LTE-A Implementation Scenarios: RF Planning Comparison

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ABSTRACT

This paper covers most aspects of LTE Radio Frequency (RF) system planning; this study has been extended to cover different implementation scenario for LTE-Advance. It explains the parameters that comprise the 4G cellular RF Link Budget and the basic propagation models in order to perform a RF Planning for LTE. Cell coverage has been estimated for different spectrum band and bandwidth and different modulation and coding schemes (MCS).

Keywords: Implementation, LTE, LTE-A, Planning, Radio Frequency

INTRODUCTION

The LTE as defined by 3GPP is a highly flexible radio interface, the first release referred as Rel8 is already coming to end and it is supposed to significantly increase peak data rate to 100Mbit/s (downlink) and 50Mbit/s (uplink). But LTE-Rel8 is not considered as a 4G standard since it do not fulfill the 4G requirements specified by the International Telecommunications Union Radio communications (ITU-R), To enhance LTE features further to fulfill all IMT-Advanced requirements and hence become an IMT-Advanced technology, 3GPP has started a new Study Item on LTE-Advanced in March 2008.

The purpose of this work is to compare the Radio Frequency planning of different implementation scenarios for LTE-A in term of spectrum bands, bandwiths and Modulation, which are considered features enhancement for the Evolved Universal Terrestrial Radio Access.

The Key features that will be investigated are:

Spectrum bands: The following spectrum bands were proposed as additions to the prior identified bands in the 3GPP Technical Report 36.814 V9.0.0 (2010-03)

- 450 MHz band
- UHF band (698-960 MHz)
- 2.3 GHz band
- C-band (3400-4200 MHz)

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The spectrum bands that will be investigated in this paper are: 450MHz, 700MHz, 900MHz, 2.3GHz and 3.4GHz.

Spectrum bandwidth: Advanced E-UTRA shall operate in spectrum allocation of different sizes including wider spectrum allocations than those of E-UTRA Release 8 to achieve higher performance. In 4G bandwidths should be on consecutive of 20 MHz and up to 100MHz are foreseen to provide peak data rates up to 1 Gbps as shown in Figure 1.

The bandwidths of 20MHz, 40MHz, 80MHz and 100MHz will be investigated in this paper.

Modulation: The actual LTE is limited to 64 QAM as a modulation scheme. We will consider 128 QAM and 256 QAM as methods to enhance throughput.

The remainder part of the paper is organized as follows: We explain the adopted planning methodology to estimate the link budget for each scenario, and give a brief description of the propagation models used. We determine the results of different scenarios. We investigate the Doppler.

**RF Link Budget**

Like any wireless system, radio frequency link budget need to be calculating for LTE to in order to estimate the coverage of the sites and ultimately determine how many sites is required (Enigmatic Consulting, 2007).

Figure 2 resumes the link budget calculation that will be followed during this paper.

In order to calculate the link budget, the radio path losses and the equipment output powers and sensitivities must be taken into account for both directions.

**Effective Radiated Power**

In radio telecommunications, Effective Radiated Power (ERP) is determined by subtracting system losses and adding system gains. ERP takes into consideration transmitter power output (TPO), transmission line attenuation (electrical resistance and RF radiation), RF connector insertion losses, and antenna directivity and is calculated as in Table 1.

2.1.1. Transmit RF Power: Is the power at the output of the equipment, in the downlink direction, it is associated with the eNode-B and in the Uplink direction, the transmit power is associated with the UE.

2.1.2. Transmit Diversity Gain: In LTE, more than 2 antennas could be used to transmit information, this will lead to coverage improvement and the gain obtained from transmits diversity is obtained from the equation:

\[
G_{TDG} = 10 \times \log \left( N_r \right) N_f
\]

is the number of transmit antennas
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