IMPACT OF MOBILITY MODELS ON SUPP-TRAN OPTIMIZED DTN SPRAY AND WAIT ROUTING PROTOCOL

Mohamed Ababou[1], Rachid Elkouch [2], Mostafa Bellafkih[3] and Nabil Ababou[4]

[1]National Institute of Posts and Telecommunications - INPT, Rabat, Morocco
University of sciences Mohamed 1 -FSO, Oujda, Maroc

ABSTRACT

The delay-tolerant networks (DTN) are networks that support communication between nodes when connectivity is intermittent, due to the difficulties encountered in this type of environment, such as node mobility frequently changing network topology, this which does not allow to route messages directly between the source and destination, the routing algorithms must consider mobility to increase the rate of message delivery. In our previous work of Supp-Tran we examine that spray and wait router was not showing good delivery probability in case of SPMBM mobility model and FIFO forwarding strategy compared to our Supp-Tran strategy.
This paper compares the behavior of the FIFO strategy used by default with spray and wait routing protocol and that of our Supp-Tran strategy under different type of mobility, to do that the most mobility models used are chosen to show how mobility model affects the forwarding strategy using as performance metric such as delivery probability, the number of dropped messages , buffer time average, the overhead ratio and average number of hops.

KEYWORDS

Mobility, Forwarding Strategies, Routing, DTN, Spray and wait, FIFO, SPMB, MOFO, GRTR RND, Delay Tolerant Networks, protocol

1. INTRODUCTION

Delay Tolerant Networks (DTN) is a concept initially created for interplanetary networks [1]. However, it also receives a great success for intermittently connected networks and particularly for opportunistic networks [2].

The objective of a DTN is to provide reliable communication in environments involving frequent breaking of network connections and extremely long delays in transmission.
In these networks, a node can send data to another if they are within the transmission range of each other. Due to the dynamic character of these networks, there is no guarantee that a direct connected path from a given source to a given destination exists at any time.
As a result, DTN routing enables communication in poor environments through replication of data from source node to transit nodes and delivery of the data to the destination by one of the nodes such as epidemic [3] and Spray and Wait [4] have been proposed to increase the message delivery ratio over such intermittently connected networks.

The performance evaluation of such protocols in terms of message delivery ratio and probability of deliverance is a difficult task due to the complexity to drive mobile network simulations. To evaluate the performance of DTN routing protocol, several simulators was been developed by researches groups to simulate the behavior of mobile nodes based on actual traces or on theoretical models .Today, The ONE simulator became a reference tool in this area [5].

Thus, in DTN, each node uses a store-carry-forward technique to send a message [2] Thus, in DTN, each node uses a store-carry-forward technique to send a message [2]. Which mean that it stores message that it receives and carries that message when it moves. Then, it forwards the message to other relay nodes or a destination node. Thereby, to design a DTN routing protocol such as epidemic and Spray and Wait have been proposed to increase the message delivery ratio, forwarding a message based on hop-by-hop routing decision is more useful than that is based on finding a fully connected end-to-end path.

The main problem for the transmission strategies is how to choose hops those have a high probability of meeting the final destination of the message, as the nodes are mobile and they continue to Create the messages when they move, that severely affects the number of node connection through its path, so the mobility model, affects the effectiveness of the chosen strategy, and then the routing protocol used. For this reason, the combination of forwarding strategy and mobility model can optimize a performance metric [7] and [8].

In our previous work of Supp-Tran [9] we inspect that spray and wait router is not showing good delivery probability in case of SPMBM and FIFO strategy compared to our technique. so in this work we explore spray and wait routing with other mobility models . And we evaluate buffer management policy FIFO and Supp-Tran with various mobility models under highly congested network. We have performed through the simulations that spray and wait routing protocol under four mobility models RWP, RW, SPMBM and MBM. The rest of the paper is organized as following: Section 2 elaborates on Existing forwarding strategies, Section 3 describes the DTN routing protocol under observation, Section 4 describes the mobility models, Section 5 summarizes the performance measures, Section 6 performance Simulation and results simulates are discussed in section 7-8 followed by a conclusion

2. FORWARDING STRATEGIES

2.1. GRTR

When two nodes A and B meet, the strategy is to calculate P(A,D) and P(B,D) which denotes respectively the delivery predictability [10] that a node A and B have for a destination D then the message must be carried by a node that has a higher delivery predictability for the destination of the message .

2.2. MOFO

This strategy records the number of times that message has been sent and classifies it according to a descending order, the more the number of the sent message is low, the more the message has a chance of being transmitted [10]. If the buffer is full the strategy deletes messages that have been sent many times. Messages that were sent several times are not sent and the ones that have not been sent or transmitted many times are sent because this increases their chances of reaching their destination

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2.3. First in First out (FIFO)

In this strategy, each node arranges its messages according to their time of reception, from the largest to the smallest, the message that arrives first must be forwarded the first [10].

2.4. Random Queue Mode (RND)

As its name suggests, this strategy selects messages to be transmitted in a random manner.

2.5. Supp-Tran

In case where the node B is not in the set of hops {(S, D, {(Ni, Ti)}} that is to say, it is neither source nor destination, nor the one of the nodes that participated in the transfer of messages, node A uses the information contained in the list of paths supplied by the set of paths extracted from the list ListeMAN (AB):

{(Sj,t0){(Ni,ti)}(Dj,tn+1)}:list of paths of messages successfully transmitted to their destination. {(Dj, tn +1) {(Ki, ti)}(Nj, tn)}: list of acknowledgments paths. Node A, creates a list of pairs of nodes (Ni, D) called Listech (D, Ni), then classifies messages in ascending order of the number of occurrence of nodes Ni and D and in descending order of hop number between them, thereafter, he selected from his neighborhoods who must carry the message [9].

3. PROTOCOL UNDER OBSERVATION

3.1 Spray and Wait Routing Protocol

Spray and Wait [4] routing protocol has been proposed to reduce the total number of copies sent across the network as is the case of epidemic routing. It uses the principle of epidemic routing but with a different strategy, in the spray phase, the nodes sent L copies to their neighbors and in the wait phase each relay nodes carrying the message until they meet the destination. In binary spray and wait version, each node sends half number of message copies to each node encountered in its path until that they have only one copy where they will wait until they successfully delivered the message to the destination.

4. MOBILITY MODELS UNDER OBSERVATION

4.1 Random Waypoint Model (RWP)

In this model, nodes move randomly in the area of simulation, each node chose his future destination, its speed and direction randomly, once arrived at the chosen place he takes wait time, and so on until the end of the simulation.

4.2. Random Walk (RW)

Random walk is a model where nodes are moved during a given time interval before changing their directions and speeds to go to another place, the choice of the speed and direction and the time interval, is a random.

4.3. Shortest Path map mobility (SPMBM)

SPMBM (Shortest Path Map Based Movement Model) [1] is a more realistic model it manages the movement of nodes in the simulation map scenario. It will provide destination coordinates, speeds, wait times, and uses Dijkstra's algorithm to find the shortest path to the destination. It places the nodes in random places but selects a certain destination in the map for all nodes.

4.4. Map mobility Models (MBM)

This model is based on a map of a given region, where nodes can randomly choose their future destination, provided they follow the predefined routes on the map.

4.5. Route map mobility Models (RMBM)

The route map mobility models are also extension of MBM [1] but it's used for the vehicle mobility, in this model, nodes travel randomly but always follow the determined paths defined by the map of simulation scenario which is effectively used for simulation of movement of nodes as in the case of buses and trams, determines stops during which nodes wait for a while before continuing their paths along the shortest way.

5. THE PERFOMANCE METRICES MEASURED

In order to show how combination of mobility models and Forwarding Strategy can optimize the performance of spray and wait routing protocol, As it was stated in many researches some parameters need to be defined to evaluate their performance. Given that to assess the impact of mobility models on forwarding strategy, we chose the metric most used in the literature.

5.1. Overhead ratio

Objective of any routing protocol is to minimize the value of overhead ratio [11] which can be defined as the subtraction of delivered (BD) from the bundle carried (BC) over bundles carried ((BC-BD)/BC).The overhead ratio reflects how many unnecessary messages are relayed to deliver one message. It reflects transmission cost in a network. The more the value of overhead is low the more the strategy used is efficient; this leads to a minimization of consumption of the network resources.

5.2. Delivery probability

This metric can be defined as ratio of the messages delivered over messages relayed. The higher values of probability mean that the performance of the algorithm is better

5.3. Hop count average

It is the mean of the number of hops which participate to relayed message from its source to its destination successfully. Higher values mean that the message has consumed many network resources before reaching its destination.

5.4. Buffer Time Average

The buffer time average is the average time spends by all messages in node buffer.

5.5. Dropped messages

It is a function to count number of messages dropped during transmission from node buffer.

6. Performance Analysis

To evaluate the combination of mobility models and forwarding strategy under spray and wait routing protocols in DTN network, the simulation has to consider performance metrics such as delivery rate, overhead ratio, number of hops, Message Drop and Buffer Time Average.

It is obvious that the higher deliver rate means the better performance on successful data delivery. However, the effort to get the higher deliver rate, a routing protocol has to send the more data into the networks. These additional data packets may result in communication overhead. Therefore, both delivery rate and communication overhead are analyzed simultaneously.

Finally, average number of hops is compared to demonstrate consumption of resources. Obviously, DTNs accept a tolerable delay for message delivery. However, some applications do not agree with the extremely higher number of hops when data is delivered from the source to the destination.

7. SIMULATION AND RESULTS

In this section, we observe the impact of different mobility models on the forwarding strategies, FIFO and Supp-Tran under spray and wait routing protocol, simulation is performed with the one simulator [5] which is developed with java language specifically to implement the bundle protocol that uses the principle store and forward. This mechanism allows nodes DTN keep messages received in their buffer and carry them along their paths until they encounter hops, which can closer the message of his final destination

First we consider delivery probability of spray and wait routing protocol with Forwarding Strategies FIFO and Supp-Tran with four mobility models as shown in figure 1. we can see that Supp-Tran have varying impact on delivery Probability, but higher delivery in case of SPMBM, RWP and RW. While in MPM Supp-Tran have the same delivery probability as FIFO. However in all the configuration of mobility models, delivery probability of Supp-Tran is improved than FIFO.

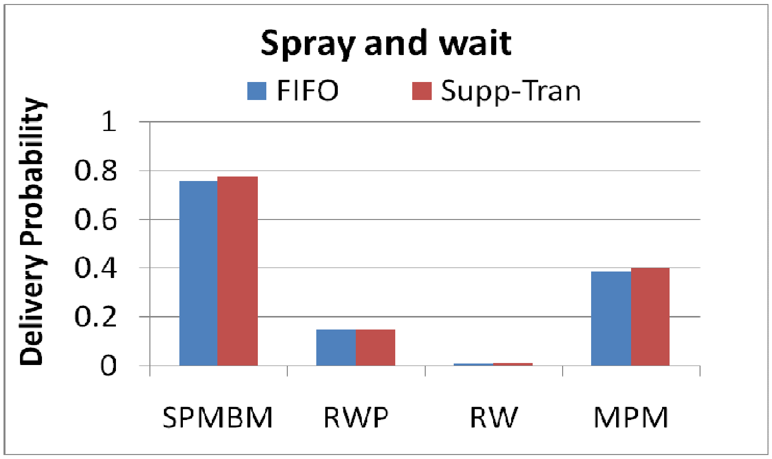

Figure 1. Delivery Probability w.r.t Mobility Models

Figure 2 represents the influence of Supp-Tran and FIFO with respect to overhead ratio with four mobility models. We can see clearly that the overhead ratio is very high in case of RW with using the two transmission strategy but FIFO has the very high result than Supp-Tran. Model SPMBM has the very low overhead in any transmission strategy. Whereas in case of RWP and MPM the two technique show the same behavior.

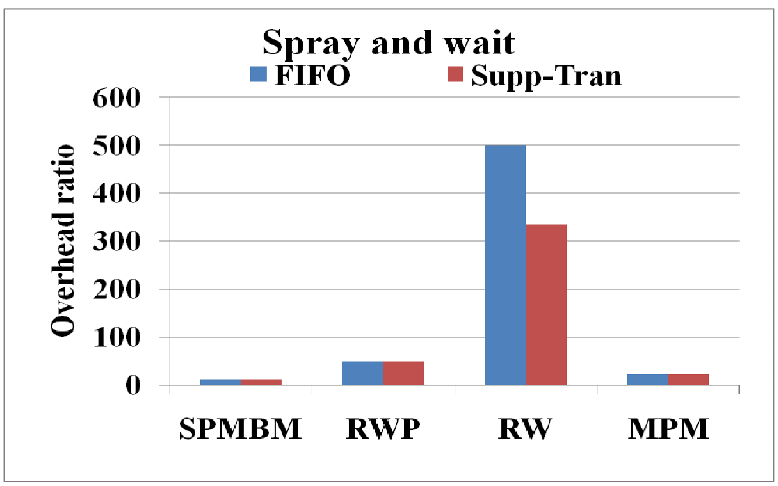

Figure 2. Overhead ratio w.r.t Mobility Models

Figure 3 observes buffer time average with FIFO and Supp-Tran under four mobility models. We note that with the FIFO strategy the value of buffer time average is higher regardless of the mobility model used, by against with supp-tran strategy buffer time average is a little low for SPMBM and MPM model and less low than that observed with FIFO in all models.

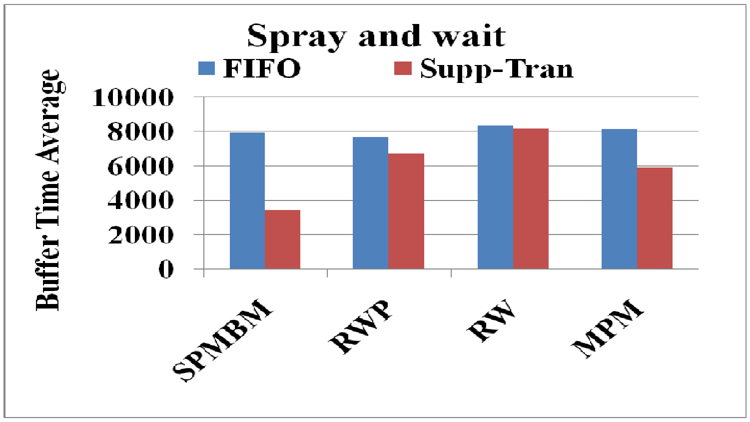

Figure 3. Buffer Time Average w.r.t Mobility Models

Figure 4 plot the impact of message dropped with Supp-Tran and FIFO. In all Mobility models configurations supp-Tran reduce the message drops to a significant quantity. with SPMBM ,MPM and RWP, FIFO strategy dropped highest ratio of the messages This is very less in case of RW model. Then we conclude that Supp-Tran optimize the message drop metric.

Figure 5 observes Hop Count Average with Supp-Tran and FIFO. It shows that the two strategies has same value of hop count average with all mobility models. Expect for RW where FIFO has a less hop count average but considering other metrics mainly overhead ratio, we see that Sup-Tran is better than FIFO.

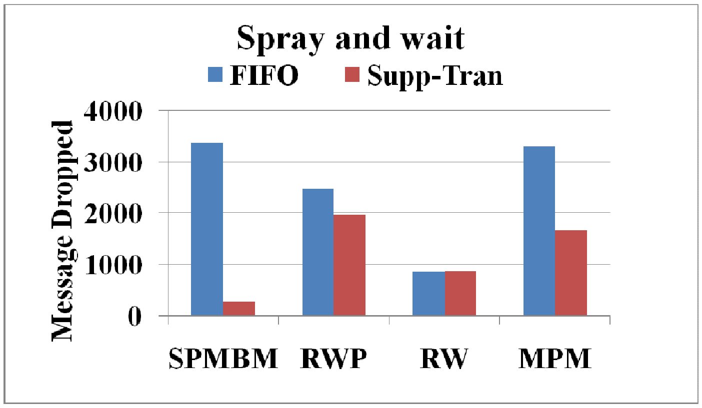

Figure 4. Message dropped w.r.t Mobility Models

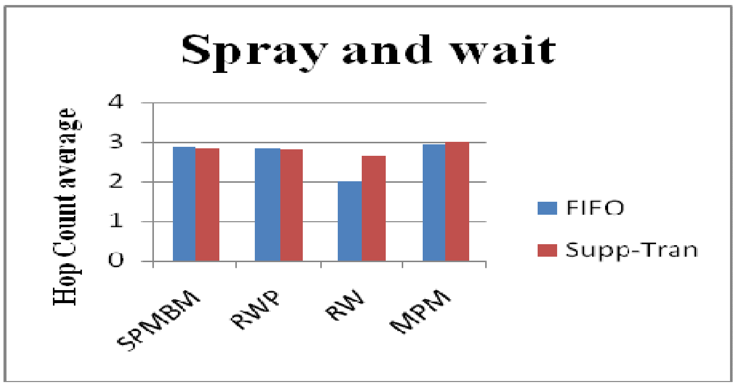

Figure 5. Hop count average w.r.t Mobility Models

8. CONCLUSIONS

In this article, we have seen the impact of different mobility models on forwarding strategies. After performing the simulation on spray and wait routing protocol it can be conclude that forwarding strategies and mobility models affect the overall performance of the routing protocol strategy used by the nodes. Given that the mobility of nodes is a key factor that affects their behavior in network. The mobility models taken are all different in characteristics and movement of nodes. By performing the simulation, it can be concluded that Supp-Tran has good results in all scenarios which mean that supp-Tran optimize the performance of the routing protocol also in metrics like overhead ratio and Message Dropped and buffer time average compared to FIFO. In this paper the spray and wait routing protocol was taken under observation. In future many other protocols can be tested with different mobility model and different forwarding strategies .In this paper we confirm the performance of our Supp-Tran strategy with four model mobility so with this work it has been shown that it is preferable to use our strategy that the FIFO strategy to increase the efficiency of routing and spray wait.

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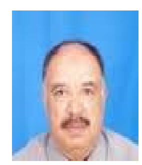
Authors

Mohamed ababou: PhD student at the doctoral studies center, National Institute of Posts and Telecommunications Rabat, Morocco.His research interests are computer science, DTN Networ k. Master Course in Informatics Telecommunications && Multimedia at Faculty of Science , Mohammed V- University, Rabat, Morocco.

Rachid Elkouch :The INPT prepares and coach engineers in networks Telecoms, Computer science and Multimedia. These engineers could be future companies responsible, in a world open to the dynamic of the networks and information systems , PHD in Maths/Telecommunications - National Institute of Posts and Telecommunications



Nabil ababou: PhD student at the doctoral studies center, Faculty Mohamed I oujda , Morocco.His research interests are computer science, research in programming language. Master Course in Informatics at Faculty of Science Mohamed 1, Oujda, Morocco