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Comparative Performance Evaluation of Routing Protocols for Mobile Adhoc Networks

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ABSTRACT : Due to mobility of nodes, dynamic topology of the network, lack of centralized mechanism makes MANET more vulnerable. One of the main issues in Ad-hoc networks is to develop a routing protocol which must be capable of handling very large number of nodes with limited bandwidth and power availability. The performance of these routing protocols is evaluated with respect to routing Throughput, Packet Delivery Ratio and End to End Delay in different scenarios.

Keywords: Dynamic topology, Destination Sequenced Distance Vector (DSDV), Ad hoc On Demand Distance Vector (AODV), OLSR

I. INTRODUCTION

The history of wireless networks started in the 1970s and the interest has been growing ever since. At present, this sharing of information is difficult, as the users need to perform administrative tasks and set up static, bi-directional links between the computers. This motivates the construction of temporary networks with no wires, no communication infrastructure and no administrative intervention required. Such interconnection between mobile computers is called an Ad hoc Network. Ad hoc networks are emerging as the next generation of networks and defined as a collection of mobile nodes forming a temporary (spontaneous) network without the aid of any centralized administration or standard support services. In Latin, ad hoc literally means "for this," further meaning "for this purpose only" and thus usually temporary [1]. An ad hoc network is usually thought of as a network with nodes that are relatively mobile compared to a wired network. dynamic and the changes are often unpredictable oppose to the Internet which is a wired network. This fact creates many challenging research issues, since the objectives of how routing should take place is often unclear because of the different resources like bandwidth, battery power and demands like latency.

MANETs have several salient characteristics : 1. Dynamic topologies 2. Bandwidth constrained, variable capacity links 3. Energy-constrained operation 4. Limited physical security. Therefore the routing protocols used in ordinary wired networks are not well suited for this kind of dynamic environment. Routing algorithms are often difficult to be formalized into mathematics they are instead tested using extensive simulation. Recently more attention. A MANET uses multi-hop routing instead of a static network infrastructure to provide network connectivity. Several routing protocols have been proposed for mobile Ad Hoc networks. In this paper we present a number of ways of classification or categorization of these routing protocols and did the performance comparison of an AODV, DSDV and OLSR routing protocols.

II. MANET ROUTING PROTOCOL

There are different criteria for designing and classifying routing protocols for wireless ad hoc networks. For example, what routing information is exchanged; when and how the routing information is exchanged, when and how routes are computed etc.

A. Proactive (Table-Driven) Routing Protocols

These routing protocols are similar to and come as a natural extension of those for the wired networks. In proactive routing, each node has one or more tables that contain the latest information of the routes to any node in the network. Each row has the next hop for reaching a node/subnet and the cost of this route. Various table-driven protocols differ in the way the information about a change in topology is propagated through all nodes in the network. There exist some differences between the protocols that come under this category depending on the routing information being updated in each routing table. Furthermore, these routing protocols maintain different number of tables. The proactive protocols are not suitable for larger networks, as they need to maintain node entries for each and every node in the routing table of every node. This causes more overhead in the routing table leading to consumption of more bandwidth. Examples of such schemes are the conventional routing schemes, Destination Sequenced Distance Vector (DSDV).

B. Reactive (On-Demand) Protocols

Reactive routing is also known as on-demand routing protocol since they don't maintain routing information or routing activity at the network nodes if there is no communication. These protocols take a lazy approach to routing. They do not maintain or constantly update their route tables with the latest route topology. If a node wants to send a packet to another node then this protocol searches for the route in an on-demand manner and establishes the connection in order to transmit and receive the packet. The route discovery usually occurs by flooding the route request packets throughout the network. Examples of reactive routing protocols are the dynamic source Routing (DSR), ad hoc on-demand distance vector routing (AODV).

C. Single Path vs. Multi Path

There are several criteria for comparing single-path routing and multi-path routing in ad hoc networks. First, the overhead of route discovery in multi-path routing is much more than that of single-path routing. On the other hand, the frequency of route discovery is much less in a network which uses multi-path routing, since the system can still operate even if one or a few of the multiple paths between a source and a destination fail. Second, it is commonly believed that using multi-path routing results in a higher throughput.

D. Table Driven vs. Source Initiated

In Table Driven Routing protocols, up-to-date routing information from each node to every other node in the network is maintained on each node of the network. The changes in network topology are then propagated in the entire network by means of updates. Destination Sequenced Distance Vector Routing (DSDV) and is scheme classified under the table driven routing protocols head. The routing protocols classified under Source Initiated On-Demand Routing, create routes only when desired by the source node. When a node requires a route to a certain destination, it initiates what is called as the route discovery process. Examples include DSR and AODV.

III. DESTINATION-SEQUENCED DISTANCE VECTORS 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. It was developed by C. Perkins and P. Bhagwat in 1994. 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, 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/path to the destination. The route labeled with the highest sequence number is always used. This also helps in identifying the stale routes from the new ones, thereby avoiding the formation of loops. Also, to minimize the traffic generated, there are two types of packets in the system. One is known as "full dump", which is a packet that carries all the information about a change. However, at the time of occasional movement, another type of packet called "incremental" will be used, which will carry just the changes, thereby, increasing 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 is necessary before the network re-converges; thus, DSDV is not suitable for highly dynamic networks.

IV. ADHOC ON DEMAND DISTANCE VECTOR (AODV)

The Ad hoc On Demand Distance Vector (AODV) routing algorithm is a routing protocol designed for ad hoc mobile networks. AODV is capable of both unicast and multicast routing. It is an on demand algorithm, meaning that it builds routes between nodes only as desired by source nodes. It maintains these routes as long as they are needed by the sources. Additionally, AODV forms trees which connect multicast group members. The trees are composed of the group members and the nodes needed to connect the members. AODV uses sequence numbers to ensure the freshness of routes. It is loop-free, self-starting, and scales to large numbers of mobile nodes. The AODV protocol uses route request (RREQ) messages flooded through the network in order to discover the paths required by a source node. An intermediate node that receives a RREQ replies to it using a route reply message only if it has a route to the destination whose corresponding destination sequence number is greater or equal to the one contained in the RREQ. The RREQ also contains the most recent sequence number for the destination of which the source node is aware. A node receiving the RREQ may send a route reply (RREP) if it is either the destination or if it has a route to the destination with corresponding sequence number greater than or equal to thatcontained in the RREQ. If this is the case, it unicasts a RREP back to the source. Otherwise, it rebroadcasts the RREQ. Nodes keep track of the RREQ's source IP address and broadcast ID. If they receive a RREQ which they have already processed, they discard the RREQ and do not forward it. As the RREP propagates back to the source nodes set up forward pointers to the destination. Once the source node receives the RREP, it may begin to forward data packets to the destination. If the source later receives a RREP containing a greater sequence number or contains the same sequence number with a smaller hop count, it may update its routing information for that destination and begin using the better route. As long as the route remains active, it will continue to be maintained. A route is considered active as long as there are data packets periodically traveling from the source to the destination along that path. Once the source stops sending data packets, the links will time out and eventually be deleted from the intermediate node routing tables. If a link break occurs while the route is active, the node upstream of the break propagates a route error (RERR) message to the source node to inform it of the now unreachable destination(s).

V. OPTIMIZED LIND STATE ROUTING (OLSR)

Optimized Link State Routing (OLSR) protocol is a proactive routing protocol where the routes are always immediately available when needed. OLSR is an optimization version of a pure link state protocol in which the topological changes cause the flooding of the topological information to all available hosts in the network. OLSR may optimize the reactivity to topological changes by reducing the maximum time interval for periodic control message transmission. Furthermore, as OLSR continuously maintains routes to all destinations in the network, the protocol is beneficial for traffic patterns where a large subset of nodes are communicating with another large subset of nodes, and where the [source, destination] pairs are changing over time.

OLSR protocol is well suited for the application which does not allow the long delays in the transmission of the data packets. The best working environment for OLSR protocol is a dense network, where the most communication is concentrated between a large numbers of nodes. OLSR reduce the control overhead forcing the MPR to propagate the updates of the link state, also the efficiency is gained compared to classical link state protocol when the selected MPR set is as small as possible. But the drawback of this is that it must maintain the routing table for all the possible routes, so there is no difference in small networks, but when the number of the mobile hosts increase, then the overhead from the control messages is also increasing. This constrains the scalability of the OLSR protocol. The OLSR protocol work most efficiently in the dense networks.

VI. EXPERIMENTAL SETUP AND PERFORMANCE MATRICS

We are using Network Simulator NS-2.30 for simulation of the routing protocols. For all the simulations, the number of traffic sources was varied as 25, 50 and 75, the maximum speed of the nodes was set to 20 m/s and the simulation time was varied as 150s, 200s, and 500s.

Table 1 : Scenario Table.

Parameter	*Value*
Number of nodes	25,50 and 75
Simulation Time	150, 200 and 500 Sec
Pause Time	5ms
Environment Size	800 × 800
Transmission Range	250 m
Traffic Size	CBR (Constant Bit Rate)
Packet Size	512 bytes
Packet Rate	5 packets/s
Maximum Speed	20 m/s
Simulator	ns-2.30

In order to evaluate the performance of ad hoc network routing protocols, the following metrics were considered :

Packet delivery fraction : The ratio of the data packets delivered to the destinations to those generated by the CBR sources.

Throughput : The ratio of the number of data packets sent and the number of data packets received.

Average End to End Delay Result : The delay is affected by high rate of CBR packets as well. The buffers become full much quicker, so the packets have to stay in the buffers a much longer period of time before they are sent.

VII. RESULTS

For 25 Nodes

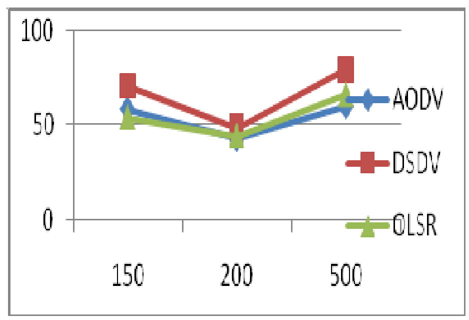

Fig. 1. Packet delivery fraction.

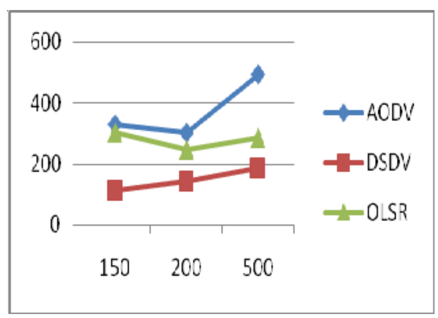

Fig. 2. Average End to End Delay.

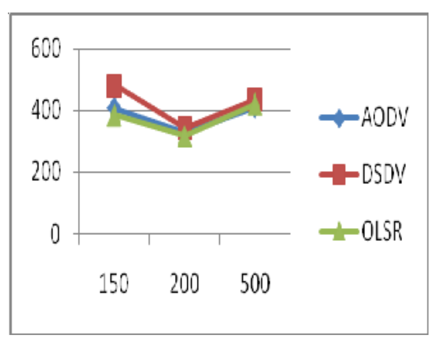

Fig. 3. Throughput.

For 50 Nodes

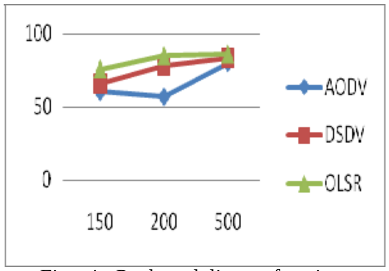

Fig. 4. Packet delivery fraction.

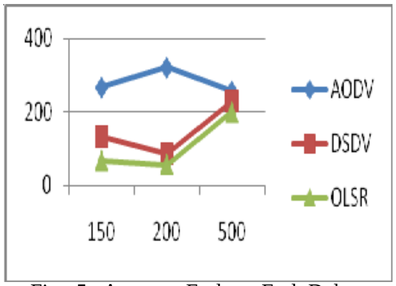

Fig. 5. Average End to End Delay.

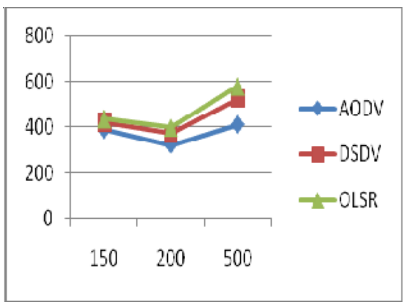

Fig. 6. Throughput.

For 75 Nodes

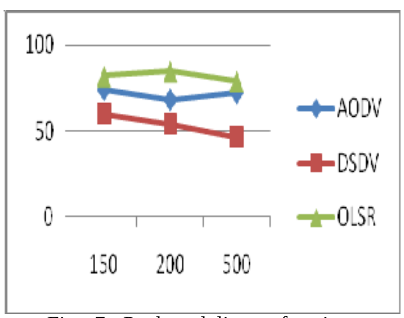

Fig. 7. Packet delivery fraction.

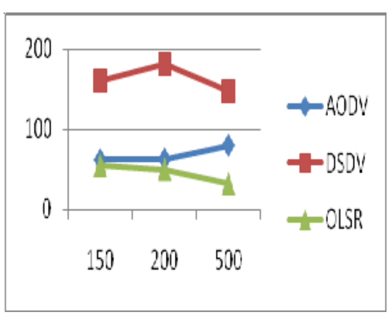

Fig. 8. Average End to End Delay.

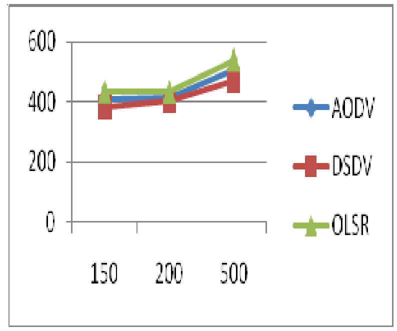

Fig. 9. Throughput.

VIII. CONCLUSION

It is difficult for the quantitative comparison of the most of the ad hoc routing protocols due to the fact that simulations have been done independent of one another using different metrics and using different simulators. This paper does the realistic comparison of three routing protocols DSDV, AODV and OLSR. The significant observation is, simulation results agree with expected results based on theoretical analysis. It is difficult to say which one among the various adhoc routing protocols give the best result because in different situations different protocols gives the best performance, which totally depends on the parameters considered for the protocols comparison. This paper does the realistic comparison of three routing protocols DSDV, AODV and OLSR. As we can find in the graph shown above three parameters are considered packet delivery fraction, end-to-end delay and throughput are considered with varying no. of nodes. As the no. of nodes are increasing performance of the protocol also varies and we can conclude from the above graphs that OLSR is the best protocol among AODV, DSDV, OLSR as it gives the best performance as per the conditions considered in the paper.

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