Downfall and Uprising of WiMAX

Anuj Edema¹, Nimasha Epitakaduwa², Ravindu Bathiya³, Chamika Rathnayake⁴, Chanaka Amarasinghe⁵, Dhishan Dhammearatchi⁶
Faculty of Information Technology, Sri Lanka Institute of Information Technology, Colombo, Sri Lanka

Abstract: Worldwide Interoperability for Microwave Access (WiMAX) is a one of an emerging wireless technology in the communication infrastructure due to rapidly increasing popularity of Broadband internet, wireless networking market is highly going up. The scope of WiMAX is to provide last mile wireless broadband access for fixed and mobile users as an alternative to the wire line DSL and cable access. There are four services that the MAC protocol supports. There are unsolicited grant service (UGS) for constant bit rate services, the real-time polling service, the non-real-time polling service, and the best-effort service. Wireless networks are not fully secure due to rapid release of innovative technologies, market demand and lack of physical infrastructure. Even though the WiMAX is a new technology it does not exist for a long time. Its features have been considered as the main issue during the design of the protocol. Therefore Long term evolution (LTE) technology became more popular in the society. WiMAX is relatively a new technology; not deployed widely g justify the evidence of threats, risk and vulnerability in real situations. This paper provides the reasons of failure of the WiMAX technology and methodologies to bring it back over LTE.

Key Words: authorization, connections, encryption, IEE 802.16, LTE, security, WiMAX

I. INTRODUCTION

In the mid-1990s, when the hasty growth of the internet clearly revealed that free and anonymous access to data, written communications were extremely valued by most individuals. The impact of computer networks on new forms of telecommunications networks lead to a network convergence. Digital voice transmission in telephone networks was one of the first signs that came into use.

For the time being, Wireless networking is by far the most popular way of communication that is available. The development of new technological devices that are made for users, they demand higher possible methods of speed, larger coverage and mobility. Thus came the existence of the technology; Worldwide interoperability for Microwave access (WiMAX). The concept technology of WiMAX was first established in 2001. The broadband system stretched the WiMAX service to a wider-mile range and had the ability to disperse its network between hundreds of terminals. WiMAX was gaining popularity back in 2005 when it was launched, as a technology which conveys carrier-class, high speed wireless broadband at a much lower cost while covering large range.

IEEE 802.16e Mobile WiMAX is the given standard for broadband wireless access in a metropolitan area. Many mobile carriers worldwide have been setting up Mobile WiMAX infrastructure. For interoperability testing, several WiMAX profiles have been developed by WiMAX Forum. WiMAX will have a superior impact in the long run than we have predicted from mobile phones in the past two decades. Large scale carriers will utilize fixed WiMAX to deliver services to residential customers many of whom are in underserved markets.

Although this technology was a big revolution back in the day, it did not succeed as predicted due to another technology named LTE (long term evolution) won the race. LTE allows the cellular provider to complement their 3G facilities by presenting higher data rates, lower latency and packet –based network. LTE practices Orthogonal Frequency Division Multiple Access (OFDMA) and advanced antenna techniques which will be later explained in the research, unlike to what WiMAX is using. In this research, the aim is to show that the technology WiMAX is far more beneficial than LTE (especially for developing countries) and how it will help users with solutions for insufficient broadcast ranges.

Fig. 1. - WiMAX Distribution
Figure 1 illustrates how a WiMAX station distributes its frequencies to users.

The research starts with section I which gives an introduction regarding WiMAX. The section II of the research starts with the background and related works to WiMAX. It mainly describes about researches regarding WiMAX and the generations of communication technology. Section III describes about the concept that the team has come up with in order to bring back WiMAX. After section III which is the conclusion, section IV gives out a brief description about the whole research. An idea regarding the forthcoming tasks that the implementation of WiMAX has been given in section V.

II. BACKGROUND AND RELATED WORKS

Literature review describes about the similar technology used systems and other research papers which related to the research. By reviewing previous research papers, it will help to cover up the target of the research and also these reviews will show the features, capabilities and weaknesses.

WiMAX is the latest state of the art of broadband technology designed to accommodate both fixed and mobile brand applications [11]. A research which was done by Chakchai So-In, Raj Jain, and Abdel-Karim Tamimi has focus on the Mobile WiMAX. The system illustrates it by estimating the capacity for three applications such as Mobile TV, VoIP and data and by giving proper scheduling and analyzing a loss free Channel [2].

Comparisons between Wi-Fi and WiMAX and the challenges in wireless networks like security, seamless handover, location and Quality of Service (QoS) are the main topics discuss in present society. Although it shows the proper security requirements that are needed to have a secure wireless network, but it does not discuss about the techniques that users could use to overcome them [1].

Due to the rapid release of new technologies, market competition and lack of physical infrastructures the wireless network become more and more unsecure. Since the WiMAX is relatively a new technology; it is still not used widely to defend the evidence of threats, risk and vulnerability in real situations [4] the main issue in WiMAX is the security. Several scientific papers call this is a big issue. For an example, the security problem in the original protocol becomes a serious problem in its producing process. The real test for WiMAX security comes when the providers begin wide scale networks. It may enable attackers to further manipulate until then the WiMAX security is limited to speculation. Therefore security wise these are very crucial for the technology, because without a good security, the technology will become useless [10].

To overcome those issues there are concept based on IEEE 802.16 standard. In here WiMAX mesh network is aimed to provider for the users. The WiMAX mesh topology connects to the internet without being connected to the base station or networks. The mesh network is composed nodes connecting to the neighboring nodes, allowing traffic to be routed through and between the nodes. Because of Line Of Sight (LOS) and Non-Line of Sight (NLOS) capabilities the network has the capability to penetrate obstacles depending on the frequency. Therefore the mesh network is flexible enough to overcome obstacles by automatically selecting the best link. Therefore it reduces the security problem [11].

Also there are lots of comparisons of WiMAX using other technologies. By comparing WiMAX with Digital subscriber line (DSL) & Cable and Wireless Fidelity (Wi-Fi) it concludes that WiMAX has many positive points. And also by comparing WiMAX with Wi-Fi it conclude that the both technologies have some identical technical characteristics, but they are approaching the wireless space from completely different perspectives. In all those comparison there are few important things considered such as efficiency, maximum range, dependability, security and mobility.

Efficiency of wireless technology is measured in terms of bandwidth and latency. Maximum range is calculated from the obtained distance between the two base stations. Dependability is defined as how much a wireless technology is dependable to the end user. Mobility is one of the major issues in case of building wireless access infrastructure [4] [12]. The following Figure 2 shows the difference between the frequencies of WiMAX and Wi-Fi.

![Fig. 2. - WiMAX Vs Wi-Fi](image)

The advantage of the WIMAX technology is that it is flexible. Well suited for fixed and nomadic users. The standard is still evolving these days and there are many problems to be solved. The latest standard for WiMAX already offers security improvements over...
the previous one. It uses better encryption methods and has more secure key management protocol and it has new authentication methods based on extensible authentication protocol. But there are lots of security issues to be solved. Especially authentication, authorization, encryption and availability and there are few identified threats in this technology such as rogue base stations, DoS attacks and man-in-the-middle attacks [10]. WiMAX used as the Layer as well in some circumstance. To show the performance of VoIP and FTP traffic when transmitted over UGS or best-effort connections. The WiMAX MAC Layer and a simplified PHY Layer model in the OPNET Modeler are used [5].

Finally the benefits of WiMAX which evidently state that WiMAX is currently the best technology to be used by consumers [3].

In order to look into the matter where WiMAX became a failure in today’s society, this research paper illustrates about the previous technologies that were used and will build up towards WiMAX technology.

A. 1st Generation (1G)

1G is the first generation of wireless technology. 1G was introduced in 1980s as analog telecommunication standards and replaced by 2G digital communications. The main difference between the two mobile systems is that the radio signals used by 1G networks are analog and 2G networks are digital.

In 1G or first generation, the land area is divided into small sectors is known as a cell. Therefore 1G contains many cells and a cell is covered by a radio network with one transceiver. Therefore same frequency can be used many times and large number of users could be accommodated easily and increase the system capability. Analog transmission was used by the first generation wireless telecommunication technology, a technique which were basically used to transmit voice signals. 1G technology consists of various standards such as Advance Mobile Phone Service (AMPS) used in North America and Australia, Nordic Mobile Telephone (NMT) used in Eastern Europe. All of the standards in 1G use frequency modulation techniques for voice signals [19].

B. 2nd Generation (2G)

2G is short for second generation wireless network. 2G cellular telecom network were commercially launched in 1991. Much greater penetration intensity is allowed by 2G. 2G used digital signal for transmission and had a speed up to 64 kbps. 2G introduced several data services for mobile network. It also provided the facility of Short Message Service (SMS), Picture messages (MMS) and internet (WAP) and used the bandwidth range of 30 – 200 KHz. 2G technology is more efficient. 2G technology holds enough security for both the sender and the receiver. All text messages are digital encrypted. All digital encryption rates from 56 Kbit/s up to 115 Kbit/s. 2G include of the mobile technologies. Those are General Packet Radio Service (GPRS), Code Division Multiple Access (CDMA), and Global System for Mobile Communication (GSM) and Enhanced Data Rates GSM Evolution (EDGE).

Many Advantages have 2G network. Those are digital signals require very little battery power. So it’s means that the mobile batteries can last longer. Other benefits of 2G technology is that the lower power emissions helped address health concerns. After 2G was introduced, the previous mobile telephone systems were changed as 1G system. Although it has been very long period of time since its inception, 2G network are still used in many parts of the world [20].

C. 3rd Generation (3G)

This technology comes after with the enhancements over the previous technologies such as the 1st and the
2nd generation. This technology came emerging in the early 21st century mainly in the UK because of its enrichment in the coverage of voice and text messaging as well as giving a prompt access to the user to surf the internet due to its capability of carrying larger amounts of data compared to Enhanced data for GSM (Global system for mobile communication) evolution technology. 3G is most commonly used with mobile phones as a means to connect to the internet. New trends such as 3G video calls were very popular with the arrival of this technology as well as video conferencing calls and internet protocol television (IPTV) also became practicable. The term “mobile broadband” came into use with the widespread of 3G because it was practical to use the net while on move. Theoretically, this technology can allow download speeds of 7.2 Megabits per second (Mbps). Nonetheless in reality we find that the technology provides average speeds of 3Mbps because the signals that is received from towers switches from tower to tower and as it is moving far away from a tower.

The development or the next step of this technology is known as High speed packet access (HSPA) and occasionally termed as 3.5G. It permits theoretical download speeds of 42 Mbps while realistic speeds incline to be around 6-9 Mbps which is twice as fast as standard 3G [19].

D. 4th Generation (4G)

4th generation is the technology that moved beyond the imitations of 3G. 4G became the most talkative subject between the periods of 2007 and 2009 because it boasted about theoretical speeds of 100 Mbps and which makes it more than twice as fast as the 3G technology and many faster than the previous versions. This technology allows more reliable mobile broadband devices like smartphones, tablets, laptops etc. to load websites quicker, stream lengthy videos in high definition and download contents from the web much faster.

The reason this is faster than 3G is due to the techniques (particularly used in Long term evolution) such as Orthogonal Frequency-Division Multiplexing (OFDM) and Multiple-input and Multiple-output (MIMO). OFDM puts in more data into the same extent of radio frequency which will result in the increase of capacity of the network. MIMO is the use of multiple antennas for both to transmit and receive which will expand communication performance. Two forms of 4G that have been developed and in use are Long term evolution (LTE) and WiMAX which will be compared and contrast in the latter part of this research [20].

E. WiMAX vs. LTE

WiMAX technology was the first form of 4G technology that was introduced to the world by the mobile telecommunications company, SPRINT. WiMAX was initially designed to deliver wireless broadband to homes and businesses because the internet service providers (ISP’s) does not require to install expensive cables to every home. Although SPRINT undertook WiMAX, the network was not built properly. It took them 3-4 years, just to cover 30 million people although the technology is working in some success in countries like Russia and Pakistan.

a. Similarities between WiMAX and LTE
1. WiMAX and LTE both support MIMO
2. Both uses similar technique based on OFDM
3. Both are all IP technologies

b. Differences between WiMAX and LTE

The following Table 1 compares and contrasts the main differences between WiMAX and LTE.
### TABLE I

<table>
<thead>
<tr>
<th>WiMAX</th>
<th>LTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does not support old legacy systems such as 2G and 3G</td>
<td>Supports legacy systems</td>
</tr>
<tr>
<td>Uses channels up to 40 Megahertz (MHz) bandwidth</td>
<td>Uses channels from 1.4 MHz-100MHz bandwidth</td>
</tr>
<tr>
<td>Frame duration is 5 milliseconds (ms)</td>
<td>Frame duration is 10 ms</td>
</tr>
<tr>
<td>Can handle speeds up to 75 mph</td>
<td>Can handle speeds up to 250 mph</td>
</tr>
<tr>
<td>Modulation technique for both uplink and downlink is OFDMA</td>
<td>Uplink technique is SC-FDMA and Downlink technique is OFDMA</td>
</tr>
</tbody>
</table>

### Advantages of LTE
1. Compatibility with the previous mobile technologies such as 2G and 3G
2. Saves up device battery consumption because it uses SC-FDMA technology for uplink.
3. Theoretically have better speeds compared to WiMAX

### Disadvantages of LTE
1. Use of additional antennas at network stations
2. Cost for the user to incur in order to buy a device that supports this infrastructure effectively and efficiently
3. Higher initial cost to the ISP

### Advantages of WiMAX
1. A single station can cover 100 of users at a time while managing very high speeds
2. Compared to LTE, the startup and maintenance cost is very low
3. Infrastructure is very easy, flexible and has maximum reliability
4. WiMAX technology offer high security due to its complex encryption systems.

### Disadvantages of WiMAX
1. Offers slow speeds compared to LTE
2. Weather conditions can interrupt signals
3. WiMAX requires high usage of electricity to function
4. High operational cost.

The following Figure 6 describes about the generations and their related technologies.

### TABLE II

<table>
<thead>
<tr>
<th>Generation</th>
<th>Speed Comparison [13]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1G</td>
<td>2G</td>
</tr>
<tr>
<td>Analog Phones</td>
<td>TDM A</td>
</tr>
<tr>
<td>2.5G</td>
<td>EDGE</td>
</tr>
<tr>
<td>3G</td>
<td>UMTS</td>
</tr>
<tr>
<td>3.5G</td>
<td>HSPA</td>
</tr>
<tr>
<td>4G</td>
<td>HSPA 14</td>
</tr>
<tr>
<td></td>
<td>HSPA+</td>
</tr>
<tr>
<td></td>
<td>WiMAX 2</td>
</tr>
<tr>
<td></td>
<td>LTE</td>
</tr>
<tr>
<td></td>
<td>LTE Advanced</td>
</tr>
</tbody>
</table>

The above Table II compares the speeds of the communication generations.

### III. OUR APPROACH

Our main concept is to bring back the WiMAX technology again to the society. In order to do that we have to come up with an idea that will avoid the main drawbacks of WiMAX technology.

WiMAX stations usually consume a lot of electricity to power up their antennas. We can overcome this main drawback by introducing Solar panels to produce power for those WiMAX antennas. And with the introduction of these solar panels, the use of high ranged antennas can come into use as well. This will result in an increase bandwidth which will also reduce the high power consumption cost and also maximize the throughput of the uplinks and downlinks. WiMAX frequency boosters are available in the market as well which are cheap compared to other devices that are used for the same purpose. Since operational costs are considered high to run a WiMAX station, ISP’s should train their employees well and check their work thoroughly. The reason why this technology is recognized by a less amount of people due to WiMAX technology and systems are still hard to recognize which makes it difficult to operate. WiMAX devices are tending to become cheaper than...
before as well, this is due to developing countries are implementing WiMAX since it can cover a larger area with a lesser cost to incur.

WiMAX still uses OFDMA modulation technique to upload and download data which results in an excess of power consumption. If it was made to use SC-FDMA to uplink and OFDMA to downlink, (same as LTE), it would not consume as much power like before. It would cost less for the ISP’s if they come up with this technique because LTE stations are considered much more expensive than WiMAX stations.

To reduce power consumption and to maximize the available throughput in mobile devices, the use of MAC implementation between hardware and software can be taken into use. This software runs on a RAM processor by providing flexibility while the MAC hardware accelerates the system performance and throughput.

Wireless Sensor Network (WSN) applications are implemented in several domains for observing industrial, medical, or environmental world. In fact, they enhance capabilities to analyze items and communicate information regarding them. These sensor networks try to implement low energy consumption medium access control (MAC) protocols. MAC layer in the sensor nodes offers a number of module consumers of energy. The 802.15.4 standard describes data link layer (DLL) and physical layer (PHY) proprieties for the supporting sensor devices with slight power consuming and functioning in a limited area. The two layers offer a reliable communication among the nodes of the network by evading the crashes to expand the efficiency [14].

This will also run while the device is in the sleep mode as well as in the idle mode. WiMAX will start to be the next generation evolution in wireless technology and will empower high-speed connectivity to meet the growing demand for Broadband Internet at home, in the office, or while on the go if the above mentioned concepts are met properly. Figure 7 below demonstrates how WiMAX users gradually increased from 2006 to 2012.

According to the Fig.7, a conclusion can be made that by promoting Mobile WiMAX concept among people and showing its benefits especially to the internet service providers will help to bring back the forgotten technology. By introducing on chip WiMAX mobile facility for mobile devices it can result in a further reduced cost and can acquire a smaller design as well. Although the mobile devices are most popular among users to browse the net in the modern society, the concept will highly spread among the people with in short period of time.

IV. CONCLUSION

Broadband wireless is an important evolving marketplace for the telecom industry to distribute a variety of applications and facilities to both mobile and fixed users. This paper presents strong key advantages of WiMAX and how it can help end users who are struggling with getting connected to the net. The paper compares the two forms of 4G networks and compares to all other generations of technology, and it shows that WiMAX is more consistent and a secure service. The grouping of both cutting-edge radio features and flexible end-to-end design makes WiMAX a striking resolution for various operators. It offers many different facilities on one network. It also provides convergence of fixed and mobile networks. The paper also shows that WiMAX provides high speed access to the user at a sensible cost when compared to LTE.

V. FUTURE WORK

WiMAX being a backhaul solution for Wi-Fi is one of the main forthcoming strategies that are planned. This is due to WiMAX gives out high speed wireless broadband to a range up to 30 miles compared to existing Wi-Fi hotspots. It is also mentioned that once the 802.16e standard is modified and approved, WiMAX will be upgraded to a standardized mobile application.

The technology is very useful for developing countries, such as Sri Lanka, small geographical area where most of the citizens are connected to the internet. Nevertheless the country finds it hard to get into a stable and a fast net connection where the implantation of WiMAX could come in handy. When the limitations are considered, users today does not like to change from one technology to another, so this will be a major concern if WiMAX is going to be implemented.

ACKNOWLEDGEMENT

With humble gratitude we acknowledge the help that was rendered to us by our Lecturer, Mr. Dhishan Dhammearatchi for his consistent encouragement and guidance that was given to the whole team in order to complete this research paper. And our thanks to one
and all whom directly or indirectly, have lent their helping hand in this research.

REFERENCES


[17] http://www.3g.co.uk/PR/June2007/WiMaxGraph.gif

