

# **TELECOM REGULATORY AUTHORITY OF INDIA**

# Independent Drive Test Report

Maharashtra LSA

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

| SI.<br>No | Drive test<br>route   | Type of<br>route                     | Distance<br>covered<br>(Kms)/<br>Locations | From date   | To date     |
|-----------|---|--------------------------------------|--|-------------|-------------|
| 1         | Ahmednagar  | City                                 | 200  | 21-Oct-2024 | 22-Oct-2024 |
| 2         | Ahmednagar  | City (Inter-<br>operator<br>calling) | 20   | 22-Oct-2024 | 22-Oct-2024 |
| 3         | Ahmednagar  | Hotspot                              | 10<br>Locations                            | 24-Oct-2024 | 25-Oct-2024 |
| 4         | Ahmednagar  | Walk Test                            | 10   | 24-Oct-2024 | 25-Oct-2024 |
| 5         | Ahmednagar<br>to Pune,<br>Pune to<br>Ahmednagar<br>via Dhaund | Highway                              | 265  | 23-Oct-2024 | 23-Oct-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, interoperator call test, hotspots, walk test and highway as per the legends shown on the map.

### 2.3 Summary of areas covered

a) City- Arangaon, Kedgaon, Nimbodi, Shendi, Wadgaon Gupta etc.

### b) Hotspot-

- 1. Ahmednagar Fort
- 2. Bhagwan Baba Chowk
- 3. Bus Stand
- 4. Chandni Chowk
- 5. Dilli Gate Chowk
- 6. District Court
- 7. Ganpati Mandir
- 8. Government Polytechnic

- 9. New Art & Commercial College
- 10. New Municipal Corporation Office.

### c) Walk Test-

- 1. Ahmednagar Railway Station
- 2. Civil District Hospital
- 3. DC Office
- 4. Kapad Bazar

### d) Highway-

- 1. Ahmednagar to Pune.
- 2. Pune to Ahmednagar via Dhaund.

# 2.4 Telecom service providers detected frequency bands

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

| S.no. | Name of TSP                | Technology | Frequency Bands (In MHz) |
|-------|----------------------------|------------|--------------------------|
| 1     | Bharti Airtel Ltd.         | 2G         | 900,1800                 |
| 2     | Bharti Airtel Ltd.         | 4G         | 900,1800,2100,2300       |
| 3     | Bharti Airtel Ltd.         | 5G         | 3500                     |
| 4     | BSNL                       | 2G         | 900                      |
| 5     | BSNL                       | 3G         | 2100                     |
| 6     | BSNL                       | 4G         | 700,2100                 |
| 7     | Reliance JIO Infocomm Ltd. | 4G         | 850,1800,2300            |
| 8     | Reliance JIO Infocomm Ltd. | 5G         | 700,3500                 |
| 9     | Vodafone Idea Ltd.         | 2G         | 900                      |
| 10    | Vodafone Idea Ltd.         | 3G         | 2100                     |
| 11    | Vodafone Idea Ltd.         | 4G         | 900,1800,2100,2300,2500  |

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

# QoS Performance Analysis-Maharashtra 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 October-2024 covering city, hotspot, walk test & highway. (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.

|                                  | Service Provider<br>3G/2G network mode only<br>AIRTEL BSNL VIL |        |       |  |
|----------------------------------|--|--------|-------|--|
| Parameters                       |  |        |       |  |
|                                  |  |        |       |  |
| Call Attempts                    | 449  | 459    | 447   |  |
| Call Setup Success Rate %        | 99.55  | 100.00 | 96.87 |  |
| Drop Call Rate%                  | 0.67 3.49  |        |       |  |
| Call Setup Time-Average (Second) | 4.89 3.59 3  |        |       |  |
| Handover Success Rate %          | 99.14  | 99.96  | 98.98 |  |



**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 |        |      |     |  |  |
|---|--------|------|-----|--|--|
| Taskus lass / Coursian Durasidan 3G/2G network mode only          |        |      |     |  |  |
| Technology/Service Provider                                       | AIRTEL | BSNL | VIL |  |  |
| 3G  | NA     | 150  | NA  |  |  |
| <b>2G</b> 632 131 522   |        |      |     |  |  |

 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)

|                                  | Service Provider            |       |       |       |  |  |
|----------------------------------|-----------------------------|-------|-------|-------|--|--|
| Parameters                       | election mode (5G/4G/3G/2G) |       |       |       |  |  |
|                                  | AIRTEL BSNL RJIL VIL        |       |       |       |  |  |
| Call Attempts                    | 666                         | 715   | 670   | 731   |  |  |
| Call Setup Success Rate %        | 100.00                      | 94.41 | 99.70 | 88.24 |  |  |
| Drop Call Rate%                  | 0.00                        | 7.11  | 0.00  | 0.31  |  |  |
| Call Setup Time-Average (Second) | 0.60                        | 2.49  | 0.80  | 1.13  |  |  |
| Handover Success Rate %          | 96.68                       | 99.54 | 96.62 | 98.17 |  |  |

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

|   | Service Provider                        |       |      |      |  |
|---|---|-------|------|------|--|
| Parameter   | Mobile-to-Mobile<br>(5G/4G - Open Mode) |       |      |      |  |
|   | AIRTEL                                  | BSNL  | RJIL | VIL  |  |
| Call Established<br>(within service provider Network) | 431                                     | 505   | 437  | 438  |  |
| Number of silence call for >4 Sec                     | 1                                       | 14    | 3    | 5    |  |
| Silence Call Rate %                                   | 0.23                                    | 2.77  | 0.69 | 1.14 |  |
| Number of silence instances for >4 Sec                | 1                                       | 16    | 3    | 6    |  |
| Number of silence instances for >3 Sec                | 2                                       | 23    | 8    | 18   |  |
| Number of silence instances for >2 sec                | 13                                      | 33    | 38   | 55   |  |
| RTP Jitter (4G & 5G) in ms                            | 4.88                                    | 11.96 | 8.85 | 4.82 |  |
| Packet loss Rate Downlink %                           | 0.71                                    | 5.25  | 0.85 | 1.37 |  |
| Packet loss Rate Uplink %                             | 0.66                                    | 4.30  | 0.96 | 1.15 |  |

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



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

| Number of unique cell id's covered in Voice test- Technology wise |        |      |      |      |  |  |
|---|--------|------|------|------|--|--|
| Auto Mode (5G/4G/3G/2G)   |        |      |      |      |  |  |
| rechnology/Service Provider                                       | AIRTEL | BSNL | RJIL | VIL  |  |  |
| 5G  | NA     | NA   | 541  | NA   |  |  |
| 4G  | 1234   | 183  | 1603 | 1066 |  |  |
| 3G  | NA     | 126  | NA   | NA   |  |  |
| 2G  | 1      | 89   | NA   | 12   |  |  |

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 |        |        |  |  |
|--|--------|------------------|--------|--------|--|--|
| Speech Quality (MOS) distribution                | AIRTEL | BSNL             | RJIL   | VIL    |  |  |
| Total Number of MOS Samples for calls in table-6 |        | 3152             | 3347   | 3378   |  |  |
| Speech Quality (Average MOS Score)               | 3.98   | 2.90             | 3.85   | 4.06   |  |  |
| Number of samples with MOS >=4 to <5 (Excellent) | 2823   | 376              | 2344   | 2787   |  |  |
| Number of samples with MOS >=3 to <4(Good)       | 418    | 1130             | 742    | 409    |  |  |
| Number of samples with MOS $>=2$ to $<3$ (Fair)  | 68     | 1197             | 148    | 85     |  |  |
| Number of samples with MOS >=1 to <2 (Poor)      | 71     | 449              | 113    | 97     |  |  |
| %age of samples with MOS >=4 to <5 (Excellent)   | 83.52% | 11.93%           | 70.03% | 82.50% |  |  |
| %age of samples with MOS >=3 to <4(Good)         | 12.37% | 35.85%           | 22.17% | 12.11% |  |  |
| % age of samples with MOS >=2 to <3 (Fair)       | 2.01%  | 37.98%           | 4.42%  | 2.52%  |  |  |
| %age of samples with MOS >=1 to <2 (Poor)        | 2.10%  | 14.24%           | 3.38%  | 2.87%  |  |  |

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



Figure- 4: Distribution of samples in MOS score range

(d) Inter-service provider voice call performance: To check the performance of inter-service provider call setup success rate, total 55 to 61 inter operator calls were attempted. The Call setup success rate and call setup time observation are as below.

| Call setup success rate % |                         |        |        |        |  |  |
|---------------------------|-------------------------|--------|--------|--------|--|--|
| To Service Provider       |                         |        |        |        |  |  |
| From Service Provider     | AIRTEL BSNL RJIL VIL    |        |        |        |  |  |
| AIRTEL                    | NA                      | 100.00 | 100.00 | 100.00 |  |  |
| BSNL                      | 100.00                  | NA     | 98.25  | 98.25  |  |  |
| RJIL                      | 100.00 100.00 NA 100.00 |        |        |        |  |  |
| VIL                       | 100.00                  | 98.18  | 100.00 | NA     |  |  |

Table-9: Call setup success rate across service providers

Note-

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

| Call setup time average (seconds) |                      |      |      |      |  |  |
|-----------------------------------|----------------------|------|------|------|--|--|
| To Service Provider               |                      |      |      |      |  |  |
| From Service Provider             | AIRTEL BSNL RJIL VIL |      |      |      |  |  |
| AIRTEL                            | NA                   | 3.08 | 2.09 | 2.31 |  |  |
| BSNL                              | 4.32                 | NA   | 2.99 | 4.83 |  |  |
| <b>RJIL</b> 2.39 3.40 NA 2.70     |                      |      |      |      |  |  |
| VIL                               | 1.71                 | 3.89 | 2.04 | NA   |  |  |

Table-10: Call setup time across service providers

Note-

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

# 3.3 Data performance

|                            |                 |                                   | Service Pr | ovider |       |  |
|----------------------------|-----------------|-----------------------------------|------------|--------|-------|--|
| Parameters                 |                 | Auto-selection mode (5G/4G/3G/2G) |            |        |       |  |
|                            |                 | AIRTEL BSNL RJIL V                |            |        | VIL   |  |
| Describer of Theorem Issue | Average         | 135.59                            | 2.08       | 251.13 | 44.20 |  |
| Download Inroughput        | 80th Percentile | 231.65                            | 3.44       | 467.62 | 70.45 |  |
| (MDRS/S)                   | 20th Percentile | 38.61                             | 0.35       | 18.94  | 15.93 |  |
|                            | Average         | 23.06                             | 1.65       | 31.52  | 14.09 |  |
|                            | 80th Percentile | 46.94                             | 2.22       | 59.13  | 24.53 |  |
| (1013/3)                   | 20th Percentile | 0.00                              | 0.77       | 5.32   | 3.91  |  |
| Ping (ms)                  | Average         | 46.42                             | 159.38     | 38.31  | 35.06 |  |

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

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 |        |                                 |      |      |  |  |
|--|--------|---------------------------------|------|------|--|--|
| Taskaslara / Camias Duovidan                                     | Auto-  | Auto-selection mode 5G/4G/3G/2G |      |      |  |  |
| rechnology/ Service Provider                                     | AIRTEL | BSNL                            | RJIL | VIL  |  |  |
| 5G   | 0      | NA                              | 913  | NA   |  |  |
| 4G   | 1234   | 139                             | 563  | 1018 |  |  |
| 3G   | NA     | 187                             | NA   | NA   |  |  |
| 2G   | 5      | 37                              | NA   | 18   |  |  |

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 and highways 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 21<sup>st</sup> October 2024 to 22<sup>nd</sup> October 2024 in Ahmednagar. (Refer Table-1)

# Militia <t

## 4.2.1 Drive test route

Figure- 6: Drive test routes

### 4.2.2 Areas covered

Arangaon, Kedgaon, Nimbodi, Shendi, Wadgaon gupta 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.

|                                  | Service Provider        |        |       |  |  |  |
|----------------------------------|-------------------------|--------|-------|--|--|--|
| Parameters                       | 3G/2G network mode only |        |       |  |  |  |
|                                  | AIRTEL BSNL VIL         |        |       |  |  |  |
| Call Attempts                    | 306                     | 311    | 309   |  |  |  |
| Call Setup Success Rate %        | 99.35                   | 100.00 | 99.03 |  |  |  |
| Drop Call Rate%                  | 0.00                    | 1.93   | 0.00  |  |  |  |
| Call Setup Time-Average (Second) | 4.96                    | 3.77   | 3.12  |  |  |  |
| Handover Success Rate %          | 99.23                   | 100.00 | 99.08 |  |  |  |





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.

| Tashnalagy | Service Provider |        |         |  |  |
|------------|------------------|--------|---------|--|--|
| rechnology | AIRTEL           | BSNL   | VIL     |  |  |
| 3G         | NA               | 55.31% | NA      |  |  |
| 2G         | 100.00%          | 44.69% | 100.00% |  |  |
| No Service | 0.00%            | 0.00%  | 0.00%   |  |  |

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

| Note | -  |
|------|--|
| ٠    | No service- Limited service and not latched on any available technology. |



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



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



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

**(C) Network Signal Strength distribution:** The following chart represents signal strength distribution for 3G/2G network mode only. (Refer figure-58, 59, 60 for map view)



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

### **Observations:**

- Airtel's 42% of samples falling in excellent signal strength category.
- BSNL's has 33% of samples falling in excellent signal strength category.
- VIL's has 33% of samples falling in excellent signal strength category.

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

|                                  | Service Provider                  |       |        |       |  |  |
|----------------------------------|-----------------------------------|-------|--------|-------|--|--|
| Parameters                       | Auto-selection mode (5G/4G/3G/2G) |       |        |       |  |  |
|                                  | AIRTEL BSNL RJIL VIL              |       |        |       |  |  |
| Call Attempts                    | 321                               | 349   | 321    | 363   |  |  |
| Call Setup Success Rate %        | 100.00                            | 95.42 | 100.00 | 84.85 |  |  |
| Drop Call Rate%                  | 0.00                              | 9.01  | 0.00   | 0.65  |  |  |
| Call Setup Time Average (Second) | 0.53                              | 2.35  | 0.92   | 1.17  |  |  |
| Handover Success Rate %          | 97.06                             | 99.22 | 96.31  | 98.51 |  |  |

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

|   | Service Provider                        |      |      |      |  |  |
|---|---|------|------|------|--|--|
| Parameter   | Mobile-to-Mobile<br>(5G/4G - Open Mode) |      |      |      |  |  |
|   | AIRTEL                                  | BSNL | RJIL | VIL  |  |  |
| Call Established<br>(within service provider Network) | 309                                     | 342  | 311  | 313  |  |  |
| Number of silence call for >4 Sec                     | 1 9 2 5                                 |      |      |      |  |  |
| Silence Call Rate %                                   | 0.32                                    | 2.63 | 0.64 | 1.60 |  |  |
| Number of silence instances for >4 Sec                | 1                                       | 11   | 2    | 6    |  |  |
| Number of silence instances for >3 Sec                | 2                                       | 17   | 7    | 18   |  |  |
| Number of silence instances for >2 sec                | 13                                      | 27   | 37   | 55   |  |  |

| RTP Jitter (4G & 5G) in ms  | 4.38 | 13.51 | 8.54 | 4.69 |
|-----------------------------|------|-------|------|------|
| Packet loss Rate Downlink % | 0.59 | 4.74  | 0.99 | 1.65 |
| Packet loss Rate Uplink %   | 0.42 | 4.25  | 1.09 | 1.38 |



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

Figure-13: Performance for call setup success rate



#### Figure-14: Performance for drop call rate

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

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

| Speech Quality (NOS) distribution                    | Service Provider |        |        |        |  |
|--|------------------|--------|--------|--------|--|
| Speech Quality (MOS) distribution                    | AIRTEL           | BSNL   | RJIL   | VIL    |  |
| Total Number of MOS Samples for calls in table-16    | 1810             | 1588   | 1785   | 1820   |  |
| Speech Quality (Average MOS Score)                   | 4.00             | 2.89   | 3.83   | 4.04   |  |
| Number of samples with MOS $>=4$ to $<5$ (Excellent) | 1528             | 202    | 1256   | 1474   |  |
| Number of samples with MOS >=3 to <4(Good)           | 226              | 557    | 374    | 235    |  |
| Number of samples with MOS $>=2$ to $<3$ (Fair)      | 27               | 583    | 77     | 49     |  |
| Number of samples with MOS $>=1$ to $<2$ (Poor)      | 29               | 246    | 78     | 62     |  |
| %age of samples with MOS >=4 to <5 (Excellent)       | 84.42%           | 12.72% | 70.36% | 80.99% |  |
| %age of samples with MOS >=3 to <4(Good)             | 12.49%           | 35.08% | 20.95% | 12.91% |  |
| % age of samples with MOS >=2 to <3 (Fair)           | 1.49%            | 36.71% | 4.31%  | 2.69%  |  |
| %age of samples with MOS >=1 to <2 (Poor)            | 1.60%            | 15.49% | 4.37%  | 3.41%  |  |

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 |        |        |         |  |  |
|------------|------------------|--------|--------|---------|--|--|
| Technology | AIRTEL           | BSNL   | RJIL   | VIL     |  |  |
| 5G         | 9.81%            | NA     | 16.75% | NA      |  |  |
| 4G         | 90.19%           | 58.02% | 83.25% | 100.00% |  |  |
| 3G         | NA               | 31.77% | NA     | NA      |  |  |
| 2G         | 0.00%            | 10.17% | NA     | 0.00%   |  |  |
| No Service | 0.00%            | 0.04%  | 0.00%  | 0.00%   |  |  |

Table-18: Time spent on technology during drive test

Note-

• No service- Limited service and not latched on any available technology.



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



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



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



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

**(g)Network Signal Strength distribution:** The following chart provide signal strength distribution for auto-selection mode (5G/4G/3G/2G). (Refer figure-61, 62, 63, 64 for plots)



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

### **Observations:**

- Airtel has 25% samples falling in excellent signal strength category.
- BSNL has 14% samples falling in excellent signal strength category.
- RJIL has 42% samples falling in excellent signal strength category.
- VIL has 24% samples falling in excellent signal strength category.

### 4.2.4 Data performance

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

|                       |                 |                                     | Service F | Provider |       |
|-----------------------|-----------------|-------------------------------------|-----------|----------|-------|
| Parameters            |                 | Auto-selection<br>mode(5G/4G/3G/2G) |           |          |       |
|                       | AIRTE           |                                     | BSNL      | RJIL     | VIL   |
| Denveloed Three shout | Average         | 152.88                              | 1.75      | 257.33   | 46.44 |
| Download Inrougnput   | 80th Percentile | 253.31                              | 2.97      | 459.66   | 75.33 |
| (1013/3)              | 20th Percentile | 33.20                               | 0.32      | 28.86    | 13.60 |
|                       | Average         | 25.69                               | 1.45      | 26.68    | 13.71 |
| Upload Throughput     | 80th Percentile | 45.56                               | 1.96      | 50.50    | 22.03 |
| (1013/3)              | 20th Percentile | 5.13                                | 0.72      | 5.09     | 3.55  |
| Ping (ms)             | Average         | 45.48                               | 219.98    | 46.58    | 36.85 |

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







Figure- 22: Upload throughput

# 4.3 Hotspots

Hotspot testing has been done on 24<sup>th</sup> October 2024 & 25<sup>th</sup> October 2024. Ten locations have been tested in the city.

### 4.3.1 Locations



Figure- 23: Hotspot locations

### 4.3.2 Hotspot covered

- 1. Ahmednagar Fort
- 2. Bhagwan Baba Chowk
- 3. Bus Stand
- 4. Chandni Chowk
- 5. Dilli Gate Chowk
- 6. District Court
- 7. Ganpati Mandir
- 8. Government Polytechnic
- 9. New Art & Commercial College
- 10. New Municipal Corporation Office.

### 4.3.3 Voice performance

| Overall Voice Performance     |  |      |      |      |  |  |                              |  |  |        |
|-------------------------------|--|------|------|------|--|--|------------------------------|--|--|--------|
|                               | Service ProviderAuto-selection mode (5G/4G/3G/2G)AIRTELBSNLRJILVIL |      |      |      |  |  |                              |  |  |        |
| Parameters                    |  |      |      |      |  |  | Auto-selection mode (5G/4G/3 |  |  | 3G/2G) |
|                               |  |      |      |      |  |  |                              |  |  |        |
| Call Attempt                  | 108  | 110  | 110  | 110  |  |  |                              |  |  |        |
| Call Setup Success Rate %     | 100.00 92.73 100.00 94.55  |      |      |      |  |  |                              |  |  |        |
| Drop Call Rate%               | 0.00   | 0.00 | 0.00 | 0.00 |  |  |                              |  |  |        |
| Call Setup Time-Average (Sec) | 0.58   | 1.95 | 0.59 | 1.08 |  |  |                              |  |  |        |

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

| Ahmednagar Fort               |                  |             |                           |        |  |  |
|-------------------------------|------------------|-------------|---------------------------|--------|--|--|
|                               | Service Provider |             |                           |        |  |  |
| Parameters                    | Auto-se          | election mo | ection mode (5G/4G/3G/2G) |        |  |  |
|                               | AIRTEL           | BSNL        | RJIL                      | VIL    |  |  |
| Call Attempt                  | 10               | 10          | 10                        | 10     |  |  |
| Call Setup Success Rate %     | 100.00           | 100.00      | 100.00                    | 100.00 |  |  |
| Drop Call Rate%               | 0.00             | 0.00        | 0.00                      | 0.00   |  |  |
| Call Setup Time-Average (Sec) | 0.71             | 1.03        | 0.58                      | 1.13   |  |  |

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

| Bhagwan Baba Chowk            |                                   |         |          |        |  |
|-------------------------------|-----------------------------------|---------|----------|--------|--|
|                               |                                   | Service | Provider |        |  |
| Parameters                    | Auto-selection mode (5G/4G/3G/2G) |         |          |        |  |
|                               | AIRTEL                            | BSNL    | RJIL     | VIL    |  |
| Call Attempt                  | 10                                | 10      | 10       | 10     |  |
| Call Setup Success Rate %     | 100.00                            | 70.00   | 100.00   | 100.00 |  |
| Drop Call Rate%               | 0.00                              | 0.00    | 0.00     | 0.00   |  |
| Call Setup Time-Average (Sec) | 0.61                              | 1.35    | 0.53     | 1.11   |  |

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

| Bus Stand                     |                                   |         |          |        |  |
|-------------------------------|-----------------------------------|---------|----------|--------|--|
|                               |                                   | Service | Provider |        |  |
| Parameters                    | Auto-selection mode (5G/4G/3G/2G) |         |          |        |  |
|                               | AIRTEL                            | BSNL    | RJIL     | VIL    |  |
| Call Attempt                  | 10                                | 10      | 10       | 10     |  |
| Call Setup Success Rate %     | 100.00                            | 100.00  | 100.00   | 100.00 |  |
| Drop Call Rate%               | 0.00                              | 0.00    | 0.00     | 0.00   |  |
| Call Setup Time-Average (Sec) | 0.65                              | 1.07    | 0.56     | 1.06   |  |

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

| Chandni Chowk                 |                         |           |          |        |  |
|-------------------------------|-------------------------|-----------|----------|--------|--|
|                               |                         | Service I | Provider |        |  |
| Parameters                    | 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) | 0.57                    | 1.05      | 0.55     | 1.10   |  |

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

| Dilli Gate Chowk              |                         |           |          |       |  |
|-------------------------------|-------------------------|-----------|----------|-------|--|
|                               |                         | Service I | Provider |       |  |
| Parameters                    | Auto Mode (5G/4G/3G/2G) |           |          |       |  |
|                               | AIRTEL BSNL RJIL V      |           |          |       |  |
| Call Attempt                  | 10                      | 10        | 10       | 10    |  |
| Call Setup Success Rate %     | 100.00                  | 100.00    | 100.00   | 90.00 |  |
| Drop Call Rate%               | 0.00                    | 0.00      | 0.00     | 0.00  |  |
| Call Setup Time-Average (Sec) | 0.61                    | 2.99      | 0.54     | 1.08  |  |

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

| District Court                     |                  |           |          |        |  |
|------------------------------------|------------------|-----------|----------|--------|--|
|                                    |                  | Service F | Provider |        |  |
| Parameters Auto Mode (5G/4G/3G/2G) |                  |           |          |        |  |
|                                    | AIRTEL BSNL RJIL |           |          |        |  |
| Call Attempt                       | 10               | 10        | 10       | 10     |  |
| Call Setup Success Rate %          | 100.00           | 100.00    | 100.00   | 100.00 |  |
| Drop Call Rate%                    | 0.00             | 0.00      | 0.00     | 0.00   |  |
| Call Setup Time-Average (Sec)      | 0.63             | 2.95      | 0.72     | 1.06   |  |

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

| Ganpati Mandir                |                         |       |        |       |
|-------------------------------|-------------------------|-------|--------|-------|
|                               | Service Provider        |       |        |       |
| Parameters                    | Auto Mode (5G/4G/3G/2G) |       |        |       |
|                               | AIRTEL BSNL RJIL VII    |       |        |       |
| Call Attempt                  | 10                      | 10    | 10     | 10    |
| Call Setup Success Rate %     | 100.00                  | 90.00 | 100.00 | 90.00 |
| Drop Call Rate%               | 0.00                    | 0.00  | 0.00   | 0.00  |
| Call Setup Time-Average (Sec) | 0.47                    | 2.53  | 0.67   | 1.06  |

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

| Government Polytechnic        |                         |           |          |        |                         |  |  |  |
|-------------------------------|-------------------------|-----------|----------|--------|-------------------------|--|--|--|
|                               |                         | Service F | Provider |        |                         |  |  |  |
| Parameters                    | Auto Mode (5G/4G/3G/2G) |           |          |        | Auto Mode (5G/4G/3G/2G) |  |  |  |
|                               | AIRTEL                  | BSNL      | 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) | 0.48                    | 7.06      | 0.56     | 1.02   |                         |  |  |  |

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

| New Art & Commercial College  |                         |           |         |       |  |
|-------------------------------|-------------------------|-----------|---------|-------|--|
|                               |                         | Service P | rovider |       |  |
| Parameters                    | Auto Mode (5G/4G/3G/2G) |           |         |       |  |
|                               | AIRTEL                  | BSNL      | RJIL    | VIL   |  |
| Call Attempt                  | 18                      | 20        | 20      | 20    |  |
| Call Setup Success Rate %     | 100.00                  | 100.00    | 100.00  | 85.00 |  |
| Drop Call Rate%               | 0.00                    | 0.00      | 0.00    | 0.00  |  |
| Call Setup Time-Average (Sec) | 0.55                    | 1.09      | 0.59    | 1.13  |  |

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

| New Municipal Corporation Office |                         |           |         |       |  |
|----------------------------------|-------------------------|-----------|---------|-------|--|
|                                  |                         | Service P | rovider |       |  |
| Parameters                       | 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  | 90.00 |  |
| Drop Call Rate%                  | 0.00                    | 0.00      | 0.00    | 0.00  |  |
| Call Setup Time-Average (Sec)    | 0.56                    | 1.15      | 0.66    | 0.99  |  |

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

### 4.3.4 Data performance

| Overall Data Performance                     |                                      |       |        |        |
|--|--------------------------------------|-------|--------|--------|
|  | Service Provider                     |       |        |        |
| Parameters                                   | Auto-selection mode<br>(5G/4G/3G/2G) |       |        |        |
|  | AIRTEL                               | BSNL  | RJIL   | VIL    |
| Download Throughput Average (Mbits/s)        | 96.63                                | 3.82  | 226.97 | 55.82  |
| Download Throughput 80th Percentile (Mbit/s) | 136.96                               | 4.53  | 384.43 | 82.85  |
| Download Throughput 20th Percentile (Mbit/s) | 13.20                                | 1.14  | 20.40  | 28.76  |
| Download Session Setup Success Rate %        | 100.00                               | 81.82 | 96.36  | 100.00 |
| Upload Throughput Average (Mbits/s)          | 20.64                                | 3.94  | 31.35  | 12.88  |
| Upload Throughput 80th Percentile (Mbit/s)   | 27.48                                | 4.95  | 55.17  | 19.33  |
| Upload Throughput 20th Percentile (Mbit/s)   | 0.00                                 | 1.22  | 5.78   | 5.53   |
| Upload Session Setup Success Rate %          | 100.00                               | 76.36 | 100.00 | 100.00 |
| Web Browsing Delay (Second)                  | 3.20                                 | 6.64  | 2.42   | 2.66   |
| Youtube Initial Buffer Delay (Second)        | 1.43                                 | 2.77  | 0.78   | 0.68   |
| Ping (ms)                                    | 47.44                                | 31.74 | 27.31  | 14.07  |
| Jitter (ms)                                  | 10.05                                | 20.38 | 10.51  | 4.61   |
| Packet Loss Rate-Ping %                      | 4.28                                 | 8.40  | 0.27   | 0.23   |

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

| Ahmednagar Fort   |  |         |          |       |  |
|---|--|---------|----------|-------|--|
|   |  | Service | Provider |       |  |
| Parameters  | Auto-selection mode (5G/4G/3G/2G)                      |         |          |       |  |
|   | AIRTEL   | BSNL    | RJIL     | VIL   |  |
| Download Throughput Average (Mbits/s)                       | 4.51   | 1.20    | 361.49   | 35.05 |  |
| Download Session Setup Success Rate %                       | wnload Session Setup Success Rate % 100.00 100.00 100. |         |          |       |  |
| Upload Throughput Average (Mbits/s)                         | 0.00   | 1.40    | 5.05     | 8.09  |  |
| Upload Session Setup Success Rate % 100.00 60.00 100.00 100 |  |         |          |       |  |

| Web Browsing Delay (Second)           | 5.50  | 11.08 | 2.47  | 5.12  |
|---------------------------------------|-------|-------|-------|-------|
| Youtube Initial Buffer Delay (Second) | 5.65  | 4.08  | 1.12  | 1.04  |
| Ping (ms)                             | 48.80 | 58.64 | 27.70 | 16.61 |
| Jitter (ms)                           | 9.85  | 30.85 | 8.13  | 3.24  |
| Packet Loss Rate-Ping %               | 1.00  | 7.80  | 0.40  | 0.20  |

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

Note-

• All Upload tests failed in Airtel.

| Bhagwan Baba Chowk                    |  |       |        |          |
|---------------------------------------|--|-------|--------|----------|
|                                       | Service ProviderAuto-selection mode (5G/4G/3G/2G)AIRTELBSNLRJILVIL |       |        |          |
| Parameters                            |  |       |        | i/3G/2G) |
|                                       |  |       |        | VIL      |
| Download Throughput Average (Mbits/s) | 76.03  | 3.16  | 266.90 | 84.24    |
| Download Session Setup Success Rate % | 100.00   | 60.00 | 80.00  | 100.00   |
| Upload Throughput Average (Mbits/s)   | 82.95  | 3.04  | 48.06  | 30.26    |
| Upload Session Setup Success Rate %   | 100.00   | 40.00 | 100.00 | 100.00   |
| Web Browsing Delay (Second)           | 3.50   | 3.68  | 2.17   | 2.01     |
| Youtube Initial Buffer Delay (Second) | 1.68   | 3.17  | 0.69   | 0.68     |
| Ping (ms)                             | 41.69  | 30.65 | 26.80  | 14.27    |
| Jitter (ms)                           | 5.83   | 17.24 | 6.82   | 2.13     |
| Packet Loss Rate-Ping %               | 1.00   | 17.40 | 0.00   | 0.10     |

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

| Bus Stand                             |                         |        |        |        |
|---------------------------------------|-------------------------|--------|--------|--------|
|                                       | Service Provider        |        |        |        |
| Parameters                            | Auto Mode (5G/4G/3G/2G) |        |        | /2G)   |
|                                       | AIRTEL                  | BSNL   | RJIL   | VIL    |
| Download Throughput Average (Mbits/s) | 175.60                  | 2.33   | 190.96 | 89.18  |
| Download Session Setup Success Rate % | 100.00                  | 60.00  | 100.00 | 100.00 |
| Upload Throughput Average (Mbits/s)   | 0.00                    | 1.30   | 7.80   | 5.47   |
| Upload Session Setup Success Rate %   | 100.00                  | 100.00 | 100.00 | 100.00 |
| Web Browsing Delay (Second)           | 2.59                    | 5.43   | 2.35   | 2.63   |
| Youtube Initial Buffer Delay (Second) | 0.83                    | 5.57   | 0.89   | 0.72   |
| Ping (ms)                             | 30.14                   | 31.72  | 27.02  | 12.13  |
| Jitter (ms)                           | 2.93                    | 25.88  | 7.31   | 2.47   |
| Packet Loss Rate-Ping %               | 0.00                    | 6.10   | 0.00   | 0.10   |

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

| Chandni Chowk                         |                         |        |        |        |
|---------------------------------------|-------------------------|--------|--------|--------|
|                                       | Service Provider        |        |        |        |
| Parameters                            | Auto Mode (5G/4G/3G/2G) |        |        |        |
|                                       | AIRTEL                  | BSNL   | RJIL   | VIL    |
| Download Throughput Average(Mbits/s)  | 40.25                   | 4.31   | 799.55 | 68.99  |
| Download Session Setup Success Rate % | 100.00                  | 80.00  | 100.00 | 100.00 |
| Upload Throughput Average (Mbits/s)   | 0.00                    | 3.16   | 87.78  | 18.61  |
| Upload Session Setup Success Rate %   | 100.00                  | 100.00 | 100.00 | 100.00 |
| Web Browsing Delay (Second)           | 4.42                    | 8.29   | 2.43   | 2.23   |
| Youtube Initial Buffer Delay (Second) | 2.04                    | 0.90   | 0.64   | 0.59   |
| Ping (ms)                             | 54.50                   | 18.03  | 26.50  | 12.26  |

| Jitter (ms)             | 23.17 | 9.60 | 6.46 | 2.45 |
|-------------------------|-------|------|------|------|
| Packet Loss Rate-Ping % | 18.10 | 0.10 | 0.00 | 0.10 |

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

Note-

• All Upload tests failed in Airtel.

| Dilli Gate Chowk                      |                                 |           |          |        |  |
|---------------------------------------|---------------------------------|-----------|----------|--------|--|
|                                       |                                 | Service P | rovider  |        |  |
| Parameters                            | Parameters Auto Mode (5G/4G/3G/ |           | /4G/3G/2 | /2G)   |  |
|                                       | AIRTEL                          | BSNL      | RJIL     | VIL    |  |
| Download Throughput Average(Mbits/s)  | 122.16                          | 2.29      | 17.38    | 66.15  |  |
| Download Session Setup Success Rate % | 100.00                          | 100.00    | 100.00   | 100.00 |  |
| Upload Throughput Average (Mbits/s)   | 19.53                           | 1.68      | 94.70    | 29.61  |  |
| Upload Session Setup Success Rate %   | 100.00                          | 100.00    | 100.00   | 100.00 |  |
| Web Browsing Delay (Second)           | 2.58                            | 7.53      | 2.38     | 2.14   |  |
| Youtube Initial Buffer Delay (Second) | 0.74                            | 4.28      | 0.69     | 0.59   |  |
| Ping (ms)                             | 66.31                           | 27.85     | 26.15    | 13.48  |  |
| Jitter (ms)                           | 22.77                           | 21.29     | 6.72     | 4.26   |  |
| Packet Loss Rate-Ping %               | 24.50                           | 21.09     | 0.00     | 0.10   |  |

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

| District Court                        |                         |       |        |        |
|---------------------------------------|-------------------------|-------|--------|--------|
|                                       | Service Provider        |       |        |        |
| Parameters                            | Auto Mode (5G/4G/3G/2G) |       |        | 2G)    |
|                                       | AIRTEL                  | BSNL  | RJIL   | VIL    |
| Download Throughput Average (Mbits/s) | 11.46                   | 0.62  | 162.23 | 45.35  |
| Download Session Setup Success Rate % | 100.00                  | 60.00 | 100.00 | 100.00 |
| Upload Throughput Average (Mbits/s)   | 3.83                    | 0.76  | 3.34   | 6.02   |
| Upload Session Setup Success Rate %   | 100.00                  | 60.00 | 100.00 | 100.00 |
| Web Browsing Delay (Second)           | 2.77                    | 12.01 | 2.50   | 2.82   |
| Youtube Initial Buffer Delay (Second) | 1.03                    | 4.87  | 1.02   | 0.61   |
| Ping (ms)                             | 53.59                   | 46.65 | 30.52  | 20.44  |
| Jitter (ms)                           | 7.82                    | 27.47 | 15.70  | 18.26  |
| Packet Loss Rate-Ping %               | 0.40                    | 7.20  | 0.60   | 0.50   |

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

| Ganpati Mandir                        |   |        |        |        |
|---------------------------------------|---|--------|--------|--------|
|                                       | Service Provider<br>Auto Mode (5G/4G/3G/2G) |        |        |        |
| Parameters                            |   |        |        | 2G)    |
|                                       | AIRTEL                                      | BSNL   | RJIL   | VIL    |
| Download Throughput Average (Mbits/s) | 99.64                                       | 1.21   | 50.34  | 40.66  |
| Download Session Setup Success Rate % | 100.00                                      | 100.00 | 100.00 | 100.00 |
| Upload Throughput Average (Mbits/s)   | 25.87                                       | 5.15   | 6.98   | 4.02   |
| Upload Session Setup Success Rate %   | 100.00                                      | 100.00 | 100.00 | 100.00 |
| Web Browsing Delay (Second)           | 4.06  | 8.58   | 2.63   | 2.57   |
| Youtube Initial Buffer Delay (Second) | 0.77  | 1.13   | 0.77   | 0.66   |
| Ping (ms)                             | 61.37                                       | 26.51  | 28.21  | 11.51  |
| Jitter (ms)                           | 11.59                                       | 20.56  | 23.18  | 2.92   |
| Packet Loss Rate-Ping %               | 1.20  | 18.00  | 0.40   | 0.00   |

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

| Government Polytechnic                |   |        |        |        |
|---------------------------------------|---|--------|--------|--------|
|                                       | Service Provider<br>Auto Mode (5G/4G/3G/2G)<br>AIRTEL BSNL RJIL VIL |        |        |        |
| Parameters                            |   |        |        | 2G)    |
|                                       |   |        |        | VIL    |
| Download Throughput Average (Mbits/s) | 209.53  | 1.52   | 378.00 | 106.97 |
| Download Session Setup Success Rate % | 100.00  | 100.00 | 100.00 | 100.00 |
| Upload Throughput Average (Mbits/s)   | 52.18   | 2.66   | 19.25  | 12.49  |
| Upload Session Setup Success Rate %   | 100.00  | 100.00 | 100.00 | 100.00 |
| Web Browsing Delay (Second)           | 2.31  | 5.98   | 2.11   | 2.23   |
| Youtube Initial Buffer Delay (Second) | 0.67  | 3.03   | 0.61   | 0.53   |
| Ping (ms)                             | 36.69   | 27.29  | 25.50  | 10.61  |
| Jitter (ms)                           | 2.54  | 18.02  | 6.85   | 2.25   |
| Packet Loss Rate-Ping                 | 0.00  | 8.10   | 0.00   | 0.40   |

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

| New Art & Commercial College          |                                       |           |         |        |
|---------------------------------------|---------------------------------------|-----------|---------|--------|
|                                       |                                       | Service P | rovider |        |
| Parameters                            | Auto Mode (5G/4G/3G/2G)AIRTELBSNLRJIL |           |         | 2G)    |
|                                       |                                       |           |         | VIL    |
| Download Throughput Average (Mbits/s) | 104.70                                | 3.74      | 119.37  | 25.60  |
| Download Session Setup Success Rate % | 100.00                                | 70.00     | 90.00   | 100.00 |
| Upload Throughput Average (Mbits/s)   | 11.46                                 | 2.10      | 9.58    | 8.13   |
| Upload Session Setup Success Rate %   | 100.00                                | 40.00     | 100.00  | 100.00 |
| Web Browsing Delay (Second)           | 2.41                                  | 5.18      | 2.43    | 2.70   |
| Youtube Initial Buffer Delay (Second) | 0.72                                  | 2.53      | 0.71    | 0.69   |
| Ping (ms)                             | 43.84                                 | 26.95     | 28.51   | 16.00  |
| Jitter (ms)                           | 5.55                                  | 16.72     | 14.11   | 4.67   |
| Packet Loss Rate-Ping %               | 0.15                                  | 2.60      | 0.65    | 0.35   |

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

| New Municipal Corporation Office      |   |            |        |        |
|---------------------------------------|---|------------|--------|--------|
|                                       |   | Service Pr | ovider |        |
| Parameters                            | Auto Mode (5G/4G/3G/2G)<br>AIRTEL BSNL RJIL |            |        | i)     |
|                                       |   |            |        | VIL    |
| Download Throughput Average (Mbits/s) | 114.37                                      | 15.82      | 17.53  | 24.08  |
| Download Session Setup Success Rate % | 100.00                                      | 100.00     | 100.00 | 100.00 |
| Upload Throughput Average (Mbits/s)   | 19.77                                       | 14.93      | 52.69  | 10.84  |
| Upload Session Setup Success Rate %   | 100.00                                      | 100.00     | 100.00 | 100.00 |
| Web Browsing Delay (Second)           | 2.63  | 2.85       | 2.78   | 2.24   |
| Youtube Initial Buffer Delay (Second) | 0.85  | 0.86       | 0.72   | 0.69   |
| Ping (ms)                             | 41.07                                       | 25.35      | 24.99  | 11.46  |
| Jitter (ms)                           | 13.02                                       | 19.55      | 6.18   | 3.42   |
| Packet Loss Rate-Ping %               | 0.60  | 1.40       | 0.30   | 0.30   |

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  $24^{th}$  October 2024 &  $25^{th}$  October 2024. Three 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. Ahmednagar Railway Station
- 2. Civil District Hospital
- 3. DC Office
- 4. Kapad Bazar

### 4.4.3 Voice performance

| Ahmednagar Railway Station    |                                   |         |          |       |                                   |  |  |  |
|-------------------------------|-----------------------------------|---------|----------|-------|-----------------------------------|--|--|--|
|                               |                                   | Service | Provider |       |                                   |  |  |  |
| Parameters                    | Auto-selection mode (5G/4G/3G/2G) |         |          |       | Auto-selection mode (5G/4G/3G/2G) |  |  |  |
|                               | AIRTEL                            | BSNL    | RJIL     | VIL   |                                   |  |  |  |
| Call Attempt                  | 24                                | 24      | 24       | 24    |                                   |  |  |  |
| Call Setup Success Rate %     | 100.00                            | 100.00  | 100.00   | 95.83 |                                   |  |  |  |
| Drop Call Rate%               | 0.00                              | 0.00    | 0.00     | 0.00  |                                   |  |  |  |
| Call Setup Time-Average (Sec) | 0.60                              | 2.36    | 0.56     | 1.11  |                                   |  |  |  |

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

| Civil District Hospital       |   |        |        |       |  |  |
|-------------------------------|---|--------|--------|-------|--|--|
|                               | Service ProviderParametersAuto-selection mode (5G/4G/3G/2G) |        |        |       |  |  |
| Parameters                    |   |        |        |       |  |  |
|                               | AIRTEL  | BSNL   | RJIL   | VIL   |  |  |
| Call Attempt                  | 25  | 26     | 26     | 30    |  |  |
| Call Setup Success Rate %     | 100.00  | 100.00 | 100.00 | 80.00 |  |  |
| Drop Call Rate%               | 0.00  | 3.85   | 0.00   | 0.00  |  |  |
| Call Setup Time-Average (Sec) | 1.22  | 3.69   | 0.54   | 1.75  |  |  |

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

| DC Office                     |                                   |       |        |       |  |
|-------------------------------|-----------------------------------|-------|--------|-------|--|
|                               | Service Provider                  |       |        |       |  |
| Parameters                    | Auto-selection mode (5G/4G/3G/2G) |       |        |       |  |
|                               | AIRTEL                            | BSNL  | RJIL   | VIL   |  |
| Call Attempt                  | 19                                | 22    | 19     | 21    |  |
| Call Setup Success Rate %     | 100.00                            | 72.73 | 100.00 | 90.48 |  |
| Drop Call Rate%               | 0.00                              | 0.00  | 0.00   | 0.00  |  |
| Call Setup Time-Average (Sec) | 0.62                              | 2.96  | 0.57   | 1.01  |  |

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

| Kapad Bazar                   |                  |                        |        |       |  |
|-------------------------------|------------------|------------------------|--------|-------|--|
|                               | Service Provider |                        |        |       |  |
| Parameters                    | A                | uto Mode (5G/4G/3G/2G) |        |       |  |
|                               | AIRTEL           | BSNL                   | RJIL   | VIL   |  |
| Call Attempt                  | 26               | 26                     | 25     | 26    |  |
| Call Setup Success Rate %     | 100.00           | 100.00                 | 100.00 | 96.15 |  |
| Drop Call Rate%               | 0.00             | 0.00                   | 0.00   | 0.00  |  |
| Call Setup Time-Average (Sec) | 0.62             | 1.06                   | 1.14   | 0.90  |  |

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

## 4.4.4 Data performance

| Ahmednagar Railway Station            |                                   |        |        |        |  |  |
|---------------------------------------|-----------------------------------|--------|--------|--------|--|--|
|                                       | Service Provider                  |        |        |        |  |  |
| Parameters                            | Auto-selection mode (5G/4G/3G/2G) |        |        |        |  |  |
|                                       | AIRTEL                            | BSNL   | RJIL   | VIL    |  |  |
| Download Throughput Average(Mbits/s)  | 139.88                            | 1.55   | 472.45 | 43.27  |  |  |
| Download Session Setup Success Rate % | 100.00                            | 100.00 | 60.00  | 100.00 |  |  |
| Upload Throughput Average (Mbits/s)   | 23.22                             | 1.85   | 79.78  | 18.08  |  |  |
| Upload Session Setup Success Rate %   | 100.00                            | 100.00 | 100.00 | 100.00 |  |  |
| Ping (milli second)                   | 24.71                             | 32.75  | 26.68  | 102.26 |  |  |
| Jitter (milli second)                 | 13.91                             | 23.45  | 5.24   | 30.90  |  |  |
| Packet Loss Rate-Ping %               | 3.72                              | 6.93   | 0.00   | 20.62  |  |  |

Table-46: Summary of Data performance of in network auto-selection mode (5G/4G/3G/2G)
| Civil District Hospital               |                                  |       |        |          |  |
|---------------------------------------|----------------------------------|-------|--------|----------|--|
|                                       | Service Provider                 |       |        |          |  |
| Parameters                            | ers Auto-selection mode (5G/4G/3 |       |        | G/3G/2G) |  |
|                                       | AIRTEL BSNL RJIL VII             |       |        |          |  |
| Download Throughput Average(Mbits/s)  | 51.21                            | 1.77  | 161.84 | 49.78    |  |
| Download Session Setup Success Rate % | 88.57                            | 11.90 | 94.87  | 96.55    |  |
| Upload Throughput Average (Mbits/s)   | 29.13                            | 1.62  | 20.43  | 15.54    |  |
| Upload Session Setup Success Rate %   | 88.57                            | 14.46 | 100.00 | 92.00    |  |
| Ping (milli second)                   | 84.95                            | 26.68 | -      | 274.38   |  |
| Jitter (milli second)                 | 20.24                            | 20.13 | -      | 34.12    |  |
| Packet Loss Rate-Ping %               | 17.20                            | 2.93  | -      | 14.96    |  |

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

Note-

• "-" All Ping tests failed in RJIL resulting Jitter and packet loss rate not being captured.

| DC Office                             |                      |           |           |          |  |
|---------------------------------------|----------------------|-----------|-----------|----------|--|
|                                       | Service Provider     |           |           |          |  |
| Parameters                            | Auto-sel             | ection mo | de (5G/40 | G/3G/2G) |  |
|                                       | AIRTEL BSNL RJIL VII |           |           |          |  |
| Download Throughput Average(Mbits/s)  | 263.94               | 1.61      | 606.91    | 43.25    |  |
| Download Session Setup Success Rate % | 100.00               | 89.29     | 100.00    | 100.00   |  |
| Upload Throughput Average (Mbits/s)   | 35.79                | 1.54      | 67.89     | 19.15    |  |
| Upload Session Setup Success Rate %   | 100.00               | 71.43     | 100.00    | 100.00   |  |
| Ping (milli second)                   | 36.41                | 46.38     | -         | 38.67    |  |
| Jitter (milli second)                 | 7.21                 | 23.02     | -         | 8.34     |  |
| Packet Loss Rate-Ping %               | 2.67                 | 8.29      | -         | 5.80     |  |

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

Note-

• "-" All Ping tests failed in RJIL resulting Jitter and packet loss rate not being captured.

| Kapad Bazar                           |                         |       |        |        |  |
|---------------------------------------|-------------------------|-------|--------|--------|--|
|                                       | Service Provider        |       |        |        |  |
| Parameters                            | Auto Mode (5G/4G/3G/2G) |       |        | 2G)    |  |
|                                       | AIRTEL BSNL RJIL VIL    |       |        |        |  |
| Download Throughput Average(Mbits/s)  | 123.82                  | 2.00  | 219.67 | 59.37  |  |
| Download Session Setup Success Rate % | 100.00                  | 78.95 | 66.67  | 100.00 |  |
| Upload Throughput Average (Mbits/s)   | 5.40                    | 23.80 |        |        |  |
| Upload Session Setup Success Rate %   | 100.00                  | 81.08 | 96.30  | 100.00 |  |
| Ping (milli second)                   | 15.24                   | 54.02 | 30.69  | 33.20  |  |
| Jitter (milli second)                 | 5.86                    | 26.08 | 8.42   | 9.08   |  |
| Packet Loss Rate-Ping %               | 1.95                    | 13.56 | 2.37   | 3.77   |  |

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

## 4.5 Highway

Drive test has been conducted on 23<sup>rd</sup> October 2024 covering 2 Highway routes. (Refer Table-1)

## 4.5.1 Drive test routes



Figure-25: Drive test route highway

## 4.5.2 Routes Covered

- Ahmednagar to Pune- Which is covered NH753F
- Pune to Ahmednagar via Dhaund- which is covered NH65 and NH160

## 4.5.2.1 Ahmednagar to Pune

Drive test for this route has been conducted on 23<sup>rd</sup> October 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.

|                                  | Service Provider<br>3G/2G network mode only |        |       |  |  |
|----------------------------------|---|--------|-------|--|--|
| Parameters                       |   |        |       |  |  |
|                                  | AIRTEL BSNL VIL                             |        |       |  |  |
| Call Attempts                    | 69  | 69     | 63    |  |  |
| Call Setup Success Rate %        | 100.00                                      | 100.00 | 82.54 |  |  |
| Drop Call Rate%                  | 1.45  | 4.35   | 0.00  |  |  |
| Call Setup Time-Average (Second) | 4.66  | 2.83   | 3.26  |  |  |
| Handover Success Rate %          | 98.92                                       | 99.84  | 98.22 |  |  |

Table-50: Summary of voice call performance in 3G/2G network mode only







Figure-27: Performance for drop call rate

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

| Technology | Service Provider |        |         |  |  |
|------------|------------------|--------|---------|--|--|
| rechnology | AIRTEL           | BSNL   | VIL     |  |  |
| 3G         | NA               | 77.56% | NA      |  |  |
| 2G         | 100.00%          | 22.44% | 100.00% |  |  |

Table-51: Time spent on technology during drive test 3G/2G network mode only



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-65, 66, 67 for map view)



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

## **Observations:**

• Airtel's 37% of samples falling in excellent signal strength category.

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

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

|                                  | Service Provider<br>Auto-selection mode (5G/4G/3G/2G) |        |       |       |  |
|----------------------------------|---|--------|-------|-------|--|
| Parameters                       |   |        |       |       |  |
|                                  | AIRTEL BSNL RJIL VI                                   |        |       |       |  |
| Call Attempts                    | 68  | 77     | 70    | 74    |  |
| Call Setup Success Rate %        | 100.00  | 89.61  | 98.57 | 90.54 |  |
| Drop Call Rate%                  | 0.00  | 8.70   | 0.00  | 0.00  |  |
| Call Setup Time Average (Second) | 0.64  | 3.05   | 0.67  | 0.97  |  |
| Handover Success Rate %          | 94.82   | 100.00 | 95.84 | 96.42 |  |

Table-52: Summary of voice call performance in network auto-selection mode

|   | Service Provider                        |      |      |      |  |
|---|---|------|------|------|--|
| Parameter   | Mobile-to-Mobile<br>(5G/4G - Open Mode) |      |      |      |  |
|   | AIRTEL                                  | BSNL | RJIL | VIL  |  |
| Call Established<br>(within service provider Network) | 57                                      | 72   | 60   | 58   |  |
| Number of silence call for >4 Sec                     | 0                                       | 1    | 0    | 0    |  |
| Silence Call Rate %                                   | 0.00                                    | 1.39 | 0.00 | 0.00 |  |
| Number of silence instances for >4 Sec                | 0                                       | 1    | 0    | 0    |  |
| Number of silence instances for >3 Sec                | 0                                       | 1    | 0    | 0    |  |
| Number of silence instances for >2 sec                | 0                                       | 2    | 0    | 0    |  |
| RTP Jitter (4G & 5G) in ms                            | 5.49                                    | 4.11 | 8.52 | 3.86 |  |
| Packet loss Rate Downlink %                           | 0.80                                    | 6.78 | 0.20 | 0.61 |  |
| Packet loss Rate Uplink %                             | 1.00                                    | 1.25 | 0.06 | 0.36 |  |

Table-53: Summary of silence instances & packet loss rate for mobile to mobile call



Figure-32: Performance for call setup success rate



Figure-33: Performance for drop call rate

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

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

| Speech Quality (MQS) distribution                 | Service Provider |        |        |        |
|---|------------------|--------|--------|--------|
| Speech Quality (MOS) distribution                 | AIRTEL           | BSNL   | RJIL   | VIL    |
| Total Number of MOS Samples for calls in table-53 | 736              | 781    | 736    | 741    |
| Speech Quality (Average MOS Score)                | 4.01             | 2.88   | 3.96   | 4.14   |
| Number of samples with MOS >=4 to <5 (Excellent)  | 628              | 56     | 567    | 649    |
| Number of samples with MOS >=3 to <4(Good)        | 88               | 307    | 139    | 64     |
| Number of samples with MOS $>=2$ to $<3$ (Fair)   | 10               | 320    | 24     | 17     |
| Number of samples with MOS $>=1$ to $<2$ (Poor)   | 10               | 98     | 6      | 11     |
| %age of samples with MOS >=4 to <5 (Excellent)    | 85.33%           | 7.17%  | 77.04% | 87.58% |
| %age of samples with MOS >=3 to <4(Good)          | 11.96%           | 39.31% | 18.89% | 8.64%  |
| %age of samples with MOS >=2 to <3 (Fair)         | 1.36%            | 40.97% | 3.26%  | 2.29%  |
| %age of samples with MOS >=1 to <2 (Poor)         | 1.36%            | 12.55% | 0.82%  | 1.48%  |

Table-54: 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.

| Tashnalagu | Service Provider |        |        |        |  |  |
|------------|------------------|--------|--------|--------|--|--|
| recimology | AIRTEL           | BSNL   | RJIL   | VIL    |  |  |
| 5G         | 6.05%            | NA     | 10.72% | NA     |  |  |
| 4G         | 93.95%           | 14.99% | 89.28% | 98.90% |  |  |
| 3G         | NA               | 77.80% | NA     | NA     |  |  |
| 2G         | 0.00%            | 5.88%  | NA     | 1.10%  |  |  |
| No Service | 0.00%            | 1.32%  | 0.00%  | 0.00%  |  |  |

Table-55: 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-68, 69, 70, 71 for plots)



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

### **Observations:**

- Airtel has 45% samples falling in excellent signal strength category.
- BSNL has 21% samples falling in excellent signal strength category.

- RJIL has 53% samples falling in excellent signal strength category.
- VIL has 38% samples falling in excellent signal strength category.

#### Service Provider **Parameters** Auto-selection mode (5G/4G/3G/2G) AIRTEL BSNL RJIL VIL 138.30 2.46 253.66 42.41 Average **Download Throughput 80th Percentile** 203.30 4.09 473.16 63.88 (Mbits/s) 62.76 **20th Percentile** 63.80 0.55 20.41 1.29 36.43 13.72 Average 38.28 Upload Throughput **80th Percentile** 64.03 1.92 65.29 22.59 (Mbits/s) **20th Percentile** 12.04 0.53 7.77 4.10 Ping (ms) 41.91 214.89 33.55 19.03 Average

## ii) Data performance

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



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

Figure-40: Download throughput



Figure-41: Upload throughput

## 4.5.2.2 Pune to Ahmednagar via Daund

Drive test for this route has been conducted on  $23^{rd}$  October 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.

|                                  | Service Provider<br>3G/2G network mode only<br>AIRTEL BSNL VIL |        |        |  |
|----------------------------------|--|--------|--------|--|
| Parameters                       |  |        |        |  |
|                                  |  |        |        |  |
| Call Attempts                    | 74   | 79     | 75     |  |
| Call Setup Success Rate %        | 100.00   | 100.00 | 100.00 |  |
| Drop Call Rate%                  | 2.70   | 8.86   | 2.67   |  |
| Call Setup Time-Average (Second) | 4.85   | 3.55   | 3.11   |  |
| Handover Success Rate %          | 99.21  | 100.00 | 99.53  |  |

**Table-57:** Summary of voice call performance in 3G/2G network mode only





Figure-42: Performance for call setup success rate

Figure-43: Performance for drop call rate

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

| Tachnology | Service Provider |        |         |  |
|------------|------------------|--------|---------|--|
| recinology | AIRTEL           | BSNL   | VIL     |  |
| 3G         | NA               | 70.55% | NA      |  |
| 2G         | 100.00%          | 29.45% | 100.00% |  |
| No Service | 0.00%            | 0.00%  | 0.00%   |  |

Table-58: Time spent on technology during drive test 3G/2G network mode only

Note-

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



Figure-44: Serving technology plots 3G/2G network mode - AIRTEL



Figure-45: Serving technology plots 3G/2G network mode - BSNL



Figure-46: 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-72, 73, 74 for map view)





#### **Observations:**

- Airtel's 26% of samples falling in excellent signal strength category.
- BSNL's has 13% of samples falling in excellent signal strength category.
- VIL's has 18% of samples falling in excellent signal strength category.

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

|                                  | Service Provider<br>Auto-selection mode (5G/4G/3G/2G) |       |       |       |  |
|----------------------------------|---|-------|-------|-------|--|
| Parameters                       |   |       |       |       |  |
|                                  | AIRTEL BSNL RJIL VIL                                  |       |       |       |  |
| Call Attempts                    | 75  | 81    | 75    | 83    |  |
| Call Setup Success Rate %        | 100.00  | 97.53 | 98.67 | 90.36 |  |
| Drop Call Rate%                  | 0.00  | 13.92 | 0.00  | 0.00  |  |
| Call Setup Time Average (Second) | 0.64  | 3.36  | 0.83  | 1.15  |  |
| Handover Success Rate %          | 97.13   | 99.60 | 98.44 | 98.05 |  |

**Table-58:** Summary of voice call performance in network auto-selection mode

|   | Service Provider                        |      |      |      |  |
|---|---|------|------|------|--|
| Parameters  | Mobile-to-Mobile<br>(5G/4G - Open Mode) |      |      |      |  |
|   | AIRTEL                                  | BSNL | RJIL | VIL  |  |
| Call Established<br>(within service provider Network) | 65                                      | 91   | 66   | 67   |  |
| Number of silence call for >4 Sec                     | 0                                       | 4    | 1    | 0    |  |
| Silence Call Rate %                                   | 0.00                                    | 4.40 | 1.52 | 0.00 |  |
| Number of silence instances for >4 Sec                | 0                                       | 4    | 1    | 0    |  |
| Number of silence instances for >3 Sec                | 0                                       | 4    | 1    | 0    |  |
| Number of silence instances for >2 sec                | 0                                       | 4    | 1    | 0    |  |
| RTP Jitter (4G & 5G) in ms                            | 5.53                                    | 9.18 | 0.76 | 5.99 |  |
| Packet loss Rate Downlink %                           | 1.18                                    | 8.35 | 0.01 | 0.01 |  |
| Packet loss Rate Uplink %                             | 1.48                                    | 5.14 | 0.69 | 0.83 |  |

Table-59: Summary of silence instances & packet loss rate for mobile to mobile call



Figure-48: Performance for call setup success rate



Figure-49: Performance for drop call rate

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

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

| Speech Quality (MOS) distribution                    |        | Service Provider |        |        |  |
|--|--------|------------------|--------|--------|--|
| Speech Quality (MOS) distribution                    | AIRTEL | BSNL             | RJIL   | VIL    |  |
| Total Number of MOS Samples for calls in table-59    | 834    | 783              | 826    | 817    |  |
| Speech Quality (Average MOS Score)                   | 3.90   | 2.95             | 3.79   | 4.05   |  |
| Number of samples with MOS $>=4$ to $<5$ (Excellent) | 667    | 118              | 521    | 664    |  |
| Number of samples with MOS >=3 to <4(Good)           | 104    | 266              | 229    | 110    |  |
| Number of samples with MOS $>=2$ to $<3$ (Fair)      | 31     | 294              | 47     | 19     |  |
| Number of samples with MOS >=1 to <2 (Poor)          | 32     | 105              | 29     | 24     |  |
| %age of samples with MOS >=4 to <5 (Excellent)       | 79.98% | 15.07%           | 63.08% | 81.27% |  |
| %age of samples with MOS >=3 to <4(Good)             | 12.47% | 33.97%           | 27.72% | 13.46% |  |
| % age of samples with MOS >=2 to <3 (Fair)           | 3.72%  | 37.55%           | 5.69%  | 2.33%  |  |
| %age of samples with MOS >=1 to <2 (Poor)            | 3.84%  | 13.41%           | 3.51%  | 2.94%  |  |

Table-60: Summary of speech quality (MOS) samples



Figure-50: 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         | 5.20%            | NA     | 9.13%  | NA     |  |
| 4G         | 94.80%           | 41.23% | 90.87% | 96.45% |  |
| 3G         | NA               | 42.14% | NA     | NA     |  |
| 2G         | 0.00%            | 16.48% | NA     | 3.55%  |  |
| No Service | 0.00%            | 0.14%  | 0.00%  | 0.00%  |  |

Table-61: 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-51: Serving technology plots in auto-selection mode (5G/4G/3G/2G) -AIRTEL



Figure-52: Serving technology plots in auto-selection mode (5G/4G/3G/2G) -BSNL



Figure-53: Serving technology plots in auto-selection mode (5G/4G/3G/2G)- RJIL



Figure-54: 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-75, 76, 77, 78 for plots)



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

### **Observations:**

- Airtel has 27% samples falling in excellent signal strength category.
- BSNL has 11% samples falling in excellent signal strength category.
- RJIL has 27% samples falling in excellent signal strength category.
- VIL has 19% samples falling in 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<br>Throughput<br>(Mbits/s) | Average         | 110.40                            | 2.32   | 155.11 | 31.93 |
|                                     | 80th Percentile | 189.95                            | 4.53   | 332.70 | 46.96 |
|                                     | 20th Percentile | 25.80                             | 0.19   | 1.40   | 9.43  |
| Upload Throughput<br>(Mbits/s)      | Average         | 9.35                              | 1.61   | 20.66  | 12.26 |
|                                     | 80th Percentile | 3.94                              | 2.38   | 42.95  | 19.17 |
|                                     | 20th Percentile | 0.00                              | 0.67   | 2.17   | 3.43  |
| Ping (ms)                           | Average         | 54.00                             | 423.08 | 63.27  | 54.86 |

Table-62: Summary of Data performance in network auto-selection mode







Figure-57: Upload throughput

## 5. Voice & Data Key findings

## 5.1 Overall Voice

## 1. Call setup success rate:

- a) Airtel, BSNL, RJIL and VIL have 100.00%, 94.41%, 99.70% and 88.24% call setup success rate respectively.
- b) Airtel and RJIL 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.
- c) All service providers except BSNL and VIL have 100.00% call setup success rate on hotspots.
- d) All service providers except BSNL and VIL have 100.00% call setup success rate on Walk Test.
- e) Airtel has 100.00% call setup success rate across the Highway routes.
- **2. Call Setup time**: Owing to circuit switched network (3G/2G), Airtel has taken comparatively longer time (4.89 second) to establish the voice call, whereas Airtel, RJIL and VIL call setup time is 0.60, 0.80 & 1.13 second respectively in open mode (5G/4G/3G/2G).
- 3. Call Silence/Mute Rate: In packet switched network (4G/5G), Airtel, BSNL, RJIL and VIL have 0.23%, 2.77%, 0.69% and 1.14% silence call rate respectively. Further BSNL has higher RTP packet loss rate in downlink (5.25%) compared to Airtel (0.71%), RJIL (0.85%) and VIL (1.37%). In uplink the RTP packet loss rate is higher for BSNL (4.30%) compared to Airtel (0.66%), RJIL (0.96%) and VIL (1.15%).

### 4. Call Drop Rate:

- a) Overall BSNL's call drop rate (7.11%) is higher (QoS benchmark of 2%), while Airtel, RJIL and VIL have 0.00%, 0.00% and 0.31% drop call rate respectively.
- b) At hotspots all service providers have 0.00% call drop rate.
- c) All operators are meeting QoS Benchmark for drop call rate in walk test except BSNL at civil district hospital.

## 5.2 Overall Data

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

- a) BSNL offers a download speed of 2.08 Mbps while VIL provides 44.20 Mbps, utilizing 3G and 4G technologies respectively. In contrast, Airtel and Jio achieve significantly higher average download speeds of 135.59 Mbps and 251.13 Mbps.
- b) BSNL (1.65 Mbps) and VIL (14.09 Mbps), operating on 3G and 4G technologies respectively, have comparatively lower upload speeds. In contrast, Airtel and RJIL offer faster speeds of 23.06 Mbps and 31.52 Mbps, respectively.
- 2. Data download and upload performance (static i.e. while stationary):

a) RJIL demonstrates superior 5G Quality of Service performance on hotspots, with average download and upload speeds of 226.97 Mbps and 31.35 Mbps, respectively.

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

- a) Airtel and VIL have a 100% download session setup success rate. BSNL has 81.82% success rate, while VIL has 96.36% success rate.
- b) Airtel, RJIL, and VIL have a 100% upload session setup success rate, while BSNL has a success rate of 76.36%.

## **5.3 Operator wise Key Findings**

### 1. Airtel:

### Voice

- In the 3G/2G network mode, a call setup success rate of 99.55% was observed, and the call drop rate of 0.67% is well within the benchmark of 2% (refer to Table-3).
- There was a 100% call setup success rate and 0% drop call rate observed for the auto-selection mode for LSA (refer to Table-5).
- 100% call setup success rate and 0% drop call rate observed for auto-selection mode during city drive (refer to Table 15).

### Data

- Airtel has an average download throughput of 135.59 Mbps and an average upload throughput of 23.06 Mbps across measured routes for LSA (refer to Table-11).
- Airtel has an average download throughput of 152.88 Mbps and an average upload throughput of 25.69 Mbps across the measured routes during the city drive (refer to Table 19).
- Ahmednagar Fort, Bhagwan Baba Chowk, Chandni Chowk, and the District Court hotspots experience lower download speeds, registering less than 100 Mbps among a total of 10 hotspots (refer to Tables 32, 33, 35 and 37).
- Ahmednagar Fort, Bus Stand, Chandni Chowk, and District Court hotspots have upload speeds less than 10 Mbps, which is below average out of a total of 10 hotspots. (refer to Tables 32, 34, 35 and 37)

## 2. BSNL:

#### Voice

- BSNL's 3G/2G network mode is experiencing a drop call rate of 3.49%, which is significantly above the benchmark of 2%. (refer to Table 3)
- BSNL's auto-selection mode has a drop call rate of 7.11%, which is considerably higher than the acceptable benchmark of 2%. (Refer to Table-5)
- 9.01% drop in call rate was observed for auto-selection mode during city drive, which does not meet the benchmark. (refer to Table 15)
- There have been observed drop call rates of 8.70% and 13.92% across the Ahmednagar to Pune and Pune to Ahmednagar via Dhaund Highway, which are higher than the benchmark. (Refer to Table 52 and 58)

#### Data

- BSNL has an average download speed of 2.08 Mbps and an average upload speed of 1.65 Mbps across measured routes for LSA (refer to Table-11).
- BSNL has an average download throughput of 1.75 Mbps and an average upload throughput of 1.45 Mbps across measured routes during a city drive (refer to Table-19).
- The following hotspots have been identified as having low download speeds (less than 5 Mbps) out of a total of 10 hotspots: Ahmednagar Fort, Bhagwan Baba Chowk, Bus Stand, Chandni Chowk, Dilli Gate Chowk, District Court, Ganpati Mandir, Government Polytechnic, and New Art & Commercial College. (refer to Tables 32, 33, 34, 35, 36, 37, 38, 39 and 40).
- Ahmednagar Fort, Bus Stand, Dilli Gate Chowk, and District Court hotspots have an upload speed of less than 2 Mbps among a total of 10 hotspots. (refer to Tables 32, 34, 36 and 37).

### 3. RJIL:

#### Voice

• RJIL's call setup success rate and drop call rate benchmarks are being achieved in all activities.

#### Data

• RJIL has an average download throughput of 251.13 Mbps and an average upload throughput of 31.52 Mbps across measured routes in LSA (refer to Table-11).

- RJIL has an average download throughput of 257.33 Mbps and an average upload throughput of 26.68 Mbps across measured routes in the city drive (refer to Table 19).
- Dilli Gate Chowk and the New Municipal Corporation Office hotspot have a download speed of less than 20 Mbps, which is among the lowest out of a total of 10 hotspots (refer to Table 36 and 41).
- Out of a total of 10 hotspots, Ahmednagar Fort, Bus Stand, District Court, Ganpati Mandir, and New Art & Commercial College have low upload speeds of less than 10 Mbps. (refer to Table 32,34,37,38 and 40).

#### 4. VIL:

#### Voice

• VIL has a 96.87% success rate for call setup on 3G/2G networks, while the drop call rate is 0.46%. (Refer to Table-3)

#### Data

- VIL has an average download throughput of 44.20 Mbps and an average upload throughput of 14.09 Mbps across the measured routes in LSA (refer to Table 11).
- VIL has an average download throughput of 46.44 Mbps and an average upload throughput of 13.71 Mbps across measured routes in the city drive. (refer to Table 19)
- Ahmednagar Fort, Bus Stand, District Court, Ganpati Mandir, and New Art & Commercial College hotspots have upload speed below 10 Mbps out of 10 hotspots. (refer to Table 32,34,37,38 and 40)

## 6. Annexure

## 6.1 Route wise coverage map

## 6.1.1 City



Figure-58: Signal strength 3G/2G network mode - AIRTEL



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



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



Figure-61: Signal strength auto-selection mode 5G/4G/3G/2G - AIRTEL



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



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



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

## 6.1.2 Highway Route

## i) Ahmednagar to Pune





Figure-66: Signal strength 3G/2G network mode – BSNL

Figure-65: Signal strength 3G/2G network mode – AIRTEL



Figure-67: Signal strength 3G/2G network mode - VIL




Figure-68: Signal strength auto-selection mode 5G/4G/3G/2G -AIRTEL Figure-69:



Figure-70: Signal strength auto-selection mode 5G/4G/3G/2G -RJIL

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



Figure-71: Signal strength auto-selection mode 5G/4G/3G/2G -VIL



ii)Pune to Ahmednagar via Dhaund

Figure-72: Signal strength 3G/2G network mode – AIRTEL



Figure-73: Signal strength 3G/2G network mode – BSNL



Figure-74: Signal strength 3G/2G network mode – VIL



Figure-75: Signal strength auto-selection mode 5G/4G/3G/2G - AIRTEL



Figure-76: Signal strength auto-selection mode 5G/4G/3G/2G - BSNL



Figure-77: Signal strength auto-selection mode 5G/4G/3G/2G - RJIL



Figure-78: 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          | 30 Sec          |  |  |
| Call Duration      | 5G/4G/3G/2G auto mode- switch<br>Call | 90 Sec /180 Sec |  |  |
| Wait/ Guard Time   | 5G/4G MOS Call                        | 15 Sec          |  |  |

#### Table-69: 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 by making Mobile to Mobile call.
- 180 Sec calls were made only in highway & railway route drive.
- 4G/3G/2G auto mode MOS call were made in BSNL as BSNL don't have 5G network availability across India.
- All values are taken up to decimal 2 places with roundoff.

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

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

#### Table-70: Data test detail

#### Note-

- 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).



Figure-79: Number of handsets used in city & higway drive MO: Mobile originating MT: Mobile terminating



Figure-80: Number of handsets used in railway/metro/walktest/hotspot

# 7.1.2 Drive test Methodology

### (a) Dynamic voice testing (on the move)

| City/                  | Metro & Coastal Area                           |               |                             |
|------------------------|--|---------------|-----------------------------|
| Call                   | Setup Time                                     | Call Duration | Wait Time                   |
|                        | 30 Sec   | 90 Sec        | 15 Sec                      |
| 00:00:00<br>Start Dial | 00:00:30<br>Max Call Setup Time<br>/ & Railway |               | 00:02:00<br>Normal call end |
| Call                   | Setup Time                                     | Call Duration | Wait Time                   |
|                        | 30 Sec   | 180 Sec       | 15 Sec                      |
| 00:00:00               | 00:00:30                                       |               | 00:03:30                    |
| Start Dial             | Max Call Setup Time                            |               | Normal call end             |

#### Figure-81: 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-82: Voice test script for walktest/hotspot

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

#### (c) Dynamic Data (internet) test City/Metro/Highway/Railway/ Walk Test & Coastal Area Ping DOWNLOAD UPLOAD ( 😞 $\odot$ $\odot$ 00:01:06 **HTTP Download** HTTP Upload Ping 00:00:00 - 00:00:30 00:00:33 - 00:01:03 00:00:00 Start Data Test Wait Walt

Figure-83: Data test script used in city/metro/railway/highway & coastal area

### (d) Static Data(internet) testing



#### Figure-84: Data test script used at hotspot/walk test

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

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

# 7.2 Appendix-II

### 7.2.1 Network Performance Parameters for Voice call

| Parameter Name          | Definition   |  |  |  |
|-------------------------|--|--|--|--|
| Call Setup Success Rate | <ul> <li>(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: <ul> <li>(a) Call attempt is made</li> <li>(b) The signaling channel is allocated</li> <li>(c) The call is routed to the outwards path of the terminating network</li> <li>(d) An alert signal is received by caller in the form of ring back tone, busy tone, or an announcement.</li> </ul> </li> <li>CSSR = (Total Call Established/ Total Call Attempt) *100 As per QoS Regulation 2024 benchmark value is &gt;=98%</li></ul> |  |  |  |
| 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<br>Call Drop Rate = (Total Call Drop/Total Call Established) *100<br>As per QoS Regulation 2024 benchmark value is <=2%  |  |  |  |
| Call Setup Time         | Time taken from call initiate to call alerting/ringing.<br>Call Setup Time = T2- T1<br>T2- Ringing (VoLTE/VoNR) & Alerting (for WCDMA & GSM),<br>T1- Invite (VoLTE/VoNR) & CM Service Request (for WCDMA &   |  |  |  |
| Voice Quality (MOS)     | Voice quality in mobile networks is measured with algorithms based<br>on ITU-T P.863 (POLQA). The grading for Voice quality has been<br>given as;<br>Excellent: $MOS \ge 4$ and $< 5$<br>Good : $MOS \ge 3$ and $< 4$<br>Fair : $MOS \ge 2$ and $< 3$<br>Poor : $MOS > 1$ and $< 2$  |  |  |  |
| Handover Success Rate   | Handover Success Rate = Count of successful handovers<br>Technology Handover combined) / Total count of Handover Atten<br>(All Technology Handover combined) *100<br>Handover type which are considered- 2G Inter & Intra cell, 3G S<br>& IRAT, 4G Inter & Intra frequency & SRVCC, 5G Inter & In<br>frequency & 5G to 4G handovers.   |  |  |  |
| Silence Call -          | A call which has ≥ 4 sec continuous RTP gap is considered as a Silence Call.<br>Silence call rate = (count of silence / Total calls established) *100<br>If a call observes multiple silence count >=4 sec in a particular established call it has been taken as one silent event.   |  |  |  |

| Jitter                    | The inter arrival jitter is the difference in the relative transit time for<br>two packets. The relative transit time is the difference between a<br>packet's Real-time Transport Protocol (RTP) timestamp and the<br>receiver's clock at the time of arrival, measured in the same units.<br>If Si is the RTP timestamp from packet i, and Ri is the time of arrival<br>in RTP timestamps units for packet i, then for two packets i and j<br>the inter-arrival jitter D can be expressed as:<br>D(i,j) = (Rj - Ri) - (Sj - Si) |            |                         |                            |                             |                 |
|---------------------------|--|------------|-------------------------|----------------------------|-----------------------------|-----------------|
|                           | The interarrival jitter will be calculated continuously as each data packet i is received from source SSRC_n, using this difference D for that packet and the previous packet i-1 in order of arrival (not necessarily in sequence), according to the formula $J(i) = J(i-1) + ( D(i-1,i)  - J(i-1))/16$ or 8  |            |                         |                            |                             |                 |
| Downlink Packet Drop Rate | Number of RTP (Real-time Transport Protocol) Packets lost divided<br>by total RTP packet received (against each source_SSRC and<br>sequence number) at call originating handset.<br>This KPI will be calculated from MOS call for packet call only<br>(VoNR/VoLTE)   |            |                         |                            |                             |                 |
| Uplink Packet Drop Rate   | Number of RTP (Real-time Transport Protocol) Packets lost divided<br>by total RTP packet received (against each source_SSRC and<br>sequence number) at call terminating handset. This KPI will be<br>calculated from MOS call for packet call only (VoNR/VoLTE).   |            |                         |                            |                             |                 |
|                           | Signal strength is the signal power level received by the wireless user.   |            |                         |                            |                             |                 |
|                           | Parameter  | Technology | Excellent               | Signal Stre                | ength (dBm                  | )<br>Door       |
|                           | Rx Level   | GSM        | 0 to <u>&gt;</u><br>-65 | <-65 to<br><u>&gt;</u> -75 | <-75 to<br><u>&gt;</u> -85  | <-85 to<br>min  |
| Signal Strength           | RSCP   | WCDMA      | 0 to <u>&gt;</u><br>-70 | <-70 to<br><u>&gt;</u> -80 | <-80 to<br><u>&gt;</u> -90  | <-90 to<br>min  |
|                           | RSRP   | LTE        | 0 to <u>&gt;</u><br>-80 | <-80 to<br><u>&gt;</u> -95 | <-95 to<br><u>&gt;</u> -110 | <-110 to<br>min |
|                           | SS_RSRP  | NR         | 0 to <u>&gt;</u><br>-80 | <-80 to<br><u>&gt;</u> -95 | <-95 to<br><u>&gt;</u> -110 | <-110 to<br>min |
|                           |  |            | •                       | •                          | •                           |                 |

**Table-71:** Network performance parmeter and definition voice

# **7.2.2 Network Performance Parameters Data tests**

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

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

Table-72: Network performance parmeter and definition Data