Performance Assessment of Distinct Mobility Models used in Wireless Body Area Network

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Abstract
In the Internet of Things (IoT) age, Wireless Body Area Networks (WBANs) have developed into a key component with a centre on different applications, as healthcare. These networks offer significant monitoring and diagnostic capabilities. In a typical WBAN setup, there is I a small network close to the body (between 1to2 metres), II a path (sink) connecting to other network groups, which can be one or more nodes with specific routing and records combined features, III a broad-ranging network, which can be an Internet or intranet system, and IV submissions with GUI for medical or different healthcare professionals. Communication between nodes and the sink as a whole becomes rather challenging since the humanoid body's gestures cause the WBAN radio broadcast's features to be robust. Nodes that are close to the static sink appear to be transmitting data constantly. As a result, the node closest to the sink uses up its energy significantly faster than nodes farther away. The solution to the aforementioned problem is sink mobility. Work that is scheduled includes calculating WBAN performance using an entity mobility model. Random waypoint mobility model, Mobility models from the Reference Point Group, and Mobility models from the Reference Velocity Group are examples of random direction mobility models with movable and static sinks. Network Simulator 2.35 is used to simulate. Metrics for evaluation include Average E2E latency, Packet Delivery Ratio, and Average Throughput. Results from simulations indicate that mobile sink improves system performance as a whole.

Keywords: Random Waypoint Mobility, Random Direction Mobility, Reference Point Group Mobility, Wireless Body Area Networks, Internet of Things, End-to-End

1. Introduction
1.1 Wireless Body Area Network (WBAN)
WBAN typically includes mote nodes that can be implanted or worn on or near the body. These sensor nodes will serve as network nodes where two-way communication, from sensor to sensor and from sensor to coordinator, is required. Since a few decades ago, wireless broadcasting has played an extremely important part in our way of life. It contributes in a variety of ways because it's a crucial component of various practical applications including tracking appliances, tracking devices, monitoring, and automation. Because of the world's rapidly expanding population, everyday life has become more expensive, especially in wealthy nations like Japan, Spain, Germany, and Italy, etc. Given the swift increase of population, the average age of those over 60 is rising, which means that they require more care for their health and spend extra on treatments [5]. Tragically, chronic and dangerous illnesses including cancer, asthma, and cardiovascular conditions are frequently detected too late, which raises the average death rate among those who receive a diagnosis. Early detection of these disorders may allow us to lessen their effects and lengthen the life expectancy of patients [7]. Recent research studies show that WBAN is an effective approach to the implementation of an electronic health care system [10].

1.2 Entity Mobility Model
A. Random Waypoint model
RWP, or the random waypoint mobility model:
A mobile path contains a series of journeys. All mobile nodes are initially given a fixed position in the zone at time 0. The mobile randomly chooses a next waypoint Mn at the beginning of each journey that is always in the zone and a following quickness Vn that is always between [Vmin; Vmax], regardless of the previous and current values. Then, it travels at a constant speed Vn in the direction of the newly chosen terminus. The mobile pauses for a

predetermined or arbitrary amount of time when it reaches Mn. It restarts the process after this period has passed.

B. Random direction mobility model

Mobile nodes are initially given a fixed position in the zone at time 0. The mobile randomly chooses a direction theta that is always between [0; 2], a speed Vn that is always between [Vmin; Vmax], and a travel duration t that is exponentially circulated with an assumed mean at the beginning of each tour. Then it moves at speed Vn for a time t in the direction theta. Similar to this, when the mobile reaches Mn, it pauses for a predetermined or random amount of time before randomly choosing a new direction, speed, and travel duration [1][2][3][4]. Several grade of service restrictions, together with PDR, Average Throughput, and Average E2E Delay, are used to assess the effectiveness of WBAN. The direction-finding technique is used to produce two alternative scenarios for testing in the network simulator, each with a different node count (25 - 50) and utilising these two static and mobile sink.

1.3 Group Mobility Model

The RPGM model is a group mobility model, where random move of a group and every node private a group is symbolized. Here, each group has a sensible centre or group leader and this group leader chooses the group's motion conduct. In tons of major uses like soldier struggle in battlefield, movement of attendee groups in an presentation etc., there is a sturdy association between the nodes and they are permissible to travel in certain limited areas only. This can be fine denoted by RPGM.

2. Related Work

Khan et al. [1] suggested a movement model that is a 3D execution of present Random Direction (RD) mobility model and presented in what way a mobility model influences the whole network. Supriya Agrahari et al. [2] presents the RWM model for relating reconstruction of mobile nodes circulation inside the network. Haque Nawaz et al. [3] explored mobility models which deliver the specific mobility outline to decide the problematic of association, communication. These mobility models deliver the podium to know and implement WBAN. Luis Irio et al. [4] distinguishes the wireless intrusion of a mobile adhoc network, where mobile nodes approves to RMP model. Scattering of the intrusion is examined compelling into clarification of the imaginary nature of path damaged because of movement of nodes. Attard S. and Zammit S. [6] proposed a highly promising technology, i.e. Body Coupled Communications (BCC) technology, has been used to connect BAN devices. Human body is used as a means through which the signals are communicated in this form of wireless communication. For attaching devices to the human body, the capacitive BCC displays very favorable properties. Low signal attenuation is one such property that improves the battery lifespan of BAN devices. The confinement of signal power near to the human body is one more property, making BANs more stable and less vulnerable to interference. Authors have attempted to show that various motions of the body develop in substantially unlike activity of the BCC channel. Channel properties are also affected by the form and speed of human body movement. The proposed work in [9] described a system called Least Distance Movement Recovery (LDMR) which is based on a distributed approach. In this approach, the recovery from network partitioning is accomplished by shifting the roles and responsibilities of failed nodes to its immediate neighbors. The major constrints of LDMR are (i) expenditure of massive proportion of energies by each node to search for the non-vertex node at time of recovery and (ii) the congestion arises in the network due to the flooding of the packets by each node to search the non-vertex node. Protocols in [8] find the updated path each time, when there is a change in topology due to postural mobility. The main drawbacks of these protocols is that a massive amount of energy is absorbed by every node because the huge amount of computation overhead for the path discovery activities during recovery from network dividing. Prabhakar D. Dorge [11] stated that the Reference Point Group
Mobility (RPGM) model is based on correlated node mobility.

3. Proposed Work

N numbers of heterogeneous sensor are deployed across geographically area. A static sink node is employed at the Centre of the network (static sink is stationary having a steady point, sit either inside or closer to the sensing zone) and mobile sink node is free to move across the entire wireless sensor network. The same fixed communication radius is used for data transfer between both sinks and all sensor nodes. The Pci (average power consumption) for a BS is designated as: Assuming static power usage and optimum conditions for data traffic,

$$\mathrm{Pc}_i = \mathrm{N}_{\mathrm{sec}} N_{ant} \left(A_i P_{tx} + \mathrm{B}_j + \mathrm{P}_{BHi} \right) \tag{1.1}$$

Nant is intended to reflect the number of antennas per sector for particular base station, whereas Nsec is meant to show the entire number of sectors. Pci is the mean of whole power of all base stations, Ptx is the transmited power for every base station. Always Ai represents the portion of Pci that is directly proportionate to the power transfered from a BS, whereas Bj represents the fraction of power used independently of the typical communicated power from a base station. These are the primary components that make up a base station's energy competency. While Nsec is supposed to display the total number of sectors, Nant is intended to depict the number of antennas for every sector for a single base station. Ptx is the communicated power for each base station, whereas Pci is the mean of aggregated power of all BS. Ai is for the portion of the Pci that is directly equivalent to the power transferred from base station, Bj speaks for the component of the Pci that is spent independently of the typical power broadcast from a base station. These are the essential characteristics that, in actuality, characterize a base station's energy competency. PBhi is introduced to control the power usage that occurs during communication. The EE model mentioned above provides the idea of a particular heterogeneous system's effectiveness in a region. We want to identify the heterogeneous network region that is fully utilized across various regions. In order to do that, we need to compute the effectiveness over a specific time frame. Assuming that Thet represents the overall data transfer period for a heterogeneous network Calculating time efficiency is as follows:

$$\mathrm{Te} = \frac{EEhet}{T\ het} \tag{1.2}$$

Table 1: Simulating Parameters

S. No.	Names	Value
1	Channel type	Wireless channel
2	Propagation model	Propagation / Two Ray Ground
3	Antenna Types	Omni Antenna/ Antenna
4	Total no. of Nodes Entity Mobility Model	25, 50
5	No. of Nodes Group Mobility Model	25-100
6	Protocol	DSDV
7	Simulation Time	1050

4. Results and Analysis

i) Entity mobility model

In this work, the EM s i) RWM ii) Random Direction Mobility Model for Stable and Random Sink Nodes are used to analyze the DSDV routing protocol. In this section, the results of DSDV with a static sink node and DSDV with a random sink node are compared. For 25, 50 nodes, the comparison is conducted.

Table 2: Performance of DSDV (Random Waypoint Mobility Model and Static Sink Node n=25)

PDR	Throughput (Kbps)	Average E2Edelay (ms)
84.28	0.790500	0.022759

Table 3: Random Direction Mobility Model with Static Sink Node Performance of DSDV (n = 25)

PDR	Throughput (Kbps)	Average E2Edelay (ms)
78.74	1.474500	0.193834

Table 4: Performance of DSDV (Random Waypoint Model and Static Sink Node n = 50)

PDR	Throughput (Kbps)	Average E2Edelay (ms)
61.42	0.437000	0.011455

Table 5: Random Direction Mobility Model with Static Sink Node Performance of DSDV (n = 50)

PDR	Throughput (Kbps)	Average E2Edelay (ms)

54.59	0.773000	0.010492

Table 6: Performance of DSDV (Random Waypoint Mobility Model and Movable Sink Node n = 25)

PDR	Throughput (Kbps)	Average E2Edelay (ms)
100	0.938000	0.001512

Table 7: Random Direction Mobility Model with Movable Sink Node Performance of DSDV (n = 25)

PDR	Throughput (Kbps)	Average E2Edelay (ms)
100	1.872500	0.001174

Table 8: Performance of DSDV (Random Waypoint Model and Movable Sink Node n = 50)

PDR	Throughput (Kbps)	Average E2Edelay (ms)
100	0.711500	0.001540

Table 9: DSDV's (Random Direction Mobility Model with Movable Sink Node n = 50) performance

PDR	Throughput (Kbps)	Average E2Edelay (ms)
100	1.416000	0.001192

Table 10: Analysis of Results for 25 Nodes

Mobility Model	PDR (%)	Throughput Kbps)	Average E2Edelay (ms)
DSDV-RWM Static Sink	84.28	0.790500	0.022759
DSDV-RDM Static Sink	78.74	1.474500	0.193834
DSDV-RWM Movable Sink	100	0.938000	0.001512
DSDV-RDM Movable Sink	100	1.872500	0.001174

Table 11: Analysis of Results for 50 Nodes

Mobility Model	PDR (%)	Throughput Kbps)	Average E2Edelay (ms)
DSDV-RWM Static Sink	61.42	0.437000	0.011455
DSDV-RDM Static Sink	54.59	0.773000	0.010492
DSDV-RWM Movable Sink	100	0.711500	0.001540
DSDV-RDM Movable Sink	100	1.416000	0.001192

ii) Group Mobility Model

Table 12: Analysis of PDR for 25 to 100 Nodes

No. of Mobile Nodes	PDR% (Reference Point Group Mobility Model)	PDR% (Reference Velocity Group Mobility Model)	PDR% Hybrid Mobility Model
25	93.52	99.2	100
50	92.8	99.1	100
75	87.45	99	95.37
100	83.35	98.9	94.03

Table 13: Analysis of Throughput for 25 to 100 Nodes

No. of Mobile Nodes	Throughput (Kbps) (Reference Point Group Mobility Model)	Throughput (Kbps) (Reference Velocity Group Mobility Model)	Throughput (Kbps) Hybrid Mobility Model
25	5.907	6.2565	46.6855
50	4.0915	4.4635	33.1775
75	3.025	3.5085	17.2285
100	2.524	3.0725	11.037

Table 14: Analysis Average of End-to-End delay for 25 - 100 Nodes

No. of Mobile Nodes	Average End-to-End Delay (ms) (Reference Point Group Mobility Model)	Average End-to-End Delay (ms) Reference Velocity Group Mobility Model	Average End-to-End Delay (ms) Hybrid Mobility Model
25	0.02851	0.001592	0.001571
50	0.01954	0.001635	0.00125
75	0.0344	0.001492	0.00139
100	0.04386	0.001557	0.001418

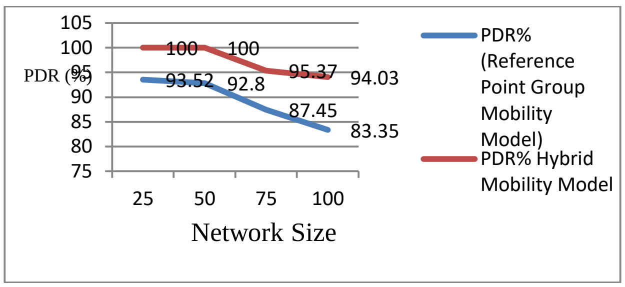
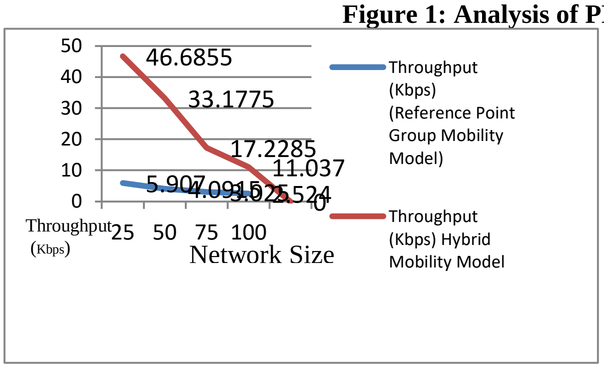


Figure 1: Analysis of PDR for 25 to 100 Nodes



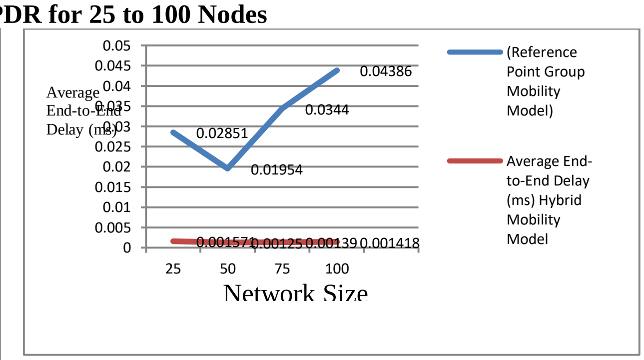


Figure 2: Analysis of Throughput for 25 to 100 Nodes	Figure 3: Analysis of Average End-to-End delay for 25 to 100 Nodes

5. Conclusion & Future scope

We looked at the most recent mobility models in this paper for a variety of environment scenario trajectories in WBAN. These models have been divided into two categories, with each group being further subdivided. These mobility models offer the framework for comprehending and applying the WBAN. The mobility models were created using the NS 2.35 simulator tool to account for different movement patterns. The results of the simulation demonstrated that a movable sink provides the greatest improvements in throughput, packet delivery ratio, and E2E delay. Future research will focus on creating fault-tolerant algorithms to handle topology changes brought on by postural movement.

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