# Experimental Synthesis of Routing Protocols and Synthetic Mobility Modeling for MANET

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Abstract: Many performance analyses are already done with a lot of flaws. But, they do not look to all influenced constraints. In this study, we aim to summarize several parameters into 90 different scenarios with an average of 1350 simulated files. That shows results of three performance metrics combined with five mobile ad hoc routing protocols under three synthetic mobility models. All these parameters are applied to two dissimilar simulation areas. Basing on one exhaustive analysis with all these details like this paper; leads to well understand the accurate behaviors of routing protocols and mobility models used. By displaying the ability of every routing protocol to deal with some topology changes, as well as to ensure network performances.

## 1 INTRODUCTION

For almost two decades, mobile communication has become a major field of research and scientific discoveries. Mobile Ad hoc Network (MANET) has achieved a huge improvement due to its flexibility, easier maintenance, the non-existence of centralized control or fixed and static infrastructure as well as self-administration and self-configuration abilities.

Several mobility models have been proposed to overcome these situations with the aim of imitating human beings' real-life. Wireless communications display many problems related to nodes density, traffic load, autonomous energy, and mobility. Routing within this network suffers from frequent topology's updates and unconnected actives routes between mobile nodes. The main challenge of MANETs routing is to develop a dynamic routing protocol expeditiously able to find a route between mobile nodes. The choice of a mobility model (MM) can favorite some designs over others. It must be efficiently readapted to every change occurring in the network topology(Srivastava et al., 2014). The performance of mobile ad hoc networks can vary significantly under different mobility models. Sometimes, they evaluate routing protocols without taken into consideration mobility models. They often analyze them using one routing protocol. Whereas, Simulation time employed is too short. It mainly impacts performance metrics of many mobility models. Or usually, simulation area used is small. It influences the number of packets received. Their optimal implementation requires a deep study of the routing protocols. Researchers find meaningful to explore mobility model decisions and metrics in modeling their wireless communication where mobile nodes move from a place to another with no fixed infrastructure.

Synthetic Mobility models(Umamaheswaran et al., 2014) imitate the movement of real mobile nodes that change speed, position and direction with time. They can be done by making prevision, mobiles move from one place to another at a given moment under varied network restrictions. They represent precisely motion characteristics of mobile nodes. They are amongst key parameters that influence performance features of the mobile network in order to judge which protocol is useful in a special scenario. Nodes' mobility need to be analyzed to explore dependency and topology requirements.

This paper will propose an intensive performance analysis of some synthetic mobility model under a mobile ad hoc network. In order to describe mobility issue of various wireless communication scenarios that heavily impacts mobile routing protocols. The entire document is divided into three principal sections. Firstly, we present brief related works where are used in the simulation. Secondly, we present the parameters of simulation; and also, we interpret the simulation results. And finally, we discuss the conclusion.



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## 2 RELATED WORKS

Many ways are proposed to classify synthetic mobility models(Batabyal and Bhaumik, 2015). Firstly the 'Entity mobility model' where every node is independent of each other. This class has been classified into the following areas: random mobility models, models with temporal dependency, models with spatial dependency and models with geographic restrictions. For random mobility models, nodes travel freely and without obstructions. Direction, speed, and destination are selected randomly and independently of prior selection. That assesses these models to be generally without a memory, e.g: Random Waypoint Mobility Model (RWMM)(Han et al., 2016). However, models with geographic restriction, node's movements are not often random or have a temporal/spatial dependency. But, it can be obstructed in a bounded area, guided by paths or restricted into a building, e.g., Manhattan Grid Mobility Model (MGMM)(Martinez et al., 2013). Secondly the 'correlated or group based mobility model', where the device node's movement is dependent on others. In this subclass, nodes move by following a leader node in the group. That is to say, each group is governed by one leader which can be a pre-defined or a logical node, e.g., Reference Point Group Mobility Model (RPGMMM)(Dong and Dargie, 2013). Thirdly the 'human or social based mobility model' where nodes are driven by socializing human behaviors, e.g., Self-Similar Least Action Walk(Hiranandani et al., 2013). And fourthly, vehicular mobility models emulate vehicle movement with changing speed, moving in queues along highway/street and stopping at traffic signals(Al-Sultan et al., 2014). That follow the shortest trajectory from a given source to a destination. However, vehicular communication becomes an important portion of the intelligent transport system.

## 3 SIMULATION PARAMETERS AND RESULTS

### 3.1 Configuration Parameters

This paper shows results of three performance metrics which are Packet Delivery Ratio (PDR), average end-to-end delay and throughput under different scenarios. we combine five mobile ad hoc routing protocols which two of them are proactive, two are reactive and hybrid one. With three synthetic mobility models which are: RWMM is a random entity synthetic MM, MGMM is an entity synthetic MM with restriction geographic MM and RPGMM is group based MM. All

Table 1: Simulation parameters.

| Parameters | Values |
|---|---|
| Propagation model | TwoRayGround model |
| Bandwidth | 10 Mb/s |
| Number of nodes | 50 |
| Packet size | CBR |
| Packet rate | 512 bytes/s |
| Speed | 10 m/s |
| Pause time (s) | 0, 20, 40, 60, 80 |
| Routing Protocols | DSDV, OLSR, AODV, DSR, and ZRP |
| Mobility models | RWMM, MGMM, and RPGMM |
| Performance metrics | PDR, Average e-e delay, and Throughput |
| Area | 220 * 220 , and 1020 * 1020 |
| Simulation time | 1000 s |
| Recursion | 15 times |

these parameters are applied under two simulation areas; small one with (220m*220m) and large one with (1020m*1020m). So, our results will represent 90 different scenarios with an average of 1350 simulated files. We combine all these details in order to well understand the accurate behaviors of routing protocols and mobility models used. Simulation settings used for the experiments are depicted in Table 1.

### 3.2 Results and Discussion

To evaluate routing protocols, a wide range of performance metrics have been considered to catch characteristics of different mobility models. Our results aim to analyze their performance impacts on routing protocols over MANET. So, different metrics have been used to compare and evaluate them against nodes' mobility, as follows:
Firstly, we start with Packet Delivery Ratio (PDR) or Fraction (PDF). It represents the ratio of data packets delivered to destinations, those generated by CBR application sources. According to this metric, simulation results are shown in Figure 1 and Figure 2.

Figure 1 is applied in the small area. From Figure 1 (a) and (c), the PDR of AODV and DSR present best results in both RWMM and RPGMM in which they reach approximately 100%. Due to their reactive strategy, routes are sure which are searched on demand. But, AODV represents the best routing protocol in MGMM of Figure 1 (b). However, in RWMM and MGMM, ZRP gives the worst results in this metric, by dint of zone network used by this protocol. DSDV and OLSR in RWMM and MGMM offer acceptable outcomes, thanks to continuously update their routing table. OLSR is the worst in RPGMM. As a result of, OLSR is based on routing by cluster heads. And, RPGMM has their own groups' leader. So, the same strategy applied for routing and mobility respectively. The coordination between clusters and leader nodes is tough in this case. In general, we notice that AODV offers best results at the PDR for all mobility used in the small area.

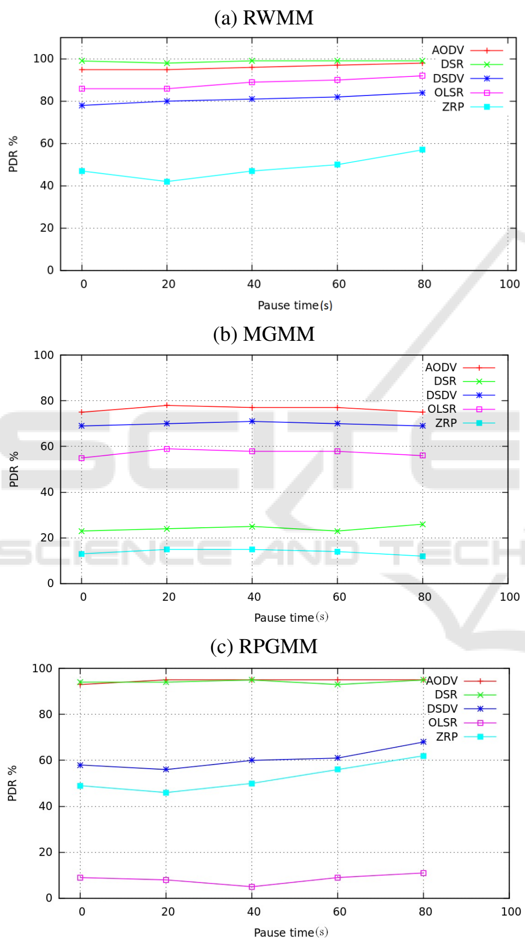


Figure 1: PDR of routing protocols under various mobility models - Small area. (a) Random Waypoint Mobility Model, (b) Manhattan Grid Mobility Model, (c) Reference Point Group Mobility Model.

Figure 2 is applied in the large area. From Figure 2 (a), (b) and (c), the DSR and ZRP offer the best PDR percentage. Due to the hidden routing table of DSR which often has an available route to the destination even in a wide field. And zone based protocol applied by ZRP which it allows to be suitable to the large area. Although, the proactive protocols OLSR and DSDV are the worst in all mobility models. Proactive protocols generally offer bad results in large simulation field. We observe that ZRP is the best in the PDR in this area. As a result of dividing spacious simulation area in a small zone which will be easier to verify transmitted packets.

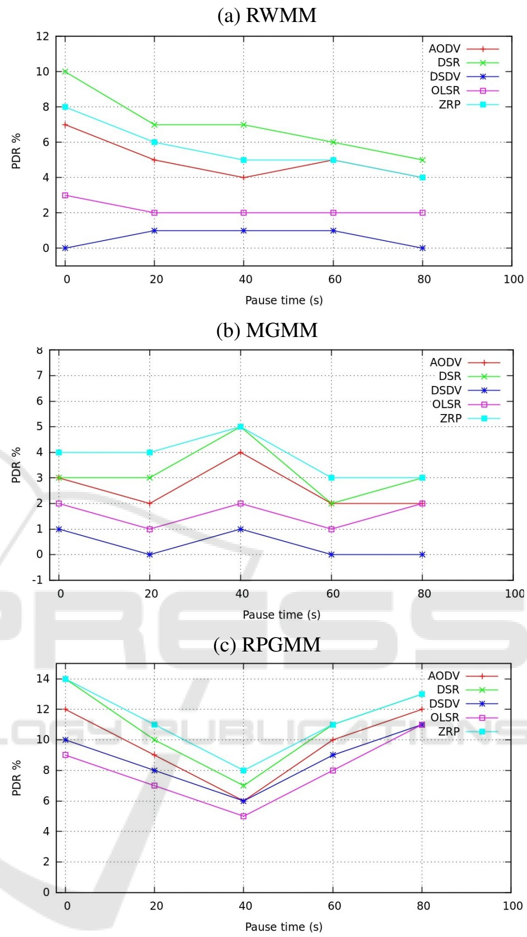


Figure 2: PDR of routing protocols under various mobility models - Large area. (a) Random Waypoint Mobility Model, (b) Manhattan Grid Mobility Model, (c) Reference Point Group Mobility Model.

Secondly, we analyze the 'Average End-to-End Delay'. It represents total time spends between application source to destination one. The simulation results are shown in Figure 3 and Figure 4.

Figure 3 is applied in a small area. From Figure 3 (a),(b) and (c), the Average end-to-end delay of DSR and ZRP are the worst in this three mobility models simulated. Due to their zone approach of ZRP and useless routes saved by DSR. However, we notice that in the small area, this metric is best with AODV, OLSR, and DSDV. Thanks to their on demand or continuous proactive strategy adopted by these routing protocols.

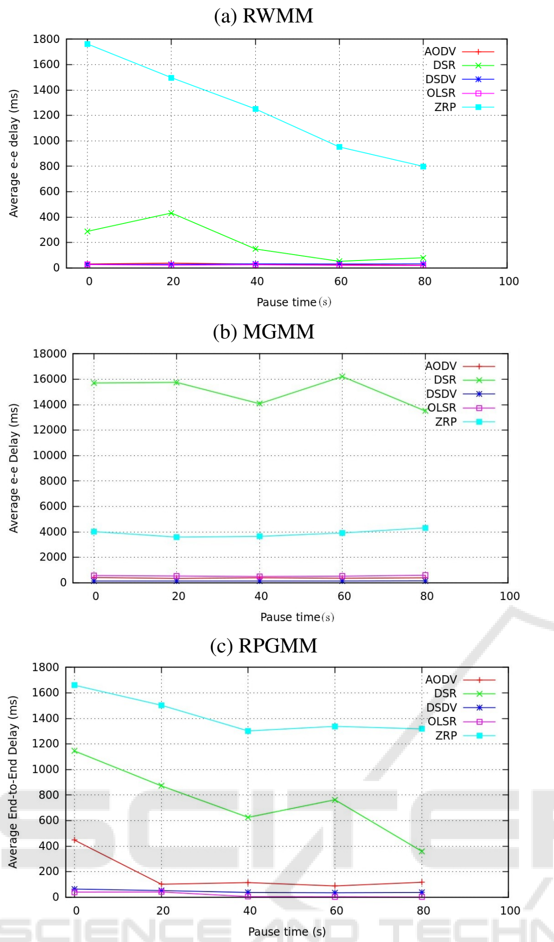


Figure 3: End-to-End Delay of routing protocols under various mobility models - Small area. (a) Random Waypoint Mobility Model, (b) Manhattan Grid Mobility Model, (c) Reference Point Group Mobility Model.

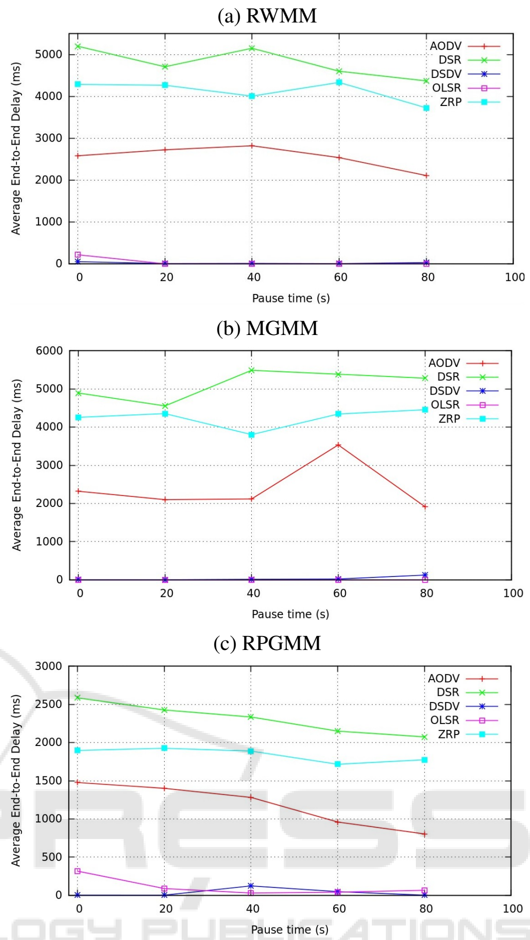


Figure 4: End-to-End Delay of routing protocols under various mobility models - Large area. (a) Random Waypoint Mobility Model, (b) Manhattan Grid Mobility Model, (c) Reference Point Group Mobility Model.



Figure 4 is applied in a wide area. From Figure 4 (a), (b) and (c) like the small one, the average end-to-end delay of DSR and ZRP are the worst in these three mobility models simulated of Figure 4 (a),(b) and (c). Due to their zone approach of ZRP and useless routes saved by DSR. So, sometimes, they borrow prolonged routes to reach the destination. However, AODV has acceptable results. Thanks to the reactive methodology which send to one neighbor without total knowledge of a correct path to the destination. We notice that average end-to-end delay of proactive protocols OLSR and DSDV is not influenced by simulation field adopted. It offers best outcomes, thanks to their continuous proactive strategy.

Thirdly, we assess the Throughput which is the sum of data rates which are delivered to all mobile nodes, indicating bits or packets received per second. The simulation results are shown in Figure 5 and Figure 6.

Figure 5 is applied in a small area. From Figure 5 (a) and (c), reactive protocols AODV and DSR show best results in RWMM and RPGMM. These protocols are suitable for small areas. But from Figure 5 (b), AODV outperforms than others at MGMM due to the reliable path used. However, ZRP is the worst in RWMM and MGMM. And, it is admissible in RPGMM. Although, DSDV and OLSR offer permissible outcomes in RWMM and MGMM. But, OLSR is the worst in RPGMM due to its cluster routing process. We conclude that AODV is the most suitable for all these mobility models simulated in a small field.

Figure 6 is applied in a large area. From Figure (a), (b) and (c), we remark that ZRP, AODV, and DSR gives best results on the throughput. Furthermore, ZRP is the best according to this metric. But, OLSR and DSDV are the worst at all models experimented. We conclude that proactive protocols are bad. And, ZRP is the best one in large areas.

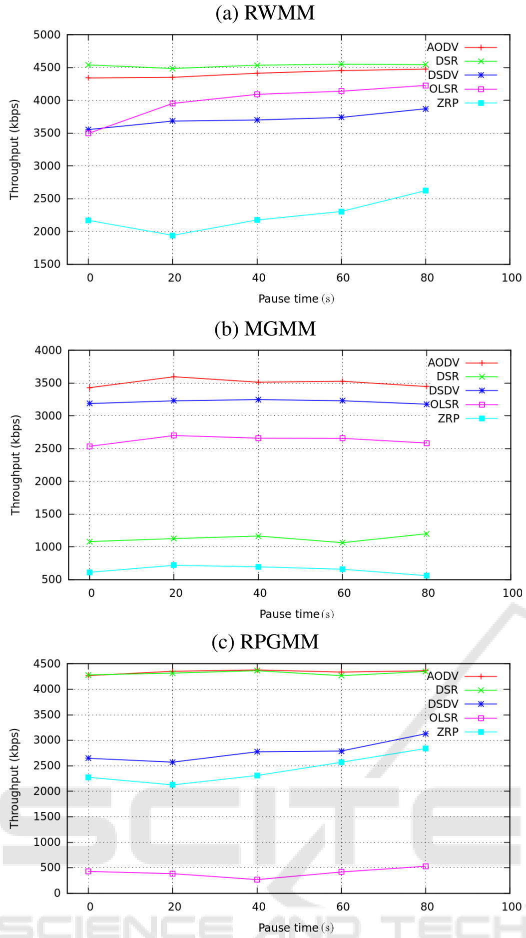


Figure 5: Throughput of routing protocols under various mobility models - Small area. (a) Random Waypoint Mobility Model, (b) Manhattan Grid Mobility Model, (c) Reference Point Group Mobility Model.

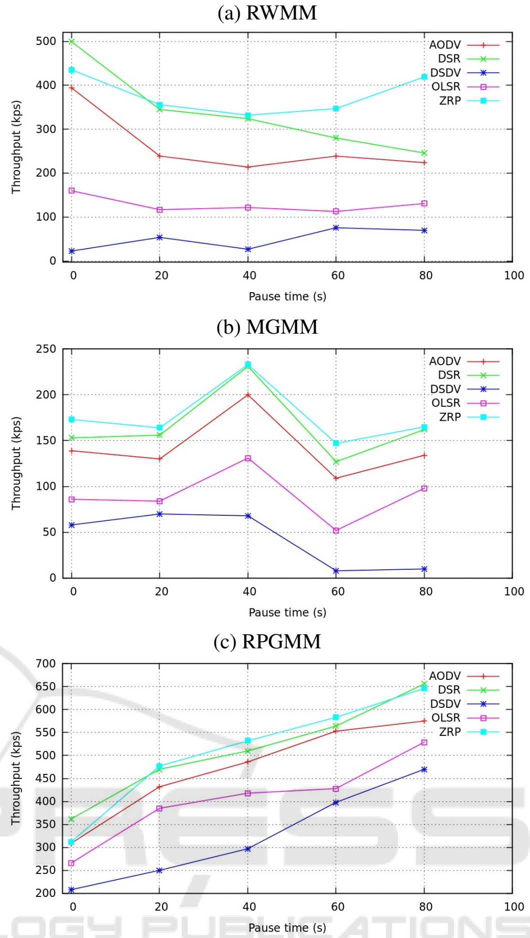


Figure 6: Throughput of routing protocols under various mobility models - Large area. (a) Random Waypoint Mobility Model, (b) Manhattan Grid Mobility Model, (c) Reference Point Group Mobility Model.



After simulating 1350 files of 90 different scenarios. Our results will be summarized in Table 2. When we are combined some routing protocols with synthetic mobility models. We obtain best outcomes which are displayed with green cells 1-2. And worst results with red color 4-5.

We result from that the Packet delivery ratio and Throughput in a small area. AODV achieve best outcomes as a result of on-demand concept based on route request RREQ and route reply RREP leads to possesses exactly the correct path. But, the worst one is represented by ZRP because it explore information of Intra-zone Routing Protocol (IARP) and Inter-zone Routing Protocol (IERP) which will be tedious to coordinate between them in a small one.

For the large area, we acquire best results with DSR due to the available path to a destination node, even if in a wide area. And ZRP as a result of dividing spacious simulation area in a small zone which will be easier to verify transmitted packets.

However, for the average end-to-end delay. In the two areas, we have best results with proactive protocols DSDV and OLSR, due to their researches in advance and continuous updates or routing tables. So, all the time, they possess correct paths to a destination. But, the worst are obtained with DSR as a result of hidden table without any strategy to erase it, and ZRP due to speed occupied to locate the destination in a specific zone in simulation field.

## 4 CONCLUSION

This paper aimed to summarize several performance evaluation scenarios of MANET routing protocols under different mobility models. Three mobility models have been applied in order to study the im-

Table 2: Experimental synthesis results.

| Performance Metrics | Routing Protocols | Mobility models | | | | | |
|---|---|---|---|---|---|---|---|
| | | Small area | | | LARGE area | | |
| | | RWMM | MGMM | RPGMM | RWMM | MGMM | RPGMM |
| PDR | AODV | 2 | 1 | 1 | 3 | 3 | 3 |
| | DSR | 1 | 4 | 2 | 1 | 2 | 2 |
| | DSDV | 4 | 2 | 3 | 5 | 5 | 4 |
| | OLSR | 3 | 3 | 5 | 4 | 4 | 5 |
| | ZRP | 5 | 5 | 4 | 2 | 1 | 1 |
| Avg e-to-e delay | AODV | 3 | 3 | 3 | 3 | 3 | 3 |
| | DSR | 4 | 5 | 4 | 5 | 5 | 5 |
| | DSDV | 2 | 1 | 2 | 1 | 2 | 1 |
| | OLSR | 1 | 2 | 1 | 2 | 1 | 2 |
| | ZRP | 5 | 4 | 5 | 4 | 4 | 4 |
| Throughput | AODV | 2 | 1 | 1 | 3 | 3 | 3 |
| | DSR | 1 | 4 | 2 | 2 | 2 | 2 |
| | DSDV | 4 | 2 | 3 | 5 | 5 | 5 |
| | OLSR | 3 | 3 | 5 | 4 | 4 | 4 |
| | ZRP | 5 | 5 | 4 | 1 | 1 | 1 |

pact of changed metrics as average end-to-end delay, throughput and the packet delivery ratio. We conclude that AODV offers best results in the small area. It is usually moderate or better for all ninety divers' scenarios. It represents an adaptable routing protocol under varied mobility models for the small and large area. Due to, its reactive routing approach which leads it to own correct path according to packets transmitted. However, ZRP is the worst. But, it is the best in the large one. And proactive protocols are the worst in this field. Three tracks in mobility modeling are allowed which we achieve the first one in this paper. Basing on one itemized analysis with all these details; leads to well understand the accurate behaviors of routing protocols and mobility models used. Our future work will focus on modeling a human trace mobility model applied in a real world scenario. That will be interesting for mobile P2P application and suitable to a crowded area.

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