IMPROVED PERFORMANCE OF WIMAX NETWORK USING ROUTING PROTOCOL IN NS3 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 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 services 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 roaming devices. This paper presented an analysis on those routing protocols especially designed for wireless networks. Implementing the Random Direction Mobility model. A study and comparison on the performance of three routing protocols (AODV, DSDV and OLSR) for Mobile WiMAX environment is done under Random Direction Mobility Model. An assumption of each subscriber station has its routing capabilities within its own network is prepared. The performance matrix includes Routing Overhead, Packet Delivery fraction (PDF), Throughput, End to End Delay, and number of packet dropped were identified. The study used NS-3.13 simulator for the comparison on the performance analysis. Successfully results found that OLSR protocol outperform the AODV and DSDV and improve efficiency of WiMAX.

Keywords— Ad-hoc On-demand distance vector, Destination-Sequenced Distance-Vector Routing protocol, Optimized Link state routing, Network Analysis, Worldwide Interoperability for Microwave Access,

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INTRODUCTION

The earliest version of WiMAX is based on IEEE 802.16 and is optimized for fixed and roaming access, 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. Broadband Internet connections are restricted to wire line infrastructure using DSL, T1 or cable-modem based connection. However, these wire line infrastructures are considerably more expensive and time consuming to deploy than a wireless one. Moreover, in rural areas and developing countries, provide 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 as fig 1. This is the first industry wide standard that can be used for fixed wireless access with substantially higher bandwidth than most cellular networks. This paper presented an analysis of the performance for wireless routing protocols in Mobile WiMAX environment. The various Wireless routing protocols have their unique characteristics. Hence, in order to find out the most adaptive and efficient routing protocol for the highly dynamic topology in ad hoc networks, the routing protocols behavior has to be analyzed using varying node mobility speed, Traffic and network size. Thus the goal is to carry out a systematic performance comparison of wireless routing protocols under mobility model.

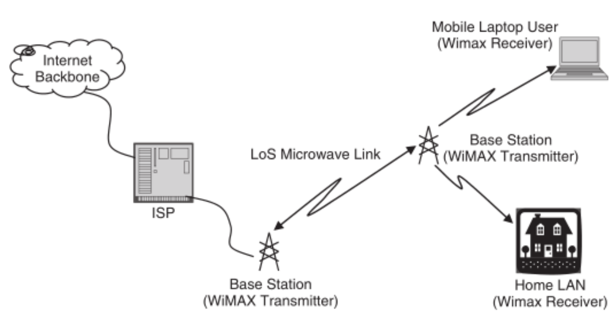

Fig 1 Operational behavior of WiMax Technology.

The main aim of this paper is:

- Acquiring the detailed understanding of Wireless routing protocols
- Implementing the Mobility model.
- Analyzing the performance differentials of routing protocols under this mobility.

A study and comparison on network performance of AODV, DSDV, OLSR routing protocols are evaluated and presented. A simulation has been setup and assumed of each of the subscriber station maintain routing table for its own network is made. This setup is made due to make sure the traffic flow is sending the 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. he introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper.

1.WIRELESS ROUTING PROTOCOLS

Three type of routing protocols has been analyzed in this research as detailed.

1.1 Ad hoc On-demand Distance Vector Routing (AODV)

Ad-hoc On-demand distance vector (AODV) [2, 3] is another variant of classical distance vector routing algorithm, a confluence of both DSDV and DSR. It shares DSR's on-demand characteristics hence discovers routes whenever it is needed via a similar route discovery process. However, AODV adopts traditional routing tables; one entry per destination which is in contrast to DSR that maintains multiple route cache entries for each destination. The initial design of AODV is undertaken after the experience with DSDV routing algorithm. Like DSDV, AODV provides loop free routes while repairing link breakages but unlike DSDV, it doesn't require global periodic routing advertisements. AODV also has othersignificant features. Whenever a route is available from source to destination, it does not add any overhead to the packets.However, route discovery process is only initiated when routes are not used and/or they expired and consequently discarded. This strategy reduces the effects of stale routes as well as the need for route maintenance for unused routes. Another distinguishing feature of AODV is the ability to provide uncast, multicast and broadcast communication. AODV uses a broadcast route discovery algorithm and then the uncast route reply massage.

1.2. Destination-Sequenced Distance Vector routing (DSDV)

Destination-Sequenced Distance-Vector Routing (DSDV) is a table-driven routing scheme for ad hoc mobile networks based on the Bellman-Ford algorithm. The improvement made to the Bellman-Ford algorithm includes freedom from loops in routing tables by using sequence numbers [2]. The DSDV protocol can be used in mobile ad hoc networking environments by assuming that each participating node acts as a router. Each node must maintain a table that consists of all the possible destinations. In this routing protocol has an entry of the table contains the address identifier of a destination, the shortest known distance metric to that destination measured in hop counts and the address identifier of the node that is the first hop on the shortest path to the destination. Each mobile node in the system maintains a routing table in which all the possible destinations and the number of hops to them in the network are recorded. A sequence number is also associated with each route or path to the destination. The route labeled with the highest sequence number is always used. This also helps in identifying the old routes from the new ones. This function would avoid the formation of loops. In order to minimize the traffic generated, there are two types of packets used that known as “full dump”, which is a packet that carries all the information about a change. The second type of packet called “incremental” is used which carried just the changes of the loops. The second type benefits that increased the overall efficiency of the system. DSDV requires a regular update of its routing tables, which uses up battery power and a small amount of bandwidth even when the network is idle. Whenever the topology of the network changes, a new sequence number needed before the network re-converges. Thus, DSDV is not suitable for highly dynamic networks.

1.3 Optimized Link State Routing (OLSR)

Optimized Link State Routing protocol is a proactive routing protocol based on the following three mechanisms:

1.3.1 Neighbor sensing using HELLO messages, efficient control

1.3.2 Traffic flooding using multipoint relays (MPRs)

1.3.3 Optimal path calculation using shortest path algorithm.

OLSR is independent of the underlying link layer. Each node sends periodic HELLO messages to discover neighbors. The neighborhood of a node A contains all those nodes which are directly linked to A. The links may be symmetric or asymmetric. OLSR also uses a concept called a two-hop neighbor. A node, C, is a two-hop neighbor of A if a node B is a symmetric neighbor of A and C is a symmetric neighbor of B, but C is not a neighbor of A. The HELLO packet contains the node's own address, a list of its neighbors and the status of the links of all its neighbors. These HELLO packets are used by the nodes to generate the immediate and two-hop neighborhoods as well as to determine the quality of links in the neighborhood. This information is stored for a limited time in each node and needs to be refreshed periodically. Flooding HELLO packets across an arbitrarily-sized MANET is costly due to the presence of multiple duplicate retransmissions. In order to avoid this, OLSR uses the concept of multipoint relay (MPR) flooding instead of full flooding. Each node uses its two-hop neighborhood information to select a minimal set of MPRs such that all the nodes in its two-hop neighborhood are reachable. Each node maintains a list of nodes, called the MPR selector set, for which it is an MPR. The node then retransmits only those messages received from nodes which have selected it as an MPR.The MPR flooding mechanism is also used to spread topology information throughout the MANET. All nodes with a non-empty MPR selector set periodically send out a topology control (TC) message. This message contains the address of the originating node and its MPR selector set. Thus, each node announces reach ability to its MPR selectors. Since every node has an MPR selector set, effectively, the reach ability to all the nodes is announced. Thus, each node receives a partial topology graph of the entire network. The shortest path algorithm is then used on this partial graph to calculate optimal routes to all nodes. The topology information is maintained only for a specific period of time and needs to be refreshed periodically.

2 Random Mobility Model

The mobility model[8] plays a very important role in determining the protocol performance in mobile wireless and adhoc Network. Hence, this work is done using the random mobility model like Random Direction. These models with various parameters reflect the realistic traveling pattern of the mobile nodes. The following are the three models with the traveling pattern of the mobile nodes during the simulation time.

2.1 Random Waypoint

The Random Way Point Mobility Model includes pauses between changes in direction and/or speed. A Mobile node begins by staying in one location for a certain period of time (i.e. pause). Once this time expires, the mobile node chooses a random destination in the simulation area and a speed that is uniformly distributed between [min-speed, ax-speed]. The mobile node then travels toward the newly chosen destination at the selected speed. Upon arrival, the mobile node pauses for a specified period of time starting the process again. The random waypoint model is a commonly used mobility model in the simulation of wireless networks. It is known that the spatial distribution of network nodes moving according to this model is non uniform. However, a closed-form expression of this distribution and an in-depth investigation is still missing. This fact impairs the accuracy of the current simulation methodology of wireless networks and makes it impossible to relate simulation-based performance results to corresponding analytical results. To overcome these problems, it is presented a detailed analytical study of the spatial node distribution generated by random waypoint mobility.

2.2 Random Walk

In this mobility model, a mobile node moves from its current location to a new location by randomly choosing a direction and speed in which to travel. The new speed and direction are both chosen from pre-defined ranges, [min-speed, max-speed] and [0, 2*pi] respectively. Each movement in the Random Walk Mobility Model occurs in either a constant time interval 't' or a constant traveled 'd' distance, at the end of which a new direction and speed are calculated.

2.3 Random Direction

A mobile node chooses a random direction in which to travel similar to the Random Walk Mobility Model. The node then travels to the border of the simulation area in that direction. Once the simulation boundary is reached, the node pauses for a specified time, chooses another angular direction (between 0 and 180 degrees) and continues the process.There are three techniques for performance evaluation which are analytical modeling, simulation and measurement. The reason for choosing simulation as a technique for performance evaluation in this research is explained below. A. Selection Techniques for Network Performance Evaluation Performance is a key criterion in the design, procurement, and use of computer systems. Computer systems professionals such as computer systems engineers, scientist, analysts and users need the basic knowledge of performance evaluation techniques as the goal to get the highest performance for a given cost. There are three techniques for performance evaluation, which are analytical modeling, simulation and measurement. Simulation had being chosen because it is the most suitable technique to get more details that can be incorporate and less assumption is required compared to analytical modeling. Accuracy, times available for evaluation and cost allocated are also another reason why simulation is chosen.

RESULT AND DISCUSSION

Simulation setup done using NS-3.13 TESTBED on UBUNTU 11.10 system and assumed of each of the subscriber station maintains routing table for its own network is made. This setup is made due to make sure the traffic flow is sending the 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.

.Details of analysis are focusing on packet-delivery fraction, packet loss, and average end to end delay and send/received ratio in term mobility. This simulation chooses 0 to 150 nodes. The standard parameters as shown in table 2.

Table 2: Standard Parameter for simulation

PARAMETER	VALUE
Simulator	NS-3.13
Protocol Studied	AODV,OLSR,DSDV
Simulation time	1000 sec
Simulation Area	1500 X 300 m2
Mobility Model	Random Direction Mobility model

1 Packet Delivery Ratio (PDR)

Result and Analysis Fig 5 shows a comparison between the routing protocols on the basis of packet delivery ratio as a function of nodes and using different number of traffic sources.

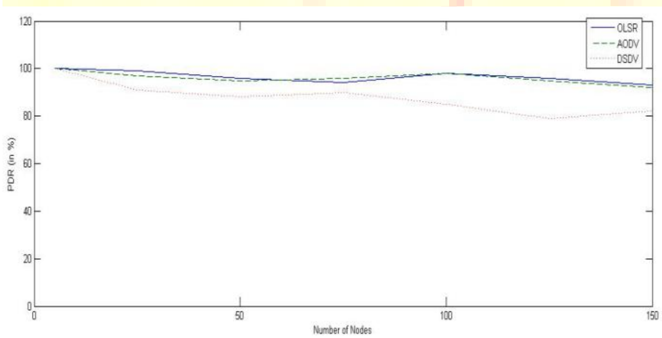

Figure:2- Packet Delivery Ratio

OLSR shows the best overall performance then AODV & DSDV, and have PDF of 100% at nodes 10. DSDV deliver less data packet compare to AODV because DSDV is a proactive or table-driven routing protocols, each node continuously maintains up-to-date routes to every other node in the network. Routing information is periodically transmitted throughout the network in order to maintain routing table consistency.

2 Averages End to End Delay Result and Analysis

Fig 3 shows the graphs for end-to-end delay vs number of nodes. We see that the average packet delay decrease for increase in number of nodes waiting in the interface queue while routing protocols try to find valid route to the destination. Besides the actual delivery of data packets, the delay time is also affected by route discovery, which is the first step to begin a communication session. The same thing happens when a data packet is forwarded hop by hop. Hence, while source routing makes route discovery more profitable, it slows down the transmission of packets. OLSR shows the best overall performance. OLSR shows the best overall performance then AODV & DSDV, and have End to End Delay of 78%..

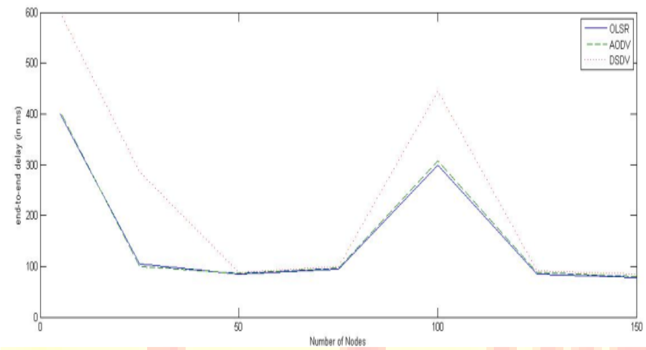

Fig :3- Average End to End Delay

AODV and DSDV show poor delay characteristics as their routes are typically not the shortest. Even if the initial route discovery phase finds the shortest route (it typically will), the route may not remain the shortest over a period of time due to node mobility. However, AODV performs a little better delay-wise and can possibly do even better with some fine-tuning of this timeout period by making it a function of node mobility. DSDV too has the worst delay characteristics because of the loss of distance information with progress.

3. Packet Loss Result and Analysis

Refer to the graph in figure 4 show not much packet loss on OLSR and AODV side. This is because when a link fails, a routing error is passed back to a transmitting node and the process repeats.. For DSDV, show the packet loss higher than OLSR and AODV because the route maintenance mechanism does not locally repair a broken link.

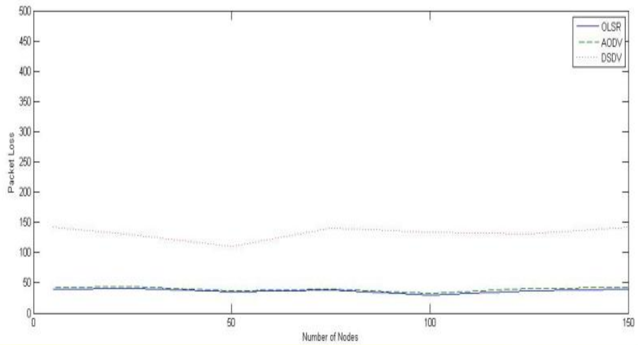

Fig:4- Packet Loss

4 . Routing Overhead

The routing over describes how many routing packets for route discovery and route maintenance need to be sent in order to propagate the data packets. Refer to the graph in fig. 5, OLSR shows the best overall performance then AODV & DSDV and giving reduce routing overhead.

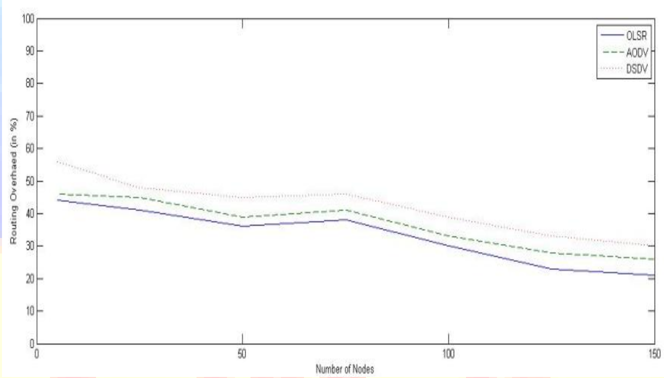

Fig: 5- Packet Loss

5.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.

VI.

CONCLUSION AND RECOMMENDATION

This paper presented the realistic comparison of three routing protocols DSDV, AODV and OLSR in WiMAX network. The significant observation shows the simulation results agree with expected results based on theoretical analysis. As expected, OLSR protocol performance is the best considering its ability to maintain connection by periodic exchange of information. AODV performs predictably. Delivered virtually all packets at low node mobility, and failing to converge as node mobility increases. Meanwhile OLSR was very good at all mobility rates and movement speeds and DSDV performs the worst, but still requires the transmission of many routing overhead packets. For the future work, this area will investigate not only the comparison between AODV, DSDV and OLSR routing protocols in WiMAX network but more on the vast areas. Security issue on routing protocol in WiMAX environment also can be studied for computer communications. Exploration on the measurement with other fields of the trace file could be done in the future. More analysis details on the things what we can get in the trace file such as jitter also could be analyzed in future works.

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