Routing VDTN for Delay Enhancement in V2V Clustering Network

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***Abstract* - Data communication especially mobility communication is growth rapidly. One of them is Vehicular Ad Hoc Network (VANET) which gives capability to communicate among vehicle nodes. These communication models have many challenges, such as node density, high mobility nodes that causing network fragmented so that the message could not be send to the destination. This research is focusing to evaluate a combination VDTN routing in clustering velocity and to maintain the enhancement delay. Analyzing the simulation is run on ONE Simulator in the real map mobility model with numbers node density to present the communication. To verify the research results for delay control are compared other VDTN routing, i.e. Spray and Wait and also Maxprop. As a result the improvement of average delay is 48% better compared to Spray and Wait and 27% better compared to MaxProp, and 5% better for development routing in VDTN without clustering configuration network.**

Keywords - VANET, VDTN, Spray and Wait, Maxprop, Average Delay.

I. INTRODUCTION

Nowadays, mobility telecommunication that empowers numerous applications for safety, traffic condition, route planning was developed and known as Vehicular Ad-hoc Network (VANET). Based on [1] VANET have specific form of Mobile Ad-hoc Network (MANET) that facilitates communication among close vehicles (V2V) and among vehicles to fixed infrastructure (V2I). High mobility of vehicles, unpredictable nodes position, and security are some challenges in VANET to be considered by develop new protocol [1]. It is impossible to use traditional method of communication which is connected direct path between source and destination in high vehicles mobility. A method was developed known as Delay Tolerant Network where the communication data is by relaying the message through the mobile node from the source node to the destination [2]. Data will be stored in buffer, as long as the other nodes are not available during relaying process. So that communication in sparse condition, intermittent connection, high latency and delay could be tolerated in DTN. Nowadays, DTN routing also been applied in VANET. The DTN construction modeling have been connected for vehicular network and known as Vehicular Delay Tolerant Networks [3]. Much research is already done about VDTN either for performance evaluation between VDTN routing or developed new VDTN routing mechanism. In [4] VDTN routing was developed to compare with previous research for some VDTN routing to cover the urban public transport area.

In [5][6][7] many DTN routing strategy were compared and mapped based on some characteristics. Some parameters were mentioned, for example broadcast strategy, performance evaluation, and drawback. Specifically in [8] Spray and Wait which is categorized as forwarding routing was introduced to improve performance in VDTN. This VDTN routing gives outperformed in performance. Spray and Wait figure out the debilitation of floading-based model and dodge the performance quandary in utility-based model. Maxprop routing [9], the other research also aims to improve the performance of VDTN routing by organizing both the declination packet sent to other peers and the declination dropped packets. The prioritizing scheme in Maxprop is according the historical data during the communication occur. In [10][11] are describe another approach to improve the performance by clustering in VANET network. By clustering, it is possible to control schemes that VANET topology less dynamic. Clustering network scheme can be defined by density, velocity, and dynamic routing. The connectivity in high mobility and density node can influence the performance of VANET, so that it need to evaluate what is the implication VDTN routing in performance of VANET.

The main focus in this paper is to figure out the performance proposed developed routing in VDTN in clustering configuration by velocity of vehicles proportionally. Analyzing will be done through simulation the proposed developed routing and compared with Spray and Wait –Maxprop routing algorithm.

This paper is composed into some section to facilitate the content: section I, the VANET and VDTN introduction. In the section II, it presents the related work. In section III, it will provide information about simulation and scenario process of the proposed developed routing. In section IV, it provides the simulation report and analysis the mobility model run in ONE Simulator. While in section V, tell the conclusion of the whole process and suggestion for the future work about VDTN routing.

II. RELATED WORK

The researches Objective is develop a method that enhances the delay in Vehicle Delay Tolerant Network. Common routing is not appropriate for the type of network

with high sparse condition and high mobility changes. By this condition, it is developed a design new algorithm in VDTN protocol known as Spray and Wait. In [8] can be described that there are two phase for communication process between nodes. It is consist of following two phases in Spray and Wait and named spray phase and wait phase. Firstly, the L copies message will be spreaded from each origin message. The next process, L copy will be forwarded, and possibly the neighbors receive the copy and relay the L message distinctly. When during the communication process the neighbor as the destination cannot be found, the message copy will be forwarded the destination directly.

This algorithm was created by concatenating the two previous routing; the direct transmission method and epidemic. A mechanism "jump-starts" in this routing scheme was created to grant the same affect with epidemic routing. This scheme will work as spreading message copies during the transmission. When there are sufficient resource copies to be spread, it will guarantee the high probability communication. The process "relay" will stop when during transmission cannot find the neighbor, and direct transmission will be undertaken by each node carrying copy message. But it leaves an issue that the L copies process in spray phase firstly. A various distinctive "spraying" heuristics can be imagined. After it common Spray and Wait, to improve the performance for it algorithm the Binary Spray and Wait was developed. In [8], it can be defined below:

Firstly, the source will initialize L copy during the transmission. Any neighbors that has n>1 will define message copy whether source or relay. It encounters to node B (no copies), handover to B (n/2) and keep for itself. When no one copy for relaying process, it will switch to direct transmission.

Maxprop[9] uses several mechanisms to create estimation for determines which packet are transmitted during the communication process. Prioritizing is used to determine the path based on historical data during the communication according to the various mechanisms.

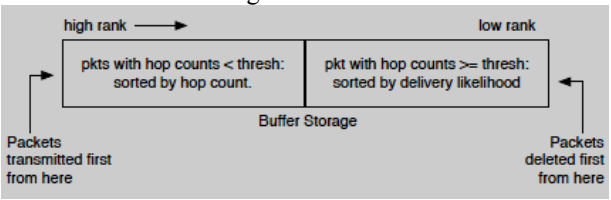


Figure 1 Maxprop Routing Strategy [9]

Based on figure 1, it can be explained that Maxprop determine the path during transmission by calculating cost that assigned to the each neighbor as the destination target. All cost will be ranked and be listed for all peers. During the transmission process, it uses acknowledgments sent to all neighbors as notification when the packet deliveries. This routing algorithm strives to prevent the packet will be sent twice and sets priority to new packets that has the highest rank. To determine a data transfer from source to destination some mechanisms were considered in the MaxProp's routing:

- *Estimating Delivery (Dijkstra Algorithm)*
  - Maxprop consider the probability. The likelihood is the following contact (node) set up to the node.
  - The smallest cost associated to the destination, will be associated with different path *d.*
- *Complementary Mechanism*

  In relaying process, when the node meets the neighbor, Maxprop will check the possibility the data packets exchanges in specific priority order. More specific, the limitation threshold will be rechecked after each transmission especially buffer availability. Process checking will use the condition:
  - If $x < b/2$, then $p = x$
  - If $b/2 \leq x < b$, then $p = \min(x, b - x)$
  - If $b < x$, then $p = 0$
- *Managing buffer*

  By managing buffer it is possibly to manage the storage limitation and transmission limitation. The different between both of them is the packets that are sent in one transfer opportunity may be sent in the next opportunity. It is never delivered when the packet is dropped from the buffer.

The clustering scheme should be considered to improve affectivity and scalability. One method of it scheme is by grouping the nodes aim to get greatly network performance. This configuration is virtually creating the formation and support data delivery enhances the resource consumption [10]. It is not only focus on forming minimum numbers of cluster to create good clustering but also dynamically maintain the cluster structure without increasing a high communication overhead over the network. It could be implemented based on metrics such as speed, location, direction movement, or radio power meter [11]. This paper considers the clustering method by grouping the small number of vehicles based on speed.

In table 1 shows the comparison between Spray and Wait and Maxprop routing for some parameters. In [15], it is described that the performance routing between Spray and Wait and Maxprop for average delay are opposite each others.

Table 1 COMPARISON SPRAY AND WAIT AND MAXPROP [15]

Parameters	SprayAndWait	MaxProp	Explanation
Overhead ratio	less	more	
Average Delay	higher	less	large buffer & big number node

Based on table 1, a developed routing in VDTN is created to enhance the delay performance that combines Spray and Wait and Maxprop routing. It developed routing will be ran in clustering configuration that is divided the vehicle nodes into group of speed. This combination VDTN

routing will allow some mechanism from Spray and Wait and MaxProp. It can be shown as follows:

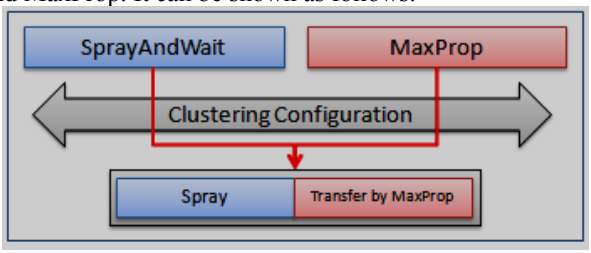


Figure 2 Proposed Developed Routing

Based on figure 2, mechanism broadcast or forwarding message will be started by Spray mechanism and Maxprop routing as transfer mechanism. All scenarios will be run on ONE Simulator. It is an agent-based discrete event simulation tools. Every step in the simulation, the modules as the main simulation function must be developed and will be run in the engine [12]. The primary capacity of ONE Simulator is how to create node movement model communication, routing, inter-code contacts and message handling. Finally the simulation process will give result. The result will be presented and analyzed through visualization, report and other data processing. With ONE Simulator VDTN could be accommodate and run properly to analyze the proposed developed routing.

III. SIMULATION SCENARIO AND PROCESS

The simulation is using ONE Simulator for mobility modeling, and java programming language. The limitation in this research will be characterized below:

- Geographical map model in Cikampek highway along 70 km length.
- Two way direction with clustering routing model.

A. Assumption and Simulation Scenario

The main scenario in this research is testing the proposed routing with clustering configuration based on velocity and compared with existing routing schemes Spray and Wait and MaxProp. During the test, some assumptions are defined as the research focus, as follows:

- In Spray and Wait and Maxprop using default parameters which are VDTN routing will be compared with proposed developed routing.
- The scenario is tested by five different density of vehicles, i.e. 30, 60, 90, 120, and 150. Not only density is defined, different buffer size also examined as research scenario, i.e. 3, 5, and 8.
- Each density and also buffer size sub scenario, it will be grouped based on velocity into three categories, i.e. For example in the 90 density sub scenario, the cars density will be divided into three speed range slow for 70 to 90 km/hour, medium for 90 to110 km/hour and fast for 110 to 130 km/hour.

B. Simulation Process

Furthermore, the research simulation process could be described using process diagram on figure 3. This process diagram is described that the simulation start from determine the system configuration of the network topology, operating system and also simulation software which are mandatory be prepared.

In figure 1, it is shown the simulation map will be loaded into the Simulator. Some VDTN routing protocol will be ran into the simulation and it will be compare with the proposed developed VDTN routing in this research. The complete process within this research will be shown as follows:

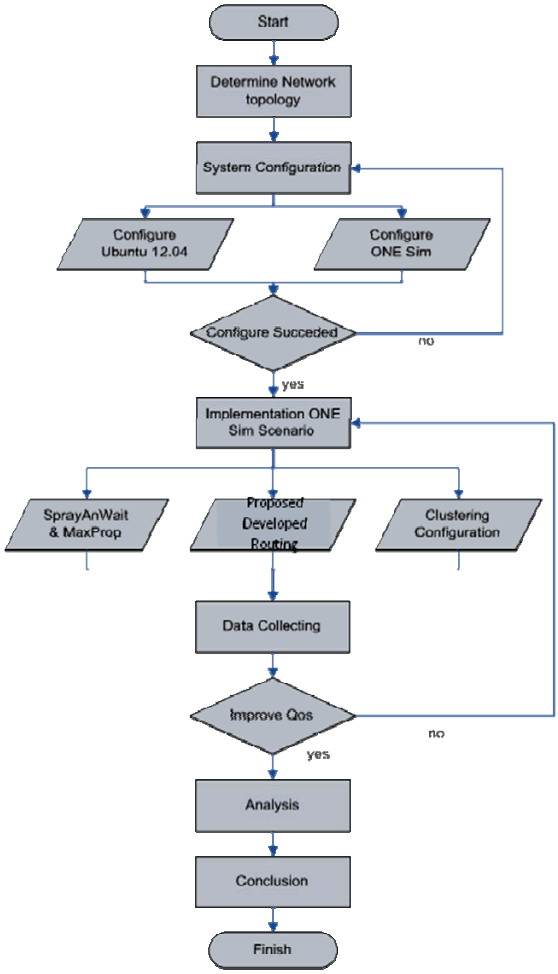


Figure 3 Simulation Process

C. Simulation Testing

After determine the network topology based on simulation scenario, it will be tested on 802.11p standard. The system configuration uses Linux Ubuntu 12.04 operating system and for mobility model and analysis uses ONE Simulator. All scenarios will be run into ONE Simulator and produce movement file during the

communication between the nodes. In processing data, some parameters were produced such as delay, packet data ratio and etc. In this research we are only focus on delay parameter as impact as vehicles density, velocity, and buffer sizes.

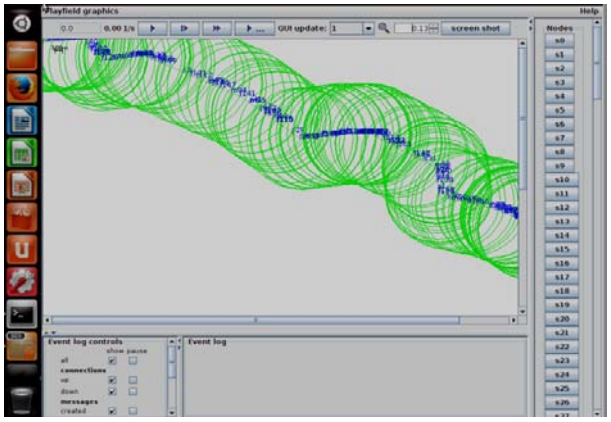


Figure 4 Node Mobility Simulation Model

Figure 4 shows the mobility model simulation, which are the nodes are divided into 3 groups within the cluster. Low speed vehicles are marked by s (slow), the middle one is marked as m (medium) and faster speed vehicles marked as f (fast). The communication radius is marked with green circle area. All simulation parameters could be shown below:

Table 2 RESEARCH PARAMETERS

Simulation Parameters	***Value***
Number of Nodes	30 - 150
Radius are focused communication	700 m
Speed range	70 - 130 km/h
Highway Length	70 km
Simulation time	1000 s
Buffer sizes	3 - 8 MB
Clustering	Velocity

Adjusting to the interface which be used during the simulation in this research is very simply. It can adjust the transmission on int.transmitSpeed or radius range on int.transmitRange. In the group setting on file .java extension, it also can be adjusted the nodes in group, vehicles speed, buffer size and the router type. In the ONE Simulator can be shown as follows:

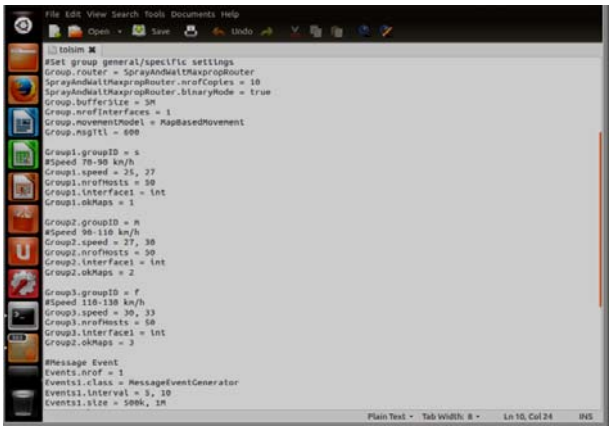
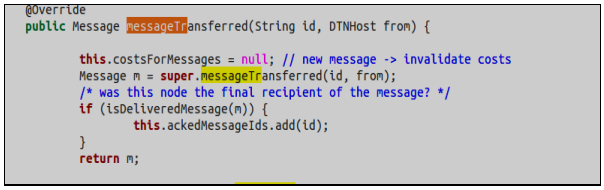


Figure 5 ONE Simulator Groups Setting

The most important thing when running the simulation is how to setup the proposed developed VDTN routing in ONE Simulator. This proposed routing uses the Spray and Wait routing as initial routing VDTN. In this condition only broadcast mechanism is used. While the transfer data mechanism is used Maxprop routing. Clustering configuration is used to create effective communication and scalability. Cluster routing is build by grouping nodes shown in figure 5.



```
@Override
public Message messageTransferred(String id, DTNHost from) {

        this.costsForMessages = null; // new message -> invalidate costs
        Message m = super.messageTransferred(id, from);
        /* was this node the final recipient of the message? */
        if (isDeliveredMessage(m)) {
                this.ackedMessageIds.add(id);
        }
        return m;
```

Figure 6 Sample the Message Transfer Script for Developed Routing

Based on figure 6, shows the transfer data mechanism using proposed developed algorithm. This mechanism receiver node will give acknowledge to the sender node after the data transfer is succeed. To fulfill all processes, some module in java class languages is need to be called. In addition, one thing that should be setting on ONE Simulator is how to create report data for analysis. ONE Simulator provides several classes to create a report file in various performance data. Herewith attached some sample performance report which are generated during the research after running mobility model in ONE Simulator.

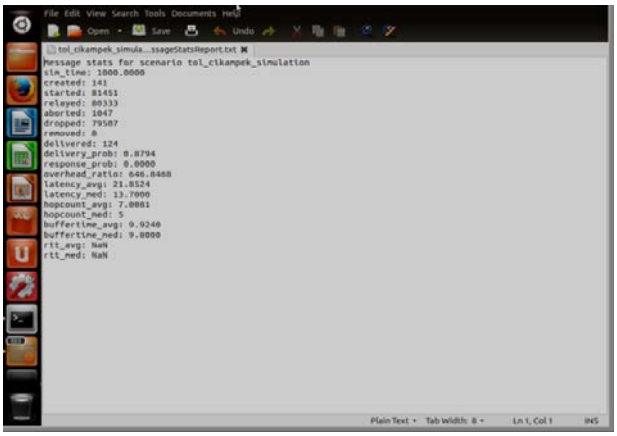


Figure 7 Report Status

On figure 7, it is show the result the data transfer delivery status between nodes during the simulation. On the report is be delivered how many data packet are created, send, failed to send, successful transfer, average delay, delivery probability, and many more. By this report, it is possible to make an analyzing the performance of protocol or routing used during the simulation.

IV.SIMULATION RESULT AND ANALYSIS

As result expected in this research, we are evaluate the average delay during the communication by increasing the number of nodes in some buffer size condition. The comparisons for all condition were done for all approach simulation scenario in Spray and Wait, Maxprop, Proposed Developed Routing in clustering configuration.

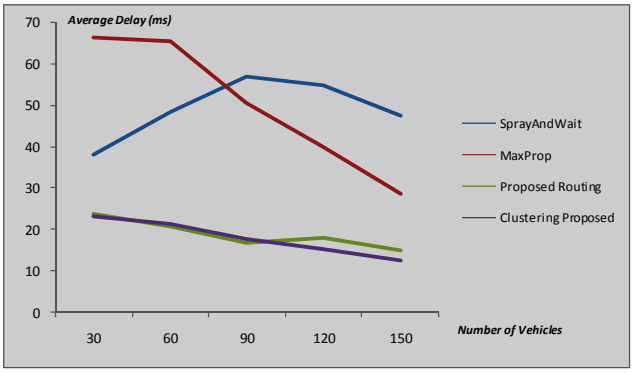


Figure 8 Average Delay in Buffer Size 3 MB

In figure 8 is shows that Spray and Wait routing is more effective than Maxprop in less vehicles density. While the proposed developed routing either in common condition without clustering and in clustering configuration give better average delay compared to others. It is effective and efficient for proposed developed routing running in small buffer and bigger vehicles.

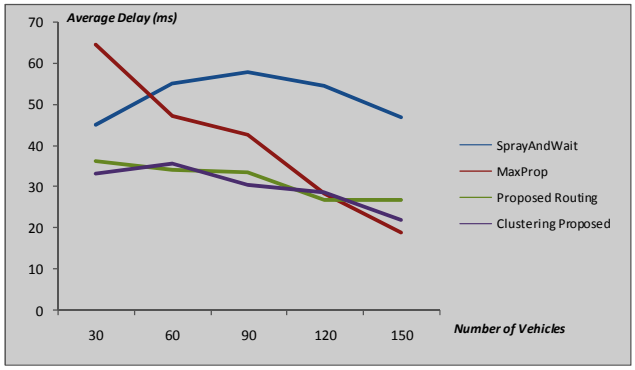


Figure 9 Average Delay in Buffer Size 5 MB

Based on figure 9, it shows that the average delay on this research for developed algorithm is better than the both previous routing algorithms. The proposed developed routing is still effective to maintain the delay compare to other routing algorithm in VDTN. The phenomenon during the research that Maxprop algorithm gives better performance for delay control compare with other with increased the number of vehicles. In the condition where vehicle more than 150 and buffer size 5MB, Maxprop already has better delay than the proposed developed routing.

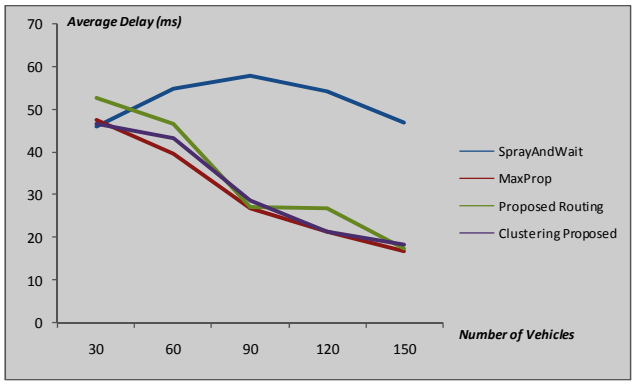


Figure 10 Average Delay in Buffer Size 8 MB

In figure 10, from the smallest number of vehicle until the biggest one, Maxprop routing effectively has better performance during simulation. The proposed developed routing is not effective for control average delay in buffer 8MB. Based on figure 8 and 9 it can be deduced for bigger buffer and bigger number of vehicle nodes need other mechanism than proposed routing in this research. By the simulation with some buffer size parameters and also with many numbers of vehicles, the clustering configuration with developed routing gives better performance in delay control.

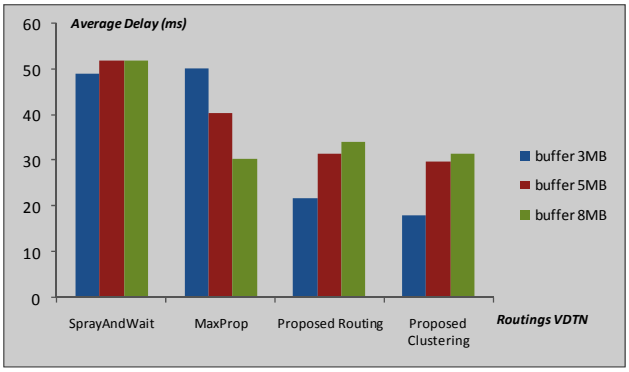


Figure 11 Summaries Average Delay Based on Buffer Sizes

The average delay is achieved by proposed developed routing in clustering network. It is generated 48% better than Spray and Wait routing, 27% better than Maxprop routing and even 5% better than common developed routing without clustering routing. The performance proposed delay start saturation on buffer size more than 5 MB with number of vehicles more than 150 vehicles.

V. CONCLUSION AND FUTURE WORK

By the simulation result, the proposed developed routing in clustering network could improve the performance delay average 48% better than Spray and Wait routing, 27% better than Maxprop routing and even 5% better than common developed routing on geographical map in Cikampek highway. Other advantages from this research are very prudent in resource allocation, especially in low buffer size. Meanwhile, the performance proposed delay start saturation on buffer size more than 5 MB with number of vehicles more than 150 vehicles. This proposed developed routing with clustering configuration network is effective for small buffer size less than 8 MB. For the large number of vehicles nodes effectively Maxprop routing is better than other. It can be concluding that developed routing in this research also give contribution saving the memory for buffer during the communication between nodes.

For the next research, to fix some weaknesses in this proposed developed routing should be developed another routing algorithm that accommodate bigger buffer and bigger number of vehicles. Another idea for next research is how much energy consumed using developed routing in VDTN.

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