Implementation of TTL and Fragmentation over the Performance of MANET Routing Protocols

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Abstract

In recent years mobile ad-hoc networks become very popular. A mobile ad-hoc network has been developed within IETF (Internet Engineering Task Force). It is a new paradigm of portable devices enabling different types of communications immediately and easily such as person-to-person, machine-to-person, and person-to-machine. In MANET, various kind of routing protocols are taken into consideration, i.e. AODV, OLSR and GRP. In this paper, MANET routing protocols are presented using fragmentation and TTL. A new node model is designed by modifying standard node model which helps to maintain the overall performance of network. Simulation has been carried for all the scenarios with and without fragmentation and TTL and results have been calculated by using different metrics i.e. network throughput, media access delay, retransmission attempts and data dropped. OPNET has been used to evaluate the simulation results.

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

1. Introduction

A Mobile Ad-hoc Network (MANET) is a collection of wireless mobile devices that having ability to communicate with each other without any fixed network infrastructure [1]. Due to the unavailability of controlling entity, routing and network management are done cooperatively by respective nodes. It is an autonomous self-organizing and dynamic system of mobile hosts that use wireless communication techniques for data transfer and forming an arbitrary graph. MANET consists of three elements namely; mobile node, router and wireless communication device [2]. Mobile nodes are wireless radio type and wireless communication devices are transmitters, receivers and smart antennas. To communicate with other node, the destination node must lies between the radio ranges of the source node. In MANET, packets are transmitted from the source node to the destination node through intermediate node [3], [7]. Though, a lot of work has already done on Trajectories, Applications, Security, route caching, QoS etc. in the field of MANETs. Due to the emerging area, new challenges are use to occur daily in the deployment of MANETs. 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 MANETs more prominent, easy and cheaper. To make the MANETs working possible, networks are needed to be configured by using different protocols designed specifically for MANETs. Low resource availability in mobile ad-hoc networks requires efficient utilization of resources and imposes severe demands on routing protocols.

The performance of mobile ad-hoc networks degrades, when congestion conditions occurs with many real applications. These congestion conditions are a serious hurdle for the deployment of mobile ad-hoc network and, therefore, a congestion control remedy is needed. MANETs are continuously expanding in terms of traffic and services like HTTP browsing, FTP and E-mail. As the new applications and utilities are getting introduced for MANETs, it is mandatory to evaluate the performance of MANETs by using traditional congestion control techniques to explore the limitations of the techniques. This helps in the designing of new and efficient techniques to deal with congestion in the networks. To ensure the better functionality of MANETs, Fragmentation and Time to Live (TTL) have been added to the MANET networks to observe the effect over the performance of congested ad-hoc network. Various different metrics have been chosen to gather the variations and the results have been presented in the graphical form.

2. Routing Protocols

A routing protocol is required to transmit a packet from source node to destination node via intermediate nodes. Numerous routing protocols have been designed for mobile ad-hoc networks [4]. Mainly, routing protocols are categorized into three types:

- Reactive Protocols
- Proactive Protocols
- Hybrid Protocols

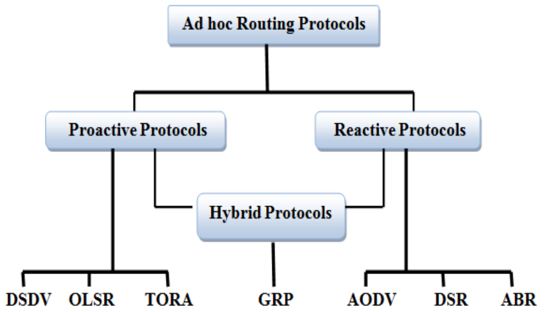

Figure 1 Classification of routing protocols

2.1. Reactive or On-Demand Routing Protocols

In reactive routing protocols, routes are established on demand for routing. When source node wants to transmit a packet to destination then routes are generated by route discovery mechanism [5]. Reactive protocols have lesser routing overhead but higher latency because these protocols do not make the nodes to start a route discovery until a route is required [9]. 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 protocol. When a node wishes to send data to another node; firstly it checks the routing table; if the node has no route to the destination node then AODV starts route discovery mechanism [1]. There are three types of control messages in AODV: Route Request Message (RREQ), Route Reply Message (RREP) and Route Error Message (RERR). HELLO messages are used to confirm the presence of the neighbor nodes [6]. Source node transmits RREQ message to all its neighbor nodes to communicate with another node. RREQ message includes source node's IP address, destination's IP address, Broadcast ID, sequence number and time to live (TTL) value [9]. Sequence number defines the freshness of the packet. If intermediate node is requested node or has a route to the destination generates a RREP message back to the source node. When the node detects a down link in an active route, then that node generates RERR message in order to inform other nodes that the link is down. If source node moves and route to destination is still required then the route discovery process is reinitialized for the route maintenance mechanism.

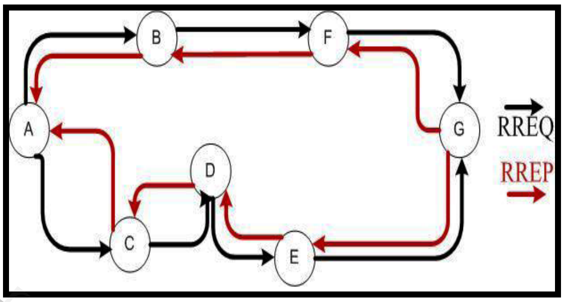

Figure 2 AODV Route Discovery Mechanism

As shown in figure 2, when a node "A" wants to start transmission with node "G", it will generate a RREQ message. If intermediate node has a fresh route to destination generates a RREP message to the source node A. When RREP message is received by source node, a route is created between the source node "A" and destination node "G".

2.2. Proactive or Table Driven Routing Protocols

In proactive routing protocols, every node in the network knows about the every other node of that network in advance. Topology information is exchanged between nodes periodically. Routing tables are updated according to the changes in the network topology. Proactive protocols have higher routing overhead due to periodic updates in routing tables and lower latency because routes are predefined [5]. 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 known as table driven protocol by the fact that it updates its routing tables. In OLSR control messages are classified into three types: Hello Message, Topology Control Message (TC) and Multiple Interface Declaration (MID). The routing overhead that is caused by flooding of control traffic is minimized by using MPR nodes. This technique significantly decrease the number of retransmissions required to transmit a message to all nodes in the network. Each node selects a set of neighbor nodes i.e. MPR nodes and which covers nodes with a distance of two hops. Whenever the node broadcasts the message, only the MPR nodes are responsible for broadcasting the message.

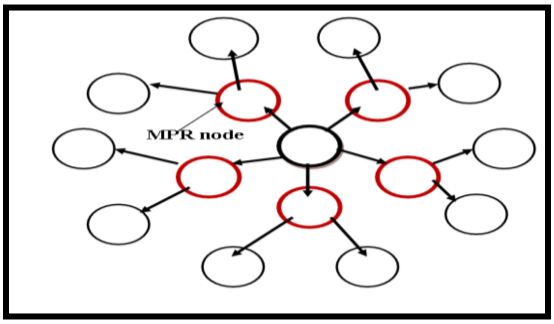

Figure 3 OLSR Network

Hello messages are used to build the neighborhood of a node and to discover the nodes that are within the vicinity of the node [9]. These messages are also used to compute the multipoint relays of a node [10]. Topology Control (TC) message contains the MPR selector set information of a particular node. These TC messages are broadcast periodically within the TC interval to other MPRs, which can further relay the information to their MPRs. MID message contains the list of all IP addresses, used by any node in the network. OLSR does not require central administrative system to handle its routing process.

2.3. Hybrid Protocols

Hybrid protocols includes the features of both reactive and proactive routing protocols [6].These protocols are suitable for large scale networks and overcome the drawback of both reactive and hybrid routing protocols. Examples:

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

2.3.1. Geographic Routing Protocol (GRP). GRP was the first hybrid routing protocol and combines the both reactive and proactive routing approach. GRP partitions the complete networks into small routing zones consisting of its k-neighborhood (e.g.-3). It is consisting of two sub routing protocols: IntrA-zone Routing Protocol (IARP) and IntEr-zone Routing Protocol (IERP) [2]. IARP is a proactive approach and used within routing zones to maintain up-to-date routing tables of zones. IERP is a reactive approach and used for area beyond the zones to discover a global routes. If the source and destination is in the same zone then source uses a route from proactively cached routing table that is maintained by IARP. If the destination is outside of the zone then route is reactively discovered by IERP [8]. In route discovery, the source node broadcasts a route request packet to its peripheral nodes or border nodes, including its own address, destination address and a unique sequence number. Route request packets are sent to peripheral nodes by using the Bordercast Resolution Protocol (BRP). After receiving the request packet, peripheral nodes check their local zone.

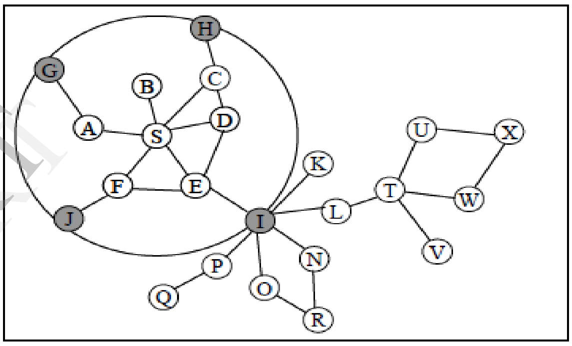

Figure 4 Routing Zone of S
Internal nodes **Peripheral nodes**

If the destination is of outside the local zone, peripheral node forwards packet to its peripheral nodes. If local zone containing a destination node then it send route reply back to source. New neighbor nodes and link failures are discovered by Neighbor Discovery Protocol (NDP). In figure 4, the node S wants to broadcast a packet to node X and the zone radius is r=*2*. The nodes from A to J belong to the routing zone of S, but not other nodes. The nodes G to J are peripheral nodes.

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. Different scenarios have been created with and without Time to Live (TTL) parameter and Fragmentation in which 40 nodes have been kept in network. Wireless server, application configuration, profile configuration and workstations (nodes) are used during the design of the network. Two applications HD Video Conferencing and High Load File Transfer Protocol (FTP) have been taken to transmit the data in network. HD Video Conferencing is peer to peer and File Transfer Protocol (FTP) is client server application. Figure 5 shows the simulation environment of scenario containing 40 mobile nodes. In this methodology, we have fragmented the packets into smaller fragments and applied the Time-to-Live constraint on the routes. If the TTL value is very less, valid routes likely to be discarded prematurely and if the TTL value is more, then invalid routes are likely to be used and network becomes congested. The optimized TTL value has been taken to control the congestion. Every protocol has different parameters for TTL. If there is no activity in any route within time to live period, then route will be expired. Fragmentation has been also applied on packets. If the packet size is larger than fragmentation threshold and, i.e. the data packets will be fragmented and in without fragmentation, data packets have not been fragmented, there are chances of buffer overflow at the receiver side, due to which receiver is not receiving all the data packets.

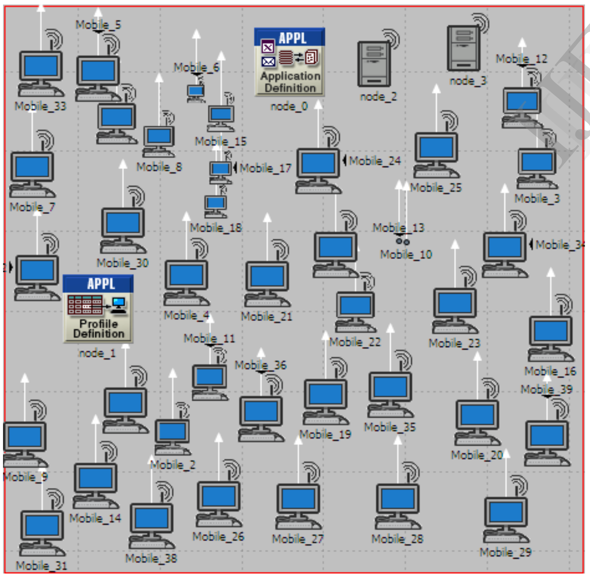

Figure 5 Network Scenario having 40 nodes

Simulation has been performed for all the scenarios i.e. with Fragmentation and TTL and without them and results have been calculated. Three different protocols AODV (Reactive), OLSR (Proactive), GRP (Hybrid) are being used to analyze the performance. Metrics like network throughput, media access delay, retransmission attempts and data dropped have been used to perform simulation. The parameters that have been used in the scenarios are summarized in Table 1.

In Proposed work, standard node model is modified to design new node model to improve the overall performance of network. The new node model that has been designed can perform function like a standard node model, which is capable of modifying the route of

Table 1Parameters for Simulation

ATTRIBUTE	VALUES
Model Family	MANET
Network Scale	Office
Date Rate(bps)	54 Mbps
Nodes	40
Operational Mode	802.11b
Buffer Size	102400000
Fragmentation Threshold(Bytes)	1024 Bytes
Simulation Time	300 Seconds
Routing Protocols	AODV/OLSR/GRP

data packets that could be routed to a different server from the initially scheduled server, when the initially scheduled server become overloaded, such that the load on the server increases from its threshold. The new node model is designed in way so that there is less chances of buffer overflow and less data dropped. It controls the excess network traffic and makes the more reliable delivery. The performances of AODV, OLSR and GRP protocols in the presence of fragmentation and Time to live (TTL) have been calculated by using various performance evaluation metrics.

3.2. Performance Metrics

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

- **Throughput**

Throughput is the average rate of successful packet delivery over the period of time. It is denoted in bits per second or packets per second.

- **Media Access Delay (sec)**

Media Access Delay is the amount of time it takes to transmit a packet from source node to destination node. It is measured in seconds.

- **Retransmission Attempts (packets)**

Total number of retransmission attempts made in the network until either packet is successfully transmitted or gets acknowledged.

- **Data Dropped (Retry Threshold Exceeded) (bits/sec)**

Total data packets dropped by in the network as a result of failing retransmissions. Data is dropped when load on server exceeds the threshold.

4. Results and Analysis

The results comparison of standard and new node model using four different metrics is shown in these given figures.

4.1. Data Dropped

Figure 6 depicts the data dropped of AODV, OLSR and GRP protocols using standard node model under two types of scenarios with and without fragmentation and TTL.

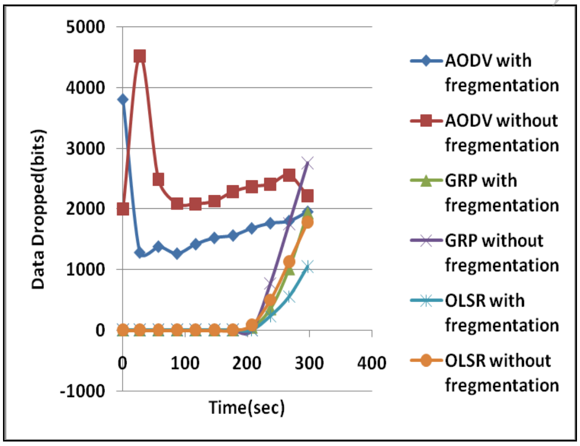

Figure 6 Data Dropped

In this graph, it has shown that for AODV with fragmentation and TTL, the data dropped has been decreased by 28.44 %. In case of fragmentation, if the packet size is large than threshold i.e. the data packets have been fragmented, there are chances of data drop has been decreased. By using optimal TTL, data dropped has been decreased because packets have not been dropped due to invalid routes. Similarly, for OLSR with fragmentation and TTL the data dropped is decreased by 47.78 % and for GRP with fragmentation and TTL the data dropped is decreased by 37.10 %.

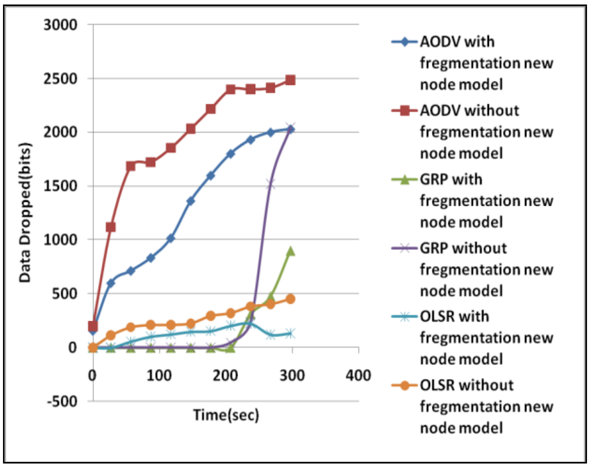

Figure 7 Data Dropped new node model

In the scenarios using new node model, the nodes are routed to other server on achieving the threshold of a server that cause in the less buffer overflow and less data dropped. In Figure 7, it has shown that AODV with fragmentation and without TTL for new node model have been decreased by 27.88 % and 24.38 % respectively because of new node model is designed in way that results less congestion due to fewer buffers overflow. For the new node model network configured by using OLSR and GRP protocols, the data dropped due to the fragmentation and optimized TTL value has decreased by 30.97 % and 49.27 % respectively. The data dropped for the network without fragmentation and configured by using OLSR and GRP has decreased by 20.23 % and 27.30 % respectively.

4.2. Media Access Delay

Figure 8 shows the Media access delay of AODV, OLSR and GRP protocols by using standard node model. In this graph, Media access delay for AODV with fragmentation and TTL has been increased by 75.74 %. Here delay is increased in case of fragmentation but still receiver will be able to receive all the fragmented packets successfully. When the network is configured by using OLSR and GRP protocols and fragmentation and TTL has applied on that then the media access delay has increased by 23.96 % and 25.94 % respectively.

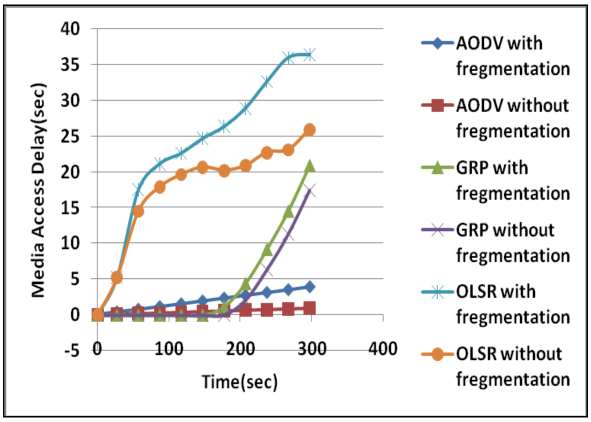

Figure 8 Media Access Delay

Figure 9 shows the network using new node model, AODV with and without fragmentation and TTL the media access has decreased by 46.21 % and 28.98 % than using standard node model. Because of the less congestion the media access delay has been decreased in new node model. For OLSR with fragmentation and TTL the media access delay has decreased by 46.45 % and for GRP using new node model the media access delay has decreased by 11.52 %. The media access delay for the network without fragmentation and configured by using OLSR and GRP has decreased by 50.27 % and 31.62 % respectively.

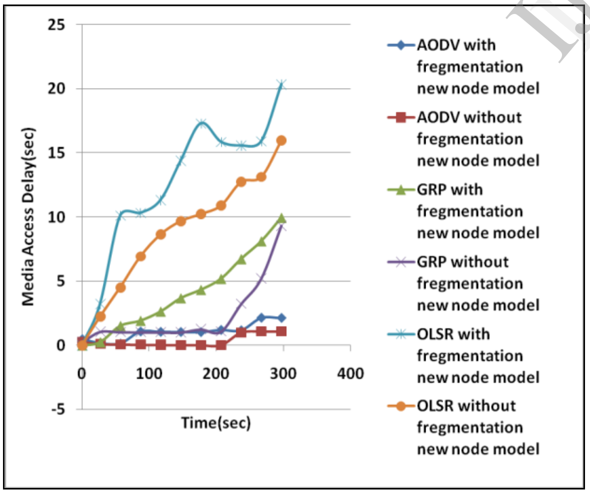

Figure 9 Media access delay new node model

4.3. Retransmission Attempts

Figure 10 depicts the retransmission attempts of AODV, OLSR and GRP protocols using standard node model under two types of scenarios with and without fragmentation and TTL. In this graph, it has shown that for AODV with fragmentation and TTL, the retransmission attempts have been decreased by 34.47 %. Similarly, for OLSR with fragmentation and TTL the retransmission attempts are decreased by 22.24 % and for GRP with fragmentation and TTL the retransmission attempts are decreased by 37.45 %.

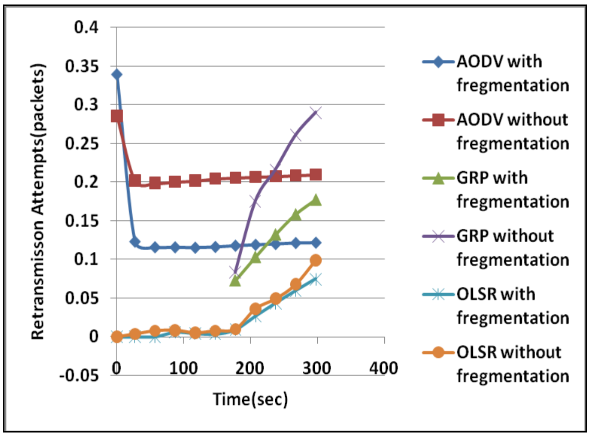

Figure 10 Retransmission Attempts

Figure 11 shows the retransmission attempts using new node model. AODV with and without fragmentation and TTL the retransmission attempts has decreased by 38.27 % and 36.84 % than using standard node model.

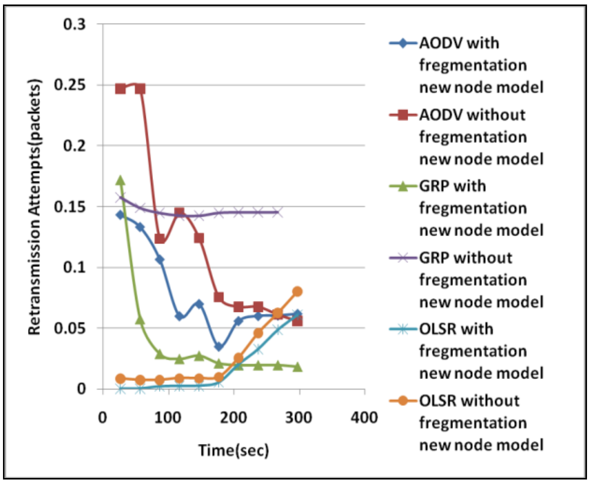

Figure 11 Retransmission Attempts new node model

When the fragmentation and TTL has been applied on the networks configured by using OLSR protocol the retransmission attempts has decreased by 30.94 % and for the GRP with fragmentation the retransmission attempts has decreased by 68.29 %. For the network without fragmentation and using OLSR protocol the decrement in the retransmission attempts is of 10.09 % and for the network of new node model configured by using GRP protocol the decrement in retransmission attempts is of 51.25 %.

4.4. Throughput

Figure 12 depicts the throughput of AODV protocol with fragmentation and TTL has increased by 39.21 %. The performance of the network could be improved if the optimized values of TTL for each route and fragmentation size to fragment the large packets be chosen. Similarly, when the fragmentation on packets and TTL constraint on routes has applied on the network then the throughput of OLSR protocol has increased by 36.32 %. For the network configured by using GRP protocol the throughput has increased by 49.19 %.

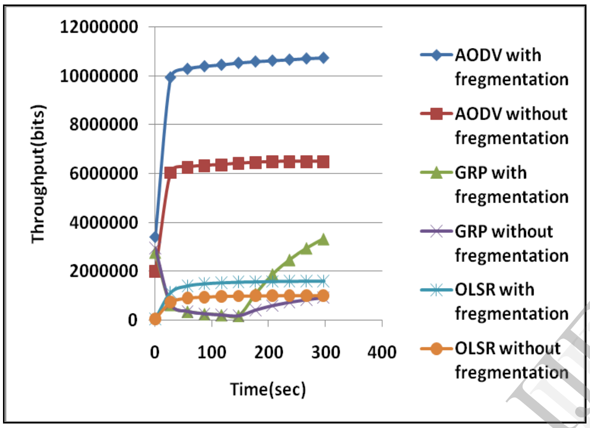

Figure 12 Throughput

Figure 13 shows throughput using new node model. The increment in throughput has seen for the AODV with and without fragmentation and TTL networks, such that the throughput has increased by 26.09 % and 20.35 % respectively. The increment of throughput of OLSR protocol using fragmentation is of 54.16 % and the throughput has increased by 23.77 % for GRP protocol. For the new node model based network of OLSR without using fragmentation, the throughput has increased by 49.41 % and for the network configured by using GRP protocol, the throughput has increased by 20.57 %.

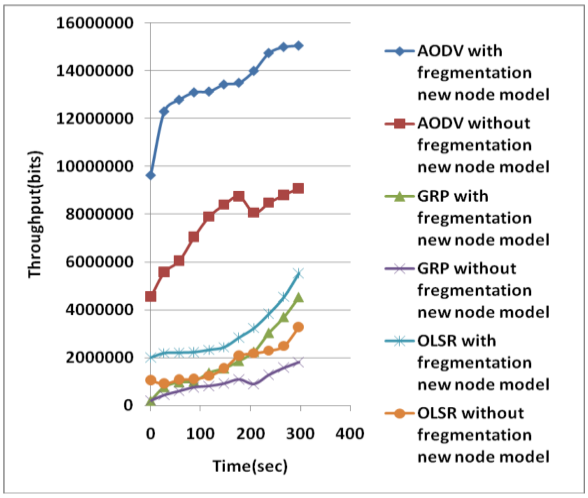

Figure 13 Throughput new node model

5. Conclusions and Future Scope

In this work, different scenarios have been developed in order to evaluate the performance of AODV, OLSR and GRP protocols using OPNET modeler. The network performance is analyzed in terms of throughput, retransmission attempts and media access delay and data dropped. To evaluate the results from scenarios, HD video conferencing and High load FTP traffic has been transmitted between nodes. Simulation results show that the performance of the network could be improved if the optimized values of TTL for each routes and fragmentation size to fragment the large packets be chosen. If the value of TTL is high then the congestion occurs in the network and if the value of TTL is very less then packets in the network would lost. The data packets using fragmentation and routes using TTL in the network performs better and giving higher throughput. In modified approach, standard node model has been changed to new node model that results less data dropped and less chances of buffer overflow. The results of the simulation indicate that performance of AODV, OLSR and GRP protocols is improved using new node model.

There is always a scope to improve the concluded results by calculating the optimized values of the fragmentation size and TTL and other parameters that are required for the configuration of the network. Performance can also be analyzed for other parameters like network load and routing overhead. Further simulations could also be done using another simulator. There are number of routing protocols available for the mobile ad-hoc networks and simulation could be done for any other protocol.

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