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Evaluation of DTN Routing Protocols

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Abstract

In Delay Tolerant Networking (DTN) data can transfer in challenging environments where a fully connected end to end path may never exist between a source and destination. These networks deal with large transmission delays, frequently disconnected paths, high link & path error and limited resources. Modern Internet protocols exhibits inefficient performance in those networks where the connectivity between end nodes has intermittent property due to dynamic topology such as Mobile Ad-hoc Networks (MANET) or Vehicular Ad-hoc Networks (VANET). Network environment where the nodes are characterized by opportunistic connectivity are referred to as Delay Tolerant Networks (DTN). In this paper we compare some of the well-known routing protocols namely First Contact, Direct Delivery, Epidemic, Spray and Wait, Probabilistic Routing Protocol using History of Encounters and Transitivity (PROPHET) and MaxProp. We evaluated the DTN routing protocols performance in terms of three metrics: Delivery Probability, Average latency and Buffer Time over simulation Time To better judge the performance of these routing protocols, the series of simulations are carried out in The ONE (Opportunistic Network Environment) simulator with program version of 1.4.1.

Keywords: Delay Tolerant Network, Routing Protocols, Opportunistic Network Environment (ONE) Simulator.

Introduction

DTN is a class of networks where no assumption regarding the existence of a defined path between source and destination. In MANET routing protocols, network is fully connected and there always exists a path between every node in the network, so traditional routing protocols for MANETS do not work well for DTNs. These types of protocols try to discover a full path between the sender and the destination before sending data. If path is not exists, protocols will not succeed to send any data. DTN architecture provides more robust networks against long delays, channel disruptions, and limited or intermittent connections. The key feature of DTN architecture store-carry-forwards paradigm, allowing the data to be stored until proper communications between nodes are established and data can be forwarded. One of the major properties of delay tolerant networks (DTN) is that there does not always exist a complete path from a source to a destination. DTN routing protocols appropriate the mobility of the nodes and buffering of messages. This also makes possible for a node to carry a message and in that way bridge partitions in the network. It knows as store-carry-forward .When a message is created and stored in the source node, if a contact becomes available to a next-hop node the message is sent over this contact. Messages are stored at the new node until the destination node is found. DTNs applications examples are: Inter-planet Satellite communication networks, Sparse mobile ad hoc networks, Country-Side area networks, Military battle field networks, Wireless Sensor networks, Exotic Media networks [1]

DTN architecture introduces a bundle layer between the transport and application layer, creating a store and-forward overlay network that allows the interconnection of highly heterogeneous networks. In this paper Section 2 describes Delay Tolerant Network, Section 3 represents the classification of DTN Routing Protocols, Section 4 presents the Simulation Scenarios and analysis of obtained results and Section 5 indicates the Conclusion.

Delay-Tolerant Networks

DTN routing protocols are categorized in single-copy schemes and multi-copy schemes. The difference between these schemes is the number of copies of a message that may exist at the same time in the network. In Single-copy schemes, forwards a single copy of each message through the network. This is a resource efficient method, but it does not work properly in long delivery. While Multi-copy scheme forwards a

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copy of each message to the network is called replication. In Multi-copy scheme several copies of the same message exists in the network, thus having a higher resource consumption compared to single-copy, but it gives lower delivery delays because the probability of finding the destination node is low when only on copy exist. [2]Direct Delivery and First Contact routing protocols are single copy protocols. In this scheme a node holds a message until it encounters the destination node.. Epidemic routing, Spray & Wait routing and PRoPHET routing are multi-copy scheme protocols so they require more buffer space.[3]

DTN Architecture

The DTN architecture follows a method for interconnecting heterogeneous networks and this method use store-carry-forwards paradigm to overcome communication disruptions. It also provides services like electronic mail, but with enhanced naming, routing, and security capabilities. Nodes unable to support the full capabilities required by this architecture, may be supported by application-layer proxies acting as DTN applications.[4]

In store-carry-forwards paradigm, source node is forwarded a message to an intermediate node (fixed or mobile) thought to be more close to the destination node. The intermediate node stores the message and carries it while a contact is not available. The process is repeated, so the message will be relayed hop by hop until reaching its destination node.[3]Figure.1 describe the DTN overlay network architecture as below.

Figure.1DTN Overlay Network Architecture

The bundle layer is called DTN nodes. It includes a hop-by-hop transfer of reliable delivery responsibility and optional end-to-end acknowledgement. Bundle layer provides internetworking on heterogeneous networks operating on different transmission media.[4]

Classification of DTN Routing Protocols

Direct Delivery Routing Protocol

Direct Delivery routing protocol is single-copy scheme DTN routing protocols. In this routing protocol only one copy of each message exists in the network and message is kept in the source and delivered only to the final destination node. The node carries messages until it encountered their final node.[10]

In this method, the message is not forwarded to the nearby nodes. The source node does not forward the message to the intermediate nodes. It keeps the message with itself until it becomes directly contact to the destination node. It uses minimum bandwidth and network resources for message transfer. If the source node is fail, the message will be lost because there is only one message copy available in to the network, thus delivery probability is poor. [6]

First Contact Routing Protocol

First Contact routing protocol is also single-copy scheme DTN routing protocols. In First Contact, the message is delivered to the node which is encountered first and deleted, being forwarded until it reaches to the destination node.[10]

In this protocol the source node and the intermediate nodes forward a message randomly to nearby node which is encounter first. If any node comes first in to the radio range of the source node will be given the message. It doesn't determine the next best hop moving to the destination. The message is forwarded randomly when two or more nodes come in contact with the source node at the same time. Local copy of the message is eliminated after successful transfer from one node to another node. Thus, a single copy of the message flows in the networks. In single copy scheme, if any intermediate node fails to carrying the message then that time the message will be lost. In this protocol delivery ratio is poor because the next hop is selected as randomly. [6]

Epidemic Routing Protocol

In Epidemic Routing Protocol does not require previous knowledge about the network. [7]Each node retains two buffers. First buffer is used for stored the messages. This is generated by the node itself. Second buffer is used for the message received from the other node. Each message has a unique message ID related with it. Each node carrying a list of the message IDs of all messages in its buffer and pending delivery is saved in form of summary vector. When two nodes are encounter, they comparing their summary vectors. Two nodes exchange all messages which they do not have in common. After the message exchanging process, multiple copies of the message flows in the network. Every node have same messages in their buffers and all

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messages are spread to the every node in to the network including the destination node.[6].

Spray & Wait Routing Protocol

Spray and Wait protocol produce an improvement over the Epidemic routing protocol by controlling the level of message spreading in the network. Similar to the epidemic routing, the spray and wait protocol assumes no knowledge of network topology and nodes mobility. The difference between this protocol and the epidemic routing scheme is that it only spreads L copies of the message. [6].This protocol has two phases first phase is Spray phase and second is Wait phase. In the First Phase, all messages are activated at the source node and passed to L decided relays in the network. Source node spreads L copies of the message to the first L encountered nodes in the network. [8].In the second phase, each node that received a copy of the message waits to meet the destination node to directly deliver the data.

PRoPHET Routing Protocol

In PRoPHET (Probabilistic Routing Protocol using History of Encounters and Transitivity) routing protocol, each node calculates a probabilistic metric called Delivery Predictability for each known destination before sending a message. Delivery Predictability indicates the probability of successful delivery of the message from the source node to the destination node.

A node will forward the message to another node, if another node has a higher value of Delivery Predictability.[9]

MaxProp Routing Protocol

MaxProp routing protocol uses several mechanisms to increase the delivery rate and lower latency of delivered packets. MaxProp routing protocol does not assume any previous knowledge of the network connectivity and it uses local information, mobility of nodes to select the next best-hop for message delivery. This protocol designed for vehicle-based delay tolerant networks. It forwards the message to any node in the network having maximum probability of delivering the message to the destination.[10]

Simulation Scenarios

The ONE Simulator

Opportunistic Network Environment (The ONE) simulator with program version of 1.4.1.Unlike Other DTN simulators, which usually focus only on routing simulation, the ONE combines mobility modeling, DTN routing and visualization in one package that is easily extensible and provides a rich set of reporting and analyzing modules. A detailed description of the simulator is available in [11]. The ONE simulator project page [12] where the source code is also available. 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.

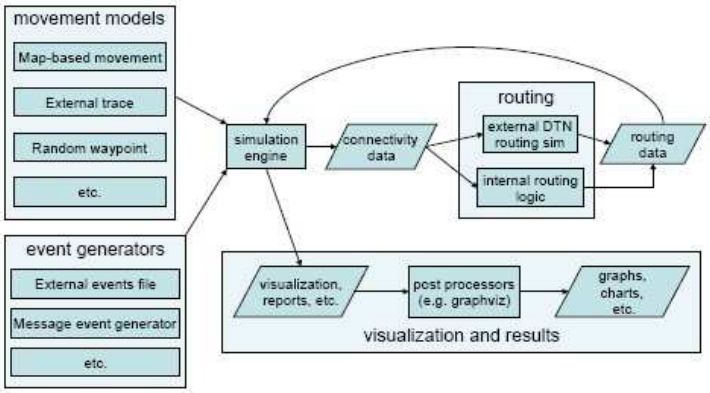

Figure 2. Overview of the ONE Simulator Environment [12].

Performance of DTN Routing Protocols

Table 1. Simulation Setup Parameters.

PARAMETERS	VALUE
Simulation Time	7200s,10800s,14400s,18000s
Interface	Blue tooth Interface
Interface Type	SimpleBroadcast
Routing Protocols	First Contact, Direct Delivery Routing, Epidemic Routing Spray and Wait Routing, ProPHET Routing, MAXProp Routing
Total No. of nodes	300
Message TTL	300 minutes
Mobility	Random Way Point

Performance of DTN routing protocols we have mainly concentrated on three performance metrics:

Packet Delivery Probability:

It is the fraction of generated messages that are correctly delivered to the final destination within given time period. This is the ratio of the total number of packets that are delivered to their destination to the total number of packets that are created.

Table 2.Probability Delivery Ratio Vs Simulation Time

Simul_Time	Probability Delivery Ratio					
	First Contact	Direct Delivery	Epidemic	Spray & Wait	ProPHET	MaxProp
7200	0.0	0.0041	0.0041	0.0124	0.0041	0.0248
10800	0.0164	0.0055	0.0519	0.0328	0.0082	0.0355
14400	0.0143	0.0102	0.0552	0.038	0.0164	0.047
18000	0.0194	0.0148	0.0591	0.0427	0.027	0.0493

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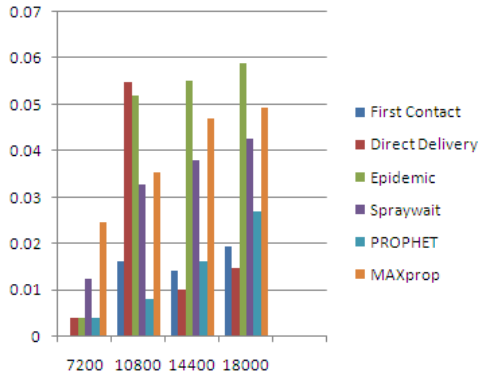

Figure 3. A Comparison Chart of Packet Delivery Probability Vs Simulation Time.

Figure 3 shows the comparison chart of packet delivery probability for First Contact, Direct Delivery Routing, Epidemic Routing, Spray & Wait Routing, PROPHET Routing and MaxProp Routing. From the chart it can be noticed that when simulation Time 11000s packet delivery probability of the Epidemic Routing, Spray & Wait routing, MAXProp and ProPHET shows increment in packet delivery probability but at the same time packet delivery probability of Direct Delivery routing and First Contact Routing decreases. It is just because the Direct Delivery routing uses hand-to-hand packet delivery strategy. If we only concentrate on Spray & Wait routing, ProPHET routing and MaxProp then from the graph it is clearly noticed that still performance of Spray & Wait routing, ProPHET routings are not up to mark whereas MaxProp routing shows excellent performance in terms of packet delivery probability.

Average Latency:

It is the measure of average time between messages is generated and when it is received by the destination.

Table 3.Average Latency Vs Simulation Time

Simul_Time	Average Latency					
	First Contact	Direct Delivery	Epidemic	Spray & Wait	ProPHET	MaxProp
7200	0.0	1899.60	1899.6	2811.50	1899	4390.866
10800	4286.65	1034	5867.01	4979.033	3904.3	5861.33
14400	4235.24	4813.84	6498.80	5049.13	5223.087	6905.01
18000	4900.39	5728.74	7888.58	6090.82	7678.929	7894.84

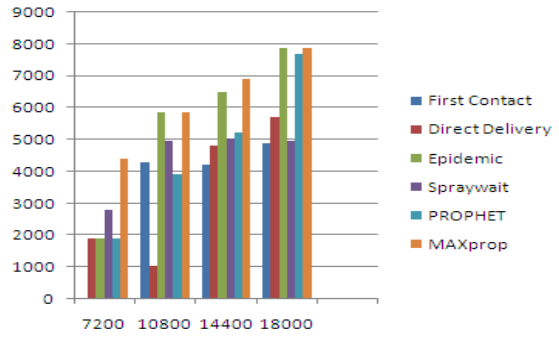

Figure 4. A Comparison Chart of Average Latency Vs Simulation Time.

Figure 4 shows the comparison chart of packet delivery probability for First Contact, Direct Delivery Routing, Epidemic Routing Spray and Wait Routing, ProPHET Routing, MAXProp Routing. From the comparison chart it can be noticed that when simulation Time is 11000s Average latency of Epidemic routing is quite higher than First Contact and MaxProp routing protocols.

Buffer Average Time

This is the average time that packets spend in the buffer of the node. It is an average of the time spent by all the packets, delivered and dropped in the intermediate node's buffers.

Table 4. Buffer Average Time Vs Simulation Time

Simul_Time	Buffertime_avg					
	First Contact	Direct Delivery	Epidemic	Spray & Wait	ProPHET	MaxProp
7200	1068.158	4036	4036	3411.94	4036	912
10800	1424.60	7045.2	3547.663	5160.31	6602.824	1374.61
14400	1599.25	8579.212	3907.27	5747.54	5677.505	1633.47
18000	1782.88	10442.55	4297.35	6551.17	5799.84	2042.79

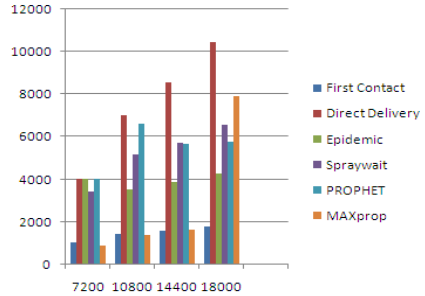

Figure 5. A Comparison Chart of Buffer Time Vs Simulation Time.

From the comparison chart it can be noticed that direct delivery protocol has highest buffer time than other routing protocols. While Maxprop and Epidemic routing protocols have less buffer time than other routing protocols. Due to the direct transmission approach used by Direct Delivery and Spray and wait, they present the highest values of buffer time in comparison with other protocols.[12]

Conclusion

After analyzing the comparison chart of packet delivery probability and average latency and buffer average time Vs simulation time for First Contact, Direct Delivery Routing, Epidemic Routing Spray & Wait Routing, ProPHET Routing and MAXProp Routing. We can conclude that Direct Delivery Routing is no more suitable for real time application because it is very poor to packet delivery probability. Whereas Epidemic routing, Spray & Wait routing and MaxProp routing protocols are suitable for real time applications. Among this Maxprop shows excellent performance in packet delivery probability and Epidemic shows good performance in average latency. Direct Delivery routing protocols has highest buffer time while Maxprop and ProPHET has less buffer time. Number of copy based in the network, best protocols are the unlimited-copy protocol and the worst is First Contact (single-copy) routing protocol, while Spray and Wait is in middle.[12]

References

[1] *Karimzadeh Mortera: Efficient Routing Protocol in Delay Tolerant Networks(DTNs), Department of communication Engineering, May 2011.*

[2] *Implementation of a Delay-Tolerant Routing Protocol in the Network Simulator NS-3 by Fredrik Herbertsson LIU-IDA/LITH-EX-A--10/046--SE 2010-12-22, Linköpings universitet SE-581 83 Linköping, Sweden.*

[3] *Improving Vehicular Delay-Tolerant Network Performance with Relay Nodes. Vasco N. G. J. Soares1,2,3, Farid Farahmand4, and Joel J. P. C. Rodrigues1,2 1Instituto de Telecomunicações, NetGNA Group,Covilhã, Portugal 2Department of Informatics, University of Beira Interior, Covilhã, Portugal 3Superior School of Technology, Polytechnic Institute of Castelo Branco, Castelo Branco, Portugal 4Department of Engineering Science, Sonoma State University, CA, USA vasco.g.soares@ieee.org;arid.farahmand@sonoma.edu;joeljr@ieee.org.*

[4] *Cerf, V., Burleigh, S., Hooke, A., Torgerson, L., Durst, R.,Scott, K, Fall, K., Weiss, H.RFC 4838, Delay-Tolerant Networking Architecture. IRTF DTN Research Group (2007).*

[5] *Journal of Internet Services and Information Security (JISIS), volume: 3, number: 1/2,pp. 37-4Corresponding author: Tel +1-416-979-5000 (x.6972), Web: http://www.scs.ryerson.ca/ iwoungan/ 37 Energy-based Performance Evaluation Dhurandher, Sharma, and Woungang.available at jisis-2013-vol3-no12-03.pdf*

[6] *A.Vahdatand, D. Becker"Epidemic Routing for Partially Connected Ad Hoc Networks ", DukeTechnical Report, CS-2000-06,July 2000. available at issg.cs.duke.edu/epidemic/epidemic.pdf.*

[7] *Chintan B. Desai et al./ International Journal of Computer Science & Engineering Technology (IJCSET),ISSN : 2229-3345 Vol. 4 No. 03 Mar 2013.available at IJCSE13-04-03-058.pdf.*

[8] *A. Lindgren, A. Doria, and O.Schelen. Probabilistic routing in intermittently connected networks. ACM SIGMOBILE Mobile Computing and Communications Review, 7:19–20, July 2003.*

[9] *J. Burgess,B. Gallagher,D. Jensen,B. N. Levine: "MaxProp:Routing for Vehicle-Based Disruption-Tolerant Networks.April 2006.*

[10] *A. Ker¨ Anen, "opportunistic network environment simulator. Special assignment report, helsinki university of technology," Department of Communications and Networking, May 2008. available at WW.netlab.tkk.fi_tutkimus_dtn_theone_pub_the_one.pdf.*

[11] *Tkk/Comnet. Project page of the ONE simulator. [Online]. Available: http://www.netlab.tkk.fi/tutkimus/dtn/theone, 2009*

[12] *Naercio,Paulo Rogerio Pereira, Miguel P. Correcia INESC-ID/IST/UTL,Rua Alves Redol,9.1000 029LISBOA,Portugal.{naercio.magaia,Miguel.p.correia}@ist.utl.pt.*