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EFFECT OF TERRAIN SIZE AND PAUSE TIME ON THE PERFORMANCE OF REACTIVE ROUTING PROTOCOLS

Muhammad Fayaz, Zia Ur Rahman, Mohsin Ur Rahman, Sohail Abbas

Department of Computer Science and IT, University of Malakand, KPK, Pakistan

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*Corresponding author
fayaz.uom@gmail.com

Abstract

A mobile ad hoc network (MANET) is a group of mobile wireless nodes without pre established infrastructure or central management with frequent changing topology. In the last few years, various routing protocols are targeted specially at MANET have been proposed however little data is available about the effect of various parameters on the performance of these protocols. In this paper, we assess the impact of several terrain areas and pause times on the performance of the two prominent reactive routing protocols; i.e. AODV and DSR and present the results of our simulations. It is observed that the hop-by-hop AODV perform much better for medium size terrain areas while DSR is suitable for small terrain areas. For larger terrain areas, the average end-to-end delay encountered by AODV is very low compared to DSR.

Keywords: Mobile ad hoc network, reactive protocols; proactive protocols; AODV, DSR.

1.0 INTRODUCTION

Mobile Ad-hoc networks can be used to provide connectivity between wireless nodes in areas where there is no fixed infrastructure or pre existing communication infrastructure is not applicable. Such a network enables the wireless nodes to operate autonomously, independently acting both as hosts or router. Further, every node communicated directly with each other that located within their radio range. For destination nodes that resides outside of its (source node) radio range, packets must pass through some intermediate nodes. These networks are also known as infrastructure less networks as they don't require any centralized management or preset infrastructure. Some uses of ad hoc networking include rescue and search operations, disaster recovery, coverage extension and, primarily, military and battlefield communication [1].

A major complexity of ad hoc networking is the discovery of "multi-hop" paths; the source node have to know the path to its required destination to enable information sharing [2]. Several routing protocols have been proposed to overcome this issue. However, small information are available regarding the performance of these protocols and no efforts has formerly been made to find the impact of several terrain areas and pause times on the performance of these protocols.

The main goal of our experiment is to evaluate the impact of several terrain areas as well as pause times on the performance of the two important reactive routing protocols, (i.e. DSR, AODV).The rest of the paper is structured as follows. In section 2 describe MANET protocols in details. Section 3 describes the simulation platform. Results are discussed in section 4. Finally the paper is concluded in section 5.

2.0 AD HOC ROUTING PROTOCOLS

Routing protocols for MANET need to be designed to deal with the specific issues of these networks, like high power expenditure, low bandwidth and high error rates [2]. These protocols are further divided into two major categories: proactive routing protocols and reactive or routing protocols.

2.1 Proactive Routing Protocols

Proactive routing protocols for MANET's are emerged from the conventional link state [4] and distance vector [3] protocols which were mainly developed for the legacy Internet. A distinguishing feature of these protocols is that the responsibility is placed on every node in MANET to constantly keep up-to-date routes to all other nodes in the network. Furthermore, the nodes use routing tables to store routing data or information and utilize sporadic and event-triggered e.g. (triggered via link addition/deletion) messages for route creation and maintenance. Destinations Sequence Distance Vector, Optimized Link State Routing, and Topology Dissemination based on Reverse Path forwarding [1, 2, 5] are typical examples of such protocols.

2.1.1 Destination Sequence Distance Vector (DSDV)

DSDV [6] uses the basic mechanism of traditional distance vector protocol with some modifications to make it suitable for mobile ad hoc networks. The common problem with the traditional distance vector is the formation of routing loop, and to avoid it, DSDV uses per-node sequence numbers to differentiate among old and new routes. To distinguish, every entry in the routing table of a node is represented by a sequence number. A fresh route usually has a higher sequence number compared to a stale one.

2.1.2 Optimized Link State Routing (OLSR)

OLSR [7] is an optimized modification of traditional link-state protocol. Optimization is accomplished through the use of multipoint relay (MPR). The basic idea is that every node in the network computes (among its neighbor nodes) its MPRs in such a way that the retransmission of the message by the MPRs, after broadcasting by the source node, is guaranteed to be received by each of its two hop neighboring nodes. Moreover, when sharing routing related information, a node lists the connections to its Multipoint Relay selector set, i.e. those neighbors that have chosen it as MPR.

2.1.3 Topology Dissemination Based on Reverse Path Forwarding (TBRPF)

TBRPF [8] uses the same link-state approach with a different optimization mechanism. TBRPF require each node to compute a shortest path tree to all of its neighbors. Optimization can be achieved by propagating only subset of the tree.

2.2 Reactive or on demand Routing Protocols

One of the major disadvantage of these routing protocols is their high routing overhead, as they use excessive route updates. Reactive on demand protocols avoid the above problem by discovering routes on a demand basis, i.e. when needed [1]. Examples of reactive protocols are Dynamic Source Routing and Ad hoc on demand Distance Vector.

The main difference of these protocols is that, DSR is source based routing protocol while AODV perform hop-by-hop routing [9]. In source based routing, sender node is responsible to identify the route to intermediary nodes throughout the path to destination node. On the other hand in hop-by-hop routing sender node only need to how to get to the next hop; then the intermediate nodes are responsible to decide the next hop in order to reach the packet to destination.

2.2.1 Dynamic Source Routing (DSR)

The basic idea is that every node maintains a route cache [10]. The source node forwards packets only when the anticipated route is available in its cache. Otherwise, the node must broadcast a route request RREQ message. A node with a route to the destination or destination node responds with a route reply RREP message, containing the new route. Furthermore, to check the route validity route maintenance is used and can be accomplished by acknowledgement and route error packets. If a node fails to send an acknowledgement, any route that contains that node is truncated.

2.2.2 Ad hoc on Demand Distance Vector (AODV)

AODV [11] is a reactive enhancement to the DSDV protocol described earlier. DSDV increases overhead by keeping a complete record of routes. In contrast, AODV creates routes when needed, thereby avoiding the above problem. Similar to DSR, AODV performs the two basic operations; route discovery and route maintenance. In order to find a route, a source (sender) node locates the desired route to destination by broadcasting RREQ message to its neighbors. To guarantee that the routes are valid, route maintenance is initiated and accomplished by acknowledgements and route error packets.

The reactive and proactive routing protocols discussed above in section 2.1 and 2.2 respectively have some pros and cons, for example reactive routing protocols having advantage of less overhead as for route discovery, the process is to begin on demand only also they don’t need periodic route updates. On the other hand these protocols have a problem of network latency because of route discovery procedure.

In contrast proactive routing protocols have the advantage that any node can communicate with any destination in the network at any time having minimal delay. However it also suffers from extra control traffic overhead that is need to update stale routes frequently.

3.0 SIMULATION ENVIRONMENT

Proactive routing protocols in MANET are based on distance vector and link state protocols which are basically designed for wired networks [12], also on the basis of [13-15] we can say that in most cases reactive protocols are best suited for mobile ad hoc environment, thus reactive protocols required more focus to investigate as compared to proactive protocols for MANET's. The main goal of our experiment was to measure effect of terrain areas and pause times on the performance of the two reactive routing protocols, i.e. AODV and DSR. We performed the simulations using NS-2 [16], a discrete event simulator and the most popular simulator in wireless networking research community.

As the objective of our simulations was to compare the two protocols, Constant Bit Rate (CBR) traffic sources are used with a random distribution of source-destination pairs. Furthermore, the size of data packets is 64 Bytes. Also, we selected a sending rate of 4 packets per seconds.

The simulations use the random waypoint mobility model [10], which defines the pattern for nodes movement in a simulated region. According to this model, every node begins its movement starting from an arbitrarily selected point (source) to a random target (destination). Once a node arrives to its destination, it stops for a pause time *p* and then randomly chooses a new destination. By repeating this behavior throughout the simulation, the model causes continuous changes in the network topology. We created mobility scenarios using 50 nodes, with pause times of 0, 300, 600 and 900 seconds, a maximum speed of 10 m/s, terrain sizes of 500m^2, 1000m^2, 1500m^2, 2000m^2, 2500m^2 and 900 seconds are sets up as a simulation time. The simulation parameters that are used throughout the experiment are presented in table 1.

Table-**1** Simulation parameters

Parameter	Value
Simulator	Network Simulator-2.35
Protocols Compared	DSR, AODV
Number of Nodes	50
Maximum connections	25
Network Load	4 packets
Terrain Sizes	500m x 500m, 1000m x1000m, 1500m x 1500m, 2000m x 2000m, 2500mx 2500m
Simulation Time	900s
Transmission Range	250m
Maximum Speed	10 m/s
Mobility Model	Random Waypoint
Type of Traffic	Constant Bit Rate
Size of Packet	64 Byte

4.0 PERFORMANCE METRICS

Metrics used for evaluation are as follows.

Packet Delivery Fraction (PDF). PDF is the fraction of the numbers of packets delivered by the "CBR sources" to the "CBR sink" at destination.

Average End-to-End Delay. It is the combination of all probable delays in seconds (i.e. queuing delay, retransmission delay, buffering during route discovery and propagation delay).

Packet Drop. If a node's (router) buffer is already full then it may lead to some packets drop depending on the state of the network e.g. congestion, nodes might drop some, none or all of the packets. Packet drop can be calculated by subtracting total delivered packets (at destination) from total sent packets (at source).

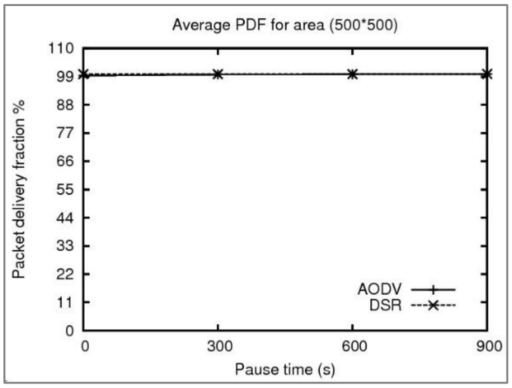
5.0 RESULTS AND DISCUSSION

As noted in Table-1, we conducted our simulations using five different terrain areas. For each of the area, simulations were performed to effectively evaluate the performance metrics and to comparatively assess the performance of both protocols. Each run of the simulations consists of 50 nodes communicating in peer to peer mode.

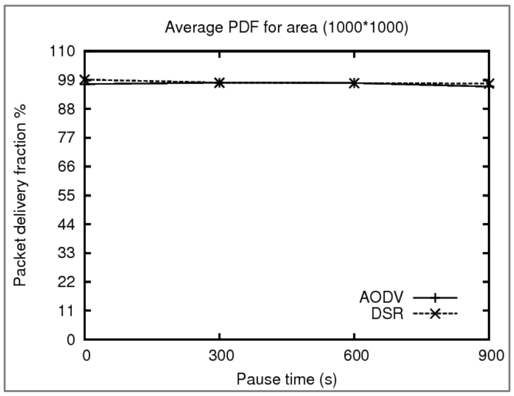
5.1 Packet Delivery Fraction

Figure1 (a)-(e), illustrate the packet delivery fraction as a function of pause time (node mobility rate) for the five different areas. The graph clearly shows that both AODV and DSR are performing equally well for the terrain areas of 500m^2 and 1000 m^2. For these areas, both protocols are able to deliver 98-99% of packets for all mobility conditions (pause times). As the area is increased to 1500m^2 as shown in Figure1 (c), AODV is still able to deliver the same percentage of packets whereas the packets delivered by DSR is dropped down to 88%, 70%, 60% and 44% for each of the pause time respectively. In this case, AODV is offering the best performance compared to DSR. This is because DSR misses the mechanism to determine which route in the cache is out of date, data packets may forwarded to a broken link.

For high terrain sizes, 2000m^2 and 2500m^2 in our simulations, as shown in Figure 1 (d) and (e), the packet delivered by both protocols significantly drop down due to link-breakages. This effect becomes more severe for larger mobility conditions.



(a)



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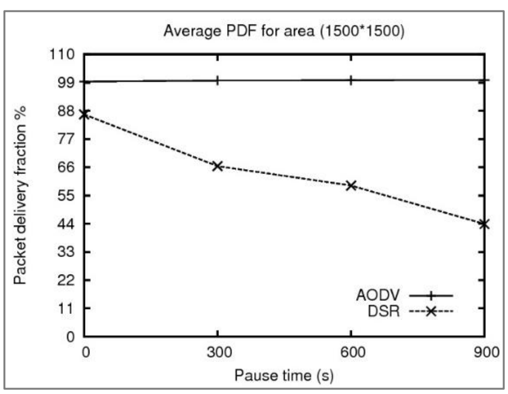

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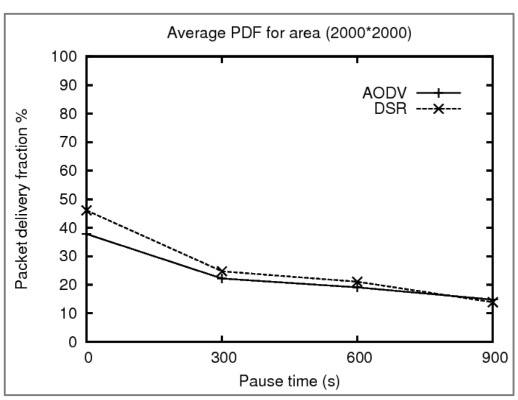

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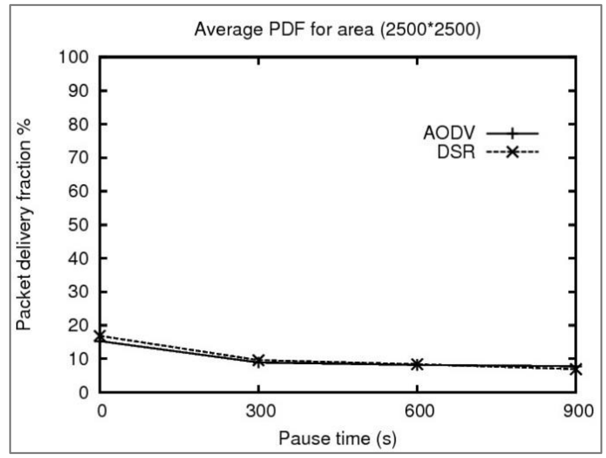
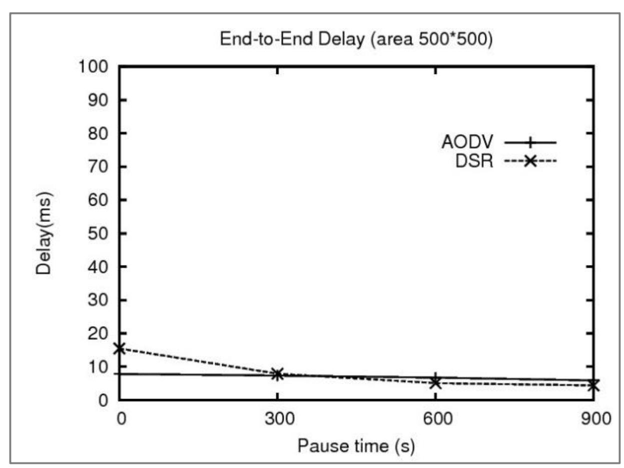


(e)

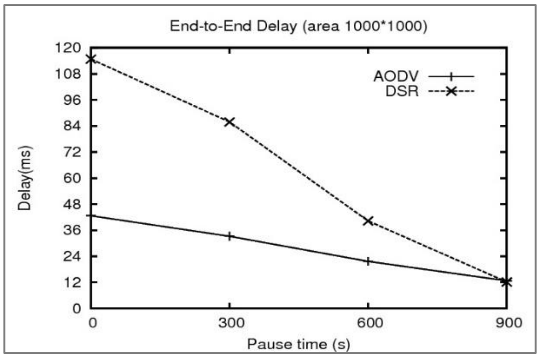
Figure1 (a) Average PDF for area (500 * 500) , **(b)** Average PDF for area (1000 * 1000), **(c)** Average PDF for area (1500 * 1500), **(d)** Average PDF for area (2000 * 2000), **(e)** Average PDF for area (2500 * 2500)

5.2 Average End to End Delay

Figure2 (a)-(e), shows the average end to end delay of both protocols for each of the terrain size respectively. For all terrain areas, the average end-to end delay of AODV is low and less effected by varying terrain size as well as pause times compared to DSR. This is because AODV uses "hop-by-hop" routing, the destination node responds only to the first RREQ. In contrast, source routing in DSR increases overhead as the destination replies to all RREQs. Also, Route discovery in source routing (DSR) requires every intermediary node to pull out information before forwarding the reply, hence increasing node processing time which in turn increases delay. Furthermore, DSR aggressive caching severely degrades performance. At higher pause times, the average end to end delay encountered by both protocols is minimum because nodes are static.



(a)



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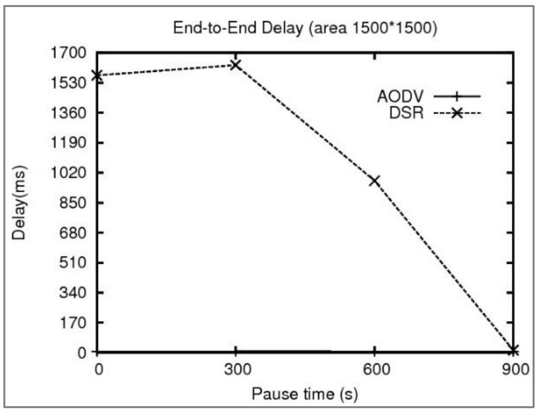

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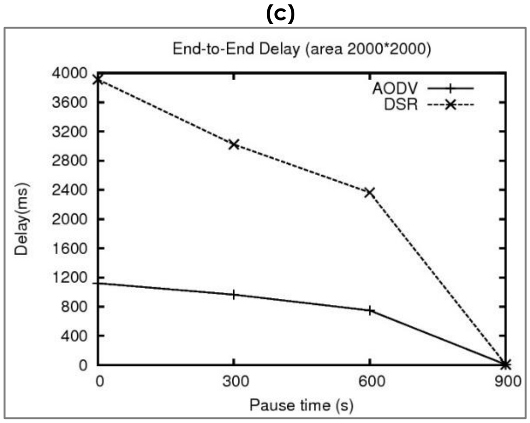

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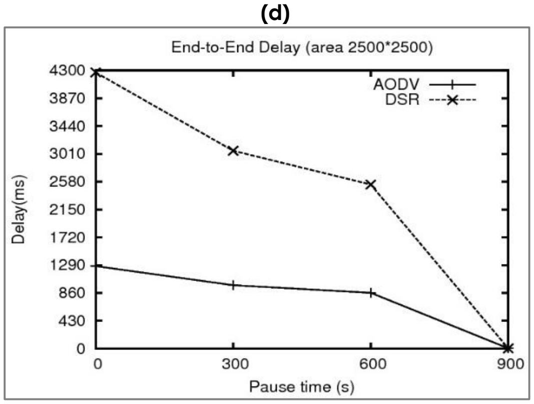
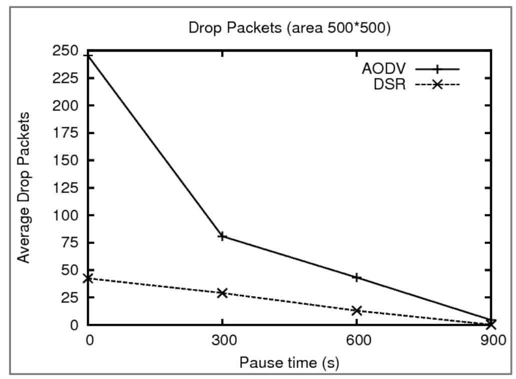


(e)

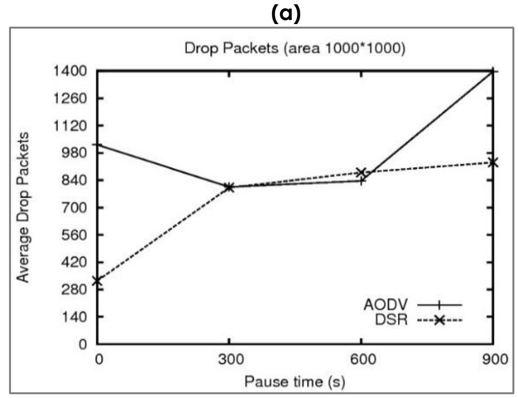
Figure 2 (a) End-to-End Delay for area (500 * 500), **(b)** End-to-End Delay for area (1000 * 1000), **(c)** End-to-End Delay for area (1500 * 1500), **(d)** End-to-End Delay for area (2000 * 2000), **(e)** End-to-End Delay for area (2500 * 2500).

5.3 Packet Drop

In small terrain areas (500m^2), DSR has lesser packet drop than AODV for low to high mobility conditions (pause time=0-900) as shown in Figure 3 (a). This is because nodes resides within each other transmission range. DSR, in this case, is able to build paths of shorter length, which reduces the probability of packet loss. In medium terrain area (1500m^2), DSR encounter smaller broken links that degrades its performance. Hence AODV outperforms DSR for all mobility conditions. AODV uses route expiration, dropping a small number of packets as a route expires. DSR, due to link break, tends to pick stale routes when the interface queues are full.



(a)



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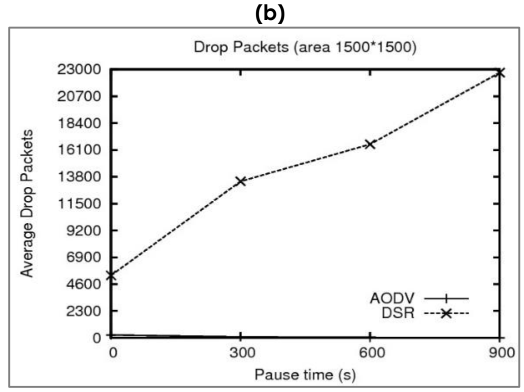

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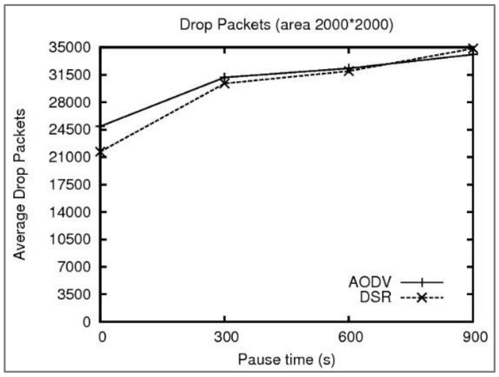

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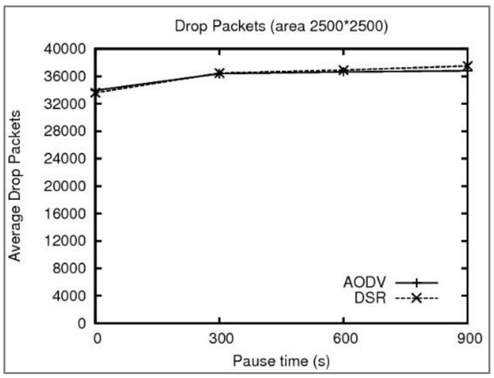

(e)

Figure3 (a) Average Packets Drop for area (500 * 500), **(b)** Average Packets Drop for area (1000 * 1000), **(c)** Average Packets Drop for area (1500 * 1500), **(d)** Average Packets Drop for area (2000 * 2000), **(e)** Average Packets Drop for area (2500 * 2500)

6.0 CONCLUSIONS & FUTURE WORK

We carried out our simulations for five different terrain sizes with respect to various pause times and observed that DSR outperforms AODV for small terrain areas in terms of packet loss, delay and PDF. An efficient algorithm usually has low packet loss and, for these areas, DSR satisfies this property. The packet delivery ratio is less than 100% due to hidden and exposed terminal phenomenon in MANET. Medium terrain areas have low node density and increased chances of link-breakages compared to small areas. Hence, AODV provides the best performance for medium terrain areas. For such areas, AODV performs quite predictably, delivering more than 99% packets with negligible delay and packet loss. Finally, when simulated in high terrain areas, AODV outperformed DSR in terms of delay. Furthermore, both protocols drop nearly the same amount of packets when simulated in such larger areas.

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