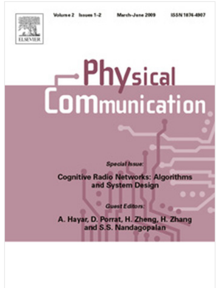
Accepted Manuscript



Non-cooperative game of effective channel capacity and security strength in vehicular networks

Zemin Sun, Yanheng Liu, Jian Wang, Weiwen Deng, Shaoqing Xu

PII: S1874-4907(17)30125-8
DOI: http://dx.doi.org/10.1016/j.phycom.2017.08.002
Reference: PHYCOM 412

To appear in: *Physical Communication*

Received date : 23 April 2017
Revised date : 2 June 2017
Accepted date : 2 August 2017

Non-cooperative Game of Effective Channel Capacity and Security Strength in Vehicular Networks

Zemin Sun[a,b], Yanheng Liu[a,b,c], Jian Wang[a,b,c,d,*], Weiwen Deng[c], Shaoqing Xu[e]

[a] *College of Computer Science and Technology, Jilin University, Changchun 130012, China*
[b] *Key Laboratory of Symbolic Computation and Knowledge Engineering of Ministry of Education, Jilin University, Changchun 130012, China*
[c] *State Key Laboratory of Automotive Simulation and Control, Jilin University, Changchun 130012, China*
[d] *Department of Intelligent Vehicle, China Automotive Engineering Research Institute (CAERI), Chongqing,404100, China*
[e] *China of Limited Company of Jilin Province Power Communication Company, State Grid, Changchun, 130012, China*

Abstract

Vehicular ad-hoc networks pose stringent requirements on quality-of-service (QoS) and security strength in parallel because of their open channels and highly dynamic topology. Harmonizing these two conflicting goals is an urgent challenge, especially in VNs that are characterized by restrictive resources, e.g. bandwidth and link lifetime. This paper aims to balance the anticipated QoS and security strength in context to fully utilize limited network and computing resources to attain a satisfactory performance rating without compromising any security. To this end, we use non-cooperative game theory to formulate node utility, synthesizing the channel capacity and security strength from the perspective of adaptively controlling the transmit power and encryption block length in Nakagami multipath fading (NMF) channels. Moreover, we analyze the non-cooperative behavior of a "communication player" in controlling the transmit power and a "security player" in deciding the encryption block length, both of whom together strive to maximize the utility function at minimum cost. We then theoretically derive the pure strategy Nash equilibrium. Extensive numerical calculations are conducted to comprehensively investigate the reaction of the Nash equilibrium against the various combinations of the considered parameters. The results show that the proposed joint optimization method is capable of self-adapting to the vehicular context and improving the communication quality without compromising on security.

Keywords: Vehicular network, non-cooperative game, Nash equilibrium, transmit power, encryption block length

1. Introduction

Vehicular networks (VNs) allow vehicles to exchange information in real-time with other vehicles (V2V) and with nearby roadside infrastructures (V2I); in this way, they provide a number of value-added services that create a safer and more efficient traffic environment [1]. Closely related to driving safety and even potential life risks, VNs impose stringent conditions on communication quality and security strength for timely and reliable information dissemination. Different from traditional wired networks, VNs are characterized by numerous new features, e.g., quick movements and unstable channels. These characteristics cause many challenges and limitations such as bandwidth shortage, latency sensitivity, and serious Doppler effects, all of which simultaneously make harmonizing quality-of-service (QoS) and security difficult. To address these technical issues in an organized way, the European Telecommunications Standards Institute

*Corresponding author. Address: No. 2699 Qianjin Avenue, Changchun 130012, China. Tel.: +86 431 85159419. Fax: +86 431 85168337

Email addresses: 1728094659@qq.com (Zemin Sun), yhliu@jlu.edu.cn (Yanheng Liu), wangjian591@jlu.edu.cn (Jian Wang), kdeng@jlu.edu.cn (Weiwen Deng), jilinatm@foxmail.com (Shaoqing Xu)