The eCall Program: Overview and Design Considerations

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Introduction

According the European Commission (EC) there were approximately 39,000 deaths and more than 1.7 million people injured in Europe during 2008[1]. The evolution of the telematics sector and the introduction of eCall has created an opportunity for deaths via vehicle accidents to be reduced.

The pan-European in-vehicle emergency call, “eCall”, is estimated to have the potential to save up to 2,500 fatalities annually in Europe when fully deployed. Furthermore, it can reduce the severity of injuries, reduce human suffering and bring significant savings to society in terms of healthcare and other related costs.[1]

Emergency calls made from vehicles or mobile telephones using wireless technology can assist in significantly reducing road deaths and injuries. However, drivers often have inaccurate location details, especially on interurban roads or abroad. In many situations the car occupants may not be in a position to call using a normal mobile phone.

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.

This white paper provides an overview of the status of eCall and associated documents. It also discusses design considerations for the eCall in-vehicle system in order to reduce cost for vehicle manufacturers.

Program Status

The initial target for the eCall deployment was scheduled for 2009 and although delayed it is still the final aim of the European Commission (EC) to fully roll out the pan-European eCall service and make it standard equipment in all new vehicles in Europe.

In August 2009 the EC stated that “it will monitor the effectiveness of the voluntary approach” and “if significant progress is not made by the end of 2009” it will consider in 2010 introducing regulatory measures for making the eCall system standard in new type-approved vehicles in Europe to ensure it is deployed in all European countries.

Despite good progress on the standardization side a regulatory approach should start soon and it will likely be mandatory for all new registered passenger cars in Europe from 2014 and beyond.

How eCall works

When a serious accident occurs, in-vehicle sensors will automatically trigger an eCall.

When activated, the in-vehicle system (IVS) establishes a 112-voice connection. 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.

1 See studies on .esafetysupport.info/en/ecall_toolbox/related_studies/.

The eCall can also be activated manually. The mobile network operator (MNO) identifies that the 112 call is an eCall from the “eCall flag” inserted by the vehicle’s communication module.

The MNO handles the eCall like any other 112 call and routes the call to the most appropriate emergency response centre - Public Safety Answering Point (PSAP). 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. At the same time, 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, police) and to rapidly dispatch the alert and all relevant information to the right service.

The European standards do not specify whether eCall is provided by using an embedded network access device (GSM module) or using nomadic or portable equipment (e.g. mobile phone). However in the pan European eCall operating requirements it is defined that:

- the solution is robust and will normally survive a crash
- the quality of service of the in-vehicle equipment, including communications equipment, is reliable.

Sierra Wireless believes no vehicle manufacturer should use a mobile phone or a similar non-embedded consumer device for such a live critical service. The most reliable solution is a fully embedded system with an embedded GSM module, embedded SIM, and the ability to manage devices over the air.

Important Standards

prEN 2782442; Intelligent transport systems, eSafety, Third party support for eCall – Operating requirements

This European Standard defines the general operating requirements and intrinsic procedures for eCall services in order to transfer an emergency message from a vehicle to a PSAP in the event of a crash or emergency, via an “eCall” communication session and to establish a voice channel between the in-vehicle equipment and the PSAP.

prEN 278243; Intelligent transport systems, eSafety, eCall high level application protocols (HALP)

This European Standard defines the high level application protocols, procedures and processes required to provide the eCall service using a TS12 emergency call over a mobile communications network. Note: HALP requirements for “Third party services supporting eCall” are to be found in the deliverable “Third party services supporting eCall operating requirements”, and have been developed in conjunction with this EN and are consistent with respect to the interface to the PSAP.

EN 15722; Road transport and traffic telematics, eSafety, “eCall” minimum set of data

This European Standard defines the standard data concepts that comprise the "Minimum Set of Data" to be transferred from a vehicle to a PSAP in the event of a crash or emergency via an “eCall” communication session.

ETSI TS 126 267; TSG services and system aspects; eCall data transfer – in-band modem solution; general description [Release 8]

This document specifies the eCall In-band Modem, which is used for reliable transmission of the eCall MSD from an In-Vehicle System (IVS) to the PSAP via the voice channel of cellular and PSTN networks.

eCall provides reliable full-duplex data communications between IVS and PSAP in addition to emergency voice call (E112) via the cellular network, and can be initiated either automatically or manually. The eCall in-band modem uses the same voice channel as used for the emergency voice call. eCall allows reliable transmission of MSD alternating with a speech conversation through the existing voice communication paths in cellular mobile phone systems.

The present document provides a general overview and algorithm description of the eCall in-band modems, including IVS modem and PSAP modem, to form the complete full-duplex transmission.

The eCall in-band modems (IVS and PSAP) are fully specified by this TS, together with the C-code reference as provided in TS 126.268.

ETSI TS 126 268; eCall data transfer – in-band modem solution; ANSI-C reference code [Release 8]

This document contains an electronic copy of the ANSI‑C code for the eCall in-band modem solution for reliable transmission of MSD data from IVS to PSAP via the speech channel of cellular networks. The ANSI‑C code is necessary for a bit exact implementation of the IVS modem and PSAP modem described in TS 26.267.

ETSI TS 126 269; eCall data transfer – in-band modem solution; conformance testing [Release 8]

This TS is for conformance testing of the in-band modem implementation.

ETSI TR 126.969 eCall Data Transfer – in-band modem solution; Characterization Report

This TR characterizes the performance under various radio and network conditions.

ETSI TS 122 101 – eCall Flag

In case of an eCall the Network Access Device (NAD = GSM modem) shall commence an emergency call set-up in accordance with ETSI TS 124 008 and include in the TS12 service category request message the “eCall Flag” as specified in ETSI TS 122 101 and ETSI TS 124 008.

ETSI TS 122 101 & TS 124 008 & TS 122 011 - NAD configured only for eCall

If the NAD is configured to make only eCalls, then, in accordance with ETSI TS 122 101 (Release 8 onwards), the IVS NAD shall not perform mobility management procedures, including registration on a PLMN, except when attempting to initiate an e-Call and during an emergency call, or to initiate a test or reconfiguration of the terminal during a maintenance operation.

NOTE: The purpose of this restriction is to avoid network congestion due to large volumes of unnecessary network registration, de-registration and location update signalling from terminals configured only to make eCalls.

The updated list of standards can be found here:
://ec.europa.eu/information_society/activities/esafety/ecallstandards/

Functional architecture of the IVS

According to the operating requirements for eCall:

- The in-vehicle system shall include a network access device (NAD, e.g. a GSM module).
- The in-vehicle system shall detect when an “eCall trigger” has been initiated.
- In the event of an accident the “eCall” system shall automatically determine whether or not to trigger an “eCall” and, where appropriate, make such an “eCall” automatically.
- An “eCall” shall also be able to be triggered manually.
- Upon triggering an “eCall” the “eCall” system shall attempt to send a MSD to any given mobile network operator (MNO) with the European pre-assigned TS12 destination address (112).
- The “eCall” system shall also try to establish a voice connection between the vehicle and that pre-assigned destination address (e.g. a PSAP with TS12).
- The system shall be robust and will normally survive a crash.
- The quality of service of the in-vehicle equipment, including communications equipment, shall be reliable.

For the MSD the IVS has to collect data from the vehicle network and maintain the last up-to-date GPS-fixes of the vehicle’s location.

This provides the following main functional blocks for an IVS:

- eCall Application
- Embedded SIM
- Cellular Network connectivity (GSM)
- GNSS (GPS, Galileo)
- Vehicle Connectivity (CAN)
- In-Band Modem for MDS transmission
- Backup battery
- Internal GSM and GPS antenna for backup
- Connection for external antennas

Design Considerations for an IVS

Several considerations are presented regarding the design of an in-vehicle system. In particular:

- Cost Reduction: Because the eCall IVS will be present in every new car, including economy as well as luxury models, cost reduction will have a high priority.
- GSM/GPS Reception Sensitivity: The eCall IVS shall provide sensitive and reliable reception since it will be in a protected location inside the car and may need to use an embedded antenna.
- Low Power Consumption: The eCall IVS shall have low power consumption, especially in standby, to avoid draining battery power when the car is immobile for a long time.
- Easy Software Integration: Software components from NAD module suppliers, manufacturers, Tier I suppliers and third party software companies shall be easy to integrate.
- Real-Time Capabilities: The eCall IVS gathers vehicle information through the vehicle’s CAN (Controller Area Network), which may require responding to interrupts with a low latency.
- Over-the-air device management: Because the eCall platform will probably host new applications in the future, secure software downloads and patching shall be easily possible via air.

Cost reduction by integration

Examining the reference architecture with a cost focus, the following opportunities appear:

- Merge as many CPUs as possible into a single one. All applications (eCall, GSM, GPS, in-band modem, CAN connectivity, etc.) would share this single CPU. Each processor eliminated also eliminates a crystal and separate memory.
- Avoid internal connectors where possible and use solder-able modules. Board-to-board connectors have a significant cost and should be avoided. Since the IVS has to survive a severe crash it is also recommended to use solder connections. Eliminating components also reduces the size and weight of the unit and its housing.
- The latest M2M Form Factor SIM shall be used in order to avoid any quality issues in the field.

Signal Reception Sensitivity

The eCall IVS is intended to be in a crash-proven location inside the vehicle that is somewhere under the dashboard or seats, in the trunk or roof light. In addition, it cannot rely on an external antenna, because a crash may break it. Therefore the eCall IVS may need to cope with reduced GSM and GPS signal strength relative to an outdoor receiver. Its receiver sensitivity then becomes an issue. Poor reception may cause errors sufficient to require retransmission of some messages. During call establishment, retransmitted signaling messages increase the call setup time. Once the call is established, the MSD will be sent to the PSAP. The NAD may also be sensitive to Bit Error Rate (BER), leading again to increased transmission time or, for a poor quality RF link, even transmission failure.

Power Consumption

As on all electronic units embedded in a vehicle, power consumption is a concern, especially when the engine is off. Low power consumption could be achieved by shutting down the eCall IVS while the car is parked, but it must be awakened if activity is detected in the car, either through the vehicle bus or through some external sensor.

Software Integration Requirements

The eCall platform software should allow easy integration of multiple third-party software applications.

The eCall IVS must be GSM-capable, requires in-band modem software, must read the vehicle CAN bus, needs to follow the vehicle manufacturer's diagnostic requirements, and needs accurate GPS positioning, including dead reckoning. These distinct functions, typically coming from different suppliers, must be integrated to work smoothly together.

Real-Time Requirements

The GSM application itself makes use of the CPU and must service interrupts with a very low latency to remain synchronized with the GSM infrastructure. The other applications will typically be assigned a lower priority than the GSM application; nevertheless, most of these applications need to have immediate access to the CPU after some external event has been detected — most often through an interrupt. Responding to interrupts quickly without affecting GSM behavior is a challenge.

Over-the-air device management

Software modifications may be required in every car to conform to new legislation. Additionally, new applications may be introduced. The embedded SIM in the IVS also has to be managed.

Ideally the GSM module supports standardized device management (OMA-DM) in order to easily manage software updates and SIM management remotely via air.

Conclusion

As a leading provider of wireless products and services to support technology rollouts in the automotive telematics industry, Sierra Wireless is committed to continuously introducing new features and products

that enable customers to innovate as their market requirements evolve and shift. We support our customers with cost-effective solutions, without compromising quality.

Our EDGE-capable protocol stack, has been integrated into many automotive projects around the world and has proven to be stable and reliable The protocol stack and hardware platform *of* Sierra Wireless AirPrime™ intelligent embedded modules along with the Sierra Wireless AirVantage™ M2M Portal includes a SIM, a device, and services to allow application management remotely through the air, provides a robust, reliable and cost-effective long term solution for OEM eCall and telematics deployments.

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Addendum

Terms

- **112:** Single European emergency call number supporting Teleservice (TS) 12.
- **E112:** An emergency communications service using the single European emergency call number, 112, which is enhanced with location information of the calling user TS12.
- **eCall**: A manually or automatically initiated emergency call (112) from a vehicle, supplemented with a minimum set of emergency-related data (MSD), as defined under the EU Commission's eSafety initiative.
- **eCall In-band Modem (eIM):** Modem pair (consisting of transmitters and receivers at IVS and PSAP) that operates full-duplex and allows reliable transmission of eCall Minimum Set of Data from IVS to PSAP via the voice channel of the emergency voice call through cellular and PSTN networks.
- **eSafety:** European Commission-sponsored forum to improve safety for European citizens.
- **IVS:** The in-vehicle system which includes the NAD, eIM, collision detectors, position location (e.g. GPS) function and vehicle interface.
- **MSD:** The Minimum Set of Data forming the data component of an eCall sent from a vehicle to a Public Safety Answering Point or other designated emergency call centre. The MSD has a maximum size of 140 bytes and includes, for example, vehicle identity, location information and time-stamp.
- **NAD:** Network access device, e.g. a GSM module.
- **PSAP:** Public Safety Answering Point.
- **TPS-eCall:** Third Party Services supporting eCall. In these cases, the vehicle dials a private number to contact a call centre, which filters the call and transmits the MSD and the call to the Public Safety Answering Points in case of emergency.
- **VIN:** Vehicle Identification Number.

References

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- 4th eSafety Communication of EC: "eCall: Time for Deployment" (August 2009)
- eSafety Forum eCall Driving Group, "European Memorandum of Understanding for Realisation of Interoperable In-Vehicle eCall", May 2004
- prEN 2782442; Intelligent transport systems, eSafety, Third party support for eCall – Operating requirements
- prEN 278243; Intelligent transport systems, eSafety, eCall high level application protocols (HALP)
- EN 15722; Road transport and traffic telematics, eSafety, "eCall" minimum set of data
- ETSI TS 126 267; TSG services and system aspects; eCall data transfer – in-band modem solution; general description [Release 8]
- ETSI TS 126 268; eCall data transfer – in-band modem solution; ANSI-C reference code [Release 8]
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