Emergency Services White Paper

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1 Introduction

Overview

The emergency services guidelines, documented in this whitepaper, characterize the main challenges of emergency communication systems in interaction with a wireless device (the User Equipment – UE) and a mobile network.

This document outlines the main challenges to implement next generation emergency services and also describes, when possible, some ideas to move forward on emergency service and/or design evolution.

The objective is to ensure a reliable and resilient end to end emergency session. A significant part of the objective is to ensure the emergency communications in roaming, which represents a notable challenge with regards to regulation that differs from one region to another.

Note: Further evolution and updates of this document will be reported in GSMA PRD NG.119 [5].

GSMA and relationship with existing standards

This emergency services whitepaper, as part of GSMA NG documentation, provides an end to end roaming and non-roaming perspective to ensure the interoperability between the UE, the network and emergency service systems.

This document helps also to adhere different regional requirements, either described by regional organisation or requested by regional authorities, in a subset of implementation options and actions to existing standards in 3GPP and ETSI.

Scope

The scope of this document includes three main areas:

- **Enrich standardised IMS emergency services**, including the evolution of the Multimedia Emergency Services as defined in 3GPP specifications and Next Generation 112 services. Also, the scope of this document supports SMS to emergency centre as a complementary solution to Total Conversation.
- **User location improvement** in order to provide an accurate handset based and a trusted network-provided location. This location harmonisation across emergency services for mobile equipment – considering the privacy and security aspects of user location information retrieval – and the capability to update throughout the emergency session is also in the scope of this document, as well as PSAP support and the ability to receive and process the location information provided.
- **Improve eCall migration** of the car ecosystem to IMS

Non-technical topics (such as regulatory aspects) are not in the general scope of the NG working group but can be considered here case-by-case when needed.

This document does not limit, by any means, the implementation of additional emergency services and related features and adaptation depending on local policies.

Definitions

Term	Description
Accuracy	LCS QoS attribute that represents the difference between actual location and estimated location. The accuracy for location services can be expressed in terms of a range of values that reflect the general accuracy level needed for the application. Different services require different levels of positioning accuracy. The range may vary from tens of meters (navigation services) to perhaps kilometres (fleet management), as specified in 3GPP TS 22.071 [11]. Also, different services require different levels of positioning, i.e. Horizontal Accuracy (see clause 4.3.1 of 3GPP TS 22.071 [11]) and Vertical Accuracy (see clause 4.3.2 of 3GPP TS 22.071 [11].
PSAP	Is composed by more than one functional element, where emergency communications from the public are received.
Reliability	Reliability provides a measure of how often positioning requests that satisfy quality of service requirements are successful. Reliability importance depends on applications, (e.g. cross-country vehicle tracking would have low reliability impact, in comparison with child tracking where reliability could be critical). See clause 4.4 of 3GPP TS 22.071 [11].
eCall	a manually or automatically initiated emergency call (TS12 or IMS emergency call), from a vehicle, supplemented with a minimum set of emergency related data (MSD), according to 3GPP TS 22.101 [1].
MSD	Minimum set of Data is 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 timestamp.
Total Conversation	An audio-visual conversation service providing bidirectional symmetric real-time transfer of motion video, Real-Time Text and voice between users in two or more locations, as defined in ITU-T Recommendation F.703 [29].
eCall over CS	eCall over Circuit Switched refers to circuit switched end-to-end eCall using in-band Modem.
NG-eCall	Next Generation eCall refers to end-to-end packet switched from an IP-CAN and PS core network to NG PSAP.
LNG	The Legacy Network Gateway is an entry point for non-IP communications user equipment and networks to and from an ESInet.
ESInet	According to ETSI TS 103 479 [3], the ESInet is an emergency services network of networks that utilises IP technology. ESInets are private, managed, and routed IP networks. An ESInet can serve a set of PSAPs, a region, a state, or a set of states. ESInets may be interconnected and shall be built upon common functions and interfaces making ESInets interoperable.
LPG	The Legacy PSAP Gateway is an interworking function that could be part of the ESInet to transcode voice from VoIP into CS Voice together with SIP-SS7 interworking and MSD from SIP message into in-band data MSD message, which is transferred to PSAP in the CS Voice channel.
sAFE	stands for Aftermarket eCall For Europe

Acronyms

Term	Description
AMF	Access and Mobility Management Function
ANP	Access Network Provider
AS	Application Server
BCF	Border Control Function
BGCF	Border Gateway Control Function
E-CSCF	Emergency – Call Session Control Function
E-UTRAN	Evolved UMTS Terrestrial Radio Access Network
EATF	Emergency Access Transfer Function
ECoNR	Emergency Communication over New Radio
ECRF	Emergency Call Routing Function
ECS	Emergency Communication System
ECSP	Emergency Call Service Provider
EECC	European Electronic Communication Code
EMS	Emergency Service Support indicator
EMF	Emergency service fallback indicator
eNB	Evolved Node B
ESInet	Emergency Services IP Network
ESRP	Emergency Service Routing Proxy
GMLC	Gateway Mobile Location Centre
gNB	Next Generation Node B
GTT	Global Text Telephony
GTT-IP	Global Text Telephony over Internet Protocol
HSS	Home Subscriber Server
IBCF	Interconnection Border Control Function
IMS	IP Multimedia Subsystem
IP-CAN	Internet Protocol – Connectivity Access Network
IVS	In vehicle system
LCS	Location Service
LIS	Location Information Server
LNG	Legacy Network Gateway
LPG	Legacy PSAP Gateway
LRF	Location Retrieval Function
LTE	Long Term Evolution
MCC	Mobile Country Code
MES	Multimedia Emergency Services
MGCF	Media Gateway Control Function
MNC	Mobile Network Code

Term	Description
MSD	Minimum Set of Data
NG112	Next Generation emergency communications to 112
NG-eCall	Next Generation eCall – eCall over IMS
NG PSAP	Next Generation PSAP
O-TDOA	Observed Time Difference Of Arrival
OTT	Over The Top
P-CSCF	Proxy Call Session Control Function
PAP	Password Authentication Protocol
PDU	Protocol Data Unit
PIDF-LO	Presence Information data format – Location Object
POTAP	Push Over The Air Protocol
PSAP	Public Safety Answering Point
PSI	Public Service identity
PSP	PSAP Service Provider
PSTN	Public Switched Telephone Network
QoS	Quality of Service
RDF	Routing Determination Function
RTT	Real-Time Text
TLS	Transport Layer Security
TTY	Teletypewriter
UE	User Equipment
UPLI	User Provided Location Info
URI	Uniform Resource Identifier
URN	Uniform Resource Name
VoLTE	Voice over Long-Term Evolution
VoNR	Voice over New Radio
VoWi-Fi	Voice over Wireless Fidelity
VSP	Voice service provider

Document cross-references

Ref	DocNumber	Title
[1]	3GPP TS 22.101	Service principles, Stage 1
[2]	3GPP TS 23.167	IP Multimedia Subsystem (IMS) emergency sessions, Stage 2
[3]	ETSI TS 103 479	Core elements for network independent access to emergency services
[4]	ETSI ES 203 178	Functional architecture to support European requirements on emergency caller location determination and transport
[5]	GSMA NG.119	Emergency Communication

Ref	DocNumber	Title
[6]	GSMA IR.92	IMS profile for Voice and SMS
[7]	GSMA IR.51	IMS Profile for Voice, Video and SMS over untrusted Wi-Fi access
[8]	GSMA NG.114	IMS Profile for Voice, Video and Messaging over 5GS
[9]	GSMA NG.115	IMS Profile for Voice, Video and Messaging over Untrusted WLAN Connected to 5GC
[10]	GSMA IR.21	GSM Association Roaming Database, Structure and Updating Procedures
[11]	3GPP TS 22.071	Location Services (LCS), Stage 1
[12]	3GPP TS 24.229	IP multimedia call control protocol based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP), Stage 3
[13]	IETF RFC 6881	Best Current Practice for Communications Services in Support of Emergency Calling
[14]	IETF RFC 6442	Location Conveyance for the Session Initiation Protocol
[15]	IETF RFC 2119	Key words for use in RFCs to Indicate Requirement Levels
[16]	IETF RFC 8174	Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words
[17]	IETF RFC 3455	Private Header (P-Header) Extensions to the Session Initiation Protocol (SIP) for the 3rd-Generation Partnership Project (3GPP)
[18]	ITU-T ECC RECOMMENDATION OF 17(04)	NUMBERING FOR eCALL
[19]	3GPP TS 23.271	Functional stage 2 description of Location Services (LCS)
[20]	3GPP TS 23.273	5G System (5GS) Location Services (LCS)
[21]	GSMA NG.120	MIoT location in Roaming
[22]	ETSI TS 103 625	Transporting Handset Location to PSAPs for Emergency Communications - Advanced Mobile Location
[23]	OMA-RD-SUPL-V2_0-20120417-A	Secure User Plane Location Requirements
[24]	OMA-AD-SUPL-V2_0-20120417-A	Secure User Plane Location Architecture
[25]	GSMA PRD IR.61	Wi-Fi Roaming Guidelines
[26]	3GPP TS 23.402	Architecture enhancements for non-3GPP accesses
[27]	3GPP TS 23.501	System architecture for the 5G System (5GS)
[28]	3GPP TS 23.502	Procedures for the 5G System (5GS)
[29]	ITU-T Recommendation F.703	Multimedia conversational services
[30]	ETSI TS 101 470	Total Conversation Access to Emergency Services

Ref	DocNumber	Title
[31]	ITU-T Recommendation T.140	Protocol for multimedia application text conversation
[32]	3GPP TS 26.114	Multimedia Telephony, Media handling and interaction
[33]	IETF RFC 6443	Framework for Emergency Calling Using Internet Multimedia
[34]	IETF RFC 3856	A Presence Event Package for the Session Initiation Protocol (SIP)
[35]	GSMA PRD IR.94	IMS Profile for Conversational Video Service
[36]	GSMA PRD NG.106	IMS profile for Video, Voice and SMS over trusted Wi-Fi access
[37]	EC MANDATE M/493	Standardisation mandate to the EUROPEAN STANDARDS ORGANISATIONS (ESO) in support of the location enhanced emergency call service
[38]		Deliverable 2.2: Architecture specification eCall over IMS
[39]	3GPP TS 22.226	Global Text Telephony (GTT); Stage 1
[40]	3GPP TS 23.226	Global text telephony (GTT); Stage 2
[41]	IETF RFC 4103	RTP Payload for Text Conversation

2 Background and regional requirements

Europe

Regulation

After more than 3 decades of legislation for harmonisation of emergency services across Europe (e.g. introduction of 112 as a single European emergency call number by council decision in 1991), the EECC Directive enforced in November 2018 has broadened the concept of “emergency calls” mention to “emergency communications” in order to combine new multimedia communication services for emergency services accessibility. Moreover, with regards to Article 109 of the EECC, the European Commission will issue delegated acts by the end of 2022 that will focus on 3 main areas to be improved throughout the EU:

- the establishment and provision of caller location information, both network-based and handset-derived.
- equivalent access to emergency services for end-users with disabilities, including in roaming situation; and
- the routing of emergency communications and caller location to the most appropriate PSAP.

Based on the EECC, the member states will have 2 years from the end of 2022 to nationally comply with the delegates acts.

Technical guidelines

ETSI has described a single functional architecture in the specification ETSI ES 203 178 [4] “Functional Architecture to Support European Requirements on Emergency Caller Location

Determination and Transport" and identifies all necessary interfaces in response to EC Mandate M/493 [37]. This architecture supports European requirements on emergency caller location determination and transport, in particular for the case where a VoIP service provider and one or several network operators - all serving the customer in the establishment of an emergency call - are independent service providers needing to co-operate to determine the location of the caller.

Four service provider roles are identified:

- Access network provider (ANP)
- Voice service provider (VSP)
- Emergency call service provider (ECSP)
- PSAP service provider (PSP)

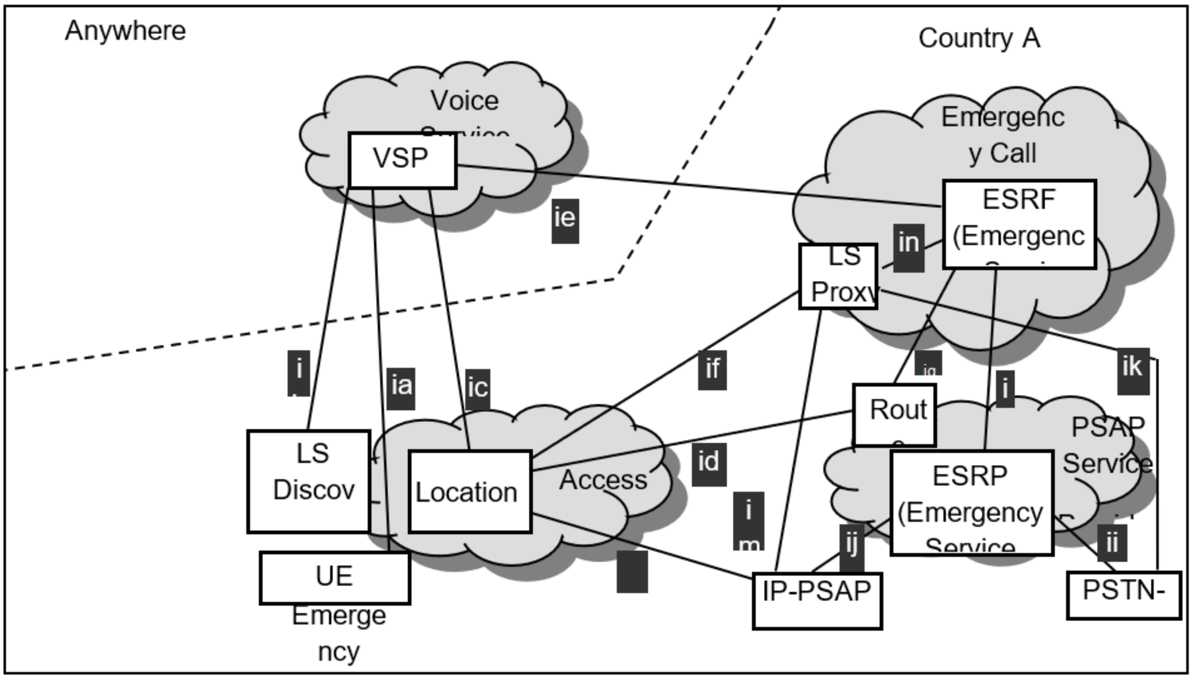


Figure 1 High level functional architecture from ETSI ES 203 178 [4]

In addition to the overall description of service providers' roles in ETSI ES 203 178 [4] that fits GSMA PRD NG112 architecture, ETSI has provided ETSI TS 103 479 [3] that addresses the specific needs of the PSAP service provider (PSP) domain and the inter-operator interfaces to other domains to provision NG112 emergency communication.

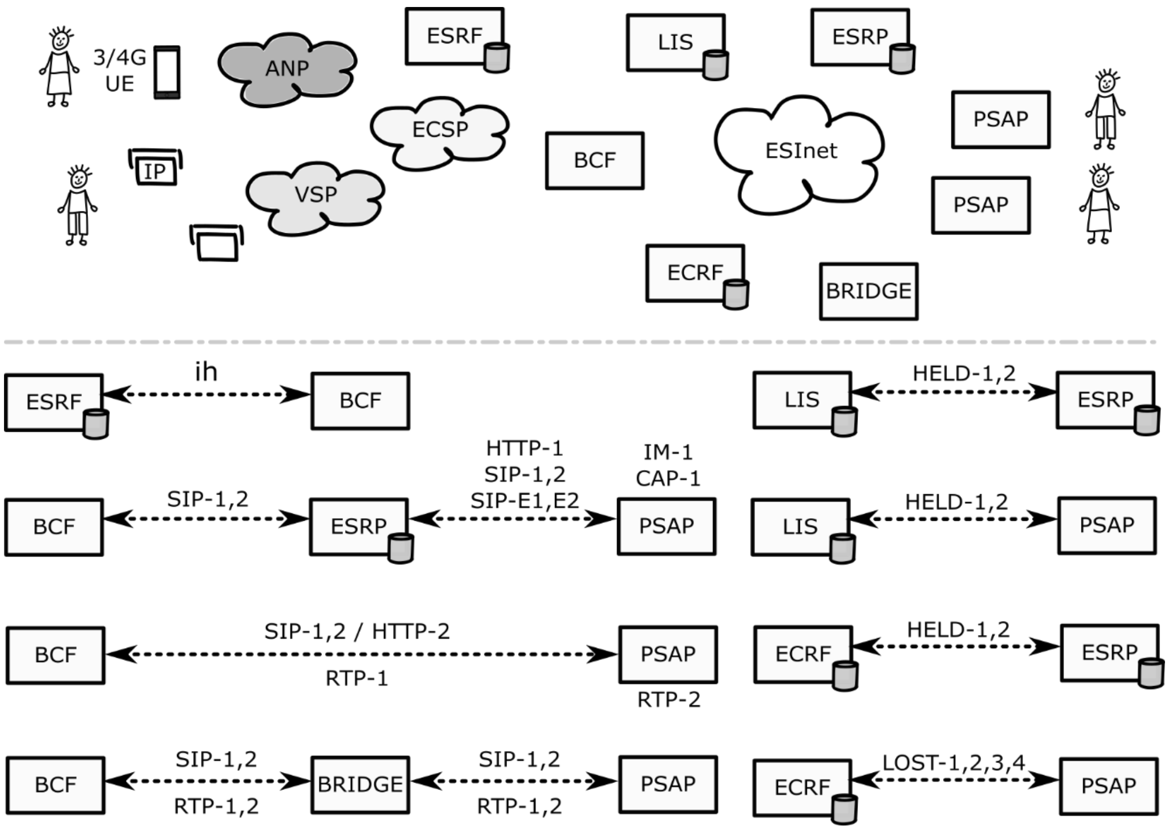


Figure 2 Functional Architecture and mandatory interfaces of ETSI TS 103 479 [3]

North America

Editor's note: This section is for further description.

Asia

Editor's note: This section is for further description.

3 Architecture

IMS architecture

The 3GPP TS 23.167 [2] describes the stage-2 service for emergency services. The Emergency CSCF (E-CSCF) interacts with a Location Retrieval Function (LRF) to retrieve location and routing information. The LRF could in turn interact with a Routing Determination Function (RDF; not depicted on the figure below) to retrieve the correct Public Safety Answering Point (PSAP) destination address based on the requested emergency service and on location information.

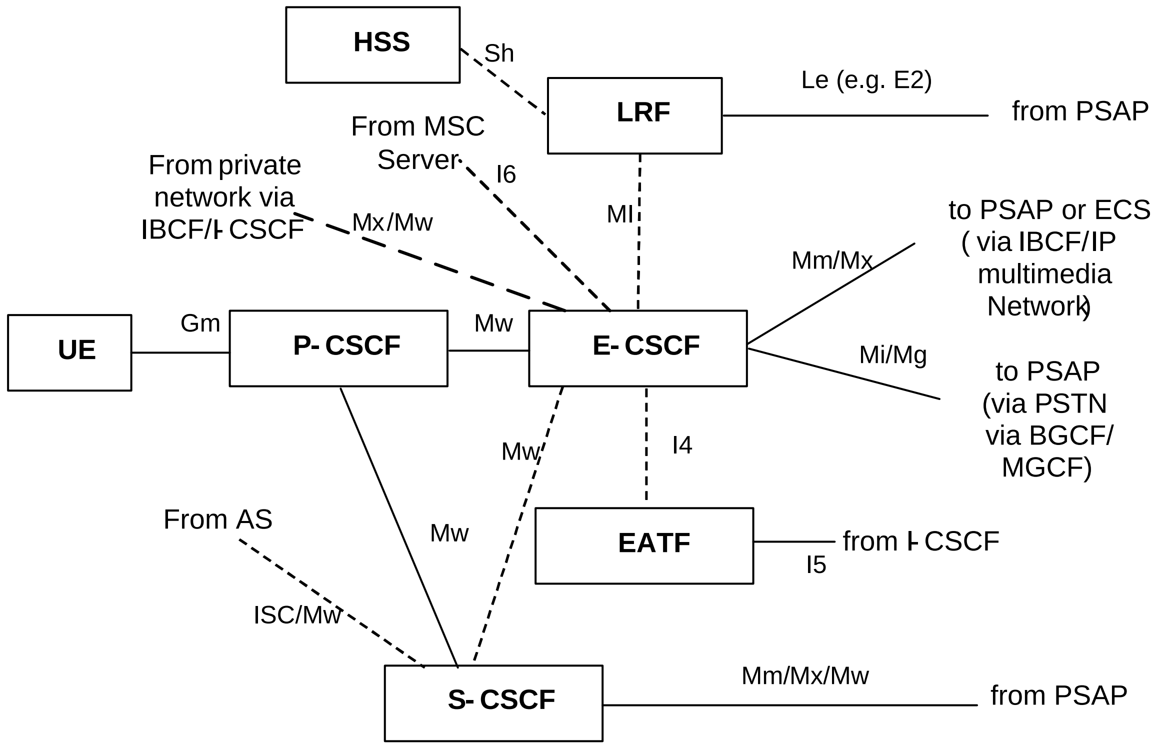


Figure 3 IMS architecture for emergency sessions (Release 17)

Applicability of ETSI functional architecture to IMS architecture

Different components represented in the functional architecture can be mapped to IMS functions and emergency service provider elements:

- **Location Server:** GMLC in cellular access network
- **VSP Call Control:** P-CSCF or VoIP platform of OTT player
- **ESRF:** E-CSCF + IBCF/BGCF/MGCF
- **LS Proxy:** LRF
- **Routing Server**: RDF

4 Enriched IMS emergency services

General

The media types allowed for IMS Multimedia Emergency Services (MES) that must be supported by the UE and the network according to regional and/or local policy, are listed in 3GPP TS 22.101 [1] as follows:

- Real time video (simplex, full duplex) synchronised with speech if present.
- Session mode text-based instant messaging.
- File transfer.
- Video clip sharing, picture sharing, audio clip sharing.
- Voice; and
- Real-Time Text.

Note: Some of the media types listed above do not comply to accessibility requirements of regional regulators (like Europe), for example Total conversation is Real-time video synchronised with voice and Real-Time text.

Multimedia Emergency services

VoLTE emergency call

The UE and the network must conform to the IMS emergency call procedures described in GSMA PRD NG.119 [5] and GSMA PRD IR.92 [6].

Knowing that VoLTE roaming emergency is not always implemented at the same time as VoLTE roaming, there is a need to track the VoLTE roaming emergency deployments independently from VoLTE roaming.

Editor's Note: The inter-PLMN selection for UE that attempts to make an emergency session over PS access networks is not specified yet.

VoWi-Fi emergency call

The UE and the network must conform to the IMS emergency call procedures described in GSMA PRD IR.51 [7] for untrusted access and GSMA NG.106 [36] for trusted access.

For UE detectable emergency numbers, the UE establishes the IMS emergency session as specified for VoLTE in GSMA PRD IR.92 [6]. For non-UE detectable emergency numbers, same as for VoLTE, the UE does not register for an IMS emergency session and the call is not prioritised.

The UE initiates an Emergency session over WLAN access only when cellular access for emergency call is not possible or available (e.g. no 3GPP coverage), as specified in Annex J of Release 14 of 3GPP TS 23.167 [2]. The domain selection rules for emergency session are defined in table H.1 of Release 14 of 3GPP TS 23.167 [2].

Note: There is no clear view of VoWi-Fi deployments worldwide.

As for VoLTE, the location information is required for VoWi-Fi emergency call. Location management procedures for Wi-Fi accesses (trusted and untrusted) are defined in Release 14 of 3GPP TS 23.402 [26] as part of the interaction between 3GPP AAA server and HSS in the HPLMN via SWx reference point, as specified in GSMA PRD IR.61 [25].

Same as for VoLTE, the UE must fulfil the requirements to convey its location, as defined in section 5.2.3 of GSMA PRD IR.92 [6].

VoNR emergency call

The UE and the network must conform to the IMS emergency call procedures described in GSMA PRD NG.114 [8] and GSMA PRD NG.119 [5].

When the 3GPP radio access network is selected by a UE connected to 5GC with NR, three alternatives are possible:

- The emergency call is performed natively over NR. For native Emergency Call over NR, UE establishes a PDU Session for Emergency service. The network function in charge of the retrieval of location information should take into account the support of New Radio Cell-ID format, as specified in GSMA PRD NG.119 [5].

- If ECoNR is not supported, the Emergency services fallback procedure is defined in 3GPP TS 23.501 [27] and 3GPP TS 23.502 [28] which the UE is instructed to request a fallback to E-UTRAN before issuing the emergency call.
- Or the network may be configured to use the same RAT or EPS Fallback procedure as for normal voice calls or to force the selection of EPS by the UE.

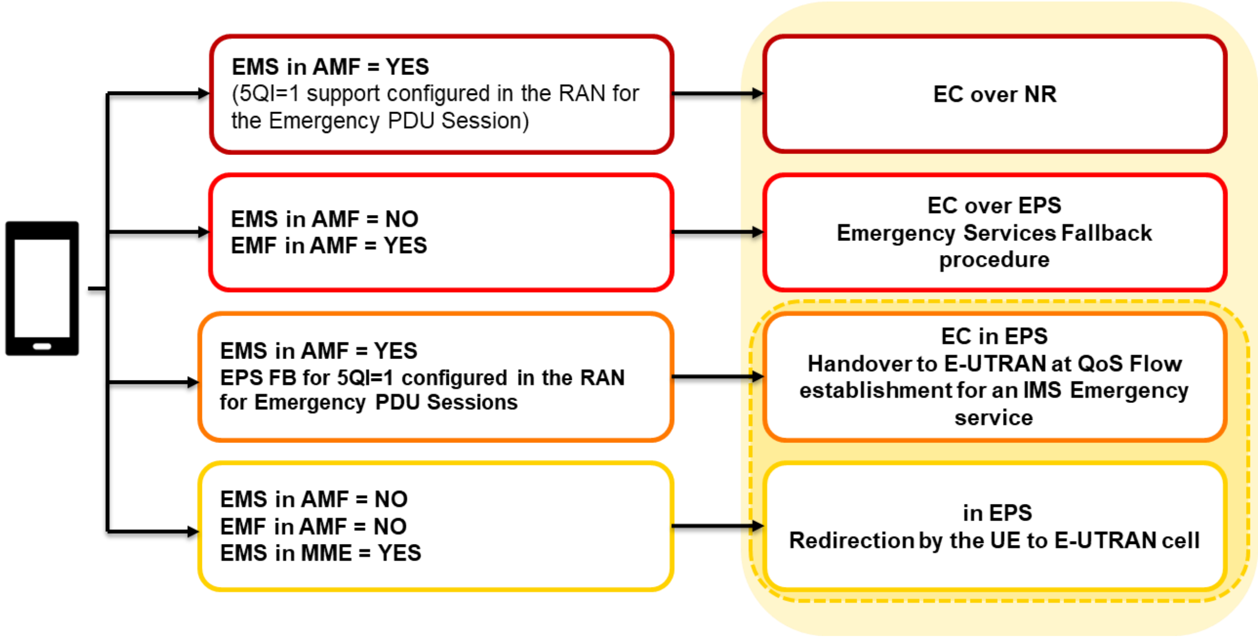


Figure 4 Emergency services procedure in 5GC

Initial 5G deployments should prioritise the reuse of IMS emergency communications over EPS, in order to minimise the deployment impact of VoNR emergency call on the network and the PSAP.

RTT / GTT-IP

The emergency session establishment for the Real-Time Text service is similar to VoLTE.

The real-time text conversation is a service that is provisioned by the Global Text Telephony (GTT) feature. GTT is supported in IMS networks and described in 3GPP of TS 22.226 [39] and TS 23.226 [40].

The UE and the PSAP must support the use ITU-T Recommendation T.140 [31] real-time text according to the rules and procedures specified in 3GPP TS 26.114 [32] and the use of RTP for the transport protocol of text conversation as described in IETF RFC 4103 [41].

The Real-Time text can be combined with voice or video, or both.

The network must support GTT and must be able to allow SDP negotiation for real-time text including the codec defined in ITU-T Recommendation T.140 [31], to fulfil the accessibility requirement in some regions.

Considering the accessibility requirements in some regions, the UE should support RTT natively within the device (and using network core services) or by using an OTT application.

Note 1: GTT-IP refers to the support of Teletypewriter (TTY) service over IP using GTT.

Note 2: UE and network procedures with regards to Real-Time text are not described in 3GPP stage 3 specifications.

The impact on the IMS core network of RTT deployment should be assessed to ensure common interworking with the PSAP and the device, especially to support roaming. Based on the proposed recommendations above, GSMA PRD NG.119 [5] should be updated.

Video / ViLTE

As specified in Annex B.2 of GSMA PRD IR.94 [35], the UE and network deployments must support IMS emergency communications using video media as well, when the capability is required by regional/local regulator. The UE and the network must support IMS emergency services as specified in 3GPP Release 11 of TS 23.167 [2], chapter 6 and Annex H. The impact on the IMS core network of video deployment should be assessed to ensure common interworking with the PSAP and the device, especially to support roaming.

Note: Based on the proposed recommendations above, GSMA PRD NG.119 [5] and GSMA PRD NG.114 [8] should be updated.

Total conversation

Total Conversation, as defined in ITU-T Recommendation F.703 [29], is a combination of three media in a conversational call: video, Real-Time Text and audio. The Total conversation access to emergency services is defined in ETSI TS 101 470 [30].

The Total Conversation UE must support Real-Time Text, speech and video in emergency sessions as defined respectively in GSMA PRD IR.92 [6], IR.94 [35], IR.51 [7], NG.106 [36], NG.114 [8] and NG.115 [9].

SMS to emergency centre

SMS design must enable SMS over IMS for emergency service in case of roaming and support emergency numbers such as 112 and 911, as part of the 3GPP Release 18 specification.

Editor's note: This section is for further update after the completion of the 3GPP Release 18 specification to enable SMS to emergency centre is on-going in 3GPP as part of Release 18.

Although there are many local deployments for SMS to emergency services worldwide, the Short Message Service could be harmonised based on a common requirement:

- Roaming: The SMS to emergency services must be based on Local breakout architecture.

- Emergency session establishment: The procedures related to emergency session establishment described in 3GPP TS 23.167 [2] must be applicable to SMS to emergency centre.
- Barring: The UE must include, in the SIP MESSAGE for SMSoIP, the PSI of the SMSC of the SM-over-IP sender, with the following format
- <visited_CC> + <emergency number>
- Unauthenticated UE / Limited-service mode: If the emergency call is authorised for a UE in a limited-service mode, It is assumed that SMS to emergency centre should be authorised as well, dependent on local policy.
- SMS to emergency centre should be free of charge for end user.

Emergency call history: As per the nature of some emergency services, the emergency call history should not be displayed in the user interface, according to local policies.

5 User location improvement

Requirements

Two main questions are to be addressed regarding location information for emergency communication:

- caller location information, both network-based and handset-derived.
- the routing of emergency communications based on caller location to the most appropriate PSAP.

The emergency centre should be able to retrieve the location information during the emergency session setup, but also after the emergency communication is established.

Positioning methods

This section lists both UE and network provided location information technologies. GSMA PRD NG.120 [21] documents the different location services for objects that are reusable for emergency communications location requests.

Location information could be provided by

- UE: mainly based on satellites positioning methods called GNSS
- Network: Cell-ID or other technologies based on location servers able to compute geographical coordinates.

Satellite (GNSS)

GNSS uses satellite constellations orbiting the earth that send location and timing data directly to a GNSS-enabled device. If the device can pick up signals from three satellites, it can provide a horizontal location on a map (Latitude, Longitude).

Network-assisted GNSS (A-GNSS) rely on a network location server to provide the GNSS assistance data. Network-assisted GNSS is now widely deployed in smartphones and enables a high accuracy (5-25m) for outdoor location requests.

Cell-ID

Cell-ID is the identity number designated by a mobile network operator to a Base Station which can be used to determine the physical location of the cell tower hosting that Base Station. Cell-ID is used in emergency communications to locate the user and route the call within the circuit switched domain to the most appropriate PSAP. It is assumed that the cell identity of the serving eNB/gNB is accurate enough for IMS emergency session routing in a PLMN.

Network Location Services methods

Other technologies based on location servers are able to compute geographical coordinates based on different positioning methods like Enhanced Cell ID, O-TDOA, …

For 4G, 3GPP TS 23.271 [19] describes the network architecture to provide the network location, mainly based on Cell-ID but also enhanced to the geographical coordinates.

For 5G, 3GPP TS 23.273 [20] describes the network architecture to provide the network location by reusing the GMLC concept and adding a new 5G core network managing the location.

Location information transport

This section describes the way to transport the location information, provided by different positioning methods as defined in the previous section.

The user location information could be transported either at the emergency session establishment, or during the emergency session or after the release of the emergency session.

The user location information transport should be embedded into the SIP INVITE of the emergency session or independent from the emergency session establishment procedure (e.g. AML, Network Location Service).

SIP (IMS)

Location information at session establishment

During the emergency session establishment procedure, the UE inserts a P-Access-Network-Info header field containing the UPLI (User Provided Location Info) in the initial SIP INVITE.

The P-Access-Network-Info SIP header defined in IETF RFC 3455 [17] can be used to convey the location.

P-Access-Network-Info value carries access type and related location information: e.g. cell identity for 3GPP access, MAC address of WLAN access point.

Then the P-CSCF inserts the location information received from the PCRF/PCF or override the location information received from the UE in a P-Access-Network-Info header field.

The P-CSCF adds in the P-Access-Network-Info header an operator-specific-GI (Geographical Identifier) deduced from the cell identity.

If no location information is received in the emergency request or if additional location information is required, the E-CSCF may request the LRF to retrieve the location information as described in section 7.3 of 3GPP TS 23.167 [2].

The Presence Information data format – Location Object (PIDF-LO) carries geographical information of a presence in a basic XML format.

The IETF RFC 6442 [14] specifies the conveyance of three SIP header fields, Geolocation, Geolocation-Routing, and Geolocation-Error, which carry a reference to a Location Object (LO), grant permission to route a SIP request based on the location-value and provide error notifications specific to location errors, respectively.

The geolocation header is appropriate for conveying a reference in the form of a location URI when location value in Coordinate Format is conveyed as a MIME body in the SIP message.

The UE procedures to convey its location in the initial SIP INVITE using the “Geolocation” header field in the Location object posted in the PIDF-LO are described in section 5.1.6.8.2 and section 5.1.6.8.3 of 3GPP TS 24.229 [12].

As per the sensitive character of location information, it is recommended to secure the location hop-by-hop, using TLS, that protects the message from eavesdropping and modification in transit, but enables exposure of the information to all proxies on the path as well as the endpoint.

Location information update

The UE must be able to create and update the location record within the PIDF-LO to supply the new location. According to IETF RFC 6443 [33], the PSAP has no way to request an update of a location provided by value.

It is recommended that the Location Information Server (LIS) relative to the specific PSAP notifies this PSAP when an accurate location is available, using SIP SUBSCRIBE method as specified in IETF RFC 6443 [33] and IETF RFC 3856 [34].

Upon the change of the location information of the UE, the UE can send a SIP UPDATE to refresh location information passed in the Geolocation header field of the PIDF-LO to the PSAP, as specified in ETSI TS 103 479 [3].

Advanced Mobile Location

Advanced Mobile Location (AML) is a location-based service triggered at an emergency call establishment to transport handset derived location information via SMS or HTTPS. AML is defined in ETSI TS 103 625 [22].

The AML is triggered by an emergency communication establishment independently from the voice technology and the access network. The AML must be integrated into all emergency communication mechanisms available on the device including the manual dial of 112 (or any other national emergency number specified for the mobile network and country being used), and the use of the Emergency Call button (as appropriate), as specified in section 5.2 of ETSI TS 103 625 [22].

Today, the AML implementation is fragmented at device and network side. This fragmentation does not serve the roaming deployment of AML.

Upon any emergency session establishment and when the SMS transport is selected, the UE should send an AML message to the local SMSC.

Note 1: AML message does not interfere with any media established for the emergency session.

Note 2: AML Roaming is described in section 6.3.4 of ETSI TS 103 625 [22].

AML evolutions could include:

- AML triggered also in case of SMS to emergency centre. According to section 5.2 of ETSI TS 103 625 [22], AML should also be triggered by an SMS message sent to the emergency centre, typically for deaf or hard of hearing users.
- AML technology could be more standardised, in order to have a unique deployment inside devices and networks.

Note 3: 3GPP standardisation should be proposed and appropriate GSMA PRDs should be updated accordingly.

Network Location Services methods

The network is able to provide location information based on GMLC request. The GMLC request will be manage by MME/SMLC in 4G and AMF/LMF in 5G.

GMLC could deliver geographical coordinates based on Cell ID or other positioning methods as described previously.

Secure User Plane Location

The Secure User Plane Location (SUPL) is a protocol defined by OMA that employs user plane data connection to transport location assistance information (such as A-GPS data).

Note: SUPL deployments are limited to the retrieval of the Assisted-GPS data from the network to a SUPL Enabled Terminal (SET).

SUPL architecture

The SUPL architecture is composed of a SUPL Location Platform (SLP) and a SET:

- SUPL Enabled Terminal (SET): A mobile UE that is configured to support SUPL transactions.
- SUPL Location Platform (SLP): A server or a stack of network elements that manages authentication, location requests, location applications.

SLP and SET operate as a separate network layer that requires minimal interaction with the signalling.

SLP consists of two functions:

- SUPL Location Centre (SLC) which coordinates the operation of SUPL in the network and manages the SPCs.
- SUPL Positioning Centre (SPC) calculates the SET position and provides positioning data to the SET.

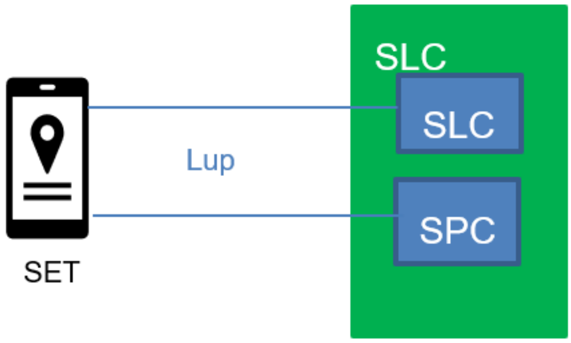


Figure 5 User graphical interface

Note: The SUPL architecture is complementary to the 3GPP LCS architecture and is associated with it through E-SMLC, as referenced in 3GPP TS 23.271 [19] and 3GPP TS 23.273 [20].

OMA SUPL supports OMA Push (PAP, POTAP), SMS, UDP/IP and SIP Push for location data conveyance.

SUPL for emergency services

SUPL requirements described in OMA-RD-SUPL-V2_0-20120417-A [23] allows the support of location requests associated with emergency communications and potentially can give a higher priority to those location requests, where applicable by local regulatory requirements.

For IMS emergency location services, the SUPL location request notification can be conveyed from the network to the SET (Network Initiated) via the Emergency IMS Core using SIP Push, as described in section 5.2.1.1 of OMA-AD-SUPL-V2_0-20120417-A [24].

Note 1: For roaming case, the SUPL location request has a home routing section.

Note 2: The applicability of SUPL is limited to packet switched networks.

Optimised routing to PSAP

IMS based routing to PSAP

In case of an IMS emergency session, emergency call centres must be able to connect the UE to the most appropriate PSAP (Public Safety Answering Point), based on the retrieval of the UE location during the emergency session establishment. The retrieval of the user location information could be:

- either via the IMS signalling, as described in section 5.3.1 of this document,
- or via an external platform (LRF)

Based on the operator routing policies, the emergency session is routed to the most appropriate PSAP that can be either centralised or regional.

SMS/HTTP based routing to PSAP location database

Location information for non-IMS emergency communications must be routed to a central location database.

Considering SMS or HTTP used for AML, the location information is stored in a central location database. The central location database should be accessible by all PSAPs, in order to correlate location information from this database to the corresponding emergency communication.

For SMS sent by the user to the emergency centre, the PSAP designated to receive SMS may distribute the SMS to the appropriate PSAP based on location information received either from the AML or from a network-provided solution.

6 eCall and migration of car ecosystem to IMS

General

This section proposes migration scenarios to eCall over IMS, so called NG-eCall, endorsing the architectural principals and procedures specified by 3GPP and the requirements defined by ETSI and CEN.

6.1 Definition

The eCall is a 3GPP standard to trigger emergency communication in vehicles in order to bring rapid assistance to road traffic incidents, capitalising on regulated voice emergency services.

eCall provides reliable full-duplex data communications between the In-Vehicle-System (IVS) and the PSAP in addition to an emergency voice call via the cellular network. The eCall uses the same voice channel as used for the emergency voice call to convey data.

The In-vehicle system (IVS) initiates an eCall either as a result of an automatic activation (in case of a road incident which triggers the eCall) or manually by the vehicle occupant.

For eCall over CS, the IVS transmitter modulates the Minimum Set of Data (MSD), which is represented by a field of 140 bytes, to generate signals suitable for transmission over the in-band voice channel to the PSAP.

For NG-eCall, the MSD is transported within the SIP INVITE during the emergency session establishment.

The UE and the network requirements to support NG-eCall are described in Annex E of GSMA PRD IR.92 [6] and GSMA PRD NG.114 [8].

eCall over CS and NG-eCall system overview is described in GSMA NG.119 [5].

Voice and NG-eCall

Emergency calls as well as eCalls are subject to local breakout. Whereas the principles of TS12 Emergency calls apply, Mobile Originated Calls without a roaming agreement can be placed as long as local regulation does not require other.

NG-eCall via VoLTE

To enable NG-eCall the prerequisites in the three domains IVS, network (access / transport) and PSAP must be in place.

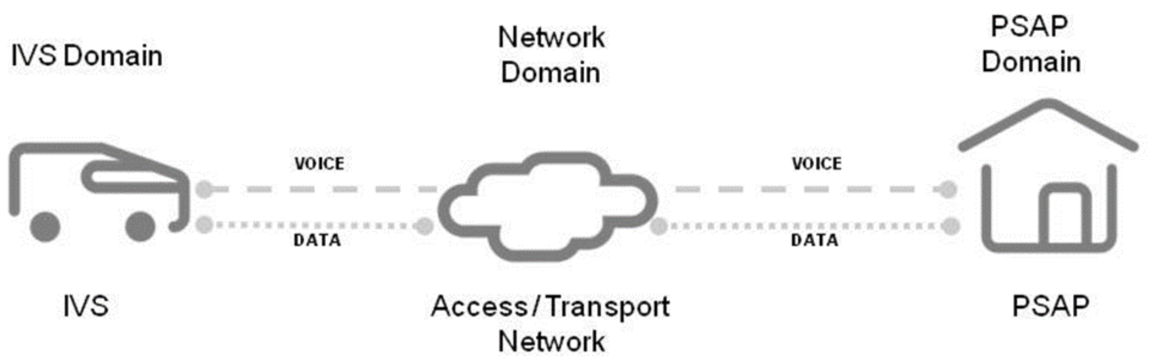


Figure 6 Prerequisites in the 3 domains

The “Study on the current and prospective use of the 900 MHz band by GSM as a technology of reference, considering present and future Union policies” (SMART 2019/0006) gives figures on eCall deployments over time proving that any further delay in updating the eCall regulation is expected to result in a significant legacy burden.

Table 4: eCall deployments forecast, EU 28

	2019	2020	2021	2022	2023	2024	2025	2026
New eCall vehicles	2.38	4.84	7.44	10.22	13.37	16.51	17.55	17.72
Installed base eCall vehicles	2.38	7.22	14.67	24.90	38.27	54.78	72.33	90.06
% of new registrations	17.2%	33.4%	49.1%	64.4%	80.5%	95%	100%	100%

Source: Consortium elaboration based on Eurostat, ACEA and GSA data

Figure 7 ECall deployment forecast

It becomes apparent that any delay hinders innovation and prevent the benefits associated with NG-eCall from being realised (e.g., instant communication between people in distress and the PSAP as opposed to muting the voice channel).

Legislative action is rapidly needed to replace the 2G/3G specific regulation. The updated legislation should avoid the shortfalls of today’s applicable regulation in a technology agnostic way.

Migration plan to NG-eCall

In the current deployments, there is a predominance of in-band modem eCall supported by IVS, PSAP service providers and mobile networks. Based on the automotive life cycle, planned future amendments to the eCall regulation and its impact on PSAP evolution to support IMS capabilities, there are two migration scenarios, as described in 3GPP TS 23.167 [2], that will coexist before the full NG-eCall E2E deployment (i.e. NG-eCall supported by IVS, networks and PSAPs).

The figure below illustrates all end-to-end scenarios, from eCall over CS to NG-eCall, that could co-exist before and during the migration phase to full NG-eCall deployment, as specified in the deliverable 2.2 [38] under the scope of sAFE initiated by the European Commission.

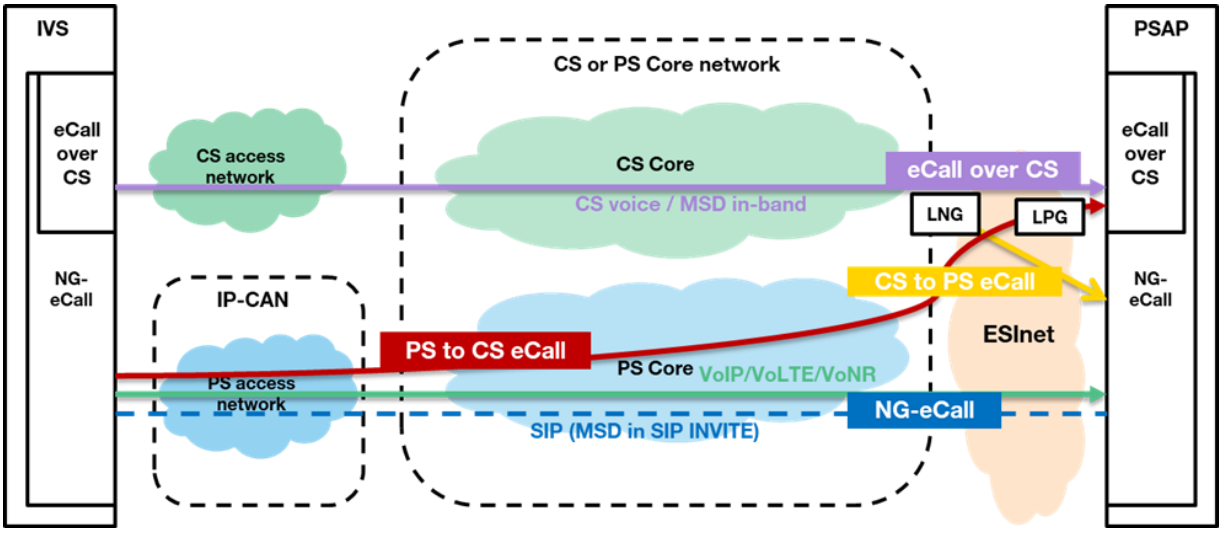


Figure 8 Overview of end-to-end co-existence scenarios from ecall over CS to NG-eCall

Interworking scenario with non-NG PSAP

When neither the PSAP nor the IVS supports NG-eCall, the UE issues an eCall over CS. The MSD data is transferred from IVS to PSAP in the voice channel using the in-band modem transcoding capability of the IVS and the PSAP.

When the UE detects that the NG-eCall is supported by the IP-CAN, but the PSAP does not support NG-eCall, the NG-eCall is established between the IVS and the PSAP using Legacy PSAP Gateway (LPG). The LPG is used to transcode voice from PS Voice into CS Voice and SIP into ISUP signalling protocol. The MSD is transcoded from SIP message into in-band data message transferred to PSAP in the CS Voice channel.

Note: To ensure the interworking from PS to eCall over CS, LPG needs to be implemented in the ESInet.

The latter scenario is described in Release 14 of 3GPP TS 23.167 [2] as an interworking scenario between a UE and a PSAP via the CS domain.

The IVS is required to support both eCall over CS and NG-eCall to ensure the continuity of eCall service before PSAP migration to support IMS capabilities.

6.1.1 Interworking scenario with IVS not supporting NG-eCall

There are two scenarios for eCall with an IVS not supporting NG-eCall:

- eCall over CS is established end-to-end between the IVS and the PSAP, or
- from CS network domain to the Packet Switched PSAP domain in which the eCall over CS is converted by the functional element Legacy Network Gateway (LNG) in ESInet into NG-eCall and further routed to the NG PSAP using the functional elements ESRP and ECRF in ESInet.

Note 1: This scenario can only exist in the presence of ESInet service network, e.g. IMS Core network itself cannot support the eCall interworking scenario from CS to PS. Hence, this scenario is not described in 3GPP specification.

Note 2: To ensure the eCall interworking scenario from PS to CS, LNG needs to be implemented in the ESInet.

Note 3: The additional functions required (LNG, LPG) have both investment and technical impacts that could increase the risk on NG-eCall establishment and decrease the resilience of the service.

The NG PSAP is required to support both eCall over CS and NG-eCall to ensure the continuity of the eCall service before all IVS support NG-eCall capabilities.

Numbering

For emergency services to be able to call back the phone numbers used for a vehicle emergency call, emergency centers or PSAPs must be able to reach the ecall SIM cards. Support of ecall numbering resources is therefore critical. These include ecall numbers under E.164 country codes 882 and 883 as those listed in the ECC Recommendation (17)04 Numbering for eCall [18]. It is currently in https://docdb.cept.org/download/093ec180-31a3/Rec1704.pdf [18].

7 NG PSAP requirements and support

General

This section clarifies the requirements that need to be supported by the device and the network to interoperate with an NG PSAP. NG PSAP requirements are mainly subject to regional regulation; thus it is generally out of the scope of this document.

NG PSAP requirements

ETSI has defined what is specifically required by an NG PSAP to handle incoming IMS emergency communications and PSAP call-back.

According to ETSI ES 203 178 [4], the Next Generation Public Safety Answering point must support:

- the SIP session interface including the multimedia capability (video, Real-Time Text and voice, as described in section 4 of this document) and location information as described in section 5.3.1,

- the SMS interface (AML and SMS to emergency centre)
- the HTTP interface (AML)
- the non-human-initiated call (eCall) capability (MSD and voice).

SIP INVITE or MESSAGE transactions can contain a Call-Info header field with a URI referencing one or more Additional Data blocks as specified by ETSI TS 103 479 [3]. The transaction to dereference the Additional Data must be protected with TLS. The dereferencing entity, which can be a PSAP, uses its credentials to dereference the Additional Data URI and should have means to render information to the user in the PSAP.

NG PSAP must be able to initiate non-emergency calls (including voice-only call back) by using normal SIP trunking mechanisms as referenced in ETSI TS 103 479 [3].

NG PSAP must support all mandatory interfaces defined in ETSI TS 103 479 [3]. When supported, the initial INVITE, sent by the NG PSAP to the network serving the emergency caller, must include the “psap-callback” value of the SIP priority header field to inform SIP entities that the request is associated with a PSAP call-back SIP session.

UE and Network procedures interworking with PSAP

When a communication is initiated to a PSAP from a UE without credentials, the E-CSCF must derive a non-dialable call-back number where required by local regulation as specified by 3GPP TS 23.167 [2].

The UE and the network must follow the procedures for the interaction with PSAP described in 3GPP TS 24.229 [12] and 3GPP TS 23.167 [2].

The UE must be able to maintain its regular IMS registration while issuing an emergency session for the PSAP call back services.

Note: According to IETF RFC 6881 [13], PSAP call-back to the Contact header URI received is expected to be placed by the PSAP within approximately 30 minutes following the termination of the emergency communication, although this value could vary according to local authorities’ requirements.

The network must not invoke the use of supplementary services on a call identified as a PSAP call-back as mentioned in GSMA PRD IR.92 [6] or within 30 minutes following the termination of an emergency communication as mentioned in IETF RFC 6881 [13].

8 Conclusions

This whitepaper outlines main challenges that are faced by the evolution of the emergency communications. It describes the implementation requirements, based on the standards, and actions to be taken to ensure end to end interoperability between the roaming and non-roaming UE, the network and the emergency service system.

This section summarises main recommendations with regards to emergency communications evolution according to the main 3 areas identified:

Enriched IMS emergency services:

Emergency communications are highly impacted by the decommissioning of the 2G and 3G networks, as well as by the progress of the VoLTE roaming deployments. It is then recommended to put in place annual tracking of the network shutdown map and list, the VoLTE roaming deployments, as well as VoLTE roaming emergency deployments.

With regards to VoWi-Fi, main challenge is the accuracy of the location information. The convenience of user location in SIP signaling is already defined in 3GPP specifications, as it is the case for VoLTE as specified in section 4.2.1.2. Nevertheless, the most deployments of VoWi-Fi are over an untrusted access as an OTT type of service. It is recommended to deploy location services for VoWi-Fi emergency communications as well, in order to ensure the emergency service continuity, considering the 2G/3G networks shutdown acceleration.

As a complementary solution to Real Time Text, Total conversation and other messaging communications for emergency services accessibility, the Short Message Service to emergency Centre should be enabled for roaming and harmonized through the standardization.

Realistically, the deployment of ViLTE lacks a real business driver. Nevertheless, video is considered as an enabler for emergency users with disabilities. Two options are possible:

- a clear regional/local regulatory requirement encourages ViLTE deployment. An assessment of the technical impact, among others, is to be considered, or
- a third-party application that covers video needs to be considered (in the scope of Total conversation for accessibility to users with disabilities).

User location improvement:

For emergency communications, the location information is required to ensure both the routing to the appropriate emergency centre and getting an accurate location of the user. For this purpose, and others, location services should be implemented at the device and at the network level.

Usually at the emergency session establishment, the location is provided within the SIP signalling. The main challenge is the accuracy of the location information provided within the session initiation, which could not be the latest one as the UE includes the latest location available at its end. On the other hand, the PSAP cannot query the UE for a location update. The UE should be able to update the location as described in the section 5.3.1.2 of this document.

Nevertheless the AML could be a good alternative to retrieve the handset derived location at the emergency call establishment. The AML mechanism has proven its efficiency. For that, the AML should be put in place for SMS and all Multimedia Emergency Services (included in section 4.2) as an enrichment of the location information conveyed in the SIP signalling.

On the other hand, the AML technology needs further standardisation to be supported by the devices and networks implementations as well as in roaming (e.g. the conditions and settings on which the AML is initiated, SMSC address).

Migration of car ecosystem to NG-eCall:

The PSAP evolution to support IMS is highly recommend, as soon as possible. This evolution will serve:

- the migration to NG-eCall avoiding putting in place any interworking function and be forced to transcode the traffic, that causes risk, delay and additional investments; and
- the enrichment of emergency communications, through IMS, as described above in this document.

In order to ensure both reliable and resilient eCall emergency service it is recommended to proceed with the migration from the full eCall over CS traffic to full NG-eCall traffic, and avoid the transitory scenarios involving interworking gateways from CS to PS or PS to CS.

Annex A VoLTE Roaming Emergency deployment

This annex presents the Mid 2022 status of VoLTE Roaming deployment, based on GSMA IR.21 roaming data configuration.

Roaming VoLTE emergency is opened in 31 countries (46 operators) compared to Roaming VoLTEte which is opened in 53 countries (91 operators): VoLTEte roaming emergency represents 50% compared to VoLTE roaming.

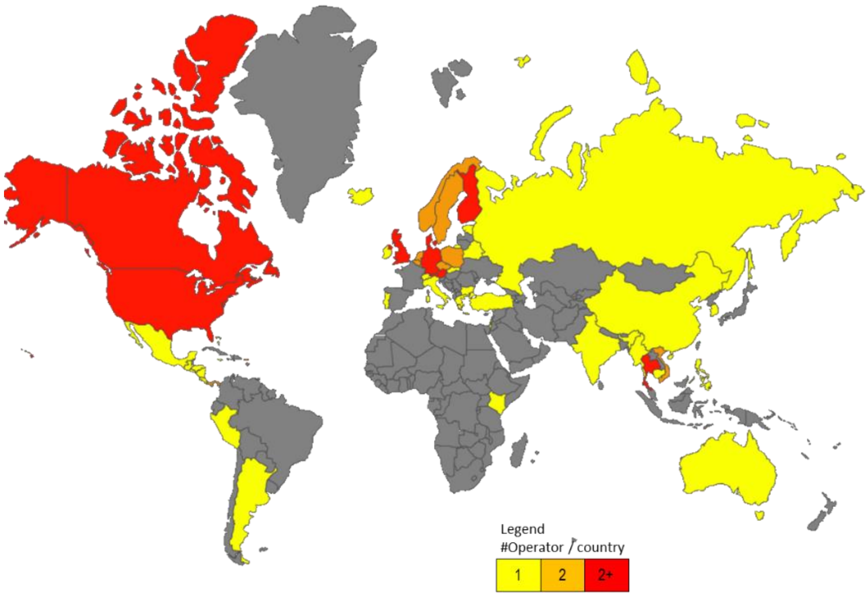


Figure 9 VoLTE Roaming Deployment

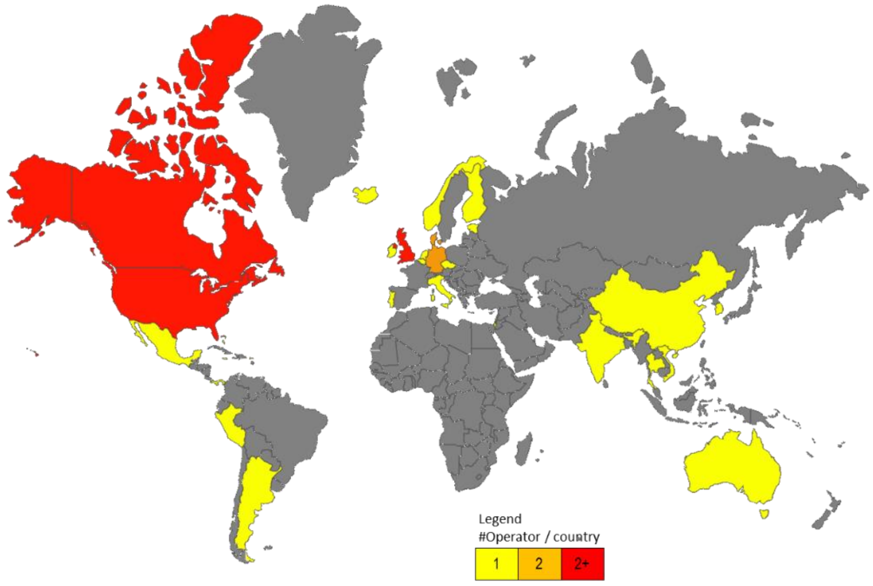


Figure 10 VoLTE Roaming Emergency deployment

Annex B 2G/3G sunset

Emergency services are widely impacted by the decommissioning of 2G and 3G networks. This induces a significant migration from legacy services to IMS services.

A lot of announcements are in the world: the full sunset including 2G and 3G networks is the real milestone for migration.

The figures hereafter describes the evolution of full legacy shutdown between 2022 and 2030 based on GSMA WAS Network Closures Report.

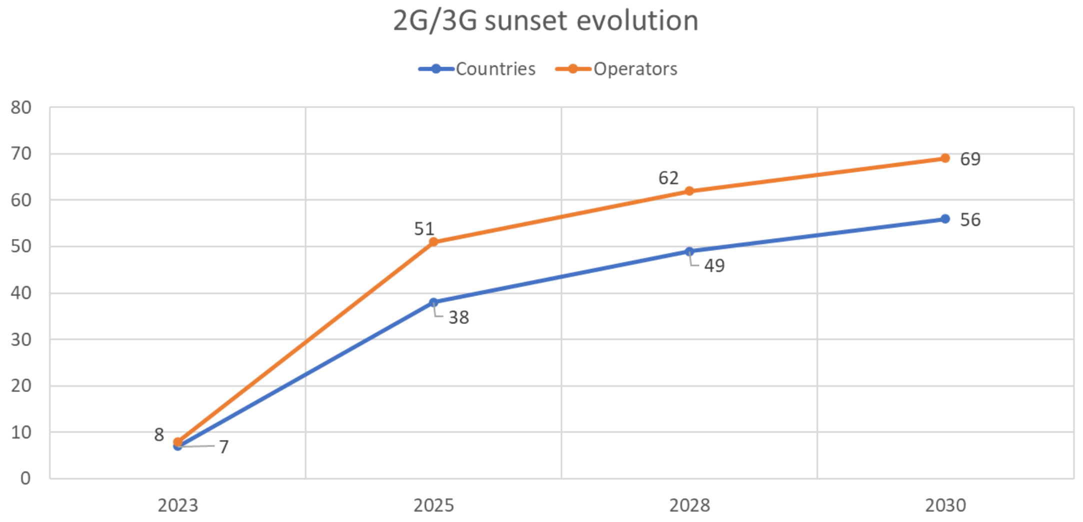
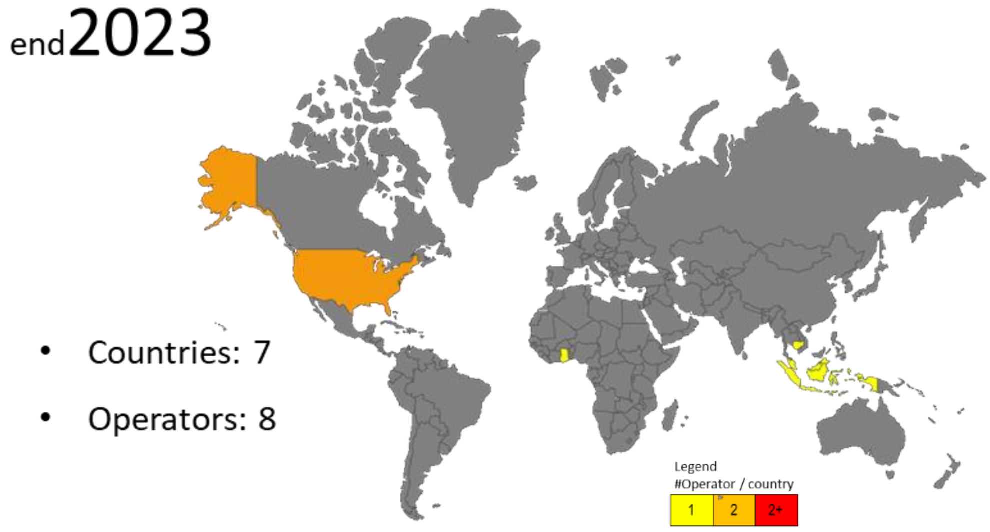
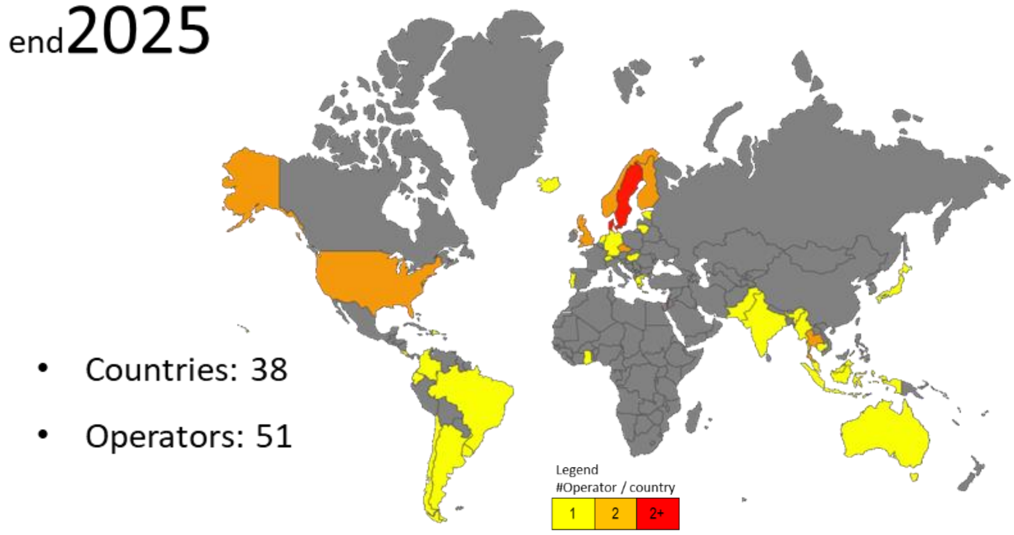
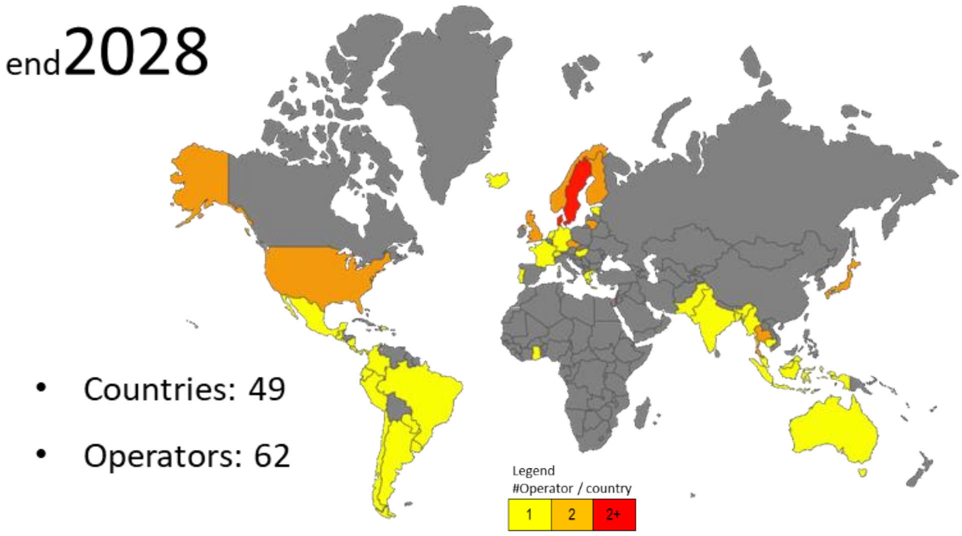


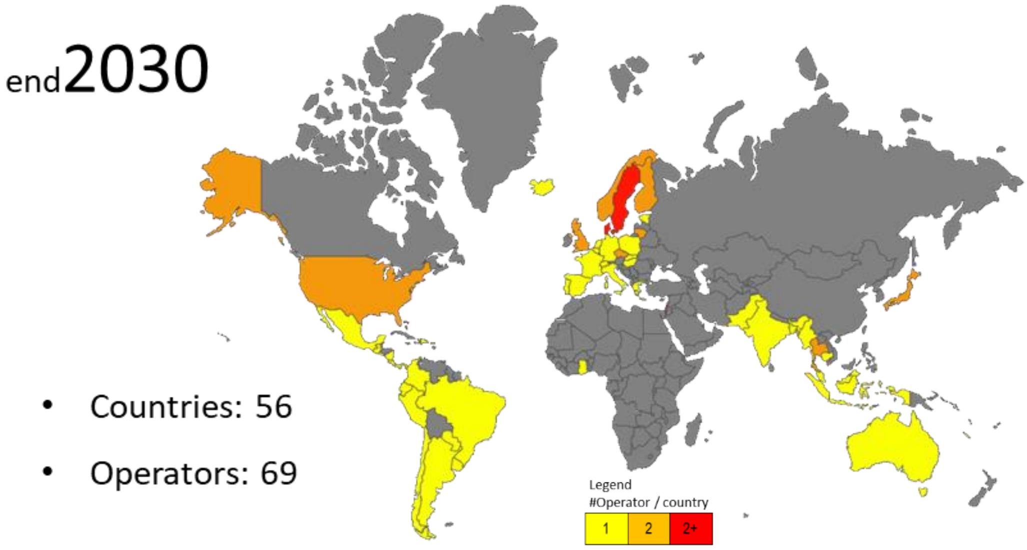
Figure 11 2G/3G Closure evolution

The figures hereafter explain the impacted regions and countries on the 2023-2030 time period.


end2023
Countries: 7
Operators: 8
Legend
#Operator / country
1
2
2+


end2025
Countries: 38
Operators: 51
Legend
#Operator / country
1
2
2+


end2028
Countries: 49
Operators: 62
Legend
#Operator / country
1
2
2+


end2030
Countries: 56
Operators: 69
Legend
#Operator / country
1
2
2+

Annex C Legal Requirements for Emergency Communications in the European Union (EU)

The table below provides a list of the legal requirements for emergency communications in the EU. The implementation date ("effective from") is provided as well as the transposition deadline where applicable. Transposition is the process of incorporating EU Directives into the national laws of the Member States.

<table>
<tr><th>Subject</th><th>Relevant Legal Requirements</th><th>Information and guidance</th><th>Effective from</th><th>Member State Transposition deadline (if applicable)</th></tr>
<tr><td>Access to emergency services</td><td>EECC[1] Article 109(2)</td><td rowspan="3">EECC Recital 285
EECC Recital 288</td><td>17/12/2018</td><td>21/12/2020</td></tr>
<tr><td rowspan="2">Equivalent access to emergency services for end-users with disabilities through emergency communications</td><td>EECC Article 109(5)</td><td>17/12/2018</td><td>21/12/2020</td></tr>
<tr><td>European Accessibility Act[2]
(Article 4(2) and (8), Annex I, Sections IV (a) and V)</td><td>07/12/2019</td><td></td></tr>
<tr><td>Routing of the emergency communication to the most appropriate PSAP</td><td>EECC Article 109(2)</td><td>EECC Recital 286</td><td>17/12/2018</td><td>21/12/2020</td></tr>
<tr><td>Appropriate answering and handling of emergency communications</td><td>EECC Article 109(3)</td><td></td><td>17/12/2018</td><td>21/12/2020</td></tr>
<tr><td>Free of charge access to emergency services</td><td>EECC Article 109(1)</td><td></td><td>17/12/2018</td><td>21/12/2020</td></tr>
<tr><td rowspan="3">Provision of network-based and handset-derived caller location information and making caller location information available without delay</td><td>EECC Article 109(6)</td><td>EECC Recital 290</td><td>17/12/2018</td><td>21/12/2020</td></tr>
<tr><td>Commission Delegated Regulation (EU) 2019/320 – essential requirements[3].</td><td>Guidelines[4] for compliance with delegated regulation (EU) 2019/320</td><td>17/03/2022</td><td>n/a</td></tr>
<tr><td>Case Law: Commission v Lithuania, C 274/07</td><td>Judgment of 11 September 2008, Commission v Lithuania, C 274/07,</td><td></td><td></td></tr>
</table>

[1] Directive 2018/1972 of the European Parliament and of the Council of 11 December 2018 establishing the European Electronic Communications Code (OJ L 321), 17 December 2018.
[2] Directive (EU) 2019/882 of the European Parliament and of the Council of 17 April 2019 on the accessibility requirements for products and services (OJ L 151), 07 June 2019.
[3] Commission Delegated Regulation (EU) 2019/320 of 12 December 2018 supplementing of Directive 2014/53/EU of the European Parliament and of the Council with regard to the application of the essential requirements referred to in Article 3(3)(g) of that Directive in order to ensure caller location in emergency communications from mobile devices (OJ L 55), 25 February 2019).
[4] Guidelines for compliance with delegated regulation (EU) 2019/320

		EU:C:2008:497, paragraph 40[5]		
Free of charge establishment and transmission of caller location information for the end-user and the PSAP	EECC Article 109(6)		17/12/2018	21/12/2020
Subject	**Relevant Legal Requirements**	**Information and guidance**	**Effective from**	**Member State Transposition deadline (if applicable)**
Caller location information accuracy and reliability	EECC Article 109(6)	EECC Recital 209	17/12/2018	21/12/2020
Effectiveness of access to emergency services (Compatibility, Interoperability, Quality, Reliability and Continuity)	EECC Article 109(8)	EECC Recital 291	17/12/2018	21/12/2020
	Delegated Act(s) under EECC Article 109(8)		21/12/2022	21/12/2024 (TBC)
eCall	Regulation (EU) 2015/758[6]	At time of writing, the regulatory framework for eCall is under review.		

[5] Judgment of 11 September 2008, Commission v Lithuania, C 274/07, EU:C:2008:497, paragraph 40

[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

Annex D Document Management

D.1 Document History

Version	Date	Brief Description of Change	Approval Authority	Editor / Company
0.7	06/07/2022	First draft, pCR Definitions, pCR Conventions and cross-reference ESTF#09, pCR Overview and PSAP requirements ESTF#10, Implementation of pCR 12_001, 12_002, 12_003, 12_004, 12_005, 13_001, 15_001, 15_002, 16_002 and 17_003, NRG14_005	ESTF/ NRG/NG	Merieme El Orch / Orange
1.0	24/11/2022	CR1001	NG/TG	Javier Sendin/GSMA

D.2 Other Information

Type	Description
Document Owner	NG NRG
Editor / Company	Merieme El Orch, Orange

It is our intention to provide a quality product for your use. If you find any errors or omissions, please contact us with your comments. You may notify us at prd@gsma.com

Your comments or suggestions & questions are always welcome.