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Research Article

Simulation Model to Improve QoS Performance over Fixed WiMAX using OPNET

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Abstract: Worldwide Interoperability for Microwave Access (WiMAX) Technology is one of the most interesting solutions for broadband wireless access, that provide multimedia traffic and applications through an appropriate QoS management for fixed and mobile devices. In this regard, we attempt to introduce a new distributed model to improve the performance of QoS over fixed WiMAX with respect to parameters including throughput, delay and application response time, to enhance the services that are provided to the end users by minimizing delay, application response time and increasing throughput. A Model was developed based on the proposed new distributed model (Master-Slave), the first scenario comprised of 3 Base Stations (BS) and thirty Subscriber Station (SS) with one Master BS selected by the designed algorithm (Nearest Neighborhood Algorithms). Simulations run while increasing the number of BSs, SSs and master BSs using point-to-multipoint connection with multicast transmission based on Orthogonal Frequency Division Multiplexing (OFDM). The design has been evaluated using the simulation tool OPNET modeler 16.0. The results obtained from the three Scenarios shows significant increase in the network throughput and drastic decrease in network delay and application response time. Furthermore, with help of the distributed Master BSs, the coverage area of WiMAX has been increased. Thus greatly enhances the performance of Quality of service (QoS).

Keywords: Fixed WiMAX, master-slave model, OFDM and OPNET modeler, QoS parameters, WiMAX architecture

INTRODUCTION

WiMAX (Worldwide Interoperability for Microwave Access) can be a communication technology for easily delivering high-speed data rates to large geographical areas using orthogonal frequency division multiplexing (OFDM) from Base Station (BS) to Subscriber Station (SS) (Chakraborty and Bhattacharyya, 2010). WiMAX deploys multicarrier transmission based on OFDM and multiple-access using the Orthogonal Frequency Division Multiple-Access (OFDMA). OFDM mitigates noise, multipath and interference effects, what exactly are primary challenges of wireless communication. OFDMA is very flexible in allocating assets which are very crucial for wireless systems (IEEE Task Group). Based on Chakraborty and Bhattacharyya (2010) the 2005 WiMAX revision provided bit rates as much as 40 Mbit/s using the 2011 update as much as 1 Gbit/s for fixed stations.

It is a part of a "fourth generation," or 4G, of wireless-communication technology offering a metropolitan area network having a signal radius of approximately 50 km (30 m). Ultimately, WiMAX advocates aspire to begin a global area network by which signals could achieve. It offers high-speed, flexible, inexpensive and last mile services with performance similar to those of wire line infrastructures T1, DSL, cable modem based connections, optical fiber or copperware with a number of Service quality (QoS) needs (Grewal and Sharma, 2010). Also based on Grewal and Sharma (2010) the Support for QoS is an integral part from the WiMAX MAC layer design which utilizes an association-oriented MAC architecture, where all downlink and uplink connections are controlled through the serving BS with every connection recognized with a Connection Identifier (CID), for data transmissions within the particular link. MAC layer assigns traffic to a Service Flow Identifier (SFID) for packets with a particular set of QoS parameters (traffic priority, maximum sustained traffic rate, maximum burst rate, minimum tolerable rate, scheduling type, ARQ type, maximum delay, tolerated jitter, service data unit type and size and bandwidth request mechanism to be used) Quality of Service (QoS) (Grewal and Sharma, 2010) as shown in Fig. 1.

In WiMAX networks, the communication path between BS as well as the SS is bi-directional: uplink or UL (from SS to BS) and downlink or DL (from BS

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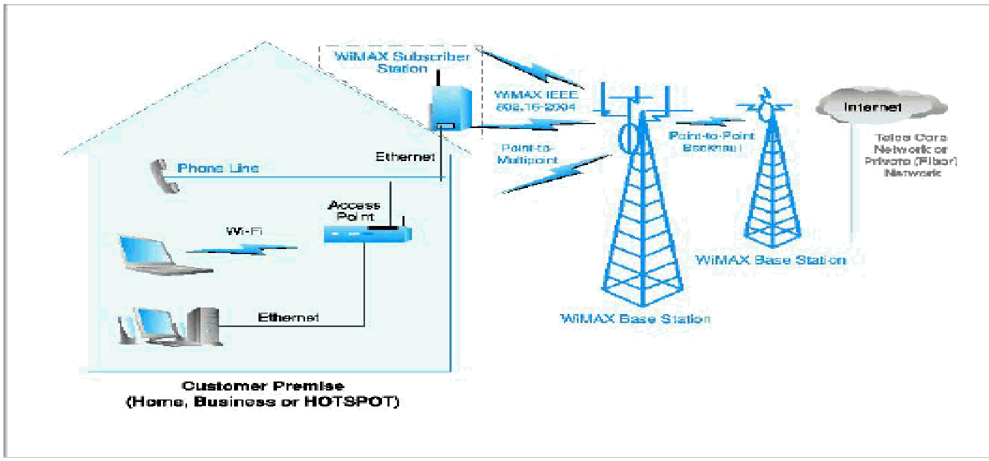

Fig. 1: WiMAX base stations / subscriber stations internet connections

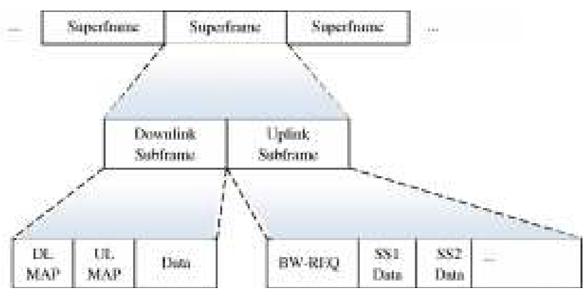

Fig. 2: 802.16 frame structure

to SS). For any uplink and downlink data transmissions, time is split into frames of fixed duration. The uplink and downlink sub frames are duplexed using one of the following techniques: Frequency Division Duplex (FDD) or Time Division Duplex (TDD). In FDD, the uplink and downlink sub frames occur simultaneously on separate frequencies. In TDD, they occur at different times while sharing exactly the same frequency. SSs are usually either full-duplex or half-duplex (Safa and Watfa, 2009).

The IEEE 802.16 uses frame-based transmission architecture, each frame is known as super frame which is split into two sub frames, the DL sub frame and also the UL sub frame as shown in Fig. 2. More precisely, Fig. 2 shows the Wireless OFDM PHY with TDD frame, one of several frame structures allowed for that PMP mode. Both sub frames define the characteristics with the physical channels. They include the more information from the DL burst profile and also the UL burst profile. The DL sub frame periodically generated from the BS provides the DL-MAP and UL-MAP which are used to announce the information from the arrangement of the downlink and uplink periods within the super frame. The DLMAP specifies the downlink channel access and also the associated burst profile. It includes the timetable from the downlink grants within the forthcoming downlink sub frame. The UL-MAP defines the uplink channel access, which is, the time slot where the SS can transmit within the uplink sub frame along with the uplink data burst profiles (Std 802.16, 2004). Both maps are transmitted through the BS at the start of each downlink sub frame. The uplink sub frame contains the data sent by different SSs. The UL-MAP grants bandwidth to specific SSs, then the SSs will transmit in their assigned allocation.

QoS required legitimate time data transmission when the consequence of recognizing task is dependent not only around the correct recognized atmosphere but furthermore around the timely delivery. QoS support in wireless systems can be a more struggle in comparison to wired systems, because of the fact that the characteristics within the wireless link are highly variable and unpredictable and both are concern with the time-dependent basis together with a location dependent basis.

To handle such issues, QoS in wireless systems is usually handled within the medium access control (MAC) layer (Grewal and Sharma, 2010). WiMAX QoS depends most significantly around the 802.16 Layers one and two, since all important BS user-terminal radio access are naturally difficult atmosphere compared to wire line broadband network. QoS refers back to the collective effectiveness from the service as perceived through the user (Andrews *et al*., 2007). All of the technical concerns when it comes to packet loss, atmospheric interference, as well as in contention along with other wireless services have been addressed as QoS by 802.16 standards (Cicconetti *et al*., 2006).

The primary goal of QoS provisioning is ought to have an overabundance tasks completed deterministic behavior by proper using the network assets. The current problems inside the performance of QoS are minimum bandwidth, maximum delay, maximum variance in delay and maximum rate of packet loss which seriously personalize the clients in one way or another. These perhaps could ultimately be prioritized in data transmission over wireless channels (Cicconetti *et al*., 2006).

Fig. 3: WiMAX network architectures for point-to-point

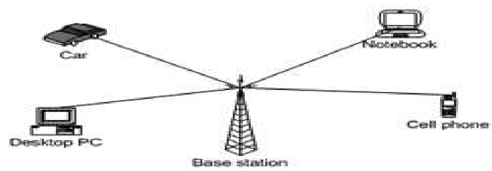

Fig. 4: WiMAX network architectures for point-to-multipoint

WiMAX wireless architecture: Broadband wireless architecture is being standardized by the IEEE 802.16e (2005) Working Group (WG) and the Worldwide WiMAX forum (Cicconetti *et al*., 2006). The basic IEEE 802.16e (2005) architecture consists of BSs (BSs) and one or more Subscriber Stations (SSs) (Grønsund and Engelstad, 2007).

There are three scenarios for a wireless deployment: point-to-point, point-to-multipoint and Mesh architecture (Sinem *et al*., 2002):

- **Point-to-point (P2P):** Point to point is used where there are two points of interest, one sender and one receiver. This is also a scenario for backhaul or the transport from the data source to the subscriber or for a point for distribution using indicates multipoint architecture. Backhaul radios comprise a business that applies to them inside the wireless industry as shown in Fig. 3. Because the architecture requires a very focused beam between two points range and throughput of point-to indicate radios will most likely be greater compared to suggest-to-multipoint items.
- **Point-to-Multipoint (PMP):** Point-to-multipoint is synonymous with distribution; one BS can service hundreds of dissimilar subscribers in terms of bandwidth and services offered as shown in Fig. 4.
- In mesh mode every subscriber can directly communicate with his neighbor without any interaction with a BS as shown in Fig. 5. Additionally, in mesh mode several subscribers can act as a BS that is directly connected to a backhaul like an Internet connection or a public network (IEEE 802.16e, 2005).

Quality of Service (QoS) issues in WiMAX: The International Telecommunication Union standard X.902 (IEEE 802.16e, 2005; IEEE Std. 802.16, 2004) refers to QoS as “a set of quality requirements on the collective behavior of one or more objects.” A quantity of QoS parameters is utilized to describe the rate and toughness for data transmission. Also (IEEE 802.16e, 2005; IEEE Std. 802.16, 2004) defines QoS as “a term which refers back to the group of ATM performance parameters that characterize the traffic on the given virtual connection.”QoS parameters apply mostly towards the lower level protocol layers and are not intended to be directly observable or verifiable through the application. These parameters include cell loss ratio, error rate, misinsertion rate, delay variation, transfer delay and average cell transfer delay.

The Internet Engineering Task Force (IETF) defines QoS (IEEE Std. 802.16, 2004) “as the interest in networked real-time services develops with requirement for shared systems to supply deterministic delivery services. Such deterministic delivery services demand that both source application and also the network infrastructure have abilities to request, setup and enforce the delivery from the data with the other useful known to as bandwidth reservation and Quality of Service”.

QoS can be broadly divided in two, User-Centric and Network-Centric QoS.

- User-Centric QoS is ‘‘the collective effect and services information performances which work out how much user satisfaction is within the service” (http://www.unstrung.com/document.asp? site = unsrung and doc-id = 103315pp10).

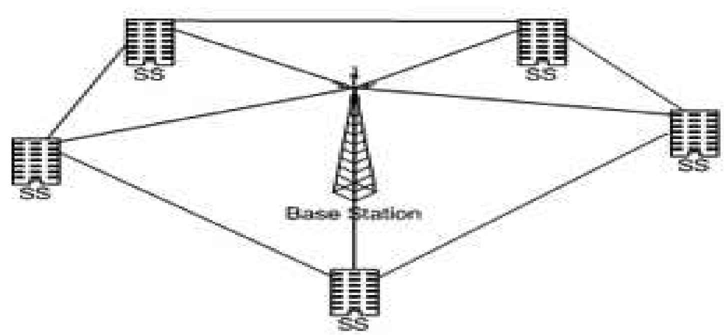

Fig. 5: WiMAX network architectures for mesh

- Network-Centric QoS comprises ‘‘the systems that provide network managers and chance to manage this combination of bandwidth, delay, variances in delay (jitter) and packet reduction in the network to capable of deliver a network service (e.g., voice over ip)” (Grønsund and Engelstad, 2007).

This study will mainly concern with the second concept of QoS, the term QoS shall instantly means ‘‘Network-Centric QoS”. Network engineers could use the current assets effectively by using a QoS mechanism. Early packet systems typically focused for starters service type and many types of packets were treated equally. There is no QoS differentiation or guarantee of reliability, minimum latency, jitter or other performance characteristics for any number of packets. Consequently, only one bandwidth intensive application might cause the performance of other programs to degrade substantially. In the multi-service network, the QoS mechanism needs to make sure that it might provide preferential delivery intend to packets according to their performance needs and QoS priority level and keep greater network utilization. QoS differentiation might be implemented on whether per-application or per-user basis. QoS systems can broadly be arranged beneath the following two categories the Admission Control and Traffic Control (Ahmet *et al*., 2009).

Fixed WiMAX QoS parameters: According (Pareek, 2006), a principal user expectation as regards to the QoS is specified if it involves the response time. The response time is influenced through the transmission delay in the access network through which the client’s workstation accesses the internet server, with the processing occasions inside the Web server, the using process as well as the DB query process and possibly the network latency involving the Web server, application and database server if they're re implemented on separate personal computers which will decrease the performance in the throughput.

- **Throughput:** Network throughput is the average data rate of successful message delivery over a communication channel. This data may be delivered over a physical or logical link, or pass through a certain network node. The throughput is usually measured in bits per second (bit/s or bps) and sometimes in data packets per second or data packets per time slot. This parameter is essential inside the outlook through the device owner and it also measures the amount of user demands that are addressed with the machine. It is an approach to calculating the quantity of service that is provided. The response quantity of confirmed system increases because the system throughput increases. Once the maximum throughput within the technique is accomplished, the response time becomes infinite because the internal queuing delays become arbitrary large. Throughput was measured for the widely used transport protocols UDP and TCP, as well as for the popular application protocol FTP. The throughput can be calculated using the following formula:

$$Throughput = \sum_{t_n}^{t_{n+1}} packetsize$$

where Packet Size is the size of served data in frame n between the start time, t_n, of frame n and the start time, t_{n+1}, of the next frame n + 1.

- **Delay:** Network delay is an important design and performance characteristic of a computer network or telecommunications network. The delay of a network specifies how long it takes for a bit of data to travel across the network from one node or endpoint to another. It is typically measured in multiples or fractions of seconds. Delay may differ slightly, depending on the location of the specific pair of communicating nodes. There is a certain minimum level of delay that will be experienced due to the time it takes to transmit a packet serially through a link, this is added a more variable level of delay due to network congestion. IP network delays can range from just a few milliseconds to several hundred milliseconds.

The delay can be calculated using the following formula:

$$Delay = \frac{\sum_{i=t_n}^{i=t_{n+1}} DeliveryTime - \sum_{i=t_n}^{i=t_{n+1}} ArrivalTime}{\sum_{i=t_n}^{t_{n+1}} Receivedpacket}$$

where, the Arrival Time is the time at which the packet arrives at the MAC layer of the source node, the Delivery Time is the time at which the packet is delivered to the MAC layer of the destination node, Received Packets is the total number of packets received between the start time, t_n, of frame n and the start time, t_{n+1}, of the next frame n+1.

Application response time: This is the most important QoS parameter from the user’s perspective. It is the time between the moments a request is sent to the time that the response has been provided to the user. It is the response time which is elapse time between an inquiry and a response.

Due to large coverage, affordable deployment and speed data rates, WiMAX can be a promising technology for delivering wireless last-mile connectivity and flexible Quality of Service (QoS) support to end subscribers.

Orthogonal Frequency Division Multiplexing (OFDM): This technology has emerged one of the promising methods of data transmission over wireless channels (Xiaodong and Georgious, 2004). It is high data rates and spectral efficiency that is resistance against multipath funnel diminishing effects (Xiaodong and Georgious, 2004). In OFDM the spectrum of signal is defined into subcarriers which are orthogonal to each other, they are allowed to overlap, so spectrum might be used effectively. Due to multi path effects different signals achieve receiver with a few other delays so inter-symbol interference can happen within the signal together with the signal following it. Using cyclic prefix decreases across the problem of Inter-Symbol Interference (ISI).

The concept of OFDM arises from Multicarrier Modulation (MCM) transmission technique. The key of MCM describes the division of input bit stream into several parallel bit streams and they are employed to modulate several sub carriers. Each subcarrier is separated with a guard band to make sure that they cannot overlap with one another. Within the receiver side, band pass filter are employed separate the spectrum of individual subcarriers. OFDM is really a special type of spectrally efficient MCM technique, which employs densely spaced orthogonal subcarriers and overlapping spectrums. The uses of band pass filters are certainly not needed in OFDM because the orthogonality nature from the subcarriers. Hence, the accessible bandwidth can be used very efficiently without resulting in the Inter Carrier Interference (ICI). The effects with this can be regarded as the desired bandwidth is reduced by removing guard band and allowing subcarrier to overlap, but still can be actually possible to recover the individual subcarrier despite their overlapping spectrum given that the orthogonality is maintained. The Orthogonality is achieved by performing Fast Fourier Transform (FFT) around the input stream. Due to the combined multiple low data rate subcarriers, OFDM comes with a composite high data rate with long symbol duration. Based on the channel coherence time, this reduces or completely eliminates potential risk of Inter Symbol Interference (ISI) that is a common phenomenon in multipath channel environment with short symbol duration. Using Cyclic Prefix (CP) in OFDM symbol can help to eliminate the result of ISI much more (Nee and Prasad, 2009), it also introduces a reduction in SNR and data rate.

Optimized network engineering tool modeler 16.0: OPNET Modeler is a highly sophisticated simulation software package that enables developers to model communications networks and distributed systems and allows them to analyse the behaviour and performance of modelled systems through Discrete Event Simulations (DES) (Staalhagen, 2007). This software is one of the most popular, accurate and applicable in the real world in the field of network simulation and is recognized for its high reliability. It allows for the simulation of different scenarios for a specific project and uses a project and scenario approach to modeling networks. The project approaches a collection of related network scenarios in which each explores a different aspect of network design. It contains at least one scenario, that is, a single instance of a network. Simulating a scenario can overcome constraints of proprietary hardware and software such as lack of development tools. The OPNET Modeler offers to its user a Graphic User Interface (GUI), standards-based LAN and WAN performance modeling and detailed library model for most protocols and devices.

In this study, we attempt to introduce a new distributed Master-Slave model to improve the performance of QoS over fixed WiMAX with respect to parameters including throughput, delay and application response time, to enhance the services that are provided to the end users by minimizing delay, application response time and increasing throughput. A distributed Master-Slave Model will be design by introducing a Master BS among BSs selected by the designed algorithm (Nearest Neighborhood Algorithms). Simulations run while increasing the number of BSs, SSs and master BSs using point-to-multipoint connection with multicast transmission based on Orthogonal Frequency Division Multiplexing (OFDM). The design will be evaluated using the simulation tool OPNET modeler 16.0. Furthermore, the new distributed Master-Slave will increase the coverage area of WiMAX through distributed master BSs. The proposed distributed model will improve the system's performance of the earlier model which used to delivered bandwidth from central server to WiMAX BSs and SSs with the distributed BSs and extend the network distance using some BSs as masters.

LITERATURE REVIEW

A Studies of Fixed WiMAX is completed by Cicconetti *et al*. (2006). These studies focuses in route lost inside the fixed WiMAX, It uses a feeling interface based on Orthogonal Frequency Division Multiplexing (OFDM) that is very robust against multi-path propagation and frequency selective diminishing. An adaptive modulation strategy is familiar with enhance performance when the link characteristics vary. There system used Frequency Division Duplexing (FDD), in which the BSs and also the user devices transmit in various frequency bands (Cicconetti *et al*., 2006).

Location Based Performance of WiMAX Network for QoS with Optimal BSs may well be a studies completed by Rakesh *et al*. (2011). This studies anxiety about the traffic organizing, they pointed out that a lots of traffic organizing information is for sale to wireless systems, e.g., Round Robin, Proportional Justness (PF) plan and Integrated Mix-layer plan of individual's conventional schemes, some cannot differentiate services, despite the fact that some can match the service differentiation wealthy in-complexity implementation (Rakesh *et al*., 2011). Furthermore (Rakesh *et al*., 2011) also pointed in regards to the use for WiMAX Radio Planning Simulation, in which the author pointed out that WiMAX deployment with optimization is difficult task, they have done survey between Bhusawal, Balwadi and Jalgam. With the Bradenton area in comparison to that particular specific, the amount of customers is thought. Furthermore they also considered about number of users when setting the number of BSs. The WiMAX coverage is 50 km in radius but when they take the practical consideration it is up to 25 to 30 km. They have also observed that one directional antenna and one Omni-directional antenna has been required for last mile operation or for total coverage.

There is an Experiments carried out by Upena *et al*. (2009) where multi-rate support (or even the Adaptive Modulation and Coding (AMC) feature) was disabled to properly determine the throughput and link quality for each one of the available modulation schemes with minimum transmit energy of 13dBm over distances varying from 220 m to 9400 m (9.4 km) in the BS. The AMC feature allows the machine to dynamically adapt the modulation plan and Forward Error Correction (FEC) coding to actual link conditions for every uplink and downlink direction. The hyperlink was examined for the TCP and UDP traffic produced both in uplink and downlink direction, therefore emulating data relevant to some situation of real customer deployment.

Another research was carried out by Raman and Chebrolu (2007) to supply rural access Network in India community using hybrid point-to-multipoint (PMP) and multihop topologies. WiMAX technology for that physical distribution of customers cause that the pure PMP option would be not optimal.

Grondalen *et al*. (2007) used a fixed WiMAX testbed in Turin, Italia, to empirically evaluate VoIP (Voice over internet protocol) performance over WiMAX. Particularly, they centered on situations where service differentiation is utilized in the existence of quite a lot of elastic background traffic. Although their testbed incorporated three SSs, the authors did not report any improvements using their synchronized use. Their evaluation views copied Voice over internet protocol calls over point-to-point links. Furthermore, possibly because of another radio resource allocation, (Grondalen *et al*., 2007) reported the bottleneck within their testbed demonstrated to become the downlink.

Martufi *et al*. (2008) Reported active traffic measurement results from a fixed WiMAX field trial near Oslo, Norwegian. They focused their evaluation across the performance of bulk Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) transfers but did not empirically consider the performance of VoIP or any other multimedia traffic. They measure throughput under both LOS and NLOS conditions and correlated it with Received Signal Strength Indicator (RSSI) values at 15 distinct locations. Martufi *et al*. (2008) Tested their WiMAX system, using the same modulation and Forward Error Correction (FEC) testbed and recognized within the following section and also observed that it can deliver a throughput of 9.6 Megabytes per second having a single flow within the downlink, this throughput level may be accomplished by SSs situated far as much as 5 km inside the BS.

DESING FOR MASTER-SLAVE MODEL

To design a new master- slave model in order to improve the performance of QoS over fixed WiMAX for parameters throughput, delay and application response time using OFDM technology and Nearest Neighborhood Algorithms the following are proposed:

Architecture of proposed system (master-slave) at abstract level: The Fig. 6 shows the architecture of

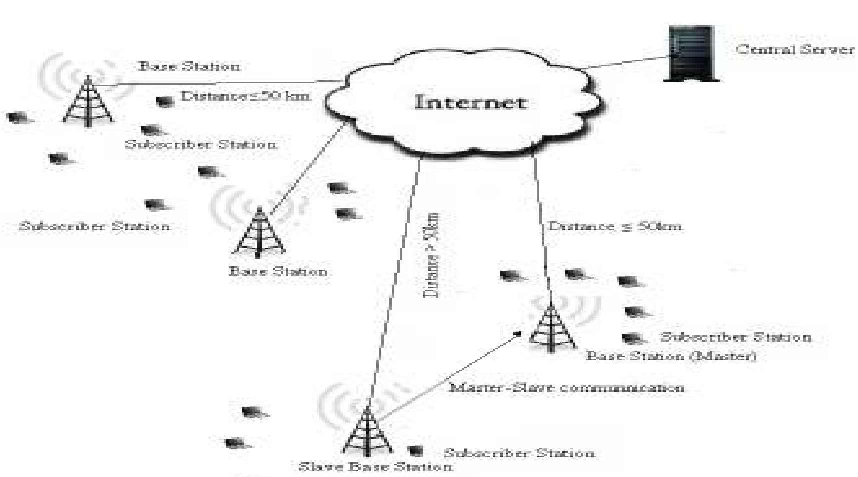

Fig. 6: Abstract level design of proposed master-slave architecture

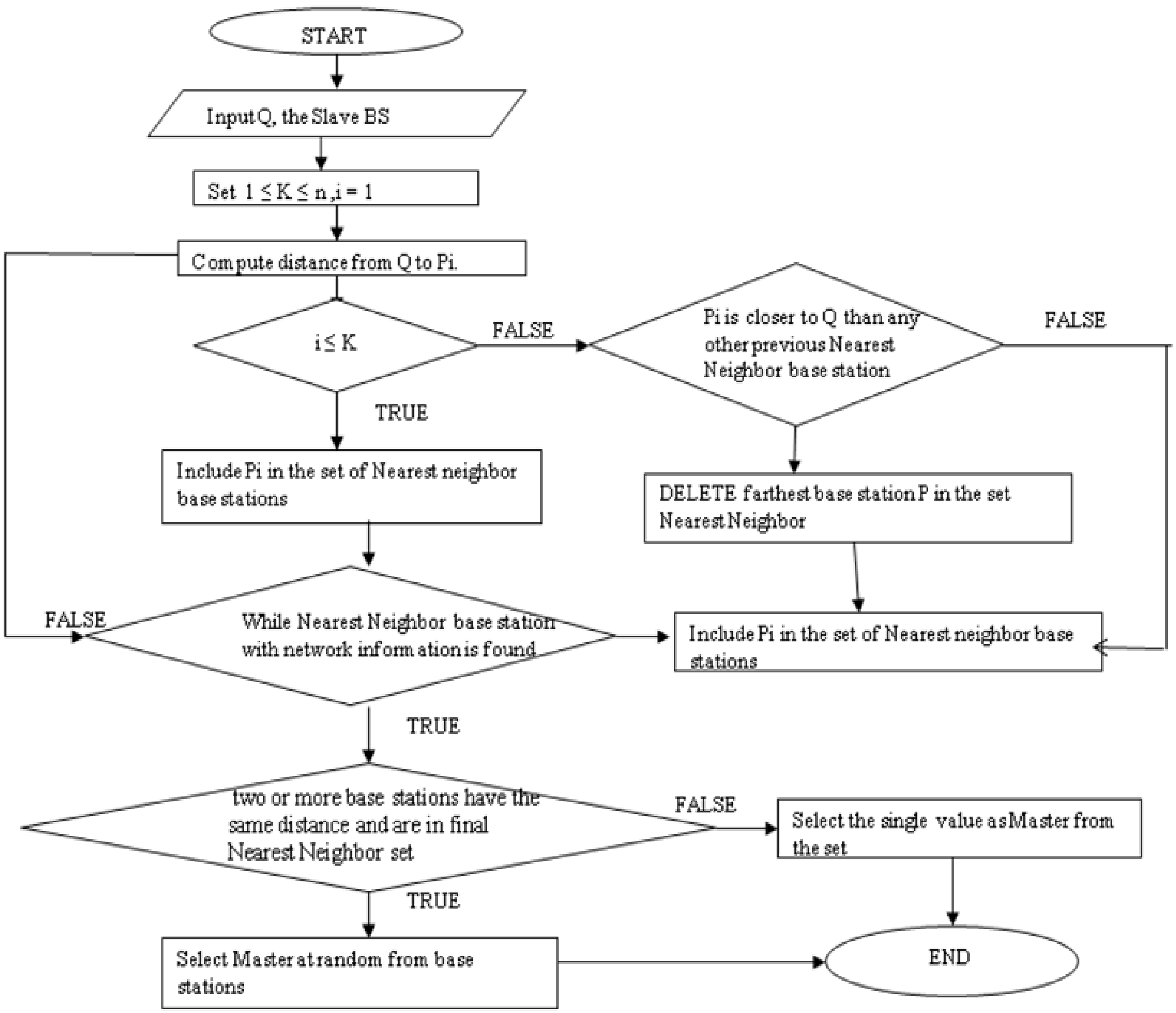

Fig. 7: Flow chart for selection of master base station

proposed system (Master-Slave) at abstract level, where some of the Slave Base Stations will receive their network information from the nearest Neighbor Base Station (Master) instead of getting from central server due to either long distance from the central server or for easy transportation.

Process of master base station selection: This section explain the Process of Master Base Station Selections

Algorithm 1: Selection of master base station:

1. Let P = {P_1, P_2, P_3, … P_n} be the set of n Base Stations (Candidates for Master). The Algorithms is as follows:
2. START
3. Input Q, the Slave Base Station
4. Set 1≤K≤n
5. Set i = 1
6. DO
7. {
8. Compute distance from Q to Pi.
9. IF(i≤K) Then
10. Include Pi in the set of Nearest Neighbors base stations
11. ELSE
12. IF (Pi is closer to Q than any other previous Nearest Neighbor base station) Then
13. Delete farthest base station P in the set Nearest Neighbor
14. End If
15. Include Pi in the set of Nearest neighbor base stations
16. End If
17. }

18. While (Nearest Neighbor base station with network information is found)
19. If (two or more base stations have the same distance and are in final Nearest Neighbor set) Then
20. Select Master at random from base stations
21. Else
22. Select the single value as Master from the set
23. End If
24. End

Flow chart: The Fig. 7 shows the Flow chart for Selection of Master Base Station from the given base stations.

Master-slave communication: Figure 8 shows the communication between the Master and Slave BSs for getting network information, where a Slave BS will send a network information request to Master BS then the Master BS will send Authentication Request to Slave BS for security and others, if everything is all right then Authentication reply will be send to Master BS after the processing, the network information will be sent to Slave BS.

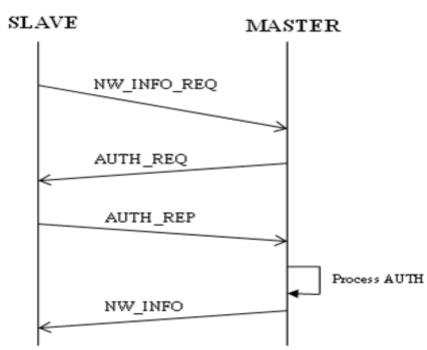

Fig. 8: Master-slave communication

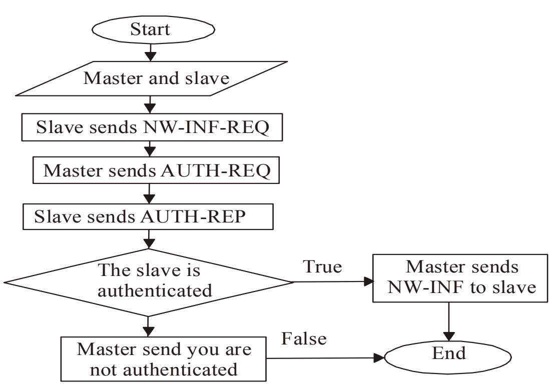

Fig. 9: Flow chart for master-slave BS communication

Algorithm for master–slave base station communication:

1. Start
2. Take input (Master Base Station *M*, Slave Base Station *Si*) from Algorithm 1
3. Each Slave *Si* sends NW- INF-REQ message to Master *M*
4. Master node *M* sends AUTH-REQ to each Slave *Si* to validate Slave's authentication
5. Slave *Si* sends AUTH-REP containing the authentication information
6. If (authentication information is verified)
7. Master *M* sends *NW- INF* to Slave *Si*
8. Else
9. Master *M* sends message that node *Si* is not authenticated
10. End if
11. End

Flow chart: Now this network information can be sent by the Slave BS to subscriber stations for further use. The Fig. 9 shows the flow chart of master-slave communications.

SIMULATION SETUP AND RESULTS

In this Section, we have developed an initial simulation setup of the proposed Master-Slave model for Fixed WiMAX in OPNET Modeler 16.0 (Staalhagen, 2007). A detailed explanation of the simulated network model together with configured traffic that was developed for evaluating the performance of the Quality of service over fixed WiMAX is given below.

Master-slave model design parameters configuration: Basic parameters associated with WiMAX Configuration attributes, Application Configuration, Application Profile, Task Definition, Base Stations configuration and Subscribers Station for the proposed Master-Slave model in fixed WiMAX are configured.

Figure 10 shows the basic *p*arameters associated with WiMAX Configuration attributes for Master-Slave Model

Figure 11, shows the parameter associated with Application Configuration for proposed Master-Slave model in fixed WiMAX
Parameters associated with Application Profile are shows in Fig. 12.

Figure 13 explains the parameter associated with BS configuration.

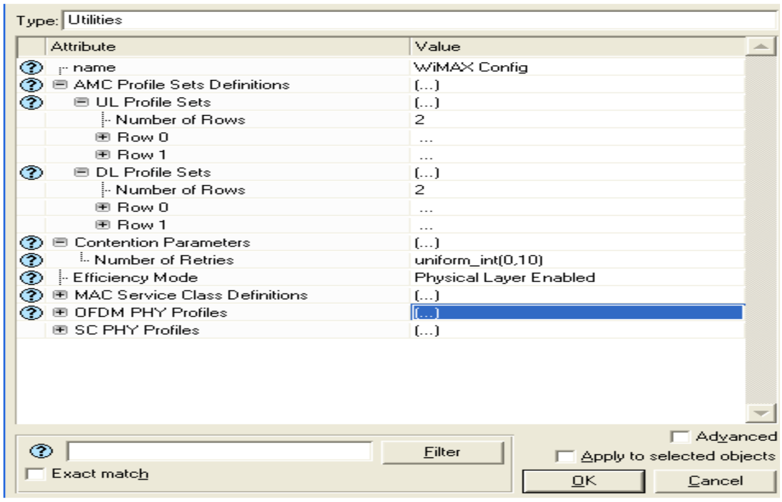

Fig. 10: WiMAX configuration attributes for master/slave model

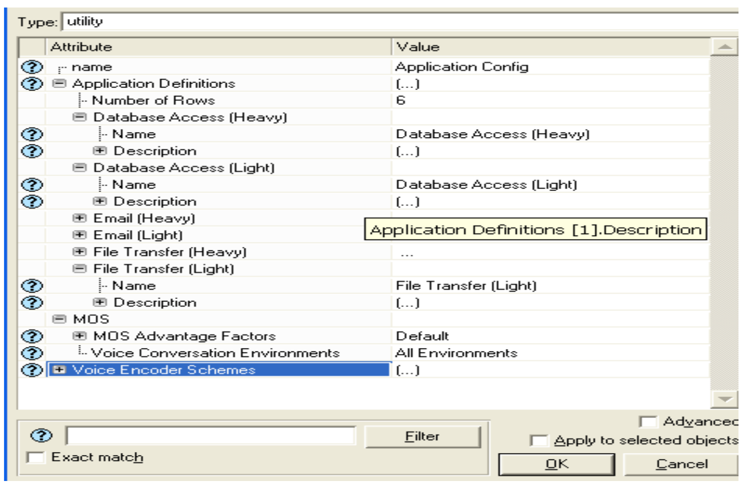

Fig. 11: Application configurations for master/slave model

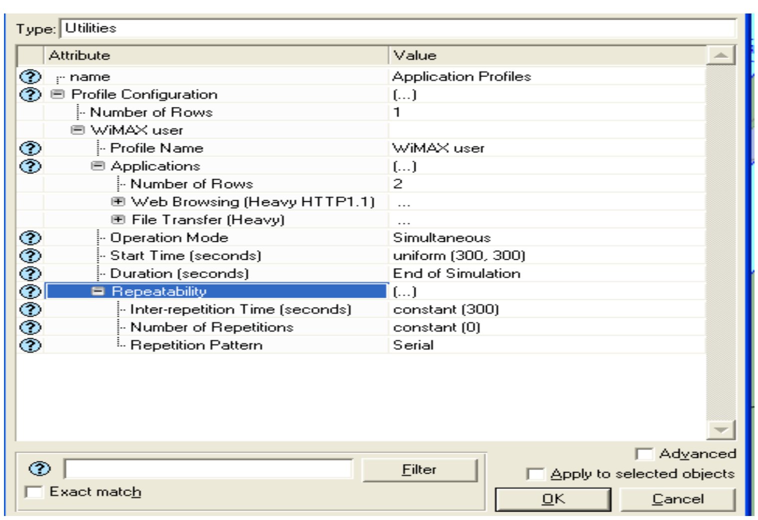

Fig. 12: Application profiles for master/slave model

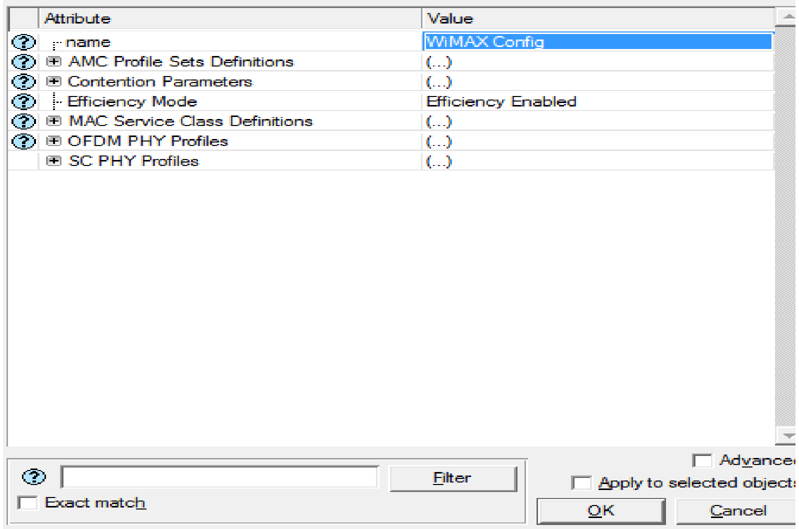

Fig. 13: BSs configuration for master /slave model

SCENARIO FOR SIMULATION

Scenario-1: In this scenario, three WiMAX Base Stations were developed with thirty subscribers stations (ten subscriber's stations around each Base Station) between the intervals of 50 km from one Base Station to another in an area of 150 km × 100 km. All the Base Stations are connected with IP backbone (Internet) using point- to- point protocol (ppp), with Base Stations A as master selected by the design algorithm and the remaining are slaves. Figure 14 shows the diagram for this scenario.

Scenario-2: In scenario 2, five WiMAX Base Stations were developed with fifty Subscriber Station (ten Subscriber Station around each Base Station) between the intervals of 50 km from one Base Station to another in an area of 150 km × 150 km, with Base Stations A and D as masters selected by the design algorithm and the remaining are slaves. All other parameters are as in scenario-1. Figure 15 shows the diagram for this scenario.

Scenario-3: In scenario 3, eight WiMAX Base Stations were developed with eighty Subscriber Station (ten Subscriber Station around each Base Station) between the intervals of 50 km from one Base Station to another in an area of 200 km×200 km, with Base Stations A , B and C as masters and the remaining are slaves as shown in Fig. 16. All other parameters are as in scenario-1.

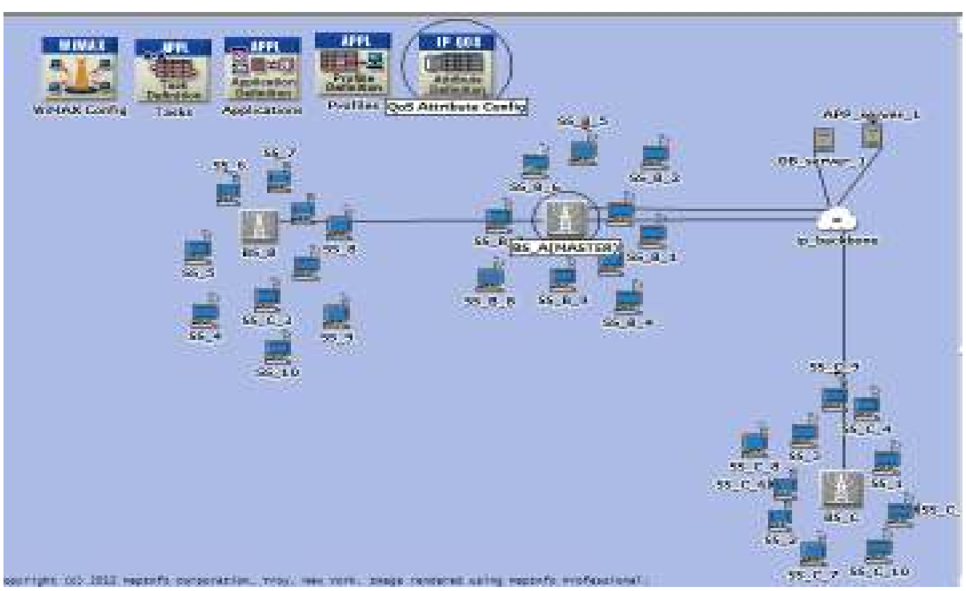

Fig. 14: Master-slave model design for the performance of QoS over fixed WiMAX (Scenarior-1)

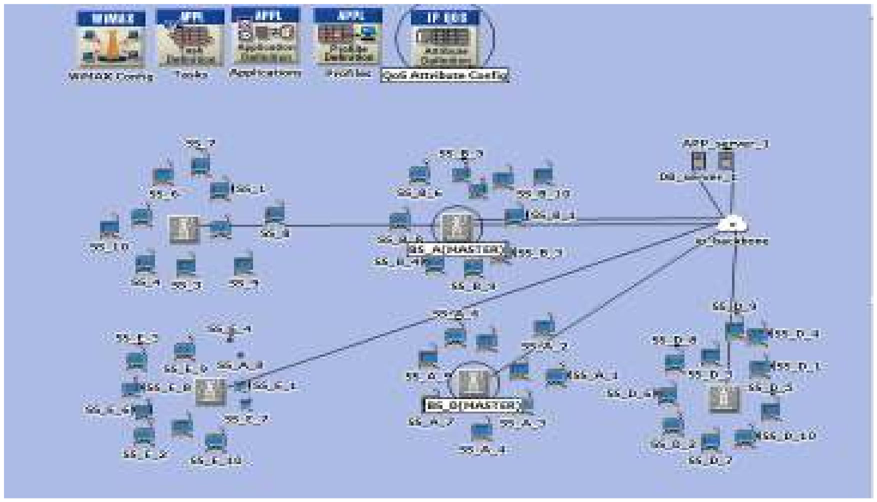

Fig. 15: Master-slave model design for the performance of QoS over fixed WiMAX (Scenarior-2)

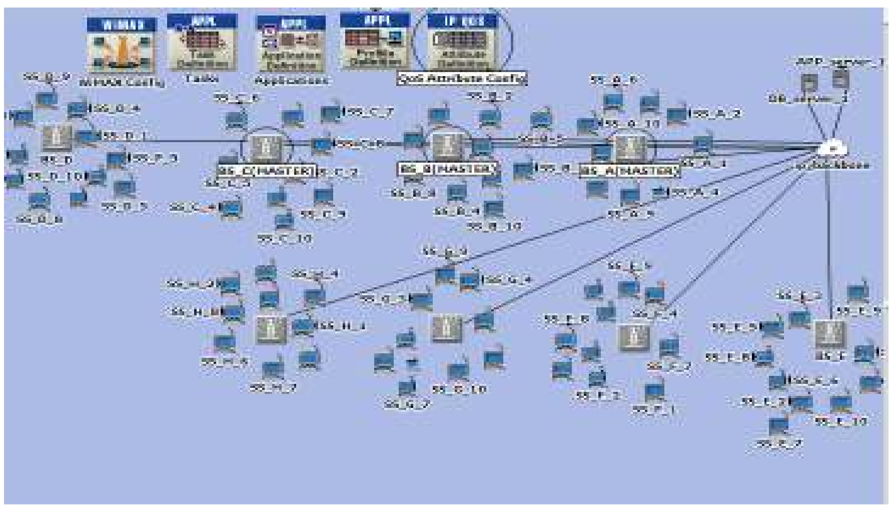

Fig. 16: Master-slave model design for the performance of QoS over fixed WiMAX (Scenarior-3)

Table 1: Simulation setup parameters

S/N	Scenarios	No of base stations	No of subscriber stations	No of master base stations	Type of connections	Areas covered
1	1	3	30	1	Point-to-multipoint	100×100
2	2	5	50	2	Point-to-multipoint	150×150
3	3	8	80	3	Point-to-multipoint	200×200

The Table 1 shows the simulation setup that shows the parameters used in the scenario by including additional base station, subscriber station and number of master Base Station, connection time as well as the areas covered.

OPNET PRELIMINARY SIMULATION RESULTS

These are preliminary results which show that the simulation of our proposed architecture is possible in OPNET simulator the fact that a WiMAX base station is effected to place in between of 50 km but with the introduction of master base station the network will be reach the next base station within the area of 100 by 100 km, 150 by 150 km 1nd 200 by 200 km. Upon completion and execution of the scenario presented in Fig. 17 to 19 which was run for 1 hour, the results are listed below. The factors that were studied in the simulation are the application response time, throughput and delay.

When we simulated scenario-1 of the proposed design, the following results were obtained. Figure 17 shows the Application response time, delay and throughput using the proposed model for scenario-1.

Figure 18 shows the Application response time, delay and throughput using the proposed model for scenario-2.

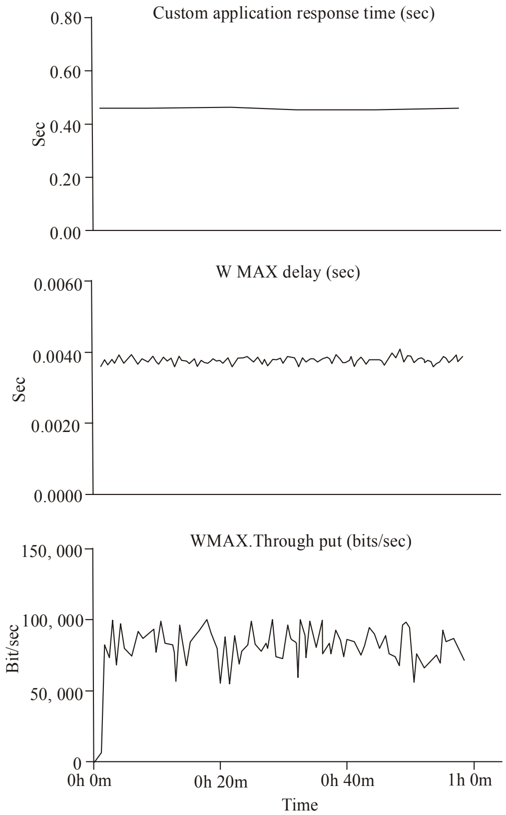

Fig. 17: Master-slave WiMAX model application response time, delay and throughput for scenario-1

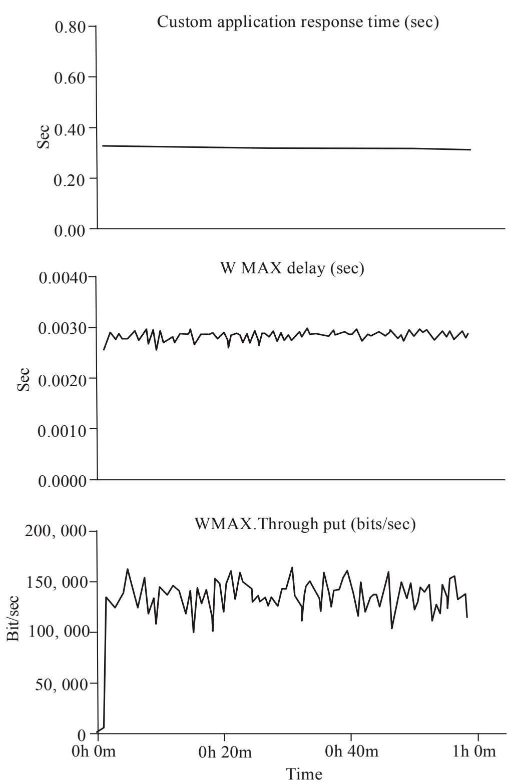

Fig. 18: Master-slave WiMAX model application response time, delay and throughput for scenario_2

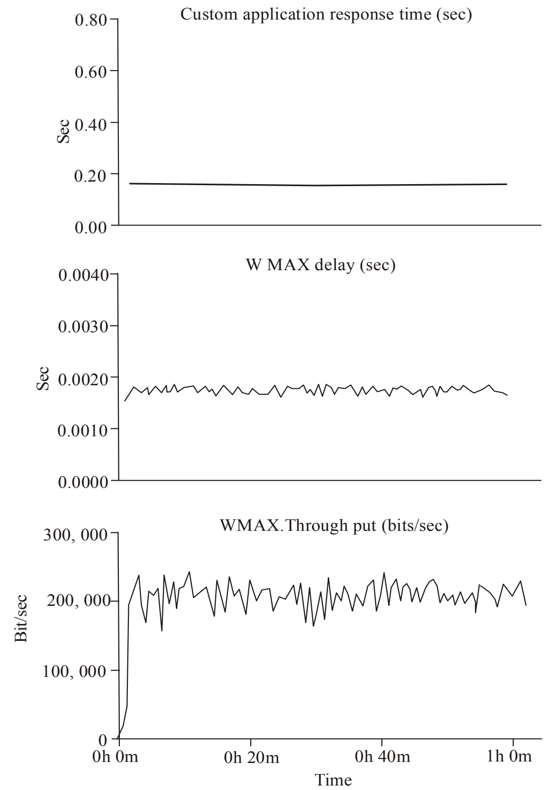

Fig. 19: Master-slave WiMAX model application response time, delay and throughput for scenario-3

Figure 19 Shows the Application response time, delay and throughput using the proposed model for scenario-3.

Analysis of the preliminary simulation results: If we look into the Fig. 16 to 18 then we can see that Application response time and delay reduced drastically in both scenarios, This is because of the addition of Master base station from 1, 2 and 3 in scenario, 1, 2 and 3 respectively despise the fact that the number of BSs and SSs are increased. Also when we look into the throughput in Fig. 15 to 17 the results are different, it increased from 102,340 bits/sec in scenario-1 to 156,201 bits/sec in scenario-2 up to 210,107 bits/sec 3 in scenario, 1, 2 and 3 respectively.

CONCLUSION AND RECOMMENDATIONS

Based on the several issues arising in wireless communication, which mostly concern with the performance of QoS this study focused on the introduction of a new model that improve the performance of QoS over fixed WiMAX. On completion, the proposed model will improve the method of point-to-point and point-to-multipoint system of delivering bandwidth from central server to WiMAX BSs and SSs which will improve the performance of QoS. In this model some of the BSs are assigned as masters who are at the same time receive and sent Network information to the nearest BS. Designing the Master-Slave model in the OPNET environment help for the testing the new algorithm to access the effect of the new model (master/slave). Furthermore, this Model will help the Internet Service Providers (ISPs) in terms of data delivery by not operating from one central server but many Master BSs that can receive and send bandwidth to the other BSs (Slaves) using propagation method, this will reduce the cost of infrastructures development. Our intention was to test that whether the new proposed model can be implemented in OPNET environment or not. In future, we will be comparing the results of proposed model with the existing model and analyze the result using analysis tools.

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