Self-Organizing Network Using The Reference Signal Received Power Measurement In Cellular Network

Ituabhor Odesanya, Kingsley Eghonghon Ukhurebor

Abstract: In mobile cellular network, coverage estimation and network optimization are important parts of the operation and maintenance procedures. These operations and maintenance procedures mainly rely on the Reference Signal Received Power (RSRP) measurements which are collected from the mobile cellular operators' site in/for any given area or region. In this study the measurements were recorded by a professional receiver with appropriate software and license in Benin City, Edo State, Southern Nigeria. In reducing the number of errors by the mobile cellular operators so as to effectively enhance the quality of service (QoS), optimization becomes imperative. The self-organizing network (SON) is applied to these RSRP data to detect, compensate and recover for the outage or error. The analysis of some RSRP measurement records was done using the SON approach. The simulation was carried out via MATLAB R2015a software. The result indicates outage in some units and compensation carried out by accelerating the traffic from the neighbouring units. The traffic of the units was served and compensated. However, they were not entirely compensated.

Index Terms: Optimization, Outage, Quality of Service, Mobile Cellular Network.

1. INTRODUCTION

Mobile network has remained one of the most active sectors in the last few decades, as such there is a tremendous increased in the data rate of wireless communication systems since the deployment of smart phones [1], [2], [3]. All over the world, there are more and more users of mobile networks, as a result cellular network operator should enhance the QoS provided [4], [5], [6]. Since customers are looking for reliability, robustness and high performance, it is essential for operators to keep up with new technologies and keep their systems updated [7] [,8]. Unambiguously, mobile network operations in Nigeria, have significantly improved since its launch in August, 2001 [1], [2], [3], [4]. Radio Frequency (RF) capacities in Long Time Evolution (LTE) networks are demarcated by the Third Generation Partnership Project (3GPP). These 3GPP are constituents of the Reference Signal Received Power (RSRP) and Reference Signal Received Quality (RSRQ). Nevertheless, we will only be working on the RSRP constituents in the course of this study. Self-Organizing Network (SON) is a technique that is applied to these RSRP data to detect, compensate and recover for the outage or error. SON is an automated process that enables a continuous observation of the service, network performance and analyses of the data that are collected from the network. It provides a suitable feedback which could be used for decision making. It comes as a solution that could assist network operators in this regard [9], [10], 11]. According to [10], SON is a computerized technology that is designed for planning simplification, configuration, administration, optimization and for recovery processing of cellular radio access [10]. Its functionality has been demarcated accordingly by 3GPP as well as the Next Generation Mobile Network (NGMN). There are three main techniques of SON viz: Self-configuration technique, Self-optimization technique and Self-healing technique.

- *Ituabhor Odesanya, Ph.D. is currently a Lecturer/Researcher in the Department of Physics, Federal University Lokoja, Kogi State, Nigeria. PH-+23470312440030. E-mail: ituabhor.odesanya@fulokoja.edu.ng*
- *Kingsley Eghonghon Ukhurebor, Ph.D. is currently a Lecturer/Researcher in the Climatic/Environmental/Telecommunication Unit, Department of Physics, Edo University Iyamho, P.M.B. 04 Auchi, Edo State, Nigeria. PH-+2348035383194. E-mail: ukhurebor.kingsley@edouniversity.edu.ng*

1.1 The Self-Configuration Technique

The self-configuration technique is a technique where recent installed nodes are organized by programmed installation measures to get the required fundamental formation for the operation of system.

1.2 The Self-Optimization Technique

The self-optimization technique is a technique where user equipment (UE) and E-UTRAN Node B capacities as well as performance measurements are used to automatic tuning of the network. Examples of self-optimization technique are: mobility load balancing optimisation, mobility robustness optimisation, interference reduction, energy savings, coverage and capacity optimization, etc.

1.3 Self-Healing Technique

The main reason for using the self-healing technique of SON is to resolve or mitigate the culpabilities that could not be resolved mechanically by generating suitable regaining actions. SON's computerized techniques are of tremendous assistance. They are proficient in saving effective and maintenance costs.

2 LTE NETWORK PARAMETER

RSRP is the first constituent in LTE signal power which are received by the UE with a precise frequency. As rightly reported by [11], the distance between site and user have significant influence on the RSRP in the sense that the distance and the RSRP received by the user have an inverse proportionality. This is illustrated diagrammatically in Figure 1. For the Reference Signal (RS) or RSRP at the respective points of the range of coverage, if the user is not within the range at that point it would be difficult to contract the LTE service [11].

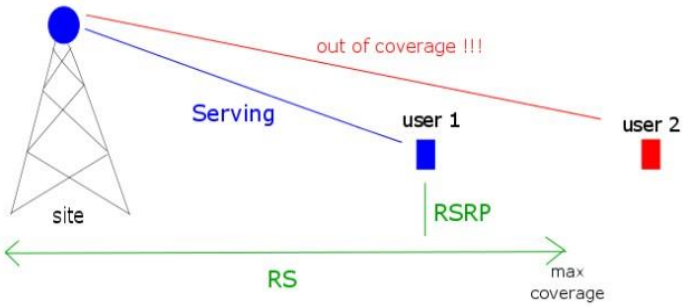

***Figure 1**. Reference Signal Received Power Measurement*

According to [11], RSRP which is measured in dBm can be estimated using:

$$RSRP = RSSI - \left(10l\,\mathrm{og}12 \times 10l\,\mathrm{og}\,N\right) \quad (1)$$

Where RSSI is the Received Signal Strength Indicator and N is the number of the resource block used by the Orthogonal Frequency-Division Multiple Access (OFDMA).

RSSI is also measured in dBm. It is known as the received signal power user with a precise frequency range in addition to noise and interference. RSRP measurement is mainly use for determination of the signal strength in LTE cell. They assist in re-positioning the various cell to cell as an input, which is rummage-sale for handover as well as cell re-selection procedure known as algorithm. Consequently, RSRP is the mean of the power of contributions of supply parameters that transmit the reference signals known as the measurement frequency bandwidth. However, RSRP is only is measured in transmitting the reference signals in the orthogonal frequency-division multiplexing digital modulation schemes. RSRP is a crucial parameter in evaluating network coverage. Since, the base station is on 24 hours transmission, there is a constant received power which the UE chooses to communicate with in relation to an E-UTRAN Node B. Measurement of LTE network constituents is an essential prerequisite for cell blackout discovery and compensation. In this study we only deliberated on the RSRP constituents that are discernible from the UE side. In this scenario, if there is a reduction in the value of RSRP received by the UE, at that moment a diminution in the traffic settings would make the cell to have a temporary suspension or/and lost in its storage in what is known as outage. The 3GPP description of the RSRP values with some steps as shown Table 1. It is assumed that a UE reports a measured RSRP value using the E-UTRAN Node B ID in order to utilize that cell. Additionally, RSRP might not be affected by the number of users, because it is always there. As a result of that, RSRP provides the coverage area of E-UTRAN Node B.

Table I
RSRP MEASUREMENT

eNode B ID	Measured Quantity Value (dBm)
50665	-140 ≤ RSRP < -110
50664	-110 ≤ RSRP <-105
50650	-105 ≤ RSRP <-100
50649	-100 ≤ RSRP <-95
50645	-95 ≤ RSRP <-85
50644	-85 ≤ RSRP <-75
50643	-75 ≤ RSRP <-40

3 MATERIALS AND METHODS

The SON mechanism used for this study, includes RSRP measurement, cell outage detection, cell outage compensation and cell recovery. The LTE measurement was conducted within Benin City, Edo State, South-South Nigeria situated around latitude 6°20'17"N and longitude 5°37'32"E, with an elevation of about 88 m above sea level. The City has an estimated population of about 1,125,058 making it the biggest City in Edo State. It operates on the West Africa time zone. The area is typically urban, comprising of buildings of various heights, open land [12], [13], [14], [15], [16]. RSRP constituents are measured from the UE, the values are processed at the cell outage discovery phase. At the stage a reduction in RSRP value or absence of RSRP value indicates cell outage. In compensating cell outage, the configuration constituents of the neighbouring cells are altered to make up for the network performance. The last stage is to help the outage cell get compensation by the neighbouring cell.

4 DISCUSSION OF RESULTS

In Figure 2, the outage units are 2, 4 and 8 with low RSRP values, either received or released by the EU. Accordingly, the cells that require compensation are units 2, 4 and 8. In compensating for the outage the SON mechanism was trained for a number of times. The outage units are now the onward cells that must get traffic compensation from the neighbouring units (units 14, 21, 11 and 10), which have the highest available traffic. In Figure 4, units 2, 4 and 8 have been compensated fairly because the traffic is not entirely served.

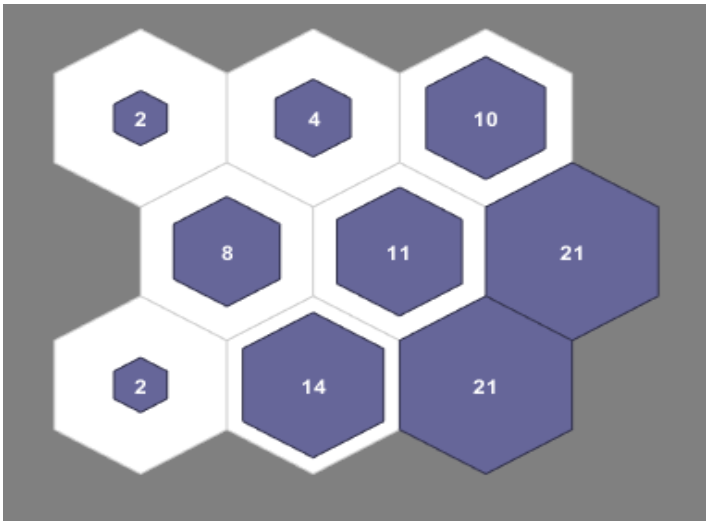

***Figure 2:** Outage Units*

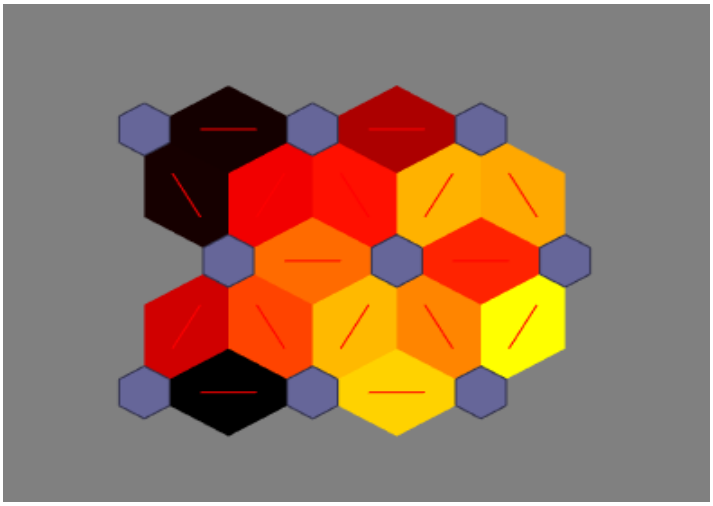

Figure 3: *U-matrix of the Outage Unit*

In Figures 3 and 5 the Unified distance matrix or U-Matrix of the outage and compensated units are shown respectively. The U-matrix visualizes the structure of the SON. The lighter colour between two map units in Figures, indicate the existence of small relative distance between their weight vectors. While dark areas on the maps identifies the boundaries between units in the underlying data.

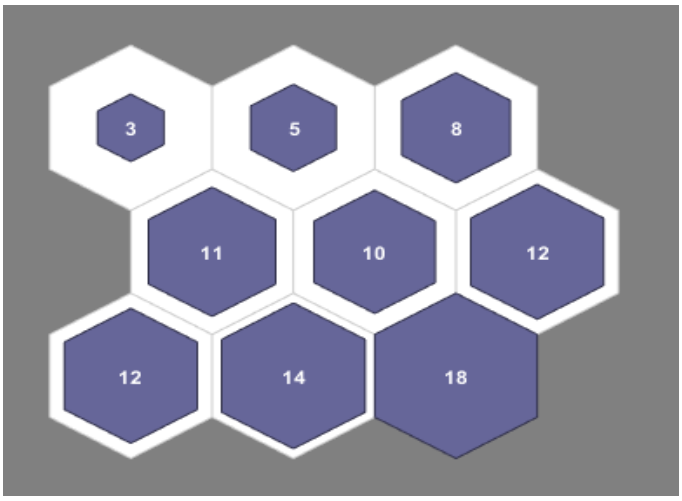

Figure 4: *Cell Units Compensated*

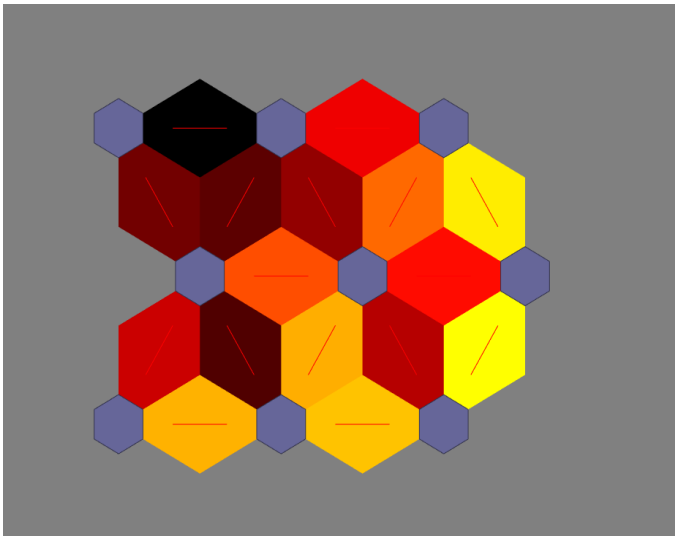

Figure 5: *U-matrix of Compensated Units*

5 CONCLUSION

In this study, the analysis of some RSRP measurement recorded by a telecommunication operator in Benin City, Edo State, South-South, Nigeria was done using the SON approach. The outage units were compensated and RSRP maximized in the area of study. It is therefore recommended that telecommunication network service providers should adapt this technique in optimizing their quality of service.

ACKNOWLEDGMENT

The authors wish to thank the management of the cellular network operator who assisted us in this study.

REFERENCES

[1] B.Y. Lawal, K.E. Ukhurebor, M.A. Adekoya, and E.E. Aigbe, “Quality of Service and Performance Analysis of A GSM Network in Eagle Square, Abuja and Its Environs, Nigeria”, International Journal of Scientific & Engineering Research, 2016, 7(8), 1992- 1999.

[2] R. Kadioglu, Y. Dalveren, and A. Kara, “Quality of Service Assessment: A Case Study on Performance Benchmarking of Cellular Network Operators in Turkey”, Turkish Journal of Electrical Engineering and Computer Sciences, 2015, 23, pp. 548-559.

[3] A. Ozovehe, and A.U. Usman, “Performance Analysis of GSM Net-works in Minna Metropolis of Nigeria”, Nigerian Journal of Technology, 2015, 34(2), pp. 359 – 367.

[4] K.E. Ukhurebor, M.S. Maor, and E.E. Aigbe, “Mollification of WCDMA Interference on Uplink Channels in Cellular Network Using the Power Control Approach”, British Journal of Applied Science & Technology, 2017, 20(4), pp. 1-11.

[5] K.E. Ukhurebor, S.O. Azi, I.C. Abiodun, and E. Enoyoze, “Approximation of the Dew Point Temperature Using a Cost-Effective Weather Monitoring System”, Physical Science International Journal, 2017, 14(3), pp. 1-6.

[6] M. Andleeb, and A.S. Ali, “A Study on the Hourly Behaviour of Key Performance Indicators of Global System for Mobile Communications”, Journal of Emerging Trends in Computing and Information Sciences, 2015, 6(3), pp. 170.

[7] E. Eyceyurt, “Performance of two US Cellular Carriers while

Video Streaming in LTE", Melbourne, Florida: Florida Institute of Technology, 2015.
[8] N. Nwankwo, and K.E. Ukhurebor, "Investigating the Performance of Point to Multipoint Microwave Connectivity across Undulating Landscape during Rainfall", Journal of the Nigerian Society of Physical Sciences, 2019, 1(3), 103-115.
[9] M. Iwamura, A. Umesh, and A.W. Hapsari, "Further Enhancements of LTE- LTE Release 9", NTT DoCoMo Technical Journal, 2010, 12(1).
[10] S. Hamalainen, H. Sanneck, and C. Sartori, "LTE Self-Organizing Networks (SON) Network Management Automation for Operational Efficiency", John Wiley & Sons, 2012, ISBN 9781119970675.
[11] R. Nofitasari and S. Haryadi, "Self-healing Mechanism with RSRP Measurement in LTE Network", 3rd International Conference on Wireless and Telematics (ICWT), Palembang, 2017.
[12] K.E. Ukhurebor, A.S. Olayinka, W. Nwankwo and C. Alhasan, "Evaluation of the Effects of some Weather Variables on UHF and VHF Receivers within Benin City, South-South Region of Nigeria", Journal of Physics: IOP Conference Series, 2019, 1299, 012052.
[13] K.E. Ukhurebor, and O.J. Umukoro, "Influence of Meteorological Variables on UHF Radio Signal: Recent Findings for EBS, Benin City, South-South, Nigeria", IOP Conference Series: Earth & Environment Science, 2018, 173, 012017.
[14] K.E. Ukhurebor, T.B. Batubo, I.C. Abiodun, and E. Enoyoze, "The Influence of Air Temperature on the Dew Point Temperature in Benin City, Nigeria", Journal for Applied Science and Environmental Management, 2017, 21(4), pp. 657-660.
[15] K.E. Ukhurebor, I.C. Abiodun, S.O. Azi S.O, I. Otete, and L.E. Obogai, "A Cost-Effective Weather Monitoring Device.", Archives of Current Research International, 2017, 7(4), pp. 1-9.
[16] K.E. Ukhurebor, S.O. Azi, I.C. Abiodun, and E. Enoyoze, "Approximation of the Dew Point Temperature Using a Cost-Effective Weather Monitoring System", Physical Science International Journal, 2017, 14(3), pp. 1-6.