

V2X Vehicular Communications System



Background

Road accidents represent a serious social problem and a leading cause of death and disability in many countries. More than 117 people have been killed each day on average on the U.S. roads in 2021, plus an amount of \$1.37 Trillion of economic and societal impact due to vehicle crashes (2019). A promising solution to make the roads safer is by equipping vehicles with wireless communication devices, which permit the vehicles to communicate with each other and with deployed roadside units (RSUs) to enhance road safety through reliably and timely exchange of safety messages, i.e., creation of Connected Vehicles (CVs). Each safety message carries vehicle status information, such as speed, acceleration, brake status, etc., which allows for the implementation of many advanced road safety applications.

The global connected vehicle/smart transportation market was valued at US\$ 105.4 Billion in 2022 and is expected to experience rapid growth mainly due to the high number of traffic accidents and its severe socioeconomic impacts, which have increased the need for safer transportation systems; and the government initiatives around the world toward mandating vehicular networking technologies.

Reference

7391 (core), 7426, 7437

Patent status

Issued patents in the US, Canada, and China on core and improvement technologies (9 issued patents):

Core technology: TDMA safety-message broadcasting for CVs

Improvement 1: enhanced reliability for safety-message rebroadcasting

Improvement 2: compatibility with IEEE802.11p, multi-hop capability, immunity to temporary GPS signal disturbance

Stage of development

Proof-of-concept

In-lab prototype testing performed
On-road demonstrations completed

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Description of the invention

Researchers at the University of Waterloo have developed a novel wireless networking protocol based on Time Division Multiple Access (TDMA), that allows each vehicle to reliably broadcast safety messages periodically; or immediately in case of an unexpected event; to other vehicles and to RSUs. The system utilises GPS' one pulse-per-second (1PPS) signal, operates in the 5.9GHz frequency band allocated for Dedicated Short-Range Communications (DSRC), and allows all nodes (cars, RSUs, etc.) to decide if a received safety message should be rebroadcasted to reach other nodes in a reliable manner, before the message is expired, and without the need of a central controller. This enables forming a multi-hop safety message broadcast system for CVs.

Advantages

- Reliable broadcast/rebroadcast of safety messages with the required Quality of Service (QoS).
- Low latency in broadcasted safety messages by vehicles and RSUs.
- Distributed "control" system.
- Compatible with IEEE802.11p standard for vehicular network architectures.

Potential applications

A variety of road safety applications:

- Vehicle Internet of Things
- Lane change warning
- Emergency brake alert
- Traffic signal violation warning