



Next Generation eCall

Integration with an Emergency Services IP Network

eena

EUROPEAN EMERGENCY NUMBER ASSOCIATION

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1. Executive Summary

Next Generation eCall: Integration with an Emergency Services IP Network

Mobile networks operators (MNOs) are currently in the process of phasing out 2G/3G networks and transitioning to 4G/5G networks based on IMS. Consequently, there is a corresponding need to transition, in a harmonised and coordinated way, to eCall based on IMS. Next Generation (NG) eCall is based on IMS.

This document describes how NG eCall can be seamlessly integrated into a NG112 architecture. In particular, the document illustrates how NG eCall can work with an ESInet. It also proposes a new approach for Third Party Service (TPS) NG eCall where a third party service provider answers the initial eCall and then conveys that call to the appropriate PSAP.

This document intends to....

Explain how NG eCall can be seamlessly integrated into a NG112 architecture, particularly within an ESInet.

This document contains....

- An explanation of the current regulations surrounding eCall
- A description of IMS-based eCall, how it can co-exist with in-band modem eCall
- The NG112 elements of IMS eCall including SIP signalling and the enhanced functionality NG eCall offers
- A series of conclusions

2. Definition of Terms & Acronyms

Term/Acronym	Definition
3GPP	3 rd generation partnership project
ASN.1	Abstract Syntax Notation One
CEN	Centre Européen de Normalisation (in French)
eCall	An emergency call generated either automatically via activation of in-vehicle sensors or manually by the <i>vehicle occupants</i> , which, when activated, provides notification and relevant location information to the most appropriate <i>Public Safety Answering Point</i> , by means of <i>mobile wireless communications networks</i> .
ETSI	European Telecommunications Standards Institute
GSM	Global System for Mobile (2G)
HLAP	eCall High Level Application Protocol
IETF	Internet Engineering Task Force
IMS	Internet Protocol Multimedia System
ISDN	Information Services Digital Network
IVS	In Vehicle System
MSD	Minimum Set of Data - a defined standardised minimum set of data notifying that there has been an incident that requires response from the emergency services.
MNO	Mobile Network Operator
NG eCall	Next Generation eCall is an evolution of the existing eCall service that is based on IMS using 4G/5G technology. With NG eCall, the IMS emergency call, as specified in 3GPP Release-14 ¹ , is used. The terms NG eCall and IMS-based eCall are used interchangeably in some sections of this document.
PDIF-LO	Presence Information Data Format Location Object (as defined in RFC 4591 ²)
PER	Packed Encoding Rules
PSAP	Public Safety Answering Point
RFC	Request For Comments
TPS	Third party service
UMTS	Universal Mobile Telecommunications System (3G)
URN	Uniform Resource Name
VoIP	Voice over Internet Protocol

¹ Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; Selective Disabling of 3GPP User Equipment Capabilities (SDoUE) Management Object (MO) (3GPP TS 24.305 version 14.0.0 Release 14).

² [IETF RFC 4591](#) - GEOPRIV Presence Information Data Format Location Object (PIDF-LO) Usage Clarification, Considerations, and Recommendations

3. Introduction

eCall is an initiative intended to bring rapid assistance to motorists involved in a collision anywhere in Europe. It works using an In-Vehicle-System (IVS) with sensors which when activated - for example, by deployment of the vehicle's airbags – can place an emergency call to the pan-European Emergency Number 112. In addition to the voice call, a minimum set of data (including location coordinates, number of passengers and heading) is also sent to the PSAP over the same connection. Since 31 March 2018³, all new M1 (passenger cars) and N1 (light duty) types of vehicles sold in the Europe Union must have the eCall capability.

Discussions around eCall have taken place since 2004 when standardisation initiatives were commenced. Both ETSI and CEN have developed technical standards for eCall in the intervening period. The current implementation of eCall relies exclusively on circuit-switched 2G and 3G technology where eCall data is transported to the PSAP in the voice channel using an in-band modem.

Mobile networks operators (MNOs) are currently in the process of phasing out 2G/3G networks and transitioning to 4G/5G networks based on IMS. Consequently, there is a corresponding need to transition, in a harmonised and coordinated way, to eCall based on IMS. Next Generation (NG) eCall is based on IMS. It is expected that MNOs will want to cease support for legacy circuit-switched services as soon as possible, and expectedly, within the next 5 to 7 years. While mobile devices have a typical lifespan of 3-4 years, vehicles have a much longer lifespan of typically 15 to 20 years. Therefore, the issue of how legacy eCall deployments in vehicles will continue to be supported, whilst network technology migrates to IMS, requires careful, yet urgent, consideration.

ETSI has already addressed how NG eCall can be implemented using an IMS emergency call in a Technical Report published in 2014⁴. The IETF has also produced an RFC⁵ on Next Generation pan-European eCall while CEN has updated the existing set of standards for eCall which *inter-alia* specify the mandatory and optional data concepts that may be transmitted as part of the Minimum Set of Data (MSD). The full list of existing and updated CEN standards for eCall is provided in Table 1 below:

Standard	Title/Description
EN 15722:2022	Intelligent transport systems - eSafety - eCall minimum set of data
EN 16072:2023	Intelligent transport systems - eSafety - Pan-European eCall operating requirements

³ [Decision No 585/2014/EU](#) of the European Parliament and of the Council of 15 May 2014 on the deployment of the interoperable EU-wide eCall service.

⁴ [ETSI Technical Report ETSI TR 103 140 V1.1.1](#) – Mobile Standards Group (MSG): eCall for VoIP, April 2014.

⁵ IETF Next-Generation Pan-European eCall <https://tools.ietf.org/html/draft-ietf-ecrit-ecall>

EN 16062:2023	Intelligent transport systems. ESafety. eCall high level application requirements (HLAP) using GSM/UMTS circuit switched networks
EN 16454:2023	Intelligent transport systems. ESafety. ECall end to end conformance testing
CEN/TS 17184:2022	Intelligent transport systems. eSafety. eCall High level application protocols (HLAP) using IP Multimedia Subsystem (IMS) over packet switched networks
CEN/TS 17240:2018	Intelligent transport systems. ESafety. ECall end to end conformance testing for IMS packet switched based systems
EN 16102:2011	Intelligent transport systems — eCall — Operating requirements for third party support

Table 1: CEN Standards/Specifications for eCall

4. Scope

This document describes how NG eCall can be seamlessly integrated into a NG112 architecture. In particular, the document illustrates how NG eCall can work with an ESI-net. It also proposes a new approach for Third Party Service (TPS) NG eCall where a third party service provider answers the initial eCall and then conveys that call to the appropriate PSAP.

5. Regulations

A three-pronged regulatory approach was set out to implement eCall in Europe. The legislation addresses the IVS, the PSAPs and the mobile communications networks.

- **In-vehicle requirements:** An EU Regulation⁶ amending the type-approval Directive for motor vehicles was adopted in April 2015. This concerned type-approval requirements for the deployment of the eCall in-vehicle system in all new M1 (passenger cars) and N1 (light duty) types of vehicles. The regulation requires all new car models to be equipped with eCall technology from 31 March 2018. eCall currently works on 2G and 3G mobile networks. Given that these networks are to be switched off in the years to come, the European Commission is preparing regulatory amendments for the transition of eCall to 4G and 5G networks.
- **Public Safety Answering Points:** An EU Decision⁷, adopted in May 2014, provides that Member States ensure all PSAPs are equipped to handle eCalls as expeditiously and effectively as any other call made to 112. They should also receive the data contents of the MSD and present them to the PSAP operator clearly and understandably. The PSAP must also have access to an appropriate Geographical Information System () or an equivalent system. This will allow the PSAP operator to identify the position and heading of the vehicle to a minimum degree of accuracy based on the location coordinates presented in the MSD. The necessary infrastructure to handle eCalls was required to be in place at least six months before the type-approval requirements for the corresponding in-vehicle device start to apply. This meant no later than 1 October 2017. Commission Delegated Regulation (EU)305/2013⁸ required that PSAPs demonstrate compliance with the relevant eCall standards. On 22 September 2023, the European Commission published a proposal for a delegated regulation⁹ amending (EU)305/2013 requiring PSAPs to comply with the updated eCall standards. The proposed date for application of this delegated regulation is 1 January 2026.
- **Mobile Communications Networks:** There is no mandatory requirement on MNOs regarding any aspect of the eCall service. An EC Recommendation¹⁰ adopted on 08 September 2011 requires EU Member States to ensure that MNOs could handle

⁶ [Regulation \(EU\) 2015/758](#) of the European Parliament and of the Council of 29 April 2015 concerning type-approval requirements for the deployment of the eCall in-vehicle system based on the 112 service and amending Directive 2007/46/EC

⁷ [Decision No 585/2014/EU](#) of the European Parliament and of the Council of 15 May 2014 on the deployment of the interoperable EU-wide eCall service

⁸ [Commission Delegated Regulation \(EU\) No 305/2013](#) of 26 November 2012 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the harmonised provision for an interoperable EU-wide eCall

⁹ <https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13845-Vehicle-safety-updated-standards-for-in-vehicle-emergency-call-systems-eCall-en>

¹⁰ [Commission Recommendation \(2011/750/EU\)](#) of 8 September 2011 on support for an EU-wide eCall service in electronic communication networks for the transmission of in-vehicle emergency calls based on 112 (eCalls)

eCalls by 31 December 2014. This is achieved by implementing what is known as “the eCall Discriminator Flag”. This provides additional information in the signalling to allow the network to discriminate between eCalls to 112 and normal calls to 112. The flag also allows the PSAP to determine if the eCall was initiated automatically by the vehicle following an accident or if it was initiated manually by the occupant of the vehicle.

In broader terms, emergency communications are an important element for the pursuit of public safety, security and health. Therefore, citizens should continue to have access to emergency services, through emergency communications, in a digital world. The European Electronic Communications Code (EECC¹¹) and in particular, Commission Delegated Regulation (EU)2023/444¹² recognise that public networks are migrating from circuit-switched to packet-switched technologies and that there is a corresponding need for emergency communications (including eCall) to transition to IP-based communications through IP Multimedia Subsystem (IMS) communications services. In this regard, Commission Delegated Regulation (EU)2023/444, requires Member States to prepare a roadmap for the upgrade of the capabilities of their PSAP systems to answer, handle and process emergency communications provided through packet-switched technologies. The roadmap should contain the expected timeline and date of deployment of novel means of access to emergency services through emergency communications through packet-switched technologies. The roadmap must be submitted by Member States no later than on 5 December 2023.

¹¹ [Directive \(EU\) 2018/1972](#) of the European Parliament and of the Council of 11 December 2018 establishing the European Electronic Communications Code (Recast)

¹² [Commission Delegated Regulation \(EU\) 2023/444](#) of 16 December 2022 supplementing Directive (EU) 2018/1972 of the European Parliament and of the Council with measures to ensure effective access to emergency services through emergency communications to the single European emergency number ‘112’

6. NG112 and IMS eCall

Next Generation (NG) 112 is a technical concept for the future of emergency communications based on all-IP. This concept is specified by ETSI¹³ and provides for an architecture and core components to support emergency communications that are capable of responding to shifts in technology, user behaviour and legislation.

With the transition to IMS-based electronic communications networks and services, it is interesting to examine how NG eCall could fit in a standard NG112 technological implementation.

The foundation of the NG112 core architecture is the Emergency Services IP Network (ESInet). The ESInet is an emergency services network of networks that utilises IP technology. ESInets are private, managed, and routed IP networks which can serve a set of PSAPs, a region, a state, or a set of states. ESInets may be interconnected and built upon common functions and interfaces making ESInets interoperable. An ESInet is capable of processing messages based on Session Initiation Protocol (SIP) to extract the necessary information to route an emergency communication. In this category, besides voice, video and text, we also include eCall as an emergency communications session that needs to be routed correctly.

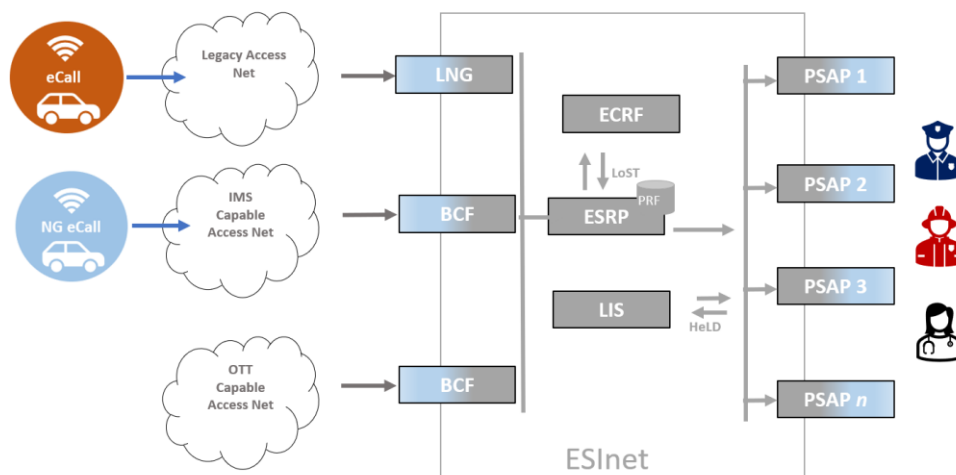


Figure 1: Simplified ESInet infrastructure with eCall and NG eCall call flows

Figure 1 above represents a simplified ESInet infrastructure, illustrating the respective call flows for an eCall originating on a legacy circuit-switched 2G or 3G network (through a legacy network gateway (LNG)) and an NG eCall originating on a 4G network using VoLTE. The next chapter provides more detailed information about the technologies involved. For a detailed explanation of the ESInet, please consult the aforementioned ETSI TS 103 479.

¹³ [ETSI Technical Specification 103 479 v1.2.1](#) - Core elements for network independent access to emergency services, March 2023.

7. IMS-based eCall

ETSI Technical Report 103 140⁷ recommends using an IMS-based emergency call as the long-term underlying communication mechanism for NG eCall. The Technical Report specifies some modifications for the handling of eCall:

- the SIP-INVITE message in the IMS emergency call for initial MSD transport should be used;
- a new URN sub-class for NG eCall should be specified for routing purposes (equivalent to the “eCall flag” used for eCall originating on circuit-switched networks);
- a new system information indicator in 3GPP to inform the IVS that the network supports NG eCall should be specified; and
- the eCall in-band modem solution should not be used over a VoIP connection as the modem signals may be impaired by de-jitter buffering.

8. Co-existence of in-band modem eCall with IMS eCall

Vehicles that have gone through the type approvals process since the mandatory eCall implementation date of 31 March 2018 were delivered with an in-band modem for circuit-switched eCalls to 112. Given, the significantly longer lifespan of vehicles compared to mobile handsets, legacy support from MNOs will be needed to provide continuity of service for approximately another 5-7 years. This may require a longer timeframe for the provision of legacy support than MNOs are willing to countenance as they want to re-farm radio spectrum for 4G and 5G services as soon as is practicable.

As IMS-based emergency calling will be extensively deployed well before the 2030s, eCall and NG eCall will have to co-exist. ETSI TR 103 140 considered this co-existence and how migration from eCall to IMS-based eCall can be managed:

- Introduction of an NG eCall IVS can occur when end-to-end testing can be performed. Such IVS will also have to be capable of continuing to support the legacy eCall (in-band modem) for several more years.
- From a certain date, PSAPs will need to be able to receive and process NG eCalls in addition to providing legacy support for the eCall using the in-band modem solution too. This aspect determines in some way also the lifespan of existing eCall modems: if IMS-based eCall is able to insert MSD data in the SIP signalling protocol instead of using in-band modulation, a SIP signalling interpreter will be sufficient to extract MSD and make it available to external users of data, without engaging a modem.
- To achieve this, the PSAPs could deploy an MSD reader, i.e., a technical solution to read the MSD in ANS.1 PER encoding, found in the SIP INVITE, and extract it in readable format, to be used by Call Takers.
- In-band modems will remain necessary at least during the transitional period.
- An IVS capable of supporting NG eCall will only use this functionality if informed (by a system information indicator) that it is supported on the originating mobile network.
- The mobile operator will only switch on the system information indicator when there is NG eCall coverage and at least one PSAP in the jurisdiction capable of receiving and processing NG eCalls.

9. NG112 Elements

9.1 Contents of the SIP signalling for NG eCall

It is expected that NG eCall will interact with ESInet services. By taking a look at the structure of the SIP INVITE including the “NG” contents, we will more clearly understand what these interactions might look like. This is illustrated in Figure 2 below:

```

INVITE urn:service:sos.ecall.automatic SIP/2.0
To: urn:service:sos.ecall.automatic
From: <sip:+13145551111@example.com>;tag=9fxced76s1
Call-ID: 3848276298220188511@atlanta.example.com
Geolocation: <cid:target123@example.com>
Geolocation-Routing: no
Call-Info: <cid:1234567890@atlanta.example.com>;
           purpose=EmergencyCallData.eCall.MSD
Accept: application/sdp, application/pidf+xml,
        application/EmergencyCallData.Control+xml
CSeq: 31862 INVITE
Recv-Info: EmergencyCallData.eCall.MSD
Allow: INVITE, ACK, PRACK, INFO, OPTIONS, CANCEL, REFER, BYE,
       SUBSCRIBE, NOTIFY, UPDATE
Content-Type: multipart/mixed; boundary=boundary1
Content-Length: ...

--boundary1
Content-Type: application/sdp

    ...Session Description Protocol (SDP) goes here...

--boundary1
Content-Type: application/pidf+xml
Content-ID: <target123@example.com>
Content-Disposition: by-reference;handling=optional

    ...PIDF-LO goes here...

--boundary1
Content-Type: application/EmergencyCallData.eCall.MSD
Content-ID: <1234567890@atlanta.example.com>
Content-Disposition: by-reference;handling=optional

    ...MSD in ASN.1 PER encoding goes here...

--boundary1--
  
```

Figure 2: Contents of the SIP signalling for IMS eCall

Skipping the traditional parts of a SIP message, it is possible to identify the newly introduced Presence Information Data Format Location Object (PIDF-LO) as shown in the red box. The PIDF-LO defines automatic call geolocation in accordance with the NG112 architecture. This will be part of every IMS-based emergency communication, including NG eCalls. The blue box identifies an extra payload, namely the NG eCall MSD which will also be stored in this portion of the SIP signalling, in the traditional ANS.1 PER¹⁴ encoding. This is a new way of transporting the MSD instead of using the in-band modem solution. It leverages the existing fields of the SIP signalling protocol, to make it easier to retrieve.

The core components of the NG112 Architecture (see Figure 1 above and ETSI TS 103 479) are described below:

¹⁴ <https://www.w3.org/Protocols/HTTP-NG/asn1.html>

9.1.1 Emergency Services Routing Proxy (ESRP)

The purpose of the ESRP is to identify the source location of the emergency communication and route it correctly once destination information is retrieved from the Emergency Call Routing Function (ECRF). The ESRP extracts and decodes the PIDF-LO to read the source location data. It could potentially also be used to extract and decode the MSD even before routing (should there be any geolocation mismatch with the PIDF-LO). Although not specifically defined in ETSI TS 103 479, the concept of an MSD extractor could be implemented as an auxiliary function of the ESRP. Data extracted in this way could be used for intelligent routing, even if the parameters are different from the traditional source geolocation.

9.1.2 Emergency Call Routing Function (ECRF)

The purpose of the ECRF is to determine the appropriate destination (e.g., a specific PSAP or specific call taker within a PSAP based on a skill or policy) to manage an emergency communication. Typically, the ECRF uses the source location provided by the ESRP to determine the result but since the NG112 standard defines how the dialogue between ECRF and ESRP must be set up, any way that does not invalidate the standard can be used to apply routing logic to NG eCalls, including other parameters belonging to the MSD.

9.1.3 Location Information Service (LIS)

The LIS is the repository of geolocation sources that are not present in the PIDF-LO payload of the SIP signaling. The LIS is interrogated by the ESRP to retrieve such data. Due to its main purpose, which is to gather all sources of geolocation for an emergency communication and make them available to the PSAP and emergency responders, the LIS can also be a repository for the eCall MSD following extraction by the ESRP. It is also another source of geolocation data to complement the location information that the MSD provides.

9.2 Conclusion

In conclusion, this chapter explains how support for NG eCall can be integrated within the NG112 architecture. All technical elements to manage NG eCall properly are already foreseen in this architecture and any updates to the ESInet modules will not break the standard. Alternatively, NG eCall can be deployed as a standalone service without the use of an ESInet provided there is support for the establishment of an end-to-end SIP-based communication.

10. Enhanced functionality of NG eCall

10.1 Contents of the SIP signalling for NG eCall

NG eCall offers enhanced capabilities when compared to legacy in-band modem eCall including:

- Faster and more reliable MSD transfer with no loss of speech path and greater capacity for including additional data over and above the 140-character limit imposed using the in-band modem;
- Support for additional media (e.g. video from dashboard cameras, speech-to-text translation or other media for hearing-impaired users);
- Two-way data communication enabling the PSAP to send instructions to the vehicle, e.g. sound horn, flash lights, lock/unlock doors, disable ignition.

It should be noted that these advantages will be initially offset by limited IMS support in electronic communications networks, enterprise networks and PSAPs, which is why support for the in-band version of eCall will remain critical for several years to come.

10.2 New user categories

The new user categories which NG eCall could support include:

- Other vehicle categories where it would be necessary to expand the MSD on the MSD limit of 140 bytes of data to provide the necessary contextual data associate with the vehicle/emergency incident, e.g. multiple occupancy vehicles such as buses or heavy goods vehicles;
- Medical emergency devices such as heart monitors which could provide contextual data about the patient e.g. blood type, existing medical conditions, allergies etc.;
- Vulnerable road users;
- Personal eCall.

10.3 Other considerations

From both an operational and procurement perspective, the implementation and use of NG eCall should be seen in conjunction with the use of the in-band modem solution for legacy eCall for the foreseeable future. This is to provide support to vehicles with legacy IVS and also to PSAPs that have not yet been upgraded to an IMS-based platform. All of these technical updates to deliver new and advanced services are likely to occur within a period of 3 to 5 years.

The procurement of new equipment to replace legacy circuit-switched network technologies such as TDM in publicly available electronic communications networks and ISDN in PSAPs is already well progressed in several EU Member States. The NG112 architecture provides the

flexibility to introduce NG eCall and onboard NG112-enabled PSAPs in a modular way while continuing to provide legacy support during the migration process.

11. Conclusions

- Mobile networks operators (MNOs) are currently in the process of phasing out 2G/3G networks and transitioning to 4G/5G networks based on IMS. Consequently, the European Commission has, and is, preparing regulatory amendments for the transition of emergency communications, including eCall, to packet-switched IMS-based networks.
- In accordance with Commission Delegated Regulation (EU)2023/444, and by 5 December 2023 at the latest, Member States are required to prepare a roadmap for the upgrade of the capabilities of their PSAP systems to answer, handle and process emergency communications provided through packet-switched technologies. In this regard, Member States should carefully consider the necessary PSAP requirements to be able to answer, handle and process NG eCalls.
- NG eCall is compatible with a NG112 architecture. The PSAPs should deploy an MSD reader, i.e. a technical solution to read the MSD in ANS.1 PER encoding, found in the SIP INVITE, and extract it in readable format, to be used by call takers.
- The path to the transition to NG eCall should be decided without delay. Under current proposals published by the European Commission, PSAPs are required to be able to support NG eCall from 01 January 2026.
- The same proposals from the European Commission also require Member States to report to the Commission by 1 April 2026 on the state of implementation of this Regulation. This shall include at least the list of competent authorities for assessing the conformity of the operations of the eCall PSAPs, the list and geographical coverage of the eCall PSAPs, the description of the conformance tests and the description of the privacy and data protection protocols.
- The issue of how legacy eCall deployments in vehicles will continue to be supported, whilst network technology migrates to IMS, is still under discussion.