

# Performance Evaluation of FTP application in MANETs using an Optimized Scalable Simulation Model

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**Abstract**—This paper aims to compare performance of three routing protocols for Mobile Ad-Hoc networks (MANET's). A Mobile Ad-Hoc Network (MANET) is a collection of wireless mobile nodes forming a temporary network without using any centralized access point, infrastructure, or centralized administration. 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 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.

## 1. 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.

## 2. 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 routes 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.

## 3. Simulation Environment

This section describes the network topology used for the simulations. We carried out simulations on Opanet 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

Routing Protocols	AODV,OLSR and GRP
802.11 data rate	11 Mbps
Node	75,150
Scenario Size	3.5*3.5 km
Simulation Time	300 second

Figure 2. Shows a sample network created with 75 and 150 Nodes, one static FTP server, application configuration and profile configuration for the network in which FTP has been chosen as an application. Figure 2 depicts a network with 75 and 150 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 and network load.

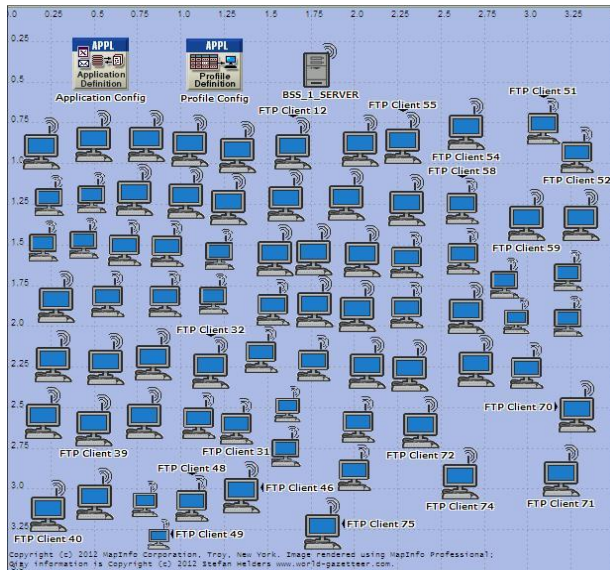


Figure 2.1:Network Topology with 75 nodes

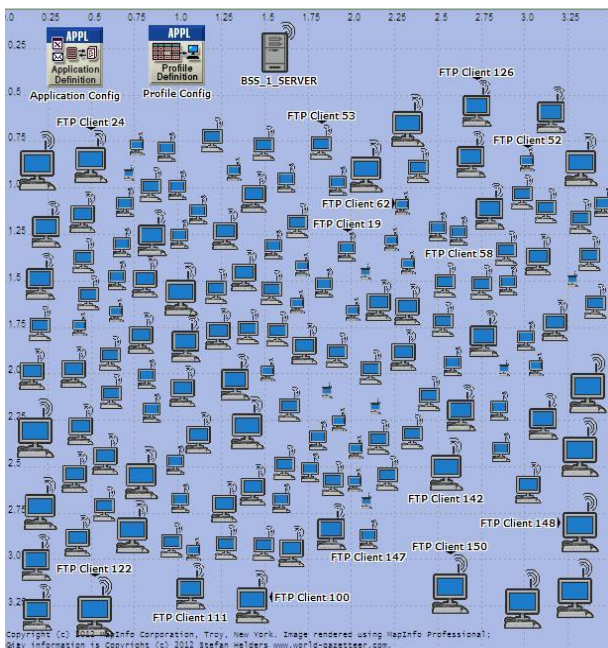


Figure 2.2: Network Topology with 150 nodes

### 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);

$$\text{end-end} = N[\text{dtrans} + \text{dprop} + \text{dproc}] \quad (1)$$

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);

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

**4. RESULT ANALYSIS AND DISCUSSION**

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. We carried out our simulations with 75 and 150 nodes. Figures 3,4,5,6,7 and 8 depicts the throughput, delay and network load of this network with respect to total simulation time which is taken as 30 minutes for which the simulation was run.

In this simulation, the networks are set to 75 and 150 nodes, the traffic is FTP mode, the data transmission rate is 11 Mbps and the simulation time is 300 seconds.

**4.1 Delay**

The maximum network delay variation for 75 nodes and 150 nodes in different scenario is shown in respectively figure 3 and 4. The network delay of AODV is higher than

GRP and OLSR. The delay of OLSR is well enough but AODV also has good delay especially when the number of nodes is more than 300.

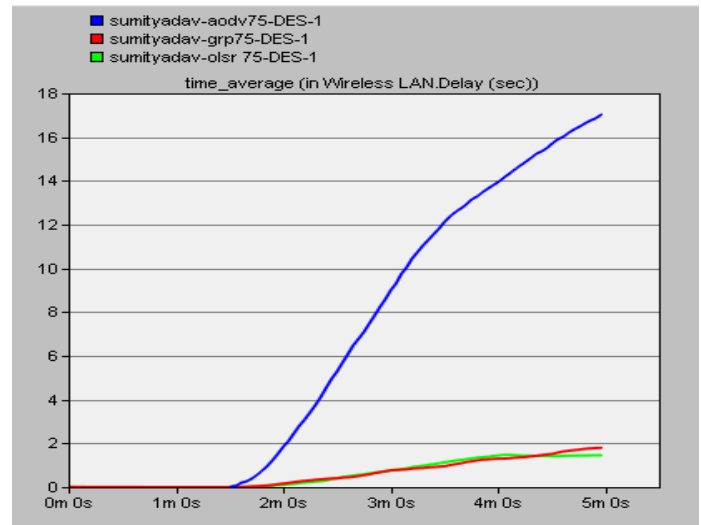


Figure 3. Delay comparison in three routing protocols with 75 nodes

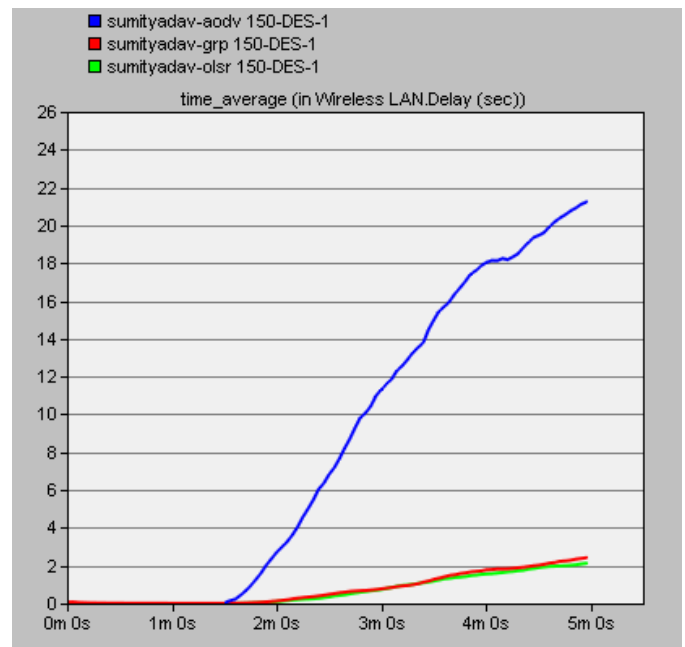


Figure 4. Delay comparison in three routing protocols with 150 nodes

We found that OLSR has poor End-to-End delay. So delay of OLSR is less than GRP and AODV. It is because the head of each data packet will carry the routing information which will increase the length of packet and the time delay for Processing and queuing. Therefore, the entire network delay of AODV is significantly longer than OLSR and GRP. 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 75 nodes and 150 nodes in different scenario is shown in respectively figure 5 and 6.

The network load of AODV is vary from 0 to 790,000 (bits/sec). In Fig. 6, we can see that under the GRP, the value of network load start with peak value equal to 850,000 bit/sec and start to decrease for some duration of simulation period and after that start to increase along the simulation period to reach the peak value 670,000 bit/ sec. Under the OLSR, the load begins with its smallest value to 200,000 bit/ sec until the 300 sec of simulation period than start to increase to reach its peak value which is equal to 730,000 bit/sec. The reason is that the routing mechanisms of the three protocols are different in which OLSR is based on purpose-driven, AODV is on-demand and GRP is based on Hybrid source routing.

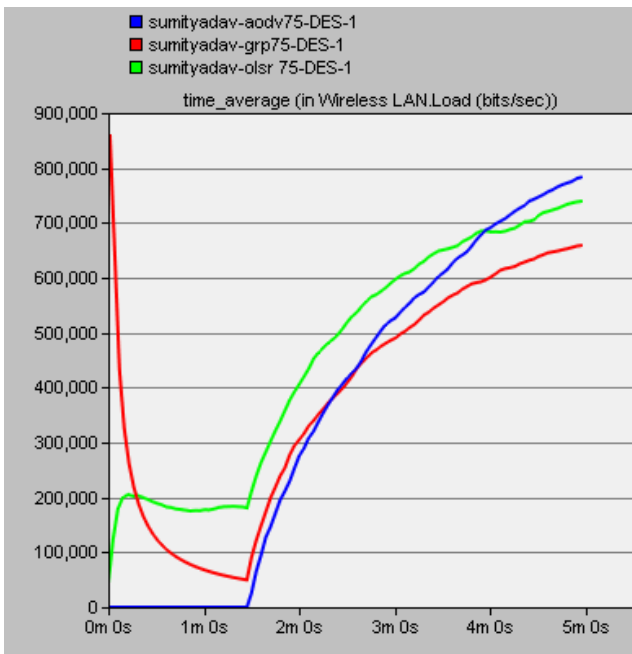


Figure 5. Load (bits/sec) comparison in three routing Protocols with 75 nodes

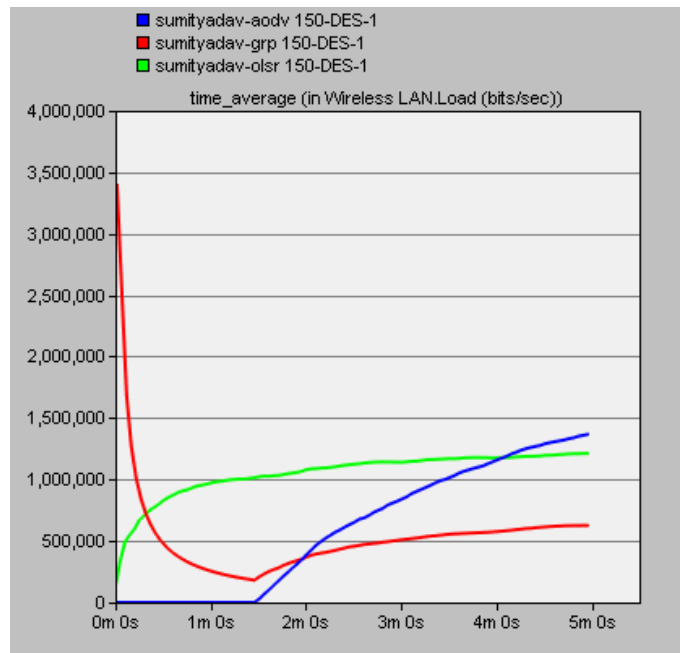


Figure 6. Load (bits/sec) comparison in three routing protocols with 150 nodes

**4.3 Throughput**

It is clearly observed from the figure 7 and 8 depicts the throughput of the network with 75 and 150 nodes respectively. The network throughput for OLSR is better as compared to AODV and GRP. Throughput is defined as the ratio of the total data reaches a receiver from the sender. In figure 7 with 75 nodes, show the OLSR throughput begins with its smallest value to 7,500,000 (bit/sec) and after that start to decrease to reach its peak value which is equal to 5,000,000 (bit/sec) until the completion of 300 seconds of simulation period.

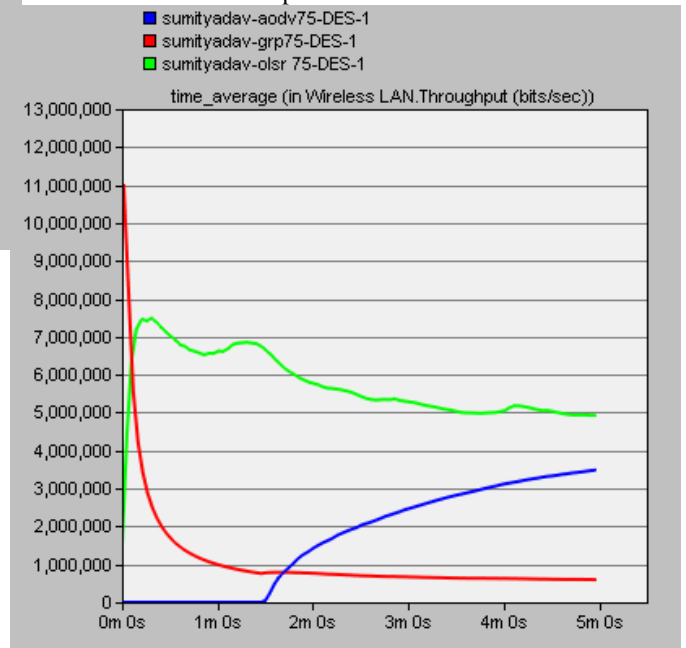


Figure 7. Throughput (bits/sec) comparison in routing protocols with 75 nodes

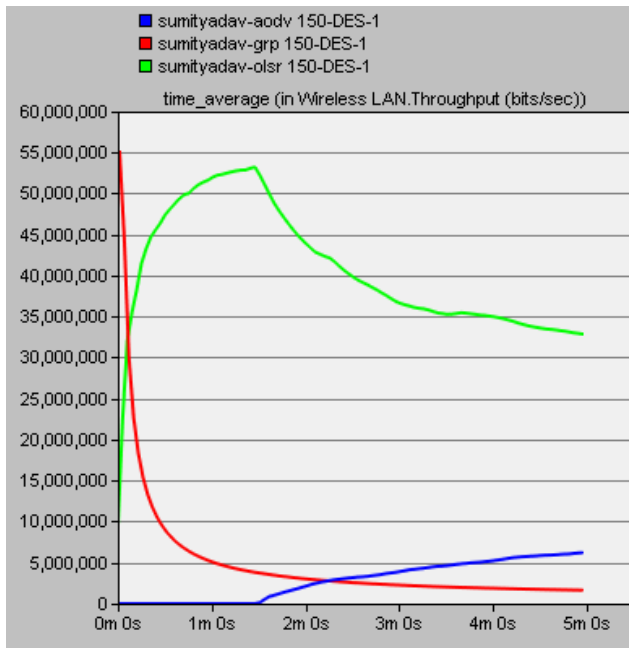


Figure 8. Throughput (bits/sec) comparison in routing protocols with 150 nodes

In figure 8 with 150 nodes, OLSR throughput begins with its smallest value to 55,000,000 (bit/ sec) and after that start to decrease to reach its peak value which is equal to 34,000,000 (bit/sec) until the completion of 300 seconds of simulation period. The network throughput for various routing protocols i.e. AODV, OLSR and GRP in successful operation of the network without any node failure is shown in fig. 7 and 8. The network throughput as evaluated is maximum for OLSR and least for GRP and throughput of AODV lies between the two.

## 5. CONCLUSIONS

In this paper the simulation study of three routing protocols AODV, OLSR and GRP deployed over MANET using FTP traffic analyzing their behaviour is analysis with respect to three parameters, delay, network load 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. The study of these routing protocols shows that the OLSR is better than AODV and GRP in MANET according to our simulation results but it is not necessary that OLSR perform always better in all the networks, its performance may vary by varying the network. At the end we came to the point from our simulation and analytical study that the performance of routing protocols vary with network and selection of accurate routing protocols according to the network, ultimately influence the efficiency of that network in magnificent way.

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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