

Performance Analysis of AODVv2 Protocol vs. AODV Protocol in MANET

Jatinder Pal Singh¹/Anuj Kr. Gupta²

Research Scholar CSE Department¹/Head CSE Department²
RIMT-IET, Mandi Gobindgarh-147301 Punjab, INDIA

Abstract: Mobile Ad-hoc Network is a type of Infrastructures less wireless network because such a Network does not require any fixed infrastructure or any form of centralized administration. It has distinguished characteristics like: self configuring, decentralized and dynamic topology. Mobile nodes in such a network communicate with each other through wireless links since the nodes are always on move, routing in such a set up is always a challenge. Internet Engineering Task Force (IETF) has developed many routing protocols to overcome this challenge. This paper investigates simulation and performance analysis based study of two On-Demand Routing Protocols that are Ad hoc on Demand Distance Vector Protocol(AODV) and Dynamic MANET On-demand (DYMO) routing protocol.

Keywords: MANETs, AODV, DYMO, AODVv2, AP.

I. Introduction

Wireless network is a type of computer network that is not connected by cables. Wireless networks can be divided into two broad categories: Infrastructure based wireless network and Infrastructure-less wireless network. In an Infrastructure-based wireless network, nodes connect to an external network like Internet or Intranet with the help of a router/modem/access point(example: Wi-Fi set up in a college campus). On the other hand an Infrastructure less network is a network in which nodes communicate with each other directly through wireless link i.e point-to-point without the need of an AP (example: transfer of data between two mobile phones using Bluetooth). Such a network is also known as an Ad-hoc network, as show in the figure below.

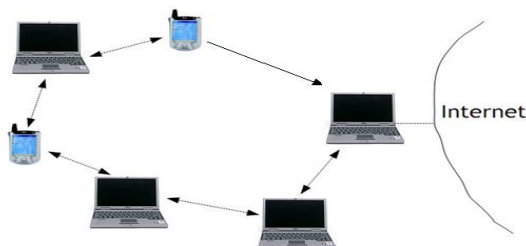


Figure1. An Ad-hoc Network

Mobile Adhoc Network[7,8] is a type of an Ad-hoc Network in which, routing paths from source to destination are found with the help of routing protocols. The success of an ad- hoc network depends on the efficiency of the routing protocol. Large numbers of protocols have been designed to make routing decisions in MANETs. Routing protocols[7,8] in MANETs are classified into many categories, but two main categories are: Table-Driven Protocols and On-Demand Protocols[7,8]. This classification is shown in the figure 2 below. The goal of this paper is to evaluate the performance of two On-demand Routing Protocols i.e. AODV[3] and AODVv2[1,2].

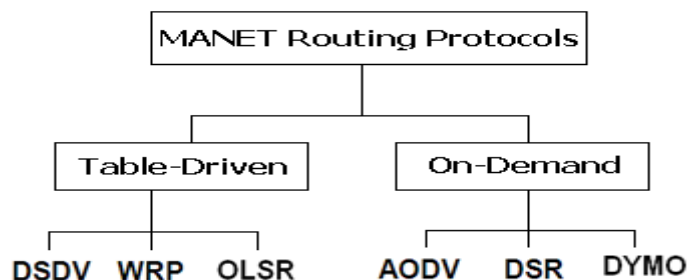


Figure 2. Routing Protocols in MANETs

The organization of this paper is as follows. In next section II, we discuss the two main categories of the MANET Routing Protocols: Table-Driven Protocols and On-Demand Protocols[7,8]. Section III analyzes the working of AODV[3] protocol and AODVv2[1,2] Protocol. Section IV deals with the simulation parameters and performance metrics used to compare AODVv2[1,2] protocol vs. AODV[3] Protocol. In Section V we have discussed the results on the basis of simulation. Section VI concludes the paper with direction to future work.

II. Classification of MANET Routing Protocols

Routing protocol is a standard that inform the nodes how to route the incoming packets from a source to the destination. Routing protocol in MANETs can be classified into two main categories on the basis of routing strategy: Proactive or Table-Driven[7,8] Protocols and Reactive or On-Demand[7,8] protocols as shown in figure 2. These two main categories of Routing Protocols are discussed in the next subsections.

A. Table-Driven Routing Protocols

These protocols are also called as proactive protocols since they maintain the routing information even before it is needed. Each and every node in the network maintains routing information to every other node in the network via routing tables. With the change in network topology these routing tables are updated periodically. 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.

B. On-Demand Routing Protocols

These protocols are also called reactive protocols since they don't maintain routing information or routing activity at the network nodes if there is no communication. 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. Two processes namely Route Discovery[3,7,8] and Route Maintenance[3,7,8] are used to carry out communication between any nodes in the network. The route discovery usually occurs by flooding the route request packets throughout the network.

C. Comparison of Table-Driven Protocols vs On-Demand Routing Protocols

Table I below gives a comparison between Table-Driven protocols and On-Demand Protocols on the basis of few parameters as mentioned below

Table I: Comparison of Routing Protocols.

Parameters	Table-Driven Protocols	On-Demand Protocols
Network Organization	Flat Hierarchical	Flat
Topology Dissemination	Periodical	On Demand
Route Latency	Always Available	Available when needed
Mobility Handling	Periodical Updates	Route Maintenance
Communication Overhead	High	Low
Periodic Update	Yes, some may use conditional	Not required.
Route Acquisition delay	Low	High
Bandwidth Requirement	High	Low

III. Working of On-demand Routing Protocols

In this section we focus on explaining the working of AODV Protocol[3] and AODVv2 Protocol[1,2]. We also discuss the difference between the working of these protocols in section 3.3

A. Working of AODV Protocol

AODV is a single-path, reactive routing protocol. It borrows the basic Route Discovery and Route Maintenance steps from DSR[4] and the use of hop-by-hop routing it borrows from DSDV[7,8]. In AODV, all nodes maintain a routing table containing the entry for each destination node. Each entry includes the next hop, sequence number and number of hops requires for reaching destination node. Using the destination sequence number ensures loop freedom. Route Requests (RREQs), Route Replay (RREPs), Route Errors (RERRs) are the control messages used to find a path from source to destination.

1. Route Discovery in AODV Protocol

Whenever any node needs to send a message to some other node that is not its neighbor, the source node initiates a Route Discovery process via RREQ messages as shown in the figure 3(a) below. This RREQ message

is sent by the source to its neighbor nodes, if the node receiving a RREQ does not have a route to the destination. It then rebroadcast the RREQ to its immediate neighbors.

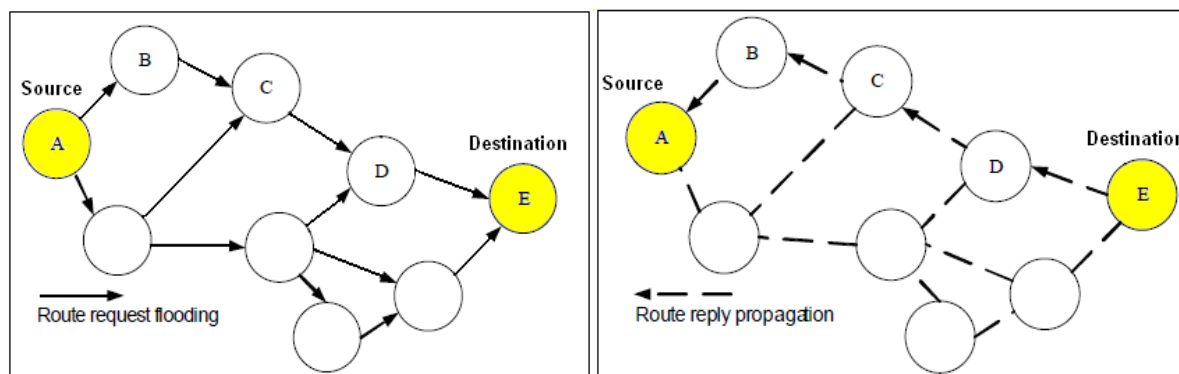


Figure 3. (a) Route Discovery process via RREQ Messages, (b) Route Maintenance Process via RREP Messages

When the RREQ reaches a node that either is the destination node or a node with a valid route to the destination, a RREP is generated and unicasted back to the requesting node as shown in the figure 3(b). While this RREP is forwarded, a route is created from destination to the source. Once the source node receives the RREP, it may begin to forward data packets to the destination. If the source later receives a RREP having a greater sequence number or contains the same sequence number with a smaller hop count, it may update its routing table for that destination and begin using the better route.

2. Route Maintenance in AODV Protocol

AODV maintains paths by using Hello messages, they help to detect that neighbors are still in range of connectivity. If for any reason a link was lost (e.g. nodes moved away from range of connectivity) the node immediately engages a route maintenance scheme. When a node detects that a route to a neighbor is no longer valid, it will remove the routing entry and send a link failure, route reply message to the neighbors informing them that this route is no longer valid. Upon receiving a RERR message, a node searches its routing table to see if it has any route(s) to the unreachable destination(s). If such routes exist, they are invalidated and the node broadcasts a new RERR message to its neighbors. The source node invalidates the listed routes and restarts the route discovery process.

B. Working of AODVv2 Protocol

Dynamic MANET On-Demand Protocol[10,11] is a reactive algorithm developed for mobile Ad-hoc network. It is a successor to AODV routing protocol and shares many of its features, so it is also called as AODVv2[10,11]. It is similar to AODV but with a significant difference that helps it to accumulate the routing information of all nodes in the path. AODVv2 protocol has been undergoing development by IETF and currently it is in its 26th version and is still in progress. AODVv2 consists of two routing operations namely: route discovery and route maintenance.

1. Route Discovery in AODVv2 Protocol

AODVv2[10,11] route discovery is very similar to that of AODV except for the path accumulation feature. But while broadcasting the RREQ message in AODVv2, the intermediate node will attach its address to the message. Every intermediate node that passes the RREQ message makes a note of the backward path. As shown in the figure 4, each intermediate node will enter the routes to RREQ message while appending its own address and forwarding the RREQ packet. The Destination replies with RREP message and a similar path accumulation process takes place along the backward path. This makes sure that the forward path is built and every intermediate node knows a route to every other node along the path. Each node maintains a unique sequence number in order to avoid loops in the route and also to discard the stale packets if any. One of the special features of AODVv2 is that it is energy efficient. If a node is low on energy, it has the option to not participate in the route discovery process. In such a case, the node will not forward any of the incoming RREQ messages.

2. Route Maintenance in AODVv2 Protocol

When a route to a destination is lost or a route to a destination is not known, then a RERR message is sent towards the packet source node, to notify it about a particular route being invalid or missing. Upon receiving RERR message the source node deletes the route. If the source node has another packet to forward for the same invalid destination node, it will again initiate a route discovery process.

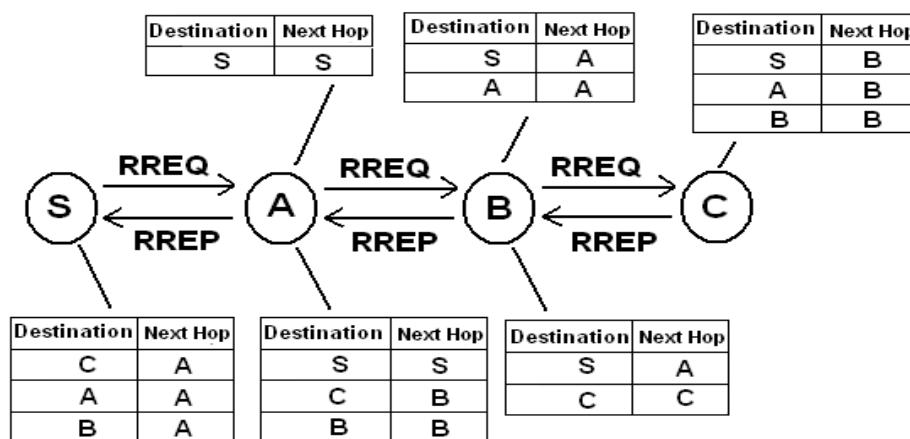


Figure 4. AODVv2 Route Discovery & Route Maintenance

C. Working Difference Between AODVv2 Protocol and AODV Protocol

AODVv2[5,11] works much like the AODV[3] routing protocol, but there is a subtle difference between the two. In AODVv2 the requested node i.e the originator of the RREQ message will also get information about all intermediate nodes in the newly discovered path. In AODV, only information about destination node and the next hop is maintained, while in AODVv2, path to every other intermediate node is also known. As shown in the figure 4 above, all nodes between the source and destination exchanges routing information via routing information accumulation. Consequently searching of routing path is not required for packet transmission which decreases the RREQ message overhead.

IV. Simulation Environment

The platform used to evaluate the performance of AODVv2 Protocol against AODV Protocol is ns-2.34[6]. Simulation parameters used are mentioned in the table II below. These two protocols are evaluated based on the basis of three performance metrics[12] namely: Throughput, End-to-End Delay and Packet loss.

1. **Throughput (bits/s):** Throughput is the measure of the number of packets successfully transmitted to their final destination per unit time.
2. **End-To-End Delay:** Average End to End Delay signifies the average time taken by packets to reach from one end to other.
3. **Packet Loss:** Packet loss is defined as no. of packets that are generated at source node but cannot be successfully delivered to the destination node within valid time.

Table II: Simulation Parameters in NS2

Simulation Parameters	
Routing Protocols	AODV, AODVv2
Mobility Model	Random
Number of Nodes	20,40,60,80,100
Simulation Area	800m x 800m
Speed	Min: 1m/s , Max: 10.0 m/s
Traffic Type	CBR
Packet Size	512 Bytes

V. Results and discussions

After using the above mentioned parameters and performance metrics we compared the performance AODVv2 protocol[9] against AODV[13] protocol and we came across the following results.

A. Throughput Analysis

Results of throughput analysis presented in Table III below. It indicates that initially when number of nodes are 20, throughput is nearly same for both the protocols. But when number of nodes are increased AODVv2 outperforms AODV. With increase in no. of nodes AODV does not show any significant variation in the results but on the other hand throughput of AODVv2 protocol increases this is because AODVv2 has much more routing packets than AODV due to the path accumulation function.

B. End to End Delay analysis

From the End to End delay analysis mentioned in below table we observe that with increase in the number of nodes, end to end delay in case of AODV increases invariably as compared to AODVv2[13]. This is due to the presence of Path accumulation function in AODVv2[12] which helps the source to know about all the paths to other nodes and also causes routes to be established faster thereby reducing the time in route acquisition process.

Table III: Simulation Results

No. of Nodes	Throughput Analysis		End to End Delay Analysis		Packet Loss Analysis	
	AODV	AODVv2	AODV	AODVv2	AODV	AODVv2
20	260.56	274.56	146.795	73.0161	206	211
40	220.83	280.23	231.514	101.442	231	175
60	245.17	323.45	306.306	107.753	313	151
80	240.86	340.85	378.604	112.826	354	132
100	235.49	372.33	365.06	120.826	512	110

C. Packet Loss analysis

From the above table, we observe that when the number of nodes is 20, the packet loss in case of AODVv2 is slightly more than that of AODV. But with increase in number of nodes increases, the Packet loss in case of AODV increases and overall the packet loss for AODVv2[9,12] is less than AODV[3]. This is due to the reason that when all the paths are established in AODVv2 Protocol, routing overhead and communication overhead is decreased which further improve the packet delivery and results in low packet loss.

VI. Conclusion and future scope

In this paper we have evaluated the performance of the two most popular On-Demand Routing Protocols. After the detailed analysis of our simulation results we conclude that the performance of AODVv2 protocol is better than the AODV protocol in terms of three performance metrics: Throughput, End to End Delay and Packet Loss. Our implementation of the AODVv2 protocol can be further extended to improve its performance in terms of end to end delay, routing overhead and packet loss. In future we intend to improve the performance of the AODVv2 Protocol by using the swarm intelligence based ACO technique.

VII. References

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