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A Study on Geographic Routing Protocols in Delay/Disruption Tolerant Networks (DTNS)

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***Abstract**:*

Delay/Disruption Tolerant Networks (DTNs) have been attracting great interest from research community, where data communication naturally does not require contemporaneous end-to-end connectivity. Although suffering from a large variation of network topology, numerous previous routing protocols proposed for DTNs still make effort on qualifying delivery potential, via network topology information. Geographic routing is an alternative, by relying on the geographic information instead of topological information. In the literature, since this technique branch has not been extensively investigated in DTNs, our article identifies the motivation and challenges forapplying geographic routing in DTNs. Also, we highlight the future research directions for this branch

Keywords

DTNs, Geographic routing

1. Introduction

Originated from Inter-Planetary Networks (IPNs), the Delay/Disruption Tolerant Networking (DTN)[1]architecture is suitable for a variety of Intermittently Connected Networks (ICNs1), where thereis no contemporaneous end-to-end path towards destination during most of the time, due to the largevariation of network topology and sparse network density. In DTNs, the connectivity is maintained whenpairwise nodes come into the transmission ranges of each other. Each node receives a message among itscurrent neighbors, stores this message and waits for the future encounter opportunities with other nodes to relay the message, which is known as Store-Carry-Forward (SCF) mechanism. It is highlighted thatrouting in DTNs relies on the SCF behavior arising from nodal mobility to asymmetrically relay themessage, rather than that in Mobile Ad hoc Networks (MANETs) [2] requiring the contemporaneousend-to-end connectivity. Thanks to the existing tutorials and surveys on DTNs [3], [4], [5], the high delay and high bit errorrate are more concerned for IPNs (referred as DTNs for deep space scenario) even when the connectivityexists. Meanwhile, DTNs envisioning for terrestrial scenarios suffer more from the frequent communicationdisruption, e.g., Pocket Switched Networks [6] (PSNs2), UnderWater Sensor Networks (UWSNs) [7],sparse Vehicular Ad hoc NETworks (VANETs) [8], [9], [10] and Airborne Networks (ANs) [11]. Notethat since the design of routing protocols in DTNs is application specific, we focus on terrestrial scenariosof DTNs because geographic routing [12] is mainly applied for mobile networks.Geographic routing, also called position based routing, requires that each node can determine its own
location and that the source is aware of the location of destination. Different from topological routing,geographic routing exploits the geographic information instead of topological connectivity information formessage relay, to gradually approach and eventually reach the intended destination. According to literature[3], we observe that previous routing protocols in DTNs, mainly, have adopted historically topologicalinformation to predict the future encounter opportunity. In contrast, the focus of this article is to highlightthe research vision and potential for applying geographic routing in DTNs, which has not been addressed
yet. The major contributions are as follows:

- Identify the research motivation and challenges for bringing geographic routing protocols in DTNs.
- Provide an up-to-date review on well-known geographic routing protocols in DTNs, following our original technique taxonomy.
- Highlight potential future directions leading the ongoing research in this explicit field.

2. LITERATURE REVIEW

We classify the existing geographic routing protocols in DTNs into three classes, depending on theawareness of destination. Following our original taxonomy in Fig.1,

A. Destination Unawareness Class:

Protocols in this branch aim to achieve efficient message replication4 using geometric utility, without the requirement to track where the destination is.

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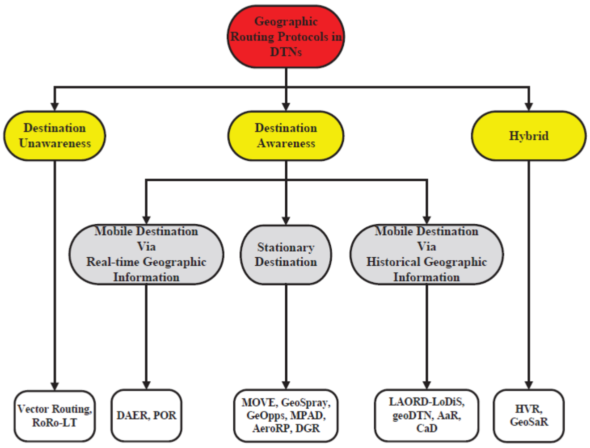


Fig 1. Taxonomy on Geographic Routing Protocols in DTNs

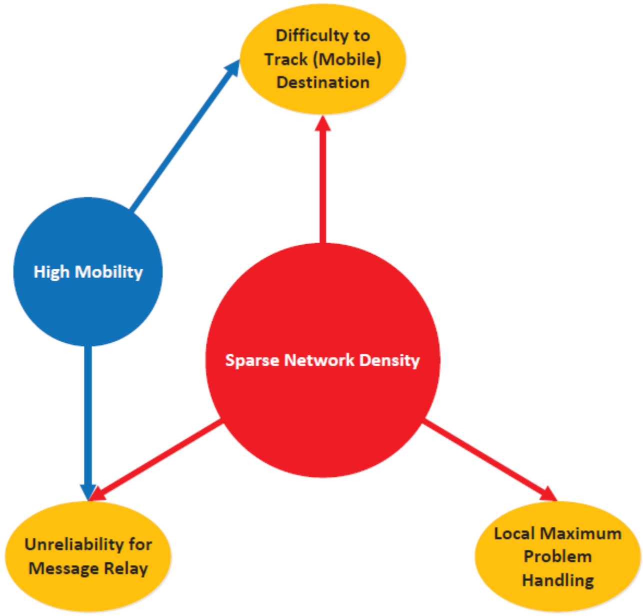
B. Destination Awareness Class:

1) Stationary Destination: By knowing the location of stationary destination in advance, protocols under this branch focus more on exploring various geometric metrics to select relay.
2) Considering Mobile Destination via Realtime Geographic Information: Protocols under this branch consider the mobility of destination. However, they ignore the feasibility to track mobile destination in sparse networks. Here, a centralized location server is still assumed to support real-time locationrequest/reply.

C. Hybrid Class:

Protocols under this branch combine the advantage of those in "Destination Unawareness" class when thelocation of destination is unavailable in initial stage, and those with the historical geographic informationin "Destination Awareness" class when an approximate location of destination is found.Conventional geographic routing protocols designed for MANETs assume that, the location of destinationis always available for all nodes in networks, such that there would make individual routing decisions
for message delivery towards destination. However, applying geographic routing in DTNs further brings following challenges as shown in Fig.2

- Reliability for Message Relaying
- Locating Mobile Destination
- Difficulty for Handling the Local Maximum problem



3. FUTURE DIRECTIONS

Thanks to the success of Global Positioning System (GPS) technique, geographic routing protocols inDTNs has a huge potential than those topological protocols, particularly for VANETs, UWSNs and ANs scenarios because of their highly dynamic characteristics. In this section, we detail a list offuture directionswhich are worthwhile studying:

Handling the Local Maximum Problem:
In a heuristic approachconcerning the nodal mobility and message lifetime is proposed and has been proven through analysis andsimulation. However, such approach is locally estimated at each node, without an overview of other copiesof a certain message in networks. On the one hand, the local maximum problem should be handled moregreedily, if all message copies are close to expiration deadline. On the other hand, more attention shouldbe paid on nodal encounter prediction, if the message can still exist in network for certain time. Therefore,apart from the knowledge of message carrier itself, it is also essential to obtain an accurate (ideally) orapproximate (practically) knowledge about how many copies of a message have been replicated. To further optimally handle the local maximum problem, an intelligent approach should be to jointlyconsider the number of copies of a message, its lifetime as well as individual nodal mobility.

Concerning on QoS Awareness:
Since it is difficult to provide an end-to-end QoS support in DTNs,appropriate message scheduling for transmission and buffer management is crucial given the limitedbandwidth and buffer space. These two factors

determine the number of messages can be successfullytransferred and received by relay nodes. Besides, since the nodes running out of energy cannot involvecommunication anymore, necessary energy saving approaches have been proposed, via an intelligentbeacon control for nodal discovery. Specifically, a frequent beacon broadcasting to discover neighbornodes is energy costly, while that with infrequent broadcasting however may miss the communicationopportunities with neighbor nodes. Note that the beacon control also has influence on the informationupdating (directly related to making routing decision) that happens between pairwise nodes.

Combining with Coding Technique:
As reviewed in [3], network coding and erasure coding techniques have been applied for routing protocols in DTNs. The network coding enablesefficient bandwidth usage, by encoding messages into a chunk block for transmission. While erasurecoding compensates the communication failure, by encoding the original message into a certain numberof smaller size blocks for transmission. Since none of them has been explicitly applied for geographicrouting protocols in DTNs, these two well-known coding techniques should be further effort. Here, the nature of GeoSpray could provide an initial guide on how to geometrically transmit those codedblocks using erasure coding technique.

Assistance of Additional Infrastructure:
Considering that the nodal mobility may be limited withincertain area, the assistance from additional infrastructure, e.g. Message Ferry (MF)/gateway mentioned in[3] is able to help relaying the message. Here, MF is a mobile entity that moves with dedicated route,whereas gateway is a deployed stationary entity. Bothcan bridge the communicationamong disconnected network islands, via trajectory controlling and location deployment. In this context,integrating them for specific scenario is worthwhile investigating.

Concerning on Application Scenario:
Combining routing protocols reviewed in this article, with thoseconventionally designed for MANETs can adapt to the variation of network density. Initial observation inshows that it is intelligent to switch from MANETs to DTNs based communication mode whennetworks become sparse. In spite that only the topological based routing protocol has been discussedin that work, such observation is also applicable to geographic routing protocol. Such intelligence hasbeen addressed by, which combine the geographic routing intelligences in MANETs and DTNs. Besides, the protocol design for PSNs is stillinadequately investigated compared to others. Even if there has been effort on linking geographic distancewith users for fixed online social networks, such issue for mobile networks is still a challenge. Besides,the influence of heterogeneous mobility should be addressed.

Concerning on Security&Privacy:
The information exchange for updating the historical geographicinformation requires security and privacy consideration. One major concern is the spoofing attack becausethe malicious node is able to create routing loops, generate false error information after information update.Besides, overhearing the message passing through neighboring nodes might emulate selective forwardingby jamming the relayed message. Further to security concerning, it is also privacy sensitive to releasenodal geographic information to any encountered node. Particularly, the location information should bereleased among friends who have common daily habits in PSNs.

4. CONCLUSION

Different from MANETs, the sparse network density is the main challenge for communication in DTNs.Motivated by the lack of attention on investigating geographic routing protocols in DTNs, we identifiedits challenges together with an original taxonomy, and further reviewed the state-of-the-art. Following thehighlighted future research directions, we hope our article would motivate the research interest for this
type of routing protocol, because of its persistent potential for academic research as well as a range ofapplication scenarios in real world.

5. REFERENCES

[1] C. Caini, H. Cruickshank, S. Farrell, and M. Marchese, “Delay-and Disruption-Tolerant Networking (DTN): An Alternative Solution for Future Satellite Networking Applications,” Proceedings of IEEE, vol. 99, no. 11, pp. 1980–1997, 2011.

[2] P. Ruiz and P. Bouvry, “Survey on Broadcast Algorithms for Mobile Ad Hoc Networks,” ACM Computing Surveys, vol. 48, no. 1, pp. 1–35, 2015.

[3] Y. Cao and Z. Sun, “Routing in Delay/Disruption Tolerant Networks: A Taxonomy, Survey and Challenges,” IEEE Communications Surveys Tutorials, vol. 15, no. 2, pp. 654–677, 2013.

[4] M. Khabbaz, C. Assi, and W. Fawaz, “Disruption-Tolerant Networking: A Comprehensive Survey on Recent Developments and Persisting Challenges,” IEEE Communications Surveys Tutorials, vol. 14, no. 2, pp. 607–640, 2011.

[5] Z. Zhang, “Routing in Intermittently Connected Mobile Ad Hoc Networks and Delay Tolerant Networks: Overview and Challenges,” IEEE Communications Surveys Tutorials, vol. 8, no. 1, pp. 24–37, 2006.

[6] K. Wei, X. Liang, and K. Xu, “A Survey of Social-Aware Routing Protocols in Delay Tolerant Networks: Applications, Taxonomy and Design-Related Issues,” IEEE Communications Surveys Tutorials, vol. 16, no. 1, pp. 556–578, 2014.

[7] J. Kartha and L. Jacob, "Delay and Lifetime Performance of Underwater Wireless Sensor Networks with Mobile Element Based Data Collection," International Journal of Distributed Sensor Networks, vol. 2015, no. 6, 2015.

[8] P. Pereira, A. Casaca, J. Rodrigues, V. Soares, J. Triay, and C. Cervello-Pastor, "From Delay-Tolerant Networks to Vehicular Delay- Tolerant Networks," IEEE Communications Surveys Tutorials, vol. 14, no. 4, pp. 1166–1182, 2011.

[9] M. Saini, A. Alelaiwi, and A. Saddik, "How Close are We to Realizing a Pragmatic VANET Solution," ACM Computing Surveys, vol. 48, no. 2, pp. 1–40, 2015.

[10] J. Rodrigues, V. Soares, and F. Farahmand, "Stationary Relay Nodes Deployment on Vehicular Opportunistic Networks," Mobile Opportunistic Networks: Architectures, Protocols and Applications, vol. 56, no. 6, pp. 227–243, 2011.

[11] T. Jonson, J. Pezeshki, V. Chao, K. Smith, and J. Fazio, "Application of Delay Tolerant Networking (DTN) in Airborne Networks," in IEEE Military Communications Conference, San Diego, California, USA, November 2008, pp. 1–7.

[12] B. Karp and H. T. Kung, "GPSR: Greedy Perimeter Stateless Routing for Wireless Networks," in ACM Mobile Computing and Networking, Boston, Massachusetts, USA, August 2000, pp. 243–254.

[13] D. B. Johnson and D. A. Maltz, "Dynamic Source Routing in Ad Hoc Wireless Networks," Springer Mobile Computing, vol. 353, no. 1, pp. 153–181, 1996.