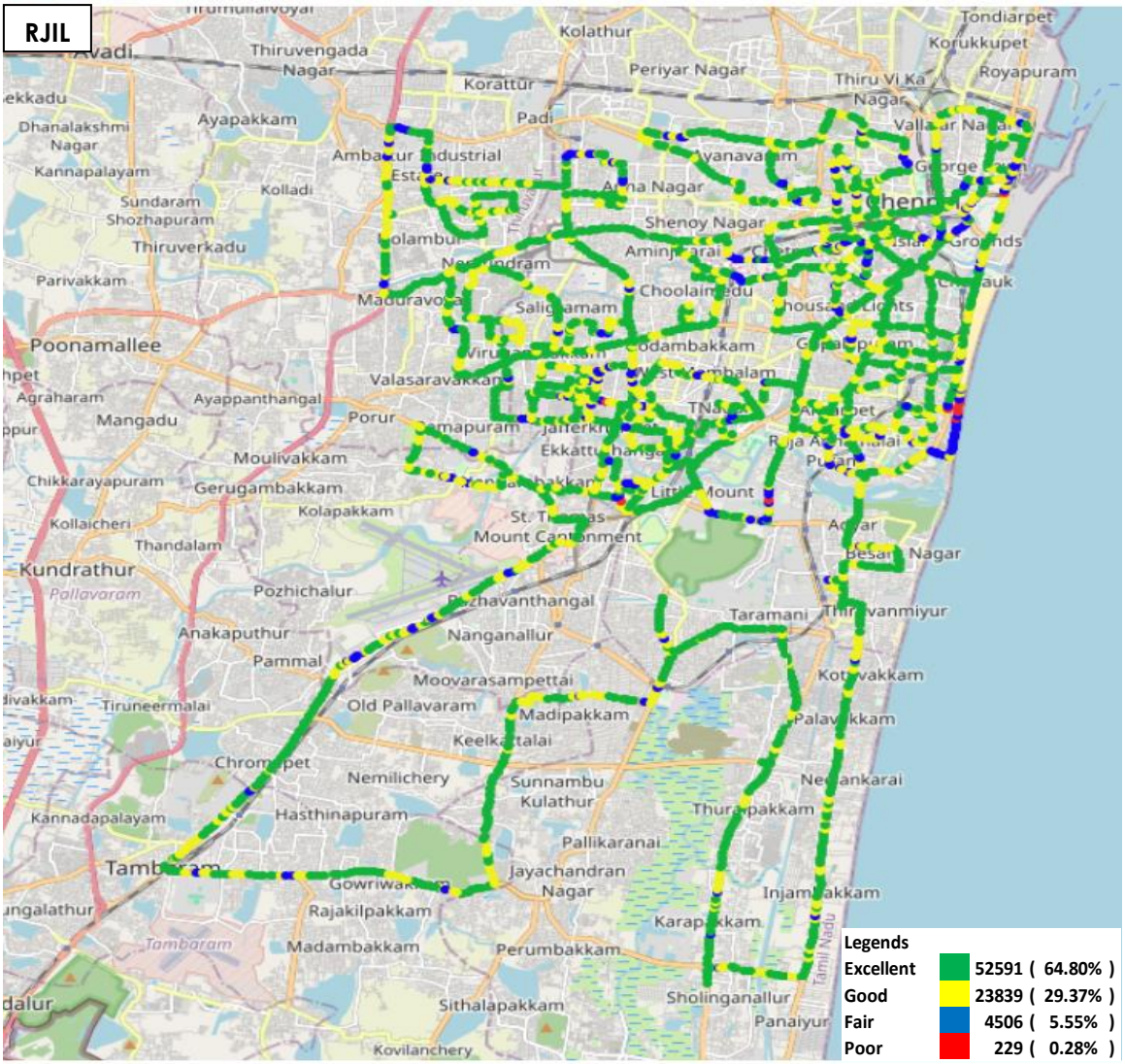


Figure-29: Signal strength auto-selection mode 5G/4G/3G/2G – RJIL

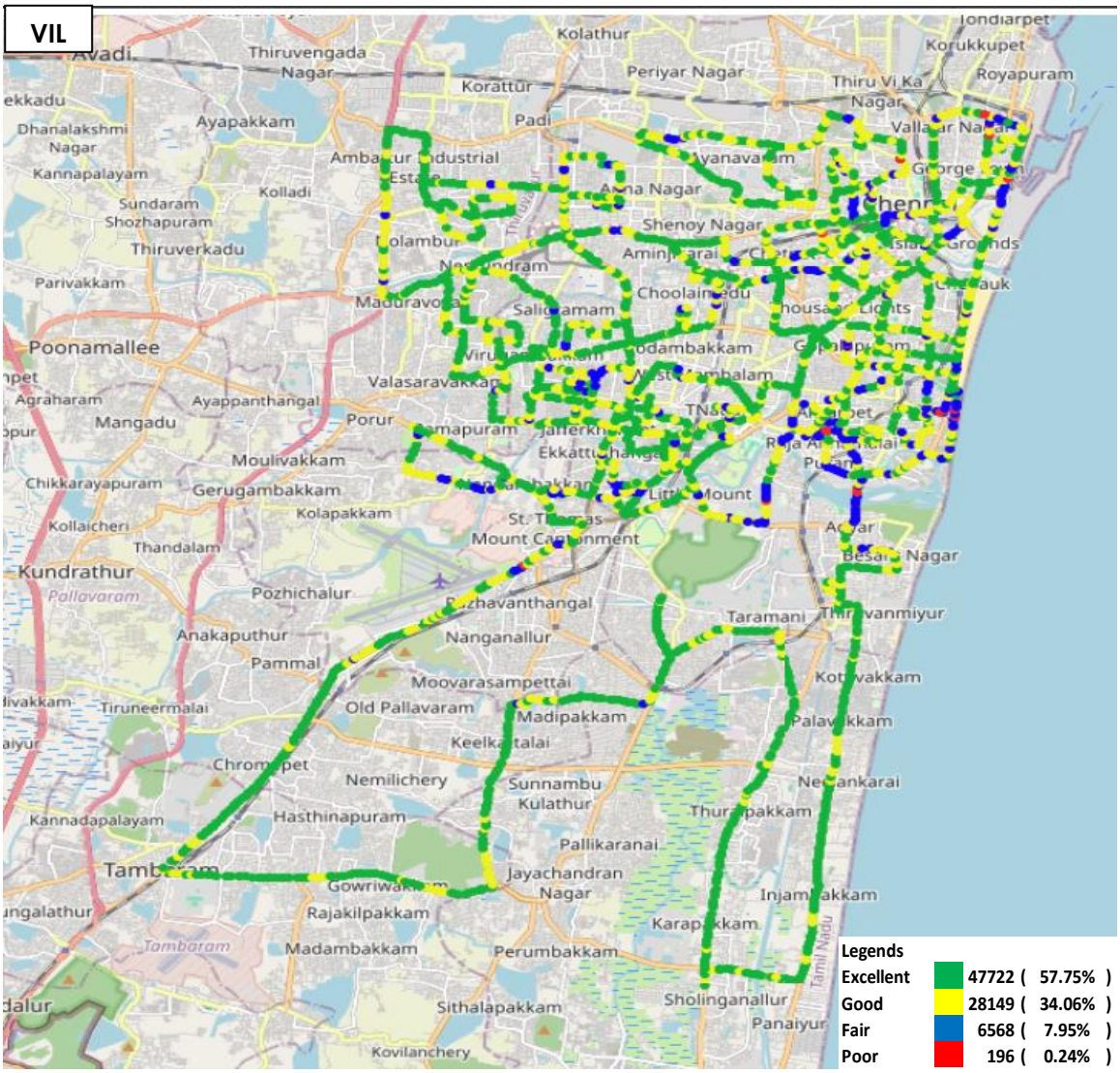


Figure-30: Signal strength auto-selection mode 5G/4G/3G/2G – VIL

7. Appendix

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

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

7.1 Appendix-I

7.1.1 Drive test setup

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

Table-38: 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.
- All values are taken up to two decimal places with round off.

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

Web Browsing		3 popular websites (www.amazon.in, www.facebook.com, www.google.co.in) 20 sec timeout (only at Hotspot)
Ping		25 count- Dynamic 1000 count- Hotspot

Table-39: 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)

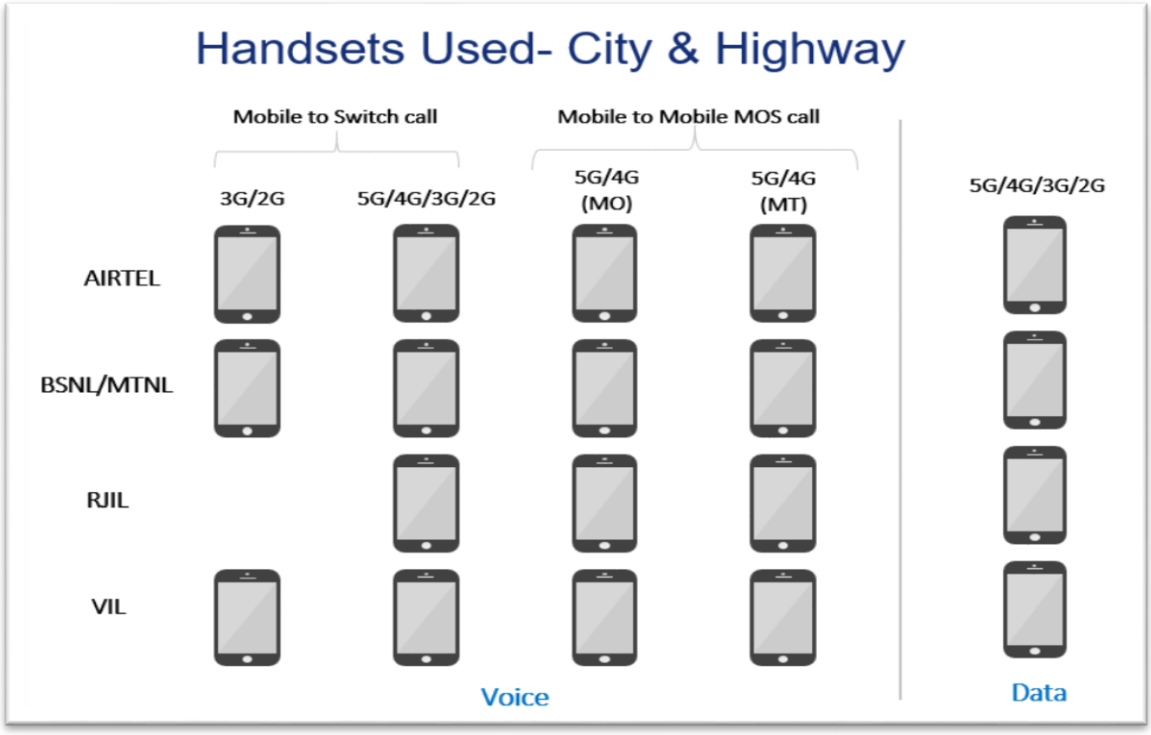


Figure-31: Number of handsets used in city & highway drive

MO: Mobile originating

MT: Mobile terminating

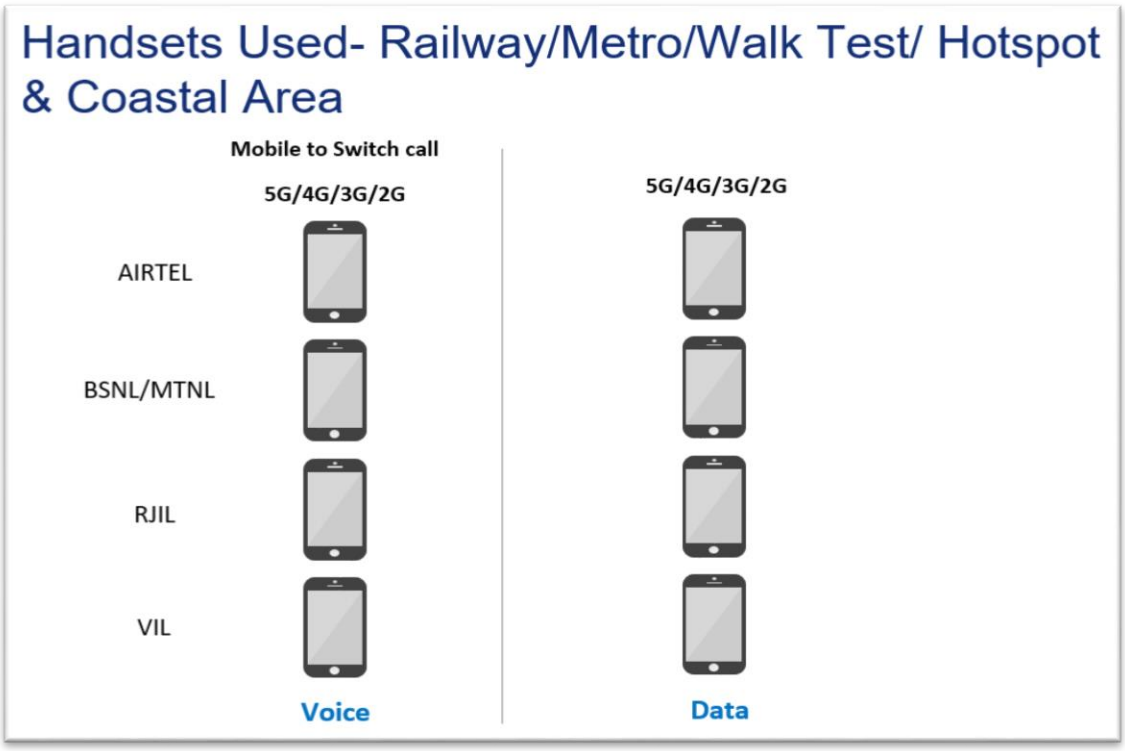


Figure-32: Number of handsets used in railway/metro/walktest/hotspot & coastal area

7.1.2 Drive test Methodology

(a) Dynamic voice testing (on the move)

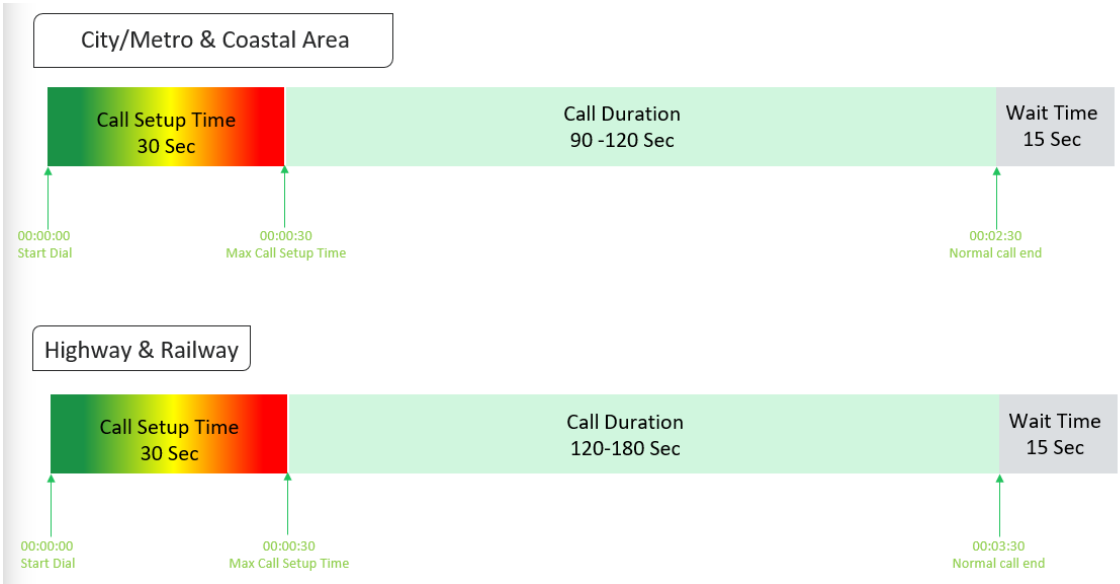


Figure-33: Voice test script for city/railway/metro/highway & coastal area

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

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

(b) Hotspot voice testing

Figure-34: Voice test script for walktest/hotspot

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

(c) Dynamic Data (internet) test

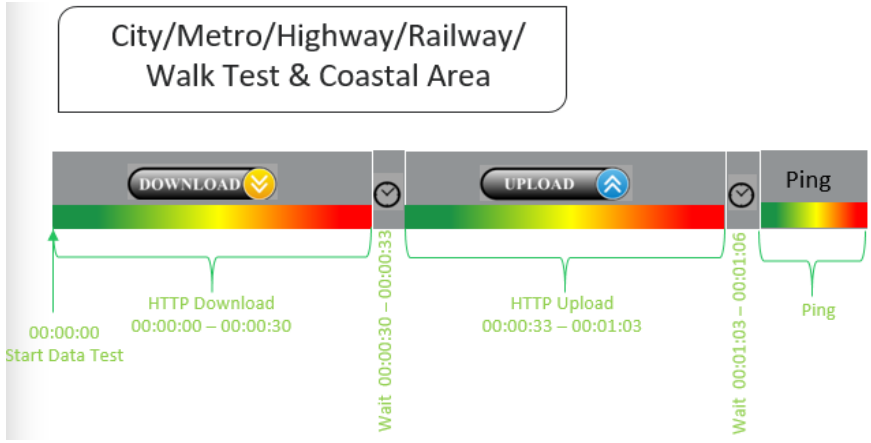


Figure-35: Data test script used in city/metro/railway/highway/walk test & coastal area

(d) Static Data(internet) testing

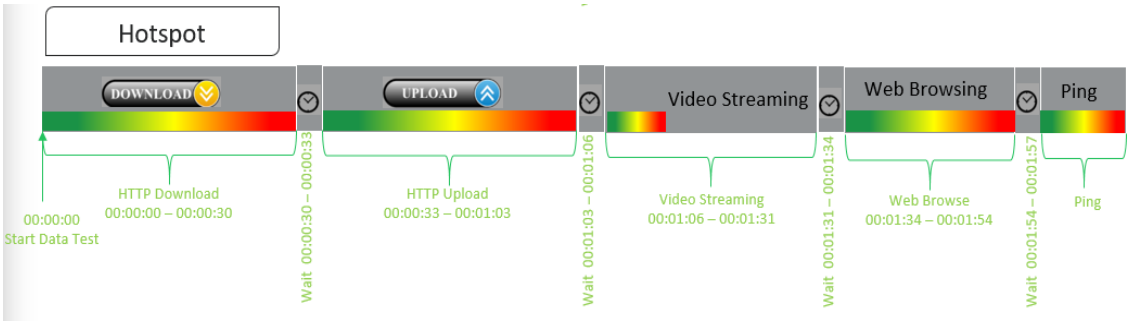


Figure-36: Data test script used at hotspot

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

7.2 Appendix-II

7.2.1 Network Performance Parameters for Voice 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 / 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 will be calculated continuously as each data packet i is received from source SSRC_n, using this difference D for that packet and the previous packet i-1 in order of arrival (not necessarily in sequence), according to the formula
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 will be 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 will be 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><td rowspan="2">Parameter Name</td><td rowspan="2">Technology</td><td colspan="4">Signal Strength (dBm)</td></tr>
<tr><td>Excellent</td><td>Good</td><td>Fair</td><td>Poor</td></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-40: 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.
Ping Test & Latency	Ping (latency is the technically more correct term) 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 ping time is measured in milliseconds (ms). To calculate the one-way ping delay we just do half of the round-trip time
Jitter- Ping	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 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 the ping testing. Packet loss rate = (Total packet lost / Total packet sent) *100 * Packet delay (ping delay) >90 ms considered as packet loss and included in packet loss rate. * Packet loss rate is calculated based on ICMP

Table-41: Network performance parameter and definition Data