Simulation-based Comparison between Reactive and Proactive Routing Protocols

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Abstract

Mobile ad hoc networks (MANETs) are widely used in recent years due to its ease of installation and configuration, and its success in a wide range of applications, such as military operations, health monitoring, and detection of natural disasters. A MANET consists of a group of mobile nodes that are formed spontaneously, i.e., no specific topology is followed. The main objective of this paper is to compare the performance of MANETs when either a reactive or proactive routing protocol is employed as its routing method. The Ad hoc on-demand distance vector (AODV), and the destination-sequenced distance-vector (DSDV) routing protocols were chosen for the comparison as they are the most commonly used reactive and proactive routing protocols. The comparison was based on a simulation method in which the network simulator (NS-2.35) and network scenario generator (NSG2.1) were used to perform the comparison process. Network metrics, such as packet delivery ratio (PDR), throughput, routing overhead, and packet loss, were involved in the comparison process as referenced values. Based on the results obtained, a MANET that employs an AODV protocol would have a better performance as it exhibits a higher packet delivery ratio, higher throughput, lower routing overhead, and lower packet loss.

Keywords: Mobile ad hoc networks MANETs; Reactive routing protocols; Proactive routing protocol; Ad hoc on-demand distance vector AODV; Destination-sequenced distance-vector DSDV.

1.Introduction

A MANET is a randomly configured network that contains a group of mobile nodes (devices) linked wirelessly. Each node in a MANET is permitted to move freely and independently, and thus can consequently alternate its associated path to other nodes repeatedly. Each must also forward traffic that is not directed to it, and thus act as a router [1]-[3]. To find out optimum paths between the nodes that are able to communicate in a MANET, a routing protocol must be employed. In general, MANET routing protocols can be categorized as either source-initiated routing protocols (reactive routing protocols), table-driven routing protocols (proactive routing protocols), or hybrid routing protocols [4]-[6]. In source-initiated routing protocols, a route is found whenever it is requested by the source node; the established route is canceled when the destination becomes not reachable. Routing protocols, such as Ad hoc On-Demand Distance Vector AODV, Dynamic Source Routing DSR, and Dynamic MANET On-Demand DYMO are source initiated-based routing protocols. In table-driven routing protocols, an up-to-date routing table is temporarily saved in each node; information of changes in the network topology is periodically broadcasted throughout the network for routing tables update. Routing protocols, such as Destination-Sequenced Distance Vector DSDV, and Optimized Link State Routing OLSR are table-driven-based routing protocols. The hybrid protocol approach is suggested for large size and intensive node density networks [7]. It seeks to combine the features of both reactive and proactive routing protocols. For example, the Zone Routing Protocol ZRP is a hybrid protocol that defines a zone and applies different protocol strategies inside and outside the perimeter of that zone. I.e., a proactive routing protocol might be used inside the zone, whereas a reactive routing protocol might be used outside the zone and vice versa. Routing protocols, such as Cluster-based routing protocol (CBRP) and Independent Zone Routing Protocol (IZRP) are also hybrid routing protocols [8]. Figure 1 provides a diagrammatic categorization of the aforementioned routing protocols. Table 1 provides a tabulated summary of these protocols; i.e., it provides a list containing each MANET routing protocol acronym, its category, and its extended name.

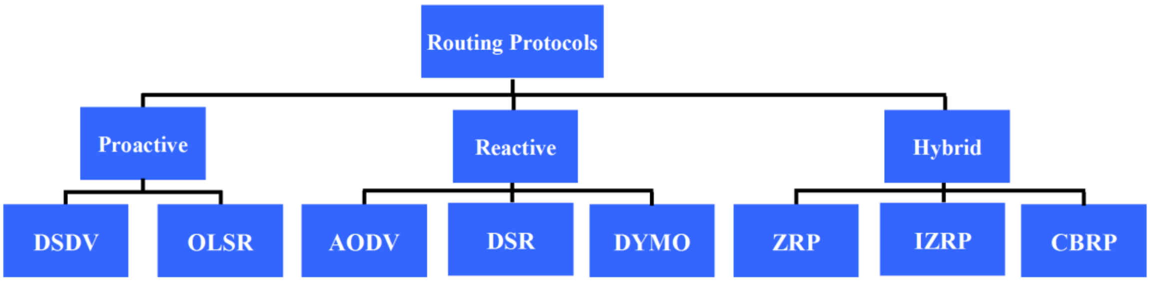


Figure 1. Categories of MANET routing protocols

Table 1. Tabulated summary of MANET routing protocols

Abbreviation and Category	Protocol Name
DSDV (Proactive)	Destination-sequenced Distance-vector
OLSR (Proactive)	Optimized Link State Routing
AODV (Reactive)	Ad hoc On-demand Distance Vector
DSR (Reactive)	Dynamic Source Routing
DYMO (Reactive)	Dynamic MANET On-Demand
ZRP (Hybrid)	Zone Routing Protocol
IZRP(Hybrid)	Independent Zone Routing Protocol
CBRP(Hybrid)	Cluster-based Routing Protocol

This paper provides a simulation-based comparison of MANETs' performance in case of using either a reactive or proactive routing protocol. AODV and DSDV were chosen for comparison as they are the most commonly used reactive and proactive routing protocols. Since AODV and DSDV were involved in the comparison process, a detailed description on its working mechanisms is provided below.

2.AODV and DSDV working mechanism

As mentioned above, it is recommended to provide a review of the working mechanism of AODV and DSDV as both are involved in the comparison process performed in this paper. Following is a detailed description of both mechanisms.

2.1AODV working mechanism

Since AODV is a source initiated-based routing protocol, a route is found when it is required, i.e. the route is established on demand. In AODV, a mobile node has no information of other nodes locations. To establish a router in AODV, the source node sends a Route_Request_Packet (RREQ) to its adjacent nodes in the network. The adjacent nodes in turn redirect the packets to other nodes in the network. This process is kept going until one node sends back a Route_Reply_Packet (RREP) that carries information of the most appropriate router [7]. In some cases in which no valid route is possible, a Route_Error_Packet (RRER) is sent back to the source node [8]. Figure 2 clarifies this process where node A represents the source node and node B represents the destination node.

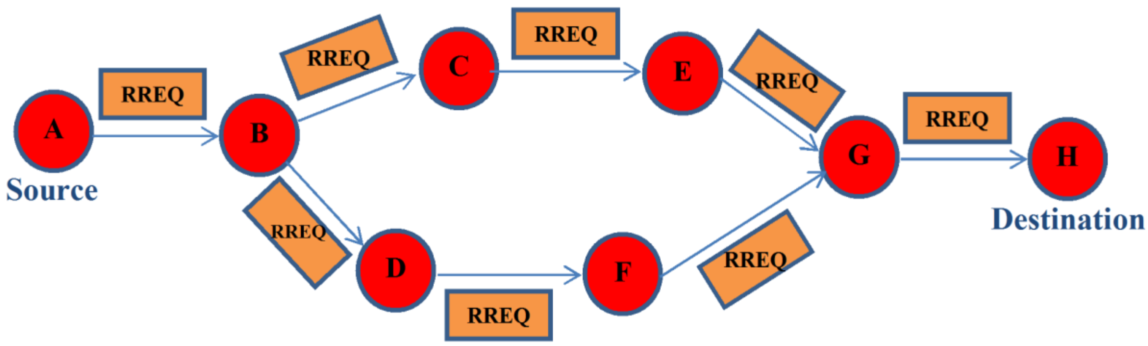


Figure 2. AODV Route Request Process

The process begins when node A sends an RREQ to its adjacent nodes if no valid route to H is found in its routing table. One of the neighboring nodes will send back an RREP if it has information of a valid route to H. If no one of the neighboring nodes has valid route information to H, they will redirect the RREQ to further neighboring nodes. The process is continued until one node sends back an RREP carrying information of the most appropriate router to H. Figure 3 shows the request reply process where an RREP is sent back by node H.

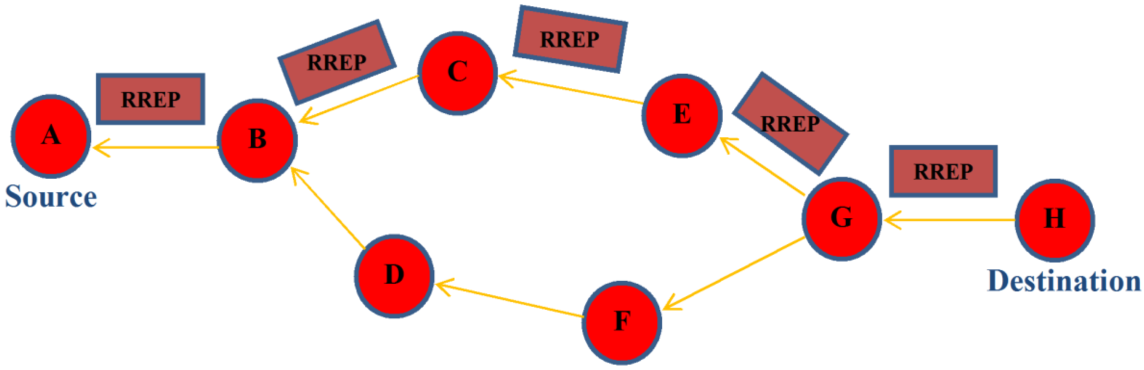
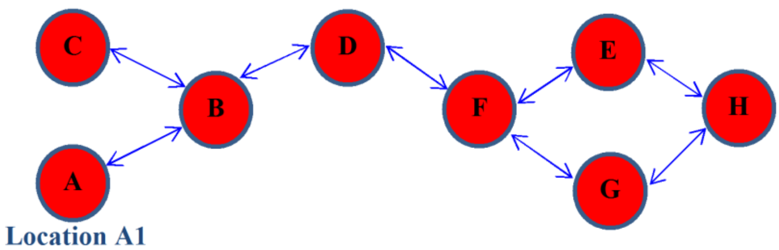


Figure 3. AODV Request Reply Process

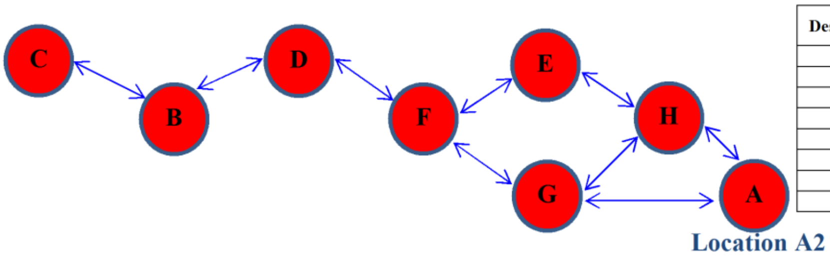
2.2DSDV working mechanism

In DSDV, each node keeps a routing table which contains the destination entries and the hops necessary to reach each one of them. A sequence number is assigned to each entry to avoid duplicated assignment of destinations. During a specific period of time, each node broadcasts updated information through the network. When a node receives updates from a sending node, it will recognize that it is one hop away from it [9]. As a result, it will insert it as a neighbor node, transfer its routing table to it, and thus becomes able to exchange data with it. Figure 4 provides a schematic representation of DSDV working mechanism. The accompanied table represents the routing table of node D. In Figure 5 the node A moved from location A1 to location A2. The accompanied table represents the updated routing table of node D after this movement.



Destination	Next Hop	Number of Hops
A	B	2
B	B	1
C	B	2
D	D	0
E	F	2
F	F	1
G	F	2
H	F	3

Figure 4. Schematic representation of DSDV working mechanism.



Destination	Next Hop	Number of Hops
A	F	3
B	B	1
C	B	2
D	D	0
E	F	2
F	F	1
G	F	2
H	F	3

Figure 5. Routing table update in DSDV (After node A moved to location A2)

3.Performance evaluation

In this section, the author defines the network metrics which are targeted for use as **references** in the comparison, and explains how they can be used as useful indicators for performance evaluation. The first network metric is the Packet Delivery Ratio which is defined as the ratio between the total amount of packets sent by a source node to the total amount of packets received by a destination node. On other word, PDR is the mean that enables measuring the rate of loss, which assist to distinguish both the validity and efficiency of an ad hoc routing protocol. A high rate of packet delivery ratio is preferable; and thus for comparison purpose a higher value indicates better performance [10]. The second network metric is the throughput which is defined as the ratio of the total amount of packets that sent from a source to a destination to the time taken by the destination to obtain the last packet. A high rate of throughput is desirable; and thus for comparison purpose a higher value indicates better performance [11]. The third network metric is the Routing Overhead which is defined as the total amount of routing packets sent during transmission. For a packet transmitted over multiple hops, each hop is counted as one transmission [12]. A low rate of routing overhead is preferable; and thus for comparison purpose a lower value indicates better performance. The last network metric is the Packet Loss which is defined as the total amount of packets lost during transmission. A low rate of packet loss is desirable; and thus for comparison purpose a lower value indicates better performance [1].

1. Simulation setup

As mentioned above, this paper compares the performance of MANETs in case of using either DSDV routing protocol or AODV routing protocol based on simulation method. The network simulator (NS-2.35) and Network scenario generator (NSG2.1) were used in this simulation to perform the comparison process. Linux Ubuntu 18.04 operating system was chosen due to its explicit compatibility with NS-2.35 and NSG2.1. NS-2.1 was employed to establish a virtual MANET and produce its corresponding Tool Command Language TCL code in either case, while NS-2.35 was used to analyze the produced TCL code at different simulation times and calculate the values of packet delivery ratio, throughput, routing overhead, and packet loss. The simulation times were 50, 100, 150, 200, 250, and 300 sec. Table 1 lists the parameters used in this simulation and its descriptions.

Table 1. Simulation Setup Parameters

Parameter	Description
MAC Protocol	Mac/802.11
Communication Area (m2)	500 x 500
Channel	Wi-Fi channel
Number of Nodes	100
Packet Size (Byte)	256

5.Results and Discussions

In this section, the author discusses the results obtained from the established MANET when either (AODV) or a (DSDV) is used after running the simulation to come up with a comparative outcome. Figures 6 and 7 show the packet delivery ratio and throughput versus time when AODV and DSDV are considered.

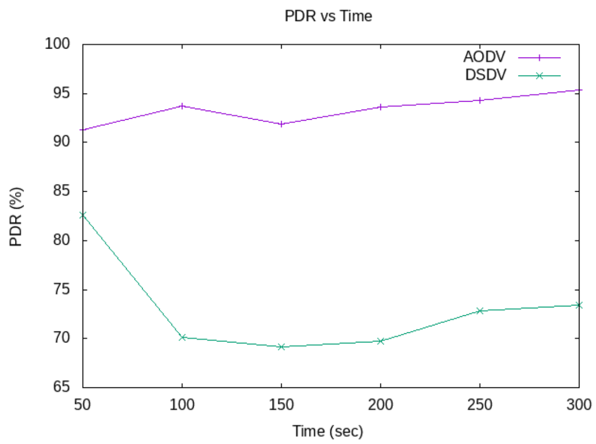


Figure 6. Packet delivery ratio versus time when AODV and DSDV are considered.

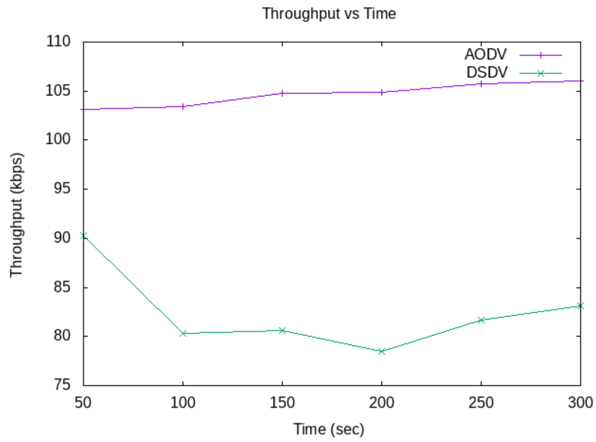


Figure 7. Throughput versus time when AODV and DSDV are considered.

It is seen from the figures that both the packet delivery ratio and throughput are higher when AODV is used at all samples of time, which indicates to an obvious advantage of AODV over DSDV. Figures 8 and 9 show the routing overhead, and packet loss versus time when AODV and DSDV are considered. It is obviously seen from the figures that both the routing overhead and packet loss are lower when AODV is used at all samples of time, which confirms the advantage of AODV over DSDV.

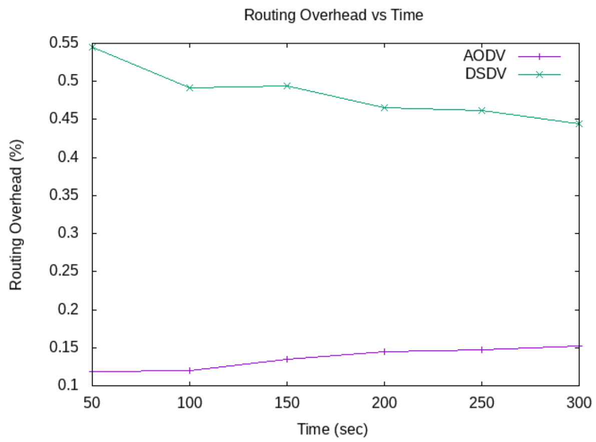


Figure 8. Routing overhead versus time when AODV and DSDV are considered.

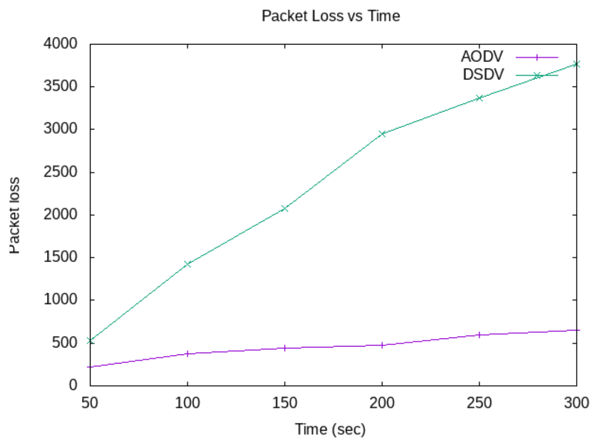


Figure 9. Packet loss versus time when AODV and DSDV are considered.

6.Conclusions

In this paper, the performance of MANETs was compared in case of using either a reactive or proactive routing protocol. AODV and DSDV routing protocols were involved in the comparison process as they are the most commonly used reactive and proactive routing protocols. The comparison was conducted using simulation tools (NS-2.35 and NSG2.1). Based on the results obtained, a MANET that employs an AODV routing protocol would have a better performance as it exhibits higher packet delivery ratio, higher throughput, lower routing overhead, and lower packet loss.

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