Routing Protocol for Delay Tolerant Network using WSN Nodes

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***Abstract* – Most of the existing routing protocol is based on the assumption that a path exists between the sender and the receiver. Due to intermittent connectivity, applications of delay tolerant networks (DTNs) are often characterized by network partitions. Intermittent connectivity can be a result of mobility, wireless range, sparsity, power management, or malicious attacks. There are many real networks that come under delay tolerant networks (DTNs) for example inter-planetary networks, wildlife tracking sensor networks, military networks etc. However, the lack of rich contact opportunities still causes poor delivery ratio and long delay of DTN routing, especially for large-scale networks. As a consequence routing in delay tolerant network has received considerable attention in the recent years. In this paper we present Filtered - Flooding Routing Protocol for delay tolerant network (DTN) using WSN nodes. We have tried to maximize the message delivery rate without compromising on the amount of message discarded. The protocol is based on the idea of exploiting nodes as carriers of messages among network partitions to achieve delivery. Filter based prediction techniques and utility theory is used to decide which contact event must be sent or dropped by the nodes. The performance of the routing protocol is evaluated using network simulator ns2 and the results are graphically presented.**

***Index Terms* - Delay Tolerant Network (DTN), Wireless Sensor Network (WSN), Routing, Mobility**

I. Introduction

Delay Tolerant Networks (DTNs) [1] are also referred as the Intermittently Connected Mobile Networks. Due to intermittent connectivity the probability of having an end-to-end path from a source to destination is low. Since DTN routing relies on mobile nodes to forward packets for each other, the routing performance (e.g. the number of packets delivered to their destinations) depends on whether the nodes come in contact with each other or not. A communication opportunity between two nodes is called a contact event (CE) in DTN. In most of DTN applications, no information about future contacts is available, hence DTN routing usually follows store-carry-and-forward approaches i.e. after receiving some contact event (CE) a node carries them around until it contacts another node and then forwards the contact event (CE). The inherent uncertainty about network conditions makes routing in DTNs a challenging problem. The primary focus of many existing DTN routing protocols is to increase the likelihood of finding a path with extremely limited information. To discover such a path, a variety of mechanisms are used including estimating node meeting probabilities, packet replication, network coding, placement of stationary waypoint stores and leveraging prior knowledge of mobility patterns. Therefore most the conventional routing schemes [2] are not applicable for DTNs since they try to find full path from source to destination before sending data.

Here in this paper we have proposed new routing protocol for delay tolerant networks (DTNs) using WSN nodes [3]. This is flooding based routing protocol implemented with filtered base prediction theory, to decide which contact events must be kept for forwarding to the collection point. The delay tolerant networking concept enables new applications and services in challenged networks such as rural and disaster areas networks, animal and environmental monitoring, lake pollution monitoring, deep space mission etc.

II. FILTERED-FLOODING ROUTING PROTOCOL

Approaches have been proposed which focus on epidemic routing [5], as a forwarding technique to achieve opportunistic communication in Delay Tolerant Networks (DTNs) in which there may not be a contemporaneous path from source to destination. Opportunistic contacts are created simply by the presence of two entities at the same place, in a meeting that was neither scheduled nor predicted. Epidemic routing is able to attain maximum message delivery ratio with minimum delivery delay at the cost of increased use of resources such as buffer space, bandwidth and transmission power over such intermittently connected networks. The protocol is based on the idea of exploiting nodes as carriers of messages among network partitions to achieve delivery. Delay Tolerant Networks (DTNs) [1] enable data transfer when mobile nodes are only intermittently connected. Due to lack of consistent connectivity, DTN routing usually follows store-carry-and-forward [4] approaches. In order to avoid storage and transmission of useless information some filters are applied permanently during the exchange of contact events (CE). These filters are the concatenation filter (COF), double filter (DOF), duals filter (DUF), random filter (PRF) and tag node advantage filter (TNAF). Mobile nodes called MULEs [6] (Mobile Ubiquitous LAN Extensions). MULEs move in the network area according to a random mobility model. Their task is to collect data from sensors, buffer it and drop it off later to a set of fixed base stations representing data sinks. The main objective of the architecture is to enhance power saving by allowing sensor nodes to exploit the random mobility of MULEs, by transmitting their data to these mobile nodes over short range radio links when they pass nearby. However, the lack of rich contact opportunities in DTN can causes poor delivery ratio and long delay of DTN routing, especially for large-scale networks. Throwboxes are small and inexpensive stationary devices equipped with wireless interfaces and storage that acts as a fixed relay. Deployment of additional stationary throwboxes can create a greater number of contact opportunities, thus improve the performance of DTN routing. We propose the use of Throwboxes [7] to enhance the contact opportunities of the nodes and hence improve the throughput. Using ns-2 simulations, we have provided insights to guide the design and deployment of throwboxes within such networks. We have focused on studying the effectiveness of adding throwboxes on the performance of epidemic routing protocols, but we did not consider the issue of designing routing approaches for these networks. The obtained results shows that, under the epidemic protocol, the performance of the network increases greatly in the presence of throwboxes at the cost of increasing the number of copy transmissions in the network. We denote this contribution by Filtered-Flooding Routing Mechanism.

III. SIMULATION SETUP

2.1 Simulation scenario

In DTNs, the performance in throughput, delay and loss rates are highly dependent on the topology and mobility of the stations. In this paper we have selected a simple generic scenario where workers move in an underground mine consisting of two galleries, as shown in Fig 1.

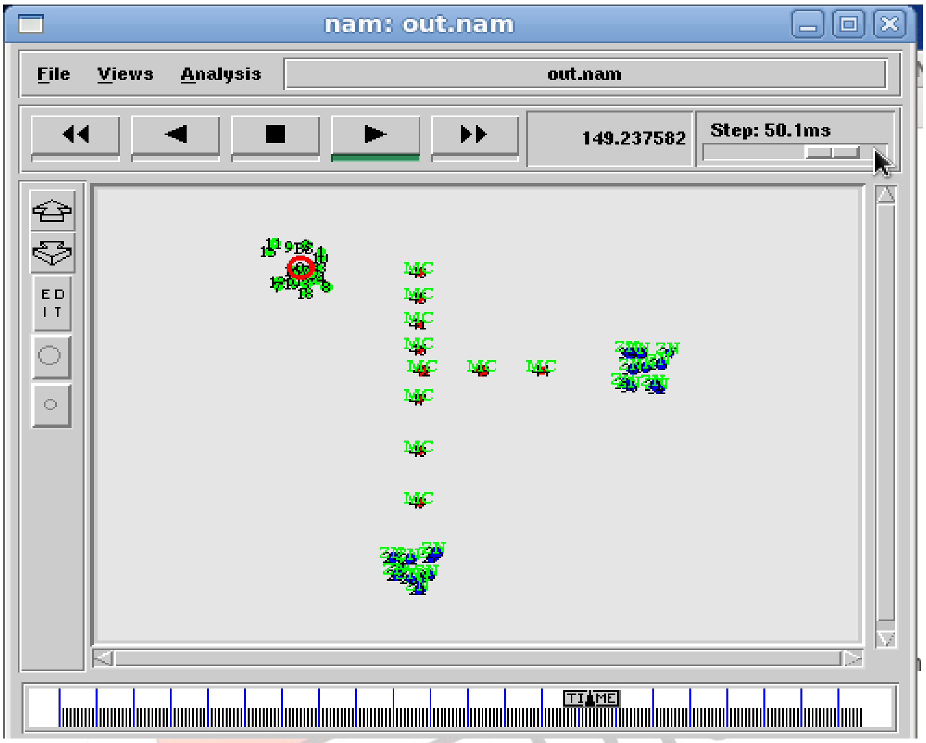

Figure 1. Snapshot of Simulated Network

2.2 Simulation tool- ns2

Network Simulator-2 (ns-2) [7] is an open source, discrete event network simulator. It is used for the simulation of network protocols with different network topologies. It is capable of simulating wired as well as wireless networks. NS-2 was built in C++ and provides the simulation interface through OTcl, an object-oriented dialect of Tcl. The user describes a network topology by writing OTcl scripts, and then the main NS program simulates that topology with specified parameters. In ns-2, network animator (NAM) is used for the graphical view of the network. NS-2 is the most common and widely used network simulator for research work. NAM interface contains control features that allow users to forward, pause, stop and play the simulation. In ns-2, arbitrary network topologies can be defined that are composed of routers, links and shared media. The physical activities of the network are processed and queued in form of events, in a scheduled order. These events are then processed as per scheduled time that increases along with the processing of events. However, the simulation is not real time; it is considered virtual.

2.3 Simulation parameter

The Table 1 illustrates the parameters that we have been used for simulation. The simulation is done for various numbers of nodes. We have analyzed the performance of the Filtered-Flooding Routing Protocol for parameters such as its packet delivery ratio, end to end delay and throughput.

Parameters	Values
Simulation time	225 sec
Topography area	1000m * 1000m
Number of nodes	50
Packet size	512 bytes
Date rate	250 kbps
MAC layer	802.11
Transmission range	225m
Network simulator	NS2 version ns2.31

Table 1:- simulation Parameter

IV. RESULTS

The results are drawn for packet delivery ratio, end to end delay and throughput for five filters i.e. concatenation (COF), double (DOF), duals (DUF), random (PRF) and tag node advantage filter (TNAF).

1. Packet delivery ratio (PDR):- It is the ratio of data packets delivered to the destination and which have been generated by the sources. It is calculated by dividing the number of packet received by destination through the number packet originated from source.

2. End to end delay: - The end to end delay of a network specifies how long it takes for a bit of data to travel across the network from source node to endpoint.

3. Throughput: - Throughput is the ratio of the total amount of data that a receiver receives from a sender to a time it takes for receiver to get the last packet.

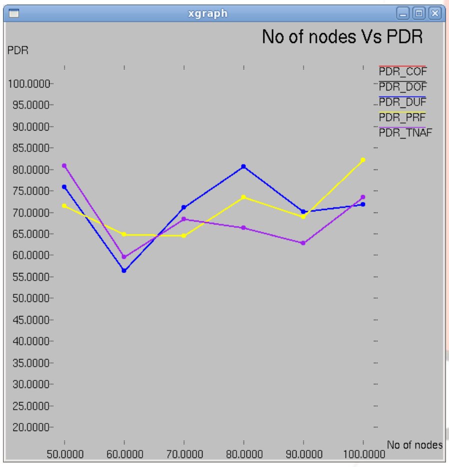

Figure 2. Number of Nodes vs PDR

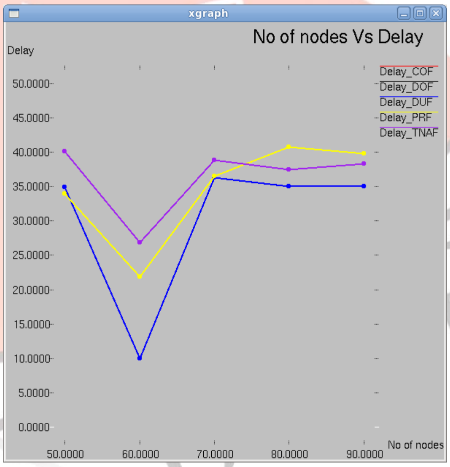

Figure 3. Number of Nodes vs Delay

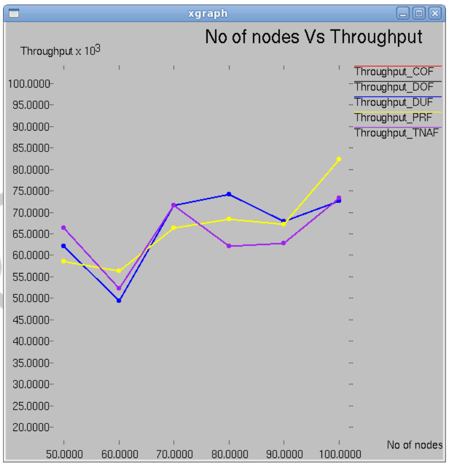

Figure 4. Number of Nodes vs Throughput

V. CONCLUSION

The performance of delay tolerant network is highly dependent on the topology and the mobility of the station, since nodes in the network are mobile nodes. The moving nodes are responsible for path failure which affects the performance of the network. The Packet delivery ratio is good for small size network but decreases as we increase the number of nodes in the network and correspondingly affects the delay. Deployment of additional stationary throwboxes can create a greater number of contact opportunities, thus improve the performance of DTN routing.

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