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CSPR Using In Delay Tolerant Networks

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Abstract - **This article studies Delay tolerant networks (DTNs) where each node knows the probabilistic distribution of contacts with other nodes. Delay tolerant networks are characterized by the sporadic connectivity between their nodes and therefore the lack of stable end-to-end paths from source to destination. Since the future node connections are mostly unknown in these networks, opportunistic forwarding is used to deliver messages. Based on the observations about human mobility traces and the findings of previous work, we introduce a new metric called conditional intermitting time. We propose Conditional Shortest Path Routing (CSPR) protocol that route the messages over conditional shortest paths in which the cost of links between nodes is defined by conditional intermitting times rather than the conventional intermitting times (CIT). 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.**

Keywords - **CSPR, CIT, DTN, END-TO-END.**

I. Introduction

This Routing in delay tolerant networks (DTN) is a challenging problem because at any given time instance, the probability that there is an end-to-end path from a source to a destination is low. Since the routing algorithms for conventional networks assume that the links between nodes are stable most of the time and do not fail frequently, they do not generally work in DTN's. Therefore, the routing problem is still an active research area in DTN's. Routing algorithms in DTN's utilize a paradigm called store-carry-and-forward. 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. Based on this paradigm, several routing algorithms with different objectives (high delivery rate etc.) and different routing techniques (single-copy, multi-copy, erasure coding based etc.)[5] Have been proposed recently. However, some of these algorithms used unrealistic assumptions, such as the existence of oracles which provide future contact times of nodes. Yet, there are also many algorithms based on realistic assumption of using only the contact history of nodes to route Messages opportunistically. Recent studies on routing problem in DTN's have focused on the analysis of real mobility traces Different traces from various DTN environments are analyzed and the extracted characteristics of the mobile objects are utilized on the design of routing algorithms for DTN's. From the analysis of these traces performed in previous work, we have made two key observations. First, rather than being memory less, the pair wise intermitting times between the nodes usually follow a log-normal distribution. Therefore, future contacts of nodes become dependent on the previous contacts. Second, the mobility of many real objects is non-deterministic but cyclic. Hence, in a cyclic Mob Space, if two nodes were often in contact at a particular time in previous cycles, then they will most likely be in contact at around the same time in the next cycle

II. Related Work

A connected hypercube with faulty links or nodes is called an injured hypercube [6]. A distributed adaptive fault-tolerant routing scheme is proposed for an injured hypercube in which each node is required to know only the condition of its own links. Despite its simplicity, this scheme is shown to be capable of routing messages successfully in an injured n-dimensional hypercube [7] as long as the number of faulty components is less than n. Moreover, it is proved that this scheme routes messages via shortest paths with a rather high probability, and the expected length of a resulting path is very close so that of a shortest path. Since the assumption that the number of faulty components is less than n in an n-dimensional hypercube might limit the usefulness of the above scheme, a routing scheme based on depth-first search which works in the presence of an arbitrary number of faulty components is introduced. Due to the insufficient information on faulty components, however, the paths chosen by this scheme may not always be the shortest. To guarantee all messages to be routed via shortest paths, the authors propose to equip every node with more information than that on its own links. The effects of this additional information on routing efficiency are analyzed, and the additional information to be kept at each node for the shortest path routing is determined.

III. Proposed System

In this proposed system, we redefine the intermitting time concept between nodes and introduce a new link metric called conditional intermitting time.

It is the intermitting time between two nodes given that one of the nodes has previously met a certain other node. This updated definition of intermitting time is also more convenient for the context of message routing because the messages are received from a node and given to another node on the way towards the destination. Here, conditional intermitting time represent the period over which the node holds the message. To show the benefits of the proposed metric, we propose conditional shortest path routing (CSPR) protocol in which average conditional intermitting times are used as link costs rather than standard intermitting times and the messages are routed over conditional shortest paths (CSP). We compare CSPR protocol with the existing shortest path (SP)[8] based routing protocol through real trace- driven simulations. The results demonstrate that CSPR achieves higher

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delivery rate and lower end-to-end delay compared to the shortest path based routing protocols. This show how well the conditional intermitting time represents internode's link costs (in the context of routing) and helps making effective forwarding decisions while routing a message. Routing algorithms in DTN's utilize a paradigm called store-carry-and-forward. We generated the multiple messages from a random source node to a random destination node at each t seconds. Clearly, CSPR algorithm delivers more messages than SPR algorithm.

3.1. Algorithm Description:

Our algorithm basically finds conditional shortest paths (CSP) for each source-destination pair and routes the messages over these paths. We define the CSP from a node n0 to a node nd as follows:

$$CSP(n0,nd) = \left\{ n0, n1, \ldots, nd-1, nd \mid Rn0(n1|t) + \sum_{i=1}^{d-1} Tni(ni+1 \mid ni-1) \text{ is minimized.} \right\}$$

Here, t represents the time that has passed since the last meeting of node n0 with n1 and Rn0 (n1|t) is the expected residual time for node n0 to meet with node n1 given that they have not met in the last t time units. Rn0 (n1|t) can be computed as in with parameters of distribution representing the intermitting time between n0 and n1. It can also be computed in a discrete manner from the contact history of n0 and n1.

Assume that node i observed d intermitting times with node j in its past. Let τ i 1 (j), τ i 2 (j) . . . τ i d (j) denote these values. Then:

$$Ri(j \mid t) = \left(\sum_{k=1}^{d} fki(j) / \left| \{T\, ki(j \ge t\} \right| \right) \text{where,}$$

$$f\,ki(j) = \begin{cases} T\,Ki(j) - t & \text{if } T\,Ki(j) \ge t \\ 0 & \text{otherwise} \end{cases}$$

Here, if none of the d observed intermitting times is bigger than t (this case occurs less likely as the contact history grows), a good approximation can be to assume Ri(j|t) = 0. We will next provide an example to show the benefit of CSP over SP. Consider the DTN illustrated in Figure 4. The weights of edges (A, C) and (A, B) show the expected residual time of node A with nodes C and B respectively in both graphs. But the weights of edges (C, D) and (B, D) are different in both graphs. While in the left graph, they show the average intermitting times of nodes C and B with D respectively, in the right graph, they show the average conditional intermitting times of the same nodes with D relative to their meeting with node A. From the left graph, we conclude that SP (A, D) follows (A, B, D). Hence, it is expected that on average a message from node A will be delivered to node D in 40 time units. However this may not be the actual shortest delay path. As the weight of edge (C, D) states in the right graph, node C can have a smaller conditional intermitting time (than the standard intermitting time) with node D assuming that it has met node A. This provides node C with a faster transfer of the message to node D after meeting node A. Hence, in the right graph, CSP (A, D) is (A, C, D) with the path cost of 30 time units.

Table 1

Symbols	Description
CSP	conditional shortest paths
n0 to nd	node n0 to a node nd
t	represents the time
(n1|t)	residual time for node n0 to meet with node n1
τD(E|B)≥τD(E|C)	Dijkstra's or Bellman-ford algorithm
DTN	Delay Tolerant Network

Each node forms the aforementioned network model and collects the standard and conditional intermitting times of other nodes between each other through epidemic link state protocol. However, once the weights are known, it is not as easy to find CSP's as it is to find SP's. Where the CSP (A, E) follows path 2 and CSP (A, D) follows (A, B, D). This situation is likely to happen in a DTN, if τD(E|B) ≥ τD(E|C) is satisfied. Running Dijkstra's or Bellman-ford algorithm on the current graph structure cannot detect such cases and concludes that CSP (A, E) is (A, B, D, and E).

3.2. Modules Description Networking Module.

Client-server computing or networking is a distributed application architecture that partitions tasks or workloads between service providers (servers)[9] and service requesters, called clients.

Often clients and servers operate over a computer network on separate hardware. A server machine is a high-performance host that is running one or more server programs which share its resources with clients [10]. A client also shares any of its resources; Clients therefore initiate communication sessions with servers which await (listen to) incoming requests.

Shortest Path Module

In multi-hop wireless networks, packets are transferred through routes that could be composed of multiple relay nodes between sources and destinations. In many multi-hop wireless networks, shortest path routing is often used for its simplicity and scalability, and this is closely approximated by straight line routing for large multi-hop wireless networks. Thus, in this paper, we will focus on straight line routing for delivering packets from sources to destinations.

Straight Line Routing Module

Both simulations and analysis show that the relay load over the network, imposed by straight line routing, depends on the model of the traffic pattern. Even if the system settings are identical and straight line routing is commonly adopted, the relay load induced by "random"[11] traffic could be distributed differently over the network. This paradoxical result is a consequence of the famous Bertrand's paradox. Thus, in contrast to traditional belief, there are many scenarios in which straight line routing itself can balance the load over the network, and in such cases explicit load-balanced routing may not help mitigate the relaying load.

Multi Hop Module

Analyze the load for a homogeneous multi-hop wireless network [12] for the case of straight line routing in shortest path routing is frequently approximated to straight

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line routing in large multi-hop wireless networks. Since geographical and geometric attributes of nodes and routes affect the nodal load, we employ results from geometric probabilities to solve the problem. Based on our analytical results, we are able to show the precise relationship between the number of nodes and the load at each node, and the geographical distribution of the relaying load over the network for different scenarios. Interestingly, straight line routing itself can balance the relay load over the disk in certain cases.

IV. Conclusion

In this paper, we proposed stability based multicast routing scheme in MANET [16]. It finds the multicast routes to receivers by using route request and route reply packets with the help of routing information maintained in MRIC[17] and link stability parameters maintained in link stability database on every node in a MANET. Multicast mesh of alternate paths between every source-destination pair is established in mesh creation phase. Stable path within a mesh is established by choosing an SFN[18] that possess higher value of link stability among its neighbors. This assures better quality of links and minimizes the possibility of link failures and the overhead needed to construct the paths. Link failure conditions are notified to the source with route error packets so as to enable the source to start route discovery for new route establishments. Extensive simulation is performed to assess the network with three performance metrics such as packet delivery ratio, control overhead and packet delay and the comparison is made with ODMRP.[21] The proposed scheme showed significant improvements in terms of packet delivery ratio, control overheads and packet delay as compared to ODMRP.

V. Future Enhancement

In future work, we will look at the performance of the proposed algorithm.[13] in different data sets to see the effect of conditional intermitting time in different environments. Moreover, we will consider extending our CSPR algorithm by using more information (more than one known meetings) from the contact history while deciding conditional intermitting times [14]. For this, we plan to use probabilistic context free grammars (PCFG)[15] and utilize the construction algorithm. Such a model will be able to hold history information concisely, and provide further generalizations for unseen data.

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