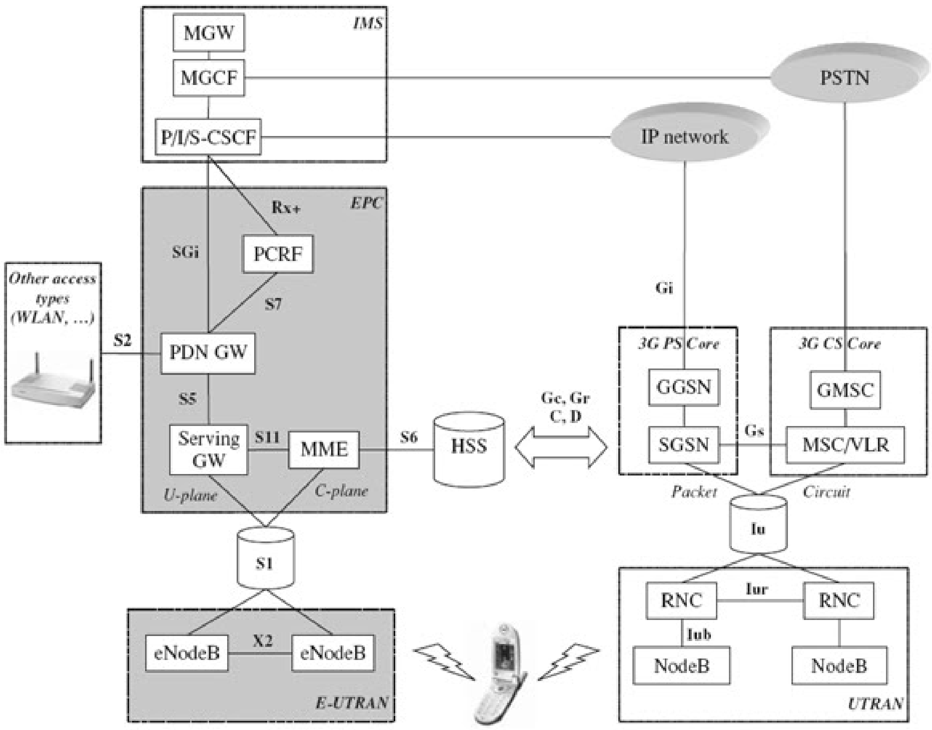
LTE Encyclopedia
Introduction
Advertising
Cell Reselection Procedures in LTE
Contact Us
LTE Acronyms
LTE Contracts and Subscriptions
LTE Directory
LTE Equipment Manufacturers
LTE Network Infrastructure and Elements
LTE Radio Link Budgeting and RF Planning
LTE Link Budget Comparison
LTE RF Planning
Public Safety LTE
Sitemap

LTE Network Infrastructure and Elements

Contents

1. Introduction

The following extract from [1] provides a very good understanding of the overall LTE Network Infrastructure and elements. The Figure below describes the LTE & UMTS overall network architecture, not only including the Evolved Packet Core (EPC) and Evolved UMTS Terrestrial Access Network (E-UTRAN), but also other components, in order to show the relationship between them. For simplification, the picture only shows the signalling interfaces. In some cases, both user data and signalling are supported by the interface (like the S1, S2 or 3G PS Gi interfaces) but, in some other cases, the interfaces are dedicated to the Control plane, and only support signalling (like the S6 and S7 interfaces).



The new blocks specific to Evolved UMTS evolution, also known as the Evolved Packet System (EPS), are the Evolved Packet Core (or EPC) and the Evolved UTRAN (or E-UTRAN). Other blocks from the classical UMTS architecture are also displayed, such as the UTRAN (the UMTS Access Network), the PS and the CS Core Networks, respectively, connected to the public (or any private) IP and Telephone Networks. The IMS (IP Multimedia Subsystem) is located on top of the Packet Core blocks and provide access to both public or private IP networks, and the public telephone network via Media Gateway network entities. The HSS, managing user subscription information is shown as a central node, providing services to all

Core Network blocks of 3G and evolved 3G architecture.

Note: The picture does not represent the nodes involved in the support of charging function.

Discussed below are the individual sub-components:

2. E-UTRAN and eNode Bs

2.1. History from UMTS

From the first releases of the UMTS standard, the UTRAN architecture was initially very much aligned with 2G/GSM Access Network concepts. The general architecture follows the good old 2G/GSM 'star' model, meaning that a single controller (the RNC) may possibly control a large number – the typical number in commercial networks is about several hundreds – of radio Base Stations (the Node B) over the Iub interface. In addition, an inter-RNC Iur interface was defined to allow UTRAN call anchoring at the RNC level and macro-diversity between different Node B controlled by different RNCs. Macro-diversity was a consequence of CDMA-based UTRAN physical layers, as a means to reduce radio interference and preserve network capacity. The initial UTRAN architecture resulted in a simplified Node B implementation, and a relatively complex, sensitive, high capacity and feature-rich RNC design. In this model, the RNC had to support resource and traffic management features as well as a significant part of the radio protocols.

2.2 eNode Bs: The Single E-UTRAN Node

Compared with UTRAN, the E-UTRAN OFDM-based structure is quite simple. It is only composed of one network element: the eNodeB (for evolved Node B.). The 3G RNC (Radio Network Controller) inherited from the 2G BSC (Base Station Controller) has disappeared from E-UTRAN and the eNodeB is directly connected to the Core Network using the S1 interface. As a consequence, the features supported by the RNC have been distributed between the eNodeB or the Core Network MME or Serving Gateway entities.

2.3 The X2 Interface

A new interface (X2) has been defined between eNodeB, working in a meshed way (meaning that all Node Bs may possibly be linked together). The main purpose of this interface is to minimize packet loss due to user mobility. As the terminal moves across the access network, unsent or unacknowledged packets stored in the old eNodeB queues can be forwarded or tunnelled to the new eNodeB thanks to the X2 interface. From a high-level perspective, the new E-UTRAN architecture is actually moving towards WLAN network structures and Wifi or WiMAX Base Stations.

2.4 eNode B Functionalities

Functional definition eNodeB as WLAN access points – support all Layer 1 and Layer 2 features associated to the E-UTRAN OFDM physical interface, and they are directly connected to network routers. There is no more intermediate controlling node (as the 2G/BSC or 3G/ RNC was). This has the advantage of a simpler network architecture (fewer nodes of different types, which means simplified network operation) and allows better performance over the radio interface. As described in Chapter 4, the termination of Layer 2 protocols in eNodeB rather than in the RNC helps to decrease data-transmission latency by saving the delay incurred by the transmission of packet repetitions over the Iub interface. From a functional perspective, the eNodeB supports a set of legacy features, all related to physical layer procedures for transmission and reception over the radio interface:

- Modulation and de-modulation.
- Channel coding and de-coding.

Besides, the eNodeB includes additional features, coming from the fact that there are no more Base Station controllers in the E-UTRAN architecture. Those features, which are further described in Chapter 4, include the following:

- Radio Resource Control: this relates to the allocation, modification and release of resources for the transmission over the radio interface between the user terminal and the eNodeB.
- Radio Mobility management: this refers to a measurement processing and handover decision.
- Radio interface full Layer 2 protocol: in the OSI 'Data Link' way, the layer 2 purpose is to ensure transfer of data between network entities. This implies detection and possibly correction of errors that may occur in the physical layer.

3. Evolved Packet Core (EPC) and its Components

The EPC (Evolved Packet Core) is composed of several functional entities:

- The MME (Mobility Management Entity)
- The HSS (Home Subscriber Server)
- The Serving Gateway.
- The PDN Gateway (Packet Data Network).
- The PCRF (Policy and Charging Rules Function) Server.

The following sub-sections discuss each of these in detail:

3.1 MME (Mobility Management Entity)

The MME is in charge of all the Control plane functions related to subscriber and session management. From that perspective, the MME supports the following:

- Security procedures – this relates to end-user authentication as well as initiation and negotiation of ciphering and integrity protection algorithms.

- Terminal-to-network session handling – this relates to all the signalling procedures used to set up Packet Data context and negotiate associated parameters like the Quality of Service.

- Idle terminal location management – this relates to the tracking area update process used in order for the network to be able to join terminals in case of incoming sessions.

The MME is linked through the S6 interface to the HSS which supports the database containing all the user subscription information.

3.2 HSS (Home Subscriber Server)

The HSS (Home Subscriber Server) is the concatenation of the HLR (Home Location Register) and the AuC (Authentication Center) – two functions being already present in pre-IMS 2G/GSM and 3G/UMTS networks. The HLR part of the HSS is in charge of storing and updating when necessary the database containing all the user subscription information, including (list is non exhaustive):

- User identification and addressing – this corresponds to the IMSI (International Mobile Subscriber Identity) and MSISDN (Mobile Subscriber ISDN Number) or mobile telephone number.

- User profile information – this includes service subscription states and user-subscribed Quality of Service information (such as maximum allowed bit rate or allowed traffic class).

The AuC part of the HSS is in charge of generating security information from user identity keys. This security information is provided to the HLR and further communicated to other entities in the network. Security information is mainly used for:

- Mutual network-terminal authentication.
- Radio path ciphering and integrity protection, to ensure data and signalling transmitted between the network and the terminal is neither eavesdropped nor altered.

3.3 The Serving GW (Serving Gateway)

From a functional perspective, the Serving GW is the termination point of the packet data interface towards E-UTRAN. When terminals move across eNodeB in E-UTRAN, the Serving GW serves as a local mobility anchor, meaning that packets are routed through this point for intra E-UTRAN mobility and mobility with other 3GPP technologies, such as 2G/GSM and 3G/UMTS.

3.4 The PDN GW (Packet Data Network Gateway)

Similarly to the Serving GW, the PDN gateway is the termination point of the packet data interface towards the Packet Data Network. As an anchor point for sessions towards the external Packet Data Networks, the PDN GW also supports Policy Enforcement features (which apply operator-defined rules for resource allocation and usage) as well as packet filtering (like deep packet inspection for virus signature detection) and evolved charging support (like per URL charging).

3.5 The PCRF (Policy and Charging Rules Function) Server

The PCRF server manages the service policy and sends QoS setting information for each user session and accounting rule information. The PCRF Server combines functionalities for the following two UMTS nodes:

- The Policy Decision Function (PDF)

- The Charging Rules Function (CRF)

The PDF is the network entity where the policy decisions are made. As the IMS session is being set up, SIP signalling containing media requirements are exchanged between the terminal and the P-CSCF. At some time in the session establishment process, the PDF receives those requirements from the P-CSCF and makes decisions based on network operator rules, such as:

- Allowing or rejecting the media request.

- Using new or existing PDP context for an incoming media request.

- Checking the allocation of new resources against the maximum authorized

The CRFs role is to provide operator-defined charging rules applicable to each service data flow. The CRF selects the relevant charging rules based on information provided by the P-CSCF, such as Application Identifier, Type of Stream (audio, video, etc.), Application Data Rate, etc.

References

[1] P.Lescuyer, and T.Lucidarme, “Evolved Packet System (EPS): The LTE and the SAE Evolution of 3G UMTS”, John Wiley & Sons Ltd.

External Links

[1] Worldwide Cellular Network Infrastructure Contracts and Market Share Q3 2011 :

http://www.marketresearch.com/Signals-and-Systems-Telecom-v3882/Worldwide-Cellular-Network-Infrastructure-Contracts-6564818/

http://www.researchandmarkets.com/research/4a851c/worldwide_cellular

[2] Worldwide LTE Market Update and Subscription Forecasts Q3 2011 (includes a list of LTE infrastructure contracts) :

http://www.marketresearch.com/Signals-and-Systems-Telecom-v3882/Worldwide-LTE-Update-Subscription-Forecasts-6564973/

http://www.researchandmarkets.com/research/3187a2/worldwide_lte_mark

Comments

You do not have permission to add comments.