GSJ: Volume 8, Issue 1, January 2020, Online: ISSN 2320-9186
www.globalscientificjournal.com

PERFORMANCE ANALYSIS OF FLOODING BASED DTN PROTOCOLS BY FOCUSING THE SIMULATION SCENARIO OF RAJSHAHI UNIVERSITY, BANGLADESHI

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KeyWords
Delay Tolerant Networks (DTNs), Epidemic, MaxProp, Prophet, Opportunistic Network Environment (ONE) simulator, Rajshahi University.

ABSTRACT

In some geographical regions, it becomes tough to exchange data between end to end nodes unless these region connection nodes have a continuous connection between source to destination. Most of the cases, the message doesn't reach the destination node for the unreliable connection between them. We can use Delay Tolerant Networks (DTNs) in this scenario. The main characteristics of DTN are variable delays and asymmetric data rates with high error rates as well as limited resources. The most emerging matter of DTN is that this network doesn't maintain the continuous connection for message successful message delivery. An essential application of DTN is to emergency message delivery in post-disaster scenarios. The principle challenge of Delay Tolerant Network is to design an appropriate routing protocol to deliver messages in most proficiently and to use less number of the redundant message. This paper investigates the performance of flooding based routing protocol of DTN, mainly Epidemic, MaxProp, Prophet, by focusing the simulation region of Rajshahi University campus as it is most significant and situated at the bank of Padma river. Our primary target is to evaluate the performance of flooding based routing protocol; for instance, message delivery when a traditional network system is failed to establish the connection. The simulation of the above scenarios is done through a simulator using java based Opportunistic Network Environment (ONE) simulator. The analysis is done based on four performance metrics such as delivery ratio, overhead ratio, average latency, as well as average hop count by changing the message size of every group. Is was investigated from the simulation results that MaxProp routing protocol performs well in high delivery ratio, less overhead rate, and average latency for considered simulation scenarios.

I. INTRODUCTION

The current Internet architecture and protocols are successful in providing different communications [1-4] services in the wired and wireless network by using the TCP/IP protocols. TCP/IP protocols require a complete end-to-end path to deliver messages from source to destination. In the context, the situations where there is a low possibility of having absolute paths, the traditional ad-hoc routing protocols such as Ad hoc On-Demand Distance Vector2 (AODV) or Dynamic Source Routing3 (DSR) do not work well because they require fully connected path between source and destination for communication to be possible, these protocols may not work properly in disconnected networks. In such cases, DTN is used.

DTNs stands for Delay/Disruption Tolerant Networks. Delay/ Disruption tolerant networks (DTN) also called as intermittently connected mobile networks (ICMN), are wireless networks where the high mobility and low density of the nodes in the network at any given time instance, the probability that there is an end-to-end path from a source to a destination is low[5,6]. DTN routing usually follows store-carry-and-forward, i.e., after receiving some packets, node stores, and carries them around until it contacts another node and then forwards the packets. Since DTN routing relies on mobile nodes to forward packets for each other, the routing performance (e.g., the number of packages delivered to their destinations) depends on whether the nodes come in contact with each other or not. DTNs support interoperability of different networks by accommodating prolonged disruptions and delays between and within those networks, and by translating between the communication protocols of these networks. In providing these functions, DTNs assist the mobility and limited power of evolving wireless communication devices.

Furthermore, DTNs are well suited for long-haul communication settings, such as space and interplanetary networks [7-8]. DTNs can accommodate many kinds of wireless technologies, including radiofrequency (RF), ultra-wideband (UWB), free-space optical, and acoustic (sonar or ultrasonic) technologies. Delay Tolerant Networks play the main role in the scenario where there is an end-to-end path between a pair of a node never be established such military battlefields, vehicular ad hoc networks, wildlife tracking sensor networks, underwater communication, social networking in remote areas etc. [9-12].

Numerous routing and forwarding techniques have been proposed over the past few years. The majority of forwarding and routing techniques uses asynchronous message passing (also referred to as store-carry-forward) scheme. The foremost difference between different DTN routing protocols is the amount of information they have available to make routing decisions [5]. Ad-hoc DTN usually applies variants of reactive protocols. Flooding protocols such as Epidemic routing [13] do not use any information. Predictive protocols such as Prophet [14] use past encounters of nodes to predict their future suitability to deliver messages to a specified target. In contrast, other protocols also exploit further (explicitly configured) schedule and context information per node.

Furthermore, the different routing protocol differs in their replication strategies, i.e., the number of copies of a message they create, which, in turn, increases/decreases the network load. In [15], the authors investigated the performance Epidemic, Prophet, and spray and wait to route protocols against varying message generation rates and the number of nodes per group and also showed that spray and wait routing protocol perform better. Moreover, the authors [16] evaluated the performance of DTN routing techniques such as Epidemic, MaxProp, Spray-and-Wait, and Spray-and-Focus by varying the message size and the number of nodes and used the campus area of Rajshahi University as a simulation area. In this paper, we have evaluated the performance of flooding based DTN routing protocols such as Epidemic, Prophet, and MaxProp for the shortest path map-based movement model in terms of delivery ratio, average latency and overhead ratio considering campus area of Rajshahi University, Bangladesh as a simulation area.

II. INVESTIGATED DTN ROUTING PROTOCOLS

A summarized description of investigated flooding based DTN routing protocols such as Epidemic, Prophet and MaxProp are explained in this section.

A. Epidemic

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Epidemic routing is historically the first DTN routing protocol. In this routing, the message is sent to all the available paths and nodes present in the network. In Epidemic algorithms, there are a number of random exchanges of data. Thus all nodes will eventually receive all messages. So there is confirmation that the target node will get the data. This routing method has lots of redundancy as every node received every message [13].

B. Prophet

To improve the delivery ratio and proper utilization of network resources than epidemic routing in 2004, A. Lindgren, A. Doriaet.al. proposed probabilistic routing protocol using history of encounter and transitivity (Prophet). In this routing scheme, the mobile nodes used to pass to some locations more than the others so passing through the previously visited location's probability are high than the other [17]. So that when two nodes are encountered, messages are forward to a node that has a higher probability [14].

C. MaxProp

MaxProp routing protocol uses several mechanisms to deliver the message source to destination node properly. In MaxProp, each node estimates the minimum cost before transmitting the message to the destination node and uses Delivery Likelihood method for estimating minimum cost. This protocol first assigns the higher priority of new packets than older packets and also prevents the message reception of the same message twice time [18].

III. SIMULATION SETUP AND PARAMETER SETTINGS

In this paper, we evaluated the performance of flooding based DTN routing protocols such as Epidemic, Prophet and MaxProp. All these routing protocols are simulated using Opportunistic Network Environment (ONE) simulator of version 1.4.1. This section explains the ONE simulator, simulation environment setup.

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A. The ONE simulator

The ONE Simulator is written in Java programming language and it's able to run on all platforms which are supported Java such as Windows, Linux and so on. ONE is an agent-based discrete event simulation engine. At each simulation step, the engine updates a number of modules that implement the main simulation functions. The main functions of the ONE simulator are the modelling of node movement, inter-node contacts, routing and message handling. A detailed description of the simulator is available in [19] and the ONE simulator project page [20] where the source code is also available.

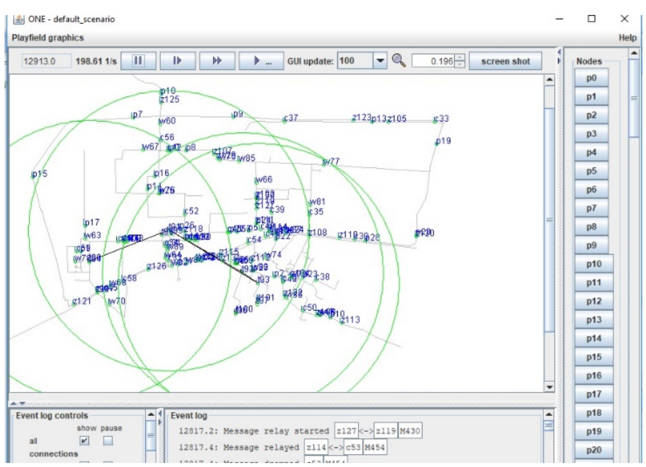

Fig. 1. Screenshot of the ONE simulator for campus area of Rajshahi University, Bangladesh

Fig. 1 display the graphical user interface of ONE simulator for the campus area of Rajshahi University, Bangladesh.

B. Simulation of Environment Setup

Parameter of simulation setup are summarized in table-1 that are used for current analysis.

TABLE-1: PARAMETERS FOR SIMULATION SET UP

Parameters	**Values**
Simulator	Opportunistic Network Simulator (ONE)
Simulation time	28800 Sec (8 hour)
Update interval	0.1 Sec
Number of group	7
Interface	Bluetooth interface
Interface type	Simple Broadcast Interface
Transmit speed	260 Kb
Transmit range	15m
Buffer size	10M
Message Size	100,300,500,700,900 KB
Total Message generation	3
Message TTL	300 min (5 hour)
Number of nodes each group	50
Routing protocol	Epidemic, Prophet, MaxProp
Movement model	Shortest path map-based movement
Simulation area size	3500x3200 m

IV. SIMULATION RESULT AND ANALYSIS

This section, we have focused the performance of flooding based routing protocols with regards to delivery ratio, overhead ratio, average latency and average hopcount varying the message size. The results are outlined here that are obtained according to running the simulation as per as the parameter defined in Table 1.

A. Delivery Ratio

Delivery ratio defined as the ratio of the number of message delivered the destination node from source node at a certain period of time.

Fig. 2. Delivery ratio by varying message size

From fig. 2, we observed that the delivery ratio by varying the message size for Epidemic, Prophet and MaxProp where it is showed that by increasing the message size the delivery ratio is continuously decreased. From this plot, we see that the MaxProp routing protocol perform better than other routing protocol because these protocol nodes follow several mechanisms for forwarding message and also estimating the minimum cost and also prevent to send duplicate message copy. Thus this protocol has higher message delivery ratio. In Prophet, the delivery ratio is lower than other protocols as it forward the message based on location. Hence, we concluded that the MaxProp routing protocol is best and Prophet is worst one for Rajshahi University campus area.

B. Average Latency

Average Latency can be defined as the average time that is required for successfully message transmission destination node from message source node.

Fig. 3 demonstrates that how average latency value is changed by varying the message size by considering the Rajshahi university campus as a simulation area. The value of average latency of Epidemic routing is gradually increased by increasing the message size. As Epidemic protocol does not follow any mechanism for forwarding the message copy to the next node. This protocol forward the message blindly that’s why this protocol need much time to reach the message to the destination node. In MaxProp routing needs less time to reach the message copy to the destination node than other routing protocol. Therefore, it is clear that MaxProp protocol performs better and Epidemic protocol performs worst.

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Fig. 3. Average Latency by varying message size

C. Overhead Ratio

Overhead Ratio is defined as how many additional message is needed for successfully message transmission to the destination node.

Fig. 4 illustrates the overhead ratio by changing the message size for Epidemic, Prophet and MaxProp. If a message can reach to the destination node spending less unnecessary messages, then this routing protocol is better. From the plot, it is evident that MaxProp routing protocol need less extra message to forward the message copy to the destination node than other routing protocols. So, it is clear that MaxProp is the best and Prophet is worst routing protocol.

Fig. 4. Overhead ratio by varying message size

V. Conclusion

In this paper, we have evaluated the performance of flooding based routing protocols in DTN namely Epidemic, Prophet and MaxProp by changing the message based on three performance metrics: deliver ratio, average latency and overhead ratio by considering Rajshahi University, Bangladesh as a simulation area. From the simulation results it is concluding that MaxProp routing protocol is the best protocol for deliver ratio, average latency and overhead ratio. In Future, we will try to investigate the performance of DTN routing protocol over various mobility model which may help us to design new routing protocols.

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