# Mobility Model Based Performance Analysis of DSDV Mobile Ad Hoc Routing Protocol

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***Abstract*—Wireless Networking has become the phrase du jour these days because of an attractive number of benefits it offers to the end users, by enabling them to access a wide pool of resources and information irrespective of the physical location of the devices used by them across the globe. Mobile ad hoc networks are a kind of infrastructure less wireless networks in which all the nodes act as peers and share information as well as resources. Mobile ad hoc networks are an open area of research since these have not been deployed widely yet. Every research in the field of networking focuses on the efficient, accurate, reliable, secure and immediate delivery of data. Therefore, the routing of data across the mobile ad hoc network is a major concern of researchers all over the world. Several routing protocols have been proposed and implemented to send data efficiently across mobile ad hoc networks. The performance evaluation of these protocols has been going on since a long time. In most of the studies, the focus has been on the variations in pause times and network size to measure the performance of various mobile ad hoc network routing protocols. A very few work has been done on the performance analysis of protocols by varying the underlying mobility models. Through this paper, investigations have been made into the behavior of DSDV mobile ad hoc routing protocol by varying the underlying mobility models. The metrics used to analyze the performance are Throughput, Average End to End delay, Routing overhead and Packet Delivery Ratio.**

***Keywords*—MANETs; DSDV; Manhattan;Random Waypoint; Random Direction; FTP;NS2;Throughput..**

## I. INTRODUCTION TO MOBILE AD HOC NETWORKS

The Wireless networks have become an epitome of revolution in the communication industry as it enables the users to access information and services through various devices like laptops, mobile phones, personal computers, tablets etc, regardless of their location. In these networks, communication takes place through standard protocols without the requirement of any network cabling thereby offering an attractive number of benefits to the end users of technology [1]. These networks can be classified as Infrastructure based or Infrastructure less as shown in fig.1.

### A. *Infrastructure based wireless networks* [2]

The nodes in infrastructure based wireless networks rely on a centralized organized point to communicate with each other.

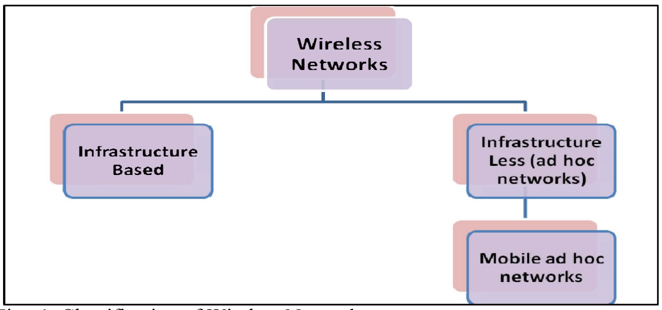


Fig. 1. Classification of Wireless Networks.

This central coordinator is usually an Access point which is needed to be contacted in case any node wants to join the network.

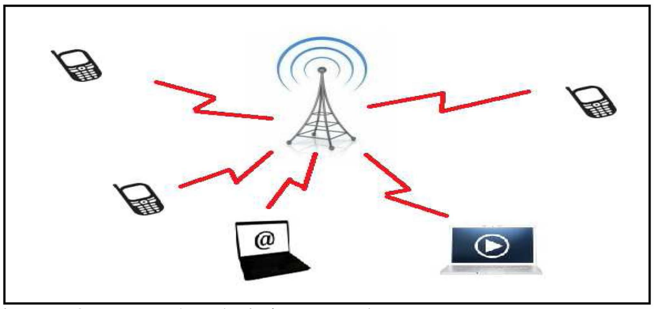

Fig. 2. Infrastructure based wireless networks.

### B. *Infrastructure less wireless networks*

Nodes in infrastructure-less wireless networks act as peers and share information with each other. Mobile ad hoc networks (MANETs) are a kind of infrastructure less wireless networks that do not rely on an organized central point. A MANET is a sovereign collection of mobile users that communicate with each other over relatively bandwidth constrained wireless links [2].

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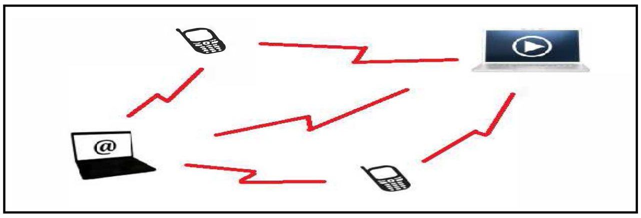

Fig. 3. Infrastructure-less mobile ad hoc networks (MANETs)

Due to the mobility of nodes, the topology keeps on changing rapidly and without prediction over time. This kind of network is decentralized which means that the nodes discover the topology and execute the delivery of messages themselves. This implies that the routing functionality is inbuilt or incorporated externally inside the mobile nodes [1]. Therefore there is a strong need of efficient routing protocols to carry out the communication between the mobile nodes inside MANET in reliable, confidential manner [2].

### C. *Mobile ad hoc Network Routing Protocols*

A Protocol is a set of rules which administer something. To send packets containing useful information from source to destination node in MANETs, a number of routing protocols have been proposed and implemented which are applied according to their suitability in a particular scenario. The protocols can be classified into two categories: Proactive and Reactive. And those protocols which make use of both proactive and reactive modes are termed as Hybrid ones [2].

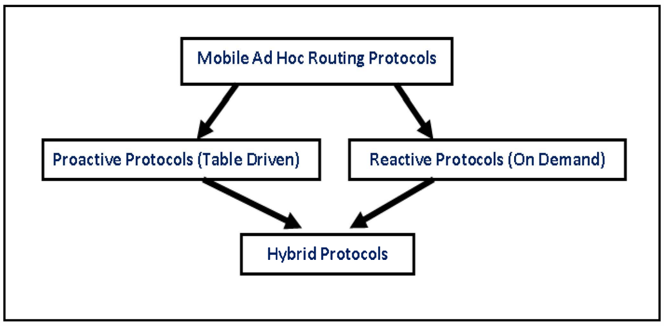


Fig. 4. Classification of mobile ad hoc routing protocols.

*1) Proactive Routing Protocols:* These protocols are also known as "table driven" routing protocols. In this, every node maintains one or more routing tables which contains information about the entire network topology. These tables are kept up-to-the-minute by regular amendments so that routing of data from one node to another could be carried out in an efficient manner. For updation purpose, nodes exchange the routing information on a regular basis and this leads to large overhead on the network [3]. Few examples of Proactive routing protocols are DSDV, WRP (Wireless Routing protocol), OLSR (Optimized Link state routing), FSR (Fisheye state routing), TBRF (Topology Broadcast Reverse Forwarding) [4].

*2) Reactive Routing Protocols:* These are also called as "on-demand" routing protocols. In these protocols, routes are searched only when needed. A route discovery process is initiated which is terminated in case the route has been found or the route is not available. Route maintainence is an important operation of these protocols. As compared to proactive protocols, control overhead is less and reactive protocols are more scalable. With these advantages, there is a disadvantage of long delays suffered by nodes while searching for routes before actually transmitting the data. Some Reactive Routing protocols are AODV (Ad-Hoc On Demand Distance Vector), DSR (Dynamic Source Routing), TORA (Temporally Ordered Routing Algorithm, LAR (Location Aided Routing), Ant-Colony-Based Routing Algorithm (ARA) [4].

## II. DSDV Mobile Ad Hoc Network Routing Protocol

### A. *DSDV's Basic Idea:*

DSDV, short for Destination Sequenced Distance Vector, is based on the idea of Routing Information protocol (RIP) that uses Bellman Ford routing algorithm. So DSDV is basically an improved version of classical Bellman Ford algorithm. It is one of the earliest ad hoc routing protocols and makes use of bidirectional links only. Packets are routed between the nodes of mobile ad hoc network using the routing tables that are stored at each node. Routing table stored at a node contains list of addresses of every other node in the network as well as address of the next hop that needs to be visited in order to reach the destination node [5].

### B. *Packet Transmission using DSDV Protocol* [6]:

Suppose node 1 wants to send packets to node 5.
Following series of events occur, as shown in figures below.

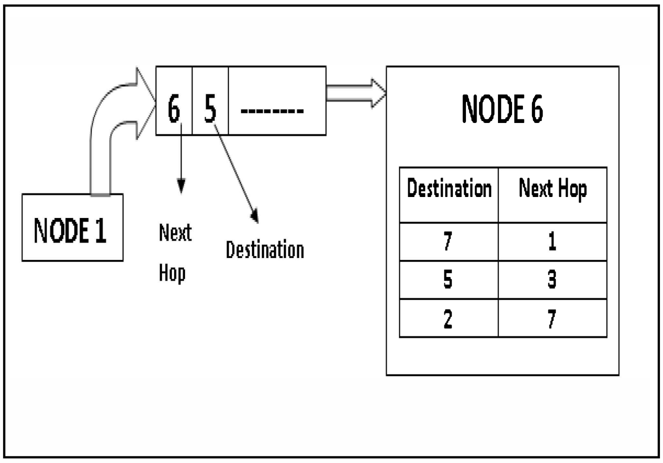


Fig. 5. Node 1 sends packet to node 5 via next hop node 6.

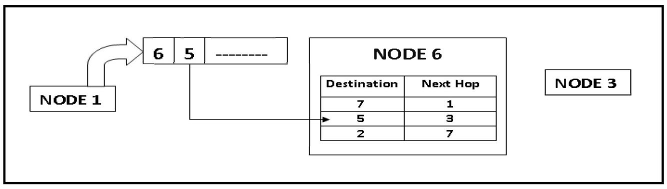


Fig. 6. Node 6 has node 3 as next hop to reach the destination node 5.

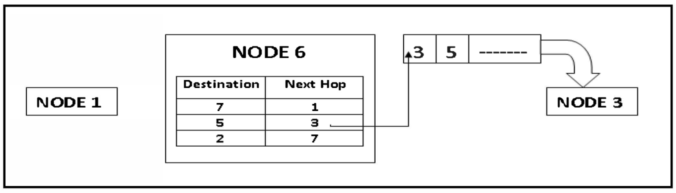


Fig. 7. Node 6 forwards the packet (meant for destination node 5) to node 3.

### C. *Managing the routing table*

The pivotal point of DSDV is the generation and maintenance of the routing tables. Everytime the network topology changes, the routing table needs updation and when routing tables are not updated, loops may be formed. To carry out routing table maintenance, some additional information is also stored inside the routing table i.e. Destination Address, Next Hop Address, Route Metric, Route Sequence Number. Each node will broadcast a routing table update packet periodically as well as immediately when there is a topology change. Update packet starts out with a metric of 1. Each receiving neighbour node is one hop away from node that sends the Update packet. The neighbours will increment this metric and then retransmit the update packet. Process is repeated round the clock until every node in the network has received a copy of the update packet with a corresponding metric. If node receives duplicate update packets, it will only consider the packet with smallest metric and ignore the rest [5, 6].

### D. *Distinguishing the Stale Packets*

To distinguish the stale packets from valid ones, each update packet is earmarked by the original node with a Sequence number which basically is a monotonically increasing number that provides the unique identification of each update packet from the given node. If a node receives an update packet from some other node, the sequence number inside that update packet must be equal to or greater than the sequence number already present in the routing table; or else the update packet is considered stale and ignored. If sequence number matches the sequence number already in the routing table, then the metric is compared and updated. Each time an update packet is forwarded; the packet not only contains the address of the concluding destination, but also contains the address of the node which transmits the packet [6].

*1) When Sequence number in update packet < Sequence number already in routing table*

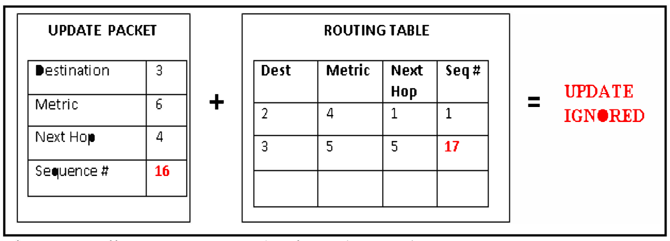


Fig. 8. Smaller sequence number in update packet.

*2) When Sequence number in update packet = Sequence number already in routing table.*

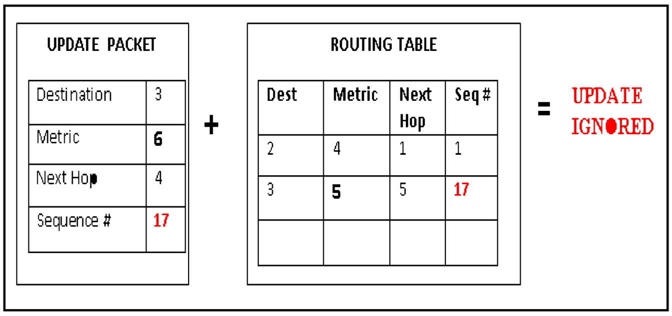


Fig. 9. Equal sequence number in Update packet.

*3) When Sequence number > Sequence number already in routing table, then UPDATE is PERFORMED.*

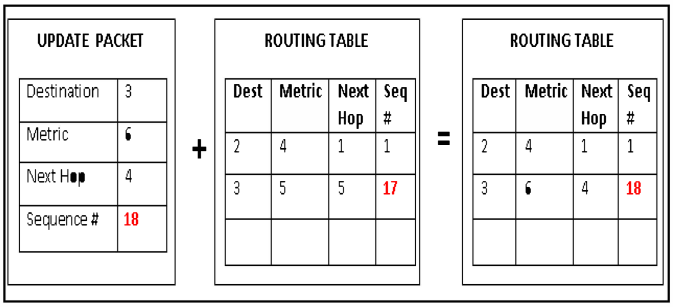


Fig. 10. Greater Sequence number in Update packet.

Each node periodically transmits its entire routing table to its neighbors using update packets. Neighbors will update their tables based on this information, if required [6].

### E. *Responding to Topology Changes*

When nodes move, they cause broken links and these broken links are detected either by the communication hardware or inferred when there are no broadcasts being received for a while from a former neighbor. Broken links have metric – Infinity. To handle topology changes, nodes only generate even sequence numbers for themselves and neighbors that respond to link changes only generate odd sequence numbers [5, 6].

## III. Mobility Models Used For Evaluation

Mobility model depicts the movement of the nodes. There are a number of mobility models which have been used to mimic the movements of nodes and tell when to change the speed and direction [7]. In this study, three models have been used for performance evaluation as discussed below.

### A. *Random Based Mobility Models*

In these models, the mobile nodes can move in random directions and freely without any constraints. The destination, speed and direction are chosen randomly and independent of other nodes.

*1) Random Waypoint Mobility Model* [8,9]*:* It is commonly used benchmark synthetic model for mobility and is an elementary model which describes the movement pattern of independent nodes by simple terms. It is simple and widely available. It can be generated directly using sedtest tool that is included in the ns2 itself. Each node moves along a zigzag line from one waypoint Wi to the next Wi+1. The waypoints are uniformly distributed over the given area. It includes pauses between the changes in direction or speed of nodes. A Mobile node stays in one location for some time interval called pause time and when this time expires, it chooses a random destination in the simulation area that is distributed uniformly between [min-speed, max-speed]. The node then travels towards its newly chosen destination at the selected speed. This process is repeated again when the node reaches the destination and pauses for a specified time. The movements using this model are shown in Fig. 11. In ns-2 distribution, the implementation of this model is as follows:

- With the initiation of simulation, each mobile node randomly selects one position in the simulation field as the ultimate destination. It then travels towards this destination with constant velocity that is chosen uniformly and randomly from the interval [0, $V_{max}$], where the parameter $V_{max}$ is the maximum allowable velocity value for every node. Velocity and direction of a node are chosen independent of other nodes. Upon reaching the destination, the node stops for some time which is termed as "pause time" parameter denoted by $T_{pause}$. If $T_{pause}$=0, then mobility is continuous which means that node does not stop.
- After $T_{pause}$ time interval the node again chooses another random destination in the simulation area and moves towards it. This process is repeated again and again until simulation terminates.
- In Random Waypoint Model, $V_{max}$ and $T_{pause}$ are two key factors that determine the mobility behavior of nodes. If the $V_{max}$ is small and pause time $T_{pause}$ is long, then topology becomes stable.
- But if node moves faster, means $T_{pause}$ is small, then topology is expected to be dynamic. By varying these two parameters, different mobility scenarios can be generated.

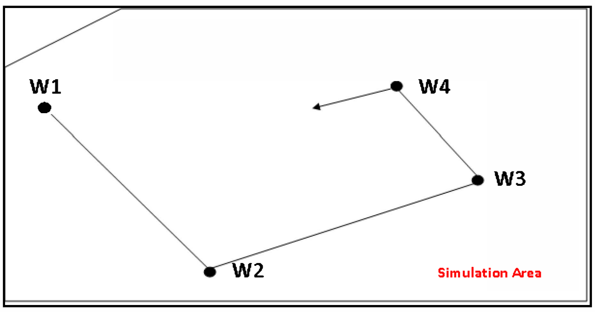


Fig. 11. Movements using Random Waypoint mobility model. [8]

*2) Random Direction Model:* It is a variant of random waypoint model. Mobile nodes choose a random direction in which to travel and the travels to the border of simulation area in that direction as depicted in Fig. 12. Once the simulation boundary is reached, the node pauses for a specified time and chooses another angular direction (between 0 and 180 degrees) and continues the process again. Following figure shows an example. Node begins in the center of the simulation area or position (300,200). When node reaches the border, it takes a pause and again chooses a new direction. Since nodes reach the border and then take pause and choose new direction, thus average hop count in this model is greater than that in Random Waypoint Model [10].

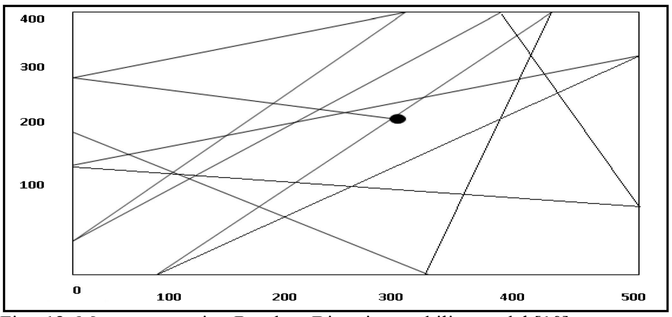


Fig. 12. Movements using Random Direction mobility model [10]

*B. City Section based Models*

*1) Manhattan Grid Mobility Model:* Manhattan Grid Mobility model is used to imitate the movement pattern of mobile nodes on horizontal and vertical streets defined by maps. It is proven to be useful in attribution of the movement in an urban area where various mobile devices are accessing a ubiquitous computing service. This model uses its own kind of map, which is composed of a number of horizontal and vertical streets with each street having two lanes for each direction (north and south direction for vertical streets, east and west for horizontal streets). The mobile node is encouraged to move along the grid of horizontal and vertical streets on the map whereby this model got its name "Manhattan Grid". The movements of nodes using this model have been shown in Fig. 13.

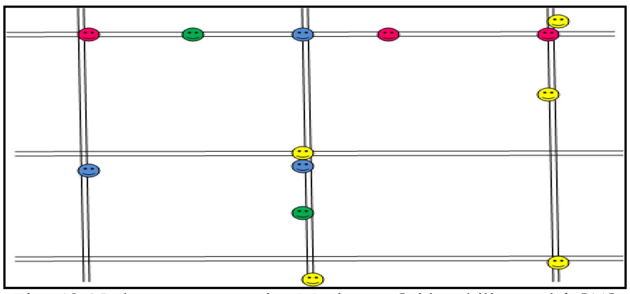

Fig. 13. Node movements using Manhattan Grid mobility model. [11]

At the intersection of a horizontal and a vertical street, the mobile node can turn left, right or head straight. The choice of movement at the intersection is probabilistic: the probability of moving on the same street is 0.5, the probability of turning left is 0.25 and the probability of turning right is 0.25. The velocity of the mobile node at a time slot is dependent on its velocity at the previous time slot. The node's velocity is also restricted by the velocity of the node preceding it on the same lane of the street [11].

## IV. PERFORMANCE MEASUREMENT OF DSDV PROTOCOL BY VARYING THE MOBILITY MODELS

The current research has been limited to the use of Random Waypoint mobility model for generating movements for the nodes in a mobile ad hoc network. But this model has been considered a poor choice in a study [16]. A very few investigations have been made regarding the performance of mobile ad hoc network routing protocols based on different mobility models. It has been observed by some studies [12, 13, 14, 15, and 17] that use of different mobility models affect the overall performance of various mobile ad hoc routing protocols. Variations can be seen in the performance of various protocols when tested under different mobility models. Through this paper, attempt has been made to analyze the performance of DSDV proactive routing protocol under 3 mobility models viz. Random Waypoint mobility model, Random Direction mobility model and Manhattan Grid mobility model. The purpose is to find out whether under which model DSDV performs better. The performance metrics used for evaluation are Throughput, Average End to End delay, Routing overhead and Packet Delivery Ratio.

### *A. Simulation Environment*

Simulation is basically a mixture of science and art. It is widely used in engineering research. There are a number of simulation tools available to simulate the behavior of various networks and routing protocols. Since Mobile ad hoc networks have not been deployed widely, simulation is a good choice to model their behavior and test their suitability under different scenarios. Simulation makes it possible to understand the behavior of the networks and the underlying routing protocols so as to find out their applicability in different situations [18].

In this study, the protocol DSDV was simulated in ns-allinone-2.35 simulation package which was installed on Ubuntu Linux version 12.04. NS2 is an open-source event-driven simulator designed distinctively to carry out research in computer communication networks [18]. The basic architecture of NS2 is shown in Fig. 14.

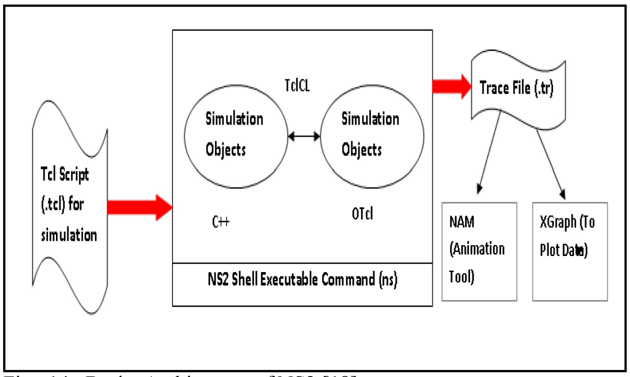


Fig. 14. Basic Architecture of NS2 [18].

The parameters used to carry out the simulation study have been listed in Table I.

TABLE I. SIMULATION PAREMETERS FOR PERFORMANCE EVALUATION

| Simulation Parameters used in the Tcl Script | |
|---|---|
| Propagation Model | TwoRayGround |
| MAC | IEEE 802.11 |
| Interface Queue (IFQ) Type | Droptail/PriQueue |
| Antenna | OmniAntenna |
| Routing Protocol | DSDV |
| Dimensions of Topography | 500x400 |
| Simulation Time | 150 ms |
| Traffic Source | FTP over TCP |
| Number of nodes | 10, 30, 50, 70, 100 |
| Maximum Packet in IFQ | 100 |
| Mobility Models | Random Waypoint,<br>Random Direction,<br>Manhattan Grid |

### *B. Scenarios for Mobility models using Bonnmotion Tool*

The scenarios for mobility models Random Waypoint, Random Direction and Manhattan Grid Model have been generated by using BonnMotion [19] tool, which is a Java software and is beneficial in investigations of mobile ad hoc network characteristics. The detailed documentation regarding installation and use of this software is available online [19].

### *C. Experiments & Results*

The experiments were performed by using the above mentioned simulation parameters inside the Tcl Script. The movements were generated for 10, 30, 50, 70 and 100 nodes respectively by using 3 mobility models Random Waypoint, Random Direction and Manhattan. The Tcl script was run and eventually two files were generated for every scenario- Trace file and NAM file. The NAM file was used to analyze the movement of nodes and the packet transmission, in short for animation. The Trace file was analyzed and the performance metrics were evaluated using AWK scripts. The experiments were repeated for these three models to understand the behavior of DSDV and find out under which model this protocol performs well.

*1) Average End to End delay comparison*

The average end to end delay was more in case of Random Waypoint model as compared to the other models. Random Direction model and Manhattan Grid model performed well in this case.

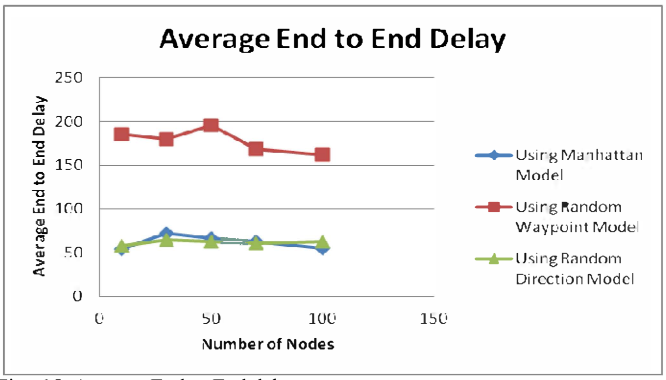


Fig. 15. Average End to End delay.

*2) Routing Overhead comparison*

Manhattan model and random direction model generated less routing overhead than random waypoint model.

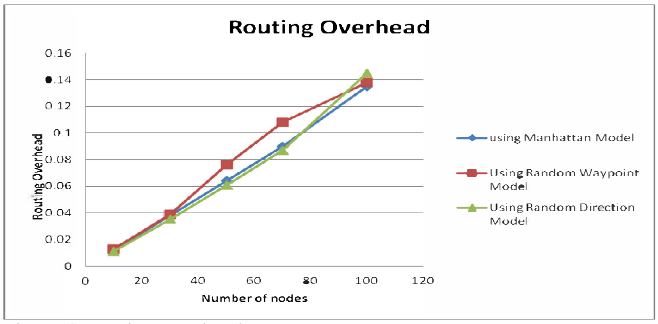


Fig. 16. Routing Overhead.

*3) Throughput comparison*

Manhattan Grid model outperformed the other two models in terms of throughput. Random Direction model performed the worst.

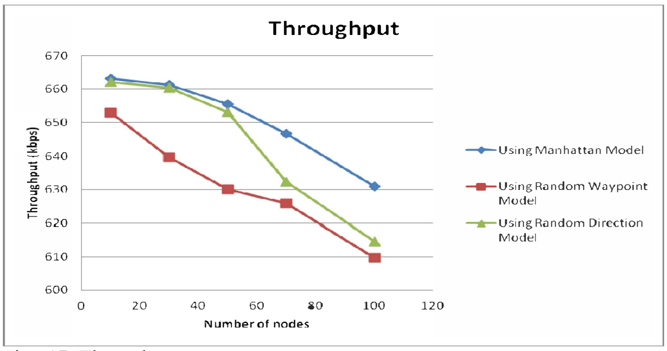


Fig. 17. Throughput.

*4) Packet Delivery Ratio*

The packet delivery ratio dropped with the increase in number of nodes. Like in case of throughput, obviously, Manhattan grid model gave the best performance.

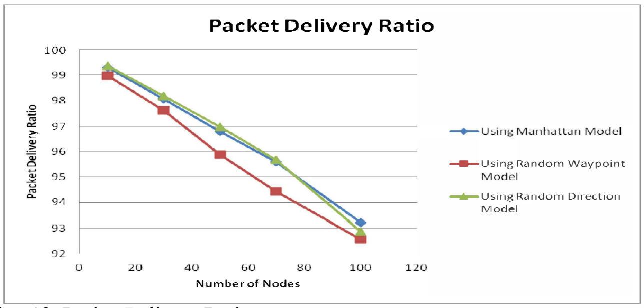


Fig. 18. Packet Delivery Ratio.

## V. CONCLUSION

Routing is a major concern when it comes to the performance of mobile ad hoc networks. Therefore, comprehensive performance evaluation of mobile ad hoc routing protocols becomes necessary. This study focused on the choice of the mobility models to evaluate the performance of DSDV protocol. Results show that DSDV protocol using Manhattan Grid model gives better throughput and packet delivery ratio and exhibits lesser average end to end delay & routing overhead than by using Random Waypoint and Random Direction model. Random Direction model performed well in terms of Average End to End delay and routing overhead. Therefore it has been concluded through this study that DSDV protocol gives best overall performance with Manhattan Grid mobility model over the other two models under the chosen simulation environment. However, it has been observed that the packet delivery ratio and hence the throughput declines with the increase in the number of nodes. In future, more mobility models like Gauss-Markov, Random Walk, Reference Point Group mobility etc can be included to analyze the behavior of DSDV as well as other reactive and proactive MANET protocols using different simulation environment.

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