International Journal of Modern Engineering Research (IJMER)
www.ijmer.com Vol.2, Issue.4, July-Aug. 2012 pp-1732-1735 ISSN: 2249-6645

# Effective routing protocols for delay tolerant network

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***Abstract:*** *Delay-tolerant Networking (DTN) enables communication in sparse mobile ad-hoc networks and other challenged environments where traditional networking fails and new routing and application protocols are required. Past experience with DTN routing and application protocols has shown that their performance is highly dependent on the underlying mobility and node characteristics. Evaluating DTN protocols across many scenarios requires suitable simulation tools. This paper presents the existing routing protocols techniques and Comparative study of existing routing protocols of Delay-Tolerant Networks based upon the metrics like Overhead Ratio, Hop Count and Buffer Size.*

## I. INTRODUCTION

Delay tolerant networks are an emerging field of networks that show some different characteristics from today's internet such as intermittent connectivity, long delays etc. Delay tolerant networks arise in a variety of situation like disaster relief, military rescue operations, rural internet access etc. There are some critical situations where the ability to communicate make a significant difference for human lives. In DTN decision to drop a message is taken on several constraints like size of message, no of copies, time to live and buffer size etc.

In DTN, end to end path is very rare and unstable in nature and opportunity to establish complete route is negligible. DTN support those applications, whose time requirement is hours or even day or longer. It is necessary to deliver high priority message during "contact" phase [1]. DTN enable communication by taking advantage of Temporary connections to relay data in a fashion similar to Postal network instead of requiring an end to end network path to be available.

However communication in DTN is a very challenging task. Traditional network simply assume a complete connected graph should be there and a period of time that is long enough to allow communication. In DTN there might not even be end to end path between a pair of nodes at any moment of time as shown in the figure 1 [2]. Due to this unique feature of DTN, existing routing algorithm that are developed for Internet and MANETS do not performing well. Reason for this is that all these algorithm assume that the network is connected and end to end path exist between each pair of nodes. DTN are often resource limited and not able to deliver required performance in case of intermittent connectivity. Due to given resource limitation and uncertainty in DTN it is very difficult to deliver data efficiently.

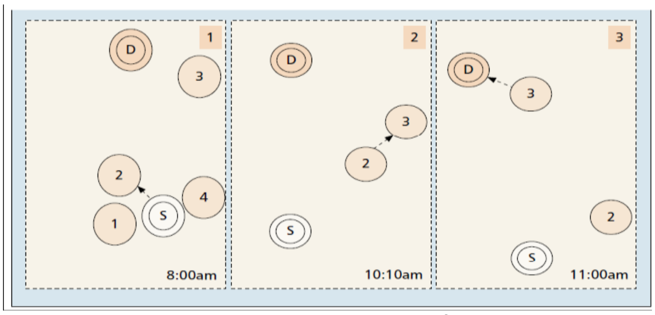


Figure 1: Time Evolving Behavior of the Network

DTN follow store carry and forward approach. Node should carry the message until proper custodian is not found. Because of resource limitation each node in DTN has some fix size of buffer. Node store the message in its own buffer until the next custodian is found in the path towards the destination. As the buffer size is limited node should follow some policy to decide which message is dropped when the buffer size is full. Develop an algorithm and a weight function to make this decision that effectively choose message to be dropped. As a result proposed algorithm has been compare with already existing DROP FRONT policy. The approach better results in terms of delivery probability, buffer time avg and Hop count avg..

## II. RELATED WORK

The major objective of routing in DTNs is to deliver packets from the source to the destination by means of the mobility of nodes. Since the end-to-end path may not be available, routing schemes have to optimize data dissemination by utilizing the connectivity information and network conditions maintained by each node. For example, in [3], the routing scheme based on the estimates of the average inter contact time between the mobile nodes in the network was proposed. This routing scheme was designed to minimize the packet delivery time. The routing properties in terms of loop-free forwarding and polynomial convergence were studied, which ensure the performance of the packet delivery in DTNs. In [4], the packet-delivery scheme based on the super node architecture and epidemic routing was introduced. With epidemic routing, the packets are forwarded to other contacted nodes (i.e., nodes with a direct connection). Unlike traditional epidemic routing, the packets are forwarded to the super nodes to improve the performance and reduce overhead. The super nodes are then responsible in carrying the packets to the destination.

## III. ROUTING PROTOCOLS

**(a) *First contact:*** – This is simplest strategy to transmit the data from source to destination in DTN. This transmit message immediately as soon as the source and destination come in contact with each other directly. This is possible when the source and destination are one hop apart or immediately neighbor of each other.

**(b) Direct delivery:-** Scheme lets the source hold the data until it comes in contact with the destination. This simple strategy uses one message transmission. It is a degenerate case of flooding family, requiring no info about network but requires a direct path between source and destination. Hence if no contact occurs, message is not delivered.

**(c) ProPHET:-**Improve the routing performance by adopting the probabilistic scheme that reflects the contact observation of nodes. However, the single copy forwarding based on the probability may affect to the performance with limitation of the initial probability distribution and a message drop. The limited buffer space and use of an ACK message should be investigated to enhance the performance further.

Finally, although Spray and Wait can overcome the shortcomings of Epidemic routing protocol, the usability of the wait phase with an efficient single copy forwarding scheme and the optimal decision of an initial spray number are open issues.

**(d) Spray and Wait:-** The operation of Spray and Wait consists of two phases:

the spray phase and the wait phase. In the spray phase, when a node generates a message, the node makes *N* copies of the message to spread it to relay nodes. When the node meets the other node, the node checks N (i.e., N > 1). If the node has the spray message, the node hands over the message and revised N (i.e., N/2) to the other node. After the spray phase is finished, each of *N* nodes carrying a message copy performs the direct message transmission until it successfully delivered the message to the destination.

**(e) *Epidemic Routing:* -** Epidemic routing is an early sparse network routing protocol proposed for DTN. It assumes that each node has unlimited storage space and bandwidth. Therefore every node can store all the messages transmitted during "contact" phase. This use the concept of database replication also a relay node can exchange the entire message during "contact" phase. Each node maintains list of messages in the database called summary vector.

## IV. Dynamic Spray and Wait with Quality of Node (QoN)

### 4.1. Delivery utility

When delivery rate stay the same, consider the relationship between network overhead and delivery utility. Delivery utility is defined as the ratio of the number of messages received by destination nodes to the number of messages forwarded by relay nodes, as shown in Equation (1).

$$delivery\_utility = \frac{\text{Messages of received}}{\text{Messages of forwarded}}$$

### 4.2. The definition of Quality of Node (QoN)

The Epidemic and The Spray and Wait routing protocols forward messages without taking node mobile patterns into consideration, therefore the delivery utility is too low.

Now present the notion of QoN. QoN indicates the activity of a node, or the number one node meets other different nodes within a given interval. In the same period of time, the more nodes that one node meets, the greater the QoN. The variation of QoN can dynamically represents the node activity in a given period of time.

## V. Drop policy algorithm

Let us assume
n= number of nodes in the network
t= number of digits in n
Bavail=buffer available at particular node
Mnew=new message
Snew=size of new incoming message
Ni(t)=no copies of message i at time t
Ttl= time to live /*time duration in which message is live means message is useful only this time duration */
Rtli=remaing time to live of message for message i

### 5.1 Proposed Algorithm

When two nodes communicate with each other they share message to each other. It might be possible when they communicate the buffer available is not enough to accommodate a new message. At that time scheduling take place. Each node have two options at that moment of time: first it will discard a new message and second one is that it will drop some message from its buffer and make some room for the new message.

Until now all DTN routing protocol follow the DROP FRONT message approach in which they drop message from the front of nodes buffer queue.

### 5.2 Weight function

This function value makes the decision to drop a message from the node buffer. This weight function consider various properties of the message and node. As a result it gives a value on basis of that a node drop a particular message whose value is minimum.

Let N= no of nodes in the network
MaxTTL= maximum value of time to live of any node in the network

```
While(Snew>Bavail)
{
Mid=call message equal (Snew); /* Search those message in the buffer of node whose size is equal to or greater then the size of incoming new message. This function will return the message id of those messages who will be drop according to SRT algo */
Bavail=Bavail+ MessageCollection.get(MID).Size();
Delete MessageCollection.get(MID);
}
/* Body of the function call messageEqual(Snew) */
Int callmessageEqual(Snew)
{
For (each message M in node buffer)
{
If (Mni>=Snew)
Add MessageCollection m; /* message id */}
}
```

```
/* Then apply a weight function on MessageCollection m.
*/
float F,F1,α;
/* initially F1 contain the function value (F) of m0
message */
int MessageId;
While (MessageCollection m)
{
F=a*(size of message)+ b/N *(no of copies) + c/MaxTTL
a=b+α+1;
α = 1/n
b=10^n;
c =RTLi /*  remaining time to live */
If (F<F1)
{
F1=F;
Messageid=MessageCollection.get(F);
}
Return MessageId;

}
```

## VI. SIMULATION

One is an agent based discrete event simulator engine. The main functions of one simulator are the modeling of node movement, inter node contact, routing and message handling. Analysis of the result are done through visualization or reports. Movement models are used to implement the node movement.

Connectivity between the nodes depends on their location and communication range. Routing modules are used to implement the routing function that decide which message to forward. Finally the message are generated through event generator. The graphical user interface(GUI) displays a visualization of the simulation.

## VII. RESULTS

The results given below indicate the comparative study between DROP FRONT and SRT. The results show the comparison between DROP FRONT and SRT drop policy. These results prove that it is beneficial to use SRT drop policy as it improves the performance of any DTN.

### 7.1 Comparison Based on Delivery Probability

The comparative study of DROP FRONT and SRT DROP policy with respect to delivery probability has been plotted in the figure 2. The DROP FRONT policy drops the front messages from the buffer; however the SRT drops the bigger size message. But in case of FIRST CONTACT and DIRECT DELIVERY router the probability of encounter is less as a result the delivery probability is not increasing significant as compared to previous results.

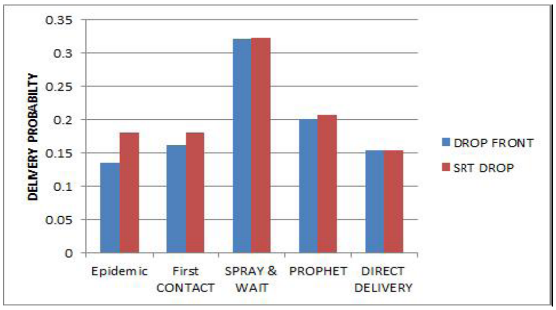


Figure 2: Drop Front, SRT Drop Delivery Probability W.R.T to Routers

### 7.2 Comparison Based on Buffer Time Average

Figure 3 indicates that the buffer time average for SRT DROP and DROP FRONT policy for various routers. The value of buffer time average is large in SRT drop as compared to DROP FRONT. High value of buffer time average increase the probability of message delivery in the DTN paradigm. High value of buffer time average also decreases the drop ratio. Figure 3 shows that SRT DROP increases the buffer time average as compared to DROP FRONT.

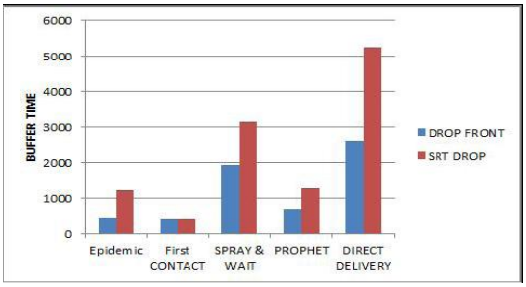


Figure 3: Drop Front, SRT Drop Buffer Time Avg. W.R.T to Routers

### 7.3 Comparison Based on Overhead Ratio

The overhead ratio with respect to various routers has been plotted in figure 4 for SRT DROP and DROP FRONT. The results show that the SRT DROP is less in terms of overhead ratio in all routers. Overhead ratio in DIRECT DELIVERY router is zero due to direct transmission while the overhead ratio is decreases in epidemic, prophet, fc, spray and waits up to a significant level. SRT DROP less no of messages as compare to DROP FRONT because it drop the message of nearly greater or equal size of messages.

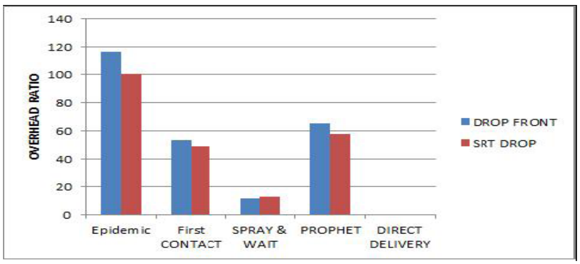


Figure 4: Drop Front, SRT Drop Overhead Ratio W.R.T to Routers

### 7.4 Comparison Based on Packet Dropped

The results in the figure 5 show that the SRT DROP drops less no. of messages as compared to DROP FRONT because it drops the message of nearly greater or equal size of messages. Therefore, the network overhead also decreases.

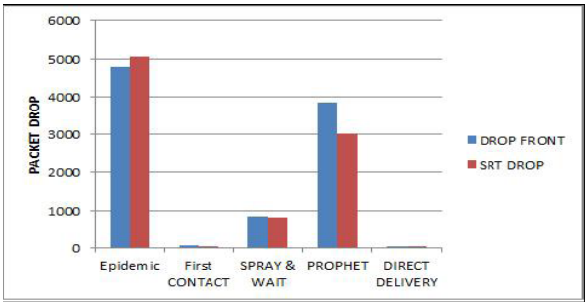


Figure 5: Drop Front,SRT Drop Packet Drop W.R.T to Routers

### 7.5 Comparison Based on Hop Count Avg.

Figure 6 shows the hop count for various routers for SRT DROP and DROP FRONT policy. The lower value of hop count means that message has consumed less resource to reach its destination. SRT DROP drops the messages whose size is nearly equal to the incoming message. Due to this logic it will drop less no of messages and decreases the value of hop count average.

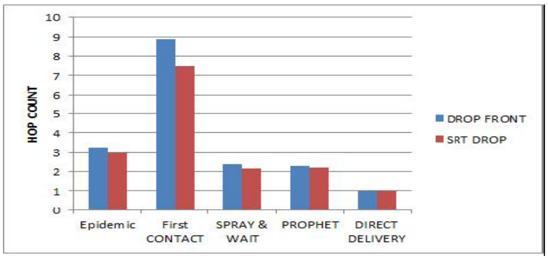


Figure 6: Drop Front,SRT Drop Hop Count W.R.T to Routers

## VIII. CONCLUSION

In this paper investigated SRT DROP policy with DROP FRONT policy with respect to DTN routing protocols. Results shows that our SRT DROP policy perform well with respect to delivery probability, buffer time, overhead ratio, hop count average and packet dropped. It should motivate to examine SRT DROP policy to other existing drop policy.

Compare the SRT DROP POLICY with DROP FRONT policy. This comparison motivate to compare SRT DROP policy with DROP LARGEST POLICY because both policy gives importance to size of messages. The routing protocol other then the EPIDEMIC, FC, DIRECT DELIVERY, SPRAY ANDWAIT and PROPHET routing protocols are also an interesting direction of work.

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