To Evaluate the Performance of IEEE 802.16 Routing Protocols using Qualnet 6.1 Simulator

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ABSTRACT
Wireless networking has become an important area of research in academic and industry. Worldwide Interoperability for Microwave Access (WiMAX) is one of the most efficient and well known area based networking system that provide fixed, and more newly, mobile broadband connectivity between fixed and mobile network access in a define coverage areas. It provides the same subscriber experience for fixed and mobile user. The main aspect of Wi-MAX is large coverage areas with high data rate than other wireless networks. This network is easily deployable and guaranteed Quality of service. In this paper, we have investigated different routing protocols and evaluated their performances on 802.16 WiMAX networks and provided performance comparison of routing protocols such as AODV, OLSR, ZRP and RIP based on the parameters including average throughput, average jitter and average End-to-End delay by using Qualnet 6.1simulators.We also tried to improve the performance of WiMAX by analysing the network with and without mobility.

Keywords
WiMAX 802.16, AODV, OLSR, ZRP, RIP, Qualnet 6.1

1 . INTRODUCTION
IEEE 802.16 Wireless Metropolitan Area Network (MAN) air interface standard [1] technology is designed to provide a cost-effective last mile broadband access. It has provided extensive details for the Physical (PHY) and MAC layers. WiMAX is designed to operate in both, licensed frequency band of 10-66 GHZ and unlicensed frequency band of 2-11GHZ. Mobile WiMAX is one of the best concepts for system designed in fixed wireless access to provide good performance and cost effective solution. WiMAX faces different challenges of meeting the additional demands for supporting mobility in WiMAX, if line of sight (LOS) operation is desired, then frequencies greater than 10 GHZ will be utilized. However, for communications that require non-line of sight (NLOS), frequency bands below the 10 GHZ are utilized. Regardless of the frequency bands used, Time Division Duplexing (TDD) and Frequency Division Duplexing (FDD) are both supported. The WiMAX Air Interface adopts Orthogonal Frequency Division Multiple Access (OFDMA).In Mobile WiMAX, the scalable sub-channel reuse is designed by sub-channel segmentation and permutation zone. The main concept regarding Mobile WiMAX is mobility in broadband wireless communication networks. Mobile WiMAX consists of high speed Internet access which provides various information and multimedia data with bit rate of 73 Mbps. Mobile WiMAX standard based on IEEE802.16e provides three types of modulation schemes which depends upon the channel condition. These are the basic modulation techniques named as QPSK, 16QAM, and 64QAM. In wireless networking, the performance of network varies with relatively high order modulation, which prevents it from obtaining stability and fairness. IEEE802.16e standard is used to support mobile multi-hop relay in the wireless broadband network. A series of IEEE802.16 standards is based on promising technologies in broadband wireless access to provide wireless broadband connectivity. IEEE802.16 working group improves the mobile Worldwide Interoperability for Microwave Access (mobile WiMAX) which is used to provide a wireless solution in the metropolitan area access networks. The WiMAX network is capable of wide range coverage, high data rates, secured transmission and mobility supported at vehicular speeds.

Some of the wireless routing protocols like AODV, OLSR, DSDV, ZRP, LAR, STAR etc. were already designed to provide communication in wireless environment, Performance comparison among some set of routing protocols are already performed by the researchers. The performance comparisons were carried out for ad-hoc networks but not for Mobile WiMAX. Therefore, we evaluated the performance of wireless routing protocols in Mobile WiMAX environment which is an active research area and moreover, we tried to study and compare the performance of AODV, DSR, OLSR and ZRP routing protocols using fixed and mobile network [3] [4].

2 . WIRELESS ROUTING PROTOCOLS
2.1 Optimized Link State Routing (OLSR)
OLSR is an IP routing protocol optimized for mobile ad hoc network which can also be used on other wireless ad hoc networks. OLSR is a proactive link state routing protocol which uses hello and topology control message to discover and then disseminate link state information throughout mobile ad hoc network .Individual nodes use this topology information to compute next hop destination for all nodes in the network using shortest hop forwarding path. The main idea of this protocol is that each node gets to know its neighborhood and broadcasts this information through the network. This is the main difference to distance vector algorithms, where topology information is only is exchanged with neighbors'. In the first version of OLSR (RFC 3626), hop count is used as routing metric. The second version of the protocol that is at the time of writing still under development will probably allow other link metrics to be used.

2.2 Routing Information Protocol (RIP) -

Routing Information Protocol (RIP) is an Interior Gateway Protocol used to exchange routing information within a domain or autonomous system. RIP provide routers exchange information about destinations for the purpose of computing routes throughout the network. Destinations may be individual hosts, networks, or special destinations used to convey a default route. RIP is distance-vector routing protocol and based on the Bellman- Ford algorithm. This means RIP makes routing decisions based on the hop count between a router and a destination. RIP does not alter IP packets; it routes them based on destination address only. RIP sends the complete routing table out to all active interfaces every 30 seconds. RIP only uses hop count (the number of routers) to determine the best way to a remote network

2.3 Ad Hoc On-demand Distance Vector Routing (AODV) protocol-

The Ad Hoc On-demand Distance Vector Routing (AODV) protocol is a reactive unicast routing protocol for mobile ad hoc networks. The meaning of reactive routing protocol is that, it establishes a route to a destination only on demand. In contrast, the most common routing protocols of the Internet are proactive, meaning they find routing paths independently of the usage of the paths. AODV is a distance-vector routing protocol. AODV avoids the counting_to-infinity_problem of other distance-vector protocols by using sequence numbers on route updates, a technique pioneered by DSDV. AODV is capable of both unicast and multicast routing. The advantage of AODV is that it creates no extra traffic for communication along existing links. Also, distance vector routing is simple, and doesn't require much memory or calculation. However AODV requires more time to establish a connection, and the initial communication to establish a route is heavier than some other approaches.

2.3 Zone Routing Protocol (ZRP)

ZRP is a hybrid routing method, where the proactive and reactive behaviour is mixed in the amounts that best match operations for an ad hoc mobile networks. Purely proactive and purely reactive protocols perform well in a limited region of this range. For example, reactive routing protocols are well suited for networks where the call-to mobility ratio is relatively low. Proactive routing protocols, on the other hand, are well suited for networks where this ratio is relatively high. There are four elements available in ZRP: MAC level function, IARP, IERP and BRP. IARP, proactive protocol is used to discover route within zone and in this case, links are considered as unidirectional. But in order to communicate with the nodes which locate in different zones, nodes use IERP, on-demand routing protocol. ZRP also follows different strategies, such as routing zone topology and proactive maintenance, for improving the efficiency and quality to discover a globally reactive route using query/reply mechanism.

3. SIMULATION MODEL AND PLATFORM

In this paper, Qualnet simulator tool are used to evaluate the performance of fixed and mobile WiMAX using different routing protocol like AODV, OLSR, ZRP and RIP. The MAC protocol 802.16 is used in this simulation. The simulation model is designed by using various node densities such as 20, 40, 60, 80 and 100. Simulation dimensions are used over an area of 1500m x 1500m and with a channel frequency of 2.4GHz. The simulation is performed by using the network simulator Qualnet 6.1for evaluating different parameters which is shown in table 1 to identify which of protocols gives better performance among other routing protocols.

Table.1 Simulation parameter

Routing protocols	AODV, OLSR, ZRP, RIP
Radio type	802.16
No. of Channels	One
Channel frequency	2.45 GHz
Simulation time	500 sec
FFT	2048
Cycle prefixed	8
Mobility modal	Fixed and random way point
Traffic type	CBR
Simulation area	1500x1500
No of nodes	20, 40, 60, 80, 100
Simulator	Qualnet 6.1

4 .RESULT AND DISCUSSIONS

In this simulation network various performance of routing protocols of fixed and random way point model are used with different node densities such as 20, 40, 60, 80, and 100through Qualnet 6.1 simulator. The simulation is used with a single channel bandwidth of 2.4 GHz.

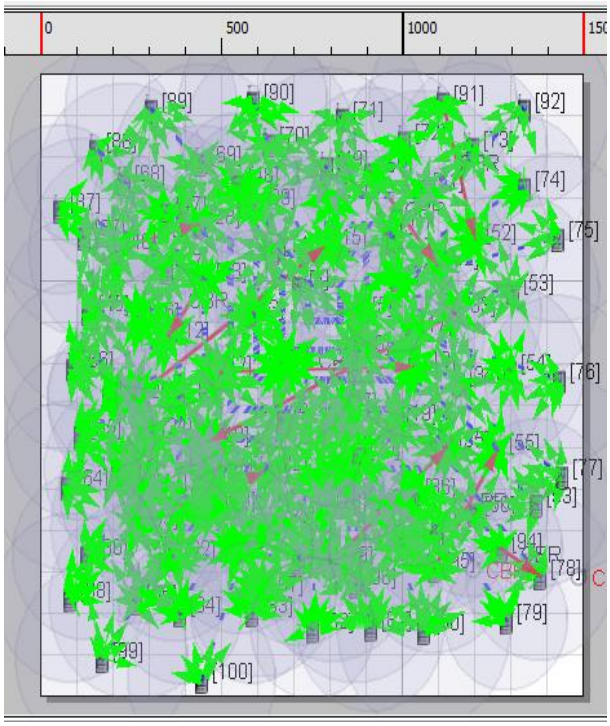

Fig.1 Simulation scenario of WiMAX with 100 nodes

The figure 1 shows the simulation network consists of 100 nodes which is placed randomly over the simulation area of 1500m*1500m. The IEEE 802.16 for WiMAX is used as the MAC layer protocol and constant bit rate (CBR) is being used as an application layer for transmitting packets between source and destination.

4.1 Throughput

Throughput is defined as the average rate of successful delivery of packet at the receiver. There are different routing protocols with different node densities used such as 20, 40, 60, 80, and 100 for fixed and random way point mobility. Figure 2 and Figure 3 shows that different protocols are used where in AODV having better performance than other routing protocols.

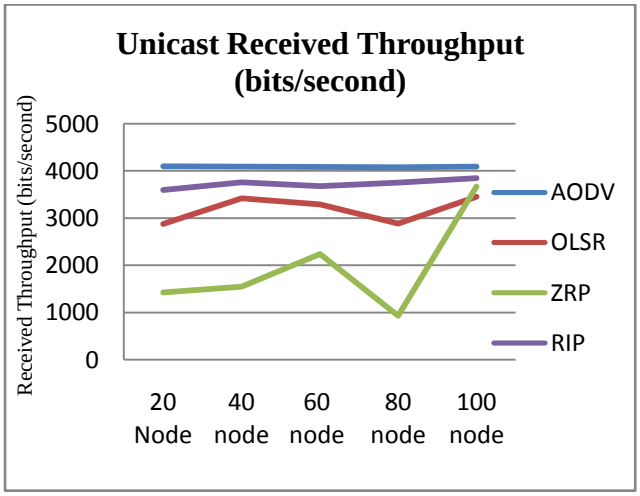

Fig.2 Unicast received throughput for fixed node density.

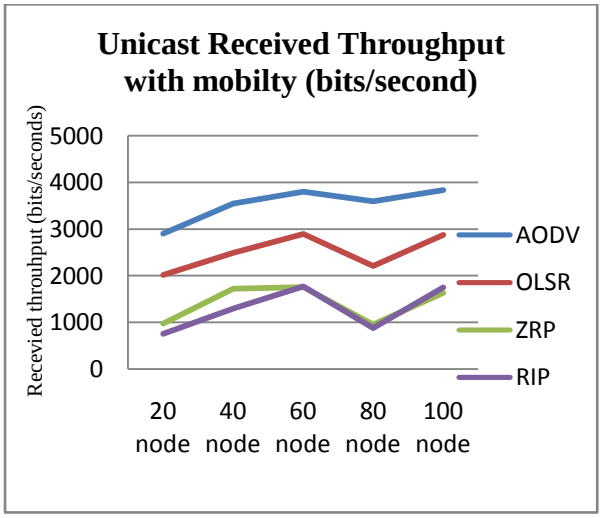

Fig.3 Unicast received throughput for random way point mobility.

4.2 Average Jitter

Jitter is the variation in delay for packet belonging to same flow. This is the difference between end to end delay and jitter. There are different routing protocols used for fixed and random way point mobility for evaluating the performance of different nodes densities such as 20, 40, 60, 80, and 100. Fig 4 shows the average unicast jitter for fixed nodes using different routing protocols in which AODV is having better results among all routing protocols. Fig. 5 shows average unicast jitter for mobile nodes using different routing protocols in which RIP is having better results among all routing protocols on the other hand, ZRP shows more jitter experienced because all the nodes in WiMAX cell is moving with constant speed that leads to drop more packet while transmission process.

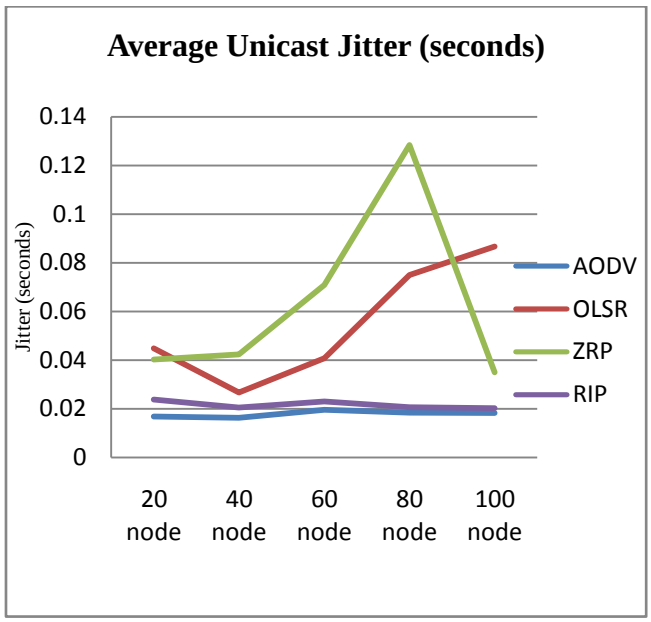

Fig.4 Average unicast jitter with fixed node density

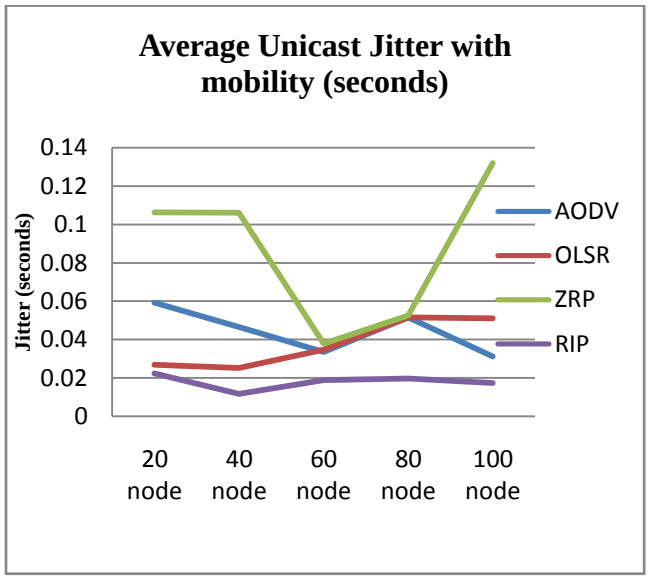

Fig.5 Average unicast jitter with random way point mobility.

4.3 Average End-To-End Delay

End-to-end defined as, the time taken by the packet to travel from sender to receiver. It represents the average data delay an application or a user experiences when transmitting data. There are different routing protocols are used for fixed and random way point mobility for evaluating the performance of different nodes densities such as 20, 40, 60, 80, 100.Fig.6 shows average end to end delay for fixed nodes using different routing protocols in which AODV is having better results among all routing protocols. Fig. 7 shows average end

to end delay for mobile nodes using different routing protocols in which RIP is having better results among all routing protocols.

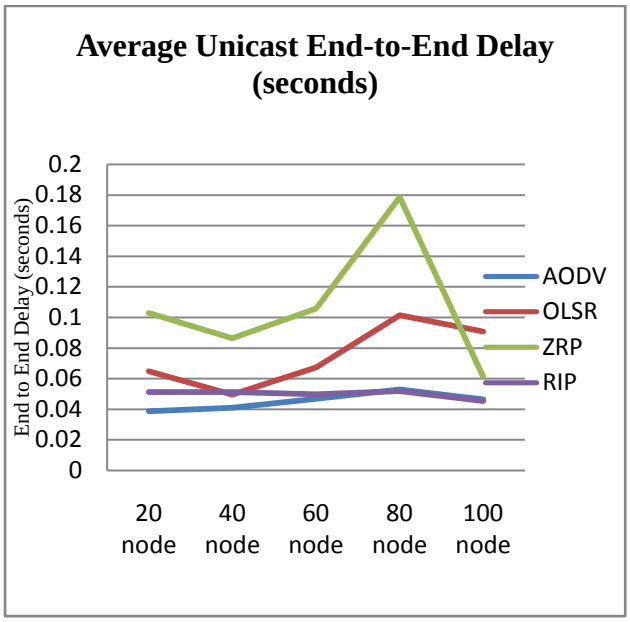

Fig.6 Average unicast end to end delay for fixed node

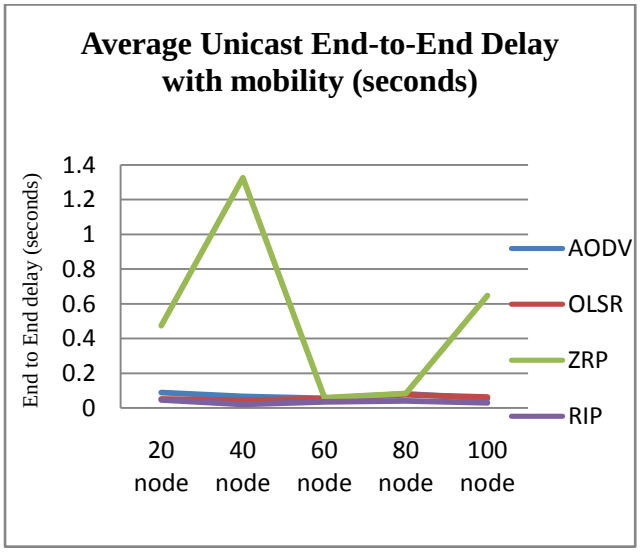

Fig.7 Average unicast end to end delay for random way point mobility.

5. CONCLUSION

The performance comparison of different routing protocols are analyzed by using Qualnet simulator 6.1. The result from the different routing protocols of fixed and random way point mobility shows several performance measures such as received throughput, end to end delay and average jitter. It is observed that AODV routing protocol provides better performance than all other routing protocols for fixed and mobile WiMAX. The future work will focus on the designing of new protocols that may performs better in Throughput, PDR, and total packets received and at the same time, it should give least amount of Jitter and End to End delay.

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