TUV SUD South Asia Pvt. Ltd.

Mumbai City Independent Drive Test Report
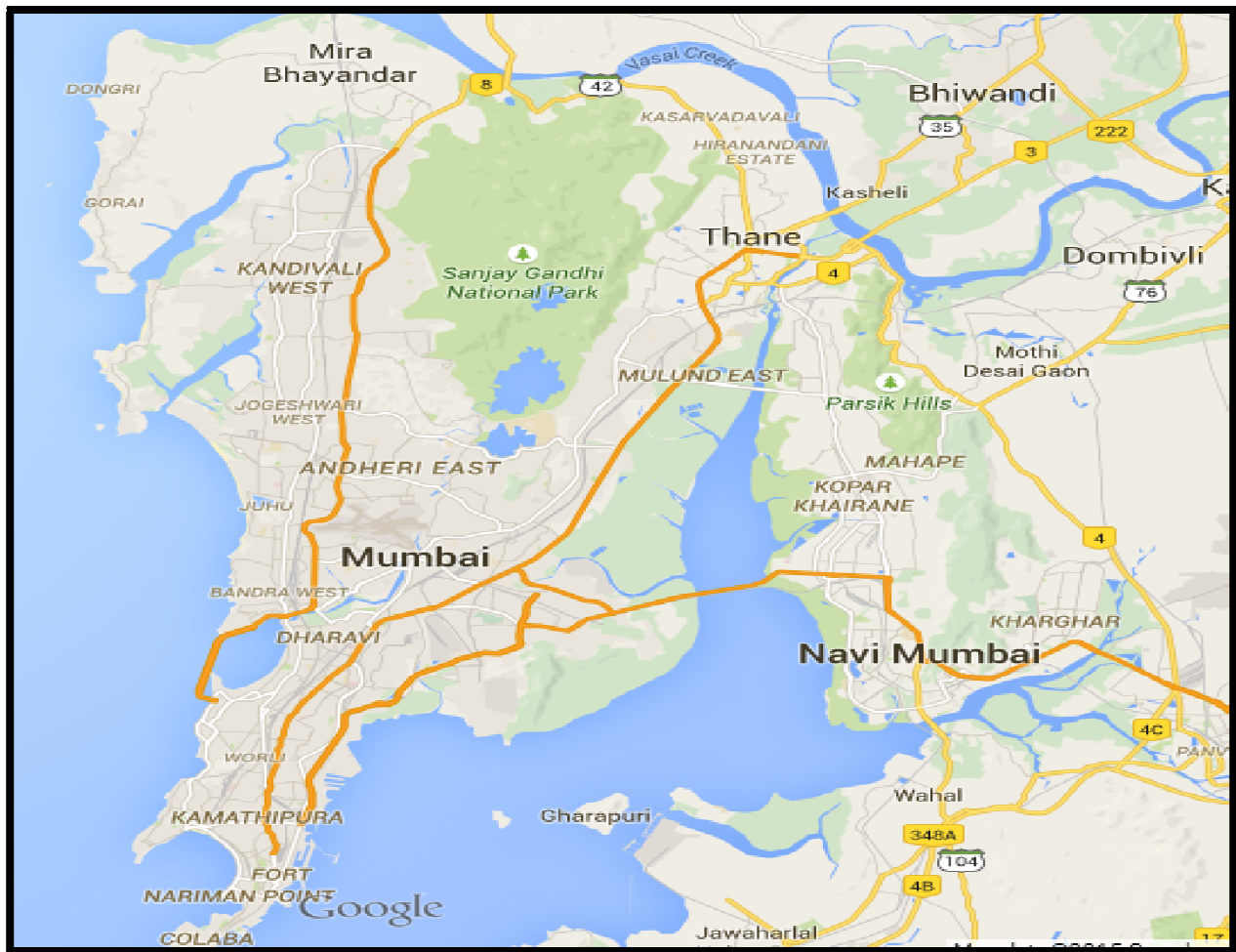
Table of Contents

1 Executive Summary

Target Network: Idea,Airtel,Vodafone,Reliance (GSM),Aircel,Tata(GSM)

Table 1.1 CITY DEMOGRAPHICS

Mumbai Circle	Details
Population	14,350,000
Area	603 Square Km
Population Density	29,650 People per Square Km

Mumbai City Map is shown as below

Table 1.2 Mumbai City Map[1]

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[1] http://maps.google.co.in

2 Benchmarking Test Overview

2.1 Benchmarking Operators

The objective was to develop a holistic view of any competitive advantage or disadvantage of competing wireless operators in the area. For purpose of these tests, only 2G BTS were covered.

Total six Operators were benchmarked which is shown as below:

BENCHMARKING OPERATOR TABLE

Operator	Technology	Band (MHz)	BTS Count	Subscribers* (Prepaid + Postpaid)	Subscribers / BTS
Idea	GSM	1800	3485	4771764	1369
Airtel	GSM	900 & 1800	4034	4014057	995
Vodafone	GSM	900 & 1800	4512	8620251	1911
Reliance (GSM)	GSM	1800	2178	2814521	1292
Aircel	GSM	1800	1829	2830137	1547
Tata(GSM)	GSM	1800	2886	2428169	841

*Subscribers data of Mumbai circle in 31 March 2015 taken from CSD audit.

2.2 Drive Test Route

In the following figure, the green route depicts the associated drive route. The total drive route covered is approximately 300 km over a period of 2 days per operator using a vehicle. The drive test was carried out from 09.00 hrs to 1930 hrs on 23th to 24 June 2015. In all about 3305 calls were made for all 6 operators.

Drive Test Route
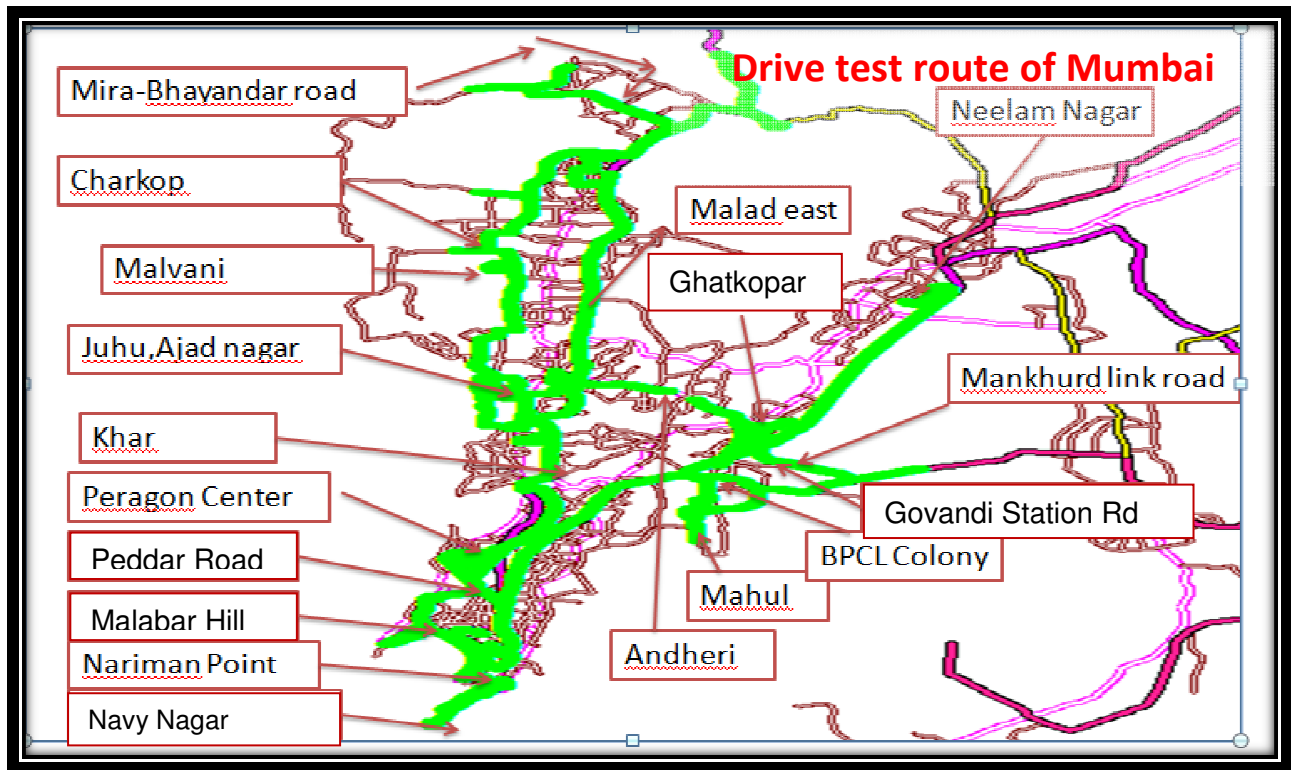
Area Covered

- Navy Nagar Colaba
- Nariman Point
- Peddar Road
- Peragon center
- Malabar Hill
- TJ Eastern Highway
- ChurchgateArea
- Dadar MarineLine Road

- Malad East
- Malad West
- Charkop
- Mira-Bhayandra Road
- AG Nagar
- Dahisar
- Malvani
- Chinchpoli

- Andheri
- BPCL Colony
- Mahul
- Ghatkopar
- Matunga
- Sion
- Juhu
- W E Highway
- Khar

- Lokhandwala
- Matunga BKC
- Shivaji Nagar
- Sakinaka
- Mankhurd
- Govandi Station
- Punam Nagar
- JVLR Road
- Neelam Nagar

2.3 Benchmarking KPI Details

Benchmarking KPI details table

KPI	Idea	Airtel	Vodafone	RelianceCommunication (GSM)	Aircel	Tata (GSM)
Coverage %	95.40%	95.13%	91.08%	89.49%	93.63%	97.07%
Accessibility %	90.00%	96.98%	96.07%	68.87%	95.64%	95.42%
Retainability %	94.44%	99.03%	95.17%	97.71%	96.81%	94.49%
Mobility %	97.87%	96.74%	97.54%	98.01%	96.86%	95.40%
Rx Quality %	86.46%	91.11%	89.56%	85.33%	85.60%	89.50%
C/I %	66.67%	64.83%	65.23%	83.44%	68.13%	69.75%

RF Coverage

RF Coverage relates to the geographical footprint within the system that has sufficient RF signal strength to provide for a call/data session. The Coverage rate of an operator is calculated basis of % of samples in which the Rx level is better than -85 dbm.

Accessibility

Accessibility is the ability of a service to be obtained within specific tolerances and other given conditions, whenrequested by the user. In other words, the ability of a user to obtain the requested service from the system.Accessibility is monitored by measuring Call Setup Success Rate (CSSR) which is defined as the ratio of Established Calls to Call Attempts.

Retainability

Retainability is "The ability of a service, once obtained, to continue to be provided under given conditions for a requested duration." For determining the Retainabiltythe regulation prescribes three important parameters namely Call drop rate (CDR), Worst affected Cells having more than 3% TCH drop and Connection with good voice quality. The call drop and Connection with good voice quality were monitored by the drive test.

Mobility

In a cellular system a base station has only a limited coverage area. Hence it is possible for a moving subscriber to be out of range of a base station while making a call. The process by which a mobile telephone call is transferred from one base station to another as the subscriber passes the boundary of a cell is called a handover. The Handover success rate (HOSR) more than 95% is considered to be good.
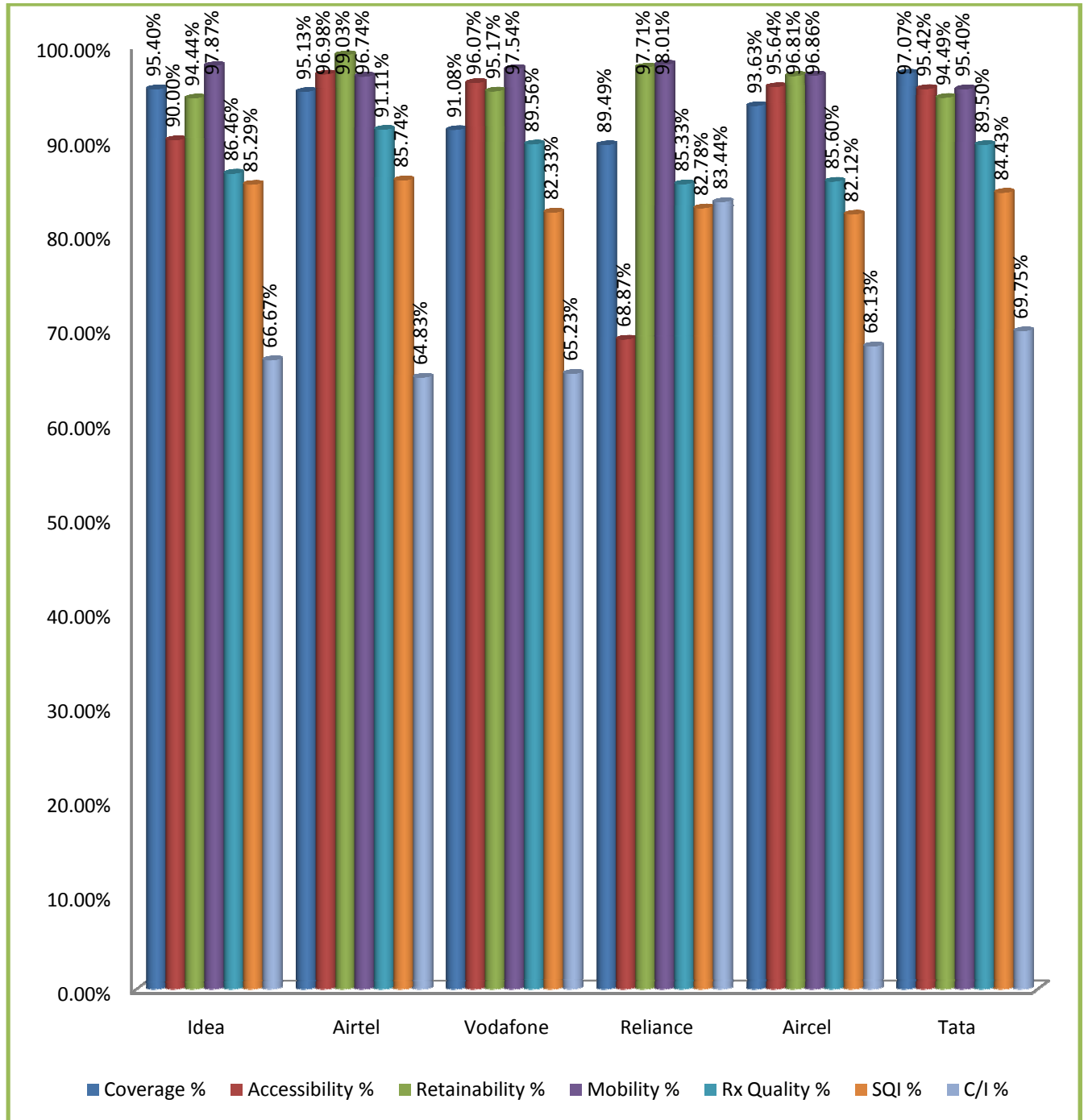
Rx Quality

For measuring voice quality, Rx Qual samples on a scale from 0 to 7 for GSM operators and Frame Error Rate (FERs) for CDMA service providers are measured. As per the QoS norms, Rx Qual between 0- 5 for GSM operators and between 0-4% FER value for CDMA operators FERs is considered to be good, where as Rx Qual beyond this benchmark is considered to be bad.

Carrier over Interference (C/I)

The carrier-over-interference ratio is the ratio between the levels of the signal strength of the current serving cell to that of the signal strength of undesired (interfering) signal components. The C/I should be more than 9 dbi.ebetween samples 15 to 30 are considered good.

KPI distribution graph

Idea — Coverage % 95.40%, Accessibility % 90.00%, Retainability % 94.44%, Mobility % 97.87%, Rx Quality % 86.46%, SQI % 85.29%, C/I % 66.67%

Airtel — Coverage % 95.13%, Accessibility % 96.98%, Retainability % 99.03%, Mobility % 96.74%, Rx Quality % 91.11%, SQI % 85.74%, C/I % 64.83%

Vodafone — Coverage % 91.08%, Accessibility % 96.07%, Retainability % 95.17%, Mobility % 97.54%, Rx Quality % 89.56%, SQI % 82.33%, C/I % 65.23%

Reliance — Coverage % 89.49%, Accessibility % 68.87%, Retainability % 97.71%, Mobility % 98.01%, Rx Quality % 85.33%, SQI % 82.78%, C/I % 83.44%

Aircel — Coverage % 93.63%, Accessibility % 95.64%, Retainability % 96.81%, Mobility % 96.86%, Rx Quality % 85.60%, SQI % 82.12%, C/I % 68.13%

Tata — Coverage % 97.07%, Accessibility % 95.42%, Retainability % 94.49%, Mobility % 95.40%, Rx Quality % 89.50%, SQI % 84.43%, C/I % 69.75%

Legend: ■ Coverage % ■ Accessibility % ■ Retainability % ■ Mobility % ■ Rx Quality % ■ SQI % ■ C/I %

2.4 Key Observation

The overall performance of all operators is mentioned in the table. Over 500+ calls were made per operator during the data collection period with more than 300 Km drive test covered.

We can explain the network condition in terms of coverage, quality, accessibility, retainability, speech quality Index and Carrier over Interference ratioof the various service providers on the basis of the values obtained. The TSPs are also relatively ranked accordingly and tabulated below:

Key observation table (RELATIVE RANKING)

OPERATOR	Coverage Rate	CSSR[2]	CCSR	Rx Quality	C/I
Idea	2	6	5	4	4
Airtel	3	1	1	1	6
Vodafone	4	4	2	2	5
Reliance (GSM)	6	2	6	6	1
Aircel	5	3	3	5	3
Tata (GSM)	1	5	4	3	2

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[2] CSSR-Call setup Success Rate, CCSR-Call Completion Success Rate, SQI-Speech Quality Index & C/I – Carrier over Interference

3 Detail Result

3.1 Voice Benchmarking

3.1.1 Coverage Rate

Coverage Rate Summary

RF Coverage relates to the geographical footprint within the system that has sufficient RF signal strength to provide for a call/data session. The Coverage rate of an operator is calculated basis of % of samples in which the Rx level is better than -85 dbm. The coverage rate varies from 97.07% for Tata GSM to 89.49 % for Reliance GSM. The details are as follows

Table 3.1 Coverage Summary and Ranking

Operator	Coverage Rate	Ranking
Idea	95.40%	2
Airtel	95.13%	3
Vodafone	91.08%	5
Reliance (GSM)	89.49%	6
Aircel	93.63%	4
Tata(GSM)	97.07%	1

Coverage Rate Details Graph
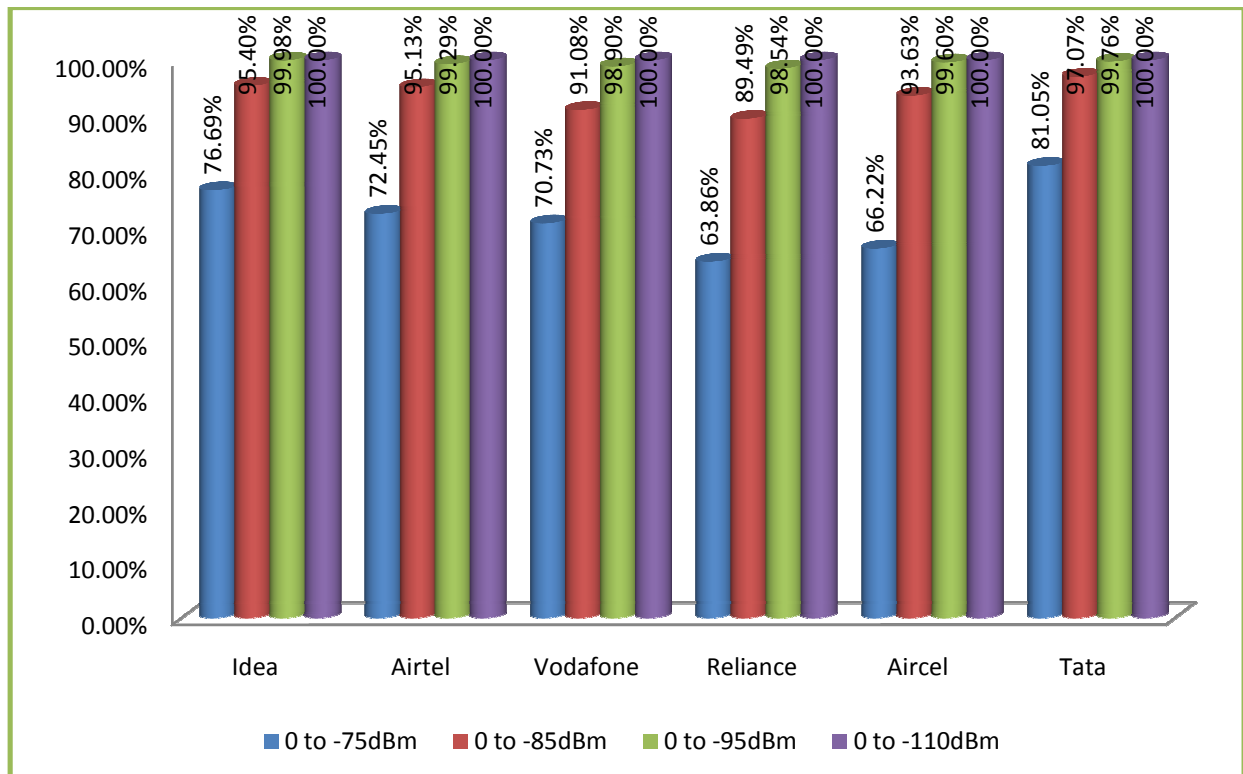
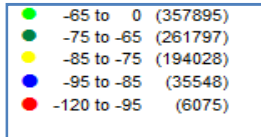**Table 3.2 Rx Level for operators**

Operator	Rx Level 0 to -75dBm	Rx Level 0 to -85dBm	Rx Level 0 to -95dBm	Rx Level 0 to -110dBm
Idea	76.69%	95.40%	99.98%	100.00%
Airtel	72.45%	95.13%	99.29%	100.00%
Vodafone	70.73%	91.08%	98.90%	100.00%
Reliance (GSM)	63.86%	89.49%	98.54%	100.00%
Aircel	66.22%	93.63%	99.60%	100.00%
Tata(GSM)	81.05%	97.07%	99.76%	100.00%

Coverage Plot

Airtel Rx Level Plot
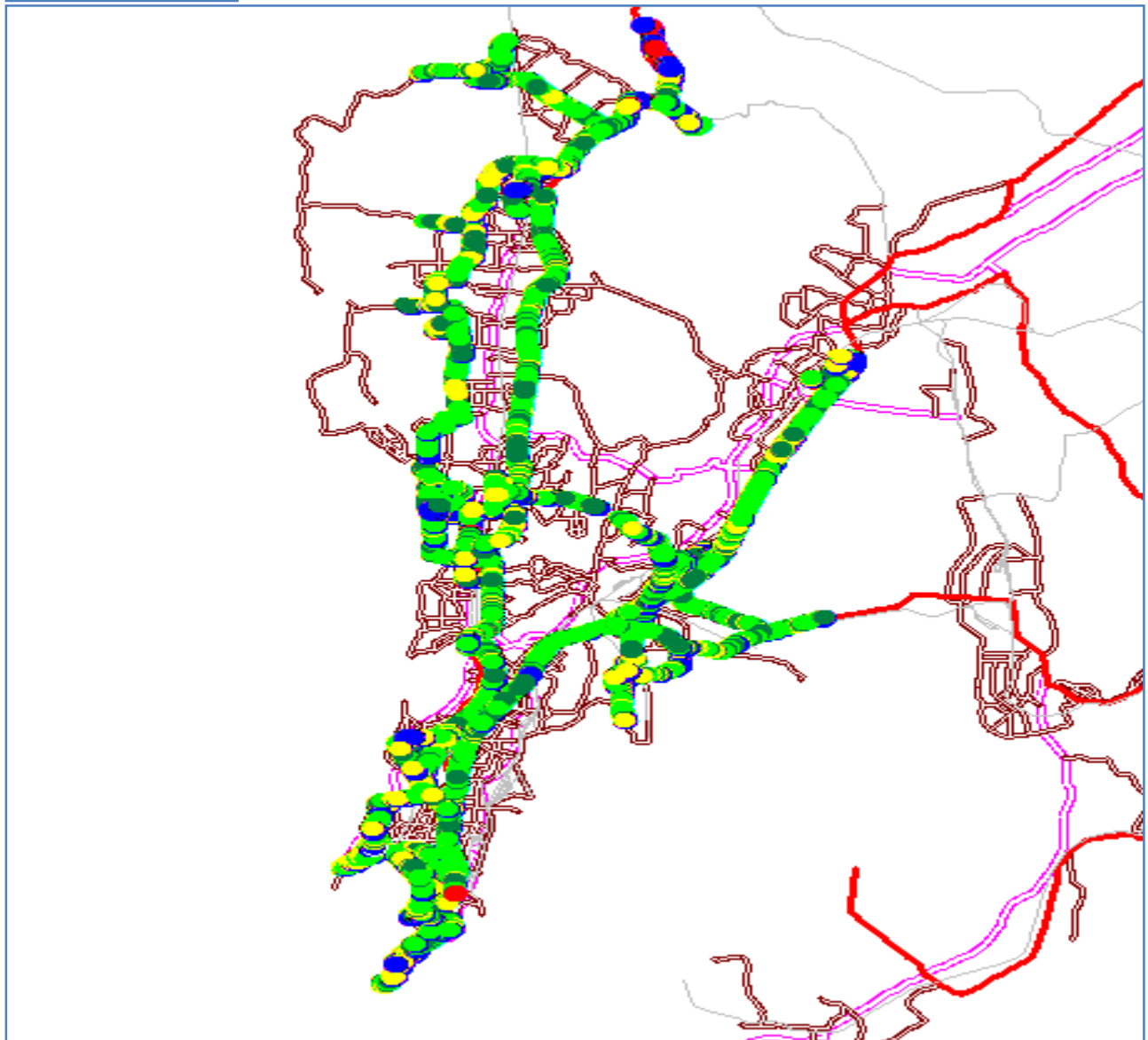
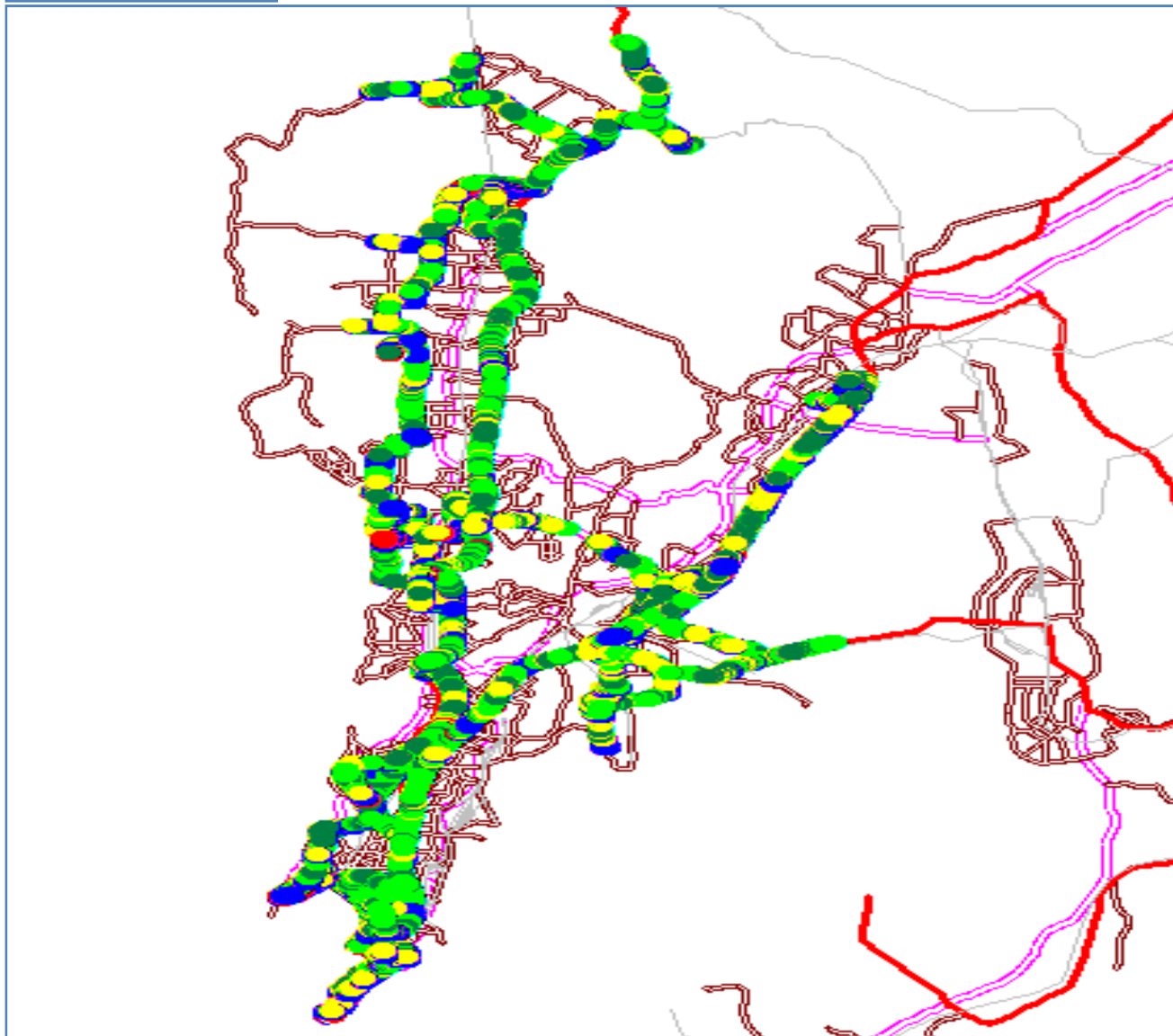|	Range	Count
🟢	-65 to 0	(357895)
🟩	-75 to -65	(261797)
🟡	-85 to -75	(194028)
🔵	-95 to -85	(35548)
🔴	-120 to -95	(6075)
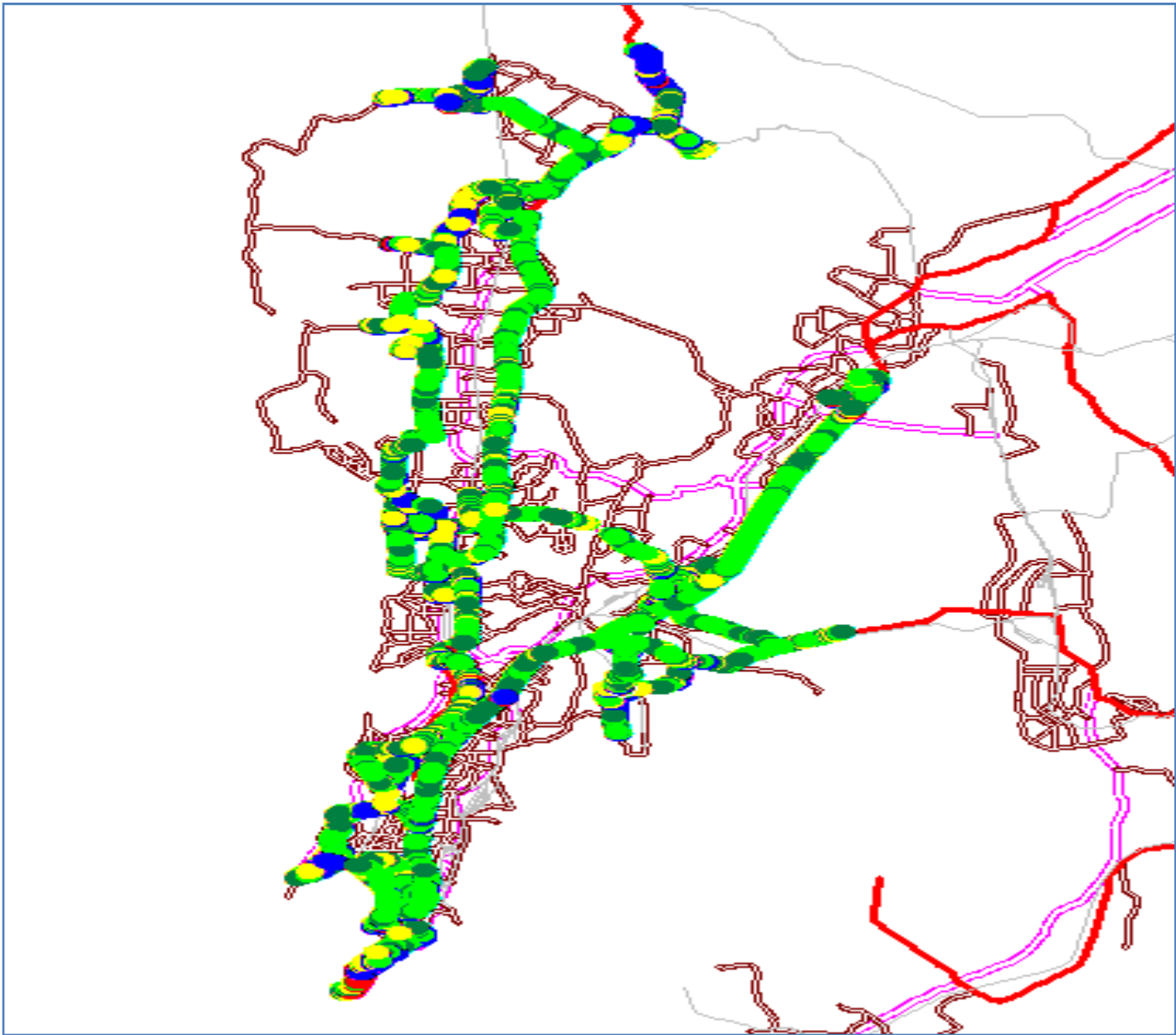
IdeaRx Level Plot

Vodafone Rx Level Plot

Legend:
- -65 to 0 (360233)
- -75 to -65 (207210)
- -85 to -75 (163232)
- -95 to -85 (62720)
- -120 to -95 (9618)
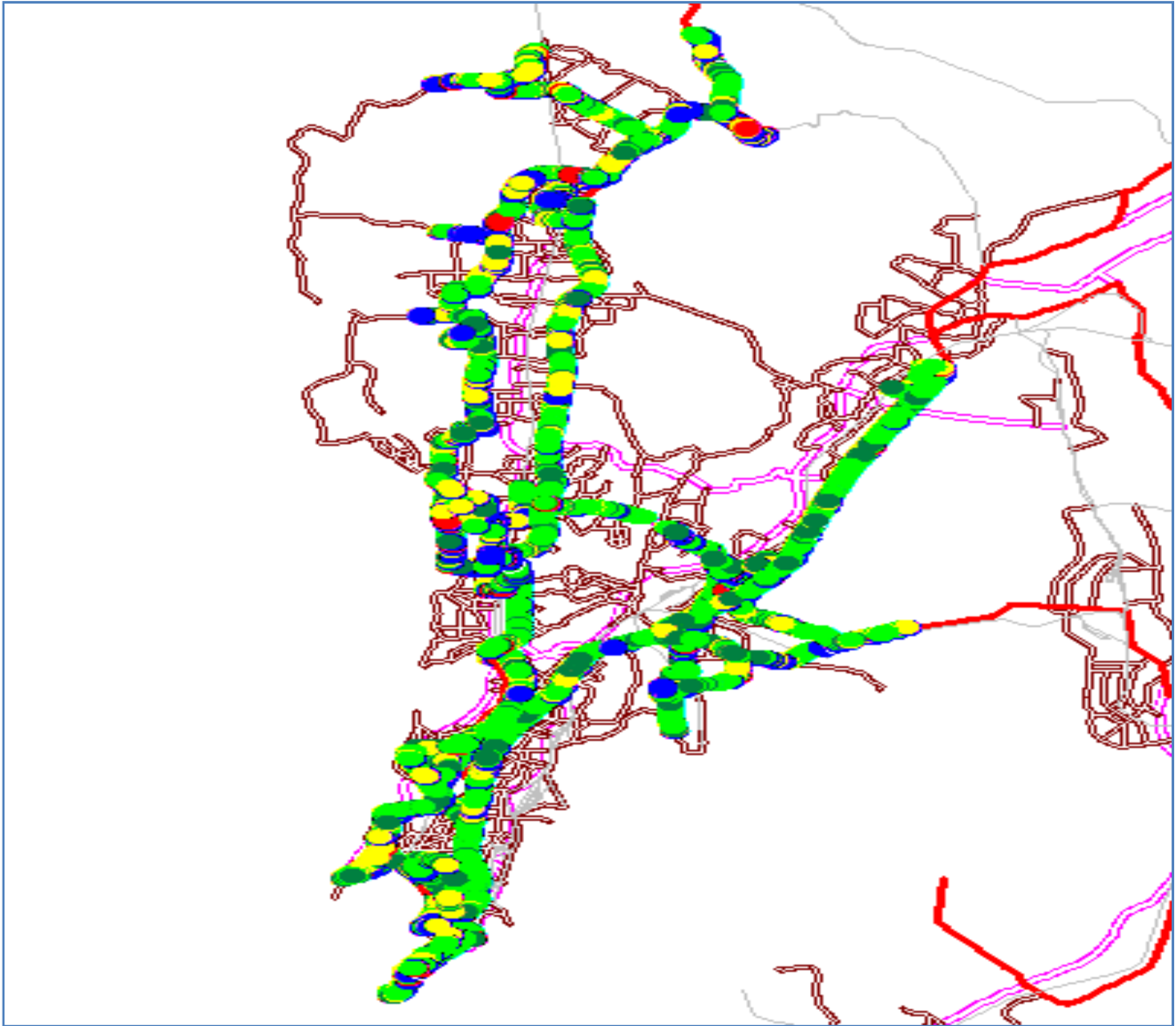
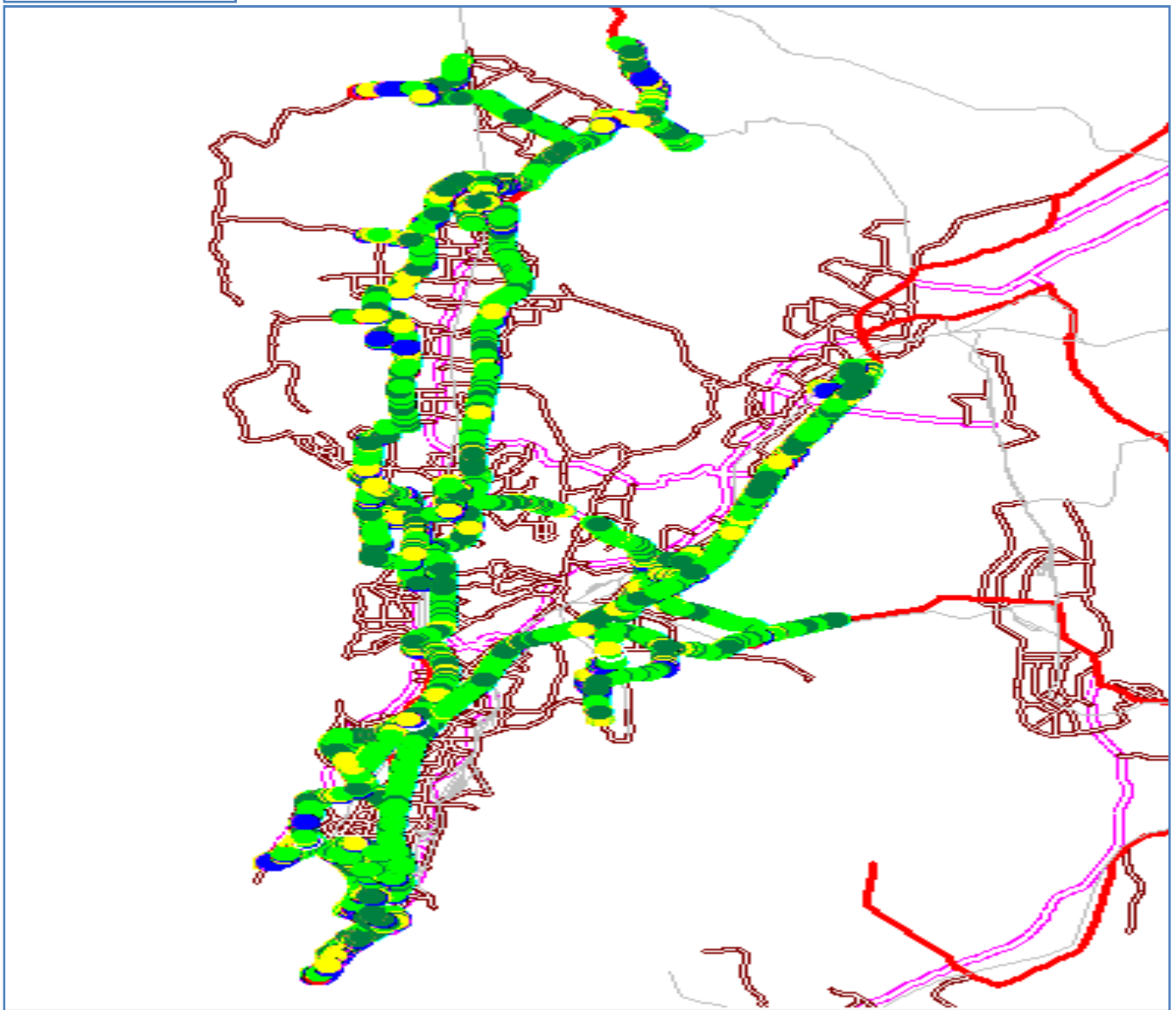## Reliance Rx Level Plot

●	-65 to 0	(250787)
●	-75 to -65	(256797)
●	-85 to -75	(203697)
●	-95 to -85	(71957)
●	-120 to -95	(12044)

Tata(GSM) Rx Level Plot

🟢	-65 to 0	(436383)
🟢	-75 to -65	(366707)
🟡	-85 to -75	(158680)
🔵	-95 to -85	(26704)
🔴	-120 to -95	(2651)

Aircel Rx Level Plot

🟢	-65 to 0	(302335)
🟢	-75 to -65	(237332)
🟡	-85 to -75	(223299)
🔵	-95 to -85	(48705)
🔴	-120 to -95	(3281)
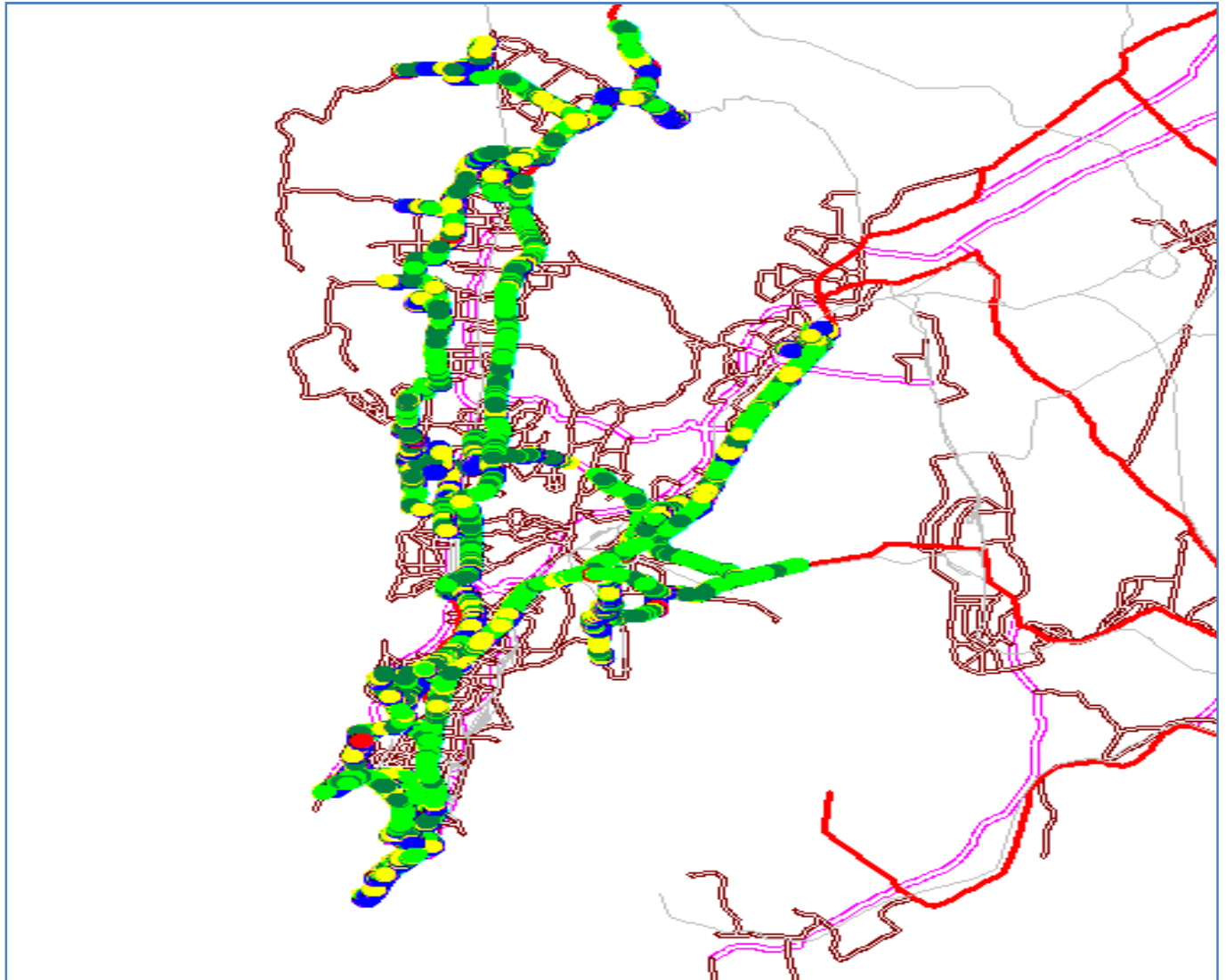
3.1.2 Accessibility

For determining the accessibility there are three important parameters to be monitored, namely Call Setup Success Rate (CSSR), Standalone Dedicated Control Channel (SDCCH)/ Paging Channel and Traffic Channel (TCH).

Call Set-up Success Rate (CSSR):

Call Setup Success Rate is defined as the ratio of Established Calls to Call Attempts. Established Calls means the following events have happened in call setup:

   i) Attempt is made

   ii) The TCH is allocated and

   iii) The call is routed to the outwards path of the concerned MSC.

Accessibility Summary

Accessibility is the ability of a service to be obtained within specific tolerances and other given conditions, whenrequested by the user. In other words, the ability of a user to obtain the requested service from the system.Accessibility is monitored by measuring Call Setup Success Rate (CSSR) which is defined as the ratio of Established Calls to Call Attempts. The benchmark is 95%. The performance of the operators varies from 96.98% (for airtel) to 68.87% (for Reliance). The details are as follows:

Table 3.3 Accessibility Summary and Ranking

| Operator Name	Total Call Attempt	Call Block	CSSR	Ranking
Idea	570	57	90.00%	5
Airtel	529	16	96.98%	1
Vodafone	535	21	96.07%	2
Reliance (GSM)	575	179	68.87%	6
Aircel	550	24	95.64%	3
Tata (GSM)	546	25	95.42%	4

CSSR & Block Call Rate Details Graph
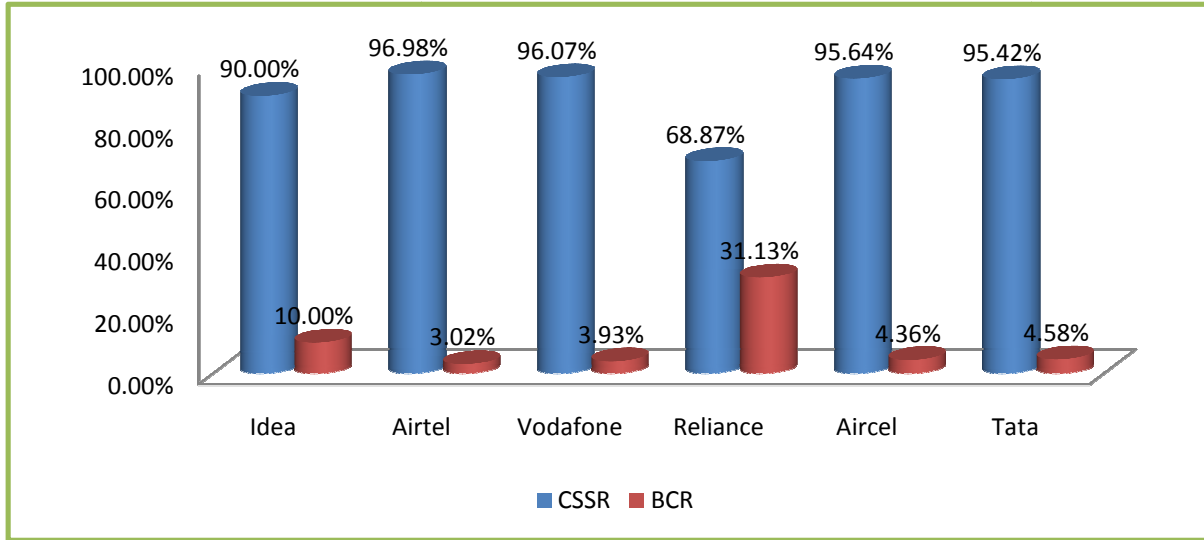
Accessibility Details Graph

Operator	Total Call Attempt	Total Call Success	Total Call Block	CSSR%	Block Rate%
Idea	570	513	57	90.00%	10.00%
Airtel	529	513	16	96.98%	3.02%
Vodafone	535	514	21	96.07%	3.93%
Reliance (GSM)	575	396	179	68.87%	31.13%
Aircel	550	526	24	95.64%	4.36%
Tata(GSM)	546	521	25	95.42%	4.58%

CSSR & Block Call Rate Statistics
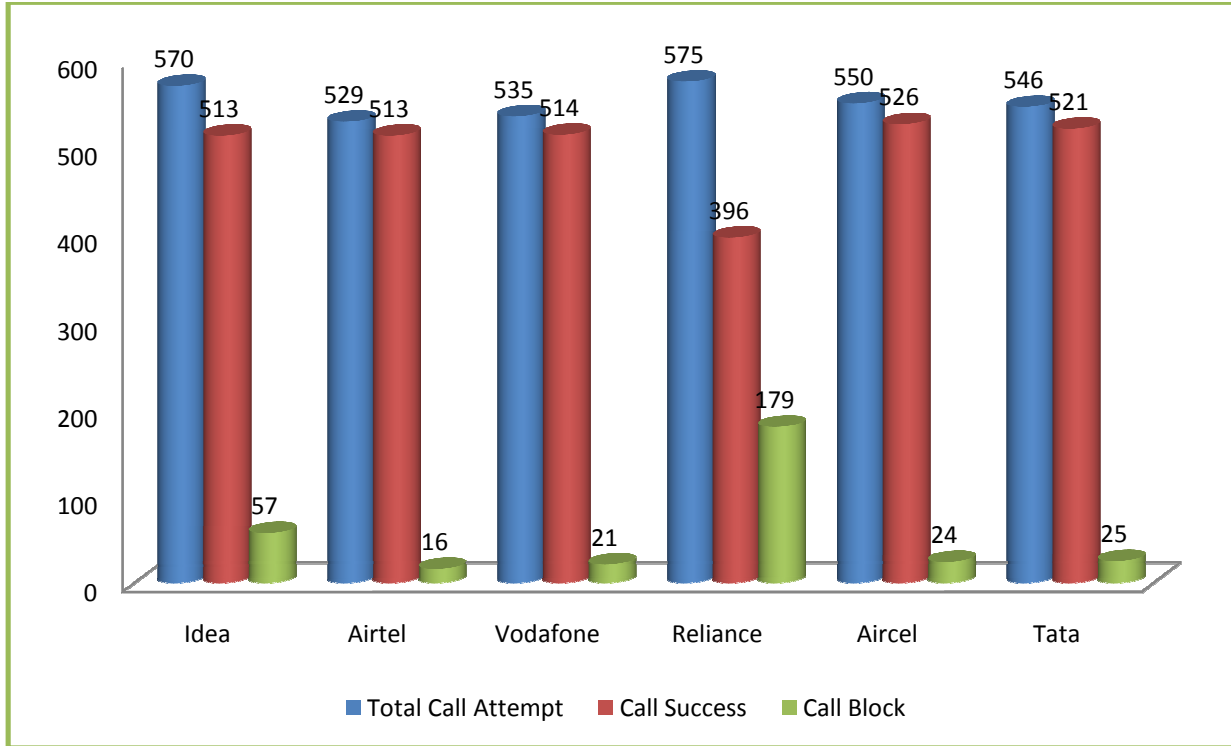
3.1.3 Retainability

Retainability is "The ability of a service, once obtained, to continue to be provided under given conditions for a requested duration." For determining the Retainabiltythe regulation prescribes three important parameters namely Call drop rate (CDR), Worst affected Cells having more than 3% TCH drop and Connection with good voice quality. The call drop and Connection with good voice quality were monitored by the drive test.

Call Drop Rate (CDR): The parameter gives a reliable measurement of the mobile network used by the service provider for maintaining a call once it has been correctly established. The Call drop rate of TSPs varies from 0.97% (Airtel) to 5.56%(Idea) as shown below:

Table 3.4Retainability Summary and Ranking

| Operator	Total Call Established	Total Call Drop	Retainability	Ranking
			CDR %	
Idea	540	30	94.44%	6
Airtel	513	5	99.03%	1
Vodafone	497	24	95.17%	4
Reliance (GSM)	393	9	97.71%	2
Aircel	533	17	96.81%	3
Tata (GSM)	526	29	94.49%	5

Success & Call Drop Rate Details Graph
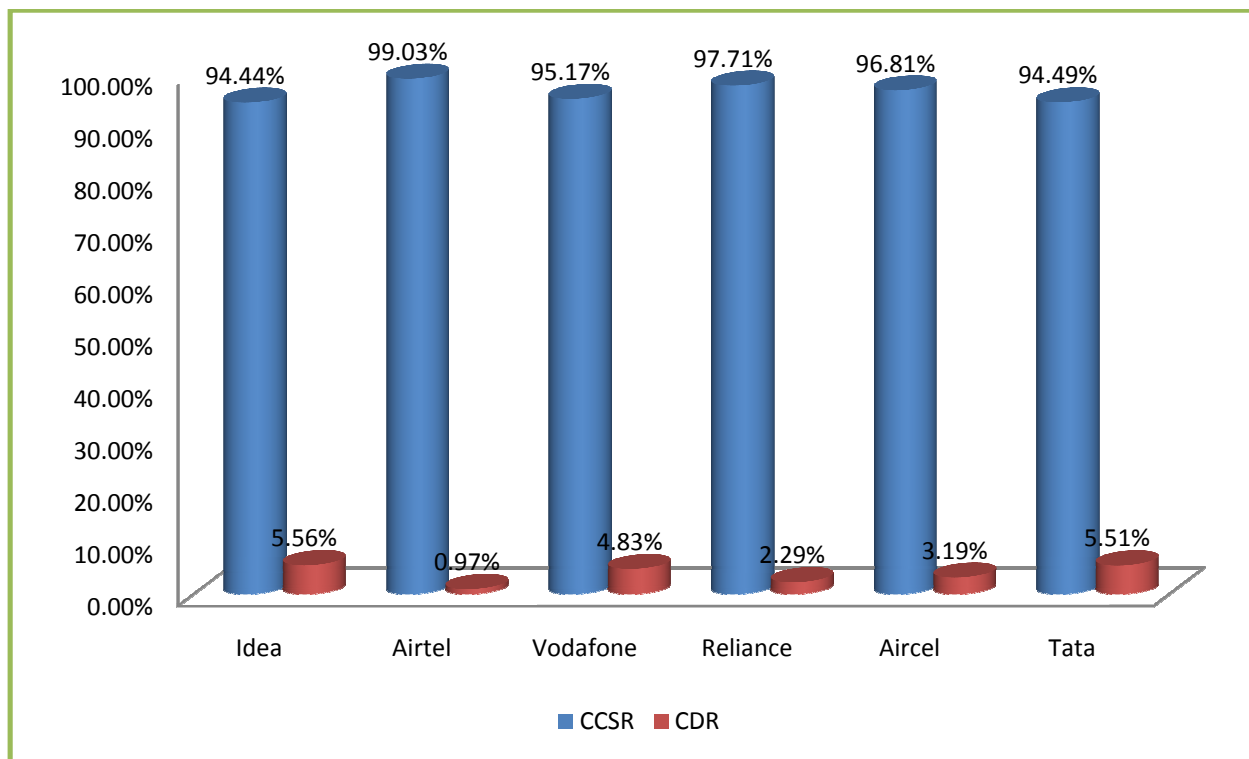
Call Established and Call Drop Statistics

Operator	Total Call Established	Total Call Drop	CCSR%	Call Drop Rate%
Idea	540	30	94.44%	5.56%
Airtel	513	5	99.03%	0.97%
Vodafone	497	24	95.17%	4.83%
Reliance (GSM)	393	9	97.71%	2.29%
Aircel	533	17	96.81%	3.19%
Tata (GSM)	526	29	94.49%	5.51%

Success & Call Drop Rate Statistics
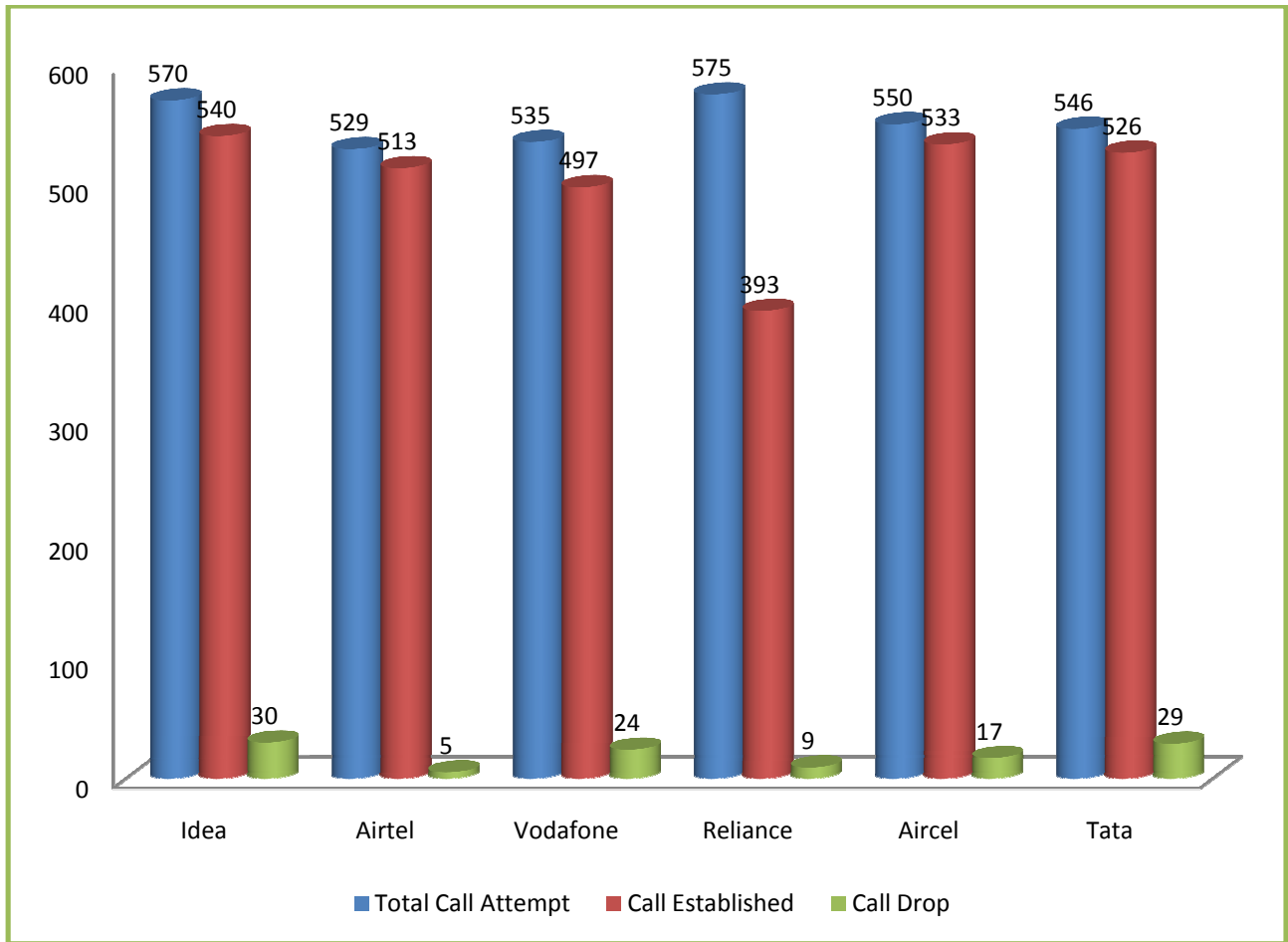
3.1.4 Mobility

In a cellular system a base station has only a limited coverage area. Hence it is possible for a moving subscriber to get out of reach of a base station while making a call. The process by which a mobile telephone call is transferred from one base station to another as the subscriber passes the boundary of a cell is called a handover.

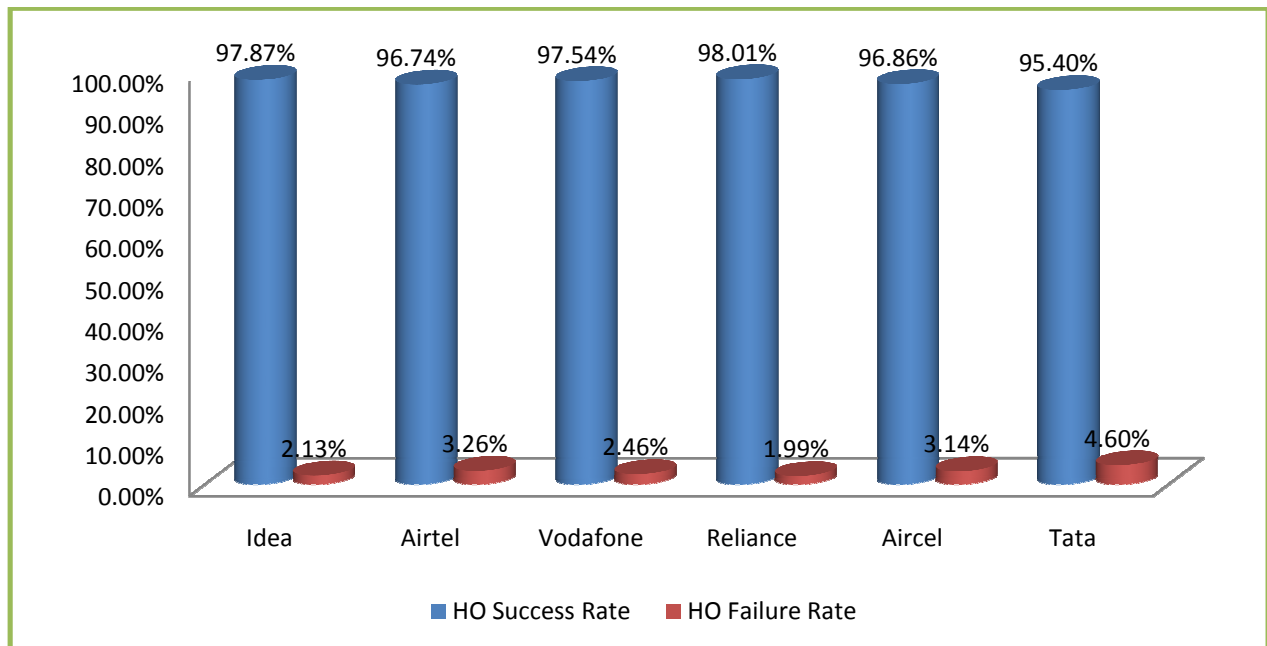The Handover success rate (HOSR) more than 95% is considered to be good.

Mobility Summary

For detail KPI definition, please refer to table 3.5 Mobility.

Table 3.5 Mobility Summary and Ranking

Operator	Total HO Attempt	Total HO Success	HO Success Rate%	Ranking
Idea	984	963	97.87%	2
Airtel	1258	1217	96.74%	5
Vodafone	1750	1707	97.54%	3
Reliance (GSM)	1004	984	98.01%	1
Aircel	795	770	96.86%	4
Tata(GSM)	1435	1369	95.40%	6

Success & Fail Handover Rate Details Graph

Success & Fail Handover Rate Statistics

	Idea	Airtel	Vodafone	Reliance	Aircel	Tata
HO Attempt	984	1258	1750	1004	795	1435
HO Success	963	1217	1707	984	770	1369
HO Success Rate	97.87%	96.74%	97.54%	98.01%	96.86%	95.40%

■ HO Attempt   ■ HO Success   ■ HO Success Rate
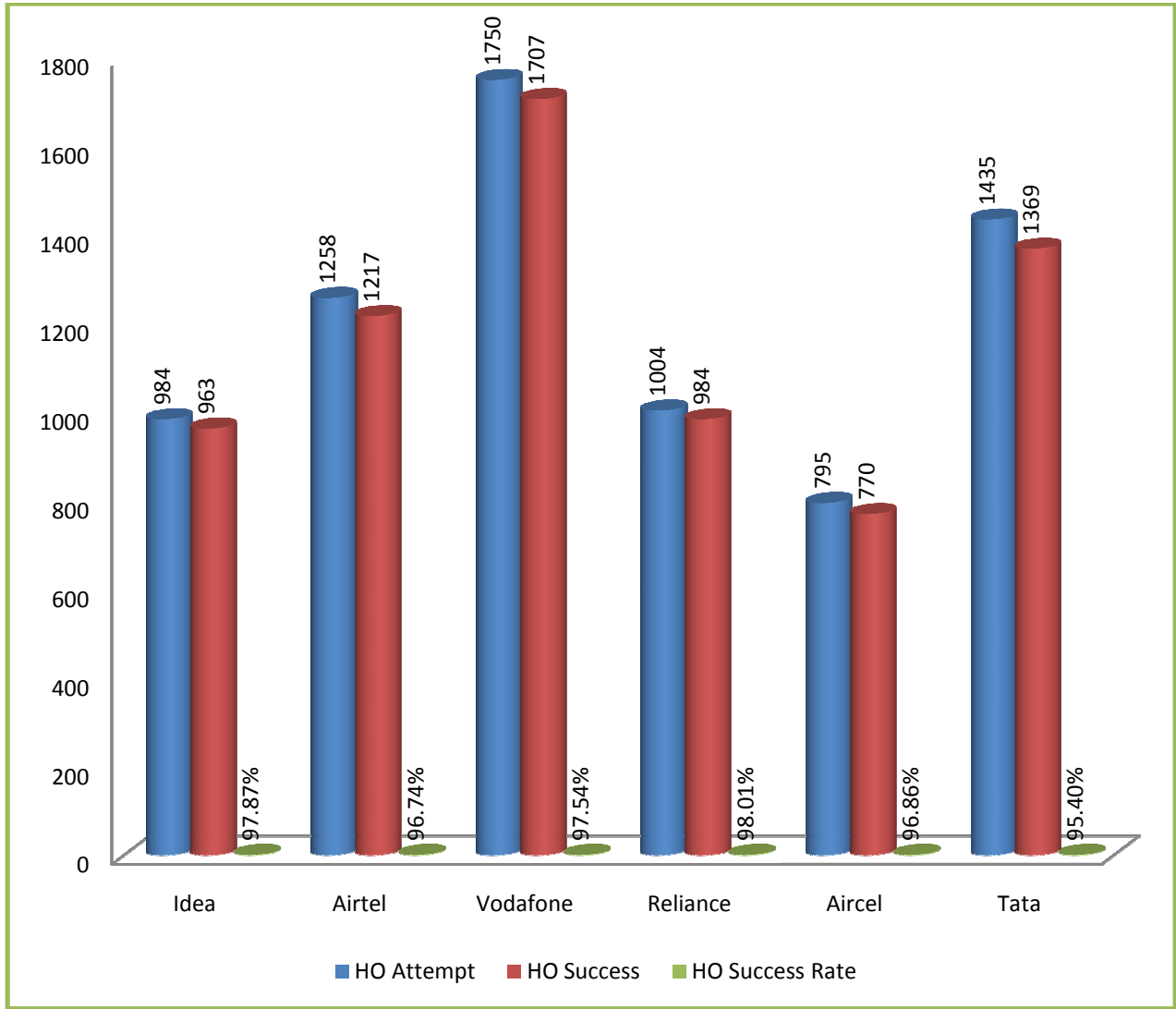
3.1.5 Rx Quality

For measuring voice quality, Rx Qual samples on a scale from 0 to 7 for GSM operators and Frame Error Rate (FERs) for CDMA service providers are measured. As per the QoS norms, Rx Qual between 0- 5 for GSM operators and between 0-4% FER value for CDMA operators FERs is considered to be good, where as Rx Qual beyond this benchmark is considered to be bad. The benchmark should usually be > 95%.

Rx Quality Summary

Please refer to table 3.6 Rx Quality.

Table 3.6 Rx Quality Summary and Ranking

Operator	Rx Quality Samples (0-7)	Rx Quality Samples (0-5)	Rx Quality Samples (0-5)%	Ranking
Idea	649800	561789	86.46%	4
Airtel	675609	615556	91.11%	1
Vodafone	600552	537860	89.56%	2
Reliance (GSM)	573717	490682	85.53%	6
Aircel	676587	579177	85.60%	5
Tata(GSM)	711097	636451	89.50%	3

Rx Quality Details Graph
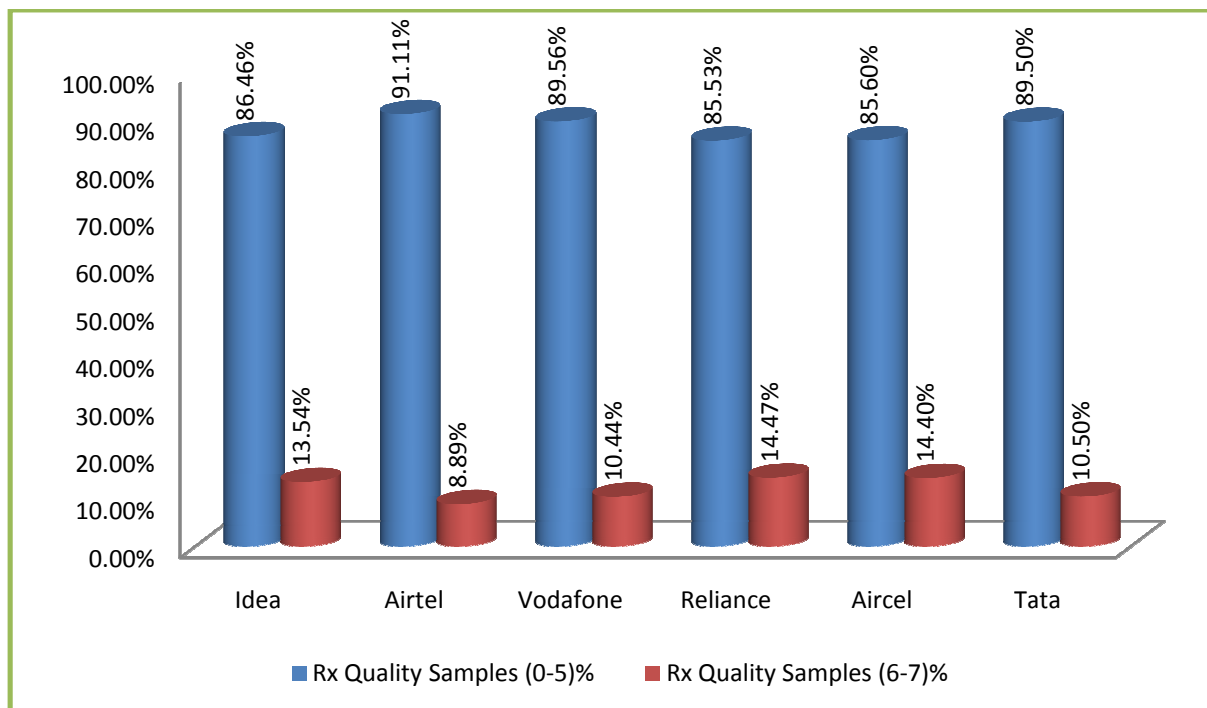
QUALITY PLOT

Airtel Rx Quality Plot

- ● 5 to 7   (60053)
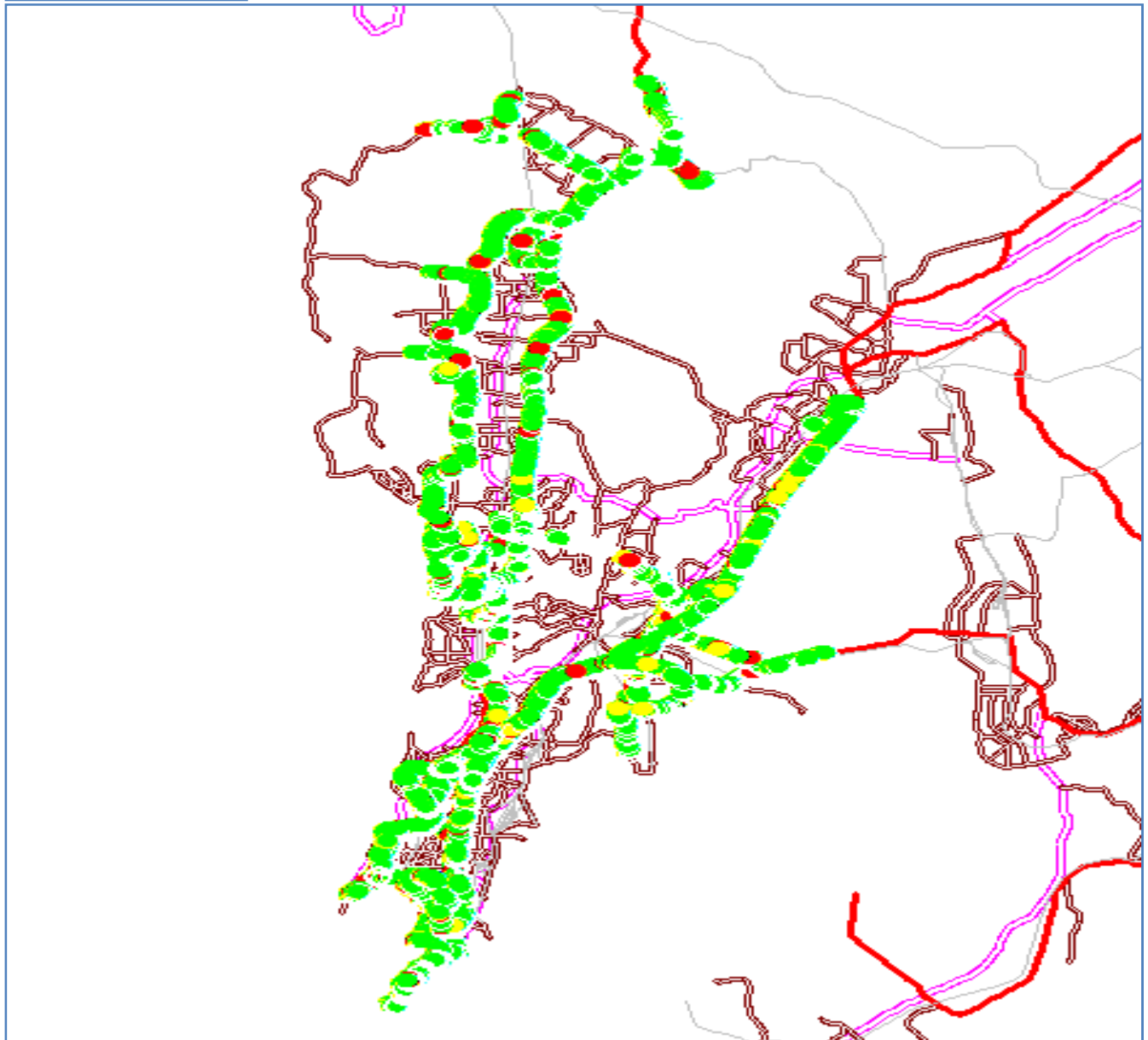- ● 2 to 5   (50892)
- ● 0 to 2   (564664)

Idea Rx Quality Plot
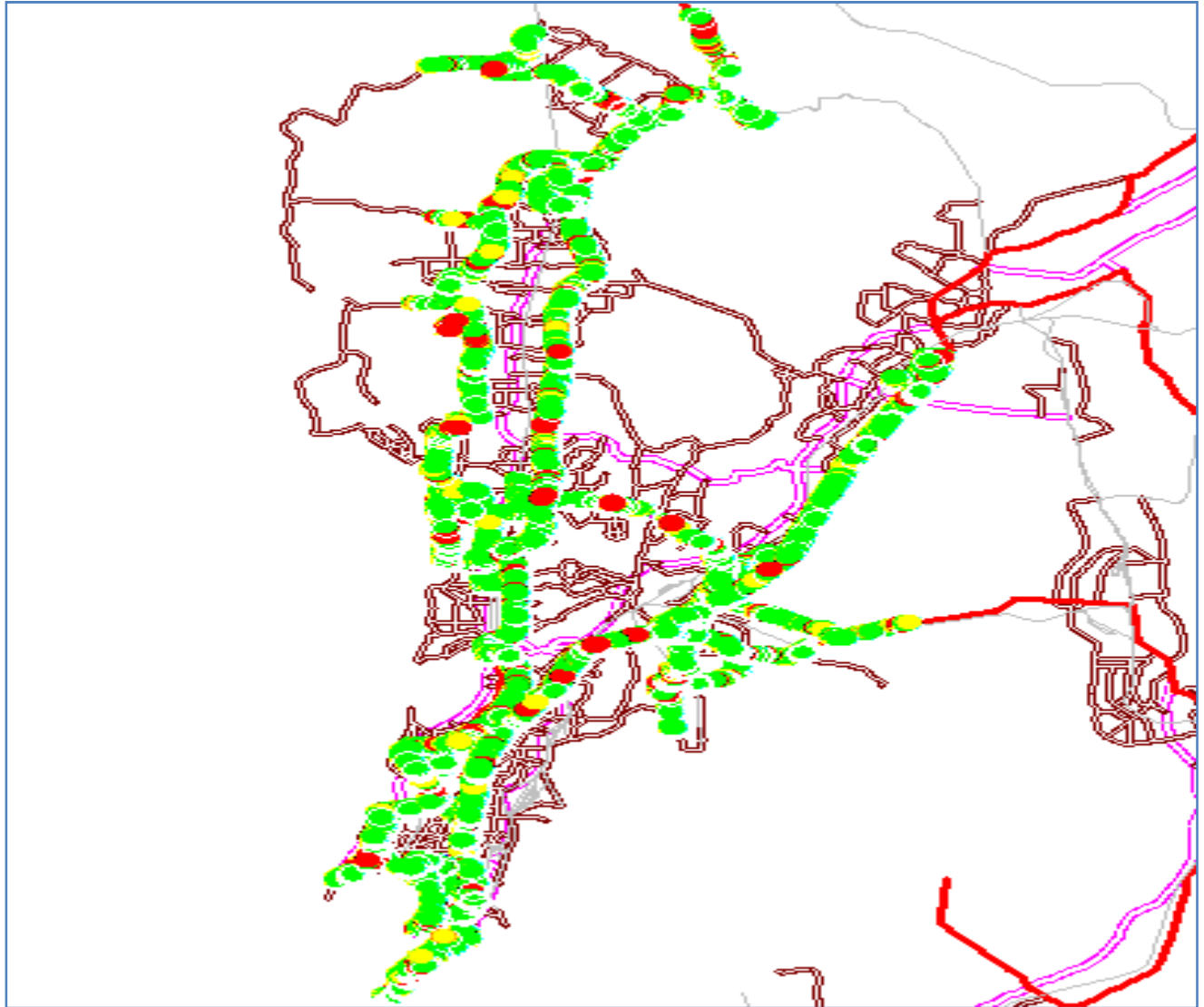
Vodafone Rx Quality Plot

Reliance Rx Quality Plot
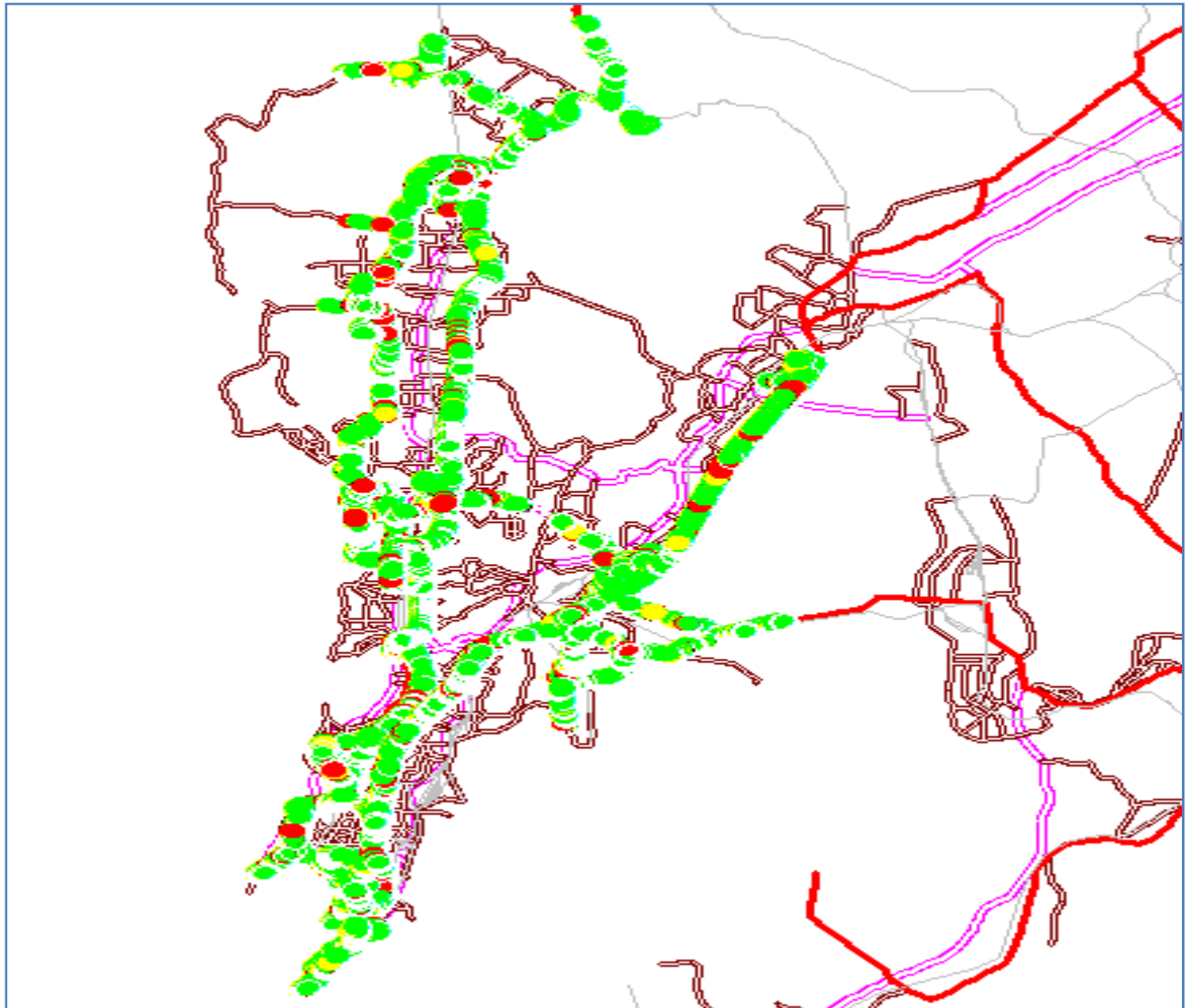
Tata(GSM) Rx Quality Plot
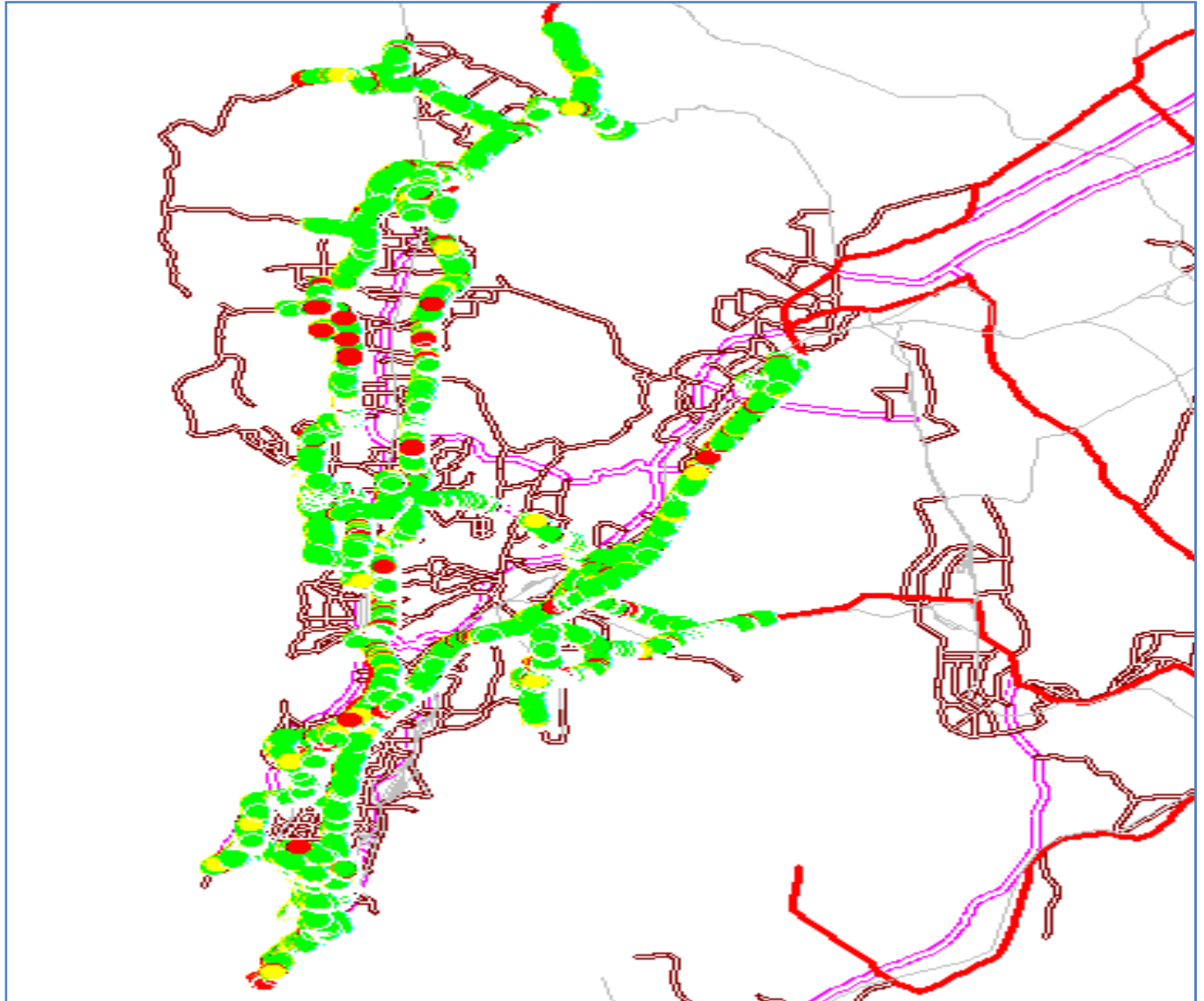
Aircel Rx Quality Plot
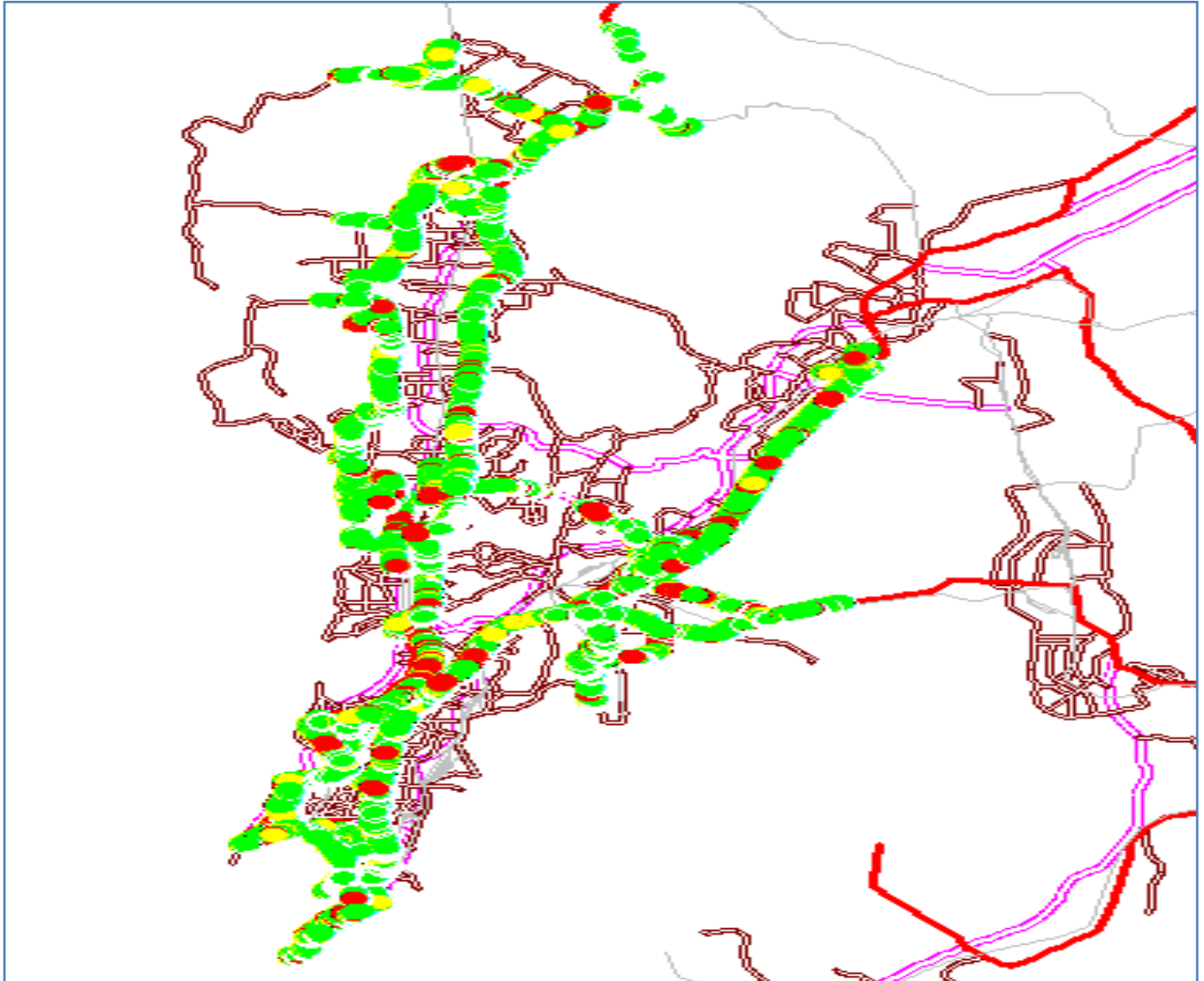
3.1.6 Carrier over Interference (C/I)

The carrier-over-interference ratio is the ratio between the levels of the signal strength of thecurrent serving cell to that of the signal strength of undesired (interfering) signal components.

The C/I should be more than 9 dbi.esamplesbetween 15 to 30 are considered good..

C/I Summary

Please refer to table 3.8for C/I Index.

Table 3.8 C/I and Ranking

Operator	C/I Samples (15-30)	C/I Total Samples	C/I Samples %	Ranking
Idea	169890	254836	66.67%	4
Airtel	90960	140311	64.83%	6
Vodafone	105460	161680	65.23%	5
Reliance	410907	492445	83.44%	1
Aircel	244760	359261	68.13%	3
Tata	261185	374478	69.75%	2

C/I Index Details Graph
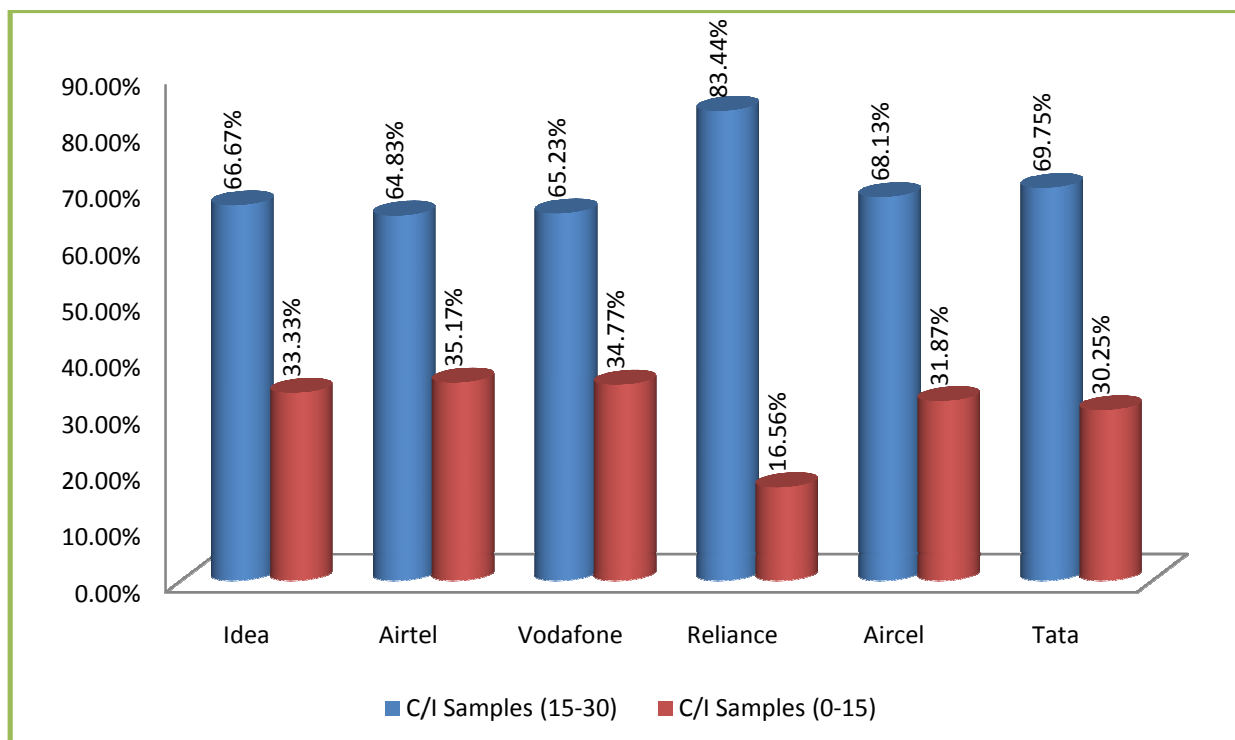
C/I PLOT

Airtel C/I Plot
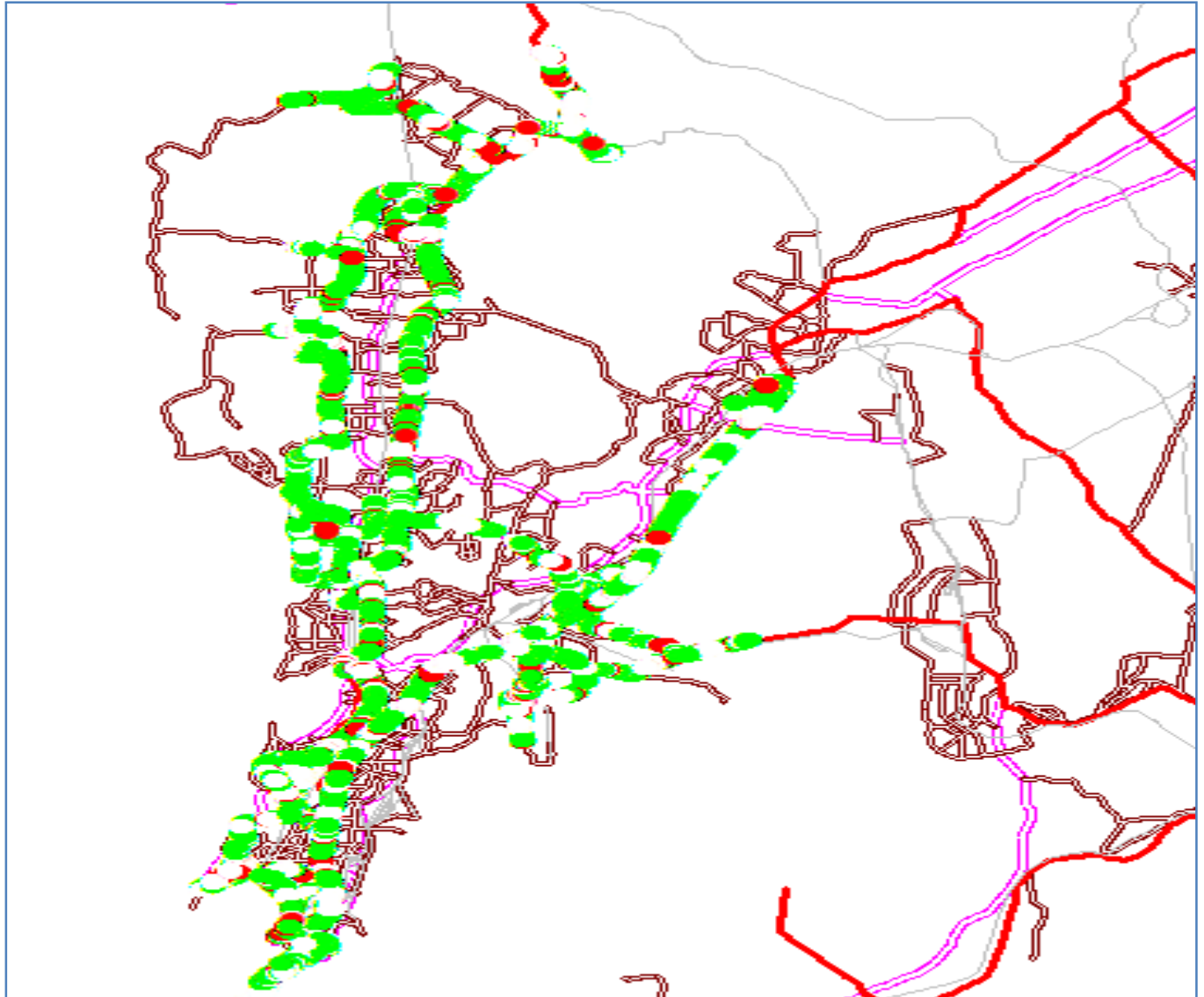
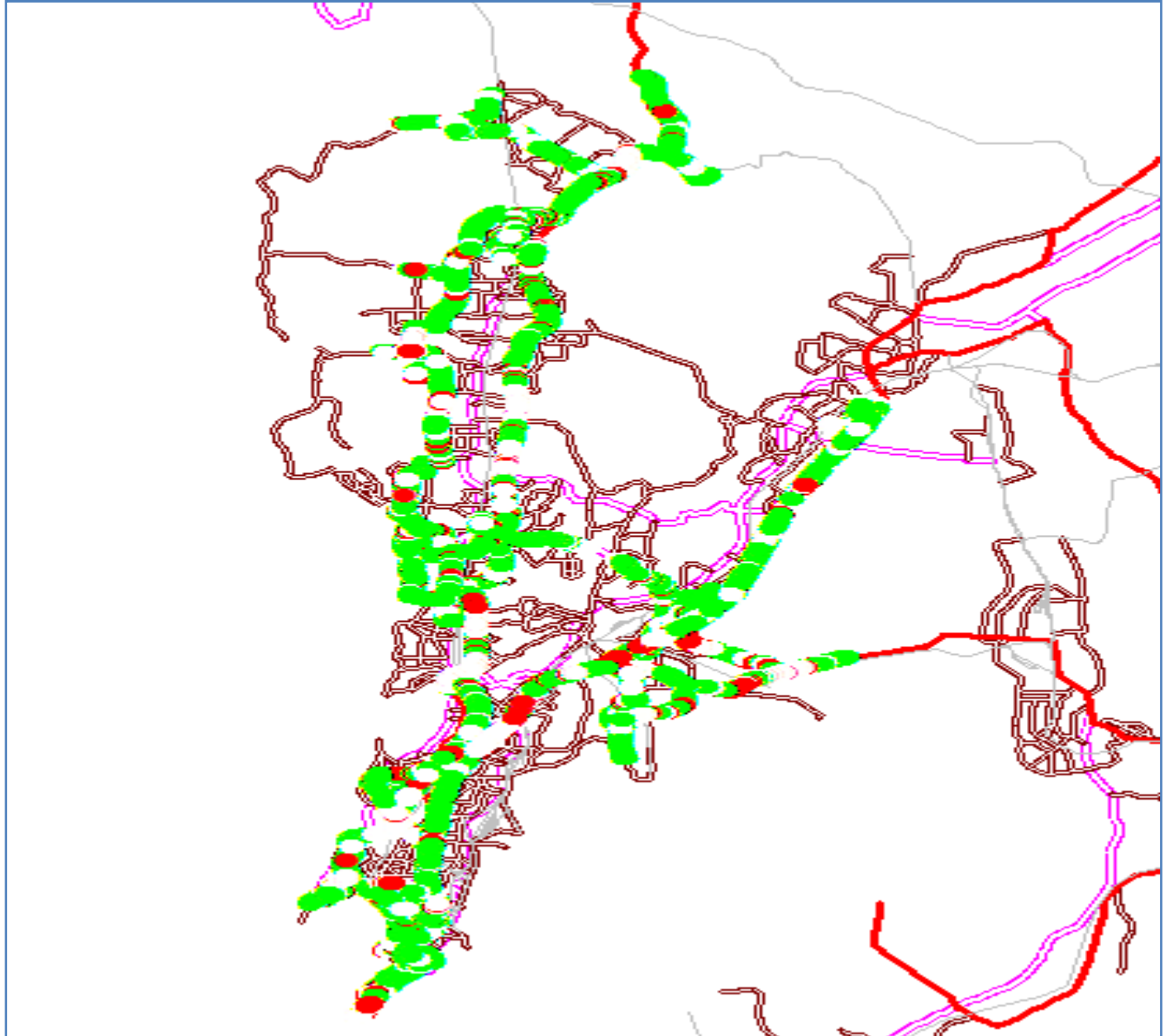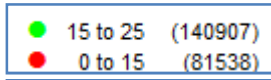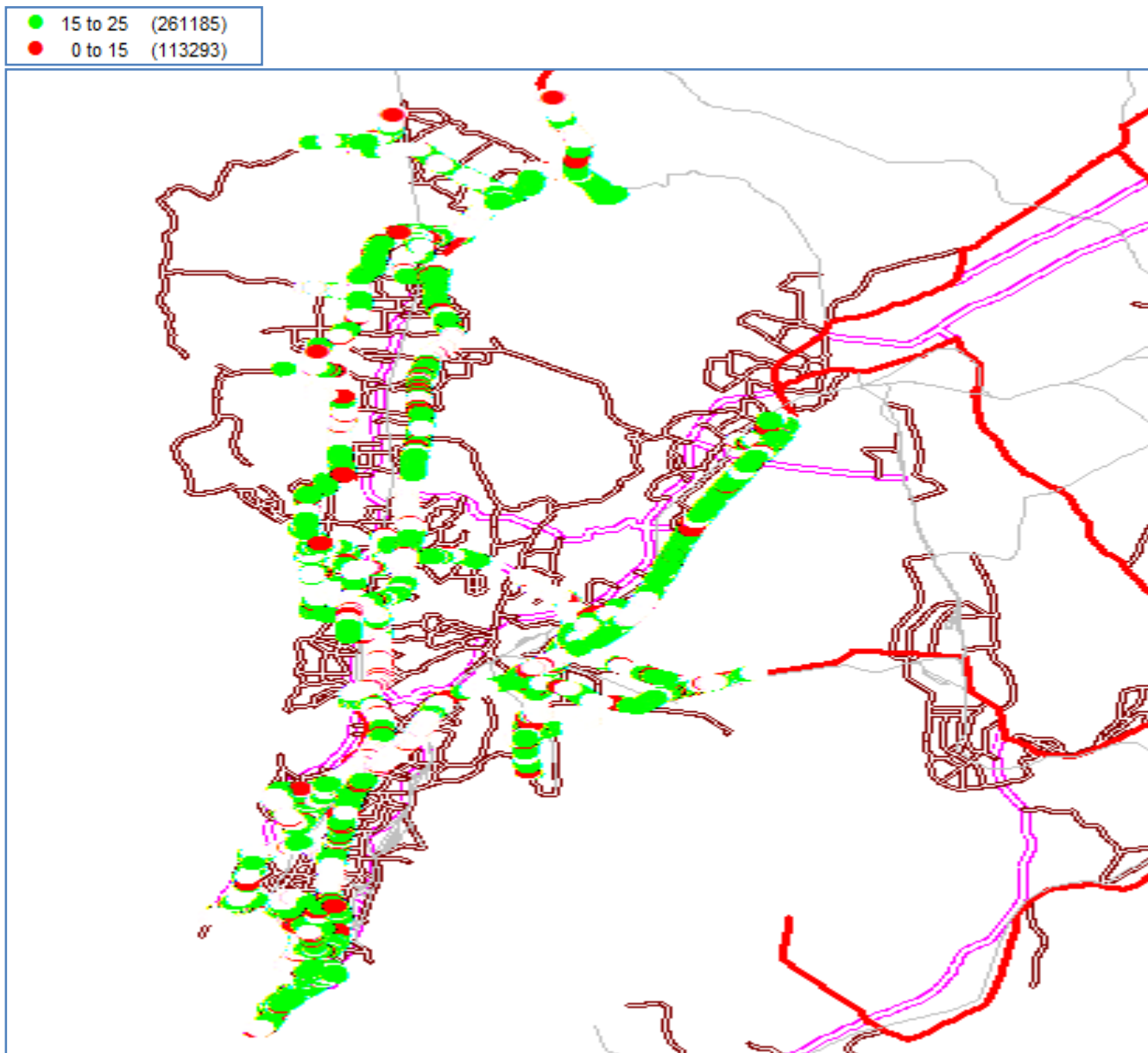## Idea C/I Plot
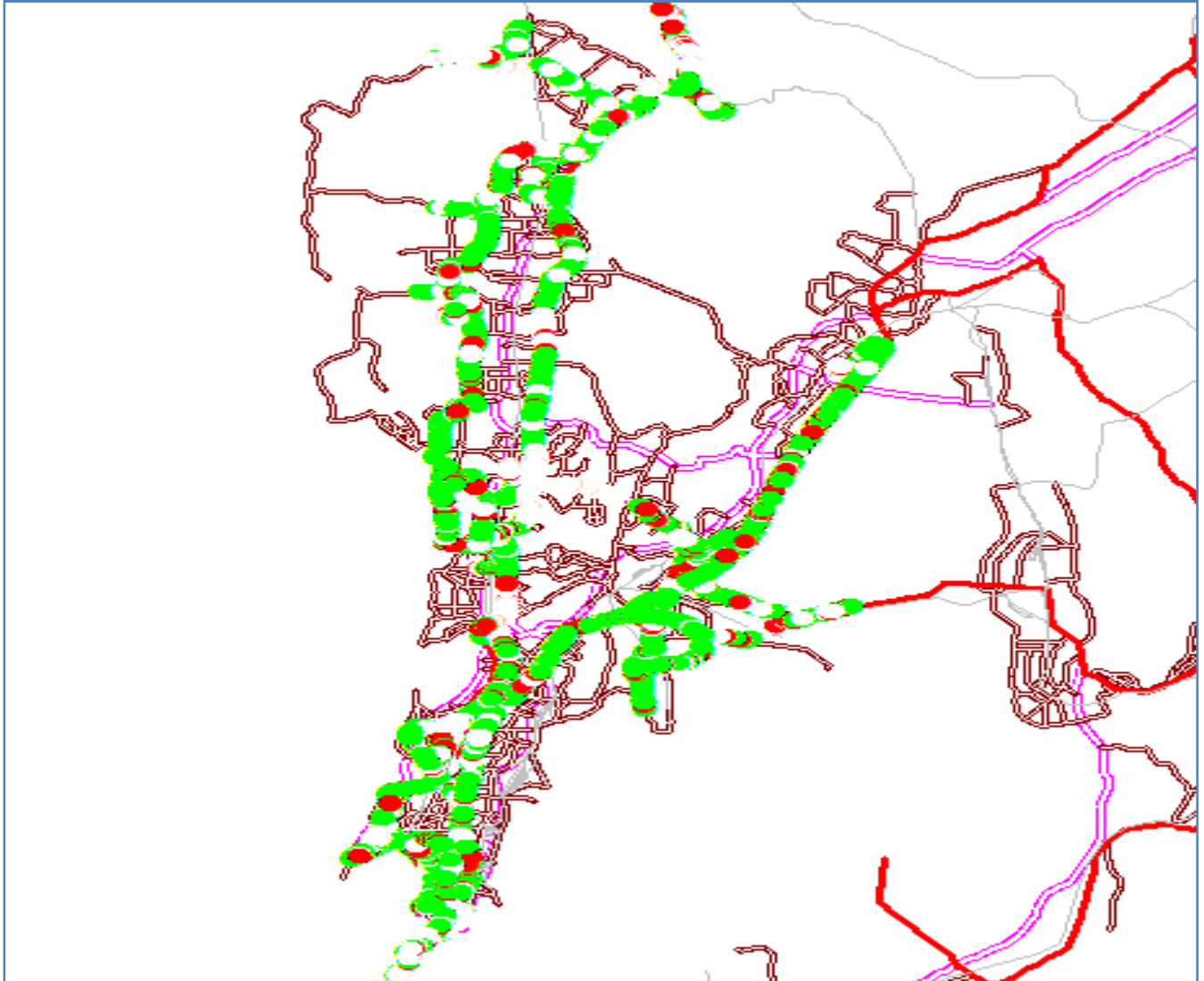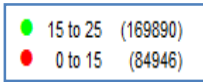
Vodafone C/I Plot
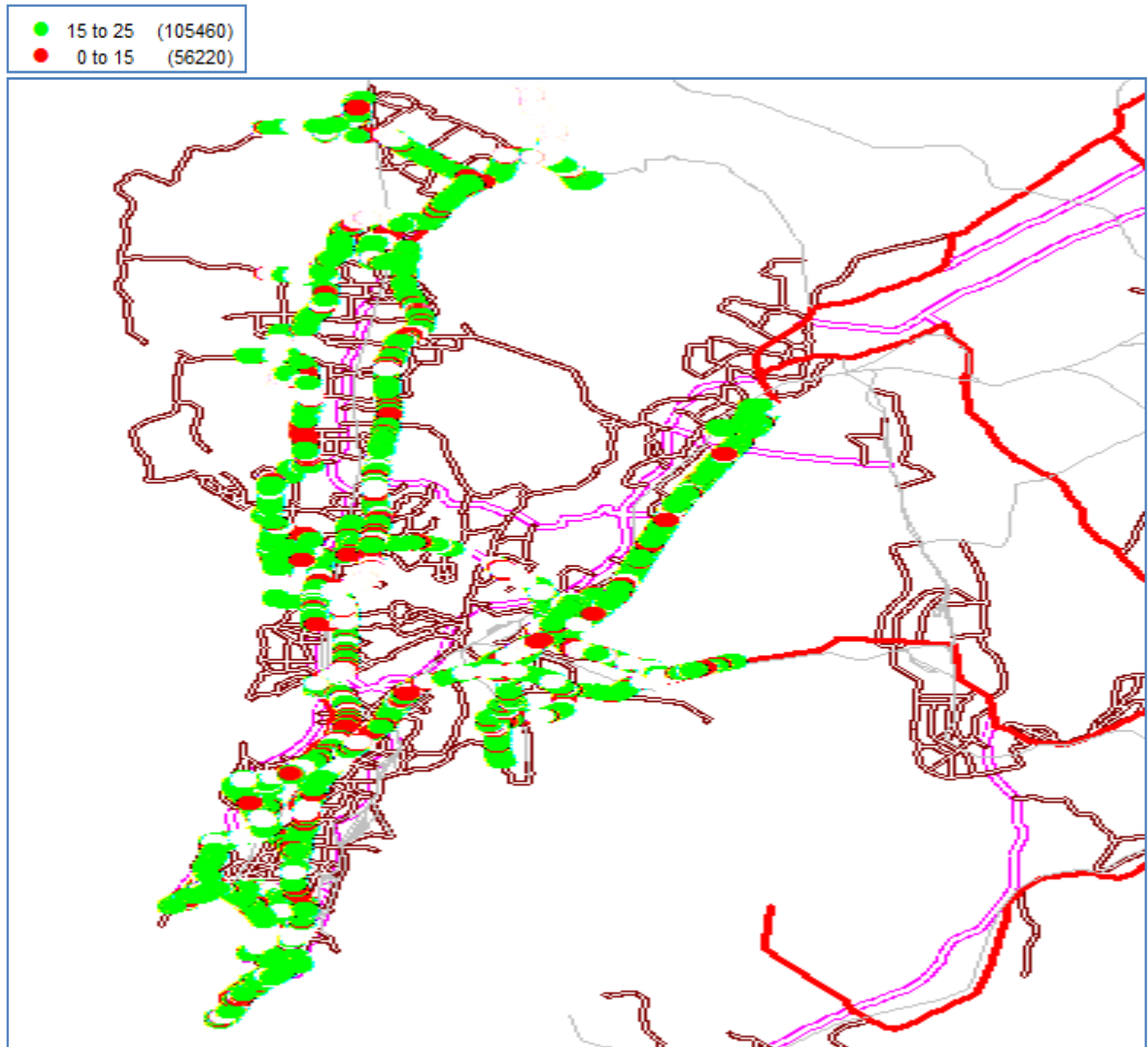
Reliance C/I Plot

Tata(GSM) C/I Plot

Aircel C/I Plot
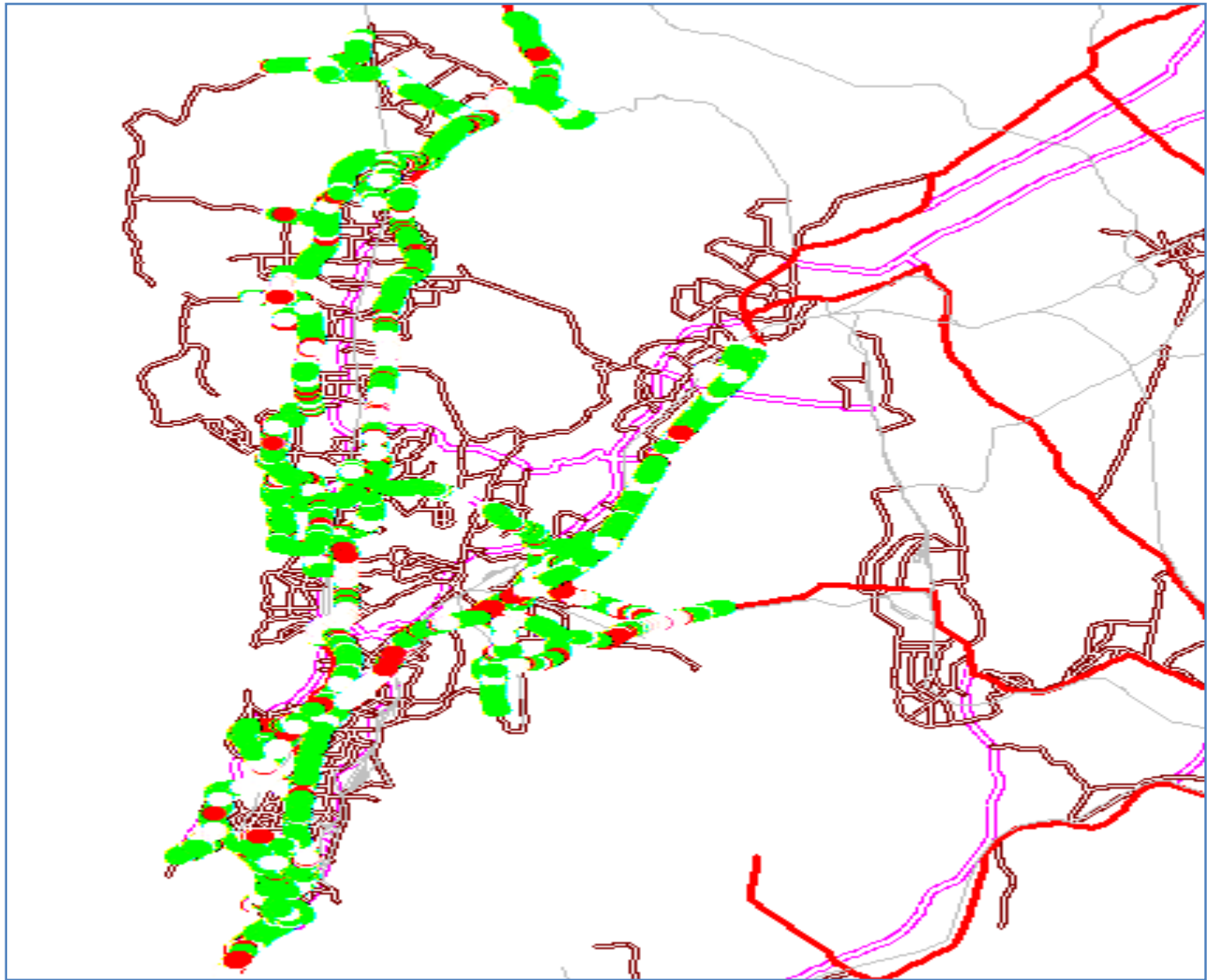
4 Troublesome / Problematic Areas:

Operator	Area Name	Observation
Airtel	Nariman Point	Poor Rx Quality Observed at Nariman Point.
	MalbarHil	Poor Rx Coverage and Rx Quality Observed at MalibarHil Area. At Some Points in MalibarHil No Network also found.
	Matunga	Poor Rx Quality Observed at Matunga.
	ONGC Area	Poor Rx Level Observed in ONGC Area.
	Andheri Kurla Road	Poor Rx Quality Observed at Andheri Kurla Road Due to Interference.
	Paragon Centre	Poor Rx Quality Observed at Paragon Centre Due to Interfrence.
Idea	Navy Nagar	Poor Rx Quality Observed Near Navy Nagar.
	Nariman Point	Poor Rx Level and Rx Quality Observed at Nariman Point.
	MalbarHil	Poor Rx Level Observed Near MalibarHil.
	Church Gate Area	Poor Rx Quality Observed Near Church Gate Area.
	Lokhandwala Area	Poor Rx Quality Observed Near Lokhandwala Area.
	Juhu	Poor Rx Quality Observed Near Juhu.
	Malvani	Poor Rx Quality Observed Near Malvani.
	Mankhurd Link Road	Poor Rx Quality Observed at Mankhurd Link Road.
	Sion	Poor Rx Quality Observed at Sion Due to Interference.
	ONGC Area	Poor Rx Level Observed in ONGC Area.
Vodafone	Ghatkoper	Poor Rx Quality Observed at Ghatkoper Due to Interference.
	Paragon Centre	Poor Rx Quality Observed at Paragon Center Due to Interference.
	MalbarHil	Poor Rx Level Observed Near MalibarHil.
	Nariman Point	Poor Rx Quality Observed at Nariman Point.
	Jung Marg	Poor Rx Quality Observed at Jung Marg.
	Khar Area	Poor Rx Quality Observed Near Khar Area.
	Juhu	Poor Rx Quality Observed at Juhu.
	Azad Nagar Juhu	Poor Rx Quality Observed Near Azad Nagar Juhu.
	Dahisar	Poor Rx Quality Observed at Dahisar.
	C Link Road Dahisar west	Poor Rx Quality Observed at C Link Road Dahisar west.
	Uttan Road	Poor Rx Level Observed Near Uttan Road.
	Mankhurd Link Road	Poor Rx Quality Observed at Mankhurd Link Road .
	ONGC Area	Poor Rx Level Observed in ONGC Area.
Aircel	MalbarHil	Poor Rx Coverage and Rx Quality Observed at MalibarHil Area. At Some Points In MalibarHil No Network also found.
	Paragon Centre	Poor Rx Quality Observed at Paragon Centre Due to Interference.
	Nariman Point	Poor Rx Quality Observed at Nariamn Point.
	Jung Marg	Poor Rx Quality Observed at Jung Marg.

Operator	Area Name	Observation
	Khar Area	Poor Rx Quality Observed Near Khar Area.
	Juhu	Poor Rx Quality Observed at Juhu.
	Azad Nagar Juhu	Poor Rx Quality Observed Near Azad Nagar Juhu.
	Dahisar	Poor Rx Quality Observed at Dahisar.
	C Link Road Dahisar west	Poor Rx Quality Observed at C Link Road Dahisar west.
	Uttan Road	Poor Rx Level Observed at Uttan Road.
	Mankhurd Link Road	Poor Rx Quality Observed at Mankhurd Link Road.
	Peddar Road	Poor Rx Quality Observed at PedarRoad.
	ONGC Area	Poor Rx Level Observed in ONGC Area.
Tata GSM	Juhu	Poor Rx Quality Observed at Juhu.
	Malvani	Poor Rx Quality Observed at Malvani.
	Mankhurd Link Road	Poor Rx Quality Observed at Mankhurd Link Road.
	Sion	Poor Rx Quality Observed at Sion Due to Interfrence.
	Navy Nagar	Poor Rx Level and Network Fluctuation Observed Near Navy Nagar.
	Nariman Point	Poor Rx Quality Observed at Nariamn Point.
	Malabar Hill	Poor Rx Coverage and Rx Quality Observed at MalibarHil Area.
	Churchgate Area	Poor Rx Quality Observed Near Church Gate Area.
	Lokhandwala Area	Poor Rx Quality Observed Near Lokhandwala Area.
	ONGC Area	No Network Found at ONGC Area.
	Neelam Nagar	Poor Rx Quality Observed Near Neelam Nagar.
	Paragon Centre	Poor Rx Quality Observed at Paragon Centre Due to Interference.
	Peddar Road	Poor Rx Quality Observed at PedarRoad.
Reliance GSM	Navy Nagar	Poor Rx Quality Observed at Navy Nagar.
	Back Bay Depot	Poor Rx Quality Observed at Back Bay Depot.
	Walkeshwar Road Nariman Point	Poor Rx Quality Observed at Walkeswar Road Nariman Point.
	Malabar Hill	Poor Rx Level and Network Fluctuation Observed Near MalibarHil.
	Paragon Centre	Poor Rx Quality Observed at Paragon Centre Due to Interference.
	Matunga	Poor Rx Quality Observed at Matunga.
	Khar	Poor Rx Quality Observed Near Khar Area.
	Juhu	Poor Rx Quality Observed at Juhu.
	ONGC Area	Poor Rx Level and Network Fluctuation Observed in ONGC Area.
	Neelam Nagar	Poor Rx Quality Observed Near Neelam Nagar.
	Charkop	Poor Rx Quality Observed Near Charkop.
	Sion	Poor Rx Quality Observed Near Sion.

5Overall Operator Analysis

KPI	Idea	Airtel	Vodafone	Reliance (GSM)	Aircel	Tata (GSM)
Call Attempt	570	529	535	575	550	546
Blocked Call Rate	10.00%	3.02%	3.93%	31.13%	4.36%	4.58%
Call Setup Success Rate (>=95%)	90.00%	96.98%	96.07%	68.88%	95.64%	95.425
Dropped Call Rate (<=2%)	5.56%	0.97%	4.83%	2.29%	3.19%	5.51%
Rx Quality (0-5) (>=95%)	86.46%	91.11%	89.56%	85.53%	85.60%	89.50%
Handover Success Rate (>=95%)	97.87%	96.74%	97.54%	98.01%	96.86%	95.40%

Analysis:

Independent Drive Test was conducted by TUV SUD on behave of TRAI for Idea, Airtel,Vodafone, Reliance (GSM),Aircel&Tata(GSM) in North Mumbai,South Mumbai, and Central Mumbai covering locations suggested by TRAI.

The Drive Test results revealed that the most of the operators were failed to meet benchmarks of network related parameters. They failed to achieve benchmark due to High Block Call Rate, High Drop Call Rate, Low Call Setup Success Rate & Rx Quality Samples. However, the Voice Quality observed was not satisfactory in some Part of North, South and Central Mumbai as shown in respective plots.