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Comparative Analysis of Ad hoc Routing Unicast Protocols (Using WiMax Enviorment)

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Abstract— Worldwide Interoperability for Microwave Access (WiMAX) is a technology that bridges the gap between fixed and mobile access and offer the same subscriber experience for fixed and mobile user. Demand for such type of mobile broadband servicesaccess, which is further extended to support portability and mobility based on IEEE 802.16e, also known as Mobile WiMAX. However, frequent topology changes caused by node mobility make routing in Mobile WiMAX networks a challenging problem. In this paper, we focus upon those routing protocols especially designed for wireless networks. Here, we study and compare the performance of four ad hoc routing protocols (AODV, DSR, and ZRP) for Mobile WiMAX environment under the assumption that each of the subscriber station has routing capabilities within its own network. From our simulation, we found that ZRP and AODV protocols outperform DSR and applications are growing rapidly as it provides freedom to the subscribers to be online wherever they are at a competitive price and other significant facilities such as increasing amounts of bandwidth, using a variety of mobile and nomadic devices etc. [1][2]. The earliest version of WiMAX is based on IEEE 802.16 and is optimized for fixed and nomadic which is further extended to support portability and mobility based on IEEE 802.16e, also known as Mobile WiMAX. However, frequent topology changes caused by node mobility make routing in Mobile WiMAX networks a challenging problem. In this paper, we focus upon those routing protocols especially designed for wireless networks. Here, we study and compare the performance of four ad hoc routing protocols (AODV, DSR, and ZRP) for Mobile WiMAX environment under the assumption that each of the subscriber station has routing capabilities within its own network. From our simulation, we found that ZRP and AODV protocols outperform DSR .

***Index Terms*— AODV, DSR, Mobile WiMAX and ZRP.**

I. INTRODUCTION

Today's broadband Internet connections are restricted to wireline infrastructure using DSL, T1 or cable-modem based connection. However, these wireline infrastructures are considerably more expensive and time consuming to deploy than a wireless one. Moreover, in rural areas and developing countries, providers are unwilling to install the necessary equipment (optical fiber or copper-wire or other infrastructures) for broadband services expecting low profit. Broadband Wireless Access (BWA) has emerged as a promising solution for "last mile" access technology to provide high speed connections. IEEE 802.16 standard for BWA and its associated industry consortium, Worldwide Interoperability for Microwave Access (WiMAX) forum promise to offer high data rate over large areas to a large number of users where broadband is unavailable. This is the first industry wide standard that can be used for fixed wireless access with substantially higher bandwidth than most cellular networks [3],[4]. Development of this standard facilitates low cost equipment, ensure interoperability, and reduce investment risk for operators. In the recent years, IEEE 802.16 working group has developed a number of standards for WiMAX. The first standard IEEE 802.16 was published in 2001 and focused on the frequency range between 10 and 66 GHz and required line-of-sight (LOS) propagation between the sender and the receiver [5]. This reduces multipath distortion, thereby increases communication efficiency. Theoretically IEEE 802.16 can provide single channel data rates up to 75 Mbps on both the uplink and downlink. Providers could use multiple IEEE 802.16 channels for a single transmission to provide bandwidths of up to 350 Mbps [6]. However, because of LOS transmission, cost-effectivedeployment is not possible. These performance comparisons are carried out for ad-hoc networks but none for Mobile WiMAX. For this reason, evaluating the performance of wireless routing protocols in Mobile WiMAX environment is still an active research area and in this paper we study and compare the performance of AODV, DSR and ZRP routing protocols.

For performing the simulation, we assume that each of the subscriber station maintain routing table for its own network, so that it can send data directly to the destination without the help of base station. However, if one subscriber station has to send data to a station located in another network, it must send data through the base station and vice versa.

2 SIMULATION ENVIRONMENT

The overall goal of this simulation study is to analyze the performance of different existing wireless routing protocols in Mobile WiMAX environment. The simulations have been performed using QualNet version 5.0 [15][14], a software that provides scalable simulations of Wireless Networks . In

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our simulation, we consider a network of 50 nodes (one source and one destination) that are placed randomly within a 1000m X 1000m area and operating over 500 seconds. Multiple runs with different seed numbers are conducted for each scenario and collected data is averaged over those runs. A two-ray propagation path loss model is used in our experiments with lognormal shadowing model. The MAC802.16 is chosen as the medium access control protocol. The specific access scheme is CSMA/CA with acknowledgements. The network layer may affect the QoS if it has fewer queues, as it will queue packets of different service types into one queue [7]. Even if the application sets a high precedence for its packets, they may be blocked by lower precedence packets in network queues. Therefore, in order to fully guarantee the service types, we configure 8 queues at the network layer.

The node movements (except base station) in these experiments are modeled using the random waypoint mobility model [10], [11] with mobility speed ranging from 10 km/h to 100 km/h. We choose this range because WiMAX support medium mobility unlike cellular system [12]. A node randomly selects a destination and moves towards that destination at a predefined speed. Once the node arrives at the destination, it stays in its current position for a pause time between 0 and 30 seconds. After that it selects another destination and repeats the same. A distinctive feature of 802.16e is its QoS support. It has five service classes to support real time and non-real time communications. They are Unsolicited Grant Service (UGS), Extended Real-time Polling Service (ertPS), Real-time Polling Service (rtPS), Non-real-time Polling Service (nrtPS)

To evaluate the performance of routing protocols, both qualitative and quantitative metrics are needed. Most of the routing protocols ensure the qualitative metrics. For this reason, we use four different quantitative metrics to compare the performance. They are

a) Packet Delivery Ratio: The fraction of packets sent by the application that are received by the receivers [13].

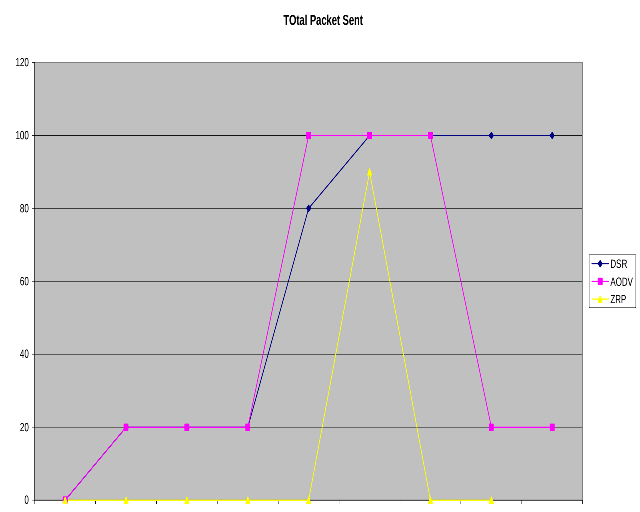
b) Average End-to-end delay: End-to-end delay indicates how long it took for a packet to travel from the source to the application layer of the destination. [13].

c) Throughput: The throughput is defined as the total amount of data a receiver R actually receives from the sender divided by the time it takes for R to get the last packet [14].

3 SIMULATION RESULTS

Fig. 1 shows the packet delivery ratio of AODV, DSR and ZRP as a function of mobility speed. All these three protocols have packet delivery ratio of 100% when the nodes are stationary. However, packet delivery ratio decline when nodes begin to move. When looking at the packet delivery ratio (Fig. 1) it can easily be observed that ZRP and AODV perform much better than DSR . Initially (10 km/h) all these protocols show poor performance. AODV demonstrate better performance when node mobility is between 20 km/h to 50 km/h. ZRP shows better performance in higher mobility than other three protocols. DSR show nearly the same behavior. However, in highly mobile situation, DSR demonstrate poor performance than other three protocols.

Fig. 1 shows the number of routing protocol packets sent by each protocol obtaining the packet delivery ratios shown in Fig. 1. AODV, ZRP and DSR have less routing overhead when the nodes are stationary. However routing overhead increases when the nodes begin to move. DSR has considerably less overhead because of its on-demand routing nature. ZRP requires sending more routing packets due to its proactive scheme, namely the frequent hello packets to update the routing table within the local zone than DSR. Though AODV uses on-demand routing scheme, it always has higher routing overhead than DSR. Due to aggressive caching, DSR will most often find a route in its cache and therefore rarely initiate a route discovery process unlike AODV. Fig 2 shows the average end-to-end delay from the source to the destination's application layer. ZRP demonstrate less delay than other two protocols due to their proactive nature. They regularly update their routing table. In case of AODV and DSR, which are reactive in nature, have higher delay. Among these two reactive routing protocols, AODV demonstrate better performance. In higher mobility scenarios (80 km/h to 100 km/h), AODV has lower delay than ZRP. DSR performs worst, because DSR often uses stale routes due to the large route cache, which leads to frequent packet retransmission and extremely high delay times. Fig. 3 shows the throughput comparison of AODV, DSR and ZRP. We measure the "throughput" at the receiver. When the nodes are stationary, all four protocols provide almost same throughput which is around 4000 bps. Throughput decline when nodes begin to move. From the figure it can easily be observed that ZRP and AODV perform better than DSR . Although in higher mobility scenario (60 km/h to 100 km/h) AODV, DSR demonstrate nearly same performance. AODV demonstrate better performance when node mobility is between 20 km/h to 50 km/h. ZRP shows better performance in higher mobility than other three protocols. DSR performs better than others in low mobility.



Mobility Km/hour fig 1 Packet Delivery Ration

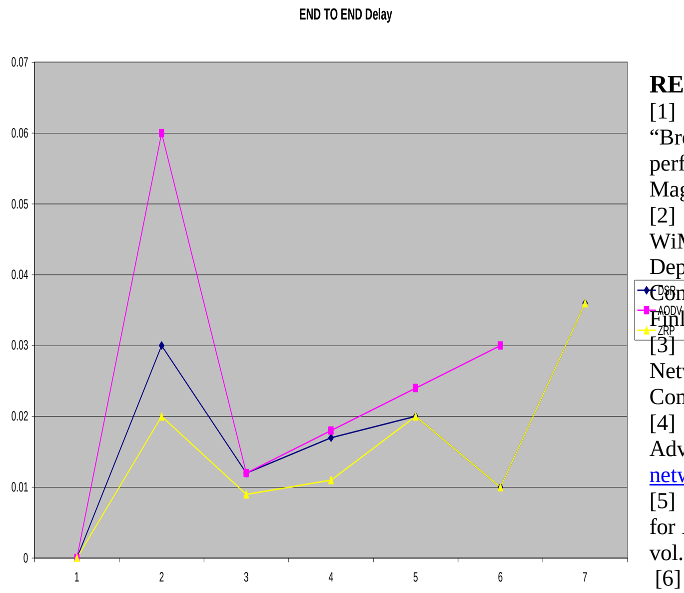


Fig 2 End to End Delay

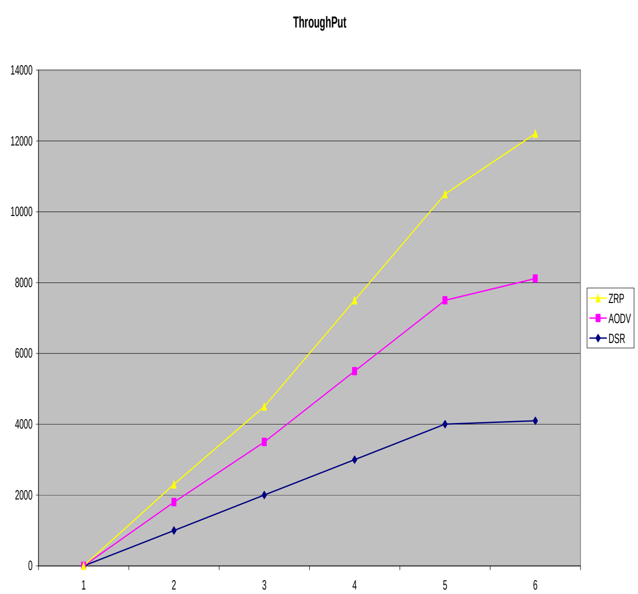


Fig 3 Through Put

CONCLUSION

A performance comparison of four different ad hoc routing protocols (AODV, DSR, and ZRP) is performed here using different mobility scenarios. Simulation has been conducted in Mobile WiMAX environment. From the result of our studies, it can be said that, on an average ZRP and AODV perform better than DSR . In case of DSR, it has less routing overhead, but average end to end delay is higher. For other metrics (packet delivery ration and throughput), DSR demonstrates poor performance.

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