



TELECOM REGULATORY AUTHORITY OF INDIA

Independent Drive Test Report

Kerala LSA

December 2024

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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 Kerala License Service Area (LSA) during the month 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)	From date	To date
1	Thiruvananthapuram	City	177	3-Dec-2024	3-Dec-2024
2	Thiruvananthapuram	City (Inter-operator calling)	13	5-Dec-2024	5-Dec-2024
3	Thiruvananthapuram	Hotspot	10 Locations	4-Dec-2024	4-Dec-2024
4	Thiruvananthapuram	Walk Test	15	5-Dec-2024	5-Dec-2024
5	Thiruvananthapuram to Kollam via parassala and kottarakkara & Kollam to Thiruvananthapuram	Highway	224	2-Dec-2024	2-Dec-2024
6	Thiruvananthapuram Railway Station to Ernakulum Junction	Railway	212	6-Dec-2024	6-Dec-2024

Table-1: Drive test summary

2.2 Drive test routes

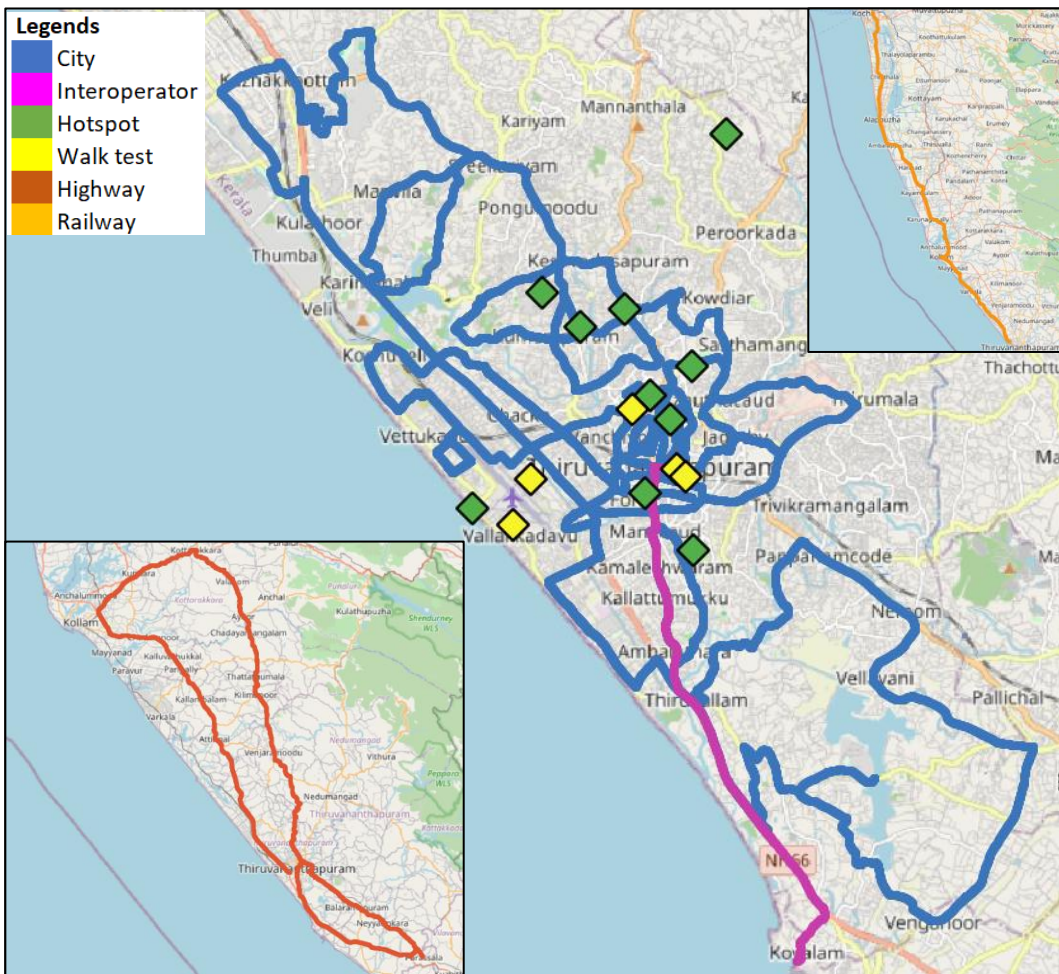


Figure-1: Drive test routes

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

2.3 Summary of areas covered

a) City- Thiruvallam, Vellayani, Vanchiyoor, Chacka, Jagathy, Kumarpuram, Poogumoodu, Shreekariyam, Kazhakkootam etc.

b) Hotspot-

1. Sree Padmanabhaswamy Temple
2. Shangumugham Beach
3. Sree Chita Triunal Institute For Medical Science
4. GG Hospital
5. University Of Kerala
6. Kerala Public Service Commission
7. Napier Museum
8. Central Stadium
9. DC Office
10. Attukal Bhagavathy Temple

c) Walk Test-

1. Central Bus Stand
2. General Hospital Trivandrum
3. Thiruvananthapuram Airport
4. Thiruvananthapuram Railway Station
5. Airport T1 domestic

d) Highway Route

1. Thiruvananthapuram to Kollam via parassala and kottarakkara & Kollam to Thiruvananthapuram

e) Railway Route

1. Thiruvananthapuram railway station to Ernakulam junction

2.4 Telecom service providers detected frequency bands

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

S.no.	Name of TSP	Technology	Frequency Bands (In MHz)
1	Bharti Airtel Ltd.	2G	1800
2	Bharti Airtel Ltd.	4G	900,1800,2100,2300
3	Bharti Airtel Ltd.	5G	3500
4	BSNL	2G	900
5	BSNL	3G	2100
6	BSNL	4G	700,2100
7	Reliance JIO Infocomm Ltd.	4G	850,1800,2300
8	Reliance JIO Infocomm Ltd.	5G	700,3500
9	Vodafone Idea Ltd.	2G	900,1800
10	Vodafone Idea Ltd.	4G	900,1800,2100,2300,2500

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

QoS Performance Analysis- Kerala 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 December-2024 covering city, hotspot, walk test, highway and railway. (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	394	394	391
Call Setup Success Rate %	99.75	99.75	98.47
Drop Call Rate %	1.02	1.53	0.00
Call Setup Time-Average (Second)	4.68	3.81	4.74
Handover Success Rate %	98.71	99.81	96.97

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

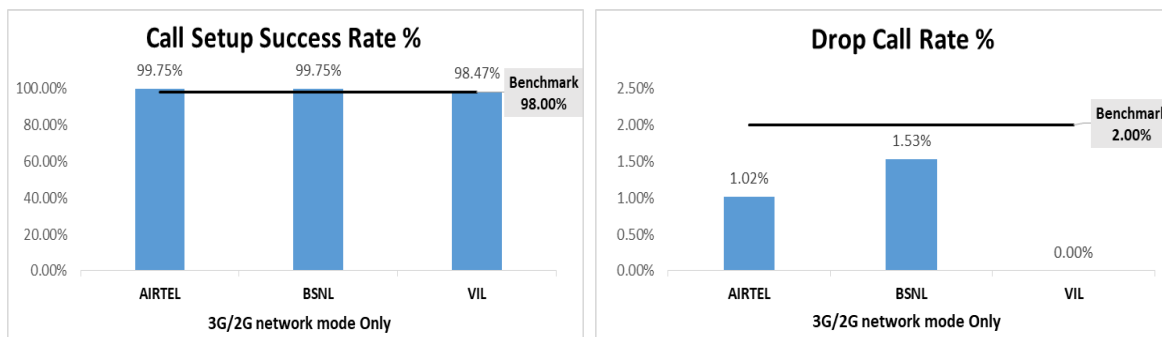


Figure-2: Call setup success rate and drop call rate performance

Number of unique cell id's covered in Voice test- Technology wise			
Technology/Service Provider	3G/2G network mode only		
	AIRTEL	BSNL	VIL
3G	NA	312	NA
2G	737	277	686

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	704	698	718	706
Call Setup Success Rate %	99.86	99.14	99.86	99.58
Drop Call Rate %	0.00	3.61	0.84	0.71
Call Setup Time-Average (Second)	1.24	4.23	0.57	1.07
Handover Success Rate %	99.98	99.64	99.80	99.91

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

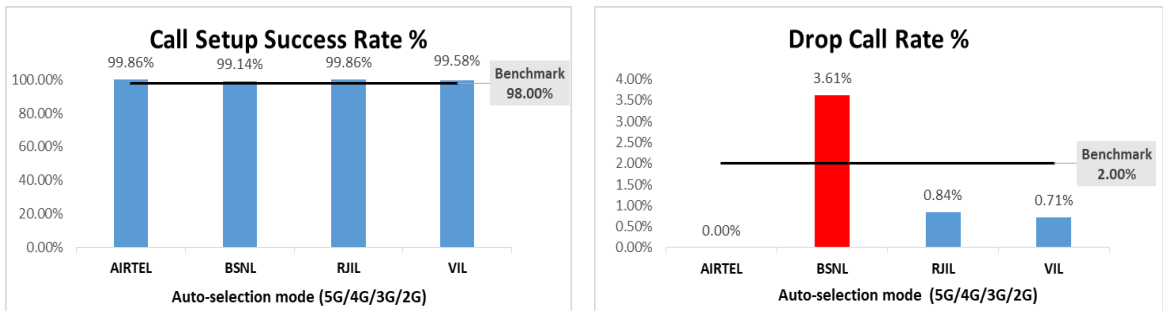


Figure-3: Performance for call setup success rate and drop call rate

Parameter	Service Provider			
	Mobile-to-Mobile (5G/4G - Open Mode)			
	AIRTEL	BSNL	RJIL	VIL
Call Established (within service provider Network)	375	388	381	384
Number of silence call for >4 Sec	2	NA	0	13
Silence Call Rate %	0.53	NA	0.00	3.39
Number of silence instances for >4 Sec	2	NA	0	13
Number of silence instances for >3 Sec	4	NA	1	24
Number of silence instances for >2 sec	7	NA	10	71
RTP Jitter (4G & 5G) in ms	4.35	NA	7.79	17.63
Packet loss Rate Downlink %	0.28	NA	0.36	2.39
Packet loss Rate Uplink %	0.21	NA	0.19	2.53

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

Number of unique cell id's covered in Voice test- Technology wise				
Technology/Service Provider	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
	5G	0	NA	664
4G	2026	235	2311	1727
3G	NA	370	NA	NA
2G	0	534	NA	53

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	BSNL	RJIL	VIL
Total Number of MOS Samples for calls in table-6	3057	2919	3032	2891
Speech Quality (Average MOS Score)	4.06	2.77	3.95	4.47
Number of samples with MOS ≥ 4 to < 5 (Excellent)	2717	69	2252	2534
Number of samples with MOS ≥ 3 to < 4 (Good)	302	972	663	231
Number of samples with MOS ≥ 2 to < 3 (Fair)	20	1609	92	55
Number of samples with MOS ≥ 1 to < 2 (Poor)	18	269	25	71
%age of samples with MOS ≥ 4 to < 5 (Excellent)	88.88%	2.36%	74.27%	87.65%
%age of samples with MOS ≥ 3 to < 4 (Good)	9.88%	33.30%	21.87%	7.99%
%age of samples with MOS ≥ 2 to < 3 (Fair)	0.65%	55.12%	3.03%	1.90%
%age of samples with MOS ≥ 1 to < 2 (Poor)	0.59%	9.22%	0.82%	2.46%

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

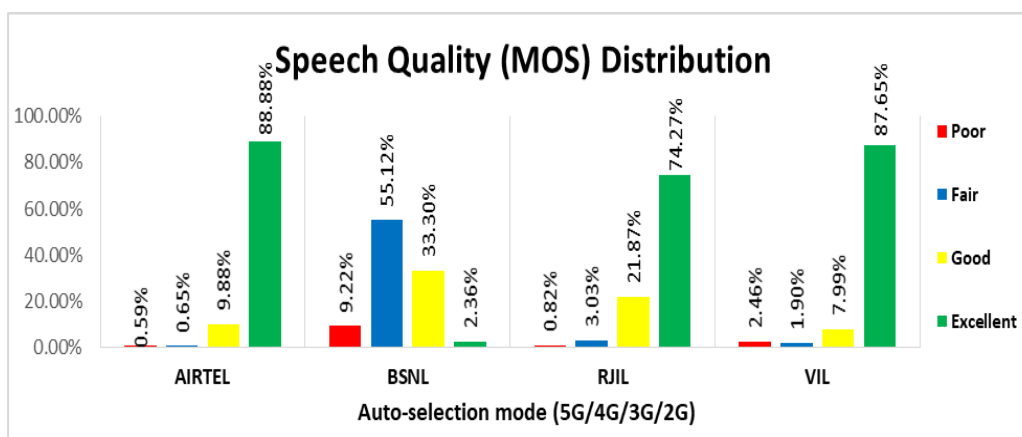


Figure- 4: Distribution of samples in MOS score range

(d) Inter-service provider voice call performance: To check the performance of inter-service provider call setup success rate, total 31 to 38 inter operator calls were attempted. The Call setup success rate and call setup time observation are as below.

Call setup success rate %				
From Service Provider	To Service Provider			
	AIRTEL	BSNL	RJIL	VIL
AIRTEL	NA	100.00	100.00	100.00
BSNL	100.00	NA	100.00	100.00
RJIL	100.00	96.88	NA	100.00
VIL	100.00	96.97	100.00	NA

Table-9: Call setup success rate across service providers

Note-
<ul style="list-style-type: none"> 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	3.38	2.05	1.70
BSNL	4.19	NA	3.97	4.46
RJIL	2.34	2.87	NA	1.51
VIL	2.35	2.88	2.38	NA

Table-10: Call setup time across service providers

Note-
<ul style="list-style-type: none"> 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	102.71	7.72	282.86	19.50
	80th Percentile	174.42	14.01	490.12	27.70
	20th Percentile	18.74	1.14	33.59	10.31
Upload Throughput (Mbits/s)	Average	18.17	4.54	24.95	11.12
	80th Percentile	31.07	7.49	47.03	18.87
	20th Percentile	4.36	1.37	4.01	2.28
Latency (ms)	50th Percentile	22.85	29.25	19.00	30.55

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

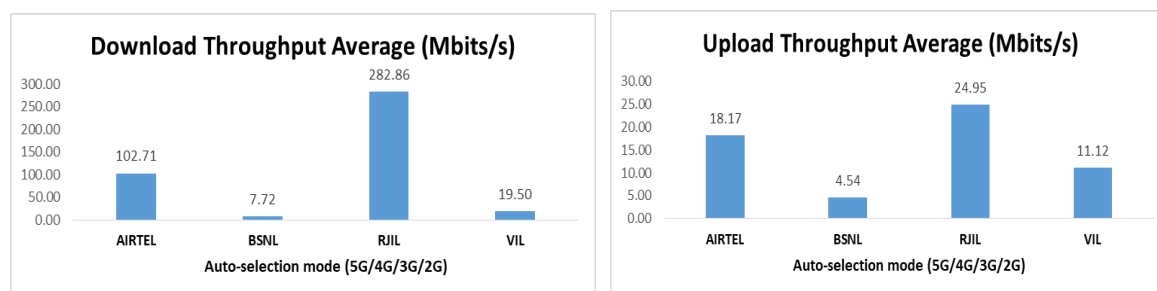


Figure- 5: Download and upload throughput

Number of unique cell id's covered in Data test- Technology wise				
Technology/ Service Provider	Auto-selection mode 5G/4G/3G/2G			
	AIRTEL	BSNL	RJIL	VIL
5G	0	NA	1276	NA
4G	2074	676	732	1787
3G	NA	120	NA	NA
2G	1	29	NA	25

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, highway and Railway 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 on 3rd December 2024 in Thiruvananthapuram. (Refer Table-1)

4.2.1 Drive test route

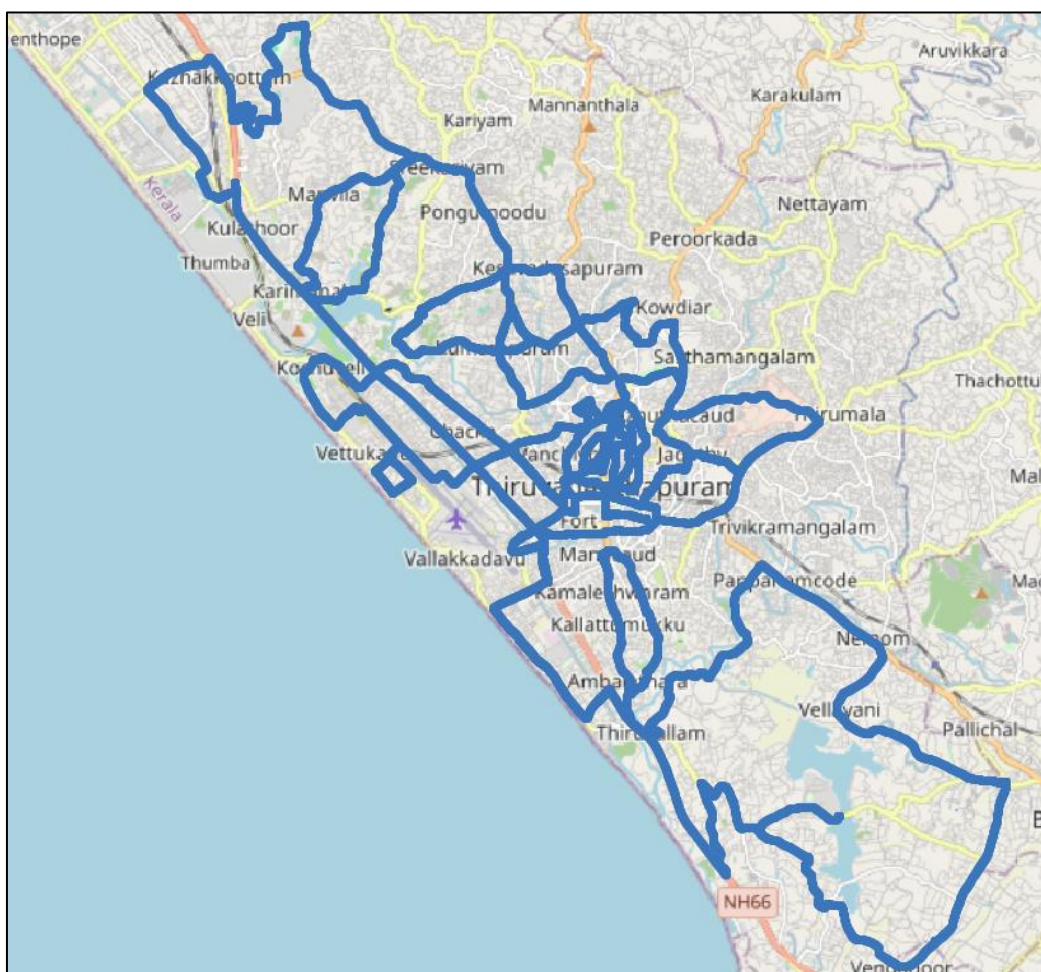


Figure- 6: Drive test routes

4.2.2 Areas covered

Thiruvallam, Vellayani, Vanchiyoor, Chacka, Jagathy, Kumarpuram, Pongumoodu, Shreekariyam, Kazhakkootam 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	257	256	256
Call Setup Success Rate %	99.61	100.00	98.44
Drop Call Rate %	0.39	1.17	0.00
Call Setup Time-Average (Second)	4.61	3.87	4.69
Handover Success Rate %	98.36	99.93	96.23

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

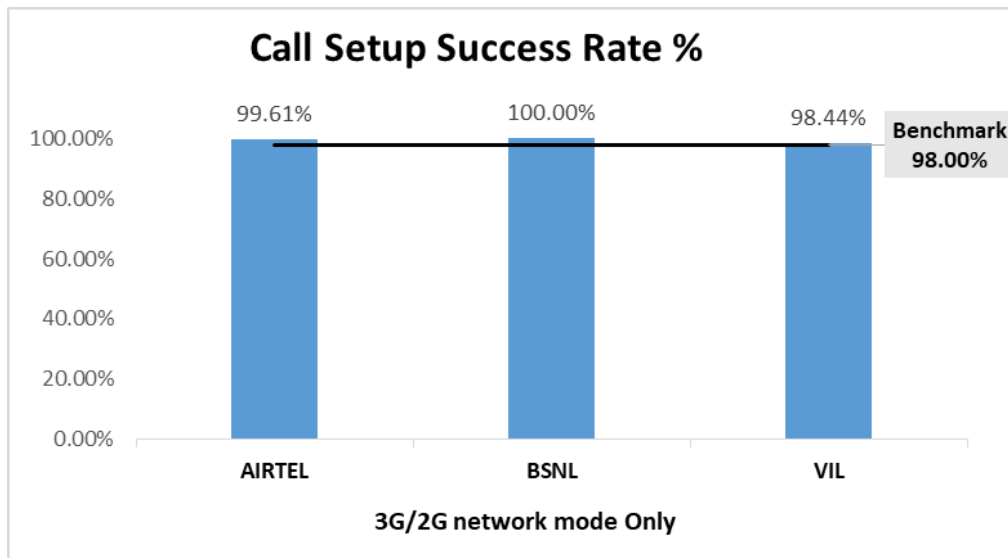


Figure-7: Performance for call setup success rate

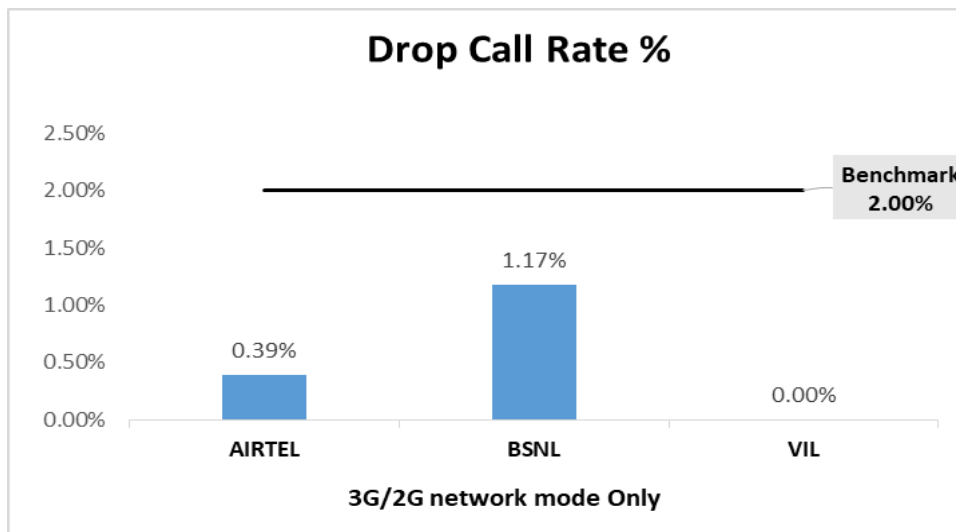


Figure-8: Performance for drop call rate

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

Technology	Service Provider		
	AIRTEL	BSNL	VIL
3G	NA	85.76%	NA
2G	100.00%	14.24%	100.00%
Limited Service	0.00%	0.00%	0.00%

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

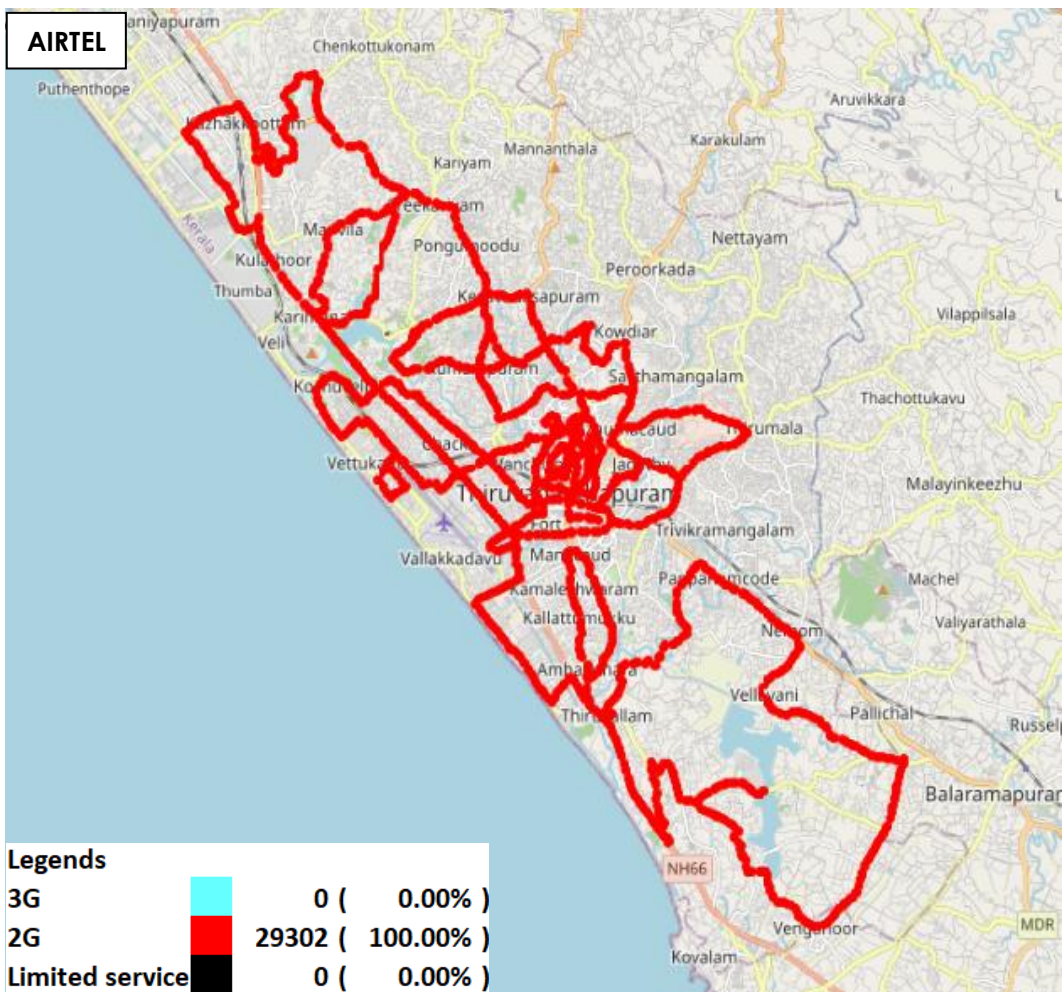


Figure-9: Serving technology plots 3G/2G network mode - AIRTEL

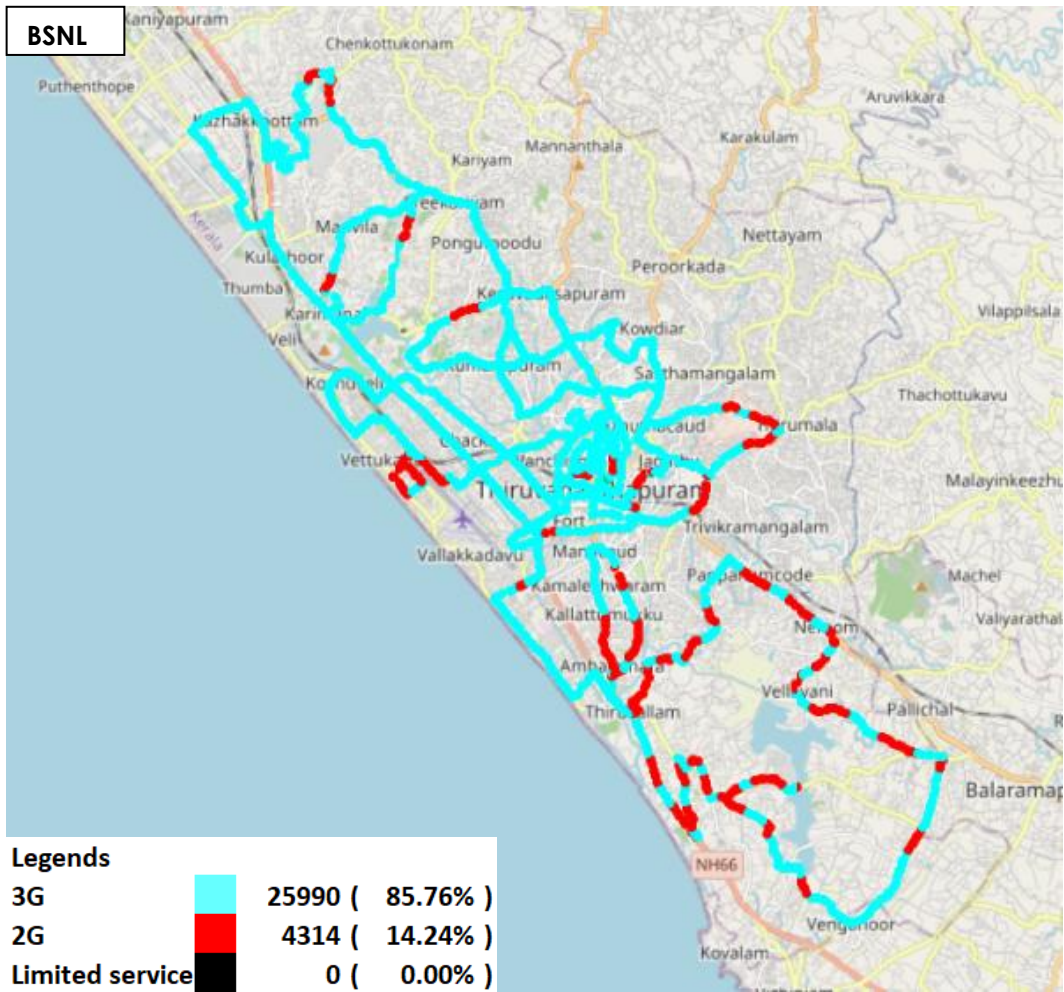


Figure-10: Serving technology plots 3G/2G network mode - BSNL

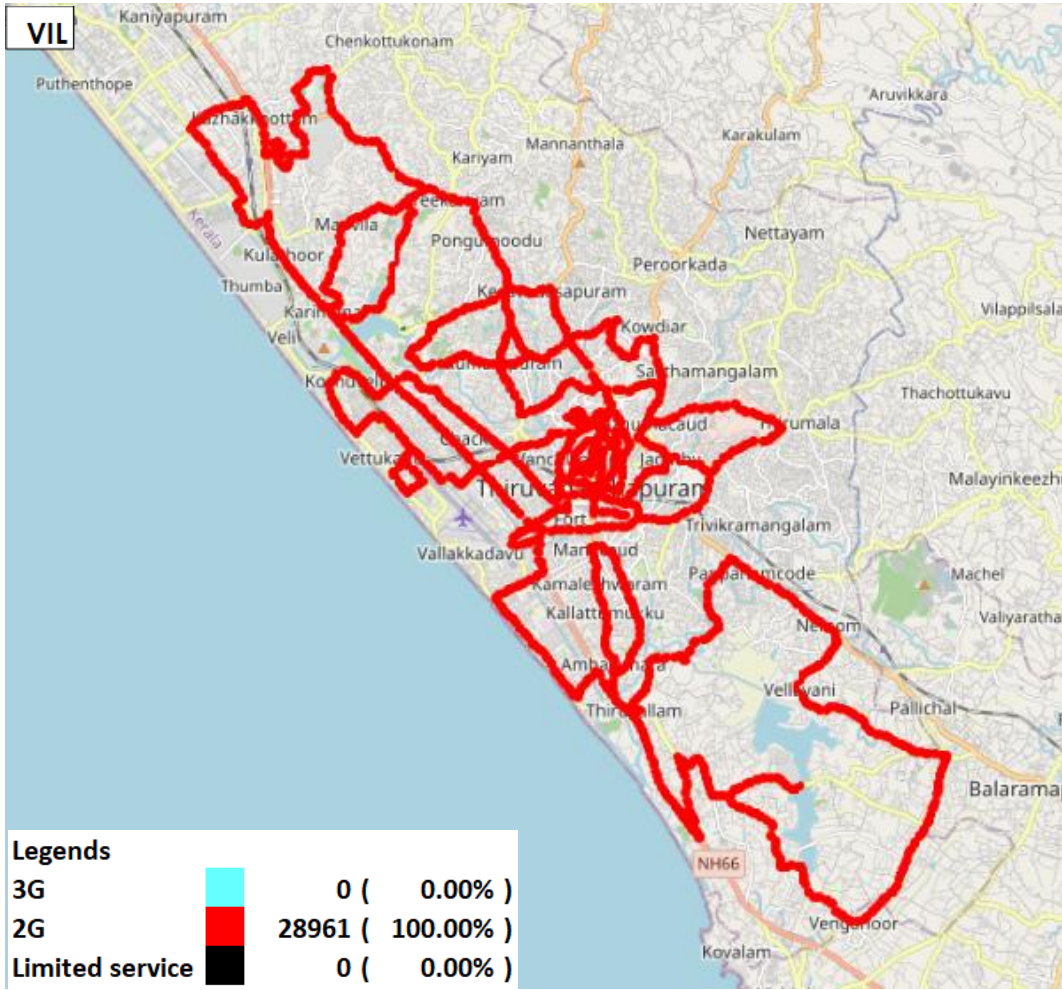


Figure-11: Serving technology plots 3G/2G network mode –VIL

(C) Network Signal Strength distribution: The following chart represents signal strength distribution for 3G/2G network mode only. (Refer figure-52, 53 & 54 for map view)

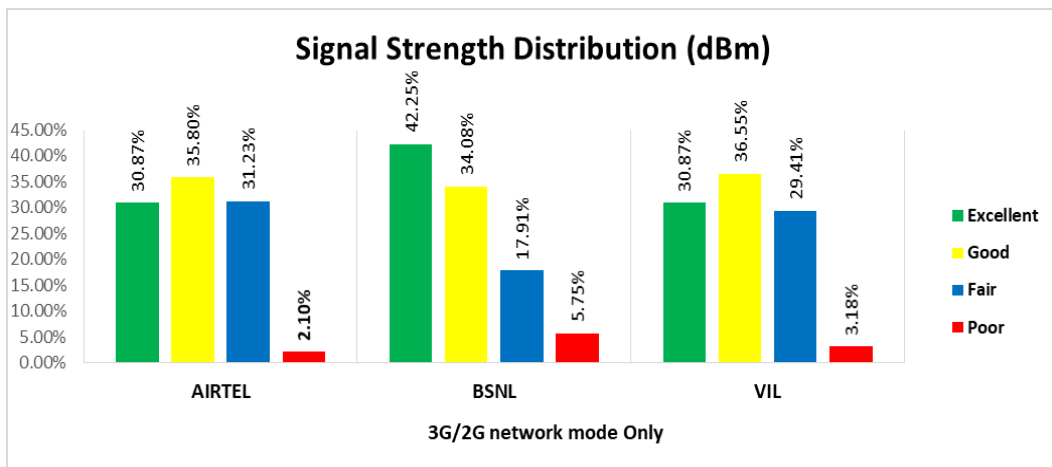


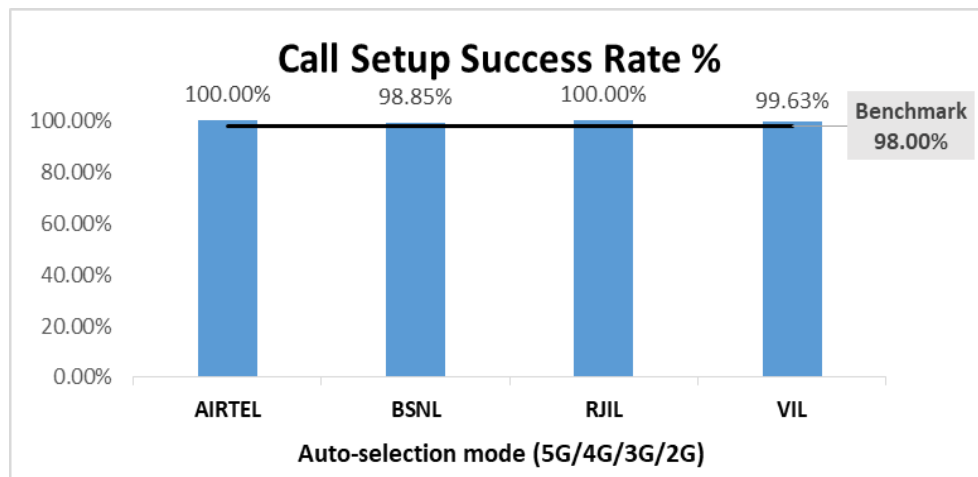
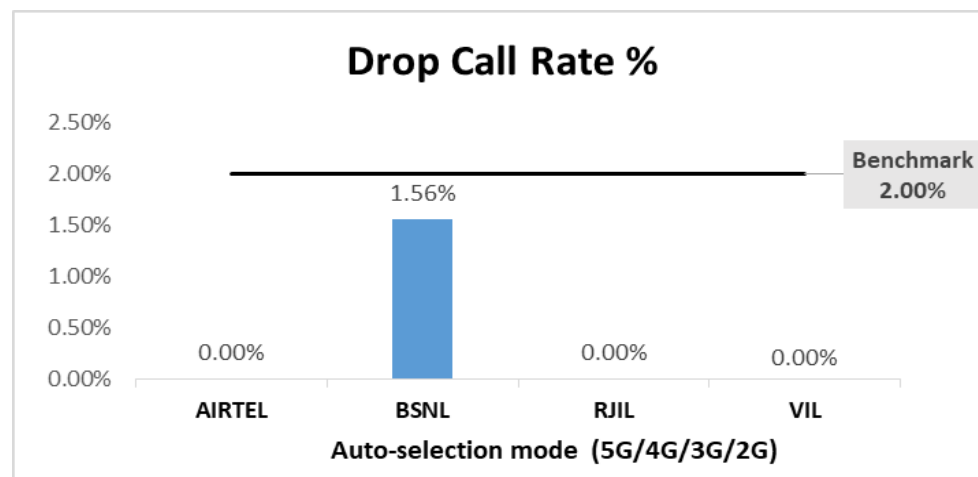
Figure-12: Signal strength distribution 3G/2G network mode only

Observations:

- Airtel's 31% of samples falling in the excellent signal strength category.
- BSNL's 42% of samples falling in the excellent signal strength category.
- VIL's 31% of samples falling in the excellent signal strength category.

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

Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Call Attempts	265	260	273	268
Call Setup Success Rate %	100.00	98.85	100.00	99.63
Drop Call Rate %	0.00	1.56	0.00	0.00
Call Setup Time Average (Second)	1.21	4.57	0.57	1.04
Handover Success Rate %	99.93	99.69	99.88	100.00

Table-15: Summary of voice call performance in network auto-selection mode**Figure-13:** Performance for call setup success rate**Figure-14:** Performance for drop call rate

Parameter	Service Provider			
	Mobile-to-Mobile (5G/4G - Open Mode)			
	AIRTEL	BSNL	RJIL	VIL
Call Established (within service provider Network)	257	252	258	263
Number of silence call for >4 Sec	1	NA	0	8
Silence Call Rate %	0.39	NA	0.00	3.04
Number of silence instances for >4 Sec	1	NA	0	8
Number of silence instances for >3 Sec	2	NA	0	11
Number of silence instances for >2 sec	3	NA	3	46
RTP Jitter (4G & 5G) in ms	4.51	NA	7.02	17.31
Packet loss Rate Downlink %	0.29	NA	0.13	2.81
Packet loss Rate Uplink %	0.19	NA	0.16	2.65

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

(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	1538	1320	1536	1490
Speech Quality (Average MOS Score)	4.05	2.83	3.96	4.41
Number of samples with MOS >=4 to <5 (Excellent)	1351	19	1157	1267
Number of samples with MOS >=3 to <4 (Good)	165	550	326	135
Number of samples with MOS >=2 to <3 (Fair)	13	646	41	35
Number of samples with MOS >=1 to <2 (Poor)	9	105	12	53
%age of samples with MOS >=4 to <5 (Excellent)	87.84%	1.44%	75.33%	85.03%
%age of samples with MOS >=3 to <4 (Good)	10.73%	41.67%	21.22%	9.06%
%age of samples with MOS >=2 to <3 (Fair)	0.85%	48.94%	2.67%	2.35%
%age of samples with MOS >=1 to <2 (Poor)	0.59%	7.95%	0.78%	3.56%

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

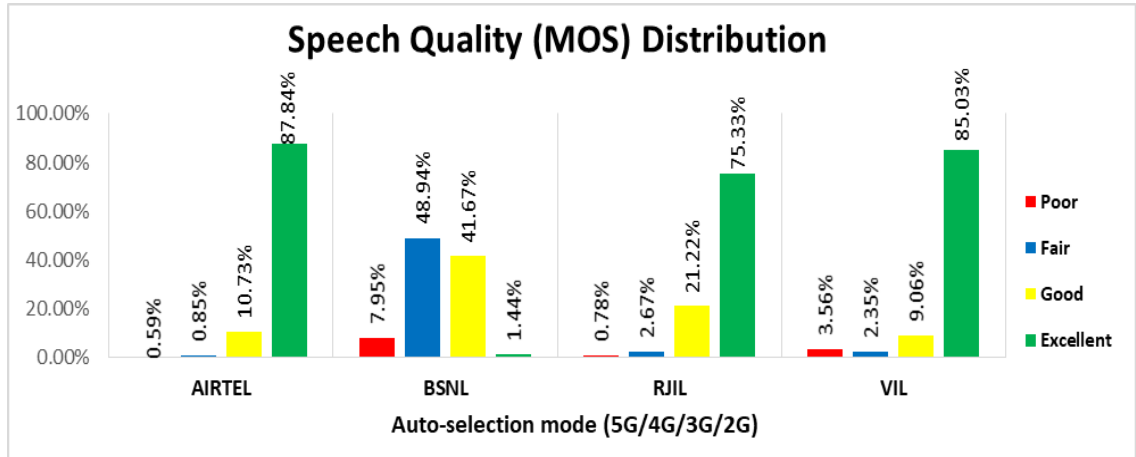


Figure-15: Distribution of samples in MOS score range

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

Technology	Service Provider			
	AIRTEL	BSNL	RJIL	VIL
5G	8.54%	NA	17.85%	NA
4G	91.46%	6.85%	82.15%	100.00%
3G	NA	69.71%	NA	NA
2G	0.00%	22.94%	NA	0.00%
Limited Service	0.00%	0.49%	0.00%	0.00%

Table-18: Time spent on technology during drive test

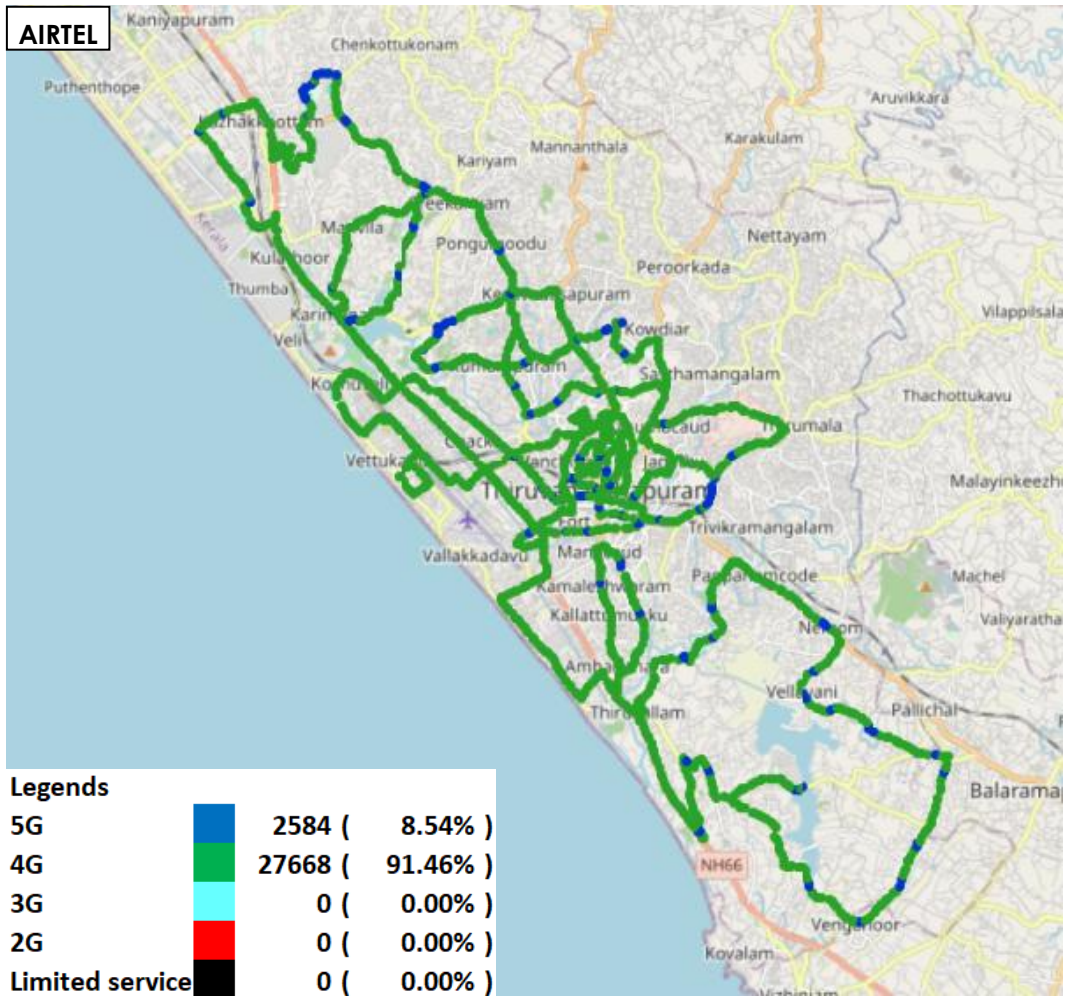


Figure-16: Serving technology plots in auto-selection mode (5G/4G/3G/2G) -AIRTEL

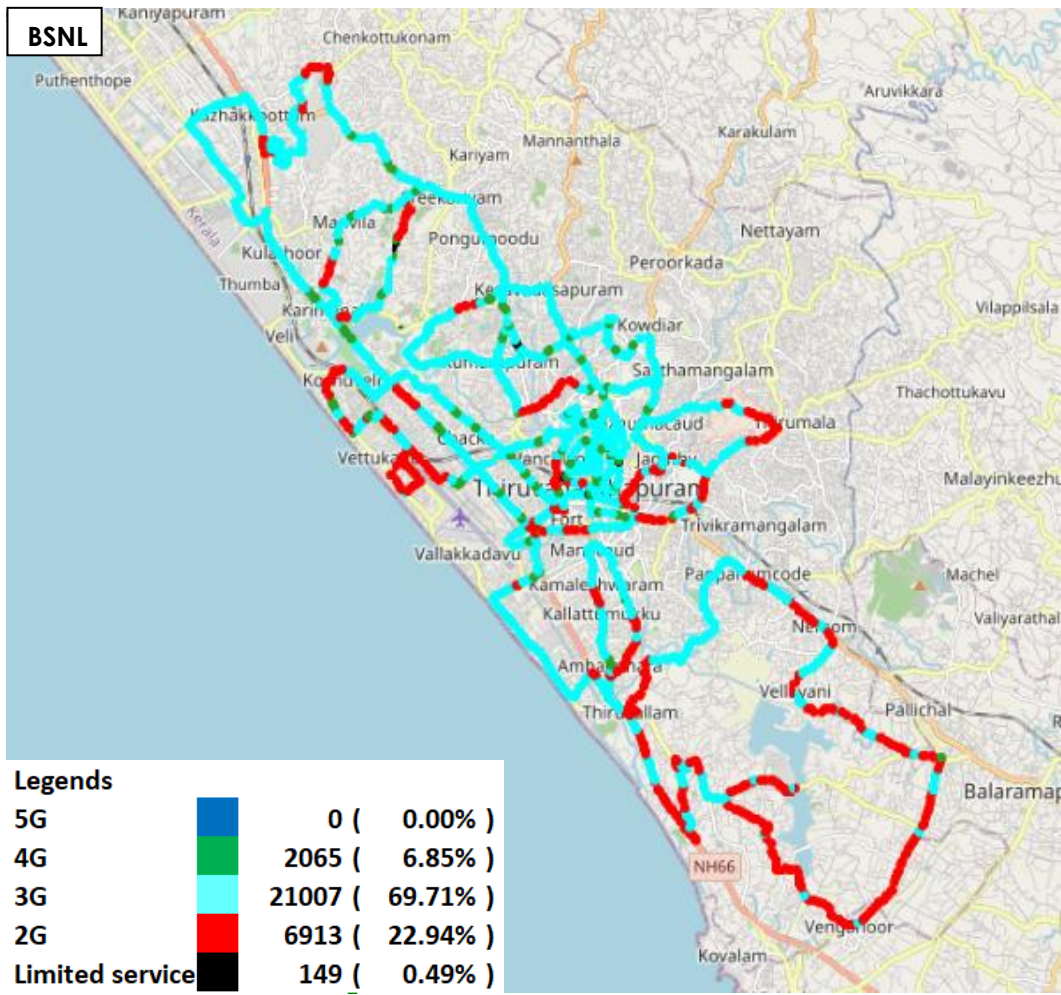


Figure-17: Serving technology plots in auto-selection mode (5G/4G/3G/2G) -BSNL

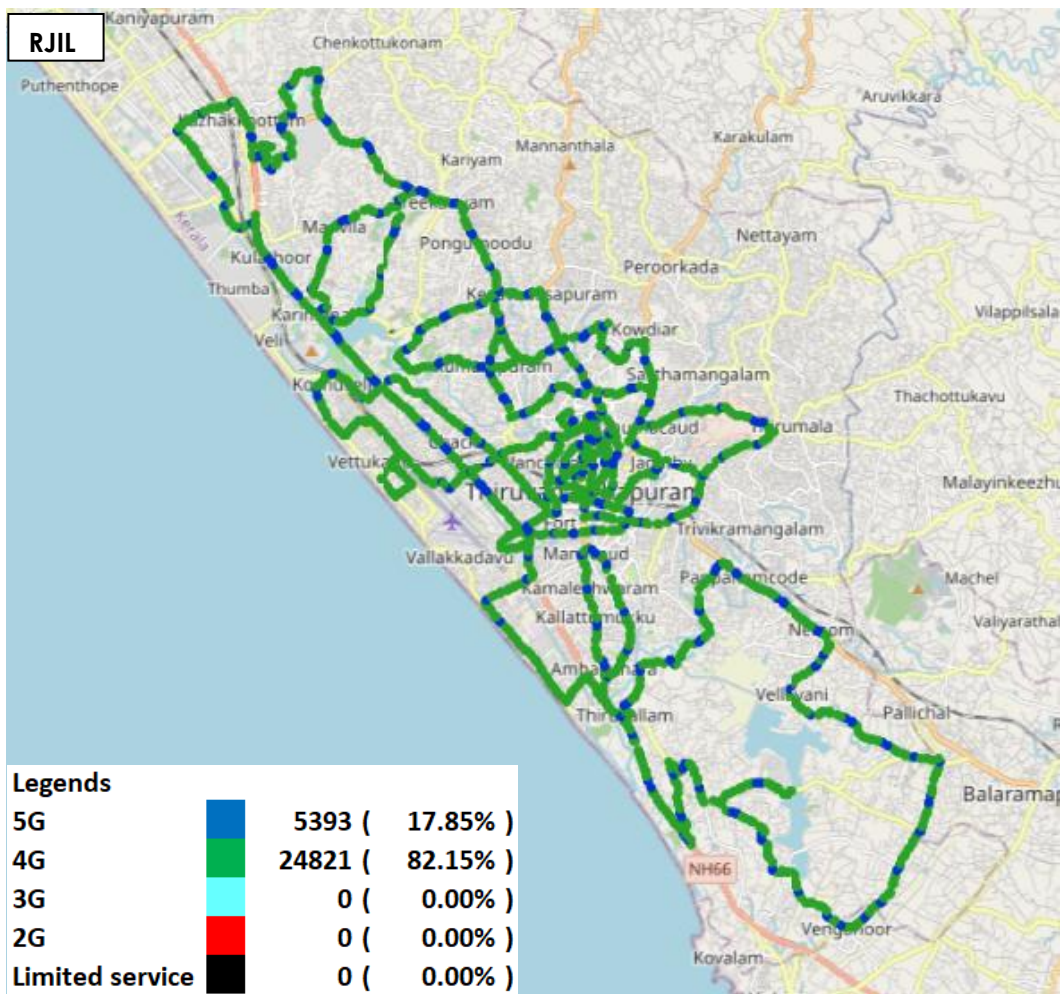


Figure-18: Serving technology plots in auto-selection mode (5G/4G/3G/2G)- RJIL

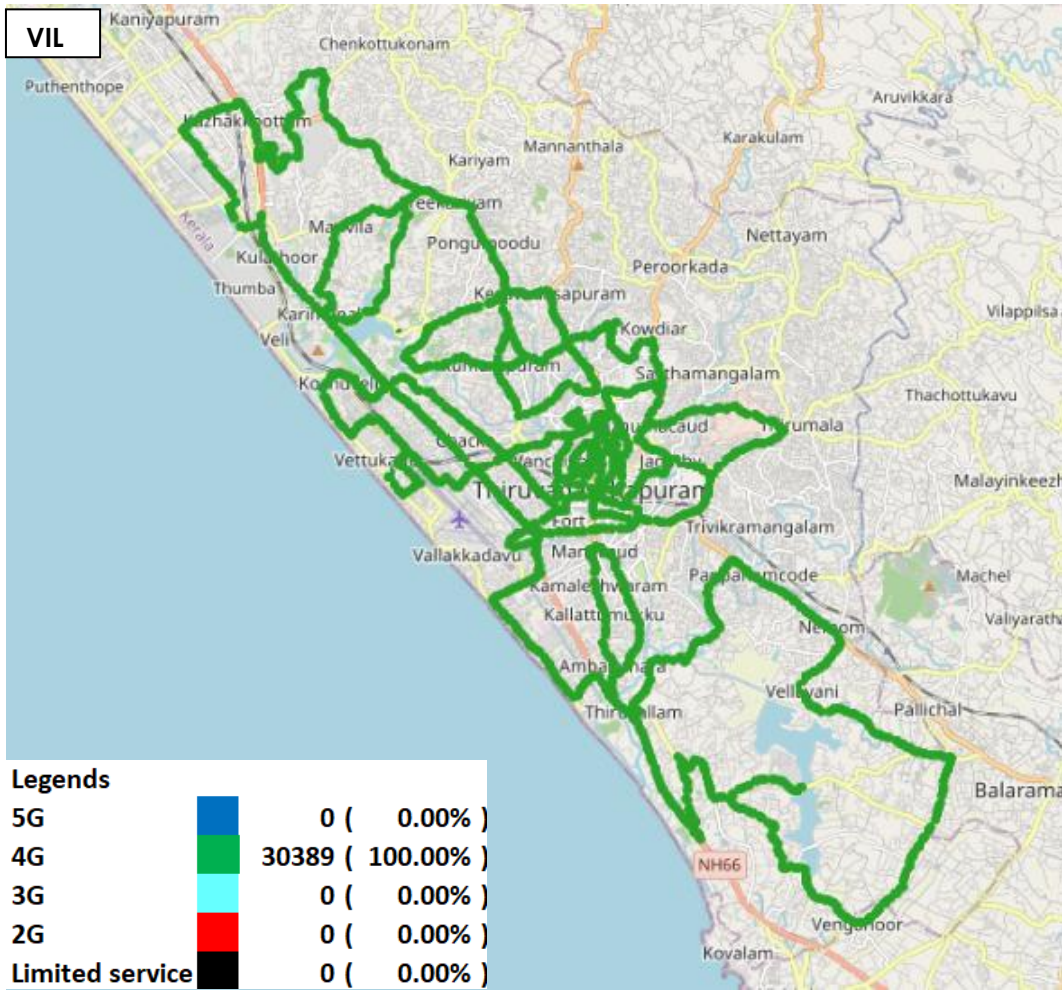


Figure-19: Serving technology plots in auto-selection mode (5G/4G/3G/2G) – VIL

(g) Network Signal Strength distribution: The following chart provide signal strength distribution for auto-selection mode (5G/4G/3G/2G). (Refer figure-55, 56, 57 & 58 for map view)

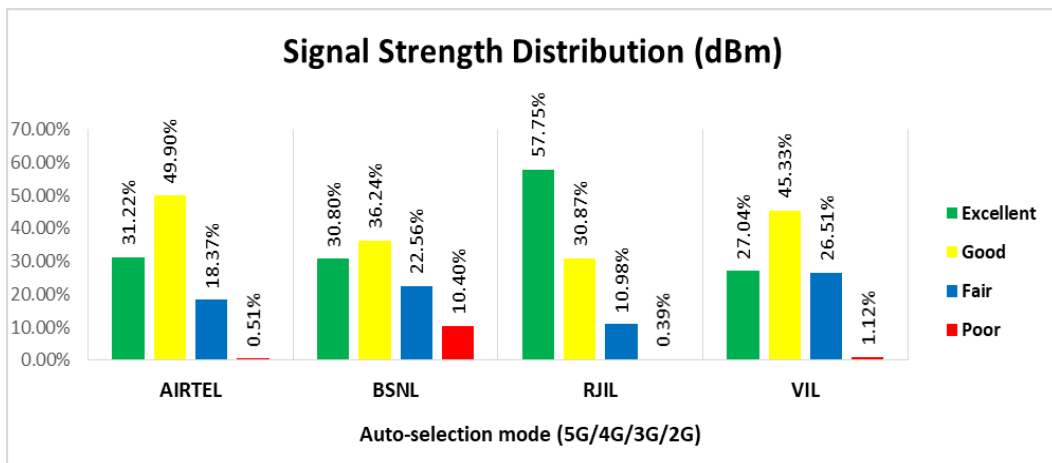


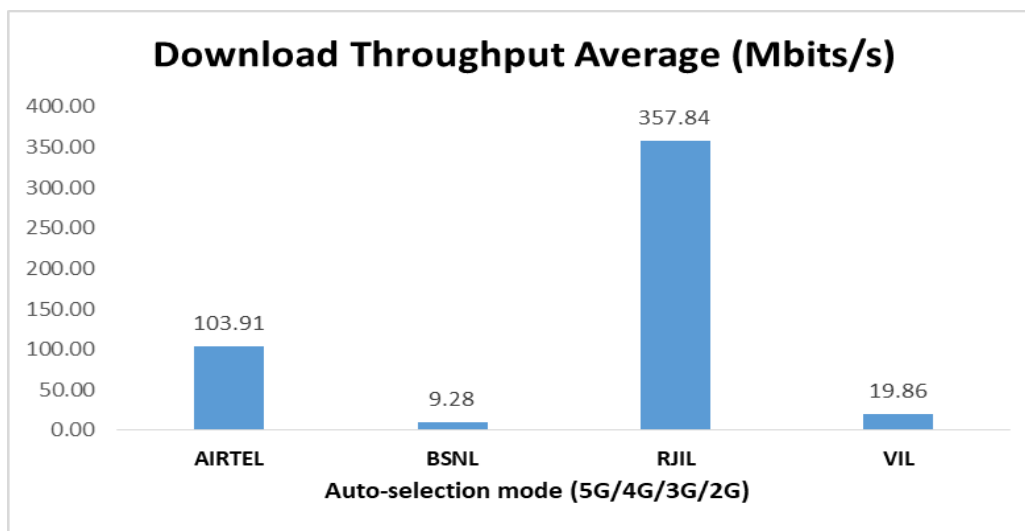
Figure-20: Signal strength distribution auto-selection mode 5G/4G/3G/2G

Observations:

- Airtel has 31% samples falling in the excellent signal strength category.
- BSNL has 31% samples falling in the excellent signal strength category.
- RJIL has 58% samples falling in the excellent signal strength category.
- VIL has 27% samples falling in the excellent signal strength category.

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

Parameters		Service Provider			
		Auto-selection mode (5G/4G/3G/2G)			
		AIRTEL	BSNL	RJIL	VIL
Download Throughput (Mbits/s)	Average	103.91	9.28	357.84	19.86
	80th Percentile	155.10	17.44	540.90	27.78
	20th Percentile	33.66	1.19	155.29	11.56
Upload Throughput (Mbits/s)	Average	19.49	5.09	28.70	9.53
	80th Percentile	31.78	9.42	51.64	16.25
	20th Percentile	5.61	1.48	5.11	2.42
Latency (ms)	50th Percentile	22.95	27.25	16.90	30.95

Table-19: Summary of Data performance in network auto-selection mode**Figure- 21:** Download throughput

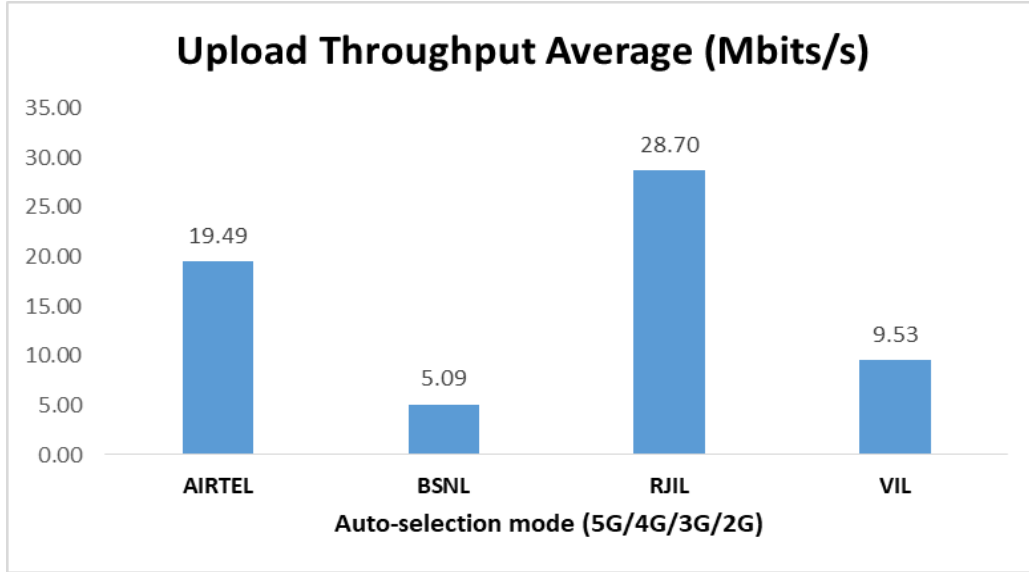


Figure- 22: Upload throughput

4.3 Hotspots

Hotspot testing has been done on 4th December 2024. Ten locations have been tested in the city.

4.3.1 Locations

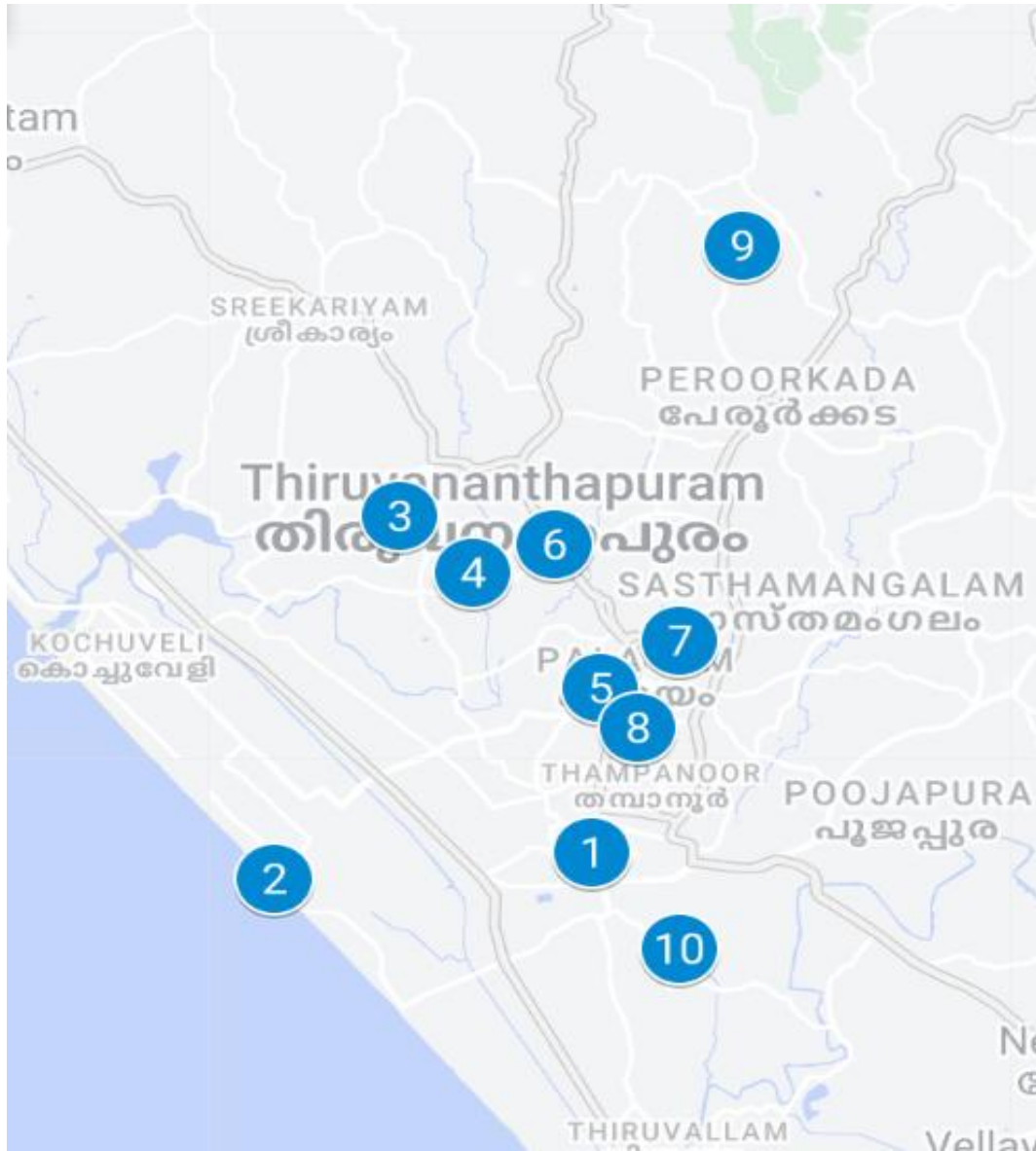


Figure- 23: Hotspot locations

4.3.2 Hotspot covered

1. Sree Padmanabhaswamy Temple
2. Shangumugham Beach
3. Sree Chita Triunal Institute For Medical Science
4. GG Hospital
5. University Of Kerala
6. Kerala Public Service Commission
7. Napier Museum
8. Central Stadium
9. DC Office
10. Attukal Bhagavathy Temple

4.3.3 Voice performance

Overall Voice Performance				
Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Call Attempt	100	100	100	100
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)	1.22	3.54	0.55	1.01

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

Sree Padmanabhaswamy Temple				
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)	1.13	3.15	0.53	0.69

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

Shangumugham Beach				
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)	1.16	3.24	0.52	0.68

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

Sree Chita Triunal Institute For Medical Science				
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)	1.10	3.50	0.64	0.75

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

GG Hospital				
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)	1.21	3.18	0.53	2.10

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

University Of Kerala				
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)	1.26	4.21	0.54	0.70

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

Kerala Public Service Commission				
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)	1.31	3.29	0.52	0.87

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

Napier Museum				
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)	1.24	3.72	0.57	2.15

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

Central Stadium				
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)	1.29	3.33	0.70	0.77

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

DC Office				
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)	1.26	4.60	0.50	0.72

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

Attukal Bhagavathy Temple				
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)	1.20	3.20	0.46	0.66

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	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	77.51	7.35	231.16	21.93
Download Throughput 80th Percentile (Mbit/s)	137.26	11.56	390.48	31.48
Download Throughput 20th Percentile (Mbit/s)	23.09	1.80	93.15	12.83
Download Session Setup Success Rate %	100.00	94.00	84.00	90.00
Upload Throughput Average (Mbits/s)	19.67	5.87	20.47	16.66
Upload Throughput 80th Percentile (Mbit/s)	32.66	13.03	33.68	33.53
Upload Throughput 20th Percentile (Mbit/s)	7.69	1.56	3.32	2.62
Upload Session Setup Success Rate %	100.00	98.00	100.00	96.00
Web Browsing Delay (Second)	3.42	3.36	2.67	3.32
Youtube Initial Buffer Delay (Second)	0.83	1.60	0.65	0.92
Latency (ms)- 50th Percentile	21.45	27.70	22.60	26.20
Jitter (ms)	5.80	15.56	28.12	4.12
Packet Loss Rate %	0.08	19.72	2.22	7.12

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

Sree Padmanabhaswamy Temple				
Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	56.78	19.83	325.89	26.12
Download Session Setup Success Rate %	100.00	100.00	80.00	80.00
Upload Throughput Average (Mbits/s)	9.72	11.05	29.46	1.78
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	5.98	2.42	1.98	3.53
Youtube Initial Buffer Delay (Second)	0.80	1.02	0.68	0.90
Latency (ms)-50th Percentile	23.20	28.65	21.80	-
Jitter (ms)	7.33	12.81	5.52	-
Packet Loss Rate %	0.10	7.50	0.10	-

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

Note-

- (-) All ping test failed in VIL.

Shangumugham Beach				
Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	29.62	5.06	134.47	34.30
Download Session Setup Success Rate %	100.00	80.00	80.00	100.00
Upload Throughput Average (Mbits/s)	6.37	2.15	33.63	25.89
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.84	4.76	3.19	3.57
Youtube Initial Buffer Delay (Second)	0.95	1.66	0.70	0.81
Latency (ms)-50th Percentile	33.85	28.85	32.70	27.60
Jitter (ms)	11.13	41.21	20.49	5.74
Packet Loss Rate %	0.10	14.30	1.20	0.70

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

Sree Chita Triunal Institute For Medical Science				
Parameters	Service Provider			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	36.93	1.09	46.76	5.91
Download Session Setup Success Rate %	100.00	100.00	100.00	80.00
Upload Throughput Average (Mbits/s)	10.96	1.24	1.59	7.27
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.69	-	4.00	3.61
Youtube Initial Buffer Delay (Second)	0.77	-	1.33	1.28
Latency (ms)-50th Percentile	25.35	31.00	23.43	-
Jitter (ms)	9.66	12.69	79.70	-
Packet Loss Rate %	0.10	3.00	3.40	-

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

Note-

- (-) All web browsing and youtube tests failed in BSNL.
- (-) All ping test failed in VIL.

GG Hospital				
Parameters	Service Provider			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	66.51	1.91	399.36	14.84
Download Session Setup Success Rate %	100.00	100.00	60.00	80.00
Upload Throughput Average (Mbits/s)	30.84	1.42	36.09	1.92
Upload Session Setup Success Rate %	100.00	100.00	100.00	80.00
Web Browsing Delay (Second)	3.48	5.16	2.25	3.28
Youtube Initial Buffer Delay (Second)	0.78	1.15	0.52	0.96
Latency (ms)-50th Percentile	20.53	28.60	18.80	-
Jitter (ms)	5.03	15.55	3.97	-
Packet Loss Rate %	0.00	1.90	0.00	-

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

Note-

- (-) All ping test failed in VIL.

University Of Kerala				
Parameters	Service Provider			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	84.97	5.17	145.63	13.16
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	19.64	3.75	4.92	20.26
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	3.04	3.15	2.26	3.15
Youtube Initial Buffer Delay (Second)	0.79	2.34	0.59	0.78
Latency (ms)-50th Percentile	22.55	32.50	23.25	28.83
Jitter (ms)	5.65	56.24	8.58	2.31
Packet Loss Rate %	0.10	83.80	0.20	33.60

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

Kerala Public Service Commission				
Parameters	Service Provider			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	79.48	11.71	242.59	33.58
Download Session Setup Success Rate %	100.00	100.00	80.00	80.00
Upload Throughput Average (Mbits/s)	22.27	13.58	24.91	37.17
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.52	2.69	2.51	2.76
Youtube Initial Buffer Delay (Second)	0.80	0.78	0.55	0.66
Latency (ms)-50th Percentile	18.85	26.60	26.85	-
Jitter (ms)	2.31	3.69	9.48	-
Packet Loss Rate %	0.00	0.10	0.50	-

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

Note-
<ul style="list-style-type: none"> (-) All ping test failed in VIL.

Napier Museum				
Parameters	Service Provider			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	74.07	8.17	152.85	28.06
Download Session Setup Success Rate %	100.00	100.00	80.00	100.00
Upload Throughput Average (Mbits/s)	8.25	7.07	3.19	18.05
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	2.41	2.64	2.49	3.09
Youtube Initial Buffer Delay (Second)	0.70	1.26	0.70	0.66
Latency (ms)-50th Percentile	20.40	25.85	26.95	26.20
Jitter (ms)	6.44	10.82	7.59	1.99
Packet Loss Rate %	0.30	0.50	0.00	0.40

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

Central Stadium				
Parameters	Service Provider			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	124.31	10.52	89.09	18.48
Download Session Setup Success Rate %	100.00	100.00	80.00	80.00
Upload Throughput Average (Mbits/s)	23.20	13.31	17.81	10.74
Upload Session Setup Success Rate %	100.00	100.00	100.00	80.00
Web Browsing Delay (Second)	2.65	2.84	3.41	2.86
Youtube Initial Buffer Delay (Second)	0.67	0.99	0.57	0.94
Latency (ms)-50th Percentile	19.60	24.75	39.85	-
Jitter (ms)	2.27	3.84	137.79	-
Packet Loss Rate %	0.00	0.40	16.80	-

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

Note-
<ul style="list-style-type: none"> (-) All ping test failed in VIL.

DC Office				
Parameters	Service Provider			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	162.11	5.71	459.22	16.12
Download Session Setup Success Rate %	100.00	80.00	80.00	100.00
Upload Throughput Average (Mbits/s)	35.79	1.83	21.00	2.92
Upload Session Setup Success Rate %	100.00	80.00	100.00	100.00
Web Browsing Delay (Second)	4.42	5.30	2.32	4.19
Youtube Initial Buffer Delay (Second)	0.77	3.38	0.75	1.40
Latency (ms)-50th Percentile	16.60	26.95	14.30	25.20
Jitter (ms)	1.81	6.94	3.89	4.30
Packet Loss Rate %	0.00	0.80	0.00	0.40

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

Attukal Bhagavathy Temple				
Parameters	Service Provider			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	60.36	2.55	386.48	26.61
Download Session Setup Success Rate %	100.00	80.00	100.00	100.00
Upload Throughput Average (Mbits/s)	29.64	2.44	32.13	36.47
Upload Session Setup Success Rate %	100.00	100.00	100.00	100.00
Web Browsing Delay (Second)	4.04	3.58	2.47	3.16
Youtube Initial Buffer Delay (Second)	1.27	3.22	0.66	0.78
Latency (ms)-50th Percentile	28.05	86.50	20.00	25.00
Jitter (ms)	6.37	68.42	4.76	5.64
Packet Loss Rate %	0.10	84.87	0.00	0.50

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

4.4 Walk Test

Walk test testing has been done on 5th December 2024. Five locations have been tested in the city.

4.4.1 Walk test location map

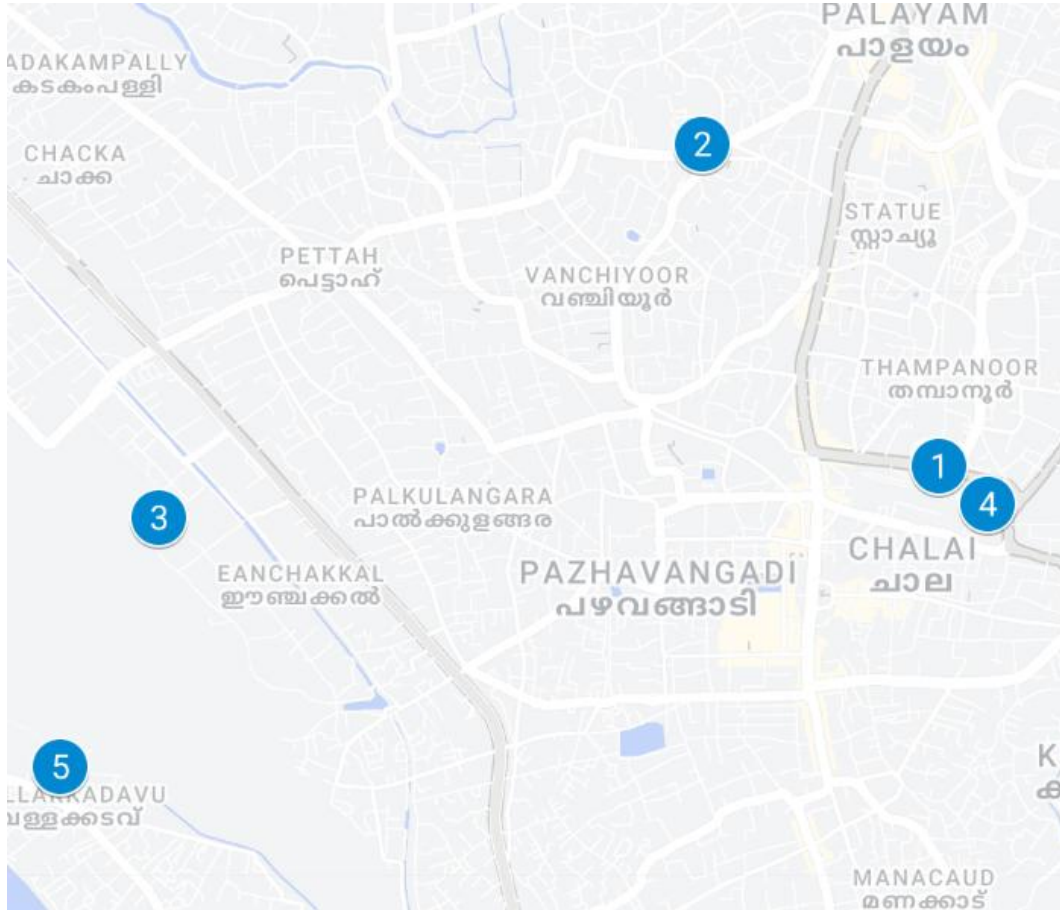


Figure- 24: Walk Test locations

4.4.2 Walk Test covered

1. Central Bus Stand
2. General Hospital Trivandrum
3. Thiruvananthapuram Airport
4. Thiruvananthapuram Railway Station
5. Airport T1 Domestic

4.4.3 Voice performance

Central Bus Stand				
Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Call Attempt	17	16	16	16
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)	1.16	3.76	0.49	0.75

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

General Hospital Trivandrum				
Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Call Attempt	14	14	14	14
Call Setup Success Rate %	100.00	100.00	100.00	100.00
Drop Call Rate %	0.00	0.00	0.00	0.00
Call Setup Time-Average (Second)	1.13	3.47	0.51	0.65

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

Thiruvananthapuram Airport				
Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Call Attempt	36	35	37	35
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)	1.16	4.21	0.56	0.64

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

Thiruvananthapuram Railway Station				
Parameters	Service Provider			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Call Attempt	30	28	30	30
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)	1.20	4.03	0.54	0.81

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

Airport T1 Domestic				
Parameters	Service Provider			
	Auto Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Call Attempt	28	27	29	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)	1.63	3.74	0.57	0.70

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

4.4.4 Data performance

Central Bus Stand				
Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	13.22	9.00	281.86	8.51
Download Session Setup Success Rate %	100.00	85.71	82.35	100.00
Upload Throughput Average (Mbits/s)	7.45	6.16	45.85	4.83
Upload Session Setup Success Rate %	100.00	95.24	100.00	100.00
Latency (ms)-50th Percentile	36.55	29.58	16.40	29.75

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

General Hospital Trivandrum				
Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	106.47	18.78	246.17	24.50
Download Session Setup Success Rate %	100.00	100.00	100.00	100.00
Upload Throughput Average (Mbits/s)	22.83	16.22	12.24	15.87
Upload Session Setup Success Rate %	100.00	92.31	100.00	100.00
Latency (ms)-50th Percentile	18.95	23.68	19.10	25.15

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

Thiruvananthapuram Airport				
Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	25.23	2.20	129.40	27.52
Download Session Setup Success Rate %	100.00	58.62	84.21	100.00
Upload Throughput Average (Mbits/s)	7.68	3.31	13.68	40.83
Upload Session Setup Success Rate %	100.00	61.11	97.30	100.00
Latency (ms)-50th Percentile	27.70	53.25	16.80	24.90

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

Thiruvananthapuram Railway Station				
Parameters	Service Provider			
	Auto-Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	31.53	11.63	219.30	13.53
Download Session Setup Success Rate %	100.00	88.24	100.00	87.50
Upload Throughput Average (Mbits/s)	18.03	9.74	43.75	4.15
Upload Session Setup Success Rate %	100.00	93.94	100.00	92.00
Latency (ms)-50th Percentile	33.70	25.00	16.00	37.95

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

Airport T1 Domestic				
Parameters	Service Provider			
	Auto-Mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Download Throughput Average (Mbits/s)	8.28	2.45	11.04	18.90
Download Session Setup Success Rate %	100.00	84.44	100.00	100.00
Upload Throughput Average (Mbits/s)	4.86	2.67	3.03	13.73
Upload Session Setup Success Rate %	100.00	79.55	100.00	100.00
Latency (ms)-50th Percentile	35.55	85.25	20.55	27.10

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

4.5 Highway

Drive test has been conducted on 2nd December 2024 covering Highway routes. (Refer Table-1)

4.5.1 Drive test routes

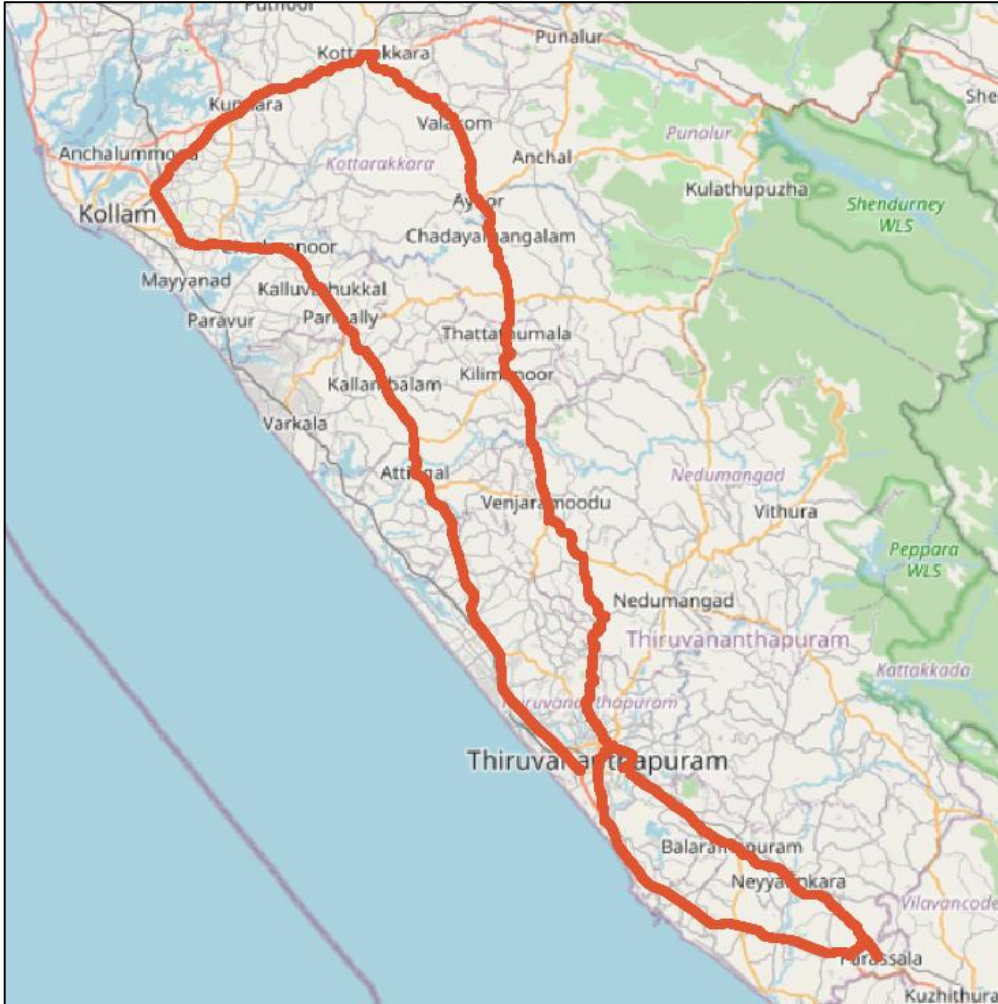


Figure-25: Drive test route highway

4.5.2 Routes Covered

- Thiruvanthapuram to kollam via parassala and Kottarakkara & Kollam to Thiruvanthapuram

4.5.2.1 Thiruvananthapuram to Kollam via parassala and kottarakkara & Kollam to Thiruvananthapuram

Drive test for this route has been conducted on 2nd December 2024.

i) 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	137	138	135
Call Setup Success Rate %	100.00	99.28	98.52
Drop Call Rate %	2.19	2.19	0.00
Call Setup Time-Average (Second)	4.82	3.69	4.83
Handover Success Rate %	99.06	99.60	97.29

Table-52: Summary of voice call performance in 3G/2G network mode only

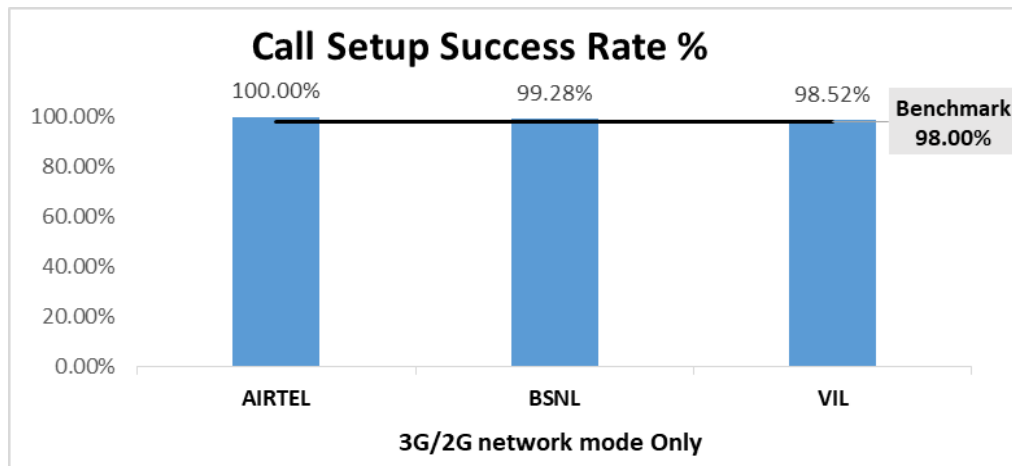


Figure-26: Performance for call setup success rate

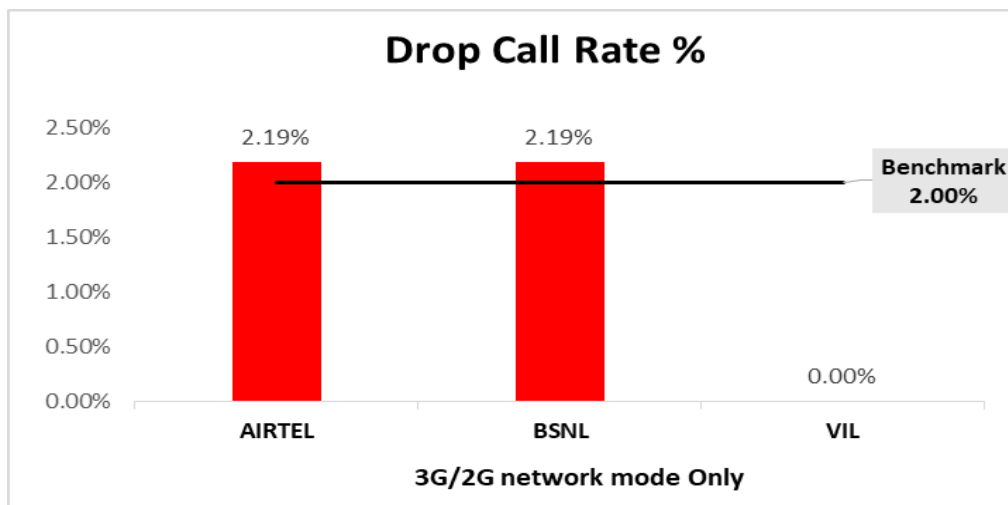


Figure-27: Performance for drop call rate

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

Technology	Service Provider		
	AIRTEL	BSNL	VIL
3G	NA	54.64%	NA
2G	100.00%	45.36%	100.00%
Limited Service	0.00%	0.00%	0.00%

Table-53: Time spent on technology during drive test 3G/2G network mode only

Note-

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

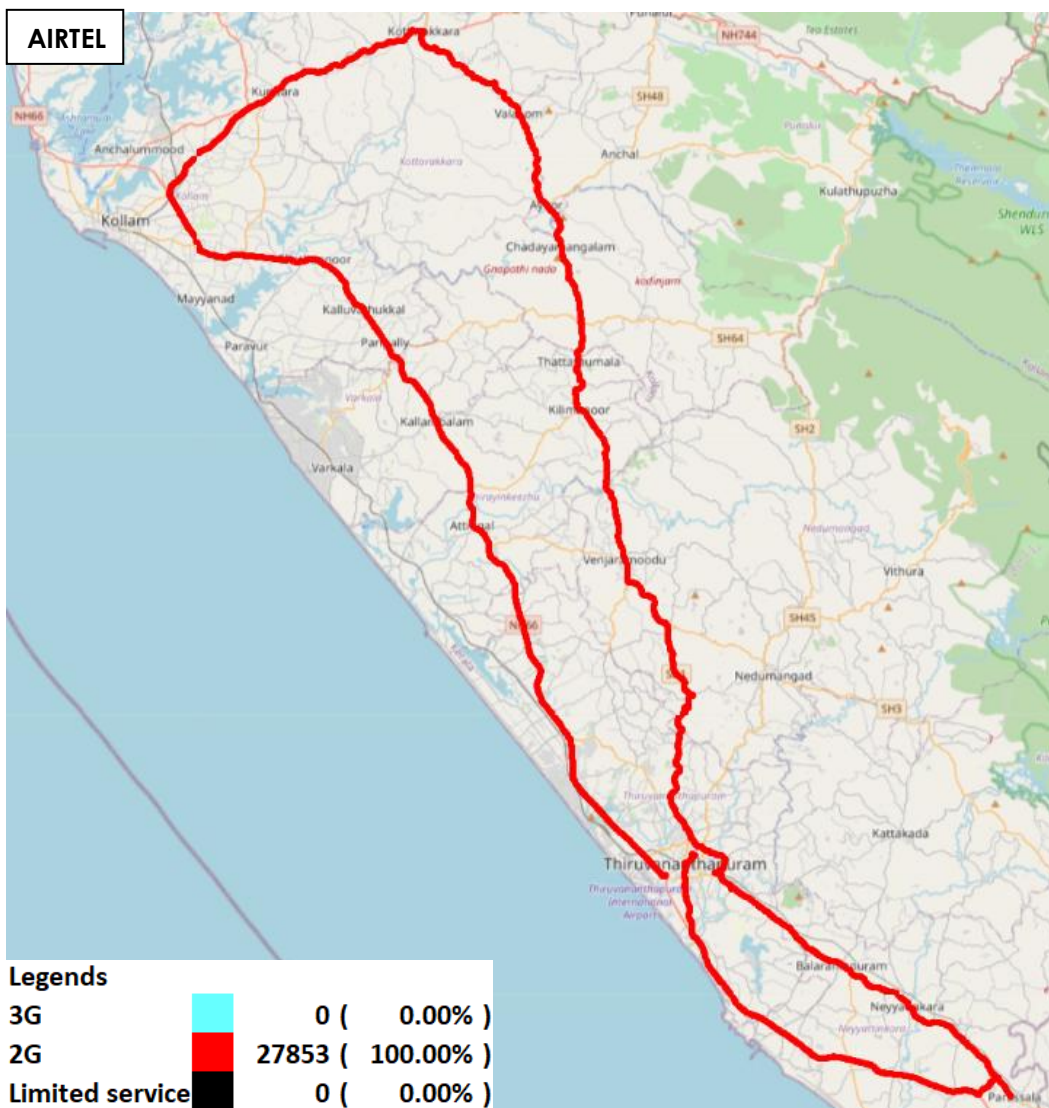


Figure-28: Serving technology plots 3G/2G network mode - AIRTEL

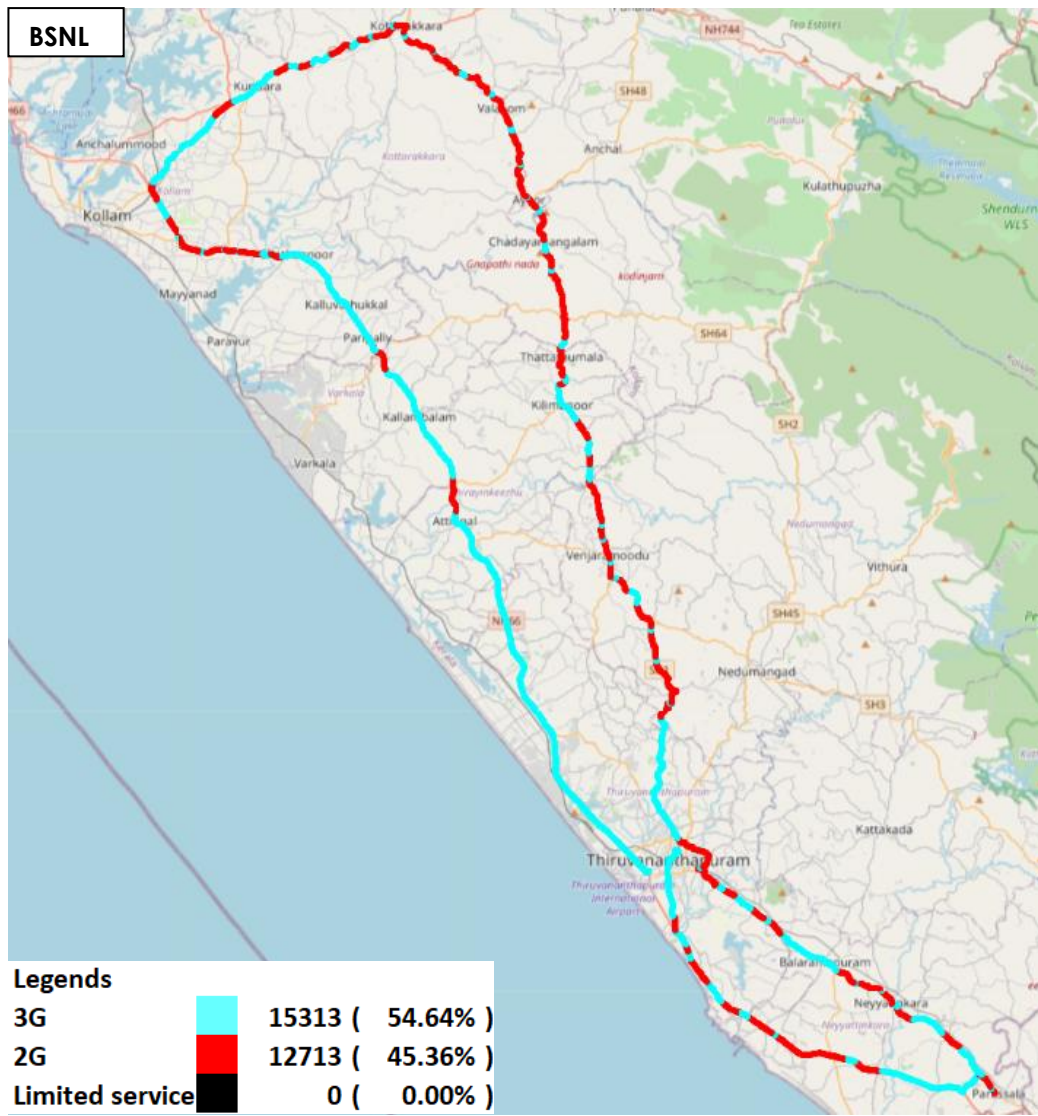


Figure-29: Serving technology plots 3G/2G network mode - BSNL

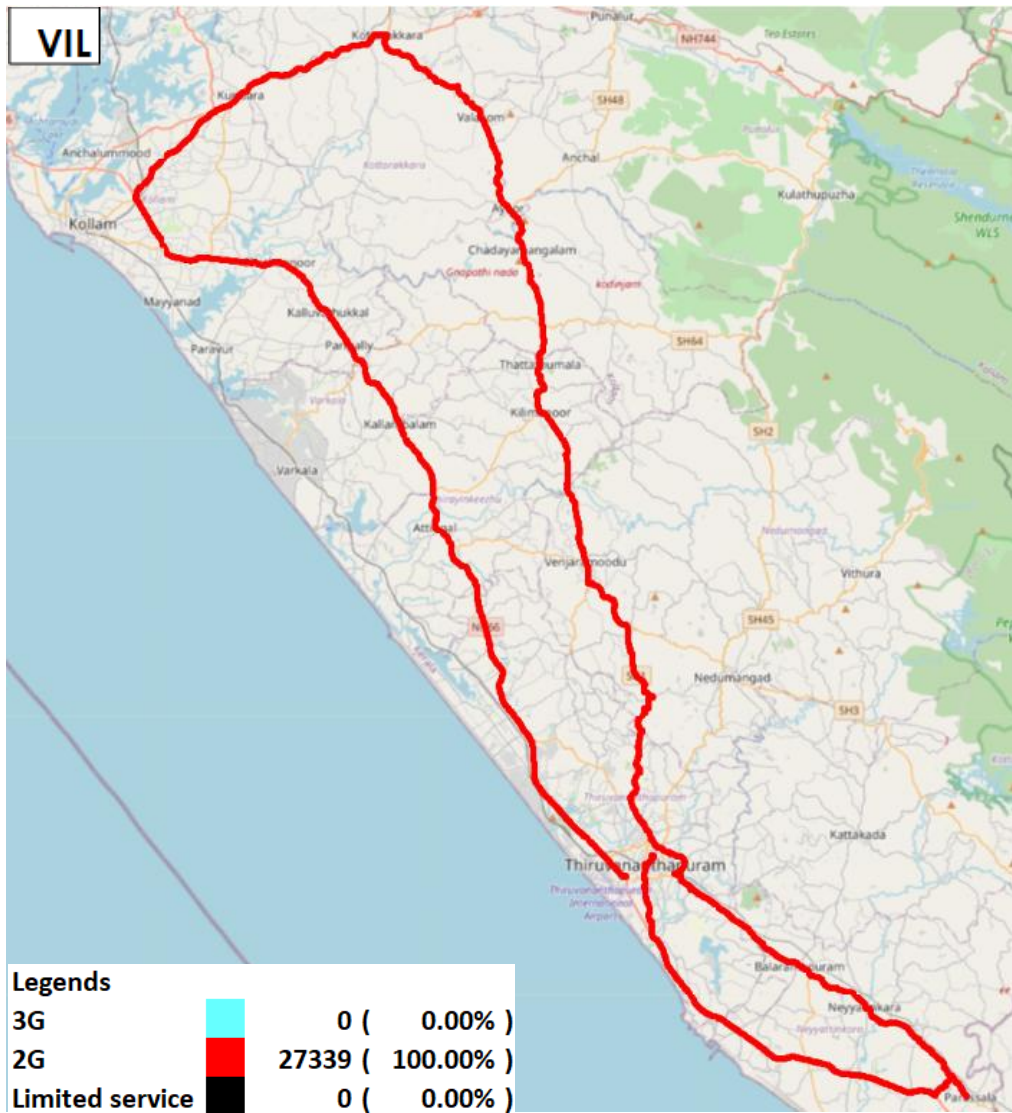


Figure-30: Serving technology plots 3G/2G network mode –VIL

(C) Network Signal Strength distribution: The following chart represents signal strength distribution for 3G/2G network mode only. (Refer figure-59, 60 & 61 for map view)

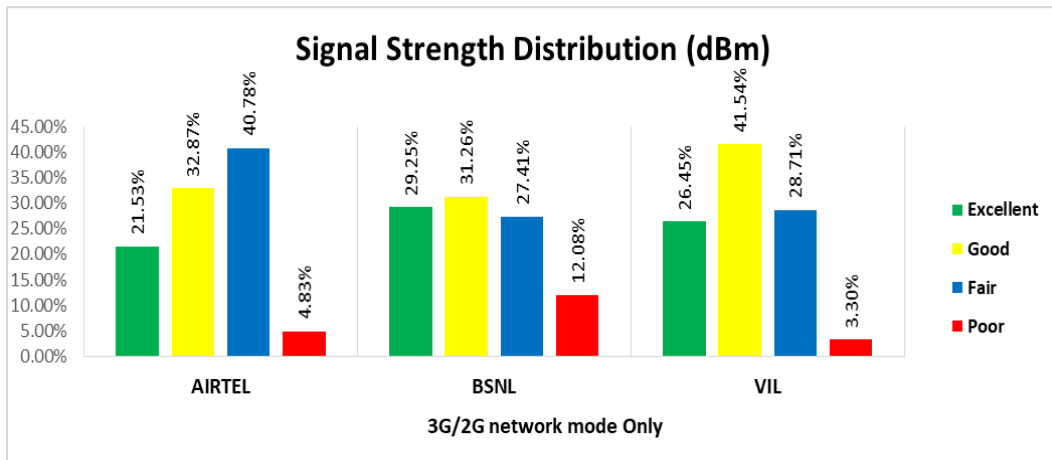


Figure-31: Signal strength distribution 3G/2G network mode only

Observations:

- Airtel's 22% of samples falling in the excellent signal strength category.
- BSNL's 29% of samples falling in the excellent signal strength category.
- VIL's 26% of samples falling in the excellent signal strength category.

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

Parameters	Service Provider			
	Auto-selection mode (5G/4G/3G/2G)			
	AIRTEL	BSNL	RJIL	VIL
Call Attempts	140	143	145	141
Call Setup Success Rate %	100.00	100.00	100.00	99.29
Drop Call Rate %	0.00	8.39	3.45	0.00
Call Setup Time Average (Second)	1.28	3.91	0.52	1.19
Handover Success Rate %	100.00	99.86	100.00	100.00

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

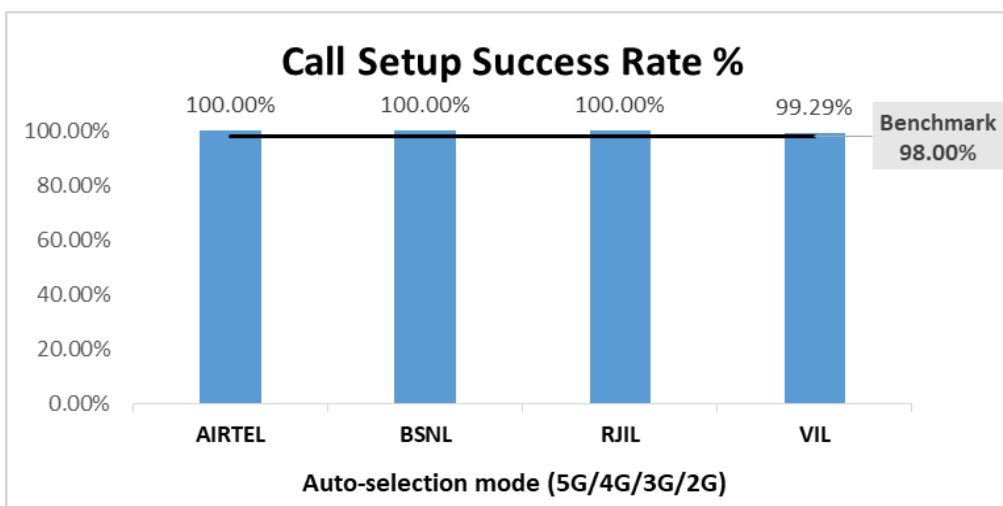


Figure-32: Performance for call setup success rate

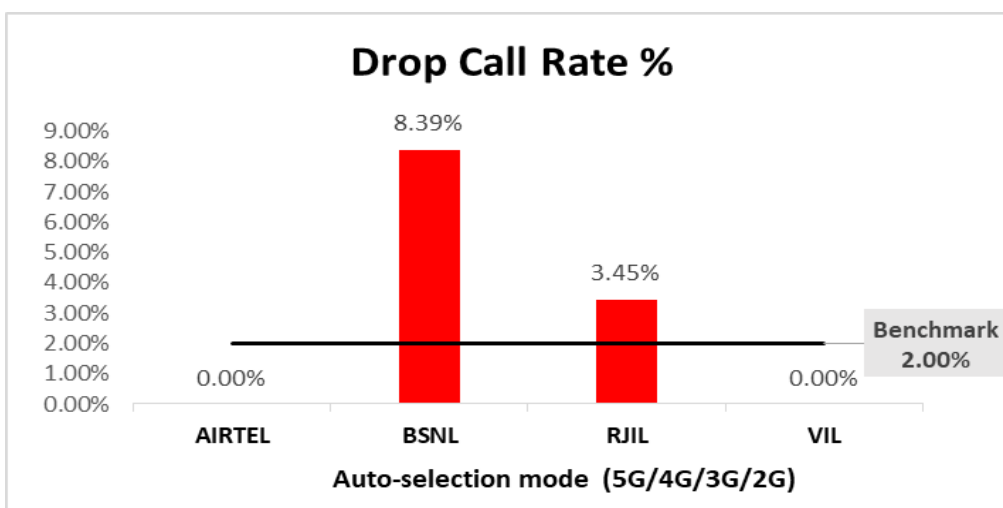


Figure-33: Performance for drop call rate

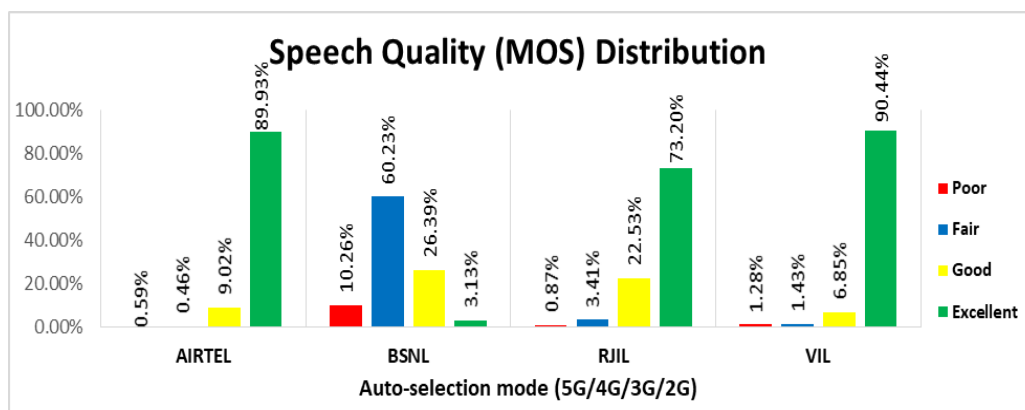
Parameter	Service Provider			
	Mobile-to-Mobile (5G/4G - Open Mode)			
	AIRTEL	BSNL	RJIL	VIL
Call Established (within service provider Network)	118	136	123	121
Number of silence call for >4 Sec	1	NA	0	5
Silence Call Rate %	0.85	NA	0.00	4.13
Number of silence instances for >4 Sec	1	NA	0	5
Number of silence instances for >3 Sec	2	NA	1	13
Number of silence instances for >2 sec	4	NA	7	25
RTP Jitter (4G & 5G) in ms	4.17	NA	8.65	17.99
Packet loss Rate Downlink %	0.25	NA	0.84	1.52
Packet loss Rate Uplink %	0.27	NA	0.26	2.25

Table-55: Summary of silence instances & packet loss rate for mobile to mobile call

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

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

Speech Quality (MOS) distribution	Service Provider			
	AIRTEL	BSNL	RJIL	VIL
Total Number of MOS Samples for calls in table-53	1519	1599	1496	1401
Speech Quality (Average MOS Score)	4.06	2.73	3.93	4.54
Number of samples with MOS ≥ 4 to < 5 (Excellent)	1366	50	1095	1267
Number of samples with MOS ≥ 3 to < 4 (Good)	137	422	337	96
Number of samples with MOS ≥ 2 to < 3 (Fair)	7	963	51	20
Number of samples with MOS ≥ 1 to < 2 (Poor)	9	164	13	18
%age of samples with MOS ≥ 4 to < 5 (Excellent)	89.93%	3.13%	73.20%	90.44%
%age of samples with MOS ≥ 3 to < 4 (Good)	9.02%	26.39%	22.53%	6.85%
%age of samples with MOS ≥ 2 to < 3 (Fair)	0.46%	60.23%	3.41%	1.43%
%age of samples with MOS ≥ 1 to < 2 (Poor)	0.59%	10.26%	0.87%	1.28%

Table-56: Summary of speech quality (MOS) samples**Figure-34:** Distribution of samples in MOS score range

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

Technology	Service Provider			
	AIRTEL	BSNL	RJIL	VIL
5G	6.33%	NA	27.68%	NA
4G	93.67%	3.00%	72.32%	99.28%
3G	NA	47.70%	NA	NA
2G	0.00%	48.99%	NA	0.72%
Limited Service	0.00%	0.30%	NA	0.00%

Table-57: Time spent on technology during drive test

Note-

- RJIL does not have 3G/2G network.
- NA- Service provider doesn't provide services in respective technology.

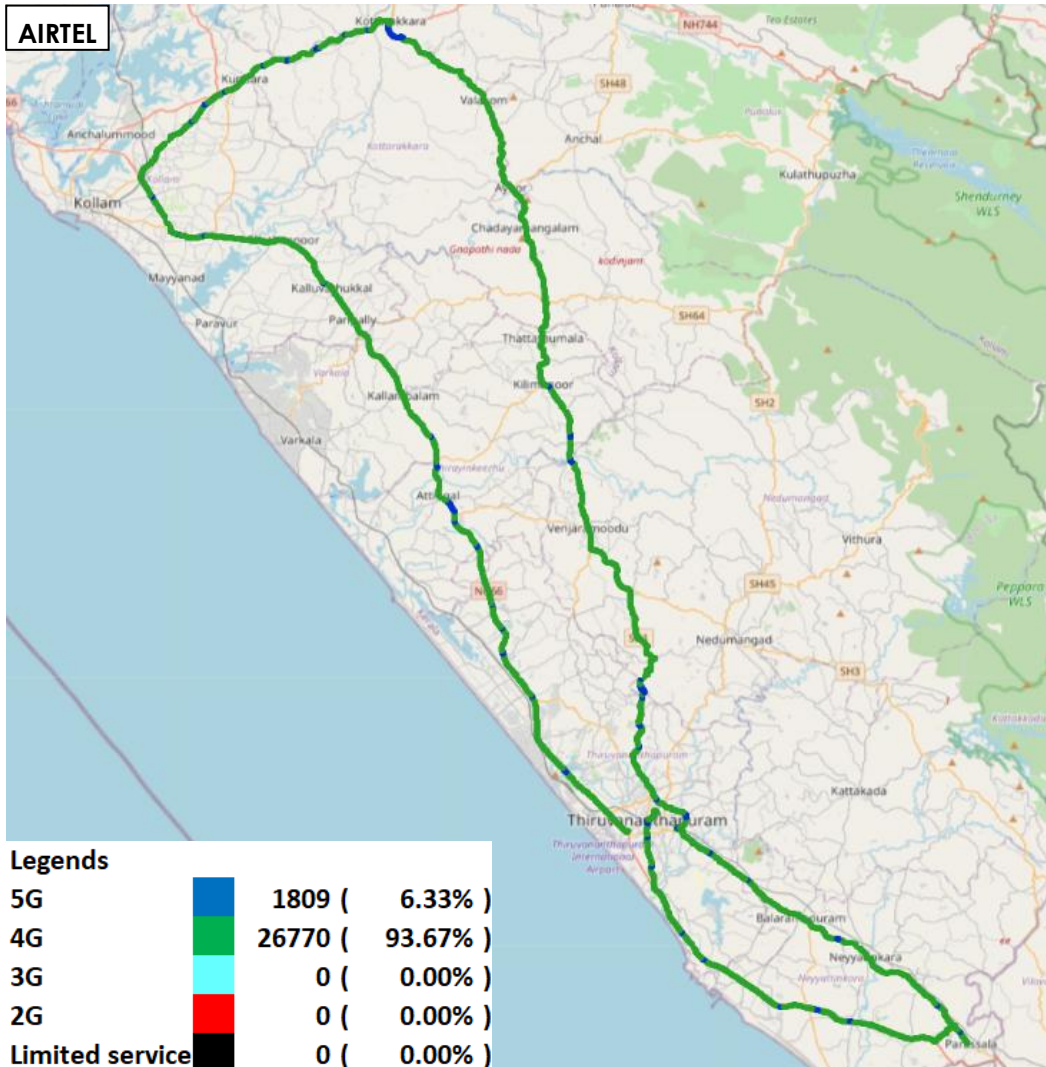


Figure-35: Serving technology plots in auto-selection mode (5G/4G/3G/2G) -AIRTEL

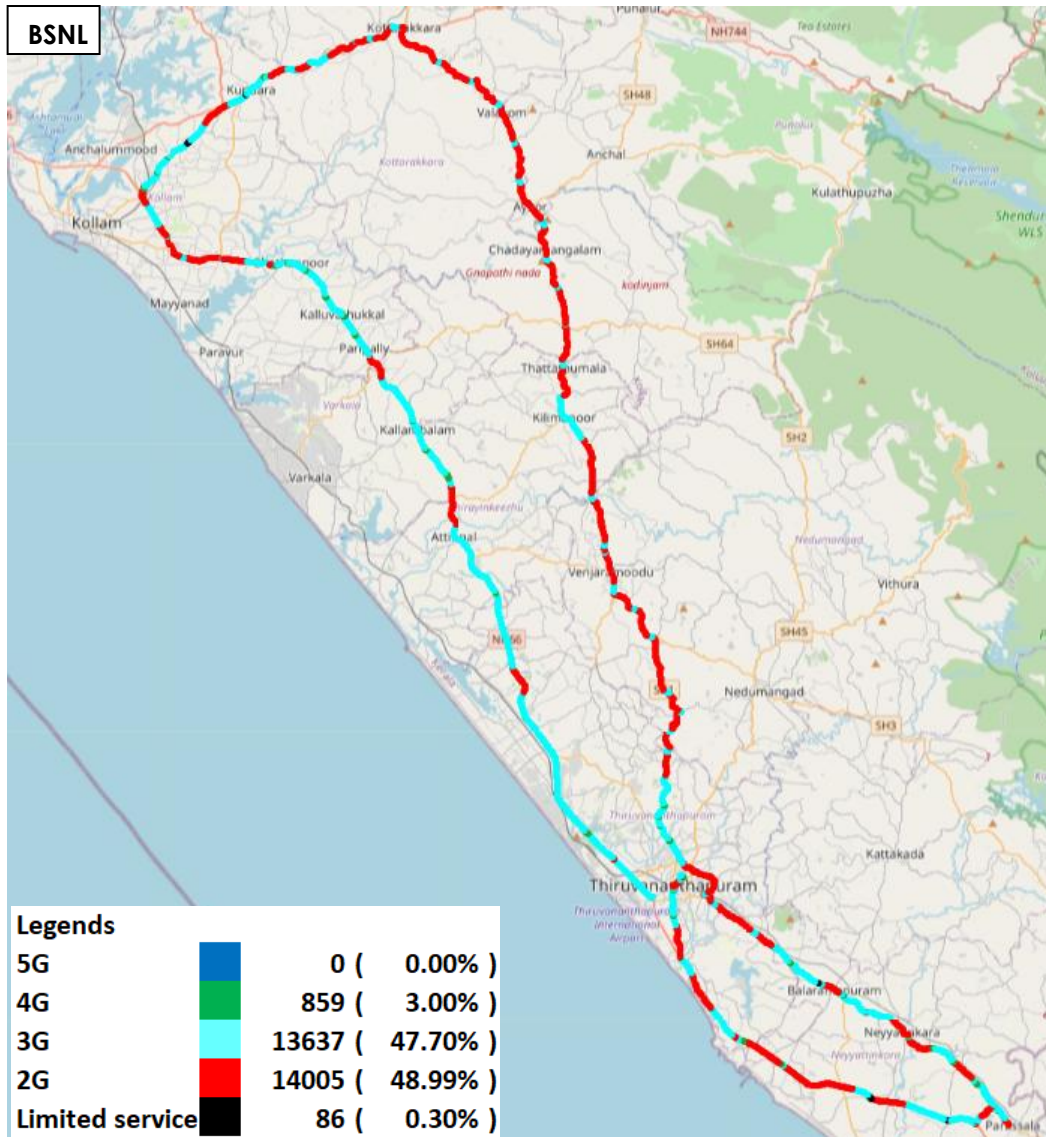


Figure-36: Serving technology plots in auto-selection mode (5G/4G/3G/2G) -BSNL

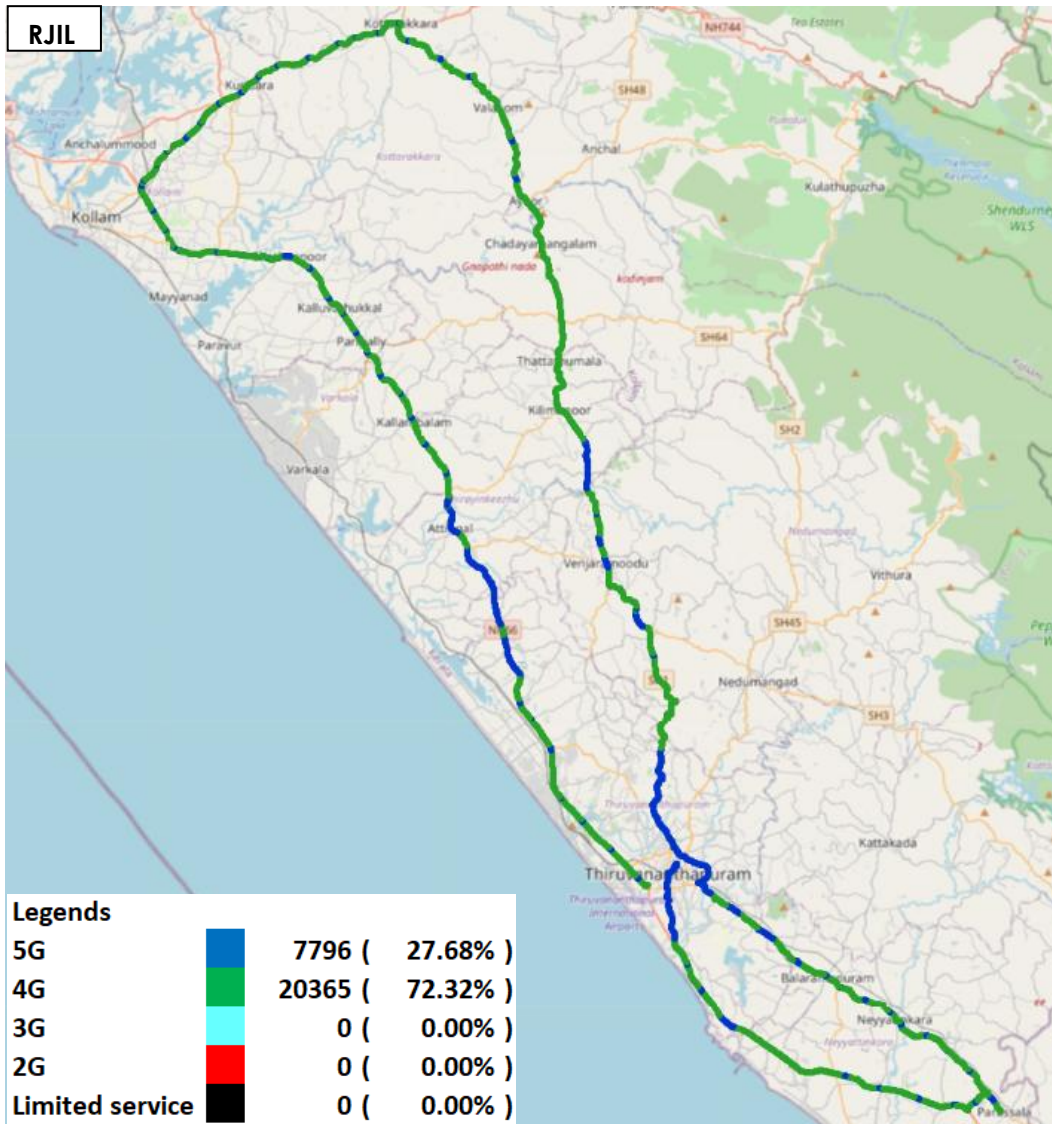


Figure-37: Serving technology plots in auto-selection mode (5G/4G/3G/2G)- RJIL

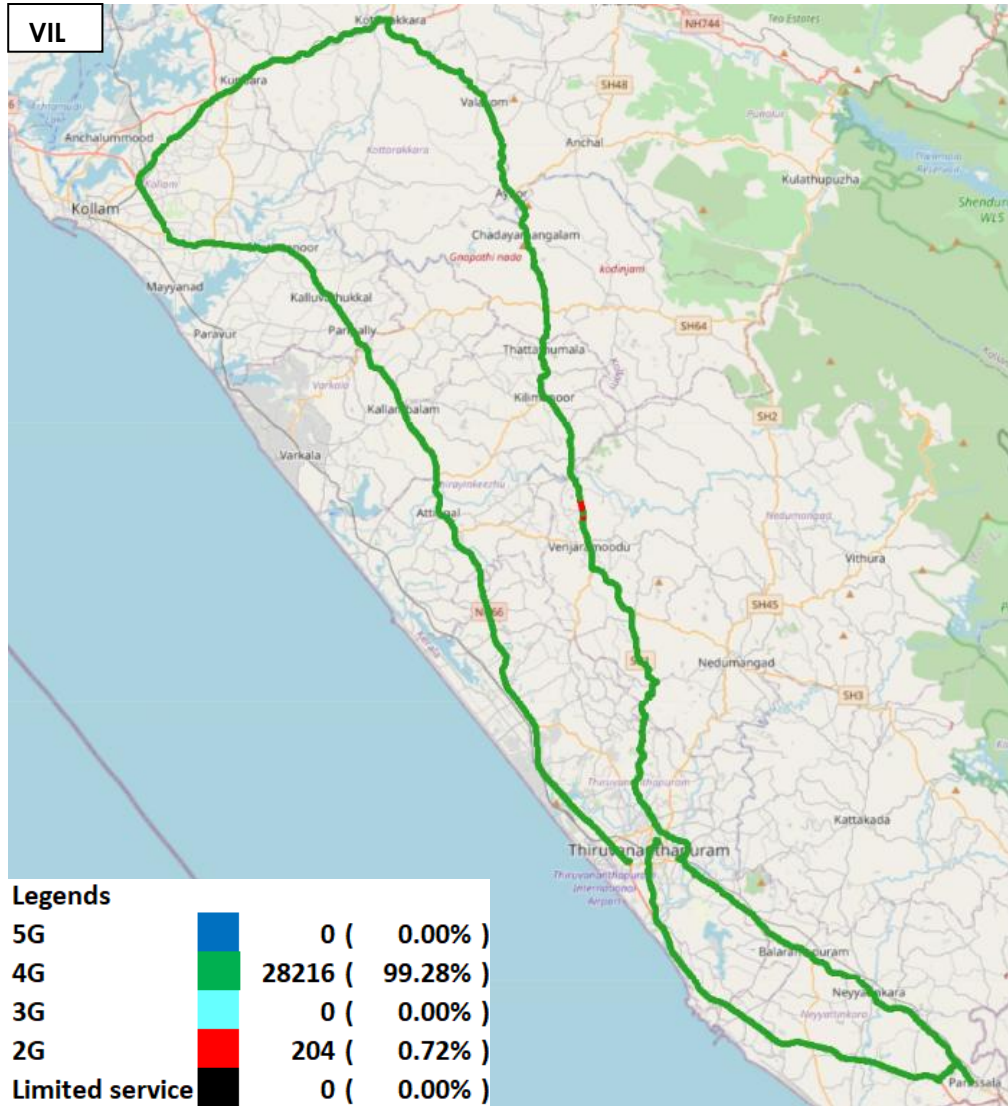


Figure-38: Serving technology plots in auto-selection mode (5G/4G/3G/2G) – VIL

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

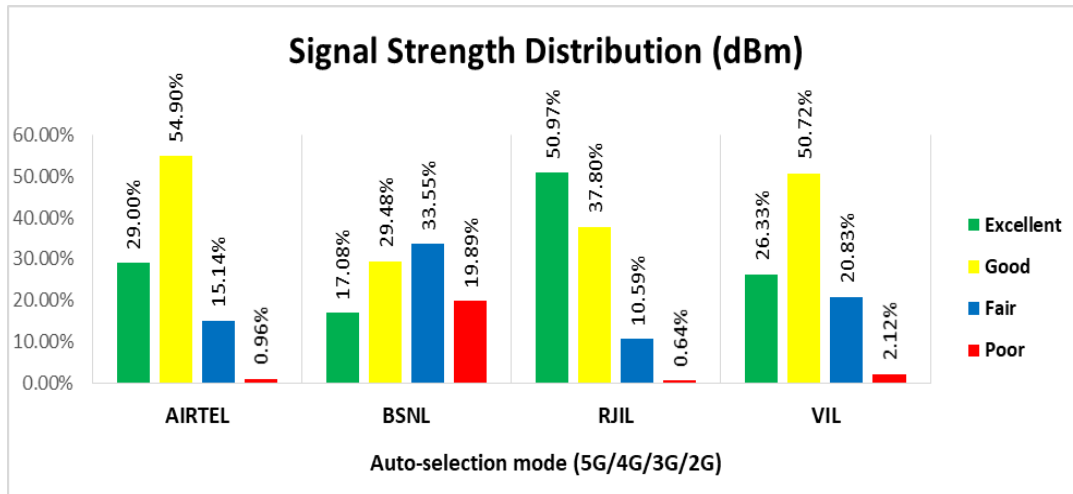


Figure-39: Signal strength distribution auto-selection mode 5G/4G/3G/2G

Observations:

- Airtel has 29% samples falling in the excellent signal strength category.
- BSNL has 17% samples falling in the excellent signal strength category.
- RJIL has 51% samples falling in the excellent signal strength category.
- VIL has 26% samples falling in the excellent signal strength category.

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	149.57	7.09	374.97	19.96
	80th Percentile	252.45	12.24	589.99	26.92
	20th Percentile	46.80	0.83	132.54	10.32
Upload Throughput (Mbits/s)	Average	23.69	3.35	30.34	9.03
	80th Percentile	39.88	4.42	52.18	15.56
	20th Percentile	5.39	1.24	5.17	2.27
Latency (ms)	50th Percentile	20.90	37.30	16.35	38.45

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

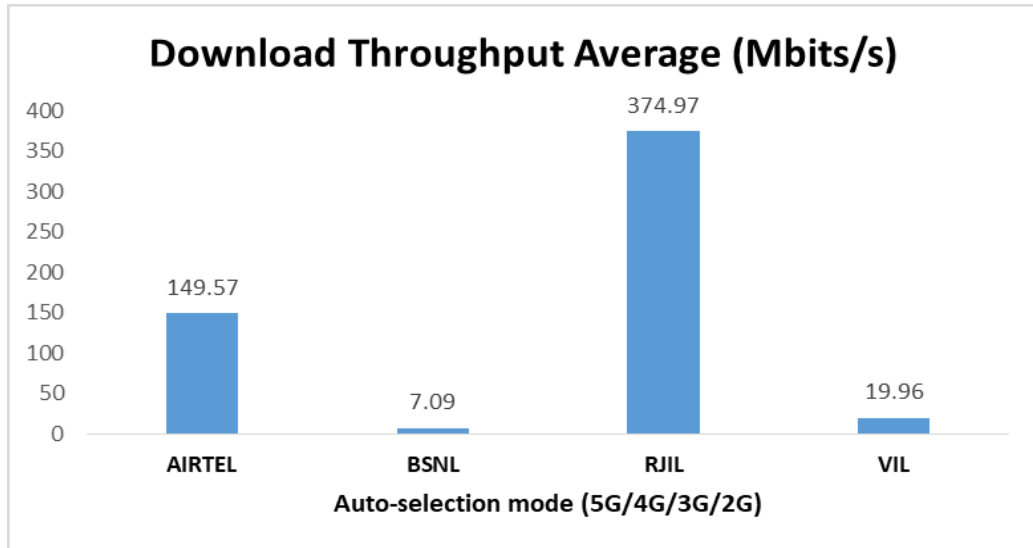


Figure-40: Download throughput

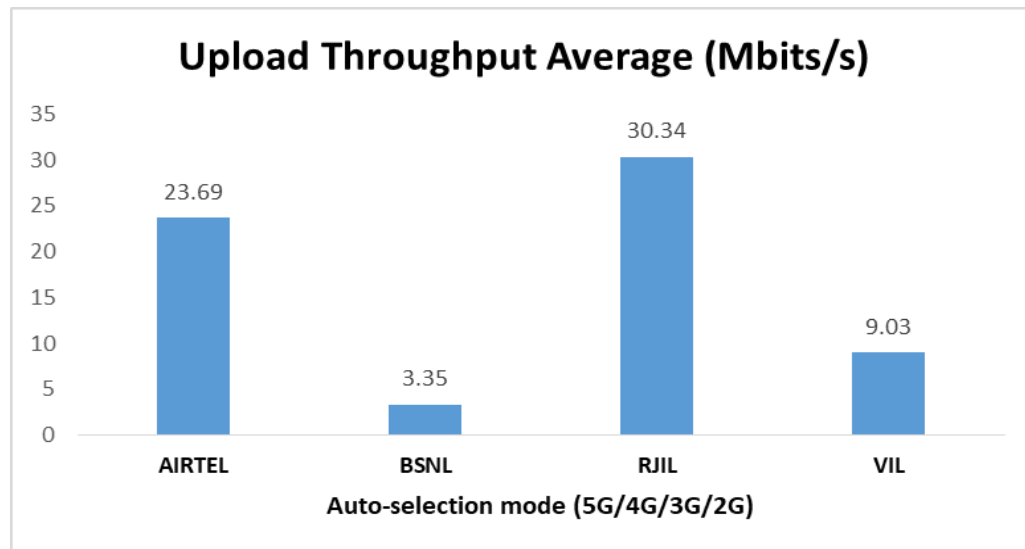


Figure-41: Upload throughput

4.6 Railways

Drive test has been conducted on 6th December 2024 covering one railway route. (Refer Table#1)

4.6.1 Drive test route

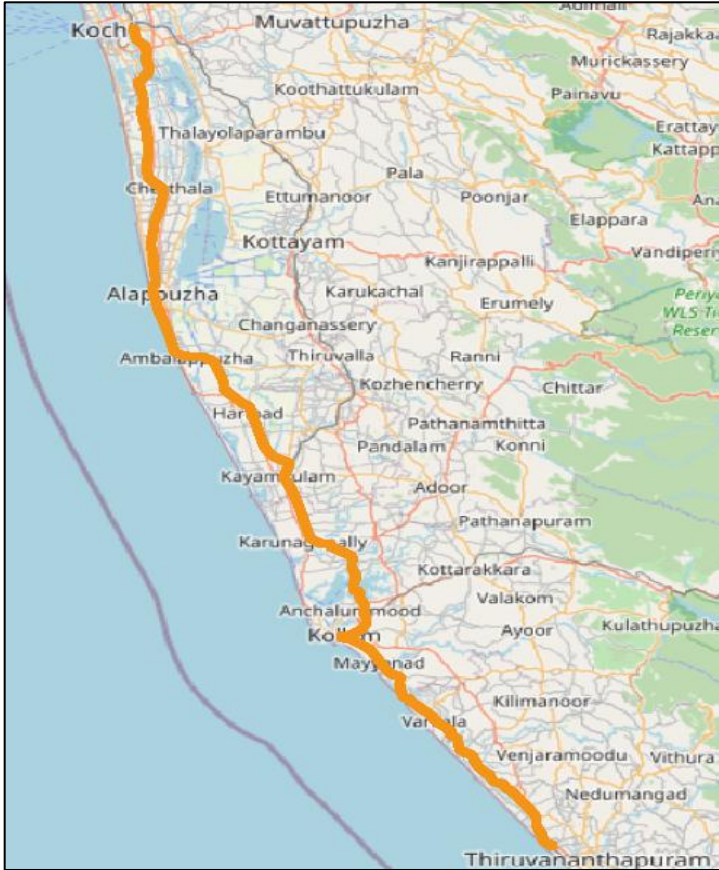


Figure-42: Drive test railway route

4.6.2 Route Covered

- Thiruvananthapuram railway station to Ernakulam junction.

4.6.2.1 Thiruvananthapuram railway station to Ernakulam junction

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	74	75	74	75
Call Setup Success Rate %	98.65	96.00	98.65	98.67
Drop Call Rate %	0.00	12.50	1.37	6.76
Call Setup Time-Average (Second)	1.22	5.10	0.77	1.61

Handover Success Rate %	100.00	98.57	99.47	99.58
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Table-59: Summary of voice call performance in network auto-selection mode

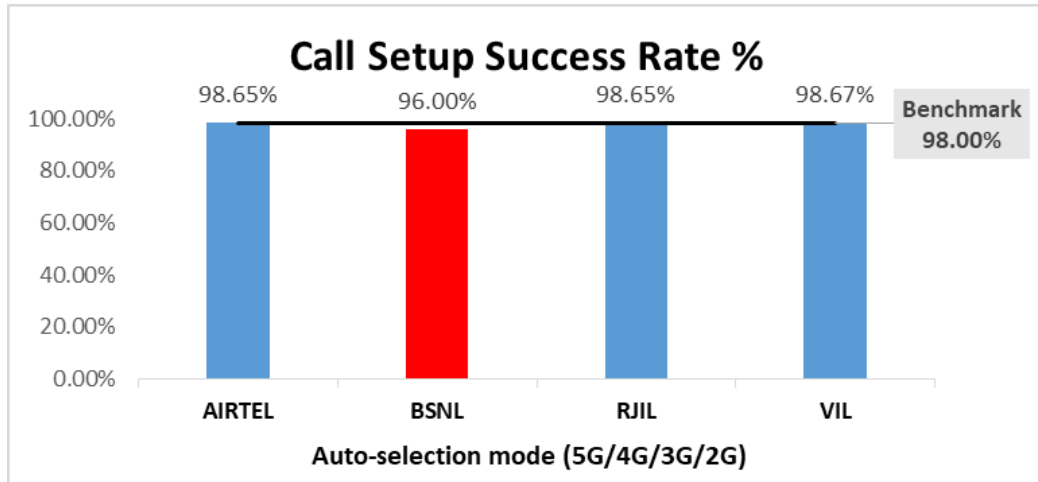


Figure-43: Performance for call setup success rate

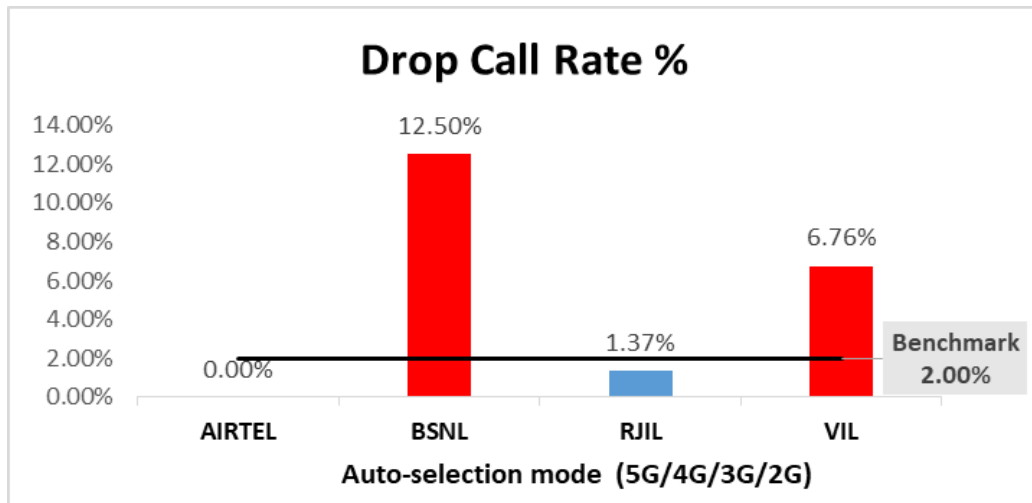


Figure-44: Performance for drop call rate

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

Technology	Service Provider			
	AIRTEL	BSNL	RJIL	VIL
5G	3.51%	NA	7.37%	NA
4G	96.49%	3.31%	92.59%	88.82%
3G	NA	28.68%	NA	NA
2G	0.00%	67.64%	NA	11.18%
Limited service	0.00%	0.38%	0.04%	0.00%

Table-60: Time spent on technology during drive test

Note-

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

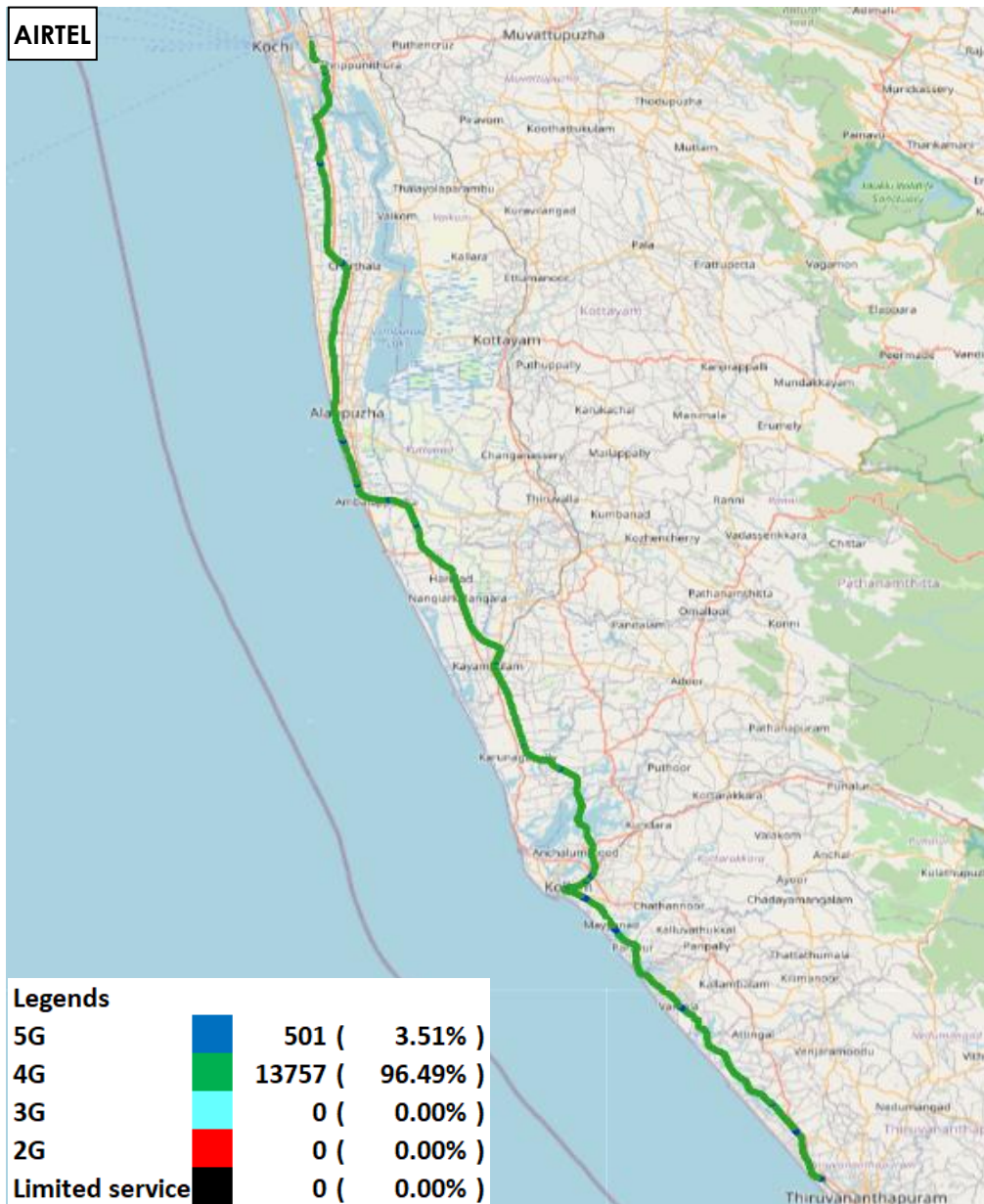


Figure-45: Serving technology plots auto-selection mode 5G/4G/3G/2G -AIRTEL

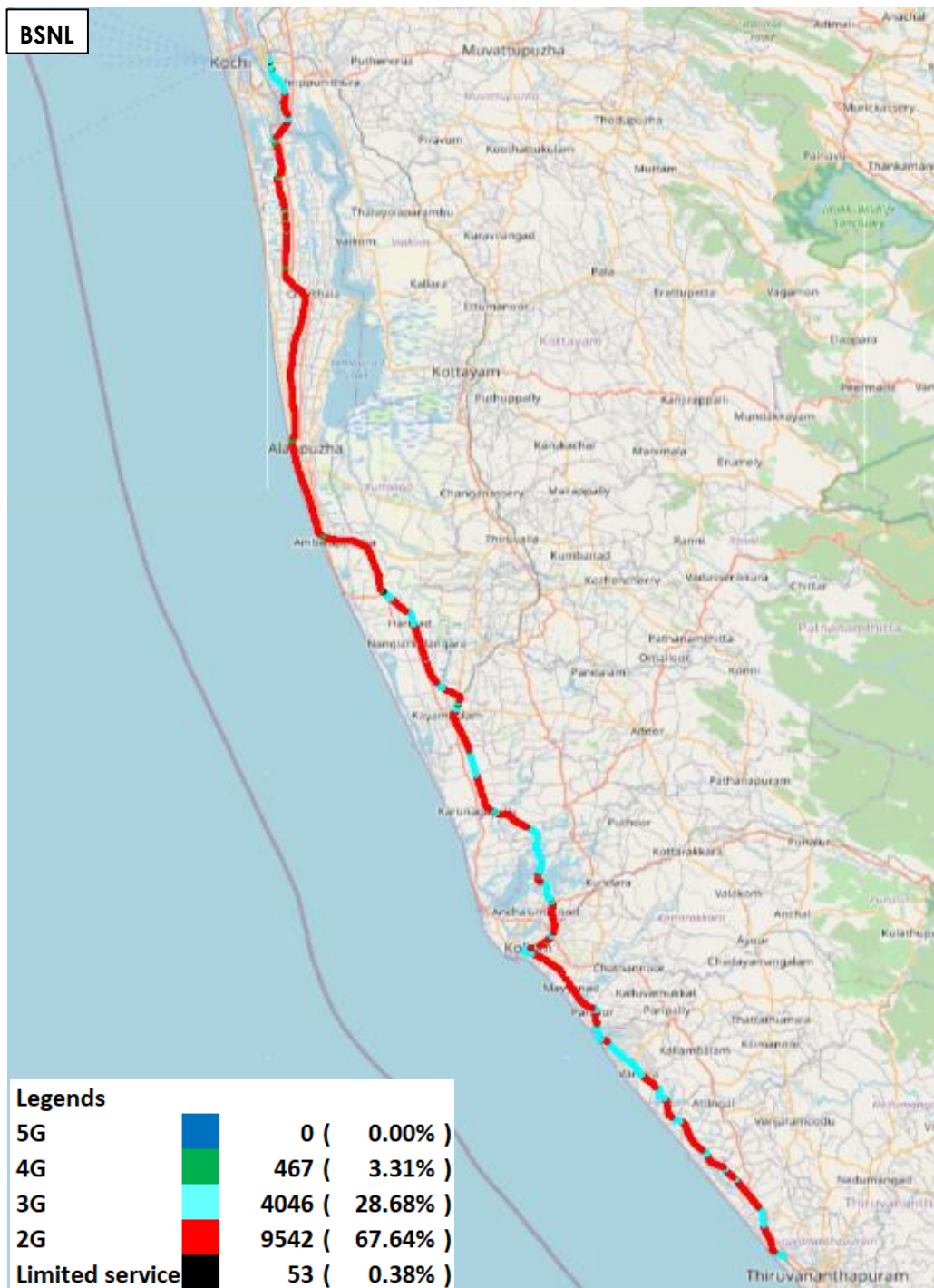


Figure-46: Serving technology plots auto-selection mode 5G/4G/3G/2G –BSNL

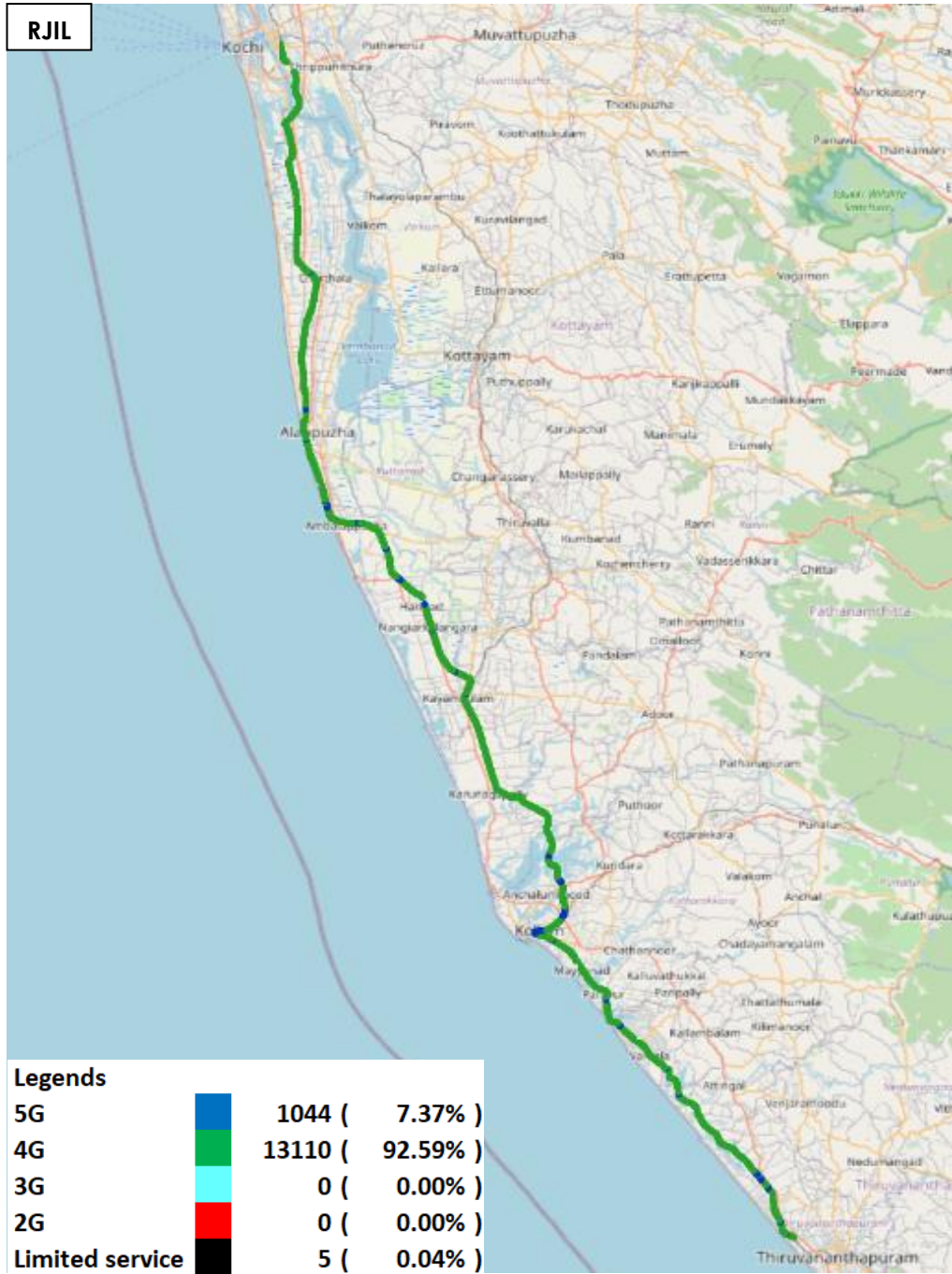


Figure-47: Serving technology plots auto-selection mode 5G/4G/3G/2G -RJIL

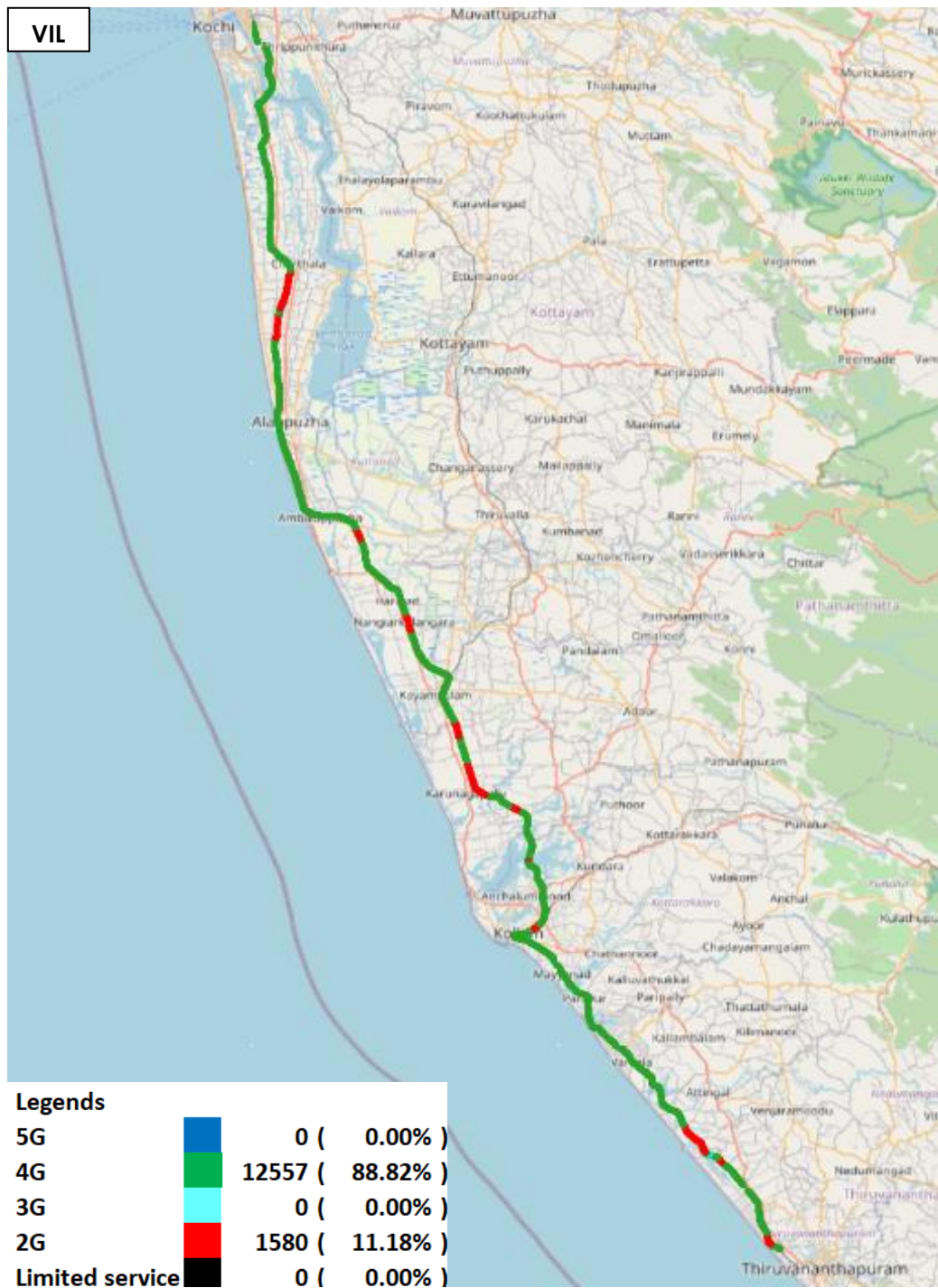


Figure-48: Serving technology plots auto-selection mode 5G/4G/3G/2G – VIL

(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)

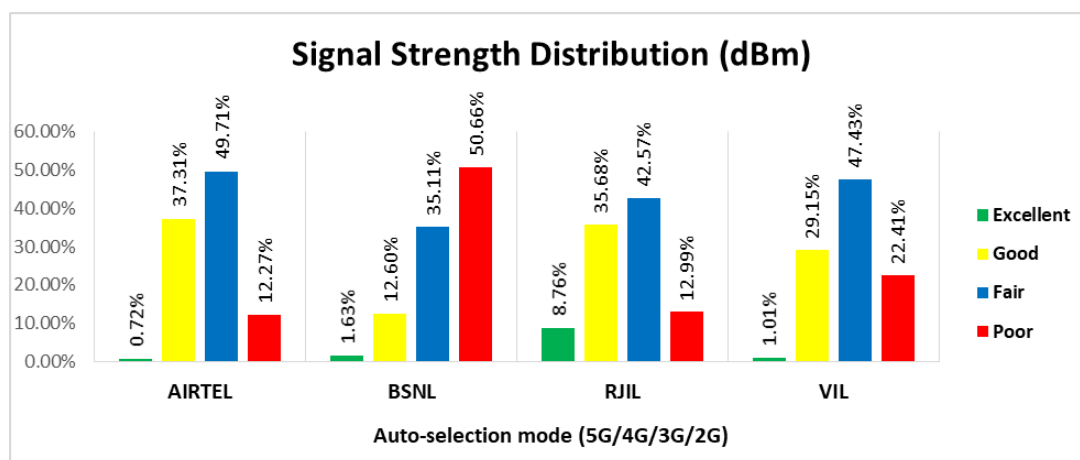


Figure-49: Signal strength distribution for auto-selection mode 5G/4G/3G/2G

ii) Data performance

(b) 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	90.42	6.20	171.48	16.24
	80th Percentile	160.58	9.03	294.13	24.04
	20th Percentile	10.49	1.32	9.90	7.69
Upload Throughput (Mbits/s)	Average	11.44	3.13	11.93	7.62
	80th Percentile	16.51	4.18	19.43	11.48
	20th Percentile	2.25	1.24	2.63	2.20
Latency (ms)	50th Percentile	26.95	29.88	21.05	31.95

Table-61: Summary of Data performance in network auto-selection mode (5G/4G/3G/2G).

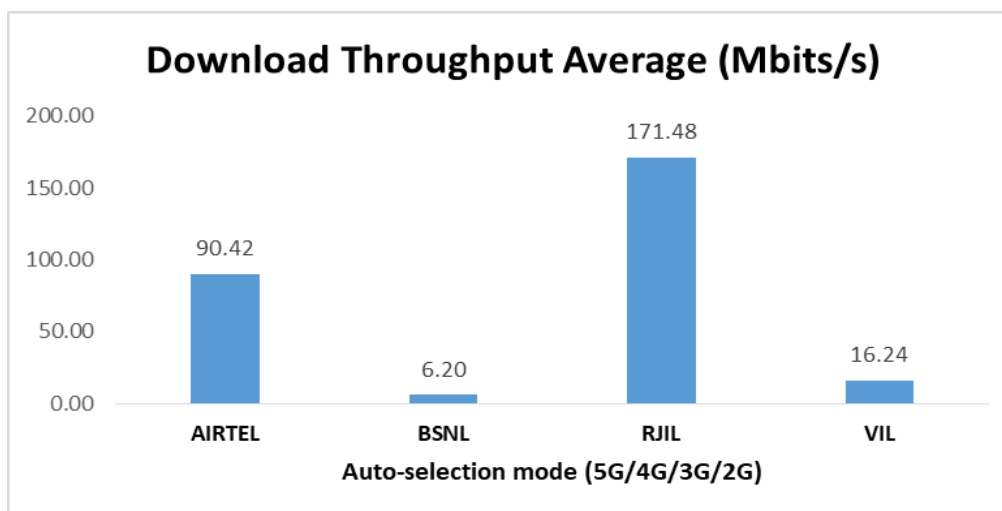


Figure-50: Download throughput

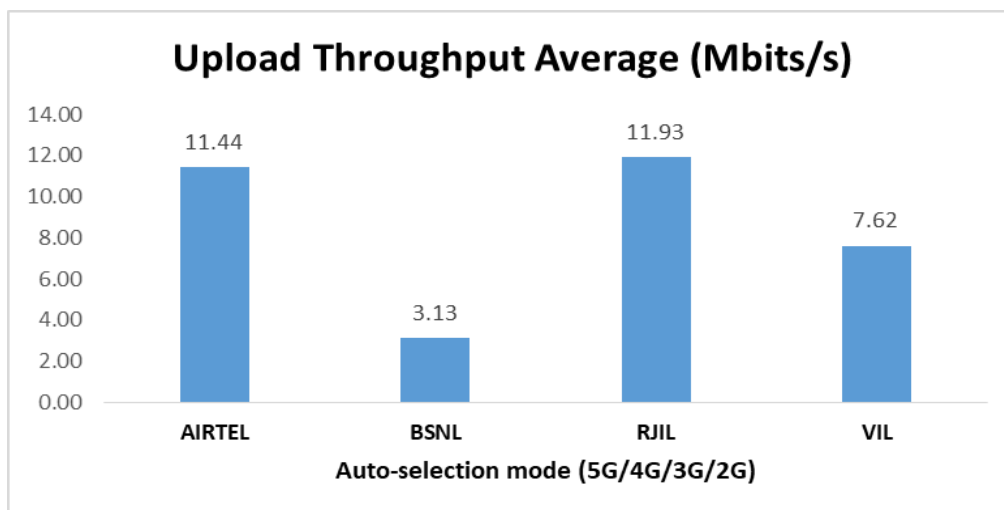


Figure-51: Upload throughput

5. Voice & Data Key findings

5.1 Overall Voice

1. Call setup success rate:

- Airtel, BSNL and VIL have 99.75%, 99.75% and 98.47 call setup success rate respectively in 3G/2G network mode. (refer table-3)
- Airtel, BSNL, RJIL and VIL have 99.86%, 99.14%, 99.86% and 99.58% call setup success rate respectively in Auto-selection mode (5G/4G/3G/2G). (refer table-5)
- Airtel and BSNL have 100.00% call setup success rate while calling on peer service provider's network, while remaining service providers have block call rate for inter-operator calls. (refer table-9)

2. Call Setup time:

- VIL has taken comparatively longer time (4.74 second) to establish the voice call, whereas Airtel and BSNL call setup time is 4.68 & 3.81 seconds respectively in 3G/2G network mode. (refer table-3)
- BSNL has taken longer time (4.23 second) to establish the voice call, whereas Airtel, VIL and RJIL call setup time is 1.24, 1.07 & 0.57 seconds respectively in Auto-selection mode (5G/4G/3G/2G). (refer table-5)

3. Call Drop Rate:

- VIL has 0.00% drop call rate whereas Airtel and BSNL have 1.02% & 1.53% drop call rate respectively in 3G/2G network mode. (refer table-3)
- Overall BSNL's call drop rate (3.61%) is higher (QoS benchmark of 2%), while RJIL, VIL and Airtel have 0.84%, 0.71% and 0.00% 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 3.39%, 0.53% & 0.00% silence call rate respectively. Further VIL has higher RTP packet loss rate in downlink (2.39%) compared to RJIL (0.36%) and Airtel (0.28%). In uplink the RTP packet loss rate is higher for VIL (2.53%) compared to Airtel (0.21%) and RJIL (0.19%). (refer table-6)

5.2 Overall Data

- 1. Data download and upload performance (Dynamic i.e. while moving) :**
 - a) BSNL (7.72 Mbps) and VIL (19.50 Mbps) being on 3G & 4G as top technology respectively, have comparatively lower download speeds. While RJIL and Airtel have average download speed of 282.86 Mbps and 102.71 Mbps respectively. (refer table-11)
 - b) BSNL (4.54 Mbps) and VIL (11.12 Mbps) being on 3G & 4G as top technology respectively, have comparatively lower upload speeds. While RJIL and Airtel have average upload speed of 24.95 Mbps and 18.17 Mbps respectively. (refer table-11)
- 2. Data download and upload performance (static i.e. while stationary):**
 - a) RJIL's 5G QoS performance shows an average download speed of 231.16 Mbps overall hotspot locations. (refer table-31)
 - b) RJIL's 5G QoS performance shows an average upload speed of 20.47 Mbps overall hotspot locations. (refer table-31)
- 3. Data session setup success rate (static i.e. while stationary):**
 - a) Airtel, BSNL, VIL and RJIL have 100.00%, 94.00%, 90.00% and 84.00% download session setup success rate and Airtel, RJIL, BSNL and VIL have 100.00%, 100.00%, 98.00% and 96.00% upload session setup success rate. (refer table-31)

5.3 Operator wise Key Findings

1. Airtel:

Voice

- 99.75% call setup success rate and 1.02% call drop rate have been observed in 3G/2G network mode. Performance is well within benchmark of 98.00% & 2.00% respectively for LSA. (refer table-3)
- 99.61% call setup success rate and 0.39% call drop rate have been observed in 3G/2G network mode. Performance is well within benchmark of 98.00% & 2.00% respectively for City. (refer table-13)
- 99.86% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for LSA. (refer table-5)
- 100.00% call setup success rate and 0.00% drop call rate observed for auto-selection mode during city drive (refer table-15).
- 100.00% call setup success rate and 0.00% drop call rate observed for auto-selection mode during hotspots (refer table-20).

- 100.00% call setup success rate and 2.19% call drop rate have been observed in 3G/2G network mode. Call drop rate is not meeting the benchmark of 2% in highway drive (refer table -52)
- 100.00% call setup success rate and 0.00% drop call rate observed for auto-selection mode during highway drive (refer table-54).
- 98.65% call setup success rate and 0.00% drop call rate observed for auto-selection mode during railway drive (refer table-59).

Data

- Airtel has an average download throughput of 102.71 Mbps and an average upload throughput of 18.17 Mbps across measured routes for LSA (refer table-11).
- Airtel has an average download throughput of 103.91 Mbps and an average upload throughput of 19.49 Mbps across the measured routes during the city drive (refer table 19).
- 8 hotspots experience lower download speeds, registering less than 100 Mbps among a total of 10 hotspots (refer tables 32, 33, 34, 35, 36, 37, 38 & 41).
- 5 hotspots experience lower upload speeds, registering less than 20 Mbps among a total of 10 hotspots (refer tables 32, 33, 34, 36 & 38).
- Airtel has an average download throughput of 149.57 Mbps and an average upload throughput of 23.69 Mbps across the measured routes during the highway drive. (refer table-58)
- Airtel has an average download throughput of 90.42 Mbps and an average upload throughput of 11.44 Mbps across the measured routes during the railway drive. (refer table-61)

2. BSNL:

Voice

- 99.75% call setup success rate and 1.53% call drop rate have been observed in 3G/2G network mode. Performance is well within the benchmark of 98% & 2% respectively for LSA. (refer table -3).
- 99.14% call setup success rate and 3.61% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G). Call drop rate is not meeting the benchmark of 2% for LSA. (refer table -5)
- 100.00% call setup success rate and 1.17% call drop rate have been observed in 3G/2G network mode in city drive. (refer table -13)
- 98.85% call setup success rate and 1.56% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G) in 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) at hotspots. (refer table -20)
- 99.28% call setup success rate and 2.19% call drop rate have been observed in 3G/2G network mode. Call drop rate is not meeting the benchmark of 2% in highway drive (refer table -52)
- 100.00% call setup success rate and 8.39% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G). Call drop rate is not meeting the benchmark of 2% in highway drive. (refer table -54)
- 96.00% call setup success rate and 12.50% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G). Performance is not meeting the benchmark of 98.00% and 2.00% respectively in railway drive. (refer table -59)

Data

- BSNL has 7.72 Mbps average download throughput & 4.54 Mbps average upload throughput across measured routes for LSA (refer table -11)
- BSNL has 9.28 Mbps average download throughput & 5.09 Mbps average upload throughput across measured routes for city drive (refer table -19)
- 7 hotspot locations experience lower download speeds, registering less than 10 Mbps among a total of 10 hotspots (Refer to table -33, 34, 35, 36, 38, 40 & 41).
- Central Bus Stand, Thiruvananthapuram Airport and Airport T1 Domestic walk test have less than 10 Mbps download speed (refer table -47, 49 & 51).
- BSNL has 7.09 Mbps average download throughput & 3.35 Mbps average upload throughput across measured routes in highway drive (refer table -58)
- BSNL has 6.20 Mbps average download throughput & 3.13 Mbps average upload throughput across measured routes in railway drive (refer table -61)

3. RJIL:

Voice

- 99.86% call setup success rate and 0.84% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G). Performance is well within the benchmark of 98.00% & 2.00% respectively for LSA. (refer table -5)
- 100% call setup success rate and 0.00% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G). Performance is well within the benchmark of 98.00% & 2.00% respectively for city. (refer table -15)
- 100.00% call setup success rate and 0.00% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G). Performance is well within the

benchmark of 98.00% & 2.00% respectively in City, Hotspots and Walk test. (Refer to table -15, 20, 42, 43, 44, 45 & 46)

- 100.00% call setup success rate and 3.45% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G) in highway drive. Call drop rate is not meeting the benchmark of 2%. (refer table -54)
- 98.65% call setup success rate and 1.37% call drop rate have been observed in auto-selection mode (5G/4G/3G/2G) in railway drive. (refer table -59)

Data

- RJIL has 282.86 Mbps average download speed & 24.95 Mbps average upload speed across measured routes in LSA. (refer table -11)
- RJIL has 357.84 Mbps average download speed & 28.70 Mbps average upload speed across measured routes in city drive. (refer table -19)
- Sree Chita Triunal institute for medical science and Central stadium hotspots have less download speed (less than 100 Mbps) out of total 10 hotspots. (refer table- 34 & 39)
- Airport T1 Domestic has less download speed (less than 100 Mbps) out of total 5 walk tests. (refer table - 51)
- RJIL has 374.97 Mbps average download speed & 30.34 Mbps average upload speed across measured routes in highway drive. (refer table -58)
- RJIL has 171.48 Mbps average download speed & 11.93 Mbps average upload speed across measured routes in railway drive. (refer table -61)

4. VIL:

Voice

- 98.47% call setup success rate and 0.00% call drop rate have been observed in 3G/2G network mode. Performance is well within the benchmark of 98% & 2% respectively. (refer table -3)
- 99.58% call setup success rate and 0.71% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) for LSA. (refer table -5).
- 98.44% call setup success rate and 0.00% call drop rate have been observed in 3G/2G network mode. Performance is well within the benchmark of 98% & 2% respectively. (refer table -13)
- 99.63% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) in city drive. (Refer to 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) in hotspots. (refer table -20).

- 98.52% call setup success rate and 0.00% call drop rate have been observed in 3G/2G network mode. Performance is well within benchmark of 98.00% & 2.00% in highway drive (refer table -52)
- 99.29% call setup success rate and 0.00% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) in highway drive. (Refer to table -54).
- 98.67% call setup success rate and 6.76% drop call rate have been observed for auto-selection mode (5G/4G/3G/2G) in railway drive. (Refer to table -59).

Data

- VIL has 19.50 Mbps average download speed & 11.12 Mbps average upload speed across measured routes in LSA. (Refer to table -11)
- VIL has 19.86 Mbps average download speed & 9.53 Mbps average upload speed across measured routes in city drive. (Refer to table -19)
- Sree Chita Triunal institute for medical science hotspots has less than 10 Mbps download speeds out of total 10 hotspots. (Refer to table - 34)
- Central Bus Stand walk tests has less than 10 Mbps download speeds out of total 5 walk tests. (refer table - 47)
- VIL has 19.96 Mbps average download speed & 9.03 Mbps average upload speed across measured routes in highway drive. (refer table -58)
- VIL has 16.24 Mbps average download speed & 7.62 Mbps average upload speed across measured routes in railway drive. (refer table -61)

6. Annexure

6.1 Route wise coverage map

6.1.1 City

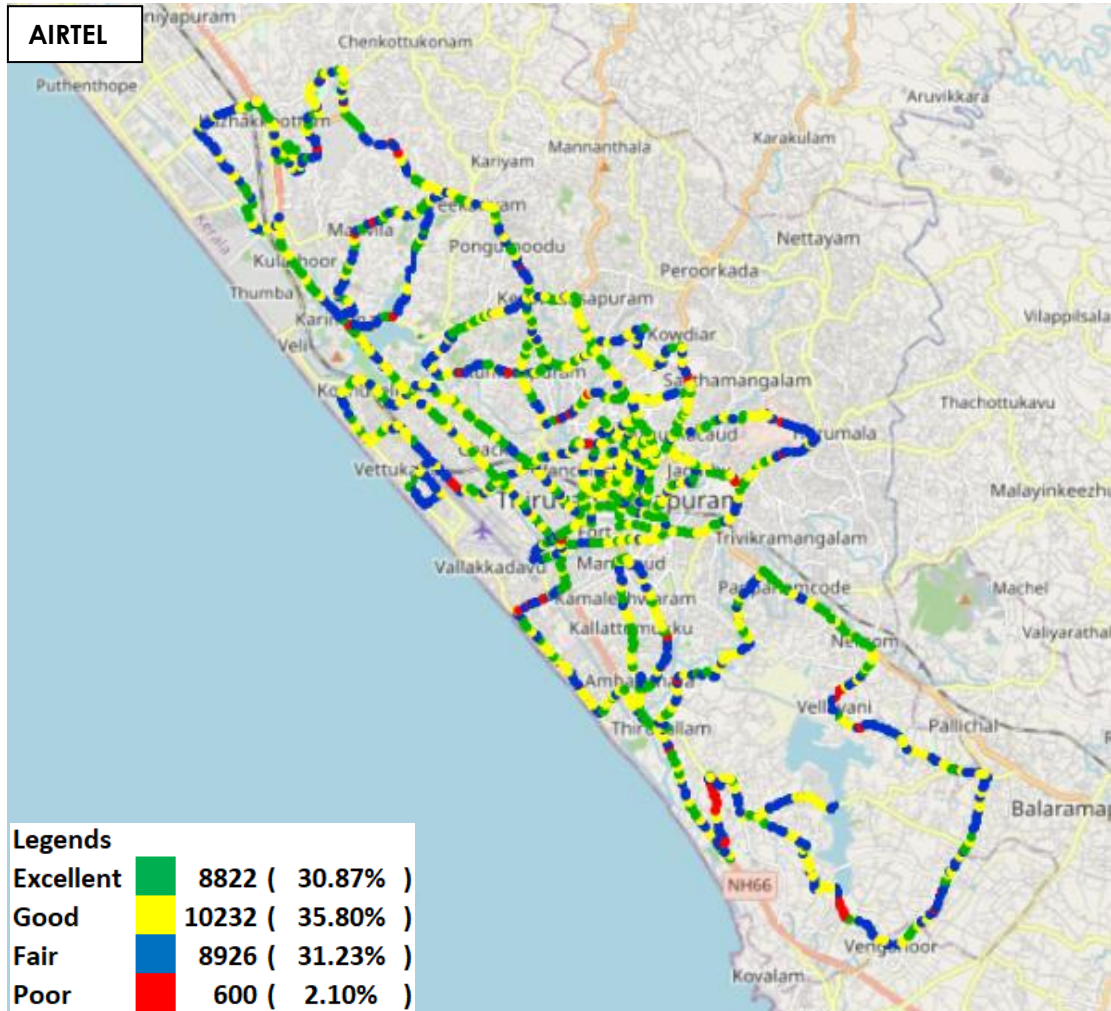


Figure-52: Signal strength 3G/2G network mode - AIRTEL

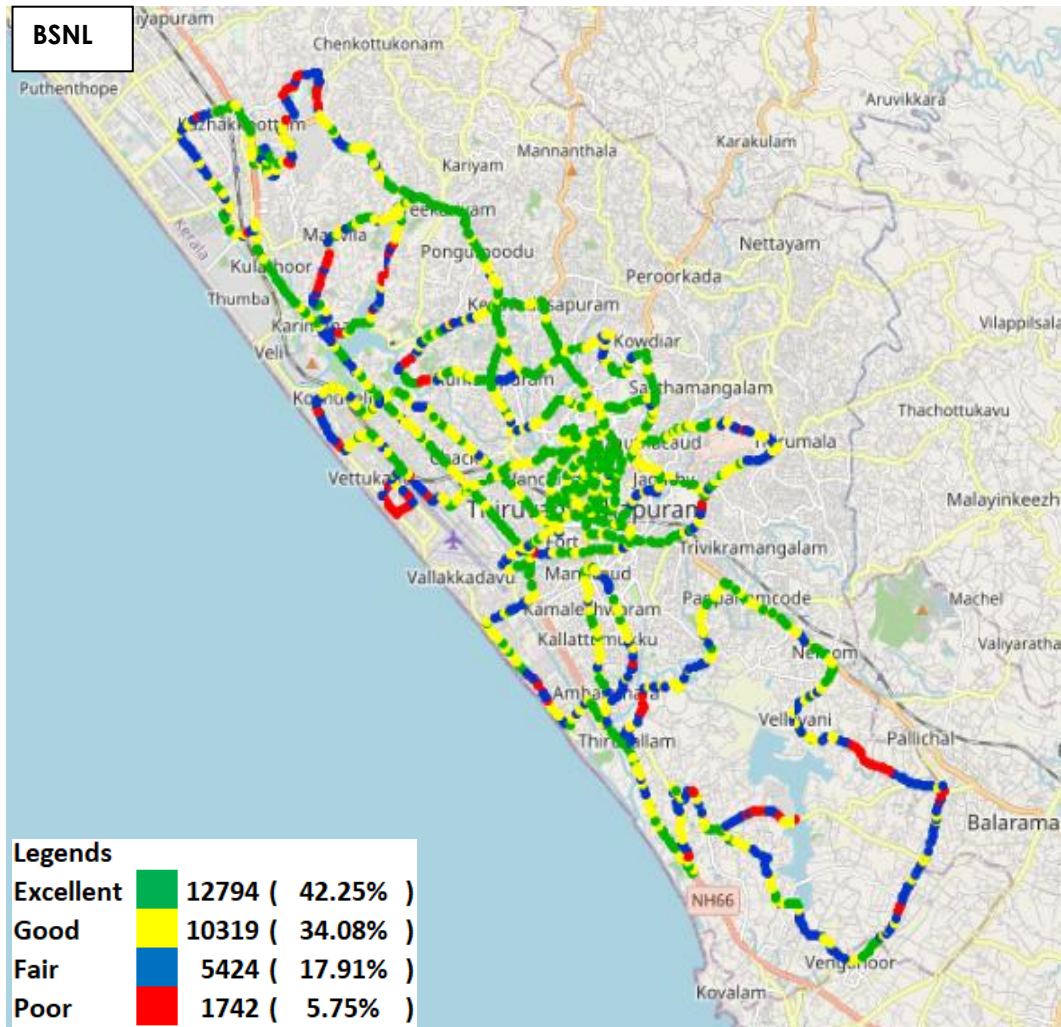


Figure-53: Signal strength 3G/2G network mode - BSNL

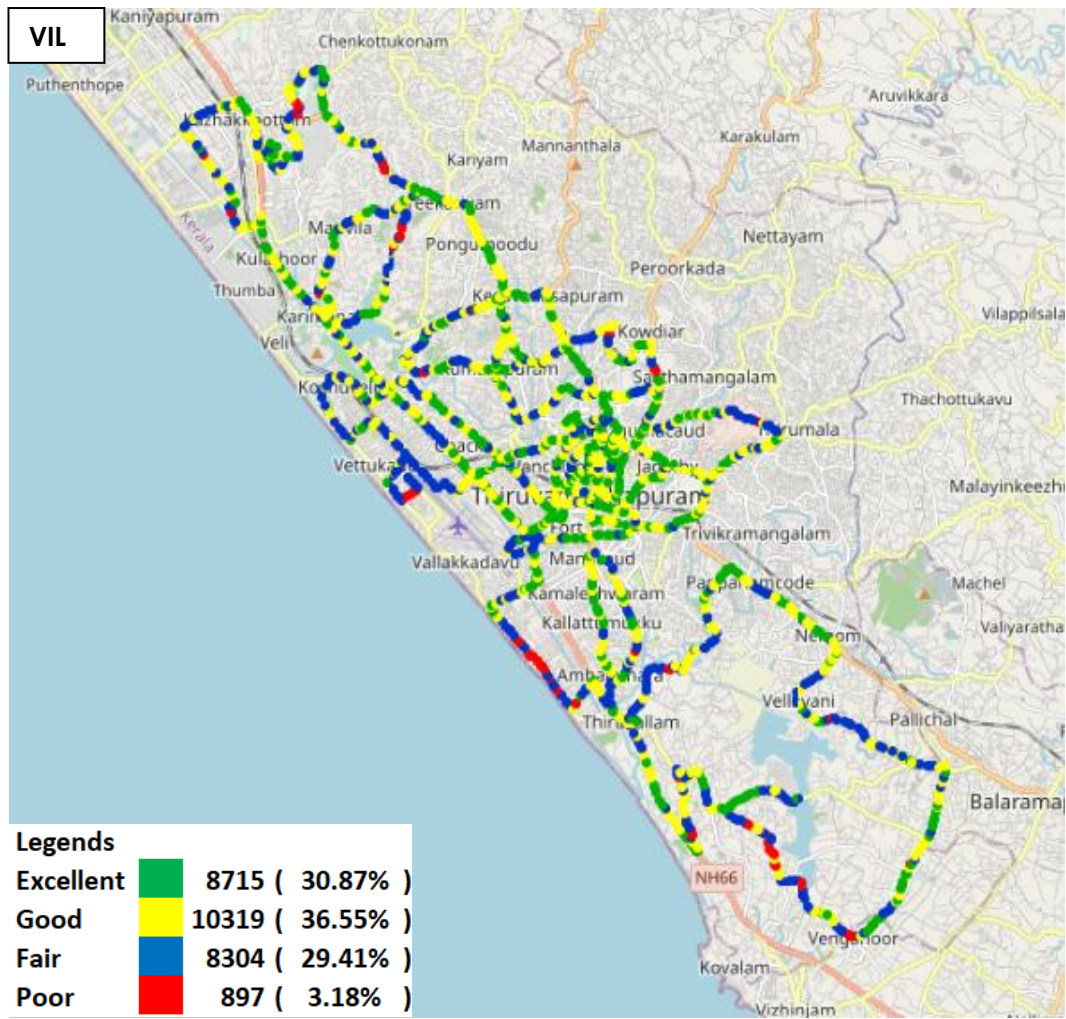


Figure-54: Signal strength 3G/2G network mode - VIL

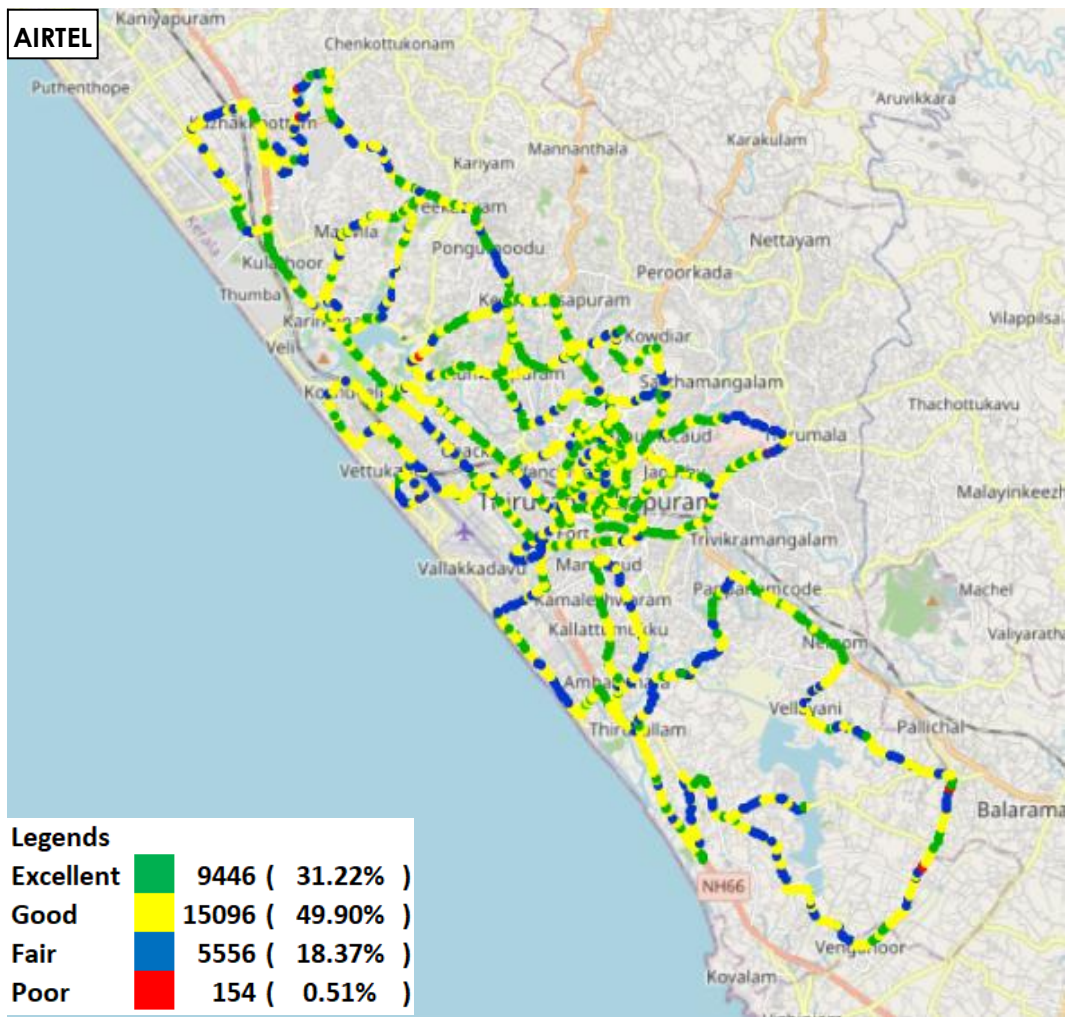


Figure-55: Signal strength auto-selection mode 5G/4G/3G/2G - AIRTEL

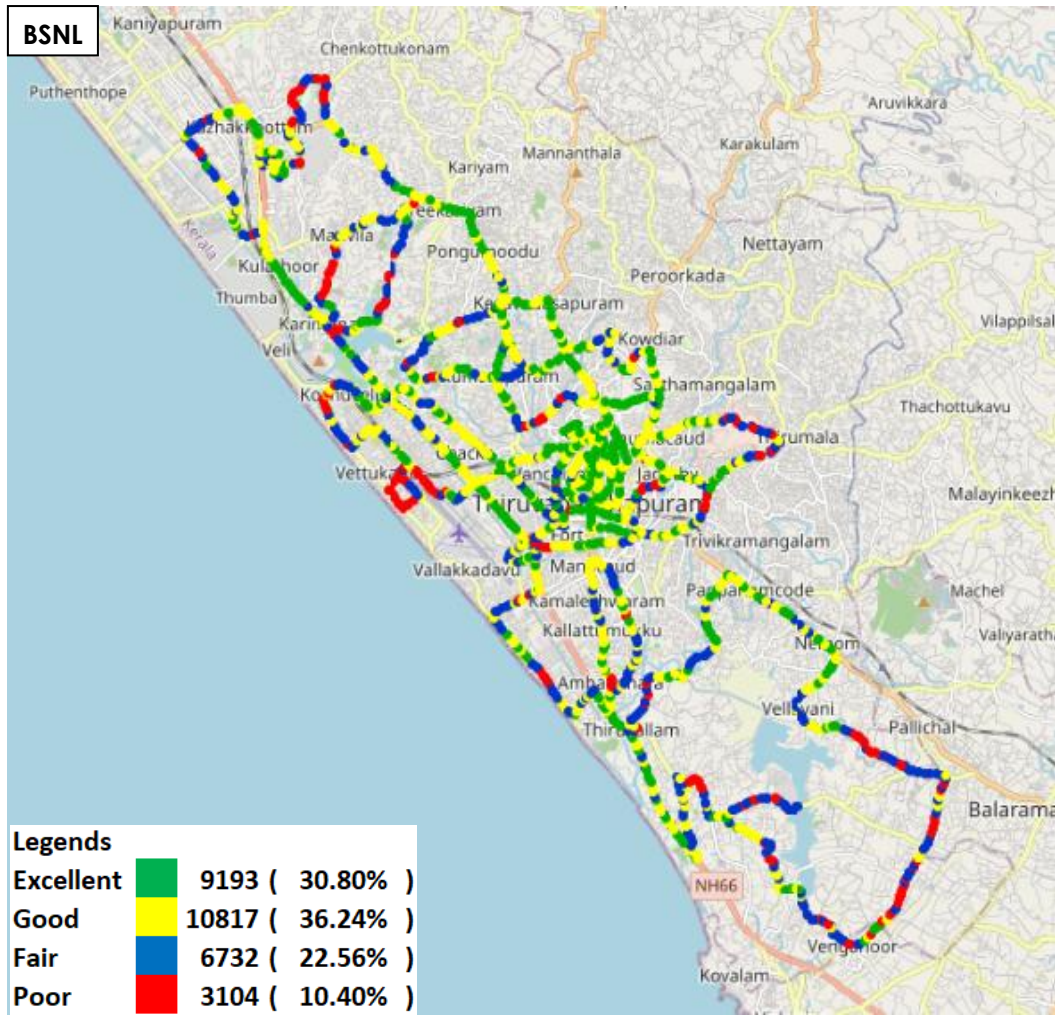


Figure-56: Signal strength auto-selection mode 5G/4G/3G/2G - BSNL

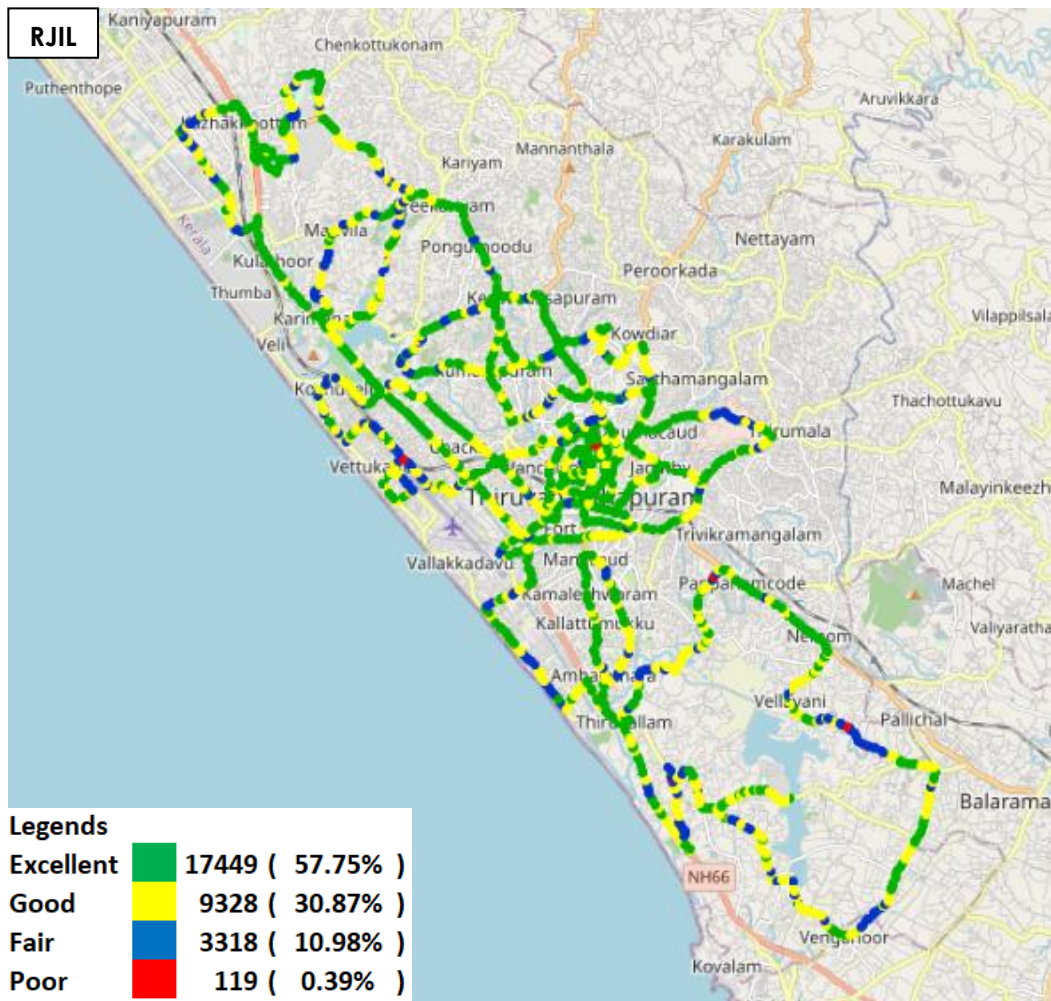


Figure-57: Signal strength auto-selection mode 5G/4G/3G/2G - RJIL

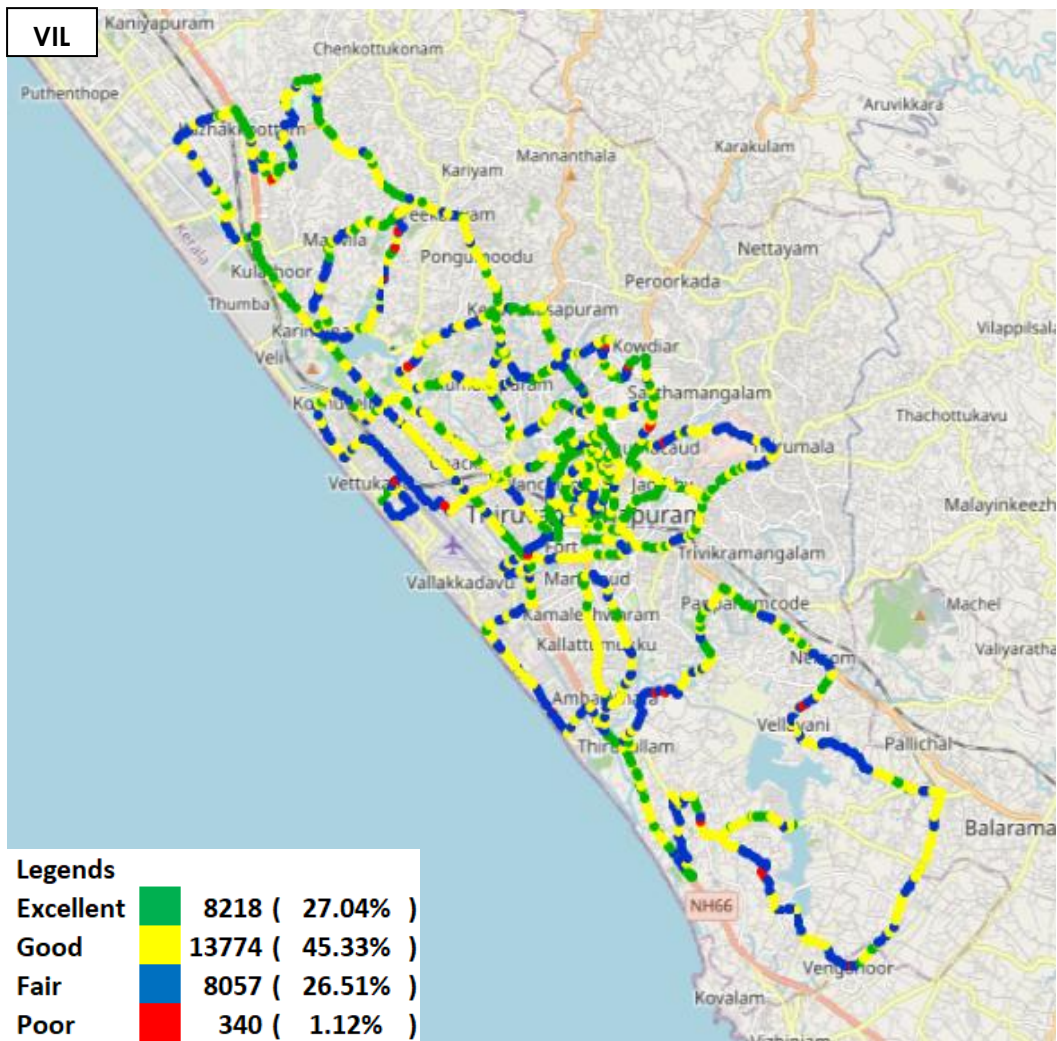


Figure-58: Signal strength auto-selection mode 5G/4G/3G/2G - VIL

6.1.2 Highway Route

i) Thiruvananthapuram to Kollam via parassala and kottarakkara & Kollam to Thiruvananthapuram

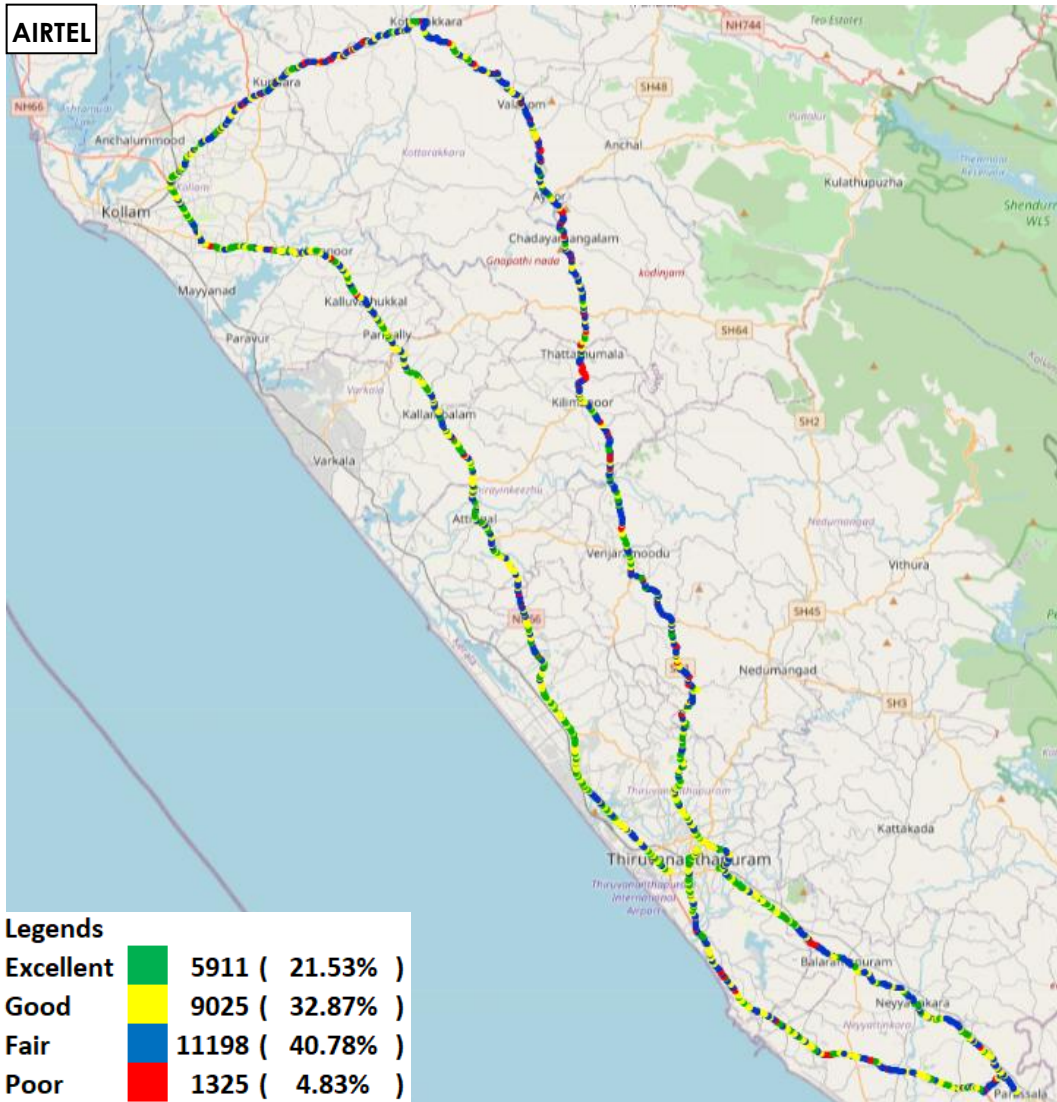


Figure-59: Signal strength 3G/2G network mode – AIRTEL

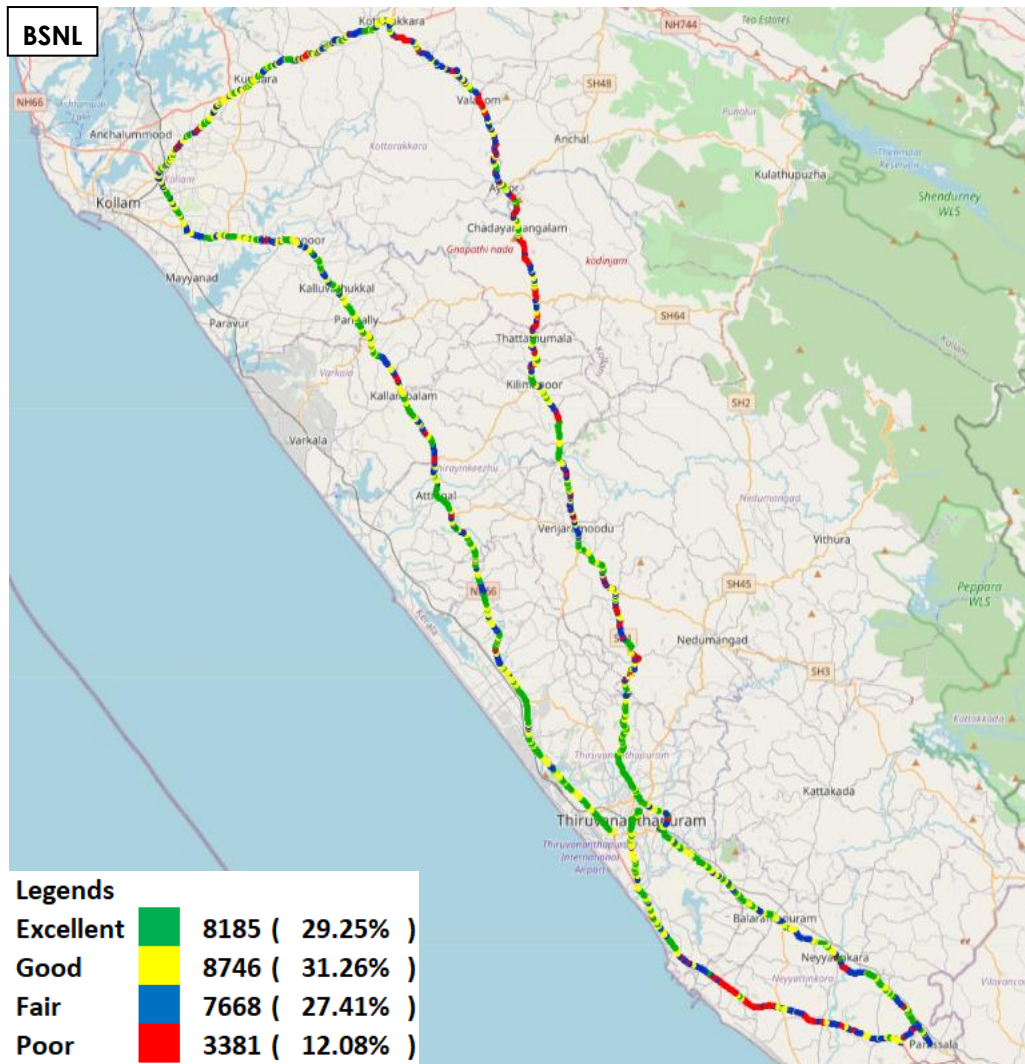


Figure-60: Signal strength 3G/2G network mode - BSNL

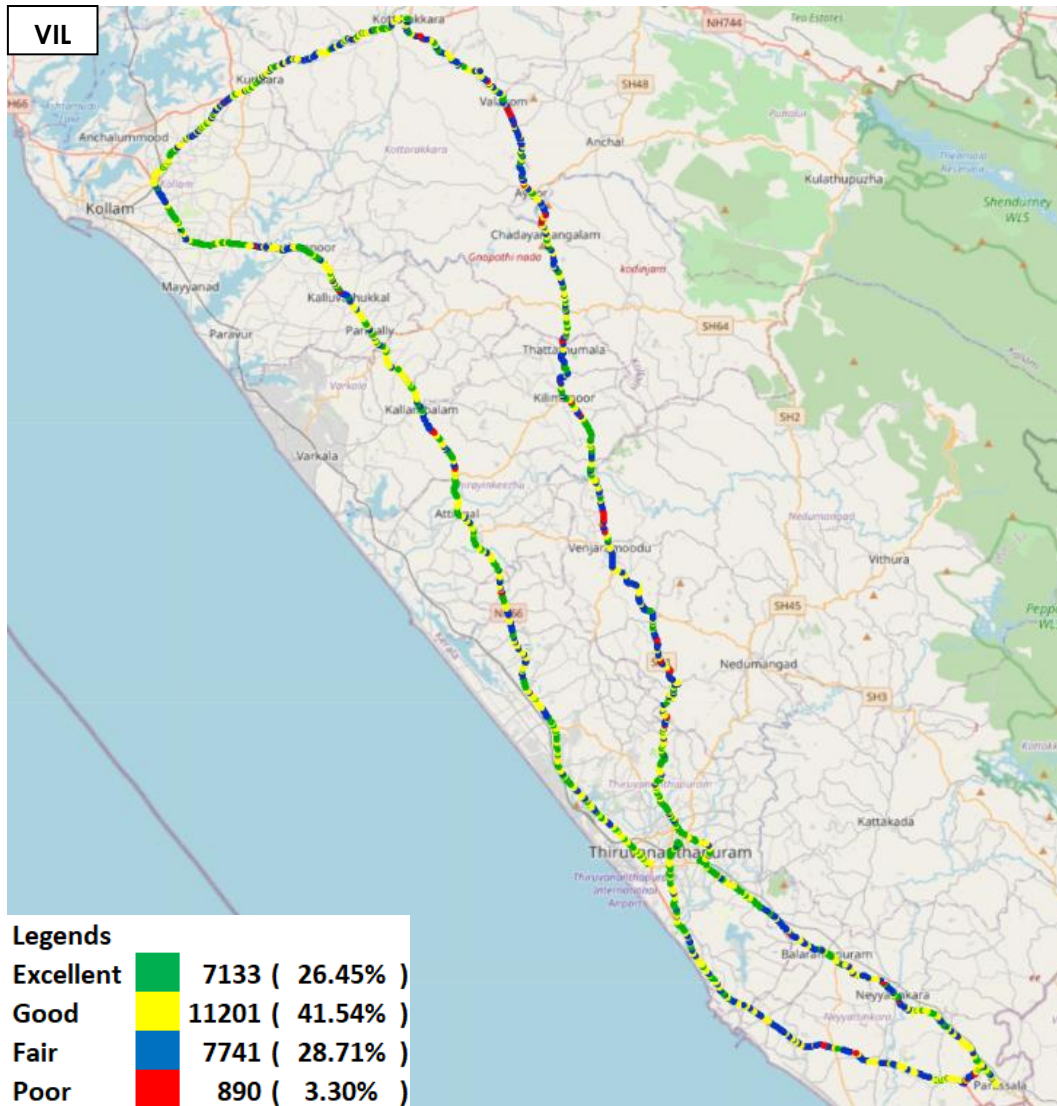


Figure-61: Signal strength 3G/2G network mode – VIL

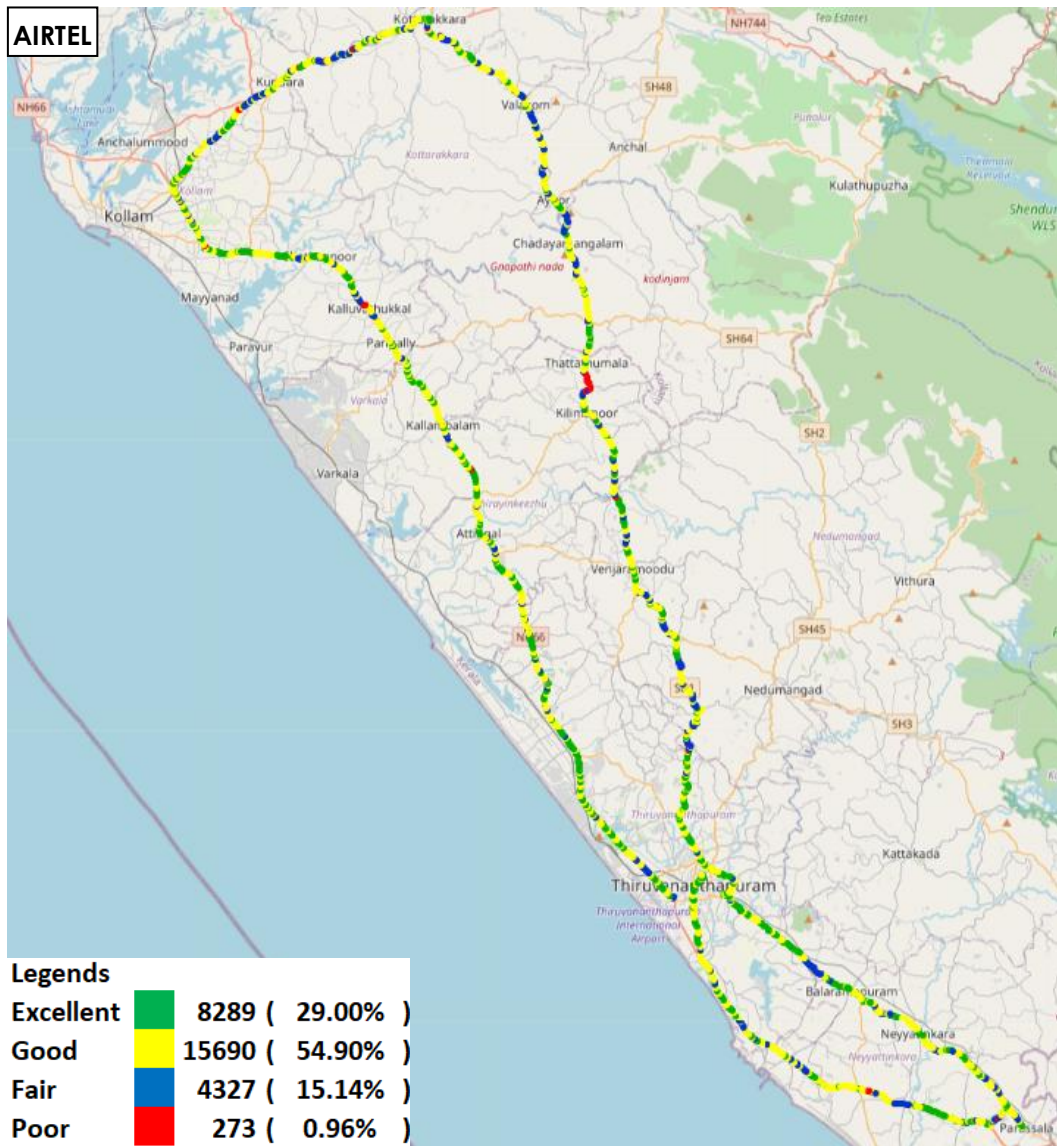


Figure-62: Signal strength auto-selection mode 5G/4G/3G/2G – AIRTEL

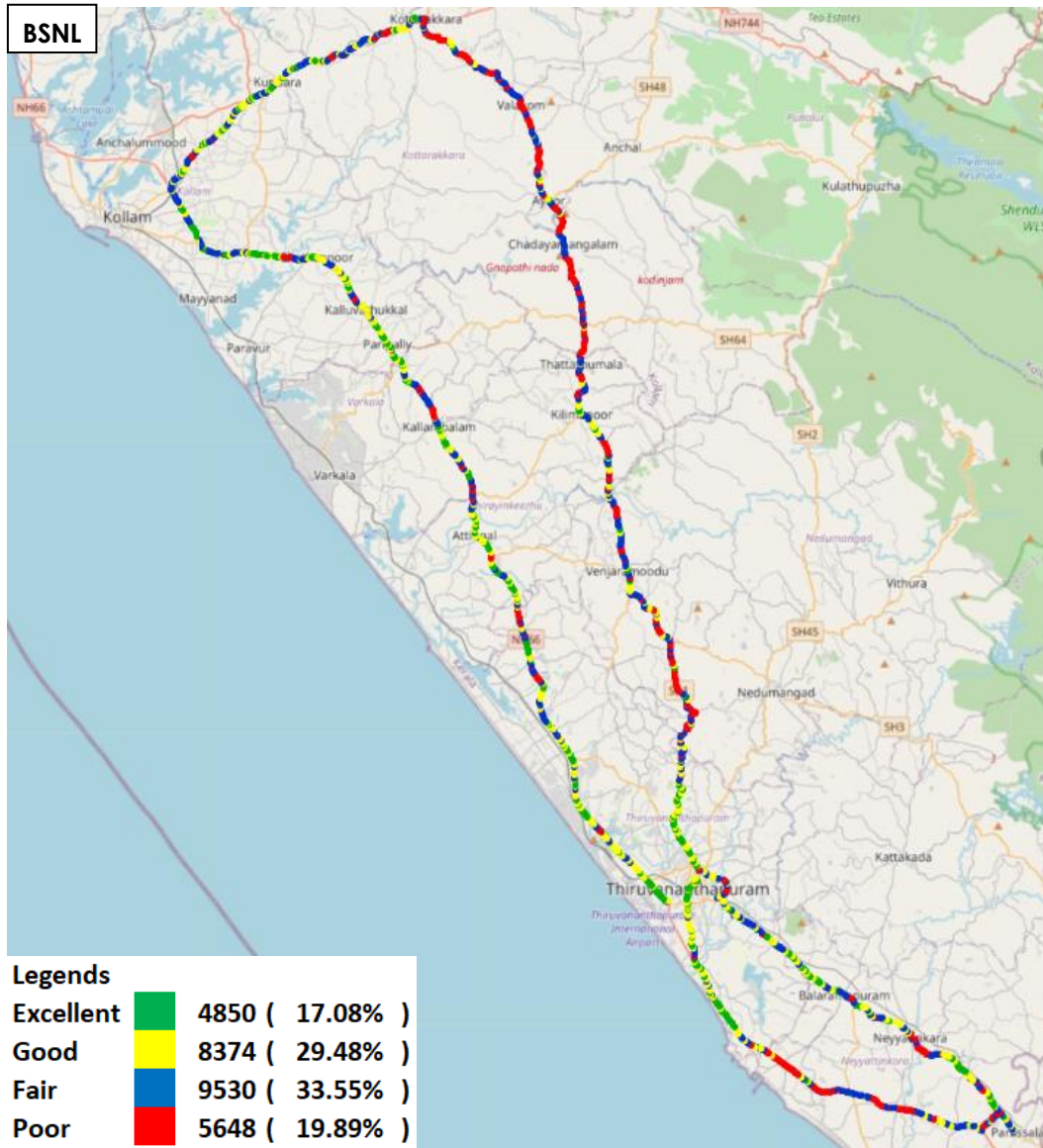


Figure-63: Signal strength auto-selection mode 5G/4G/3G/2G – BSNL

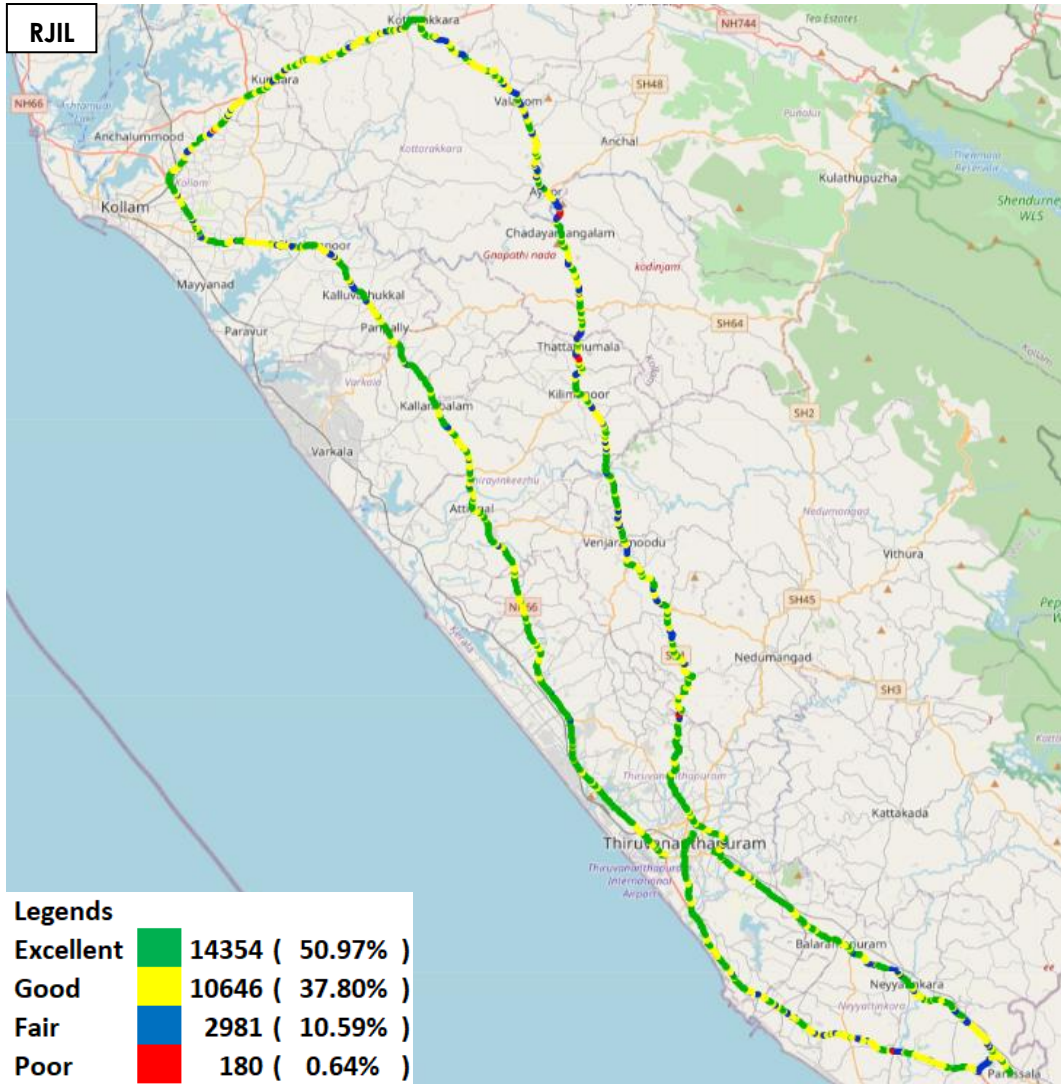


Figure-64: Signal strength auto-selection mode 5G/4G/3G/2G – RJIL

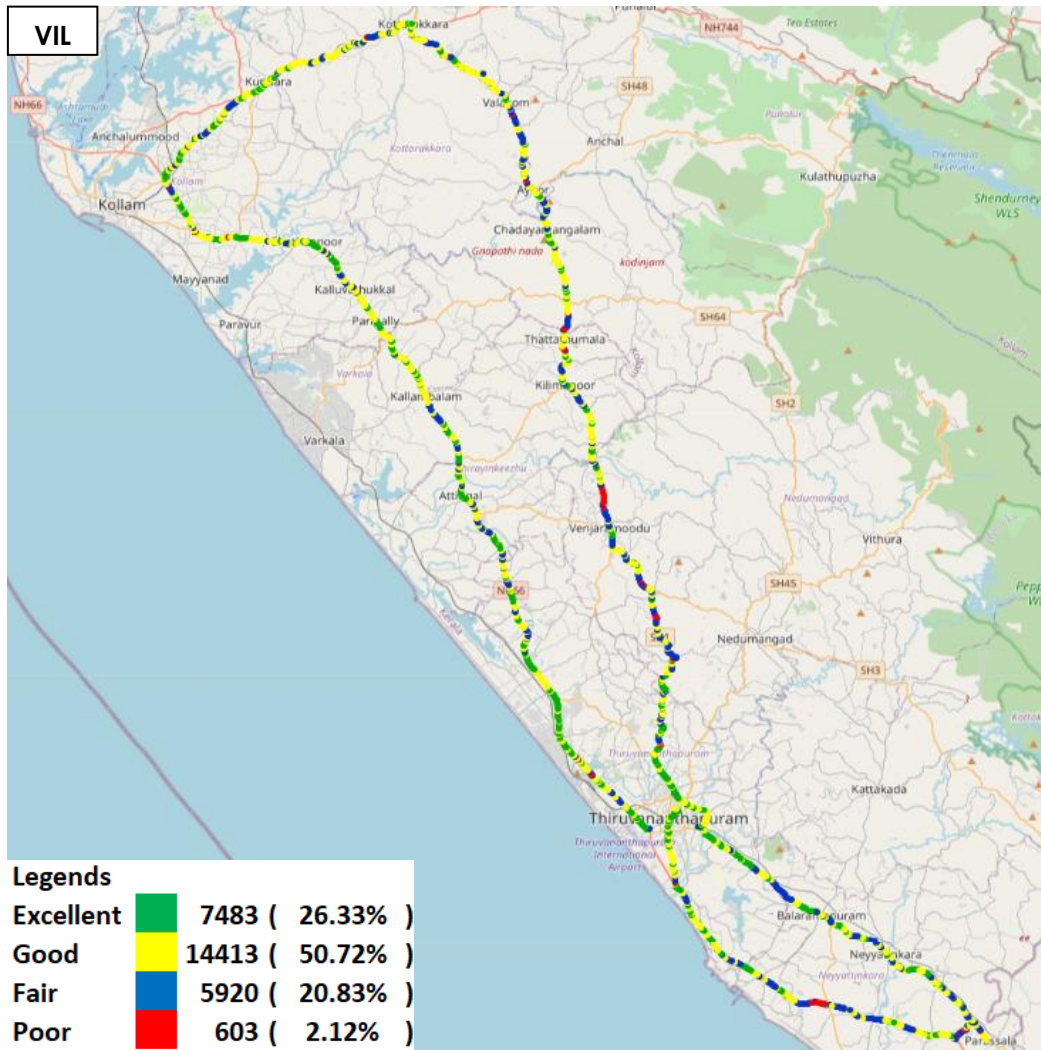


Figure-65: Signal strength auto-selection mode 5G/4G/3G/2G – VIL

6.1.3 Railway Route

i) Thiruvananthapuram railway station to Ernakulam junction

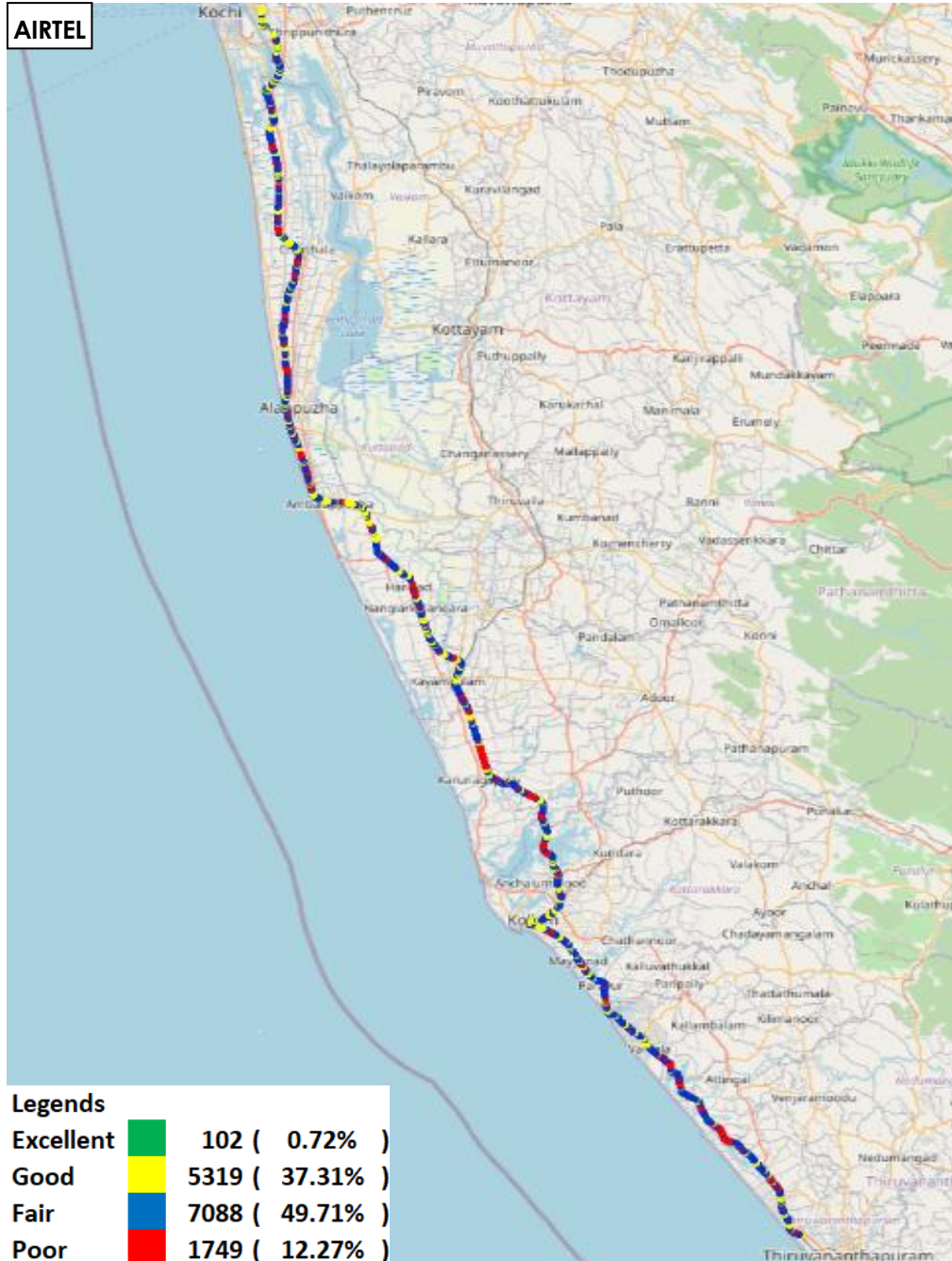


Figure-66: Signal strength auto-selection mode 5G/4G/3G/2G – AIRTEL

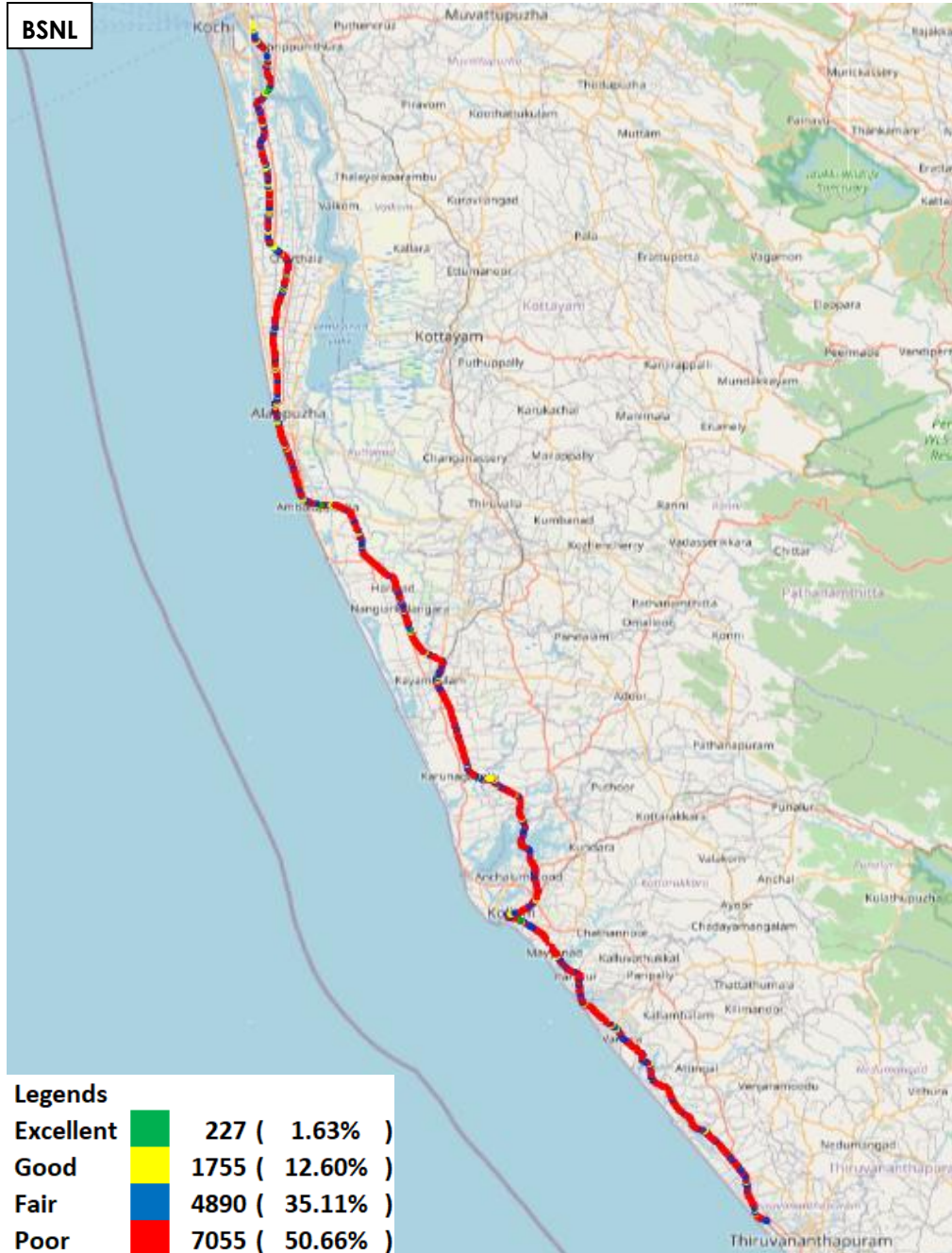


Figure-67: Signal strength auto-selection mode 5G/4G/3G/2G – BSNL

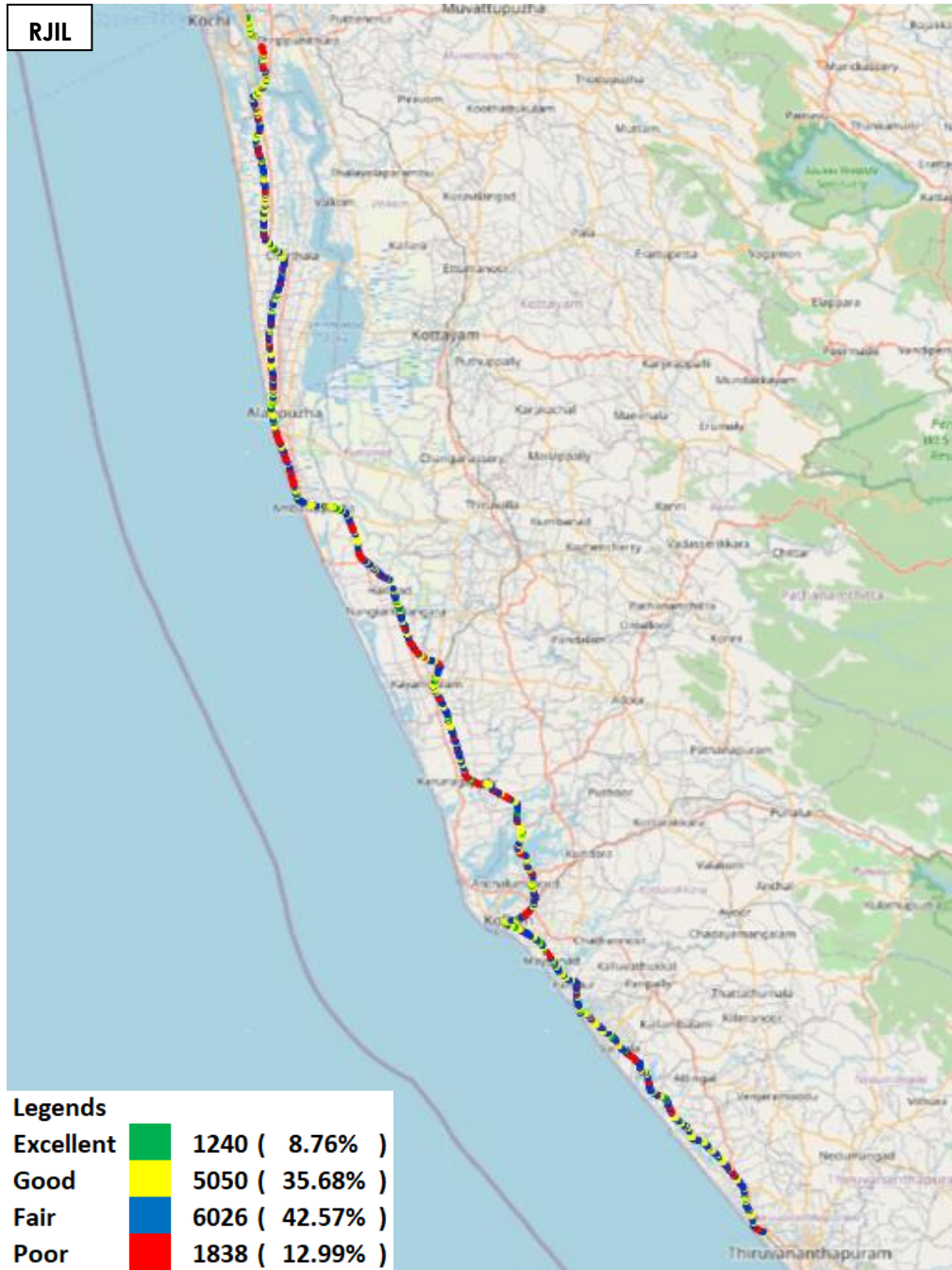


Figure-68: Signal strength auto-selection mode 5G/4G/3G/2G – RJIL

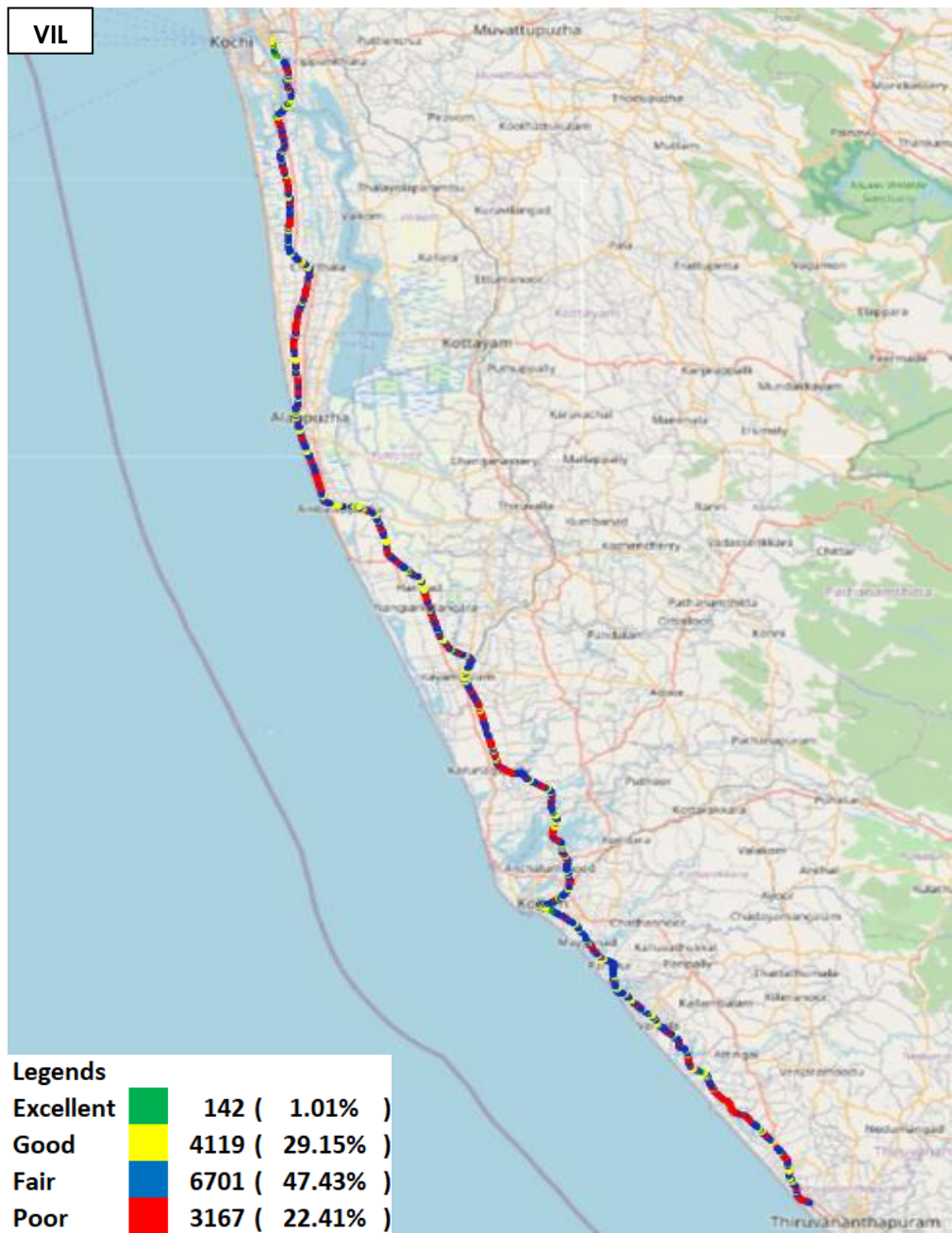


Figure-69: Signal strength auto-selection mode 5G/4G/3G/2G - VIL

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	<ul style="list-style-type: none"> • 3G/2G auto mode- switch Call • 5G/4G/3G/2G auto mode- switch Call • 5G/4G MOS Call 	30 Sec
Call Duration		120 Sec
Wait/ Guard Time		15 Sec

Table-62: Voice test detail

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)

Note-

- There is 15 sec wait time after locking and before starting first call in 3G/2G call.
- 10 calls to be made at each Hotspot location.
- Minimum 10 Calls to be made during the walk test. Call count will be increased based on walk test distance.
- Speech quality (MOS) has been measured only in city drive & highway by making Mobile to Mobile call.
- 180 Sec calls were made only in highway & railway route drive.
- 5G/4G/3G/2G auto mode MOS call were made in BSNL as BSNL don't have VoLTE & VoNR network availability.
- All values are taken up to two decimal places with round off.

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

Table-63: Data test detail

<p>Note-</p> <ul style="list-style-type: none"> • 5 Data iteration to be done at each hotspot location. • Min. 5 iteration to be made during the walk test. Iteration count will be increased based on walk test distance. • Ping test performed only once at hotspot location. • Youtube & Web browsing test performed at static location only. • All values are taken up to two decimal places with round off. • Download and upload testing has been done on FTP server for Airtel, BSNL & RJIL. (Airtel, BSNL & RJIL not provided HTTP server). • VIL download and upload testing is done on HTTP Server.

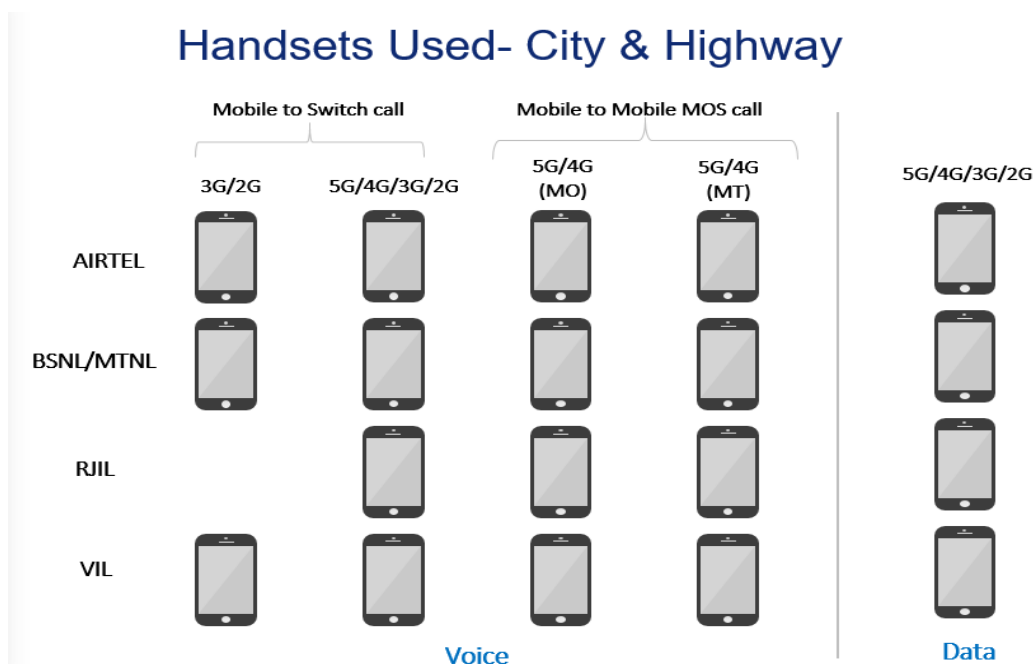


Figure-70: Number of handsets used in city & highway drive
 MO: Mobile originating
 MT: Mobile terminating

Handsets Used- Railway/Metro/Walk Test & Hotspot

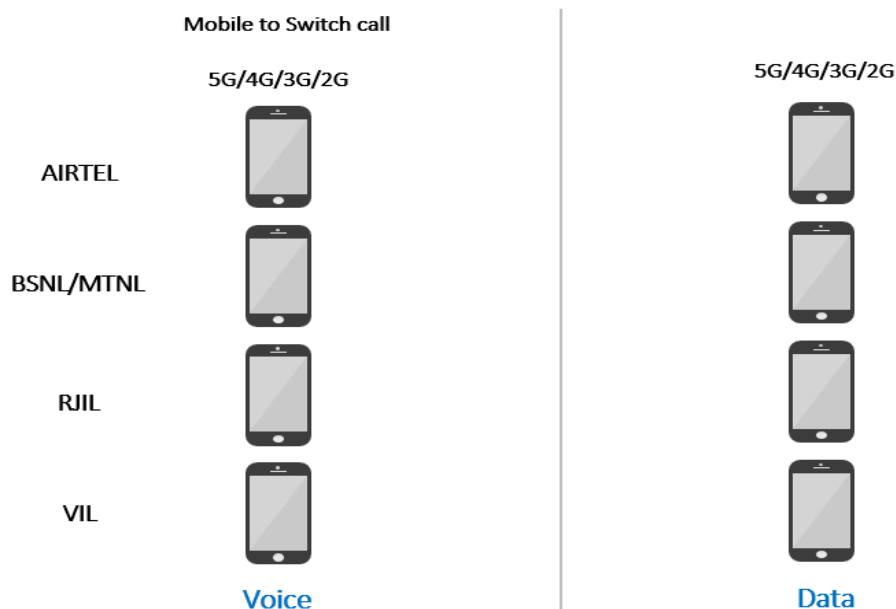


Figure-71: Number of handsets used in railway/metro/walktest/hotspot

7.1.2 Drive test Methodology

(a) Dynamic voice testing (on the move)

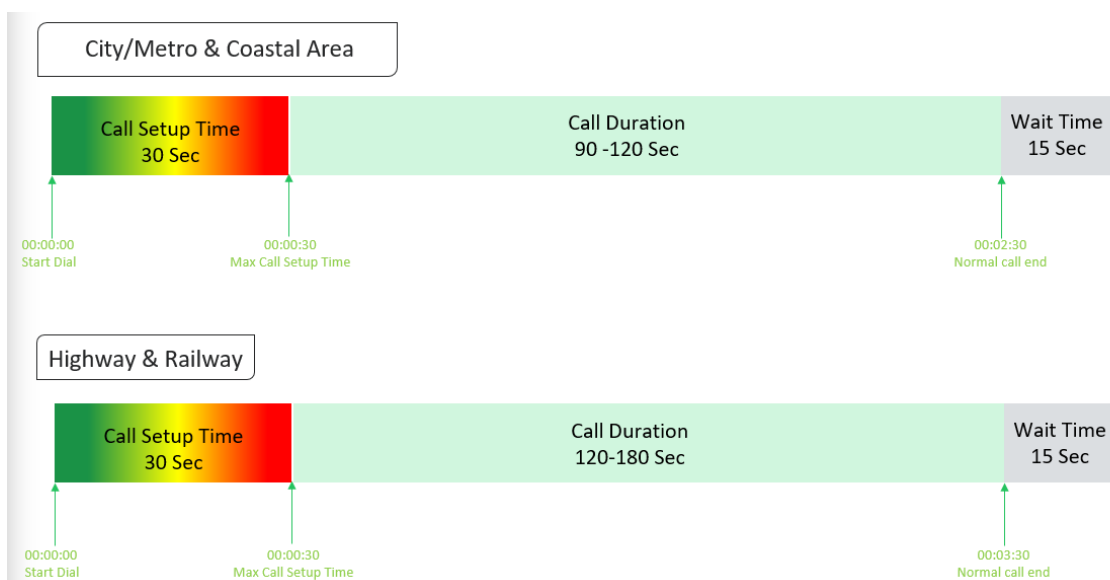


Figure-72: Voice test script for city/railway/metro/highway & coastal area

- 15 sec wait time is applied after locking 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-73: Voice test script for walktest/hotspot

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

(c) Dynamic Data (internet) test

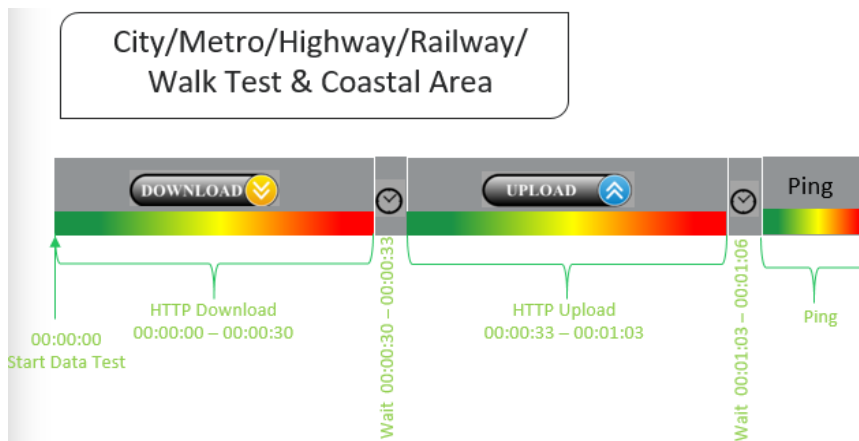


Figure-74: Data test script used in city/metro/railway/highway & coastal area

(d) Static Data(internet) testing

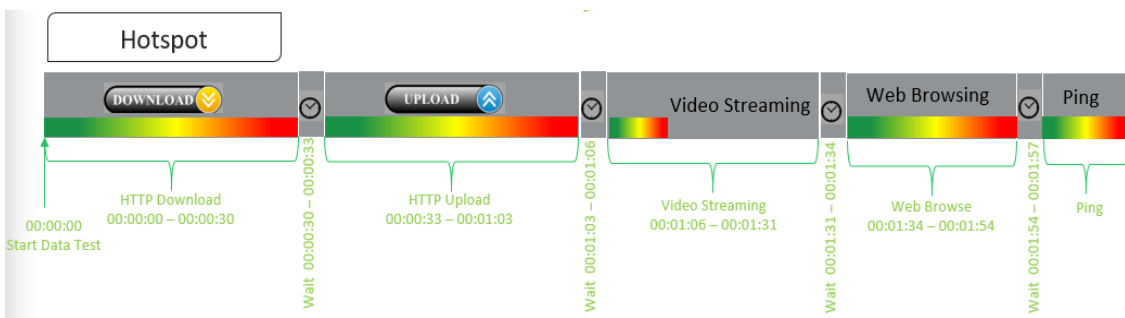


Figure-77: Data test script used at hotspot/walk test

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

7.2 Appendix-II

7.2.1 Network Performance Parameters for Voice call

Parameter Name	Definition
Call Setup Success Rate	<p>(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:</p> <ol style="list-style-type: none"> Call attempt is made The signaling channel is allocated The call is routed to the outwards path of the terminating network An alert signal is received by caller in the form of ring back tone, busy tone, or an announcement. <p>CSSR = (Total Call Established/ Total Call Attempt) *100</p> <p>As per QoS Regulation 2024 benchmark value is >=98%</p>
Call Drop Rate	<p>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</p> <p>Call Drop Rate = (Total Call Drop/Total Call Established) *100</p> <p>As per QoS Regulation 2024 benchmark value is <=2%</p>
Call Setup Time	<p>Time taken from call initiate to call alerting/ringing.</p> <p>Call Setup Time = T2- T1</p> <p>T2- Ringing (VoLTE/VoNR) & Alerting (for WCDMA & GSM), T1- Invite (VoLTE/VoNR) & CM Service Request (for WCDMA & GSM)</p>
Voice Quality (MOS)	<p>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;</p> <p>Excellent: MOS ≥ 4 and < 5 Good : MOS ≥ 3 and < 4 Fair : MOS ≥ 2 and < 3 Poor : MOS ≥ 1 and < 2</p>
Handover Success Rate	<p>Handover Success Rate = Count of successful handovers (All Technology Handover combined) / Total count of Handover Attempt (All Technology Handover combined) *100</p> <p>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.</p>
Silence Call	<p>A call which has ≥ 4 sec continuous RTP gap is considered as a Silence Call.</p> <p>Silence call rate = (count of silence call / Total calls established) *100</p> <p>If a call observes multiple silence count ≥ 4 sec in a particular established call it has been taken as one silent event.</p>

Jitter	<p>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 S_i is the RTP timestamp from packet i, and R_i 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: $D(i,j) = (R_j - R_i) - (S_j - S_i)$</p> <p>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</p>																																		
Downlink Packet Drop Rate	<p>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)</p>																																		
Uplink Packet Drop Rate	<p>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).</p>																																		
Signal Strength	<p>Signal strength is the signal power level received by the wireless user.</p> <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th rowspan="2">Parameter Name</th> <th rowspan="2">Technology</th> <th colspan="4">Signal Strength (dBm)</th> </tr> <tr> <th style="background-color: #92D050;">Excellent</th> <th style="background-color: #FFD700;">Good</th> <th style="background-color: #4682B4;">Fair</th> <th style="background-color: #FF0000;">Poor</th> </tr> </thead> <tbody> <tr> <td>Rx Level</td> <td>GSM</td> <td>0 to \geq -65</td> <td><-65 to \geq- 75</td> <td><-75 to \geq- 85</td> <td><-85 to min</td> </tr> <tr> <td>RSCP</td> <td>WCDMA</td> <td>0 to \geq -70</td> <td><-70 to \geq- 80</td> <td><-80 to \geq- 90</td> <td><-90 to min</td> </tr> <tr> <td>RSRP</td> <td>LTE</td> <td>0 to \geq -80</td> <td><-80 to \geq- 95</td> <td><-95 to \geq- 110</td> <td><- 110 to min</td> </tr> <tr> <td>SS_RSRP</td> <td>NR</td> <td>0 to \geq -80</td> <td><-80 to \geq- 95</td> <td><-95 to \geq- 110</td> <td><- 110 to min</td> </tr> </tbody> </table>	Parameter Name	Technology	Signal Strength (dBm)				Excellent	Good	Fair	Poor	Rx Level	GSM	0 to \geq -65	<-65 to \geq - 75	<-75 to \geq - 85	<-85 to min	RSCP	WCDMA	0 to \geq -70	<-70 to \geq - 80	<-80 to \geq - 90	<-90 to min	RSRP	LTE	0 to \geq -80	<-80 to \geq - 95	<-95 to \geq - 110	<- 110 to min	SS_RSRP	NR	0 to \geq -80	<-80 to \geq - 95	<-95 to \geq - 110	<- 110 to min
Parameter Name	Technology			Signal Strength (dBm)																															
		Excellent	Good	Fair	Poor																														
Rx Level	GSM	0 to \geq -65	<-65 to \geq - 75	<-75 to \geq - 85	<-85 to min																														
RSCP	WCDMA	0 to \geq -70	<-70 to \geq - 80	<-80 to \geq - 90	<-90 to min																														
RSRP	LTE	0 to \geq -80	<-80 to \geq - 95	<-95 to \geq - 110	<- 110 to min																														
SS_RSRP	NR	0 to \geq -80	<-80 to \geq - 95	<-95 to \geq - 110	<- 110 to min																														

Table-64: Network performance parameter and definition voice

7.2.2 Network Performance Parameters Data tests

Parameter Name	Definition
Download Speed (Mbps)	<p>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.</p> <p>Download Speed = Total bytes transferred during download / Total time for transfer</p> <ul style="list-style-type: none"> 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)	<p>The upload speed is the data transmission rate that is achieved for uploading a test file from a test device to a test server.</p> <p>Upload Speed = Total bytes transferred during upload / Total time for transfer.</p>

	<ul style="list-style-type: none"> 80th percentile (upper range) & 20th percentile (lower range) value has been calculated for upload throughput in dynamic drive and Hotspot combine data.
Download Session Setup Success Rate	(total download session established (successfully connected to server)/ total download session attempt) *100. This KPI has been calculated for Hotspot only.
Upload Session Setup Success Rate	(total upload session established (successfully connected to server)/ total upload session attempt)*100. This KPI need to report for Hotspot only.
Web Page Download Time	Web browsing test is used to measure performance in terms of opening a web/HTTP page. Time taken to open the web page successfully is considered as web browsing delay/web page download time.
Video Streaming Delay	The Video streaming delay is time taken from start of video transfer to First video frame displayed in player.
Latency	Latency is the time it takes for a small data set to be transmitted from a device to a server on the Internet and back to the same device again. The Latency is measured in milliseconds (ms). To calculate the one-way latency we just do half of the round-trip time. 50th percentile of one way latency has been reported.
Jitter	Measure of variation in time in arrival of packets from a source to destination The consideration of packet delay jitter is considered by standard deviation of Inter Packet Delay Variation. If IPDV is used. By standard deviation is meant the average of standard deviation of IPDV on DL $IPDV(i) = D(i) - D(i-1)$ then Stdvs of IPDV is considered as jitter.
Packet Loss Rate	Number of packets lost out of total packet transferred during test. Packet loss rate = (Total packet lost / Total packet sent) *100 * Packet delay (using ping) >90 ms considered as packet loss and included in packet loss rate. * Packet loss rate is calculated based on ICMP

Table-65: Network performance parameter and definition Data