RESEARCH ARTICLE OPEN ACCESS

Social Properties Based Routing in Delay Tolerant Network

Aliasger k. Dhilawala[1], Vishal shah[2]
[1](Computer Department , S.V.I.T, Vasad,India
[2](Computer Department, S.V.I.T, Vasad,India

--************************----------------------------------

Abstract:

Delay tolerant networks (DTNs) may lack continuous network connectivity. Routing in DTNs is thus challenging since it must handle network partitioning, long delays, and dynamic topology in such networks. In recent years, social-based approaches, which attempt to exploit social behaviors of DTN nodes to make better routing decision, have drawn tremendous interests in DTN routing design. In this article, we summarize the social properties in DTNs, and provide a survey of recent social-based DTN routing approaches.

Keywords :- **Delay tolerant network, social metrics, social based routing protocol**

--************************----------------------------------

I. INTRODUCTION

In recent years, Delay Tolerant Networks (DTN) which is original from the research in deep-space communication and Interplanetary Internet, has been tremendous interesting for MANET research to cope with the problems of intermittent connectivity and mobility. The main concept of DTN, which differs from the traditional networks is that whether the disconnection happens, DTN assumes that this is the delay and data is still kept somewhere on the networks, in waiting to have the opportunity in order to reach the destination. To achieve this aims, DTN suggests a reliable Overlay architecture for asynchronous Store-and-Forward messages as the appropriate approach in intermittent network environment. Message, which is called Bundle, have arbitrary size, and is forwarded hop-by-hop between DTN-nodes (bundle routers).all bundles have a finite lifetime prior to be discarded.

Various proposed algorithms have different assumptions, the most appropriate assumption for real delay tolerant networks is zero knowledge about the network. In other words, since the future node contact times and their durations often can not be known exactly in a real DTN, the routing algorithms making their decisions based only on their local observations are the most useful ones. Although many routing algorithms for DTNs were proposed in the literature, very few of them take into account the effect of social structure of the network on the design of the routing algorithm. It is always noted in many studies that the movement of nodes in a mobile network and the interactions between nodes is not purely random and homogeneous but it is somewhat a mixture of homogeneous and heterogeneous behaviors. In other words, in a real mobile network, we always see grouping of nodes into communities such that the nodes within the same community behave

similarly and the nodes from different communities show different behaviors. Consider a Pocket Switched Network (PSN) which is a kind of social network in which people are intermittently connected via different wireless devices including cell phones and GPS devices. The connectivity between these human carried devices is achieved when they get into the range of each other. In a social network, the relationship defining the frequency of connectivity between nodes can be various interdependencies including friendship, trade and status. That's why, for an efficient routing of messages in such networks, the mobility of nodes and the underlying community structure of the members of the whole society has to be carefully analyzed. For example, consider a high school network. Students in the same class have higher chance to see (so also to transfer data to) each other than the students from other classes (i.e. they can probably meet only during breaks)..

II. CONTACT GRAPH CONTEXT

In DTNs, each possible packet forwarding happens when two mobile nodes are in contact (i.e., within transmission range of each other). By recording contacts seen in the past, a contact graph can be generated where each vertex denotes a mobile node (device or person who carries the device) and each edge represents one or more past meetings between two nodes. An edge in this contact graph conveys the information that two nodes encountered each other in the past. Thus the existence of an edge intends to have predictive capacity for future contacts. A contact graph can be constructed separately for each single time slot in the past, or it can be constructed to record the encounters in a specific period of time by assigning a set of parameters to each edge to record the time, the frequency and the duration of these encounters. From the observation that people with close relationships such as friends, family members, etc. tend to meet more often, more regular and with longer duration, we can extract DTN nodes' relationships from the recorded contact graph, estimate their social metrics, and use sucn information to choose relays with higher probabilities of successful forwarding. How to detect people's relationships and create the relative social graph from the recorded contact graph may affect estimation accuracy and the efficiency of social-based approaches. Most of the current social-based DTN routing algorithms [1], [2], [3] directly treat the aggregated contact graph (merging the contact graphs of several time slots into one graph) as the social graph of all entities in the network, and uses this graph to generate social metrics for forwarding selection. This strategy is based on the observation that although the contact graph reflects the encounter history while the social graph reflects the social relations among people, the aggregated contact graph (the sum of contact graph over time) and the social graph are statistically similar. After building the aggregated contact graph, different social metrics can be obtained.

III. SOCIAL PROPERTIES IN DTN

A. *Community*

Community is an important concept in ecology and sociology [4]–[5]. In ecology, a community is an assemblage of two or more populations of different species occupying the same geographical area. In sociology, community is usually defined as a group of interacting people living in a common location. It has been shown that a member of a given community is more likely to interact with another member of the same community than with a randomly chosen member of the population [6]. Therefore, communities naturally reflect social relationship among people. Since wireless devices are usually carried by people, it is natural to extend the concept of social community into DTNs to explore interactions among wireless devices. It is believed that devices within the same community have higher chances to encounter each other.The knowledge of community structures could help a routing protocol to choose better forwarding relays for particular destinations, and hence improve the chance of delivery.

B. *Centrality*

In graph theory and network analysis, *centrality* is a quantitative measure of the topological importance of a vertex within the graph. A central node, typically, has a stronger capability of connecting other nodes in the graph. In a social graph, the centrality of a node describes the social importance of its represented person in the social network. In DTNs, the sociological centrality metrics [7] can also be used for relay selections (nodes with high centralities are always good candidates of relay nodes). There are several ways to define centrality in a graph. Three common centrality measures are *degree centrality*, *betweenness centrality*, and *closeness centrality* [8]–[10]. Degree centrality is the simplest centrality measure which is defined as the number of links (i.e., direct contacts) incident upon a given node. A node with a high degree centrality is a popular node with a large number of possible contacts, and thus it is a good candidate of a message forwarder for others (i.e., a hub for information exchange among its neighborhood). Betweenness centrality measures the number of shortest paths passing via certain given node. Nodes that occur on many shortest paths between other nodes have higher betweenness than those that do not. A node with high betweenness centrality can control or facilitate many connections between other nodes, thus it is ideal for a bridge node during message exchange. The closeness centrality of a node is defined as a the inverse of its average shortest distance to all other nodes in the graph. If a node is near to the centre of the graph, it has higher closeness centrality and is good for quickly spreading messages over the network.

C. *Similarity*

Sometimes it has been seen and noticed that when two individuals have same common friend the probability of those two individuals getting acquainted is quite high. The same phenomenon is applicable in the case of delay tolerant networks. Similarity is a measure to calculate how different two nodes are and what their degree of separation is. So this can be understood that if two nodes have a common neighbour, their probability of getting connected is quite high. Similarity can also be found on different contexts other than common neighbours. Similarity on the basis of common interests [11] and locations [12] can also be defined. In a network, the probability of two nodes being connected by a link is higher when they have a common neighbor. When the neighbors of nodes are unlikely to be in contact with each other, diffusion can be expected to take longer than when the similarity is high (with more common neighbors).

D. *Friendship*

Friendship is another concept in sociology which describes close personal relationships. In DTNs, friendship can be defined between a pair of nodes. On the one hand, to be considered as friends of each other, two nodes need to have long-lasting and regular contacts. On the other hand, friends usually share more common interests as in real world. In sociology, it has been shown that individuals often befriend others who have similar interests, perform similar actions and frequently meet with each other [13]. This observation is

TABLE I

ROUTING SCHEME BASED ON SOCIAL METRICS

called *homophily phenomenon*. Therefore, the friendship in DTNs can be roughly determined by using either contact history between two nodes [14] or common interests/contents claimed by two nodes [15].

IV SOCIAL BASED ROUTING IN DTN

Year	Protocol	Main feature	Drawbacks	Best suited network
2005	CAR [16]	Exchanges a multi-objective delivery probability	Needs time to learn Context	Social networks
2007	HiBOp [18]	Exchanges user interests	Needs a time to learn Context	Social networks
2007	SimBet[2]	Ego-centric centrality and its social similarity	It may overload nodes with high centrality	Social networks
2008	BubbleRap[3]	Groups and ranks nodes within a Community	May not work in random Networks	Clustered nerwork
2010	SSAR [19]	Uses the selfish properties of the Users	Demands user intervention	Social networks
2010	HYMAD [17]	Hybrid of ad hoc and opportunistic forwarding	Tested only in high density scenarios	Dense network
2010	People Rank [20]	Ranking of central nodes	Can overload the central Node	Social networks
2011	3R [21]	Characterizes user habits	Long warm up time	Social networks
2011	SREP [22]	Ranking central nodes inside Communities	Can overload the central Node	Social networks
2011	Friendship[14]	Uses history of encounters	Poor in sparse network	Social networks

E. Context-Aware Routing protocol

The Context-Aware Routing protocol (CAR) attempts to predict if a destination belongs to the same connected part of the network of the sender (or the relay node) [16]. The authors use as context information the number of neighbors of a node and its current energy level. We classified this protocol as partial context since in order to gather the network information a node does not require explicit message exchanges. If the destination is on the connected part of the network, the message is forwarded using DSDV (ad hoc routing); otherwise, it employs a utility function based in the change rate of the connectivity and the probability of the destination to be in the same cluster of the relay node.

F. HYMAD

HYMAD is a hybrid DTN-MANET forwarding protocol, since MANET routing tends to have a lower overhead in highly connected groups of nodes [17]. In HYMAD, nodes identify ‘‘groups’’ of connected neighbors. It forwards messages using
MANET routing within the groups, while inter-group communication occurs using the DTN paradigm. The authors evaluated HYMAD using the Rollernet trace, which is a dense trace with high connectivity among the nodes. As the analyzed scenario presents strong clusters and regular mobility patterns, the hybrid protocol achieves a good performance when compared to epidemic. However, the authors do not analyze how HYMAD would perform in sparse scenarios.

G. HiBOp

HiBOp (History Based Opportunistic Routing) [18] uses past and current context information like shared attributes and history of encounters to calculate delivery probabilities. The context information may describe the user’s environment and capture social relationships among nodes. The message is transferred if the encountered node’s delivery probability for the destination is greater than the current node. The source nodes may replicate messages and inject several copies into the network. When compared to Epidemic and PRoPHET in community-based mobility simulations, HiBOp reduces the consumption of resources and message loss rate for limited buffer scenarios. Delay, however, is shown to increase with HiBOp.

H. SIMBET

SimBet [2] is a forwarding protocol based on social interactions that uses centrality and social similarity metrics to define the probability of the node contacting the destination. In this context, nodes with high centrality values will be bridges between different communities in the network. Further, nodes with higher similarity indexes have the highest probabilities to find a common neighbor with the destination. Thus, first the authors use the centrality metric to exchange the message among the communities and next the similarity metric is used within the community to deliver the message to the destination

I. Bubble Rap

BUBBLE expands on this idea by using community affiliation labels with betweenness centrality measures to forward messages [3]. A minimum of two centrality measures are calculated per node based on the node’s global popularity in the whole network and local popularity within its community or communities. The algorithm calls for a message to be transferred to nodes with higher global rankings (centrality) until the carrier encounters a node with the same community label as the destination node. The message is then forwarded to nodes with higher local rankings until successful delivery. This approach prevents messages from getting stuck at a node with a high global rank, but with little or no affiliation with the destination community. Community detection and centrality estimation influence the design of BUBBLE. Centralized and distributed degree and betweenness measures impact the protocol performance. Through simulations, the centralized BUBBLE approach is shown to provide performance improvements in terms of resource utilization compared to flooding and PRoPHET. A modified version of BUBBLE deletes the message from the buffer of the original carrier once the message is transferred to the destination community. Results show that decreasing the number of copies (further reducing the cost) does not negatively impact the delivery ratio for the cases studied.

J. Social Selfishness Aware Routing

Li et al. [19] proposed the Social Selfishness Aware Routing (SSAR), a forwarding protocol that employs social characteristics to define if the node should forward a message. The authors define social selfishness as the willingness of a node to forward messages received from nodes with which it has no social ties. This contrasts with most protocols in the literature, which assume that the nodes will always forward the messages. The protocol assumes that every node knows its social relationship with other nodes and allocates resources based in this knowledge. The authors evaluate SSAR using a real trace of MIT student mobility in a custom simulator, where each node generates a message per day to a random destination, and compared SSAR against Prophet and Simbet [65]. The authors considered the TTL of a message varying from 0 up to 150 days, i.e., they assume a delay of six months, which is unrealistic for any network application.

K. People Rank

PeopleRank is a social opportunistic forwarding protocol proposed in [20]. Based on the idea of page rank to index web pages on Google, the authors proposed a scheme to rank nodes based on its ''importance'' in the network. A social relationship between two nodes is defined when they are declared friends and share k common interests. When two nodes meet, they exchange their current PeopleRank values and the number of social neighbors they have. A message is forwarded only to nodes with greater rank. The authors evaluate PeopleRank with a large number of real traces available in Crawdad [68] comparing it against Epidemic, contact based and social algorithms. The following metrics are employed for forwarding: (i) centrality, where a node forwards the message if its betweness centrality is lower than that of the contacted node; (ii) degree, a message is forwarded for nodes with higher degree). The authors computed the delay-optimal path to
use as their benchmark

L. The Social Relationship Enhanced Predicable Routing protocol (SREP)

The Social Relationship Enhanced Predicable Routing protocol (SREP) was proposed in [21]. SREP assumes that user mobility has a deterministic behavior, and as such users have preferred places (also called a community) which they visit frequently. The authors adapted a semi-deterministic Markov process to model the probability of a node belonging to a certain community. SREP also employs a page rank-like algorithm to rank nodes inside a community. The authors make strong assumptions, for example that two nodes in the same community have enough bandwidth and time to always forward a message. In this case we can see the community as a strong connected graph. SREP was the only analyzed protocol which evaluated its warm up time, that is, the time needed to construct the probability table required in forwarding decisions.

M. 3R

Vu et al. proposed a forwarding protocol based on the observations of a real trace [22]. The authors collected Wi-Fi/Bluetooth traces of 123 phones during six months in 2010. They characterized the trace as a fine-grained encounter trace, since the phones made a Bluetooth scan each 60 s and, if a phone can scan a device, then they are in the same location. The authors show that the pattern of those encounters is regular and predictable. As a consequence, they proposed 3R, which learns the patterns of encounters, creating a table with per-node encounter probabilities for each hour of each day (weekday and weekend). The granularity of the table was evaluated, since the method can create quite large probability tables. The main drawback of 3R is that it requires a long bootstrapping period.

N. Friendship protocol

Bulut *et al.* [14] also used friendship to aid the delivery of packets in DTNs. They introduced a new metric, social pressures metric (SPM), to accurately detect the quality of friendship. Here friendship is defined by users based on their social relationships, this approach considered friends as nodes which contact to each other frequently and have long-lasting and regular contacts. this friendship based routing method uses the node contact information in each period to calculate the friendship metric (i.e., SPM), and constructs the friendship community. These social metrics can indeed help with making smarter forwarding decisions. If the source node fails to meet with any node in the same friendship community with the destination node, the delivery fails. Therefore, more felicitous forwarding strategies should be studied for this friendship based routing.

IV. CONCLUSIONS

By analyzing and studying social based properties we have concluded that social based routing scheme are more effective in delivering data as they are more realistic and practical when real time circumstances are concerned. Social parameters are less likely to change rapidly hence considering these we can design a router which take advantage of this. We have observed and our study shows that combining different metrics can lead to more effective routing and delivery of data. If we can combine centrality and friendship it will be effective under sparse network as well. Hence social based routing have raised a new horizon in the DTN research area.

ACKNOWLEDGMENT

We express our sincere gratitude to the management of S.V.I.T vasad, for providing us opportunities and their whole hearted support for such activities.

REFERENCES

[1] P. Hui, A. Chaintreau, J. Scott, R. Gass, J. Crowcroft, and C. Diot, "Pocket switched networks and the consequences of human mobility in conference environments," in *WDTN '05: Proc. 2005 ACM SIGCOMM workshop on Delay-tolerant networking*, 2005.

[2] E. M. Daly and M. Haahr, "Social network analysis for routing in disconnected delay-tolerant manets," in *MobiHoc '07 Proc. 8th ACM international symposium on Mobile ad hoc networking and computing*, 2007.

[3] P. Hui, J. Crowcroft, and E. Yonek, "Bubble rap: Social-based forward in delay tolerant networks," in *Proc. 9th ACM International Symposium on Mobile Ad Hoc Networking and Computing (MobiHoc)*, May,2008.

[4] G.A. Hillery, "Definitions of community: areas of agreement," *Rural Sociology*, vol. 20, no. 4, pp. 111, 1955.

[5] D.D. Perkins, P. Florin, R.C. Rich, A. Wandersman, and D.M. Chavis, "Participation and the social and physical environment of residential b locks: Crime and community context," *American Journal of Community Psychology*, vol. 18, pp. 83–115, 1990

[6] S. Okasha, "Altruism, group selection and correlated interaction," *British Journal for the Philosophy of Science*, vol. 56, no.4, pp. 730–725, 2005

[7] P. V. Marsden, "Egocentric and sociocentric measures of network centrality," *Social Networks*, vol. 24, no. 4, pp. 407–422, October 2002.

[8] L. C. Freeman, "A set of measures of centrality based on betweenness," *Sociometry*, vol. 40(1), pp. 35–41, 1977.

[9] L. C. Freeman, "Centrality in social networks: conceptual clarification, *Social networks*, vol. 1(3), pp. 215–239, 1979.

[10] M. J. Newman, "A measure of betweenness centrality based on random walks," *Socail networks*, vol. 27(1), pp. 39–54, 2005

[11] M. J. Newman, "A measure of betweenness centrality based on random walks," *Socail networks*, vol. 27(1), pp. 39–54, 2005.

[12] A. Mei, G. Morabito, P. Santi and J. Stefa, "Social-aware stateless forwarding in pocket switched networks," in *Proc. 30th IEEE Conference on Computer Communications(INFOCOM) mini-conference*, 2011

[13] M. McPherson, L. Smith-Lovin, and J. M. Cook, "Birds of a feather: Homophily in social networks," *Annual Review of Sociology*, vol. 27, pp. 415–444, 2001

[14] E. Bulut and B. K. Szymanski, "Friendship based routing in delay tolerant mobile social networks," in *Proc. IEEE Global Telecommunications Conference (GLOBECOM)*,, Dec, 2010.

[15] Y. Zhang and J. Zhao, "Social network analysis on data diffusion in delay tolerant networks," in *MobiHoc '09: Proc. tenth ACM international symposium on Mobile ad hoc networking and computing*, 2009.

[16] S.H.M. Musolesi, C. Mascolo, Adaptive routing for intermittently connected mobile ad hoc networks, in: Sixth IEEE International Symposium on a World of Wireless Mobile and Multimedia Networks, 2005, pp. 183–189.

[17] J. Whitbeck, V. Conan, Hymad: hybrid dtn-manet routing for dense and highly dynamic wireless networks, Comput. Commun. 33 (13) (2010) 1483–1492.

[18] C. Boldrini, M. Conti, J. Jacopini, A. Passarella, Hibop: a history based routin protocol for opportunistic networks, in: IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks, WoWMoM 2007, IEEE, 2007, pp. 1–12.

[19] Q. Li, S. Zhu, G. Cao, Routing in socially selfish delay tolerant networks, in: 2010 Proceedings IEEE INFOCOM, 2010, pp. 1–9.

[20] A. Mtibaa, M. May, C. Diot, M. Ammar, Peoplerank: social opportunistc forwarding, in: 2010 Proceedings IEEE INFOCOM, IEEE, 2010, pp. 1–5.

[21] X. Xie, Y. Zhang, C. Dai, M. Song, Social relationship enhanced -- 9predicable Routing in opportunistic network, in: 2011 Seventh International Conference on Mobile Ad-hoc and Sensor Networks (MSN), IEEE, 2011, pp. 268–275.

[22] L. Vu, Q. Do, K. Nahrstedt, 3R: fine-grained encounter-based routing in delay tolerant networks, in: 2011 IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM), IEEE, 2011, pp. 1–6.