

# Performance of QoS Parameters for Wimax Networks

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**Abstract:** *Quality of Service is an essential parameter to judge performance of any Network. Our paper focuses on analyzing essential QoS parameters for Wimax Network. Essential QoS parameters like delay, Jitter, Packet delivery Ratio (PLR), Packet Loss Ratio (PLR) and throughput have been calculated for 500 mobile nodes in a WiMax network. Ad Hoc on Demand Distance Vector Routing (AODV) protocol has been chosen as a routing protocol because of its ability to perform well under highly mobile and random conditions. MATLAB software version R2011 was used for creating WiMax network architecture and Regression analysis is done for each of the QoS parameter. Our results help in critically 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, voip, delay

## 1. Introduction

Wimax technology stands for worldwide interoperability for microwave access. It aims to provide business and consumer wireless broadband services on the scale of the metropolitan area network (MAN). It is based on Institute of Electrical and Electronics Engineers 802.16 standard [1], [2]. This technology has a target range of up to 31 miles and a target data transfer rate exceeding 100 Mbps [3]. Wimax supports various multimedia applications like VoIP, voice conference and online gaming.

Quality of Service in Wimax Networks: The word Quality is the degree to which a set of inherent characteristics fulfills a particular requirement [5]. The term Quality of service refers to the probability of the telecommunication network meeting a given traffic contract. In the field of networking it could be termed as the probability of a packet successfully passing between two points in the network. QoS actually is the ability of network element (e.g. an application, host or router) to have some level of assurance that its traffic and service requirements would be satisfied.

## 2. Methodology

- 1) Service area (50x50 km<sup>2</sup> dimensions) for Wimax infrastructure is developed:
  - The service area will further be divided into femto cells.
  - Each femto cells will have a set of mobile nodes.
  - Each mobile node communicate with each other.
  - Each mobile node is moving randomly in some direction with some mobility rate.
- 2) Deploy this topology (developed in step 1) and randomly select the source (from where the communication will start to the destination) i.e Transmission to Reception. Here Minimum shift keying (MSK) is chosen as a modulation technique.
- 3) To choose the shortest path an efficient form of AODV protocol is used in which TTL (time to live) is chosen as a threshold parameter for finding the path.
- 4) To create a real time environment, effect of noise is also considered. So each node loses some energy in the form

of noise.

- 5) Simulation is run for fixed number of packets (3000 packets/simulation). Here CBR (Constant Bit Rate) is chosen as the traffic type.
- 6) Based on the modulation scheme and routing protocol developed in step 2 run this simulation for particular number of nodes
- 7) Keep on increasing and the number of nodes in each simulation. Here the simulation is run for 500 mobile nodes. Table 3 briefly mentions the various simulation parameters chosen for WiMax Network communication.

## 3. Related Work

A survey has been done on various Wimax QoS parameters which affect the performance of a Wimax network in various scenarios. Analyzed various critical QoS parameters like throughput, packet loss, average jitter and average delay for VOIP and Video traffic using 2 simulator. Their simulation showed that UGS has lowest values for these QoS parameters but the values were not drastically reduced. The simulation was done for less number of mobile nodes(50). Similar analysis of a location based performance scenario was carried out in[4],[6] and critical QoS parameters delay and throughput (packets / seconds) were analyzed. The values of the QoS parameters were not optimized and lesser number of nodes were taken into consideration.

## 4. Simulation Steps

We have used MATLAB software version R2011 for our simulations due to its ease of node deployment and network set up. With the help of MATLAB we were able to critically analyze our results by applying regression technique on them.

### A) QoS Parameter Calculation a delay:

Delay or latency could be defined as the time taken by the Packets to reach from source to destination. The main sources of delay can be categorized into: propagation delay, source processing delay, network delay and destination processing delay. Here 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. Here the packet losses some energy as well in the form of noise which is also taken into consideration. End to end delay could be measured as the difference of Packet arrival and packet start time [9]. Equation 1 shows the calculation of average end to end delay.

$$\text{Delay} = \frac{\sum \text{Packet Arrival}_i - \text{Packet Start}_i}{N} \quad (1)$$

Delay equation

**B) Packet Delay variance (Jitter):**

Jitter could be termed as the variation in delay or packet delay variation. The value of jitter is calculated from the end to end delay. Measuring jitter is critical element to determining the performance of network and the QoS the network offers. It is the variation in the time between packets arriving. Jitter is commonly used as an indicator of consistency and stability of a network. Equation 2 shows how to calculate jitter.

$$\text{Jitter} = \frac{\sum_{i=0}^n \text{square}(\text{Delay}_i - \overline{\text{Delay}})}{N} \quad (2)$$

Jitter Equation

**C) Packet Delivery Ratio (PDR):**

Packet delivery ratio signifies the the total number of packets successfully delivered to the destination. Equation 3 shows how to calculate PDR (Packet Delivery Ratio).

$$\text{PDR} = \frac{\sum_i \text{Packets Delivered}}{\sum_i \text{Packets Sent}} \times 100 \quad (3)$$

PDR Equation

**D) Packet Loss Ratio (PLR):** Packet loss affects the perceived quality of the application. Several causes of packet loss or corruption would be bit errors in an erroneous wireless network or insufficient buffers due to network congestion when the channel becomes overloaded [7]. Some of the packets are lost due to network congestion or due to noise. Packet loss ratio should be minimum, so as to keep the successful delivery of high QoS. According to ITU (International Telecommunication Union) standards, the value of packet loss should be kept at minimum level.

$$\text{PLR} = \frac{\sum_i \text{Packets Lost}}{\sum_i \text{Packets Sent}} \times 100 \quad (4)$$

PLR Equation

**E) Throughput (Th):** Throughput is measure of number of packets successfully delivered in a network. It is measured in terms of packets/second. The value of throughput should be

$$\text{Th} = \frac{\sum_i \text{Packets Delivered}}{\sum_i \text{Packet Arrival} - \text{Packet Start time}_i} \quad (5)$$

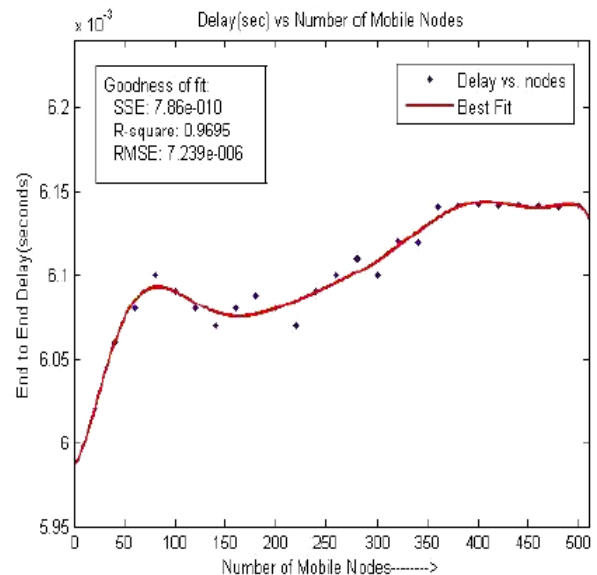
Throughput Equation

**5. Simulation Results and Discussion**

To analyze the quality of service parameters in WiMAX network, a simulation environment for WiMax was set up as per the methodology and routing protocol explained before. MATLAB R2011 was used as a simulation tool. Here an assumption was made that all the SS (Subscriber Station) have routing capability of their own. The simulation was carried out for Nodes starting from 20, up to 500 nodes. QoS parameters were calculated for each simulation and a database was created with increasing number of nodes and regression analysis was done on it. Goodness of fit and R square was calculated for each QoS parameter. The simulation results are discussed below.

**Delay:**

To calculate delay/Latency for the Wimax network, equation (1) is used. According to ITU standards, the value of delay should be within 150 ms for VoIP in Wimax. Here we have calculated delay for nodes up to 500. The graph for delay vs. number of nodes is shown below in figure



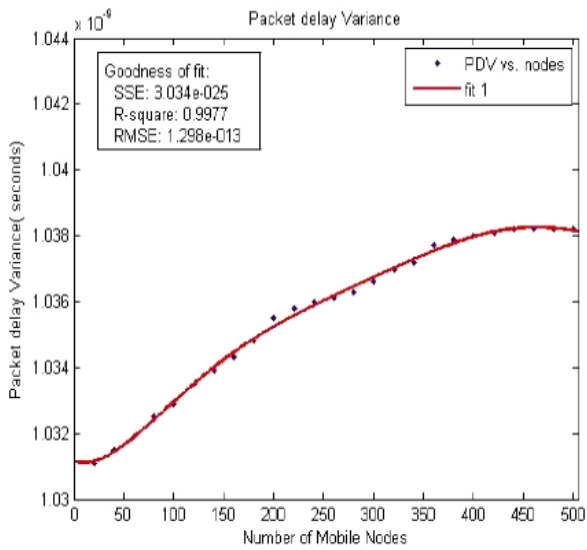
**Figure 2:** Delay v/s Number of Mobile Nodes

The graph drawn in figure shows that as the number of node increases, the delay increases up to a certain point due to high network traffic but the nit becomes constant to up to an average value of 6.15ms. Here a very low value of delay is obtained. The graph also shows a best fit curve which is drawn to analyze the results. Here the mobile nodes were moving so randomly that the data points were very scattered, So we have applied regression technique. The goodness of fit is also shown in the text box of the graph. A very high value of R square is achieved which shows that our data fits around 97 percent.

**Packet Delay Variance (Jitter)**

Equation (2) is used to calculate the Jitter (PDV). The figure 3 shows the graph between PDV and number of mobile nodes. Here it shows that a very low value of jitter is obtained. The value of jitter increases with increase in number of nodes but reaches an optimum level. On the average 1.033x10-9 seconds of jitter is obtained, which is very low as per ITU standards. The fit1 line in the graph

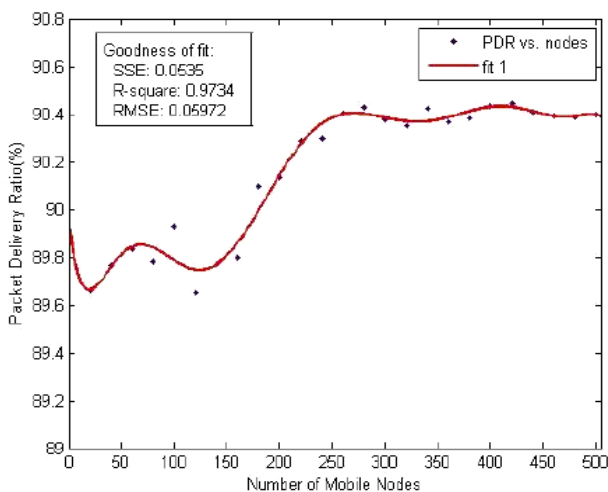
shows the best fit curve for random data and regression analysis results were shown in the text box drawn in the figure.



**Figure 3:** Packet delay Variance Vs Number of Mobile Nodes

**Packet delivery Ratio (PDR):**

Packet delivery Ratio is the measure of successful delivery of packets. It is calculated by equation (3). The Graph is drawn between PDR and number of mobile nodes, which is shown in figure 4. With increase in number of mobile nodes, the value of PDR increases but then it actually becomes constant. Regression analysis is done on the data and a very high value of R square (0.937) is achieved which shows that the data fits 97 percent successfully.

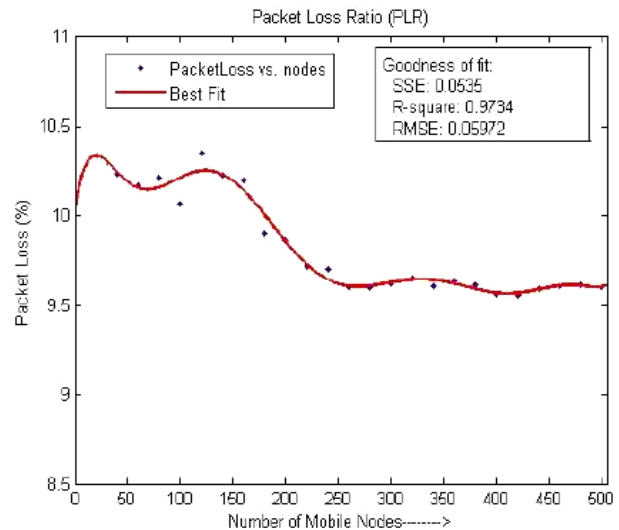


**Figure 4:** Packet Delivery ratio Vs Number of Mobile Numbers

**Loss Ratio (PLR):**

Packet loss Ratio (PLR) signifies the number of packets lost during the transmission from source to destination. It is actually the measure of number of packets undelivered or lost in the network . PLR is calculated from equation (4). The value should be kept to minimum according to ITU standards. The graph is drawn between PLR and number of mobile nodes shown in figure 6. It shows that if we keep on increasing the number of mobile nodes, then the value of PLR decreases but it eventually becomes constant after 250

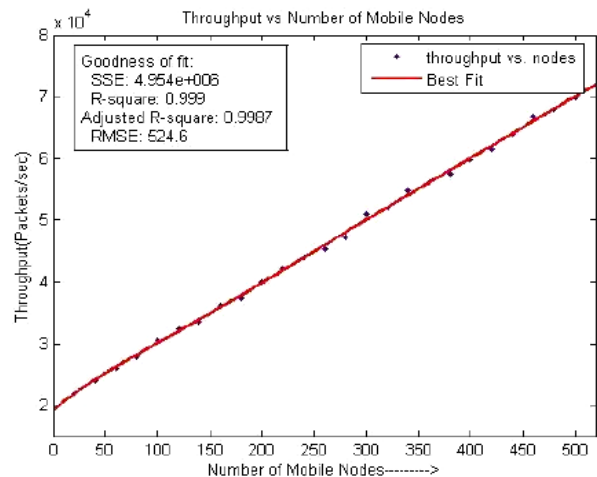
mobile nodes. Regression analysis is performed on the results from the simulations and the calculated values were shown in the text box, drawn in the graph. Regression analysis shows that a very high value of R square (0.97).



**Figure 5:** Packet Loss Ratio Vs Number of Mobile Nodes

**Throughput:**

Throughput is a measure of successful delivery of packets in a given interval of time. The calculation of throughput was done by equation (5). The graph between Throughput Vs number of mobile nodes is shown in figure 6. It depicts that as the number of mobile nodes increases, throughput increases as well. The regression analysis shows that a very high value of fit is achieved. The results of regression analysis is shown in the form of text box in the graph which depicts a high value of R square (0.99) and low value of mean square error (MSE).



**Figure 6:** Throughput Vs Number of Mobile Nodes

**6. Conclusion**

Measurement of QoS is essential for any Wimax / broadband wireless communication. In order to ensure that a user- centric broadband experience becomes a reality, the broadband wireless access networks must meet a number of Quality of Service (QoS) parameters, including guaranteed throughput, and low delay, jitter and packet loss. Today in broadband wireless access (BWA) the perception is that as adoption grows, so does the need for guaranteeing a good

QoS. The issue of QoS, therefore, has become a critical area of concern for suppliers of broadband wireless access equipment and their customers too. Enforceable QoS is an essential foundation for widespread acceptance of broadband wireless, since it allows for more efficient sharing of the operators infrastructure, as demand for capacity increases with subscriber take-up. Our paper helps in analyzing various essential WimaxQoS parameters which are critical in determining the performance of a Wimax network. A very low value of Jitter (approx.  $1 \times 10^{-9}$  seconds), delay(6 milliseconds) and packet loss( 9 percent) is achieved , whereas a very high average value of throughput and packet delivery is obtained using AODV protocol. From the results it could be interpreted that as the mobile nodes keep on 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 given Wimax network.

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