Volume 5, Issue 7, July 2015 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

A Review of 3GPP-LTE System

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Abstract*— *3GPP LTE (Third Generation Partnership project Long Term Evolution) is introduced with new architecture and features, to meet user's high data rate demand for a long term in the future. 3GPP LTE/SAE is a next generation radio access system that supports future end-user requirements. The aim of LTE system is to achieve higher throughput, increased base station capacity. Also to reduce user and operators cost by improving coverage, data rates, and reducing latency. This paper makes review on LTE Architecture, communication channel structure in LTE, challenges for LTE. This review also gives an insight into QoS and frequency reuse concept in LTE, which is important for future crowd in mobile communication. The paper provides the valuable and concise information to the researchers in the area of 3GPP LTE and 4G.

Keywords*— *Quality of Service (QoS), Long Term Evolution (LTE), System Architecture Evolution (SAE), Evolved Packet System (EPS).

I. INTRODUCTION

A long way in a remarkably short time has been achieved in the history of wireless. Mobile data traffic continues to grow rapidly. Day by day mobile users and their demand for high data rates are increasing. Mobile users have become much more mature and their satisfaction comes with higher capacity, better coverage and Quality of service (QoS) with cheaper rates. They are not satisfied with a voice call or text message, but they want to make video calls and run real time applications i.e. video streaming and playing online games etc [1].

The challenge for wireless operators is to support more subscribers with an increasing bandwidth demand. To meet these bandwidth requirements, there is a need for new technologies that assist the operators in efficiently utilizing the available network resources. User demands have driven researchers and mobile manufacturers to move forward towards new mobile broadband technologies [2].

The first release of 3GPP LTE (Third Generation Partnership Project Long Term Evolution) standard completely fulfill ITU (International Telecommunication Union). Advanced 4G technology is the first release LTE. 4G network is based on LTE advanced 3GPP. LTE is a series of upgrades to existing UMTS (Universal Mobile Telecommunication System) technology and using 1800MHz frequency band. Download speed is of 100Mbps and upload speed of 50Mbps [3].

LTE introduced in release 8 having 2600MHz frequency band. It further improves data rates in downlink up to 170 Mbps and 85 Mbps in uplink [4].

LTE network architecture is termed as 3GPP EPS (Evolved Packet System) which is designed to be flat and all IP based structure. It support only packet switched services [5], [11].

Further improvements in LTE are brought in LTE advanced which is compatible with LTE and was introduced in release 10 [4]. Release 12, release 13 has been planned in March 2015 and March 2016 respectively [2]. Mobile communication evolution path is as shown in figure 1.

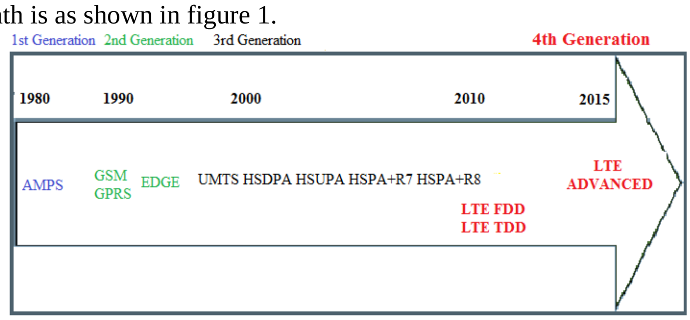

Fig. 1 Mobile communication evolution path [4]

II. OVERVIEW OF 3GPP LTE

An easy way to comply with the conference paper formatting requirements is to use this document as a template and simply type your text into it. To achieve LTE objectives an evolution to the system architecture and radio interfaces was necessary. Keeping this in mind, LTE was standardized and developed to provide long term competitiveness. LTE provides a smooth upgrade path from various technologies. A GSM operator can upgrade to LTE without routing through 3G technologies. It is designed to co-exist with 2G and 3G technologies. New radio interfaces, flat and all IP architecture help to achieve LTE targets [4], [13].

A. Quality of service

To reduce delays, one of the most and possible evolution of the current 3GPP is QoS concept. Apart from allowing for substantially reduced setup delays, the concept aims to give operators an easy and effective means of controlling QoS LTE network provides service to heterogeneous users with different QoS requirements. As shown in figure 2 call blocking, call dropping, degrading channel conditions are improved because of QoS in LTE. Due to effective QoS mobile users get improvements in their mobile systems i.e. 4G systems get better QoS than that of 3G and 3.5G systems. [7].

In order to analyse quality of different services, it is necessary to define the QoS parameters of wireless IP networks. There are two groups of parameters:

1) Call level performance parameters
2) Packet-level performance parameters

1) QoS Parameters on call level: In circuit switched networks new calls are blocked if there are no available channels when call is initiated. The following parameters are considered on call level in wireless IP networks:

- Mean call time during connection
- Handover intensity
- Average number of handovers per call
- New call blocking probability
- Handover call blocking probability
- Call dropping probability

2) QoS Parameters on Packet-level: For this first define packet flow. A flow is a continuing communication between two network entities. It may be one-way or two-way, which results in sending and receiving IP packets.
QoS Parameters on Packet-level are as follows:

- Packet losses
- Packet delay
- Jitter
- Throughput [8], [12].

Factors influencing QoS are illustrated in figure 2.

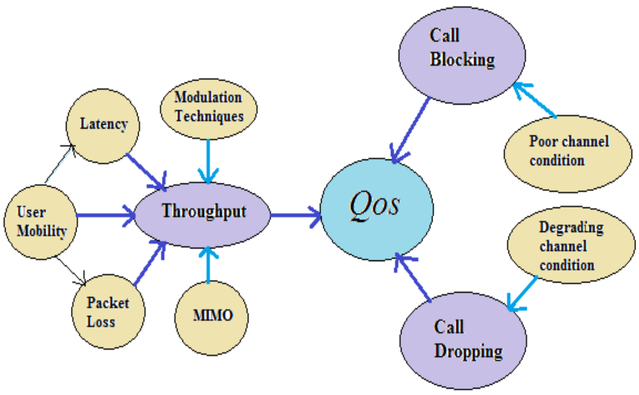

Fig. 2 Factors influencing QoS [9]

B. Challenges of LTE

For understanding a system it is very necessary to understand its goals and targets. Challenges for LTE are given below briefly:

- Scalable bandwidth from 1.25 to 20 MHz. To support transmission bandwidth up to 20MHz LTE include a modified radio-interface physical layer along with new transmission schemes.
- LTE is being designed to ensure high performance between 15 and 120km/h and still expected to maintain mobility at speeds between 120 and 350km/h even up to 500km/h for some frequency bands. LTE support for high speed mobility with reliability for example in high speed trains up to 500km/h. LTE is expected to support voice and real-time service quality without interruption.
- LTE has significantly increase data rates e.g. 100 Mbps in downlink and 50Mbps in uplink with increase in data rates for cell edge users too.
- There is significantly improved spectrum efficiency and reduced latency in LTE.
- LTE supports for inter working with 3G and non 3G systems.
- LTE supports enhanced- IP Multimedia Services and Multicast Broadcast Multimedia Services.
- This system has reduced cost and power consumption.

Advantages of LTE

1. Makes better utilization of network.

2. Provides enhanced reception performance

3. Multiple site reception increases received power

4. By using specialized combining techniques it is possible to utilize the interference constructively rather than destruct [10].

III. LTE ARCHITECTURE

LTE network architecture is termed as 3GPP EPS (Evolved Packet System) which is designed to be flat and all IP based structure. It support only packet switched services. EPS framework consist of Evolved Packet Cores (EPCs) and Evolved UMTS i.e. Evolved Universal Terrestrial Radio Access Networks (E-UTRAN) as shown in figure 3.

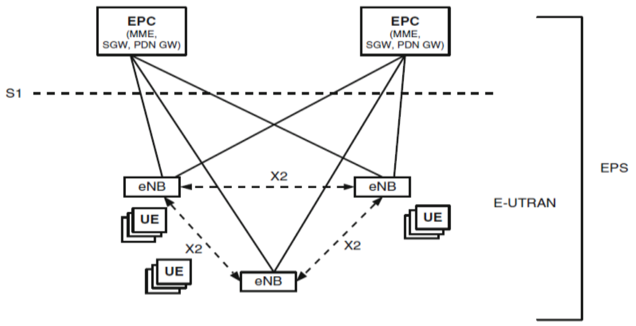

Fig. 3 LTE architecture [6]

As shown in figure 3 EPCs communicate with each other and with E-UTRANs. EPC contains a Mobile Management Entity (MME), System Architecture Evolution Gateway (SGW), Packet Data Network Gateway (PDN GW). E-UTRAN alone contains Evolved Universal Terrestrial Radio Access Network Base Stations (eNB) where the User Equipment (UE) communicates with eNB and eNBs communicate with each other and with the EPCs. There is one-to-one communication between UE and eNB but there is one-to-many communication among eNB, MME, and SGW.

● <u>The EPS (Evolved Packet System):</u> It is based on TCP/IP protocols to enable PC-like services including voice, video, rich media, and messaging. This migration also enables improved interworking with other fixed and wireless communication networks as seen in Fig. 4.

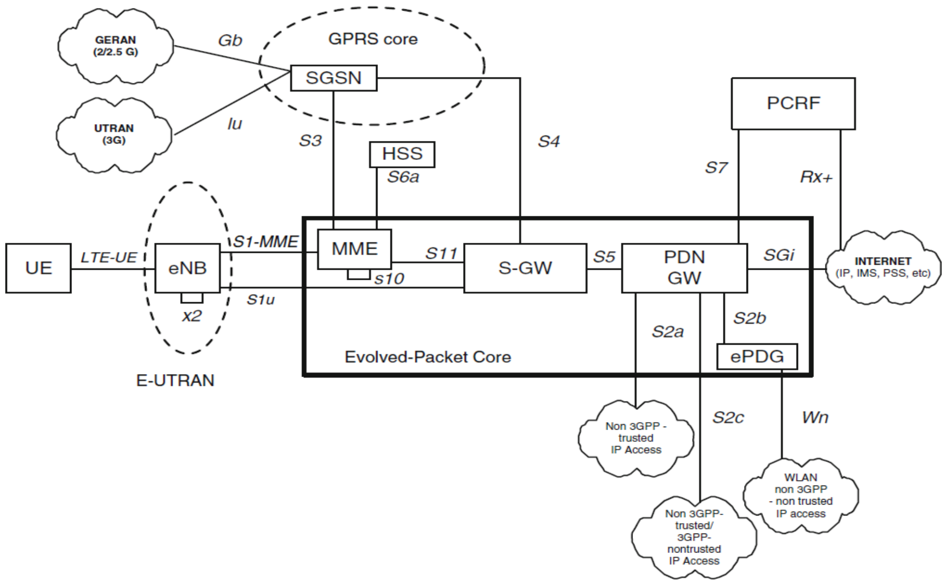

Fig. 4 LTE integration [5]

● <u>MME (Mobility Management Entity):</u> MME connects to eNBs with S1-MME interface, SGWs with S11 interface and to SGSN through S3 interface as seen in figure 4. The NAS protocols hosted in the MME support for the mobility between LTE and other 3GPP or non-3GPP access networks.

In short, MME performs the following functions:

1. Selecting SGW for a UE at the network entry

2. Performing intra-LTE handover

3. Paging – distribution of messages to eNBs

4. Handing security key management

5. Providing mobility in idle state

6. Ciphering and integrity protection of NAS signaling

7. Allocating temporary IDs to UEs
8. Handling mobility to other 3GPP or non-3GPP access networks
9. Terminating the S6a interface toward the home HSS when UE roams.

● SGW (Serving Gateway): SGW is responsible to provide routing and forwarding of user data packets with S1-U interface.

● PDN GW (Packet Data Network Gateway): The Packet Data Network Gateway (PDN GW) provides connectivity to external packet data networks and operates as the main mobility point.

● E-UTRAN (Evolved UMTS- Evolved Universal Terrestrial Radio Access Network): It consists of eNBs, which is the base station of LTE and responsible to provide the E-UTRA user plane and control plane.

● eNB (Evolved Node B): Evolved NodeB (eNB) is the only entity in the evolved-RAN (E-UTRAN) that interfaces with User Equipment (UE) through LTE-UE interface. eNB hosts the PHY, MAC, Radio Link Control (RLC), and Packet Data Control Protocol (PDCP) layers.

● UE (User Equipment): User Equipment (UE) consists of user-plane and control-plane protocol stack. User-plane protocol stack consists of PDCP, RLC, MAC, and PHY layers, which communicates with eNB through LTE wireless link.

IV. COMMUNICATION CHANNEL STRUCTURE

Communication between the layers of UE and eNB is established via channels as shown in figure 5. There are logical channels that are mapped to transport channels and transport channels that are mapped to physical channels. Logical channels are identified with respect to the information carried by them and transport channels are distinguished according to their transmission characteristics.

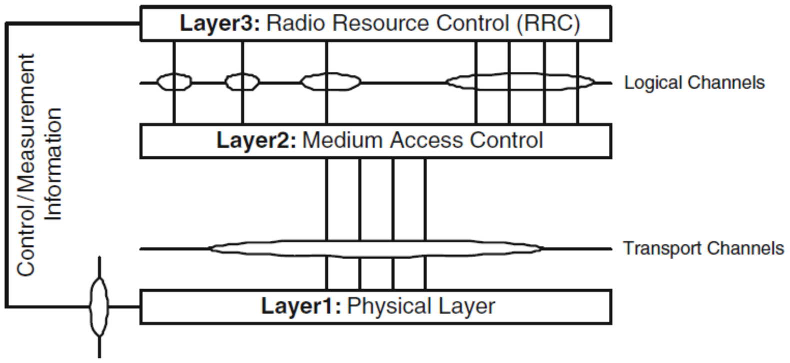

Fig. 5 Communication Channel Structure [5]

There are two types of logical channels: control and traffic channels.

Control channels are as follows:

● BCCH: Broadcast Control Channel is to transmit broadcasting system control information.

● PCCH: Paging Control Channel is to transmit paging information when UE is unlocated.

● CCCH: Common Control Channel is used by UE when UE has no RRC connection.

● MCCH: Multicast Control Channel is used to transmit MBMS control information, which is point-to-multipoint (eNB to UEs) and only UEs that receive MBMS use it.

● DCCH: Dedicated Control Channel is a point-to-point bidirectional channel used by UE for RRC connection.

Traffic channels are as follows:

● DTCH: Dedicated Traffic Channel is a point-to-point bidirectional channel dedicated to one UE to transfer user information.

● MTCH: Multicast Traffic Channel is a point-to-multipoint channel for transmitting traffic data from the network to the UE.

Transport channels provide structure passing data to/from higher layers. Transport channels are connected to physical channels.

Transport channels for downlink are as follows:

● BCH: Broadcast Channel transmits entire cell area with fixed transport format.

● DL-SCH: Downlink Shared Channel is used for HARQ.

● PCH: Paging Channel is used for UE DRX, broadcast over cell coverage.

● MCH: Multicast Channel provides support for Multicast Broadcast.

Transport channels for uplink are as follows:

● UL-SCH: Uplink Shared Channel is used for HARQ.

● RACH: Random Access Channel is for limited control information.

LTE downlink physical channels are as follows:

● PDSCH: Physical Downlink Shared Channel is utilized for data and multimedia transport. It is designed for high data rates with QPSK, 16QAM, and 64QAM modulation.

● PDCCH: Physical Downlink Control Channel conveys UE-specific information with QPSK.

● CCPCH: Common Control Physical Channel conveys cell information with QPSK modulation.

LTE uplink physical channels are as following:

● PUSCH: Physical Uplink Shared Channel is allocated by the UL scheduler with QPSK, 16QAM, or 64QAM modulation.

● PUCCH: Physical Uplink Control Channel carries uplink control information and uplink scheduling requests [5], [11].

V. CONCLUSION

The third Generation Partnership Project (3GPP) addresses next generation IP-based OFDMA technology with Long-Term Evolution (LTE) in order to accommodate increasing mobile data usage and new multimedia applications. 3GPP LTE/SAE is a next generation radio access system which supports future crowd in mobile communication. To reduce delays, one of the most and possible evolution of 3GPP is QoS concept. LTE introduced in release 8 having 2600MHz frequency band. It further improves data rates in downlink up to 170 Mbps and 85 Mbps in uplink. The paper provides the valuable and concise information to the researchers in the area of 3GPP LTE and 4G.

ACKNOWLEDGMENT

This paper could not be completed without my guide Dr. Uttam Kolekar who helped me a lot with continuous spirited guidance and inspiration.

I would also like to thank our Ph.D. Coordinator Dr. M. D. Patil, Principal Dr. Ramesh Vasappanavara for encouraging me to shape my interest and ideas.

Finally I would like to acknowledge most especially to my family, friends and especially to God who made all things possible.

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