

Analysis of the Network Performance of the Telecom Service Providers in Mumbai and Delhi

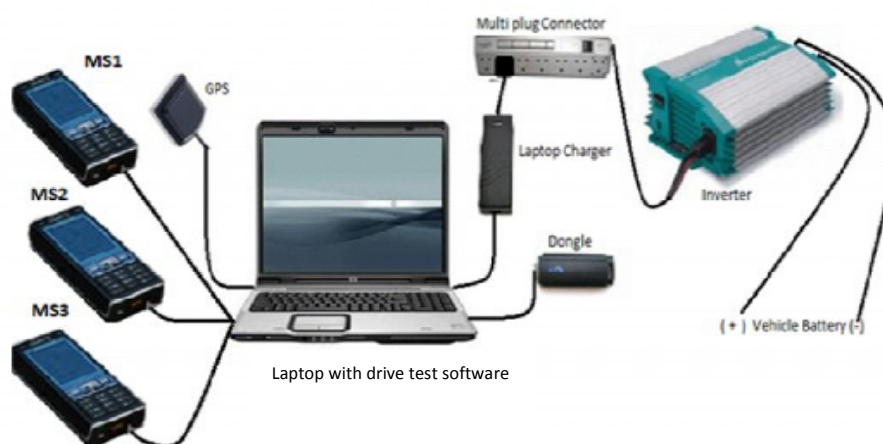
Background

1. TRAI is regularly monitoring the performance of Telecom Service Providers (TSP) against the benchmarks for the various Quality of Service (QoS) parameters laid down by the Authority. TSPs submit Performance Monitoring Reports to TRAI every quarter.
2. TRAI also undertakes audit and assessment of Quality of Service through independent agencies to verify the Quality of Service claimed. The Audit agencies conduct sample 'Drive tests' across various cities all over the country as part of audit and assessment of the TSPs' performance. The audit reports of these agencies are published on the website of TRAI.
3. In view of complaints on call drops and other network issues, on behalf of TRAI, an independent Drive Test (IDT) was conducted by M/s TUV SUD on
 - a. 23rd and 24th June 2015 covering various locations in South and Central Mumbai. The performance of Idea, Airtel, Vodafone, Reliance (GSM), Aircel & Tata (GSM) was monitored;
 - b. 9th to 11th July 2015 covering various locations in South Delhi, Central Delhi and West Delhi. The performance of Idea, Airtel, Vodafone, Reliance (GSM), Aircel & Tata (CDMA) was monitored.
4. A team from the TRAI HQ was present for these Drive tests during these days. For the purpose of these tests, only **2GBTS** were covered.
5. The test results obtained from these drive tests are presented to explain the network condition in terms of Radio Frequency (RF) Coverage; Rx Quality; Accessibility; Retainability; and Carrier to Interference ratio. Of these parameters, performance benchmarks have been prescribed by TRAI or the Licensor for RF Coverage; Rx Quality; Accessibility and Retainability. However, for a comprehensive examination of the network quality, the parameters relating to Carrier over Interference have also been added.

What is a Drive Test?

6. Drive Test is a test performed to evaluate the performance of various cellular networks on predetermined parameters. A Drive test is performance oriented and therefore technology neutral.
7. A Drive test is conducted by driving a vehicle at a steady speed over the selected route. The vehicle carries the testing equipment which measures the key performance indicators (KPI) by repeatedly making calls, establishing the call, recording the quality of connection, measuring dropped calls, etc. in accordance with the predetermined parameters.

8. The Drive test, equipment consists of:
- (i) A laptop computer - or other similar device;
 - (ii) Data collecting software installed on the laptop;
 - (iii) A Security Key - Dongle - common to these types of software;
 - (iv) One mobile phone for each mobile network that is being tested; and
 - (v) One GPS antenna.
9. The following is a schematic diagram of the standard setup used in a Drive test:



10. The test data being collected can be viewed/ analyzed in real time during the Drive test, allowing the auditors the opportunity to view the network performance on the field. Further, the collected data from all data collecting units are also grouped by collection software and stored in one or more output files for post – test evaluation and analysis.

11. The main limitations of a Drive test are that it is based on the data collected at a specific point in time. Also, it shows the network conditions/ performance only along the route covered by the Drive test vehicle. It does not reflect the long term performance of the networks nor does it reflect the network conditions away from the route covered.

Drive Test Route

12. Determining the Drive Test routes is the first and the most important step. The route is defined on the basis of several factors that include - areas from where call drop complaints are commonly received; areas of heavy usage; residential areas away from arterial roads; office areas; areas where previous Drive tests showed network issues; etc.

RF DRIVE TEST IN MUMBAI

23rd AND 24th June 2015

Target Network:

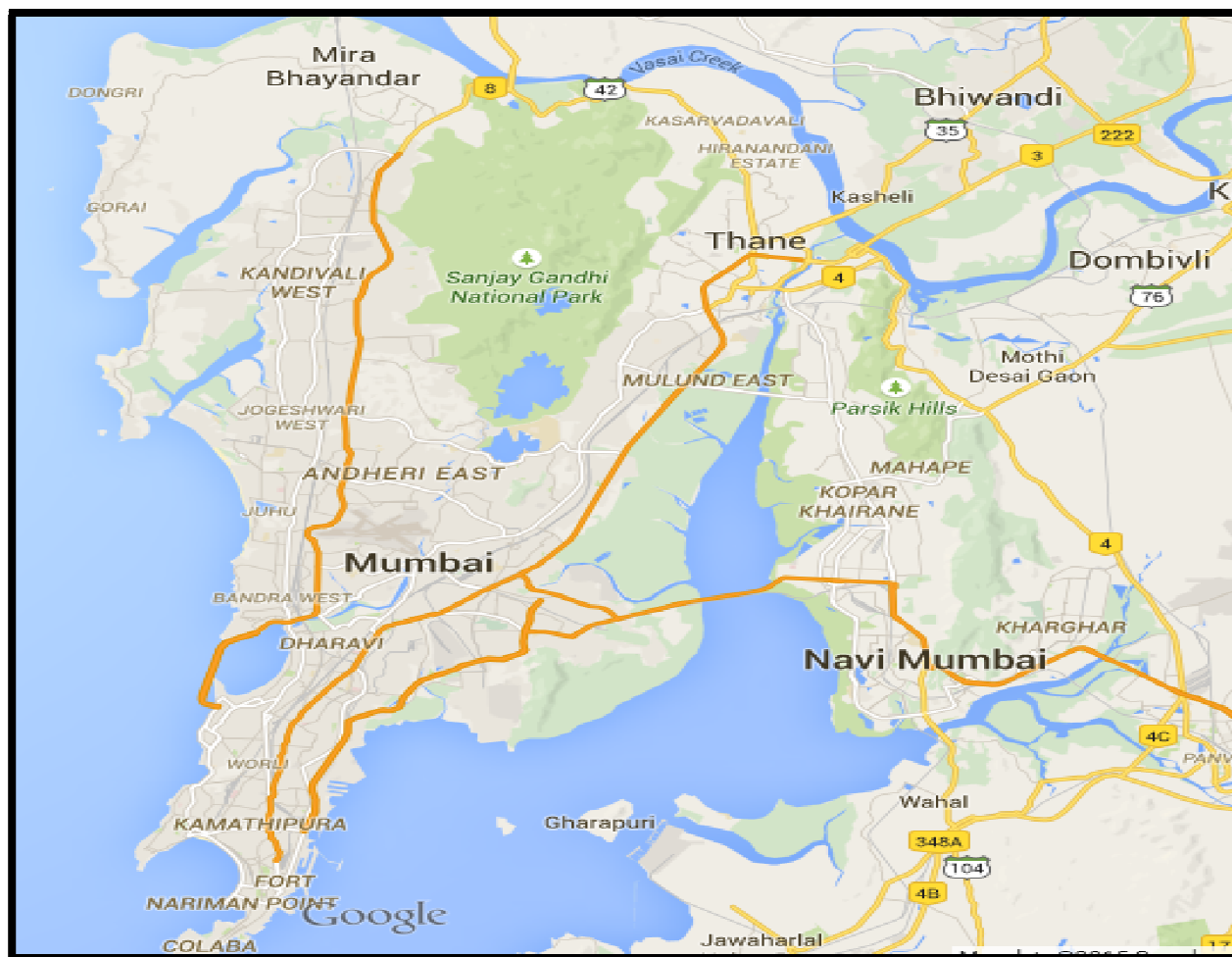
1. The target networks for the IDT were -Idea, Airtel, Vodafone, Reliance (GSM), Aircel &Tata (GSM).

Table 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 below:

Table 2 Mumbai City Map¹



¹<http://maps.google.co.in>

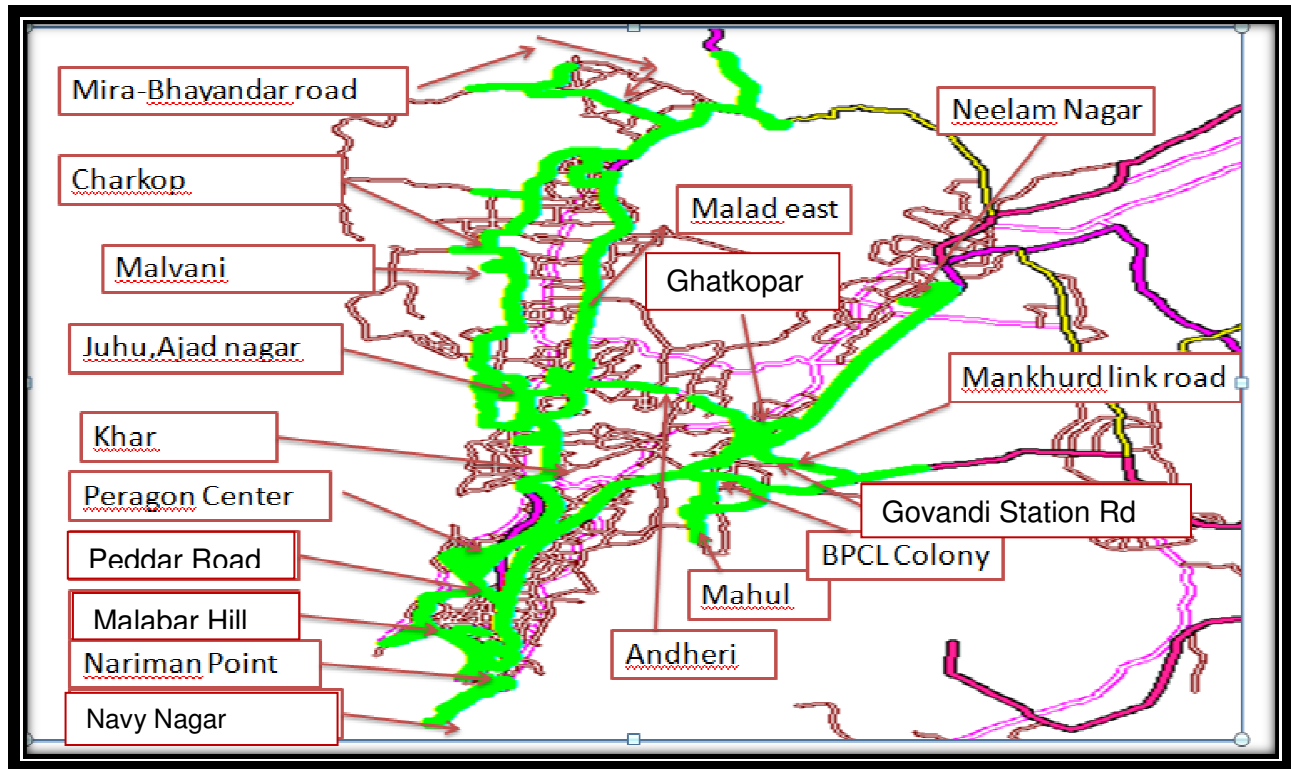
2. The number of BTS count and the subscriber base of the target networks are given below:

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

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

Drive Test Route

3. The total Drive test route covered over the two days was approximately **300 kms**. Major areas covered included **Colaba, Churchgate, Andheri, Malad, Ghatkopar, Lokhandwala & Juhu**. The map below depicts the route that was followed during the Mumbai Drive test.



Drive Test Schedule

4. The test was performed from 0900 hrs. to 1930 hrs. to cover peak and off-peak hours. In all about 3305 calls were made for all the 6 operators.

5. The tests were conducted as Benchmarking tests aimed to compare the performances of the various networks for the same parameters and against the same benchmarks for comparability. The Key Performance Indicators' recorded were RF Coverage (%), Accessibility (%), Retainability(%), Mobility (%), Rx Quality(%), Carrier over Interference(%).

A. RF Coverage rate

6. Radio Frequency (RF) Coverage relates to the geographical footprint within an area that has sufficient RF signal strength to allow for a call/data session. The RF Coverage rate of an operator is calculated on the basis of % of samples in which the receive level (Rx) is better than **-85 dbm** at street level. The test results obtained in Mumbai on the drive test route (approx. 300 km) are as follows:

Operator	Coverage Rate Rx Level 0 to -85dBm	Coverage Rate Rx Level 0 to -95dBm
Aircel	93.63%	99.60%
Airtel	95.13%	99.29%
Idea	95.40%	99.98%
Reliance (GSM)	89.49%	98.54%
Tata(GSM)	97.07%	99.76%
Vodafone	91.08%	98.90%

7. As per the drive test report, the coverage along the selected route of **all the operators** was found to be satisfactory.

B. Accessibility

8. Accessibility is the ability of a user to obtain the requested service from the network.

9. Accessibility is monitored by measuring the Call Setup Success Rate (CSSR). The CSSR is defined as the ratio of Established Calls to number of Call Attempts. When a user "A" initiates a call to user "B" in the same network, a Stand Alone Dedicated Control Channel (SDCCH) is allocated for setting up the call. Once the call is setup, a Traffic Channel (TCH) is allocated for the call. Non availability of control channel or traffic channel will lead to congestion which is measured through the SDCCH congestion and the TCH congestion. The SDCCH congestion and TCH congestion are monitored through the 'Blocked Call rate' parameter in the Drive test.

10. TRAI has laid down the QoS benchmarks for **CSSR >95%; SDCCH congestion at 1% and TCH congestion at 2%** respectively [the **blocked call rate at 3%**]. The test results obtained are as follows:

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

11. As per the drive test report, **none of the operators** have met the prescribed **QoS benchmark for blocked call rate and the performance of two of the operators is found to be very poor.**

C. Retainability

12. Retainability is the ability of a service, once obtained, to continue to be provided under given conditions for a requested duration. During the Drive test, Retainability is measured by making a call from user A to user B and after the call is successfully setup, holding the call for a duration of 90 sec/ 120 sec. If the call drops during this period it is considered to be a dropped call. The Call Drop Rate (CDR) parameter gives a reliable measure of the ability of the mobile network to maintain a call once it has been correctly established. TRAI has laid down the QoS benchmarks for **call drop rate to be less than 2%**. The test results obtained for this parameter are:

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

13. As per the drive test report, **except for one operator, no other operator is meeting the prescribed benchmark.**

14. The specific reason for a call drop in a particular case cannot be determined during the drive test or from the test results themselves. The common reasons attributed for call drops are given below.

- Spectrum related issues such as limited spectrum or unavailability of spectrum;
- Coverage gaps;
- Inadequate capacity in a BTS;
- Interference issues caused by illegal repeaters, private wide band repeaters, and other wireless devices;
- Equipment failure, transmission media fluctuations/ disruptions.

D. Mobility

15. 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 or during 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. A Handover success rate (HOSR) more than 95% is considered to be good. The various operators' performance observed during the Drive Test was:

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

16. As per the drive test report, **all of the operators** are meeting the benchmark.

E. Rx Quality

17. For measuring voice quality, Rx Qual samples on a scale from 0 to 7 for GSM operators are measured. As per the TRAI QoS norms, Rx Qual between 0- 5 for GSM operators is considered to be good, whereas Rx Qual beyond this benchmark is considered to be poor. TRAI has set down the QoS norm requiring connections with good voice quality to be >95%. Accordingly the RxQuality is determined and as can be seen from the table below:

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

18. As per the drive test report, **none of the operators** are meeting the prescribed benchmark.

F. Carrier over Interference (C/I)

19. The carrier-over-interference ratio seeks to test the level of optimisation of the signal strength of a network. It is the ratio between the levels of the signal strength of the current serving cell to that of the signal strength of undesired or interfering signal components. The measurement range extends from 0 dB to 30 dB. A C/I below 4 dB would normally result in a dropped call. The C/I values between 9 and 15 is acceptable; while values between 15 and 30 are considered good.

20. No specific QoS Benchmark has been laid down for C/I. The performance of TSPs is given below:

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

Overall Operator Analysis

21. The results of these Key Performance Indicators is summarised in the table below:-

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

Analysis of the RF drive report

22. The overall performance of the TSPs, as determined by the independent audit agency, is summed up below:

KPI	Aircel	Airtel	Idea	Reliance (GSM)	Tata (GSM)	Vodafone
Call Attempt	550	529	570	575	546	535
Blocked Call Rate (<3%)	4.36%	3.02%	10.00%	31.13%	4.58%	3.93%
Call Setup Success Rate (>=95%)	95.64%	96.98%	90.00%	68.88%	95.425	96.07%
Dropped Call Rate (<=2%)	3.19%	0.97%	5.56%	2.29%	5.51%	4.83%
Rx Quality (0-5) (>=95%)	85.60%	91.11%	86.46%	85.53%	89.50%	89.56%
Handover Success Rate (>=95%)	96.86%	96.74%	97.87%	98.01%	95.40%	97.54%

23. The Drive test results revealed that most of the operators are not meeting the benchmarks of the network related parameters. They failed to achieve the benchmarks due to High Block Call Rate, High Drop Call Rate, Low Call Setup Success Rate & poor Rx Quality. However, as mentioned earlier, this result reflects only the network conditions on the route followed by the Test vehicles and as determined during the day and time of the Drive test.

RF DRIVE TEST IN NEW DELHI

9th to 11th July 2015

Target Network

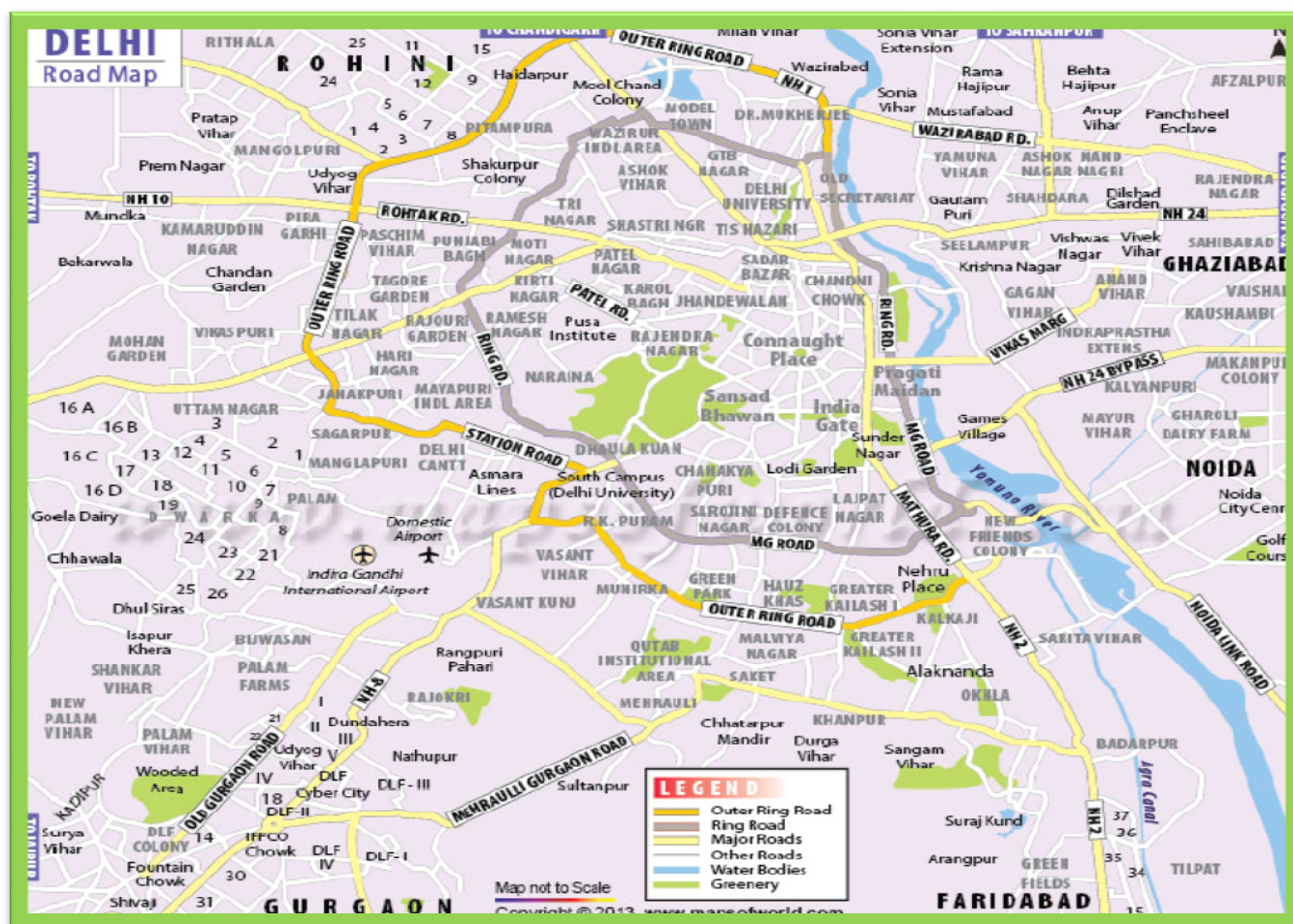
- The target networks for the IDT were- Aircel, Idea, Vodafone, Airtel, Reliance (GSM) and Tata (CDMA)

Table 1 City Demographics

Delhi Circle	Details
Population	1.68 Crores (Census 2011)
Area	1483 Square Km
Population Density	11,320 People per Square Km

Delhi City Map is shown below

Table 2 Delhi City Map²



² www.mapsofworld.com

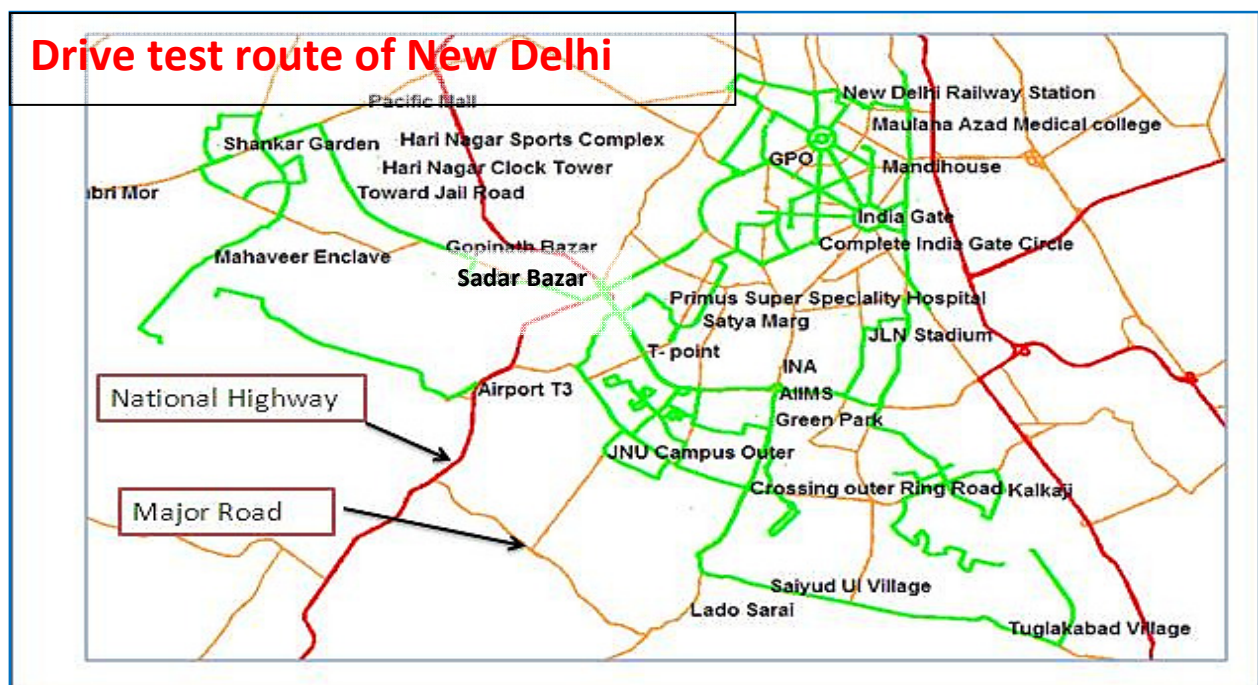
2. The number of BTS count and the subscriber base of the target network are given below:

Operator	Technology	Band (MHz)	BTS Count	Subscribers* (Prepaid + Postpaid)	Subscribers / BTS
Aircel	GSM	1800	3749	5059783	1350
Airtel	GSM	900 & 1800	5988	10395690	1736
Idea	GSM	1800	4804	5930462	1234
Reliance	GSM	1800	2494	5443345	2183
Tata	CDMA	800	1466	2634426	1797
Vodafone	GSM	900 & 1800	6115	9585884	1568

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

Drive Test Route

3. The total Drive test route covered was approximately **300 kms**. Major areas covered included **Connaught Place (CP) inner and outer circle, India gate, Lutyens Zone, Chankyapuri, South Campus, IIT, AIIMS, Delhi Cantt, Delhi Gate, Daryaganj and different parts of South and West Delhi**. The map below depicts the route that was followed during the Delhi Drive test.



Drive Test Schedule

4. The test was performed from 0900 hrs to 2030 hrs, to cover both peak as well as off-peak hours. In all about 3626 calls were made for all the 6 operators.

5. The Key Performance Indicators' recorded were RF Coverage (%), Accessibility (%), Retainability(%), Mobility (%), Rx Quality(%), Carrier over Interference(%) in the Delhi IDT is explained below.

A. RF Coverage rate

6. The test results obtained in Delhi on the drive test route (approx. 300 km) are as follows:

OPERATOR	Coverage Rate [0 to -85dBm]	Coverage Rate [0 to -95dBm]
Aircel	74.32%	96.06%
Airtel	91.26%	99.96%
Idea	87.42%	98.63%
Reliance	57.96%	86.10%
Tata(CDMA)	58.07%	82.12%
Vodafone	87.29%	98.10%

7. As per the drive test report, **the coverage for all the operators except one is poor.**

B. Accessibility

8. The test results obtained are as follows:

Operator	Total Call Attempts	Total Call Success	Total Calls Blocked	Blocked Call Rate (%)	CSSR (%)
Aircel	441	428	14	2.95%	97.05%
Airtel	587	539	44	8.18%	91.82%
Idea	782	578	283	26.09%	73.91%
Reliance	603	540	51	10.45%	89.55%
Tata(CDMA)	723	715	20	1.11%	98.89%
Vodafone	490	467	22	4.69%	95.31%

9. As per the drive test report, **most of the operators have not met the prescribed QoS benchmark for blocked call rate and the performance of three of the operators was found to be very poor.**

C. Retainability

10. The test results obtained for this parameter are:

Operator	Total Calls Established	Total Calls Dropped	Call Drop Rate (%)	Retainability (%)
Aircel	425	22	5.18%	94.82%
Airtel	535	43	8.04%	91.96%
Idea	388	11	2.84%	97.16%
Reliance	538	93	17.29%	82.71%
Tata(CDMA)	714	6	0.84%	99.16%
Vodafone	467	20	4.28%	95.72%

11. As per the drive test report, **except for one operator, none of the operators are meeting the prescribed benchmark.**

D. Mobility

12. The performance of the various operator's observed during the Drive Test was:

Operator	Total HO Attempt	Total HO Success	HO Success Rate%
Aircel	652	638	97.85%
Airtel	1085	1041	95.94%
Idea	1258	1241	98.65%
Reliance	795	770	96.86%
Tata(CDMA)	765	720	94.12%
Vodafone	1368	1288	94.15%

13. As per the drive test report, **two of the operators are not meeting the benchmark.**

E. Rx Quality

14. The Rx Quality for the operators are as shown in the table below:

Operator	Rx Quality Samples (0-5)	Rx Quality Samples (0-7)	Rx Quality Samples (0-5) %
Aircel	481687	582511	82.69%
Airtel	507273	601609	84.32%
Idea	529115	580274	91.12%
Reliance	415370	486637	85.36%
Tata(CDMA)	876877	879742	99.68%
Vodafone	499062	550272	90.67%

15. As per the drive test report, **none of the operators except one operator are meeting the prescribed benchmark.**

F. Carrier over Interference (C/I) ³

16. The performances of TSPs on this parameter is given below:

Operator	C/I Samples	C/I Total Samples	C/I Samples (%)
Aircel	211576	394468	53.64%
Idea	207274	343713	60.30%
Vodafone	210290	357543	58.82%
Airtel	186808	426292	43.82%
Reliance	145012	270320	53.64%
Tata(CDMA)-Ec/Io	841916	1052948	79.96%

Overall Operator Analysis

17. The results of the Key Performance Indicators are summarised in the table below:-

KPI	Aircel	Airtel	Idea	Reliance	Tata (CDMA)	Vodafone
Coverage %	74.32%	91.26%	87.42%	57.96%	58.07%	87.29%
Accessibility %	97.05%	91.82%	73.91%	89.55%	98.89%	95.31%
Retainability %	94.82%	91.96%	97.16%	82.71%	99.16%	95.72%
Mobility %	97.85%	95.94%	98.65%	96.86%	94.12%	94.15%
Rx Quality %	82.69%	84.32%	91.12%	85.36%	99.68%	90.67%
C/I %	53.64%	43.82%	60.30%	53.64%	79.96%	58.82%

³In GSM, the C/I value is measured through samples having more than 15 to 30. In CDMA, it is usually measured as Ec/Io. The Ec/Io is used to measure the forward link coverage performance.

Analysis of the RF drive report

18. The overall performance of the service providers is as given below:

KPI	Aircel	Idea	Vodafone	Airtel	Reliance	Tata (CDMA)
Call Attempt	441	782	490	587	603	723
Blocked Call Rate (> 3%)	3.27%	48.96%	4.71%	8.16%	9.44%	2.80%
Call Setup Success Rate (95%)	94.82%	97.16%	95.72%	91.96%	82.71%	99.16%
Dropped Call Rate (2%)	5.18%	2.84%	4.28%	8.04%	17.29%	0.84%
Rx Quality (0-5) (95%)	82.69%	91.12%	90.67%	84.32%	85.36%	99.68%
Handover Success Rate > 95 %	97.85%	98.65%	94.15%	95.94%	96.86%	94.12%

19. The Drive test results revealed that most of the operators are not meeting the benchmarks of network related parameters. They failed to achieve the benchmarks due to High Block Call Rate, High Drop Call Rate, Low Call Setup Success Rate & poor Rx Quality. However, as mentioned earlier, this result reflects only the network conditions on the route followed by the Test vehicles and as determined during the day and time of the Drive test.

SUMMARY

1. The issue of call drop is regularly taken up by TRAI with the Chief Technology Officers (CTOs) of all the TSPs and certain measures including network optimization discussed. They have been advised to undertake their own Drive tests to effectively optimize their networks. Given the adverse impact of call drops on the consumers, the TSPs were advised to take initiatives and improve their performance, including exploring suitable compensation for call drops.
2. The TSPs have claimed that following are the main reasons contributing to frequent call drops:
 - a. Spectrum related issues such as limited spectrum; delay in allocation of spectrum; reduction in 2G frequency band after the spectrum auction; and major changeover of frequencies within and across the 900 MHz and 1800 MHz bands on the live networks for some TSPs.
 - b. Poor coverage due to non-availability of sites for BTS in some areas; sealing of existing sites; forced closure of existing sites by local bodies. During the last six months around **801 sites (Details at Annexure “A”)** in Mumbai and **523 sites (Details at Annexure “B”)** in Delhi were shut-down due to various reasons (sealing of sites by municipal authorities, RWA, EMF related issues, owner issues). The closure of each site impacts three to four neighbouring sites which could result in increased call drops at such locations.
 - c. EMF radiation issues causing fear in the minds of general public.
 - d. Interference issues caused by illegal repeaters, private wide band repeaters, and other wireless devices installed by individuals.
3. During the last one and half years the independent auditors appointed by TRAI have conducted around 400 RF drive tests, each covering about 300 route Kms, totalling in excess of about 1.2 lakh route Kms. Thus, all the states of the country have been covered by at least one RF Drive Test. Based on these tests the TSPs are being/ have been instructed to take necessary action to improve coverage/quality in the identified affected areas.
4. TRAI is evaluating the need for a consultation paper on ‘Regulatory Framework on Call Drops’, based on available information and facts, discussions with TSPs, independent RF drive tests, international best practices and other related issues.
