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A Peculiar Advent for DTN Routing Protocols in One Simulator

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Abstract: Delay/disruption Tolerant Networks (DTN) provides end to end connectivity in those networks which lack continuous association or substantial detention like that of terrestrial mobile networks ,military ad-hoc networks. Appraising DTN protocols across many schemes requires relevant simulation tools. This paper instants the Opportunistic Networking Environment (ONE) simulator specifically designed for evaluating DTN routing and application protocols. It allows users to create scenarios based upon different synthetic movement models and real-world traces and offers a framework for implementing routing and application protocols. Bilateral visualization and post-processing tools support evaluating experiments and an emulation mode allows the ONE simulator to become part of a real-world DTN testbed. In this protocols are analyzed based on the perceptible data gathered by simulating each protocol in simulator. The performance is deliberate and correlated for disparate routing protocols and results are to be debate for distinct performance metrics.

Keywords: Delay-tolerant Network, Simulations, ONE Simulator Tool.

I. INTRODUCTION

In the Internet of Things era, every one of over a trillion everyday items will include at least some ability to store and process information; additionally, and more importantly, sharing that information over the global Internet with the other trillion items. The technological goal is to integrate the Internet and the web with everyday objects (such as doors, chairs, electric appliances, cars, etc.) and ultimately interconnect the digital and physical domains. Clearly, the types of objects to be connected with the Internet, e.g., in terms of usage, size and numbers, are extremely diverse, thus having different computation and communication requirements.

A delay-tolerant network is a network designed to operate effectively over extreme distances such as those encountered in space communications or on an interplanetary scale. In such an environment, long latency -- sometimes measured in hours or days -- is inevitable. However, similar problems can also occur over more modest distances when interference is extreme or network resources are severely overburdened. Delay-tolerant networking involves some of the same technologies as are used in a disruption-tolerant network but there are important distinctions. A delay-tolerant network requires hardware that can store large amounts of data. Such media must be able to survive extended power loss and system restarts. It must also be immediately accessible at any time. Ideal technologies for this purpose include hard drives and high-volume flash memory. The data stored on these media must be organized and prioritized by software that ensures accurate and reliable store-and-forward functionality. In a delay-tolerant network, traffic can be classified in three ways, called expedited, normal and bulk in order of decreasing priority. Expedited packets are always transmitted, reassembled and verified before data of any other class from a given source to a given destination. Normal traffic is sent after all expedited packets have been successfully assembled at their intended destination. Bulk traffic is not dealt with until all packets of other classes from the same source and bound for the same destination have been successfully transmitted and reassembled.

Research on routing in DTN is still in its infancy. However, so many routing protocols are proposed and classified for DTN till date and there are several parameters of interest to judge the performance of them. Some of them are: delivery probability, delivery latency, resource usage, information gathering and usage, hop count, number of copies of message in the network. In this paper we have mainly concentrated only on three DTN routing protocols which are Direct Delivery, Epidemic routing and Spray and Wait routing and to examine the performance of them we have concentrated mainly two parameters which are Packet Delivery Probability and Average Latency. This paper is organized as follows: First the detailed explanation of Direct Delivery, Epidemic and Spray and Wait routing protocols are given in section II. In section III, the whole simulation strategy is discussed. A result analysis of Packet Delivery Probability and Average Latency are discussed in section IV. The final concluding remark is given in section V.

II. ROUTING PROTOCOLS

A. Direct Delivery Routing:

Direct delivery routing uses a simple hand to hand message delivery strategy. In the direct delivery routing scheme the source hold the data until it comes in contact with the destination. This simple strategy uses one message transmission. It is a degenerate case of flooding family, requiring no info about network but requires a direct path between source and destination. Hence if no contact occurs, message is not delivered.

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B. Epidemic Routing:

Epidemic routing is flooding-based in nature, as nodes continuously replicate and transmit messages to newly discovered contacts that do not already possess a copy of the message. In the simplest case, epidemic routing is flooding; however, more sophisticated techniques can be used to limit the number of message transfers. Epidemic routing has its roots in ensuring distributed databases remain synchronized, and many of these techniques, such as rumor mongering, can be directly applied to routing.

C. Spray and Wait Routing:

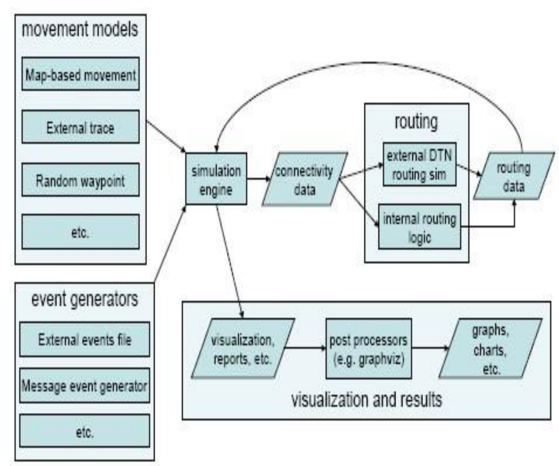
Wasteful resource consumption in the epidemic routing, could be significantly reduced if the level of distribution is somehow controlled. Spyropoulos et al. (2005) proposed the spray and wait mechanism to control the level of spreading of messages throughout the network. Similar to the epidemic routing, the spray and wait protocol assumes no knowledge of network topology and nodes mobility patterns and simply forwards multiple copies of received messages using flooding technique. The difference between this protocol and the epidemic routing scheme is that it only spreads L copies of the message. The authors in [9] proved that the minimum level of L to get the expected delay for message delivery depends on the number of nodes in the network and is independent of the network size and the range of transmission.

Spray and Wait is a routing protocol that attempts to gain the delivery ratio benefits of replication-based routing as well as the low resource utilization benefits of forwarding-based routing. Spray and Wait was developed by researchers at the University of Southern California. It was first presented at the 2005 ACM SIGCOMM conference, under the publication "Spray and Wait: An Efficient Routing Scheme for Intermittently Connected Mobile Networks". Spray and Wait achieves resource efficiency by setting a strict upper bound on the number of copies per message allowed in the network.

III. SIMULATION STRATEGY

A. The ONE Simulator:

To make complex DTN simulations more feasible and understandable, we created a new simulation environment that combines movement modeling, routing simulation, visualization and reporting in one program. Movement modeling can be done either on-demand using the integrated movement models or movement data can be imported from an external source. The node position data that the movement models provide is then used for determining if two nodes can communicate and exchange messages. This information can be exported for routing simulation in external simulators (such as dtnsim) or it can be given to the internal routing modules which implement several different DTN routing algorithms. The internal routing modules perform operations on the messages on their own, but they can also be commanded using event generator modules or external traces. The movement modeling and routing simulation is interactively observable in the simulator's GUI and report modules can gather data of the simulation for further analysis or interaction with other programs. An overview of the whole process is depicted in figure. The core of the ONE is an agent-based discrete event simulator. To make it suitable and efficient enough for simultaneous movement and routing simulation, it uses time slicing approach, so the simulation time is advanced in fixed time steps. The time slicing can be complemented by scheduling update requests between the fixed time steps for higher simulation time resolution. The simulations can contain any number of different types of agents, i.e., wireless nodes. The nodes are grouped in node groups and a one group shares a set of common parameters such as message buffer size, radio range and mobility model. Since different groups can have different configurations, creating e.g., a simulation with pedestrians, cars and public transportation is possible. All movement models, report modules, routing algorithms and event generators are dynamically loaded into the simulator so extending and configuring the simulator with different type of plugins is made easy for users and developers: just creating a new class and defining its name in the configuration file is usually enough.



B. Simulation Setup Information:

In our simulation we have assigned simple broadcast type blue tooth interface with the transmit speed of 2 Mbps to all the nodes. To make our simulation scenario comparable to real time application, we have assigned random way point mobility to all the nodes with mobility varies from 0.5 to 1.5 m/sec. To better judge the performance of all the three routing protocols, we have assigned 10Mb buffer size to each node and also their transmit range is limited to 10 m only. So, during store-carry-forward methodology each node can carry messages only up to 10Mb and node can forward messages to those nodes only which are in 10m range of it. This situation will increase packet drop probability during the transmission of messages. As ONE simulator supports external event generator, we have set message event generator in such a way that it generates the messages in every 25 to 35 seconds and every time message size can also be varied from 500 Kb to 1Mb. To advocate the performance of the Direct Delivery, Epidemic and Spray and Wait routing, we have run the simulation for 10000 seconds for each routing protocols separately and we have noted that every time message event generator feds 342 messages in 10000 seconds in network. The complete simulation setup information is given in Table I.

To advocate the performance of routing protocols we have mainly concentrated on two performance metrics:

(i) Packet Delivery Probability: It is the fraction of generated messages that are correctly delivered to the final destination within given time period.

(ii) Average Latency: It is the measure of average time between messages is generated and when it is received by the destination.

IV. RESULT ANALYSIS

A. Packet Delivery Probability:

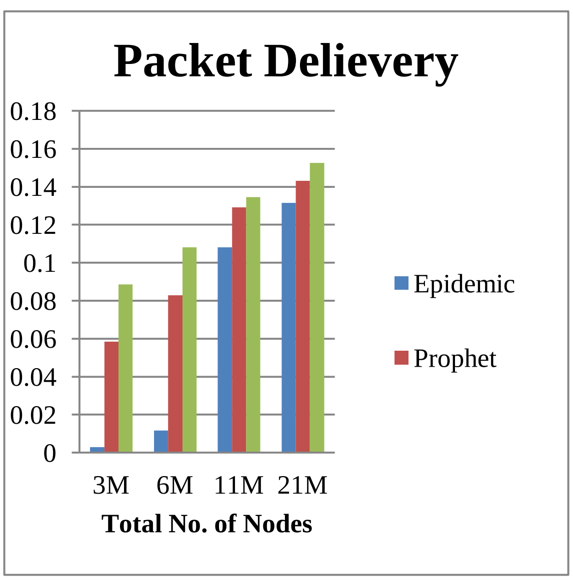


Figure 2 shows the comparison chart of packet delivery probability for Direct Delivery Routing, Epidemic Routing and Spray and Wait Routing. From the chart it can be noticed that when 5 nodes are there at that time packet delivery probability given by all the three routing protocols are almost equal. Whereas in the case when total number of nodes are 10, 20, 50 and 100, the Epidemic Routing and Spray and Wait routing shows increment in packet delivery probability but at the same time packet delivery probability of Direct Delivery routing decreases. It is just because the Direct Delivery routing uses hand-to-hand packet delivery strategy. So, as the total number of nodes increase the possibilities to meet with the destination node in the Direct Delivery routing decreases. If we only concentrate Epidemic routing and Spray And Wait routing then from the graph it is clearly noticed that still performance of Epidemic routing is not up to mark whereas Spray and Wait routing shows excellent performance in terms of packet delivery probability.

B. Average Latency:

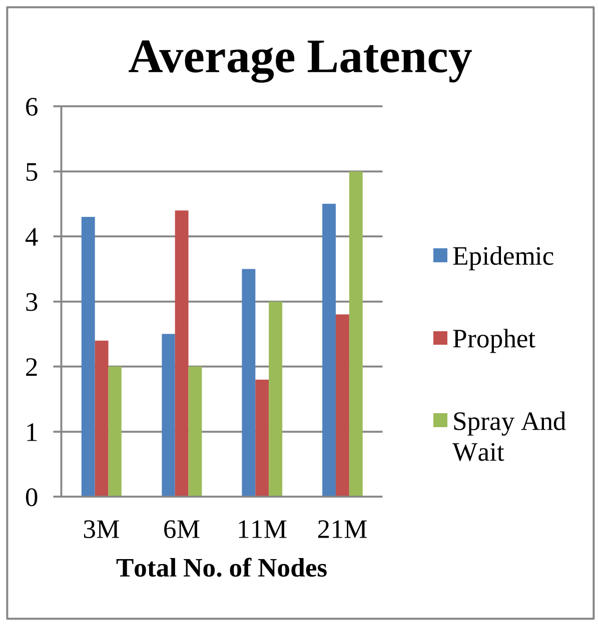


Figure 3, shows the comparison chart of average latency for Direct Delivery Routing, Epidemic Routing and Spray and Wait Routing protocols. From the comparison chart it can be noticed that average latency of Epidemic routing is quite higher than Direct Delivery routing and Spray and Wait routing when the total number of nodes are 5 only. In the case when total numbers of nodes are 10, average latency for Spray and Wait routing is much higher than the Direct Delivery and Epidemic routing. Not only that, but in the another cases when the total nodes are 20, 50 and 100, the average latency of Spray and Wait routing is quite higher than Epidemic routing whereas direct delivery shows very less average latency.

V. Conclusion

After analyzing both the comparison chart of packet delivery probability and average latency for Direct Delivery Routing, Epidemic Routing and Spray and Wait Routing we can conclude that Direct Delivery Routing is no more suitable for real time application because of its very poor packet delivery probability. Whereas Epidemic routing and Spray and Wait routing is suitable for real time applications. Among this two routing protocols, Spray and Wait routing shows the excellent overall performance than Epidemic routing.

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