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A New Approach of Enhanced Buffer Management Policy in Delay Tolerant Network (DTN)

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Abstract—**Delay tolerant-network is emerging technology in wireless communication. This network is applied generally when there is no end-to-end path from source to destination. In current TCP/IP technology communication is possible only when end-to-end path is available. But two major issues in DTN (Abbreviation) are routing and buffer management. Routing strategy determine which message should be forwarded when node comes in contact with another. Buffer management policy strategy determines which message will be dropped when node is overflow. These two are very useful strategies that are used in DTN. In this paper we have proposed a new buffer management policy based on message forwarding and message replication on the network. We have introduced two utility functions. These functions are to find which message will be dropped when buffer overflow occurs. There is a special protocol named Bundle Protocol (BP) that is not in TCP/IP. Bundle protocol (BP) provides store-carry-forward mechanism that means when node is not in radio range then message is hold by the node and when node comes in range then message will be forwarded.**

Keywords—**Delay Tolerant, Routing, Buffer Management, ETR, MF,EBMP.**

I. INTRODUCTION

Delay-tolerant network (DTN) is a field of network research focused on architectures and protocols that can operate in tough situation networking environments with extremely low resource , particularly in terms of CPU processing power, memory size and network capacity [1]. The Bundle Protocol [2] aims to resolve issue in DTN network, such as intermittent connectivity, long or variable delays and high error rates. Example of DTN networks are MANET, vehicular networks and deep-space networks. In most of these case , there is not a continuous end-to-end path between the sender and the receiver; the receiver might be available after the sender has been disconnected or an intermediate routing node may be moving constantly between the always connected.

To improve the delivery of message in such challenged network environment, we need to consider several research issues. One of the issues of routing in DTN and the solution proposed thus far for DTN routing range from the easiest mechanisms to complicated mechanisms. The easiest mechanism is epidemic routing [3-5], where message are flooded through the network to reach as much of the network as possible in the hope that each message will eventually reach its destination. Complicated mechanisms can make use of special knowledge of the scenario [3], or try probabilistic routing [7-10] to establish the probability that a certain node will deliver a message to its destination on the basis of previous events, even or analyzed the network structure to reduce the number of replicated message by adopting the concept of concept of social network [11-12].

Another most important issue and paper based on particular this issue is buffer management policies because DTN basically uses a store-carry-forward routing protocol [13]. In store-carry-forward routing, if the next hop is currently not available for the current node to forward a message, the node should store the message in its buffer and carry it along while moving until the node gets a communication (contact) opportunity to forward this message farther. Therefore the nodes must be capable of buffering messages for a considerable time. Moreover, to increase the probability of delivery, we need to ensure the message are replicated many times in the network because of lack of complete information about others nodes [14]. As a result, the limited buffer in each node is likely to be consumed very rapidly when the flooding message are stored in buffer.

According to the literature, buffer management polices significantly affect the performance of DTN [13-14]. Zhang et al. [13] showed that widely used traditional buffer management policies, such as drop tail and drop front , perform poorly in DTN .Recently , the history –based drop (HBD) policy based on global knowledge of the network was proposed [14]; it outperforms traditional buffer management policies in terms of the delivery ratio and the average delay . Although the HBD outperforms traditional policies, the buffer management of DTN still has searching improvement algorithms. This study proposes an enhanced buffer management policy (EBMP) that utilizes message properties to calculate the utility value of each message. Experiments on two types of well-known real-would mobility trace data and synthetic data show that the EBMP outperforms traditional buffer management policies and the HBD policy in terms of the number of delivered messages and average delay.

This study is organized as follows: in section II, we offer an in depth-review of related works. In section III, we explain the proposed policy, EBMP. In section IV, we present our conclusions.

II. Related Work

Buffer Management policy is crucial for DTN as well as wireless sensor network (WSN). The performance of a WSN or DTN can be deteriorated as the network has high load of packets or message since the limited buffer size of each node leads to serious traffic congestion.

Many buffer management policies for WSN are adopted to release the burden of the buffer to increase the throughput of the network without increasing the transmission delay. Proposed a congestion avoidance scheme based on light weight buffer management where they described simple approaches that prevent data packets from overflowing the buffer space of the intermediate sensors. Proposed another buffer management policy based on random linear network coding as the in-network processing on data packet. Their scheme distributes the buffer requirement among the nodes on the path with buffer allocation from source to sink path. Recently, proposed the prioritized buffer management policy for different category uniquely by classifying the packets into different categories.

On the other hand, the buffer management policy for DTN has not been studied adequately as far as we know. Zhang et al. [13] showed that widely used traditional buffer management policies, such as drop tail and drop front , can be applied to DTN through they perform poorly in DTN. Lindgren and Phase [13] also evaluated diverse traditional buffering policy, evict the most forwarded first (MOFO) policy, evict the most favorably forwarded first policy, evict the shortest lifetime first (SHLI) policy and evict the least probable first policy. They conclude that the MOFO is the best buffering policy in terms of the message delivery and that the SHLI is the best in terms of average delay. These traditional buffer management policies are very reasonable and easy to implement as long as the buffer size on all hosts is larger than the expected number of messages in transmit at any given time. However, whenever the available buffer size is limited in relation to the number of messages, these policies perform poorly in a DTN environment [14].

Advanced buffer management policies for DTN have recently been proposed. Krifa et al [14] introduced a policy called the global knowledge-based drop, which is based on global knowledge about the network and they also proposed a distributed algorithm called the history-based drop (HBD), which , in practice , uses statistical learning , to approximate the global knowledge required by the global knowledge – based drop policy. proposed an adaptive optimal buffer management policy for DTN; it expand the HBD algorithm and extends its applicability to situation where the bandwidth is limited and message vary in size. Although these advanced buffer management policies outperform traditional policies in terms of the message delivery rate and the average delay, there is still plenty of room for improvement.

In this study, to improve the performance of DTN buffer management, we intensively explore message properties and develop an EBMP as the next section explains.

III. Proposed Buffer Management Policy

In this section, we explain the proposed buffer management policy called the EBMP and the message properties used in its utility functions.

A. *Message Properties for the EBMP*

In DTN environments, buffer management of a node is complicated by the difficulty of obtaining knowledge about messages and other nodes. Answers are needed on questions such as how many message are distributed in the network or which node has a message that is the same as the message in my buffer or which node has a message that is the same as message in my buffer or which message have already delivered to their destinations. Accordingly, buffer management of a node is performed on the basis of the restricted information which the node has at that time. To accurately provide useful information to nodes for the purpose of buffer management, this study utilizes three message properties: the estimated number of replicas, the age and the remaining time-to-alive (TTL) of the message.

The first important step in managing the buffer of each node is to know the number of replicas of each message in an entire network. However, for a node in DTN, it is quite difficult to know the exact number of replicas of a message in an entire network. Thus, to estimate the number of replicas of message, we introduce two message variable: the estimated total of replicas (ETRs) and my forward (MF).

Definition 1: The term $\mathrm{ETR}_\mathrm{i}^\mathrm{A}$ means the total number of replicas of messages i as estimated by node A at the current time; and the term $\mathrm{MR}_\mathrm{i}^\mathrm{A}$ means the number of replicas of message i which node A has replicated by itself to forward the message to other nodes.

If node B meets node A and receiving message i from node A, the MF value of node B is set to 0, and the ETR value of node B is inherited from node A.(The value of ETR_i is set to 1 whenever message i is created.) thus

$$\mathrm{ETR}_\mathrm{i}^\mathrm{B} \leftarrow \mathrm{ETR}_i^A\ ,\ \ \mathrm{MR}_i^A \leftarrow 0$$

$$(\mathrm{ETR}_i^A \leftarrow \mathrm{ETR}_i^A + 1,\ \mathrm{MR}_i^A \leftarrow \mathrm{MR}_i^A + 1)$$

If node B meets node C, which does not have message i, then node B forward message i to node B , and the values of ETRi and MF_i of node B are increased by 1 , and the ETR_i value of node B is copied to node C. thus

$$\mathrm{ETR}_\mathrm{i}^\mathrm{B} \leftarrow \mathrm{ETR}_\mathrm{i}^\mathrm{B} + 1, \mathrm{MR}_i^A \leftarrow \mathrm{MR}_i^A + 1,$$

$$\mathrm{ETR}_\mathrm{i}^\mathrm{C} \leftarrow \mathrm{ETR}_\mathrm{i}^\mathrm{B}\ , \qquad \mathrm{MR}_i^A \leftarrow 0$$

If node B meets node D , which has the same message i , then the MF_i value of nodes B and D are exchanged so that the ETR_i value of both nodes can be updated . thus

$$\mathrm{ETR}_\mathrm{i}^\mathrm{B} \leftarrow \mathrm{ETR}_\mathrm{i}^\mathrm{B} + \mathrm{MR}_i^D, \qquad \mathrm{ETR}_\mathrm{i}^\mathrm{D} \leftarrow \mathrm{ETR}_\mathrm{i}^\mathrm{D} + \mathrm{MR}_i^B$$

The ETR of message is managing efficient buffer management policy because high the value of ETR means message is distributed throughout the network and result is replicated many times.

For ease of understanding fig 1 and 2 show how message is replicated for ex. $\mathrm{ETR}_\mathrm{i}^1$ is 18 and MF_i^1 is 2 which shown in fig 1.(a). This means that message i is replicated 18 times and 1 time itself. When this node comes in contact of other nodes, ETR and MF value change. Means the node 1 come in contact of other node here is assume node 3 which not have message i the value of ETR and MF value increased by one. Node 1 has also increased by one his ETR and MF value but node 3 ETR value only increased not his MF value this value initially set to 0.

Pseudo Code:

TABLE 1: Notation Used

Name Used	Meaning
v_i	Network i[th] Node
N	No of node in network
ETR_m^i	Total replica of node i
MF_m^i	Message forward of node i

EBMP(I ,N, ETR_m^i, MF_m^i)

[1]. For i=1 to N
[2]. ETR_m^i=0 (Estimated Total Replica of message m at node i)
[3]. For each source message (generated)
[4]. When message is replicated in network then ETR_m^i is increment by 1
[5]. MF_m^i=0 (Message m forward to contact node)
[6]. When message forward to contact node then MF_m^i value increment by 1 on updated value.

After scan all node in the network then updated ETR_m^i and MF_m^i is used to check which message is drop from buffer on the basis of utility value. Utility value is calculated on the basis of ETR and AGE of message.

Another way to calculate utility value is by using utility function on the basis of RTTL (Remaining Time-to-Live) and ETR (Estimation of Total Number of Replica) in Network. If message is generated in the system then a value is assigned that value hold with this message till message will be delivered this value is Time-to-live of message in the network.

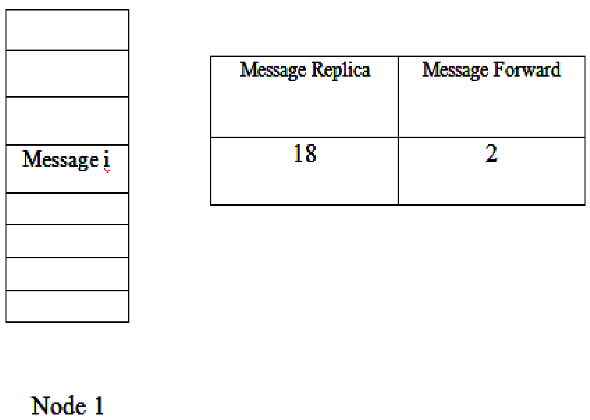

Fig 1.(a): Node 1 currently held message i

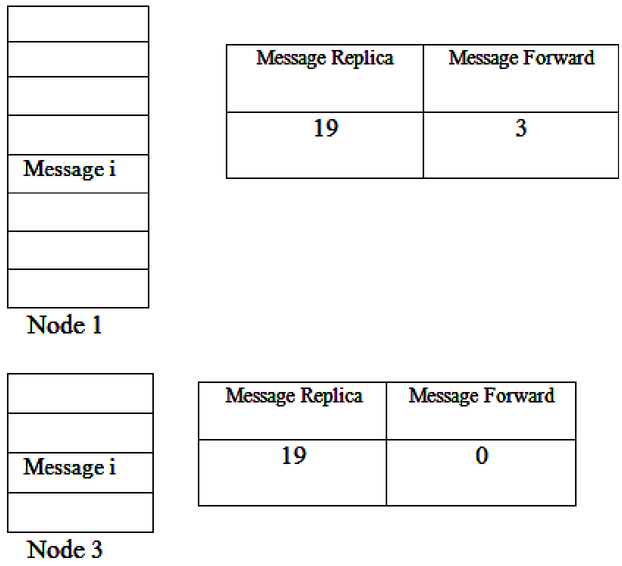

Fig 1.(b): Transmission between node 1 to node 3.

Two other message properties, namely the age and remaining TTL of a message, are also used to manage the buffer efficiently.

Definition 2: The term AGE_i means the elapsed time since message i was created .it will be calculated by subtracting the current time of message i and creation time of message i.

AGE_i=Time (Current) – Creation Time (Message i)

The TTL (Time-to-live) means a message is live in the network for a particular value of TTL. RTTL (Remaining Time-to-Live) depends on current time. RTTL and AGE deals with message, that how long these messages live on the network? Older message has long time in the network means probability higher the message will be delivered.

B. Proposed utility function

We propose two utility function, EBMP_delivery and EBMP_delay, which utilize the three above mentioned message properties as follows.

$$EBMP_i^{delivery} = \frac{1}{ETR_i} + \frac{1}{\log AGE_i}$$

where ETR_i and AGE_i are the ETRs and the age of message i.

$$EBMP_i^{delay} = \frac{1}{ETR_i} + \log(RTTL_i)$$

Where RTTL is Remaining time_to_live of message i.

Here we log because log gives small value as compared to exponential if, we use exponential then reciprocal, it tend to zero. Because AGE and RTTL value is given in thousand and unit is second. As compared I used log give a real number that is suited here more appropriately.

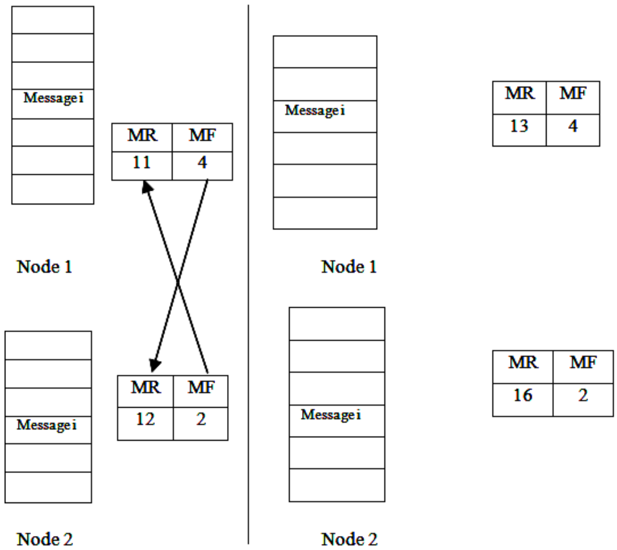

Fig 2 : Transmission between node 1 , node 2 and MR, MF

Here node 1 and node 2 has same message i but here MR(Message Replica) and MF(Message Forward) value exchanged to each other only affected MR value of each node not MF value of a node and MF value remain same. MR value change because of MF means message already replicated on the network only MR value change.

IV. Conclusion

DTN is expected to become more useful in next generation internet structure. One of the important research issues in DTN is buffer management and routing. In this study, we proposed an EBMP for DTN. This policy utilize the properties of each message such as number of replicas of particular message , remaining time-to-live and the age to calculate the utility value of each message. With this utility value node decides which message is to be deleted from buffer whenever the buffer overflows.

In future we will work on this topic, and try to enhance this buffer management policy in delay tolerant network (DTN).

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