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Comparison of WiMaX and LTE Network Using MATLAB

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***Abstract*— The Worldwide interoperability for microwave access (WiMAX) based on IEEE 802.16 and Long Term Evolution (LTE),are the most emerging broadband wireless technologies and is viable alternative to traditional wired broadband techniques due to its high resource utilization, easy implementation and low cost. In the recent years, WiMAX(3G) technology is widely used for wireless communication systems in many countries because it has rich set of features with promising broadband wireless access networks. However, WiMAX technology has some drawbacks such as low bit rate for long distance, low speed of connectivity, low coverage area, security problem and so forth. Among these limitations, network coverage for WiMAX technology in mainly considered in this study. In order to overcome network coverage limitation of WiMAX and problem of connectivity, we search a new technology.Mobile WiMAX is a wireless networking system which provides wireless broadband to fixed and mobile terminals.WIMAX(worldwide interoperability for microwave access) is next generation high speed wireless technology provides long distance transmission .Generaly WIMAX is OFDM based architecture standardised by IEEE 802.16.Our aim to analyse the performance of WiMAX in MC-CDMA(multi carrier code division multiple access) as compare to LTE and also find the which suits better in the given bandwidth.**

***Keywords*— WiMAX,LTE,OFDMA,CDMA etc.**

I. INTRODUCTION

Wireless systems are more prone to security hazards than the wired ones. On the other hand, the adaptability of any wireless network technology is mainly dependent on the security features it provides to secure the data as per norms specified by IEEE 802.16e-20005[1]. With the introduction of smartphones like the iPhone and Android platforms, the emergence of new tablets like the iPad, and the continued growth of netbooks and laptops, there is an explosion of powerful mobile devices in the market capable of displaying high-quality video content. In addition, these devices are capable of supporting new interactive video applications, like videoconferencing, and can capture video for video sharing, video blogging, video Twitter, and video broadcasting applications. As a result, future wireless networks will need to be optimized for the delivery of a range of video content and video-based applications, including significant uplink traffic, which could include both video streaming and video uploading[2]. The WiMAX technology, based on the IEEE 802.16 Air Interface Standard is quickly establishing itself as a technology that will take part of key role in broadband wireless metropolitan area networks. IEEE 802.16 standard for BWA (Broadband Wireless Access) and its related industry association WiMAX forum guarantee to offer high data rate over large coverage areas to a large number of users where broadband is unavailable. Fixed WiMAX, based on the IEEE 802.16-2004 Air Interface Standard, has confirmed to be a cost efficient fixed wireless substitute to cable and DSL services. In 2005 the IEEE approved the 802.16e improvement to the 802.16 standard. This improvement includes the characteristics and attribute to the standard essential to hold mobility. The WiMAX Forum describes the network architecture mandatory for implementing an end-to-end Mobile WiMAX network. Mobile WiMAX is a broadband wireless solution that permits meeting of mobile and fixed broadband networks throughout a common wide area broadband radio access technology and flexible network architecture.

The first version of the IEEE 802.16 standard activates in the 10-66 GHz frequency band and requires line of sight (LOS) towers. Afterward the standard increased its operation through different PHY specification to 2-11 GHz frequency band enabling non line of sight (NLOS) connections. The Mobile WiMAX Air Interface approves Orthogonal Frequency Division Multiple Access (OFDMA) for enhanced multi-path performance in non-line-of-sight (NLOS) environments. IEEE 802.16 standards are intended for the transmission of multimedia services (voice, Internet, email, games, video and others) at high data rates. Mobile WiMAX systems present scalability in both radio access technology and network architecture, therefore offering an immense deal of flexibility in network exploitation options and service providing [13].

LTE is the most recent telecommunication technology standardized by 3GPP and is the part of the GSM evolution path further to 3G technology. The modern enlarge of mobile data usage and emergence of new applications such as MMOG (Multimedia Online Gaming), mobile TV, Web, streaming contents have motivated mostly the 3GPP to work on the LTE. LTE is the most recent standard in the mobile network technology tree that earlier recognized the GSM/EDGE and UMTS/HSPA network technologies [6]. The purpose for LTE is to present an extremely high performance radio-access technology that provides full vehicular speed mobility. LTE, whose radio access is called E-UTRAN, is expected to significantly pick up sector capacity, end-user throughputs, and reduce user plane latency, bringing

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extensively improved user experience with full mobility [7]. With the emergence of Internet Protocol (IP) as the protocol of choice for carrying all types of traffic, LTE is scheduled to offer IP-based traffic with end-to-end Quality of service. Voice traffic will be supported mainly as VoIP enabling better integration with other multimedia services. LTE has been put hostile performance requirements that rely on physical layer technologies, like as, OFDM and Multiple-Input Multiple-Output (MIMO) systems, Smart Antennas to accomplish these targets. The main goals of LTE are to minimize the system and User Equipment (UE) complications, permit flexible spectrum exploitation in present or new frequency spectrum and to facilitate co-existence with other 3GPP Radio Access Technologies (RATs).

WiMAX (also known as IEEE 802.16) is a wireless digital communications system that is intended for wireless "metropolitan area networks" (WMAN). It can provide broadband wireless access (BWA) up to 30 miles (50 km) for fixed stations, and 3 - 10 miles (5 - 15 km) for mobile stations. In contrast, the WiFi/802.11 wireless local area network standard is limited in most cases to only 100 - 300 feet (30 - 100m). WiMAX can be used for wireless networking in much the same way as the Wi-Fi protocol. WiMAX is a second-generation protocol that allows for more efficient bandwidth use, interference avoidance, and is intended to allow higher data rates over longer distances. The IEEE 802.16 group was formed in 1998 to develop an air-interface standard for wireless broadband.

The group's initial focus was the development of a LOS-based point-to-multipoint wireless broadband system for operation in the 10GHz–66GHz millimeter wave band. The resulting standard—the original 802.16 standard, completed in December 2001—was based on a single-carrier physical (PHY) layer with a burst time division multiplexed (TDM) MAC layer. The IEEE 802.16 group subsequently produced 802.16a, an amendment to the standard, to include NLOS applications in the 2GHz– 11GHz band, using an orthogonal frequency division multiplexing (OFDM)-based physical layer [1]. LTE is Wireless data communication standard was developed by 3GPP and was first commercialized by Telia Sonera in 2009 named as 4G LTE. LTE is the evolution of the GSM/UMTS standards. Goals of LTE was to increase the capacity, speed of wireless data networks using DSP technique, redesign and simplification of the network architecture, provide improved data rate, cell edge throughput, power consumption, latency, etc. The LTE wireless interface is incompatible with 2G and 3G networks; a separate wireless spectrum is required to implement LTE.

RELATED WORK

Chia-Lin Lai, Hui-Tang Lin, Hung-Hsin Chiang, and Yu-Chih Huang [1] has explained the integration of Ethernet passive optical networks (EPONs) and broadband wireless access (BWA) networks, such as LTE and WiMAX, provides a promising solution for fixed mobile convergence architectures. The complementary features of these two network systems provide high bandwidth and mobility together with a low deployment cost. However, even though many hardware architectures have been proposed for integrated EPON/ BWA networks, the problem of achieving an effective bandwidth division among the EPON and wireless traffic remains unresolved. Accordingly, the present study proposes a novel frame-based dynamic bandwidth allocation (FB-DBA) scheme to accommodate the different protocols of EPON and BWA networks, respectively, in an efficient manner. The proposed scheme adopts a framed approach, in which the time domains of the optical and wireless access networks are partitioned into contiguous frames of a fixed length. Within each frame, wireless traffic is transmitted in a pipeline fashion between the optical and wireless domains, which significantly reduces the delay of wireless traffic. Furthermore, sufficient network resources are provided to ensure the respective quality-of-service requirements of the EPON and wireless traffic. The performance of the proposed FB-DBA scheme is evaluated by means of a series of simulations based on an N-user M/G/1 queuing model.

Result of **[1]** has proposed a FB-DBA scheme to achieve an effective division of the available upstream bandwidth in an integrated EPON/WiMAX access network. In the proposed scheme, a “pipeline” transmission approach is used to reduce the end-to-end delay of the WiMAX traffic and to provide consistent QoS support across the optical and wireless access networks. Moreover, a “grant-on-demand” method is used to adjust the boundary between the W-sub-frame and the E-sub-frame in each OLT scheduling frame dynamically in accordance with changes in the WiMAX traffic load. An N-user M/G/1 queuing model has been developed to derive the mean packet delay under the FB-DBA scheme. The validity of the queuing model has been confirmed by comparing the analytical results for the mean packet delays of the Ethernet and WiMAX traffic with the simulation results. In general, the simulation results have shown that FB-DBA achieves an efficient allocation of the available bandwidth to the heterogeneous traffic within the integrated EPON/WiMAX network and therefore results in a lower mean packet delay than existing schemes such as CS-DBA and SB-DBA.

Chen Jengyueng, Yang Chunchuan and Mai Yiting[2], Long Term Evolution (LTE) and IEEE 802.16 WiMAX are competing access network technologies adopted in 4G wireless networks in recent years. LTE complies with 3GPP standards whereas 802.16 WiMAX is regulated by the Institute of Electrical and Electronics Engineers (IEEE). Although WiMAX is already operating commercially in Taiwan, the system is limited to an independent new system that is incompatible with the current 3G system. Hence, the cost of implementing the WiMAX system is relatively high, this being an impediment to its rapid uptake and widespread use. On the other hand, LTE conforms to 3GPP that is supported by telecommunication manufacturers and operators and is, moreover, backward compatible with 3G/UMTS

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cellular systems. The LTE specifications define how user equipment (UE) connects and communicates with evolved Node B (eNB) base stations.

Result of **[2]** depicts about the LTE and LTE Advanced as Both LTE and LTE-Advanced, which are backward compatible with 3G/UMTS cellular systems, are promising technologies that have high potential for incorporation into the prospective 4G standard. The LTE-Advanced adds a new entity called RN to enlarge service coverage and to resolve the problems associated with duplicate radio wireless transmissions in the regular forwarding scheme. We propose an efficient wireless transmission radio interface scheme between the RN and DeNB, and a smart forwarding scheme that improves handover performance in LTE-Advanced networks. The performance analysis shows that our proposed smart forwarding scheme can efficiently reduce handover latency, signal overhead and operational transmission costs

Jongwon Yoon, Mustafa Y. Arslan, , Karthikeyan Sundaresan, , Srikanth V. Krishnamurthy, and Suman Banerjee [3], next generation wireless networks (i.e., WiMAX, LTE) provide higher bandwidth and spectrum efficiency leveraging smaller (fem-to) cells with orthogonal frequency division multiple access (OFDMA). The uncoordinated, dense deployments of fem-to-cells however, pose several unique challenges relating to interference and resource management in OFDMA fem-to-cell networks. Towards addressing these challenges, we propose RADION, a distributed resource management framework that effectively manages interference across femtocells. RADION's core building blocks enable femtocells to opportunistically determine the available resources in a completely distributed and efficient manner.

Result of [3] can be interpreted as design and implementation of RADION, arguably the first self organizing resource management framework for OFDMA femtocell networks. RADION consists of four key building blocks, client throughput estimation, client categorization, resource decoupling and two-phase adaptation and allocation.

Kejie Lu and Yi Qian, Hsiao-Hwa Chen [13**]** WiMAX, Worldwide Interoperability for Microwave Access, is an emerging wireless communication system that can provide broadband access with large-scale coverage. As a cost-effective solution, multihop communication is becoming more and more important to WiMAX systems. To successfully deploy multihop WiMAX networks, security is one of the major challenges that must be addressed. Another crucial issue is how to support different services and applications in WiMAX networks. Since WiMAX is a relatively new standard, very little work has been presented in the literature. In this article we propose a secure and service-orientednetwork control framework for WiMAX networks.

Result of [13] can be analyzed as WiMAX is a promising wireless communication technology for wireless MANs. In this article we address the design issue in multihop WiMAX networks. Specifically, they propose a secure and service-oriented network control framework in which both security concerns and the requirements of potential WiMAX applications are taken into account. In the framework there are two major components: a service-aware control framework and a unified routing scheme. they then demonstrate how these schemes can provide the required service from the network layer perspective. In addition to the design of the framework, we also study several enabling technologies for the framework, including the deployment of BSs and key management, and secure routing. We believe that our study can provide a guideline for the design of a more secure and practical WiMAX network.

Reena A.Hamada, Hanaa S.Ali, M.I.Abdalla [19] they explains the architecture for LTE-WiMax WLAN Internetworking as, The next-generation heterogeneous networks aim to offer users of various networks seamless high quality IP-based multimedia services access anywhere at any time. IMS (IP Multimedia Subsystem) comes as a promising overlay service that provides a platform through which telecommunications operators can merge various networks to provide seamless data services. In this paper, we propose an architecture framework for interworking of the Worldwide Interoperability for Long Term Evolution (LTE), Worldwide Interoperability for Microwave Access (WiMAX) and Wireless Local Area Network (WLAN) technologies. The aim is the evolution of a seamless service provisioning heterogeneous networks.

Result of **[19]** can be analyzed by a novel IMS infrastructure, services and applications have been proposed for the next generation heterogeneous networks that merges LTE, WiMAX and WLAN using IP Multimedia Subsystem (IMS) and it is compared with UMTS-WiMAX-WLAN Tight Coupled architecture along with IMS. An overview of the IMS infrastructure, services, and applications has been explained. The proposed approach is driven by upgrading the network from UMTS to LTE in the framework of the already established heterogeneous network (UMTS-WiMAX- WLAN) tight coupled architecture. Using OPNET Modeler 17.1, the results show that the proposed architecture gives high performance during data transfer and less times during IMS registration and IMS session establishment. Thus, extending IMS beyond 3G has the effect of improving the performance of the heterogeneous network, and offer users of various networks seamless high quality IP-based multimedia services.

PROPOSED WORK

1. Channel Modulation and Coding

Mobile WiMAX uses BPSK, QPSK, 16-QAM, and 64-QAM techniques for modulation purpose in UL and DL. QPSK, 16-QAM, 64-QAM is mandatory in DL but 64-QAM is optional in UL. Convolutional Coding (CC) and Convolutional Turbo Coding (CTC) are

TABLE I MODULATION TECHNIQUE FOR WIMAX

Modulation Type	Coding Rate	Weight	K
BPSK	1/2	5%	1
QPSK	1/2	2.5%	2

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QPSK	3/4	2.5%	2
16-QAM	1/2	5%	4
16-QAM	3/4	5%	4
64-QAM	2/3	40%	6
64-QAM	3/4	40%	6

TABLE II: MODULATION TECHNIQUE FOR LTE

Modulation Type	Coding Rate	Weight	K
QPSK	.076	2.6%	2
QPSK	.117	2.6%	2
QPSK	.188	2.6%	2
QPSK	.301	2.6%	2
QPSK	.438	2.6%	2
QPSK	.588	2.6%	2
16-QAM	.369	4%	4
16-QAM	.479	4%	4
16-QAM	.602	4%	4
64-QAM	.455	12%	6
64-QAM	.554	12%	6
64-QAM	.650	12%	6
64-QAM	.754	12%	6
64-QAM	.853	12%	6
64-QAM	.926	12%	6

2. METHODOLOGY

In this paper we did analysis of overhead in WiMAX and LTE networks and to find the actual bandwidth used we have reduced the total overhead in only transfer the data and by that we can find out how many maximum numbers of users may be connected to network and what bandwidth will be the allocated to the users.

3. Downlink Overhead

In DL sub-frame overhead consist of DC-subcarrier and Guard, preamble, FCH, UL-MAP, DL-MAP, burst used in DCD (DL Channel Descriptor) and UCD (UL Channel Descriptor). Here DC-subcarrier (transmission gap) and guard is used to separate the DL/UL sub-frame and the cyclic prefix in OFDM symbol structure represents it. FCH provides some properties of burst like duration and number of the bursts. Broadcasted Channel allocation information is provided by DL/UL MAP. DL and UL MAP information for WiMAX contain 8 and 11 bytes respectively for header, 4 and 6 bytes respectively for information element. After listening the MAP information user can identify the subcarriers allocated to user in both DL and UL. DCD and UCD in WiMAX contain DL/UL burst profile information which occupied 9 and 4 bytes respectively. DL and UL MAP information for LTE contains 40 and 48 bytes respectively for header, and 36 and 40 bytes respectively for information element.

4. Uplink Overhead

Useful bandwidth calculation procedure in UL is alike to the DL in numerous steps. BRH is used for bandwidth request allocation within the contention intervals that are periodically assigned in the UL sub-frame. But here in UL initial ranging and contention interval also used. The network administrator defines the size of initial ranging and contention interval. Initial and periodical ranging permits the BS and the MS to achieve time and power synchronization. Initial ranging take place once per connecting user and the periodical ranging should be done at least each 1.5 seconds in WiMAX and 2 seconds in LTE.

SIMULATION AND RESULTS

Mobile WiMAX and LTE are essentially focused on PHY and MAC layers applications with the aim of offering interoperability between different system specifications. Thus, a high amount of flexibility is believed in each and every of the application services provided by WiMAX and LTE Networks. Those that are correlated to access provision such as resource allocation and scheduling process are considered significantly flexible. So a specific system performance simulation is hardly attainable [9]. In addition, the dynamic channel allocation and scheduling makes it complicated to initiate a practical capacity estimation procedure. On the other hand, the amount of signaling overhead is not constant and alters with the number of users in an unpredictable way. In other words, as the subscribers may have different capabilities in their supporting technologies the required signaling procedure is different from one subscriber to the other in both DL and UL. In addition, since the system holds different QoS specifications, different service provision methodologies, those are used in resource allocations and scheduling processes on a subscriber based manner. Considering all doubts over the actual throughput calculation seems to be tremendously difficult.

To Analyze the performance of WiMAX and LTE network, we build the simulation model developed using MATLAB. Two different case studies are deliberate base on dissimilar system parameters and traffic services. We have analyzed the performance of WiMAX and LTE network in the form of Capacity and Demand. We have two different types of user urban class and suburban class for both WiMAX and LTE Networks.

As in first case we have taken 40% urban users and 40% sub urban users, require data rate for urban and sub urban class users are 1000 Kbps and 800 Kbps respectively. Contention ratio for urban and sub urban class users are 30, 10 respectively. WiMAX and LTE system input

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parameters are given in Table below. As can be examined, in this case study, on the basis of input parameters, 58, 68 users can be simultaneously supported with the specified sector for WiMAX and LTE networks respectively. Peak offered data rate for WiMAX in DL is 8041.12Kbps that decreases to 1987.93Kbps as the number of users reaches to

Parameters	Values (WiMAX)	Values (LTE)
Chan	5	10
nel	3/1	5/3
Band	4	4
width	8	16.7
DL/UL	3	5
Frame	3	5
Ratio		
DL/UL		
Traffic		

80 and for LTE it is 18543.6Kbps that decreases to 8145.26Kbps as the number of users reaches to 83.

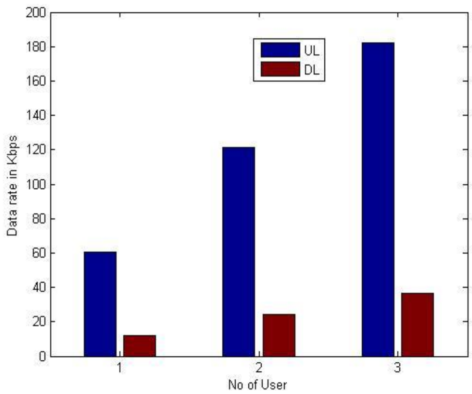

Fig.1.DL/UL Demand for WIMAX

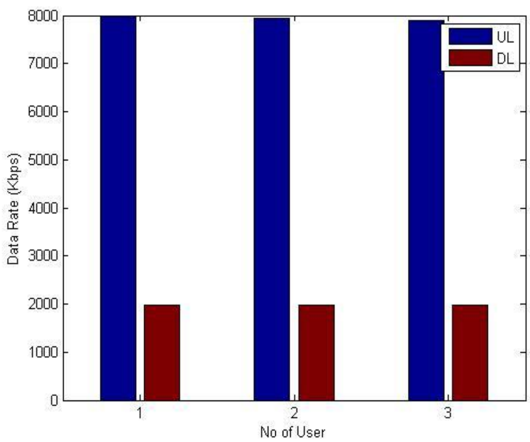

Fig 2. DL/UL Demand for LTE

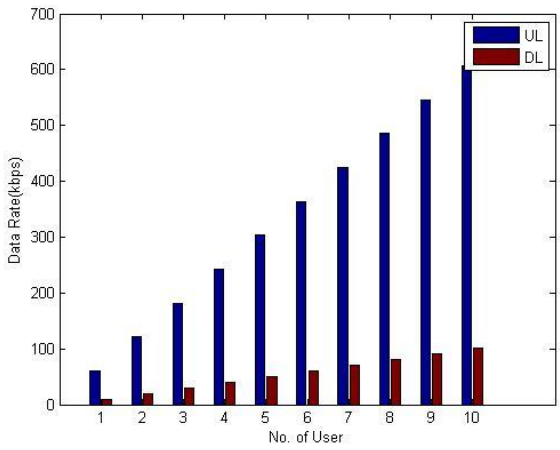

Fig.3 DL/UL Capacity of WiMaX

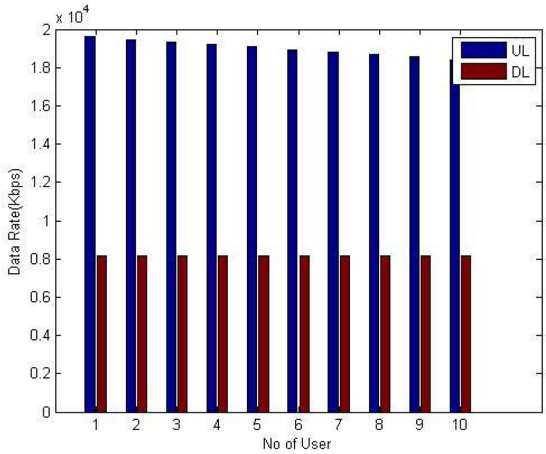

Fig.4 DL/UL Capacity of LTE.

Result Analysis

As we have taken two cases to evaluate the performance in both the network in rural and urban areas. According to the number of user connected in each area and the amount of data they use in various applications also varies as we have mentioned approximate uses in Table 5.1. A key component in network arrangement is to calculate the maximum number of user that each base station (BS) may hole. To know regarding the maximum number of subscribers that a usual BS can serve the information of probable different traffic types and their parameters are necessary. There are numerous applications that are identified based on IEEE-802.16e-2005 and LTE standard.

Channel bandwidth is our primary stage of input which provides us with a number of critical parameters. In this thesis we have considered 5,10, 20 MHZ for WiMAX and 2.5,5,10,15,20 MHZ are considered for LTE that are frequently used bandwidths. To decide the number of data sub-carriers we must know the channel bandwidth. We have followed our algorithm to compute the useful

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bandwidths in DL and UL directions independently by defining and eliminating the connecting users (N) raises the demand will increase as well. The DL and UL overheads inspection have a dynamic feature in which the final existing bandwidth decreases as the number of connection increases. The tradeoff between these two data-rates and the number of users is the key to our algorithm.

As we have shown the result of different input parameters, we are finding the DL/UL ratio in selected area and capacity of network also. In the first case we are taking 40% of urban user and 60 % of sub-urban users which require data speed of 1000 kbps and 800 kbps respectively. Contention ratios for these two areas are 25 and 15 respectively. In this case we are getting a result as per our expectation and we see that LTE is providing better result as compare to WiMAX. It means that performance of LTE is better than that of WiMAX as on the same bandwidth. We also find the peak offered data rate for WiMAX in DL as 8041.12Kbps that decrease to 1987.93Kbps as the number of users reaches to 68. And for LTE it is 18543.6Kbps and that decreases to 8145.26Kbps as the number of users reaches to 73.

CONCLUSION

In this paper we have analyzed the cell range and capability of Mobile WiMAX and LTE network. Some overview part of LTE and WiMAX network is presented by this thesis then we have find the maximum capacity and minimum demand for the network after reducing the overhead part. Physical layer Overhead(Uplink and Downlink), MAC layer in mobile LTE and WiMAX are analyzed by this thesis. After reducing the all overhead we have done the comparison of WiMAX and LTE network in the form of maximum number of user support table, allocated bandwidth to each user and minimum demand.

This work reduces all the overhead related to physical layer and MAC layer in both Mobile WiMAX and 4G(LTE) Networks and then find the actual bandwidth to transfer the only data. All the overhead related to DL and UL in Physical layer as well as overhead related to MAC PDU in MAC Layer was analyzed by this work.

Summarily, developing a user friendly setting up tool by exploring the capacity calculation and transmission and coverage modeling that wrap the overall network consideration over a city-wide implementation would be area of interest.

Advanced releases of Mobile WiMAX and LTE will implement a significant number of pioneering technologies such as AAS (Adaptive Antenna System) and beam forming. Exploitation of each of these techniques can have an effect on the capacity by increasing the total throughput and resource effectiveness, via different signaling procedure.

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