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Analysis of Random Way Point and Random Walk Mobility Model for Reactive Routing Protocols for MANET Using NetSim Simulator

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***Abstract* -- With the rising popularity of Wireless Communication, Mobile Ad hoc Network (MANET) has obtained its own place to be analyzed. The potential applications of MANET are growing tremendously due to its rapid changing technology. Wireless network can be established in two modes. One is "Ad hoc mode" where the nodes are self-organized and another is "Infrastructured mode" where the nodes are managed by a central coordinator such as Base Station or Access Point. However, routing plays a major role in MANET as all the nodes are mobile. Mobility Modeling and Control makes the topology of MANET more complicated which requires considerable amount of attention. To handle this scenario, different solutions are proposed in the literature. This paper attempts to evaluate the performance of the DSR and AODV routing protocol with different mobility model using NetSim Simulator to extend the applicability of the protocol. As of now, much result has not been reported in the literature with NetSim Simulator and Mobility Modeling has a great impact on future Internet of Things (IoT). So, performance metrics such as Throughput, End to End delay, Packet Delivery Ratio (PDR), Routing Overhead, and Network Lifetime has been measured and comparative results are presented in this paper.**

Keywords -- MANET, AODV, DSR, NetSim Simulator

I. INTRODUCTION

Wireless Networks can be classified into two categories; infrastructured based and infrastructure less networks. In infrastructure based networks, all the nodes are controlled by a centralized access point or base station whereas in infrastructure less networks the nodes are self-organized by nature and co-operate with each other without any central control. Mobile Ad-Hoc Network (MANET) is an example of infrastructure less network. It can be established any where any place at any time without any pre-determined plan. The nodes are connected to each other without any central access point. The self-organizing capability of each node makes each node to find the next hop neighbor to send the data packet. Data is transmitted from one node to the other node to reach at the destination in the absence of a central coordinator. So, MANET is considered as infrastructure less, multi hop and fast growing dynamic topology. The wide applications of MANET such as defence, military, disaster hit areas, battle field, health care, agriculture etc. has brought a lot of curiosity among the researchers to analyze the routing protocols as routing is mostly effected due to the mobile node. "Fig.1" shows the general model of MANET. The major challenge in MANET is how to provide reliability and link connectivity for efficient transport of data. The dynamic topology, error prone wireless channel, and self organizing capacity of MANET makes routing more challenging compared to traditional cellular network. The purpose of routing protocol is to define some set of rules that each node has to follow to communicate with other nodes. Routing algorithm follows the specific choice of path to disseminate the data and to select a path between any two nodes available in the network. Each node knows the network topology in advance and also maintains its own routing table. Routers collect information about network topology by distributing information among proximate neighbors [4]. The protocol architecture of a MANET is illustrated in "Fig. 2".

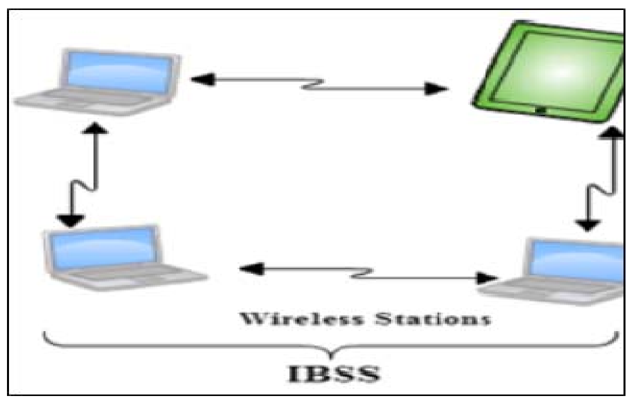

Figure 1. Topology of MANET

Node: User Service and Applications
OS IP Network Layer Operative Protocol Functions
OS IP Ad Hoc Networking Routing Layer (MANET)
Node Link Layer and Radio Network

Figure 2. Architecture of MANET

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In MANET, when the node moves from one location to other the velocity, acceleration, and location of users vary with respect to time. Hence, different mobility models are used to identify these mobility patterns and there is a requirement to analyze various mobility models. The reason is that the mobility model has great impact on the performance of the routing protocol. Otherwise, the performance measures of MANET may not be accurate and it can mislead the application. So, it is necessary and essential requirement to choose the underlying mobility model while evaluating the performance of MANET. In general, Random way point and Random walk mobility model are the two mobility models associated with MANET. In Random way point mobility model, mobile nodes select the direction and speed randomly and independently to reach at the destination. Random way point mobility model has several variations. Random walk mobility model is one of them. Random way point mobility model with zero pause time is considered as random walk mobility model. It is a memory less mobility process where the information about previous status is not considered for the future decision. For every new interval *t*, each node chooses its new direction $\Theta(t)$ from 0 to 2π randomly and uniformly.

Rest of the paper is organized as follows. Section II discusses about the existing routing protocols available in the literature. Section III presents the experimental setup for NetSim Simulator. Section IV discusses about the simulation results followed by a concluding remark in Section V.

II. EXISTING LITERATURE

Routing protocols for MANETs can be broadly classified into three main categories; Proactive, Reactive, and Hybrid routing protocol. This section presents an overview of these protocols. As this paper emphasizes on reactive routing protocols for MANETs, only two routing protocols such as AODV and DSR have been considered in our simulation. Other protocols are not discussed in detail in this paper. For detail information one can refer [3] [9].

A. *Proactive routing protocols*

Proactive routing protocols are also known as table driven routing protocols. All the nodes maintain a routing table that contains the information regarding the network topology even if it is not required for them. Each node has one or more number of paths to any possible destinations at any point of time. Different types of table driven routing protocols are available in the literature. Few well known routing protocols are discussed below.

- Destination-Sequenced Distance-Vector Routing (DSDV).
- Optimized Link State Routing (OLSR).

B. *Reactive routing protocols*

In reactive routing protocols, the path from the source node to destination node is decided based on the current traffic and topology. Hence, it is called as on-demand routing protocols. Different types of on-demand routing protocols are available in the existing literature. Few famous reactive routing protocols are discussed here.

- Dynamic Source Routing (DSR)
- Ad-Hoc on demand Distance Vector (AODV).
- Temporally ordered routing algorithm (TORA).
- Associativity Based routing (ABR).
- Signal Stability-Based Adaptive Routing (SSA).
- Location-Aided Routing Protocol (LAR)

C. *Hybrid routing protocols*

Hybrid routing protocols combine the feature of both proactive and reactive routing protocols. In this protocol, each node works in a reactive manner within its neighbourr-hood whereas it acts proactively beyond that region. Few of the hybrid routing protocols are given below.

- Core Extraction Distributed Ad Hoc Routing (CEDAR) Protocol
- Zone Routing Protocol (ZRP)
- Zone-based Hierarchical Link State (ZHLS) Routing Protocol
- Preferred link–based routing (PLBR) protocols
- Optimized link state routing (OSLR) protocols

1) Dynamic Source routing (DSR): It is also known as reactive routing protocol. DSR operates on two principles such as routing and caching [8]. There are two phases in DSR such as Route discovery and Route maintenance. Route discovery process starts by the source node by flooding Route Request (RREQ) packet for inter nodal communication. Every other node follows three principles. If any node receives the RREQ packet and it is a destination node, it receives the packet. If it is not a destination node, adds it own id and forwards the packet. If that node has already received the previous packet, it drops the packet. Each node retransmits the packet in this fashion until it reaches at the destination. The navigational path of route reply packet (RRPL) to the source node is the same path established by the RREQ packet. When a link is disconnected or any other error occurs, the corresponding node sends the information to the source node by sending request error packet (RERR). An intermediate node caches that route for future reference [9][10].

2) Ad-hoc On-Demand Distance Vector Routing (AODV):
AODV is also a reactive routing protocol which uses current traffic and topology to find the path. This protocol is different from any other reactive routing protocol in the sense that it includes destination sequence number to find the more recent path. This protocol follows the same route discovery procedure as used in DSR. It operates in two phases. The first phase involves in discovering the route and second phase maintains the route. But the main difference

between DSR and AODV is that DSR uses source routing in which the data packet carries the complete path to be traversed. But in AODV, source node and intermediate node carries the next neighbor information on per flow basis for data packet transmission. Route discovery phase starts by sending the hello message to perform inter nodal communication. It tries to find neighbor node and if any disconnectivity is found by any other node, it sends route-error message. In second phase, the communicating node sends a route request message (RREQ) message to its neighbors. The message propagates in a multi hop fashion till it reaches at the destination.

Each RREQ message carries source identifier, destination identifier, the source sequence number, destination sequence number, broadcast identifier and a TTL value. Destination sequence number identifies the freshness of the route that is accepted by source node. If the destination is not found within that TTL, the TTL value is increased in the subsequent packet. The route reply message (RRPL) follows the same path traversed by the RREQ packet. Each node maintains a routing table in AODV. Each data packet contains the header from which recently traversed path can be identified by destination sequence number. A higher sequence number is used for each new request packet. A node updates its path information only if it receives the current destination sequence number is greater than the last destination sequence number stored at each node. In this way data packets are forwarded using routing tables. This also ensures that route is not part of the packet header. An intermediate node resolves the packet drops by creating a Route error message (RERR) having a higher destination sequence number. After receiving RERR packet, sender node starts a fresh route discovery process to identify the target node [2] [10].

III. EXPERIMENTAL ENVIRONMENT

"Fig. 3" shows the simulation environment. We have considered 40 mobile nodes to measure the performance of AODV and DSR protocols with a grid area of 1000*1000m using NetSim simulator. For clarity, the snapshot of our simulation window is provided which is shown in "Fig. 3". The details simulation parameters of our interest are given in Table I. Random way point simulation result window is shown in "Fig. 4".

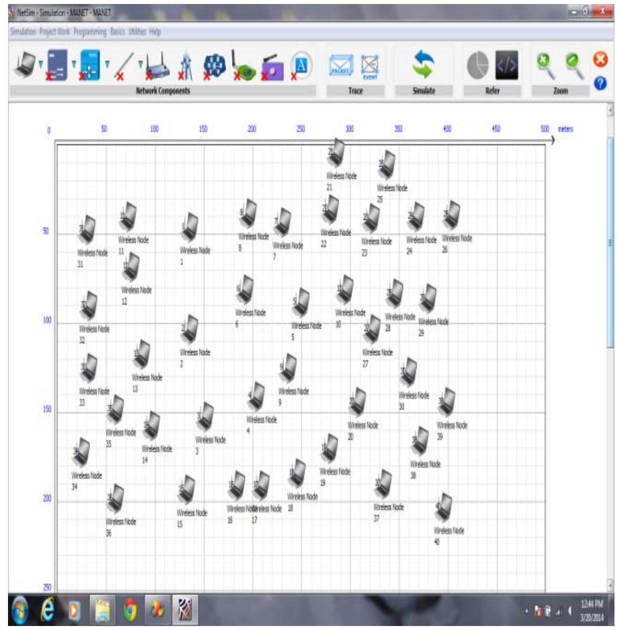


Figure 3. Simulation Window for 40 Nodes.

TABLE I. SIMULATION PARAMETERS WITH VARYING NODES

Protocols	**AODV and DSR**
Simulation duration	200 seconds
Simulation area	1000 m x 1000 m
Number of nodes	40
Transmission range	250 m
Movement model	Random Way point/Random Walk
MAC Layer Protocol	IEEE 802.11
Pause Time	10sec
Maximum speed	20 m/s
Packet rate	4 packets/sec
Traffic type	CBR (UDP)
Data Payload	512 bytes/packet

IV. SIMULATION RESULTS AND ANALYSIS

To verify the experimental results, we considered total number of nodes 40 in our simulation. First, we varied the number of nodes from 6 to 40 in the given area of 1000x1000m. In our simulations, both the Random Way Point and Random Walk Mobility Model have been considered. In Random Way Point Mobility model, nodes move freely in any direction and speed to reach at the destination with different pause times. The speed and direction is non-uniform by nature. Random walk mobility model is a simple mobility model based on random directions and speeds with zero pause time. In our simulation, pause time is considered as 10sec for random way mobility model. We run the simulation for 200 seconds. After extensive simulations, the results have been plotted from "Fig. 5 to Fig. 9".

When we increased the no. of nodes, the no. of transmitted and delivered packets were varied accordingly. It is observed from the "Fig. 5" and "Fig. 7" that the Throughput and Packet delivery ratio is better in case of DSR compared to AODV. The reason is that data packet follows the source routing. But it is concluded from Figure 6 that the End to End delay is less in AODV than the DSR protocol. Further, we made an attempt to check the performance metrics such as routing overhead and network lifetime of these two protocols. Both the mobility model has been considered to check the routing overhead and lifetime of the network. "Fig. 8" conveys that routing overhead is more in AODV than DSR protocol in case of random way mobility model but it is nearly equal in random walk model. It justifies that in AODV, the path is decided from one node to next hop node on per flow basis. Source node and intermediate nodes cache the information about the next hop only. No complete path is decided prior to the transmission of the data packet. But, DSR follows the source routing where the data packet carries complete path to be traversed. Overall, "Fig. 9" proofs that network lifetime is longer in case of DSR compared to AODV. Finally, the taxonomy of both Random Way Point and Random Walk Mobility Model for AODV and DSR protocol is provided in Table II.

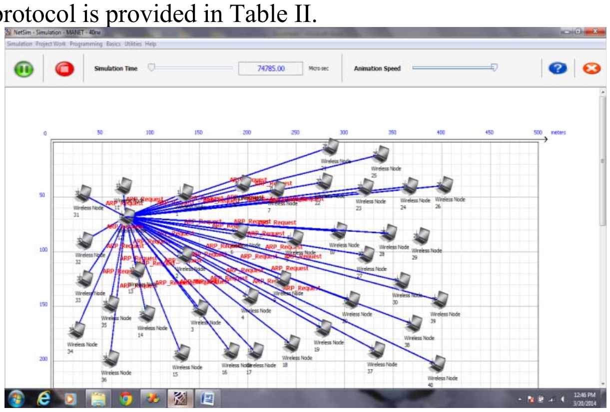
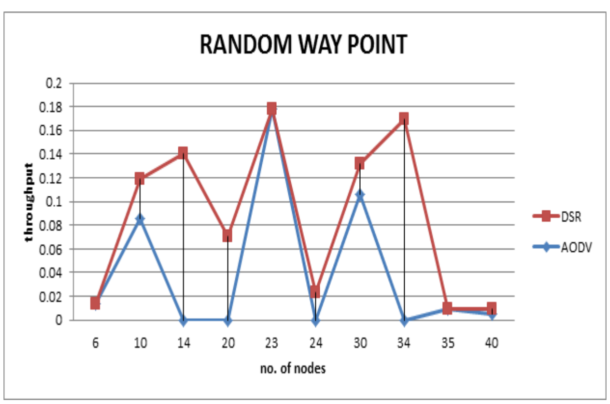


Figure 4. Random Way Point Simulation Result Window.



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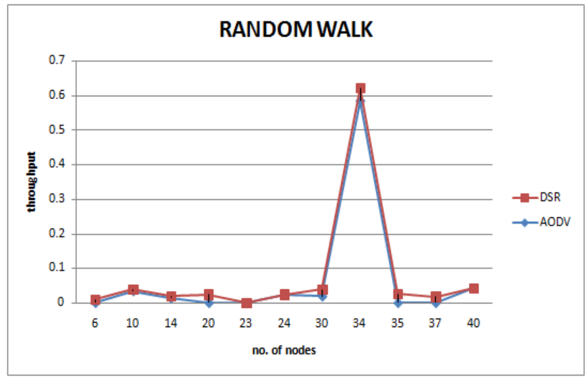
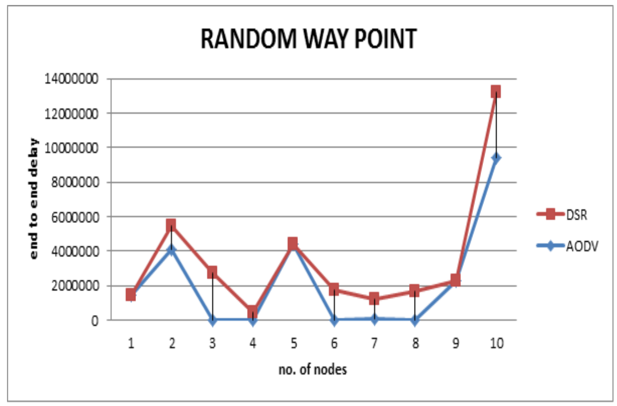


(b)

Figure 5. Throughput Vs no. of nodes.



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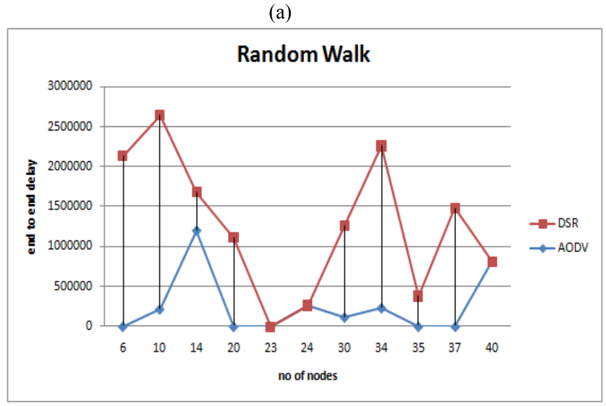

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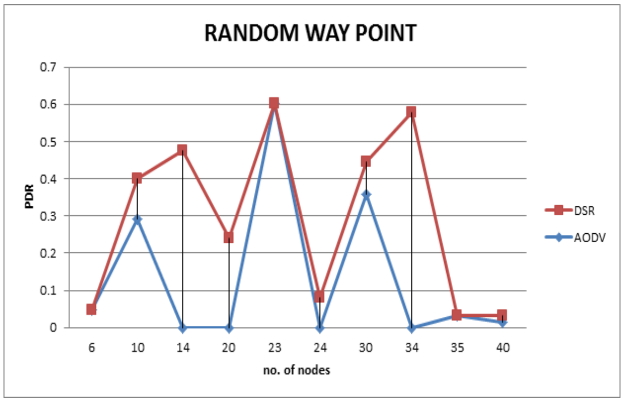
Figure 6. End to End delay Vs no. of nodes



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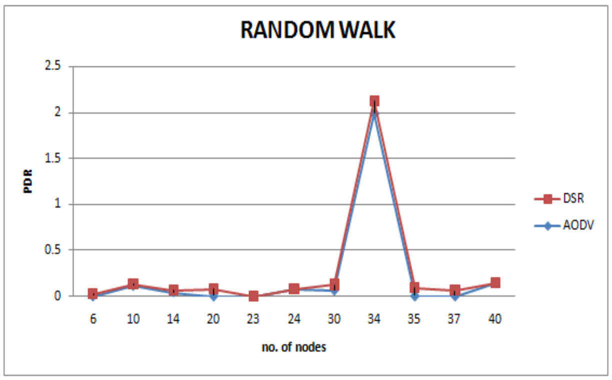
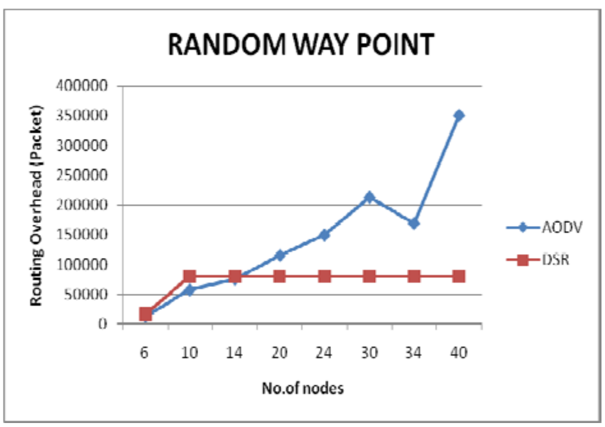


(b)

Figure 7. Packet delivery ratio Vs no. of nodes



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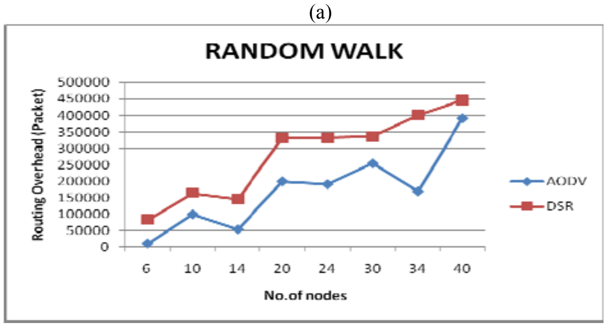
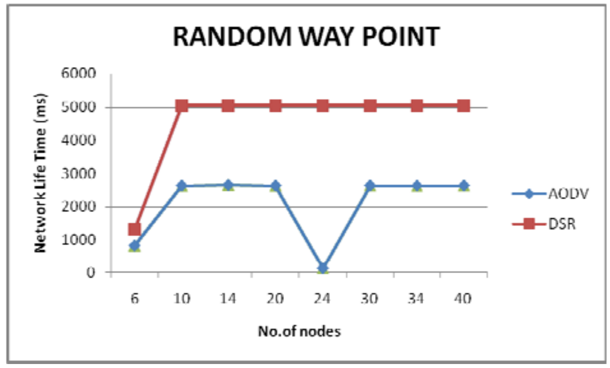


(b)

Figure 8. Routing Overhead Vs no. of nodes



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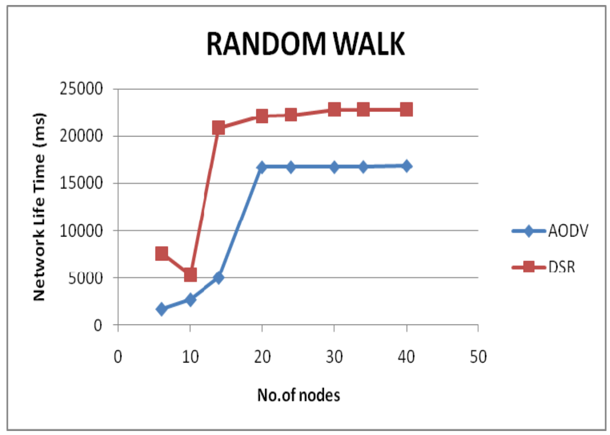

(b)

Figure 9. Network Life time Vs no. of nodes

TABLE II. ATAXONOMY OF RANDOM WAY POINT AND RANDOM WALK MOBILITY MODEL

Parameters	**Random way point**		**Random walk**	
	AODV	***DSR***	***AODV***	***DSR***
Throughput	Less	More	Less	More
End to End delay	Less	More	Less	More
Packet delivery ratio	Less	More	Less	More
Routing Overhead	More	less	Nearly equal	Nearly equal
Network Life Time	Less	More	Less	More

V. CONCLUSION

This paper presents an in-depth study of AODV and DSR reactive routing protocols considering both random way point and random walk mobility model. NetSim Simulator has been used as the simulation tool to test the performance metrics of these protocols. Some parameters such as end-to-end delay, throughput, packet delivery ratio, routing overhead and network lifetime has been considered as the performance metrics to check the applicability of these protocols. Simulation results indicate that (between DSR and AODV) DSR is better than AODV in terms of packet delivery ratio and throughput whereas AODV has less average end to end delay than DSR. Again, surprisingly with increasing no. of nodes AODV and DSR produce almost constant throughput. But, the routing overhead supports DSR and overhead is more in AODV in case of random mobility model and nearly equal in case of random walk model. Further, our simulation study concludes that network survives for longer period of time using DSR protocol than AODV protocol. A brief taxonomy of these two protocols with random way point and random walk mobility model is given in a Table II.

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