Coverage and QoS Analysis of LTE Radio Network Planning Considering Khartoum City

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Abstract: *Long Term Evolution (LTE) is engaged the attention of wireless operators, investors, and industry watchers around the world in the late years. LTE was initiated by 3GPP, to maintain its competitive edge in the world of mobile networks in the future; it represents the first generation of cellular networks to be based on a flat IP architecture. The essential part of any system to be deployed is the planning operation, because the existence of all activities is related to its existence. The radio network planning process is designed to maximize the network coverage, the QoS is a big problem in planning, its mandatory to client ensure good coverage for calls, in this paper explain capacity and QoS analysis based on CINR and Throughput in LTE planning in Khartoum city, Sudan. And we show The network coverage improvement graphs and maps.*

Keywords: LTE, Radio Network Planning, planning process, coverage analysis.

1. Introduction

4G LTE networks. Then, we outline the planning steps of LTE planning. UMTS Long Term Evolution (LTE) is one of the choices for next generation broadband wireless networks. LTE network are aiming at several target. LTE supports data rates of over 100Mbps in the downlink and more than 50 Mbps in the uplink. LTE reduces packet latency by reducing number of nodes in network. It use OFDM – based technology resulting in higher spectral efficiency and increased capacity. By improving data rates. LTE reduce latency and offers a rich multimedia user experience.

LTE uses Orthogonal Frequency Division Multiple Access (OFDMA) technology for downlink transmission. It uses Single Carrier Frequency Division Multiple Access (SC-FDMA) technology for uplink transmission. LTE supports both TDD (Time Division Duplex) and FDD (Frequency Division Duplex) modes operation [1].

Radio network planning is a very vital step for a wireless communication technology. As standardization work of LTE is approaching the end line, it's high time to go for efficient radio network planning guideline for LTE. For the same reason, along with the fact that LTE radio network planning work just like other cellular technologies, initial stage plans is normally guided by various industries and vendors at their own discretion. They aren't likely to disclose their advancements and findings. That makes the job even more challenging. Whenever new cellular technology is considered for mass deployment hundreds of its RF parameters go through tuning process with a view to find out optimum value. But this phase is time consuming and very costly. So, before commercial deployment if extensive simulation can be run this tuning phase can be facilitated in numerous ways. Cost can also be greatly minimized. That is the benefit of running simulation before mass commercial deployment. In this sub-continent LTE is expected to be commercially launched in Q4 of 2012. All these aim at proper radio network planning of LTE. So, looking for optimizing the vital parameters in the least possible time is a

very challenging issue which will obviously help network operators in a greater extent. The ultimate objective of this work is to come up with the detailed radio network planning guideline with respect to Khartoum city. With this mission ahead, in this paper a step by step method was followed starting from gathering preplanning information which went up to coverage and capacity analysis. For this link and system level simulation had to be performed and link budget had to be prepared. All these have been presented here. Prior to that, a brief description of radio network planning methodology has been given [2].

2. Related Work

In [3] coverage and capacity estimation is carried out in radio network dimensioning. Radio link budget is investigated for coverage planning. Theoretical work is later put into the development of an Excel based dimensioning tool which is designed to keep the interface simple and to set the functional parts clearly distinguishable. The final product gives the number of sites (cells) needed in order to support a certain subscriber population with a given capacity. In [4] an attempt to provide analysis of LTE system performance from radio network planning aspects has been made. Determination of the number of resources to be allocated to the PDCCH and how UEs should be efficiently signaled over the PDCCH is addressed in [5]. Resource allocation in LTE downlink and LTE PHY layer simulation aspects have been featured respectively in [6] and [7]. [8-14] are the 3GPP Technical Specifications related to this work. Link and system level simulations have been performed using [15] and [18] respectively. Effect of change in number of transmitting antennas has been shown in [16].

3. Case Study

In the present study, analyze the coverage and QoS based on CINR and Throughput Furthermore, an optimized network requires less maintenance cost, meaning more saving. The primary goal of LTE network planning tools is to provide an optimum topology for the network.

4. Radio Network Planning Process

Network planning is a complicated process consisting of several phases. The final target for the network planning process is to define the network design, which is then built as a cellular network. The network design can be an extension of the existing LTE network or a new network to be launched. Environmental factors also greatly affect network planning.

4.1 Network planning process steps

The radio network planning process is divided into five main steps, where four steps are prelaunch and the last one comes after the network has been launched. The flowchart for the network planning process is shown in Figure 1. The five main steps are: preplanning, planning, detailed planning, acceptance and optimization.
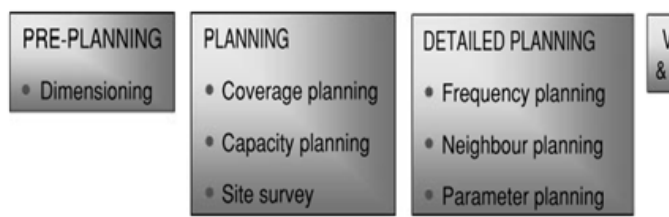
Figure 1: Planning steps

- **Preplanning**
  The preplanning phase covers the assignments and preparation before the actual network planning is started. As in any other business it is an advantage to be aware of the current market situation and competitors. The network planning criteria are agreed with the customer.
- **Planning**
  The planning phase takes input from the dimensioning, initial network configuration. This is the basis for nominal planning, which means radio network coverage and capacity planning with a planning tool. The nominal plan does not commit certain site locations but gives an initial idea about the locations and also distances between the sites.
- **Detailed planning**
  After the planning phase has finished and the site location and configurations are known, detailed planning can be started. The detailed planning phase includes frequency, adjacency and parameter planning.
- **Verification and acceptance**
  In addition to fine-tuning a search is made for possible mistakes that might have occurred during the installation. Prelaunch optimization is high level optimization but does not go into detail. Network optimization continues after the launch at a more detailed level.
- **Optimization**
  As we know that optimization is a continuous process. All available information about the network and its status is required as input for the optimization. Some necessary components like statistical figures, alarms and traffic have to be monitored carefully.

5. Results and Discussion

Khartoum is the capital of Sudan. Efficient radio network planning is obviously a big challenge here with the optimal utilization of limited resources. In this part of the work, coverage analysis-link level simulation result along with link budget preparation and capacity analysis-system level simulation have been performed . As a result, it can be included for the complete part of Khartoum city radio planning performing the simulations with planning tool like Atoll.

5.1 Coverage Analysis

Coverage or cell range is determined for coverage-limited scenario or for interference-limited scenario. This depends on fading margin, cell edge target throughput, average network load, etc.

The following figures (2 & 3) illustrate C/(N+I) thresholds and Quality graph C/(N+I) Vs BER depend on Pedestrian mobility.
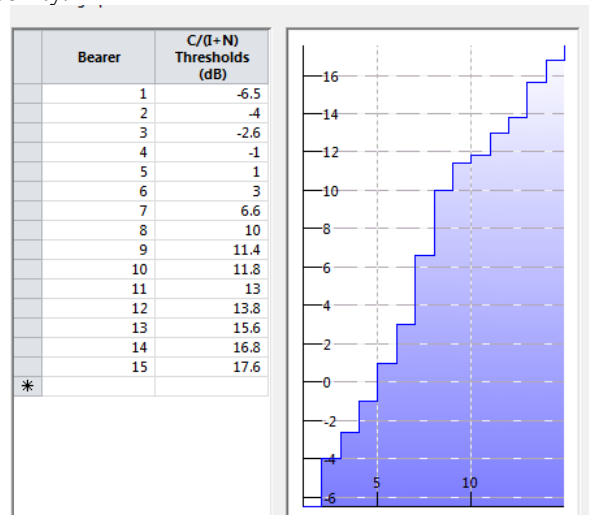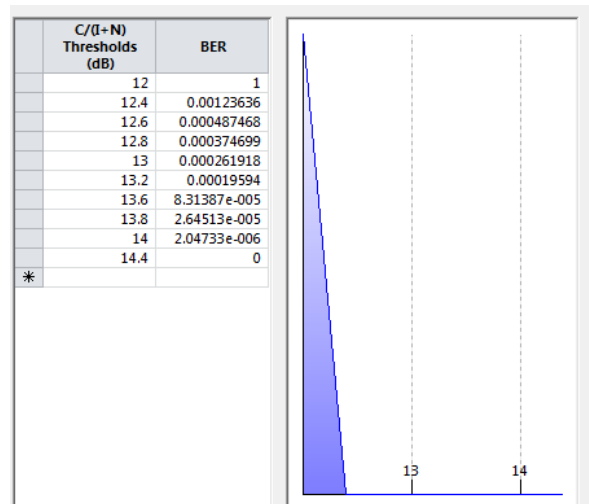

Figure 2: C/(N+I) thresholds (dB)

Figure 3: Quality graph C/(N+I) Vs BER

5.2 Prediction Study Reports Optimization Report

A synthesized view of the optimization results of the objectives (RS coverage and RS CINR) optimization, if one was made. Shown in figures below (4 & 5).
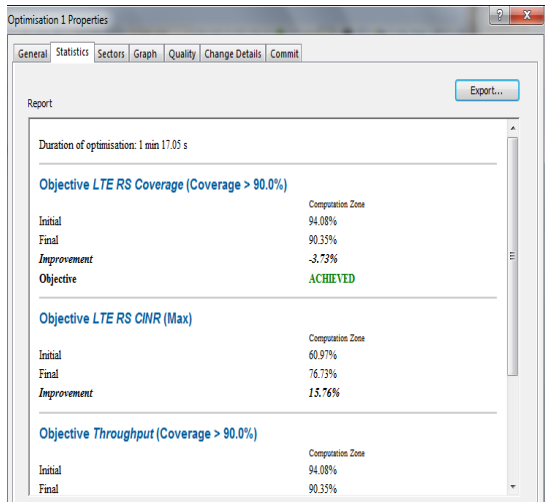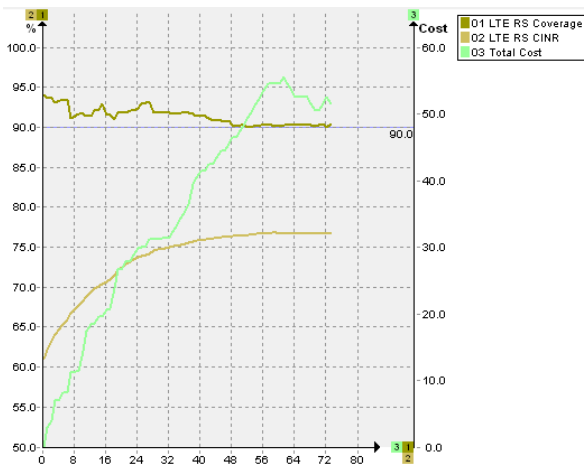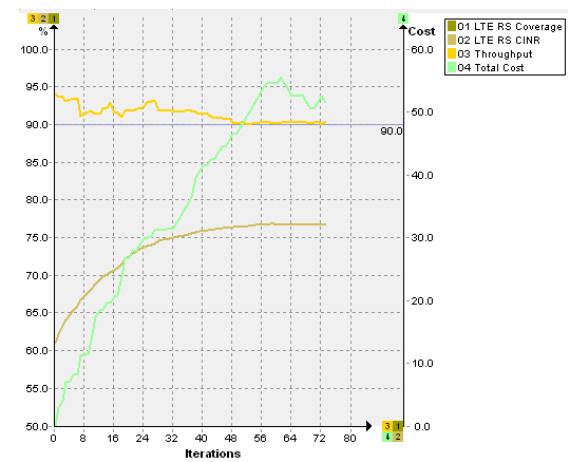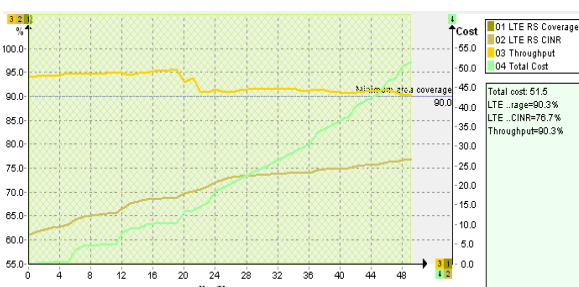
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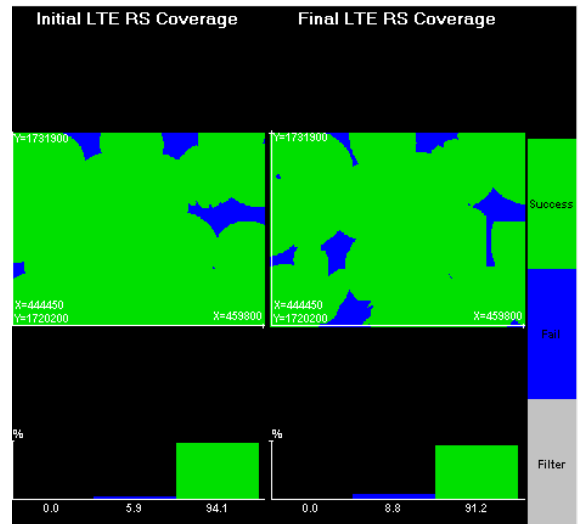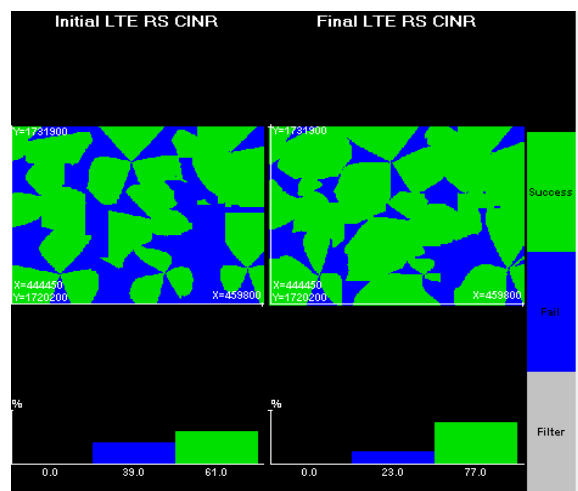**Figure 4:** optimization report
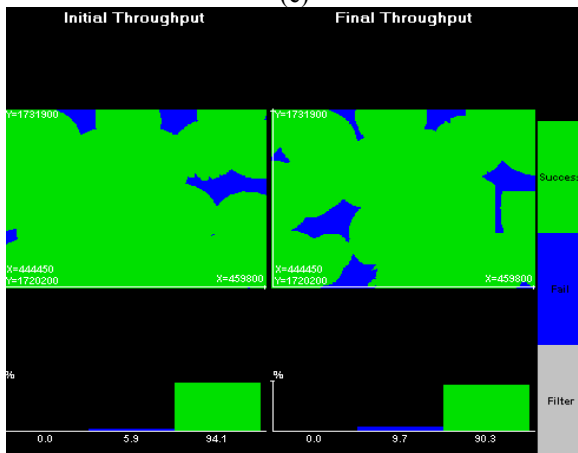

(a)

(b)

(c)

(d)

(e)

(f)

Figure 5 (a, b, c, d, e, f): The network coverage improvement graphs and maps.

Here, a light difference is found in the number of sites required in terms of capacity and coverage. In this paper, number of cell required for coverage exceeds that of capacity. The target capacity and coverage values can be attempted in the nominal and detailed radio planning stage and obtained 94% QoS in initial and 90.3 % in final coverage, 77% CINR and 94.08% throughput with radio planning tools like Atoll for complete radio network planning.

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6. Conclusion and Future Work

The number of mobile broadband users are increasing at an accelerated pace and in the current competitive cellular market, extensive coverage, capacity and quality of service have become key factors in increasing end-user base. The main purpose of this paper was to attempt to study coverage and Quality of Service. The dimensioning stage coverage analysis was performed. Again, using the system level simulator threshold level capacity analysis was performed. For initial network deployment. Future measurement would have to be carried out from outdoor-to-indoor so as to measure the Received Signal Strength Indicator (RSSI) inside the building.

7. Acknowledgement

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