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# Comparative Analysis of Indoor Mobility Scenarios Creation (IMSC) in Mobile Ad hoc Networks

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## Abstract

**Objectives:** Mobile Ad hoc Networks (MANETs) are self configuring mobile nodes each mobile node connected with other mobile node without any physical connection, nodes connected thorough wireless links. Major issues in MANET are routing and mobility. Each mobile node can act as router, it stores routing information such as Neighborhood id, hop count, source and destination address. **Analysis:** Here, we have compared indoor mobility models of Mobile Ad hoc Networks (MANETs) such as Manhattan Grid (MG), Random way Point (RWP) and Random Direction (RD) mobility models. This comparison based on their existing routing protocols like Dynamic Source Routing (DSR) and Ad hoc On Demand vector (AODV) protocols. Mobility node (MN) plays a very significant role while moving node from one to another. Mobility scenarios are created with help of BonnMotion tool version 2.1.3. The full simulation work done under Network Simulator 2.3.4. **Findings:** We have compared Routing protocols with different mobility models under different scenarios; found RWP-DSR gives some better results. **Improvement:** Out of three mobility models, RWP-DSR mobility model gives better results when compared with other models. The Performance measurements are based on various QoS parameters like Average End to End Delay, Average Throughput and Average Packet Delivery Ratio. In Future we implement a novel Bio inspired mobility models based on group mobility behavior.

**Keywords:** Bonn Motion, MG, Mobility Models, RD, Routing Protocols, RWP

## 1. Introduction

The network of MANET may change uncertainly and rapidly due to high mobility of the independent mobile nodes. Because of network decentralization, each node in MANET would act as a “router” to discover a routing path or to forward the data packets[1,2]. Each node connected with each other nodes, Ad hoc network no need of any centralized network all nodes are individual node, but still have a number of drawbacks in Ad hoc networks like energy consumption, scalability, and high mobility, hidden and exposed problems and so on. Figure 1 shows a simple ad hoc network design.

For the past recent decade Ad hoc network becomes very active research area field. As mobile and wireless technology proliferate, this area is receiving more attention and there are more industry and standards effort such as Internet engineering task force (IETF’s) MANET group, Asynchronous transfer mode (ATM) forum and a number

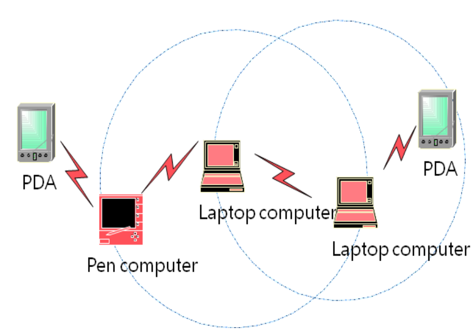


**Figure 1.** A Simple Ad hoc Network.

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of efforts in third-generation wireless standards[3]. An ad hoc Routing Protocols can be categorized into three types.

- Proactive Protocols
- Reactive Protocols
- Hybrid Protocols

The main theme of this work is to give a well organized and complete analysis of the two classic representatives of MANET protocols, two reactive protocols (DSR and AODV), with respect to the three mobility models (MG, RWP and RD). The Performance evaluation and routing comparison includes Average Packet Delivery Ratio, Average End to End Delay and Average Throughput with different network dimension and node speed. Mobility scenarios are created with help of BonnMotion Tool.

## 2. An Indication of Routing Protocols

Generally routing protocols has two phases, route discovery and route maintenance. In route discovery phase includes route request ant route reply sections. For example in a topology have 6 nodes, first node and last node consider as a source and destination nodes. It sends a route request to neighboring nodes if the node identifies a destination node reply to its corresponding nodes otherwise it keep on sending route request to other neighboring nodes. If any links broken between nodes automatically sends route error message to either sender side or receiver side. This[4] type of routing creates routes only when a node requires a route to a destination.

The lists of Proactive routing protocols are DSDV, WRP, FSR, STAR, GSR. Zone Routing Protocol (ZRP) comes under Hybrid Routing Protocol. Reactive Routing Protocols are DSR, AODV, ROME, LMR.

### 2.1 Ad hoc on-Demand Distance Vector Routing (AODV)

The Ad hoc on Demand Distance Vector[5] routing algorithm is a reactive routing protocol. Behavior of this routing protocol is different from other proactive routing protocols because it is an on demand based routing protocol i.e. when the source is initiated at that time only it will be performed. Every node maintains its own routing table which consists of node id, source and destination id, hop count and so on. For example, Source nodes intends to find a route to destination noded, the process is shown in Figure 2. Hello messages that nodes sends at certain time intervals because let them nodes are still there. Suppose if any one of the node stop receiving hello messages that know there is no route exists. If source node moves reinitiate the path to discover new routes to destinations.

In a Route Discovery Phase Source node broadcast the messages to its neighborhood nodes. AODV works under two major mechanisms are route request messages and route reply messages. If node wants to communicate to another node, it first sends a route request message to it's beside nodes. The route request messages contain source address and its sequence number besides destination address and its sequence number. If a neighbor of source node does not identify a destination, broadcast the route request messages. If[6] they receive a RREQ which they have already processed, they discard the RREQ and do not forward it. Sequence number is a unique number each message has its own number to identify a messages from source to destinations and also routing table contains life span, it denotes if the message does not received by receiver the source node will send the longer life span. Figure 2 shows the routing behavior of AODV protocol.

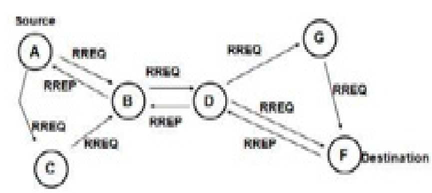


**Figure 2.** Routing Behavior of AODV.

AODV consists of Route Request (RREQ), Route Reply (RREP) and Route Error (Route ERR). For Example a topology consists of 5 nodes, first node sends a Route Request to its neighborhood nodes. Again neighbor node sends a Route Reply to Source node, until it finds a finest destination. If any link broken intermediate node will sends a Route Error to either source node or destinations. AODV Broadcasts Route request to relay nodes. It is a purely On Demand Protocol, when the source node initiates at that time only it will be an active mode otherwise it will not maintain knowledge of another node. AODV uses a symmetric link for a route reply mechanisms because it follows the turnaround time of route reply.

### 2.2 Dynamic Source Routing (DSR) Protocol

Dynamic Source Routing[7] is another reactive routing protocol for wireless Ad hoc network. It is also similar to AODV routing protocol i.e. on demand based protocol. In this work, we used for comparison purpose with different Ad hoc mobility models.

DSR is similar to on demand protocol i.e., AODV traditional routing mechanisms. In this protocol, a node maintains cache route it knows. The Route Discovery and Route Maintenance are similar to previous protocol. The source node sends a packet to neighborhood nodes which contains source and destinations IP addresses and Sequence number. An IP address is a distinctive number to identify a particular source or destination. Followed by a sequence number identify a messages from source to destinations. It always check the route table if the route is available it sends a route request messages otherwise discards it.

The route reply is using same link, otherwise use symmetric links to reverse path from source to destinations. Both the mechanisms are not used the destination node discovery the new routes to source node. Whenever a node transmits a packet, it must verify next hop is correctly receives or not. If data packets are not received that will intimate to the corresponding node. A particular node will resend data packets to next hop node. The key feature of this Routing protocol is routing tables are not periodically exchanged, it always refer new routes are available or not when link failure.

## 3. Indoor Mobility Models

A mobility models here took only three mobility models such that Manhattan Grid (MG), Random way Point (RWP) and Random Direction (RD) mobility models. Mobility models behave distinct from each other, here how the mobility models performed with routing protocols certainly increasing mobile nodes. Some of them gives better results when compared with other mobility models. Routing protocols are AODV and DSR are used for comparison purpose. Figure 3 shows the moving of nodes at different direction and different speed.

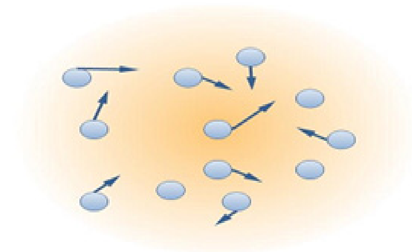

**Figure 3.** Mobile nodes moving different direction.

### 3.1 Manhattan Grid (MG) Mobility Model[8]

This mobility model shows the row and column based moments of mobile nodes. The below scenarios are created using BonnMotion tool and its parameters are number of nodes, simulation dimension, x and y position in simulation field, and so on. If any congestion occurs in a grid mobile can moves either left or right side based on some probability values. Actually this mobility model based on Manhattan city based network. In this simulation work, we used totally 60 mobile nodes in simulation area and also compared with DSR routing protocol. The below Manhattan Grid (MG) mobility model figure are not original to authors, some of the important features are mentioned below.

#### *3.1.1 Distinctiveness of Manhattan Mobility (MG) Model8*

* Except the above difference, the inter-node and intra-node relationships involved in the Manhattan model are the same as in the Freeway model.

Figure 4 illustrates the Manhattan Grid mobility model.

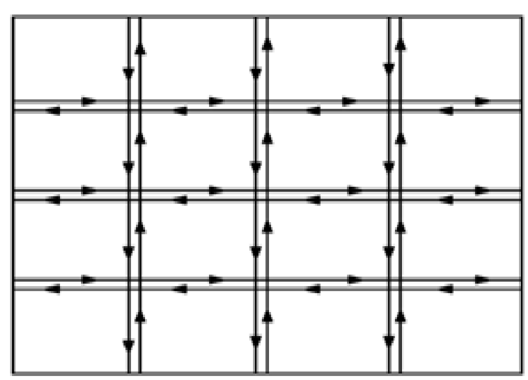

**Figure 4.** Manhattan Grid (MG) mobility model.

### 3.2 Random Waypoint Mobility Model

The Random Waypoint Model was first proposed by Johnson and Maltz[9]. It becomes a benchmark mobility model. In this work, we totally used 60 mobile nodes and other mobility models used for comparative purpose. The properties of this mobility modes are number of nodes, simulation dimension, x and y position in simulation area. The sample scenarios creation of this mobility model shows in section 4. The below diagram are not original to authors, figure 5 represents a how the node randomly moves in simulation area using Random way point model.

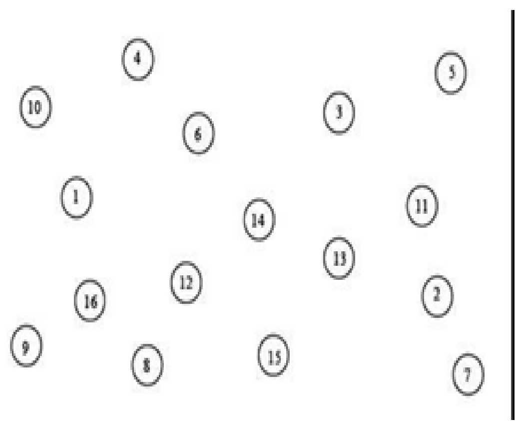


**Figure 5.** Random Way Point (RWP) mobility model.

### 3.3 Random Direction Mobility Model

Random Direction mobility model overcome the drawback of Random Waypoint model, RWP model rottenly chooses a new destinations but rather than RDM model chooses fixed destination point. In this work, we totally used 60 mobile nodes in simulation area. The similar parameters are used in RDM model like number of nodes, x and y position, simulation dimension and simulation duration time. The same RDM model scenarios creation shows in section 4. The below diagram are not original to authors. The Random Direction Mobility Model was created in order to overcome a flaw discovered in the Random Waypoint Mobility Model[10]. Figure 6 illustrates the behavior Random Direction mobility model.

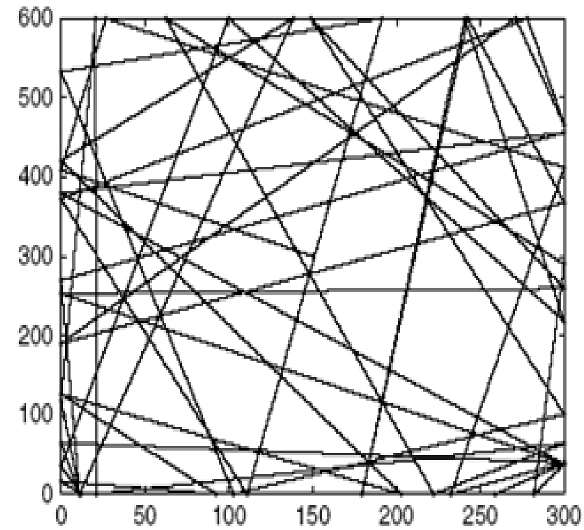


**Figure 6.** Random Direction (RD) mobility model.

## 4. Mobility Scenarios Creation

Mobility models Scenarios creation is as follows

### 4.1 Manhattan Grid (MG) Scenario

./bm –f indoor ManhattanGrid –n 15 –d 100.0 –x 120.0 –y 120.0 –e 0.25 –u 1 –v 1

### 4.2 Random Way Point (RWP) Scenario

./bm –f indoor RandomWayPoint –n 15 –d 100.0 –x 120.0 –y 120.0 –e 0.25 –h 0.5 –l 0.3

### 4.3 Random Direction (RD) Scenario

./bm –f indoor RandomDirection –n 15 –d 100.0 –x 120.0 –y 120.0 –e 0.25 –u 1 –v 1

Where,
./bm – Package name
-f – NSFile
Indoor – file name
Manhattan Grid, RWP, RD - Mobility model name
-n – Number of Nodes
-d – Simulation Duration
-x, -y – Height and Width of Window
-e – Pause Time

Parameter Initialization
**Scheduler creation**
Create node()
//create trace and nam file
**Node Cofiguration**
for i = 0 to no.of nodes
//set nodes
end for
**Define mobility model()**
//random position of mobility model
**Traffic creation**
//set no.of connections
Stop procedure
Proc stop()
End define

-u , -v – Set the Number of block between the source and destination paths.
Procedure of Mobility Scenario Creation (MSC) is as follows:

## 5. Simulation Environment

The simulation study was done using network simulator-2.34[11]. The mobility models scenarios were generated using BonnMotion-2.1.3[12] scenarios creation tool. In this simulation table were mentioned various parameters like type of antenna, mobility model, routing protocols are specified here. Parameters utilized were Average Throughput, Average Packet Delivery Ratio, and Average End-to-End Delay (Heterogeneous model) as metrics. Table 1 illustrates the simulation environment.

**Table 1.** Simulation Environment

| Parameters | Values |
|---|---|
| Simulation Tool | NS - 2.34 |
| Channel | Wireless Channel |
| Propagation | Shadowing |
| Antenna | Omni Antenna |
| Protocols | AODV and DSR |
| Simulation Duration | 300s |
| Mobility Models | MG, RWP and RD |
| MAC Protocol | 802.11 |
| Traffic Type | CBR |
| Number of Connections | 5 |
| Number of Nodes | 15, 30, 45, 60 |

### 5.1 Average Throughput

The Average Throughput calculating the total number of packets successfully delivered from each source node to each destination node. The below figure examines the performance evaluations with three mobility models and two routing protocols. When certainly increasing number of nodes Random Direction AODV gives consistent performance but Manhattan Grid AODV gives lower performance when number of node is 30.

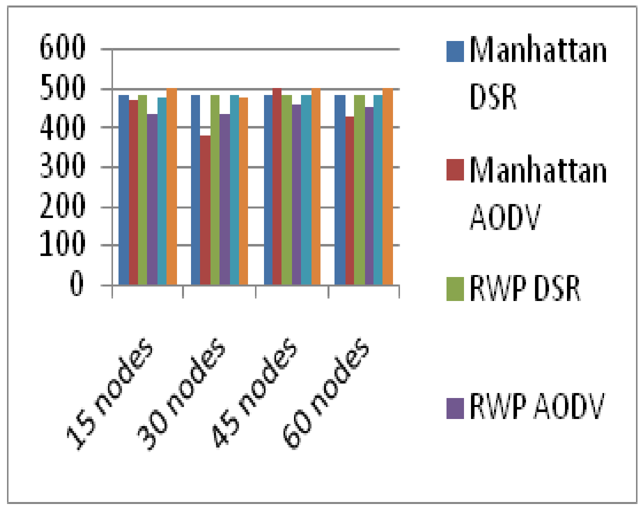


**Figure 7.** Variation of average throughput.

Figure 7 illustrates the throughput variation of AODV and DSR with different mobility models.

### 5.2 Average End to End Delay

The Average End to End Delays are calculated using Equation 1. An arrival time and sending time are considered with number of connections. The below Equation (1) are not original to authors and figure 8 Depicts the Average End to End Delay, here RWP-DSR gives some poor results when compared with other methods.

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

Figure 8 illustrates the Average End to End delay variation of AODV and DSR protocols with different mobility models.

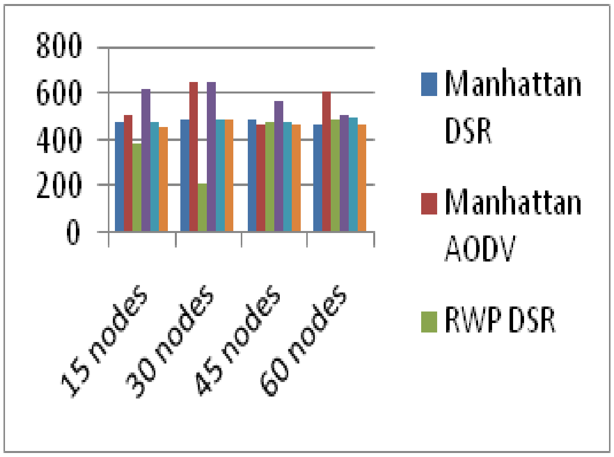


**Figure 8.** Variation of end to end delay.

### 5.3 Packet Delivery Ratio (PDR)

Packet delivery ratio shows total number of data packets successfully received and send. The below Equation (2) are not original to authors, figure 9 shows the packet delivery ratio of mobility models, here RWP-AODV gives better results when compared with other mobility models.

$$PDR = \frac{\sum noofpacketreceive}{\sum noofpacketsend} \tag{2}$$

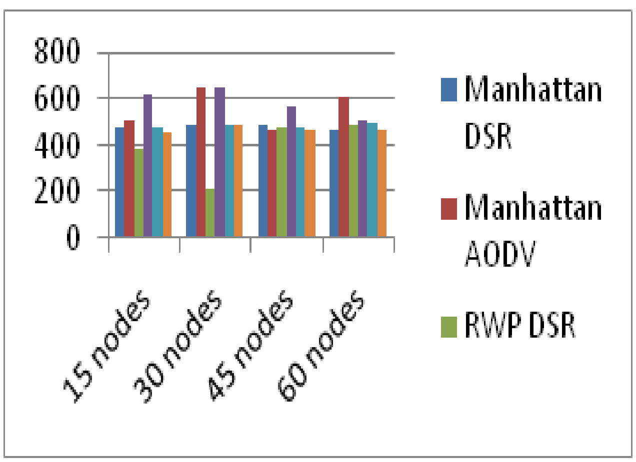


**Figure 9.** Variation of Packet delivery fraction.

Figure 9 illustrates the Average Packet Delivery Ratio variation of AODV and DSR protocols with different mobility models.

## 7. Conclusion and Future Work

In this paper, we have compared the mobility models with existing routing protocols are DSR and AODV. We ran different simulations to compare the performance of Manhattan Grid (MG), Random waypoint (RWP) and Random Direction (RD) mobility models with reactive routing protocols. While simulating MG-DSR gives some better result when compared with MG-AODV in an average throughput and also here we used three QoS Performance matrices are used like Average Throughput, Average End to End Delay and Packet Delivery Ratio.

In an Average End to End Delay, MG-AODV, RWP-AODV and RD-AODV gives better result when compared with respective mobility models with DSR protocol.

In Average Packet Delivery Ratio, RWP-AODV gives some better result when compared with other mobility models.

Although in this work we have considered small number of nodes for each mobility models, in future to propose a new group mobility models. Also, in this study considered only indoor mobility models with reactive routing protocols for comparison, but proactive and reactive protocols also are considered. Moreover, increase a network size; include other performance matrices like routing overhead, link stability.

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