PERFORMANCE ANALYSIS OF SPRAY AND FOCUS ON VEHICULAR DELAY TOLERANT NETWORK (VDTN) WITH SHORTEST PATH MAP BASED MOVEMENT

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Abstract - DTN is wirelees network where nodes communicate cannot be determined time or it can be said that the relationship between nodes rare. Unlike conventional network mobile ad hoc network (MANET), the end-to-end between the source with destination node will only is ready in a short time and are not predictable. DTN has the dynamic characteristics. The node on the DTN can be a source node, intermediate nodes or destination node, consisting of mobile node and static nodes connected with high delay. Spray and Focus Routing there are 2 schemes, the first scheme to be generated a spray scheme (spraying). The spraying scheme is a number of copies or "forwarding tokens" to a number of different nodes, the node is called the relay node. Then, go to the second scheme where each relay will carry the copy and move to another node corresponding to the destination node, if the node does not directly meet the destination node and the previous step will continue to repeat until the destination node or Time To Live of the message is up. Based on observation, the resulting Spray and Focus routing algorithm improve performance packet delivery ratio (PDR)than Spray and Wait routing algorithm, but Spray and Wait have better Avarage Latency than Spray and Focus routing algorithm.

Index Terms - Spray and Focus,One Simulator, Packet Delivery Ratio, Average latency

I. INTRODUCTION

Delay Tolerant Network (DTN) is a wireless network where the not have of a proper time for nodes communicating with other nodes or it can be said that the communicating between nodes are rare. Unlike conventional network mobile ad hoc network (MANET), besides the path end-to-end between the source with destination will only is ready in a short time and are not predictable. Characters from the DTN is a dynamic [1]. The node on the DTN can be a source node, intermediate nodes (relay) or destination node node, and connect with a high delay. In the case of a network like this is called opportunistic network [1] [2].

Opportunistic network is the development of Mobile Ad hoc Network (MANET). On Opportunistic network nodes can be connected to other nodes by although no route between the two nodes. Next, the node which works on Opportunistic network topology will not know on the network that are running the node, which it sorely needed on conventional MANET [3]. On Opportunistic network, network topology are not reflected explicitly because the nodes are always moving with speed and random movement. Because the connection end-to-end is not always there, so the mobility on opportunistic network can be used as a means of communication between separate nodes. By using the paradigm store-carry-and-forward [4].

Routing is processto be looking for a line (search for line that will pass) optimized for connecting the source nodes and destination nodes so that data packets are delivered on time. Could have been a route on the network topology VANET has many other nodes that must be traversed. And because the network topology VANET often change then it will be very concerned with the Energy Consumption of each nodes. In addition to that of the many protocols of ad-hoc routing protocol-based DTN, rated as the most efficient routing protocol for VANET [5].

VDTN is a communication-based Delay Tolerant Nework (DTN) with the characteristics that vehicle haverouters and communicate with other vehicle units to receive the data from the source to the traffic to the destination. On this final assignment authors will analyse the performance of the Spray and Focus Routing in Vehicular Delay Tolerant Network to find out the influence of major changes the density of nodes, message size, Time to Live. A routing protocol is called Spray and Focus Routing where packets shipped to the destination by selecting the node was ever associated with the destination node, so the message can be quickly delivered to the destination node.

Next section will explain more about routing algorithm Spray and Focus. In Section 3 is the result about algorithm routing Spray and Focus with specific scenario and last section about the conclusion.

II. SPRAY AND FOCUS

Spraying scheme that already exist [6, 7], it will generate and then distribute (“spray”) with small number of relay node, it will distribute fixed number of copies or it called “forwarding tokens”. Then every relay that have the copy will carries the copy until it find the destination node or TTL (Time To Live) for the packet is expires. With this spraying schame it

will make many relay node that independently looking for the destination node, these protocols will make connectivity graph more efficiently and make haste to find the destination node.Although the spray scheme has been shown to perform well in some scenarios, the scheme also requires high mobility to reach this best performance [8].

A. Spraying Phase

Each time message will be send, it will be generated by source node and message is will need routing path to the destination. That why Spray and Focus will enter first phase, it called "Spray phase" :

Each node maintains a "summary vector" with the ID of all messages that have been stored, and which acts as a relay; each time the two nodes meet each other, they exchange vectors and check their message that has the equation (as epidemic routing [9]).

When a new message is generated on the source node, it will also generate L "forwarding tokens" for this message. Forwarding tokens initialize that nodes that have this token forwarding can duplicate and forward additional copies of messages provided, when if a node carries "forwarding token" = n > 1 and meets the node without a copy message, then the node that has forwarding token will pass n / 2 (half) and keep n / 2 (half) for himself(Binary Spraying [7]). When a node has a copy of message but there is only one forwarding token (n = 1) for the message, then the message can only be forwarded further according to the "focus phase".

Node encounters: Assume that nodes periodically send beacons to recognize the presence of nodes with each other. This beacon period has an effect on the performance of the protocol if it is not often sent, consequently the opportunity for "forwarding" will be missed.Ideally the nodes "encounters" to each other once the node is within range of communication. In addition, overhead is also involved in exchanging message summaries (message summaries). Therefore, each ID of the message is expected to occupy a location in just a few bytes (eg source ID, destination ID, and sequence number). It is expected that the incoming message delivery queue into the buffer is relatively low[8].

Spraying mechanism: The number of copies of the message (forwarding token) that must be distributed to different relay nodes using a binary spraying algorithm. Ideally, a relay node is chosen based on its tendency to meet the destination more often[8].

B. Focus Phase

When a relay node that gets a message has only one forwarding token, it is in this condition that we will switch to "focus phase". In this phase, the message can be forwarded to a different relay according to the given forwarding criteria. In particular, this forwarding decision is taken based on a set of timers that record the time when the last two nodes meet.

C. Spray and Focus

This is the summarize for how Spray and Focus routing protocols works:

Message summary vectors: every node have to maintains "summary vector" with the ID of all message that it have in it buffer; whenever two node meet each other, they will exchange their vector and message that they have on buffer. And each message have TTL (Time To Live) that when it was expired, the message and vector will be drop.

Last encounter timers: every node also have to maintains a timer when node encounter other node in the network.

III. SCENARIO AND SYSTEM DESIGN

The above mentioned routing protocols were analyzed on Opportunistic Network Environment (ONE) simulator. This simulator is designed for evaluating the performance of DTN routing protocol. ONE simulator uses Java programming language. The main functions of ONE are modeling the node movement, inter node contacts The interface in network are Wifi interfaces with transmit range is 10 meters and transmission speed is 2 Mbps or 250 kBps. Actually there are two wireless technologies available for ad-hoc connectivity on mobile phones namely WiFi and Bluetooth. In this paper considering Wifi connection due to only one with a reference implementation supporting the deployment of DTN protocols. The map size is width 4500 meters and height 3400 meters. The time simulation is 5 hours. The simulation configuration consists of varying density node, varying message size and varying time to live (TTL).

Table1
Simulation Parameters

Parameter	Skenario
Operation Systen	Linux Ubuntu 12.04 64 bit (dalam vmware windows 10 64 bit)
Simulator for Mobility	ONE Simulator (version 1.4.1)
Routing Algorithm	Spray and Focus dan Spray and Wait
Mobility Model	Shortest Path Map Based Movement
Vehicle Density	60 - 150
Buffer Size	5MB
Speed of Vehicle	90 km/jam
Simulation Time	18000 seconds/ 5 hours
Transmission Speed	2Mbps
Message Size	20kB – 30kB, 400kB – 600kB
Mobility Model	Map based movement
Time To Live	5 – 50 menit, 60 menit

IV. PERFORMANCE METRICS

There are two metrics are concerned for measurement the performance namely delivery probability, and latency average. The results of these metrics are obtained by ONE simulator. The performance metrics descriptions are shown in below.

A. Delivery probabilityis ratio between successful messages arrives in destination node and number of message has been delivered [16]. The network has good performance if high the delivery probability. It means more messages are received in destination node.

$$\text{Delivery Probability} = \frac{\Sigma \text{ number of message received}}{\Sigma \text{ number of message sent}}$$

B. Latency average is average time between messages are produced and messages are received by destination node [17]. Opportunistic network has high latency average due to nature of its network. Network called good performance if less latency average.

$$= \sum_{i=1}^{n} \left(\frac{time\ massage\ received - time\ massage\ produce}{number\ of\ massage\ received}\right)$$

V. RESULT AND EVALUATION

This section discussed about performance of this algorithms namely, Spray and focus, and Spray and wait according to value of delivery probability, and latency average. The experiments consist of varying of buffer size, varying of message size and varying of time to live. The results are obtained from the experiment on ONE simulator and it defines in below.

A. Varying Density Node (Message Size 20kB – 30kB)

This chapter discussed the performance of network if give the varying value of density node. The value of density node are 60 – 150 nodes with the addition of 10 per step.

TABLE 2
THE TEST RESULT AS DENSITY NODE ARE VARIED (20KB-30KB)

Density Node	started		delivered	
	Focus	Wait	Focus	Wait
60	1663	993	74	45
70	1732	1159	102	39
80	2091	1293	88	44
90	2387	1564	125	70
100	2577	1658	96	42
110	1980	1980	71	71
120	3380	2103	131	71
130	3723	2266	135	77
140	3681	2290	132	83
150	4217	2473	149	84

As we can see that all routing protocol have increase performance as long as density node increase.

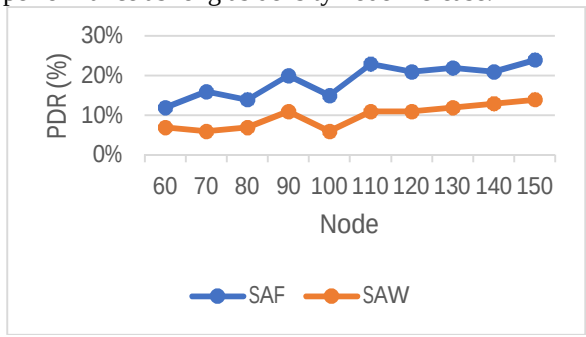


Figure 1. Delivery Probability as density Node are varied

At the first measurement, the writer will analyze packet delivery ratio (PDR) using message size 20 KB – 30kB can be seen that the node density of 50 nodes up to 150 nodes to PDR obtained, growing population density his node then its the larger percentage of PDR, although not every node density increase the percentage increase in the PDR. But in general the node density of 50 to 150 increase PDR obtained. In addition from the routing algorithm used both spray and focus showed better results than spray and wait with the end result as follows, at a density of 150 nodes percentage of PDR of 24% while the spray and wait gain PDR percentage 14%.

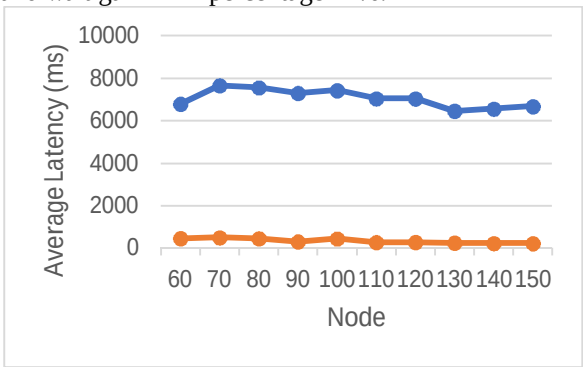


Figure 2. Average Latency as density Node are varied

On the measurement of the first to analyze the average latency by using message size 20 KB – 30kB can be seen that the node density effect on the average delay, the greater the density of his increasingly good node also average latency obtained. But can be seen in Figure 2 that the routing algorithm Spray and Focus get average latency greater than routing algorithm with Spray and Wait. The author will explain why this could happen. Can be seen in table 2 that packages sent by the routing algorithm Spray and the Focus is always greater or equal to Spray and Wait, for example at a density of 70 nodes Spray and Focus can send messages up to 102 messages. Whereas in Spray and Wait only can send messages up to 39messages. Since the results obtained from the Result file are by using average latency, then the value obtained by Spray and Focus will be great as many packets are successfully sent to the destination node.

C. Varying Density Node (Message Size 400kB – 600kB)

TABLE 3
THE TEST RESULT AS DENSITY NODE ARE VARIED (400KB-600KB)

Density Node	started		Delivered	
	Focus	Wait	Focus	Wait
60	929	866	30	13
70	1044	606	41	10
80	1262	1183	32	10
90	1547	1436	51	26
100	1761	1565	41	12
110	2246	1959	50	19
120	2383	2113	56	28
130	2640	2360	70	29
140	2663	2426	68	26
150	3056	2693	69	22

As we can see that all routing protocol have increase performance as long as density node increase.

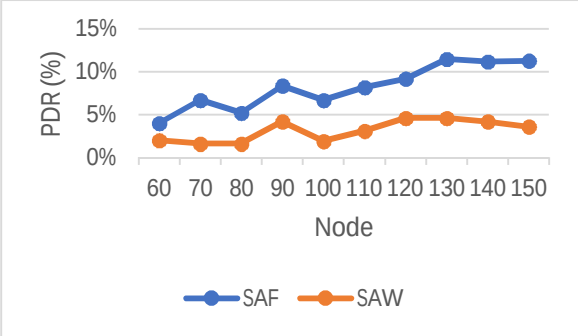


Figure 3. Delivery Probability as density Node are varied

At the second measurement for analyzing packet delivery ratio (PDR) by using 400kB – 600 KB message size, it can be seen that the node density of 50 nodes up to 150 nodes to PDR acquired, increasing the density of its node then his increasingly larger percentage of the PDR, although not every node density increase the percentage increase in the PDR. But in general the node density of 50 to 150 increase PDR obtained. When compared to Figure 1 can be seen that the Figure 1 has better result than Figure 2. Because the routing algorithm get loads more by sending message size magnitude 20 times compared in Figure 1, therefore There is a decline in PDR quality. In addition from the routing algorithm used both spray and focus showed better results than spray and wait with the end result as follows, at a density of 150 nodes PDR percentage of 11% while the spray and wait gain PDR percentage of 4%.

On the measurement of both to analyze the average latency by using message size 400kB – 600 KB can be seen that the node density effect on the average delay, the greater the density of his increasingly good node also average latency obtained. But can be seen in Figure 4 that the routing algorithm Spray and Focus get average latency greater than routing algorithm with Spray and Wait. The author will explain why this could happen. Can be seen in table 3 that packages sent by the routing algorithm Spray and the Focus is always greater or equal to Spray and Wait, for example at a density of 70 nodes Spray and Focus can send messages up to 41, where in Spray and Wait can only send message up to 10. Since the results obtained from the Result file are by using average latency, then the value obtained by Spray and Focus will be great as many packets are successfully sent to the destination node.

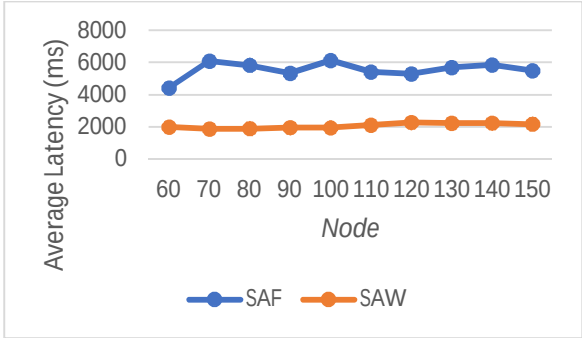


Figure 4. Average Latency as density Node are varied

D. Varying Time To Live (Message Size 20kB – 30kB)

This chapter discussed the performance of network if give the varying value of Time To Live. The value of density node are 5 – 50 nodes with the addition of 5 per step.

TABLE 4
THE TEST RESULT AS TIME TO LIVE ARE VARIED (20KB-30KB)

Time To Live	started		delivered	
	Focus	Wait	Focus	Wait
5	4217	261	149	4
10	4217	620	149	11
15	4217	976	149	17
20	4217	1260	149	22
25	4217	1495	149	26
30	4217	1730	149	31
35	4217	1896	149	34
40	4217	2066	149	44
45	4217	2197	149	55
50	4217	2302	149	66

As we can see that routing algorithm Spray and Focus give stagnan result as long as Time To Live increase.

This measurements to analyzing packet delivery ratio (PDR) using message size 20 KB – 30kB can be seen that the Time To Live in the PDR to node obtains, the more Time To Live used node then the percentage PDR him getting bigger. But it can be seen from Figure 5 that Spray and Focus gives the results of the measurements does not change though the TTL

offered up. It can be seen from the table 4, started to see that Spray and Focus have 4217 copies and Spray and Wait only has 50 TTL on 50 minutes. That why Spray and Focus was stagnan result of the PDR result though with very small TTL. In this scenario author just use stagnan value of speed node, and in this scenario just have single cluster. This scenario also affect the result. In addition from the routing algorithm used both spray and focus showed better results than spray and wait with the end result as follows, in a 50-minute node TTL percentage PDR of 24% while the spray and wait gain PDR percentage of 10%.

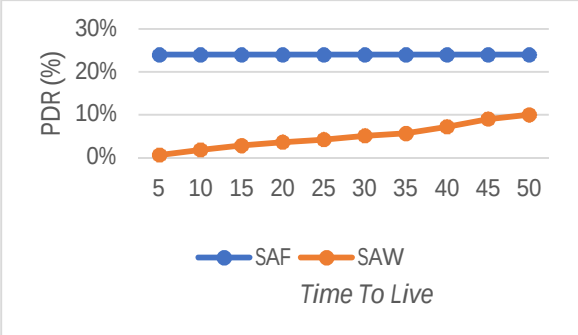


Figure 5. Delivery Probability as Time To Live are varied

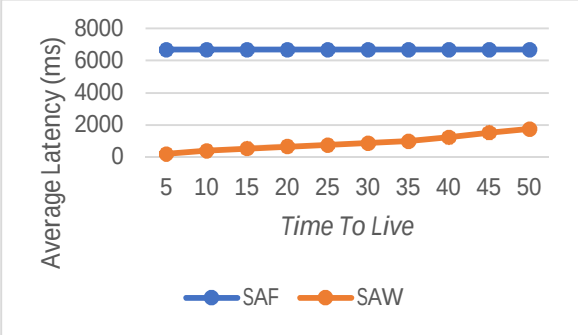


Figure 6. Average Latency as Time To Live are varied

This measurement to analyze the average latency by using message size 20 KB – 30kB can be seen that the Time To Live have an effect on the average delay, the greater the Time To Live his increasingly good node also average latency obtained. But can be seen in Figure 6 routing algorithm that Spray and Focus get average latency greater than routing algorithm with Spray and Wait. The author will explain why this could happen. Can be seen in table 4 that packages sent by the routing algorithm Spray and the Focus is always greater or equal to Spray and Wait, for example on a 50-minute TTL Spray and Focus have been sending messages up to 149, where as in Spray and Wait is only can send message up to 66. In this scenario author just use stagnan value of speed node, and in this scenario just have single cluster. This scenario also affect the result. Although not in all circumstances Spray and Focus better than Spray and Wait.

E. Varying Time To Live (Message Size 400kB – 600kB)

TABLE 5
THE TEST RESULT AS TIME TO LIVE ARE VARIED (20KB-30KB)

Time To Live	started		delivered	
	Focus	Wait	Focus	Wait
5	3056	250	69	3
10	3056	561	69	5
15	3056	876	69	7
20	3056	1178	69	8
25	3056	1420	69	8
30	3056	1674	69	8
35	3056	1876	69	9
40	3056	2081	69	9
45	3056	2256	69	11
50	3056	2409	69	14

As we can see that routing algorithm Spray and Focus give stagnan result as long as Time To Live increase.

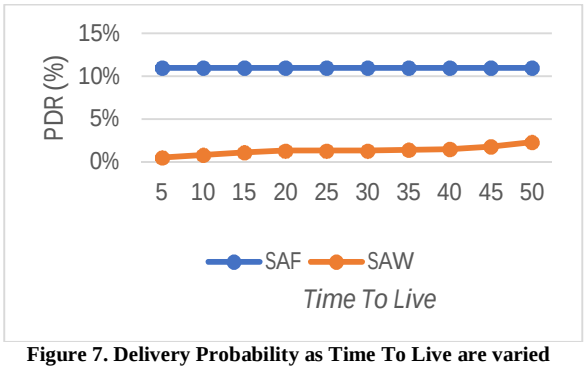


Figure 7. Delivery Probability as Time To Live are varied

This measurements to analyzing packet delivery ratio (PDR) using message size 20 KB – 30kB can be seen that the Time To Live in the PDR to node obtained by Spray and Wait, the greater the Time To Live that is used the node then its the larger percentage of PDR. But it can be seen from Figure 4.7 that Spray and Focus delivers results measurement of the PDR has not changed although the TTL offered up. It can be seen from the table in section 5, started to see that Spray and Focus have 3056 copies and Spray and Wait only have 50 minutes TTL on 2409. In this scenario author just use stagnan value of speed node, and in this scenario just have single cluster. This scenario also affect the result. In addition from the routing algorithm used both spray and focus showed better results than spray and wait with the end result as follows, in a 50-minute node TTL PDR percentage of 11% while the spray and wait gain PDR percentage 2%.

This measurement to analyze the average latency by using message size 400 KB – 600kB can be seen that the Time To Live have an effect on the average delay, the greater the Time To Live his increasingly good

node also average latency obtained. But can be seen in Figure 8 routing algorithm that Spray and Focus get average latency greater than routing algorithm with Spray and Wait. The author will explain why this could happen. Can be seen in table 5 that packages sent by the routing algorithm Spray and the Focus is always greater or equal to Spray and Wait, for example on a 50-minute TTL Spray and Focus have been sending messages up to 69, where as in Spray and Wait is only can send message up to 14. In this scenario author just use stagnan value of speed node, and in this scenario just have single cluster. This scenario also affect the result. Although not in all circumstances Spray and Focus better than Spray and Wait.

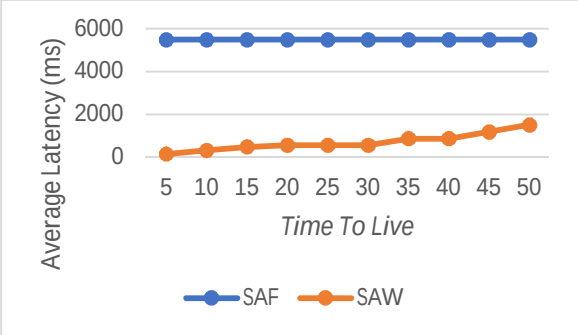


Figure 8. Average Latency as Time To Live are varied

CONCLUSIONS

The conclusion that can be drawn from the entire process of design, simulation and analysis are as follows:

Spray and Focus routing algorithm routing algorithm is the best in terms of packet delivery ratio (PDR) compared to Spray and Wait routing. With the highest percentage of PDR product 24% at the time of the TTL = 50 minutes, message size 20 KB – 30kB, 400kB – masssage size 600 KB, and with a density of 150 nodes.Because at the moment Focus Phase makes each node able to duplicate its message and send it to relay node which has destination node ID or directly to destination node.

Spray and Focus routing algorithm has greater average latency result than Spray and Wait routing for message size 20 kB - 30 kB and message size 400 kB - 600 kB. Due to the large number of messages on Spray and Focus that are up to a large latency.

In addition the overall message size has decreased performance, both on Spray and Focus and Spray and Wait due with a large message size and with a limited delivery speed of just 2 Mbps to make longer messages sent and the magnitude of the message makes the bundle layer full fast, thus creating many dropped messages.

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