Utilising SCM – MIMO Channel Model Based on V-BLAST Channel Coding in V2V Communication

Ahmad Baheej Al-Khalil, Scott Turner, and Ali Al-Sherbaz

The University of Northampton, School of Science and Technology, St. Georg Avenue, Northampton NN2 6JD, UK
{ahmad.al-khalil,scott.turner,ali.al-sherbaz}@northampton.ac.uk

Abstract. Vehicular ad hoc networks VANETs has recently received significant attention in intelligent transport systems (ITS) research. It provides the driver with information regarding traffic and road conditions which is needed to reduce accidents, which will save many people's lives. In Vehicle-to-vehicle V2V communication the high-speed mobility of the nodes is the challenge, which significantly affects the reliability of communication. In this paper the utilising of SCM-MIMO channel model, (which is based on V-BLAST channel coding) is present to evaluate the performance of the PHY layer in V2V communication. The simulation results observed that the SCM model can overcome the propagation issues such as path loss, multipath fading and shadowing loss. The simulation considered three different environments, high, medium and low disruptions in urban traffic.

Keywords: VANETs, V2V, MIMO, SCM, V-BLAST.

1 Introduction

In the recent years the advent of Vehicular Ad-hoc Networks VANETs considers one of the most important developments in the wireless communications systems. In a recent United Nation UN road safety report around the world, it was documented that road safety deaths made up 2.2% of the leading causes of death in 2004. It has been predicted that this will rise to 3.6% by 2030. There have been recommendations made by the Global Status Report regarding the poor collaboration between the sectors made responsible for collecting and reporting data on road traffic incidents. These recommendations have also included communication between the police, health and transport services and their ability to man such operations [1]. There is therefore a need to provide the driver with information regarding traffic and road conditions to reduce these incidents, thus will keep many people's lives. VANETs is a technology which uses the moving vehicles as nodes in the wireless network, which also considers as a special case of the Mobile Ad-hoc Networks MANETs [2]. VANETs is dedicated to exchange the messages between the vehicles in two forms: vehicle to vehicle V2V and vehicle to infrastructure V2I [3]. The aim of the use of VANETs technology is to produce a full wireless communication solution among vehicles, to satisfy the
safety and the comfortable applications requirements such as less congestion, accident warning, road exploration, etc. An important advantage of VANETs is battery power is generated during the journey, providing an extended battery life.

The paper is organized as follows. In Section 2, important general background information on VANETs standards, MIMO technology with VANETs and V-BLAST coding are provided. The SCM channel model is explained in section 3. Next, the parameters and environments settings are presented in section 4. Section 5 is the discussion of the simulation results. Finally Section 6 is concluding this paper.

2 Background

2.1 VANETs Standard

Dedicated Short Range Communication DSRC is the wireless communication protocol for the Vehicular Ad-hoc Networks, it was approved by the United State Federal Communication Commission FCC in 1992 [4]. DSRC is allocated to support the Intelligent Transport System ITS applications in the licensed band of 5.9 GHz. In 2004, the DSRC joined the IEEE (Institute of Engineering Electrical and Electronics) and classified as a part of the IEEE 802.11 family known as IEEE 802.11p [5]. The IEEE 802.11p standard uses the same physical layer as the IEEE 802.11a standard. However, the only difference is the bandwidth channel which is 10MHz instead of the 20MHz [6]. The purpose of the IEEE 802.11p standard is to provide the minimum specification, ensuring that the devices are able to communicate in rapidly changing environment [7].

2.2 MIMO Technology with VANETs

In VANETs communications the advantages of having unlimited battery life and multiple antennas positions are strong factors in using Multiple-Input-Multiple-Output MIMO systems with VANETs [8]. MIMO systems perform higher capacities compared to single antenna systems. However, there are significant challenges which need to be taken in the consideration like: channel modeling, processing of space time signals in VANETs and channel coding. MIMO provides considerable advantages including having wider coverage area, enhancing the multi fading environments and improving higher data throughputs [9]. Providing high data rate at high QoS in VANETs communication system, is considered as the greatest challenges in this research area [10] [11]. Due to the factors that could affect to the signal strength such as scattering, reflection and interference, the bandwidth is needed to improve the QoS. To improve the bandwidth there are two methods in general [8], in the first approach the diversity technique is used to improve link reliability in term of improving the transmit diversity and/or the receive diversity. The use of higher modulations and efficient codes will increase the data rate which consequently leads to improving the reliability of the link [8]. In the second approach MIMO systems are used in both transmitter and receiver, while each transmitting antenna transmits a separate stream