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A Comparative Study of Buffer Management Strategies for Epidemic Routing Protocols in DTN

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ABSTRACT

The intermittent network in which end to end path is not exist between source and destination node, large delay in the message with high data errors and asymmetric data rates are called Delay Tolerant Networks (DTNs). In such type of network Store-Carry and Forwarding (SCF) approach is used to send message between source and destination. Each node in network has limited buffer space to store message. The message is discards or dropped from the buffer space when it is full. To discover which message is discards form the buffer space a number of buffer management strategies are developed by the researcher such as the first in first out (FIFO), Drop oldest, Drop large, Drop last, Drop Random (DR), Drop Least Recently Received (DLR), Evict most forward first (MOFO) and E-drop drop strategies etc. In this paper DLR, MOFO and E-Drop buffer strategies performances are evaluated on Epidemic routing protocol.

1. Introduction

DTN is the extended class of Ad hoc wireless networking. DTNs are challenged networks where most of the time the path between source to the destination does not exist completely. Sometime this type of network is also known as intermittently disconnected network. The irregularity of connectivity in such networks is due to node mobility, transmission range and energy resources and interference. The purpose to designed DTN is to work efficiently over large distances such as communication in space or IPN. [1]. The main issue in such type of networks is message delivery. To overcome such issues, researchers design the store-carry-forward method to disseminate message. In such strategy source node store and carry a message in its buffer space while moving and forward messages to the encountering node, until the destination node is reached. To improve the delivery probability of message in such a network, the first routing algorithm i.e. Epidemic routing [2] is proposed to flood copies of message to all encountered nodes until the destination is reached. Based on this principle many routing algorithms [3,4,5,6,7,8]using limited copies of messages are developed.

2. Existing buffer management strategies

The existing buffer management strategies which control the number of message drop when buffer is full [9] is as follow:

- **First In First Out (FIFO):** The selection of message to be dropped from buffer space is based upon the first in first out approach.
- **Drop Oldest:** The message with shortest remaining lifetime (TTL) in the network is dropped.
- **Drop Large:** the message which has large in size to be selected for drop.
- **Drop Last:** it dropped the newly received message.
- **Drop Random:** the selection of message to be dropped is random
- **Drop Least Recently Received (DLR):** the messages which are stay for long time in buffer will be dropped.
- **Evict most forward first (MOFO):** the messages which are forwarded number of times in the network are selected to be dropped first [13].
- **E-Drop:** In this strategy only those messages are dropped from the buffer space whose message size is equal or greater than the incoming message size form encounter node in the network [9, 12].

3. Protocol under evaluation

3.1 Epidemic routing protocol

The first routing protocol for DTN is Epidemic routing protocol [11] which is totally based on the flooding behavior. The aims of Epidemic routing protocol are:

a) To enhance the delivery probability in the network.
b) Minimize the average delivery latency in the network
c) Optimize utilization of resources during the packet delivery.

In Epidemic routing, the node receiving a packet and forwards a replica to all other nodes which are encounters in the network. Due to this mechanism the packet in the network is broadcast by mobile nodes and at last each node in the network have same packet. Even though delivery guarantees are not provided. This algorithm does the best effort to deliver the packet to the destination. The buffer capacity of the node stores the packet along with its unique identity (ID). Each node buffer in the network has a list of packet ID called summary vector. Whenever the two nodes are coming in the transmission range of each other, a contact is established between these two nodes, they swap the summary vector and compare it and identify the message which they don't have and request for the same. All the packets are stored in the node buffer according to first come first serve (FCFS) basis and transmitted to other node. When the packets counter equal to zero, it discards the packet. Alternative approach is to define the lifetime of the packet i.e. TTL (time to live). A TTL is set to

each packet during routing. The packet in the network will remain on receiving replica from one node to the other node till its TTL expires. The algorithm Epidemic Routing Protocol as follow:

Algorithm 1 Epidemic Routing Protocol

1. Name of Procedure : On_Contact
2. Input : nod a, nod b, int Contact_Duration
3. Drop_Expired_Packets(a,b) //Drop both the nodes when its lifetime (TTL) Expired//
4. Swap_Summary_Vector(a,b)
5. If Contact_Duration> 0 then
6. packet = Getpkt(a)
7. If packet then
8. If Not_Received_Before(packet, b) then
9. If Is_Destination(packet, b) then
10. Send_Packet(packet, a)
11. Conusme_Packet(packet, b)
12. Else
13. Send_Packet(packet, a)
14. Store_Packet(packet, b)
15. End if
16. Contact_Duration=Contact_Duration-size(packet)
17. End if
18. End if
19. End if

4. Performance Metrics

The performances of various buffer drop strategies are evaluated by using Epidemic routing protocol. The following metrics are used to evaluate the performance [10]:

- **Message Delivery Probability (MDP):** It is defined as the ratio of the number of messages actually delivered to the destination and the number of messages sent by the sender.
- MDP = no of message delivered to destination/ no of message sent by sender
- **Number of Message Drop (NMD):** Number of Message drop is the ratio of message drop during transmission to destinations among all messages generated.
- **Overhead Ratio (OHR):** It is defined as the ratio of total number of relayed messages by source nodes minus total number of delivered messages to the destination nodes divided by total number of delivered messages to the destination nodes.

5. Simulation and Results

The simulation is performed on ONE simulator which is discrete event simulator written in Java. Simulation scenarios are created by defining simulated nodes and their characteristics. The simulation parameters are set as mentioned in Table 2. The simulation is modeled as a network of mobile nodes positioned randomly within an area (4500 x 3400 m2).

Table-1
Parameter Setting

Parameter	Pedestrians (P)	Cars (C)
No. of hosts	50	50
Speed	0.5-1.5 km/h	2.7- 13.9 km/h

Router	Epidemic
Buffer Capacity	2-10MB
Message size	200, 500 KB
Message Inter-arrival Time	25-35 seconds
Transmission speed	5Mbps
World Size (meters)	4500 x 3400m
Simulation Time	72,000 sec

The various drop strategies are evaluated by varying buffer size.

5.1 Message Delivery Probability (MDP)

From Figure 1 the following points are evaluated:

- It has been seen that in Epidemic routing protocol the delivery probability of the entire drop strategies is increases with increasing the buffer size.
- Reason of this is that as the buffer size increases, more buffer capacity becomes available to store and carry more messages, in this manner enhancing the performance.

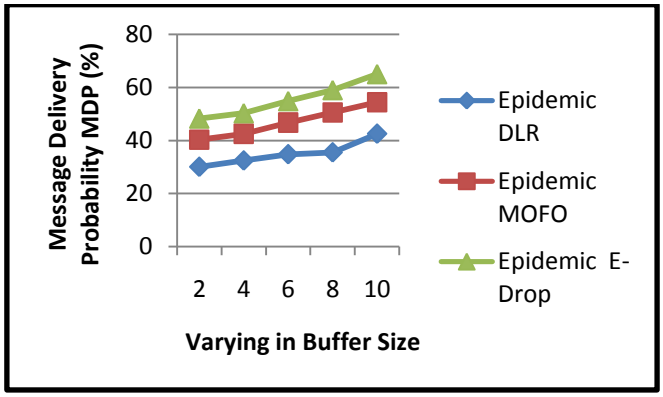

Fig 1. MDP vs. Varying in Buffer Size

- E-drop strategy has the highest delivery probability among all the drop strategies. Its delivery probability increase with increasing the buffer size. The delivery probability of E-Drop strategy is improved over DLR and MOFO by 22.43% and 10.6% respectively at buffer size 10MB.

5.2 Number of Message Dropped (NMD)

From figure 3 the following points are concluded:

- Epidemic routing protocol the number of messages dropped of the entire drop strategies is decreases with increasing the buffer size.

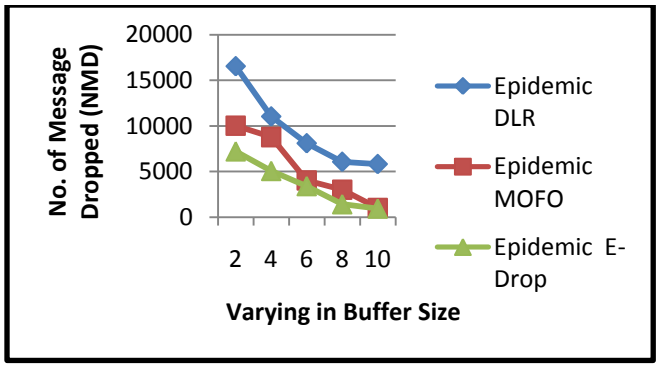

Fig. 2. NMD vs. Varying in Buffer Size

- We can evaluate the E-Drop strength, which drop messages of equal size and free those buffer messages that are equal to the received message size which means lesser drop.
- E-drop strategy has the lowest number of message dropped among all the drop strategies. Its number of message dropped decreases with increasing the buffer size. Its maximum number of message dropped is 7234 at buffer size 2MB and its minimum number of message dropped is 955 at buffer size 10MB.

5.3 Overhead Ratio (OHR)

The following results are evaluated from figure 3:

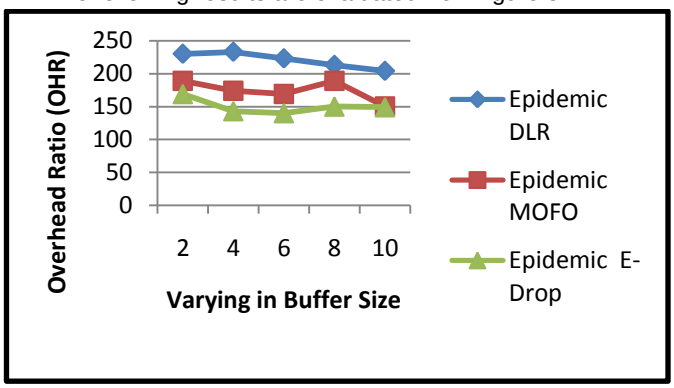

Fig. 2. OHR vs. Varying in Buffer Size

- In Epidemic routing protocol the overhead ratio of the entire drop strategies is decreases with increasing the delivery probability as shown in figure 3.
- The Epidemic routing protocol has large network overhead ratio because of its flooding behavior and the energy consumption is more when large network overhead ratio is occurred in the network during transmissions and receptions.
- E-drop strategy overhead ratio decreases as the buffer size increases because it delivery probability increase (as shown in figure 1) with increasing the buffer size.
- The E-Drop strategy under Epidemic routing protocol performs better as compared to DLR and MOFO strategies.

6. Conclusion

In this paper, buffer management drop strategies such as DLR, MOFO and E-Drop are compared and evaluated its performance on Epidemic DTN routing protocol. The evaluation is performed on ONE simulator. It has analyzed form the simulation that E-Drop strategy performs better as compared to DLR and MOFO strategies. The delivery probability of E-Drop strategy is improves 18.12% to 22.43% over DLR and 7.88% to 11% over MOFO strategies with parameter varying buffer size 2MB-10MB respectively

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