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MWSN Modeling Using OMNeT++ Simulator

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***Abstract*—The Mobile Wireless Sensor Network (MWSN) plays an important role in many applications and activities and we have presented our experience to design the MWSN which execute the realistic explanation by using OMNeT++. The simulation is based on proper selection and estimated parameters for generating and establishing better performance. A detailed analysis of the design using OMNet++ (MiXiM Framework) helped in depth understanding of the network and has resulted into a better MWSN design. In this paper, we also discuss in detail the mobile nodes architecture, mobile nodes movement at different time interval and evaluate the results for the simple scenario of MWSN.**

***Keywords*—mobile wireless sensor networks; mobile nodes; OMNeT++; MiXiM;**

I. Introduction

Mobile wireless sensor networks (MWSN) are used to effectively address countless challenging issues of monitoring and of performance of different tasks in our daily routine. The major benefit of mobile node is to permit superior channel capacity, minimize the hops messages and use communication pathways to preserve data integrity. MWSN is generally being practiced in applications like military operations, intelligence activities, monitoring communication, controlling devices, and surveillance activities. The advantage of using mobile node is that it has the ability to move and sense by itself. Due to the multi operations of MWSN in many applications, the current research focuses on effectiveness of energy, communication overhead and protocols in MWSN [1]. Currently, MWSN has become important for dealing with security threats and monitoring issues [2].In many applications, the security issues are related to energy computation, monitoring and communication performance evaluation of the network [3]. To eliminate the security threats, networks should be modified with respect to handover methods like monitoring, communication approaches and surveillance. Nodes deployment is necessary for performance analysis, effectiveness and evaluation of different parameters in MWSN. Accordingly, simulation is the valuable tool to demonstrate, analyze and evaluate various scenarios in sensor networks. Further, complex and impossible scenario of various designs and value testing can be performed by simulations [4].

In this paper, we have presented a design of a mobile wireless sensor network (MWSN) based on the realistic explanation by using OMNeT++. Further, we have explained step by step, the essential parameters to design MWSN. Our emphasis is that MWSN design parameters must be accurately settled for generating, analyzing and establishing better performance. This design presents a detailed analysis that characterizes the behavior of MWSN and provides brief knowledge about performance analysis in various fields. In this paper, we thoroughly discuss the design of node with mobility features and evaluate the results for the simple scenario of MWSN. The implementation, analysis and visualization of MWSN design (using OMNeT++) has been explained in this paper. Major focus of simulation design is to get accurate results and evaluation of real world pattern performance model by using real mobility situation in the networks [5]. This paper reports our knowledge, contribution and outcomes of the basic model design (MWSN) using OMNeT++ simulator. This is because the network simulator is really helpful to demonstrate and establish different structures in this field. In this paper, we also estimate the performance of MWSN using the specific framework MiXiM (OMNeT++ simulator) [6]. In terms of mobility; this framework has ability to demonstrate the modeling required for all necessary elements for MWSN [7]. In paper [8], author has given a detailed overview of the MiXim Framework. He divided the MiXim Base Model in four different categories: a) Environmental Model, b) Connection Model, c) Wireless Channel Models and Physical Layer Models. Further, comparison of OMNet++ simulator and other simulator has been discussed in detail [9], which illustrates the standard simulation tool for wired and wireless models.

Motivation: Currently, the main focus of the research is to capture and resolve the issue regarding the mobility in an effective and timely manner. OMNeT++ is the source to design the different aspects of MWSN model for analysis, monitoring, communication and observation of the mobile nodes.

Contribution : In this paper, we have utilized our experience in this field to explain the procedure for analyzing the design of various parameters of MWSN and an approach to get better performance, evaluation and outcomes [10]. In this paper, the major and an important concern is to introduce the MWSN model design in OMNet++ (MiXim Framework), as it would be very informative and helpful for the new researcher.

Organization: In the beginning, we briefly introduce

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the MWSN, and its applications and advantages over WSN. Section II explains the motivation and contribution regarding model design in OMNeT++ using MiXiM framework. The remaining paper is systematized into further different sections. Section III illustrates the proposed model of MWSN whereas section IV demonstrates the simulation outcomes which exhibit the influence of various functional parameters of MWSN. The last section, section V highlights the performance evaluations and results of our work.

II. An Overview of MWSN

The network consists of huge number of small mobile devices known as mobile nodes. Every node has a power source, sensors, memory, Micro-controller, mobility features and a transceiver. The sensor node's functionality, effectiveness and value can be improved by using mobility. Mobile nodes can be used to reduce installation costs, extend the connectivity to wireless, enhance the latitude in various applications, establish a robust behavior to vary environmental conditions and sustain whole coverage in limited period [2]. The simple MWSN model design in Fig.1 has been showed. It operates for comprehensive analysis regarding channel connectivity models, mobility, obstacles design, communication protocols and graphical representation of wireless developments [11]. A design of MWSN is generated that illustrates a report regarding different steps and their outcome evaluation. An analytical analysis, connectivity issues and understating of various performances has been provided through this model. The performance metrics in MWSN are coverage, uniformity, time and distance [12]. MWSN has extra valuable functionality compared to WSN in term of coverage, data routing, data mulling, user access point and intermediate data. The mobile node has brought distinct challenges in terms of coverage, resource management, routing protocols and security. The mobility feature has advantages as well as some problems in sensor networks such as time and space consideration while gathering information and data processing can be delayed due to moving nodes and positioning effect of nodes. The most important

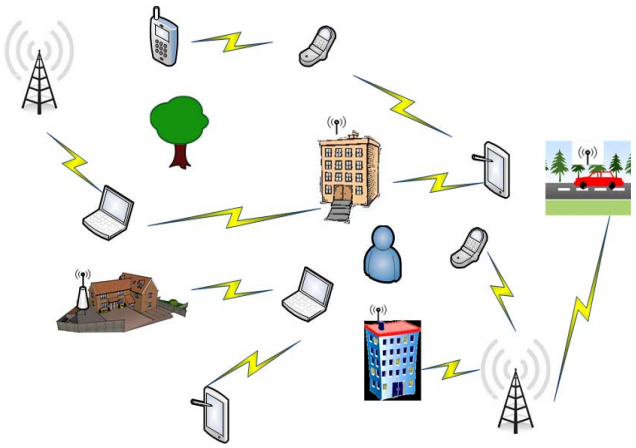

Fig. 1. Mobile nodes in MWSN

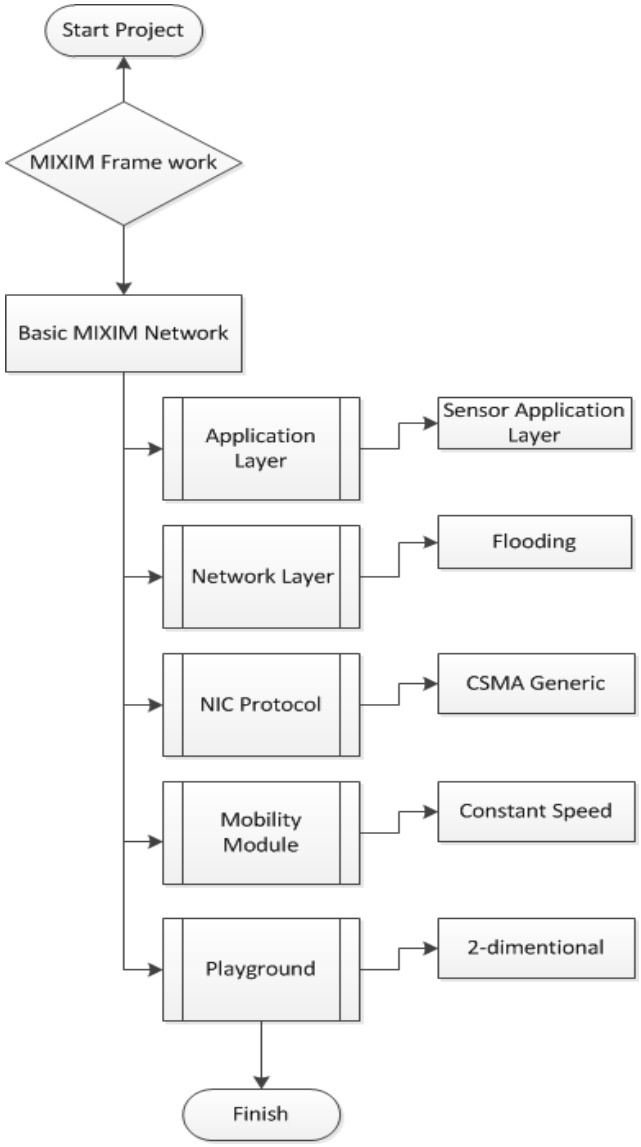

Fig. 2. Steps for MWSN project design on OMNET++

influence of mobile nodes in sensor networks depends upon management of energy and topology [13]. The topology management is used to establish the nodes routing and connection between nodes [14].

III. MWSN Proposed Model

To establish the simulation models, the OMNeT++ (discrete event network) has been used which consists of libraries and tools for designing of different models [9]. Due to its generic behavior it can be used in different fields like models architecture, ability to analyze the characteristics of complex models and hardware modeling. MiXiM is an

enhanced version of mobility framework established for WSN and MWSN in OMNeT++ [15].

A. System Model

We executed the MWSN model in the MiXiM version2.3 (OMNeT++ 4.3) network simulator. We presented MWSN comprising the features of mobile nodes with limited battery, processing and storage. For communication between sensors nodes, single channel has been used, which required the establishment of MAC (Medium Access Control) protocol. For reliable communication, MAC has challenging issues pertaining to mobility and energy. The MWSN design developments are slightly complicated as it requires in-depth knowledge to present a comprehensive analysis. We demonstrate that MWSN structural design consists of a total of 10 mobile nodes. In the MWSN model, the mobile nodes are responsible for establishing connection, gathering, transferring and delivering information. The mobile node has ability to randomly move, transfer and swap locations [16].

B. OMNeT++ Project Design

For WSN and MWSN model simulations in OMNeT++, a mixed framework known as MiXiM is used [8]. Through this, the features of wireless channel connection and different mobility model like circular, rectangular and constant speed can be elaborated extensively. The advantage of MiXiM framework is that it reduces the complexity of the model and we can obtain accurate analysis. The OMNeT++ consists of various tools: the NED, INI file, MSG file, result analysis tools, simulation launcher, documentation generator, C++ development and debugging [17] and building application modules which include the outline view, problem view, module hierarchy view, Parameters view and NED inheritance view respectively [18]. To build a model in OMNeT++, requires following steps:

1) Create Project
2) Design the model(the NED file and C++ Codes)
3) Configure the Project(the INI file)
4) Build the Project
5) Analyze the results

Fig.2 shows the steps used in our proposed model of MWSN. First, select the new project and then MiXiM frame which is going to be used for the designing of sensors network. The MiXiM framework is further divided into two types: Analogue Module test and Basic MiXiM network. We chose the Basic MiXiM network for simulation as it has ability to select the various features. It consists of five different parameters: (a)Application Layer,(b)Network Layer,(c)NIC protocol,(d)Mobility Module and(e)Playground. In our proposed method, we used sensor application layer, flooding, CSMA Generic, Constant speed and 2-dimensional features [11].

C. Mobile Nodes Architecture

The architecture of a mobile node in MWSN is comprised of different layers; i.e. NIC, application, physical, MAC and network [14]. We elaborate complete operations of application, MAC and network layer. Fig.3 demonstrates the build in architecture of node in MiXiM framework [19]. The packet transmission between Mac layer, Network layer and Application layer using OMNet++ (MiXiM framework) in Fig.4 has been showed. The Macpkt, Netwpkt and Applpkt are the packets used for the data transmission from one layer to another.

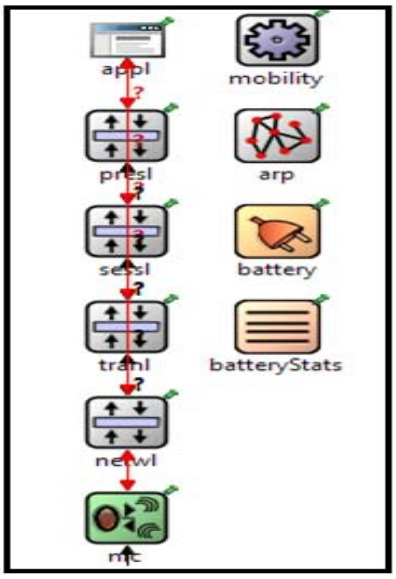

Fig. 3. Mobile node architecture using MIXIM framework (OMNET++)

1) Application layer: It is responsible for sending the request to the MWSN generated by the user. The application layer comprises, generates and evaluates the sensors of mo-

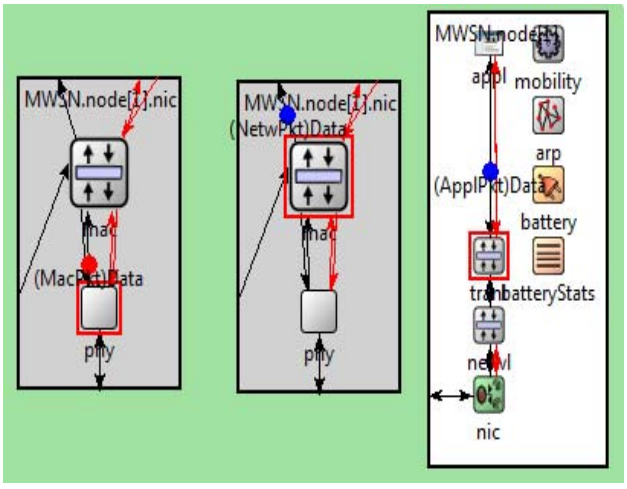

Fig. 4. Packets transmission between (MAC,Network and Application) layers using MIXIM framework(OMNET++)

bile nodes and transmits information. After request delivery, the node starts to collect the information and sends it back in form of a message. It can also be used for routing protocols.

2) MAC layer: Transceiver is the essential parameter regarding energy consumer in a mobile node at Mac layer. According to our information, there is no far executions in aspect of MAC protocol that can be helpful to fix mobile node architecture [19].

3) Network layer: The network layer has ability to perform reconfiguration and code re-usability in a quick manner by using routing protocols. For the upper layers in MWSN, a connectionless multi-hop communication is provided by network layer and plays an important role in forwarding packets to the multiple destinations, retransmissions, acknowledgments, routing establishment and maintenance. Generally, the operation remains the same in routing protocol, only the logic and approaches of module vary which practice different parameters [19].

D. Simulation Parameters

The evaluation of MWSN model consists of 10 mobile nodes. The size of the playground is 300mx300m. The mobile nodes considered were periodic traffic type, node type is Nic CSMA, data rate is15360b/s, queue length is 5, voltage is 3V, thermal noise is -100dbm, velocity is 5m/s, packet size is 24bits, mobility model is Random Way Point (Constant Speed), layer is sensor application layer and simulation time is 60sec. Table I shows the parameters used in the design model of MWSN.

TABLE I. SIMULATION PARAMETERS OF MWSN MODEL

Parameter	Value
Network size	300x300m
Nic Type	Nic CSMA
Number of mobile nodes	10
Mobility model	Random way point
Velocity	5m/s
Packet size	24bits
Voltage	3V
Simulation time	60sec
Traffic type	periodic
Layer	Sensor Application Layer
Thermal noise	-100dbm
Carrier frequency	2.412e+9Hz
Queue length	5
Bit rate	15360b/s

IV. SIMULATION RESULTS AND ANALYSIS

We analyzed the mobile nodes movement at t=0 when mobile nodes were not moving and at t=10sec when they

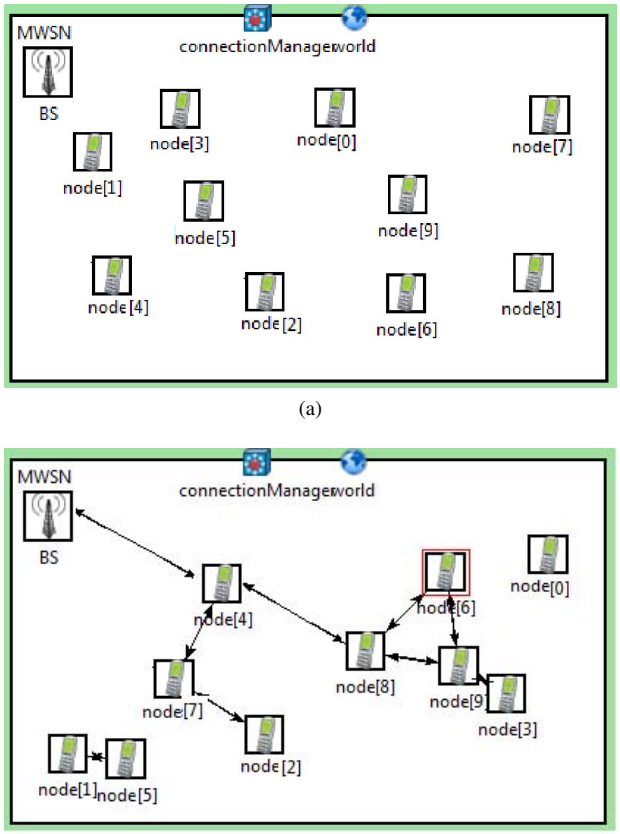

Fig. 5. MWSN Model in OMNet++(MiXim Framework)(a) At t=0. (b) At t=10sec.

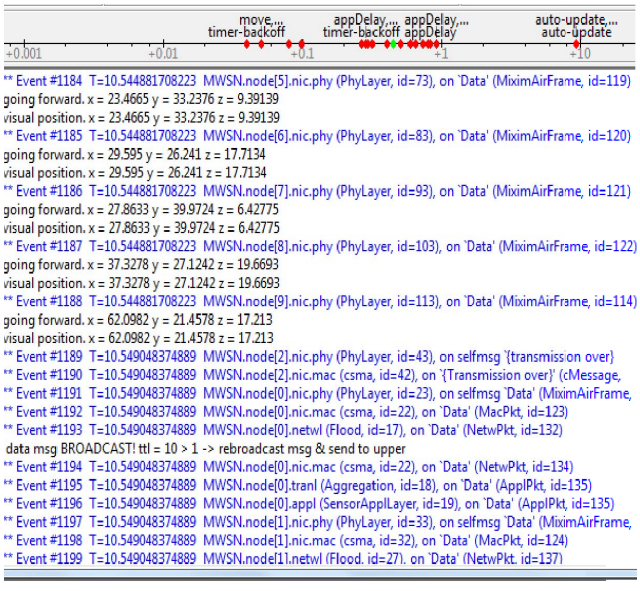

Fig. 6. Events regarding data transmission in MWSN

moved according to the Random Way Point Model (Constant speed) in our proposed model. The Fig.5 shows the captured position of the mobile node at t=0 and at t=10sec respectively after some time interval. Fig.5 (a) illustrates the behavior of nodes with no mobility, i.e., at t=0, whereas Fig.5 (b) demonstrates the mobility of nodes and arrows between them and also shows the communication between mobile nodes, which explains the scenario of packets transmission, and the information exchanged when mobile nodes met with each other [20]. We can thereby conclude easily from observation that when the time interval changed, the position of nodes also changed.

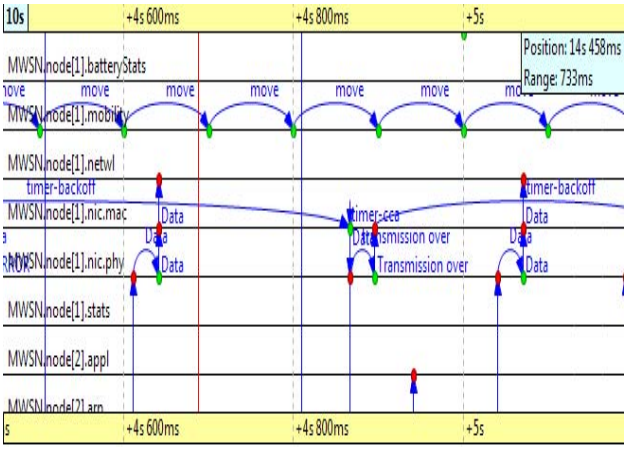

Fig. 7. Overall transmission of mobile nodes in network

The events regarding message received, sent and delivered have been illustrated in Fig.6. This explains the simulation procedure of MWSN model. All information regarding packets transferred, acknowledged, received and sent, identity (ID) wise, to the nodes has been shown in the figure. Fig.7 shows the overall transmission of the packets transfers by mobile nodes in MWSN. Nodes are moving and transferring the data to the node which has smallest path. The move indicates in the fig.8 the node mobility with constant speed identical to RWP model (Random Way Point Model). With establishing a connection, a mobile node obtains channel access and begins sending data. The successfully transmitted data of node can be examined by Transmission over as indicated in Fig.7.

We can note and examine the data transformation of mobile nodes through MWSN model outcomes. We concluded from the results that the average packet delay and node mobility has direct relationship; when one factor increases other also rises. Generally, the energy consumption is affected by mobility model, but beneficially considers the maximum area.

V. CONCLUSION

In this paper, we illustrated the behavior and performance of MWSN for accurate analysis of different parameters

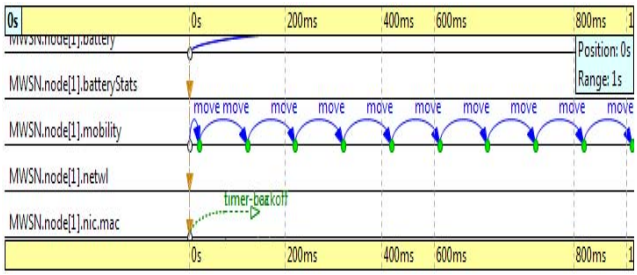

Fig. 8. Mobile nodes movement in MWSN

of connectivity. We considered OMNeT++ (MiXiM framework) to achieve reliable, authentic and precise results of evaluation for node mobility in MWSN. Further, we also explained the node movements and packet transmission of mobile nodes through concluded results. The output graphs that we acquired by using OMNeT++ simulator verify the efficiency and accuracy of MWSN model. Generally, this analysis leads to better observance of different processes, working and operation involved in MWSN.

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