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GSM Network Optimization Technique in Urban Area

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Abstract

The increasing demand of wireless network leads to poor quality and coverage unbalance. Optimization helps in balancing and smooth operation of network, improving quality and coverage. Optimization is the process of optimal use of radio resources, maintaining the network quality and grade of services by analyzing, the report generated from drive test and key performance indicators from network management system. Pre drive test, analyzing pre drive reports and post drive test are done for optimization. Physical optimization of GSM network enhance quality by 14% and found optimization cannot be generalized to single solution. Every case has different solution to be handled distinctly. After swapping antenna cables, azimuth and tilt adjustment, defining neighbors and retune of BCCH channel quality and grade of service is maintained. Improvement in network quality is possible only when proper optimization is carried out.

Keywords: *GSM, Network planning, optimization, Drive test, KPI, Signal Level, Signal Quality, Overshooting*

1. Introduction

Deployed planned network must be tuned for proper operation. In order to maintain customers' requirement, business flow and ensure growth of the company competing with their rivals, it is the main duty of mobile operators to retain their networks by continuous monitoring and optimizing. Optimization is the process of deployed management network which helps to check the present network condition by extracting various statistical reports from drive test and OSS. To ensure the expanded growing demands of users, the network can be enhanced to support the new users. Thus, the optimization plays a major role in troubleshooting of the network [1 - 3].

Service rendered by the operator is voice and data, where voice is used for communication and data is used for updating with the world. While designing of GMS network, RF planner considers all required parameters to comply quality services, for their valuable customers. These planning parameters are calculation of sites number, cell radius, azimuth planning, tilt, frequency, capacity, neighbor and other network related parameters. Though planned

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network is deployed, customers still experience network issues where continuous complain is received. These network related issues encountered by users are low quality, low signal level, scatter signal, overshooting, interference, handover failure, call drop and many more. These all issues cannot be resolved by changing values in BSC. Furthermore, it is difficult to identify main problems in particular area without visiting to the site. For this, Network optimization is to be carried out. Field drive test is the optimal solution for identifying network related issues in particular area. Analyzing the data received from drive test, can clearly identify the actual problems in network. Rectifying those issues received from pre-drive test can again be verified through post-drive test. Therefore, network related issues are managed by optimization process.

Consequently, the real challenge is how to carry out a proper network optimization to resolve the network problems and improve the end users satisfaction rate, with the good quality and grade of service (GoS).

2. NETWORK OPTIMIZATION

The large number of variables available are for network parameters in the process of network optimization. It impacts different aspect of network performance. As continuous repetition is required this activity is time consuming. The process involves the use of various methods to maximize the system performance by optimally configuring the network and utilizing its resources. To simplify optimization process some working plans and methods are required [6, 7].

In this study, the following methods are adopted to achieve our goal:

- Grouping of Sites in cluster
- Defining Drive routes
- Defining some algorithm for drive test
- Pre swap drive test
- Collecting log files
- Analysis of log files
- Implementing findings after report analysis
- Post swap drive test
- Post swap drive test analysis and recommendation/ customers feedback

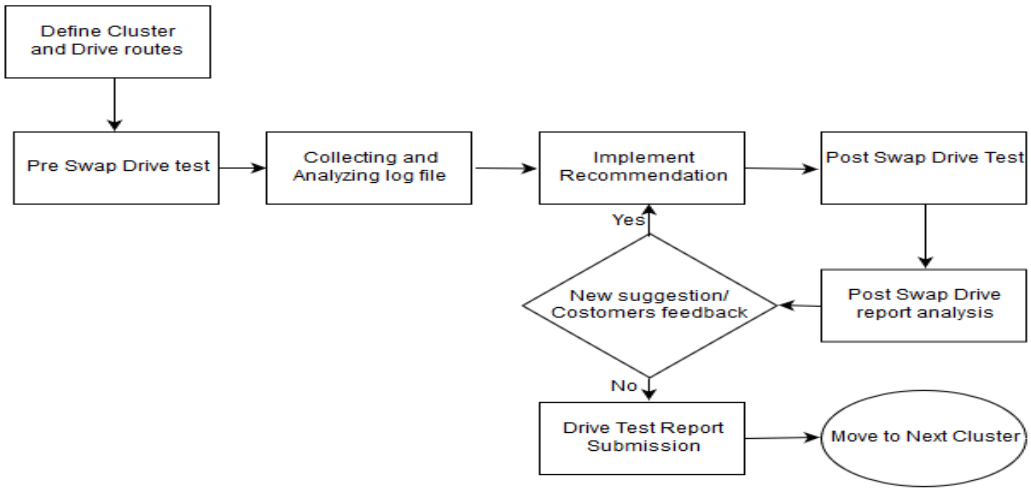


Figure 1. Network Optimization Flow chart

3. Study of Smart Telecom Network in Kathmandu valley

Pre and Post drive test was performed for network optimization in Kathmandu valley. In Kathmandu, there are 210 sites so it is better to perform drive test based on cluster. Sites are grouped into four different clusters and routes for each cluster were defined to perform drive test. One of the cluster is considered for discussion and optimization in this study. Optimization activities was carried out on May 2018. Drive routes are defined for pre swap drive test considering main roads, side roads. Inner Streets were not considered because vehicle was not possible to enter those streets. For those inner streets and inside the commercial buildings, pocket TEMS are recommended for drive test where application is installed in handset and all required information is recorded in handset, which can be analyzed afterward. During drive, some of the BTS were down due to power and transmission issue, other issues like suddenly shutdown of laptop, slow response of software and crash of it causes repetition of drive test. Furthermore, high road traffic and construction of road delayed in drive test, resulting slow optimization activity. After performing drive test of this cluster, all the log files received from pre swap drive test are analyzed through Actix Analyzer tool [4]. Different findings and optimization activities were implemented in this cluster.

Overall quality for this cluster was improved by re-aligning antennas, changing tilt, and removing swap, resetting malfunctioning of sectors, changing broadcast channels and removing overshooting. Figure 2 and Figure 3 shows that the quality has been improved in the drive route.

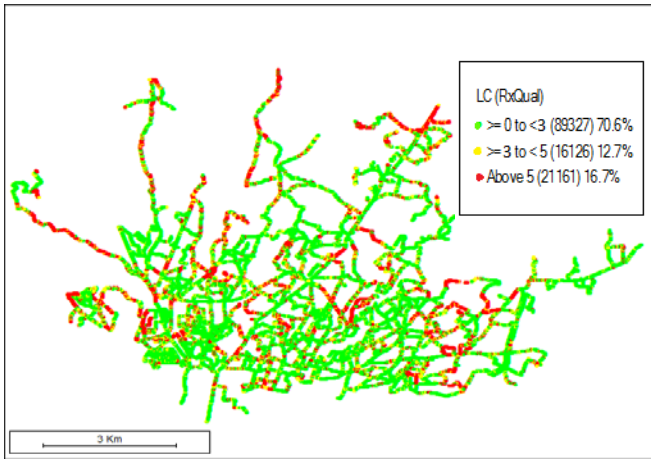


Figure 2. Pre drive Rx Quality for dedicated mode

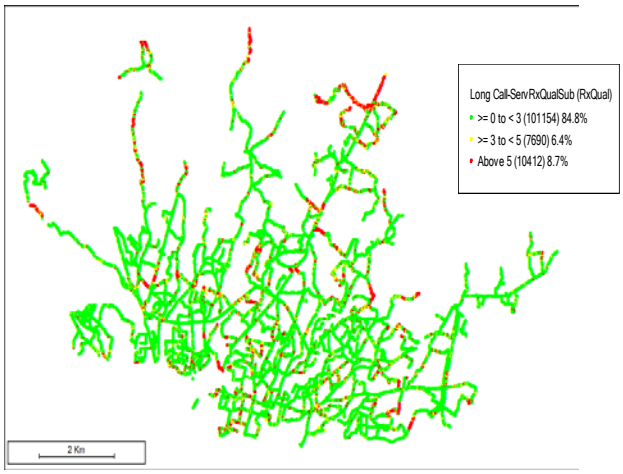


Figure 3. Post drive Rx quality for dedicated mode

Table 1. No. of samples of quality for pre and post drive

Rx Quality	Pre drive No. of sample	Post Drive No. of sample	Pre Drive Rate(%)	Post Drive Rate(%)
>=0 to <2	89327	101154	70.6	84.8
>=3 to <5	16126	7690	12.7	6.4
Above 5	21161	10412	16.7	8.7

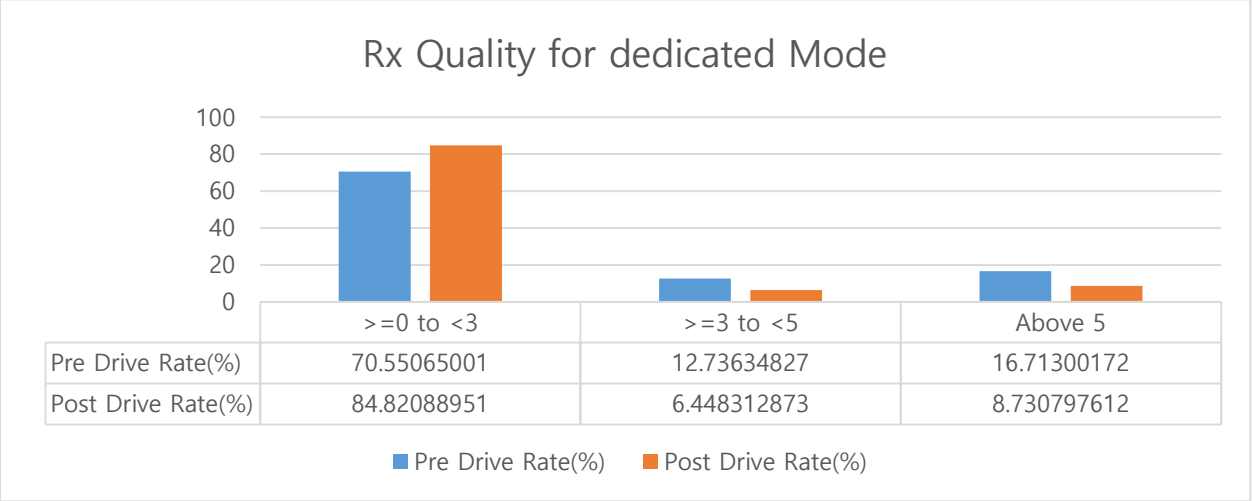


Figure 4. Rate Comparison of pre and post drive for Rx quality

Receiving quality in GSM network is an integer value between 0 to 7 where 0 represents the best quality and value 7 represents the worst quality. Value between 0 to less than 3 is considered to be good quality and from 3 to less than 5 is acceptable quality whereas above 5 quality is poor and should be maintained. As shown in Figure 4 receiving quality has been increased by 14% between 0 to less than 3, and above 3, quality has been reduced by 50%. This means, there is highly improvement in quality after optimization. This is only possible after performing pre-drive test, analyzing of each case individually and conducting post-drive test. Signal level and data throughput was also improved after optimization.

4. Results and Discussion

The major focus of this study was to get higher optimization from installed BTS, so that the users of this network would get better Quality of services. Furthermore, optimization activities helped in reducing the number of new BTS by changing physical parameters in site or logical parameters in BSC level. Drive test was done in one of the cluster of Smart Telecom network where 54 BTS were considered and we observed different cases of network issues which were:

- Poor signal level
- Poor signal quality
- Sector swap
- Overshooting
- Interfering BCCH
- Missing neighbors
- Scattered signal
- Null zone

Network issues were rectified by adjusting Azimuth, Mechanical and electrical tilt, adding neighbors, swapping sectors cables, changing BCCH frequency in interfering zone, in addition with proposing new BTS in low signal, low quality, null zone, scatter signal and overshooting signals. New BTS was proposed only after post drive test

task but still couldn't meet the network requirements.

The cases of optimization found, it cannot be generalized to one particular solution since issues are not common and each issue should be handled by different approach. Moreover, optimization is not the process of doing once but needed to be repeated time and again. Only then, the actual problems could be identified and could be resolved appropriately. As a result of improper optimization, it may lead to poor quality of services. This might have negative impact on services provided to customers, leading customers to switch on other operators and ultimately decrease in market share. Also, BTS number will get increased to fulfill the network issue area if optimization is not carried out properly. Thus, optimization should be done properly for prevention of new sites misleading plans.

Post-drive test report presented in table 2 explains the average received signal level which is lowered by 1.5 dbm and is acceptable because there is no degradation but improvement in quality. Location update is also enhanced. Drop call and Handover success rate are improved whereas, call setup does not depict the same success rate. Call setup success rate was unable to progress because of block calls in the area with low signal level and null zone. Hence, to improve CSSR or to nullify block call we proposed new sites in those considering locations. Total 17 new sites were proposed after analyzing and optimizing the drive test report as mentioned in cluster details in table 3.

Table 1. Key performance Indicators comparison

2G voice parameters	Pre-DT	Post-DT
Average Signal Level(Dedicated Mode)dBm	-60.3	-61.8
Average Signal Quality	1.2	0.8
Location Update attempt success	25	23
Location Update attempt fail	5	2
Call Attempt	1156	1087
Call Established	1102	1044
Number of Blocks	54	43
Dropped Call	24	8
Handover Attempt	992	832
Handover Complete	952	816
Handover Failure	40	16

Table 3. New proposed site location in cluster 1

SITE ID	Latitude	Longitude	SITE ID	Latitude	Longitude
STKTM1416	27.7211	85.3709	STKTM1425	27.7143	85.3382
STKTM1417	27.7265	85.3676	STKTM1426	27.7304	85.3326
STKTM1418	27.7235	85.3247	STKTM1427	27.7373	85.3402
STKTM1419	27.746	85.3422	STKTM1428	27.7443	85.2968
STKTM1420	27.7417	85.3265	STKTM1429	27.7389	85.3128
STKTM1421	27.7341	85.3106	STKTM1430	27.7526	85.3198
STKTM1422	27.767	85.2998	STKTM1431	27.745	85.3103
STKTM1423	27.7382	85.3599	STKTM1432	27.7354	85.3242
STKTM1424	27.7146	85.3265			

In urban area like Kathmandu, distribution of cluster is not uniform; the height and materials used for

construction varies from building to building due to which, radio frequency penetration losses also differentiate from location to location. As compared to the signal received inside concrete building is lesser than in non-concrete bricks wall. Similarly, width of the road varies from place to place so does the signal level. We have noted that signal received in inner corner of building street area is low as compared to the area having wider roads. This indicates high path loss in narrow roads than in wider roads due to path blockade. Operators have tried optimizing such problematic area by initiating nearby sites but result were not as desired. To overcome such situation, operators are deploying new sites in those where received signal levels are way too low. Indoor coverage in hospital and commercial buildings was also found as poor. Operators are still lacking in providing good services inside commercials building.

Site location and height of tower were not uniformly distributed as of network planning because of inappropriate location for construction of sites. Also tower height was not as of planned due to diverse building height. These resulted in non-uniform signal distribution and null zone. For this reason quality issues were seen in urban area like Kathmandu.

Human errors and tower fabrications also resulted in poor QoS. These errors were seen due to improper installation of GSM antenna and unplanned installation of azimuths angle. There were 15 to 30 degree deviations, resulting change in coverage zone. Mechanical and electrical tilt of antenna did not match with planned data due to which coverage area was fluctuated resulting poor quality. Some of the BTS tower was not perpendicular to base because of fabrication error. These tilts in tower or antenna boom causes tilt in antenna which may bring change in coverage area with the change in QoS.

Improper neighbor relation and overshooting by same BCCH have caused issues in network quality. Optimization helped in identifying such physical and quality issues throughout pre-drive test and was also rectified respective issues before post-drive test. Thus, planning, installation, commissioning, operation and optimization team should work effectively as a crew to maintain Quality of service.

5. Conclusion

GSM network optimization is a challenging and continuous process for maintaining quality of network. Due to wave propagation complexity, changing cluster size and mobility of users, the quality of network degrades. Drive test was done to improve network performance and quality of network using the existing resources. Drive test identified the area of low signal strength, poor quality, handover failure of call, overshooting of signals, null zones and interference, overlapping and dropped signals. These issues were greatly improved with the balance in network achieved from all aspects after optimization. Furthermore, this study also incorporates about the antenna alignment and tilt, which helps planner to predict the actual signal penetration in defined area. The KPI's network can be maintained by Quality enhancement of GSM network which is achieved through optimization process. This study concludes that management of RF signal can be done through optimization. Beside this, drive testing for GSM network helped to identify null zone and the location of required BTS. Therefore, to build a quality network, optimization must be done. Increasing area of settlement and population in urban area, hence, optimization must be carried out continuously to monitor the network status and retain costumers' requirements due to increased population and settlement in urban area.

According to this study, Optimization can again be carried out after deployment of proposed sites. Furthermore, Self-organizing network (SON) is the automatic network management system where different parameters of network are adjusted according to its requirement. Therefore, it is recommended to deploy self-organizing network (SON) for the better performance of cellular network. Likewise, I would recommend of using Picocell inside commercial and public buildings.

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