IJCSE International Journal of Computer Sciences and Engineering Open Access
Technical Paper Volume-1, Issue-3 E-ISSN: 2347-2693

4G By WiMAX2 and LTE-Advance

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Received: 02 Oct 2013 Revised: 10 Oct 2013 Accepted: 29 Oct 2013 Published: 30 Nov 2013

***Abstract*—**4G refers to the fourth generation of wireless communications. Two emerging technologies Mobile WiMAX standard and Long Term Evolution (LTE) standard are being considered as candidates for the fourth generation (4G) of mobile networks. But initial versions of these two were not able to fulfill the requirement set by International Telecommunications Union. In this paper a comparison of their later versions WiMAX2 and LTE-Advance standards has been made.

***Keywords*—**LTE-Advanced;WiMAX;4G;MIMO;Carriear Aggregation

I. INTRODUCTION

4G is the fourth generation of wireless standards for mobile communication technology. It is planned successor to 3G (third generation) standards. Many applications of 4G are similar to that of 3G with the difference that 4G offer these applications with higher internet speed. Other applications of 4G such as High Definition mobile TV, IP telephony, interactive gaming services, video conferencing, 3D television, and cloud computing are difficult to achieve with currently available 3G data speed. The International Telecommunications Union (ITU) has specified the speed requirements for the 4G standard are to be 100Mbps for a mobile connection (Users present in cars or trains) and 1Gbps for stationary connections (Users sitting at a computer or Laptops) [1].

Two main candidates for 4G are: the Mobile WiMAX standard and Long Term Evolution (LTE) standard. But initial versions of these two do not meet the requirement set by ITU. The ITU has now recognized two standards LTE-Advanced and Wireless MAN-Advanced (WiMAX-Advanced) that are planned to meet the 4G IMT-Advanced requirements [2].

II. 4G

The IMT-Advanced Standard has recommended following requirements for 4G:

a) Peak data rates must be up to 100Mbps in high mobility situations such as users present in car or trains and up to 1Gbps for low mobility or stationary user users sitting on laptop or desktop.

b) It must be based on an all-IP packet switched network.

c) It must be able to support multiple users and dynamically share and use the various network resources on the same network connection

d) It should have the ability to offer high quality of service for next generation multimedia support on various mobile devices.

e) It should be able to use scalable channel bandwidth between 5, 20 and up to 40MHz.

f) Connection handovers or transitions should be smooth across heterogeneous networks [1].

Main application areas for 4G are:

a) Internet access such as E-mail or general web browsing will be available with ultra high speed.

b) Multiple User Video conferencing facility users will be see as well as talk to more than one person.

c) Location-based services - a provider sends wide spread, real time weather or traffic conditions to the computer or phone, or allows the subscriber to find and view nearby businesses or friends whilst communicating with them.

d) HDTV - Service provider redirects a HDTV channel signal directly to the subscriber.

e) High Definition Video on demand facility

f) Video games on demand - service provider send game data directly to the subscriber where they can play in real time [1].

III. WIMAX AND WIMAX2

WiMAX (Worldwide Interoperability for Microwave Access) operates similarly as Wi-Fi but with much higher speed. WiMAX provides high-speed Internet access like broadband. It covers larger distances as compared to Wi-Fi which can cover only whole campus building or a block of city and can be used by many users simultaneously. One more feature of WiMAX is that it uses licensed or unlicensed spectrum to deliver connection to a network. Two main components of WiMAX system are: A WiMAX tower that provides coverage to a very large area. WiMAX tower works similar like GSM network phone towers broadcasting radio signals into air. A WiMAX receiver: It could be a

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small box or PCMCIA card, or they could be embedded into a laptop and operates similarly the way Wi-Fi access network. A WiMAX tower station connects directly to the Internet using a higher bandwidth wired connection. It also connects to another WiMAX tower using a line-of-sight, microwave link. This connection to a second tower is known as a backhaul. It provides coverage to remote rural areas also. Wireless MAN-Advanced (WiMAX-Advanced) is also called WiMAX2. WiMAX belongs to IEEE 802.16 family whereas WiMAX2 is building upon 802.16m and it is backward compatible with WiMAX [3].

IV. LTE-ADVANCE

LTE-A is standardized by the 3rd Generation Partnership Project (3GPP). It is enhancement of the Long Term Evolution (LTE) standard. The first version was not able meet the requirements for 4G such as peak data rates up to 1 Gbit/s [4].

The main features added to LTE-Advanced are Carrier Aggregation (CA), enhanced use of multi-antenna techniques and support for Relay Nodes (RN) [9].

Carrier Aggregation: LTE Advanced offers higher data rates than the initial releases of LTE. One of them is carrier aggregation. One way to achieve higher data rates is to increase the band width. Initial versions of LTE work on band width up to 20MHz. In this band width higher data rates cannot be achieved. So channel band width is increased to get wider band width and this is done with the help of channel aggregation [5].

Multiple component carriers are aggregated to form a wider transmission bandwidth. There are a number of ways to meet 4G requirements, LTE carrier can be aggregated with following schemes: intra-band contiguous, intra-band non-contiguous, and inter-band non-contiguous aggregation. In intra- band carrier aggregation single band is used. It can be contiguous or non contiguous. In contiguous carrier aggregation carrier are adjacent to each other. So aggregated channel can be considered as a single enlarged channel. Here only one transceiver is required within the terminal. Non-contiguous: In Non-contiguous intra-band carrier aggregation carrier are not adjacent to each other and it is more complicated than the contiguous carrier aggregation. Here more than one transceiver is required. Inter-band non-contiguous carrier aggregation uses different bands [5].

Enhanced use of multi-antenna techniques:

MIMO or multiple input and multiple-output are the use of multiple antennas at both the transmitter and receiver to improve the overall bitrates. In this technology multiple transmitters and receivers are used to send more data at the same time. MIMO technology offers significant increases in data throughput and link range without using additional bandwidth. The signal carrying data can take many paths between transmitter and receiver. By moving the antennas even a small distance the paths used will change. These multiple paths only increase interference. By using MIMO, these additional paths are used to increase data rates by placing antenna at different locations [6].

Relay Nodes:

Relaying is also one of the features proposed for the 4G LTE Advanced. The aim of LTE relaying is to enhance coverage area and capacity.

A relay node receives data signal then demodulates and decodes the data, apply any error correction technique and then re-transmitting a new signal. So signal quality is enhanced rather than suffering degradation from a reduced signal. Main advantages of using relay nodes are:

a) They can be easily deployed. Increasing the number of eNB capacity of the network can be increased. So now network is available to all users.

b) If there is any small area in the coverage area where the network signal is not available then there LTE relays can be used as a convenient method. In this area there is no need to install a complete base station, the relay node can be quickly installed in this are so now the signal is available to all users in that area [7].

V. COMPARISON

a) Physical Layer

LTE-Advance physical layer implements OFDMA scheme for downlink. In the uplink, LTE-Advanced uses SC-FDMA that is OFDMA with DFT pre-coding. Whereas WiMAX2 uses OFDMA for both downlink as well as for uplink [8][4].

b) Peak Data Rates

LTE-Advanced will support higher transfer rates up to 1 Gbit/s in downlink. In case of uplink transfer rate will be up to 300Mbps.In case of WiMAX2 downlink speed is up to 350 Mbps using 4 x 4 antennas and Uplink speed is up to 200 Mbps using2 x 4 antennas at 20 MHz. So LTE -A is superior to WiMAX2 in case of Data transfer [8].

c) Band width

LTE-A uses channel bandwidth up to 100MHz whereas WiMAX2 utilizes 5, 10, 20, 40 MHz channel band width [4] [8].

d) Coverage Area

Coverage area for Wimax2 is up to 50km. whereas coverage area for LTE-A is up to 100km. So in this case LTA-A covers double area as compared to WiMAX2 [8].

e) Security

Security in case of WiMAX is achieved by following steps: authentication, key establishment or management and data encryption and decryption [10]. LTE also uses similar mechanism for security. For establishing secure connection between transmitter and receiver it uses security keys. Data to be sent across the network is also encrypted [8].

f) Quality of Service

Quality of Service (QoS) means ability of the network to provide a desired level of service for selected traffic on the network. The QoS in LTE is achieved with the help of packet data network gateway and the user equipment. The data flow between a client application and a service is differentiated into separate service data flows [12].

WiMAX2 support legacy services more effectively than WiMAX. It also supports different quality of service level for different services [11]

VI. CONCLUSION

The ITU has recommended LTE-Advance and WiMAX2 as a 4G wireless standard. WiMAX2 technology is standardized by IEEE and LTE-A is standardized by 3GPP are very much technically similar. Both of these standards support MIMO configurations. The main difference is bandwidth utilization. LTE-A utilizes bandwidth up to 100MHz whereas WiMAX2 uses bandwidth up to 40MHz.WiMAX2 uses OFDMA for both downlink as well as for uplink whereas LTE-A uses OFDMA for downlink whereas OFDMA,SC-FDMA for uplink. One more difference is LTE-A covers large area as compared to WiMAX2. In case of data transfer also LTE-A is superior to WiMAX2.

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