भादूविप्रा
TRAI

TELECOM REGULATORY AUTHORITY OF INDIA

Independent Drive Test Report

Mumbai LSA

December 2024

File No. RP-4/18/4(1)/2024-RO_BGLR (Computer No. 14209)
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Contents

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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 Mumbai License Service Area (LSA) during the month of December, 2024 under the supervision of TRAI Regional Office (RO), Bengaluru. Details of route/area covered during the IDT is as given below:

Sl. No	Drive test route	Type of route	Distance covered (KMs)/ Locations	From date	To date
1	Navi Mumbai	City	323.78	16-Dec-2024	17-Dec-2024
2	Navi Mumbai	City (Inter-operator calling)	26.48	20-Dec-2024	20-Dec-2024
3	Navi Mumbai	Hotspot	10 Locations	19-Dec-2024	20-Dec-2024
4	Navi Mumbai	Walk Test	12.85	18-Dec-2024	20-Dec-2024
5	Navi Mumbai	Coastal	6.71	18-Dec-2024	18-Dec-2024
6	Navi Mumbai	Metro	10.63	18-Dec-2024	18-Dec-2024
7	Navi Mumbai	Railway	20.40	18-Dec-2024	18-Dec-2024

Table-1: Drive test summary

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2.2 Drive test routes

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

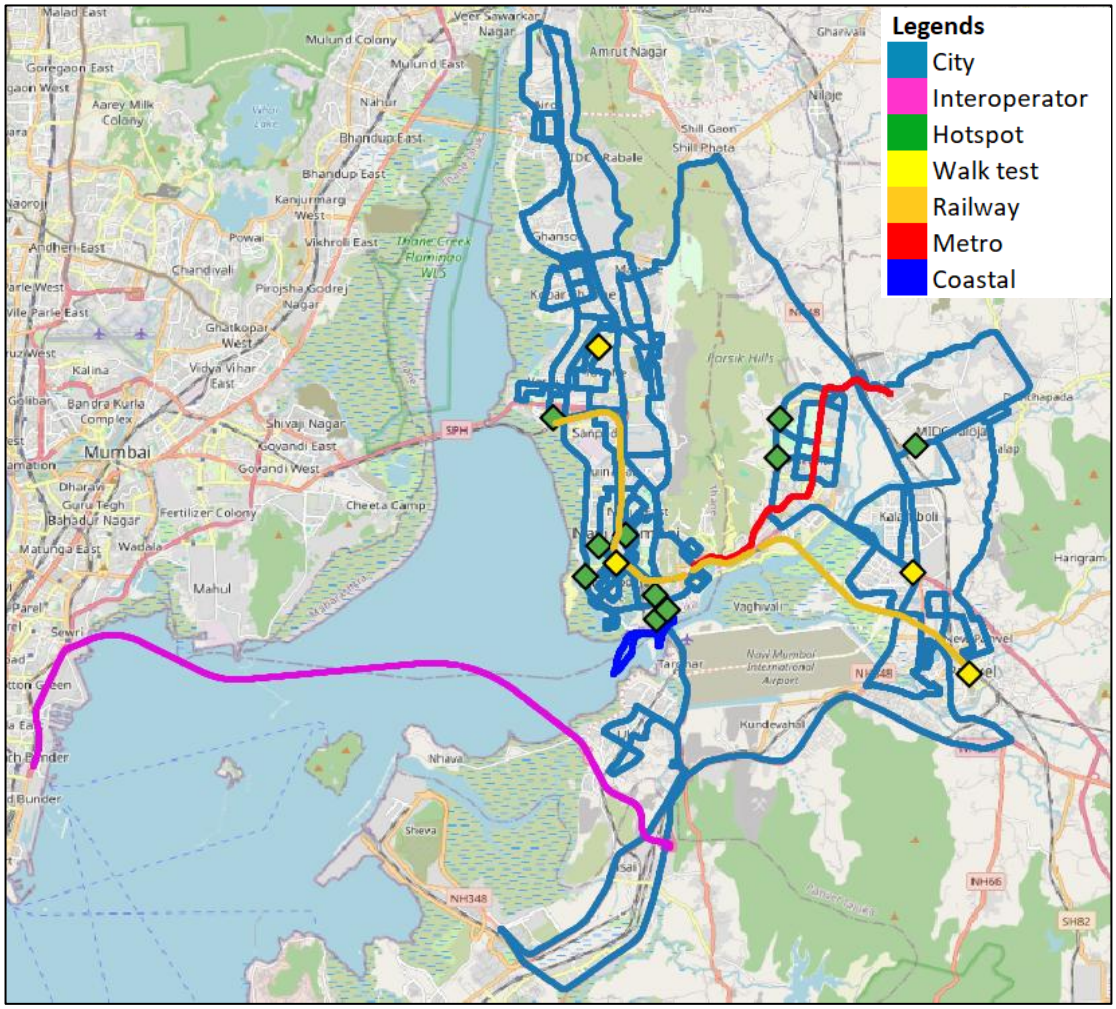

Figure-1: Drive test routes

2.3 Summary of areas covered

a) City- Airoli, MIDC Rabale, Ghansoli, Mahape, Vashi, Sanpada, Seawoods East, Seawoods West, Belapur West, Belapur East, Jasai, Panvel, Kalamboli and MIDC Taloja etc.

b) Hotspot

1. Aditya Birla Science and Tech
2. Belapur Fort
3. Iskon Kharghar
4. Jewel of Navi Mumbai Park
5. Navi Mumbai District Court
6. Navi Mumbai Municipality Co-operation Head Office
7. Rock Garden Stadium

8. T.S Chanakya Maritime College
9. Tata Memorial Hospital
10. Vashi Railway Station

c) Walk Test

1. Dana Market
2. MGM Hospital
3. Panvel Station
4. Seawoods Grand Central Mall

d) Railway

1. Panvel to Vashi

e) Metro

1. Belapur to Pendhar.

f) Coastal

1. JNPT Belapur area towards Vashi.

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	MTNL	2G	900,1800
5	MTNL	3G	2100
6	MTNL	4G	NA
7	Reliance JIO Infocomm Ltd.	4G	850,1800,2300
8	Reliance JIO Infocomm Ltd.	5G	700,3500
9	Vodafone Idea Ltd.	2G	1800
10	Vodafone Idea Ltd.	4G	900,1800,2100,2500

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

Note-

- NA - 4G Frequency band not detected during data collection.

QoS Performance Analysis – Mumbai LSA

3. QoS performance analysis- LSA level

3.1 Overview

This section provides summary of overall QoS performance of the telecom service provider's network in the LSA by aggregating the results of drive tests conducted in the LSA during the month of December-2024 covering city, hotspot, walk test, railway, metro and coastal area. (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	MTNL	VIL
Call Attempts	491	734	496
Call Setup Success Rate %	97.56	56.95	98.19
Drop Call Rate %	0.42	20.57	0.62
Call Setup Time-Average (Second)	5.27	5.10	4.97
Handover Success Rate %	98.47	100.00	98.87

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

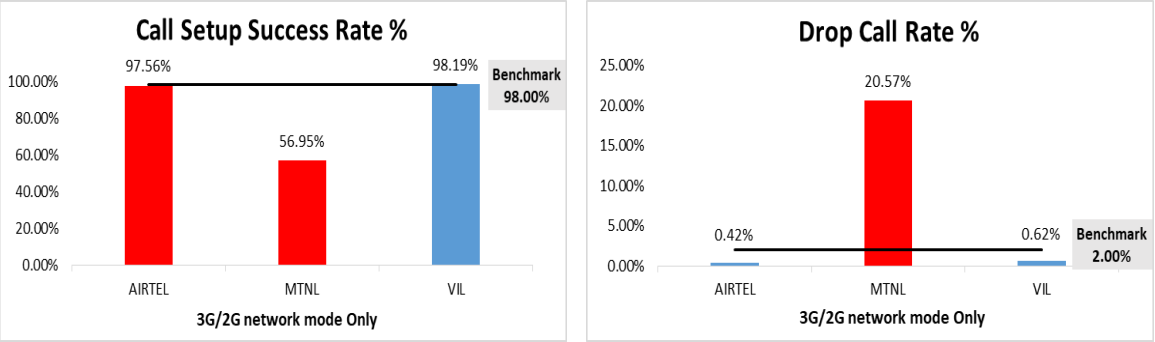

Figure-2: Call setup success rate and drop call rate performance.

Number of unique cell id's covered in Voice test- Technology wise			
Technology	Service Provider		
	3G/2G network mode only		
	AIRTEL	MTNL	VIL
3G	NA	64	NA
2G	849	96	866

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	MTNL	RJIL	VIL
Call Attempts	789	1098	804	799
Call Setup Success Rate %	99.49	43.81	99.88	99.00
Drop Call Rate %	0.00	21.41	0.25	0.13
Call Setup Time-Average (Second)	1.30	5.40	0.58	1.01
Handover Success Rate %	99.98	100.00	99.93	99.76

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

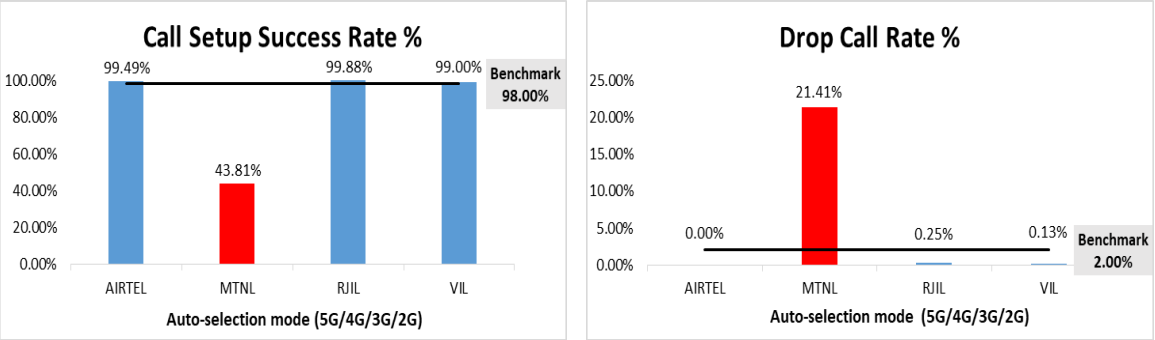

Figure-3: Performance for call setup success rate and drop call rate.

Parameter	Service Provider			
	Mobile-to-Mobile (5G/4G - Open Mode)			
	AIRTEL	MTNL	RJIL	VIL
Call Established (within service provider Network)	509	295	503	496
Number of silence call for >4 Sec	5	NA	2	8
Silence Call Rate %	0.98	NA	0.40	1.61
Number of silence instances for >4 Sec	7	NA	2	8
Number of silence instances for >3 Sec	14	NA	3	14
Number of silence instances for >2 sec	36	NA	11	42
RTP Jitter (4G & 5G) in ms	5.61	NA	13.26	13.44
Packet loss Rate Downlink %	0.95	NA	0.58	0.91
Packet loss Rate Uplink %	0.80	NA	0.69	0.97

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

Note-

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

Number of unique cell id's covered in Voice test- Technology wise				
Technology	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
5G	0	NA	658	NA
4G	1970	NA	2717	1717
3G	NA	65	NA	NA
2G	0	193	NA	2

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

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

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

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

Speech Quality (MOS) distribution	Service Provider			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Total Number of MOS Samples for calls in table-6	2882	1165	2904	2878
Speech Quality (Average MOS Score)	3.95	2.56	3.91	4.42
Number of samples with MOS >=4 to <5 (Excellent)	2275	0	2078	2425
Number of samples with MOS >=3 to <4 (Good)	470	384	664	370
Number of samples with MOS >=2 to <3 (Fair)	80	544	114	52
Number of samples with MOS >=1 to <2 (Poor)	57	237	48	31
%age of samples with MOS >=4 to <5 (Excellent)	78.94%	0.00%	71.56%	84.26%
%age of samples with MOS >=3 to <4 (Good)	16.31%	32.96%	22.87%	12.86%
%age of samples with MOS >=2 to <3 (Fair)	2.78%	46.70%	3.93%	1.81%
%age of samples with MOS >=1 to <2 (Poor)	1.98%	20.34%	1.65%	1.08%

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

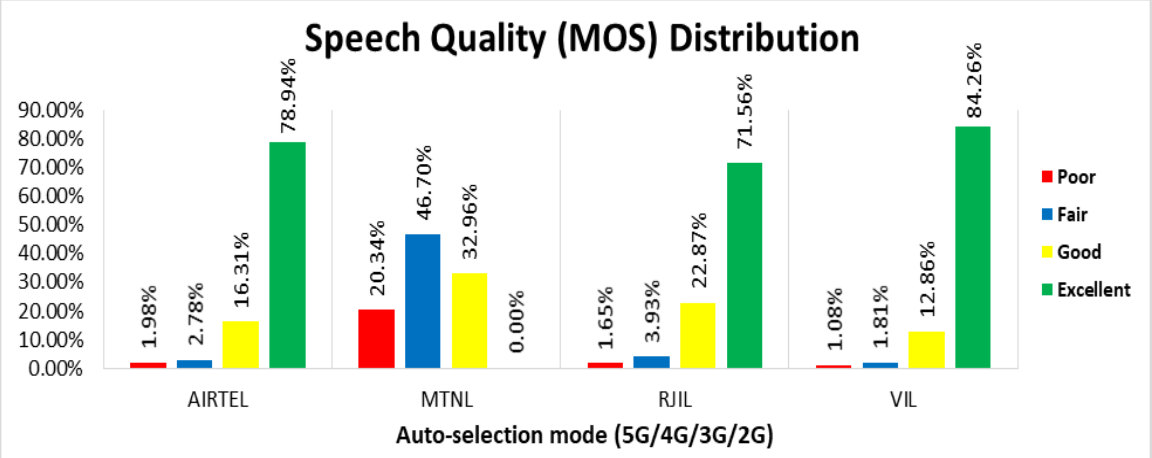

Figure- 4: Distribution of samples in MOS score range.

(d) Inter-service provider voice call performance: To check the performance of inter-service provider call setup success rate, total 26 to 48 inter operator calls were attempted. The call setup success rate and call setup time observation are as below.

Call setup success rate %				
From Service Provider	**To Service Provider**			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
AIRTEL	NA	96.55	93.62	100.00
MTNL	18.52	NA	34.62	17.86
RJIL	93.48	76.67	NA	91.67
VIL	97.87	93.10	97.92	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	**MTNL**	**RJIL**	**VIL**
AIRTEL	NA	3.75	1.93	2.41
MTNL	3.59	NA	5.98	5.68
RJIL	2.72	3.20	NA	1.97
VIL	2.26	3.48	2.15	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	**MTNL**	**RJIL**	**VIL**
Download Throughput (Mbits/s)	**Average**	161.89	0.54	319.93	41.21
	80th Percentile	245.71	0.88	532.70	63.55
	20th Percentile	59.14	0.20	99.87	19.61
Upload Throughput (Mbits/s)	**Average**	29.58	0.46	43.94	11.17
	80th Percentile	51.39	0.65	69.33	16.83
	20th Percentile	7.72	0.13	16.57	5.50
Latency (ms)	**50th Percentile**	11.50	100.00	14.75	17.35

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

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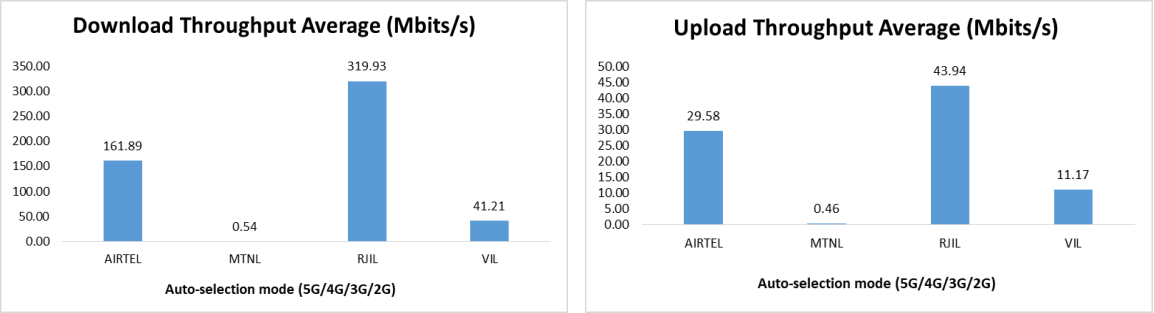

Figure- 5: Download and upload throughput.

Number of unique cell id's covered in Data test- Technology wise				
Technology	**Service Provider**			
	Auto-selection mode 5G/4G/3G/2G			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
5G	0	NA	915	NA
4G	2039	NA	153	1659
3G	NA	65	NA	NA
2G	4	281	NA	7

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, walk test, railway, metro and coastal for all telecom service providers, the results of drive tests conducted are shown individually for respective areas/locations.

4.2 City

Drive test has been conducted from 16th to 17th December 2024 in Navi Mumbai. (refer table-1)

4.2.1 Drive test route

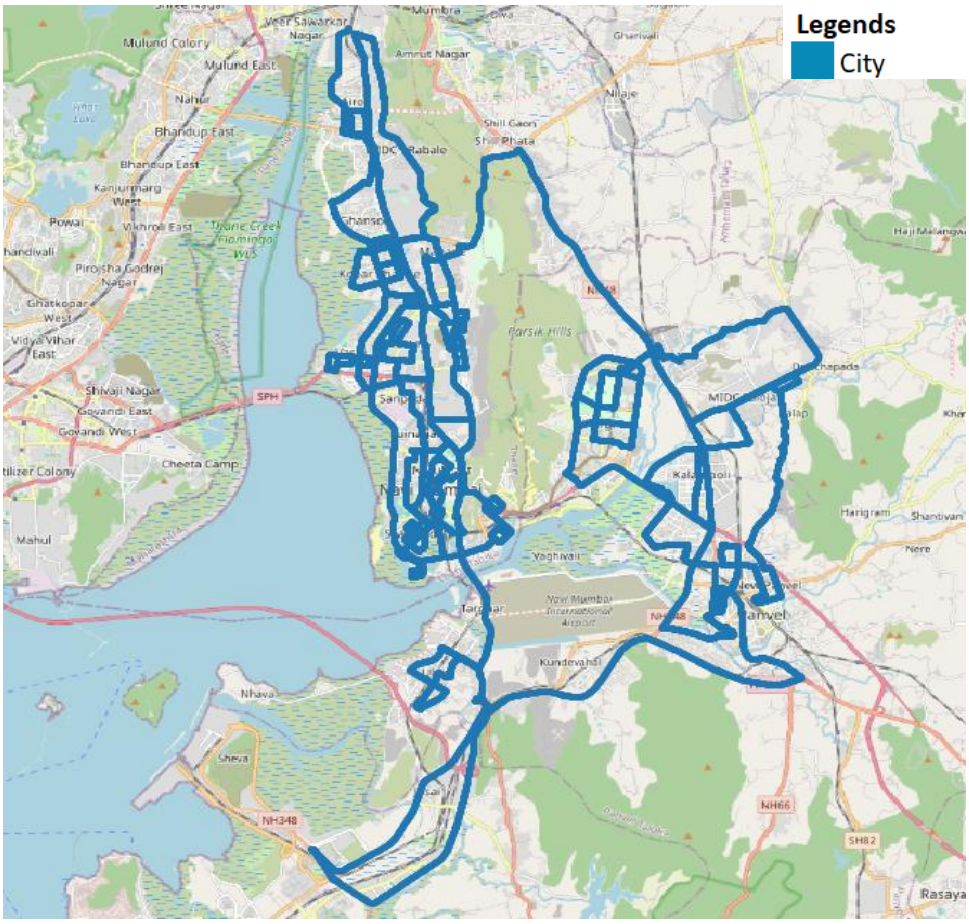

Figure- 6: Drive test routes.

4.2.2 Areas covered

Airoli, MIDC Rabale, Ghansoli, Mahape, Vashi, Sanpada, Seawoods East, Seawoods West, Belapur West, Belapur East, Jasai, Panvel, Kalamboli and MIDC Taloja 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	MTNL	VIL
Call Attempts	491	734	496
Call Setup Success Rate %	97.56	56.95	98.19
Drop Call Rate %	0.42	20.57	0.62
Call Setup Time-Average (Second)	5.27	5.10	4.97
Handover Success Rate %	98.47	100.00	98.87

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

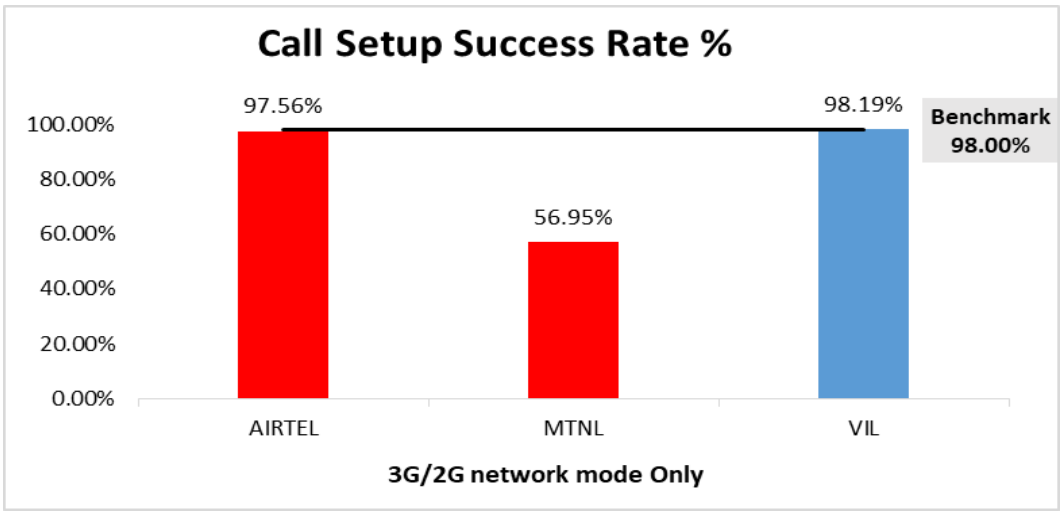

Figure-7: Performance for call setup success rate.

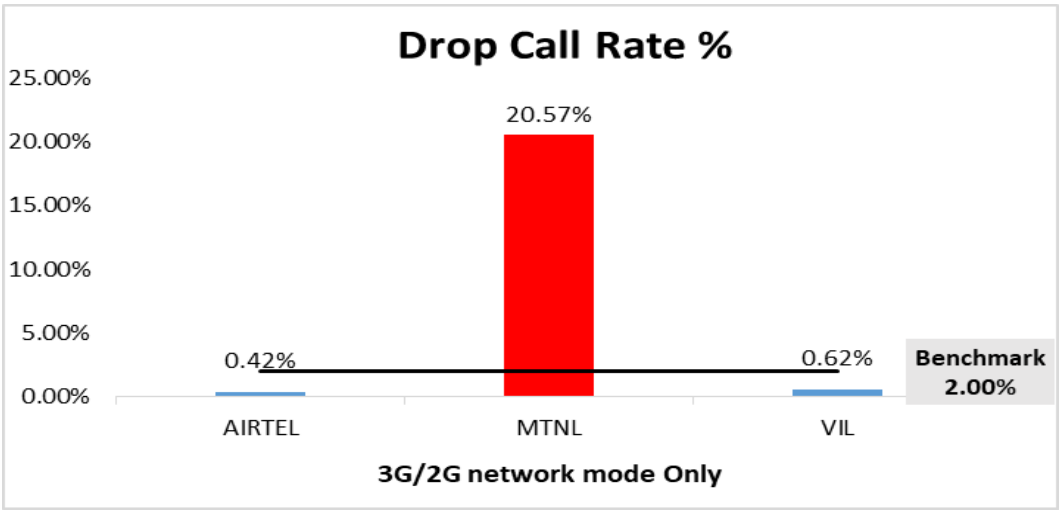

Figure-8: Performance for drop call rate.

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

Technology	Service Provider		
	AIRTEL	MTNL	VIL
3G	NA	77.38%	NA
2G	99.79%	12.65%	99.94%
Limited Service	0.21%	9.97%	0.06%

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

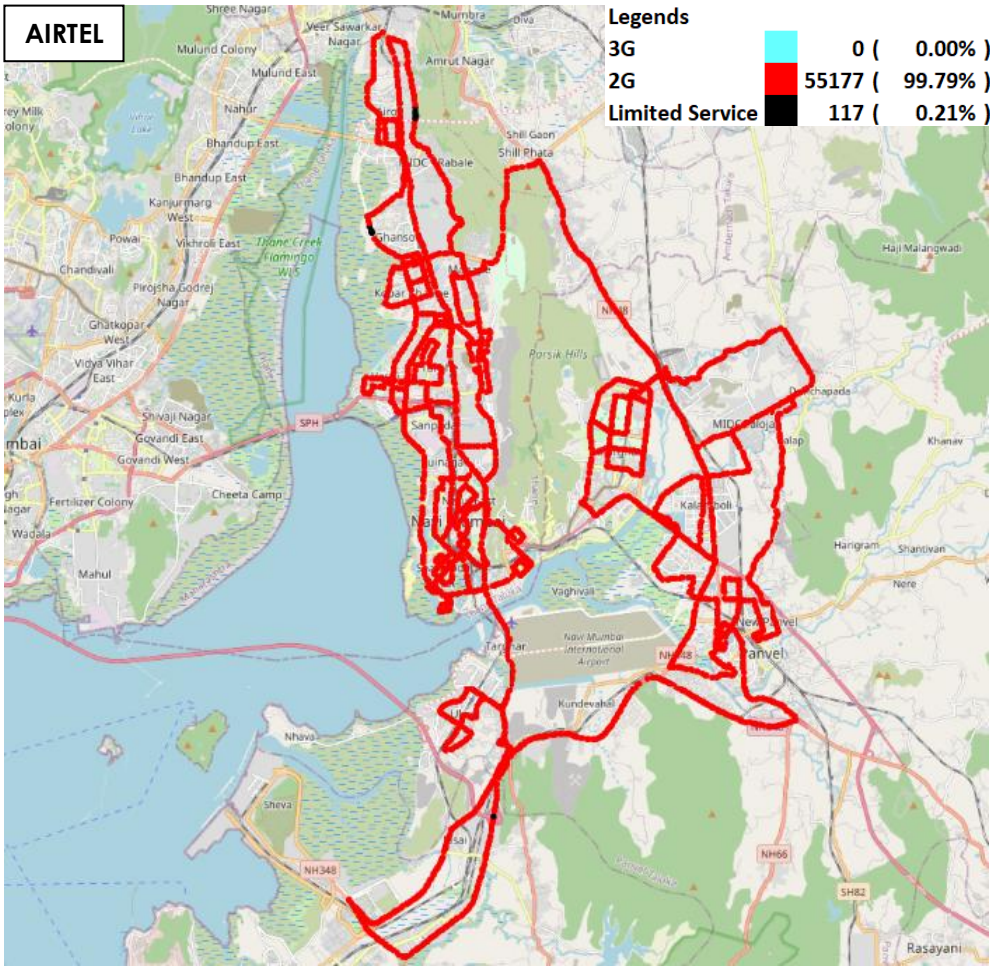

Figure-9: Serving technology plots 3G/2G network mode – AIRTEL.

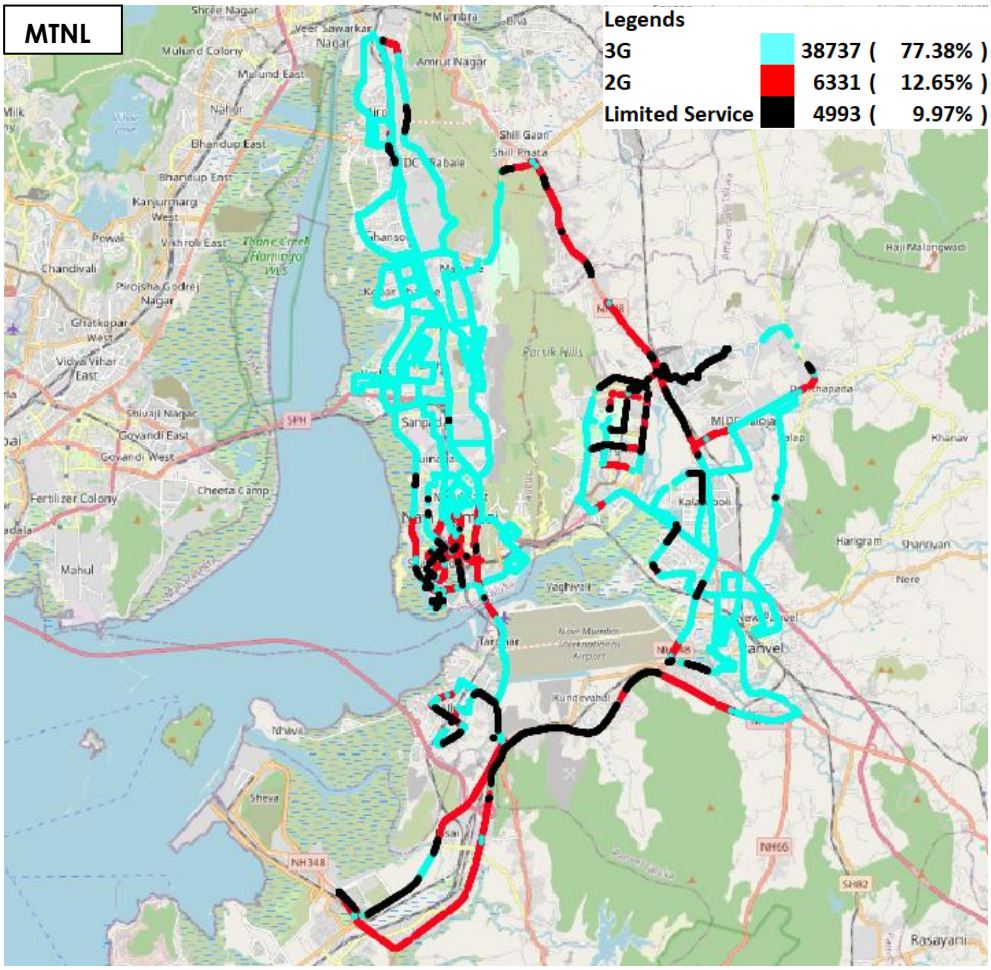

Figure-10: Serving technology plots 3G/2G network mode – MTNL.

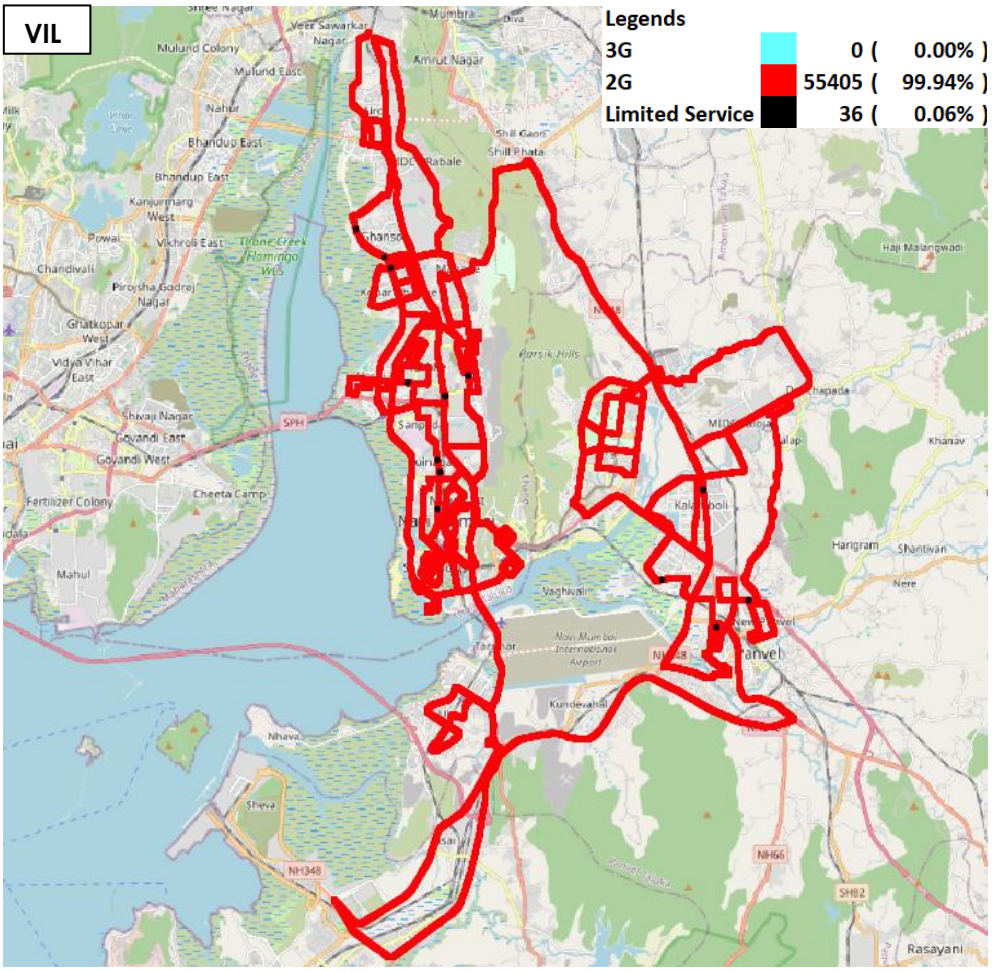

Figure-11: Serving technology plots 3G/2G network mode –VIL.

(c) Network Signal Strength distribution: The following chart represents signal strength distribution for 3G/2G network mode only. (refer figure-55, 56 & 57 for map view)

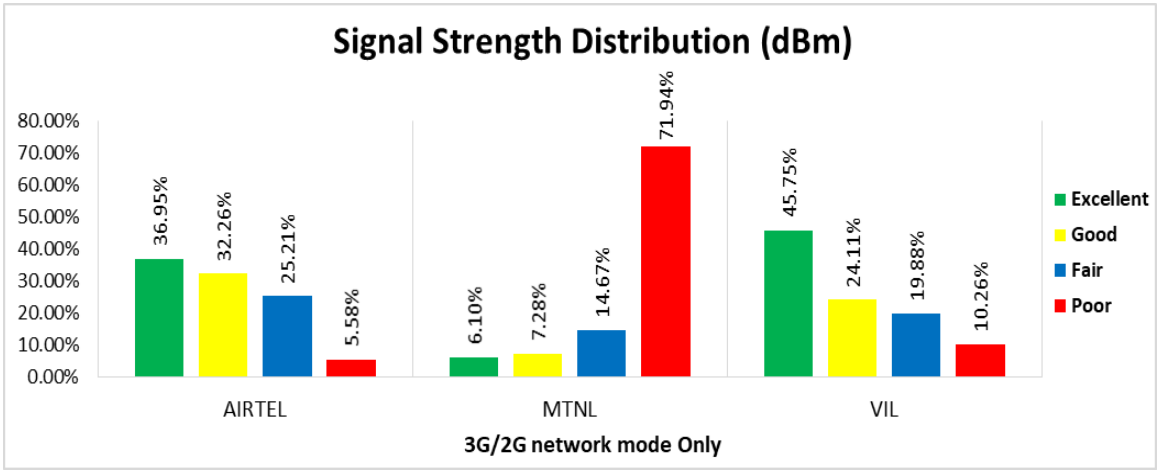

Figure-12: Signal strength distribution 3G/2G network mode only.

Observations:

- Airtel has 37% of samples falling in the excellent signal strength category.
- MTNL has 6% of samples falling in the excellent signal strength category.
- VIL has 46% 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	MTNL	RJIL	VIL
Call Attempts	513	700	524	519
Call Setup Success Rate %	99.42	49.71	99.81	99.04
Drop Call Rate %	0.00	23.85	0.38	0.19
Call Setup Time Average (Second)	1.24	5.27	0.56	1.02
Handover Success Rate %	99.97	100.00	99.96	99.68

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

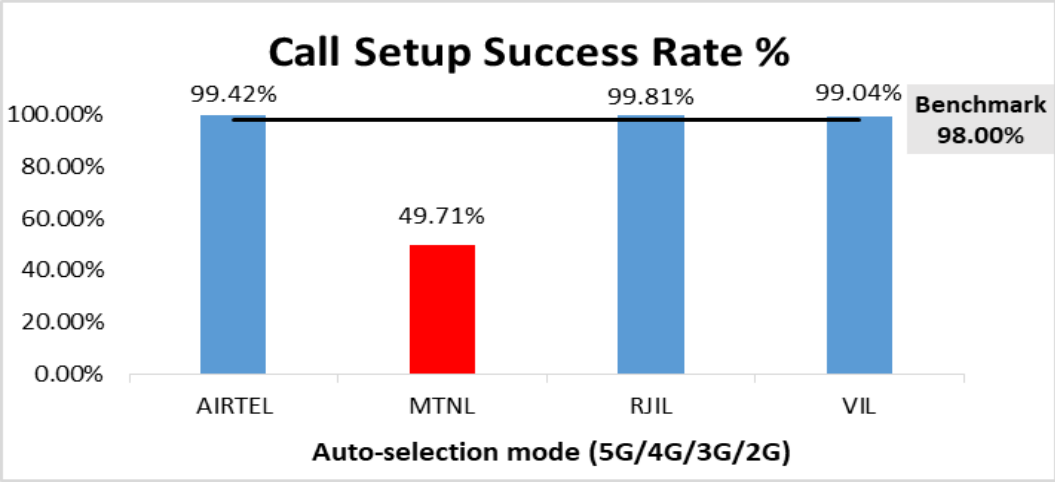

Figure-13: Performance for call setup success rate.

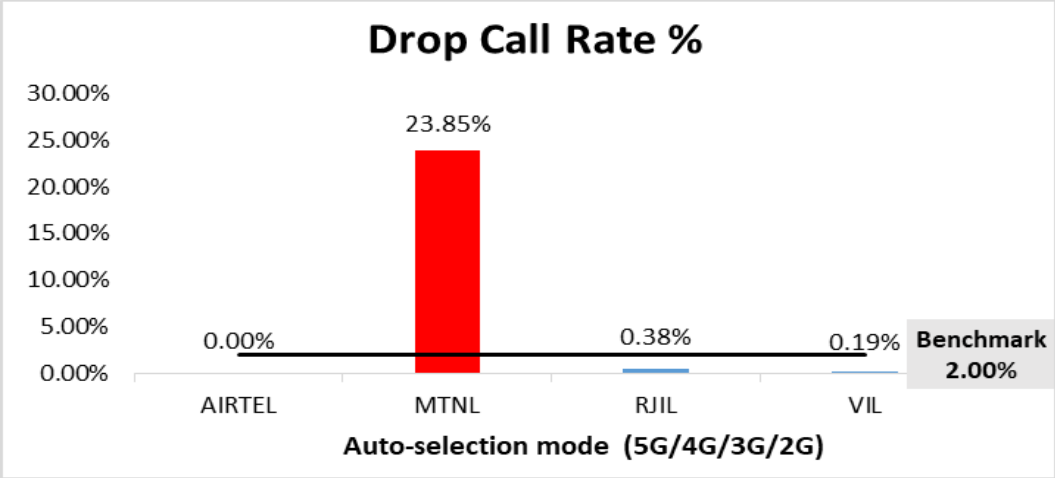

Figure-14: Performance for drop call rate.

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Parameter	Service Provider			
	Mobile-to-Mobile (5G/4G - Open Mode)			
	AIRTEL	MTNL	RJIL	VIL
Call Established (within service provider Network)	509	295	503	496
Number of silence call for >4 Sec	5	NA	2	8
Silence Call Rate %	0.98	NA	0.40	1.61
Number of silence instances for >4 Sec	7	NA	2	8
Number of silence instances for >3 Sec	14	NA	3	14
Number of silence instances for >2 sec	36	NA	11	42
RTP Jitter (4G & 5G) in ms	5.61	NA	13.26	13.44
Packet loss Rate Downlink %	0.95	NA	0.58	0.91
Packet loss Rate Uplink %	0.80	NA	0.69	0.97

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

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

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

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

Speech Quality (MOS) distribution	Service Provider			
	AIRTEL	MTNL	RJIL	VIL
Total Number of MOS Samples for calls in table-16	2882	1165	2904	2878
Speech Quality (Average MOS Score)	3.95	2.56	3.91	4.42
Number of samples with MOS >=4 to <5 (Excellent)	2275	0	2078	2425
Number of samples with MOS >=3 to <4 (Good)	470	384	664	370
Number of samples with MOS >=2 to <3 (Fair)	80	544	114	52
Number of samples with MOS >=1 to <2 (Poor)	57	237	48	31
%age of samples with MOS >=4 to <5 (Excellent)	78.94%	0.00%	71.56%	84.26%
%age of samples with MOS >=3 to <4 (Good)	16.31%	32.96%	22.87%	12.86%
%age of samples with MOS >=2 to <3 (Fair)	2.78%	46.70%	3.93%	1.81%
%age of samples with MOS >=1 to <2 (Poor)	1.98%	20.34%	1.65%	1.08%

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

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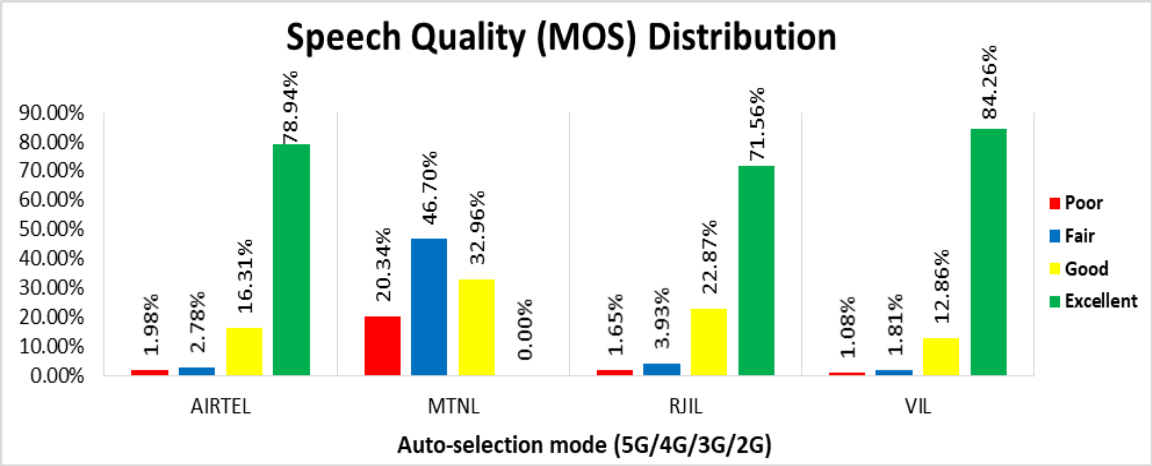

Figure-15: Distribution of samples in MOS score range.

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

Technology	Service Provider			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
5G	15.03%	NA	18.75%	NA
4G	84.97%	0.00%	81.25%	100.00%
3G	NA	62.33%	NA	NA
2G	0.00%	10.49%	NA	0.00%
Limited Service	0.00%	27.18%	0.00%	0.00%

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

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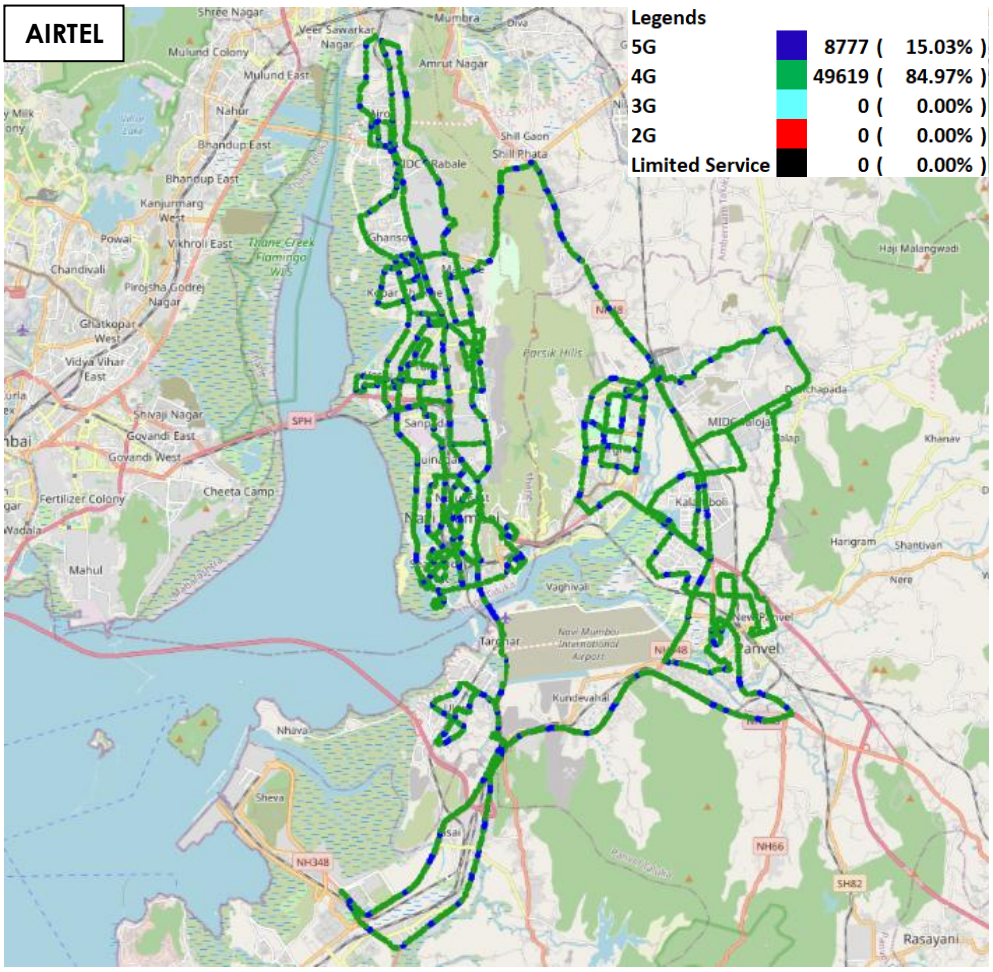

Figure-16: Serving technology plots in auto-selection mode (5G/4G/3G/2G) –AIRTEL.

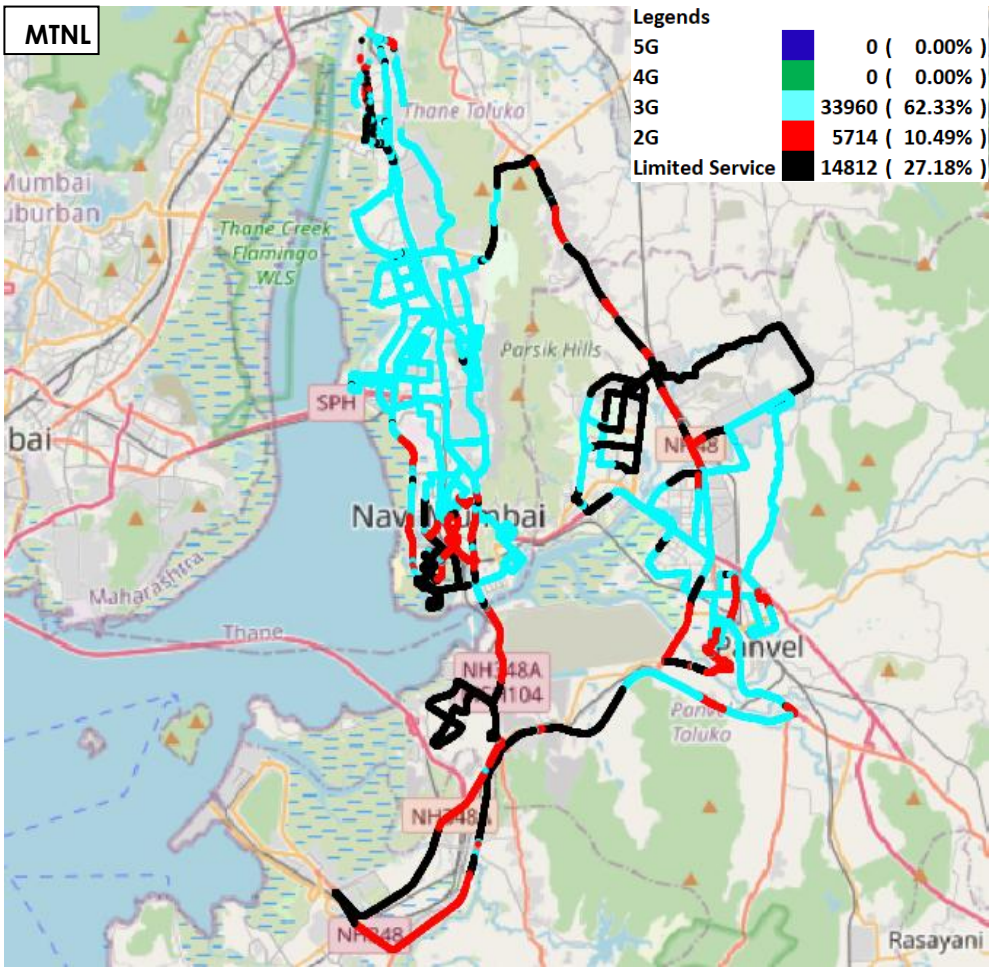

Figure-17: Serving technology plots in auto-selection mode (5G/4G/3G/2G) –MTNL.

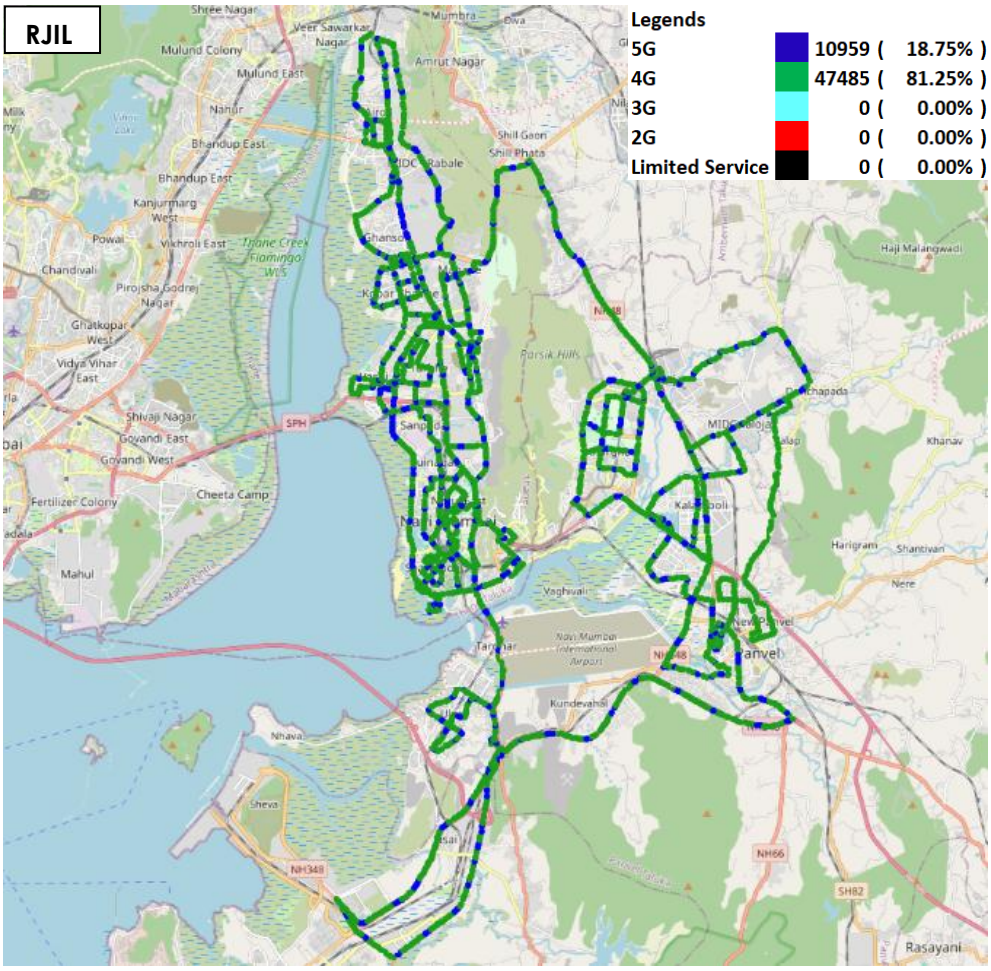

Figure-18: Serving technology plots in auto-selection mode (5G/4G/3G/2G)- RJIL.

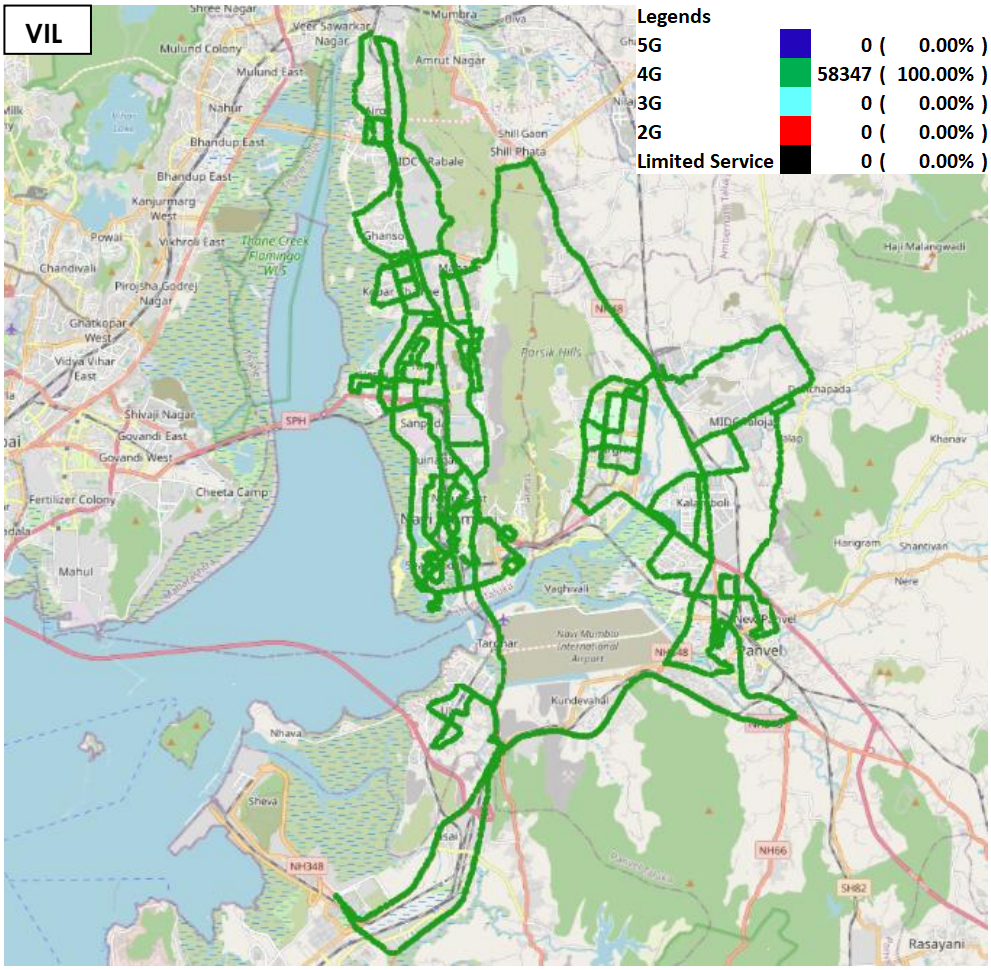

Figure-19: Serving technology plots in auto-selection mode (5G/4G/3G/2G) – VIL.

(g) Network Signal Strength distribution: The following chart provide signal strength distribution for auto-selection mode (5G/4G/3G/2G). (refer figure-58, 59, 60 & 61 for map view)

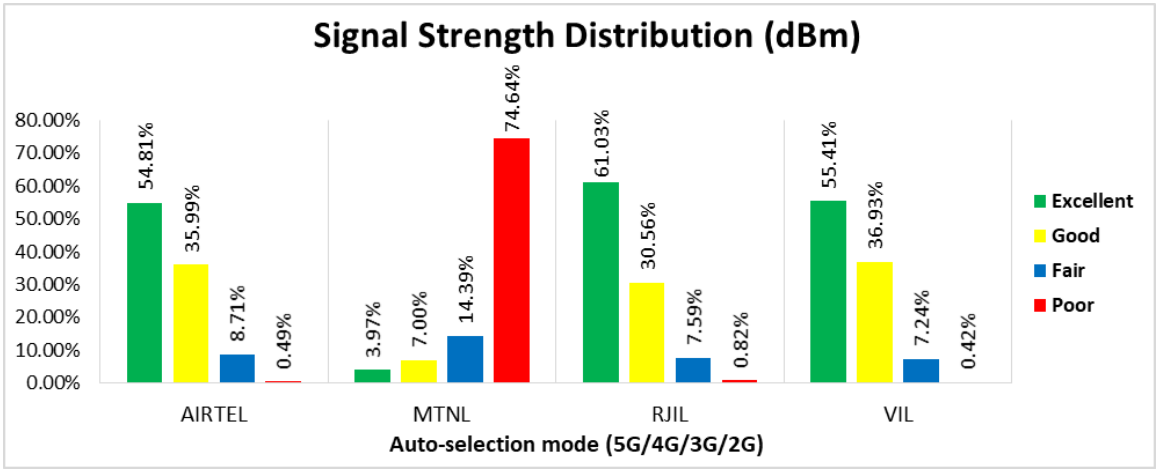

Figure-20: Signal strength distribution auto-selection mode 5G/4G/3G/2G.

Observations:

- Airtel has 55% of samples falling in the excellent signal strength category.
- MTNL has 4% of samples falling in the excellent signal strength category.
- RJIL has 61% of samples falling in the excellent signal strength category.
- VIL has 55% of samples falling in the excellent signal strength category.

4.2.4 Data performance

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

Parameters		Service Provider			
		Auto-selection mode (5G/4G/3G/2G)			
		AIRTEL	MTNL	RJIL	VIL
Download Throughput (Mbits/s)	Average	181.19	0.50	341.01	42.58
	80th Percentile	258.03	0.79	539.62	65.54
	20th Percentile	89.29	0.19	118.19	20.65
Upload Throughput (Mbits/s)	Average	31.56	0.50	45.66	11.57
	80th Percentile	51.79	0.86	70.10	17.11
	20th Percentile	11.78	0.13	20.59	5.84
Latency (ms)	50th Percentile	10.75	111.00	14.65	17.20

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

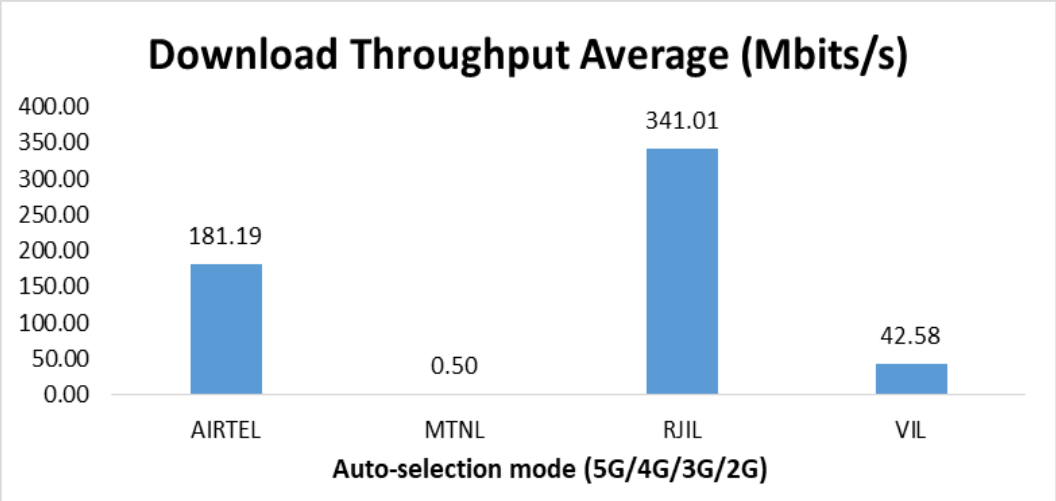

Figure- 21: Download throughput.

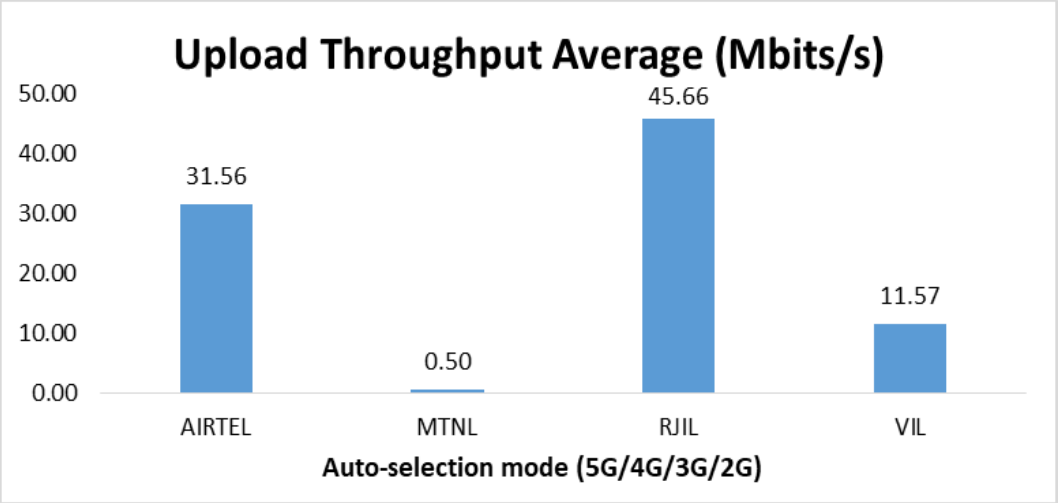

Figure- 22: Upload throughput.

4.3 Hotspots

Hotspot testing has been done on 19th & 20th December 2024. Ten locations have been tested in the city.

4.3.1 Locations

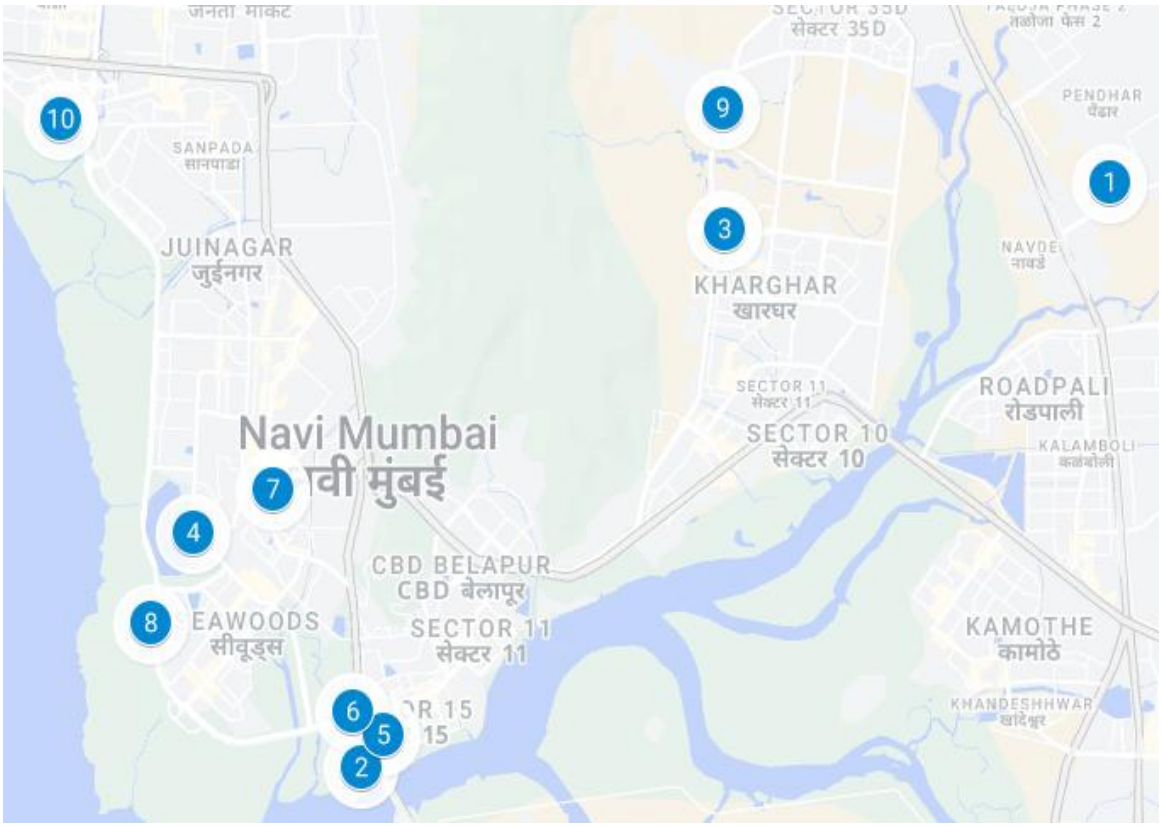

Figure- 23: Hotspot locations

4.3.2 Hotspot covered

1. Aditya Birla Science and Tech
2. Belapur Fort
3. Iskon Kharghar
4. Jewel of Navi Mumbai Park
5. Navi Mumbai District Court
6. Navi Mumbai Municipality Co-operation Head Office
7. Rock Garden Stadium
8. T.S. Chanakya Maritime College
9. Tata Memorial Hospital
10. Vashi Railway Station

4.3.3 Voice performance

Overall Voice Performance				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Call Attempt	100	100	100	100
Call Setup Success Rate %	100.00	29.00	100.00	100.00
Drop Call Rate %	0.00	10.34	0.00	0.00
Call Setup Time-Average (Sec)	1.17	5.63	0.49	0.94

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

Aditya Birla Science and Tech				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	40.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Sec)	1.32	12.06	0.42	0.97

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

Belapur Fort				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	60.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Sec)	1.21	6.80	0.51	0.98

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

Iskon Kharghar				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Sec)	1.06	2.70	0.55	0.84

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

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Jewel Of Navi Mumbai Park				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	0.00	100.00	100.00
Drop Call Rate %	0.00	-	0.00	0.00
Call Setup Time-Average (Sec)	1.16	-	0.51	0.97

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

Navi Mumbai District Court				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	0.00	100.00	100.00
Drop Call Rate %	0.00	-	0.00	0.00
Call Setup Time-Average (Sec)	1.33	-	0.49	0.93

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

Navi Mumbai Municipality Co-operation Head Office				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	0.00	100.00	100.00
Drop Call Rate %	0.00	-	0.00	0.00
Call Setup Time-Average (Sec)	1.18	-	0.50	0.98

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

Rock Garden Stadium				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	10.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Sec)	1.07	2.50	0.49	1.00

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

T.S. Chanakya Maritime College				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	0.00	100.00	100.00
Drop Call Rate %	0.00	-	0.00	0.00
Call Setup Time-Average (Sec)	1.07	-	0.49	0.91

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

Tata Memorial Hospital				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	0.00	100.00	100.00
Drop Call Rate %	0.00	-	0.00	0.00
Call Setup Time-Average (Sec)	1.16	-	0.49	0.89

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

Vashi Railway Station				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Call Attempt	10	10	10	10
Call Setup Success Rate %	100.00	80.00	100.00	100.00
Drop Call Rate %	0.00	37.50	0.00	0.00
Call Setup Time-Average (Sec)	1.19	5.55	0.45	0.93

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

4.3.4 Data performance

Overall Data Performance				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	116.18	0.78	406.11	47.91
Download Throughput 80th Percentile (Mbit/s)	219.62	1.16	705.62	71.51
Download Throughput 20th Percentile (Mbit/s)	27.50	0.34	130.44	24.02
Download Session Setup Success Rate %	94.00	14.00	92.00	100.00
Upload Throughput Average (Mbits/s)	19.98	0.44	48.65	10.90
Upload Throughput 80th Percentile (Mbit/s)	32.58	0.53	63.54	15.89
Upload Throughput 20th Percentile (Mbit/s)	4.50	0.40	31.73	5.60
Upload Session Setup Success Rate %	94.00	12.00	98.00	100.00
Web Browsing Delay (Second)	2.47	5.07	2.05	2.26
Youtube Initial Buffer Delay (Second)	1.03	6.43	0.70	0.72
Latency (ms)-50th Percentile	11.95	43.25	14.45	17.40
Jitter (ms)	7.53	267.12	7.85	7.02
Packet Loss Rate%	0.87	67.12	0.06	0.81

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

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Aditya Birla Science and Tech				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	91.81	NA	668.44	32.84
Download Session Setup Success Rate %	100.00	0.00	100.00	100.00
Upload Throughput Average (Mbits/s)	4.39	NA	76.98	13.97
Upload Session Setup Success Rate %	100.00	0.00	100.00	100.00
Web Browsing Delay (Second)	2.71	NA	1.81	2.13
Youtube Initial Buffer Delay (Second)	0.82	NA	0.72	0.64
Latency (ms)-50th Percentile	13.00	NA	12.40	17.90
Jitter (ms)	16.18	NA	6.41	3.22
Packet Loss Rate%	0.40	NA	0.00	0.40

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

Note-
- NA- All data tests were failed in MTNL.

Belapur Fort				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	340.26	NA	220.57	72.73
Download Session Setup Success Rate %	100.00	0.00	80.00	100.00
Upload Throughput Average (Mbits/s)	28.92	NA	12.53	10.75
Upload Session Setup Success Rate %	100.00	0.00	100.00	100.00
Web Browsing Delay (Second)	2.14	NA	2.12	2.13
Youtube Initial Buffer Delay (Second)	0.50	NA	0.79	0.73
Latency (ms)-50th Percentile	9.00	10314.75	14.48	15.30
Jitter (ms)	3.36	4771.08	6.56	2.39
Packet Loss Rate%	0.00	99.05	0.00	0.40

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

Note-
- NA- MTNL's Download, Upload, Web Browsing and YouTube tests were failed at this location.
- MTNL latency is exceptionally high.

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Iskon Kharghar				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	184.91	1.05	842.75	47.02
Download Session Setup Success Rate %	100.00	100.00	80.00	100.00
Upload Throughput Average (Mbits/s)	21.79	0.53	68.18	16.85
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.29	5.07	2.09	2.14
Youtube Initial Buffer Delay (Second)	0.63	6.14	0.64	0.80
Latency (ms)-50th Percentile	13.80	40.15	14.43	18.65
Jitter (ms)	2.66	39.32	7.05	4.10
Packet Loss Rate%	0.00	10.00	0.00	0.50

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

Jewel Of Navi Mumbai Park				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	24.73	NA	763.77	16.37
Download Session Setup Success Rate %	80.00	0.00	80.00	100.00
Upload Throughput Average (Mbits/s)	2.16	NA	52.86	5.40
Upload Session Setup Success Rate %	80.00	0.00	80.00	100.00
Web Browsing Delay (Second)	3.69	NA	2.06	2.35
Youtube Initial Buffer Delay (Second)	2.80	NA	0.72	0.83
Latency (ms)-50th Percentile	10.55	NA	14.60	16.83
Jitter (ms)	6.59	NA	10.87	4.32
Packet Loss Rate%	0.20	NA	0.10	0.60

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

Note-
- NA- All data tests were failed in MTNL.

Navi Mumbai District Court				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	66.23	NA	507.66	26.44
Download Session Setup Success Rate %	100.00	0.00	100.00	100.00
Upload Throughput Average (Mbits/s)	6.85	NA	51.09	5.82
Upload Session Setup Success Rate %	100.00	0.00	100.00	100.00
Web Browsing Delay (Second)	2.43	NA	2.17	2.47
Youtube Initial Buffer Delay (Second)	0.73	NA	0.63	0.75
Latency (ms)-50th Percentile	12.18	NA	14.60	20.05
Jitter (ms)	4.94	NA	6.85	4.50
Packet Loss Rate%	0.00	NA	0.00	1.00

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

Note-
- NA- All data tests were failed in MTNL.

Navi Mumbai Municipality Co-operation Head Office				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	245.44	NA	353.08	62.03
Download Session Setup Success Rate %	100.00	0.00	80.00	100.00
Upload Throughput Average (Mbits/s)	61.16	NA	53.59	8.57
Upload Session Setup Success Rate %	100.00	0.00	100.00	100.00
Web Browsing Delay (Second)	2.06	NA	2.16	2.67
Youtube Initial Buffer Delay (Second)	0.55	NA	0.70	0.65
Latency (ms)-50th Percentile	9.50	NA	14.85	23.83
Jitter (ms)	4.21	NA	10.70	24.94
Packet Loss Rate%	0.00	NA	0.40	2.20

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

Note-
- NA- All data tests were failed in MTNL.

Rock Garden Stadium				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	38.63	NA	50.45	36.35
Download Session Setup Success Rate %	100.00	0.00	100.00	100.00
Upload Throughput Average (Mbits/s)	15.05	NA	24.61	7.25
Upload Session Setup Success Rate %	100.00	0.00	100.00	100.00
Web Browsing Delay (Second)	2.15	NA	2.07	2.41
Youtube Initial Buffer Delay (Second)	0.78	NA	0.65	0.70
Latency (ms)-50th Percentile	16.53	NA	15.25	15.25
Jitter (ms)	11.45	NA	7.00	4.22
Packet Loss Rate%	0.70	NA	0.00	0.70

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

Note-
- NA- All data tests were failed in MTNL.

T.S. Chanakya Maritime College				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	71.21	NA	129.16	92.02
Download Session Setup Success Rate %	100.00	0.00	100.00	100.00
Upload Throughput Average (Mbits/s)	40.36	NA	39.16	22.24
Upload Session Setup Success Rate %	100.00	0.00	100.00	100.00
Web Browsing Delay (Second)	2.20	NA	2.16	2.23
Youtube Initial Buffer Delay (Second)	2.67	NA	0.67	0.63
Latency (ms)-50th Percentile	9.85	NA	15.50	18.20
Jitter (ms)	2.61	NA	6.45	2.85
Packet Loss Rate%	0.30	NA	0.00	0.40

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

Note-
- NA- All data tests were failed in MTNL.

Tata Memorial Hospital				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	31.51	NA	457.02	60.56
Download Session Setup Success Rate %	100.00	0.00	100.00	100.00
Upload Throughput Average (Mbits/s)	6.89	NA	62.41	16.51
Upload Session Setup Success Rate %	100.00	0.00	100.00	100.00
Web Browsing Delay (Second)	2.72	NA	1.83	1.92
Youtube Initial Buffer Delay (Second)	0.98	NA	0.61	0.69
Latency (ms)-50th Percentile	14.70	NA	14.78	18.10
Jitter (ms)	6.62	NA	7.30	3.50
Packet Loss Rate%	0.20	NA	0.00	0.80

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

Note-
- NA- All data tests were failed in MTNL.

Vashi Railway Station				
Parameters	**Service Provider**			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	3.94	0.11	179.37	32.79
Download Session Setup Success Rate %	60.00	40.00	100.00	100.00
Upload Throughput Average (Mbits/s)	1.21	0.00	45.88	1.68
Upload Session Setup Success Rate %	60.00	20.00	100.00	100.00
Web Browsing Delay (Second)	5.07	NA	2.06	2.13
Youtube Initial Buffer Delay (Second)	NA	7.89	0.87	0.78
Latency (ms)-50th Percentile	14.30	780.00	13.95	15.40
Jitter (ms)	16.70	783.65	9.31	16.19
Packet Loss Rate%	6.90	92.30	0.10	1.10

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

Note-
- MTNL latency is exceptionally high.
- MTNL all Web Browsing tests were failed.
- Airtel all YouTube tests were failed.

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4.4 Walk Test

Walk test has been conducted from 18th to 20th December 2024. Four locations have been tested in the city.

4.4.1 Walk test location map

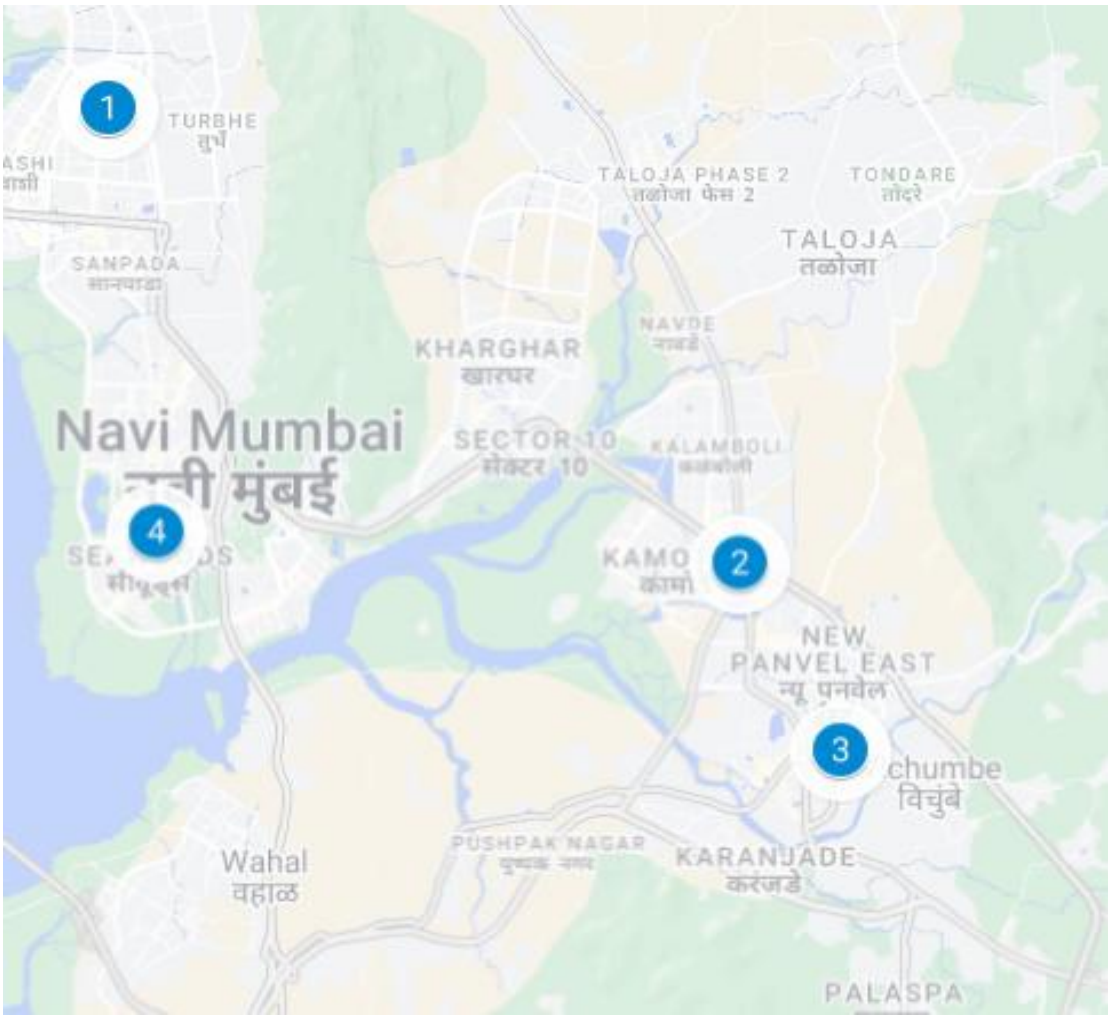

Figure- 24: Walk Test locations.

4.4.2 Walk Test covered

1. Dana Market
2. MGM Hospital
3. Panvel Station
4. Seawoods Grand Central Mall

4.4.3 Voice performance

Dana Market				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Call Attempt	27	31	27	27
Call Setup Success Rate %	96.30	74.19	100.00	96.30
Drop Call Rate %	0.00	8.70	0.00	0.00
Call Setup Time-Average (Second)	1.97	4.45	0.71	0.95

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

MGM Hospital				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Call Attempt	23	35	24	23
Call Setup Success Rate %	100.00	25.71	100.00	100.00
Drop Call Rate %	0.00	33.33	0.00	0.00
Call Setup Time-Average (Second)	1.12	9.93	0.47	0.92

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

Panvel Station				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Call Attempt	27	26	27	27
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Second)	1.17	5.41	0.47	0.90

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

Seawoods Grand Central Mall				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Call Attempt	32	51	33	34
Call Setup Success Rate %	100.00	0.00	100.00	94.12
Drop Call Rate %	0.00	-	0.00	0.00
Call Setup Time-Average (Second)	1.14	-	0.69	1.02

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

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4.4.4 Data performance

Dana Market				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	223.61	0.57	410.45	30.17
Download Session Setup Success Rate %	100.00	74.07	58.62	59.26
Upload Throughput Average (Mbits/s)	35.31	0.36	73.36	14.55
Upload Session Setup Success Rate %	100.00	70.37	89.29	57.69
Latency (ms)-50th Percentile	10.00	149.00	14.33	15.35

Table-46: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

MGM Hospital				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	115.98	0.14	162.30	25.71
Download Session Setup Success Rate %	100.00	17.14	53.85	100.00
Upload Throughput Average (Mbits/s)	32.85	0.15	24.95	5.90
Upload Session Setup Success Rate %	100.00	14.29	88.46	100.00
Latency (ms)-50th Percentile	13.30	251.00	13.85	17.95

Table-47: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

Panvel Station				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	147.66	0.82	301.44	58.36
Download Session Setup Success Rate %	100.00	40.00	50.00	100.00
Upload Throughput Average (Mbits/s)	44.32	0.34	69.27	15.05
Upload Session Setup Success Rate %	100.00	36.67	85.71	100.00
Latency (ms)-50th Percentile	11.05	85.50	13.60	17.85

Table-48: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

Seawoods Grand Central Mall				
Parameters	**Service Provider**			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
Download Throughput Average (Mbits/s)	43.62	NA	80.74	36.64
Download Session Setup Success Rate %	100.00	0.00	57.14	100.00
Upload Throughput Average (Mbits/s)	8.69	NA	11.53	9.54
Upload Session Setup Success Rate %	100.00	0.00	88.57	100.00
Latency (ms)-50th Percentile	27.50	NA	19.50	16.00

Table-49: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

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Note-
- NA- All data tests were failed in MTNL.

4.5 Railways

Drive test has been conducted on 18th December 2024 covering one railway route. (refer table-1)

4.5.1 Drive test route

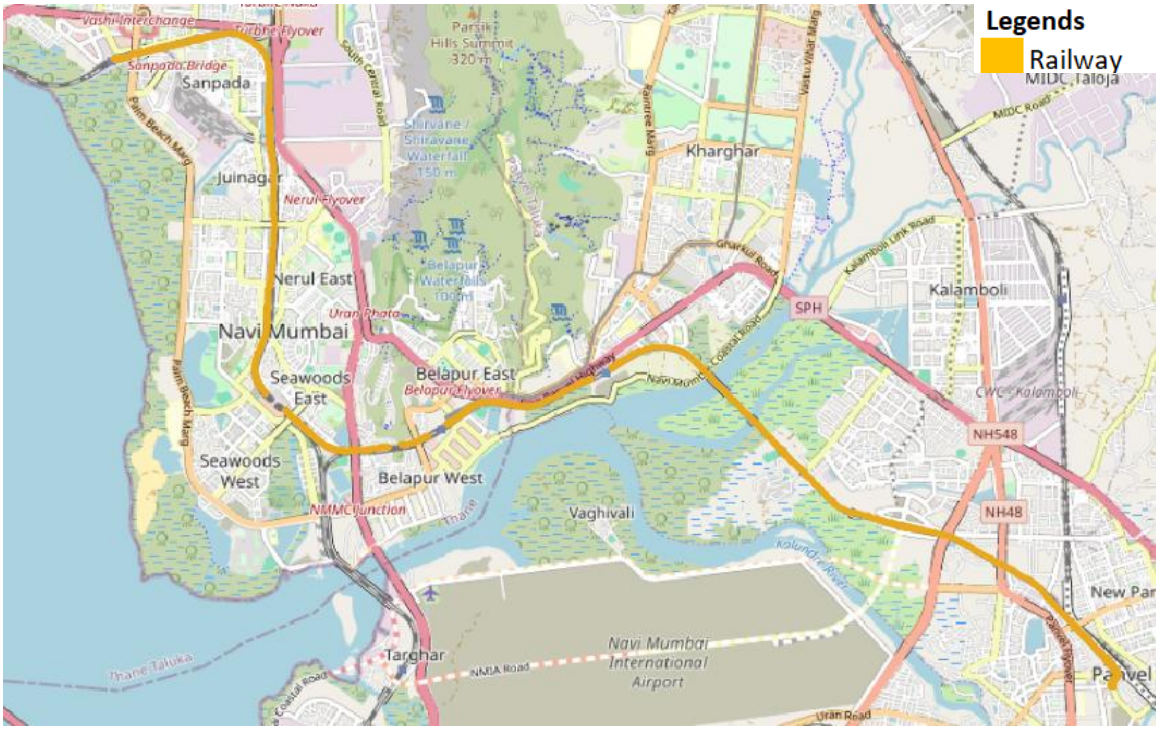

Figure-25: Drive test railway route

4.5.2 Route Covered

- Panvel to Vashi.

4.5.3 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	MTNL	RJIL	VIL
Call Attempts	27	58	28	28
Call Setup Success Rate %	100.00	34.48	100.00	100.00
Drop Call Rate %	0.00	25.00	0.00	0.00
Call Setup Time-Average (Second)	2.55	4.48	0.92	1.14
Handover Success Rate %	100.00	100.00	100.00	100.00

Table-50: Summary of voice call performance in network auto-selection mode

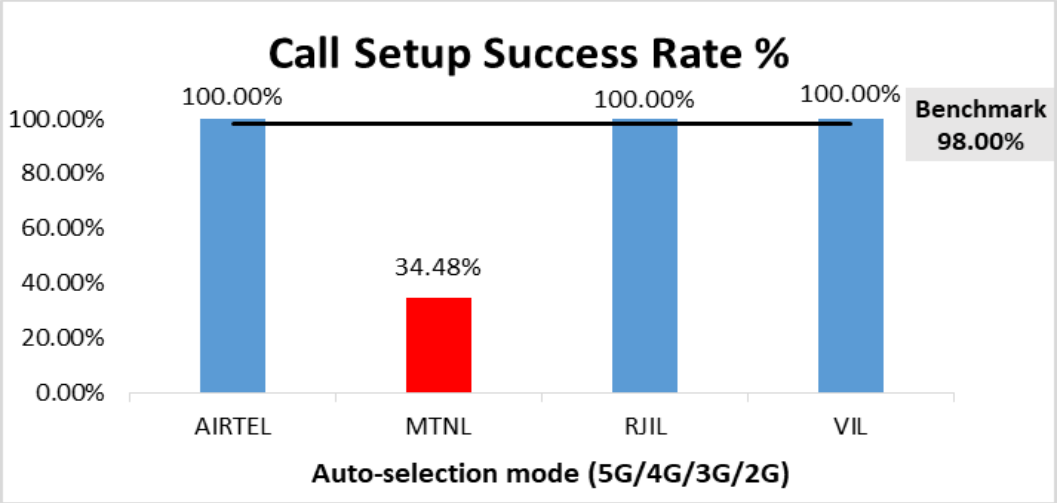

Figure-26: Performance for call setup success rate

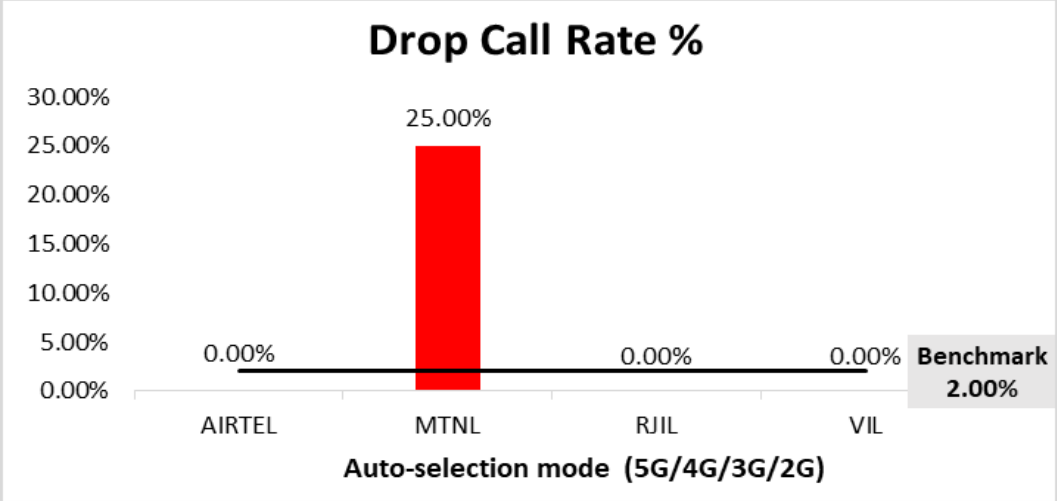

Figure-27: Performance for drop call rate

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

Technology	Service Provider			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
5G	0.06%	NA	15.17%	NA
4G	99.94%	NA	84.60%	100.00%
3G	NA	77.61%	NA	NA
2G	0.00%	10.60%	NA	0.00%
Limited Service	0.00%	11.79%	0.22%	0.00%

Table-51: Time spent on technology during drive test

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

File No. RP-4/18/4(1)/2024-RO_BGLR (Computer No. 14209)
Generated from eOffice by VIRENDRA SINGH RAJPUT , SRO (VSR) - QoS-I, SENIOR RESEARCH OFFICER, TRAI on 27/02/2025 03:37 pm

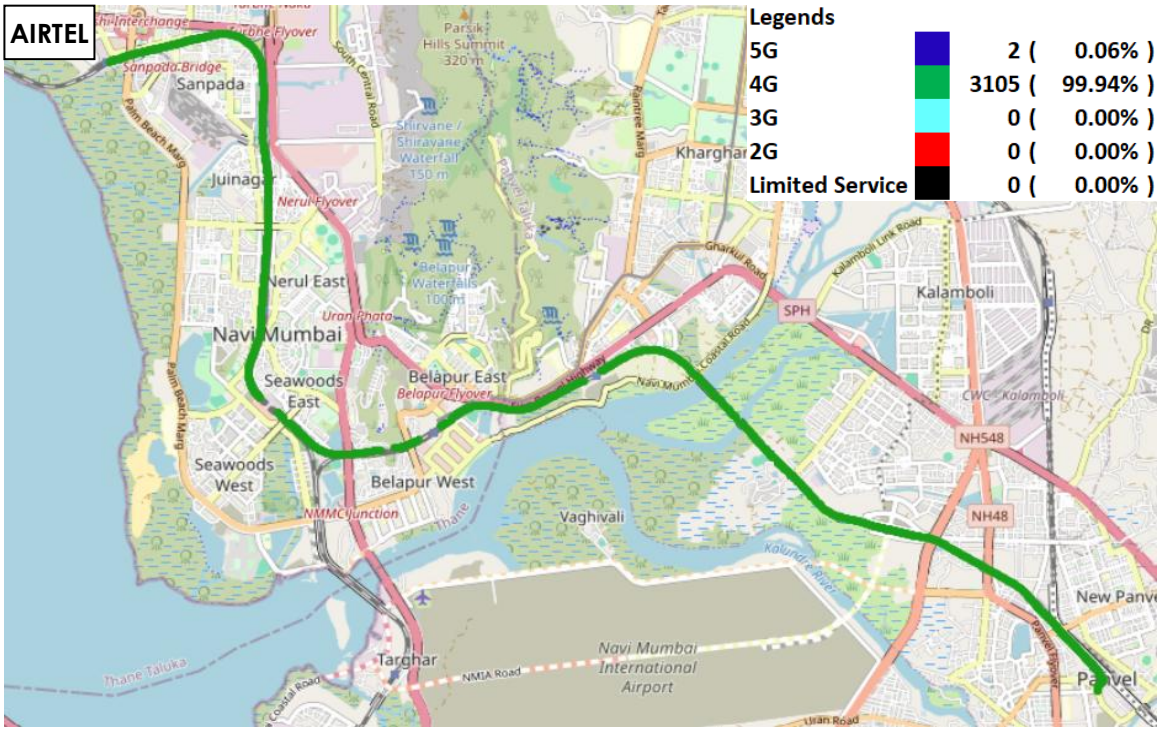

Figure-28: Serving technology plots auto-selection mode 5G/4G/3G/2G –AIRTEL.

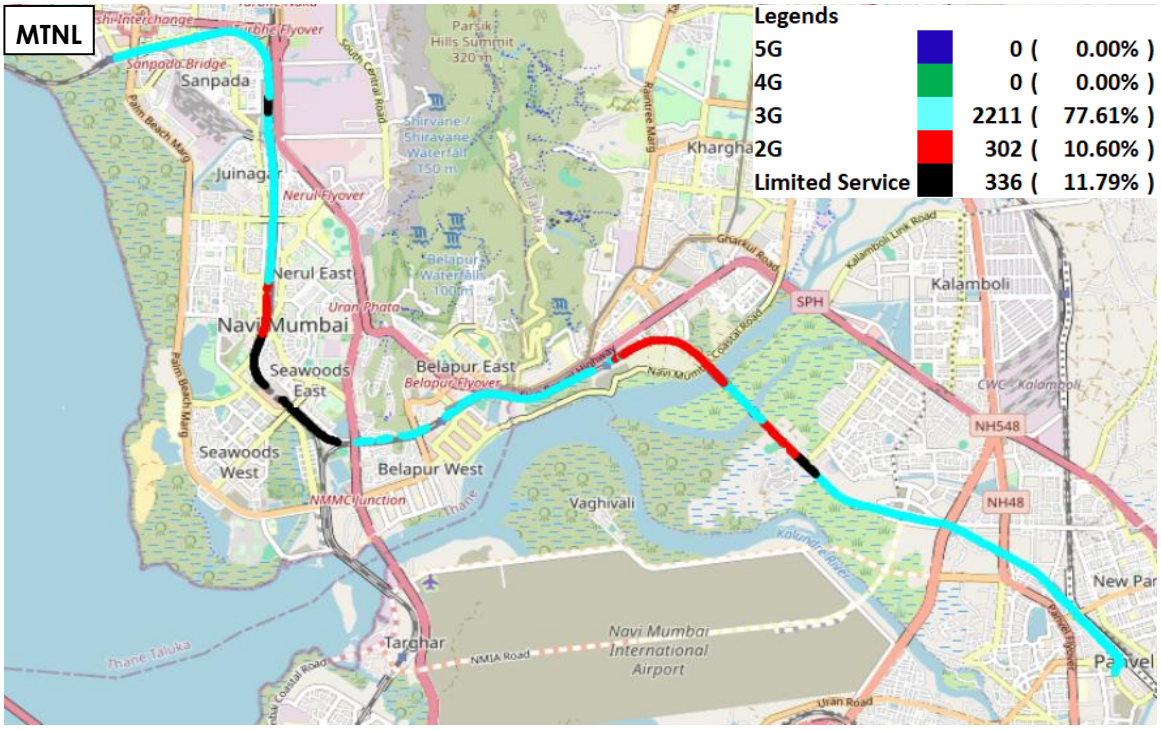

Figure-29: Serving technology plots auto-selection mode 5G/4G/3G/2G –MTNL.

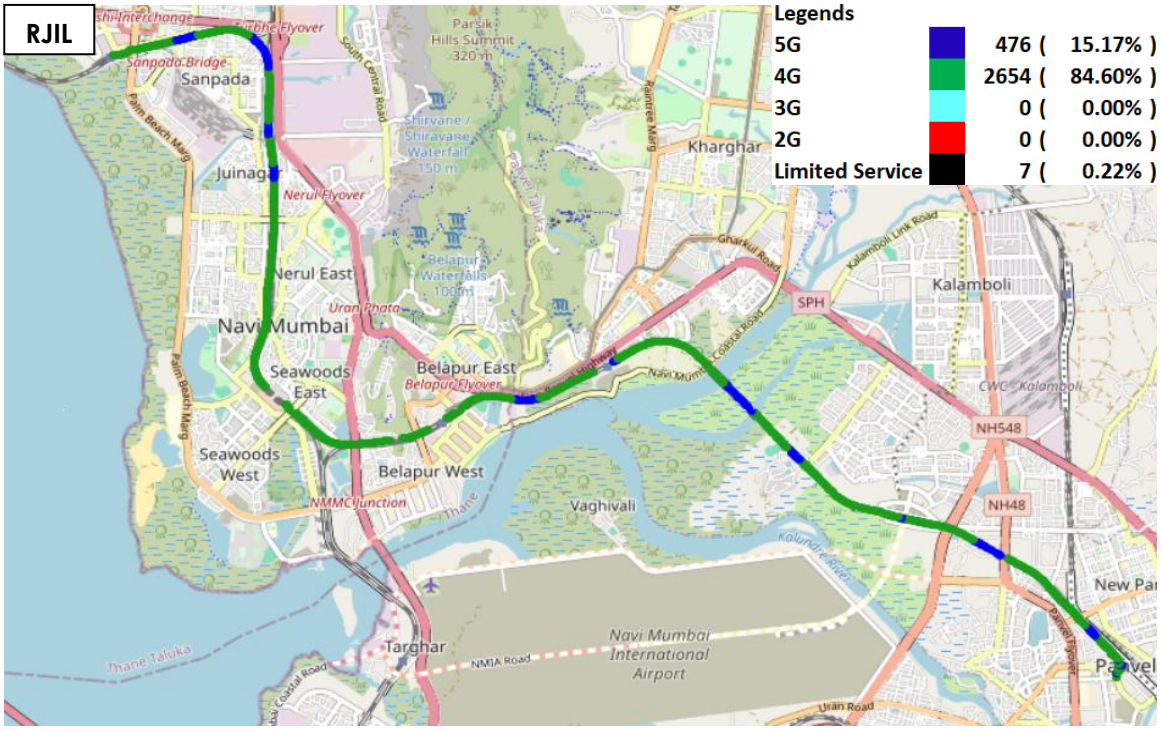

Figure-30: Serving technology plots auto-selection mode 5G/4G/3G/2G –RJIL.

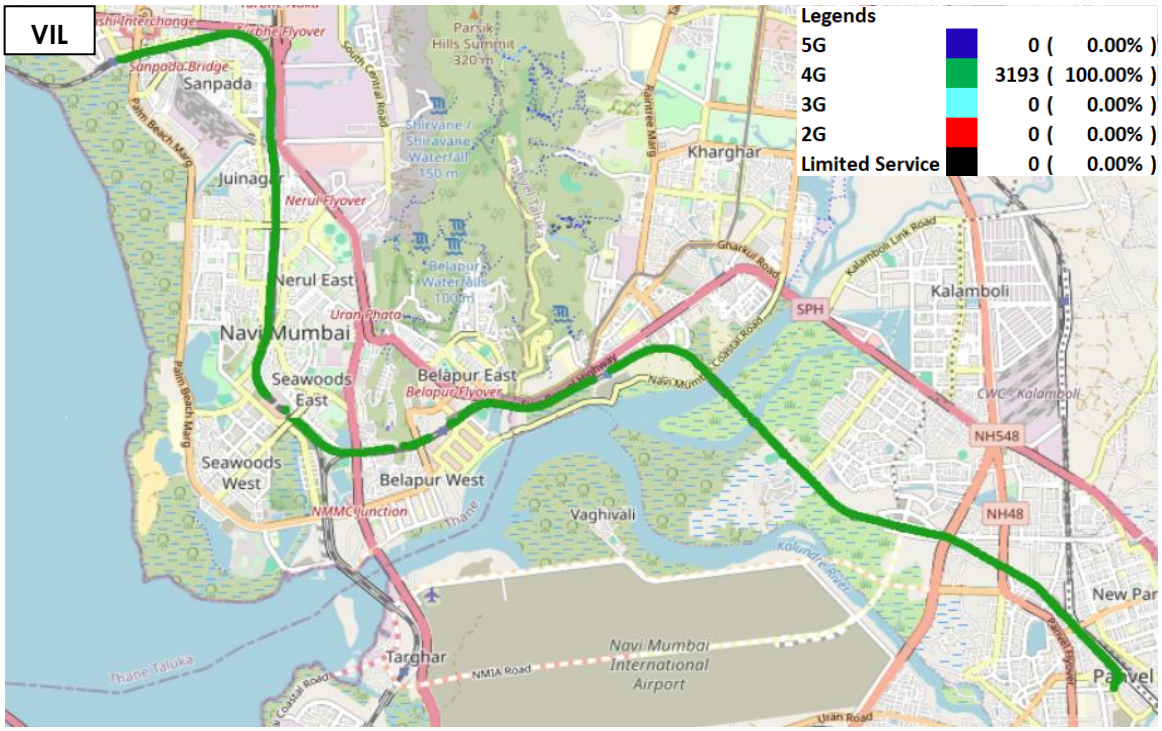

Figure-31: Serving technology plots auto-selection mode 5G/4G/3G/2G – VIL.

(c) Network Signal Strength distribution: The following chart provide signal strength distribution for auto-selection mode (5G/4G/3G/2G) (refer figure-62, 63, 64 & 65 for map view)

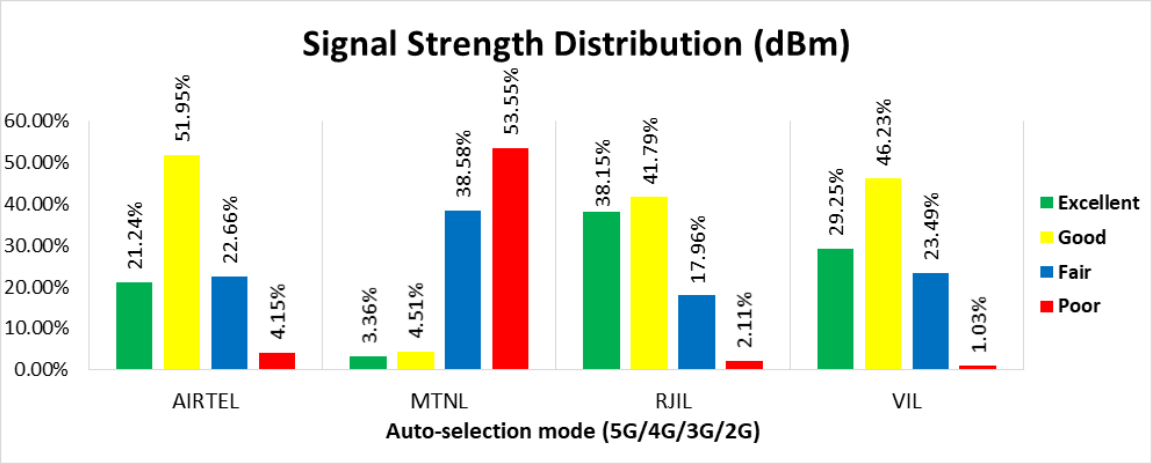

Figure-32: Signal strength distribution for auto-selection mode 5G/4G/3G/2G

4.5.4 Data performance

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

Parameters		Service Provider			
		Auto-selection mode (5G/4G/3G/2G)			
		AIRTEL	MTNL	RJIL	VIL
Download Throughput (Mbits/s)	Average	75.20	0.79	165.37	31.93
	80th Percentile	115.90	1.09	320.88	54.13
	20th Percentile	20.80	0.48	25.63	7.72
Upload Throughput (Mbits/s)	Average	22.22	0.51	35.51	9.11
	80th Percentile	37.87	0.67	59.58	14.55
	20th Percentile	5.90	0.35	2.69	1.64
Latency (ms)	50th Percentile	14.25	157.50	17.35	19.18

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

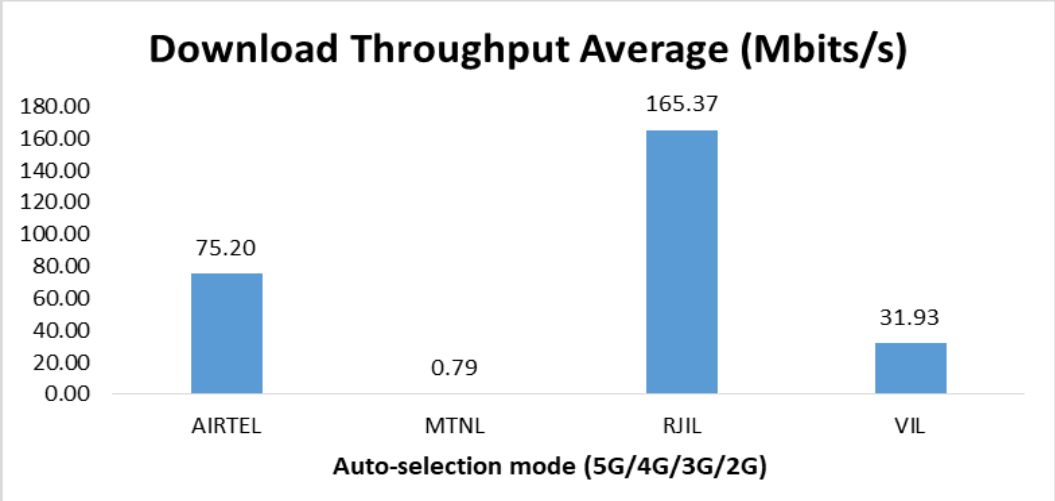

Figure-33: Download throughput

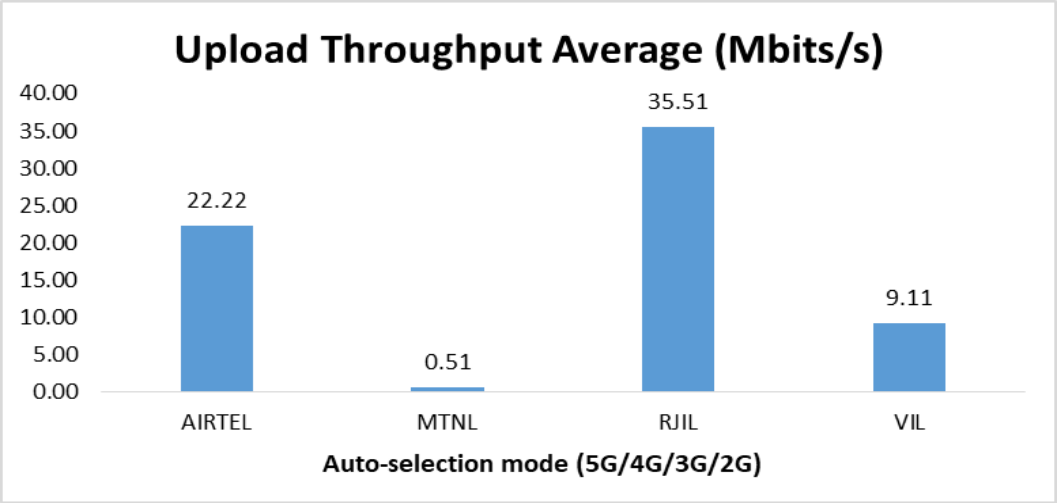

Figure-34: Upload throughput

4.6 Metro

Drive test has been conducted on 18th December 2024 covering one metro route. (refer table-1)

4.6.1 Drive test route

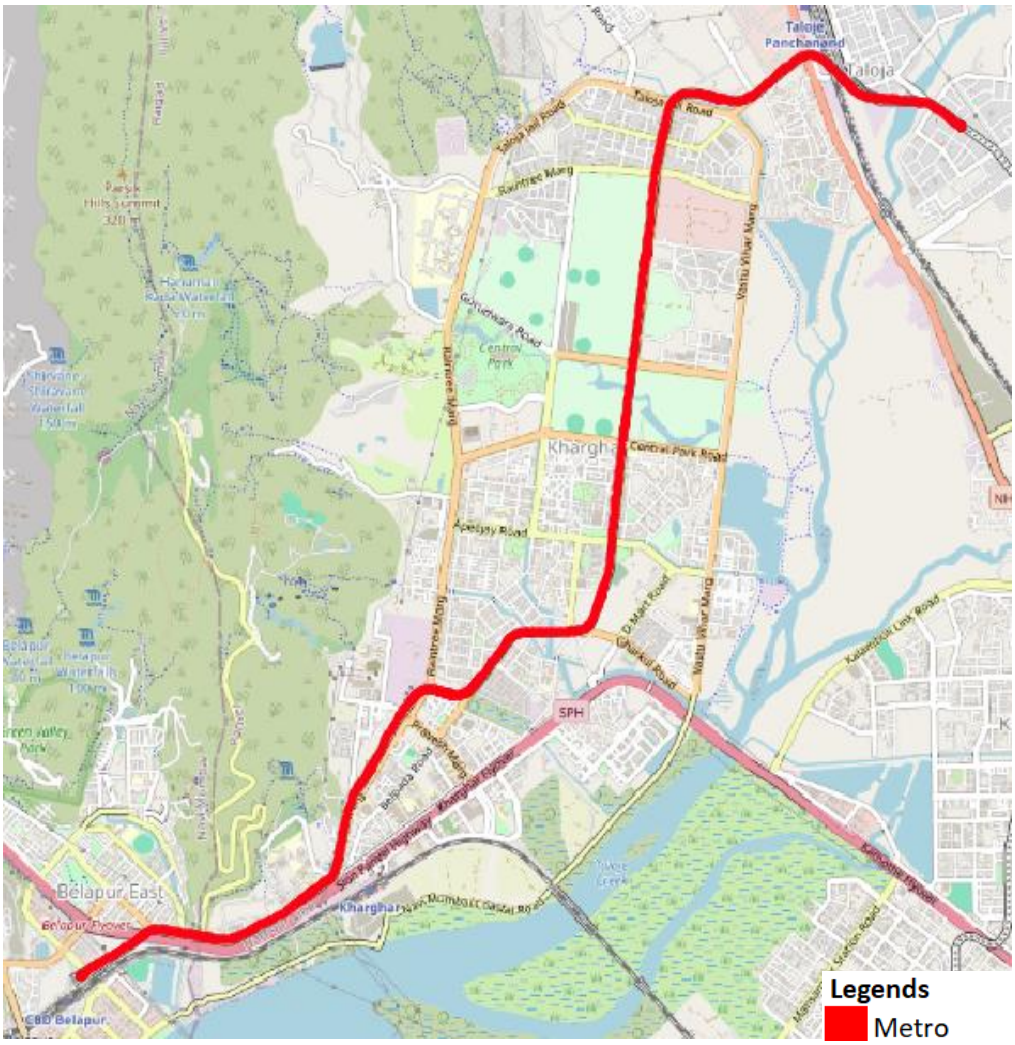

Figure-35: Drive test metro route

4.6.2 Route Covered

- Belapur to Pendhar.

4.6.3 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	MTNL	RJIL	VIL
Call Attempts	16	45	16	16
Call Setup Success Rate %	100.00	24.44	100.00	100.00
Drop Call Rate %	0.00	18.18	0.00	0.00
Call Setup Time-Average (Second)	1.17	7.39	0.51	0.92
Handover Success Rate %	100.00	100.00	100.00	100.00

Table-53: Summary of voice call performance in network auto-selection mode

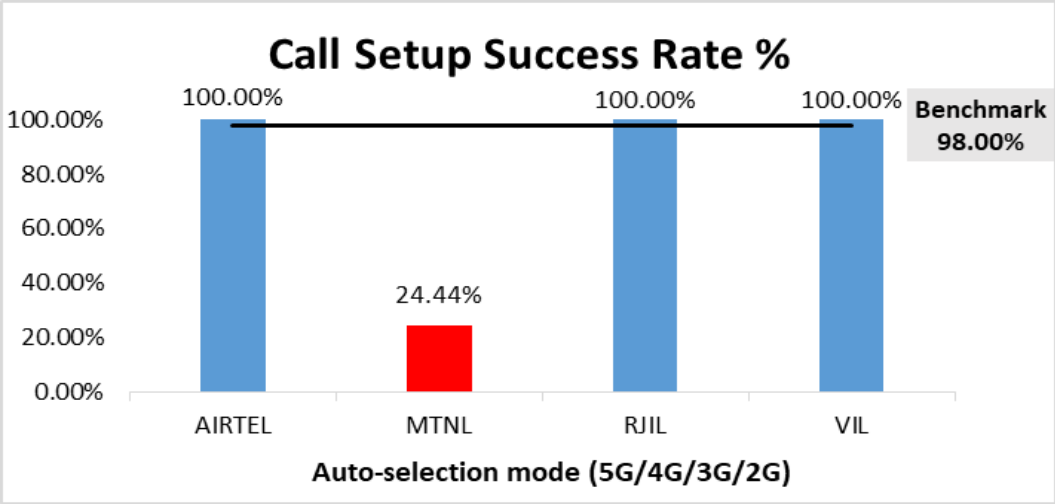

Figure-36: Performance for call setup success rate

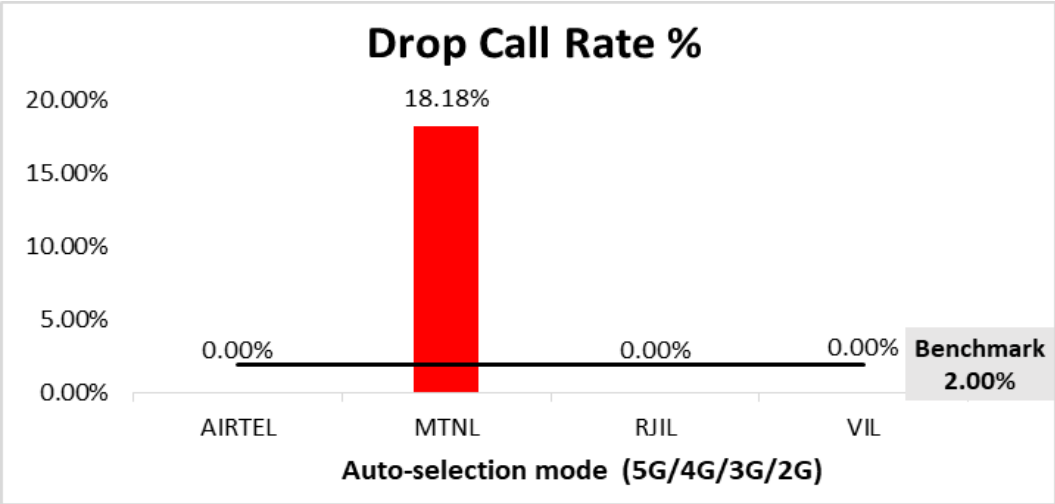

Figure-37: Performance for drop call rate

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

Technology	Service Provider			
	AIRTEL	MTNL	RJIL	VIL
5G	0.00%	NA	19.29%	NA
4G	100.00%	NA	80.71%	100.00%
3G	NA	34.28%	NA	NA
2G	0.00%	39.17%	NA	0.00%
Limited Service	0.00%	26.55%	0.00%	0.00%

Table-54: Time spent on technology during drive test

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

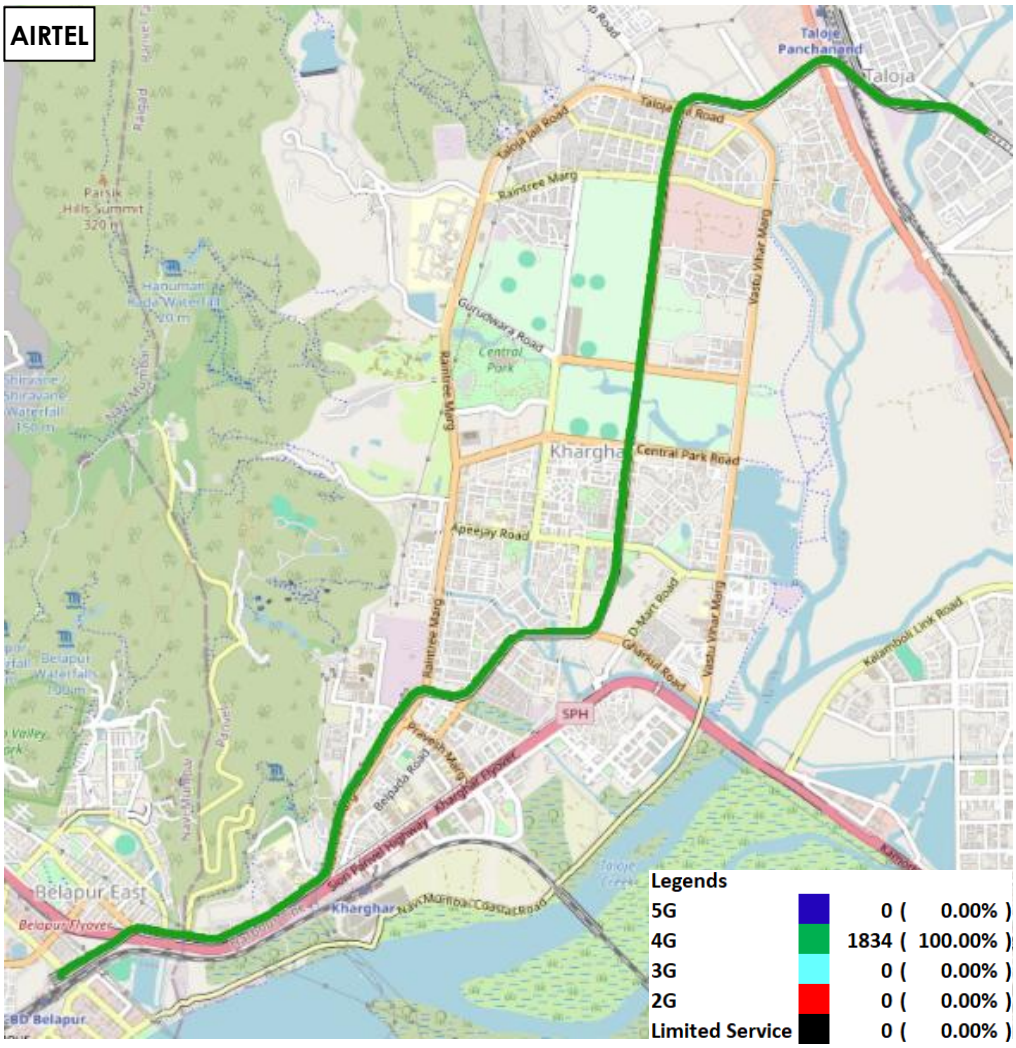

Figure-38: Serving technology plots auto-selection mode 5G/4G/3G/2G –AIRTEL.

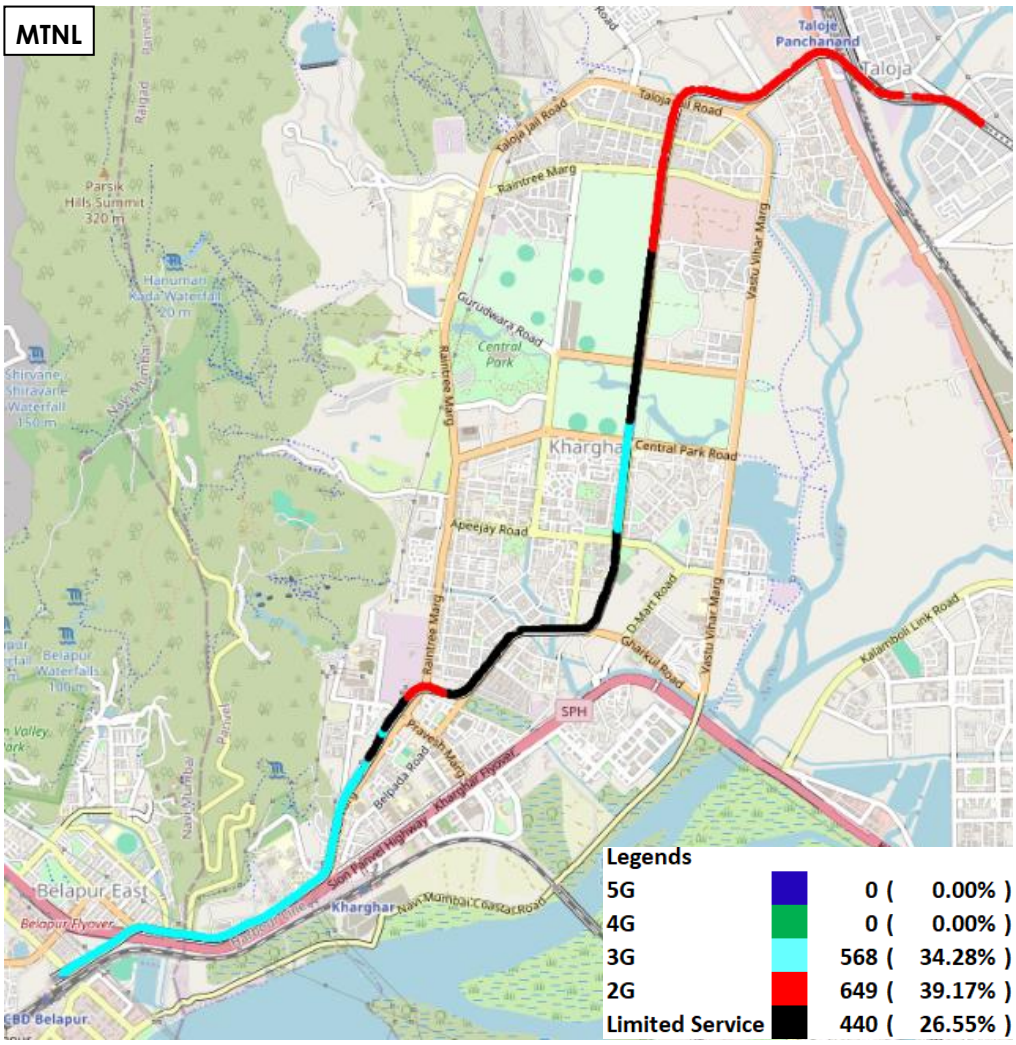

Figure-39: Serving technology plots auto-selection mode 5G/4G/3G/2G –MTNL.

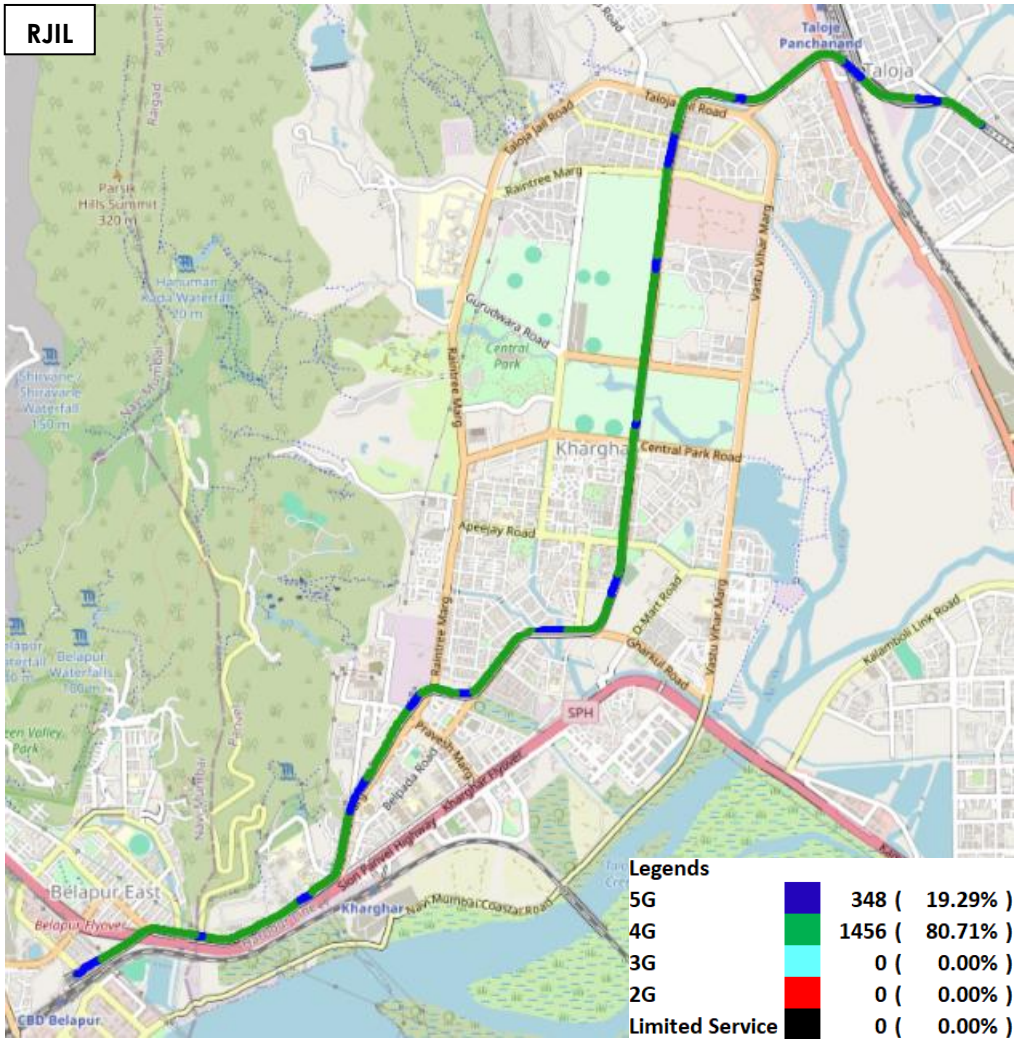

Figure-40: Serving technology plots auto-selection mode 5G/4G/3G/2G –RJIL.

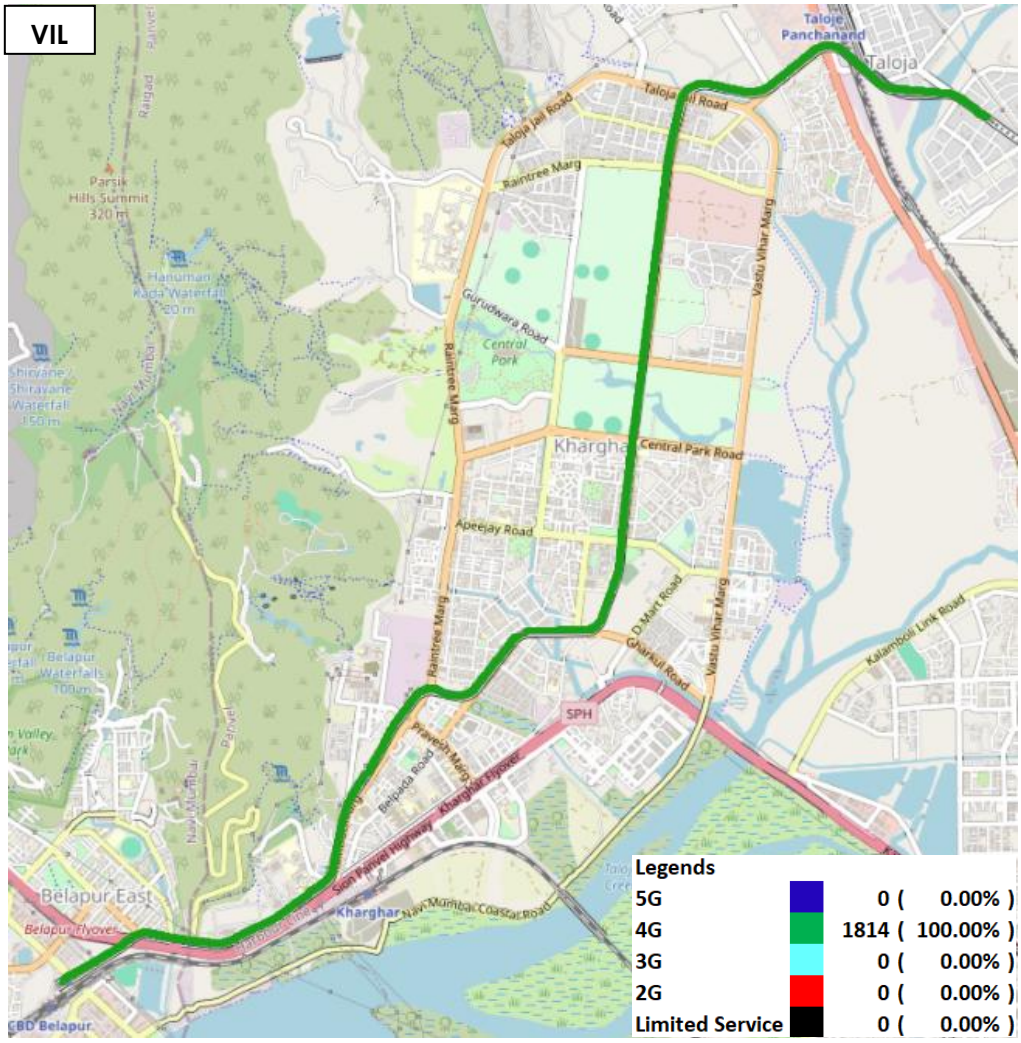

Figure-41: Serving technology plots auto-selection mode 5G/4G/3G/2G – VIL.

(c) Network Signal Strength distribution: The following chart provide signal strength distribution for auto-selection mode (5G/4G/3G/2G) (refer figure-66, 67, 68 & 69 for map view)

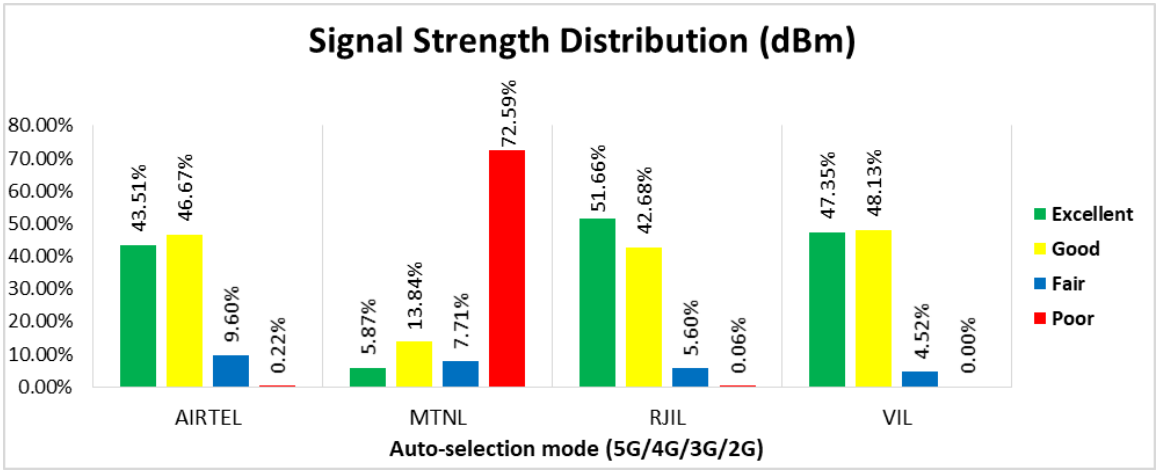

Figure-42: Signal strength distribution for auto-selection mode 5G/4G/3G/2G

4.6.4 Data performance

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

Parameters		Service Provider			
		Auto-selection mode (5G/4G/3G/2G)			
		AIRTEL	MTNL	RJIL	VIL
Download Throughput (Mbits/s)	Average	148.06	0.33	352.79	32.61
	80th Percentile	222.62	0.41	560.50	48.36
	20th Percentile	80.90	0.24	149.86	15.99
Upload Throughput (Mbits/s)	Average	33.99	0.27	38.71	12.92
	80th Percentile	55.81	0.39	67.36	18.82
	20th Percentile	16.86	0.11	16.23	9.06
Latency (ms)	50th Percentile	11.30	72.25	13.90	17.75

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

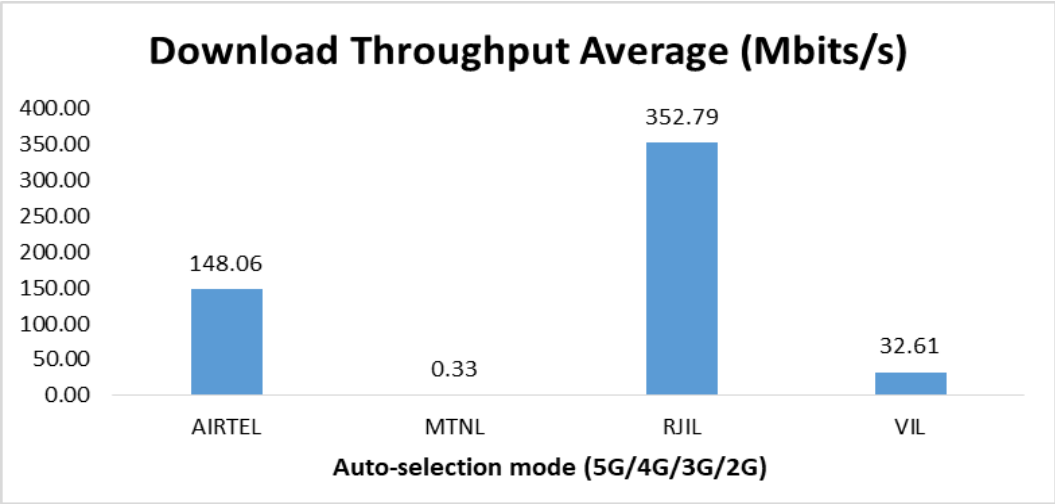

Figure-43: Download throughput

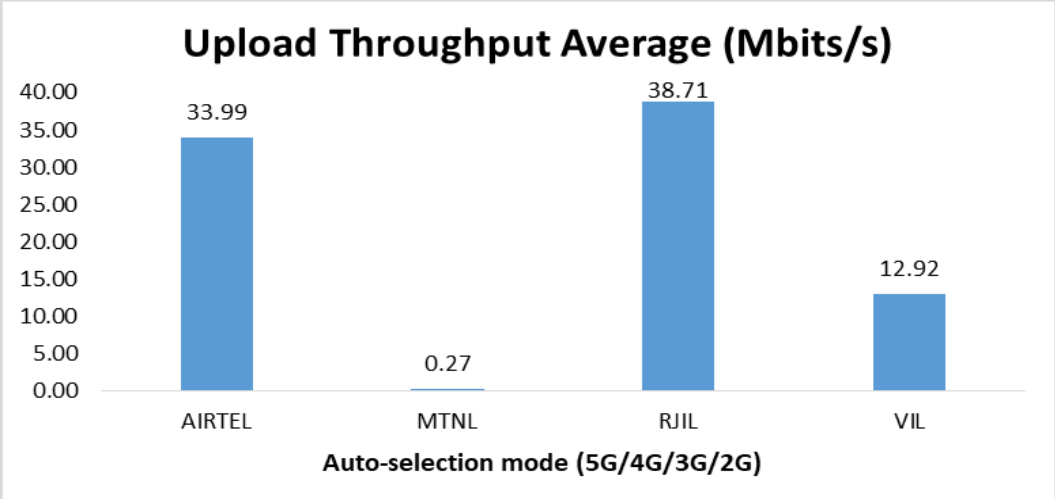

Figure-44: Upload throughput

4.7 Coastal

Drive test has been conducted on 18th December 2024 covering one coastal area. (refer table-1)

4.7.1 Drive test route

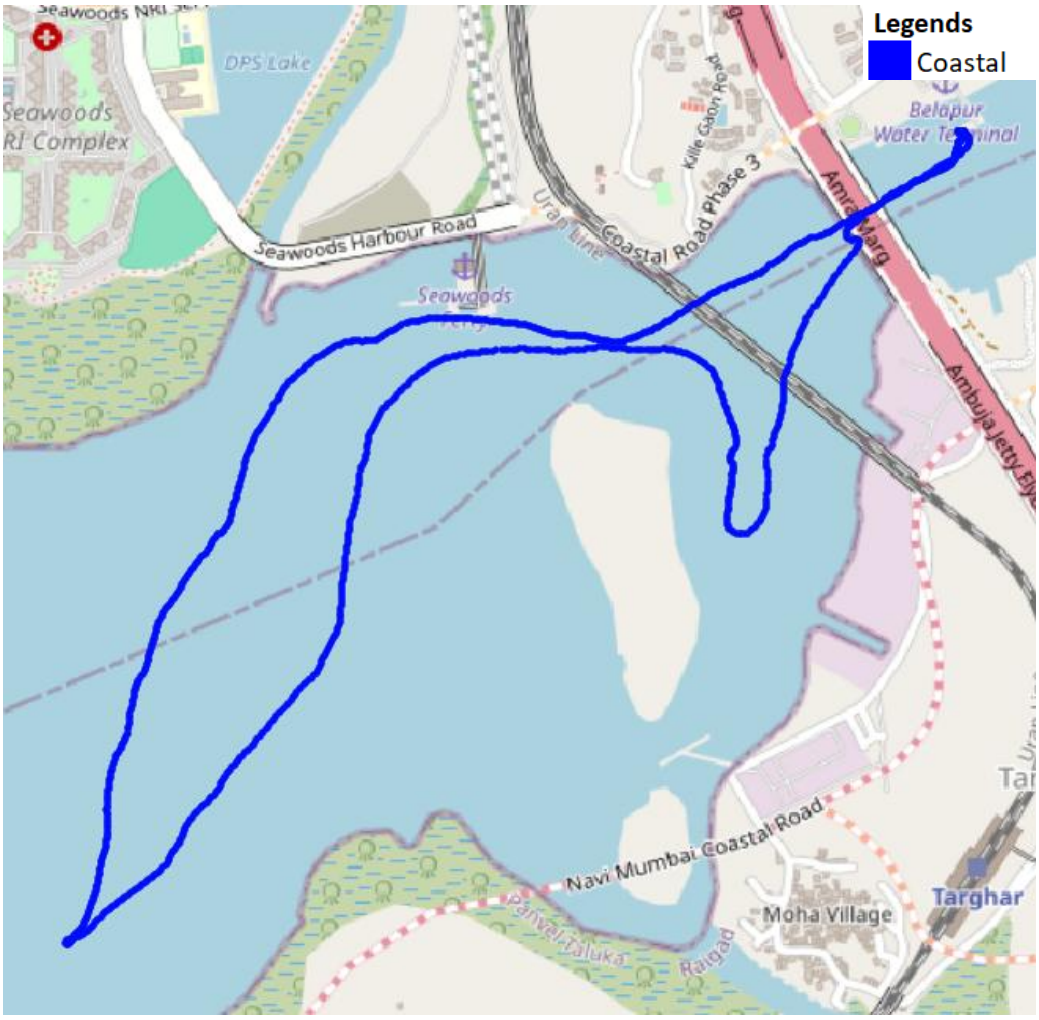

Figure-45: Drive test route

4.7.2 Route Covered

- JNPT Belapur area towards Vashi.

4.7.3 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	MTNL	RJIL	VIL
Call Attempts	24	52	25	25
Call Setup Success Rate %	100.00	28.85	100.00	100.00
Drop Call Rate %	0.00	33.33	0.00	0.00
Call Setup Time-Average (Second)	1.48	6.36	1.07	1.13
Handover Success Rate %	100.00	100.00	99.68	100.00

Table-56: Summary of voice call performance in network auto-selection mode

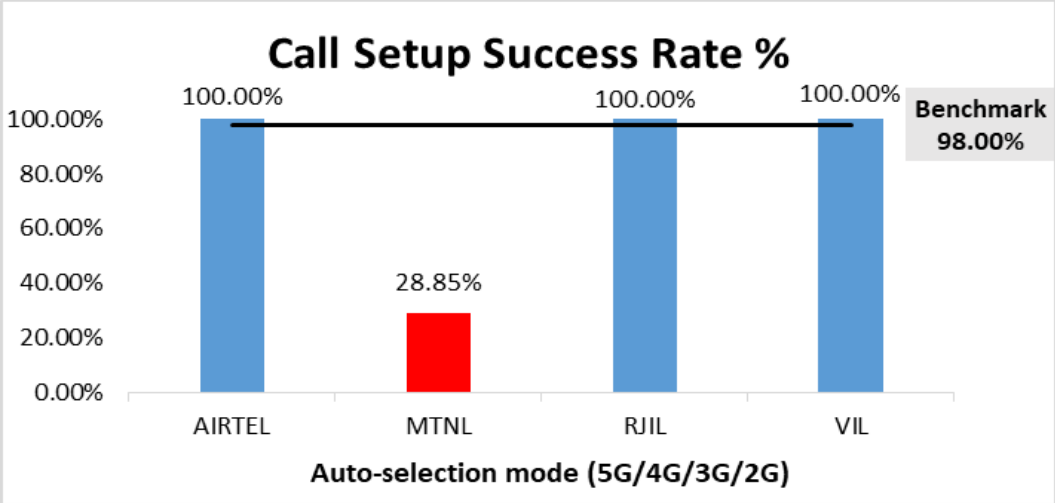

Figure-46: Performance for call setup success rate.

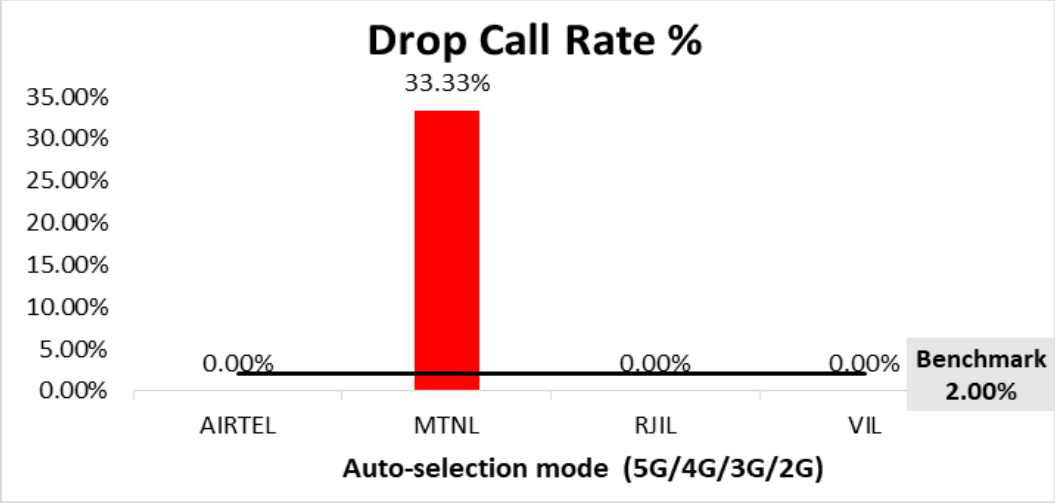

Figure-47: Performance for drop call rate.

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

Technology	Service Provider			
	AIRTEL	**MTNL**	**RJIL**	**VIL**
5G	0.14%	NA	17.24%	NA
4G	99.86%	NA	82.62%	100.00%
3G	NA	35.77%	NA	NA
2G	0.00%	39.12%	NA	0.00%
Limited Service	0.00%	25.11%	0.14%	0.00%

Table-57: Time spent on technology during drive test

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

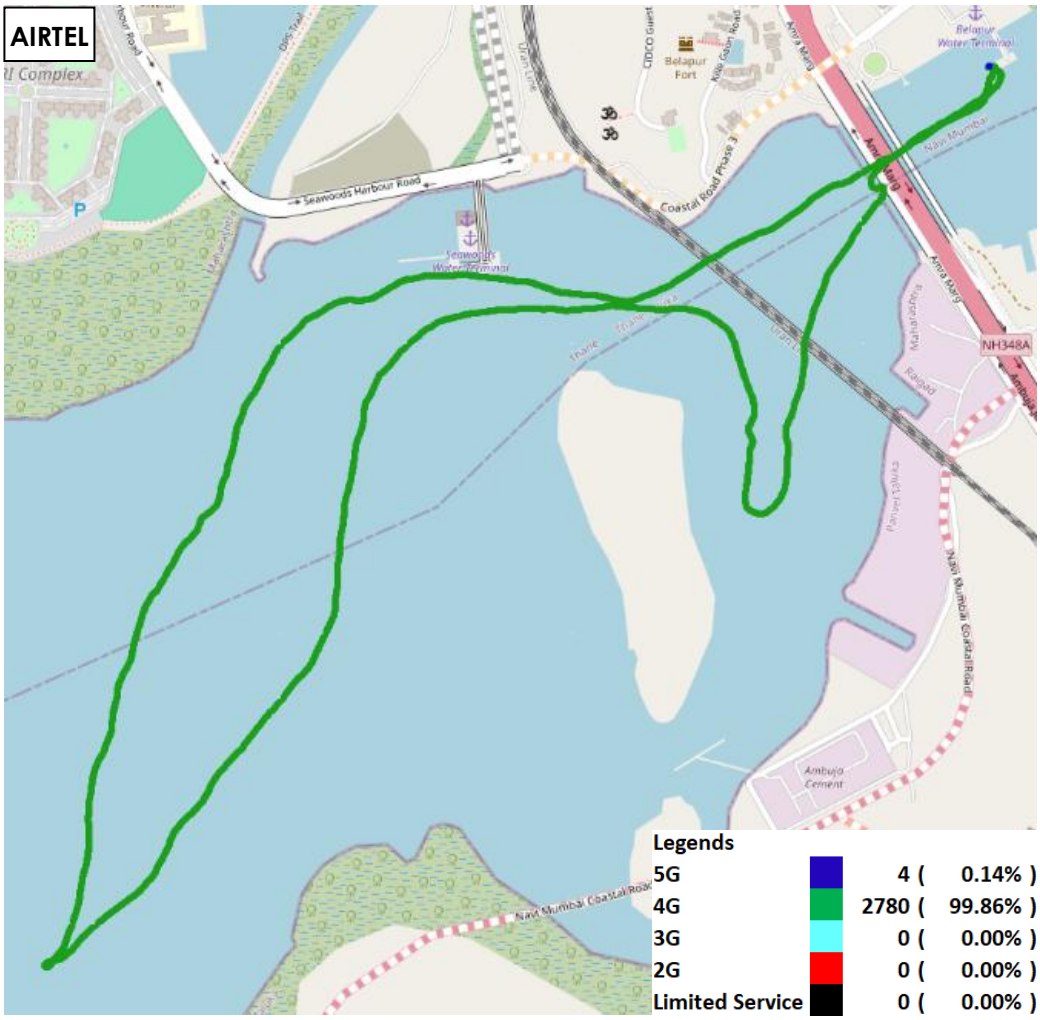

Figure-48: Serving technology plots auto-selection mode 5G/4G/3G/2G –AIRTEL.

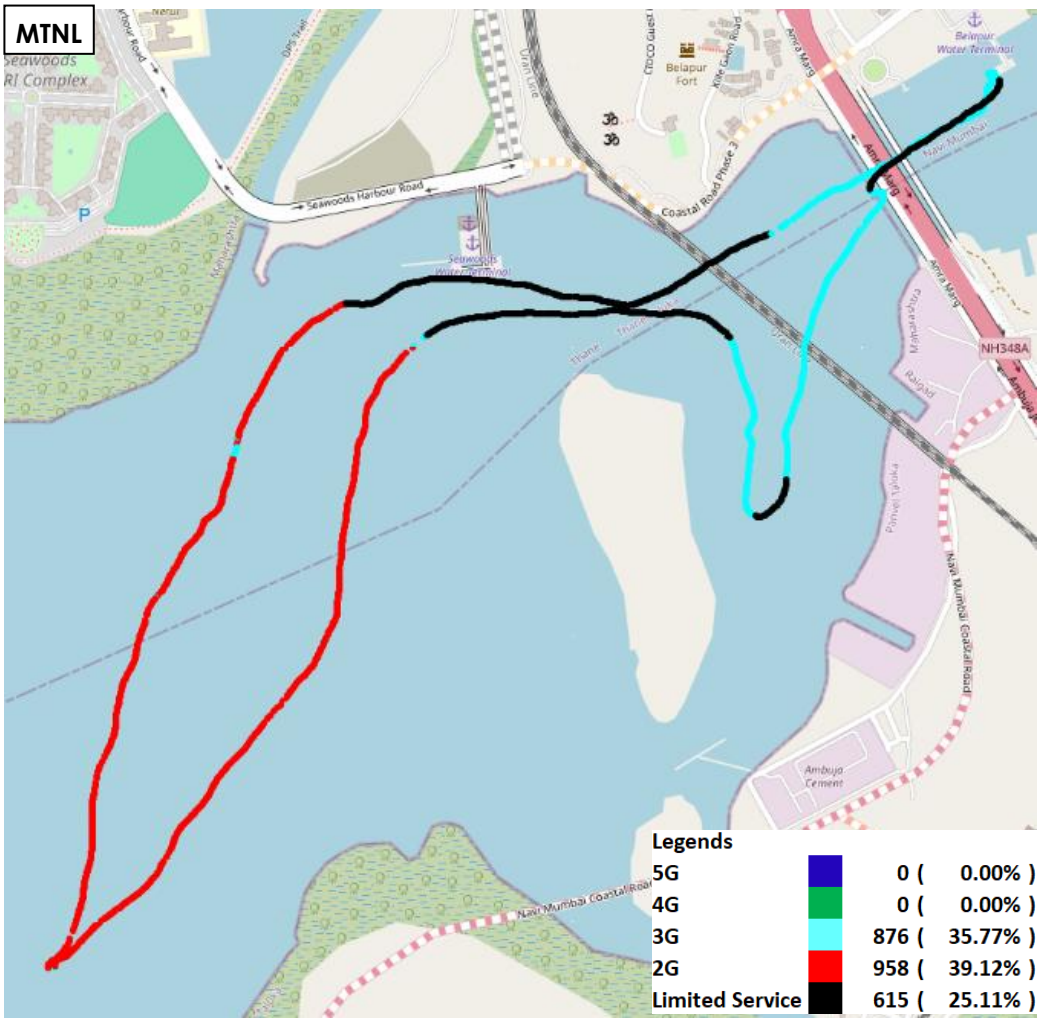

Figure-49: Serving technology plots auto-selection mode 5G/4G/3G/2G –MTNL.

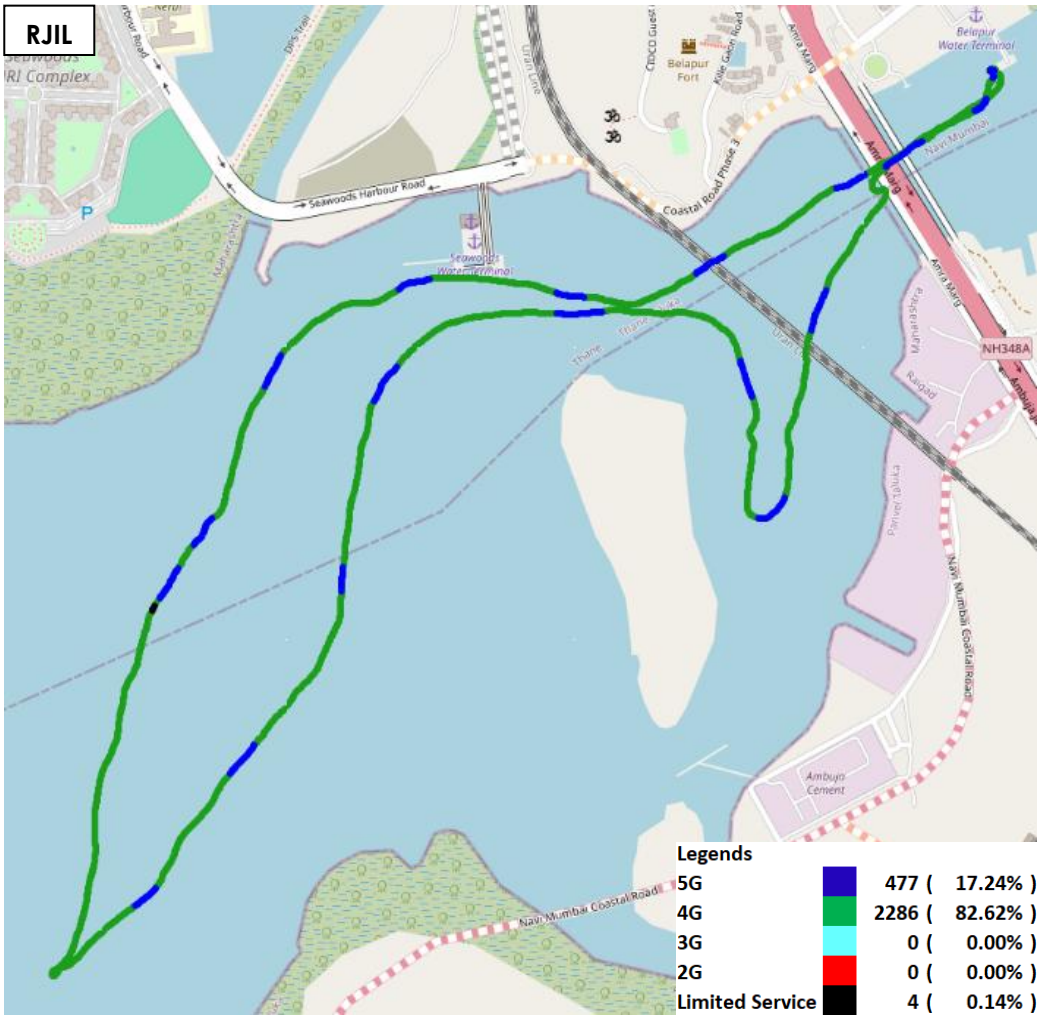

Figure-50: Serving technology plots auto-selection mode 5G/4G/3G/2G –RJIL.

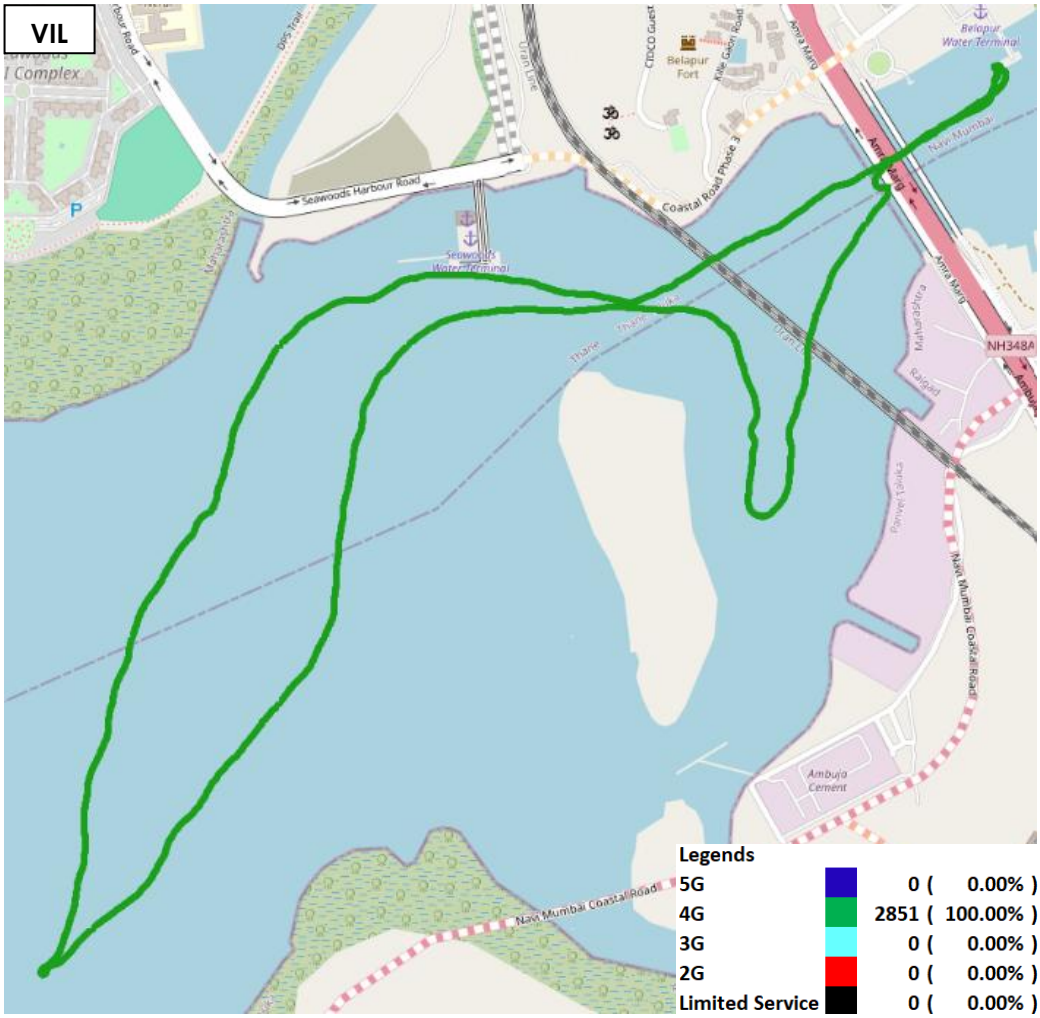

Figure-51: Serving technology plots auto-selection mode 5G/4G/3G/2G – VIL.

(c) Network Signal Strength distribution: The following chart provide signal strength distribution for auto-selection mode (5G/4G/3G/2G) (refer figure-70, 71, 72 & 73 for map view)

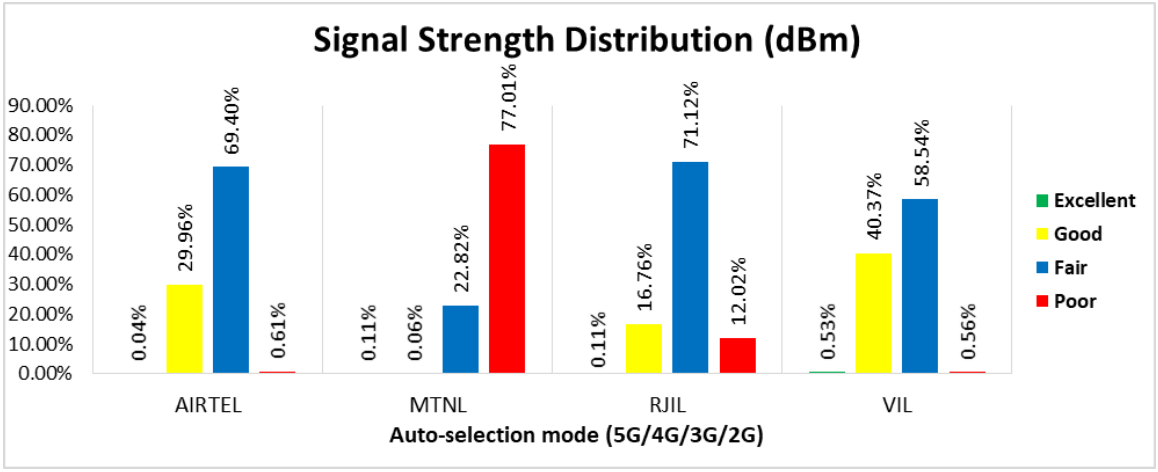

Figure-52: Signal strength distribution for auto-selection mode 5G/4G/3G/2G

4.7.4 Data performance

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

Parameters		Service Provider			
		Auto-selection mode (5G/4G/3G/2G)			
		AIRTEL	MTNL	RJIL	VIL
Download Throughput (Mbits/s)	Average	80.91	0.15	245.26	23.86
	80th Percentile	187.36	0.21	406.40	35.74
	20th Percentile	4.41	0.09	69.47	12.57
Upload Throughput (Mbits/s)	Average	9.90	0.03	16.92	5.19
	80th Percentile	16.14	0.03	29.30	7.55
	20th Percentile	2.94	0.03	5.21	2.81
Latency (ms)	50th Percentile	15.10	224.00	17.40	18.30

Table-58: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

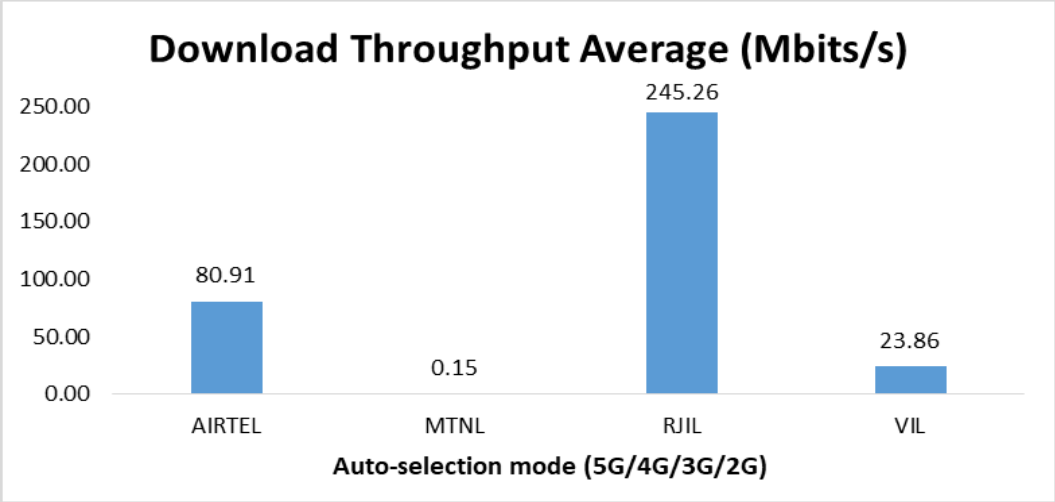

Figure-53: Download throughput

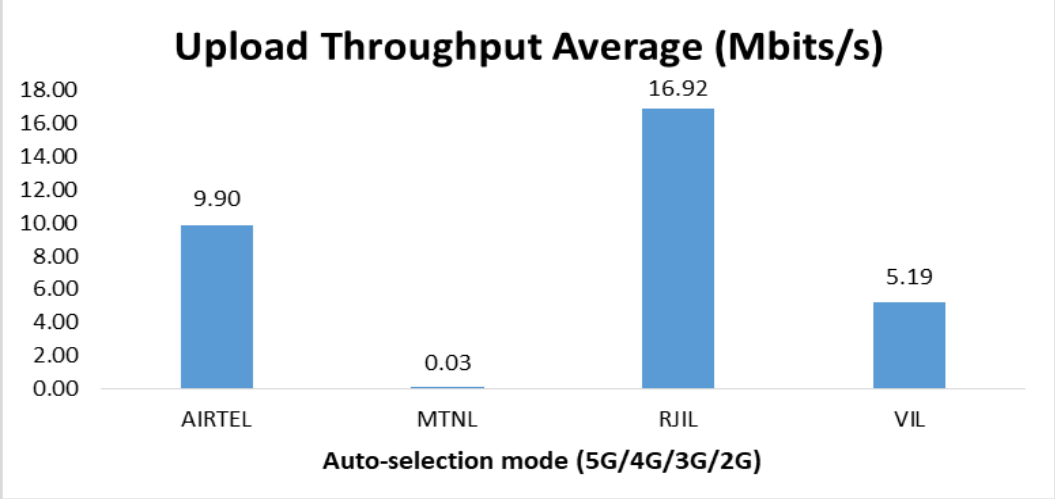

Figure-54: Upload throughput

5. Voice & Data Key findings

5.1 Overall Voice

1. Call Setup Success Rate:

a) Airtel, MTNL and VIL have 97.56%, 56.95% and 98.19% call setup success rate respectively in 3G/2G network mode. (refer table-3)

b) Airtel, MTNL, RJIL and VIL have 99.49%, 43.81%, 99.88% and 99.00% call setup success rate respectively in Auto-selection mode (5G/4G/3G/2G).(refer table-5)

c) While calling on peer service provider's network, All service providers have block calls for inter-operator calls. (refer table-9)

2. Call Setup time:

a) Airtel has taken comparatively longer time (5.27 second) to establish the voice call, whereas MTNL and VIL call setup time is 5.10 & 4.97 seconds respectively in 3G/2G network mode.(refer table-3)

b) MTNL has taken longer time (5.40 second) to establish the voice call, whereas Airtel, RJIL and VIL call setup time is 1.30, 0.58 & 1.01 seconds respectively in Auto-selection mode (5G/4G/3G/2G).(refer table-5)

3. Call Drop Rate:

a) Overall MTNL call drop rate (20.57%) is higher (QoS benchmark of 2%), while Airtel and VIL have 0.42% & 0.62% drop call rate respectively in 3G/2G network mode. (refer table-3)

b) Overall MTNL call drop rate (21.41%) is higher (QoS benchmark of 2%), while Airtel, RJIL and VIL have 0.00%, 0.25% and 0.13% drop call rate respectively in Auto-selection mode (5G/4G/3G/2G). (refer table-5)

4. Call Silence/Mute Rate: In packet switched network (4G/5G), VIL, Airtel and RJIL have 1.61%, 0.98% & 0.40% silence call rate respectively. Further Airtel has higher RTP packet loss rate in downlink (0.95%) compared to VIL (0.91%) and RJIL (0.58%). In uplink the RTP packet loss rate is higher for VIL (0.97%) compared to Airtel (0.80%) and RJIL (0.69%). (refer table-6)

5.2 Overall Data

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

a) MTNL (0.54 Mbps) and VIL (41.21 Mbps) being on 3G & 4G as top technology respectively, have comparatively lower download speeds. While Airtel and RJIL have average download speed of 161.89 Mbps and 319.93 Mbps respectively. (refer table-11)

b) MTNL (0.46 Mbps) and VIL (11.17 Mbps) being on 3G & 4G as top technology respectively, have comparatively lower upload speeds. While Airtel and RJIL have average upload speed of 29.58 Mbps and 43.94 Mbps respectively.(refer table-11)

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

a) RJIL has higher 5G QoS performance shows an average download speed of 406.11 Mbps overall hotspot locations. (refer table-31)

b) RJIL has higher 5G QoS performance shows an average upload speed of 48.65 Mbps overall hotspot locations. (refer table-31)

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

a) Airtel, MTNL, RJIL and VIL have 94.00%, 14.00%, 92.00% and 100.00% download session setup success rate respectively. (refer table-31)

b) Airtel, MTNL, RJIL and VIL have 94.00%, 12.00%, 98.00% and 100.00% upload session setup success rate respectively. (refer table-31)

5.3 Operator wise Key Findings

1. Airtel:

Voice

- Call setup success rate 97.56% and call drop rate 0.42% have been observed in the 3G/2G network mode respectively in LSA & city drive. (refer table-3 & 13)
- 99.49% call setup success rate and 0.00% drop call rate have been observed for the auto-selection mode (5G/4G/3G/2G) for LSA. (refer table-5)
- 99.42% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for city drive. (refer table -15)
- 100.00% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) at hotspot locations. (refer table - 20)
- 96.30% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) at Dana Market walk test. (refer table -42)
- 100.00% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for railway route, metro and coastal. (refer table –50, 53 & 56)

Data

- Airtel has average download throughput of 161.89 Mbps and average upload throughput of 29.58 Mbps across measured routes for LSA. (refer table-11)
- Airtel has average download throughput of 181.19 Mbps and average upload throughput of 31.56 Mbps across the measured routes during the city drive. (refer table -19)
- Aditya Birla Science and Tech, Jewel of Navi Mumbai Park, Navi Mumbai District Court, Rock Garden Stadium, T.S Chanakya Maritime College, Tata Memorial Hospital and Vashi Railway Station hotspot locations have download speed less

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than 100 Mbps out of 10 hotspot locations. (refer to table 32, 35, 36, 38, 39, 40 and 41)

- Aditya Birla Science and Tech, Jewel of Navi Mumbai Park, Navi Mumbai District Court, Rock Garden Stadium, Tata Memorial Hospital and Vashi Railway Station hotspot locations have upload speed less than 20 Mbps out of 10 hotspot locations. (refer table 32, 35, 36, 38, 40 & 41)

- Dana Market has average download throughput of 223.61 Mbps and average upload throughput of 35.31 Mbps, MGM Hospital average download throughput of 115.98 Mbps and average upload throughput of 32.85 Mbps, Panvel Station has average download throughput of 147.66 Mbps and average upload throughput of 44.32 Mbps and Seawoods Grand Central Mall has average download throughput of 43.62 Mbps and average upload throughput of 8.69 Mbps during walk test. (refer table- 46, 47, 48 & 49)

- Airtel has average download throughput of 75.20 Mbps and average upload throughput of 22.22 Mbps across the measured routes during the railway route. (refer table -52)

- Airtel has average download throughput of 148.06 Mbps and average upload throughput of 33.99 Mbps across the measured routes during the metro. (refer table - 55)

- Airtel has average download throughput of 80.91 Mbps and average upload throughput of 9.90 Mbps across the measured routes during the coastal area. (refer table - 58)

2. MTNL:

Voice

- 56.95% call setup success rate and 20.57% call drop rate have been observed in 3G/2G network mode for LSA & city drive. Performance is not meeting benchmark of 98.00% & 2.00% for LSA & City. (refer table -3 & 13)

- 43.81% call setup success rate and 21.41% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G). Performance is not meeting benchmark of 98.00% & 2.00% for LSA. (refer table -5)

- 49.71% call setup success rate and 23.85% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G) for city drive. Performance is not meeting benchmark of 98.00% & 2.00%. (refer table -15)

- 29.00% call setup success rate and 10.34% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G) for overall hotspot locations. Performance is not meeting benchmark of 98.00% & 2.00%. (refer table -20)

- At Dana Market 74.19% call setup success rate and 8.70% drop call rate and MGM Hospital 25.71% call setup success rate and 33.33% drop call rate have

been observed for auto-selection mode (5G/4G/3G/2G) during walk test location drive. (refer table -42 & 43)

- 34.48% call setup success rate and 25.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for railway route. Performance is not meeting benchmark of 98.00% & 2.00% respectively. (refer table –50)

- 24.44% call setup success rate and 18.18% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for metro. Performance is not meeting benchmark of 98.00% & 2.00% respectively. (refer table – 53)

- 28.85% call setup success rate and 33.33% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for coastal. Performance is not meeting benchmark of 98.00% & 2.00% respectively. (refer table – 56)

Data

- MTNL has 0.54 Mbps average download throughput & 0.46 Mbps average upload throughput across measured routes for LSA. (refer table -11)

- MTNL has 0.50 Mbps average download throughput & 0.50 Mbps average upload throughput across measured routes for city drive. (refer table -19)

- Iskon Kharghar and Vashi Railway Station hotspot location have download speed less than 10 Mbps. (refer table -34 & 41)

- Iskon Kharghar and Vashi Railway hotspot locations have upload speed less than 2 Mbps. (refer table-34 & 41)

- All test were failed at Aditya Birla Science and Tech, Jewel of Navi Mumbai Park, Navi Mumbai District Court, Navi Mumbai Municipality Co-operation Head Office, Rock Garden Stadium, T.S. Chanakya Maritime College and Tata Memorial Hospital. (refer table-32, 35, 36, 37, 38, 39 & 40)

- Download, Upload, Web Browsing and YouTube has been failed at hotspot location Belapur Fort. (refer table-33)

- Dana Market has average download throughput of 0.57 Mbps and average upload throughput of 0.36 Mbps, MGM Hospital average download throughput of 0.14 Mbps and average upload throughput of 0.15 Mbps, Panvel Station has average download throughput of 0.82 Mbps and average upload throughput of 0.34 Mbps. All Test were failed at Seawoods Grand Central Mall. (refer table-46, 47, 48 & 49)

- MTNL has average download throughput of 0.79 Mbps and average upload throughput of 0.51 Mbps across the measured routes during the railway route. (refer table -52)

- MTNL has average download throughput of 0.33 Mbps and average upload throughput of 0.27 Mbps across the measured routes during the metro. (refer table - 55)

- MTNL has average download throughput of 0.15 Mbps and average upload throughput of 0.03 Mbps across the measured routes during the coastal area. (refer table - 58)

3. RJIL:

Voice

- 99.88% call setup success rate and 0.25% drop call rate have been observed for the auto-selection mode for LSA. (refer table-5)

- 99.81% call setup success rate and 0.38% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G) for city drive. (refer table -15)

- 100.00% call setup success rate and 0.00% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G) for overall hotspot locations and walk test. (refer table – 20, 42, 43, 44 & 45)

- 100.00% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for railway route, metro and coastal. (refer table –50, 53 & 56)

Data

- RJIL has 319.93 Mbps average download speed & 43.94 Mbps average upload speed across measured routes for LSA. (refer table -11)

- RJIL has 341.01 Mbps average download speed & 45.66 Mbps average upload speed across measured routes for city drive. (refer table -19)

- Rock Garden Stadium hotspot location have download speed less than 100 Mbps out of 10 hotspot locations. (refer table - 38)

- Belapur Fort hotspot location have upload speed less than 20 Mbps out of 10 hotspot locations. (refer table - 33)

- Dana Market has average download throughput of 410.45 Mbps and average upload throughput of 73.36 Mbps, MGM Hospital average download throughput of 162.30 Mbps and average upload throughput of 24.95 Mbps, Panvel Station has average download throughput of 301.44 Mbps and average upload throughput of 69.27 Mbps and Seawoods Grand Central Mall has average download throughput of 80.74 Mbps and average upload throughput of 11.53 Mbps during walk test. (refer table 46, 47, 48 & 49)

- RIL has average download throughput of 165.37 Mbps and average upload throughput of 35.51 Mbps across the measured routes during the railway route. (refer table -52)

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- RIL has average download throughput of 352.79 Mbps and average upload throughput of 38.71 Mbps across the measured routes during the metro. (refer table - 55)

- RIL has average download throughput of 245.26 Mbps and average upload throughput of 16.92 Mbps across the measured routes during the coastal. (refer table - 58)

4. VIL:

Voice

- 98.19% call setup success rate and 0.62% call drop rate have been observed in 3G/2G network mode for LSA & city drive. (refer table -3 & 13)

- 99.00% call setup success rate and 0.13% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for LSA. (refer table -5)

- 99.04% call setup success rate and 0.19% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for city drive. (refer table -15)

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

- 96.30% call setup success rate at Dana Market and 94.12% call setup success rate Seawoods Grand Central Mall have been observed for auto-selection mode (5G/4G/3G/2G) during walk test drive. (refer table -42 & 45)

- 100.00% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for railway route, metro and coastal. (refer table –50, 53 and 56)

Data

- VIL has 41.21 Mbps average download speed & 11.17 Mbps average upload speed across measured routes for LSA. (refer table -11)

- VIL has 42.58 Mbps average download speed & 11.57 Mbps average upload speed across measured routes for city drive. (refer table -19)

- Vashi Railway Station hotspot location has less than 2 Mbps upload speed. (refer table - 41)

- Dana Market has average download throughput of 30.17 Mbps and average upload throughput of 14.55 Mbps, MGM Hospital average download throughput of 25.71 Mbps and average upload throughput of 5.90 Mbps, Panvel Station has average download throughput of 58.36 Mbps and average upload throughput of 15.05 Mbps and Seawoods Grand Central Mall has average download throughput of 36.64 Mbps and average upload throughput of 9.54 Mbps during walk test. (refer table 46, 47, 48 & 49)

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- VIL has average download throughput of 31.93 Mbps and average upload throughput of 9.11 Mbps across the measured routes during the railway route. (refer table -52)

- VIL has average download throughput of 32.61 Mbps and average upload throughput of 12.92 Mbps across the measured routes during the metro. (refer table - 55)

- VIL has average download throughput of 23.86 Mbps and average upload throughput of 5.19 Mbps across the measured routes during the coastal. (refer table - 58)

6. Annexure

6.1 Route wise coverage map

6.1.1 City

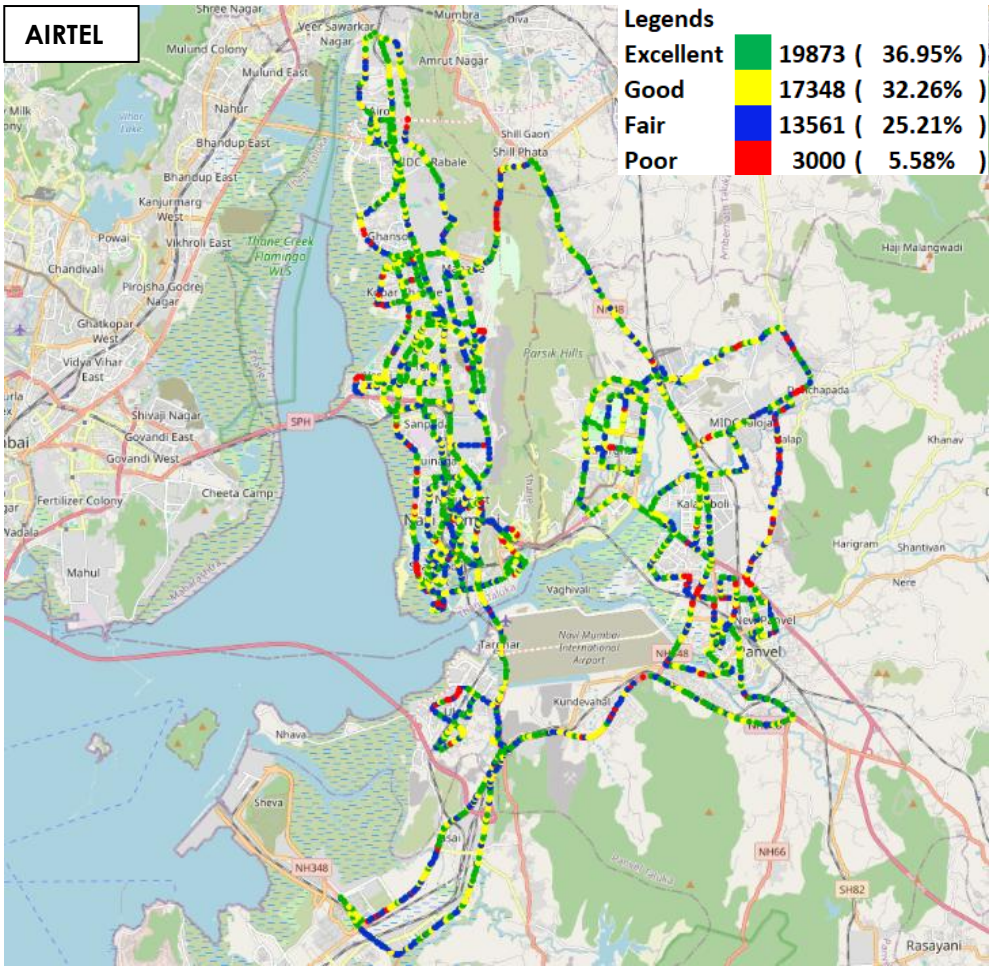

Figure-55: Signal strength 3G/2G network mode – AIRTEL.

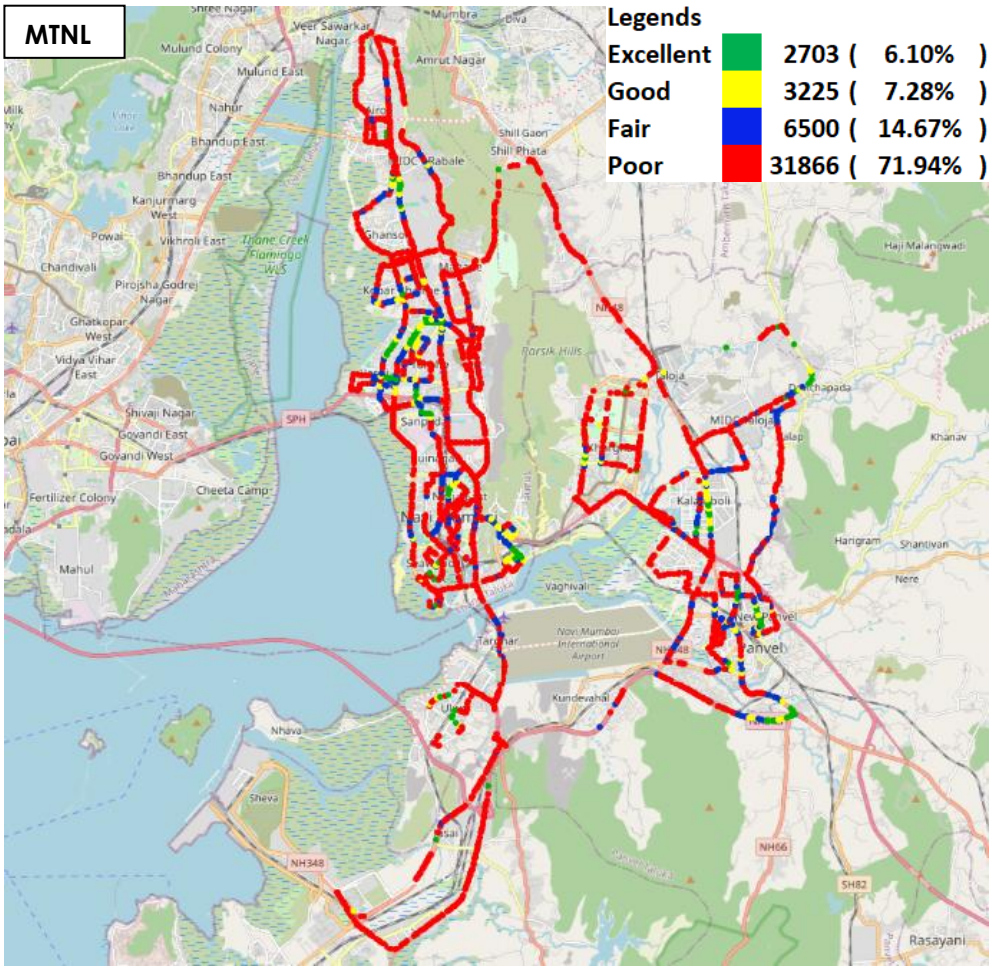

Figure-56: Signal strength 3G/2G network mode – MTNL.

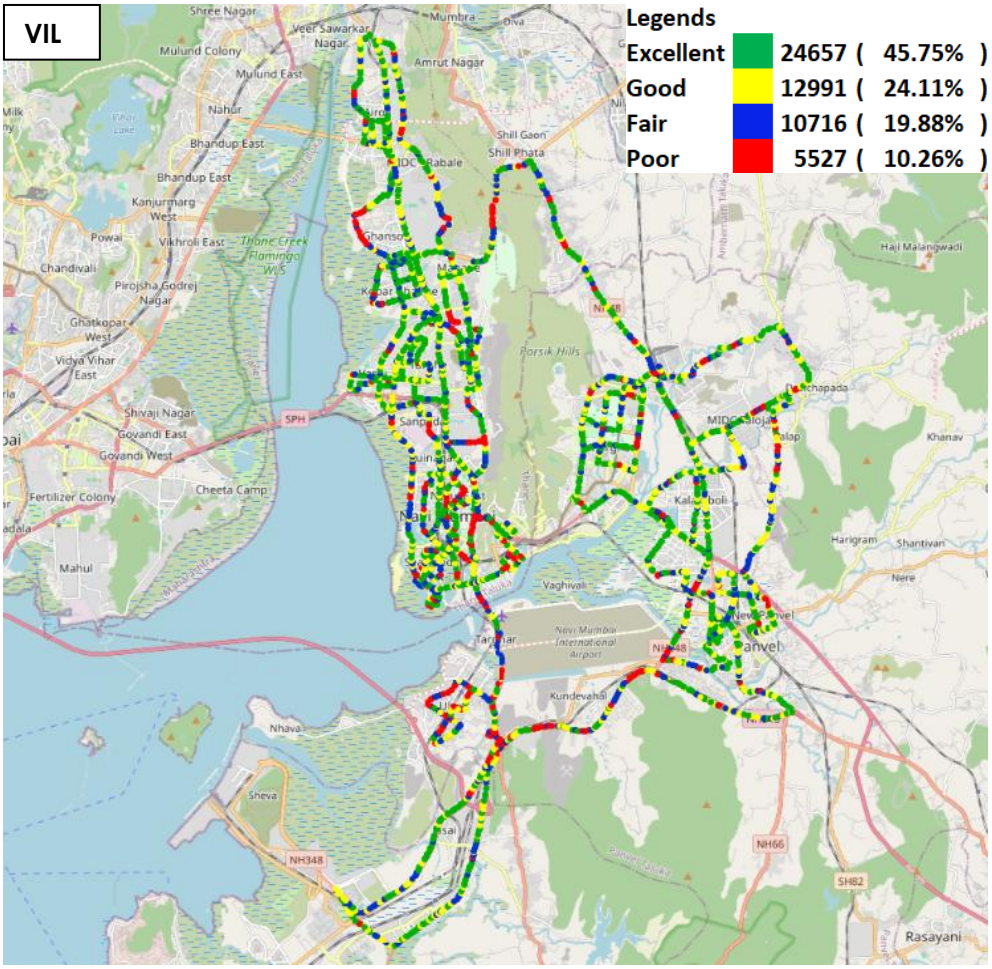

Figure-57: Signal strength 3G/2G network mode – VIL.

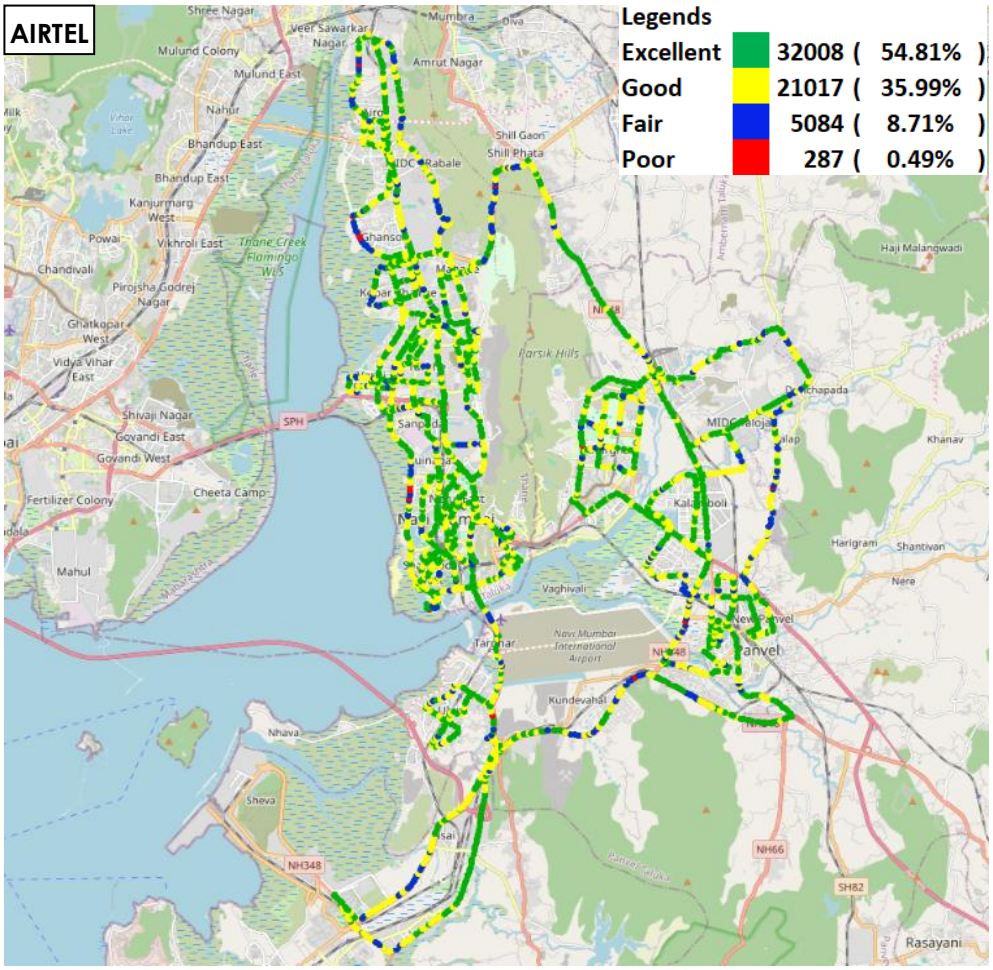

Figure-58: Signal strength auto-selection mode 5G/4G/3G/2G – AIRTEL.

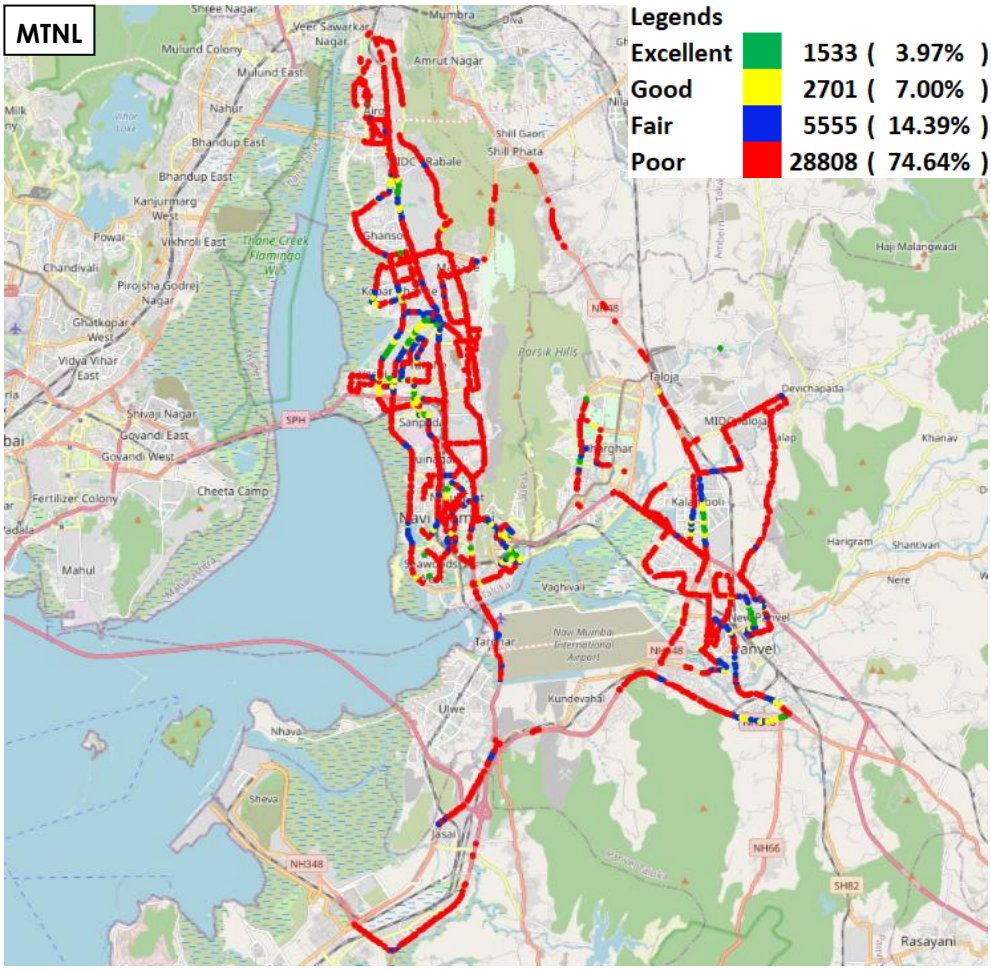

Figure-59: Signal strength auto-selection mode 5G/4G/3G/2G – MTNL.

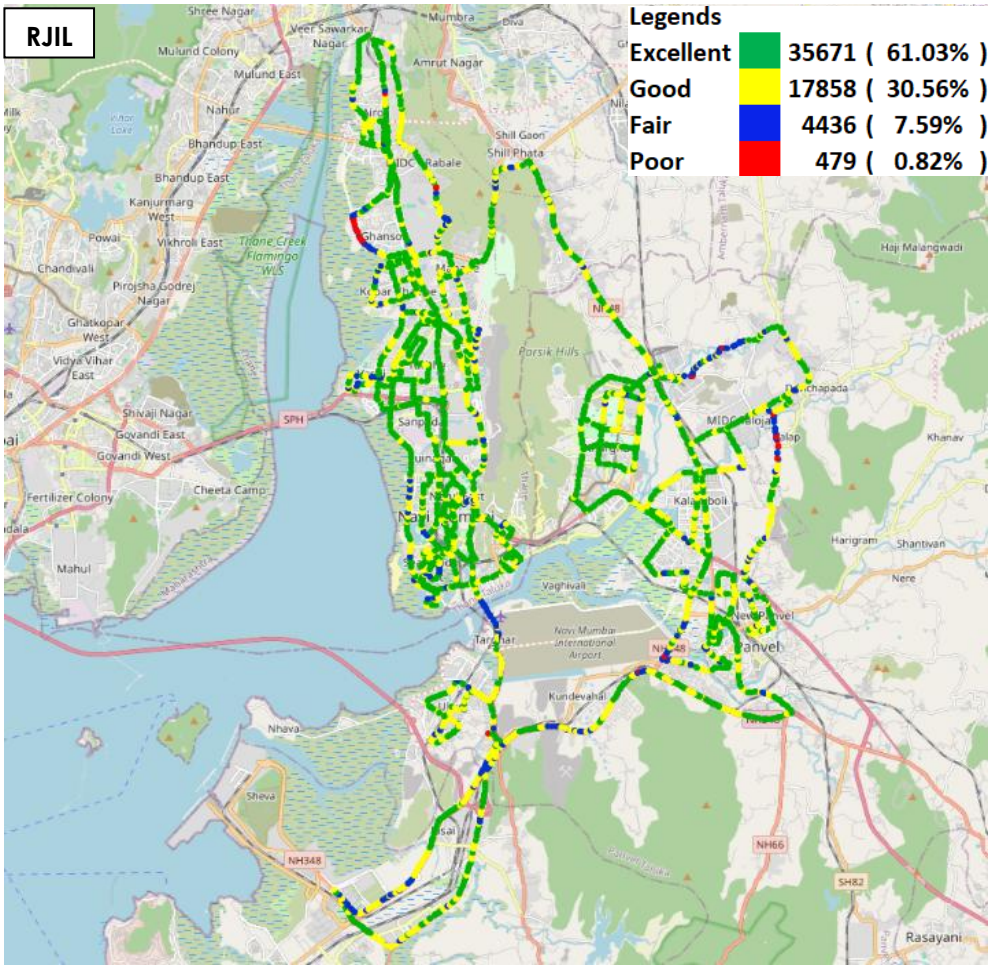

Figure-60: Signal strength auto-selection mode 5G/4G/3G/2G – RJIL.

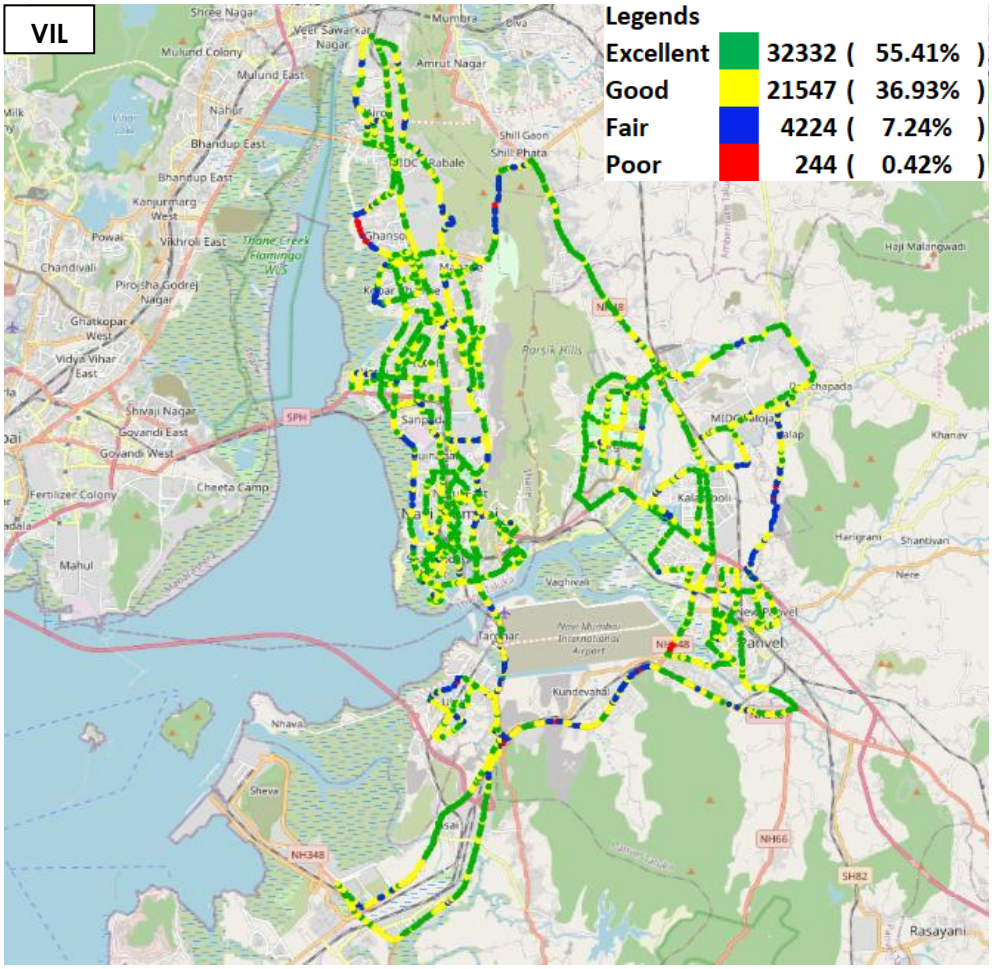

Figure-61: Signal strength auto-selection mode 5G/4G/3G/2G – VIL.

6.1.2 Railway Route

i) Panvel to Vashi

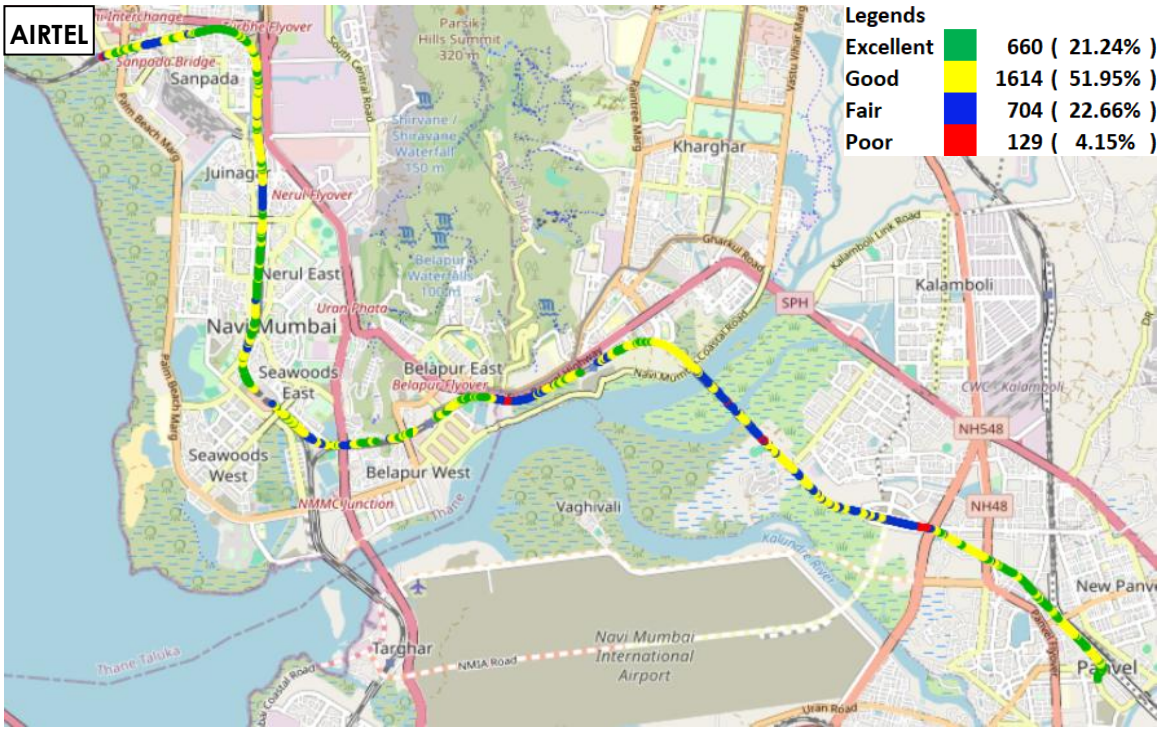

Figure-62: Signal strength auto-selection mode 5G/4G/3G/2G – AIRTEL.

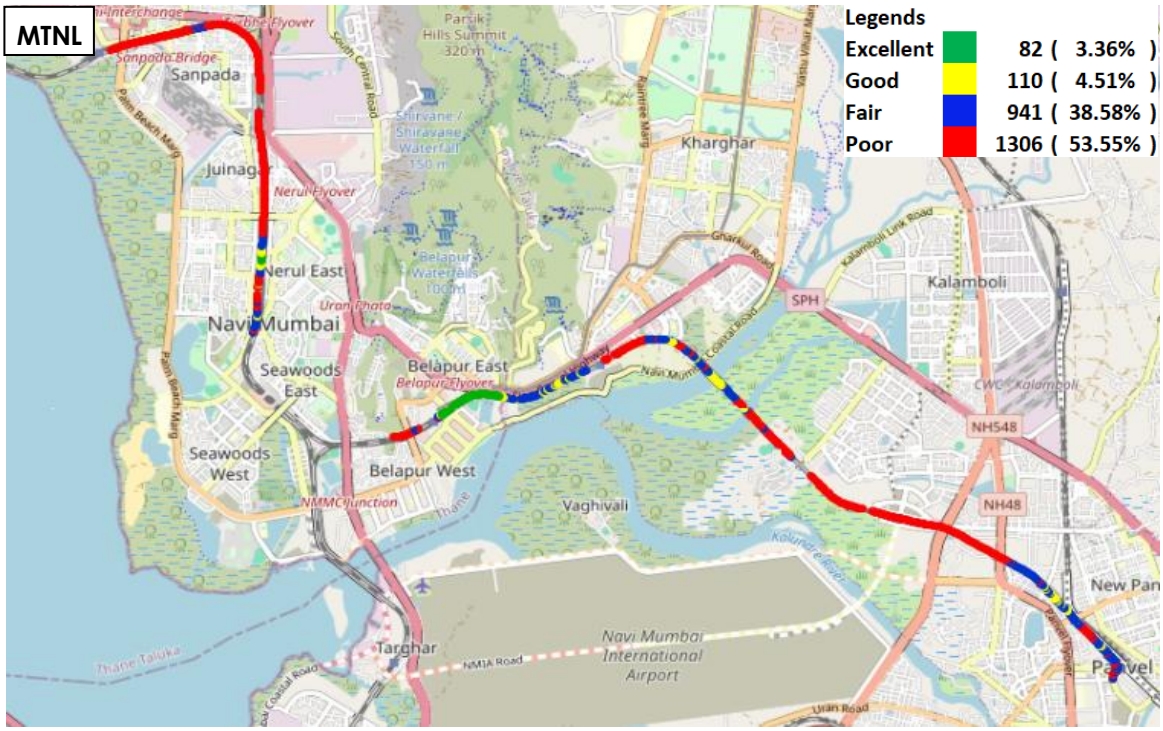

Figure-63: Signal strength auto-selection mode 5G/4G/3G/2G – MTNL.

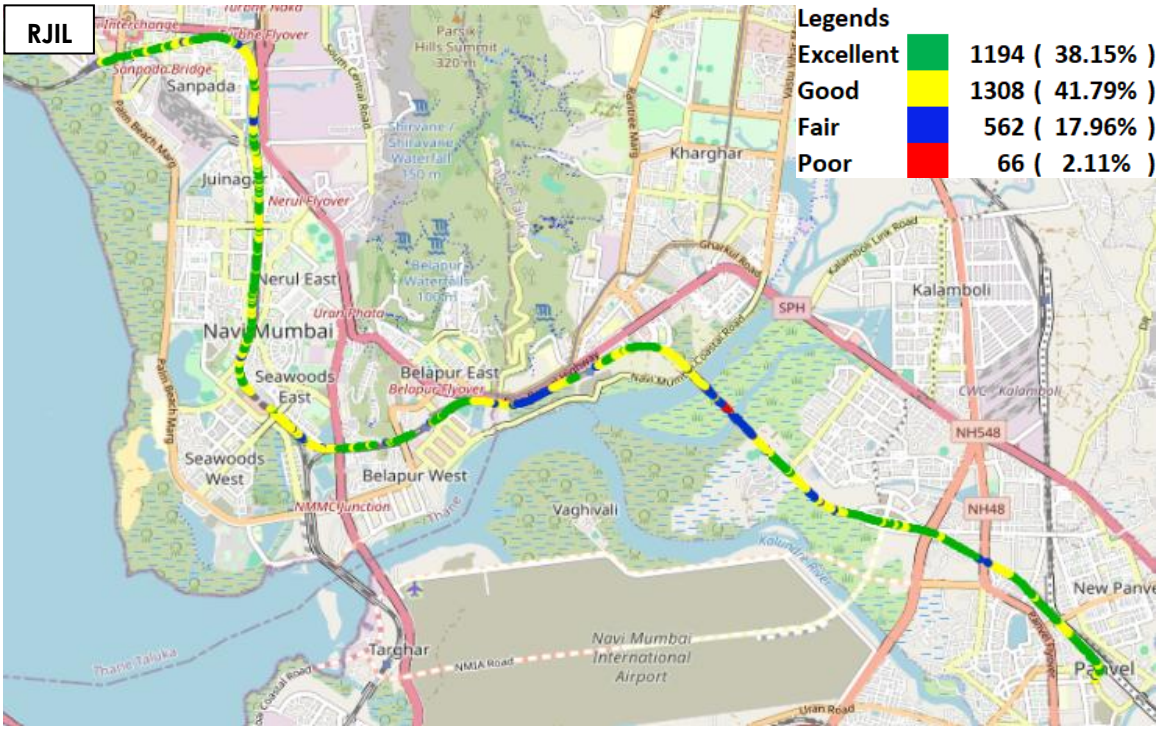

Figure-64: Signal strength auto-selection mode 5G/4G/3G/2G – RJIL.

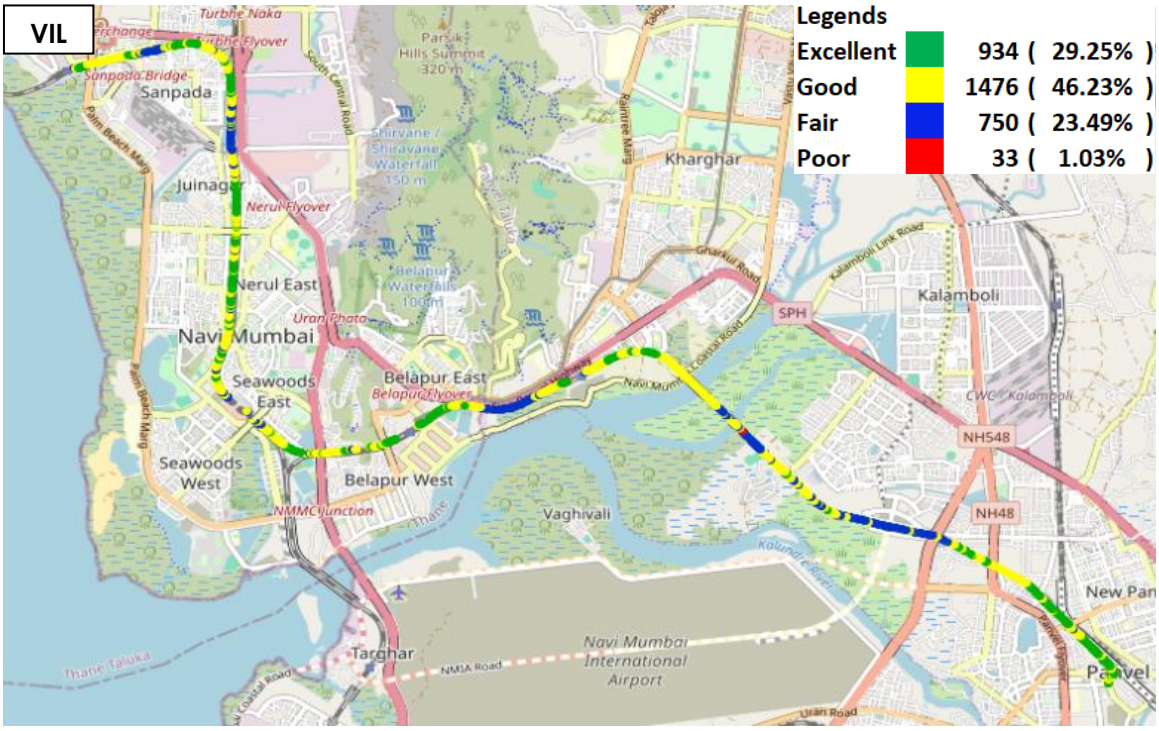

Figure-65: Signal strength auto-selection mode 5G/4G/3G/2G – VIL.

6.1.3 Metro Route

i) Belapur to Pendhar

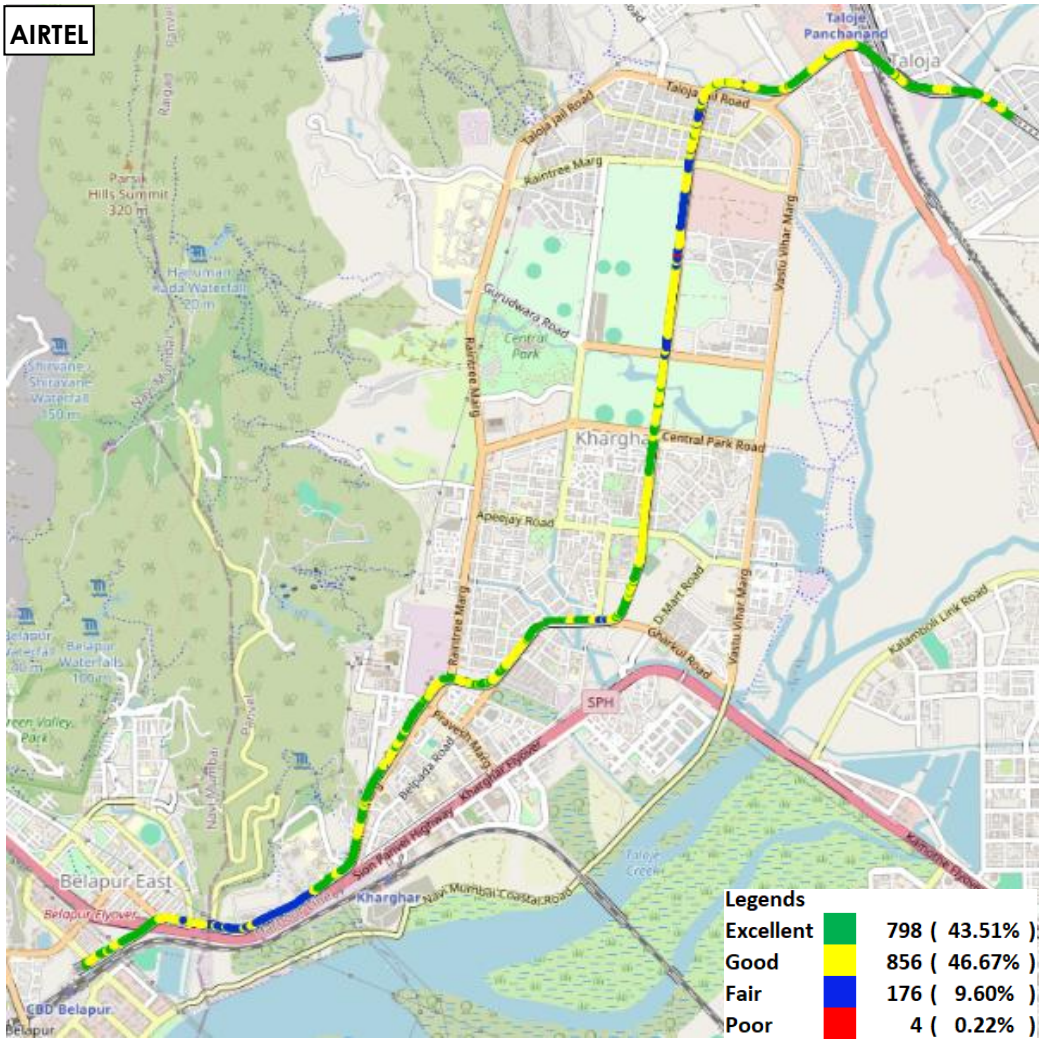

Figure-66: Signal strength auto-selection mode 5G/4G/3G/2G – AIRTEL.

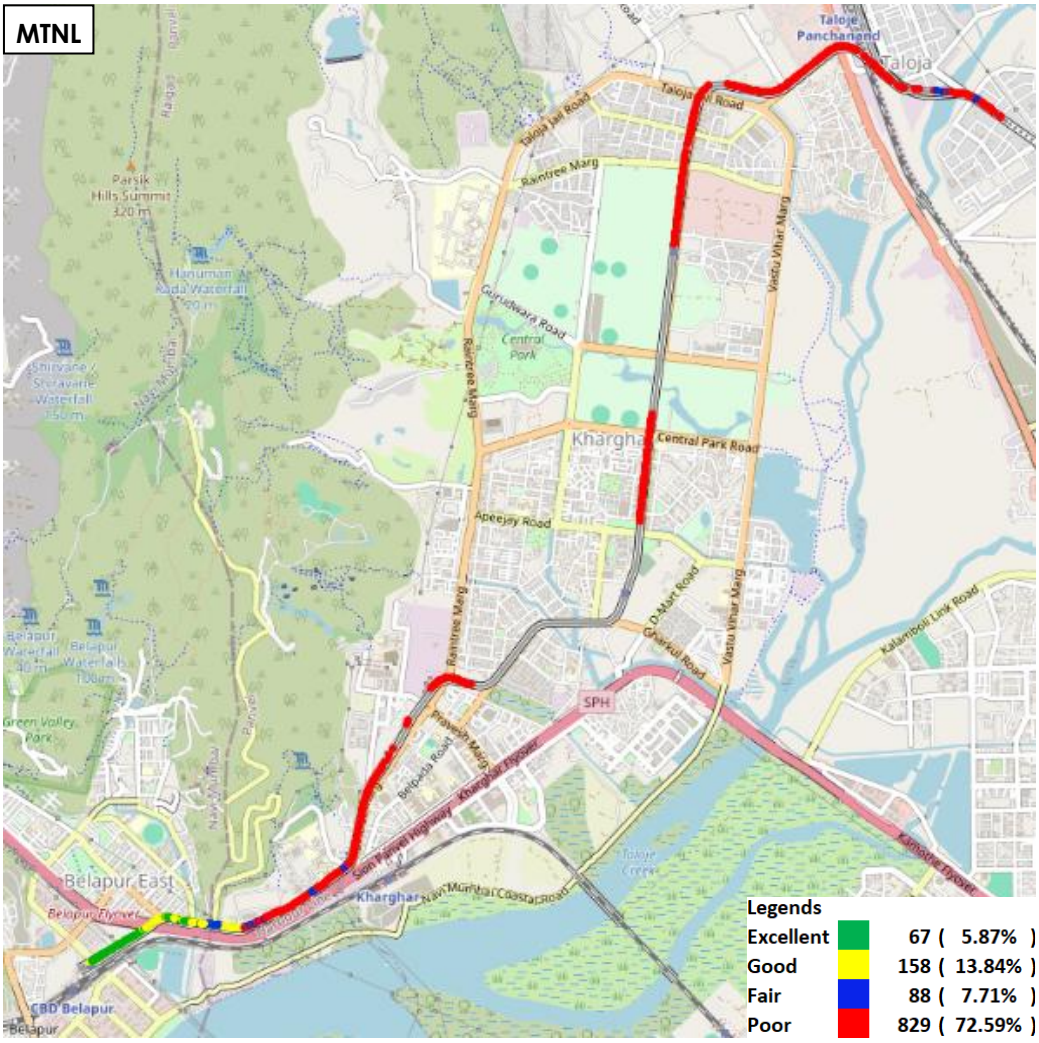

Figure-67: Signal strength auto-selection mode 5G/4G/3G/2G – MTNL.

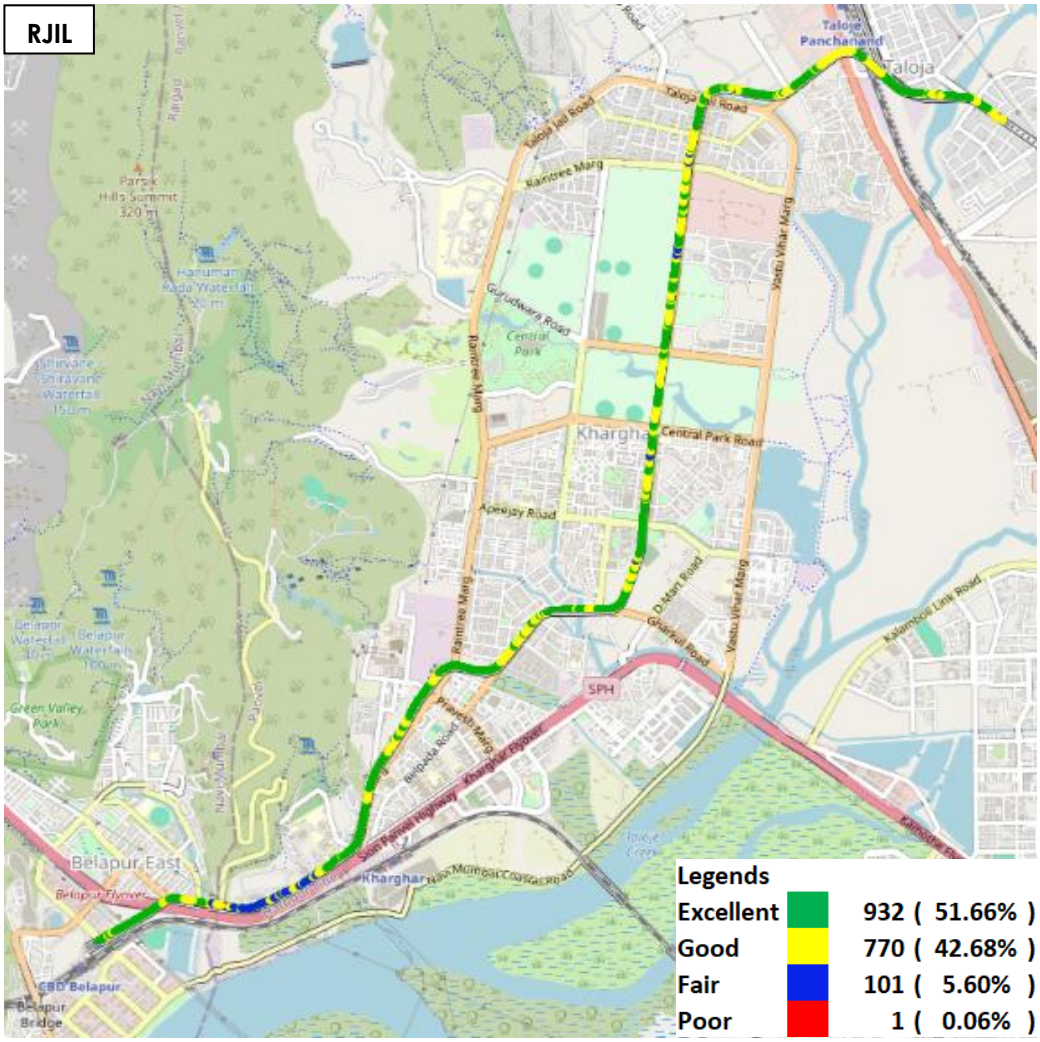

Figure-68: Signal strength auto-selection mode 5G/4G/3G/2G – RJIL.

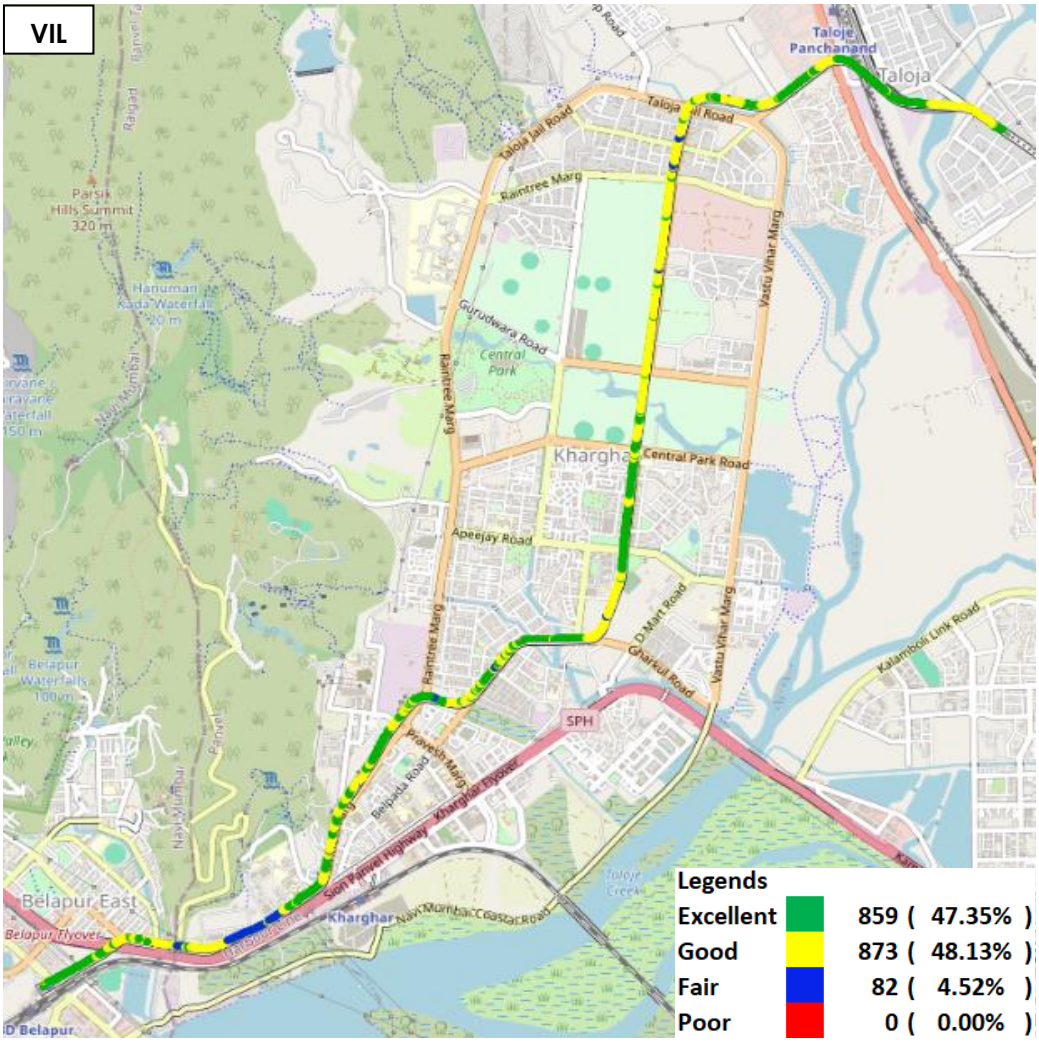

Figure-69: Signal strength auto-selection mode 5G/4G/3G/2G – VIL.

6.1.4 Coastal Area

i) JNPT Belapur area towards Vashi.

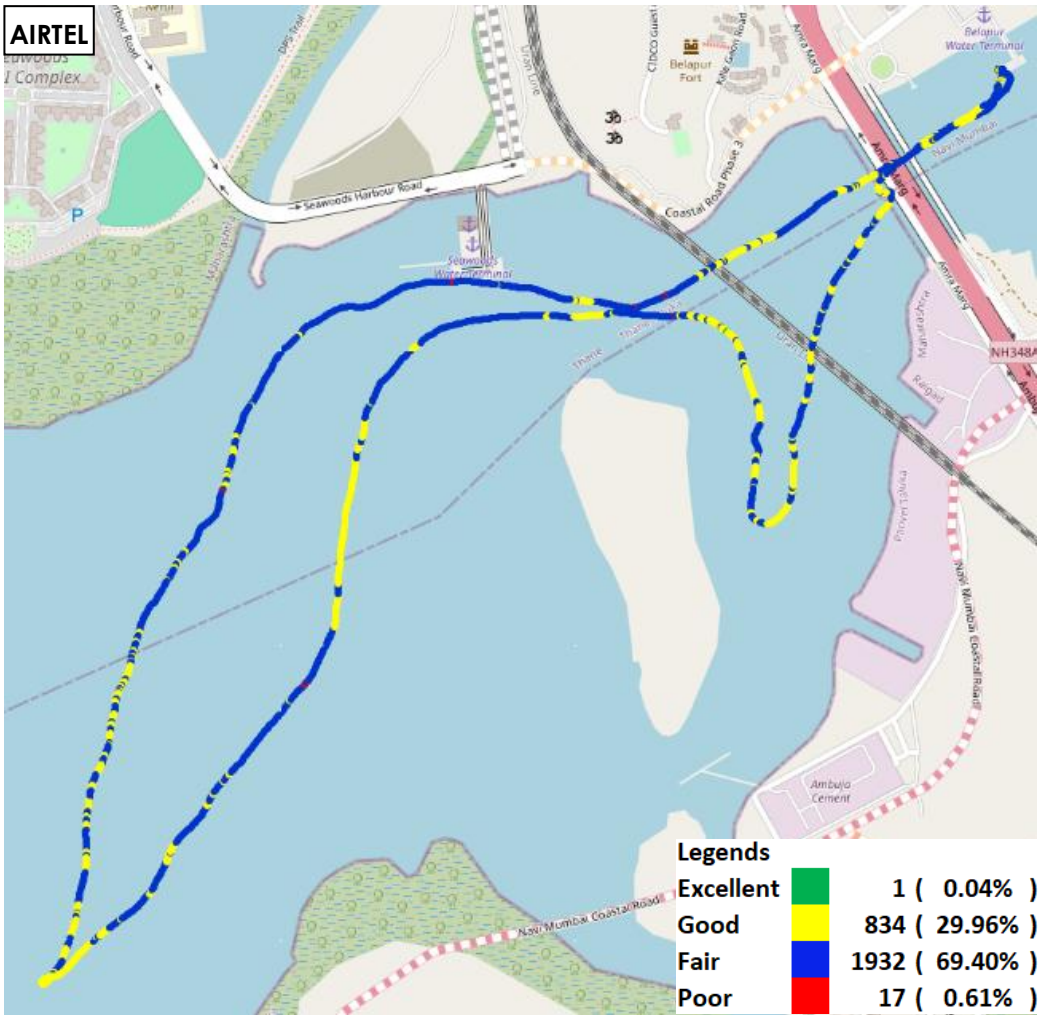

Figure-70: Signal strength auto-selection mode 5G/4G/3G/2G – AIRTEL.

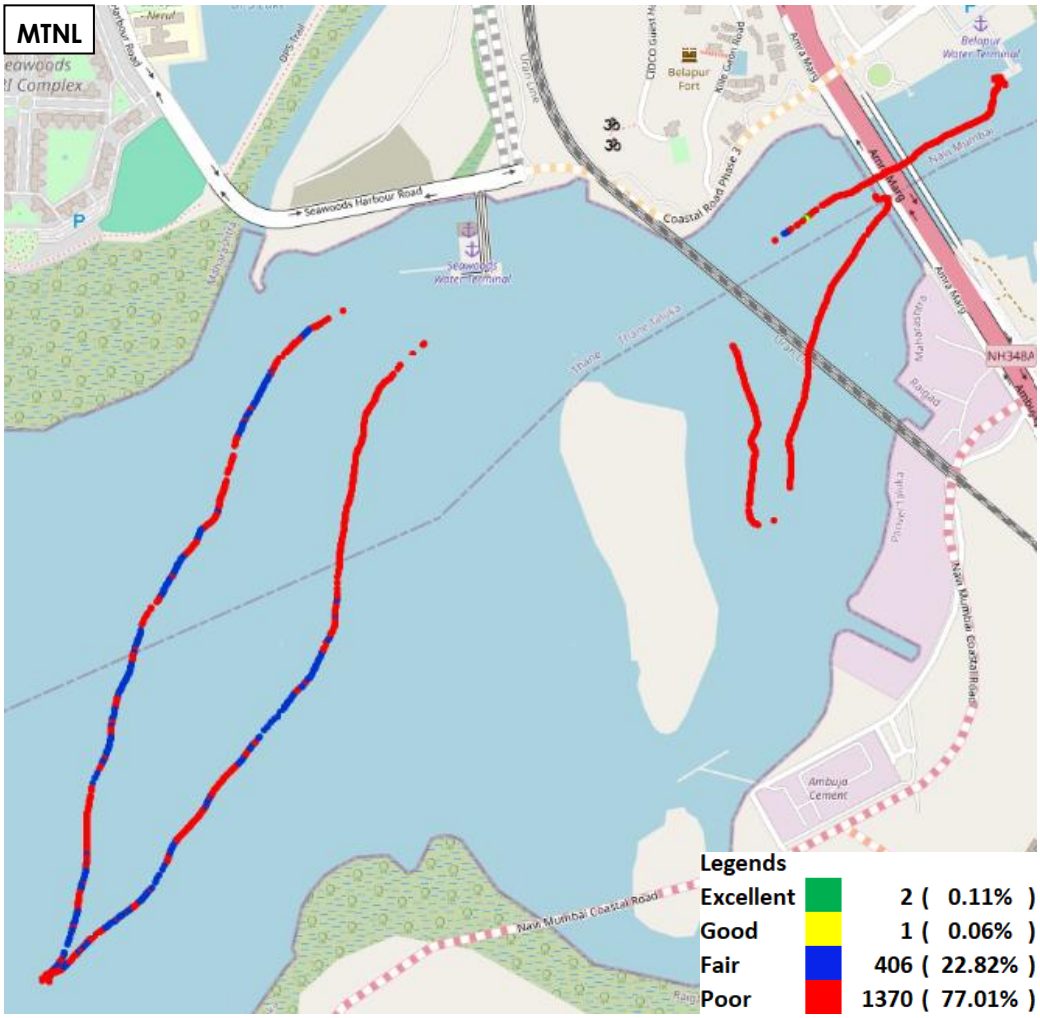

Figure-71: Signal strength auto-selection mode 5G/4G/3G/2G – MTNL.

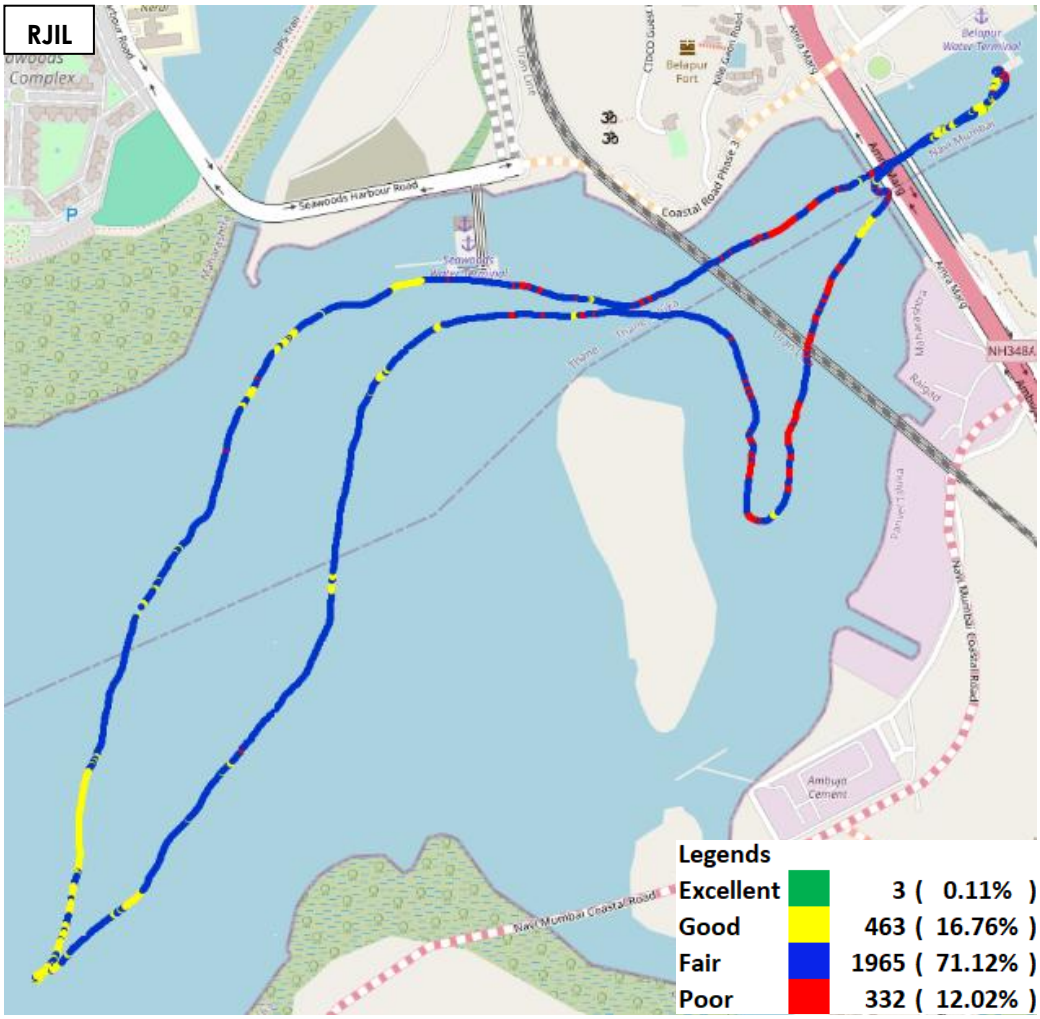

Figure-72: Signal strength auto-selection mode 5G/4G/3G/2G – RJIL.

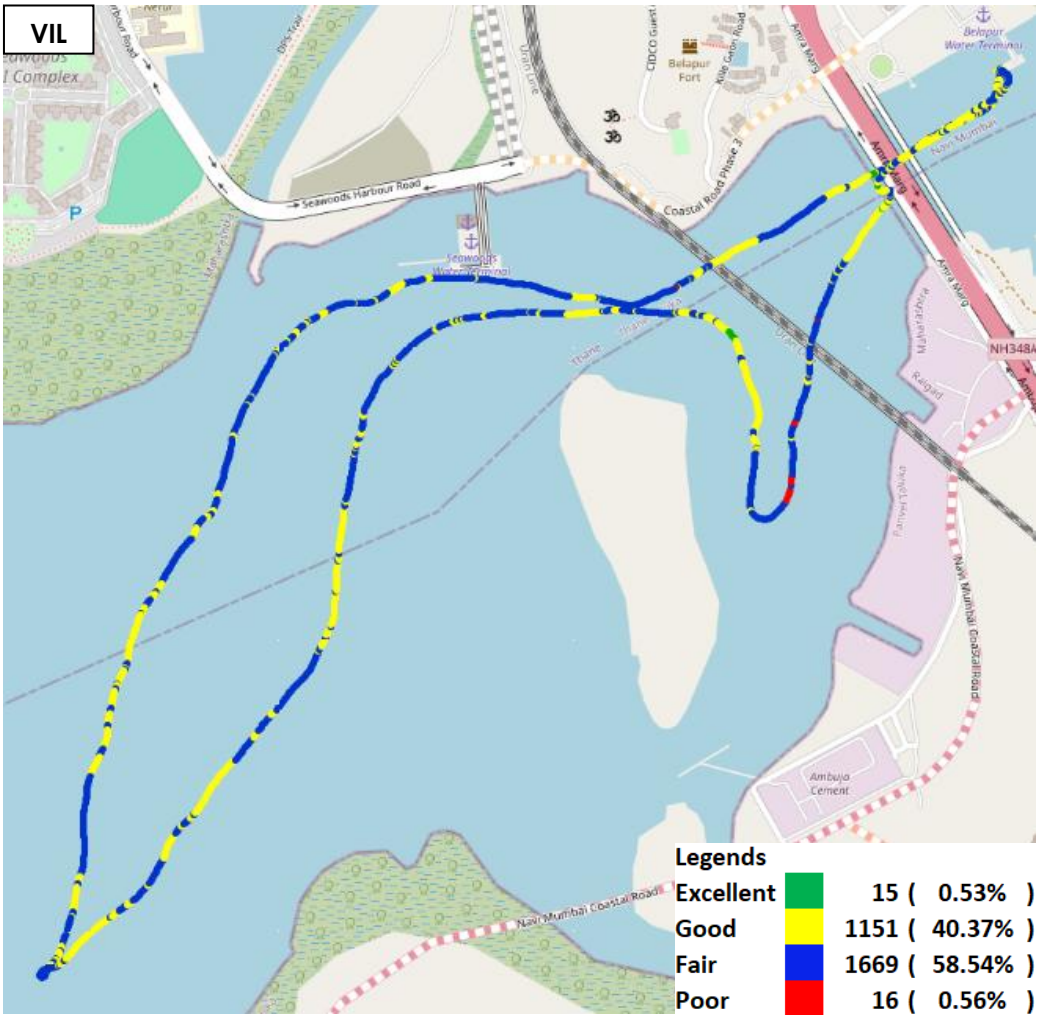

Figure-73: Signal strength auto-selection mode 5G/4G/3G/2G – VIL.

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-59: 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 MTNL as MTNL don't have VoLTE & VoNR network availability.

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

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Web Browsing		3 popular websites (www.amazon.in, www.facebook.com, www.google.co.in) 20 sec timeout (only at Hotspot)
Latency		25 count- Dynamic 1000 count- Hotspot Payload- 42 bytes in all drive

Table-60: 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, MTNL & RJIL. (Airtel, MTNL & RJIL not provided HTTP server)
- VIL download and upload testing is done on HTTP Server.

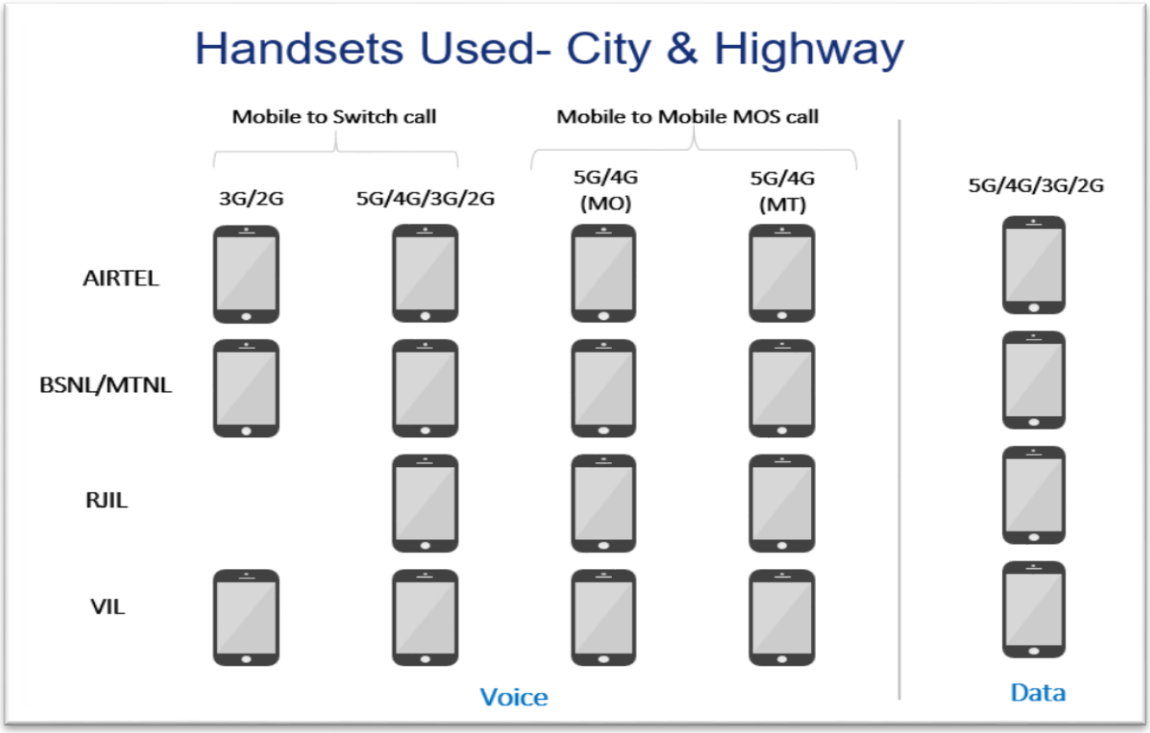

Figure-74: Number of handsets used in city & highway drive
MO: Mobile originating
MT: Mobile terminating

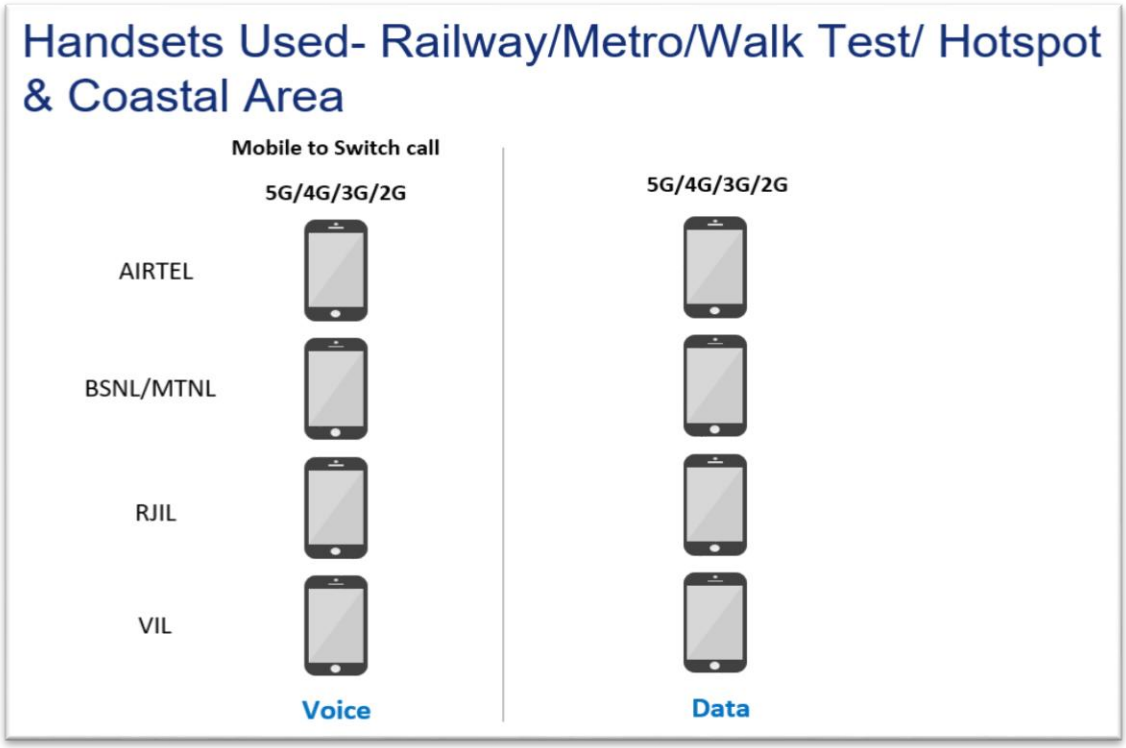

Figure-75: Number of handsets used in railway/metro/walktest/hotspot & coastal area

7.1.2 Drive test Methodology

(a) Dynamic voice testing (on the move)

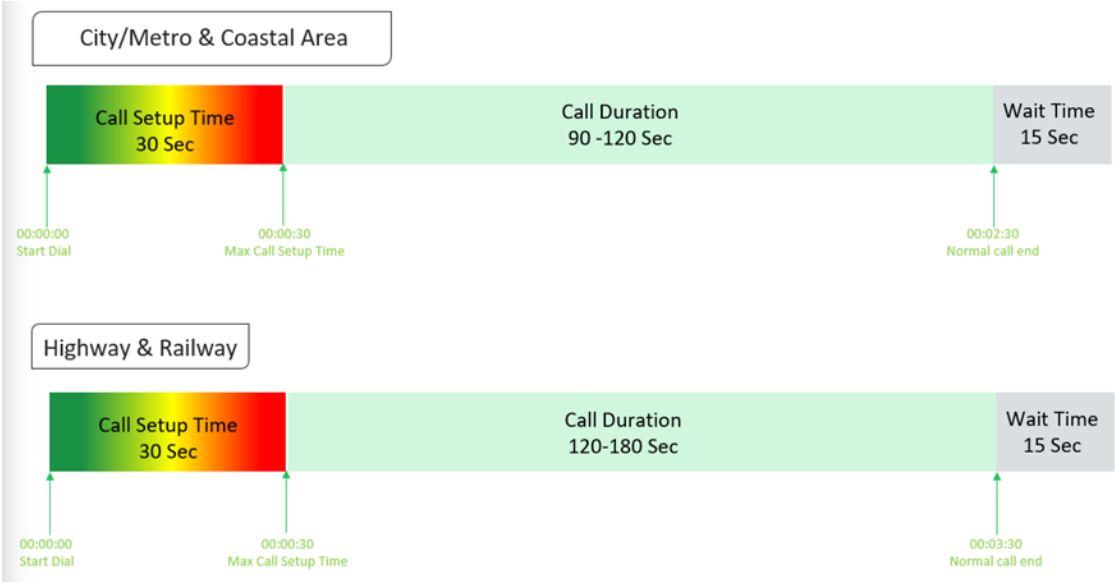

Figure-76: Voice test script for city/railway/metro/highway & coastal area

- 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-77: Voice test script for walktest/hotspot

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

(c) Dynamic Data (internet) test

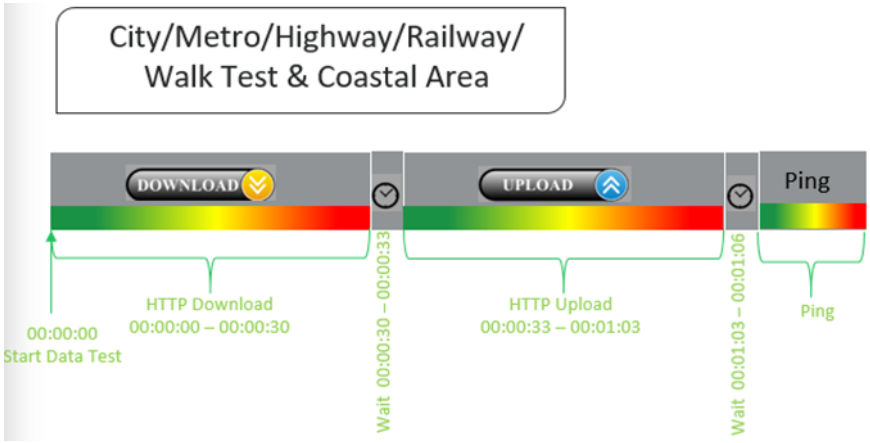

Figure-78: Data test script used in city/metro/railway/highway/walk test & coastal area

(d) Static Data(internet) testing

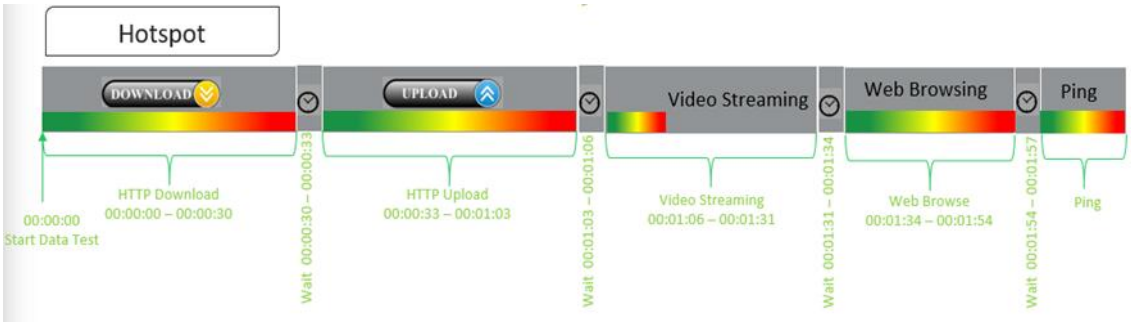

Figure-79: Data test script used at hotspot

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

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

7.2 Appendix-II

7.2.1 Network Performance Parameters for Voice calls

Parameter Name	Definition
Call Setup Success Rate	(i) Call Setup Success Rate is defined as the ratio of Established Calls to Call Attempts. 'Established Calls' mean the following events have happened in call setup: (a) Call attempt is made (b) The signaling channel is allocated (c) The call is routed to the outwards path of the terminating network (d) An alert signal is received by caller in the form of ring back tone, busy tone, or an announcement. CSSR = (Total Call Established/ Total Call Attempt) *100 As per QoS Regulation 2024 benchmark value is **>=98%**
Call Drop Rate	Call drop represents the service provider network's ability to maintain a call once it has been successfully established. This parameter shall include both incoming calls and outgoing calls which, once they have been established and have an assigned traffic channel/ bearer, are dropped, or interrupted before their normal completion by the user, the cause of the early termination being within the service provider's network Call Drop Rate = (Total Call Drop/Total Call Established) *100 As per QoS Regulation 2024 benchmark value is **<=2%**
Call Setup Time	Time taken from call initiate to call alerting/ringing. Call Setup Time = T2- T1 T2- Ringing (VoLTE/VoNR) & Alerting (for WCDMA & GSM), T1- Invite (VoLTE/VoNR) & CM Service Request (for WCDMA & GSM)
Voice Quality (MOS)	Voice quality in mobile networks is measured with algorithms based on ITU-T P.863 (POLQA). The grading for Voice quality has been given as: Excellent: MOS $\geq$ 4 and < 5 Good : MOS $\geq$ 3 and < 4 Fair : MOS $\geq$ 2 and < 3 Poor : MOS $\geq$ 1 and < 2
Handover Success Rate	Handover Success Rate = Count of successful handovers (All Technology Handover combined) / Total count of Handover Attempt (All Technology Handover combined) *100 Handover type which are considered- 2G Inter & Intra cell, 3G Soft & IRAT, 4G Inter & Intra frequency & SRVCC, 5G Inter & Intra frequency & 5G to 4G handovers.
Silence Call -	A call which has ≥ 4 sec continuous RTP gap is considered as a Silence Call. Silence call rate = (count of silence call / Total calls established) *100 If a call observes multiple silence count >=4 sec in a particular established call it has been taken as one silent event.

<table>
<tr><td>Jitter</td><td>The inter arrival jitter is the difference in the relative transit time for two packets. The relative transit time is the difference between a packet's Real-time Transport Protocol (RTP) timestamp and the receiver's clock at the time of arrival, measured in the same units. If Si is the RTP timestamp from packet i, and Ri is the time of arrival in RTP timestamps units for packet i, then for two packets i and j the inter-arrival jitter D can be expressed as:
D(i,j) = (Rj - Ri) - (Sj - Si)

The interarrival jitter is calculated continuously as each data packet i is received from source SSRC_n, using this difference D for that packet and the previous packet i-1 in order of arrival (not necessarily in sequence), according to the formula
J(i) = J(i-1) + (|D(i-1,i)| - J(i-1))/16 or 8</td></tr>
<tr><td>Downlink Packet Drop Rate</td><td>Number of RTP (Real-time Transport Protocol) Packets lost divided by total RTP packet received (against each source_SSRC and sequence number) at call originating handset.
This KPI is calculated from MOS call for packet call only (VoNR/VoLTE)</td></tr>
<tr><td>Uplink Packet Drop Rate</td><td>Number of RTP (Real-time Transport Protocol) Packets lost divided by total RTP packet received (against each source_SSRC and sequence number) at call terminating handset. This KPI is calculated from MOS call for packet call only (VoNR/VoLTE).</td></tr>
<tr><td>Signal Strength</td><td>Signal strength is the signal power level received by the wireless user.

<table>
<tr><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-61: Network performance parameter and definition voice

7.2.2 Network Performance Parameters Data tests

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

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

Table-62: Network performance parameter and definition Data