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Performance Analysis of Drop Policies for Different Mobility Models in DTN

Samina Mansuri
Dept. of Computer Engineering
U.V.Patel College of Engineering
Mehsana, India

Hemal Shah
Dept. of Computer Engineering
U.V.Patel College of Engineering
Mehsana, India

Yogeshwar Kosta
Professor and Director
Marwadi Education Foundation
Rajkot,
India

ABSTRACT

Delay-Tolerant Networks are wireless networks with no existing infrastructure, where disconnections between nodes may occur frequently due to node mobility and power outages. In order to achieve data delivery, store-and-forward protocols are used in DTN. Thus routing protocols based on epidemic message dissemination has been proposed, such as Epidemic routing. Thus the nodes in such networks are required more buffer space to carry the data until the communication opportunity arrives. When the buffer gets full it needs to discard some of the messages from it based upon the drop policies implemented. As the nodes are mobile, mobility models play an important role to measure the performance of any protocol.

In this paper the performance of Epidemic Router is analyzed with different drop policies by varying the mobility models through the simulation.

Keywords

DTN, drop policies, mobility models.

1. INTRODUCTION

A Delay Tolerant Network (DTN) is a network where nodes may not be stable. The nodes' random and unpredictable movement needs to be taken care of; as well facts like intermittent connectivity and possibly no available end-to-end path also need a serious amount of attention. Delay-tolerant networks (DTN) have been designed to operate in environments where traditional Internet Protocol Suite does not seem to work well due to non existence of the end-to-end connectivity [1]. Delay-tolerant networks use a message oriented overlay that supports intermittent connectivity, overcome communication disruptions and delays [2]. Many protocols were proposed to deal with these networks and their performances were mainly evaluated through simulations. The perfect way to mimic the nodes mobility is to inject real movements in the simulation. In this way, efficient evaluation of the performances of any protocol can be done. Thus, many mobility models were proposed in order to simulate the displacement of a node or of a group of nodes.

As the buffer management is the serious issue in these buffer constrained environment. Various drop policies has been implemented to achieve the good throughput of the protocol in use.

Therefore combination of node mobility models with proper buffer management policy can optimize the results in our concern domain areas of disruption environment.

In this paper the impact of these many different kinds of mobility models with different drop policies such as drop head, drop largest, drop tail, their affect on the Epidemic routing protocol is shown.

The rest of paper is organized follows Section 2 discusses about the existing buffer management policies used in DTN. Section 3 describe about the protocol under observation. Section 4 discuses about the various mobility models taken for the observation. Section 5 summarizes performance matrices. Section 6 is for simulation and results. Section 7 is about conclusion and future work

2. EXISTING BUFFER MANAGEMENT POLICIES

2.1 FIFO – First in first out /Drop Front/Drop Head

Description: As per this policy the queue is handled in a FIFO manner. The message that arrived first in to the buffer will be selected to drop first [3].

2.2 MOFO – Evict most forwarded first

Description: In this drop policy the message that has been forwarded the largest number of times is the first to be dropped, thus the messages that have been forwarded fewer times will get more chances of getting forwarded [3].

2.3 MOPR – Evict most favorably forwarded first

Description: This policy can be considered to be a weighted version of MOFO, because instead of increasing a counter by one each times a message is forwarded, it is increased by the delivery predictability of the other node for the destination. Every node keeps a value FP (initialized to zero) for each message in its queue. Each time the message is forwarded, FP is updated according to Eq. 1, where P is the delivery predictability the receiving node has for the message [3].

$$FP = FP_{old} + P \quad \dots (1)$$

The message with the highest FP value is the first to be dropped [3].

2.4 SHLI – Evict shortest life time first / Drop Oldest

Description: Each message has a time to live (TTL) value which specifies when it is no longer useful for network and should be deleted. In this policy the message with the shortest remaining life time is selected first to be dropped [3].

2.5 LEPR – Evict least probable first

Description: In this policy the probability value of a message is considered. Since the node is least likely to deliver a message for which it has a low P-value, drop the message for which the node has the lowest P value [3].

2.6 Drop Random

Description: This strategy randomly selects message from queue to drop. Here all messages have equal deletion priority. The schemes work without network knowledge and perform poorly in highly congested networks [4].

2.7 Drop – Last-In First-Out (LIFO)/Drop Last/Drop Tail

Description: In this policy messages are handled in a LIFO order. The message that was last entered into the queue is the first message to be dropped [5].

2.8 E-DROP (Equal Drop)

Description: When node buffer is full and new message arrives, the node search and drops the buffered message having the nearly or exact the same size message from buffer.
If the size of buffered and new arrival is equal, this scheme minimizes the drop of messages [6].

2.9 Drop Youngest

Description: When this strategy is used, it selects the message with the longest remaining life time (TTL) to drop first [7].

2.10 Drop Largest

Description: If this policy is used then message with the largest size in buffer is evicted first to drop [5].

2.11 N-Drop

Description: This policy is based on the formula if any message that achieves N number of forwarding will be selected to drop first [7].

2.12 T-Drop

Description: According to this policy message which has the size up to the threshold set value is selected as victim to be drop first [12].

2.13 GBD (Global Knowledge based Drop)

Description: GBD based on global knowledge about the network state. As global Knowledge is required, GBD is difficult to be implemented, thus, it will serve as a point of reference [8].

2.14 HBD (History Based Drop)

Description: A deployable variant of GBD that uses the new utilities based on past history. It works on history-based learning process [8].

2.15 FBD(Flood Based Drop)

Description: FBD accounts only for the global information collected using simple message flooding, that is, without considering past history or other messages [8].

3. PROTOCOL UNDER OBSERVATION

3.1 Epidemic Routing Protocol

It is the protocol where random pair-wise exchanges of messages among mobile hosts ensure eventual message delivery [9]. The goals of Epidemic Routing are to: i) maximize message delivery rate, ii) minimize message latency, and iii) minimize the total resources consumed in message delivery.
The approach, called Epidemic Routing [9] is to distribute application messages to hosts, called carriers, within connected portions of ad hoc networks. In this way, messages are quickly distributed through connected portions of the network. Epidemic Routing then relies upon carriers coming into contact with another connected portion of the network through node mobility. At this point, the message spreads to an additional island of nodes. Through such transitive transmission of data, messages have a high probability of eventually reaching their destination.

4. ABOUT MOBILITY MODELS USED

4.1 Randomwalk

Since many entities in nature move in extremely unpredictable ways, the Random Walk (RW) Mobility Model [10] was developed to mimic this erratic movement in this mobility model, an MN moves from its current location to a new location by randomly choosing a direction and speed in which to travel [10].

4.2 SPM (Shortest Path Map-Based Movement Model)

SPMBM initially places the nodes in random places but selects a certain destination in the map for all nodes and uses Dijkstra's shortest path algorithm to find the shortest path to the destination [11].

4.3 RWP (RandomWayPoint)

The random way point [10] proposed by Johnson and lee works by moving the mobile nodes randomly according to direction speed at regular time intervals. In this model a mobile node stays at location for certain period of time, once the time expired, the node moves to the new destination by choosing the random speed from [0- MAXSPEED]. Hence node continues to move till the end of simulation along with crisscross path [10].

4.4 MapRouteMovement

Some nodes can also have predetermined routes that they travel on the map [11]. This kind of Route-Based Models, RBMs, are good for simulating e.g., bus and tram routes. Routes consist of map points that model the stops on the route and nodes wait on every stop for some time before continuing, using the shortest path, to the next stop. Both POIs and routes can be defined using the same GIS programs that are used for converting the map data [11].

5. THE PERFOMANCE METRICES MEASURED

5.1 Delivered message

Total number of successfully delivered to the destination from source [11].

5.2 Dropped messages
Number of messages dropped during transmission [11].

5.3 Overhead ratio
It is the negation of number of messages relayed to number of message delivered. Low value of overhead means less processing required delivering the relayed messages. Objective of algorithm is to minimize the value of overhead [11].

5.4 latency_avg
It's the average message delay from creation to delivery. Latency is that contributes to network speed. The term latency refers to any of several kinds of delays typically incurred in processing of network data. A supposed low latency network link is one that normally small delay times, whereas a high latency link usually experiences from long delays in DTN latency is high due to its network nature [11].

5.5 Buffertime_avg
It defines the average time of the message that remains into buffer of the node [11].

6. SIMULATION AND RESULTS
For the experimentation purpose simulator used was Opportunistic Network Environment (ONE) [11].

6.1 About ONE
The goal of it is to add more realism to the simulations. Unlike other DTN simulators, which usually focus only on routing simulation, the ONE combines mobility modeling, DTN routing and visualization in one package [11].

6.2 Configuration
To perform this experiment various input parameters were taken. The simulation was of 43,200 seconds (i.e. 12 hour) by taking the number of 6 groups and 126 nodes in a group total, with the transmission speed of 250kbps.The timetolive (ttl) was 300.The interface used was Bluetooth. The simulation is performed by taking various drop policies namely Drop FIFO, Drop LIFO, Drop Largest, Drop MOFO. Detailed information about all other input parameters is given in appendix. Those parameters were kept as default parameters for the entire simulation.

6.3 Simulation Results
All the results got from the simulation are shown below in form of graph representation and observations are discussed.

1. Mobility Models vs. Delivered messages.

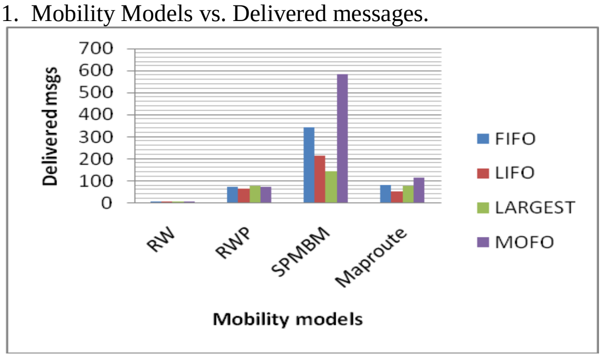

Fig.1.1 Mobility Models vs. Delivered messages.

Observation: As in the above graph no. of messages delivered is high incase of Maproute and SPMBM model. MOFO policy gives the best performance in all the cases.Whereas the FIFO have almost same performance in all the mobility models.LIFO and Largest drop policies have the varying performance in case of SPMBM and MOFO.While in case of RW and RWP all the policies shows very poor performance comparatively.

2. MobilityModel vs.Dropped Message

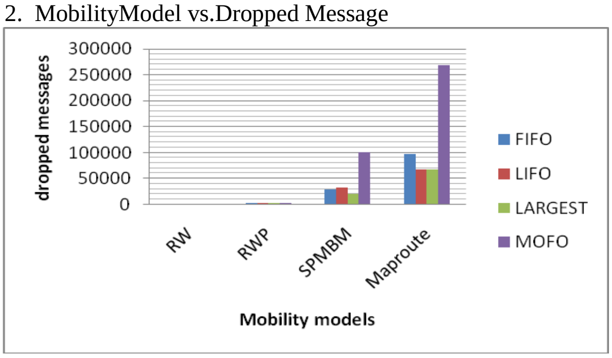

Fig.1.2 Mobility Model vs. Dropped messages.

Observation: Fig. 1.2 shows the dropped number of messages. MOFO policy have the highest ratio of the messages those are dropped by the nodes in Maproute. Which is very less in case of RW and RWP models.

3. Mobility Model vs. Overheadratio.

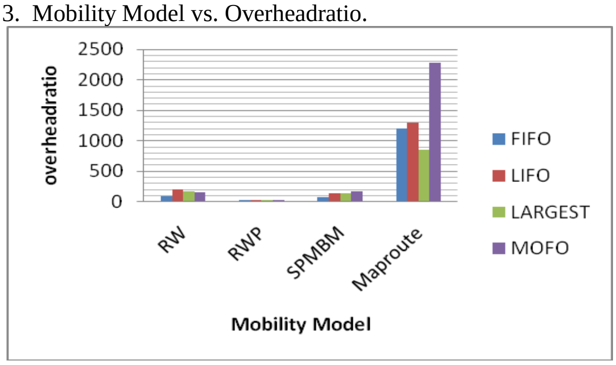

Fig.1.3 Mobility Model vs. Overheadratio.

Observation: The FIFO,LIFO and Largest mobility models show almost same behaviour in case of all the models.It is clearly seen that the overhead ratio is very high in case of Maproute with using the any drop policy but MOFO has the very high result among all. Model RWP has the very low overhead in any drop policy. Whereas in case of RW and SPMBM all policies show the same behavior.

4. Mobility model vs. Latency_avg

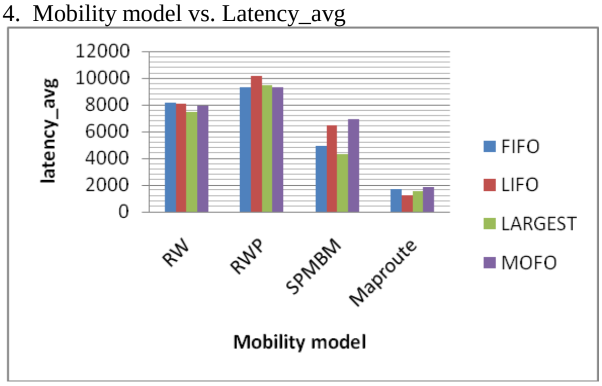

Fig.1.4 Mobility model vs. Latency_avg

Observation: The Fig 1.4 shows the latency average related to various drop policies with the different mobility models. Here the LIFO policy has the high latency average in RW and RWP models. Whereas MOFO policy has the high latency average in SPMBM and Maproute models. Among all the mobility models drop policy Largest has the very steady performance. Whereas FIFO has the varying performance.

5. Mobility Model vs. Buffertime_avg.

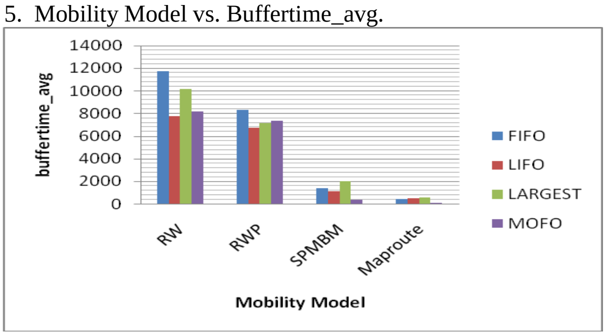

Fig.1.5 Mobility Model vs. Buffertime_avg.

Observation: The simulation result shows that messages have the high buffertime average using FIFO policy in case of RW and RWP models.In SPMBM and Maproute models the buffertime average is very less in any of the drop policy.Policies LIFO and Largest have the same performance in all the models.Whereas MOFO has verying performance. Here in our simulation result in all the model the delivered packet is increasing as we increase the size of the buffer

7. CONCLUSION

In this paper impact on various mobility models of the Drop policies is shown. After performing the simulation on the Epidemic routing protocol it can be conclude that drop policies have great impact and they affect the overall performance of the routing strategy used by the nodes. And also affects the overall network throughput. Since the mobility models represents the behaviour of the node that in fact responsible to form a well configured network.The mobility models taken are all different in charecteristics and movement of nodes.

By performing the simulation, it can be conclude that the policy Largest have good results in all the scenarios. FIFO and LIFO have the varying performance depends on the mobility models and they have the high overhead ratio and latency average in RW respectively. The MOFO policy have the good performance to achive high delivery ratio in any of the mobility model which is the main requirement of such challenged networks. Thus this policy optimize the performance of the routing protocol also in metrices like overheadratio and latency average.

In this paper the Epidemic protocol was taken under observation. In future many other protocols can be taken to analyze i.e. DirectDelivery, FirstContact, Spray&Wait, PROPHET also supported by ONE [11]. As in this work four mobility models only were taken for simulation further work can be carried out by taking the mobility models like Mapbased,Bus,Car,Stationary to check the impact of the drop policy,which are also included by ONE [11] simulator.

8. APPENDIX

All the input parameters taken for simulation are listed in tabular form (Table 1).

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Appendix

Table 1: This table shows all the parameters used during simulation.

Transmit speed	250k(2 Mbps)
Transmit range	10M
No. of Host Groups(1,2)	6
Buffer Size(1,2)	5,50MB
Ttl	300
Total no. of nodes	126
Message Creation Interval	30,50
Message Size (variable)	500k-1M
Area	4500,3400
Warmup	1000