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A Distributed QoS-Oriented Model to Improve Network Performance for Fixed WiMAX

Ibrahim A. Lawal [1], Abas Md Said [1], Kashif Nisar[2] and Abubakar Aminu Mu'azu [1]
[1] Department of Computer & Information Sciences, Universiti Teknologi PETRONAS Malaysia
Seri Iskandar, Tronoh 31750, Perak, Malaysia
Ibrahim_g01867@utp.edu.my, abass@petronas.com.my, & abuaminu_g01797@utp.edu.my
[2]School of Computing InterNet Works Research Laboratory UUM College of Arts and Sciences, Universiti Utara Malaysia, Sintok 06010 Kedah Malaysia
kashif@uum.edu.my

***Abstract*— Worldwide Interoperability for Microwave Access (WiMAX) is a promising wireless technology based on the IEEE 802.16 standards that provide high-speed and reliable communications in large areas up to 30 miles (50 km). In our research a Distributed Quality of service (QoS)-oriented Model was developed to improve Network Performance for Fixed WiMAX. Two models were analyzed based on Centralized and the New Distributed Master-Slave models. The first model comprised of three (3) Base Stations (BS) and thirty Subscriber Station (SS) without Master-Slave BS while the new distributed model includes Master-Slave BSs selected by the designed algorithm (Nearest Neighborhood Algorithms). Simulations run while increasing the same number of BSs, SSs and master-slaves BSs the in New Distributed model using point-to-multipoint connection with multicast transmission based on Orthogonal Frequency Division Multiplexing (OFDM) techniques. The design has been evaluated using the simulation tool OPNET modeler 16.0. Comparing the results obtained from the two simulated models, it shows significant increase in the network throughput and drastic decrease in network delay and application response time which greatly enhances the performance of QoS.**

***Index Terms*— QoS parameters, Fixed WiMAX, Master-Slave model, Base Station, Subscriber Station, OFDM Techniques, and OPNET Modeler.**

I. INTRODUCTION

The prospect of broadband Internet access anywhere, at any time, has seemed a distant dream, far from reality for the vast majority of PC, laptop and handheld users. However, with WiMAX, it will soon become something users cannot live without in terms of network delivery [1]. WiMAX is one of the hottest wireless technologies around the world today. WiMAX systems are expected to deliver broadband access services to residential and enterprise customers in an economical way [1]. Although it has one name, WiMAX but there are two main classes of WiMAX systems called fixed WiMAX and mobile WiMAX. Fixed WiMAX is targeted for providing fixed and nomadic services, while mobile WiMAX will also provide portable, (simple and full) mobile connectivity [2]. Also according to [1] the fixed is for fixed wireless and falls under the IEEE 802.16-2004 standards while the mobile is for mobile applications, which will be under the 802.16e specification. As of now, fixed WiMAX is capable of becoming a replacement for DSL or cable or for network backhaul. In future, WiMAX will transform the world of broadband by enabling the cost-effective deployment of metropolitan area networks based on the IEEE 802.16d standard to support end users.

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The fixed WiMAX system uses a feeling interface based on orthogonal frequency division multiplexing, that's very robust against multi-path propagation and frequency selective diminishing. An adaptive modulation strategy is familiar to enhance the performance of OFDM when the link characteristics vary. WiMAX used Frequency Division Duplexing (FDD), where the base stations as well as the user products transmit in a variety of frequency bands. The MAC layer is connection oriented and uses Time Division Multiplexing (TDM) in the downlink (DL) together with a Time Division Multiple Access (TDMA) in the uplink (UL) [3].This reflects the reason to Point-to-Multipoint (PMP) architecture. QoS is extensively supported through four QoS classes with options for constant bit rate, guaranteed bandwidths and greatest effort. When the first WiMAX Forum licensed equipment was released in 2006, they made a decision to put together an assessment bed mattress and provide real existence dimensions together with comprehensive analyses of performance. To date as everyone knows, minimum launched material can be obtained about WiMAX performance based on dimensions in solid existence area tests [3]. The figure 1 below shows the fixed and mobile WiMAX relations.

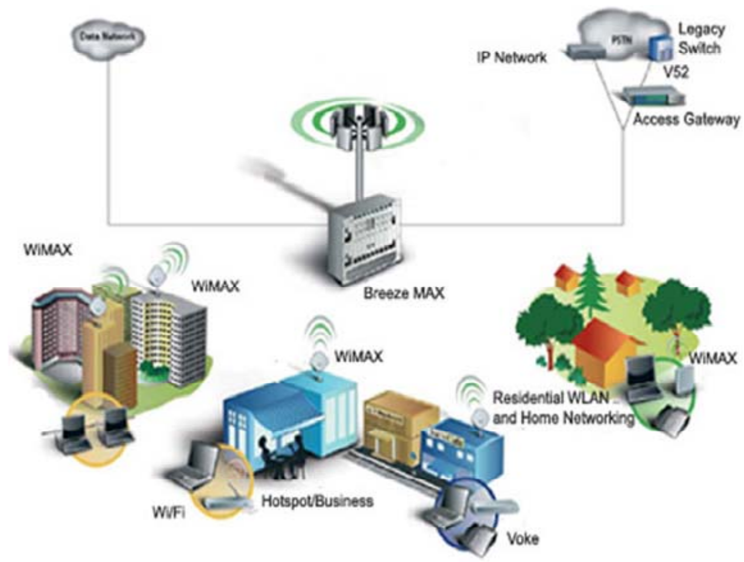

Figure1: fixed and mobile WiMAX relations [3]

Also based on [4] 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 Fundamental 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 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 is becoming an important feature of data routing in Wireless Networks.

Network applications offer an adaptive quality guaranteed service to satisfy user requirements [5]. Different applications involve different QoS concerns, together with different QoS control parameters. [5] Presents an adaptive QoS algorithm by discussing the QoS specifications of three wireless access technologies, i.e. 3G, WiMAX and Wi-Fi, according to cross-layer and cognition concepts, these environmental parameters are integrated using the sensing of spectral and received signal strength originating from a cognitive radio paradigm.

WiMAX can offer wide area coverage and excellence of service abilities for programs varying from real-time delay-sensitive voice-over-IP to real-time streaming video and non-real-time downloads, making certain that customers have the performance they expect for all sorts of communications [6].

The growing need for WiMAX VoIP and high-speed multimedia is a result of simplesness installation and cost reduction compared to the conventional wired DSL cable. The difficulties to service providers lie together with the QoS under different fading environment and time increasing for resource utilization. An extensive and comprehensive performance study of WiMAX has grown to be with regards to adaptive modulation and coding techniques along with the variation within the speed, path-loss, scheduling services and application type for comparing with the fixed form of modulations [7].

In this research we developed a Distributed Quality of service (QoS)-oriented Model to improve Network Performance for Fixed WiMAX. Two models are designed based on Centralized and new distributed Master-Slave models using OPNET modeler 16.0 simulations as discussed in section III.

The Nearest Neighborhood Algorithms is used in selecting the master and slave BS. Ultimately, additional of master BSs enhances the performance of QoS with respect to throughput, delay and application response time. However, the network is distributed in such a way that the master BS can provides network information from central Server and sends to the nearest slave BS. Thus improving the system's performance of the earlier model which used to delivered bandwidth from central server to WiMAX BSs and SSs.

II. AN OVERVIEW OF WIMAX

In this section we discuss in details the WiMAX QoS and Scheduling Services, Fixed WiMAX QoS parameters, Orthogonal Frequency Division Multiplexing and OPNET Modeler 16.0.

A. *WiMAX QoS and Scheduling Services*

The Scheduling service determines the quantity of the UL and DL transmission options, in addition to BW allocation systems. Initially, four different service types were supported inside the 802.16 standard: Unsolicited Grant Service (UGS), Real-time polling service (rtPS), Non-real-time polling service (nrtPS) and Best Effort (BE) [8, 9]

1. The UGS (Unwanted Grant Service) resembles the Constant Bit Rate (CBR) Service in an Asynchronous Transfer Mode (ATM) which produces a collection size burst periodically. A reverse lookup might be accustomed to replace T1/E1 wired line or possibly a continuing rate service. Furthermore, it might be accustomed to support real-time programs for instance Voice over IP or streaming programs. Even though the UGS, may possibly not function as the finest choice for the Voice over IP because it might waste bandwidth through the off amount of voice calls.
2. The rtPS is ideal for an adaptable bit rate real-time service for instance Voice over IP. Every polling interval, BS polls as well as the asked to transmit between requests (bandwidth request) whether or not this has data to provide. The BS grants or loans or financial loans the data burst using UL-MAP-IE upon its reception.
3. The nrtPS is much like the rtPS with the exception that it enables contention based polling.
4. In BE Service can be used as programs for example e-mail or FTP, by which there's no strict latency requirement. The allocation mechanism is contention based while using varying funnel. Another service type known as ertPS (Ex-tended rtPS) [10] was brought to support variable rate real-time services for example Voice over internet protocol and video streaming. We have an edge on UGS and rtPS for Voice over internet protocol applications since it carries lower overhead than UGS and rtPS as show in table 1.

TABLE I. SCHEDULING SERVICES PARAMETERS

UGS	Real time data streams with fixed size data packets issued at periodic intervals	T1/E1, VoIP without silence suppression.
rtPS	Real time data streams with variable size data packets issued at periodic intervals	MPEG video, VoIP with Silence suppression
nrtPS	Delay Tolerant data streams with variable size data packets issued at periodic intervals	FTP, Telnet
BE	Delay Tolerant data streams, background traffic or any either application without significant QoS constrains	HTTP, E-mail

B. *Fixed WiMAX QoS Parameters*

According [11], 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.

1) Throughput

Network throughput is the average data rate of successful message delivery over a communication channel. The throughput is usually measured in bits per second (bit/s or bps). 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 [12]:

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

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.

2) Delay

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 [12]:

$$Delay = \frac{\sum_{i=t_n}^{t_{n+1}} DeliveryTime - \sum_{i=t_n}^{t_{n+1}} ArrivalTime}{\sum_{i=t_n}^{t_{n+1}} Receivedpacket} \qquad (2)$$

Where *DeliveryTime* is the time packet from a frame was delivered, *ArrivalTime* is the time packet arrived at destination and *RecievedPaket* is the number of packet successfully arrived in frame *n* between the start time t_n, of frame *n* and the start time t_{n+1}, of the next frame $n+1$

3) 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 [13].

$$ART = \frac{n}{r} - Tthink \qquad (3)$$

Where *n* is the number of concurrent users and *r* is the number requests per second the server receives Tthink is the average think time (in seconds).

C. Model Scheduling Architecture for WiMAX

For a WiMAX network, packet scheduling will be required both at SSs and the BS. The UL request/grant scheduling is carried out by the BS, with the aim of providing each subordinate SS with a bandwidth for UL transmission or opportunities to request bandwidth [14]. Thus by specifying scheduling service and its QoS parameters, the BS scheduler can anticipate throughput and latency requirements and provide polls or grants at suitable intervals.

The need for network bandwidth is increasing with an unprecedented rate. Optical networks, utilizing their ultrahigh transmission speeds and infrastructure to satisfy the increasing demands of bandwidth [15]

1) Scheduling at Base Stations

To satisfy the stringent QoS guarantees for a number of traffic classes of WiMAX, a competent scheduler is needed in the BS. It will work as well for UL and DL transmission of information. The need of every traffic class is going to be converted into a suitable of quantity of time slots in the BS, which is utilized by the bandwidth asking for SSs. The scheduler in the BS will intimate its arranging choices to SSs by giving the UL-MAP and DL-MAP messages at the beginning of each frame. By the way of these MAP messages, each SS knows just that which slots happen to be allocated for the whole process of the UL and DL channels. Thus, an effective selection of scheduler in the BS is extremely crucial for maximum performance of the WiMAX network [16]. The QoS needs of every connection is going to be converted into the amount of time slots needed, that may be offered by using the easy weighted round robin (WRR) discipline [17].

2) Scheduling at Subscriber Stations

After you have a bandwidth grant in the BS, the SSs need to divide it at all traffic classes. Each SS is free of charge to select a scheduler at its output interface, thus manipulating the allocation of bandwidth inside a preferred manner towards the individual connections, while operating in GPSS mode. For example, consider an SS that is one router within an office that connects a LAN using the Internet through WiMAX, for the reason that situation arranging in the SS controls services provided to various departments. Similarly, BS can pick a scheduler in the interface employed for hooking up towards the wired Internet. However, it may be envisaged the wired Internet may have a greater capacity than WiMAX, hence an easy FIFO policy is going to be fine [18].

D. Orthogonal Frequency Division Multiplexing

OFDM is a multiple carrier transmission technique that is used for high speed bi-directional wireless data communication transmission. This technique has the ability to manages less the amount of bandwidth needed for data transmission by producing compressing multiple modulated carriers as well as keeping the modulated signals orthogonal to each other to eliminate interference[19]. OFDM is a process of the defining principles for the frequency division multiplexing (FDM). In FDM, signals coming from multiple transmitters are transmitted simultaneously in the same time slot over multiple frequencies so that each sub carrier (i.e., frequency range) is modulated individually to transfer individual's data streams. To avoid signal overlap, a guard band will be introduced between each sub carrier as shown in figure 2.

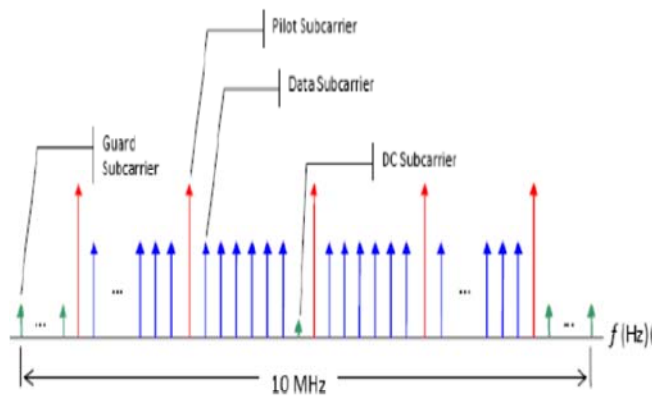

Figure 2: OFDM carrier structure [19]

E. OPNET 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) [20]. 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.

III. A DISTRIBUTED MASTER-SLAVE MODEL

The purpose is to design a new distributed master- slave model which will improve the performance of QoS over fixed WiMAX based on the following:

i. QoS parameters (throughput, delay and application response time)
ii. OFDM technology
iii. Nearest Neighborhood Algorithms

A. Architecture of the distributed Master-Slave at Abstract Level

The Figure 3 below shows the architecture of proposed system (Master-Slave) at abstract level, where some of the Slave BSs will receive their network information from the nearest Neighbor BS (Master) instead of getting from central server.

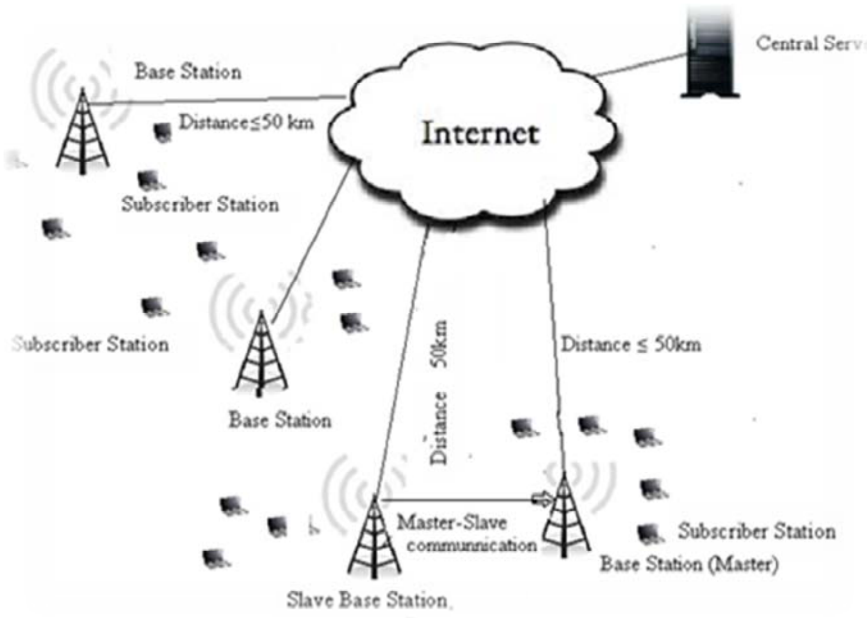

Figure _3: Abstract level design of distributed Master-Slave architecture

Algorithm 1 describes the process of Master-Slave BS selection from the BSs.
Algorithms 1

```
1.   Let P= {P1, P2, P3,....., Pn }  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
```

B. Master-Slave Communication

Figure 4 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.

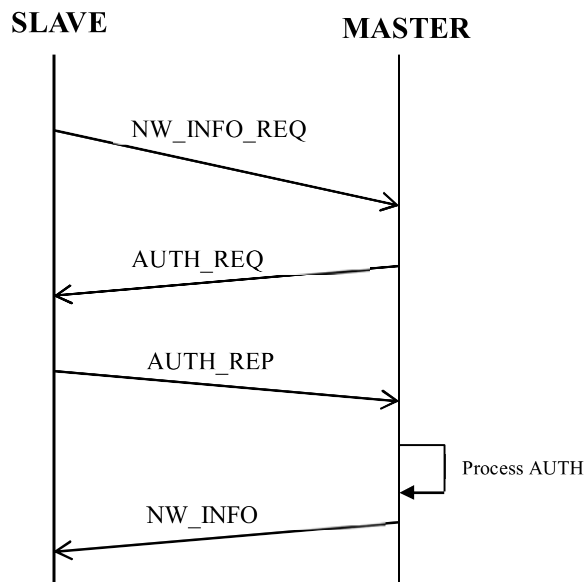

Figure_4: Master-Slave communication

Algorithm 2

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

C. Base Station Process Mode

The process model of the BS has most of its functionality in the idle state. Figure 5 shows the state diagram of the WiMAX BS with Master-Slave model.

Idle: Packets coming from upper and lower layer are processed in the idle state. Traffic from higher layer is stored in separate buffers for every established connection. Received MAC management messages in particular bandwidth requests are processed and the requested bandwidth is recorded for the corresponding connection.

Schedule: The transition from "idle" to "schedule" occurs at the beginning of every downlink frame. The BS decides on the structure of the next uplink and downlink frame and allocates polls and grants to the SSs. A detailed description of how the scheduler works is found in the "Scheduling Algorithm" section. Broadcast: The BS generates and transmits the configuration burst according to the scheduling decisions made in the previous state. In case of empty buffers, the process model returns immediately to the idle state. Otherwise, the transition to the tx_data state takes place.

tx_data: The BS transmits data bursts according to the scheduling decisions made by the scheduler.

rcv_burst: The transition from the idle to the rcv_burst state occurs when an uplink data burst is received from the PHY Layer. The incoming data burst is decapsulated and the included fragments are reassembled.

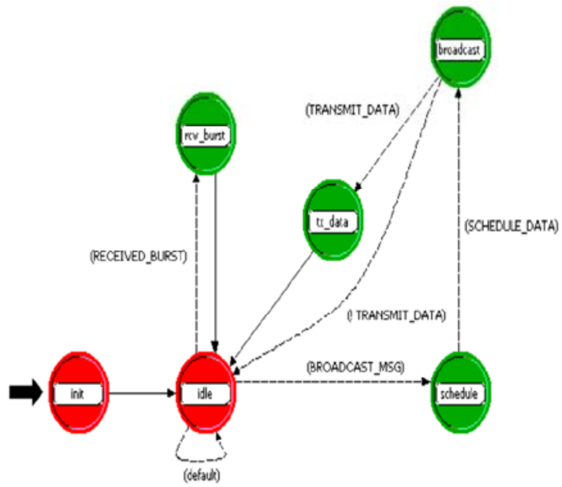

Figure_5: WiMAX BS Process Model

A. Subscriber Station Process Model

When the SS is registered to the BS and the connection is established, the SS remains in the idle state waiting for interrupts to occur. The forced states (green) around the idle state represent actions that are performed as response to incoming events figure 4 shows the state diagram of the SS as shown in Figure 6.
rcv_Burst: A burst received by the PHY Layer is evaluated depending on its type. The SS differentiates between data and configuration bursts (burst #1 in downlink frame). If the ULMAP contains a grant for the SS, it initiates a transmission timer that triggers the tx_data action. An incoming data burst is decapsulated if the data is designed for the SS. The included fragments are reassembled and complete packets are immediately sent to the higher layer.
tx_data: The SS enters this state on expiration of the transmission timer. It transmits the amount of data as specified in the UL-MAP of the last configuration burst.
tx_bw_req: The subscriber station transmits a bandwidth request to the PHY Layer. The transition to enter the state is triggered by a self-interrupt.

IV. SIMULATION SETUP & RESULTS

OPNET Modeler can provide different levels of modeling depending on the different need and requirements of the simulation. OPNET simulations are discrete-event-driven simulations (DES). A simulation in OPNET is divided into three-tiered structures, namely network model, node model, and process model [20].
In this Section, we have developed a simulation setup for the Centralized and New distributed Master-Slave models for Fixed WiMAX Network in OPNET Modeler 16 [20]. A detailed explanation of the simulated network models together with configured traffic that was developed for the Distributed QoS-oriented Model to Improve Network Performance for Fixed WiMAX is given below.

A. Simulation Parameters

Basic parameters associated with WiMAX Configuration attributes, Application Configuration, Application Profile, Task Definition, BSs configuration and Subscribers Station for the proposed Master-Slave model in fixed WiMAX are configured.
Table 2 shows the simulation setup parameters used in the scenario by including additional BSs, SSs, and number of master BS, connection time as well as the areas covered.

B. Scenarios for the Centralized model: Scenario 1

In this scenario, three WiMAX BSs were developed with thirty SSs (ten subscriber's stations around each BS). All the BSs are connected with IP backbone (Internet) using point- to- point protocol (ppp), without any master BS. Basic parameters associated with WiMAX Configuration attributes, Application Configuration,

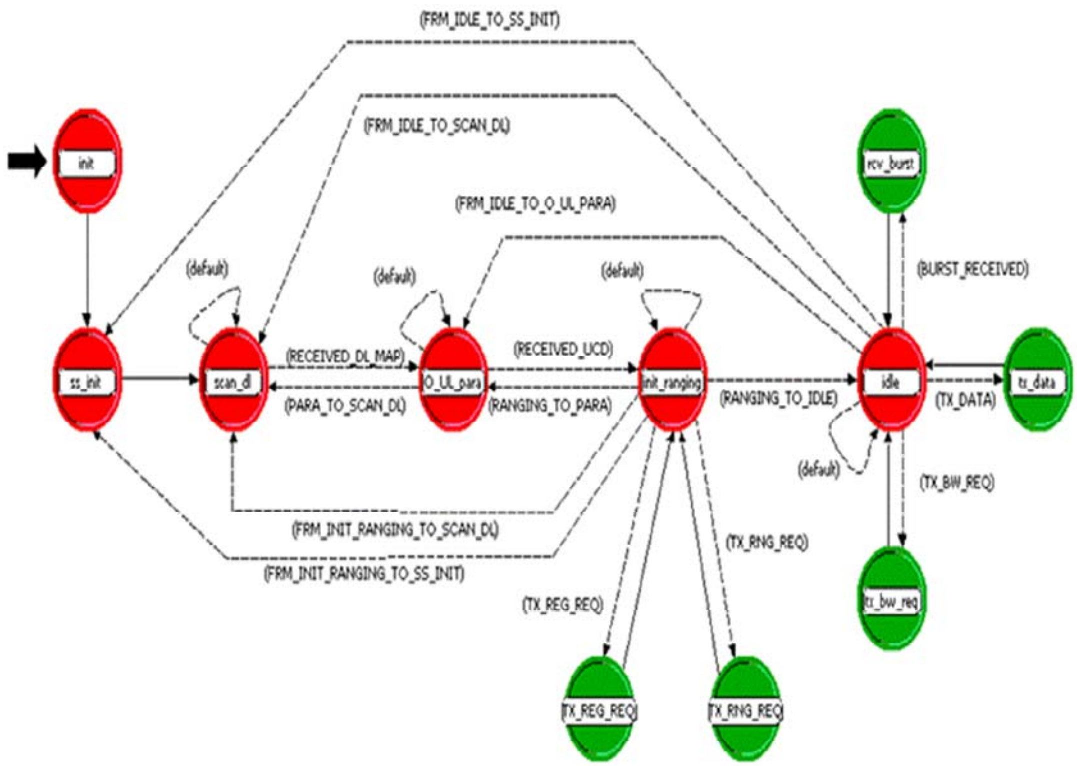

Figure_6: WiMAX SS Process Model

TABLE II. SIMULATION SETUP PARAMETERS TABLE

S/ No	Scenario	No. of BSs	No. of SSs	No. of Master BSs		Simulation Time
				Centralized model	New model	
1	1	3	30	0	1	1 hour
2	2	5	50	0	2	1 hour
3	3	8	80	0	3	1hour

Application Profile, Task Definition, BS configuration and SS for the model are configured. Figure 7 shows this scenario.

Scenario 2

In scenario 2 of the Centralized model five WiMAX BSs were developed with fifty SSs, ten SS around one BS without master BS, as shown in Figure 8. All other parameters are as in scenario_1.

Scenario 3

In scenario 3 of the existing WiMAX model eight WiMAX BSs were developed with eighty SS ten SS around one BS without master BS, as shown in Figure 9. All other parameters are as in scenario_1.

C. *Scenarios for New Distributed Master-Slave Model: Scenario1*

Figure 10 shows this scenario. In this scenario, of the Master-Slave model three WiMAX BSs were developed with thirty subscribers stations ten subscriber's stations around each BS. All the BSs are connected with IP backbone (Internet) using point- to- point protocol (ppp), with BS A as master BS selected by the design algorithm and the remaining are slaves. Basic parameters associated with WiMAX Configuration attributes, Application Configuration, Application Profile, Task Definition, BS configuration and SS for the model are configured.

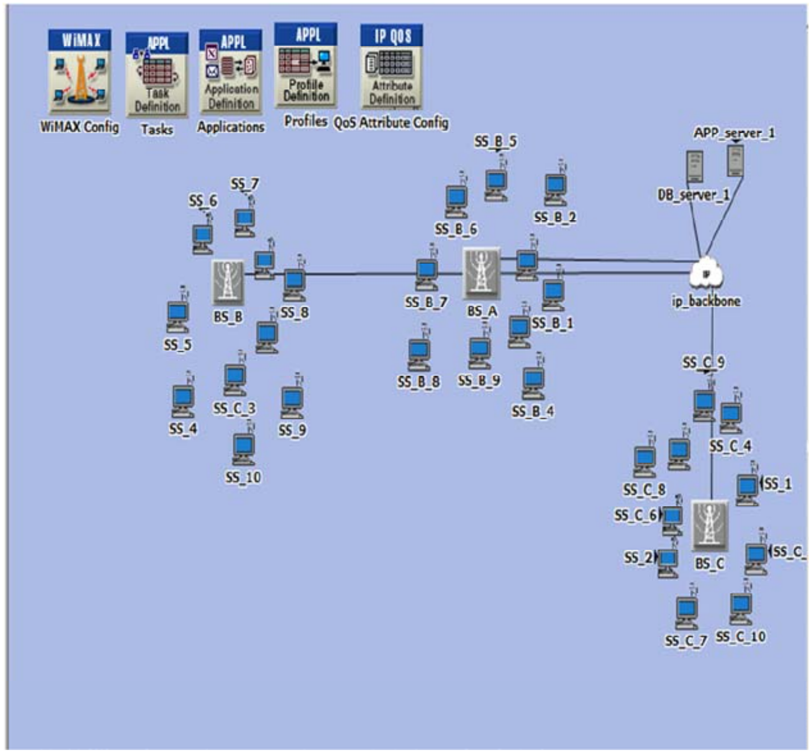

Figure_7: Performance of QoS over Fixed WiMAX Design for Centralized model (Scenarior_1)

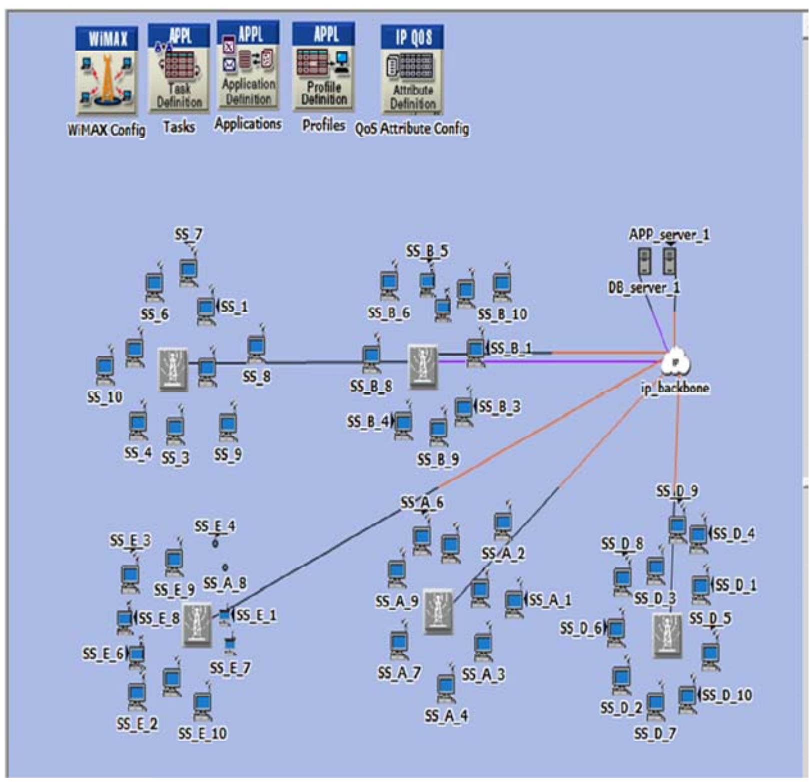

Figure_8: Performance of QoS over Fixed WiMAX Design for Centralized model (Scenarior_2)

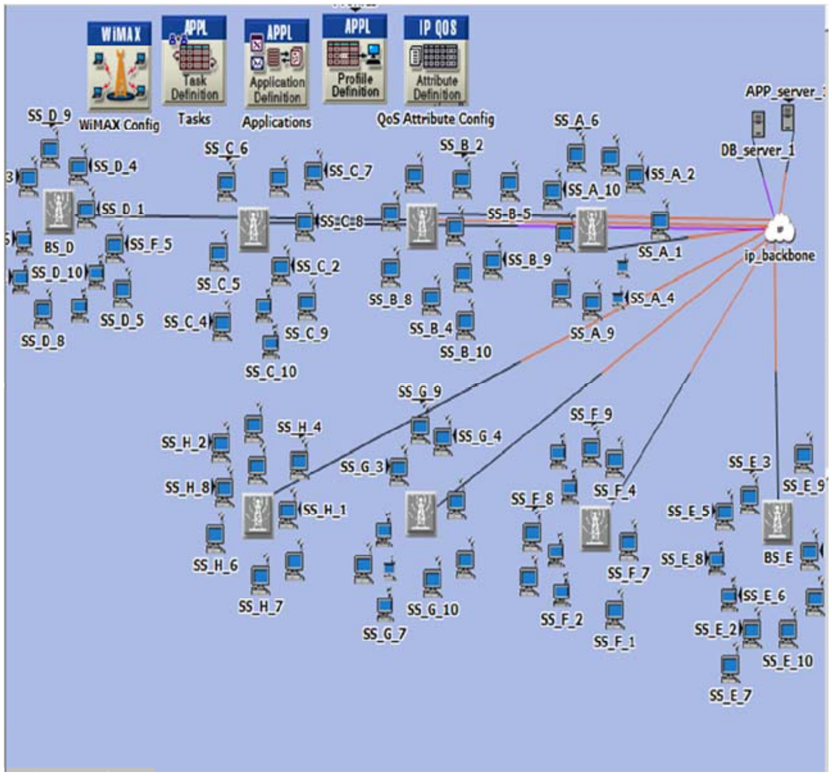

Figure_9: Performance of QoS over Fixed WiMAX Design for Centralized model (Scenarior_3)

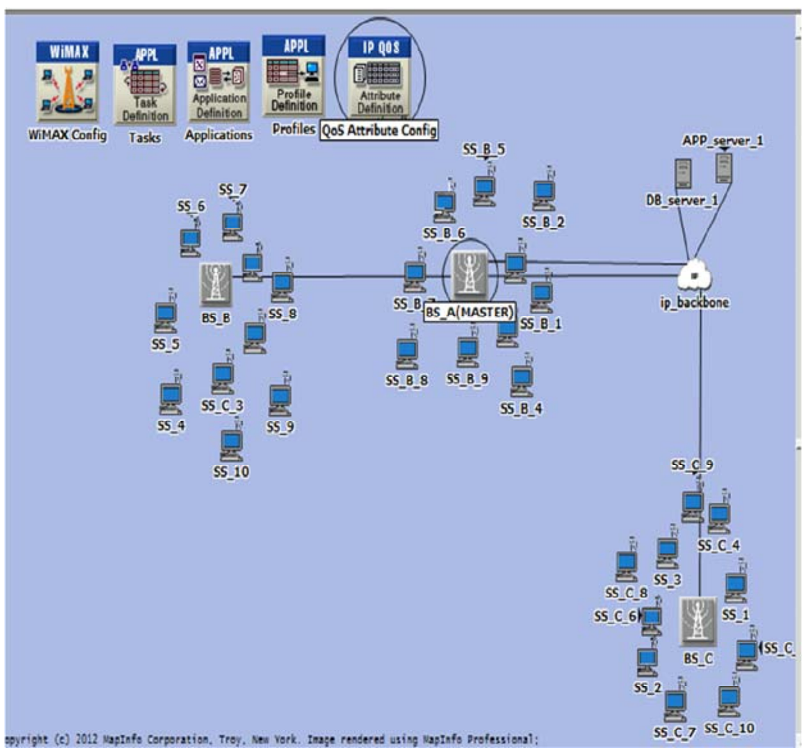

Figure_10: Performance of QoS over Fixed WiMAX Design for New Master-Slave Model (Scenarior_1)

Scenario 2

In scenario_2, of Master-Slave model five WiMAX BSs were developed with fifty SSs, ten SSs around each BS with BS A and D as masters selected by the design algorithm and the remaining are slaves, as shown in Figure 11. All other parameters are as in scenario_1.

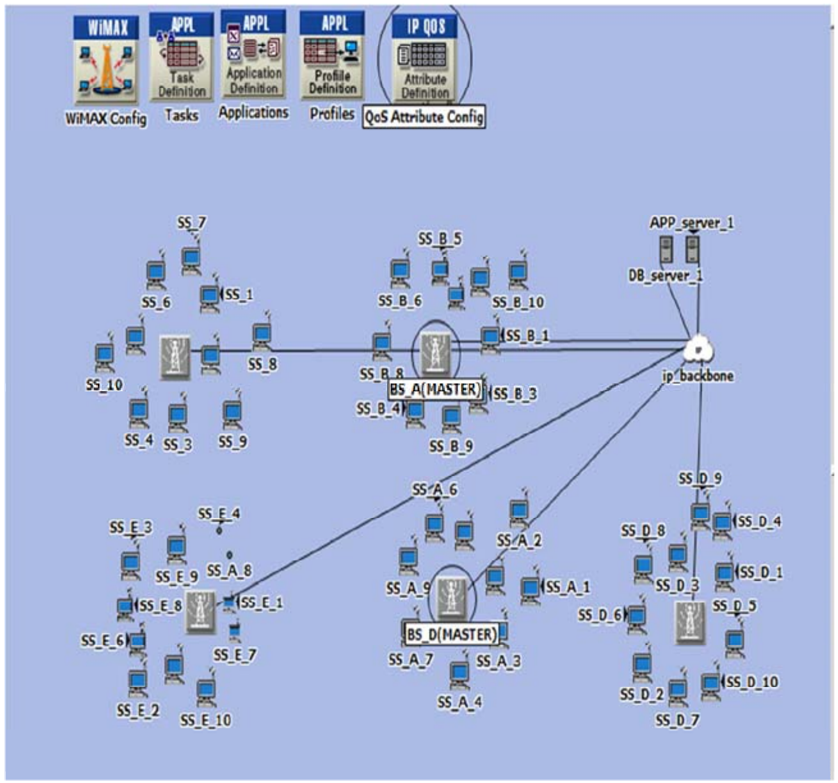

Figure_11: Performance of QoS over Fixed WiMAX Design for New Master-Slave Model (Scenarior_2)

Scenario 3

In scenario_3, as shown in Figure 12, Master-Slave model with eight WiMAX BSs were developed with eighty SSs, ten SS around each BS with BS A, B and C as masters BS and the remaining are slaves. All other parameters are as in scenario_1.

D. Results

This section shows the results obtained through simulations in OPNET Modeler for delay, throughput and application response time for the existing and Master-Slave models for both Scenario 1 and 2.

1) Application Response Time, Delay and Throughput for Centralized model results

When the design of scenario_1 of the Centralized model, was simulated, the following graph was obtained as showed in figure 13 below.

Figure 14 shows result obtained in the design of scenario_2 of the Centralized model.

Also figure 15 shows the result obtained when the scenario_3 of the Centralized model was simulated.

2) Application Response Time, Delay and Throughput for New-Model results

The design of scenario_1 of the new distributed model was simulated and figure 16 show the graph obtained.

When the design of scenario_2 of the new distributed model was simulated, the following graph was obtained as showed in Figure 17.

Figure 18 shows the result obtained in the design of scenario_3 of the new distributed model.

E. Analysis of the Result

If we compare the result obtained from Figures 13, 14, 15, 16, 17 and 18, we can observed that the result of the new distributed master-slave model has an improved performance as compared to the Centralized model, because the results showed an increase in the network throughput with time from 50,000 bit/sec in the

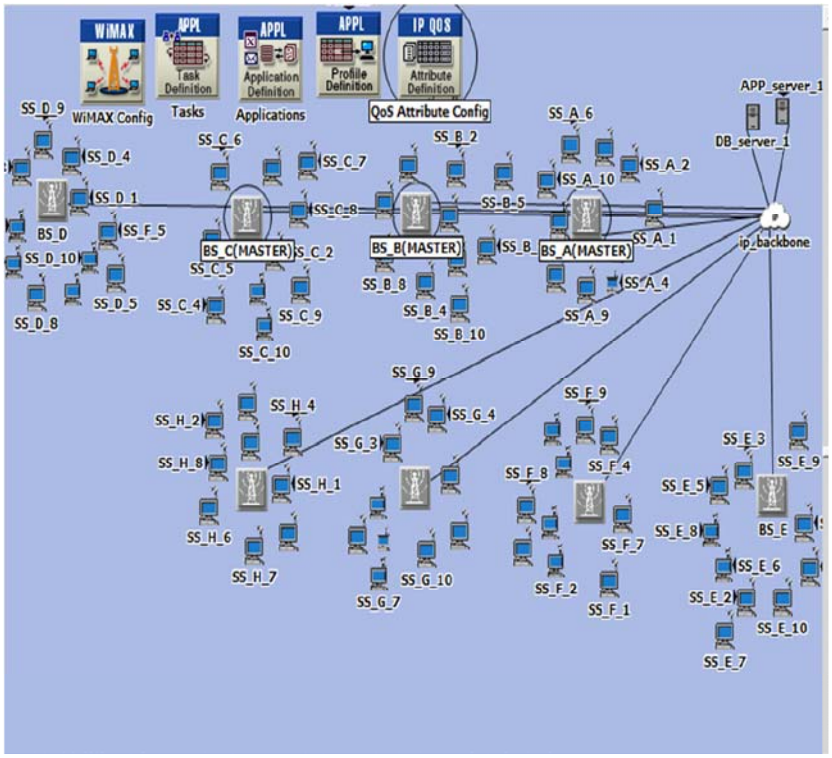

Figure_12: Performance of QoS over Fixed WiMAX Design for New Master-Slave Model (Scenarior_3)

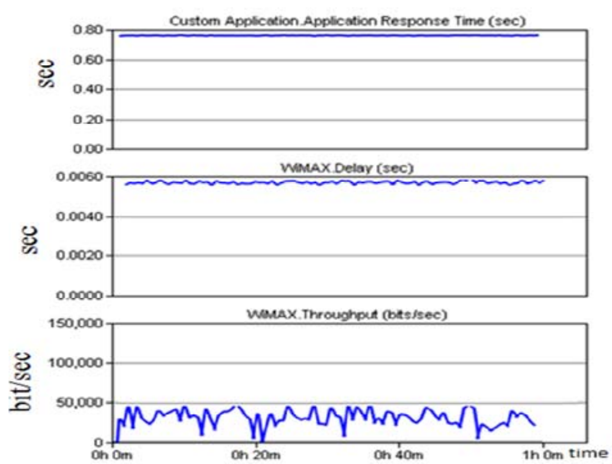

Figure_13: Fixed WiMAX Application Response Time, Delay &Throughput for Centralized model (scenario_1)

centralized to 100, 000bit/sec in the new distributed Master-Slave model of scenario 1 and also increase respectively in scenario 2 and 3 with 100, 000bits/sec by 150,000bits/sec and 150, 000bits/sec by 200,000bits/sec. Also a drastic decrease in network delay in scenario 1, 2 and 3 of the both models of 0.0060sec by 0.0040sec, 0.0040sec by 0.0030sec and 0.0030sec by 0.0019sec respectively. Lastly application response time also decreased by 0.79sec by 0.59sec, 0.59 by 0.41sec and 0.39sec by 0.22sec respectively with increasing number of BSs, SSs and the introduction of additional master BSs. The introduction of this new distributed Master-Slave model greatly enhances the performance of Quality of service.

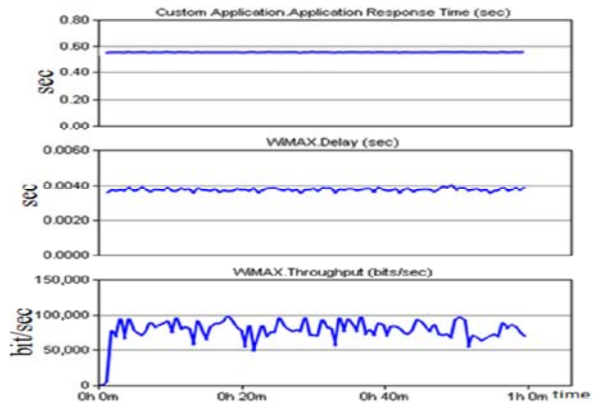

Figure_14: Fixed WiMAX Application Response Time, Delay &Throughput for Centralized model (scenario_2)

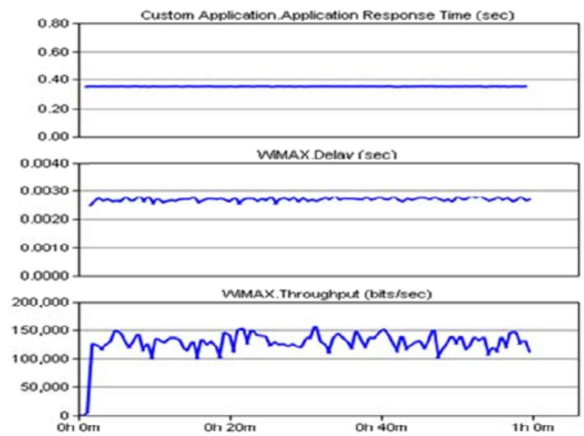

Figure _15: Fixed WiMAX Application Response Time, Delay &Throughput for Centralized model (scenario_3)

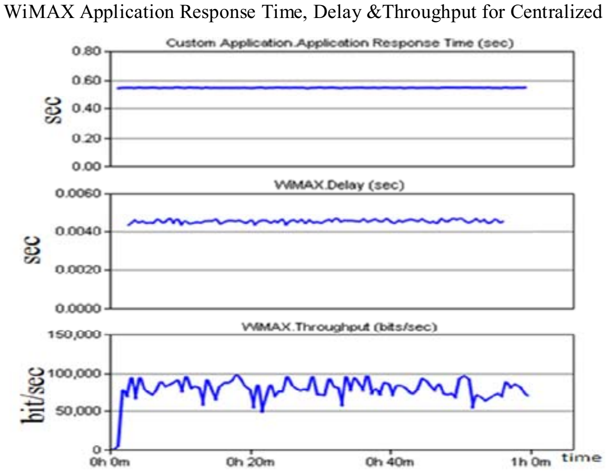

Figure_16: Fixed WiMAX Application Response Time, Delay &Throughput for New-Model (scenario_1)

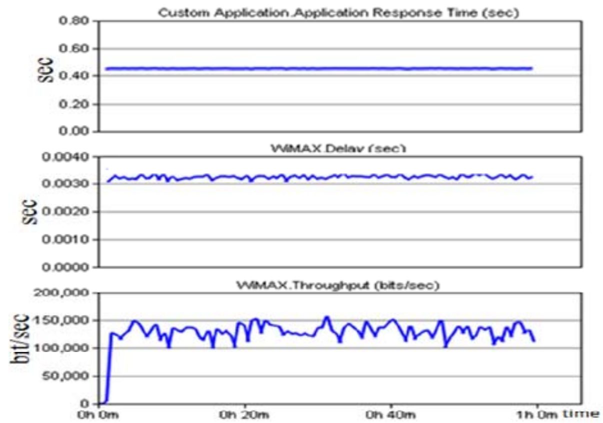

Figure_17: Fixed WiMAX Application Response Time, Delay &Throughput for New-Model (scenario_2)

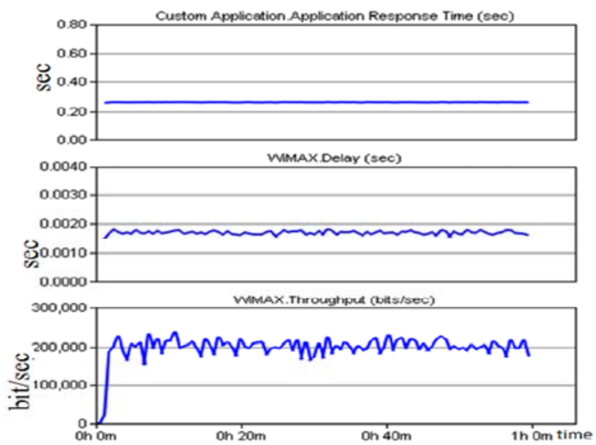

Figure_18: Fixed WiMAX Application Response Time, Delay &Throughput for New-Model (scenario3)

V. CONCLUSION& FUTURE WORK

The paper analyzed the Distributed QoS-oriented Model to improve Network Performance for Fixed WiMAX. Two models were analyzed based on Centralized and the New Distributed Master-Slave models using QoS parameters which include throughput, delay and application response time system evaluated using OPNET modeler 16.0.

The new model improved the method of point-to-point and point-to-multipoint system of delivering bandwidth from central server to WiMAX BSs and SSs. 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 BSs selected by design Algorithm (Nearest Neighborhood Algorithms).

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.

The result compared between the two models shows a significant increase in the network throughput and drastic decrease in network delay and application response time. Thus greatly enhances the performance of Quality of service.

Also with the completion of the proposed Algorithms, and some topology changes the coverage area of WiMAX will be increase through distributed master BSs which will greatly enhance WiMAX QoS performance and this is our future work.

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AUTHORS PROFILE

Ibrahim A. Lawal is a Ph.D. Candidate in IT at the Universiti Teknologi PETRONAS Malaysia, Department of Information and Computer & Information Science. He received his B.Sc. in Mathematics, Postgraduate Diploma in Computer Science and M.Sc. in Computer Science from Bayero University Kano Nigeria. He is also a Cisco Certified Network Associate from Cisco Networking Academy U.S.A. He is now a Lecturer in the Department of Computer Science, Federal College of Education Kano, Nigeria. His research interests include Computer Networks, WLAN, Ad hoc Networks and Mesh Networks, VoIP, IPv6, QoS and WiMAX.

Abas Md Said obtained the Bachelor of Science and the Master of Science from the Western University, USA. He received his PhD degree from Loughborough University, UK. He is working as an Associate Professor in Universiti Teknologi PETRONAS, Malaysia. His current research interests include VoIP, Networks, Visualization and Computer Graphics.

Dr. Kashif Nisar received his first degree Bachelor in Computer Science from Karachi, Pakistan and his MS degree in Information Technology from the Universiti Utara Malaysia (UUM). He received his PhD degree in Computer Networks (specializing in WLANs, VoIP, IPv6 and he proposed a novel Voice Priority Queue (VPQ) scheduling system model) from the Universiti Teknologi PETRONAS (UTP) in the Malaysia. Dr. Kashif's research interests are in multi-disciplinary areas, including Real-time Multimedia Technologies, Network Performance, Network Traffic Engineering, Wireless and Mobile Networking, Local Area Networking, Telecommunications/Network Management, Wireless Sensor Networks (WSNs), Mobile Ad Hoc Networks, Audio/Video Transport Extensions, Call Control UUI Service for SIP, Audio/Video Transport Payloads, VoIP, IPv6, and evaluation of wireless networks.

Abubakar Aminu Mu'azu received the BSc. degree in computer science from Usmanu Danfodiyo University Sokoto, Nigeria, in 2003, and the MSc. in Information Technology Management from the Universiti Teknologi Malaysia (UTM), in 2010. He currently is pursuing his PhD studies at Universiti Teknologi PETRONAS, Malaysia. He is an assistant Lecturer of computer science at the Umaru Musa Yar'adua University Katsina Nigeria. His current research interests include VANET simulation, intelligent transportation systems, quality of service, routing protocol design, and implementation. He is also a member of the IEEE computer society.