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Delivery Delay & Distribution in DTN using Probabilistic Routing of Packets

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Abstract: ***Delay Tolerant Networks (DTNs) are new as well as promising developed research in network research areas. Delay Tolerant Networks are those networks end to end path may not be possibly established among nodes instantly or may be remain absent for a long duration. The purpose of this study was to survey about the DTN routing protocols each of which aiming at maximizing the average delivery probability as well as minimizing the communication overhead, reducing the delivery latency, as well as energy consumed by the routing protocols during the process of delivering the messages with in the network. Hence, the performance of these routing protocols will be calculated using the simulator called NS2 Network Simulator2 which is peculiarly used for simulation of routing protocols.***

Keywords: Delay Tolerant Networks (DTNs), Comparison, Routing Schemes, Epidemic Routing, PRoPHET Routing, Simulation by NS2 Simulator.

1. Introduction

A wide range of mobile devices can be interconnected with each other over vast distances either in wired or wireless network. Considering an example of; possibly connecting a cell phone to millions of available dominant servers across the world. Being powerful and successful, all these networks still cannot reach everywhere, and instead of this, their cost for some of the applications is prohibiting. The reason behind these limitations is because the current networking technology relies on a set of fundamental hypothesis which are not legitimate in all situations. The first and most essential assumption is that end to end connection exists between source and destination possibly via multiple intermediaries due to power saving mobility and unreliable networks. This assumption can be breached for example, if any wireless device wants to communicate in the network but unfortunately its out of range (e.g. the cell tower 802.11 base station) it may not be able to use any application which needs network communication. DTN are wireless networks where disconnections, due to propagation phenomena delays may occur frequently such as mobility of nodes, power goes out of range and many more. One of the main reasons behind these is untimely and random migration of intermediary nodes (called mobile hosts) carry packets of data from any source node to destination node. Delay Tolerant Networks rises; due to unavailability of instantaneous node to node route formation among nodes, delays are examined. It provides exchange of information between "challenged" networks, which will encompass deep space networks, sensor networks, mobile ad hoc networks and low cost networks. For example let us take a lecture hall where each student sitting with a laptop without having any infrastructure to communicate with internet, using the wireless network cards in laptops, students are allowed to hook up on projects. This can be shown with figure 1.1. For the exchange of information laptops communicate with each other. If the case occurs, destination laptop is not present in the network provides the storage of messages until that device returns. To provide the successful exchange of messages with the internet the school should service via a router attached to a bus which travels between school and internet gateway.

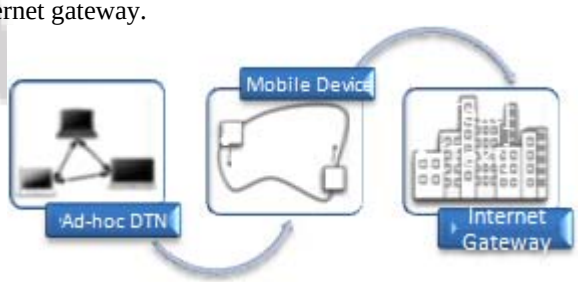

Figure 1.1: Mobile devices or laptops communicating among themselves and Internet through Delay tolerant network

2. Epidemic Routing

The Epidemic Routing protocol is a Flooding based protocol in nature, as devices continuously replicate and transmits messages to newly discovered device / nodes that don't possess a copy of message. It contains mostly homogenous nodes. Epidemic routing protocol provides very high degree of replication and do not use any mobility information. In terms of performance, this routing scheme is fast as well as robust, but in terms of buffer space and bandwidth it consumes resources. Hence, the performance can degrade at a very fast rate, if resource constraints are present (less buffer and low bandwidth). Epidemic routing protocol adopts mainly " store-carry-forward" paradigm, this approach has been introduced for routing in highly sparse or mobile networks where there may not be path formation from source to destination.

Figure 2 (a) represents a source node S, who wants to send message to destination node D, but there is no connected path between them. Consider two neighbors k_1 and k_2 through which S transmits its messages by making direct communication range. After some time, at time $t == t_b > t_a$, as

In figure 2 (b), node k_2 comes in direct range with other node k_3 and transmits message to it. As shown clearly in figure node k_3 is in direct contact with destination node D so finally the message is being sent to D.

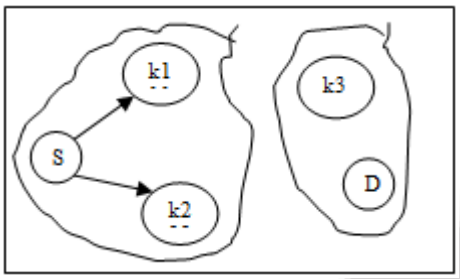

Figure 2 (a): at time == t_a

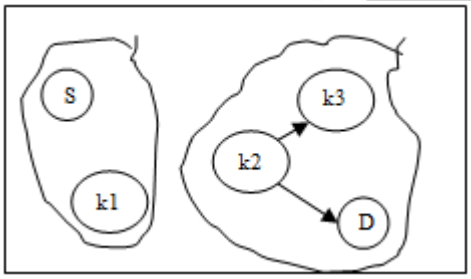

Figure 2 (b): after some time, at time== $t_b > t_a$

When the nodes comes in direct contact with each other, two of the nodes first exchange the summary vectors containing the list of messages and then replicas of messages, which of them they have not exchanged. In this manner, ultimately all nodes contain the copies of all messages. This will result in high delivery ratio, low latency delay if there are no resource constraints.

3. PRoPHET

PRoPHET is Probabilistic routing protocol using History of Encounters and Transistors. Although, epidemic routing approach provides benefits such as excellent latency and high delivery rates, it shows fair flaw by unceasing spreading of messages even if messages are delivered already and this will lead to over usage of resources and high bandwidth.

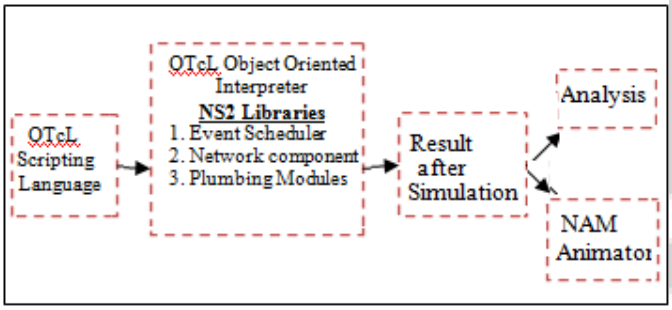

Figure 3: User's View of NS2

So ,prophet was made currently as an alternative it was introduce to estimate the probability about which of the nodes going to have the right predictability for the next hop.

The prophet routing scheme derives metric called delivery predictability metric which is calculated at each hop node, the first case can be when source node u send message to the destination node v. P (u, v) ε (0, 1], the equation signifies the probability that node u deliver messages to node v. P values keep on updating whenever comes in contact between nodes. To get stable P values, it tries to exploit underlying mobility pattern. When a comes in direct contact with b, the formation of equation is:

$$P(u, v) = P(u, v)_{old} + (1-P(u, v)_{old}) * P_{init}, P_{init} \varepsilon (0,1] .$$

The second case introduces β, which is the transitive constant perimeter helps in calculating the effect of transitivity. When u comes in contact with v the transitive updating is:
$P(u, v) = P(u, w)_{old} + (1- P(u, w)_{old}) * P(u, v) * P(v, w) * \beta$
The third defines Aging that is , if node u do not comes in contact with v for some time the equation form is $P(u, v)= P(u, v)_{old} * ¥^k$,Where k is the period of time since last aging, ¥ ε (0, 1] is the aging constant. In this paper, focus is maintained on a improvement of prophet routing protocol in comparison with epidemic scheme.

4. Simulation Setup

The above mentioned routing protocols are analyzed through simulation using the popular simulation technique called Network Simulators. NS2 is used for carrying out simulation process. It is based on object oriented and discrete event driven simulation of network which was conventionally developed at university of California-Berkeley. The two programming languages used are C++ and OTcL. The promising feature of simulator is event scheduler. In NS2, to evaluate the simulation time the event scheduler is used. Data path implementation is separated by NS2 from the control path implementation. The event scheduler uses C++ and the basic network component objects are written and compiled in the data path to reduce packet information and processing time of event. OTcl contains those features that C++ lacks.

Hence, the aggregation of two languages proves to be very potent. To implement protocol in detail C++ is used and to control the simulation scenario and to schedule the events OTcl is used. The research focus on providing comparative analysis for flooding based protocols such as Epidemic routing and Prophet Routing. Figure 3 helps in displaying the user's view of Network Simulator 2.

4.1 Simulation Parameters

Table 1 summarizes the simulation parameters which are used in the configuration of experiment. Optimized concept of Epidemic and Prophet Communication have been compared and discussed to provide better overview of performance of both of the communication routing protocols.

Table 1: Parameters used for the experimentation

Parameters	Value
Simulator	NS2
Simulation Time	40 sec
No of Subnets	6 Logical subnets
No of Nodes	48
Traffic Model	CBR
Pause Time	20 sec
Speed	26 mps
Number of connections	Single

Sub-packet size	256 bytes
Transmit Power	15mW
Receiving Power	13 mW
MAC layer protocol	802.S11s
Servers	Single
Sub Server	4

The parameters used helps in defining the working of Simulator. Secondly, the device mobility and inter connection characteristics are analyzed from enhanced mobility schemes. Finally, the DTN simulation engine is used for evaluating the performance of different DTN routing protocols.

4.2 Performance Metrics

The performance metrics used are Communication Overhead, Average Delay, Average packet delivery Ratio, and the Throughput. The performance metrics are evaluated with the help of network simulator. In this section, evaluation of performance is presented using the flooding based mechanisms. The simulations experimentation can be carried out in an wired or wireless network using an grid topology where 48 nodes are separated in a (1000*1000) square area as shown in figure 3.1. In this simulation, the nodes used in the experimentation are kept fixed and the topology used should be connected to result in successful transmission between end to end nodes. In this manner, all nodes present in the communication network act as both sender and receiver. The data packets are sending and generated by them are circulated between all of the 48 nodes.

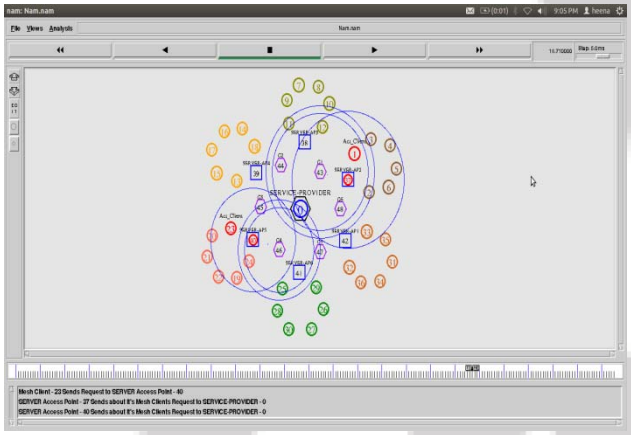

Figure 3.1 The grid network topology

In figure 3.2, the graph shows the “average delivery delay” metric which helps in defining the average time taken between the first transmission of data packet and its successful reception and decoding at the destination nodes. This metric is calculated only for those packets which are received correctly.

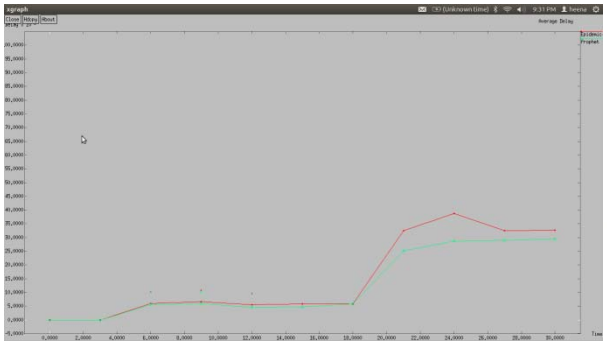

Figure 3.2, Green Color represents Prophet and Red represents Epidemic showing results of Delivery Delay.

Figure 3.3, the graph represents “communication overhead” metric which specifies the ratio of the number of packets transmitted successfully at the MAC layer. As shown in graph, Red line specifies Epidemic which has high overhead than that of Prophet.

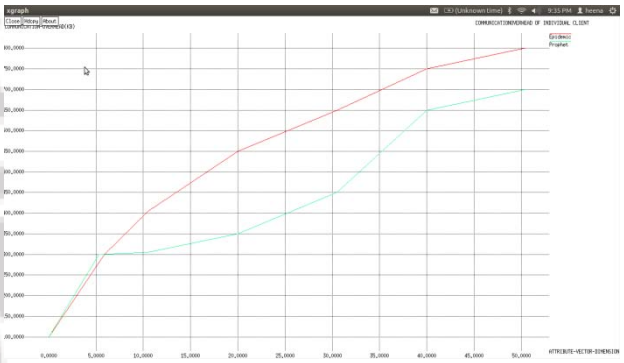

Figure 3.3, Green Color represents Prophet and Red represents Epidemic showing results of Communication Overhead.

Figure 3.4 represents the graph “packet delivery ratio” which determines the average fraction of data packets transmitted that actually approach destination. Prophet has high delivery rates than epidemic.

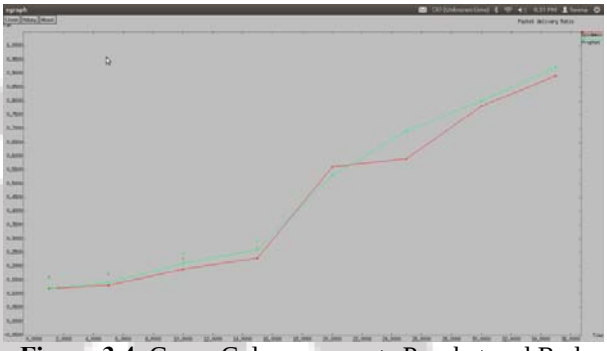

Figure 3.4, Green Color represents Prophet and Red represents Epidemic showing results of Packet Delivery ratio.

Figure 3.5 representing graph showing performance metric “throughput” is a rate of successful delivery of messages over a communication network, the data delivered may be through the wired or wireless channel. The throughput is measured in bits per second (bit/s).

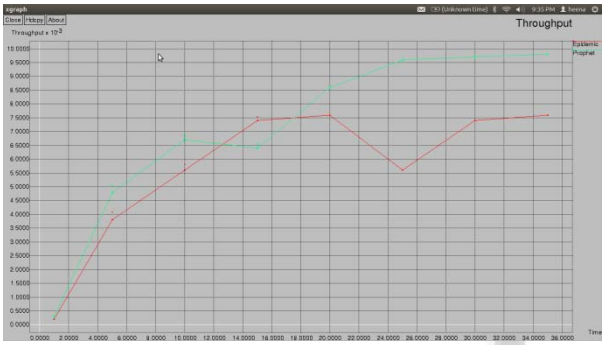

Figure 3.5, Green Color represents Prophet and Red represents Epidemic showing results of throughput.

5. Results &Discussions

From the previous section that is simulation setup, the performance metrics used for both routing schemes are compared with each other. The table helps in describing the comparison between both. Table 2 as shown below:

Parameters	EPIDEMIC	PROPHET
Packet Delivery Ratio	90	93
Overhead (Messages travelled)	800	700
Delay	35 bits	30 bits
Throughput	76 Kbps	98 bps

6. Conclusion & Future Scope

In this research paper, comparison of two communication protocols known as prophet and epidemic is done. Normally delay tolerant networks are useful network type in avoidance of delay which exists in communication and are very useful in providing faster communication for various applications from different domains. Prophet provided better results than epidemic protocols as throughput is 20 % improved in case of prophet as compared to epidemic protocols. Prophet has also shown better packet delivery ratio as compared to epidemic communication. Overall communication overhead is also low in case of prophet.

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