Formal Measure of the Effect of MANET size over the Performance of Various Routing Protocols

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Abstract

In the competition of this current technology, the aim of Mobile Ad-hoc NETwork (MANET) is to provide efficient real time communication in wireless technology by using routing functionality in mobile devices. The ease of deployment and the self-organizing nature of MANET make them highly attractive for the present day multi-media communications. Traditional routing protocols may not be enough for communication which depends upon our requirements and situations. The routing mechanisms in MANET must be able to reduce the interaction of fundamental difficulties such as congestion, contention and node connectivity to meet the defined Quality of Services (QoS) standards. The paper described the performance of three MANET routing protocols like AODV, OLSR and GRP, when the node density varies and to improve the QOS of MANET. The QoS depends upon several metrics like media access delay, retransmission attempts, throughput and network load. OPNET Modeler (Ver. 14.0) tool is used for network simulation

Keywords: *MANET, IETF, AODV, OLSR, GRP, TTL.*

1. Introduction

Ad-hoc means [1] "for one specific purpose". Mobile Ad-hoc NETwork (MANET) follows this definition as they are formed when needed. MANET is an autonomous system, where nodes are connected through wireless links and discover its neighbors and communication between mobile nodes is carried out without the use of fixed network infrastructure or any centralized administration. MANET is dynamic network topology because the mobile nodes are freely moving in the network and can organize themselves randomly [2]. This characteristic constitutes the MANET unpredictable from the concept of topology and scalability. All available mobile nodes are aware of all other nodes within range. The whole collections of mobile nodes are connected with each other in many distinct ways.

Mobile Ad-hoc NETwork (MANET) is a collection of mobile nodes that are dynamically established in such a way that the interconnections between nodes can be changed on a continual basis [3]. Though, a lot of work has already done on Trajectories, Applications, Security and QoS etc. in the field of MANET. Due to the emerging area, new challenges are used to occur daily in the deployment of MANET. Various types of applications are getting designed on the daily basis with different requirements such that data traffic, node density etc., due to which again and again the evaluation of the existing protocols in need to be done to make the deployment of MANET more prominent, easy and cheaper. To make the MANET working possible, networks are needed to be configured by using different protocols designed specifically for MANET. Choosing of best routing protocols under the given network condition is also a big challenge.

Although many routing protocols have been proposed for mobile ad-hoc network, there is no universal plan that works well in network scenarios with distinct network sizes, node mobility patterns and traffic loads, so mobile ad-hoc routing protocol election presents a great challenge. Every mobile ad-hoc routing protocol has their own advantages that based on the performances in the network. A lot of work has done over the Quality of Services in MANET. In which, new modified node model is designed by modifying standard node model to enhance the overall performance of network. This work is about the simulation of various MANET routing protocols under varying node densities and high traffic load applications to improve the Quality of Services (QOS) and the result will be evaluated by using various performance evaluation metrics.

2. Routing Protocols

Routing [4] is the process of transferring a packet from source to its destination. Various routing protocols have been designed for ad-hoc networks. Routing protocols are required for the communication purpose of the network. Routing protocols are classified into three types:

- Reactive Protocols
- Proactive Protocols
- Hybrid Protocols

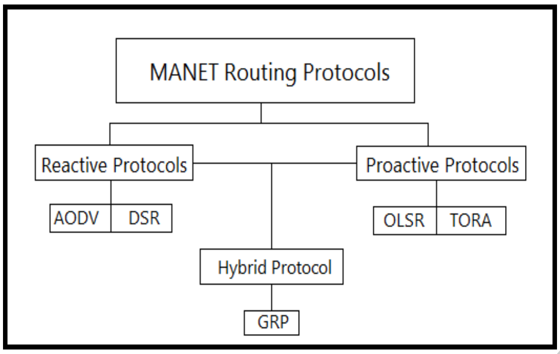

Figure 1 Classification of routing protocols

2.1. Reactive or On-Demand Routing Protocols

Reactive protocols are based on demand for data transmission. These protocols setup routes when demanded. They do not start route discovery by themselves, until they are requested [5]. Routes are only discovered whenever they are actually needed to forward packets from source to destination. They can reduce routing overhead when the traffic is low and do not need to find and maintain routes when there is no traffic and no need to update route information regularly [2]. Examples:

- AODV (Ad-hoc On-demand Distance Vector Routing Protocol).
- DSR (Dynamic Source Routing Protocol).

2.1.1. Ad-hoc On-Demand Distance Vector Routing Protocol (AODV). AODV is a reactive or on-demand Routing Protocol. AODV provides on-demand route discovery in MANET. When the source node is required to send data to the destination, if the source node doesn't have routing information in its routing table, route discovery process initiate to discover the routes from source to destination. Route discovery start with broadcasting a route request (RREQ) packet by the source node to its neighbors. RREQ packet consists of broadcast ID, two sequence numbers, hop count and addresses of source and destination. When the intermediate node receive the RREQ packet, it is divided into two steps: If it's the destination node then it will send reply message, route replay (RREP), directly to the source node from which it was received the RREQ packet otherwise it'll rebroadcast the RREQ packet to its neighbors. Each node has a sequence number. When a node needs to start route discovery process, it consist its sequence number and imperative fresh sequence number for the destination. The intermediary node that receive the RREQ packet, reply to the RREQ packet only when the sequence number of its path is greater than or the same to the sequence number consist in the RREQ packet. It is also Route Error (RERR) message that used to identify the other nodes about some failures in other nodes or links.

2.2. Proactive or Table Driven Routing Protocols

Proactive protocols maintain routes to all nodes in routing table, comprising nodes to which no packets are sent. When the network topology becomes different, then routing tables are update according to the changes [6]. Packets are transferred over the predefined route notified in the routing table. In this, the packet delivering is done faster but the routing overhead is greater because all the routes have to be declared before sending the packets. They have lower latency because all the routes are maintained at every times [2]. Examples:

- DSDV (Destination-Sequenced Distance-Vector Routing Protocol).
- OLSR (Optimized Link State Routing Protocol).

2.2.1. Optimized Link State Routing Protocol (OLSR). OLSR is proactive routing protocol that is also called as table driven protocol. It usually contains and updates its routes, when a route is needed, it present the route immediately without any initial delay. In OLSR, multipoint relays (MPRs) are chose and responsible to facilitate efficient flooding of broadcast packets in the network [7]. This technique decreases the overhead in the network by reducing redundant retransmission in the same region [1]. OLSR performs two types of control messages: HELLO message and Topology Control (TC) message. In OLSR protocol, MPR's uses of 'HELLO' message to find its two hops (i.e. neighbors of the neighbors). HELLO messages are sent at a certain interval. HELLO messages means when a node senses and chooses its MPR's with control messages. They usually ensure a bidirectional link with the neighbor node. TC message is used to broadcast information for own notified neighbors which comprises at least the MPR selector list. Nodes broadcast Topology control (TC) messages to examine its MPR's [8].

2.3. Hybrid Protocols

Hybrid protocols are combination of both reactive and proactive routing protocols and takes advantages of both reactive and proactive protocols and as a result, routes are found quickly in the routing zone. Examples:

- GRP (Geographic Routing Protocol).
- TORA (Temporally Ordered Routing Algorithm Protocol).

2.3.1. Geographic Routing Protocol (GRP). GRP is a hybrid protocol, in which all the routing path is created by source node in Mobile Ad-hoc network. In GRP the Global Positioning System (GPS) is used to mark the location of node and divides the network into many routing zones and notifies two disconnected protocols that work inside and between the routing zones [5]. Every node has an intra-zone mechanism and extra-zone mechanism. When a node moves and crosses neighborhood then the flooding process is updated. The neighbors and their positions are defined by the exchange of "Hello" message. When the node wants to work in the intra-zone, it will communicate using any proactive ad hoc routing protocol, such as DSDV. When the node wants to communicate outside the intra-zone (which is the extra-zone), it will use one of the reactive ad hoc routing protocol, such as DSR or AODV. The reactive protocol is used for finding the routes between distinct routing zones. The protocol then broadcasts a Route Request (RREQ) message to all border nodes within their routing zone, which in turn sends the request if the destination node is not found within their routing zone [9]. This process repeated until a route reply (RREP) message is sent back to the source indicating the route.

3. Simulation and Performance Metrics

3.1. Simulation Environment

The OPNET modeler 14.0 has been used to design the network model and get out the various results and to check out the varying parameters. In this Research work, different scenarios of size 20, 40, 60 and 80 nodes that have been created in OPNET modeler 14.0. The networks entities are used during the design of the network model are application configuration, profile configuration, wireless server and workstations (nodes). The "Application Config" is used to specify Heavy HTTP Browsing and High Load Remote Login applications. The "Profile config" is used for configuring the user profiles and object profiles. Three different protocols AODV (Reactive), OLSR (Proactive), GRP (Hybrid) are being used to analyze the performance. Network throughput, media access delay, retransmission attempts and network load metrics are considered as the performance evaluation parameters. Figure 3.2 shows the simulation environment of scenario containing 20 mobile nodes.

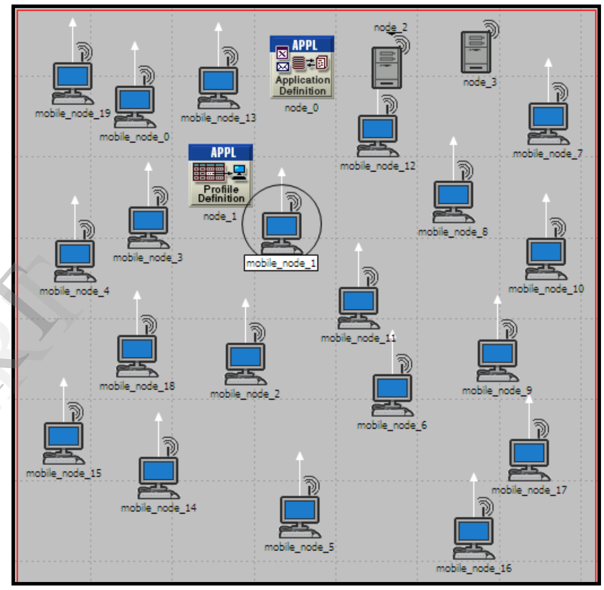

Figure 5 Network Scenario having 20 nodes

In proposed work, To design new node model by adapting standard node model according to our proposed work by using standard Node Projector and Process Projector to enhance the overall performance of network and also able to reduce the interaction of fundamental difficulties such as congestion, contention and node connectivity to meet the Quality of Services (QoS) standards. The new or modified node model can perform like as standard node model. Changing the route path of packet from one server to other server is the function of modified node model, when the buffer depth of initially scheduled server is reached at the maximum threshold that cause in the less routing overhead and less packet dropped. The performance of three MANET routing protocols AODV, OLSR, GRP have been calculated by using new node model and standard node model. Network throughput, media access delay, retransmission attempts and network load metrics are considered as the performance evaluation parameters. The parameters that have been used in the network scenario are summarized in Table 1.

Table 1Parameters for Simulation

ATTRIBUTE	VALUES
Simulator	OPNET Modeler 14.0
Model Family	MANET
Network Scale	Office
Date Rate(bps)	54 Mbps
Nodes	20, 40, 60, 80
Node Placement	Randomly
Operational Mode	802.11b
Buffer Size	102400000
Traffic Types	Heavy HTTP Browsing and High Load Remote Login
Simulation Time	300 Seconds
Routing Protocols	AODV/OLSR/GRP

3.2. Performance Metrics

Performance metrics are used for the evaluation of routing protocols. They represent different characteristics of the overall network performance.

- **Throughput**

It represents the total number of bits (in bits/sec) delivered from wireless LAN layers to higher layers in all WLAN nodes of the network. Throughput is the ratio of the total amount of data that reaches a receiver from a sender to the time it takes for the receiver to get the last packet is referred to as throughput. It is expressed in bits per second or packets per second.

- **Media Access Delay (sec)**

Media Access Delay 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.

- **Retransmission Attempts (packets)**

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.

- **Network Load (bits/sec)**

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.

4. Results and Analysis

The performance is analysed that is based on the different node densities from 20 to 80 nodes under network scenario using with modified node model and standard node model is shown in figures.

Throughput for AODV

Figure 4.1 shown the throughput possessed by the network configured by using a reactive protocol i.e. AODV with different network sizes of 20 to 80 nodes under network scenario using with modified node model and standard node model.

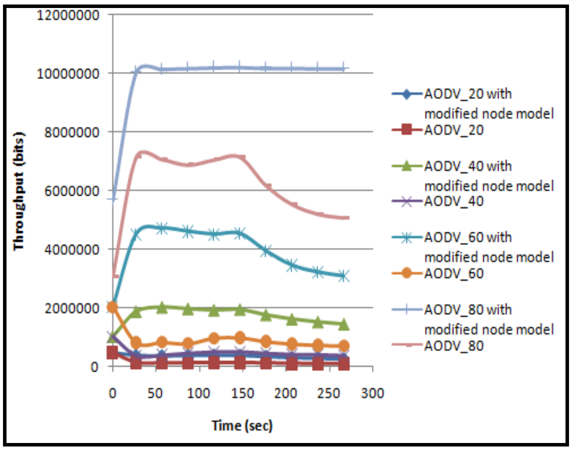

Figure 4.1 Throughput of AODV

The graph depicts that the throughput for the network of 20 and 40 nodes designed by modified node model using high traffic load applications to generate data in the network has increased by 39.15% and 58.38% respectively. At the same time, the throughput of AODV protocol with large network size begins with greater value. The network that is designed by 60 and

80 nodes, throughput has increased by 71.64% and 75.67%.

Throughput for OLSR

Figure 4.2 shows throughput of OLSR protocol with varying node densities from 20 to 80 nodes under network scenario of using with modified node model and standard node model. The throughput of network of 20 and 40 nodes has been increased by 40.09% and 49.99% respectively. The increment is 50.72% and 51.42% in network of 60 and 80 nodes of network.

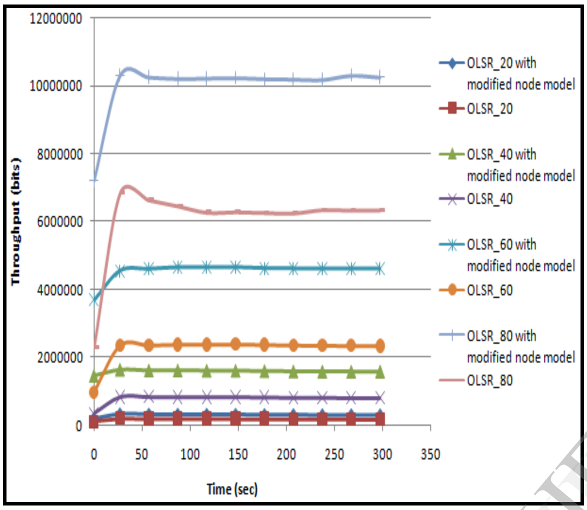

Figure 4.2 Throughput of OLSR

Throughput for GRP

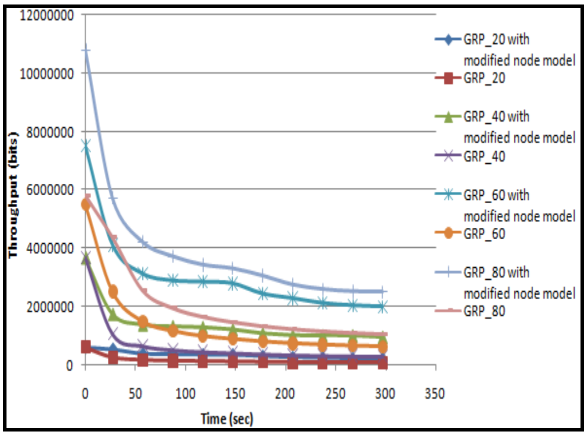

Figure 4.3 Throughput of GRP

Figure 4.3 shows throughput of GRP protocol with varying node densities from 20 to 80 nodes. The rendered graph depicts that the throughput for the network designed by using new node model using high traffic load applications to generate data in the network has increased by 38.20% and 46.63% for network of 20 and 40 nodes. The throughput of network that is designed by 60 and 80 nodes has been increased by 53.44% and 58.64% respectively.

Retransmission Attempts for AODV

Figure 4.4 depicts the retransmission attempts of AODV protocol with varying node densities from 20 to 80 nodes. The graph depicts that the retransmission attempts for the network designed by using 20 and 40 nodes has been decreased from the network using standard node models by 30.82% and 37.86% respectively. The decrement in retransmission attempts has 36.20% and 42.36%, when node density of network is 60 and 80 nodes.

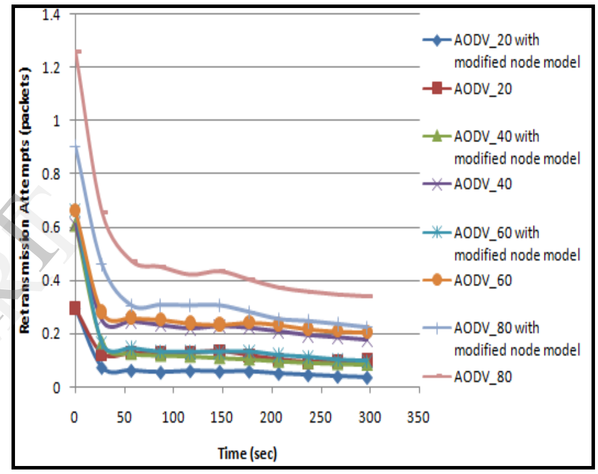

Figure 4.4 Retransmission Attempts of AODV

Retransmission Attempts for OLSR

The retransmission attempts of OLSR protocol with varying node densities from 20 to 80 nodes under two types of scenarios using with modified node model and standard node model is shown in figure 4.5. The network that is designed by using 20 and 40 nodes, retransmission attempts has decreased by 15.94% and 13.30% respectively. Retransmission attempts have decreased by 23.51% and 25.97% for the node density 60 and 80 nodes of network.

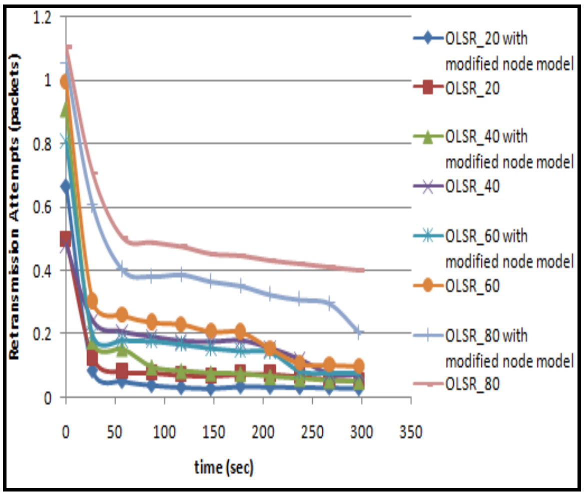

Figure 4.5 Retransmission Attempts of OLSR

Retransmission Attempts for GRP

Figure 4.6 shown the retransmission attempts possessed by the network of 20 and 40 nodes configured by using a hybrid protocol has been decreased by 11.96% and 20.81% respectively. The decrement in retransmission attempts has 10.14% and 25.96% for 60 and 80 nodes.

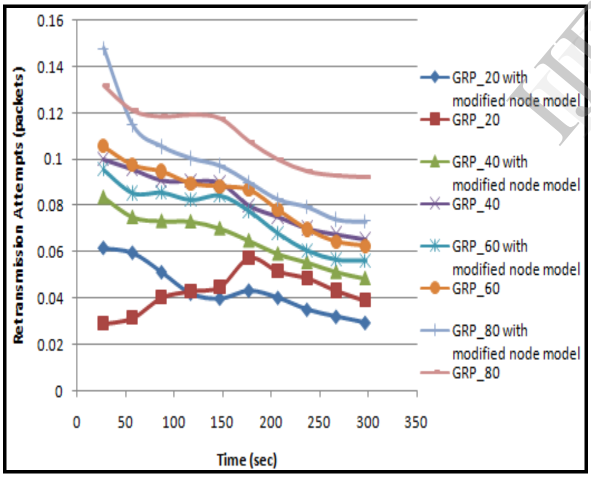

Figure 4.6 Retransmission Attempts of GRP

Media Access Delay for AODV

Figure 4.7 shows the Media access delay of AODV protocol of network scenario using with modified node model and standard node model. The network using the new node model has shown a decrease in the media access delay for all protocols. The media access delay has been decreased by 15.38% and 12.58% for 20 and 40 nodes network. The network that is designed by 60 and 80 nodes, decrement in media access delay is 18.96% and 25.40%.

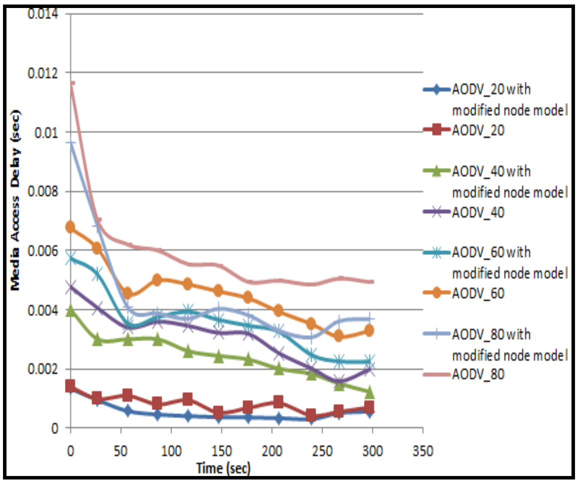

Figure 4.7 Media Access Delay of AODV

Media Access Delay for OLSR

Figure 4.8 shown the media access delay possessed by the network configured by using a proactive protocol, OLSR with varying node densities from 20 to 80 nodes. Media access delay has been decreased by 10.14% and 8.94% for node density 20 and 40 networks and the decrement in media access delay is 15.56% and 20.65% for 60 and 80 nodes networks.

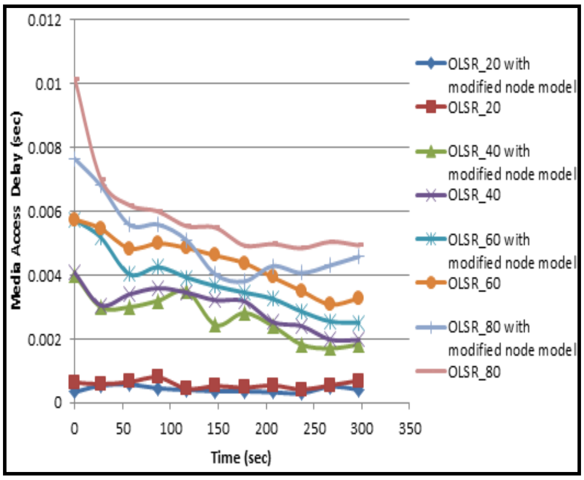

Figure 4.8 Media access delay of OLSR

Media Access Delay for GRP

Media access delay of GRP protocol with varying node densities from 20 to 80 nodes is shown in figure 4.9. The network that is designed by 20 and 40 nodes, decrement in media access delay is 24.31% and 28.08% respectively. Media access delay has been decreased by 31.87% and 34.11% for the 60 and 80 nodes network.

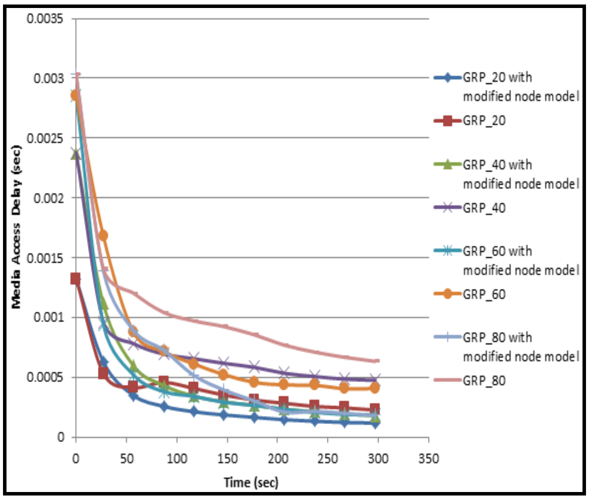

Figure 4.9 Media access delay of GRP

Network Load for AODV

This graph 4.10 depicts the network load of AODV possessed by the network using standard node model and modified node model under different types of network sizes that varies from 20 to 80 nodes. In the graphs, it has shown that for AODV protocol, the network load for the network new node model has increased by 9.66% and 17.05% for node density 20 and 40. The increment in network load is 30.34% and 38.62% for the network of 60 and 80 nodes.

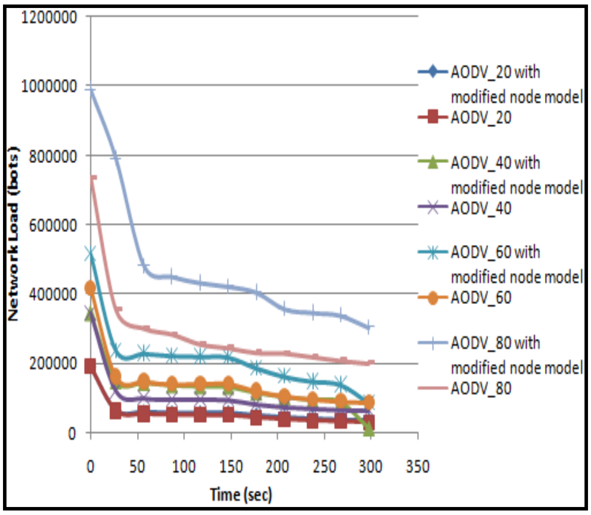

Figure 4.10 Network Load of AODV

Network Load for OLSR

As shown in figure 4.11, the network load for OLSR protocol has decreased for all the networks using standard node model under different types of network sizes that varies from 20 to 80 nodes. In the case of the new node model based networks, the network load has increased by 12.06% and 21.35% for 20 and 40 nodes networks. The network that is designed by 60 and 80 nodes, network load has increased by 24.72% and 27.99% respectively.

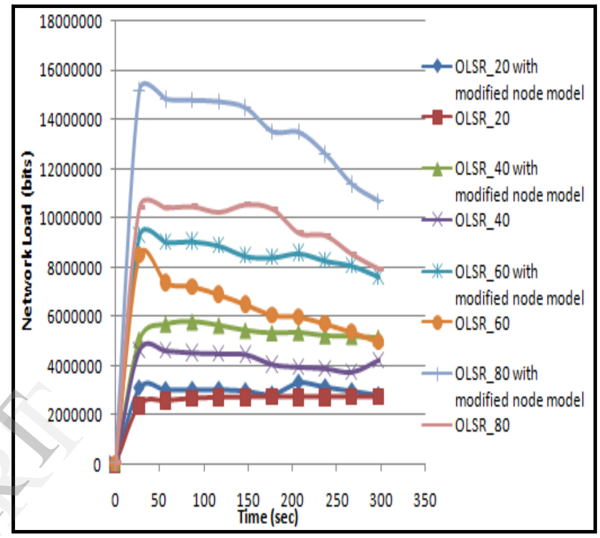

Figure 4.11 Network Load of OLSR

Network Load for GRP

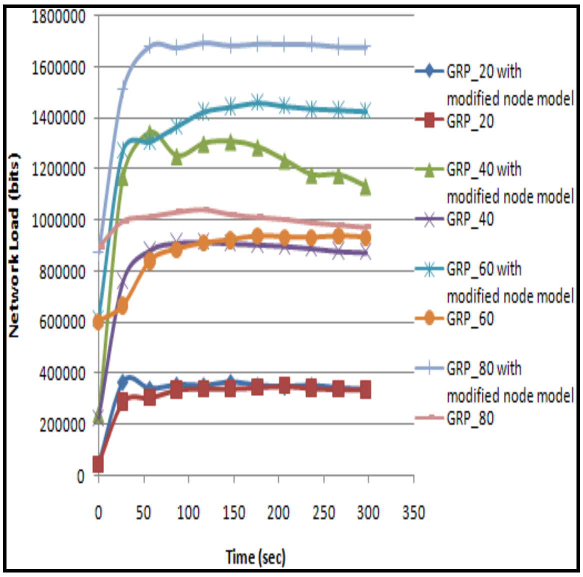

Figure 4.12 Network Load of GRP

Figure 4.12 shows the network load of GRP possessed by the network that varies from 20 to 80 nodes. In the graphs, it has shown that for AODV protocol, the network load for the network new node model has increased by 15.76% and 28.27% for 20 and 40 nodes network. The increment in network load is 35.09% and 37.57% for 60 and 80 node density networks.

5. Conclusions and Future Scope

In thesis work, Simulations of three MANET routing protocols AODV, OLSR and GRP under different web based applications such as Heavy HTTP Browsing, High Load Remote Login using OPNET modeler are performed. I have analysed performance of three MANET Routing Protocols with increasing the MANET size and its effects on QoS (Quality of Services) of MANET. One of the distinguishing characteristics of our strategy is that, the Mobile Ad-hoc Network is provided a better QoS with appropriate routing protocol with increasing the nodes. In the research work, the QoS depends upon several metrics like Media access delay, retransmission attempts, throughput and network load are considered as the performance evaluation parameters. The simulation results conclude that on increasing the number of nodes, the performance of all protocols has improved through using new modified node model that causes less routing overhead and less packet dropped and also improve the QoS, but it varies from protocol to protocol. As the number of nodes increased the network load also increased for all three routing protocols. Finally, simulation results confirm that AODV protocol giving better performance under such types of circumstances, providing better QoS based on good throughput, delay and less data dropped. In case of network load too it is observed that on varying the node density performance of GRP protocol is very high. OLSR performance is average during the simulation. High network load affects the MANET routing packets. By comparing AODV, OLSR and GRP the results in the entire figures, it can be seen that AODV perform well than OLSR and GRP in delay, network load and throughput and retransmission attempts.

A lot of work has done over the Quality of Services in MANET. But there is always a scope to improve the previous work to get the results better. This thesis work is about the simulation of various AODV, OLSR and GRP routing protocols under varying node densities and high traffic load applications to improve the Quality of Services (QOS) and the result will be evaluated by using various performance evaluation metrics. Various parameters have been varied and tested during the work such as number of nodes, network area etc. Number of nodes is varied from 20 to 80 nodes. So, simulation can be performed by increasing the nodes to a large number. Other routing protocols apart from AODV, GRP and OLSR can also be taken into account for the evaluation of web based applications.

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