Isolation Probability of Obstacle-based Highway Vehicular Ad Hoc Networks

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Over the past decades, the communication performance of vehicular ad hoc networks (VANETs) has attracted wide attentions, especially for the highway scenarios. A great amount of work focuses on the connectivity performance, which can be regarded as a fundamental property for the system design of VANETs. Most of the literature studies a great many metrics of connectivity performance such as the probability distribution of cluster size and node isolation probability under some simple channel models, i.e. the unit disk model and lognormal shadowing model. While the connectivity performance has been widely analyzed under the simple assumptions of wireless channel, there is still a lack of accurate connectivity analysis under more realistic channel models. It is meaningful to evaluate the connectivity performance such as the isolation probability under a realistic measurement-based path loss model which presents the effects of moving obstructions on the wireless radio propagation environment in the highway scenarios.

We adopt the measurement-based dual-slope path loss model (T. Abbas, F. Tufvesson, and J. Karedal, Computing Research Repository (CoRR), vol. abs/1203.3370, 2012, pp. 1-13) and consider the impacts of moving obstacles on the vehicle isolation probability, which is defined as the probability that any one vehicle in the network cannot communicate with others directly. By introducing the neighbor degree of the vehicle, a closed-form expression of isolation probability can be derived, and the impacts of channel parameters on the isolation probability can also be evaluated.

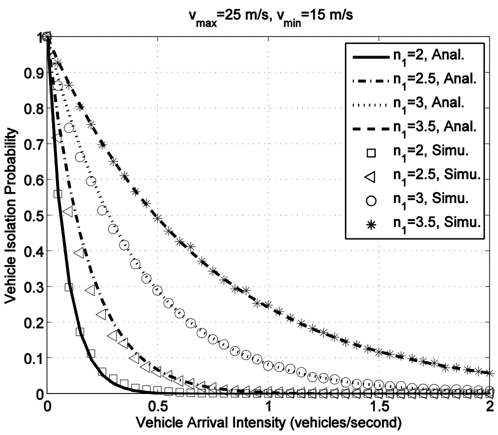

Fig. 1 Isolation probability with various path loss exponents n_1.

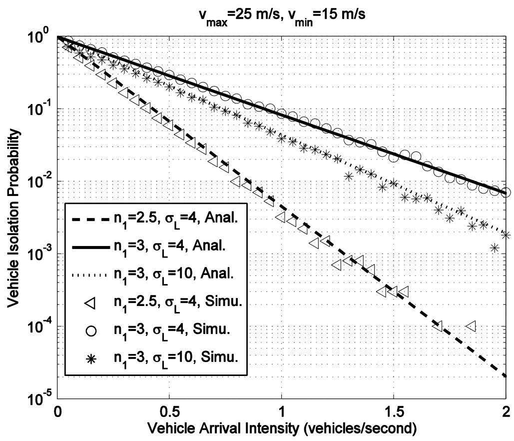

Fig. 2 Comparison of different shadowing deviations σ.

Extensive simulations can be conducted under various channel conditions when the speeds of vehicles are identically independently uniformly distributed in the interval [v_{min}, v_{max}], which are set as 15 and 25 m/s, respectively. Fig. 1 demonstrates the impacts of path loss exponents n_1 on the vehicle isolation probability, which increases dramatically with the larger n_1. This shows that the larger path loss exponents can lead to a worse connectivity. In Fig. 2, the effects of shadowing deviations σ on the isolation probability are presented. It is found that the isolation probability significantly decreases with the increasing shadowing deviations σ. Therefore, the connectivity performance can be improved by a larger shadowing deviation.