भादूविप्रा
TRAI

TELECOM REGULATORY AUTHORITY OF INDIA

Independent Drive Test Report

Andhra Pradesh LSA

October 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 Andhra Pradesh License Service Area (LSA) during October-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	Hyderabad	City	279	22-Oct-2024	24-Oct-2024
2	Hyderabad	City (Inter-operator calling)	16	25-Oct-2024	25-Oct-2024
3	Hyderabad	Hotspot	07 Locations	25-Oct-2024	25-Oct-2024
4	Nagole to Raidurg, Miyapur to LB Nagar	Metro	56	24-Oct-2024	24-Oct-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, metro and hotspots as per the legends shown on the map.

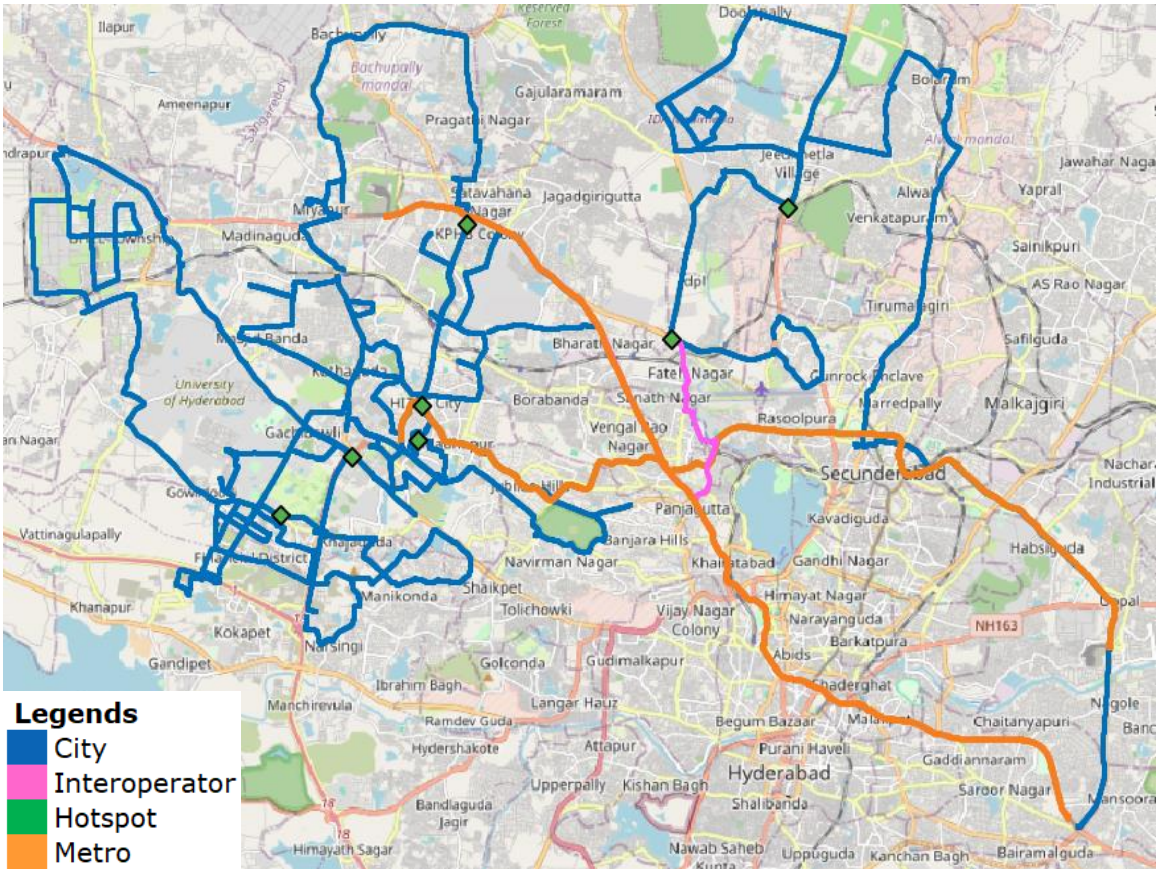


Figure-1: Drive test routes

2.3 Summary of areas covered

a) City- Nearby University of Hyderabad, Bharath Nagar, Secunderabad, Pragathi Nagar, Kokapet, Navirman Nagar, Saroor Nagar, Venkatapuram etc.

b) Hotspot-

1. Cyber Towers
2. Gachibowli Flyover
3. Nanakramguda Circle
4. Balanagar Junction
5. Suchitra Junction
6. Mind Space
7. JNTU Junction

c) Railway/ Metro-

1. Nagole to Raidurg
2. Miyapur to LB Nagar

2.4 Telecom service providers detected frequency bands

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

S.no.	Name of TSP	Technology	Frequency Bands (In MHz)
1	Bharti Airtel Ltd.	2G	900,1800
2	Bharti Airtel Ltd.	4G	900,1800,2300
3	Bharti Airtel Ltd.	5G	3500
4	BSNL	2G	900
5	BSNL	3G	2100
6	BSNL	4G	NA
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.	3G	NA
11	Vodafone Idea Ltd.	4G	900,1800,2100,2500

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

Note-

- NA - Frequency band not detected during data collection.

QoS Performance Analysis- Andhra Pradesh LSA

3. QoS performance analysis-LSA level

3.1 Overview

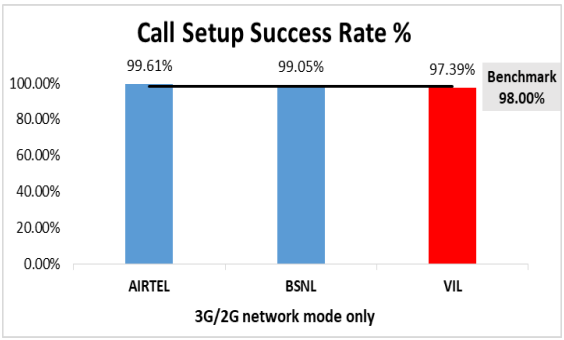
This section provides summary of overall QoS performance of the telecom service provider's network in the LSA by aggregating the results of drive tests conducted in the LSA during October-2024 covering city, metro and hotspots. (Refer Table-1)

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	512	529	499
Call Setup Success Rate %	99.61	99.05	97.39
Drop Call Rate%	0.39	3.63	2.88
Call Setup Time-Average (Second)	6.04	2.73	16.07
Handover Success Rate %	97.34	99.88	96.59

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



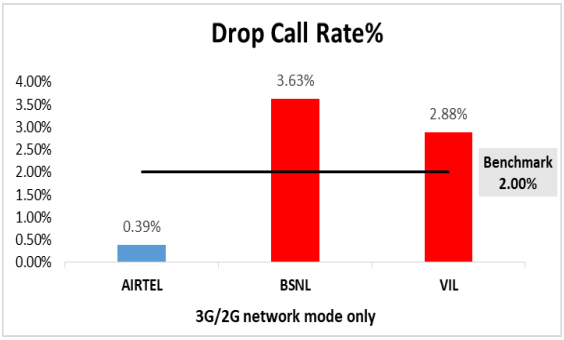


Figure-2: Call setup success rate and drop call rate performance

Number of unique cell ids covered in Voice call test- Technology wise			
Technology	Service Provider		
	3G/2G network mode only		
	AIRTEL	BSNL	VIL
3G	NA	133	NA
2G	929	205	593

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	662	666	675	648
Call Setup Success Rate %	99.85	99.85	100.00	98.92
Drop Call Rate%	0.00	3.76	0.30	0.00
Call Setup Time-Average (Second)	4.20	2.86	0.75	11.82
Handover Success Rate %	97.53	99.94	98.65	95.46

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)	535	525	528	485
Number of calls silent for >4 Sec	6	NA	11	10
Silence Call Rate %	1.12	NA	2.08	2.06
Number of silence instances for >4 Sec	13	NA	13	15
Number of silence instances for >3 Sec	21	NA	21	30
Number of silence instances for >2 sec	32	NA	43	60
RTP Jitter (4G & 5G) in ms	5.39	NA	13.55	16.77
Packet loss Rate Downlink %	0.74	NA	0.60	1.28
Packet loss Rate Uplink %	0.51	NA	1.03	1.53

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

Note-

- Due to unavailability of packet switched (4G & 5G) network in BSNL silence instances are not captured.

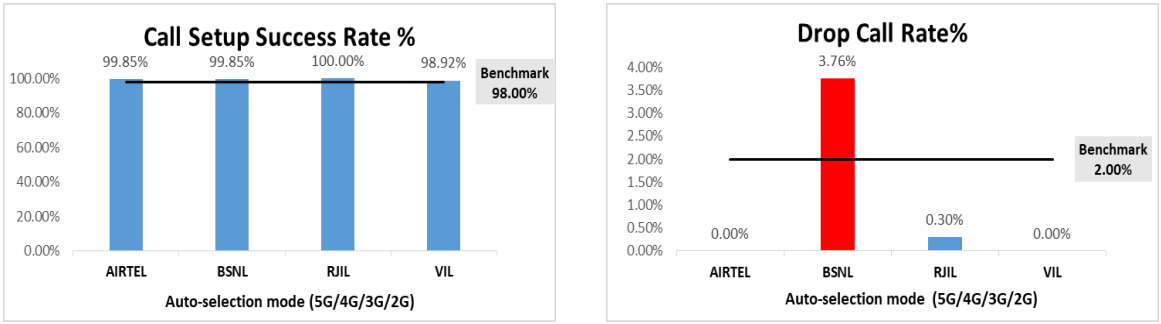


Figure-3: Performance for call setup success rate and drop call rate.

Number of unique cell ids covered in Voice test- Technology wise				
Technology	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
5G	0	NA	935	NA
4G	1872	NA	1394	1264
3G	NA	149	NA	NA
2G	0	246	NA	10

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 on respective technology.

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

Mean opinion score indicates quality of speech observed during the drive test across different technologies. This parameter has been calculated for mobile-to-mobile calls made within same operator's 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	3112	2811	3074	2770
Speech Quality (Average MOS Score)	3.98	2.66	3.81	3.72
Number of samples with MOS ≥ 4 to <5 (Excellent)	2534	0	1871	1258
Number of samples with MOS ≥ 3 to <4(Good)	468	1120	946	1247
Number of samples with MOS ≥ 2 to <3 (Fair)	62	1249	178	171
Number of samples with MOS ≥ 1 to <2 (Poor)	48	442	79	94
%age of samples with MOS ≥ 4 to <5 (Excellent)	81.43%	0.00%	60.87%	45.42%
%age of samples with MOS ≥ 3 to <4(Good)	15.04%	39.84%	30.77%	45.02%
%age of samples with MOS ≥ 2 to <3 (Fair)	1.99%	44.43%	5.79%	6.17%
%age of samples with MOS ≥1 to <2 (Poor)	1.54%	15.72%	2.57%	3.39%

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

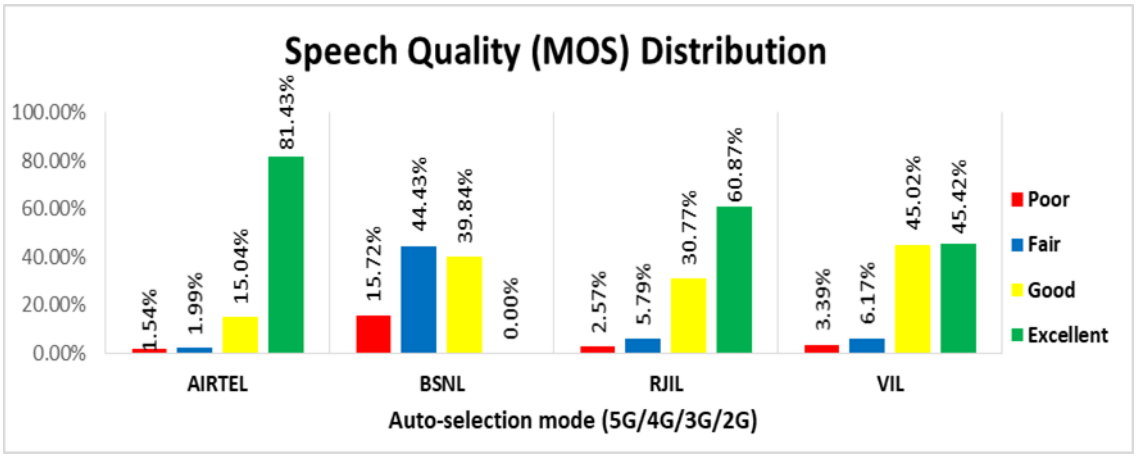


Figure- 4: Distribution of samples in MOS score range

(d) Inter-service provider voice call performance: To check the performance of inter-service provider call setup success rate, total 43 to 48 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	97.78	NA	97.83	100.00
RJIL	100.00	100.00	NA	100.00
VIL	100.00	97.44	97.50	NA

Table-9: Call setup success rate across service providers

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

Call setup time average (seconds)				
From Service Provider	**To Service Provider**			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
AIRTEL	NA	3.43	1.62	2.84
BSNL	3.09	NA	3.21	2.61
RJIL	2.13	3.82	NA	2.37
VIL	13.63	14.65	13.16	NA

Table-10: Call setup time across service providers

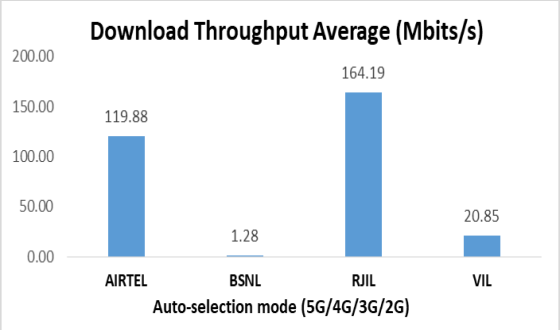
Note-
- NA- Only inter-operator calls were measured during test

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	119.88	1.28	164.19	20.85
	80th Percentile	192.10	2.25	259.81	31.69
	20th Percentile	47.69	0.09	48.09	7.56
Upload Throughput (Mbits/s)	Average	26.76	1.33	20.43	8.83
	80th Percentile	50.33	2.10	38.91	14.61
	20th Percentile	4.23	0.48	2.77	2.94
Ping (ms)	Average	44.01	519.53	314.11	36.01

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



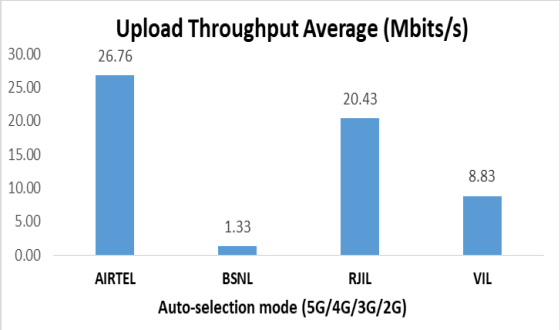


Figure- 5: Download and upload throughput

Number of unique cell ids covered in Data test- Technology wise				
Technology	Service Provider			
	Auto-selection mode 5G/4G/3G/2G			
	AIRTEL	BSNL	RJIL	VIL
5G	0	NA	1073	NA
4G	2066	NA	311	1335
3G	NA	197	NA	NA
2G	2	69	NA	15

Table-12: Technology wise number of network cell ids 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 & Metro 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 22nd October 2024 to 24th October 2024 in Hyderabad. (Refer Table-1)

4.2.1 Drive test route

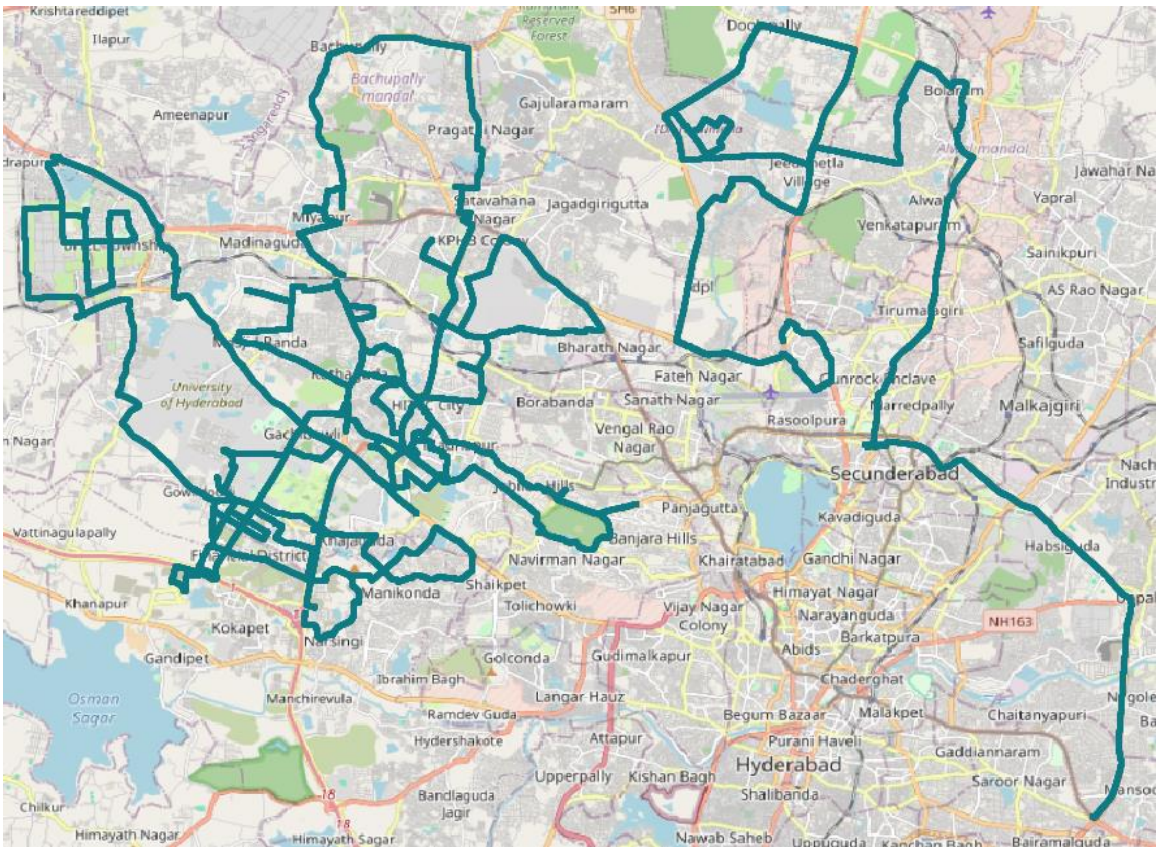


Figure- 6: Drive test routes

4.2.2 Areas covered

Nearby University of Hyderabad, Bharath Nagar, Secunderabad, Pragathi Nagar, Kokapet, Navirman Nagar, Saroor Nagar, Venkatapuram 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	512	529	499
Call Setup Success Rate %	99.61	99.05	97.39
Drop Call Rate%	0.39	3.63	2.88
Call Setup Time-Average (Second)	6.04	2.73	16.07
Handover Success Rate %	97.34	99.88	96.59

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

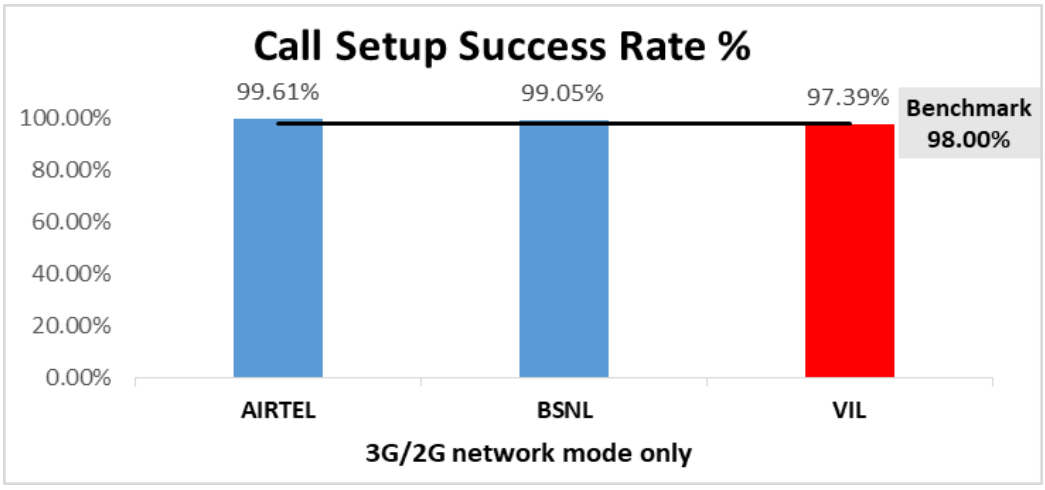


Figure-7: Performance for call setup success rate

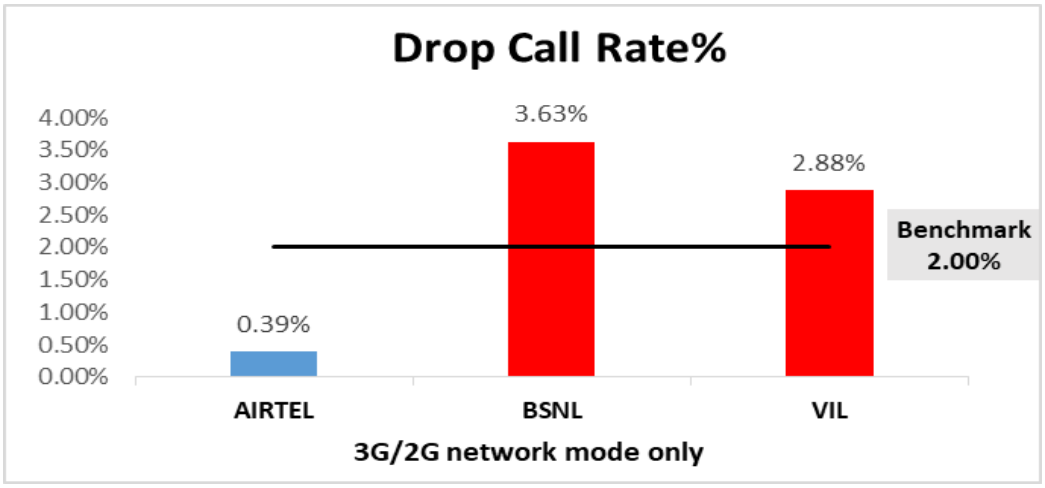


Figure-8: Performance for drop call rate

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

Technology	Service Provider		
	AIRTEL	BSNL	VIL
3G	NA	54.45%	NA
2G	100.00%	45.55%	99.76%
No Service	0.00%	0.00%	0.24%

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

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

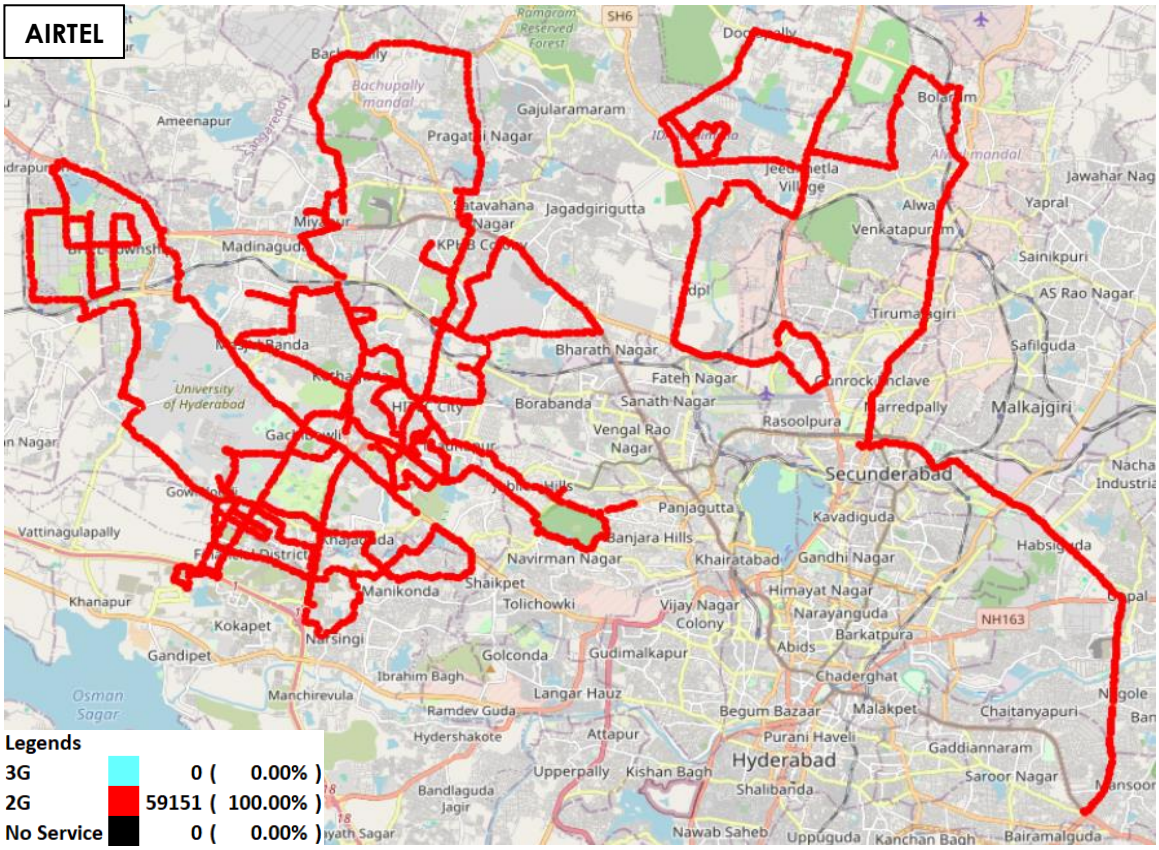


Figure-9: Serving technology plots 3G/2G network mode - AIRTEL

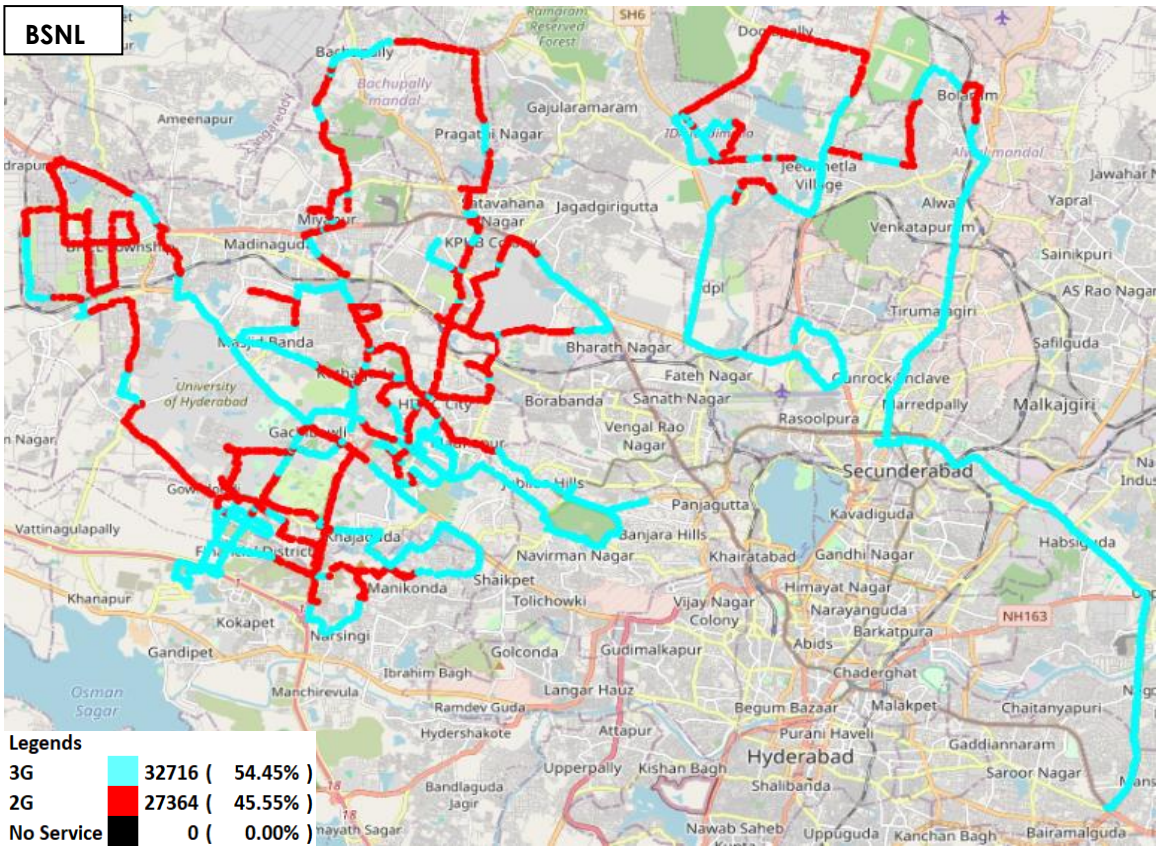


Figure-10: Serving technology plots 3G/2G network mode – BSNL

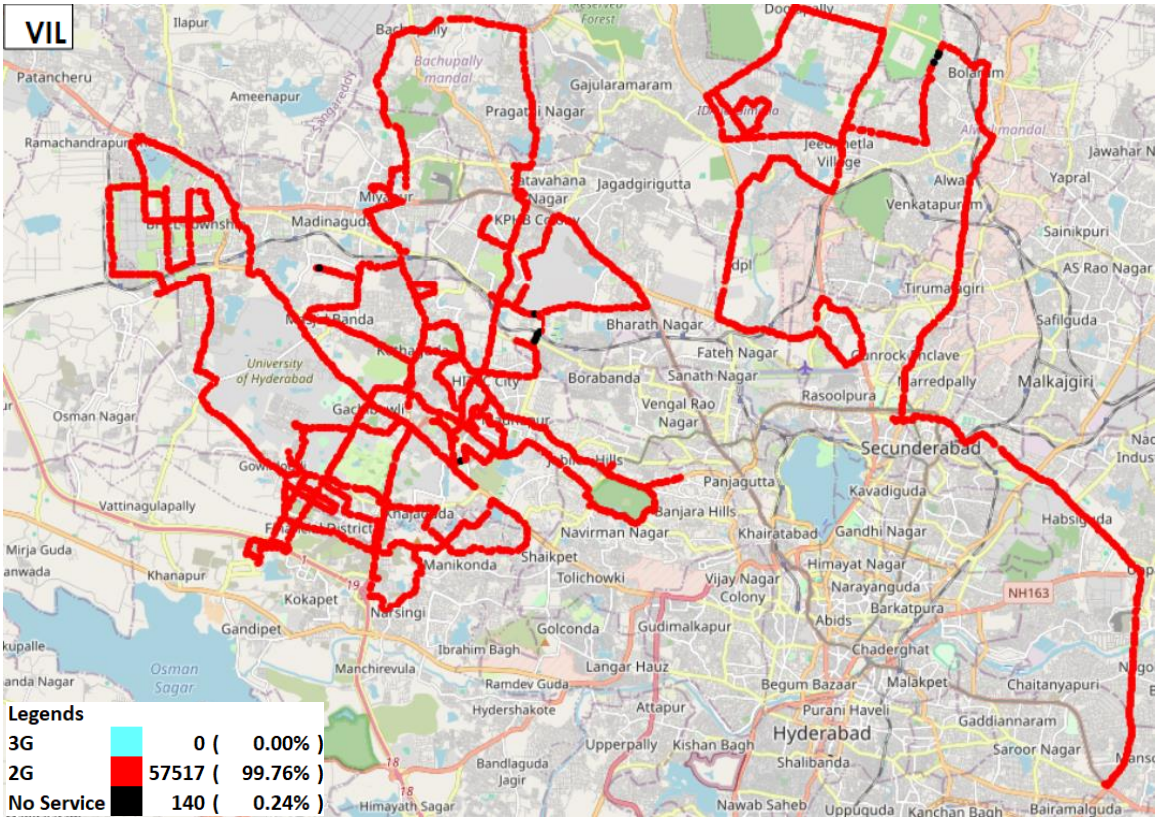


Figure-11: Serving technology plots 3G/2G network mode –VIL

(C) Network Signal Strength distribution: The following chart represents signal strength distribution for 3G/2G network mode only. (Refer figure-43, 44, and 45 for plots)

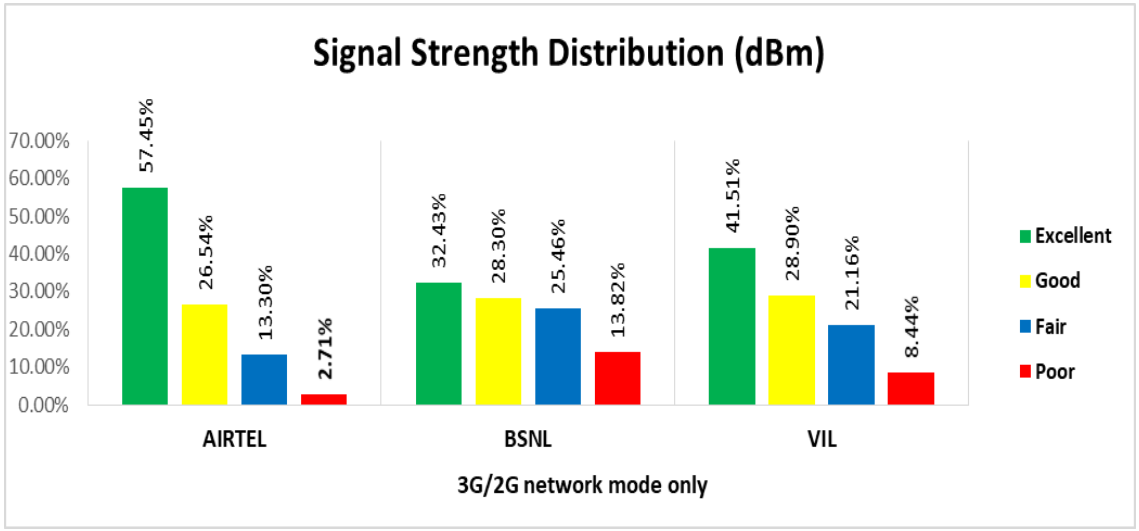


Figure-12: Signal strength distribution 3G/2G network mode only

Observations:

- Airtel's 57% of samples falling in excellent signal strength category.
- BSNL's has 32% of samples falling in excellent signal strength category.
- VIL's has 42% of samples falling in 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	534	536	545	522
Call Setup Success Rate %	100.00	99.81	100.00	98.66
Drop Call Rate%	0.00	3.74	0.37	0.00
Call Setup Time Average (Second)	4.13	2.98	0.77	12.00
Handover Success Rate %	98.02	99.92	98.67	95.51

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)	535	525	528	485
Number of silence call for >4 Sec	6	NA	11	10
Silence Call Rate %	1.12	NA	2.08	2.06
Number of silence instances for >4 Sec	13	NA	13	15
Number of silence instances for >3 Sec	21	NA	21	30
Number of silence instances for >2 sec	32	NA	43	60
RTP Jitter (4G & 5G) in ms	5.39	NA	13.55	16.77
Packet loss Rate Downlink %	0.74	NA	0.60	1.28
Packet loss Rate Uplink %	0.51	NA	1.03	1.53

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

Note-

- Due to unavailability of packet switched (4G & 5G) network in BSNL silence instances are not captured.

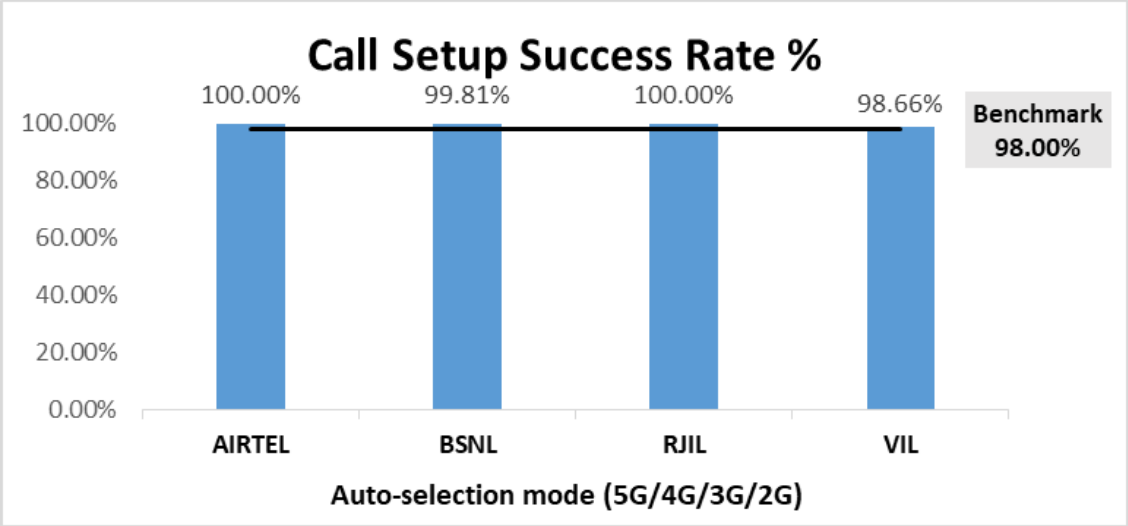


Figure-13: Performance for call setup success rate

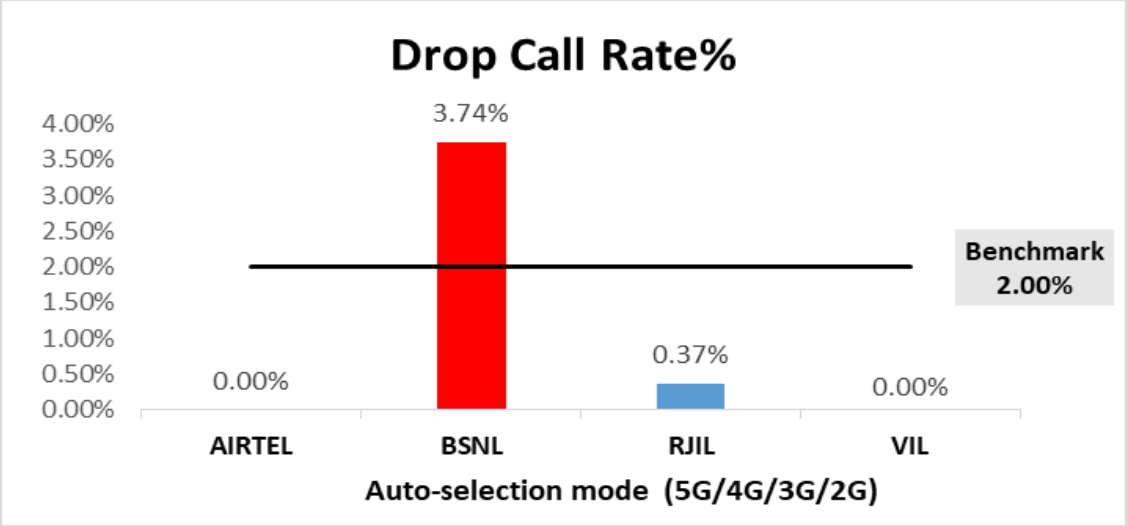


Figure-14: Performance for drop call rate

(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	3112	2811	3074	2770
Speech Quality (Average MOS Score)	3.98	2.66	3.81	3.72
Number of samples with MOS >=4 to <5 (Excellent)	2534	0	1871	1258
Number of samples with MOS >=3 to <4(Good)	468	1120	946	1247
Number of samples with MOS >=2 to <3 (Fair)	62	1249	178	171
Number of samples with MOS >=1 to <2 (Poor)	48	442	79	94
%age of samples with MOS >=4 to <5 (Excellent)	81.43%	0.00%	60.87%	45.42%
%age of samples with MOS >=3 to <4(Good)	15.04%	39.84%	30.77%	45.02%
%age of samples with MOS >=2 to <3 (Fair)	1.99%	44.43%	5.79%	6.17%
%age of samples with MOS >=1 to <2 (Poor)	1.54%	15.72%	2.57%	3.39%

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

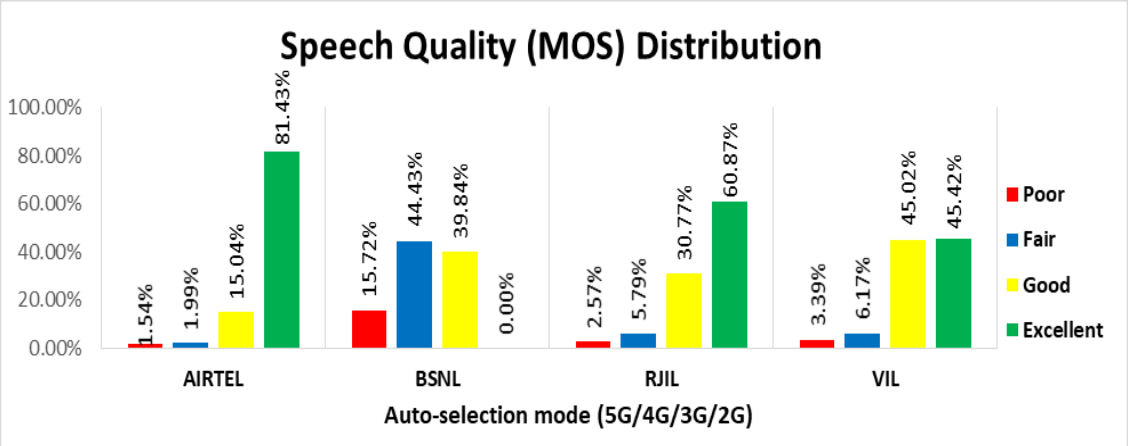


Figure-15: Distribution of samples in MOS score range

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

Technology	Service Provider			
	AIRTEL	BSNL	RJIL	VIL
5G	3.71%	NA	53.52%	NA
4G	96.29%	0.00%	46.44%	98.87%
3G	NA	51.19%	NA	NA
2G	0.00%	48.50%	NA	1.13%
No Service	0.00%	0.31%	0.04%	0.00%

Table-18: Time spent on technology during drive test

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

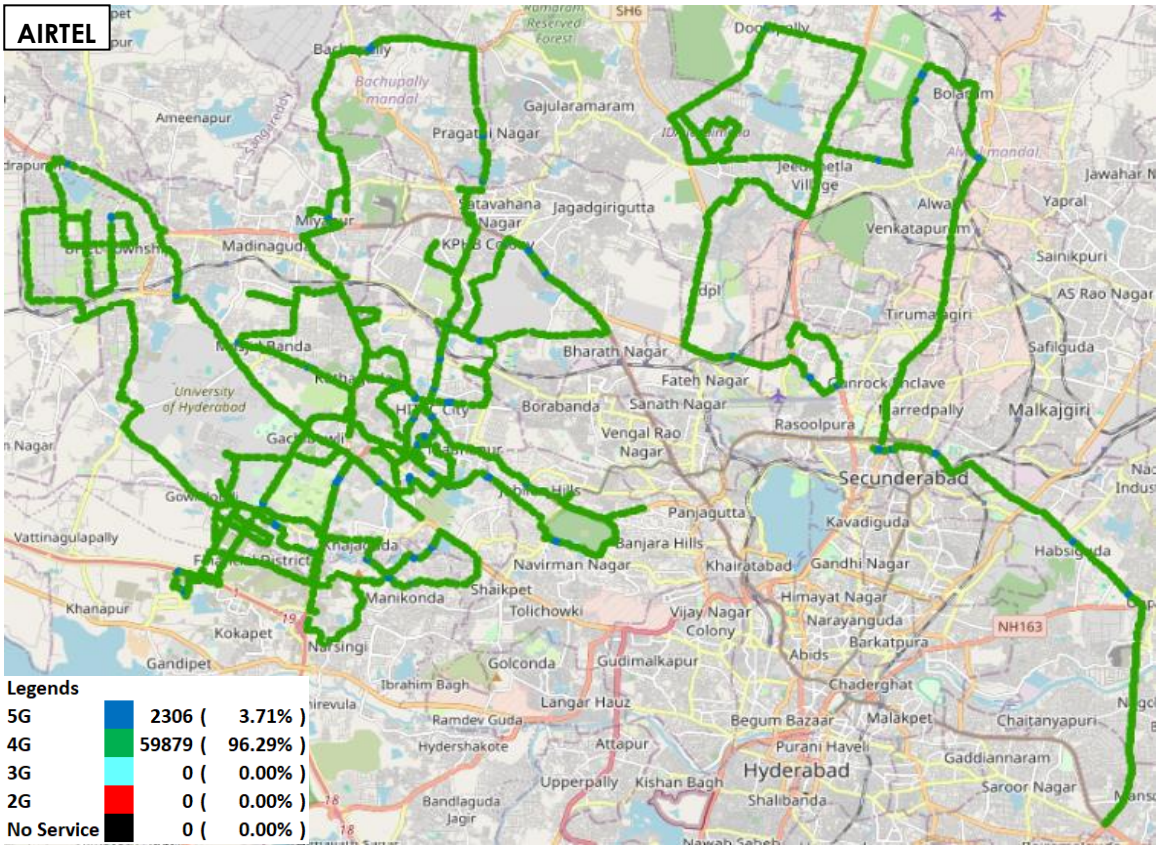


Figure-16: Serving technology plots in auto-selection mode (5G/4G/3G/2G) –Airtel

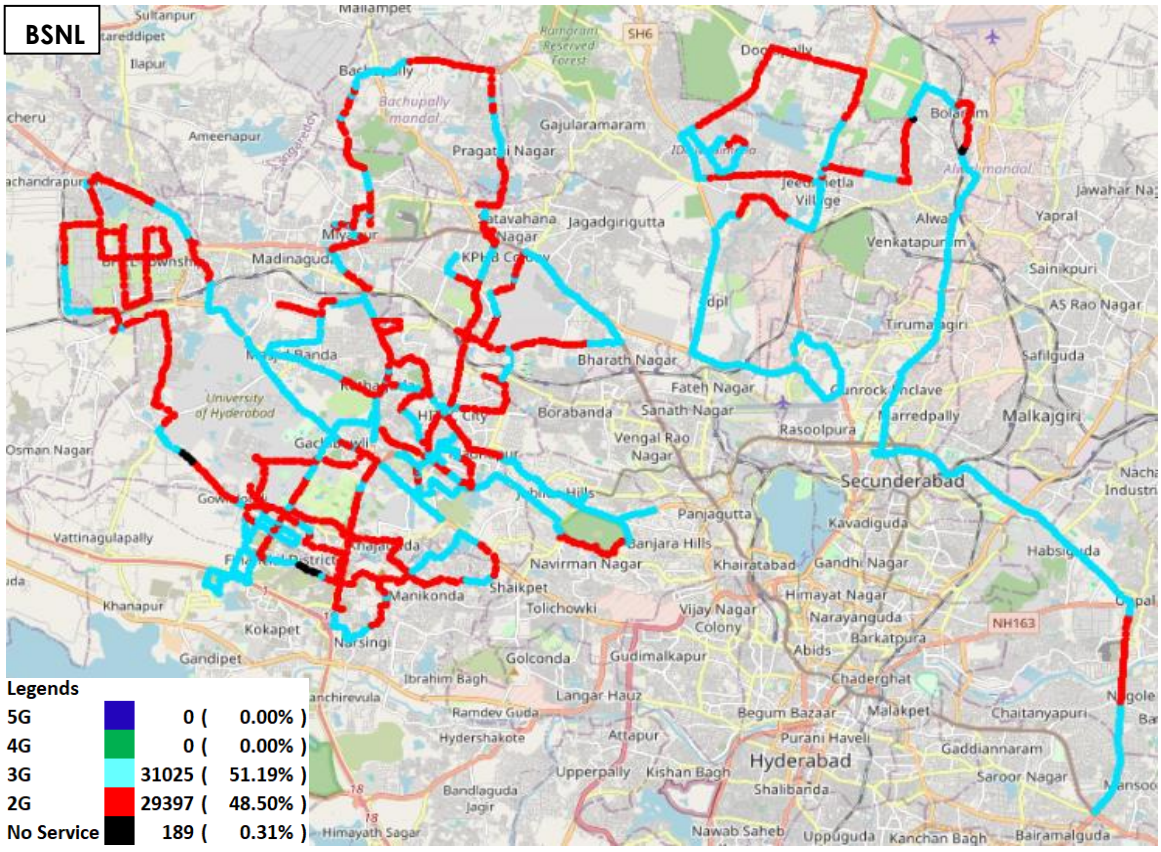


Figure-17: Serving technology plots in auto-selection mode (5G/4G/3G/2G) -BSNL

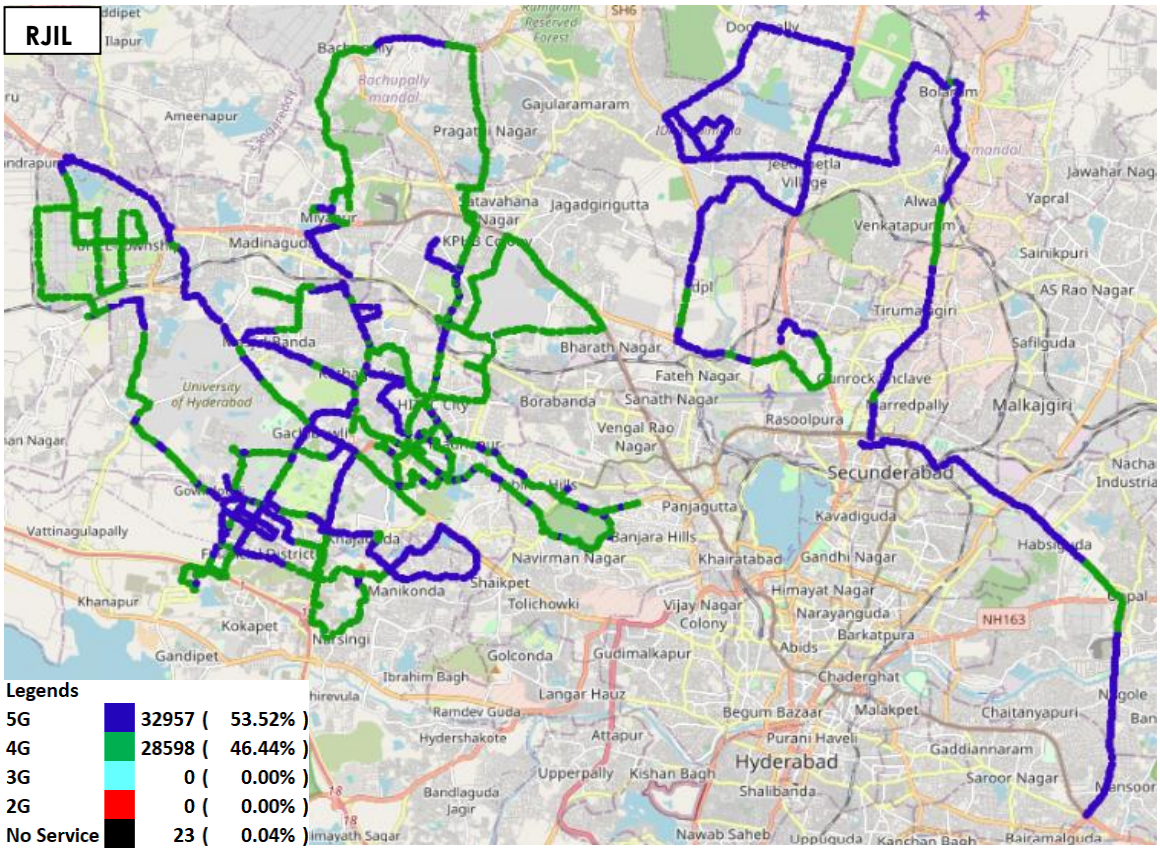


Figure-18: Serving technology plots in auto-selection mode (5G/4G/3G/2G)- RJI

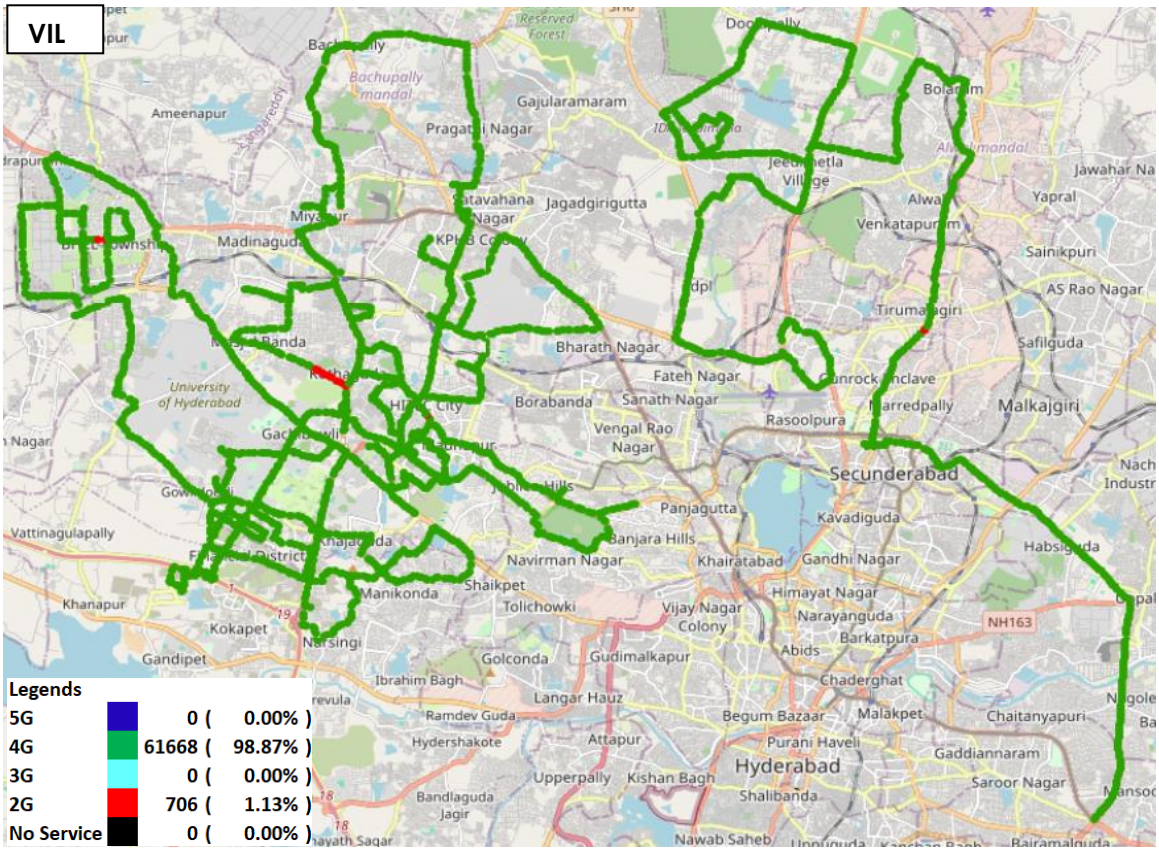


Figure-19: Serving technology plots in auto-selection mode (5G/4G/3G/2G) - VIL

(g)Network Signal Strength distribution: The following chart provide signal strength distribution for auto-selection mode (5G/4G/3G/2G). (Refer figure-46, 47, 48 & 49 for plots).

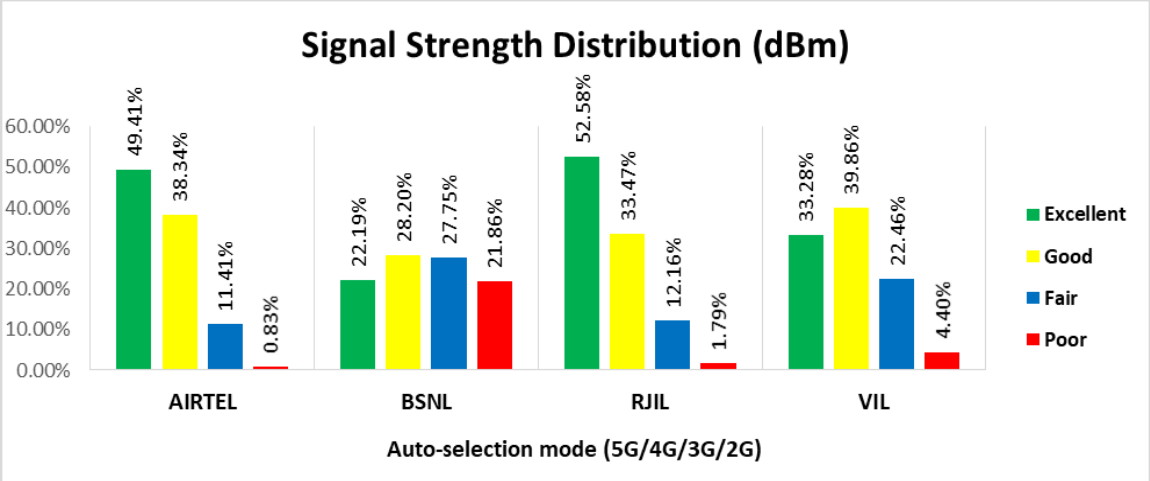


Figure-20: Signal strength distribution auto-selection mode 5G/4G/3G/2G

Observations:

- Airtel has 49% samples falling in excellent signal strength category.
- BSNL has 22% samples falling in excellent signal strength category.
- RJIL has 53% samples falling in excellent signal strength category.
- VIL has 33% samples falling in 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	122.60	1.25	162.03	19.86
	80th Percentile	198.21	2.26	260.97	30.26
	20th Percentile	46.78	0.06	46.50	7.16
Upload Throughput (Mbits/s)	Average	25.30	1.26	18.59	7.89
	80th Percentile	47.35	2.03	35.92	12.64
	20th Percentile	4.23	0.41	2.40	2.54
Ping (ms)	Average	49.54	817.84	184.32	44.54

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

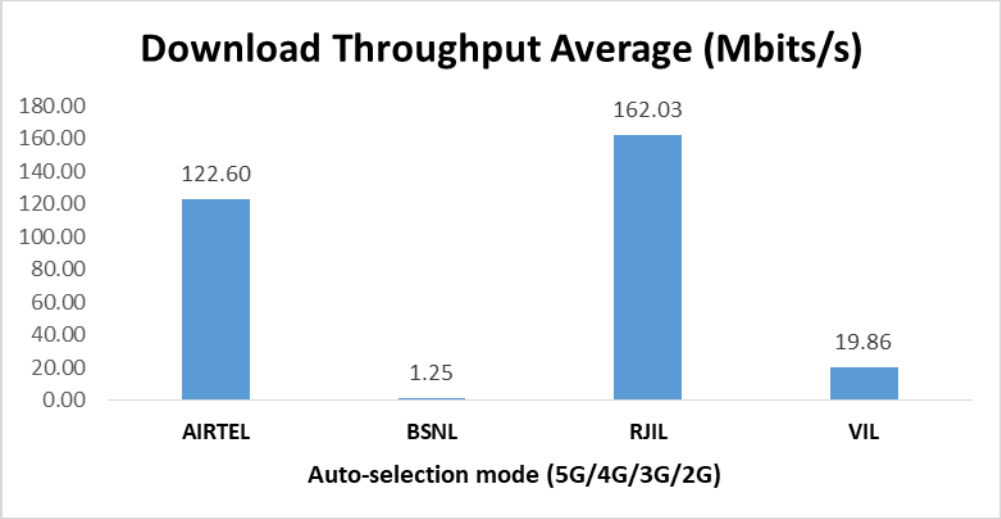


Figure- 21: Download throughput

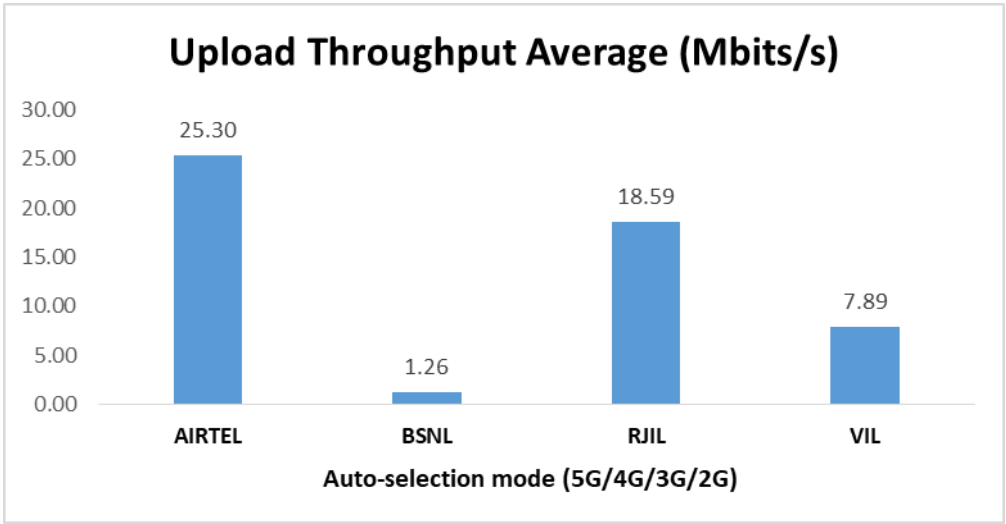


Figure- 22: Upload throughput

4.3 Hotspots

Hotspot testing has been done on 25th October 2024. Seven locations has been tested in the city.

4.3.1 Locations

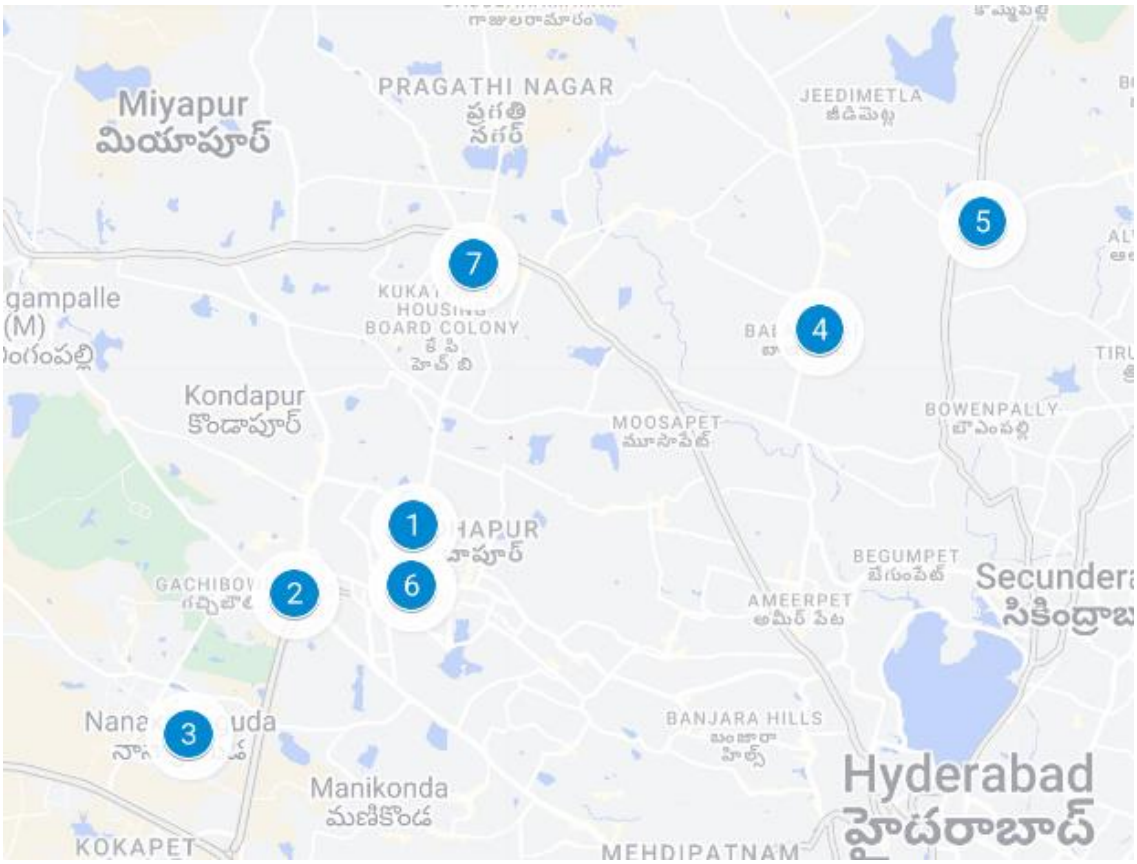


Figure- 23: Hotspot locations

4.3.2 Hotspot covered

1. Cyber Towers
2. Gachibowli Flyover
3. Nanakramguda Circle
4. Balanagar Junction
5. Suchitra Junction
6. Mind Space
7. JNTU Junction

4.3.3 Voice performance

Overall Voice Performance				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	70	70	70	70
Call Setup Success Rate %	98.57	100.00	100.00	100.00
Drop Call Rate%	0.00	0.00	0.00	0.00
Call Setup Time-Average (Sec)	4.96	2.26	0.72	10.34

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

Cyber Tower				
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)	3.94	2.28	0.67	11.86

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

Gachibowli Flyover				
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)	4.09	2.16	0.71	12.00

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

Nanakramguda 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)	4.07	2.58	0.91	12.46

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

Balanagar Junction				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	90.00	100.00	100.00	100.00
Drop Call Rate%	0.00	0.00	0.00	0.00
Call Setup Time-Average (Sec)	7.91	2.19	0.66	11.91

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

Suchitra Junction				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate%	0.00	0.00	0.00	0.00
Call Setup Time-Average (Sec)	4.11	2.15	0.62	0.63

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

Mind Space				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate%	0.00	0.00	0.00	0.00
Call Setup Time-Average (Sec)	7.09	2.02	0.77	11.94

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

JNTU Junction				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate%	0.00	0.00	0.00	0.00
Call Setup Time-Average (Sec)	4.12	2.46	0.71	11.88

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

4.3.4 Data performance

Overall Data Performance				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	100.72	1.33	189.19	24.77
Download Throughput 80th Percentile (Mbit/s)	141.82	2.23	273.67	34.41
Download Throughput 20th Percentile (Mbit/s)	58.62	0.41	90.28	13.77
Download Session Setup Success Rate %	100.00	100.00	88.57	100.00
Upload Throughput Average (Mbits/s)	10.25	1.15	24.05	14.47
Upload Throughput 80th Percentile (Mbit/s)	15.37	1.35	41.01	23.49
Upload Throughput 20th Percentile (Mbit/s)	0.00	0.88	8.18	8.43
Upload Session Setup Success Rate %	100.00	100.00	88.57	100.00
Web Browsing Delay (Second)	3.16	7.51	2.10	2.00
Youtube Initial Buffer Delay (Second)	1.28	5.49	0.72	0.64
Ping (ms)	28.28	43.65	637.52	23.19
Jitter (ms)	8.88	19.01	168.01	3.60
Packet Loss Rate-Ping %	0.39	12.53	17.19	0.87

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

Cyber Tower				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	118.84	1.90	434.34	17.88
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	0.00	1.21	65.53	17.09
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.85	8.98	1.87	1.98
Youtube Initial Buffer Delay (Second)	0.61	-	0.75	0.65
Ping (ms)	42.51	32.67	21.13	17.76
Jitter (ms)	9.54	31.14	12.41	2.19
Packet Loss Rate-Ping %	0.30	2.40	0.00	0.30

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

Note-

- All youtube tests failed in BSNL.

Gachibowli Flyover				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	34.70	1.47	105.26	21.69
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	2.44	1.07	10.19	9.07
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	3.42	5.50	1.61	2.07
Youtube Initial Buffer Delay (Second)	3.18	-	0.64	0.59
Ping (ms)	31.86	32.27	14.11	33.62
Jitter (ms)	12.24	13.23	9.91	5.62
Packet Loss Rate-Ping %	0.80	0.80	0.20	5.10

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

Note-

- All youtube tests failed in BSNL.

Nanakramguda Circle				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	151.78	1.33	22.23	47.94
Download Session Setup Success Rate %	100.00	100.00	80.00	100.00
Upload Throughput Average (Mbits/s)	44.10	1.16	1.56	23.04
Upload Session Setup Success Rate %	100.00	100.00	60.00	100.00
Web Browsing Delay (Second)	4.66	5.84	10.62	1.84
Youtube Initial Buffer Delay (Second)	0.77	5.39	2.01	0.56
Ping (ms)	22.14	27.37	4672.16	23.46
Jitter (ms)	8.66	12.84	1162.84	5.03
Packet Loss Rate-Ping %	0.00	0.80	84.60	0.20

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

Balanagar Junction				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average(Mbits/s)	72.20	0.78	163.02	30.35
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	3.00	1.74	16.28	9.60
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	1.74	8.52	1.61	1.80
Youtube Initial Buffer Delay (Second)	2.23	-	0.63	0.60
Ping (ms)	19.73	34.42	16.36	19.17
Jitter (ms)	10.29	22.76	7.22	2.60
Packet Loss Rate-Ping %	0.60	4.30	0.00	0.00

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

Note-

- All youtube tests failed in BSNL.

Suchitra Junction				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average(Mbits/s)	121.31	1.14	222.33	8.24
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	7.28	0.69	36.38	24.02
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.41	10.04	2.13	1.87
Youtube Initial Buffer Delay (Second)	0.81	6.88	0.66	0.65
Ping (ms)	23.82	104.32	20.56	17.59
Jitter (ms)	8.96	13.26	13.96	2.05
Packet Loss Rate-Ping %	0.00	66.60	0.20	0.30

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

Mind Space				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	69.65	0.14	1.55	16.74
Download Session Setup Success Rate %	100.00	100.00	40.00	100.00
Upload Throughput Average (Mbits/s)	0.00	0.73	3.01	10.95
Upload Session Setup Success Rate %	100.00	100.00	60.00	100.00
Web Browsing Delay (Second)	5.59	-	-	2.13
Youtube Initial Buffer Delay (Second)	0.78	-	-	0.68
Ping (ms)	48.67	46.87	93.83	18.29
Jitter (ms)	10.49	21.42	53.21	2.35
Packet Loss Rate-Ping %	0.90	10.80	35.00	0.00

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

Note-

- All web browsing & youtube tests failed in BSNL & RJIL.

JNTU Junction				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	136.55	2.54	229.66	30.56
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	14.91	1.44	18.02	7.49
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	1.63	5.75	2.14	2.33
Youtube Initial Buffer Delay (Second)	0.56	4.24	0.68	0.72
Ping (ms)	9.29	29.24	23.92	32.93
Jitter (ms)	1.99	18.28	15.17	5.44
Packet Loss Rate-Ping %	0.10	2.00	0.30	0.20

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

4.4 Railways/Metro

Drive test has been conducted on 24th October 2024 covering two metro route. (Refer Table-1)

4.4.1 Drive test routes

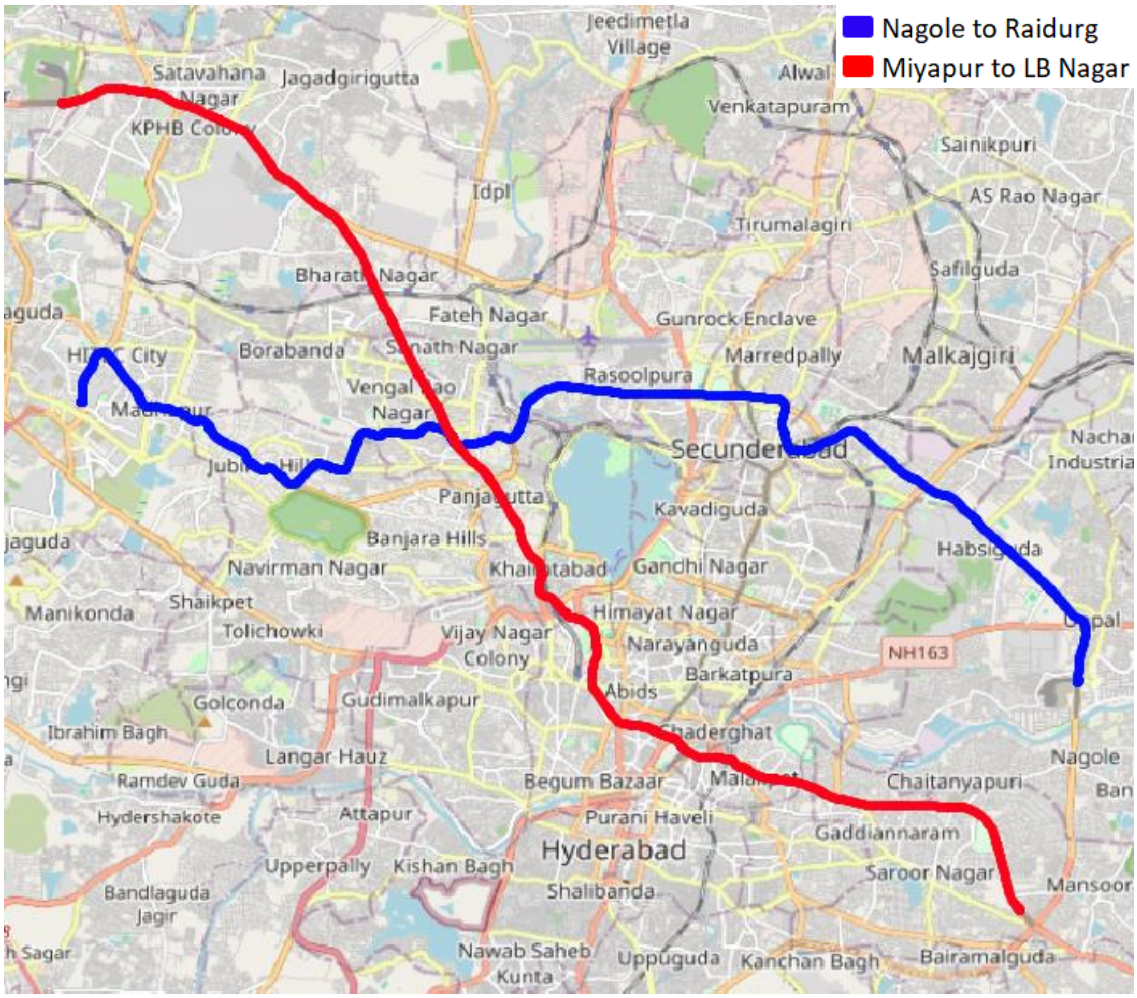

Figure-24: Drive test route metro

4.2.2 Routes Covered

- Nagole to Raidurg.
- Miyapur to LB Nagar.

4.2.2.1 Nagole to Raidurg

Drive test for this route has been conducted on 24th October 2024.This route has 23 metro stations, which are entirely elevated.

i) Voice performance

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

Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Call Attempts	30	31	31	29
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate%	0.00	9.68	0.00	0.00
Call Setup Time-Average (Second)	4.02	2.49	0.64	12.10
Handover Success Rate %	99.26	100.00	99.61	95.31

Table-36: Summary of voice call performance in network auto-selection mode

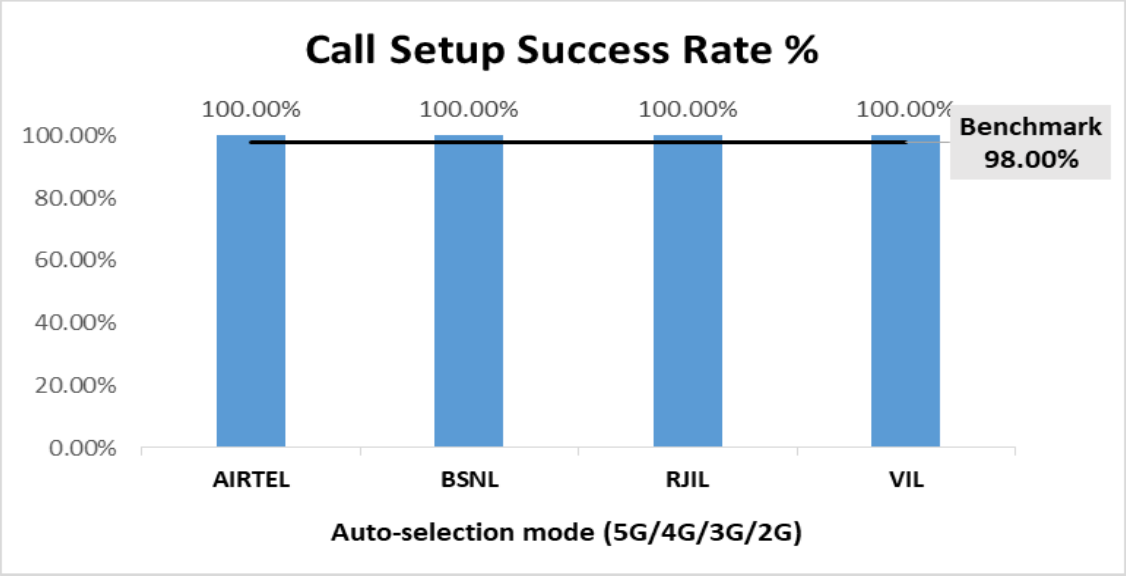

Figure-25: Performance for call setup success rate

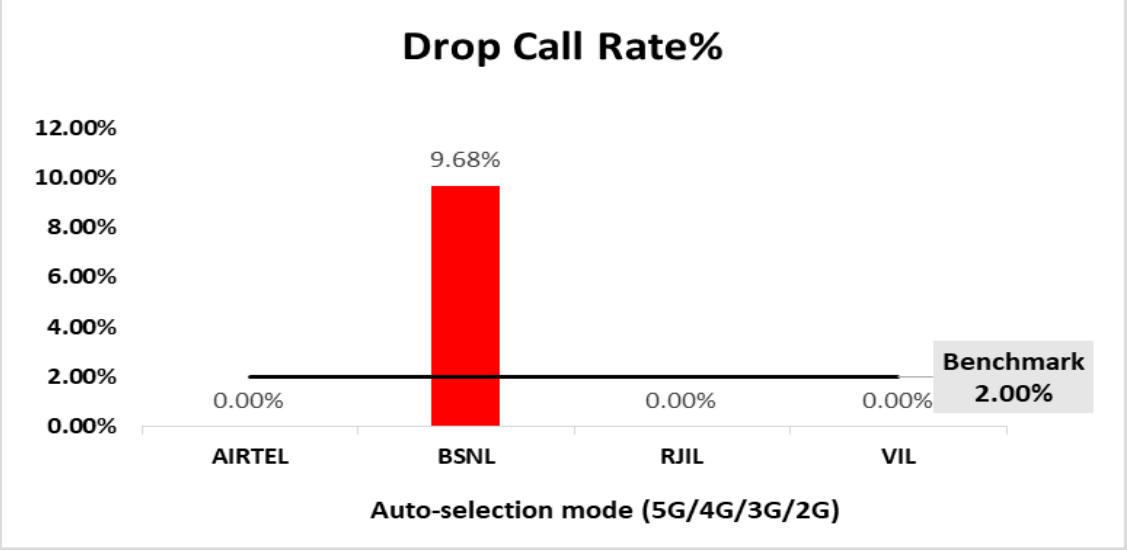

Figure-26: Performance for drop call rate

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

Technology	Service Provider			
	AIRTEL	BSNL	RJIL	VIL
5G	1.85%	NA	77.69%	NA
4G	98.15%	NA	22.31%	100.00%
3G	NA	85.60%	NA	NA
2G	0.00%	13.32%	NA	0.00%
No service	0.00%	1.08%	0.00%	0.00%

Table-37: Time spent on technology during drive test

Note-

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

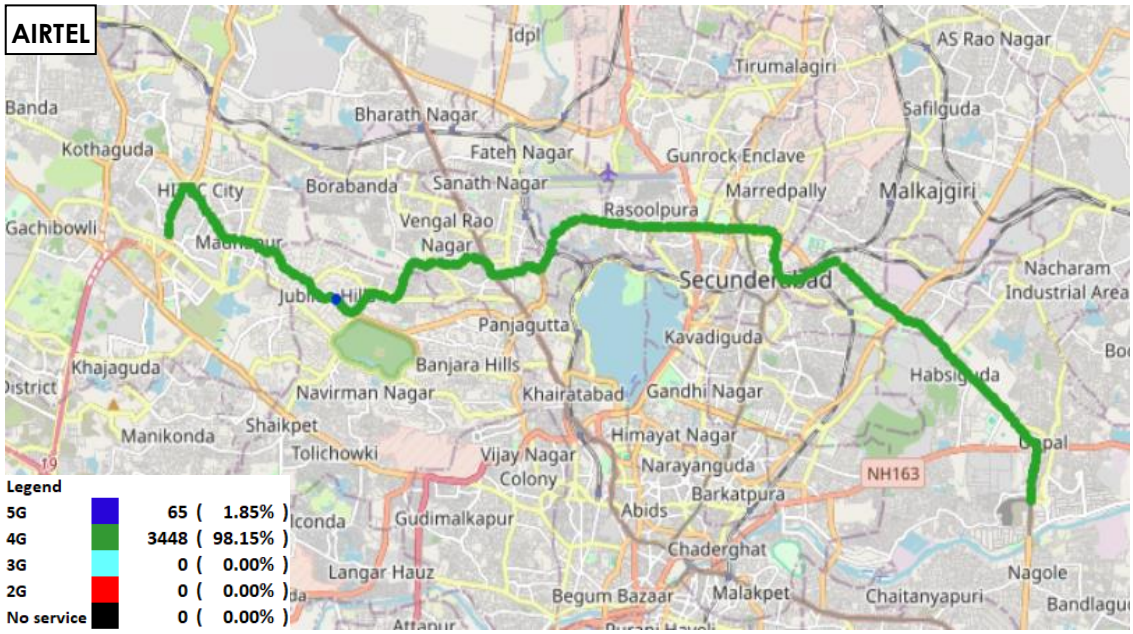

Figure-27: Serving technology plots auto-selection mode 5G/4G/3G/2G -Airtel

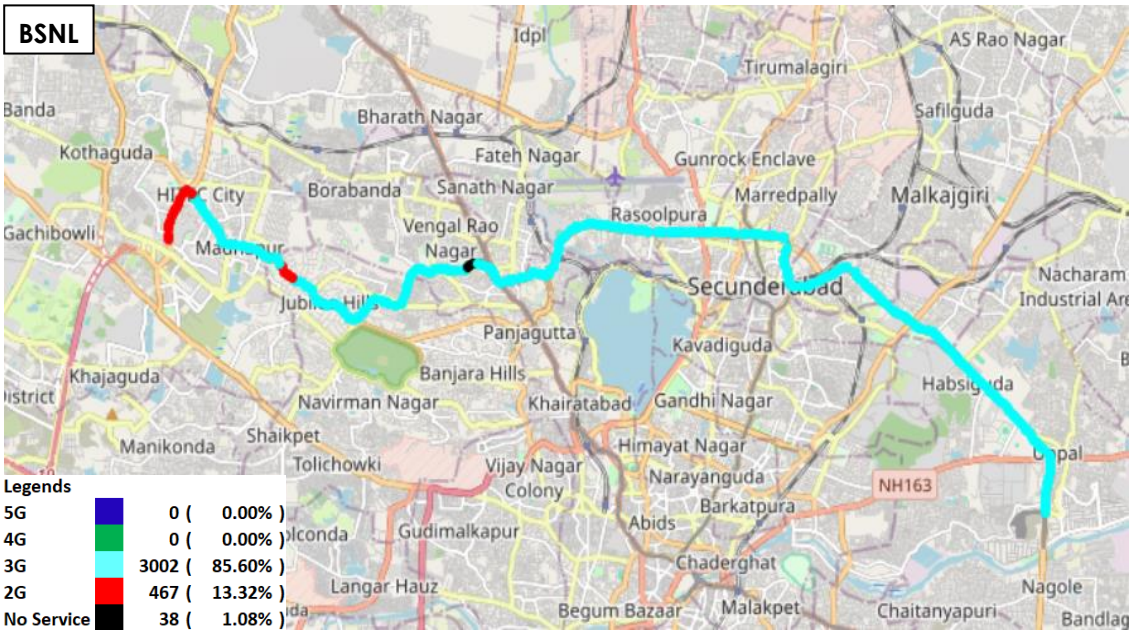

Figure-28: Serving technology plots auto-selection mode 5G/4G/3G/2G –BSNL

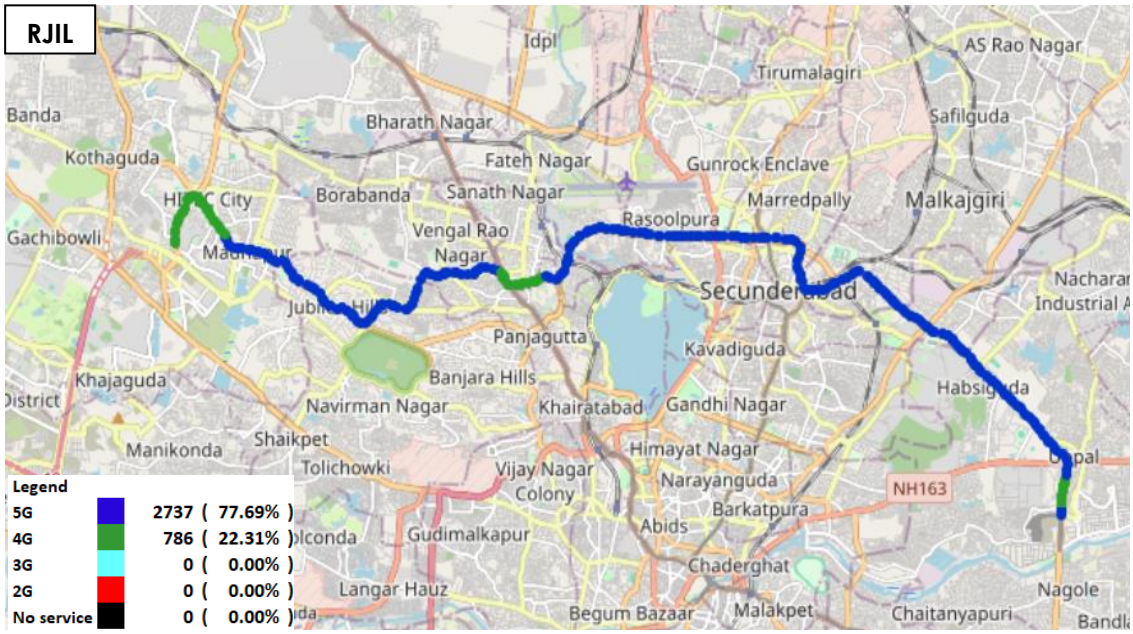

Figure-29: Serving technology plots auto-selection mode 5G/4G/3G/2G –RJIL

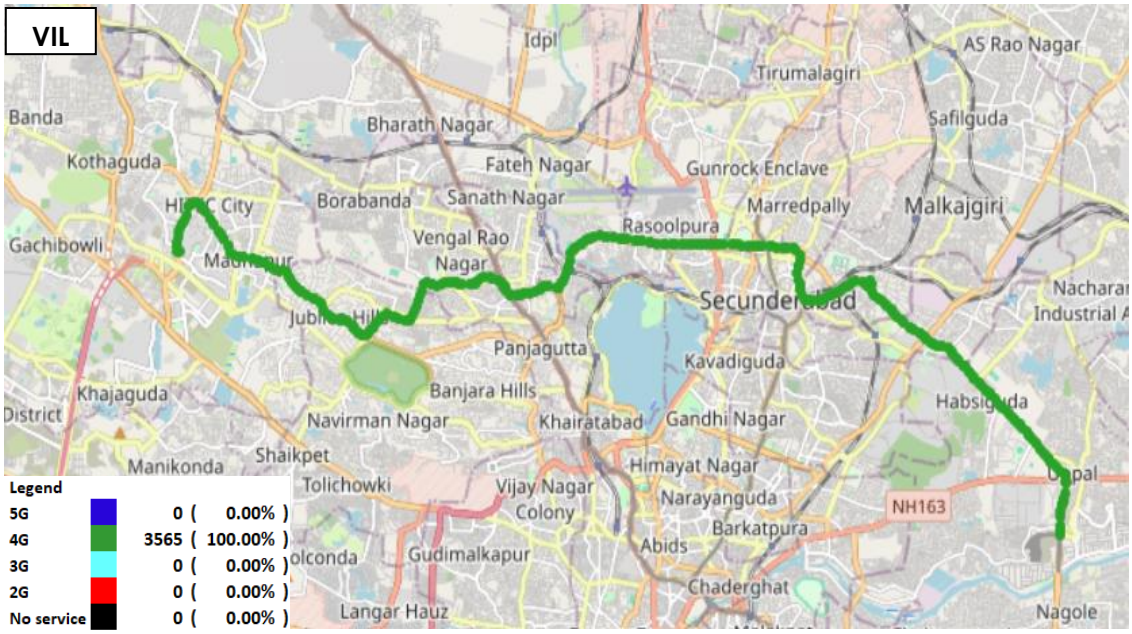

Figure-30: Serving technology plots auto-selection mode 5G/4G/3G/2G – VIL

(c) Network Signal Strength distribution: The following chart provide signal strength distribution for auto-selection mode (5G/4G/3G/2G) (Refer figure-50, 51, 52 & 53 for plots)

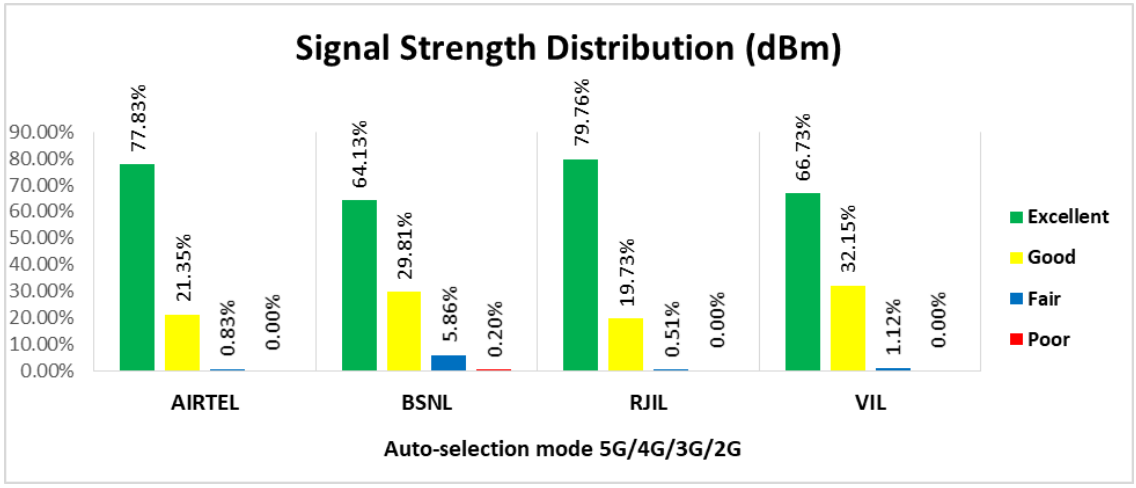

Figure-31: Signal strength distribution for auto-selection mode 5G/4G/3G/2G

ii) 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	81.23	1.55	150.28	23.11
	80th Percentile	127.63	2.54	213.14	29.51
	20th Percentile	42.05	0.32	104.10	9.51
Upload Throughput (Mbits/s)	Average	46.95	2.17	37.19	11.65
	80th Percentile	70.25	2.94	50.34	18.12
	20th Percentile	28.10	1.06	14.75	5.75
Ping (ms)	Average	48.65	307.57	25.55	22.75

Table-38: Summary of Data performance in network auto-selection mode

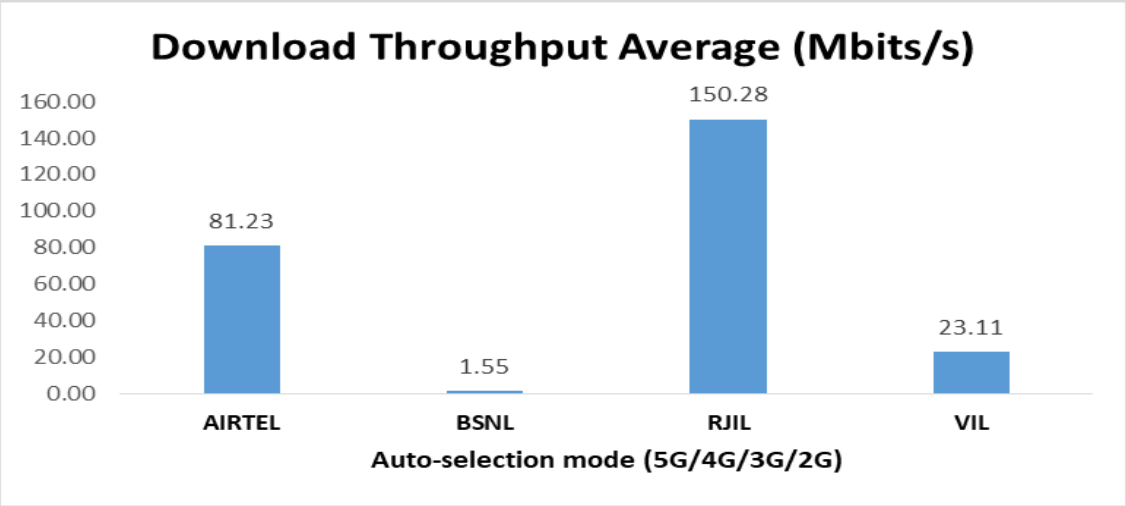

Figure-32: Download throughput

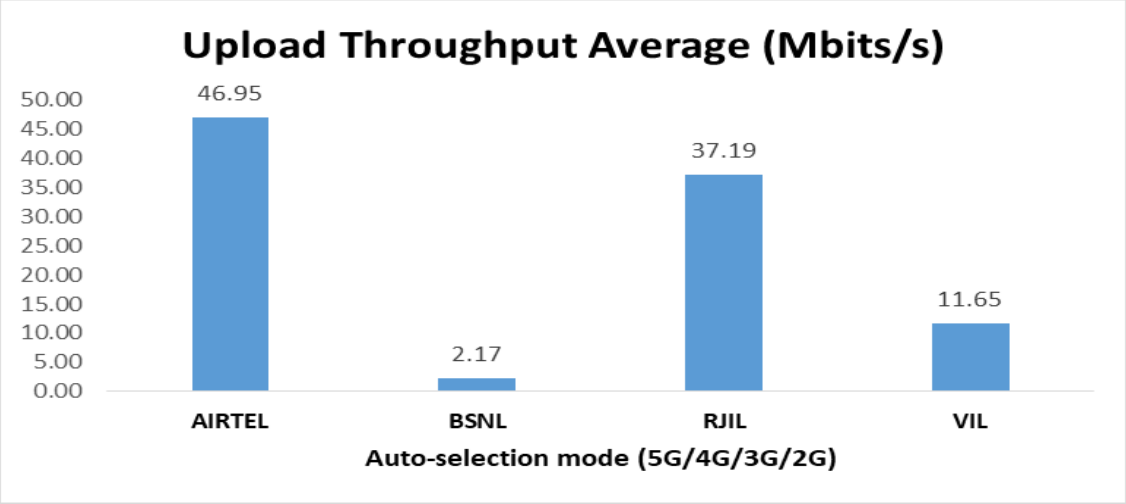

Figure-33: Upload throughput

4.2.2.2 Miyapur to LB Nagar

Drive test for this route has been conducted on 24th October. This route has 27 metro stations, which are entirely elevated.

i) Voice performance

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

Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Call Attempts	28	29	29	27
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate%	0.00	6.90	0.00	0.00
Call Setup Time-Average (Second)	4.03	2.45	0.66	11.96
Handover Success Rate %	91.49	100.00	97.44	95.16

Table-39: Summary of voice call performance in network auto-selection mode

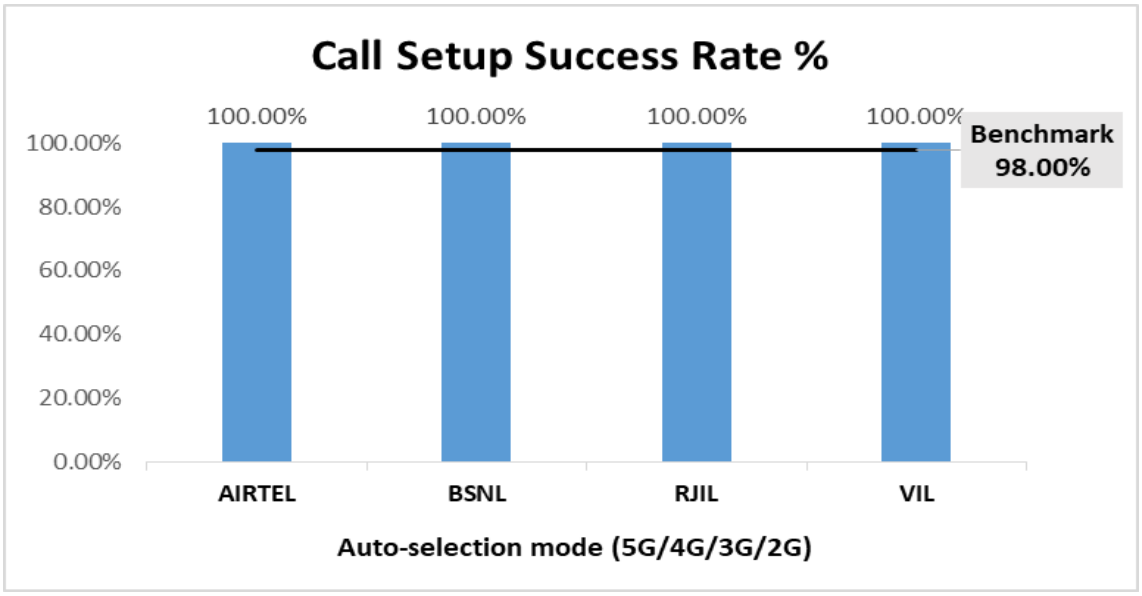

Figure-34: Performance for call setup success rate

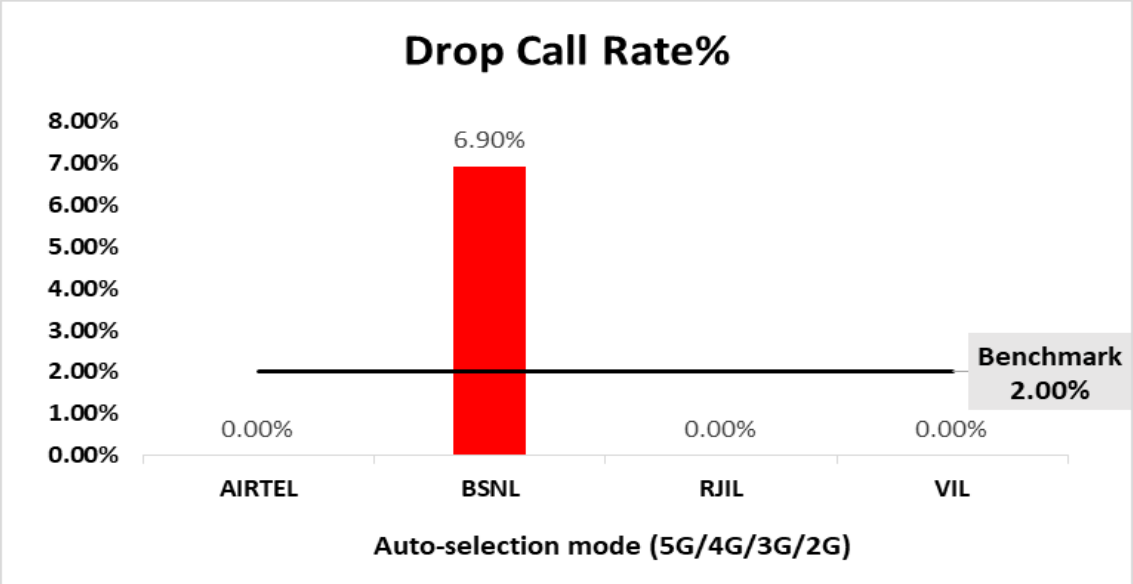

Figure-35: Performance for drop call rate

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

Technology	Service Provider			
	AIRTEL	**BSNL**	**RJIL**	**VIL**
5G	1.37%	NA	62.88%	NA
4G	98.63%	NA	37.12%	100.00%
3G	NA	79.02%	NA	NA
2G	0.00%	20.34%	NA	0.00%
No service	0.00%	0.64%	0.00%	0.00%

Table-40: Time spent on technology during drive test

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

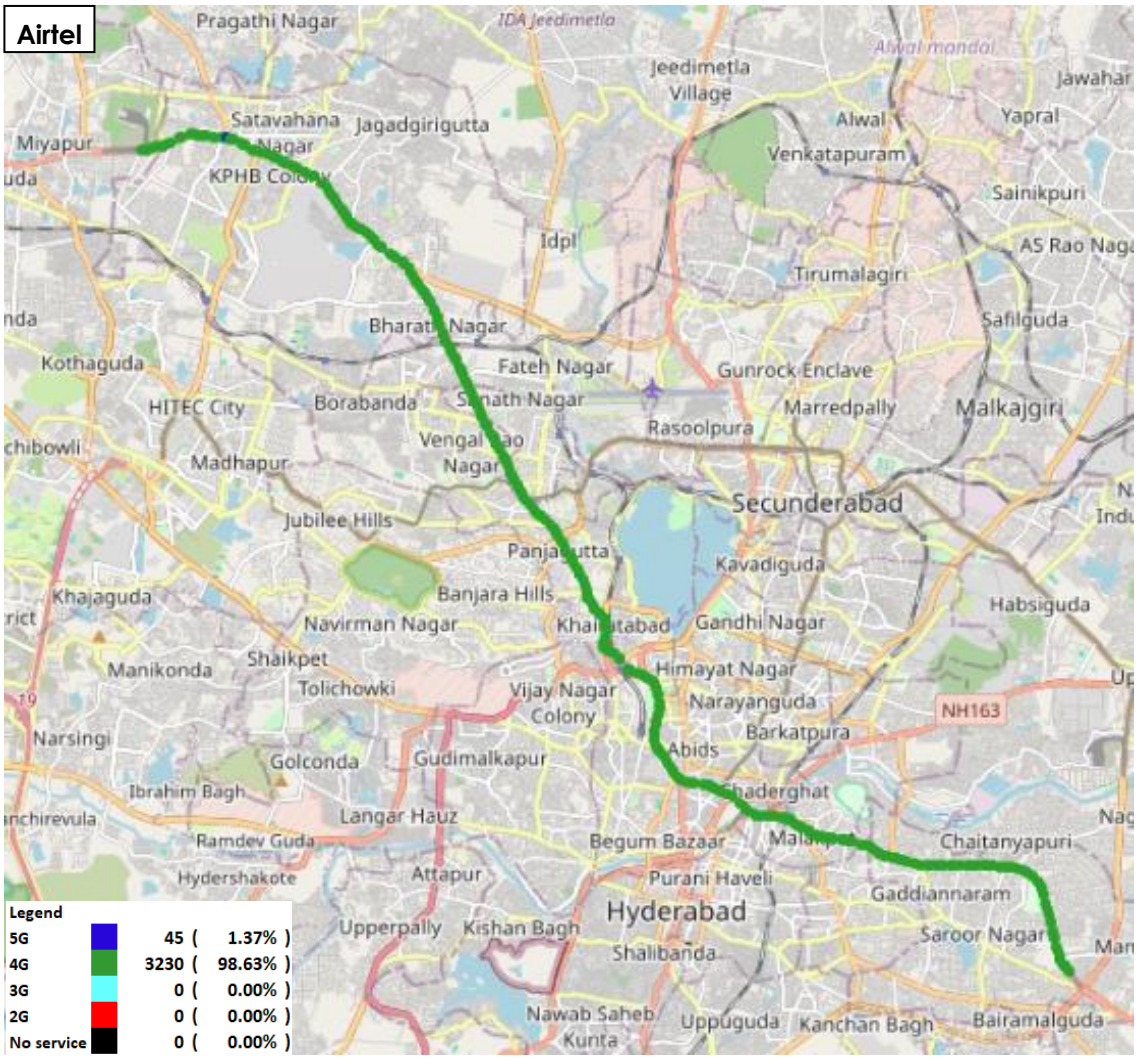

Figure-36: Serving technology plots auto-selection mode 5G/4G/3G/2G -Airtel

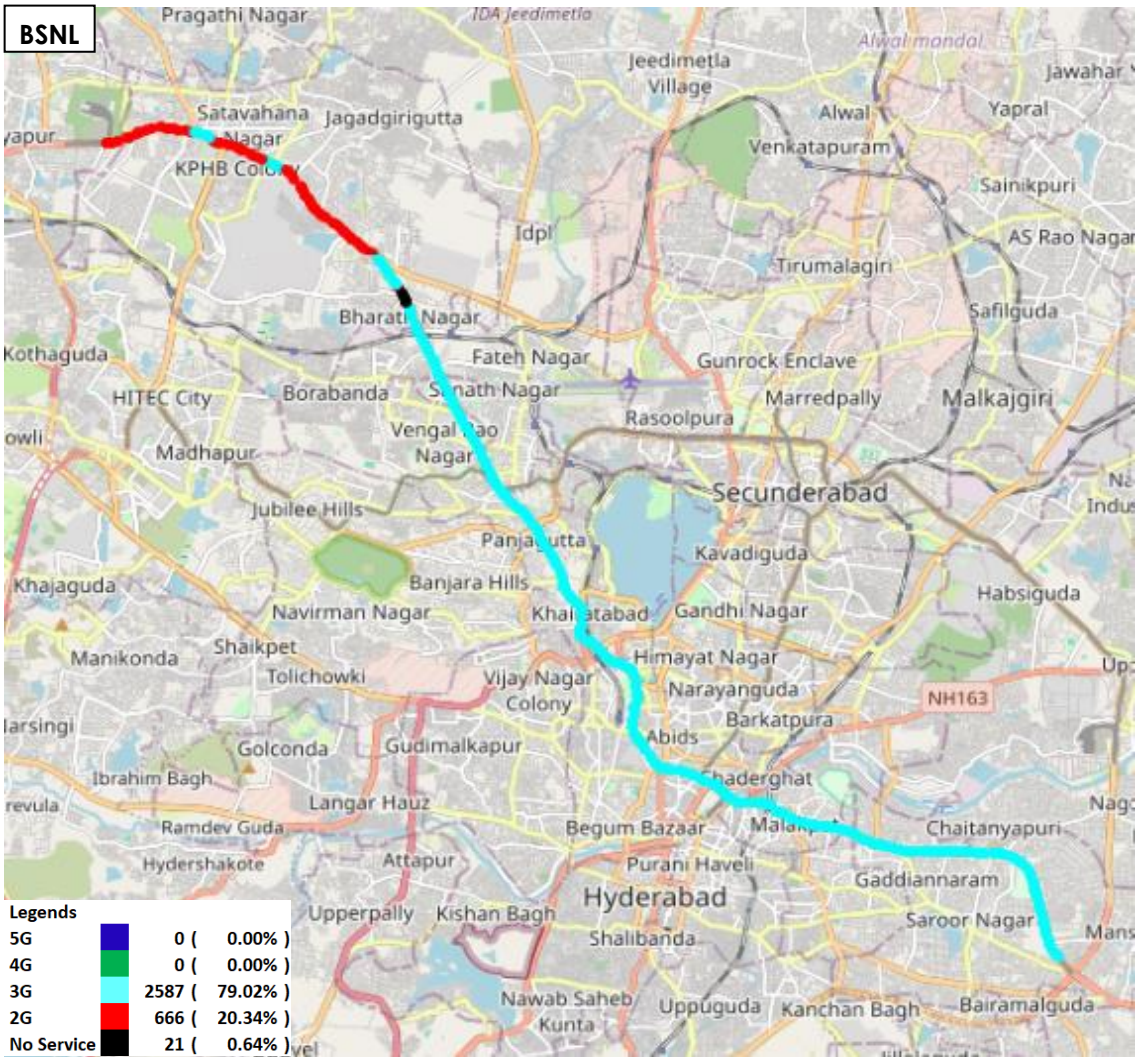

Figure-37: Serving technology plots auto-selection mode 5G/4G/3G/2G -BSNL

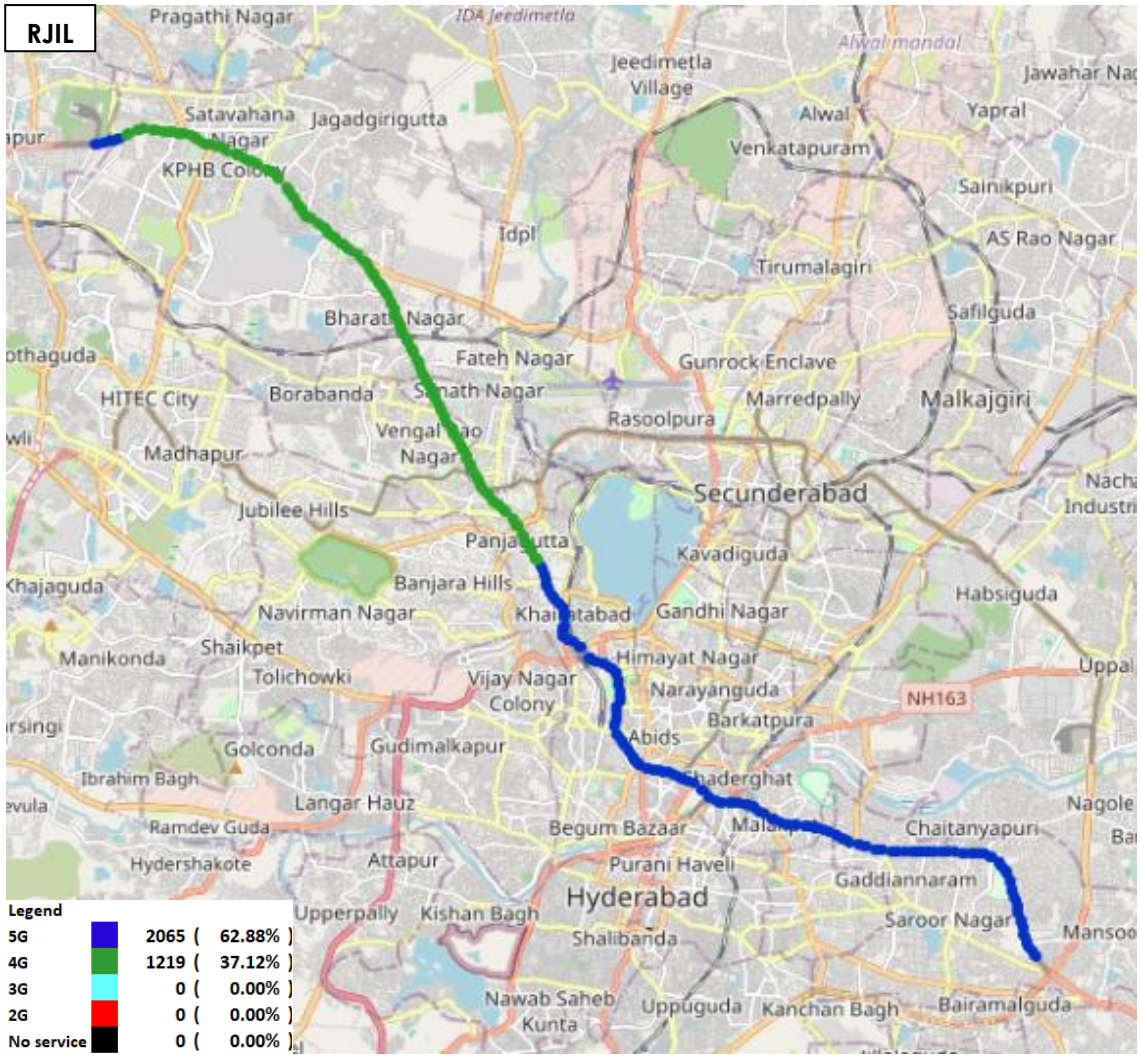

Figure-38: Serving technology plots auto-selection mode 5G/4G/3G/2G –RJIL

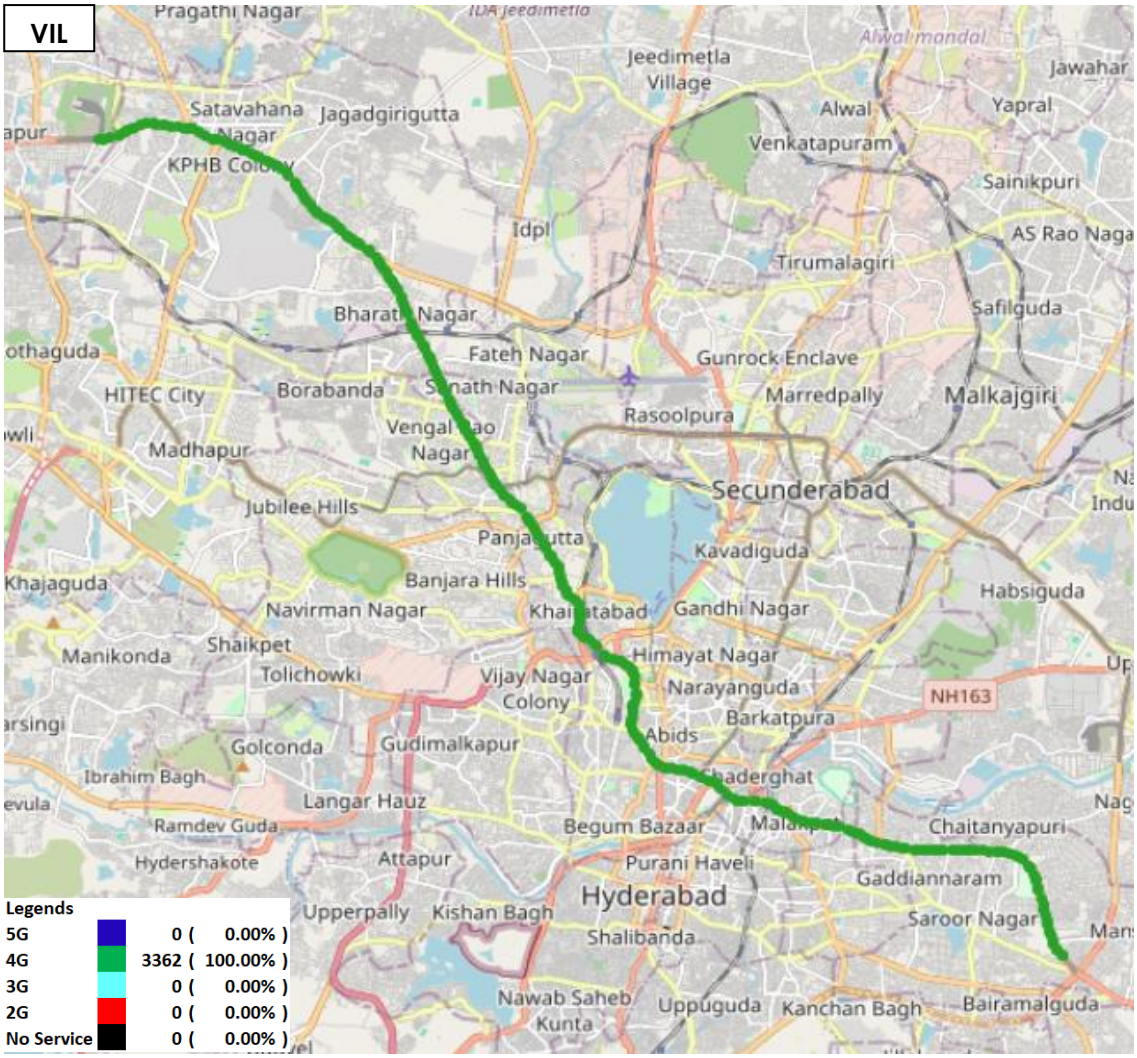

Figure-39: Serving technology plots auto-selection mode 5G/4G/3G/2G –VIL

(c) Network Signal Strength distribution: The following chart provide signal strength distribution for auto-selection mode (5G/4G/3G/2G) (Refer figure-54, 55, 56 & 57 for plots)

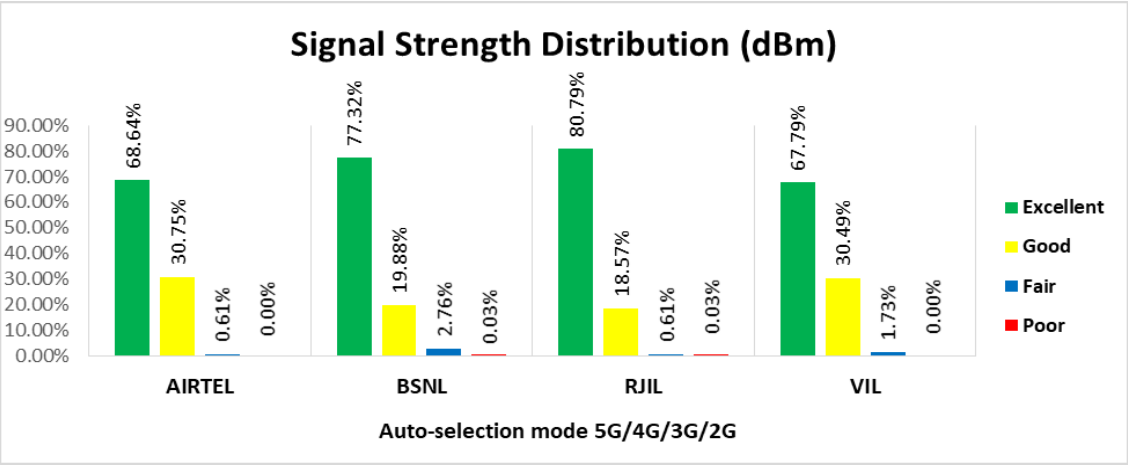

Figure-40: Signal strength distribution for auto-selection mode 5G/4G/3G/2G

ii) 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	123.14	1.28	193.18	30.15
	80th Percentile	190.94	2.19	269.47	38.36
	20th Percentile	59.73	0.24	89.63	10.38
Upload Throughput (Mbits/s)	Average	46.37	1.47	23.11	15.15
	80th Percentile	71.17	2.25	29.51	19.80
	20th Percentile	22.36	0.74	9.51	8.45
Ping (ms)	Average	40.32	602.44	20.28	31.95

Table-41: Summary of Data performance in network auto-selection mode

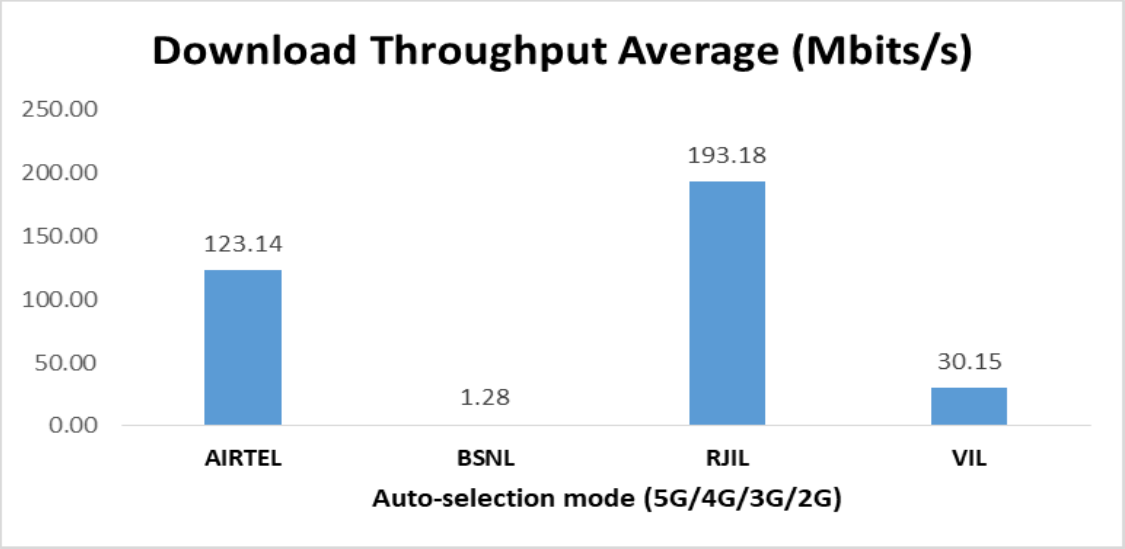

Figure-41: Download throughput

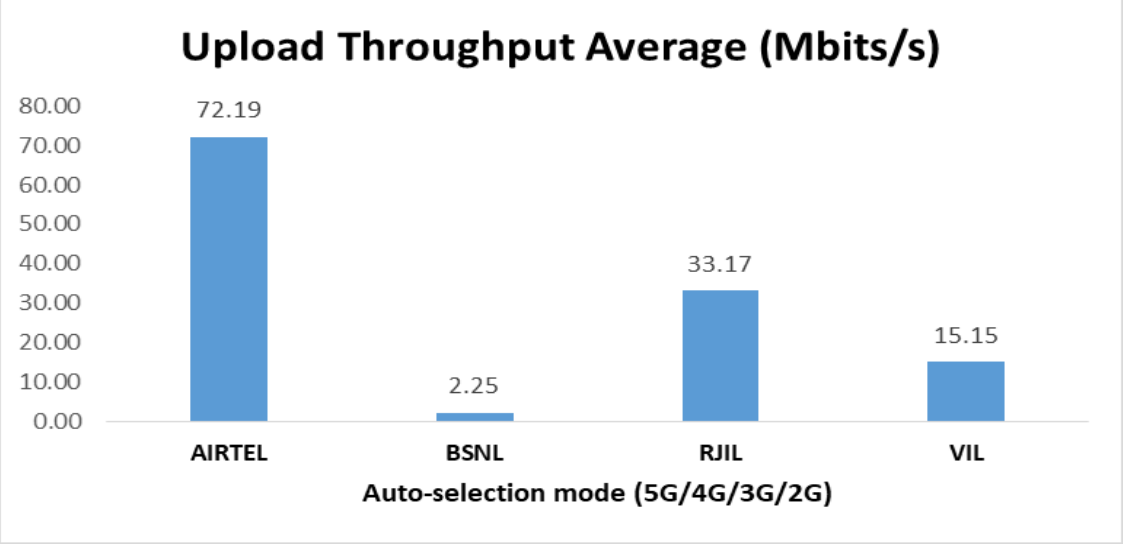

Figure-42: Upload throughput

5. Voice & Data Key findings

5.1 Overall Voice

1. **Call setup success rate:**
   a) Airtel, BSNL, RJIL and VIL have 99.85%, 99.85%, 100.00% and 98.92% call setup success rate respectively.
   b) Airtel and RJIL 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.
   c) All service providers except Airtel have 100.00% call setup success rate on hotspots.
   d) All service providers have 100.00% call setup success rate in both metro routes.

2. **Call Setup time**: VIL has taken comparatively longer time (11.82 second) to establish the voice call, whereas Airtel, BSNL and RJIL call setup time is 4.20, 2.86 and 0.75 second respectively in Auto-selection mode (5G/4G/3G/2G).

3. **Call Silence/Mute Rate**: In packet switched network (4G/5G), Airtel, RJIL and VIL have 1.12%, 2.08% and 2.06% silence call rate respectively. Further VIL has higher RTP packet loss rate in downlink (1.28%) compared to Airtel (0.74%) and RJIL (0.60%). In uplink the RTP packet loss rate is higher for VIL (1.53%) compared to RJIL (1.03%) and Airtel (0.51%).

4. **Call Drop Rate**:
   a) Overall BSNL's call drop rate (3.76%) is higher (QoS benchmark of 2%), while Airtel, RJIL and VIL have 0.00%, 0.30% and 0.00% drop call rate respectively.
   b) At hotspots all service providers have 0.00% call drop rate.
   c) All operators are meeting QoS Benchmark for drop call rate for both metro routes except BSNL.

5.2 Overall Data

1. **Data download and upload performance (Dynamic i.e. while moving)** :
   a) BSNL (1.28 Mbps) and VIL (20.85 Mbps) being on 3G & 4G as top technology respectively, have comparatively lower data speeds. While Airtel and RJIL have average download speed of 119.88 Mbps and 164.19 Mbps respectively.
   b) BSNL (1.33 Mbps) and VIL (8.83 Mbps), operating on 3G and 4G technologies respectively, have comparatively lower upload speeds. In contrast, Airtel and RJIL offer faster speeds of 26.76 Mbps and 20.43 Mbps, respectively.

2. **Data download and upload performance (static i.e. while stationary):**
   a) BSNL (1.33 Mbps) and VIL (24.77 Mbps) have lower data download speed at hotspots compared to Airtel and RJIL, which have values of 100.72 Mbps and 189.19 Mbps, respectively.
   b) BSNL (1.15 Mbps) and Airtel (10.25 Mbps) have lower data upload speed at hotspots compared to VIL and RJIL, which have speeds of 14.47 Mbps and 24.05 Mbps, respectively.

3. **Data session setup success rate (static i.e. while stationary):**
    a) Airtel, BSNL, and VIL have a 100% success rate for setting up download sessions. In comparison, RJIL has a success rate of 88.57% for download sessions. For upload sessions, Airtel, BSNL, and VIL also have a 100% success rate, while RJIL has an 88.57% rate.

5.3 Operator wise Key Findings

1. Airtel:

Voice

- In a 3G/2G network mode, a call setup success rate of 99.61% was observed. The call drop rate of 0.39% is well within the benchmark of 2%. (Refer to Table 3 and Table 13).
- In auto-selection mode for LSA, 99.85% call setup success rate and 0.00% call drop rate were observed (refer to Table-5).
- There is a 100.00% call setup success rate and a 0.00% drop call rate observed for auto-selection mode during city drive (refer to Table-15).
- Both, Nagole to Raidurg and Miyapur to LB Nagar metro routes have achieved a 100.00% call setup success rate and a 0.00% call drop rate, surpassing the benchmark. (refer to Tables 36 and 39)

Data

- Airtel has an average download throughput of 119.88 Mbps and an average upload throughput of 26.76 Mbps across measured routes for LSA (refer to Table-11).
- Airtel has an average download speed of 122.60 Mbps and an average upload speed of 25.30 Mbps across measured routes for the city drive (refer to Table-19).
- Gachibowli Flyover, Balanagar Junction and Mind Space hotspots have download speeds of less than 100 Mbps among the total of 7 hotspots. (refer to Tables 30, 32, and 34)
- Cyber Tower, Gachibowli Flyover, Balanagar Junction, Suchitra Junction and Mind Space hotspots have upload speeds below 10 Mbps among the total of 7 hotspots. (refer to Tables 29, 30, 32, 33, and 34)
- Nagole to Raidurg route has lower download speed compared to the Miyapur to LB Nagar metro routes. (refer to Table 38 and 41)
- Both metro routes have comparable upload speed. (refer to Table 38 and 41)

2. BSNL:

Voice

- Call drop rate of 3.63% in 3G/2G network mode does not meet the benchmark of 2% (Refer to Table 3 and Table 13).
- Call drop rate of 3.76% in auto-selection mode for LSA does not meet the benchmark of 2% (Refer to Table 5).
- BSNL auto-selection mode is experiencing a drop call rate of 3.74%, significantly higher than the acceptable benchmark of 2%. (refer Table-15)
- There has been a 9.68% drop in the call rate observed on the Nagole to Raidurg metro route, which is lower than the benchmark for call setup success rate (refer to Table-36).
- Drop call rate of 6.90% has been observed on the Miyapur to LB Nagar metro route, which is lower than the benchmark for call setup success rate. (refer to Table-39)

Data

- BSNL has 1.28 Mbps average download throughput & 1.33 Mbps average upload throughput across measured routes for LSA (refer Table-11)
- BSNL has 1.25 Mbps average download throughput & 1.26 Mbps average upload throughput across measured routes for city drive (refer Table-19)
- All hotspot locations have less download speeds (less than 5 Mbps) out of total 7 hotspots. (refer Table- 29,30,31,32,33,34 & 35)
- All hotspot locations have less upload speed (less than 2 Mbps) out of total 7 hotspots. (refer Table- 29,30,31,32,33,34 & 35)
- Both metro routes have less than 5 Mbps download and less than 2 Mbps upload speed. (refer Table- 38 and 41)

3. RJIL:

Voice

- RJIL's call setup success rate stands at 100.00% in auto-selection mode within the LSA. Drop call rate was observed in RJIL 0.30%. (refer Table-5)
- RJIL's call setup success rate in auto-selection mode during the city drive test is at 100.00% and drop call rate is 0.37%. (refer Table-15)

- 100.00% and 0.00% call setup success rate and call drop rate has been observed at both Nagole to Raidurg and Miyapur to LB Nagar metro routes. (refer Table-36 & 39)

Data

- RJIL has 164.19 Mbps average download throughput & 20.43 Mbps average upload throughput across measured routes in LSA. (refer Table-11)
- RJIL has 162.03 Mbps average download throughput & 18.59 Mbps average upload throughput across measured routes in city drive. (refer Table-19)
- Nanakramguda Circle and Mind Space hotspots have less download speeds (less than 100 Mbps) out of total 7 hotspots. (refer Table- 31 & 34)
- Nanakramguda Circle and Mind Space hotspots have less upload speed (less than 10 Mbps) out of total 7 hotspots. (refer Table- 31 & 34)

4. VIL:

Voice

- In 3G/2G network mode, a call setup success rate of 97.39% was observed. The call drop rate is 2.88%, which is below the benchmarks of 98% and 2% (refer to Table-3 and 13).
- In auto-selection mode of LSA, there was a call setup success rate of 98.92% and a drop call rate of 0.00%. (refer to Table-5)
- In auto-selection mode of city a call setup success rate of 98.66% was observed, with a drop call rate of 0.00% (refer to Table-15).
- Both the Nagole to Raidurg and Miyapur to LB Nagar metro routes have observed a call setup success rate of 100.00% and a call drop rate of 0.00% (refer to Table-36 & 39).

Data

- VIL has 20.85 Mbps average download throughput & 8.83 Mbps average upload throughput across measured routes in LSA. (refer Table-11)
- VIL has 19.86 Mbps average download throughput & 7.89 Mbps average upload throughput across measured routes in city drive. (refer Table-19)
- Suchitra Junction has less download speeds (less than 15 Mbps) out of total 7 hotspots. (refer Table-33)
- Gachibowli Flyover, Balanagar Junction and JNTU Junction hotspots have less upload speed (less than 10 Mbps) out of total 7 hotspots. (refer Table- 30, 32 & 35)

- The download speed on the Nagole to Raidurg route is lower compared to the Miyapur to LB Nagar metro routes. (refer to Table 38 and 41)
- The Nagole to Raidurg route has a lower upload speed compared to the Miyapur to LB Nagar metro routes. (refer to Table 38 and 41)

6. Annexure

6.1 Route wise coverage map

6.1.1 City

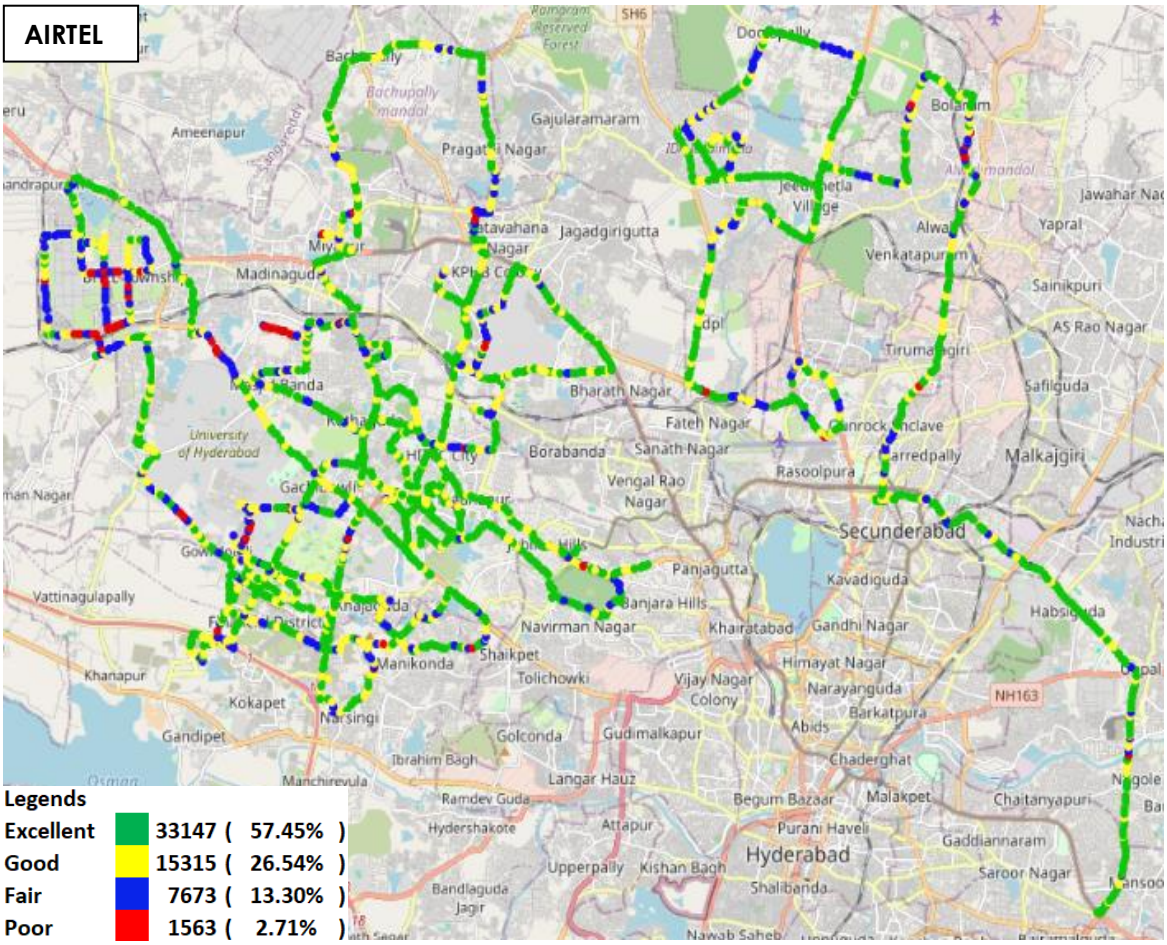

Figure-43: Signal strength 3G/2G network mode - AIRTEL

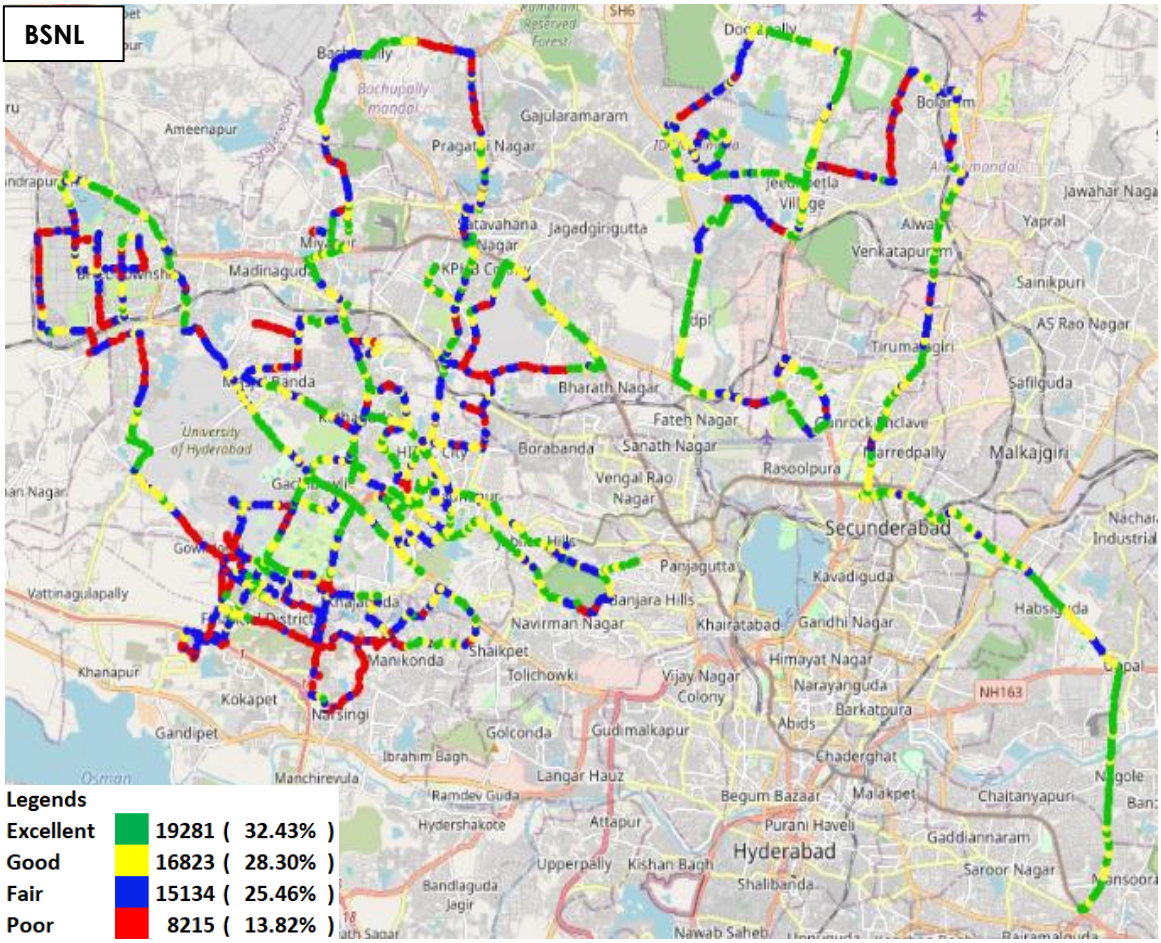

Figure-44: Signal strength 3G/2G network mode - BSNL

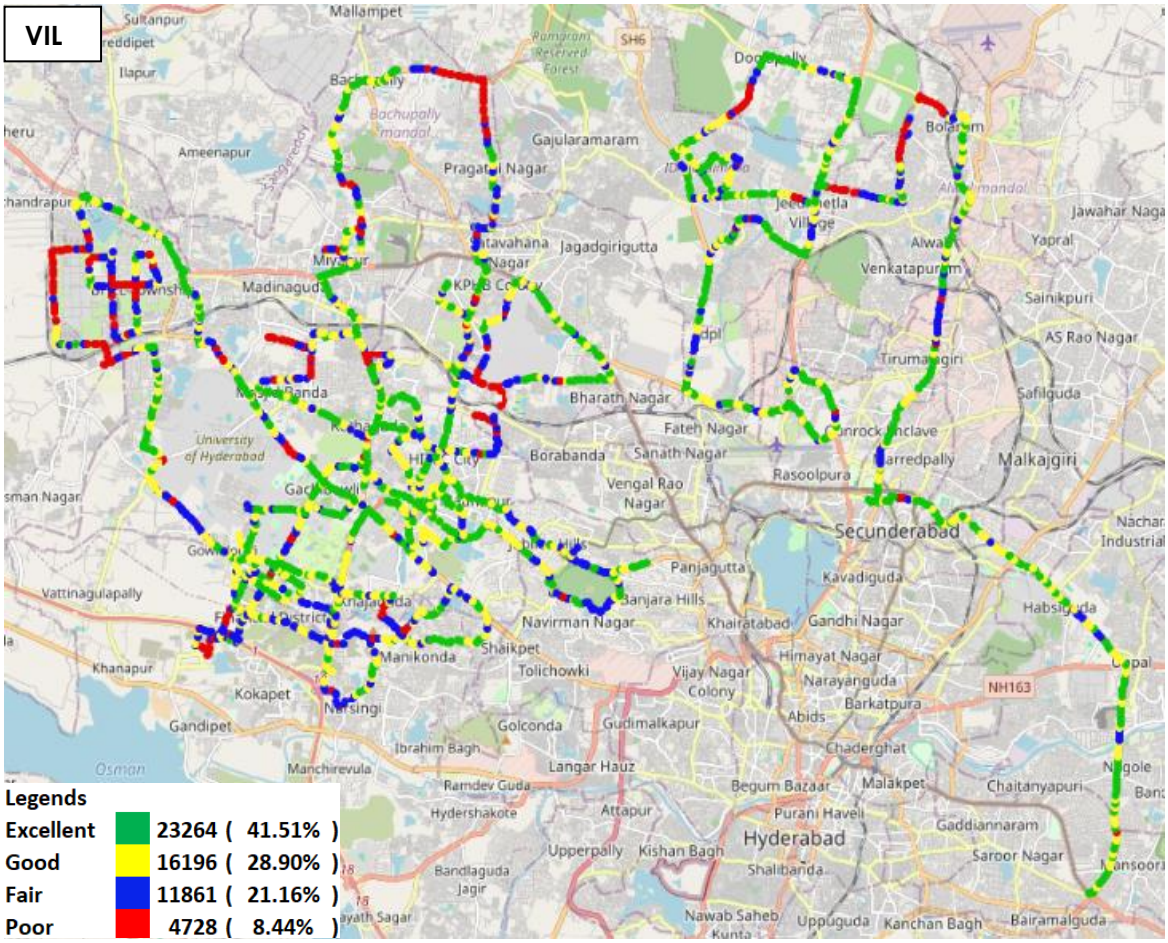

Figure-45: Signal strength 3G/2G network mode - VIL

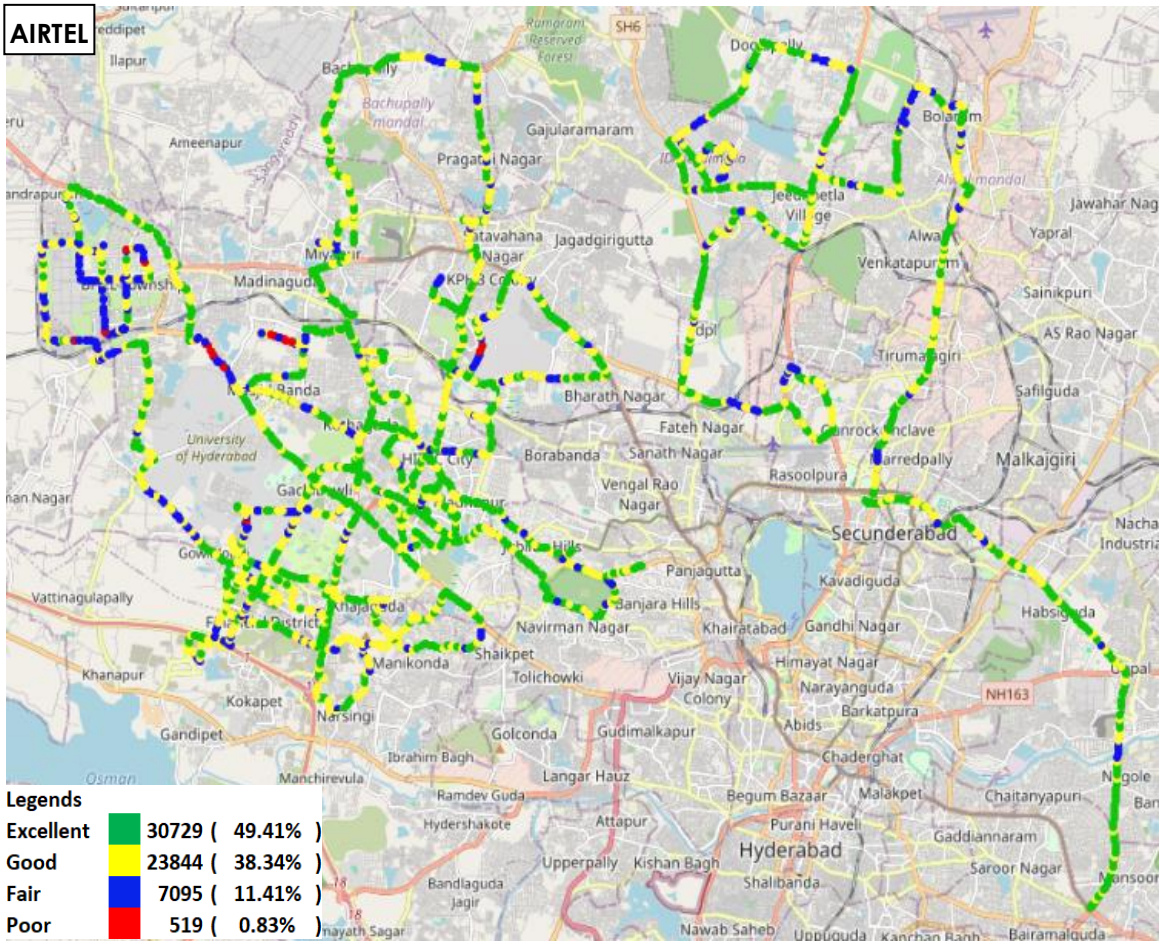

Figure-46: Signal strength auto-selection mode 5G/4G/3G/2G - Airtel

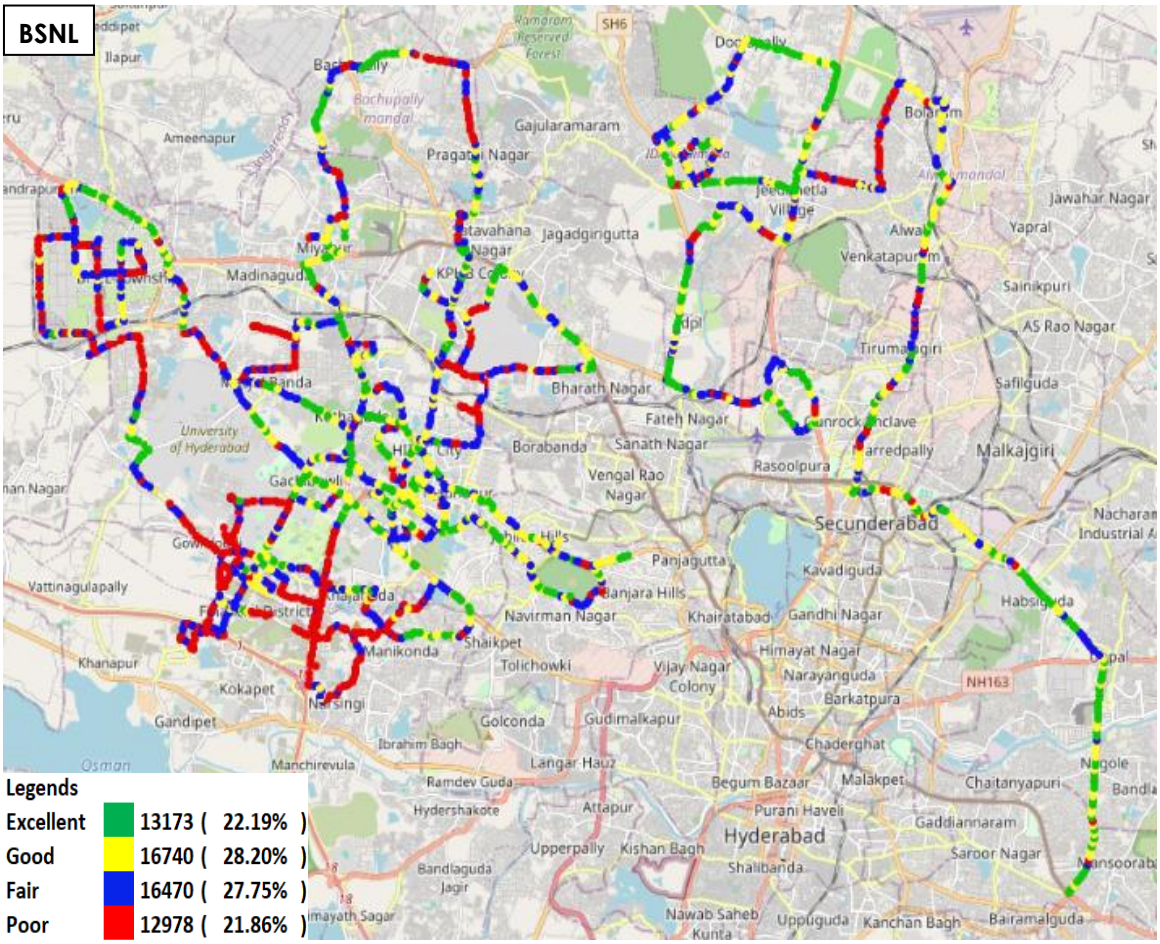

Figure-47: Signal strength auto-selection mode 5G/4G/3G/2G - BSNL

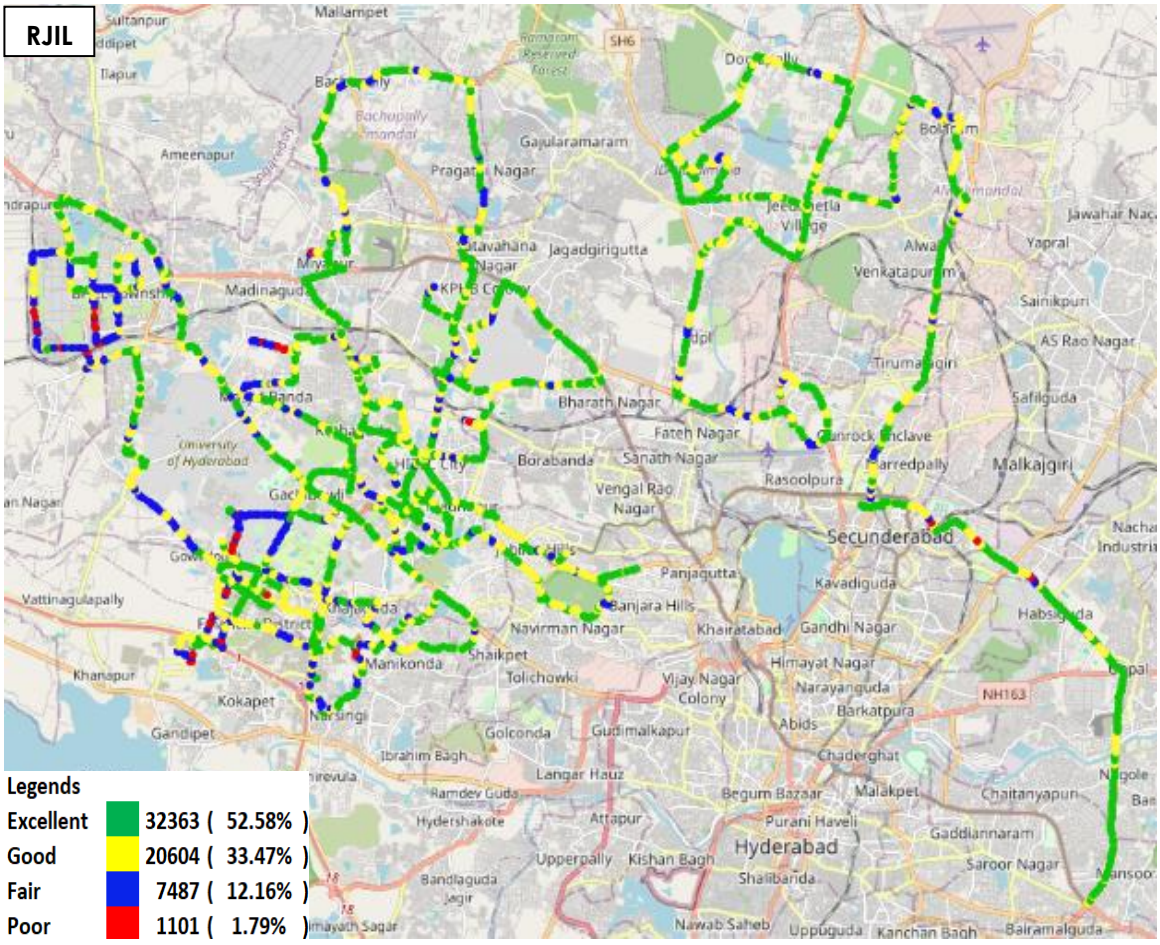

Figure-48: Signal strength auto-selection mode 5G/4G/3G/2G - RJIL

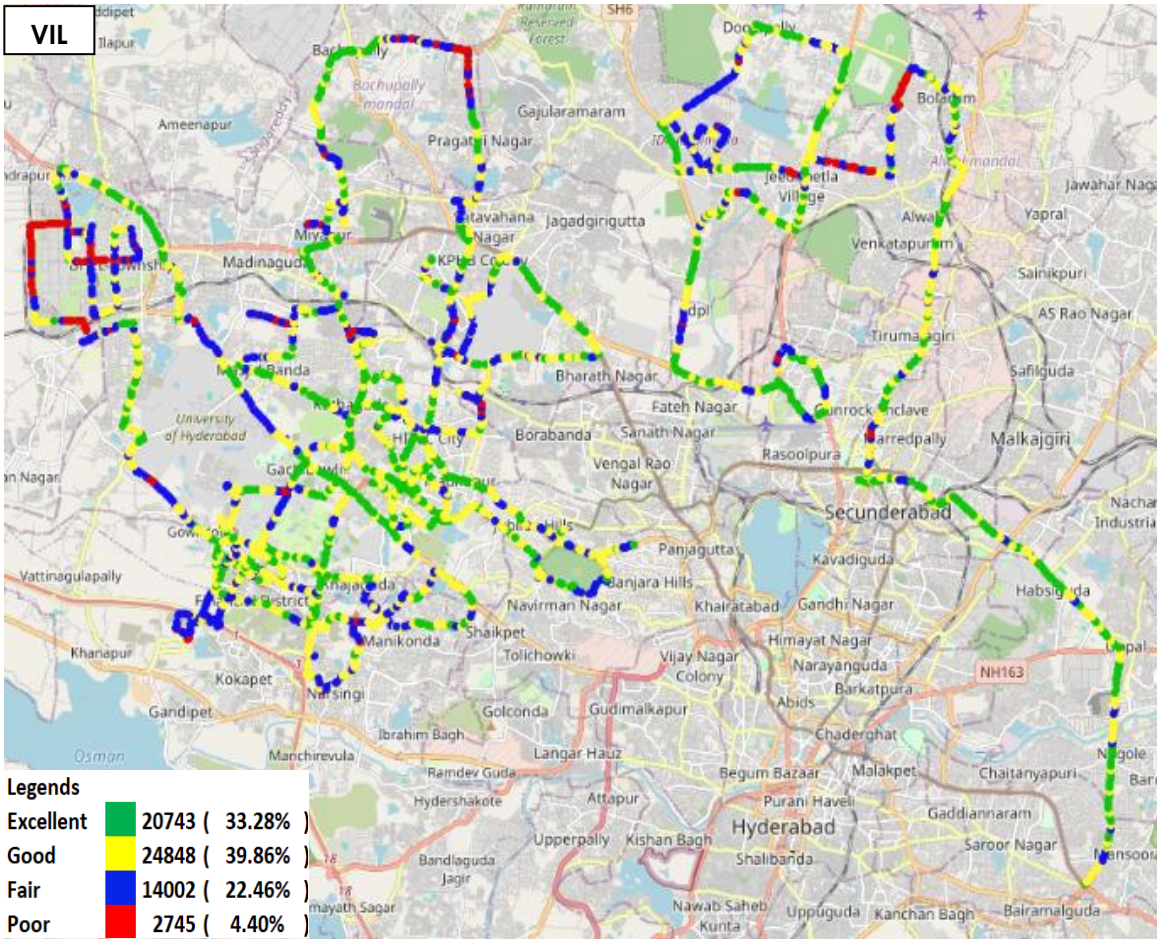

Figure-49: Signal strength auto-selection mode 5G/4G/3G/2G - VIL

6.1.2 Metro Route

i) Nagole to Raidurg

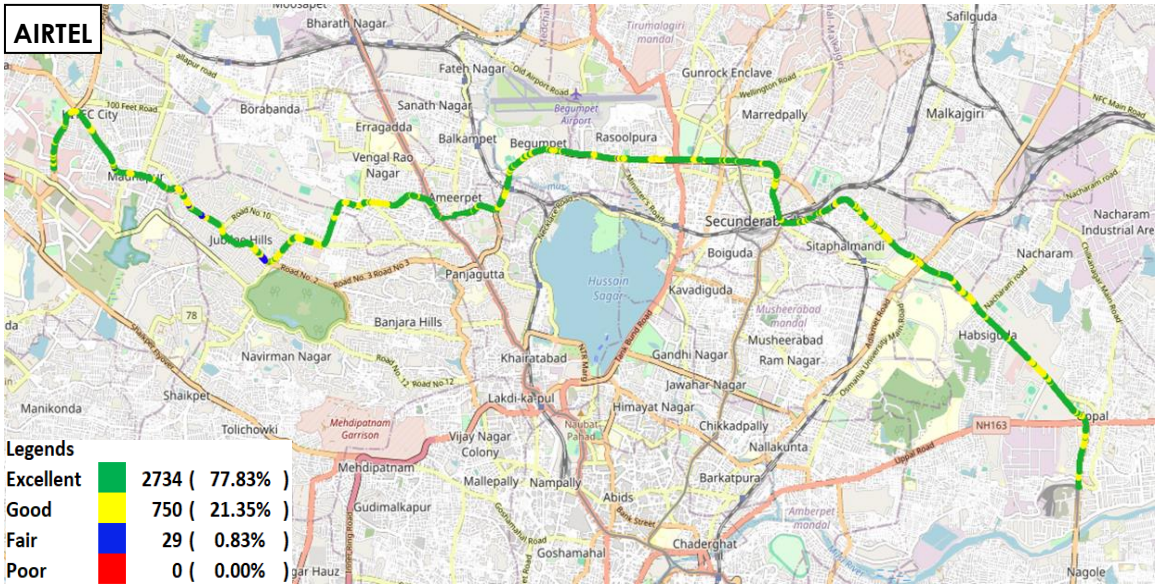

Figure-50: Signal strength auto-selection mode 5G/4G/3G/2G – AIRTEL

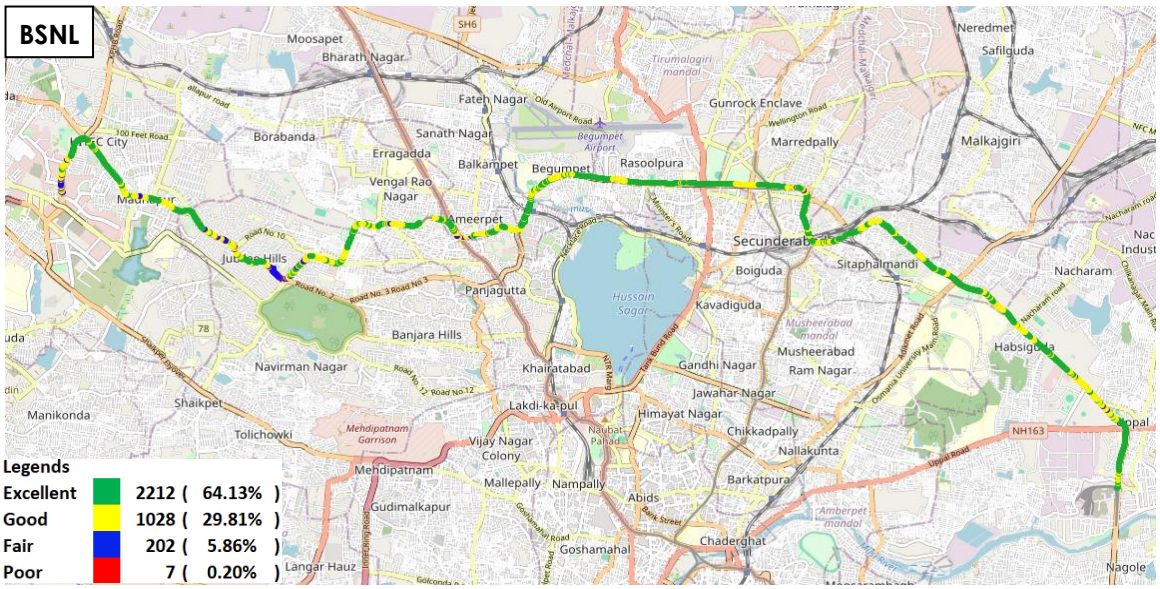

Figure-51: Signal strength auto-selection mode 5G/4G/3G/2G – BSNL

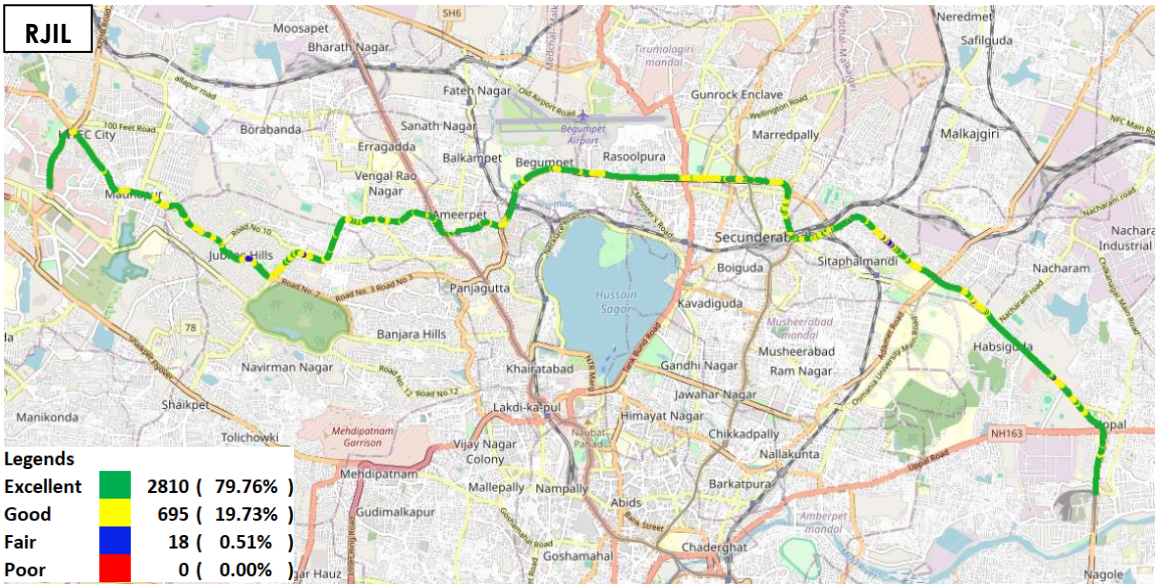

Figure-52: Signal strength auto-selection mode 5G/4G/3G/2G – RJIL

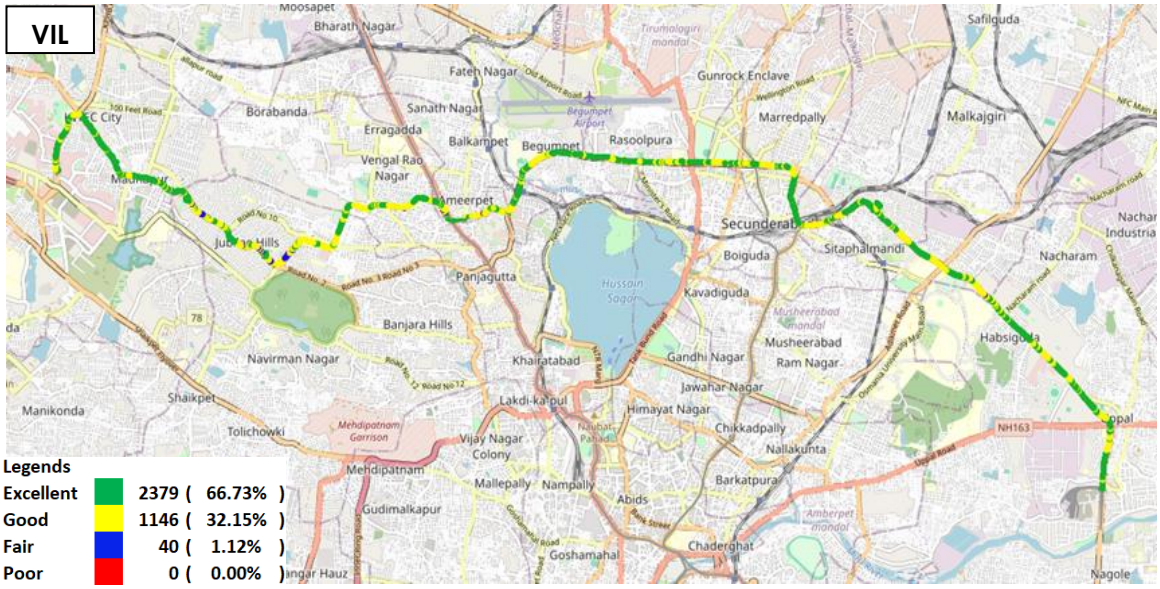

Figure-53: Signal strength auto-selection mode 5G/4G/3G/2G – VIL

ii) Miyapur to LB Nagar

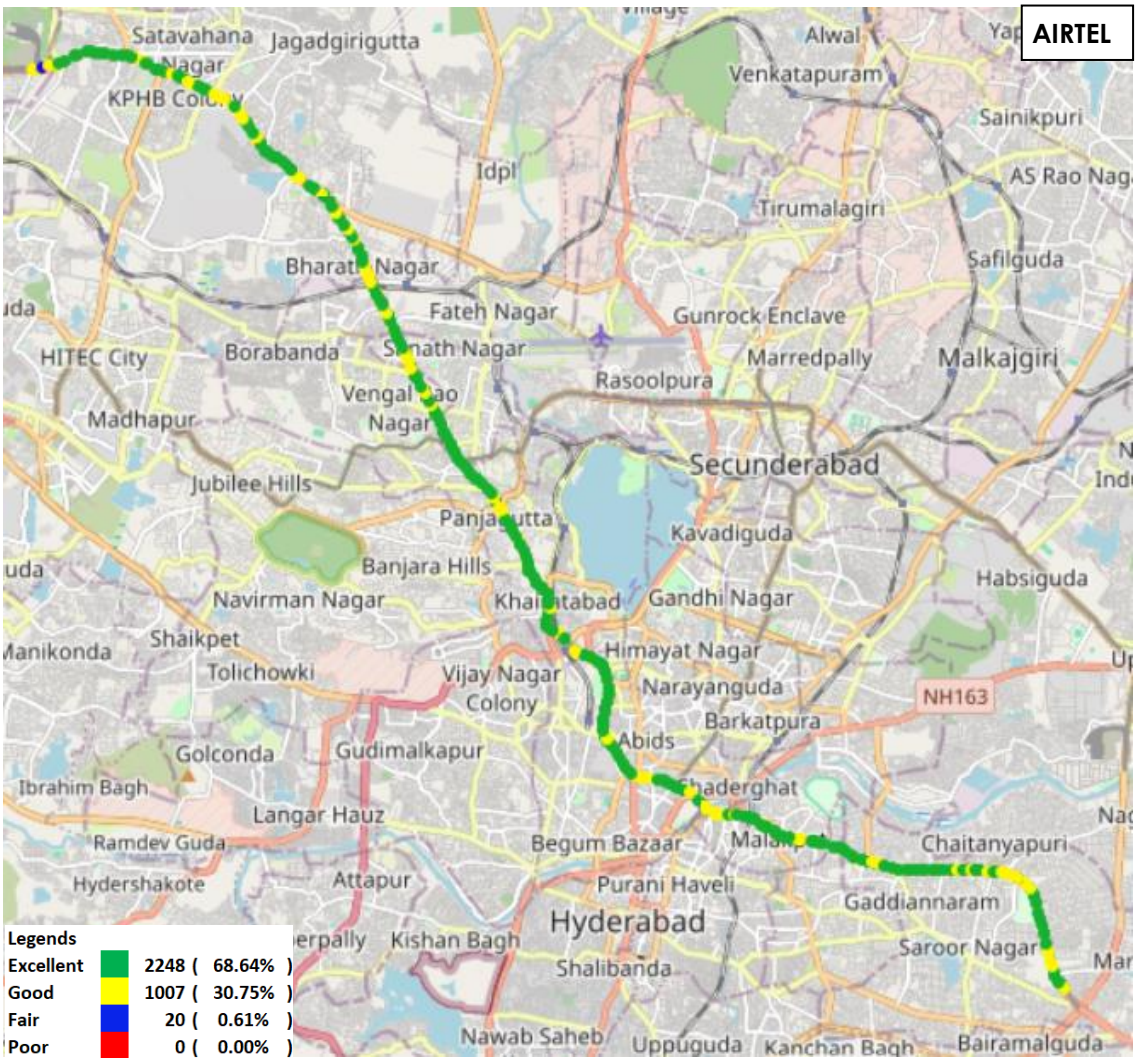

Figure-54: Signal strength auto-selection mode 5G/4G/3G/2G - Airtel

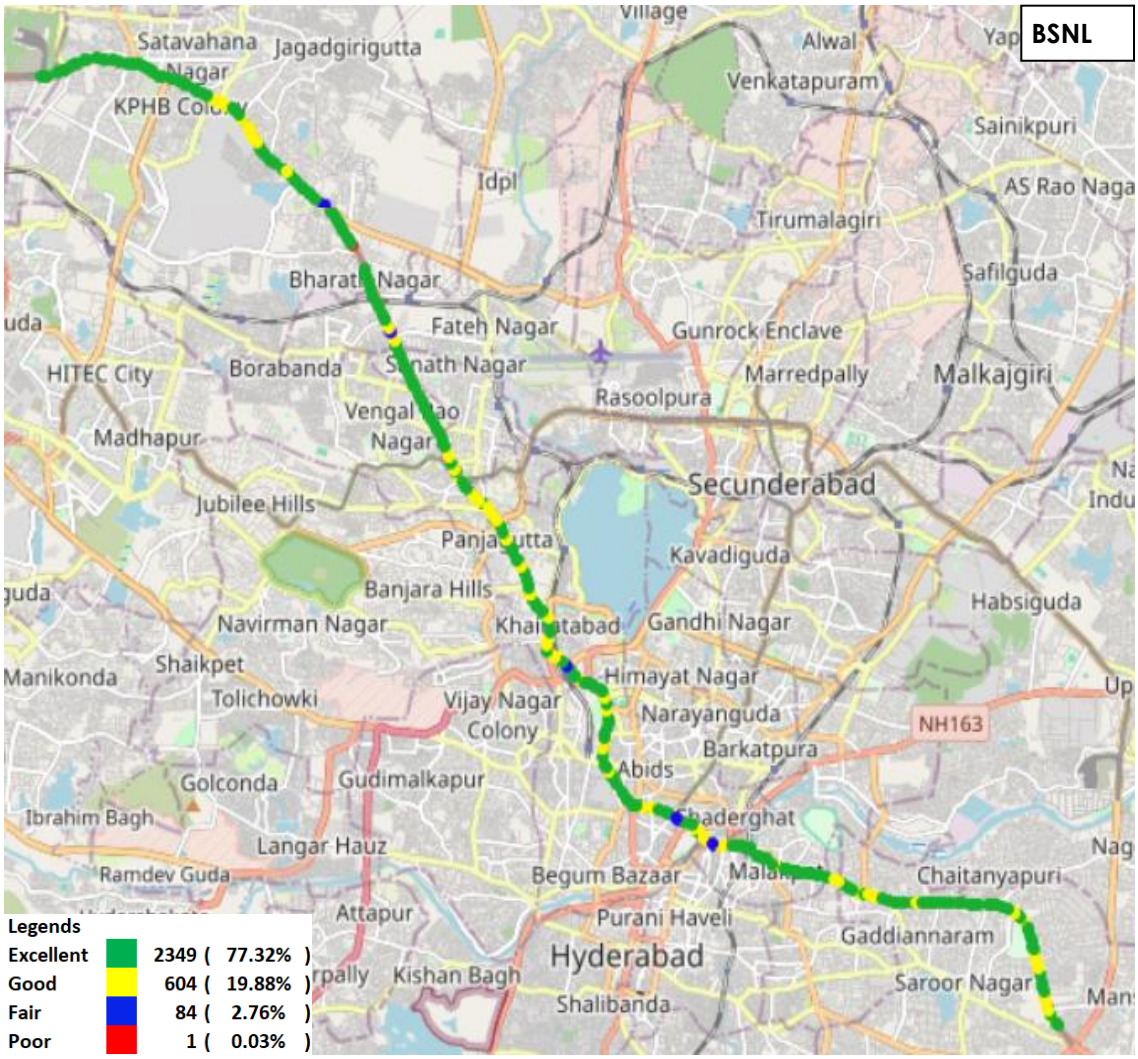

Figure-55: Signal strength auto-selection mode 5G/4G/3G/2G - BSNL

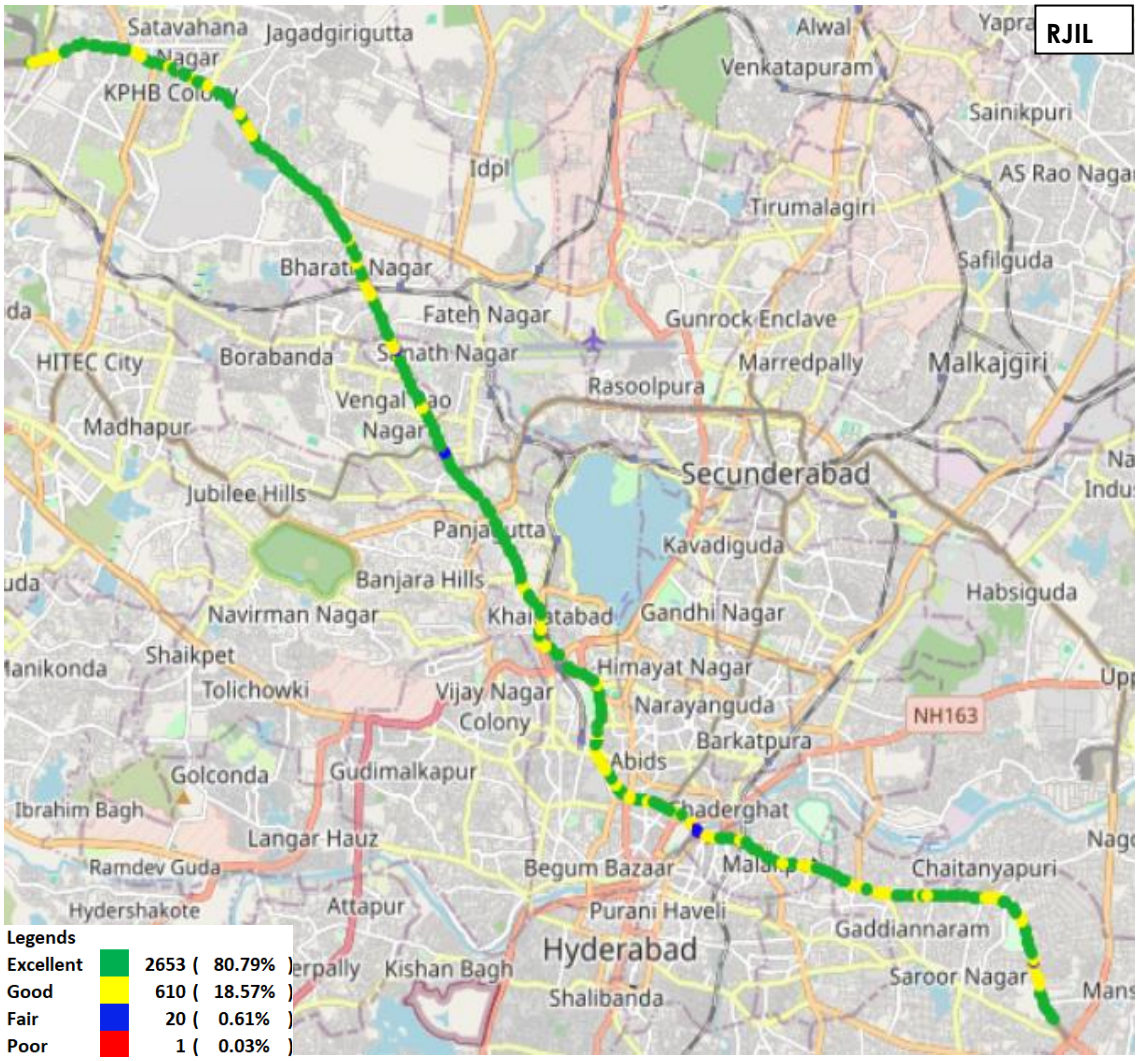

Figure-56: Signal strength auto-selection mode 5G/4G/3G/2G - RJIL

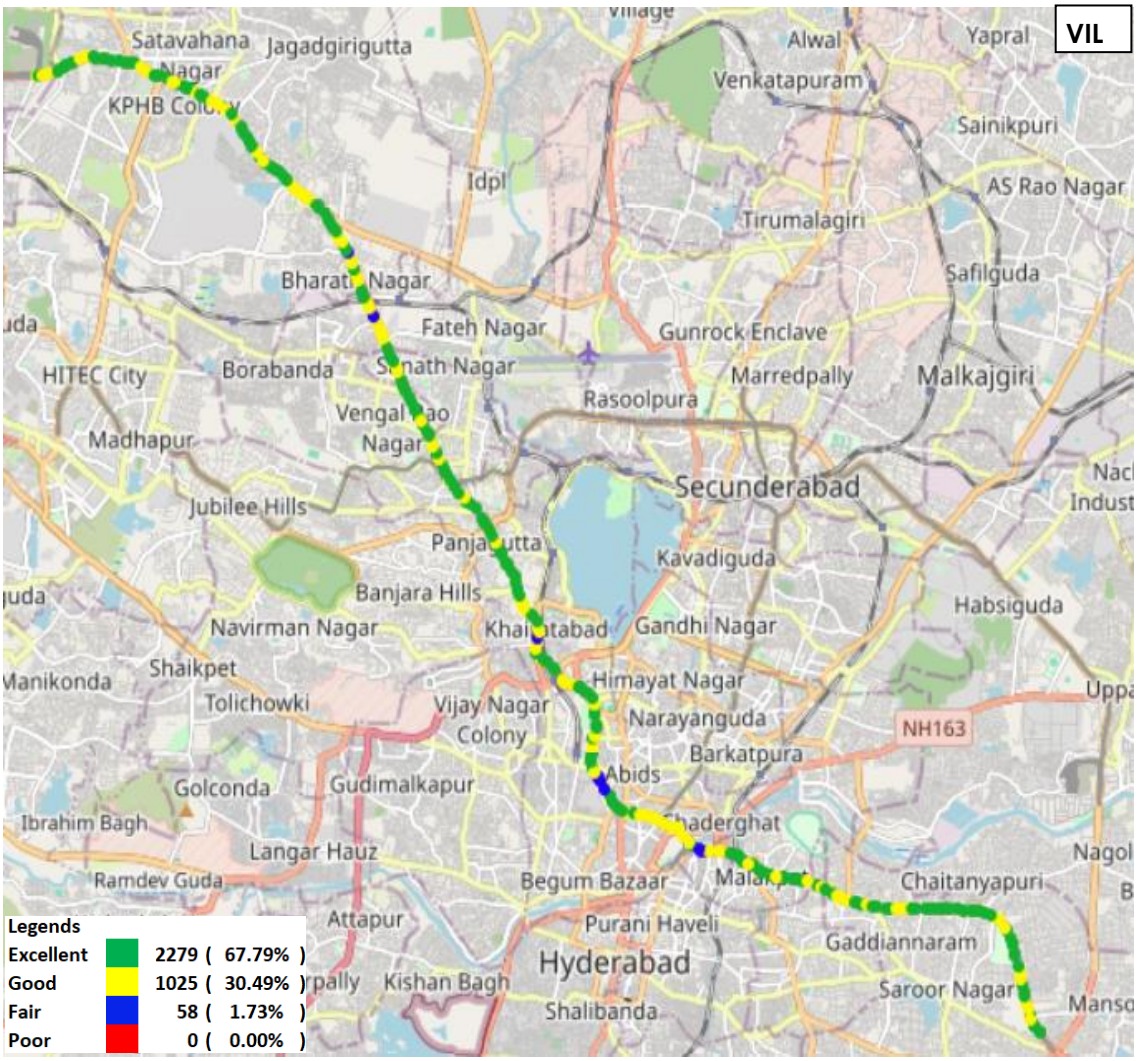

Figure-57: Signal strength auto-selection mode 5G/4G/3G/2G for VIL

7. Appendix

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

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

7.1 Appendix-I

7.1.1 Drive test setup

Voice Call		
Call details	**Technology**	**Detail**
Call Setup Timeout	• 3G/2G auto mode- switch Call • 5G/4G/3G/2G auto mode- switch Call • 5G/4G MOS Call	30 Sec
Call Duration		90 Sec /180 Sec
Wait/ Guard Time		15 Sec

Table-42: 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.
- 4G/3G/2G auto mode MOS call were made in BSNL as BSNL don't have 5G network availability across India.
- 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.google.co.in, www.facebook.com, www.amazon.in) 20 sec timeout (only at Hotspot)
Ping		25 count- Dynamic 1000 count- Hotspot

Table-43: 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)

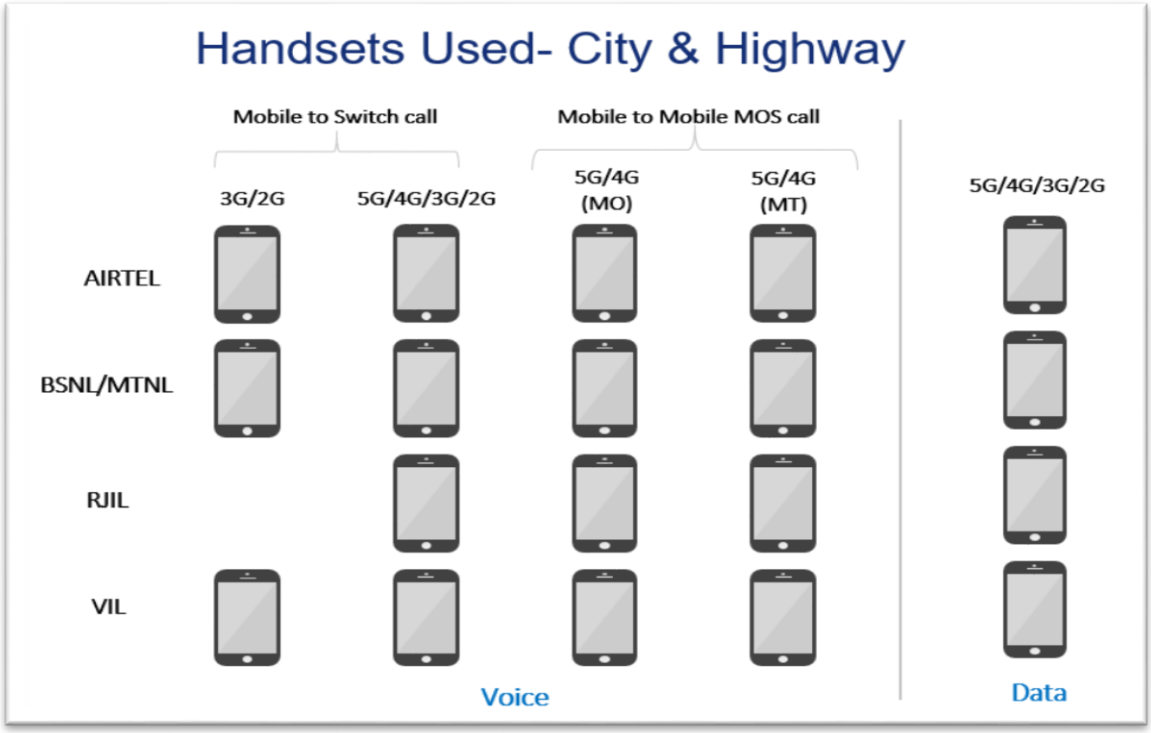

Figure-58: Number of handsets used in city & highway drive

MO: Mobile originating

MT: Mobile terminating

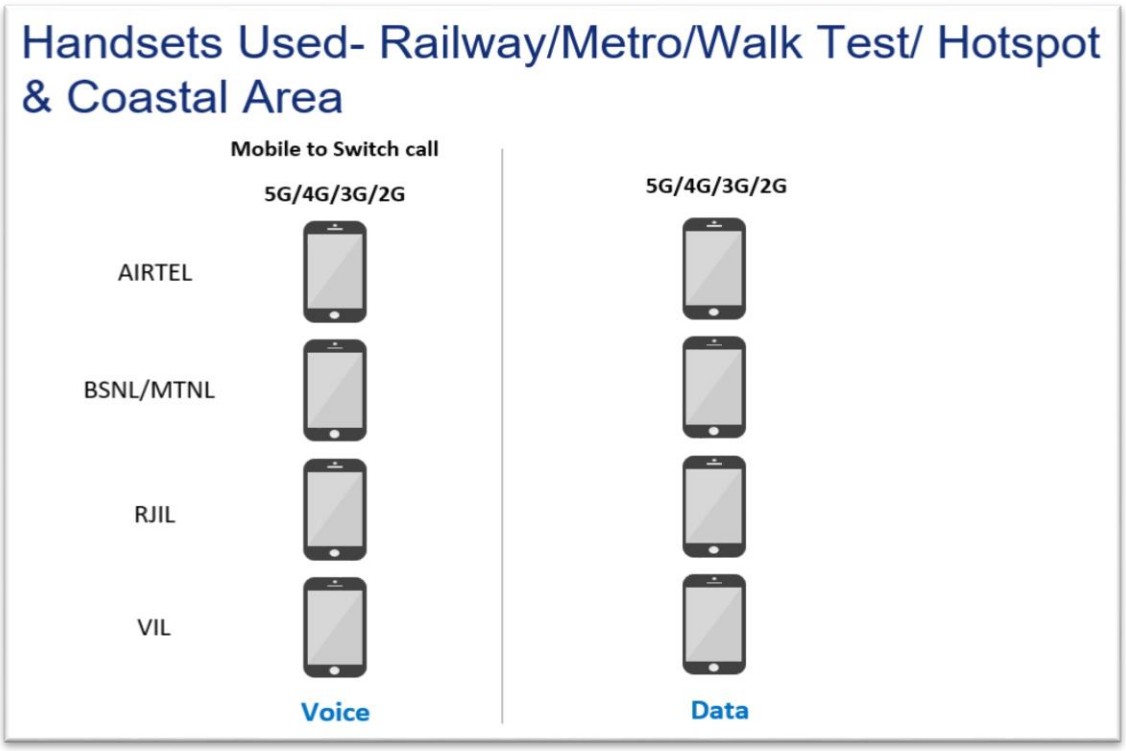

Figure-59: Number of handsets used in railway/metro/walktest/hotspot & coastal area

7.1.2 Drive test Methodology

(a) Dynamic voice testing (on the move)

Figure-60: 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

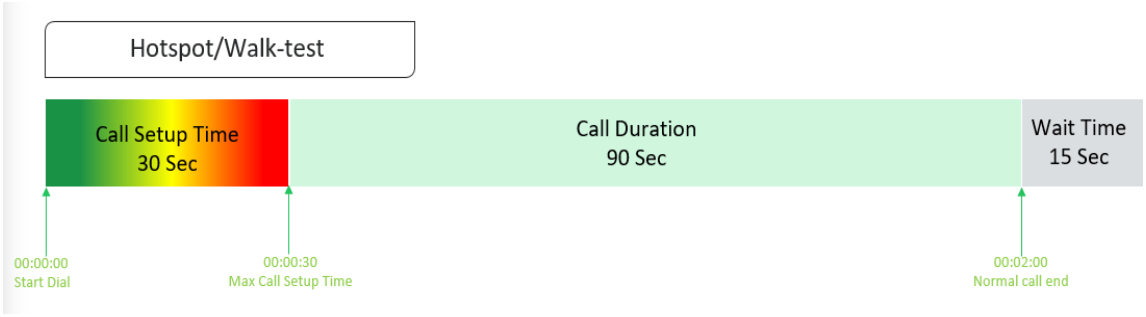

Figure-61: Voice test script for walktest/hotspot

- 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

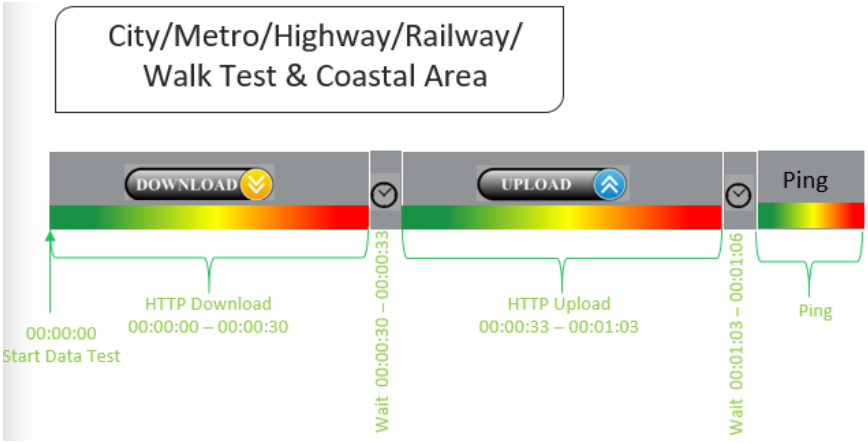

Figure-62: Data test script used in city/metro/railway/highway/walk test & coastal area

(d) Static Data(internet) testing

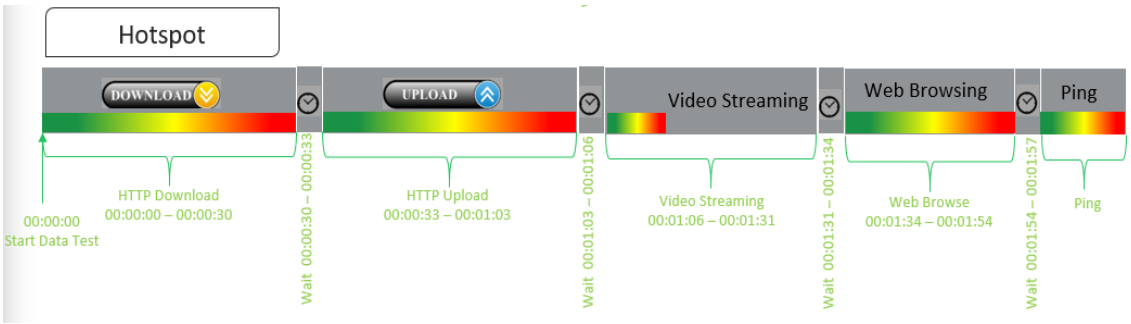

Figure-63: Data test script used at hotspot/walk test

- 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 call

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 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 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-44: Network performance parmeter 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 can be calculated based on using ICMP/UDP/TCP or TWAMP.

Table-45: Network performance parmeter and definition Data