

CELESTE

Cross-border Esinet and LoST
Emergency Services TEsting



In this Final Report for EENA's
Next Generation 112 Project,
discover the findings of the
CELESTE consortium.

CELESTE

NG112 Project Report



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INTRODUCTION

European Telecommunications Standards Institute (ETSI) Plugtests have already shown that early implementations of Next Generation 112 (NG112) core services are interoperable and ready for field deployments. An Austrian Pilot that supports accessibility to Austrian emergency services based on NG112 core services - DEC112 - went live in February 2019. The DEC112 project provides an open source ESInet as well as a text chat application and several means to integrate with the Public Safety Answering Point (PSAP) (call processing equipment or computer aided dispatching). Other services with similar capabilities are being launched and discussed in European countries alike.

Currently, NG-based communications are bound to single countries, receiving a service unavailability message when crossing borders. Assuming each neighboring country runs an ESInet (ECRF and ESRP) supporting ETSI standardised interfaces (LoST and SIP, respectively), the LoST architecture uses the term Forest Guide (FG) to define such an element that can interconnect multiple ESInets managed through authoritative mappings.

This **project** aims to provide local or regional ESInet deployments and a Forest Guide that are interconnected to allow roaming with DEC112 and other similar services, providing multimedia capabilities (audio, video and text). Participating PSAPs integrate with the ESInet to receive call or chats in case a person in need is using the the DEC112 application or other VoIP clients.



EENA launched the NG112 Project to test and deploy the technical architecture enabling NG112 in different European countries, with a focus on demonstrating its use in real-life environments.

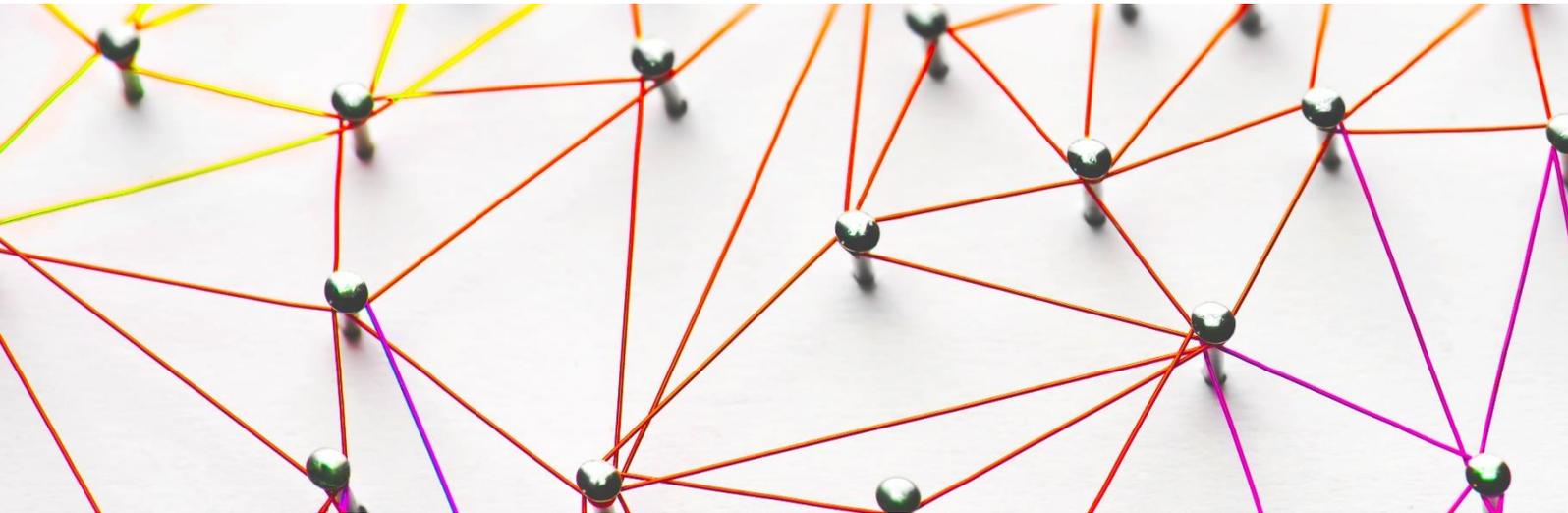


Three consortia were selected for the project:

CELESTE : Austria, Italy, Denmark

Croatia

Turkey



1 | CONSORTIUM



 Federal Ministry
Republic of Austria
Interior

PSAP Tirol, Austria

Role: DEC112 endpoint - basically a single position to receive emergency text chat and location (Emergency Numbers: 122, 144 and 140)

Contact: Thomas Dilitz, thomas.dilitz@leitstelle.tirol

About: The PSAP Tirol is a subsidiary of the Austrian Federal State Tyrol and the central control centre of the Tyrolean blue light organisations. It receives the emergency calls via 122 (fire brigade), 140 (alpine emergency call) and 144 (rescue services) and coordinates the emergency forces. Up to 25 employees work continuously in shifts. A total of 75 employees work at the control centre in Tirol.

Federal Police Control Centre Innsbruck, Tirol, Austria

Role: DEC112 endpoint - basically a single position to receive emergency text chat and location (Emergency Numbers: 112 and 133)

Contact: Siegfried Wallner, siegfried.wallner@bmi.gv.at

About: The Austrian Ministry of the Interior has introduced a new software, ELKOS, for the Austrian police. ELKOS (an acronym translated as "operational dispatch and communication system") is a nationwide software of the Federal Police of Austria, which is intended to enhance the service for people in search of help. Furthermore, ELKOS provides an interface between the police and other emergency services throughout Austria. The eCall service is implemented as well. The Public Safety Answering Point (PSAP) in Innsbruck is one of nine PSAPs in Austria and one of the first using the new ELKOS system. In future, citizens will only have to disclose their data once when making an emergency call (or eCall). Even if they are later transferred to another competent emergency call centre, the data will be automatically forwarded. In this way, parallel operations and double data collection can be avoided and the chain of assistance can be accelerated. The police are thus able to reach citizens even faster. ELKOS is not only intended to speed up the processing of an emergency call, but also to speed up access to the scene of the emergency and parallel communication with other emergency organisations.

Regulatory Authority for Broadcasting and Telecommunications (RTR), Austria

Role: Observer

Contact: Mehdi Safaei, Mehdi.Safaei@rtr.at

About: The Austrian Regulatory Authority for Broadcasting and Telecommunications (RTR) is wholly owned by the Republic of Austria. RTR's core mandate is to promote competition in the broadcasting, telecommunications and postal markets as well as to achieve the goals set out in the KommAustria Act and the Telecommunications Act.



PSAP Greater Copenhagen, Denmark (The Greater Copenhagen Fire Department)

Role: DEC112 endpoint - basically a single position to receive emergency text chat and location (Emergency Number: 112) and service hosting.

Contact: Jens C. Behrens, behrens@112.dk

About: The first Copenhagen fire brigade was established in Copenhagen on 9 July 1687 when King Christian V set up the Royal Copenhagen Fire Brigade through the appointment of the "Presidency of the fire, lamplighting and watchman service". In 1870, the Copenhagen Fire Brigade was established as a municipal institution. In step with changes in society, the tasks of the Copenhagen Fire Brigade were extended to include an ambulance service (1898), the smoke diver service (1930) and the pioneer service (1941).

The year 1946 saw the introduction of a permanent smoke diver watch service, and in 1965 the Alarm and Control Room at the main fire station took over as the emergency control centre for the entire Greater Copenhagen Area (112 PSAP). The patient transportation service was added in 1974, while the most recent addition is the civil emergency preparedness system which was created in 1998. On 1st January 2016, the Greater Copenhagen Fire Department was created as a joint venture between 8 municipalities in the Greater Copenhagen Area.

The Greater Copenhagen Fire Department has almost 1000 employees, including a preparedness force of approximately 700 professional firefighters and ambulance crew. The employees, who are engaged in fire prevention activities and the rest of the staff, make up the backbone of an institution, which ensures that the citizens of the eight municipalities are guaranteed an efficient fire, rescue and ambulance service.

The 112 Group is the Greater Copenhagen Fire Department IT department dedicated to IT uses under operational conditions. The group develops 112 call taking systems, Computer Aided Dispatch and Control systems and on-site fire and rescue incident support systems.

PSAP 112 Trento

Role: NG112 voice/video/chat and DEC112 endpoint - basically a single position to receive emergency voice, video, chat and location (Emergency Number: 112)

Contact: Silvia Marchesi, Silvia.Marchesi@tndigit.it

The 112 PSAP in Trento was created in 2017 and it is a unit of the Civil Protection Department of the Autonomous Province of Trento. Up to twenty employees work continuously on shifts and another five belong to the technical staff (made of technicians, clerks and coordinator). The 112 PSAP in Trento is one of the thirteen 112 PSAPs in Italy and serves a population of about 500,000 citizens. Every day it receives an average of 1000 calls and, after processing them, call takers dispatch them to the fire department, emergency medical service and police. The northern part of the territory served by the 112 PSAP of Trento borders with the territory of the Autonomous Province of Bolzano, served by the 112 PSAP of Bolzano, and in some border areas both the PSAPs suffer from the wrong routing of calls.

PSAP 112 Bolzano

Role: NG112 voice/video/chat and DEC112 endpoint - basically a single position to receive emergency voice, video, chat and location (Emergency Number: 112). Bordering with Austria for cross-border scenarios.

Contact: Markus Rauch, Markus.Rauch@provinz.bz.it

The 112 PSAP in Bolzano was created in October 2017 and is a unit of the Health company of the Autonomous Province of Bolzano. Up to 20 employees work continuously on shifts. The technical staff (5 technicians) are from the Civil Protection Agency, who are responsible for resolving all technical problems and providing all hardware and software required, as well as the premises. The 112 PSAP in Bolzano is one of the thirteen 112 PSAPs in Italy and serves a population of about 500.000 citizens. Every day, it receives an average of 600-700 calls and, after processing them, call takers dispatch them to the fire department, emergency medical service and police. The southern part of the territory served by the 112 PSAP of Bolzano borders with the territory of the Autonomous Province of Trento, served by the 112 PSAP of Trento. In some of border area, both the PSAPs suffer from wrong routing of calls. In the northern part, the Autonomous Province of Bolzano borders with Austria, with the Region Tyrol. With this region, the 112 PSAP in Bolzano suffers the same problems with wrong routing of calls.



Beta 80 Group

Role: Beta 80 hosts a regional ESInet deployment for the region Trentino-Südtirol.

Contact: Luca Bergonzi, Luca.Bergonzi@beta80group.it

About: Beta 80 is a leading provider of software solutions for public safety. Our products are the result of our extensive experience as well as a constant research and development and are currently used in 75 PSAPs spanning 7 countries in Europe and beyond. Beta 80 is the no.1 provider for CAD since 1992 in Italy, serving all kinds of emergency forces: Ambulance, Fire, 112, Coast Guard and other types of Contact Centres. Mainly known for CAD, Beta 80 develops emergency apps for citizens certified with PEMEA standard, eCall modem solutions and currently provides all the core software components for the deployment of an NG112/NG911 ESnet.

Frequentis AG

Role: Frequentis hosts and manages a regional ESInet deployment (ESRP) for the region Tirol, Greater Copenhagen and all DEC112 application backend services.

Contact: Wolfgang Kampichler, wolfgang.kampichler@dec112.at or wolfgang.kampichler@frequentis.com

About: Frequentis Public Safety has been supplying emergency services organisations with highly reliable, easy-to-use control centre solutions for more than two decades. Extensive expertise gained from a comprehensive and scalable voice communication and information offering across key industries sets the foundation for supporting multiple segments with solutions tailored to customer needs. As communication technology evolves toward more open and multimedia-oriented standards and platforms, Frequentis is leading the way in defining and implementing these standards through active participation in industry organisations, such as EENA, NENA, APCO and TCCA. Frequentis hosts a regional ESInet deployment (ESRP) for the region Tirol and all DEC112 application backend services.

GridGears

Role: GridGears hosts a regional ESInet deployment (ECRF) for the region Tirol and a centralised Forest Guide.

Contact: Michael Pröstler, michael.proestler@gridgears.at

About: GridGears was founded in 2017 with the goal of enabling better, more integrated and more efficient emergency services. Standards such as NG112 or NG9-1-1 define a common language that allows easy, extensible and future-proof integration between systems that provide modern, dynamic and efficient emergency services. GridGears provides multiple products of the NG112/NG9-1-1 architecture and is actively participating in driving these standards.

Mario Murrent - Software Solutions

Role: Mario Murrent - Software Solutions, provides a DEC112 Test-Application to be customised for several countries.

Contact: Mario Murrent, software-solutions@murrent.at

About: Mario Murrent - Software Solutions was founded in 2015 with the goal to build personalised and customisable software solutions for different businesses. In 2017, Mario Murrent - Software Solutions joined the DEC112 team to help implement the DEC112 Application.



2 | OVERVIEW

In this project report, we will explore different testing scenarios of several use cases. These include DEC112 (text chat) and VoIP/WebRTC (audio, video, text chat) scenarios.

Problems are often found in routing calls in border regions. The goal of the project is therefore to demonstrate routing capabilities within the NG112 architecture across international borders. In order to accurately test this capability, the scenarios have been tested in regional and international contexts in Austria, Denmark and Italy.

Testing the international cases involves using a mapping hierarchy that includes a Forest Guide. The Forest Guide redirects the response according to the mapping configuration. In Chapter 3, the detailed technicalities of these scenarios are explored. The CELESTE architecture, including examples of message charts and sequences, is explained in Chapter 4.

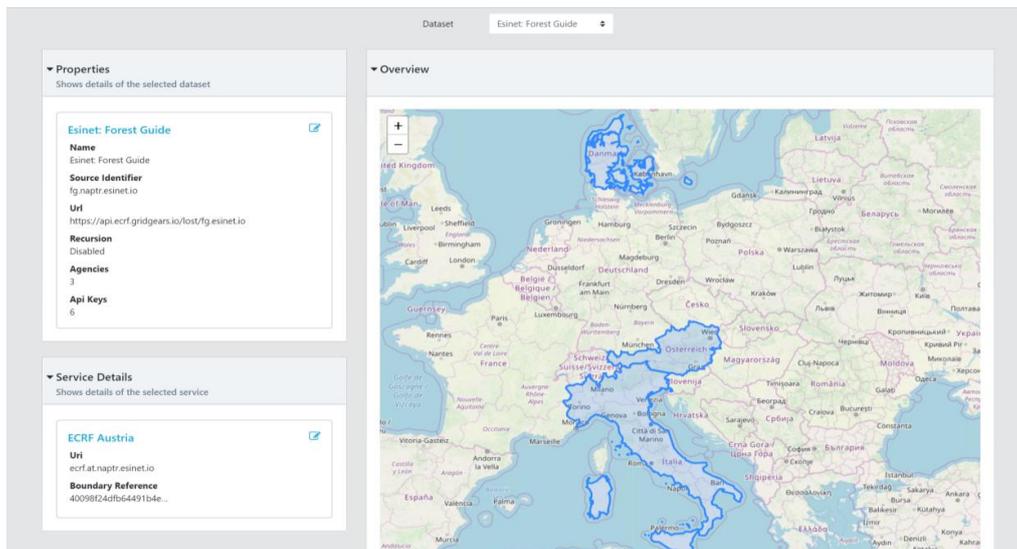


Figure 1: Forest Guide Configuration & Mapping

During the testing phase, the main objectives were to compare ESInet routing capabilities with legacy emergency systems, as well as demonstrate interconnected ESInets in a cross-vendor configuration.

The use cases involved utilising the DEC112 application (text chat). To start an emergency chat, the use selects a service in home screen. This generates an automatic message. After receiving the first response from the control room, the use may continue with chat conversation.

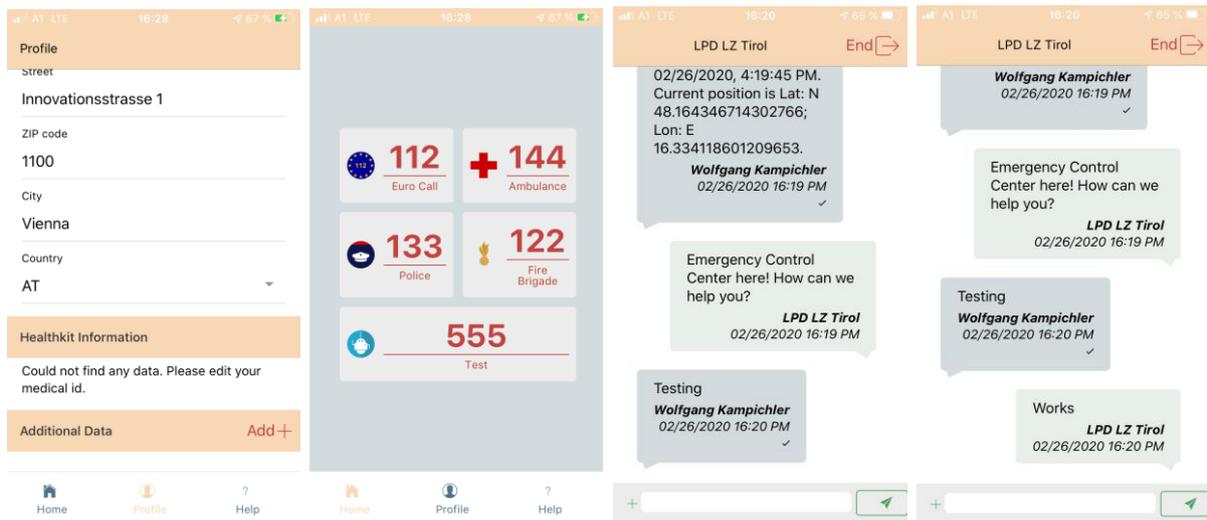


Figure 2: DEC112 Application (Region: Austria)

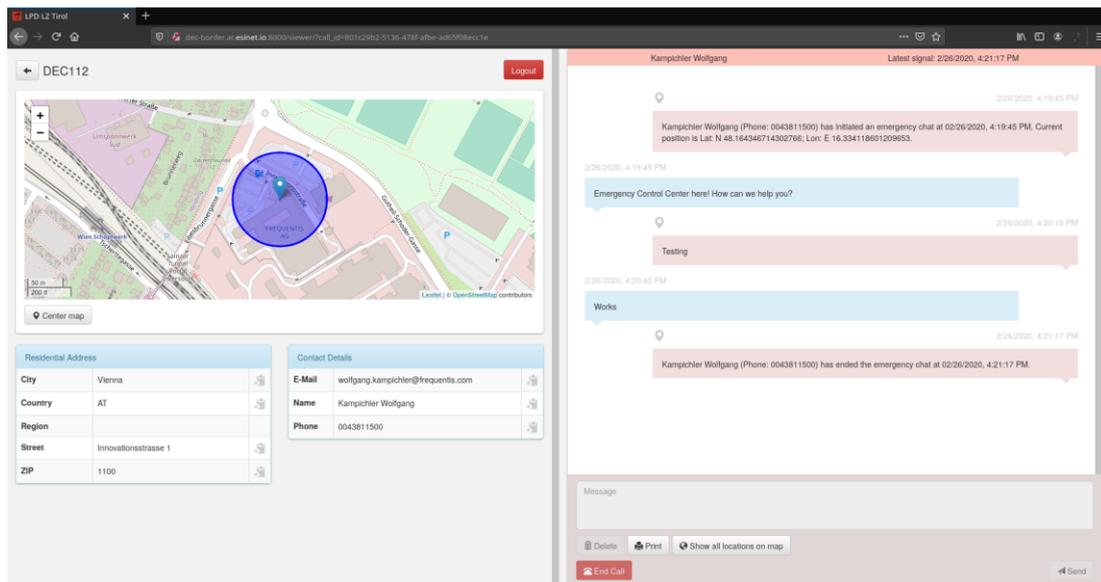


Figure 3: DEC112 PSAP Viewer (LPD LZ Tirol)

Several tests also involved videocalls. The videocall is monodirectional: the emergency call taker can see the scene but cannot be seen by the citizen.

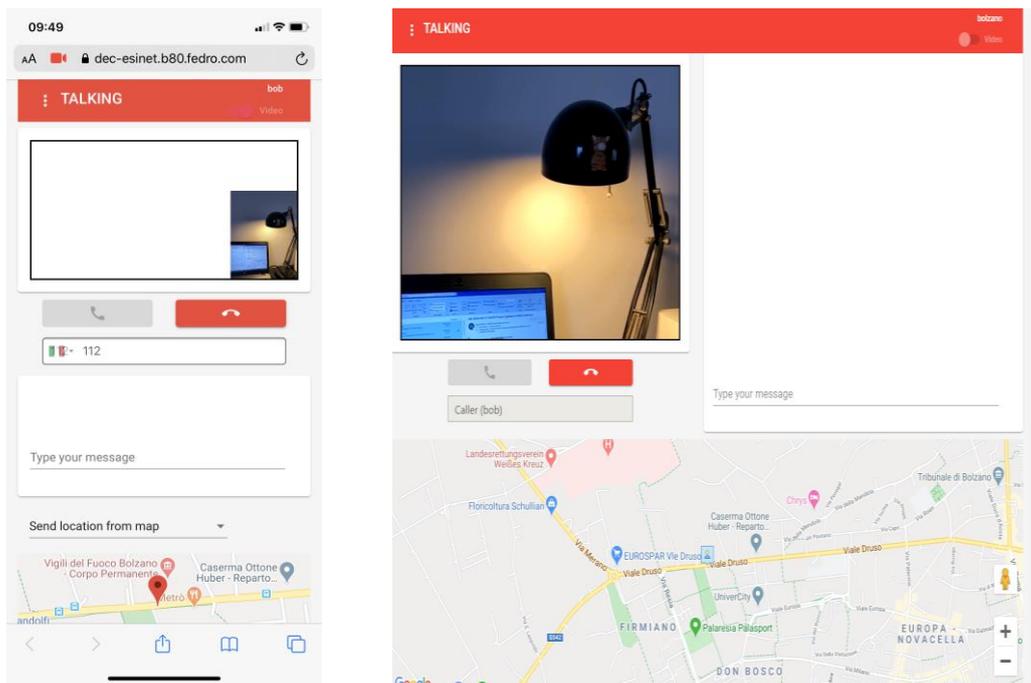


Figure 4: webRTC client (left) and PSAP user interface, with ongoing videocall and location of the caller (blue icon in the center of the map)

Alongside these use cases, the CELESTE project also compared cross-border calls routed with traditional network-based routing and those routed with the Next Generation 112 architecture (NG112). The current traditional routing has created challenges when the geolocation is not always precise enough to accurately route the call to the correct PSAP.

The following image shows a test in Italy with a call made in Senale San Felice, a town under the Province of Bolzano, close to the Regional border with Trento. Due to routing mechanisms, calls placed in Senale with the current 112 platform end up in Trento instead of Bolzano. By placing calls with NG112 platform, calls are correctly received in Bolzano.

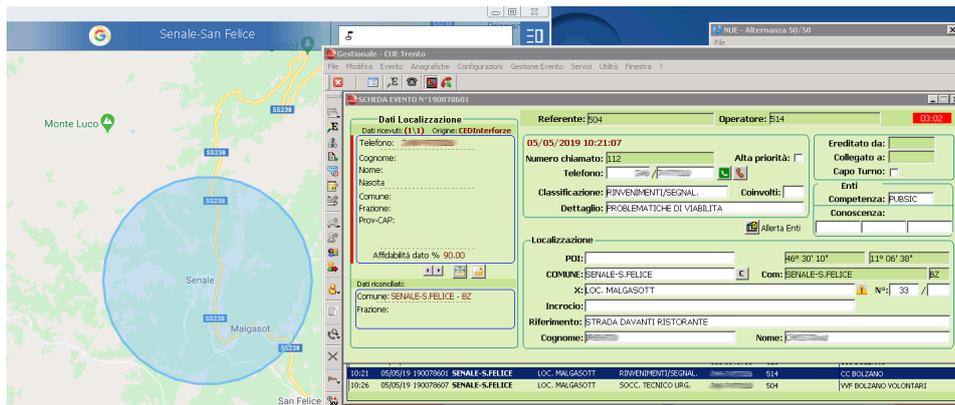


Figure 5: 112 CAD in Trento showing the incident in Senale and GIS showing the approximation of geolocalization of the caller. The CAD also shows in the bottom the list of Dispatching agencies that should be alerted, referring to Bolzano agencies and not Trento.

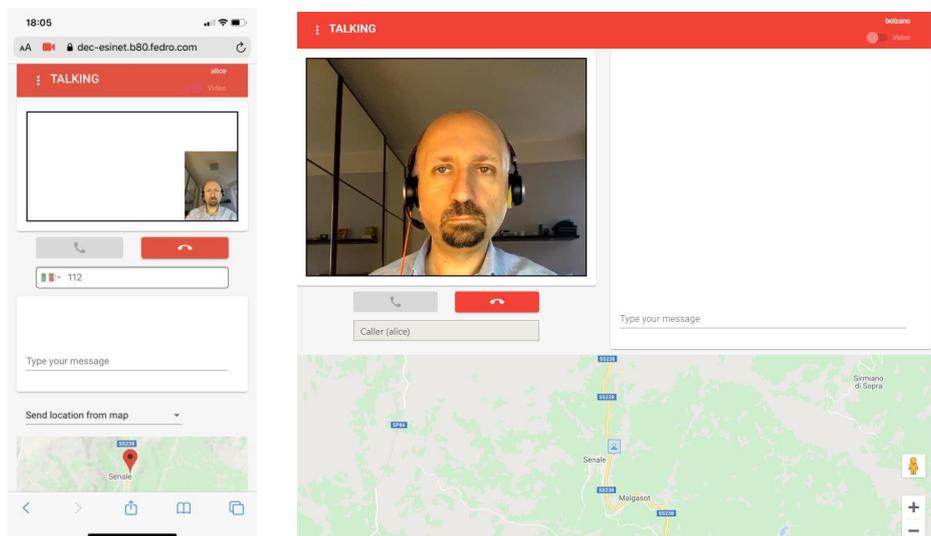


Figure 6: webRTC client (left) and PSAP user interface, with ongoing videocall and location of the caller (blue icon in the center of the map). The location, Senale, is corresponding to 112 Bolzano PSAP in the NG112 call scenario.

All the testing scenarios and their results are presented in detail in Chapter 5 and 6. In Chapter 7, recommendations are provided on authentication mechanisms, geographic data and the forest guide.

3 | CELESTE SCENARIOS

The goal of the project is to demonstrate the routing capabilities within the NG112 architecture across international borders. Multiple vendor implementations of the different core components are integrated to enable the routing capabilities within and across multiple independent ESInets of different countries.

REGIONAL SCENARIO

All use cases rely on a regional ESInet deployment including core services (ECRF and ESRP), and a PSAP that supports interfaces to receive a location object (location by value or reference), text messages or calls utilising the Session Initiation Protocol (SIP), as defined in TS 103 479. In addition, a complete infrastructure to run the DEC112 application ecosystem is put in operation per region. To get a better understanding of how the services interwork, we differentiate among APPLICATION/PUBLIC, CORE SERVICES/ESInet and PSAP, as shown in the image below (Figure 7).

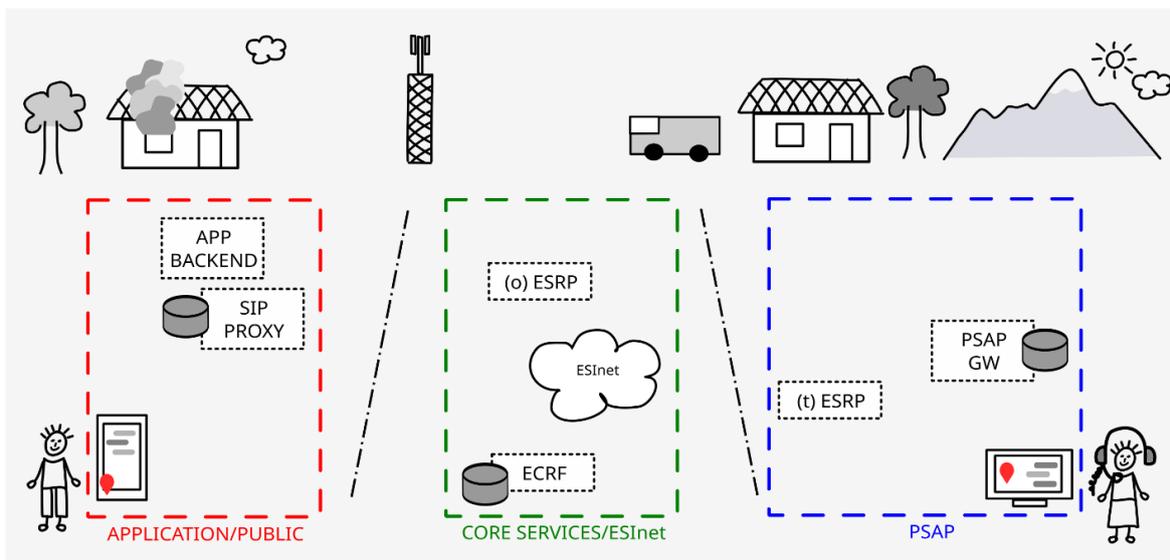


Figure 7: Regional deployment

The PUBLIC part is considered as an originating network, or application service provider (e.g. messaging or voice communication) and the ESInet to provide mapping and routing functionality. Finally, the PSAP to receive emergency calls or chats.

Per configuration, the application service provider (in this case represented by a SIP Proxy) connects to or peers with its regional *originating* ESRP, which, together with the ECRF makes up for the regional ESInet. Emergency text messages or calls are forwarded via the ESInet to the PSAP that is responsible for this region. In general, PSAPs may choose different types of integration, starting from a simple PC/Browser setup to a more complex integration of the CPE/CAD with the ESInet infrastructure via a specific gateway (GW).

A prerequisite to any scenario is a SIP registration with a service endpoint, the *terminating* ESRP for the PSAP and SIP Proxy for DEC112 or a VoIP client. In the case of the originating entity, this may happen upon starting the application – in the case of a PSAP this is typically done when starting operations, as shown in Figure 8.

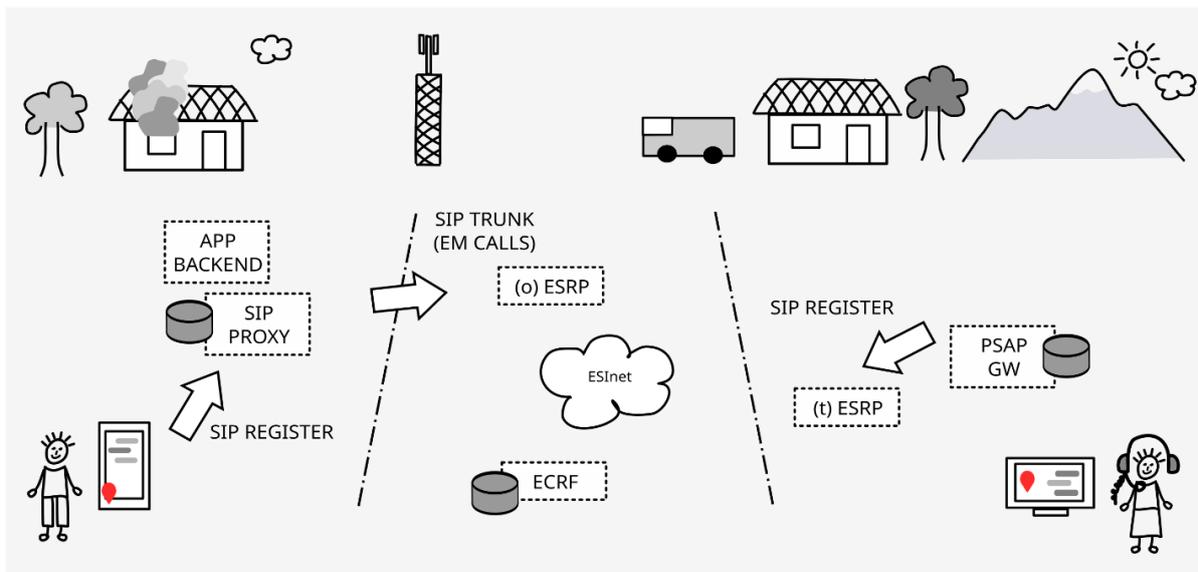


Figure 8: Initial registration

The originating application is now ready to initiate an emergency conversation (messaging or voice communication). The following illustrates a use case example based on DEC112 (note that the same applies to voice communication, except the use of different SIP methods). Upon activation of an emergency chat, an initial message (providing location and user data) is sent via the SIP Proxy (1 in Figure 9) to the *originating* ESRP (2). Based on the number or service URN and location received, the ESRP queries the ECRF (3, 4) to retrieve the next hop's SIP URI - in this specific case the *terminating* ESRP (5). Finally, the message is forwarded to the PSAP (6).

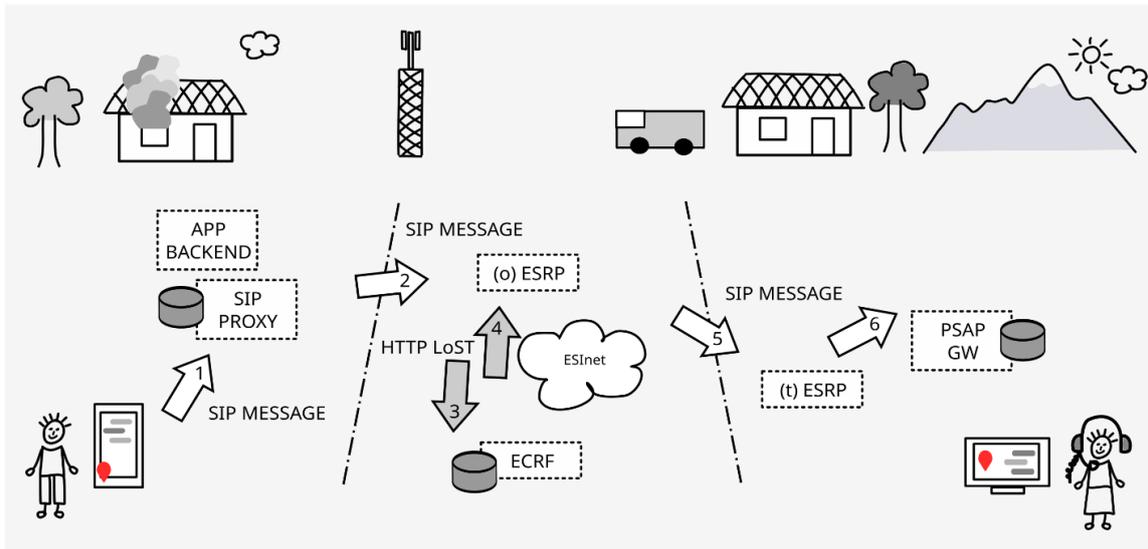


Figure 9: Regional message flow (inbound)

In the case of DEC112, an automatic response is returned to the originating application based on default SIP routing mechanisms (7, 8, 9) as shown in Figure 10 (top).

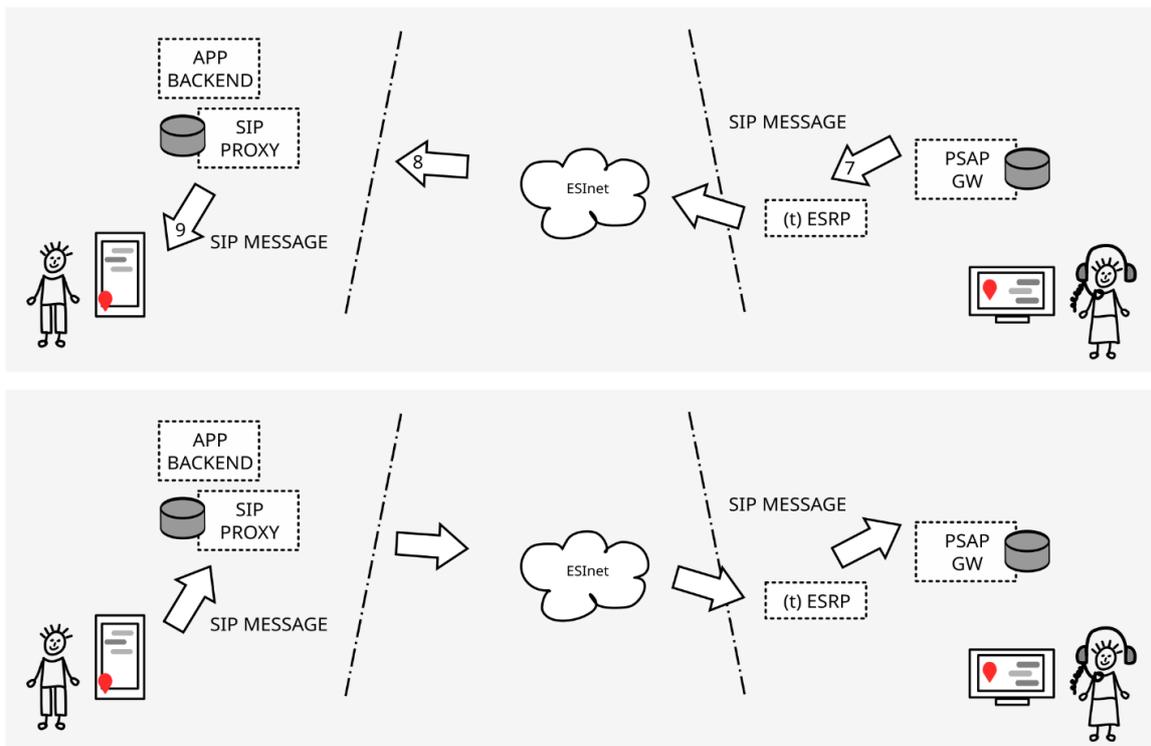


Figure 10: Regional message flow (outbound) and conversation

The initial automatic conversation is used to set up a messaging conversation (session mode), as illustrated in Figure 10 (bottom) and also helps to measure latencies in different uses cases as explained later in this document. As already mentioned, the same applies to voice calls except that other SIP methods are used. Figure 11 illustrates the message flow in case of a call set up, where location information and service URN are provided with a SIP INVITE message.

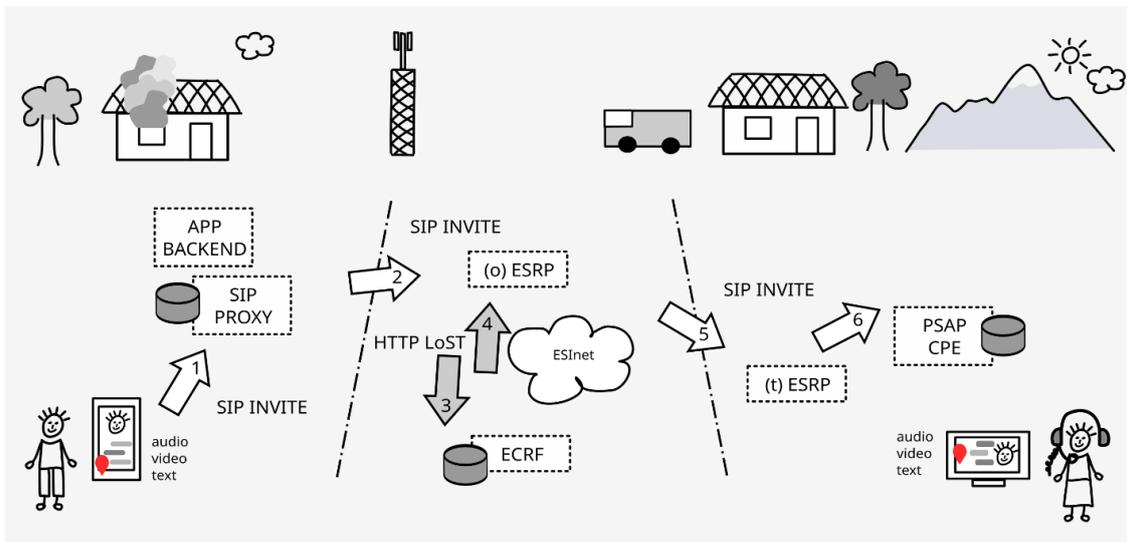


Figure 11: Call set up



INTERNATIONAL SCENARIO

In addition to the regional use case, the project aims to test international use cases utilising a mapping hierarchy that includes a Forest Guide (FG).

Figure 15 shows the mapping configuration of the different ESInet deployments in Austria, Denmark and Italy. Figure 12 shows a scenario with a user from Region A that moved abroad (Region B) but still connects to its public service provider in Region A. Any started conversation includes location information somewhere in Region B, which shall result in being connected to a PSAP serving that specific region. Assuming bilateral agreements to accept conversations that are forwarded via ESInet peering, the use case may be similar to what is being illustrated next in Figure 13.

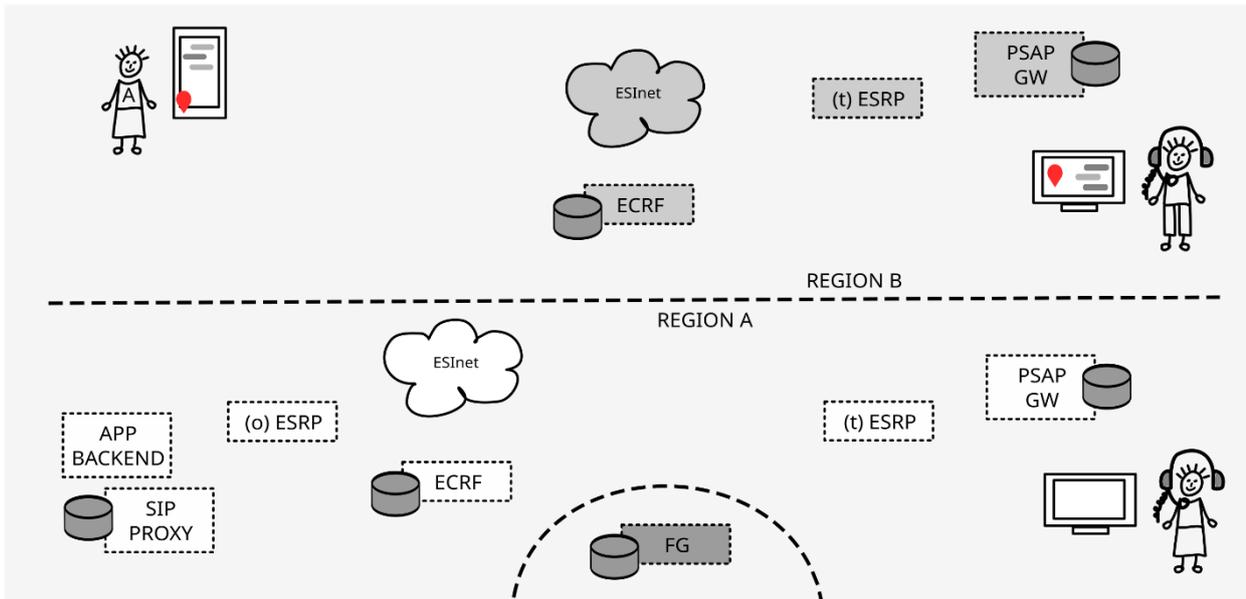


Figure 12: International scenario

Similar to the regional use case, a call or chat initiating message is forwarded via the SIP Proxy to the *originating* ESRP of Region A (1, 2 in Figure 13). Since an *originating* ESRP just knows its local ECRF, the mapping request (3) is sent to the ECRF of Region A. The provided location (Region B) won't resolve to a PSAP SIP URI and therefore, the ECRF consults (4) the FG that, in turn, responds with a redirect message that includes information of the authoritative mapping entity (ECRF) of Region B. Then, the ECRF of Region A retrieves mapping information from Region B's ECRF (5), which is returned to the ESRP. Finally, the request is forwarded to the *terminating* ESRP that manages the PSAP (6). The remaining message flow is similar to the regional use case.

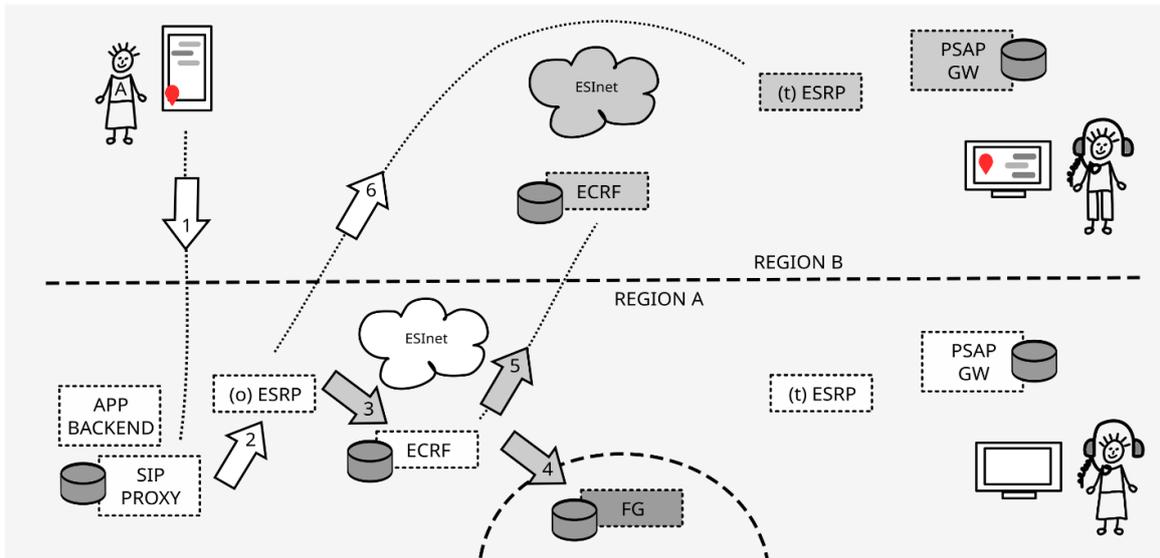


Figure 13: International scenario (chat)

Figure 14 illustrates the message flow of an international scenario in case of a call set up, where location information and service URN are provided with a SIP INVITE message.

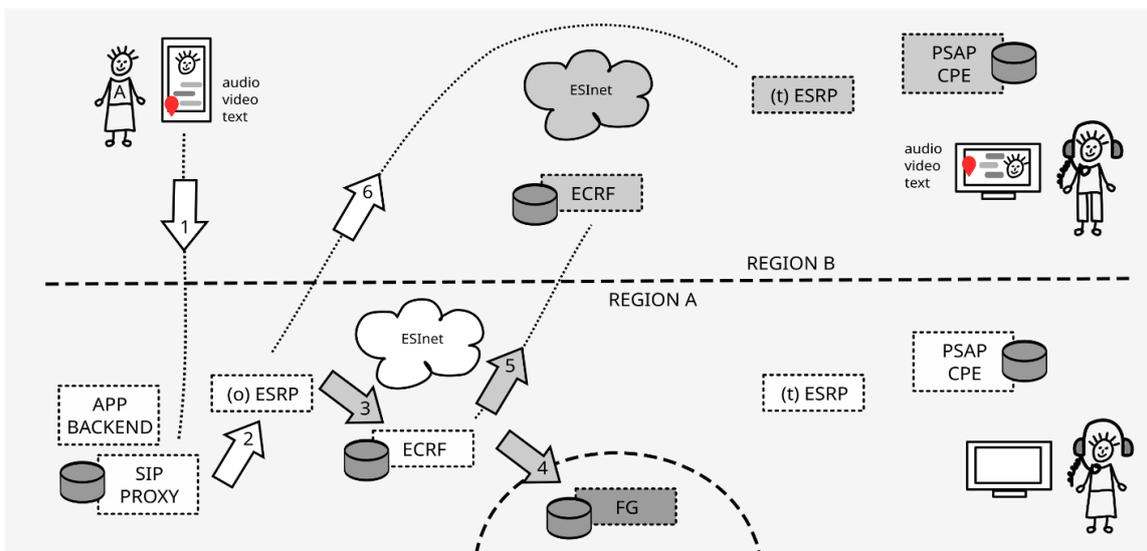


Figure 14: International scenario (voice call)

One advantage of this approach is that each country maintains its own infrastructure and authoritative mappings. The FG only redirects to national ECRFs and does not need to know about national PSAPs (and how they are organised). Figure 16 shows an example of a Forest Guide redirecting a response according to the mapping configuration. Further, national borders are not changing that often so there is basically little effort in running a Forest Guide and peering agreements are only necessary between ECRFs for mapping and ESRPs for international routing.

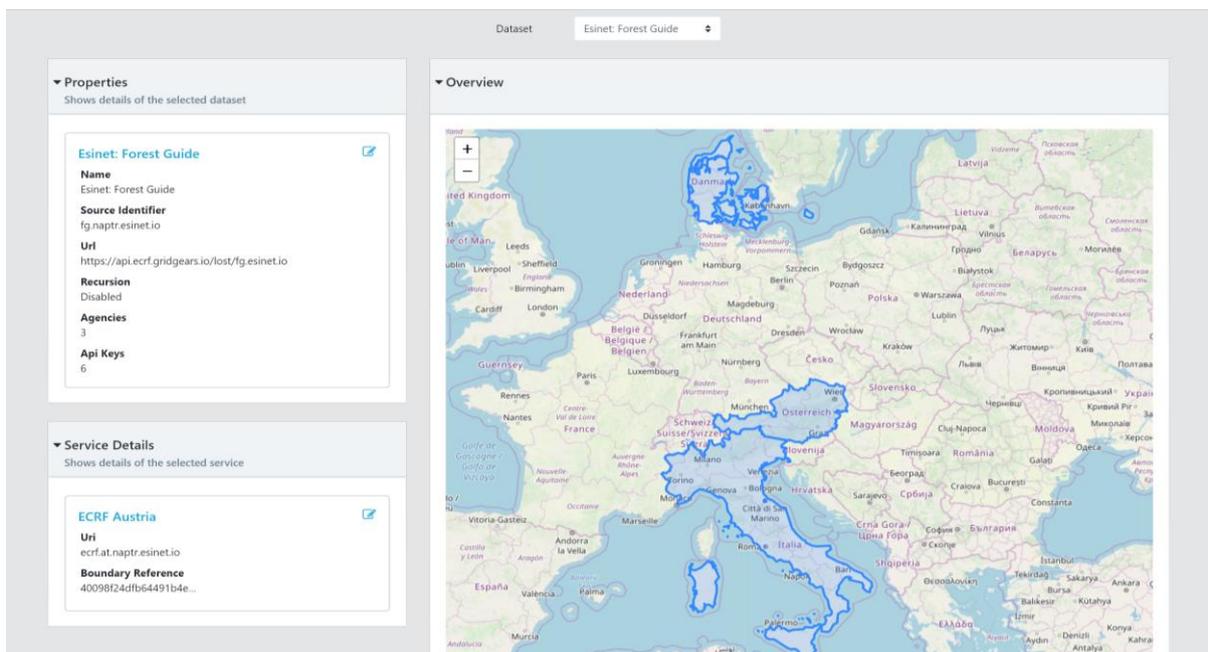


Figure 15: Forest Guide Configuration & Mapping

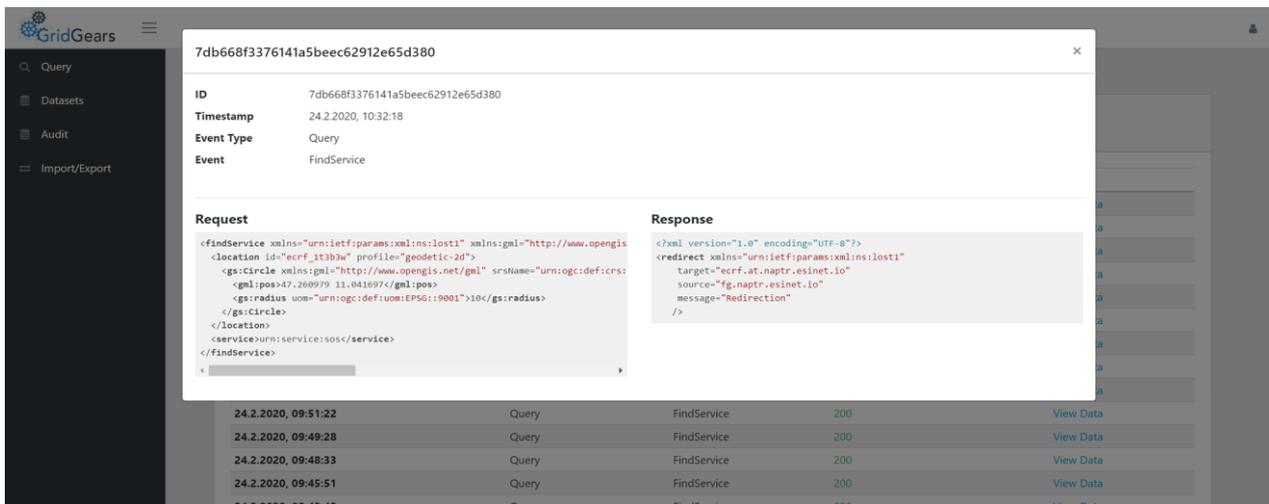
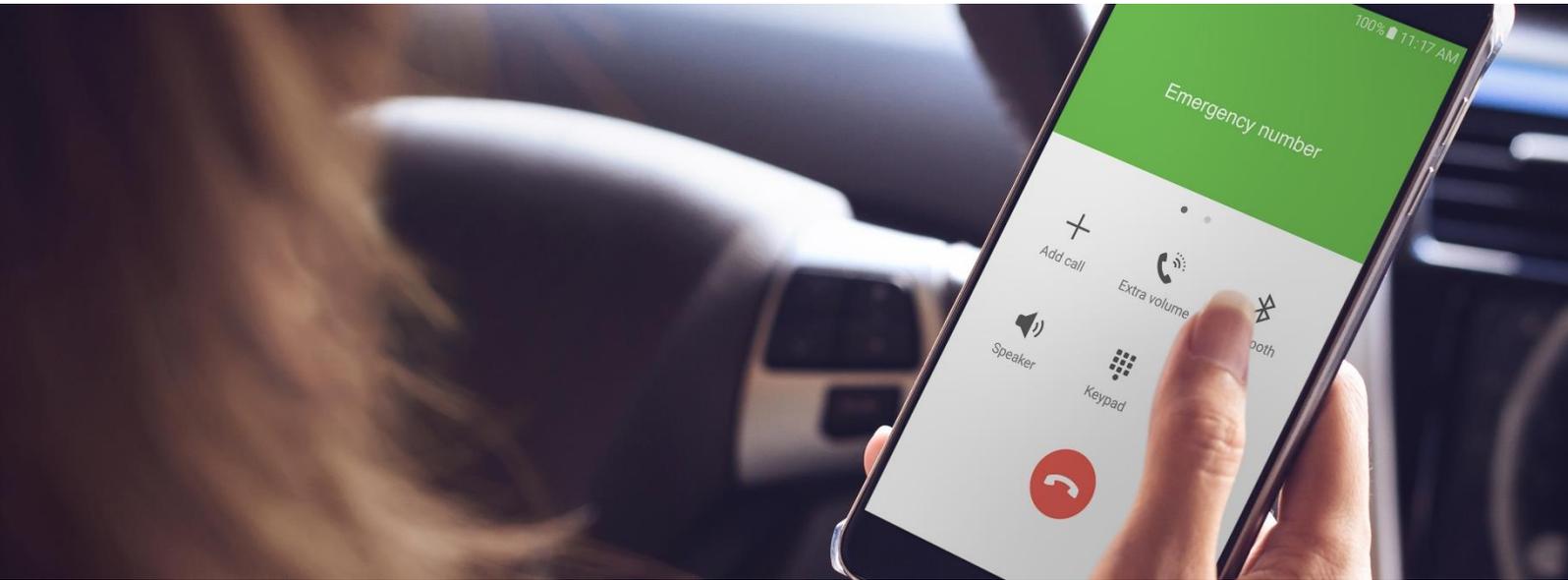


Figure 16: Forest Guide Redirection Example



4 | CELESTE ARCHITECTURE

OVERVIEW

The architecture follows the principle of separating public services from ESInet and PSAP endpoints and considers available core services and hosting capabilities. It is noted that the architecture misses a BCF as none of the project members has access to a similar product – basically, the SIP Proxy would peer with a BCF and not directly with the *originating* ESRP. In general, the architecture supports any type of media session that is negotiated during session setup.

In general, there are three different regional deployments – Austria [at], Denmark [dk] and Italy [it] – where [at] and [dk] are similar in terms of service configuration but hosted at different sites. Service backends, SIP Proxy and ESRPs for Austria are hosted at RTR (VMs and Docker container) and the corresponding ECRF resides at an Austrian hosting provider. CPFD hosts Service backends, SIP Proxy and ESRPs for Denmark (VMs and Docker container) and the ECRF resides at a European data center, as illustrated in Figure 17.

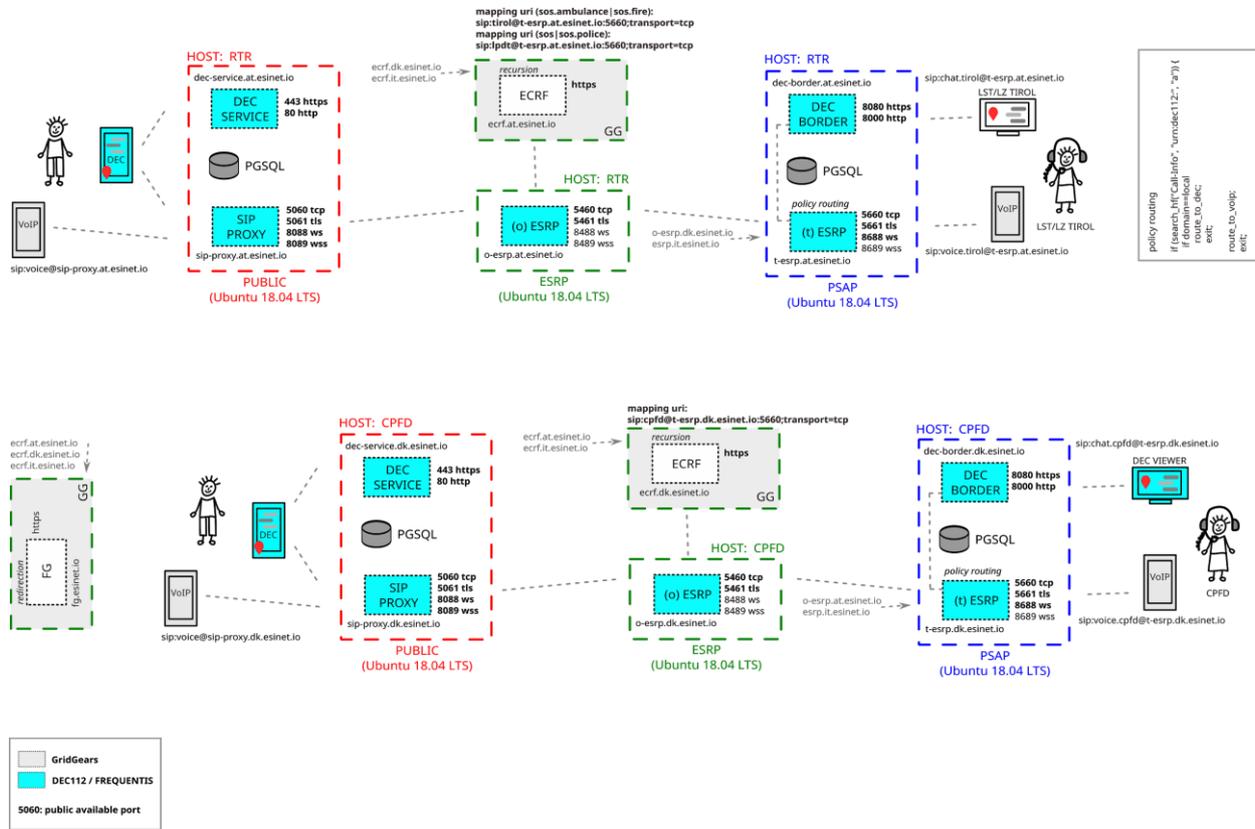


Figure 17: Regional deployment for Austria (top) and Denmark (bottom)

To support different hosting options (e.g. single or multiple VMs), each core service or service backend has its unique port number and name to be configured in the public DNS (e.g. `t-esrp.dk.esinet.io:5660` represents the *terminating* ESRP located in regional ESInet of Denmark and is reachable from other ESInets).

To introduce the architecture, we start with the left upper part illustrated in Figure 15 – the public application service provider. Initially, user equipment (UE) is provisioned manually (e.g. SIP configuration parameter to register with the regional SIP proxy), or automatically via the DEC112 service. The APP first connects to a root service (note that for the sake of simplicity this is not shown in Figure 15) in order to request available regional DEC112 services. As the next step, and depending on the selected country, configuration parameters are requested from the regional DEC112 service. After that UEs are configured and ready to start a conversation.

Another prerequisite is that peering (SIP trunk) is enabled between SIP Proxy and *originating* ESRP. This is basically a static SIP routing in case a UE provides an emergency number (e.g. 112) or a service URN (`urn:service:sos`) with a conversation set up. In addition, the *originating* ESRP needs to know how to reach the local ECRF in order to retrieve mapping information. Again, this is a static configuration of the *originating* ESRP. SIP URIs of possible next hops (i.e. any

terminating ESRP) are returned when querying the local ECRF with a given location and service URN. Note that the Austrian deployment differs in the sense that more than one service URN is configured. Requests containing service URNs `urn:service:sos` and `urn:service:sos.police` are routed to the PSAP of the Federal Police Department, whereas service URNs `urn:service:sos.ambulance` and `urn:service:sos.fire` shall terminate at PSAP Tirol. Therefore mappings provide either `sip:lpdt@-esrp.at.esinet.io` or `sip:tirol@-esrp.at.esinet.io`.

The FG serves as a redirecting entity in case a local ECRF doesn't cover regions an UE is calling from (see Figure 13 or 14). The terminating ESRP (top right in Figure 17) manages PSAP endpoints that may receive calls or DEC112 chats. Note that this is a simplified PSAP integration to support use cases introduced earlier in the document. A terminating ESRP may serve different PSAPs and typically maintain SIP trunks, whereas automatic call distribution to a free call taker is managed within the PSAP system.

Figure 18 shows a slightly different architecture with the aim to demonstrate two main scenarios – cross vendor interoperability and policy routing capabilities of an ESInet. In this specific case the PSAP hosts two applications that are capable of chatting, but with different characteristics (page mode and session mode). In order to make sure that requests are finding the correct endpoint within the PSAP, the terminating ESRP utilises a PRF (Policy Routing Function) that looks for specific details that characterise one or the other messaging modes. In general, such a PRF may also be used to re-target requests based on actual load or simply the time of day.

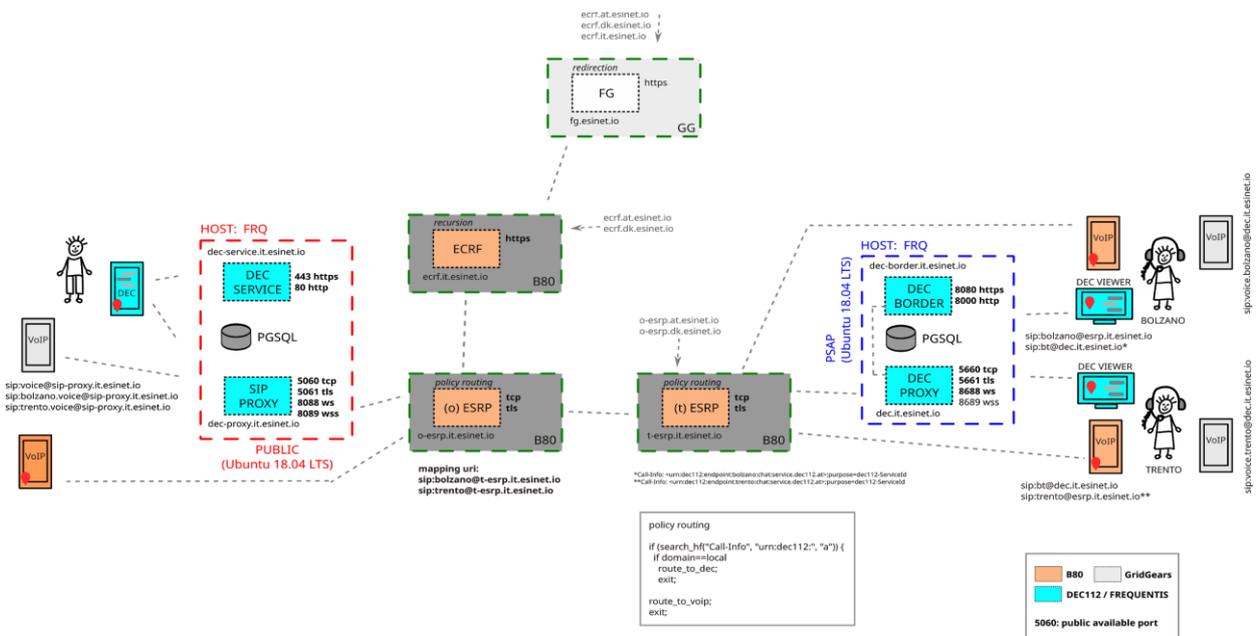


Figure 18: Regional deployment for Italy

MESSAGE CHARTS

The following section provides detailed message sequence charts of the introduced scenarios. It is noted that for the sake of simplicity, not all header fields or message bodies are included.

Message Sequence Charts (DEC112 regional deployment)

Figure 19 shows the message sequence in the case of a regional emergency messaging (session mode) conversation started by the UE.

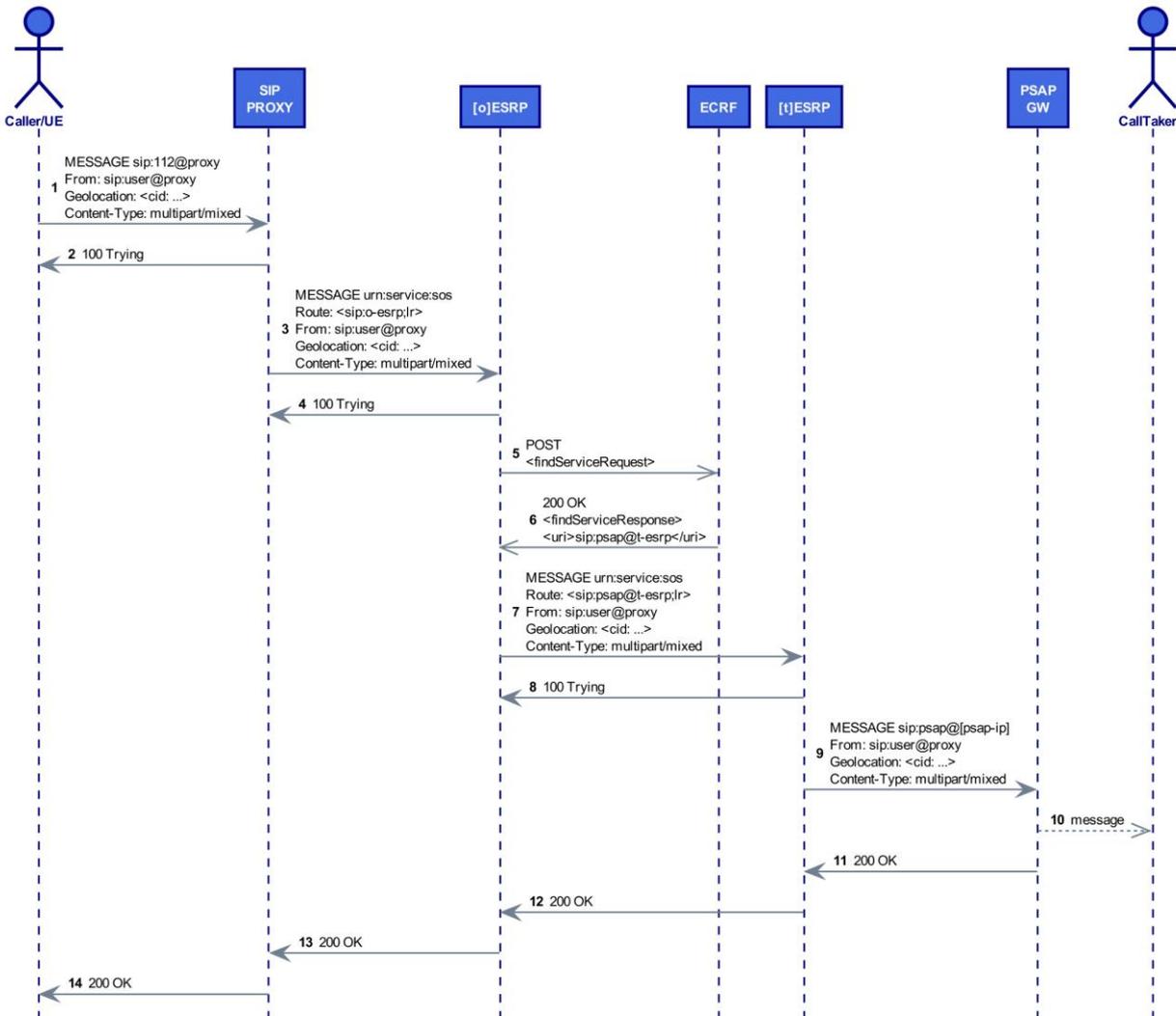


Figure 19: Messaging (session mode: initial message)

The following message snippet (note that some parts were shortened to fit the page width) received at the *Federal Police Control Center Innsbruck* (sip:lpdt@t-esrp.at.esinet.io) shows the SIP entities and ESInet core services that are part of the initial message sequence (i.e. message 9 in Figure 19) in a regional use case. Furthermore, the example also illustrates the use of sub services of a service URN (e.g. sos.police), Call-Info and Geolocation header as well as the multipart MIME body (pdf-lo, vcard and text).

```
MESSAGE urn:service:sos.police SIP/2.0
History-Info: <sip:o-esrp.at.esinet.io:5460;transport=tcp>;index=1
Route: <sip:lpdt@t-esrp.at.esinet.io:5660;transport=TCP;lr>
Via: SIP/2.0/TCP o-esrp.at.esinet.io:5460;branch=z9hG4bK52b3.c9975...74077e26c80f4.0;i=8797
Via: SIP/2.0/TCP sip-proxy.at.esinet.io:5060;rport=52930;received=...;branch=z9h...de;i=085
Via: SIP/2.0/TCP ...:41143;received=...;rport=41143;branch=z9hG4bKPj...C5F3DZD2pORCJ;alias
Max-Forwards: 68
From: <sip:pinger@sip-proxy.at.esinet.io>;tag=NbypPepcayxsJznHLSSy.8DSbLv7MrMI
To: <sip:133@sip-proxy.at.esinet.io>
Call-ID: Yqgv1516dGfNBtoYTsGftZeMAGpBojff2
CSeq: 58072 MESSAGE
Call-Info: <urn:dec112:uid:callid:3VEp2Lbg...Up9yzO:service.dec112.at>;purpose=dec112-CallId
Call-Info: Call-Info: <urn:dec112:uid:msgtype:21:service.dec112.at>;purpose=dec112-MsgType
Call-Info: <urn:dec112:uid:msgid:202002291111:service.dec112.at>;purpose=dec112-MsgId
Geolocation-Routing: yes
Geolocation: <cid:DebhEr9UuGigk4nr@dec112.app>
Content-Type: multipart/mixed;boundary=vqEMc1G8BLia6nbM0RPznMJRGdbheHqM
Content-Length: 2174

--vqEMc1G8BLia6nbM0RPznMJRGdbheHqM
Content-ID: <DebhEr9UuGigk4nr@dec112.app>
Content-Type: application/pdf+xml
Content-Length: 561

<?xml version="1.0"?>
<presence xmlns="urn:ietf:params:xml:ns:pidf" xmlns:gp="urn:ietf:params:xml:ns:pidf:geopriv10"
xmlns:gs="http://www.opengis.net/pidflo/1.0" entity="sip:pinger@sip-proxy.at.esinet.io"><tuple
id="circle"><status><gp:geopriv><gp:location-info><gs:Circle xmlns:gml="http://www.opengis.net/gml"
srsName="urn:ogc:def:crs:EPSG::4326"><gml:pos>47.006581 11.506064</gml:pos><gs:radius
uom="urn:ogc:def:uom:EPSG::9001">10</gs:radius></gs:Circle></gp:location-info><gp:usage-
rules/><gp:method>gps</gp:method></gp:geopriv></status></tuple></presence>

--vqEMc1G8BLia6nbM0RPznMJRGdbheHqM
Content-Type: application/addCallSub+xml
Content-Length: 1083

<?xml version="1.0" encoding="UTF-8"?><sub:EmergencyCallData.SubscriberInfo
xmlns:sub="urn:ietf:params:xml:ns:EmergencyCallData:SubscriberInfo"
xmlns:xc="urn:ietf:params:xml:ns:vcard-4.0"
privacyRequested="false"><sub:SubscriberData><xc:vcards><xc:vcard><xc:fn><xc:text>Kampichler
Wolfgang</xc:text></xc:fn><xc:n><xc:surname>Kampichler</xc:surname><xc:given>Wolfgang</xc:given><xc:
prefix></xc:prefix><xc:suffix/></xc:n><xc:tel><xc:parameters><xc:type><xc:text>cell</xc:text><xc:tex
t>voice</xc:text><xc:text>text</xc:text></xc:type></xc:parameters><xc:text>0043811500</xc:text></xc:
tel><xc:email><xc:parameters><xc:type><xc:text>home</xc:text></xc:type></xc:parameters><xc:text>wolf
gang.kampichler@frequentis.com</xc:text></xc:email><xc:adr><xc:parameters><xc:type><xc:text>home</xc:
text></xc:type></xc:parameters><xc:street>Innovationsstrasse_1</xc:street><xc:locality>Vienna</xc:l
ocality><xc:region/><xc:code>1100</xc:code><xc:country>AT</xc:country></xc:adr><xc:note><xc:text>{<
/xc:text></xc:note></xc:vcard></xc:vcards></sub:SubscriberData></sub:EmergencyCallData.SubscriberInf
o>
--vqEMc1G8BLia6nbM0RPznMJRGdbheHqM
Content-Type: text/plain
Content-Length: 154

Kampichler Wolfgang (Phone: 0043811500) has initiated an emergency chat at 02/29/2020, 11:11:34 AM.
Current position is Lat: N 47.006581; Lon: E 11.506064
--vqEMc1G8BLia6nbM0RPznMJRGdbheHqM--
```

Figure 20 shows the message sequence of an automatic response from a PSAP in the case of a regional emergency messaging conversation (session mode) started by the UE.

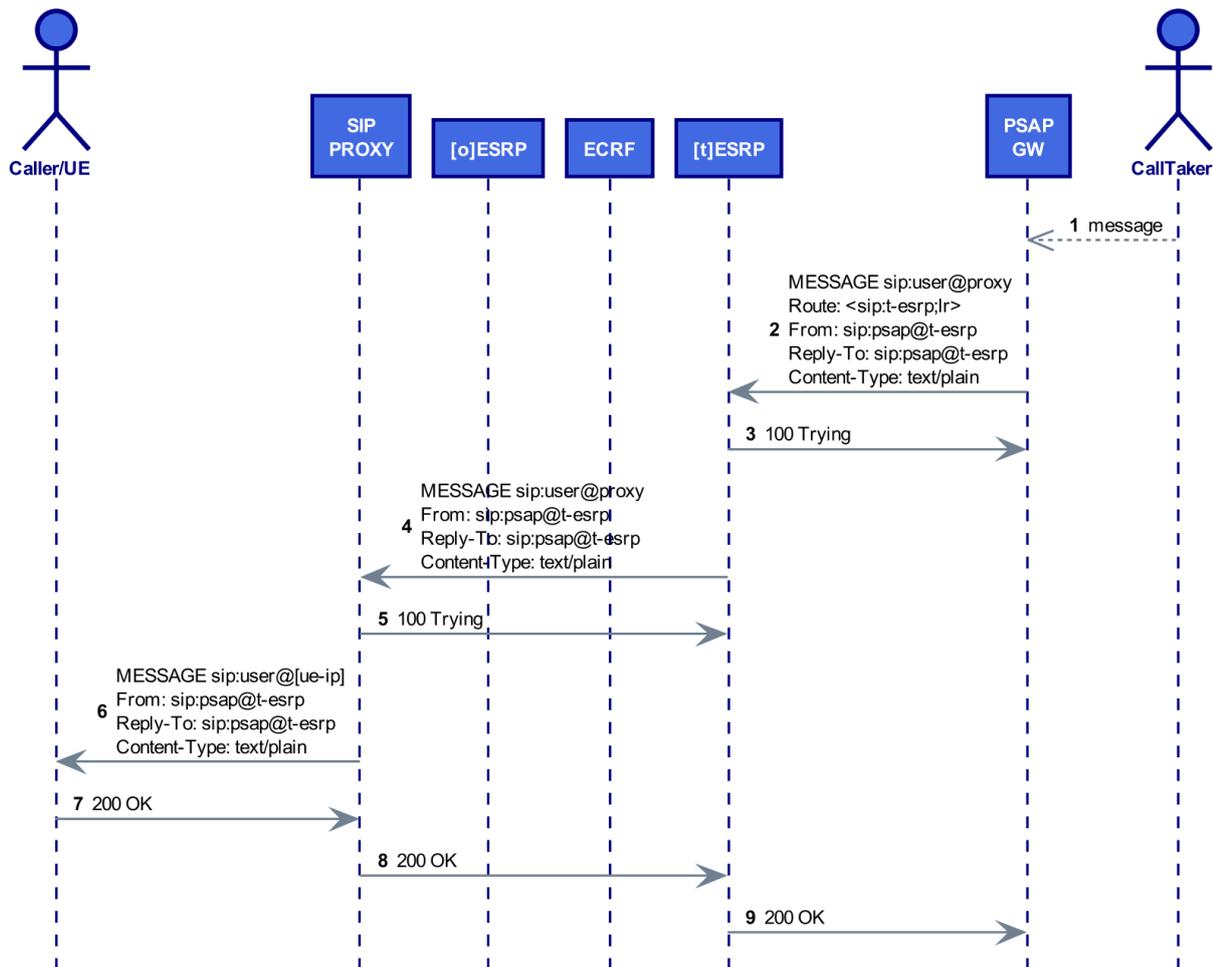


Figure 20: Messaging (session mode: automatic or manual response)


```

MESSAGE urn:service:sos SIP/2.0
History-Info: <sip:o-esrp.at.esinet.io:5460;transport=tcp>;index=1
Route: <sip:cpfd@t-esrp.dk.esinet.io:5660;transport=TCP;lr>
Via: SIP/2.0/TCP o-esrp.at.esinet.io:5460;branch=z9hG4bKbf14.1faf...093817007f.0;i=1
Via: SIP/2.0/TCP sip-proxy.at.esinet.io:5060;rport=58548;received=...;branch=z9hG...3.0;i=785
Via: SIP/2.0/TCP ...:58033;received=...;rport=58033;branch=z9hG4bKPj...8gJ8sPvP8zdhQ6;alias
Max-Forwards: 68
From: <sip:pinger@sip-proxy.at.esinet.io>;tag=MrA.D-mtZ0s5F8x6HaVcJDi8q-gmGvTJ
To: <sip:112@sip-proxy.at.esinet.io>
Call-ID: 0Q4EDX7pRPi8ykJn8Ohb40mUEaY6Z5ay
CSeq: 56223 MESSAGE
Call-Info: <urn:dec112:uid:callid:SLF6k...mVQeHvk1:service.dec112.at>;purpose=dec112-CallId
Call-Info: <urn:dec112:uid:msgtype:21:service.dec112.at>;purpose=dec112-MessageType
Call-Info: <urn:dec112:uid:msgid:202002291156:service.dec112.at>;purpose=dec112-MsgId
Geolocation-Routing: yes
Geolocation: <cid:DebhEr9UuGigk4nr@dec112.app>
Content-Type: multipart/mixed
Content-Length: 2174

--DlKUPggBkVihTpraulNCxSpewI4BdwWs
Content-ID: <DebhEr9UuGigk4nr@dec112.app>
Content-Type: application/pidf+xml
Content-Length: 561

<?xml version="1.0"?>
<presence xmlns="urn:ietf:params:xml:ns:pidf" xmlns:gp="urn:ietf:params:xml:ns:pidf:geopriv10"
xmlns:gs="http://www.opengis.net/pidflo/1.0" entity="sip:pinger@sip-proxy.at.esinet.io"><tuple
id="circle"><status><gp:geopriv><gp:location-info><gs:Circle xmlns:gml="http://www.opengis.net/gml"
srsName="urn:ogc:def:crs:EPSG::4326"><gml:pos>55.692881 12.599243</gml:pos><gs:radius
uom="urn:ogc:def:uom:EPSG::9001">10</gs:radius></gs:Circle></gp:location-info><gp:usage-
rules/><gp:method>gps</gp:method></gp:geopriv></status></tuple></presence>

--DlKUPggBkVihTpraulNCxSpewI4BdwWs
Content-Type: application/addCallSub+xml
Content-Length: 1083

<?xml version="1.0" encoding="UTF-8"?><sub:EmergencyCallData.SubscriberInfo
xmlns:sub="urn:ietf:params:xml:ns:EmergencyCallData:SubscriberInfo"
xmlns:xc="urn:ietf:params:xml:ns:vcard-4.0"
privacyRequested="false"><sub:SubscriberData><xc:vcards><xc:vcard><xc:fn><xc:text>Kampichler
Wolfgang</xc:text></xc:fn><xc:n><xc:surname>Kampichler</xc:surname><xc:given>Wolfgang</xc:given><xc:
prefix></xc:prefix><xc:suffix/></xc:n><xc:tel><xc:parameters><xc:type><xc:text>cell</xc:text><xc:tex
t>voice</xc:text><xc:text>text</xc:text></xc:type></xc:parameters><xc:text>0043811500</xc:text></xc:
tel><xc:email><xc:parameters><xc:type><xc:text>home</xc:text></xc:type></xc:parameters><xc:text>wolf
gang.kampichler@frequentis.com</xc:text></xc:email><xc:adr><xc:parameters><xc:type><xc:text>home</xc
:text></xc:type></xc:parameters><xc:street>Innovationsstrasse_1</xc:street><xc:locality>Vienna</xc:l
ocality><xc:region/><xc:code>1100</xc:code><xc:country>AT</xc:country></xc:adr><xc:note><xc:text>{}<
/xc:text></xc:note></xc:vcard></xc:vcards></sub:SubscriberData></sub:EmergencyCallData.SubscriberInf
o>
--DlKUPggBkVihTpraulNCxSpewI4BdwWs
Content-Type: text/plain
Content-Length: 154

Kampichler Wolfgang (Phone: 0043811500) has initiated an emergency chat at 02/29/2020, 11:56:22 AM.
Current position is Lat: N 55.692881; Lon: E 12.599243
--DlKUPggBkVihTpraulNCxSpewI4BdwWs--

```

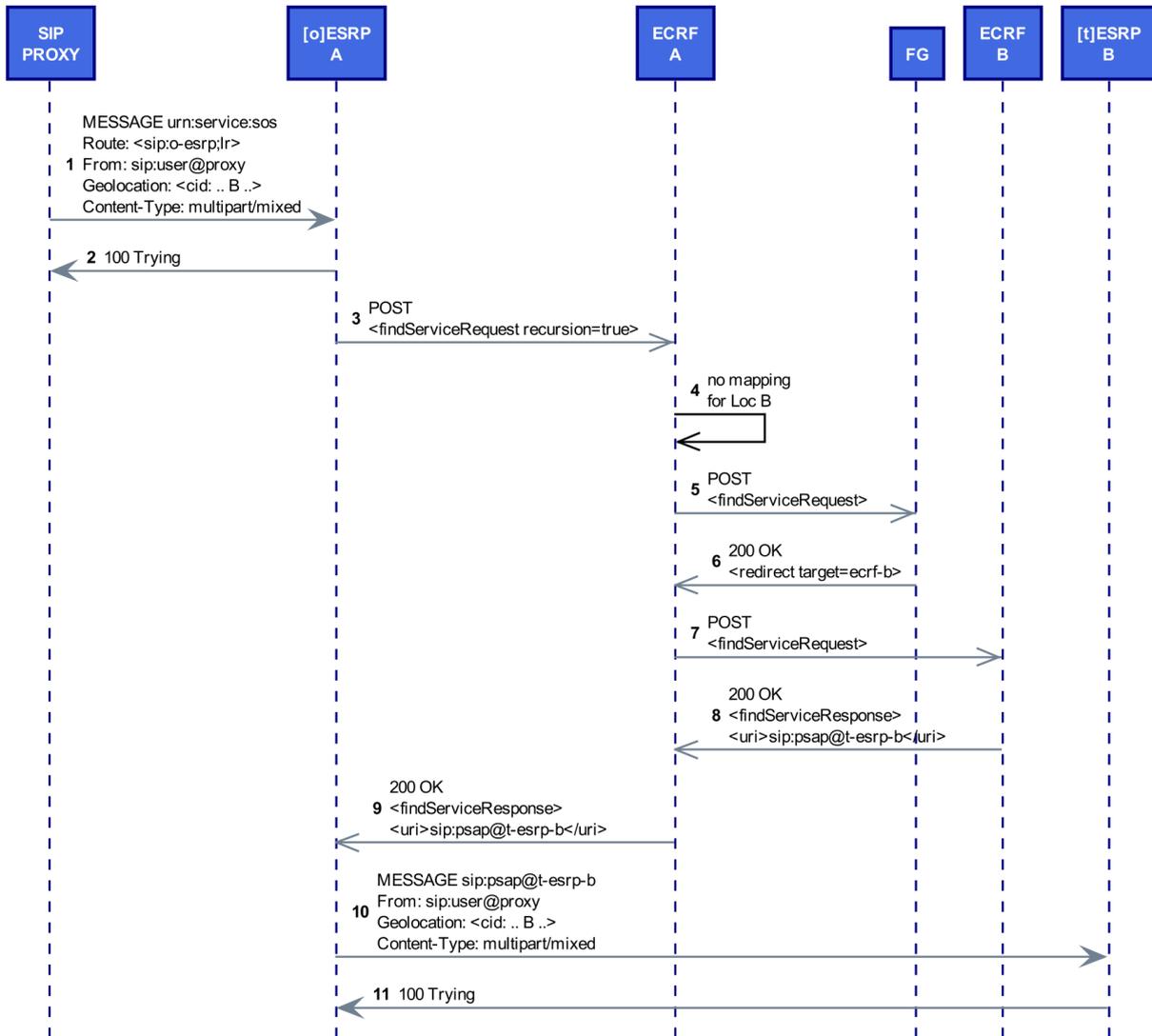


Figure 22: Messaging (session mode: initial message; roaming)

An example illustrating the content of message 3 and 9 in Figure 22 is given below. ECRF A is part of the Austrian ESInet and ECRF B is part of the Danisch ESInet. The Forest Guide (FG) redirects ECRF A to ECRF B (refer to the <path> attribute in message 9 below).

Message 3 (findServiceRequest):

```
<findService xmlns="urn:ietf:params:xml:ns:lost1"
xmlns:p2="http://www.opengis.net/gml" serviceBoundary="reference" recursive="true">
<location id="NI6kZ4yqOAiOkimv" profile="geodetic-2d">
<gs:Circle xmlns:gml="http://www.opengis.net/gml"
xmlns:gs="http://www.opengis.net/pidflo/1.0" srsName="urn:ogc:def:crs:EPSG::4326">
<gml:pos>55.692881 12.599243</gml:pos>
<gs:radius uom="urn:ogc:def:uom:EPSG::9001">10</gs:radius>
</gs:Circle>
</location>
<service>urn:service:sos</service>
</findService>
```

Message 9 (findServiceResponse):

```
<findServiceResponse xmlns="urn:ietf:params:xml:ns:lost1">
<mapping expires="2021-07-18T07:14:26+00:00" lastUpdated="2019-07-19T07:14:26+00:00"
source="ecrf.dk.naptr.esinet.io" sourceId="cpfdId">
<displayName xml:lang="en">Cpfd</displayName>
<displayName xml:lang="de">Cpfd</displayName>
<service>urn:service:sos</service>
<serviceBoundaryReference source="ecrf.dk.naptr.esinet.io"
key="b3045b97e07b47e1a68a4e25c955b5f0"/>
<uri>sip:cpfd@t-esrp.dk.esinet.io:5660;transport=TCP</uri>
<serviceNumber>112</serviceNumber>
</mapping>
<path>
<via source="ecrf.at.naptr.esinet.io"/>
<via source="fg.naptr.esinet.io"/>
<via source="ecrf.dk.naptr.esinet.io"/>
</path>
<locationUsed id="NI6kZ4yqOAiOkimv"/>
</findServiceResponse>
```

Message Sequence Charts (VoIP or WebRTC regional and international deployment)

Figures 23 and 24 are showing a multimedia session setup with similar ESInet routing steps as explained in previous charts.

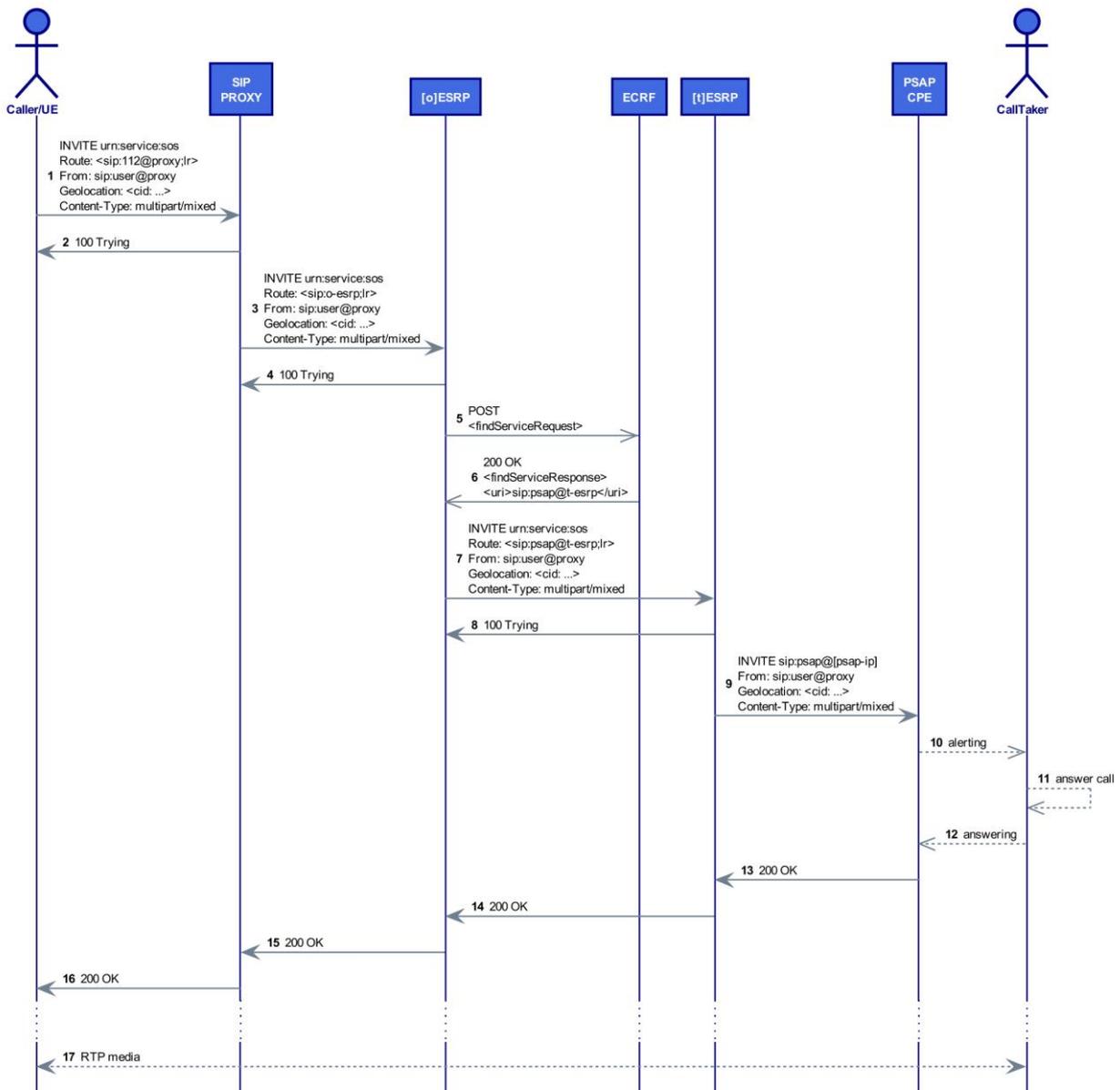


Figure 23: Multimedia conversation (initial setup message)

The SIP INVITE for this chart includes the position in the PIDF-LO message and the original destination that is going to be changed after the response for the ECRF routing message.

```

INVITE sip:112@sip-proxy.it.esinet.io SIP/2.0
Record-Route: <sip:172.16.10.5:5260;r2=on;lr=on;rtp=bridge;rtp=ws>
Record-Route: <sip:172.16.10.5:8289;transport=ws;r2=on;lr=on;rtp=bridge;rtp=ws>
Via: SIP/2.0/UDP 172.16.10.5:5260;branch=z9hG4bK5174.18f77b51f3376a2642f13747104c4123.0
Via: SIP/2.0/WSS 192.168.56.1;rport=52559;received=82.85.104.146;branch=z9hG4bK9526432
Max-Forwards: 68
To: <sip:112@sip-proxy.it.esinet.io>
From: "Caller" <sip:alice@sip-proxy.it.esinet.io>;tag=svr5qco4lq
Call-ID: hisjm4p0noi8hkplslm8
CSeq: 7487 INVITE
Geolocation: <cid:DebhEr9UuGigk4nr@dec112.app>
Geolocation-Routing: yes
Contact:
<sip:alice@192.168.56.1;transport=ws;ob;alias=82.85.104.146~52559~6;alias=82.85.104.146~52559~6>
Allow: ACK,CANCEL,INVITE,MESSAGE,BYE,OPTIONS,INFO,NOTIFY,REFER
Supported: 100rel, outbound
User-Agent: SIP.js/0.13.6.mod - Chrome 80.0.3987.132 Windows
Content-Type: multipart/mixed; boundary=boundary123
Content-Length: 4137

--boundary123
Content-Type: application/sdp

...snip Standard SDP content

--boundary123
Content-ID: <DebhEr9UuGigk4nr@dec112.app>
Content-Type: application/pidf+xml

<?xml version="1.0" encoding="UTF-8"?>
  <presence
    xmlns="urn:ietf:params:xml:ns:pidf"
    xmlns:gp="urn:ietf:params:xml:ns:pidf:geopriv10"
    xmlns:gbp="urn:ietf:params:xml:ns:pidf:geopriv10:basicPolicy"
    xmlns:cl="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
    xmlns:gml="http://www.opengis.net/gml"
    xmlns:dm="urn:ietf:params:xml:ns:pidf:data-model"
    entity="pres:alice@atlanta.example.com">
    <dm:device id="r9UuGigk4n">
      <gp:geopriv>
        <gp:location-info>
          <gml:Point srsName="urn:ogc:def:crs:EPSG::4326">
            <gml:pos>46.071642 11.126569</gml:pos>
          </gml:Point>
        </gp:location-info>
        <gp:usage-rules>
          <gbp:retransmission-allowed>false</gbp:retransmission-allowed>
          <gbp:retention-expiry>2020-11-14T20:00:00Z</gbp:retention-expiry>
        </gp:usage-rules>
        <gp:method>802.11</gp:method>
      </gp:geopriv>
      <dm:deviceID>mac:00:0a:95:9d:68:16</dm:deviceID>
      <dm:timestamp>2020-11-04T20:57:29Z</dm:timestamp>
    </dm:device>
  </presence>
--boundary123--

```

The messages with ECRF show how the location is eventually defined (Trento is the destination) and the subsequent INVITE is opportunely modified to address Trento PSAP.

ECRF request

```
<?xml version="1.0" encoding="UTF-8"?>
  <findService xmlns="urn:ietf:params:xml:ns:lost1"
    xmlns:gml="http://www.opengis.net/gml"
    xmlns:gs="http://www.opengis.net/pidflo/1.0"
    xmlns:p2="http://www.opengis.net/"
    recursive="true" serviceBoundaryReference="value">
    <location id="ecrf_1t3b3w" profile="geodetic-2d">
      <gml:Point srsName="urn:ogc:def:crs:EPSG::4326">
        <gml:pos>46.071642 11.126569</gml:pos>
      </gml:Point>
    </location>
    <service>urn:service:sos</service>
  </findService>
```

ECRF response

```
<?xml version="1.0" encoding="utf-8"?>
  <findServiceResponse xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:xsd="http://www.w3.org/2001/XMLSchema"
    xmlns="urn:ietf:params:xml:ns:lost1">
    <path>
      <via source="beta80.lost" />
    </path>
    <mapping expires="2023-02-24T12:41:47Z"
      lastUpdated="2020-01-20T13:18:55Z"
      source="beta80.authoritative.example"
      sourceId="PSAP Trento">
      <displayName xml:lang="en">PSAP Trento</displayName>
      <service>urn:service:sos</service>
      <serviceBoundaryReference source="beta80.authoritative.example"
        key="PSAP Trento" />
      <uri>sip:trento@t-esrp.it.esinet.io</uri>
      <serviceNumber>112</serviceNumber>
    </mapping>
    <locationUsed id="ecrf_1t3b3w" />
  </findServiceResponse>
```

Modified SIP INVITE

```
INVITE sip:112@sip-proxy.it.esinet.io SIP/2.0
Record-Route: <sip:172.16.10.5:5260;r2=on;lr=on;rtp=bridge;rtp=ws>
Record-Route: <sip:172.16.10.5:8289;transport=ws;r2=on;lr=on;rtp=bridge;rtp=ws>
Route: <sip:trento@t-esrp.it.esinet.io;lr>
Via: SIP/2.0/UDP 172.16.10.5:5260;branch=z9hG4bK5174.18f77b51f3376a2642f13747104c4123.0
Via: SIP/2.0/WSS 192.168.56.1;rport=52559;received=82.85.104.146;branch=z9hG4bK9526432
Max-Forwards: 68
To: <sip:112@sip-proxy.it.esinet.io>
From: "Caller" <sip:alice@sip-proxy.it.esinet.io>;tag=srv5qco4lq
Call-ID: hisjm4p0noi8hkp1slm8
CSeq: 7487 INVITE
Geolocation: <cid:DebhEr9UuGigk4nr@dec112.app>
Geolocation-Routing: yes
Contact:
<sip:alice@192.168.56.1;transport=ws;ob;alias=82.85.104.146~52559~6;alias=82.85.104.146~52559~6>
Allow: ACK,CANCEL,INVITE,MESSAGE,BYE,OPTIONS,INFO,NOTIFY,REFER
Supported: 100rel, outbound
User-Agent: SIP.js/0.13.6.mod - Chrome 80.0.3987.132 Windows
Content-Type: multipart/mixed; boundary=boundary123
Content-Length: 4137

--boundary123
STANDARD SDP PAYLOAD

--boundary123
Content-ID: <DebhEr9UuGigk4nr@dec112.app>
Content-Type: application/pidf+xml

<?xml version="1.0" encoding="UTF-8"?>
  <presence
    xmlns="urn:ietf:params:xml:ns:pidf"
    xmlns:gp="urn:ietf:params:xml:ns:pidf:geopriv10"
    xmlns:gbp="urn:ietf:params:xml:ns:pidf:geopriv10:basicPolicy"
    xmlns:cl="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
    xmlns:gml="http://www.opengis.net/gml"
    xmlns:dm="urn:ietf:params:xml:ns:pidf:data-model"
    entity="pres:alice@atlanta.example.com">
    <dm:device id="r9UuGigk4n">
      <gp:geopriv>
        <gp:location-info>
          <gml:Point srsName="urn:ogc:def:crs:EPSG::4326">
            <gml:pos>46.071642 11.126569</gml:pos>
          </gml:Point>
        </gp:location-info>
        <gp:usage-rules>
          <gbp:retransmission-allowed>false</gbp:retransmission-allowed>
          <gbp:retention-expiry>2020-11-14T20:00:00Z</gbp:retention-expiry>
        </gp:usage-rules>
        <gp:method>802.11</gp:method>
      </gp:geopriv>
      <dm:deviceID>mac:00:0a:95:9d:68:16</dm:deviceID>
      <dm:timestamp>2020-11-04T20:57:29Z</dm:timestamp>
    </dm:device>
  </presence>

--boundary123-
```

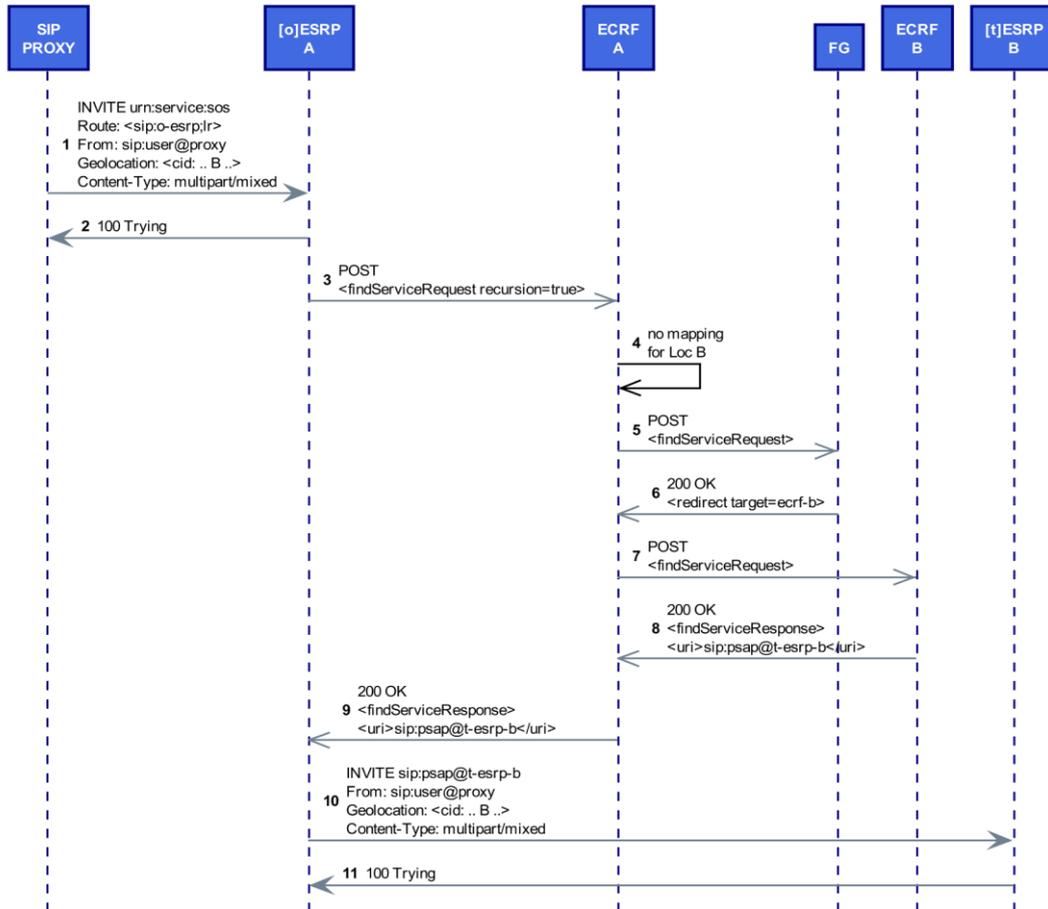


Figure 24: Multimedia conversation (initial setup message; roaming)

5 | CELESTE TESTING

Testing includes several use cases to cover DEC112 (chat) and VoIP/WebRTC (audio, video, chat) deployment scenarios. The main objectives are to compare ESInet routing capabilities with legacy emergency systems and to demonstrate interconnected ESInets in a cross-vendor configuration.

DEC112 TESTING

The DEC112 application receives initial settings from a root APP backend including a list of countries and their regional application-based services. This supports a dynamic UI based on regional emergency numbers or service URNs. For instance, the Austrian DEC112 backend provides four different emergency numbers [112, 122, 133, 144] and corresponding URNs as well as a test facility [555], see Figure 25. This takes into account the way control centres are operated in Austria. However, the model is different in Italy and Denmark, where the DEC112 UI just provides [112] and [555], refer to Figure 27.

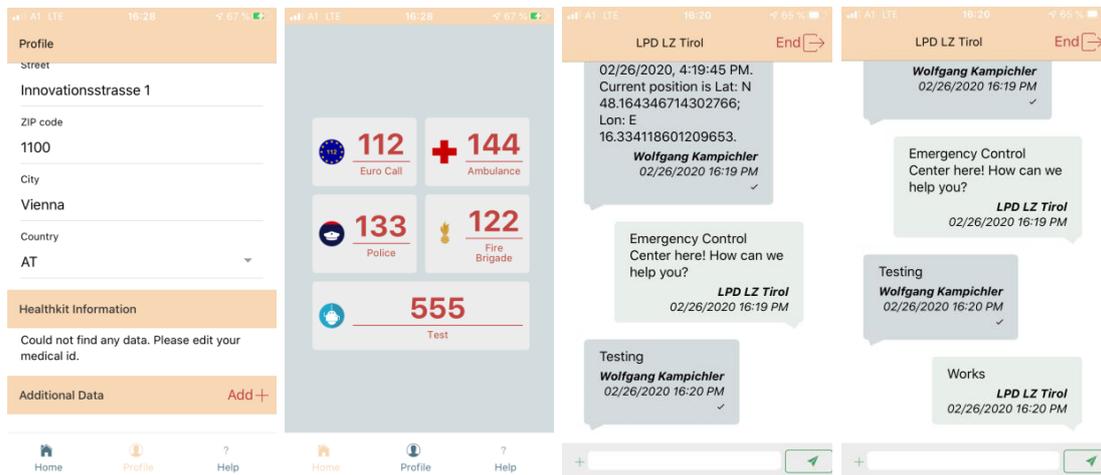


Figure 25: DEC112 Application (Region: Austria)

Note that a user selects a country upon the initial user registration process of DEC112. The shown test version of DEC112 allows changing the country of origin "on the fly" in order to support several different CELESTE test scenarios without initial user re-registration. Figure 26 shows the corresponding DEC112 PSAP UI (Viewer) including a map to show the caller's location, some user data below and a chat UI object.

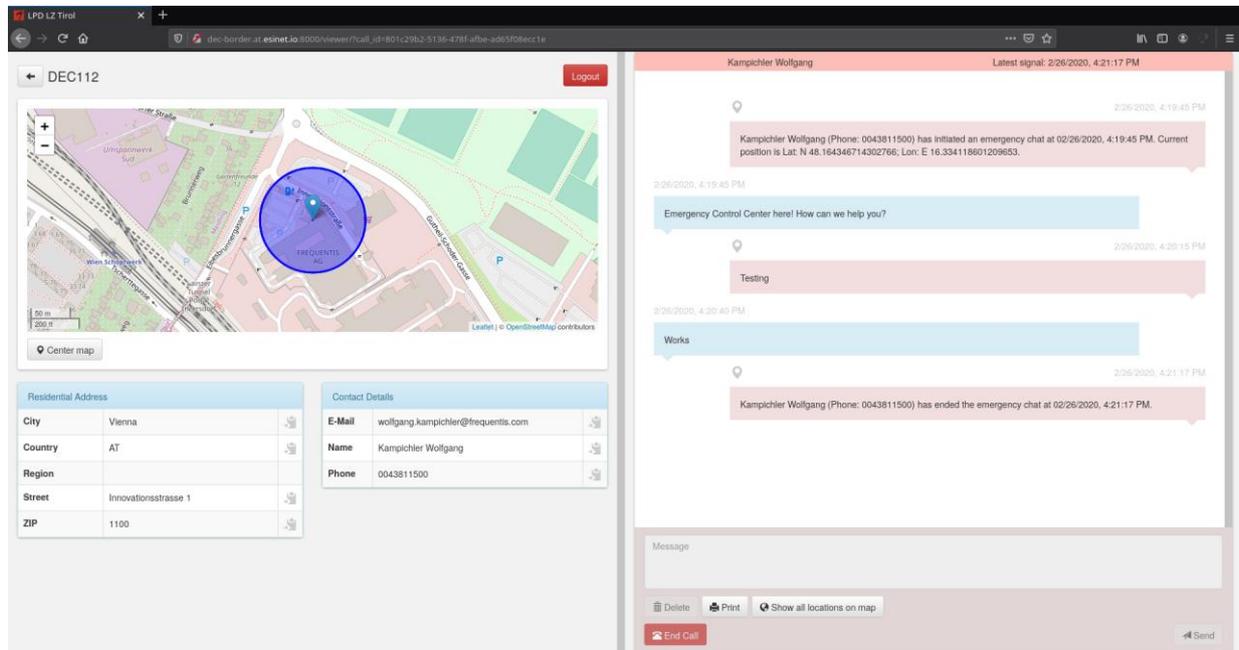


Figure 26: DEC112 PSAP Viewer (LPD LZ Tirol)

To initiate an emergency chat, a user just selects a service shown in the home screen (refer to screenshot number 3 from left in Figure 27) by pressing the button, e.g. [112]. This generates an automatic message being sent to the next hop (local SIP Proxy). After receiving the first response from the control room, the user may continue with a chat conversation, as illustrated in screenshot number 4 from left in Figure 27.

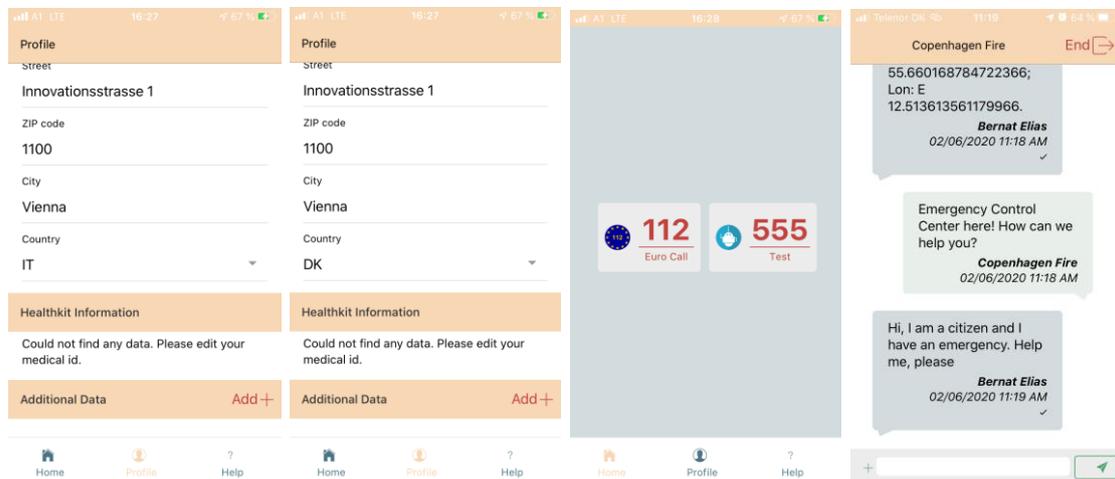


Figure 27: DEC112 Application (Region: Denmark | Italy)

The PSAP's UI of the previous conversation example is shown in Figure 28 that illustrates how DEC112 may be integrated with PSAP Call Processing Equipment (CPE).

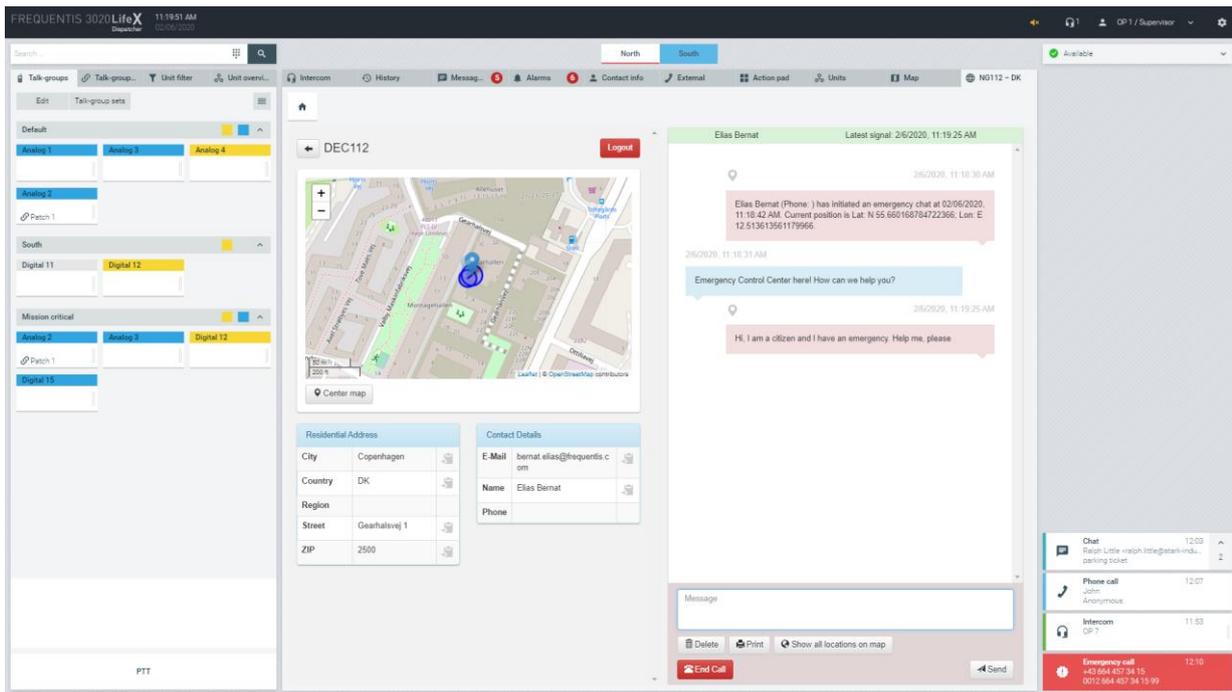


Figure 28: DEC112 PSAP CPE Integration (Region: Denmark)

The following section describes different test scenarios (regional and international) utilising the DEC112 Application, each regional ESInet deployment, the Forest Guide and different control rooms integrating with DEC112.

REGIONAL TESTING

(1A) Austrian citizen in Austria/Tirol [112, 133]

Austrian emergency numbers 112 and 133 (police) are routed to a Federal Police control centre. The figure below shows the Federal Police Control Centre Innsbruck with one call taker position answering a DEC112 emergency chat or a 112 emergency call during the test.

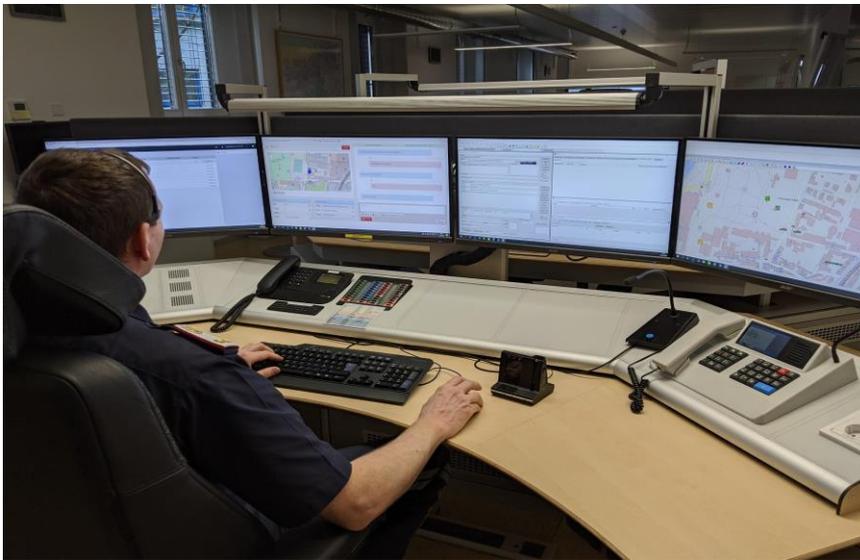


Figure 29: Federal Police Control Centre Innsbruck (from left: CPE, DEC112, CAD, MAP)

An example emergency chat (112) with a user located north of the border between Austria and Italy at Brenner is shown in the following figure. The chat request was received at Federal Police Control Centre Innsbruck.

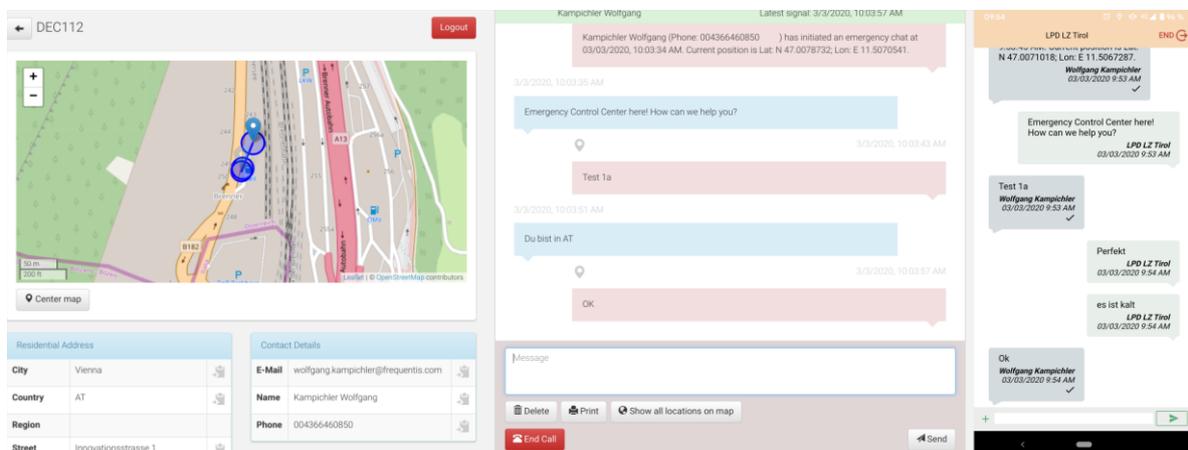


Figure 30: Federal Police Control Centre Innsbruck (DEC112 Viewer and DEC112 App)

(1B) Austrian citizen in Austria/Tirol [122, 144]

Austrian emergency numbers 122 (fire brigade) and 144 (ambulance) are routed to Leitstelle Tirol (PSAP Tirol). The figure below shows an emergency chat (144) originating from an Austrian location. The chat request was received at Leitstelle Tirol (PSAP Tirol).

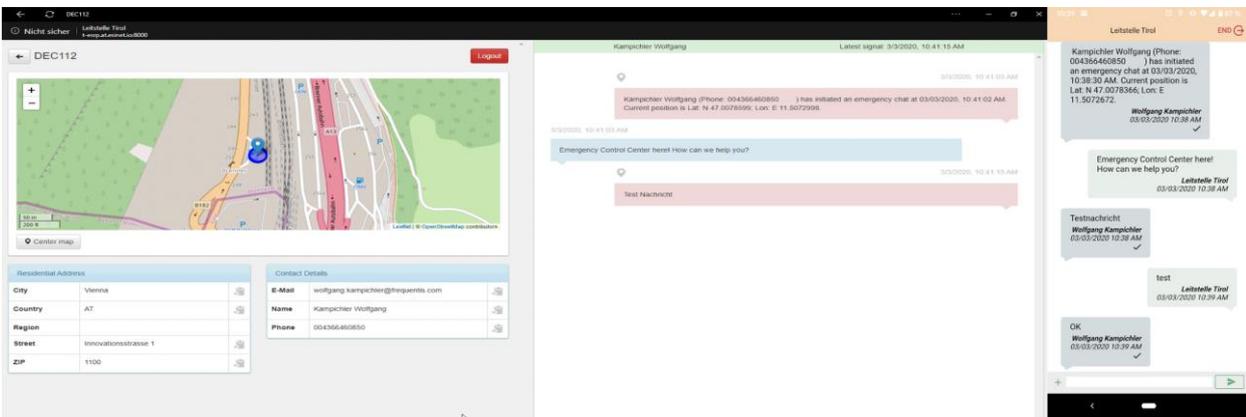


Figure 31: Leitstelle Tirol / PSAP Tyrol (DEC112 Viewer and DEC112 App)

Message Sequence (simplified)

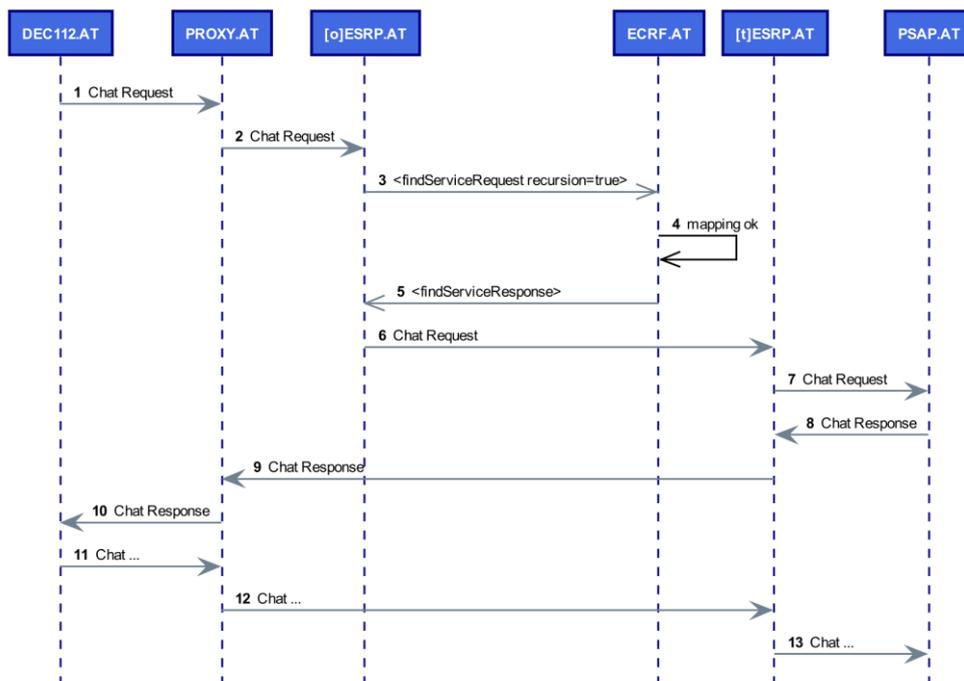


Figure 32: Simplified message sequence (AT in AT)

Chat Setup Delay

| Sample | Delay (Message 1 - Message 10, as in Figure 23) |
|--------|---|
| 1 | 355 ms |
| 2 | 331 ms |
| 3 | 306 ms |

TCP RTT between DEC12.AT and PROXY.AT: 2ms

(2) Danish citizen in Denmark [112]

The screenshot displays the FREQUENTIS 3020 LifeX Testclient interface. The main window shows a chat session with 'Elias Bernat' (Phone) who initiated an emergency chat at 02/06/2020, 11:18:42 AM. The chat history shows the following messages:

- 2/6/2020, 11:18:30 AM: Elias Bernat (Phone) has initiated an emergency chat at 02/06/2020, 11:18:42 AM. Current position is Lat: N 55.660168784722366, Lon: E 12.51361356117966.
- 2/6/2020, 11:18:31 AM: Emergency Control Center here! How can we help you?
- 2/6/2020, 11:19:25 AM: Hi, I am a citizen and I have an emergency. Help me, please

The interface also includes a map of the location (Copenhagen), contact details for Elias Bernat (E-Mail: bernat.elias@frequentis.com, Name: Elias Bernat, Phone: [redacted]), and a list of active chat sessions on the right side.

Figure 33: FD Copenhagen (3020 LifeX Testclient)

(3A) Italian citizen in Italy [112]

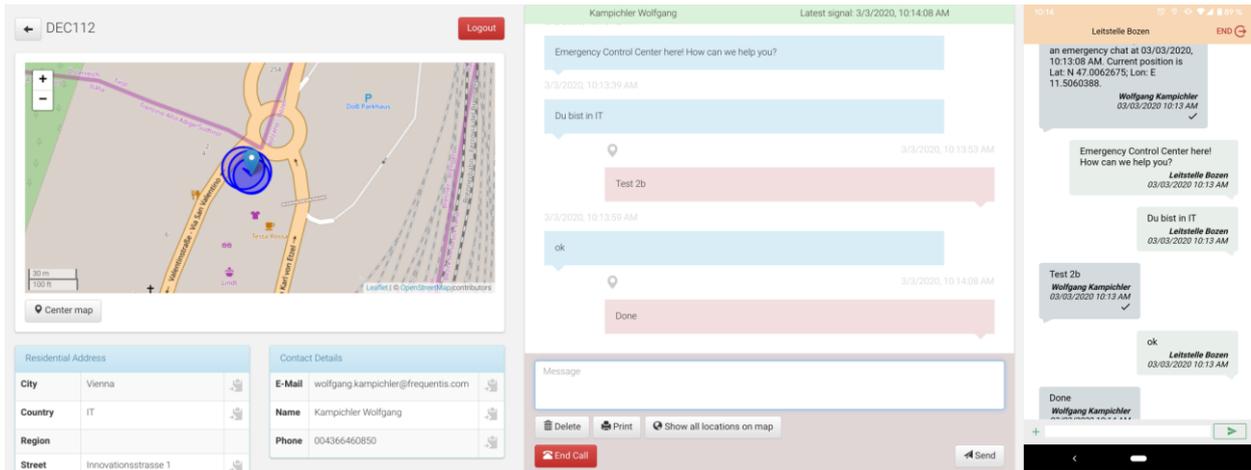


Figure 35: Leitstelle Bozen / PSAP Bolzano (DEC112 Viewer and DEC112 App)

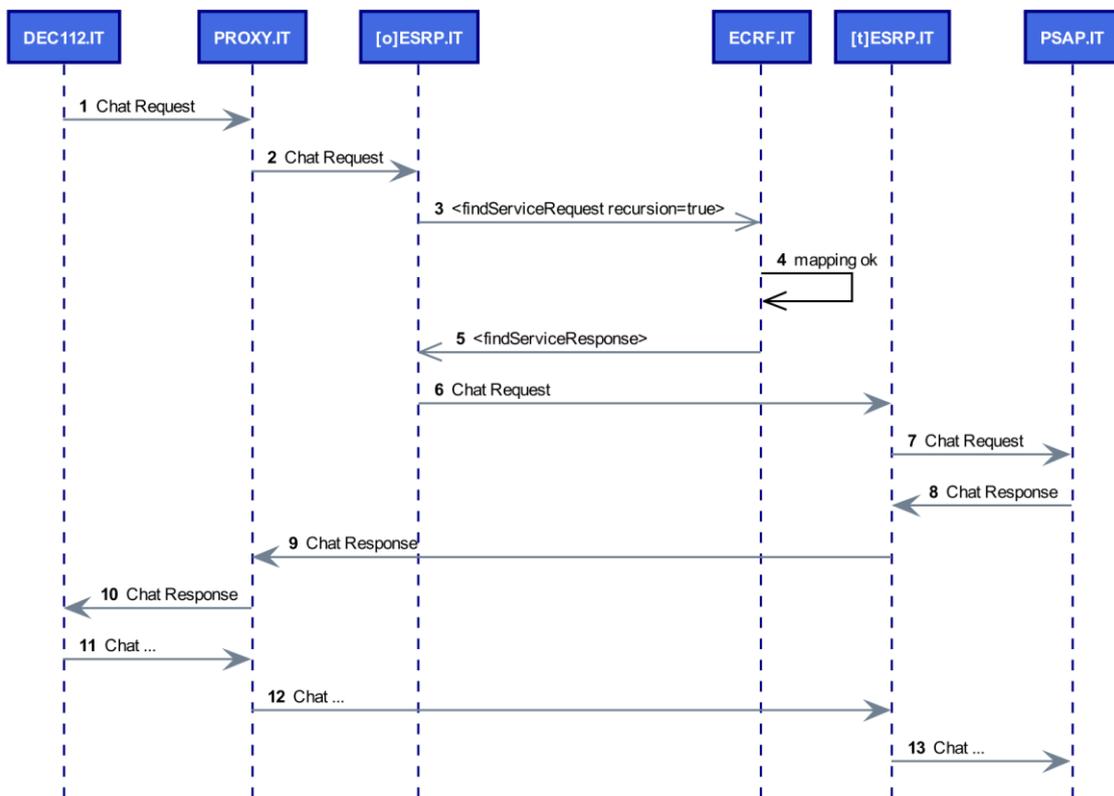


Figure 36: Simplified message sequence (IT in IT)

Chat Setup Delay

| Sample | Delay (Message 1 - Message 10, as in Figure 23) |
|--------|---|
| 1 | 2403 ms |
| 2 | 2151 ms |
| 3 | 1651 ms |

TCP RTT between DEC112.IT and PROXY.IT: 2ms

(3B) Italian citizen in Italy - webRTC client (Bolzano)

The tests 3B and 3C were performed at the 112 PSAPs in Bolzano and Trento, showing the location made by the NG112 web client, establishing a videocall with the PSAP.

Please note: the videocall is mono-directional as we considered a 112 call taker being able to see the scene, but not to be seen by the citizen.



Figure 37: 112 PSAP in Bolzano, location of the call

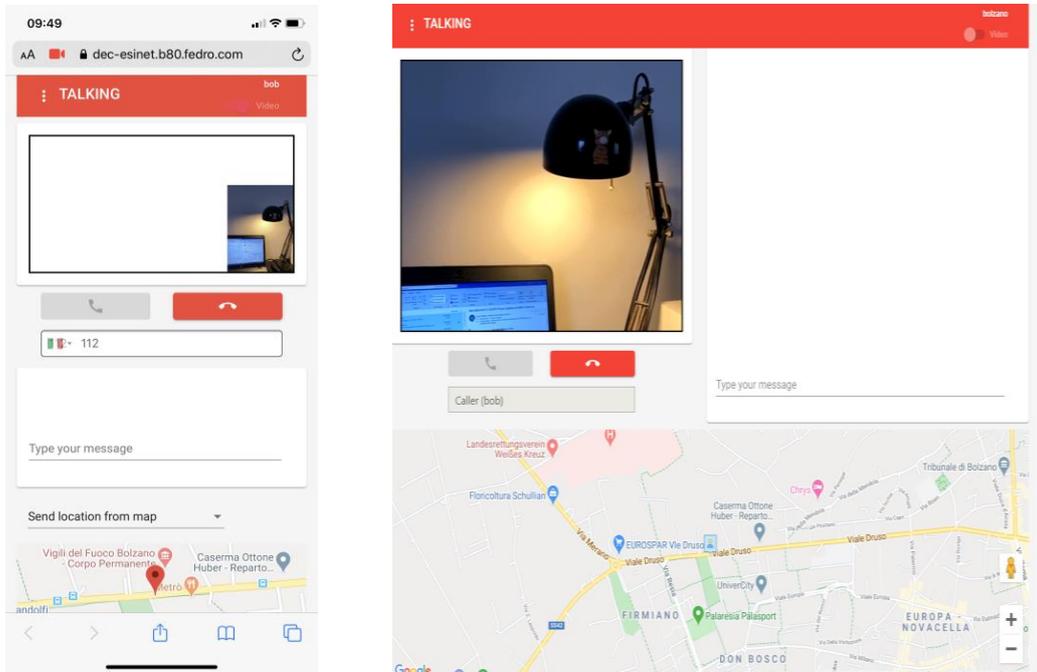


Figure 38: webRTC client (left) and PSAP user interface, with ongoing videocall and location of the caller (blue icon in the center of the map)

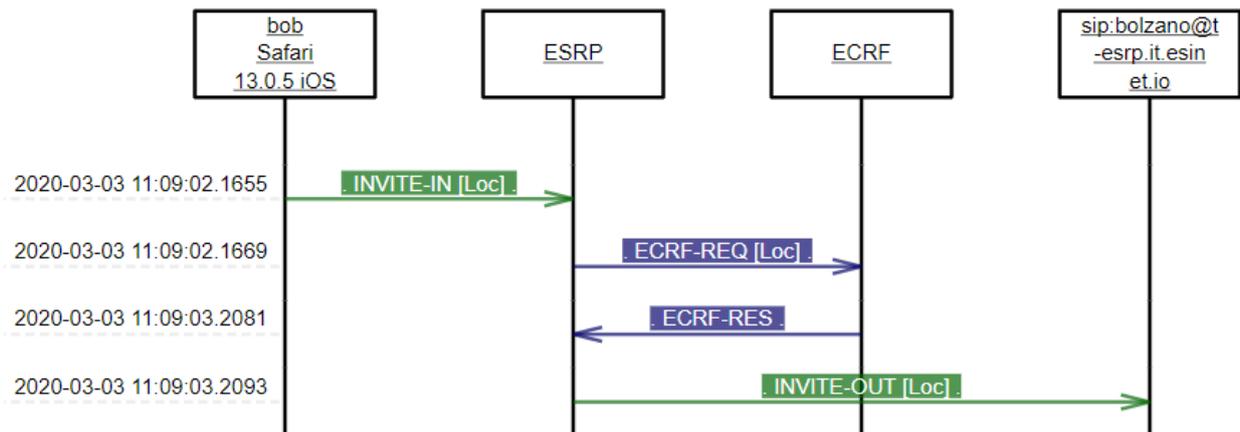


Figure 39: call chart, with time delays expressed on the left-hand side

(3C) Italian citizen in Italy - webRTC client (Trento)



Figure 40: 112 PSAP in Trento

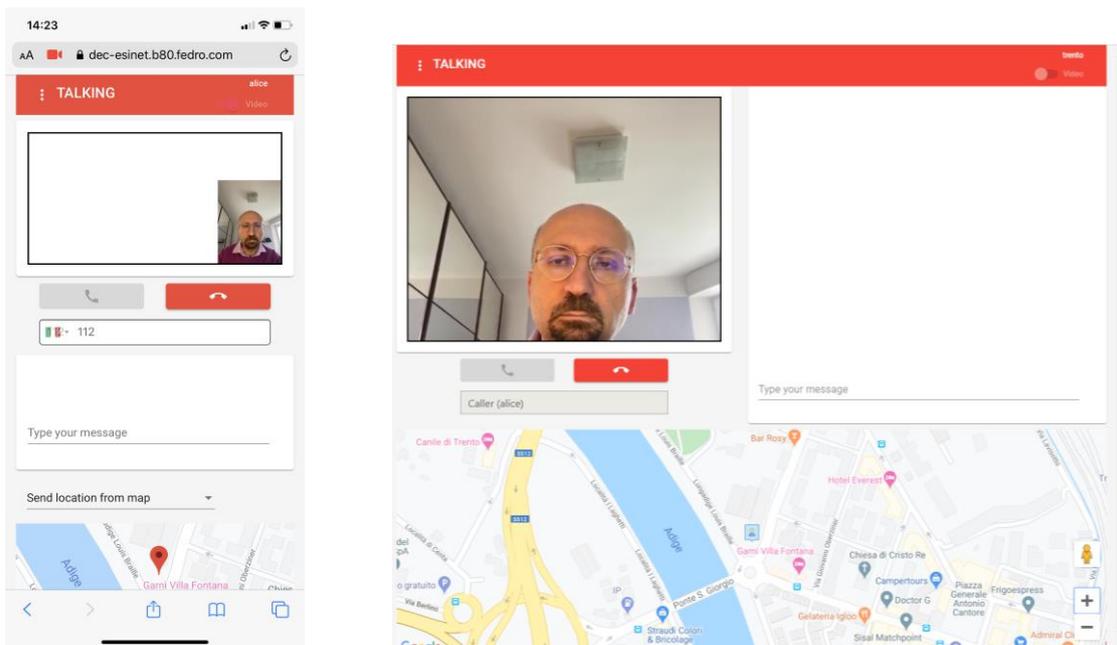


Figure 41: webRTC client (left) and PSAP user interface, with ongoing videocall and location of the caller (blue icon in the center of the map)

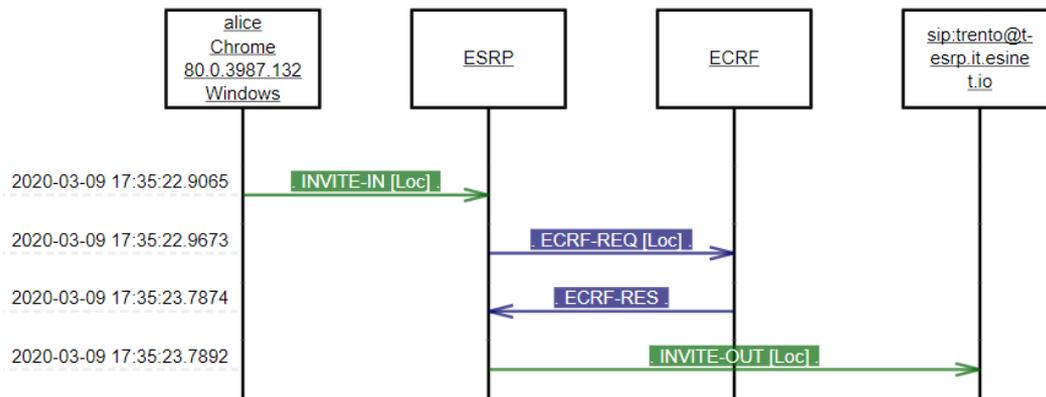


Figure 42: call chart, with time delays expressed on the left-hand side

6 | INTERNATIONAL TESTING

(1) Danish visitor in Austria [112]

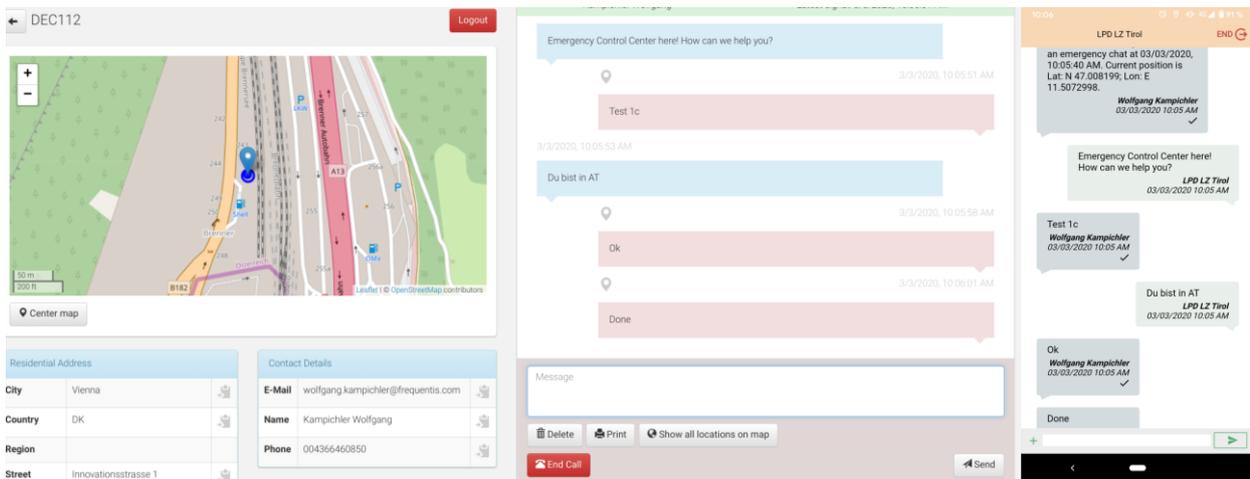


Figure 43: Federal Police Control Center Innsbruck (DEC112 Viewer and DEC112 App)

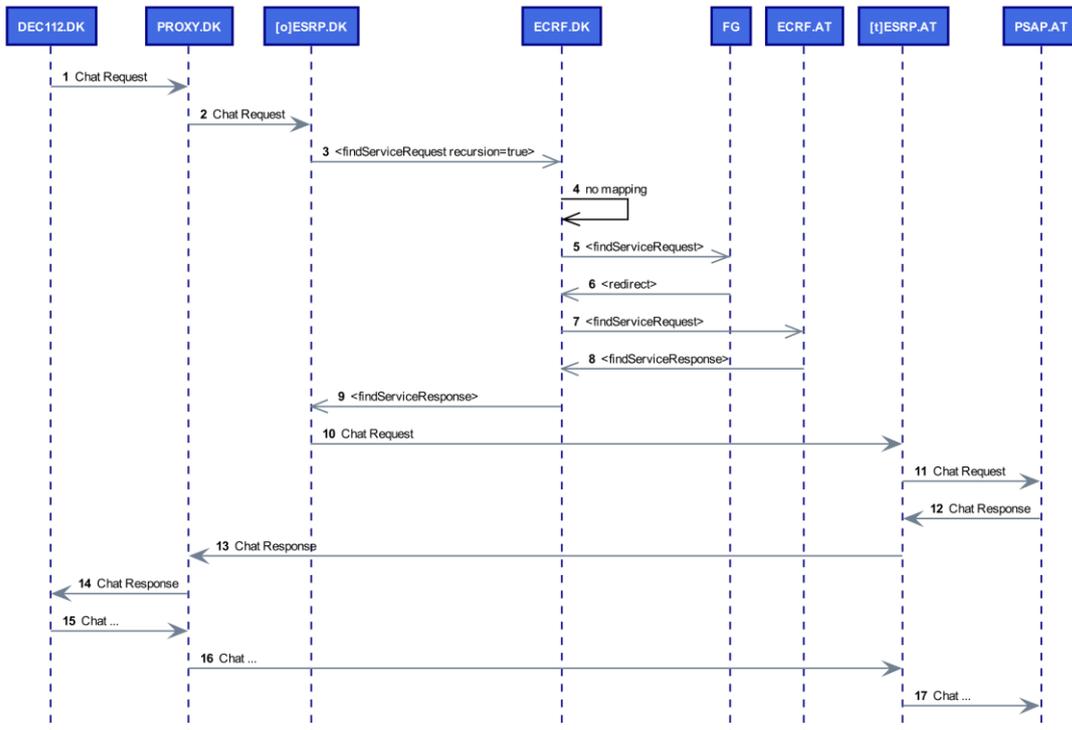


Figure 44: Simplified message sequence (DK in AT)

Chat Setup Delay

| Sample | Delay (Message 1 - Message 14, as in Figure 23) |
|--------|---|
| 1 | 882 ms |
| 2 | 980 ms |
| 3 | 807 ms |

TCP RTT between DEC112.DK and PROXY.DK: 31ms

(2) Austrian visitor in Denmark [112]

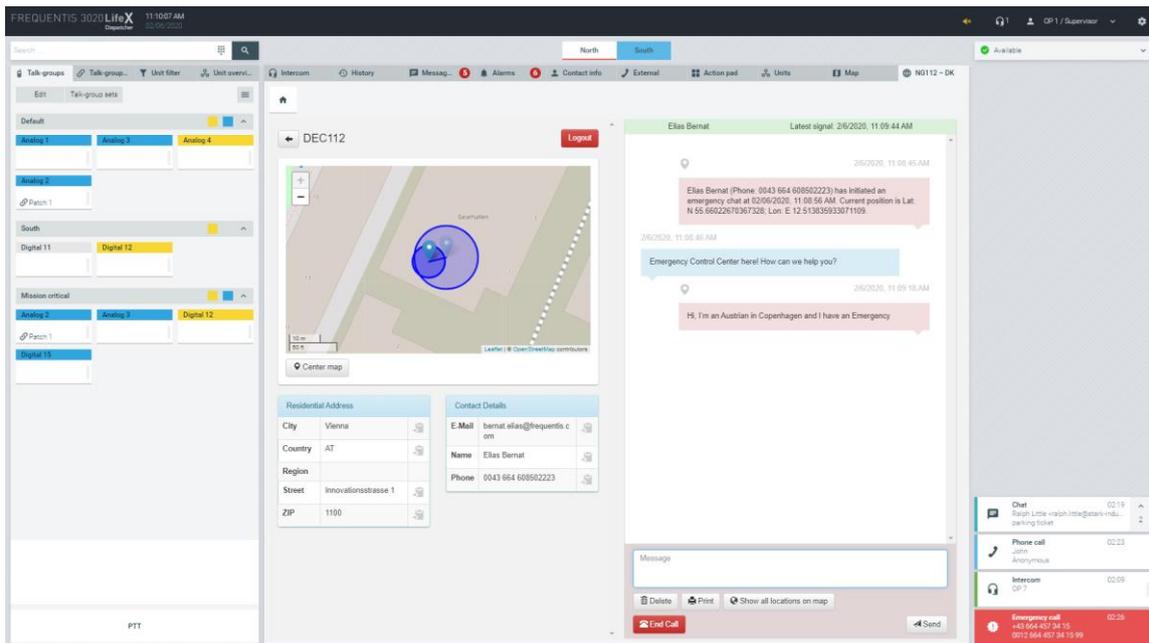


Figure 45: FD Copenhagen (3020 LifeX Testclient)

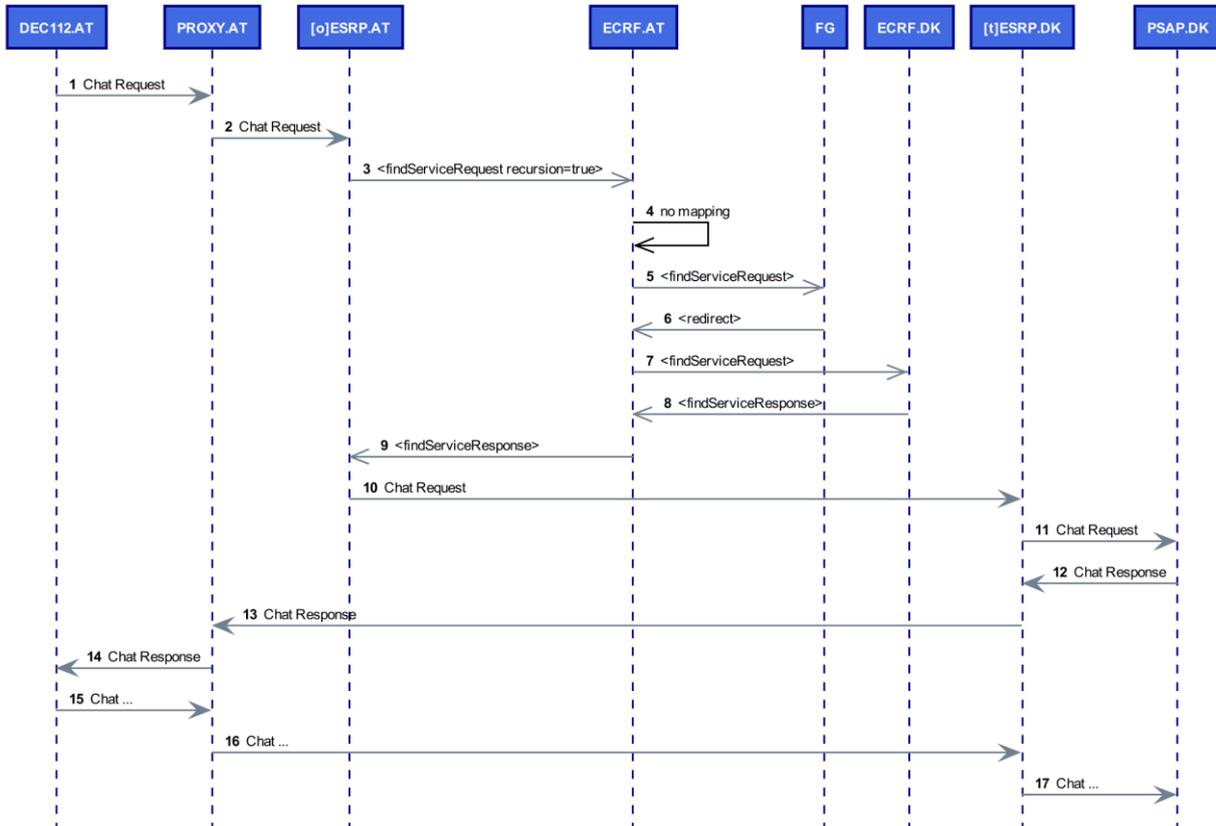


Figure 46: Simplified message sequence (AT in DK)

Chat Setup Delay

| Sample | Delay (Message 1 - Message 14, as in Figure 23) |
|--------|---|
| 1 | 1870 ms |
| 2 | 1437 ms |
| 3 | 1434 ms |

TCP RTT between DEC112.DK and PROXY.DK: 31ms

(3) Italian visitor in Austria [112]

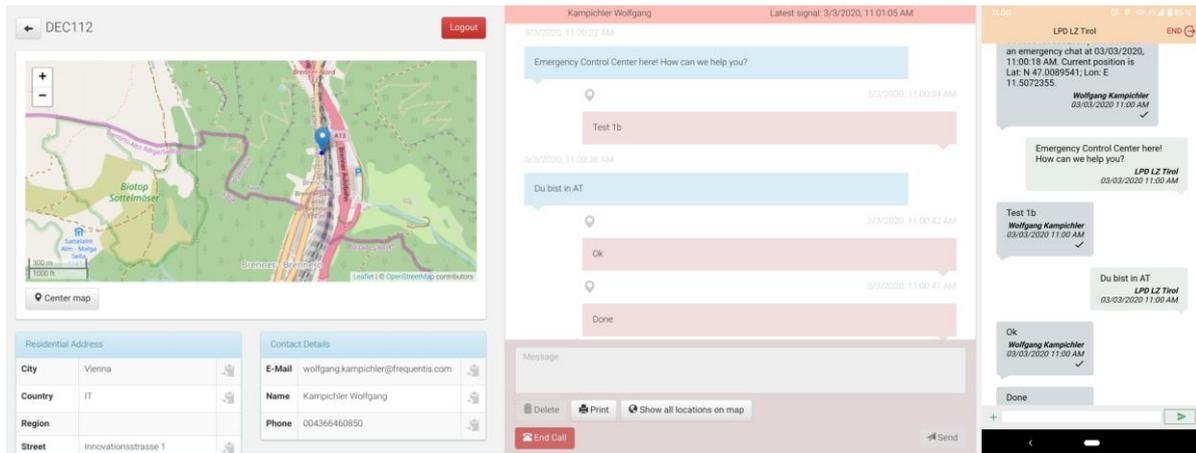


Figure 47: Federal Police Control Center Innsbruck (DEC112 Viewer and DEC112 App)

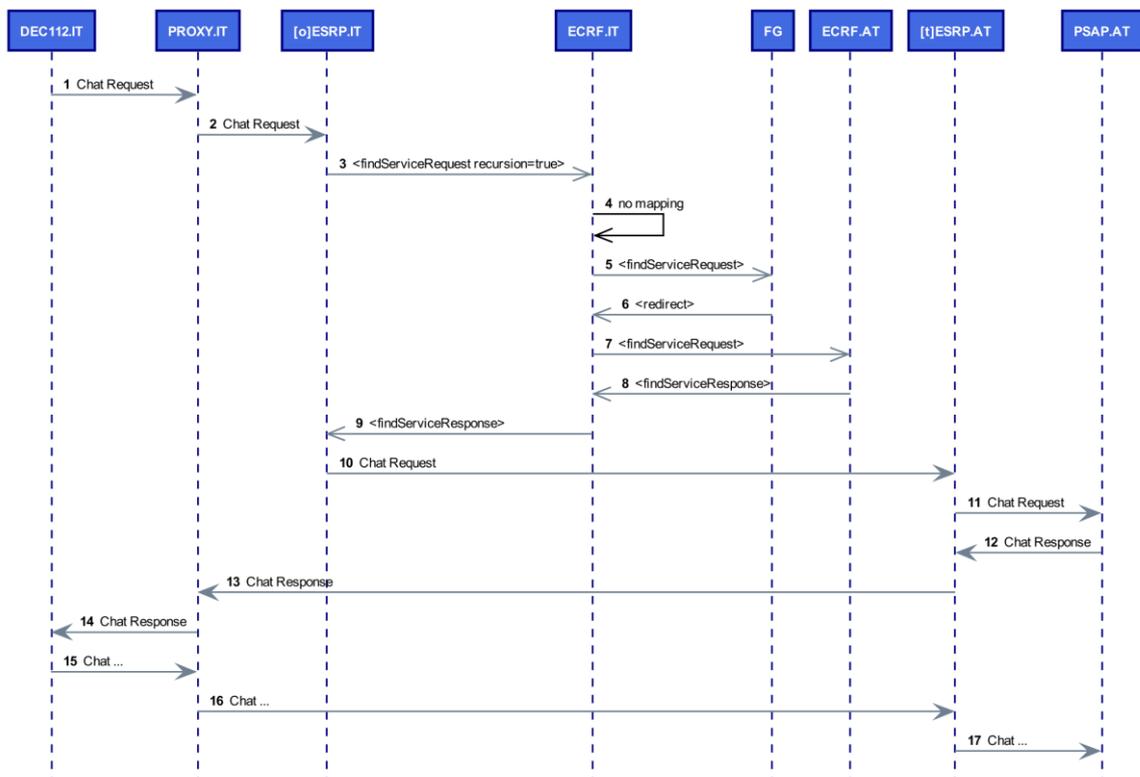


Figure 48: Simplified message sequence (IT in AT)

Chat Setup Delay

| Sample | Delay (Message 1 - Message 14, as in Figure 23) |
|--------|---|
| 1 | 3820 ms |
| 2 | 4066 ms |
| 3 | 3603 ms |

COMPARISON WITH CROSS-BORDER REGULAR 112 CALLS

Another type of scenario tested in the CELESTE project was the interregional cross-border behaviour of NG112 vs. the current situation.

Regular 112 calls are routed today by means of a network-based routing for both landline and mobile calls. Cross-border locations may stumble into wrong routing situations, since the precision of geolocation in those areas may be not accurate enough. We tested these scenarios:

- 4) An Austrian citizen walking into Italian territory then making an emergency call. Currently, if the caller is still under the coverage of the Austrian network provider, the call will be received in Innsbruck as the most appropriate PSAP, according to network rules. This will not happen with NG112, since the routing is based on the device location and by the ESInet intelligence, which follows the precise geographical borders defined in its structure.
- 5) A Danish citizen walking into Italian territory. Same test as before, with a remotely connected ESInet, using international Forest Guide capabilities.
- 6) A citizen from Bolzano province, on the border with Trento, calling 112. This call is likely to be received by 112 Trento (wrong routing) rather than Bolzano. We tested the real scenario by placing a 112 call from Senale San Felice, on the border of Bolzano province, seeing the call landing in 112 Trento and repeating the call from the 112 multimedia application. The Italian ESInet which defines the borders of the two provinces was able to route the call correctly to the most appropriate PSAP.

(4) Austrian visitor in Italy (Bolzano) [112]

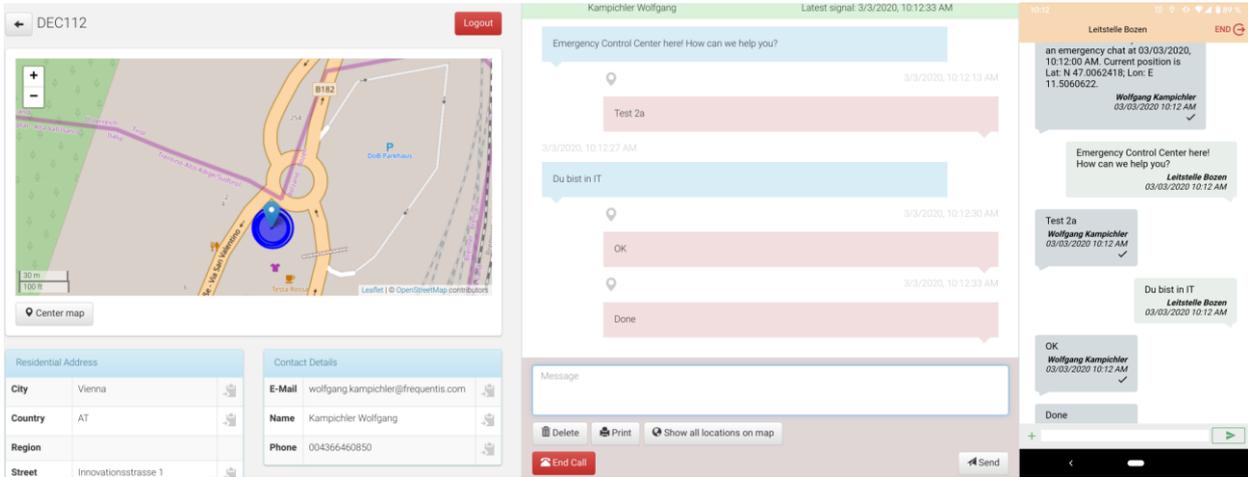


Figure 49: Leitstelle Bozen / PSAP Bolzano (DEC112 Viewer and DEC112 App)

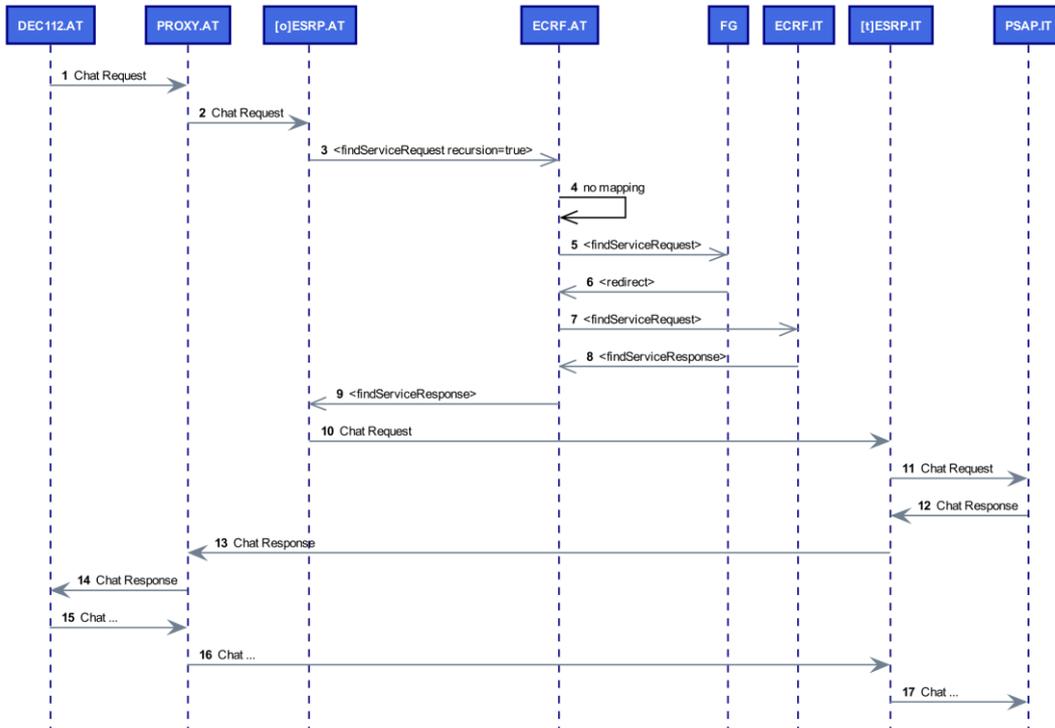


Figure 50: Simplified message sequence (AT in IT)

Chat Setup Delay

| Sample | Delay (Message 1 – Message 14, as in Figure 23) |
|--------|---|
| 1 | 2682 ms |
| 2 | 2663 ms |
| 3 | 2205 ms |

In addition, a regular 112 call was made from a location in Italy but still connected to an Austrian mobile network operator. The call was received at Federal Police Control Centre Innsbruck, as illustrated in the image below.

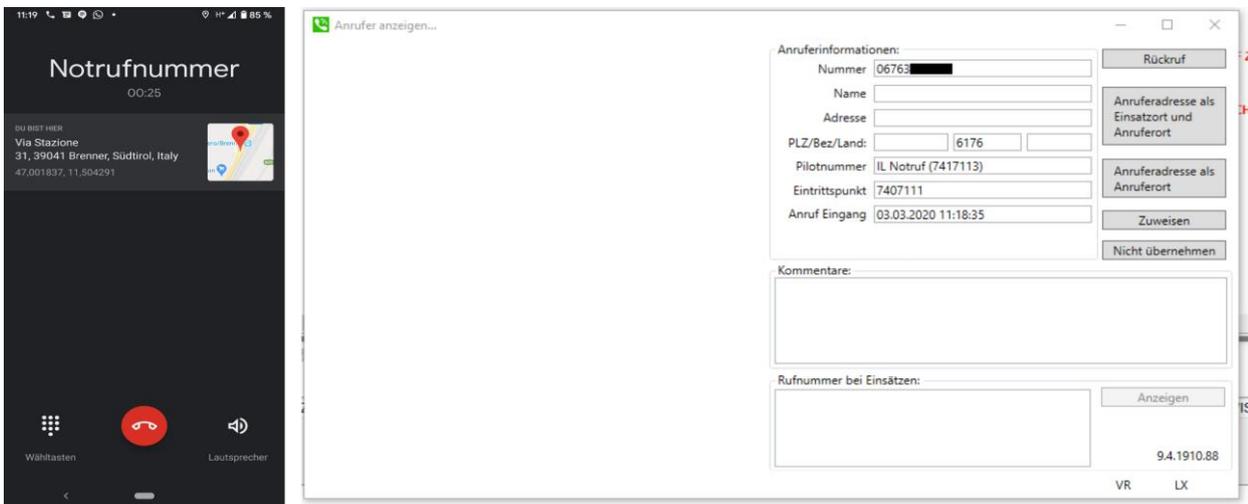


Figure 51: 112 emergency call (AT in IT) received at Federal Police Control Center Innsbruck (left: smartphone screenshot /11:19, right: CAD displaying the incoming call / 11:18:35)

(5) Danish visitor in Italy (Bolzano) [112]

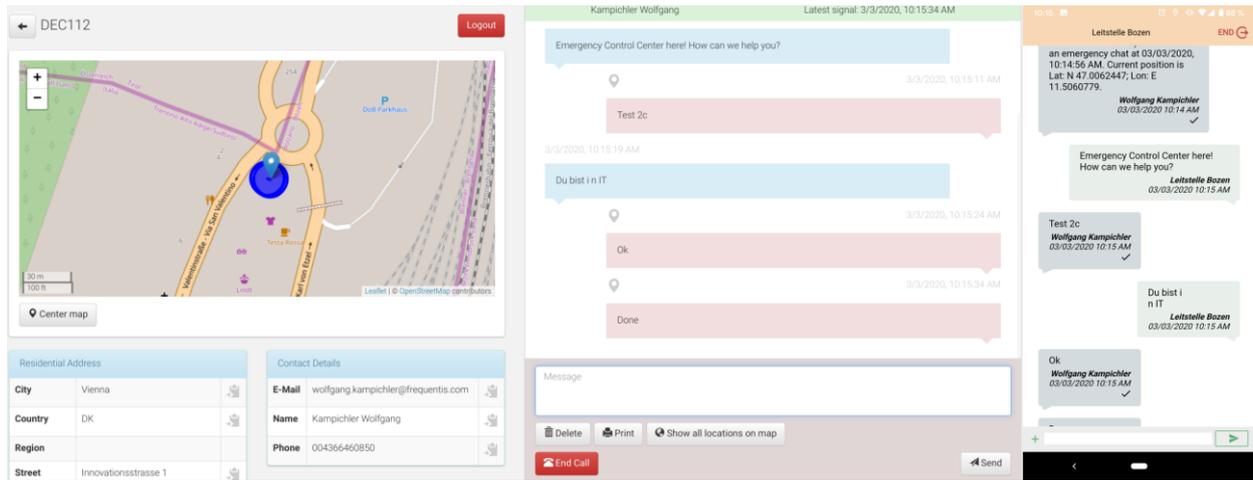


Figure 52: Leitstelle Bozen / PSAP Bolzano (DEC112 Viewer and DEC112 App)

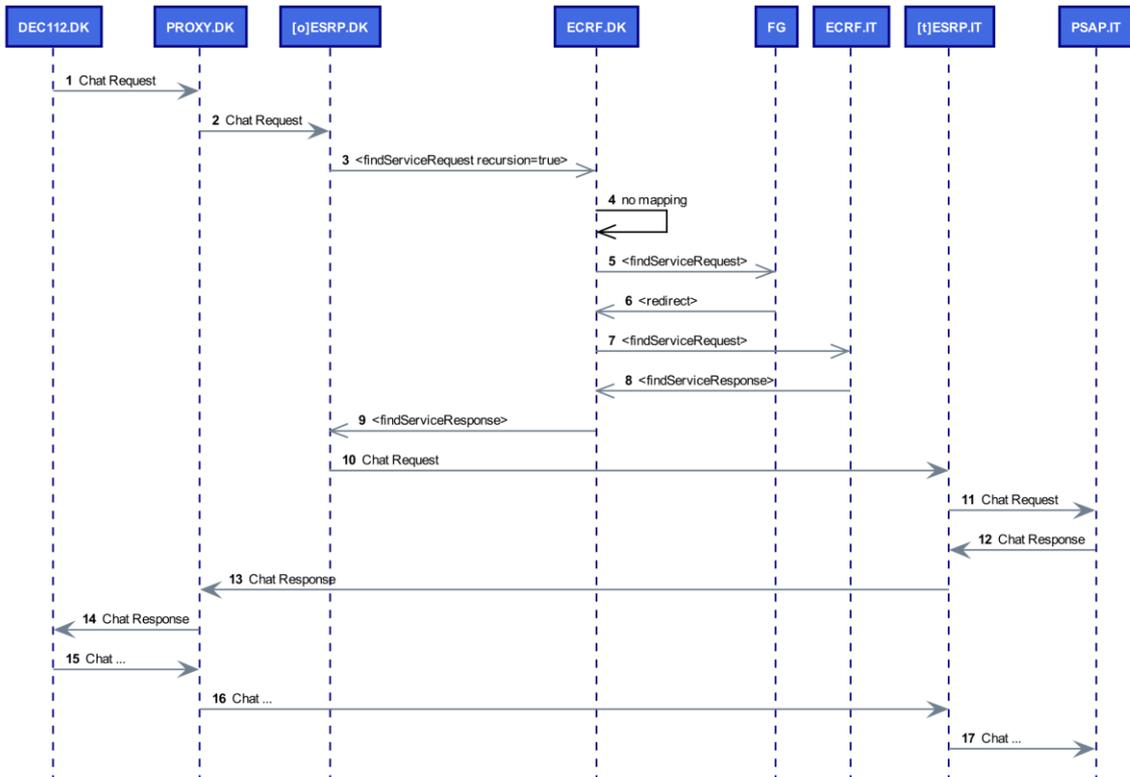


Figure 53: Simplified message sequence (DK in IT)

Chat Setup Delay

| Sample | Delay (Message 1 - Message 14, as in Figure 23) |
|--------|---|
| 1 | 1950 ms |
| 2 | 1675 ms |
| 3 | 2108 ms |

(6) Wrong call routing between the Provinces of Bolzano and Trento

The following image shows the call made in Senale San Felice, a town under the Province of Bolzano, close to the Regional border with Trento. Due to routing mechanisms, calls placed in Senale with the current 112 platform end up in Trento instead of Bolzano. By placing calls with NG112 platform, calls are correctly received in Bolzano.

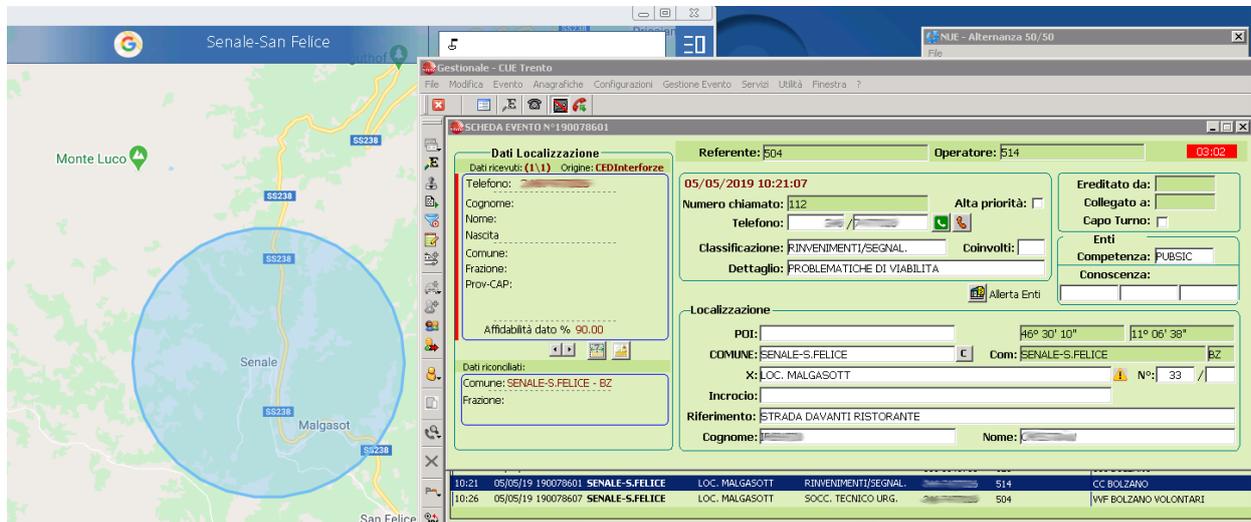


Figure 54: 112 CAD in Trento showing the incident in Senale and GIS showing the approximation of geolocalization of the caller. The CAD also shows in the bottom the list of Dispatching agencies that should be alerted, referring to Bolzano agencies and not Trento.

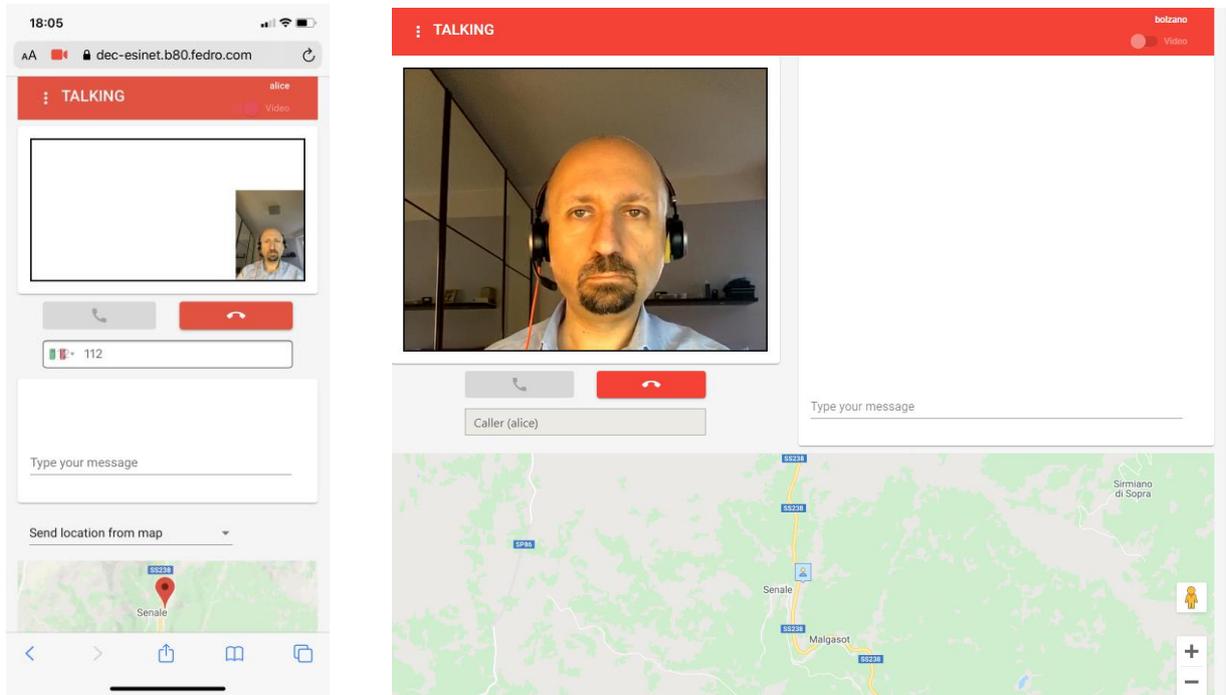


Figure 55: webRTC client (left) and PSAP user interface, with ongoing videocall and location of the caller (blue icon in the center of the map). The location, Senale, is corresponding to 112 Bolzano PSAP in the NG112 call scenario.

7 | LESSONS LEARNT & RECOMMENDATIONS

AUTHENTICATION MECHANISMS

The NG112 standard specifies mutual TLS authentication for server to server communication, which requires a Certificate Authority (CA). Within a single ESInet this can be realised via a Certificate Authority that is private to the country/state authorities running the ESInet (e.g. CA for Austria, CA for Italy, CA for Denmark).

In order to realise mutual TLS authentication across multiple ESInets, it is necessary to establish a European-wide Certificate Authority for Next Generation Emergency Services. This CA needs to be operated by an independent European organisation.

Alternatively, until such a CA is implemented, ESInets providers can grant additional certificates to the direct neighboring countries/states in order to enable cross ESInet communication. It is assumed that such bilateral agreements already exist in order to enable cross border operations, which might be extended for certificate exchange.

GEOGRAPHIC DATA

Geographical data for each country's jurisdiction needs to be specified to enable flexible routing capabilities. Since this data can be different based on the level of detail, a single data set is needed.

It is recommended to specify a single data set including the geographical data for each country's jurisdiction to prevent overlapping and blind spots for emergency services.

FOREST GUIDE

The Forest Guide enables flexible routing across multiple ESInets by providing routing information for locations outside of a country's jurisdiction. This routing information is based on the geographical data specifying the country's borders and the entry points of the corresponding country's ESInet.

It is recommended to enable multiple concurrent Forest Guide deployments by providing the previously specified data to Forest Guide vendors. Similar to Domain Name System (DNS), an ESInet can then choose and balance between the multiple Forest Guides to ensure fault tolerance and availability.