Analysis of LTE Performance of V2V Communications on Indonesia Toll Road

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***Abstract*—Vehicle-to-vehicle (V2V) is a transportation technology that uses wireless communication developed to solve transportation problems. In carrying out V2V communication, it has developed from the 802.11p ad-hoc communication protocol or what is known as Vehicular Ad-hoc Network (VANET) to Long Term Evolution (LTE). LTE performance, with data transmission speed on the download line of 150 Mbps and upload of 75 Mbps, gives an advantage over VANET on the communication line. However, the performance of LTE at data transmission speeds with vehicle speeds on freeways when applied in Indonesia with vehicle speeds between 60 km/h and a maximum of 100 km/h provides a different scenario from vehicles in cities with speeds of only 30 km/h up to 50 km/h. In this study, an analysis of V2V communication performance on LTE networks using Omnet++ will be carried out on freeways in Indonesia. From the results obtained for packages of 100,200 and 300 Bytes and speeds of 60 km/h to 100 km/h, the average delay is 0.00037 ms, and the average throughput is 0.00018797466667 bps.**

Keywords—V2V, LTE, Omnet++, toll road

I. INTRODUCTION

Vehicle-to-vehicle (V2V) is used as a tool in intelligent car communication to drive safely and reduce the number of traffic accidents. Several studies have been conducted to improve driving safety in intelligent transport systems (ITS) [1]–[4]. In this V2V communication method, message-based communication between vehicles provides information in the form of security notifications calculated based on location, speed, acceleration, and surrounding conditions. V2V communication performance is influenced by several factors, propagation, road topology, number of vehicles [5], data communication type [6], power allocation control on devices [7], and others. The messages conveyed can be in the form of periodic messages and messages based on events or incidents. The Basic Safety Messages (BSMs) message mechanism defined in SAE J2735 and Cooperative Awareness Messages (CAMs) specified in ETSI TC ITS [8] are transmitted periodically at certain times to announce vehicle status. In some terms, the use of V2V, such as Car-to-Car Communication Consortium (C2C-CC) in EU countries and Advanced Safety Vehicle (ASV) in Japan [9].

In Indonesian constitution law, Number 22 of 2009 concerning Road Traffic and Transportation, the maximum speed limit is adjusted for residential areas, urban areas, inter-city roads, and toll roads. Government Regulation 43 of 1993 adjusted the maximum speed limit for toll roads—class and type of vehicle. Therefore, determining the speed limit (maximum and minimum) must consider traffic characteristics, road conditions, and environmental conditions [10]. Speed regulations on toll roads are regulated in Indonesian government regulation no 79 of 2013 concerning the Road Traffic and Transport Network (LLAJ) article 23 paragraph 4 and the Indonesian Minister of Transportation regulations concerning Procedures for Determining Vehicle Limits article 3 paragraph 4 in article 23 paragraph 4. It is stated that the speed limit on toll roads is 60 to 100 kilometers per hour [11].

Indonesia, especially the island of Java, has a toll road infrastructure through which at least 50,000 vehicles pass daily [12]. Of course, with so many vehicles, the implementation of V2V communication technology needs to be compared to the form of communication used. Although the Long Term Evolution (LTE) network on the V2V communication network has not been implemented in Indonesia with limited spectrum, the application of Long-Term Evolution (LTE) technology in Indonesia is unsuitable for spectrum allocation. 3GPP has launched the latest technology to overcome this problem. Namely, LTE-advanced supports carrier aggregation (CA) features that enable higher throughput and more efficient spectrum use [13].

In this research, a V2V network communication simulation will be carried out using the LTE network on the Indonesian freeway. Even though the 4G network has been developed on the 5G network, the distribution map in Indonesia on the 5G network has yet to be evenly distributed in almost all Indonesian toll roads, especially the island of Java, which is the population center in Indonesia. Even toll roads with the most 5G coverage can only be found in Jakarta [14]. Several previous studies have been put forward on V2V networks in urban areas, so it is necessary to carry out studies with specific driving conditions on Indonesian toll roads. The simulation is carried out on Omnet++ using two nodes simulated as cars at a distance in a predetermined scenario at the minimum and maximum speed on the Indonesian toll road.

II. RELATED WORKS

Yang et al. [1] presented a new FCW system that detected the driving intention of the front vehicle to provide earlier warning compared to previously used systems. The FCW system consisted of three steps. The driving intention recognition module determined the front vehicle's driving intention. Secondly, the front vehicle's driving intention and other driving parameters were transmitted to the following