MNK Publication

International Journal of Latest Research in Science and Technology **ISSN (Online):2278-5299**
Volume 3, Issue 3: Page No. 35-39. May-June 2014
https://www.mnkpublication.com/journal/ijlrst/index.php

RADIO RESOURCE OPTIMIZATION OF A GSM NETWORK USING ACTIX ANALYZER SERVICE VERIFICATION SOLUTION

I. H. Usman [1], A.A.Garba[2], A.M Shehu[3]
[1, 2]Electrical and Electronic Engineering Technology Department
School of Engineering, Federal Polytechnic Bauchi, P. M. B. 0231 Bauchi-Nigeria.
[3] Electrical Department, School of Engineering Technology Federal Polytechnic Bida, P.M.B 055, Niger-Nigeria

Abstract - : ***Radio Resource optimization on the three sectors (A, B, and C) of a BTS belonging to ZTE ZXG-10 BSS system was carried out adopting Ajay (2004) processes. The preprocessing raw data was obtained through the use of Ericsson TEMs Phones incorporated with GPS tool for location updates during the Drive Test (DT). The post-processing of the DT data was done by Actix Analyzer Service Verification Solution tool. The result showed a significant mobile service degradation experienced by the BTS with cell identity (cellID) number 93. The BTS experienced severe call drop rate, poor call success rate, event handover failures and poor traffic streams. The BTS sectors were optimized by parameter tuning of the RxLev to -69dBm, -73dBm and -79dBm while the RxQual to values of 0, 1, and 2 for the sectors A, B and C respectively. A repeat of DT along the service coverage area of the BTS of cellID number 93 yielded an optimized result with no single call drop recorded.***

***Keywords* - :** BTS, ZTE, ZXG-10, BSS, DT, RxLev, RxQual.

I. INTRODUCTION

The Global Systems for Mobile Communications' (GSM) business model has been changing since after it was launched in 2001 in Nigeria. Competition for subscribers amongst network operators becomes fierce. Subscribers have their choices than ever before which wireless service to use. Therefore, the mobile phone network operators strive to maximize the capacity and quality of their networks in order to ensure customer satisfaction which increases their revenue collection profile. Consequently, the need to collect and analyze network's Key Performance Indicators (KPIs) becomes inevitable. The analyzed result would then be used for the network optimization.

The Actix Analyzer Service Verification Solution is one of the most commonly used tools for GSM networks optimization. It is a post-processing tool that supports a wide variety of mobile data file formats obtained from drive test collection tools (using Ericsson TEMS, Nemo TOM, Comarco baseline, Ascom Q-voice, etc), OMC-R traffic record traces (using Ericsson MTR, Nokia online) and protocols analyzers on the A, Abis, Gb interfaces for GSM/GPRS (using Tektronix K1205, Ocean, Nethawk). The analyzer has many other important features like the easy–to-understand window interface which facilitates user interactions and the ability to interface with the Excel application allows statistical analysis of any data set, Actix (2005).

This paper presents a practical radio resource optimization carried out by one of the mobile network operators currently in Nigeria using Actix Analyzer tool on ZXG-10 BSS system. The ZXG-10 BSS is a ZTE- made Base Station Subsystem comprises of the Base Station Controller (BSC) having the Operation and Maintenance Center for Radio resource management (OMC-R) and the Base Transceiver Station (BTS) having sectors that interact with the Mobile Subscribers (MS), ZTE (2004). The OMC-R provides many platforms for the management of the entire BSS system including parameter tuning and configuration during optimization of various radio resource elements.

The rest of the paper is organized as follows:

Subsection 1.1 gives a general overview of radio wave propagation principles while Subsection 1.2 deals with threshold operational guides for ZXG-10 BSS system. Section 2.0 describes the methodology and Section 3.0 offers the results and discussion. Section 4.0 finally concludes the paper.

1.1 Radio Wave Propagation Principles

In GSM technology, radio frequencies are employed in signal transmission. To this end, understanding radio wave propagation principle is inevitable. Radio wave is an electromagnetic wave defined between the frequencies of 0.001 and 10^{16} Hz. The operating band for GSM 900, for example, is 890-915 MH_Z (uplink) and 935-960MH_Z (Downlink).The bandwidth is 25MH_Z and carrier spacing of 0.2 MH_Z. This entails that only 124 carriers are available for particular Mobile Country Code (MCC), Dunlop and Smith (1998). The network operators must share these frequency carriers. This poses a practical problem in terms of spectrum utilization and capacity demand. Frequency re-use theory should come in force. However to ensure good call quality, optimal frequency planning has to be implemented. Also, for smooth hand over and call distribution, accurate neighbouring topologies are to be ensured.

Publication History

Manuscript Received	:	*24 June 2014*
Manuscript Accepted	:	*27 June 2014*
Revision Received	:	*29 June 2014*
Manuscript Published	:	*30 June 2014*

From the wave propagation point of view, a radio wave suffers attenuation (or fading) during its journey in free space. The amount of power received at any point in space is inversely proportional to the distance covered by the signal. This can be understood by using the concept of an isotropic antenna (a hypothetical source radiating power in equal direction). As the power is radiated equally, it is assumed that a sphere of power is formed as shown in Figure 1

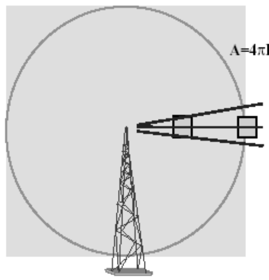

Figure 1: Isotropic Antenna.

The surface area of power sphere (A) $= 4\pi R^2$ ---1

Power density (S) at any distance R from the transmitting antenna is given as:

$$S = P_t * \frac{G}{A} \quad (w/m^2)$$ ---2

Where Pt = transmitted power (watts), G = the gain of the antenna (numeric), A = the surface area (m^2).

Thus, the power received, P_r, at a distance R is;

$$P_r = P_t \, G_t \, G_r * \left(\frac{\lambda}{4\pi R}\right)^2$$ ---3

Where G_t, G_r (numeric) = gains of receiving and transmitting antenna,

λ = wavelength (m)

Converting equation 3 to decibel,

$$P_r = P_t\,(dB) + G_t\,(dB) + G_r\,(dB) + 20log\,(X) - 20log\,R$$
--- 4

Where,

$X = \lambda / (4\pi)$ and

$P_t\,(dB) + G_t\,(dB) = effective\ isotropic\ radiated\ power\ (EIRP).$

$$20log\left[\frac{\lambda}{4\pi}\right] - 20log\,R - Free\ Space\ Loss\ (LdB)$$
---5

Simplifying equation 5 and putting R=d,

$$Free\ Space\ Loss\ (LdB) = 92.5 + 20logf + 20log\,(d)$$
---6

Where *f* = frequency (GHz), *d* = distance (Km)

Equation 6 gives the signal power loss that takes place from the transmitting antenna Base Transceiver Station (BTS)/Mobile Subscriber (MS) to the receiving antenna MS/BTS accordingly, Ajay (2004).

In practical situations, propagation of radio signal depends heavily on its frequency and obstacles in its path. Some of the major effects on signal behaviour are reflection and multipath, diffraction, foliage loss, and propagation over water surface and so on. As a matter of fact, the nature of the point of incidence on an obstacle determines whether a signal can be reflected, refracted, diffracted or absorbed. The nature is in form of smoothness or roughness of that point which could be determined by employing the Rayleigh and Fraunhofer criteria, Rappaport (2002).

1.2 Threshold Operational Guides for ZXG10-BSS System

The ZTE (2003) clearly explained the different scenarios for the threshold values of parameters used in the ZXG-10 BSS system. For the purpose of this paper, only events having to do with power and handover controls are discussed.

2.1 Power Control

The purpose of power control is to lower interference within a cell, save power and to guarantee call/data transmission quality. ZTE (2003) gave detailed MS power control strategy as shown in Table 1 and also gave the relationship between RxQual and Bit Error Rate (BER), the value range of downlink RxLev and RxQual Thresholds as in Tables 2, 3 and 4 respectively.

Table 1: MS Power Control Strategy

Normal Level: LEVECAUSE = 0 Low Level: LEVELCAUSE = 1 High Level: LEVECAUSE = 2	Normal BER: QUALCAUSE = 0 Low BER: QUALCAUSE = 1 High BER: QUALCAUSE = 2	
0	2	INCREASE
1	0	STAY
1	1	STAY
1	2	INCREASE
2	0	DECREASE
2	1	DECREASE
2	2	INCREASE

Table 2: Relationship between RXQual and BER

RXQUAL	BER (%)	Typical(%)
0	BER<0.2	0.14
1	0.2<BER<0.4	0.28
2	0.4<BER<0.8	0.57
3	0.8<BER<1.6	1.13
4	1.6<BER<3.2	2.26
5	3.2 <BER<6.4	4.53
6	6.4<BER<12.8	9.05
7	12.8<BER	18.10

Table 3: *Value Range of Downlink RxQual Threshold*

Value	Power level (RxLev in dBm)
0	< -110
1	-110 to -109
2	-109 to -108
⋮	⋮
61	-50 to -49
62	-49 to -48
63	> -48

Table 4: *Value Range of Downlink RxQual Threshold*

Value	Quality Level	Meaning
0	0	BER<0.2%
1	1	0.2%<BER<0.4%
2	2	0.4%<BER<0.8%
⋮	⋮	⋮
6	6	6.4%<BER<12.8%
7	7	12.8%<BER

The following steps summarize BTS power control strategy;

- Keep current transmission power when received level is normal.
- Lower the transmission power when received level is high.
- Increase the transmission power when received level (Rx Level) is low.
- Keep current transmission power when BER is normal.
- Increase the transmission power when BER is high.
- Lower the transmission power when BER is low

1.2.2 Handover Control

This is a process that transfers an MS that is setting up or in a busy state is assigned to a new traffic channel under the following condition:

- A busy MS which is moving from a cell into another
- An MS making a call over an over- lapping area of two cells, one of which is very busy.

The causes of handover are:-

- ❖ Weak signal level (RxLev), for example, something less than -110 dBm.
- ❖ Bad signal quality (RxQual), for example, something greater than 7 (BER of about 0.128)
- ❖ Severe interference.

Tables 3 and 4 could be used as reference thresholds.

2.0 Methodology

The radio resource optimization of ZXG-10 BSS system was realized by implementation of the processes shown in Figure 4, Ajay (2004).

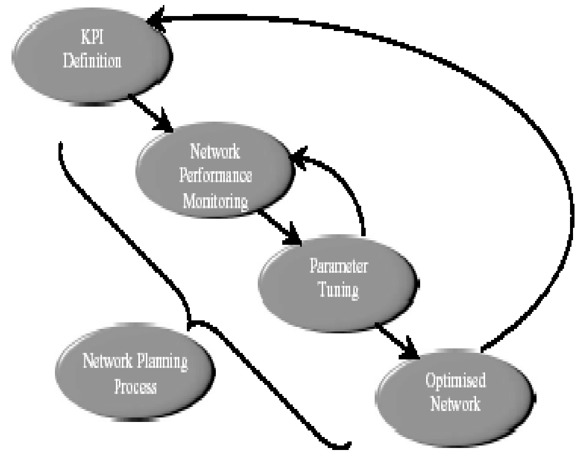

Figure 4: Radio Network Optimization Processes.

The KPIs are parameters that are closely observed during network monitoring process. They are defined as key performance indicators of a network. Examples of KPIs for GSM system are Call Success Rate, Call Drop Rate, Handover-Success Rate and so on**.** They are obtained through Drive Tests (DT) or directly from the online Network Management System (OMC-R). Drive Tests (DT) were conducted in some selected areas. Sites and cells were clearly identified by their identification codes called the Site ID and Cell ID.

The detail Site/Cell data configuration is usually called the CellRefs. DT involved driving at very low speed along the path of interest, while at the same time placing and monitoring of calls by the Ericsson TEMS phones integrated with Global Positioning system (GPS) for location updates. The raw data obtained was stored for post-processing action using the Actix Analyzer during which the KPIs were diagnosed and compared with their thresholds settings. Their results or values would then determine whether to be modified or not. The optimization process was completed by parameter tuning of the corrected KPIs. This was done on the dedicated OMC-R terminal through the Configuration Management Interface.

3.0 Results and Discussion

The flexibility of Actix Analyzer in post-processing of raw data and the different ways of result presentation offer it a very indispensable tool to network optimization Engineers. The results obtained in terms of RxLev, RxQual, event handover failure rate and event call dropped rate, differentiated by colours, are shown in Figure 5 while the DT paths along with RxQual, also in different colours, is shown in Figure 6. The results for these KPIs except handover failure rate are shown in Table 5.

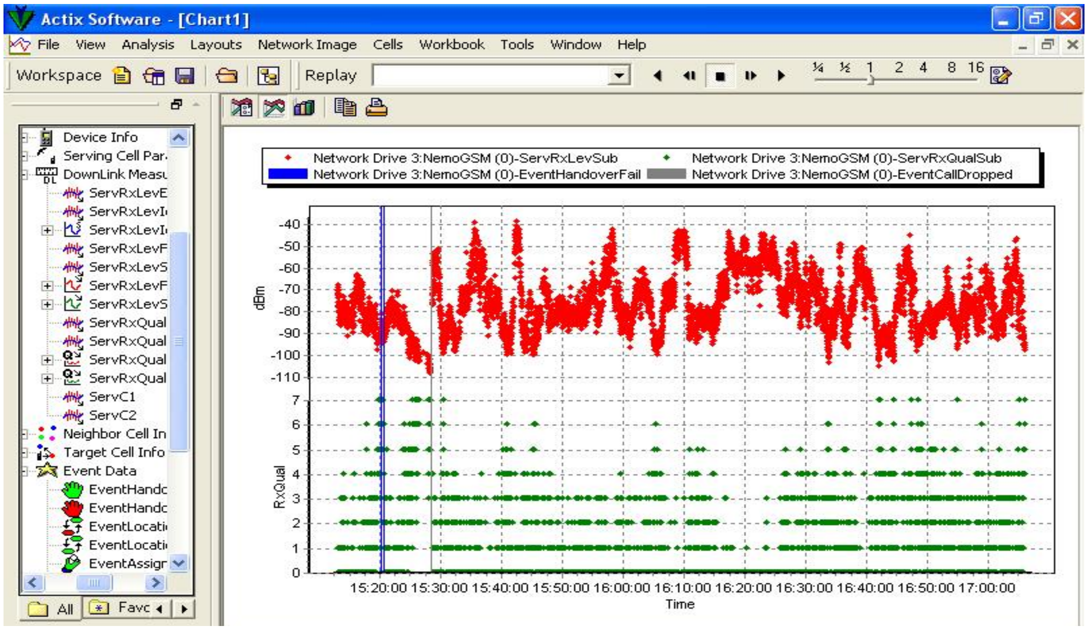

***Figure 5:** RxLev, RxQual, Event Handover Failure Rate and Event Call Dropped Rate Results*

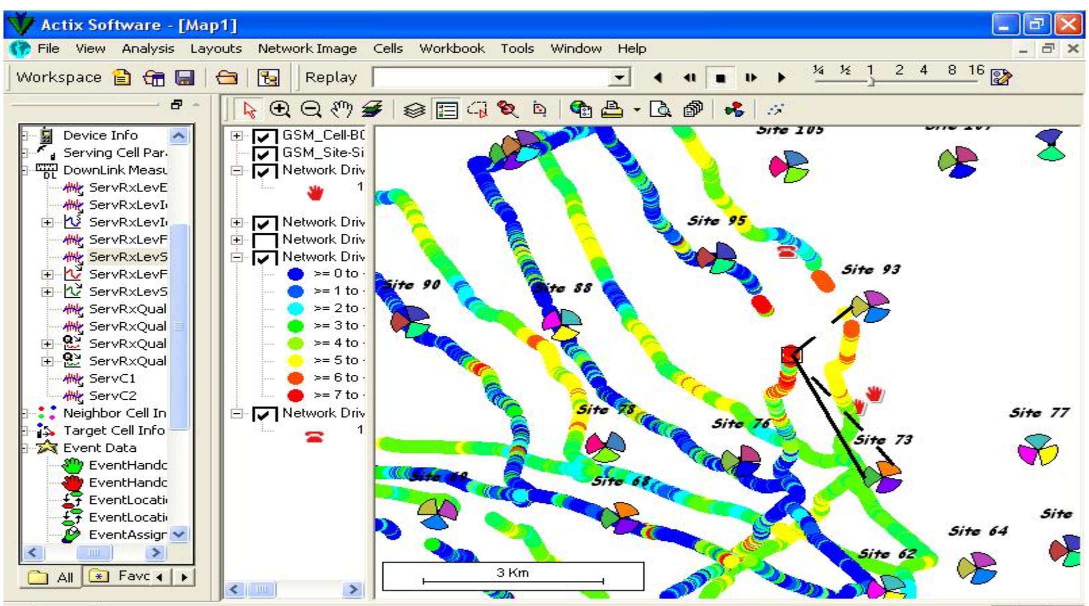

***Figure 6:** Drive Test Map showing Movement Paths and RxQual in colours*

***Table 5**: RxLev, RxQual, and Event Call Dropped Rate Results*

ServingCellID (last valid value)	ServingSectorID (last valid value)	Mean SerRxLevsub	Mean RxQualSub	# Dropped Calls
Site 105	A	-65	0	0
Site 105	B	-79	1	0
Site 105	C	-87	1	0
Site 107	A	-82	1	0
Site 107	B	-82	0	0
Site 107	C	-62	0	0
Site 109	A	-72	1	0
Site 109	B	-86	1	0
Site 109	C	-68	1	0
Site 110	B	-69	1	0
Site 110	C	-73	1	0
Site 115	A	-70	1	0
Site 115	B	-76	0	0
Site 115	C	-75	0	0
Site 60	A	-96	2	0
Site 60	C	-90	1	0
Site 60	A	-95	4	0
Site 73	A	-84	3	1
Site 73	B	-73	0	0
Site 73	C	-83	2	0
Site 76	A	-78	0	0
Site 76	B	-81	0	0
Site 76	C	-88	1	0
Site 93	A	-109	6	20
Site 93	B	-102	7	15
Site 93	C	-99	5	06

3.1 Discussion

By observation of the processed DT data by the Actix optimization software tools, the results in Figures 5, 6 and Table 5 showed a significant mobile service degradation experienced by the BTS with cell identity (cellID) number 93. All the BTS's Sectors A, B and C suffered from a very low received power level (RxLev) as experienced by the MS having values of -109, -102, and -99 dBm respectively. Also, coupling with the different types of interferences, the signal qualities (RxQualities) were too poor signifying high BER of a value greater than 3.2 having RxQual values of 6, 7 and 5 respectively. With these results, this BTS experienced severe call drop rate, poor call success rate, event handover failures, poor traffic streams and so on. The BTS sectors were optimized by parameter tuning of the RxLev to -69dBm, -73dBm and -79dBm while the RxQual to values of 0, 1, and 2 for the sectors A, B and C respectively. The parameter tuning was done through the dedicated OMC-R under the system configuration management. A repeat of DT along the service coverage area of the BTS of cellID number 93 yielded an optimized result shown in Table 6 with no single call drop recorded.

***Table 6:** Optimized Radio Resource for BTS CellID 93*

ServingCellID (last valid value)	ServingSectorID (last valid value)	Mean SerRxLevsub	Mean RxQualSub	# Dropped Calls
Site 93	A	-69	0	0
Site 93	B	-73	1	0
Site 93	C	-78	2	0
Site 95	A	-76	1	0
Site 95	B	-85	3	1
Site 95	C	-70	1	0

4.0 CONCLUSION

With the help of the Actix Service Verification Solution software tool which has the ability to support and process a variety of mobile network data file's formats obtained from different sources, the sectors of the BTS with CellID 93 of a current network operator in Nigeria were optimized from the raw data of DT carried out in Bauchi Town Metropolis. The radio resource optimization was observed to have enhanced the call success rate, handover success rate and high traffic streams values.

References

[1] Actix International Limited (2005). **Introduction to SVS for GSM 1.3.** Edition B, 90 High Holborn, London, UK

[2] Ajay R.M. (2004). **Fundamentals of Cellular Network Planning and Optimisation.** John Wiley and Sons Ltd, West Sussex, England, UK. Pp 19-53.

[3] Dunlop J. and Smith D.G. (1998). **Telecommunication Engineering.** Third Edition, Stanley Thornes Publishers Ltd, Wellington Street, UK.

[4] Rappaport, T.S. (2002), **Wireless Communications, Principles and Practice**. Prentice Hall Inc.

[5] ZTE Corporation (2003). **ZXG-10 Base Station Subsystem Man-Machine Interface Manual.** ZTE Plaza, Shenzhen, China.