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Spray and Wait Routing Protocol in Delay Tolerant Networks

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***Abstract*— An intermittently connected mobile network means that there does not exist a complete path from the source to the destination. It is also called as wireless networks. These networks are categorized in delay tolerant networks. Wildlife tracking sensor networks, military networks, vehicular ad hoc networks (VANETs), inter-planetary network and under water networks are the application of delay tolerant networks. To deal with such networks researchers have suggested to use spray and wait routing protocol that "sprays" a number of copies into the network, and then "waits" till one of these nodes meets the destination. Spraying methods that can reduce the overhead of flooding-based schemes by distributing a small number of copies to only a few relays. For the simulation we have used Opportunistic Network Environment (ONE) Simulator. We analyzed the performance on six metrics: number of packet delivered, Delivery Probability, latency, buffer time, hop count and Overhead Ratio. From the Simulation it is analyzed that the spray and wait routing protocol gives the best performance in the considered scenario and simulation setting.**

Keywords **— DTN, Spray and wait, Average latency, Delivery probability, overhead ratio, Hop count, buffer time.**

I. INTRODUCTION

Core function of communication network is Routing means to Find a path from a source to some destinations [7].There are two types of networks.1) Traditional network and 2) Delay tolerant networks. In Traditional network we assume that there exists an end-to-end path between communicating nodes as shown in fig 1.

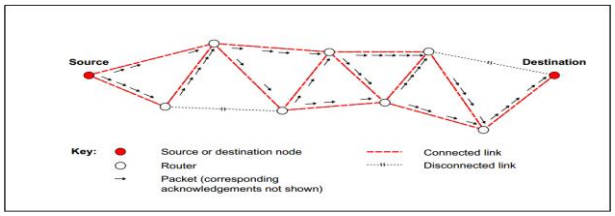

Fig. 1: Packet Switching In Conventional Internet

In Delay tolerant networks Communication is possible even if end-to-end connectivity is never achievable [8]. In DTN All the connection of the network is maintained by nodes.

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 routing protocol fails. Hence, Solution: 'store, carry and forward' [10] is used.

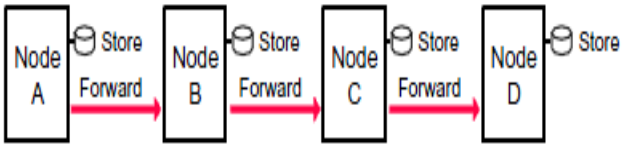

Fig.2: Store carry and forward mechanism

In this mechanism buffer Store a bundle for a long period of time and Forward when the next contact is available. Here we analyzed three protocols that are spray and wait, epidemic and direct delivery routing and compare their results in terms of delivery probability, average latency, buffer time, hop count, and overhead ratio.

The remainder of paper is organized as follows: section2 briefly gives the introduction of the DTN routing and Routing protocols - Epidemic, spray and wait and direct delivery. Section 3 gives the details of simulator and the simulation setup used to carry out the work. Section 4 discusses the results. Section 5 concludes the paper.

II. ROUTING PROTOCOLS IN DTN

In this section detail description of three routing protocol is explain. In direct delivery router data packet can be transmitted in one hop [8].This strategy does not consume much resources. It uses exactly one message transmission when source node is directly connected with destination node. Epidemic router is based on assumptions that each node has infinity buffer space. Here the entire node can store the entire message during contact with other nodes. It use database replication concept. When the contact is available node can exchange all the messages having in its buffer so large number packet is generated in this protocol. It is kind of waste of resources so when no batter method is available at that time we use epidemic router protocol [6].

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Basic Idea behind Spray & Wait

- In DTN, the traditional protocols will fail to discover a complete path or will fail to converge, resulting in a deluge of topology update messages.
- However, this does not mean that packets can never be Delivered in such networks[10]
- Over time, different links come up and down due to node mobility. If the sequence of connectivity graphs over a time interval is overlapped, then an end-to-end path might exist.
- This implies that a message could be sent over an existing link get buffered at the next hop until the next link in the path comes up, and so on, until it reaches its destination

Spray and wait router works same as epidemic router. It has two phace.1) Spray phase and 2) Wait phase. In spray phase source node forward the packet to L different node. If destination is found then the message or packet transfer is successfully terminated. If not than wait phase is started [7].When the destination is encounter it will perform the direct transmission that means source node itself send the data to destination node.

III. 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 [5]. Using ONE simulator we evaluate the performance according to the following parameter.

1) *Delivery Probability:* It is the fraction of generated messages that are correctly delivered to the final destination within given time period [2].
2) *Average Latency:* It is the measure of average time between messages is generated and when it is received by the destination.
3) *Buffer time:* It indicates for how long the messages were queued in the node's buffers.
4) *Hop count:* It indicates the number of nodes the packet traversed with the exception of the source node.
5) *Overhead:* It is the number of message transmissions for each created message [2].

We run thirty independent simulations using different seeds for each protocol-percentage pairs, and the results were averaged. 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 10000 seconds for each routing protocols separately and we have noted that every time message event generator feds 342 messages in 10000 seconds in network [5].

IV. Simulation Result And Discussion

Simulation Parameters (Setup Information)	
Simulation Time	10000 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	5,10,20,50,100,200

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Figure 3 shows that as the number of host increase the more packets are delivering to the destination in spray and wait router.

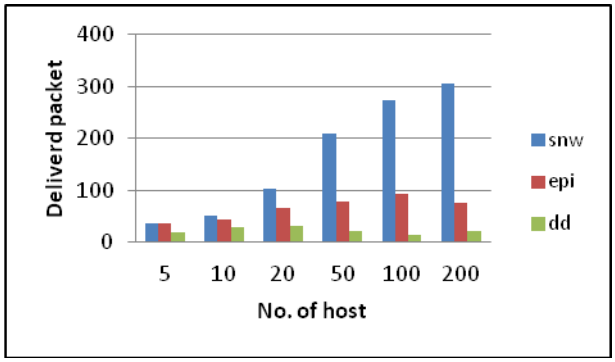

Fig 3: No. of host vs. delivered packet

Figure 4 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 5 nodes are there at that time packet delivery probability of Epidemic Routing and Spray and Wait Routing are almost equal. Whereas in the case when total number of nodes are 10, 20, 50, 100 and 200 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[1].

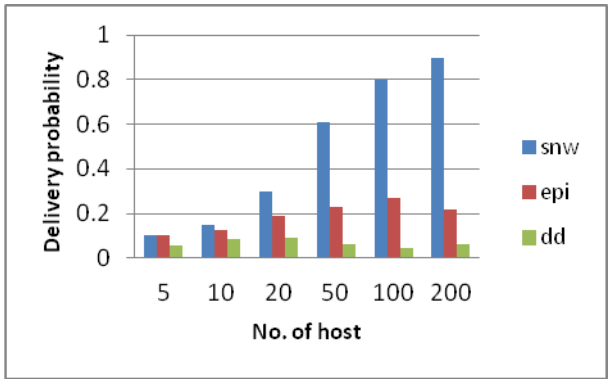

Fig 4: No. of host vs. delivery probability

Figure 5 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 Epidemic routing is quite higher than Direct Delivery routing and Spray and Wait routing when the total number of nodes are 10 only. In the case when total numbers of nodes are 20, average latency for Spray and Wait routing is much higher than the Direct Delivery and Epidemic routing. Not only that, but in the another cases when the total nodes are 50, 100 and 200, the average latency of Spray and Wait routing is quite higher than Epidemic routing whereas direct delivery shows very less average latency[1][4].

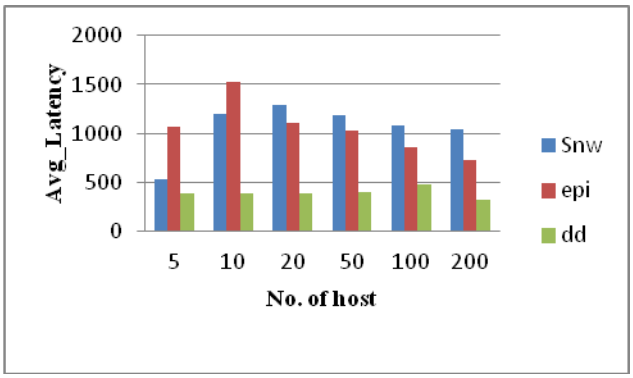

Fig 5: No. of host vs. average latency

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.

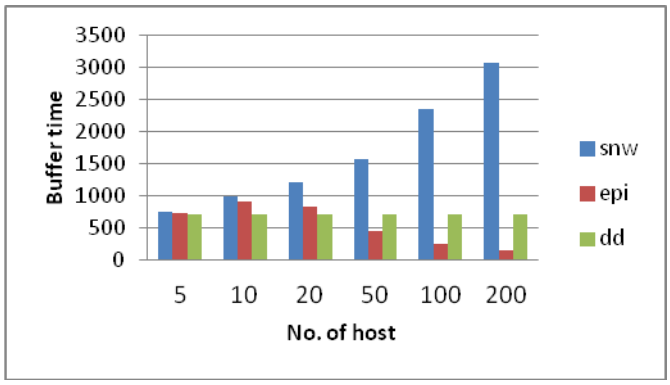

Fig 6: No. of host vs. buffer time

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Figure 7 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 7 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 [3]. 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.

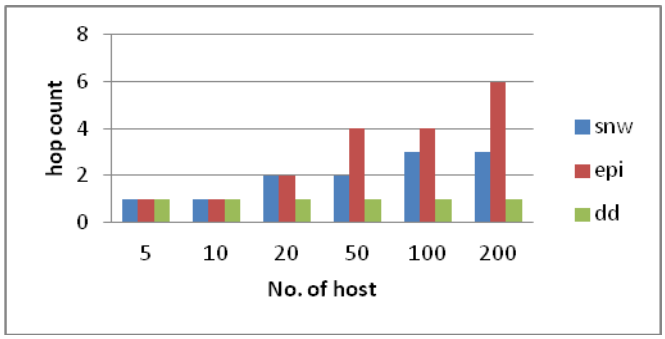

Fig 7: No. of host vs. Hop count

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 8 show that Epidemic has the highest values of overhead ratio.

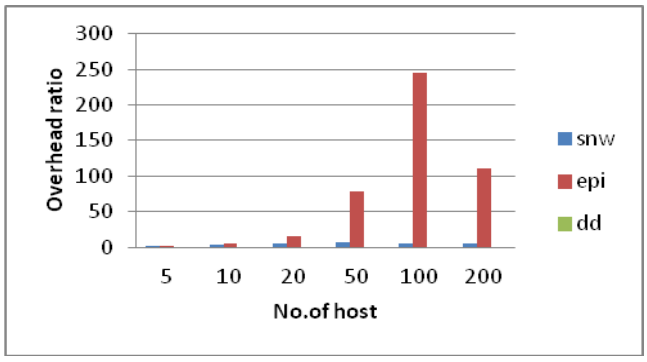

Fig 8: No. of host vs. overhead ratio

V. CONCLUSION

After analyzing all the parameter for three routers we can conclude that delivery probability is high for spray and wait because more number of packets is generated as number of host increase.

Though latency of spray and wait router is high it transfer more number of packet to the destination compared to epidemic. Result show that packet consumes more time when it is in the buffer in spray and wait because it perform the direct transmission in wait phase. To reach to the destination, number of hop used by spray and wait is less as compared to the epidemic. Because of the direct transmission in direct delivery router number of hop is very less or 1. The overhead ratio is much less for spray and wait as compared to Epidemic. Finally we conclude that Direct Delivery Routing is not suitable for real time application, whereas Epidemic routing and Spray and Wait routing is suitable for real time applications. Well Among this two routing protocols, Spray and Wait routing shows the excellent overall performance with respect to delivery probability, buffer time, overhead ratio and hop count average Epidemic routing [1].

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