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Emerging Technologies: LTE vs. WiMAX

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ABSTRACT
There are two up-and-coming technologies and these two are the 3GPP LTE whose complete meaning is Third Generation Partnership Project Long Term Evolution and the IEEE 802.16 WiMAX whose full meaning is Worldwide Interoperability for Microwave Access. The main aspire found from both technologies are to give mobile data transmission, voice communication and video services by promoting sound level cost deployment and service models through friendly architectures for Internet and protocols. It is as well as true that, that are being well thought-out like a candidate for the Fourth Generation (4G) of Mobile Communications or networks. However, the analyses from the case study of this paper is performing a depth assessment between the LTE and WiMAX standards and delves into the intricacies study with each of them.

Keywords
Long Term Evolution, Worldwide Interoperability for Microwave Access, Circuit Switched (CS), Radio Access Network, Orthogonal Frequency Division Multiple Access, Quality of Service.

1. INTRODUCTION
It is true that the telecommunication user is continuously growing up. However, the first generation of wireless communication has followed by the analog technology and has been replaced by the technique of digital system. The telecommunication network of the second generation started with a circuit-switched (CS) approach called the Global System for Mobile Communication (GSM) [1]. From the technology guide, it is obvious that, circuit-switched approach was well known Fixed Telephone System and as well as got permission the compatibility of both systems. Without a doubt it is understandable for everyone that, internet facility makes the mobile communication more global. Again, General Packet Radio Service has shown his own performance in the area of mobile communication when the plan of bringing data transmission to the devices of mobile, lead to the first packet-switching extension of Global System for Mobile

communication. Furthermore, the unbroken growth of mobile users guides to several GSM extensions and finally leads to Universal Mobile Telecommunications System which was standardized by the Third Generation Partnership Project. From the technological history it has cleared to each person that, Third Generation has guided by the UMTS and it has made the deployment more difficult with cost-intensive because Universal Mobile Telecommunication System required new frequency and base station. Alternatively, Telecommunication sector has given huge data rate support for their client [1].

Moreover, from technological development, it has found that, the Fourth Generation (4G) of mobile technology does not maintain any circuit-switched domain. On the other hand it has found from a deep analysis result that, the mobile user has grown dramatically and therefore, it has needed more and more data transfer which shows that efficiencies and more advanced mobile networks are needed [2]. It is also observable result that, the mobile handset has continuously developed from plain phones to general purpose computers which is called Smartphone is a key driver for the fourth generation networks. From the smart phone, the mobile user has got further mobile services that go beyond telephony and messaging. Particularly fresh examine a scenario like Mobile Payment, IPTV or Real-time gaming has need of very low delay, high bandwidth and also high availability [3]. In addition to the communication networks of fourth generation can be used to carry high speed access to more rural area's which are not enclosed by the help of fixed high speed networks. International Telecommunication Union Radio and the Communication Sector have mentioned the International Mobile Telecommunications Advanced specified the necessity for fourth generation network standards. However, in the term of Fourth Generation (4G) networks is broadly used for highly developed telecommunication networks based on Orthogonal Frequency Division Multiple Access (OFDMA), use Multiple Input Multiple Output (MIMO) and have an IP-only architecture.

However, this paper will clearly present the two most ordinary approaches for the next generation telecommunication networks that are Long Term Evolution (LTE) and Worldwide Interoperability for Microwave Access (WiMAX). The key explanation of protocol architecture and characteristics for LTE and WiMAX will be discussed broadly in the Section of Protocols, Hardware Configurations and Multimedia and from those section everyone will be understand clearly the main difference for both of technologies in various aspects such as hardware with Network scenarios and Multimedia. From the part of Future Developments, it will be analysis briefly for the comparison future development of LTE and WiMAX. Furthermore,

summarizes for this paper will be publish from the last section in conclusion.

2. PROTOCOLS

Networking protocols helps to establish the data communication between the sender and receiver. However, it is very important to understand the type of protocol because the Packet switching performance depends on the quality and the structure of protocol.

2.1 WiMAX Protocol Architecture

The WiMAX communication system is an end-to-end, all-IP wireless system designed to provide wide area mobile access to broadband IP services. 802.16 employs the Open system interconnect OSI physical (PHY) and media access control (MAC) layer to reference the air interface and the wireless medium. The purpose of the Physical layer is the transport of data. The PHY uses the following techniques to ensure efficient Delivery of data [4]. They include OFDM, TDD, and FDD and Adaptive Antenna systems.

Table 1: Provides key physicals layer attributes of the Mobile WiMAX Parameters [5]

Duplex	Primarily TDD
Channel Bandwidth	From 1.25MHz to 10mhz
Modulation type	QPSK, 16QAM,64QAM (down-link only)
Multiple Access Technique	OFDMA
TDMA frame duration	5ms
Number of symbols per frame	48
Sub-carrier spacing	10.94 kHz
Symbol duration	102.9 us
Typical cyclic prefix	1/8 symbol period
Multipath migration	OFDM/Cyclic prefix
Base station synchronization	Frequency and time synchronization required
Forward error correction	Convolution is coding at rates1/2,2/4,3/4 and 5/6 and repetition coding at rates /2,1/3 and 1/6
Advanced antenna techniques	Space time coding and spatial multiplexing

The MAC layer provides intelligence for the PHY layer by utilizing the MAC protocol data units PDU to exchange information between the Base Station and Subscriber Station. The WiMAX protocol stack also includes sub- layers [6] and the functional purposes include:

The MAC privacy sub-layer, where most authentication, encryption and key exchange for traffic encryption is handled, MAC sub-layer, where framing,

packing error handling and quality of services are supported, MAC convergence sub-layer, where an upper layer packet can be encapsulated for transmission, Below is simplified illustration of IP - based WiMAX network architecture [7]. All over the network can be divided by logically into the following parts such as, Mobile Stations (MS) which is used from the last part of user to right to use the network and the Base Station (BS) which is in charge for given that the air interface to the MS. There are some supplementary functions that may be part of the BS are micro mobility management functions, for example, session management, multicast group management, Dynamic Host Control Protocol (DHCH proxy), key administration, handoff triggering and tunnel establishment, RRM whose full meaning is Radio Resource Management, Quality of Service policy enforcement also the traffic classification. ASN which means Access Service Network, gateway generally acts as a layer two traffic aggregation point within an Access Service Network. Supplementary functions include the resource of radio management and admission control, caching of subscriber profiles and encryption keys, the functionality of AAA Client, CSN means Connectivity service network, which provides Internet Protocol connectivity and all the Internet Protocol center network functions [8]. The connectivity services network (CSN) similar to the UTRAN is used as a link between the core network CN and the user equipment UE. Moreover, it is also true that, the IP address Management is also maintains by the CSN.

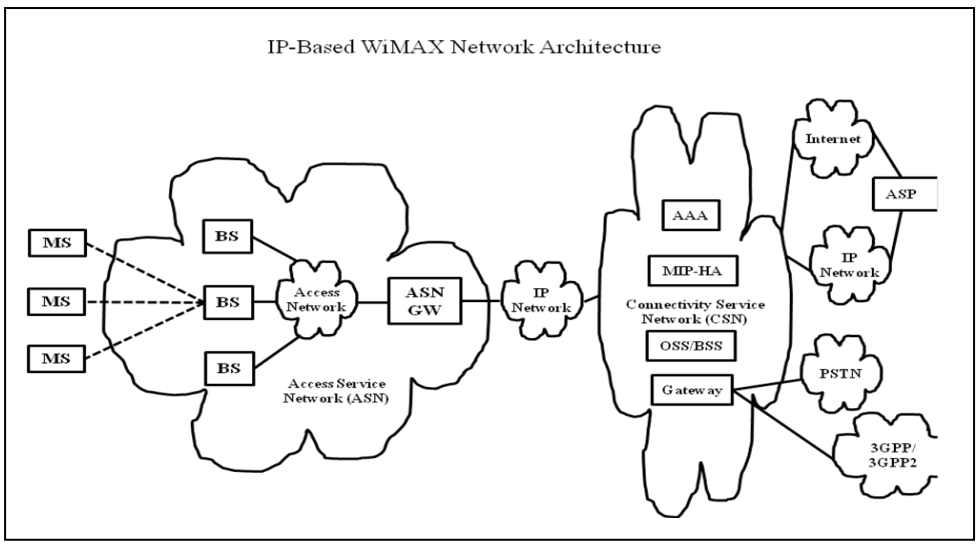

Figure 1: IP-Based WiMAX Network Architecture

2.2 LTE Protocol Structure

Table 2: Provides key physicals layer attributes of the Mobile LTE Parameters [10]

Duplex	FDD and TDD
Channel Bandwidth	From 1.25mhz to 20mhz
Modulation type	QPSK,16QAM,64QAM (optional in UL)
Multiple Access Technique	Downlink: OFDMA, Uplink :SCFDMA
TDMA frame duration	10ms with 1 ms sub-frame
Number of symbols per frame	140
Sub-carrier spacing	15 kHz
Symbol duration	66.7 us
Typical cyclic prefix	4.69 and 16.67 us
Multipath migration	OFDM/Cyclic prefix
Base station synchronization	Frequency and time synchronization required
Forward error correction	1/3 rate Convolution and turbo coding
Advanced antenna techniques	MIMO 2X2, 4X4

In general it is found from the 3GPP specifications for Long Term Evaluation that the communication network of radio access is mainly divided split two separate parts, the first one is E-UTRA whose full meaning is the Evolved UMTS Terrestrial Radio Access and the another one is E-UTRAN whose complete meaning is the Evolved UMTS Terrestrial Radio Access Network [9]. Again, the Mobile part of LTE describes by the E-UTRA and on the other hand E-UTRAN who explains the BS part and the eNB sector has described by that explanation.

Again, from the side of LTE qualifications, 3GPP is running on a complementary task called the SAE whose full meaning is System Architecture Evolution and it is defines the split between EPC and LTE. This new architecture is a flatterer, packet - only center network that will assist deliver the highest throughput, lower latency and lower cost with the purpose of LTE [12]. EPC component's description and is realized through the following elements:

Serving Gateway (SG-W) - The main job for SGW is like a part of a data plane whose major function is to manage the client for example, plane mobility and be acting as a demarcation point between the core networks and RAN. Again, SGW controls data paths between the PDN Gateway and the eNodeBs. From a functional point of view, the SGW is shows like an

extinction position of the data frame communication network crossing point towards E-UTRAN [13][21]. Gateway (PGW) PDN – such as the SGW, the PDN Gateway is the execution position of the packet data crossing point towards the Packet Data Networks [21]. Like a great secure position when it is thinking for sessions towards the outside Packet Data Networks, PDN Gateway supports the MME whose full meaning is Mobility Management Entity. However, from the function of Mobility Management Entity, it is clear to understand that, he is doing like a jointing component with the Exact Perform the signaling and controlling. This shows the exact perform the signaling and control function to manage the UE access to network connections. Mobility Management Entity maintains all control plane functions related to client and the session management. Moreover, a lot of eNode elements is maintains by the Mobility Management Entity (MME).

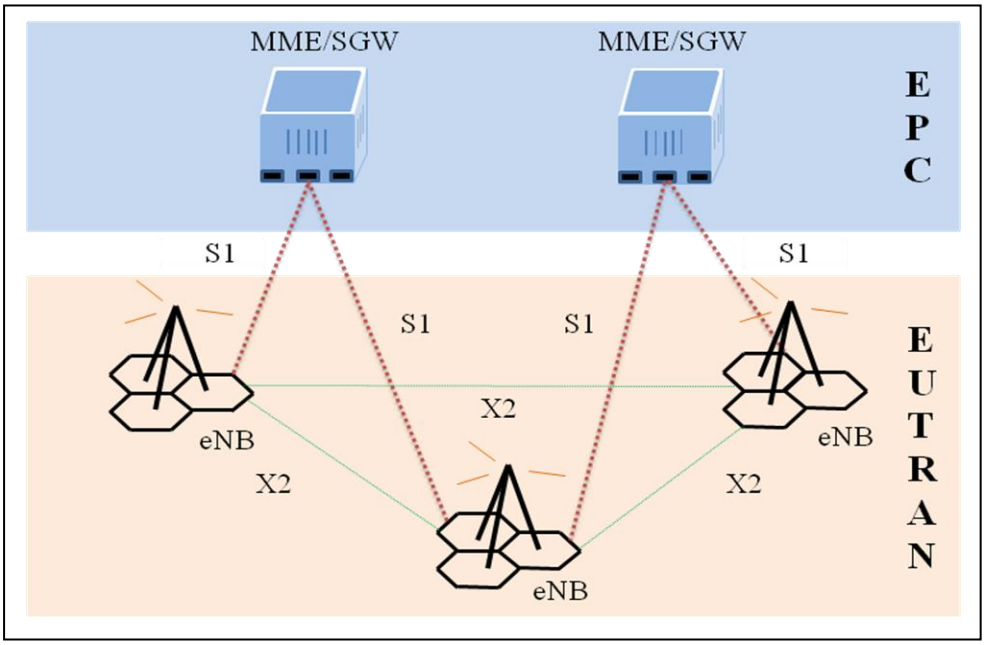

Figure 2: 3GPP LTE Network Architecture

3. HARDWARE CONFIGURATION

3.1 WiMAX Base station

In WIMAX, the base station has a connection with the public network which utilizes optic fibers, cables, microwave links or any other point to point connections offering a high speed. The base station feeds the customer premises equipment (CPE) also known as the subscriber station by the use of a non- line of sight or a line of sight point to multipoint connectivity. The limitation in a worldwide acceptance of the broadband wireless access has been as a result of the customer premises equipment (CPE).

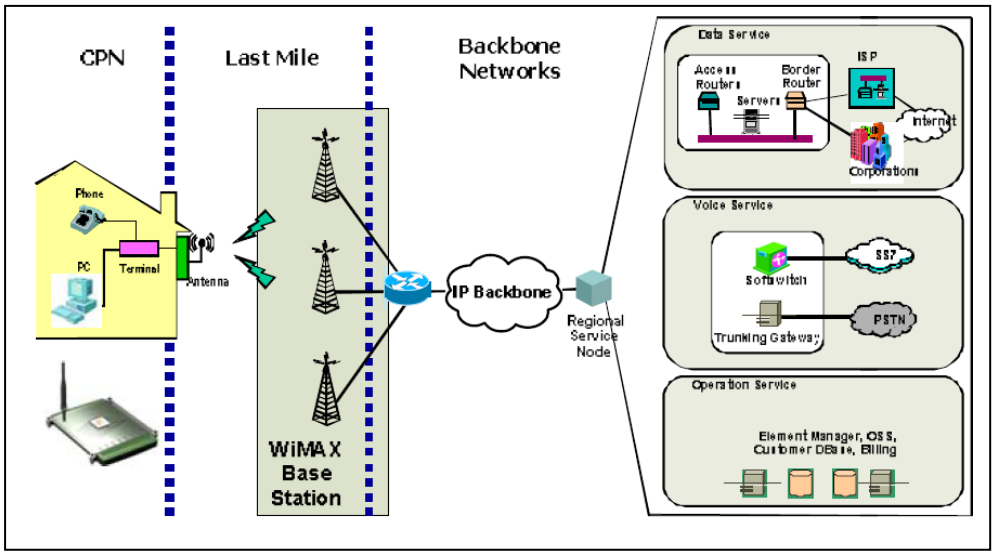

Figure 3: WiMAX Base Station and network backbone [14]

The base station for WiMAX is typically made of a tower and an indoor electronics. In the theory WiMAX base station can cover up to a 50km radius or 30miles while in practice it is only limited to 10km or 6miles. Within the coverage distance of the base station, any node can be able to have internet reception [15]. There is the allocation of uplink and downlink bandwidth to its subscribers based on their need by the use of the MAC layer in the standard. It is needed to justify the Components of WiMAX Base Stations' Hardware Structure and the hardware structure consists of four parts:

- Ethernet Switch Fabric: This helps to achieve system expansibility by offering help to multi MAC line cards access through Giga Ethernet.
- Multi PHY Channel Cards: The card facilitate in the QPSK/16QAM/64QAM modulation and demodulation. Also the card has an RF front end module that performs RF signal transceiver.
- FPGA: This instigates the interface conversions between DS1 and SP13, package router.
- MAC line card; It has a maximum throughput of about 100Mbps and it maintain up to four PHY channel card. The MAC line card centers on Intel IKP2350 to implement WiMAX and IPV4 routing Encrypt/Decrypt, Ethernet IPV4 forwarding.

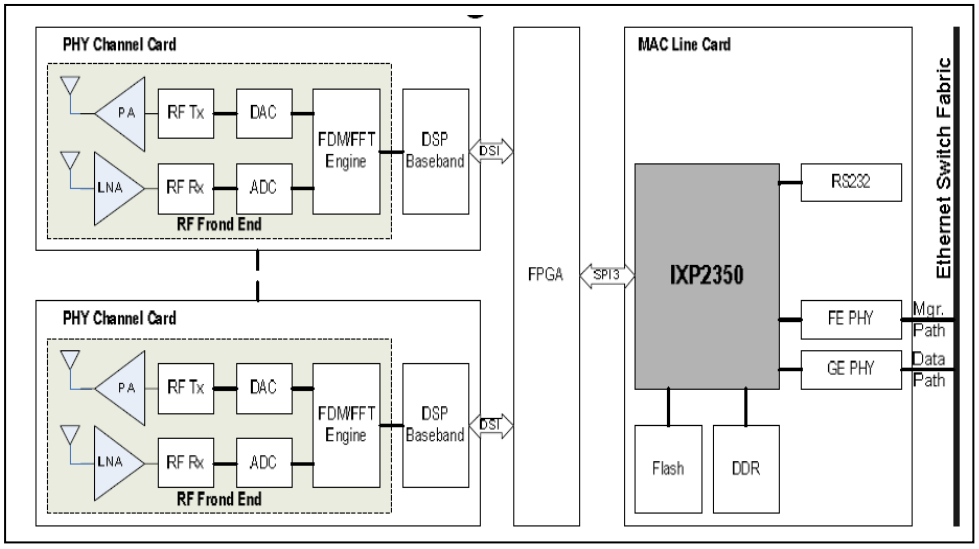

Figure 4: WiMAX Base Station hardware structures [14]

The Intel2350 help WiMAX MAC to carry out a high data throughput and very scalable architecture to meet different standard options and service requirements.

3.2 LTE Hardware

The hardware components making up the Long Term Evolution (LTE) are the base stations, antennas, and feeders. The base station of an LTE is called an eNodeB. This eNodeB is the major aspect of an LTE RAN (Radio Access Network) structural design. To plan a network deployment for LTE the operator takes some factors into consideration which includes, determining if the existing cell site can support the new equipment. The issue of antenna size for the new installation has to be considered. It should be understood that LTE leverages Multiple In, Multiple Out (MIMO) which control group of antenna at the base station. Also the distance of the cell site to the wire line infrastructure is to be considered and the cell site can leverage fiber for backhaul if it is located less than one mile. This is a good practice for transporting LTE traffic.

3.3 Comparison of WiMAX and LTE Hardware

The technologies of both WiMAX and LTE are somewhat different but both of them share the same methodology for downlinks. The two have Multiple Input Multiple Output (MIMO) which means that two or more antennas are used to receive information from a single cell site to expand reception. Also both WiMAX and LTE use the downlink from the cell tower to the end user which is enhanced with the Orthogonal Frequency Division Multiplexing (OFDM) which allows video and multimedia transmission [15].

4. MULTIMEDIA – WiMAX vs. LTE

In terms of mobile multimedia WiMAX and LTE systems can be used to complement each other. LTE offers coverage over large areas and unlimited roaming whist WiMAX offers high speed data rates offering mobile broadband in hotspot areas [16].

4.1 Mobile Multimedia and standards

Mobile multimedia consisted almost entirely of devices that become mobile by virtue of the cellular networks i.e. LTE/3G type networks. The requirements for these devices have been defined by the third generation partnership projects (3GPP and 3GPP2); thus devices used are called 3GPP devices. An example of mobile TV technology standards, such as DVB-H, DMB has emerged, which have aligned themselves closely to the 3GPP standards.

However, it is possible with a WiMAX network to accommodate a range of new devices and services that work on technologies such as Multicast Streaming, IPTV, VoIP, Broadband Data and Multimedia downloads. Because Interworking is an important part of a WiMAX network, LTE/3GPP specifications are an important design consideration for applications in WiMAX networks [17]. Example of a Multimedia device working in a multiple standard environment as previously mentioned, if we look at a case of a WiMAX mobile phone. It could say this phone should have the ability to work under a Wi-Fi, CDMA, 3G-UMTS or GSM. So in order to use this phone the manufacture will have to make sure it will operate under the IEEE 802.16e Standard as well as to use the GSM forum 3GPP (2) standards and comply with OMA rules for encryption. Other standards such as DVB-H would also have to be considered. An example of this challenging standardization issue can be seen in Figure 5.

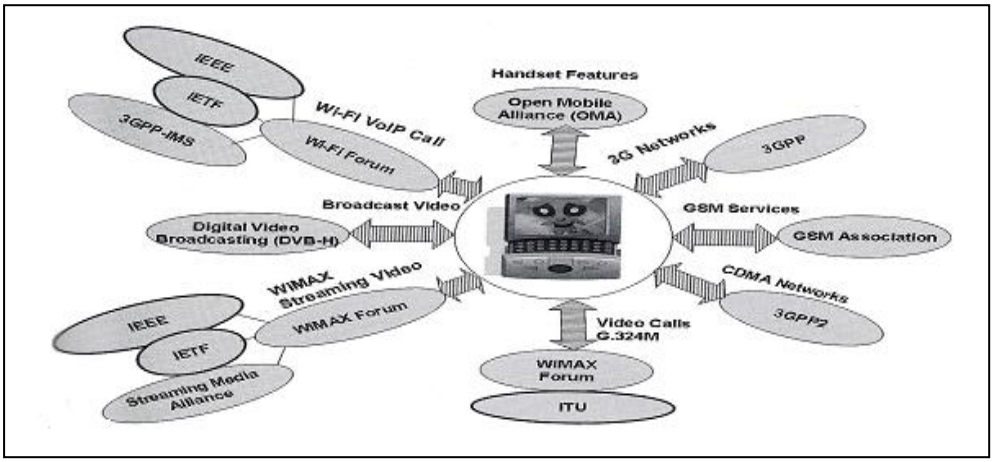

Figure 5: Example of standardization issues Concerning LTE and Wimax systems

4.2 IP Multimedia Systems

IMS – IP Multimedia Subsystem is a standard gives the end user such services as video, text, voice, pictures, basically a seamless multimedia experience over wireless and wired networks. IMS architecture for LTE/3GPP networks is defined as the element which gives a good maintains capability for the services of multimedia. Moreover, that will be guided on the switching of data packet include the QoS and the terms of AAA whose full meaning is Authentication and Authorization. The way in which the network is designed to split the core networking into two different networks, one is to maintains the signaling network and the another one is to control a data or transport network. The signaling network has a set of control function nodes, whose task is to modify, establish and release media sessions with QoS and AAA. In a WiMAX system the IEEE 802.16 provides a specification for a wireless last mile as well as providing the backhaul for 801.11 hotspots (Wi-Fi). The 802.16d and e standard will be the standard more applicable to multimedia applications i.e. it will support low latency applications such as voice and video. It will also support nomadic roaming and will provide broadband connectivity without line of sight between nodes [18].

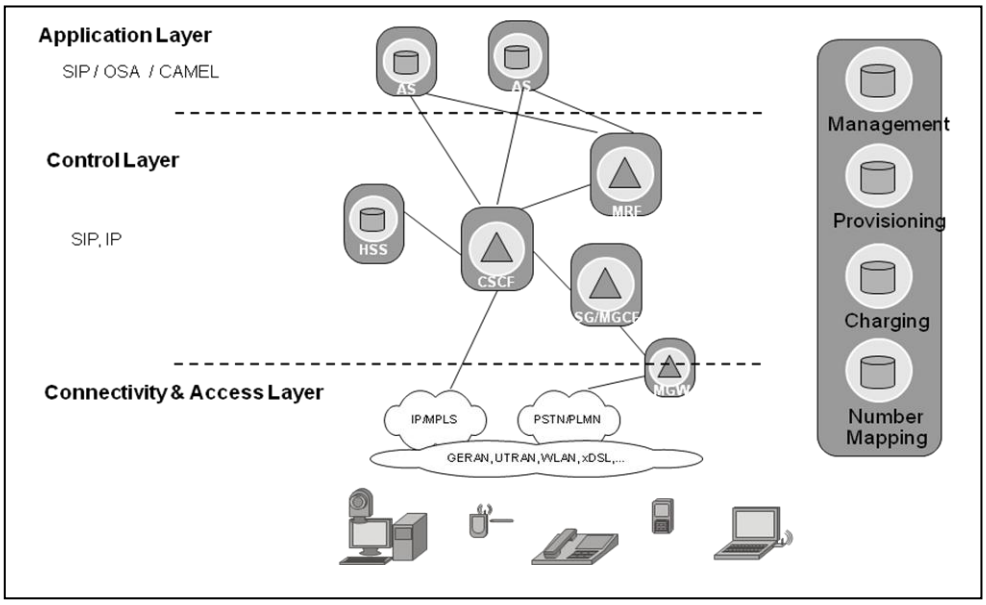

Figure 6: Diagram of IMS Architecture

The defined model architecture of IMS is split into three different areas as follows:

The Application Layer – In this layer content and application servers are used to provide Services to the end user. Also in this layer a SIP (Session

Initiation Protocol) application server is used to implement generic service enablers.

The Control Layer – This layer has the several for managing the call functions, the most important of which being the CSCF (Call Session Control Function), also known as the SIP server. The Connectivity Layer – This layer is for the backbone and the access network, which will comprise of switches and routers [19].

5. FUTURE DEVELOPMENTS

WiMAX is a high performance, next-generation wireless solution available today, employing a proven OFDMA-MIMO based solution governed by the IEEE 802.16 standard. From [19] has shown the statistical report that, WiMAX is guided by an open, broad and also innovative ecosystem together with more than 530 member companies in the WiMAX forum. WiMAX addresses a range of profitable business models with much lower cost per bit than other available technologies, making it suitable for connecting remote villages or delivering mobile Internet services in urban areas.

However, in the area of communication sector WiBro has effect with very positive on voice and data transmission systems. Moreover, it is provided from that company that, the Wireless Broadband facility in the areas of metropolitan to go together their Code Division Multiple Access (CDMA) 2000 service with the contribution of a great performance for entertainment service, multimedia messaging and video Conversation. Cellular Broadband has got a great solution from the Wireless Broadband (WiBro). However, its band has improved from 2.0 GHz to 2.3 GHz or more by ETRI whose complete meaning is Electronics and Telecommunications Research Institute, Korea. It is a great point that, for the future evaluation the internet user needs higher speed and this problem will be possible to solve by mobile WiMax and it can be used to support voice-over-IP services in the future.

Again, day after day the technology user wants to get more facility such as, mobile entertainment. However, this facility has got from the differential personal broadband service and more surprising is that WiMax has given this milestone offer to their clients. Furthermore, it has also accepted from the WiMax that, the multiple levels of QoS (Quality-of-Service) and the flexible channel bandwidth to be used by service providence for the low latency and the differentiated high bandwidth entertainment application. It is possible to make it clear more by some great example, such as, video service delivered to the portable media player and another example like would be streaming audio services to MP3 or MP4 players. Again, Internet Protocol Television (IP-TV) is one of the most important protocols for the

telephone company because sometimes they move into the entertainment area with that protocol. However, it will be possible to extend that application by the use of portable WiMax [20].

On the other hand, for the downlink and uplink performance, it has got a great support from the LTE and this is that, a peak data rate is 100Mbps or more in the downlink and 50 Mbps or more in the uplink. It is very needed to observe with carefully that, there have a great similarity found from LTE and WiMax and this is that, both technologies involvement of the air interface will possibly be the band on OFDM/OFDMA and Multiple Input/Multiple Output (MIMO) [21][22].

Table 3: General Comparison between WiMAX and LTE

		LTE	WiMAX Mobile
Spectrum	IMT2000 other	√ ×	WiMAX IMT-2000 member √ (2.3, 2.5 & 3.5 GHz)
Services	Circuit Switched, Voice Packet Switched, Data	√ √ √ (VoIP) √ √ √	√ √ (VoIP) √ √ √
Mobility	Full Mobility Nomadic Mobility	√ √ √ √	√ √ √
Backwards Compatibility		√ √ Full 3GPP Interoperability	×
Roaming		√ √	( ) WiMAX to WiMAX
Performance	Converge	√ √ √ √ √ (LTE-900)	√ √ √, if f < 3.5GHz
	Capacity	√ √ √	√ √ ( )
	Latency	√ √ √	√ √ ( )
Availability		2009/2010	2007/2008

6. CONCLUSIONS

WiMAX and LTE are two mobile broadband systems designed for purely packet bearer support. With these two wireless technologies, we now have two true all-IP systems which define IP interfaces between base stations. From the discussions, it is clear with the future pointing towards VOIP and internet applications, an all-IP design is the best alternative. UMTS, HSPA and leading to LTE are all IP based technologies, but they are encumbered with numerous migration and backward compatibility requirements. LTE overall Network architecture is encumbered by 3G legacy network protocols and result is a network with many layers and proprietary protocols although the EPC and SAE were designed to reduce such complexities. For higher

data rate capabilities, it is found that, the accessible mobile operators' are less likely to adopt carry on along the path of WiMAX and more likely to 3G evolution. It can be shown like a scenario, however, in which established mobile operators may set up WiMAX as a superimpose solution to make available even higher data rates in certain metropolitan areas WiMAX thus has good advantages from a few vantage points. The WiMAX architecture is simple and protocol implementation is clean from the scratch based on IP. WiMAX network is a flat, simple all-IP network with few protocols. All protocols are IETF-based (Internet Engineering Task Force) and so WiMAX may be simpler to implement.

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