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Comparative Analysis of Group Mobility Models in MANETs based on Bird Flocking

T. Sudhakar[1] and H. Hannah Inbarani[2]

ABSTRACT

Mobile Ad hoc Networks are collection of mobile nodes forming an ad hoc network without any fixed centralized network. Actual problem of this network is rapid mobility *i.e.*, Mobile nodes are frequently changing their position. Node mobility is one of the major parameters that affect the performance of routing protocols. In order to avoid this problem, Bird Flocking group mobility is combined with popular existing mobility models and routing protocols. In this paper, three group mobility models and reactive routing protocols such as Ad hoc On Demand Vector (AODV) protocol, Dynamic Source Routing Protocol are compared. The results acquired through experiments in terms of performance metrics, such as packet delivery ratio, throughput and end to end delay, Bird flocking mobility gives better results when compared with existing mobility models are Column, Nomadic, Pursue and Reference Point Group Mobility model (RPGM).

Keywords: Bird Flocking, RPGM, DSR and AODV.

1. INTRODUCTION

An Ad hoc is a collection of mobile nodes without forming any existing infrastructure based network. In ad hoc network mobile nodes are connected with each other while infrastructure based network each device connected with some medium i. e cellular network. The main challenges in MANETs are mobility and routing problems. In mobility models used various type of models such as random way point model, Manhattan models etc. The main applications of ad hoc network used in rescue operations at the time of earthquake, flood. Each node [1] in MANET acts as a router to those forwarded data packets to other nodes.

In this paper, we give a comparative study of the bird flock model with three popular existing mobility models such as the Column, nomadic and pursue mobility models to analyze the effect of mobility models on the performance of routing protocols.

Remainder of this paper is described as follows. In Section 2 describes group mobility models, in which pursue, nomadic and column mobility models are discussed. In section 3 describes bird flocking model and its basic functionalities are cohesion, alignment and separation. Simulation results are discussed in section 4. In section 5 conclusion of this paper.

2. GROUP MOBILITY MODELS

Mobility models are described the mobile node movements and how their acceleration, location and velocity change over by time. In MANETs mobility plays a very significant role while moving from one location to another location with some mobility parameters. In this work mobility models are created with help of Bonnmotion Tool. Moreover, mobility models are classified into random models, temporal, spatial and Geographic models.

| Research Scholar, Dept. of Computer Science, Periyar University, Salem-11. *E-mail: sudhakarmecmca2013@gmail.com*

[2] Assistant Professor, Dept. of Computer Science, Periyar University, Salem-11. *E-mail: hhinba@gmail.com*

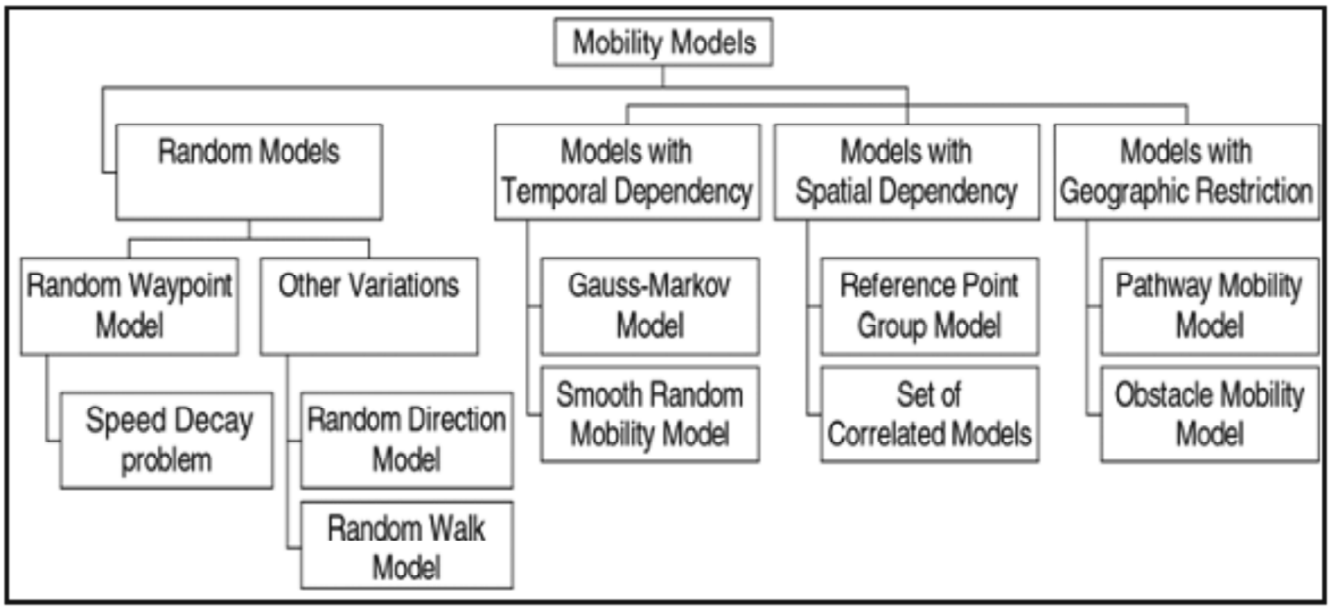

Figure 1: Categories of mobility models

In Figure 1, we provide a categorization for various mobility models into several classes based on their specific mobility characteristics. The above figure is not original to authors used from [2].

A. Column Mobility Model

The Column Mobility Model [3] represents a set of mobile nodes (*e.g.*, robots) that move in a certain fixed direction. In this mobility model movement can be done with help of old position and advance vector values such as x and y values.

$$\text{New point} = \text{old point} + \text{advance vector}$$

Where: $\text{advance vector} = (x, y)$

In Figure 2, provide node movements using column mobility models, the mobile nodes moving beyond the simulation area it is flipped into 180 degree. Then the mobile node moving center point of new destination point. The above figure is not original to authors used from [3].

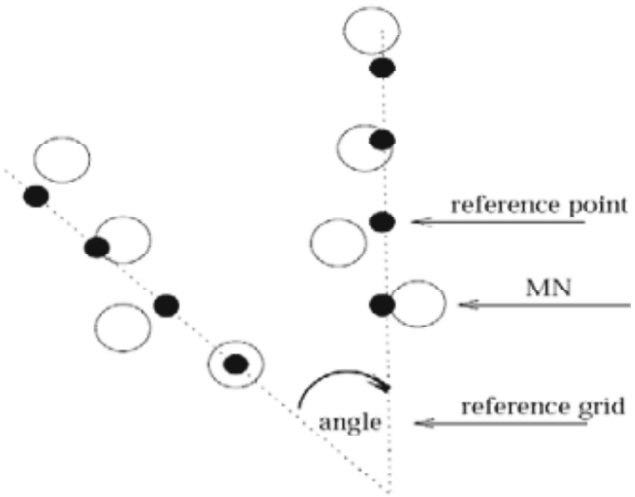

Figure 2: Node movements using column mobility model

B. Nomadic mobility Model

The Nomadic Mobility Model [3] represents the mobility scenarios where a group of nodes move together. In this model, shows group of mobile nodes moving one location to another location. Commonly this type of model implemented in conference or military applications. In Figure 3 shows a mobile node movement in nomadic mobility model.

Nomadic model compared with column model is grid type model such as rows and columns. The important constraint in nomadic model is share the same previous grid reference but in column model has its own reference grid point. Moreover, the mobile node movement in this model is very infrequent but in column is less constant mobility model in column model. The above figure is not original to authors adopted from [3].

C. Pursue mobility Model

The Pursue Mobility Model [3] emulates scenarios where several nodes attempt to capture single mobile node ahead. This mobility model performs like random waypoint model, randomly choose a target position and move from source in the simulation area. In figure 4 provides a group of mobile node movements in pursue mobility model

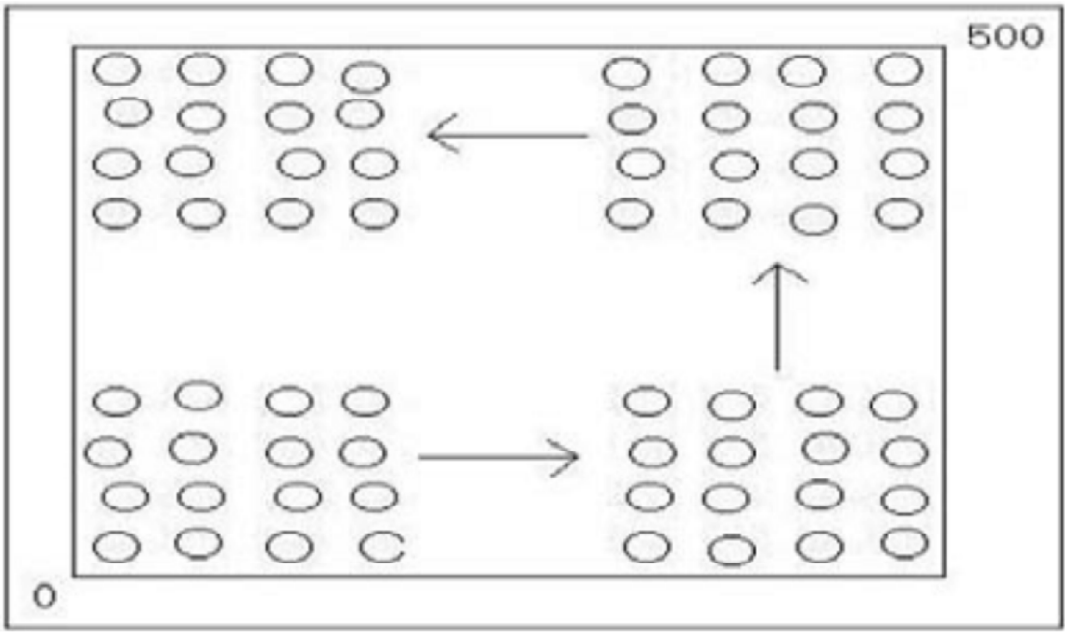

Figure 3: Node movements using Nomadic mobility model

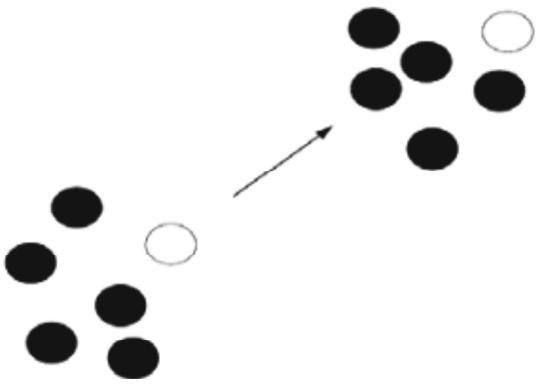

Figure 4: Node movements using pursue mobility model

3. BIRD FLOCKING GROUP MOBILITY MODEL

In this mobility model three simple rules are used for bird flocking which are alignment, cohesion and separation. The main drawback of mobility is speed-decay problem. Bio-inspired [4] approaches solve various problems in wireless ad hoc networks which have been gaining ground lately among researchers working in this area. Swarm intelligence [5] which is a type of artificial intelligence based on the collective behavior of decentralized, self-organized systems, has been an area of considerable research in the field of networking, as well as diverse fields such as, controlling unmanned aerial vehicles. Specifically, swarm intelligence techniques have been applied to solve routing problems [6] in ad hoc networks. An inspiration from a flock of birds, has observed similarities of ad hoc network operations with bird flying [7]. Some characteristics of bird flock, such as

1. Each group has a one leader which leads the group of birds with less energy and long distance capable to fly.
2. In this model, each mobile node used only local neighborhood information to express their node movement within the group.
3. Individual bird that not directs the movement of mobile nodes *i.e.*, birds. All the birds move in a directed manner.

A. Alignment

Each Bird steers itself to align its heading with that of its neighbors. The below image is not original to authors, adopted from Craig Reynolds' article [8].

B. Cohesion

Cohesion is a behavior that causes agents to steer towards the "center of mass" - that is, the average position of the agents within a certain radius. The above image is not original to authors, adopted from Craig Reynolds' article [8].

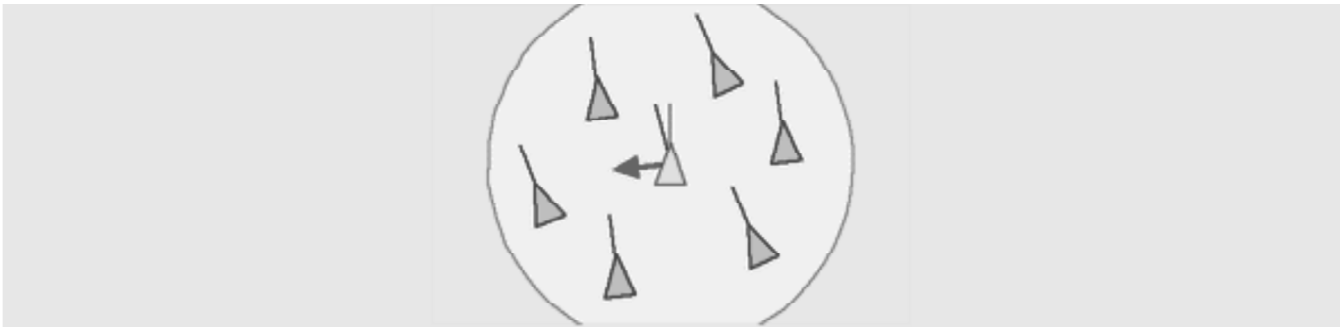

Figure 5: Alignment of mobile nodes

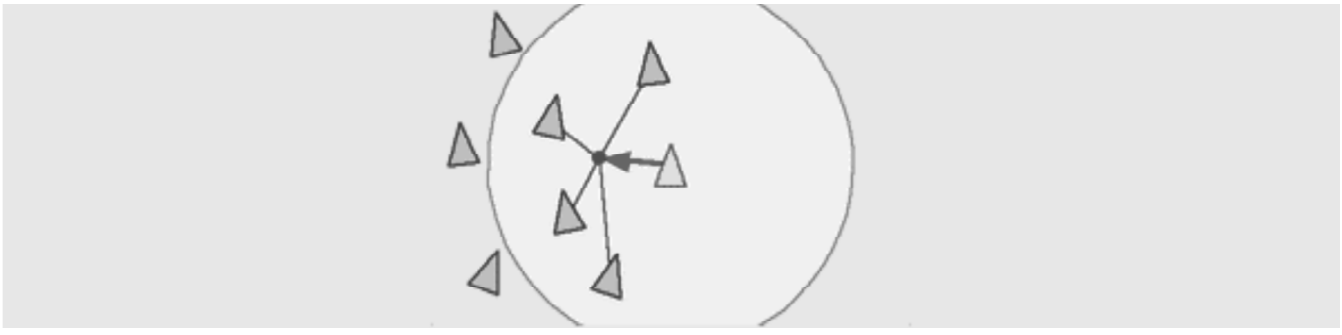

Figure 6: Cohesion of mobile nodes

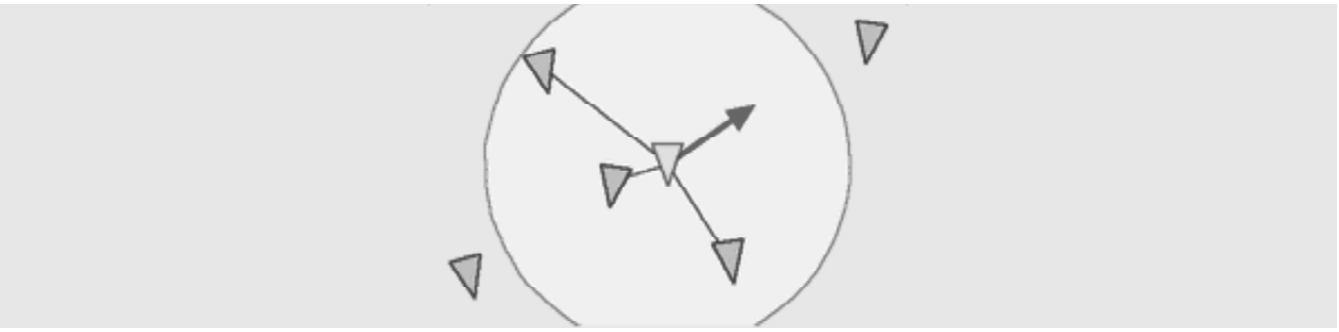

Figure 7: Separation of mobile nodes

C. Separation

Separation is the behavior that causes an agent to steer away from all of its neighbors. The below image is not original to authors, adopted from Craig Reynolds' article [8].

D. Algorithm

This algorithm is based on the work of Sudip Misra *et. al.* [4]

```
define node( )
    build number of node( );
    Define number of Groups( );
    Set initial Position( );
end define
    main( )
    node( );
    do
    for j = 1 to numgroups do
    select random destination();
    for i = 1 to numnodes do
    update( );
end main
define update( )
    Cohesion( );
    Alignment( );
    Separation( );
    update velocity( );
    update position( );
end define
```

4. EXPERIMENTAL RESULTS

In this section, we analyze bird flocking mobility model with respect to the mobility and connectivity distinctiveness and also compare the performance of the fundamental MANETs routing protocol, DSR and AODV, in terms of average throughput, average end to end delay and average packet delivery ratio for mobility scenarios generated by our Mobility model. These Metrics capture various interesting characteristics of Mobility models. The simulation environment used was Ns-2.34 [9].

A. Simulation Configuration

In our simulations, we compared the characteristics of mobility and connectivity of our model with Column, Nomadic and Pursue mobility models. The mobility code for three mobility models has been created using Bonnmotion tool. Table 1 gives the simulation parameters we had set for conducting our simulation experiments.

Table 1
Simulation Parameters

Parameters	*Specifications*
Simulator	NS 2.34
Channel	Wireless Channel
Propagation	Shadowing
Antenna	Omni Antenna
Protocols	AODV and DSR
Simulation Duration	500s
Mobility Models	Column, nomadic and pursue
MAC Protocol	802.11
Traffic Type	Constant Bit Rate (CBR)
Number of Connections	5
Number of Nodes	15, 30, 45, 60

B. PERFORMANCE RESULTS

Average throughput:

Figure 8 illustrates the variation of average throughput. Bird flocking DSR gives better results when compared with other three mobility models. In this result, pursue mobility model shows less throughput rather than other models.

Average End To End Delay

Figure 9 shows that average end to end delay. Bird flocking DSR gives less average delay when compared with other mobility models.

$$E2E = \frac{\sum(\text{arrivaltime} - \text{sendtime})}{\sum \text{noofconnections}} \tag{1}$$

Average Packet Delivery Ratio

Figure 10 shows the average packet delivery ratio of mobility models. Bird flocking DSR gives better results when compared with other three mobility models.

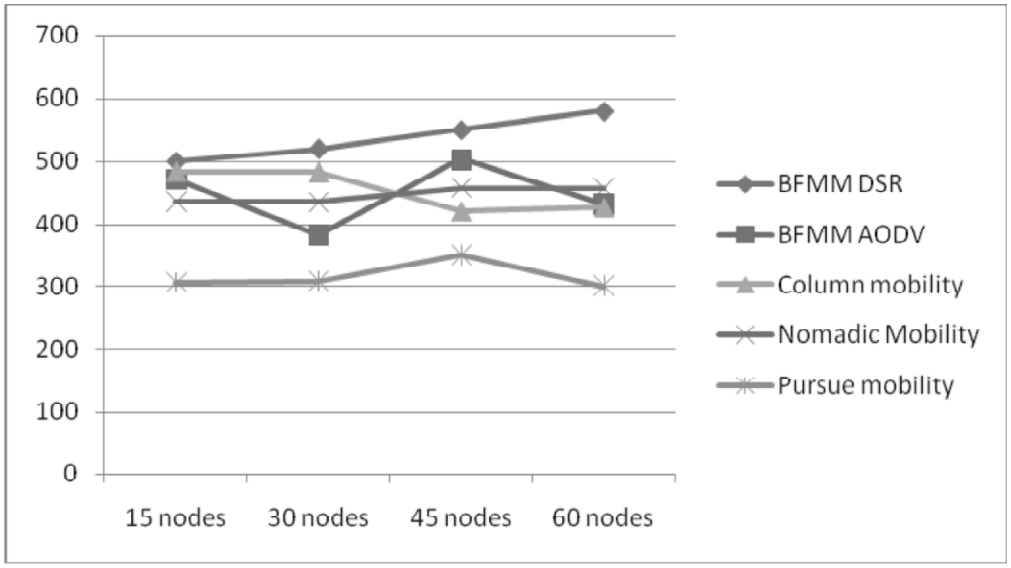

Figure 8: Variation of average throughput

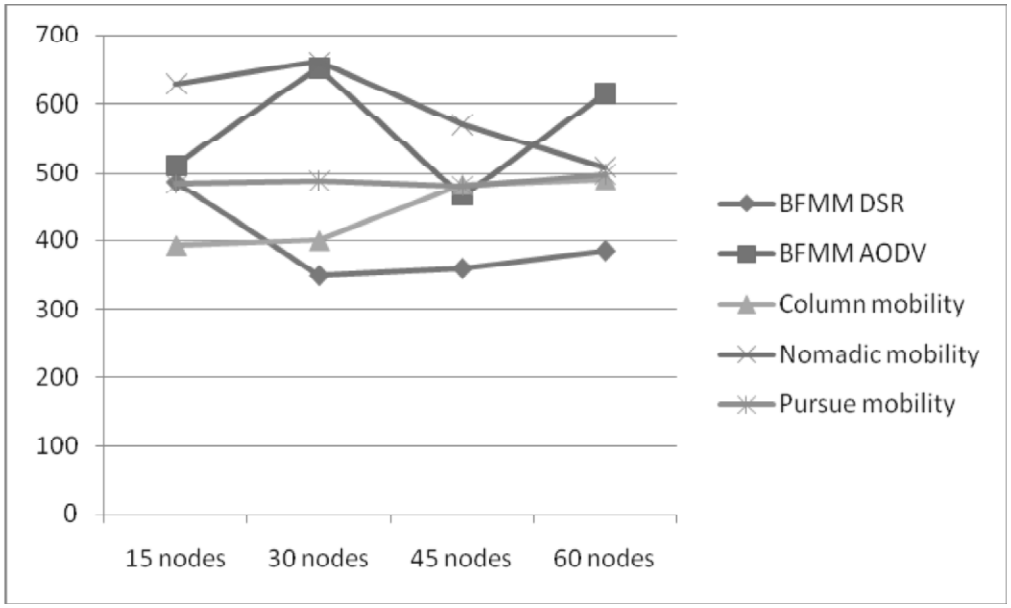

Figure 9: Variation of average end to end delay

$$PDR = \frac{\sum \text{no of packet receive}}{\sum \text{no of packet send}} \quad (2)$$

5. CONCLUSION AND FUTURE WORK

In this paper, we have used a bird-flocking behavior Inspired from group mobility model to model mobility of nodes in MANETs. This model is capable of representing group Behavior, while considering independent behaviors for the entity nodes within a group. Our approach is based on the simple bird-flocking rules such as cohesion, Alignment and separation. We ran different simulations to compare the performance of the bird flock model with the column, nomadic and pursue mobility models by considering some Connectivity metrics. The simulation results show that the bird flocking DSR and AODV but bird flocking DSR gives some results when compared with other mobility models.

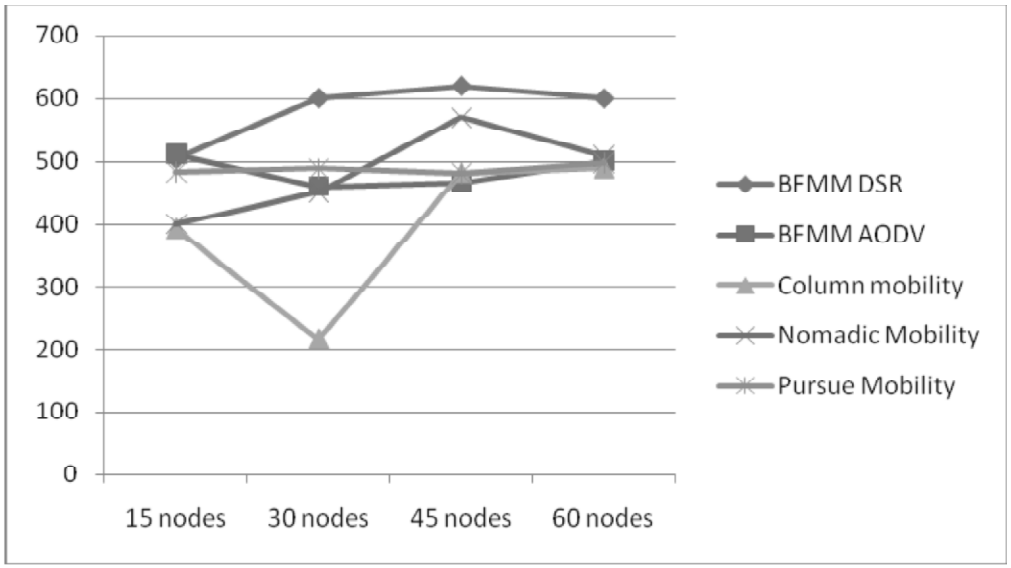

Figure 10: Variation of average packet delivery ratio

Even though in this work we have considered a tiny number of nodes for each mobility model, in the future, we propose to explore the behavior of the model as the network size increases to larger. Also, in this study, we only consider the AODV and DSR routing protocol for performance comparison, but in future other reactive and proactive routing protocols and avoid collision avoidance can also be considered.

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