The automotive emergency call system of the future

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The introduction of eCall, the automatic car emergency call system, was preceded by years of discussion and coordination at the European level. Since March 2018, it has been mandatory for all new homologated car models in the EU. It has only been installed in relatively few vehicles, yet it is already technologically obsolete. Its successor is waiting in the wings.

When a serious accident occurs, eCall automatically contacts the public safety answering point (PSAP) via mobile telephony. The in-vehicle electronics determine whether or not a serious accident has taken place. Airbag actuation is a typical indicator of the seriousness of an accident. The system can also be manually triggered using an SOS button to report a different kind of emergency or an accident involving other vehicles.

Existing eCall installations are based on ETSI and CEN standards. Development of these standards began about 15 years ago. The system uses an in-band modem to acoustically transmit (using peep tones similar to a fax machine) the eCall minimum set of data (MSD) to the 112 emergency number over a GSM voice channel. This technologically outdated solution was chosen because at the time only GSM appeared to provide the necessary international coverage. It made good sense back in the planning phase, but the pace of mobile phone development now calls it into question. The German insurance industry estimates that near-complete market penetration of eCall will not be reached until 2035. But by then, some European countries will no longer have GSM networks since the frequencies are desperately needed for LTE and 5G. Already today, more than 95% of the European population has access to an LTE network. So the question is: What will happen to eCall? Network operators cannot be forced to maintain a GSM infrastructure just to keep this service going. The solution will probably be hybrid. eCall based on GSM and a modern successor system will coexist in in-vehicle telematics systems so that functionality is maintained wherever the car is.

From eCall to NG eCall

The successor to eCall is next generation eCall (NG eCall), and it has already been specified. Naturally NG eCall will not use modulated tones for data transmission in the IP-based LTE system. But it will still use voice transmission since eCall

doesn't just transmit data, but also establishes a voice link to the accident vehicle. The LTE IP multimedia subsystem (IMS) acts as a service enabler. IMS is a transmission technology for IP-based multimedia applications in landline and mobile telephony networks. One of its main purposes is to enable telephony, which in LTE is known as voice over LTE (VoLTE).

Coexistence of eCall and NG eCall

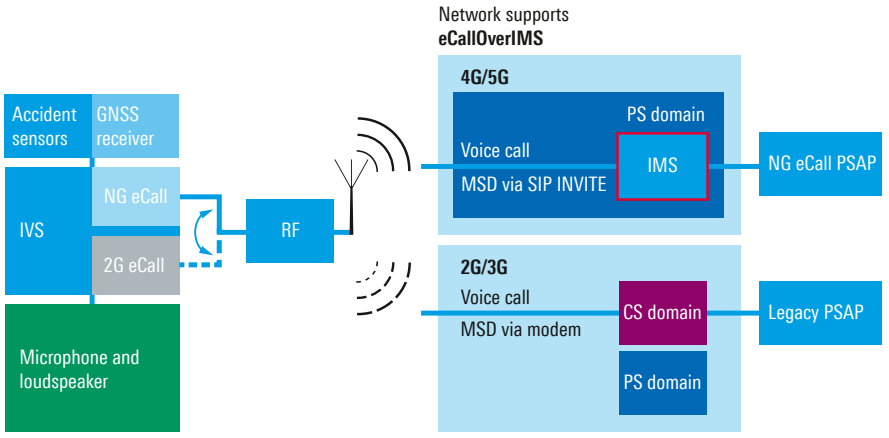
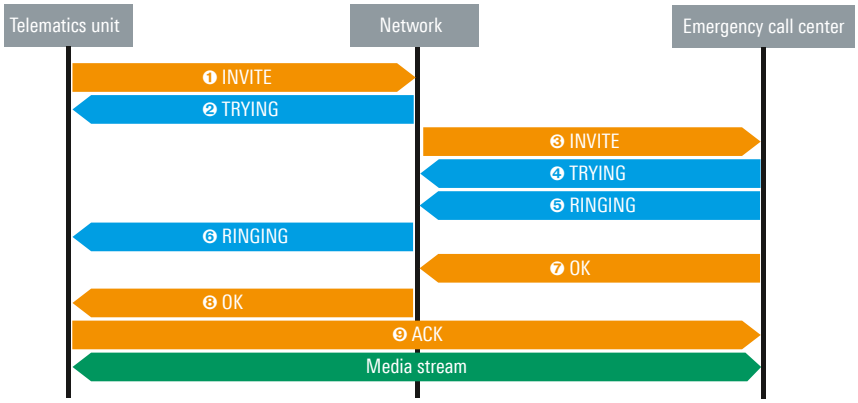


Fig. 1: In an LTE network, a network support indicator determines whether NG eCall is supported or if a legacy eCall needs to be placed.

NG eCall connection setup



❶ SIP INVITE message (including MSD).
❷ bis ❻ The network and the PSAP (emergency call center) answer with TRYING and RINGING.
❼ bis ❾ As soon as the PSAP receives the MSD, it sends OK, which the caller acknowledges with ACK. The call connection is now established and all media data such as voice, video or other data can be transmitted.

Fig. 2: Details of establishing an NG eCall connection between the telematics unit, network and emergency call center.

IMS is not new. It was developed in the early 2000s and is based on older industry standards developed by ETSI (TISPAN) and 3GPP (IMS). The IMS framework became established with the introduction of LTE. It is used for voice transmission, video telephony, SMS service and much more. IMS is also the perfect basis for NG eCall and was suitably adapted. Release 14 of 3GPP specifies a network support indicator that tells the network whether NG eCall is supported or if legacy eCall has to be used. This ensures that eCall and NG eCall can coexist (Fig. 1).

How does NG eCall work?

If an accident occurs while the vehicle is connected to an LTE network, the telematics system evaluates the network support indicator for NG eCall. If NG eCall is supported, the vehicle can place an emergency call via IMS using the session initiation protocol (SIP) and session description protocol (SDP). If NG eCall is not supported, there needs to be a handover (circuit switch fallback) to the GSM network in order to make a legacy eCall over the GSM in-band modem. Fig. 2 shows how the connection is established.

Routing of the call to the PSAP is controlled by the resource name in the transmitted SIP. The following uniform resource names have been defined:

- urn: service: sos.ecall.manual: manual eCall
- urn: service: sos.ecall.automatic: automatic eCall
- urn: service: test.sos.ecall: test call

So as not to lose any time, the MSD is transmitted to the PSAP while the call is being established. The dataset is presently limited to 140 bytes. But the data volume can easily be increased in the LTE network.

Fig. 3 shows a comparison of eCall and NG eCall.

Advantages of NG eCall

Since NG eCall sets up a fast data connection, the system can transmit data other than the MSD, data that might be helpful in an emergency situation, for example driver health data, which could be supplied by a smart watch connected to the vehicle by Bluetooth®. If there is a connected dashcam, a video link can be set up so that the call center has visual information. In the other direction, it is conceivable that the emergency call center could send remote control commands to the vehicle, for example to unlock the doors or turn off the ignition. Notwithstanding the data privacy and IT security aspects of such features, the fact remains that NG eCall has substantially more potential functionality than the technologically outdated legacy eCall. This is one reason that eCall services are likely to become increasingly divided – between the public system that uses the 112 emergency number and manufacturers' proprietary systems that call private emergency call centers. Manufacturers are required to install standard eCall, but can also implement their own fee based services. If they do, they still have to let the vehicle operators choose which system they want to use and also ensure that if the proprietary system is unavailable, the vehicle will automatically switch to public eCall.

Why start now with NG eCall?

Even though the EU Commission has not yet made any binding directive concerning NG eCall, it can be safely assumed that it will. Once a sufficient number of network operators configure their LTE IMS for NG eCall, the automotive industry can use it with suitably designed telematics systems, including for private emergency call services. It does not need to, and definitely will not, wait for legislation to force the issue.

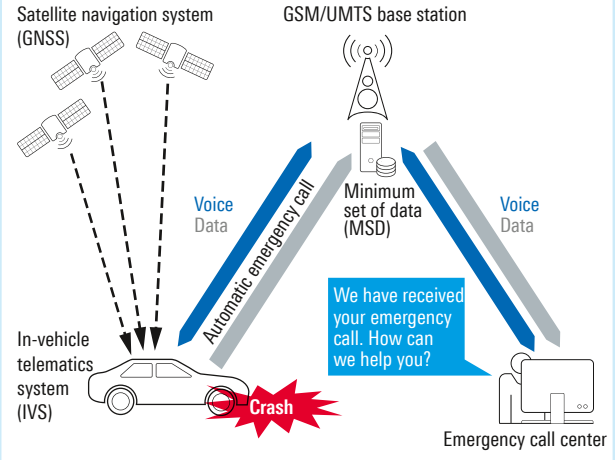
Even where NG eCall functionality has already been implemented in a mobile network, testing telematics systems in real networks can be difficult and time-consuming. And reproducibility is never achievable in field tests. It is also hard to obtain test results on the IMS since it is part of the network infrastructure that is inaccessible to the user. But a custom-designed test and measurement system can deliver the necessary data easily and reliably.

T&M solution

Rohde&Schwarz has long offered a comprehensive test solution for GSM-based eCall (Fig. 4). The system's design is so universal that it can even

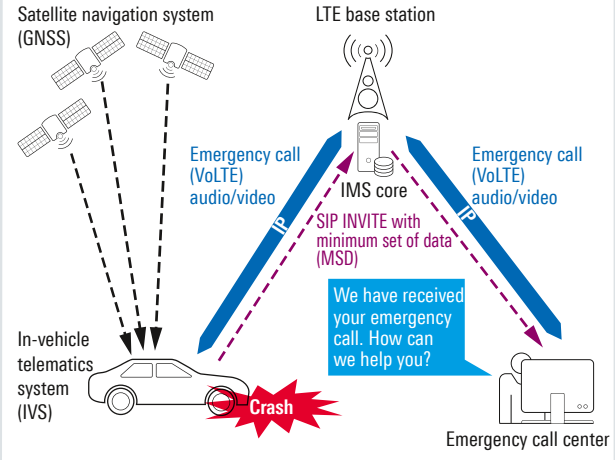
eCall versus NG eCall

The first, and currently used, version of eCall is based on circuit-switched voice telephony and uses an in-band modem.



- Accident
- IVS calls 112 via GSM
- Establishment of voice connection
- MSD transfer via in-band modem
- Voice connection between vehicle and emergency call center

Next generation eCall uses the IP multimedia subsystem (IMS) of packet switched telecommunications networks



- Accident
- IVS calls 112 via VoIP/VoLTE and sends the MSD during call setup
- Establishment of voice channel between vehicle and emergency call center
- Optional transmission of additional multimedia data (video or sensor data)

Fig. 3: NG eCall (right) can use the capabilities of a fast IP network to transmit large data volumes.

be used for the Russian emergency call system ERA-GLONASS – and now also NG eCall. To handle NG eCall, the R&S®CMW-KA096 has been added to the PC test software suite. The R&S®CMW500 wideband radio communication tester as a mobile network simulator and the R&S®SMBV100A GNSS simulator already have all the necessary capabilities.

The R&S®CMW-KA096 software simulates an NG eCall capable emergency call center and remotely controls the R&S®CMW500, which replicates an LTE mobile network and the necessary IMS infrastructure.

With a test setup consisting of a control computer and the R&S®CMW500, it is possible to verify whether the onboard NG eCall electronics (IVS) can trigger an NG eCall, choose the right network, transmit the correct MSD data and establish voice communications with a voice-over-LTE call to the emergency call center. The data in the MSD is available in RAW format and in a decoded format. If an R&S®SMBV100A vector signal generator with GNSS option is incorporated into the test setup, it is also possible to check the GNSS position accuracy of the MSD entry.

NG eCall standards	Specification
IP Multimedia Subsystem (IMS) emergency session	3GPP TS 23.167
IP Multimedia Call Control Protocol based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP)	3GPP TS 24.229
Next-Generation Pan-European eCall	IETF rfc8147
Additional Data Related to an Emergency Call	IETF rfc7852
Next-Generation Vehicle-Initiated Emergency Calls	IETF rfc8148
Intelligent transport systems – eSafety – eCall High level application Protocols (HLAP) using IMS packet switched networks	CEN TS 17184
ECall end to end conformance testing for IMS packet switched based systems	**CEN TS 17240**

NG eCall is based on a series of standards (list incomplete) that are met by the test solution described here.

The test procedure can be easily expanded to multi-cell scenarios. Such scenarios are used in interoperability testing to simulate the vehicle entering a zone where NG eCall is not supported. In this case, it is necessary to test whether the telematics system can correctly place the emergency call using the legacy eCall backup system.

Christian Hof

Video

Fig. 4: All vehicle emergency call systems can be tested for acceptance with this setup.