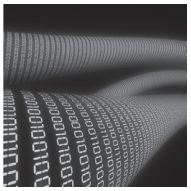

Archives of
Transport System
Telematics

Volume 11

Issue 4

November 2018

Implementation of Intelligent Vehicle Safety System eCall type, India Case Study

A.K. YADAV, J. SZPYTKO
AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY, UNESCO AGH Chair (India), Adama Mickiewicza 30, 30-059 Krakow, Poland
EMAIL: aruyad1@gmail.com

ABSTRACT

The Indian government is still promoting eCall to minimize the number of roadway disaster by reducing the response time when an accident has occurred. The eCall system is combination of an In Vehicle System(IVS), consisting of a device with a GSM cell phone and GPS (Global Positioning System)for location Tracking facility and it all consist of corresponding infrastructure of Public Safety Answering Points (PSAPs).This Intelligent Vehicle Safety System uses information and communication technologies for providing solutions for improving road safety in particular in the pre-crash phase when the accident can still be avoided or at least its severity significantly reduced. By using this system which can operate either manually or autonomously on-board the vehicle, the number of accidents and their severity can be reduced. The implementation of on board emergency call (eCall) is an ITS (Intelligent Transport System) service which has been already been deployed in different countries. Several private and public initiatives have already resulted into preliminary and pure private eCall services, mainly to the car industry. Location, enhanced emergency calls like in vehicle eCall have their primary benefit to society of saving lives and in offering an increased sense of security significance.

KEYWORDS: eCall, Functional architecture, PSAP, IVS

1. Introduction

According to European Union, every new car to be equipped with the eCall system from 2010. The system will automatically generate an emergency call after a serious accident. With this call the data of the vehicle including location is transmitted to the 112 emergency call centre i.e. Public Safety Answering Points (PSAP). The eCall generator initiates the eCall by the use of sensors triggered (automatically) or manually, send the in-vehicle triggered eCall to a PSAP. The eCall consists of two features: a pure voice (audio) telephone call based on 112 and the by use of Minimum Set of Data (MSD).

The eCall (data plus voice) carried through the mobile networks, is recognized by the Mobile Network Operator (MNO) as a 112 emergency call and is first handled by the MNO. Based on the 112 handling, the MNO enrich the call with CLI (Caller Line Identification) and at the same time according to E112 recommendation add the best location available. After the 112 handling the telecom operator delivers the 112 voice together with the CLI mobile location and the eCall MSD to the appropriate PSAP[6]. Than the PSAP transmits an acknowledgement to the eCall generator specifying that the MSD have been properly received [1], whole process is shown below in Fig.1.

In other way when a serious accident occurs, in vehicle sensor will automatically triggers an eCall. When activated the in-vehicle establishes a 112 voice connection and as soon as the communication channel is successfully connected, an emergency message known as

the Minimum Set of Data (MSD) including key information about the accident such as time, accurate location, driving direction (resulting from accurate satellite, based data such as EGNOS1 and from 2013 on Galileo 2) and vehicle description is sent.This normally takes a very few seconds after which the voice channel is free, so that the PSAP can talk directly with the occupants of the vehicle.

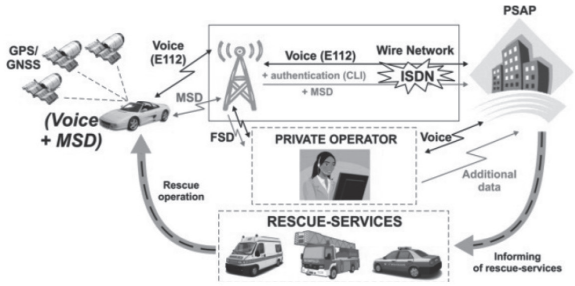

Fig. 1. General flow of information in eCall System [8]

Than Mobile Network Operator (MNO) identifies that the 112 call is an eCall from the eCall flag, provided by the vehicle Network Access Device (NAD). The MNO handles the eCall like any other 112 call and routes, the call to the most appropriate response centre Public Safety Answering Point (PSAP), which is defined by the Public Authorities. The PSAP operator will receive both the voice call and the MSD. Than the information provided by the MSD will be decoded and displayed on the PSAP operator screen. The location and driving direction of the vehicle can be shown using a Geographic Information System (GIS). As soon the MSD has been sent, the operator will be able to hear what is happening in the vehicle and talk with the occupants of the vehicle if possible. This will help the operator ascertain which emergency services are needed at the accident scene (ambulance, fireman, police, etc.) and to rapidly dispatch the alert and all relevant information to the right service.

2. eCall Service Chain

The Overall Performance Criteria OPC for the eCall service chain have been derived from a range of studies and experiences from the various stakeholder group involved. Furthermore, from the comparable automatic and manual vehicle emergency or assistance calling system and current PSAP operation systems and emergency response system have been taken into account. In order to provide a clear understanding of the different aspects of the eCall chain six different domains have been noticed:

1. Vehicle eCall Triggering System→112 eCall triggers (eCall Sensors or manual) →Transmission over Vehicle Bus;
2. eCall Generator (EG)→In-Vehicle Software triggers 112 Call --- In-vehicle Communication module initiates 112 all and send MSD;
3. EG 2 MNO→Receive 112 call and MSD;
4. Mobile Network Operator (MNO) --- 112 call with CLI, cellular location and MSD;
5. MNO 2 PSAP→Forward 112 Voice, CLI Cellular location and MSD to PSAP;
6. PSAP → Answer 112 voice call, decode and visualize cellular location and MSD;

3. Functional Architecture

The eCall System consist many units which performs their particular task (Fig.2). Here are some functions of eCall units:

1. Collect data from the vehicle network and from vehicle sensors and maintain an up to date GPS identify the vehicle location.
2. On Board System Automatically detect a crash based on car sensor information.
3. Than it automatically call a PSAP when a crash is detected or when driver press the manual switch than a dedicated call will generate
4. Each call has two main parts: Establish voice contact between the car occupant and a PSAP operator to provide assistance to the driver and other passengers

It transmits a Minimum set of Data (MSD) to the PSAP including the current GPS position and direction the car was heading [5].

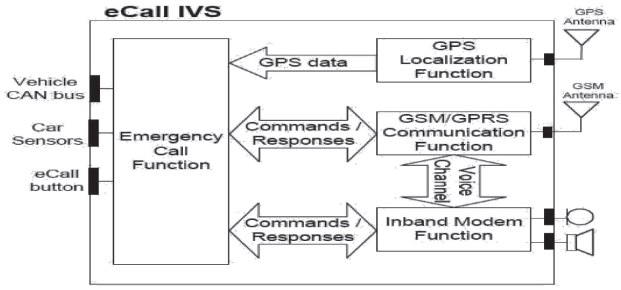

Fig. 2. Functional Architecture of eCall IVS [2]

The functional blocks of IVS:

1. Emergency call Function: This is the eCall application. It gathers all information of vehicle through the CAN bus or by the use of other sensors and geo-location information from the use of GPS function. In a case of a crash it generates and sends emergency message to the nearest PSAP through the GSM/GPRS function.
2. GPS(Global Positioning System): The main function of GPS is gathering information from GPS satellites and processing this information to accurately find the vehicle's geo-location.
3. GSM/GPRS: The GSM/GPRS function is responsible for establishing and maintaining a GSM call to the PSAP so that the Crashed Vehicle Information (CVI) can be sent and a fast connection established between the accidental car driver and the operator.
4. In-Band Modem: There are few technologies to send data to the PSAP (SMS, GPRS,Inband Modem). The most likely way to be used is the in-band modem. This technology uses the voice channel, typically a special processing unit in the audio path encodes/ decodes messages.

It is a challenging task to transmit data over the mobile voice channel as required of an in-band modem since speech codec's used in digital cellular systems are optimized explicitly for speech signal compression. Therefore, modem signals may in occur heavy distortion after passing through the effective transmission channel consisting of speech codec, possible degradations on the radio channel and speech decoder with error concealment. Furthermore,

in digital cellular communications frame losses occur regularly and increase the burden of data recovery by the in-band modem.

CTM was developed in 3GPP for transmitting text data for text telephony. It was evaluated as a potential solution for EIM in the technical report (3GPP TR 26.967 [4]) and found not able to meet eCall requirements The present EIM solution consists of an IVS data modem and a PSAP data modem, employing signals that have been designed to pass through modern speech codec's with only moderate distortion, yet providing sufficiently high data rates for quick MSD transmission. The overall cellular system architecture, including the IVS and PSAP data modems, is presented in publication [6].

After an emergency voice call has been (automatically or manually) established, the IVS modem receiver constantly monitors the incoming signal from the speech decoder output. When prompted by a request from the PSAP operator for MSD, the IVS connects the IVS data modem transmitter to the input of the speech coder and mutes any speech from the motorist for the duration of MSD transmission to prevent it from interfering with the eCall data transmission [7].

4. Architecture of In-vehicle System

Vehicle manufacturers should include the eCall in-vehicle system in the design plans for new type-approved vehicles. The eCall in-vehicle system equipment comprises different parts:

1. Electronic Control Unit (ECU)
2. Positioning system
3. Communication system
4. Human-Machine Interaction (HMI)

Electronic Control Unit (ECU) includes the subsystems and devices allowing, on one side the identification and qualification of an incident that has caused the triggering of an eCall (e.g.: airbag deployment) and the triggering mechanism (automatic and manual), and the subsystems allowing the bundling of the MSD. The ECU needs to be equipped with a memory to store the data needed to bundle the MSD and interact with the positioning system, receive input from the positioning system and possibly from the CAN bus and provide input to the communication module [6].

Positioning System includes the subsystem and devices necessary to supply the accurate location of the vehicle and the direction of driving. Due to the requirements on accuracy the positioning system will be normally based on Global Navigation Satellite Systems (GNSS), such as EGNOS and from 2013 on Galileo.

Communication System includes the subsystems and the network access device (NAD) necessary to set up the 112 voice call and forward the data (using the standardized protocols defined by ETSI, i.e., the in-band modem) via the PLMN (public land mobile network) through the mobile network operators to the most relevant PSAP. The communication system comprises subsystems and devices such as the communication device, able to set-up the eCall flag, antenna, the required cabling, the loudspeakers and microphones for the voice connection between the vehicle occupant and the PSAP operator. The communication system can be configured to perform only emergency calls with associated transfer of data (eCall only mode), in this case it shall not perform mobility management procedures, including registration on a PLMN, except when attempting to initiate and during an emergency call, or to initiate a test or reconfiguration of the terminal upon request from the user

Human-Machine Interaction (HMI) includes the necessary actions to inform the vehicle occupants about the status of the eCall system, as well as the status of the eCall transaction when triggered, according to the specifications defined in the relevant standards. The HMI may be part of the general vehicle HMI or one dedicated to the eCall device [6].

5. Role of MSD (Minimum Set of Data)

The main use of minimum set of data were set by the emergency group service provider in the Driving Group (DC)eCall. The requirements are based on the information that is required by the emergency group to speed up the response time and to ensure a correct deployment of emergency service [2].The Driving Group eCall recommends that the below MSD content be standardized by the a standardization body .

The MSD provides these below mentioned information: GPS position, direction of travel, number of triggers of the call, colour/ makemodel of vehicle, indicates the particular sensor is triggered: airbag, roll-over, front crash, side crash or rear crash sensor; time stamp of the event, SP ID (Service Provider Identification), SP telephone number, we can add more information in MSD according to the requirement of the emergency group. It is recommended to use the 112 voice channel to the PASP by the use of MSD via a specific protocol Global Telemetric Protocol (GTP). During the testing consortium decided to use short message service to transfer the eCall MSD to the PSAP and if subscribed there to the full set of data (FSD) to the service provider using the same vehicle protocol (GTP) .

Here in eCall system PSAP is a Public Controlled Call Centre which is responsible for providing a first point of contact to a 112 call. The PSAP is thus receiving the emergency 112 voice call and the MSD. Based on the voice connection and the MSD content, the PSAP operator decides the handover to the correct dispatcher, which will handle the remaining part of the specific emergency response. The main source of PSAP's is the voice, the MSD and the location details that is provided by E112. In special cases where the driver is subscribing to a SP the additional set of data can be dragged by the PSAP operator by the use of the secure internet IP connection. Sometimes it can happen that PSAP operator dose not able to understand or speak the language of the driver which is involved in accident. In that case and under the sole condition that the driver has a service provider subscription, it is possible for the PASP operator to make a conference voice call between himself, the vehicle occupant and the operator at the responsible service provider [4].

The PSAP is the public controlled call centre responsible for providing a first point of contact to a 112 call. The PSAP is thus

receiving the Emergency 112-voice call and the MSD. Based on the voice connection and the MSD content, the PSAP operator decides the handover to the correct dispatcher, which will handle the remaining part of the specific emergency response. The PSAP's source of information is the voice, the MSD and the location information provided by E112. For cases where the driver is subscribing to a SP the additional set of data can be pulled by the PSAP operator over a secure Internet IP connection. It may happen that the PSAP operator does not speak the language of the driver involved in the accident. In that case and under the sole condition that the driver has a service provider subscription, it is possible for the PSAP operator to set up a conference voice call between himself, the vehicle occupant and the operator at the responsible service provider [4].

The definition of the MSD was made in close co-operation with the vehicle makers because in the end, the vehicle manufacturers need to make sure that the information was present. The minimum set of data has been coded using the GTP protocol and consist of the following information that will be forwarded, together with the voice call to the PSAP operator when receiving an in vehicle eCall

1. when by time stamp,
2. where by the precise location of satellite position including the driving direction,
3. who by the vehicle description (caller line identification, color, make and model including, VIN),
4. where to get more information via the service provider (IP address, including for example telephone number and country code),
5. how by the eCall qualifier (source of the trigger, manual or automatic including what type of sensor).

6. Conclusion

In order to get the reporting time of an accident it is important to give more simple and more information about the vehicle to the emergency call operator, the Indian commission launched a communication to aware the respective states to implement the single Indian emergency call number 112, which has been follow by all the states across India. In addition of this the Indian Communication launched a recommendation about the enhanced E112 which is provided with a feature of providing the location when an emergency call is made from cellular phone. Today the main problem with the existing eCall solutions provided by the different vehicle manufacturers and service providers is that they only operate in on country.

From the network operators and service providers, perspective they are developing different systems for the all the vehicles manufacturers, which is making the system expensive and because of that they are not able to work all across whole country. Another conclusion from this article is that if there is Pan – India eCall system, all the vehicle manufactures or the network providers can not develop this by themselves and it is very important to include the public authorities in this matter.

Acknowledgment

The work has been supported by the Polish Ministry of Science and Higher Education.

Bibliography

[1] CĂRUȚAȘU G., et al.: Current status for eCall post-crash vehicle safety system in Europe, Proceedings of 10th International Conference of Innovative Technologies, MIT, Fiesa –Slovenia, 2009, pp. 35

[2] CĂRUȚAȘU G.: Further Challenges of eCall Service and Infrastructure, MIT Conference Proceedings, Fiesa- Slovenia, 2016

[3] SEIDL M., et al.: eCall–Defining Accident Conditions for Mandatory Triggering of Automatic Emergency Calls, 24th International Technical Conference on the Enhanced Safety of Vehicles (ESV), Gothenburg, Sweden, 2015

[4] Preventive and Active Safety Applications, Architecture and specification for preventive and active safety, 1985 Available: http://www.prevent-ip.org/ [date of access: 22.01.2018]

[5] Implementing eCall: Vehicle Emergency Communication, wavecom blue paper no 2-implementing eCall, January 2007, Available on :www.wavecom.com, [date of access: 22.01.2018]

[6] GSM Global system for mobile communication, ETSI TS 126 267 v8.0.0 ,3GPP TS 26.267 version 8.0.0 Release 8 , Technical specification (2009-14)

[7] MANSO M., et al.: The Application of Telematics and Smart Devices in Emergencies: Use Cases in Next Generation Emergency Services, IEEE First International Conference on Internet-of-Things Design and Implementation (IoTDI),2016, pp. 289-292

[8] KAMINSKI T., et al.: Implementation Problems of Automatic Emergency Information System – eCall, Archives of Transportation System Telematics, Volume 3, Poland, 2010, pp. 23-26