Performance Evaluation of MANET Routing Protocol by Varying Mobility and Traffic (CBR, VBR and TCP) Using an Optimized Scalable Simulation Model

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ABSTRACT
Mobile ad hoc networks (MANETs) are one of the fastest growing areas of research according to today’s scenario. They are an attractive technology for many applications, such as free and planned operations, due to the flexibility provided by their dynamic structure. In the current study we have compared the performance of three MANET protocols AODV as reactive, OLSR and TORA as proactive using random walk model. All these protocols share some similar features, but the protocols internal structure direct to considerable performance difference. We have analysed the performance of protocols by varying network mobility and type of traffic (CBR, VBR and TCP). A detailed simulation has been carried out in OPNET. The metrics used for performance analysis are Network load, jitter and MOS. According to this research the Random Way Point mobility model for most of the MANET routing protocols give better performance than Random Walk Mobility Model.

Keywords- MANET, Routing Protocols, Traffics, Mobility Models, Performance Metrics.

1. INTRODUCTION
Mobile Ad-hoc Network is defined by some wireless nodes communicating each other without having any central point to control their function. Such a network is helpful in defining communication between different nodes that may not be in outside wireless transmission range. Similar wireless networks have valuable applications in a huge range of areas such as health and military systems.

If we talk about MANET, as the Some MANETs [1] are constrained to a local area of wireless devices (such as a group of computers), while others may be connected to the Internet. Basically, Mobile Ad hoc Network (MANET) is a collection of independent mobile nodes that can communicate to each other. The mobile nodes that are in radio range of each other should be directly coordinated, whereas others need the aid of intermediate nodes to route their packets. These types’ networks are totally distributed, and should work at any place without the help of any structure. This feature makes these networks highly better and vigorous.
2.1 Ad-Hoc on Demand Distance Vector (AODV)

Reactive protocols seek to establish routes on demand. If a node wants to start communication with a node to which it has no route, the routing protocol will try to set up such a route. The philosophy in AODV [2], as we know that all reactive protocols transmitted by nodes on-demand. When a node wants to transmit traffic to a host to which it has no route, it will generate a route request (RREQ) message that will be flooded in a limited way to other nodes. This control traffic overhead to be dynamic and it will result in an initial point to delay when starting such communication. A route is well throughout defined when the RREQ message should be at their destination, then an intermediate node with a valid route entry for the destination. Say we have nodes likes A, B, C and D defining a MANET as exemplify in figure 3. A is not modified on the base of its route to D through C is ruined. This means that A has a qualified route, with a dimension of 2, to D. C has qualified that the link to D is below, so when node B is modified on the link breakage between C and D, then it will calculate the shortest path to D to be through A using a dimension of 3. C gets information that B can reach to D in 3 hops and updates its dimensions to 4 hops. Then, A registers an update in hop-count for their route to D through C and updates the dimension to 5. So, they continue to increment the metric in a loop.

This is avoided in AODV according to way like is by B noticing that As route to D is old based on a sequence number. Then B will discard the route and C will be the node with the most recent routing information by which B will modified their routing table. So, AODV defines three types of control messages for route maintenance:

RREQ - A route request message is only transmitted by a node having a route to a node. As we already know that an optimization AODV uses an expanding ring technique when flooding these types of messages. Every RREQ holds a time to live (TTL) value that states for how many hops this message should be forwarded. This value is define to a predefined value at the initial transmission and incremented at re transmissions, The Re transmissions occur if no reply is received.

RREP - A route response message is uni-cast back to the starting point of a RREQ, if the receiver either using the node requested tackle, or it has a valid route to the requested tackle. The reason only one can uni-cast the message back to originator, So, that every route forwarding a RREQ a route back to the originator.

RERR - The nodes examine the link status of next hops in active routes. When a link breakage in an active route is recognized, a RERR message is used to alert other nodes of the loss of the link. In order to enable this mechanism, each node keeps a “preceptor list”, having the IP address for each their neighbors that they are very likely to use it as a next hop to each destination.

2.2 Optimized Link State Routing (OLSR)

The OLSR [3] is a modular proactive hop by hop routing protocol. It provides the new path of destination bases of table driven approach. It is an optimization of weak link state algorithm in ad hoc network. The routes are always immediately available when needed according to their proactive nature. The main concept of the protocol is to use of “multipoint relays” (MPR). Every node selects a set of their neighbour nodes as MPR. Only nodes, selected as such MPRs are responsible for developing and forwarding topology information, planned for circulation into the whole network. So, This MPR selector is obtained from HELLO packets sending between the neighbor nodes. These routes are made before any source node be determined to send a message to a specified destination in order to exchange the topological information the Topology Control (TC) message is broadcasted to the entire network. the Nodes in the network send HELLO messages to its neighbours. These messages are sent at a predefined interval in OLSR to define the link state. Here we can understand by this Figure 5.
Say, if node A and node B are neighbours, node A sends HELLO message to B node. If B node receives this message so, we can say the link is asymmetric in nature. If B node sends the same HELLO message to A node then this is the same as first case, called asymmetric link. Now if it is possible to define the two way communication is possible then we can call it symmetric link, as shown in above Fig. The HELLO messages contain all the neighbor information. This enables the mobile node to have a table in which it has information about all its multiple hop neighbors.

2.3 Temporally Ordered Routing Algorithm (TORA)

Basically, TORA is a routing algorithm. It is basically used in MANETs to increase scalability. This is an adaptive routing protocol. It is used in multi-hop networks. In this two nodes are defined that are a destination node and a source node that should be set. TORA developing balanced routes between the source and the destination by using the Directed Acyclic Graph (DAG) built in the destination node. TORA does not use ‘shortest path’ concept, it is defined secondary. TORA defined optimized routes using four types of messages. This initiate with a Query message followed by an Update message after that clear message and Optimizations message. This operation is basically performed through each node to send various parameters between the source and destination node. The parameters include time to break the link (t), the originator id (oid), Reflection indication bit (r), frequency sequence (d) and the nodes id (i). The first three parameters are called the reference level and last two are offset for the respective reference level. The Links built in TORA are referred to as ‘heights’, and the flow is from high to low. At the starting, the height of all the nodes is defined as NULL (---,---,i) and that destination is set to (0,0,0,0,dest). The heights adjusted whenever there is any modification in the topology. When a node wants a route to a destination sends a query message with their route required flag. A query packet has a node id of the required destination. When a query packet reaches a node with information about the destination node, a response known as an Update is sent on the reverse path. The update message sets the height value of the neighboring nodes to the node sending the update. It also defines a destination field that shows the required destination.

See in Figure 6, node A is the source and node H is the destination. Node A should broadcasts a query message across the network. When the query reaches a node with information about the destination, this node sends back an update. In this case, node D and node G are one hop away from the destination. Therefore, they will propagate Updates as shown in Figure 7.

3. TRAFFICS IN MANET

In MANETs, several factors influences the performance of the routing protocols that are selected to use across the MANETs, and these factors include security level employed across the network, maintenance of the route, configuration of router, various types of applications supported by MANETs and different kinds of traffic that are sent throughout the network. MANET supports different types of traffic and the most important and frequently used traffics are TCP, VBR and CBR traffics here VBR means Variable bit rate and CBR means Constant bit rate. The traffic type selected across the routing procedure will influence the routing protocol performance. The performance of the routing protocol is also based on the nodes selected in the MANETs generally two types of nodes can be used in MANETs and they are mobile nodes and fixed nodes. MANETs are basically dynamic in nature and so it supports a large variety of applications and the most important and most commonly used applications of MANETs are FTP, video conferencing, VOIP, Email, voice and web applications. The characteristic of the traffic sent across the MANET is decided by the selected type of application. The application selected is also used to influence the performance of the routing protocol similarly the selected traffic type also influence the performance of routing protocol that may be reactive or proactive that is used throughout the MANET. The issues related to these MANETs are discussed in many existing studies and researches which also includes the comparison of performance of routing protocols in various aspects which are done mostly among the selected routing protocols when compared to the selected kind if traffic.

4. MOBILITY MODELS

In MANETs, mobile nodes roam around the network area. Mobility models are designed to evaluate the performance of ad-hoc networks and characterize the movements of real mobile node in which variation in speed and direction must occur during regular time interval. Therefore, many researchers attempted to design approximate mobility models to resemble real node movements in MANETs such as follows:
4.1 Random way point mobility model

In this model, the position of each MN is randomly chosen within a fixed area and then moves to the selected position in linear form with random speed. This movement has to stop with a certain period called pause time before starting the next movement. The pause time is determined by model initialization and its speed is uniformly distributed between [Min Speed, Max Speed].

The Random Waypoint Mobility Model is the most widely used mobility model. Many researchers use it to compare the performance of various mobile ad hoc network routing protocols. When the node reaches the selected destination, it halts again for pause-time, selects another destination and starts to move towards the new destination. This process is repeated for the duration of the simulation. In [6], it has been shown that the average speed of a mobile node decays with time. This is because of the fact that low speed nodes spend more time to reach their destinations than high speed nodes. It is also shown that increasing the speed of nodes results in increased network connectivity. Another reason for the popularity of the Random Waypoint mobility model is that NS2 and GloMoSim have it built in.

4.2 Random walk mobility model

In this mobility model mobile host moves from current location to new location by choosing randomly direction and speed from the predefined ranges between min speed and max speed. Since many entities move in unpredictable ways, the Random Walk Mobility Model was developed to mimic this erratic movement [1]. In this kind of mobility model, a mobile node randomly chooses a direction and speed to move from its current location to a new location. The speed and direction are chosen from predefined ranges, [minimum speed, maximum speed] and [0, 2] respectively. If a mobile node reaches a simulation boundary, it bounces off the simulation border with an angle determined by the incoming direction. The node then continues along this new path. Several varieties of the model have been developed such as the 1-D, 2-D, 3-D, and n-D walks. Because the Earth’s surface is usually modelled using a 2-D representation, the 2-D Random Walk Mobility Model is of special interest. The Random Walk Mobility Model is widely used [1], and it is a memory-less mobility pattern because it does not have any knowledge concerning its past locations and speed values. The current direction and speed of the node are independent of its past direction and speed [5]. This model may generate unrealistic movements such as sudden stops and sharp turns.

5. SIMULATION SETUP & RESULT ANALYSIS

5.1 Simulation Setup

We have created 12 scenarios in total. 6 scenarios for 50 nodes with Random Way Point mobility Model and 6 scenarios for 100 nodes with Random Walk Mobility Model. Here, we present 6 out of 12 simulation diagrams.
5.1.1 **Performance Metrics**

The following metrics are used in varying scenarios to evaluate the different protocols:

- **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.

- **Jitter:** Jitter describes the degree of variability in packet arrivals, which can be caused by network congestion (bursts of data traffic), timing drift or because of route changes. Jitter is the delay variance from point to point.

- **MOS:** In voice communication, quality usually dictates whether the experience is a good or bad one. Besides the qualitative description we hear like 'quite good' or 'very bad', there is a numerical method of expressing voice quality. It is called Mean Opinion Score (MOS). MOS gives a numerical indication of the perceived quality of the media received after being transmitted.

5.2 **Result Analysis**

Figures 13,14,15,16,17,18,19,20,21,22,23,24 give the comparative analysis for network load for three different protocols viz. AODV, OLSR, TORA with two mobility models i.e. Random Way Point and Random Walk Mobility Figures Model.
Table 2 Comparison table

<table>
<thead>
<tr>
<th>Jitter</th>
<th>AODV RW</th>
<th>AODV RWP</th>
<th>OLSR RW</th>
<th>OLSR RWP</th>
<th>TORA RW</th>
<th>TORA RWP</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 Nodes</td>
<td>0.1</td>
<td>0.01</td>
<td>0.19</td>
<td>0.08</td>
<td>0.15</td>
<td>0.07</td>
</tr>
<tr>
<td>100 Nodes</td>
<td>0.08</td>
<td>0.07</td>
<td>0.35</td>
<td>0.27</td>
<td>0.03</td>
<td>0.09</td>
</tr>
</tbody>
</table>

Table 3 Comparison table

<table>
<thead>
<tr>
<th>MOS</th>
<th>AODV RW</th>
<th>AODV RWP</th>
<th>OLSR RW</th>
<th>OLSR RWP</th>
<th>TORA RW</th>
<th>TORA RWP</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 Nodes</td>
<td>1.2</td>
<td>1.4</td>
<td>1.2</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
</tr>
<tr>
<td>100 Nodes</td>
<td>1.3</td>
<td>1.3</td>
<td>1.2</td>
<td>1.2</td>
<td>1.1</td>
<td>1.1</td>
</tr>
</tbody>
</table>
6. CONCLUSION & FUTURE WORK

We have evaluated the three performance measures i.e. Network Load, Jitter and MOS with different mobility models (Random Walk model and Random Waypoint Mobility model) and TCP, CBR and VBR as traffic type while taking 50 and 100 density of nodes. From the wide range of simulation results, it is found that OLSR produce the best performance in terms of network load. Moreover, Random Way Point Model outperforms Random Walk Model for all three routing protocols i.e. AODV, OLSR and TORA in terms of Network Load, Jitter and MOS. However, the variations in delay are higher for OLSR than rest two. Random Way Point mobility model for most of the MANET routing protocols give better performance than Random Walk Mobility Model. In future, the node density can be varied to study its impact on the performance of the routing protocols and thus check their efficiency as the nodes increase. Doing so would bring out the contrast between the two mobility models and thus help in making reaching accurate conclusions.

REFERENCES


