3GPP: LTE- AN INNOVATIVE TECHNOLOGY TOWARDS 4G WIRELESS NETWORKS

J Vijay Franklin
Lecturer, Department of Computer Science and Engineering,
Bannari Amman Institute of Technology, Sathyamangalam
Dr. K.Paramasivam
Professor, Department of Electronics and Communication Engineering,
Bannari Amman Institute of Technology, Sathyamanglam

Abstract:

3GPP: LTE –Long term evolution is baseline to the modern 4th generation communication technology, that is an enhanced version of Universal Mobile Telecommunication System (3G). LTE is introduced by 3GPP.LTE is standardized in the form of REL-8, this is operated in data rate 100 Mbps for downlink and 50 Mbps for uplink in the 20 MHz bandwidth. LTE can accommodate up to 200 users in cell (5 MHz). The objective of LTE is to reduce costs, providing high performance, enhances the features, improves the data transfer speed, and reduce resource utilization. The main advantages are it provides end –to-end Qos, Enhanced multimedia broadcast service, spectrum flexibility. It uses OFDM for modulation. In OFDM a large no of sub carriers are used to convey the data. Each and every sub carrier carries one data. Data will be split into no of data streams. And also it uses SC-FDMA, for single carrier modulation. For downlink LTE uses OFDMA with CP. MIMO (multiple-input Multiple-output) is an antenna technology used to improve the performance of communication. In this multiple antenna are used to send and receive multiple data streams. LTE uses a new resource scheduling algorithm called multi carrier channel dependent resource scheduling

Key Words: LTE, HSPA, OFDM, Qos, Handoff

Introduction

Modern wireless technologies have grown in tremendous way. LTE is a new technology that has been developed by 3GPP 2 LTE focus on enhancement in UMTS system. It optimizes the architecture of 3G system. LTE operates 15 to

100 times faster than current 3GPP system. LTE supports both frequency division duplex (FDD) and time division duplex (TDD) modes, allowing operators to address all available spectrum types. Nowadays people are using HSPA (high speed packet access) technology for send and receiving data through internet. LTE will replace HSPA by providing the following benefits,

- *Simplicity*-supports flexible carrier bandwidth
- *Capacity*-provides key features for uplink and downlink
- *Performance*-operates in very high speed eg:160 Mbps by Ericsson
- *Wide range of terminals*- operates in heterogeneous terminals

It allows the existing HSPA to create UMTS with high data rates, low latency and wider spectrum. LTE managing multimode devices that is compatible with existing 3G technologies. Cost efficiency plays an important role in the success of LTE in 4G technology evolution. This paper describes the architecture, Qos, Security, Handovers and advantages of LTE advanced system.

LTE Architecture

LTE architecture is designed for improving the performance, reducing the cost and delivering the services in more efficient way. Fig shows the Service Architecture Evolution (SAE) of LTE. It has two nodes, eNodeB (evolved Node B) as base station of LTE, and AGW (SAE Gateway). All base stations are interconnected with IP based network AGWs are connected with eNodeB by using IP-based interfaces. LTE system standardizes the existing interfaces of HSPA for the interconnection of networks.

The existing architecture of WCDMA, CDMA2000, HSPA, and SGSN are integrated for developing the design of LTE. This helps the system to achieve the handovers in various networks. The architecture has several modules, each and every module have specific functionalities. LTE uses retransmission technology for regulating the packets in eNodeB. For this base station have control plane and buffer for high speed data retransmission S1 interface is used to connect eNodeB and Evolved packet core, X2 is used to interconnect eNodeBs. eNodeBs is providing compression and encryption methodologies to the users. It is responsible for Routing.

Protocol Architecture

Fig.2 shows the protocol structure of LTE, Physical layer is used to offers the information to higher channels by using transport channels. Physical layer is also called as Layer 1 of the protocol stack.

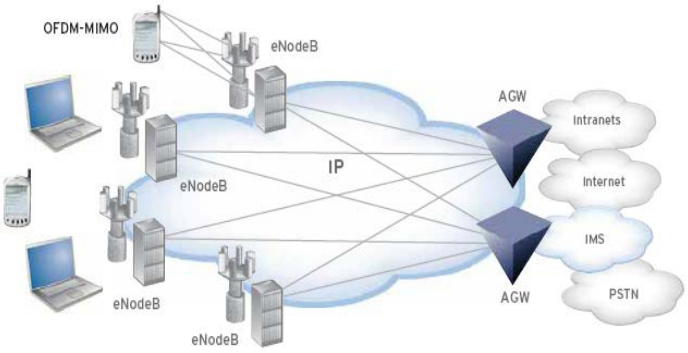

Fig1: Architecture of 3GPP: LTE

Transport channels describe characteristics of the data is to transmit. In layer 1 uses different channels for uplink and down link those are,

Down Link Transport channels

- *Down Link Shared Channel* (DL-SCH) - Shared among UEs with in cell.
- *Broadcast Channel* (BCH) - broadcasts the information to UE
- *Paging channel*(PCH)-Supports for Broad cast
- *Multicast Channel*(MCH)-Broad cast to multiple cells

Uplink transport channels

- *Uplink shared channel*(USCH)- shared between all UEs within a cell
- *Random access channel*(RACH)- access to UTRAN

Layer 2

Layer 2 of the protocol stack is divided into three sub layers *Medium Access layer(MAC),Radio link control(RLC)* and packet data convergence protocol it describes what to be transferred by using the transport channels of Layer 1

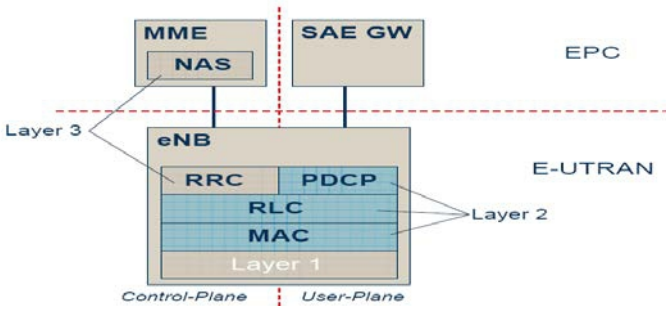

Fig2: Protocol Architecture

These logical channels are divided into control channels and traffic channels. Control channels transfers the control plane information. Traffic channels transfers the user plane information

Control channels

- Broad cast control channels(BCCH)-Broad casting control information
- *Common Control Channel*(CCCH)-transfers control information between UEs
- *Dedicated Control Channel*(DCCH)-Point to point channel transfers data between UEs and network
- *Multicast Control Channel* (MCCH)-point to multi point channel transfer MBNS information.

Traffic channels

- *Dedicated Traffic Channel* (DTCH)-dedicated to one UE for uplink and down link
- *Multicast Traffic channel*(MTCH)-one to many channel transfers traffic information to entire network

Radio Resource control

RRC is layer3 of LTE protocol stack, which is used to takes care of control signals and handovers between eNodeBs in the network, it is responsible for paging, intera-cell handovers, Qos, Broadcasting, security and reporting & control information. And also it takes care of the establishment of radio barriers.

Orthogonal frequency division multiple access (OFDM)/ Downlink

In LTE system uses OFDM for downlink transmission. OFDM splits the entire system is divided into multiple data streams. Each stream is modulated independently by low rate data stream. OFDM provides flexibility, spectrum efficiency and throughput for data streams. It allows the user to access the provided bandwidth. TDD is used by user to access the bandwidth .data is allocated in terms of resource blocks. Each block consists of 24 sub carriers in frequency domain. Total number of blocks available is depends upon the bandwidth. Size of the block is same for all blocks. it uses FFT for converting the signals into data streams. Allocation of blocks will be performed in scheduling process that is taken place in eNodeB. In down link operation the following are the major tasks.

- Scheduling
- Symbolization & Cell search
- Link adaptation
- Hybrid ARQ

The first task is scheduling the time and resources are allocated in a downlink format.

Adaptive modulation and coding technique is used for link adaptation. Hybrid ARQ is retransmission protocol; it retransmits the incorrectly received data packets**.**

Single carrier Frequency division Multiple Access (SC-FDMA)/ UPLINK

For uplink Data transmission. In OFDM Technology it uses multiple data streams, it does not require for uplink the data. So that it uses SC-FDMA scheme for uplink User equipment needs the flexible and power efficient methodology. SC-FDMA provides these constrains in effective manner.

Fig3: Interfaces in LTE Source: [16]

It has the features of OFDM and PAPR (Peak –to-Average Power Ratio) .SC-FDMA uses DFT for converting the signals. It uses the data sub carriers of OFDM scheme it coverts the binary input to modulated sub carriers. In OFDM it uses FFT but here SC-FDMA uses DFT.

Multiple Input Multiple Output (MIMO)

The communication link between the sender and receiver is made-up of MIMO system. MIMO is innovative antenna technology that is used in LTE. In this each antenna uses same spectrum for transmission. At the time of transmission the data stream is divided among multiple antennas, these antennas improve the data rate of transmission. It allows multiple UEs can transmit at same time. Each eNodeB consist of two antennas for sending and two antennas for receiving the data. MIMO is used to achieve throughput and spectral efficiency. The capacity of wireless environment is improved by the combination of MIMO and OFDM. It enhances the spectral efficiency. it maximizes the spectrum of usage. The magnitude of data streams for uplink and downlink will be increased. The entire data stream is mapped with the multiple antennas of MIMO.MIMO performs the beam forming operation, and enhance the air interfaces for transmission.

Quality of service

LTE provides end to end Qos. Qos is defined as facility to provide the guarantee of the performance of data flow for heterogeneous users. Qos ensures the service quality for each user. This will be depends upon the requests made by users. In the LTE system all Mobile broadband services are performed by packet switched connections. LTE Qos has two parameters one is for delay sensitive packets from the user equipment and another is for monitoring the packet lose ratio.

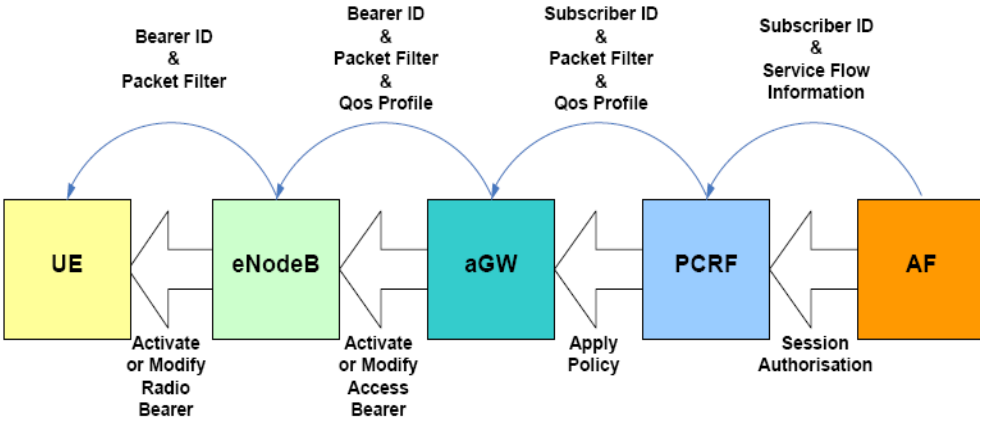

Fig 4: QoS Architecture Source: [2]

Fig 4 shows QOS architecture for LTE in this Application Function (AF) initiates the session authorization activity which has information about Subscriber ID (SID) and service flow. By using this information policy charging and rules function generates QoS profile and packet filtering function. Access Gate Way (aGW) is used to perform the activation, modification of access barrier operation and applies the end to end Qos policy. Enhanced Node B (eNodeB) is a base station (as per standards of 3GPP) transfers the profiles of quality policy and barrier ID for user Equipment (UE).in the first phase AF gives the details need to frame the Quality policy. PCRF frames the QP and applies the policy in the aGW. QP assures the following

- Guaranteed delivery
- End to end Qos
- Applied to all traffic

Handover in LTE

Hand over mechanisms in LTE are defined in 3GPP TS 23.401standard.The user equipment is moving one place to another place the UE has change its eNodeB, aGw, and MME. The LTE interface architecture consist of s1 and X2 interfaces, based on these two the handovers or classified into two categories

- S1 based handovers: For change in eNodeB, aGw and MME
- X2 based handovers: For change in SGW

Hand over mechanism of LTE has several control transfer operations. The Source eNodeB will have the

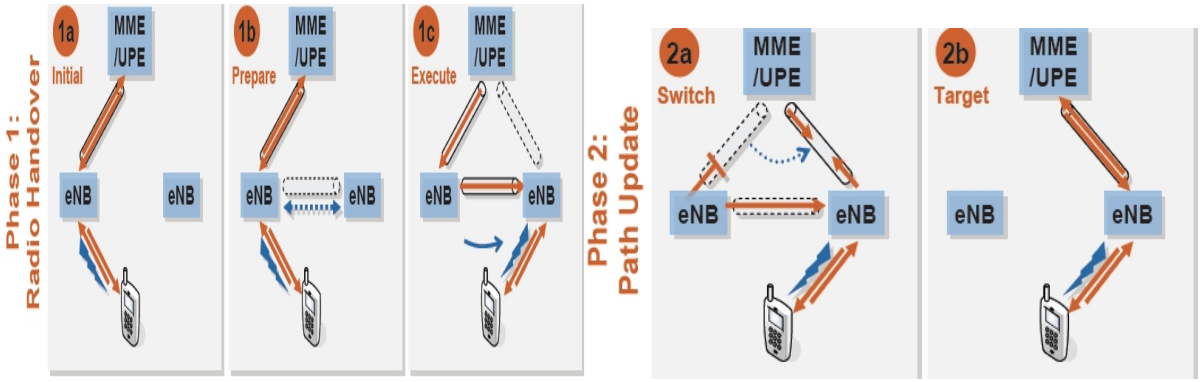

Fig 5: Hand over in LTE Source: [2]

Collection of measurement reports and its sends the handover request to the target eNodeB. The target eNodeB replies the ACK message to the source. Downlink allocation and handover command will be issued to UE by source eNodeB. The UE will get detach from the Source eNodeB and perform the delivery of SN status and data. This data will be stored in the buffer of target eNodeB the signal request. Synchronization and handover conformation will be performed as per the path switch and its response of user plane control of SGW.

Security in LTE

LTE uses specific security functions for data transmission; it concentrated on signaling protection, user plane protection, network domain security, authentication and key agreement. The same UMTS AKA is reused in LTE; it provides confidentiality and integrity for data transmission. LTEs security mainly deploys on the subscribers authentication and traffic protection. The enhanced version of 3G AKA protocol is used to provide subscriber authentication between UE and MME. Access management entity (ASME)[9] is used to provide the protection for architecture of LTE over traffic.

The authentication mechanism consist of for major operations those are eNodeB authentication, Integrity verification, device authentication and device binding authentication can be provided by either operator of the network or mutual authentication by eNodeB or authentication by certificates. The third is performed by IKEv2 protocol ASME provides the keys for authentication and as well as encryption of data for MME and encryption schemes for the interfaces in LTE system.

In this system the keys (K_ASME) are derived from the ASME and to allocate to MME; the keys derived from K_ASME are send to UE. LTE provides end –to- end security to the interfaces. This system uses crypto algorithms for security, it uses128-EEA1 and 128-EIA1 and also AES is used for encryption and decryption in UE.LTE has plenty of other security mechanisms like Device integrity check, location locking, access control mechanism, clock synchronization The following figure shows integrity protection optimum cost.

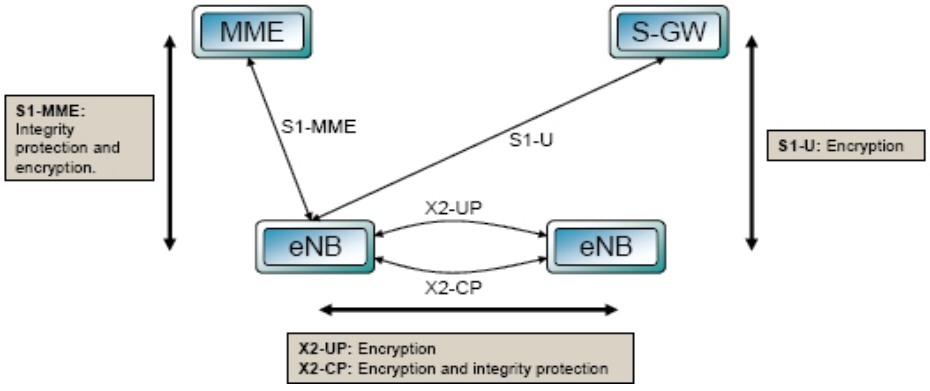

Fig 6: Encryption in LTE Architecture Source: [4]

Conclusion

LTE 3GPP: is designed to provide a incredible performance with high data rates, high security, low latency and high flexibility. And also it provides end to end Qos, Handovers with spectral efficiency and cost. This paper describes the introduction to the methodologies and the behavior of 3GPP: LTE system. The tremendous features of LTE will gives higher end technology with the and UE.

The architecture of LTE has the compatibility to accommodate future enhancements like LTE – Advanced. IMS towards the Rel-9, Rel-10 of 4G. The access methodology of this LTE supports instantaneous radio interfaces; it uses new technologies like MIMO, it improves the power consumption, reduced interferences and increased quality of signal. LTE provides advanced security mechanisms for data transmission and hand over. The security functions of LTE will provide a secured architecture for business environments LTE architecture has established a baseline to future 4G wireless networks.

Glossary:

HSPA High Speed Packet access
LTE Long Term Evolution
OFDM Orthogonal FDMA
MIMO Multiple input, multiple outputs
MME Mobile Management Entity
PAPR Peek to Average Ratio
E-UTRN Evolved Universal Terrestrial
Radio Access Network
SC-FDMA Single Carrier FDMA
3GPP 3G partnership program
aGW access Gateway
QoS Quality of service

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