# Proximity based Routing Protocol in Opportunistic Networks

## Li Liu

Shandong Jiaotong University, Jinan 250023, China.

liuli_free@126.com

**Abstract.** Mobile devices carried by human are more and more popular now days. Opportunistic Networks are used in intermittent connected networks by use of store-carry and forward fashion. In this paper, we present proximity based routing protocol (ProR) to predict the future meet opportunity. We establish experiment based on ONE and simulations shown that the efficiency of ProR outperforms Epidemic and PROPHET with higher delivery ratio and lower overhead.

**Keywords:** Opportunistic Networks; Physical Proximity; Routing Protocol.

## 1. Introduction

With the popular using of the mobile devices such as PDA and iPhone, the applications based on mobile devices are more and more popular. While, occasional ad hoc networks are easily formed through short range transmission technology such as Bluetooth or WiFi. That is the Opportunistic Networks [1], which utilize opportunistic contact opportunity to deliver messages using store-carry –forward fashion.

When a source node wants to deliver a message to a destination node, intermediate nodes may be selected to help the forwarding process hop by hop. Generally, the device which has more probability to meet the destination device is prior selected. Therefore, it is the key problem for Opportunistic networks that how to predict the contact opportunity between nodes. Recent works utilize the contact information to implement the prediction.

Physical proximity is an important factor related to the contact information. The mobile devices can be able to deliver messages, only if they are closely enough. In this paper, we present a proximity based routing protocol (ProR), which is based on proximity informaiton of human's mobility to predict the future meet opportunities. We establish experiments and evaluate the performance of ProR through comparing to Epidemic and PROPHET routing protocol. The results demonstrate the higher efficiency of ProR.

The remainder of this paper is organized as follows. Section 2 describes the system model and implementation of ProR Routing. We illustrate simulation of ProR using real trace data in Section 3. Finally, conclusion is presented in Section 4.

## 2. System Model and Implement

### 2.1. System Model.

In this section, we describe the system model. We assume there are M mobile nodes and they deliver messages with each other through Bluetooth. Mobile nodes maintain a list of contact information to record contact information, including node's ID and contact frequency. In unit time period, the contact frequency is higher if two nodes meet frequently. Therefore, we utilize the meet times in unit time as their contact frequency. And when coming into a new time period, the contact frequency is reassigned as 0 and ProR re-start the calculation.

When two nodes contact, they exchange their message list. For each message, there is a destination node. Two nodes compute the similarity between itself and the destination node respectively. Then the node with higher similarity value is chosen as forwarder.

**2.2 Implement of ProR.**

In ProR, mobile nodes record and maintain the contact nodes' information. Based on these information, ProR computes the similarities values between two contact nodes and destination. Then it compares the similarities and chooses the better forwarder.

The ProR routing protocol are presented as follows, which consists of 4 steps.

1) The mobile nodes record and maintain the proximity information by themselves in unit time intervals.

2) When two mobile mobiles are in their transmission range. Two nodes (called A and B for simply description) exchange the message list with each other.

3) A checks each message's destination and computes the similarity value ($S_A$) between A and the destination (message's destination). Then A compares $S_A$ to $S_B$ in message list. If $S_A > S_B$, the message will be delivered by A. Otherwise, the message is stayed in B. B has the similar process with A.

4) Start the transmission process until beyond the transmission range.

## 3. Simulation

In the simulation, we use real data set collected by an opportunistic mobile social application MobiClique during INFOCOM06 conference [2]. Around 78 mobile devices were distributed to a set of volunteers during the conference. The experiment is carried out through the Opportunistic Network Environment (ONE) Simulator [3]. We handle proximity information of devices to satisfy external movement requirement of ONE. The messages with 10 hours TTL are generated randomly.
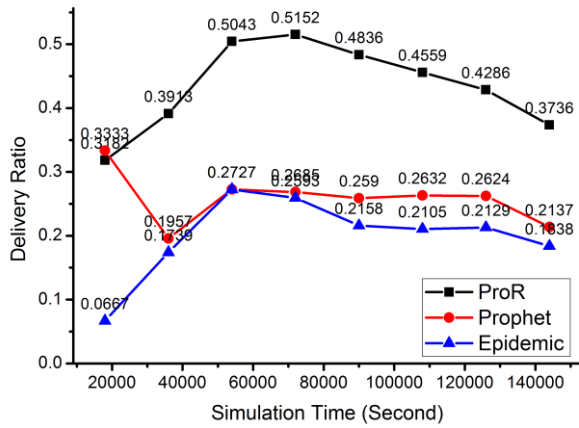
In the simulations, three performance metrics are evaluated with four criterions: delivery ratio, overhead, average latency and average hop count.

We compare the effectiveness of our ProR with two 'non-oblivious' routing protocols: Epidemic and PROPHET. Epidemic delivers messages to every contact nodes, which is call flooding method. PROPHET predicts and selects the forwarders by the use of history encounter records. We use the default parameters provided by ONE for PROPHET.

In Fig 1, we show comparison of all algorithms in terms of delivery ratio, overhead ratio, average latency and average hop count. As shown, the ProR obtain higher performance comparing to Epidemic and PROPHET. For example, in 18 hours, ProR forwards 51.52% messages with overhead ratio of 27.29, average latency of 5239 and average hop count of 42. While the delivery ratios of Epidemic and PROPHET are 25.93% and 26.85% respectively with overhead ratio of 1433 and 8870 respectively. The average latency of Epidemic and PROPHET are 7022 and 5468. The average hop count of Epidemic and PROPHET are 1 and 7.

## 4. Conclusion

In this paper, we present proximity based routing protocol in Opportunistic Networks, named ProR. In ProR, each mobile device records and maintains proximity information. And based this information, ProR selects the higher meet probability to the destination device as forwarder in order to improve the efficiency. The simulation shows that ProR obtains higher perfomance comparing to Epidemic and PROPHET.
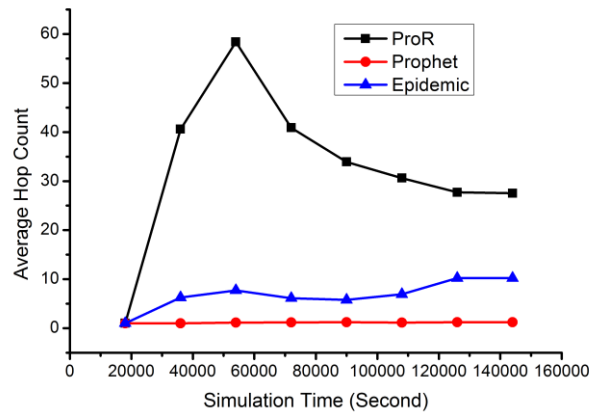
(a) Delivery Ratio
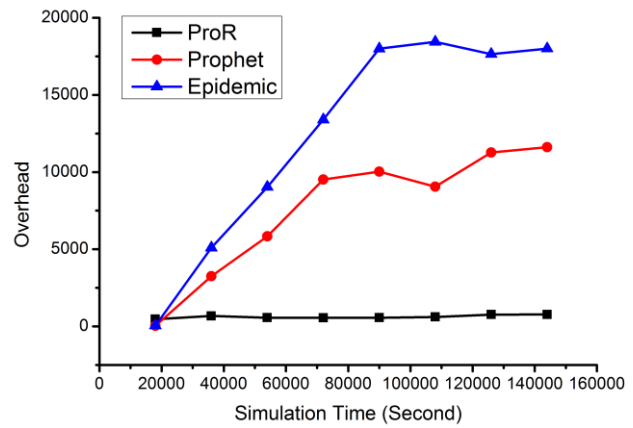

(b)Overhead
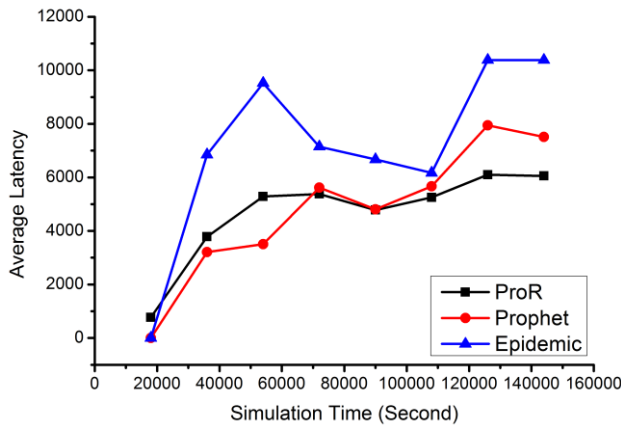

(c) Average Latency


(d) Average Hop Count

Fig. 1 Efficiency Comparison

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