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OPTIMAL FORWARDING IN DELAY TOLERANT NETWORKS WITH MULTIPLE DESTINATIONS

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***Abstract*— The tradeoff between delivery delay and energy consumption in a delay-tolerant network in which a message (or a file) has to be delivered to each of several destinations by epidemic relaying. In addition to the destinations, there are several other nodes in the network that can assist in relaying the message. It first assumes that, at every instant, all the nodes know the number of relays carrying the message and the number of destinations that have received the message. This formulates the problem as a controlled continuous-time Markov chain and derives the optimal closed-loop control (i.e., forwarding policy). However, in practice, the intermittent connectivity in the network implies that the nodes may not have the required perfect knowledge of the** system **state. To address this issue, it can obtain an ordinary differential equation (ODE) (i.e., a deterministic fluid) approximation for the optimally controlled Markov chain. This fluid approximation also yields an asymptotically optimal open-loop policy. Finally, evaluate the performance of the deterministic policy over finite networks. Numerical results show that this policy performs close to the optimal closed-loop policy.**

***Index Terms*— Delay-tolerant networks (DTNs), epidemic relaying and optimal control.**

I. INTRODUCTION

Delay Tolerant networks are sparse wireless adhoc networks With highly mobile nodes. In these networks, the link between any two nodes is up when these are within each other's transmission range, and is down otherwise. In particular, at any given time, it is unlikely that there is a complete route between a source and its destination. We consider a DTN in which a short message (also referred to as a *packet*) needs to be delivered to multiple (say, M) destinations. There are also N potential relays that do not themselves "want" the message but can assist in relaying it to the nodes that do. At time t = 0, N_0 of the relays have copies of the packet. All nodes are assumed to be mobile. In such a network, a common technique to improve packet delivery delay is *epidemic* relaying [2]. We consider a controlled relaying scheme that works as follows. Whenever a node (relay or destination) carrying the packet meets a relay that does not have a copy of the packet, then the former has the option of either copying or not copying. When a node that has the packet meets a destination that does not, the packet can be delivered.

II. RELATED WORK

Analysis and control of DTNs with single source and single-destination has been widely studied. Groenevelt et al. [3] modeled epidemic relaying and two-hop relaying using Markov chains, and derived the average delay and number of copies generated until the time of delivery.

Zhang et al. [4] developed a unified framework based on ordinary differential equations to study epidemic routing and its variants.

Neglia and Zhang [5] were the first to study the optimal control of relaying in DTNs with a single destination and multiple relays. They assumed that all the nodes have perfect knowledge of the number of nodes carrying the packet. Their optimal closed loop control is a threshold policy - when a relay that does not have a copy of the packet is met, the packet is copied if and only if the number of relays carrying the packet is below a threshold. Due to the assumption of complete knowledge, the performance reported is a lower bound for the cost in a real system.

Altman et al. [6] addressed the optimal relaying problem for a class of *monotone relay strategies* which includes epidemic relaying and two-hop relaying. In particular, they derived *static* and *dynamic* relaying policies.

Altman et al. [7] considered optimal discrete-time two-hop relaying. They also employed stochastic approximation to facilitate online estimation of network parameters.

In another paper, Altman et al. [8] considered a scenario where active nodes in the network continuously spend energy while *beaconing*. Their paper studied the joint problem of node activation and transmission power control.

Li et al. [9] considered several families of open loop controls and obtain optimal controls within each family. Deterministic fluid models expressed as ordinary differential equations have been used to approximate large Markovian systems.

III. SYSTEM MODEL

In consider a set of $K := M + N$ mobile nodes. These include M destinations and N relays. At $t = 0$, a packet is generated and immediately copied to N_0 relays (e.g., via a broadcast from a cellular network). Alternatively, these N_0 nodes can be thought of as source nodes.

1) Mobility Model: We model the point process of the *meeting instants* between pairs of nodes as independent Poisson point processes, each with rate λ. Groenevelt et al. [3] validate this model for a number of common mobility models (random walker, random direction, random waypoint). In particular, they establish its accuracy under the assumptions of small communication range and sufficiently high speed of nodes.

2) Communication Model: Two nodes may communicate only when they come within transmission range of each other, i.e., at the so called *meeting instants*. The transmissions are assumed to be instantaneous. We assume that that each transmission of the packet incurs unit energy expenditure at the transmitter.

3) Relaying Model: It assumes that a controlled epidemic relay protocol is employed. Throughout, we use the terminology relating to the spread of infectious diseases. A node with a copy of the packet is said to be *infected*. A node is said to be *susceptible* until it receives a copy of the packet from another infected node. Thus at $t = 0$, N_0 nodes are infected while $M + N - N_0$ are susceptible.

A. THE FORWARDING PROBLEM

The packet has to be disseminated to all the M destinations. However, the goal is to minimize the duration until a fraction α (α < 1) of the destinations receive the packet. At each meeting epoch with a susceptible relay, an infected node (relay or destination) has to decide whether to copy the packet to the susceptible relay or not. Copying the packet incurs unit cost, but promotes the early delivery of the packet to the destinations. We wish to find the trade-off between these costs by minimizing

$$E\{T_d + \gamma E_c\} \quad (1)$$

where T_d is the time until which at least $M\_ := \lceil \alpha M \rceil$ destinations receive the packet, E_c is the total energy consumption due to transmissions of the packet and γ is the parameter that relates energy consumption cost to delay cost. Varying γ helps studying the trade-off between the delay and the energy costs.

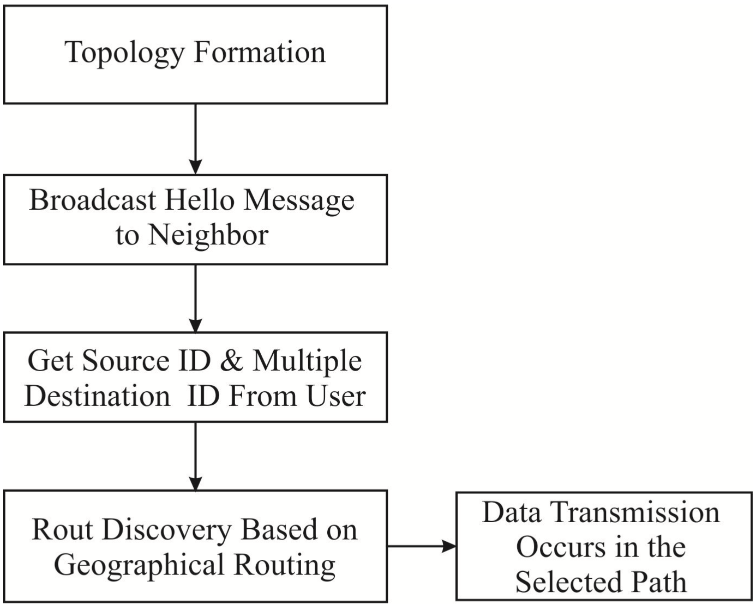
B. OPTIMAL FORWARDING

We derive the optimal forwarding policy under the assumption that, at any instant of time, all the nodes have full information about the number of relays carrying the packet and the number of destinations that have received the packet.

IV. SYSTEM ARCHITECTURE

Constructing Project design in NS2 should takes place. Each node should send hello packets to its neighbor node which are in its communication range to update their topology.

In computer networking, multicast (one to many or many to many distribution) is group communication where information is addressed to a group of destination computer simultaneously.



Geographic routing (also called geo routing or position-based routing) is a routing principle that relies on geographic position information. It is mainly proposed for wireless network and based on the idea that the source sends a message to the geographic location of the destination instead of using the network address. Geographic routing requires that each node can determine its own location and that the source is aware of the location of the destination. With this information a message can be routed to the destination without knowledge of the network topology or a prior route discovery. Route Discovery is the finding a path based geographical routing and data transmission occurs in the selected path.

In this phase, multicasting is performed in which single source transmits the data Multiple Destinations.

V. OVERVIEW OF EXISTING SYSTEM

In a delay tolerant network, a message has to be delivered to each of several destinations by epidemic relaying. In addition to the destinations, there are several other nodes in the network that can assist in relaying the message. at every instant, all the nodes know the number of relays carrying the packet and the number of destinations that have received the packet. The intermittent connectivity in the network implies that the nodes may not have the required perfect knowledge of the system state.

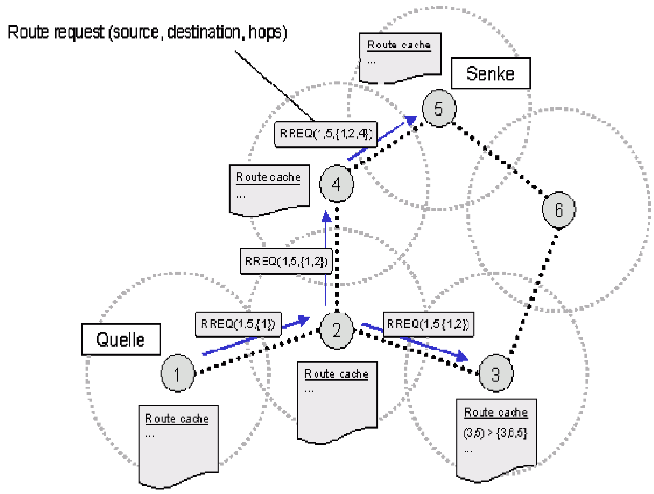
VI. ALGORITHM

DSDV (Destination-Sequence Distance Vector)

DSDV has one routing table, each entry in the table contains: destination address, number of hops toward destination, next hop address. Routing table contains all the destinations that one node can communicate. When a source A communicates with a destination B, it looks up routing table for the entry which contains destination address as B. Next hop address C was taken from that entry. A then sends its packets to C and asks C to forward to B. C and other intermediate nodes will work in a similar way until the packets reach B.

DSDV use two types of packet to transfer routing information: full dump and incremental packet. The first time two DSDV nodes meet, they exchange all of their available routing information in full dump packet. From that time, they only use incremental packets to notice about change in the routing table to reduce the packet size. Every node in DSDV has to send update routing information periodically. If two routes have the same sequence number, route with smaller hop count to destination will be chosen. DSDV has advantages of simple routing table format, simple routing operation and guarantee loop-freedom. The disadvantages are (i) a large overhead caused by periodical update (ii) waste resource for finding all possible routes between each pair, but only one route is used.

Figure1: Path Finding Process: Route Request



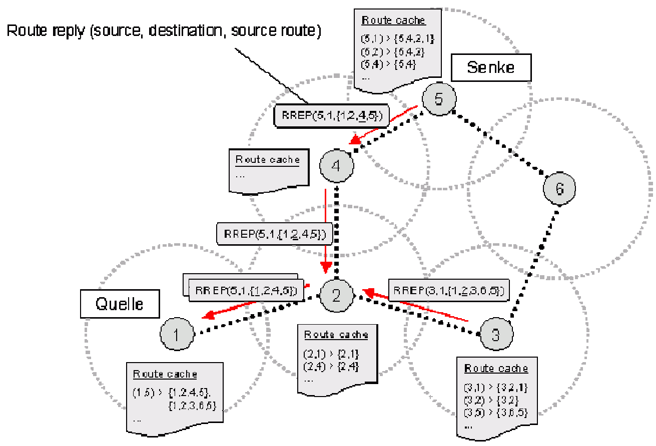


Figure 2: Path Finding Process: Route Reply

VII. OVERVIEW OFTHE PROPOSED MECHANISM

Security is also a challenging factor in adhoc networks. All the nodes in an ad hoc network are categorized as friends, acquaintances or strangers based on their relationships with their neighboring nodes. During network initiation all nodes will be strangers to each other. A trust estimator is used in each node to evaluate the trust level of its neighboring nodes. Accordingly, the neighbors are categorized into friends (trusted) and strangers (not trusted).

A Trust model algorithm is used to above this method. In this model, trust is made up of two components: direct observation trust and indirect observation trust. With direct observation from an observer node, the trust value is derived using Bayesian inference, which is a type of uncertain reasoning when the full probability model can be defined. On the other hand, with indirect observation, also called secondhand information that is obtained from neighbor nodes of the observer node, the trust value is derived using the Dempster-Shafer theory, which is another type of uncertain reasoning when the proposition of interest can be derived by an indirect method. Combining these two components in the trust model, we can obtain more accurate trust values of the observed nodes in MANETs.

VIII. PERFORMANCE EVALUATION

It show that some numerical results to demonstrate the performance of the deterministic control. Let X = 0.2, Y = 0.8, α = 0.8, Y0 = 0.2 and γ = 0.5. We vary λ from 0.00005 to 0.05 and use K = 50, 100 and 200. In plot the total number of copies to relays and the delivery delays corresponding to both the optimal and the asymptotically optimal deterministic policies. Evidently, the deterministic policy performs close to the optimal policy on both the fronts. We observe that, for a fixed K, both the mean delivery delay and the mean number of copies to relays decrease as λ increases. We also observe that, for a fixed λ, the mean delivery delay decreases as the network size grows. Finally, for smaller values of λ, the mean number of copies to relays increases with the network size, and for larger values of λ, vice-versa happens.

A. PERFORMANCE METRICS

We evaluate mainly the performance according to the following metrics.

False positive: In case of network failure, nodes may be falsely accused of misbehavior. The false positive should be kept low.

Detection Efficiency: The ratio of detected misbehaving nodes to the total number of nodes.

Delay Constraint: The delay constraint is averaged over all surviving data packets from the sources to the destinations.

Packet delivery ratio (PDR): PDR is the ratio of the number of data packets received by a destination node and the number of data packets generated by a source node.

Throughput: Throughput is the total size of data packets correctly received by a destination node every second.

B. RESULTS ANALYSIS

Node Creation on set the values from source to Multiple Destinations. Neighbour Discovery to find the all nodes and packet transfer from source to multiple destinations. Finally, find the best path from source to multiple destinations on Figure6. Then find the xgraph on Packet Delivery Ratio of Figure 8.

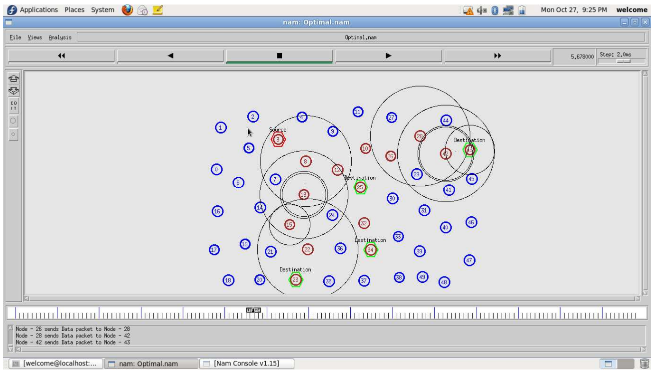


Figure 5: Enter Source and Destination Values and also Packet Transfer

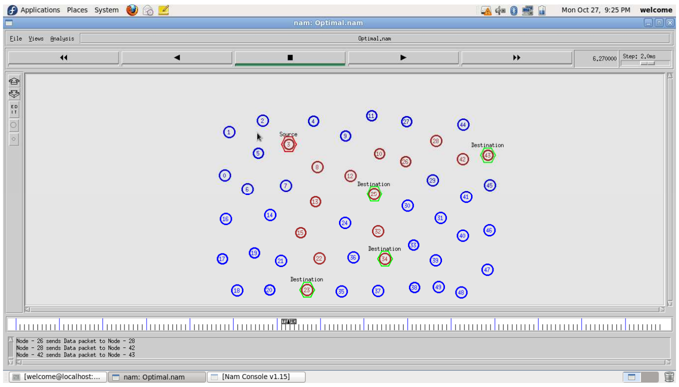


Figure 6: Find the Best Path from Source to Multiple Destinations

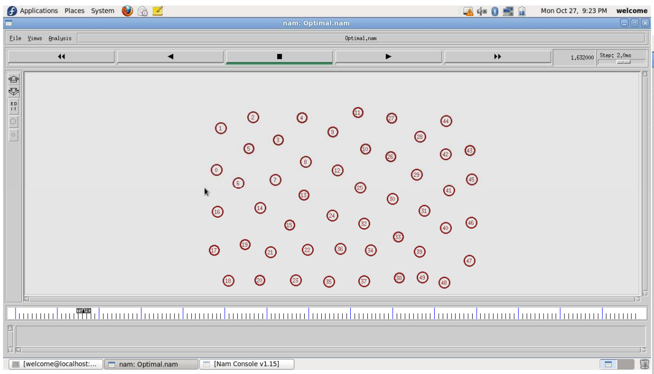


Figure 3: Node Creation

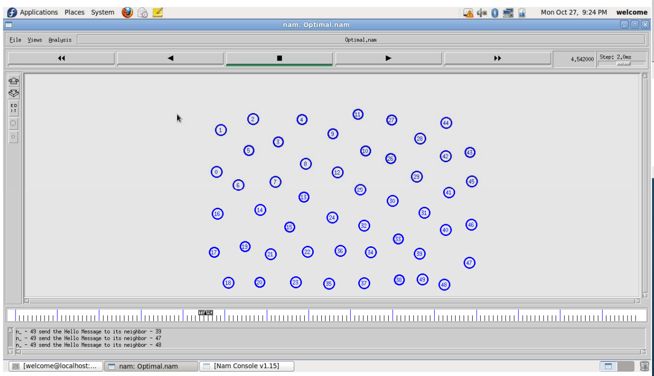


Figure 4: Neighbour Discovery

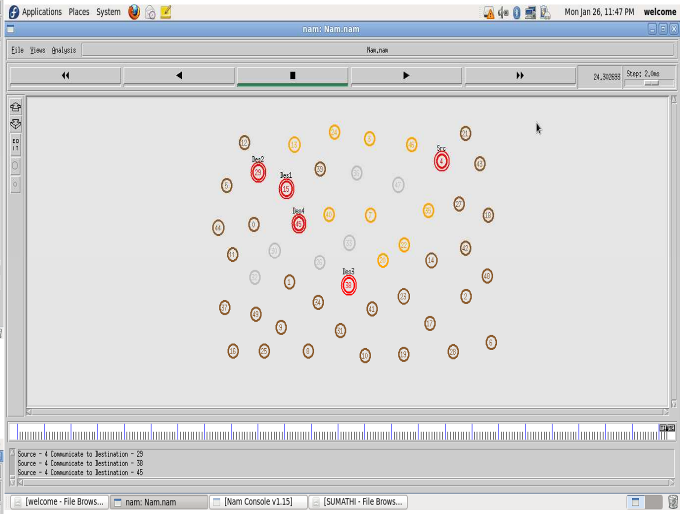


Figure 7: Trust model using trusted and untrusted node concept

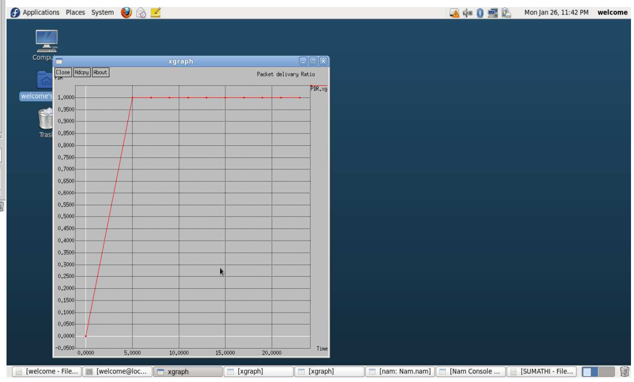


Figure 8: show the results of xgraph on Packet Delivery Ratio.

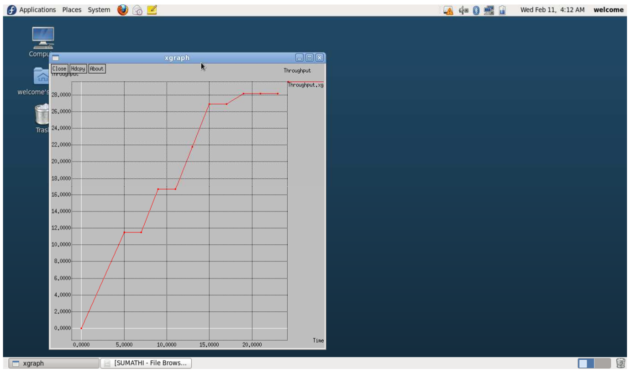


FIGURE 9: THROUGHPUT

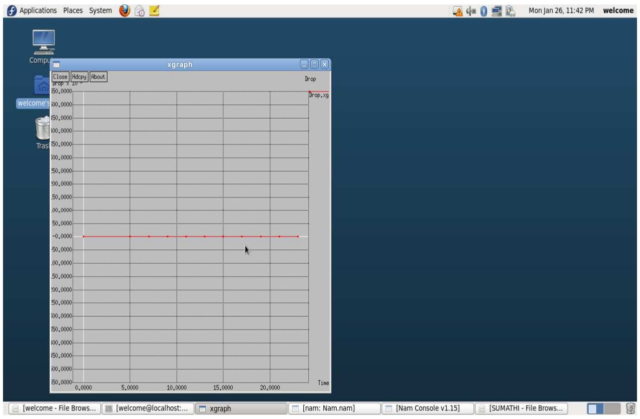


FIGURE 10: PACKET DROP

IX. CONCLUSION

In this research work, developed the control of forwarding in DTNs employing epidemic relaying, and obtained the optimal policy. It obtained an asymptotically optimal policy that does not require any information on the dynamic network state, and hence is feasible. In order to do so, this also extended the existing differential equation approximation results for Markov chains to controlled Markov chains. In our future work to study the scenario where packets come with a life-time and the goal is to maximize the fraction of destinations that receive the packet subject to the energy constraint. This also want to study the adaptive controls for the case when the network parameters (M,N, λ etc.) are not known to the source.

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