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A SURVEY OF MOBILE WIMAX STANDARD

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Abstract: Recently, WiMAX has been proposed as an attractive wireless communication technology for providing broadband access for metropolitan areas. Undeniably, networks have become very important techniques of exchanging information (data) in fast ways. (WIMAX) Worldwide Interoperability for Microwave Access is one of the greatest technologies in the communication area. WIMAX has been used widely in telecommunication for long distance communication. From this point, this paper will explore four important sections related to this technique. Firstly, it will discuss the performance conduct of the WIMAX as compared to that of Wi-Fi. Secondly, it will critically evaluate the current solutions for the security problems in WIMAX network. Thirdly, it will attempt to design a new method to improve the security performance of WIMAX network. Fourthly, it will provide a security system that can be applied in real life applications to support the security performance of WIMAX network.

Keywords: Mobile WiMax, QoS , Scalability, IEEE 802.16 PHY layer, MAC layer

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INTRODUCTION

Worldwide Interoperability for Microwave Access (WiMAX) is an emerging global broadband wireless system based on IEEE 802.16 standard. WiMAX is a new OFDM based technology and promises to combine high data rate services with wide area coverage (in frequency range of 10 – 66 GHz (Line of sight) and 2 -11 GHz (Non Line of Sight)) and large user densities with a variety of Quality of Service (QoS) requirements. WiMAX can provide broadband wireless access (BWA) up to 30 miles (50 km) for fixed station and 3 to 10 miles (5-15 km) for mobile stations with theoretical data rates between 1.5 and 75 Mbps per channel.

Mobile WiMAX is a broadband wireless solution that enables convergence of mobile and fixed broadband networks through a common wide area broadband radio access technology and flexible network architecture. The Mobile WiMAX Air Interface adopts Orthogonal Frequency Division Multiple Access (OFDMA) for improved multi-path performance in non-line-of-sight environments. Scalable OFDMA (SOFDMA) [1] is introduced in the IEEE 802.16e Amendment to support scalable channel bandwidths from 1.25 to 20 MHz. The Mobile Technical Group (MTG) in the WiMAX Forum is developing the Mobile WiMAX system profiles that will define the mandatory and optional features of the IEEE standard that are necessary to build a Mobile WiMAX compliant air interface that can be certified by the WiMAX Forum.

LITERATURE REVIEW

Numerous studies evaluated the PSCs in IEEE 802.16e. Y. Xiao and Y. Zhang [2][3] proposed an analytical model of PSC I and investigated the energy consumption of IEEE 802.16e for both uplink and downlink traffic. L. Kong *et al* proposed a theoretical framework based on the semi-Markov to design an optimal sleep mode selection scheme so as to maximize the energy efficiency in a mobile WiMAX system while providing a certain QoS guarantee. In [4][5][6] the authors use Markov-chain model to analyse both energy consumption and response delay in PSC I of IEEE 802.16e affected by relative size of these two operating parameters. In the traffic pattern characteristics follow Poisson distribution whereas some authors consider the other traffic patterns such as Erlang distributed inter arrival time and Hyper-Erlang distributed interarrival time [7]. In [8] the paper has established a general approach for analysing queuing models with repeated in homogeneous vacations. In Zhanqiang also used a discrete-time Geom/G/1 queuing model with a close-down time and multiple vacations is built in the paper. By employing an embedded Markov chain method, the average queue length and the average sojourn time of the system model are derived.

Based on the previous studies, several researchers attempted to deploy adaptive power saving mechanisms in the IEEE 802.16e system by dynamically adjust initial and final sleep interval according to the average traffic overload or the remaining energy stage. In a statistical sleep window control approach is proposed to improve the energy efficiency of a mobile station with non-real-time downlink traffic.

WiMAX ARCHITECTURE

The WiMAX protocol architecture is structured into two major layers (see Fig. 1): - the MAC layer and the PHY layer. MAC layer contains 3 sub layers. Starting from the base, the first sub layer is SS which encrypts and decrypts the data which are entering and leaving in and from PHY layer. This sub layer uses for data traffic 56bit DES (Data Encryption Standard) encryption and for Key Exchanges uses 3DESencryption. The second MAC sub layer is the CS (Service Specific Convergence Sub layer). This sub layer maps higher level data services to MAC layer service flow and connections. The third sub layer is the CPS (Common Part Sub layer). In this sub layer are constructed the MPDUs (MAC Protocol Data Units). The CPS sub layer defines rules and mechanisms for ARQ (Automatic Repeat Request 10), forconnection control and for system access bandwidth allocation. It also provides centralization, channel access and duplexing. CS and CAP are communicated by MAC SAP (Service Access Point).

The PHY layer it's a connection between MPDU and the PHY layer frames with the encoding of the radio frequency signals when sent and received through modulation. WiMAX technology architecture was created so as to allow its connection with IP networks which provide Internet services.

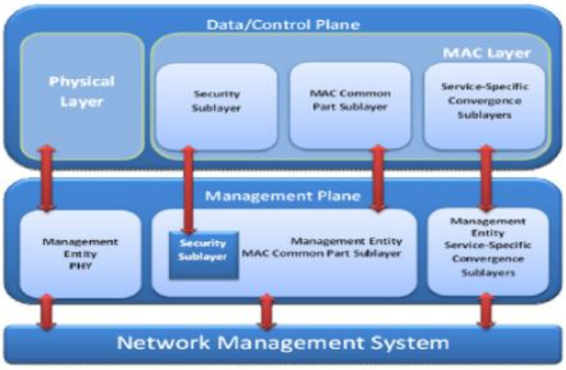

Figure 1. WiMAX Protocol Layers

PHYSICAL LAYER DESCRIPTION OF DMA Basics

Orthogonal Frequency Division Multiplexing (OFDM) [9,10] is a multiplexing technique that subdivides the bandwidth into multiple frequency sub-carriers as shown in Figure 2.In an OFDM system, the input data stream is divided into several parallel sub-streams of reduced data rate (thus increased symbol duration) and each sub-stream is modulated and transmitted on a separate orthogonal sub-carrier. The increased symbol duration improves the robustness of OFDM to delay spread. Furthermore, the introduction of the cyclic prefix (CP) can completely eliminate Inter-Symbol Interference (ISI) as long as the CP duration is longer than the channel delay spread. The CP is typically a repetition of the last samples of data portion of the block that is appended to the beginning of the data payload as shown in Figure 2. The CP prevents inter-block interference and makes the channel appear circular and permits low-complexity frequency domain equalization. Apperceived drawback of CP is that it introduces overhead, which effectively reduces bandwidth efficiency. While the CP does reduce bandwidth efficiency somewhat, the impact of the CP is similar to the “roll-off factor” in raised-cosine filtered single-carrier systems. Since OFDM has a very sharp, almost “brick-wall” spectrum, a large fraction of the allocated channel bandwidth can be utilized for data transmission, which helps to moderate the loss in efficiency due to the cyclic prefix.

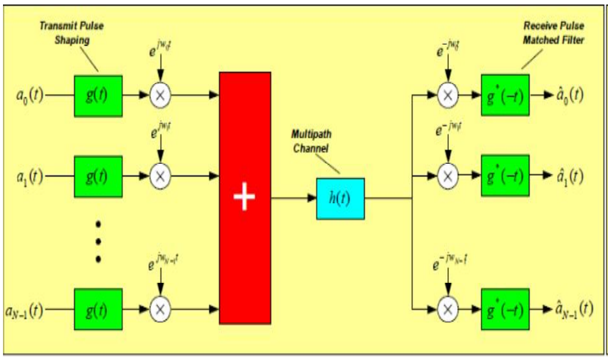

Figure 2: Basic Architecture of an OFDM System

OFDM exploits the frequency diversity of the multipath channel by coding and interleaving the information across the sub-carriers prior to transmissions. OFDM modulation can be realized with efficient Inverse Fast Fourier Transform (IFFT), which enables a large number of sub-carriers (up to 2048) with low complexity.

In an OFDM system, resources are available in the time domain by means of OFDM symbols and in the frequency domain by means of sub-carriers. The time and frequency resources can be organized into sub-channels for allocation to individual users. Orthogonal Frequency Division Multiple Access (OFDMA) is a multiple-access/multiplexing scheme that provides multiplexing operation of data streams from multiple users onto the downlink sub-channels and uplink multiple access by means of uplink sub-channels. Fig. 3 shows a sample OFDM sub-carrier structure in frequency domain.

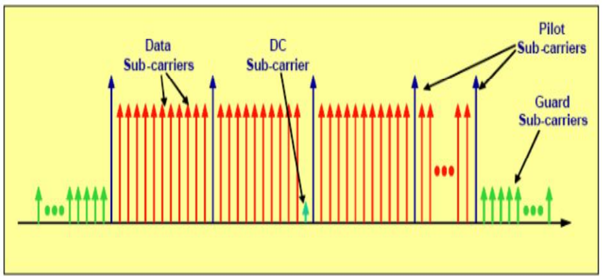

Figure. 3: OFDM Sub-carrier Structure

MAC layer description

QoS support

Before providing a certain type of data service, the base station and user-terminal first establish a unidirectional logical link between the peer MACs called a connection. The outbound MAC then associates packets traversing the MAC interface into a service flow to be delivered over the connection. The QoS parameters associated with the service flow define the transmission ordering and scheduling on the air interface.

The connection-oriented QoS therefore, can provide accurate control over the air interface. Since the air interface is usually the bottleneck, the connection-oriented QoS can effectively enable the end-to-end QoS control. The service flow parameters can be dynamically managed through MAC messages to accommodate the dynamic service demand. The service flow based QoS mechanism applies to both D Land UL to provide improved QoS in both directions. Mobile WiMAX supports a wide range of data services and applications with varied QoS requirements.

Some of the important functions of the MAC layer in WiMAX are to

- Segment or concatenate the service data units (SDUs) received from higher layers into the MAC PDU (protocol data units), the basic building block of MAC-layer payload.
- Select the appropriate burst profile and power level to be used for the transmission of MAC PDUs Retransmission of MAC PDUs that were received erroneously by the receiver when automated repeat request (ARQ) is used.
- Provide QoS control and priority handling of MAC PDUs belonging to different data and signaling bearers.
- Schedule MAC PDUs over the PHY resources.
- Provide support to the higher layers for mobility management.
- Provide security and key management.

- Provide power-saving mode and idle-mode operation

MOBILE WiMAX SYSTEM PARAMETERS

Since Mobile WiMAX is based on scalable OFDMA, it can be flexibly configured to operate on different bandwidths by adjusting system parameters. We consider a Mobile WiMAX system with the following characteristics as a case study for a quantitative evaluation of Mobile WiMAX system performance.

Parameters	Value
Number of 3-Sector Cells	19
Operating Frequency	2500 MHz
Duplex	TDD
Channel Bandwidth	10 MHz
BS-to-BS Distance	2.8 kilometers
Minimum Mobile-to-BS Distance	36 meters
Antenna Pattern	70° (-3 dB) with 20 dB front-to-back ratio
BS Height	32 meters
Mobile Terminal Height	1.5 meters
BS Antenna Gain	15 dBi
MS Antenna Gain	-1 dBi
BS Maximum Power Amplifier Power	43 dBm
Mobile Terminal Maximum PA Power	23 dBm
# of BS Tx/Rx Antenna	Tx: 2 or 4; Rx: 2 or 4
# of MS Tx/Rx Antenna	Tx: 1; Rx: 2
BS Noise Figure	4 dB
MS Noise Figure	7 dB

Table 1: Mobile WiMAX System Parameters

CONCLUSION

The attributes and performance capability of Mobile WiMAX makes it a compelling solution for high performance, low cost broadband wireless services. Mobile WiMAX is on a path to address a global market through a common wide area broadband radio access technology and flexible network architecture. This technology is based on open standard interfaces developed with close to 400 companies contributing to and harmonizing on the system specifications thus laying a foundation for worldwide adoption and mass market.

This paper presents an overview of the IEEE 802.16m PHY layer issues ,MAC protocol, specifically issues associated with scheduling and QoS provisioning. It also discusses the main features of the newly standardized mobile WiMAX, IEEE 802.16e to IEEE 802.16m. With the introduction of mobile WiMAX technology, it can be expected that future work will focus on the mobility aspect and interoperability of mobile WiMAX with other wireless technologies. For high quality voice and video, Internet and mobility, demand for bandwidth is more. To address these needs IEEE 802.16m appears as a strong candidate for providing aggregate rates to high-speed mobile users at the range of Gbps.

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