Volume 2, Issue 12, December 2012 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

A Stable Mobility Model Evaluation Strategy for MANET Routing Protocols

R. Mohan*
M.Tech (IT)
Dept of Information Technology
K.S.Rangasamy College of Technology, Tiruchengode, India

C. Rajan
Assistant Professor
Dept of Information Technology
K.S.Rangasamy College of Technology, Tiruchengode, India

Dr. N. Shanthi
Professor & Head
Dept of Information Technology
K.S.Rangasamy College of Technology, Tiruchengode, India

Abstract - A Mobile Ad-Hoc Network (MANET) is a self-configuring network of mobile nodes connected by wireless links to form an arbitrary topology without the use of existing infrastructure. In this paper, we have evaluated the performance of two routing protocols Ad-Hoc On-Demand Distance Vector Routing Protocol (DSR-Reactive Protocol) and Destination-Sequenced Distance-Vector (DSDV-Proactive Protocol) based upon different Mobility Models to obtain a Stable Mobility Model for MANET Routing Protocol. For experimental purposes, we have considered four mobility model scenarios: Random Waypoint, Reference Group Point Mobility, Freeway and Manhattan models. These four Mobility Models are selected to represent the possibility of practical application in the future. Performance comparison has been conducted across the varying Node Speed with fixed Network size. Experimental results illustrate that performance of the routing protocol varies across different mobility models.

Keywords— MANET, Throughput, End-to-End Delay, Packet Delivery Ratio, Routing overheads, Packet loss, AODV,DSDV, RWPM, RPGM, MGM, Freeway.

I. INTRODUCTION

A mobile ad-hoc network (MANET) is a self-configuring network of mobile nodes connected by wireless links, to form an arbitrary topology. The nodes are free to move randomly. Thus the network's wireless topology may be unpredictable and may change rapidly. Minimal configuration, quick deployment and absence of a central governing authority make ad hoc networks suitable for emergency situations like natural disasters, military conflicts, emergency medical situations etc. [1] [2].

Simulation studies of MANET routing protocols have mostly assumed random waypoint (RWPM) as a reference mobility model [3], [4]. In order to examine many different MANET applications there is a need to provide additional mobility models. Typical examples are modelling a movement in the city street environment, university campuses and the movement of groups of nodes, e.g. for specific military purposes. Recently, a performance comparison of DSR and AODV protocols based on the Manhattan grid (MGM) model has been published [5]. A performance study of DSR and AODV considering a probabilistic random walk and the boundless simulation area has been presented in [6]. A performance evaluation of DSDV and AODV using scenario based mobility models has been presented in [7]. A comparative analysis of DSR and DSDV protocols, considering Random Waypoint, Reference group mobility, Freeway and Manhattan models can be found in [8].

The objective of this work is to provide a systematic and comprehensive comparative analysis of the two typical representations of MANET routing protocols, DSDV (proactive routing protocol) and AODV (reactive routing protocol), with respect to the four mobility models. They include Random Waypoint mobility model, Reference Point Group mobility model, Freeway and Manhattan mobility model. Performance analysis and comparison encompass packet delivery fraction, end-to-end delay, throughput, and packet drop with respect to different node speeds and fixed network size. The analysis covers a wide range of MANET scenarios and aims to be useful in a variety of applications, for the purpose of network research, design and implementation.

II. OVERVIEW OF ROUTING PROTOCOLS

Considering procedures for route establishment and update, MANET routing protocols can be classified into three types:

- Proactive Protocols
- Reactive Protocols and
- Hybrid Protocols.

Proactive or table-driven protocols attempt to maintain consistent up-to-date routing information from each node to every other node in the network. Each node maintains tables to store routing information, and any changes in network topology need to be reflected by propagating updates throughout the network.

Reactive or on demand protocols are based on source-initiated on-demand reactive routing. This type of routing creates routes only when a node requires a route to a destination. Then, it initiates a route discovery process, which ends when the route is found.

Hybrid protocols combine proactive and reactive schemes.

A. Destination-Sequenced Distance-Vector Routing protocol (DSDV)

Destination-Sequenced Distance-Vector Routing protocol is a proactive table driven algorithm based on classic Bellman-Ford routing. In proactive protocols, all nodes learn the network topology before a forward request comes in. In DSDV protocol each node maintains routing information for all known destinations. The routing information is updated periodically. Each node maintains a table, which contains information for all available destinations, the next node to reach the destination, number of hops to reach the destination and sequence number. The nodes periodically send this table to all neighbours to maintain the topology, which adds to the network overhead. Each entry in the routing table is marked with a sequence number assigned by the destination node. The sequence numbers enable the mobile nodes to distinguish stale routes from new ones, thereby avoiding the formation of routing loops [9].

B. Ad hoc On-demand Distance Vector Routing (AODV)

AODV is an on-demand protocol, which initiate a route request only when needed. When a source node needs a route to a certain destination, it broadcasts a route request packet (RREQ) to its neighbours. Each receiving neighbor checks its routing table to see if it has a route to the destination. If it doesn't have a route to this destination, it will re-broadcast the RREQ packet and let it propagate to other neighbours. If the receiving node is the destination or has the route to the destination, a route reply (RREP) packet will be sent back to the source node. Routing entries for the destination node are created in each intermediate node on the way RREP packet propagates back. A hello message is a local advertisement for the continued presence of the node. Neighbours that are using routes through the broadcasting node will continue to mark the routes as valid. If hello messages from a particular node stop coming, the neighbor can assume that the node has moved away. When that happens, the neighbours will mark the link to the node as broken and may trigger a notification to some of its neighbours telling that the link is broken. In AODV, each router maintains route table entries with the destination IP address, destination sequence number, hop count, next hop ID and lifetime. Data traffic is then routed according to the information provided by these entries [10].

III. DESCRIPTION OF MOBILITY MODELS

A. Random Waypoint Model (RWPM):

The Random Waypoint model is the most commonly used mobility model in research community. At every instant, a node randomly chooses a destination and moves towards it with a velocity chosen randomly from a uniform distribution [0, V_max], where V_max is the maximum allowable velocity for every mobile node.

After reaching the destination, the node stops for a duration defined by the 'pause time' parameter. After this duration, it again chooses a random destination and repeats the whole process until the simulation ends. Fig. 1 illustrates examples of a topography showing the movement of nodes for Random Mobility Model [11].

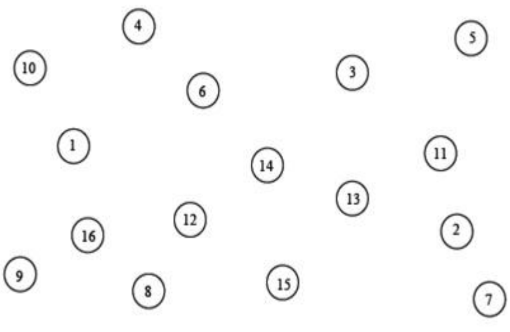

Fig. 1 Random Waypoint Mobility Model.

B. Reference Point Group Mobility Model (RPGM):

Reference point group mobility can be used in military battlefield communication. Here each group has a logical centre (group leader) that determines the group's motion behaviour. Initially each member of the group is uniformly distributed in the neighbourhood of the group leader. Subsequently, at each instant, every node has speed and direction that is derived by randomly deviating from that of the group leader. Fig. 2 shows example topography showing the movement of nodes for Reference Point Group Mobility Model [12].

Each node deviates from its velocity (both speed and direction) randomly from that of the leader. The movement in group mobility can be characterized as follows:

$$| V_{member}(t) | = | V_{leader}(t) | + random () * SDR * max\_speed$$

$$| \Theta_{member}(t) | = | \Theta_{leader}(t) | + random () * ADR * max\_angle$$

where 0 <<ADR, SDR<< 1. SDR is the Speed Deviation Ratio; ADR is the Angle Deviation Ratio.

SDR and ADR are used to control the deviation of the velocity (magnitude and direction) of group members from that of the leader. Since the group leader mainly decides the mobility of group members, group mobility pattern is expected to have high spatial dependence for small values of SDR and ADR.

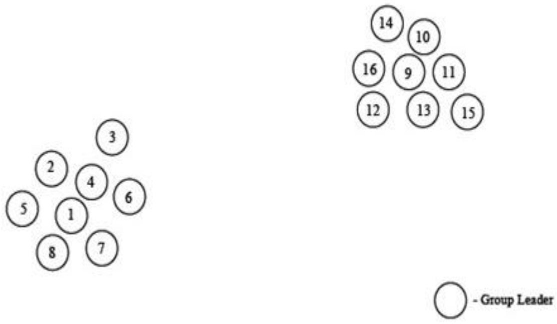

Fig. 2 Reference Point Group Mobility Model

C. Manhattan Grid Model (MGM):

In this model nodes move only on predefined paths. The arguments -u and -v set the number of blocks between the paths [13, 14] Maps are used in this model too. However, the map is composed of a number of horizontal and vertical 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 with certain probability. It too imposes geographic restrictions on node mobility. Fig. 3 shows the topography movement of nodes for Manhattan Mobility Model.

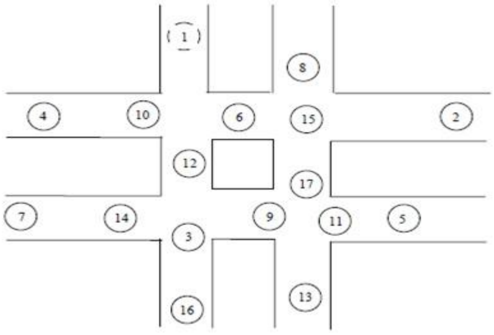

Fig. 3 Manhattan Mobility Model

D. Freeway Model:

This model emulates the motion behaviour of mobile nodes on a freeway map and each freeway has lanes in both directions [14]. It can be used in exchanging traffic status or tracking a vehicle on a freeway. Each mobile node is restricted to its lane on the freeway. The velocity of mobile node is temporally dependent on its previous velocity. Fig. 4 shows topography movement of nodes for Freeway Mobility Model with twelve nodes.

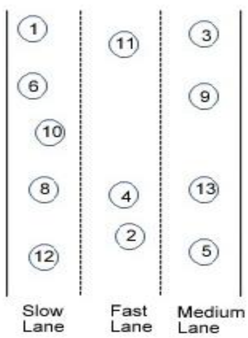

Fig. 4 Freeway Mobility Model

IV. PERFORMANCE METRICS

The Routing Protocols Performance is evaluated using four mobility models like RWPM, RPGM, Manhattan, and Freeway. The Routing Protocol Performance Metrics that evaluated are.

Throughput: Throughput is the average rate of successful message delivery over a communication channel. This data may be delivered over a physical or logical link, or pass through a certain network node. The throughput is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second or data packets per time slot.

$$Tp = (Tbr/St) * (8/1000) \text{ kbps}$$

where
Tp = Throughput
Tbr = total no of bytes received
St = Simulation time

Packet Delivery Fraction: Packet Delivery Ratio is the delivery ratio of the data packets which are generated by the CBR sources to the destination. The performance of the protocol is better if PDF value is higher which implies that how successful the packets have been delivered.

$$PDR = Ps / Pr$$

where
Ps = Packet sent
Pr = Packet received

End to End Delay: Average end-to-end delay is an average end-to-end delay of data packets. This delay can be caused by many reasons, like, latching during route discovery latency, queuing at interface queue, and retransmission delays at the MAC. End to end delay can be calculated by dividing the time difference between every CBR packet sent and received, in the total number of CBR packets received. For the better performance of the protocol end to end delay must be as low as possible.

$$d_{end\text{-}end} = N [d_{trans} + d_{prop} + d_{proc}]$$

where
$d_{end\text{-}end}$ = end-to-end delay
d_{trans} = transmission delay
d_{prop} = propagation delay
d_{proc} = processing delay
N= number of links

Packet Loss: Due to many reasons packets will be dropped while moving from source to the destination. Packet Loss is used to measure of the number of packets dropped by the routers It is defined as the difference between the number of packets sent by the source and received by the destination.

$$PL = Ps - Pr$$

where
Ps = Packet sent
Pr = Packet received

V. SIMULATION SETUP

This section of the paper gives simulation workflow and simulation environment setup to evaluate the effect of mobility on the performance of routing protocols. The routing protocol used for the simulation is available with NS-2 (version 2.35). Simulation Parameters are found in Table I.

TABLE I
SIMULATION PARAMETERS

Parameter	**Values**
Protocols	AODV, DSDV
Simulation Area	1100m x 1100m
Simulation Time	200 Sec
No of Nodes	40
Traffic type	CBR
MAC Protocol	MAC/802.11
Antenna	Omni Directional
Maximum Speed	1,10,20,30,40,50 m/Sec
Mobility Model	RWPM, RPGM, Freeway, MGM
Network Simulator	NS 2.35

Four mobility models RWPM, RPGM, Manhattan, and Freeway Models are used and the scenarios, movements for these Models were generated using a software called Mobility Generator [15] which is based on a framework called Important (Impact of Mobility Patterns On Routing in Ad-hoc Networks, from University of Southern California) which upon inputs of number of nodes, mobility model and scale (area) generates the TCL script for mobility. Background traffic, using TCL script is also employed along with the traffic, which we have monitored. Standard 802.11 MAC layer was used and transmission range in each simulation was 250 meters Fig. 5 shows the Simulation Environment setup. All the nodes in the simulation had Omni directional antennas. A standard CMUPri model for queue of buffer size 50 was used. The simulation had 40 nodes and runs for 200 secs. Flat 1100x1100 mtr scenario was created in all the mobility cases.

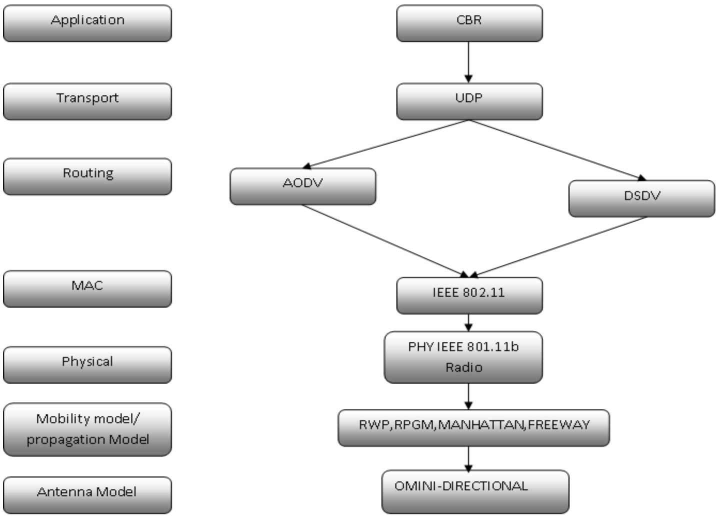

Fig. 5 Simulation Environment Setup

VI. PERFORMANCE EVALUATION

The objective of the analysis is to observe how the routing protocol performance gets affected with different mobility pattern in fixed network size of 40 nodes and varying node speed 1,5,10,20,30,40,50 (m/Sec) with 200s simulation time in mobile ad-hoc environment. A 'cbr' data packet application of size 512 bytes is taken. The simulation is carried out in the region of 1100m x 1100m in the present analysis.

We have evaluated the performance based on End-to-End delay, Throughput, Packet Delivery Ratio and Packet Loss as the metrics. These metrics describe nature of Ad hoc networks and formulate boundary conditions of Ad hoc networks but these properties do not directly related to performance. To measure external performance of a protocol, we consider end-to-end delay as metrics and to measure internal effectiveness of a protocol; we consider throughput, packet delivery ratio and packet loss as the metrics. All these metrics are most widely used for representing performance of routing protocols because higher data delivery, lower control overhead and lower delay are always desirable.

A. Analysis of AODV Performance Metrics with Different Mobility Models:

It has been observed that the Throughput for AODV protocol has different effects according to various Mobility models, but the throughput is constant for AODV in RPGM model other than Freeway, Manhattan and RPGM models, In RWPM the throughput is low as the node speed decreases and it keeps constant as the node speed increases shown in Fig. 6 (a).

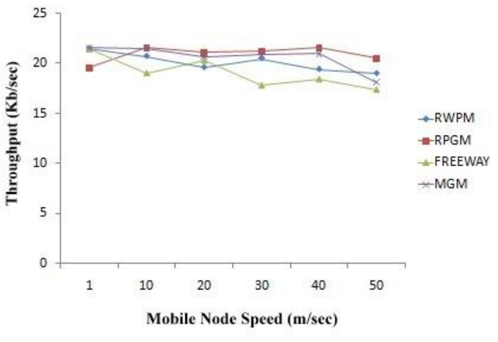

Fig. 6 (a) AODV – Node Speed (m/Sec) vs. Throughput (KB/Sec)

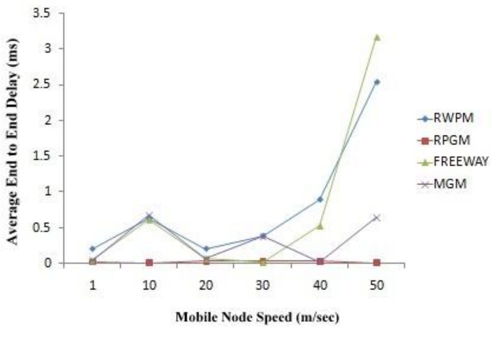

Fig. 6 (b) AODV – Node Speed (m/Sec) vs. Average End- to - End Delay (ms)

Considering the Average End-to-End Delay for AODV it has lower Delay for the RPGM than other models like RWPM, Freeway and Manhattan Model. It has been also observed that the delay increases in RWPM and Freeway model as the node speed increases. The delay is constant in the Manhattan mobility model as shown in Fig. 6 (b).

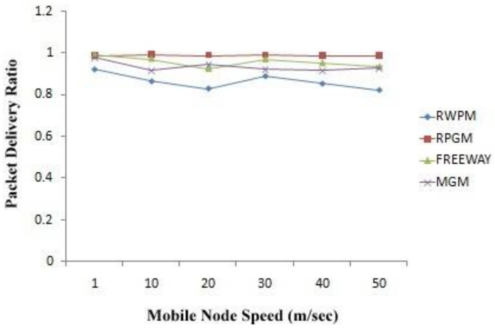

Fig. 6 (c) AODV – Node Speed (m/Sec) vs. PDR (%)

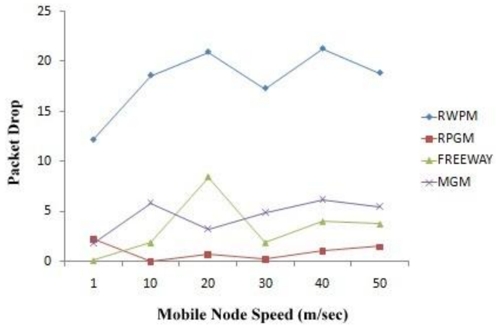

Fig. 6 (d) AODV – Node Speed (m/Sec) vs. Packet Drop (%)

The Packet Delivery Ratio for AODV is constant for RPGM other than RWPM, Freeway, and Manhattan Models; While RWPM has a low Packet Delivery ratio shown in Fig. 6 (c). Considering the Packet Drop in AODV RWPM has a high Packet Drop other than RPGM, Freeway and Manhattan Models, RPGM has a low Packet Drop, where Freeway and Manhattan Models have a constant drop in Packets as shown in Fig. 6 (d).

From the above results it is clear that mobility models have varying characteristics depending upon Routing protocols. Mobility models behave randomly. Table II shows the Performance Comparison of AODV Protocol's Metrics with Mobility Models.

TABLE II
AODV Performance vs. Mobility Models

	AODV			
	Through put	End to End Delay	PDR	Packet Drop
RWPM	80.57 %	23.27 %	72.00 %	72.88 %
RPGM	83.65 %	0.61 %	82.55 %	3.88 %
MGM	76.23 %	8.71 %	77.91 %	18.46 %
FWM	82.42 %	21.26 %	79.80 %	13.42 %

The Overall comparison of AODV Performance Metrics and the Mobility Models clearly states that, Throughput for AODV is good with RPGM while it is bad with MGM Model; Average End to End Delay is low in RPGM while it is high in RWPM and freeway Model. PDR is good in RPGM and Bad in RWPM. Packet Drop is low in RPGM than RWPM, MGM, and Freeway Models. Finally it is clear that RPGM is Stable with the Performance Metrics of AODV Routing Protocol.

B. Analysis of DSDV Performance Metrics with Different Mobility Models:

It has been observed that throughput for DSDV increases in RPGM other than RWPM, Freeway Model and Manhattan Model, and the throughput decreases very low in Freeway and Manhattan Model as the node speed increases shown in Fig. 7 (a). Considering the Average End-to-End Delay for DSDV it has lower Delay for the RPGM than other models like RWPM, Freeway and Manhattan Model. Average End-to-End Delay increases drastically in Freeway and Manhattan models as the node speed increases shown in Fig. 7 (b).

The Packet Delivery Ratio for DSDV is constant for RPGM other than RWPM, Freeway, and Manhattan Models, While in RWPM, Freeway, and Manhattan Models the Packet Delivery ratio decreases slightly as the node speed increases shown in Fig. 7 (c).

Considering the Packet Drop in DSDV a low Packet Drop is observed in RPGM, where RWPM, Freeway and Manhattan Models have high drop in Packets. Manhattan Model has the high Packet drop while Freeway and Random waypoint model has High Drop in Packets as the node speed increases from 10 to 30 (m/Sec) shown in fig 3 (d).

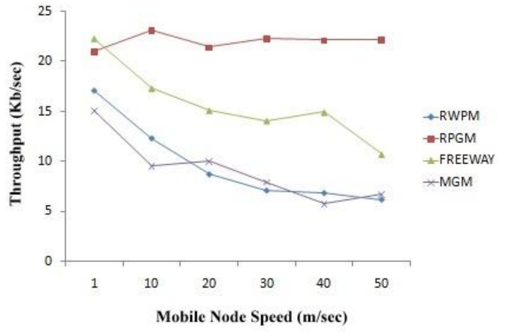

Fig. 7 (a) DSDV – Node Speed (m/Sec) vs. Throughput (KB/Sec)

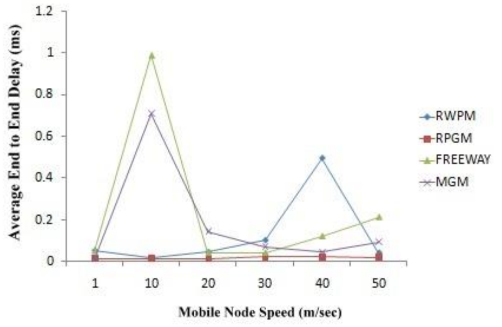

Fig. 7 (b) DSDV – Node Speed (m/Sec) vs. Average End-to- End Delay (ms)

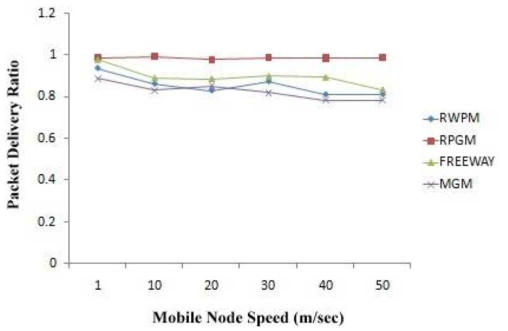

Fig. 7 (c) DSDV – Node Speed (m/Sec) vs. PDR (%)

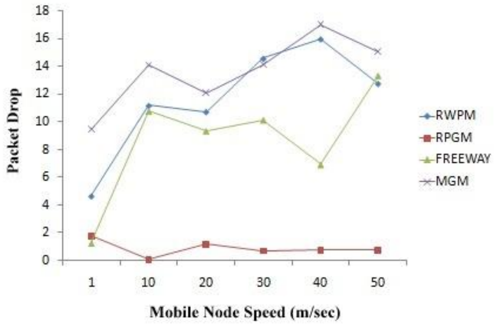

Fig. 7 (d) DSDV – Node Speed (m/Sec) vs. Packet Drop (%)

From the above results and Performance analysis of DSDV protocol it is stated that Mobility models has varying impact on the Routing Protocols. Table III shows Performance Comparison of DSDV Protocol's Metrics with Mobility Models.

TABLE III
DSDV Performance vs. Mobility Models

	DSDV			
	Through put	End to End Delay	PDR	Packet Drop
RWPM	71.25 %	10.66 %	38.80 %	64.57 %
RPGM	82.21 %	1.63 %	88.06 %	4.90 %
MGM	68.94 %	20.34 %	36.79 %	75.80 %
FWM	74.76 %	14.96 %	62.99 %	47.90 %

The Overall comparison of DSDV Performance Metrics and the Mobility Models clearly states that, Throughput for DSDV is good with RPGM while it is bad with MGM and RWPM; Average End to End Delay is low in RPGM while it is high in MGM and freeway Model. PDR is good in RPGM and Bad in RWPM and MGM. Packet Drop is low in RPGM while it is high in RWPM, MGM, and Freeway Models. Finally it is clear that RPGM is Stable with the Performance Metrics of DSDV Routing Protocol.

VII. CONCLUSION AND FUTURE WORK

This paper studied the performance of the two widely used MANET routing protocols (DSDV, AODV) with respect to Random Waypoint Mobility Model, Reference Point Group mobility model, Manhattan and Freeway model. We have developed a set of simulation scripts for the NS2 simulation environment merged with the Mobility Generator scenario generation tools. Simulation results indicate that the relative ranking of routing protocols may vary depending on mobility model. The relative ranking also depends on the node speed as the presence of the mobility implies frequent link failures and each routing protocol reacts differently during link failures.

The Reactive protocol AODV experiences the most Stable performance with all mobility models. This protocol performs best with Group Mobility model and Freeway Model. The Proactive protocol DSDV experiences the unstable performance with mobility models like Random Waypoint, Freeway and Manhattan models. This protocol performs best with entity models that have lower levels of randomness (Group Mobility Model). It has been observed that the both AODV and DSDV experience a good performance with the Reference Point Group Mobility Model. While AODV has high Throughput and Low End to End Delay comparing to DSDV Protocol. Packet Delivery Ratio for both AODV and DSDV is relatively same. Considering about the Packet Drop DSDV suffers a high Packet Drop comparing to AODV Protocol.

In Future Work we have planned to prove the Reliability of Protocols by varying the Network size and to compare the Performance of Multicast Routing Protocols like MAODV and ODMRP with varying node speeds and Different Mobility models.

REFERENCES

[1] S. Corson and J. Macker, Mobile Ad hoc Networking (MANET): Routing Protocol Performance Issues and Evaluation Considerations, RFC: 2501, Jan 1999.

[2] Carlo Kopp, “Ad Hoc Networking”, Systems Journal, pp 33-40, 1999.

[3] S. Sesay et al., “Simulation Comparison of Four Wireless Ad Hoc Routing Protocols”, Information Technology Journal 3(3), 2004, pp: 219-226.

[4] S. Shah et al, “Performance Evaluation of Ad Hoc Routing Protocols Using NS2 Simulation”, Conf. of Mobile and Pervasive Computing, 2008.

[5] G. Jayakumar, G. Gopinath, “Performance Comparison of MANET Protocol Based on Manhattan Grid Model”, Journal of Mobile Communications, vol. 2, no. 1, pp. 18-26, 2008.

[6] M. K. Jeya Kumar, R.S. Rajesh, “A Survey of MANET Routing Protocols in Mobility Models”, Int. Journal of Soft Computing 4(3), 2009, pp. 136-141.

[7] Sham-ul-Arfeen et al, “Performance Evaluation of MANET Routing Protocols Using Scenario Based Mobility Models”, Innovative Algorithms and Techniques in Automation, Industrial Electronics and Telecommunications, Springer, 2007. pp. 419-424.

[8] B. Divecha et al, “Impact of Node Mobility on MANET Routing Protocols Models”, Journal of Digital Information Management, February 2007.

[9] Charles E Perkins and Pravin Bhagwat, “Highly Dynamic Destination Sequenced Distance Vector Routing (DSDV) for Mobile Computers”, SIGCOMM 94, pp. 234-244, 1994.

[10] Aditya Goel, Ajaii Sharma , “Performance Analysis of Mobile Ad-hoc Network Using AODV Protocol”, International Journal of Computer Science and Security (IJCSS), Volume (3): Issue (5), Page No.334

[11] Nils Aschenbruck, Elmar Gerhards-Padilla, and Peter Martini 2008,” A survey on mobility models for performance analysis in tactical mobile networks”, JTIT, pp: 54-61

[12] X. Hong, M. Gerla, G. Pei, and C.-C. Chiang 1999, “A group mobility model for ad hoc wireless networks,” in ACM/IEEE MSWiM..

[13] F. Bai, N. Sadagopan, and A. Helmy 2003, “IMPORTANT: a framework to systematically analyze the impact of mobility on performance of routing protocols for adhoc networks”, in Proc. IEEE INFOCOM, San Francisco, USA, pp. 825–835.

[14] Fan Bai, Narayanan Sadagopan, Ahmed Helmy 2004, “User Manual for Important Mobility Tool Generators in NS-2 Simulators”.

[15] Mobility Generator (version 1.0) from the site, http://nile.usc.edu/important/software.htm, February 2004.

