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A Novel Contact Based Mechanism to Decrease Overhead Ratio in Delay Tolerant Networks

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***Abstract*—** DTN (Delay Tolerant Network) is wireless network in which data is transmitted through intermediate nodes. DTN provides store carry and forward mechanism to transfer messages from one node to another node. To transfer data between nodes, DTN provides some standard routing algorithms named epidemic routing, spray and wait routing, prophet and many more. Each routing mechanism has its own features as well as some drawbacks. In spray and wait routing, rate of replication of messages is too high while delivery ratio is also high. So, to overcome drawback of too high replication, the present research paper focuses on mechanism to measure contacts between nodes to reduce replication of messages .The contact is calculated between two nodes when they are in range of each other. In proposed algorithm, *popularity vector* is calculated based on duration of contacts between nodes. The value of the *popularity vector* of nodes will be used for selecting most appropriate node for message forwarding. High popularity value of a node will have more probability of successfully delivering the message. Proposed mechanism will reduce replication of messages and hence delivery ratio will be increased and overhead ratio will also decrease significantly.

***Keywords*—** DTN (Delay Tolerant Network), intermittent connectivity, Spray and Wait routing, Contact, ONE simulator

I. INTRODUCTION

The networks that do not possess end-to-end connectivity for most of time are categorized as Delay Tolerant Networks or simply DTNs. DTNs represent infrastructure-less mobile and wireless systems that possess long and frequent network partitions with long delays, asymmetric bidirectional data transfers and very high possibility of bit-errors in data transfer over links in the network. Challenged environments possess characteristic of long/variable delays, high asymmetry in data rates, ambiguous patterns in node mobility and these environments do not have end-to-end continuous connectivity also. DTN is an important element for deep-space related networking problems in space missions. DTNs work on store, then carry and after that forward mechanism. In this approach, each node has some buffer space where it stores the messages, and then that node carries the stored messages with it and forwards the message to the next mobile node. This process carries on till message is received by destination node. DTN is an alternate to Internet in challenged networks. Solar System Internetwork is being developed by space agencies which is basically a DTN [1].

A. DTN Architecture

In DTN architecture, a new protocol called as bundle protocol is used which sits above the transport layer. Bundle protocol is same for entire DTN network while other protocols vary to suit the particular communication scenario [2].

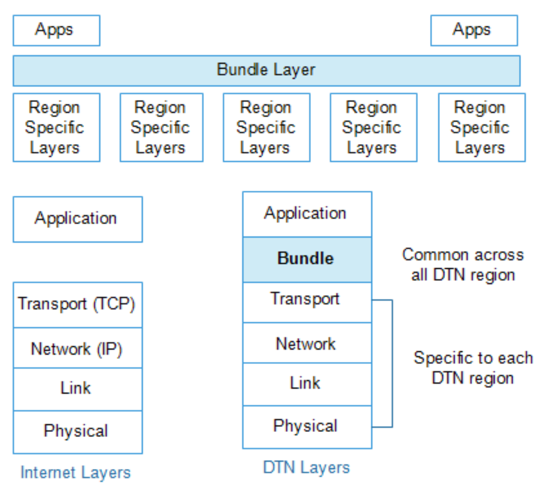

Figure 1. DTN Architecture [2]

B. Routing Protocols in DTN

Different routing protocols are used for delivering message in DTN networks. The routing protocols used commonly in DTNs are Direct Delivery routing, Epidemic routing, Spray and Wait routing, ProPHET routing etc.

In Direct Delivery protocol, the source node delivers only to the destination node and not to any other node. But this is not suitable for most of the cases since the source and destination may never meet. Message delay may be indefinite in this routing.

In Epidemic routing protocol, the source node floods all those nodes that it encounters. This protocol does not resend the messages to any node that already has that message. It almost guarantees delivery of the message.

Spray and Wait is a form of flooding that is controlled. In this protocol, a spray phase and then a wait phase take place.
In ProPHET routing, history of encounters of nodes is maintained and the messages are forwarded based on the delivery predictability metric [3].

C. Movement Models in DTN

Different movement models are used in DTNs for message transfer between nodes. Some of commonly used movement models are Map Based movement model, Shortest Path Map Based movement model, Random Way Point model etc.

In Map Based movement model, nodes follow a predetermined path. These paths/routes are based on a predefined map.

Shortest Path Map Based movement model also uses maps. In this model, a node chooses a destination randomly or from Points of Interest. Then the node follows the shortest path to the chosen destination.

In Random Way Point method, any node will randomly choose its destination and then it moves to the destination randomly without any type of restriction [4].

The paper is organized as follows - Section I contains the introduction of DTNs, Section II contains the related work regarding overhead ratio reduction and replication reduction, Section III contains proposed work, section IV is Results and Analysis section, Section V contains Conclusion and Future Scope.

II. RELATED WORK

In [5] discussed issues that occur due to buffer management and resource constraints to utilize delivery ratio with less time delay. They proposed buffer management technique based on power laws to reduce time delay and improve contacts durations.

In [6] studied impact of buffer size or message size on Dlife routing protocol by varying buffer size and analyzed that as buffer increases overhead decreased.

In [7] proposed a mechanism in which messages are forwarded on the basis of node remaining battery and delivery possibility to deliver message to next destination. They compared proposed mechanism with existing prophet routing mechanism.

In [8] proposed a mechanism of calculating the community space between two nodes on the basis of multi-hop deliverance possibility over the most possible path.

In [9] examined adequacy of deletion code based multi-way directing for DTN as far as secure transmissions under presence of enemy nodes.

In [10] proposed a mechanism that isolates definitive messages and organizes them as indicated by their significance so that essential messages get the most elevated need and get sent in the opportunistic system at the principal conceivable opportunity.

In [11] projected an improved contact-based routing for the transmission of messages in opportunistic networks.

In [12] proposed a method called CONHIS in which nodes contact history is used to transmit selected messages to improve delivery ratio and decrease replication rate.

In [13] proposed location based routing mechanism in which nodes' location is first determined and then message is transmitted to that particular node to improve lifetime of nodes.

III. PROPOSED WORK

Following algorithms are proposed, which are implemented using ONE simulator for reducing overhead ratio in DTNs to provide enhancement to Spray and Wait routing:

Proposed Algorithm I

1. START
2. Set Nodes in network area, N includes sender too.
3. For (j=1; j<N; j++)
4. {
5. If two nodes encounter within TTL.//Time to Live
6. {
7. Set initial number of copies of message M.
8. Set PV=0// popularity vector.
9. Compute most popular contact and update PV.// call algorithm II
10. Else
11. No contact is present then we can't forward message from these nodes.
12. }
13. }
14. END

Description of algorithm: In this algorithm we initialize N number of nodes in the network area. We consider a parameter i.e. popularity of node. It describes that how many successful messages are transmitted by a node. We increase the popularity of node when it successfully transmits a message. This process only works when there is contact present between nodes. If no encounter is present then no message is transmitted and sender will again re-compute the path. To compute message path of each node algorithm II is called.

Proposed Algorithm II - Message path information computation

1. START.
2. (For i=1; i<N; i++)
3. {
4. If (message ID =N1, N2, N3… until TTL expires)
5. {
6. Then message delivered path is N1>N2>N3...// Intermediate Hops
7. Else
8. No message delivered path.
9. }
10. }
11. END

IV. RESULTS AND ANALYSIS

To assess proposed mechanism we use ONE (Opportunistic Network Environment) simulator. It is an open source simulator that can be used on any operating system that supports java [14].
Performance Metrics:

- **Overhead Ratio**: Overhead Ratio is created in network due to occurrence of number of replications of messages.
- **Delivery ratio**: Deliver ratio is calculated by taking ratio of number of messages delivered to number of messages created.

Table 1. Simulation Parameters

Parameter Description	Value
Simulation Area	4500m X 3400m
Simulation Time	30000s
Mobility Model	Shortest Path Map Based Movement
No. of Groups	6
Transmission Range	10meter
Node Speed	2m/s
Warm-up Period	1000seconds
Time To Live	300
Buffer Size	[5M;10M;15M]
Routing Scheme	[Spray And Wait Routing; proposed]

Results are analyzed using various performance evaluation factors i.e., Overhead Ratio, and Delivery ratio with respect to varying buffer size parameter.

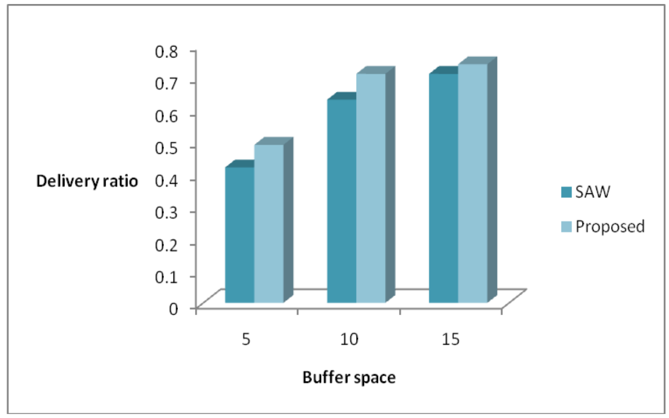

Figure 2. Delivery ratio v/s Buffer Space

Figure 2 depicts delivery ratio of spray and wait routing and proposed mechanism. Buffer space is varied from 5M to 15M for calculating delivery ratio. The delivery ratio is found to be higher in proposed mechanism than the existing routing.

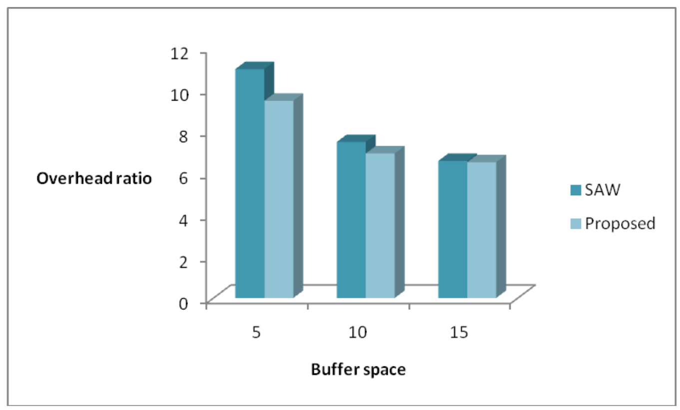

Figure 3. Overhead ratio v/s Buffer Space

Figure 3 depicts overhead ratio of spray and wait routing and proposed mechanism. In proposed mechanism, overhead ratio is low when compared to existing spray and wait routing. It means that rate of replication of messages is reduced in proposed mechanism.

Results clearly show that use of proposed algorithm for selection of a node for message forwarding increases the delivery ratio. The algorithm also helps in reducing overhead in the network. This happened due to decrease in rate of replication of messages through implementation of proposed algorithm. Both the delivery ratio and overhead ratio metrics are showing better results than the existing mechanism.

V. CONCLUSION AND FUTURE SCOPE

In this paper, we have proposed a mechanism to reduce the rate of replication based on contact duration between nodes. We proposed an algorithm that calculates the popularity vector for each node. The use of popularity vector allows us to select the most appropriate node for message forwarding based on its popularity value. The buffer space is varied from 5M to 15M. Simulation results show that reducing the replication of messages has increased the delivery ratio. Results also show that overhead ratio has reduced significantly in comparison to existing mechanism which is also attributed to reduction in rate of replication.

The message delay is slightly higher in our proposed mechanism. In future, we will continue our work by using least recent nodes concept to further improve delivery ratio and to reduce the message delay.

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