

Simulation of Random Waypoint Mobility Model Using Colored Petri Nets

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Abstract. Due to dynamic nature of ad-hoc networks and in order to simulate a communication protocol, it is essential to use a mobility model that represents how the mobile node utilizes the given protocol. Selection of mobility model can determine whether the proposed protocol will be useful or not. This paper introduces random waypoint mobility model for describing simulation of mobile nodes distribution within then network. Before simulation, UML (Unified modeling language) modeling is done to describe the structural view of a model and also for error correction. The simulation process has been done with the help of hierarchical colored petri net which is extension of normal colored petri nets.

Keywords: Random Waypoint Mobility Model, Colored Petri Nets, Unified Modeling Languages.

1. Introduction

Mobile ad-hoc network is infrastructure less network where nodes can move freely within the network boundary. So the node mobility is major issue in mobile ad-hoc networks. There are several Mobility models, which are used to describe node movement within the network and are needed in the evaluation of protocols for medium access, power management, leader election, routing, and so on. Therefore, the choice of mobility model can significantly affect the simulation result [2]. Simulation of ad-hoc network uses two types of mobility model: 1) Traces and 2) Synthetic model [1]. The mobility pattern in real time systems is observed by traces. Synthetic model provide realistic behavior of mobile nodes without use of traces [3]. Random Waypoint mobility model is a synthetic model. RWP mobility model is one of the mobility model, which is the basic building block of most of the routing protocols. In RWP mobility model, node movement is concentrated in the middle of a simulation area (border effect) [4, 5, 6], because node bounce back, when it reaches to the network boundary.

Ad-hoc networks protocol has ability to behave correctly in dynamic environment. Main key issue is that the nodes may change their position continuously, and therefore modeling of user's movement is required in such dynamic network [8]. This include several considerations like allocation of nodes at the start up, dynamic nature of nodes, total number of nodes present and the selection of mobility models[7].

In this paper, nodes are spread in a two dimensional area using random waypoint mobility model. This is the most popular mobility model because of its simplicity. Every node chooses a random direction, destination and speed for its mobility pattern and after reaching to its destination it pauses for some time (called pause time) and again it chooses random direction and destination until the simulation stops. This pause time is independent of direction and speed (vary from $[1, v_{max}]$). So there are three major factor in RWP mobility model: speed (s), direction (d) and pause time (p). In RWP mobility model, node distribution is done randomly although mobility parameters and direction are independent variable.

The rest of this paper is organized as follows. Section 2 describes related work on CPN and RWP mobility model in ad-hoc network. Section 3 contains UML diagram of RWP mobility model. Section 4

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presents implementation of Random waypoint mobility model using CPN tool. Section 5 describes the Simulation parameters and results .We make the conclusion of the paper in the last section.

2. Related Work

2.1. Work done in Ad-hoc networks Using CPN tool

Colored Petri Nets have been used by some of the researchers for validating and modeling some of the features of the mobile ad hoc networks. Chinara et al. [9] have proposed the validation of neighbor detection protocol for ad-hoc network by using the CPN tools.

Erbas et al. [10] proposed a two designed position based routing approach based model on Colored Petri Nets for mobile ad-hoc network. Here the author shows that the multicast routing protocol delivers better result than the basic ODMRP (On Demand Multicast Routing Protocol). This model (CPN model) developed reliable unicast and multicast routing method based on geographical position of a node.

It has been studied that much work has not been done on the mobility pattern of the ad hoc networks by using CPN tools. This provides a motivation for the current work where CPN tools have been used for the modeling of the Random Way Point mobility for MANET.

2.2. Random Waypoint Mobility Model

Random waypoint mobility model is most common choice of researchers and its already implemented in NS2, GLOMOSIM and also used in implementation of many network protocols and algorithms. In the previous papers, simulation of random waypoint as a mobility model begins with the nodes distribution informally in the simulation area. Uniform distribution of mobility parameter in the random waypoint mobility model is quite different from the stationary distribution. In stationary distribution [9][10][2], nodes are concentrated around the center of the network. So the point chosen by node while travelling spend more time at center.

For initialization problem [3], there are three approaches. The first approach save the location as position file after that simulation has executed. For every simulation it has to make position file, so that each simulation starts with the stationary distribution. The Second approach suggests discarding starting 1,000 seconds of the simulation time to prevent the initialization problem. The difficulties of these two approaches are that, how long we have to discard. In third approach position and speed of a node are chosen by stationary distribution.

3. UML diagram of Random Waypoint Mobility Model

UML is graphical oriented language. It provides structural and behavioral diagrams. In structural diagram, it consists of class, collaboration and use case diagram. It provides static view of a model. In behavioral diagram, it consists of state machine and other diagrams.

Fig. 1 shows the use case diagram of RWP mobility model. Use case define relationship between actor and use cases [11].In this diagram, NETWORK ANALYST act as an actor .Each ellipse or circle define the use cases (velocity of point, analysis mobility scheme, calculate distance, select route etc).Use cases are set of operation to represent a set of action in order to achieve a goal.

4. Implementation of RWP Mobility Model Using Colored Petri Nets

4.1. Colored Petri Nets and its Component

Colored petri nets are used for modeling and validation of a system. It provides communication, concurrency and synchronization.CPN has three basic elements places, arcs and transition. We can write inscriptions by using CPN ML programming language. Component of CPN [12]:

- Places: Places drawn as ellipses or circles. Places contain token and each token is attached to data value.
- Arc: Arcs can be unidirectional or bidirectional.
- Transition: Transitions drawn as rectangular boxes.

Meanwhile the second module selects angle by which it has to move as shown in fig. 5. In CPN tool, we can not take any decimal or negative value so the simulation has limited angle movement. After selecting the angle, it calculates the X and Y co-ordinates.

Suppose we have initial point (x_1, y_1) and we have to find the next point (x_2, y_2) . The known parameter are distance (d) and angle (a) . By applying a trigonometric formula, we can find the co-ordinates of the next point which is (x_2, y_2) and this process will continue till the simulation ends (fig 6). The formula is given below:

For finding x co-ordinate: $X_i = r_i \sin a_i$

For finding y co-ordinate: $Y_j = r_j \cos a_j$

Where, r is radial distance and i, j is identity factor.

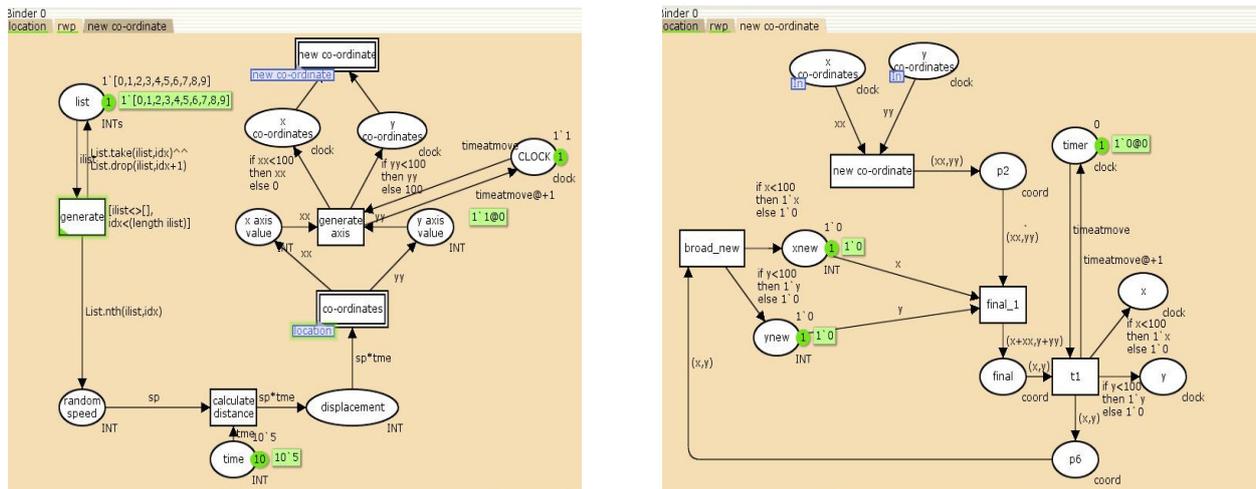


Fig. 7:Running model of RWP MM in CPN

The simulation has done within the 100 m x 100 m area. Fig. 7 Illustrates the modeling of RWP MM in CPN .Here pause time taken as 2 ms. In the second part of this above model X and Y co-ordinate are initialize as 0.It mainly meant for checking border condition, each time X and Y co-ordinate value add to the previous value, if it cross the border it bounce back to the border.

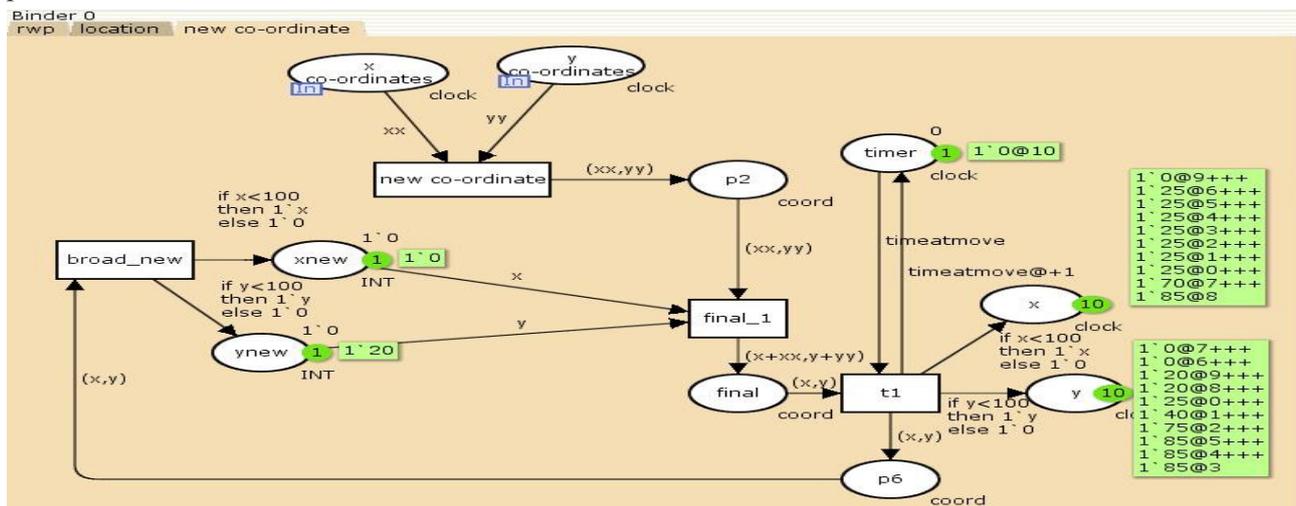


Fig. 8: Simulation result

5. Simulation Result

After simulation, it will generate co-ordinate value. The Figure 8 shows how the node moves around the network.

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7. References

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