EENA NG112 Technical Committee Document

NG112 Transition Models
Implementation Activities

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1 Executive Summary

The industry has been abuzz with the term NG112 for some time but exactly what it is, the benefits it provides, the issues involved with getting there, and how emergency services move to it, have been relatively poorly explained.

Public safety answering points have to face changes that have an impact on their organisations. Some of them are:

- ISDN trunking interfaces to TSPs have reached their end-of-life (see Germany, UK) and have to be replaced with new technologies (SIP/IP)
- PSAP consolidation processes across jurisdictions, due to austerity are prevalent, which significantly reduces the number of PSAPs raising the question for an efficient location/ policy based routing
- Interoperability requirements between EROs increase, which implies standardized interfaces for call data conveyance between PSAPs, even in staged deployments
- The harmonization of public agency IP network infrastructures on a member/ country state level as a hosted service takes place
- Telecommunication services organisations develop their network infrastructure towards packet based services (IMS, VoLTE) and the number of VoIP subscribers increases
- New services – beyond emergency voice calls – are expected by citizens and have found early adopters in the ERO communities e.g. Apps, SMS.

This document describes the current state of emergency networks within Europe at a high-level and then goes on to explain how to move those systems to NG112, what some of the benefits/drawbacks are with different approaches was well as some of the challenges that will be faced in getting to the solutions that European citizens and PSAPs require in order to best serve people in need while making the best use of the resources available.

2 Abbreviations

3GPP	Third Generation Partnership Project
4G	Fourth Generation
BCF	Border Control Function
ECRF	Emergency Call Routing Function
ECSCF	Emergency Call Session Control Function
ERO	Emergency Responder Organization
ESInet	Emergency Service IP Network
ESRP	Emergency Service Routing Proxy
GW	Gateway
IMS	IP Multimedia Subsystem
IP	Internet Protocol
ISDN	Integrated Services for Digital Network
LIS	Location Information Server
LRF	Location Retrieval Function
LOC	Location
LTE	Long Term Evolution
MNO	Mobile Network Operator
MoI	Ministry of Interior
MSRP	Message Session Relay Protocol
NG112	Next Generation 112
POP	Point-of-Presence
PSAP	Public Safety Answering Point
PSTN	Public Switched Telephone Network
R/M	Routing/Mapping
REG	Regulator
RTP	Real-time Transport Protocol
SCSCF	Serving Call Session Control Function
SIP	Session Initiation Protocol
SMS	Short Message Service
TSP	Telephone Service Provider
UE	User Equipment
VoIP	Voice over IP
VoLTE	Voice over LTE
VSP	VoIP Service Provider

3 Introduction

At present, emergency calling is based on straightforward technical building blocks and a few legal/regulatory aspects. Technical elements, typically part of an incumbent telephone service provider (TSP), ensure that emergency calls are routed to the most appropriate PSAP. Routing the call to the PSAP is based on static information that is configured into the TSP switch at the local telephone exchange. This static information provides a mapping between the address of the subscriber and the PSAP and is provided by the emergency responder organizations (EROs), the Ministry of Interior (MoI) or the Federal State Administration. The mapping information itself is managed by the national regulator. For the most part, this static mapping information is represented by dialling code/area code and a table that maps those codes to PSAPs, which are identified by unlisted and often undialable numbers. An incumbent TSP is legally responsible to route an emergency call, fixed or mobile, to the most appropriate PSAP based on the pre-set mapping data. The terms "routing" and "mapping", as shown in Figure 1, refer to this process, which typically executes within a telephone service provider's infrastructure. Any fixed or mobile provider may, depending on termination contracts, forward emergency calls from their network to a Point-of-Presence (PoP) that serves as a gateway to the emergency network. PSAPs typically connect to an incumbent TSP, and other TSPs may connect to this incumbent TSP to ensure all callers have access to emergency services as shown in Figure 1.

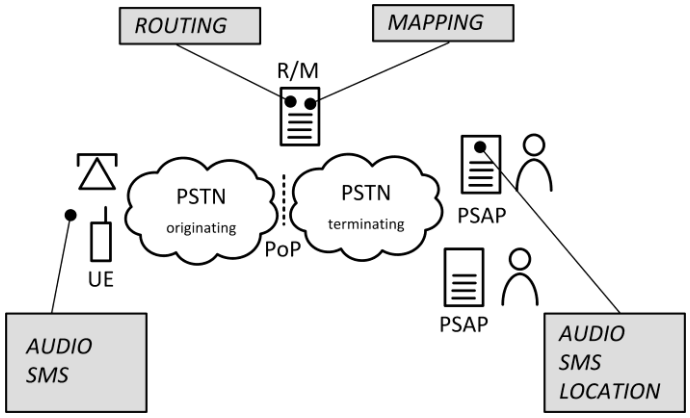

Figure 1: 112 emergency call routing

Accessing emergency services, for the most part, is limited to an ordinary voice call though some areas now support SMS to 112. Mobile location information is generally restricted to coverage area of the serving cell, and is provided via proprietary interfaces that a PSAP has to implement per mobile network operator (MNO).

The aim of NG112 is to address most of the limitations that arise from legacy technology. Some key advantages are:

- an all IP based infrastructure that implements open standards and ensures interoperability across borders, agencies and vendors,
- a consistent means of acquiring and representing location information regardless of the type of originating network,
- allowing citizens to access emergency services anywhere from any device using different types of media and applications,
- new mapping/routing features based on geographical polygons that describe a jurisdictional area replace dialling or area codes
- policy based call routing features within interconnected PSAPs based on time of the day, skills and call queue states,
- contingency operation (overflow, fail-over, etc.)

In order to better understand different transition programs it may help to introduce essential elements and protocols of the NG112 architecture first. A regular TSP, using the PSTN as an originating network, allows access to emergency services via a voice call or SMS and requires basic mapping and routing capabilities within the TSP such as forwarding emergency calls to a gateway (GW). The GW itself represents a Point-of-Presence (PoP) and provides access to an Emergency Service IP Network (ESInet), as in Figure 2.

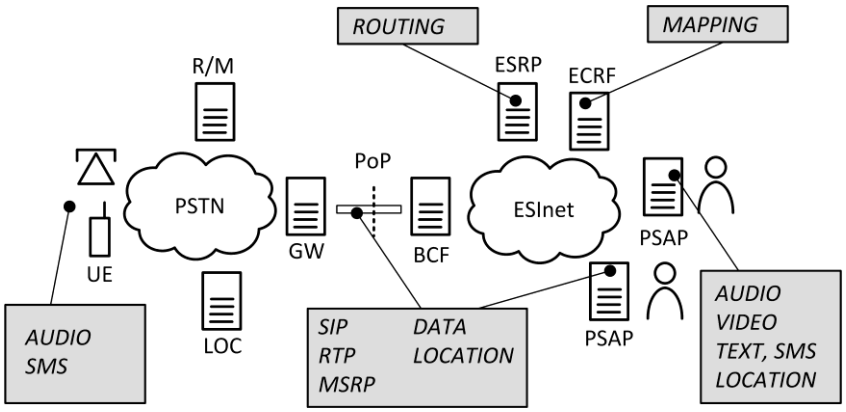

Figure 2: PSTN as originating network

NG112 introduces standardized interfaces at the PoP that provide session control (SIP), Real-time media streaming (RTP) and support for SMS messages (MSRP). A common data structure for representing location (LOC) information (civic address or geodetic) is used and, if applicable, additional data related to the call can be provided (DATA). The Gateway (GW) acts also as a central exchange for location information independent of any underlying access network technology, and provides location from mobile devices or from the PSTN. Further it normalizes different location data formats. For the sake of completeness, a Border Control Function (BCF) provides security measures at the PoP to guard against various forms of cyber-attack.

In NG112, the mapping and routing functions are performed by separate entities. The mapping function (ECRF, Emergency Call Routing Function) in the ESInet uses the caller's location and provides the address of the requested ERO-type. The routing function (ESRP, Emergency Service Routing Proxy) is responsible for getting the call to the address of the ERO provided by the mapping function. Considering 4G/IMS as an originating network (Figure 3) does not necessarily change or add functionality to the PoP interface but it introduces different elements within the originating network that require extra attention during transition in order to avoid interoperability issues. 3GPP defines elements and functions that guarantee resources, route emergency calls within an IMS environment (home and roaming network) and perform position determination. Depending on the UE capabilities, media other than voice may be used in order to contact emergency services.

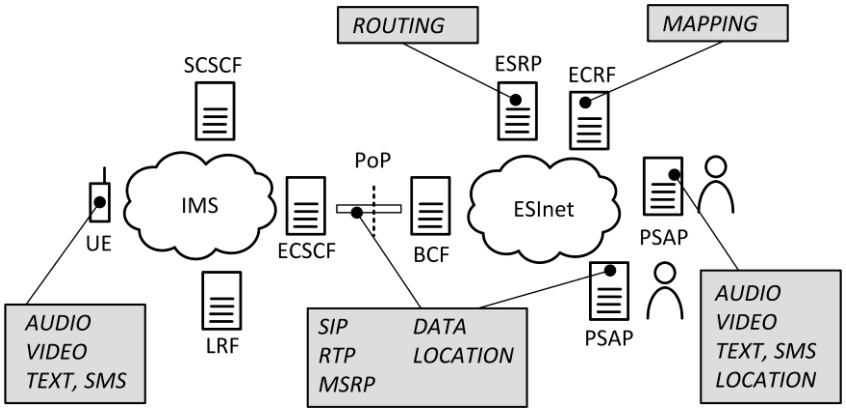

Figure 3: IMS as originating network

Finally, we consider an IP network as the originating network for transition to NG112. This scenario has location determination challenges as it is most likely that the network service provider and VoIP service provider (VSP) are different stakeholders. Therefore, the VSP, a network provider, or most probably complexes of the two need to implement services for mapping, routing and location retrieval via a location information service (LIS) when connecting the IP call-origination network to the ESInet. In a possible scenario, a mapping function in the originating IP network determines the most appropriate PoP based on the caller's location and forwards the request messages via a proxy to that PoP, as shown in Figure 4.

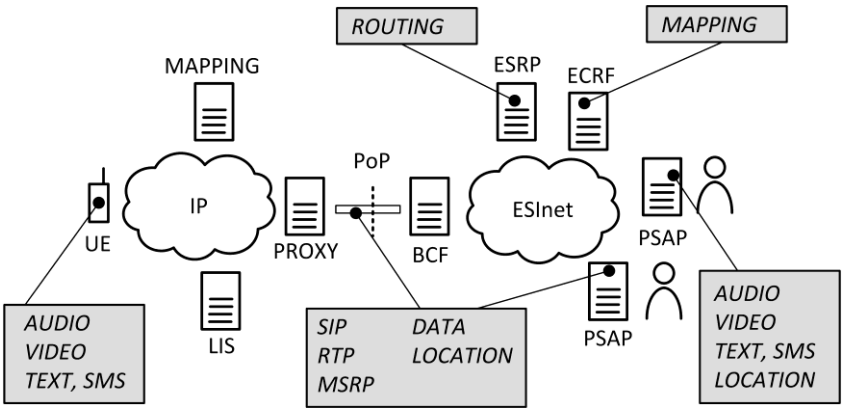

Figure 4: IP as originating network

Such new capabilities may change responsibilities, introduce new stakeholders and, of course, require new regulations and/or legislation. Transition models (as in NG112 Transition Models EENA Document[1]) may have different requirements in terms of regulatory, legal and technical issues. The following chapter introduces different but most probable scenarios to help identify stakeholders, define who needs to do what and in which sequence.

[1] http://www.eena.org/pages/ng-112#transition_models

4 NG112 Implementation Scenarios

This section starts with the current situation and further introduces two different approaches in order to implement NG112 – interconnected EROs or PSAPs and a single or centralised PSAP that terminates NG112 emergency calls. Both options have slightly different aspects that need to be considered for transition.

4.1 Transition Options

Depending on the local PSAP model, expansion stage of the infrastructure or legislative aspects we may differentiate two possible ways of transition – a centralized PSAP that implements NG112 capabilities, where routing and mapping executes within a public service provider infrastructure or a centralized PoP that connects to an ESInet, where routing and mapping processes mostly reside within the ESInet as shown in Figure 5. Even though both options offer the same interface towards a public infrastructure, they vary in terms of legislation, regulation and stakeholder's investments.

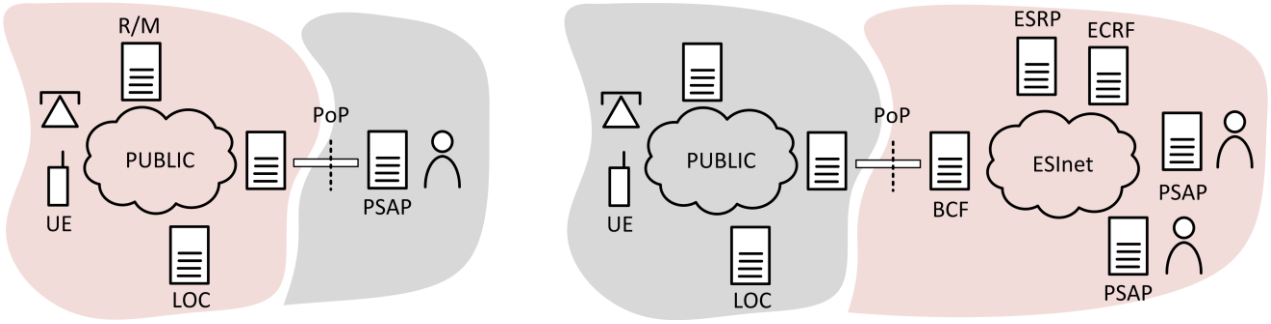

Figure 5: Centralized PSAP and centralized PoP

The most obvious difference is where the routing and mapping processes take place, or, to put it differently, who takes the responsibility (red areas in Figure 5) to deliver an emergency call to the most appropriate PSAP. Considering future scenarios, where emergency calls originate in non-traditional environments (Apps, Social Media, etc.) we may say that a centralized PoP approach is the preferred option as it simplifies routing within the originating network. Any service provider would then only have to determine a national PoP and route calls to it. Complex mapping that determines the most appropriate PSAP and (policy based) routing is independent of the originating infrastructure and moved to PSAP agencies.

4.2 Current Situation

Today, the typical infrastructure that routes emergency calls from user equipment (UE) to a PSAP is the PSTN operated by an incumbent TSP. Mobile network operators (MNOs) or other TSP simply route emergency calls to the incumbent TSP's PoP, which then takes care of mapping and routing tasks in order to reach the most appropriate PSAP. Data collection in order to provide such a mapping service is, in most cases, managed by the national regulator (REG) together with EROs, the MoI and/or Federal State Administration. In Figure 6 (and following figures) areas of responsibility are schematically illustrated and stakeholders (TSP, MoI, REG and ERO) are listed per area.

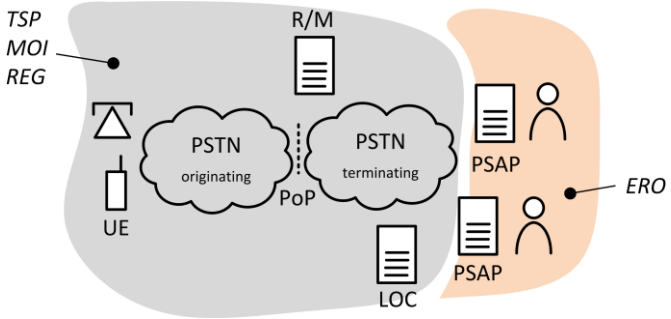

Figure 6: Current situation

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4.3 Centralized PSAP

Starting from the current situation and considering a centralized PSAP which implements NG112 capabilities, three difference scenarios are discussed in the following paragraphs.

4.3.1 PSTN Termination

The simplest approach – simplest in terms of actions to be taken for transition – is a centralized NG112 PSAP that terminates calls from the PSTN[2], as in Figure 7. All mapping and routing action is done within the PSTN and a dedicated Gateway (GW) terminates and translates calls. Such a PSAP provides readiness for further NG112 transition scenarios, e.g. terminating other originating networks or interconnecting with stage-2 PSAPs via an ESInet.

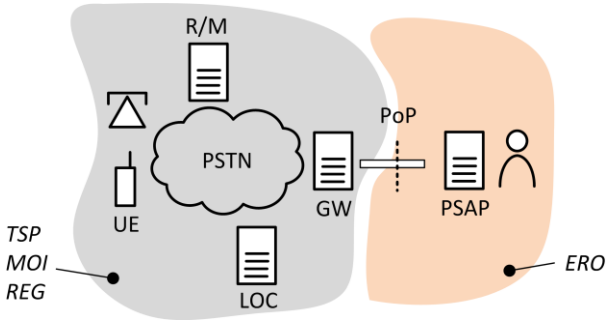

Figure 7: Centralised NG112 PSAP terminates PSTN

Transition actions

Stakeholder	Legislation	Regulation	Invest
TSP	caller location	-	mapping/routing update
MOI/REG	-	mapping data collection	-
ERO	-	-	NG112 PSAP equipment, gateways

Risks/Challenges

- Even if this is a major step towards NG112 it lacks features like policy based routing, advanced load balancing or fail-over mechanisms that characterize an ESInet.
- This type of solution may cause problems in countries where the different EROs use different technologies from one another in order to support emergency calls for their specific service.

[2] NOTE: eCall is considered as PSTN call

4.3.2 IMS Termination

As a next step a PSAP may next decide to terminate Voice over LTE (VoLTE) emergency calls originating in the 4G/IMS network of an MNO (see Figure 8). The mapping and routing tasks are part of the MNO's infrastructure and, depending on how much signalling and media transport differs at the PoP, some technical integration efforts are required. Depending on regulatory requirements PSAPs may have access to different sources of caller location and media other than voice may be used in order to contact emergency services.

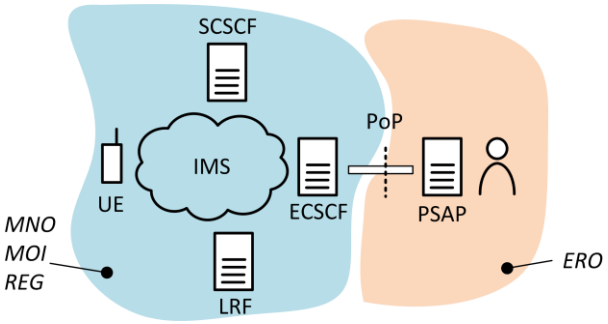

Figure 8: Centralised NG112 PSAP terminates IMS

Transition actions

Stakeholder	Legislation	Regulation	Invest
MNO	caller location, emergency call delivery	caller location	mapping/routing implementation, integration efforts
MOI/REG	-	mapping data collection, harmonize PoP interface, shape-files describing jurisdictional areas to replace area/dialling codes	-
ERO	-	-	NG112 PSAP equipment, integration efforts

Risks/Challenges

- This is a major step towards NG112, however, it lacks features like policy based routing, advanced load balancing or fail-over mechanisms that characterize an ESInet.
- This type of solution may cause problems in countries where the different EROs use different technologies from one another in order to support emergency calls for their specific service.
- Mobile operators may have a legal requirement compelling them to route emergency calls to the most appropriate PSAP.
- Migration to NG112 may require effort to ensure signalling and media compatibility between the IMS provider and the PSAP.

4.3.3 IP Termination

Finally, a PSAP may decide to terminate VoIP emergency calls originating in a public IP network (see Figure 9). The mapping and routing tasks are part of the IP infrastructure and, depending on how much signalling and media transport differs at the PoP, some technical integration efforts are required. Depending on regulatory requirements PSAPs may have access to different sources of caller location and media other than voice may be used in order to contact emergency services.

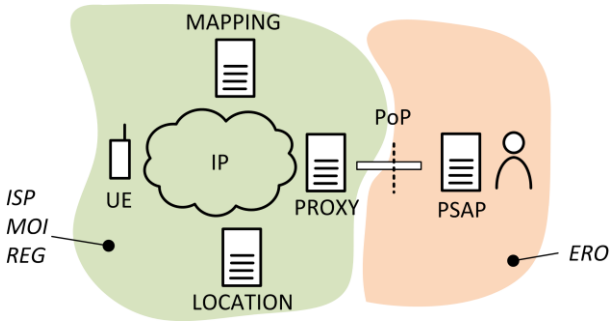

Figure 9: Centralised NG112 PSAP terminates IP

Transition actions

Stakeholder	Legislation	Regulation	Invest
VSP	caller location, VoIP emergency calls permitted by law, emergency call delivery		mapping service, location service, emergency call application, integration efforts
MOI/REG	-	mapping data collection, shape-files describing jurisdictional areas to replace area/dialling codes	
ERO	-	-	NG112 PSAP equipment, integration efforts
ISP	-	caller location/mapping service	location service, mapping service

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Risks/Challenges

- This is a major step towards NG112, but it lacks features like policy based routing, advanced load balancing or fail-over mechanisms which are benefits provided by an ESInet.
- This type of solution may cause problems in countries where the different EROs use different technologies from one another in order to support emergency calls for their specific service.
- Migration away from dial strings (service urns instead of service numbers) may require legislation.
- VSPs may have a legal requirement compelling them to route VoIP emergency calls to the most appropriate PSAP.
- Migration to NG112 may require effort to ensure signalling and media compatibility between the VSP provider and the PoP.

4.4 Centralized PoP

In order to take advantage of new NG112 features and to create a collaborative environment that considers any PSAP model EROs or PSAPs may interconnect their sites via a common, managed IP infrastructure for the purpose of handling emergency calls (ESInet). Starting from the current situation and considering a centralized PoP that connects to an ESInet and implements NG112 capabilities, three different scenarios are discussed in the following paragraphs.

4.4.1 PSTN Termination

As a first step we consider a centralized PoP that connects a PSTN to an ESInet via a Gateway (GW). Mapping and complex routing tasks are moved to functional elements within the ESInet, these are the ESRP, the ECRF and a BCF as in Figure 10. Mapping does not require the use of geographical polygons but it is recommended to smoothly migrate to shape-files describing jurisdictional areas in order to replace area/dialling codes. This simplifies the routing process within originating networks as TSPs just need to know a national PoP and thus do not have to maintain complex mapping data. Further, it also leads to the support of national number portability that is difficult to achieve when using dialling-prefixes with a real significance.

Of course, this requires implementation and operation of such an infrastructure but, in the long-term, reduces operational costs and provides instant value to citizens as it improves emergency services through features like policy based routing, advanced load balancing or intelligent fail-over mechanisms. In addition, we note that this approach does not necessarily require PSAP consolidation and thus loss of local call-taker knowledge in environments where this is considered to improve caller's safety.

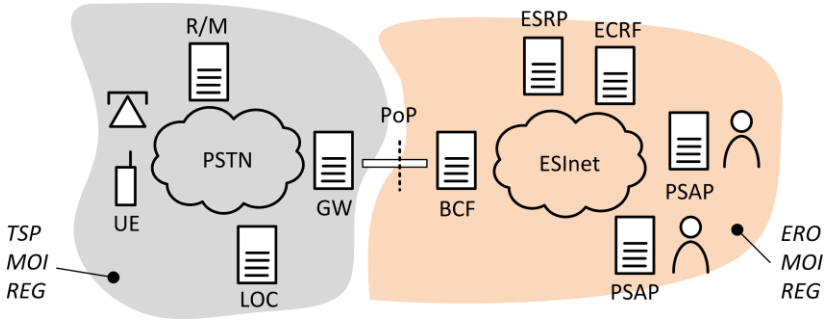

Figure 10: ESInet terminates PSTN

Transition actions

Stakeholder	Legislation	Regulation	Invest
TSP	caller location	-	mapping/routing update
MOI/REG	-	mapping data collection shape-files describing jurisdictional areas to replace area/dialling codes	-
ERO	-	-	state/nation-wide ESInet, NG112 PSAP equipment, gateways, BCF, ESRP, ECRF, mapping/routing update

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Risks/Challenges

- One major challenge is the implementation and operation of a common infrastructure where different EROs are handling emergency calls.
- It may also take some time before industry is ready to provide functional elements that are certified or have proved to conform and interoperable with other elements of an NG112 architecture.
- Certification requires a certification body, an associated test bed and an agency to stand-up and provides this capability.

4.4.2 IMS Termination

In addition to what has been noted in 4.4.1 this scenario simplifies mapping and routing tasks for the originating network. Depending on regulatory requirements PSAPs may have access to different sources of caller location and media other than voice may be used in order to contact emergency services. Mapping and complex routing tasks are moved to functional elements within the ESInet, these are the ESRP, the ECRF and a BCF as in Figure 11. Mapping requires the use of geographical polygons and therefore it is recommended to immediately migrate to shape-files describing jurisdictional areas in order to replace area/dialling codes.

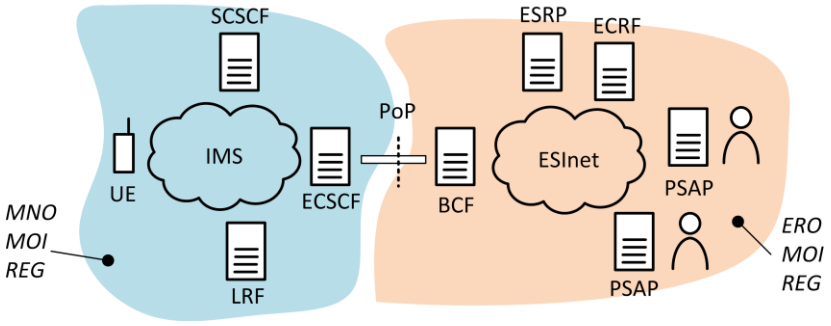

Figure 11: ESInet terminates IMS

Transition actions

Stakeholder	Legislation	Regulation	Invest
MNO	caller location	-	mapping/routing update
MOI/REG	-	mapping data collection, harmonize PoP interface, shape-files describing jurisdictional areas to replace area/dialling codes	-
ERO	-	-	state/nation-wide ESInet, NG112 PSAP equipment, gateways, BCF, ESRP, ECRF, mapping/routing update

Risks/Challenges

- One major challenge is the implementation and operation of a common infrastructure where different EROs are handling emergency calls.
- It may also take some time before industry is ready to provide functional elements that are certified or have proved to conform and interoperable with other elements of an NG112 architecture. Certification requires a certification body, an associated test bed and an agency to stand-up and provide this capability.
- Mobile operators may have a legal requirement compelling them to route emergency calls to a national PoP.
- Migration to NG112 may require effort to ensure signalling and media compatibility between the IMS provider and the PoP.

4.4.3 IP Termination

In addition to what has been noted in 4.4.1 and 4.4.2 we may say that this option represents the long-term vision of NG112 and requires to consider any challenge that arises from IP networks like for instance private networks or the separation of infrastructure and service provisioning. These include not only technical but also legislative and regulative challenges. Nonetheless it has the capacity to provide the feature richest environment for citizens that request assistance from an emergency service.
Even if most of the mapping and routing tasks are executed within the ESInet an ISP or VoIP service provider (or a complex of both) need to route emergency calls to the most appropriate PoP, as seen in Figure 12.

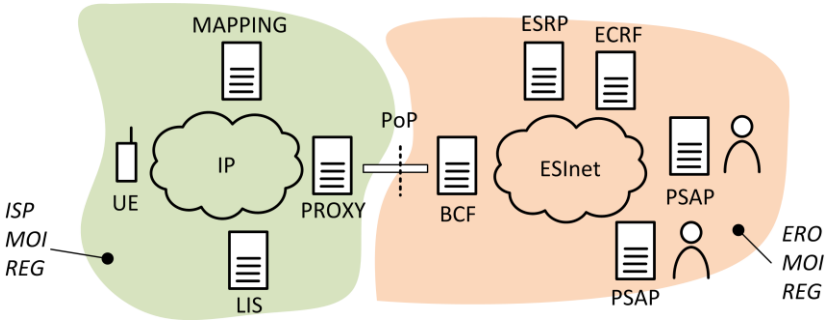

Figure 12: ESInet terminates IP

Transition actions

Stakeholder	Legislation	Regulation	Invest
VSP	caller location, VoIP emergency calls permitted by law, emergency call delivery	caller location	mapping service, location service, emergency call application,
MOI/REG	-	mapping data collection, harmonize PoP interface, shape-files describing jurisdictional areas to replace area/dialling codes	-
ERO	-	-	state/nation-wide ESInet NG112 PSAP equipment, gateways, BCF, ESRP, ECRF, mapping/routing update
ISP	-	caller location/ mapping service	Caller location and mapping service equipment.

Risks/Challenges

- One major challenge is the implementation and operation of a common infrastructure where different EROs are handling emergency calls.
- It may also take some time before industry is ready to provide functional elements that are certified or have proved to conform and interoperable with other elements of an NG112 architecture. Certification requires a certification body, an associated test bed and an agency to stand-up and provides this capability.
- VSPs may have a legal requirement compelling them to route emergency calls to a national PoP.
- Migration to NG112 may require effort to ensure signalling and media compatibility between the VSP provider and the PoP.
- Legal requirements for emergency call delivery are currently on voice service providers and this solution requires legislative and regulatory changes requiring access providers to make location and routing information available to emergency calls.

5 EENA recommendations

Stakeholders	Actions
European Authorities	Should create the necessary legal instruments to mandate access to 112 via a NG112 compliant PoP interface and enforce them accordingly with Member States. Such a standardised interface is the key enabler for further transition. Location information should also be made available in the same manner independent of technology used in originating networks.
National Government	Member States should ensure the transposition of any such legal instruments and ensure that the competent authority enforces such legal requirements in full. This should include all the relevant businesses that sell or utilise equipment as part of originating networks.
National / Regional Authorities	Should ensure the creation of a state/nation-wide ESInet. They have to provide the necessary budget for NG112 PSAP equipment, gateways, BCF, ESRP, ECRF, mapping/routing update
Emergency services	Should ensure that their staff is suitably skilled to manage such calls and be aware of any technological developments. Further, planners are encouraged to consider NG112 PSAP equipment in tender specifications (retrofit or renewal).
National telecommunication regulator / Network operators	Regulators and or the competent authorities should set the licence conditions on the relevant network providers to ensure their compliance with the NG112 interface to emergency services.

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