Search

Fachgespräch Inter-Vehicle Communication 2016 inter-veh-comm-2016 (Humboldt-Universität zu Berlin)

Search in collection

Impressum
Fachgespräch Inter-Vehicle Communication 2016 (inter-veh-comm-2016) - Humboldt-Universität zu Berlin

Herausgeber

Björn Scheuermann; Stefan Dietzel

Erscheinungsdatum
20.04.2016

Recent Submissions

2016-04-20 **Konferenzveröffentlichung**

On Computation and Application of k Most Locally-Optimal Paths in Road Networks

Döbler, Holger; Scheuermann, Björn

For some applications, e.g. route planning services, it is desirable to answer a point-to-point shortest path query on a road network with a set of alternative paths. We discuss the general requirements for such sets ...

2016-04-20 **Konferenzveröffentlichung**

Impact of a Three Dimensional Environment to Inter-vehicle Connectivity

Kristiana, Lisa; Schmitt, Corinna; Stiller, Burkhard

Developing non-safety applications, such as Web surfing and social network, for inter-vehicle networks requires a reliable and stable connectivity among vehicles. One challenge to reach such a reliable and stable ...

2016-04-20 **Konferenzveröffentlichung**

On Context-Aware Communication Mode Selection in Hybrid Vehicular Networks

Gopinath, Smriti; Wischhof, Lars; Jaumann, Michael; Ponikwar, Christopher; Hof, Hans-Joachim

Future vehicles will most-likely have multiple communication technologies and modes available. After classifying V2X applications in five distinct classes, a context-aware selection of the communication mode is advocated. ...

2016-04-20 **Konferenzveröffentlichung**

Byzantine Consensus in Vehicle Platooningvia Inter-Vehicle Communication

Wegner, Martin; Xu, Wembo; Kapitza, Rüdiger; Wolf, Lars

Cooperative driving and platooning have gained a growing focus recently. Letting vehicles to reach a consensus and make a joint decision is necessary for some applications. To address this problem, we propose a novel ...

2016-04-20 **Konferenzveröffentlichung**

Quantifying the Influence of Route ChoiceOptimization on Emissions and Fuel Consumption

Cagara, Daniel; Scheuermann, Björn

Genetic algorithm-based route choice optimization techniques have recently demonstrated their potential to reduce the travel costs on the system level. In this context, the costs are reduced according to exactly one ...

2016-04-20 **Konferenzveröffentlichung**

Physical Layer-Based Message Authentication inVANETs

Al-Momani, Ala'a; Kargl, Frank; Waldschmidt, Christian

Authenticating legitimate nodes is a major concern of the envisioned vehicular networks. To achieve this, standards and literature propose to use asymmetric cryptographic mechanisms which generate significant overheads ...

2016-04-20 **Konferenzveröffentlichung**

Feasibility of Verify-on-Demand in VANETs

Bittl, Sebastian; Roscher, Karsten

Wireless ad hoc networks are an important topic in the automotive domain. Thereby, strict security requirements lead to high effort for verification of digital signatures used to secure message exchange. A popular ...

2016-04-20 **Konferenzveröffentlichung**

Security Evolution in Vehicular Systems

Lang, Dominik; Corbett, Christopher; Kargl, Frank

Modern vehicles contain a complex network of computer systems, which makes security considerations a necessary part of the design process. Due to a vehicle's long deployment phase, static security solutions become ...

2016-04-20 **Konferenzveröffentlichung**

Using Searchable Encryption to Protect Privacy in Connected Cars

Matousek, Matthias; Bösch, Christoph; Kargl, Frank

Providing vehicles with extended connectivity introduces new opportunities for services, and also security applications such as misbehavior detection. However, for many applications, personal data needs to be processed ...

Impact of a Three Dimensional Environment to Inter-vehicle Connectivity

Lisa Kristiana, Corinna Schmitt, Burkhard Stiller
Communication Systems Group CSG, Department of Informatics IFI, University of Zurich
Binzmühlestrasse 14, CH—8050 Zurich, Switzerland
[kristiana|schmitt|stiller]@ifi.uzh.ch

***Abstract*—Developing non-safety applications, such as Web surfing and social network, for inter-vehicle networks requires a reliable and stable connectivity among vehicles. One challenge to reach such a reliable and stable connectivity is the road in a large city environment, as it appears in a three dimensional topology (*i.e.* a road with overpasses). These situations lead potentially to restricted connectivity since with respect to propagation vehicles are driven on different road levels, which can well form obstacles such that the connectivity among vehicles is disturbed. This paper addresses specifically the three dimensional topology of roads in terms of a level environment model and investigates the impact of various height of overpass between two communicating vehicles.**

***Index Terms*—Road topology, Inter-vehicle connectivity, Three-dimensional forwarding**

I. Introduction

The inter-vehicle connectivity for non-safety applications, such as Web surfing and social network can be performed during transportation [1]. Therefore, reliable and stable inter-vehicle connectivity is required. The term inter-vehicle connectivity refers to a process of basic communication between two vehicles such as exchanging mutual message and locating position coordinates [2].

Fig. 1. Road Level Topology. (Source: www.media.viva.co.id)

As in large city environment, there are several major factors that influence reliable and stable connectivity. The first factor is propagation [3]. During transmission and reception phase, a signal propagates over the environment components (e.g., buildings, trees, and other vehicles) [4], [5], and the attenuation occurs. The second factor is the mobility of vehicles which leads to frequent network topology changes [2]. Last but not least, three-dimensional topology of road, as shown in Figure 1, affects the signal reception [6]. Looking to the aspect of road level topology, (i.e., an overpass), the signal reception is often weak due to distraction such as reflection, attenuation, and scattering by overpass' shapes [7]. This poor signal reception can cause disconnection of transmission and followed by probability of reconnects and reestablishment of a new connection.

Several proposed approaches do not consider the road level topology. Thus, the major issue that is still being investigated is the decreasing of signal reception when vehicles move in the different road level. In order to analyze the impact of various height of road topology level to inter-vehicle connectivity, this situation leads to the following research questions:

1) How is the impact of overpass to network performance?

2) Will the height of road level influence the inter-vehicle connectivity?

This paper is organized as following: Section II provides related work with respect to the technology, propagation model, and forwarding method. Section III discusses road level forwarding model in details. Section IV provides simulation parameters and evaluation of the addressed road level forwarding model with various road levels. Finally, summary and future work are provided.

II. Related work

The term mobile node represents a vehicle and it is assumed to be equipped with a navigation system as Global Positioning System (GPS) and wireless communication (Wi-Fi/IEEE 802.11), therefore, the term mobile node and vehicle can be used alternately. In inter-vehicle network, Wi-Fi/IEEE 802.11 as a short range radio technology is possible to be used to establish a communication between vehicles [9]. A Wi-Fi ad-hoc mode can support inter-vehicular networking through the ad-hoc broadcast [10]. This communication technology has been enhanced for non-safety application with required modification since it has to support communication between vehicles moving at high speeds [9]. In consideration of two-dimensional area which refers to an euclidean area, therefore, it leads to inaccuracy of three-dimensional modeling [8], [13].

Normally, roads in a large city environment can have contour characteristic. This means that some roads can have various levels topology. This overpass topology leads to two key issues *i.e.*, propagation model and forwarding scheme are discussed as following:

A. Propagation model in large city environment

The characteristic of propagation channel may vary depending on the environment. Propagation characteristic influences both signal transmission and reception [17]. A consideration of propagation model that is influenced by the existence of obstacles is proposed as an approach to obtain an optimum transmission [17]. In case of buildings, composed of a concrete block, signal transmission will be attenuated or even restricted [7], [18]. In case of overpasses, it is assumed that the overpass is not made from material with good conductivity, thus, signal attenuates or restricted along the overpass [8].

By definition, signal transmission that enter the overpass is assumed as signal loss since it will fade, depending on overpass length (*e.g.*, GPS signal for navigation systems and Wi-Fi signals degradation) [7]. The longer the overpass, the signal loss probability rises and the signal reception is decreased. There is a trade-off whether to disconnect the transmission and search for a new connection or to maintain the current and distracted connection. For instance, when a vehicle moves below overpass with high speed, but suddenly decreasing the speed due to traffic condition, the distracted connection expands or the vehicle becomes temporary unreachable [14].

It is important to define the particular environment as a preliminary set up. In a free space environment, (*i.e.* the environment where the electromagnetic wave transmits without any obstructions) the propagation channel is considered as line-of-sight transmission model. This model is only in theoretical case and used as a reference to other models. In case of road hierarchy topology, the propagation channel is modeled as a propagation loss model with overpass as an obstacle [8]. This model takes into account of height of road and it is assumed one electromagnetic wave ray will be received directly, while another ray will reflect on the ground and other objects which is known as nakagami propagation model [17], [24].

B. Forwarding Method

Generally, routing protocols play an important role to ensure all packets are transmitted from sender node to destination node. The main core of routing protocols is a forwarding decision mechanism. This forwarding mechanism decides the best method to transmit the information from sender node (*S*) to the next receiver node (*R*) and finally to the destination node (*D*). During the decision process, *S* has to select the proper *R* of all intermediate nodes (*I*). Intermediate nodes are mobile nodes which has a possibility as a next hop node.

In order to select most appropriate *I*, complete information of all neighboring nodes is collected to provide a valid forwarding decision. Methods of forwarding decision vary with respect to vehicle's complete information, such as planar position information (*i.e.* distance between vehicles) [12], [19], transmission power information (*i.e.* signal power), mobility information (*i.e.* velocity) [13], and non-planar position information (*i.e.* angle) [25].

Most of all forwarding method experiments are applied in two-dimensional area. Thus, several challenges are considered in applying forwarding method in three-dimensional area. These challenges are: (1) The distance of the corresponding vehicles on upper road level and lower road level, can form further transmission range. (2) The various speed of the vehicles can form a frequent topology changing, which can effect transmission disconnection. (3) The direction factor becomes more complex when it is applied in three-dimensional environment than in two-dimensional environment. Based on greedy forwarding method [20], Link State Aware Hierarchical Road (LSHR), takes into account of vehicles which are located on the same road level to forward the packet and avoid the vehicle which are located in different road level [22]. However, the overpass is not considered as obstacle in this work.

III. Road Level Forwarding Model

This work deploys the angle-based propagation scheme to greedy forwarding concept. The idea of deploying the angle-based propagation is to realistically restrict the area of forwarding. Angle-based restricted scheme filters out intermediate node candidates due to the width of road and the height of road. In one hand the horizontal relative angle concept is implemented when vehicles are in the planar area, on the other hand, the vertical relative angle is implemented in the non-planar area. When the area restriction is set, thus, the greedy forwarding concept is implemented.

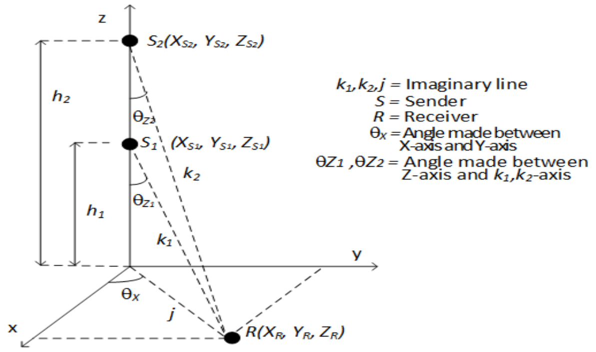

Fig. 2. Two Angles Describe Vehicles' Position on Different Road Layer Topology.

The scenario as illustrated in Figure 2, black dots represent vehicles which are located on both upper road level and lower road level. In three-dimensional environment, it is necessary to considers *z*-coordinate as an important parameter to locate a position accurately [21]. Thus, the location of a vehicle can be represented as coordinates (*x, y, z*).

Distance: It is influenced by speed and direction factors. Distance factor leads to maximum, optimum, and minimum transmission modes. It is based on distance between current and intermediate nodes allowing to define the transmission range mode as follows. Given a current mobile node b_i has geographical coordinates of x_i, y_i and z_i. The potential neighbor node n_d with coordinates of x_d, y_d and z_d. Thus, the Euclidean distance between the two is given in Equation 1:

$$\Delta d = \sqrt{(x_d - x_i)^2 + (y_d - y_i)^2 + (z_d - z_i)^2} \qquad \text{(Eqn. 1)}$$

The closer the distance, the better the connectivity. In addition, the distance between vehicles is correlated with speed. Thus, the speed given a velocity vector of a current node b_i is given in Equation 2:

$$v_i = \left(\sqrt{v_{xi}^2 + v_{yi}^2}\right) \qquad \text{(Eqn. 2)}$$

Relative Angle: It is also necessary to consider various height and width of the road due to signal transmission and reception. A current node and intermediate node on a different road level (*i.e.* vehicles on upper road layer and lower road layer) can create an angle between them as illustrated in Figure 2. Angles in degrees are measured in two ways: First, it is measured between the positive *x*-axis and positive *y*-axis, which results in θ_x while the second angle θ_z is measured between positive z-axis and the vehicle located on lower layer road. This θ_z angle influences transmission range between vehicles on upper and lower road level. In order to simplify and clearly describe two communicating vehicles, S - a vehicle moving on upper road level - forms an angle θ_z with respect to R - a vehicle moving on lower road layer.

$$\theta_{z1} = atan\left[\frac{\sqrt{x_R^2 + y_R^2}}{h1}\right] \quad \text{(Eqn. 3)}$$

$$\theta_{z2} = atan\left[\frac{\sqrt{x_R^2 + y_R^2}}{h2}\right] \quad \text{(Eqn. 4)}$$

To generalize the complexity of road level topology, it is important to analyze various road levels means that different heights of roads form different angles can be calculated by Equations (3) and (4), where $h_1 = z_{S1} - z_R$ and $h_2 = z_{S2} - z_R$, (cf. Figure 2). It can be assumed that the higher the upper road, the smaller angle measured as following the right-angled triangle formula. In this work, a modified propagation loss model is used with an addition of obstacle aware propagation. The obstacle aware propagation will block the signal within the specific range as briefly described in section II.A.

First assumption that has to be made is the vehicle distribution. Vehicles are located both on upper and lower road level. Sending process are done by vehicles on upper road level and receiving process are done by vehicles on lower one. By default, this scenario uses the overpass height of 10 m to 20 m. Both road levels have two lanes and in the middle of lower road level, an overpass crosses over the lower road level. The angle is measured from S to R. S can be both the origin source or the current sender. The x-axis represents the width of road, y-axis represents the length of road and z-axis represents the height of road. In order to simplify the relative-angle calculation between two nodes (*i.e.*, source and intermediate nodes), the z-axis is predefined.

Second assumption is that the angle is measured when S detects an intermediate node, which is located on the lower road level and in line with S. The intermediate node can be a final destination or the next forwarded mobile node. Thus, the measured angles between S and R (*i.e.* θ_x and θ_z), forms perpendicular intersection of two straight lines.

IV. Simulation

The measurement of link performance assumes end-to-end point connection which means that the connection is evaluated from original sender to final destination.

TABLE I: Parameter Settings

Parameter	Units
Transmission Range IEEE 802.11b/g	140 m
Number of Nodes	10 - 40
Simulation Area	500 m x 500 m
Upper Road Height	10 - 20 m
Average Vehicle Velocity	30-70 km/h
Packet Size	1024 Byte
Simulation Time	500 s
Number of Driving Lanes	2

Table I lists the chosen parameters using NS3 [26] as a simulation tool. The experiment is conducted with the following scenario: The simulation area is set as 500 m x 500 m with the first assumption that the vehicles are moving in a free traffic (*i.e.* no traffic light and no traffic jam). The second assumption is to ensure that vehicles, which are driving on both road levels, experience out of coverage from one vehicle to another. An initial position of each vehicle is located on both road levels with the average speed of vehicles span from 30 to 70 km/h. In this scenario the routing protocols GPRS is used. This routing protocol is selected since it represents a position-based routing protocol which is not using beacon but relying on position of current node. Thus, GPSR is suitable due to rate of change of the topology.

V. Initiate Evaluation

The evaluation results are illustrated in Figures 3-6. The simulation describe the existence of overpass and the various height of road level. These different heights of road level, In the other words, the height of road level creates non-extreme disconnection with due to the occurrence of the out of coverage events.

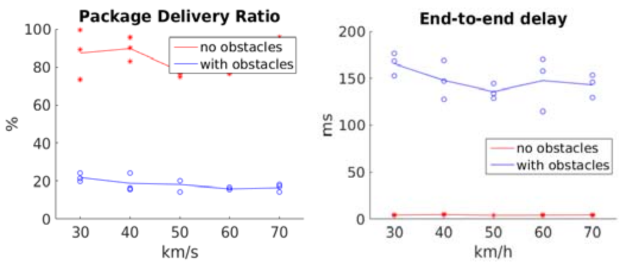

Fig. 3. Impact of Overpass versus Speed

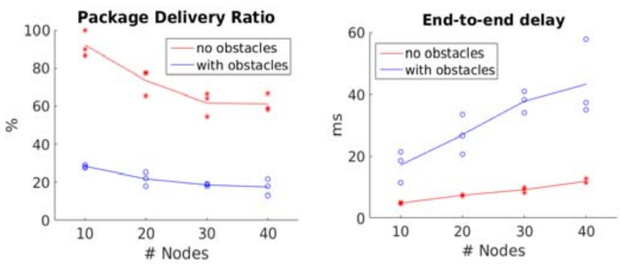

Fig. 4. Impact of Overpass versus Number of Nodes

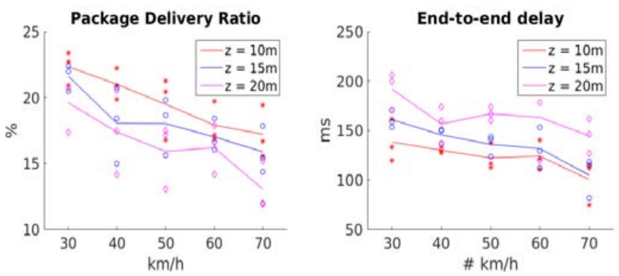

Fig. 5. Impact of Road Height versus Speed

Figure 3 is the result of applying the obstacle propagation model and it is compared with the nakagami propagation model. In this case obstacles are simply blocking the signal

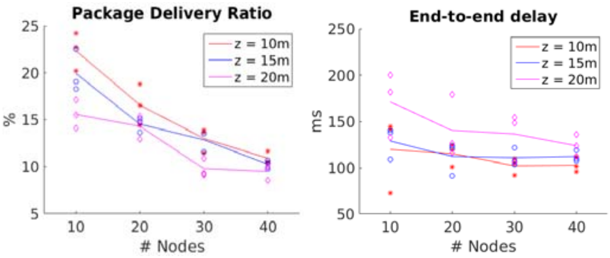

Fig. 6. Impact of Road Height versus Number of Nodes

transmission, thus, both Packet Delivery Ratio (PDR) and End-to-End (E2E) delay have less performance compare to the nakagami propagation. Figure 4, describe the network performance with respect to Figure 3. With the high mobility, high E2E delay also occurs due to obstacle existence. Figure 5 and Figure 6 show network performance of the various height of overpass. In these two cases, overpass is considered as the obstacle with the horizontal position, thus, simply blocking the signal transmission whenever a connection occurs between vehicles which are located in the same x-axis coordinates, which basically means that one vehicle is located right on the top of other vehicle (i.e., on the overpass). Therefore, it is obvious that disconnections occur. This also shows the higher the road topology level leads to the higher chance of disconnection due to the transmission range.

VI. Summary and Future Work

This work discusses the impact of environment to inter-vehicle connectivity by applying obstacle propagation model in order to obtain the realistic three-dimensional environment. The various heights of road topology level have shown the different transmission range which required for a realistic three-dimensional case. The z-axis location coordinate is considered as a additional weight value in order to spot the location on the different altitude, thus, it can not be neglected. The relative angle calculation can be further required in order to locate the precise node position.

For further step, it is important to define the detail of obstacle model, since there is a substantial information due to connection opportunity of obstacle types such as building, trees, and other participant vehicles. In addition, buildings have the various shapes which lead to various propagation models. The further investigation of appropriate channel model will be considered in three-dimensional case.

VII. References

[1] M. Mauve, B. Scheuermann, V*ANET Convenience and Efficiency Applications*, VANET Vehicular Applications and Inter-Networking Technology, 2010, pp 81-105.

[2] M. Aoki, H. Fujii, *Inter-vehicle Communication: Technical Issues on Vehicle Control Application*, IEEE Communications Magazine, Vol. 34, No. 10, Aug 2002, pp 90 - 93 .

[3] T. K. Sarkar, Z. Ji, K. Kim, A. Medouri, M.S. Palma, *A Survey of Various Propagation Models for Mobile Communication*, IEEE Antennas and Propagation Magazine, Vol. 45, No. 3, June 2003, pp 51-82.

[4] J. Walfisch, H. Bertoni, *Theoretical Model of UHF Propagation in Urban Environments,* IEEE Transactions on Antennas and Propagation, Vol. 36, No. 12, Dec 1988, pp 1788-1796.

[5] M. Boban, T. T. V. Vinhoza, M. Ferreira, J. Barros, O. K. Tonguz, I*mpact of Vehicles as Obstacles in Vehicular Ad-hoc Networks*, IEEE Journal on Selected Areas in Communications, Vol. 29, No. 1, Jan 2011, pp 15-28.

[6] N. P. Vaity, D. V. Thombre, *Road Topology-based Performance Analysis of Distance Vector Routing Protocol in VANET*, International Journal of Advance Computational Engineering and Networking (ISSN), Vol. 1, No. 2, Apr 2013, pp 24-31.

[7] A. Hrovat, G. Kandus, T. Javornik, *A Survey of Radio Propagation Modeling for Tunnels*, IEEE Communications Surveys and Tutorial, Vol. 16, No. 2, Oct 2013, pp 658 - 669.

[8] L. Kristiana, C. Schmitt, B. Stiller, *Investigating a Reliable Inter-vehicle Network in a Three Dimensional Environment,* Fachgespräch (GI-IVG), Ulm, Germany, March 2015.

[9] V. Gonzales, A. L. Santos, C. Pinart, F. Milagro, *Experimental Demonstration of the Viability of IEEE 802.11b Based Inter-vehicle Communication*, International Conference on Testbeds and Research Infrastructures for the Development of Networks and Communities (TridentCom), Mar 2008.

[10] L. S. Mojela, M. J. Booysen, *On the Use of WiMAX and Wi-Fi to Provide In-vehicle Connectivity and Media Distribution*, IEEE International Conference on Industrial Technology (ICIT), Feb 2013, pp 1353-1358.

[11] V. Naumov, R. Baumann, T. Gross, *An Evaluation of Inter-Vehicle Ad-hoc Networks Based on Realistic Vehicular Traces*, The 7th ACM International Symposium on Mobile Ad-hoc Networking and Computing (MobiHoc), 2006, pp 108-119.

[12] G. Kao, T. Fevens, J. Opatrny, *Position-Based Routing on 3D Geometric Graphs in Mobile Ad-hoc Networks,* The 17th Canadian Conference on Computational Geometry, (CCCG), 2005, pp 88-91.

[13] S. M. N. Alam, Z. J. Haas, *Coverage and Connectivity in Three-Dimensional Networks,* 12th International Conference on Mobile Computing and Networking (MobiCom), Sep 2006, pp 346-357.

[14] A. F. Molisch, F.Tufvesson, J. Karedal, C. F. Mecklenbräuker, *A Survey on Vehicle-to-Vehicle Propagation Channels*, IEEE Wireless Communication, Vol.16, No. 6, Dec 2009, pp 12-22.

[15] S. Durocher, D. Kirkpatrick, L. Narayanan, *On Routing with Guaranteed Delivery in Three-Dimensional Ad-hoc Wireless Networks*, Wireless Networks, Vol. 16, No. 1 Jan 2010, pp 227-235.

[16] F. Huang, K. Leung, V. Li, *Transmission Radius Control in Wireless Ad-hoc Networks with Smart Antennas,* IEEE Transaction on Communications, Vol. 58, No. 8, Jul 2010, pp 2356-2370.

[17] Y. Yoon, J. Kim, M. Jung, Y. Chong, *Radio Propagation Characteristics in the Large City,* 16th International Conference on Advanced Communication Technology (ICACT), Feb 2014, pp 558-562.

[18] R. K. Schmidt, T. Köllmer, T. Leinmüller, B. Böddeker, G. Schäfer, *Degradation of Transmission Range in VANETs caused by Interference,* Praxis der Informationsverarbeitung und Kommunikation, PIK, Vol. 32, No. 4, Jan 2010, pp 224–234.

[19] C. Lochert, M. Mauve, H. Füssler, *Geographic Routing in City Scenarios,* ACM SIGMOBILE Mobile Computing and Communications, Vol. 9, No. 1, Jan 2005, pp 69-72.

[20] B. Karp, H.T. Kung, *GPSR: Greedy Perimeter Stateless Routing for Wireless Network*, International Conference on Mobile Computing and Networking (MobiCom), 2000, pp 243-254.

[21] A.E. Abdallah, T. Fevens, J. Opatrny, *High Delivery Rate Position-based Routing Algorithms for 3D Ad-Hoc Networks*, Computer Communications, Vol. 31, No. 4, Oct 2007, pp 807-817

[22] Q. Lin, C. Li, X. Wang, L. Zu, *A Three-Dimensional Scenario Oriented Routing Protocol in Vehicular Ad-hoc Networks,* Vehicular Technology Conference (VTC), June 2013, pp 1-5.

[23] T. Fevens, G. Kao, and J. Opatrny, *3-D Localized Position-Based Routing With Nearly Certain Delivery in Mobile Ad-hoc Networks*, International Symposium on Wireless Pervasive Computing (ISWPC), Feb 2007, pp 344-349.

[24] T. Islam, Y. Hu, E. Onur, B. Boltjes, J.F.C.M. de Jongh, *Realistic Simulation of IEEE 802.11p Channel in Mobile Vehicle to Vehicle Communication*, 13th Conference on Microwave Techniques (COMITE), 2013, pp 156-161.

[25] L. Kristiana, C. Schmitt, B. Stiller, *Survey of Angle-based Forwarding Methods in VANET Communications*, IFI Technical Report No. 2, 2016, https://files.ifi.uzh.ch/CSG/staff/schmitt/Extern/publications/IFI-2016.02.pdf

[26] NS3, https://www.nsnam.org/, Last visit August 28, 2015.