IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-6, Issue-5, May 2018 E-ISSN: 2347-2693

Performance Evaluation of Routing Protocols in WiMax

Nidhi Singh[1], Anil Sangwan[2], Harkesh Sehrawat[3], Rajat Malik[4]

[1,2]ECE Department, University Institute of Engineering & Technology (UIET), MDU, Rohtak, Haryana, India
[3,4]CSE Department, University Institute of Engineering &Technology (UIET), MDU, Rohtak, Haryana, India

Corresponding author: nidhirajian9494@gmail.com

Available online at: www.ijcseonline.org

Accepted: 22/May/2018, Published: 21/May/2018

Abstract: WiMax stands for World Wide Interoperability for Microwave Access. It is subjected on IEEE 802.16 air interface. WiMax enhances point to point and point to multipoint wideband wireless access and meets the requirements of millions of users demanding high speed at affordable cost. This paper presents four routing protocols namely Ad hoc On-Demand Distance Vector (AODV), Dynamic Source Routing (DSR), Optimized Link State Routing (OLSR), Zone Routing Protocol (ZRP) in different node density scenarios of (25, 50, 75 and 100). Their performance comparison is done by taking throughput, average jitter, and average end to end delay as performance metrics. All the scenarios are subjected on random way point mobility. Results are generated using QualNet simulator. This paper also presents a comparison of CBR and VBR traffic application taking protocol OLSR at 100 nodes.

Key words: WiMax, Routing protocols, jitter, throughput, delay

I. Introduction

In 1998 the IEEE 802.16 union was set to evolve an air interface norms for wireless wideband. The IEEE 802.16 union, first objective was to design a LOS subjected point to multipoint wireless wideband structure which could operate on 10 - 66 GHz millimeter wave band. The final 802.16 norms were subjected on physical layer having a burst time division multiplexed (TDM) MAC layer. Figure 1 shows the improvements/amendments made in 802.16.

SALIENT FEATURES OF WIMAX

PHY layer: WiMax physical layer is subjected on orthogonal frequency division multiplexing. OFDM technique manages fine opposition to multipath, OFDM enable WiMax to work in (NLOS) surroundings.

Bit rate: WiMax assists elevated data rates. Bit rate may be as inflated as 74 Mbps while performing utilizing a 20 MHz wide range. When 10 MHz range is used, having a TDD format with 3:1 as downlink to uplink ratio, peak PHY bit rate is around 25 Mbps for the downlink and 6.7 Mbps for the uplink. With the help of multiple antenna and spatial multiplexing inflated peak rates can be attained.

Scalable bandwidth and data rate support: With the available channel bandwidth data rate can be easily scaled since WiMax has a scalable physical

	802.16	802.16-2004	802.16e-2005
Status	Completed December 2001	Completed June 2004	Completed December 2005
Frequency Band	10-66 GHz	2-11 GHz	2-11 GHz for fixed and 2-6 GHz for mobile applications
Applications	Fixed LOS	Fixed NLOS	Fixed LOS and NLOS
MAC architecture	Point to multipoint	Point to multipoint	Point to multipoint
Modulation	QPSK,16 QAM,64 QAM	QPSK,16 QAM,64 QAM	QPSK,16 QAM,64 QAM

Figure 1: Amendments made in IEEE 802.16

Layer architecture. In OFDMA mode, scalability is supported. Scaling can be achieved dynamically to enhance roaming facility over various open works that might have divergent bandwidth allocation.

Modulation and coding: A variety of modulation and forward error detection coding ways are endorsed by WiMax. It also supports customization of schemes on per user and per

frame basis, subjected on channel constraints. AMC implementation optimizes the throughput in a time volatile channel.

Link layer transmission: WiMax enhances ARQ at the link layer.ARQ enabled tie up demands that each sent packet has to be recognized at the receiver, the packets which are not recognized at the receiver are presumed to be off track and has to be sent again. Hybrid ARQ is also enhanced by WiMax.

Support for TDD and FDD: TDD and FDD both are supported by IEEE 802.16-2004 and IEEE 802.16e-2005.TDD is preferred because it is more flexible in preferring uplink to downlink bit rate ratios, capacity to utilize channel interdependence, capacity to enact in non paired spectrum range and a easy Transreciever structure.

OFDMA: Wimax utilizes the OFDM technique; OFDMA aids the utilization of multiuser diversity as well as frequency diversity to enhance the system ability.

Resource allotment: Base station administers the uplink and downlink resource allotment. On demand basis utilizing a burst TDM scheme capacity is distributed among multiple users. When OFDMA –PHY mode is used, distinct sets of OFDM subcarriers are allocated to distinct users.

Endorsement for advanced antenna techniques: In physical layer design Wimax has several hooks which allow utilization of multiple antenna techniques for example beam forming, spatial multiplexing and space time coding. These schemes overall improves the system capacity.

Quality-of-service endorsement: The architecture of Wimax MAC layer is tied so that it is directed to enhance several applications. Variable bit rate , real time, constant bit rate and non real time traffic flows are sustained by the system.

WIMAX ARCHITECTURE

Wimax architecture is comprises of Mobile station, Base station, Access Service Network, Connectivity Service Network, ASN gateway.

Mobile user is utilized by the end user, its also termed as Customer Premises Equipment. Base station provides air interface to mobile stations. Base station also performs channel establishment, key management, quality of service enforcement, DHCP, multicast group management. Access service network may have one base station or more than one base station and one gateway or more than one gateway. ASNs are tied with CSN.ASN gateway does validation of users, admission control, and mobility management. ASN gateway can perform intra ASN location management, caching of subscriber profiles, management of tunnels, path creating to the selected CSN. CSN provides IP connectivity and IP core network functions. Figure 2 shows Wimax architecture:

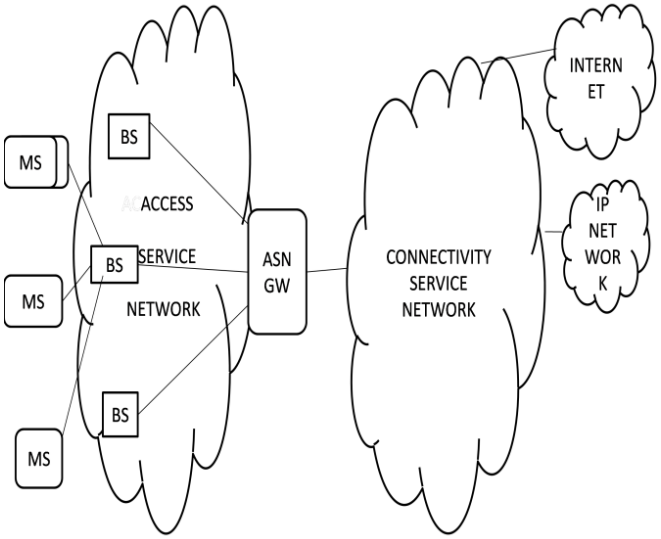

Figure 2: Wimax Architecture

This paper has introduction of WiMax in Section I. Section II contains the brief explanation of routing protocols. Section III contains the literature review and Section IV explains the proposed work. Section V describes the results and discussions. Section VI contains the Conclusion and at last there are references.

II. ROUTING PROTOCOLS

AODV (AD HOC ON-DEMAND DISTANCE VECTOR)
AODV is subjected on source initiated on call path creating (routing). In this path creating process, paths are created which are preferred by the source code. When the demand is displayed by the source, path discovery process begins. The process is terminated only when a route is found or all routes are already investigated. AODV protocol provides broadcast, multicast and unicast communication in ad hoc mobile networks. Paths are retained till that is required by the origin node. AODV nodes retain a path (route) table in which next hop path creating data for terminating nodes is cached [8].

When data is sent from source node to terminating node and no path table data is handy, path investigation process detects the terminating node. In path exploration process RREQ (route request) packet is broadcasted to adjacent nodes till terminating node is reached. Each node has a broadcast ID as well as a serial number. For each generated RREQ broadcast ID is incremented. RREQ packet comprises of node serial number, as well as the most recent serial number it has for end (terminating) node and broadcast ID. Only those nodes which have serial number exceeding or equal to the number carried in RREQ packet, reply to RREQ [8].

DSR (DYNAMIC SOURCE ROUTING)

It is a on demand path creating protocol that is subjected on the idea of source path creating. In DSR protocol nodes find a source path across various openwork hops to any end node. The protocol maintains two functions: path revelation and path preservation. When a node aspires to transmit data from a source node to terminating node it scrutinizes its own cache for a prevailing path. If a path is accessible, the origin node utilizes that path otherwise a path discovery happens. A path request packet is produced which contains the origin and end address, besides distinctive identification number[8]. Each intermodal node checks this packet and examines if it is accustomed with a path to the end (terminating) node or not. If it is not aware about the path, it attaches its individual address to packet and progresses the packets to the next node. An answer is produced by the final node when the path request packet attains the terminating node or when an intermediary node discovers a valid path.

OLSR (OPTIMIZED LINK STATE ROUTING PROTOCOL):

It is a path creating protocol that is proactive in nature where paths are unfailingly handy when required. OLSR is an upgraded genre of a pure link state protocol. The topological reorganization leads to inundating of the topological data to all handy hosts in the openwork. To decrease the manageable overhead in the openwork protocol multipoint relay (MPR) are utilized. Decreasing the time interval for the control messages conveyance ushers more reactivity to the topological variance. OLSR operates two types of the control messages specifically hello and topology control. Hello messages are operated for detecting the data concerning the link status and the host's neighbors. Topology control messages are operated for conveying data among its own advertised neighbors [14].

ZRP (ZONE ROUTING PROTOCOL):

Proactive path creating utilizes surplus bandwidth to preserve path creating data, while the reactive path creating incorporates long path request delays. Reactive routing also inefficiently surplus the entire network for route determination. The zone routing protocol (ZRP) aims to address the obstacles by joining the prime properties of both the proactive and reactive approaches. In openwork, it can pretend that the enormous sector of the queue is pointed to adjacent nodes. Thus, ZRP decreases the proactive range to a zone centered on each node. The maintenance of routing information is simple in the limited zone. Further, the volume of path creating data never used is diminished. In ZRP each node is pretended to preserve path creating data only for those nodes that are inside its path creating zone as the updates are only generated locally, the volume of update traffic needed to preserve a path creating zone does not rely on aggregate of openwork nodes. A node gains its zone via a proactive scheme Intra zone Routing Protocol (IARP). For nodes exterior to the path creating zone, inter zone Routing Protocol (IERP) is accountable for reactively discovering paths to destinations situated beyond a node's path creating zone. The IERP is differentiated from quality inundating-based response protocols by utilizing the structure of path creating zone. The path creating zones enhance the probability that a node can answer affirmatively to a path query [14].

III. LITERATURE REVIEW

The authors of [1] proposed that Wimax that is Worldwide Interoperability for Microwave Access was a Broadband Wireless Technology. It was very cheaper than other and based on 4G Technology. In order to get rid of the problems like Quality of Service, Data rates faced in the wireless technology, they have gone for some valuable technology. To control the congestion WiMax was considered and TCP variants used in this were Tahoe, New Reno, Sack and Reno. Throughput, packet delivery ratio etc were the Performances metrics that were considered in this paper. For implementing the proposed scenarios QualNet 5.0.2 was used. Standard IEEE 802.11 b and standard IEEE 802.16 or Wimax were evaluated in this paper. After analyzing the four TCP variants Tahoe, New Reno, Sack, Reno, the New Reno was considered better with respect to others. Comparing with WLAN, WiMax performance was better in all parameters.

The authors of [2] proposed that WiMax was a new technology that gave quick access to data. The data can be accessed through various ways. The handover in the cellular communication was possible efficiently through WiMax that there was no loss of data. The last mile connectivity in the metropolitan cities was provided with the help of WiMax. Various frequency spectrums were affiliated with WiMax. To manage the access to air interface combination of scheduling and contention was used. High data rates will be provided by next generation wireless communication that will use IP core. Efficient soft handover was included in the paper and switching was fast base station and parameters considered were signal strength, distance, delay and congestion. QualNet simulator was used for all simulations. To determine the parameters which affected the handover was the main task. Average jitters, received throughput, average end to end delay were the results. To improve performance in terms of moving speed and delay optimization was required.

The authors of [3] proposed that wireless solution was provided by WiMax in the metropolitan areas. Secured transmission, wide range coverage and high data rates were provided by WiMax. To provide cost effective solution and good performance, Wimax was the best concept in fixed wireless access. Packet reception, through put, end to end delay and jitters were the parameters that were used for analyzing the performance of Wimax in this paper. QualNet simulator was used for carrying out the simulation. Routing

protocols such as ZRP, AODV and DYMO were applied in this paper. DYMO showed low end to end delay, best packet reception, low jitter and highest throughput. Out of ZRP, AODV best performance was showed by DYMO. With DYMO protocol we compared Wimax scenario with no mobility 3and mobility. Low end to end delay, best packet reception, low jitter and highest throughput were showed by Wimax scenario with no mobility as compared with mobility. After this we applied no fading condition to this Wimax scenario and compared it with fading condition. In no fading condition we got high packet reception and high through put as a result in Wimax scenario. Throughput is dependent on simulation time as well as scenario. High packet reception and high throughput received under fading condition in Wimax mobility scenario.

The authors of [4] proposed that associated functions and air interface of broadband wireless system were defined by the IEEE 802.16 standard which includes MAC layer and PHY layer. The design of Wimax was basically for high bandwidth wireless access and for high range. The Wimax had radio range and high bandwidth of 70 mbps accessed up to 50 km. Different QOS were provided by Wimax. It was alternate and cost effective idea to replace network such as 3G/4G and Wi-Fi9. QualNet simulator 6.1 was used to improve the performance of IEEE 802.1e. With less power consumption and less packet losses we tried to improve performance. Parameters such as through put, packet received unicast fragment, delay jitter and end to end delay were defined by the improved performance of Wimax. The performance of Wimax mobile was identified by evaluating the simulation results. The problem of range coverage and power efficiency in homogenous networking was dealt in this paper. Two Wimax station were introduced to improve the Wimax performance and reduce it. In future the focused will be on heterogeneous networking to observe the handover effect.

The authors of [5] proposed that based on IEEE 802.16 air interface, Wimax was a standard based technology and future mode of communication. Therefore, in different scenarios Wimax performance was evaluated. Performance analysis for Constant Bit Rate (CBR) traffic without and with mobility of Wimax was presented in this paper. Random mobility and flag mobility were the two models that were considered for evaluation of performance. Using QualNet three scenarios-two for mobility models and one for fixed network were generated. Results were presented in the form of total received and sent packets, end to end delay, received throughput and jitters. A fixed trajectory path was established in case of flag mobility model according to needs of user that provide minimum delay and maximum throughput. All the nodes in the Wimax cell moved with different speed in random way out model. Therefore, during transmission maximum packets were lost.

The authors of [6] proposed that Wimax promised a high-data rates services and was a promising broadband wireless technology. It enabled fixed broadband networks and junction of mobile through a common wide area broadband radio access technology. It was based on OFDM/OFDA technology. Coding in both uplink and downlink with variable packet size and adaptive modulation was also supported by it. A new form of Adaptive modulation (AM) was presented in this paper which had the capacity to enhance the bit rate of mobile Wimax OFDMA system at low SNR values. Also, the recommended Algorithm established his effectiveness to attenuate the out- of – band noise emission power.

The authors of [7] proposed that nowadays 4G Technologies were used to meet the requirement of high speed applications whose demand was growing at faster rate. The outcome in this direction was OFDM based Wimax which promised to supply these high quality and high speed applications. Wimax employs COFDM. Bit Error Rate for Wimax subjected on COFDM system with BPSK was analyzed in this paper under various channel conditions like Nakagami, AWGN, Rican and Rayleigh. In addition, work was carried out for Rician and Rayleigh channels with different K-factors and Doppler shifts respectively. It was concluded that as K-factors increases the BER improves whereas as Doppler shifts increases BER degrades. It was observed that SNR increases BER deteriorates.

The authors of [8] proposed that while designing an efficient and scalable wireless system selection of an appropriate path creating protocol was the key problem. In wireless network various routing protocols were used. We investigated different routing protocols in this paper and their performance was evaluated on 802.16 Wimax networks. With various network parameters different routing protocols have been tested with the help of simulation. The results showed that DSDV outperformed other routing protocol but delays experienced by DSDV packets were greater than the on-demand routing protocols.

The authors of [9] proposed that in mesh networking, WPAN utilizing Zigbee application had many advantages. This paper provided data regarding Zigbee technology and facilitates in research in an efficient manner.

The authors of [10] proposed that AODV protocol performs better as compared with DSR, ZRP in a scenario for traffic control in MANET. The authors had used different node density for the comparison of scenarios. It was concluded that in MANET congestion control AODV performs better.

The authors of [11] proposed that different scenarios needed different protocols to adapt in different topologies as well as end user should be provided more incentives so that he could be connected always and protected against threats. The

authors proposed that more security protocols were also needed to make networks more secure and free from attacks.
The authors of [12] proposed that routing protocols were the main research area of wireless networks. The authors surveyed a sample of routing protocols and there had been lot of challenges to be addressed in the WSN. Various routing protocols have been analyzed and categorized in three types according to the network architecture in WSN.
The authors of [13][15] proposed that WSN was the air interface between the virtual and physical world. The authors have focused on the general ideas behind WSN and comprehensive study of WSN suggesting that the WSN was key area of research for better connected networks.

IV. PROPOSED WORK

In this paper QUALNET simulator is used. It's a trading simulator that is utilized to model and inspect the accomplishment of open works and various open working protocols. QualNet has upgraded features like good debugging support, parallel execution, advanced GUI support. QualNet is utilized for designing new protocol models, optimizing recent and old models for wired and wireless open works. For preferable visualization of scenario it supports 3D. It has smart architecture and optimized memory management that offers faster simulation speed and scalability. QualNet has a Exata + cyber package.
This paper presents the implementation of proactive (OLSR), reactive (AODV, DSR) and hybrid (ZRP) path creating protocols. The physical medium used is 802.16 and the MAC protocol used is 802.16. The simulations are carried out of network densities 25, 50, 75, 100. The area considered is 1500 x 1500 m. The mobility used is random way point. Simulations are configured for the implementation of various path creating protocols with the metrics like average end to end delay, throughput, average jitter.

Simulation parameters are as follows:

Protocol	OLSR, AODV,DSR,ZRP
Physical medium	802.16 RADIO
MAC protocol	802.16
Cartesian coordinates	1500*1500
Number of nodes	25,50,75,100
Application	CBR,VBR
Items to send	1000
Item size	80
Stimulation time	500 sec
End time	500 sec
Interval time	1 sec
Mobility	Random way point

The scenario with 100 nodes is as:

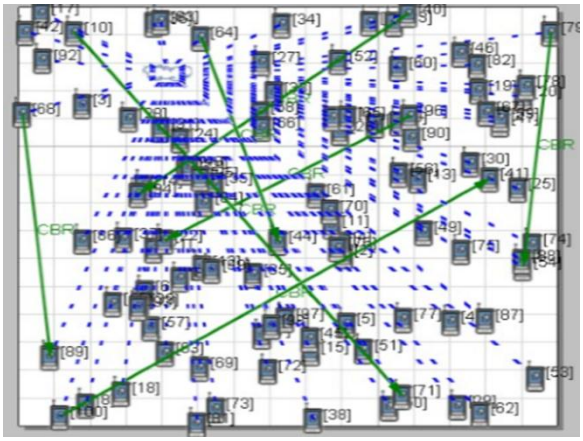

Figure 3: Scenario with 100 nodes

The scenario with CBR simulation is shown as :

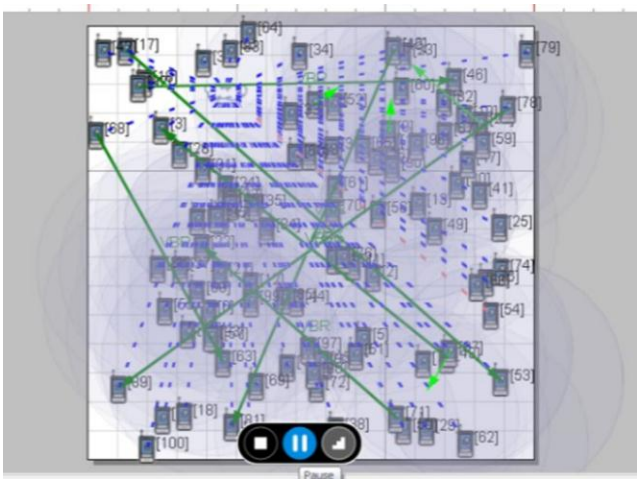

Figure 4: CBR Simulation

V. RESULTS AND DISCUSSION

Throughput: Average throughput is the proportion of number of packets transmitted to the aggregate number of packets received. It refers to the rate of data processing through a point in the network. It demonstrates the mean rate of successfully received packets throughout the medium channel. Throughput shows the efficiency of the scenario. It is measured in bits per second [3]. Figure 5 shows the throughput comparison results among protocols:

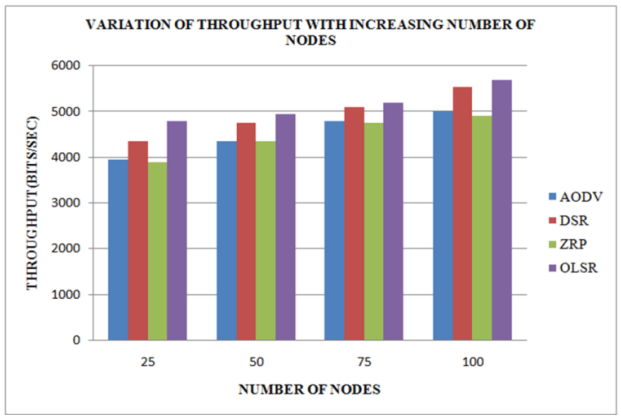

Figure 5: Throughput

From this graph it can be concluded that the OLSR gives favorable results as compared to others.

AVERAGE JITTER:

Jitter is defined as the alteration in delay of various data packets that reach the terminating nodes. Jitter has to be least for the optimum performance of the openwork. It is the volatility in latency from packet to packet. High jitter might prompt the buffers to underflow or overflow. It may prompt the algorithm to collapse. It is measured in seconds [3]. Figure 6 shows the jitter comparison results among protocols:

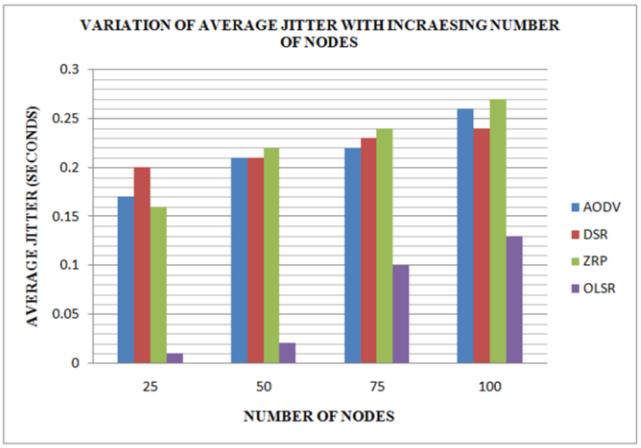

Figure 6: Jitter

From the graphs it can be concluded that the OLSR gives favorable results as compared to others.

AVERAGE END TO END DELAY:

Average end to end delay shows how much time it takes for a packet to progress from the origin to the terminating node.[3]Figure 7 shows the comparison of end to end delay among protocols.

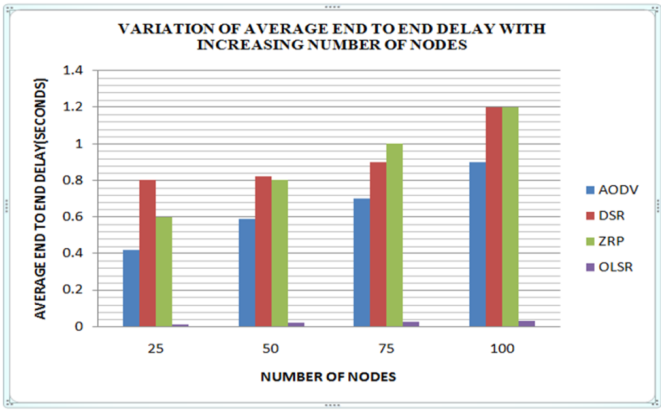

Figure 7: End to end delay

From this graph it can be concluded that the OLSR gives favorable results as compared to others.

Comparing CBR and VBR

The CBR and VBR application is compared using protocol OLSR at 100 nodes. Figure 8 shows the throughput comparison, Figure 9 shows the average jitter comparison. Figure 10 shows the end to end delay comparison respectively.

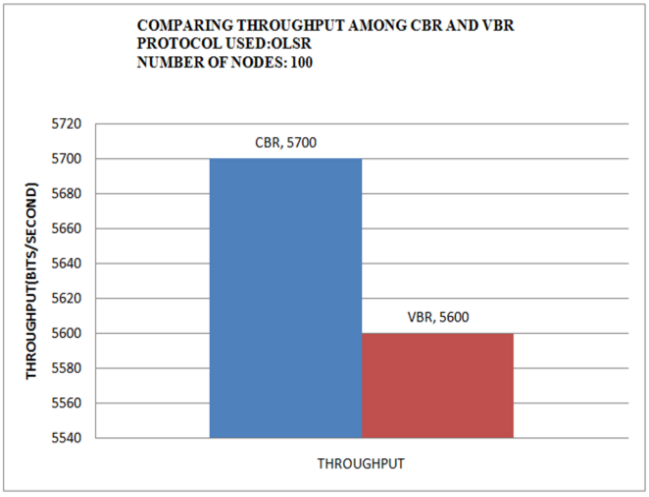

Figure 8: Throughput

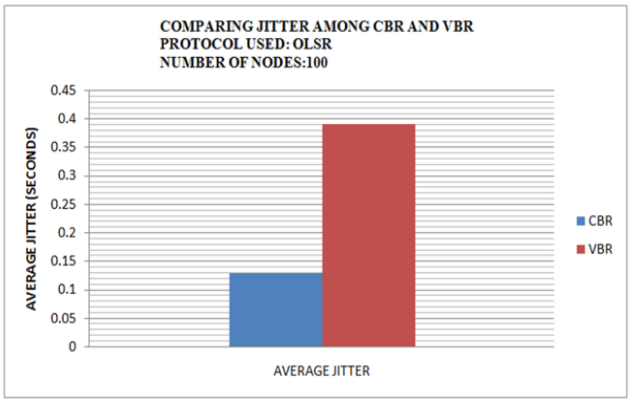

Figure 9: Jitter

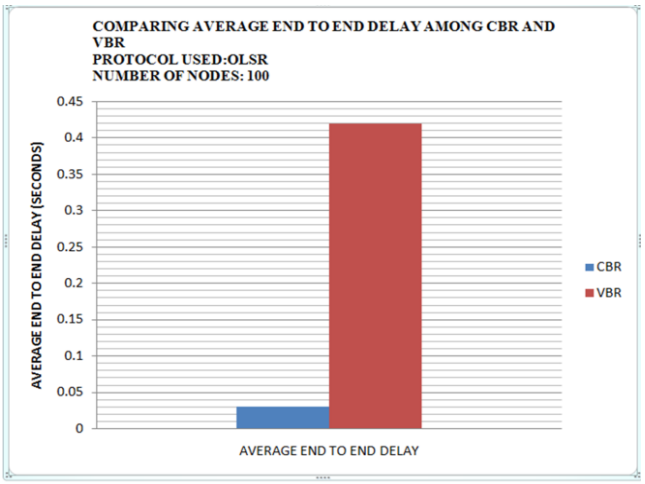

Figure 10: End to end delay

From the graphs it can be concluded that CBR application has greater throughput and lower average jitter and average end to end delay as compared to VBR application.

VI. CONCLUSION

The performance evaluation of AODV, DSR, ZRP, and OLSR is studied by varying the node density (25, 50, 75, 100) using QualNet network simulator. From the results it can be concluded that throughput is best given by OLSR. Delay and jitter both are least in OLSR. Thus overall we can say that OLSR gives favorable results. This paper also shows the comparison of CBR and VBR for OLSR protocol at 100 nodes. Comparing the CBR and VBR application it can be concluded that CBR outperforms VBR.CBR has less delay and less jitter as compared to VBR, also CBR has more throughput than VBR.

REFERENCES

[1]. M.Suresh,C.Kamalanathan,S.Valarmathy, "Avoiding Congestion in IEEE 802.16 and IEEE 802.11b using Qualnet" 2013 Fifth International Conference on Advanced Computing (ICoAC)

[2]. Saikat das,Prof. Siladitya Sen, "ANALYSIS OF WIRELESS NETWORK THROUGH WIMAX IN QUALNET" International Research Journal of Engineering and Technology (IRJET) Volume: 03 Issue: 11 | Nov -2016 pp (1197-1203) p-ISSN: 2395-0072 DOI

[3]. Pavithra K, Dr. G.F Ali Ahammed, "WIMAX NETWORK PERFORMANCE ANALYSIS USING QUALNET NETWORK SIMULATOR" Adarsh Journal of Information Technology Vol. 6, Issue 1 April 2017 pp(20-28) ISSN No. 2320–0340

[4]. Ashish Shukla, Rajeev Paulus, Tanbeer Kaur, Shivveer Singh Rajput "Performance Improvement of Mobile WIMAX using Qualnet Simulator 6.1"

[5]. Fahoud, A.Y. and Lobiyal, D.K.," Comparative analysis of WiMAX performance through mobility mode and fixed mode using qualnet simulator", PP. 1308 – 1313, (ICCCA), 2015.

[6]. S. M. B. Taslim, S. M. R. Tousif and M. Tareq, "A novel algorithm with a new form of Adaptive Modulation for Mobile WiMAX performance improvement," *13th International Conference on Advanced Communication Technology (ICACT2011)*, Seoul, 2011, pp. 300-305.

[7]. H. Kaur and M. L. Singh, "Performance evaluation of coded OFDM based WiMax system under different fading environments," *2013 2nd International Conference on Information Management in the Knowledge Economy*, Chandigarh, 2013, pp. 64-68. **ISBN:** 978-1-4673-4535-4

[8]. M. Rehan Rasheed, M. Kamran Khan, M. Naseem, Aisha Ajmal and Ibrahim M. Hussain," Performance of Routing Protocols in WiMAX Networks" IACSIT International Journal of Engineering and Technology, Vol.2, No.5, October 2010 pp(412-417) ISSN: 1793-8236

[9]. Kirti Mor, Suresh Kumar, &Deepak Sharma, "Ad-Hoc Wireless Sensor Network Based on IEEE 802.15.4: Theoretical Review". International Journal of Computer Sciences and Engineering. Vol.6. Issue 3, pp (219-224) March 2018. ISSN 2347-2693.doi: 10.26438/ijcse/v6i3.219224.

[10]. Sapna Khurana ,Dr. (Col.) Suresh Kumar, Deepak Sharma, "*Performance Evaluation of Congestion Control in MANETs using AODV, DSR and ZRP Protocols*", International Journal of Advanced Research in Computer Science and Software Engineering (IJARCSSE),Vol. 7,Issue 6 June 2017 ,pp(398-403) ISSN: 2277 128X. DOI: 10.23956/ijarcsse/V7I6/0218 .

[11]. Deepak Sharma, Col. (Dr) Suresh Kumar, "*A Comprehensive Review of Routing Protocols in Heterogeneous Wireless Networks*", International Journal of Enhanced Research in Management & Computer Applications, Vol. 4 Issue 8, Aug-2015,pp(105-121) ISSN: 2319-7471

[12]. Preeti Boora, Deepak Sharma Shamsher Malik, , "*A Review of Routing Protocols in Wireless Sensor Network"* International Journal of Enhanced Research in Management & Computer Applications, Vol. 4 Issue 5, May-2015,pp(34- 40) ISSN: 2319-7471

[13]. Deepak Sharma, "*An overview of Wireless Sensor Networks"* International Journal of Enhanced Research in Management & Computer Applications, Vol. 4 Issue 4, April-2015,pp(47-51) ISSN: 2319-7471.

[14]. Subramanya Bhat.M, Shwetha .D , Devaraju .J.T, "Performance study of proactive reactive and hybrid protocols using qualnet stimulator" *International Journal of Computer Applications (0975 – 8887)Volume 28– No.5, August 2011*

[15]. Payal, Deepak Sharma, Col. (Dr) Suresh Kumar, "Performance Evaluation of Reactive Routing Protocols Using IEEE 802.15.4 Application in Designed Wireless Sensor Network."International Journal of Computer Sciences and Engineering. Vol.6. Issue 4, pp (90-96) March 2018. ISSN 2347-2693.doi: 10.26438/ijcse/v6i4.9096.

