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Research paper

Design of the Emergency Messages Integration for Vehicle to Everything (V2X) Communications of Connected Cars

Eom Young-Hyun[1], Inhwan Kim[2], Hyunmi Yoo[3], Sungguk Cho[4] and Byungkook Jeon[5]*

[1,2,3,5]Dept. of Software, Gangneung-Wonju National University, Wonju City, Gangwon Prov., 26403 Korea
[4]Dept. of Multimedia Engineering, Gangneung-Wonju National University, Wonju City, Gangwon Prov., 26403 Korea
**Corresponding author E-mail: jeonbk@gwnu.ac.kr*

Abstract

So far, international standardization of message specifications between V2X(Vehicle to Everything) safety communications are BSM(Basic Safety Message) by US-led SAE and CAM(Cooperative Awareness Message)/DENM(Decentralized Environmental Notification Message) by EU-led ETSI. However, in the emergency situation such as car accidents or road traffic jam, there may be insufficient time to process all messages. In this paper, we propose an integration of emergency messages for V2X communications of connected vehicles in VANETs(Vehicular Ad hoc Networks), To do this, we are using the Mobile Virtual Fence(MVF), which has been preliminarily researched and developed. So we extract and integrate only emergency messages as the fields of similar messages between BSM and CAM/DENM, and apply it to the MVF. If it will be the connected MVFs like connected cars in the future and any traffic accident or traffic jam occurs, the proposed messages will be communicated to each other to avoid the accident. Therefore the proposed integration of emergency messages between BSM and CAM/DENM specification will be contribute to improve the safety and reliability as the unified and integrated emergency messages.

Keywords: *Mobile Virtual Fence, Emergency Message, Connected cars, Vehicle-to-Everything, Vehicular Ad hoc Networks*

1. Introduction

V2X(Vehicle to Everything) communications in VANETs(Vehicular Ad hoc Networks) are emerging in the field of wireless networks[1-8]. Autonomous vehicles periodically send messages in which they have driving status information about what they are doing to mobile everything such as vehicles, ITS(Intelligent Transport Systems), pedestrians, and so on. Until now, international standardization of message specifications between V2V(Vehicle to Vehicle) safety communications are BSM Part I, II by US-led SAE and CAM/DENM) by EU-led ETSI[1,3,9-12]. However two messages' specification was not integrated into one unique message while trying to integrate by ISO. Moreover, in an emergency situation such as car accidents, road traffic jam, there may be insufficient time to process all messages.

Therefore, in this paper, we design an integration of emergency messages between BSM and CAM/DENM specification for V2X communications of connected vehicles in VANETs, To do this, we are using the Mobile Virtual Fence(MVF) which has been preliminarily researched and developed[8,13-16]. The MVF on behalf of vehicles, ITS and pedestrians, etc. runs and manages on smartphone, and is not only fixed and stationary geofencing services but also dynamic, floatable and flexible geofencing services which can be movable in the indoors or outdoors by location-aware computing[13-16]. So we extract and integrate only emergency message as the common message elements between BSM and CAM/DENM, and apply it to the MVF. If it will be the connected MVFs like connected cars in the future and any kind of abnormal situation such as traffic accidents or traffic jam occur on the road, the proposed messages will be communicated to each other to avoid the abnormal situation.

2. Related Works

2.1 CAM/DENM

CAMs are messages exchanged in the ITS network among ITS-Ss to create and maintain awareness of each other and to support cooperative performance of vehicles using the road networks[9]. The content of CAM varies depending on the type of the ITS-S. For vehicle ITS-Ss, the status information of CAM includes times, reference position, motion state, activated systems, etc. and the vehicle attribute information of CAM includes data about the vehicle's type and state, and role in the road traffic, and so on[9]. Especially, DENM is a facilities layer message that is mainly send by ITS applications in order to alert road users of any detected event using ITS communication technologies and used to describe any variety of events that can be detected by ITS stations[10].

2.2 BSM

SAE J2735 DSRC(Dedicated Short Range Communications standard) defines fifteen types of messages which are used for communication in the VANETs[11,12]. An important type among fifteen types is a BSM. A BSM which is used by V2V safety applications contains information about the status of vehicle such as time, position, heading, speed, acceleration, with optional information also possible. Especially, safety applications that use BSM include blind spot warning, forward collision warning, lane change warning and pre-crash warning, and so on[12].

3. Integration of the Emergency Messages

In this chapter, the fields of BSM and CAM/DENM are extracted as emergency messages for V2X communications, and the integrated emergency messages are constructed. That is, the message set of events for both CAM/DENM and BSM contains a wide variety of data to allow application authors to selectively include the required data. Therefore, the events message of this paper includes information about vehicles that sensed the first accident event and the data for understanding the effect of the emergency event on the vehicle.

3.1. The Emergency Messages in CAM/DENM

The current version of CAM/DENM has no possibility to mark a message as safety relevant and also has no mechanism to set an urgency level for a message. So, user devices need to consider the appropriate presentation based on the specific message as received. The DENM situation container shall include an event type as one of the fields, which has causeCode and subCauseCode. For the event types that have been assigned with the causeCode and subCauseCode values in TISA TAWG11071, the same values are used[17]. In Table 1, causeCode and related subCauseCode are only indicated what we choose about emergency[17].

Table 1: Selection of emergency fields among references to TISA TAWG11071 for ETSI use case

cause Code	causeCode description	subCause Code	subCause description
2	Accident	1 ~ 7	As specified in tec102 of clause 9.12 in TISA TAWG11071
		8	Assistance requested (e-call)
92	Post crash	1	Accident without e-Call triggered
		2	Accident with e-Call manually triggered
		3	Accident with e-Call automatically triggered
		4	Accident with e-Call triggered without a possible access to a cell network.
99	Dangerous situation	1	Emergency electronic brake lights
		2	Pre-crash system activated
		3	ESP(Electronic Stability Program) activated
		4	ABS (Anti-lock braking system) activated
		5	AEB (Automatic Emergency Braking) activated

3.2. The Emergency Messages in BSM

BSM Part II is about vehicle safety as an option, which is the VehicalSafetyExtension. It has two fields for events, that is, events and extevents field. The fields match each of EventsFlag and EventsFlagExt in DSRC[12]. Therefore the flags for the events are data that contain information about the type of event generated when the emergency event occurs and transmit the message to the server containing the data that occurred when the value of the emergency event message becomes 'true'. The description of selected field for the emergency events among a lot of the EventsFlag and EventsFlagExt fields is as shown in the following Table 2.

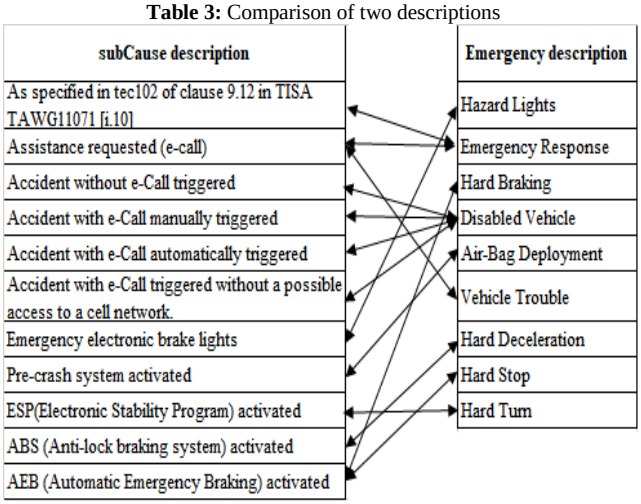
Table 2: The selected emergency messages

Event Type	Code	Emergency description
EventsFlag	0	Hazard Lights
	1	Emergency Response
	2	Hard Braking
	3	Disabled Vehicle
	4	Air-Bag Deployment
EventsFlagsExt	0	Vehicle Trouble
	1	Hard Deceleration
	2	Hard Stop
	3	Hard Turn

3.3. Comparison of Emergency Attributes

Table 3 is to compares similarity and association according to the urgent situation description of two fields of DENM and DSRC. Here, even though each code is different they can be associated with the same or similar property with an arrow. In particular, the DENM follows TISA TAWG11071, which, unlike the DSRC, contains a representation of event handling before and after an accident. In conclusion, both CAM/DENM and BSM have only one field and two fields related to the events.

Table 3: Comparison of two descriptions



4. Experimental Results

When any urgent situation such as car crash, road traffic accident occur, we propagate the integrated emergency message to another connected device for connected car. In order to experiments, we apply it using the MVF on each device that used six mobile devices, which are implemented using smartphones based on Android OS.

Fig. 1 shows the implementation screen when the client application is started. The top of the screen shows the button to start the connected car service and the button to click the button to generate manually the emergency event since only for experiments. When you click the button that generates the emergency event, 'Emergency occurred' appears in the toast message. At the same time, the server analyzes the Id of the device informed of the emergency from the connected vehicle list and displays it in the 'Send a Message' section at the bottom of the screen.

Fig 1 : A screenshot of an emergency event on a client

The server establishes a connected car environment by allowing a connection when there is a request from each client (mobile device), and receives a basic message concurrently with the connection. As shown in Fig. 2, it is confirmed that all six clients belong to Group1 and are all located in the same area. As a result, all of the clients are connected to 'All Connected device in Group1'. Also, Fig. 2 shows a screenshot of the server that the message was received as soon as an emergency event occurred at '9d1ec2181794e387' (Device Id). To show that an emergency has occurred, it shows that an emergency message has been broadcast to all connected devices.

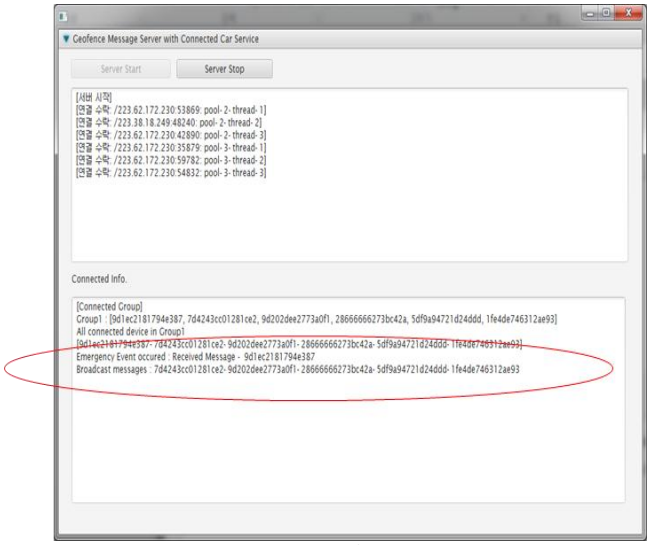


Fig. 2: A screenshot of the server side

5. Conclusion

Any emergency situation information such as car crash, accidents, road traffic accidents are included CAM/DENM and BSM. However, since these message sets have different attributes, they need to be integrated.

Therefore this paper compared and analyzed these attributes, and extracted and integrated only emergency message as common fields between BSM and CAM/DENM, and apply them to the MVF. If it will be constructed the connected MVFs like connected cars and any traffic accidents or road traffic jam occurs, these messages will be communicated to each other to avoid such accidents.

In the future, to support automated driving and coordinated maneuverings, connected vehicles communication is indispensable. Therefore the proposed integration of emergency messages between BSM and CAM/DENM will be contribute to improve the safety, and reliability as the unified and integrated emergency messages.

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