Prototyping Delay-Aware V2X Safe Communications

1 Context

Car accidents represent one of the major problems against which efforts in both research and industry are channeled to shape and scale new technologies to improve traffic flow and guarantee the safety of road users. In this context, Intelligent Transportation Systems (ITSs) are the current trends in the automotive industry to tackle these issues: both information and communication technologies are applied to provide innovative services for traffic management, enable users to be better informed about the circulation circumstances, and make safer, more coordinated and smarter the use of transport networks.

The usage of ITS in automobiles entail Vehicle-to-X (V2X) communications with third party entities X (vehicles, infrastructure, users, etc) inside adapted networks. The concept behind V2X is that the on-board equipment of each vehicle periodically transmits information about its speed and location (among others) to other vehicles and stationary roadside devices mounted on traffic signs and lights in order to mitigate possible accidents. V2X is based on the amendment 6 of the widely accepted IEEE 802.11 (IEEE 802.11p [2] for short) for *Wireless Access in Vehicular Environments* (WAVE). It is a set of specifications of media access control (MAC) and physical layer (PHY) for implementing wireless network support for high speed radio environments. There are higher-level protocol stacks built upon IEEE 802.11p designated for cooperative safety ITS applications based on the standard families ETSI ITS-G5 [1] and IEEE 1609 WAVE [3].

2 Internship

The standards IEEE 802.11p, ITS-G5 and IEEE 1609 do not require connected entities to be synchronized and acknowledged since the vehicular network topology is highly dynamic. However, delay-aware synchronization between them may be mandatory especially in safety-critical scenarios (left turn, overtaking, circulation in tunnels, etc). In this case, the software layer and the network stack of each connected entity should be respectively designed and configured to tackle these issues. This internship project has four main objectives:

1) setting up a suitable run-time environment compliant with the standards mentioned above on specific hardware platforms (already bought cf. Figure 1);
2) integration of precise time stamps (based on real-time clocks) in the network stack packets to ensure delay-aware synchronization and acquittal mechanisms between connected entities;
3) design of software libraries allowing users to i) reason about relevant communication safety properties, ii) analyze faulty scenarios caused by network latency and disturbance, and iii) evaluate the reliability of the runtime and hardware platforms;
4) tests under real circumstances of car circulation.

Figure 1: Hardware platform.

Desired skills and application

- Minimum qualifications: master/5^{th} year engineer candidate in networking and/or computer sciences;
- Programming languages: C/C++, Python and Linux Shell for scripting, Ada ...
- Proven written and verbal communication skills.
- **Application documents**: detailed CV (grades, teaching units, student projects, tools and skills, etc); cover letter (futur projects, motivations for a PhD extension, etc); scores of the last two years; recommendations are appreciated.

Contact

Sebti Mouelhi (`sebti.mouelhi@ece.fr`), Rafik Zitouni (`rafik.zitouni@ece.fr`)

References

[1] European Telecommunications Standards Institute. EN 302 663: Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band, 2012. Standard, URL: http://www.etsi.org/deliver/etsi_en/302600_302699/302663/01.02.00_20/en_302663v010200a.pdf.

[2] IEEE Standards Association. 802.11p-2010. Standard, Institute of Electrical and Electronics Engineers, 2010. URL: https://standards.ieee.org/standard/802_11p-2010.html.

[3] IEEE Standards Association. 1609.4. Standard, Institute of Electrical and Electronics Engineers, 2016. URL: https://standards.ieee.org/standard/1609_4-2016.html.