ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 3, Issue 12, June 2014

Effect of Mobility Models on the performance of Proactive and Reactive Routing Protocols

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***Abstract:** With emerging trend in technology wireless networks allow user to travel from one location to another. Mobile Ad hoc network (MANET) is one of the subareas of wireless network that dynamically form infrastructure less temporary network. MANET is a collection of intercommunicating mobile nodes forming a temporary network without any centralized administration. Due to the dynamic property of mobile nodes in MANET, they require good routing protocol. This paper analyzes the effect of random based mobility models on the performance of Proactive Routing Protocol (DSDV Destination Sequence Distance Vector) and Reactive Routing Protocol (AODV- on Demand Distance Vector, DSR- Dynamic Source Routing). Performance analysis is done with respect to end-to-end delay, throughput and Packet delivery ratio for varying node densities.*

Keywords: **MANET, DSDV, AODV, DSR, Random based mobility model**

I. INTRODUCTION

A mobile ad hoc network (MANET) is an autonomous, infrastructure-less, self-configuring and self-healing system of mobile nodes connected by wireless links. The nodes are free to move about randomly and may join or leave the network at their will. Due to this element of randomness, the network topology becomes unpredictable and may change rapidly. A major issue to be addressed in the design of MANETs is, therefore, the development of dynamic routing protocols that can efficiently find routes between two communicating nodes. In view of the unpredictable making/breaking of links caused by node mobility, the routing protocols need to quickly adapt to network changes and find new paths that avoid the failed links. The movement pattern of MANET nodes is characterized by mobility models and each routing protocols exhibits specific characteristics for these models. In order to find the most adaptive and efficient routing protocol for dynamic MANET topologies, the behavior of routing protocols needs to be analyzed at varying node speeds, number of traffic nodes, network size, as well as node density . The node movement patterns differ for different scenarios; military ad hoc networks have both random and group movement of soldier nodes of low speed, and vehicle nodes (e.g. tanks, APVs etc) of quite high speeds. Similarly, behavior and mobility of nodes in airborne ad hoc networks is different from military ad hoc networks or a network comprising of participants attending a conference.

The above discussion leads us to believe that it is important to first understand and evaluate the performance of routing protocols in different mobility scenarios before selecting a protocol for a particular scenario. Most previous studies with routing protocols select the Random Waypoint mobility model for simulations. However, surveys on mobility models and impact on routing performance verify that the analysis of protocol performance using just Random Waypoint model is not enough; a given routing protocol may not deliver optimum performance under other mobility models. Certain mobility models have been developed based on network traces. Mobility models have also been developed for simulating specific scenarios to evaluate the network performance. Therefore, in this thesis, we aim to analyze the performance of MANET routing agents under various mobility models with different network parameters.

II. MANET ROUTING PROTOCOLS A BRIEF OVERVIEW

A. Proactive Routing Protocols

Proactive routing protocols are *table driven* protocols, where each node maintains a route to all destinations in its routing table. Nodes frequently update the routing tables to refresh information about the destination nodes. This allows the table driven routing protocols to transmit less overall control packets, keeping the protocol overhead minimum. However, when frequency of link breakage is high, the proactive routing protocols need a higher rate of routing table updates, which lowers the network performance.

1) Destination Sequenced Distance Vector (DSDV)

DSDV [13] is a table driven routing protocol based on the Bellman-Ford algorithm. Routing table entries are tagged with sequence numbers which are originated by the destination nodes. Nodes manage their own sequence numbers by assigning a value two greater than the old one. Route entries are replaced when new routes of higher sequence numbers are received. Route updates are transmitted either periodically or immediately after a significant topology change is detected. Updates can either be full dump where nodes transmit their routing table entries or incremental where nodes only forward newly updated entries. For route stability, settling time data is used and broken links are detected through layer-2 protocol.

B. Reactive Routing Protocols

In reactive routing protocols, a route is discovered only when needed. A source node initiates route discovery by

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ISO 9001:2008 Certified
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broadcasting route query or request messages into the network. All nodes maintain the discovered routes in their routing tables. However, only valid routes are kept and old routes are deleted after an active route timeout; the scheme improves network routing efficiency by preventing the use of stale routes.

1). Ad hoc on Demand Distance Vector (AODV)

AODV is an on-demand routing algorithm that builds routes only when desired. It makes use of sequence numbers to ensure the freshness of routes. To find a path to a destination, a node using AODV broadcasts a route request (RREQ) packet. The RREQ contains the node's *IP address*, current sequence number, broadcast *ID* and most recent *sequence number* for the destination known to the source node. The destination node on receipt of RREQ, unicasts a *route reply* (RREP) packet along the reverse path established at the intermediate nodes during the route discovery process. In case of a link failure, a *route error* (RERR) packet is sent to the source and destination nodes. By the use of sequence numbers, the source nodes are always able to find new valid routes.

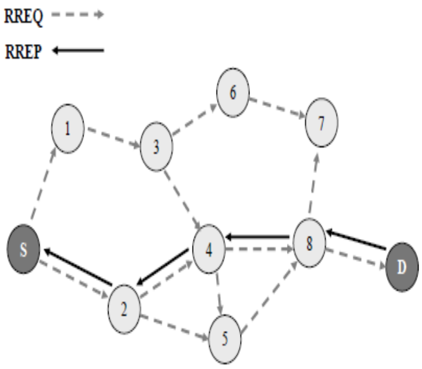


Fig 1. Route Discovery Process

2). Dynamic Source Routing (DSR)

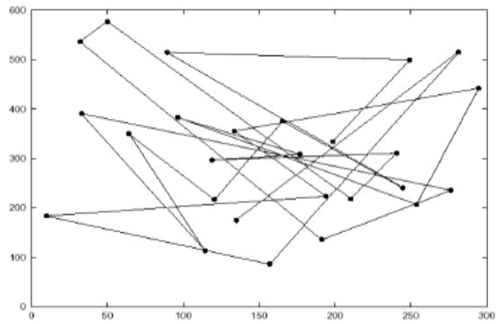
Like AODV, DSR [9] establishes a route to the destination when a source node requests one. DSR uses the *source routing* strategy. In this technique, the source node determines the complete sequence of nodes through which the data packets will be sent. In DSR, the source node initiates route discovery and broadcasts a *route request* packet. If the discovery operation is successful, the initiator receives a response packet that lists the sequence of nodes through which the destination can be reached. The route request packet thus contains a record field, which accumulates the sequence of nodes visited during propagation of the query in the network.

III. MOBILITY MODELS

In mobile ad hoc networks, the movement of nodes is characterized by a rate of change of speed and direction. Based on node mobility, synthetic and traces types of mobility models have been proposed. Synthetic models realistically represent node movement, but without using real network traces. While traces type models comprise representation of real time movement of nodes in the network. Further, we can classify mobility and node movement dependency on any constraint, may it be geological, spatial or hybrid. We carry out performance evaluation of the routing protocols using three mobility models the Random Way Point, Manhattan Grid & Gauss Markov

A) 1). Random Way Point Mobility Model

The Random Waypoint Model was first proposed by Johnson and Maltz. Soon, it became a 'benchmark' mobility model to evaluate the MANET routing protocols, because of its simplicity and wide availability. Random Waypoint Model is the most widely used and studied mobility model. In this model, a host randomly chooses a destination called waypoint and packet moves towards it in a straight line with a constant velocity, which is selected randomly from some given range. After it reaches the waypoint, it pauses for some time and then repeats the procedure. The Random Waypoint model is most commonly used mobility model in research community. In the current network simulator (ns2) distribution, the implementation of this mobility model is as follows: At every instant, a node randomly chooses a destination and moves towards it with a velocity chosen uniformly randomly from [0,Vmax], where V-max is the maximum allowable velocity for every mobile node . After reaching the destination, the node stops for a duration by the 'pause time' parameter. After this duration, it again chooses a random destination and repeats the whole process again until the simulation ends.



Movement of people in a cafeteria or mall, and movement of nodes in a conference are some of its practical applications. Mathematically, if currently a node is at point $d(x-1, y-1)$ then the next waypoint is given as:

$d(x, y) = d(x-1, y-1) + Vi$

2) Manhattan Grid Mobility Model

The Manhattan model was introduced to emulate the movement pattern of mobile nodes on streets defined by maps. It is useful in modeling movement in an urban area where a pervasive computing service between portable devices is provided. Maps are composed of a number of horizontal and vertical streets used in this model. Each street has two lanes for each direction (North and South direction for vertical streets, East and West for horizontal streets). The mobile node is allowed to move along the grid of horizontal and vertical streets on the map. At an intersection of a horizontal and a vertical street, the mobile node can turn left, right or go straight. This choice is probabilistic: the

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ISO 9001:2008 Certified
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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 a mobile node at a time slot is dependent on its velocity at the previous time slot. Also, a node's velocity is restricted by the velocity of the node preceding it on the same lane of the street. Thus, the Manhattan mobility model is also expected to have high spatial dependence and high temporal dependence as well as geographic restrictions

3) Gauss-Markov Mobility Model

The Gauss-Markov Mobility Model was originally proposed for the simulation of a personal communication service network; but is also found useful for simulation of ad hoc network protocols .Described below is how the model was implemented. The Gauss-Markov Mobility Model was designed to adapt to different levels of randomness via one tuning parameter. Initially each mobile node (MN) is assigned a current speed and direction. At fixed intervals of time, *n*, movement occurs by updating the speed and direction of each MN. Specifically, the value of speed and direction at the nth instance is calculated based upon the value of speed and direction at the $(n-1)th$ instance and a random variable using the following equations:

$s_n = \alpha s_{n-1} + (1-\alpha)s + \sqrt{(1-\alpha^2)}\, s_{x_{n-1}}$ (3)

$d_n = \alpha d_{n-1} + (1-\alpha)d + \sqrt{(1-\alpha^2)}\, d_{x_{n-1}}$ (4)

where s_n and d_n are the new speed and direction of the MN at interval n. α is the tuning parameter used to vary the randomness, where $0 <= \alpha <= 1$. s and d are constants representing the mean value of speed and direction as n and $s_{x_{n-1}}$ and $d_{x_{n-1}}$ are random variables from a Gaussian distribution. Totally random values (or Brownian motion) are obtained by setting $\alpha = 0$ and linear motion is obtained by setting $\alpha = 1$.

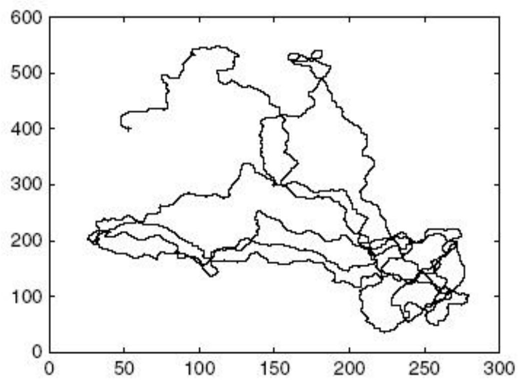


Fig 2 Gauss Markov Mobility Model

IV. PERFORMANCE EVALUATION

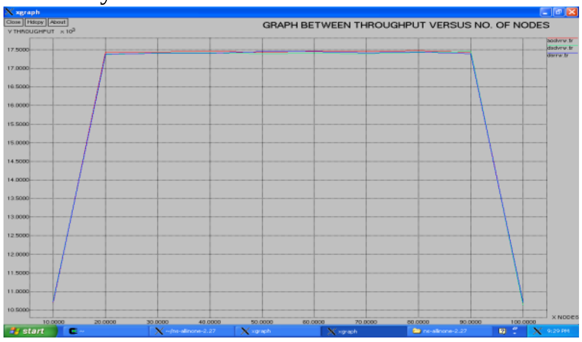
• **Throughput:** It is defined as the total number of packets received by the destination. (Data packets correctly delivered to the destination)[14].

• **Packet Delivery Ratio (PDR):** Packet delivery ratio is calculated by dividing the number of packets received by the destination through the number of packets originated by the CBR source.

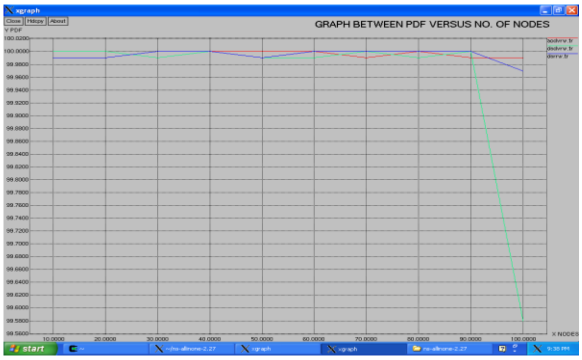
•**End to End Delay (Davg):** This delay includes processing and queuing delay in each intermediate node.

V. SIMULATION RESULTS

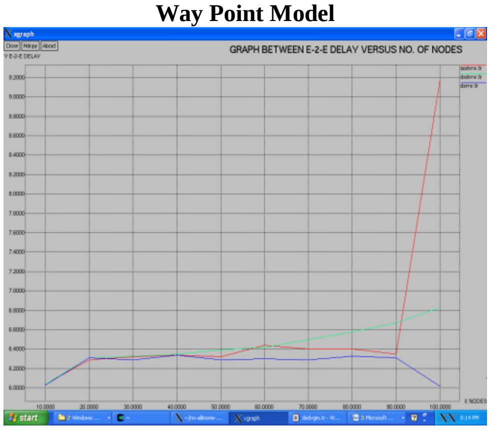
The simulation results are carried out from NS-2 Network Simulator .The Comparison of different proactive (DSDV) and reactive (AODV & DSR) ad hoc network routing protocols on the basis of different mobility models (Random way Point, Manhattan Grid & Gauss Markov) with Parameters like Throughput, PDF & E-2-E Delay. Throughput Comparison of AODV, DSDV & DSR in Random Way Point



PDF Comparison of AODV, DSDV & DSR in Random Way Point Model



E-2-E Delay Comparison of AODV, DSDV & DSR in Random Way Point Model



Throughput Comparison of AODV, DSDV & DSR in Manhattan Grid

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ISO 9001:2008 Certified
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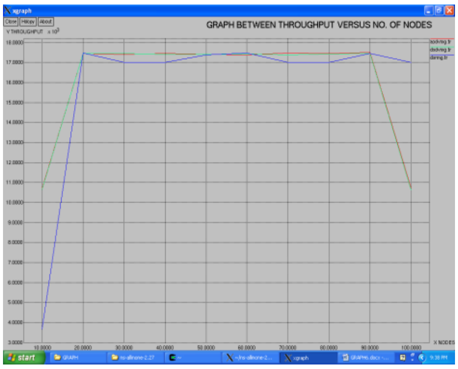
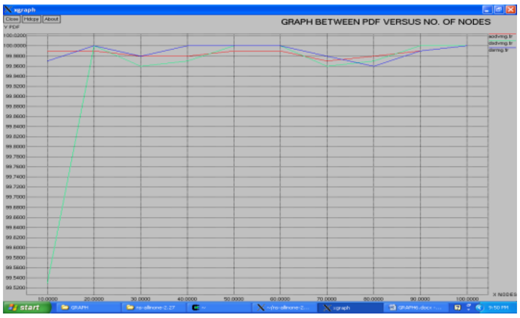
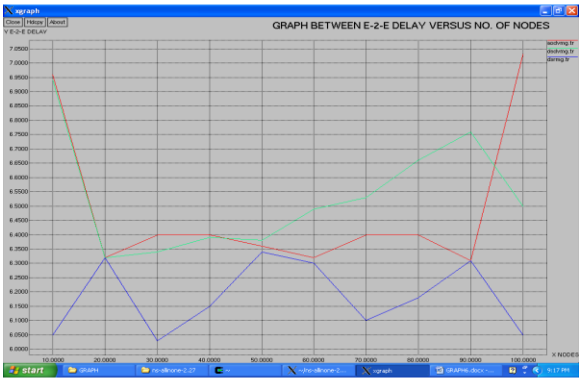


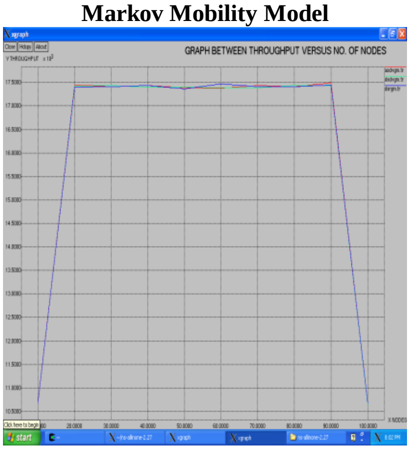
PDF Comparison of AODV, DSDV & DSR in Manhattan Grid Model



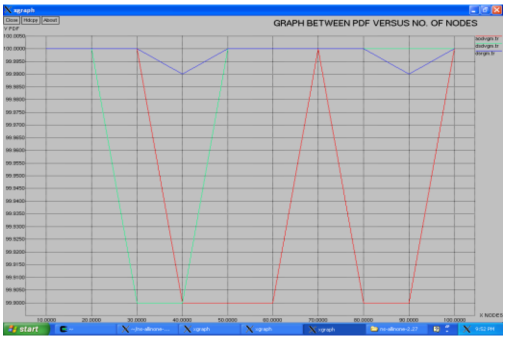
E-2-E Delay Comparison of AODV, DSDV & DSR in Manhattan Grid Model



Throughput Comparison of AODV, DSDV & DSR in Gauss Markov Mobility Model



PDF Comparison of Protocol AODV, DSDV& DSR in Gauss Markov Model



E-2-E Delay Comparison of AODV, DSDV & DSR in Gauss Markov Model

VI. CONCLUSION

Presented an overview of the comparison of various protocols in different mobility model. From the study, a comparison table is provided which clears the fact that protocol AODV performs well in Random Way Mobility Model but with more delay. For Manhattan Grid Model & Gauss Markov Model protocol DSR works extremely well & best suitable for the Models, but as network increases the performance of throughput parameter become inconsistent. So for small network DSR works extremely well for model Manhattan Grid & Gauss Markov. DSR protocol is also having least delay for all the three models. Protocol DSDV does not work well for the entire three model. But protocol DSDV has larger throughput for Gauss Markov Model .Hence with some limitations we can say that DSR is best suitable protocol for the entire three model. DSR works extremely well but for small under various limitations. None of the protocol is able to accomplish all the parameters.

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ISSN: 2277-3754
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