Poster: Field Testing Vehicular Networks using OpenC2X

Florian Klingler, Gurjashan Singh Pannu, Christoph Sommer,
Bastian Bloessl and Falko Dressler
Heinz Nixdorf Institute and Dept. of Computer Science, Paderborn University, Germany
{klingler,gurjashan.pannu,sommer,bloessl,dressler}@ccs-labs.org

ABSTRACT

We present OpenC2X, an Open Source approach to field testing of vehicular networking solutions. Field Operational Test (FOT) and real-world experimentation are becoming more relevant to our research community as well as to industry and regulation. Unfortunately, available commercial solutions make experimental modifications to the protocol stack time consuming or prohibit it completely. To overcome this limitation, we implemented the ETSI ITS-G5 stack on a standard embedded PC hardware and running Linux system. OpenC2X is the first complete Open Source experimentation and prototyping platform. Our system is fully interoperable to commercial solutions, yet easily extensible with new protocols and applications for vehicular networks.

1. INTRODUCTION

In the last decade, we have seen many striking advances in the field of vehicular networks. The work led to the standardization of access layers (DSRC, IEEE 802.11p) as well as complete network stacks (IEEE WAVE, ETSI ITS-G5, ARIB T109) [3]. As protocols matured, the focus shifted towards Field Operational Tests (FOTs) in order to identify possible limitations and to ensure seamless integration in real-world applications. As of today, Japan already started to deploy DSRC using its local ARIB standard and car makers in both Europe and the US announced first units to become standard in selected cars.

FOTs are usually conducted with proprietary commercial equipment, which limits the ability to modify or even fine-tune protocol layers. To overcome this limitation, we developed OpenC2X [2], the first Open Source experimentation and prototyping platform that can easily be extended and parameterized for R&D on vehicular networking protocols. We continued and extended previous work to present version 2.0 of our framework, which is fully compatible to commercial tools like the Cohda Wireless MK5, a popular choice for FOTs. It is now possible to use OpenC2X to investigate and validate details of (almost) all protocol layers. We plan extending the platform with a Software Defined Radio (SDR) to even allow fine-tuning the physical layer [1].

MobiSys'17 June 19-23, 2017, Niagara Falls, NY, USA

ACM ISBN 978-1-4503-4928-4/17/06.
DOI: http://dx.doi.org/10.1145/3081333.3089322

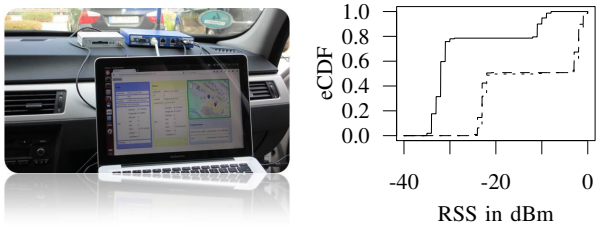

Figure 1: Setup and results of OpenC2X running on an embedded Linux system in the car.

2. FIELD TESTING WITH OPENC2X

Field testing using OpenC2X is simple as our software runs on a standard Linux system. It uses Atheros 9k WLAN cards, which can operate on the 5.9 GHz band, using 10 MHz channels and all parameters according to the IEEE 802.11p standard. We support almost all aspects of the ETSI ITS-G5 standard, particularly, congestion control mechanisms according to Decentralized Congestion Control (DCC), a mechanism that is considered for the US IEEE WAVE standard as well. In a set of experiments, we explored the capabilities of OpenC2X. The hardware setup and sample results are depicted in Figure 1. We confirmed interoperability with the Cohda Wireless MK5 by sending and receiving Cooperative Awareness Messages (CAMs) and Decentralized Environmental Notification Messages (DENMs). Our OpenC2X system also connects to typical GPS receivers as well as to the car's CAN bus via an ELM 327 based OBD-II adapter. The system also features a graphical web interface that shows and logs detailed information about the ego vehicle, neighboring vehicles, and the latest CAMs and DENMs.

3. REFERENCES

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