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LTE Network Structure, QoS Considerations, Bearers and Interfaces

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Abstract: ***in this paper a comprehensive discussion about the entire EPS network structure and functionality of the various nodes residing in both radio access part and non radio network part is provided. The EPS interfaces, bearer establishment, QoS criteria and interworking with other networks such GSM also have outlined.***

Keywords: *EPS, CN, UE, SAE, RAN, PLMN, GBR, QCI, APR, P-GW, S-GW, TFT, SCTP, TCP.*

1. Introduction

In the previous generation of cellular networks the circuit switching technologies are defined and it has used to rout the traffic between the sources and destinations. The long term evaluation (LTE) has exploited the packet switching technology to deliver the data in form of packets through the evolved packet core (EPC) and user equipment UE. LTE goals to provide IP connectivity between network pairs. It encompasses the evaluation of previous cellular network Universal Mobile Telecommunication System (UMTS). That advancement has existed in the system by implementing non-radio aspect services (SAE) along with Radio access network E-UTRAN.

The both SAE and LTE are comprised the Evolved Packet System (EPS). The later is containing of multi functional nodes which are connected by means of unique interfaces. That is allowing network equipments to be resourced from multi vendor. And hence, network operators will be having great opportunity to deal with the manufacturer who fit the requirement from the operator point of view. Different levels of QoS are provided by the network for different data traffic that is taking place by the bearer establishment and efficient traffic flittering.

2. The Network Architecture

LTE network is comprised of two major units, the radio access network which known by E-UTRAN and none radio part that calls core network (CN). The overall system architecture is shown in the figure (1) and describes the two main parts of evolved packet system (EPS) which are the access network and core network. Moreover, the interfaces that link different elements entire the network are standardized in such way that permits the diversity of element vendors hence, that is acting as economical and technical benefit.

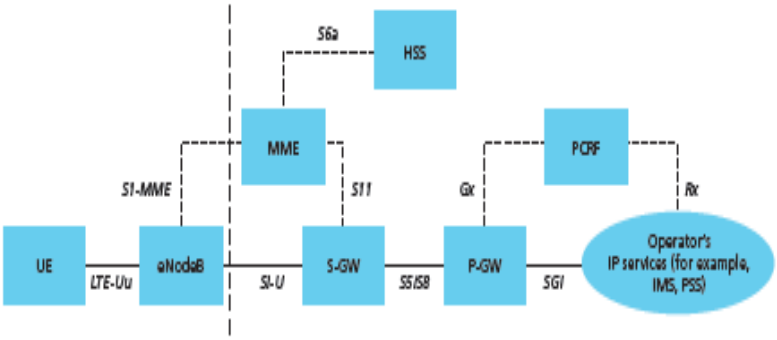

Figure 1: LTE. network

3. The Access Network (E-UTRAN)

The radio related section of (EPS) which are comprised of multiple evolved nodes eNodeBs and it is functional for normal user and network traffics. eNodeBs are connected with each other by means of X2 interfaces and connected with EPC by interfaces call S1. The figure (2) shows the network interfaces and node distributions.

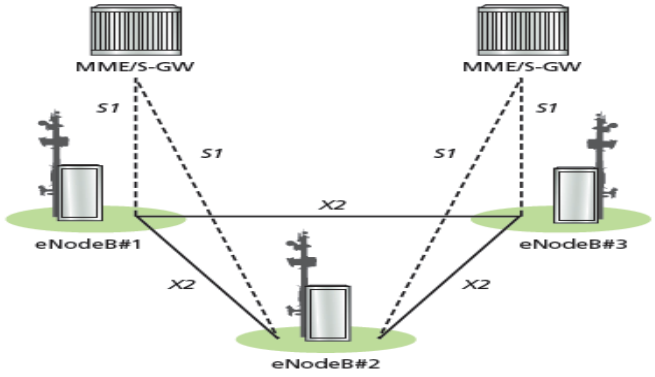

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Figure 2: standard interfaces and nodes

4. The Evolved Nodes eNodeB

In contrast with the lake of centrized control node in LTE system which is managing the cells within the network, LTE has integrated the functions of radio management through the geographical cells into eNodeB. The same has played a big role to improve the interaction efficiency between various layers in Radio Access Network (RAN). One eNodeB can be feed from multiple core networks (CN). The cell which has experienced such circumstances is kwon by pool area. The pool is shown by figure (2) in eNodeB labeled by numerical value (two). The UE whereby controlled in such style will be shared between many core networks (CN). That permits the load sharing among the multiple LTE network and reduce the chance of signal failure.

5. LTE Interconnection with Foreign Networks

All mobile networks has defined the roaming facility when the User Equipment (UE) can connect different with Public Land Mobile Network (PLMN) other than its mother PLMN. LTE has no exception in terms of roaming facilities the P.GW in the core network is handling the roaming facilities within the both home network (that is the user has directly subscribed into it) and the visited network (the one at the area where mobile equipment is roaming through). However, in other scenario when it demands to connect other generation mobile networks such as GSM and UMTS (2G or 3G technologies), LTE has the capability to link such networks also.

The noticeable property in this regard is P.GW which is acting as anchor when 3GPP based network such as GSM and UMTS is willing to connect with LTE and S.GW is playing the same role when none 3GPP networks such as WIMAX and CDMA2000 willing to connect with LTE.

6. Bearers and QoS Aspects

Different QoS levels must be ensured for various applications resided at UE and demanded by LTE subscribers. In order to meet the QoS criteria required by those applications, LTE network has defined bearers and each bearer is associated with certain level of OoS. Each bearer is reserved for particular serves. Different bearers for different applications and they can be segregated base on the bit rate and bandwidth preservation requirements. Hence we have two kinds of bearers: guaranteed bit rate (GBR) and non GBR. The first terminology is used when the application has stringent QoS demands i.e. the VOIP applications that required a high bandwidth and resource availability. On the other hand non GBR is used by the applications required best effort traffic i.e. web browsing file transportation etc.

At eNodeB , the process to assign the QoS variable to the bearers are taking place. Each single bearer will be assigned QCI and ARP values. These two variables are characterized the packet priority, packet delay and the maximum allowable packet losses. The QCI has a standard values from numerical 1 to 12. This unified standard allows the same understanding of the venders who are manufacturing the equipments. This is regarding the underlying network characteristics so that the network operator will be able to behave uniformly with all the traffics from various equipment of network irrespect to their manufacturers. The table below describes the QCI characteristics.

QCI	BEARER	PRIROTY	DELAY	EXAMPLE
1	GRB	2	10^-2	VOICE
2	GRB	4	10^-3	VIDEO
3	GRB	5	10^-6	BUFFERED VEDIO
4	N.GRB	3	10^-3	REAL T.GAMES
5	N. GRB	1	10^-6	IMS
6	N. GRB	7	10^-3	INTERACTIVE GEAMS
7	N. GRB	6	10^-6	VEDIO
8	N. GRB	8	10^-6	CHAT
9	N. GRB	9	10^-6	--

Table 1: the QCI standardized values and applications

7. End to End Bearers Establishment

Bearers are sat up between various interfaces in evolved packet system (EPS) nodes and hence the data are being transported between the UE and EPS effectively as shown in figure (3).

The bearers can be categorized into 3 types depending on which part of networks it take place: S5/S8 transports the data packets between P-GW and S-GW, S1transports packets between S-GW and eNodeB and the radio bearer that transports the packets among eNodeB and UEs. In such style we can separate the bearers in order to meet the QoS criteria demanded form different applications. Therefore the EPS packets need to be filtered based on the QoS aspects as shown in the figure (3) and then the filtered packets are mapped to separated bearers. EPS packet filtering is based on TFT. In which use the IP addresses of both source and destination and the TCP port numbers in order to filter the packets so that the packets will be mapped down (down link TFT) to their particular bearer.

The process of attaching the user equipment into the EPS is being initiated as UE assigns IP address by P-GW and at least single bearer to be created. Such process are called default bearer.

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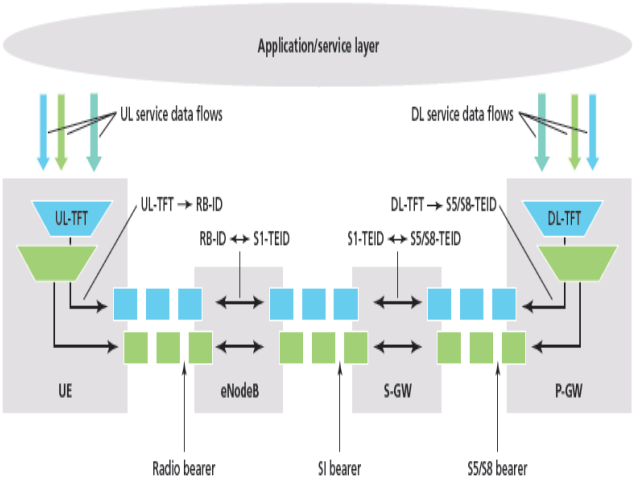

Figure 3: Bearers and interfaces relation

8. S1 Network Interface

The main object of LTE network is to grant the best performance and serve the better QoS to their subscribers. In order to do that the LTE has configured as self optimized network (SON). The LTE self optimized network is implemented and considered at the time of designing step. Also the aspect of self optimized network has taken place in terms of interfaces S1 and X2. S1 interface is established between the eNodeB and evolved packet core (EPC). Logically S1 is contained of two planes: respectively user and control plane.

The control plane is using the SCTP protocol which is an advanced feature inherited from TCP and it is responsible to deliver the signaling control messages effectively. The user plane it defined to deliver the data packets. As discussed the control signaling and data payload traffic are efficiently separated in LTE network.

9. Conclusion

After the review of LTE network structure the noticeable pointes we can make out of this system are the advantages as compare with those networks in previous generation. In terms of the system capacity and data rate as well as the economical and trade effectiveness for both the users who are subscribed to the network and network operators.

Since the interfaces are taking place between different nodes within the network are standardized that is solved the vendors inoperability. Hence the network operator can resource the devices from different vendors according to their own benefits. In the other hand that opens the door of computation among the devices and equipments vendors to provide the best performance in worthy prices.

At the time of design the LTE network the SON concept is implemented. That can ensure the best QoS for the end user in terms of coverage and resources availability.

The need of soft hand off is eliminated in LTE network as a result to integration of radio management and control functions into eNodeB. Thus the performance and network efficiency are improved and roaming services cost has minimized.

The other advantage for the network operator can be dedicated in LTE network is that QCI variable. These variables are standardized and have a values up to 12. So the operator will be expecting a uniformed traffic irrespect to the devices and equipments manufacturers.

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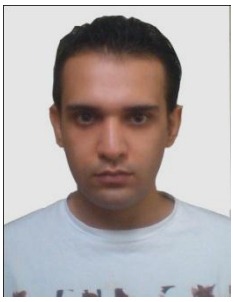

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