Relative Performance Analysis of Reactive (on-demand-driven) Routing Protocols

Mukesh Kumar Garg, Dr. Ela Kumar

Abstract— **A Mobile Ad Hoc Network (MANET) is a group of wireless mobile computers (or nodes); in which nodes collaborate by forwarding packets for each other to allow them to communicate outside range of direct wireless transmission without using any pre-existing infrastructure. The highly dynamic nature of MANET coupled with limited bandwidth and battery power imposes severe restrictions on routing protocols especially on achieving the routing stability. Due to all these constraints, designing of a routing protocol is still a challenging task for researchers. In this paper an attempt has been made to evaluate and compare the performance of two most commonly used on-demand-driven routing protocols named as AODV and DSR. The performance of both these routing protocols has been simulated using QualNet 5.0 simulator. The results show that neither of the protocol is better in all situations. For some parameters one outperforms the other and vice-versa as reported in the paper. The conclusions drawn in the paper can be useful in selecting the better routing protocol depending upon various parameters under consideration.**

Index Terms—**MANET, Network Simulation, Routing Protocols.**

I. INTRODUCTION

Mobile Ad Hoc Networks (MANETs) are the collection of wireless nodes that can dynamically form a network anytime and anywhere to exchange information without using any pre-existing infrastructure [1], [2]. Mobile means moving and Ad Hoc means temporary without any fixed infrastructure, so Mobile Ad Hoc Network is a kind of temporary network in which nodes are moving without any fixed infrastructure or centralized administration. Routing is a mechanism which is used to find the path between the source to the destination among randomly distributed nodes. Routing protocol plays an important role to send data from source to the destination that discovers the optimal path between the two communication nodes. Every protocol has its own rules to finds the route or maintenance the route. There are various routing protocols proposed by researchers. Routing protocols in MANETs are broadly divided into three categories (based on the Routing Information Update Mechanism) [2]: Proactive (table-driven), Reactive (source-initiated on-demand-driven) and Hybrid.

Traditional table-driven routing approach was used in which tables are created at each node and when a node wishes to communicate with a distant node that is not within its vicinity the node consults its routing table and routes the packet accordingly. The protocols based on the above mechanism such as DSDV and CGSR consumes large memory and significant control overhead is consumed in maintaining tables which can be bearable in wired network but in the case of wireless networks like MANETs this approach is not feasible due to above mentioned constraints.

The second method of routing is on demand. These protocols start to set up routes on-demand. The routing protocol will try to establish such a route, whenever any node wants to initiate communication with another node to which it has no route. This kind of protocols is usually based on flooding the network with Route Request (RREQ) and Route reply (RREP) messages. By the help of Route request message the route is discovered from source to target node; and as the target node gets a RREQ message it send RREP message for the confirmation that the route has been established. The two prominent on-demand routing protocols are AODV [2], [4] and DSR [2], [3].

The Hybrid routing protocols are using the best features of table driven and on-demand-driven routing protocols. For example: Temporally Ordered Routing Algorithm (TORA), Zone Routing Protocol (ZRP).

This paper considers both these routing protocols and compares them using QualNet 5.0 simulator [8] on different parameters. The rest of the paper is organized as follows: Section 2 describes literature survey of both AODV and DSR routing protocols. Section 3 discusses the results and simulation. Finally we present the conclusion.

II. LITERATURE SURVEY

A. Ad Hoc On-Demand Distance-Vector Routing Protocol (AODV):

Ad Hoc On-demand Vector routing protocol (AODV) [4], [5] is a reactive routing protocol for ad hoc and mobile networks that creates routes only between nodes which wishes to communicate. It has three phases:

The Route Request Phase:

Firstly, the source node broadcasts a Route Request (RREQ) packet to its neighbors. The neighbors in turn broadcast the packet to their neighbors until it reaches to an intermediate node that has recent route information about the

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destination or it reaches the destination itself. A node discards a Route Request (RREQ) packet that it has already seen. The Route Request (RREQ) packet uses sequence number to ensure that the routes are loop free and to make sure that if the intermediate nodes reply to route request, they reply with the latest information only. During the process of forwarding the Route Request (RREQ) packet, intermediate nodes record in their route tables the address of the neighbor from which the first copy of the Route Request (RREQ) is received. This information is used in the next phase.

The Route Reply Phase:

To inform the source node about the destination a route reply (RREP) packet is used. As the Route Reply (RREP) packet traverses back to the source, the nodes along the path enter the forward route into their tables.

The Route Maintenance Phase:

Once the route from source to destination is set each node in the network starts its maintenance phase. In this phase if the source moves, it can easily reinitiate route discovery process to the destination but if one of the intermediate nodes moves, then the moved nodes neighbor realizes the link failure and sends a link failure notification (Route Error) to their upstream neighbors and so on until the source node is notified. The source node may then choose to re-initiate route discovery for that destination.

B. *Dynamic Source Routing Protocol (DSR):*

Dynamic Source Routing Protocol (DSR) [3], [5] protocol was proposed for routing in MANET by Broch, Johnson and Maltz. In DSR, each mobile node is required to maintain a route cache that contains the source routes of which the mobile node is aware. The node updates entries in the route cache as and when it learns about new routes. The protocol consists of two phases:

Route Discovery:

The route discovery process initiates whenever the source node wants to send a packet to some destination. Firstly, the node consults its route cache to determine whether it already has a route to the destination or not. If it finds that an unexpired route to the destination exists, it makes use of this route to send the packet. On the other hand, if the node does not have such a route, it initiates route discovery by broadcasting a Route Request (RREQ) packet. The Route Request (RREQ) packet contains the address of the source and the destination, and a unique identification number as well. Each intermediate node that receives the packet checks whether it knows of a route to the destination. If it does not, it appends its own address to the route record of the packet and forwards the packet along to its neighbors. However, in case it finds a route, a Route Reply (RREP) packet containing the optimal path is transmitted back to the source node through the shortest route. To limit the number of route requests propagated, a node processes the Route Request (RREQ) packet only if it has not already seen the packet and its address is not present in the route record of the packet. A Route Reply (RREP) is generated when either the destination or an intermediate node with current information about the destination receives the Route Request (RREQ) packet. As the Route Request (RREQ) packet propagates through the network, the route record is formed. If the Route Reply (RREP) is generated by the destination then it places the route record from Route Request (RREQ) packet into the Route Reply (RREP) packet. The Route Reply (RREP) packet is sent by the destination itself.

Route Maintenance Phase:

When a node encounters a fatal transmission problem at its data link layer, it generates a Route Error (RERR) packet. When a node receives a route error packet, it re-moves the hop in error from its route cache. All routes that contain the hop in error are truncated at that point. Acknowledgement (ACK) packets are used to verify the correct operation of the route links. This also includes passive acknowledgements in which a node hears the next hop forwarding the packet along the route.

III. RESULTS AND SIMULATION

Various researchers have evaluated the performance of on demand routing protocols [5], [6], [7] on different simulators such as NS2, Glomosim, MATLAB but in our case we used QualNet 5.0 simulator [8] as it provides actual environment (its speed, scalability, accuracy and portability). For the purpose of simulation different scenarios were created for different number of nodes (15, 20, 25 and 30). The following parameters were configured as shown in Table 1. Our work was concentrated on the most popular network layer protocols AODV and DSR.

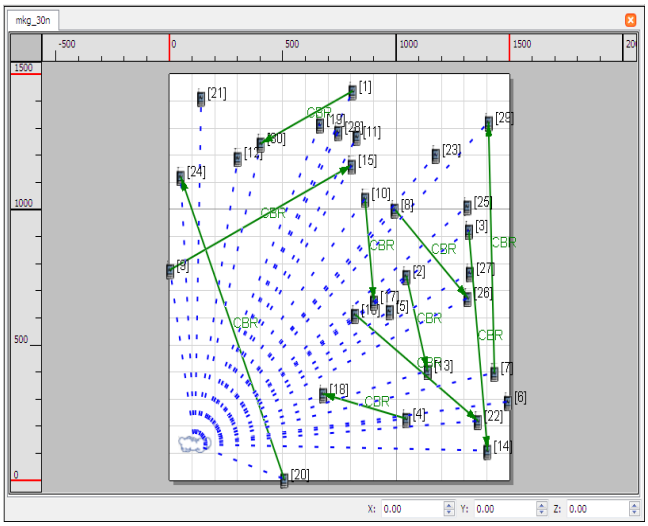

Fig. 1. A Scenario for AODV and DSR Routing Protocols (on 30 Nodes).

TABLE 1
CONFIGURED PARAMETERS

Physical Layer Protocol	802.11
Routing Protocol	AODV, DSR
Fading Model	Rayleigh
Shadowing Model	Constant
Energy Model	Linear
Battery Power	Simple Linear
Area	1500 X 1500
Mobility	Random Way Point
Mobility Speed	0-30 mps
Data Link Layer	802.11.DCF
Application Layer	CBR Traffic

In Fig. 1, a scenario with 30 nodes is shown. The nodes were randomly distributed in 1500 X 1500 unit area. The nodes 1, 2, 3, 4, 7, 8, 9, 10, 16, 20 (as Source) and 30, 13, 14, 18, 29, 26, 15, 17, 22, 24 (as Destination) were connected and 1kb data was transmitted. The simulation was run for 30 seconds. The routing protocols taken were AODV and DSR and a comparison of the following parameters have been done.

● *Number of Routes Selected:*

In case of AODV, the numbers of routes selected are very less in comparison to DSR which indicates that redundant paths are more in route finding in case of DSR, as shown in Fig. 1(a) and Fig. 1(b).

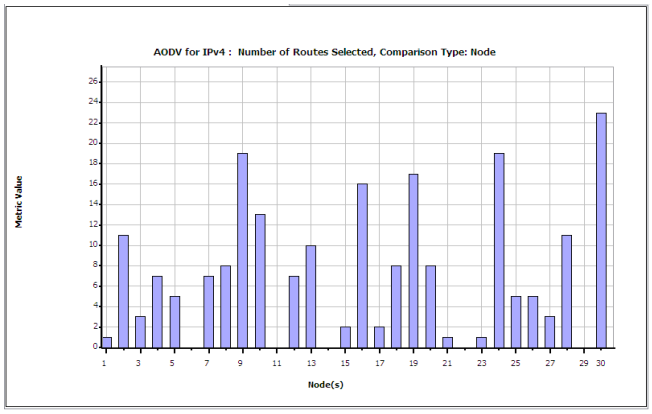

Fig. 1(a): Number of Routes Selected in AODV

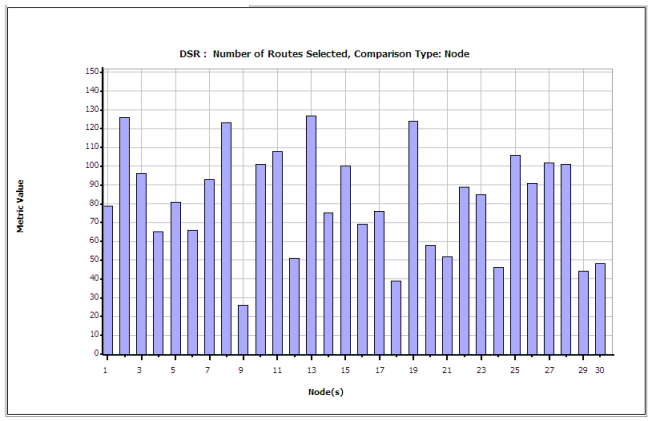

Fig. 1(b): Number of Routes Selected in DSR.

● *Number of Hop Counts:*

In case of DSR, numbers of hop counts are very high which indicates that congestion will be quite more in DSR in comparison to AODV, as shown in Fig. 1(c) and Fig. 1(d).

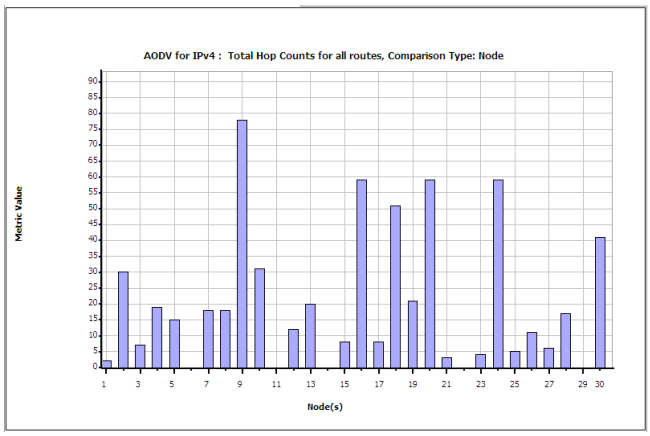

Fig. 1 (c): Number of Hop Counts in AODV.

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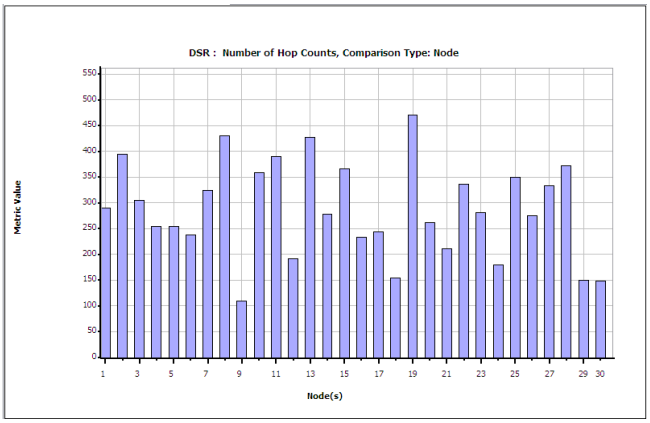

Fig. 1 (d): Number of Hop Counts in DSR.

● *Number of RREQ Packets Forwarded:*

In case of AODV, the numbers of route request (RREQ) packets are more as compared to DSR, as shown in Fig. 1(e) and Fig. 1(f).

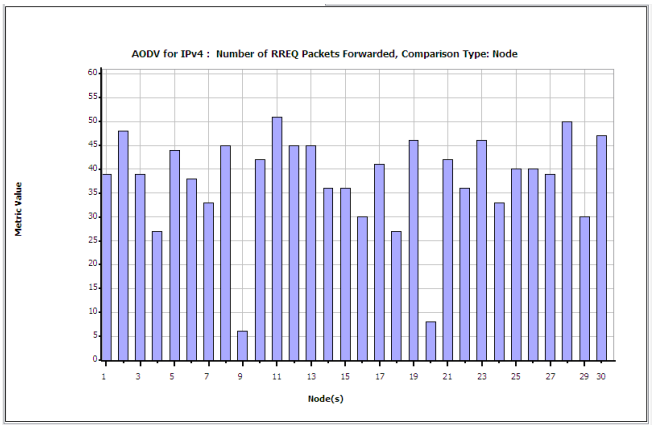

Fig. 1 (e): Number of RREQ Packets Forwarded in AODV.

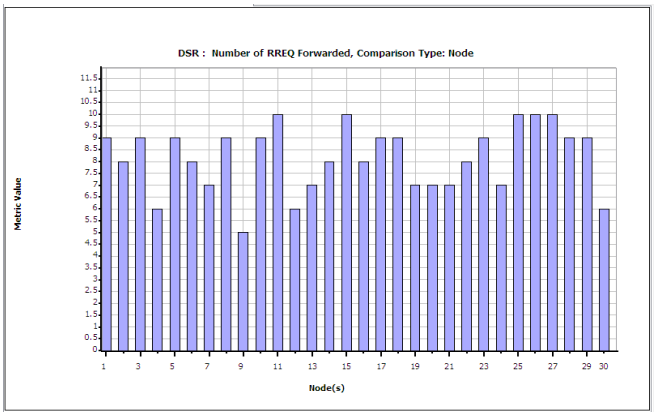

Fig. 1(f): Number of RREQ Packets Forwarded in DSR.

● *Number of RREP Packets Received:*

In AODV, the numbers of route reply (RREP) packets are more as compare to DSR, as shown in Fig. 1(g) and Fig. 1(h).

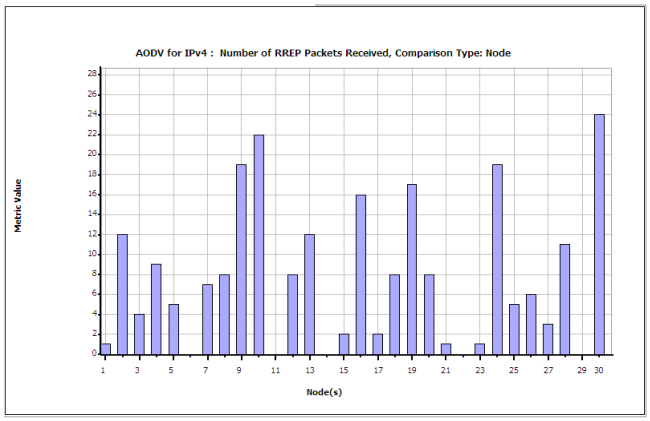

Fig. 1 (g): Number of RREP Packets Received in AODV.

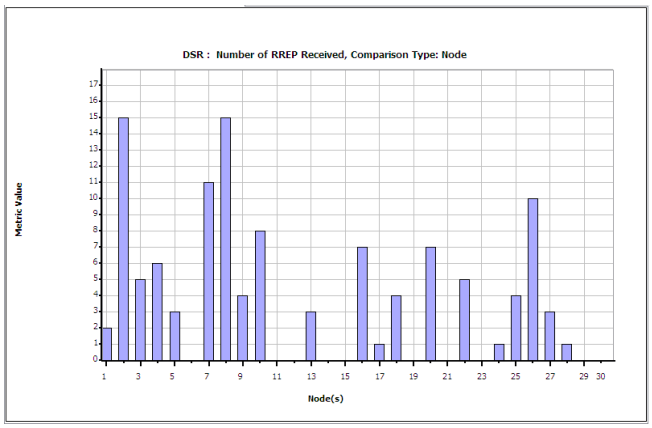

Fig. 1 (h): Number of RREP Packets Received in DSR.

● *Number of RERR Packets Received:*

In AODV, the numbers of route error (RERR) packets are more as compare to DSR, as shown in Fig. 1(i) and Fig. 1(j).

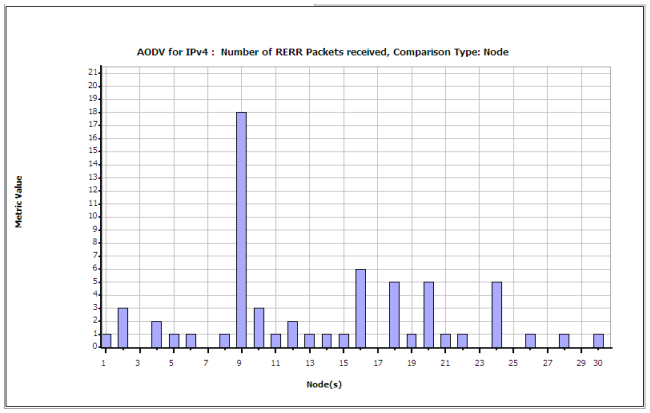

Fig. 1(i): Number of RERR Packets Received in AODV.

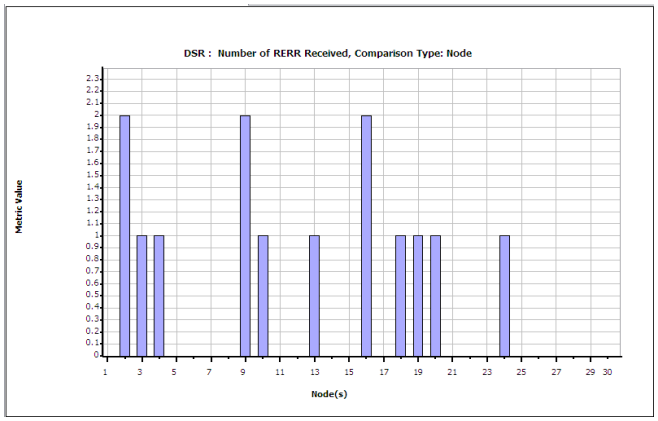

Fig. 1 (j): Number of RERR Packets Received in DSR.

● *Number of Data Packets Forwarded:*

The load sharing is more in DSR as compare to AODV, as shown in Fig. 1 (k) and Fig. 1(l).

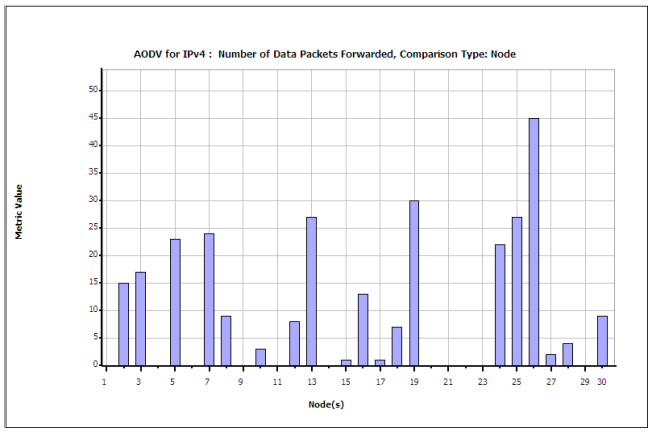

Fig. 1 (k): Number of Data Packets Forwarded in AODV.

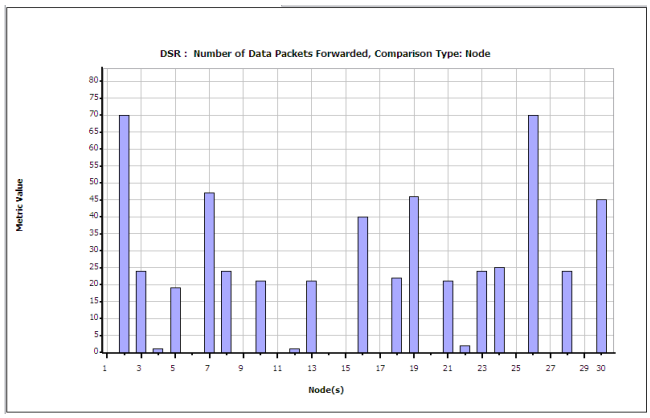

Fig. 1(l): Number of Data Packets Forwarded in DSR.

From the above simulation results/graphs which are generated on different scenarios and on different parameters, the relative performance comparison of both AODV and DSR routing protocols can be analyzed (see Table 2).

IV. Conclusion

TABLE 2
COMPARISON OF AODV AND DSR ROUTING PROTOCOLS (ON 30-NODES PLACEMENT)

Sr. No.	Parameter	AODV	DSR
1	Number of Routes Selected	Very Less	Very High
2	Number of Hop Counts	Very Less	Very High
3	Number of RREQ Packets Forwarded	More	Less
4	Number of RREP Packets Received	More	Less
5	Number of RERR Packets Received	More	Very Less
6	Number of Data Packets Forwarded	Less	More

In this paper, the relative performance comparison of routing protocols AODV, DSR has been presented after their simulation on different scenario by using the QualNet 5.0 simulator. The following conclusions were drawn:

- The study shows that the number of possible routes selected is quite less in case of AODV in comparison to DSR. This implies that on using DSR we have more redundant paths.
- The hop count for a route is quite less in case of AODV in comparison to DSR indicating that it is less prone to network congestion.
- The congestion due to route reply is more in AODV than DSR.
- The number of route error messages is quite high in case of AODV implying that under given condition there are more chances of error in AODV in comparison to DSR.

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