IEEE 802.16 Wimax: A Survey

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Abstract- The IEEE 802.16 mesh network is a promising next generation wireless backbone network. Over the last few years IEEE 802.16 has been established as one of the most promising solution for broadband wireless metropolitan area network. In these days, WiMAX is considered as one of the prominent technology for the future generation communication systems. It provides better services than its predecessor technologies such that Wi-Fi in terms of coverage area, data rate, flexibility etc. But due to the emerging technology, there are number of challenges that need to take care of when designing a WiMAX network. In this paper, a detailed study of WiMAX with its challenges is done focusing on its working, specifications, evolution, deployment challenges and future scope of the technology

1. INTRODUCTION

WiMAX stands for Worldwide Interoperability for Microwave Access. WiMAX technology provides wireless broadband service for fixed and/or mobile users, and became a reality in 2006 when Korea Telecom started the deployment of a 2.3 GHz version of mobile WiMAX service called WiBRO we access internet in today's time with basically three different options: broadband access, Wi-Fi and Dial-up access. The main problem with broadband access are that it is pretty expensive and it doesn't reach all areas. The main problem with Wi-Fi is that hot spots are very small, so coverage is less. The new technology WiMAX covers all these problems and provide better services like high speed of broadband services, wireless rather than wired access, that is less expensive than cable it is much easier to extend to rural areas and provides broad coverage like cell phone networks. WiMAX can provide broadband wireless access up to 30miles(50km) for fixed station and 3-10miles(5-15km) for mobile stations. It allows a user to browse the internet on a laptop without physically connecting it to a router. It involves microwaves for the transfer of data wirelessly. It has various advantages like bandwidth flexibility, quick installation, WiMAX allows interpenetration for broadband service of video and internet simultaneously. Imax is of two types fixed and mobile WiMAX. WiMAX has the potential to do to broadband Internet access what cell phones have done to phone access. In the same way that many people have given up their "land lines"

in favor of cell phones, WiMAX could replace cable and DSL services, providing universal Internet access just about anywhere you go. WiMAX will also be as painless as Wi-Fi -- turning your computer on will automatically connect you to the closest available WiMAX antenna.

Day by day, the deployments of the networks are going beyond the imagination. New network standards, new applications, applications of new standards are getting designed or under research. In recent years, the most revolutionary standard is 802.11 that came into picture in 1985. But as the usage of the networks increased, users required the wireless networks more flexible and easy to use. Users always need the networks ready to use and the networks that give the users free to move anywhere facility. By taking 802.11 base, research was carried out and new commercial standards like 802.15 (Wireless Personal Area Networks), 802.16 (WiMAX) came out as a result to meet the user requirements. New technologies like MANETs, Mesh Networks are also designed for the deployment of different standards Mesh Networks are a kind of personal internet. To get connected with different locations over the different geographical locations, firms need to get an internet connection from an Internet Service Provider (ISP) for which the firms have to pay big bounty to the ISPs. Mesh Networks give an alternate to create a network of networks similar to the internet but smaller than the internet by passing to the ISPs. It is very important to understand the Mesh Network technology to make it more reliable and sustainable. A lot of research is going in the field of Mesh Networks in these days to extend to geographical limits of Mesh Networks, new optimized applications that could be used over the mesh networks, security procedures to ensure the integrity of the data exchanged over the mesh network etc. As the limits of mesh networks are increasing, users required them to be more flexible. Users required the use of various high data rate services like video conferencing, voice calling, online gaming etc. There are many fields in which a lot of work was done and currently the researchers are focused on, such that, routing protocols optimization, data integrity, trajectories, energy efficiency, security etc

2. HOW WiMAX WORKS

In practical terms, WiMAX would operate similar to Wi-Fi but at higher speeds, over greater distances and for a greater number of users. WiMAX could potentially erase the suburban and rural blackout areas that currently have no broadband Internet access because phone and cable companies have not yet run the necessary wires to those remote locations.

A WiMAX system consists of two parts: A WiMAX tower is similar in concept to a cell-phone tower and a single WiMAX tower can provide coverage to a very large area as big as 3,000 square miles (~8,000 square km). A WiMAX receiver - The receiver and antenna could be a small box or they could be built into a laptop the way Wi-Fi access is today. A WiMAX tower station can connect directly to the Internet using a high-bandwidth, wired connection It can also connect to another WiMAX tower using a line-of-sight, microwave link. This connection to a second tower along with the ability of a single tower to cover up to 3,000 square miles, is what allows WiMAX to provide coverage to remote rural areas. WiMAX offers the kind of

service where you can get a connection and wherever u may be when WiMAX is fully developed , u will no longer be limited to 300 feet within the Wi-Fi hotspot and u won't have to drive around looking for a connection. WiMAX is very cost effective and has the ability to get a higher connection speeds farther away from the transmitter. WiMAX operates on the same general principles as Wi-Fi and it sends data from one computer to another via radio signals. A computer (either a desktop or a laptop) equipped with WiMAX would receive data from the WiMAX transmitting station, probably using encrypted data keys to prevent unauthorized users from stealing access.

3. IEEE 802.16 Specifications

The fastest Wi-Fi connection can transmit up to 54 megabits per second under optimal conditions. WiMAX should be able to handle up to 70 megabits per second. Even once that 70 megabits is split up between several dozen businesses or a few hundred home users, it will provide at least the equivalent of cable-modem transfer rates to each user. Wi-Fi's range is about 100 feet (30 m). WiMAX range is of 30 miles (50 km) with wireless access. The increased range is due to the frequencies used and the power of the transmitter. Of course, at that distance, terrain, weather and large buildings will act to reduce the maximum range in some circumstances. In WiMAX Line-of-sight not needed between user and base station and Frequency bands - 2 to 11 GHz and 10 to 66 GHz (licensed and unlicensed bands). it defines both the MAC and PHY layers. There are two ways WiMAX can be implemented -- as a zone for wireless connections that single users go to when they want to connect to the Internet on a laptop (the non-line-of-sight "super Wi-Fi" implementation), or as a line-of-sight hub used to connect hundreds of customers to a steady, always-on, high-speed wireless Internet connection.

IEEE 802.16 can provide wireless broadband access with its support to both single hop and multi-hop mesh modes.But, it is not quite clear how well an IEEE 802.16 network could support real-time services such as video streaming and voice over Internet protocol services, especially in its mesh-mode operation. An analyse of delay and throughput properties of an IEEE802.16 mesh network was done by Y.Li[7] for evaluating the performance of various real-time applications. An analytical model was proposed to calculate delay and throughput of IEEE 802.16 distributed scheduling schemes. It helped to investigate how delay and throughput vary in terms of network parameters in order to optimise the system design via proper parameter configuration and by deriving three metrics, such that MSH-DCSH access delay, three-way handshaking delay and throughput explicitly. After the extensive simulations done to demonstrate the accuracy of the model, it was revelead that the increase of MCL helps to reduce both MSH-DCSH access delay and three way handshaking delay, and there exists an optimal value os MCL which maximises the throughput. Onefundamental issues in IEEE 802.16 mesh networks is Qos provisioning. Although IEEE 802.16 standard has made certain efforts to address this issue, many technical problems still exists in this field. Yajun Li et al. [8] presented a detailed investigation of Qos issues in IEEE 802.16 mesh networks in order to provide a better understanding of the

research challenges of Qos provisioning under Mesh model

4. WiMAX Technology at Home

Here's what would happen if you got WiMAX. An Internet service provider sets up a WiMAX base station 10 miles from your home. You would buy a WiMAX-enabled computer or upgrade your old computer to add WiMAX capability. You would receive a special encryption code that would give you access to the base station. The base station would beam data from the Internet to your computer (at speeds potentially higher than today's cable modems), for which you would pay the provider a monthly fee. The cost for this service could be much lower than current high-speed Internet-subscription fees because the provider never had to run cables. If you have a home network, things wouldn't change much. The WiMAX base station would send data to a WiMAX-enabled router, which would then send the data to the different computers on your network. You could even combine Wi-Fi with WiMAX by having the router send the data to the computers via Wi-Fi. The WiMAX protocol is designed to accommodate several different methods of data transmission, one of which is voice over internet protocol (VoIP). VoIP allows people to make local, long-distance and even international calls through a broadband Internet connection, bypassing phone companies entirely. If WiMAX-compatible computers become very common, the use of VoIP could increase dramatically. Almost anyone with a laptop could make VoIP calls.

5. Evolution of 802.16

WIMAX is the commercialization of 802.16 standards done by WiMAX Forum industry alliance. There are various versions of 802.16 standard:

5.1. IEEE 802.16-2001

The first version of the IEEE Standard 802.16-2001 [1] was completed in October 2001 and published on 8 April 2002 which defined the Wireless MAN™ air interface specification for wireless metropolitan area networks (MANs). The intention behind the first release of the standard was to define a technology for broadband wireless access (BWA) for fixed users, as an alternative to cabled access networks, such as a digital subscriber line (DSL) links. For this reason, the original IEEE 802.16 defines a point-to-multipoint (PMP) network architecture where resources are shared by a central node called base station (BS) to a set of subscriber stations (SS). In fact, the PMP operational mode fits a typical fixed BWA scenario, where multiple subscribers are served by one centralized service provider to access external networks (e.g., the Internet) or services (e.g., digital video broadcasting – DVB). From its first release, the medium access control (MAC) layer was connection-oriented and supported quality of service (QoS). Moreover, the standard was designed to evolve as a set of air interfaces based on a common MAC protocol, but with physical layer specifications dependent on the spectrum of use and the associated regulations. The standard, as approved in 2001, addresses frequencies from 10 to 66 GHz in line-of-sight (LOS) operations using single carrier transmission only. In 2003, a new version of the standard, IEEE 802.16a-2003, was published with support for non-LOS operations in frequencies from 2 to 11 GHz.

5.2. IEEE 802.16 with mobility support

802.16-2004 introduced support for two additional physical layers: orthogonal frequency division multiplexing (OFDM) and orthogonal frequency division multiple access (OFDMA). In 2005, a new version of the standard was released to enable combined fixed and mobile operations in licensed bands. The IEEE 802.16e-2005, was defined as an amendment to IEEE 802.16-2004 and added several features related to mobile operations and mobile stations (MS), including power-saving, idle mode, handover and an improved OFDMA physical layer. After the 2005 release, the standard development continued to define the management information base (MIB) for MAC and PHY (IEEE 802.16f) and the management plane and procedures (IEEE 802.16g), to improve the co-existence for license exempt operation (IEEE 802.16h), to introduce relay capabilities (IEEE 802.16j-2009), and to refine the MAC and PHY procedures for mobile operations (IEEE 802.16-2009). The latter is also known as the 2009 release, and brings the following major changes: half-duplex mobile terminal operations in OFDMA frequency division duplexing (FDD), load balancing, support for location based services (LBSs) and multicast and broadcast services (MBSs).

5.3. IEEE 802.16 and the WiMAX

The IEEE 802.16 specifications were designed for various BS and MS implementations. Moreover, the standard only deals with the MAC and physical layers, without defining the over-the-air upper layer signaling nor the overall network architecture and protocols. These two factors were the main part for the establishment, in 2001, of the WiMAX. Since its birth, the goal of the WiMAX Forum has been to enable conformity and inter-operability of SSs and BSs based on IEEE 802.16. Since June 2008, the WiMAX Forum has been working on a new version of the Mobile WiMAX, called Release 1.5, based on the latest IEEE 802.16-2009 standard. This release is aimed at enabling mobile WiMAX in new spectrum bands, including those for FDD operation, addressing the most recent MAC improvements, and introducing advanced network capabilities.

5.4. IEEE 802.16m

The aim of IEEE 802.16m is to join both IEEE 802.16-2009 and IEEE 802.16j-2009 standards, which specifies relay capabilities, in order to design an advanced air interface Since the beginning of 2007, the IEEE 802.16m technical working group has been working on the following documents: the system requirement document (SRD), the evaluation methodology document (EMD), the system description document (SDD), and the draft IEEE 802.16m amendment. The aim of the SRD is to describe the high-level requirements of the new standard, including: support capabilities, design complexity, supported services, operating frequencies and bandwidths, advanced antenna techniques, and support for emergency and military services.

6. WiMax Survey

Most researchers are familiar with the technical features of Wimax technology but the evolution that WiMAX went through, in terms of standardization and certification, is missing and unknown to most people. Knowledge of this historical process would however aid to

understand how WiMAX has become the widespread technology that it is today. Therefore, Daan Pareit, Bart Lannoo [4] presents a survey on all relevant activities that took place within three important organizations: the 802.16 Working Group of the IEEE (Institute of Electrical and Electronics Engineers) for technology development and standardization, the WiMAX Forum for product certification and the ITU (International Telecommunication Union) for international recognition. An elaborated and comprehensive overview of all those activities is given, which reveals the importance of the willingness to innovate and to continuously incorporate new ideas in the IEEE standardization process and the importance of the WiMAX Forum certification label granting process to ensure interoperability.

The WiMAX technology based on the IEEE 802.16 standard is a Broadband Wireless Access (BWA) technology and considered to be an important ingredient of the composition of the Next Generation Networks (NGN). Till date, due to lack of deployment not enough data is available in terms of its operational capabilities and efficiencies. In addition to this standard, some methodologies and paths for controlling and evaluating of IEEE802.16 standard are given by Morteza Nabipoor [6]. Their main focus is on classifying and evaluating some basic subjects and topics in IEEE802.16 , based on WiMAX technology. A. Bacioccola, C. Cicconetti [1], first presented a historical overview of the IEEE 802.16 standard from the first version released in 2001 to the current version. Then, they have provided a detailed technical analysis of the PHY, MAC layer, and other relevant aspects of the new standard, including a detailed description of its relay architecture and support for self organizing networks and Femto cells. To better understand the technical impact of the new release, they have also presented a comparison of the downlink control overhead between IEEE 802.16-2009 and IEEE 802.16m. In fact, one of the biggest problems in IEEE 802.16-2009 and its previous revisions was the high signaling overhead. The simulation results have shown that the new version of the standard introduces several effective mechanisms to reduce the signaling overhead.

7. IEEE 802.16 Quality of Services

The IEEE 802.16 is a standard for broadband wireless communication in Metropolitan Area Networks (MAN). To meet the QoS requirements of multimedia applications, the IEEE 802.16 standard provides four different scheduling services: Unsolicited Grant Service (UGS), real-time Polling Service (rtPS), non-real-time Polling Service (nrtPS), and Best Effort (BE). Verification of effectiveness of these four different scheduling services wad done by Claudio Cicconetti, Alessandro Erta et al. [3] in managing traffic generated by data and multimedia sources. Performance is assessed for an IEEE 802.16 wireless system working in Point-to-Multipoint (PMP) mode, with Frequency Division Duplex (FDD), and with full-duplex Subscriber Stations (SSs). Results show that the performance of the system, in terms of throughput and delay, depends on several factors. These include the frame duration, the mechanisms for requesting uplink bandwidth, and the offered load partitioning, i.e., the way traffic is distributed among SSs, connections

within each SS, and traffic sources within each connection. The results also highlight that the rtPS scheduling service is a very robust scheduling service for meeting the delay requirements of multimedia applications.

To ensure meeting the QoS requirements, the 802.16 base station must run some algorithm to allocate slots between connections. A simple and an efficient solution that is capable of allocating slots based on the QoS requirements, bandwidth request sizes, and the 802.16 network parameters is proposed by Alexander Sayenko , Olli Alanen [2]. To test the proposed solution, 802.16 MAC and PHY layers are implemented in the NS-2 simulator. According to the simulation results, the proposed scheduling solution ensures the QoS requirements of all 802.16 service classes. The solution shares free resources fairly and demonstrates work-conserving behaviour. The frame-based medium access of 802.16 requires rigorous protection against interference from wireless local area networks in order to operate properly. The 802.11e enhancements of the medium access control of 802.11 introduce the capability to support QoS. These enhancements define a central entity as main element: The Hybrid Coordinator. It realizes a contention free, centrally controlled medium access and introduces QoS limitations to the contention based access of 802.11e. A central coordinating device was proposed by Lars Berlemann, Christian Hoymann et al. [5] combines the central base station of 802.16 with the hybrid coordinator of 802.11e and thus referred to as Base Station Hybrid Coordinator. The Base Station Hybrid Coordinator is capable to operate in an 802.16 and an 802.11(e) protocol mode in the same frequency band. It has been shown that interworking influences the medium access of all spectrum sharing wireless networks. Restrictions and requirements of each protocol have to be combined to enable QoS support under coexistence. The adherence of a common frame structure can be regarded as extreme cooperation

8.CONCLUSION

Mesh networking is one of the most promising technologies for next-generation wireless networking. In this paper we have also introduced ivolutions of WiMAX, In this paper we have presented historical overview of IEEE 802.16 .We have also presented IEEE 802.16-2001,IEEE 802.16 with mobility support,IEEE 802.16m further result of these will show new standards which will reduce signaling overhead. We have given a survey to this topic which is very helpful in future studies. We believe that certain topics presented above are also applicable to general Wireless Mesh Networks. Finally, we advance several open research challenges in this article with an objective to spark new research interests in this field.

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