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UMTS vs LTE Coverage by signal level and overlapping zone A Comparative Study

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Abstract-- The purpose of this research is to compare between UMTS and LTE especially in coverage by signal level and overlapping zones . Mobile communication technologies are aiming at responding to the growing demand for higher connectivity . In telecommunication LTE (4G) is the fourth generation of mobile communication technology standards, it is a successor of UMTS (3G), third generation standards. Standards specify how airwaves must be used for transmitting information (voice and data). All radio access technologies have to solve the same problems: to divide the finite RF spectrum among multiple users as efficiently as possible. UMTS use CDMA. LTE use OFDM. Code-division multiple access (CDMA) This uses a digital modulation called spread spectrum which spreads the voice data over a very wide channel in pseudorandom fashion using a user or cell specific pseudorandom code. The receiver undoes the randomization to collect the bits together and produce the original data. As the codes are pseudorandom and selected in such a way as to cause minimal interferenceto one another, multiple users can talk at the same time and multiple cells can share the same frequency. This causes an added signal noise forcing all users to use more power, which in exchange decreases cell range and battery life.

Orthogonal Frequency Division Multiple Access (OFDMA) uses bundling of multiple small frequency bands that are orthogonal to one another to provide for separation of users. The users are multiplexed in the frequency domain by allocating specific sub-bands to individual users. This is often enhanced by also performing TDMA and changing the allocation periodically so that different users get different sub-bands at different times.

An extensive examination of the UMTS and LTE architecture will be explained.

Keywords— UMTS; LTE; CDMA ; OFDMA.

I. INTRODUCTION

The Universal Mobile Telecommunications System (UMTS) is a third generation mobile cellular system for networks based on the GSM standard. Developed and maintained by the 3GPP (3rd Generation Partnership Project), UMTS is a component of the International Telecommunications Union IMT-2000 standard set and compares with the CDMA2000 standard set for networks based on the competing cdma One technology. UMTS uses wideband code division multiple access (W-CDMA) radio access technology to offer greater spectral efficiency and bandwidth to mobile network operators.

UMTS specifies a complete network system, which includes the radio access network (UMTS Terrestrial Radio Access Network, or UTRAN), the core network (Mobile Application Part, or MAP) and the authentication of users via SIM (subscriber identity module) cards.

The technology described in UMTS is sometimes also referred to as Freedom of Mobile Multimedia Access (FOMA)[1] or 3GSM.

LTE, an abbreviation for Long-Term Evolution, commonly marketed as 4G LTE, is a standard for wireless communication of high-speed data for mobile phones and data terminals. It is based on the GSM/EDGE and UMTS/HSPA network technologies, increasing the capacity and speed using a different radio interface together with core network improvements.[2][3]

The standard is developed by the 3GPP (3rd Generation Partnership Project) and is specified in its Release 8 document series, with minor enhancements described in Release 9.

LTE is the natural upgrade path for carriers with both GSM/UMTS networks and CDMA2000 networks. The different LTE frequencies and bands used in different countries will mean that only multi-band phones will be able to use LTE in all countries where it is supported.

Although marketed as a 4G wireless service, LTE (as specified in the 3GPP Release 8 and 9 document series) does not satisfy the technical requirements the 3GPP consortium has adopted for its new standard generation, and which were originally set forth by the ITU-R organization in its IMT-Advanced specification. However, due to marketing pressures and the significant advancements that WiMAX, HSPA+ and LTE bring to the original 3G technologies, ITU later decided that LTE together with the aforementioned technologies can be called 4G technologies.[4] The LTE Advanced standard formally satisfies the ITU-R requirements to be considered IMT-Advanced.[5] To differentiate LTE Advanced and WiMAX-Advanced from current 4G technologies, ITU has defined them as "True 4G".[6][7]

II. METHODOLOGY

In this paper has been used tool simulation program to simulate the third and fourth generation of mobile network and compare the results with each other by using ATOLL simulation .

III. LITERATURE REVIEW

A. UTMS

Universal Mobile Telecommunications System (UTMS) is considered to be an effective and efficient 3G mobile communication system in which there is an incorporated radio interface system. Additionally, it has been observed that the radio interface system is

significantly based on Wideband Code Division Multiple Access (WCDMA). The radio frequencies that have been used in this system are of the order of 1900-2025 MHz as well as 2110-2200 MHz. It may not be wrong to say that the system is considered to be among the top most 3G mobile systems[8]. In this mobile system, a range of wireless multimedia communications is possible that are spread across the entire internet protocol. It has been observed that this system allows a number of different mobile internet users for the purpose of enabling them to access a variety of multimedia contents. These contents are available across the entire internet and they are considered to be arranged in a seamless fashion with data rates that are as much as up to 2 Mbps inside and 384 Kbps outside[9].

1) UMTS Architecture

It may not be wrong to say that the entire UMTS system effectively utilizes the most used and most common architecture that is incorporated by almost all primary 2G systems. A simplified structure of architecture is significantly composed of various elements that are related to the logical network. These compositions are based on the basis of well-defined functionalities. In addition to this, it has also been observed that UTMS effectively employs WCDMA as on if its main and principle standard for the purpose of carrying out tasks that are related to air interface [9]. Moreover, this concept is effectively defined to be standardized by the prominent 3rd Generation Partnership Project (3GPP). In addition to this, the network elements that are the components of the system are carefully grouped into UTMS Terrestrial Radio Access Network (UTRAN), the Core Network (CN) and the User Equipment (UE)[10].

The CN is defined as the one in which the switching and routing of the calls as well as data connection is done with the external and far-fetched networks. Furthermore, the UE is responsible for effectively interfacing the user applications with the radio interface. This is done so that a better transmission and communication between the objects is possible and the losses due to noise signals may be effectively removed. It has been observed that the UTRAN is significantly composed of a Node Bs which is observed to be connected to a suitable and error free Radio Network Controller (RNC)[11]. This connection is made via a productive Iub interface. Here, it is significant to understand that a comparatively more generic and commonly used term for a Node B is considered to be a base station. Additionally, CN, which is unambiguously and rightfully considered to be the backbone of the entire system of UMTS, aims to correctly encompass the Serving GPRS Support Node (SGSN). CN also works to encompass the Gateway GPRS Support Node (GGSN) also. Apart from this, UE is such a mobile station that is effectively linked to the Node B. This linkage or connection is made through the whole radio interface of UMTS[12].

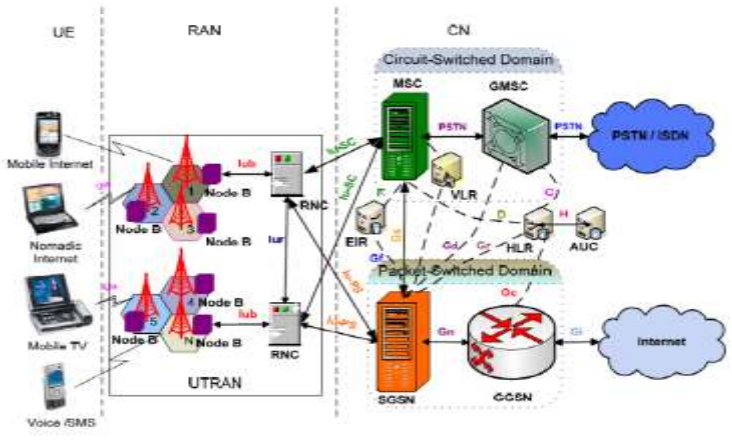

Fig.1 UMTS Architecture (Source: Google)

2) Core Network (CN)

To understand the concept of CN in absolute detail, it may not be wrong to say that the processes of the UTMS systems that are associated to CN are considered to be the primary reason behind the telecommunications system at large. These CN aims to provide absolute connections with the different devices in the system. One of the most common types of 3GNC is considered to be the one, which is based on the GSM network with the GPRS. In addition to this, the most important primary functions of the CN are related to the provision of switching, routing and transiting for effective user traffic. In addition to this, it has also been observed that the entire 3G network is divided into two main domains. These are defined as the two domains related to circuit switching and packet switching. The following lines aim to discuss the elements and components of circuit switched domain in comprehensive detail[13].

3) User Equipment (UE)

This type is effectively called as the user equipment. In addition to this, it has been observed the UMTS UE is typically based on the same principles as that of the GSM MS. This may aptly be defined as the separation or segregation between the mobile equipment and the UMTS subscriber. In addition to this, it has been observed that the USIM card is found to contain the subscriber-related information which is linked to the concepts such as authentication and encryption [11].

4) Benefits of UMTS

It has been observed that there are a number of different benefits that are related to the UMTS network. Some of these are described in brief detail in the following lines.

- It is a subscription, which is always-on.
- It is personalized and has a feature that is aware of the location.
- It operates in real-time and is considered to be flexible.
- A wider range of services that are related to multimedia.
- Data rates are higher for a large number of users.
- Network efficiencies are improved, which are considered to have a positive impact on lowering the cost in the long-term.
- There is a feature of IP transport in not only Access but core networks as well.
- The support and the transport functionalities are found to be in separation.
- Mobile devices have this feature of IP multimedia services [12].

5) Pitfalls in UMTS

In addition to the advantages discussed in the aforementioned paragraph, there are certain pitfalls and challenges that are related to UMTS. The following points aim to discuss them briefly (UMTS Forum, n.d).

- The overall financial cost of the entire cellular infrastructure is extremely high because it has the costs of the upgrading data base station incorporated in it.
- The structure is designed as such that it needs a number of different handsets.
- significantly leads to a comparatively higher data rate for different users that are found to have certain favorable radio conditions[8].
- it has been observed that the power consumption related to the system is high.
- It requires closer base stations and therefore they are considered to be expensive.

- The costs that are related to licensing of the spectrum, network deployment and the handset subscribers are found to be tremendous [14].

B.LTE

The pre-4G 3GPP Long Term Evolution (LTE) technology is often branded "4G-LTE", but the first LTE release does not fully comply with the IMT-Advanced requirements. LTE has a theoretical net bit rate capacity of up to 100 Mbit/s in the downlink and 50 Mbit/s in the uplink if a 20 MHz channel is used — and more if multiple-input multiple-output (MIMO), i.e. antenna arrays, are used.

The physical radio interface was at an early stage named High Speed OFDM Packet Access (HSOPA), now named Evolved UMTS Terrestrial Radio Access (E-UTRA). The first LTE USB dongles do not support any other radio interface.

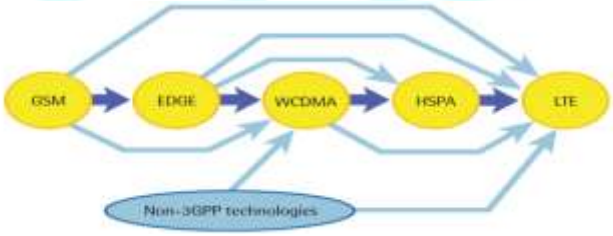

Fig.2 mobile generation (Source: Google)

LTE provides a smooth evolutionary path for operators deploying all 3GPP and non-3GPP technologies. In parallel with its advanced new radio interface, realizing the full potential of LTE requires an evolution from today's hybrid packet/circuit switched networks to a simplified, all-IP (Internet Protocol) environment. From an operator's point of view, the pay-off is reduced delivery costs for rich, blended applications combining voice, video and data services plus simplified interworking with other fixed and wireless networks. By creating new value-added service possibilities, LTE promises long-term revenue stability and growth for around two hundred mobile operators that are already firmly committed to the UMTS/HSPA family of 3G systems. Just as importantly, it provides a powerful tool to attract customers who are provided with an increasing number of technology options for broadband connectivity on the move. Based on the UMTS/HSPA family of standards, LTE will enhance the capabilities of current cellular network technologies to satisfy the needs of a highly demanding customer accustomed to fixed broadband services. As such, it unifies the voice-oriented environment of today's mobile networks with the data-centric service possibilities of the fixed Internet.

Another key goal of the project is the harmonious coexistence of LTE systems alongside legacy circuit switched networks. This will allow operators to introduce LTE's all-IP concept progressively, retaining the value of their existing voice-based service platforms while benefiting from the performance boost that LTE delivers for data services[12].

LTE Key Features

From a technical point of view, a fundamental objective of the LTE project is to offer higher data speeds, for both down- and uplink transmission. Apart from this increase in raw data rates, LTE is characterized by reduced packet latency; the restriction that determines the responsiveness of gaming, VoIP, videoconferencing and other real-time services.

From an operator's perspective, the flexible channel bandwidths and harmonized FDD/TDD modes of LTE provide a more efficient use of carriers' existing and future spectrum resources. LTE also provides a more robust platform for operators to offer compelling value-added services in the mobile domain. The key

characteristics of LTE are summarized here, with specific comparison with today's UMTS/HSPA networks:

- Enhanced air interface allows increased data rates
- High spectral efficiency
- Flexible radio planning
- Reduced latency
- An all-IP environment
- Co-existence with legacy standards and systems [15].

2) Advantages of LTE

Higher data rates and lower latency make LTE connections more responsive, enabling real-time multicast applications, such as online gaming and video conferencing. Choosing the 700 MHz frequency as the basis of the Verizon Wireless network results in a longer range from the base station, compared with systems operating at 2.5 GHz or 3.5 GHz. In addition, using the 700 MHz frequency allows for better in-building penetration and coverage by wireless signals, helping to improve network conditions. LTE also offers mobile users better coverage as they travel by providing seamless handover and roaming for true mobility.

LTE is better suited for global adoption than WiMAX. Although 2.5 GHz, 3.5 GHz, and 5.8 GHz bands are allotted in many regions of the world, many growth markets require new allocations to service their populations. Given the diverse requirements and regulations of various governments, it will be a challenge for WiMAX to achieve global harmonization.

LTE has strong and widespread support from the mobile industry, including support from a majority of the industry's key players. Many vendors will enable operator transition to LTE in a progressive, scalable, and cost-effective way—protecting investments in existing technologies made by today's GSM and CDMA carriers. GSM is the most popular mobile communications standard currently in use. Carriers on the GSM standard predominate around the globe and will use LTE as their wireless network upgrade pathway[14].

3) LTE Architecture

The LTE architecture consists of E-UTRAN (Evolved UMTS Terrestrial Radio Access Network) on the access side and EPC (Evolved Packet Core) on the core side.

A typical LTE/SAE network will have two types of network elements.

The first is the new enhanced base station, so called "Evolved NodeB (eNodeB)" per 3GPP standards. This enhanced BTS provides the LTE air interface and performs radio resource management for the evolved access system.

The second is the new Access Gateway (AGW). The AGW provides termination of the LTE bearer. It also acts as a mobility anchor point for the user plane. It implements key logical functions including MME (Mobility Management Entity) for the Control Plane and for the User Plane. These functions may be split into separate physical nodes, depending on the vendor-specific implementation.

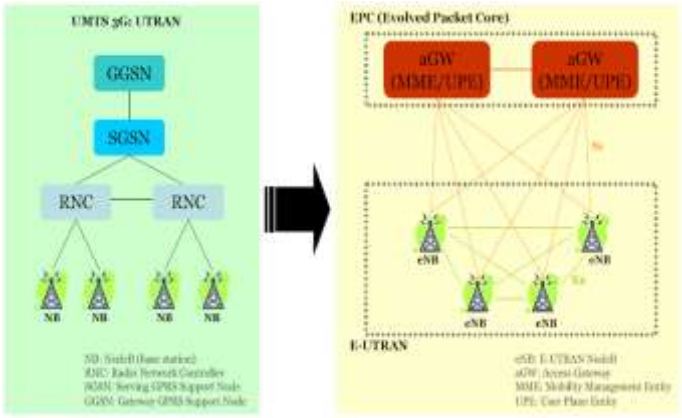

Fig 3. LTE architecture (Source:Technical Overview of 3GPP Long Term Evolution (LTE) Hyung G. Myung)

System Architecture Evolution(SAE)

is the core network architecture of 3GPP's future LTE wireless communication standard.

SAE is the evolution of the GPRS Core Network, with some differences.

The main principles and objectives of the LTE-SAE architecture include :

- A common anchor point and gateway (GW) node for all access technologies IP-based protocols on all interfaces;
- Simplified network architecture All IP network All services are via Packet Switched domain Support mobility between heterogeneous RATs, including legacy systems as GPRS, but also non-3GPP systems (say WiMAX)[15]

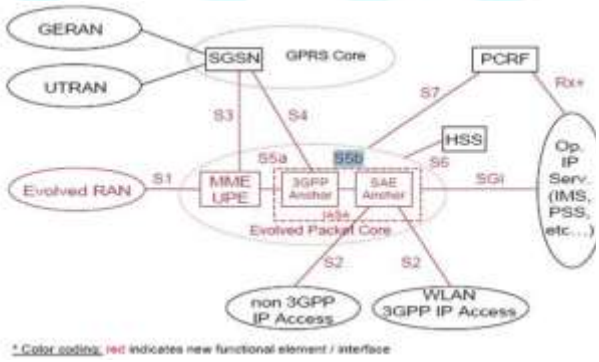

Fig 5 . SAE (Source: http://www.3gpp.org/Highlights/LTE/LTE.htm)

S1: provides access to Evolved RAN radio resources for the transport of user plane and control plane traffic. The S1 reference point enables MME and UPE separation and also deployments of a combined MME and UPE

S2: mobility support between WLAN 3GPP IP access or non 3GPP IP access and Inter AS Anchor

S3: Enables user and bearer information exchange for inter 3GPP access system

S4 : Mobility support between GPRS Core and Inter AS Anchor

S5a: Provides the user plane with related control and mobility support between MME/UPE and 3GPP anchor.

S6: Provides transfer of subscription and authentication data for user access to the evolved system .

S7: provides transfer of (QoS) policy and charging rules from PCRF (Policy and Charging Rule Function) to Policy and Charging Enforcement Function (PCEF)

GERAN-GSM EDGE Radio Access Network

UTRAN-UMTS Terrestrial Radio Access Network

SGSN Serving GPRS Support Node[15]

Evolved Packet Core(EPC)

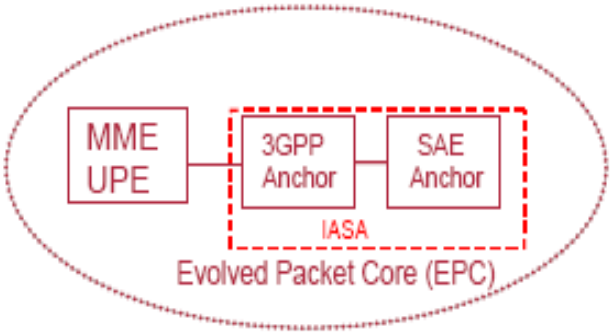

Fig 6. EPC

MME (Mobility Management Entity):

-Manages and stores the UE control plane context, generates temporary Id, provides UE authentication, authorization, mobility management

UPE (User Plane Entity):

-Manages and stores UE context, ciphering, mobility anchor, packet routing and forwarding, initiation of paging

3GPP anchor:

-Mobility anchor between 2G/3G and LTE

SAE anchor:

-Mobility anchor between 3GPP and non 3GPP (I-WLAN, etc)[15]

V. RESULT

In this paper will compare between UMTS and LTE in term of the coverage by signal level and overlapping zone where we used ATOLL simulation.

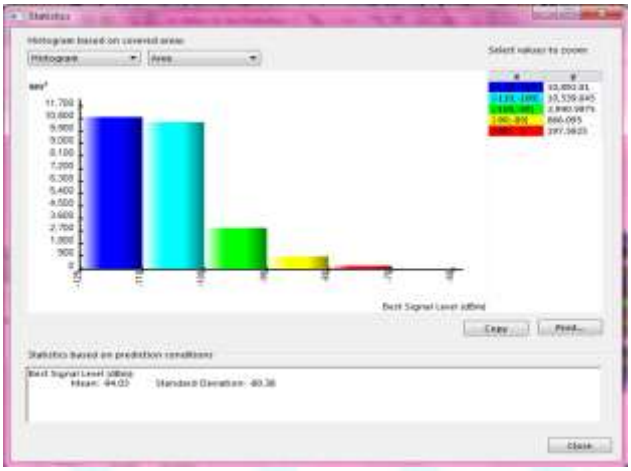

Fig. 7 Coverage by Signal in UMTS

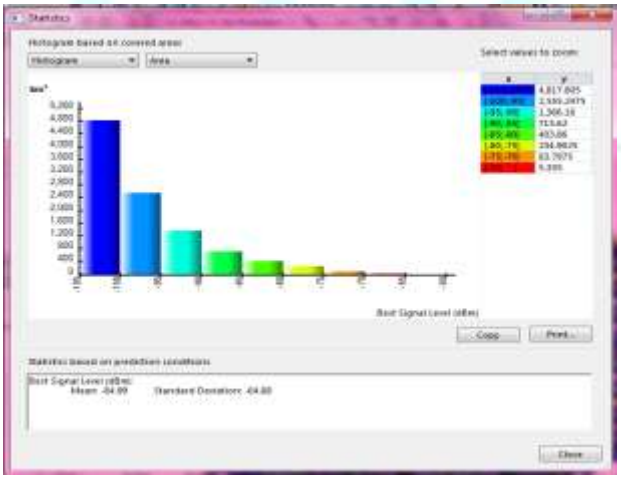

Fig.8 Coverage by Signal in LTE

Fig.9 Overlapping zones in Umts

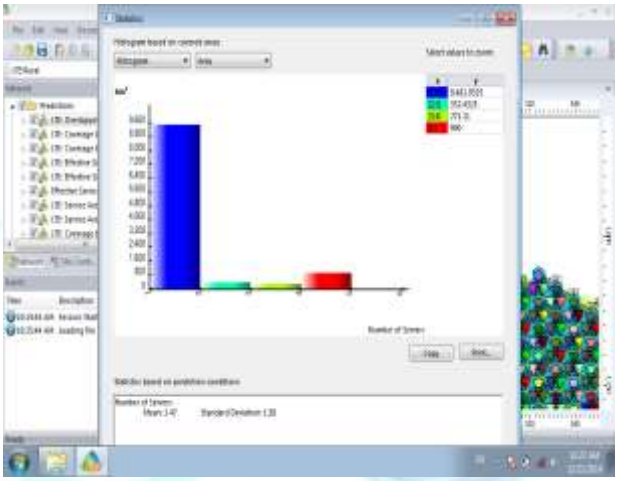

Fig.10 Overlapping zones in LTE

CONCLUSION

find the difference between LTE and UMTS clear through design, find that the number of ground stations in LTE much less than the stations in UMTS, this provides the lowest cost for the application, operation and maintenance of the cellular network, and thus achieve full satisfaction of all of the system, and the presence of fewer ground stations reduces the overlapping zone.

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