Evaluation comparison of AODV DSR and OLSR in ad hoc networks routing protocols

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Abstract— Mobile ad hoc networks (MANETs) are categorized by multi-hop wireless connectivity, frequently varying network topology and the need for efficient dynamic routing protocols plays an important role. A mobile ad hoc network (MANET) consists of mobile wireless nodes. The communication among these mobile nodes is carried out without any centralized control. MANET is a self-configurable andself-organized network where the mobile nodes move randomly. The mobile nodes can accept and forward packets as a router. Routing is a serious issue in MANET and hence the focus of this thesis along with the performance analysis of routing protocols. A variety of routing protocols targeted specifically at this environment have been developed and some performance simulations are made on numbers of routing protocols like Ad hoc On-Demand Distance Vector Routing (AODV), Dynamic Source Routing (DSR) and Open Link State Routing (OLSR).We compared three routing protocols i.e. AODV, OLSR andDSR. Our simulation tool will be OPNET modeller. The presentation of these routing protocols is examined by three metrics: delay,throughput andnetwork load. All the three routing protocols are explained in a deep way with metrics. The comparison study will be carrying out about these protocols and in the last the conclusion will be presented, that which routing protocol is the finest one for mobile ad hoc networks.

Key words: OLSR, DSR, AODV, MANET and Routing.

I. INTRODUCTION

Ad-Hoc network is called as Mobile Ad-Hoc Network (MANET) because of mobility of nodes in network. They are IBSS(Independent Basic Service Set), since they does not need AP(Access Point) for conversation in nodes. MANETs is a self-configuring network and form an uninformed topology. These nodes act like routers in network to route thepacket. MANETs are used in those extents where wire and wireless infrastructures are inaccessible. Due to rapid change of topology in MANETs, MANETs routing protocols are necessary. The routing protocol is necessary whenever the sourceneeds to communicates with destination. Routing protocols are categorized as Proactive (Table Driven Routing Protocol),Reactive (On Demand Routing Protocol) and Hybrid (having the advantages of both proactive and Reactive routing protocols) routing protocols.

MANETs routing protocols are categorized as:-

(1) Reactive protocols
(2)Proactive protocols
(3) Hybrid protocols

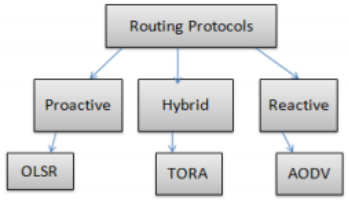

Fig. 1**:** MANETs Routing Protocols

A. Reactive Protocols:

Reactive protocols are also called as on demand driven reactive protocols. It is mostly used to find the route among source and destination as desired. As per the request of source this routing protocol initiate route discovery, to find the route to the destination. Then this route is used for more communication [1, 2] e.g. AODV.

B. Proactive Protocols:

Proactive protocols also called as Table driven routing protocols. Each node retains routing tables which are consistent and up-to-date containing routing information for every node in the network. Whenever new node is arrived in the network or removes from the network, control messages are sends to nearest nodes then they update their routing tables. This protocol uses link-state routing algorithms which frequently flood the link information about its neighbors.Proactive routing protocols are OSPF and OLSR [2].

C. Hybrid Routing Protocol:

Hybrid routing protocol have advantages of both proactive and reactive routing protocols. Firstly it act like proactive routing protocol, as in starting nodes have tables. Then whenever nodes catches that they does not have route to destination, they initiate route discovery and behave like reactive routing protocols .Hybrid protocols are TORA and ZRP.

II. OVERVIEW OF PROTOCOLS

A. Ad-Hoc on Demand Distance Vector Protocol (AODV):

AODV [3] is reactive protocol, Ad-hoc On-demand Distance Vector is one of the most popular MANET routing protocols. Upon arrival of data, if there is no route, AODV broadcasts a route request to the destination. Each intermediate hop automatically builds a reverse route to the source and also rebroadcasts the route request. The destination answers to the "first" route request and sends a route reply in the direction it was received.When a source wants to initiate transmission with another node as destination in the network, AODV use control messages to

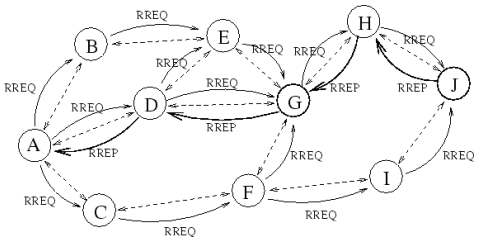

Fig. 2: Message routing in AODV

discover a route to the destination node in the network. AODV will provide topology information (like route) for the node. Fig.2 displays the message routing for AODV protocol. Node "A" wants to send messages to another node "F". It will generate a Route Request message (RREQ) and forwarded to the neighbors, and those node transmit the control message to their neighbours. Whenever the route to destination node is located or an intermediate node have route to destination. They generate route reply message (RREP) and send to source node. When the route is established between "A" and "F", node then they communicate with each other.

B. Optimized Link State Routing Protocol (OLSR):

OLSR is proactive routing protocol or table driven protocol. Primarily nodes have routing tables and they update their routing tables periodically. It is based on the link-state algorithm. Each node preserves the topology information of network and sending this information from time to time to neighbors. The rareness of OLSR is that it minimizes the size of control messages and rebroadcasting by using the MRP (Multipoint Relaying). The basic concept of MPR is to decrease the loops of retransmissions of the packets. Only MPR nodes can broadcast route packets. The nodes within the network preserve a list of MPR nodes. MPR nodes are carefully chosen within the environs of the source node. The selection of MPR is done by the neighbor nodes in the network, with the assistance of HELLO messages.

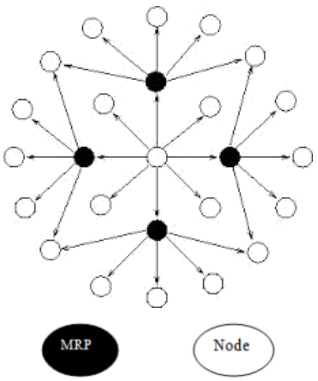

Fig. 3: Flooding Packets using MPR

C. Temporally Ordered Routing Algorithm (TORA):

TORA is a hybrid protocol, based on a "link reversal" algorithm. It expresses multiple routes to a destination, create routes quickly, and diminish communication overhead. Nodes have routing tables, so it assistances the sending node to find the route to destination with the help of given tables. Routing tables also keeps the longer routes to avoid discovering newer routes.

When a node finds that a route to a destination is no longer effective, it adjusts its height so that it is a local maximum with respect to its neighbors and transmits an UPDATE packet. If the node has no neighbors of fixed height with respect to this destination, then the node determine a new route. When a node detects a network partition, it produces a CLEAR packet which resets routing tables and removes invalid routes which does not exist from the network.

III. PROBLEM FOUND IN AODV ROUTING PROTOCOL

Default AODV Routing Protocol focused only on finding the shortest path. Meanwhile it is not bearing in mind any communicational cost for the links between the nodes. If we want to send data between A(s) to B(d) then if there are two ways for hops, one of them contains less nodes with lesser transfer rate and another having more nodes with high data transfer speed , so according to minimal hop count AODV will select first way which is less nodes with lesser data transfer rate.

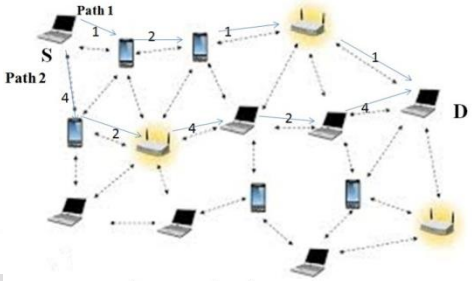

Fig. 4: Data rates between nodes is shown in mbps.

There are two routes from Source to Destination, AODV will choose 1st path which is more costlier than 2nd one.

Performance Estimation of Proactive and Reactive Protocols In this chapter we will present different metrics considered in the performance evaluation of proactive and reactive routing protocols. First we will briefly discuss the performance parameters considered in the comparison. The simulation design will also be discussed.

IV. PERFORMANCE PARAMETERS

Here are different kinds of parameters for the performance evaluation of the routing protocols. These have different behaviours of the overall network performance. We will gauge three factors for the comparison of our study on the overall network performance. These factors are delay,throughput, and network load for protocols evaluation. These factors are important in the consideration of evaluation of the routing protocols in a communication network. These protocols want to be checked against certain factors for their performance. To check protocol effectiveness in finding a route towards destination, we will aspect to the source that how much control messages it sends. It provides the routing protocol inner algorithm's efficiency. If the routing protocol provides 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 great throughput so it is the efficient and best protocol than the routing protocol which have small throughput. These parameters have great impact in the selection of an efficient routing protocol in any communication network.

A. 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 proceeds to go across the network. This time is expressed in sec. In future all the delays in the network are called packet end-to-end delay, similar totransmission time andbuffer queues. Occasionally this delay can be named as latency; it has the same sense as delay. Some applications are sensitive to packet delay such as voice is a delay sensitive application. So the voice needs a low average delay in the network. The FTP is forbearing to a certain level of delays. There are different types of activities because of which network delay is amplified. Packet end-to-end delay is a measure of how sound a routing protocol adapts to the various constraints in the network to give reliability in the routing protocol. We have several types of delays which are processing delay (PD), queuing delay (QD), transmission delay (TD) and propagation delay (PD). The queuing delay (QD) is not involved, as the network delay has no concern with it [16]. Mathematically it can be shown as equation (i).

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

Where
$d_{end\text{-}end}$ =End to end delay
d_{trans}=Transmission delay
d_{prop}= Propagating delay
d_{proc}= Processing delay

Assume 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.

B. 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 [23]. When there is more traffic coming on the network, and it is hard for the network to handle all this traffic so it is called the network load. The efficient network can simply cope with large traffic coming in, and to make a finest 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 relaxed to stabilize. Network load is shown in the below figure 4-1.

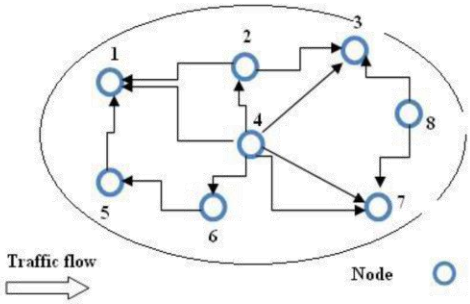

Fig. 5: Network Load

C. 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 receiver the last message is called as throughput [11]. Throughput is expressed as bytes or bits per sec (byte/sec or bit/sec). Some issues affect the throughput as; if there are many topology changes in the network, unreliable communication among nodes, limited bandwidth accessible and limited energy [11]. A high throughput is absolute choice in every network. Throughput can be evaluate mathematically as in equation (ii);

$$Throughput = \frac{\text{Number of delivered packet} * \text{Packet size} * 8}{\text{total duration of simulation}}$$

equation (ii)

We are using the Optimized Network Engineering Tool (OPNET v14.5) software for our simulations. OPNET is a network simulator. It provides multiple solutions for managing networks and applications such as network operation, planning, research and development (R&D), network engineering and performance management. OPNET 14.5 is designed for modelling communication devices, protocols,technologies and to simulate the performance of these technologies.

OPNET Technologies provides solutions for the academic research, for example assessment and improvement of wireless network technologies such as WiMAX (Worldwide Interoperability for Microwave Access), Wi-Fi, UMTS (Universal Mobile Telecommunications System) and seamless communication. Design and assessment of MANET protocols, analysis of optical network, and enhancement in the core network technologies such as IPv6, MPLS, and power management schemes in wireless sensor network [2]. Now a day OPNET is very useful software in research fields. The OPNET usability can be distributed into four main steps. The OPNET first step is the modelling, it means to generate network model. The second step is to choose and select statistics. Third step is to simulate the network. Fourth and final step is to view and analyse results. All these steps are shown schematically in the below figure 4-2.

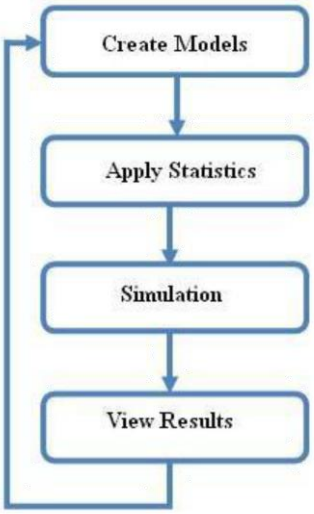

Fig. 6**:** Flow chart of OPNET

D. Building Model:

Run the OPNET modeller 14.5 to make a network model. The first step is to create a blank scenario by start-up wizard and the project editor workspace will be opened. Now we will design the network in this work space. The network design is done through two methods, one is automatically and the other is manually. The first method is automatically generating different topologies using rapid configuration. The sec method is by dragging different kind of objects from the object palette to the project editor workspace. A user can also import some predefined setups from the hard drive. But however wireless network cannot be designed by importing scenarios. When the network is designed then the nodes need to be configured. This configuration can also be performed manually or by using pre-defined parameters in the workspace.

E. Simulation results and Statistics:

In OPNET there are two kinds of statistics, one is Object statistics and the other is Global statistics. Object statistics can be defined as the statistics that can be collected from the individual nodes. On the other hand Global statistics can be collected from the entire network. When someone choose the desired statistics then run the simulation to record the statistics. These collected results are viewed and analyzed. To view the results right click in the project editor workspace and choose view results or click on DES, results then view results. Then a browser pops up as shown in this figure 4-3.

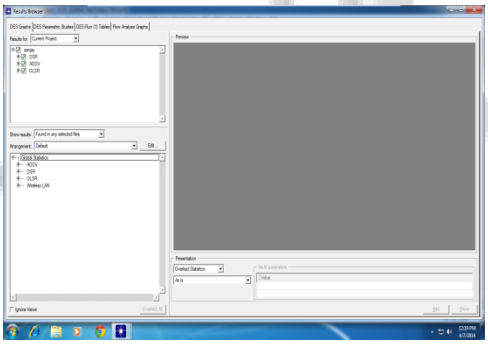

Fig. 7**:** OPNET results browser

The master thesis simulation is carried out in the OPNET Modeler 14.5. Below in figure 4-4 it is showing the simulation environment of one scenario having 34 mobile nodes for OLSR routing protocol. The key parameters are provided here i.e. delay, network load and throughput.

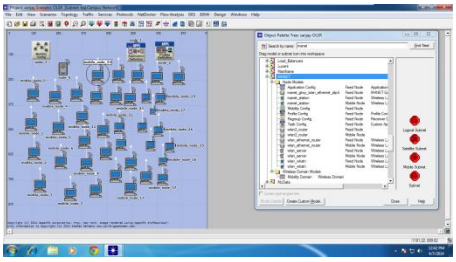

Fig. 8: Simulation setup

We simulate three scenarios. Each scenario was run for 240 sec (simulation time). All the simulations indicate the required results. Under each simulation we check the behaviour of AODV, DSR and OLSR. We get multiple graphs from simulations like first we get for delay, second is for the network load, and last one is for the throughput. Key goal of our simulation was to model the behaviour of the routing protocols. We collected DES (global discrete event statistics) on each protocol and Wireless LAN. We examined average statistics of the delay, throughput andnetwork load for the MANET. A campus network was modelled within an area of 1000m x 1000m. The mobile nodes were spread within the area. We take the FTP traffic to analyse the effects on routing protocols. We configured the profile with FTP application. The nodes were wireless LAN mobile nodes with data rate of 11Mbps.

Random waypoint mobility model was used in this simulation. The mobility model used is humble and it show more good mobility behaviour. Mobile nodes move at a constant speed of 100 m/s, and when touches the destination, the pause time is 200 sec and after that it choose a new random destination.

V. RESULTS ANALYSIS

A. Simulation Environment:

We will analyse and discuss the results of simulations we done. We begin the analysis of AODV, DSR and OLSR. We check these protocols by three parameters such as delay, network load, and throughput. The results obtained in the form of graphs, all the graphs are displayed as average.

Here in first scenario we used 37 mobile nodes and one fixed wlan server. The network size is of 1000 x 1000 meters. After that IPv4 addressing was assigned to all the nodes. The application configuration and profile configuration was drag to workspace. All the settings must be done according to the requirement. The FTP was selected as traffic Great Load. Now deploy the configured profile by clicking Protocol tab and select Deploy Defined Application. Drag the Mobility Configuration to the workspace. Set all the attributes and in last random mobility was set to MANET as a profile. The first scenario is shown in figure 5-1 below. The three protocols such as AODV, DSR and OLSR are tested against three parameters i.e. delay, network load and throughput.

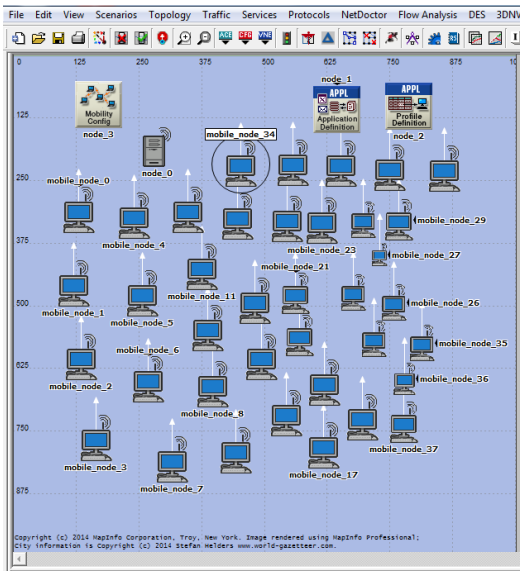

Fig. 9: Scenario

B. Analysing simulation:

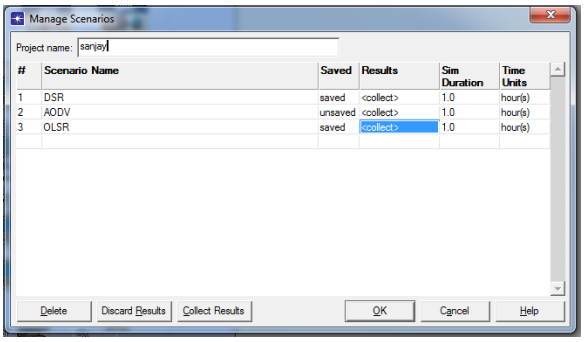

Fig. 10: Analysing simulation

C. AODV performance:

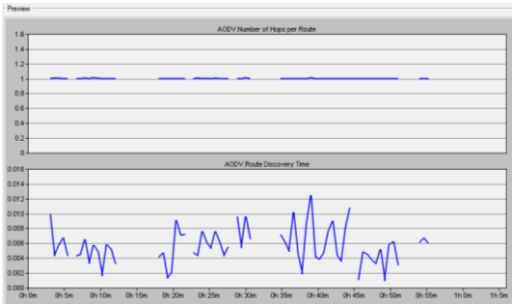

Fig. 11: AODV Performance

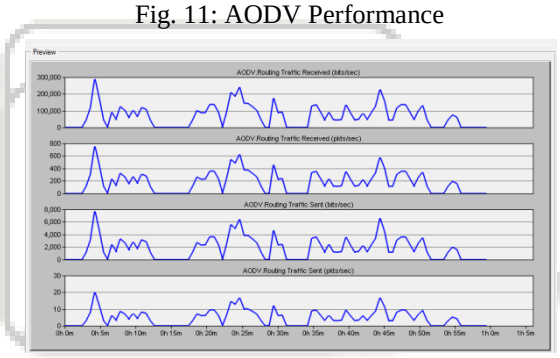

Fig. 12: AODV Performance

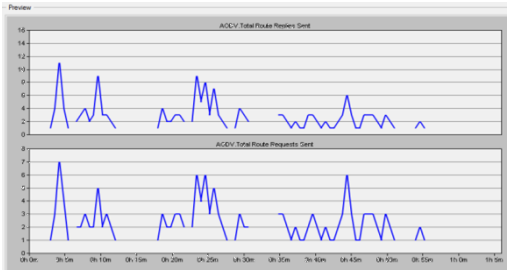

Fig. 13: AODV Performance

D. DSR Performance:

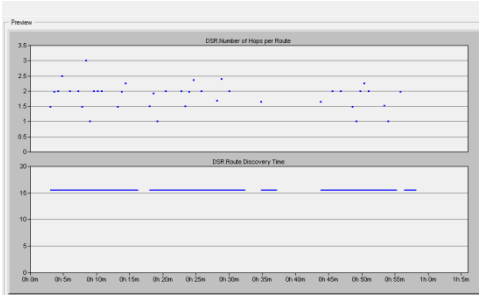

Fig. 14: DSR Performance

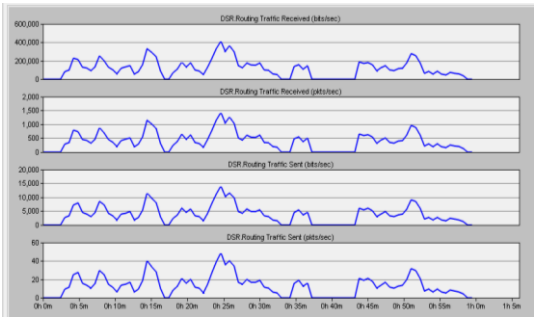

Fig. 15: DSR Performance

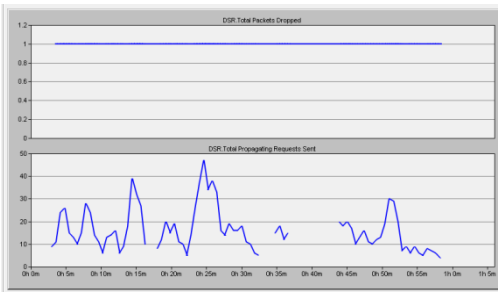

Fig. 16: DSR Performance

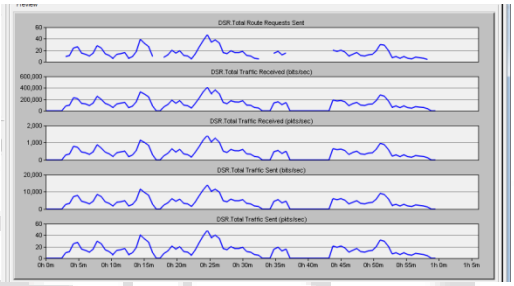

Fig. 17: DSR Performance

E. OLSR performance:

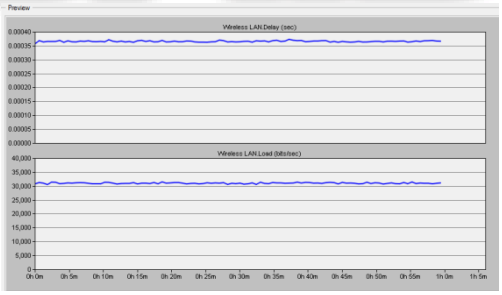

Fig. 18: OSLR Performance

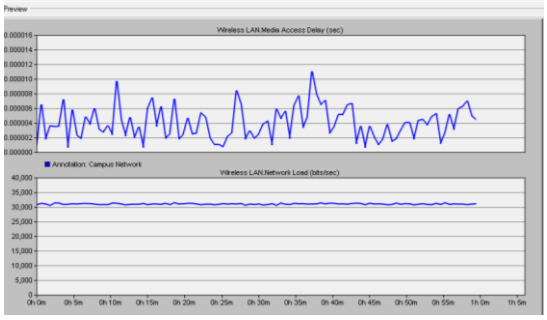

Fig. 19: OSLR Performance

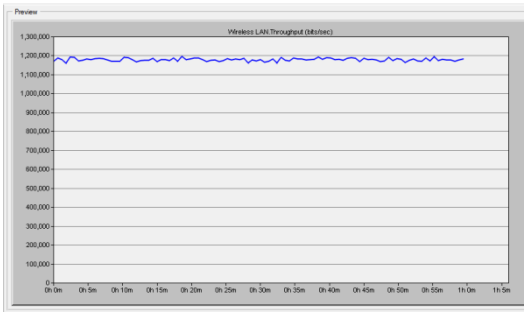

Fig. 20: OSLR Performance

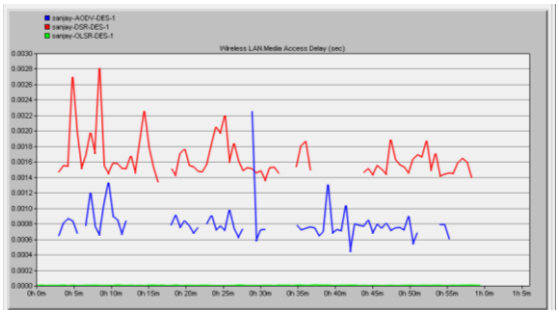

Fig. 25: Comparison results of AODV, DSR and OLSR

F. Comparison results of AODV, DSR and OLSR:

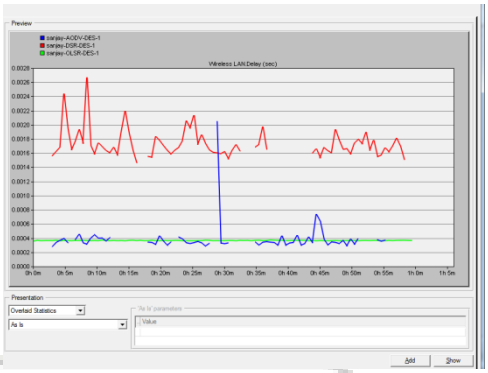

Fig. 21: Comparison results of AODV, DSR and OLSR

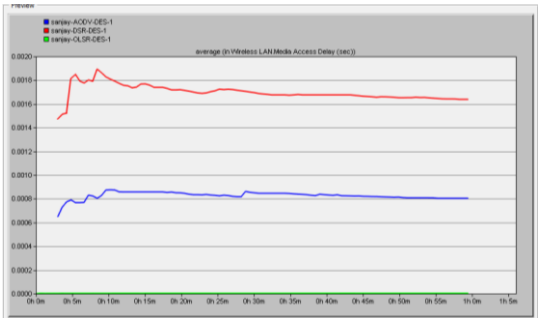

Fig. 26: Comparison results of AODV, DSR and OLSR

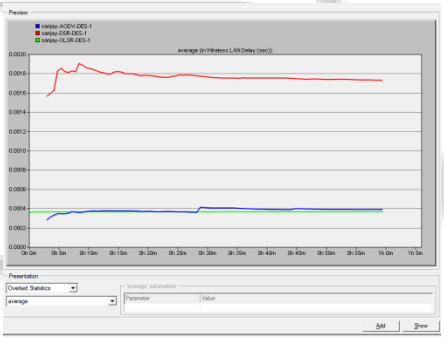

Fig. 22: Comparison results of AODV, DSR and OLSR

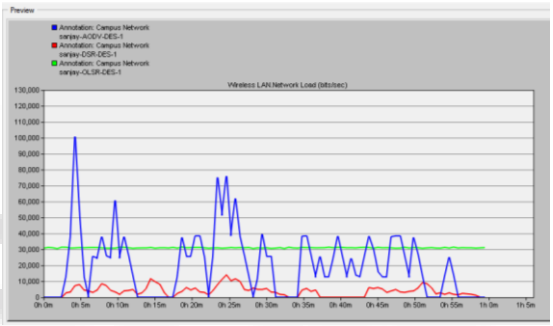

Fig. 26: Comparison results of AODV, DSR and OLSR

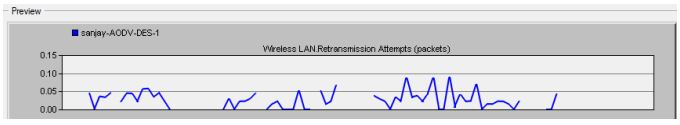

Fig. 27: Comparison results of AODV, DSR and OLSR

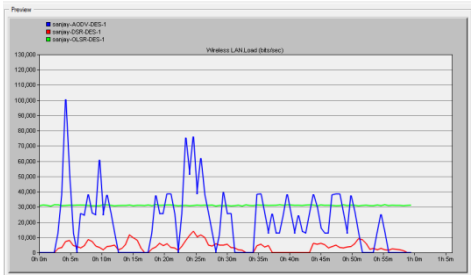

Fig. 23: Comparison results of AODV, DSR and OLSR

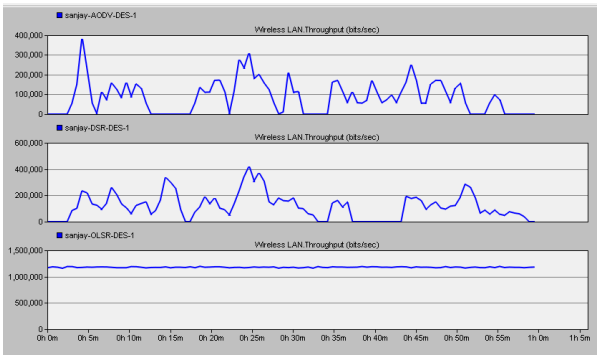

Fig. 28: Comparison results of AODV, DSR and OLSR

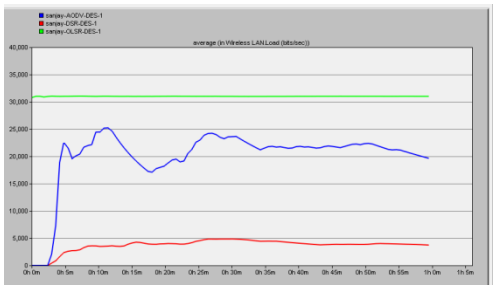

Fig. 24: Comparison results of AODV, DSR and OLSR

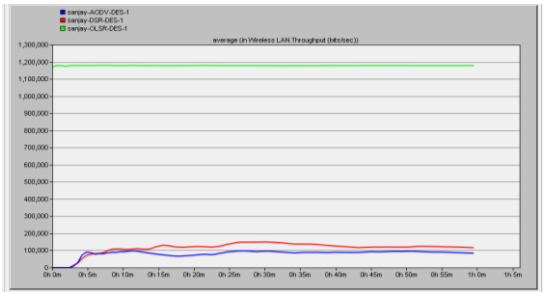

Fig. 29: Comparison results of AODV, DSR and OLSR

VI. CONCLUSION AND FUTURE WORK

In this paperwe mainly containtwo readings, one is analytical study and other is simulation study. From analytical study we concluded that routing protocols in new modern arena ofinternet systems, telecommunications and in seamless communication play prominent role to develop better communication among end users. Different routing protocols have different attributes according to their environmental scenarios. The selection of appropriate protocol according to the network definitely increases the reliability of that network, for example in case of mobile ad hoc networks routing protocols should be loop free according to our research. Categorically it has been analyzed that there are two classes of routing protocols used in mobile ad hoc networks that are reactive routing protocols and proactive routing protocols, both classes have their own usage, so the selection of these classes in ad-hoc networks is very important.

The simulation study of our thesis consisted of three routing protocols AODV, DSR and OLSR deployed over MANET using FTP traffic analysing their behaviour with respect to three parameters, delay,throughput and network load. Our motive was to check the performance of these three routing protocols in MANET in the above mentioned parameters. The assortment of efficient and reliable protocol is a critical issue. In this simulation work we acquire two kinds of results, first one is the simulation graphs and second one is the concluded average statistical data from these graphs.

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