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Performance Evaluation of Mobility Models over UDP Traffic Pattern for MANET Using NS-2

Alaa Taima Albu-Salih^{1}*

Gesoon Al – Abbas²

¹ Ministry of Education, General Directorate for Education in Al-Qadisiyah, Iraq

² Department of Computer, College of Veterinary Medicine, Al- Muthanna University , Al- Muthanna, Iraq.

*Corresponding author: alaa_alhasany1983@yahoo.com, ghusoonjawad@mu.edu.iq

*ORCID ID: <https://orcid.org/0000-0001-5006-5898> *, <https://orcid.org/0000-0001-7803-6896>

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Abstract:

The current study presents the simulative study and evaluation of MANET mobility models over UDP traffic pattern to determine the effects of this traffic pattern on mobility models in MANET which is implemented in NS-2.35 according to various performance metri (Throughput, AED (Average End-2-end Delay), drop packets, NRL (Normalize Routing Load) and PDF (Packet Delivery Fraction)) with various parameters such as different velocities, different environment areas, different number of nodes, different traffic rates, different traffic sources, different pause times and different simulation times . A routing protocol...was exploited AODV(Adhoc On demand Distance Vector) and RWP (Random Waypoint), GMM (Gauss Markov Model), RPGM (Reference Point Group Model) and MGM (Manhattan Grid Model) mobility models above CBR traffic sources. The results of Reference Point Group Model simulation illuminate that routing protocol performance is best with RPG mobility model than other models.

Key word: Bonn Motion, MANET, Mobility Models, Performance Evaluation, Traffic Pattern.

Introduction

The Mobile Ad-hoc Network (MANET) is a gathering of lymph node, which has the likelihood to interface on a radio communication sensitive and green goods a dynamic arrangement with radio connection and with no associate infrastructure. The network can dynamically alter with sentence, some client can leave, and other nodes can junction to the network, (1).

Most researches of MANET depends on simulation techniques using the RWP (Random Waypoint model), which is one of the default cases in the NS-2 (Network Simulator-2). In the recent years, various mobility models have been suggested, (2).

It is so significant to evaluate the available routing communications protocols functioning in various mobility examples before choosing the most appropriate protocol for a specific modelling. Most MANET researches through routing communications protocol selected the RWP mobility model for simulations. Nevertheless, studies on RWP model and influence on the performance routing confirm that the psychoanalysis of the protocol performance using just RWP model is not sufficient; a given routing

protocol may not deliver good performance with other mobility models, (3).

The current study investigates the mobility models performance based on both CBR based traffic pattern for various parameters such as different velocities, different stop times, different simulation environment area, different traffic rates, different no. of nodes, different traffic sources and different simulation times. The aim of this evaluation is to know the best mobility model for MANET based on five performance metrics: the throughput, PDF (packet delivery fraction), NRL (normalizes routing load), packet loss and AED (average end-2-end delay). To the best of the researcher's knowledge, this the first evaluation of mobility models' performance that includes the above seven parameters above UDP traffic pattern.

The remainder of the study is organized as follows: The second section presents the related work. The third section provides an overview of routing protocols, mobility and traffic pattern used in this study. Section 4 describes the Network Simulator NS-2 and Bonn Motion are described in section two. The performance metrics are included in the fifth section. In Section 6, the steps of the

proposed strategy are presented. The environment of simulation is defined in seventh section and then the simulation results are presented in section 8. The last section includes conclusion of the current study.

Background

R. Manoharan and E. Iavarasan, 2010 studied three most widely used mobility patterns such as RWP(Random Way Point), PPGM (Reference Point Group) and MG(Manhattan Grid) mobility that as well as to the weaknesses and strengths of the multicast routing protocols, the mobility models does also have effect on the performance of the routing protocols. AODV protocol and Adaptive Demand driven routing protocol have been selected and executed in NS-2. They observed that the mobility models do also have effect on the performance of the routing protocols, (4).

A. Garg, et. al. , 2017 have observed the impact of CMM (Column Mobility Model), RPGM (Reference Point Group Mobility) and RWP (Random Waypoint Model) mobility models on the functioning of Cluster Based Multicast Tree (CBMT) approach with DSDV routing protocol varies widely across different no. of nodes and node mobility speed in terms of QoS metrics as average end2end delay, energy consumption, packet delivery ratio and overhead for MANETs. They observed that the movement of nodes is characterized based on mobility velocity. They found that the RWP has better results in suitable conditions than the other two models in such MANET environment, (5).

Prajakta M. Dhamanskar and et al. at 2012 presented the on demand routing protocols performance such as AODV, TORA and DSR for mobile nodes following four mobility patterns such as RWP, RW (Random Walk), MG (Manhattan Grid) and RPGM (Reference Point Group) mobility models. They indicated that from the results of the simulation, the conclusion is that the Reference Point Group mobility model performance is the best and the MG performance is the worst as compared to other mobility models for all the three protocols. PDR of AODV and TORA is better than that of DSR but PDR of TORA is the best. Delay is average in TORA and NRL is the worse in DSR, (6).

Routing protocols, Mobility and Traffic Pattern:

MANET Routing protocols:

Numbers of different routing protocols for MANET were developed and used. Protocols were classified as proactive and reactive protocols, (7). This work focuses on applying and using the

AODV as a proactive protocol. AODV Protocol stands for Ad hoc On Demand Distance Vector Routing which preserves the table of routing at each single node. It is proactive communications protocol & contains three inputs in the routing table for a name and address, a next hop node, a sequence number and a hop count. All packets sent to the target are directed to the next hop leaf node. The successiveness number indicates the freshness of a route. The hop count represents the present distance to the target, (8).

Mobility Models (MMs):

An MM must be tried to imitate the movements of actual nodes. MMs depend on setting out different parameter related to the possible apparent movement of node. Basic factors are the starting position of leaf node, their movement direction, the range of a function of velocity, and the changes of speed over time. MMs can be categorized into group and entity mobility models. Entity mobility models (EMM) support situations when mobile nodes move completely freely from each other, while in GMM (group mobility models) nodes are dependent on some predefined leader node or on each other, (9). This paper, refer to the used of the following Mobility models:

- RWP (Random Waypoint Mobility Model):
In RWP model, every node of the system chooses a random destination and travels to it with certain picked random speed. When a node achieves the goal, the node stays for a length characterized by the stop time factor. Next, node chooses a random goal and rehashes the entire procedure till the point when the time of simulation is finished, (10).
- RPGM (Reference Point Group Mobility Model):
In RGGM, nodes are separated into groups. Each single group has a pioneer that decides the all nodes movements in the group. At every moment, velocity group member is calculated in light of speed and heading of pioneer node right then and there. This model denotes the warriors movement in a battle, or voyagers following traveler leaders,(11).
- GMM (Gauss Markov Mobility Model):
In GMM, at first every node is allocated a present velocity (direction and speed) at each settled time interval. The motility of node happens by refreshing the velocity of every node. Due to temporal dependency, the estimation of velocity at the specific time is ascertained based on the estimation of past velocity,(12).
- MGM (Manhattan Mobility Model):
In MGM, movement pattern of node were characterized by outline made out of various

vertical and horizontal roads. Node allows mobility along the grid of horizontal and vertical grid on the map. In light of temporal dependency, speed of a node at a specific time is subject to the speed of its past time, (13).

In the created scenarios of mobility model of MMs utilizing Bonn Motion 2.0 (BM-2.0), so they can be fused into TCL scripts. BM is java based instrument for producing mobility scenarios for a few mobility models, created by University of Bonn.

Traffic Type

Traffic sources define how the data is conveyed from source to target. Two types of Traffic sources can be used in MANET and can be used in this paper a) UDP (CBR) and b) TCP Traffic patterns.

- User Datagram Protocol (UDP):

The characteristics of Constant Bit Rate (CBR) traffic model are I) predictable: static size of packet, static interval amongst packets, and static stream span, ii) unidirectional: there will be no affirmation from goal for affirming the information transmission and iii), unreliable: since it has no connection foundation stage, there is no certification that the information is conveyed to the goal (13).

- Transmission Control Protocol (TCP):

The characteristics of TCP (Transmission Control Protocol) traffic pattern are I) reliable: since connection is created before transmitting information. II) conformity: there will be flow restraint of data to avoid overloading the goal and congestion controller exists to shape the dealings such that it conforms to the available network capacity iii) bi-directional: every packet that has to be transmitted by the target is acknowledged by the destination, and. Today more than 90% of the IP traffic is carried out through TCP traffic pattern, (14).

In order to create a new traffic generation between nodes, should first follow "ns-allinone-2.35/ns-2.35/indep-utils/cmu-scen-gen".

Simulation Tools

NS-2 (Network Simulator):

This simulation subject has been done using the ns-2.35. The NS-2.35 is discrete issue simulation software program for network. It simulates receiving, sending, dropping and forwarding packets events. The ns-allinone-2 .34 supports simulation for adhoc wireless networks routing protocols. NS-2 is with written in OTCL (Object Tool Common Language) and C++ programming language. ns-2.35 can be constructed on several platforms, (15).

In the current study, an Ubuntu platform was chosen. Linux presents a no. of computer programming tools that were used in the required simulation test procedure. To run and test ns-2.35, the user must write the simulation script of OTCL programming language. The parameters of performance can be graphically pictured in GRAPH program. Moreover, NS-2 also shows a visual representation of the simulated network by tracing cases and movements of nodes and registering them in a data file called a Network Animator (NAM file).

Bonn Motion(BM):

BM is the apparatus used to compute intermittent links and the changes of connection in every one of the models of mobility. BM 2.1a is the dependable to make all movements data in OTCL with respect to the mobility model. When the movement models created , they display a brief period so awareness of first seconds skirt is necessary because they don't present the properties needed from the mobility model needed, the places and movements of the nodes of each simulation and even the movement among them are randomly chosen. BM is responsible for the random properties of the place and movements of the nodes and for the traffic ns-2.35 random factors utilized, (16).

Performance Metrics

- Throughput

The throughput is defined as the total number of packets received by the destination per time unit that is delivered from one node through the channel, (15).

- PDF (Packet Delivery Fraction)

PDF is the packets ratio delivered to the goals to those created by the sources, (14). $(PDF = (\text{Received packets number} / \text{Sent packets number}) * 100)$

- AED (Average number end-2-end delay)

AED produced by queuing, buffering, latency, retransmission and route discovery. The AED is measured in milliseconds, (9). The AED is computed by gathering the time which occupied by all received data packets divided by number of received packets.

- NRL (Normalize Routing Load)

NRL is the no. of control packets transferred per data packet received at the target, (4). $(NRL = \text{All routing control packets} / \text{All received packets})$.

- Drop Packets :

It is defined as the no. of packets that have been sent by the sources but have not been received at

the destinations, (17): (Packets loss = Sent packets – Received packets)

Methodology for Performance Evaluation

The following flowchart shown in Fig. 1 is to evaluate the effect of the four mobility models on the performance of 5 metrics (Throughput, Packet Delivery Fraction (PDF), Average End-to-end Delay (AED), Normalize Routing Load (NRL) and packets loss) for an AODV routing protocol in MANET with various parameters such as different number of nodes, different traffic sources, different speeds, different pause times, different simulation times, different environment area and different traffic rates.

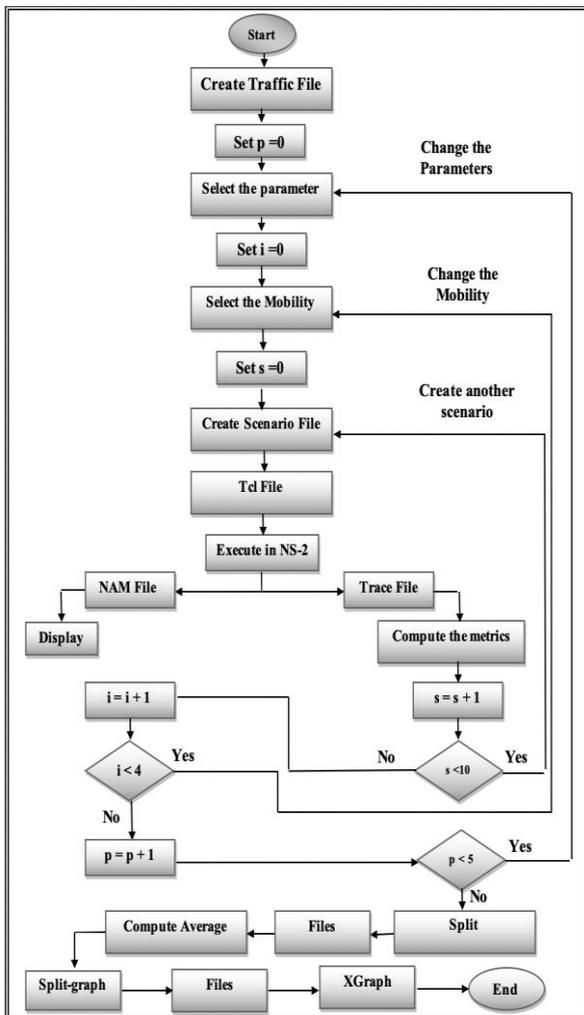


Figure 1. A performance evaluation process

Simulation Environment

To run simulation with NS2.35, the OTCL simulation script must be written. The performance parameters are graphically pictured in X graph code. Table 1, represents the required Hardware (HW) and the Operating System (OS) configurations while Table 2, presents the suggested MANET’s simulation environment implemented in this paper.

Table 1. Hardware and Operating System configuration

Processor	Core i5 , 2.4 GHz
RAM	4 GB
Hard Disk	700 GB
OS	Linux, Ubuntu 14.04

Table 2. simulation environment

Network Simulator	
The Network simulator	NS-2.35
NAM	1.13
MAC Type	802.11
Radio Wave Propagation	Two Ray Ground
Antenna	Omni Antenna
Traffic and Mobility	
Data Traffic Type	CBR
Data Payload	512 bytes
Interface Queue Type	DropTail / PriQueue
Mobility Models	RWP , RPGM , GMM and MGM
Routing Protocols	
Routing Protocols	AODV

Simulation Results

In this section, seven scenarios were suggested and implemented to evaluate and analyze the four mobility models performance for MANET over CBR traffic pattern, these parameters determine the effect of mobility models on the MANET routing protocols performance over this traffic pattern, these parameters will investigate as displayed in Table 3.

The simulation was carried out 10 times for each mobility model, the sum of times is 40 for four mobility models, and the total number of times is 200 for all mobility models under five parameters. The performance metrics used for rating and evaluation are packet delivery fraction (PDF), throughput, no. of packet drop, NRL and AED. The parameters used in this paper are varying number of nodes, varying velocities, varying pause times, varying simulation areas and varying traffic rates. The results are shown in the following Figures:

Figure 2 a-e, shows the performance metrics of AODV over four mobility models (RWP, RPGM, GMM, and MGM) under CBR traffic type for parameter 1. In Fig. 2a, the throughput of AODV is more significant with RPGM and RWP and the throughput is less significant with GMM and MGM. Fig. 2.b, shows the PDF of AODV is best in RPGM and in RWP is somewhat best. PDF in GMM and MGM is worst. (Fig. 2c) displays the number of AODV drop packets in GMM and

MGM is higher than RPGM and RWP, the packets loss are increased when the no. of nodes decreased. In Fig.(2.d), the NRL of this protocol is decreased when the no. of nodes increased. The NRL in RPGM is low because the leader of group decides the speed of the members of group, the NRL in MGM is high. Figure 2e, shows the AED is decreased when the no. of nodes increased. AED in RPGM is least and in GMM and MGM is highest. Figure 3a-e shows the performance metrics of AODV over four mobility models (RWP, RPGM, GMM, and MGM) under CBR traffic type for parameter 2. In Fig. 3a, the throughput of AODV were decreased when the node speed was increased. RPGM and RWP have high throughput and PDF while MGM and GMM have low of it. Figure 3b displays the PDF of AODV protocol were decreased when the node speed were increased. RPGM and RWP have high throughput and PDF while MGM and GMM have low of it. Figure 3c, shows the no. of packets loss in GMM and MGM is highest while in RPGM and RWP is lowest, the loss packet is increased when the node speed increased. In Fig. 3d, the NRL of this protocol is increases with high speed for all mobility models. RPGM has low NRL than other mobility models while MGM has high NRL. Figure 3e, shows The AED increased when the node speed increased. AED in RPGM is lowest and in MGM and GMM is highest because in RPGM, the group leader determines the velocity of group members.

Figure 3b displays the PDF of AODV protocol were decreased when the node speed were increased. RPGM and RWP have high throughput and PDF while MGM and GMM have low of it. Figure 3c, shows the no. of packets loss in GMM and MGM is highest while in RPGM and RWP is lowest, the loss packet is increased when the node speed increased. In Fig. 3d, the NRL of this protocol is increases with high speed for all mobility models. RPGM has low NRL than other mobility models while MGM has high NRL. Figure 3e, shows The AED increased when the node speed increased. AED in RPGM is lowest and in MGM and GMM is highest because in RPGM, the group leader determines the velocity of group members.

Table 3. General Parameters for All Simulation Parameters.

Scenario Name	Parameter Number	No. of nodes	Node Speed	Pause Times	Area Size	Traffic Rate	Traffic Sources	Simulation Times
Varying No. of Nodes	1	25, 50 75,100	20	15	1000*1000	4	5	75
Varying Node Speeds	2	25	10, 20 40, 60	10	1000*1000	4	5	75
Varying Pause Times	3	50	40	0, 6 10, 14	1000*1000	4	5	75
Varying Area Sizes	4	60	20	12	500*500, 700*700 1000*1000 ,1200*1200	4	5	75
Varying Traffic Rates	5	75	15	10	1000*1000	4, 8 12, 16	5	75
Varying Traffic Sources	6	25	20	10	1000*1000	4	5, 10 15, 20	75
Varying Simulation Times	7	75	20	10	1000*1000	4	5	100,200, 300,400

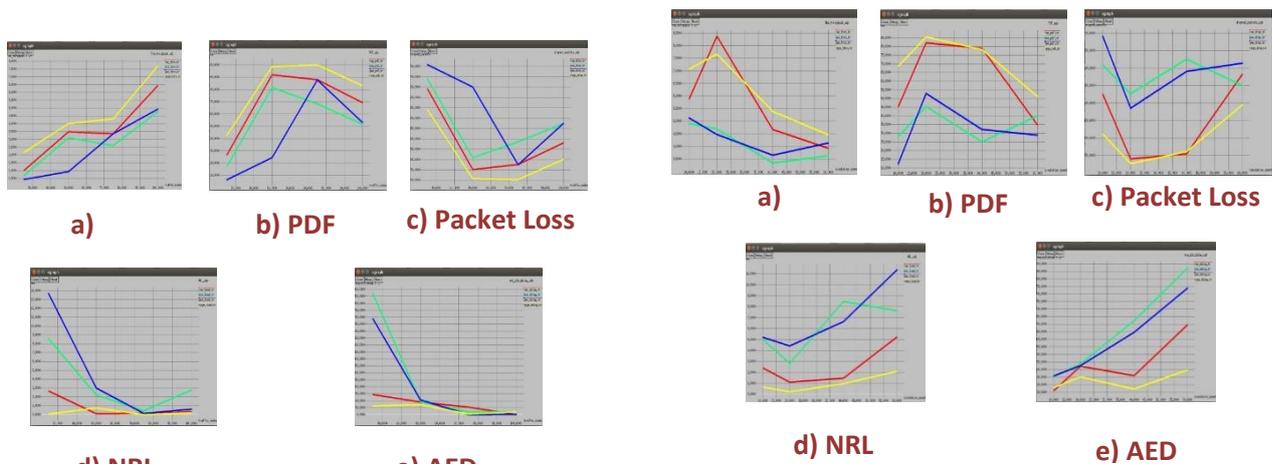


Figure 2.[a-e]: The performance metrics of AODV over four mobility models (RWP, RPGM, GMM, and MGM) under CBR traffic type for parameter 1.

Figure 3. [a-e]: The performance metrics of AODV over four mobility models (RWP, RPGM, GMM, and MGM) under CBR traffic type for parameter 2

Figure 4a-e, shows the performance metrics of AODV over four mobility models (RWP, RPGM, GMM, and MGM) under CBR traffic type for parameter 3. In Fig. 4a, the throughput of RPGM is extremely better than all the other mobility models and MGM and GMM have clearly worst results. Fig. 4b, shows the AODV has best PDF with RPGM mobility model. RWP is better next to RPGM. PDF in MGM and GMM is very low when compared to RWP and RPGM Models. Figure 4c, shows that in MGM and GMM, the number of packets loss increased when the value of pause time increased. RPGM and RWP provide a lowest no. of packet loss. In Fig. 4d, the normalized routing load of AODV can be simply sorted in an order from worst to best as follows: MGM, GMM, RWP and RPGM. Figure 4e, shows the RPGM and RWP exhibit the lowest delay and GMM and MGM have highest delay.

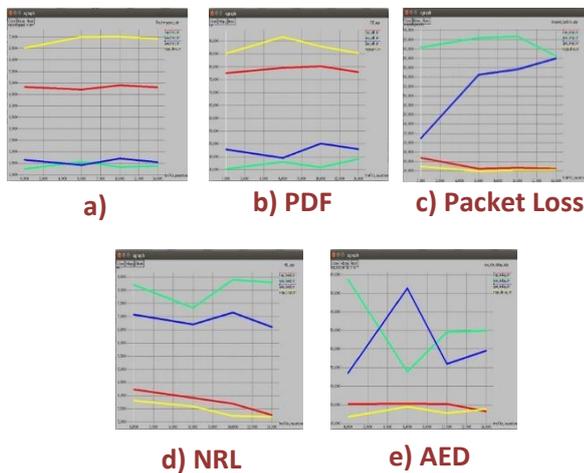


Figure 4. [a-e]: The performance metrics of AODV over four mobility models (RWP, RPGM, GMM, and MGM) under CBR traffic type for parameter 3.

Figure 5a-e, shows the performance metrics of AODV over four mobility models (RWP, RPGM, GMM, and MGM) under CBR traffic type for parameter 4. In Fig. 5a, the throughput of AODV became lower when the network load is higher. This protocol is highest in throughput with RPGM and lowest with MGM and GMM. Figure 5b, shows the PDF of AODV became lower when the network load is higher. This protocol is highest in PDF with RPGM and lowest with MGM and GMM. In Figure 5c, the no. of packets loss in GMM and MGM is highest while in RPGM and RWP is lowest, the loss packet is increased when the node speed increased. Figure 5d, shows the NRL of this protocol is decreases with large environment size for all mobility models. RPGM has low NRL than other mobility

models while MGM has high NRL due to the restriction of node movement in MGM. In Fig.5e, the AED increased when the environment size is increased because the no. of dropped packet was increased. AED in RPGM is lowest and in MGM and GMM is highest.

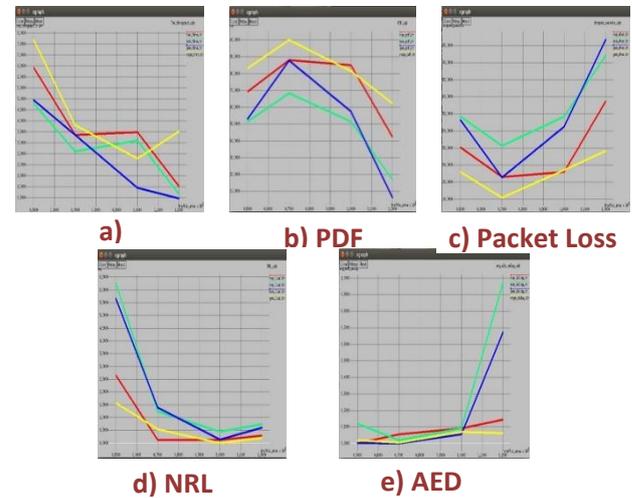


Figure 5. [a-e]: The performance metrics of AODV over four mobility models (RWP, RPGM, GMM, and MGM) under CBR traffic type for parameter4.

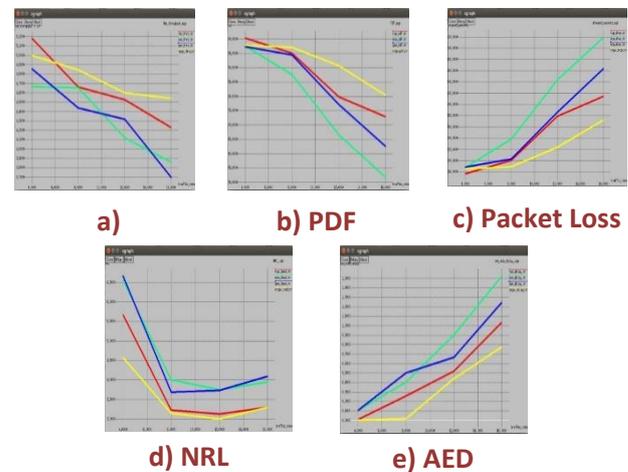


Figure 6. [a-e]: The performance metrics of AODV over four mobility models (RWP, RPGM, GMM, and MGM) under CBR traffic type for parameter5

Figure 6a-e, shows the performance metrics of AODV over four mobility models (RWP, RPGM, GMM, and MGM) under CBR traffic type for parameter 5. In Fig. 6a, the throughput of AODV became lower when the network load is higher. This protocol is highest in throughput with RPGM and lowest with MGM and GMM. Figure 6b, shows the PDF of AODV became lower when

the network load is higher. This protocol is highest in PDF with RPGM and lowest with MGM and GMM. Figure 6c, shows the no. of packets loss in GMM and MGM is highest while in RPGM and RWP is lowest, the loss packet is increased when the node speed increased. In Fig. 6d, the NRL. is decreased when the traffic rate is increased. The NRL in RPGM is low and in MGM is high. In Fig. 6e, the AED of AODV is increased when the traffic rate is increased. This protocol with GMM and MGM shows highest AED but with RPGM gives lowest AED.

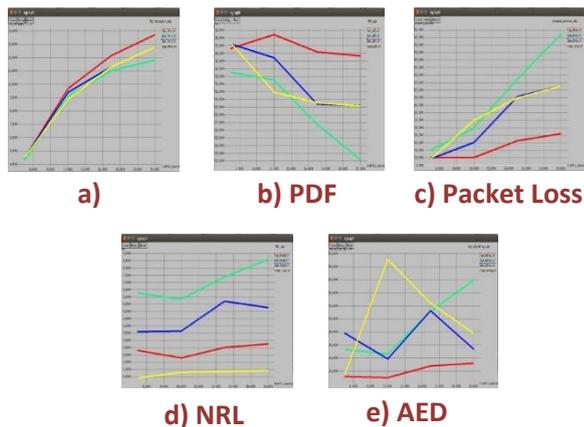


Figure 7. [a-e]: The performance metrics of AODV over four mobility models (RWP, RPGM, GMM, and MGM) under CBR traffic type for parameter 6.

Figure 7 a-e, shows the performance metrics of AODV over four mobility models (RWP, RPGM, GMM, and MGM) under CBR traffic type for parameter 6. In Fig. 7a, the throughput of AODV became lower when the traffic source is higher. This protocol is highest in throughput with RWP and lowest with MGM and GMM. Figure 7b, shows the PDF of AODV became lower due to the number of packet loss are decreased. This protocol is highest in PDF with RWP and lowest with MGM and GMM because in RPGM, the group leader in each group determines the group motion behavior and each member in group deviates its speed and direction randomly from that leader. Figure 7c, shows the no. of packets loss in GMM and MGM is highest while in RPGM and RWP is lowest, the loss packet is increased when the traffic source increased. In Fig. 7d, the NRL in Figure. is increased when the traffic source is increased. The NRL in RPGM is low and in MGM is high. Figure 7e, shows the AED of AODV is increased when the traffic source is increased. This protocol with GMM and MGM shows highest AED but with RPGM gives lowest AED.

In Fig. 8a, throughput of RPGM is extremely better than all the other mobility models and MGM and GMM have clearly worst results. Fig. 8b, shows the AODV has best PDF with RWP and RPGM mobility models. RWP is better next to RPGM. PDF in MGM and GMM is very low when compared to RWP and RPGM Models. Figure 8c, shows that in MGM and GMM, the no. of packets loss increased when the simulation time increased, RPGM and RWP provide a lowest no. of packet loss. In Fig. 8d, the NRL of AODV protocol can be simply sorted in an order from worst to best as follows: MGM, GMM, RWP and RPGM. Figure 8e, shows the RPGM and RWP exhibit the lowest delay and GMM and MGM have highest delay because in MGM and GMM, the nodes can move only in four direction with predefined probabilities to change direction only at the intersection point.

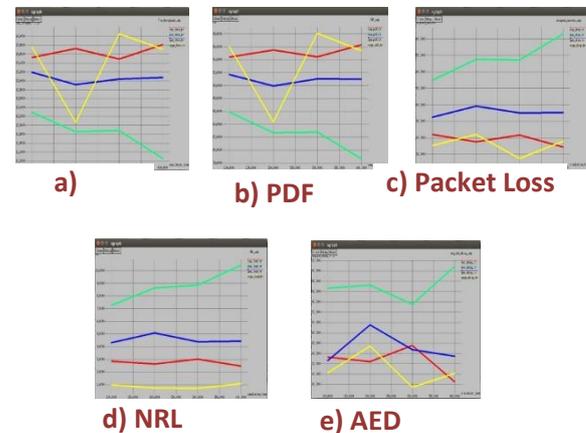


Figure 8. [a-e]: The performance metrics of AODV over four mobility models (RWP, RPGM, GMM, and MGM) under CBR traffic type for parameter 7.

Conclusion:

This paper presented an evaluated and analyzed the four mobility models performance using NS-2.35 and Bonn Motion-2.1.a according to several performance metrics with various parameters over CBR traffic pattern. After this evaluation, it has been found the RPGM is the best mobility model suited for AODV routing protocol when compared to other mobility model.

Although the RWP is widely used in MANETs, but the results of simulation shows that it is not the best among the mobility models in the case of CBR traffic pattern. The AODV routing protocol performance is the best with RPG mobility model than with other models. The routing protocol has poor performance when the mobility model is GMM or MGM mobility models. In Future work, would prolong this work to study the impact of these mobility and traffic sources on the most widely used MANETs routing protocols.

Authors' declaration:

- Conflicts of Interest: None.
- We hereby confirm that all the Figures and Tables in the manuscript are mine ours. Besides, the Figures and images, which are not mine ours, have been given the permission for re-publication attached with the manuscript.
- Ethical Clearance: The project was approved by the local ethical committee in Ministry of Education.

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تقييم أداء نماذج التنقل عبر نمط الحركة UDP لشبكة MANET باستخدام محاكي الشبكات-٢

غصون العباس²

علاء طعيمة البوصالح¹

¹ وزارة التربية، بغداد، العراق.
² قسم علوم الحاسبات، كلية الطب البيطري، جامعة المثنى، المثنى، العراق.

الخلاصة:

تعرض الدراسة الحالية دراسة وتقييم نماذج محاكاة شبكة الـ MANET على نمط حركة UDP لتحديد تأثيرات نمط الحركة هذا على نماذج التنقل في MANET والتي يتم تنفيذها في محاكي الشبكة NS-2.35 وفقاً لمقاييس الأداء المختلفة (الإنتاجية، نسبة الحزم المنقولة من المصدر الى الهدف (PDF) ، تحميل التوجيه الطبيعي (NRL) و زمن التأخير من نهاية إلى نهاية (AED)) مع مختلف المعلمات مثل السرعات المختلفة، ومناطق بيئة مختلفة، وعدد مختلف من العقد، ومعدلات مرور مختلفة، ومصادر مختلفة للحركة، اختلاف وقت التوقف وأوقات محاكاة مختلفة. نستخدم بروتوكول التوجيه AODV ونموذج نقطة الطريق العشوائية (RWP)، نموذج مجموعة نقاط المرجعي (RPGM)، نموذج غاوس ماركوف (GMM) ونموذج شبكة مانهاتن (MGM) ونماذج التنقل مع نمط الحركة CBR. تُظهر نتائج المحاكاة أن أداء بروتوكول التوجيه مع نموذج نقطة مجموعة المراجع RPGM هو الأفضل مقارنةً بنماذج التحرك الأخرى.

الكلمات المفتاحية: BonnMotion ، MANET ، نماذج التنقل ، تقييم الأداء ، نمط الحركة.