ANALYSIS & IMPLEMENTATION OF DIFFERENT ROUTING PROTOCOLS FOR DELAY TOLERANT NETWORK

Disha P.Raval[1], Nikita Joshi[2]
[1]Student, ME, Computer Engineering Department, SOCET, [2]Assistant Professor, IT Department, SOCET

ABSTRACT: Delay tolerant networks are wireless networks where disconnections and delays occur frequently due to propagation phenomena such as node mobility, power outages etc. Nowadays, Delay tolerant networks (DTNs) are promising new development in network research field. Satellite Communication, Deep-space, vehicular, under water, remote rural area networks, wild life tracking sensor networks those are the applications of the delay tolerant network. Routing is one of the major issues affecting the overall performance of DTN networks in terms of resource consumption, data delivery. In this paper we studied and analyzed three routing protocols namely direct delivery, epidemic, spray and wait routing. And we provide proposed algorithm for modify binary spray and wait protocol for improving delivery probability with different number of message copy. The modifications based on stored number of message copies at source/rely nodes and encountered nodes ratio.

Keywords: DTN, Epidemic Routing, Direct Delivery Routing, Spray & wait Routing

I. INTRODUCTION

There is no complete network from source to destination in intermediately connected mobile networks which is also called as sparse wireless networks. Those types of networks are categorized in delay tolerant networks. Delay tolerant networks (DTNs) are promising new development in network research field[1].Itis also referred as the Intermittently Connected Mobile Network [5]. Routing means to find a path from source to some destinations. There are two types of networks. 1) Traditional Network and 2) Delay Tolerant Network. In Traditional network we assume that there exists an end-to-end path between communicating nodes means when the message or data packet leave the source there exist a complete path from source to destination while In DTN there is no preexisting complete path is provided and Communication is possible even if end-to-end connectivity is never achievable [4] as shown in fig 1.

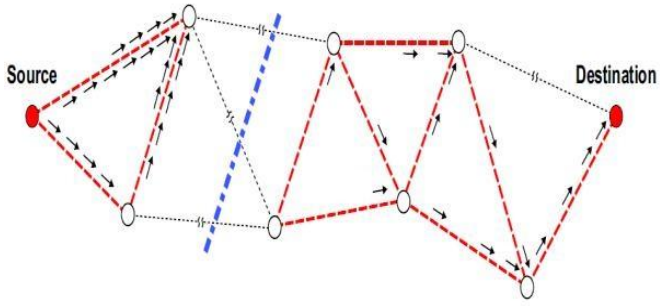

Fig 1 Message Passing on DTN [2]

If source node has data packet to transmit but the link from the next node is not available, it stores the data packet until the next contact is available from intermediate node. In this way packet reach to the destination node. In DTN There is no end to end path. So, Convectional or MANET routing protocol fails [6][9]. Hence, Solution: "Store, Carry and Forward" is used. The below figure (fig. 2) shows rough graphical representation of Store, Carry and Forward Mechanism.

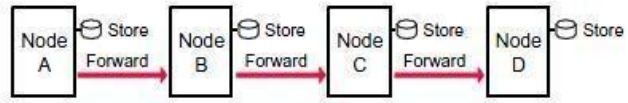

Fig. 2 Store, Carry and Forward Mechanism

The DTN implements store-and-forward message switching by overlaying a new protocol layer called the bundle layer- on top of heterogeneous region-specific lower layers [4].

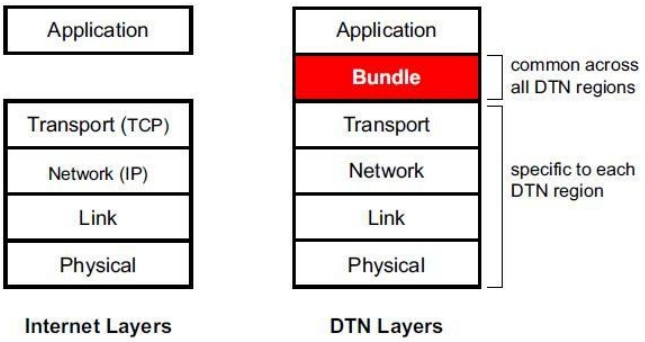

Fig. 3 Internet layers and DTN layers [5]

Bundles are also called messages. The bundle layer stores and forwards entire bundles between nodes. A single bundle-layer protocol is used across all regions that make up a DTN.

II. CHARACTERISTICS OF DTN

The Characteristics of DTN are briefly introduced in this section:

Intermittent connectivity

Due to limitation of mobility and energy of nodes, DTN frequently disconnected, thus resulting in continue change in DTN topology [3]. Meaning to say, the network keeps the status of intermittent connectivity and partial connection so that there is no guarantee to achieve end-to-end route.

Long Variable Delay

End to end latency of data delivery is dominated by the variable delay. In DTN the variable delay is come because there is more disconnection in compared to the conventional

networks. Queuing delay is in seconds or typically very much less. In contrast for traditional network queuing delay could be extremely large in terms of hours. In DTN source node initiate the transmission that may be expensive because of the limited number of transmission opportunity. Combine this issuesuggest that message need to be stored for long period of time in message buffer.

Asymmetric Data Rate
End-to-end delay indicates that the sum of the total delay of each hop on the route. Each hop delay might be very high due to the fact that DTN intermittent connection keeps unreachable in a very long time and thus further leading to a lower data rate and showing the asymmetric features in up-down link data rate [7].

High error rate

Relatively high loss or corruption of data on each link.

III. CLASSIFICATION OF ROUTING PROTOCOLS

The existing routing protocols in DTNs are classified with respect to their strategies for controlling message copies and making the forwarding decision [3].

Number of destination
According to the number of destination nodes of a message, routing protocols can be classified into three categories: unicast routing, multicast routing, and broadcast routing.

- Unicast routing: Single destination for each message.
- Multicast routing: Group of destination nodes for each message.
- Broadcast routing: All the nodes in the network are destination nodes for each message.

Number of copy
Depending on the number of message copies utilized in the routing process, protocols can be classified into two categories: single-copy and multiple-copy.

- Single-copy routing protocols: only a single copy for each message exists in the network at any time.
- Multiple-copy routing protocols: multiple copies of same message can be generated and distributed into the network.
- Moreover, multiple copy routing protocols can be further divided into flooding-based and quota based.
- Flooding-based routing protocol: dissemination a copies of each message to as many nodes as possible.
- Quota-based routing protocol: intentionally limit the number of message copies.

Available Network knowledge
In addition, according to whether the forwarding decision is based on the knowledge derived from the nodes' encounters or not, protocols can as well be classified into two categories: Deterministic and Non-deterministic (Opportunistic).

- Deterministic routing protocol: Complete knowledge of node trajectories, encounter probability of nodes and node meeting times and period to make the forwarding decision.
- Non-deterministic routing protocols: Zero knowledge of pre-determined path between source and destination.

IV. THREE ROUING PROTOCOLS OF DTN

4.1 DIRECT DELIVERY ROUTING PROTOCOL

Direct delivery routing uses a simple hand to hand message delivery strategy. In the direct delivery routing Scheme the source hold the data until it comes in contact with the destination. This simple strategy uses one message transmission [8].

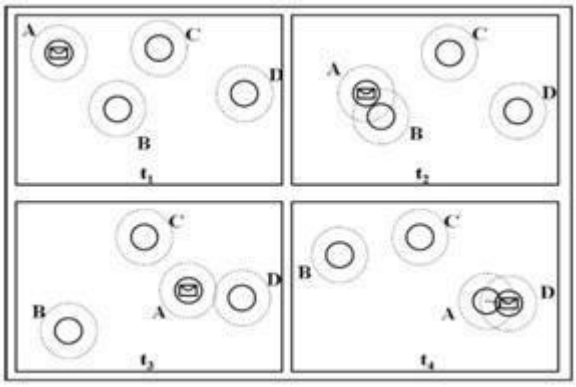

Fig 4. Direct Delivery Routing [8]

4.2 EPIDEMIC ROUTING PROTOCOL

In the epidemic routing scheme, the node receiving a message, forwards a copy of it to all nodes it encounters. Thus, the message is spread throughout the network by mobile nodes and eventually all nodes will have the same data [8]. Although no delivery guarantees are provided, this algorithm can be seen as the best effort approach to reach the destination. Each message and its unique identifier are saved in the node's buffer. The list of them is called the summary vector. Whenever, two adjacent nodes get opportunity to communicate with each other, they exchange and compare their summary vectors to identify which message they do not have and subsequently request them.

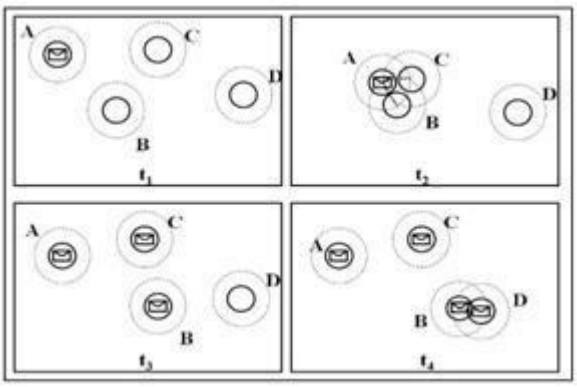

Fig 5. Epidemic Routing [8]

The major disadvantage of epidemic routing is wastage of resources such as buffer, bandwidth and nodes power due to forwarding of multiple copies of the same message. It causes contentions when resources are limited, leading to dropping of messages. It is especially useful in those conditions when there are no better algorithms to deliver messages.

4.3 SPRAY & WAIT ROUTING PROTOCOL

Spyropoulos et al., (2005) proposed the spray and wait routing protocol to control the level of spreading of messages throughout the network. Similar to the epidemic routing, the spray and wait protocol assumes no knowledge of network topology and mobility pattern of nodes. It simply forwards multiple copies of received messages using flooding technique. The difference between spray and wait protocol and epidemic routing scheme is that it only spreads L copies of messages [9]. The author in proved that minimum level of L to get the expected delay for message delivery depends on the number of nodes in the network and independent of the size of network and transmission range.

Spray and Wait routing consists of two phases [9]:

- Spray phase: In this phase, a limited number of copies (L) of messages are spread over the network by the source and some other nodes which later receives a copy of the message.
- Wait phase: After the spreading of all copies of the message is done and the destination is not encountered by a node with a copy of the message in the spraying phase, then each of these nodes carrying a message copy tries to deliver its own copy to destination via direct transmission independently (i.e., will forward the message only to its destination).

V. SIMULATION PARAMETER SETUP

We use THE ONE simulator and it is a very good DTN simulator to conduct experiments. Not only it is straightforward, but also it is very flexible for us to improve some special features for our work. Using ONE simulator number of simulation is carried out to evaluate the above protocol. Using ONE simulator we evaluate the performance according to the following parameter.

- Delivery Probability: It is the fraction of generated messages that are correctly delivered to the final destination within given time period.
- Average Latency: It is the measure of average time between messages is generated and when it is received by the destination.
- Buffer time: It indicates for how long the messages were queued in the node's buffers.
- Hop count: It indicates the number of nodes the packet traversed with the exception of the source node.
- Overhead: It is the number of message transmissions forach created message.

Simulations usually run much faster than in real-time. In our simulation we have assigned simple broadcast type Bluetooth interface with the transmit speed of 2 Mbps to all the nodes.To make our simulation scenario comparable to real time application, we have assigned random way point mobility to all the nodes with mobility varies from 0.5 to 1.5 m/sec. To better judge the performance of all the three routing protocols, we have assigned 5Mb buffer size to each node and also their transmit range is limited to 10 m only. So, during store-carry-forward methodology each node can carry messages only up to 10Mb and node can forward messages to those nodes only which are in 10m range of it. This situation will increase packet drop probability during the transmission of messages. As ONE simulator supports external event generator, we have set message event generator in such a way that it generates the messages in every 25 to 35 seconds and every time message size can also be varied from 500 Kb to 1Mb. To advocate the performance of the Direct Delivery, Epidemic and Spray and Wait routing, we have run the simulation for 43200 seconds for each routing protocols separately and we have noted that every time message event generator feds 1463 messages in 43200 seconds in network.

Simulation Parameters (Setup Information)	
Simulation Time	43200 seconds
Interface	Bluetooth Interface
Interface type	Simple Broadcast
Transmit Speed	2 Mbps
Transmit Range	10 m
Mobility	Random Way Point
Buffer Size	5 MB
Speed of Nodes	0.5 to 1.5 m/sec
Message Size	500Kb to 1MB
Message Interval	25 to 35 sec
Message TTL	300 minutes
Report	Message State Report
Host	40,60,80,100,120

Table 1 Simulation Parameter(Set up info)

VI. SIMULATION RESULT AND DISCUSSION

Figure 6 shows that as the number of host increase the more packets are delivering to the destination in spray and wait router.

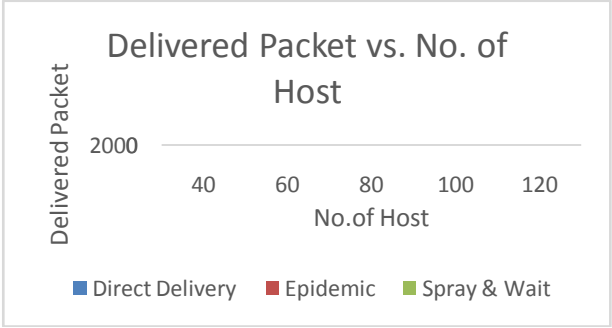

Fig. 6 Delivered Packet vs. No. of Host

Figure 7 shows the comparison chart of packet delivery probability for Direct Delivery Routing, Epidemic Routing and Spray and Wait Routing. From the chart it can be noticed that when total number of nodes are 40, 60, 80, 100 and 120 the Epidemic Routing and Spray and Wait routing shows increment in packet delivery probability but at the same time packet delivery probability of Direct Delivery routing decreases. It is just because the Direct Delivery routing uses hand-to-hand packet delivery strategy. So as the total number of nodes increase the possibilities to meet with the destination node in the Direct Delivery routing decreases. If we only concentrate Epidemic routing and Spray And Wait routing then from the graph it is clearly noticed that still performance of Epidemic routing is not up to mark whereas Spray and Wait routing shows excellent performance in terms of packet delivery probability.

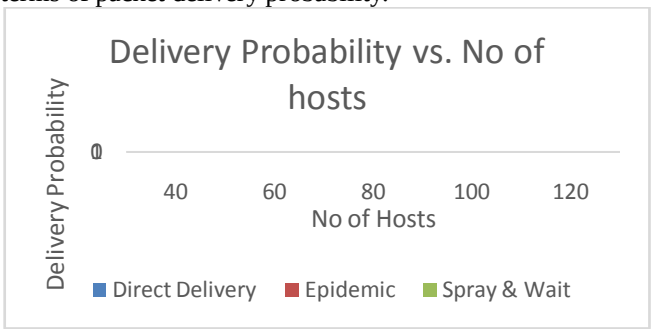

Fig. 7 Delivery Probability vs. No. of Host

Figure 8 shows the comparison chart of average latency for Direct Delivery Routing, Epidemic Routing and Spray and Wait Routing protocols. From the comparison chart it can be noticed that average latency of Direct Delivery routing is quite higher than Epidemic routing and Spray and Wait routing.

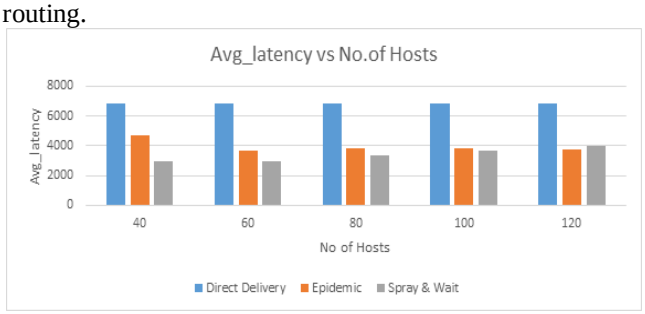

Fig. 8 Average Latency vs. No. of Host

Due to the direct transmissions approach used by DD and Spray and Wait, they present the highest values of buffer time in comparison with other protocols. Among these two router spray and wait router take more time in buffer as the number of host increase.

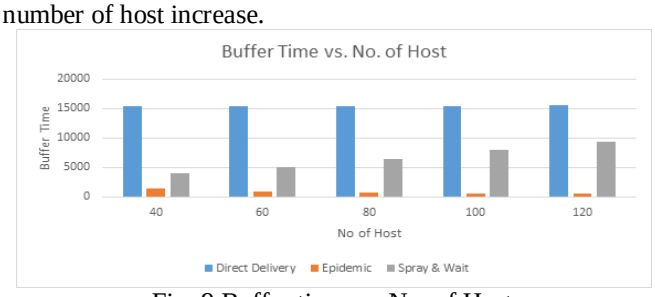

Fig. 9 Buffer time vs. No. of Host

Figure 10 shows the hop count for various routers. The lower value of hop count means that message has consumed less resource to reach its destination and the upper value of hop count means that message has consumed more resource to reach its destination. Figure 10 show that Epidemic router presents the highest hop count. This is due to the fact that it forwards messages to the encountered nodes and these messages are continuously forwarded until they reach the intended destination node. As expected, DD has the smallest value of hop count due to the use of a direct transmission approach. Because of the spray phase, Spray and Wait has a few more hops.

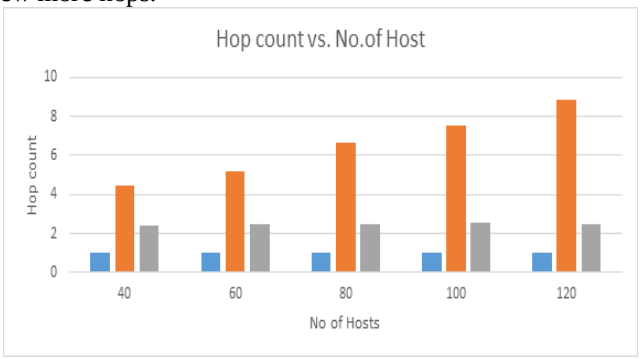

Fig. 10 Hop Count vs. No. of Host

The overhead ratio with respect to various routers has been plotted in figure F. Overhead ratio in direct delivery router is zero due to direct transmission while the overhead ratio is decreases in spray and waits. Figure 11 show that Epidemic has the highest values of overhead ratio.

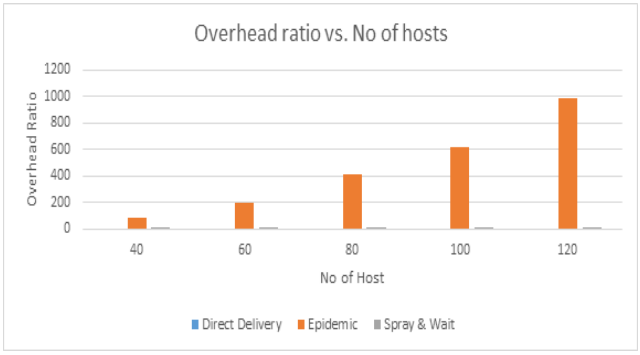

Fig. 11 Overhead Ratio vs. No. of Host

VII. DIFFERENCE BETWEEN EXISTING BINARY SPRAY AND WAIT PROTOCOL& MODIFY BINARY SPRAY AND WAIT PROTOCOL

In this paper, we propose the modify Binary Spray and Wait protocol with less buffer consumption by changing ratio of stored message within node or relay and encountered node. We choose binary spray and wait protocol for performances enhancement, because of its simplicity and efficiency characteristic with limited number of message copies.

In existing binary spray and wait protocol the source of a message initially starts with L copies. When it encounter first node with no copies then it handover (L/2) copies to that node and keeps (L/2). Now this process is repeated for both source and relay that has L>1 message copies and when the node either is left with only one copy, it switches to wait

phase and wait till the direct transmission to the destination. According to this it can be say that in existing binary spray and wait when node encounter node with no copies than it handover 50% copies to that node and keeps 50% . This process is repeated. In modify spray and wait this ratio is changed with 80-80%. This modification detail information is given in next section. Because of this modification more number of message copy are spread in network for each new generated message. This will increase chances of successful transmission and that will increased delivery probability.

VIII. PROPOSED ALGORITHM

This section contains information regarding algorithm for 80-80% modification ratio.

Algorithm

- Set variable with initial number of copies
- Check whether any node encounter
- If yes
    - Transfer 80% of message copies to encounter node and Set source/relay node contained message to 80% by setting number of copies variable.

Else Go to step 5

Check whether source/relay node contain number of message copies > 1

If yes

Repeat step from 2 to 4

Else Direct transfer copy to destination only

In modify binary spray and wait protocol (modified with 80-80 % ratio) have modification in java program according to above given algorithm only in some portion, reaming part of program as per existing spray and wait protocol programs. In this algorithm to set source /relay node contained copy initial number of copies stored into variable before transfer, then transfer 80% copies to encounter node and after transfer process number of message copies variable adjust according 80 % of initial stored value. In this way both source/relay as well as encounter node both contain 80% message copies respectively.

IX. SIMULATION RESULT

We measured delivery probability for different number of message copies for modify protocol with compare existing binary spray & wait protocol.

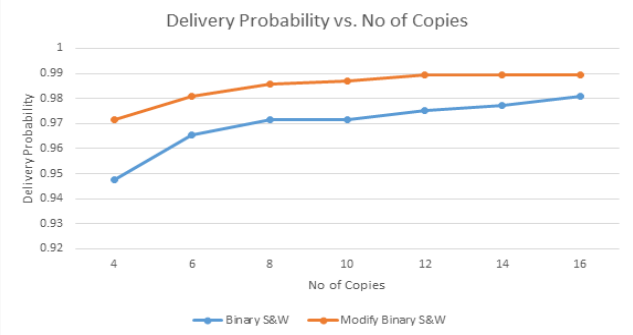

Figure 12 Delivery Probability vs. No. of Message copies graph for modify binary spray and wait protocols with compare to existing binary spray and wait protocol

No. of Message copies	Delivery Probability	
	Binary SaW	Modify binary SaW (80-80 %)
4	0.9477	0.9715
6	0.9656	0.9810
8	0.9715	0.9857
10	0.9715	0.9869
12	0.9751	0.9893
14	0.9774	0.9893
16	0.9810	0.9893

Table 2: Delivery Probability vs. No. Of Message copies For Modify binary Spray and Wait Protocols With Compare To Existing Binary Spray and Wait Protocol

By concentrating on delivery probability vs. number of message copies graph and resultant data table 1 it can be observed that whatever delivery probability achieved with 8 message copies in existing binary spray and wait, that same was achieved in modify protocol with 4 message copies and whatever delivery probability achieved with 16 message copies in existing binary spray and wait that same was achieved in modify protocol for 80-80% ratio with 6 message copies.

X. CONCLUSION

In this paper we introduced delay tolerant network & also studied three DTN routing protocols namely direct delivery, epidemic and spray & wait routing protocols and then compare to these three routing protocols. After analyzing all the parameter for three routers we can conclude that Direct Delivery Routing is not suitable for real time application, whereas Epidemic routing and Spray and Wait routing issuitable for real time applications. Well Among this two routing protocols, Spray and Wait routing showsthe excellent overall performance with respect to delivery probability, buffer time, overhead ratio and hop count. And In this paper we proposed and presented a description of a modification of binary sprays and wait algorithm. By changing the ratio of message copies stored at source/relay and encounter node as per obtained simulation result of this paper we can efficiently increase delivery probability. Change in message copy ratio with result in more spreading of messages in network

convert in increases chance for successful transmission of message. That will increases delivery probability.

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