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Performance Evaluation of various Flooding and Forwarding Protocols based on Delay Tolerant Network's: A Review

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Abstract: ***Now these days Delay Tolerant networks (DTN) are used rather than ad-hoc networks because DTN networks work in that situation when there is no end-to-end path between the nodes including emergency scenarios and battlefield applications. The objective of routing in DTN is to maximize probability of delivered messages. In this see how DTN provides an effective alternative and also explain security of data that has become important in delay tolerant networks and various attacks that are detecting in different-different protocols will be analyzed. In this Epidemic, Spray-and-Wait (SNW), Prophet Protocols are compared and analyzed using one simulator***

Keywords: DTN, Epidemic Protocol, Spray-and-Wait, Prophet Protocols, Security mechanisms in Delay Tolerant Network

1. Introduction

Today's Internet has been successful at connecting devices through which communicate around the world. In this using set of protocols which has been made i.e. widely known as TCP/IP for transferring data from source to destination with the minimum possible delay and high reliability. End-to-End data transfer is the main principle of TCP/IP protocol. At any time if there is no path between source to destination then this protocol not work correctly or whole system stop working completely. In these circumstances a newer network has evolved i.e. DTN (Delay Tolerant Network) which is independent of end to end connectivity [2] [18] [23] shown in figure 1.1. It promises to enable communication between "challenged" networks i.e. deep space networks, outer-space networks, sensor networks, mobile ad-hoc networks, vehicular networks**,** exotic media networks, inter-planetary networks [1][10][18][21]. Characteristics of Delay Tolerant Networks are Lack of Connectivity, Irregular Delays, High Latency, Short Range Contact[1][23].

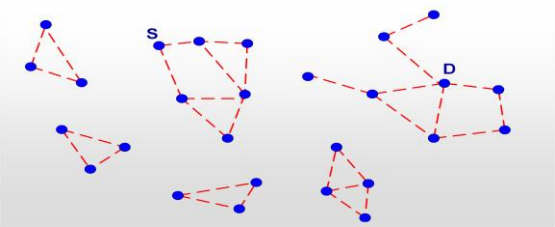

Figure 1.1: Delay Tolerant Network [25]

1.1 Architecture of Delay Tolerant Network

The architecture of DTN is designed in such a way that it counters the assumptions and conditions of the traditional TCP/IP Protocol based networks. This designed includes concept of regions and gateways.DTN architecture shown in figure 1.2 is based on following designed principles [2] [18].

- Region is similar network stack and addressing
- DTN gateways are interconnection points between dissimilar network protocol and addressing families called regions e.g. Internet-like, Ad-hoc, Mobile etc.
- Use naming syntax that supports a wide range of naming and addressing conventions to enhance interoperability.

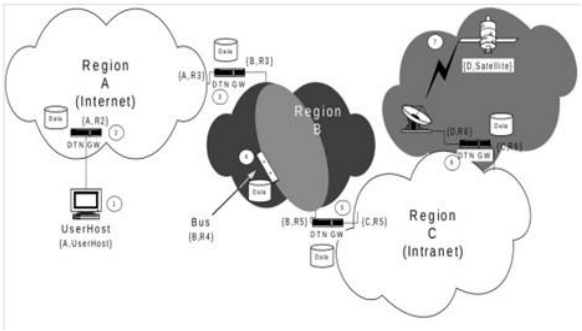

Figure 1.2: Delay Tolerant Network Architecture [15]

1.2 Routing in DTN

In Delay Tolerant Network, a distance function is used to measure the cost of delivering messages from one place to another. The intermittent connectivity of DTN makes it difficult to ensure end-to-end delivery of data and longetivity of delays makes it impossible to provide acknowledgements and retransmissions. The objective of routing is to maximize the probability of delivering messages. Routing in DTN mainly includes two strategies i.e. flooding and forwarding strategies in it and protocols divide into table 1.

Table 1: Routing Protocols in DTN

Flooding Strategies	Forwarding Strategies
Epidemic Protocol	PROPHET
RAPID	FRESH
Spray And Wait	MAXPROP
Prioritized Epidemic	MV(MEET ND VISIT)
FUZZY SPRAY	
Spray And Focus	

1.3 Routing Techniques in DTN

Store and Forward Technique-Delay Tolerant Networks have overcome the problems associated with the conventional protocols in terms of lack of connectivity, irregular delays, asymmetric bidirectional data rates etc. using the concept of store and forward. Figure 1.3 use the method of store and forward is very analogous to real life postal service. Every letter has to pass through a set of post offices; here it is processed and forwarded, before reaching the destination. Here complete message of it is transferred and stored in nodes successively until it reaches the destination.

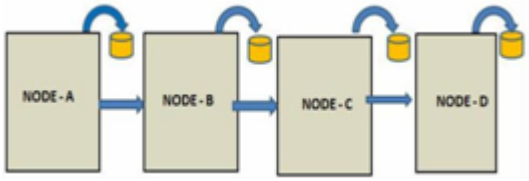

Figure 1.3: Store and Forward Approach [18]

Custody Transfer Technique-This Technique acknowledged the delivery of message from one DTN hop to the next and passing of reliability delivery responsibility. The DTNs support error-checking of transferred messages. Retransmission of messages is done in- case of corrupted or lost data. In case of no acknowledgement, retransmission of the message occurs. There are two types of nodes that can be persistent and non-persistent. In these persistent nodes assumed to contain persistent memory storage and participate in custody transfer. A non-persistent node can transfer custody of a message to a persistent node which then accepts responsibility for reliably delivering the message.

1.4 Routing Strategies

The intermittent connectivity of DTN makes it difficult to ensure end-to-end delivery of data and longetivity of delays makes it impossible to provide acknowledgements and retransmissions. Routing in Delay Tolerant Networks can be classified into 2 types. These are as:-

- Dissemination Based (Flooding).
- History Based (Forwarding Based).

Dissemination Based: In Dissemination based routing in Delay Tolerant Network, the main focus is laid on better way for dissemination of the message in the network. When the nodes which carry a particular message are not clumped into a small region but are spread throughout the network then there are higher chances that a node carrying the message will come in direct contact towards the destination. This is also called flooding strategy. Some of the basic ways that proposed are that of **Epidemic, Spray and wait, Rapid, Prioritized Epidemic** etc.

History Based: - History Based approach also called forwarding approach because many protocols that are used in both approaches. The history of encounters is exploited in many works. The Zebranet project is one of the foremost attempts to use history of encounters for routing decisions and use this to encounter the delivery of messages. In this approach various protocols are used these protocols are Probabilistic Protocol using History of Encounters and Transitivity (PROPHET), Fresher Encounter Search(FRESH), MED(Minimum Expected Delay), MaxProp etc.

1.5 Related Work

Vahdat and Becker et al. (2000) [29] purposed Epidemic routing protocol i.e. flooding based forwarding algorithm.**Lindgren et al., (2003) [30]** developed by probabilistic routing protocol using history of encounter and transitivity (PROPHET) is a probabilistic routing protocol abstracts 'History of Encounters' into delivery predictability parameter. **Spyropoulos et al., (2005) [31]** proposed the spray and wait routing protocol to control the level of spreading of messages throughout the network. **John Burgess et al., (2006) [32]** proposed MaxProp, a protocol for effective routing of DTN messages. **Aruna Balasubramanian et al., (2007) [33]** present RAPID, an DTN routing protocol can optimize a specific routing metric such as worst-case delivery delay or the fraction of packets that are delivered within a deadline.

Name of the Protocol	Year	Work Done
Epidemic Routing Protocol	2000	No knowledge about the network. Large numbers of messages are transferred and multicopy scheme used in it.
PROPHET	2003	History based and using delivery Predictability to deliver a message from one to another node.
Spray and Wait Protocol	2005	In this two phases are used if first not deliver message at destination then wait phase directly deliver the message from nodes. Reduce overhead and congestion.

1.6 Security in Delay Tolerant Network

In DTN the possibility of various resources scarcity dictates that the some form of authentication and access control to network in various ways. It is not acceptable for the unauthorized user to flood the network in easy way and it is possible for only authorized users. In some cases it is not possible for unauthorized user to be forwarded to certain network links. In this there are various protocols that are designed to address various nodes misbehavior or attacks describe in table 2.

Shally et al., (2014) [34] to evaluate the performance of RAPID and SPRAY-and-WAIT DTN routing protocols under the black hole attack. **Preeti Nagrath et al.,** (2014) [35] using flooding attack in delay tolerant networks. **Harminder Singh Bindra et al.,** (2014) [36] investigate the Performance of Extended Epidemic Routing Protocol of DTN under Routing Attack. **Yinghui Guo et al.,** (2013) [37] Detecting the Blackhole and Greyhole Attacks in Vehicular Delay Tolerant Networks. **Yanzhi Ren et al.,** (2010) [38] detect wormhole attacks in delay tolerant networks. **Fai Cheong Choo et al.,** (2010) [39] detect Robustness of DTN against Routing Attacks.

Table 2: Various Security Mechanisms in DTN

S No	*Year*	*Name of Paper*	*Protocol/ Mechanism*	*Attack*
1.	2014	Performance Evaluation of Rapid And Spray-and-Wait Dtn Routing Protocols Under Black Hole Attack	Rapid And Spray-And-Wait	Black Hole Attack
2.	2014	Flooding Attack In Delay Tolerant Network	Epidemic, Prophet, Maxprop, Spray-and-Wait	Flooding Attack
3	2014	Investigatig Performance of Extended Epidemic Routing Protocol of DTN Under Routing Attack	Epidemic	Routing Attack
4	2013	Detecting Blackhole And Greyhole Attacks In Vehicular Delay Tolerant Networks	Epidemic And Spray-And-Wait	Blackhole and Greyhole Attacks
5	2010	Detecting Wormhole Attacks In Delay-Tolerant Networks	Prophet	Wormhole Attack
6	2010	Robustness of DTN Against Routing Attack	Maxprop	Routing Attack

2. Tools and Platform

For the above protocols, the platform is used in it is ONE (Opportunistic Network Environment) simulator to the beginners in Windows platforms. Since the ONE simulator provides very less documentation. To make complex DTN simulations more feasible and understandable, create a new simulation environment that combines movement modeling, routing simulation, visualization and reporting in one program. A series of simulations are carried out to judge the performance of above mentioned protocols using the Opportunistic Network Environment (The ONE) simulator (Keranen et al. 2009) with program version of 1.5.1 shown in 2.1. At its core, ONE is an agent-based discrete event simulation engine. Detail is available in [5] [7].

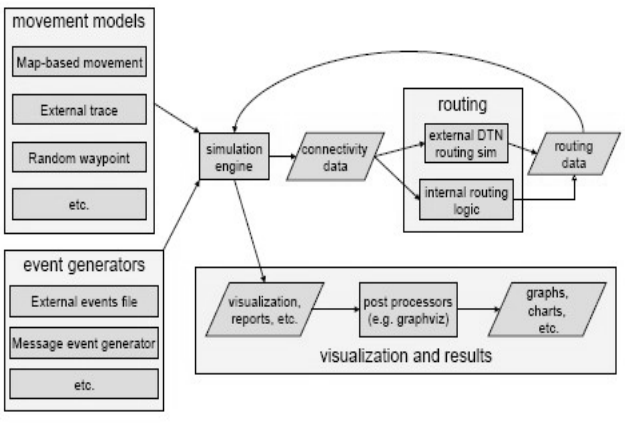

Figure 2.1: Overview of ONE Simulator Environment [16]

3. Simulation and Result Analysis

Simulation Setup Information

In our simulation we have assigned simple broadcast type blue tooth interface with the transmit speed of 2Mbps to all the nodes. Our simulation scenario comparable to real time application, to better judge the performance of all the three routing protocols, we have assigned 5 messages buffer size to each node. 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. The complete simulation setup information is given in Table 3. To advocate the performance of routing protocols we have mainly concentrated on two performance metrics:

1) **Delivery Probability**: Fraction of generated messages that are correctly delivered to the final destination within given time period.
2) **Average Latency**: Measure of average time between messages is generated and when it is received by the destination.
3) **Overhead Ratio**: Ratio between the total numbers of transmissions over the number of delivered messages.
4) **Hop count med**: - The hop count refers to the intermediate devices (like routers) through which data must pass between source and destination. Hop count is a rough measure of distance between two hosts.
5) **Buffer time-med: -** It is the extra time added into a time estimate to keep a project on track.

Table 3: Simulation Setup Information

Parameters	Value
Simulation Time	43200.1000
Interface	Blue tooth Interface
Interface Type	Simple Broadcast
Routing Protocols	Epidemic, SNW, PROPHET
Buffer size	5 messages
No. of nodes	10
Speed	2.7,13.9
Msg TTL	300(5 hours)

4. Result Analysis

Delivery Probability:-Figure 3.1 shows the comparison between three protocols i.e. Epidemic, Spray and wait and PROPHET. In this the delivery probability of Spray and wait protocols are more compare to other protocols that are used in it.

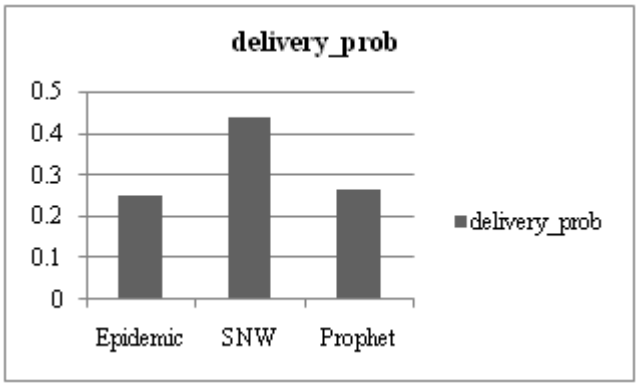

Figure 3.1: Comparison of Delivery Probability of Epidemic, SNW and Prophet

Overhead Ratio: - Figure 3.2 compare the overhead ratio of all the protocols. In this Overhead ratio of the Epidemic routing protocol is more compared to others and spray and

wait protocol has less overhead ratio then the other two protocols.

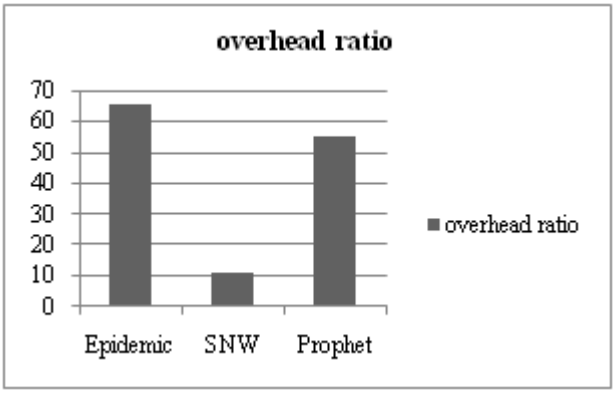

Figure 3.2: Comparison of Overhead Ratio of Epidemic, SNW and Prophet

Latency med:-Figure 3.3 shows the comparison between the three protocols i.e. Epidemic, Spray and wait and PROPHET. In this Latency med. of PROPHET routing protocol has more and spray and wait protocol has less Latency med.

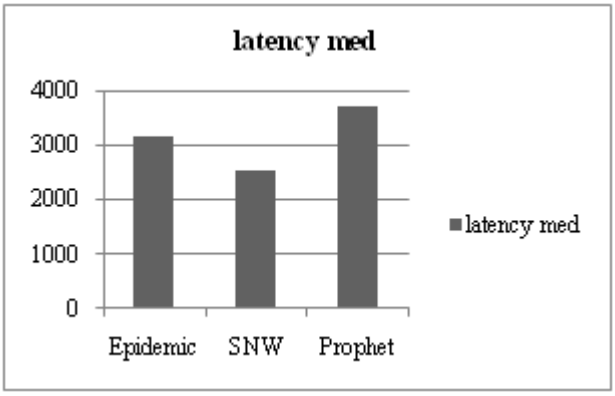

Figure 3.3: Comparison of Latency med. of Epidemic, SNW and Prophet

Hop count-med:-Figure 3.4 shows comparison of Hop count-med between three protocols i.e. Epidemic, Spray and wait and PROPHET. Hop count-med of the PROPHET routing protocol and epidemic is same compared to Spray and Wait.

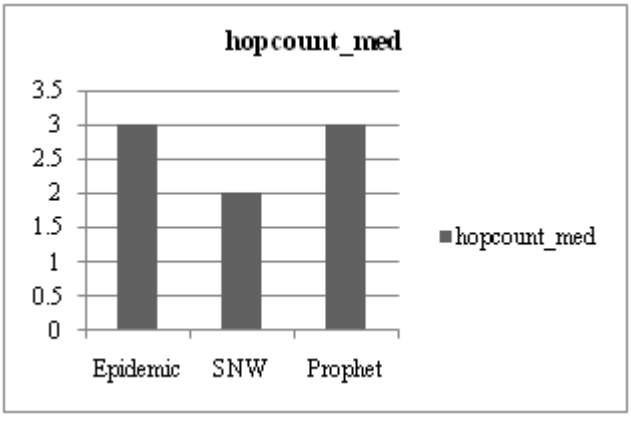

Figure 3.4: Comparison of Hop count-med of Epidemic, SNW and Prophet

Buffer time -med: - Figure 3.5 show comparisons between three protocols i.e. Epidemic, Spray and wait and PROPHET. Buffer time -med of the PROPHET routing protocol and epidemic are same compared to the Spray and Wait. In this spray and wait protocol has more buffer time -med

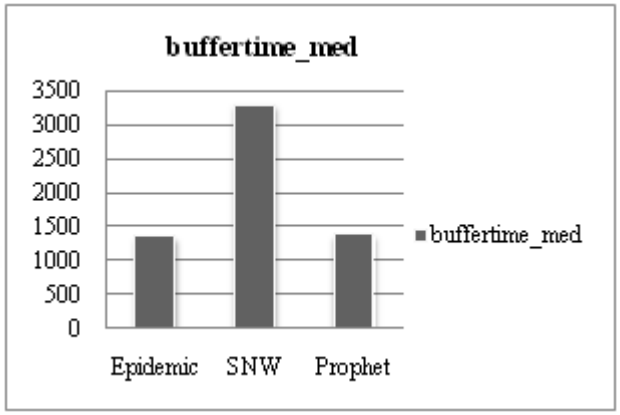

Figure 3.5: Comparison of buffer time-med of Epidemic, SNW and Prophet

5. Conclusion

Delay Tolerant Networks will form important facts of modern day networking given the necessity of connectivity. The traditional TCP/IP protocol is not worked when there is no end to end connectivity in the networks. In DTN can have many applications that have capabilities that can extend to applicable to challenged networks such as used by space, military and intelligence areas. In this there are various protocols that are using various parameters and perform operation on this using one simulator. Using various papers that show the attacks in delay tolerant network. It shows the proposed work in it to check the performance, bandwidth, latency of the different-different protocols and also checks which is higher and which is lower in it.

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