ISSN: 2321-7782 (Online)
Volume 2, Issue 5, May 2014
International Journal of Advance Research in Computer Science and Management Studies
Research Article / Survey Paper / Case Study
Available online at: www.ijarcsms.com

Effect of Varying Mobility Model on routing protocols under different scalability and offered load over Wireless ad-hoc network

Upneet Singh Kalra[1]
Dept. of Computer Science and Engg
Maharishi Ved Vyas Engineering College
Yamuna nagar, Haryana – India

Mohinder Singh[2]
Dept. of Computer Science and Engg
Maharishi Ved Vyas Engineering College
Yamuna nagar, Haryana – India

Shanu Malhotra[3]
Dept. of Computer Science and Engg
Institute of Science and Technology
Ambala, Haryana – India

Abstract: : A Mobile Ad hoc Network (MANET) is a dynamic multi-hop wireless network that is established by a group of mobile stations without necessarily using pre-existing infrastructure or centralized administration. It can be easily deployed which makes it very attractive for civilian and military applications. It is an infrastructure less network where self-configuring mobile nodes are connected by wireless links. Because of its decentralized property, these nodes relay on each other to store and forward packets. These are characterized by bandwidth constrained links, varying link qualities, and highly dynamic topologies. Mobility models define the movement of mobile nodes with respect to location, velocity and acceleration in MANET. Transmissions of Packets between the mobile devices are controlled by Routing Protocols. Performance of routing protocol is affected by mobility rate as well as mobility model used in the simulation. Mobility Models that are used commonly are either non-realistic (Random Waypoint) or Semi-realistic (Reference Point Group, Manhattan and Freeway mobility). In this paper, we have used routing protocols from reactive, proactive and hybrid categories to make comparison. The performance routing protocols is observed in non-realistic as well as semi- realistic mobility model. The aim of this paper, is to determine the performance measures like throughput, packet delivery ratio, Average end-to-end delay, and Routing overhead of MANET's Routing - AODV, DSDV, OLSR and ZRP with varying scalability and offered load under different mobility models. The impact of network density on the performance of these said routing protocols under Random Way Point, Random Point Group mobility, Manhattan and Freeway mobility models is observed under NS2 simulator.

Keywords: MANETS, AODV, ZRP, NS-2, PDR,, CBR traffic.

I. INTRODUCTION

Wireless Communication is an application of science and technology that has come to be vital for modern existence. Wireless networking is an emerging technology that allows users to access information and services electronically, regardless of their geographic position. From the early radio and telephone to current devices such as mobile phones and laptops, accessing the global network has become the most essential and indispensable part of our lifestyle. Wireless communication is an ever-developing field, and the future holds many possibilities in this area. The concept of ad hoc networks is not new. Its history can be dated back to the Department of Defense, sponsored Packet Radio networks (PRNET) research for military purpose in 1970s. The whole life cycle of ad-hoc networks could be categorized into the first, second, and the third generation ad-hoc networks systems. Present ad-hoc networks systems are considered the third generation [7,11].

There are two distinct approaches for enabling wireless communications between mobile hosts. The first approach is to use a fixed network infrastructure that provides wireless access points. In this network, a mobile host communicates with the network through an access point within its communication radius. When it goes out of range of one access point, it connects with a new access point within its range and starts communicating through it. An example of this type of network is the cellular network infrastructure. A major problem of this approach is handoff, which tries to handle the situation when a connection should be smoothly handed over from one access point to another access point without noticeable delay or packet loss. Another issue is that networks based on a fixed infrastructure are limited to places where there exist such network infrastructures [13]. Fig. 1 shows a simple infrastructure network.

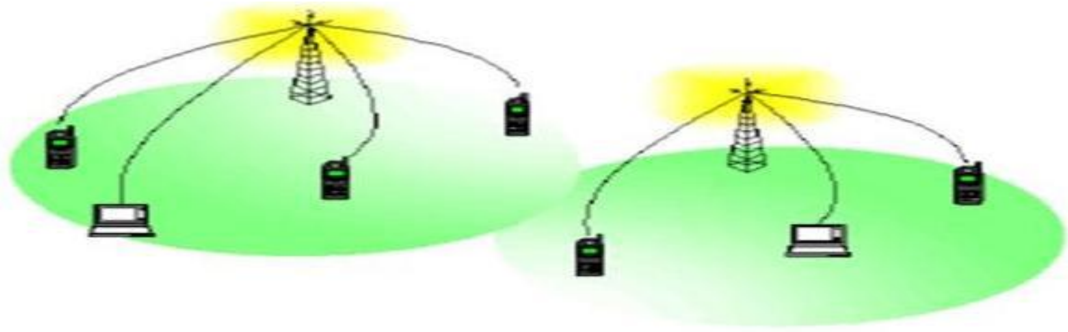

Fig. 1: Infrastructure based wireless network [18].

The second approach which is the focus of this thesis research is to form a wireless ad hoc network among users wanting to communicate with each other with no pre-established infrastructure. Laptops and personal digital assistants (PDAs) that communicate directly with each other are examples of nodes in an ad hoc network. Nodes in the ad-hoc network are often mobile, but can also consist of stationary nodes. Each of the nodes has a wireless interface and communicates with others over either radio or infrared channels. Mobile ad hoc networks consist of wireless hosts that communicate with each other in the absence of a fixed infrastructure. Routes between two hosts in MANET may consist of hops through other hosts in the network. The task of finding and maintaining routes in MANET is nontrivial since host mobility causes frequent unpredictable topological changes. A number of MANET protocols for achieving efficient routing have been recently proposed. They differ in the approach used for searching a new route and/or modifying a known route, when hosts move. It is assumed that each node is aware of the geographic location of all other nodes in MANET. Of course, for this work all nodes must be able to see all the other nodes of the network, to be able to establish communication with them. When a node goes out of range, it just looses connection with the rest of ad-hoc network. The vision of mobile ad hoc networking is to support robust and efficient operation mobile wireless networks by incorporating routing functionality into mobile nodes [11].

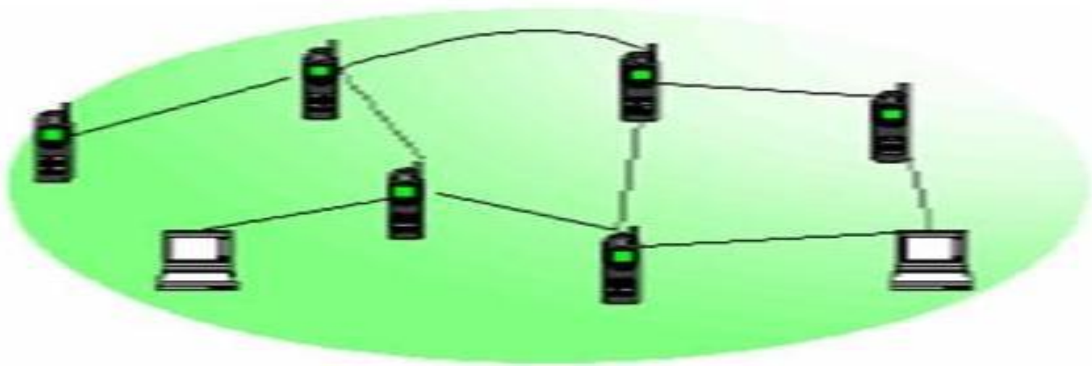

Fig. 2: Mobile Ad hoc network [18].

II. Mobility Models

Mobility is anything that causes a change in the topology, able to move or be moved freely or easily. A mobility generation tool called "setdest" is developed by CMU for generating random movements of nodes in the wireless network of NS-2 is used to generate mobility model and USC mobility generator tool for generating mobility model for Random Point Group Mobility (RPGM), Manhattan (MHM) and Freeway (FWM) model for varing scalability and offered load Scenarios.There are many mobility models proposed. We are going to use the following four mobility model for our research [2].

A. Random Way Point Mobility (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.

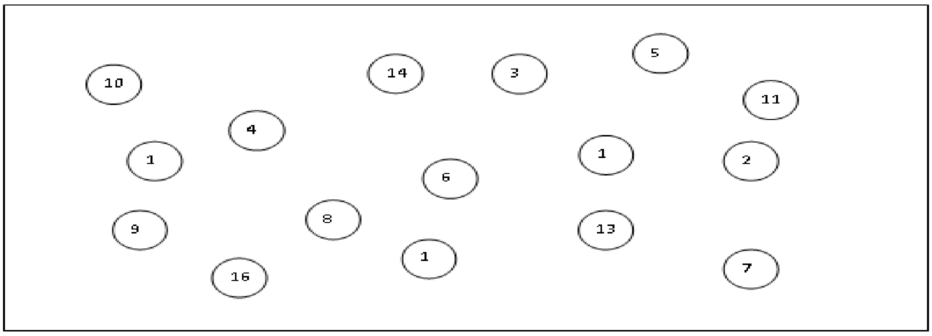

Fig. 3: Random way Point Mobility Model [2].

B. Random Point Group Mobility (RPGM)

The group mobility model we proposed here is called Random Point Group Mobility (RPGM) model. Each group has a logical "center". The center's motion defines the entire group's motion behavior, including location, speed, direction, acceleration etc. Thus, the group trajectory is determined by providing a path for the center. Usually, nodes are uniformly distributed within the geographic scope of a group [2].

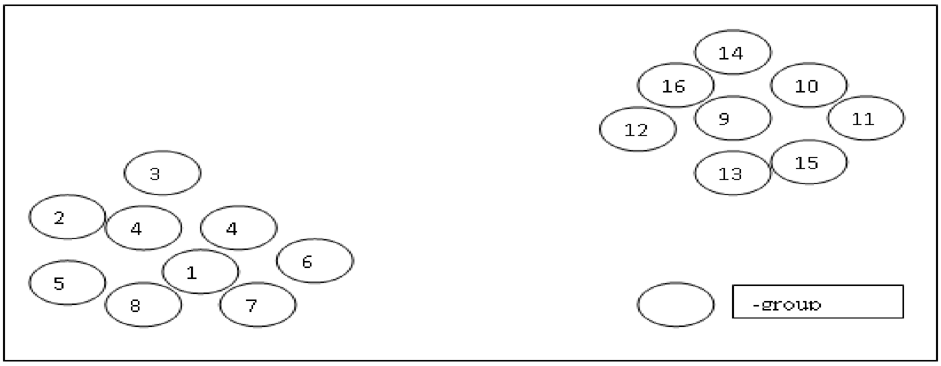

Fig. 4: Random Point Group Mobility Model [2].

C. Manhattan Model (MHM)

The Manhattan model can be useful in modeling movement in an urban area .The scenario is composed of a number of horizontal and vertical streets. Given below is example topography showing the movement of nodes for Manhattan Mobility Model with seventeen nodes? The map defines the roads along the nodes can move [2].

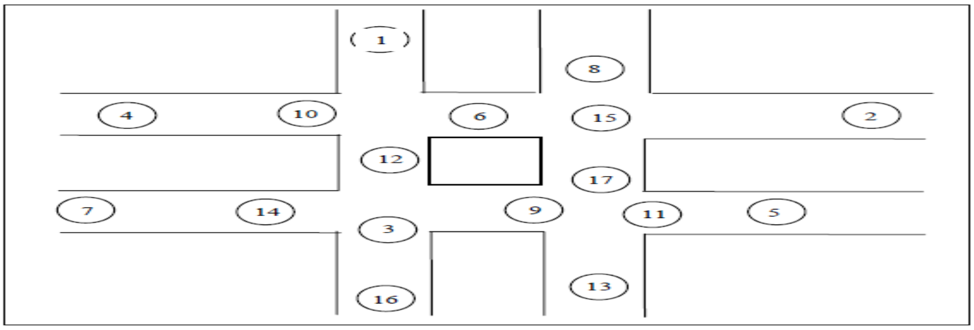

Fig. 5: Manhattan mobility model [2].

D. Freeway mobility model (FWM)

This model emulates the motion behavior of mobile nodes on a freeway. 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. In this model we use maps. There are several freeways on the map and each freeway has lanes in both directions.

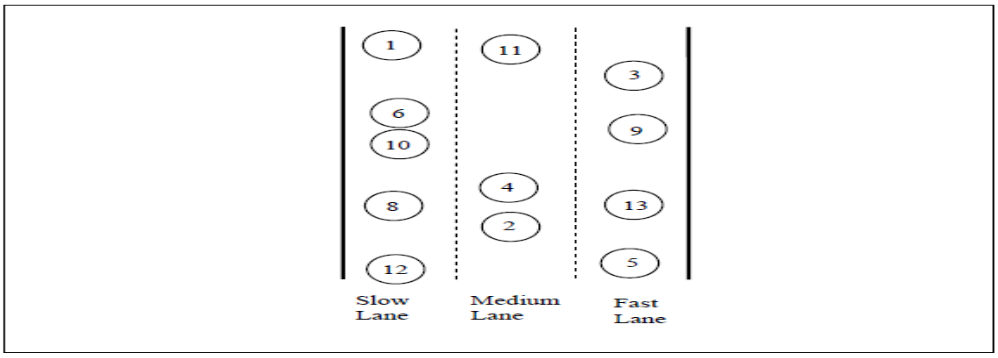

Fig. 6: Freeway mobility model [2].

III. SURVEY OF ROUTING PROTOCOLS

A. Routing protocols in MANETs

A Routing Protocol is a protocol that specifies how routers communicate with each other to disseminate information that allows them to select routes between any two nodes on a network. Typically, each router has a priori knowledge only of its immediate neighbors. A routing protocol shares this information so that routers have knowledge of the network topology at large. The specific characteristics of routing protocols include the manner in which they either prevent routing loops from forming or break routing loops if they do form, and the manner in which they determine preferred routes from a sequence of hop costs and other preference factors. There are many protocols already have developed for MANET environments [6,18,14]. All these protocols can be classified in different ways. Based on the network structure the routing protocols can be classified as flat routing, hierarchical routing and geographic position assisted routing. Flat Routing protocols can be divided into proactive, reactive and hybrid protocols, depending on the routing topology [6,12].

1. Proactive protocol

With a proactive protocol, each node maintains one or more tables containing routing information to every node in the network. All nodes update these tables so as to maintain a consistent and up-to-date view of the network. When the network topology changes, the nodes propagate update messages throughout the network to update the tables. These protocols differ in the method by which the topology change information is distributed across the network, and the number of routing tables that are required [12].

2. Reactive protocol

Reactive protocols do not maintain up-to-date routing tables at the nodes; instead the routes are created as and when required. When a source wants to send to a destination, it invokes a route discovery mechanism to find a suitable path to the destination. The route remains valid until the destination is unreachable or until the route is no longer needed. These protocols differ in the way route discovery and route maintenance is done [12].

3. Hybrid Routing Protocol

Hybrid routing protocols are a new generation of protocol, which are both proactive and reactive in nature. These protocols are designed to increase scalability by allowing nodes with close proximity to work together to form some sort of a backbone to reduce the route discovery overheads. This is mostly achieved by proactively maintaining routes to nearby nodes and determining routes to far away nodes using a route discovery strategy. Most hybrid protocols proposed to date are zone-based, which means that the network is partitioned or seen as a number of zones by each node, other group of nodes into trees or clusters [4,5].

B. Comparative Study of Routing Protocols for Mobile Ad-hoc Networks

Thomas Heide Clausen et al described [14] the Optimized Link State Routing Protocol (OLSR), a proactive routing protocol for Mobile Ad-hoc Network (MANET). This paper evaluated its performance through exhaustive simulations using the Network Simulator 2 (ns2), and compare with other ad-hoc protocols, specifically the Ad-hoc On-Demand Distance Vector (AODV) routing protocol and the Dynamic Source Routing (DSR) protocol. they studied the protocols under varying conditions (node mobility, network density) and with varying traffic (TCP, UDP, different number of connections/streams) to provide a qualitative assessment of the applicability of the protocols in different scenarios.

C. Investigation of MANET routing protocols for mobility and scalability

Ashish Shrestha et al. analyzed the performance of AODV, OLSR and TORA using OPNET modeler 14.5. The protocols were tested using the same parameters with high CBR traffic flow and random mobility. Performance of protocols with respect to scalability has also analyzed. Results showed that, AODV and OLSR experienced higher packet delay and network load compared to TORA. This was due to the localization mechanism employed in TORA. On the other hand, when segment delay is considered both OLSR and AODV performed very reliably and established quick connection between nodes without any further delay. TORA showed high end-to-end delay due to formation of temporary loops within the network [1]. Throughput was considered as the main factor because it is the actual rate of data received successfully by nodes in comparison to the claimed bandwidth. TORA again performed worst among the three analyzed protocols, delivering much lower throughput than AODV and OLSR. AODV and OLSR performed pretty well showing average performance throughout the simulation which is equivalent to result generated by other researchers.

D. Analysis of Reactive Routing Protocols for Mobile Ad-Hoc Networks

Yogesh Chaba et al. analyzed the reactive routing protocols for MANETs. Route is determined when needed and traffic volume control is lower than global routing and can be further improved using GPS. LAR storage, communication and time complexity depends on the number of nodes, routes and diameter of network. Network scalability depends on the level of traffic and the levels of multi hoping which may be up to few hundred nodes but point-point may scale higher [10].

E. Zone Base Routing Protocol for high mobility MANETs

Hongyan Du proposed a Zone-Based routings protocol, where the network area was divided into fixed none-overlapping square zones. As we know that Zone routing protocol is a hybrid protocol. It combines the advantages of both proactive and reactive routing protocols. This paper used a source routing, which reduces the routing overhead. Mobility factor is defined and can be collected by each node itself according to the statistic data and is considered in zone head selection and route determination. A more stable path has been discovered which leads to lower probability of link breakage, and reach higher throughput for the network [8].

F. Performance Evaluation of ZRP on MANETs Using QUALNET Simulator Version 5.0

M.N. SreeRangaRaju et al. proposed an algorithm to provide improved quality of service via hybrid routing protocol- Zone Routing Protocol (ZRP). In this paper considered two reactive routing protocols Dynamic Source Routing (DSR) and Ad hoc On Demand Distance Vector (AODV) as reference for analyzing ZRP by considering route acquisition delay and quick route reconfiguration during link failure. These parameters viz., route acquisition delay and quick route reconfiguration have their impact on increase in end to end delay, this automatically decreases the number of packets received thus the throughput. In this paper used well known network simulator QualNet version 5.0 to compare QoS parameters viz., throughput, number of bytes received, number of packets received, average end-to-end delay and the time at which first packet is been received for DSR, AODV and ZRP [18].

IV. Proposed Methodology

There are several environmental factors affect the performance, stability and accuracy. These factors can be listed as Degree of Connectivity among Nodes, Degree of Mobility, Number and Duration of Data Flows. The MANETs routing protocol are categorized in accordance with network size and location base services: flat routing protocols, hierarchical routing protocols and location based routing protocols.

A. Simulation And Results

In this, proposed work four routing protocols: AODV, DSDV, OLSR and ZRP are to be compared to evaluate their performance in accordance with the various mobility models namely – Random way point model, Random point Group model, Manhattan and free way mobility model. TCP has been considered as transport protocol and CBR as traffic generator. Protocol evaluations are based on the simulation using ns2.

B. Research Methodology

There are several network simulation softwares like NS2, NS3, Glomosim, Opnet, Omnet++ and Qualnet available to evaluate the performance of routing protocols. Each one is having its own advantages and disadvantages. we are going to use NS2 [19] for my study which suits me. In general, a simulation comprises the following phases:

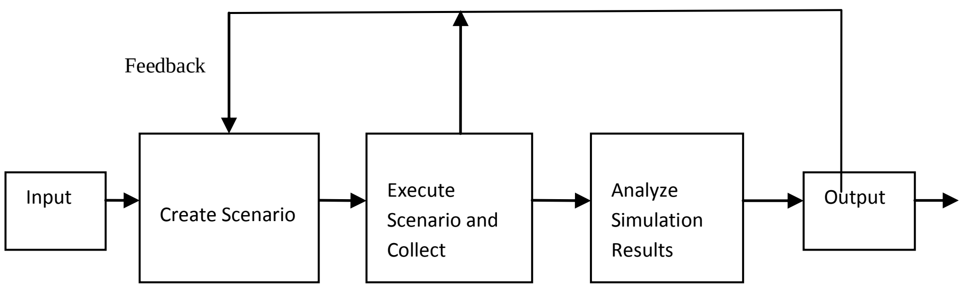

Fig. 7: Scenario-based Simulation Phases.

NS2 is one of the most popular open source network simulators. The original NS is a discrete event simulator targeted at networking research. The current NS project is supported through DARPA. The current second version NS2 is widely used in academic research and it has a lot of packages contributed by different non-benefit groups. First and foremost, NS2 is an object-oriented, discrete event driven network simulator which was originally developed at University of California-Berkely [19].

Table I Salient Simulation Parameters

Parameter	**Value**
Mobility Models	Random Way Point, Random point Group Mobility, Manhattan and freeway models
Radio Propagation Model	Two Ray Ground Model
MANET Routing Protocols	AODV, DSDV, OLSR, ZRP
Nominal Traffic Type	FTP
No. of Nodes	40, 60, 80, 100
Simulation Time	200 seconds
Data Rate	2 Mbs
Terrain Area	1500x1500 m^2
Packet Size	512 bytes
MAC type	802.11
MAC Method	CSMA/CD
Antenna	Omni-Antenna

C. **Network Scenarios**

In the ad hoc network, we have simulated the following two different scenarios:

1. Network density with Random Way Mobility.
2. Network density with Random Point Group Mobility.
3. Network density with Manhattan Mobility.
4. Network density with Freeway Mobility.

There are many parameters which can be used to evaluate the performance of routing protocols. Performance metrics are considered as follows**:**

Throughput

Throughput is, bits per second delivered to destination, so that unicast network throughput is sum of bits delivered to all destinations over time. It is one of the dimensional parameters of the network which gives the fraction of the channel capacity used for useful transmission selects a destination at the beginning of the simulation, information whether or not data packets correctly delivered to the destinations. Mathematically,

Throughput = (number of delivered packet * packet size)/Total duration of simulation

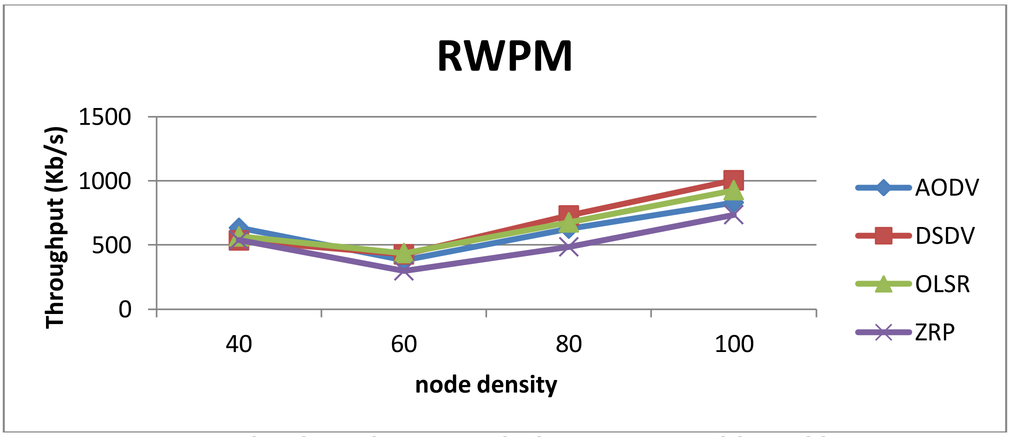

Fig. 8: Throughput with respect to nodes density in RWPM Mobility Model.

From the Fig. 8, it is observed that DSDV has highest throughput as compared with others protocols.

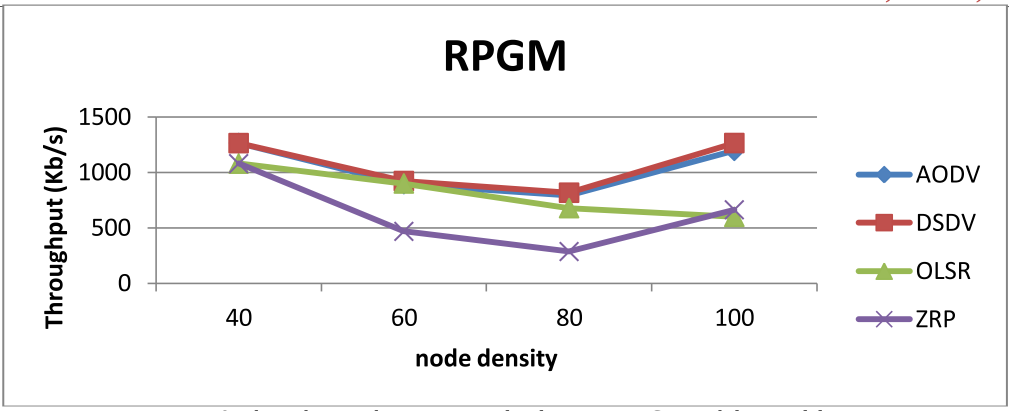

Fig. 9: Throughput with respect to nodes density in RPGM Mobility Model.

Graph shows the effect of node density on the throughput in Group Mobility model. AODV and DSDV are good in throughput when we increase the network density. But ZRP protocol has lowest throughput among all.

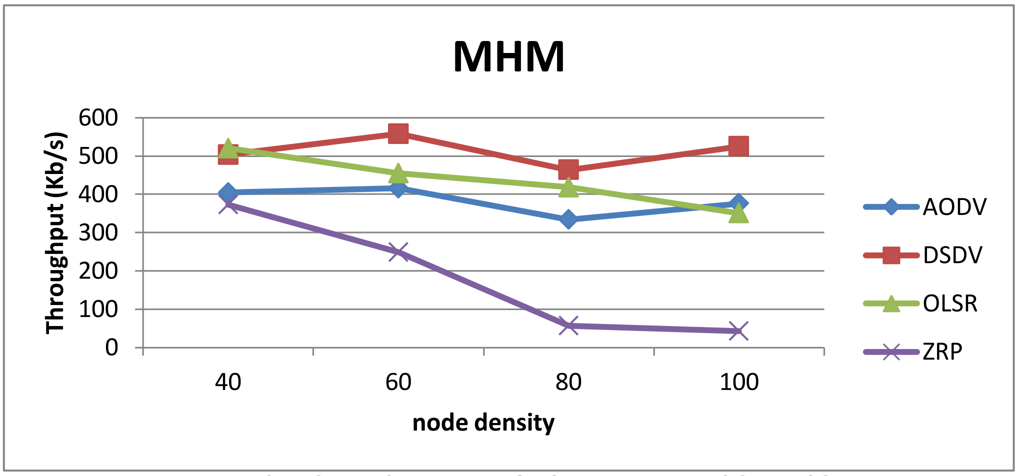

Fig. 10: Throughput with respect to nodes density in MHM Mobility Model.

Graph shows the effect of node density on the throughput in Manhattan mobility model. DSDV are good in throughput when we increase the network density. But ZRP protocol has lowest throughput among all.

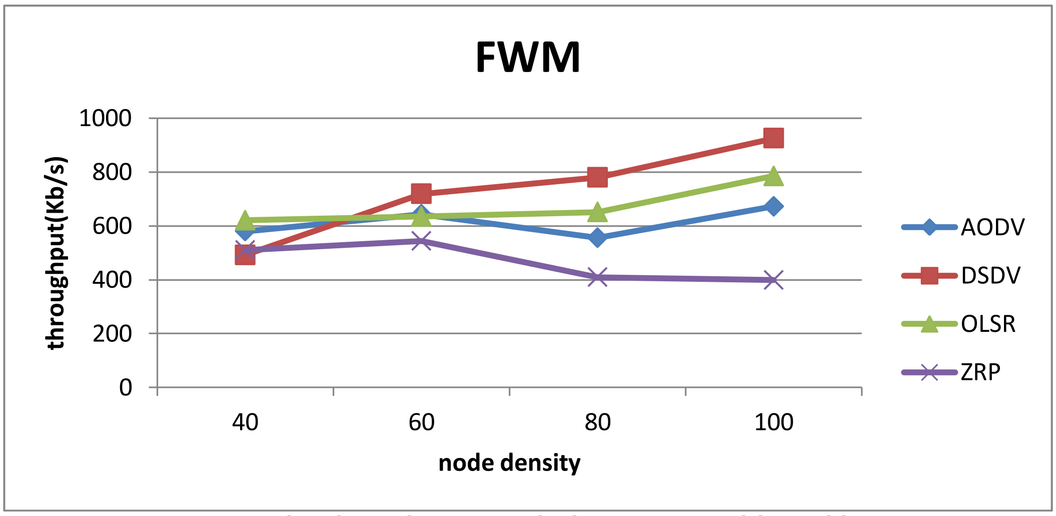

Fig. 11: Throughput with respect to nodes density in FWM Mobility Model.

Graph shows the effect of node density on the throughput in Freeway mobility model. DSDV and OLSR are good in throughput when we increase the network density.

Packet Delivery Ratio

Packet delivery ratio is calculated by dividing the total number of data packets received at all the nodes, by the total number of data packets sent out by the FTP sources. This number represents the effectiveness and the throughput of a protocol in delivering data to the intended receivers within the network. Number of successfully delivered legitimate packets as a ratio of number of generated legitimate packets.

PDR = Total no. of Packets Received/Total no. of Packet sent

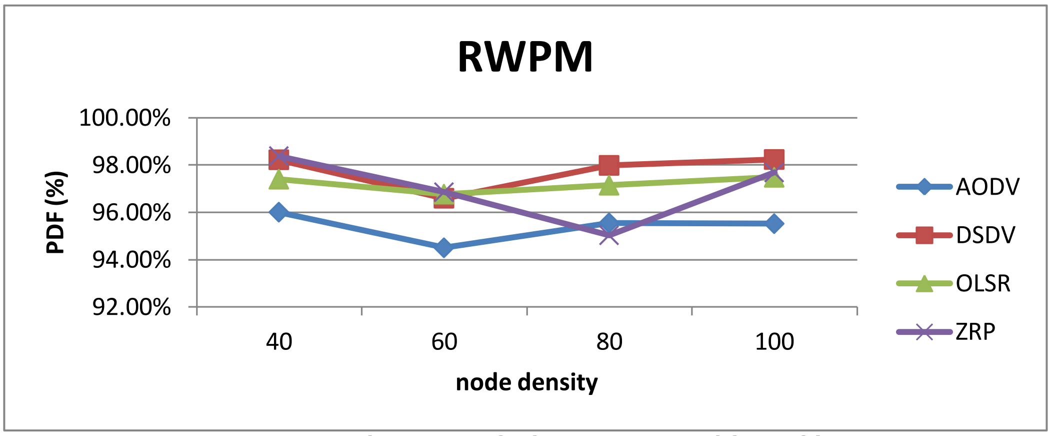

Fig. 12: PDR with respect to nodes density in RWPM Mobility Model.

Graph shows the effect of mobility on PDR in Random Wave Point Mobility model. AODV is good in terms of PDR in this mobility model. DSDV and OlSR has better PDR than AODV. AODV protocol has lowest PDR among all.

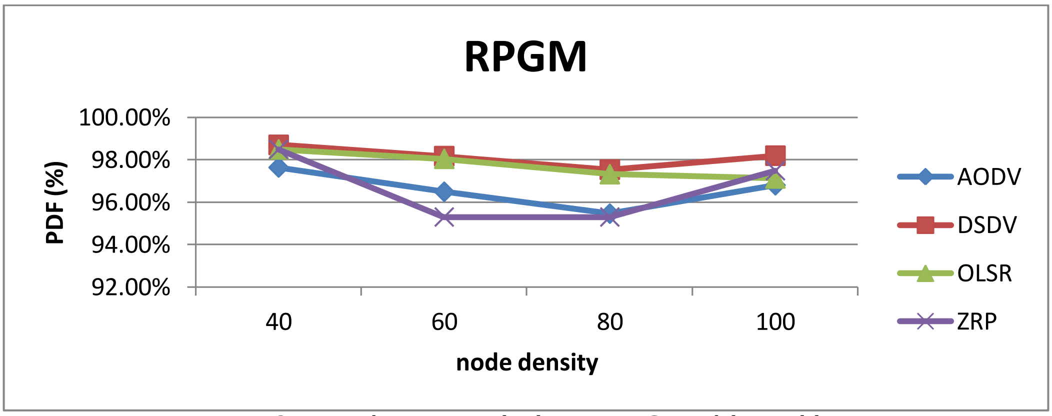

Fig. 13: PDR with respect to nodes density in RPGM Mobility Model.

Graph shows the effect of mobility on PDR in RPGM model. ZRP is bad in terms of PDR in this mobility model. AODV has better PDR than ZRP. DSDV protocol has highest PDR among all.

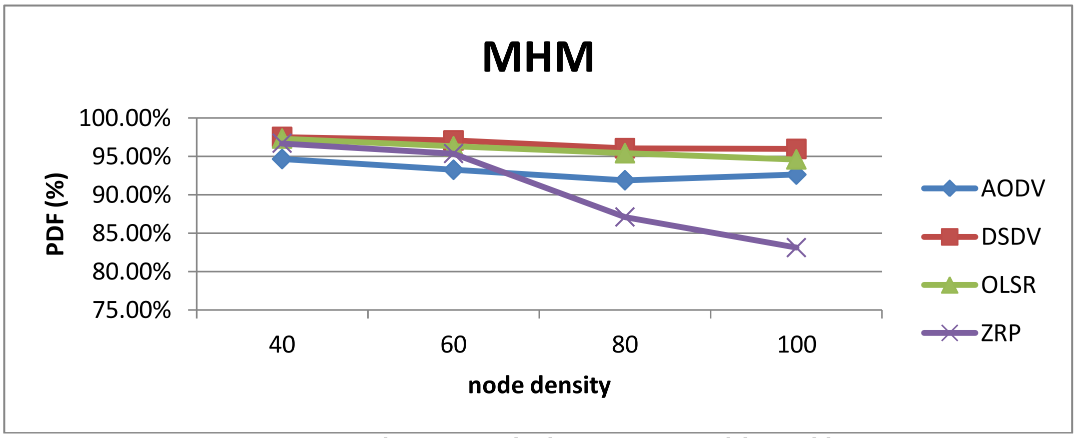

Fig. 14: PDR with respect to nodes density in RPGM Mobility Model.

Graph shows the effect of mobility on PDR in RPGM model. ZRP is bad in terms of PDR in this mobility model. AODV has better PDR than ZRP. DSDV and OLSR protocol has highest PDR among all.

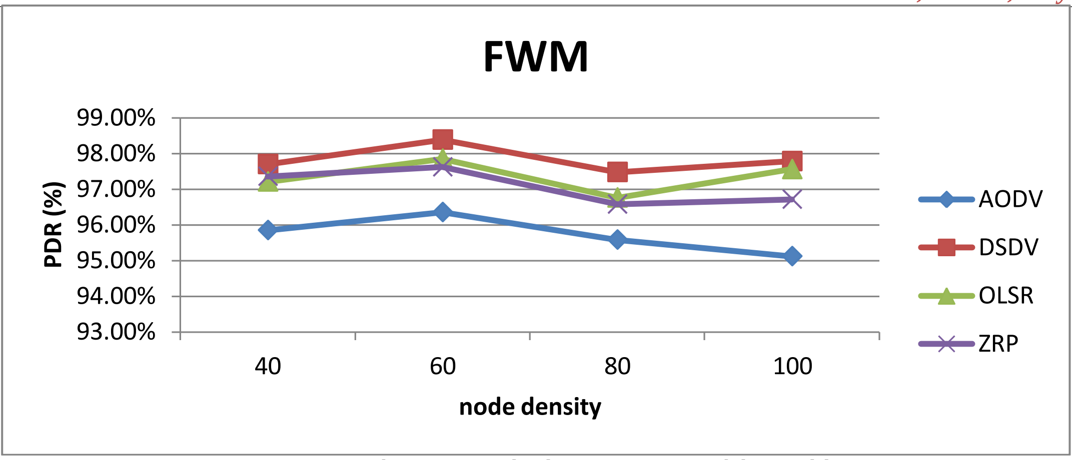

Fig. 15: PDR with respect to nodes density in RPGM Mobility Model.

Graph shows the effect of mobility on PDR in RPGM model. AODV is bad in terms of PDR in this mobility model. OLSR and ZRP have better PDR than AODV. DSDV protocol has highest PDR among all.

V. Conclusion and Future Work

Simulation results shows the effect of various network desity on to compare the performance of four protocols AODV (reactive), DSDV(proactive), OLSR (proactive) and ZRP (hybrid) under the FTP traffic in Random Way Point Mobility and Random Point Group, Manhattan and freeway Mobility Models under varying network density. This comparison shows that the DSDV protocol performed the best in Random Way Point Mobility model and this type of scenario with throughput and packet delivery ratio. OLSR performs almost similar to DSDV in terms of different performance metrices .In Group Mobility Model scenario when we compared, DSDV is good in throughput, PDR ratio than AODV and ZRP. But overall result shows that DSDV is good in Random way point mobility model scenario. But ZRP gives poor performance when we increase the network density. When we increase the network density all the protocols are affected in accordance with mobility models. Similarly DSDV show better results for considered scenarios under Manhattan and freeway mobility.

We can extend this work by evaluating the performance by considering other scenarios like other traffic generators, congestion control algorithms, packet interarrival duration etc.

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AUTHOR(S) PROFILE

UPNEET SINGH KALRA received the B.E in Computer Science and Engineering from KITM, Kurukshetra, Haryana, India in 2011.

MOHINDER SINGH received the B.E. degree in Electronics and Communication Engineering from C.R. State College of Engineering, Murthal, Haryana, India and the M.E. information technology from

Presently he is working as Dean Academic in Maharishi Ved Vyas Engineering college, Jagadhri, Haryana, India.

SHANU MALHOTRA received the B.E. degree in Computer Science and Engineering from Haryana Engineering College, Jagadhari, Haryana, India and the M.E. in Computer Science and Engineering from SIET, Ambala, Haryana in 2009 and 2013.

Presently he is working as Assistant Professor in Institute of Science and Technology, Ambala, Haryana, India.