Performance Evaluation of Personal Ad-hoc Area Network Based on Different Mobility Models

Elmustafa S.Ali Ahmed[1], Bakhita El.Sheikh Ali[2], Eman Omer Osman[3], Tagwa Amin M. Ahmed[4]

Electrical and Electronic Engineering Department, Red Sea University, Sudan

---

Abstract: ***One of the main characteristics of ad hoc networks is their mobility. In order to evaluate an ad hoc network performance it is necessary to develop and use mobility models that accurately represent movements of the mobile nodes. In this paper, we analysis various mobility models: Reference Point Group Mobility, Random Waypoint Mobility, Freeway Mobility and City Section Mobility on the performance of IEEE 802.15.4 MAC ZigBee using AODV protocol in Network Simulator (NS 2.34). The comparative conclusions are drawn based on various performance metrics such as Packet Delivery Ratio, data loss, overhead, end-to-end delay and Throughput. The simulation results show that freeway mobility model is better than other mobility models.***

Key words: PANET, Mobility Models, MAC 802.15.4, Freeway, RPGM, RWP, City Section.

1. Introduction

Personal Ad-Hoc Networks (PANET) is a short distance wireless network specifically. As people use more electronic devices, with the proliferation of peripherals, a clear need for wireless connectivity between these devices has emerged. When you add mobility into the mix, the challenge becomes daunting. If the setup and administration of a WPAN becomes simple and intuitive in the future for the end user [1]. The technology ZigBee IEEE 802.15.4 falls under the category of Wireless Personal Area Network (WPAN). IEEE 802.15.4 can be used to connect devices wirelessly at a very low cost and with little energy consumption. ZigBee, which operates on the frequency band of 2.4 GHz and on 16 channels, can reach transfer speeds of up to 250 Kbps with a range of about 10 meters [2]. In this paper, we focus on the impact of mobility models on the performance of Personal Ad-Hoc Networks (PANET). Routing protocols detect the optimum path between the source node and destination node in a complex network of nodes and deliver the data packets between those nodes in an efficient manner [3]. We have use AODV, is a mainly used for wireless network where nodes are not stationary, on-demand routing protocol. Routes, in AODV protocol, are established based on minimum hop count, when it requires sending the data from source. So called AODV routing protocol as reactive routing protocol [4].

2. Mobility Models

Mobility model depicts the movements of the nodes inside a network. It is essential that mobility models used in simulating different scenarios must emulate closely the real scenario in order to assess the MANET performance as accurately as possible. There are many mobility models proposed. We are going to use the following four mobility model for our research.

2.1 Random Waypoint Mobility Model

In RWP, a specific node starts its motion from initial point and goes towards the destination with specific speed within simulation area. After reaching the destination, specified node wait for some time (pause time) and then randomly select other direction to move. The topological situation of RWP is dependent on two parameters, pause time and speed. If a node moves with high speed having short pause time then the topology is said to be more dynamic [5].

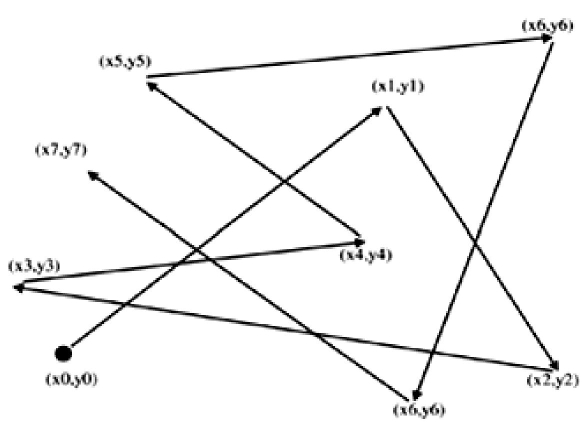

Figure- 1: The movement of one node with an RWP mobility model

2.2 Reference Point Group Mobility Model (RPGM)

In RPGM, each group has a logical center (group leader) that determines the group's motion behavior. Initially, each member of the group is uniformly distributed in the neighborhood of the group leader. Subsequently, at every instant, each node has a speed and direction that is derived by randomly deviating from that of the group leader. RPGM can be used in military battlefield communications [6].

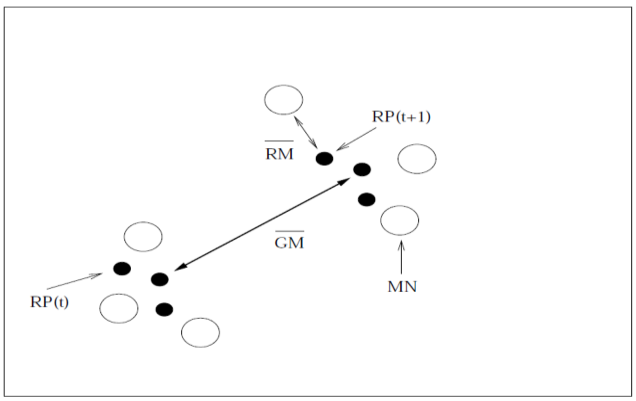

Figure -2: Movements of three MNs using the RPGM model

2.3 Freeway Mobility Model

This model emulates the motion behavior of mobile nodes on a freeway. It can be used in exchanging traffic status or tracking a vehicle on a freeway. Each mobile node is restricted to its lane on the freeway. The velocity of mobile node is temporally dependent on its previous velocity. In this model, we use maps [7].

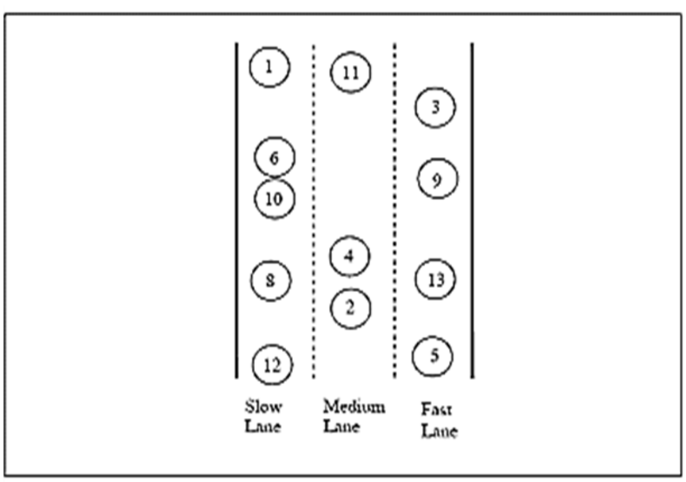

Figure -3: freeway mobility model

2.4 City Section Mobility Model

The City Section mobility model puts constraints on the movement of a node on a city street grid, constructed of horizontal and vertical streets [8]. Each street on the grid has two lanes for each direction (North and South direction for vertical streets, East and West for horizontal streets). The mobile node is allowed to move along the grid of horizontal and vertical streets on the map [9].

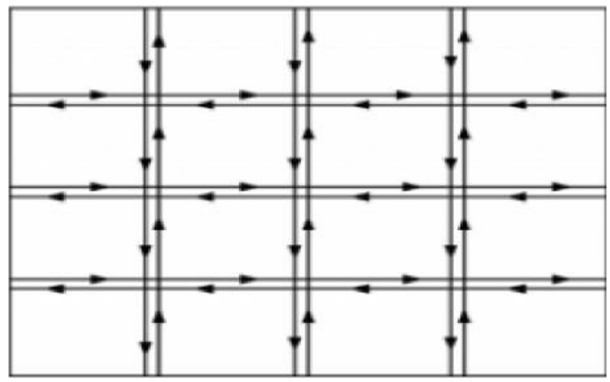

Figure -4: Maps used in city section mobility model

3. Simulation Models

The MANET network simulation, which is used to analyze the performance of mobility model in IEEE802.15.4 MAC protocols by using AODV routing protocol, consists of 50 mobile nodes. That mobility model are; Random Waypoint mobility model, Reference Point Group mobility model, Freeway mobility model and City Section mobility model.

For our simulations, we used the ns-2.34 network simulator and linked to matlab to draw the performance figures. The simulated performance results obtained using different performance metrics such as throughput, packet delivery ratio (PDR), routing overhead, end-to-end delay, and loss. Throughput is the average rate of successful data packets received at destination. End-to-End Delay represents a delay of a specific packet transmitted from source to destination by calculating the difference between send times and received times. Packet Deliver Ratio (PDR), is defined as the ratio between the amount of packets sent by the source and received by the destination [10]. Routing overhead, is the total number of control or routing packets generated by routing protocol during the simulation. Packet Loss, occurs when one or more packets fail to reach to their destination [11]. The following table shows the values of the various parameters used during simulation to evaluate the performance of mobility models in ZigBee network using IEEE802.15.4 MAC protocol.

Table -1: ZigBee Simulation Parameters

Parameters	**Values**
Routing protocol	AODV
Simulation time (sec)	100
Simulation area	100 x 100
MAC protocol	IEEE802.15.4 ZigBee
Application Traffic	CBR
Distribution model	RWP, RPGM, Freeway, City Section
No. of mobile nodes	50
Pause time(sec)	20, 40, 60, 80

4. Results and Discussion

We simulated four mobility models to evaluate the performance of IEEE802.15.4 using some performance metrics, the results of simulation we obtained are in the following figures.

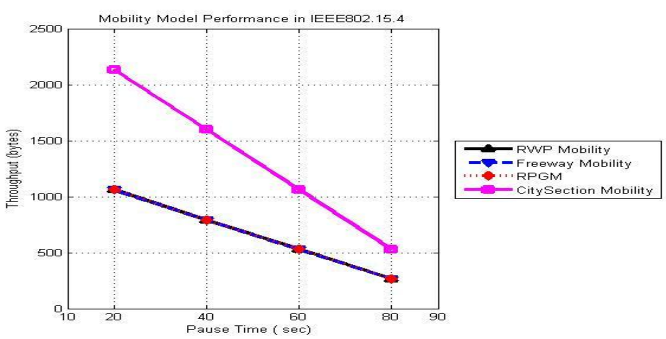

Figure -4: Throughput of different mobility models

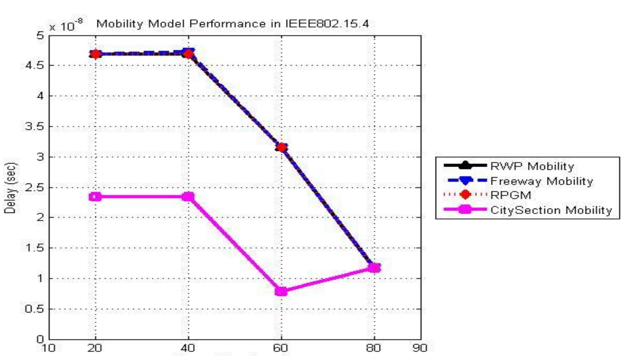

Figure -5: End-to-End delay of different mobility models

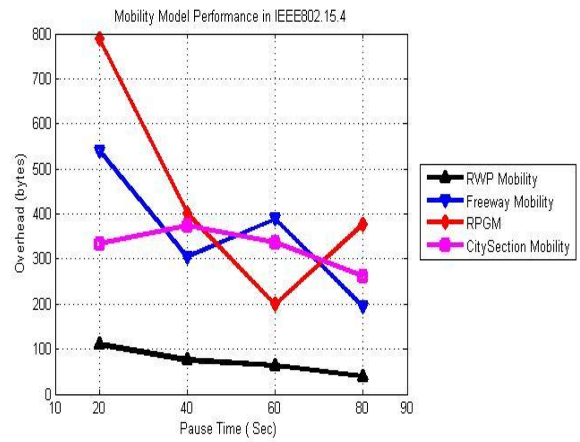

Figure -6: Overhead of different mobility models

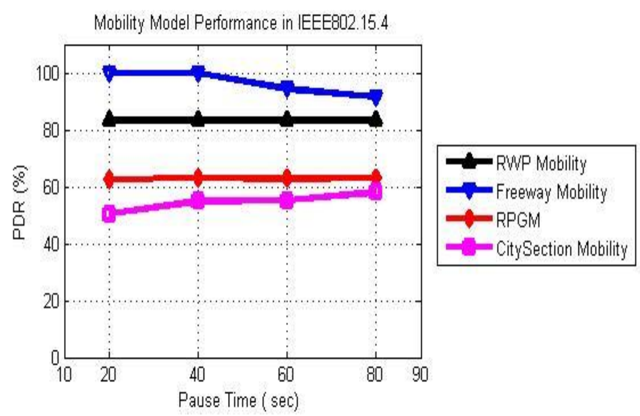

Figure -7: PDR of different mobility models

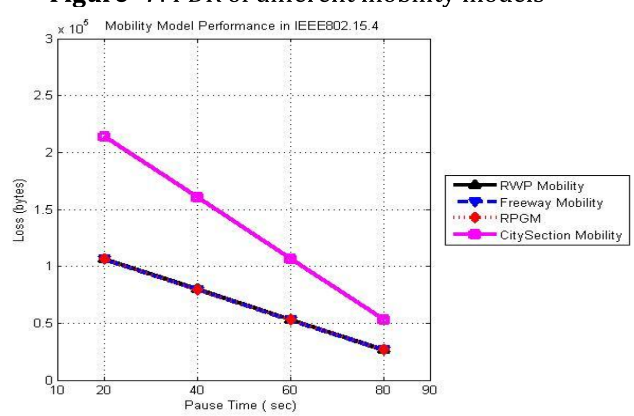

Figure- 8: Data loss of different mobility models

Figure-4 shows the mobility models performance in Wireless personal area network in terms of throughput in pause time 20, 40, 60, 80 under AODV routing protocol. The throughput begin with a high value when pause time

20sec and decreases when increasing the pause time until it reaches lowest value at pause time 80sec. Observes that city section has better throughput compared with the rest of the models, because the throughput in pause time 20s up to 210Kbyte and when pause time 80s up to 53Kbyte.

Figure-5 shows the mobility models performance in wireless personal area network in terms of average end-to-end (e2e) delay of data packets. It observes that the delay at the pause time 20sec has a high value for all models, because the time it takes the packet to arrive to the destination be large, and at the pause time 80sec the delay be lowest.

Figure-6 shows the mobility models performance in wireless personal area network in terms of overhead, under AODV routing protocol. The overhead is decreased with increase pause time, better performance is shown by RWP.

Figure-7 shows the mobility models performance in wireless personal area network in terms of PDR, under AODV routing protocol. Observes that freeway mobility model has better as compare to other mobility models, and also it is observed that among all the four mobility models PDR in city section is the worst because in city section model nodes move in forward and backward direction, right or left and directions are perpendicular to each other and the velocity of a node is restricted by the velocity of the preceding node on the same lane also when two mobile nodes diverge the probability of breaking the traffic signal increases.

Figure-8 shows the mobility models performance in wireless personal area network in terms of loss, under AODV routing protocol. It observes that the loss at the pause time 20sec has a highest value for all models. When the pause time is increase the loss is decreased. From the figure, it has clearly seen that the city section mobility has highest loss.

5. Conclusion and Future Work

This work evaluates the effect of four mobility models such as Reference Point Group Mobility, Random Waypoint Mobility, Freeway Mobility and City Section Mobility on the performance of IEEE 802.15.4 zig bee ad-hoc network, using AODV routing protocol. From the simulation results, we conclude that the performance of freeway mobility model is the best in terms of PDR when compared with the rest of the models. City section has highest throughput and lowest end-to-end delay. For the loss of data, we find that the three models has the same result which is lowest loss and the city section mobility has highest loss. In future the performance of MAC 802.15.4 ZigBee network could be evaluated by change in traffic pattern.

References

[1] http://library.tebyan.net/newindex.aspx?pid=102834ParentID=0&BookID=23799&MetaDataID=223665&Volme=1&PageIndex=26&PersonalID=0&NavigateMode=CommonLibrary&Content =. [Accessed in January 2015]

[2]http://en.kioskea.net/contents/834-wpan-wireless personal-area-network. [Accessed in March 2015].

[3] Nasser Ali Husieen, Mohammad M. Rasheed;"Analyzing Optimal Setting Of Reference Point Group Mobility Model Using DSR Protocol In MANETS"; International Conference on Information Technology; 2015

[4] Supriya Sawwashere, Ashutosh Lanjewar;"Improved Cost Efficient AODV Routing Protocol"; International Journal of Engineering Research and General Science; March-April, 2015.

[5] Zahid Khan 1, Tayeba2, Haleem Farman3, Isra Iqbal Awan2, Abdul Nawaz2; "Impact of Mobility Models over Multipath Routing Protocols"; International Journal of Information Technology & Computer Science (IJITCS).

[6] Harminder S. Bindra, Sunil K. Maakar and A. L. Sangal ;"Performance Evaluation of Two Reactive Routing Protocols of MANET using Group Mobility Model"; International Journal of Computer Science Issues, May 2010

[7] Aaliya Manzoor, Virender Sharma; "A Survey of Routing and Mobility Models for Wireless Ad hoc Network"; SSRG International Journal of Computer Science and Engineering (SSRG-IJCSE) – EFES April 2015

[8] Nicholas Cooper and Natarajan Meghanathan; "Impact of mobility models on multi-path routing in mobile ad hoc network"; International Journal Of Computer Networks & Communications (IJCNC), Vol. 2, No.1, January 2010

[9] Fan Bai, Narayanan Sadagopan, Ahmed Helmy;" IMPORTANT: A framework to systematically analyze the Impact of Mobility on Performance of Routing protocols for Ad hoc Networks"; IEEE INFOCOM 2003.

[10] Parma Nand, Dr. S.C. Sharma ;"Performance study of Broadcast based Mobile Ad hoc Routing Protocols AODV, DSR and DYMO"; International Journal of Security and Its Applications; Vol. 5 No. 1, January, 2011.

[11] Suman Kumari , Sunil Maakar, Suresh Kumar, R K Rathy ; "Traffic Pattern Based Performance Comparison of AODV, DSDV & OLSR MANET Routing Protocols using Freeway Mobility Model"; (IJCSIT) International Journal of Computer Science and Information Technologies; Vol. 2 (4) , 2011.

Authors Biography

Bakhita El.Sheikh Ali, She is presently doing B.Sc. degree with honors in red sea university faculty of Engineering, complete her graduate research in September 2015. Her research interest on field MANETs and Wireless Networks.

Eman Omer Osman, She is presently doing B.Sc. degree with honors in red sea university faculty of Engineering, complete her graduate research in September 2015. Her research interest on field MANETs and Wireless Networks.

Tagwa Amin M. Ahmed, She is presently doing B.Sc. degree with honors in red sea university faculty of Engineering, complete her graduate research in September 2015. Her research interest on field MANETs and Wireless Networks.

Elmustafa Sayed Ali Ahmed, received his M.Sc. degree in electronic engineering, Telecommunication in 2012, and B.Sc. (Honor) degree in electrical engineering, Telecommunication. He was a wireless networks (Tetra system, Wi-Fi and Wi-Max) engineer in Sudan Sea Port Corporation for four years and a head department of electrical and electronics engineering, faculty of engineering in Red Sea University for one year. He published papers on wireless communications and networking in peer-reviewed academic international journals and book chapters in big data clouds. His areas of research interest include MANETs, wireless networks, VANETs, image processing, computer networks, and Cloud computing.