4G Wireless Technology: A Brief Review

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ABSTRACT
Mobile Communication has been developed rapidly since last few decades. The growth of the wireless broadband technologies in the modern years was the answer of increasing demand for mobile Internet and wireless multimedia application such as live TV, live Movies, video conferencing etc. Mobile communication plays a vital role in telecommunication industry. During a common wide area radio access technology and supple network architecture WiMAX and LTE has facilitate convergence of mobile and fixed broadband network. Since 2007, the IEEE 802.16 working group has been developing a new improvement if the IEEE 802.16 standards as a higher level air interface to meet the requirement of ITU-R/IMT-advanced for 4G system as well as for the next generation. In 4G mobile technology, assures the high mobility with high level speed of data rates and high capacity IP based services and application. This paper describes the 4G wireless system, its architecture, security services, benefits and challenges of 4G wireless technology.

Keywords— WiMAX, LTE (Long Time Evolution), OFDMA (Orthogonal Frequency Division Multiplex Access), MIMO (Multiple Input Multiple Output), MME (Mobility Management Entity).

I. INTRODUCTION

The mobile and wireless communication technologies have been enhancing rapidly day by day. Gadgets continue to shrink in size and at the same time rising in processing power. Users generally insist in more sophisticated and worthwhile applications. Hence, capacity improvement is the paramount necessity in wireless communications [1]. The evolution of various mobile services initiating from the 1G (first generation) to 4G (fourth generation) is begun as follows:

1G: First generation (1G) was a wireless network which basically constituted an analog cellular system along with circuit switched network architecture. These wireless networks only supported basic voice telephony and were mainly confronted by low capacity and limited coverage region. Hence in telecommunications sector an increased requirement for high frequency ranges paved the way for the development of digital transmission techniques from analog transmission techniques [2].

2G: In the early 1990s, second generation (2G) wireless technology arrived to meet the capacity requirements of burgeoning voice plus telephony, limited circuit switched data services and text messaging. This technology utilized digital transmission system which is capable of compressing the signal much more efficiently and effectively as compared to analog system and at the same time allows the transmission of more packets in the same bandwidth with lesser power [2].

2.5G: 2.5G, an interim step being taken after 2G and prior to 3G, was basically an improvement of the two chief 2G technologies. This technology provided an enhanced capacity on the 2G RF (radio frequency) channels and also presented higher throughput data rates, up to 384 kbps [3].

3G: 3G, third generation of mobile and wireless technology, supersedes 2G technology and precedes 4G technology. 2.5G was a transitory bridge between 2G and 3G for providing high data rates. Hence 3G wireless technology was introduced for bestowing higher data-transmission speeds, superior network capacity and more sophisticated and enhanced network services. In May 2001 NTT DoCoMo launched the first pre-commercial 3G network, branded as FOMA, in Japan. Subsequently after the first pre-commercial launch, NTT DoCoMo launched the first commercial 3G network in Japan in Oct. 2001.

4G: 4G, the fourth-generation of wireless service, is an enhancement from 3G and is presently the most extensive, widespread, expeditious and high-speed wireless service. Presently 4G is available only in limited regions. 4G wireless service has been devised to deliver high speed irrespective of the technology which drives 4G. For instance Sprint employs a technology called WiMax for its 4G services, whereas Verizon Wireless employs Long Term Evolution, or LTE. On an average, 4G wireless technology is expected to provide data rates from four to ten times higher than today's conventional 3G networks.

II. FOURTH GENERATION NETWORKS

The 4G is the most innovative wireless technology which has replaced the 3G systems. The vital characteristics of the 4G networks include accessing information with a flawless connection anytime, anywhere
with a wide range of services, receiving greater amounts of information, pictures, data, video, and so on. The future 4G network infrastructures assimilate numerous networks employing the use of IP (Internet protocol) as a common protocol to ensure that every user will be able to opt for every application and environment. In this era of emerging trends in mobile and wireless communications, 4G focuses on ensuring a flawless service, have larger bandwidth, higher data rates, and smoother and faster handoff across a wide range of wireless networks and systems. Incorporating the 4G potentials with the existing mobile technologies by the use of enhanced technologies is the major concept. The major characteristics of 4G services of user interest include application adaptability and high dynamism which implies that different services can be delivered and available to users’ personal preferences and support the user traffic, air interfaces, quality of service, and radio environment. Effective and efficient connection with the network applications can be achieved in numerous forms and at different levels [4].

Enhanced Features of 4G Wireless Technology are as follows:

- Wider and extensive mobile coverage region.
- Larger bandwidth - higher data rates.
- Terminal Heterogeneity and Network Heterogeneity.
- Smoother and quicker handoff.
- WLAN for hot spots, an extension of 2G and 3G.
- Better scheduling and call admission control techniques.
- Global roaming and inter-working among various other access technologies.
- Supports interactive multimedia, video, wireless internet, voice and various other broadband services.
- User Friendliness and Personalization.

III. BENEFITS AND CHALLENGES

A. Benefits of 4G networks

The benefits of 4G networks assist in ensuring a larger range of services and use-cases. However, the commercial models and eco-systems have not yet been established that are required in driving adoption from a user and service provider perspectives.

1) Technology Performance Improvement: Delivers higher uplink and downlink throughput besides lesser latency and network capabilities. It has been universally believed that there will be a prolong growth in mobile data traffic significantly in the coming years. It is also a matter of fact that the majority of the core transport and throughput bottlenecks will undoubtedly be delivered by the technology itself despite of the 4G technology used (LTE or WiMAX) in comparison to 3G. 4G technologies provide at least two times more effective and efficient use of spectrum, enhanced support for real-time applications, and greater max speeds. Though there exist further network and capacity confronts such as edge or gateway management, signalling management which are needed to be fully addressed to increase benefits from the upgrade [5].

2) New Mobile Application Enablement: It enables new mobile applications to enhance the existing ones (Streaming Music). Several 4G services such as digital storage or smart home monitoring will get enhanced by the improved 4G bandwidth and latency. Other services such as MMS, digital picture frames and various near-field communication applications will notice no significant improvement in riding on a 4G network. Hence, it is very crucial to have a very close look at the services and applications which are likely to be enhanced by 4G advancements. We can see that services which gain the most from the 4G technology’s deployment are video streaming, MMOG/gaming and expertise applications such as interactive learning [5].

3) Addressable Device Expansion: Network potentials and chipset scale could expand the connectivity to various innovative gadgets. Handset technologies persist in evolving along a huge range of features and value added services by means of smart phones and more specialized gadgets. A carrier controlled service experience has been conventionally supported by the Terminal operating model. Commercial operating systems such as Windows Mobile or RIM have attracted heavy data users and hence fostered network congestion by reducing some control [5]. In addition, the increasingly growing open eco-systems, further enabled by 4G, offer a challenging opportunity for operators since third parties develop services, applications and customization tools in order to meet user needs. Gadgets are becoming highly configurable because of open standards and more expertise gadgets such as netbooks, eReaders, tablets etc. are coming into the market. To meet lesser user segment needs we believe that vendors must think of a micro-segmentation based device roadmap; various new distribution channels are requisite to support the acceptance of Converged Mobile Gadgets and 4G applications [5].

4) Differentiated Customer Experience: It enables in managing the user expectation and experience with new features and services. We consider the user’s experience in gaining a profound understanding of how these services are completely facilitated and how it mingles into the fabric of our living, the necessity or capability to deploy expertise or configured gadgets to support enhancement, and finally, how to make money and when to share the income from the service delivery. Till now, it has been inadequate in understanding the experience of a 4G user and it is uncertain that how greatly the user experience will alter as many more and various 4G services arrive [5]. We are much aware of the fact that user expectations regarding price points are retuning with growing expectations to pay “a little for a little” which confronts the present costing and
monetization approaches. We also believe that users are expecting an additional bunching of services and applications into a “solution” which assists the way they live. Hence, accomplished adoption of 4G services will be highly reliant in resolving the most probable Use-Cases for 4G services.

5) Business Model Evolution: 4G wireless technology will be the key in facilitating the alternative partnership and monetization models. The previous couple of years or so have exposed the industry to the myth of all you can eat pricing models, or flat rate voice and data plans. This has motivated performance consistent with Pareto’s data usage rule where 4% of users generally utilize more than 70% of the bandwidth. The consequential network bottlenecks restrain access in regions with a high tally of smart gadgets [5]. The bandwidth requirements of several 4G use cases suggests that the above problem will only get worse if present pricing methods move further. One alternative presently being considered by operators motivates in moving towards the tiered pricing based on conventional aspects such as time, speed and quality of service. An additional capable service model is bandwidth on demand and the associated pricing method to charge premium pricing for these burst requirements. This may be proved advantageous in planning high bandwidth utilizing events such as video streaming or LIVE TV.

Given that what we are aware of today, 4G wireless technology will need an extension of pricing models to favour lower up-front prices (subscriptions, one time purchases, ad-based, fermium and per-use). Though, open development manifestoes and collaborative solution deployment/development methods may influence how manifold charging models may work. Undoubtedly new 4G service eco-system and use-cases arrangements head to the significant query of who will generate the bill for the services and how will the income be shared [5].

B. Challenges

1) Security and Privacy: Security measures must be instituted in the development of 4G Wireless Networks which will facilitate the safest possible technique for data transmission. Explicitly, “The 4G core delivers mobility, security, and QoS by means of reusing the existing methods while still working on a few mobility and handover concerns” [5]. Hence, for securing data, to be transmitted across the network, from hackers and further security contraventions it is obligatory for the organization to develop an efficient and effective series of tools which will support the utmost 4G security measures. As a result of the nature of the 4G wireless network, there is a more possibility of security intrusions, and hence, manifold levels of security, including increased necessities for validation, will be essential for protecting data and information transmitted across the network. One of the major objectives of 4G wireless networks is to envelope very wide geographic region with flawless service. Clearly, smaller local area networks will operate on different operating systems. The heterogeneity of these networks that exchange different sorts of data complicates the privacy and security concerns. Moreover, since new gadgets and services are being introduced for the first time in 4G wireless networks, the encryption and decryption schemes being used for 3G wireless networks are not suitable for 4G wireless networks. To prevail over these issues, two methods can be followed. The former method relies on modifying the current privacy and security methods so as to employ them to heterogeneous 4G wireless networks. The latter method relies in developing new, fresh dynamic reconfigurable, lightweight and adaptive mechanisms whenever the existing employed methods fail to get adapted to 4G wireless networks [5].

2) Quality of Service: Regarding the network quality, various telecommunication service providers assure the users for the enhanced connectivity, and the utmost possible data quality which is transmitted across the network, just as Ericsson’s 4G Wireless Networks for TeliaSonera [5]. With the data rates of almost 10 times higher as compared to today's conventional mobile broadband networks and real-time performance, it allows users to be connected always, even “on the move”. Consequently, it is essential for service providers to develop an efficient and effective method to the 4G Wireless Networks which will improve quality, bestows effectual security measures, and will make sure that all users are provided with widespread options for downloading music, video, and picture files without any delays. The major confront for 4G wireless networks is incorporating IP-based and non-IP-based gadgets. We know that gadgets which are non-IP address based are usually used for services such as VoIP. In contrast, gadgets which are IP address based are generally used for delivering data [5].

IV. EVOLUTION OF MOBILE WIMAX TECHNOLOGY

Mobile WiMAX has turned out to be a vital part of today’s modern and digitized world. As a result, people are now showing more dependency on mobile computing. The demand for downloading and transporting the data on mobile devices moving with high speed has stirred up the development of new techniques so as to meet the various requirements of mobile computing. In the field of wireless networks our world has witnessed numerous revolutionary changes in the last two decades. Today wireless network has become an essential part of peoples’ life in their day to day requirements and is becoming more popular by each passing day due to the necessity of mobility along with high speed broadband access. Presently, new and fast emerging technologies are being introduced in the field of wireless networks which allow high speed broadband wireless access. Mobile WiMAX, stands for Worldwide Interoperability for Microwave Access, is a sophisticated
next generation mobile broadband wireless network based on IEEE 802.16e-2005[7] which supports 4G. Primarily it was developed for the solutions of problems faced by wired networks but later it became the part of 4G wireless network with the improvements from 802.16-2004, 802.16e-2005 to 802.16m. IEEE 802.16e -2005 is an improvement to IEEE 802.16 -2004[8] and the latter was the fixed data transmission technique for broadband connection to MAN. Wireless MAN-OFDMA specification assists in providing an enhanced air interface for operation in either unlicensed or licensed bands. Nowadays user wants to remain online every time and also want speedy transmission of data at low price without any data loss. Presently a large number of PDAs (Personal Digital Assistance) in the market are capable of supporting wireless data transmission flawlessly with mobility. In the upcoming future such type of requirement will raise immensely, therefore developers (for example WiMAX Forum) are looking for such type of requirements for making these gadgets more supportive in accordance with the user necessities. WiMAX (802.16e-2005) is the solution for such type of problems. WiMAX can support data rates up to 75 Mbps with a range of nearly about 30 miles.

Architecture of WiMAX

The IEEE 802.16e-2005 standard includes specified air interface for WiMAX without having an end-to-end WiMAX network. The WiMAX Forum’s Network Working Group, using IEEE 802.16e-2005 as the air interface, is creditworthy for devising the end-to-end network requirements, protocols, and architecture for WiMAX. For providing architecture framework for WiMAX deployments and to certify interoperability among several WiMAX equipments and operators a network reference model has been developed by the WiMAX NWG. The network reference model is based on an IP service model for supporting fixed, nomadic, and mobile deployments.

The whole network may be logically segregated into three major parts: (1) mobile stations employed by the end user for accessing the network, (2) the access service network (ASN) consisting of one or more base stations and one or more ASN gateways forming the radio access network on the edge, and (3) the connectivity service network (CSN) for providing IP connectivity and entire IP core network functions. A basic demonstration of IP-based WiMAX network architecture is shown in Figure 1. The following architecture allows for three distinct business articles: (1) network access provider (NAP), which owns and operates the ASN; (2) network services provider (NSP), that provides the IP connectivity and WiMAX services to users by utilizing the ASN infrastructure which is provided by one or more NAPs; and (3) application service provider (ASP), that can provide various value-added services such as multimedia applications using IMS (IP multimedia subsystem) and corporate VPN (virtual private networks) that run on top of IP. This division among NAP, NSP, and ASP is devised to permit a richer ecosystem for WiMAX service business, which leads to more competition and hence better services.

The IEEE has created the 802.16m Task Group for developing the subsequent improvement to the 802.16e standard. This article mainly emphasise on the improvement of the IEEE Wireless MAN standards. There are several research and development following the IEEE 802.16e standard related to Mobile WiMAX networks.

Air Interface Features of WiMAX

The term WiMAX is generally employed as a name for the family of IEEE standards since 1999 created by the 802.16 working group. The TABLE I presents the various aspects for 802.16e explaining that 802.16e allows for a broad range of design alternatives that offers flexibility in meeting the necessities of most deployment scenarios. The significant parametric quantities of WiMAX RAN (Radio Access Network) are being explained in the subsection.
TABLE I
SUMMARY OF WIMAX AIR INTERFACE FEATURES

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Capacity</th>
<th>Coverage</th>
<th>QoS</th>
<th>Deployment Flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating frequency choices</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Flexible channel bandwidth</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>TDD or FDD duplexing</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>OFDM sub-channelisation</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Adaptive modulation and coding</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Variable cyclic prefix</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Fractional reuse</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>ARQ and hybrid ARQ</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Integral MIMO</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Quality of service support</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

(✓)Primary benefit (✓) Secondary benefit

V. EVOLUTION OF LONG TERM EVOLUTION

LTE Overview

LTE has improved the Universal Mobile Telecommunication Services (UMTS) in a series of points on account of the requirements of future generation cellular technology and rising mobile communication services necessities. Such improvements are generated owing to LTE background needs, motivations and objectives, as presented in section 2.1. The concise account concerning LTE technique and specifications is also being covered in the following subsections.

LTE Background:

LTE was first proposed in Toronto conference in 2004 for attaining higher speed and lesser packets latency in UMTS 3G wireless systems. Therefore, LTE must fulfill a set of high-level requirements which are shown below [11]:

- Reduced cost per bit.
- Simple architecture and open interfaces.
- Flexible use of existing and future frequency bands.
- Reasonable consumption of terminal power.
- Improved user experience-more services with lower cost and higher speed.

As for the motivations and objectives, 3GPP LTE aspires to deliver superior performance as compared to HSPA technique. The major performance objectives are listed below [12]:

- 2 to 4 times higher spectral efficiency than HSPA Release 6.
- Peak rates exceed 100 Mbps in Downlink and 50 Mbps in Uplink.
- Round trip time is less than 10 ms.
- Optimized packet-switching.
- High-level mobility and security.
- Efficient and optimized terminal power consumption.
- Flexible frequency with 1.5 MHz to 20 MHz allocations.

LTE Technology:

LTE is constituted of several new technologies as compared to the previous generations of wireless systems. These new technologies are employed in generating more efficiency with respect to the spectrum and enhanced data rates as expected by designers. Here we presented only the snapshots of the techniques which will be explained in detail in the third section.

OFDM (Orthogonal Frequency Division Multiplex) [13]: During the transmission of packets, for achieving high data bandwidth, LTE incorporates OFDM technology which provides a high-degree of resilience to interference and reflections simultaneously. Moreover, the access schemes can be further divided into two access methods that are used in the Downlink and Uplink respectively. The former one that is used for the Downlink is OFDMA (Orthogonal Frequency Division Multiplex Access); the latter one that is used for the Uplink is SC-FDMA (Single Carrier- Frequency Division Multiplex Access). These access schemes have the advantages of smaller ratio of peak to average power and more steady power capable of getting higher RF power amplifier efficiency in the mobile handsets.

1. MIMO (Multiple Input Multiple Output) [12] [14]: MIMO operations consist of spatial multiplexing in addition to pre-coding and transmit diversity. These operations deal with the problems of multiple signals rising
from various reflections that were faced by prior telecommunications systems. In addition, use of MIMO also improves the throughput by means of the additional signal paths subsequent to those operations. To distinguish different paths MIMO needs two or more dissimilar antennas with unlike data streams, such as the schemes employing 2 x 2, 4 x 2, or 4 x 4 antenna matrices.

**LTE Architecture:**

The presently agreed LTE architecture employs a flat architecture, that can be demonstrated by the use of four functional elements as discussed below (see also Figure 2) [15]:

A. **Evolved Radio Access Network (RAN):** It primarily constitutes a single RAN node termed as eNodeB (eNB). The eNB hosts the physical layer (PHY), Medium Access Control (MAC), Radio Link Control (RLC), and Packet Data Control Protocol (PDCP) layers and interfaces with the User Equipment (UE). Its functions include admission control, radio resource management, scheduling and enforcement of negotiated UL QoS and compression/decompression of Downlink/Uplink user plane packet headers.

B. **Serving Gateway (SGW):** It works as the mobility anchor between LTE and other 3GPP technologies for the user plane during inter-eNB handovers. Simultaneously, it directs and forwards the user data packets. While Downlink data approaches UE the SGW functions in controlling the termination of the Downlink data path and imitates the user traffic during lawful and rational interception. In addition it also manages and stores UE information such as network internal routing information, parameters of the IP bearer service.

C. **Mobility Management Entity (MME):** It is the key control-node for the LTE access network which tracks and pages the idle mode UE, even during retransmission. MME chooses the SGW for a UE at first attach and at the time of intra-LTE handover which involves Core Network (CN) node relocation. During the authentication of the user, it interacts with the HSS (a master user database which supports IP Multimedia Subsystem including subscriber information) [16] through the specified interface.

D. **Packet Data Network Gateway (PDN GW):** It has two major tasks in terms of functionality. Foremost, the PDN GW supports the connectivity to the UE and also to the external packet data networks by the entry and exit of UE traffic. The other major role of the PDN GW is to act as a mobility anchor between 3GPP and non-3GPP technologies, for instance, WiMAX and 3GPP2 (CDMA 1X and EvDO).

![Figure 2: High Level Architecture for 3GPP LTE](image)

For the LTE architecture to run typically and efficiently it has to have the ingenious physical and transport channels between Downlink and Uplink, as all packets transmissions inevitably involve both the two links. And then the design of the channels for enabling dynamic resource deployment becomes significant. The LTE PHY Downlink and Uplink are reasonably different and are dealt separately within the specification documents [17]. Hence for achieving the different objectives in transmission the physical and transport channels for Downlink and Uplink are also different which are simply introduced in the following subsections.

**Physical and Transport Channels for Downlink [12] [18]**

**Physical Channels:**

- Physical Broadcast Channel (PBCH): It is used for holding the system information for UEs require in accessing the network.
- Physical Control Format Indicator Channel (PCFICH): It is employed in managing the transmission format.
- Physical Downlink Control Channel (PDCCH): The primary objective of this channel is to carry the scheduling information.
- Physical Hybrid ARQ Indicator Channel (PHICH): This channel is used in reporting the status of Hybrid ARQ.
- Physical Downlink Shared Channel (PDSCH): It is employed for unicast and paging.
- Physical Control Format Indicator Channel (PCFICH): It is used for supplying information for decoding the PDSCH by UE.

**Transport Channels:**
• Broadcast Channel (BCH): This channel maps to Broadcast Control Channel (BCCH)
• Downlink Shared Channel (DL-SCH): This is the most important channel for transferring downlink data and is used by many logical channels.
• Paging Channel (PCH): This channel is used to convey the Paging Control Channel (PCCH)
• Multicast Channel (MCH): This channel is used in transmitting Multicast Control Channel (MCCH) information.

Physical and Transport Channels for Uplink [12] [18]

Physical Channels:

• Physical Uplink Control Channel (PUCCH): For sending Hybrid ARQ acknowledgement.
• Physical Uplink Shared Channel (PUSCH): This channel is on the Uplink and is the counterpart of PDSCH.
• Physical Random Access Channel (PRACH): This UL channel is used for random access functions.

Transport Channels:

• Uplink Shared Channel (UL-SCH): It is similar to Downlink Shared Channel (DL-SCH).
• Random Access Channel (RACH): It is used for random access requirements.

VI. ORTHOGONAL FREQUENCY DIVISION MULTIPLEX ACCESS IN WIMAX AND LTE

The Orthogonal frequency division multiple access (OFDMA), a multi-carrier transmission technique for providing high speed bi-directional wireless data communication, has recently been accepted as an outstanding multiple access technique for the downlink receivers of the next generation. Each and every proposal that has been considered for the 4G wireless technologies has adopted orthogonal frequency division multiple access. IEEE 802.16e based WiMAX and 3GPP based LTE are the two chief competitors in the 4G marketplace that are likely to dominate the 4G Wireless landscape [2]. Both WiMAX and LTE employ the use of orthogonal frequency division multiple access (OFDMA). In WiMAX OFDMA is employed both on the uplink (UL) and the downlink (DL) and, whereas LTE uses OFDMA only on the downlink (DL). There are numerous reasons in opting for OFDMA. Some of them are multipath handling potential, scalability of operation in different bandwidths, ability to handle different data rates and the ease in combining with multiple antennas techniques [2]. To support higher data rates is the key necessity in modern wireless systems. Hence, the use of OFDM has been considered appropriate for the above reasons. Frequency diversity (FD) and channel feedback can be used efficiently for improving robustness and throughput. Owing to its capability in handling multipath, 4G cellular networks have adopted OFDM as the basic technique. An integrated radio and core network furnishing different services is envisioned for the next generation wireless systems. The use of OFDM technique assists in splitting resources into smaller granular units for allocation to various services as required. OFDMA is considered crucial for attaining high spectral efficiencies in 4G wireless systems owing to its ability to incorporate well with MIMO technology (also called as MIMO-OFDM) [2].

USE OF OFDMA IN WIMAX AND LTE

A. Frame Structure

In WiMAX, frame duration of 5 ms is used along with time division duplexing (TDD). The frame is then divided into OFDM symbols (for example, 48). Some of them are allocated for downlink (DL) and the rest for uplink (UL) transmissions. The first symbol in the frame is used for preamble transmission. For control and data transmissions sub channels are then formed out of a group of subcarriers [2]. The base station (BS) announces a schedule after every frame period (i.e., 5 ms) to convey the downlink (DL) and uplink (UL) allocation.

In LTE, the frame duration of 10 ms is divided to form sub frames of 1 ms duration. A sub frame is used to form two slots each of 0.5 ms duration. The base station (BS) programs transmissions after every 1 ms and the subcarriers form resource blocks for allocation on the downlink (DL) [2].

B. Subcarrier’s resource mapping

Subcarrier (also known as resource elements in LTE) is the smallest granular unit in the frequency domain and OFDM symbol duration is the smallest granular unit in the time domain [2].

In an OFDM symbol, groups of subcarriers are considered together since subcarriers are too large in number to handle the allocation plane. For supporting numerous services, a group of OFDM symbols are handled together for minimizing the signaling overhead and achieving granularity in the achievable rates.

C. Frequency Diversity

In WiMAX sub channels are formed by grouping 24 subcarriers, present in different parts of the spectrum, in the PUSC (partially used subcarriers) sub channelization
method. This pseudorandom selection of the positions of the subcarriers over the entire band depends on the CELL_ID. For sending all the basic control messages diversity based subchannelization approach is employed [2].

In LTE, a RB (resource block) constitutes the similar 12 adjacent subcarriers for 7 OFDM symbols. However, a different RB can be used in the second slot of the sub frame to leverage FD (frequency diversity) instead of using the similar RB in the second part of the sub frame [2].

D. Multiuser Diversity

For achieving multiuser diversity in WiMAX, groups of adjacent subcarriers are spread out over a few OFDM symbols in the BAMC approach. The subcarriers are then arranged into groups of 9 adjacent subcarriers called as bins. A group of four bins is termed as a band where each bin constitutes 8 data and 1 pilot subcarrier. The base station chooses 2 bins in one of these bands and assigns the same bin over 3 consecutive OFDM symbols which results in 48 data subcarriers for a BAMC slot. BAMC subchannelization approach is the most widespread approach desired for WiMAX certification [2].

In LTE, the BTS opts for the RB for sending data to a user. It makes use of the channel feedback from the mobile device to schedule a RB for the user in a frame. The base station receives configuration from the channel feedback in LTE for its scheduled downlink (DL). Usually, 160 ms is the maximum gap between feedback messages and is 2 ms is the minimum duration between feedback messages and the channel status report is requested from the mobile by the BTS in a periodic feedback. In LTE simultaneous use of FD and MUD for different users is possible whereas in WiMAX, it cannot coexist in time [2].

E. Interference Diversity

Sub channel formation in WiMAX depends on the CELL_ID. Sub channels will be different for different users. Hence, the user experiences interference diversity which is likely to provide improved performance as compared to the dominant interferer case. Note that interference diversity leverages only in the case of PUSC transmissions. Hence interference diversity cannot be used for BAMC transmissions [2].

In LTE, RBs are allocated to the users independent of the CELL_ID. The interference on the downlink (DL) will not be randomly distributed across RBs of adjacent cells. Hence there is no interference diversity on the downlink (DL) in LTE [2].

VII. CONCLUSION

This paper presents a brief account on the 4G wireless technology and networks, the evolution of WiMAX and LTE Network architecture and the OFDMA technique. We have observed that the count of wireless broadband users have surpassed the count of fixed broadband users. Hence, in a world going digitized and wireless, the technologies with higher throughputs are getting more importance with each passing day. For an accomplished and sophisticated 4G wireless network, coverage and capacity are most vital elements. LTE-Advanced and WiMAX are the most feasible technologies for a successful 4G deployment. Therefore the need of today’s world is a novel technology which is affordable in cost with higher throughput, better coverage and capacity.

REFERENCES