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Analysis of Quality of Service for WCDMA Network in Mwanza, Tanzania

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Abstract
This paper presents an analysis and evaluation of WCDMA network in both rural and urban areas of Mwanza, Tanzania. The analysis of data starts by collecting data through a drive test measurements by using TEMS Investigation tool. The parameters which are analyzed in this paper are such are Received Signal Code Power (RSCP), Transmitted Power (TX), Speech Quality Index (SQI) and the ration of received power to noise (Ec/N0). The data collected shows that only 24.02% of the region has got the good coverage, 23.24% has poor coverage and the 52.74% has a fair coverage. Also by using the basic Key Performance Indicators (KPI's) we analyzed the data for the quality of service (QoS) of the area which shows only 27.61% of the region has good QoS, while the poor value recorded with 2.76% of the region. We can use the analysis done in this work as a platform and benchmark to aid in the system optimization for telecoms services providers improved performance in the region.
Keywords: WCDMA, Received Signal Code Power, Coverage and Quality of Service

1. Introduction

We define quality of service in cellular network as the capability of the cellular service providers to provide a satisfactory service which includes voice quality, signal strength, low call blocking and dropping probability, higher data rates for multimedia and data applications etc.

Tremendous growth of mobile phone market in Africa and the introduction of smart phone for communication have changed the way we used to look on cellular network services. There is an increase demand for converged services supporting multimedia such as video and audio in mobile communication systems. Provisioning of quality of service (QoS) in converged networks is becoming much more complex.

The main challenges when considering the issue of QoS in mobile phone environment are issues like bandwidth allocation, varying rate channel characteristics, fault tolerance level and handoff support in heterogeneous wireless networks. Each layer of the Open System Interconnection (OSI) model has its own mechanism to provide better QoS so as to attain interoperability, various standards, network flexibility and tolerance. One of the biggest challenges in the mobile phone network of today's world is the proper and efficient usage of spectrum resource such as frequencies, scrambling codes, spreading factors, power for common and dedicated channels Bandwidth allocation plays a vital role in this aspect. Things get even more complicated when, video, data and voice service has to be parallel supported. Voice services are very delay sensitive and require real - time service. On the other hand data services are less delay sensitive but are very sensitive to loss of data and also they expect error free packets. All these factors have to be considered for providing QoS for voice and data services in converged mobile phone networks.

The following parameters where the keys of this analysis;

1.1 Received Signal Code Power (RSCP)

The "Received Signal Code Power" (RSCP) is the collected Radio Frequency (RF) energy after the correlation / descrambling process, usually given in dBm. The descrambling process it filters out the signal with the correct code (The code meant for the specific user equipment (UE)). Due to this we cannot calculate the total received RF power that a normal monitoring receiver measures but instead the RSCP has to be measured for the specific code only in the code domain. Only this code power is of interest for the receiver when judging the quality of service.

1.2 Ec/No

That's the received energy per chip (Ec) of the pilot channel divided by the total noise power density (No). In other words the EcNo is the RSCP divided by the RSSI. And again in other words: The better this value the better can a signal of a cell be distinguished from the overall noise. The EcNo is usually expressed in dB as it's a relative value. The value is negative as the RSCP is smaller than the total received power. As the RSCP this value can be used to compare different cells on the same carrier and handover or cell reselection decisions can be taken.

Ec/No for a UE is the measure of PCPICH (code power) over Total Wideband Power on that particular carrier.
Measure of PCPICH (RSCP) dBm and
Measure of Total Wideband power = RSSI dBm
so our Ec/No will become Ec/No = RSCP / RSSI
Ec/No = RSCP – RSSI (db) (By applying logarithmic rule)

1.3 Speech Quality Index (SQI)
SQI is a performance metric for voice quality in telecommunication. It is specific only to the TEMS family of drive testing/field testing tools. SQI aims to provide a reasonable estimate of the voice quality, as perceived by a human ear.

1.4 Transmitting Power (Tx power)
This is the performance metric used to measure the transmitting ability of a base station.

2. Methodologies

2.1 Feasibility Study

While conducting analysis of QoS in Mwanza, a keen feasibility study was conducted to gather information about; system parameters of equipment which have been installed in Mwanza, including the transmission capacity for sites, class of services offered and network configuration in terms of data rates, Number of sites, prospective customers and criteria for addition of sites, Frequency Band (Uplink and Downlink), Modulation schemes, and factors which degrades Quality of Service.

2.2 Drive Test

The analysis of QoS in Mwanza region was done through Drive Test measurement where the tester collected log files through TEMS investigation tool and analyses them through Actix Analyzer and Map Info. The main objectives of this DT were to check the coverage of the area, accessibility, handover success rate and retain-ability of the cellular network in general.

3. Results and Discussion

The following graphs where obtained after the log files collected from the drive test was simulated and analyzed in Actix analyzer and Map Info software.

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3.1 Coverage in terms of RSCP

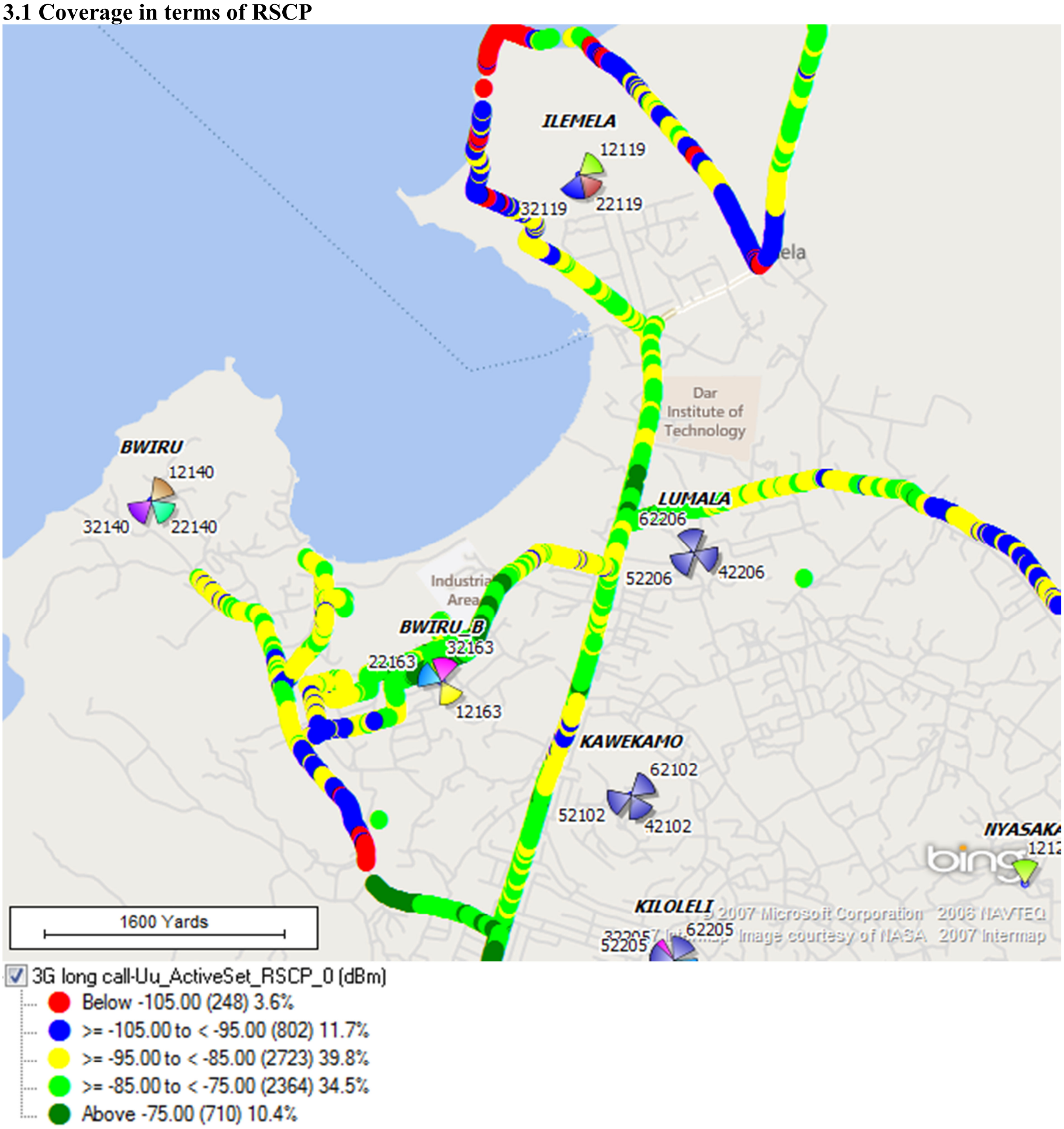

Fig.1: Coverage KPIs _RSCP_Long Call Mode

3.2 Coverage in terms of Ec/No

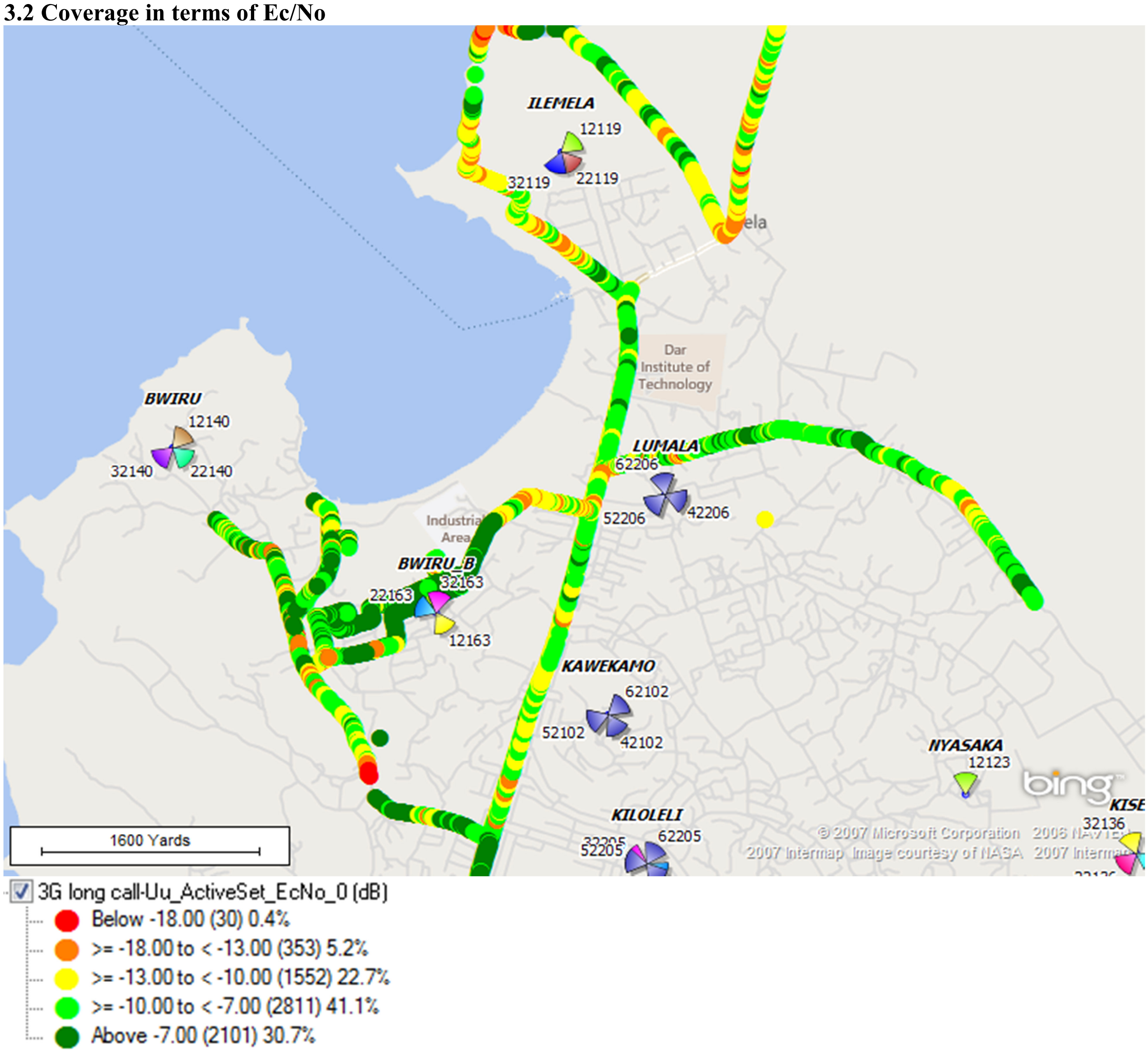

Fig. 2: Coverage KPIs _CPICH Ec/No

Below is the summary of the above findings from the maps

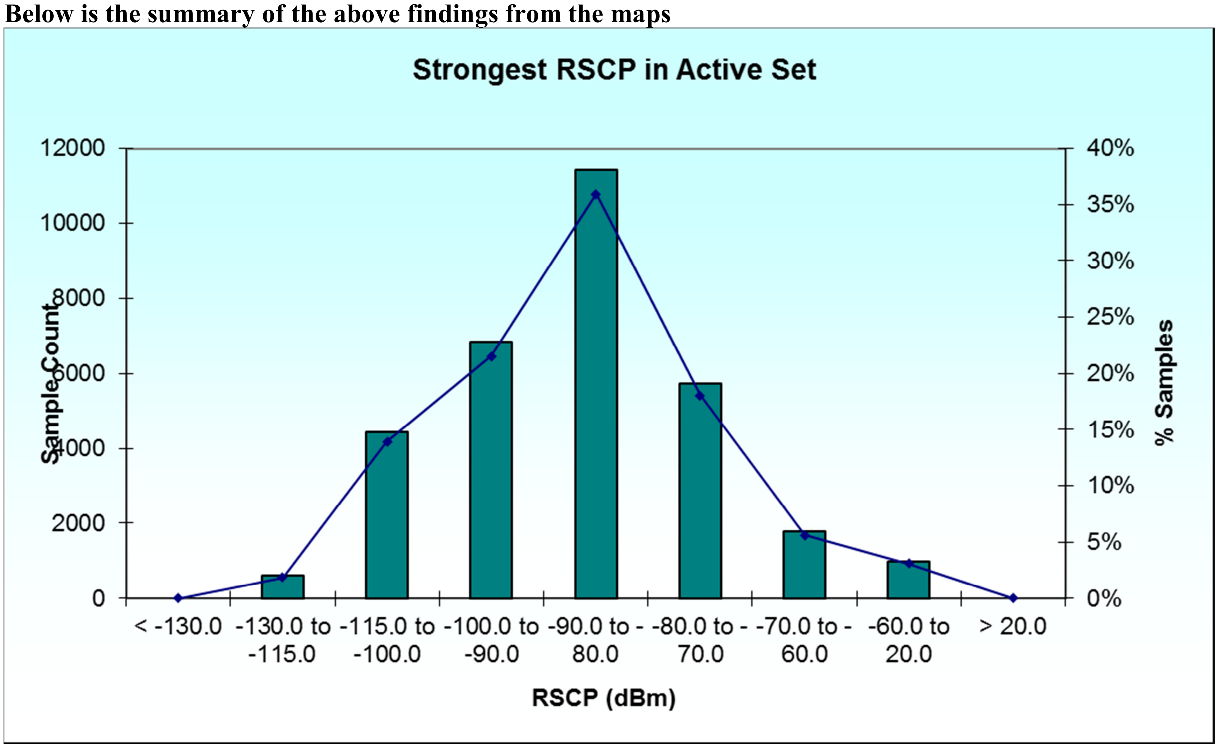

Fig. 3: RSCP in active set count

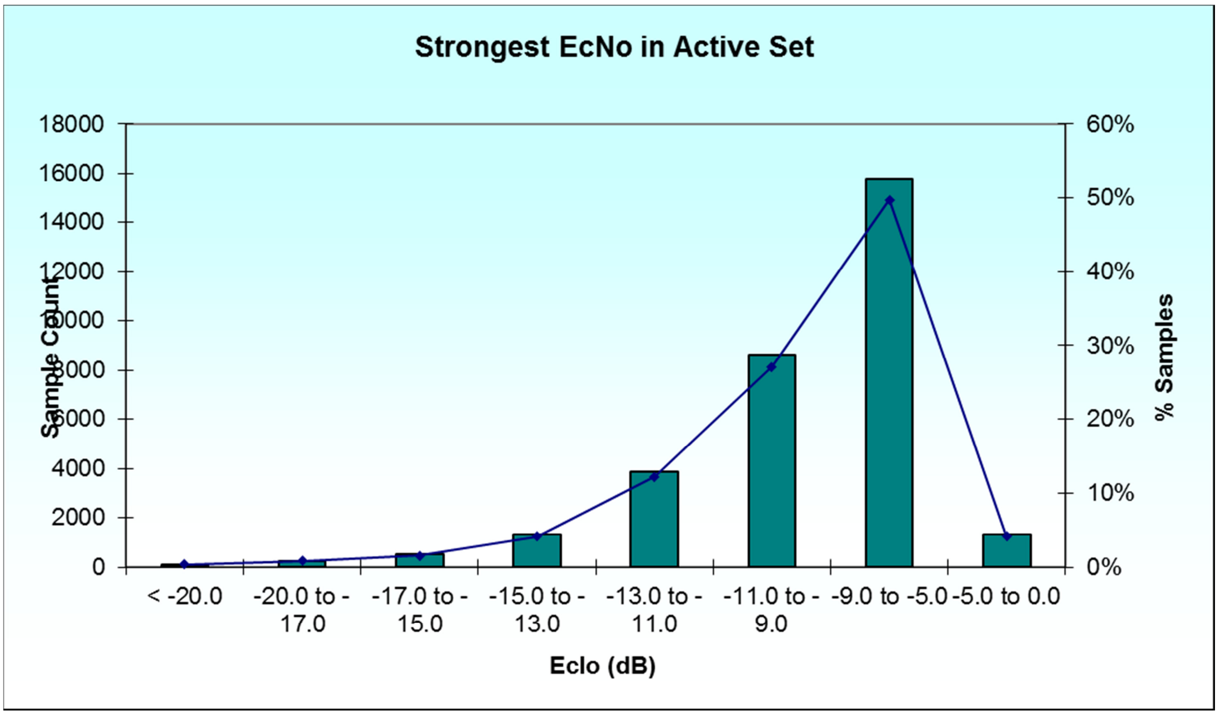

Fig. 4: The Ec/N0 in active set count

Statistic	Strongest EcNo in AS	Strongest RSCP in AS
Mean	-9.3	-87.4
Mode	-9.0	-89.0
Median	-9.0	-87.0
Maximum	-2.5	-50.0
Minimum	-24.0	-121.0
Count	31792	31792
Standard Deviation	2.7	12.7
Variance	7.1	161.9

Fig. 5: Mean, Mode, Median, Variance, Standard deviation and maximum and minimum ranges of both RSCP and Ec/N0 in active set count

3.3 Transmission Power

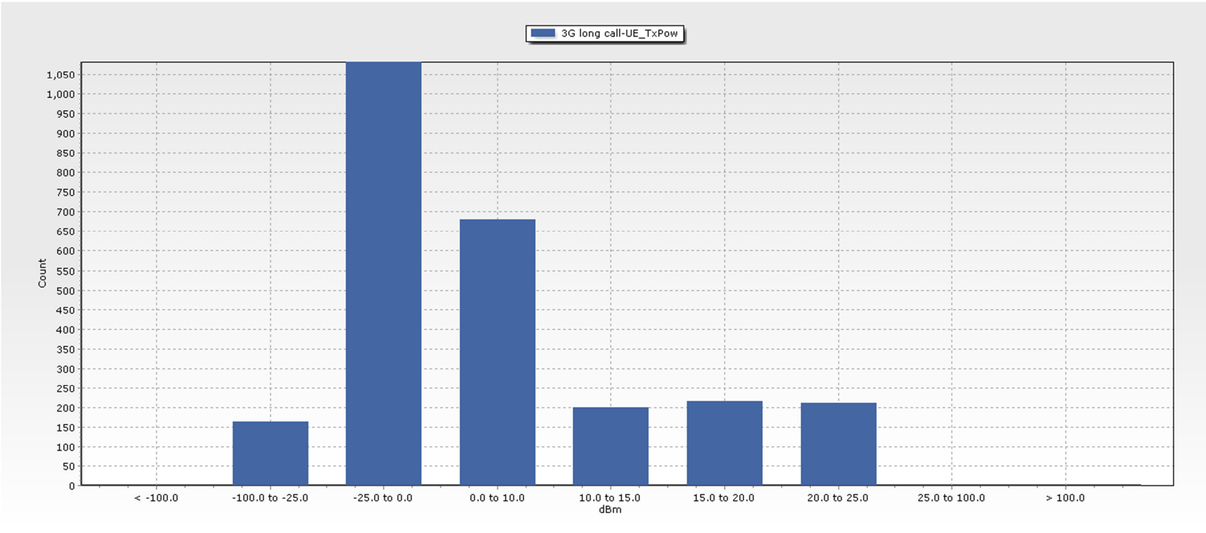

Fig. 6: Transmission Power from the base stations

Coverage summary

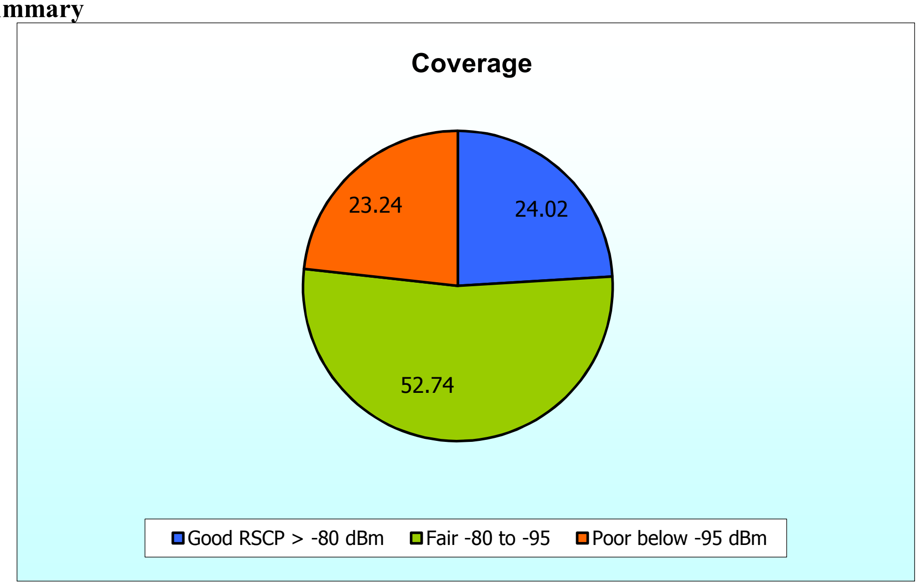

Fig. 7: Coverage summary of the whole sample region

The results show the good coverage in the entire sample of evaluation was only 24.02% while the poor coverage below the minimum value was 23.24% of the whole region. This shows the rest of the region has a fair coverage which is not enough for the good quality of service of the whole region.

Quality of Service Summary

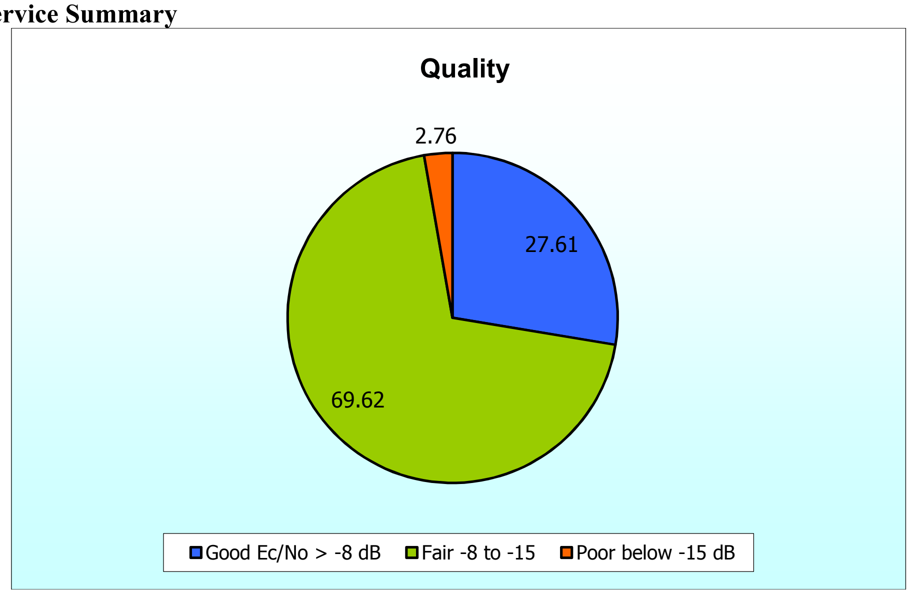

Fig. 8: Quality of Service summary of the entire sample region

The overall QoS which is greater than -8dB was only 27.61% and the poor quality of service which is below the -15dB was 2.76%. The results shows most of the region is under fair quality of service of about 69.62%.

3.4 Call Information Overview

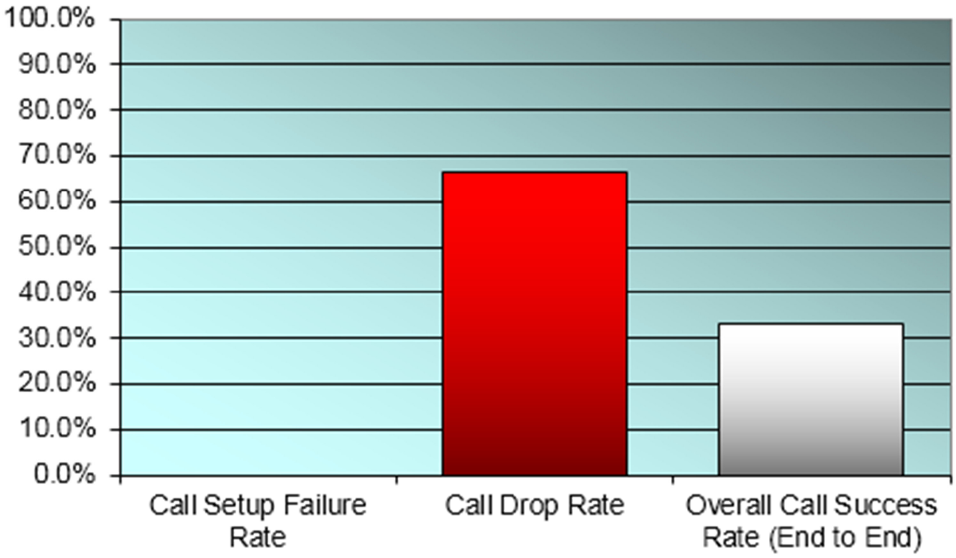

Fig. 9: Summary of the call information overview

Bad quality of service of the entire region shows the rate of call drop was above 60% while the rate of overall call success rate was below 40%.

Now from the above graphs we can say that;

3.5 Low Received signal level

Most of the places of this region is covered by different types of terrain structures like hills, mountains and tall rocks which results into loss of line of sight to the transmitted signal. In places where the signal received level is below the threshold then there are coverage holes and those places can be seen with the red colour on the above two maps. Low level on down link signal strength can mostly occur because of low number of sites in the network, high attenuation from the obstacles like buildings or hills, or high path loss caused by Rayleigh Fading. Poor coverage due to low received signal level results into bad quality of service and hence call drops.

3.6 Lack of Dominant Server

Due to low value of CPICH power, the MS was experiencing high number of handover. This was because the

MS was located at the border of the cell and there was no any best server to keep the call. It keep on receiving signals from more than one cell hence results into interference and handover.

3.7 Sudden appearance and disappearance of neighbor

Due to different terrain changes and obstacles from tall rocks the neighbors cells where popping up with high levels of signal hence causing the BSC to give wrong handover decisions. The calls kept on being handled for very short period with each neighbor cell "The ping pong effect".

3.8 Drop Call due to Bad Coverage:

The signal level goes down beyond the minimum RX Access level to which prevents the on-going call to drop. This is mostly due to bad coverage as it is shown in both coverage maps of RSCP and CPCIH.

4. Recommendation

The best solution in most of the coverage problems will be installations of new base station. But due to budget limits and operations under low profit margins in most of this areas it is difficult to be implemented.

Therefore it is better to do site auditing to check for corrects antenna orientations, antenna tilts and antenna type as for specific environment. Also to check the possible attenuation of the cells through faulty feeders, jumpers, connectors and other faulty equipment.

To increase strong received signal it is better to deal with unnecessary down tilts, proper investigation on existence of natural diversity like forest hills, tall rocks and valleys as well as to increase height of the site. Putting high gain antennas and increasing output power could improve the coverage.

5. Conclusion

The coverage of this region is bad in most of the places due to poor RSCP as it shows in the above analysis from the map extracted from the log files. The transmitting power also degrades as the User Equipment moves away from the BTS. All of this and other factors which have been discussed above results into call drops, muted calls and fluctuation on coverage for both data and voice. Even though the quality of service is not that much bad but there are many problems due to coverage and they need to be taken care as soon as possible. Proper optimization is need to be done in most of the area to increase the quality of service of the region. New sites can be added to complement the problems of coverage especially in areas where they lack dominant server.

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