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Performance Evaluation of QoS Parameters in WiMAX Network

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Abstract: ***Quality of Service is an important parameter to evaluate the performance of any Network. This paper focuses on analyzing important QoS parameters in Wimax Network. Essential QoS parameters like delay, Packet dropped Ratio (PDR) and throughput has been calculated for (3-35) mobile nodes in a WiMax network. Opnet module was used to create WiMax network architecture and analysis is done for each QoS parameter. The results are helpful in analyzing QoS parameters for WiMax Network and it has been found that an optimum value of QoS parameters is obtained with increasing number of mobile nodes for WiMax Network.***

Keywords: Wimax, QoS Parameters, Delay, Data Dropped ratio, Throughout.

1. Introduction

WiMAX (Worldwide interoperability for micro wave access technology) is the most recent technology to establish wireless access network. It acts as broad band access solutions for wireless communications. WIMAX has been regarded as a promising alternative for constructing the next broadband wireless metropolitan area networks (WMAN). There are two types of the WIMAX, fixed WIMAX and mobile WIMAX, Fixed WIMAX is based on IEEE-802.16d standard for fixed application form its base stations. Mobile WIMAX targets mobile application allows mobile nodes to move from one place to other. OFDM is widely used in WLAN and WMAN. The original frequency carrier is divided into group of sub carriers that are orthogonal to each other. In OFDM each sub-channel is accessed to only one user at a given time slot. IEEE 802.16e WIMAX air interface uses orthogonal frequency division multiple access (OFDMA) for improved multi-path performance in non-Loss of sight (NLOS). The radio link MS is named as the access link, but the link between BS and RS is called relay link. Theses access link and relay link can be used for uplink and downlink data transmission. This standard defines the physical and the MAC layer specifications. The MAC layer supports functions such as network entry, bandwidth request, connection management and Hand over. The PHY layer adopts orthogonal frequency division multiple access (OFDMA) as the primary channel access mechanism for non-line of sight (NLOS) communications in the frequency band less than 11 GHz. It supports point to multipoint (PMP) network topology[1].

2. Related Works

Author in [7] made a survey on various Wimax QoS parameters which affect the performance of a Wimax network in various scenarios. The survey suggests that these critical QoS parameters are essential in underlining the performance of a Wimax network. The author analysed various critical QoS parameters like throughput, packet loss, average jitter and average delay for VOIP and Video traffic using ns 2 simulator. The simulation showed that UGS has lowest values for these QoS parameters.

Author in [8] has done similar analysis of a location based performance scenario and critical QoS parameters delay and throughput (packets / seconds) were analysed. The values of the QoS parameters were not optimized because less number of nodes were taken into consideration.

Authors in [10] had done statistical analysis of QoS parameters of mobile Wimax. Two important QoS parameters of VoIP service in Mobile Wimax network were end-to-end delay and jitter. The paper presented the statistical analysis for these two parameters, from the previous work, It was found that the key parameters which affect the quality of service for a network are throughput, delay, jitter (Packet Delay Variance), packet delivery ratio and packet loss ratio.

3. WI-MAX Network Architecture

The overall WiMAX network consists of a number of different entities and these include:

A. Mobile Station, MS

Used by the end user to access the network.

B. Base Station, BS

The base-station forms an essential element of the WiMAX network. It is responsible for providing the air interface to the subscriber and mobile stations. It provides additional functionality in terms of micro-mobility management functions, such as handoff triggering and tunnel establishment, radio resource management, QoS policy enforcement, traffic classification, DHCP (Dynamic Host Control Protocol) proxy, key management, session management, and multicast group management.

C. ASN Gateway, ASN-GW

The ASN gateway within the WiMAX network architecture typically acts as a layer 2 traffic aggregation within the overall ASN. The ASN-GW may also provide additional functions that include: intra-ASN location management and paging, radio resource management and admission control, caching of subscriber profiles and encryption keys. The ASN-GW may also include the AAA client functionality(see below), establishment and management of mobility tunnel with base stations, QoS and policy enforcement, foreign agent functionality for mobile IP, and routing to the selected CSN.

D. Authentication, Authorization and Accounting Server, AAA

As with any communications or wireless system requiring subscription services, an Authentication, Authorisation and Accounting server is used. This is included within the CSN. The architecture of WiMax network is shown in Fig 1.

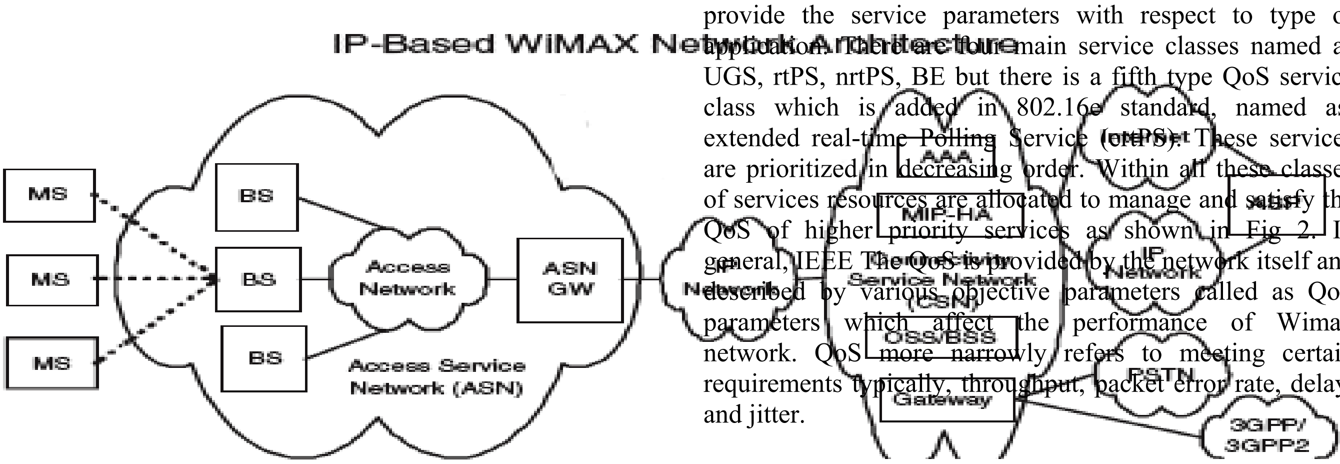

Figure 1: Wimax Network Architecture

4. Quality of service in wi-max network

QOS is defines as the ability of the network to provide different services for different users with high performance level, it depends on the application and the use to which end user. It employs a range of measurable performance metrics such as Bandwidth , Latency, Jitter, throuput, data dropped.

A. Bandwidth

is the most basic QOS parameter for many end users, and is defined by the physical-layer link between the base station and the client terminal in WiMAX network, and also by the number of clients that are active in the network.

B. Latency

The end-to-end packet transmission time is caused by the granularity of the physical-layer chain, and is typically almost 5ms in 802.16 systems. Latency is also affected by how packet queuing, various QOS protocols, and user characterizations are implemented.

C. Jitter

The variation of latency over different packets – has to be limited by packet buffering. Since the buffer on the mobile terminal is likely to be small, jitter control in wireless networks tends to fall onto the base station, which has to ensure that different packets receive different prioritization if necessary.

The proportion of successfully delivered packets – leads to more complications in wireless networks than in fixed-line, and the problems are specifically acute in mobile networks. The issue is that wireless networks have an inherent unreliability because of the vicissitudes of radiowave propagation – especially to mobile terminals with small antennas and low powers in cluttered environments such as urban areas, so packet loss (and numbers of errored packets) will be higher than for fixed-line networks.

5. QoS Service Classes in Wi-Max

The QoS is granted on the basis of applications and services under consideration. The traffic management is necessary to provide the service parameters with respect to type of application. There are four main service classes named as UGS, rtPS, nrtPS, BE but there is a fifth type QoS service class which is added in 802.16e standard, named as: extended real-time Polling Service (ertPS). These services are prioritized in decreasing order. Within all these classes of services resources are allocated to manage and satisfy the QoS of higher priority services as shown in Fig 2. In general, IEEE The QoS is provided by the network itself and described by various objective parameters called as QoS parameters which affect the performance of Wimax network. QoS more narrowly refers to meeting certain requirements typically, throughput, packet error rate, delay, and jitter.

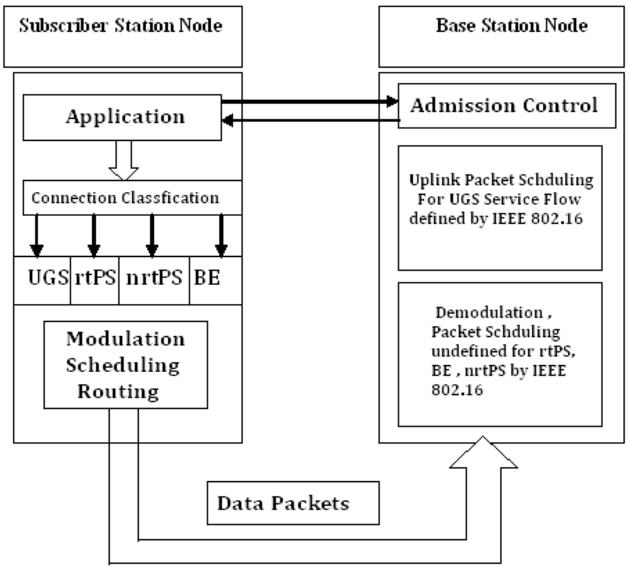

Figure 2: QoS Classes in Wimax

6. Simulation Steps

In this paper we used OPNET Modeler to simulate WiMAX network because it provides a development environment for modeling and simulation of deployed wired and wireless networks. OPNET Modeler enables users to create customized models and to simulate various network scenarios. In Scenario I a service area about (50x50 km2) was designed for Wimax network. A wireless topology (WiMAX) was deployed, and one mobile node was configured for each 3 cells as shown in Fig 3. Adaptive modulation is chosen as a modulation technique.

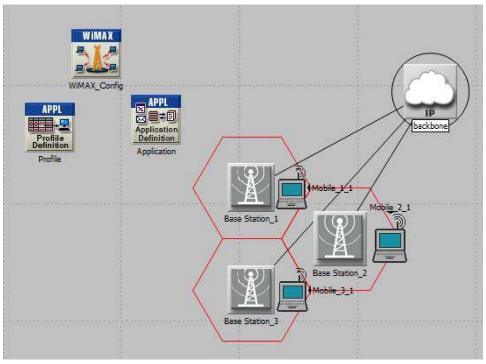

Figure 3: Scenario 1 Wimax Network with 3 cells and 3 mobile

In scenario 2 the same configuration to scenario 1 was done but the number of mobile nodes was increased to 15 as shown Fig 4.

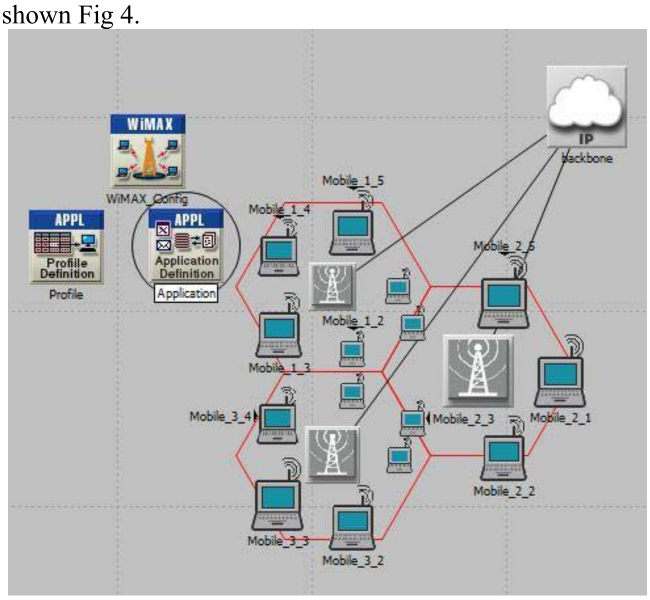

Figure 4: Scenario 2 Wimax Network with 3 cells and 15 mobile nodes.

In scenario 3 the same service area was designed but the number of cells and mobile nodes has been increased to be 7 cells as shown in Fig 5 with 21 mobile nodes. The same modulation technique was used. As shown in Fig 6 scenario 4 provides a wireless network with the same parameters and 35 mobile nodes was randomly selected for 7 cells.

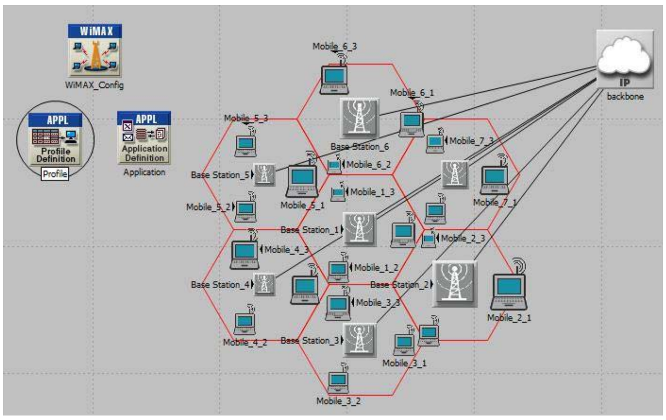

Figure 5: Scenario 3 Wimax Network with 7 cells and 21 mobile nodes.

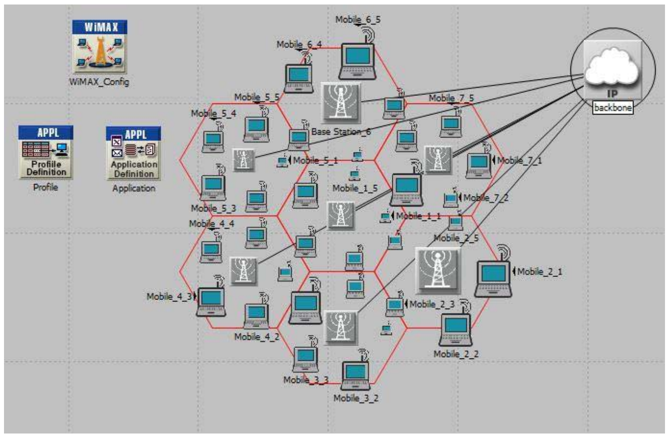

Figure 6: Scenario 4 Wimax Network with 7 cells and 35 mobile nodes.

7. Simulation Results and Discussion

A. Delay

Delay or latency could be defined as the time taken by the packets to reach from source to destination. The main sources delay can be categorized into: propagation delay, source processing delay, network delay and destination processing delay. For the designed network we have calculated end to end delay which is a measure of elapsed time taken during modulation of the signal and the time taken by the packets to reach from source to destination. From the results in scenario 1 which have less number of mobile nodes, the maximum taken delay was 0.016 (sec). in scenario 2 when the number of mobile nodes increased to 15, the maximum delay also increased to 0.018 (sec). For scenario 3, the maximum delay increased to 0.019 (sec) as mobile nodes increased to 21. Scenario 4 shows the maximum delay about 0.18 (sec) as mobile nodes increased to 35. From the above results it shown that the average value of delay increased when the number of mobile nodes increased as shown in Fig 7.

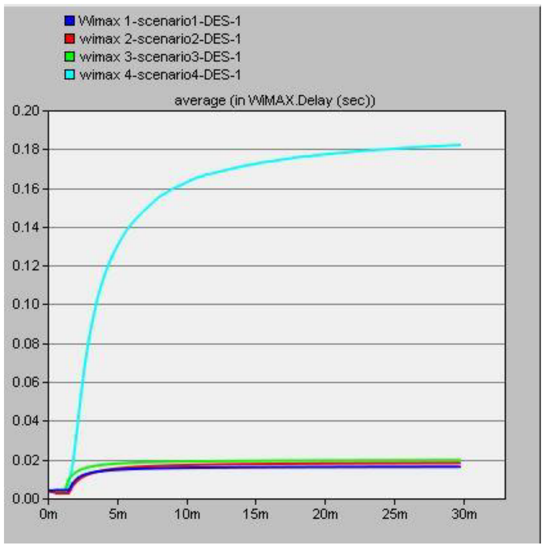

Figure 7: Wimax Delay (sec)

B. Packet Dropped Ratio

Packet dropped affects the perceived quality of the application. Several causes of packet dropped or corruption would lead to bit errors in wireless network. Some of the packets are lost due to network congestion or due to noise. Packet dropped ratio should be minimum, from the graph it appears that in scenario 1 when mobile nodes are 3, the average packet dropped is (0 Packet /second) because there is no congestion due to low number of nodes. For scenario 2 when the number of mobile nodes increased the average packet dropped increased as well and become (20.2 Packet /second). In scenario 3 as the number of mobile node increased to 21 the average packet dropped also increased to its maximum value (168.4 Packet /second). Scenario 4 showed the average packet dropped about (57.5 Packet /second) as shown in Fig 8. The above results showed that one of the major drawbacks of WiMax network is the increase of packet dropped as the number of mobile nodes increased.

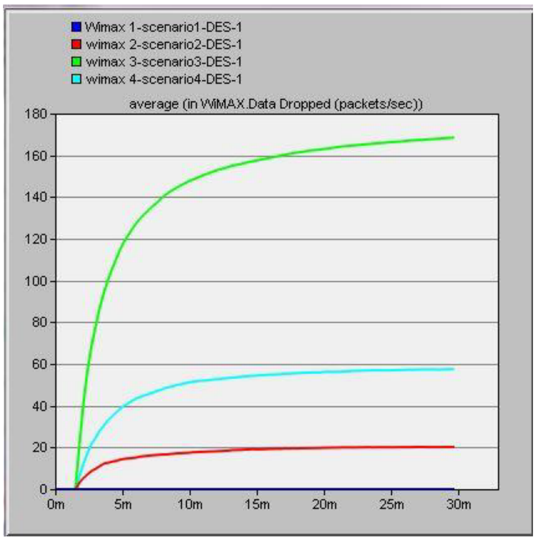

Figure 8: Wimax Packet Dropped (Packet /sec)

C. Throughput

Throughput is measure of number of packets successfully delivered in a network. It is measured in terms of packets/second or bits/second. The value of throughput should be high. In scenario 1 when the mobile nodes are low, the average throughput is minimum about (506 Packet /second). Scenario 2 showed average throughput about (1,081 Packet /second). For scenario 3, the average throughput increased to (1,687 Packet /second). Scenario 4 presents the highest value of average throughput about (2,639 Packet /second) because it contains the largest number of mobile nodes this shown in Fig 9. The results show that one of the major advantages of WiMax network is that the average throughput would increase as the number of mobile node increased.

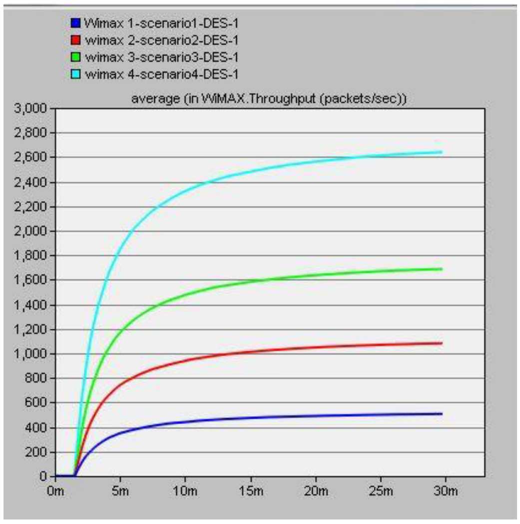

Figure 9: Wimax Throughput (Packet /sec).

8. Conclusion

Measurement of QoS is important for any Wimax or broadband wireless communication, in order to ensure satisfaction of users. The broadband wireless access networks must meet a number of Quality of Service (QoS) parameters, including throughput, and low delay, jitter and packet dropped. The issue of QoS became critical for broadband wireless access equipment and their customers too. Our paper helps in analyzing various Wimax QoS parameters which are critical in determining the performance of a Wimax network. An optimum Wimax network should have a very low value of delay and packet dropped, whereas a very high value of throughput. From the results it is clear that as the mobile nodes keep increasing, an optimum value of QoS parameters is obtained. Therefore our paper helps in understanding these critical QoS parameters which helps in improving performance for a Wimax network.

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