Scalable and Efficient Conditional Shortest Path Routing (SECSPR) for Delay Tolerant Networks

#1B.Mrudhula, #2G.Manthru Naik

#1iammrudhula@gmail.com, #2manthru1979@gmail.com

#1M.Tech student, Sri Mittapalli Institute of Technology for Women.

#2Assistant professor in Sri Mittapalli Institute of Technology for Women.

Abstract: Since a decade Delay-Tolerant-Networking (DTN) becomes very popular as they helpful in implementing the continuous network connectivity between the heterogeneous networks efficiently. Conventional network routing algorithms are not adoptable to DTN's in general, therefore routing in DTN is still a challenging issue and an open active research area for research scholars. Due to the sporadic connectivity DTN nodes are suffering from lack of stable connectivity in longer communications. Therefore decision making in route selection for packet forwarding becomes a challenging issue. To avoid these problems in DTN's, in this paper we introduce Scalable and Efficient Conditional Shortest Path Routing (SECSPR) to initiate the scalable data transfers through the efficient shortest path routing in a conditional way. We used conditional intermeeting time instead of conventional intermeeting time to construct the efficient shortest paths for scalable data transfer. Simulations of this new approach are showing that SECSPR is having the potential scalability and efficiency over existing methodologies in terms of shortest path construction, stable links and scalable data transfer among the heterogeneous networks.

Keywords: Delay-Tolerant-Networking, conditional intermeeting time, Shortest Path Routing, stable connectivity, data transfer

I. Introduction

A DTN [1 and 2] is a network of smaller networks. It is an overlay on top of special-purpose networks, including the Internet. DTNs support interoperability of other networks by accommodating long disruptions and delays between and within those networks, and by translating between the communication protocols of those networks. In providing these functions, DTNs accommodate the mobility and limited power of evolving wireless communication devices. DTNs were originally developed for interplanetary use, where the speed of light can seem slow and delay-tolerance is the greatest need. However, DTNs may have far more diverse applications on Earth, where disruption-tolerance is the greatest need. Basic Delay Tolerant Network (DTN) architecture is described by figure1.

Due to the low probability between the end points of DTN architecture, routing in DSN become a challenging issues where the traditional routing algorithms are not applicable. Therefore DSN routing become a prominent research area to improvise the

IJDCST @June-July-2015, Issue- V-3, I-5, SW-15
ISSN-2320-7884 (Online)
ISSN-2321-0257 (Print)

scalability of data transfer while maintain the communication between hetero networks.

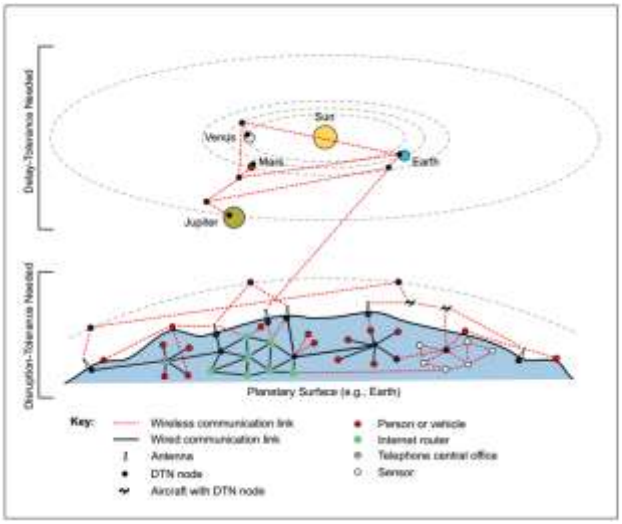


Figure1 Basic DTN Architecture

Because of the high rate of relevant node in availability for routing and data transfer, DTN model uses the "store-carry-and-forward" paradigm for network operations. In this paradigm when a node receives a message from one of its contacts, it stores the message in its buffer and carries the message until it encounters another node which is at least as useful (in terms of the delivery) as itself. Then the message is forwarded to it. Several algorithms of same paradigm were proposed by some previous researches on same topic by following the unrealistic assumptions like single copy and multi-copy etc. Current researches on DTN have proposed the "real mobility traces [3 and 4]" for efficient routing in DTN's based on past connectivity history related mined attributes instead of false assumptions. Although the current researches on DTN routing introduced real mobility traces, still the routing is suffering from the below serious problems like lack of guidance in initiating the data transfer, efficient shortest path finding and establishing the stable connections for longer connectivity etc.

In order to overcome the above mentioned issues, in this paper we introduced Scalable and Efficient Conditional Shortest Path Routing (SECSPR) to initiate the scalable data transfers through the efficient shortest path routing in a conditional way. We used conditional intermeeting time instead of conventional intermeeting time to construct the efficient shortest paths for scalable data transfer. To show the benefits of the proposed metric, we adopted it for the shortest path based routing algorithms [7] [10] designed for DTN's. We compare ESCSPR protocol with the existing shortest path (SP) [5 and 6] based routing protocol through real-trace driven simulations.

II. Related work

In this section we discuss about the centralized topic of our new approach is conditional intermeeting time in brief. With advent of wireless communications, mobility became a widespread feature than the traditional wired features. Mobility helps to maintain the ongoing communication while moving from one location to another. This facility helps in various situations like virtual conferences, on-demand communications, remote discussions etc. Recent analysis over mobility tracing reveals that assumption based intermeeting time identification fails to design the efficient routing in Delay Tolerant Networks. To avoid these false assumptions recent studies introduced the real data based knowledge extraction [8 and 9] topic for efficient and stable routing implementation in DTN's.

ISSN-2320-7884 (Online)
ISSN-2321-0257 (Print)

This new approach design the routing among multiple nodes of DTN based on their past data extracted knowledge instead of false assumptions. More formally, if X is the random variable representing the intermeeting time between two nodes, P (X > s + t | X > t) =_ P (X > s) for s, t > 0. Hence, the residual time until the next meeting of two nodes can be predicted well if the node knows that it has not met the other node for t time units.

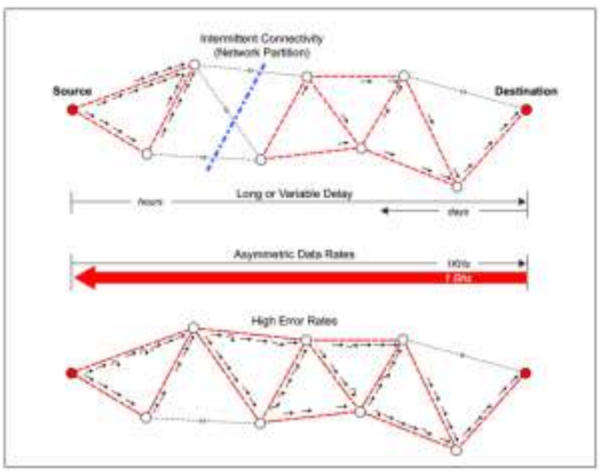


Figure 2 Conditional Intermeeting Connectivity

In order to utilize this exempted feature knowledge, we proposed a new metric called conditional intermeeting time that measures the intermeeting time between two nodes relative to a meeting with a third node using only the local knowledge of the past contacts. This kind of approach is beneficial exactly in the case of cyclic communications among two nodes, which have a strong and longer connectivity in previous data transfer tasks. This is exactly useful in making the decisions while need the connectivity between two node for longer as shown in above figure2.

III. Scalable and Efficient Conditional Shortest Path Routing (SECSPR)

In this section we discuss about our proposed approach Scalable and Efficient Conditional Shortest Path Routing (SECSPR) in detail. Like conventional networks related shortest path algorithms, in DTN's also we need the shortest path routing algorithms. Data packets will be transferred between source and destination along with the assigned cost values for generate links. This procedure will helps to update the link costs for each transfer, which causes to initiate the stable node connectivity in routing. Due to the mobility feature of DTNs we also consider the dynamic behavior relevant metrics minimum expected delay (MED) and minimum estimated expected delay (MEED). Based on past connectivity history, our approach calculates the expected waiting time and packet transmission delay time in delay tolerant networks.

We implemented the route design decisions at each end points are the source node, destination node and intermediate nodes at hop level in either single hop or multi hop technology. By using the extracted knowledge at hop we calculate the efficient neighbor to design the route by considering the delay. This process continues at each level, when a new message is ready to transfer at the hop. In this approach we design a routing table with link weights, which confirms the selection of stable link among the available links from routing table. The same procedure will be used at each node/hop level to construct the efficient routing with better forwarding decisions.

SECSPR Design Model

We model a DTN as a graph G = (V , E) where the vertices (V) are mobile nodes and the edges (E) represent the connections between these nodes. However, different from previous DTN network models [7] [10], we assume that there may be multiple unidirectional (Eu) and bidirectional (Eb) edges between the nodes. The neighbors of a node i are denoted with N (i) and the edge sets are given as follows:

$E = E_u \cup E_b$

$E_b = \{(i, j) \mid \forall_j \in N(i)\}$ where, $w(i, j) = \tau i(j) = \tau j(i)$

$E_u = \{(i, j) \mid \forall j, k \in N(i)$ and $j \_= k\}$ where,

$w(i, j) = \tau i(j|k)$

The above definition of Eu allows for multiple unidirectional edges between any two nodes. However, these edges differ from each other in terms of their weights and the cor-responding third node. This third node indicates the previous meeting and is used as a reference point while defining the conditional intermeeting time (weight of the edge). The below diagram figure 3 we illustrate a sample DTN graph with four nodes and nine edges.

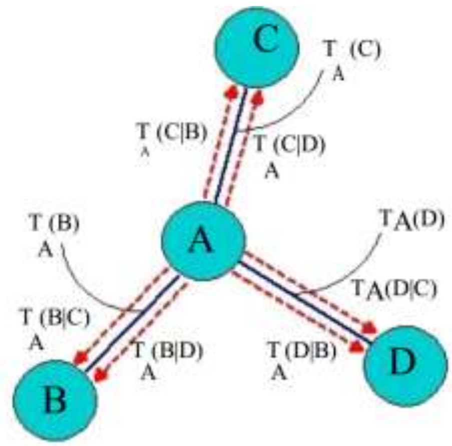


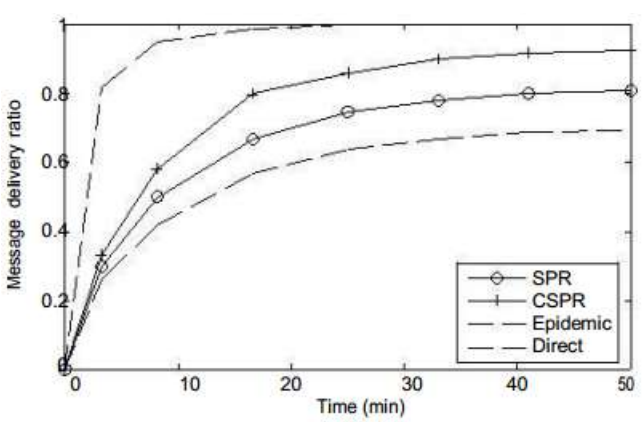
Figure 3 Graph with a sample four node DTN

IV. SECSPR Simulations

In this section we discuss about the conducted simulation experiment to prove the efficiency of our proposed routing approach. To implement the simulation of this research we used JAVA as a base platform for simulator implementation. After the design of simulator we transformed the design of our SECSPR as a java program file with extension java. To identify the shortest paths for data transmission in our routing approach SECSPR we used Standard Shortest Path Routing algorithm. We started the simulation with 14 active nodes with predefined link weight as shown in figure 4.

Figure4 SECSPR implementation with JAVA simulator

After running of several times we updated the link weights based on their longer connectivity while transferring the data through the link. For all iterations we update the routing table with node positions, shortest paths and link weights also. This information will be used as past data to extract the knowledge by SECSPR approach. In total we transferred 150 messages with different size and different content in our experiments. At the end the recorded results will be compared against the existing approaches like SPR, Epidemic and Direct etc. These result graphs (Graph1 and Graph 2) are showing that our SECSPR is having the high scalability and efficiency over all other approaches.



Grpah1. Message Delivery ration vs time comparison

V. Conclusion

Due to the low probability between the end points of DTN architecture, routing in DSN become a challenging issues where the traditional routing algorithms are not applicable. Therefore DSN routing become a prominent research area to improvise the scalability of data transfer while maintain the communication between hetero networks. In order to overcome the above mentioned issues, in this paper we introduced Scalable and Efficient Conditional Shortest Path Routing (SECSPR) to initiate the scalable data transfers through the efficient shortest path routing in a conditional way. We used conditional intermeeting time instead of conventional intermeeting time to construct the efficient shortest paths for scalable data transfer. We compare ESCSPR protocol with the existing shortest path (SP) based routing protocol through real-trace driven simulations.

VI. References

1. Delay tolerant networking research group, http://www.dtnrg.org
2. V. Conan, J. Leguay, and T. Friedman, “Fixed point opportunistic routing in delay tolerant networks,” IEEE Journal on Selected Areas in Communications, vol. 26, pp. 773-782, June 2008.
3. T. Spyropoulos, K. Psounis,C. S. Raghavendra, Efficient routing in inter-mittently connected mobile networks: The

multi-copy case, IEEE/ACM Transactions on Networking, 2008.

4. Y. Wang, S. Jain, M. Martonosi, and K. Fall, Erasure coding based routing for opportunistic networks, in Proceedings of ACM SIGCOMM workshop on Delay Tolerant Networking (WDTN), 2005.
5. S. Jain, K. Fall, and R. Patra, Routing in a delay tolerant network, in Proceedings of ACM SIGCOMM, Aug. 2004.
6. T. Spyropoulos, K. Psounis,C. S. Raghavendra, Spray and Wait: An Efficient Routing Scheme for Intermittently Connected Mobile Networks, ACM SIGCOMM Workshop, 2005.
7. A. Lindgren, A. Doria, and O. Schelen, Probabilistic routing in intermittently connected networks, SIGMOBILE Mobile Computing and Communication Review, vol. 7, no. 3, 2003.
8. M. Kalantari and R. J. La, “A DTN packet forwarding scheme inspired by thermodynamics,” in Proceedings of Annual Conference on Information Sciences and Systems (CISS), pp. 1216-1221, March 2008.
9. I. Carreras, J. Rana, and L. Telesca, “Coordination protocol for financial application in delay tolerant networks,” in Proceedings of International Conference on Communication Systems Software and Middleware and Workshops (COMSWARE), pp. 283-286, January 2008.
10. Q. Liu, S. Zhou, and G. B. Giannakis, “Queuing with adaptive modulation and coding over wireless links: cross-Layer analysis and design,” IEEE Transactions on Wireless Communications, vol. 4, no. 3, pp. 1142- 1153, May 2005.