A Survey: An Energy Efficient Routing Protocol in Delay Tolerant Networks (DTN)

Prachi M. patel[1], Mala H. Mehta[2]

[1]PG Student, Information Technology Department, SVIT Engineering Collage, Vasad, Gujarat, India
[2]Assistant Professor, Information Technology Department, SVIT Engineering Collage, Vasad, Gujarat, India[3]

ABSTRACT

In a resource constrained network such as Delay Tolerant Networks (DTN), efficient utilization of resources such as energy is important for optimum network performance. However, due to nodes mobility, frequency of encounters and message transmission, most of node's energy in this type of network is continuously depleted. A node's energy in DTN plays an important role in the success of delivering messages. The lower the energy a node has, the lower its chance to deliver messages across the network. Thus, a proper energy-efficient routing protocol should be selected for message transmission for DTN applications. This issue leads us to investigate on the energy consumption of nodes in DTN. This paper presents a survey on energy efficient routing in DTN.

Keyword: *-Delay Tolerant Networks, Energy Efficiency, Epidemic Routing, n-Epidemic Routing etc….*

1. INTRODUCTION

Mobile ad hoc networks (MANET) are wireless networks that are formed by mobile nodes. In MANET it is assumed that it is always possible to identify an end-to-end path on which data can be forwarded. But, in reality it is not always possible that end-to-end connection is always exist between nodes since, nodes move from one place to another. To overcome this problem, a Delay Tolerant Network (DTN) is used. In DTN, mobile devices are moving around the network and contact each other opportunistically in order to deliver the data. However, the node in DTN_S are sparse and the unknown movement patterns of nodes may cause the network divided frequently. Hence, DTN are networks that are characterized by the non-existence of end-to-end path between the source and the destination of message or connection are intermittent. There are many real life networks, which follow this DTN paradigm, for example, Satellite communication [2], Wildlife tracking sensor network [3], Military networks, vehicular ad-hoc networks [4], etc.

DTN overcomes the problems associated with intermittent connectivity, long or variable delay, asymmetric data rates, and high error rates by using Store-Carry and Forward Mechanism [5]. The key idea is to facilitate opportunistic transport on a hop-by-hop basis rather than end-to-end streaming of data as in TCP/IP. A node in DTN essentially stores the received message in their buffer and wait for an opportunity or when the connection is available to retransmit them either directly to the final destination or to another relay to bring them closer to their final destination. This process is repeated until the message is relayed to it's destination or it's life time expires. Since, the path from one node to another node is not available due to intermittent connection, traditional routing algorithm for searching a path between a source to a destination cannot be used in DTNs.

Several DTN routing algorithms based on this mechanism have been proposed. Such as routing protocols: Epidemic [6], Spray and Wait [7], Prophet [8, 9]. The objective of these protocols are improved delivery rate, reducing the overhead generated and minimizing the average delivery time without taking into account the energy level of the batteries and the nodes of buffer space DTN, which are essential elements for a good performance of DTN network, to find out if those resources are sufficient for the nodes to participate in the transport of the messages. However, the majority of well-known DTN routing protocols do not consider energy constraints of mobile nodes in DTNs.

A node cannot forward message, if it does not have sufficient energy for performing the task. Energy is a crucial parameter of concern in DTNs, essentially in application like post disaster scenario where the nodes are often placed

in such location that cannot be connected to the power source. In such a scenario, residual energy of the nodes needs to be considered in almost all the activities of the network including designing routing strategies. Many mobile nodes such as computer, PCs and so on have limited energy resources. They use large amount of energy to transmit and receivemessages, routing protocol take care of energy consumption of mobile nodes are necessary for DTN.

2. EPIDEMIC ROUTING PROTOCOL

We briefly describe the original epidemic routing protocol here. The detail can be found in [6]. Epidemic routing protocol works as follows. The protocol relies upon the transitive distribution of messages through ad hoc networks, with messages eventually reaching their destination. Each host maintains a buffer consisting of messages that it has originated as well as messages that it is buffering on behalf of other hosts. For efficiency, a hash table indexes this list of messages, keyed by a unique identifier associated with each message. Each host stores a bit vector, called the summary vectorthat indicates which entries in their local hash tables are set. While not explored here, a "Bloom filter" [10, 11] would substantially reduce the space overhead associated with the summary vector. When two hosts come into communication range of one another, the host with the smaller identifier initiates an anti-entropy session(this term is borrowed from the literature [12]) with the host with the larger identifier. To avoid redundant connections, each host maintains a cache of hosts that it has spoken with recently. Anti-entropy is not re-initiated with remote hosts that have been contacted within a configurable time period.
During anti-entropy, the two hosts exchange their summary vectors to determine which messages stored remotely have not been seen by the local host. In turn, each host then requests copies of messages that it has not yet seen. The receiving host maintains total autonomy in deciding whether it will accept a message.

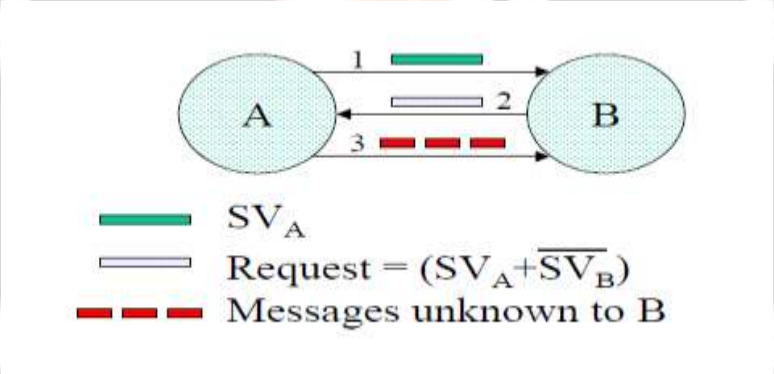

Figure 1: Epidemic Routing Protocol[6]

The goals of Epidemic Routing are to:

i) Efficiently distribute messages through partially connected ad hoc networks in a probabilistic fashion,
ii) Minimize the amount of resources consumed in delivering any single message
iii) Maximize the percentage of messages that are eventually delivered to their destination.

3. RELATED WORK

Various energy efficient routing schemes in Delay Tolerant Networks:
In [13], authors aim to change the way to spread messages of Epidemic Routing. They propose a new routing algorithm in which messages are spread faster by using only a few number of forwarding messages. They increase the speed of messages spreading by letting a node forwards messages without waiting for notifications from advertisement messages. They also show how to use broadcast transmission (the nature of the wireless medium) to reduce the number of message exchanges. It means a message is delivered to a destination faster while using only a small number of forwarding messages.

In [14], authors proposed a method in which a nodetransmits only when it has n-number of neighbors to inhibit the transmission and reduce energy consumption in nodes. Though, the method reduces the number of transmissions, it needs an appropriate value of n for its success. However, choosing the value of n is difficult because if it is smaller

then there will be many transmissions and the method will not differ from the original Epidemic method. If the value of n is large, there will be less or no transmissions and there will be less data delivery to the destination.

In [15], authors have proposed three heuristics all based on the dynamic setting of n parameters to improve the proposal of [14]. The value of n is based on the basis of the current energy level or current neighbor nodes. Unlike [14] where the value of n is statically chosen, here the value of n is dynamically chosen based on the pre-defined set of thresholds for energy level and its current neighbor nodes. However, the thresholds are fixed and need to be defined. Finding the appropriate pre-defined thresholds is difficult and may not work in all network environments.

In [16], authors consider only a node with higher energy than the sending/transmitting node and with enough available free buffer to store the message receives a copy of the message. This reduces the number of copies of a message in the network as well as number of transmissions of the message, thus reducing the energy consumption of nodes. As a result network life time is extended and delivery probability also improves.

In [17], authors presents a context-metric queuingmethod, called CEAMS for DTN that aims to optimize the delivery of message with HIGH priority by exploiting time variant context information of a node in the network. Theirapproach introduces a Node Delivery Capability (NDC) metric using node's remaining energy, estimated distance to the destination and speed as metric in queuing and sorting messages in a buffer. They also design and implement the use of an energy aware message priority transmission scheme with the proposed buffering model with admission and transmission control unit components.

In [18], authors discussed existing methods for buffer management and proposes a novel buffer management and scheduling policy and compared it traditional buffer management schemes. Their proposed method uses partial network knowledge so that it is most suitable DTN characteristics.

4. CONCLUSIONS

DTN are networks that are characterized by the non-existence of end-to-end path between the source and the destination of message or connection are intermittent. Various DTN routing protocols have been proposed to reduce the number of copies and improve the delivery probability of messages. However, very few of them consider the energy constraint of mobile nodes in routing protocols. It is essential to consider energy constraint while designing routing protocols for DTNs.

6. REFERENCES

[1] K. Fall, "A delay-tolerant network architecture for challenged internets," in Proceedings of the 2003 Conference on Applications, Technologies, Architectures, and Protocols for Computer Communications, ser. SIGCOMM '03. New York, NY, USA: ACM, 2003, pp. 27–34.

[2] F. De Rango, M. Tropea; G. B. Laratta, S. Marano, "Hop-by-Hop Local Flow Control over InterPlaNetary Networks based on DTN Architecture," in *IEEEICC 2008*, Bejing, China, May 2008.

[3] P. Juang, H. Oki, Y. Wang, M. Martonosi, L. S. Peh, and D. Rubenstein, "Energy-efficient computing for wildlife tracking: design tradeoffs and early experiences with zebranet," in *Proc. of ACM ASPLOS*, San Jose, CA, USA, Dec. 2002, pp. 96–107.

[4] J. Ott and D. Kutscher, "A disconnection-tolerant transport for drive-thru internet environments," in *Proc. of IEEE INFOCOM*, Miami, FL, USA, Mar. 2005, vol. 3, pp. 1849–1862. [4].

[5] Paritosh Puri and M.P Singh," A Survey Paper on Routing in Delay- tolerant Networks", in *International Conference on Information Systems and Computer Networks* 2013 IEEE, pp. 215-220.

[6] A. Vahdat and D. Becker, "Epidemic Routing for Partially-Connected Ad Hoc Networks," CS-200006, Duke University, Tech. Rep., Apr. 2000. [Online]. Available: http://issg.cs.duke.edu/epidemic/epidemic.pdf

[7] T. Spyropoulos, K. Psounis, and C. S. Raghavendra, "Spray and wait: An efficient routing scheme for intermittently connected mobile networks," in Proceedings of the 2005 ACM SIGCOMM Workshop on Delay-tolerant Networking, ser. WDTN '05. New York, NY, USA: ACM, 2005, pp. 252–259.

[8] A. Lindgren, A. Doria, and O. Schel´en, "Probabilistic routing in intermittently connected networks," SIGMOBILE Mob. Comput. Commun. Rev., vol. 7, no. 3, pp. 19–20, Jul. 2003.

[9] A. Lindgren, A. Doria, E. Davies, and S. Grasic, "Probabilistic routing protocol for intermittently connected networks," Internet Requests for Comments, RFC Editor, RFC 6693, August 2012, http://www.rfc-editor.org/rfc/rfc6693.txt. [Online]. Available: http://www.rfc-editor.org/rfc/rfc6693.txt

[10] Burton Bloom. Space/Time Trade-offs in Hash Coding with Allowable Errors. *Communication of ACM*, 13(7):422–426, July 1970.

[11] Li Fan, Pei Cao, Jussara Almeida, and Andrei Broder. Summary Cache: A Scalable Wide-Area Web Cache Sharing Protocol. In *Proceedings of ACM SIGCOMM'98*, pages 254–265, 1998.

[12] Douglas B. Terry, Marvin M. Theimer, Karin Petersen, Alan J. Demers, Mike J. Spreitzer, and Carl H. Hauser. Managing Update Conflicts in Bayou, a Weakly Connected Replicated Storage System. In *Proceedings of theFifteenth ACM Symposium on Operating Systems Principles*, pages 172–183, December 1995.

[13] TeerapongChoksatid, WorrawatNarongkhachavana, and SumetPrabhavat," An Efficient Spreading Epidemic Routing for Delay-Tolerant Network13th IEEE Annual Consumer Communications & Networking Conference (CCNC) 2016 IEEE ,pp. 1-4.

[14] X. Lu and P. Hui, "An energy-efficient n-epidemic routing protocol for delay tolerant networks," in Networking, Architecture and Storage (NAS), 2010 IEEE Fifth International Conference on, July 2010, pp. 341–347.

[15] F. De Rango, S. Amelio, and P. Fazio, "Enhancements of epidemic routing in delay tolerant networks from an energy perspective," in Wireless Communications and Mobile Computing Conference (IWCMC), 2013 9th International, July 2013, pp. 731–735.

[16] Bhed Bahadur Bista and Danda B. Rawat," A Robust Energy Efficient Epidemic Routing Protocol for Delay Tolerant Networks", 2015 IEEE International Conference on Data Science and Data Intensive Systems, pp. 290-296.

[17] Regin Cabacas and In-Ho Ra, " A Novel Energy-Aware Priority Transmission Scheme based on Context-Metric Queuing for Delay Tolerant Networks", 2014 IEEE, pp. 1095-1099.

[18] Sobin cc, " An Efficient Buffer Management policy for DTN", 6th International Conference On Advances In Computing and Communications, ICACC 2016 , pp. 311-314.

[19] Z. Mottaginia, S. Dabaghipoor, A. Ghaffari, "Distance and Energy Aware Routing Protocol for Delay Tolerant Mobile Sensor Networks." World Applied Sciences Journal, pp. 38-46, 2012.

[20] A. Ker¨anen, J. Ott, and T. K¨arkk¨ainen, "The ONE simulator for DTN protocol evaluation," in Proceedings of the 2Nd International Conference on Simulation Tools and Techniques, ser. Simutools '09. ICST, Brussels, Belgium, Belgium: ICST (Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering), 2009, pp. 55:1–55:10.