Communication Technologies for Vehicles: eCall

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Abstract. Traffic accidents are one of the major causes of deaths and injuries in Europe. A timely and efficient intervention of emergency services is crucial to save lives and reduce human suffering. In order to reduce the fatality rate in the EU the European Commission is working since 2009 to develop the eCall system. eCall is a project design for the improvement of road safety by providing rapid assistance to motorist involved in a collision anywhere is the European Union. In case of an accident the intended solution establishes automatically a communication with emergency services and sends a set of data such as location, vehicle type and other relevant information timely and reliably from the in-vehicle system (IVS) over the cellular network. This paper provides a general vision of how it works and different kinds of eCall. In addition, it describes the studies that have taken place to validate the deployment of eCall based on 112 across Europe and introduces some future targets.

Keywords: ecall · European commission · Emergency · 112

1 Introduction

Road fatalities in the EU have fallen 18 % since 2010 [1], when the Road Safety Strategy (2010–2020) started. While achievements to date are good – cutting the number of annual deaths by almost one fifth in this period– they are not quite in line with the ambitious target. Even with these improvements, traffic incidents are still one of the major causes of deaths and injuries in Europe [2]. According to the European Commission (EC), there were 26,000 deaths and more than 1.4 million people injured on road network during 2014 [3]. The Intelligent Car Initiative had a significant positive impact, but in order to halve the number of road deaths by 2020, the road fatality numbers must go down at a higher speed from today and onwards.

In 2010 the EU Commission launched the European Intelligent Transport Systems (ITS) Action Plan, which covered a section for Road safety and security. This section promotes support for a harmonized introduction of the Pan European eCall, including awareness campaigns, upgrading Public Service Access Points (PSAP) infrastructures and an assessment of the need for regulation. Feasibility studies by the European Commission have indicated that eCall can make a significant reduction to the number of people died on the road and reduce the severity of injuries, by enabling an early intervention by the emergency services, providing more rapid access to medical services in that vital "golden hour" following an incident.

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Emergency calls made from vehicles or mobile telephones using wireless technology can assist in significantly reducing road deaths and injuries. However, in many situations, the passengers of a vehicle involved in an incident may not be in a position to call using a mobile phone, because either they have been injured or trapped or do not know the local emergency number to be called. Additionally, they have inaccurate location details, especially if travelling on rural roads or whilst travelling abroad. Furthermore, travellers driving abroad may have language problems trying to communicate with emergency services.

The objective of implementing the Pan European in-vehicle emergency call system (eCall) is to automate the notification of a traffic accident from anywhere in the European Union and associated countries, using the same technical standards.

2 How eCall Works

eCall is a 112 emergency call triggered either manually by vehicle occupants or automatically as soon as an in-vehicle sensor detects a serious accident.

When activated, the in-vehicle system (IVS) will establish a voice connection directly with the relevant Public Safety Answering Point (PSAP). After the triggering of the eCall, other communications that are in progress are suspended, if needed. Microphone and loudspeakers are fully dedicated to the emergency call. At the same time an emergency message, the minimum set of data (MSD) including key information about the accident, such as time, location, driving direction and vehicle description, is sent with the voice call.

The mobile network operator (MNO) handles the eCall like any other 112 call and routes the call to the most appropriate emergency response centre. The PSAP operator will receive both the voice call and the MSD.

The information provided by the MSD will be decoded and displayed in the PSAP operator screen. The PSAP operator may at any time request for a new MSD (e.g. data appears corrupted or inconsistent, or the PSAP operator believes that the data may have changed). In the meantime, audio link is established and 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, fire brigade, police) and to rapidly dispatch the alert and all relevant information to the right service. Once the communication with the vehicle is finished, only the PSAP is allowed to clear down the call. Even so, in-vehicle equipment remains registered to the network in order to allow the call back.

Furthermore, the PSAP operator will be able to immediately inform the road/traffic management centres that an incident has occurred in a specific location, facilitating rapid information to other road users and thus preventing secondary accidents, helping to clear the carriageway, and therefore reducing congestion (Fig. 1).

2.1 eCall Flag

Some emergency services have required a system to separate eCalls from 112 calls in order to route the calls differently. This is the main reason of the eCall flag implementation. The eCall flag is also able to differentiate automatically and manually initiated eCalls.

The flag is included in the MSD information. That way, the flag enables the telecommunication mobile network operator to route to a different long number (E.164 number) depending of the nature of the call (eCall or 112 call).

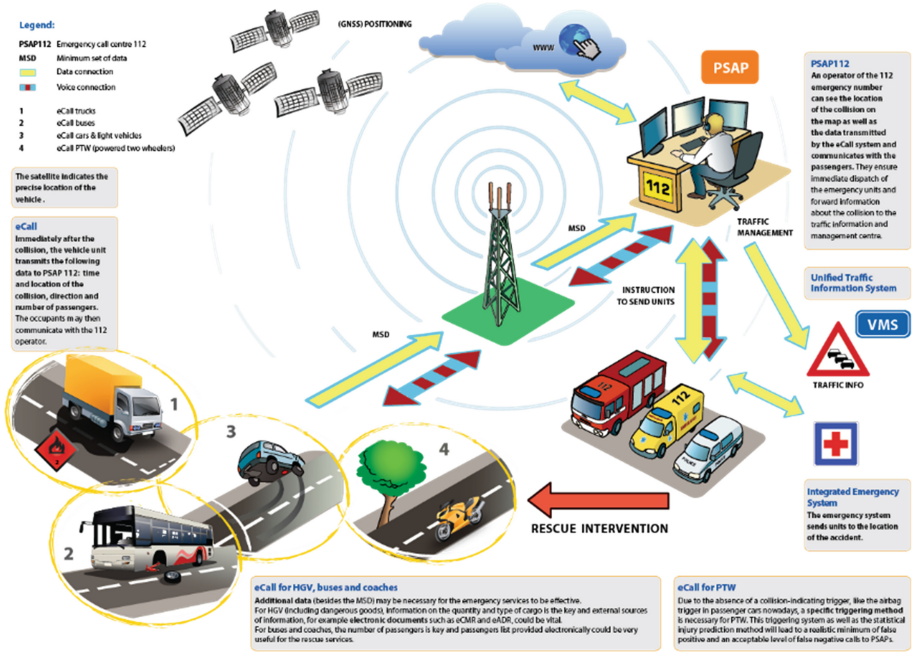

Fig. 1. Graphic of eCall operating summary (extracted form: Infrastructure Harmonised eCall European Pilot (IHeERO) http://iheero.eu/about_ecall/)

2.2 In-Band Modem eCall

Communication between the passengers of the crashed vehicle and emergency services is based on a quasi-simultaneous data and voice link over the same channel. In-band modem eCall uses Circuit Switched (Cs) technology. This system forces to mute the voice path while the MSD is being transmitted.

3 Pan European and Third Party Services eCall

The Pan-European eCall concept benefits from its direct prioritised emergency link to the appropriate PSAP through the existing 112 mechanisms. The 112 call over the mobile network is required to work in all European countries for free, even if no roaming agreement between the vehicle's home network and the guest network is in place. For the pan-European eCall, the priority given to normal 112 calls in the mobile network also applies to the eCall data transmission. Therefore, the coverage and availability of the eCall service is maximized. [4].

Otherwise, European legislation leaves room for the existence of Third Party Service eCall (TPS eCall), apart from the Pan European eCall based on 112.

Private companies can offer services similar to the public eCall on their own. That way, the respective customer will be able to opt either for the service offered by the state (managed by a public authority or a private company) or for a private service. Drivers could also change to the state-provided eCall even if initially they chose the privately offered service.

TPS eCall is based on using a third party to filter and route calls prior to the PSAP routing. Calls are received by call centre agents (TPSP operators) and handled accordingly of the type of the call (emergency call, assistance call, etc.). In of real emergency, data and voice are forwarded to the most appropriate PSAP using the 'long' number of each PSAP.

Compared to the Pan European eCall, filtering false emergency calls allows to lighten PSAP work load. However, the fact that it is not a direct link to the PSAP increases the potential sources of failure in the emergency call provision.

4 Minimum Set of Data

The Minimum set of Data (MSD) is information of the accident that would receive the PSAP when the eCall is established.

MSD has been standardised by the European Committee for Standardisation (CEN TS 15722: 2015) [5]. The information from the MSD can be divided in two categories: mandatory and optional. The mandatory information includes: message ID, vehicle identification, vehicle propulsion storage type, time stamp, vehicle location and direction and format field.

- *Message identifier:* MSD format version as well as a message identifier. The message identifier will initially have a value of 1, which will be incremented with every MSD retransmission after the incident event.
- *Activation type:* whether the eCall has been manually or automatically generated (0 for automatic and 1 for manual).
- *Call type:* whether the eCall is a real emergency or a test call (1 for test call and 0 for an emergency call).
- *Vehicle type:* passenger vehicle, buses and coaches, light commercial vehicles, heavy duty vehicles or motorcycles.
- *Vehicle identification number* (VIN) according to ISO 3779.

- *Vehicle propulsion storage type:* This is important particularly relating to fire risk and electrical power source issues (e.g. Gasoline tank, Diesel tank, compressed natural gas (CNG), etc.)
- *Time stamp:* the time of the accident, expressed in seconds elapsed since midnight January 1st 1970 UTC.
- *Vehicle location:* determined by the on-board system at the time of message generation. It is the last known vehicle's position (latitude and longitude).
- *Position Confidence:* this bit is to be set to "Low confidence in position" if the position is not within the limits of ±150 m with 95 % confidence (1 for low confidence in position or 0 if the position can be trusted)
- *Direction:* helpful to determine the carriageway vehicle was using at the moment of the incident
- *Format field:* It contains information regarding the optional additional data. 0– No optional additional data, 1– Binary data, 2– BCD, 3– XML encoded data, 4– ASN. 1 BER defined data, 5– ASN.1 PER defined data, 6– ASCII encoded data.
- *Recent vehicle location n (Optional):* vehicle's position in (n-1) and (n-2).
- *Number of passengers (Optional):* number of fastened seatbelts

5 Important Standards

The most efficient way to address interoperability issues in the eCall implementation is to use the agreed common standards. The European Standardisation Bodies CEN and ETSI are working on eCall standards since 2004 and, as a result, the following technical and operational standards have been developed so far:

- CEN EN 15722: Intelligent transport systems - eSafety - eCall minimum set of data
- CEN EN 16062: eCall- High Level Applications Protocols
- CEN EN 16072: Pan European eCall Operating Requirements
- EN/ISO 24978: ITS Safety and emergency messages using any available wireless media - Data registry procedures
- ETSI TS 126 267: In-band modem solution, general description
- ETSI TS 124 008: Pan-European eCall discriminator

6 Privacy and Data Protection

Although the added value of a service such as eCall cannot be easily questioned, concerns about the data privacy should be well addressed. It is worth separating Public eCall service from TPS eCall service for this issue.

The public Pan European 112 eCall in-vehicle system is not connected to mobile network and therefore there is no tracking or data transmission unless a serious accident takes place. Only in this case or after a manual activation, the information contained in the Minimum Set of Data is transmitted to the PSAP. On top of that the data included in the MSDS are those strictly needed by the emergency services to handle the emergency situation.

On contrast there is the TPS eCall system. If a car is equipped with TPS devices, it usually offers additional services such as GPS navigation, integrated hands-free cell phones, road assistance, and so on. In consequence, since it might need to transmit data depending on the other services provided, a dormant eCall device cannot be guaranteed.

7 About HeERO

The pre-deployment evaluation of eCall as a part of ITS action plan started with the EU co-founded R&D projects "HeERO" and "HeERO 2" (Harmonised eCall European Pilot).

HeERO addresses the Pan European in-vehicle emergency call service "eCall" based on 112, the common European Emergency number. For three years (January 2011 to December 2013), the nine European countries forming the HeERO 1 consortium (Croatia, Czech Republic, Finland, Germany, Greece, Italy, The Netherlands, Romania and Sweden) carried out the start-up of an interoperable and harmonised in-vehicle emergency call system.

The second phase of the HeERO project - HeERO 2 - started on 1st January 2013 and lasts 2 years. 6 new countries (namely Belgium, Bulgaria, Denmark, Luxembourg, Spain and Turkey) have joined the other 9 pilot sites of HeERO 1. Furthermore, other countries who wished to become HeERO partners, but have not succeeded for several reasons, (Hungary, Cyrus, Iceland and Israel) became associate partners, a status allowing them to benefit from the expertise of HeERO 1 and 2 but not granting them access to EC funding [6] (Fig. 2).

Those projects have paved the way for the deployment of eCall based on 112. The architectures to be used are defined and the published standards have also been validated. Now, the I_HeERO project (January 2015 to December 2017) proposal draws directly from these results and as such adds real value to the work already undertaken to achieve the mandated deployment of eCall based on 112 for member state PSAP by 1st October 2017 and for vehicles 6 months after that date (31st March 2018).

This project proposal, I_HeERO, ("I" for "Infrastructure") also addresses the mandated pan European in-vehicle emergency call service based on 112.

I_HeERO will

- Upgrade the necessary PSAP infrastructure to support eCall as a Pan European concept.
- Boost Member States investment in the PSAP infrastructure and interoperability of the service within the roadmap including the cross-border communications.
- Prepare for deployment for eCall for HGV and Dangerous Goods and Long Distance Coaches.
- Prepare for deployment for eCall for Powered two wheeled vehicles.
- Define and then perform PSAP Conformity Assessments, which is a legal obligation for all PSAP handling eCall based on 112.
- Look at advancements in the management of data and next generation 112 for eCall.
- Provide Associate Partnership for I_HeERO open to both Member States and Commercial Organisations who are involved in eCall deployment [7].

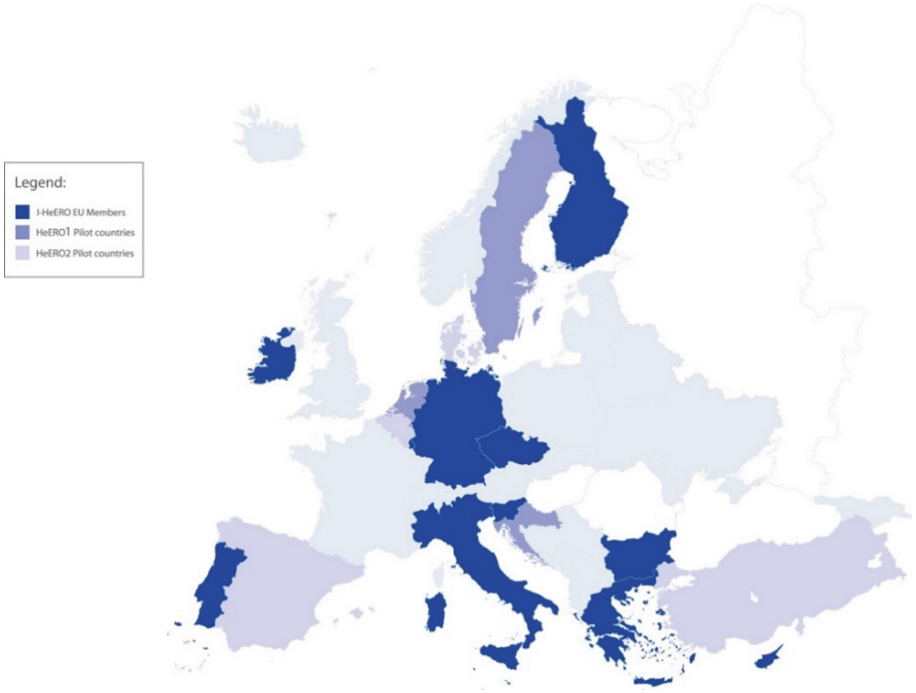

Fig. 2. HeERO project Member States. (extracted form: Infrastructure Harmonised eCall European Pilot (IHeERO) http://iheero.eu/about-iheero/)

8 eCall Benefits

Getting an immediate alert in the event of an accident and knowing the exact location of the crash site reduce the reaction time for the emergency services by 50 % in rural and 40 % in urban areas [8]. Thanks to this gain in time, eCall system is expected to save several hundred lives, and to mitigate the severity of tens of thousands of injuries in the EU annually when fully implemented. eCall will also result in faster treatment of injured people, thereby giving accident victims better recovery prospects.

The early arrival to the accident scene will also allow faster clearance of crash sites, thus reducing the risk of secondary accidents, decreasing congestion times, cutting fuel waste and lowering CO2 emissions.

In addition, the value of life saved and severe injury prevented must be also translated into monetary benefits. Road collisions cost the EU around 160 billion €/year, but if all cars were equipped with the eCall system, up to 20 billion € could be saved annually. [9].

9 Next Generation eCall

As technology advances the eCall system will also include necessary changes. eCall technology was originally conceived for 2&3G network, but future networks will be based on IP technology.

In future there will be a mixed vehicle poll of 2, 3, 4, and 5G eCall equipped vehicles so I_HeERO study will consider the migration of eCall to Next Generation eCall (NG112).

NG112 is going to be achieved using IP Multimedia Subsystem (IMS) eCall. This technology qualifies eCall system to do faster and more reliable MSD transfer without losing speech path and enabling more than 140 bytes MSD. Moreover, IMS eCall would have the capability to include additional media (e.g. video from dashboard cameras, text from speech or hearing impaired users) and two-way data enabling the PSAP to send instructions to vehicle (e.g. sound horn, flash lights, lock/unlock doors, disable ignition).

Due to the fact that lifetime of the cars is much longer than a mobile phone, cars being deployed with in-band modem eCall will need circuit switched 112 support from the network until the 2030s approximately. So, in-band modem eCall and IMS eCall will have to co-exist. A relevant strategy for the migration of the PSAP will allow effective management thus ensuring that eCall remains effective.

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