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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Mobile Standards Group (MSG).

Introduction

Current eCall is based on CS emergency call in GSM and UMTS networks.

LTE spectrum auctions are taking place in the EU and there will be extensive LTE coverage before the implementation of eCall becomes mandatory in 2015. The longevity of GSM networks in the EU over the lifetime of vehicles is uncertain and GSM spectrum is likely to be re-allocated for UMTS and/or LTE. There is no CS emergency call in LTE.

The applicability of the existing technical solution for eCall (in-band modem) should be assessed for VoIP/VoLTE, as well as new technical solutions to be developed that are suitable for packet switched (UMTS and LTE) and offer better performance for eCall for VoIP.

Longer term strategies need to be considered and guidance (probably for further work) provided in respect of the long term migration of eCall to support over packet switched networks, and the co-existence and possible integration of eCall and other ITS communication equipment installed in vehicles.

1 Scope

The present document contains the findings of STF456. The following areas are addressed:

- Assessment of in-band modem solution in case of no use of CS bearers.
- Study the adaptation of IMS emergency call and IMS Multimedia Emergency Service for supporting current and future service required by eCall.
- Hybrid CS/IMS solution.
- Migration options and recommendations.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

Not applicable.

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] Next-Generation Pan-European eCall, draft-gellens-ecrit-ecall-01.

NOTE: Available at http://tools.ietf.org/html/draft-gellens-ecrit-ecall-01.

[i.2] ETSI TS 122 101: "Universal Mobile Telecommunications System (UMTS); Service aspects; Service principles (3GPP TS 22.101 Release 8)", eCall requirements for data transmission.

[i.3] ETSI TS 124 008: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Mobile radio interface Layer 3 specification; Core network protocols; Stage 3 (3GPP TS 24.008)", eCall Discriminator Table 10.5.135d.

[i.4] ETSI TS 126 268: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); eCall data transfer; In-band modem solution; ANSI-C reference code (3GPP TS 26.268)", eCall Data Transfer - ANSI-C Reference Code.

[i.5] ETSI TR 126 969: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); eCall data transfer; In-band modem solution; Characterization report (3GPP TR 26.969)", eCall Data Transfer - Technical Report - Characterisation Report.

[i.6] eCall minimum set of data CEN EN 15722 Road transport and traffic telematics - eSafety - eCall minimum set of data.

[i.7] CEN EN 16062: "High Level Application Protocols".

[i.8] ETSI TS 124 229: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; IP multimedia call control protocol based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP); Stage 3 (3GPP TS 24.229)", clause 5.1.6 Emergency Service".

[i.9] ETSI TS 136 331: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification (3GPP TS 36.331)", clause 6.2.2 Message definitions, SIB for IMS Emergency Support.

[i.10] IETF RFC 3051: "A Uniform Resource Name (URN) for Emergency and Other Well-Known Services".

[i.11] IETF RFC 4975: "Message Session Relay Protocol".

[i.12] Internet Protocol-based In-Vehicle Emergency Calls; draft-gellens-ecrit-car-crash-01.

[i.13] ETSI TS 123 167: "Universal Mobile Telecommunications System (UMTS); LTE; IP Multimedia Subsystem (IMS) emergency sessions (3GPP TS 23.167)".

[i.14] ETSI TS 124 301: "Universal Mobile Telecommunications System (UMTS); LTE; Non-Access-Stratum (NAS) protocol for Evolved Packet System (EPS); Stage 3 (3GPP TS 24.301)".

[i.15] ETSI TS 131 102: "Universal Mobile Telecommunications System (UMTS); LTE; Characteristics of the Universal Subscriber Identity Module (USIM) application (3GPP TS 31.102)".

[i.16] IETF RFC 6086: "Session Initiation Protocol (SIP) INFO Method and Package Framework".

[i.17] IETF RFC 2326: "Real Time Streaming Protocol (RTSP)".

[i.18] IETF RFC 6881: "Best Current Practice for Communications Services in Support of Emergency Calling".

[i.19] IETF RFC 5547: "A Session Description Protocol (SDP) Offer/Answer Mechanism to Enable File Transfer".

[i.20] IETF RFC 4103: "RTP Payload for Text Conversation".

[i.21] IETF RFC 3265: "Session Initiation Protocol (SIP)-Specific Event Notification".

[i.22] ETSI TS 122 173: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; IP Multimedia Core Network Subsystem (IMS) Multimedia Telephony Service and supplementary services; Stage 1 (3GPP TS 22.173)".

[i.23] Additional Data related to an Emergency Call draft-ietf-ecrit-additional-data-20.

NOTE: Available at http://datatracker.ietf.org/doc/draft-ietf-ecrit-additional-data/.

[i.24] ETSI TS 127 007: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; AT command set for User Equipment (UE) (3GPP TS 27.007)".

[i.25] ETSI TS 125 331: "Universal Mobile Telecommunications System (UMTS); Radio Resource Control (RRC); Protocol specification (3GPP TS 25.331)".

[i.26] ETSI TS 123 272: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Circuit Switched (CS) fallback in Evolved Packet System (EPS); Stage 2 (3GPP TS 23.272)".

[i.27] ETSI TS 126 114: "Universal Mobile Telecommunications System (UMTS); LTE; IP Multimedia Subsystem (IMS); Multimedia telephony; Media handling and interaction (3GPP TS 26.114)".

[i.28] ETSI TS 123 401: "Universal Mobile Telecommunications System (UMTS); General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access (3GPP TS 23.401)".

[i.29] ETSI TS 123 060: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); General Packet Radio Service (GPRS); Service description; Stage 2 (3GPP TS 23.060)".

[i.30] ETSI TS 123 228: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; IP Multimedia Subsystem (IMS); Stage 2 (3GPP TS 23.228)".

[i.31] ETSI TS 102 936-1: "eCall Network Access Device (NAD) conformance specification; Part 1: Protocol test specification".

[i.32] ISO 21217:2014: "Intelligent transport systems -- Communications access for land mobiles (CALM) -- Architecture".

[i.33] ETSI TS 126 073: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; ANSI C code for the Adaptive Multi Rate (AMR) speech codec (3GPP TS 26.073)".

[i.34] EN 16102: "Intelligent transport systems - eCall - Operating requirements for third party support".

[i.35] CEN TS 16405: "Intelligent transport systems - eCall - Additional data concept specification for heavy goods vehicles".

[i.36] Draft-jesske-ecrit-ecall-urn-extension-00: "Uniform Resource Name (URN) extension for automatic and manual Emergency Services".

NOTE: Available at http://tools.ietf.org/html/draft-jesske-ecrit-ecall-urn-extension-00.

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

circuit switched emergency call: CS voice call type TS12 teleservice, that is applicable in CS (2G and 3G) networks

NOTE: This type is not applicable for PS based networks.

eCall: Pan European in-vehicle Emergency Call defined under the eSafety initiative of the European Commission

IMS eCall: eCall over IMS

NOTE: That there can be other packet based solutions.

IMS emergency call: IP based emergency call that is applicable for PS based 3G and 4G networks

In-band eCall: CS voice call where the MSD is sent in the same voice channel, using in-band modem

ITS-station: entity in a communication network capable of communicating with other similar entities

NOTE: This definition is based on ISO standards 21217.

The following definitions are copied from TS 124 008 [i.3]:

eCall-only: eCall-only mode, as described in TS 122 101

removal of eCall-only restriction: limitations as described in TS 122 101 for the eCall-only mode do not apply any more

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ACEM	Motorcycle Industry European Association
ACN	Automatic Crash Notification
ADR	Agreement on Dangerous goods by Road
AMR	Adaptive Multi Rate
ANSI	American National Standards Institute
ANSI-C	American National Standard Programming Language C
APN	Access Point Name
ASN	Abstract Syntax Notation
AT	Attention (command)
BSMD	Bounded Secured Managed Domain
CALM	Communications Access for Land Mobiles
CAN	Controller Area Network (vehicle bus)
CB	Call Barring
CDU	Command Definition Utility
CLI	Calling Line Identification
CM	Connection Management
CR	Change Request
CS	Circuit Switched
CSCF	Call Session Control Function
CSFB	Circuit Switched Fall Back
DJB	De-Jitter Buffer
ECRIT	Emergency Context Resolution with Internet Technologies
EPS	Evolved Packet Switch
ESM	EPS Session Management
ETSI TC MSG	ETSI Technical Committee MSG
FFS	For Further Study
FG	First Generation
GPRS	General Packet Radio Service
GPS	Global Positional System
HLAP	High Level Application Protocol
IANA	Internet Assigned Numbers Authority
ICB	Incoming Call Barring
IETF	Internet Engineering Task Force
IMS	IP Multimedia Subsystem
IP	Internet Protocol
ISIM	IP Multimedia Services Identity Module
ITS	Intelligent Transport System(s)
ITS-S	ITS Station
IVS	In-Vehicle System
LTE	Long Term Evolution
MGW	Media Gateway
MNO	Mobile Network Operator
MSD	Minimum Set of Data
MSRP	Message Session Relay Protocol
MT	Mobile Terminated
NAS	Non-Access Stratum
NG	Next Generation
OCB	Outgoing Call Barring
OMA	Open Mobile Alliance
OTT	Over The Top
PCM	Pulse Code Modulation
PDN	Packet Data Network
PE	Pan European
PLMN	Public Land Mobile Network
PS	Packet Switching
PSAP	Public Safety Answering Point
QoS	Quality of Service

RFC	Request for Comment
RTP	Real Time Protocol
RTSP	Real Time Streaming Protocol
SAP	Service Access Point
SDP	Session Description Protocol
SIB	System Broadcast Information
SIP	Session Initiation Protocol
SMS	Short Message Service
SS	System Simulator
STF	Special Task Force
TCP	Transmission Control Protocol
TPS eCall	Third Party Supported eCall (CEN)
TPS	Third Party Supported
UDP	User Datagram Protocol
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
URI	Uniform Resource Identifier
URN	Uniform Resource Name
USIM	Universal Subscriber Identity Module
UTRAN	Universal Terrestrial Radio Access Network
VoIP	Voice over IP
VoLTE	Voice over LTE
WAVE	Wireless Access in the Vehicular Environment
XML	Extended Markup Language

4 Introduction and General requirement

4.1 Context

Pan European eCall is an emergency call generated either automatically via activation of in-vehicle sensors or manually by the *vehicle occupants*; when activated, it provides notification and relevant location information to the most appropriate *Public Safety Answering Points* (PSAP), by means of *mobile wireless communications networks* and carries a defined standardized *minimum set of data*, notifying that there has been an incident that requires response from the emergency services and establishes an audio channel between the occupants of the vehicle and the *most appropriate PSAP*.

This European Commission initiative of eCall was conceived in the late 1990s, and has evolved to a European Parliament decision requiring the implementation of In-vehicle system in new vehicles and the deployment of eCall in the European Member States in 2015.

Automotive manufacturers, and to a lesser extent aftermarket system providers have, in conjunction with PSAPs and MNOs, been working towards the Standardization and introduction of eCall for a decade. Although legally implementation will not be required until 2015, it takes several years of work in advance to build changes into automotive type acceptance tests and to introduce in-vehicle system into new models. Further, several automotive manufacturers already have private third party 'emergency call' support which they have had to amend to be consistent with and compliant with eCall. There is therefore already significant commitment and investment already made into the introduction of the system.

The Standardization aspects, both at the telecommunications level and at the application level were defined and standardized in the period 2002 - 2012 and the communications aspects are based on CS emergency call in GSM and UMTS networks.

The telecommunications sector, which always evolves rapidly, has made particular advances in the past decade. While the period 2000 - 2012 saw the widespread deployment of UMTS networks, which continue to expand to cover most of the continent, the next generation of cellular mobile communications, LTE/4G has been standardized and is beginning to roll out across Europe. This has a particularly significant impact on eCall because, while GSM and UMTS are partly 'circuit switched' networks, LTE are 'packet switched' only networks, therefore there is no circuit switched emergency call in LTE.

The existing standardized solution for eCall identification procedures and protocols are determined using the circuit switching technologies considering the circuit switched 'Teleservice 12' for voice. Further, eCall, as currently defined, establishes a voice channel and sends data within the voice channel, whereas the normal modus operandi for a packet switched network is the obverse - transmitting packets of data.

The existing standards relevant to IMS eCall are the "IMS Emergency Service" and the "IMS Emergency Multimedia Service". Only comparatively small additions are necessary to specify IMS eCall based on existing (and already implemented and deployed) standards [i.8],[i.9]. The existing IMS Emergency Call standards provide a very good basis for routing eCalls to the most appropriate PSAP if new URN classes can be defined in IETF [i.10], [i.1] for sos.eCall-Automatic, sos.eCall-Manual and eCall-Test. The IETF ECRIT is currently working on drafts for eCall [i.1] and ACN [i.12], the latter which contains information about activities outside Europe.

4.2 General considerations for IMS eCall

IMS is a platform for emergency voice calls in LTE. General requirements for eCall over IMS are based on requirements for eCall over CS defined in TS 122 101 [i.2] and additional considerations for the support of IMS that are mainly:

NOTE: Some of these additional considerations are dependent on future CEN requirement changes.

- The voice component is based on VoIP and not TS12.
- The data to be carried over IP need not have limitations of max size of 140 bytes.
- Even though not required for eCall, it would be possible to have other media besides voice within eCall, between the IVS and the PSAP, as long as the required capabilities are supported by all involved parties (IVS, PSAP, MNO).
- eCall voice component and the Minimum Set of Data (MSD) are transported transparently and are subject to privacy considerations.
- The MSD and voice are sent to (or accessible by) the same PSAP-entity.
- An end-to-end receipt acknowledgement from the PSAP to the IVS is needed.
- In IMS eCall, there should be a network support indication for "IMS eCall" without first registering on a PLMN.
- In the future, IVSs need to support eCall for both CS and IMS to guarantee its connectivity across different networks and PSAP-implementations.
- There is no specific requirement to encrypt the MSD.

5 Non IMS solutions

5.1 In-band modem over VoIP

The eCall in-band modem is based on a pulse-position modulation scheme which requires proper time synchronization between the IVS and PSAP. Functions or systems that distort the timeline of the eCall signal by inserting or removing samples (e.g. sample slips, adaptive de-jitter buffering, and time-warping) can cause the sender and receiver to lose synchronization.

The eCall in-band modem employs a synchronization-tracker feature designed to compensate for occasional and small sample slips that occur in circuit-switched networks. This synchronization-tracker has also been shown to compensate for the occasional loss or insertion of voice frames caused by adaptive de-jitter buffering. The simulation results in Annex C illustrate how the performance of the in-band modem degrades when operating over a VoIP network with jitter. The results also demonstrate that, despite the degradation, the performance is still generally acceptable in conditions with modest amounts of jitter and when employing an adaptive de-jitter buffer that does not perform time-warping.

In commercial deployments, network equipment and devices can use more advanced de-jitter buffering techniques such as time-warping. This technique adapts to delayed or early-arriving packets by inserting or deleting sub-frame intervals into speech frames, spreading out the adaptation over multiple frames. This generally results in more frequent modifications to the timeline of the eCall signal which the synchronization tracker in an eCall modem cannot properly compensate for. Given the sensitivity of the in-band modem to time-warping that may be employed in commercial VoIP networks, the use of the eCall in-band modem is not recommended for operation over IMS. Besides dejitter problems, the other limitations of CS eCall would remain with this option such as only 140 octets MSD, loss of voice channel, and delay in establishing a voice path.

5.2 eCall over LTE with CS Fallback

CS Fallback enables fallback from LTE access to UTRAN/GERAN CS domain access. It is described in TS 123 272 [i.26] and available from Release 8. CS Fallback is only applicable for UEs that support also other services than eCall. Hence, while the UE is registered on LTE and eCall is triggered then CS Fallback may be performed.

NOTE: eCall-only UEs are expected to only use IMS eCall if the network is broadcasting an IMS eCall support indicator (see clause 6).

An eCall IVS connected to LTE may perform the CS Fallback (CSFB) procedures defined in LTE and UTRAN/GERAN. In this case eCall IVS will use in-band modem over the CS domain and connect to a PSAP that supports the in-band modem capability.

The only requirement here is that the IVS and the MNO support CS fallback capabilities. No IMS/IP based eCall is involved in this solution.

5.3 eCall over LTE using Over The Top services (OTT)

Over The Top services run over internet based networks. In this case IMS is not required, the in-band modem is not available, and no standardized mechanism exists to transmit the MSD. However, in general, OTT currently does not provide and guarantee emergency services that are compatible to legal and regulatory requirements.

There is no standardized solution available for emergency services over mobile networks using OTT. Also, OTT may not fulfil some of the existing eCall requirements, e.g. routing to the eCall PSAP. Further, the MNO has little control over OTT. Therefore OTT is not discussed further in the present document.

5.4 ITS-Stations

ITS is an emerging technology which may potentially be applicable for eCall and related services. This is an area for further study.

In the past, it was proposed that the eCall platform could be the basis of hosting many telematics services into vehicles, indeed it could provide the 'Trojan horse' to get telematics technology into vehicles. This is unlikely to be the case and it is far more probable, and practicable, that future generation eCall can be carried over modern, secure, high capacity ITS-station platforms evolving to support a wide range of services.

Such telematics platforms will be digital, and most probably internet linked, and so will be 'packet switched' systems where, instead of the current solution of data being carried in the voice channel, the reverse will apply and voice will be carried in the data packets.

Concurrently, at the same time that the eCall project has been developed using existing GSM/UMTS technologies, the ITS sector has been developing systems based on a common telematics platform enabling bidirectional communication between vehicles, and between vehicles and the infrastructure.

The overall concept is to separate applications from the communications medium/media being used to carry the data.

In some cases, these systems may rely simply on architectural system design combined with security provisions for the public media to transfer data to safe 'addresses', by design removing much of the communications risk involved, with the main application services being conducted and provided 'landside' between a service provider and another landside client.