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LTE Network : Scale And Capacity Measurement

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Abstract

LTE or Long Term Evolution, marketed as 4G LTE, is a standard for wireless communication of high-speed data for mobile phones and data terminals. It is based on the GSM/EDGE and UMTS/HSPA network technologies, increasing the capacity and speed using a different radio interface together with core network improvements. LTE has very features like FDD (Frequency Division Duplex) and TDD (Time Division Duplex). In this paper, we presented methods in five steps for capacity and scale measurement of LTE networks. In experimental result and phase, we have input, that evaluate by Evaluator and give results calculated on the basis of current year data and forecast provided by the customer.

1. Introduction

The recent increase of mobile data usage and emergence of new applications such as MMOG (Multimedia Online Gaming), mobile TV, Web 2.0, streaming contents has motivated the 3rd Generation Partnership Project (3GPP) to work on the Long-Term Evolution (LTE). LTE is the latest standard in the mobile network technology tree that previously realized the GSM/EDGE and UMTS/ HSxPA network technologies that now account for over 85% of all mobile subscribers. LTE will ensure 3GPP's competitive edge over other cellular technologies. HSPA (high speed packet access) is the most widely deployed mobile broadband technology in the world today and will build upon the more than 6 billion connections with the GSM family of technologies. HSPA is the terminology used when both HSDPA (3GPP Release 5) and HSUPA (3GPP Release 6) technologies are deployed on a network, And MBMS (multimedia broadcast and multicast service) is a point-to multipoint interface specification for existing and upcoming 3GPP cellular networks, which is designed to provide efficient delivery of broadcast and multicast services, both within a cell as well as within the core network. For broadcast transmission across multiple cells, it defines transmission via single-frequency network configurations. Target applications include mobile TV and radio broadcasting, as well as file delivery and emergency alerts.

2. Long term evolution of 3gpp

2.1. LTE overview

Many of the new LTE spectrum allocations are relatively small, often 10 - 20MHz in bandwidth, and this is a cause for concern. With LTE-Advanced needing bandwidths of 100 MHz, channel aggregation over a wide set of frequencies many be needed, and this has been recognized as a significant technological problem. Radio access technology for LTE is OFDM (Orthogonal Frequency Division Multiplexing) which provides higher spectral efficiency and more robustness against multipath and fading, as compared to CDMA (Code Division Multiple Access). LTE FDD and TDD were both defined and introduced as part of the 3GPP specification in 2009 to make efficient use of paired and unpaired spectrum allocations over a common, core network architecture. The main differences are around the duplex method used. In both LTE FDD and LTE TDD, the transmitted signal is organized into sub frames of one millisecond (ms) duration and 10 sub frames constitute a radio frame. Each sub frame normally consists of 14 orthogonal frequency division multiplexing (OFDM) symbols (12 OFDM symbols in an extended cyclic prefix). Although the frame structure is, in most respects, the same for LTE FDD and LTE TDD, there are some differences between the two—most notably the use of special sub frames in TDD. The sub frames in TDD are allocated either for uplink (UL) or downlink (DL) transmission.

3. LTE architecture

Wireless operators are rapidly expanding their LTE networks to take advantage of additional efficiency, lower latency and the ability to handle ever-increasing data traffic.LTE architecture is designed and organized base on the three Purposes: for Packet Switching, low latency and reducing the cost. For receive the above goals, LTE should be formed to include small number of nodes for reduce the overall amount of protocol-related processing, testing cost and interfaces. This is important because It can be facilitates the radio interface protocol optimization. It can be integrated into some of the protocols used for control and signalling, leading to shorter sequences Installation. Using LTE architecture has two colour nodes. Overview of the LTE architecture which is shaded yellow boxes depicts the logical nodes, white boxes depict the functional entities of the C-plane and blue boxes depict the functional U-plane Figure 1.

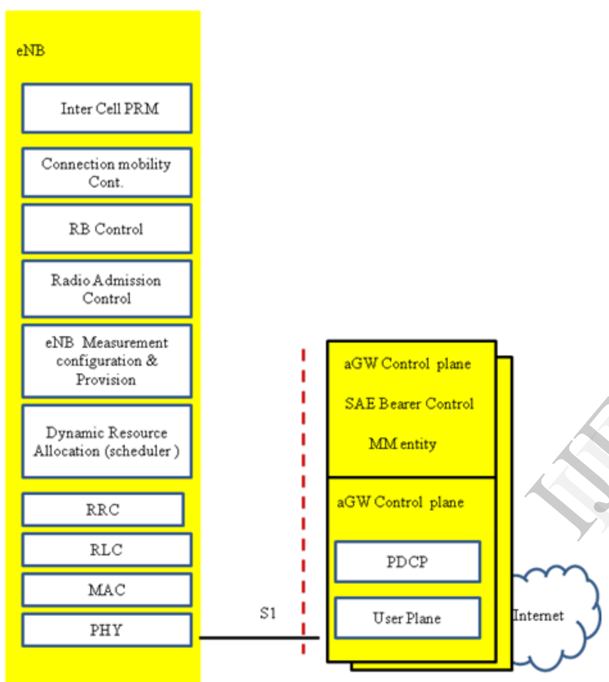

Figure1. LTE architecture

4. Measurement OF LTE network

Measurement is the first step of network planning. Measurement provides the first appraisal of the elements count in network and capacity of those elements. The main purpose of measurement is to appraisal the number of radio stations that are required to support a specified traffic load in an area.

4.1. Estimation process

Calculate the radio link budget is a first step for initial measurement of the LTE network. Outcome depends on the propagation model used that includes the required number of eNBs (Enhanced Node B). Follow the above procedure for computing capacity is estimated to cover. LTE scale measurement process includes the following steps:

Step 1: Data Analysis

The first step of measurement of the LTE network is data analysis. It gather the input data and analysis them.

Step 2: Traffic Analysis

The second step of measurement of the LTE network is traffic analysis. This step use for analyze the network traffic for choose the best solution. There are three types of traffic: VoIP, streaming and browsing.

Step 3: Coverage scheme

The third step is one of the important steps in the design of LTE network. Radio Link Budget is at the core of coverage scheme the will discuss in next. Also, coverage scheme use for the path loss testing. Coverage scheme test the range of cell that and calculate the number of the sites for coverage.

Step 4: Capacity Planning

With calculate of the size of the cell and number of the site count, confirmation of coverage results use for the capacity. The SINR distribution is main factor for capacity In LTE. This distribution is obtained by carrying out system level simulations. The capacity of LTE cell has impacted by supported MCS (Modulation Coding Scheme).

Step 5: Transport scaling
Transport scaling is measurement of interfaces between different elements of network. S1 and S2 are the two interfaces to be calculated between two enhanced node and access gateway.

4.1.1. Radio link budget

As the name implies, a link budget is an accounting of all the gains and losses in a transmission system. The link budget looks at the elements that will determine the signal strength arriving at the receiver. The link budget may include the following items: Transmitter power, Antenna gains (receiver and transmitter), Antenna feeder losses (receiver and transmitter), Path losses, Receiver sensitivity (although this is not part of the actual link budget, it is necessary to know this to enable any pass fail criteria to be applied.

(1)

PathLoss = TxG + TxP – RxN – RxL – RSINR + RxG – TxL + RxN

Where,

Path Loss = Total path loss encountered by the signal from transmitter to receiver (W)

TxP = Power transmitted by the transmitter antenna (dB)

TxG = Gain of transmitter antenna (dB)

TxL = Transmitter losses (dB)

RSINR = Minimum required SINR(Signal to Interference and Noise Ratio) for the signal to be received at the receiver with the required quality or strength (dB)

RxG = Gain of receiver antenna (dB)
RxL = Receiver losses (dB)
RxN = Receiver Noise (dB)

Equation 1 can be written as absolute terms:

$$\text{PathLoss} = \frac{RxG * TxG * TxP}{RxN * RxL * RSINR * Txl} \quad (2)$$

Where,
Path Loss = Total path loss encountered by the signal from transmitter to receiver (W)

TxP = Power transmitted by the transmitter antenna (W)

TxG = Gain of transmitter antenna

TxL = Transmitter losses (W)
RSINR = Minimum required SINR for the signal to be received at the receiver with the required quality or strength

RxG = Gain of receiver antenna

RxL = Receiver losses (W)

RxN = Receiver Noise (W)

SINR can be calculated in following equations:

$$SINR \geq requiredSINR \quad (3)$$

$$SINR = \frac{AveRxPower}{Interference + RxNoise}$$

$$= \frac{AveRxPower}{OwnCellInterference + OtherCellInterference + RxNoise}$$

Where,

SINR = Signal to interference and noise ratio

AveRxPower = Average received power (W)

Interference = Interference power (W)

OwnCellInterference = Power due to own cell interference (W)

OtherCellInterference = Power received for neighboring cells (W)

In telecommunication, free-space loss (FSL) is the loss in signal strength of an electromagnetic wave that would result from a line-of-sight path through free space (usually air), with no obstacles nearby to cause reflection or diffraction. It does not include factors such as the gain of the antennas used at the transmitter and receiver, nor any loss associated with hardware imperfections. Free-Space Loss can be calculated using the following equations:

$$FSL = \left(\frac{4\pi d}{\lambda}\right)^2$$

Where,

FSL = Free-Space Loss

λ =Signal's wavelength (m)

d = Distance between transmitter and receiver (m)

5. Experiments

The scaling tool calculates the capacity of the LTE network. This tool performs the calculations to obtain the number of sites based on network traffic. MATLAB and Excel are chosen as the implementation software for the scaling tool. Excel is a spreadsheet application with special features for performing calculations and providing a wide variety of graphics, making it one of the most popular and widely used PC applications [5].

5.1. Inputs

Input sheet is an important part of the structure of the scaling tool. It gathers all of the data as a inputs in one place. The content of the Excel datasheet carrier frequency, channel bandwidth. Coverage inputs that are in scaling toll are Scattering model RLB data. All the information is used to calculate the capacity and coverage. This data sheet includes all of the data that needed for different processes, Conflation Method (CM) and procedures in LTE networks.

5.2. Evaluator

The important part of our research in this paper is Calculate the capacity. For this reason we design the evaluator for calculates cell performance for a particular cell range. Therefore, it can be calculate the capacity of single node in LTE network. Also, estimate the cell performance is based on SINR. A simple approach, CM-SINR presented for calculate the cell performance. Finally, data rate that can be achieved, using CM by using system parameters.

```
IF (SNR<minimum _SNR_CM)

Then

       Data Rate = 0;
Else
      Data Rate = (SNR, Downlink Rate related to
        CM)
```

5.3. Output

Outputs include the final information about area; cell Performance, Capacity, and site count. Measurement method calculates the number of sites that require for coverage and capacity Measurement.

6. Conclusion

LTE technology offers a number of distinct advantages over other wireless technologies. These advantages include increased performance attributes, such as High peak speeds (100 Mbps downlink and 50 Mbps uplink), Scalable bandwidth, improved spectrum efficiency, improved cell edge data rates and Enhanced support for end-to-end quality of service.

References

[1] Anssi Hoikkanen, "Economics of 3G Long-Term Evolution: the Business Case for the Mobile Operator," IEEE Conference on Wireless and Optical Communications Networks. July 2007.

[2] Dahlman, Parkvall, Skold and Beming, 3G Evolution: HSPA and LTE for Mobile Broadband, Academic Press, Oxford, UK,2007.

[3] "3GPP webpage for LTE Overview," 3rd Generation Partnership Project, viewed on 17.11.07, available at http://www.3gpp.org/Highlights/LTE/LTE.htm

[4] "Long Term Evolution (LTE): an introduction," Ericsson White paper, October 2007.

[5] 3GPP Technical Specification TS 36.300 V8.2.0, "E-UTRA and E-UTRAN Overall description; Stage 2"

[6] Harri Holma and Antti Toskala, "WCDMA for UMTS" Third Edition, John Willey and Sons, 2004.

[7] Jamalipour, A., Mirchandani, V., Kibria, M.R., "Dimensioning of an enhanced 4G/B3G infrastructure for voice traffic," IEEE 16th International Symposium on Personal, Indoor and Mobile Radio Communications, 2005. PIMRC September 2005.

[8] RuzIcka, Z. Hanus, S., "Radio Network Dimensioning in UMTS Network Planning Process," 18th International Conference on Applied Electromagnetics and Communications, 2005. ICECom October 200