Internet of Things and Cloud Computing
2018; 6(4): 69-74
http://www.sciencepublishinggroup.com/j/iotcc
doi: 10.11648/j.iotcc.20180604.11
ISSN: 2376-7715 (Print); ISSN: 2376-7731 (Online)

Performance Investigation of Long Term Evolution- LTE- Based on OFDM Using QPSK & 64 QAM

Jaskaran Singh, Tania Sharma, Gaurav Soni

Department of Electronics and Communication Engineering, Amritsar College of Engineering & Technology, Amritsar, India

Email address:
Gauravsoniece28@gmail.com (G. Soni)

To cite this article:
Jaskaran Singh, Tania Sharma, Gaurav Soni. Performance Investigation of Long Term Evolution- LTE- Based on OFDM Using QPSK & 64 QAM. *Internet of Things and Cloud Computing*. Vol. 6, No. 4, 2018, pp. 69-74. doi: 10.11648/j.iotcc.20180604.11

Received: January 10, 2018; **Accepted**: March 26, 2018; **Published**: December 24, 2018

Abstract: *Long Term Evolution (LTE)* based on OFDM technology is popular 3rd Generation Partnership Project that dominates the 4th generation of mobile telecommunication network. In this paper our work is unique in providing a detailed performance study based on NI VST 5644. Our performance study includes TDD and FDD operation modes for uplink and downlink transmission in physical channel, data modulation, EVM, SEM etc. In this paper LTE performance is being evaluated using VST with QPSK, QAM modulation schemes.

Keyword: LTE, EVM, QAM, QPSK, VST

1. Introduction

Long Term Evolution (LTE) is a standard for high-speed wireless communication for mobile phones and data terminals, It increases the capacity and speed using a different radio interface together with core network improvements. The standard is developed by the 3GPP (3rd Generation Partnership Project). LTE [1-7] is the upgrade path for carriers with both GSM/UMTS networks and CDMA2000 networks. The goal of LTE was to increase the capacity and speed of wireless data networks using new DSP (digital signal processing) techniques and modulations that were developed around the turn of the millennium. A further goal was the redesign and simplification of the network architecture to an IP-based system with significantly reduced transfer latency compared to the 3G architecture. The LTE wireless interface is incompatible with 2G and 3G networks, so that it must be operated on a separate radio spectrum. The LTE Advanced standard formally satisfies the ITU-R requirements to be considered IMT-Advanced. To differentiate LTE Advanced and WiMAX-Advanced from current 4G technologies, ITU has defined them as "True 4G". The LTE standard covers a range of many different bands, each of which is designated by both a frequency and a band number. In North America, 700, 750, 800, 850, 1900, 1700/2100, 2300, 2500 MHz in South America; 700, 800, 900, 1800, 2600 MHz in Europe;800, 1800 and 2600 MHz in Asia and 1800 MHz and 2300 MHz[14] in Australia and New Zealand. As a result, phones from one country may not work in other countries. Users will need a multi-band capable phone for roaming internationally.

2. LTE -OFDM Architecture

LTE (Long Term Evolution) or the E-UTRAN (Evolved Universal Terrestrial Access Network), [16] introduced in 3GPP R8, is the access part of the Evolved Packet System (EPS). The main requirements for the new access network are high spectral efficiency, high peak data rates, short round trip time as well as flexibility in frequency and bandwidth.

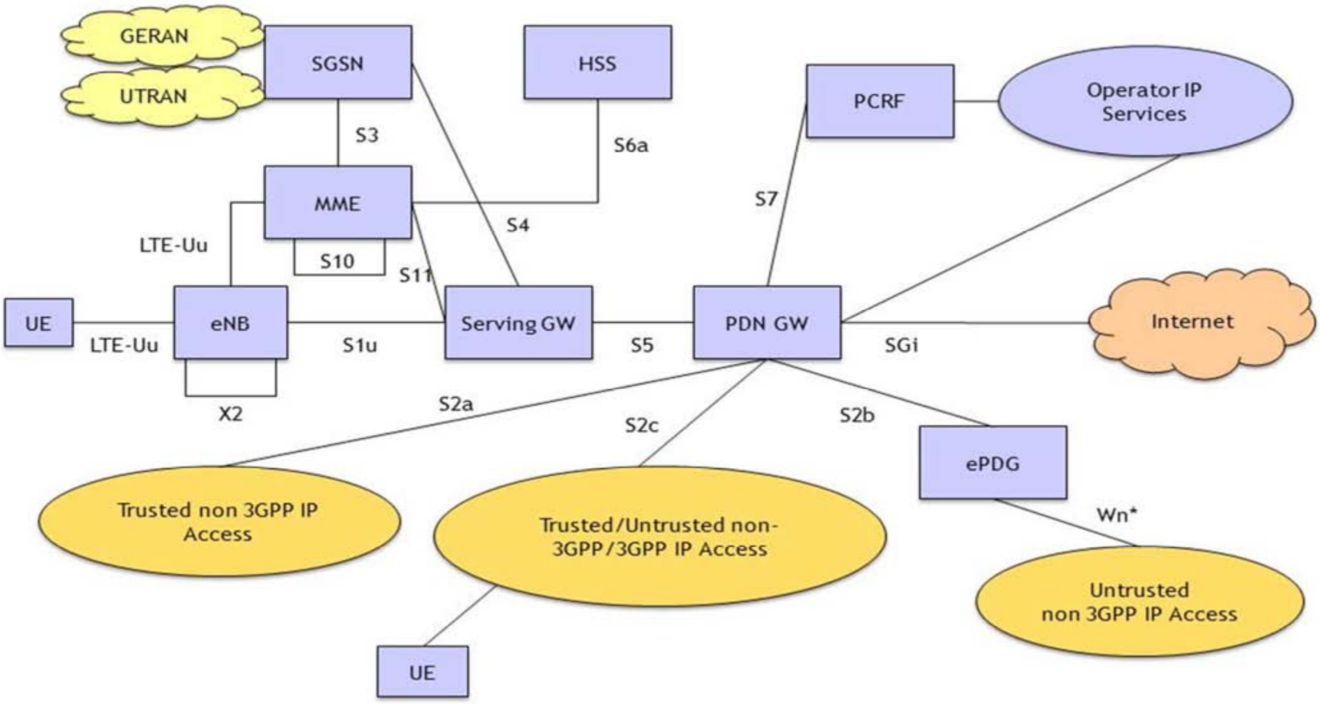

Figure 1. *LTE Architecture*

GSM was developed to carry real time services, in a circuit switched manner with data services only possible over a circuit switched modem connection, with very low data rates. The first step towards an IP based packet switched solution was taken with the evolution of GSM to GPRS, using the same air interface and access method, TDMA. To reach higher data rates in UMTS (Universal Mobile Terrestrial System) a new access technology WCDMA (Wideband Code Division Multiple Access) was developed. The access network in UMTS emulates a circuit switched connection for real time services and a packet switched connection for datacom services. In UMTS the IP address is allocated to the UE when a datacom service is established and released when the service is released. Incoming datacom services are therefore still relying upon the circuit switched core for paging. The Evolved Packet System (EPS) is purely IP based. Both real time services and data communication services will be carried by the IP protocol. The IP address is allocated when the mobile is switched on and released when switched off. The new access solution, LTE, is based on OFDMA (Orthogonal Frequency Division Multiple Access) and in combination with higher order modulation (up to 64QAM), large bandwidths (up to 20 MHz) and spatial multiplexing in the downlink (up to 4x4) high data rates can be achieved. The highest theoretical peak data rate on the transport channel is 75 Mbps in the uplink, and in the downlink, using spatial multiplexing, the rate can be as high as 300Mbps. The LTE access network is simply a network of base stations, evolved NodeB (eNB), generating a flat architecture There is no centralized intelligent controller, and the eNBs are normally inter-connected via the X2-interface and towards the core network by the S1-interface (The reason for distributing the intelligence amongst the base-stations in LTE is to speed up the connection set-up and reduce the time required for a handover. For an end-user the connection set-up time for a real time data session is in many cases crucial, especially in on-line gaming. The time for a handover is essential for real-time services where end-users tend to end calls if the handover takes too long.

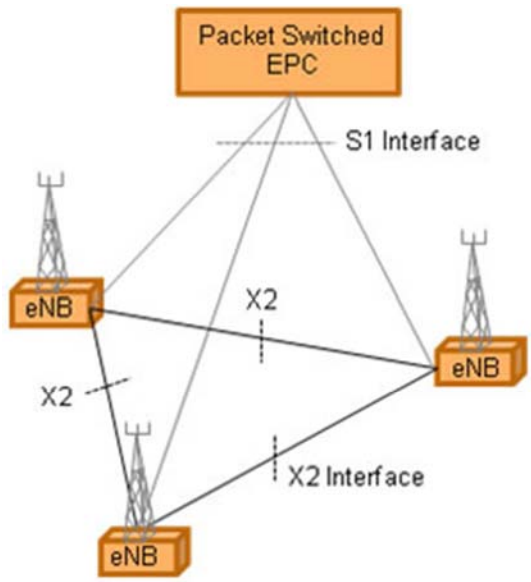

Figure 2. *X2 and S1 Interfaces.*

To enable possible deployment around the world, supporting as many regulatory requirements as possible, LTE is developed for a number of frequency bands – E-UTRA operating bands- currently ranging from 700 MHz up to 2.7

GHz. The available bandwidths are also flexible starting with 1.4 MHz up to 20 MHz. LTE [18]is developed to support both the time division duplex technology (TDD) as well as frequency division duplex (FDD). In R8 there are 15 bands specified for FDD and eight bands for TTD.

3. The Motivation for LTE [19]

Need to ensure the continuity of competitiveness of the 3G system for the future

User demand for higher data rates and quality of service

Packet Switch optimised system

Continued demand for cost reduction

Low complexity

Avoid unnecessary fragmentation of technologies for paired and unpaired band operation

4. Result Analysis

Figure 3 shows the setup based on VST for analyzing the performance of LTE signal at bandwidth of 5 MHz.

EVM (Error Vector Magnitude) "The Error Vector Magnitude is a measure of the difference between the reference waveform and the measured waveform. This difference is called the error vector. The EVM result is defined as the square root of the ratio of the mean error vector power to the mean reference power expressed as a %. The measurement interval is one timeslot as defined by the CPICH(when present) otherwise the measurement interval is one timeslot starting with the beginning of the SCH. Figure 4 shows Spectral Emmision mask for 64 QAM. The PAPR value obtained is 7.3153dB.

Figure 3. *NI PXIe VST based Set-up for LTE.*

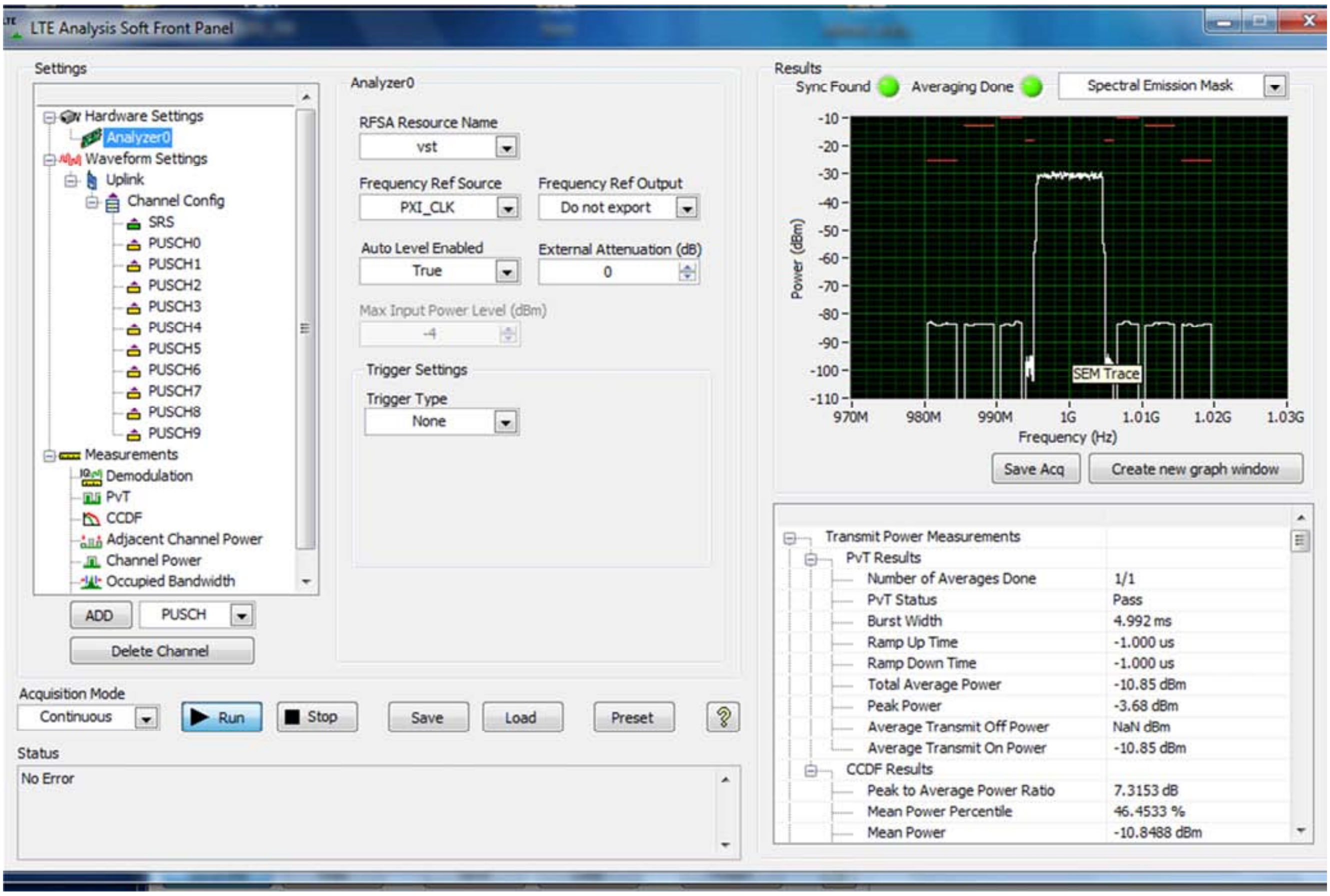

Figure 4. *Spectral Emmision mask for 64 QAM.*

EVM (also called relative constellation error) is a measure used to quantify the performance of a digital communication channel. An ideal digital communication channel would have all constellation points precisely at the ideal locations. Imperfections cause the actual constellation points to deviate from ideal, and EVM is a measure of how far the points are from those ideal locations. The constellation diagram of the measured signal is normalized, in other words the mean distance between the origin and the sampling points is set to one. Figure 5 shows constellation Diagram using QPSK modulation. The diagrm represents acceptable link performance with PAPR value of 7.1791dB.

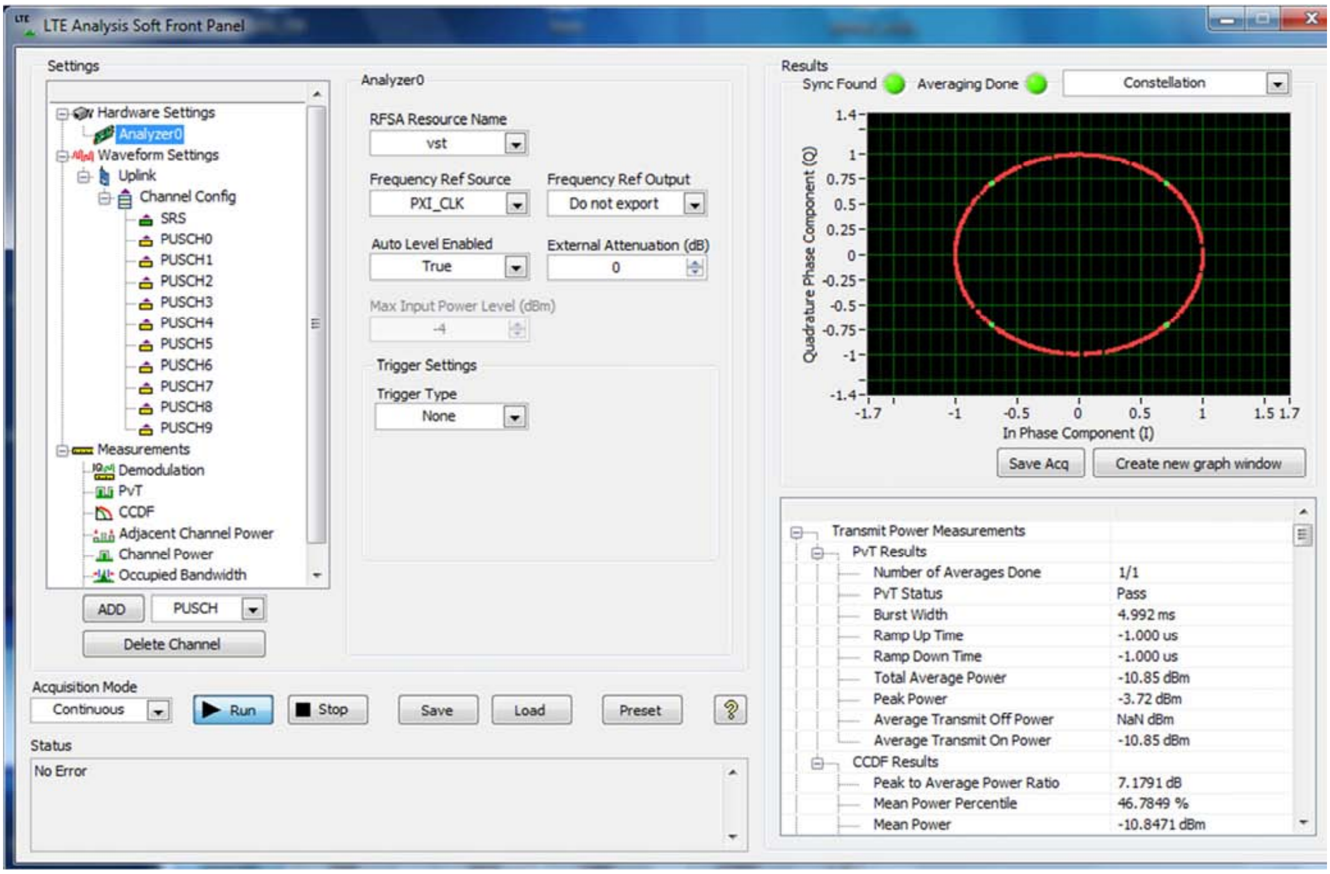

Figure 5. *Constellation Diagram using QPSK modulation.*

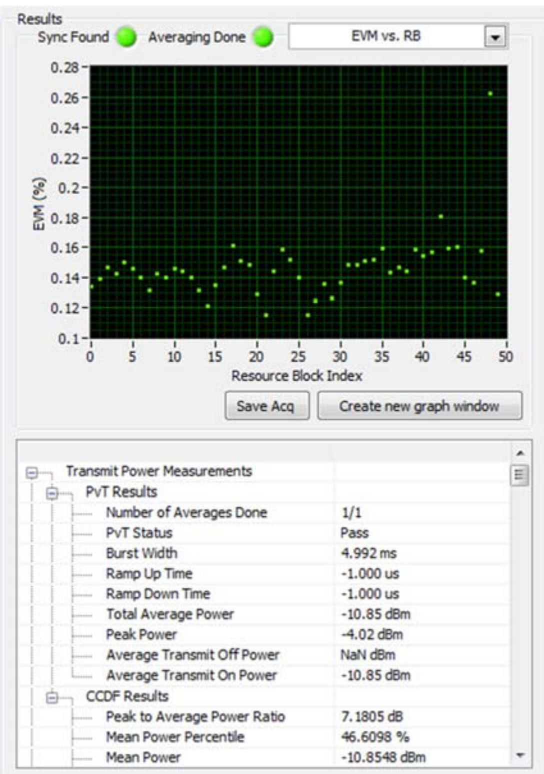

Figure 6. *EVM and scatter plot for QPSK.*

A good measurement of the quality of a received digital signal is Error Vector Magnitude, or EVM (Figure 5). This is the ratio of the received signal's amplitude and phase compared to its Ideal amplitude and phase. Figure 6 shows EVM and scatter plot for QPSK. The LTE standard defines the EVM test as an average measurement over 20 frames using preamble-only equalization and pilot phase tracking, with a minimum of 16 data symbols per frame.. Note that the EVM requirements for the low-density constellations are very relaxed, and for the highest density 64 QAM an EVM of -32 dB is required. This implies that test equipment EVM floor must be much less than -32 dB to provide measurement margin for 64QAM signals. Spectral Emmision Mask (SEM) Spectrum emissions mask is also known as "Operating Band Unwanted emissions". These unwanted emissions are resulting from the modulation process and non-linearity in the transmitter but excluding spurious emissions. Spectral measurements for some of the latest communication standards like LTE Advanced, require wide bandwidth acquisitions. Traditionally, such spectral measurements can be performed using tune able narrowband analyzers and work well when the signal is continuous since the signal is present throughout the measurement duration. Figure 7 shows EVM and scater plot for 64 QAM

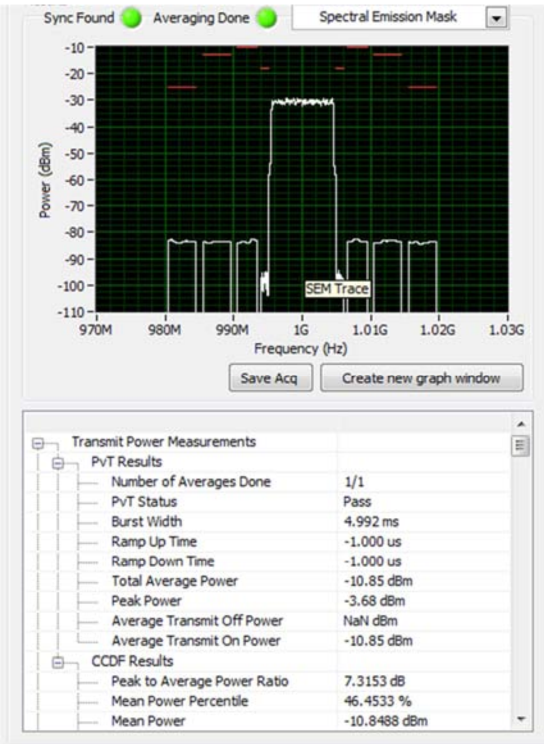

Figure 7. *Spectral emmision Mask for 64 QAM.*

5. Conclusion

To achieve very high data rates it is necessary to increase the transmission bandwidths over those that can be supported by a single carrier or channel. The results show that better performance can be achieved for LTE link by using QPSK as compared to 64 QAM. Using LTE carrier aggregation, it is possible to utilize more than one carrier and in this way increase the overall transmission bandwidth. These channels or carriers may be in contiguous elements of the spectrum, or they may be in different bands. Spectrum availability is a key issue for 4G LTE. In many areas only small bands are available, often as small as 5 or 10 MHz. As a result carrier aggregation over more than one band is contained within the specification, although it does present some technical challenges. Carrier aggregation is supported by both formats of LTE, namely the FDD and TDD variants. This ensures that both FDD LTE and TDD LTE are able to meet the high data throughput requirements placed upon them.

References

[1] Zhaokun Qin, Lin Zhang, Ming Jiang, A dynamic subcarrier exchange scheme for SFR-aided LTE networks, Physical Communication 13 (2014) 133–141.

[2] Sonia BenRejeb, Nidal Nasser, SamiTabbane, A novel resource allocation scheme for LTE network in the presence of mobility, Journal of Network and Computer Applications 46(2014)352–361.

[3] Salam Doumiatia, Hassan Artaila*, David M. Gutierrez-Estevez, A framework for LTE-A Proximity-based Device-to-Device Service Registration and Discovery, Procedia Computer Science, 34 (2014) 87–94.

[4] Rohit Prasad, Rajat Kathuria, The value of 1800 MHz and 2100 MHz spectrums in India and implications for auction design, Telecommunications Policy38(2014)223–235.

[5] Rasha Alkhansaa, Hassan Artaila*, David M. Gutierrez-Estevezb, LTE-WiFi Carrier Aggregation for Future 5G Systems: A Feasibility Study and Research Challenges, Procedia Computer Science 34 (2014) 133–140.

[6] Nora A. Ali, Mohamed A. El-Dakroury, Magdi El-Soudani, Hany M. ElSayed, Ramez M. Daoud, Hassanein H. Amer, New hybrid frequency reuse method for packet loss minimization in LTE network, Journal of Advanced Research (2014).

[7] Mourad Abdeljebbar, Rachid El Kouch, Fast Authentication during Handover in 4G LTE/SAE Networks, IERI Procedia 10 (2014) 11–18.

[8] Liljana Gavrilovska, Jaap van de Beek, Yong Xie, Erik Lidström, Janne Riihijärvi, Petri Mähönen, Vladimir Atanasovski, Daniel Denkovski, Valentin Rakovic, Enabling LTE in TVWS with radio environment maps: From an architecture design towards a system level prototype, Computer Communications 53 (2014) 62–72.

[9] Ji-Su Kim a, Jae-Hyun Kim a, Sunghyun Cho, Enhanced handoff scheme based on efficient uplink quality estimation in LTE-Advanced system, Computer Networks 69 (2014) 133–146.

[10] Giovanni, Antonio Virdis, A comprehensive simulation analysis of LTE Discontinuous Reception (DRX), Computer Networks 73 (2014) 22–40.

[11] Bahattin Karakaya, Hakan A. Çırpan b, 1, Hüseyin Arslan, Channel interpolation for LTE uplink systems with high mobility using Slepian sequences, Physical Communication 10 (2014) 169–178.

[12] Wei Kuang Lai ⇑, Chang-Lung Tang, QoS-aware downlink packet scheduling for LTE networks, Computer Networks 57 (2013) 1689–1698.

[13] WANG Jun, GUAN Bao, LIU Shou-yin, XIE Wen-wu, Frequency offset estimation based on peak power ratio in LTE system, December 2013, 20(6): 49–54.

[14] Nadine Akkari, An IMS-based integration architecture for WiMax/LTE handover, Computer Networks 57 (2013) 3790–3798.

[15] Mehmet Bahadır Çelebi, İsmail Güvençb, Hüseyin Arslan, Khalid A. Qaraqe, Interference suppression for the LTE uplink, Physical Communication 9 (2013) 23–44.

[16] Padmapriya Praveenkumara, Rengarajan Amirtharajanb, K Thenmozhib and John Bosco Balaguru Rayappanb, Phase for Face saving - a multicarrier Stego, Procedia Engineering 30 (2012) 790–797.

[17] Jos´e Fernando Ortega Mu˜noz, H´ector Manuel F´elix Ibarra, Arturo Garc´ıa Melchor, Guillermo Galaviz, David H. Covarrubias Rosales, Resource assignment without service priorities using channel quality information in LTE-advanced systems, Procedia Engineering 35 (2012) 126–134.

[18] Jooyoung Kwak, Heejin Lee, Do Bum Chung, The evolution of alliance structure in China's mobile telecommunication industry and implications for international standardization, Telecommunications Policy 36 (2012) 966–976.

[19] Yang Sun, JosephR. Cavallaro, Efficient hardware implementation of a highly-parallel 3GPP LTE/LTE-advance turbo decoder, integration, the VLSI journal 44(2011)305–315.

[20] Ping'an Lia, Bin Wu, An Effective Approach to Detect Random Access Preamble in LTE Systems in Low SNR, Procedia Engineering 15 (2011) 2339–2343.

[21] Pablo Ameigeiras, Juan J. Ramos-Munoz, Jorge Navarro-Ortiz, Preben Mogensen, Juan M. Lopez-Soler, QoE oriented cross-layer design of a resource allocation algorithm in beyond 3G systems, Computer Communications 33 (2010) 571–582.

[22] Ian F. Akyildiz, David M. Gutierrez-Estevez, Elias Chavarria Reyes, The evolution to 4G cellular systems: LTE-Advanced, Physical Communication 3 (2010) 217–244.

Biography

Gaurav Soni received his B-Tech Degree in ECE from PTU, Kapurthala in the year 2005 and M-Tech Degree in ECE from D. A. V. I. E. T, Jalandhar. He has more than ten years of teaching and research experience. He has to his credit 91 research papers in various refereed international journals like JOC and IEEE conference Proceedings. He is currently working as Associate Prof. in ECE Deptt., Amritsar College of Engineering and Technology, Amritsar. He has served as reviewer to IEEE Journal of Lightwave Technology, reviewer & editor of Advances in Science, Technology and Engineering Systems Journal.