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Impact of Random Waypoint Mobility on Reactive routing Protocols of Scalable Mobile Ad hoc Network

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Abstract: Mobile ad hoc networks are the self-configuring network, in which, there is no centralized access point. The mobile nodes itself act as the routers for one another. MANET is basically a wireless ad hoc network with the routing capability. Scalability and Mobility have measure impact on the behavior of ad hoc routing protocols. Before deploying these protocols on the network, we must observe their performance under various circumstances. Simulation is a very effective and efficient technique for measuring their behavior in this decentralized infrastructure less network. This paper focuses on the characteristic measure of reactive routing protocols (DSR, AODV, DYMO, IERP and LAR1) for different criteria on application layer and transport layer of Internet .We compare the behavior of these protocols with the increasing number of nodes using Random Waypoint Mobility Model and taking pause time as the main criterion. Traffic load is constant and network load is varying in this analysis.

Keywords: Ad hoc networks, QualNet, Simulation, Routing protocols, Pause time, Random Waypoint mobility.

Introduction

The ad hoc routing protocols have different criteria and methodology. So, these protocols are deployed according to the need of communication. It is not feasible to deploy the network with any protocol and test it. If the network fails to fulfill the criteria after deployment, it is very costly to redesign it using another protocol. Hence it is a need to compare the protocols' behavior prior to its use and this is done by simulation. In simulation, we have an artificial, but exact environment of the real network. Here, we are comparing different reactive routing protocols. As performance comparison is essential to analyze their behavior and effectiveness [6], we can find out the most effective protocol using simulation.

In this research, we concentrated mainly on reactive routing protocol. Qualitatively, reactive protocols are preferred over proactive routing protocols [1] [10]. The main issue is to find various ways to improve the runtime performance of these protocols. The path is established when needed, which reduces overhead of regular updating of the table. But it reduces the throughput of these protocols. In reactive routing, we do not maintain regular table for several routes from source to destination. The source node sends route request packet (RREQ) to its neighbors and all neighbors again broadcast the message to their neighbors and next again do the same and in this way the route is find out and the reply packet (RREP) is sent back to the source following the same path that of RREQ packet [2].
In the remaining part of this paper, we have described each section in the following manner. The various types of protocols used in our research is given in section 2. In section 3, we describe the mobility models and in section 4, we describe the simulation setup and its environment and next to it, in section 5, we discuss over the expected result of our simulation and describe the actual outcome of it. However, in section 6, we conclude our research with some future scope of this research.

Protocols Specifications

In our paper, we are discussing about the reactive protocols. The various reactive protocols are as follows:

A. Dynamic Source Routing

In DSR route is established by flooding the route request messages. Each node maintains a route cache in which the recent routes are being cached [1] [3]. Whenever there is a need of a route, and if the route is in cache, it is returned immediately without the need of moving up to the destination. In this routing, source determines exact sequence of nodes through which packet is propagated. This mechanism of "Route Discovery" and "Route Maintenance" are the major components of DSR

[4] [5]. It eliminates the periodic update feature of DSDV and other Proactive routing protocols. DSR allows the senders to select and control the route.

B. Ad- Hoc On-Demand Distance Vector

AODV is the protocol which includes the best features of DSR, on demand routing mechanism of route discovery and route maintenance and of DSDV, hop by hop routing sequencing number and periodic updating of packets. When a route is demanded and if it is not available, a route request (RREQ) message is generated and flooded in a limited way to its neighbors [5]. Initial delay is caused to transmit the packet to the selected nodes but it controls the traffic. Once the RREQ is reached to its destination or to the node, which has the path up to the route in its cache, the route is found [1] [4]. After establishing the connection, message is sent to the destination. AODV is highly adaptive to the dynamic networks and also are very scalable to the large network [7].

C. Dynamic MANET on-Demand

DYMO routing protocol is very recently proposed protocol which is basically an AODV protocol but removes unnecessary Route Reply, RREP packets. It enjoys the "Path accumulation" property of DSR and simplifies AODV by removing the precursor lists and Hello messages. Hence it includes multihop routing property of proactive along with the reactive approach. It has two basic operation "route discovery" and "route management". In discovering the route, RREQ is flooded throughout the network to find out the target node. After receiving the RREQ, target responds by sending the RREP packets towards the source. The transmission of packets is in hop-by-hop fashion. When the source receives the RREP, then the connection is established between the source and the target node. While maintaining a route, a Route ERROR packet, RERR, containing the list of unreachable nodes is broadcasted. It indicates that the route is broken. The receiving node checks in its cache that if the listed node is there or not. If yes, the entry is invalidated and if not, the RERR is broadcasted again. By using sequence numbers, DYMO also enjoys the loop free routing.

D. Inter zone Routing Protocol

IERP is the reactive approach of the zone based routing technique of hybrid protocol. In hybrid routing, nodes have predefined path up to some level but after crossing that level, it has to find its route only when demanded. IERP is the protocol responsible for finding the paths which are not within that level means that routing zone. It broadcasts using unicast routing to send the packet to the boundary and then to the peripherals of the current zone. If a route is found by any node, then it replies it. Otherwise the request is transmitted to the further peripheral zones.

E. Location Aided Routing

LAR1 uses the location information of the mobile nodes. Locations can be categorized into two parts, expected zone and request zone. According to the previous position of the node, some zones are defined as the expected zone of the node. The RREQ is only sent to that expected zone. The zone which includes the expected zone and the surrounding is known as request zone. Hence the RREQ is only flooded in the request zone and so, it reduces very large traffic overhead. Once the destination node receives the RREQ, it replies with its position, speed and the current time.

Mobility Model-Random Waypoint Mobility Model

To evaluate the performance evaluation of a protocol for an ad hoc network, the protocol should be tested under realistic conditions but not limited to transmission range, limited buffer space, data traffic models and realistic movement of mobile users (mobility models). In order to thoroughly simulate a protocol for an ad hoc network, an accurate mobility model is a must [9]. Mobility model is mainly subdivided into three models: File Mobility Model, Random Waypoint Mobility Model and Group Mobility Model. In random waypoint mobility model, nodes move randomly and independent of each other. It includes pause time between changes in direction and speed [11]. The mobile hosts begin by staying in one location for a certain period of time i.e. a pause time. After completion of this pause time, the host moves towards the chosen waypoint at some selected speed [3][11]. Then again it waits for a constant pause time to begin its movement towards new waypoint. This process always continues in the network. Here, Pause time is the time period for which the nodes in the mobile ad hoc network do not move anywhere. So, if the nodes are always moving; their neighbors will change too frequently to make a session for transmitting the packets. It is also possible that even after making the route, the nodes move out of range of its neighbors, hence breaking the route. Then the source node has to reinitiate the whole routing process again. In this paper, we propose the simulation based upon Random Waypoint mobility model with the pause of 10 seconds in a scalable network.

Simulation Setup and Performance Metrics

In our research, we are evaluating the performance of the different reactive routing protocols on ad hoc network. So, main agenda of this simulation is to analyze the behavior of these protocols on ad hoc environment. We have used a very scalable and portable simulation tool, QualNet 5.0, for this simulation [8]. The terrain used is of 1500*1500 areas. Moreover number of routers varies from 10, 20 and 30… up to 120 nodes. The mobility model used is Random Waypoint mobility model. In addition, pause time taken is of 10 seconds. The data is sent at constant bit rate with the throughput of 4274 bits per second. Moreover total number of packets sent is 24 and total number of bytes sent is 12288.Energy model used is mica motes and battery model is linear. In Figure 1, a scenario with 120 nodes is shown in design mode. The nodes were randomly distributed in 1500 X 1500 unit area.

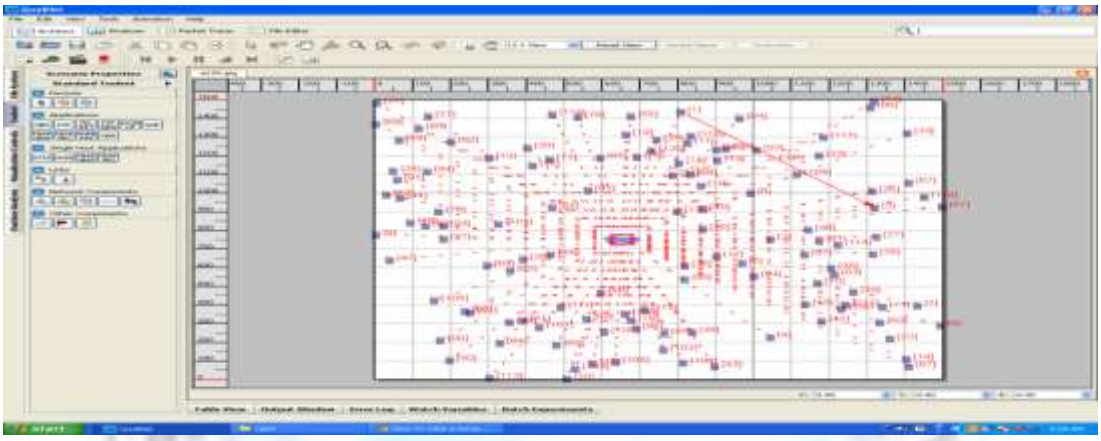

Figure 1. Design scenario of 120 nodes

In Figure 2, scenario with 60 node is shown in simulation mode. The simulation was run for 30 seconds. The reactive routing protocols taken were AODV, DSR, DYMO, IERP, LAR1 and a comparison of the following parameters have been done:

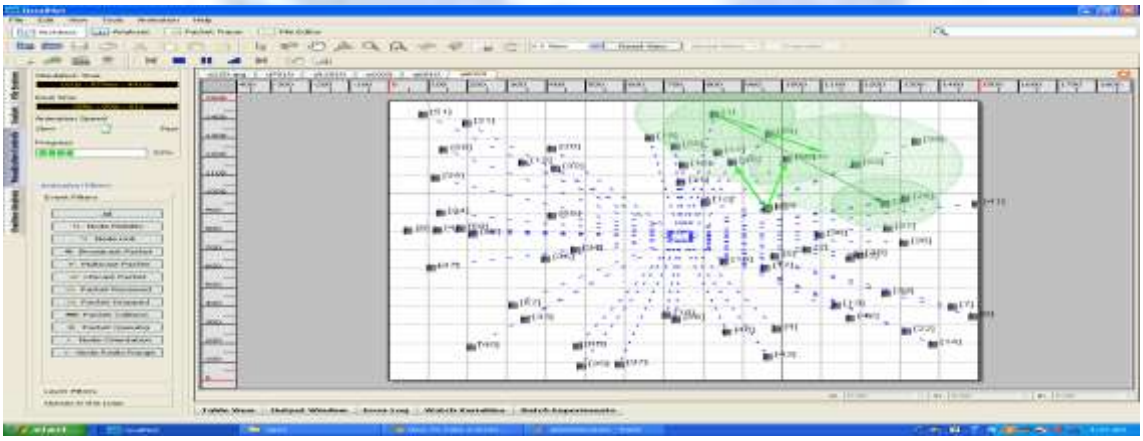

Figure 2. Design scenario in simulation mode

Results and Discussions

This section includes the simulation and its results. The parameters' values are investigated by varying the load. Number of iteration for each experiment is 10.The protocol which posses the constant and best behavior, that is taken as the best protocol for that parameter. First of all application layer parameters are discussed.

A. Average Jitter: As shown by the figure 3, in reactive protocols, DSR has very consistent performance. Hence the delay in between the packets is less and so average jitter is least in this.

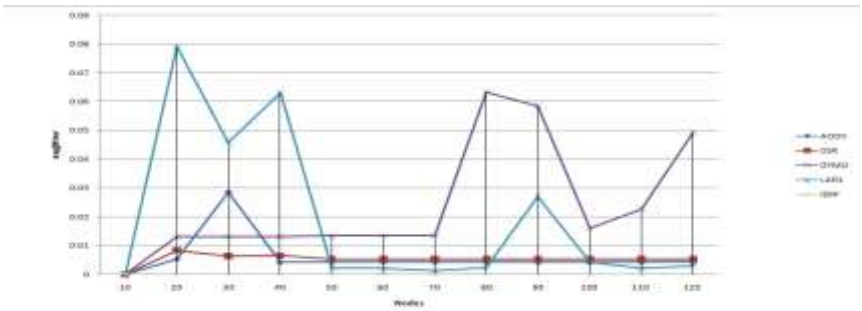

Figure 3. Average Jitter

B. First Packet Received: Figure 4 tells that 1st packet is first received by those networks which are using LAR1. Hence LAR1 responds to the transmission quickest. DSR is also very quick. But in LAR1 we have an additional advantage that LAR1 uses location information of the nodes. But, DSR is best because it is consistent with smaller delay in first packet receiving.

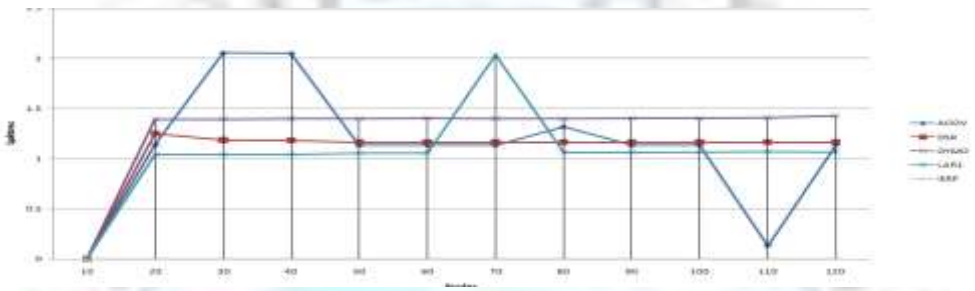

Figure 4: First Packet received

C. Total bytes and packets sent: In Figure 5 and 6, we can see that networks using DSR receives the maximum bytes and packets. Hence the least number of packets are lost in this case. So, it's the most reliable protocol amongst reactive routing protocols. After DSR, AODV is the most reliable protocol. LAR1 is the least reliable one as it loses many packets.

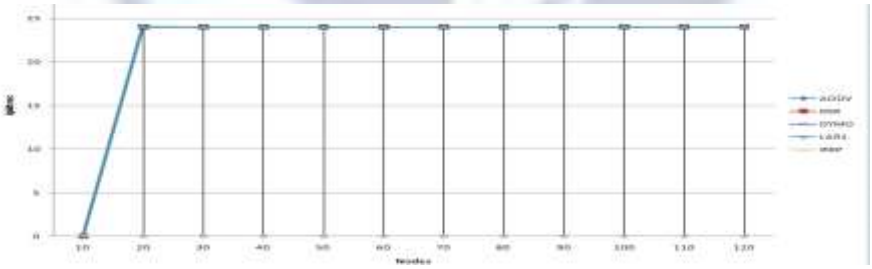

Figure 5: Total bytes sent

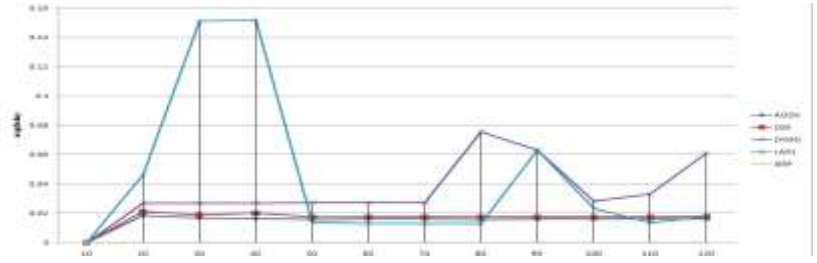

Figure 6: Total Packets sent

D. Last Packet Received: The study shows that last packet is received almost in same time by all the protocols. By investigating closely, DYMO is the fastest protocol among all reactive protocols. This is illustrated in figure7.

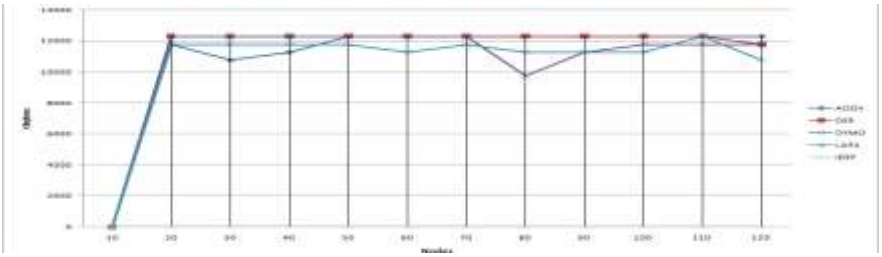

Figure 7. Last packet received

E. Average end to end delay: Figure 8 shows that minimum average end to end delay is incurred by AODV in almost all cases. It is because AODV possess lower setup delay for connections and detection of latest route to the destination.

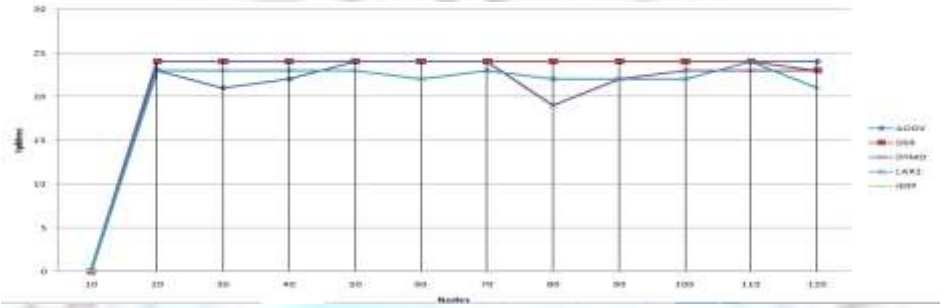

Figure 8. Average End to End delay

F. Packets from and to the application: Now for transport layer protocol: In fig.9, we have a graph of behavior of protocols on the parameter, packet from application. In reactive routing protocol, all applications send same number of packets to the network. But in fig. 10, which is for packet to application, we can see that packets received by the applications are not same. Furthermore discussing about the best among all and that is DSR.

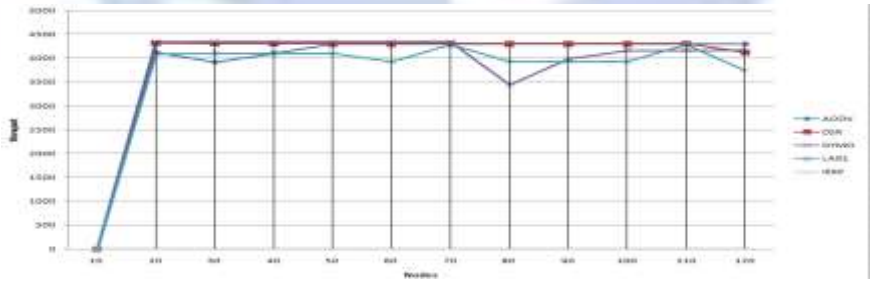

Figure 9. Packets from application

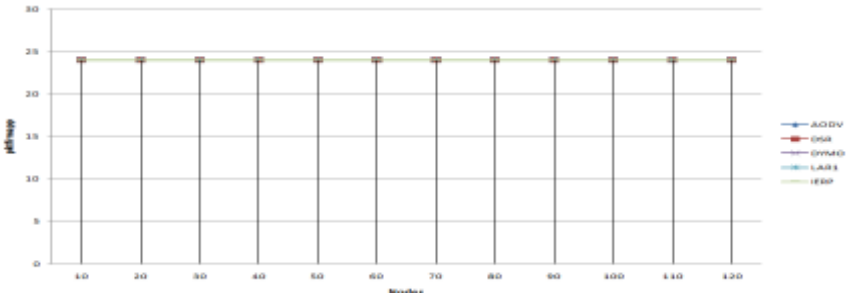

Figure 10. Packet to application

Conclusion and future work

In this paper, we have investigated the reactive routing protocol and analyzed the best protocol for each criterion. In future, we can expand this research on proactive as well as hybrid protocols. Also we can find out the best protocol among proactive, reactive and hybrid protocols. DSR is the best protocol and showing consistently good performance. The average end to end delay of DSR is higher than AODV.It means both can send maximum data in minimum time. So these are the most feasible protocol. DYMO is also performing well when the load is less. But as we increase the number of nodes in the network, a decline in the graph of DYMO is clearly visible.

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