



Comparative Study of Routing Protocols in Delay Tolerant Networks

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ABSTRACT: In Mobile Adhoc Network (MANET) packets can be transferred only if link between the nodes are established. If link is not established then packets will be lost. So packet delivery ratio will be decreased in MANET. To overcome this problem, Delay Tolerant Network (DTN) is used. In DTN each node has some storage capacity. So if the links of nodes are not established then packets will be stored in the storage. DTN is able to provide communication services in unreachable & unfriendly environments. There is no end to end connectivity between source & destination in DTN. Delay tolerant network use store & carry forward the data from one node to other node In this paper we have introduced DTN and its routing protocols. We have also compared these protocols and mentioned future research work in DTN.

Keywords: DTN, MANET, Routing, Flooding, Forwarding

I. INTRODUCTION

Data communications have come a long way in the last few years and we are experiencing faster and more reliable networks which allow the deployment of data intensive and media rich applications. Such networking infrastructures rely on a variety of connections that include fiber, short and long range wireless links and 3G, 4G and LTE. Based on their experiences from many urban areas, users start viewing Internet access as a ubiquitous service and begin to demand connectivity wherever they are around the globe[1].

On the other hand, we still find many places in the world where connectivity is unreliable or not available at all and there is a need for data transfers to and from such locations e.g. for processing data gathered by sensors or medical devices, for providing basic communications such as email etc. Delay Tolerant Networking (DTN) seems to be the ideal candidate for complementing existing communication infrastructures where deployment practicalities and costs are a prohibitive factor. An environment where this condition applies is the sea; it is well known that satellite Communication costs are pretty high but seaborne vessels do not have any alternative and “always on” communication options available and hence have to endure this expense. Our aim is not to establish basic communications per se (although this may be true in cases where satellite communication is not affordable or feasible) but to assess the feasibility of using DTN for data transfers between sailing vessels and shore-based stations. Such data transfers may be initiated by mobile users on board who require access to entertainment data (e.g. movies), touristic data (e.g. maps) or involve low importance mission data (e.g. weather data). In main difference between the MANAT and DTN is storage capacity of node[2].

II. LITERATURE SURVEY

A. Problem with routing without DTN

In routing the link between the routers are established so packet can be transferred from one node to other node. Now if link is not established then packets will be dropped. Figure 2.1 shows the problem during routing.

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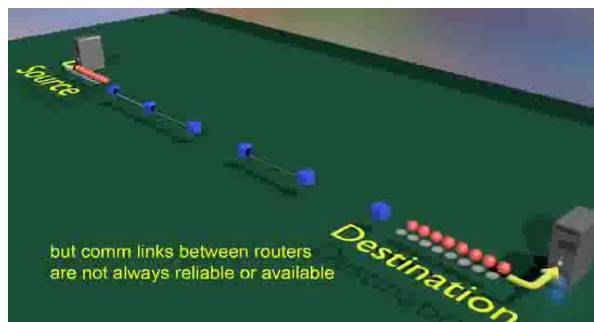


Fig.1 Problems during routing

B. Routing in DTN

In Delay Tolerant Network each node have a resource to store the package. Now node will check if link between node is established or not. If no, then the node will store the packet & forward the same when the link is established. The DTN scenario is given in the figure3.2.



Fig.2 DTN

Thus, DTN use store & carry forward mechanism to send packets from source to destination.

C. Routing protocols in DTN

In general the routing protocols in DTN are classified into 2 categories based on which property is used to find the destination: Flooding families & forwarding families. To find the estimation, two different approaches of replication & knowledge are used. The replication is used in the flooding strategy & there are many algorithms to manage multiple copies of message & to make those copies. while the knowledge is used in forwarding strategy & some works have been devoted to derive more efficient methods to obtain some network state information & then to use it make routing decision[3].

Flooding families:In flooding families, each node has a number of copies of each message & transmits them to a set of nodes (sometime called relays).all the relays maintain the copies and store them in their buffer space until they connect with the next nodes. The works in the area of DTN routing fall into this family early. Using the message replication can increase the probability of message delivery. The basic protocols in this family do not want any information about network. However if some knowledge about network is referred to as an additional routing metric, the flooding strategy can be significantly improved. Direct contact, tree-based flooding, epidemic routing, prioritized epidemic routing, probabilistic routing and reconfigurable ubiquitous networked embedded system (RUNES), two-hop relay routing protocols belong to the flooding family



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1. *Direct contact*: This routing protocol permits that data can be transmitted in one hop only. Due to its simple characteristics, it does not consume many resources, and it uses exactly one message transmission when the source can directly contact with the destination.
2. *Two-hop relay*: The transmission has two hops between source and destination. If there are n nodes around the source & directly connect with the source, then there are n copies of the message should be generated from source, and be transmitted to these nodes
3. *Tree-based flooding*: In this routing protocol, the way of flooding is based on tree structure. Both deciding how make copies & ensuring the number of copies are important issues in this routing protocol
4. *Epidemic routing*: In this protocol all nodes can become the carrier, and it is ensured that messages can be delivered with a high probability. However, the network resources are consumed heavily.
5. *prioritized Epidemic Routing*: The key idea about prioritized epidemic routing is to impose a partial ordering on message called Bundles. Therefore, the priority functions of transmission and deletion are used, which are based upon four inputs such as the current cost to destination, the current cost from source, the expiry time & the generation time.
6. *Probabilistic Routing*: In this routing, when a message arrives at a node which does not have an available contact with other node, it must be stored in the buffer until the node encounters with another node.. we should set a probability threshold on the nodes. it only admits that a node can receive the message when its delivery probability exceeds the threshold

Forwarding Families: In the forwarding families, the network topology information is used to select the best path and the message is then forwarded from node to node along with the path. These routing protocols require some knowledge about network. The node will try to send single message along with the best path, so they do not use replication. Location based routing, source routing, per-hop routing, per-contact routing, & hierarchical routing protocols belong to the forwarding family

1. *Location based routing*: In this routing protocol a distance function is used to estimate the cost of delivering messages from one to other. The advantage of this protocol is that it requires very less information about the network. However, it has two problems. The one problem is that even if the distance between 2 nodes is small, there is no guarantee that they will be able to communicate with each other. The other is that a node's coordinates should usually change.
2. *Source routing*: In brief, source routing means the source node is in charge of the whole transmitting and determines the path based on the topology of the network before the message gets into the node. This routing protocol will have good performance only when the distance between source and destination is low.
3. *Per-Hop Routing*: In this routing protocol, the forwarding decision is made by the intermediate node when a message arrives at the node. The node determines the next hop for the destination & places it in a queue for that contact.
4. *Per-contact routing*: In this routing table is recomputed each time a contact is available, instead of computing the next hop for a message. It ensures that each routing decision is made with most recent information. However, to guarantee the loop freedom is a big problem.
5. *Hierarchical routing*: It is a hop-by-hop routing rather than a source routing. The advantage is that it is scalable for Localized traffic patterns and it does not need location information. However, the contact information is time-variant. For solving this problem, we need a method to aggregate the time- Varying information.

III. ROUTING ISSUES IN DTN [3,4]

A. Routing Objectives in DTN

The most important routing objective in DTN is to maximize the probability of message delivery. To minimize resources like buffer space battery energy is also an important routing objective. While DTN applications are expected to be tolerant of delay, this does not mean that they would not benefit from decreased delay but it's still meaningful to minimize the delivery latency.



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B. Energy

In DTN nodes are moving from one place to another place so it's always lack of energy. Lots of energy is consumed for sending, receiving & storing messages.

C. Security

It is always an important issue not only in DT but also in all networks. In DTN message can traverse from one node to other node before reaching to the destination. So security issue may occur at all node.

D. Buffer space

The intermediate routes should require enough buffer space to store all the messages to be transmitted. More number of pending messages needs more available buffer space.

E. Resource Allocation

The routing protocols must balance the goals of maximizing message delivery & minimizing resource consumption which are conflict with each other.

IV. COMPARISON

We compare the flooding families in terms of various characteristic like hope count, resource usage, effectiveness or latency. DTN is a very important network for communication which uses a storage device to each & every node. So if the link is not established among nodes then packets at that node will be stored & wait till the link to be established. we can also minimize the no. of nodes using DTN & cost also can be reduced. But in DTN routing is not efficient as delay of packets may occur sometime. The comparisons of all routing protocols in DTN are given in the table[3].

TABLE I
 COMPARISON FOR FLOODING FAMILIES

Protocols	Hope Count	Resource Usage	Delivery Ration	Routing-vector/ table	Multipath support	Effective-ness	Latency
Direct Contact	1	Low	Min	No	No	Bad	Long
Two-hop relay	2	Low	Low	No	Yes	Bad	Long
Tree-based flooding	Many	High	Low	No	Yes	Bad	Long
Epidemic routing	Many	Max	Max	Yes	Yes	Normal	Long
Prioritized epidemic routing	Many	Limited	Normal	Yes	Yes	Good	Normal
Probabilistic routing	Many	Limited	Normal	Yes	No	Good	Normal
RUNES	Many	Limited	Normal	Yes	May be	Good	Long



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TABLE II

COMPARISON FOR FORWARDING FAMILIES

Protocols	Resource Consumption	Information Usage	Routing Vector/ Table	Scalability	Loop free	Effective - ness	Delivery ratio	Latency
Location based routing	Little	Little	No	Bad	Yes	Bad	Min	Normal
Source Routing	Normal	Normal	No	Bad	Yes	Bad	Low	Long
Per-hop routing	Normal	Normal	No	Bad	Yes	Bad	Low	Long
Per-contact routing	Many	Many	Yes	Bad	No	Normal	normal	Normal
Hierarchical routing	Many	Many	Yes	Good	Yes	Good	Max	Normal

V. CONCLUSION AND CHALLENGES

From this paper we can conclude that to overcome the problem in routing we can use DTN which can store & carry forward data from node to node. This is very new & effective concept to send packets from source to destination. We have also describes the comparative study of various routing protocols in DTN. In flooding families, resource usage is very high in Epidemic routing & effectiveness is good in the epidemic routing, prioritized routing & probabilistic routing. While in Forwarding families hierarchic routing is best among all cause delivery ratio is maximum in this. But resource usage is also high in this. The main challenges of DTN are (1) Latency is very high as when connection is broken it will wait till re-establishment of the connection. (2) Routing is very difficult in Delay Tolerant Network as each node has to wait for the link establishment of each node.

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