WiP abstract: Reception probability model for vehicular ad-hoc networks in the vicinity of intersections

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ABSTRACT

In order to guide and validate the communication system design for vehicular ad-hoc networks (VANETs), and to obtain important insight about scalability and performance in these networks, analytical expressions of key performance metrics are necessary. In this study, we present an analytical model based on stochastic geometry to evaluate the reliability of packet transmission in VANETs in the vicinity of intersections.

1. INTRODUCTION

In VANETs, vehicles continuously share information with each other and their surrounding through wireless communication. This opens up for a new set of applications that are expected to enhance traffic safety and efficiency. The IEEE 802.11p standard has been defined to meet the communication demands of these applications. In order to guide and validate the communication system design, extensive simulations and measurements are often used to evaluate the reliability of packet transmission, e.g., for the important scenario of intersections [1]. We present an analytic performance assessment tool based on stochastic geometry, building on [2], that accounts for the spatial statistics of the vehicles for a road-crossing scenario.

2. MAIN RESULT

We consider an intersection scenario with four lanes (see Fig. 1), where each lane carries vehicles according to a one-dimensional Poisson point process with homogeneous intensity λ_i, $i \in \{1,2,3,4\}$. Neighbouring lanes are separated with a distance d_l. All vehicles broadcasts packets with a transmit power P according to a slotted Aloha protocol with transmit probability $p \in [0,1]$. Furthermore, we consider a target receiver (Rx) located a distance d away from the intersection, and a target transmitter (Tx) located a distance r_{tx} away from the receiver. The signal propagation model comprises Rayleigh fading, path loss $(Ar_{\text{tx}})^{-\alpha}$ for antenna gain A and path loss exponent α, and white Gaussian noise with variance σ^2. Successful reception occurs when the signal-to-interference-plus-noise ratio (SINR) exceeds a threshold ζ. The probability that Rx can decode a packet from Tx is given by

$$\mathbb{P}_s(\zeta) = \exp\left(-p\lambda_1\sqrt{\zeta}r_{\text{tx}}\pi\right)\exp\left(-\frac{p\lambda_2\pi r_{\text{tx}}^2\zeta}{\sqrt{d_l^2+r_{\text{tx}}^2\zeta}}\right)$$
$$\exp\left(-\frac{p\lambda_3\pi r_{\text{tx}}^2\zeta}{\sqrt{(d-d_l)^2+r_{\text{tx}}^2\zeta}}\right)\exp\left(-\frac{p\lambda_4\pi r_{\text{tx}}^2\zeta}{\sqrt{d^2+r_{\text{tx}}^2\zeta}}\right)$$
$$\times\exp\left(\frac{-\zeta(Ar_{\text{tx}})^{\alpha}\sigma^2}{P}\right),$$

where the 5 factors correspond to the contributions from (i) the own lane of the Rx; (ii) the parallel lane; (iii) the near perpendicular lane; (iv) the far perpendicular lane; and (v) the noise and fading. The model provides fundamental insights in vehicular communication systems and can easily be extended to roads with different orientations and to scenarios where vehicles are clustered around the intersection. Ongoing work includes the adoption of realistic medium access control and shadowing.

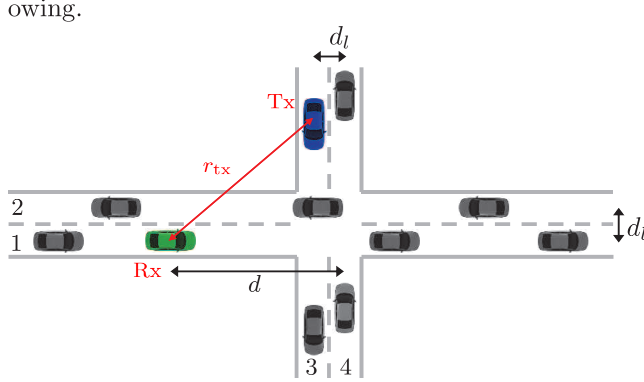

Figure 1: Intersection scenario with four lanes.

3. REFERENCES

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