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Density Based Multi-Hop Periodic Spraying for Intermittently Connected Networks

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ABSTRACT: Intermittently connected mobile network (ICMN) is a delay-tolerant ad hoc network that is made up of mobile nodes. In real time scenarios like battlefield, wildlife tracking sensors nodes usually suffer from frequent network partitions. In these scenarios, there is no end to end path exists between source and destination due to frequent link breaks and high mobility of nodes. To address these challenges in these networks, several flooding schemes have been introduced but the resource consumption is high. Then many spraying methods also introduced. But the existing spraying methods will not spread the message faster to reduce the average delay. Hence, we propose a new spraying technique in which spraying is done by combining density aware spray and wait with multi-hop periodic spraying. So, there is a chance of spreading the messages faster. Hence, the delay will be decreased and delivery ratio will be increased while maintaining the limited number of replicas of message.

KEYWORDS: Challenged networks, Intermittently connected networks (ICMN), spraying, Mobile ad hoc networks (MANETs), Density Aware Spray and Wait (DA-SW)

I.INTRODUCTION

Mobile ad-hoc networks (MANETs) allow mobile users to obtain access to interact directly with one another even when they are outside the coverage area of cellular networks or wireless LAN.

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In MANETs there is no need to deploy any fixed infrastructure network. Many routing protocols have been proposed to establish and maintain reachability between communicating nodes in such dynamic environments.

Challenged networks may arise from MANETs due to high mobility and sometimes due to network partitions which may occur due to less battery. These challenged networks are characterized by high latency, bandwidth limitations, high error probability, node longevity, or path stability that are substantially worse than is typical of today's TCP/IP based networks [1]. Existing TCP/IP network protocols could not be utilized for these challenged networks since they operate on a principle of providing end-to-end inter-process communication Conventional Internet routing protocols e.g., RIP and OSPF, as well as routing schemes for mobile ad hoc networks such as DSR, AODV, etc., assume that a complete path exists between a source and a destination, and try to discover these paths before any useful data is sent. Thus, if no end-to-end paths exist most of the time and these protocols fail to deliver the messages.

The major issue in MANET is intermittent connectivity. In intermittently connected networks (also known as disruption tolerant networks), disconnections are so frequent that there may never exist a fully connected path through the network between a source and a destination that wish to communicate. Examples include real time scenarios such as battlefield and disaster recovery scenarios

If the sequence of connectivity graphs is over a time interval are overlapped, then an end-to-end path might exist. This implies that a message could be sent over an existing link, get buffered at the next hop until the next link in the path comes up e.g., a new node moves in range or an existing one wakes-up, and so on and so forth, until it reaches its destination. This model of routing constitutes a significant departure from existing routing practices. It is usually referred to as mobility-assisted routing because node mobility often needs to be exploited to deliver a message to its destination other names include "encounter-based forwarding" or "store-carry-and-forward".

The majority of existing protocols are flooding-based that distribute duplicate copies to all nodes in the network or a subset of them. Although flooding can be quite fast in some scenarios, the overhead involved in terms of bandwidth, buffer space, and energy dissipation is often prohibitive for small wireless devices e.g., sensors. The schemes which use more than one copy per message are "multi-copy" schemes. Single-copy schemes that only route one copy per message can considerably reduce resource waste. They have magnitude slower than multi-copy algorithms and are inherently less reliable. There were numbers of routing protocols proposed for ICN and they

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are divided into replication based and knowledge based [2]. The proposed routing is replication based but controlled to have smaller number of replications per message.

II. RELATED WORK

Various DTN routing and forwarding schemes have been proposed For challenged Networks such as Intermittently Connected Networks (ICN) which utilizes store-and-forward mechanism is proposed. [1]. There were number of routing protocols also proposed which are based on replication and knowledge routing strategies [2]. An example for extreme replication strategy is epidemic routing [3]. It is very simple but it does not requires knowledge about the network. This protocol relies by doing pair-wise information of messages between nodes as they get contact with each other to eventually deliver messages to their destination. Hosts buffer messages even if no path to the destination is currently available. But the disadvantage is that it requires a large amount of buffer space, bandwidth and power to process large number of copies generated. Therefore in order to minimize the resource utilization, the protocols which is based on both resource and knowledge such as Encounter based routing protocols [8] is proposed. They limit the number of replicas generated inside the network based on the previous contact or encounter value.

Other spraying protocols include Spray and wait [4] and Spray and Focus[5]. In spray and wait strategy, it includes two phase namely: spray and wait phase. In spray phase, for every message originating at source node, L message copies are initially spread forwarded by the source and possibly other nodes receiving a copy to L distinct relays. In wait phase, if the message is not received to the destination during spray phase, then each of the L nodes carrying the copy of a message performs direct transmission (ie. It will forward the message directly to the destination).

Other spraying protocol is Density aware spray and wait[7]. Encounter table is maintained in each node and node degree is calculated. Node degree is calculated as number of contacts that each node maintains for certain period of time. Node degree gets updated every time when a node meets the other node. The number of copies to be sprayed is decided based on the node degree.

III. DENSITY AWARE SPRAY AND WAIT

Source spraying is done. Initially the source node spread ‘K’ copies to other nodes which it meets first. Then, these intermediate or relay nodes will spread the copies to destination when it meets or to the other relay nodes which have good contact behavior. The reason to choose initially the source spraying without considering the good relay is to spread the copies faster, rather than waiting for good relays. Based on the number of nodes in a network K copies are already fixed. But, based only on the number of nodes is not suffice for the copies to be spread. Since the ICMN will have sparse and dense areas at different times. Hence, a mechanism is needed to measure the density of nodes and then to decide on the number of copies to spread. It makes use of the node degree as the property to decide upon the copies.

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The encounter table is maintained at each node. Whenever node meets the other node then meeting value in encounter table gets updated each time. For each node, the node degree is the number of contacts that the node had within an interval time. Based on that value which is considered to be node degree, the number of copies to be sprayed is decided. If the node degree keeps on increasing, then number of copies to be spread is decreased. If the node degree decreases, then number of copies to be spread increases in order to meet the destination soon.

After the source node sprays the message to the relay node, if relay node meets the destination, then it delivers the message to the destination and relay node removes that message from its buffer. If the node met is found to be intermediate node then the other node will not transfer the message.

IV. PROPOSED WORK

The proposed work deals with routing in intermittently connected mobile networks and describes periodic spraying using multiple hops while the density is high. Our problem setup consists of nodes which are moving inside a bounded area according to a stochastic mobility model. Additionally, we assume that the network is partially disconnected at most times, and that transmissions are faster than node movement.

Spraying will limit the copies to certain extent and try to get the optimal delay in reaching the destination. The efficiency of spraying method depends upon the fixed number of copies that are sprayed for message dissemination. Also, it is necessary to disseminate the messages to a relay node which are having the chance to meet the destination or having the chance to meet many number of nodes. Hence, we designed a protocol to satisfy the following prerequisites,

- To deliver messages faster and to get optimal delay than all the existing single copy and multi-copy schemes,
- To Perform significantly smaller amount of transmissions and to generate smaller number of replications than multi-copy based routing schemes
- Require only a little knowledge about the network nodes as possible.

4.1 Multi-hop periodic spraying

Spraying methods proposed for intermittently connected networks such as spray and wait will limit the copies of a message to a great extent. But these methods will not address the message dissemination while the nodes have constrained mobility or very few mobile nodes are available. Though the spray and focus [SF] is proposed for constrained mobility, it will not spread the messages further if a relay node didn't already encountered the destination. Hence, the messages will not be disseminated if nodes are not encountered by the destination. Ultimately delay in reaching the destination may get increased. In order to make the disseminations faster it is necessary to find a relay node which is having a chance to meet many nodes. The

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mobile nodes which are faster and having good contact with many nodes are identified by updating each nodes contact behavior.

The relay nodes spread the messages in different periods to reduce number of replications further. The relay node initially spread K/3=K1 copies and wait for acknowledgement,if no acknowledgement is received for a certain period then again the (K-K1)/2=K2 copies will be forwarded. Then again if no reply at last the remaining (K-(K1+K2))=K3 copies will be forwarded. The periodic spraying[6] will reduce the replications to greater extent if the destination is available nearby.

4.2 Density Aware Multi-hop Periodic Spraying

The density of nodes is measured using node degree and not on the number of nodes present. Based on the node degree, number of copies to be sprayed is decided and they are sprayed through multiple hops in order to reach the destination sooner periodically in order to reduce the replications to a certain extent. The periods may vary from two to three.

4.3 Acknowledgement of delivery

If a message is delivered to a destination, but a specific node is not notified about the delivery, this node will continue spraying the message, increasing the average cost of copying. So, better method is to broadcast the acknowledgement after the message copy reaches the destination. We assume that the destination uses one time broadcast over the more powerful radio than the other nodes so the broadcast reaches all the nodes in the network. Here, the acknowledgement message is short, so its broadcast is inexpensive. The acknowledgement mechanism makes the nodes to delete the messages which are already reached the destination.

V. SIMULATION RESULTS

For simulation QUALNET simulator is used. The performance is analyzed by considering two parameters. From the obtained results, it is inferred that the performance is improved by using Density aware spray and wait. The following are the parameters, which taken into account for comparison:

1. Delivery Ratio
2. Average end-to-end Delay

Delivery ratio is calculated by using the formula ,
Delivery Ratio = Total number of packets_received / Total number of packets sent

Average end-to-end delay is calculated by using the formula,
Average end-to-end delay = Total transmission delays of all received packets / Number of packets received
Where,

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Transmission delay of packet = Time at which packet received at destination – time at which packet transmitted at source

Table 1 Simulation parameters

Routing Protocol	Spray and Wait, DA-SW
Dimension	1500x1500m
Mobility model	Random waypoint
Simulation time	500 sec
Packet size	512 kb
Number of Packet transmitted	100
Traffic type	CBR
Path loss model	Two ray model

5.1 Comparison Graphs

5.1.1 Nodes Vs Delivery ratio

As the number of nodes increases, Delivery ratio is high in DA-SW when compared to spray and wait and it increases from 6% to 18%. The variation in delivery ratio for the protocols is shown in Fig 1.

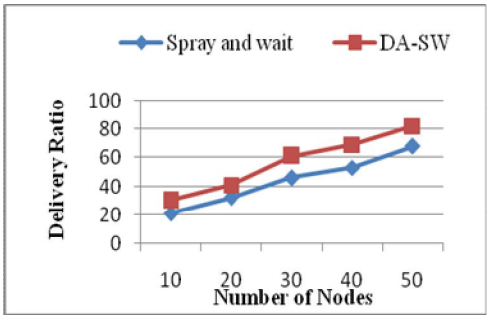

Fig 1: Number of nodes Vs Delivery ratio

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5.1.2 Nodes Vs Average End –to- End Delay

As the number of nodes increases, Average end–to-end delay decreases for DA-SW when compared to spray and wait and it decreases from 9% to 4%. The variation in delay is shown in the Fig 2.

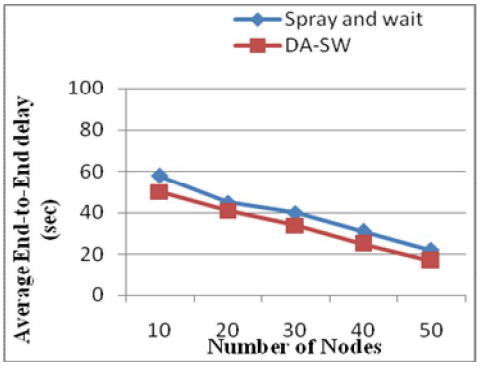

Fig 2: Number of nodes Vs Average End-to-End Delay

VI. CONCLUSION

In this research, we evaluate the performance by comparing the different routing protocols such as spray and wait and Density aware spray and wait. The result shows that DA-SW have better performance when compared to spray and wait in terms of considering parameters such as Average end-to-end delay and Delivery ratio. In future further analysis can be made by designing a new protocol by combining Density aware spray and wait with multi-hop periodic spraying which will further improves performance.

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