Evaluating the performance of Mesh Network using AODV, DSDV and DSR protocols Based on IEEE 802.16 at node level

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Abstract: Wimax stands for World Wide Interoperatability for Microwave Access. This technology is based on the IEEE 802.16 standard (also called as Broad band Wireless Access). Wimax is a telecommunication technology that provides wireless transmission of data in different transmission modes from Point-to-Point, Point-to-Multipoint providing the 75 mb/s broadband speed without the need of cables. Different Routing Protocols have been used in wireless network. This paper presented an analysis on those routing protocols especially designed for wireless networks. A study and comparison on the performance of three routing protocols (AODV, DSR, and DSDV) for Mobile WiMAX environment is done. The performance matrix includes Packet Delivery fraction (PDF), Throughput, End to End Delay, and number of packet dropped were identified. The study used OPNET 14 simulator for the comparison on the performance analysis. Successfully results found that AODV protocol outperform the DSR and DSDV.

I. INTRODUCTION

The IEEE standard 802.16-2001 defines the wireless MAN air interface terms for wireless metropolitan area network. The completion of this standard signs the entry of broadband wireless access as a major new tool in the special effects of link end station to the core telecommunication network worldwide. Wimax can be used for wireless networking like the popular Wi-Fi. Wimax allow higher data rates over longer distances efficient use of bandwidth and avoid interference almost to the minimum. The Bandwidth and reach of Wimax makes it suitable for the following applications: connecting Wi-Fi hotspots with each other and to other parts of the internet, providing a wireless alternative to cables and DSL for last mile broad band access, providing high speed mobile and telecommunication services [1]. Wimax is the solution for such wireless networks when this technology is considered for mobile networks. It is expected to provide around 15 mbps of channel capacity contained by a particular cell [7].

II. PROTOCOLS AT NODE LEVEL

This section describes the main features of three protocols AODV (Adhoc on demand routing protocols), DSR (Dynamic Source Routing) and DSDV (Destination Sequenced Distance Vector Routing Protocol) deeply studied using OPNET 14.0.

A. AODV(Adhoc On-Demand Distance Vector)

Ad Hoc on Demand Distance Vector Protocol is a Reactive Protocol. They don't retain routing information if there is no communication. They don't retain or constantly update their route tables with the latest route topology. AODV enables multihop routing between participating mobile nodes wishing to establish and maintain an ad-hoc network. AODV is based upon the distance vector algorithm. AODV only requests a route, when needed and does not require nodes to maintain routes to destinations which are not actively used in communication. Features of this protocol contain, loop freedom and the link breakage cause immediate notification to be sent to the affected set of nodes. AODV uses Destination Sequence Number (DSN) to keep away from counting to infinity that is why it is loop free. This is the quality of this algorithm .When a node send request to a destination, it sends its DSN simultaneously with all routing information. There are three AODV messages i.e. Route Request (RREQs) and Route Reply (RREPs) and Route Errors (RERRs) when the source node requests to create a new route to the destination. The RREQ message is broad cast from source node A to the destination node B. The source node broadcast the RREQ message to the neighbor nodes. Once the neighbor node receives the RREQ message it creates a reverse route to the source node A. This neighbor node is the subsequently hop to the source node A. The hop count of the RREQ is incremented by one. The neighbor nodes ensure if it has an active route to the destination or not. If it has a route so it will forward a RREP to the source node A. If it does not have an active route to the destination it will broadcast the RREQ message to their neighbor nodes yet again with an incremented hop count value. The RREQ packet propagates throughout the network until it reaches to the destination or a node with a fresh enough routes to the destination. The algorithm uses "hello message" that are broadcasted periodically to the intermediate neighbors. If the "hello message" stop coming from the particular node, the neighbor can suppose that the node has moved away and mark that link as broken and inform the affected set of nodes by sending a link failure notification to that set of nodes.

B. Dynamic Source Routing (DSR)

The Dynamic Source Routing (DSR) [4] is one of the purest examples of an on-demand routing protocol that is based on the concept of source routing. It is designed especially for use in multihop ad hoc networks of mobile nodes. It allows the network to be completely self organizing and self-configuring and does not need any existing network infrastructure or administration. DSR uses no periodic routing messages like AODV, thereby reduces network bandwidth overhead, conserves battery power and avoids large routing updates. Instead DSR needs support from the MAC layer to identify link failure. DSR is composed of the two mechanisms of Route Discovery and Route Maintenance, which work together to allow nodes to discover and maintain source routes to arbitrary destinations in the network. DSR has a unique advantage by virtue of source routing. As the route is part of the packet itself, routing loops, either short – lived or long – lived, cannot be formed as they can be immediately detected and eliminated. This property opens up the protocol to a variety of useful optimizations. Neither AODV nor DSR guarantees shortest path. If the destination alone can respond to route requests and the

source node is always the initiator of the route request, the initial route may the shortest.

C. 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.

Table 1: A comparison of the characteristics of the above three routing protocols DSDV, DSR, and AODV

Protocol Property	AODV	DSR	DSDV
Multicasting Routes	NO	Yes	No
Distributed	Yes	Yes	Yes
Unidirectional Link Support	No	Yes	No
Multicasting	Yes	No	No
Periodic Broadcast	Yes	No	Yes
Qos Support	No	No	No
Reactive	Yes	Yes	No

Table 1: A comparison of characteristics of (AODV, DSR and DSDV) protocols

D. OPNET

OPNET (Optimized Network Engineering Tool) provides a comprehensive development environment for the specification, simulation and performance analysis of communication networks. A large range of communication systems from a single LAN to global satellite networks can be supported. Discrete event simulations are used as the means of analyzing system performance and their behavior.

The first step while creating the network is to generate blank scenario by using startup wizard. Project editor workspace opens by this in order to design the network. The design is completed either manually or automatically. When the network has been designed the nodes should be configured either by the pre-defined parameters or manually.

1. Firstly, Create Scenario.
2. Number of Node
3. Implement Protocols node level AODV, DSDV,DSR.
5. Compilation.
6. Check Result.
7. Compare.

III. PERFORMANCE PARAMETERS

The following Performance Metrics has been used for evaluating the performance of various WIMAX Routing Protocols:

Network Load: The statistic represents the total data traffic (in bits/sec) received by the entire WLAN BSS from the higher layers of the MACs that is accepted and queued for transmission.

Delay: There are possible delay caused by buffering during route discovery latency .The end-to-end delay is an average end-to-end delay of data packets. Once the time difference between every CBR packets sent and received was recorded, dividing the total time difference over the total number of CBR packets received gave the average end-to-end delay for the received packets. This metrics describes the packet delivery time: the lower the end-to-end delay the better the application performance.

$$\mathbf{D= \frac{1}{N}\sum_{i=1}^{s}(ri - si)}$$

Where N is the number of successfully received packets, i is unique packet identifier, r i is the time at which a packet with unique id I is received, s i is the time at which a packet with unique id i is sent and D is measured in ms. It should be less for high performance.

Throughput: Throughput is defined as the ratio of the total data reaches a receiver from the sender. The time it takes by the receiver to receive the last message is called as throughput. It can be measured in (byte/sec or bit/sec). Some factors affect the throughput as; if there are many topology changes in the network, unreliable communication between the nodes, limited bandwidth available or limited energy. A high throughput is absolute choice in every network. Throughput can be represented mathematically as in equation below.

$$\mathit{Throughput}= \frac{\mathbf{Number\ of\ delivered\ packets * Packets\ size * 8}}{\mathbf{Total\ duration\ of\ simulation}}$$

Data Packet Loss: Mobility –related packet loss may occur at both the network layer and the MAC layer. In the project packet loss concentrate or network layer. The routing protocol forwarding the packets if a valid route to the destination is known. Otherwise, the packet is buffered until the route is available. A packet is dropped in two cases: the buffer is full when the packet needs to be buffered and the time that the packet has been buffered exceeded the limit.

PDF (Packet Delivery Fraction): PDF means the number of packets successfully delivered to the destination node divide by the total number of generated packets. PDF also known as the ratio of the data packets delivered to the destination to those generated by CBR sources.

IV. RESULT AND DISCUSSION

Details of analysis are focusing on, Average end-to-end delay, Data packet loss, Packet delay fraction and send/received ratio in term node. This simulation chooses 5, 10, 15, 20, 25, 30, 35, 40, 45 and 50 nodes. The standard parameters as shown in table 2.

Parameter	Value
Simulator	Opnet 14
Protocols	(AODV,DSDV,DSR)
Simulation time	100 seconds
Bandwidth	20 MHz
Simulation area	500m X 500m
Traffic type	CBR

Table 2: The Standard Parameters for Simulation

1. Packet Delivery Fraction (PDF) Result and Analysis

Figure 5.1 shows a comparison between the routing protocols on the basis of packet delivery fraction as a function of nodes and using different number of traffic sources.

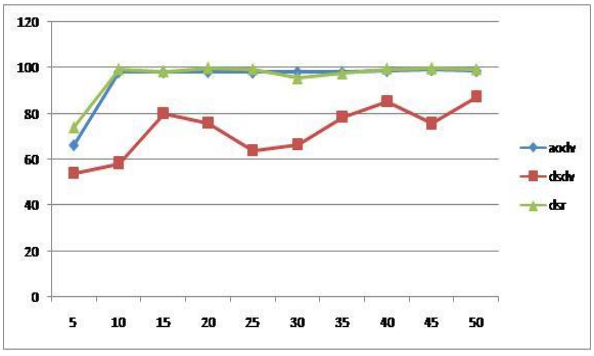

Figure 2: A Comparison between the Routing Protocols

AODV shows the best overall performance. AODV & DSR have PDF of 100% at nodes 10. DSDV deliver less data packet compare to DSDV 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. Average End to End Delay Result and Analysis

Figure 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 source routing protocols have a longer delay because their route discovery takes more time as every intermediate node tries to extract information before forwarding the reply. 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.

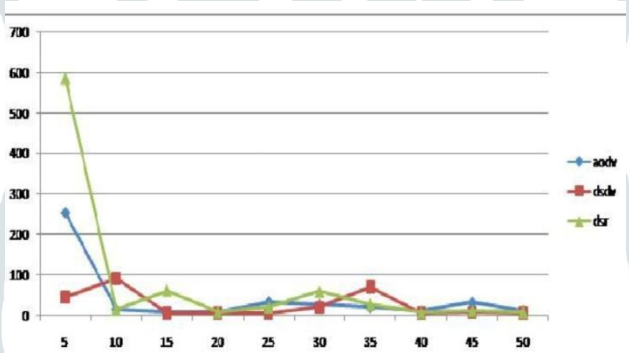

Figure 3: Graphs for End-To-End Delay Vs Number of Nodes

AODV and DSR 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. Also in TORA route construction may not occur quickly. This leads to potential lengthy delays while waiting for new routes to be determined. In DSR Route Discovery is fast, therefore shows a better delay performance than the other reactive protocols at low pause time (high mobility). But in case of congestion (high traffic) DSR control messages get loss thus eliminating its advantage for fast establishing new route. Under such situations DSR has a relatively high delay that AODV, but however the delay decreases with increase in number of nodes.

3. Packet Loss Result and Analysis

Refer to the graph in figure 4 show not much packet loss on AODV side. This is because when a link fails, a routing error is passed back to a transmitting node and the process repeats. Meanwhile for DSR, this routing protocol shows it is as good as AODV if packet loss be as indicator. For DSDV, show the packet loss higher than DSR and AODV because the route maintenance mechanism does not locally repair a broken link.

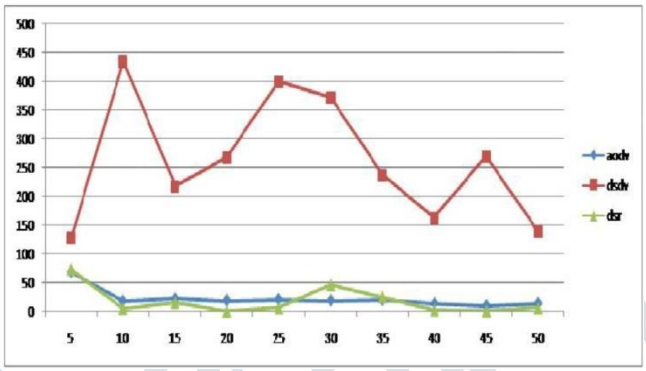

Figure 4: Packet Loss on AODV

V. CONCLUSION AND FUTURE SCOPE

1. Conclusion

In this thesis it is analyzed that different protocols have different qualities, the selection of a right protocol definitely increase the performance of the network. Mobile ad-hoc network has the recognition to use two categories of routing protocols, one of them is proactive routing protocols and the other is re-active routing protocols. The collection of these two categories is called hybrid routing protocols. The best choice between these protocols is the torchbearer to best possible solution and effective performance.

The performance issues of routing protocols, AODV, DSDV and DSR in Wimax network environment have been analyzed in our simulation study. The major performance in the key areas of Average end-to-end-delay, PDF and Packet Loss which duly affect the QoS has been studied.

This thesis presented the realistic comparison of three routing protocols DSDV, AODV and DSR. The result shows the simulation results agree with expected results based on theoretical analysis. As expected, reactive routing protocol AODV 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 DSR 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. At higher rates of node mobility it's actually more expensive than DSR.

2. Future Work

For the future work, this area will investigate not only the comparison between AODV, DSDV and DSR 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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