

## ABSTRACT

Delay Tolerant Networks are a newest and promising class of wireless networks with sparse population of heterogeneous mobile nodes. These networks may not have full source to destination path at any particular instant due to intermittent connection between the nodes. The intermittency may possibly be attributed to variable propagation delays across links, asymmetric data rates, limited bandwidth, link or node failures, limited power and radio range of the nodes. These characteristics of Delay Tolerant Networks make it suitable for deployment in underdeveloped areas or when established infrastructure is shattered by natural calamities or armed forces. There are many environments in which a Delay Tolerant Network can operate namely interplanetary networks, underwater networks, wildlife tracking sensor networks, military networks and remote rural village networks.

Owing to the absence of contemporaneous end to end path, routing in Delay Tolerant Network is a highly challenging task. Routing in Delay Tolerant Network is tough because nodes have very little information about the peer nodes. Also, path from source to destination is non-existent at any particular time due to frequent disconnections. The Delay Tolerant Network architecture proposes the bundle layer as an overlay layer between the transport layer and the application layer in the existing networks to provide interoperability. Thus, it proposes to achieve message communication over intermittent connections through the store and forward mechanism. In Delay Tolerant Network routing, the intermediate nodes buffer received messages, carry them for a long period of time and forward them to the destination or an intermediate node that would meet the destination when an appropriate

opportunity arises. In addition, messages are replicated during forwarding to achieve high delivery probability.

A new routing approach that employs erasure codes and buffer capacity evaluation before routing messages is proposed. This protocol evaluates the worthiness of a node before handing over the message blocks to other nodes. The quantity of message blocks exchanged between nodes depends on the ability of the intermediate relay nodes to store and carry them. Transmission of erasure coded message fragments through high probable nodes gives an extra edge for achieving improved routing performance. The impact of buffer size and transmission range on delivery ratio, delivery delay and network overhead are evaluated and found to have a good improvement.

The Markov model based routing approach utilizes the history of meeting durations to predict the probability of next contact between nodes. The proposed protocol performs message selection and replication in the initial stage and node selection in the later stage. The message selection and replication is done to roll out messages across the network which would increase their chance of getting delivered to destination. The message selection is based on prioritizing the scheduled transmission of messages using the remaining life time of the message. The node selection for transfer of messages is accomplished depending on Markov prediction. The protocol also implements buffer decongestion in an effective manner through periodic evaluation of buffer occupancy. Simulation results reveal that the proposed protocol efficiently improves the delivery ratio and reduces the delivery delay.

In the fuzzy logic based routing approach, messages are transmitted to multiple intermediate relay nodes encountered in order to increase the opportunity for the message to reach the destination. The encounter and non-encounter duration are the most valuable information available to a node for

gaining knowledge about the location of other nodes in a Delay Tolerant Network where the connectivity is unscheduled and sporadic. Hence the values of encounter time and non-encounter time are used to perform the fuzzy logic based utility computation of a node referred to as transfer opportunism in the proposed encounter based fuzzy logic routing protocol. The proposed protocol has shown good improvement in terms of delivery ratio, delivery latency and overhead ratio.

A novel approach for routing based on ant colony optimization has been proposed. The message transfers happen depending on the heuristic information obtained through contact with other nodes. This approach utilizes the locally available heuristic information about the node's individual quality and its social proximity to secure knowledge about other nodes in a Delay Tolerant Network. It benefits from the self organizing nature and adaptation of the ant colony learning structure by gathering knowledge from previous experiences. Thus, it guides the future messages over a more optimal path than the preceding messages. Simulation results have shown that the proposed protocol has achieved better delivery ratio and delivery delay.