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Cooperative Adaptive Cruise Control and Platooning at SDOs
draft-petrescu-its-cacc-sdo-00.txt

Abstract

This document describes the use-cases of Cooperative Adaptive Cruise Control, and Platooning, as defined by several Standards Development Organizations such as ETSI, IEEE 1609, SAE and 3GPP.

C-ACC and Platooning involve concepts of direct vehicle-to-vehicle, and device-to-device communications, which are developped by 3GPP and precursory by the METIS EU project. They are illustrated very clearly in emergency settings such as FirstNet.

IP messages - instead of link-layer messages - are pertinent for C-ACC and Platooning use-cases because applications for road safety such as WAZE, iRezQ and Coyote (currently involving infrastructure) are IP messages, and proved succesful in deployments. Applications such as Sentinel are direct between vehicles but are not IP, currently.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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This Internet-Draft will expire on September 10, 2015.

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1. Introduction

Cooperative Adaptive Cruise Control and Platooning are two use-cases described recently at particular Standards Development Organizations. C-ACC describes the formation of chains of automobiles following each other at constant speed, in an automatic manner. This is to offer more comfort for human drivers on long journeys on straight roads.

Platooning is a concept related to larger vehicles following each other. The goal in this case is not necessarily comfort, but the

expected gains in terms of gas consumption: when large vehicles can follow each other at small distance the air-drag is much lower, directly influencing on gas consumption, tyre use, and more.

Both C-ACC and Platooning are relying on information exchange between vehicles. These exchanges may happen in a direct manner (direct vehicle to vehicle communications) or with assistance from a fixed communication infrastructure (vehicle-to-infrastructure-to-vehicle communications).

This document describes the C-ACC and Platooning use-cases as described at ETSI ITS. These use-cases are widely accepted as Vehicle-to-Vehicle applications. For this reason, we present the perspectives on V2V from IEEE, SAE, ISO and LTE.

In emergency settings the concepts of direct vehicle-to-vehicle communications are of paramount importance. FirstNet, an overarching example described later in this document, covers V2V, V2I and V2I2V communication needs, together with strong security requirements.

In the market, several systems for vehicular communications have demonstrated a number of benefits in the context of vehicle-to-vehicle communications. The Sentinel system is used between vehicles to warn each other about approach; the WAZE application on smartphones created a community where users influence others about the route choice; the iRezQ and Coyote applications communicate between vehicles, via infrastructure, about route risks.

In [I-D.petrescu-ipv6-over-80211p] the use of IPv6 over 802.11p is described. This link layer is potentially used in direct vehicle-to-vehicle communications. It is obviously not the only link layer pertinent for V2V.

2. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

C-ACC: Cooperative Adaptive Cruise Control.

V2V: Vehicle-to-Vehicle communications.

3. ETSI ITS C-ACC and Platooning use-case and reqs

4. IEEE 1609 perspective on vehicle-to-vehicle communications

5. SAE perspective on C-ACC and Platooning

6. 3GPP and EU project use of LTE Device-to-Device

6.1. METIS

METIS is co-funded by the European Commission as an Integrated Project under the Seventh Framework Programme for research and development (FP7).

METIS defines test cases and requirements of "Traffic safety and efficiency", as depicted in [METIS-D1.1], which is intended for 5G in 2020 but may also be applicable for LTE and beyond.

The use cases include:

1. Dangerous situation that can be avoided by means of V2V communications.

2. Dangerous situation with vulnerable road users (i.e. pedestrians, cyclists,...) that can be avoided by means of V2D communications. "D" can denote any cellular device that the vulnerable road user may carry (e.g. smart phone, tablet, sensor tag).

3. Assistance services that can improve traffic efficiency by means of V2X communications, e.g. traffic sign recognition and green light assistance.

4. Platooning (or road trains) in an autonomous manner to increase traffic flows and reduce fuel consumption and emissions.

5. Highly automated vehicles.

To support the above use cases, METIS works out the corresponding network requirements, such as E2E latency should be within 5ms, required data rates for various scenarios, service ranges in highway/rural/urban scenarios, etc.

6.2. 3GPP

Proximity Service (ProSe) allows a UE to discover and communicate with other UEs that are in proximity directly or with the network assistance. This may also be called as Device-to-Device (D2D) communication. ProSe is intended for purposes such as public security, network offloading, etc [GPP-TR-22-803].

The ProSe Communication path could use E-UTRAN or WLAN. In the case of WLAN, only ProSe-assisted WLAN direct communication (i.e. when ProSe assists with connection establishment management and service continuity) is considered [GPP-TS-22-278].

The work on ProSe is initiated in 3GPP Release 12. Some enhancements are being added in Release 13, e.g. Restricted ProSe Discovery. Some use cases are identified in [GPP-TR-22-803], but most of which are intended for common mobile users, e.g. walking people, not for vehicles moving at high speed, for example the latency in ProSe communication may be a problem for V2X.

Although ProSe does not support V2X communication before Release 14, but it has some very good characteristics which makes it a good candidate for V2X besides DSRC. ProSe communication does not have to go through the EPC, which will significantly reduce the latency. ProSe also support group and broadcast communication by means of a common communication path established between the UEs.

There are some efforts at 3GPP Release 14, trying to address V2X communication. The efforts are proposed by experts in the industry, and may be subject to change. These efforts include the following:

1. To address the V2X use cases in 3GPP. The use cases may have been defined by other SDOs, e.g. ETSI ITS, 3GPP can reference to them. Requirements for V2X communication should also be considered, for example network delay, packet loss rate, etc. [METIS-D1.1] already propose some requirements, but those are intended for future mobile network, which may be too critical for LTE.

2. To address V2X applications and messages. The messages may include message defined in SAE J2735, ETSI Cooperative Awareness Message (CAM) and ETSI Decentralized Environmental Notification Message (DeNM). The messages defined by different SDOs might be similar to each other.

3. Study of possibility to add enhancements to ProSe, and to make it able to support and enhance DSRC.

4. Study of using existing LTE technologies for unicast/multicast/ broadcast communication.

The above are just some examples, not an exhaustive list.

7. FirstNet EMS use of LTE and IP in V2I2V

FirstNet is a corporation housed inside the US Department of Commerce. It gets capitalization budget from, among other sources, sale of spectrum by the US FCC. It gets operating budget from sale of services to state emergency services entities.

The specific use-cases for FirstNet include vehicle-to-vehicle, vehicle-to-infrastructure and vehicle-to-infrastructure-to-vehicle communications using in certain cases LTE and IP:

1. Emergency communications to vehicles from government entities conveying, for example: weather warnings, road conditions, evacuation orders. The government entities might include PSAPs or mobile vehicles such as police cruisers.

2. Instrumented emergency services vehicles such as ambulances. An example is the ability to telemeter casualty (patient) data from sensors attached to the casualty to a hospital emergency room.

3. Emergency communications from vehicles' occupants to government entities such as Public Safety Access Points (PSAPs, also known as 911 operators in US).

The National Public Safety Telecommunications Council describes FirstNet as an emergency communications system (largely viewed through the prism of the familiar Land Mobile Radio systems most emergency services use.) The cellular telephone industry views FirstNet as supplementary to an existing commercial cellphone system (e.g. reusing the same towers and backhaul). Perhaps a better view of FirstNet is as an extension of the Internet to emergency services vehicles (including foot-borne).

It is clear that FirstNet overlaps to a large extent to the concepts that have been discussed in vehicle-to-vehicle communications for other purposes.

FirstNet has not been clear about its communication technology choices to date. But LTE has been discussed as the most likely layer 2 protocol. A segregated segment of spectrum in the 700MHz band has been set aside by Congressional action for emergency services and control of that spectrum has been passed to FirstNet. There appear to be no new protocols, development of which is fostered by FirstNet. Several Internet applications would need rework to handle high availability, security and assured access needs of emergency services.

8. ISO perspective on V2V

The International Standards Organization's Technical Committee 204 (ISO TC204, in short) has specified a communication architecture known as the "ITS station reference communication architecture" [ISO-21217]. This communication architecture covers all layers (access technologies, network, transport, facilities and applications) of a typical communications protocol stack. It is designed to accommodate communications between ITS stations engaged in ITS services. ITS stations can be deployed in vehicles of any type, roadside infrastructure (traffic lights, variable message signs, toll road gantries, etc.), urban infrastructure (parking gates, bus stops, etc.) nomadic devices (smartphones, tablets) and control centers (traffic control center, emergency call centers, data centers and services centers). The ITS stations can be distributed in several nodes (e.g. an in-vehicle gateway and a set of hosts attached to the internal in-vehicle network). The ITS station architecture is designed to support many kinds of wired and wireless access technologies (vehicular WiFi 802.11p, urban WiFi 802.11b/g/n/ac/ad; cellular networks; satellite; infra-red, LiFi, millimeter wave, etc.)

The ISO ITS station architecture can thus support both broadcast and unicast types of communication, vehicle-to-infrastructure communications (road infrastructure using e.g. WiFi, or cellular infrastructure using e.g. 3G/4G) and, most notably, direct vehicle-to-vehicle communications.

The architecture includes the possibility to communicate using IPv6 [ISO-21210] or non-IP (ISO FNTP, currently being harmonized with IEEE WAVE).

9. Internet apps: WAZE, iRezQ, Coyote, Sentinel

Applications using the Internet have been developped in the particular context of vehicular communications. These applications are designed for parties situated in vehicles. Their profile is less of client-server kind, but more of peer-to-peer kind (vehicle to vehicle).

Some use vehicle-to-infrastructure-to-vehicle IP paths, whereas others involve direct vehicle-to-vehicle paths (without infrastructure).

These applications are described in more detail in draft-liu-its-scenario-00.txt issued on March 9th, 2015, authored by Dapeng Liu.

10. Security Considerations

All government-to-vehicle and vehicle-to-government communications require authenticity; there will be no exceptions.

Some, but not all, communications from government-to-vehicle and vehicle-to-government require confidentiality (some of these requirements, such as medical data, have the force of law, many have custom or respect as the requirements base).

These requirements pertain to the content.

11. IANA Considerations

mandatory

12. Contributors

contributors

13. Acknowledgements

The authors would like to acknowledge .

14. References

14.1. Normative References

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Appendix A. ChangeLog

The changes are listed in reverse chronological order, most recent changes appearing at the top of the list.

From nil to draft-petrescu-its-cacc-sdo-00.xml:

o initial version

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