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A Review on Worldwide Interoperability for Microwave Access (WiMAX) Networks

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Abstract— Worldwide interoperability for Microwave Access (WiMAX), that is additionally called IEEE 802.16 standards. WiMAX may be a recent analysis space for the forefront of the technology drive thanks to the growing demand for high-speed wireless broadband networks. Multihop WiMAX networks are significantly helpful as they increase the coverage space while not the requirement to deploy valuable base stations. It's grew to assist solve barriers to adoption, like ability and price of readying and to facilitate the wireless metropolitan area networks for trade by process and conducting ability testing and labeling seller systems with a label once testing has been completed with success. WiMAX has several benefits as well as wide coverage space and high information measure. These benefits modify WiMAX to support long transmission range and high data rate compared to cellular and LAN network. WiMAX a wireless normal that uses orthogonal frequency division multiple access (OFDMA) and guarantees to supply mobile broadband services even at a conveyance speed of up to a hundred and twenty km/h. although the WiMAX normal supports both mounted and mobile broadband information services, the latter have larger demand. During this research paper a general review on WiMAX for physical layer, MAC layer, QoS in WiMAX, and applications of WiMAX.

Keywords: WiMAX, IEEE 802.16, WiMAX, PHY layer, Survey, QoS, MAC Layer.

I. INTRODUCTION

WiMAX is associate IEEE standard (IEEE 802.16d/e) for wireless broadband access network was planned by the WiMAX Forum, an association of regarding 420 members as well as major companies like AT&T, Fujitsu, Intel and Siemens, was established in June 2001 to promote correspondence and ability of the technology and promote its commercial use within the market. The WiMAX Forum and IEEE 802.16 committee area unit each concerned within the development of open standards primarily based broadband wireless networks. The IEEE 802.16 committee is solely a technical body that defines the 802.16 family of broadband wireless radio interface standards. IEEE 802.16 defines the layer one (PHY) and layer two (MAC) of the (Open Systems Interconnection) OSI seven layer network model. The IEEE 802.16 commonplace provides specification for the mac and PHY layers for the air interface. The quality includes details regarding the varied flavors of PHY layers supported and characteristics of the MAC layer like information measure request mechanisms and also the programming services supported. It doesn't outline standardized specification beyond the bottom station. The WiMAX Forum fills this gap associated creates an end-to-end

broadband wireless network, thus it prepares profiles for systems that go with the IEEE 802.16 commonplace and build ability tests to ensure totally different vendors' implementation will work along. In theory, a WiMAX base station will give broadband wireless access in range up to thirty miles (50 kms) for fastened stations and three to ten miles (5 to fifteen kms) for mobile stations with a most rate of up to seventy Mbps compared to 802.11a with fifty four Mbps up to many hundred meters, Enhanced Data Rates for Global (EDRG) Evolution with 384 kbps to some kms. IEEE 802.16 standards cluster has been developing a collection of standards for broadband (high-speed) wireless access in a very metropolitan space. These days analysis is predicated on the factors effecting programming in WiMAX and includes all the classes within which programming algorithms are often divided to avoid the traffic and conjointly increasing turnout, reducing delay and packet losses. The most benefits of WiMAX over different access network technologies area unit longer vary and a lot of refined support for Quality of Services.

II. RELATED WORKS

Fundamentals of WiMAX Understanding Broadband Wireless Networking have been discussed by JG Andrews et. al. (2007). Scheduler for IEEE 802.16 networks have been developed by JF Borin et. al. (2008). Dynamic QoS-based bandwidth allocation framework for broadband wireless networks have been discussed and developed by E Amir et. al. (2011). A survey and key issues in Scheduling in IEEE 802.16e mobile WIMAX networks have been studied and discussed by C So-In, et. al. (2009). Adaptive downlink and uplink channel split ratio determination for TCP-based best effort traffic in TDD-based WiMAX networks have been investigated by CH Chiang, et. al. (2009). IEEE 802.16 capacity enhancements using an adaptive TDD split have been discussed by R Pries et. al. (2008). Adaptive sub frame allocation in WiMAX networks have been developed by I Adhicandra, (2010). Performance Evaluation of an Uplink Scheduling Algorithm in WiMAX have been discussed and analysed by Yekanlu E. et. al. (2009). Analyzing the Throughput and QoS Performance of a WiMAX Link in an Urban Environment have been developed by Daniel, K. et. al. (2009). A survey on scheduling in IEEE 802. 16 mesh mode have been discussed by Miray K, et. al. (2011). Comparative studies of scheduling algorithms in WiMAX have been analyzed by Sabri A. et. al. (2011). An overview of scheduling strategies for PMP mode in IEEE 802.16 have been studied and discussed by Murrawat S, et. al. (2012). Comparative study of scheduling algorithms for WiMAX have been discussed and analyzed by Jain A et. al. (2008). Overview of mobile WiMAX technology and evolution have been studied and discussed by Etemad K, et. al. (2008). Performance evaluations of the IEEE 802.16 MAC for QoS support have been analyzed by Cicconetti. et. al. (2007). Flexible resource allocation in IEEE 802.16 wireless metropolitan area networks have been developed by Xergias AS, et. al. (2010). Comparisons of WiMAX scheduling algorithms and proposals for the rtps QoS class have been analyzed by Loutfi, et. al. (2008). Performance analysis of temporary removal scheduling applied to mobile WiMAX Scenarios in tight frequency reuse have been investigated and developed by Ball CF, et. al. (2011). Performance evaluations for scheduling algorithms in WiMAX network have been discussed by Cherng JL et. al. (2012). Packet scheduling for QoS support in IEEE 802.16 broadband wireless access systems have been developed by Ganz A. et. al. (2003). IEEE 802.16 based last mile broadband wireless military networks with quality of service support have been discussed and developed by Wongthavarawat K, et. al. (2003). Quality of service scheduling for 802.16 broadband wireless access systems have been

developed by Sun J, et. al. (2006). Uplink scheduling with quality of service in IEEE 802.16 networks have been investigated by Freitag J, et. al. (2010). A three tier framework and scheduling to support QoS service in WiMAX have been analyzed by Maode M, et. al. (2010).

III. WiMAX

WiMAX is that the most rising technology that permits present delivery of broadband wireless access for fastened and mobile users. It's been developed to accelerate the introduction of broadband wireless access into the marketplace. The foremost effective ways those to get access to broadband web service were primarily through T1, Digital Subscriber Line (DSL), or cable modem. However, these wired infrastructures are significantly costlier, particularly for preparation in rural areas and developing countries. The standard wireless cellular networks have a stratified design within which centralized controllers facilitate resource management and quality support during an extremely efficient manner, usually for voice call services. Though they're designed primarily for wireless web access, presently deployed mobile WiMAX networks additionally adopt this cellular-style hierarchical design, however they use less hierarchy. It additionally provides high rate applications with a spread of Quality of Service (QoS) necessities. The notable companies like Motorola and Samsung are already developing WiMAX phones and PDAs and that they are already in use in Korea with WiMAX full cousin technology, Wireless Broadband. Today WiMAX is taken into account joined of the most technologies for next generation high speed wireless access networks. It provides a bigger coverage compared to Wi-Fi whereas supporting string QoS and security mechanism due to its optimizable physical layer and too several flexible capabilities. This latest innovative WiMAX technology is taken into account joined of the most standards for future wireless networks. Many technologies utilized by WiMAX, like Orthogonal Frequency-Division Multiple Access (OFDMA) and resource allocation ways with differentiated QoS are elements of Next Generation Networks (NGN) standards. Mobile WiMAX commonplace offers quantify ability in each radio access technology and network architecture; therefore, it provides flexibility in network preparation and repair offerings in fig 1. WiMAX may be convenient for Hybrid Networks, native space Networks or long vary transmission due to MAC relays outlined in802.16j.

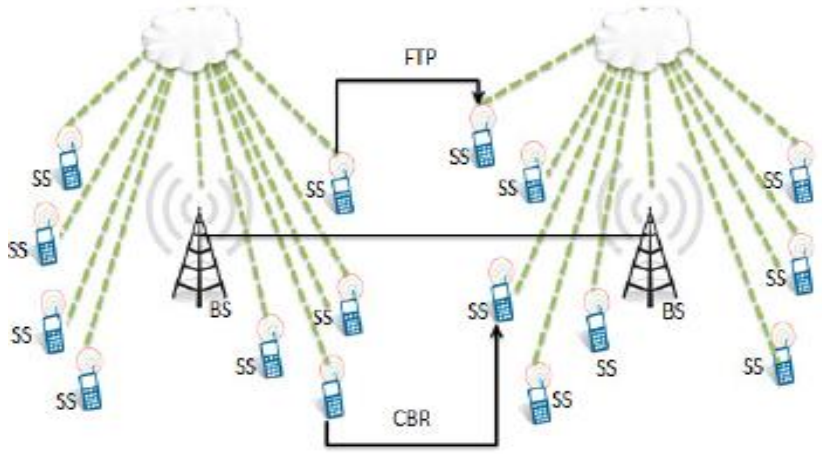

Figure 1.WiMAX

Issues and challenges for WiMAX

Scheduling is the method by which data flows are given access to system resources (communications bandwidth in this case).This is usually done to load balance a system effectively and/or achieve a target quality of service. In theory, there are 3 schedulers needed for IEEE 802.16, one for outbound transmission scheduling at the Base Station for downlink another for uplink burst scheduling at the BS and last is the outbound transmission scheduling at the SS. The goal of this section is to provide better understanding about the issues for the design of schedulers. Since WiMAX has to deal with heterogeneous traffic therefore the major design issues concerning the development of schedulers may be stated as under

- Guaranteeing a certain degree of fairness to the subscribers and different types of flows. However ensuring fairness to every node or flow may not be always easy as it may be conflicting with efficiency.

- Guaranteed delivery of QoS requirements that are negotiated at the time of connection establishment.

- Effective Channel utilization: It may be measured in terms of throughput, in order to improve channel utilization several other factors like AMC, MIMO techniques and fragmentation mechanism needed to be explored.

- Complexities associated with the implementation of algorithm shall be small.

- Good bandwidth- request strategy i.e. it shall be able to choose whether to piggyback, multicast, broadcast or send stand-alone messages to request more bandwidth. This could add a substantial burden to the resources if not handled carefully.

- Efficiency in terms of delay, throughput, scalability, robustness and graceful degradation of scheduler.

- In TDD mode the amount of bandwidth allocated shall be adapted dynamically by the scheduler.

- Focus of schedulers is being shifted to the study of congestion and other network layer parameters and scheduler may make its scheduling decision based on congestion, routing or queue lengths.

IV. PHYSICAL LAYER IN WiMAX

The original version of the standard on it WiMAX relies (IEEE 802.16) form of a physical layer operative among the 10 to sixty six rate vary. 802.16a, updated in 2004 to 802.16-2004, any specifications for the 2 to eleven rate vary. In 802.16-2004 was updated by 802.16e-2005 uses scalable orthogonal frequency-division multiple access as opposition the

mounted Orthogonal Frequency-Division Multiplexing (OFDM) version with 256 sub-carriers (of that two hundred unit used) in 802.16d. This brings potential edges in terms of coverage, self-installation, power consumption, frequency use and knowledge live efficiency. In 802.16e additionally adds a capability for full quality support. The certification of WiMAX is permit to vendors with 802.16d product to sell their instrumentality certified, thus guaranteeing grade of ability with absolutely entirely completely different certified product, as long as they match identical profile. Most business interest is among the 802.16d and 802.16e standards, since the lower frequencies used in these variants suffer less from inherent signal attenuation thus offer improved vary and in-building penetration. Already lately, quite networks throughout the world unit in business operation victimization certified WiMAX instrumentality compliant with the 802.16d normal.

V. MEDIA ACCESS CONTROL (MAC) LAYER IN WiMAX

The WiMAX-MAC uses a scheduling algorithmic program that the Subscriber Station (SS) must compete one time for initial entry into the network. When network entry is allowed, the subscriber station is allotted associate access slot by the base station. The slot will enlarge and contract, however remains appointed to the subscriber station, which implies that alternative subscribers cannot use it. The MAC of WiMAX is reservation-based and contention-free. The Selective Service System have to be compelled to contend only they access the channel for the primary time at the affiliation admission control stage. The reservation-based resource allocation permits the WiMAX BS to serve an oversized variety of Selective Service System still because the guarantee of QoS within the affiliation level for each transmission and downlink traffic. Compared with WiMAX terminals typically have intermittent traffic that contends when before transmission, wherever the potency is considerably impaired once a lot of stations enter the network.

The main purpose of the MAC protocol is that the sharing of radio channel resources among multiple accesses of various users. In IEEE 802.16, the MAC layer is split into 3 sub layers: the service-specific convergence, common half sub layer, and security sub layer. The first task of service-specific convergence sub layer is to classify external Service Data Units (SDU) and associate every of them with a correct MAC service flow symbol and affiliation symbol. The MAC layer protocol is versatile and economical over completely different traffic sorts. The common half sub layer is freelance of the transport mechanism, that is that the kernel bearing all the MAC characteristics. It's answerable for fragmentation and segmentation of every MAC SDU into raincoat Protocol Data Units (PDUs), system access, information measure allocation, affiliation maintenance, QoS management, and programming transmission, etc. The MAC conjointly contains a separate security sub layer handling authentication, secure key exchange, and secret writing.

VI. QUALITY OF SERVICE (QoS) IN WiMAX

WiMAX supports connection-oriented MAC that is additional sub divided into 3 completely different sub layers namely: Convergence, Common part and security sub layer. Connections are documented with 16-bit affiliation identifiers (CIDs) and should need continuously granted information measure or information measure on demand. There are 2

forms of connections: information and Management. Management connections may be either basic (urgent), primary (less urgent) or secondary and wont to transfer management messages like RNG-REQ/REP-RSP/RST etc. Quality of Service (QoS) provisioning is one amongst the essential options in WiMAX. However, there are variations within the normal specifications, specifically in WiMAX and next target 2 QoS problems together with service flow and information measure grant services. A service flow is outlined as a unidirectional flow of MAC SDUs on an affiliation related to specific QoS parameters like latency, jitter, and output. These QoS parameters are used for transmission and programming. Service flows are generally known by Selective Service System and BSs supported their SFID. There are 3 basic forms of service flows: provisioned service flows, admitted service flows, and active service flows. A provisioned service flow is outlined within the system with an SFID; however it would not have any traffic presence. It should be waiting to be activated for usage. An admitted service flow undergoes the method of activation. In response to an external request for a particular service flow, the BS/SS can check for out there resources supported the QoS parameters to visualize if it will support the request. If there are sufficient resources, the service flow is deemed admitted. The resources appointed to the current service flow should be utilized by different services. A service flow is active once all checks are completed and therefore the resources are allotted. Packets can flow through the affiliation allotted to the service flow. The employment of service flows is that the main mechanism utilized in QoS provisioning. Packets traversing the mac sub layer are related to service flows as known by the CID once QoS is needed. Information measure grant services outline information measure allocation supported the QoS parameters related to an affiliation. In downlink transmissions a BS has sufficient info to perform programming, however in transmission transmissions a BS performs the programming of varied service transmissions supported info gathered from Selective Service System. In such cases an SS can request transmission information measure from the BS, and therefore the BS can apportion information measure on an as required basis. For correct allocation of information measure, four services are outlined to support differing types of information flows.

VII. APPLICATIONS OF WiMAX

WiMAX thanks to its varied applications is used as another to existing telecommunications infrastructures. This technology primarily provides Internet Protocol (IP) property using mobile broadband information access to the subscriber. The potential applications employed in information science networks have staggeringly accrued within the recent years globally. During a fixed WiMAX variant it will substitute the telephone company's copper wire networks, the cable TV's coaxial cable infrastructure whereas giving Internet Service Provider (ISP) services. In mobile wireless configuration, it will substitute cellular networks and can also be used for rising applications like Mobile TV, streaming audio/video once user is mobile. WiMAX has the potential to impact all kinds of telecommunications as shown in fig 2.

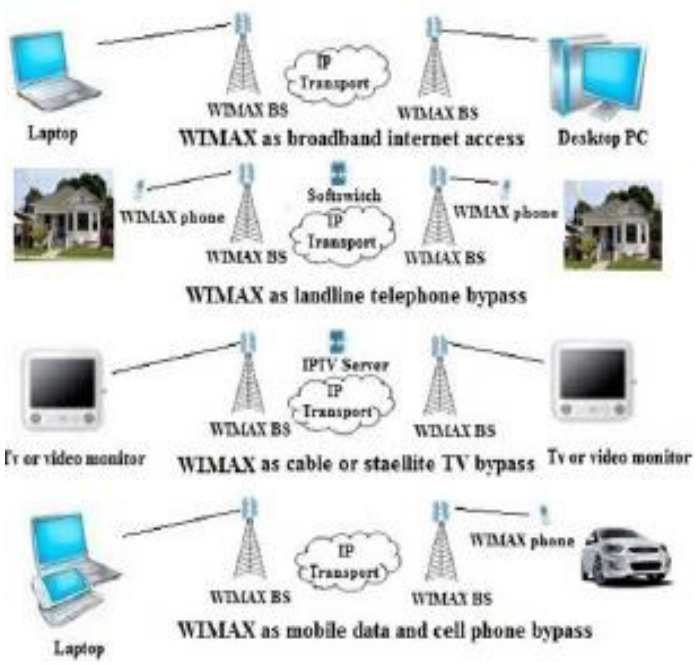

Figure 2. WiMAX Applications

Internet Access: it is a major demand in WiMAX networks. In developing countries like India with low broadband connectivity, WiMAX is a straightforward method to provide a unicast connection between SSs and the BS, which has the link toward the Internet. Due to its wireless nature, it is faster to deploy, easier to scale and more flexible, so it is competent to serve users not satisfied by wired broadband alternative.

Group Communications: WiMAX networks cover comparatively large area and serve many group communications, such as videoconferences. To support such communication scenarios, multicast is the key technology. Since all nodes in a WiMAX network are located inside, providing such group communication becomes possible.

Metropolitan Area Distributed Service: WiMAX is an emerging wireless communication system that is expected to provide high data rate communication in metropolitan area networks. WiMAX network has enabled more value added services in a metropolitan area. To efficiently support a large number of customers, distributed services can be enabled. In other words, a customer can access the service from any of the servers in the network in which these servers are distributed to serve the entire metropolitan area.

Content-Based Distribution: This is content-based routing scheme is a service-oriented communication model. In this scheme the sender of a message does not need to explicitly specify its destination. The network layer will automatically deliver the message to receivers that are interested in the content of the message.

Quality Guaranteed Applications: It is essentially desired that the network layer should provide a sufficient quality of service (QoS) guarantee, mainly in terms of bandwidth,

data rate, delay and delay jitter. It is very difficult to provide such a guarantee in a wireless networks as they are generally error prone. In order to address this issue, multipath routing has been studied by many researchers.

Multi-homing Applications: It is a technology that can provide services similar to those of multipath routing with a difference that in multi-homing, one station has two or more IP addresses and generally has the same number of interfaces. In this manner, the station can have multiple paths to access the same resources. In short, the application layer requirements routing must be addressed in the network layer design.

VIII. CONCLUSION

The communication systems over the recent research year have been changed by rapid advances in wireless networks. Additional demand for high speed wireless internet access, voice and multimedia applications has revolutionized growth of Internet. The WiMAX is a low cost solution for Internet access in metropolitan and rural areas. Although it defines five service levels to support real-time and bandwidth demanding applications, scheduling mechanisms are not specified in the standard. This is particularly useful in regions with little existing wired infrastructure. Adding multihop technology increases the coverage area of WiMAX networks without the need to deploy expensive base stations. A multihop WiMAX network may also lead to increased user throughput as more efficient modulation techniques can be used over shorter links. In this paper a general review on WiMAX for physical layer, MAC layer, QoS in WiMAX, and applications of WiMAX.

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