APWiMob

# IEEE ASIA PACIFIC CONFERENCE ON WIRELESS AND MOBILE 2017

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## PROCEEDINGS

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# Welcome Message from General Chair of APWiMob 2017

Welcome to APWiMob 2017, Bandung – Indonesia

It is our great pleasure to invite you to attend the 2017 IEEE Asia Pacific Conference on Wireless and Mobile (APWiMob 2017), which is the 4th of the consecutive series initiated in 2014 in Bali, followed in 2015 and 2016 in Bandung.

APWiMob 2017 is international: papers have been submitted not only from Asia-Pacific countries but also from America, Europe and Africa. We cordially welcome you to APWiMob 2017. Besides, we would like to take this opportunity to take this opportunity to express our sincere appreciation to the leading scientists, session organizers and all contributors for their great help and valuable supports to APWiMob 2017. Many thanks also to the Technical Program Committee, the Organizing Committee, and the International Steering Committee as well as the sponsors, the IEEE Communications Society Chapter Indonesia, for their efforts to bring all the participants an excellent technical program and an opportunity to spend a pleasant time at the conference.

APWiMob 2017 provides an international forum for researchers, academicians, professionals, and students from various engineering fields and with crossdisciplinary interests in wireless communications and mobile technologies, networks, services, and applications to interact and disseminate information on the latest developments. It is expected that the attendees will bring many benefits to the scientific and technological development for all countries and to formation of new international cooperation and strengthening of established international collaborations. The committee is doing its best effort for the inclusion of the conference proceedings to the IEEE Xplore Data Base. The presentations of this conference will be accessible to a wider range of readers and will have continual impact to this research field.

Bandung is the capital city of West Java Province. It is the historic site of the first university in Indonesia. It is also popular place for leisure activities for people not only from Jakarta, the capital of Indonesia, but also from Malaysia and Singapore thanks to its strategic location that is reachable by railways, highways, as well as air plane. We hope all of attendees an enjoyable and memorable stay in Bandung, Indonesia.

Best Regards,

Dr. Rina Pudji Astuti
Chair of APWiMob 2017

# Welcome Message from TPC Chair of APWiMob 2017

Dear Ladies and Gentleman,

It has always been a pleasure to host and to welcome researchers, academics, practitioners, and students from across national borders for a shared, prestigious event like APWiMob 2017, the IEEE Asia Pacific Conference on Wireless and Mobile 2017, in Bandung, where the high qualified papers in wireless communications and mobile technologies, networks, services, and applications to interact and disseminate information on the latest developments, will be presented. The conference received 57 papers from 122 authors of 11 countries and through high qualification of reviewing process and tight registration process APWiMob 2017 will publish 25 papers from 71 authors of 6 countries with high qualified papers.

The research in advanced information and communication technologies and services, and also communications networks with advanced technologies are very important since it represents a great achievement in topics of interest, which the best contributors coming from excellent laboratories and schools throughout the world, precipitate to come and contribute their finest works. Therefore, this conference will become the landmark for engineering society to express their thoughts and skills in finding best algorithms or modern mathematical modeling for the future technology. Not only the high qualified papers, the conference is supported by 2 distinguished experts in keynote sessions.

We would like to express special appreciation for 96 TPC members and reviewers that supported the review process, thus enable us to present high qualified conference in communications technology.

We wish to express strong appreciation to our most important sponsors IEEE ComSoc Indonesia Chapter. We are also blessed to have two distinguished Guest Speakers: Prof. Dr. Jan Martin Pawlowski and Prof.Dr.Mustafa Mat. Deris. As always, many thanks are due to all members of APWiMob 2017 committee for their dedication for making this conference a success. Above all, thank you to all of you for coming to this conference.

We warmly invite you to taste Bandung food, walk its streets, and bring from Bandung some memorable items that will keep your heart in touch with this historical and pleasant city of Bandung.

Best regards,

Dr. Muhammad Ary Murti
TPC Chair of APWiMob
2017

# Program at a Glance

| Tuesday, November 28th 2017 | | |
|---|---|---|
| NO | Time | Event |
| 1 | **08:00-09:00** | **Registration Venue: BoardRoom Foyer, Trans Hotel** |
| | **08:45-09:00** | **Safety Conduct** |
| 2 | **09:00-10:00** | **Opening Ceremony** |
| | 09:10-09:20 | Conference Report (Dr. Irfan Darmaan) |
| | 09:20-09:30 | Welcoming Speech |
| | 09:30-09:50 | Opening Remarks |
| | 09:50-10:00 | Art Perfomance |
| 3 | **10:00-10:20** | Keynote Speech-1, Prof. Dr. Jan Martin Pawlowski (Business Information Systems at the Ruhr West University of Applied Sciences and Research) Professor at the University of Jyväskylä, Finland |
| 4 | **10:20-10:40** | Keynote Speech-2, Prof.Dr.Mustafa Mat. Deris (Universiti Tun Hussein Onn Malaysia) |
| | **10:40-10:45** | Paralel Session Announcement |
| 5 | **10:45-11:00** | Coffee Break |
| 6 | **11:00-12:30** | **Paralel Session 1 - Paper Presentation (Room 4)** |
| 7 | **12:30-13:30** | **LUNCH** |
| 8 | **13:30-15:00** | **Paralel Session 2 - Paper Presentation (Room 4)** |
| 9 | **15:00-15:30** | **Coffee Break** |
| 10 | **15:30-17:00** | **Paralel Session 3 - Paper Presentation (Room 3&4)** |
| 11 | **19:00-21.00** | **Conference Gala Dinner** |
| | | **Best Paper Awards** |
| | | **Photo Session** |
| **Wednesday, November 29th 2017** | | |
| **12** | **08:00-end** | **Tour** |

## Keynote Session

**Prof. Dr. Jan Martin Pawlowski**
Institute of Computer Science Ruhr West University of Applied Sciences Mülheim an der Ruhr, Germany

Born global innovation – towards sustainable, collaborative innovation processes across borders
How can we develop innovation in the global context? Can we find sustainable models for collaborative innovation across the globe? These are the key questions for researchers and practitioners in enterprises and universities. The presentation will shed light on current research trends and future challenges which can only be addressed on a global scale. Innovation is a key to success of organizations and societies - different forms of innovation processes are suitable for different contexts such as frugal innovation for less developed countries. In most cases, researchers and product developers compete for new products and faster product lifecycles. However, innovation can be more fruitful for all, individuals, organizations and societies when executed in a collaborative way. As a starting point, the presentation proposes a new form of innovation: born-global innovation. Born-global innovation describes a partly open innovation process which aims at parallel innovation processes in different countries and markets to increase time-to- market and outreach / scale of innovations. To successfully initiate these processes, trust building and idea creation is a key. I will discuss the main barriers to born-global innovation as well as possible solutions and future research issues.

**Prof.Dr.Mustafa Mat. Deris**
Universiti Tun Hussein Onn Malaysia

**INFORMATION REDUCTION USING ROUGH SET THEORY AND CONDITIONAL ENTROPY**
The growing size of data is a new challenge to discover knowledge in order to support the decision- making process. Another important reason is that, to find rules to support the process of data classification based on users' need is computationally intensive. With the growing of data the information size becomes growing elsewhere. However, some information comprises of redundant records/ elements that can be reduced in order to improve the efficiency of processing. Several techniques have been proposed to reduce records only but not both records and attributes. The classical rough set theory has been used in analyzing complete information systems, where all attribute values are available to all objects. With this capacity, the presentation would like to propose an approach by means of rough set theory for record reduction and conditional entropy for attribute reduction that can reduce the processing time, and at the same time does not jeopardize the accuracy of the decision process. Another important issue is that some Information systems are incomplete where some attribute values are not available or missing. Subsequently, the attribute selection is one of the main problems in incomplete information systems. Only few studies were proposed for the attribute selection problem in incomplete information systems due to its complexities, specifically on attribute selection. Thus, this is another challenge in order to come out a new technique/approach that would be able to solve the issues.

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# APWiMob 2016 - IEEE Asia Pacific Conference on Wireless and Mobile 2016, Conference Proceedings

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**SCOPE**

APWiMob 2016 is organized by the international organizing committee of APWiMob and is sponsored by the IEEE Communications Society Chapter Indonesia, so that APWiMob has a strong foundation of bringing together industry and academia. This conference provides an international forum for researchers, academicians, professionals, and students from various engineering fields and with cross-disciplinary interests in wireless communications and mobile technologies, networks, services, and applications to interact and disseminate information on the latest developments.

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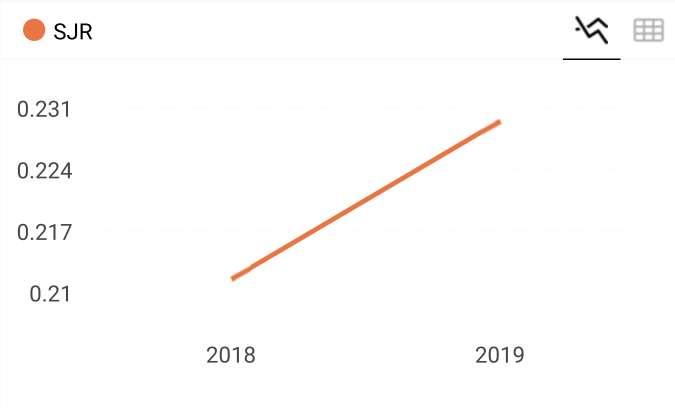


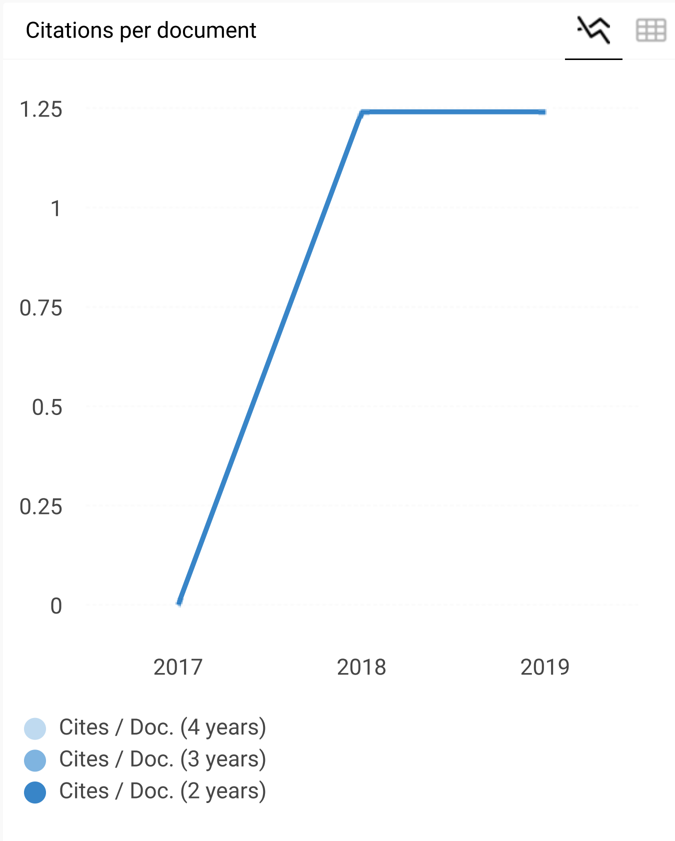


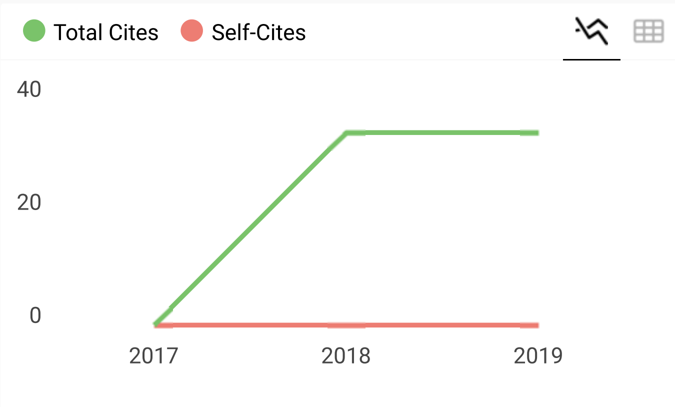


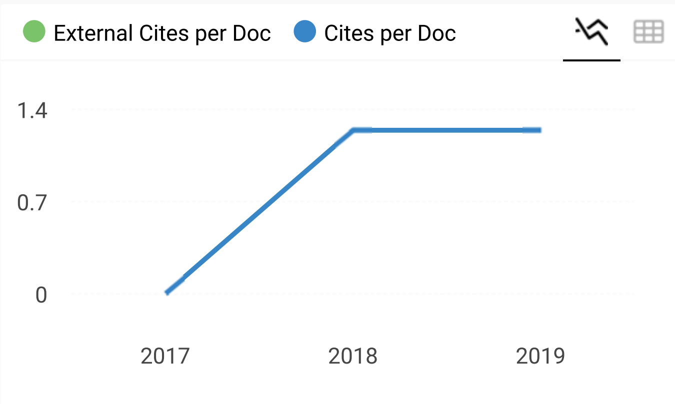


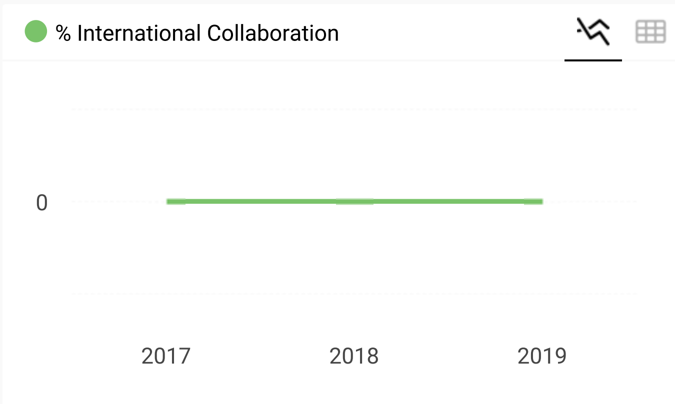


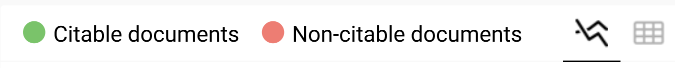


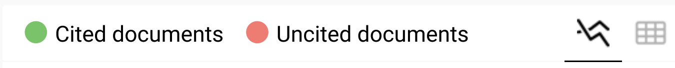

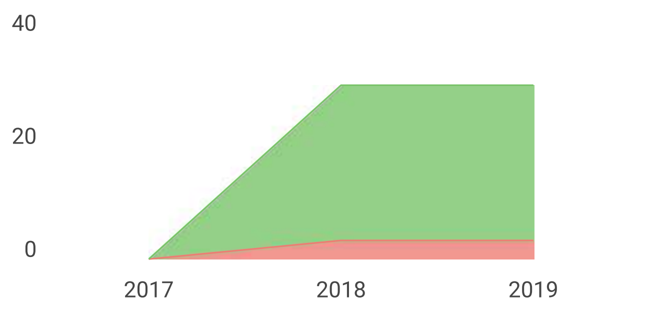


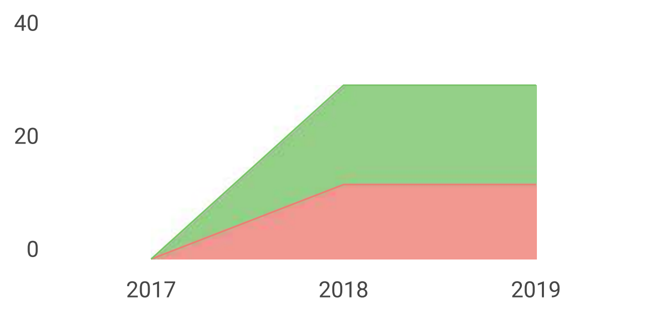



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# Application of an Enhanced V2VUNet in a Complex Three-dimensional Inter-vehicular Communication Scenario

Lisa Kristiana[1,2], Corinna Schmitt[1], Burkhard Stiller[1]
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***Abstract*—A complex road topology in a large city environment have become one of the most challenging factors in vehicular communications. Besides inevitable overpass and building constructions, road topologies with a non-straight structure, *i.e.*, curvy- and circle-shaped road topologies, will lead to particular investigations and evaluations. This paper addresses the challenge of a three-dimensional road topology in Jakarta, Indonesia, and investigates the possibility to design vehicular communication efficiently with a three-dimensional environmental awareness approach. The main work performed here is to evaluate the previously proposed approach Vehicular-to-vehicular Urban Network (V2VUNet) for complex three-dimensional road topologies. This enhancement takes into account the combination of (a) the area restriction scheme and (b) predictive forwarding scheme. The simulation shows that supplication of the enhanced V2VUNet compared to the traditional three-dimensional forwarding scheme leads to 20% better network performance in a such road topologies.**

***Index Terms*—Packet forwarding, Inter-vehicle Communication (IVC), area restriction, predictive forwarding, complex road topology.**

## I. Introduction

Mobile communications in a large city environment have become a main demand in a modern society. A high demand of non-safety applications, such as social media, road traffic, and emails, emerges the requirement of real-time yet high bandwidth capacity can be doable by implementing Inter-vehicle Communication (IVC) [8]. The main reason of implementing IVCis because of its infrastructureless feature, thus, it accommodates high mobility communications. In addition, IVC offers a low cost communication compared to Long Term Environment (LTE) under the assumption that in the future, vehiclewill be equipped with wireless technology devices.

The challenge rises when the communication between vehicles occurs in a non-straight and complex road topology as illustrated in Fig. 1. The complex road topology has a form of circle roads, cross and parallel roads, and three-dimensional road topologies, *i.e.,* different heights of road levels. This complex road topology can be a drawback due to limitations of the physical layer, which is caused by interference of the road construction itself. Therefore, this interference has to be and can be overcome by implementing a suitable forwarding scheme, which can minimize the loss packet [1].

Fig. 1. A Complex Road Topology in Jakarta City, Indonesia [19]

This paper works in line with the continuing importance of implementing three-dimensional parameters in location coordinates and forwarding schemes, which was proposed as the Vehicular-to-vehicular Urban Network (V2VUNet) in [12] and which was here enhanced to solve the communication problems for a complex road topology.

The remainder of this paper is structured as follows: Section II discusses related work of a three-dimensional environment and the challenges due to different road level topologies. Section III discusses forwarding mechanisms to cope many three-dimensional scenarios. In turn, Section IV evaluates existing forwarding mechanisms and analyses the outcomes as a result of implementing various communication schemes in a non-straight three-dimensional road topology. Finally, a summary and future work are provided in Section V.

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## II. Related Work

A complex road topology can be represented as many roads with various road levels and types as needed. For instance, roads with different levels and non-straight road paths can be considered as a complex road topology. Thus, this road condition can have many aspects to be taken into account, for instance, the impact of the road level topology to the Packet Delivery Ratio (PDR) as a result of interference of road constructions.

Several researchers have discussed such effects with regard to the interference of signal transmission (in physical layer point of view) [4], [2], [5] or the packet forwarding issue (in the network layer point of view) [18], [8], [16], [3], [7]. From a physical layer point of view, the interference of the signal transmission is overcome by modelling the interference and propagation loss. From a network layer point a view, the packet forwarding issues are overcome by various forwarding schemes, which depend on many parameters and conditions.

However, the packet forwarding issue is the important aspect, since it will discover the number of packets that can be successfully transmitted and predict the delay as well as the result of a packet transmission algorithms. Many packet forwarding schemes are focusing on straight road topology only, however, it is important due to existing road layouts to discover the effectiveness of packet forwarding in non-straight road topology. In addition to packet forwarding, the location coordinate plays an important role with respect to the road topology. In inter-vehicle communication, a promising strategy in case of packet forwarding relies on the current location coordinates of participating vehicles. It is proven in [11], [17], [13] that location-based forwarding schemes do scale for high mobility, low overhead, and frequent topology change.

### *A. Location-based Forwarding Scheme*

In general, a location-based forwarding scheme shows three steps in its algorithm as illustrated in Fig. 2. The first step is the relay selection, where various parameters are used to calculate participating vehicles and it selects one of those participating vehicles as a relay. The second step is the forwarding mode, where the process of forwarding a packet to a selected relay is performed. This process can be done either in a forwarding path that is closest to the destination or is closest to the source. The last step is the recovery strategy that is required when the second step fails.

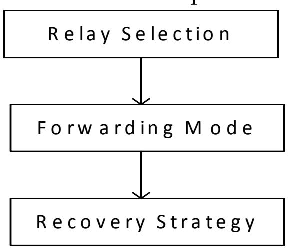


Fig. 2. Location-based Forwarding Scheme Algorithm

Several existing three-dimensional forwarding schemes are investigated to address a practical aspect in static or non-static wireless communication, such as in Wireless Sensor Networks (WSN) or Vehicular Ad-hoc Networks (VANET). The 3D geographical routing (3DGR) is the three-dimensional forwarding scheme in WSN, which operates in a static condition [17]. In Three-dimensional Routing (TDR) [15], a three-dimensional forwarding scheme is applied in Vehicular Ad-hoc Networks (VANET) that focus on non-static vehicle movement. Since TDR only operates in a simple road topology, the authors develop TDR to a Complex Three-dimensional Routing (C-TDR) [6] to inherently address the complexity of the road topology.

As mentioned above, this paper here propose the enhanced V2VUNet, where the state-of-the art is defined in comparison as shown in Table I

TABLE I. Comparison 3D location-based forwarding scheme

| Factor | 3DGR | TDR | C-TDR | V2VUNet |
|---|---|---|---|---|
| Mobility | Static | Non-static | Non-static | Non-static and Static |
| Scenario | WSN | VANET | VANET | IVC |
| Road Topology | Simple | Simple | Less Complex | Simple and Complex |
| Propagation | LOS | Two-ray Ground | Two-ray Ground | Nakagami |
| Forwarding Method | Greedy-based | Greedy-based | Greedy-based | Greedy-based |
| Strategy | Reduce number of nodes | Avoid different road topology | Virtual neighbor | Area restriction and path prediction |

### *B. Parameter in 3D Forwarding Scheme- V2VUNet*

Two different environments are defined as two-dimensional (2D) and three-dimensional (3D) areas. In a 2D area, the location coordinates are determined as x- and y-axis coordinates. While in a 3D area, three location coordinates are included, *i.e.*, x-, y-, and z-axis.

The 3D forwarding scheme relies on a precise location, especially on different road layer topologies. Thus the current location calculation is defined as a Horizontal Relative Angle (HRA) and a Vertical Relative Angle (VRA) as illustrated in Fig. 3, which is detailed in [13].

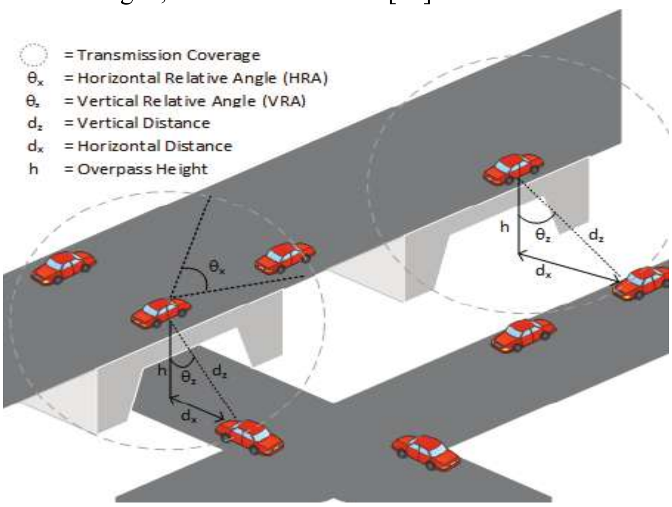


Fig. 3. HRA and VRA Calculation [12]

### *C. Area Restriction and Predictive Forwarding Schemes*

In previous works V2VUNet is defined by two separate algorithms [12], [14]. The first algorithm — called area restriction forwarding scheme [12] — works on the predefined road path with some restrictions, such as an overpass construction and a road width. This area restriction is determined from the HRA and VRA calculation, thus, the transmission forwarding area is defined and set. The transmission area outside the HRA and VRA calculation area is often ignored. This strategy is useful to maintain the direction's homogeneity of intermediate vehicles. In addition, the angle that is formed by HRA and VRA refers to the ordinary road width and transmission range.

The second algorithm uses a predictive scheme to overcome the high probability of disconnection, especially when a vehicle moves into an underpass road [14]. This strategy is useful to predict which vehicle that will move into the overpass by scaling the initial position and velocity. Thus, this algorithm will search for another intermediate candidate before substituting the current pair of communicating vehicle. This predictive scheme is expected to overcome inevitable disconnections that often occurs due to overpass construction.

## III. Design of Enhanced V2VUNet

V2VUNet was now enhanced to provide a solution to the road complexity as illustrated in Fig. 1. The advantages of an area restriction and predictive forwarding schemes are combined to enhance the capability of V2VUNet. The algorithm of the enhanced V2VUNet basically is the combination of the area restriction and the predictive forwarding scheme. The enhanced V2VUNet uses the three-dimensional environment awareness which is often oversimplified in three-dimensional simulations.

Referring to the location-based forwarding algorithm as illustrated in Fig. 2, the design of the enhanced V2VUNet has additional strategies as indicated by the blue boxes in Fig. 4, which are defined as follows:

1 )*Area-dimensional detection* distinguishes the location of a particular vehicle by indicating the z-axis value. The simple area-dimensional detection is indicated in Fig. 5.

2 )*The angle measurement* defines the next step after the relay selection. The angle measurement is done in two ways depending on the result of the area-dimensional detection. HRA and VRA measurements are illustrated in Fig. 6. In this case, the V2VUNet uses the smallest angle value to forward the packet.

3 )*Direction aware* determines the current vehicle's direction. The same direction between sender and next relay is preferable, since it can maintain a longer communication. The relative direction, as illustrated in Fig. 7, is used to measure the relative direction of a particular vehicle.

4 )*Obstacle aware* is the strategy to address the inevitable obstacle, such as building and overpass construction, that show a significant impact on packet transmission.

5 )*Prediction scheme* initiates the loss connection that will occur in the later period of time after calculating the current position and current velocity.

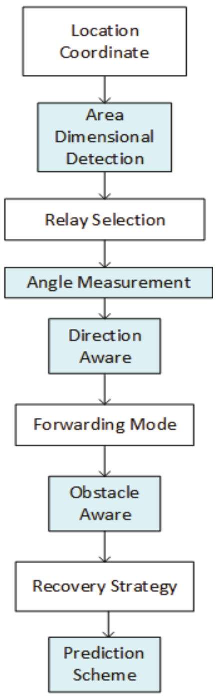


Fig. 4. the Design of Enhanced V2VUNet Algorithm

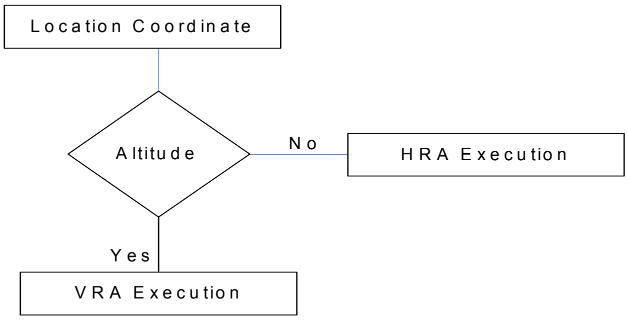


Fig. 5. Area-dimensional Detection

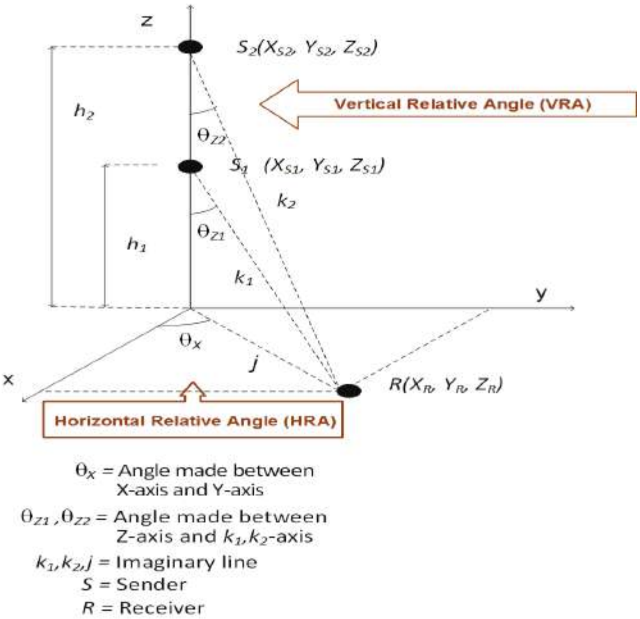


Fig. 6. HRA and VRA Measurement

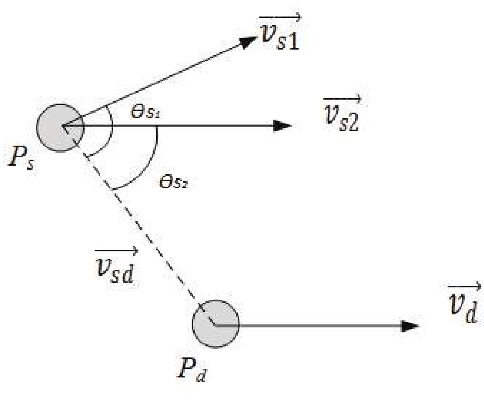


Fig. 7. Relative Direction of Vehicles [14]

Since various issues may occur in a complex road topology, thus, those strategies are integrated to address the particular issue in packet forwarding process.

## IV. Simulation and Result

In order to obtain a realistic road topology, which refers to Fig. 1, the road topology is modeled using the OpenStreetMap (OSM) [23]. The use case of a complex road topology is taken at Semanggi street in Jakarta, Indonesia. This road

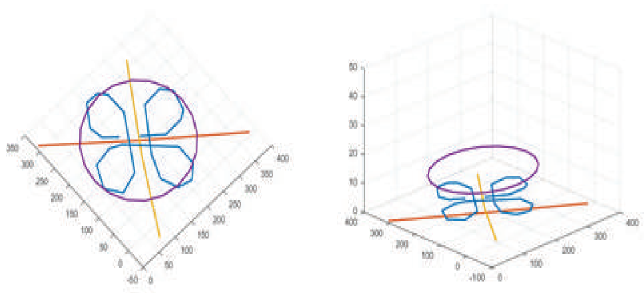

Fig. 8. Four Layers Road Topology Model of Semanggi Street

topology has four road topology layers with different heights and it is modelled from a three-dimensional point of view as shown in Fig. 8.

These four layers reflect the realistic and updated road topology, which was just finished in May 5, 2017 (cf. Fig. 1). Since this road will be inaugurated in August 2017, the real mobility, which is provided by active users is not available yet. To overcome this problem, the GPSies [21] are used to generate mobility tracks on any of those predefined roads. In addition to this four layers road topology, the height of each layer is obtained from them as follows:

1) The first layer of a straight road with the height of 0 m (ground level).
2) The second layer of a cross overpass with the height of 5 m above the ground lever (first level)
3) The third layer of a clover-shaped road with the height of 10 m (second level). Some parts of this clover-shaped road provides ramp and connects to the first layer.
4) The fourth layer of a circle-shaped road with the height of 15 m (third level).

This simulation for this street model is conducted in 20 runs with all parameters and values as listed in Table II. The IEEE 802.11p [4], [5] communication technology is used, since it is designed to cope with transmission issues due to frequent topology changes in IVC. Nakagami's propagation model [1] is implemented in this three-dimensional scenario, since it is best suited to reflect the practical propagation in a city environment. The mobility of vehicles is modeled by the Intelligent Driver Mobility (IDM) to perform a realistic mobility. This IDM is generated by the Simulation of Urban Mobility (SUMO) [22] and is integrated into NS3 [20] as the scenario simulator. Finally, Greedy Perimeter Stateless Routing (GPSR) [9] is used to perform the greedy-based forwarding scheme feature with some adjustments due to the three-dimensional environment, which selects the intermediate vehicle that closest is to the destination as the weight value.

TABLE II: PARAMETER SETTINGS

| Parameter | Unit |
|---|---|
| Transmission Range IEEE 802.11p | up to 300 m |
| Location-based Routing | Greedy |
| Number of Nodes | 20 - 100 |
| Simulation Area | 500 m x 500 m |
| Upper Road Height | 0 - 15 m |
| Vehicle Velocity | 30 -70 km/h |
| Packet Size | 512 Byte |
| Simulation Time | 200s |
| Propagation Model | Nakagami |
| Data Rate Model | Constant Bit Rate |

The first set of results show in Fig. 9 the network performance of the enhanced V2VUNet compared to the traditional greedy forwarding method, *i.e.*, without V2VUNet. At an average speed of 30 km/h, the performance of the enhanced V2VUNet is almost 10% better than a traditional forwarding scheme. This less significant enhancement is due to the slow traffic condition, thus, it does not reflect the high mobility challenges. As the speed of vehicles increases, the network performance of enhanced V2VUNet increases significantly over the traditional forwarding scheme. The overall PDR reaches a 20% better value than traditional forwarding schemes due to the fact that the prediction forwarding algorithm in V2VUNet can predict the disconnection in the next period of time and it can search for the substitution relay vehicle, especially in an overlapped road construction set-up, *i.e.*, cross overpasses or circle-shaped roads over the straight road.

The second set of results show in Fig. 10 the End-to-End (E2E) delay, which is measured from the time a source vehicle starts to transmit the packet until the packet reaches the destination vehicle. The packet can be transmitted in multiple hops, which results in a hop-by-hop delay, however, it is more significant to provide the E2E delay, since it is more practical to measure the time taken for a packet to be transmitted across a network. The fluctuating E2E delays in Fig. 10, show that the traditional forwarding scheme has a 10% smaller delay than the enhanced V2VUNet. This E2E delay in V2VUNet is caused by the predictive algorithm at the recovery strategy part that significantly requires additional time to locate a new intermediate vehicle. Moreover, fluctuating E2E delays are caused by the initial random placement of vehicles that can cause the connection or disconnection between pairs of vehicles at the beginning of simulation.

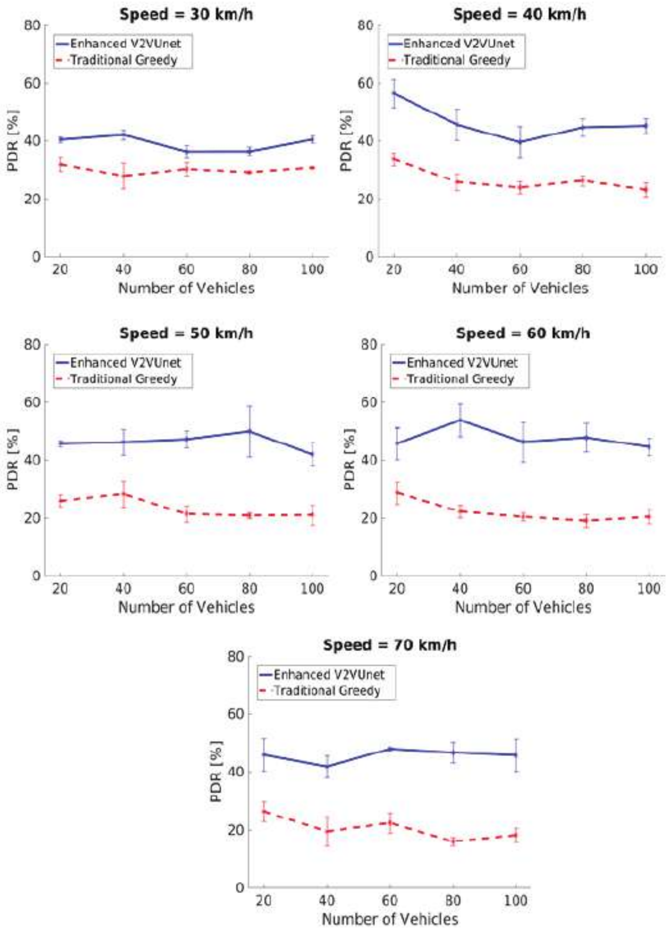


Fig. 9. Network Performance of Enhanced V2VUNet

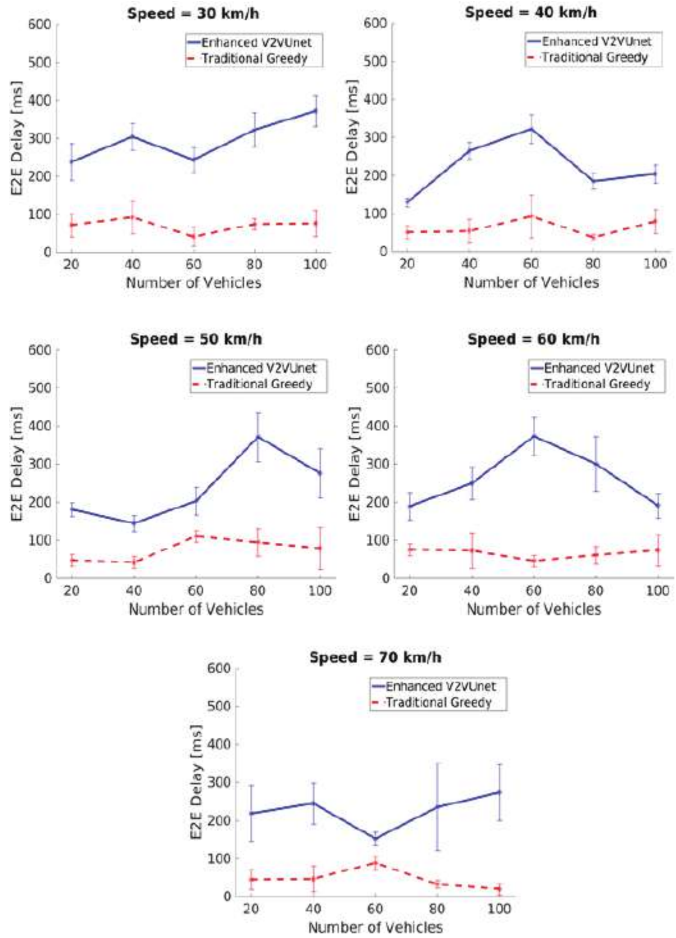


Fig. 10. Acceptable E2E Delay of Enhanced V2VUNet

## V. Summary and Future Work

This work evaluated enhanced V2VUNet in a complex three-dimensional road topology, more specifically, roads with multi level topology and non-straight road paths that represent complex road scenarios in a large city environment.

The enhanced V2VUNet takes into account the advantage of an area restriction and prediction forwarding schemes. As evaluated within a complex road topology, this approach increases the PDR significantly. Thus, it is proved that the enhanced V2VUNet is reliable to a packet forwarding, especially in the complex road environment.

For future work, the online OpenStreetMap (OSM) is considered to be implemented in order to obtain a real time road mapping. The OSM will provide even more realistic data, since it will be operated interactively by many users. In addition, the IVC will be integrated with cellular networks. Thus, the LTE-IVC collaboration will be investigated in order to accomodate heavy data interchanges and support the direct communication between vehicles.

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