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NS2 Simulator to Evaluate the Effective of Nodes Number and Simulation Time on the Reactive Routing Protocols in MANET

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Abstract
A Mobile Ad-hoc Network is defined as a network that is wireless and dynamic. It can be designed with no necessity for prior infrastructure where every node acts as router. A mobile Ad hoc Network is a self-configuring system of mobile nodes that are connected wirelessly. Every node functions as a sink, as well as a router to send packets. These nodes can move freely and independently in any direction and able to get organized into a network. Hence, they change their positions frequently. In this study, a comparison is made between Ad-hoc On Demand Distance Vector protocol and Ad-hoc On Multipath Demand Distance Vector protocol using network simulator NS2.35. AODV is reactive gateway discovery algorithm where a MANET mobile device connects only on-demand. AOMDV was basically made for highly dynamic ad-hoc networks to respond to link breakages and failures in network. It works on sustaining paths for the destinations and uses destination sequence numbers to define the fresh routing information to ensure loop freedom at all times and to avoid problems. It is a protocol based on timer that finds ways for the mobile nodes to respond to breakages in links and changes in topology. Three protocols have been compared together and separately to see their performance. The performance matrix contains Packet Delivery Ratio, End to End Delay, Throughput, and Routing overhead. The comparison of routing protocols' performance is made under two scenarios when the number of nodes changes, when simulation time changes. The results show that the AODV is better than AOMDV when the number of node increases. On the other hand, the AOMDV has better performance when the simulation increases.

Keyword: AODV, AOMDV, NS2, MANET

INTRODUCTION

A Mobile Ad-Hoc Network (MANET) is defined as a collection of digital data terminals provided with wireless transceivers which communicates with each other with no need to the use of fixed network infrastructure [4]. It uses a common wireless channel to transmit data packets thus maintains communication. Ad-hoc networks differ totally from other wireless LANs because there is no need for fixed infrastructure as the case in arrayed base stations[1] [5]. On the other hand, a mobile terminal communication like cellular one in an infrastructure-based network usually gets maintained using a fixed base station. Ad hoc network's mobile terminal 'node' has the ability of direct communication with other nodes which are found within the range of its radio transmission. If a node is found outside the radio range, transmission can be made to this node when data packets are relayed over a sequence of intermediate nodes through the use of the principle of store-and-forward-multi hop transmission[9]. Ad hoc network's nodes are all demanded to relay packets on the part of other nodes. Therefore, MANET is occasionally termed a multi hop wireless network .

There are some challenges for designing ad-hoc network. The first of these challenges is that all nodes in MANET might be mobile, including the corresponding destinations, the source nodes, and the routing nodes forwarding traffic between nodes. Because of the limited range of wireless transmission, a break occurs in the wireless link between two neighboring nodes once they exceed the range.

Another reason for the complexity of MANET' design is the lack of administration. All the functions of network like network topology's determination, multiple accesses, and data routing over suitable multi hop paths, should be implemented in a distributed way. Such tasks are chiefly challenging because the communication bandwidth is limited[2]. The resolve of such challenges is done by various layers. One of these layers is the physical layer which deals with fading, path loss, and multi-user interference in order to sustain stabilized communication links among the nodes. The data link layer (DLL) should create reliability to the physical link as well as resolve the contention among unsynchronized users via the transmission of packets on a shared channel. This task is done by the medium access control (MAC) sub layer in the Data Link Layer. The network layer should observe the changes in the network's topology and make a decision of which route is the best for any favorite destination. The transport layer in its turn has to make matching between the delay and packet loss characteristics definite for the dynamic wireless network. Even the application layer needs to handle frequent disconnections. Many routing protocols have been proposed but a few comparisons have been made. In [10] [11] made compare between proactive and reactive routing protocol. In [7] the evaluated the performance of reactive routing protocols. In this paper we will evaluate the performance for two routing protocols; AODV and AOMDV by using two scenarios; number of nodes and simulation time.

ROUTING PROTOCOLS' CLASSIFICATION

MANET's Routing protocols are classified in various ways. They can be classified as Proactive (Table Driven), Reactive (on-demand) and Hybrid relying on the structure of network [11].

PROACTIVE ROUTING PROTOCOLS

Routing procedures are done by Proactive protocols between all nodes from time to time, regardless of the need for these routes. They try to maintain shortest path routes via the use of occasionally updated information of the network's topology. Usually, they are maintained in routing tables in each node and get updated with new changes in the network. Proactive protocols are merited with supplying lower latency in the delivery of data and having the chance to support certain applications which have quality-of-service restraints. The disadvantage of proactive protocols is the irrelevant sent messages which caused bandwidth's wastage periodically, as in the case of lack of link breaks or the need for few routes only. Optimized Link State Routing (OLSR), Fish-eye State Routing (FSR), Destination-Sequenced Distance Vector (DSDV) etc. are some examples of Proactive MANET Protocols [10].

REACTIVE ROUTING PROTOCOLS

These Reactive protocols have the objective of minimizing routing overhead behind their creation. Instead of following the network topology's changes in order to preserve the shortest path routes to every destination, routes are determined by these protocols in necessity. Typically, these protocols implement an operation to find the path from source's node to destination's node, when the data packet sent fails to recognize the route to the destination. Since the route is live, these protocols implement operations for route maintenance only. As well, they attempt to discover a new route in case of breakage of the existing route. The advantage of on-demand operation is that it requires the least routing overhead messages if compared to proactive protocols. However, there is also a disadvantage related to the discovery of a route in which the entire network could be flooded with route packets. Flooding though wasteful can be demanded regularly when there is a high mobility or a large number of active source-destination pairs exist. In addition, the discovery of route adds to the latency in packet delivery as the source needs to keep waiting the route determination before transmitting. Though the disadvantages, on-demand protocols get comparatively wider consideration than proactive protocols, as the merit of bandwidth turns them to be more developable[6] [3].

HYBRID ROUTING PROTOCOLS

The components of on-demand and table-driven routing protocols are integrated in the hybrid routing schemes. The common idea here is that areas with slow connection changes are more suitable for table-driven routing and areas with high mobility for source-initiated approaches. Hybrid protocols combine both the Proactive and Reactive approaches such as the Zone Routing Protocol (ZRP) [9]. The discussion here follows two on-demand ad-hoc routing protocols AOMDV and AODV:

AD-HOC ON-DEMAND MULTIPATH DISTANCE VECTOR ROUTING PROTOCOL

Ad-hoc On-demand Multipath Distance Vector Routing (AOMDV) protocol can be defined as an extension to the AODV protocol that computes multiple loop-free paths and link disjoint paths. Every destination has route entries that include a group of the hops and the corresponding hop counts too. The nodes share an identical sequence number, which helps in having a track for a route. A destination's node tries to calculate and broadcast all possible paths with number of hops to the specific source. Loop freedom is granted for a node through the acceptance of alternative paths to the destination when the hop count is less than the advertised hop count for destination. In case of using the maximum hop count, the advertised hop count does not change for the same sequence number [1] [8]. When a route advertisement, received for a destination is greater in sequence number, the next-hop list and the advertised hop count are therefore re-initialized. AOMDV is used to find the node-disjoint or link-disjoint routes. In order to find node-disjoint routes, every node does not directly reject the duplicate RREQs for every RREQs arriving via a different neighbor of the source gives a definition to a node-disjoint path. This is due to the inability of nodes broadcast duplicate RREQs. Thus, any two RREQs reaching at an intermediate node by a different neighbor of the source could not have traversed the same node. In order to have multiple link-disjoint routes, there would be a reply to duplicate RREQs by destination, which replies only to RREQs arriving through distinctive neighbors. After the first hop, the RREPs follow the reverse paths, which are node disjoint and thus link-disjoint. There is a possibility that the paths of each RREP intersects at multi hopes, but each one follows another reply path to the source to guarantee link disjoint [2] [7]. The AOMDV's merit is that it gives the chance to the intermediate nodes to reply to RREQs, while still using disjoint paths. But, AOMDV has consumed more overhead message to find out the routes from any source to destination. Since all possible path must reply to the source by a RREP message, this approach led to increase the routing overhead messages.

AD HOC ON-DEMAND DISTANCE VECTOR ROUTING PROTOCOL

The AODV routing protocol is defined as a reactive routing protocol. This reactive routing seeks routes when the node sends data. Thus, routes are designed when there is a need. The AODV routing protocol contains four control packets: hello messages, route replies (RREPs), route error messages (RERRs), and route requests (RREQs). These are used in two protocol mechanisms, which are discovery of route and route maintenance [3].

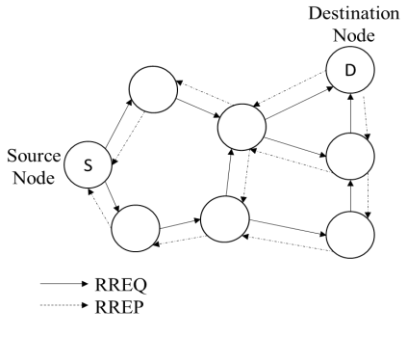

Figure 1: Represent the flooding of RREQ

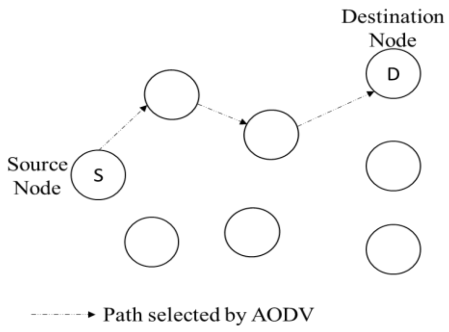

Figure 2: Represent the path selection by AODV

A routing table is maintained by all the nodes in the AODV protocol in order to store information concerning active routes from source to destination. The stored information includes number of hops, destination sequence number, next hop, active neighbors for a route, and the destination of a route table entry and its expiry time. Update of route entry timeouts is done whenever used. In order to stop looping in distance vector routing, a sequence number is sent with RREQs and RREPs. Both of RREQs and RREPs are saved in the routing table. When there are multiple replies for the node, the reply that has the higher sequence number is used. Mechanism of AODV determines that when two routes have the same sequence number, the use of the shorter route is required [5].

NETWORK SIMULATOR

An object-driven network simulator, network simulator version 2 (NS-2) was developed at the University of California-Berkeley. Such simulator utilises two programming languages: C++ and OTcl. NS-2 is useful for the simulation of the wide-area and local networks [6]. These programming languages are used for numerous reasons; most importantly because of their internal characteristics. While C++ provides efficiency in its implementation of a specific design, it encounters some difficulties in graphic representation. Without a visual language that is easy-to-use and descriptive, it could be difficult to perform the modification and assembly of different components as well as the altering of different parameters [9].

The effectiveness of NS-2 is evident in the way it separates the implementation of the control path from the data path implementations. To lessen packet and event processing time, the basic network component objects contained in the data path, as well as the event scheduler, are written and compiled with the use of C++. On the other hand, OTcl possesses a few features that C++ does not possess. Combining these two programing languages is thus influential in the meantime of its practical implementation. C++ is used to perform the detailed protocol, while OTcl is employed to enable users to schedule the events and have control over the simulation scenario. The OTcl script has the following functions: to initiate the event scheduler and to create the network topology. It also controls when the traffic source will start or stop sending packets using the event scheduler. By changing the OTcl script based on the user's needs, each scenario could be easily changed. Figure 3.4 illustrates NS-2 from the user's perspective.

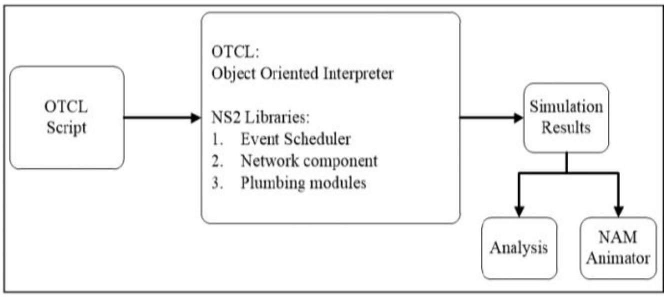

Figure 3: Structure of NS2

PERFORMANCE METRICS FOR COMPARISON

There are different performance metrics used to evaluate the protocol. These metrics use to calculate the amount of data that received by destination, the number of packets drop, the require time to send data, and the energy consumption for the nodes in the network. In this paper we used five performance metrics that shown below:

Packet Delivery Ratio: The percentage of data packets that is received by destinations over the percentage of data packets sent by the source. It determines the rate of packet loss, which creates limits to the network's maximum throughput.

End-to-end Delay: This metric defined as summation of time spend to send data from source node to destination node. There are different types of delay such as packet wait in queue, processing, propagation.

Throughput is defined as an actual data packet that received by the destination node. The most significant for best-effort traffic are the first two metrics. The routing load metric gives an evaluation to the routing protocol's efficiency. It is noteworthy, however, that these metrics are not independent.

Routing Overhead Ratio The metric of routing overhead ratio is the total number of routing packets. The number is divided by the overall number of data packets that were delivered. Hence, this metric offers an idea about the extra bandwidth that is consumed by the overhead for the sake of delivering data traffic. Routing overhead has an effect on the network's robustness in terms of the bandwidth utilisation and battery power consumption of the nodes.

SIMULATION PARAMETERS AND RESULTS

As already outlined we have taken Ad hoc On-Demand Distance Vector Routing (AODV), and Ad-hoc On-demand Multipath Distance Vector Routing (AOMDV). Random waypoint mobility is the mobility model used due to its modeling of the mobile nodes' random movement. We used two seniors, in the first one we varying the number of nodes from 50 up to 150, the second scenario we change the simulation time, these scenarios shown in the table 1.

Table 1: Represent the simulation paramaeters

PARAMETER	VALUE	UNIT
Simulator	NS 2.35	
Simulation area	750X750	m2
Number of nodes	50, 75, 100, 125,125	node
Simulation time	10, 30, 50, 70, 90, 110	Sec
Packet rate	512	Kbps
Traffic type	CBR	

The ratio of Packet delivery, end to end delay, routing overhead and throughput are calculated for AODV and AOMDV. Below is the analysis of the results and their corresponding graphs.

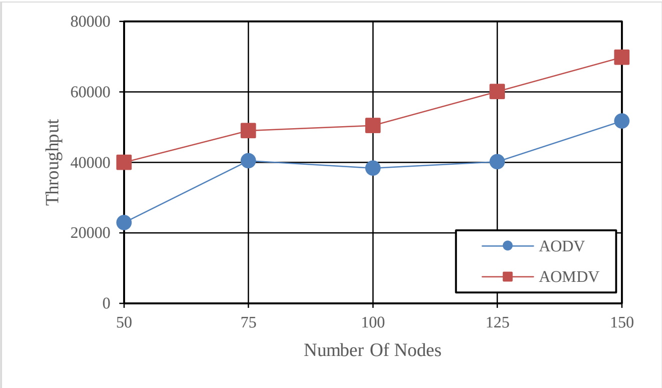

Figure 4

The varied throughput for AODV and AOMDV is represent in figure (4). The throughput of both protocols are increase when the number of nodes increase due to the connection between source and destination be faster and easier.

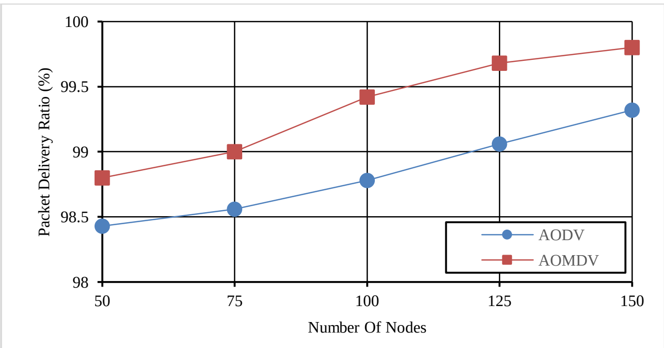

Figure 5

The study of the figure 5 for PDF shows that when the number of nodes increases the AOMDV has a better PDF when compared to AODV because the AOMDV have different route between source and destination nodes.

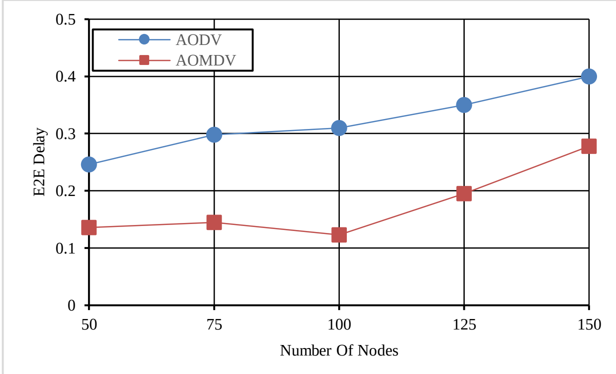

Figure 6

Figure: 6 for E2E delay, we note that when the number of nodes increase the delay increase in AOMDV and AODV. But The AOMDV has a less end-to-end delay than AODV. In general the end-to-end delay is caused by route failure so the source needs to initiate a RREQ to find other routes to the destination, queuing in the interface queue and many other reasons.

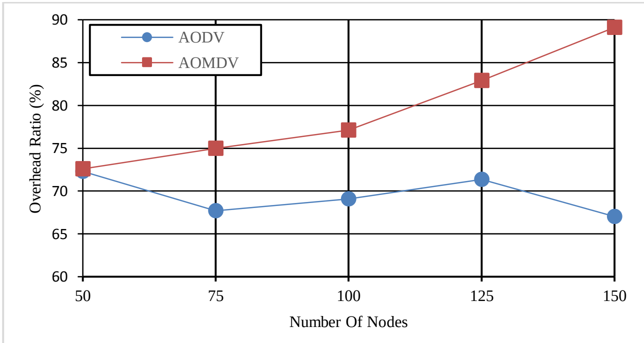

Figure 7

Figure: 7 represent the varied overhead ratio for AODV and AOMDV. The AODV protocol has better performance than AOMDV protocols in terms of routing overhead ratio. The reason is as the AODV need a less RREQ message than AOMDV.

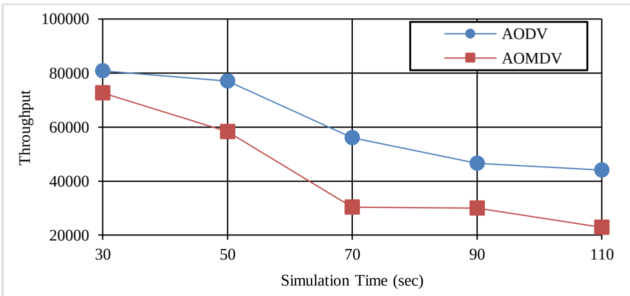

Figure 8

Figure: 8 represent the varied throughput for AOMDV and AODV. The AODV protocol has better performance than AOMDV protocols in terms of throughput when the simulation time increase on account of the probability of link failure in AODV is less Than AOMDV.

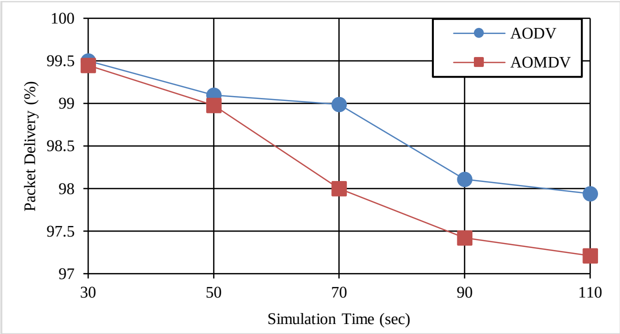

Figure 9

The study of the figure 9 for PDF shows that when there is an increase in simulation time, the AODV has a better PDF when it is compared to AOMDV. The better performance of AODV protocol is due to the strong and short routes it selects to forward the data traffic, which reduce the packet loss.

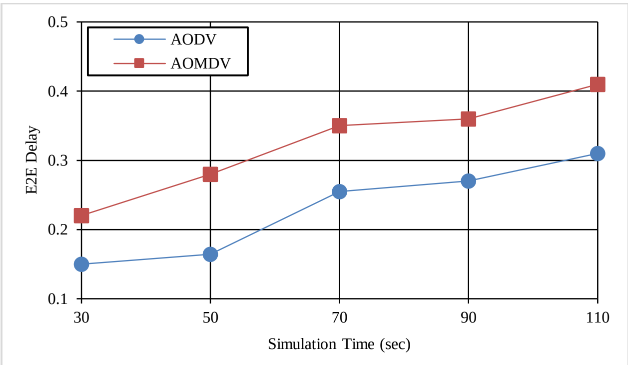

Figure 10

Figure: 10 shown the AODV routing protocol has better end-to-end delay than AOMDV routing protocols, the reason is that the source node will always select short and stable routes which minimize the time taken for a packet to transfer over the network.

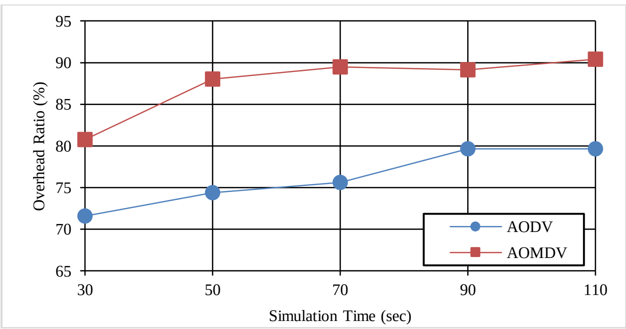

Figure 11

Figure: 11 represent the varied overhead ratio for AODV and AOMDV. The AODV protocol has better performance than AOMDV protocols in terms of routing overhead ratio. The reason is as explained previously, The reason is as the AODV need a less RREQ message than AOMDV due to the AODV establish only one path from source and destination nodes, this mechanism require lees routing message in the network.

CONCLUSION AND FUTURE WORK

This paper introduced the evaluation of the performance of AODV and AOMDV via the use of ns-2.35 simulator. The comparison depended on the number of nodes and simulation time. Thus, we conclude that these parameters have a significant impact on the performance metrics of the routing protocols analysed in this study.The results shown the AODV has better performance than AOMDV when the number of nodes increased. But AOMDV has better performance when simulation time increased except the overhead. The overhead ratio for AOMDV is higher than AODV in both scenarios that mean the AOMDV consume energy more than AODV. Future studies would involve the study of optimization algorithms like local search or the global search algorithms, or even involve a hybrid between the two algorithms which would enable tackling the problem of overhead ratio in the AOMDV routing protocols.

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