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Performance Evaluation of Prophet Routing Protocol on Different Buffer Management Policies

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Abstract

Delay Tolerant Networks (DTNs) is the advanced class of Ad-hoc network. DTN is wireless network in which connections between nodes are occasionally, due to which there is no permanent path is established between source and destination node. The connection between nodes are made instantly, when one node come into the range of another node. Therefore, in these network, message delivery is totally depends open the connection of nodes made in network. In DTN, mechanism used for routing the message is Store-Carry and Forward (SCF) approach. 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 performance of Drop Random, DLR, MOFO and E-Drop buffer policies are evaluated on Prophet routing protocol.

Keywords: DTN, Drop Random, DLR, MOFO and E-Drop.

1. Introduction

Delay Tolerant Networks (DTNs) is the one of the most challengeable network over the last decade. To overcome challenges of the network a possible solution is delineate in which internet architecture support the intermittent networks. In this network no end-to-end route is exist between source and destination node. Moreover, the communication links among nodes in the network are irregular, data flows in asymmetric way and high latency delay. In such type of networks, routing messages is a challengeable task because the message carrier nodes having limited advance information [1]. To send a message in such a network, routing algorithms use store-carry and forwarding approach (SCF). Nodes in DTN have limited resources such as bandwidth, buffer space and energy etc. So it is necessary to use these limited resources in efficient way during routing messages from source to destination node. To improve the delivery probability of message in such a network, the researcher proposed different DTN routing such as Direct Delivery, First Contact, Epidemic [2], Spray and Wait [3], Prophet [4] and MaxProp [5]. In this paper, Prophet routing protocol is evaluated on different buffer management policies.

2. Existing Buffer Management Strategies

The various buffer management optimization policies have explored by the researchers in the field of Delay Tolerant Networks (DTNs) such as FIFO, Drop Random, Drop oldest, DLR, Drop Largest, MOFO, Drop Last and E-Drop [7,8]. These policies are used to decide which message is dropped from the buffer space if Buffer space is full when a new message is arrived from the other nodes encountered in the network. In this paper, Drop Random, DLR, MOFO and E- Drop [11,12, 13] polices are evaluated on Prophet routing protocol.

- Drop Random: In this drop policy the messages will be dropped randomly from the buffer space to accommodate the message transmitting from the other nodes. This policy continues to drop the messages randomly until it free the buffer space required for the newly arrived message buffer space.
- Drop Least Recently Received (DLR): In this policy those message will be dropped which are stay for long time in the buffer space. The main reason behind DLR policy is that the messages which are stay for long time in a buffer space have a lesser amount of delivery probability to be conceded to other nodes.
- Evict most forward first (MOFO): In this policy only that messages are dropped first from the buffer space which are forwarded to utmost number of times, i.e. the message which are propagated number of hop counts in the network are dropped first. In this policy only those messages which are travelled less number of hop counts are allowed to forward in the network.
- E-Drop: In this policy 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 otherwise no messages will be dropped from the buffer space [6].

3. Prophet Routing Protocol

In Prophet routing protocol [9] delivery predictability is defined as estimate probabilistic metric i.e. P(node a, node b), at each node a for each destination node b. whenever two nodes meet in the network scenario its swap the summary vector which consist of delivery predictability values. After swap process each nodes updates their own delivery predictability in the summary vector. A low predictability value is assigned to the node if the contacts between two nodes are very rare or no contact exists between two nodes. If the nodes are meet regular interval then it delivery predictability is very high. The transitivity property of Prophet routing protocol state that if node A regularly meets B and node B regularly meet node C, then C is appropriate node for A, hence A marks C delivery predictability value as high in the summary vector. The operation performed by the Prophet routing protocol is totally depend upon the delivery predictability value in the summary vector. The calculation of delivery predictability of nodes is divided into three parts.

Direct update: Direct update is done whenever the two nodes a and b are encounter directly with each other. The equation 1. given below show the direct update of delivery predictability values.

$(a,b) = Pol\ ) + (1 - Pold\ \ ) \ Pinit$ …….(1)

Where

$Pold$ = Value of P(a, b) before updating

$Pinit \in [0,1]$ = initialization constant.

$(a,b$

(a,b)

Aging : In case of aging, the equation 2 given below decreases the node delivery predictability by the time elapsed without direct contact between two nodes a and b.

$(a,b) = old\ {}^{\gamma}K$ (2)

Where

$\gamma \in [0, 1]$ = aging constant.

K= number of time units that have elapsed since the last time the metric was aged.

Transitive update:

In case of transitivity update, the equation 3 given below update the delivery predictability of node a towards node b during the transitive contact among node a and node c.

$(a,b) = Pol\ ) + (1 - Pold\ \ ) \ P(a,c)\ P(c,b)\ \beta$ …..(3)

Where

$(a,b$

(a,b)

β ∈ [0, 1] = transitivity constant which reflects the impact of transitivity on the delivery predictability.

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.
- **Average Delivery Latency (ADL):**The average time taken to deliver the message form source nodes to destination nodes is called average delivery latency.

ADL=Average (total time taken to deliver the message form source nodes to destination nodes)

5. Simulation and Results

In DTN, different types of network environments can be designed and implemented, in current network setting two types of groups are considered, first group is pedestrians which engaged 50 nodes, second is cars which occupied 50 nodes. The Shortest Path Map Based Movement Model mobility model is used in our evaluation. The simulation area is 4500m x 3400m.

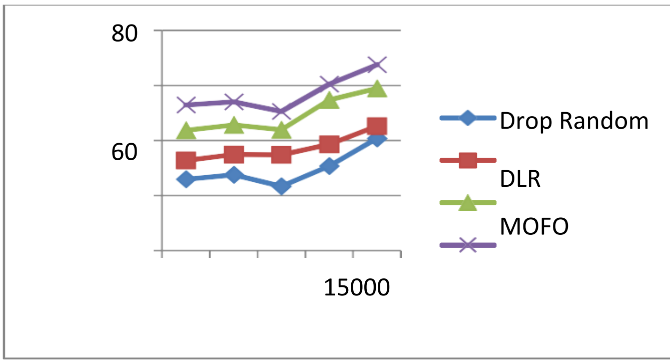
Table 1. Parameter Setting

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

Message Delivery Probability (MDP)

From fig.1 the following points are evaluated:

- In Prophet routing protocol the delivery probability of the entire drop policies is increases with increasing the buffer size because Prophet routing protocol provides the information towards destination node by tracing the meeting between nodes and assigning weight to these meeting whether they meet directly or by intermediate nodes.
- In Prophet routing protocol, E-drop policy has the highest delivery probability among all the drop policies. Its delivery probability is 50% throughout the scenario. Its maximum delivery probability is 67.51% at buffer size 10MB.



Number of Message Dropped (NMD)

From figure 3 the following points are concluded:

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- In
- In Prophet routing protocol, E-drop policies have least number of messages dropped as compared to other drop policies.

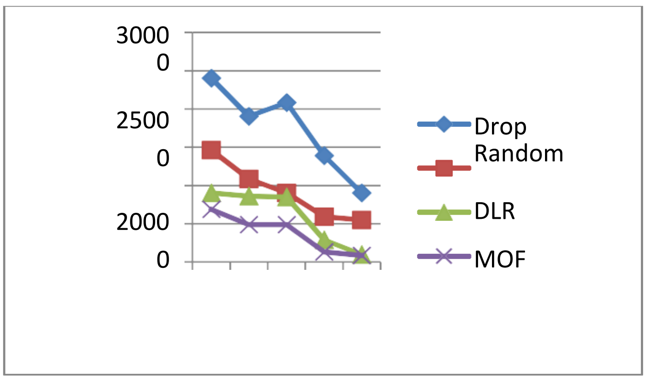
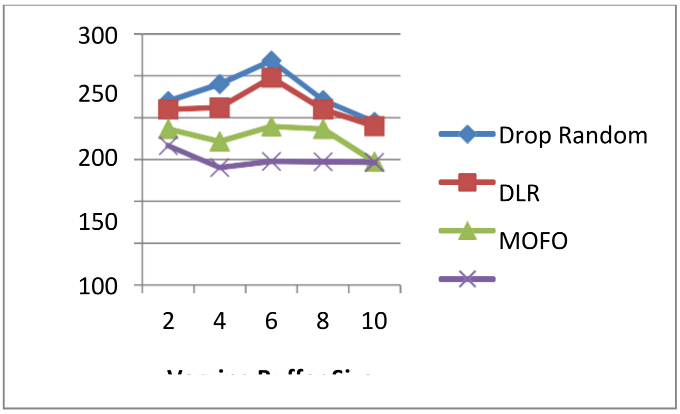


Fig. 2. NMD vs. Varying in Buffer Size

Overhead Ratio (OHR)

The following results are evaluated from figure 3.

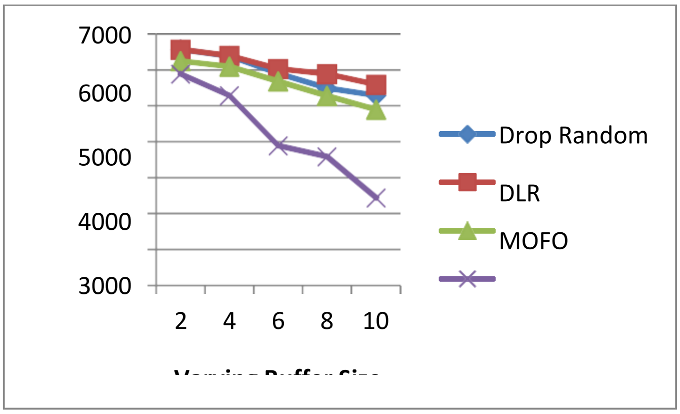
- In prophet routing protocol, the overhead ratio is minimum with increasing buffer size because the nodes in the network are not required to perform more computations to take decision which message to be accommodate in buffer capacity.
- Overhead ratio of E-Drop policy is approximately equal with increasing the buffer size.
- Overhead ratio of E-Drop policies is lesser as compared other drop policies.



Average Delivery Latency

The following points are analyzed from the fig 4.

- In Prophet routing protocol, the average delivery latency of the entire drop policies are gradually decreases with increasing buffer size due to flooding behavior of protocol.
- The variation between maximum and minimum average delivery latency in case of Drop Random, DLR, MOFO and E- Drop policies are 24.18%, 17.49%, 27.74% and 141.57% respectively.
- E-drop policies are performed better among all other drop policies.



6. Conclusion

Fig. 4. ADL vs. Varying in Buffer Size

In this paper, the performance of buffer management drop policies such as Drop Random DLR, MOFO and E-Drop are evaluated on Prophet routing protocol using ONE simulator. It has examined form the simulation that E-Drop strategy performs outstanding as compared to Drop Random, DLR and MOFO policies on Prophet routing protocol. The delivery probability of E-Drop strategy is improves 29.68 % over Drop Random, 22.24% over DLR and 10% over MOFO policies with varying buffer size.

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