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Performance comparison of DSR and AODV Routing Protocol in Mobile Ad hoc Networks

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Abstract

Mobile ad hoc network is a dynamic network. In this network the mobile nodes dynamically form a temporary network without any centralized administration or the use of any existing network infrastructure. A number of routing protocols like Ad Hoc On-Demand Distance Vector Routing (AODV), Dynamic Source Routing (DSR) and Destination-Sequenced Distance-Vector (DSDV) have been proposed. On-Demand Distance Vector Routing (AODV), Dynamic Source Routing protocol (DSR) are an efficient routing protocol designed specifically for use in wireless ad hoc networks of mobile nodes. In this work an attempt has been made to check the performance comparison of AODV and DSR routing protocols for mobile ad hoc networks on the basis of varying number of nodes and varying node speed. The simulations are carried out using MATLAB.

Index Terms: DSR, AODV, MANET, Performance Evaluation, Protocol, MATLAB

I. INTRODUCTION

A mobile ad hoc network (MANET) is formed from the collection of a number of wireless mobile devices without having any fixed infrastructure. Here each node can work as a source, destination or routing node. The nodes of MANET are allowed to move freely in random pattern. The mobility and transmission power of mobile nodes plays an important role on performance of MANET routing protocols[1] .There is a classification for these protocols as table-driven (proactive) and source initiated (routing) protocols. In proactive routing protocols, routing tables are used to keep route information from each source to every destination in network before the route is needed. On the other hand, in reactive routing protocols, a source sends a route discovery through the network, only when the route is required .Dynamic Source Routing (DSR) and Ad hoc On-Demand Distance Vector (AODV) are two types of reactive Protocols [2] .Without any wired infrastructure, MANET could be deployed in applications such as search and rescue, automated battlefields, disaster recovery, intelligent transportation and sensor networks [3]. A basic hypothesis in ad-hoc networks is that each node can be used to send data packets among arbitrary sources and destinations. Hence, some kind of routing protocol is required in order to make routing decisions. Many problems such as mobility and limited bandwidth are introduced in a wireless ad-hoc environment which makes routing complicated [4] .Dynamic topology, asymmetric links, routing overhead and interference are challenges that make routing in mobile ad hoc networks a difficult task [5] .The performance analysis of a mobile ad-hoc network depends on the routing scheme employed, and the conventional routing protocols do not work efficiently in a MANET. In MANET Energy efficient routing protocols are the only solution to above circumstances. Most of the existing work of making protocols energy efficient has been done on “on demand routing protocols” because these protocols are more energy efficient rather than proactive protocols but still these have some problems [6]. Ad hoc networks are based on the multi-hop relaying principle, where a node that needs to communicate with another one, which is positioned outside of its wireless transmission range of the source, depends on the intermediate nodes to transfer the message from the source to the destination. Hence, intermediate nodes cooperate within the network in order to deliver messages designating each node to act as a router [7] .One of the important issues in MANETs is energy consumption since mobile nodes have limited energy resources. The design of energy efficient routing protocols has been considered a critical and key issue. The efficiency of MANET routing protocol is not only to establish an efficient route between a pair of nodes, but also to find a proper way to conserve mobile node energy. There have been many researches related to energy issue in MANET routing protocols. Energy management can be performed by finding optimal path that costs minimum energy consumption, improving battery life and enhancing hardware devices such as processor (CPU) and network interface card (NIC) [8] .Compared to wired network, mobile network have unique characteristics. In mobile network node mobility may cause frequent change in network topology, which is rare in wired network. In contrast to the stable link capacity of wired network, wireless link capacity continuously varies because of the impacts from transmission power, receiver sensitivity, noise, fading and interference. Active research work for mobile ad-hoc network is carried out mainly in field of medium access control, routing, resource management, power control and security [10] .For the optimum performance, it is necessary that all the nodes in the network cooperate with others because these nodes has limited resources like limited memory and battery power, it may be possible that after some time node will not cooperate in the network for saving its resources for its own use [11].

II. DSR ROUTING PROTOCOL

DSR uses 'source routing' i.e. the senders node knows the complete hop-by-hop route to the destination and these routes are stored in its route-cache. In route cache a number of routes may be available to the destination [1]. When the destination is not known, node caches the packet and finds the routing information to the destination by sending route queries to all nearby nodes. Then it sends the Route-Replies back to the source [2] Therefore, bandwidth overhead reduces, battery power conserves and large routing updates will be avoided. Nonetheless, for discovering a link failure, it requires the MAC layer support. The DSR routing protocol uses two major mechanisms to discover routes and maintain the route information from one node to another. These are: Route discovery – to discover the route between the source and destination and Route maintenance – facing with route failure, another route is invoked from the destination. DSR has a distinctive advantage which is source routing. Since the route is a partial of the packet, routing loops, both short – lived or long – lived, cannot be created as detecting or eliminating quickly. This property creates a number of helpful optimizations for DSR. This routing protocol responds the idea of source routing, meaning that the source defines the whole path from the source to the destination node that the messages should be transmitted, and thus ensures that routing is inconsequentially loop-free in the network. In DSR each packet carries all information related to route in its header. Therefore, the intermediate nodes are permitted to accumulate the route information in their routing tables for future usage [4]. If a node has to send a packet to another one, and it has no route, it initiates a route discovery process. The route discovery in DSR is performed by flooding the network with RREQ packets. However, the major difference is that the RREQ packet contains a route record in this protocol. While the RREQ traverses the intermediate nodes, each node performs a cache check to examine, if it has a route to the destination; if it does not, it appends its own address in the route record and forwards the packet to the next node. Once the RREQ packet reaches the destination or an intermediate node that has the destination route, it generates a RREP message, which contains the route record of the RREQ including the addresses of the intermediate nodes. Therefore, the source node will possibly receive many RREP packets from different nodes containing multiple routes to the destination. The DSR protocol selects one of these routes, which constitutes the shortest one and caches the others in case of a link failure. DSR allows those nodes that have already dealt with a RREQ message to reject any further RREQ regarding the same source node [7]. One big advantage is that intermediate nodes can learn routes from the source routes in the packets they receive. Since finding a route is generally a costly operation in terms of time, bandwidth and energy, this is a strong argument for using source routing. Another advantage of source routing is that it avoids the need for up-to-date routing information in the intermediate. Finally, it avoids routing loops easily because the complete route is determined by a single node instead of making the decision hop-by-hop [9]. If any link of this route is broken, the source node is informed by a route error (RERR) packet and this route is discarded from cache. Intermediate nodes store the source route in their cache for possible future use [12].

III. AODV ROUTING PROTOCOL

AODV is an on-demand routing protocol, in which the route search process is initiated between the source and destination node as when needed. In this protocol each node maintains routing information in the form of a routing table having one entry per destination [1] .AODV uses the destination sequence number to guarantee the route freshness and loop freedom of the route [2]. The drawback of such protocols is that broadcasting is derived from request for packets. Hence, some stale routes might be present in the routing tables which are not updated. It means misbehavior routing is not detectable rapidly [4]. Each time a request is received for sending a message by an AODV router, its routing table will be checked for existence of a route. When a route exists, the message is forwarded to the next hop by the router. Otherwise, the message will be sent in a message queue, and then a route request will be initiated to find out a route. Four types of control messages are used in AODV protocol. Route Request (RREQ) and Route Reply (RREP) messages are used for route finding. Route Error (RERR) messages and HELLO messages are utilized for route repairs [10]. Route discovery process begins when one of the nodes wants to send packets. That node sends Route Request (RREQ) packets to its neighbors. Neighbors return RREP, packets if they have corresponding route to destination. However, if they don't have corresponding route, they forward RREQ packets to their neighbors, except the origin node. Also, they use these packets to build reverse paths to the source node. This process occurs until a route has been found [5]. Every mobile node maintains a next hop routing table, which contains the destinations to which it currently has a route. In AODV, when a source node desires to send packets to the destination but no route is available, it initiates a route discovery process [6]. The reactive property of the routing protocol implies that it only requests a route when it needs one and does not require that the mobile nodes maintain routes to destinations that are not communicating [9] .If an intermediate node is unable to forward the packet to the next hop or destination due to link failures, it generates the route error (RERR) message by tagging it with a higher destination sequence number. When the sender node receives the RERR message, it initiates a new route discovery for the destination node [12].

IV. SIMULATION ENVIORNMENT AND PERFORMANCE MEASURING PARAMETERS

The main method of evaluating the performance of MANETs is simulation. The simulation of AODV and DSR routing protocol is done in MATLAB. The network is taken as 1000X1000 square meters. The performance is recorded taking different number of nodes and varying speed. The nodes are placed randomly in the network. The packet size is taken as 512 bytes and the traffic type is Constant bit rate (CBR). The parameters taken for simulation are listed below in the Table 1

Table 1

PARAMETERS	USED IN SIMULATION
Simulator/software	MATLAB(2010)
Channel type	wireless channel
Antenna type	Omni Antenna
Radio-propagation model	two ray ground
Mac type	Mac/802.11
Protocols studied	DSR and AODV
Simulation area	1000×1000 square meter
Transmission range	250m
Node movement model	Random waypoint
Traffic type	CBR(UDP)
Packet size	512 Bytes
Number of nodes	50
Speed	10to 50m/sec

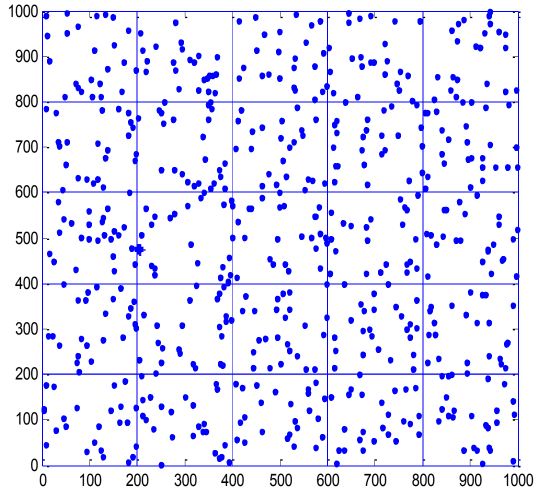
The performance is measured on the basis of some parameters which are described as follows:

Packet Delivery Ratio- Packet delivery ratio is defined as the number of packets actually delivered to the Destination to the number of data packets supposed to be received .The better the packet delivery ratio, the more complete and correct is the routing protocol.

Average end-to-end delay: - Average end-to-end delay signifies how long it will take a packet to travel from source to destination node. It includes delays due to route discovery, queuing, propagation delay and transfer time. This metric is useful in understanding the delay caused while discovering path from source to destination.

Throughput- Throughput is the ratio of number of packets sent and total number of packets. It describes the average rate of successful message delivery over a communication channel. Throughput measures the efficiency of the system.

Normalized Routing Load (NRL): It is the ratio of number of routing packets and number of received packets at the destination.



Simulation environment 1000X 1000 sq .m

V. SIMULATION RESULTS AND ANALYSIS

Simulation study shows that performance of routing protocol in terms of throughput, packet delivery ratio, end to end delay and routing overhead and energy consumption strongly depends upon network conditions such as mobility, no. of nodes .The set of experiments uses varying no. of nodes and varying speed to analyze throughput, packet delivery ratio, end to end delay, routing overhead and energy consumption.

Performance analysis with varying node density and node mobility

1) packet delivery ratio vs. nodes

Figure 1indicates the plot between packet delivery ratio and no. of nodes. Packet Delivery Ratio decreases as the number of nodes increases. Packet delivery ratio for AODV is better than DSR in high mobility condition. This happens because there are more link break in DSR due to source routing and less in AODV because of its table driven routing. As packets move from source to destination, the collision occurs due to traffic, which causes loss of packets. Moreover, the mobility of nodes may lead nodes to move out of network and packet does not reach the desired destination node. In low mobility, link break in both protocols is less but packet delivery ratio in DSR is better than AODV because of alternate route available in route chache of DSR. In case of AODV it has to reinitiate a route discovery again.

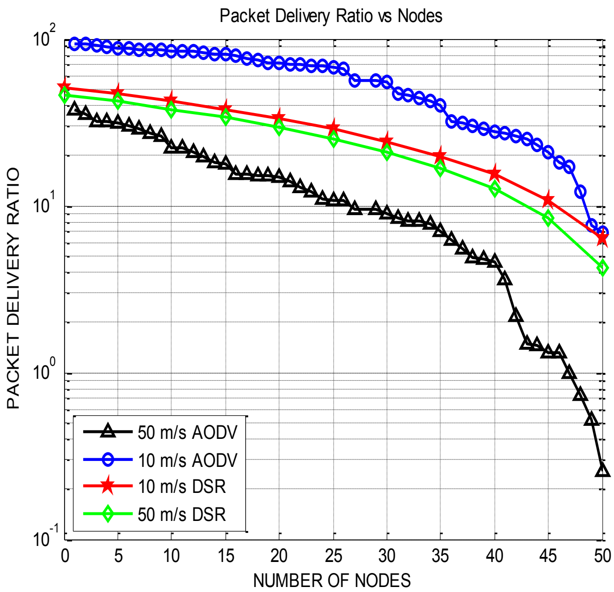


Fig.1 Packet delivery ratio vs. no. of nodes for speed 10m/s and 50m/sec

2) Packet miss ratio vs. number of nodes

Figure 2 indicates the plot between packet miss ratio and no. of nodes. Packet Miss Ratio increases as the number of nodes increases. Packet miss ratio for AODV is less than DSR in high mobility condition. This happens because there are more link break in DSR due to source routing and less in AODV because of its table driven routing. As packets move from source to destination, the collision occurs due to traffic, which causes loss of packets. In low mobility, link break in both protocols is less but packet miss ratio in DSR is less than AODV because of alternate route available in route chache of DSR. In case of AODV it has to reinitiate a route discovery again.

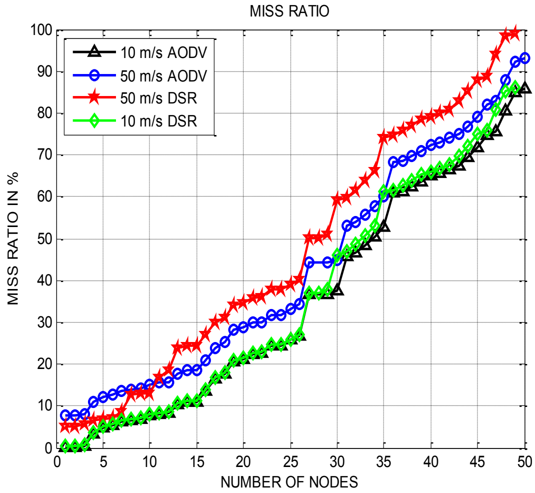


Fig.2 Packet miss ratio vs. no. of nodes for speed 10m/s and 50m/sec

3) Throughput vs. no. of nodes

Figure 3 indicates the graph between throughputs vs. no. of nodes. As the no. of nodes increase, the throughput decrease. This is due to the fact that packet delivered to the destination are lost during transmission. For higher speed AODV perform better than DSR.

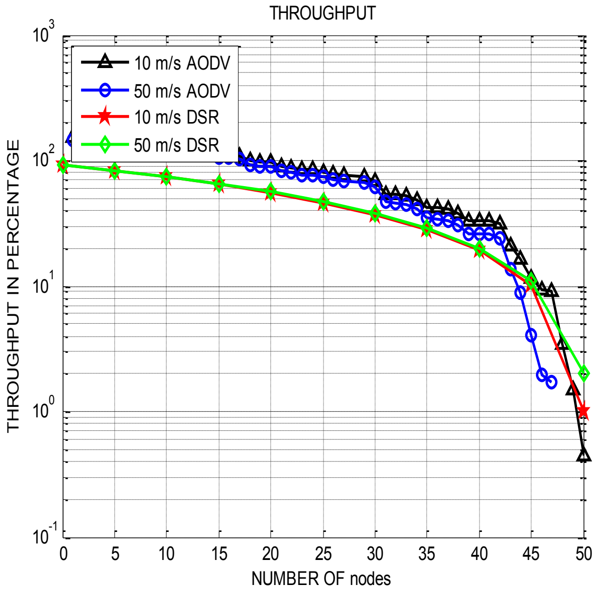


Fig.3 Throughput vs. no. of nodes for speed 10m/s and50m/sec

4) End to End Delay vs. no. of nodes

Figure 4 indicate the graph between end to end delay vs. no. of nodes. It increases as number of nodes increases. End to end delay increases due to aggressive use of caching and lack of any mechanism to expire stale routes or determine the freshness of routes in DSR. AODV protocol has a large delay because route discovery takes more time. End to End delay mostly depends on mobility, which is the main cause of link failure. When mobility increases, the probability of link break increases, therefore the no. of control packets for establishing new route increases .Which leads to increases in end to end delay. AODV shows more end to end delay at low and high speed in comparison to DSR. It is observed that routing load is mostly due to RREQ packets .In case of link break, source generates the RREQ packets in search of new route to destination.

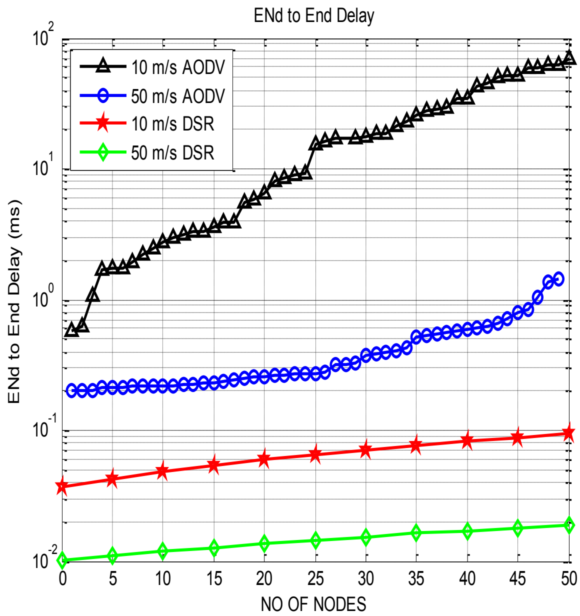


Fig. 4 End to end delay vs. no. of nodes for speed 10m/s to50m/sec

5) Routing Over head vs. no. of nodes

Figure 5 indicates the plot between routing overhead and no. of nodes. Node density may increases the probability of collision, which in turn, leads to more retransmission attempts, thereby number of control packets for establishing a new route increases, which leads to increase in routing overhead in DSR. Routing load mostly depends on mobility, which is the main cause of link failure. When mobility increases, the probability of link break increases therefore the no. of control packets for establishing new route increases, which leads to increases in Routing overhead. AODV shows more routing overhead at low and high speed in comparison to DSR. It is observed that routing load is mostly due to RREQ packets as in case of link break, source generates the RREQ packets in search of new route to destination

6) Energy consumption vs. no. of nodes

Figure 6 indicates the plot between energy consumption and no. of nodes .When the number of nodes increases, the energy consumption of AODV increases .To maintains the routing information of all nodes, the number of the packets needed increased rapidly at high node density. So the consumption increases sharply in case of AODV. Energy consumption remains constant for DSR for both speeds.

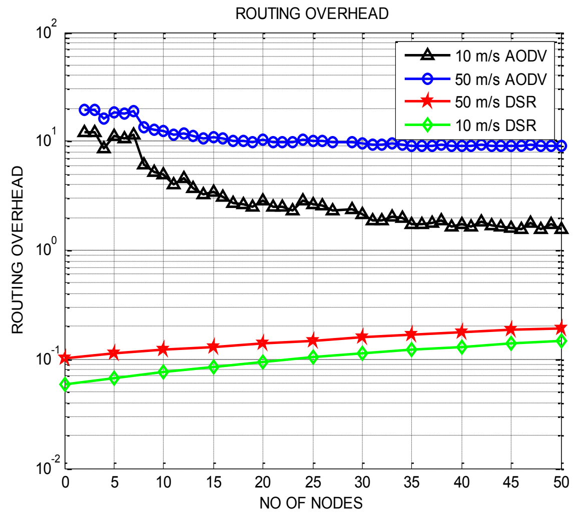


Fig.5 routing overhead vs. no. of nodes for Speed 10m/sec and50m/s.

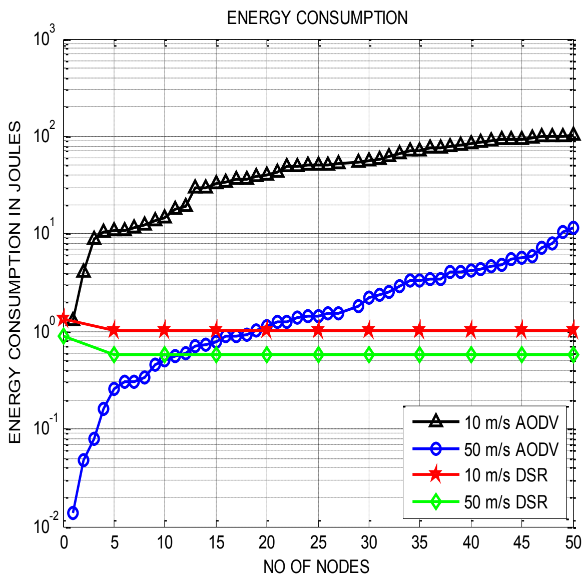


Fig.6 *Energy consumption* vs. no. of nodes for speed 10m/sec and 50m/s

VI. CONCLUSION

In this work, performance of mobile ad hoc network routing protocol DSR and AODV has been studied and evaluated by using MATLAB. Performance carried out in terms of packet delivery ratio, packet miss ratio, Throughput, end to end delay, routing overhead and energy consumption. From the analysis, it is observed that packet delivery ratio, throughput decreases as node density and node speed increases. Also it is observed that end to end delay and routing overhead increases as node density and node speed increases for both protocols. Packet delivery ratio for AODV is better than DSR in high mobility condition. AODV shows more end to end delay at low and high speed in comparison to DSR. Also it is analyzed that AODV shows more routing overhead at low and high speed in comparison to DSR. Energy consumption in DSR is almost constant as the no. of nodes increases but in case of AODV it increases as no. of nodes increases.

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