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Performance Evaluation of Routing Protocols For High Density Ad Hoc Networks based on Qos by GlomoSim Simulator

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***Abstract*—**Ad hoc networks are characterized by multihop wireless connectivity, frequently changing network topology and the need for efficient dynamic routing protocols. We compare the performance of three routing protocols for mobile ad hoc networks: Dynamic Source Routing (DSR) , Ad Hoc On-Demand Distance Vector Routing (AODV), location-aided routing(LAR1).The performance differentials are analyzed using varying network load, mobility, and network size. We simulate protocols with GLOMOSIM simulator. Based on the observations, we make recommendations about when the performance of either protocol can be best.

***Keywords*—**Ad hoc Network , Glomosim , routing protocols.

I. INTRODUCTION

IN an *ad hoc* network, mobile nodes communicate with each other using multihop wireless links. There is no stationary infrastructure; for instance, there are no base stations. Each node in the network also acts as a router, forwarding data packets for other nodes. A central challenge in the design of ad hoc networks is the development of dynamic routing protocols that can efficiently find routes between two communicating nodes. The routing protocol must be able to keep up with the high degree of node mobility that often changes the network topology drastically and unpredictably. Such networks have been studied in the past in relation to defense research, often under the name of packet radio networks [1].

Routes between two hosts in a Mobile Ad hoc NETwork (MANET) may consist of hops through other hosts in the network [7]. Host mobility causes frequent unpredictable topology changes. Therefore, the task of finding and maintaining routes in MANET is nontrivial. Many protocols have been proposed for mobile ad hoc networks, with the goal of achieving efficient routing [6]-[9]-[11]-[13]-[12]-[14]-[15]-[16]-[17]-[18]-[19]-[20]. These algorithms differ in the approach used for searching a new route and/or modifying a known route, when hosts move. The ad hoc routing protocols may be generally categorized as table-driven and source-initiated on-demand driven. The simulation results reported in several papers [23]-[24] show that normally on demand routing protocols have higher packet delivery ratio and need less routing messages than table-driven routing protocols.

Our goal is to carry out a systematic performance study of three on demand routing protocols for high density ad hoc networks: the Dynamic Source Routing protocol (DSR) [3, 4] and the Ad Hoc On-Demand Distance Vector protocol (AODV) [5]- [8] Location-Aided Routing (LAR)[2].

The rest of the article is organized as follows: In the following section, we briefly review the LAR1, DSR and AODV protocols. We present a detailed critique of the three protocols, focusing on the differences in their dynamic behaviors that can lead to performance differences. This lays the foundation for much of the context of the performance study. We describe the simulation environment. We present the simulation results, followed by their interpretations. We finally draw conclusion.

II. DESCRIPTION OF THE PROTOCOLS

A. LAR1

This algorithm uses a request zone that is rectangular in shape. Consider a node *S* that needs to find a route to node *D*.

Assume that node *S* knows that node *D* was at location *(Xd, Yd)* at time *t0*. At time *t1*, node *S* initiates a new route discovery for destination *D*. It assumes that node *S* also knows the average speed **v** with which *D* can move. Using this, node *S* defines the expected zone at time *t1* to be the circle of radius *R = v(t1 _ t0)* centered at location *(Xd, Yd).* When a node receives a route request, it discards the request if the node is not within the rectangle specified by the four corners included in the route request.

For instance, in Fig. 1, if node *I* receives the route request from another node, node *I* forwards the request to its neighbors, because *I* determines that it is within the rectangular request zone. However, when node *J* receives the route request, node *J* discards the request, as node *J* is not within the request zone [2].

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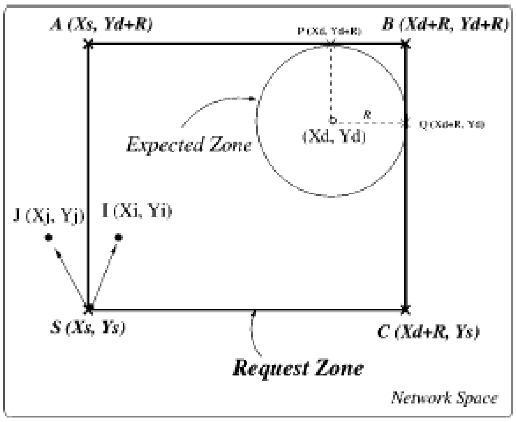

Fig. 1 LAR1 Routing protocol

B. DSR

The key distinguishing feature of DSR [3, 4] is the use of *source routing*. That is, the sender knows the complete hop-by-hop route to the destination. These routes are stored in a *route cache*. The data packets carry the source route in the packet header.

When a node in the ad hoc network attempts to send a data packet to a destination for which it does not already know the route, it uses a *route discovery* process to dynamically determine such a route. Route discovery works by flooding the network with *route request* (RREQ) packets.

Each node receiving an RREQ rebroadcasts it, unless it is the destination or it has a route to the destination in its route cache. Such a node replies to the RREQ with a *route reply* (RREP) packet that is routed back to the original source. RREQ and RREP packets are also source routed. The RREQ builds up the path traversed across the network. The RREP routes itself back to the source by traversing this path backward. The route carried back by the RREP packet is cached at the source for future use. If any link on a source route is broken, the source node is notified using a *route error* (RERR) packet. The source removes any route using this link from its cache. A new route discovery process must be initiated by the source if this route is still needed [4].

C. AODV

AODV [5, 8] shares DSR's on-demand characteristics in that it also discovers routes on an *as needed* basis via a similar route discovery process. Similar to DSR, AODV uses the route discovery and route reply mechanism to create and maintain a route on demand.

However, AODV adopts a very different mechanism to maintain routing information. It uses traditional routing tables, one entry per destination. This is in contrast to DSR, which can maintain multiple route cache entries for each destination. Without source routing, AODV relies on routing table entries to propagate an RREP back to the source and, subsequently, to route data packets to the destination. AODV uses sequence numbers maintained at each destination to determine freshness of routing information and to prevent routing loops [5].

These sequence numbers are carried by all routing packets. Different from DSR, AODV uses a distributed approach, meaning that source nodes do not maintain a complete sequence of intermediate nodes to reach a destination. An important feature of AODV is the maintenance of timer-based states in each node, regarding utilization of individual routing table entries. A routing table entry is *expired* if not used recently. A set of predecessor nodes is maintained for each routing table entry, indicating the set of neighboring nodes which use that entry to route data packets. These nodes are notified with RERR packets when the next-hop link breaks. Each predecessor node, in turn, forwards the RERR to its own set of predecessors, thus effectively erasing all routes using the broken link.

In contrast to DSR, RERR packets in AODV are intended to inform all sources using a link when a failure occurs. Route error propagation in AODV can be visualized conceptually as a tree whose root is the node at the point of failure and all sources using the failed link as the leaves [14].

III. THE SIMULATION MODEL

To compare the routing protocols, a parallel discrete event-driven simulator, *GloMoSim*, was used. GloMoSim (Global Mobile Information System Simulator) is a simulation tool for large wireless and wired networks [10]. We focused on three performance measurements to compare the three routing protocols: mean end-to-end delay, packet delivery rate and routing overhead as measured by the number of control packets generated for routing.

The three measurements in our experiments were defined as follows:

(i) End-to-end Delay: The average time from the beginning of a packet transmission (including route acquisition delay) at a source node until packet delivery to a destination.

(ii) Packet Delivery Rate: Packet delivery rate is the ratio of the number of user packets successfully delivered to a destination to the total number of user packets transmitted by source nodes.

(iii) Messaging Overhead: The number of control packets generated for routing by each routing protocol.

The control parameters we used in our simulation experiments were *traffic load(TL), node density(n)* and *node mobility*.

Traffic load generated by each source node was modeled by a constant bit rate data stream, whose transmission rate was defined by packet transmission interval for fixed size packets. Two different levels of traffic load defined by the packet transmission intervals are, (i) low traffic load: one packet transmitted at every 10 seconds, (ii) medium traffic load: one packet at every second. Movement of each node was modeled using the random waypoint model. In the random waypoint model, each node remains stationary for the duration of its "pause-time". At the end of a pause time, a node starts moving in a randomly selected direction in the network terrain at a fixed speed. Once a node reaches its new location, it remains stationary during its next pause-time. At the end of the new pause time, a node again starts moving in another randomly selected direction in the network. This movement process was continued during a simulation experiment. The network terrain size was fixed for 2,000 * 2,000 meters. The simulation time was 450 seconds for all the experiments.

IV. SIMULATION RESULTS

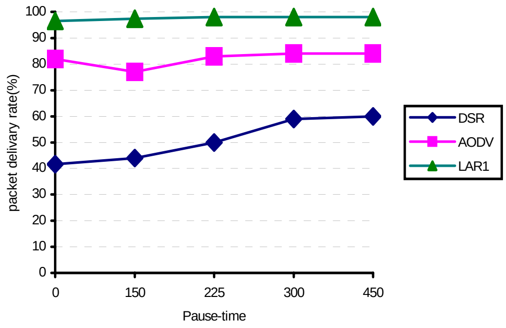

Fig. 2 Packet delivery (n=500, TL=1S)

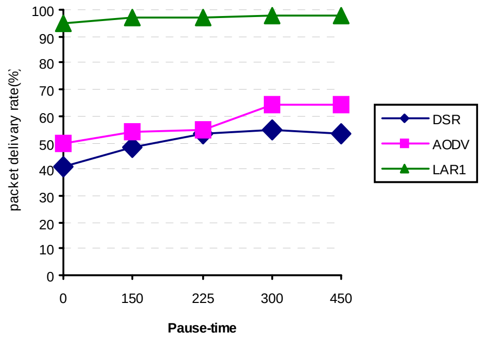

Fig. 3 Packet delivery (n=100, TL=1S)

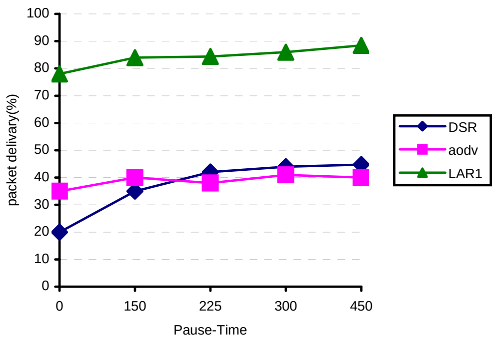

Fig. 4 Packet delivery (n=100,TL=10S)

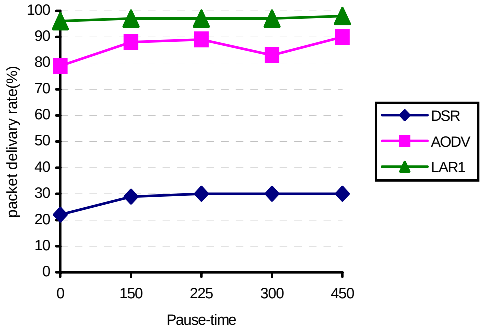

Fig. 5 Packet delivery (n=1000, TL=1S)

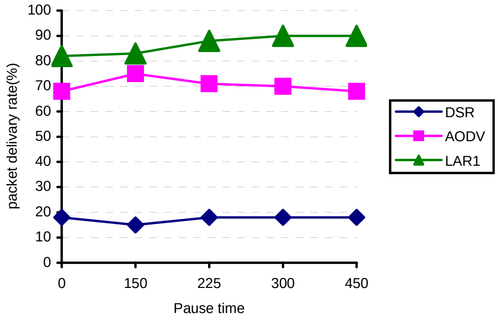

Fig. 6 Packet delivery (n=1000, TL=10s)

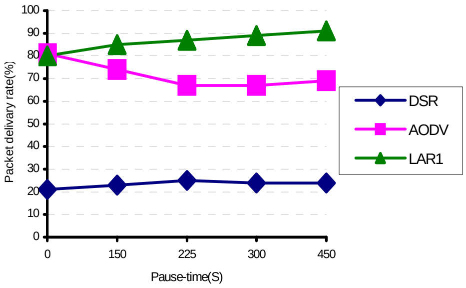

Fig. 7 Packet delivery (n=500, TL=10S)

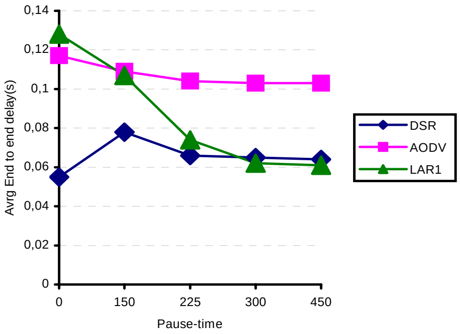

Fig. 8 End to end delay (n=500, TL=1S)

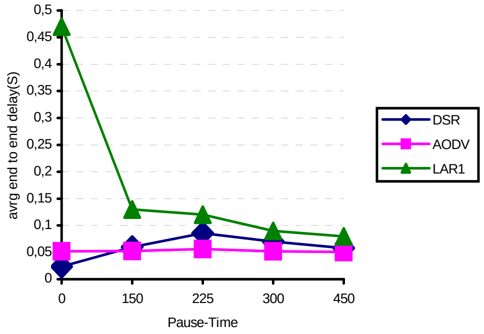

Fig. 9 End to end delay (n=100, TL=1S)

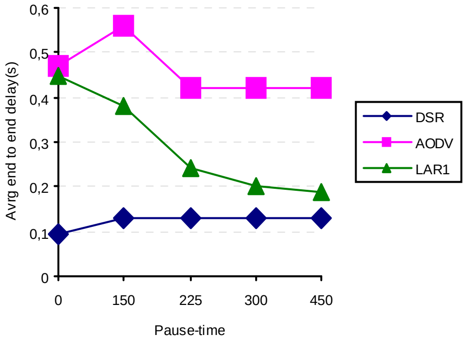

Fig. 12 End to end delay (n=1000, TL=10S)

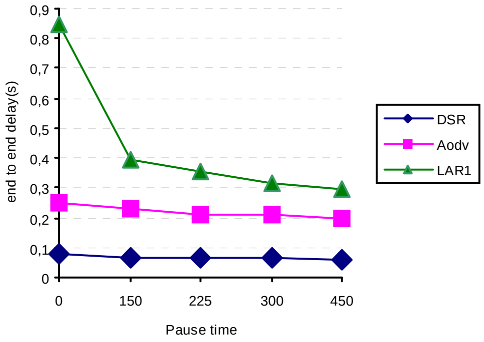

Fig. 10 End to end delay (n=100, TL=10S)

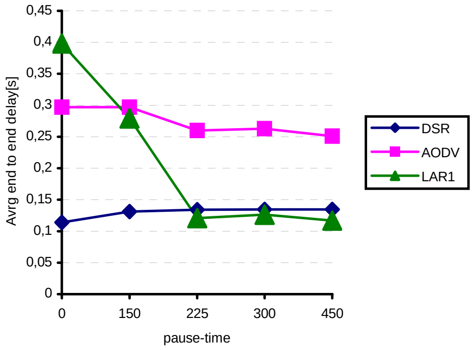

Fig. 13 End to end delay (n=500, TL=10S)

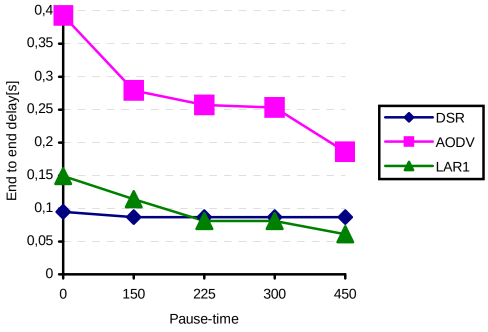

Fig. 11 End to end delay (n=1000, TL=1S)

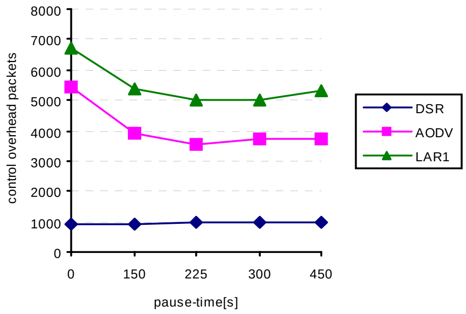

Fig. 14 Routing overhead (n=100, TL=10S)

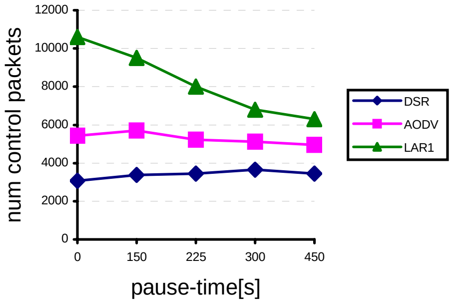

Fig. 15 Routing overhead (n=100, TL=1S)

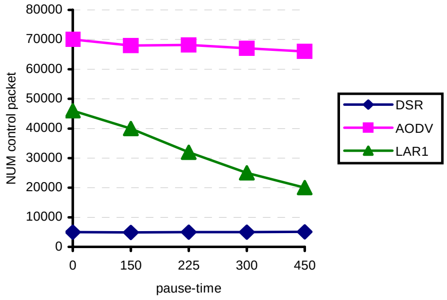

Fig. 16 Routing overhead (n=1000, TL=10S)

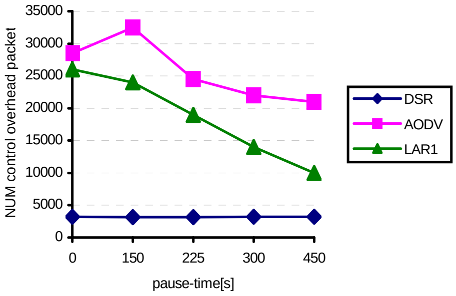

Fig. 17 Routing overhead (n=500, TL=10S)

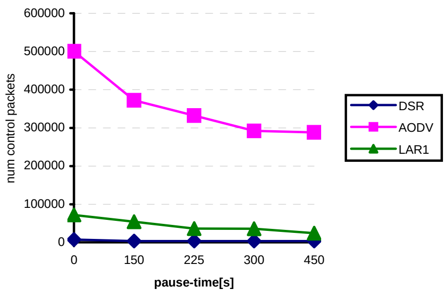

Fig. 18 Routing overhead (n=1000, TL=1S)

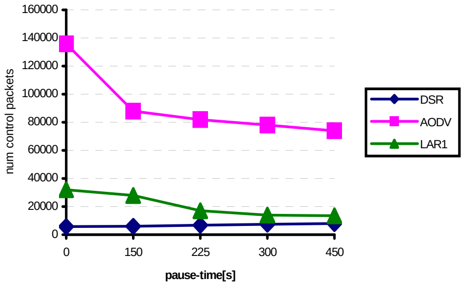

Fig. 19 Routing overhead (n=500, TL=1S)

V. CONCLUSION

We have compared the performance of LAR1, DSR and AODV, three prominent on-demand routing protocols for ad hoc networks. The following is a list of key findings obtained from our experiments:

Finding 1: Contrary to our prediction, *LAR1* performed much better than expected for high density networks .LAR1 is better in packet delivery rate generally.

Finding 2: DSR resulted in the best (i.e.,the least) messaging overhead for all the experiments, and AODV generated higher volume of control packets even than the LAR1 in high density networks. But in low density networks LAR1 generated higher volume of control packets.

Finding 3: End-to-end delay for LAR1 was constantly longer than those of the two other protocols in low density networks. When the node mobility was increased from zero mobility to perpetual mobility, LAR1 resulted in the highest increase rate in end-to-end delay.

Finding 4: End-to-end delay for AODV was constantly longer than those of the two other protocols in high density networks. When the node mobility was increased from zero mobility to perpetual mobility, LAR1 resulted in the highest increase rate in end-to-end delay.

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