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Research Article

Performance Evaluation of Mobile Wi-Max with and without Mobility

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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 upcoming generations (4G) promising networks to cover some of the consumers' needs. It is a promising technology that is intended to deliver fixed, and more newly, mobile broadband connectivity. Worldwide Interoperability for Microwave Access (WiMAX) is a technology that provides the connection between fixed and mobile network access. It provides the same subscriber experience for fixed and mobile user. WiMAX network is developed mainly due to the coverage area which is larger as compared to all other 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

WiMAX (Worldwide Interoperability for Microwave Access) is a wireless communications standard designed to provide high data rate and cover the larger area. IEEE 802.16 Wireless Metropolitan Area Network (MAN) air interface standard 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 Network provides scalability in radio access technology as well as network architecture, therefore WiMAX technology introduce a great idea of flexibility in network deployments and service offerings. Since 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. A segment is a sub division of the available OFDMA sub-channels (one segment may include all sub-channels) (Zaggoulos *et al.*2007). One segment is used for deploying a single instance of MAC. 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.

A number of wireless routing protocols are already designed to provide communication in wireless environment, such as AODV, OLSR, DSDV, ZRP, LAR, LANMAR, STAR, DYMO (Shim *et al.* 2008).

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Performance comparison among some set of routing protocols are already performed by the researchers. These performance comparisons are carried out for ad-hoc networks but none for Mobile WiMAX. For this reason, we evaluated the performance of wireless routing protocols in Mobile WiMAX environment which is still an active research area and in this paper we tried to study and compare the performance of AODV, DSR, OLSR and ZRP routing protocols using fixed and mobile network (Marina *et al*. 2006) and (Rengaraju *et al*. 2009)

2. Wireless Routing Protocols

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

Ad-hoc on-demand Distance Vector Routing protocol is designed for wireless mobile ad-hoc networks.. AODV comes in the category of Reactive routing protocols. In reactive protocols routes are discovered and created on demand. The other category is proactive, in which each node has to maintain tables including the information about all the nodes in the network and periodical updates are necessary along with the updates about the change in the network topology. Periodic global broadcasting increases the control message and bandwidth requirements. In AODV, nodes never participate in periodic global routing-table exchange. When a node wants to communicate to another node, then only it finds and maintains a route to that node. Nodes discover other nodes in its neighborhood by locally broadcasting a packet called Hello message with Time-to-live value of, so that it cannot be rebroadcasted outside the neighborhood. To initiate the path discovery, the source node broadcast a RREQ (route request) packet to its neighbors. The RREQ packet contains the fields as: source-address, request id, destination-address, source sequence number, destination sequence number and hop-count. Source and destination address are the IP addresses of source and destination nodes respectively. Request id is a counter which is incremented whenever the source generates a new RREQ. Hop count is counter initially set to zero and incremented after each hop. Whenever an intermediate node gets a RREQ, it checks the source address and request id to detect whether it is a new request or a duplicate. If duplicate, it is discarded; if fresh, table update is done. The intermediate node compares the destination sequence numbers in the received RREQ packet with the stored one in its route-entry. If the sequence number in the RREQ packet is greater than or equal to the stored one, then RREQ is rebroadcasted, also the greater sequence number is updated in the route entry; otherwise it unicast RREP (Request Reply) packet back to the source via the node from which it received RREQ to declare that it has a valid route to the destination. With the traverse of RREQ, reverse pointers were set up from all intermediate nodes towards the source node. As RREP travels towards the source, each node in the path sets up a forward pointer and also updates its table.

A node propagates the first RREP it received for a particular source towards that source; more RREPs for the same source are propagated, if these replies contain the destination sequence number greater than the previous one, or equal to the previous one with a smaller hop count; otherwise these are discarded. Thus resulting in the decrease of redundant replies and confirming the latest routing information. Data transmission is initiated by the source node as soon as first RREP is received by it, however, if a better alternative for the route is found in future, it can update its routing table.

Link breakage is obvious in mobile networks, which invokes the need of path maintenance. In the case of link failure during an active session, the node upstream of the breakpoint, broadcasts the RERR (Route Error) message. In this way RERR propagates back to the source node, which in turn re-initiates path discovery process if it still requires.

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 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. ARP, 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.

Optimized Link State Routing (OLSR)

OLSR permanently stores and updates its routing table (Jacquet *et al.* 2003). It keeps track of routing table in order to provide a route if needed. OLSR can be implemented in any ad hoc network. Due to its nature it is called as proactive routing protocol. All the nodes in the network do not broadcast the route packets. Just Multipoint Relay (MPR) nodes broadcast route packets. These MPR nodes can be selected in the neighbor of source node. Each node in the network keeps a list of MPR nodes. This MPR selector is obtained from HELLO packets sending between in neighbor nodes. These routes are built before any source node intends to send a message to a specified destination. Each and every node in the network keeps a routing table. This is the reason the routing overhead for OLSR is minimum than other reactive routing protocols and it provide a shortest route to the destination in the network. There is no need to build the new routes, as the existing in use route does not increase enough routing overhead. It reduces the route discovery delay. Nodes in the network send HELLO messages to their neighbors. These messages are sent at a predetermined interval in OLSR to determine the link status.

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 based on the Bellman- Ford or the distance-vector 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. Routing information protocol (RIP) is a distance-vector routing protocol. 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

3 Simulation Model and Platform

In this paper, we have used network simulator Qualnet 6.1 to evaluate the performance like AODV, OLSR, and ZRP and RIP routing protocols for WiMAX network. The MAC protocol 802.16 is used in this simulation. The performance of network is calculated by using mobility and without mobility. The simulation model is designed by using various node densities such as 20, 40, 60, 80 and 100. The parameters used in this network are throughput, average jitter, average and end- to-end delay. 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

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 100 through Qualnet 6.1 simulator. The simulation is used with a single channel bandwidth of 2.4 GHz. The figure 4 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 a application layer for transmitting packets between source and destination.

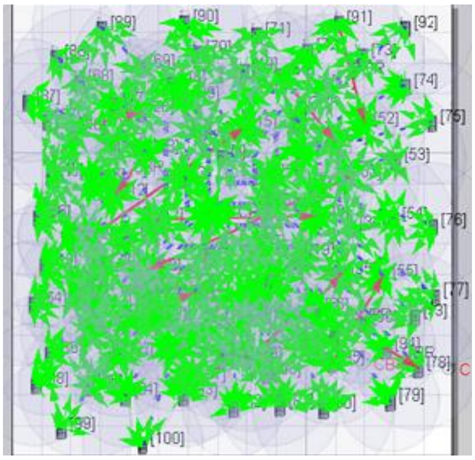

Fig.4 Simulation scenario with 100 nodes

4.1 Throughput

Throughput is defined as the total amount of data a receiver receives from the sender divided by the time it takes for the receiver to get the last packet.

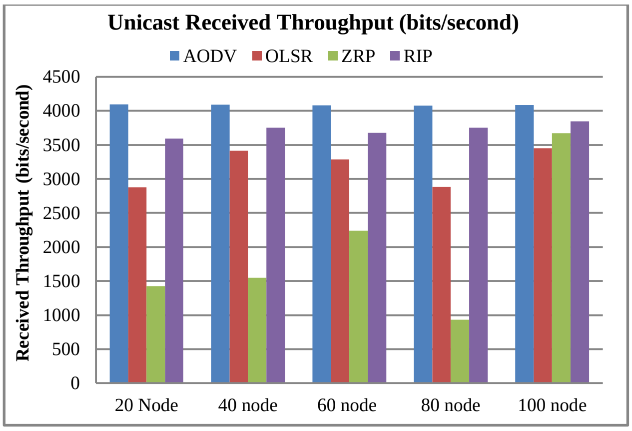

Fig.4.1 (a) Unicast received throughput for fixed node density

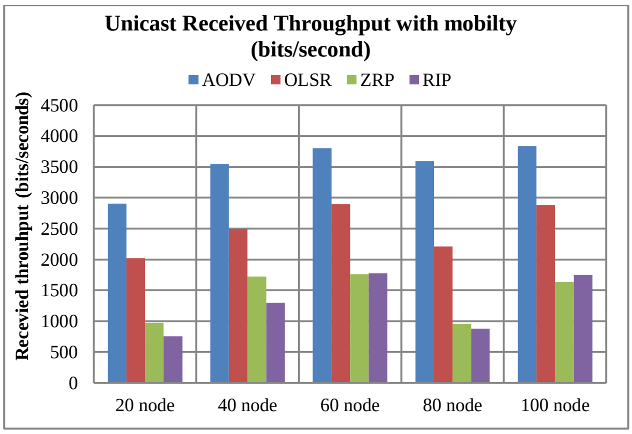

Fig.4.1 (b) Unicast received throughput for random way point mobility

The throughput is measured in bits per second (bit/s or bps). Figure 4.1 (a) and Figure 4.1 (b) shows that different protocols are used where in AODV having better performance than other routing protocols.

4.2 Average Jitter

Jitter is the variation in the time between packets arriving, caused by network congestion, timing drift, or route changes. Jitter should be small for a routing protocol to perform better. From fig 4.2(a) and 4.2(b) average jitter of AODV has better than other routing protocol.

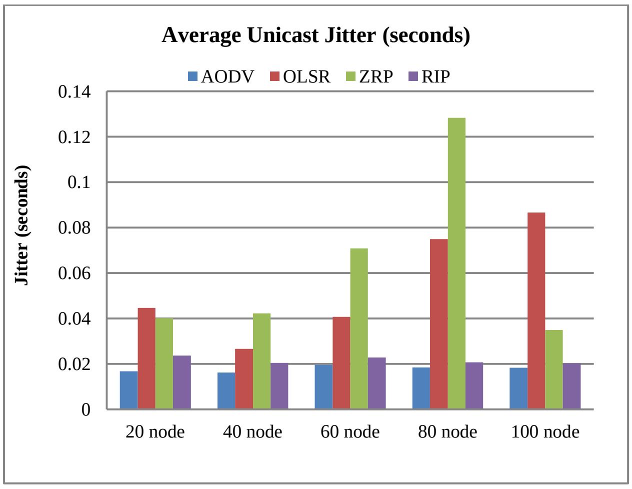

Fig.4.2 (a) Average unicast jitter with fixed node density

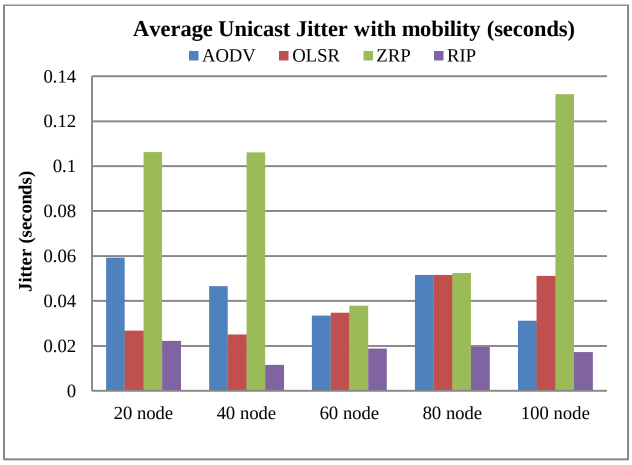

Fig.4.2 (b) Average unicast jitter with random way point mobility

4.3 Average End-To-End Delay

End-to-end delay indicates how long it took for a packet to travel from the CBR source to the application layer of the destination. It represents the average data delay an application or a user experiences when transmitting data. From figure 4.3(a) and 4.3(b) end to end delay with AODV is good as compared to OLSR, ZRP and RIP.

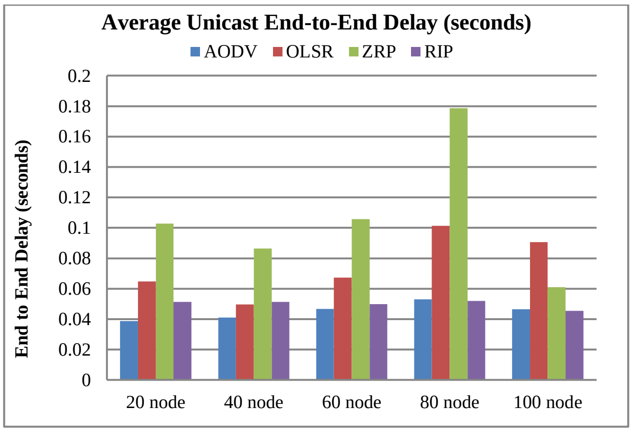

Fig.4.3 (a) Average unicast end to end delay for fixed node

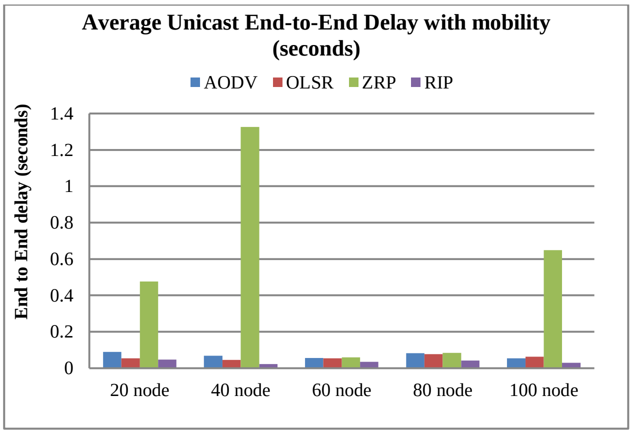

Fig.4.3 (b) Average unicast end to end delay for random way point mobility

Conclusion

After comparing the performance of mobile Wi-Max using AODV, ZRP, RIP and OLSR. It is concluded that the throughput, end to end delay and average jitter performance of AODV routing protocol for fixed and mobile WiMAX is better as compared to ZRP,OLSR and RIP. Furthermore throughput, end to end delay and average jitter performance of Mobile WI-max without mobility is better than the with mobility of Mobile WI-max.

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