



ECC Report **361**

Next Generation Emergency Communications – transition from circuit-switched to packet-switched networks, services and PSAPs

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0 EXECUTIVE SUMMARY

Every citizen has a fundamental right to access emergency services promptly, free of charge and without discrimination. These principles are enshrined in both European Union (EU) legislation and the national laws of CEPT member countries. Historically, dialling a specific emergency number to make a voice call has been the primary method for accessing emergency services but technology continues to evolve and these technological advancements have broadened the scope of emergency communications. The transition from circuit-switched to packet-switched technologies presents opportunities and challenges for public networks and Public Safety Answering Points (PSAPs), who must evolve to meet new regulatory requirements and end-user expectations for additional and appropriate means of access to emergency services for all citizens.

This Report outlines the transition from circuit-switched to packet-switched technologies for emergency communications in Europe, addressing the evolving landscape of electronic communications networks and services, the challenges and opportunities this transition presents, and the regulatory framework guiding it. The report also examines the existing and emerging means of accessing emergency services, the architecture and core components for network-independent access and provides case studies on implementation projects in various CEPT countries.

The document begins by discussing the current state of emergency communications, primarily based on circuit-switched voice calls, and the transitioning to packet-switched networks due to advancements in technology and regulatory requirements. This shift, which is advancing in public networks as legacy technologies like 2G and 3G are being phased out, is essential to ensure the continuity of access to emergency services through emergency communications. This transition is also necessary to meet evolving regulatory requirements, address end-user expectations, and ensure compatibility with modern communication devices.

Chapter 1 provides an overview of the emergency communications supply chain, highlighting the roles of different stakeholders, including public authorities, private companies, and PSAPs.

Chapter 2 defines key terms used throughout the Report.

Chapter 3 analyses the legal requirements governing emergency communications, including the European Electronic Communications Code (EECC), the European Accessibility Act (EAA), and other relevant regulations governing inter-alia access to emergency services through emergency communications (including eCall and NG-eCall) the establishment and provision of caller location information, routing of emergency communications to the most appropriate PSAP and equivalent access to emergency services for end-users with disabilities, including the use of relay services.

Chapter 4 provides an overview of the emergency communications supply chain in Europe and describes on the emergency communications handling systems differences as they are adapted to the answering and handling of emergency communications in different CEPT countries to suit national circumstances.

Chapter 5 explores existing and emerging means of access to emergency services. For example, traditional methods such as voice calls and Short Message Service (SMS), and emerging methods such as real-time text (RTT) and Total Conversation. This chapter also explores the opportunities and challenges presented by the transition to packet-switched technologies and the implications for emergency communications during and after the transition to new technological means of access.

Chapter 6 explains the architecture and core components for network-independent access to emergency services through emergency communications as described in ETSI TS 103 479 [18]. This specification provides a blueprint for network-independent access for emergency communications thereby providing the capability to provide continuity of emergency communications during the transition to packet-switched technologies while legacy elements remain in the device, public network or PSAP domains.

Chapter 7 makes some observations and draws conclusions with aim of providing guidance to CEPT countries on the process of transitioning to packet-switched emergency communications, ensuring that emergency services remain reliable, accessible, and effective in a rapidly evolving technological landscape.

Annex 1 provides information on the different national models for handling emergency communications.

Annex 2 provides information on country case studies on transitioning to packet-switched technologies for emergency communications. Case studies from countries like Portugal, Romania and Canada detailing their approach to upgrading PSAP infrastructures and transitioning to packet-switched technologies are described.

Hereunder is a summary of the important observations made and conclusions drawn in this report in relation to the transition of emergency communications from circuit-switched to packet-switched environment:

- A key consideration in the transition to packet-switched emergency communications is to ensure the continuity of existing legacy means of access to emergency services until all public networks and PSAPs become fully IP-enabled;
- ETSI TS 103 479 [18] provides a network-independent architecture and core components to support the simultaneous handling of circuit-switched and packet-switched emergency communications as long as there are legacy elements in the end-user (i.e. in end-user devices), network or PSAP domains;
- By itself, the transition to packet-switched emergency communications, including the use of SIP, does not enhance location accuracy in fixed networks where the physical address of the network termination point is already available to PSAPs. However, in cases where third-party databases are not consistently updated, or the representation of the data is not consistent, there may be potential inaccuracies. SIP allows the originating service provider to insert the subscriber's location directly from its own records, improving data integrity. While some countries have stringent regimes ensuring accurate and timely updates to these databases, in scenarios where such updates are less reliable, direct insertion by the originating service provider via SIP may offer a more reliable alternative;
- The transition to packet-switched technologies will enhance access to emergency services, particularly for end-users with disabilities, by supporting various communication methods like Real-Time Text (RTT) and Total Conversation in addition to voice, thereby aligning with the requirements of the European Accessibility Act (EAA);
- It is also important to note, that a RTT or Total Conversation emergency communications will inherit the caller location information available for the emergency voice call without the need to define or develop specific procedures for that, thereby ensuring that the functional equivalence requirements related to location establishment and provision are met;
- The transition to packet-switched emergency communications requires substantial upgrades to existing PSAP infrastructures, including both hardware and software, to handle the increased data flow and multimedia communication formats. CEPT countries will need to fund these upgrades and this represents a significant cost;
- The transition to packet-switched emergency communications requires upgrades in public networks for PSAPs' connections and call handling;
- Cybersecurity is paramount in the transition to packet-switched technologies. The integration of Internet Protocol (IP)-based systems increases vulnerabilities to cyber threats, highlighting the need for robust security measures to protect sensitive emergency communications data and to safeguard the resilience of the emergency communications infrastructure;
- Ensuring compatibility and interoperability between different national systems and across various communication technologies remains a critical challenge, impacting the continuity of cross-border emergency communications. These challenges need to be overcome through cooperation, collaboration and rigorous testing involving handset providers, network equipment vendors, electronic communications network/service providers, PSAP solutions providers and PSAPs;
- It will allow new means of accessing emergency services through emergency communications and thus some public education campaigns to inform citizens and raise awareness may be needed.

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LIST OF ABBREVIATIONS

Abbreviation	Explanation
AML	Advanced Mobile Location
BCF	Border Control Function
BEREC	Body of European Regulators for Electronic Communications
CA	Competent Authority
CEN	European Committee for Standardization
CEPT	European Conference of Postal and Telecommunications Administrations
CJEU	Court of Justice of the European Union
CS	Circuit-switched
EAA	European Accessibility Act
ECC	Electronic Communications Committee
ECN	Electronic Communications Network
ECRF	Emergency Call Routing Function
ECS	Electronic Communications Service
EEA	European Economic Area
EECC	European Electronic Communications Code
EENA	The European Emergency Number Association
ESRP	Emergency Services Routing Proxy
ETSI	European Telecommunications Standards Institute
EU	European Union
HELD	HTTP-Enabled Location Delivery protocol
IAS	Internet Access Services
IP	Internet Protocol
IMS	IP Multimedia Subsystem
ILEC	Incumbent Local Exchange Carrier (i.e. in Canada)
ISDN	Integrated Services Digital Network
IVS	in-vehicle system
LIS	Location Information Service
LNG	Legacy Network Gateway
LoST	Location-to-Service-Translation

Abbreviation	Explanation
MLP	Mobile Location Protocol
MNO	Mobile Network Operator
MSC	Mobile Switching Center
MSD	Minimum Set of Data
NRA	National Regulation Authority
NG-eCall	Next-Generation eCall
NTP	Network Termination Point
OS	Operating System
PIDF-LO	Presence Information Data Format – Location Object
PSAP	Public Safety Answering Point
PS	Packet-switched
RTT	Real-Time Text
SIM	Subscriber Identity Module
SIP	Session Initiation Protocol
SMS	Short Message Service
TDM	Time-Division Multiplexing
TS	Technical Specification
TTY	Fax and Teletype
USD	Universal Service Directive ¹
VoLTE	Voice over Long-Term Evolution

¹ Directive 2002/22, as amended by Directive 2009/136

1 INTRODUCTION

Every citizen has a fundamental right to access emergency services promptly, free of charge and without discrimination. These principles are enshrined in both European Union (EU) legislation and the national laws of CEPT member countries. Access to emergency services, through emergency communications, must be adaptable to various needs and capabilities. It must enable clear communications between the end-user and the Public Safety Answering Point (PSAP) so that the right emergency services resources can be dispatched in a swift and timely manner to the right location in the shortest possible amount of time to facilitate effective emergency intervention.

Historically, dialling a specific emergency number to make a voice call has been the primary method for accessing emergency services but technology continues to evolve and these technological advancements have broadened the scope of emergency communications. In anticipation of these developments, the European Electronic Communications Code (EECC) [1] therefore moves beyond the traditional term "emergency calls" by using the more expansive term "emergency communications", which encompass a broader range of communications media including voice, Short Message Service (SMS), messaging, video, and other forms of communication like RTT, Total Conversation, and relay services. This shift in policy acknowledges the wide variety of technologies that can be used to enable access to emergency services.

ECC Report 265 [2] observed that growing demand for innovative services and increased capacity has made traditional circuit-switched communication technologies obsolete, ushering in an era dominated by packet-switched, Internet Protocol (IP) networks with an IP Multimedia Subsystem (IMS) architecture providing the platform for supporting multimedia communications across both fixed and mobile networks.

The transition from circuit-switched to packet-switched technologies presents opportunities and challenges for public networks and PSAPs, who must evolve to meet new regulatory requirements and end-user expectations for additional and appropriate means of access to emergency services. One of the main opportunities is that the adoption of packet-switched technologies allows for a wider range of devices to access emergency services, through emergency communications, while facilitating the transmission of vital contextual information to PSAPs. One main challenge is to be able to ensure continuity of access to emergency services throughout the transition process. This means being able to handle emergency communications originating on both circuit-switched and packet-switched networks simultaneously as long as there are legacy elements in the end-user (i.e. end user devices), network or PSAP domains.

The migration to packet-switched technologies, including the introduction of SIP PIDF-LO, will allow the transmission of richer contextual information, improving caller location accuracy and enabling more reliable routing of emergency communications from OTT providers. While the organisation of emergency services remains a national competence, these technological upgrades can support call routing to the most appropriate PSAP across countries.

To address these opportunities and challenges, ETSI has developed a technical specification (ETSI TS 103 479) [18] describing an architecture and core components for network-independent access to emergency services through emergency communications. It is designed to ensure that end-users can reach emergency services regardless of the network infrastructure in place. Several CEPT countries have, or are, implementing the projects for transitioning to next generation emergency communications in accordance with this technical specification.

It should be noted that the transition to all-IP emergency communications is not optional. Technological developments and regulatory requirements make it a necessity. Requirements set out in the EECC, its supplementing Delegated Regulation (EU) 2023/444 [9], the European Accessibility Act (EAA) [6] and recent amendments to the eCall regulatory framework are now providing the catalyst for transitioning PSAP infrastructure across Europe to be able to handle multimedia emergency communications based on IP technologies. Implementation dates between June 2025 and June 2027 are specified in these regulatory requirements.

Target Date	Requirements	Regulatory instrument
28 June 2025	All services shall comply with the accessibility requirements, including availability of RTT and Total Conversation if video is provided, in emergency communications	EAA
1 January 2026	PSAPs must be compliant with this regulation - establishing the specifications for the upgrading of the PSAP infrastructure required for the proper receipt and handling of NG-eCalls, in order to ensure the compatibility, interoperability and continuity of the harmonised EU-wide eCall service	Delegated Regulation (EU) 2024/1084
	Vehicles, systems, components or separate technical units must be compliant with this regulation requiring all new types of vehicles of categories M ₁ and N ₁ to be equipped with a 112-based eCall in-vehicle system	Delegated Regulation (EU) 2024/1180
1 January 2027	In the case of new vehicles approved after 31 March 2018 in accordance with Regulation (EU) 2015/758 which do not comply with the technical specifications set out in CEN/TS 17184:2022 and CEN/TS 17240:2018, national authorities shall consider the certificates of conformity to be no longer valid for the purposes of Article 48(1) of Regulation (EU) 2018/858.	Delegated Regulation (EU) 2024/1180
28 June 2027	PSAP must be compliant specific accessibility requirements, including availability of RTT and Total Conversation if video is provided	EAA

The transition to packet-switched technologies has already commenced with some CEPT countries having already completed the transition. Some countries have implementation projects ongoing while others are at the planning stage.

The purpose of this report is to:

- Describe the evolving landscape for electronic communications networks and services and the opportunities and challenges for providing continuity of access to emergency services through emergency communications;
- Provide a general description of the emergency communications supply chain;
- Set out the regulatory framework for emergency communications and how it applies in a packet-switch environment;
- Examine the existing and emerging means of access to emergency services, through emergency communications;
- Describe the architecture and core components for network-independent access to emergency services through emergency communications as described in ETSI TS 103 479 and their applicability to the organisation of emergency communications handling systems in CEPT countries;
- Describe the different approaches for the organisation of emergency handling systems that exist in the different CEPT countries;
- Explore case studies on planned and ongoing implementation projects to support emergency communications in a packet-switched environment in Europe and beyond.

Finally, the report will make some observations for emergency communication transition from a circuit-switched to a packet-switched environment and also make some observations and draw some conclusions on the applicability of next generation emergency communications across the different stakeholders with a specific focus on the PSAP infrastructure in Europe.

2 DEFINITIONS

In the table below, some definitions are provided directly from other sources (e.g. European legislation, ETSI deliverables etc). Other definitions have been formulated from multiple sources solely for the context of this ECC Report.

Term	Definition
Caller location information	Means, in a public mobile network, the data processed, derived from network infrastructure or handsets, indicating the geographic position of an end-user's mobile terminal equipment, and, in a public fixed network, the data about the physical address of the network termination point - EECC Article 2(40)
Effective Emergency Communication	Means emergency communication as defined in EECC Article 2(38) that ensures: <ul style="list-style-type: none"> a) timely communication between the end-user and the most appropriate PSAP, and b) the making available in a timely manner of contextual information, including caller location information. – Delegated Regulation (EU)2023/444 Article 2(1)
Emergency Communication	Means communication by means of interpersonal communications services between an end-user and the PSAP with the goal to request and receive emergency relief from emergency services – EECC Article 2(38)
Emergency Service	Means a service, recognised as such by the Member State, that provides immediate and rapid assistance in situations where there is, in particular, a direct risk to life or limb, to individual or public health or safety, to private or public property, or to the environment, in accordance with national law – EECC Article 2(39)
Emergency Number	Means a telephone number, typically a 3-digit short code, designated for the purpose of calling the emergency services, such as police, fire or ambulance. As specified in ECC Decision (17)05 [16], 112 is the harmonised number for accessing emergency services in Europe. Moreover, the EECC recognises 112 as the single European emergency number in addition to any other national emergency number specified by an EU Member State. The term "emergency number" in this document as an inclusive term that encompasses both pan-European '112' and any emergency numbers established at national level by CEPT countries
Most appropriate PSAP	Means a PSAP established by responsible authorities to cover emergency communications from a certain area or for emergency communications of a certain type – EECC Article 2(37)
Network-independent access	Refers to the capability of handling emergency communications across various network technologies. This ensures interoperability and seamless access to emergency services, through emergency communication, from any network type, facilitating reliable and efficient emergency response regardless of the originating network infrastructure
Public Safety Answering Point (PSAP)	Means a physical location where an emergency communication is first received under the responsibility of a public authority or a private organisation recognised by the Member State - EECC Article 2(36)
Contextual Information	The information conveyed through an emergency communication by the end-user or derived and transmitted automatically from the device of the end-user or the relevant network in order to enable the timely identification of the intervention resources of the emergency services and the fast arrival of the emergency services at the intervention scene. – Delegated Regulation (EU) 2023/444 Article 2
Total Conversation	Means a multimedia real time conversation service that provides bidirectional symmetric real time transfer of motion video, real time text and voice between users in two or more locations – EECC Article 2(35)

3 REGULATORY FRAMEWORK

The relevant aspects of the European legislation and case law related to the topic are described in detail further in this section.

Technological developments have opened up new possibilities for emergency communications and these developments have been reflected also on a legislative level, e.g. in EU regulatory frameworks.

At EU level, Article 109 of the EEC Directive provides the conceptual framework for emergency communications covering several distinct aspects in a form of legal obligations including new and also long-standing requirements:

- Free of charge access to emergency services through emergency communications - EEC Directive Article 109(1-3);
- The establishment and provision of caller location information – EEC Directive Article 109(6);
- Equivalent access to emergency services for end-users with disabilities – EEC Directive Article 109(5);
- Routing of emergency communications to the most appropriate PSAP – EEC Directive Article 109(2);
- Continuous access to emergency services while roaming in the EU – EEC Directive Article 109(8).

Article 109 paragraph 8 places an obligation on the European Commission to adopt delegated acts to ensure effective access to emergency services through emergency communications to the single European emergency number '112' in the Member States that supplement paragraphs 2 (routing to the most appropriate PSAP), 5 (equivalent access for end-users with disabilities) and 6 (establishment and provision of caller location information). This is to ensure the compatibility, interoperability, quality, reliability and continuity of emergency communications in the Union. The European Commission (EC) must consult BEREC before the adoption of any such acts. The first such delegated act (Delegated Regulation (EU) 2023/444 [9]) was adopted on 16 December 2022 and published on 2 March 2023 in the Official Journal of the European Union.

3.1 ACCESS TO EMERGENCY SERVICES THROUGH EMERGENCY COMMUNICATIONS

Access to emergency services was first introduced in EU legislation through a Council Decision [3] mandating the introduction of the single European emergency call number '112' in the EU. This was followed up in 2002 with the entry into force of the original Universal Service Directive (USD) [4] and amended in 2009 [5]. This Directive recognised the importance of access to emergency services and extended the scope of EU law to ensure that all end-users, including end-users with disabilities, have access to emergency services.

The entry into force of the EEC Directive in 2018 recognised the technological developments that have made it possible for end-users to access emergency services through a wider range of interpersonal communications services other than through traditional voice calls. The concept of "*emergency communications*" is defined in Article 2 of the EEC Directive as a "*means of interpersonal communications with the goal to request and receive emergency relief from emergency services*". EEC Directive Recital 285 further describes, that the form of an emergency communications can be taken as "means of communication, that include not only voice communications but also SMS, messaging, video or other types of communications, for example RTT, total conversation and relay services".

The legal requirement to provide access to emergency services through emergency communications applies to all providers of number-based interpersonal communication services that allow end-users to originate calls to a number in a national or international numbering plan. Although not explicitly required in EU regulatory frameworks, emergency communications may be provided also through emergency applications that enable number-independent interpersonal communication with the PSAP and the provision of end-user data, including caller location, and which rely on Internet Access Services (IAS).

The legal requirement to ensure access to emergency services through emergency communications applies to EU/EEA Member States, in various forms of legal obligations.

This includes, that EU/EEA Member States shall ensure that end-users are adequately informed about the existence and the use of the single European emergency number '112', as well as its accessibility features.

Also EU/EEA Member States in the manner best suited to the national organisation of emergency systems shall establish a national emergency communication handling system, that ensures that all emergency communications to the single European emergency number '112' are appropriately answered and handled.

Under the umbrella of the concept of creating an effective pan-European emergency communication handling system it is essential, that the national PSAPs are enabled to communicate with each other. In this respect, there is a need for a database of E.164 numbers of EU/EEA Member State emergency services, in order to ensure that they are able to contact each other from one EU/EEA Member State to another. As a first step a legal obligation to maintain such a database² was created to harmonise the national efforts.

3.2 ESTABLISHMENT AND PROVISION OF EMERGENCY CALLER LOCATION INFORMATION

The amendment to the USD of 2009 required caller location information to be provided with emergency calls. At the time it was envisaged that location information would be provided by the network. However, further technological developments provided for vast improvements in the accuracy and reliability of caller location information which can now be retrieved from certain handset models, such as smartphones, as well as from the network.

3.2.1 Commission Delegated Regulation (EU) 2019/320

The provisions of the EECC relating to the establishment and provision of caller location information are complemented by a European Commission Delegated Regulation supplementing the Radio Equipment Directive [7] which requires that all smartphones available for sale on the European market must be capable of providing handset emergency caller location information.

3.2.2 Judgement of the Court of Justice of the European Union

The provision of accurate and reliable caller location information is also supplemented by case law, namely, the Judgement of the Court of Justice of the European Union (CJEU) in Case C-417/18 [10].

The CJEU judgement stated that Article 26(5) of the USD, "...must be interpreted as requiring the Member States, subject to technical feasibility, to ensure that the undertakings concerned make caller location information available free of charge to the authority handling emergency calls to the single European emergency call number '112' as soon as the call reaches that authority, including in cases where the call is made from a mobile telephone which is not fitted with a SIM card".

The CJEU also stated, that Article 26(5) of USD, "...must be interpreted as conferring on the Member States a measure of discretion when laying down the criteria relating to the accuracy and reliability of the information on the location of the caller to the single European emergency call number '112'; however, the criteria which they lay down must ensure, within the limits of technical feasibility, that the caller's position is located as reliably and accurately as is necessary to enable the emergency services usefully to come to the caller's assistance...".

3.2.3 European Electronic Communications Code

According to the EECC, EU/EEA Member States shall ensure that caller location information is made available to the most appropriate PSAP without delay after the emergency communication is set up. This obligation not only includes network-based location information, but also, where available, handset-derived caller location information.

With regard to all emergency communications to '112' the establishment and the transmission of the caller location information are free of charge for the end-user and the PSAP as well. EU/EEA Member States may extend that obligation to cover emergency communications to national emergency numbers, according to EECC Article 109(6).

² The European Communications Office (ECO) is at present maintaining this database (PSAP Directory).

Furthermore, Competent Authorities (CAs) are obliged to lay down criteria for the accuracy and reliability of this caller location information.

3.2.4 Commission Delegated Regulation (EU) 2023/444

In order to foster and ensure effective access to emergency services through emergency communications to '112' the Commission adopted the first Delegated Regulation ((EU) 2023/444) [9], complementing the EECC, on the measures necessary to ensure the compatibility, interoperability, quality, reliability and continuity of emergency communications in the EU with regard to caller location information solutions, access for end-users with disabilities and routing to the most appropriate PSAP.

As regards caller location information the Delegated Regulation ((EU) 2023/444) establishes principles for CAs in order to lay down criteria for the accuracy and reliability of caller location information.

CAs within the limits of technical feasibility shall ensure that the end-user's position is located as reliably and accurately as is necessary to enable the emergency services to come to the end-user's assistance.

With respect to the fixed networks:

- The accuracy criterion for caller location information shall be expressed as information related to the physical address of the network termination point;
- The reliability criterion for caller location information shall be expressed as the success rate, in percentage, of the technical solution or mix of technical solutions to establish and transmit to the most appropriate PSAP a caller location information corresponding to the accuracy criterion.

With respect to the mobile networks:

- The accuracy criterion for caller location information shall be expressed in metres. If applicable, the elevation or vertical accuracy criterion shall be expressed in metres as well;
- The reliability criterion for caller location information shall be expressed as the success rate, in percentage, of the technical solution or mix of technical solutions to establish and transmit to the most appropriate PSAP a search area corresponding to the accuracy criterion.

As regards routing, the Delegated Regulation ((EU) 2023/444) requires EU/EEA Member States to ensure that emergency communications and caller location information are routed without delay to the most appropriate PSAP that is technically capable to convey the contextual information to the emergency services when alerting those services.

3.3 EQUIVALENT ACCESS TO EMERGENCY SERVICES FOR END-USERS WITH DISABILITIES

The EECC also requires EU/EEA Member States to ensure that access by end-users with disabilities to emergency services is available through emergency communications, including when travelling within the EU and that such access is equivalent to that enjoyed by other end-users. The requirement of equivalence was first mandated in the amendment to the USD 2009 when access to emergency services was only mandated through calls to '112', a two-way voice communication. Therefore, meeting the requirement of functional equivalence of a means of access to emergency services through emergency communications may be assessed by comparing and contrasting it to the effectiveness of a voice call to '112'. Those means of access could include a RTT service or Total Conversation service as provided for by the EAA [6] or other non-voice communications services, such as fax, SMS, messaging or video services through emergency applications, or relay services, which EU/EEA Member States deploy taking into account the requirements laid down in Union law and the capabilities of national PSAPs to receive and process such communications. Therefore, when assessing equivalence, the legal and functional requirements explained above for the calls to '112' have to be met in order for a means of emergency communications to be considered equivalent with regards a specific type of disability.

When implementing means of access to emergency services through emergency communications for end-users with disabilities, Article 4 of the Delegated Regulation ((EU) 2023/444) sets out specific functional equivalence requirements that must be met to ensure that, subject to technical feasibility, the following functional equivalence requirements are met:

- The emergency communication enables two-way interactive communication between the end-user with disabilities and the PSAP;
- The emergency communication is available in a seamless way, without pre-registration, to end-users with disabilities travelling in another EU/EEA Member State;
- The emergency communication is provided to end-users with disabilities free of charge;
- The emergency communication is routed without delay to the most appropriate PSAP that is qualified and equipped to appropriately answer and process the emergency communication from end-users with disabilities;
- Equivalent levels of accuracy and reliability of caller location information are ensured for the emergency communication for end-users with disabilities as for emergency calls by other end-users.

The EAA is an EU legal instrument, that requires products and services, including emergency services to be accessible for persons with disabilities by harmonising the accessibility requirements.

EU/EEA Member States have **general** obligation to ensure that the answering of emergency communications to '112' by the most appropriate PSAP, complies with *all the accessibility requirements* set out in the EAA, in the manner best suited to the national organisation of emergency systems.

As regards emergency services **additional** accessibility requirements are defined in order to maximise the use of them by persons with disabilities, by including functions, practices, policies and procedures and alterations in the operation of the service targeted to address the needs of persons with disabilities and ensure interoperability with assistive technologies:

- Electronic communications services, including emergency communications referred to in EECC Article 109(2):
 - Providing real time text in addition to voice communication;
 - Providing total conversation where video is provided in addition to voice communication;
 - Ensuring that emergency communications using voice, text (including real time text) is synchronised and where video is provided is also synchronised as total conversation and is transmitted by the electronic communications service providers to the most appropriate PSAP.

As regards emergency services EAA also defines **specific** accessibility requirements related to the answering of emergency communications to '112' by the most appropriate PSAP as follows:

- In order to maximise their foreseeable use by persons with disabilities, the answering of emergency communications to the single European emergency number '112' by the most appropriate PSAP, shall be achieved by including functions, practices, policies and procedures and alterations targeted to address the needs of persons with disabilities;
- Emergency communications to the single European emergency number '112' shall be appropriately answered, in the manner best suited to the national organisation of emergency systems, by the most appropriate PSAP using the same communication means as received, namely by using synchronised voice and text (including real time text), or, where video is provided, voice, text (including real time text) and video synchronised as total conversation.

In accordance with the EAA, voice synchronised with real time text and, where video is available, total conversation shall be deployed by electronic communication service providers by 28 June 2025. EU/EEA Member States will have to ensure that by 28 June 2027³ at the latest, the PSAP systems handle emergency communications based on real time text and, where video is available, total conversation to the single European emergency number '112'.

³ EU/EEA Member States have the option to defer, by way of derogation, the implementation of certain obligations specified in Article 4(8) of the European Accessibility Act until 28 June 2027, providing an additional two-year period beyond the standard deadline set for other measures under this Act. This includes the capability of PSAPs to be able to appropriately answer emergency communications to the single European emergency number '112', in the manner best suited to the national organisation of emergency systems using the same communication means as received, namely by using synchronised voice and text (including real time text), or, where video is provided, voice, text (including real time text) and video synchronised as total conversation.

3.4 eCall

eCall is a service designed for automotive vehicles to provide quick emergency response in case of a road accident or emergency, anywhere in the EU. Its aim is to advance European citizens' protection and safety and to reduce fatalities caused by road accidents as well as related injuries and property loss. In practice, an "eCall" is a 112 emergency call that can be generated either manually by a vehicle's occupants, by pressing a dedicated eCall button, or automatically, via activation of in-vehicle sensors when a road accident occurs. When activated, the eCall in-vehicle system establishes a voice connection towards the relevant PSAP [13].

According to Decision 585/2014/EU [11], EU/EEA Member States were required to deploy, by 1 October 2017, the necessary PSAP infrastructure to receive and handle eCalls. According to Regulation (EU) No 2015/758 [12], the fitting of the eCall in-vehicle system (IVS) is mandatory in all new types of M1⁴ and N1⁵ vehicles from 31 March 2018.

The current implementation of eCall is based on legacy circuit-switched technology which relies exclusively on the availability of 2G and 3G networks. As 2G and 3G networks are phased out to accommodate more advanced and efficient 4G and 5G services, significant challenges will arise in providing continuous support for the current eCall system.

In anticipation of this market-driven technological shift, the regulatory framework for eCall has been updated to ensure its compatibility with 4G and 5G network infrastructure⁶. Transitioning to eCall over IMS (or next-generation eCall (NG-eCall)) is essential to ensuring continuity of the lifesaving capabilities it provides.

Commission Delegated Regulation (EU) 2024/1084 [15] amends Delegated Regulation (EU) No 305/2013 supplementing Directive 2010/40/EU by establishing specifications for upgrading the PSAP infrastructure to enable the proper receipt and handling of eCalls originating on packet-switched networks to ensure compatibility, interoperability and continuity of the eCall service. The delegated regulations contain references to a suite of new technical specifications required to introduce NG-eCall in PSAPs (i.e. EN16072:2022; EN16062:2023; EN17184:2022; EN15722:2020; EN16454:2023 and CEN/TS 17240:2018). PSAPs must be able to properly receive and handle NG-eCall by 01 January 2026. PSAPs also must continue to properly receive and handle eCalls originating on legacy circuit-switched networks as long as there are circuit-switched public mobile wireless communications networks in operation on the territory of the EU/EEA Member States.

Commission Delegated Regulation (EU) 2024/1180 [19] amends Regulation (EU) 2015/758 by introducing references to a suite of new technical specifications required to introduce NG-eCall in in-vehicle systems (IVS) (i.e. CEN/TS 17184:2022 and CEN/TS 17240:2018). The Delegated Regulation sets out three key dates with regard to IVS:

- With effect from 1 January 2025, national authorities shall not refuse to grant new type approvals or extensions for existing approvals for vehicles, systems, components or separate technical units where those comply with the technical specifications set out in CEN/TS 17184:2022 and CEN/TS 17240:2018, if a manufacturer so requests;
- With effect from 1 January 2026, national authorities shall refuse to grant new type approvals or extensions for existing approvals for vehicles, systems, components or separate technical units, where those do not comply with Regulation (EU) 2015/758, as amended by this Regulation;
- With effect from 1 January 2027, in the case of new vehicles approved after 31 March 2018 in accordance with Regulation (EU) 2015/758, which do not comply with the technical specifications set out in CEN/TS 17184:2022 and CEN/TS 17240:2018, national authorities shall consider the certificates of conformity to be no longer valid for the purposes of Article 48(1) of Regulation 2018/858.

It should be noted that the implementation dates for NG-eCall align in practice with the implementation date for RTT and total conversation set out in the EAA.

⁴ Category M: used for the carriage of passengers. Category M1: no more than eight seats in addition to the driver seat (mainly, cars)

⁵ Category N: used for the carriage of goods (trucks); Category N1: having a maximum mass not exceeding 3.5 tonnes (7700 lb)

⁶ Although the regulatory framework has been updated, a related recommendation, EC Recommendation 2011/750/EU on support for an EU-wide eCall service in electronic communication networks for the transmission of in-vehicle emergency calls based on 112 ('eCalls'), has not been updated.

4 EMERGENCY COMMUNICATIONS SUPPLY CHAIN IN EUROPE

Access to emergency services through emergency communications enables the end-user to request and receive emergency relief from emergency services. End-users have the right to use electronic communications services to engage in an emergency communication with the most appropriate PSAP. The communication between the most appropriate PSAP and the emergency services, in case these are different entities, go beyond the concept of emergency communications. The organisation of emergency services is an exclusive national competence within each CEPT country. However, the PSAP systems should comply with the technical requirements that enable the implementation of the legal requirements listed in Chapter 3.

The number of PSAPs, and the way they are structured to operate, varies from one CEPT country to another and is organised to suit national circumstances. Some CEPT countries follow a centralised structure and have PSAPs handling emergency communications for the entire territory while others follow a decentralised structure with multiple PSAPs responsible for handling emergency communications within each region. Some CEPT countries have dedicated PSAPs to handle emergency communications to 112, while others rely on the PSAPs of one of the emergency services (e.g. Police, Fire and Rescue) to handle them. Moreover, some CEPT countries have a single emergency number, namely 112, that serves all types of emergencies, while others have additional national emergency numbers for certain specific emergency services such as Fire, Police, Ambulance or Coastguard. A simplified overview of the emergency communications supply chain is illustrated in Figure 1.

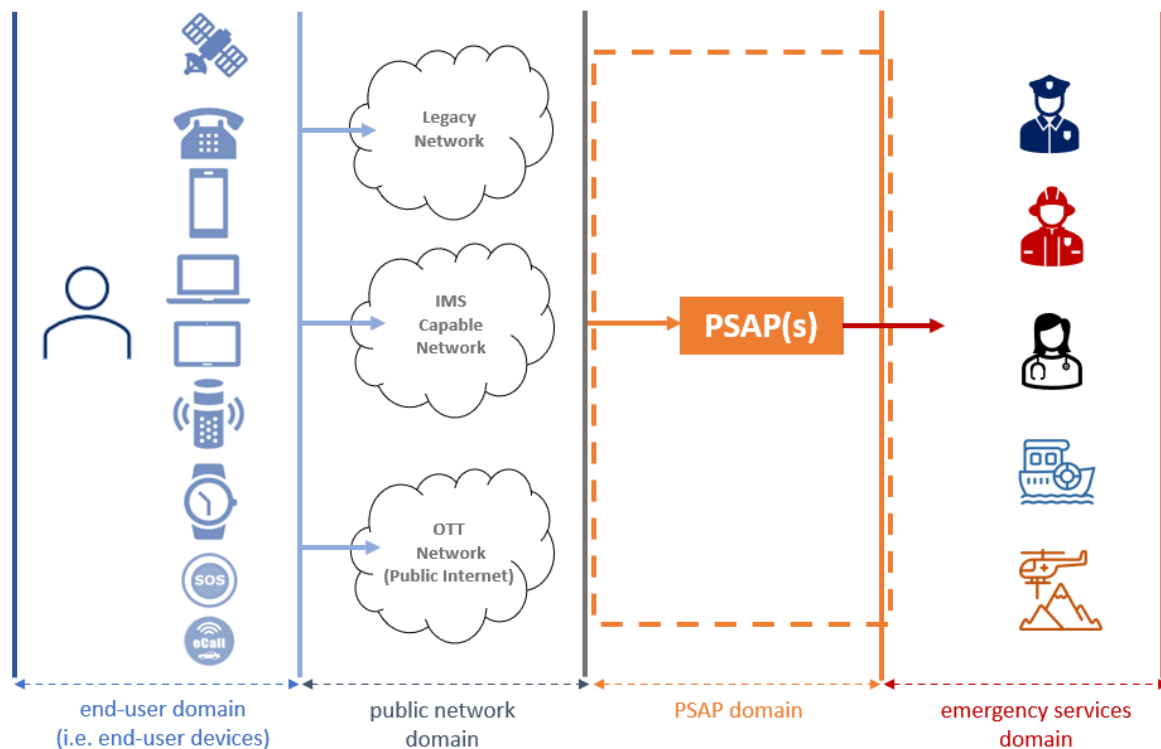


Figure 1: Overview - Emergency communications supply chain

Specific tasks are executed such as the reception of the emergency communication at the PSAP, the data collection (caller location, detailed data about the emergency situation and, if possible, call history data), the classification of the call and the dispatch of appropriate intervention resources. These tasks may be executed in several steps and by different organisations depending on the type or channel of emergency communication and the national structure of the emergency services.

The speed with which these tasks are executed depends on the speed of communication and availability of relevant information that optimise the operational tasks. The main differences between the models relate to the number of organisations involved in the chain, the types of organisations in charge of the first reception of emergency communications and the tasks they fulfil. Further information on the different centralised and decentralised emergency communications handling models is provided in Annex 1 and Annex 2.

5 EXISTING AND EMERGING MEANS OF ACCESS TO EMERGENCY SERVICES

In Europe, the means of access to emergency services, through emergency communications, are undergoing a significant transformation, from mainly traditional voice-based means or access to more advanced means that support multimedia. This chapter explores the existing and emerging means of emergency communications in Europe, discussing the challenges and opportunities presented by this shift to packet-switched technology.

5.1 EXISTING MEANS OF EMERGENCY COMMUNICATIONS

The most common means of emergency communication in Europe is still the traditional circuit-switched voice call to an emergency number. Access to emergency services via voice has been in place for many decades and the emergency numbers used are well-known to the public. However, there are some limitations to voice calls, such as not being able to support end-users who cannot, or have difficulty, communicating using voice or where discretion is necessary during the emergency communication and speaking could attract attention to the caller which may put them in danger.

In addition to voice calls, there are a number of other existing means of emergency communication that have emerged in the last 10-15 years:

These include:

- SMS: Originally introduced to provide a means of access for end-users who are deaf or hard of hearing to communicate with emergency call takers by text message;
- Fax and Teletype (TTY) Services: Were introduced also as a means of access for persons with certain disabilities. While these services are still available in some countries, they are gradually being phased out;
- Mobile apps: Many European countries now have mobile apps specifically designed for access to emergency services. The motivation for introducing such apps was:
 - To leverage the capabilities of smartphones (e.g. provision of handset-derived location information) as smartphone penetration increased rapidly;
 - To enable multimedia methods of communications (e.g. video);
 - As well as having a means for public authorities to send emergency alerts to citizens.
- Text and video relay services: A relay service involves a third party that can relay a request for emergency assistance to the PSAP. With text relay services, the end-user communicates with the third-party relay service using text and with the PSAP operator using voice. Today, video relay services are provided using mobile apps and are mainly used to support sign language. The end-user communicates with the third-party relay service over video and the message is relayed to the PSAP call taker using voice;
- eCall: eCall became a mandatory requirement in all new M1 and N1 passenger vehicles that went through type-approvals on or after 31 March 2018. eCall is essentially a circuit-switched voice call to 112 initiated automatically (or manually by pressing a button) and having the added benefit of transmitting a minimum set of data (MSD) to the PSAP in the same channel. The MSD includes important information such as location coordinates.

5.2 EMERGING MEANS OF EMERGENCY COMMUNICATIONS

The transition to packet-switched technology is opening up new possibilities for emergency communications in Europe. Some of the emerging means of emergency communication include:

- Packet-switched voice call: From the user perspective is a voice call. But a voice call established, based on IMS (e.g. 4G, 5G, fixed VoIP) allows the transfer of caller location information to the PSAP during the call. For example, in mobile networks, this allows the provision of handset-derived location information delivered to the PSAP in the signalling of the communication (PIDF-LO). This information could already be used today if AML is implemented;
- Real-time text (RTT): Allows people, especially who are deaf or hard of hearing, to communicate with emergency call takers in real time using text. RTT enabled in the operator's network also allows for text and voice to be synchronised in a single communication;

- Total Conversation: Is a multimedia communication service that allows people to communicate with emergency dispatchers using a combination of synchronised voice, text, and video;
- Next Generation eCall (NG-eCall): As 2G/3G mobile networks are phased out, eCall will need to continue to be supported on 4G/5G networks. NG-eCall is an evolution of the existing eCall system that works on 4G/5G networks. It is IMS-based and relies on the Session Initiation Protocol (SIP) for voice calls.

5.3 THE TRANSITION TO PACKET-SWITCHED EMERGENCY COMMUNICATIONS – OPPORTUNITIES AND CHALLENGES

Migrating to packet-switched emergency communications involves a transition from traditional circuit-switched networks to more versatile, IP-based networks. This shift offers significant opportunities but also presents notable challenges across the emergency communication supply chain.

Table 1: Opportunities and challenges in the end-user device domain

End-user device domain	
Opportunities	<ul style="list-style-type: none"> ▪ Packet-switched networks allow end-user devices to support multiple media types (voice, video and text) and to send a wide variety of contextual data. This can significantly improve the quality and quantity of information transmitted during emergencies. ▪ Modern devices facilitate more accessible emergency communications for people with disabilities, such as video calling or RTT for the deaf or hard-of-hearing community.
Challenges	<ul style="list-style-type: none"> ▪ Not all end-user devices may be compatible with packet-switched technologies. Older devices, in particular, might not support new protocols or features, requiring upgrades or replacements. This is particularly relevant in the context of 2G/3G shutdown. ▪ Packet-switched fixed line services, based on broadband connectivity, are heavily dependent on the availability of power and can become unreliable during emergencies, particularly in regions prone to extreme weather events.

Table 2: Opportunities and challenges in the public network domain

Public network domain	
Opportunities	<ul style="list-style-type: none"> ▪ Packet-switching enables more flexible and scalable networks, as it's easier to add or adjust services and bandwidth based on demand. ▪ Transitioning to IP-based networks can reduce operational costs and environmental impact by utilising common hardware and shared networks for multiple services, including emergency communications. ▪ Multi-media and contextual data handling capabilities of significant benefit to end-users and to PSAPs. ▪ The transition to packet-switched technologies presents an opportunity for the transmission of detailed location data, including handset-derived location, to the PSAP using SIP PIDF-LO [17] (Presence Information Data Format Location Object) for emergency communications originating on both fixed and mobile networks.
Challenges	<ul style="list-style-type: none"> ▪ IP-based networks are potentially more vulnerable to cyber-attacks, which can disrupt emergency communication services when they are most needed. ▪ Ensuring prioritisation for emergency communications over regular data traffic can be technically challenging, requiring sophisticated Quality of Service (QoS) mechanisms.

Public network domain	
	<ul style="list-style-type: none"> ▪ There is still work to be done to implement Voice over Long-Term Evolution (VoLTE), RTT and SIP Presence Information Data Format – Location Object (PIDF-LO) and to resolve associated device compatibility and network interoperability issues, particularly for roamers. ▪ Regulatory deadlines for the implementation of packet-switched services make deployment timeframes challenging.

Table 3: Opportunities and challenges in the PSAP domain

PSAP domain	
Opportunities	<ul style="list-style-type: none"> ▪ PSAPs can receive richer information (e.g. medical data sent from a caller’s device or video/photos from the scene) thereby better informing decision making and improving situational awareness. ▪ Packet-switched systems allow for the integration of various communication channels, such as voice, video, messaging, RTT, images into the emergency response framework. ▪ Packet-switched end to end leverage enhancements in caller location, in the establishment (e.g. using handset-based location) and in transmission (more reliable due to the possibility to use SIP standards).
Challenges	<ul style="list-style-type: none"> ▪ Many PSAPs need complete overhauls to support new technologies, which involves significant investment and potential service disruptions during the transition. ▪ The complexity of the new systems requires extensive training for call takers, which can be resource-intensive. ▪ Ensuring that emergency services are continuously available during the transition to new technologies is critical and challenging, especially given potential technical failures or cyber threats. ▪ Modern technology can have a negative impact on call takers well-being. For example, exposure to graphic video or photos from the scene. ▪ Upgrades required to facilitate RTT

Overall, while the migration to packet-switched emergency communications promises enhanced capabilities and potentially lower costs in the long term, it requires careful planning, significant investment, and robust security measures to mitigate the associated risks. The transition also highlights the need for ongoing adaptation of regulatory and operational frameworks to accommodate and facilitate the technological advances in emergency communications.

6 ARCHITECTURE AND CORE COMPONENTS FOR NETWORK-INDEPENDENT ACCESS TO EMERGENCY SERVICES

Transitioning PSAP systems to facilitate the receipt of packet-switched emergency communications is a critical and complex process that necessitates careful consideration of several key factors. This chapter will focus on three main considerations:

- The current organisation of call handling systems within each CEPT country and finding an approach that suits local circumstances;
- The need to maintain uninterrupted emergency communications during the transition process while legacy elements remain in end-user device, public networks and PSAPs;
- Finding and implementing an appropriate architecture to facilitate the abovementioned points.

These factors are essential to ensuring that enhancements to PSAP infrastructure lead to improved efficiency and reliability without compromising the quality of emergency communications and emergency response.

6.1 ORGANISATION OF EMERGENCY COMMUNICATIONS HANDLING SYSTEMS IN EUROPE

The organisation of emergency communications handling is determined independently by each CEPT country, leading to varied approaches across Europe. EENA published a document [14] identifying five distinct models for handling emergency communications, ranging from centralised to decentralised systems, as detailed in Annex 1.

For example, the UK, Ireland, Netherlands, and Finland employ a centralised model where all emergency calls are first routed to a primary PSAP that can filter non-emergency calls and redirect only genuine emergencies to a secondary PSAP for dispatch. This model maximises the efficient use of resources by ensuring that only true emergencies are forwarded. Conversely, countries like Germany, France, and Switzerland use a decentralised approach, routing emergency communications based on the caller's location or the nature of the emergency, facilitating faster local response times without the intermediary step required in centralised systems.

The choice between centralisation and decentralisation not only influences the efficiency and response times of emergency services but also impacts the financial and technological strategies for adopting packet-switched technologies. Centralised systems may consolidate technological upgrades at primary PSAPs, potentially reducing costs and improving operational efficiency. On the other hand, decentralised models might necessitate duplicated investments across numerous local PSAPs, raising issues with consistency and cost-effectiveness. The shift towards new technologies offers a chance to reassess and perhaps reorganise PSAP structures, considering the advantages and disadvantages of both approaches in the context of the best approach needed to suit national circumstances.

6.2 FACILITATING CONTINUITY OF SERVICE DURING THE MIGRATION TO PACKET-SWITCHED TECHNOLOGIES

Facilitating continuity of emergency communications during the migration to packet-switched technologies presents a complex challenge, particularly when legacy systems and new infrastructure must coexist and function seamlessly. As upgrades are implemented across end-user devices, public network elements, and PSAPs, maintaining continuity and uninterrupted service is paramount. Strategies must be developed to ensure that legacy devices can still communicate even as newer, packet-capable technologies are phased in. Public networks and PSAPs must be equipped to handle emergency communications across circuit-switched and packet-switched platforms without degradation of service. This necessitates not only robust technical solutions but also comprehensive training for call takers to manage the transitional environment effectively.

6.3 ETSI TS 103 479 – ARCHITECTURE AND CORE COMPONENTS FOR NETWORK-INDEPENDENT ACCESS TO EMERGENCY SERVICES

ETSI TS 103 479 defines an architecture and core components for PSAPs in packet-switched environment and interworking with packet-based public electronic communication networks. The evolution of this standard

can be traced back to the early discussions about Next Generation 112 (NG112) in Europe, mirroring similar developments in the United States with Next Generation 911 (NG911). These initiatives sought to create a more integrated and technology-neutral emergency communication system that could handle voice, text, and data sent from various types of devices and networks. ETSI TS 103 479 [18] specifically addresses the need for an architecture that can operate independently of the underlying network technology, thereby enabling access to emergency services across different networks and platforms simultaneously. This includes fixed networks, mobile networks, satellite networks and the Internet.

Figure 2 provides an illustration of this architecture. and the core components are described below.

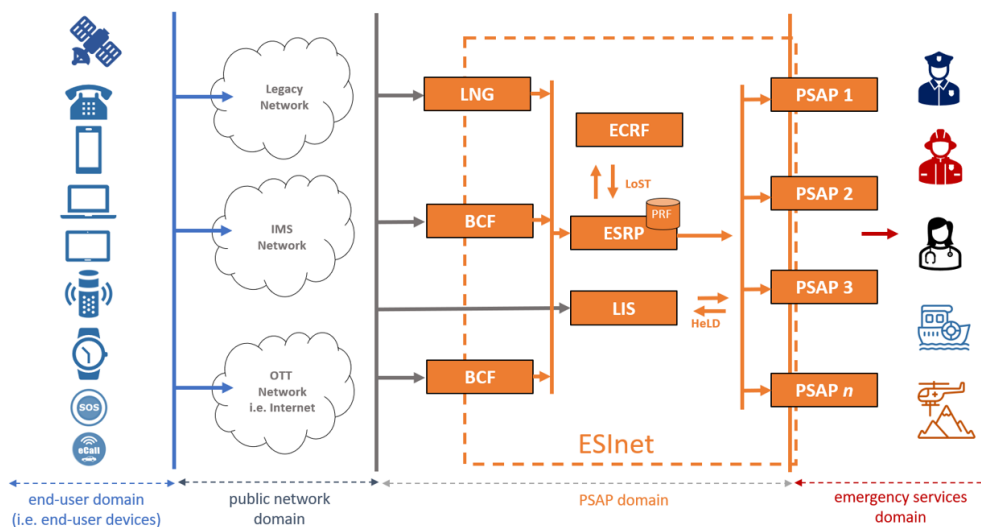


Figure 2: Architecture and core elements for network-independent access to emergency services (compiled from description contained in TS 103 479 [18])

In the PSAP domains the following core elements are identified:

- ESInet - is according to ETSI a dedicated IP network specifically designed for the PSAP domain to securely connect individuals in emergency situations;
- **Border Control Function (BCF)** – The point of interconnect between the public network and the ESInet. It provides a firewall and additional security layer for protecting the other core components. Emergency communications received at the BCF are forwarded to the ESRP;
- **Emergency Services Routing Proxy (ESRP)** – With its policy routing functionality (PRF), the ESRP provides dynamic routing capabilities. Multiple rules can be evaluated in order to determine the most appropriate PSAP or the next “hop” *en route* to the most appropriate PSAP. The ESRP interacts with the ECRF and the LIS;
- **Emergency Call Routing Function (ECRF)** – The ECRF is queried by the ESRP for information on which PSAP is responsible for a specific service type (e.g. police, fire or ambulance) at the caller’s specific location. This query is performed using the Location-to-Service-Translation (LoST) protocol;
- **Location Information Service (LIS)** – The LIS provides location information for a specific entity (e.g. an end-user’s phone) using the HTTP-Enabled Location Delivery protocol (HeLD);
- **Legacy Network Gateway (LNG)** – A key component during migration, the LNG provides the interface between legacy circuit-switched networks and the ESInet.

As CEPT countries transition to packet-switched technologies for emergency communications, ETSI TS 103 479 has emerged as the blueprint for ensuring that regulatory requirements can be met and continuity of service maintained. Across Europe, CEPT countries are implementing solutions based on ETSI TS 103 479 to ensure that emergency communication systems are not only interoperable but also adaptable to future advancements in technology. Some case studies are provided in Annex 2.

Annex 2 gives an overview of implementation of next generation emergency communication plans and projects in some countries.

7 OBSERVATIONS AND CONCLUSIONS – EMERGENCY COMMUNICATION TRANSITION FROM CS TO PS ENVIRONMENT

Hereunder is a summary of important observations made and conclusions drawn in this report in relation to the transition of emergency communications from circuit-switched to packet-switched environment:

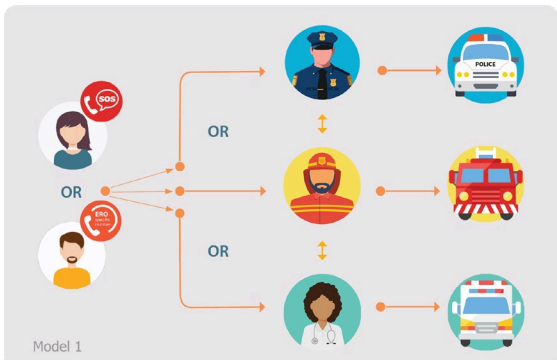
- A key consideration in the transition to packet-switched emergency communications is to ensure the continuity of existing legacy means of access to emergency services until all public networks and PSAPs become fully IP-enabled;
- ETSI TS 103 479 [18] provides a network-independent architecture and core components to support the simultaneous handling of circuit-switched and packet-switched emergency communications as long as there are legacy elements in the end-user (i.e. in end-user devices), network or PSAP domains;
- By itself, the transition to packet-switched emergency communications, including the use of SIP, does not enhance location accuracy in fixed networks where the physical address of the network termination point is already available to PSAPs. However, in cases where third-party databases are not consistently updated, or the representation of the data is not consistent, there may be potential inaccuracies. SIP allows the originating service provider to insert the subscriber's location directly from its own records, improving data integrity. While some countries have stringent regimes ensuring accurate and timely updates to these databases, in scenarios where such updates are less reliable, direct insertion by the originating service provider via SIP can offer a more reliable alternative;
- The transition to packet-switched technologies will enhance access to emergency services, particularly for end-users with disabilities, by supporting various communication methods like RTT and Total Conversation in addition to voice, thereby aligning with the requirements of the European Accessibility Act;
- It is also important to note, that an RTT or Total Conversation emergency communication will inherit the caller location information available for the emergency voice call without the need to define or develop specific procedures for that, thereby ensuring that the functional equivalence requirements related to location establishment and provision are met;
- The transition to packet-switched emergency communications requires substantial upgrades to existing PSAP infrastructures, including both hardware and software, to handle the increased data flow and multimedia communication formats. CEPT countries will need to fund these upgrades and this represents a significant cost;
- The transition to packet-switched emergency communications requires upgrades in public networks for PSAPs' connections and call handling;
- Cybersecurity is paramount in the transition to packet-switched technologies. The integration of IP-based systems increases vulnerabilities to cyber threats, highlighting the need for robust security measures to protect sensitive emergency communications data and to safeguard the resilience of the emergency communications infrastructure;
- Ensuring compatibility and interoperability between different national systems and across various communication technologies remains a critical challenge, impacting the continuity of cross-border emergency communications. These challenges need to be overcome through cooperation, collaboration and rigorous testing involving handset providers, network equipment vendors, electronic communications network/service providers, PSAP solutions providers and PSAPs;
- It will allow new means of accessing emergency services through emergency communications and thus some public education campaigns to inform citizens and raise awareness may be needed.

ANNEX 1: DIFFERENT NATIONAL MODELS FOR HANDLING EMERGENCY COMMUNICATIONS

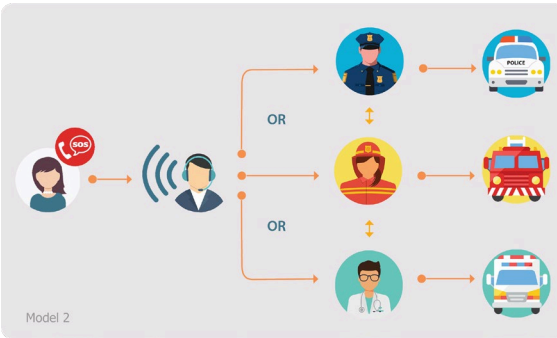
EENA has published a document [14] which defines five different call handling models. This document was developed in collaboration with emergency services professionals to provide a general overview of the main stages of the handling of emergency communications and the organisation in different countries.

The designation of the “most appropriate PSAP” is normally the first PSAP to receive the emergency communication.

A1.1 MODEL 1 - PSAPS OF THE EMERGENCY SERVICES ACTING AS PSAPS FOR HANDLING EMERGENCY COMMUNICATIONS

<p>In Model 1, several emergency numbers may co-exist in the country. Emergency communications made to the general emergency number (i.e. 112 in the European Union) are routed to one of the PSAPs of the emergency services e.g. police, fire and rescue, or medical emergency services. If the intervention of a different emergency service is required, the emergency communication and/or data about the emergency situation are forwarded to the PSAP of the required emergency service. (Examples: Austria, Germany and France):</p> <ul style="list-style-type: none"> ▪ Reception of the emergency communication by a PSAP of the emergency services; ▪ Re-routing emergency communications to PSAPs of other emergency services if necessary (e.g. a 112 communications is answered by the police but the citizen needs an ambulance); ▪ Dispatch of the intervention resources done by the PSAP of the emergency services. 	
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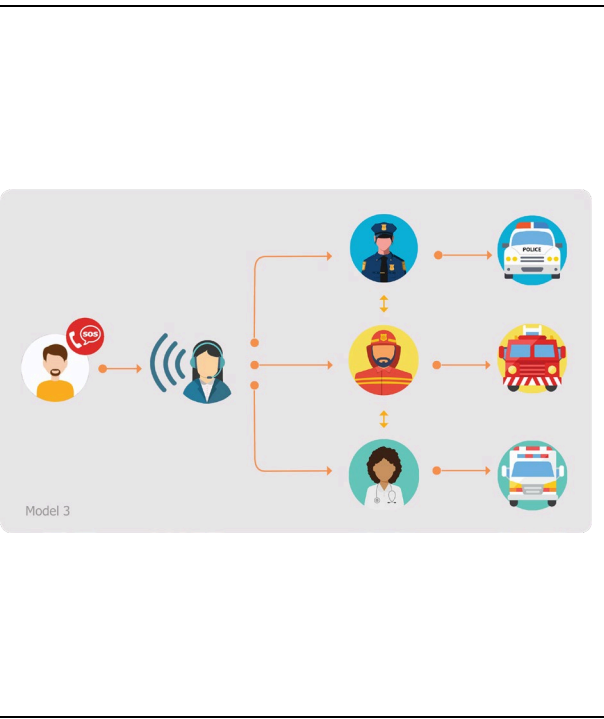
A1.2 MODEL 2 - FILTERING STAGE 1 PSAP AND RESOURCE DISPATCHING STAGE 2 PSAP(S)

<p>Emergency communications handling is organised over two levels. First, there is a stage 1 PSAP in charge of the first reception of the emergency communication which is then filtered and re-routed to the stage 2 PSAP of the most appropriate emergency service (Examples: Ireland, UK):</p> <ul style="list-style-type: none"> ▪ Emergency communications (to 112/999) handled by stage 1 PSAP call takers; ▪ Stage 1 PSAP: Filtering tasks. The call-taker locates the caller and where the incident is. They ask the caller which emergency service they want to get in contact with (e.g. “What do you need? police, ambulance, fire and rescue services?”). The detailed gathering of data is not done by the stage 1 call-taker; ▪ Transfer to medical / fire and rescue / police services: stage 1 PSAP re-routes the communication to the appropriate local emergency service; ▪ Detailed data gathering is done by the PSAP call taker of the emergency services operator. Dispatch of the intervention resources is done by the emergency services. 	
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A1.3 MODEL 3 - ONLY ONE EMERGENCY NUMBER (I.E. 112 IN EU). DATA GATHERING BY STAGE 1, RESOURCE DISPATCHING BY STAGE 2

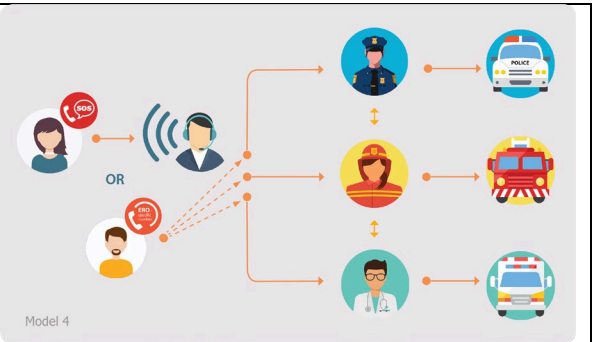
As in model 2, the handling of emergency communications is organised in two levels. The difference in this model is the role played by the stage 1 PSAP. In this case, the call-taker is in charge of the classification of the communication and makes a parallel dispatch to the most appropriate PSAPs of the emergency services. In some cases, police, fire and rescue and medical specialists are available to support the call takers. (Example: Romania):

- Classification and data gathering done by the stage 1 PSAP call-taker: the call taker asks what is happening and decides which emergency services should be contacted depending on the information given by the caller. The call taker gathers detailed data about the location and emergency situation of the caller;
- All emergency services are contacted in case multiple emergency services required;
- Dispatch of the intervention resources done by emergency services. A conference between the caller, stage 1 call taker and the relevant emergency service(s) may take place.



A1.4 MODEL 4 – EMERGENCY COMMUNICATIONS TO NATIONAL EMERGENCY NUMBERS ROUTED DIRECTLY TO THE PSAPS OF EMERGENCY SERVICES. EMERGENCY COMMUNICATIONS TO 112 ROUTED TO A DATA-GATHERING STAGE 1 PSAP

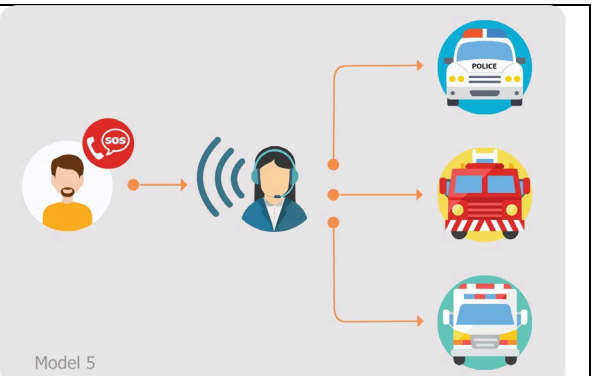
- For the emergency communications made to the 112 general emergency number, the Emergency communications handling chain is the same as model 3;
- For emergency communications made to the national specific numbers (e.g. 118, 11x) of the PSAPs of the emergency services., the Emergency communications handling chain is the same as model 1. (Example: Spain, some regions).



A1.5 MODEL 5 - CALL-TAKING & DISPATCHING BY THE SAME ORGANISATION

Emergency communications to the general emergency number (i.e. 112) are handled by stage 1 PSAP call takers. These call takers are highly trained and handle both call-taking and dispatching of intervention resources. In some cases, police, fire and rescue and medical specialists are available to support the call-takers.

The same PSAP is in charge of all tasks: classification of calls, data collection and dispatching the intervention resources to the incident. (Example: Finland)



ANNEX 2: IMPLEMENTATION OF PACKET-SWITCHED ENVIRONMENT FOR EMERGENCY COMMUNICATION – PLANS AND PROJECTS IN SOME COUNTRIES

Case studies could be useful for countries with different PSAP structures e.g. centralised and de-centralised.

A2.1 PORTUGAL

In Portugal, the PSAP architecture in operation falls under model 3. Over the last few years, several improvements have been made to the PSAP system, which now has the following functionalities: compatibility with eCall since 2017, MAI112 app for deaf community since 2019 and compatibility with AML (via SMS and https) since 2020.

The process of upgrading PSAP architecture will be phased into two main steps. First step involves equipping PSAP with the capacity to receive IP communications (SIP). Second step includes the installation of hardware, software and configuration of an ESInet, with the ultimate goal of implementing an NG112 infrastructure, in accordance with the ETSI TS 103 479 [18]. Prior to this modernization process at the PSAP, the communications networks are also moving from circuit-switched to packet-switched - an action that has already been carried out.

Considering these 3 technological movements, the current scenario in Portugal is:

- Emergency communications run over packet-switched networks (IP) between operators – following the specification of ANACOM's decision in July of 2021, which was based on the recommendations for mapping between protocols in ETSI TS 129 163 [20]. This traffic is delivered to an aggregator, which delivers it to the PSAP;
- Delivery to the PSAP on ISDN circuits; meanwhile, these circuits will be decommissioned, with the completion of the first step in the modernization of the PSAP (communication over IP to the PSAP).

For the second step, a next generation architecture, the option involved the acquisition of a standard ESInet solution, with NG112 core elements, in accordance with ETSI TS 103 479. This architecture will be developed and tested during 2024 and will be live in 2025.

To align with the current Electronic Communications Law (national transposition of the EEC) and to take advantage of these technological movements, new regulation [21] regarding the provision of information on the location of caller to the PSAP was published in August of 2024. This new regulation will enter into force on the 28 August of 2025 and specifies that the caller location information must be sent to the PSAP using PIDF-LO, regarding the network (mobile, fixed, public internet) and the type of location (network or handset based).

For fixed networks, the caller location will be the Network Termination Point (NTP) address like it is today, but will be transmitted during the call in the PIDF-LO; today, the PSAP queries a database using the caller line identification to retrieve the address. For mobile networks, the network-based location, will have the form of sector or arcband to represent the possible area where the caller is, which will be an enhancement because today is used the form of a circle independent of the real cell coverage.

This new regulation sets up targets for accuracy and reliability criteria. In fixed networks, 95% of the communications must meet the reliability criteria, so the NTP address has to be delivered to the PSAP. In mobile networks, 60% of the communications have to be on a radius of 100 meters.

Other aspects were also covered in this regulation, for example, a flag in the routing number to signal lack of confidence on the sent location (could be used in nomadic cases if applicable), network based location for communications made in VoWifi, identification of the operator, additional caller location information in complement (details about the location in a campus or building, geographic coordinates of an address), location criteria when using public internet, etc.

A2.2 ROMANIA

In Romania the applicable PSAP handling model is the EENA model 3 (Annex 1): one emergency number (112), one 112 PSAP in each of the 41 counties (one per county, Bucharest and Ilfov served by the same PSAP) and 2 backup Call Centres, one of which serves as backup for the whole country.

Location methods currently used in Romania for mobile calls:

- **Primary Location** - Cell ID/Sector ID uses the data transmitted by the mobile phone cell serving the caller at the time of call initiation and presents an indicative area in the form of a circle or a sector of a circle, representing the estimated coverage of the cell;
- **Advanced Mobile Location (AML)** technology (available only for smartphones). This technology allows the geographical coordinates associated with the location from which the call is made, established by the device to be transmitted to the 112 system;
- **HTML 5 Geolocation 112** - if needed. the call-taker sends the caller an SMS containing a location link, which, once accessed, allows with the caller's consent, the transmission (using the data service) of the geographical coordinates provided by the smart phones operating system, using the data service;
- **112 CALL mobile app (Ape112)** - free to download on smart phones. The app allows to call the emergency service and to also transmit the phone's location to the 112 system, using the data service.

Ongoing projects:

a) Upgrading the PSAP

Currently, there is an ongoing process of upgrading the 112 System at national level, both from hardware and software standpoints and of transitioning to Next Generation 112 and packet switched technologies, which will ensure a centralised and fully redundant architecture that will allow operating the 112 Emergency Service at county, regional or national level. Ensuring continuity during the transition is also a key concern and several developments and have been made in this direction as well.

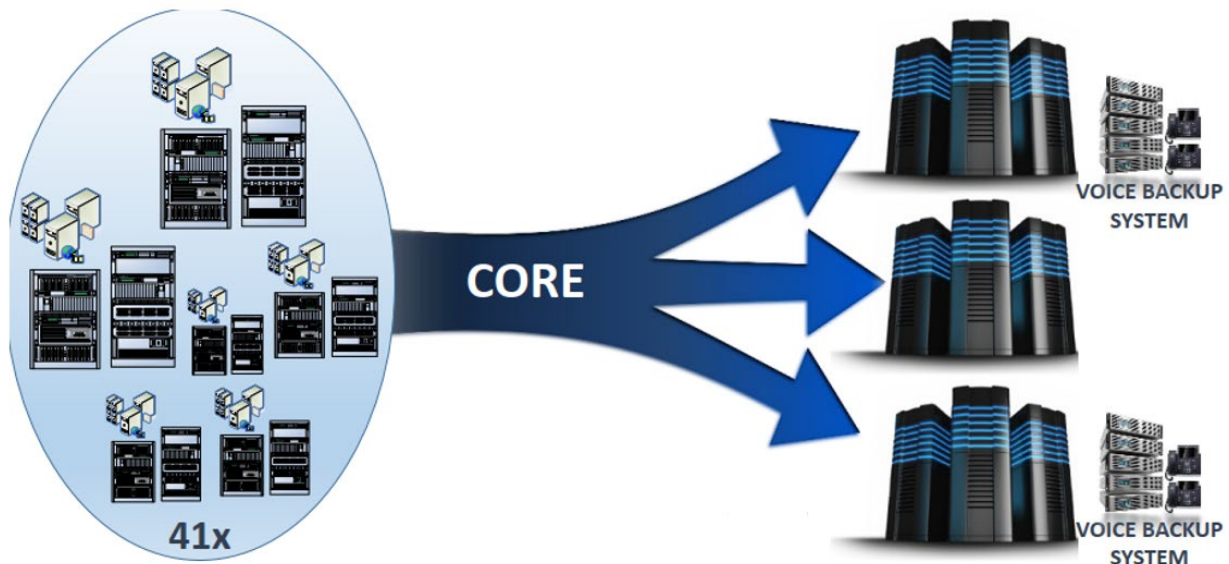


Figure 3: NG 112 Architecture
(Source: the PSAP Administrator)

b) Improving the mobile caller location

Last year (2023) the implementation of a new project started, in order to provide additional and accurate location information for the mobile emergency calls.

The new network-based location system was implemented this year nationwide, for all MNOs. It is based on the calculation of determined location information obtained by extracting technical parameters from the mobile network infrastructure, using specific algorithms.

The solution delivers the determined location information for all technologies currently implemented in Romania (2G/3G/4G), for both packet-switched and circuit-switched technologies, using the following methods:

- CGI - Cell Global Identity is the concatenation of the LAI (Location Area Identity) and the CI (Cell Identity) and uniquely identifies a given radio cell;
- CGI/TA - Cell Global Identity + Timing Advance (the length of time a signal takes to reach the base station from a mobile phone);
- E-CGI/E-CID (Enhanced Global Cell Identity/ Cell Identity) - Global Cell ID/Cell ID + Timing Advance + Radio Measurements (list of neighbours' cells/their Rx levels);
- A-GNSS (Assisted Global Navigation Satellite System) – location solution provides assistance data for faster and more reliable satellite detection.

The new system provides a caller location success for almost 98% of real emergency calls (comparable to the Cell ID method) and an accuracy of less than 560 meters for more than 80% of real emergency calls and does not depend on the mobile terminal (whether or not it is a smartphone or with a dedicated software).

If the mobile terminal has location sensors, as required by the European regulation, during the emergency call, the location information is pulled by the network-based location system and transmitted to the PSAP.

By including the results of the new network-based location system, the accuracy of caller location for real emergency calls is:

- 50 meters for almost 70% of calls;
- 560 meters for almost 95% of calls.

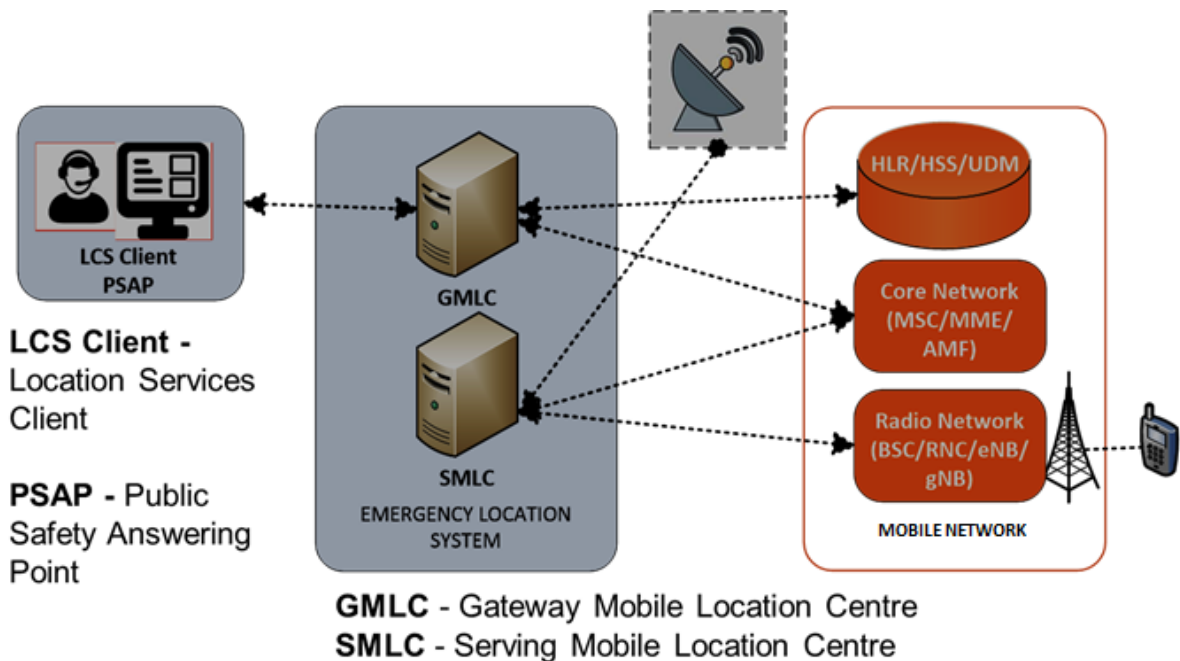


Figure 4: New location solution architecture (Source: Orange, Romania)

c) Improving accessibility

The PEMEA architecture is being implemented. It also includes a mobile app with RTT, Total Conversation and accurate caller location capabilities.

d) Enabling Emergency over VoLTE

The process of enabling 112 calls over 4G networks in Romania has started since late 2023, involving technical adaptations on the PSAP side, as well as within the MNOs' and national telecommunications aggregator's infrastructure. Currently, there are ongoing testing activities and pilot with real 112 traffic in small area for a gradual geographical roll-out starting with September 2024. Enabling access to 112 via packet-switched networks (i.e. 4G/5G networks) should bring the following benefits to emergency services and ultimately, to the citizens:

- shorter processing and transit time of emergency communications through the MNO infrastructure as there will be no need for a circuit-switched fallback procedure;
- a better precision of the location information (both Network-based location methods, as well as User-Derived) resulting from an increase in the success rate of A-GNSS location information implemented for the Advanced Network-Based Location, an enhanced transmission speed of AML messages by ensuring a continuous mobile data connection during the 112 call, as well as smaller coverage areas for Cell-ID location method for 4G cells.

e) Updating the legislation

ANCOM is in process of supplementing the legal framework for regulating emergency communications to the 112 System through packet-switched technologies.

f) Next steps that need attention:

The amendment to the USD of 2009 required caller location information to be provided with emergency calls.

According to the EECC, EU/EEA Member States shall ensure that caller location information is made available to the most appropriate PSAP without delay after the emergency communication is set up.

As the Delegated Regulation states, location information should actually be useful enough for each intervention to help the citizens that called the emergency service, hence a high accuracy for every emergency call is required.

The transition to packet-switched technologies presents an opportunity for the transmission of detailed location data, including handset-derived location, to the PSAP using SIP for emergency communications originating on both fixed and mobile IP networks, but here is still work to be done.

In order to reap the benefits of packet-switched technology in terms of location information in case of emergency, additional and urgent activities and measures are needed at least for:

- regulating how the actual physical address of a SIP client calling the 112 emergency number from a fixed IP network (including software using an internet connection) is available to the PSAP (e.g.: provided by the SIP client or network and transported to the PSAP), including in the case of location independent service users;
- defining the actual configuration of SIP messages to transfer the contextual data (location information).

A2.3 SWEDEN

In Sweden the PSAP is provided by a public sector company (SOS Alarm) and the PSAP architecture in operation mainly falls under model 3 according to Annex 1. Sweden has 112 as a single emergency number and routing to the appropriate PSAP is based on origin of the emergency communication.

Over the last few years, several improvements have been made to the 112-service which now has the following functionalities handled by the PSAP:

- Support for network based caller location information since 2007;
- Support for eCall since 2017;
- Support for AML (via SMS and not https) since 2018;
- Support for Location in Call-Set-Up since Q2 2024;

- Support for Real-Time Text coming 2025;
- Support for NG-eCall planned during late 2025.

The process of upgrading PSAP architecture for the support of IP started 2020 and all communication from the operators is since Q1 2023 over IP. The legacy TDM-based interface is closed.

The four dominant Mobile Network Operators (MNO) are directly connected to SOS Alarm over fiber. The connections are redundant. Operators without direct interconnection transfer calls through one of the four MNOs with direct interconnection.

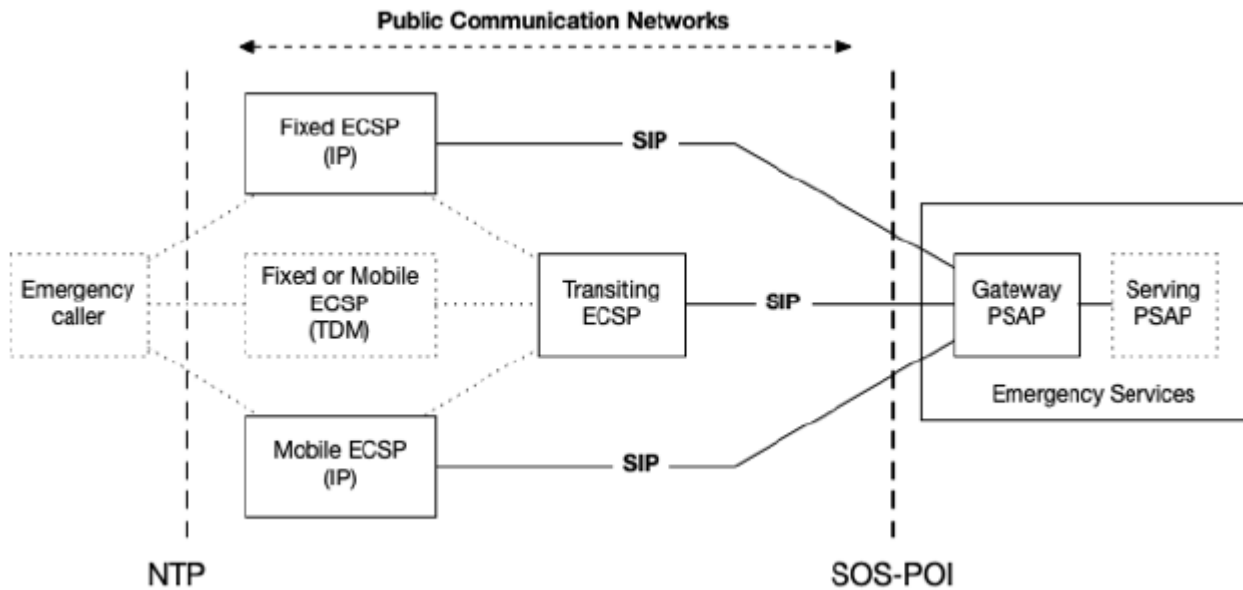


Figure 5: Emergency call routing in Sweden
(Source: SOS Alarm, Sweden)

Caller location information

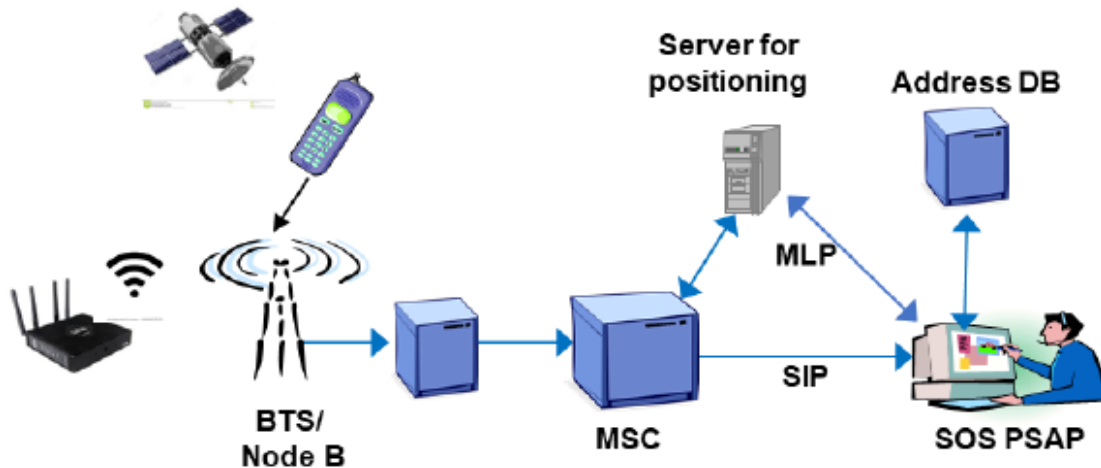
There are solutions for one or more methods for providing support for caller location information:

- Network based caller location information since 2007
 - Applies to mobile calls
 - Will always work since it is based on sending of coordinates of Base Station (Cell-ID).
 - No support for emergency roaming and SIM-less calls.
 - Added support for calls from emergency roaming and SIM-less calls from 2014
- “Weblink”, PSAP send out SMS with link for positioning device since 2017
- Support for AML since 2018.
 - Over SMS, needs subscriber to be logged into a mobile network.
- Support for SOS Alarm APP, since 2019.
 - Handset-derived location information sent over https.
 - Requires subscriber to be logged into a mobile network.
- Location for eCall since 2017.
- Location in Call Set Up from Q2 2024
 - PIDF-LO sent in SIP
- Support for NG-eCall planned during late 2025

Databases

User provided location information is sent from the terminal of the emergency caller. It can be AML or Location in Call Set-Up.

Concerning network provided location information it requires a database storing the requested information. In Sweden a third-party database contains name and address information for all subscriptions. This database is updated regularly. The base station (Cell) information is conveyed from MNO to SOS Alarm PSAP over Mobile Location Protocol, MLP.



**Figure 6: Base station (Cell) information conveyed from MNO to SOS Alarm PSAP over Mobile Location Protocol, MLP
(Source: SOS Alarm. Sweden)**

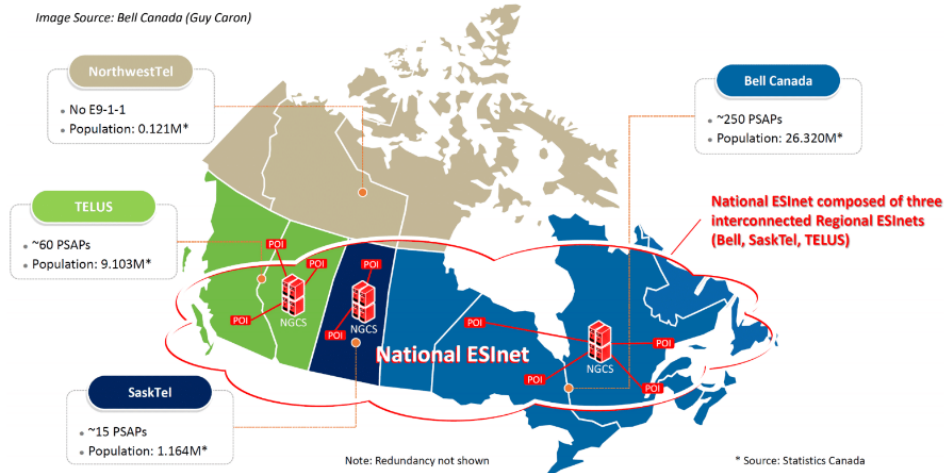
Since more than one type of caller location information can be sent to the SOS Alarm PSAP the operators display prioritizes which information to display. Normally setting user provided information higher than network provided but the network provided information retrieved from database is always present but less accurate whereas the user provided can fail e.g. for SIM-less calls. The possibility to send location information in the call set-up phase delivers the information quicker.

A2.4 CANADA

The drivers for transitioning from circuit-switched to packet-switched emergency communications are no different in Canada to what they are in Europe (e.g. network sunsets, enhanced access for end-users with disabilities, routing to the most appropriate PSAP, more accurate and reliable location information). Having observed developments in NG911 in the USA, Canada took a different approach to the implementation of ESInets. In Canada, ILECs (Incumbent Local Exchange Carriers) are telecommunications companies that traditionally provided local telephone services and continue to serve as important providers of telecommunications infrastructure. As the main originators of emergency communications traffic, and as aggregators for emergency communications traffic originating from smaller service providers, the ILECs have implemented an ESInet composed of three interconnected regional ESInets based on the provinces/territories each ILEC covers.

NG9-1-1 Network Architecture

Image Source: Bell Canada (Guy Caron)



- 9,985 million km², specific geographical challenges
- 37.6 million Canadians over 10 provinces and 3 territories
- 9-1-1 used throughout Canada by 98% of the population (96% Enhanced, 2% Basic)

CRTC.GC.CA

8

Figure 7: NG9-1-1 Network Architecture in Canada (Source: CRTC)

ILECs are subject to regulatory requirements and standards set by the Canadian Radio-television and Telecommunications Commission (CRTC). These regulations can impact how ILECs implement and maintain ESInets.

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- [8] [Regulation \(EU\) 2022/612](#) of the European Parliament and of the Council of 6 April 2022 on roaming on public mobile communications networks within the Union (recast)
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- [10] [Case No. C-417/18](#) - Judgment of the Court (Fourth Chamber) of 5 September 2019 (request for a preliminary ruling from the Vilniaus apygardos administracinis teismas — Lithuania) — AW, BV, CU, DT v Lietuvos valstybė, represented by the Lietuvos Respublikos ryšių reguliavimo tarnyba, the Bendrasis pagalbos centras and the Lietuvos Respublikos vidaus reikalų ministerija
- [11] [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
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- [14] EENA Document: “[Emergency Call Handling Service Chain Description](#)”, Version 2.0, 7 December 2020
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- [19] [Commission Delegated Regulation \(EU\) 2024/1180](#) of 14 February 2024 amending Regulation (EU) 2015/758 of the European Parliament and of the Council as regards the standards relating to eCall

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