Routing In Disruption-Tolerant Networks Based On Mobility History and Contact Time Prediction

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Abstract: In Disruption-Tolerant Networks, routing is one of the most challenging and open problems, because the wireless links are short-lived. The connection between the nodes in the network changes over time and the nodes do not move completely at random. Instead they move around a set of well-visited locations. The routing is done based on the prediction of future contacts by using the node's mobility history. The node's mobility is estimated based on the history of observations. The existing DTN routing methods predict whether two nodes would encounter each other, without considering when the contact occurs. In the proposed Predict and Relay method, the routing is done based on the prediction of contact times, which focus on the time-based mobility prediction. The Time-Homogeneous Semi-Markov model is used to predict the node's future contacts and the time of contact. After predicting the mobility, the relay node is selected that has the highest probability of delivery to the destination. Packets are forwarded hop-by-hop in the succession of contacts. The simulation result shows that this approach improves the delivery ratio and also reduces the energy required to predict the node's mobility and the delivery latency.

Keywords: Disruption-Tolerant Network, routing, prediction, mobility history.

1. INTRODUCTION

Wireless ad hoc networks have been traditionally modeled as connected graphs with stable end-to-end paths. However, for emerging wireless applications, such as sensor networks for wildlife tracking and MANETs operating in challenging environments [2], wireless links are short-lived and end-to-end connectivity turns out to be sporadic. Such phenomena are prevalent in disruption-tolerant networks (DTNs) [3], [4], [8], [9], where the connection between nodes in the network changes over time, and the communication suffers from frequent disruptions, making the network partially connected. The intermittent end-to-end paths and the changing topology make conventional MANET routing protocols fail, as they are designed with the assumption that the network stays connected. Routing in DTNs is an especially challenging problem because of the temporal scheduling element in a dynamic topology, which is not present in traditional MANETs. Nodes have to decide who the next hop is, but also when to forward, as they route packets to destinations in a store-and-carry way.

DTN ROUTING METHODS

Researchers have proposed a number of broad methods to solve the above issue. In general, previous related works fall into three categories: mobile resource-based, opportunity-based, and prediction-based.

2.1.Resources-Based Routing:

In this category [1], [10], systems employ mobile resources (data mules and mobile agents) as message ferries. These can be directed to pick up, move toward the next hop, and deliver messages to implement end-to-end store-and-carry message delivery. Researchers in [10] present an architecture to collect data in sparse sensor networks, which uses data MULEs to pick up data from the sensors when in close range, buffer it, and drop off the data to wired access points. Similarly, in [1], buoys monitor the water quality in a lake, and onboard sensors relay measurements using nodes on tourist tour-boats and pleasure cruisers. Both of these approaches improve routing performance with additional mobile nodes, although controlling these resources leads to extra cost and overhead.

2.2. Opportunity-Based Routing:

In opportunity-based schemes [11], [12], nodes forward messages during contacts that are unscheduled or random. The opportunity-based schemes utilize neither the mobile resources nor the prediction methods for routing. Instead, messages are exchanged only when two nodes meet at the same place by chance.

2.3.Prediction-Based Routing:

For the prediction-based schemes [5], [6], internode contacts and mobility behavior are predicted, generally using prior contact history. The next hop and the contact in which a message is forwarded are selected using the predictions such that a quality of service (QoS) metric (e.g., delay or delivery ratio) is maximized. In the prediction-based schemes, nodes' mobility is estimated based on a history of observations. Most of the existing prediction-based routing protocols focus on the prediction of whether two nodes would have a contact in the future without considering when the contact occurs. We believe that lack of contact timing information undermines the contact prediction accuracy, and consequently reduces routing performance.

3. OVERVIEW

This paper proposes predict and relay (PER), a routing method for DTNs that relies on predicting future contacts. We use a model based on a time-homogeneous semi-Markov process (TH-SMP) model to predict the probability distribution of the time of contact, and the probability that two nodes will have a contact in the future.

The objective of this paper is to explore the solutions to the routing problem in DTNs with a semi-Markov model. The main contributions of this paper are: 1) a landmark trajectory prediction method that uses a time-homogeneous semi-Markov process to determine the probability distribution of node arrival time at landmarks, 2) a method to determine a probabilistic contact profile that predicts internode contacts, and 3) a set of message forwarding rules that improve the message delivery ratio by controlling the selection of the contact in which a message is transmitted to the next hop. Simulation results show that our approach raises the delivery ratio using the improved contact prediction accuracy, compared with other traditional routing protocols. Furthermore, results show that PER also reduces the delivery latency in DTNs.

4. NETWORK MODEL

The DTN is created with a finite number of mobile nodes is defined as a place where nodes can communicate directly, i.e., any two nodes that are located at a landmark at the same time can establish a contact to exchange messages..

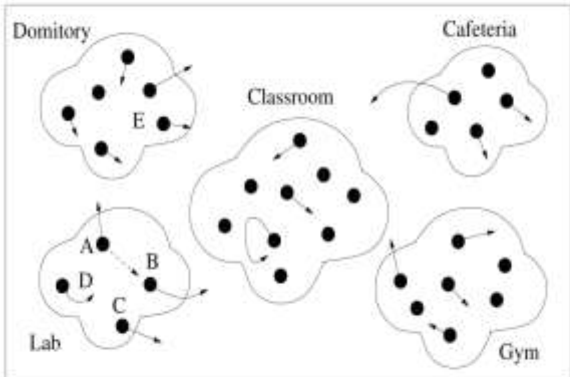

Figure1. An example network with mobility of nodes

Nodes at different landmarks cannot establish a contact. Landmarks are also assigned unique IDs. Nodes are aware of which landmark they are located at anytime. Also, we assume that the whole network is composed of the neighborhoods of landmarks, which means a node is always associated to a certain landmark in the network.

4.1.Prediction Function:

To calculate the prediction function f, PER needs to compute two parameters: the transition probability matrix P^m and the sojourn time probability distribution matrix, $S_{ij}^m(k)$ for each node m. These two parameters are retrieved from node mobility history. P^m is the transition probability matrix of the embedded Markov chain for node m. To predict node mobility in the PER algorithms, every node needs to know other nodes' mobility history information.

4.2.Mobility History:

The history mobility information is defined as a 5-tuple {nodeID, P, S, T_{rec}, $LandmarkID_{cur}$}. Where P is the transition probability matrix, S is the sojourn time probability distribution matrix, T_{rec} is the recording time when the record is generated, and $LandmarkID_{cur}$ is the recorded landmark where the node is located when the record is generated. Whenever two nodes become neighbor, they exchange their mobility information and store the new information in its database.

PER is a single-copy DTN routing protocol – only a single instance of a message is forwarded towards the destination. Each message carries in its header a time-to-live (TTL) field. After the TTL, expires the message should be dropped. Messages are forwarded hop-by-hop in a succession of contacts using a greedy approach. At each forwarding step, PER selects the next hop that has the highest probability of delivery to the destination. When a node u has to forward a message from its queue (e.g. at the beginning of a contact, or when a message is received from an application) it computes a probability metric f(x) for all nodes currently in contact with u (the set Nu), and for itself, $x \in \{u\} \cup Nu$. This metric indicates the delivery performance to the destination if node u selects node x as the next hop and forwards the message to x. The current node then selects the next hop h as the node for which the delivery probability metric is maximized.

5. CONCLUSION

This paper proposes the Predict and Relay scheme, an efficient routing scheme in DTNs. Time-homogeneous semi-Markov process model is used to predict the future contacts of two specified nodes at a specified time. With this model, a node can select a proper neighbor as the next hop to forward the message. The Simulation result shows that this approach raises the delivery ratio, as well as reduces the energy required to predict the node's mobility and the delivery latency.

REFERENCES

[1] "Sensor Networking with Delay Tolerance(SeNDT),"http://down.dsg.cs.tcd.ie/sendt/, 2011.

[2] I. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, "A Survey on Sensor Networks," IEEE Comm. Magazine, vol. 40, no. 8, pp. 102-114, Aug. 2002.

[3] A. Balasubramanian, B.N. Levine, and A. Venkataramani, "DTN Routing as a Resource Allocation Problem," Proc. SIGCOMM, 2007.

[4] N. Banerjee, M. Corner, and B. Levine, "An Energy-Efficient Architecture for DTN Throwboxes," Proc. IEEE INFOCOM,2007.

[5] J. Burgess, B. Gallagher, D. Jensen, and B.N. Levine, "Maxprop: Routing for Vehicle-Based Disruption-Tolerant Networks," Proc. IEEE INFOCOM, 2006.

[6] I. Cardei, C. Liu, J. Wu, and Q. Yuan, "DTN Routing with Probabilistic Trajectory Prediction," Proc. Int'l Conf. Wireless Algorithms, Systems and Applications (WASA '08), 2008.

[7] H. Dubois-Ferriere, M. Grossglauser, and M. Vetterli, "Age Matters: Efficient Route Discovery in Mobile Ad Hoc Networks Using Encounter Ages," Proc. Fourth ACM Int'l Symp. Mobile Ad Hoc Networking and Computing (MobiHoc '03), 2003.

[8] K. Fall, "A Delay-Tolerant Network Architecture for Challenged Internets," Proc. SIGCOMM, 2003.

[9] P. Hui, J. Crowcroft, and E. Yoneki, "Bubble Rap: Social Based Forwarding in Delay Tolerant Networks," Proc. Ninth ACM Int'l Symp. Mobile Ad Hoc Networking and Computing (MobiHoc '08),2008.

[10] R. Shah, S. Jain, S. Roy, and W. Brunette, "Data Mules: Modeling a Three-Tier Architecture for Sparse Sensor Networks," Technical Report IRS-TR-03-001, Intel Research Seattle, 2003.

[11] A. Vahdat and D. Becker, "Epidemic Routing for Partially Connected Ad Hoc Networks," Technical Report CS-200006, Duke Univ., 2000.

[12] J. Wu, M. Lu, and F. Li, "Utility-Based Opportunistic Routing in Multi-Hop Wireless Networks," Proc. 28th Int'l Conf. Distributed Computing Systems (ICDCS '08), 2008.