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Improving the Quality of Service in WiMax Using NS3

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Abstract: **A quality of service framework is a fundamental component of a 4G broadband wireless network for satisfactory service delivery of evolving Internet applications to end users, and managing the network resources. Today's popular mobile Internet applications, such as voice, gaming, streaming, and social networking services, have diverse traffic characteristics and, consequently, different QoS requirements. A rather flexible QoS framework is highly desirable to be future-proof to deliver the incumbent as well as emerging mobile Internet applications. This article highlights QoS frameworks and features of OFDMA-based 4G technologies — IEEE 802.16e, IEEE 802.16m — to support various applications' QoS requirements. A few advanced QoS features such as new scheduling service (i.e., aGP), quick access, delayed bandwidth request, and priority controlled access in IEEE 802.16m are explained in detail. A brief comparison of the QoS framework of the aforementioned technologies is also provide**

Keywords: **IEEE 802.16, network simulation, QoS, WiMAX.**

1. INTRODUCTION

As the number of mobile broadband subscribers and the traffic volume per subscriber are rapidly increasing, quality of service (QoS) is becoming significant as operators move from single to multiservice offerings, and emerging rich devices capable of running multimedia and gaming applications. Fourth-generation (4G) broadband wireless technologies such as IEEE 802.16e, IEEE 802.16m, and Third Generation Partnership Project (3GPP) Long Term Evolution (LTE) have been designed with different QoS frameworks and means to enable delivery of the evolving Internet applications. As the Internet evolves, Internet applications and associated traffic patterns are also evolving over time. Web 2.0 supports rich media applications such as interactive voice and video services, web audio/video streaming services, and online gaming services, with smart optimization engines at both the client and server sides [1]. QoS specifically for evolving Internet applications is a fundamental requirement to provide satisfactory service delivery to end users and also to manage network resources. In other words, today's popular Internet applications, including real-time and non-real-time traffic such as multimedia services and online gaming, have very different traffic patterns and distinct QoS requirements. The traffic patterns of these emerging Internet applications show non-periodic variable-sized packet arrivals. The traditional QoS framework is no longer efficient and/or sufficient to support these new mobile Internet applications with good or required user experience. The organization of the article is as follows. The next section reviews the key elements of the QoS framework in IEEE 802.16e. We then highlight some advanced features in IEEE 802.16m to improve performance of a WiMAX network compared to a legacy network based on IEEE 802.16e. We then explain QoS framework of the LTE wireless technology. We then provide a high-level comparison between QoS frameworks of these three 4G wireless technologies focusing on the air interface.

2. QOS IN IEEE 802.16E

The QoS framework in IEEE 802.16e is based on service flows (SFs). An SF is a logical unidirectional flow of packets between the access service network gateway (ASN-GW) and a mobile station (MS) with a particular set of QoS attributes (e.g., packet latency/jitter and throughput) identified by a connection ID [2].Based on IEEE 802.16e, packets traversing the medium access control (MAC) interface are associated with SFs according to classifier rules. Figure 1 demonstrates SFs in IEEE 802.16e. Traffic mapping to appropriate SFs is done at the ASN-GW for downlink (DL) and at the MS for uplink (UL) directions, respectively. Between the ASN-GW and the base station (BS), the QoS of the SFs is supported by backhaul transport QoS. On the air interface, a BS scheduler provides QoS for DL, and cooperation between the BS and MS schedulers provides QoS for UL. This air interface scheduler at the MAC sublayer determines how radio resources are assigned among multiple SFs based on QoS attributes.

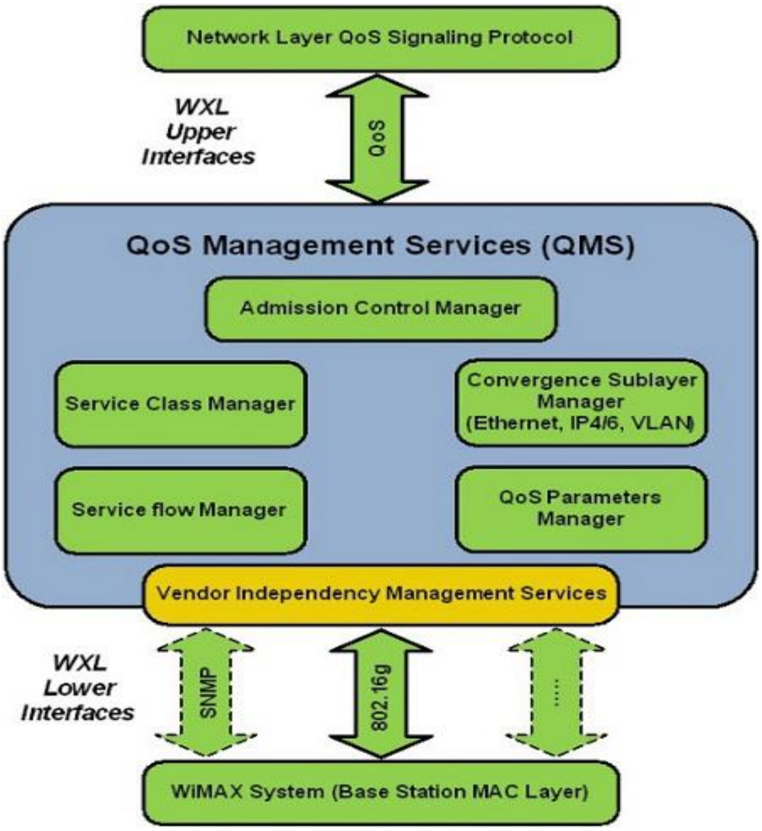

Figure 1. Service flows in the WiMAX QoS framework.

Resources assigned to an MS enable it to receive traffic over DL and transmit data over UL. Details of air interface scheduler operation are not specified by the standard; therefore, it is vendor-specific. Traffic classification and mapping from application packets onto SFs in WiMAX is done at the convergence sublayer (CS), based on protocol-specific packet matching criteria like a combination of five-tuple, such as source and destination IP addresses, source and destination port address, protocol, and differentiated services codepoint (DSCP) [2]. IEEE 802.16e supports both QoS control paradigms: network-initiated, where SF creation is initiated by the BS, and terminal-initiated, where SF creation is initiated by the MS. With network-initiated, an application function (AF) inside the network can trigger messaging signals to set up SFs with appropriate QoS attributes; consequently, the client application can be left access-agnostic, and there is no need for accessspecific information in application layer signaling [2]. On the other hand, with terminal-initiated QoS control, the MS requests creation of SFs with appropriate QoS attributes; hence, the client application is aware of the specifications of the access QoS model [2]. Network-initiated SF creation is a mandatory, but terminal-initiated SF creation is an optional capability of IEEE 802.16e [2]. SFs may be created, changed, or deleted through a series of MAC management messages referred to as DSX (i.e., DSA, DSC, and DSD).

3. QOS ARCHITECTURE IN WIMAX NETWORKS

The WiMax Forum's Network Working Group [3], is responsible for developing the end-to-end network requirements, architecture, and protocols for WiMax, using IEEE 802.16e-2005 as the air interface. The network reference model envisions unified network architecture for supporting fixed, nomadic, and mobile deployments and is based on an IP service model. Figure 1.8 shows a simplified illustration of IP-based WiMax network architecture. [2] The overall network may be logically divided into three parts:

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Mobile Station (MS): It is for the end user to access the mobile network. It is a portable station able to move to wide areas and perform data and voice communication. It has all the necessary user equipments such as an antenna, amplifier, transmitter, receiver and software needed to perform the wireless communication. GSM, FDMA, TDMA, CDMA and WCDMA devices etc are the examples of Mobile station. Mobile stations used by the end user to access the network

Access Service Network (ASN): It is owned by NAP, formed with one or several base stations and ASN gateways (ASNGW) which creates radio access network. It provides all the access services with full mobility and efficient scalability. Its ASN-GW controls the access in the network and coordinates between data and networking elements. ASN comprises one or more base stations and one or more ASN gateways that form the radio access network at the edge.

Connectivity Service Network (CSN): Provides IP connectivity to the Internet or other public or corporate networks. It also applies per user policy management, address management, location management between ASN, ensures QoS, roaming and security. CSN provides IP connectivity and all the IP core network functions. The architecture allows for three separate business entities: i.Network access provider (NAP), which owns and operates the ASN; ii.Network services provider (NSP), which provides IP connectivity and WiMax services to subscribers using the ASN infrastructure provided by one or more NAPs; iii.Application service provider (ASP), which can provide value-added services such as multimedia applications using IMS (IP multimedia subsystem) and corporate (virtual private networks) that run on top of IP.

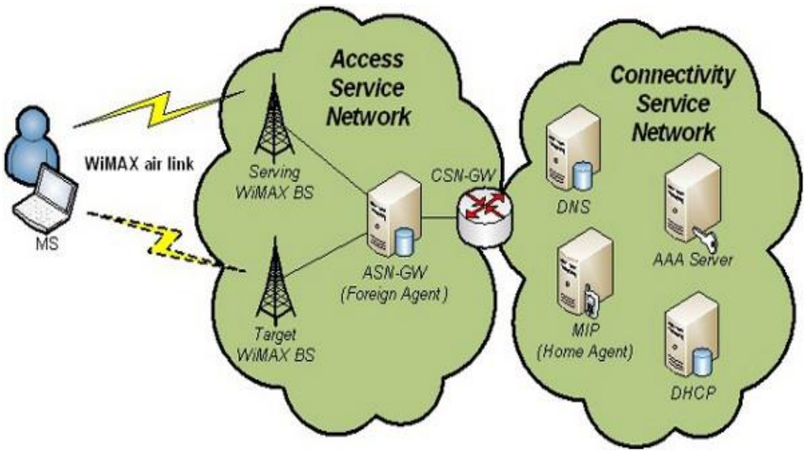

Figure 2: WiMax architecture based on IP

The IEEE 802.16 standard supports both point-to-point (PP) and point-to-multipoint (PMP) topologies, and an optional mesh configuration. In a fixed PMP WiMAX network, a BS communicates with multiple stationary SSs, as shown in Figure 2.TheMACof a PMP WiMAX network is centrally managed by the BS, which offers connection-oriented services to individual traffic flows. Each traffic flow is uniquely identified by a connection identifier (CID), and belongs to one of the listed QoS classes, which are defined at the WiMAX MAC layer [1] to provide differentiated traffic treatment.

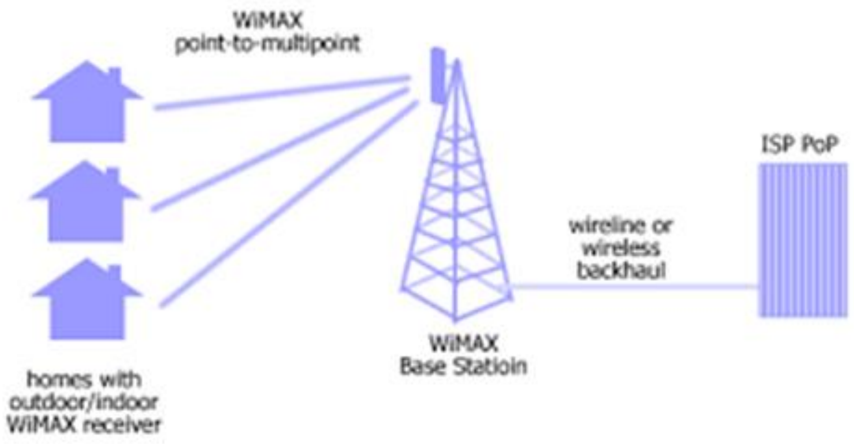

Figure 3: Point to Multipoint Wimax Network

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4. SERVICE FLOW TYPES IN IEEE 802.16E AND ASSOCIATED PARAMETERS

IEEE 802.16e supports five SF types [2]: ‘

• **Unsolicited grant service (UGS)**: support real-time data streams consisting of fixed-size data packets issued at periodic intervals.Such as T1/E1 and **Voice over IP** without silence suppression

• **Real-time polling service (rtPS)**: Supports real-time traffic with variable-size data packets that are issued at periodic intervals. Such as moving pictures experts group (**MPEG**) video.

• **Extended rtPS (ertPS)**: Supports real-time traffic that generates variable-size data packets on a periodic basis with a sequence of active and silence intervals

• **Non-real-time polling service (nrtPS)**: Supports delay-tolerant traffic that requires a minimum reserved rate. Such as **FTP**

• **Best effort (BE) service**: support data streams for which no minimum service level is required and therefore may be handled on a space-available basis.

5. WIMAX NETWORK SCENARIO

Figure 4: N/W scenario for 7 nodes and sub nodes

The N/W scenario is designed using ns3 software .The WiMAX N/W scenario is shown in Fig 4. .It is designed for total 4 number nodes and sub nodes with base station all are fixed size node.

The simulation parameters and node parameter are set as per table 1

Table 1 Simulation parameters

Sr no	Efficeincy mode	Mobility and ranging
1	AC service of class Defination (QoS)	1.UGS Eg. VoIP 2.rtps Eg. MPEG
2	Modulation Technique	Wireless of OFDM
3	Number of subcarriers	2048
4	Bandwidth	20MHz
5	Duplexing Technique	TDD
6	Scheduling Type	rtps
7	Maximum substained Traffic Rate	5Mbps
8	Maximum Reserved Traffic Rate	1Mbps

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6. PERFORMANCE ANALYSIS

The N/W scenario for 7 nodes and sub nodes is simulated and tested using NS3 software .The overall transmission and reception response given by 7 nodes in 10 seconds. The total 80 packets are transmitted and received 80 packets therefore the packet delivery ratio is 100%. The throughput is 78.384Kbps is shown in Fig 6 and delay time analysis is 0.0236642 seconds between two nodes communication

7. CONCLUSION

In this chapter we presented an enhancement for the WIMAX using NS3 model in order to efficiently support QoS. Specifically, a packet classification mechanism and the associated scheduler, based on priority RR (PRR), have been designed, implemented and tested. Through the performance evaluation measurements with different topologies, point-topoint (PTP) and point-to-multipoint (PMP), it was possible to verify the differentiated behavior of the implemented WiMAX QoS classes. Based on the obtained results, we can conclude that there is a traffic differentiation visible by the different values obtained for the QoS parameters (delay, bandwidth usage) in the test scenarios. Moreover, it was always assured a minimum transmission for all the service classes, although with different performances due to prioritization. The observed parameters degradation when using more subscribers is related to the priority RR implemented scheduler, in which less priority queues may not be served in the case of network overload or congestion.

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