



International Congress of Information and Communication Technology (ICICT 2017)

Opportunistic Networks Model with Restricted Time-Space

Ming-hui Yao^a, Xiao-ling Bao^b, Sheng Zhang^{a,*}, Yu Wang^a, Zhao-jun Shi^a

^a*School of Information Engineering, Nanchang Hangkong University, 696 Fenghe South Ave., Nanchang, China, 330063*

^b*School of Foreign Languages, Nanchang Hangkong University, 696 Fenghe South Ave., Nanchang, China, 330063*

* *Corresponding author. zxwzs168@126.com Tel.: 86-18970987919; fax: 86-791-83953400.*

Abstract

Mobility model characterize node movement patterns in opportunistic networks, it is usually used for simulation purposes when new communication or navigation techniques are proposed. There are two kinds of mobility model at present. One is the mobility model based on the theory, and other is the mobility model based on the realistic networks. But they cannot characterize the inherent property of opportunistic networks well. We try to tradeoff their two extreme cases, and put forward an opportunistic networks model with restricted time-space (RTSM), which cannot only describe the community characteristic and activity scheduling of nodes on the macro, but also obey the node mobility rules of Random waypoint model (RWP) in the micro. The simulation results show that we set the different parameters (such as, τ and δ) to get the different simulating scenarios which is closer the realistic network scenarios than the classical mobility models (such as, Random waypoint, Community movement and Map based movement), and the proposed mobility model has good encounter duration time distribution and flexible parameter controllability.

Keywords: Opportunistic networks; Mobility model; Restricted time; Restricted space

1. Introduction

Mobility models represent the movement of mobile nodes, and how their location, direction, velocity and acceleration change over time¹. Such models are usually used for simulation purposes when new communication or techniques are investigated. When we study a new communication protocol, it is important to simulate the protocol and evaluate its protocol performance. Protocol simulation has several key parameters, including mobility model and communicating traffic pattern. For the existing mobility models, they are mainly divided into two kinds: (1) the mobility model based on the theory and (2) the mobility model based on the realistic networks. The former can provide parameters for simple cases through mathematical calculations, such as Brownian model, random waypoint model, random walk model, random direction model, random Gauss-Markov model, and so on. The latter considers

more detailed and realistic mobility scenarios, such as the reference point group model (RPGM), the pursue model, the map based model, the traffic model, the post disaster mobility model, etc. However, the above two kind models both cannot characterize the inherent property of opportunistic networks well. The mobility model based on the theory mainly focuses on the theoretical analysis. It is too idealistic to apply to realistic opportunistic networks. On the other hand, the mobility model based on the realistic networks is mostly derived from the test bed or specific application scenario. It focuses on the engineering application, so it does not characterize the universality and regularity of opportunistic networks.

Aiming at the imperfections of existing mobility models, we consider the key factors in opportunistic networks, such as the meeting location and lasting time of nodes, and put forward opportunistic networks model with restricted time-space (RTSM). In the new model, the partial nodes are restricted with meeting location and time, and other nodes movement obeys the rules of RWP. The new model not only shows the characteristics of the mobility model based on the theory, but also has the characteristics of the mobility model based on the realistic networks.

2. Related Works

At present, a variety of mobility models are proposed. There are different movement characteristics of nodes in different mobility model. According to the correlation between nodes, the proposed mobility models can be divided into two mainly types: (1) the entity mobility model and (2) the group mobility model². The entity mobility model focuses on the independent movement of each node, and the motion mode and the state of the individual node are independent of other nodes. Such as, the random waypoint model (RWP)³, the random direction model (RD)⁴, the modified random direction model (MRD)⁵. The velocity and direction of nodes in the random movement model are not related to time, and there is a mutation in the velocity and direction. They cannot reflect the actual situation of the node movement well. At the same time, the average velocity of this model is not stable, and will decay⁶⁻⁸.

Group mobility model focuses on the relative movement of the nodes in group, which emphasizes the common movement of the group. There are the exponentially correlated random mobility model (ECRM)⁹, the reference point group mobility (RPGM)¹⁰, the group force mobility model¹¹, the reference region group mobility model (RRGM)¹², and the event-driven mobility model (EMM)¹³.

Among all above mobility model, the RWP is one of the most popular mobility models to evaluate mobile ad hoc network (MANET) routing protocols, because of its simplicity and wide availability. In random-based mobility models, the nodes move randomly and freely without restrictions. To be more specific, the destination, speed and direction are all chosen randomly and independently of other nodes. The movement of nodes is governed in the following manner: Firstly, each node pauses for a fixed number of seconds. Then they select a random destination and a random speed between 0 and some maximum speed in the simulation area. Each node moves to the destination and pauses for a fixed period again, before they select another random location and speed. This behavior is repeated for the length of the whole simulation time. In random waypoint model, the network topology changes by controlling the size of maximum speed and pause time. When the maximum speed is larger and pause time is smaller, the nodes move violently, and the network topology changes rapidly. When the maximum speed is small and pause time is larger, the movement speed of the nodes is small, and the network topology changes slowly.

In many cases, the time and place of the encounter nodes are not random, the behavior of partial nodes obey some rules, but are restricted. For example, we hold regular meetings on someday in our laboratory room every week, and the migratory birds fry to Poyang Lake on someday in winter, etc. Based on some schedule encounter characteristics of opportunistic networks, this paper puts forward opportunistic networks model with restricted time-space based on random waypoint model.

3. Model Description

In the new model of RTSM, all nodes are divided into two types, the first type is free nodes which movement obey the rules of RWP, and other type nodes are restricted with location and time. The restricted nodes may cluster in one community or several communities, the nodes in the same community need to meet at fixed periods in appointed location. The new model not only shows the characteristics of the mobility model based on theory, but also has the characteristics of the mobility model based on realistic networks.

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