Simulation and Performance Analysis of AODV,OLSR,GRP Routing Protocol by considering IEEE 802.11 Standard

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Abstract— **A Mobile Ad-hoc Network (MANET) is a self-configuring infrastructure less network of mobile devices connected by wireless. Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. Routing in MANET is a challenging task due to mobility of nodes, infrastructure-less and lack of central administration. The main classes of MANET Routing Protocols are Proactive, Reactive and Hybrid. This paper evaluates performance of OLSR (Proactive), AODV (Reactive) and GRP (Hybrid) routing protocols by considering IEEE 802.11 Wireless LAN Standard and 48 Mbps data rate. . Two simulations have been carried out for these protocols, One for IEEE-802.11a and other for IEEE-802.11g WLAN Standard for scenario with 80 nodes and similarly for 100 nodes. The network performance is evaluated using OPNET, based on the quantitative metrics Media Access Delay (sec), Retransmission Attempts (packets), Throughput (bits/sec), Data Dropped (Retry Threshold Exceeded (bits/sec)) by varying Physical Characteristics and Network Size. The results are given with graphical representation.**

Keywords— **MANET, AODV, GRP, OLSR, OPNET, IEEE802.11a, IEEE802.11g**

I. INTRODUCTION

A Mobile Ad hoc Network (MANET) is a collection of wireless mobile nodes forming a dynamic autonomous network. Nodes communicate with each other without the intervention of centralized access points or base stations. In such a network, each node acts both as a router and as a host. Due to the limited transmission range of wireless network interfaces, multiple hops are needed to exchange data between nodes in the network. MANET is the rapid growing technology from the past 20 years. The gain in their popularity is because of the ease of deployment, infrastructure less and their dynamic nature. MANETs created a new set of demands to be implemented and to provide efficient better end to end communication. MANETs works on TCP/IP structure to provide the means of communication between communicating work stations. Work stations are mobile and they have limited resources, therefore the traditional TCP/IP model needs to be refurbished or modified, in order to compensate the MANETs mobility to provide efficient functionality. Therefore the key research area for the researchers is Routing [1]. Routing protocols in MANETs is a challenging and attractive tasks, researchers are giving tremendous amount of attention to this key area [2].

II. WIRELESS OPERATING MODE

In 1997, the Institute of Electrical and Electronics Engineers (IEEE) created the first WLAN standard. They called it 802.11 after the name of the group formed to oversee its development. Unfortunately, 802.11 only supported a maximum network bandwidth of 2 Mbps - too slow for most applications. For this reason, ordinary 802.11 wireless products are no longer manufactured. In our research 802.11a operational mode used to assign the parametric value in network model. Table1 show the IEEE 802.11a/b/g standard with release year, bandwidth, frequency, data rate, modulation technique is used to simulate our networks.

TABLE 1

Standard	802.11a	802.11b	802.11g
Release	Sep 1999	Sep 1999	Jun 2003
Bandwidth(MHz)	20	20	20
Frequency(GHz)	5	2.4	2.4
Data Rate(Mbit/s)	6,9,12,18,24,36, 48,54	5.5,11	6,9,12,18, 24,36, 48,54
Modulation	OFDM	DSSS	OFDM,D SSS

While 802.11b was in development, IEEE created a second extension to the original 802.11 standard called 802.11a. Because 802.11b gained in popularity much faster than did 802.11a, some folks believe that 802.11a was created after 802.11b. In fact, 802.11a was created at the same time. Due to its higher cost, 802.11a is usually found on business networks whereas 802.11b better serves the home market. 802.11a supports bandwidth up to 54 Mbps and signals in a regulated frequency spectrum around 5 GHz. This higher frequency

compared to 802.11b shortens the range of 802.11a networks. The higher frequency also means 802.11a signals have more difficulty penetrating walls and other obstructions. Because 802.11a and 802.11b utilize different frequencies, the two technologies are incompatible with each other. Some vendors offer hybrid 802.11a/b network gear, but these products merely implement the two standards side by side (each connected devices must use one or the other).

III. ROUTING PROTOCOLS IN MANET
These are classified into three different categories:
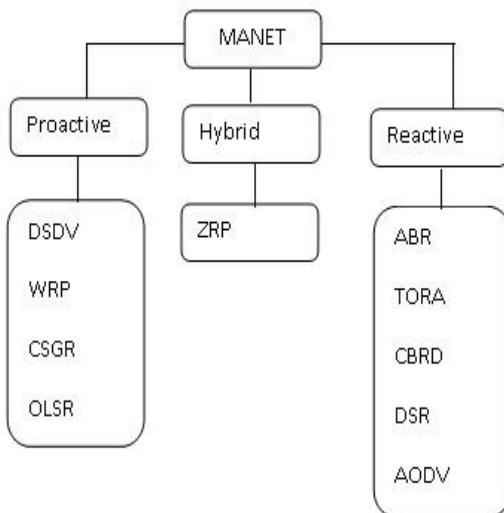
Fig. 1 Classification of MANETs Routing Protocols

A. Proactive Protocols
Proactive methods maintain routes to all nodes, including nodes to which no packets are sent. Such methods react to topology changes, even if no traffic is affected by the changes. They are also called table-driven methods. Thus using a proactive protocol, a node is immediately able to route (or drop) a packet. Optimized Link State Routing Protocol (OLSR) is an example of Proactive Protocol.
1). OLSR Protocol
OLSR is a proactive or table driven, link-state routing protocol. Link-state routing algorithms choose best route by determining various characteristics like link load, delay, bandwidth etc. Link-state routes are more reliable, stable and accurate in calculating best route and more complicated than hop count. To update topological information in each node, periodic message is broadcast over the network. Multipoint relays are used to facilitate efficient flooding of control message in the network. Route calculations are done by multipoint relays to form the rout from a given node to any destination in the network. The OLSR protocol is developed to work independently from other protocols. Conceptually, OLSR contain three generic elements: a mechanism for neighbor sensing, a mechanism for efficient flooding of control traffic, and a specification of how to select and diffuse sufficient topological information in the network in order to prove optimal routes [3], [4].

In OLSR, neighbor nodes related information are gathered with "HELLO" messages which are send over network periodically [5]. These "HELLO" message detect changes in neighbor nodes and related information such as interface address, type of link symmetric, asymmetric or lost and list of neighbors known to the node. Each node update and maintain an information set, describing the neighbor and two-hop neighbor periodically after some time.

The idea of multipoint relays is to minimize the overhead of flooding message in the network by reducing redundant retransmission in the same region. In MPR (Multi Point Relay) a node which is selected by its one hop neighbor to "re-transmit" all the broadcast messages that it receive from other node, provided that the message is not a duplicate, and that the time to live field of the message is greater than one [5]. In OLSR protocol, Multi Point Relays use of "HELLO" message to find its one hop neighbor and its two hop neighbors through their response. Each node has a Multi Point Relay selection set, which indicates, which node acts as a MPR. Message is forward after the node gets new broadcast message and message sender's interface address in the MPR Selector Set. MPR Selector Set is update continuously using "HELLO" message which are periodic because neighbor nodes is called of dynamic nature of MANET.

Topology Control messages are diffused with the purpose of providing each node in the network with sufficient link-state information to allow route calculation [5]. TC messages are broadcast periodically by a node. Like "HELLO" messages with these TC messages the topological information are diffused over the entire network. A minimum criteria for the node is to send at least the link of its MPR Selector Set [3], [6].
B. Reactive Protocols
Reactive methods are based on demand for data transmission. Routes between hosts are determined only when they are explicitly needed to forward packets. Reactive methods are also called on-demand methods. They can significantly reduce routing overhead when the traffic is lightweight and the topology changes less dramatically, since they do not need to update route information periodically and do not need to find and maintain routes on which there is no traffic. Ad-hoc On-demand Distance Vector (AODV) is an example of Reactive Protocol.
1). AODV Protocol
Ad hoc On-demand Distance Vector Routing (AODV) is a novel algorithm for the operation of ad hoc networks. Each mobile node operates as a specialized router and routes are obtained as needed i.e. on-demand with little or no reliance on periodic advertisements. The new routing algorithm is quite suitable for a dynamic self-starting network as required by users wishing to utilize ad hoc networks. AODV provides loop free routes even while repairing broken links. Because the protocol does not require global periodic routing advertisements, the demand on the overall bandwidth available to the mobile nodes is substantially less than in those protocols that do necessitate such advertisements.

AODV can be called as a pure on-demand route acquisition system, in this nodes do not lie on active paths neither maintain any routing information nor participate in any periodic routing table exchanges. Further, a node does not have to discover and maintain a route to another node until it needs to communicate. To maintain the most recent routing information between nodes the concept of destination sequence numbering will be used. Each ad hoc node maintains a monotonically increasing sequence number counter which is used to supersede stale cached routes.

C. Hybrid Protocols

Hybrid routing protocol combines the advantages of both proactive and reactive routing protocols, the routing is initially established with some proactively prospected routes and then serves the demand from additionally activated nodes through reactive flooding. Gathering Based Routing Protocol (GRP) is an example of Hybrid Protocol.

1). GRP Protocol

GRP (Gathering based routing protocol) protocol is source initialized protocol in MANET routing protocol in which all the routing path is created by source node in Mobile Ad-hoc network. In this protocol, source node collects all the information about the route to the designation. In this procedure, source node sends a destination Query toward the destination through network. It works like AODV and DSR using RREQS (Reverse Request Query by Source). In it, when destination Query reached to the destination, destinations send a packet called Network Information Gathering (NIG) which approach through network. When NIG packet reached at a router, router gives it all the information about the network and its resources. There are many nodes called Effective Outgoing Links (EIL) where NIG packet does not riches, routers send this information to these EILs. At last NIG reaches at source node and source node get all the information [7], [8].

IV. RELATED WORK

FAN Ya-qin [7] used OPNET simulation tool for the performance of DSR routing protocol simulation, build a small scale (30 node), Medium size (50 nodes) and large scale (100 nodes) the complexity of the MANET model, the DSR routing algorithm, the average route discovery time, the average route length, throughput, data network latency, and data loss rate in three scenarios for the simulation analysis and performance comparison. The simulation result of the research has practical reference for further study.

Hetal Jasani [8] evaluates the QOS performance of MANETs by comparing the results of using AODV and DSR routing protocols. Using the OPNET Modeler, we have conducted an extensive set of performance experiments for these protocols with a wide variety of settings. The results show that DSR would be the best protocol to use with voice based traffic as long as mobility is kept to a minimum. As network size and mobility increases, AODV is the better choice due to the on-demand nature allowing for much higher mobility because of the non-caching nature of the routes. However, when resource intensive applications such as voice

and video are introduced, the on-demand nature of AODV severely hampers network performance. Even with QOS, AODVs route discovery cannot keep up with the requirements of these applications and this is where DSR's route caching truly shines.

Mostafa Fazeli [9] we study the throughput performance in Mobile Ad Hoc Networks (MANETs) and compares emulated test bed results with simulation results from OPNET (Optimized Network Engineering Tool). The performance of the Mobile Ad Hoc Networks is very sensitive to the number of users and the offered load. When the number of users/offered load is high then the collisions increase resulting in larger wastage of the medium and lowering overall throughput. The aim of this research is to compare the throughput of Mobile Ad Hoc Networks using three different scenarios: 10, 15 and 20 users using simulator OPNET Modeler 14.0. By analysing the graphs in MANETs, it is concluded when the number of users is increased beyond the certain limit, throughput decreases.

N.Adam [10] described the formal evaluation of performances of three types of MANET routing protocols when the node density or the number of nodes varies. The protocols included the Dynamic Source Routing (DSR), Ad Hoc On-demand Distance Vector (AODV) and Temporally Ordered Routing Algorithm (TORA) protocol. The analysis had been done theoretically and through simulation using an Optimized Network Engineering Tools (OPNET) Modeler. Using OPNET Modeler software, these performances had been analysed by the following metrics: packet delivery ratio, end-to-end delay, packet dropped, routing load and end-to-end throughput.

Patrick Sondi [11] they evaluate the performance of OLSR protocol on voice communication by using OPNET simulator. The network model can represent various locations like railway stations, Campus University or traffic jam. We describe the performance end users involved in voice communication session can expect, even in presence of other traffics, like file transfer between other users in the same network.

P.Suganthi [12] proposed to evaluate OLSR routing protocol in a high mobility network with different route refresh intervals. The throughput and delivery ratio are also studied to evaluate the efficiency of the routing protocol.

Singh Annapurna [13] we compare the performance of three on-demand routing Protocols for mobile Ad-hoc network (MANET) networks: Dynamic Source Routing (DSR), Ad Hoc On-demand distance Vector Routing (AODV) and Temporarily Ordered Routing Algorithm (TORA) in by varying the size of the networks. The performance metrics selected to make the performance differences are Total Traffic Received, Traffic Load, Throughput, Number of Hops per Route and Route Discovery Time. AODV shows a Considerable better performance over the others for any number of nodes. TORA and DSR show moderate

performance for minimum number of nodes, where in the case of large networks, DSR shows some performance rather than TORA.

V. SOFTWARE ENVIRONMENT

This research is conducted by using OPNET modeler 14.5. It provides multiple solutions for managing networks and applications e.g. Research and development (R&D), network engineering and performance management. OPNET 14.5 is designed for modeling communication devices, technologies, protocols and to simulate the performance of these technologies. The OPNET usability can be divided into four main steps. The OPNET first step is the modeling, it means to create network model. The sec step is to choose and select statistics. Third step is to simulate the network. Fourth and last step is to view and analyze results.

TABLE II: Simulation Parameters

Simulation Parameter	Value
Simulator	OPNET Modeler 14.5
Area	1500*1500 (m)
Network Size	80 and 100 nodes
Mobility Model	Random way point
Traffic Type	FTP
Simulation Time	240 sec
Address Mode	IPV4
Standard	IEEE 802.11
Routing Protocols	AODV, OLSR, GRP

Below in fig. 2 it is showing the simulation environment of one scenario having 100 mobile nodes for OLSR routing protocol. We run four scenarios. Two simulations have been carried out for 80 mobile nodes and two simulations for 100 mobile nodes, One for IEEE 802.11a and other scenario for IEEE 802.11g WLAN Standard. Main goal of our simulation was to model the behavior of the routing protocols. We collected DES (global discrete event statistics) on each protocol and Wireless LAN. A campus network was modeled within an area of 1500m x 1500m. The mobile nodes were spread within the area. We take the FTP traffic to analyze the effects on routing protocols. We configured the profile with FTP application. The nodes were wireless LAN mobile nodes with data rate of 48Mbps. Random waypoint mobility model was used in this simulation. The mobility model used is simple and it show more good mobility behavior [13]. Mobile nodes move at a constant speed of 12 m/s, and when reaches the destination, the pause time is 150 sec and after that it choose a new random destination.
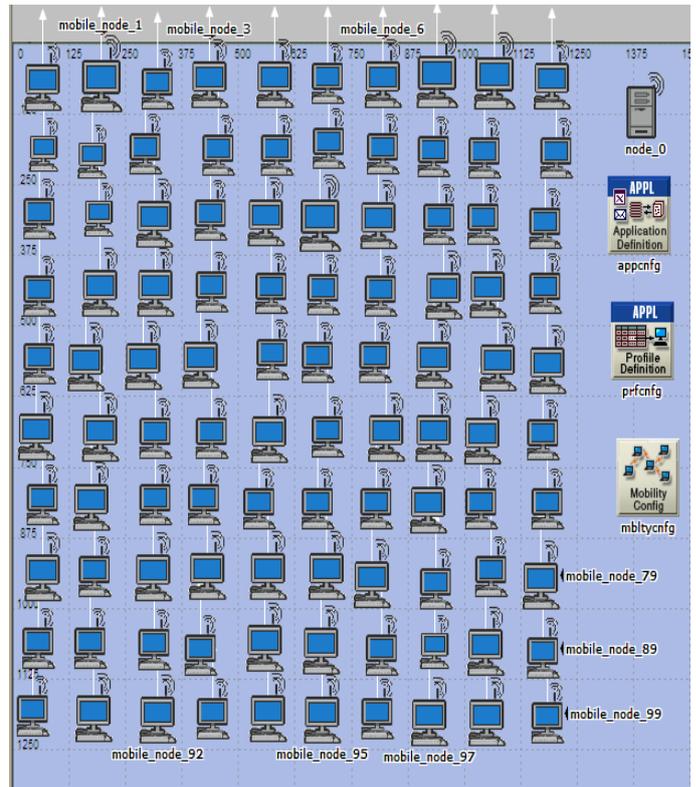

Fig. 2 Simulation Scenario having 100 nodes

VI. PERFORMANCE METRICS

A. Media Access Delay (sec)
It represents the global statistic for the total of queuing and contention delays of the data, management, delayed Block-ACK and Block-ACK Request frames transmitted by all WLAN MACs in the network.

B. Throughput (bits/sec)
It represents the total number of bits (in bits/sec) forwarded from wireless LAN layers to higher layers in all WLAN nodes of the network.

C. Retransmission Attempts (packets)
It is the 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.

D. Data Dropped (Retry Threshold Exceeded (bits/sec))
This statistic represent the total higher layer data traffic (in bits/sec) dropped by the all the WLAN MACs in the network as a result of consistently failing retransmissions

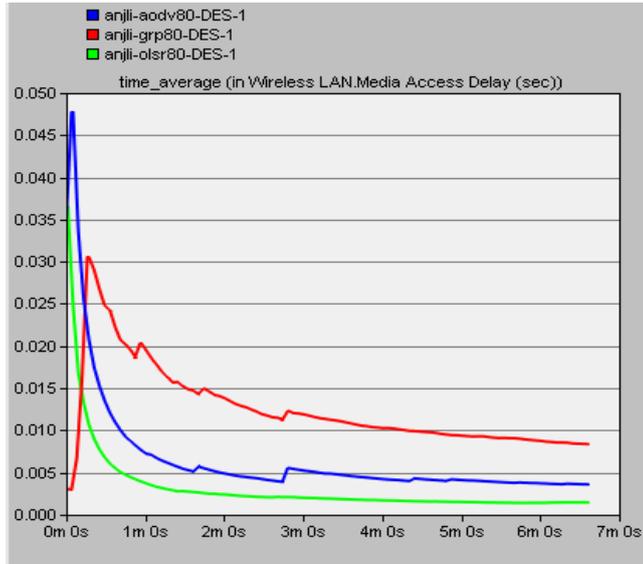## VII. RESULTS AND GRAPHS

Fig. 3 Media Access Delay for IEEE 802.11g with 80 nodes
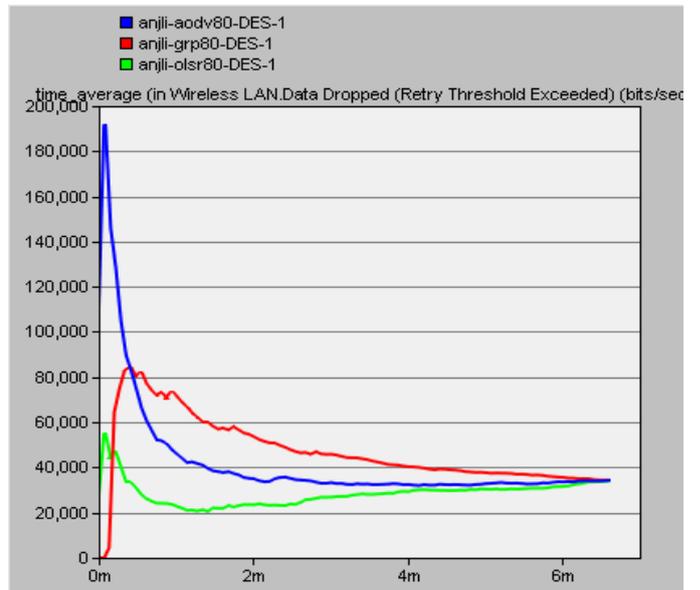

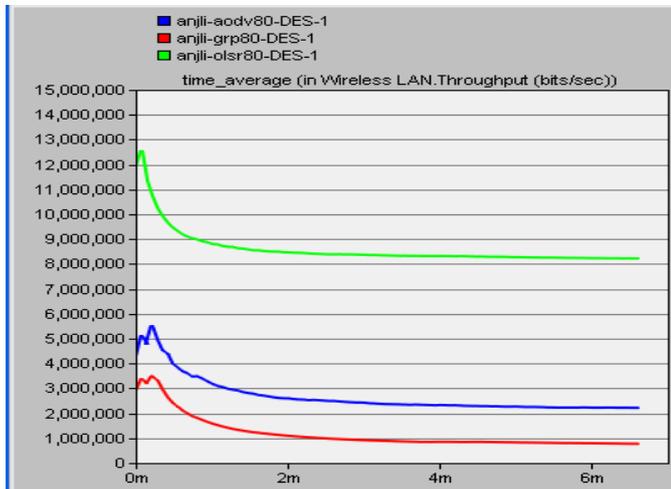Fig. 6 Data Dropped for IEEE 802.11g with 80 nodes

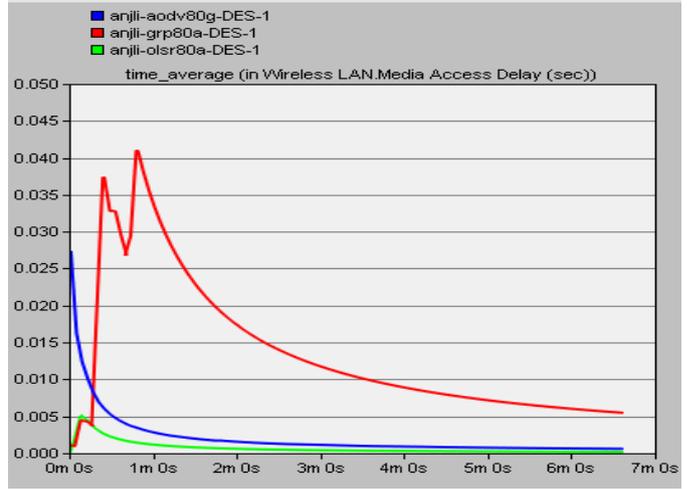Fig. 4 Throughput for IEEE 802.11g with 80 nodes

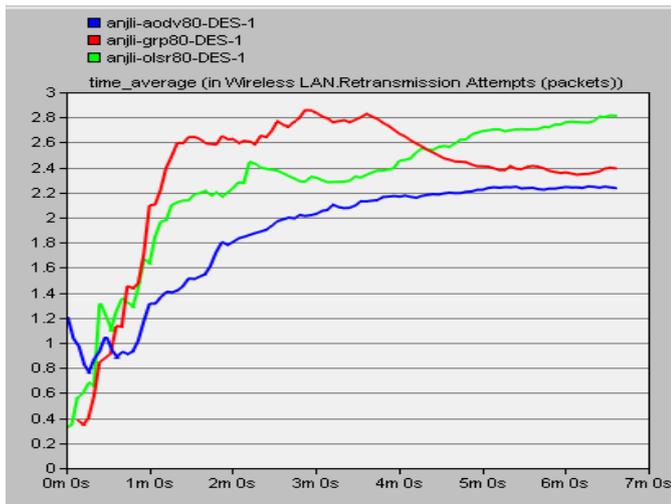Fig. 7 Media Access Delay for IEEE 802.11a with 80 nodes

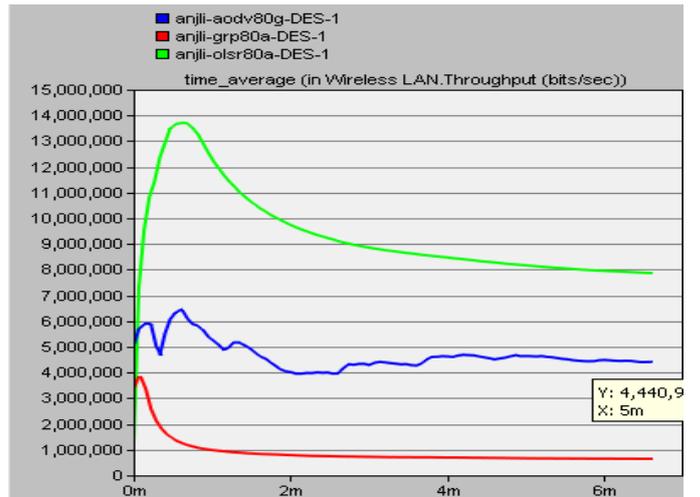Fig. 5 Retransmission Attempts for IEEE 802.11g with 80 nodes

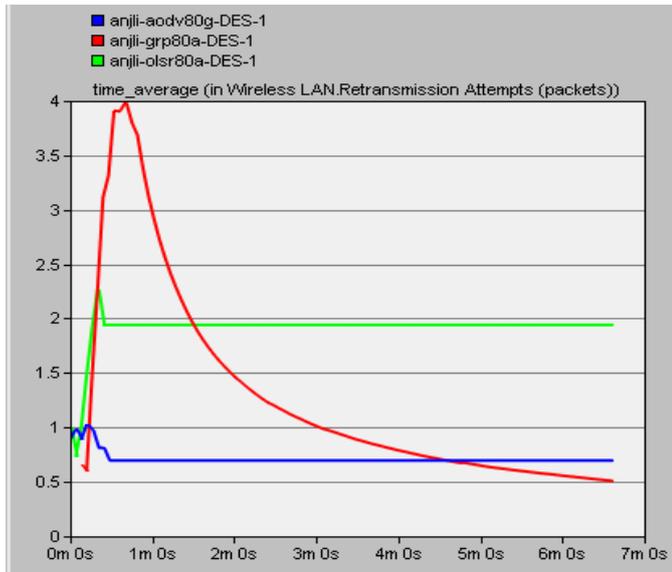Fig. 8 Throughput for IEEE 802.11a with 80 nodes

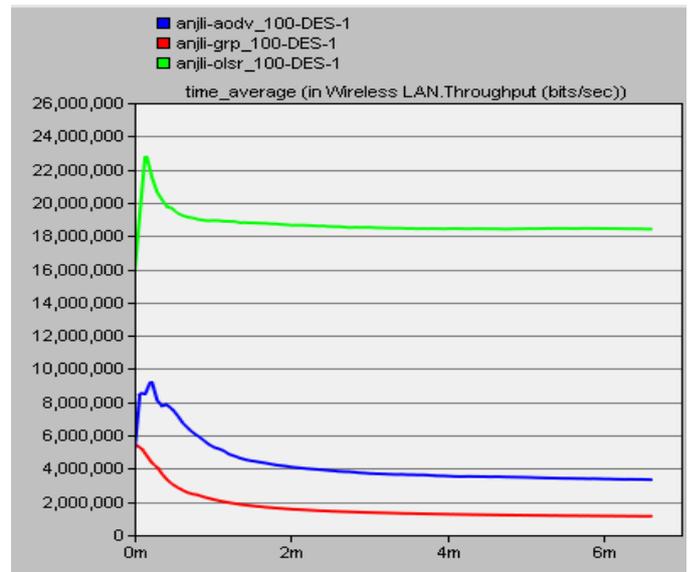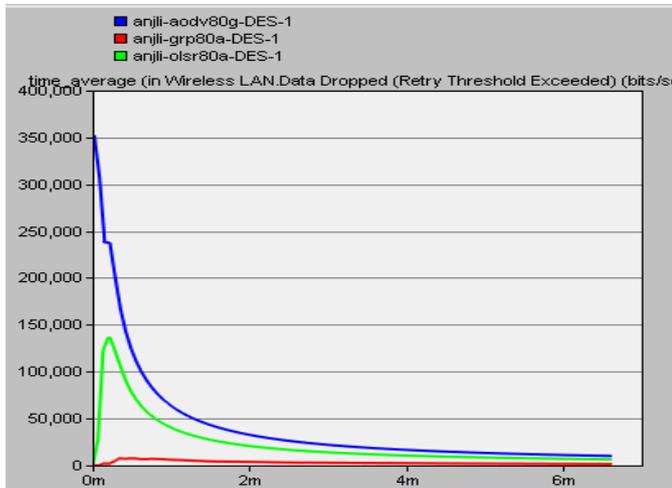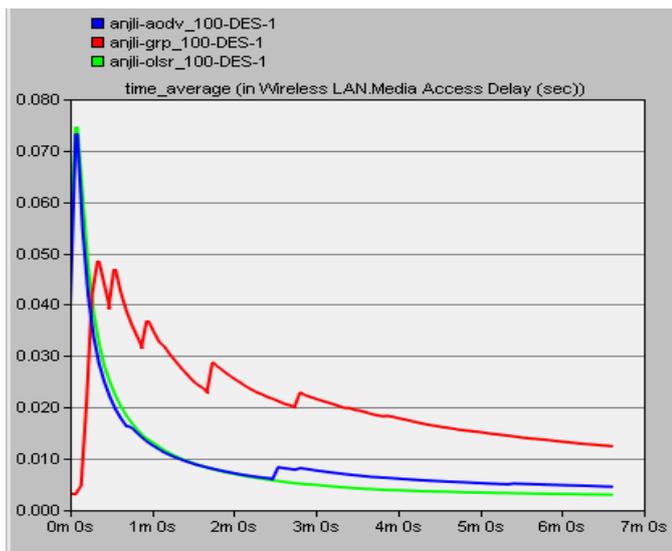Fig. 9 Retransmission Attempts for IEEE 802.11a with 80 nodes

Fig. 12 Throughput for IEEE 802.11g with 100 nodes

Fig. 10 Data Dropped for IEEE 802.11a with 80 nodes
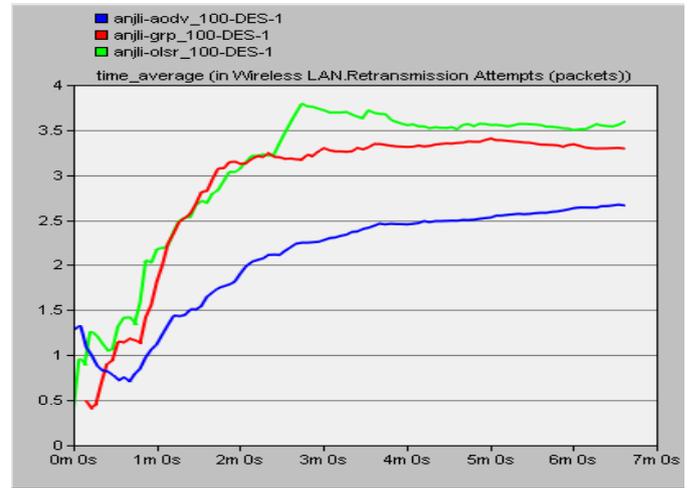
Fig. 13 Retransmission Attempts for IEEE 802.11g with 100 nodes

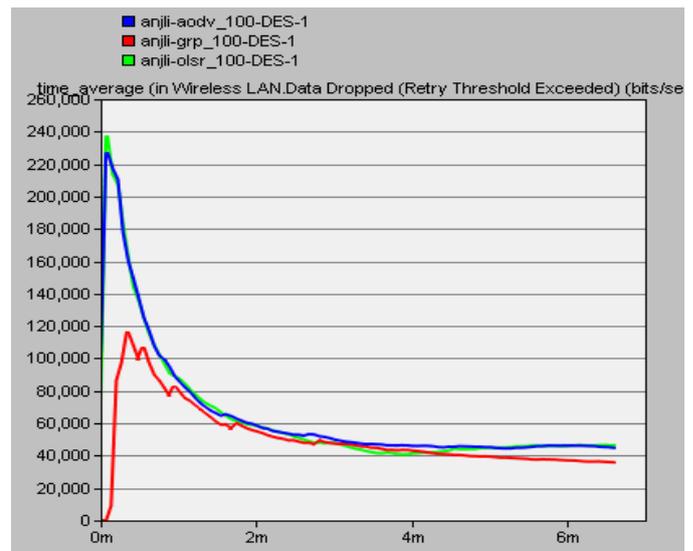Fig. 11 Media Access Delay for IEEE 802.11g with 100 nodes

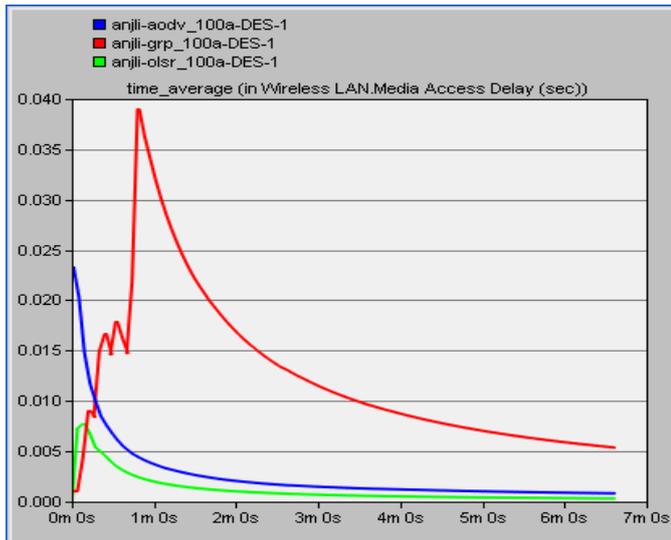Fig. 14 Data Dropped for IEEE 802.11g with 100 nodes
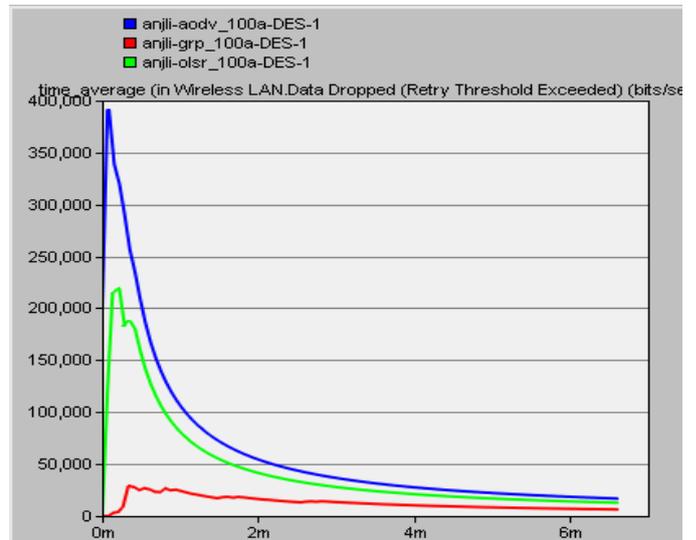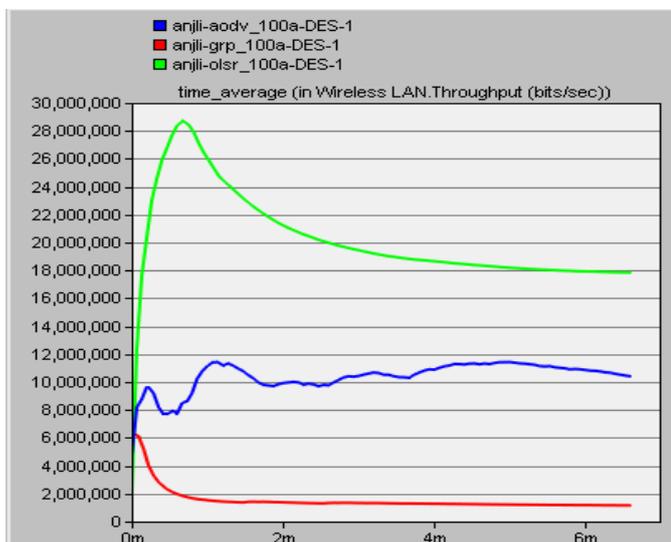
Fig. 15 Media Access Delay for IEEE 802.11a with 100 nodes
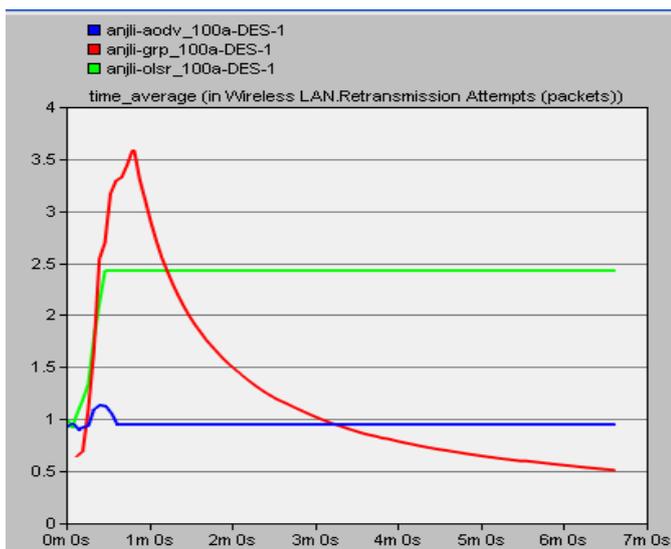

Fig. 16 Throughput for IEEE 802.11a with 100 nodes

Fig. 17 Retransmission Attempts for IEEE 802.11a with 100 nodes

Fig. 18 Data Dropped for IEEE 802.11a with 100 nodes

VIII. CONCLUSION

In this paper, we present the comparative study of MANET Proactive Routing Protocol (OLSR), Reactive Routing Protocol (AODV) and Hybrid Routing Protocol (GRP). We use OPNET to establish the simulation models of these protocols. 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.

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