

# Energy efficient Optimized Link State Routing in Mobile Ad-hoc Networks using Manhattan Grid Mobility and Reference Point Group Mobility model

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**Abstract** - A Mobile Ad-hoc Network (MANET) is a self-configuring infrastructure less network of mobile devices connected by wireless links. In this paper using OSLR protocol were simulated using Manhattan Grid Mobility Model and Reference Point Group Mobility model. The reactive OSLR protocol's internal mechanism leads to considerable performance difference. The performance differentials are analysed using NS-2 which is the main network simulator, NAM (Network Animator), AWK (post processing script) and were compared in terms of energy consumed different environments specified by varying network load, mobility rate and number of nodes. Our results presented in this research work demonstrate the performance analysis of OSLR routing protocols. The nodes are battery operated and therefore energy is a scarce resource in MANET. Many routing algorithms are proposed in literature and evaluated under different scenarios. The Performance of MANETs not only depends upon the routing mechanism but also on mobility model chosen. Mobility model is used to represent the mobility of individual node and it plays a crucial role when evaluating the performance of routing protocols. The energy being limited is crucial for MANET operations. The aim of this research work is to study the impact of mobility model on the energy consumption in MANET routing protocols. The energy consumption under Manhattan and Reference Point Grid mobility Model is evaluated through simulation using NS2. The well-known OLSR protocol is taken as the candidate protocol for performing experiments under different scenarios. It has been observed that, under Manhattan Grid mobility model, OSLR performs better than RPGM model.

**Index Terms** - Mobile Ad-hoc Networks, Mobility Models, OSLR, MGM, RPGM, NS2.

## I. INTRODUCTION

Advances in wireless communications and small, lightweight, portable computing devices have made mobile computing possible. In coming years, information technology will be mainly based on wireless technology. One of the unique features of wireless networks compared to wired network is that data is transmitted from one point to another through wireless links i.e. there is no need of wired link between the two nodes for transmission. A Mobile Ad hoc Network (MANET) is autonomous, self-configuring network of mobile nodes that can be set up randomly and formed without the need of any existing network infrastructure or centralized administration. All nodes can be mobile resulting in a possibly dynamic network topology which is a real challenging issue in mobile ad hoc networks. The dynamic nature of MANET topology imposes the use of efficient routing protocols that ensure the delivery of packets safely to their destinations with acceptable delays. Network nodes just need to be in the transmission range of each other. But due to transmission limitations all the nodes may not be able to communicate with one another directly. Hence a multi-hop scenario occurs, and several nodes may need to relay a packet before it reaches to its final destination. MANETs are complex distributed systems consist of wireless links between the nodes and each node also works as a router to forwards the data on behalf of other nodes. Whenever a node is in the range of several base stations then it connect to any one of them on the bases of some criteria [1]. The nodes are free to join or left the network without any restriction. Thus the networks have no permanent infrastructure. Routing is an important process for the operations of MANETs [2]. A number of routing

protocols have been proposed in the literature. When any source node wants to send a packet to a destination, it broadcasts a route request (RREQ) packet. The neighboring nodes in turn broadcast the packet to their neighbors and the process continues until the packet reaches the destination. During the process of forwarding the route request, intermediate nodes record the address of the neighbor from which the first copy of the broadcast packet is received. This record is stored in their route tables, which helps for establishing a reverse path. If additional copies of the same RREQ are later received, these packets are discarded. The reply is sent using the reverse path for route maintenance.

## II. REVIEW OF WORK

A number of studies evaluating the performance of traditional ad hoc routing protocols like DSDV [4], DSR etc. under different mobility models are found in literature. Madhusudan Singh et al [5] has discussed some Mobility Models and their impact on various networks and routing parameters. They used discrete-event simulation language PARSEC for the following simulation and used AODV, DSR, and ZRP protocols for the experiments. Authors found that the topology and movement of the nodes in the simulation are key factors in the performance of the network protocols under study. May Zin Oo et al [6] evaluated and compared AODV and AOMDV protocols under Manhattan Grid mobility model. They used TCP as a source traffic and measured the performance in terms of throughput, packet loss rate, average delay, and normalized routing load by varying node speed, offered traffic load and node density. Authors found that as the number of nodes increases, maintaining multiple routes to destinations in the routing tables and bringing next hop routes in RREQ message significantly reduces routing load of AOMDV. On the other hand, the throughput of AOMDV is significantly higher than AODV in all background changes, whereas the average delay and packet loss rate of AOMDV is not good enough under the variations of the offered traffic loads. Doshi et al. [7] extended the DSR protocol to support energy efficient routing. A working path is first identified through a power-unaware route-discovering circle. Each node that is not on the identified working path sends a reply message to the source node if it would be power-

efficient by inserting itself onto the route. The source can then draw a partial view of network state by using information extracted from the received reply. Hrudya et al. [8] studied the impact of mobility on the performance of various routing protocols in terms of different parameters. Authors found that mobility greatly affects the performance of routing. Among the studied routing models, the RPGM model was found best

## III. OLSRAND MOBILITY MODELS

OLSR stands for Optimized Link State Routing Protocol. In this, each node periodically floods status of its links and also re-broadcasts link state information received from its neighbors. Each node keeps track of link state information received from other nodes and uses above information to determine next hop to each destination. It is proactive and table-driven. It uses Multipoint Relay (MPR) sets for routing. For each node, a set of its neighbor nodes that have symmetric links are selected as MPRs, which alone forward the control traffic. When a node is selected as multipoint relay, it announces this information in the control messages at periodic intervals. Using this, routes are formed from a given node to various destinations. Nodes that belong to MPR set cover all symmetric strict 2-hop neighbor nodes. In OLSR, HELLO messages and topology control messages are used. HELLO messages are transmitted at regular intervals and they are never forwarded. The HELLO messages help in link sensing, neighbor detection and MPR selection signaling. Link-state information of each and every node is transmitted to all other nodes in the network via the topology control messages.

To thoroughly and systematically study a new Mobile Ad hoc Network routing protocol, it is important to simulate the protocol and evaluate its performance. Among other parameters mobility is an important parameter for MANET's routing protocols evaluation.

### ▪ Manhattan Grid Mobility Model

An approach to restrict the movement area geographically is to use information from road maps. Manhattan model was introduced to emulate the movement pattern of mobile nodes on streets. It can be useful in modeling movement in an urban area [9].

The scenario, as shown in Figure. 3.1 [10], is composed of a number of horizontal and vertical streets. Nodes are modeled as pedestrians moving on

the vertices of the squares (streets). Initially the nodes are randomly distributed on the streets. Each node chooses a direction and a velocity. At an

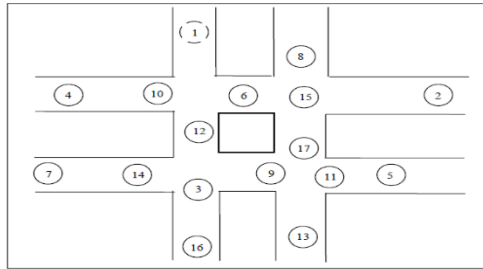


Figure 3.1 Movements of Nodes for Manhattan Mobility Model

Intersection of a horizontal and a vertical street, the mobile node can turn left, right or go straight with certain probability. If a node reaches a corner, the node changes direction with a certain probability. The velocity is changed over time.

• Reference Point Group Mobility Model

One approach to realizing spatial dependence is the use of reference points. The Reference-Point-Group-Mobility model (RPGM) [8] models the movement of groups of nodes. The movement of the groups is modeled according to an arbitrary mobility model. The movement of the nodes inside a group is realized using a reference point for each node as shown in Figure 3.2 [9]. The actual position of a node is a random movement vector added to the position of his reference point. The absolute positions of the reference points do change according to the arbitrary mobility model, but the relative positions of the reference points inside a group do not change. Hence, the spatial dependence is realized using the reference points.

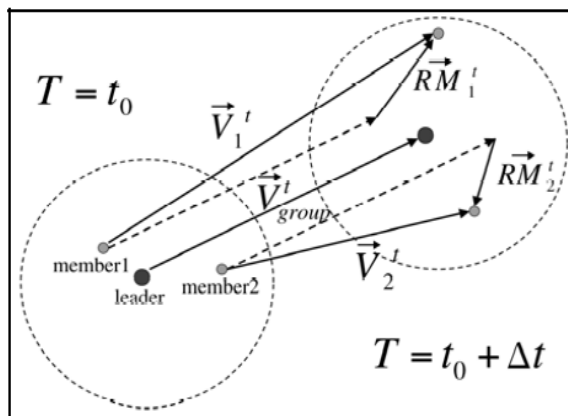


Figure 3.2: Node Movement in Reference Point Group Mobility Model.

IV. EXPERIMENTS RESULTS AND ANALYSIS

The routing protocols are evaluated using Network Simulator-2 (NS-2) [13] in its version 2.34. The network consists of varying nodes spread over an area of 1000m\*1000m with a constant in speed 20m/s the details is given Table 4.1. One more tool BonnMotion [14] is used to generate node movements for different mobility models.

TABLE 4.1 Simulation parameters

Protocol	OSLR	Pause Time	10 seconds
Mobility Model	Manhattan Grid, RPGM	Speed of Nodes	20 m/s
Queue Length	50	Antenna	Omni directional
Interface Queue	Drop Tail/Priori Queue	Simulation Area	1000m x 1000m
Traffic Type	CBR	Number of Nodes	10, 20, 30, 40, 50
Number of Connection	70% of the nodes	Initial Node Energy	1000 joules
Packet Rate	8 packets/second	Simulation Time	900 seconds

Following performance metrics have been used to analyze the energy utilization behavior of routing protocols.

- Transmission energy: It is the energy consumed by a network node in transmitting packets across the network. The total network energy utilized in transmitting different packets by the network nodes is calculated by taking the sum of transmission energy of individual nodes. Average transmission energy is defined by the equation (4.1).

$$\text{Average Transmission Energy} = \frac{\text{Total Transmission Energy}}{\text{Total number of nodes}} \quad (4.1)$$

- Receiving energy: It is the energy consumed by a network node in receiving different packets from other nodes. The total network energy consumption in receiving the packets is computed by taking the sum of energy consumed by individual nodes in receiving the packets from other nodes in the network. Average energy used in receiving is defined by the equation (4.2).

$$\text{Average Receiving Energy} = \frac{\text{Total Receiving Energy}}{\text{Total number of nodes}} \quad (4.2)$$

- Idle energy: The network nodes do not always transmit or receive; sometimes they just do nothing but still consume some energy. The total idle energy is the sum of the energy consumed by all the individual network nodes in idle state.

Average idle energy consumed is defined by the equation (4.3).

$$\text{Average Idle Energy} = \frac{\text{Total Idle Energy}}{\text{Total number of nodes}} \quad (4.3)$$

- **Remaining energy:** This is the energy left with the network nodes at the end of the simulation time. The total remaining energy is the sum of the remaining energies of all the individual network nodes. Larger remaining energy indicates longer the network lifetime. Average remaining energy is given by equation (4.4).

$$\text{Average Remaining Energy} = \frac{\text{Total Remaining Energy}}{\text{Total number of nodes}} \quad (4.4)$$

The routing protocols are simulated using NS-2 and results are obtained by varying number of nodes, speed (m/s), and transmission range. The performance metrics are average energy consumed, average remaining energy Figure 4.1, figure 4.2, figure 4.3 and figure 4.4 summarizes the Average consumed energy under two different mobility models. It can be observed that Average consumed energy on OSLR protocol for two models Manhattan mobility model best among the two mobility models studied in different scenario.

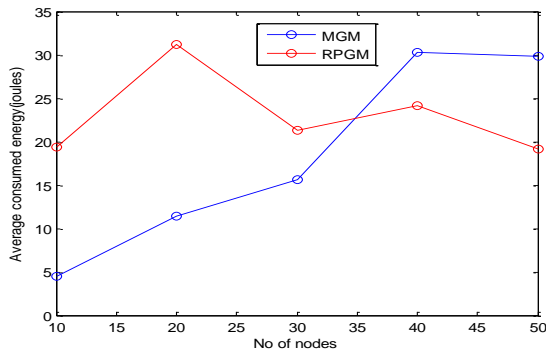


Figure 4.1 Energy consumption on transmission mode

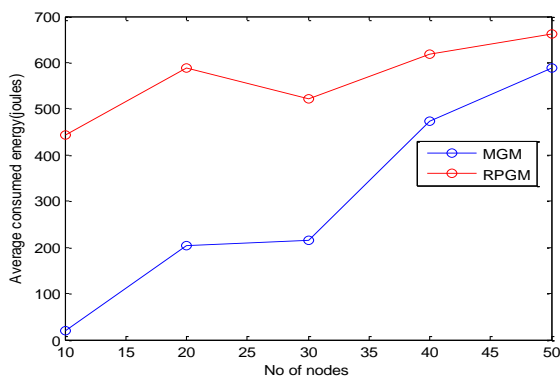


Figure 4.2 Energy Consumption in Receive Mode

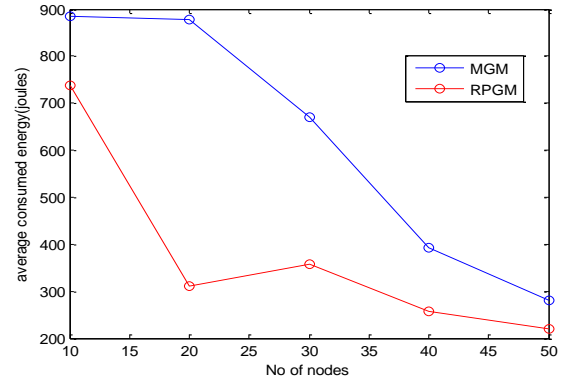


Figure 4.3 Energy Consumption in Idle Mode

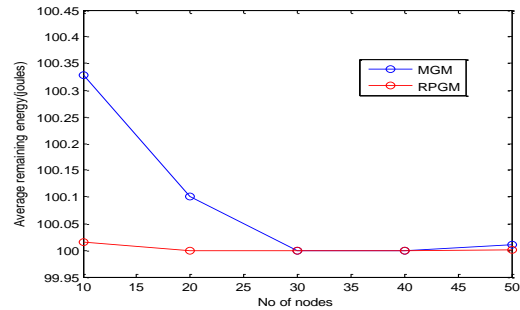


Figure: 4.4 Average Remaining Energy

## V. CONCLUSION

In this research work, the impact of mobility on the energy consumption of routing protocols in mobile ad hoc networks have been analysed through extensive simulation studies. The OSLR routing protocol have been evaluated over different mobility models MGM and RPGM model at varying node density. The network simulator NS-2 was used to simulate the mobile ad hoc network and Bonn motion tool was used to generate node movements for different mobility models. The results node movements for different mobility models.

The results were obtained for different modes of energy consumption by varying node density from 10 nodes to 50 nodes in a simulation area of 1000m×1000m. By analyzing the results obtained, the following conclusions are drawn:

- **Transmission Mode:** It is found that Manhattan grid is the most efficient model for this mode of operation. The RPGM is clearly best model when the number of node increases in the simulated scenario.
- **Receive Mode:** Like transmission mode, the Manhattan grid and RPGM model we show that

RPGM model are again the most efficient for receiving operation.

- Idle Mode: In idle mode the energy consumption of MGM and RPGM models we show that RPGM is most efficient while Manhattan grid is poorest model in the idle mode.
- Remaining Mode: In Remaining mode the RPGM model is the constant remaining energy.

Overall it is found that RPGM model best among the two mobility models studied. So it can be concluded that energy consumption is very much affected by the mobility model in use and Manhattan grid is the most efficient mobility model as far as energy consumption is concerned.

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