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# A Review: Buffer Management Policies for Delay Tolerant Networks (DTN)

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## ABSTRACT

**Delay tolerant networks (DTN) are a class of traditional mobile ad-hoc networks that can tolerate delays in data delivery. DTN Consists of network partitions where bandwidth is restricted therefore contains storage issues [1]. Researches have proposed many routing protocols for delay tolerant networks but delivery ratio in DTN is mostly dependent on buffer management policy and the routing strategy used. This paper presents a review of buffer management policies on the basis of size, heuristics and time.**

**Keywords:** *Buffer management, algorithm, routing protocol*

## 1. INTRODUCTION

Delay tolerant networks (DTN) are a class of traditional mobile ad-hoc networks that can tolerate delays in data delivery. DTN Consists of network partitions where bandwidth is restricted therefore contains storage issues[1].Researches have proposed many routing protocols for delay tolerant networks but delivery ratio in DTN is mostly dependent on buffer management policy and the routing strategy used. Buffer management policy is important aspect in delay tolerant networks because buffer is limitedly available to all nodes[2].Messages in Delay Tolerant networks can be dropped or forwarded first according to scheduling policy and buffer overflow. On the basis of information used by them, buffer management techniques have been classified as local or global information of messages in the networks [3].

In DTNend to end path is not always available, hence there is always a chance of disruptions. In environments like underwater, deep space or oceans sensor networks delays are increased[4].To get message delivery in these situations, store-carry-and-forward technique is proposed by researchers, where nodes can accumulate messages in buffer for unlimited time till the message forwarding possibility occurs. Hence, duplication of messages may also occur. Because of data stay in node for a long interval,

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overhead ratio of storage may increase, hence to decide which messages needs to be dropped to overcome overflow requires efficient drop policies [5].

TCP/IP protocol (Transfer control protocol/internet protocol)gives reasonable communication by connecting millions of devices with each other on internet using standard protocols. In order to get operational use of internet we need consistent two directional end to end path. Similar data rates and less chances of errors etc. Number of Mobile device are increasing day by day; therefore, it is very difficult to provide satisfactory internet connectivity among millions of mobile devices. While using TCP/IP or traditional MANET routing protocols where frequent network partition can occur. Link may be interrupted by obstacles or power shut down, this protocol requires node to node connection therefore successful delivery is not ensures. for example, military and terrestrial networks. Delay tolerant networks can tolerate discontinuous connectivity, extended interruptions, asymmetric data rates and high error rates[6][7].

DTN uses two paradigms for the delivery of message to the target i.e. store and forward because in DTN without these paradigms the chances of successful delivery of message is very low. In DTN, a message is forward to the encountered node whenever a node is trying to send a message to any node which is not in his neighborhood[8]. The buffer is then used by encountered node to place that message for forward it to the destination node. There are two major problems in these two paradigms (Store and Forward), which leads to two separate research areas in DTN. The first problem is the feasibility of the message transferred to the encountered node. The cause of that problem is in the designing of routing protocol[9].This problem arises because of sending message to excessive nodes gives load to network resources like Buffer and also effects on the restricted bandwidth. As the message is broadcast so it also leads to the network contention. So in order to overcome this problem, we have to choose the node carefully for sending messages [10].

Ever node in DTN has limited buffer space which leads to another major problem. The buffer memory of each node in DTN is rapidly filled because it works on store, carry and forward mechanism. So a time comes when each of the node buffer is completely filled with messages. So in this situation, on the arrival of every new message, a node either has to remove a message from the message buffer to pick new message or a node has to deny the newly arrived message[11].DTN have some buffer management policies. These policies are used to handle and overcome the problems discussed earlier.

In Delay tolerant networks frequency of occurrence of high bandwidth as well as storage overhead is high because of the message replication and long term storage of messages. So that’s why we can say that Buffer Management is very significant in DTN[12].

In DTN most probably, in order to give place to a new message a node might have to drop an important message if the node's buffer is completely filled[13].If we implement a dropping policy that can prioritize the sequence of dropped messages, then it will prove very beneficial in the delivery of messages in network. In Delay tolerant networks Buffer management also have schedule policies. Sorting the message in a proper sequence is very important in successful message delivery and it also overcomes the partial transmission mechanism of DTN [14]. Partial transmission means that two nodes are connected in a network and they want to share messages but their transmission has aborted due to power disconnection or failure of link. Thus we can say that both policies either it is dropping or Scheduling play very important role in the DTN network's performance[8].Improving message delivery and decreasing overhead are the achievements of buffer management policy. This is done by reducing relay number over which a message is sent[15].

In this paper, many buffer management policies are studied and reviewed. On the basis of locally and globally available information of messages buffer management policies are classified. In this paper all policies are discussed with respect to their pros and cons in Delay tolerant network environment.

## 2. RELATED WORK

### 2.1 SIZE BASED BUFFER MANAGEMENT

- Drop Largest (DLA)
  In drop largest buffer management policy messages that have the largest size will be dropped first[16].
- T-DROP
  T-drop is related to threshold; it is a buffer management technique in which messages that lies in the given threshold will be dropped first[2].
- Drop Smallest (DSA)
  In drop smallest, messages are sort according to the size and the one with smallest size is dropped[17].
- E-DROP
  E-drop refers to equal message size. During congestion, the message of size equivalent to the incoming message in the node will be dropped first [2].

### 2.2 Heuristic Based buffer management policies

- Drop Random
  In drop random policy messages are dropped in random order[18].
- MOFO - Evict most forwarded first.
  In MOFO technique, the more forwarded message in term of count is chosen to drop first[19].
- N-Drop
  In N-Drop, the messages will be dropped that does N number of forwarding first[20].
- MOPR - Evict most favorably forwarded first

In MOPR technique a forwarding predictable FP is taken in consideration. It is initialized to zero in the beginning. With each time of message forwarding the value is value of FP is updated. In order to drop a message highest value of FP is considered[21].

- LEPR - Evict least probable first

In LEPR a P-value is considered. The node that has less chances of message delivery has the lowest P-value. LEPR drops the messages on the node having less P-value[21].

- GBD (Global Knowledge based Drop)

In GBD global knowledge is required, hence it is very difficult to implement it. But GBD is used as a reference point[5].

- HBD

HBD is the modified form of GBD that can be implemented. It uses new utilities and uses values of m and n[5].

- FBD (Flood Based Drop)

In Flood based drop past history and other messages is not considered. Only global information is collected by using message flooding[5].

### 2.3 Time Based buffer management policies

- Drop–Least-Recently Received (DLR)

Messages that remain in the node for more tome will be dropped first[20].

- Drop-Oldest (DOA)

Drop oldest refers to the shortest remaining time to live. Messages having shortest TTL will be dropped first from network. Small TTL gives high probability that message is already delivered[18].

- DL-Drop last (DL)

It drops the recently received message[18].

- Drop front (DF)

In this technique the firstly arrived message in the buffer will be dropped first[18].

- SHLI - Evict shortest life time first

The message having minimum time to live will be dropped first[21].

- FIFO

In FIFO stands for First in first out. In FIFO messages are placed in queue according to arrival time. Hereby the oldest message will be sent first[22].

- LIFO

LIFO stands for Last in First out. Same like FIFO in LIFO messages are placed in queue according to arrival time. Hereby the newest messages will be sent first [22].

## 3. COMPARISON

Performance of different buffer management policies is observed in this section. Table 3.1 illustrates the comparison table of all buffer management policies considered for comparison. Parameters for example Message delivery, Message drop, Overhead ratio, and buffer time average, Hop Count, Delay, Latency and Relay metrics are considered for comparison. Policies that have addressed any parameter are marked orange and assigned a count 1. Whereas the parameters that are not addressed or improved by the buffer management policy is marked Zero and green. The overall count of all the management policies is counted individually.

| **Sr. No** | **Policy** | **Message Delivery** | **Message Drop** | **Overhead ratio** | **Buffer time average** | **Hop Count average** | **Throughput** | **End to End delay** | **Latency** | **Relay Metrics** | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Size based** | | | | | | | | | | | |
| **1** | Drop Largest | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 4 |
| **2** | T-Drop | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 4 |
| **Heuristics** | | | | | | | | | | | |
| **3** | MOFO | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| **4** | N-Drop | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 3 |
| **5** | MOPR | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 3 |
| **6** | LEPR | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 3 |
| **7** | GBD | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |
| **8** | HBD | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |
| **9** | FBD | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |
| **10** | E-DROP | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 6 |
| **11** | MDC-SR | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 5 |
| **Time based** | | | | | | | | | | | |
| **12** | DLR | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| **13** | DOA | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **14** | DLE | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **15** | SHLI | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |
| **16** | FIFO | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **17** | LIFO | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

**Table 3.1** Comparison of buffer management policy

## 4. RESULTS

After Comparing all buffer management policies performed in a sequence of E-Drop having the best count, then comes MDC-SR, Drop Largest, and T-drop. All other buffer management policies performed less than these.

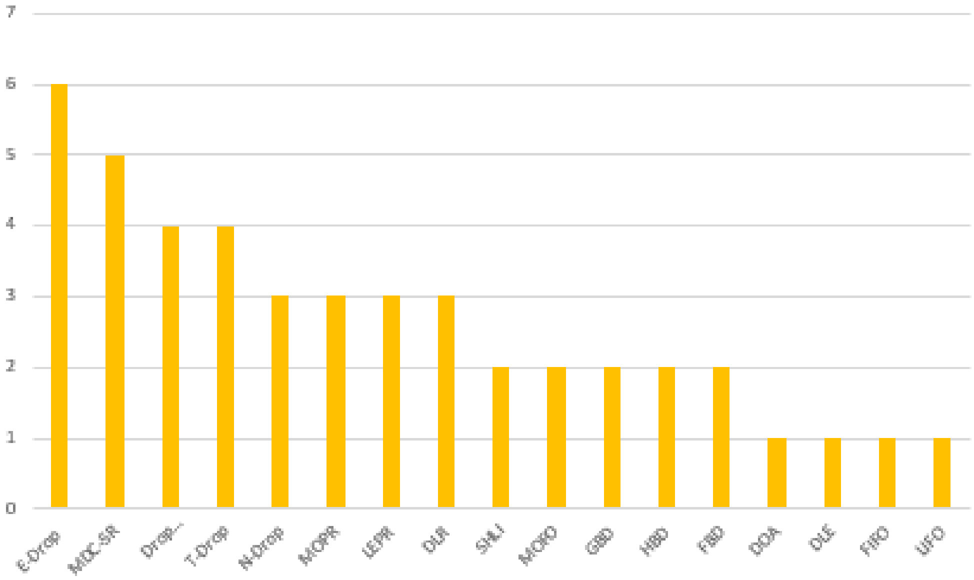

**Table 4.1** Comparison table of buffer management policies

## 5. CONCLUSION AND FUTURE WORK

In this work, different buffer management policies are categorized according to size, heuristics and time based. In comparison on the basis of Message delivery, Message drop, overhead ratio, buffer time average, Hop Count, Throughput, Delay, latency and Relay metrics E-Drop addressed a greater number of parameters than others after it MDC-SR, Drop largest and T-drop are in queue.

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