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Improve Routing Efficiency Based on Mobility Models in Mobile Ad hoc Network

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Abstract— ***Mobile Ad Hoc Networks (MANET) is network without infrastructure, where every node functions as transmitter, router and data sink. Every node must discover its local neighbours and through them it will communicate to nodes that are out of its transmission range. In present study, a comparison of reactive routing protocol i.e. Ad Hoc On-Demand Distance Vector Routing (AODV),proactive routing protocol i.e. Optimized Link State Routing (OLSR) and hybrid routing protocol i.e. gathering-based routing protocol (GRP) has been made on the basis of throughput, delay, retransmission and network load with increasing in number of nodes in the network. We have used OPNET Simulator from Scalable Networks to perform the simulations. Three routing protocols are being analysed on the above mentioned parameters and it can be concluded that OLSR performs remarkably better than AODV and GRP on prevailing node increasing in the network.***

Keywords— MANET, AODV, OLSR,GRP, OPNET, Routing Protocols.

I. INTRODUCTION

A MANET [1,2] is a collection of mobile nodes that can communicate with each other without the use of predefined infrastructure or centralized administration.Since no fixed infrastructure or centralized administration is available, these networks are self-organized and end-to-end communication may require routing information via several intermediate nodes. Nodes can connect each other randomly and forming arbitrary topologies. Each node in MANET acts both as a host and as a router to forward messages for other nodes that are not within the same radio range. The primary challenge in building a Mobile Ad hoc Network is equipping each device to continuously maintain the information required to route traffic. The up to date standardised protocols are classified into three categories: Proactive routing protocols, Reactive routing protocols, Hybrid routing protocols. Proactive protocols, such as Optimized Link State Routing (OLSR) [3, 4] attempt to monitor the topology of the network in order to have route information between any source and destination available at all time. Proactive Routing Protocols are also called table driven routing protocols as all the routing information is usually kept in tables. Reactive routing protocols such as Ad hoc On Demand Distance Vector (AODV) [5, 6], find the route only when there is data to be transmitted and as a result, generate low control traffic and routing overhead. Hybrid protocols such as Gathering-based routing protocol (GRP) [8] could be derived from the two previous ones, containing the advantages of both the protocols, using some quality of one type and enhancing it with the participation of the other one. In this paper we evaluate the performance of a Proactive Routing Protocol (OLSR), a Reactive routing protocol (AODV) and an Hybrid protocol (GRP).

This paper is organized as follows: Section 2 presents overview of Routing protocols in MANETs. Section 3 describes the Simulation Environment studied. Section 4 analyzes results and discussion. Section 5 concludes this paper.

II. ROUTING PROTOCOLS IN MANETS

Routing protocols in MANET [8] are divided into four categories: proactive, reactive and hybrid routing protocols. The most popular ones are AODV, DSR (reactive), OLSR (proactive) and GRP (hybrid) .Reactive protocols like DSR and AODV find the routes only when requested and data need to be transmitted by the source host using distance-vector routing algorithms. Proactive protocols like OLSR are table driven protocols and use link state routing algorithms. Gathering-based routing protocols use the node position (i.e., geographic coordinates) for data forwarding. A node forwards a packet with considering its neighbours and the destination physical positions. In these protocols packets are sent to the known geographic coordinates of the destination nodes. We will focus in this paper on the following MANET routing protocols:

This section describes the main features of three protocols AODV (Ad Hoc On-Demand Distance Vector Protocol), OLSR (Optimized Link State Routing) and GRP (Gathering-based Routing Protocol) deeply studied using OPNET 14.5. An ad-hoc routing protocol is a convention, or standard, that it improves the scalability of wireless networks compared to infrastructure based wireless networks because of its decentralized nature. Ad-hoc networks are best suited due to minimal configuration and quick operation.

2.1 Ad Hoc On-Demand Distance Vector Protocol (AODV)

AODV [9] is a reactive routing protocol that minimizes the number of broadcasts by creating routes on demand. The AODV algorithm is an improvement of DSDV [10] protocol. It reduces number of broadcast by creating routes on demand basis, as against DSDV that maintains mutes to each known destination. The main advantage of AODV protocol is that routes are established on demand and destination sequence numbers are used to find the latest route to the destination. The source broadcasts a route request (RREQ) packet when it wants to find path to the destination. The neighbors in turn broadcast the packet to their neighbors until it reaches an intermediate node that has recent route information about the destination or until it reaches the destination. When a node forwards a RREQ to its neighbors, it also records in its tables the node from which the first copy of the request came. This information is used to construct the reverse path for the route reply packet (RREP). AODV uses only symmetric links because the RREP follows the reverse path of the RREQ. An important feature of AODV is the maintenance of timer based states in each node, regarding utilization of individual routing table entries. A routing table entry is expired if not used recently. Another distinguishing feature of AODV is the ability to provide unicast, multicast and broadcast communication.

2.2 Optimized Link State Routing (OLSR)

OLSR [11] is a modular proactive hop by hop routing protocol. It is an optimization of pure link state algorithm in ad hoc network. The routes are always immediately available when needed due to its proactive nature. The key concept of the protocol is the use of "multipoint relays" (MPR). Each node selects a set of its neighbor nodes as MPR. Only nodes, selected as such MPRs are responsible for generating and forwarding topology information, intended for diffusion into the entire network. The MPR nodes can be selected in the neighbor of source node. Each node in the network keeps a list of MPR nodes. This MPR selector is obtained from HELLO packets sending between in neighbor nodes. These routes are built before any source node intends to send a message to a specified destination In order to exchange the topological information; the Topology Control (TC) message is broadcasted throughout the network. Each node maintains the routing table in which routes for all available destination nodes are kept. Control traffic in OLSR is exchanged through two different types of messages: “HELLO” and “TC” messages. HELLO messages are exchanged periodically among neighbor nodes, in order to detect links to neighbors, to detect the identity of neighbors and to signal MPR selection. TC messages are periodically flooded to the entire network, in order to signal link-state information to all nodes. The best working environment for OLSR protocol is a dense network, where the most communication is concentrated between a large numbers of nodes.

2.3 Gathering-based Routing Protocol (GRP)

Gathering-based Routing Protocol [12] combines the advantages of Proactive Routing Protocol (PRP) and of Reactive Routing protocol (RRP). PRP are suitable for supporting the delay sensitive data such as voice and video but it consumes a great portion of the network capacity. While RRP is not suitable for real-time communication, the advantage of this approach is it can dramatically reduce routing overhead when a network is relatively static and the active traffic is light. However, the source node has to wait until a route to the destination can be discovered, increasing the response time. The function of Gathering-based Routing Protocol (GRP) [13] for mobile ad hoc network is to gather network information rapidly at a source node without spending a large amount of overheads. It offers an efficient framework that can simultaneously draw on the strengths of Proactive routing protocol (PRP) and reactive routing protocol (RRP) collects network information at a source node at an expense of a small amount of control overheads. The source node can equip promising routes on the basis of the collected information, thereby continuously transmitting data packets even if the current route is disconnected, its results in achieving fast (packet) transfer delay without unduly compromising on (control) overhead performance.

2.4 Mobility Models in MANET

Mobility models are graphic design to evaluate the performance of ad-hoc networks [13]. It also characterizes movements with variation in speed and direction of real mobile node occurs in regular interval of time. Therefore, many researchers had attempted to design mobility models approximately to resemble with real node movements in MANETs. There are such as follows:

1 Random way point mobility model:- In this model, the position of each node is selected randomly and moved in linear form within fixed area, when it will move to next movement before that it has to stopped for certain period is known as pause time [14]. The pause time is directly determined by its model initialization and speed ,which is uniformly distributed between in Min Speed and Max Speed.

2 Random walk mobility model: - In this mobility model mobile host node can be moved from current location to new one by choosing randomly. It is just like normal human walk. The direction and speed between min speed and max speed defined previously ranges.

3 Group mobility model:-. In this mobile nodes moves in group form. In this model nodes are moved independently from each other .In ad hoc network, sometime, there are many situations where, it is necessary to model the behave like MNs as move together..

*4 Pursue mobility model:-*This Model is basically designed to describe the pursuit for a single node by a group of mobile nodes. Earlier it us described follows as SMOOTH-VARIATION motion. In randomly varying speed between Min is zero and have Max Speed. The nodes in runaway node have a direction, which an instant will have in a straight line.

*5 Vector mobility model:-*This model is used to avoid the unrealistic behavior, which is impossible physically. It remembering mobility state for nodes and also in the current mobility state allow only partial changes, only natural motions are reproduced. This model has various Advantages like easily implemented, simplification for positional updates and also provides mobility prediction opportunity.
6 Pursue shortest mobility model: - In this model, every node wants to attempts for chase a particular node moving towards a particular direction set as target but it starts from the nearest one segment. Every node chooses a shortest path to achieve it. But in the Pursue suit for every node.
*7 Reference Point Group Mobility model:-*The Reference Point Group Mobility model (RPGM) has a special logical centre. The motion of this mobile node defines with feature for entire groups like speed, direction, location and acceleration, etc. Basically nodes are uniformly distributed particularly within the geographic range. Each node is assigned by reference point which followed as group movement. This reference point allows independent behavior random motion for each node.
9 Chain mobility model: - The Chain model is not considered itself as a model but it is concatenation of some implemented models like Random Waypoint, RPGM, and Manhattan etc. In some cases required to necessary have model scenarios from which mobile nodes behave differently, depending on position and time.

2.5 Multimedia Applications for Mobility Models

MANETs are basically dynamic in nature and so it supports a large variety of applications and the most important and most commonly used applications of MANETs are HTTP, video conferencing, VOIP, Email, voice and web applications. The characteristic of the traffic sent across the MANET is decided by the selected type of application. The application selected is also used to influence the performance of the routing protocol similarly the selected traffic type also influence the performance of routing protocol that may be reactive or proactive that is used throughout the MANET. The issues related to these MANETs are discussed in many existing studies and researches which also includes the comparison of performance of routing protocols in various aspects which are done mostly among the selected routing protocols when compared to the selected kind if traffic. Real-time include video conferencing applications over wireless ad hoc networks at a location with no wireless infrastructure, transmitting video towards battlefield, search and rescue operations. Real-time applications are different fundamentally from other best-effort applications. Real-time applications are sensitive for delay and loss packet. The later packets will be dropped in real-time while best-effort packets can be accepted. Therefore, the re-transmissions are not generally applicable to real-time applications, especially in multicast situations.
These applications in the ad hoc networks are performed under one–to–many or many–to–many communications so multicasting technique is very important for these applications.

III. SIMULATION ENVIRONMENT

This section describes the network topology used for the simulations. We carried out simulations on Opnet simulator. OPNET is chosen for this research because it carries the distinct features of a good simulator. OPNET [14] provides a comprehensive modelling environment for unique specification, simulation and analysis of the performance of computer networks. OPNET has several modules and tools embedded; this includes OPNET modeler [15, 16] model library, analysis tools and planner. It is widely used in modelling networks, and also for evaluating and analysing network performances.
The simulation parameters are summarized in table 1. Modeler is commercial network simulation environment for network modelling and simulation. It allows the users to design and study communication networks, devices, protocols, and applications with flexibility and scalability. It simulates the network graphically and its graphical editors mirror the structure of actual networks and network components.

Table 1: Network Parameters

Statistic	Value
Simulator	OPNET 14.5
Parameter for HTTP	Retransmission Sent and Received
Traffic	HTTP
Mobility Model	Random Way Point and Vector Mobility Model
802.11 data rate	11 Mbps
Node	50
Scenario Size	3.5*3.5 km
Routing Protocols	AODV,OLSR and GRP
Simulation Time	1800 second

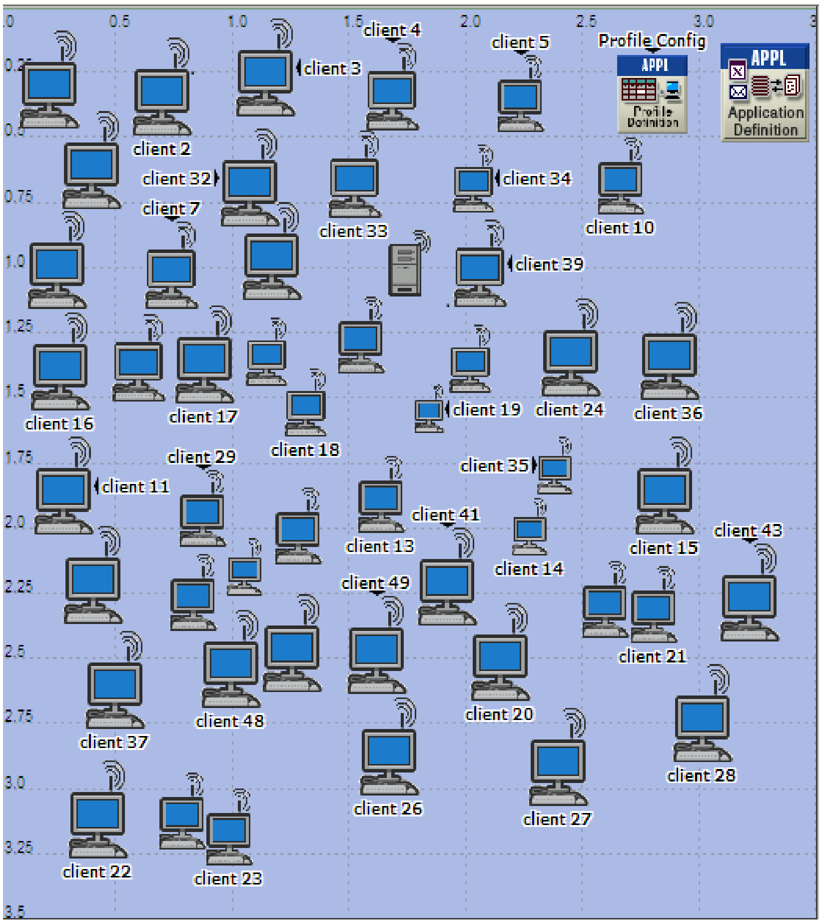

Figure 1: Network Topology with 50 nodes

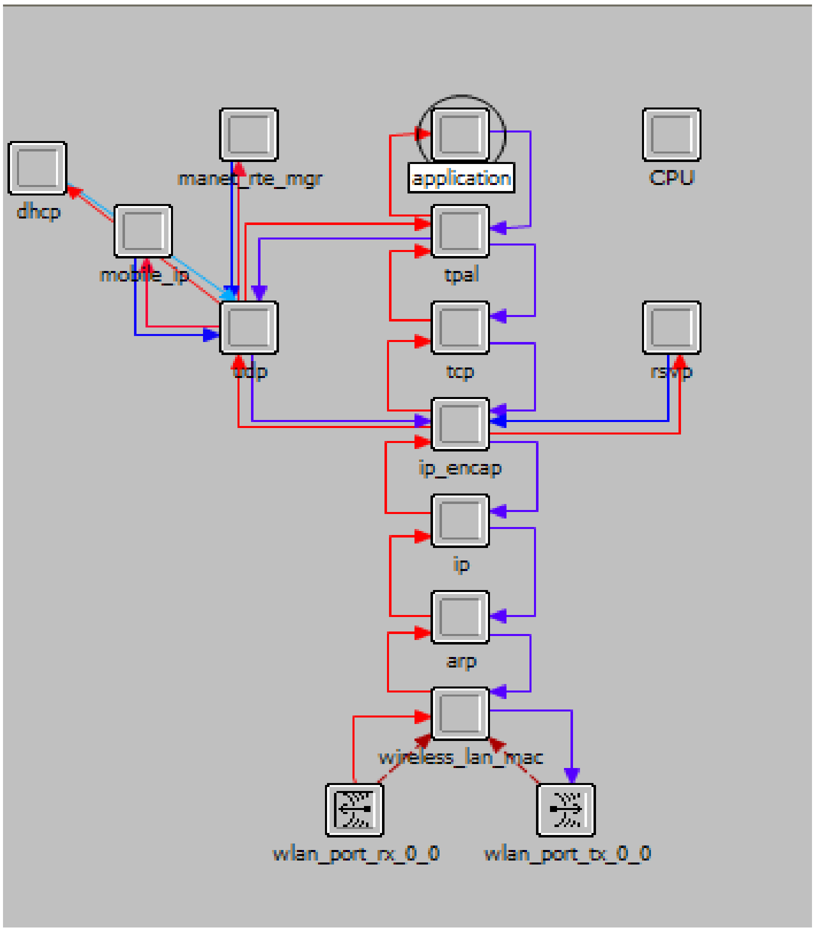

Figure 2: Traffic System in MANET

Figure 1. Shows a sample network created with 50 Nodes, one static HTTP server, application configuration and profile configuration for the network in which HTTP has been chosen as an application. Figure 2 depicts a traffic system for network with 50 fixed nodes whose behaviour has to be analyzed nodes in the network with respect to time to determine the effecting features of each protocol. OPNET modeler 14.5 is used to investigate the performance of routing protocols AODV, OLSR and GRP with varying network sizes, data rates, and network load. We evaluate three parameters in our study on overall network performance. These different types of parameter show the different nature of these Protocols, the parameters are throughput, delay, network load and retransmission.

3.1 Parameters used in the network

There are different kinds of parameters for the performance evaluation of the routing protocols. These have different behaviours of the overall network performance. We will evaluate three parameters for the comparison of our study on the overall network performance. These parameters are delay, network load, and throughput for protocols evaluation. These parameters are important in the consideration of evaluation of the routing protocols in a communication network. These protocols need to be checked against certain parameters for their performance. To check protocol effectiveness in finding a route towards destination, we will look to the source that how much control messages it sends. It gives the routing protocol internal algorithm's efficiency. If the routing protocol gives much end to end delay so probably this routing protocol is not efficient as compare to the protocol which gives low end to end delay. Similarly a routing protocol offering low network load is called efficient routing protocol. The same is the case with the throughput as it represents the successful deliveries of packets in time. If a protocol shows high throughput so it is the efficient and best protocol than the routing protocol which have low throughput. These parameters have great influence in the selection of an efficient routing protocol in any communication network.

3.1.1 Delay: The packet end-to-end delay is the time of generation of a packet by the source up to the destination reception. So this is the time that a packet takes to go across the network. This time is expressed in sec. Hence all the delays in the network are called packet end-to-end delay, like buffer queues and transmission time. We have several kinds of delays which are processing delay (PD), queuing delay (QD), transmission delay (TD) and propagation delay (PD). The queuing delay (QD) is not included, as the network delay has no concern with it. Mathematically it can be shown as equation (1);

$$d_{end-end} = N[d_{trans} + d_{prop} + d_{proc}] \quad (1)$$

Where

dend-end= End to end delay
dtrans = Transmission delay
dprop = Propagating delay
dproc = Processing delay

Suppose if there are n number of nodes, then the total delay can be calculated by taking the average of all the packets, source destination pairs and network configuration.

3.1.2 Network Load: Network load represents the total load in bit/sec submitted to wireless LAN layers by all higher layers in all WLAN nodes of the network. When there is more traffic coming on the network, and it is difficult for the network to handle all this traffic so it is called the network load. The efficient network can easily cope with large traffic coming in, and to make a best network, many techniques have been introduced.

High network load affects the MANET routing packets and slow down the delivery of packets for reaching to the channel and it results in increasing the collisions of these control packets. Thus, routing packets may be slow to stabilize.

3.1.3 Throughput: Throughput is defined as; the ratio of the total data reaches a receiver from the sender. The time it takes by the receiver to receive the last message is called as throughput. Throughput is expressed as bytes or bits per sec (byte/sec or bit/sec). Some factors affect the throughput as; if there are many topology changes in the network, unreliable communication between nodes, limited bandwidth available and limited energy. A high throughput is absolute choice in every network. Throughput can be represented mathematically as in equation (2);

$$Throughput = \frac{Number\ of\ delivered\ packet * Packet\ size * 8}{Total\ duration\ of\ simulation} \quad (2)$$

3.1.4 Retransmission Sent and Received: Total number of retransmission attempts by all WLAN MACs in the network until either packet is successfully transmitted or it is discarded as a result of reaching short or long retry limit.

For 802.11e-capable MACs, the retransmission attempt counts recorded under this statistic also include retry count increments due to internal collisions. Additionally, if any 11e-capable MACs use Block-ACK mechanism, this statistic will furthermore record retransmitted Block-ACK Requests, delayed Block-ACKs and block MPDUs, which are not acknowledged in received Block-ACKs.

IV. RESULT ANALYSIS AND DISCUSSION

We begin the analysis of AODV, OLSR and GRP. We check these protocols by four parameters such as delay, network load, and throughput and retransmission sent and received under Random Way Point and Vector Mobility Model. The results obtained in the form of graphs, all the graphs are displayed as average. We used three scenarios i.e. 50 node with Random Way Point, 50 node with Vector Mobility Model and the last one is 50 nodes with all graph that is representing the performance of routing protocols. We carried out simulations on Opnet simulator 14.5. The results show differences in performance between considered routing protocols, which are the consequence of various mechanisms on which protocols are based nodes. Figures 3,4,5 and 6 depicts the delay, network load, throughput and retransmission of this network with respect to total simulation time which is taken as 30 minutes for which the simulation was run.

4.1 Delay

The maximum network delay variation for 50 nodes in different scenario is shown in respectively figure 3. We observe in that OLSR consistently presents the lowest delay, regardless of network size. This may be explained by the fact that OLSR, as a proactive protocol, has a faster processing at intermediate nodes. When a packet arrives at anode, it can immediately be forwarded or dropped because OLSR protocol proactively holds routes to all destinations in its table, regardless of topology changes. e. When a packet arrives at anode, it can immediately be forwarded or dropped because OLSR protocol proactively holds routes to all destinations in its table, regardless of topology changes. GRP has the least End-to-end and MAC delay (for most of the time), but its performance for packet delivery ratio decreases more than other protocols with increasing the number of nodes because of more traffic and congestion.

4.2 Network Load

The maximum network load variation for 50 nodes in different scenario is shown in figure 4. Network load of AODV has the best performance with regardless of Network size and mobility. That stable behaviour of AODV is desirable property of a protocol as it indicates that it can scale well in networks in which the mobility changes over time. In AODV protocol although each node sends out periodic Hello message to monitor connectivity, it is limited and the size of the control message is smaller than those used by OLSR, hence using less bandwidth for route maintenance thus create less network load.

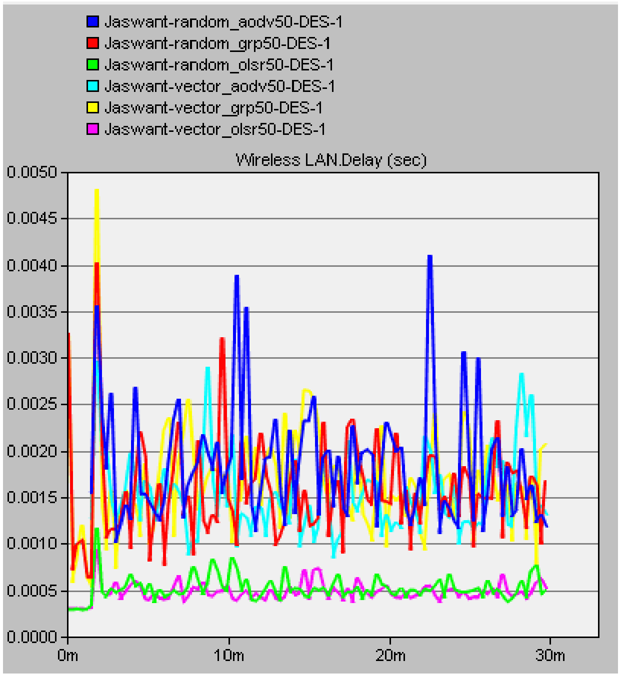

Figure 3. Delay comparison in three routing protocols with 50 nodes

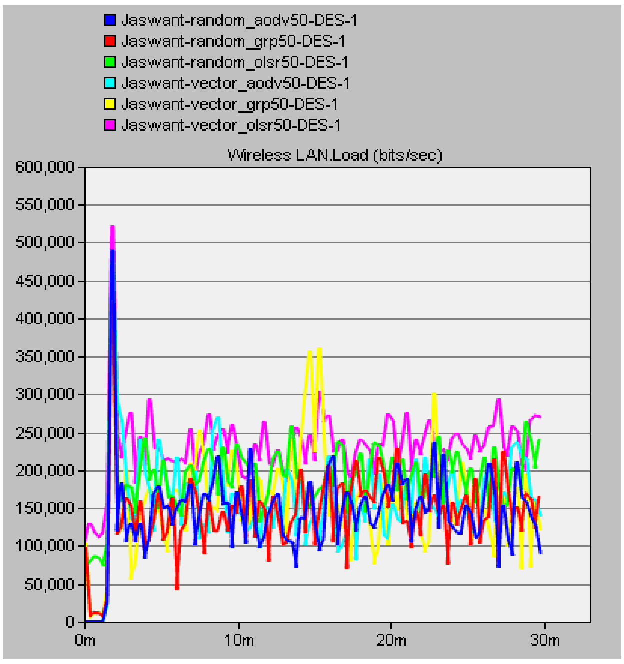

Figure 4. Network Load comparison in three routing protocols with 50 nodes

4.3 Throughput

It is clearly observed from the figure 5 depicts the throughput of the network 50 nodes. When a path break occurs, new routes need to be found. As OLSR always have up-to-date topology information at hand, new routes can be calculated immediately when a path break is reported.

Optimised Link State Routing protocol (OLSR) perform the best as compare to both Ad Hoc on Demand Distance Vector (AODV) and Gathering Based Routing Protocol (GRP) Protocol in 50 nodes simulation operation. OLSR under vector mobility model gives improved results than random Way Point Model.

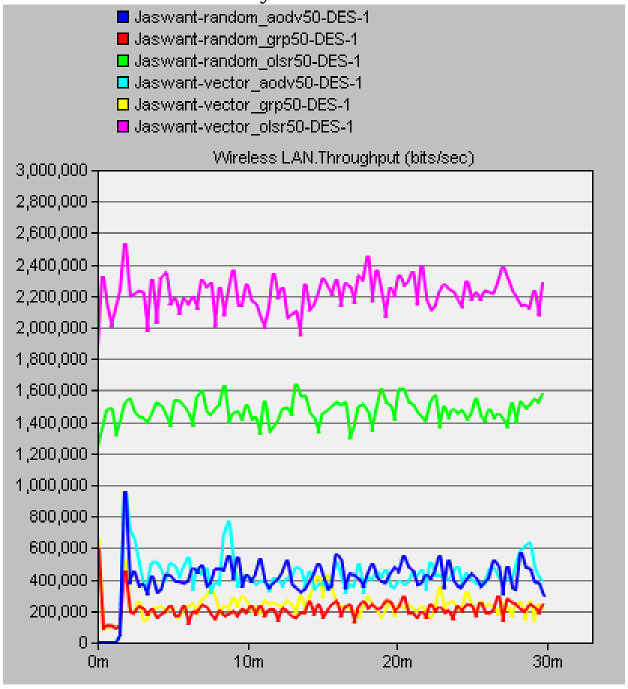

Figure 5. Throughput (bits/sec) comparison in routing protocols with 50 nodes

4.4 Retransmission Sent and Received

It is clearly observed from the figure 6 depicts the retransmission bits of the network with 50 nodes.

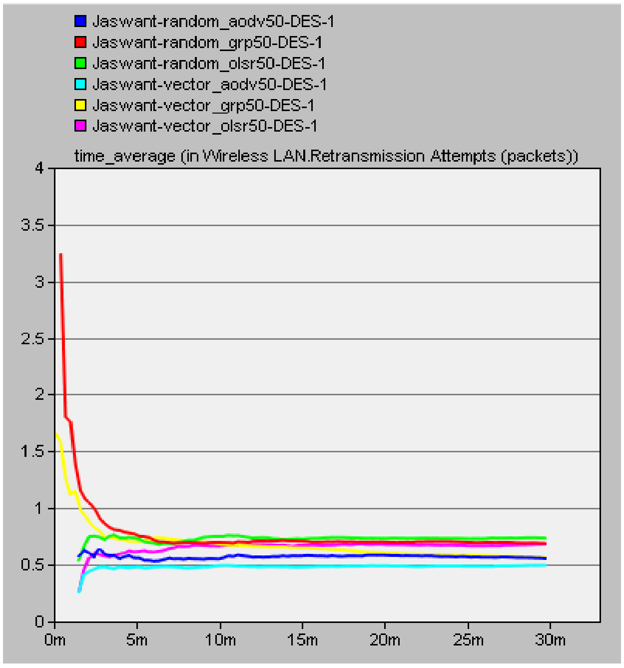

Figure 6. Retransmission comparison in routing protocols with 50 nodes

Again Optimised Link State routing protocol (OLSR) and Ad Hoc on Demand Distance Vector (AODV) perform the best as to Gathering Based Routing Protocol (GRP) Protocol in 50 nodes simulation operation of retransmission proficient in the network.

The Overall comparison of AODV Performance Metrics and the Mobility Models clearly states that, retransmission bits for AODV is less with vector mobility model while it is bad with random way point model.

V. CONCLUSIONS

In this paper the simulation study of three routing protocols AODV, OLSR and GRP deployed over MANET using HTTP traffic analyzing their behaviour is analysis with respect to three parameters, delay, network load, retransmission and throughput. Our motive was to check the performance of these three routing protocols in MANET in the above mentioned parameters. The selection of efficient and reliable protocol is a critical issue. According to the literature view number of researchers are find efficiency of routing protocols in different-different mobility models in MANET, but research significant of my research work on ad hoc network, evaluated the performance with different mobility models vector mobility model and random waypoint mobility model and HTTP as traffic type while taking 50 as the nodes. From the extensive simulation results, it is found that OLSR shows the best performance in terms of throughput, and end-to-end delay. Moreover, Vector Mobility Model outperforms Random Way Point Model for all three routing protocols i.e. AODV, OLSR and GRP.

The future work suggested is the development of modified version of the selected routing protocols which should consider different aspects of routing protocols such as rate of higher.

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