

# Pave the Way to Future Smart Living Space - Cross-layer Enhanced AAA for 4G Core Network

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## Abstract

*The 4th generation mobile communication system certainly will have a lot of improvement such as supporting higher multimedia loading, faster transmission rate, and implementation of IP, the future service of the network will definitely convey into an All-IP network. To allow people to better perform their daily living activities, improve the quality of life, and enjoy entertainment and leisure activities. In this paper, we proposed our system. This system is build upon a new technology of a 4G network. The user authentication in heterogeneous network, the key generation, and data encryption, that later merged together into a cross layer network for smart living space. This technology can develop a smart and convenience of living.*

## 1. Introduction

The rapid development of Internet and wireless network enabled people to enjoy the commodity of wireless devices to transmit voice message, exchange data or access to multimedia services. These technologies were developed to modify life style with human being. Nowadays, actually, there are different kinds of technologies and functions for mobile node. The users face the problems with bandwidth limited, dispersible accounting and a great deal interface. The 4th generation network is solution to this problem, it is expected to provide higher multimedia carrier loading ability, higher transmission rate and also it adopts All-IP network structure.

The traditional 7 layered OSI network was implemented for years, each layer is designated some specific task, the layers are working together as the purpose of networking. The layered structure can diminish the complexity of the network structure, and faster the implementation of new technology, make the use of network more flexible. But this also brings the disadvantage, this issues are referred low efficiency in

wireless and mobile network caused by high error rate, power consumption administration, QoS and new mobile networks.

Due to those issues, in this paper, we proposed our system. This system is build upon a new technology of a 4G network. The user authentication in heterogeneous network, the key generation, and data encryption, that later merged together into a cross layer network for smart living space.

Section II introduces motivation. Section III describes the System design analysis. Section IV presents the experiment results. The conclusions are given in section V.

## 2. Motivation

### 2.1. The goal and function of the integration of 4G and WLAN network

Few years ago, 3GPP had analyzed thoroughly the possibility of the merge of WLAN and 3GPP. It proposed 6 steps to reach the goal, starting from the first and the easiest goal “accounting service” until the completion of convergence of all 6 mentioned stages. Each stage will include the works of previews stage. We will give a brief description of each stage.

#### 1) Common billing and service care:

The archive this goal, there is no additional requirement in both 3GPP and WLAN, this is administrative issue, provide the users common billing information that will provide users with the charging information of both 3GPP and WLAN.

#### 2) 3GPP System Based Access Control and Charging:

Using the original AAA mechanism in 3GPP system to unify both networks, the user won't feel any difference while accessing to both different networks. During this stage, users still can't access 3GPP services through WLAN. 3GPP has

designed related standard of this stage, In AAA-server of 3GPP system incorporates the authentication of IEEE802.1x belonging to WLAN, by EAP-SIM authentication. At this moment, the technology has matured.

3) Access to 3GPP system PS Based Service:

Providing the users access to services of 3GPP system through WLAN, such as IMS Based Services, location Based Service, Instant Messaging etc. Since 3GPP system is a private network, to enable its access through other network will need special attention in security issues. To this stage, 3GPP has also defined related standard. It is still in development.

4) Service Continuity:

Enable users having seamless connection while switching from networks while roaming, during the handoff process, the user might experience few moments of transmission interruption, but doesn't require to manually connecting back to the network again. Some services might be stopped due to the new network might not have those service capabilities, related to this issue, there are still many ongoing researches in many organization, and 3GPP hasn't defined yet its standard.

5) Seamless Service:

Eliminate and minimize the tolerated data loss and disconnection of preview stages during roaming. To this stage, 3GPP has also defined related standard. It is still in development.

6) Access to 3GPP Circuit Switch Services:

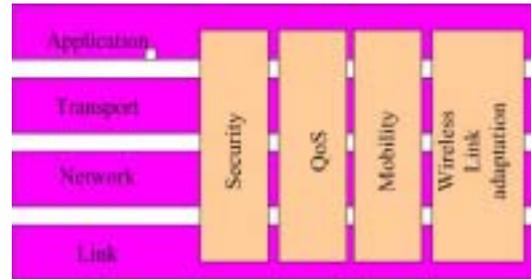
This final step will enable the users to have access to 3GPP Circuit Switch Services through WLAN. To this stage, 3GPP has also defined related standard. It is still in development.

**2.2. Cross-layer**

TCP/IP of traditional 7-layer OSI structure was used for years, using traditional TCP/IP might not be able to solve all encountered problems. Cross-Layer is considered one of the possible solutions. Figure 1 is cross-layer coordination plane, from the picture we can observe that the security is no longer build in a single network layer, the same happens to the mobility.

We used to focus on problems of handoff at IP level,

but now we re-think consider is from the multi-layer point of view, will be possible to solve those problems. Therefore, we proposed to build a 4G testbed which merged many other components such as Wi-Fi network, Core-network, user authentication in heterogeneous network, generation of key, encryption etc.



**Figure 1. The cross-layer coordination plane**

**3. System design analysis**

This system can be separated into few main parts: 1) Combined authentication system of 4G network, WiFi and WiMAX. 2) AAA-Analyzer. 3) Cross layer encryption key generation. 4) Accounting in heterogeneous network. And will be explained by following:

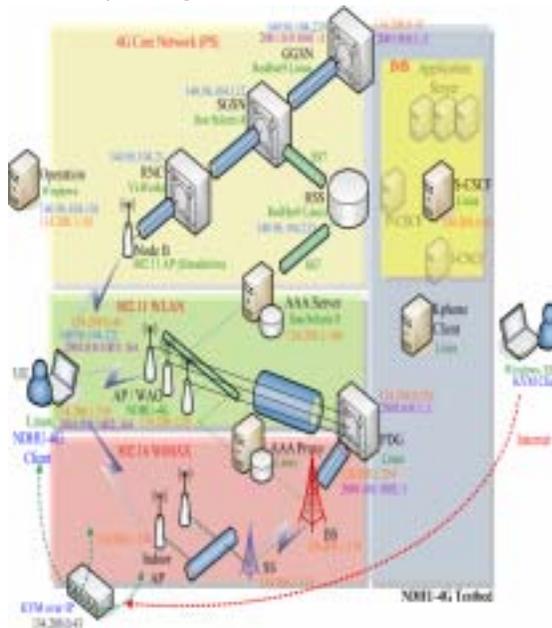
**3.1. Combined Authentication System of 4G, Wi-Fi and WiMAX**

We followed the specification defined in 3GPP to design out system, this system is composed by 2 main components: RAN (Radio Access Network) and Core-Network. RAN includes RNC and Node B. The Core-Network then includes SGSN (Serving GPRS Support Node), GGSN (Gateway GPRS Support Node), and HSS (Home Subscriber Server), as shown in figure 2.

At RAN, Node B works like the access point of wireless network, providing the ability for UE (User Equipment) to connect to core network through radio interface, each RNC can work with single or multiple Node B to form a RNA. RAN is then constituted by these RNS.

At core network, SGSN is responsible for tasks such as connecting to core network with single or multiple RAN, access control, location management, routing management etc. GGSN is an interface responsible of connecting Core Network and outer network, also

routing traveling packets. It is also responsible for mobility management.



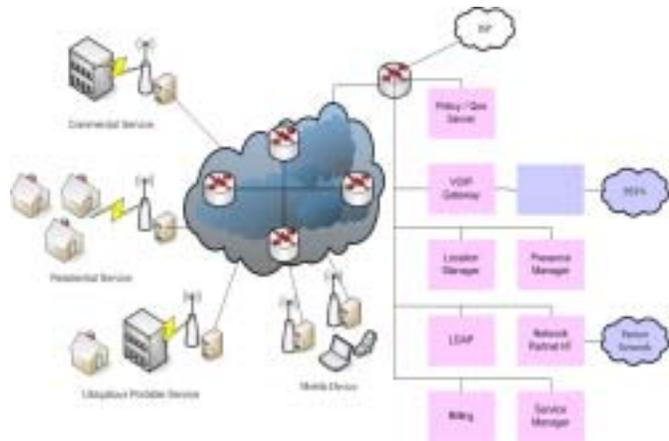
**Figure 2. The cross-layer coordination plane**

HSS is a data center in charged for recording the operations of entire network. HLR is its main component, its function is to store users identity location and registered services that are allowed to be used by the user.

Since the radio frequency used by 3GPP cell phone is licensed band, must acquire legal license, so we used 802.11g which belongs to ISM band instead, through the broadcasting of UDP packets to simulate the radio network, since the protocol stack of the simulation program executed in UE are according to 3GPP standard, all generated packets are identical to packets generated by real 3GPP cell phone, with this program, UE enable us to acquire the flow chart of packets generated through the process of data exchange between UE and the network.

Figure 3,4 is the 4th generation mobile communication system base on WiMAX transmission topology. IEEE802.16 technology was developed in smart living space. Table 1. To classifying WiMAX standards. The integration of heterogeneous network, UE can access to WLAN by acquiring authentication from AAA server with EAP-SIM method. During the authentication process, AAA server must acquire

information related to SIM from HRL, then can perform the later authentication procedure with UE. Beside, AAA server also gathers accounting information, that later will be provided as billing information.



**Figure 3. WiMAX Network Architecture**



**Figure 4. WiMAX is applied Home region environment**

### 3.2. AAA Analyzer

The future telecom services provide will no longer use a plain simple network but an heterogeneous network, authentication and accounting will be the challenge that they will soon experience, as shown in figure 5. AAA-Analyzer can assist in this issue, it's task is to analyze inter-domain or intra-domain procedures performed in single and heterogeneous network, with AAA-Analyzer, we can monitor and analyze the procedure of each packet, and then present it with an easy-understanding graphic. For example, this system can also track the position of children. To avoided lose or