Impact of Mobility Models with Different Scalability of Networks on MANET Routing Protocols

Santosh Kumar, S.C.Sharma, Bhupendra Suman

Abstract. MANET routing protocols performance is perceptive to mobility and scalability of network. The performance of any routing protocol depends on the duration of interconnection among the nodes in the networks. This interconnections results an average connected path for whole network. This paper evaluates, the impact of three mobility models i.e. File mobility model , Random Waypoint and Group mobility model on a proactive uniform routing protocol (FSR) and a proactive non-uniform routing protocols (LANMAR, OLSR).The simulation based analysis are carried out with constant traffic load of varying network size and TDMA is considered at MAC layer.

Keywords: Mobility model, TDMA, Routing Protocol-FSR, LANMAR, OLSR.

1 INTRODUCTION

A mobile ad hoc network (MANET), sometimes called a mobile mesh network, is a self-configuring network of mobile devices connected by wireless links [1, 2]. Self connectivity and easy deployment of MANETs makes it apt for emergency, surveillance situations and rescue operations. It is usually referred to a decentralized autonomous system. Mobile nodes engaged in MANET often work as client/servers. Mobile nodes incorporate laptop, mobile phone, MP3 player, home computer or personal digital assistance etc. MANET routing protocols performance is perceptive to mobility, scalability of network. The performance of any routing protocol depends on the duration of interconnection among the nodes in the networks for transferring the data. This interconnections results a average connected path for whole network. The nodes mobility affects the number of average path as well as the performance of the routing protocols.

The objective of this paper to observe how the routing protocols perform at application layer with different network size (scalability) and different mobility scenario in mobile ad-hoc network environment with consideration of TDMA protocol at MAC layer.

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The performance analysis of a proactive uniform routing i.e. Fisheye State Routing (FSR) with flat network architecture and a proactive non-uniform i.e. LANMAR, Optimized Link State Routing protocol (OLSR) are carried out under consideration of three mobility model i.e. File mobility model, Random Way Point and Group mobility model with constant traffic load & different network size (scalability).

The rest paper is organized as, section 2 gives the description of MAC layer specification with TDMA protocol and routing protocols, section 3descibes about the taken mobility model in this paper, section 4 defines the simulation plan and results analysis which is used to carried out for analysis, section 5 concludes the paper work and future direction.

2 OVERVIEW OF MAC LAYER AND ROUTING PROTOCOLS

2.1 TDMA Protocol specification

Time Division Multiple Access (TDMA) is a multiplexing protocol that splits the channel into distinct time slots for different transmitters. Each line of the TDMA scheduling file specifies the state of each node (transmitting, receiving, or idle) in one slot. Each line in the TDMA scheduling file has the following format:

<slot-ID> <node-ID-1>-----<mode-1>-----<node-ID-n>---<mode-n> where

<slot-ID> Slot identification number.

<Node-ID-i> Node ID for ith or the string “All”.

<mode-*i*> Mode of the ith node. This can be “Rx” (if the node is in receiving mode in the slot) or “Tx” (if the node is in transmitting mode in t he

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slot). If <node-ID-*i*> is "All", then <mode-*i*> applies to all nodes.

The parameters values are based on their corresponding request for comment (RFC) as shown in table 1

Table 1 MAC layer Specification with TDMA

S. No	Property	Value
1	MAC Protocol	TDMA
2	Slot Duration	10milli second
3	Inter-frame time	1 micro- second
4	Slot per frame	30
5	MAC propagation Delay	1 micro- second

2.2Uniform routing protocol

In this paper, a proactive uniform routing behaviour i.e. Fisheye State Routing (FSR) is considered. FSR is a link state type protocol that maintains a topology map at each node. It differs from the standard link state algorithm in the following:

- Having only neighboring nodes exchange the link state information.
- Utilizing only time-triggered, not event-triggered link state exchanges.
- Using different exchange intervals for nearby versus far away nodes.

FSR uses a hierarchical or layered, routing scheme. The "fisheye" technique was developed [3] to reduce the size of the information needed for data representation. This routing scheme is representative of how the eye of a fish operates. Near the focal point, the eye of the fish is able to capture very high detail, but as the distance from the focal point increases, the detail captured by the eye decreases. In fisheye routing, this technique is applied to distance and path information. Near the focal point, accurate distance and path quality information is maintained in higher detail. As distance from the focal point increases, less routing detail is maintained.

2.3Non-Uniform Routing Protocol

A proactive non-uniform routing behaviour i.e. LANMAR and OLSR are considered in the paper. These are a core node based routing protocols.

2.3.1 Landmark Ad Hoc Routing (LANMAR)

Landmark Ad Hoc Routing (LANMAR) protocol utilizes the concept of landmark for scalable routing in large, mobile, ad hoc networks. LANMAR uses Fisheye as the local scope routing protocol. Landmark Ad Hoc Routing Protocol [4] is designed for an ad hoc network that exhibits group mobility. Namely, one can identify logical subnets in which the members have a commonality of interests and are likely to move as a group (e.g., a brigade or tank battalion in the battlefield). LANMAR uses an IP like address consisting of a group ID (or subnet ID) and a host ID, i.e.< GroupID,HostID >. The notion of landmarks is used to keep track of such logical groups. Each logical group has one dynamically elected node serving as a "landmark". A global distance vector mechanism propagates the routing information about all the landmarks in the entire network. Further, LANMAR works in symbiosis with a local scope routing scheme. The local routing scheme can use the flat proactive protocols mentioned previously (e.g., FSR). FSR maintains detailed routing information for nodes within a given scope. As a result, each node has detailed topology information about nodes within its local scope and has a distance and routing vector to all landmarks. When a node needs to relay a packet to a destination within its scope, it uses the FSR routing tables directly. Otherwise, the packet will be routed towards the landmark corresponding to the destination's logical subnet, which is read from the logical address carried in the packet header. When the packet arrives within the scope of the destination, it is routed using local tables possibly, without going through the landmark. LANMAR reduces both routing table size and control overhead effectively through the truncated local routing table. In general, by adopting different local routing schemes LANMAR provides a flexible routing framework for scalable routing.

2.3.2 Optimized Link State Routing (OLSR)

The Optimized Link State Routing (OLSR) protocol, developed by the French National Institute for Research in Computer Science and Control (INRIA), was developed for mobile ad-hoc networks. It operates in a table-driven and proactive manner, i.e., topology information is exchanged between the nodes on periodic basis. Its main objective is to minimize the control traffic by selecting a small number of nodes, known as Multi Point Relays (MPR) for flooding topological information [5]. In route calculation, these MPR nodes are used to form an optimal route from a given node to any destination in the network. This routing protocol is particularly suited for a large and dense network. OLSR generally proposes four types of periodic control messages, namely:

- Hello messages
- Topology Control (TC) messages
- Multiple Interface Declaration (MID) messages, and
- Host and Network Association (HNA) messages.

3 Mobility Models

This paper describes the three mobility model i.e. File mobility model, Random Waypoint mobility model and Group mobility model.

3.1File mobility model

The File-based mobility model uses waypoints for each node specified by the user in a node position file. Each waypoint is a specification of a node's location and (optionally) orientation and the time at which the node arrives at that location. The node moves from one waypoint to the next in a straight line at a constant speed. Each line in the node position file has the following format:

< node-ID > <time> <position> Where
<node-ID> Node identifier
< Time > Simulation time for which the position is specified.
For the initial node position, this should be 'zero'.
<Position > Node position

The node position is specified as the coordinates in Cartesian or Lat-Lon-Alt optionally followed the orientation (azimuth and elevation).Specifying node Orientation is optional and is assumed to be (0.0.0.0) when not specified.

3.2 Random Waypoint Mobility model

The random waypoint mobility model was first introduced by Broch et al [6]. It is very popular model in modern research and can be considered as a foundation of building other mobility model. It includes pause times between changes in direction and speed [7].A mobile node stay in one location for certain period of pause time. In original model mobile node are distributed randomly in the simulation area between speed [Vmin, Vmax]. After reaching at waypoint , the node wait again a constant pause time and do it again choose next waypoint. This process repeated after choosing pause time from interval [Pmin, Pmax] [7].

3.3 Group Mobility Model

Group mobility model is for simulating the group movement behaviors in the real world, such as a group of travelers, etc [8]. The members of the same group tend to have similar movement tracks. However, inside the group, members also have relative mobility. To depict such behaviors, the mobility vector of a node can be considered as the sum of two mobility vectors. One is called the group mobility vector, which is shared by all members of the same group. The other is called the internal mobility vector, which represents the relative mobility of a node inside the group. The vector sum of the two mobility vectors decides the mobility of the node. The movements of a node are also limited by the group boundary.

4 Simulation Plan

A detailed simulation model based on QualNet 5.0 is used in the evaluation. TDMA is used as a MAC layer protocol with the consideration of Phy layer- radio type 802.11b radio, Packet reception model- PHY 802.11b reception model,Antenna model- Omnidirctinal model,Path Loss Model- two ray, shadwoing model-constant,Temperature-290.0 k,Noise factor -10(db) and channel frequency of 2.4Ghz for File mobility model , Random waypoint mobility model and also for group mobility model. The simulations are carried out a network size of 20,40,60,80 and 100 nodes, terrian size of 1500m x1500m with CBR traffic of 512 bytes of packet size has been considered because it appropriately represents the constant rate vocoder voice service and simulations are run for 300 seconds.

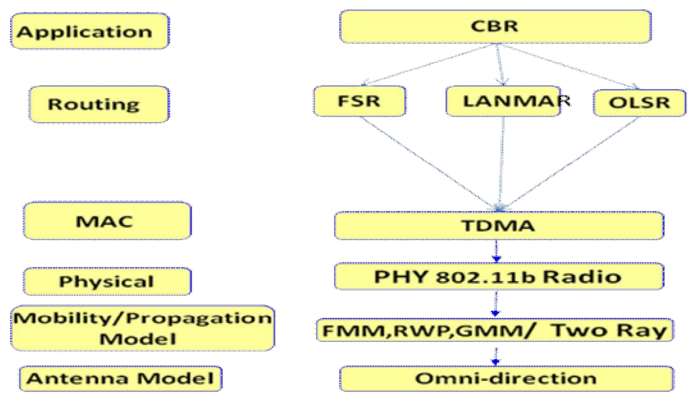

Figure 1 Simulation Plan

In this paper , for the variable network size the specification of mobility models parameters and its values are shown in table 2. In group mobility models the nodes are organized into 5 different groups (0-4groups) each group has equal no. of nodes. Group-0 is static, Group-1 is a fast moving group with speed between 40 m/s to 60 m/s, Group 2 having speed between 20m/s to 40m/s, Group-3 having speed between 10 m/s to 20 m/s and Group-4 is a slow-moving group with speed between 1 m/s to 10 m/s.

Table 2 Mobility models specification

S.No.	Mobility Model	Parameter	Value
1	File mobility model	Position Granularity (meters)	1.0
2	Random waypoint model	Pause time	20 seconds
		Min speed	0 mps
		Max speed	10 mps
		Position Granularity (meters)	1.0
3	Group mobility model	No. of Group (0-4)	5
		Group 0	Static
		Group 1	40 m/s to 60 m/s

		Group 2	20m/s to 40m/s
		Group 3	10 m/s to 20 m/s
		Group 4	1 m/s to 10 m/s

4.1Simulation Results

The representative uniform, proactive routing protocols i.e. FSR and non- uniform, core node based, proactive i.e. LANMAR, OLSRv2NIIGATA are included with typical configuration parameters. The parameters values are based on their corresponding request for comment (RFC) as shown in table 3

Table 3Protocols parameters and RFC values

Protocol	Parameters	Value
FSR	Fisheye Scope	2 hops
	Intra scope update Interval	2s
	Inter scope update interval	4s
LANMAR	Min Member Threshold	8
	Landmark update interval	4s
	Landmark maximum age	12s
	Fisheye scope	2
	Fisheye update interval	2s
OLSR	Hello interval	2s
	Neighbour Hold Time	6s
	Topology Hold Time	15s
	Hello interval	2s

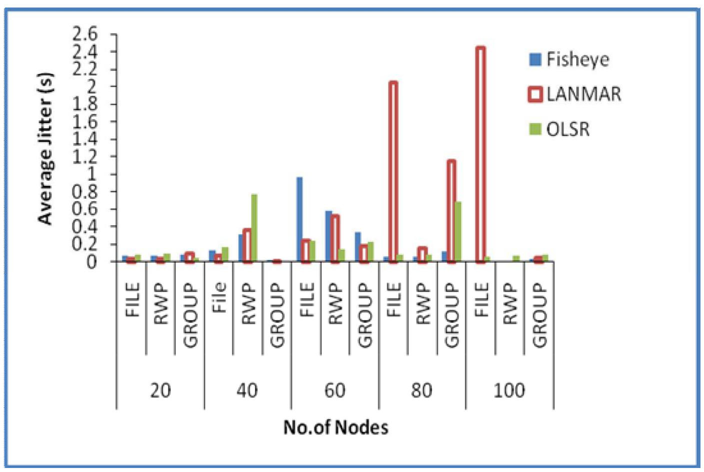

Figure 2 Average Jitter(s)

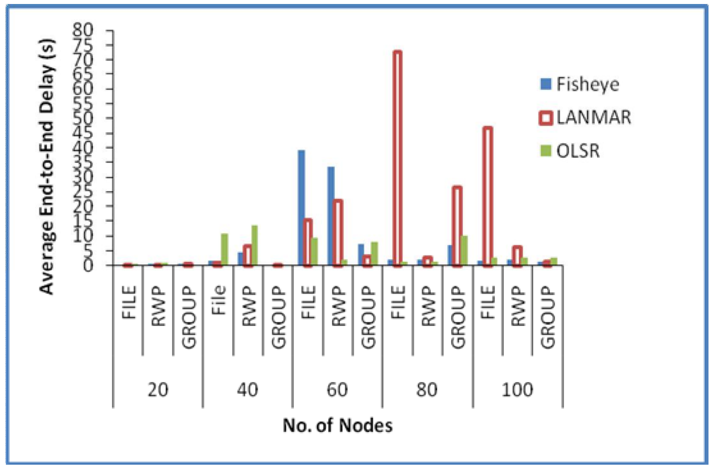

Figure 3 Average End-to-End Delay(s)

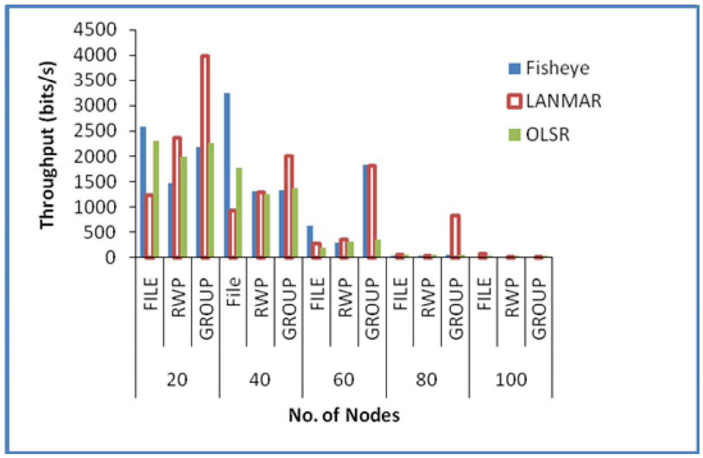

Figure 4 Throughput (bits/s)

The figure 2-4 evaluates the three QoS parameter i.e. average jitter, average end-to-end delay and throughput at application layer with network size of 20, 40, 60, 80 and 100 nodes with respect to the mobility models and its impacts are visualized in the above figure 2-4.

Fisheye: the Average jitter is very less in all three mobility models except 60 nodes size of network, it becomes high in file mobility but deceases in RWP and group mobility models. It gets to zero in both file and RWP when network size taken 100 nodes in simulation. It is because of the results shows that the average End –to –End delay is high in network size increases from 60 nodes to100 with respect to file and random waypoint model.

The results evaluates that the throughput achieved is good upto the small network size as the size of network increased the throughput decreases. It is observed in the simulation the performance of this protocol is good in group mobility in small size of group in dense environment.

LANMAR: The average jitter increases respectively as the network size increases in file mobility model but in RWP decreases in network size of 80 nodes and finally it gets zero at 100 nodes of network size. In group mobility model, it increases upto the network size of 80 node and falls again at network size of 100 nodes. The average End-to End delay is also high as the network size increases from 80 nodes to 100 nodes; it observed that it is more in file mobility model as compared to other two mobility models. When the network size is 20 nodes the throughput achieved in group mobility is very high as compared to others two mobility models as shown in figure 4.

OLSR: The average jitter is very less as compared to other routing protocol in all three mobility models it also happens in the case of average end-to-end delay followed with mobility model as well as other routing protocols. The throughput of OLSR decreases as the network size increases in this simulation work. It gets more when the size of network is 40 nodes in all taken mobility models.

5 Conclusions and Future Work

It is well known that the some of the application are very high sensitive, medium sensitive and low sensitive with the QoS parameter jitter and delay. Since all network introduce some jitter because of variability in delay introduced by each network size of nodes as packets are queued. Therefore the minimum number of jitter is acceptable but as the jitter increases, the application may be unusable. As literature [4] shows that LANMAR exhibits for group mobility model, simulation also signify this fact that the performance of LANMAR achieved best followed by FSR and OLSR in group mobility scenario as compared to other file mobility scenario as well as random scenario, having consideration of TDMA protocol at MAC layer. This work could be extended for the evaluation of above said protocols with different mobility models scenario, having consideration of dynamic TDMA protocol at MAC layer.

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