Pilot project on the design, implementation and execution of the transfer of GNSS data during an E112 call to the PSAP

Contract No 440/PP/GRO/PPA/15/8308

Deliverable D3.1 – Description of the scenarios

Loïc Bellon
July – 2017
Contract No 440/PP/GRO/PPA/15/8308

Deliverable D3.1 – Description of the scenarios

Pilot project on the design, implementation and execution of the transfer of GNSS data during an E112 call to the PSAP

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<td>Loïc Bellon</td>
<td>08 Jun 2016</td>
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<td>Matthieu Forte</td>
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<td>M. Forté</td>
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LIST OF ABBREVIATIONS

3GPP - 3rd Generation Partnership Project
A-GNSS - Assisted Global Navigation Satellite System
A2C - Authorities to Citizens communication
ACE - Accredited Center of Excellence
AML - Advanced Mobile Location
API - Application Program Interface
BSC - Base Station Controller (2G)
BSSAP-LE - LCS Extension for Lb, Lp and Ls interfaces
BSSMAP-LE - BSSMAP LCS Extension
BSSLAP - BSS LCS Assistance Protocol
C&C - Command & Control
C2A - Citizens to Authorities communication
CAD - Computer-aided dispatch
CAPEX - Capital expenditures
CEN - European Committee for Standardisation
CERN - European Organisation for Nuclear Research
CNES - French Space Agency
EC - European Commission
E-CID – Enhanced Cell ID
ECAS - Emergency Call Answering Service
ECC - Electronic Communications Committee
EE - British mobile phone operator, formerly Everything Everywhere
EGNOS - European Geostationary Navigation Overlay Service
EISEC - Enhanced Information System for Emergency Calls
ESA - European Space Agency
ESSN - Emergency Services Staff Network
ETC - Electronic Toll Collection
ETSI - European Telecommunications Standards Institute
EU - European Union
FP7 - Framework Programme 7
GIS - Geographical Information System
GMLC - Gateway Mobile Location Center
GNSS - Global Navigation Satellite System
GPS - Global Positioning System
GSM - Global System for Mobile Communications
HSS - Home Subscriber Server
ICE - In Case of Emergency
IETF - Internet Engineering Task Force
IP - Internet Protocol
IPR - Intellectual Property Right
IRSN - French Nuclear Safety Institute
Iupc - Interface between RNC and SAS (RNC interface)
IVE - in-vehicle equipment
IVS - in-vehicle systems
KPI - Key Performance Indicator
LAC - Location Area Code
LBS - Location based Services
LCS - LoCation Services
LCS-AP - LCS Application Protocol
LPP - LTE Positioning Protocol
LTE - Long-Term Evolution
LPP - LTE Positioning Protocol
MAC - Media Access Control
MEP - Member of the European Parliament
MLC - Mobile Location Centre
MME - Mobility Management Entity (4G)
MNO - Mobile Network Operator
MSD - Minimum Set of Data
MSG - Mobile Standard Group
MT-LR - Mobile Terminating Location Request
NG - Next Generation
NG112 - Next Generation 112
OPEX - Operating Expenditures
OS – Operating System
OTDOA - Observed Time Difference Of Arrival
PCAP - Positioning Calculation Application
PCO - Project Control Office
PEMEA - Pan-European Mobile Emergency Application
PSAP - Public Service Answering Point
R&D - Research & Development
RNC - Radio Network Controller (3G)
Rx - Received Signal level
RRLP - Radio Resource Location services Protocol
RTT - Round Trip Time
SAS - Standalone SMLC
SET - SUPL enabled terminal
SIM - Subscriber Identity Module
SIP - Session Initiation Protocol
SL - SUPL Location
SLA - Service Level Agreement
SLC - SUPL Location Center
SLP - SUPL location platform
SMLC - Serving Mobile Location Center
SMS - Short Message Service
SSID - Service Set IDentifier
SUPL - Secure User Plane
TDOA - Time Difference of Arrival
TA - Timing Advance (between an MS and its serving BTS)
TL - Task Leaders
TLRR - Trigger Location Reporting Request
TM - Technical Manager
TOA - Time of Arrival
TTFT - Time To First Fix
WP - Work Package
WPL - Work Package Leader
UE - User Equipment (mobile)
UMTS - Universal Mobile Telecommunication System
URI - Uniform Resource Identifier
URN - Uniform Resource Name
WGS84 - World Geodetic System Datum 84
VoLTE - Voice over LTE
1. INTRODUCTION

1.1 PLACE OF THIS DOCUMENT AND OBJECTIVES

This document is the “Description of the Scenarios Document”, identified as D3.1 in the list of project deliverables.

It is generated as part of the contract 440/PP/GRO/PPA/15/8308.

The objectives of the document are to analyse the requirements and the user scenarios defined in WP1 deliverable D1.1, depict the technical impact at the architecture level in order to respond to users’ requirements based on prior analysis of WP1 deliverables, and finally regroup the technical solutions in comprehensive scenarios of architecture implementation for the pilots. Based on these objectives, this document is a first step to identify the technologies that can fill the gaps between existing technologies and the requirements, and also define the interfaces that will need to be modified or created to reach these requirements. The chart below defines the place of this document and its interaction with others work packages deliverables:

![Table 1 - HELP112 flow chart](chart.png)

As a reminder, here are the goals of each work package’s deliverable:

- **WP1:**
  - D1.1: Defines the **user requirements and formulates a set of user scenarios** that will lead the implementation and evaluation of the architecture.
  - D1.2: Analyses and compares the **existing solutions and the underlying technologies** for the provision of caller location.
D1.3: Analyses how **existing solutions satisfy the requirements**, reports the barriers for deployment and provides recommendations for the implementation.

- **WP2:**
  - D2.1: Defines the **key location and transmission technology scenarios** and assess the costs and benefits of each scenario.
  - D2.2: Recommends the **optimal scenario(s)** for the help112 caller location based on the results of the cost-benefit analysis.
  - D2.3: Provides a more detailed assessment of the costs linked to implementation of the selected technology scenario(s) as well as key operational and financial recommendations.

- **WP3:**
  - D3.1: Defines possible implementation architectures for the pilot sites, covering location/transmission tech. alternatives of WP1.
  - D3.2: Describes technicalities of these architectures and recommendations for their implementation.
  - D3.3: Selects the architecture to be deployed for the pilots based on outputs of WP2.
  - D3.4: Analyses the gaps between the selected architecture and the existing standards (eCall, 3GPP, ECC-REP-225).

### 1.2 FOREWORD

Emergency caller location is the most important piece of information for both PSAPs and first responders. Ensuring it is accurate, reliable and timely will save lives and significant emergency services resources. Not having it will mean negative outcomes for our citizens.

In the absence of a detailed and prescriptive regulatory framework, emergency mobile caller location information in Europe has typically relied on Cell-ID. Often, Cell-ID is inadequate because the cell radius is too large, notably in rural areas.

Developments in location technologies and the proliferation of GNSS enabled smartphones are leading to improved location information being available in the handset. Making such handset derived positioning information available to PSAPs during emergency communications in a secure and reliable manner is highly desirable.

This consortium, known as the HELP112 consortium, aims demonstrate that accurate and reliable caller location information is highly effective and is also highly efficient. It also studies possible deployment strategies across Europe in a cost effective manner, securing better outcomes for our citizens and simultaneously not placing any additional burden on the emergency services, mobile network providers or public authorities.

### 1.3 APPLICABLE DOCUMENTS

<table>
<thead>
<tr>
<th>AD</th>
<th>Title of the document &amp; reference</th>
</tr>
</thead>
</table>

Copyright © 2016 – HELP112 consortium, all rights reserved - Confidential only for consortium members and EC
**1.4 Reference Documents**

<table>
<thead>
<tr>
<th>RD</th>
<th>Title of the document &amp; reference</th>
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</table>
| RD 1 | Help112 Technical, Management & Financial Proposal  
  TPZF/SSA-T2015-PP-0451 is1.0 31/07/2015 |
| RD 2 | Help112 Deliverable D1.1 “Requirements Document”  
  HELP112-D1.1-EENA-017 21/03/2016 |

Table 2 – Reference documents
2. ANALYSIS OF USER REQUIREMENTS AND USER SCENARIOS

Based on HELP112 deliverable D1.1, we analysed the user requirements and use cases, and split them to specify requirements and user scenarios. These requirements and user scenarios are described hereinafter. The definition of each type of requirement is as defined in HELP112 deliverable D1.1.

2.1 USER REQUIREMENTS

The requirement ids are in the form:

Requirement id: XXXX_NNN

where

XXXX is a four character abbreviation identifying the requirement category and
NNN is a three digit number identifying the requirements in each category

The category’s four character abbreviations are:

- **ACCU** for accuracy and reliability requirements
- **RESP** for response time requirements
- **PRES** for presentation of the caller location in the PSAP
- **PRIV** for privacy requirements
- **ACCE** for requirements regarding the acceptance of the solution
- **SECU** for security requirements
- **LOCA** for requirements regarding the use of different positioning methods
- **BATT** for requirements regarding the battery life of the handset
- **CHAR** for requirements regarding the charges that a caller may occur
- **TRAN** for data transmission requirements
- **ROAM** for roaming callers requirements
- **AML** for AML specific requirements
## 2.1.1 Accuracy/Precision and Reliability requirements

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<th>Requirement description</th>
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<tr>
<td>ACCU_001</td>
<td>The confidence radius of the location measured shall be transmitted in meters.</td>
<td>4.1.3</td>
</tr>
<tr>
<td>ACCU_002</td>
<td>The confidence radius of the location measured shall be less than 30 meters in urban areas for 67% of calls.</td>
<td>4.3.4</td>
</tr>
<tr>
<td>ACCU_003</td>
<td>The confidence radius of the location measured shall be less than 100 meters in urban areas for 95% of calls.</td>
<td>4.3.4</td>
</tr>
<tr>
<td>ACCU_004</td>
<td>The confidence radius of the location measured shall be less than 30 meters in rural areas for 67% of calls.</td>
<td>4.3.4</td>
</tr>
<tr>
<td>ACCU_005</td>
<td>The confidence radius of the location measured shall be less than 50 meters in rural areas for 95% of calls.</td>
<td>4.3.4</td>
</tr>
<tr>
<td>ACCU_006</td>
<td>The accuracy(^1) of location estimate should always be less than its precision, i.e. the actual position should always be within the radius define by the precision criterion.</td>
<td>4.1.1</td>
</tr>
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\(^1\) The term “accuracy” is defined in section 4.1.1 of D1.1 Requirements document.

## 2.1.2 Response time requirements

<table>
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<tr>
<td>RESP_001</td>
<td>The response time shall be less than 5 seconds for a Cell-ID location solution.</td>
<td>4.2.3</td>
</tr>
<tr>
<td>RESP_002</td>
<td>The response time shall be less than 30 seconds for any location solution that provides more accurate and precise caller location and satisfies the accuracy/precision requirements (E-GNSS, A-GNSS, WiFi, Enhanced Cell-ID, ...)</td>
<td>4.2.3</td>
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</table>
# 2.1.3 Presentation of the caller location in the PSAP

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>PRES_001</td>
<td>The caller’s location has to be received on the GIS available at the call taker’s terminal that has answered the call.</td>
<td>4.4</td>
</tr>
<tr>
<td>PRES_002</td>
<td>No additional task shall be assigned to the call taker to get caller’s location through the HELP112 location server.</td>
<td>4.4</td>
</tr>
<tr>
<td>PRES_003</td>
<td>The trigger of the presentation of the caller’s location shall not be modified by the use of HELP112 location server. The caller’s location could either be pushed from the HELP112 location server to the call taker CAD, or pulled by the call taker CAD.</td>
<td>4.4</td>
</tr>
<tr>
<td>PRES_004</td>
<td>The caller’s location shall be displayed in WGS84 coordinate system on the call taker’s CAD.</td>
<td>5 (D1.2)</td>
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# 2.1.4 Privacy requirements

<table>
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<th>Id</th>
<th>Requirement description</th>
<th>Source (section of D1.1)</th>
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<tbody>
<tr>
<td>PRIV_001</td>
<td>The HELP112 solution shall ensure that the caller location is available only to respond to emergency calls. Privacy restrictions for uses not related to emergency calls shall be maintained and strictly enforced.</td>
<td>4.5</td>
</tr>
<tr>
<td>PRIV_002</td>
<td>Storage of caller location at the time of the emergency call in the PSAP shall be in agreement with the PSAPs operating policy and the national data protection legislation.</td>
<td>4.5</td>
</tr>
<tr>
<td>PRIV_003</td>
<td>The caller’s data storage shall be protected from unauthorized access. Only PSAP and legal authorities shall have access to the caller’s data.</td>
<td>4.5</td>
</tr>
<tr>
<td>PRIV_004</td>
<td>The caller’s location data obtained during an emergency call shall not be stored on the handset during or after the call.</td>
<td>4.5</td>
</tr>
<tr>
<td>PRIV_005</td>
<td>The E112 caller shall not be able to suppress or degrade the availability of the location information for a 112 call.</td>
<td>4.5</td>
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### 2.1.5 Acceptance of the solution requirements

<table>
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<th>Requirement description</th>
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<td>ACCE_001</td>
<td>The HELP112 solution shall be available for the widest range of handset types.</td>
<td>4.6</td>
</tr>
<tr>
<td>ACCE_002</td>
<td>The process to initiate the estimate and transmission of the caller location to the PSAP shall be initiated without the need for caller intervention.</td>
<td>4.6</td>
</tr>
<tr>
<td>ACCE_003</td>
<td>The estimate and transmission of the location information to the PSAP shall not be visible or accessible to the user.</td>
<td>4.6</td>
</tr>
<tr>
<td>ACCE_004</td>
<td>The location process and the transmission of location data to the PSAP shall not interfere with the voice call.</td>
<td>4.6</td>
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### 2.1.6 Security requirements

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<td>SECU_001</td>
<td>HELP112 shall provide a solution that is always available to the entities authorized to access it. For example it must remain available if wide-scale attacks are performed, e.g. denial of service, or access with appropriate privileges is gained that can make the service unavailable or unusable.</td>
<td>4.7</td>
</tr>
<tr>
<td>SECU_002</td>
<td>HELP112 solution shall be protected from attacks that attempt to block the HELP112 solution to specific callers or to take advantage or profit from transmitting the location to other sources.</td>
<td>4.7</td>
</tr>
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</table>
## 2.1.7 Method of estimating the location information requirements

<table>
<thead>
<tr>
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<th>Requirement description</th>
<th>Source (section of D1.1)</th>
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<tbody>
<tr>
<td>LOCA_001</td>
<td>HELP112 solution shall estimate the caller location by the GNSS capabilities of the handset if available and if the battery power level is sufficient.</td>
<td>4.8</td>
</tr>
<tr>
<td>LOCA_002</td>
<td>HELP112 solution shall make use of, trial and demonstrate the advantages of estimating the caller location by EGNOS and Galileo.</td>
<td>4.8</td>
</tr>
<tr>
<td>LOCA_003</td>
<td>When it is possible, HELP112 location solution shall combine multiple methods in order to fit the requirements as widely as possible.</td>
<td>4.8</td>
</tr>
<tr>
<td>LOCA_004</td>
<td>In the case that a location method fails to provide accurate caller location with regards to the accuracy requirements, the HELP112 solution shall ensure that a fall-back location solution would be available to provide a more accurate caller’s location than the one estimated by Cell-ID.</td>
<td>4.11</td>
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## 2.1.8 Battery life requirements

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<tr>
<th>Id</th>
<th>Requirement description</th>
<th>Source (section of D1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BATT_001</td>
<td>HELP112 solution shall ensure that in cases of low battery power level, priority shall be given to the emergency voice call.</td>
<td>4.9</td>
</tr>
<tr>
<td>BATT_002</td>
<td>In the HELP112 solution, the battery power level needed and expected to use either A-GNSS, stand-alone GNSS, or WiFi without GNSS, shall be different for each type of location solution, and dependant on the battery capacity of the handset.</td>
<td>4.9</td>
</tr>
</tbody>
</table>
### 2.1.9 Incurring charges requirements

<table>
<thead>
<tr>
<th>Id</th>
<th>Requirement description</th>
<th>Source (section of D1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHAR_001</td>
<td>HELP112 solution shall ensure that the data channel is used for the processes of estimating and transmitting the location if and only if the data connection is already activated on the handset. Considering that way of running the solution, it is assumed that if the data connectivity is used, the caller’s incurring charges shall be in accordance with his ongoing contract with a network operator. It is also assumed that if the data connection is deactivated on the caller’s handset, all methods to estimate the caller’s location that need data connectivity to process the location will not be used in the location estimate. It could include A-GNSS and WiFi solutions.</td>
<td>4.10</td>
</tr>
<tr>
<td>CHAR_002</td>
<td>HELP112 solution shall ensure that if a SMS is used to transmit the location information to the PSAP, it shall be recognised as an E112 SMS by the network and shall be free of charge for the caller. Considering that zero-rated SMS relies on MNOs configuration, the deployment of the HELP112 solution can proceed even without resolving this issue for the trials.</td>
<td>4.10</td>
</tr>
</tbody>
</table>

### 2.1.10 Data transmission requirements

<table>
<thead>
<tr>
<th>Id</th>
<th>Requirement description</th>
<th>Source (section of D1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRAN_001</td>
<td>HELP112 shall study the possibility of using the IP channel to transmit the caller’s location data to the PSAP.</td>
<td>4.14</td>
</tr>
<tr>
<td>TRAN_002</td>
<td>If the data connectivity is not available or is deactivated on the caller’s handset, HELP112 solution shall ensure that a fall-back solution that doesn’t use the data channel is available to transmit the location data to the PSAP.</td>
<td>4.11</td>
</tr>
</tbody>
</table>
2.1.11 Roaming requirements

<table>
<thead>
<tr>
<th>Id</th>
<th>Requirement description</th>
<th>Source (section of D1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROAM_001</td>
<td>HELP112 shall study ways to be robust to a caller from a home HELP112 enabled country A that use the E112 service in a visited HELP112 enabled country B.</td>
<td>4.12</td>
</tr>
</tbody>
</table>

2.1.12 Improvement of AML specific requirements

<table>
<thead>
<tr>
<th>Id</th>
<th>Requirement description</th>
<th>Source (section of D1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AML_001</td>
<td>HELP112 shall study the possibility to transmit extra data related to the caller's location in addition to the ones already expected in the current AML solution, such as Cell-ID, Radio Measurement Report, floor, and altitude when available.</td>
<td>4.14</td>
</tr>
<tr>
<td>AML_002</td>
<td>HELP112 shall examine ways to configure the AML solution to be triggered when an emergency SMS is sent.</td>
<td>4.14</td>
</tr>
</tbody>
</table>

In addition to the two specific requirements above, the conformity to the following requirements shall be verified during the trial phase of a HELP112 architecture including AML in the UK pilot:

- TRAN_001.
- TRAN_002.
- ROAM_001.

2.2 User scenarios

In the HELP112 D1.1 deliverable, several user scenarios are depicted and separated in three categories:

- Location types which refers to the local environment of the caller.
- Location estimate method which refers to which technologies are available to the caller to determine his location.
- Handset settings which refers to the connectivity, battery power saving, and privacy parameters of the handset.

Since the environment of the caller and the location estimate method are intrinsically linked, these two types of user scenarios are gathered in several new user scenarios that cover the two aspects.
The following user scenarios will be used to define the technical architecture and to make the association between an architecture and a pilot site.

<table>
<thead>
<tr>
<th>Id</th>
<th>User scenario description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCEN_001</td>
<td>Rural countryside with GNSS/A-GNSS available but no WiFi available. An outside location far away from buildings or constructions that could block GNSS.</td>
</tr>
<tr>
<td>SCEN_002</td>
<td>Rural building with all location methods available. An outside location out of town and over 3 meters away from buildings that could block GNSS, but where WiFi signals are present. For example in a village within WiFi range of house with a WiFi router.</td>
</tr>
<tr>
<td>SCEN_003</td>
<td>Rural car with GNSS/A-GNSS available but no WiFi available. A location in the open countryside and inside a parked car far away from buildings or constructions that could block GNSS.</td>
</tr>
<tr>
<td>SCEN_004</td>
<td>Urban with GNSS/A-GNSS available but disrupted and WiFi available. An outside location in a town or city street where WiFi signals are present and GNSS signals are disrupted by buildings.</td>
</tr>
<tr>
<td>SCEN_005</td>
<td>Motorway or Dual carriageway with GNSS/A-GNSS available but no WiFi available. While driving different sides of a carriageway where GNSS signals are available.</td>
</tr>
<tr>
<td>SCEN_006</td>
<td>House location with all location methods available. A location inside a house that has WiFi and in a location that offers a partial satellite coverage.</td>
</tr>
<tr>
<td>SCEN_007</td>
<td>Office location with WiFi available but no GNSS available. A location inside an office, which itself is deep inside a building where GNSS signals cannot reach, but WiFi is present.</td>
</tr>
<tr>
<td>SCEN_008</td>
<td>Urban with mobile data disabled. An outside location in a town or city street where the caller has deliberately disabled his handset data connection.</td>
</tr>
<tr>
<td>SCEN_009</td>
<td>Abroad and urban with mobile data disabled. An outside location in a town or city street not in the home country of the caller’s MNO. To avoid extra charges, the caller has disabled his handset data connection.</td>
</tr>
<tr>
<td>SCEN_010</td>
<td>Caller’s handset in battery saving mode. The caller’s has configure his handset so as to save battery power. Only WiFi and Cell-ID methods are enabled.</td>
</tr>
<tr>
<td>SCEN_011</td>
<td>Caller’s handset in privacy conscious settings. The caller’s has configure his handset so as to protect his private life. Only stand-alone GNSS is enabled or can be activated.</td>
</tr>
<tr>
<td>SCEN_012</td>
<td>SIMless user. A caller in a rural environment who makes an emergency call with a handset without SIM card. This user scenario is limited to country/region where emergency call without SIM card is foreseen by legislation.</td>
</tr>
</tbody>
</table>
3. CANDIDATE FOR E112 DESIGNING METHODOLOGY

The HELP112 architecture definition process followed the method described below to define the best technologies to be used in HELP112 with the aim of covering as widely as possible user requirements (Requirements that apply to all HELP112 stakeholders: Caller, MNOs, PSAP, OS provider, Handset manufacturers, …) and user scenarios (Use cases based on the environment of the emergency caller) defined in HELP112 D1.1 deliverable. The analysis of D1.1 deliverable clarifies users’ expectations from the side of E112 caller as well as from the side of PSAP call taker who will handle the emergency call and dispatch resources. Based on this analysis, our expertise, and technical documentation analysis, it is possible to identify existing technologies that are wholly or partially supposed to respond to user requirements and user scenarios. Finally these technical solutions dealing with the determining of the caller’s location, the activation of its transmission, the way it is conveyed on the mobile network, the storage on a location server, and how it is used by the call taker, are put together to define HELP112 possible technical solutions.

The D1.1 analysis has highlighted the fact that it is essential for all stakeholders of a 112 emergency call that the position of the caller shall be transmitted to the call taker as accurately, reliably and quickly as possible. In addition, other criteria have to be taken into account during the whole process of an emergency call, such as the presentation of the caller’s location in the PSAP, the privacy of caller’s location data, the security of the system, the method to be used to estimate the location information, the battery life of the caller’s handset with regards to the location method, the caller’s charges, and so forth. Concerning the method of estimating the location information, the HELP112 solution shall make use of, trial and demonstrate the advantages of estimating the caller location by EGNOS and Galileo, as well as supplementary fall-back solution such as network based location acting as a safety net. On the other hand, roaming considerations and limitations will have to be taken into account in the solutions proposed, as well as the conveyance of data using an IP transmission channel.

In the first part of this document, possible solutions of estimating the caller’s location are presented. Some of them are already implemented in the E112 call process in different European countries. The others could be used to fill the gap between the implemented solutions and the user requirements. We will see in the architecture descriptions how we can combine different location solutions to improve accuracy, reliability, and response time of an E112 caller’s location.

In the second part, possible ways to activate and transmit the location data are described. Such as for the estimate of the caller location, several solutions presented in this section are already implemented, and the others aim to improve the coverage of user requirements and user scenarios.

Due to the range of implementation in the PSAP, the interfaces between the PSAP and the HELP112 location server (a server provided by the PSAP, which is able to receive the location data sent by the handset of the caller and to make it available to the PSAP call taker), and between the
HELP112 location server and a potential pre-existing location server will not be described in this document. Nevertheless, these two interfaces shall be based on the interface that already exists between the PSAP and the potential pre-existing server so as not to increase the complexity of the implementation of HELP112 solution at the PSAP level.

The last part is a description of the foreseeable implementation architecture that most widely reach the user requirements and the user scenarios.
4. LOCATION METHODS

4.1 NETWORK BASED SOLUTION

The first way to locate a mobile user’s handset is to use the fixed stations that form the wireless carrier’s network. Each of these stations contains radio intercept equipment that can receive a signal from any active mobile handset. The location of the mobile user can be determined by using the signals from one or more base stations. The more base stations are used to compute the position solution, the more accurate the user’s location information will be.

The advantage of Network based solutions is that they can work with all types of handsets, making them an ideal first step in providing location information to the HELP112 PSAP. Most of PSAPs in Europe that have already implemented an automatic location solution for mobile users, use Network based location solution, but limiting it to the provision of the basic Cell-Id location precision, possibly due to the current lack of EU legislation asking for higher accuracy/precision.

Hereafter are described Network based solutions that already exist in the market (but not implemented in Europe for 112 purposes) and a focus will be made on Enhanced Cell-ID solutions. Finally, we will check the relevance of each solution with regards to the user requirements.

4.1.1 Existing technologies

4.1.1.1 Common Cell-ID methods

Cell identity is the most simplistic and cost-effective way to provide position information. Cell ID positioning simply returns the geographic position of the area covered by the device’s serving cell. This area is dependent on the angle of coverage and cell radius. The latter can vary from 550 meters to several kilometers. Important note: the serving cell is not necessarily the closest cell tower from the caller.

The provision of Cell-ID location requires the integration of Gateway Mobile Location Center (GMLC) with the MNO network.

4.1.1.2 Enhanced Cell-ID solution (2G, 3G, 4G)

Additional mobile terminal and/or mobile access network radio resource related measurements can be used in order to improve the accuracy of the Cell ID mobile location. They usually refer to calculations between timestamps of different events, the strength of certain signals or the angle under which a signal is received.
These additional radio network information could be retrieved from the network by integrating Serving Mobile Location Center (SMLC) for 2G or Standalone SMLC (SAS) for 3G or E-SMLC for 4G to the MNO network, by connecting them to the BSC, RNC and MME respectively.

It is worth noting that the SMLC (or SAS or E-SMLC) has typically the following elements:

1. The location calculator, which is responsible for producing an estimate of the position of mobiles based on the radio information provided by the BSC through the Lb interface, or by the RNC through the Iupc interface.
2. The Cell Tower Updater is usually triggered on a regular basis, typically every night, to update the database with new or modified cells. The Database maintains the position of all towers and performs pre-calculations for all location methods.

4.1.1.2.1 Cell-ID and Time Advance (2G, 4G)

In 2G networks the TA is based on the existing Timing Advance parameter. It measures the time between the emission of a radio wave from mobile terminal and its arrival to the BTS of the mobile network. The TA value is known for the serving BTS. The Cell ID of the serving cell and the TA is returned as the result of the TA measurement procedure. TA may be used to assist all positioning mechanisms, but the network does not store this kind of information without additional software. The TA parameter is only available for the serving cell and not for any other cells that the mobile terminal might see.

In 4G networks a Timing Advance parameter (TADV) can be measured for helping to improve the accuracy in a similar way.

4.1.1.2.2 Cell-ID and Round Trip Time (3G)

This variant uses in addition the NodeB measurements of the signal Round-Trip-Time (RTT). These measurements can be made for all NodeBs in the active set. If RTT measurements to several geographically dispersed NodeBs are available, the mobile terminal location may be found via trilateration. The RTT measurements may be complemented by the mobile terminal measurement of the Rx-Tx Time Difference. In case of TDD mode, the distance measurement may be based on RX Timing Deviation and/or Timing Advance. The RTT parameter is only available for the serving cell and not for any other cells that the mobile terminal might see.

4.1.1.2.3 Cell-ID, Time Advance and Received Signal – 2G

CITARX is an abbreviation of Cell ID, Timing Advance and Received Signal levels. With the addition of received signal strengths from the co-sited cells the position of the device may be calculated and a more accurate position calculated along the given TA band.

4.1.1.2.4 Cell ID with Path loss and Related Measurements (2G, 3G, 4G)

The RF Pattern Matching positioning method is based on radio link measurements collected from the network and/or the mobile terminal. The method relies on predictions or models of the radio environment against which it performs an algorithmic comparison of the measurements to
determine a best match estimation of the mobile terminal location. RFPM may utilise measurements other than the path loss measurements noted above, e.g. RTT or TA.

4.1.1.2.5 Observed Time Difference of Arrival – 4G

Observed Time Difference Of Arrival (OTDOA) parameters are also available from 4G networks. The measurement of this parameter is more accurate than that for ECID and therefore once the multilateration calculation are computed, the returned accuracy is correspondingly greater.

4.1.1.2.6 Enhanced Cell-Id Solutions - Summary

The Location Calculator (LC) could perform the following location solution, depending on the type of network, the content of the Radio Network Measurement Report, and the algorithms available at the SMLC or LC level:

- Basic Cell-Id method.
- Cell-Id + Round Trip Time in 3G networks.
- CITARX in 2G networks.
- RF Pattern Matching (RFPM) in 2G/3G/4G networks.
- Observed Time Difference Of Arrival (O-TDOA) in 4G networks.

4.1.1.3 User Plane Network Location

Conventional network based location (both cell Id and enhanced cell methods) are typically installed within the mobile network operators infrastructure. Network measurements are obtained through the control plane (either pull or can be pushed based upon emergency calls).

However, introducing an application or capability on the handset (similar to AML) opens up a number of opportunities to provide locations based upon network measurements provided from the handset. A location calculator would be hosted alongside a HELP112 location server, and would give the following benefits:

- **Multi-network locates.**
  
  The handset might be able to provide network measurements from all networks, not just the current connected network (needs to be assessed and trialed). If a full set of measurements are made available to a location calculator on the HELP112 location server it is possible to perform multi-network multilateration. This will have significant advantage in low cell density (rural) user scenarios.

- **Better location validation.**
  
  A centralised location calculator as part of the HELP112 location server provides a valuable network based fallback in the situations where a location cannot be derived through WiFi or GNSS. It can also be used to validate the WiFi or GNSS location.
• **Crowd sourced fingerprinting.**

Pattern matching algorithms rely upon fingerprinting to give very good accuracy (can be below 50m). By calling the location calculator with a full set of network measurements and GNSS or WiFi based location it is possible for the location calculator to generate crowd sourced fingerprints giving better accuracy with low maintenance requirements.

• **Light integration requirements**

Most mobile networks have a GMLC installed, but have not yet introduced an SMLC to provide better accuracy. A user plane Location Calculator would have a very light integration requirement. The Location Calculator would require periodic deliveries of cell tower data (definitions of where each cell is, its orientation and power) from each of the networks. No actual physical integration into the network is required, making this a very attractive option to provide better network based fallback location for enabled handsets.

• **SIMless locates**

In the same way that a handset can be capable of making a call if there is no signal on their home network or if there is no sim, it is still possible to obtain the network measurements, thus giving the ability to calculate a location.

### 4.1.2 Accuracy/Precision and response time of network based location solutions

The table below presents the average precision of each location estimate solution available from Network measurements detailed here above.

<table>
<thead>
<tr>
<th>Location algorithm</th>
<th>Urban¹</th>
<th>Suburban²</th>
<th>Rural³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell-Id (2G/3G/4G)</td>
<td>500m</td>
<td>1,500m</td>
<td>5,000m</td>
</tr>
<tr>
<td>Cell-Id + TA (2G, 4G) and Cell-Id + RTT (3G)</td>
<td>250m</td>
<td>800m</td>
<td>2,500m</td>
</tr>
<tr>
<td>CITARX (2G)</td>
<td>200m</td>
<td>500m</td>
<td>1,000m</td>
</tr>
<tr>
<td>RF Pattern Matching (RFPM)</td>
<td>150m – 200m</td>
<td>300m – 400m</td>
<td>700m – 800m</td>
</tr>
<tr>
<td>O-TDOA (3G/4G)</td>
<td>50m – 100m</td>
<td>50m – 100m</td>
<td>50m – 100m</td>
</tr>
</tbody>
</table>

**Table 2 – Network Based Method precision estimates per environment/method**

1. Average inter BTS distance = 500m
2. Average inter BTS distance = 1,500m
3. Average inter BTS distance = 5,000m

<table>
<thead>
<tr>
<th>Location algorithm</th>
<th>ACCU_002</th>
<th>ACCU_003</th>
<th>ACCU_004</th>
<th>ACCU_005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell-Id</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Cell-Id + TA (2G, 4G) and Cell-Id + RTT (3G)</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CITARX (2G)</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>RF Pattern Matching (RFPM)</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>O-TDOA (3G/4G)</td>
<td>✗</td>
<td>✔</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>

Table 3 - Compliance of Network Based Method with accuracy/precision requirements

The compliance with requirement ACCU_006 has to be validate during the trial phase of HELP112 by collecting the location data of all the tests and comparing them with the location references.

The response time depends on the location solution that will be used and the way the PSAP retrieves the location information from the GMLC (Control Plane) or the Location Server (User Plane). Nevertheless, in all cases, the response time requirements RESP_001 and RESP_002 are covered by either approach since it is below 3 seconds.

4.2 **Handset Based Solution**

4.2.1 WiFi Positioning System

A Wi-Fi positioning system (WPS) relies on the fixed wireless IEEE 802.11 access point’s features to calculate a location estimate. It is used where Galileo, GPS and GLONASS are inadequate due to various causes including multipath and signal blocking indoor. Wi-Fi positioning system is particularly adapted to indoor positioning where no satellite coverage is available. It is also a well-adapted solution for urban environments where a WPS can take advantage of the high density of wireless access points. In this case WPS is a good alternative to disrupted GNSS signals.

There are two categories of location techniques that use wireless access points. The first one is based on measuring the Received Signal Strength Indication (RSSI) between the WiFi access point and the receiver and the second one is the method of “fingerprinting".
The RSSI method uses a signal propagation model to convert measured signal strength into distance information. The mobile handset connects to a WiFi hotspot database, then a trilateration process is performed to calculate the mobile handset coordinates according to the distance between the mobile handset and the multiple access points with known coordinates into the reference database. As stated in ECC report 225², this approach is simple to implement, but it does have difficulties in building a sufficiently good model of signal propagation that is adequate for real world applications since many factors affect the signal propagation.

The fingerprinting method is also RSSI based, but it simply relies on the recording of the signal strength from several WiFi access points in range and storing this information in a database along with the known coordinates of the mobile user. Then the location of any mobile terminal can be identified by comparing its signal strength measurements with the reference data. Its main disadvantage is that any changes of the environment such as adding or removing furniture or buildings may change the "fingerprint" that corresponds to each location, requiring an update to the fingerprint database.

For each method, the database and location capacities used to compute the mobile handset location based on WiFi signals measurements might be of several types. It might be performed at the network level in the GMLC/SMLC or at a server outside the network, for instance at a private SUPL server which can provide location solutions to the handset based on its WiFi environment.

In the case of a SUPL server, the location solution is provided by the server and transmitted to the mobile terminal in the first messages of the SUPL transaction between the SUPL agent on the user’s handset and the SUPL server:

- A SUPL START message is sent to the SUPL server to start a session (identified by a session id). This request contains the Radio Network Measurement Report consisting of the current serving Cell-Id and WiFi Access points information (locationId and RSS for each of them), the SUPL Enabled Terminal (SET) capabilities in terms of positioning methods, and potentially the Quality of Position requested (QoP; horizontal accuracy and maximum location age).
- The SUPL server then responds with a SUPL RESPONSE message with the same session id and a first location solution based on the current serving Cell-Id WiFi Access points information (locationId and RSS for each of them) by using RSSI method. The SUPL RESPONSE message also contains information required for the next steps of the SUPL transaction.

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² ECC Report 225, “Establishing Criteria for the Accuracy and Reliability of the Caller Location Information in support of Emergency Services”, 21 October 2014, section 7.4.1, p.44
4.2.2 Standalone GNSS

Nowadays, GNSS chipsets are embedded in the majority of mobile handsets. This makes a standalone GNSS location method available for almost every mobile phone user. To compute the location of the handset, this method uses only the capacities of the mobile GNSS chipset.

GNSS location is based on a global network of satellites that transmit radio signals to a receiver. The receiver is then able to determine the distance between each satellite in visibility and itself on the basis of the time needed to receive each signal. Finally, the receiver performs a triangulation algorithm to determine its position on the earth based on the distance to each satellite in visibility and their position on their orbits. These satellites can be part of GPS constellation developed by the United States, or/and part of GLONASS constellation developed by Russia, or/and part of Galileo constellation under development by Europe, or/and part of Beidou constellation under development by China. Some receivers can also handle assistance data from Satellite Based Augmentation Systems (SBAS) like EGNOS (European Geostationary Navigation Overlay System). SBAS provide orbits and satellite clock corrections, and delays due to ionosphere crossing, as well as confidence intervals on the location accuracy. Therefore the use of SBAS systems improve the location accuracy as well as the confidence interval about the calculated location.

The type of GNSS chipset can vary significantly from one manufacturer to another (eg: from GPS only to multi-constellation and SBAS enabled). For instance Galileo or Beidou enabled chipsets are not yet implemented in smartphones, but their implementation is expected very soon.

The advantage of this method of location is that it is totally data connection independent. On the other hand, by using this method, the power consumption is huge, and the HELP112 activation method shall check the battery life level of the handset before using GNSS standalone method.

4.2.3 A-GNSS

By using a GNSS standalone method, the TTFF (Time To First Fix) could be too long in the case of an emergency call. Indeed in the case of a cold start (when the mobile phone has not fixed a GNSS location before in their current Power ON period), the TTFF could be longer than 5 minutes (worst case), which could be useless when rapid answer and resources allocation is needed. Besides, the accuracy of GNSS standalone could be degraded if the range of the caller is subject to satellite masking or multipath (Urban, Indoor, Forest, Mountain, etc).

To improve GNSS location TTFF and accuracy in disrupted environments, a wide range of mobile handsets are A-GNSS (Assisted-GNSS) enabled. This method uses additional data collected through the data channel to determine a GNSS location solution faster and more precisely than
GNSS standalone method. As stated in ECC Report 225\(^3\), the aim of A-GNSS is to improve the availability of the location service, the accuracy of the position, the sensitivity to e.g. fading, the integrity of the signal, the reliability of the signal, the in-building functioning and, most importantly, the time needed to get results from the positioning calculation (TTFF).

The additional data provided by the assistance server can be of several types depending on the capacities of the server and of the mobile handset GNSS:

- Orbital information about satellites (Almanac, Ephemeris, Long Term Ephemeris, etc). In the case where the satellite signal strength is too low because the user is in an obstructed environment (e.g: Urban or Indoor), the mobile phone GNSS receiver will not be able to receive and decode the satellite ephemeris, and then it will not be able to compute a GNSS location. By collecting ephemeris data from another path, A-GNSS aims at improving the TTFF of the location process and even sometimes allowing GNSS location in places where GNSS standalone could not work.

- Clock information about satellites (Clock corrections, UTC model, etc). This information is used to improve location accuracy and TTFF by modelling satellite/satellite, constellation/UTC, and satellite/receiver clock variations and drifts.

- Ionospheric information (Ionospheric corrections, Ionospheric model). Also used to improve location accuracy and TTFF by modelling delays due to ionosphere crossing.

- SBAS corrections

- Satellite signal Doppler, code phase

The improvement of GNSS location TTFF will mainly depend on the availability and the accuracy of assistance data.

\(^3\) ECC Report 225, “Establishing Criteria for the Accuracy and Reliability of the Caller Location Information in support of Emergency Services”, 21 October 2014, section 7.2.6, p.40
There are two possible architecture to transmit the assistance data: a control plane solution and a user plane solution.

4.2.3.1 Control Plane A-GNSS Solution

The GMLC could support control plane based A-GNSS positioning. For a control plane based A-GNSS solution, SMLC/SAS will periodically interact with third party satellite reference node to obtain assistance data.

4.2.3.1.1 2G

In 2G network, the SMLC will establish RRLP based interface towards the BSC to interrogate the handset capabilities and send assistance data to the handset if applicable. Handset will utilize the assistance to either perform location estimates itself or return GNSS measures via BSC to SMLC.

4.2.3.1.2 3G

In 3G networks, SAS will provide the assistance data to the handset via RNC on IUPC interface using PCAP protocol. Handset will utilize the assistance to either perform location estimates itself or return GNSS measures via RNC to SAS.

4.2.3.1.3 4G

In a LTE network, the E-SMLC will provide the assistance data to the handset via MME on SLs interface using LCS-AP/LPP protocol. The handset will utilize the assistance to either perform location estimates itself or return GPS/GNSS measures via MME to E-SMLC.

Figure 1 - Time To First Fix (TTFF) with different assistance data as a function of signal strength (Source: uBlox AG "GPS Essentials of Satellite Navigation Compendium", 2009)
4.2.3.2 User Plane A-GNSS Solution

In a user plane solution, the communications between the Location Server and the mobile terminal take place over a standard data connection. The server communicates directly with the mobile end devices over an IP Connection (Internet Protocol Connection), for which the radio and switching networks require no modification. The Open Mobile Alliance (OMA), an association of Mobile Network service providers and manufacturers, has produced a Standard for location technology (OMA-SUPL).

In the case of a user plane solution with a SUPL agent on the caller’s handset that communicate with a SUPL server (in or out of the network), the A-GNSS SUPL transaction could be part of an hybrid solution composed of A-GNSS location following a WiFi+Cell-Id based location. The SUPL transaction for this hybrid location solution would start with the SUPL messages described in section 4.2.1 to determine a coarse position of the caller based on WiFi and mobile network environment. As a reminder, to get a coarse position on the basis of WiFi access points and cells in the range of the user, a SUPL START message and a SUPL RESPONSE message are exchanged between the SUPL agent on the handset and the SUPL server. Then the SUPL transaction could continue to provide other assistance data for A-GNSS location. The SUPL sequence could be as follows:

- A SUPL POS INIT message is sent by the client to the SUPL server using the same session id than the one defined in the SUPL START message. This message contains a request for a subset of assistance data in the line with the handset’s GNSS capabilities.
- The server extracts the requested assistance data from its internal storage. The server then provides the requested assistance data in a binary payload following 3GPP RRLP standard. Upon receiving that data, the client may request more data until it has all the assistance data needed for its positioning. The position is then computed by the client and returned back to the server.
- Once the position calculation is complete the server terminates the transaction with a SUPL END message.

4.2.4 Accuracy and response time of handset based location methods

The accuracy of the location calculated through its capacities depends on the configuration of the handset and the surrounding environment of the caller.

In case only WiFi is available at the moment of the call, the accuracy will depend on several parameters that should be taken into account:

- The number of WiFi access points available in the range of the caller. More access points are in the area of the caller, more accurate will be the location solution.
- The level of awareness the WiFi database has got about the WiFi access points available in the caller’s area. If the database does not know the WiFi access point around the user’s handset, it will not be possible to calculate a position based on these WiFi access points.
The ability of the algorithm that calculates the position to handle the information about WiFi access points that moved since the last update of the WiFi database.

Nonetheless, the main purpose of WiFi based location solutions is to fill the gap in urban and indoor areas where GNSS signals are poor or unusable. Since the range of WiFi access points is less than 100 meters, if the user’s handset location capacities return a WiFi based location solution, the accuracy of the solution will be under 100 meters and most of the time under 30 meters. Therefore, all the accuracy/precision requirements are met when a WiFi positioning method is used.

Besides, in Urban/Indoor environment, the accuracy and precision compared to Cell-Id’s location solution could be significant and even achieve less than 5 meters if the number of WiFi access points known from the WiFi database is significant in the user’s range.

And in Rural/Indoor environment, available WiFi access points could also be used to compute the caller’s location as a satisfactory improvement of Cell-Id location solution if GNSS signals are not available.

In the case A-GNSS is available at the moment of the call, the accuracy relies on the following parameters:

- The assistance data server capacities. Basically the type of assistance data the server is able to provide to the A-GNSS user, and its level of awareness of the user radio environment.
- The number of satellites in view in the range of the caller.

In any case, if A-GNSS is available and used in addition to other location method (WPS or Cell-Id methods), the location calculate will be as accurate as possible.

When only standalone GNSS is available on the handset, the accuracy relies on the environment of the user (mountainous, forest, urban canyon, indoor, open-sky condition) and the capacities of the GNSS chipset embedded into the handset (multi or mono-constellation, SBAS enabled or not, ...). Therefore the accuracy in this case could vary from sub-meter to hundreds of meters. This solution might even not compute any location at all in some situations (e.g. indoor or in a thick forest).

The compliance with requirement ACCU_006 has to be validate during the trial phase of HELP112 by collecting the location data of all the tests and comparing them with the location references.

From the handset point of view, the response time of a WiFi Positioning System is less than 5 seconds and the response time of A-GNSS is most of the time under 30 seconds. So these two solutions should be compliant with RESP_002 requirement.
On the other hand, a standalone GNSS location might take several minutes (in worst case) and this solution is not compliant with RESP_002 requirement. Nonetheless this solution could still be used to provide later to the PSAP a location of the caller more accurate than the one calculated by another location method (less accurate than GNSS) during the first seconds of the call.
5. ACTIVATION AND TRANSMISSION METHODS

5.1 Activation methods

This section aims for describing the possible activation process of a HELP112 architecture implementation. By activation process, we mean the way the location estimate is triggered and how the necessary location data are formatted. There are two main ways of activating an HELP112 process.

The first one is entirely automated, and triggered by a 112 call or a 112 SMS (e.g.: for deaf people in country where this service is available). There is therefore no need for 112 caller intervention in this type of solution. With regards to this type of activation, a significant work has already been done by British Telecom in the development of Advance Mobile Location (AML), and we will focus on how the AML activation process is implemented to describe automated activation process in the following sections.

Another way of activating the location process and the transmission process is to use a 112 App following the requirements, deployment guidelines, and certification program defined in the EENA’s "Pan-European Mobile Emergency Application (PEMEA)" document.

5.1.1 Automated activation process

Considering an automated activation, the process that triggers the location estimate and the sending of the related information to the PSAP is implemented as a software set up in the phone by manufacturers or even at the operating system side by OS providers. It is integrated with all existing E112 call mechanisms available on the handset.

The whole process is automatically triggered so as to be independent of any E112 caller intervention. And in this case, the estimated location and the data sent to the PSAP are also invisible to the caller.

Furthermore, if a country has a specific E112 SMS service for disabled people, the location process is triggered by this SMS sent to the PSAP.

In order to allow a managed rollout of this type of activation, the use of the HELP112 functionality is dependent on the ability of the PSAPs in a country to handle this type of information. And then the use or not of the HELP112 functionality depends on the Mobile Country Code (MCC) and Mobile Network Code (MNC) identified by the handset.

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The handset’s HELP112 software is able, based on battery check, to switch on or switch off all the location facilities of the handset including GNSS and WiFi. The use of A-GNSS depends on the configuration of the handset and is not managed by the software. At the end of the location process, the state of each location facility is returned to its original state as prior to the E112 call was initiated.

This type of activation uses a configurable “send us what you have now” timeout, which means that all available location methods in the handset are performed in parallel and once the timeout is reached, the most accurate location obtained is sent:

- If a GNSS (Standalone or A-GNSS) location becomes available before the timeout, it is sent to the PSAP without waiting for the timeout.
- If no GNSS location is available after the timeout, but a WiFi location is available, then this location is sent to the PSAP.
- If no WiFi location data is available, then a Cell-Id based location is sent to the PSAP.
- And finally, if no location is available at the timeout, then a “no location” information is sent to the PSAP.

In the case of repeated 112 voice calls by the same handset, if the repeated voice call takes place before the configured timeout and the handset is still trying to determine location then the handset continues based on the original call trigger. If the location has already been determined when the repeat voice call appears, then the location process restarts from the beginning.

In order to discard all location data that are too old or have a date in the future, a Time Of Positioning (TOP) is computed at the same time as the location estimate and both pieces of information are sent together to the PSAP. If available, the handset tries to determine the TOP by using a NTP server (network connection needed). If NTP is not available, the handset tries to use GNSS to get time. And at last resort, if both NTP and GNSS are not available, the handset time and date is used.

This type of activation is the basis of Advanced Mobile Location (AML) for which recent standardisation efforts have been made (ETSI TR 103 393\(^5\)).

### 5.1.2 Activation process using App

112 Apps can be seen as smartphone applications based on Handset based location methods, and on the transmission methods that will be described in next sections (data channel or SMS). Work has already been done to define requirements and deployment guidelines and a certification program that aims to allow multiple apps from different or the same regions operating effectively

\(^5\)ETSI TR 103 393, « Advanced Mobile Location for emergency calls »
everywhere across Europe (pan-European emergency applications). Result of this work can be found in the EENA’s ”Pan-European Mobile Emergency Application” (PEMEA) document. Hereafter is the activation sequence of an E112 call initiated by a 112 App:

- The user uses the 112 App speed dial button to contact emergency services.
- The user confirms his/her willing to establish a 112 call in order to avoid false emergency calls.
- The voice call to 112 is set up with no delay.
- If the handset’s location services are switched on, a location is estimated using the location methods available on the handset with regards to the user’s location settings. Otherwise, no location will be available at the handset level.
- As soon as a location estimate is calculated, it is sent to the PSAP that answered the voice call, using the data channel if available or an SMS otherwise.

By using an app, it is possible for the user to send useful additional data on demand from the PSAP, such as video, photo, etc. Nevertheless, by using an App, the compliance with some meaningful HELP112 project requirements will not be possible:

- An android smartphone App has no permission to switch on or off the location services on the handset. Anytime the caller has disabled location services on his handset, this might result in a location estimate by a simple Cell-Id method and lead to the incapacity of PSAP to deploy the needed emergency resources at the right place.
- By using a 112 App, all the location information is visible to the caller.
- Even if all the available 112 Apps follow the PEMEA document and are supported by PSAPs, all emergency services’ users in Europe will have to download a Pan-European 112 App and use it when a distress situation occurs. Besides, in country where 112 Apps exist, the experience shows that users who have indeed downloaded a 112 App, do not use it to contact emergency services in the majority of emergency situations.
- The use of an app will critically increase the power consumption on the handset and therefore might jeopardise the emergency call.

Since 112 Apps do not bring meaningful advantages compared to the automated activation method, and on the contrary bring their own set of disadvantages with regards to the HELP112 user requirements, this technology will not be further developed in this document and particularly in the architecture design part. 112 Apps could nevertheless be used in the trial phase of HELP112 project to test the location method(s) available or not at the handset level with regards to each user scenarios.

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7 HELP112-D1.2-EENA,
5.2 TRANSMISSION METHODS

This section aims at describing the possibilities to transmit the location data obtained based on the activation and location process described in prior sections. Four ways to transmit the data (SMS; data channel; IMS SIP, and in-band modem) are described hereafter and will be the basis for the definition of HELP112 technical architecture possibilities depicted in section 6.

Before describing the transmission methods, we will depict in a first sub-section the Minimum Set of Data (MSD) the HELP 112 solution should transmit to the PSAP in order to define the caller’s location. Based on this MSD, some of the transmission methods described hereafter will allow to transmit additional data that could be useful for the PSAP.

5.2.1 HELP112 Minimum Set of Data

When it comes to define the location of an emergency caller the more precise/accurate and reliable as possible, it becomes essential to transmit the following information to the PSAP:

- **Latitude**: The latitude of the caller in decimal degrees in WGS84 coordinates system. This latitude is the latitude of the centre of the area returned by the location method (It has to be returned with a precision up to 5 decimal places giving resolution to 1.1 metres).
- **Longitude**: The longitude of the caller in degrees in WGS84 coordinates system. This longitude is the longitude of the centre of the area returned by the location method (It has to be returned with a precision up to 5 decimal places giving resolution to 1.1 metres)
- **Radius**: The confidence radius of the location measurement in meters.
- **Time of Positioning**: The date and time at which the handset has determined its location, specified in GMT (UTC). This field is useful to determine if the location is reliable. If the location transmitted in the MSD is out of date, it cannot be trusted.
- **Positioning method**: The method used to determine the location area (GNSS, WiFi, Cell, Not possible). This field is important to determine the level of reliability of the location transmitted to the PSAP. It is also useful to validate the location transmitted in the MSD by comparing it with the location obtained with another location method (such as Network Based Positioning method).

In addition to this location information, some other data is required in order to determine the identity of the caller and to have information about the network used during the emergency call (e.g. for routing purpose). This will be useful at the PSAP level to match the location information with an emergency call. This data is the following:

- **International Mobile Subscriber Identity (IMSI)**: If available, the SIM card identifier of the handset that made the E112 call.
- **International Mobile Equipment Identity (IMEI)**: The identifier of the handset that made the E112 call.
- **Mobile Country Code (MCC)**: If available, the Mobile Country Code, used to determine the network country from which the E112 call was made on.
- **Mobile Network Code (MNC)**: The Mobile Network Code of the network used to make the E112 call.
This information described above is the essential data that should be transmitted to the PSAP in order to define a caller's location. In addition to this data, other information such as the following could be useful in order to increase the reliability of the location data and the precision of the caller's location:

- **Cell ID**: The Cell Id the handset used to make the emergency call.
- **Altitude**: If available, the altitude of the caller in meters in WGS84 coordinates system
- **Floor number**: If available, the floor number within the building the user is calling from.

In the range of the location MSD transmitted to the PSAP, two options are already available on the market. The Advanced Mobile Location MSD described in *ETSI TR 103 393* standard, and MSD based on eCall technology which has been standardised by the European Committee for Standardisation (Pan European 112 Apps use this type of MSD).

The AML MSD is entirely compliant with the HELP112 MSD described above. Annex A is an example of AML location MSD transmitted to the PSAP by SMS.

The MSD based on eCall technology could be as described below:

- **ID**: An identifier to discriminate the several MSD formats (later versions to be backwards compatible with existing versions).
- **Message identifier**: the purpose of this field is to be able to discriminate an updated MSD from the original MSD.
- **Control**: The purpose of this field is to advise the emergency services of
  - Whether the position information can be trusted.
  - Whether the call is a real emergency or known to be a test call.

This is considered useful information for the PSAP/emergency services.

For example: If the position cannot be trusted the emergency services may take extra steps to help confirm the location.

- **IMEI**: (Vehicle identification number in eCall MSD). The purpose of this field is to give a unique identifier to the mobile handset of the calle to the emergency services. It can be useful to combat false emergency calls.
- **IMSI**: (Vehicle propulsion storage type in eCall MSD). The purpose of this field is to be used by emergency services for call-back.
- **Time stamp**: (Timestamp of incident event in eCall MSD). In our case, this field could be used to transmit the timestamp of the location computation.
- **Caller location**: This field is used to provide the position of the mobile handset to the PSAP in WGS84 coordinates (latitude and longitude).
- **Blank**: (Vehicle direction in eCall MSD).
- **Blank**: (Recent Vehicle Location n-1 in eCall MSD).
- **Blank**: (Recent Vehicle Location n-2 in eCall MSD).
- **Blank**: (Number of passengers in eCall MSD).
- **Optional additional data** (Optional): in some cases, optional data may be relevant for emergency services. This data incorporate a tag for the identification in the beginning of the optional data (type and structure identification). The additional data field may include
an address or the language of the caller where other relevant related data or functions are available.

5.2.2 Transmission using SMS

The first way to transmit the location data to the PSAP is a simple SMS message (location SMS). This method offers the widest possible geographical coverage since it does not depend on the type of network being used during the emergency call. It is important to note that whenever an emergency call can be made, it is possible to send a SMS.

The location SMS is routed to the home network SMSC of the caller. This SMSC has to be programmed to send emergency location SMS via an SMS gateway to a location server that handles emergency location SMS.

To be routed to the corresponding location server, the SMS is identified by an SMS number such as 112, or a dedicated full length MSISDN of the PSAP.

The call taker CAD has access to the location server and then is able to retrieve and display the location of the caller.

The use of an SMS to transmit the location data to the PSAP gives a maximum 160 characters of data to transmit all the needed location information.

As an example, for an AML location SMS, if all information is available, the maximum length of this location SMS is 129 characters, which let 31 free characters for additional data that could be included in future versions of AML. If a “Data SMS” is used, the number of free characters drops to 23 considering that at least 7 bytes over 140 are used by User-Data-Header and that the encoding used by AML is the GSM 7-bit alphabet.

5.2.3 Transmission using the data channel

In the case where the handset’s data connection is available and sufficiently reliable (3G or 4G network) to be used at the time of the emergency call, a data push across the data channel could be used to transmit the location data to the PSAP instead of using a SMS. The location data are pushed to a location server using an HTTPS message, using the same data elements as in the SMS message, probably using XML within the HTTPS message.

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8 EENA “Advanced Mobile Location (AML) Specifications & Requirements”, Section 3.4.2 page 16
There are two approaches to implement a solution using the data channel depending on the implementation of emergency services in each country:

- National approach
- Regional approach

In the national approach, PSAPs operate at the national level or there are national locations server that regional PSAPs can all access. In this case, by using the MCC and the current serving Cell-Id, the handset is able, on the basis of a regularly updated handset database, to identify the URL for a national location server to which the data shall be pushed. And then the PSAP can pull the location data from the national location server. This solution would therefore easily handle roaming.

In the regional approach, PSAPs operate at the regional level and the location data should be maintained in the regional jurisdiction. In this case, the transmission of the location data to the PSAP is more complicated and poses additional challenges. Once the data have been pushed to the national location server, the solution could be to establish a hierarchy of proxy-servers that reside inside each PSAP region, and then the national location server should be able to identify the correct regional proxy server to push the data to and push it. Then the regional PSAP could pull the location data from the proxy server, for instance using the caller's handset MSISDN as a key.

### 5.2.4 Transmission using IMS/SIP

Current PSAPs support voice calls and real-time text calls placed through PSTN (Public Switched Telephone Network) facilities or systems connected to the PSTN. However, future PSAPs will support Internet connectivity and a wider range of media types and provide higher functionality, and therefore, transport solution using IMS (IP Multimedia Subsystem) can be foreseen. This section aims at describing an improved transmission method using a call signalling protocol (SIP) on a full IP network to transmit the location data to the PSAP during a Voice on IP emergency call. Since end-to-end IP mobile phone communication description is out of the scope of HELP112, this section will only describe a way to transmit location data on an IP network using SIP protocol without describing potential transmission issues that may occur due to the network (interoperability ...).

SIP (Session Initiation Protocol) is a standard IETF signalling protocol (RFC 3261, RFC 3265) which has been developed to initiate, modify, and terminate multimedia sessions. In our case, the SIP protocol is used to initiate the voice session between the caller and the PSAP, and the caller’s location data are carried in the SIP messages. SIP manages the authentication and the location of the end users. SIP does not convey the data exchanged during the session (e.g.: voice), and therefore any type of data and protocol can be used in the session. Nonetheless, this is the RTP protocol (Real Time Protocol) that is used most of the time for a voice session.

A SIP architecture is composed of 4 entities:
• **User Agent (UA):** Application that uses SIP at the end user level (mobile terminal and PSAP). Each SIP user is identified by his SIP address (e.g.: SIP:user@domain).

• **Registrar:** A server that establishes a link between SIP addresses and IP addresses.

• **Proxy server:** It is an intermediary between two UA that do not know their respective locations (e.g.: IP address). The proxy server makes a request to a database filled by the registrar to know the link between the SIP addresses of the UA and their IP addresses.

• **Redirect Server:** It is a SIP server that is able to provide alternative addresses to reach a UA.

SIP is the ideal candidate to transmit emergency call to PSAP on IP networks. It does not require any SIP specialized header fields, request methods, status codes, message bodies, or event packages to support emergency calling. However, the location mechanism shall be used in a specific way.

An emergency call can be distinguished from any other call by a unique service URN (Uniform Resource Name). Hereafter is an overview of how emergency calls are placed using SIP protocol:

- **When the handset boots:**
  - The handset gets its location by the network (coarse position).
  - The UA on the handset makes a request to the registrar to register its SIP and IP addresses.
  - The UA on the handset makes a query containing its location to the LoST server (Location-to-Service Translation Server) and gets the PSAP URI (Uniform Resource Identifier which is the SIP address of the appropriate PSAP with regards to the handset location).

- **Some time later, an emergency call is made using this handset:**
  - The handset of the caller gets its location by the network (coarse position).
  - The UA on the handset makes a query containing its location to the LoST server and updates the PSAP URI.
  - The UA on the handset creates a SIP INVITE request that includes the location in a SIP Geolocation header (ETSI RFC 6442).
  - This INVITE message is routed to the Emergency Services Routing Proxy (ESRP), which is the first inbound proxy for the emergency services domain.
  - The INVITE message is then routed by the ESRP towards the most appropriate PSAP for the handset’s location, as determined by the location and other information.
  - A proxy in the PSAP chooses an available call taker and extends the call to its UA.

"ETSI TS 124 229", and "ETSI RFC 6443" described in details how SIP can be uses in emergency voice call.

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9 IETF RFC 6443, « Framework for Emergency Calling Using Internet Multimedia », Section 3
The idea of using SIP to transport the location data would be to enhance the SIP INVITE message (headers and body). Once the location has been determined by the handset, the SIP INVITE message containing the location information would be re-sent to the PSAP, which could update the location of the caller and dispatch the emergency resources. The location data and even additional data can be sent (like video from dashboard cameras or text from speech or hearing impaired users) in the header and body of a SIP INVITE message as described in draft-ietf-additional-data\(^10\).

IMS emergency call will provide a faster and more reliable location data transfer, the voice connectivity will not be lost, and significantly more than 140 bytes will be possible in the location information transmitted to the PSAP.

It is good to notice that work is in progress to standardise the transition to IMS emergency networks. For instance, IETF, 3GPP and CEN are currently working on Next Generation eCall (NG eCall) using IMS. IETF has already produced NG eCall drafts\(^11\). ETSI TR 103 140 recommended IMS emergency call, with minor modifications as the long term underlying communication mechanism for eCall.

### 5.2.5 Transmission using in-band modem

In this section, we will describe how the eCall in-band modem technology could be re-used as a part of the HELP112 solution. The main advantage of eCall is that it is well standardized in Europe for in-vehicle purpose with more than 12 standards from CEN, 3GPP/ETSI, and ISO introducing eCall. All member states in the European Union will have to upgrade their 112 systems to be able to receive and handle eCalls. Besides, eCall will be required by law in new cars in Europe from 2018.

We will talk here about Personal eCall. Personal eCall is essentially eCall initiated by a user from a mobile phone rather than (e.g. automatically) from a vehicle. Personal eCall has been discussed in CEN TC 278 and in ETSI TC MSG but no standardization has yet been done.

In eCall, the technology used to establish the connection between the vehicle in distress and the most appropriate PSAP is based on in-band modem technology using the voice channel to transmit the location data. This technology could be used in smartphones.

In the case of a personal eCall solution, the emergency voice call is routed to the appropriate PSAP using the existing emergency routing procedures for voice E112 calls. In order to transmit the


Minimum Set of Data (MSD) to the PSAP, the personal eCall system uses in-band data modems at the mobile handset and PSAP sides. By using this transmission method, the MSD is transmitted through the voice path which enables the system to use the E112 routing protocols deployed in existing networks. The main disadvantage of the in-band modem is that whilst the MSD is sent, the voice connectivity is lost for typically 4 seconds (but potentially 20 seconds). It may be problematic for an emergency situation when emergency resources have to be dispatched as quickly as possible. In order to mitigate the loss of voice connectivity, the MSD could be not sent after a timeout is reached but requested by the PSAP operator after telling the caller that there will be a few seconds of silence whilst the data is collected. Existing eCall protocols allow this to be done.

Since each category of call may potentially need to be handled differently, the existing vehicular eCall flags cannot be used to distinguish Personal eCalls from vehicle eCalls. Ideally, a new flag for Personal eCalls would be standardised in 3GPP. There is only one spare bit in the emergency service category information element (ETSI TS 124 008) so it would be better to use this as an extension bit and use a bit in a new octet for Personal eCall. As an alternative, a new subscription option might be created that informed a network operator (e.g. an MSC) that any emergency call for a particular subscriber would support personal eCall. Both alternatives require some impact (probably small) to networks.

If there is no new flag and no new subscription option, then Personal eCalls would be routed to the same PSAP as other 112 calls. In this case, the PSAP may or may not be eCall capable. If the PSAP was eCall capable and knew that the handset was capable of Personal eCall, then the PSAP could "pull" the MSD. A handset may be able to indicate its capability to the PSAP by in-band signaling (e.g. DTMF tones) or some new control plane signaling. The latter would need 3GPP standardisation. If neither of these are deployed, and the PSAP is eCall capable but does not know the UE capabilities, the PSAP could still try to pull the MSD anyway; for instance during silent calls or as a last resort. As one alternative, users with phones capable of personal eCall could be registered (e.g. via their MSISDN) in some national database which a PSAP could access to determine the capability. The database (which would need to be secure) might be populated by network operators and/or by users. This is not an elegant solution but appears low cost and avoids any new impacts to networks and any new in-band or new control signaling.
6. HELP112 ARCHITECTURE DESCRIPTIONS

6.1 INTRODUCTION

This section aims to define several possible HELP112 implementation architectures based on the technologies described in prior sections (Location – Activation – Transmission). These architectures will be the basis for next steps of Task 3 (Definition of E112 Architecture using GNSS), that will lead to the choice of the most adapted HELP112 architecture to be implemented in the near future, and recommendations for future work to be done in the context of transmitting caller’s location to the PSAP.

A distinction should be made between the HELP112 implementation scenarios (architectures) described hereafter and the user scenarios described in section 2.2. The different implementation scenarios described in the following sections will be used to define the HELP112 technical architecture that best covers the user requirements. Once the choice of the best HELP112 architecture will be made, it will be tested in the trial phase of the project for each user scenario (Environment and capabilities of the caller) previously described in this document. Since HELP112 pilot sites might not be able to implement the whole HELP112 technical architecture in the timeframe of the project, the HELP112 architecture could be split in several technical parts (Location – Activation – Transmission) that would be tested or not depending on the level of implementation in each pilot. Here are some examples of offline tests that could be foreseen due to implementation roadmap issues:

- Demonstrate the advantages of using a User Plane Network Based location method as safety net when GNSS is unavailable or cannot be trusted.
- Demonstrate offline the advantages of estimating the caller location by EGNOS and Galileo with specific material if no Galileo-ready smartphone is available during the trial phase of HELP112.

Each technical architecture described hereafter implements a delta with respect to the existing solutions to get and transmit caller’s location to the PSAP (These existing solutions are depicted in HELP112 deliverable D1.2 "Analysis of the state of the art"). The technical architectures have been derived after the analysis of the user requirements, the state of the art and the recommendations in D1.3. The next steps of HELP112 project will focus on the feasibility in the near future to merge these deltas in a robust and more reliable HELP112 technical architecture solution.

The table below shows the mapping between the foreseen HELP112 implementation architectures and the Location/Activation/Transmission methods described in prior sections.
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<th>Architecture 3</th>
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<tr>
<td>A-GNSS</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Automated activation</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>SMS transmission</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Data channel transmission</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>IMS SIP transmission</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>In-band modem transmission</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
</tr>
</tbody>
</table>

Table 4 - Mapping of HELP112 implementation architectures vs Location/Activation/Transmission methods
Based on the all above technologies (sections 4 & 5), we designed the implementation scenarios in the following way:

- Location method:
  - With regards to the penetration of smartphones, that is expected to reach 100% by the end of this decade, and the increasing availability of Hybrid Positioning methods (using A-GNSS, WiFi, ...) in smartphones, all the HELP112 implementation scenarios include a smartphone capable to compute a location based on A-GNSS and/or WiFi positioning system and/or Cell-Id, or Standalone GNSS. Hence, it will cover all the handset based location methods, from WiFi Positioning System up to Hybrid Positioning System (A-GNSS+WiFi). In the trial phase of HELP112 project, each handset based positioning method will be tested depending on the environment of the caller (user scenario).
  - Architecture 3 is nevertheless an alternative to smartphone based location methods by integrating a User Plane Network Based Location method (section 4.1.1.3) to tackle the case of mobile phones not being smartphones and cases where for any reason, the smartphone cannot provide a location or the handset based location cannot be trusted, hence acting as a reliable safety net. The foreseen User Plane Network Based Location method implements a Location Calculator out from the network (minimum involvement of MNOs) in order to handle regulation and cost issues related to the implementation of a location platform into the mobile network.
  - E-GNSS and assisted E-GNSS are available technologies but not yet deployed in the market, and will probably not be deployed in the timeframe of HELP112 project. We have therefore defined a specific architecture (Architecture 1) that is based on an E-GNSS and assisted E-GNSS SUPL server and a specific E-GNSS chipset.

- Activation method:
  - As described in section 5.1.2, and with regards to the HELP112 survey (HELP112 deliverable D1.1 "Requirements document") that demonstrates the majority of PSAPs in Europe are in favour of automated activation rather than 112 Apps, the HELP112 architecture scenarios do not use 112 Apps. In pilot sites where 112 Apps are already deployed, they could nevertheless be used in the trial phase of the project to test a location method or a transmission method used in the foreseen implementation scenarios.

- Transmission method:
  - Based on the results of WP1, we consider SMS as the baseline technology to transmit the location information to the PSAP: it is available everywhere. We have therefore associated SMS to the 3 location architectures defined above (Architectures 1, 2, 3). Architecture 2 is an improved implementation of SMS transmission method that handles international roaming.
  - The 3 alternative transmission technologies (data, IMS/SIP, in-band modem) are associated to the baseline location method (smartphone based) to create 3 different architectures (Architectures 4, 5, 6). Despite the use of in-band modem as a transmission method, i.e. the Personal eCall solution, is not recommended in D1.3,
it is not excluded in D3.1 (Architecture 6) in order to take it into account in the Cost/Benefits analysis of WP2.

The next sections of the document described these foreseen HELP112 implementation scenarios, their compliance with user requirements, and the user scenarios they cover.

**6.2 Architecture 1: Handset Based Hybrid Positioning Method using SUPL Server + Automated Activation + SMS Transmission**

**6.2.1 Architecture**

This architecture is composed of a handset based location solution that is E-GNSS (A-GNSS including Galileo and EGNOS) enabled, with an automated activation method and a transmission of the location data using SMS. In this case, the HELP112 MSD is transmitted to the PSAP using a zero rated SMS.

Since A-GNSS based on the network capabilities (GMLC, SMLC) will not be E-GNSS compatible in the coming months, HELP112 solution must use another way to demonstrate the advantages of using Galileo and EGNOS to increase the accuracy and reliability of the location estimate by the handset. One possibility is to use the location solution developed by Telespazio which uses a SUPL server.

The location solution of Telespazio is composed of a SUPL (Secure User Plane Location) client on the user handset requesting for its position to a SUPL server. The SUPL server then implements HTTP requests to obtain a coarse position from a database managed by RX Networks on the basis of WiFi and Cell-ID environment of the user. This position is available at the user level in less than 3 seconds.

Then the SUPL client requests for assistance data to the SUPL server, in order to compute a more accurate location and speed up the TTFF. The assistance data is of several types as described in section 4.2.3 including Real Time assistance data (the data downlinked at that time by the satellites from the different GNSS constellations) and long duration assistance data (the Extended Ephemeris, also called the seeds. One seed contains, for each satellite of a GNSS constellation, the compacted information on the precise satellite trajectory over 14 days. This information is transported as such, compacted, to the GNSS chipset in the user terminal where it will be de-compacted and process.)

This assistance data covers Galileo and EGNOS.

Telespazio can also provide specific algorithms for GNSS chipset that use GALILEO signal specific features (e.g. CBOC) in order to get a better accuracy on location and better sensitivity.

These specific algorithms also include multi-path processing (5 to 10 points) and integrity (based on comparison of position computed from each GNSS constellation). Such a chipset has been developed in collaboration with ST Microelectronics and could be used in the trial phase of HELP112 project.
By using the SUPL server from Telespazio, the location solution available, with regards to the user's settings, are the following.

- GNSS standalone if the handset location service is set to use device sensors only (In this case, the SUPL server is not used).
- WiFi and Cell-Id using Telespazio SUPL server if the handset location service is set to “battery saving” mode.
- E-GNSS using Telespazio SUPL server if the handset location service is set to “high accuracy”.

The location estimate will also rely on the environment of the caller.

In this architecture, a handset’s HELP112 software is automatically triggered by a 112 call in order to determine the location of the caller which is transmitted to the PSAP using an SMS. This type of activation and transmission have been described in sections 5.1.1 and 5.2.2.

The chart below shows an example of such an architecture:

![Diagram](image)

**Figure 2 - Architecture 1: Handset based hybrid positioning method using SUPL server + Automated activation + SMS transmission**

**6.2.2 I/F description**

In this architecture, the SUPL client part of Telespazio location solution could be directly integrated in the HELP112 solution. Once the HELP112 software is triggered by an E112 emergency call or SMS, and if the handset is configured in the proper user settings and the battery power level is sufficient, the location process begins using the SUPL server of Telespazio. The SUPL interface
between the SUPL client and the SUPL server uses LPP data format. SUPL an LPP are standards for location services defined by the Open Mobile Association (OMA). In this solution, this is SUPL 2.0 that is implemented.

As soon as a GNSS location solution is calculated or after the configured timeout, the HELP112 location SMS is formatted and transmitted to a location server through the network as described in section 5.2.2. The network’s SMSC has to be programmed to send emergency location SMS via an SMS gateway to a location server. In the UK, the SMS gateway is provided by an SMS aggregator which takes SMPP (Short Message Peer to Peer) output from the SMSC’s of all mobile networks and sends an HTTPS message containing the SMS content to the HELP112 location server. Each country will have to provide a server to receive the HELP112 location SMS message from SMSCs or make use of existing server for emergency SMS service for deaf/hard of hearing users.

The access to HELP112 location information from the PSAP depends on how PSAP obtains location in country concerned. In UK, an http post from the HELP112 location server containing the HELP112 location information is forwarded to existing, centralised stage 1 PSAP location server, and stage 2 PSAPs then retrieve the location information in normal way.

6.2.3 Covered requirements

- **Accuracy requirements**

  In this solution, the location SMS conveys a confidence radius of the location measurement in meters. So it is compliant with ACCU_001 requirement.

  In the case of an automated activation process (see section 5.1.1), all the location methods available at the time of the call at the handset level (E-GNSS, A-GNSS, GNSS standalone, WiFi, Cell-Id) are used on condition that the battery power level is sufficient. Besides, precision of latitude and longitude transmit into the HELP112 location SMS is up to 5 decimal places which will equate to 1.1 meters precision on the ground. Therefore the compliance to the accuracy/precision requirements relies on the location method and have already been described in section 4.1.2 and 4.2.4.

  In the case where the handset only manages to compute a simple Cell-Id location solution, this architecture is not compliant with all the accuracy/precision requirements.

- **Response time requirements**

  From the handset point of view, the response time of a WiFi Positioning System is less than 5 seconds and the response time of A-GNSS and E-GNSS is most of the time under 30 seconds. So these two solution should be compliant with RESP_002 requirement.

  On the other hand, a standalone GNSS location might take several minutes (worst case – cold start) and this solution would not be compliant with RESP_002 requirement in this case. Nonetheless this solution could still be used to provide, later to the PSAP, a location of the caller
more accurate (especially with Galileo enabled chipsets) than the one calculated by another location method (less accurate than GNSS) during the first seconds of the call.

In this architecture using an automated activation process, the location estimate is sent to the PSAP when the configured timeout is reached (or even before the timeout for a GNSS-made location). HELP112 solution could re-use the AML timeout, which is set by default to 20 seconds\textsuperscript{12}. Therefore, in the case an E-GNSS, A-GNSS, GNSS standalone, or WiFi location solution has been computed during these 20 seconds, this architecture solution is compliant with RESP\textsubscript{002} requirement.

On the other hand, if only a simple Cell-Id location estimate or even worse no location has been computed during the timeout period, this solution is not compliant with RESP\textsubscript{001} requirement. Nonetheless, most of PSAP already retrieve a location estimate based on simple Cell-Id by making a request to the network GMLC less than 5 seconds after the call taker answers the voice call.

- **Presentation of the caller’s location to the PSAP**

The location information will still be displayed on the PSAP operator GIS if available and the process to extract location data from the HELP112 location SMS should be automated and not lead to extra tasks for the call-taker. This architecture is therefore compliant with PRES\textsubscript{001} and PRES\textsubscript{002}.

The HELP112 location server has to be configured so as to push the location data to the PSAP or to wait for the PSAP to pull the location data. One or the other configuration will depend on the current implementation for each PSAP. If no such system already exists at the PSAP level, it is recommended for the PSAP to pull the location data from the HELP112 location server. With respect to these recommendations, this architecture is compliant with PRES\textsubscript{003} requirement.

In this solution the caller’s location and the confidence circle determined by the handset are communicated to the PSAP using a WGS84 latitude/longitude measured in decimal degrees and a radius measurement in meters. This information is included in the HELP112 emergency location SMS and is not modified during its transmission to the PSAP. This solution is therefore compliant with PRES\textsubscript{004} requirement.

- **Privacy requirements**

The HELP112 automated activation process is enabled to switch on the location device of the caller’s mobile phone during the emergency call, and then at the end of the call, set all location

\textsuperscript{12} ETSI TR 103 393, « Advanced Mobile Location for emergency calls », Section 6.2 page 8
devices back to their state prior to the call. This architecture is therefore compliant with PRIV_001 requirement.

In this architecture, the coverage of requirements PRIV_002 and PRIV_003 is handled by the PASPs on the basis of their operating policies and each national or regional data protection legislation. Besides, the national or regional data protection legislation is also applicable to the HELP112 location server in this case.

In the AML solution, no record of the location SMS data is available to the caller during or after the emergency call\(^{13}\), and it is therefore recommended that HELP112 solution re-uses this functionality. By following this recommendation, this solution is compliant with PRIV_004.

- **Acceptance of the solution requirements**

In this architecture, to use E-GNSS or WiFi positioning systems, a SUPL client that will use the external SUPL server has to be implemented in each mobile handset that embeds the HELP112 software. Once the HELP112 software is triggered by an emergency call or SMS, the handset based location methods (E-GNSS, A-GNSS, WiFi) shall use the external SUPL server, and therefore the related SUPL client shall be integrated in the HELP112 software. On the other hand, most of the mobile handset are not currently Galileo enabled, and assistance data provider likewise. This will however change in the coming months or year since Galileo will soon be operational. From the location method, this solution is therefore not compliant with ACCE_001 requirement. Concerning the activation of the location process and the transmission to the PSAP, this architecture uses SMS which offers the widest possible geographic coverage. Besides, such activation and transmission process are already implemented in the AML solution and Google is interested to implement AML directly into the Android Operating System, which will make this solution available for all the Android European market in the coming years. This activation and transmission method is therefore compliant with ACCE_001 requirement.

Concerning the activation of the location estimate and transmission, the solution presented in this architecture is entirely automated, so this solution is compliant with ACCE_002 requirement.

It is recommended that HELP112 solution process should be entirely invisible to the caller, and therefore this architecture should be compliant with ACCE_003.

Since this method of activation checks if the battery power level is sufficient before using any location method, and transmits the location data on a channel apart from the voice call, it is compliant with ACCE_004.

\(^{13}\) ETSI TR 103 393, « Advanced Mobile Location for emergency calls », Section 6.2 page 8
• Security requirements

In standalone GNSS mode, no network transmission is needed to estimate the location so this method is compliant with SECU_002 requirement. Concerning WiFi positioning, A-GNSS, and E-GNSS, this architecture uses a SUPL server apart from the network. The security issues are therefore transferred to the SUPL server that shall ensure the location data that are transmitted between the server and the caller’s handset are protected from attacks that attempt to block the HELP112 solution to specific callers or to take advantage or profit from transmitting the location to other sources.

On the other hand, the HELP112 location server shall also take into consideration the HELP112 security requirements.

• Method of estimating the location information requirements

In the table hereafter are described the different cases where these requirements are covered by this architecture.

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Location method</th>
<th>GNSS Standalone</th>
<th>WiFi + Cell-Id</th>
<th>A-GNSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCA_001</td>
<td></td>
<td>✓</td>
<td>×</td>
<td>✓</td>
</tr>
<tr>
<td>LOCA_002</td>
<td>OK in the case where the handset’s GNSS chipset is Galileo a/o EGNOS enabled</td>
<td>×</td>
<td>×</td>
<td>OK in the case where the handset’s GNSS chipset is Galileo a/o EGNOS enabled</td>
</tr>
<tr>
<td>LOCA_003</td>
<td></td>
<td>×</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>LOCA_004</td>
<td></td>
<td>×</td>
<td>×</td>
<td>✓</td>
</tr>
</tbody>
</table>

Table 5 - Compliance of Architecture 1 with location method requirements

One major information to take into account concerning requirement LOCA_002 is that GNSS chipsets manufacturers are going to flood the mobile phone market with Galileo enabled chipsets in the coming months. The first Galileo-ready smartphone is expected to be available from October 2016.
• **Battery life requirements**

In this solution, a check is made to know if there is sufficient battery life for a short (5 minute) voice call before switching on any location devices likely to consume appreciable battery life. Equally should any location devices already be switched on when an emergency call is made, and likely to jeopardise a short voice call, they should be switched off. This makes this solution compliant with BATT_001 requirement.

Since the level of battery life needed to use one location method or another depends on the handset capacities, the BATT_002 is transferred to handset, battery and chipset manufacturers. Nonetheless, some GNSS message need a lot of power to be decoded in standalone mode (Ephemeris, ...), and therefore the use of A-GNSS or E-GNSS will decrease the battery consumption when compared with GNSS standalone.

• **Incurring charges**

The HELP112 automated activation process does not switch on the data connection if it is switched off at the time of the emergency call, so it is compliant with CHAR_001.

Concerning CHAR_002, the location SMS sent by the HELP112 software should not be charged to end users, and therefore MNOs should ensure that they recognize the HELP112 location SMS as a zero-rated emergency SMS.

• **Data transmission requirements**

The TRAN_001 requirement is not applicable to this solution using SMS to transmit the location data.

Since the solution described here uses SMS to transmit the location information to the PSAP, it is compliant with TRAN_002.

• **Roaming requirement**

All the handset based solution to estimate the caller’s location are available to a caller from a country A that is in another country B, so these location solutions are compliant with ROAM_001.

The location SMS transmission in this architecture does not handle a caller that roams, and is therefore not compliant with the ROAM_001 requirement. The SMS is routed to the home country SMSC which direct it to the home country HELP112 location server. This server has no path to the HELP112 server in the visited country, so the location SMS cannot be used.
6.2.4 Covered user scenarios

The table below shows, for this architecture, the location methods available for each user scenario.
<table>
<thead>
<tr>
<th>User scenarios</th>
<th>Positioning methods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A-GNSS</td>
</tr>
</tbody>
</table>
| Rural countryside with GNSS available but no WiFi available | Available. Assistance data for Galileo and EGNOS available.  
E-GNSS availability relies on handset’s chipset capacities | Available | Not available | Not available | Not available | Not available | Not available | Available |
| Rural building with all location methods available | Available. Assistance data for Galileo and EGNOS available.  
E-GNSS availability relies on handset’s chipset capacities | Available | Available | Not available | Not available | Not available | Not available | Available |
| Rural car with GNSS available but no WiFi available | Available. Assistance data for Galileo and EGNOS available.  
E-GNSS availability relies on handset’s chipset capacities | Available but potentially poor signal reception | Not available | Not available | Not available | Not available | Not available | Available |
| Urban with GNSS available but disrupted and WiFi available | Available. Assistance data for Galileo and EGNOS available.  
E-GNSS availability relies on handset’s chipset capacities | Available but poor signal reception | Available | Not available | Not available | Not available | Not available | Available |
| Motorway or Dual Carriageway with GNSS available but no WiFi available | Available. Assistance data for Galileo and EGNOS available.  
E-GNSS availability relies on handset’s chipset capacities | Available | Not available | Not available | Not available | Not available | Not available | Available |
<p>| House location with all location methods            | Available. Assistance data for Galileo and EGNOS available. | Available | Available | Not available | Not available | Not available | Not available | Available |</p>
<table>
<thead>
<tr>
<th>Available</th>
<th>E-GNSS availability relies on handset’s chipset capacities</th>
<th>Office location with WiFi available but no GNSS available</th>
<th>Urban with mobile data disabled</th>
<th>Abroad and urban with mobile data disabled</th>
<th>Caller’s handset in battery saving mode</th>
<th>Caller’s handset in privacy consious settings</th>
<th>SIMless user</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not available</td>
<td>Available but the transmission method does not handle roaming</td>
<td>Available</td>
<td>Available</td>
<td>Available</td>
<td>Available</td>
<td>Available</td>
<td>Available</td>
</tr>
<tr>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
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<tr>
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<td>Available</td>
<td>Available</td>
<td>Available</td>
<td>Available</td>
<td>Available</td>
</tr>
</tbody>
</table>

Table 6 - HELP112 architecture 1 vs User Scenarios
6.3 ARCHITECTURE 2: HANDSET BASED HYBRID POSITIONING METHOD + AUTOMATED ACTIVATION + SMS TRANSMISSION ROAMING ENABLED

6.3.1 Architecture

In this architecture, we consider an A-GNSS enabled handset, an automated activation process, and transmission of the location data by SMS that handles roaming.

In this solution, according to the user’s settings, the location solutions available are the following:

- GNSS standalone if the handset location service is set to use device sensors only or if the data connectivity is not available at the time of the emergency call.
- WiFi and Cell-Id if the handset location service is set to “battery saving” mode.
- A-GNSS if the handset location service is set to “high accuracy” (Mainly A-GPS).

In each of these three types of location solution, the location result will also rely on the local environment of the caller and the capacities of the location device of the handset (outdoor/indoor, satellite coverage, constellations and assisted data handled by the handset, density of the WiFi access points, density of the cellular network, etc).

In this architecture, a handset’s HELP112 software is automatically triggered by a 112 call in order to determine the location of the caller which is transmitted to the PSAP using an SMS. This type of activation and transmission have been described in sections 5.1.1 and 5.2.2. Besides, in this case, the HELP112 architecture shall be robust to a caller that roams.

In the architecture 1 presented in prior section, a user who roams is not handled by the solution. Indeed, the SMS is routed to the home country SMSC which recognizes this type of emergency location SMS and directs it to the home country HELP112 location server. This server has no path to the HELP112 location server in the visited country, so the location SMS cannot be used.

There are however two options that could be implemented in order to handle roaming with a transmission method using SMS:

- The visited country in which the mobile handset is making the emergency call can be determined by the handset using the MCC component of the current serving Cell-Id. The handset has also information about the Mobile Network being used (MNC: Mobile Network Code). With these information and on the basis of a regularly updated handset database of each HELP112 location server MSISDN in Europe, the home SMSC would be able to route the location SMS to the corresponding HELP112 location server in the visited country. All mobile networks involved should be agreed to zero rate such emergency location SMS for end users.

The chart below shows the architecture of this solution (Solution A):
In the case it is not possible to use the full length MSISDN for the HELP112 location server of each country, another option is possible to handle roaming. In this case, all HELP112 location servers in Europe would be linked together and the MCC and MNC of the visited country would be used to forward the location data to the appropriate HELP112 location server in the visited country.

The chart below shows the architecture of this solution (Solution B):
6.3.2 I/F description

In both architecture (A and B), as soon as a GNSS location solution is calculated or after the configured timeout, the HELP112 location SMS is formatted and transmitted to a location server through the network as described in section 5.2.2.

In "Architecture 2-A", before sending the SMS, the handset makes a request to a local database to get the full MSISDN of the most appropriate HELP112 location server based on the MCC and MNC provided by the network.

The home network’s SMSC then forwards the emergency location SMS to the visited network’s SMSC based on the HELP112 visited location server full MSISDN. The visited network’s SMSC has to be programmed to send emergency location SMS via an SMS gateway to a location server by using its full MSISDN. The protocols used to transmit the location data are the same than in Architecture 1 (6.2.2), and in this case, this is the HELP112 location server that will receive the location data.

In "Architecture 2-B", the location data are transmitted to the home HELP112 location server in the same way than in Architecture 1 (6.2.2). And then, based on the MCC and MNC included in the HELP112 MSD, the home HELP112 location server forwards the HELP112 location MSD to the visited HELP112 location server using HTTPS.
For both architectures, the access to HELP112 location information from the PSAP depends on how PSAP obtains location in country concerned. In UK, an http post from the HELP112 location server containing the HELP112 location information is forwarded to existing, centralised stage 1 PSAP location server, and stage 2 PSAPs then retrieve the location information in normal way.

6.3.3 Covered requirements

- **Accuracy requirements**
  In this solution, the location SMS conveys a confidence radius of the location measurement in meters. So it is compliant with ACCU_001 requirement.

  In the case of an automated activation process (see section 5.1.1), all the location methods available at the time of the call at the handset level (A-GNSS, GNSS standalone, WiFi, Cell-Id) are used on condition that the battery power level is sufficient. Besides, precision of latitude and longitude transmit into the HELP112 location SMS is up to 5 decimal places which will equate to 1.1 meters precision on the ground. Therefore the compliance to the accuracy/precision requirements relies on the location method and have already been described in section 4.1.2 and 4.2.4.

  In the case where the handset only manages to compute a simple Cell-Id location solution, this architecture is not compliant with all the accuracy/precision requirements.

- **Response time requirements**
  From the handset point of view, the response time of a WiFi Positioning System is less than 5 seconds and the response time of A-GNSS is most of the time under 30 seconds. So these solutions should be compliant with RESP_002 requirement.

  On the other hand, a standalone GNSS location might take several minutes (worst case – cold start) and this solution would not be compliant with RESP_002 requirement in this case. Nonetheless this solution could still be used to provide, later to the PSAP, a location of the caller more accurate (especially with Galileo enabled chipsets) than the one calculated by another location method (less accurate than GNSS) during the first seconds of the call.

  In this architecture using an automated activation process, the location estimate is sent to the PSAP when the configured timeout is reached (or even before the timeout for a GNSS-made location). HELP112 solution could re-use the AML timeout, which is set by default to 20 seconds\(^\text{14}\).

\(^\text{14}\) ETSI TR 103 393, « Advanced Mobile Location for emergency calls », Section 6.2 page 8
Therefore, in the case an A-GNSS, GNSS standalone, or WiFi location solution has been computed during these 20 seconds, this architecture solution is compliant with RESP_002 requirement.

On the other hand, if only a simple Cell-Id location estimate or even worse no location has been computed during the configured timeout, this architecture is not compliant with RESP_001 requirement. Nonetheless, most of PSAP already retrieve a location estimate based on simple Cell-Id by making a request to the network GMLC less than 5 seconds after the call taker answers the voice call.

- **Presentation of the caller’s location to the PSAP**

  The location information will still be displayed on the PSAP operator GIS if available and the process to extract location data from the HELP112 location SMS should be automated and not lead to extra tasks for the call-taker. This architecture is therefore compliant with PRES_001 and PRES_002.

  The HELP112 location server has to be configured so as to push the location data to the PSAP or to wait for the PSAP to pull the location data. One or the other configuration will depend on the current implementation for each PSAP. If no such system already exists at the PSAP level, it is recommended for the PSAP to pull the location data from the HELP112 location server. With respect to these recommendations, this architecture is compliant with PRES_003 requirement.

  In this solution the caller’s location and the confidence circle determined by the handset are communicated to the PSAP using a WGS84 latitude/longitude measured in decimal degrees and a radius measurement in meters. This information is included in the HELP112 emergency location SMS and is not modified during its transmission to the PSAP. This solution is therefore compliant with PRES_004 requirement.

- **Privacy requirements**

  The HELP112 automated activation process is enabled to switch on the location device of the caller’s mobile phone during the emergency call, and then at the end of the call, set all location devices back to their state prior to the call. This architecture is therefore compliant with PRIV_001 requirement.

  In this architecture, the coverage of requirements PRIV_002 and PRIV_003 is handled by the PASPs on the basis of their operating policies and each national or regional data protection legislation. Besides, the national or regional data protection legislation is also applicable to the HELP112 location server in this case. For this solution, several HELP112 location servers could be involved (In the home country and the visited country).
In the AML solution, no record of the location SMS data is available to the caller during or after the emergency call, and it is therefore recommended that HELP112 solution re-uses this functionality. By following this recommendation, this solution is compliant with PRIV_004.

- **Acceptance of the solution requirements**

WiFi positioning systems are available on all recent mobile phone that are WiFi enabled. In the same way all recent smartphone have an embedded GNSS chipset and most of them are A-GNSS enabled. Concerning the activation of the location process and the transmission to the PSAP, this architecture uses SMS which offers the widest possible geographic coverage. Besides, such activation and transmission process are already implemented in the AML solution and Google is interested to implement AML directly into the Android Operating System, which will make this solution available for all the Android European market in the coming years. This architecture is therefore compliant with ACCE_001 requirement.

Concerning the activation of the location estimate and transmission, the solution presented in this architecture is entirely automated, so this solution is compliant with ACCE_002 requirement.

It is recommended that HELP112 solution process should be entirely invisible to the caller, and therefore this architecture should be compliant with ACCE_003.

Since this method of activation checks if the battery power level is sufficient before using any location method, and transmits the location data on a channel apart from the voice call, it is compliant with ACCE_004.

- **Security requirements**

In standalone GNSS mode, no network transmission is needed to estimate the location so this method is compliant with SECU_002 requirement. Concerning WiFi positioning, and A-GNSS, this architecture uses the capacities of the network to provide assistance data. Since there is no known network threat to the A-GNSS process, this location solution is currently compliant with SECU_002 requirement.

On the other hand, all the potential HELP112 location server involved in the emergency process shall also take into consideration the HELP112 security requirements.

- **Method of estimating the location information requirements**

15 ETSI TR 103 393, « Advanced Mobile Location for emergency calls », Section 6.2 page 8
In the table hereafter are described the different cases where these requirements are covered by this architecture.

<table>
<thead>
<tr>
<th>Requirements</th>
<th>GNSS Standalone</th>
<th>WiFi + Cell-Id</th>
<th>A-GNSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCA_001</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>LOCA_002</td>
<td>OK in the case where the handset’s GNSS chipset is Galileo enabled</td>
<td>✓</td>
<td>OK in the case where the handset’s GNSS chipset and assistance data provider are Galileo enabled</td>
</tr>
<tr>
<td>LOCA_003</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>LOCA_004</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

Table 7 - Compliance of architecture 2 with location method requirements

One major information to take into account concerning requirement LOCA_002 is that GNSS chipsets manufacturers are going to flood the mobile phone market with Galileo enabled chipsets in the coming months. The first Galileo-ready smartphone is expected to be available from October 2016.

Regarding the providing of Galileo assistance data (E-GNSS), it might take some time to make the facilities of each assistance data provider with Galileo assistance data.

- **Battery life requirements**

In this solution, a check is made to know if there is sufficient battery life for a short (5 minute) voice call before switching on any location devices likely to consume appreciable battery life. Equally should any location devices already be switched on when an emergency call is made, and likely to jeopardise a short voice call, they should be switched off. This makes this solution compliant with BATT_001 requirement.

Since the level of battery life needed to use one location method or another depends on the handset capacities, the BATT_002 is transferred to handset, battery and chipset manufacturers. Nonetheless, some GNSS message need a lot of power to be decoded in standalone mode (Ephemeris, ...), and therefore the use of A-GNSS will decrease the battery consumption when compared with GNSS standalone.
• **Incurring charges**

The HELP112 automated activation process does not switch on the data connection if it is switched off at the time of the emergency call, so it is compliant with CHAR_001.

Concerning CHAR_002, the location SMS sent by the HELP112 software should not be charged to end users, and therefore MNOs should ensure that they recognize the HELP112 location SMS as a zero-rated emergency SMS. Particular attention shall be made to zero rate this type of SMS in the case where this architecture is implemented by following the architecture B (6.3.1); i.e. by using the HELP112 location server in the home country to redirect the location SMS to the HELP112 location server in the visited country.

• **Data transmission requirements**

The TRAN_001 requirement is not applicable to this solution using SMS to transmit the location data.

Since the solution described here uses SMS to transmit the location information to the PSAP, it is compliant with TRAN_002.

• **Roaming requirement**

All the handset based solution to estimate the caller’s location are available to a caller from a country A that is in another country B, so these location solutions are compliant with ROAM_001.

The design of the two possibilities presented in section 6.3.1 is made to handle a caller that roam and therefore is compliant with ROAM_001.

**6.3.4 Covered user scenarios**

The chart below shows, for this architecture, the location methods available for each user scenarios.
<table>
<thead>
<tr>
<th>User scenarios</th>
<th>A-GNSS</th>
<th>Standalone GNSS</th>
<th>WiFi + Cell-Id (3G/4G)</th>
<th>O-TDOA (2G/3G/4G)</th>
<th>RF Pattern matching (RFPM) (2G/3G/4G)</th>
<th>CITARX (2G)</th>
<th>Cell-Id + TA (2G/4G)</th>
<th>Cell-Id + RTT (3G)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural countryside with GNSS available but no WiFi available</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities. Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>Rural building with all location methods available</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities. Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Available</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>Rural car with GNSS available but no WiFi available</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities. Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Available but potentially poor signal reception</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>Urban with GNSS available but disrupted and WiFi available</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities. Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Available but poor signal reception</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>Motorway or Dual Carriageway with GNSS available but no WiFi available</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities. Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>House location with all location methods available</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities.</td>
<td>Available</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
</tr>
</tbody>
</table>
### Table 8 - HELP112 architecture 2 vs User Scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Available</th>
<th>Assistance for Galileo and EGNOS availability relies on assistance data provider</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office location with WiFi available but no GNSS available</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>Urban with mobile data disabled</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>Abroad and urban with mobile data disabled</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>Caller’s handset in battery saving mode</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>Caller’s handset in privacy conscious settings</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>SIMless user</td>
<td>Not available</td>
<td>Available</td>
</tr>
</tbody>
</table>
6.4 Architecture 3: Handset Based Hybrid Positioning Method + Automated Activation + SMS Transmission + Enhanced Network Positioning Method as Safety Net

6.4.1 Architecture

In this architecture, the location of the caller is initially calculated on the basis of the handset’s capacities. According to the user’s settings, the location solutions available at the handset level are the following:

- GNSS standalone if the handset location service is set to use device sensors only or if the data connectivity is not available at the time of the emergency call.
- WiFi and Cell-Id (or Enhanced Cell-Id) if the handset location service is set to “battery saving” mode.
- A-GNSS if the handset location service is set to “high accuracy” (Mainly A-GPS).

In this architecture, a handset’s HELP112 software is automatically triggered by a 112 call in order to determine the location of the caller which is transmitted to the PSAP using an SMS. This type of activation and transmission have been described in sections 5.1.1 and 5.2.2.

After the HELP112 configured timeout, it might be possible that no location has been calculated and the HELP112 location SMS is then sent with a “No location” message.

In this case, when an HELP112 location SMS is received at the HELP112 location server with no location in it, it should be possible to provide another location estimate based on the Network capacities and as accurate as possible.

The network based Location Calculator solution (Section 4.1.1.3: User Plane Network Location) is a good candidate to fill this gap, acting as a Safety Net. It can be implemented at the HELP112 location server level in a way where there will be no involvement from either mobile operators or network vendors, by adding the measurement report information to the location data sent in the HELP112 location SMS to the HELP112 location server.

Note that this measurement report is already and automatically sent by the handset to the network in dedicated mode (when a voice call is ongoing) every 480ms for the purposes of managing the allocated radio resources by the network. This measurement Report contains the Time advance value from the Serving Cell in addition to the Received Signal Strengths from both the Serving Cell and up to 6 best neighbouring cells.

Work is planned between the HELP112 Project team and Google to find a way to add the network measurement report to the location SMS (data SMS) information.

The location methods that the Location Calculator software will be able to perform will depend on the content of the measurement report, and the type of network used by the caller (2G, 3G, and 4G). These types of locations methods are described in section 4.1.1 of this document.
To compute the location based on the network Radio Measurement Report, the Location Calculator software needs to access a database containing the mapping of the Cell-Id on the network. This is the only point in this solution that involves MNOs, who would need to provide period update to this database, each related to their own network, understandably.

The chart below shows an example of such an architecture:

![Architecture 3: Handset based hybrid positioning method + Automated activation + SMS transmission + Location Calculator as safety net](image)

**6.4.2 I/F description**

In this architecture, the HELP112 location MSD is formatted with additional data containing the network Radio Measurement Report. The adding of this report is part of the HELP112 software into the handset.

Then, up to the HELP112 location server, the interfaces are the same than in a classic SMS transmission solution:

- SMPP between the SMSC and the SMS Gateway.
- HTTPS between the SMS Gateway and the HELP112 Location server.
Each country will in any case have to provide a server to receive the HELP112 location SMS message from SMSCs or make use of existing server for emergency SMS service for deaf/hard of hearing users.

In this architecture, either the required data parameters (Radio Measurement Report) would be included in the existing HELP112 location SMS process, or the HELP112 location server would trigger request to the handset for this data in case of a "No location" result in the HELP112 information. The HELP112 software would extract the network Radio Measurement Report as an input for the Location Calculator solution.

An interface has to be defined between the Location server and the database that will provide the mapping of network’s cells to the Location Calculator software.

The access to HELP112 information from the PSAP depends on how PSAP obtains location in the country concerned.

### 6.4.3 Covered requirements

- **Accuracy requirements**

In this solution, the HELP112 location SMS conveys a confidence radius of the location measured in meters. So it is compliant with ACCU_001 requirement.

In the case of an automated activation process (see section 5.1.1), all the location methods available at the time of the call at the handset level (A-GNSS, GNSS standalone, WiFi, Cell-Id) are used on condition that the battery power level is sufficient. Besides, precision of latitude and longitude transmit into the HELP112 location SMS is up to 5 decimal places which will equate to 1.1 meters precision on the ground. Therefore the compliance to the accuracy/precision requirements relies on the location method and have already been described in section 4.1.2 and 4.2.4.

In the case where the handset only manages to compute a simple Cell-Id location solution, the Location Calculator software at the HELP112 location server level will attempt to estimate a more precise location estimate based on the Radio Measurement Report provided by the handset in the HELP112 location SMS. The compliance of this architecture with accuracy/precision requirements therefore relies on the location method used by the Location Calculator software and have already been described in section 4.1.2.

- **Response time requirements**

From the handset point of view, the response time of a WiFi Positioning System is less than 5 seconds and the response time of A-GNSS is most of the time under 30 seconds. So these solutions should be compliant with RESP_002 requirement.
On the other hand, a standalone GNSS location might take several minutes (worst case – cold start) and this solution would not be compliant with RESP_002 requirement in this case.

In this architecture using an automated activation process, the location estimate is sent to the PSAP when the configured timeout is reached (or even before the timeout for a GNSS-made location). HELP112 solution could re-use the AML timeout, which is set by default to 20 seconds\(^{16}\). Therefore, in the case an A-GNSS, GNSS standalone, or WiFi location solution has been computed during these 20 seconds, this architecture solution is compliant with RESP_002 requirement. Besides, when the HELP112 location SMS transmit a "No location" message, the Location Calculator software at the location server level is able to compute a location estimate in less than 3 seconds based on the Radio measurement report included in the HELP112 location SMS. The response will therefore be below the 30 seconds required and this architecture will be compliant with RESP_002 requirement if the Location Calculator is able to compute an Enhanced Cell-Id location solution.

On the other hand, if only a simple Cell-Id location estimate or even worse no location has been computed during the 30 seconds by either the handset location methods or Location Calculator, this architecture is not compliant with RESP_001 requirement. Nonetheless, most of PSAP already retrieve a location estimate based on simple Cell-Id by making a request to the network GMLC less than 5 seconds after the call taker answers the voice call.

- **Presentation of the caller’s location to the PSAP**

The location information will still be displayed on the PSAP operator GIS if available and the process to extract location data from the HELP112 location SMS should be automated and not lead to extra tasks for the call-taker. This architecture is therefore compliant with PRES_001 and PRES_002.

The HELP112 location server has to be configured so as to push the location data to the PSAP or to wait for the PSAP to pull the location data. One or other of these configurations will depend on the current implementation for each PSAP. If no such system already exists at the PSAP level, it is recommended for the PSAP to pull the location data from the HELP112 location server. The same applies with the Location Calculator location solution if generated; it is recommended that PSAPs do a pull request to get accurate locations in order not to use the resources if an accurate location is not necessary. The push option is nevertheless still possible if this is the usual trigger used by the PSAP. With respect to these recommendations, this architecture is compliant with PRES_003 requirement.

\(^{16}\) ETSI TR 103 393, « Advanced Mobile Location for emergency calls », Section 6.2 page 8
In this solution the caller’s location and the confidence circle determined by the handset or the Location Calculator solution are communicated to the PSAP using a WGS84 latitude/longitude measured in decimal degrees and a radius measurement in meters. This information is either included in the HELP112 emergency location SMS, either directly provided by the Location Calculator and is not modified during its transmission to the PSAP. This solution is therefore compliant with PRES_004 requirement.

- **Privacy requirements**

The HELP112 automated activation method is enabled to switch on the location device of the caller’s mobile phone during the emergency call, and then at the end of the call, set all location devices back to their state prior to the call. On the other hand, the Location Calculator method is entirely independent from the caller’s handset and does not interfere with its settings. This architecture is therefore compliant with PRIV_001 requirement.

In this architecture, the coverage of requirements PRIV_002 and PRIV_003 is handled by the PASPs on the basis of their operating policies and each national or regional data protection legislation. Besides, the national or regional data protection legislation is also applicable to the HELP112 location server embedded Location Calculator.

In the AML solution, no record of the location SMS data is available to the caller during or after the emergency call\(^{17}\), and it is therefore recommended that HELP112 solution re-uses this functionality. By following this recommendation, this solution is compliant with PRIV_004.

- **Acceptance of the solution requirements**

WiFi positioning systems are available on all recent mobile phone that are WiFi enabled. In the same way all recent smartphone have an embedded GNSS chipset and most of them are A-GNSS enabled. Concerning the activation of the location process and the transmission to the PSAP, this architecture solution uses SMS which offers the widest possible geographic coverage. Besides, such activation and transmission process are already implemented in the AML solution and Google is interested to implement AML directly into the Android Operating System, which will make this solution available for all the Android devices in the European market in the coming years. On the other hand the Location Calculator solution, in the way it is used in this architecture, is entirely handset independent. This architecture is therefore compliant with ACCE_001 requirement.

Concerning the activation of the location estimate and transmission, the solution presented in this architecture are entirely automated. For the Location Calculator solution, it is automatically\(^{17}\) ETSI TR 103 393, « Advanced Mobile Location for emergency calls », Section 6.2 page 8

\(^{17}\) ETSI TR 103 393, « Advanced Mobile Location for emergency calls », Section 6.2 page 8
activated on the reception of a HELP112 location message with “No Location” information or a Cell-Id location. This architecture is therefore compliant with ACCE_002 requirement.

It is recommended that HELP112 solution process should be entirely invisible to the caller, and therefore this architecture should be compliant with ACCE_003.

Since the HELP112 automated activation method checks if the battery power level is sufficient before using any handset based location method, and transmits the location data on a channel apart from the voice call, it is compliant with ACCE_004. This requirement is not applicable to Location Calculator solution.

- **Security requirements**

  From the handset point of view, in standalone GNSS mode, no network transmission is needed to estimate the location so this method is compliant with SECU_002 requirement. Concerning WiFi positioning, and A-GNSS, this architecture uses the capacities of the network to provide assistance data. Since there is no known network threat to the A-GNSS process, this location solution is currently compliant with SECU_002 requirement.

  On the other hand, the HELP112 location server including the Location Calculator software shall also take into consideration the HELP112 security requirements.

- **Method of estimating the location information requirements**

  In the table hereafter are described the different cases where these requirements are covered by the handset based location methods used by this architecture solution.
<table>
<thead>
<tr>
<th>Requirements</th>
<th>GNSS Standalone</th>
<th>WiFi + Cell-Id</th>
<th>A-GNSS</th>
<th>Enhanced Cell-Id positioning</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCA_001</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>LOCA_002</td>
<td>OK in the case where the handset’s GNSS chipset is Galileo enabled</td>
<td>✗</td>
<td>OK in the case where the handset’s GNSS chipset and the assistance data provider are Galileo enabled</td>
<td></td>
</tr>
<tr>
<td>LOCA_003</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>LOCA_004</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

Table 9 - Compliance of architecture 3 with location method requirements (1)

One major information to take into account concerning requirement LOCA_002 is that GNSS chipsets manufacturers are going to flood the mobile phone market with Galileo enabled chipsets in the coming months. The first Galileo-ready smartphone is expected to be available from October 2016.

Regarding the providing of Galileo assistance data using the (E-GNSS), it might take some time to make the facilities of each assistance data provider compatible with Galileo assistance data.

In the table hereafter is described the compliance of Location Calculator location methods with the related requirements.
### Table 10 - Compliance of architecture 3 with location method requirements (2)

<table>
<thead>
<tr>
<th>Location algorithm</th>
<th>LOCA_002</th>
<th>LOCA_003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell-Id</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Cell-Id + TA (2G, 4G) and Cell-Id + RTT (3G)</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>CITARX (2G)</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>RF Pattern Matching (RFPM)</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>O-TDOA (3G/4G)</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

- **Battery life requirements**
  The Location Calculator location solution software is entirely handset independent and is therefore not concerned by these requirements.

Concerning the HELP112 activation process, a check is made to know if there is sufficient battery life for a short (5 minute) voice call before switching on any location devices likely to consume appreciable battery life. Equally should any location devices already be switched on when an emergency call is made, and likely to jeopardise a short voice call, they should be switched off. This makes this solution compliant with BATT_001 requirement.

Since the level of battery life needed to use one location method or another depends on the handset capacities, the BATT_002 is transferred to handset, battery and chipset manufacturers. Nonetheless, some GNSS message need a lot of power to be decoded in standalone mode (Ephemeris, ...), and therefore the use of A-GNSS will decrease the battery consumption when compared with GNSS standalone.

- **Incurring charges**
  In our case, the radio measurement report is embedded in the HELP112 location SMS and the charges incurred by the caller are all related to this SMS. The Location Calculator solution is then performed at the HELP112 location server level and the user will not be charged for this location solution. These requirements are therefore not applicable to the Location Calculator solution.

The HELP112 automated activation process does not switch on the data connection if it is switched off at the time of the emergency call, so it is compliant with CHAR_001.
Concerning CHAR_002, the location SMS sent by the HELP112 software should not be charged to end users, and therefore MNOs should ensure that they recognize the HELP112 location SMS as a zero-rated emergency SMS.

- **Data transmission requirements**

  The TRAN_001 requirement is not applicable to this solution using SMS to transmit the location data.

  Since the solution described here uses SMS to transmit the location information to the PSAP, it is compliant with TRAN_002.

- **Roaming requirement**

  All the handset based solution used in this architecture solution to estimate the caller’s location are available to a caller from a country A that is in another country B, so these location solutions are compliant with ROAM_001. The same applies for the Location Calculator location solution as long as the cellular environment of the caller is known by the database interrogated by the software.

  The location SMS transmission in this architecture does not handle a caller that roams, and is therefore not compliant with the ROAM_001 requirement. The HELP112 location SMS is routed to the home country SMSC which direct it to the home country HELP112 location server. This server has no path to the HELP112 location server in the visited country, so the HELP112 location SMS cannot be used.

6.4.4 **Covered user scenarios**

The table below shows, for this architecture, the location methods available for each user scenario.
<table>
<thead>
<tr>
<th>User scenarios</th>
<th>A-GNSS</th>
<th>Standalone GNSS</th>
<th>WiFi + Cell-Id (3G/4G)</th>
<th>O-TDOA</th>
<th>RF Pattern matching (RFPM) (2G/3G/4G)</th>
<th>CITARX (2G)</th>
<th>Cell-Id + TA (2G/4G)</th>
<th>Cell-Id + RTT (3G)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural countryside with GNSS available but no WiFi available</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities. Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Available</td>
<td>Not available</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available</td>
</tr>
<tr>
<td>Rural building with all location methods available</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities. Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Available</td>
<td>Available</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available</td>
</tr>
<tr>
<td>Rural car with GNSS available but no WiFi available</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities. Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Available but potentially poor signal reception</td>
<td>Not available</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available</td>
</tr>
<tr>
<td>Urban with GNSS available but disrupted and WiFi available</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities. Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Available but poor signal reception</td>
<td>Available</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available</td>
</tr>
<tr>
<td>Motorway or Dual Carriageway with GNSS available but no WiFi available</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities. Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Available</td>
<td>Not available</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available</td>
</tr>
<tr>
<td>House location with all location methods</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities.</td>
<td>Available</td>
<td>Available</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available</td>
</tr>
<tr>
<td>Available</td>
<td>Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Installed at Location server side.</td>
<td>Installed at Location server side.</td>
<td>Installed at Location server side.</td>
<td>Installed at Location server side.</td>
<td>Installed at Location server side.</td>
<td>Installed at Location server side.</td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
<td></td>
</tr>
<tr>
<td>Office location with WiFi available but no GNSS available</td>
<td>Not available</td>
<td>Available</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td></td>
</tr>
<tr>
<td>Urban with mobile data disabled</td>
<td>Not available</td>
<td>Available</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td></td>
</tr>
<tr>
<td>Abroad and urban with mobile data disabled</td>
<td>Not available</td>
<td>Available, but the transmission method does not handle roaming</td>
<td>Available as long as the Location Calculator is installed at Location server side, but the transmission method does not handle roaming.</td>
<td>Available as long as the Location Calculator is installed at Location server side, but the transmission method does not handle roaming.</td>
<td>Available as long as the Location Calculator is installed at Location server side, but the transmission method does not handle roaming.</td>
<td>Available as long as the Location Calculator is installed at Location server side, but the transmission method does not handle roaming.</td>
<td>Available, but the transmission method does not handle roaming.</td>
<td></td>
</tr>
<tr>
<td>Caller's handset in battery saving mode</td>
<td>Not available</td>
<td>Available</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td></td>
</tr>
<tr>
<td>Caller's handset in privacy conscious settings</td>
<td>Not available</td>
<td>Available</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td></td>
</tr>
<tr>
<td>SIMless user</td>
<td>Not available</td>
<td>Available</td>
<td>Availability relies on Radio Measurement</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td>Available as long as the Location Calculator is installed at Location server side.</td>
<td></td>
</tr>
</tbody>
</table>

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| Report and Cell database content. | installed at Location server side. | installed at Location server side. |

**Table 11 - HELP112 architecture 3 vs User Scenarios**
6.5 Architecture 4: Handset Based Hybrid Positioning Method + Automated Activation + Data Channel Transmission

6.5.1 Architecture

In this architecture, the location estimate is handset based and the handset is A-GNSS-ready. A handset’s HELP112 software is automatically triggered by a 112 call in order to determine the location of the caller which is transmitted to the PSAP using the data channel. This type of activation and the two transmission approaches (National or Regional) have been described in sections 5.1.1 and 5.2.3. This solution is therefore dependent of the data connectivity of the 112 caller’s mobile phone.

According to the user’s settings, the location solutions available in this architecture are the following:

- GNSS standalone if the handset location service is set to use device sensors only.
- WiFi and Cell-Id if the handset location service is set to “battery saving” mode
- A-GNSS if the handset location service is set to “high accuracy” (Mainly A-GPS)

In each of these three types of location solution, the location result will also rely on the local environment of the caller and the capacities of the location device of the handset (outdoor/indoor, satellite coverage, constellations and assisted data handled by the handset, density of the WiFi access points, density of the cellular network, etc).

In this architecture, the handset’s HELP112 software transmits the HELP112 location MSD over the handset’s data channel using an HTTPS message probably using XML within the HTTPS message. This solution is a step forward to transmit the HELP112 location MSD over the IP channel and it can lead to a solution that transmit more data about the E112 caller than the one transmits in a limited space SMS.

The chart below shows the architecture of this solution with a National approach (see section 5.2.3):

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6.5.2 I/F description

In both approaches (National and Regional), as soon as a location estimate based on GNSS sensors (GNSS standalone or A-GNSS) is calculated or after the HELP112 configured timeout, the
HELP112 location MSD is formatted in XML format and transmitted to a national HELP112 location server through the network using HTTPS.

Considering a National approach, before sending the HELP112 location data, the handset makes a request to a local database to get the URL of the most appropriate HELP112 national location server based on the MCC and MNC provided by the network. This URL is then used by the handset’s HELP112 software to push the HELP112 location data to the related HELP112 National location server using HTTPS.

In the Regional approach, the handset makes a request to a local database to get the URL of the most appropriate National HELP112 location server based on the MCC and MNC provided by the network. This URL is then used by the handset’s HELP112 software to push the HELP112 location data to the related HELP112 National location server using HTTPS. Once the National HELP112 location server receives the HELP112 location data pushed by the handset’s HELP112 software, it could then extract the location information and use it to map the HELP112 location data to the most appropriate HELP112 Regional proxy server using a HTTPS data push.

For both architectures, the access to the HELP112 location data from the PSAP depends on how PSAP obtains location in country concerned. For instance, in UK, the HELP112 location data would be pushed to the National stage 1 PSAP location server (National approach), and stage 2 PSAPs then would pull the location information in normal way. In a Regional approach, the regional PSAP that has handled the emergency call could make a request to pull location data from the related HELP112 Regional proxy (probably using the originating device’s telephone number/MSISDN as a key).

6.5.3 Covered requirements

- Accuracy requirements

In this solution, the HELP112 location data (in XML format) conveys a confidence radius of the location measurement in meters. So it is compliant with ACCU_001 requirement.

In the case of an automated activation process (see section 5.1.1), all the location methods available at the time of the call at the handset level (A-GNSS, GNSS standalone, WiFi, Cell-Id) are used on condition that the battery power level is sufficient. Besides, precision of latitude and longitude transmit into the HELP112 location MSD is up to 5 decimal places which will equate to 1.1 meters precision on the ground. Therefore the compliance to the accuracy/precision requirements relies on the location method and have already been described in section 4.1.2 and 4.2.4.
In the case where the handset only manages to compute a simple Cell-Id location solution, this architecture is not compliant with all the accuracy/precision requirements.

- **Response time requirements**

From the handset point of view, the response time of a WiFi Positioning System is less than 5 seconds and the response time of A-GNSS is most of the time under 30 seconds. So these solutions should be compliant with RESP_002 requirement.

On the other hand, a standalone GNSS location might take several minutes (worst case – cold start) and this solution would not be compliant with RESP_002 requirement in this case. Nonetheless this solution could still be used to provide, later to the PSAP, a location of the caller more accurate (especially with Galileo enabled chipsets) than the one calculated by another location method (less accurate than GNSS) during the first seconds of the call.

In this architecture using an automated activation process, the location estimate is sent to the PSAP when the configured timeout is reached (or even before the timeout for a GNSS-made location). HELP112 solution could re-use the AML timeout, which is set by default to 20 seconds\(^\text{18}\). Therefore, in the case an A-GNSS, GNSS standalone, or WiFi location solution has been computed during these 20 seconds, this architecture solution is compliant with RESP_002 requirement.

On the other hand, if only a simple Cell-Id location estimate or even worse no location has been computed during the configured timeout, this architecture solution is not compliant with RESP_001 requirement. Nonetheless, most of PSAP already retrieve a location estimate based on simple Cell-Id by making a request to the network GMLC less than 5 seconds after the call taker answers the voice call.

- **Presentation of the caller’s location to the PSAP**

The HELP112 location information will still be displayed on the PSAP operator GIS if available and the process to extract location data from the HELP112 location XML data should be automated and not lead to extra tasks for the call-taker. This architecture is therefore compliant with PRES_001 and PRES_002.

The HELP112 location server (National approach) or the HELP112 proxy server (Regional approach) has to be configured so as to push the location data to the PSAP or to wait for the PSAP to pull the location data. One or the other configuration will depend on the current implementation for each PSAP. If no such system already exists at the PSAP level, it is recommended for the PSAP to pull the HELP112 location data from the HELP112 location server or the HELP112 proxy server.

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\(^\text{18}\) ETSI TR 103 393, « Advanced Mobile Location for emergency calls », Section 6.2 page 8
With respect to these recommendations, this architecture is compliant with PRES_003 requirement.

In this solution the caller’s location and the confidence circle determined by the handset are communicated to the PSAP using a WGS84 latitude/longitude measured in decimal degrees and a radius measurement in meters. This information is included in the HELP112 location data and is not modified during its transmission to the PSAP. This solution is therefore compliant with PRES_004 requirement.

- **Privacy requirements**

  The HELP112 automated activation process is enabled to switch on the location device of the caller’s mobile phone during the emergency call, and then at the end of the call, set all location devices back to their state prior to the call. This architecture is therefore compliant with PRIV_001 requirement.

  In this architecture, the coverage of requirements PRIV_002 and PRIV_003 is handled by the PASPs on the basis of their operating policies and each national or regional data protection legislation. Besides, the national or regional data protection legislation is also applicable to the HELP112 location server or the HELP112 proxy servers.

  In the AML solution, no record of the location SMS data is available to the caller during or after the emergency call\(^{19}\), and it is therefore recommended that HELP112 solution re-uses this functionality. By following this recommendation, this solution is compliant with PRIV_004.

- **Acceptance of the solution requirements**

  WiFi positioning systems are available on all recent mobile phone that are WiFi enabled. In the same way all recent smartphone have an embedded GNSS chipset and most of them are A-GNSS enabled. This solution is therefore compliant with ACCE_001 requirement with regards to the location method. Concerning the transmission of the location data to the PSAP, this solution using the data channel relies on the caller having a data subscription and the data connectivity to be enabled and reliable on his handset, so this transmission solution is currently not compliant with ACCE_001 requirement.

  Concerning the activation of the location estimate and transmission, the solution presented in this architecture is entirely automated, so this solution is compliant with ACCE_002 requirement.

\(^{19}\) ETSI TR 103 393, « Advanced Mobile Location for emergency calls », Section 6.2 page 8
It is recommended that HELP112 solution process should be entirely invisible to the caller, and therefore this architecture should be compliant with ACCE_003.

Since the HELP112 automated activation method checks if the battery power level is sufficient before using any location method, and transmits the location data on a channel apart from the voice call, it is compliant with ACCE_004.

- **Security requirements**

In standalone GNSS mode, no network transmission is needed to estimate the location so this method is compliant with SECU_002 requirement. Concerning WiFi positioning, and A-GNSS, this architecture uses the capacities of the network to provide assistance data. Since there is no known network threat to the A-GNSS process, this location solution is currently compliant with SECU_002 requirement.

On the other hand, all the potential HELP112 location servers or proxy servers involved in the emergency process shall also take into consideration the HELP112 security requirements.

- **Method of estimating the location information requirements**

In the table hereafter are described the different cases where these requirements are covered by this architecture.

<table>
<thead>
<tr>
<th>Requirements</th>
<th>GNSS Standalone</th>
<th>WiFi + Cell-Id</th>
<th>A-GNSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCA_001</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>LOCA_002</td>
<td>OK in the case where the handset’s GNSS chipset is Galileo enabled</td>
<td>✗</td>
<td>OK in the case where the handset’s GNSS chipset and assistance data provider are Galileo enabled</td>
</tr>
<tr>
<td>LOCA_003</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>LOCA_004</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
</tr>
</tbody>
</table>

*Table 12 - Compliance of architecture 4 with location method requirements*
One major information to take into account concerning requirement LOCA_002 is that GNSS chipsets manufacturers are going to flood the mobile phone market with Galileo enabled chipsets in the coming months. The first Galileo-ready smartphone is expected to be available from October 2016.

Regarding the providing of Galileo assistance data (E-GNSS), it might take some time to make the facilities of each assistance data provider with Galileo assistance data.

- **Battery life requirements**

  In this solution, a check is made to know if there is sufficient battery life for a short (5 minute) voice call before switching on any location devices likely to consume appreciable battery life. Equally should any location devices already be switched on when an emergency call is made, and likely to jeopardise a short voice call, they should be switched off. This makes this solution compliant with BATT_001 requirement.

  Since the level of battery life needed to use one location method or another depends on the handset capacities, the BATT_002 is transferred to handset, battery and chipset manufacturers. Nonetheless, some GNSS message need a lot of power to be decoded in standalone mode (Ephemeris, ...), and therefore the use of A-GNSS will decrease the battery consumption when compared with GNSS standalone.

- **Incurring charges**

  If the data connection is deactivated on the caller’s handset, this type of location data transmission will not be used. On the contrary, if the data connection is enabled and a transmission via the data channel is used, the caller will be charged in accordance with his data subscription. Therefore it is compliant with CHAR_001.

  CHAR_002 is not applicable to this architecture since no SMS is involved.

- **Data transmission requirements**

  This solution uses the data IP channel to transmit the location data to the PSAP, therefore it is compliant with TRAN_002.

  Since this solution depends on the availability of the data channel, it will be compliant with TRANS_002 if and only if a fall-back solution that does not use the data channel (e.g.: SMS) exists on the handset.

- **Roaming requirement**
All the handset based solution to estimate the caller’s location are available to a caller from a country A that is in another country B, so these location solutions are compliant with ROAM_001.

Since the HELP112 location server URL to which is sent the HELP112 location MSD relies on the MCC and MNC of the caller’s serving cell, this solution is independent from the location of the caller (home country or foreign country) as long as the emergency services in the country from which the person in distress is calling are able to handle such HELP112 location data, and the MCC and MNC from the serving cell are known from the database in the handset. The two approaches presented here (National or Regional) are therefore compliant with ROAM_001.

6.5.4 Covered user scenarios

The table below shows, for this architecture, the location methods available for each user scenario.
### User scenarios

<table>
<thead>
<tr>
<th>Positioning methods</th>
<th>A-GNSS</th>
<th>Standalone GNSS</th>
<th>WiFi + Cell-Id</th>
<th>O-TDOA (3G/4G)</th>
<th>RF Pattern matching (RFPM) (2G/3G/4G)</th>
<th>CITARX (2G)</th>
<th>Cell-Id + TA (2G/4G)</th>
<th>Cell-Id + RTT (3G)</th>
<th>Cell-Id (2G/3G/4G)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural countryside with GNSS available but no WiFi available</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities. Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>Rural building with all location methods available</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities. Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Available</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>Rural car with GNSS available but no WiFi available</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities. Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>Urban with GNSS available but disrupted and WiFi available</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities. Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Available</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>Motorway or Dual Carriageway with GNSS available but no WiFi available</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities. Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>House location with all location methods</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities.</td>
<td>Available</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>available</td>
<td>Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>----------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office location with WiFi available but no GNSS available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
<td></td>
</tr>
<tr>
<td>Urban with mobile data disabled</td>
<td>Not available</td>
<td>Available, but the transmission method needs a data connectivity</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available, but the transmission method needs a data connectivity</td>
<td></td>
</tr>
<tr>
<td>Abroad and urban with mobile data disabled</td>
<td>Not available</td>
<td>Available, but the transmission method needs a data connectivity</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available, but the transmission method needs a data connectivity</td>
<td></td>
</tr>
<tr>
<td>Caller’s handset in battery saving mode</td>
<td>Not available</td>
<td>Available</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
<td></td>
</tr>
<tr>
<td>Caller’s handset in privacy conscious settings</td>
<td>Not available</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
<td></td>
</tr>
<tr>
<td>SIMless user</td>
<td>Not available</td>
<td>Available, but the transmission method needs a data connectivity</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available, but the transmission method needs a data connectivity</td>
<td></td>
</tr>
</tbody>
</table>

Table 13 - HELP112 architecture 4 vs User Scenarios
6.6 Architecture 5: Handset based hybrid positioning method + automated activation + IMS SIP transmission

6.6.1 Architecture

This architecture involves an A-GNSS enabled handset and an IMS solution to transmit the location data to the PSAP. The automated activation method is used to trigger the HELP112 process. Since it is an IP (VoIP) based solution, it will only work for UMTS-PS and LTE networks and when the data connectivity is available on the caller’s handset.

In this solution, according to the user’s settings, the location solutions available are the following:

- GNSS standalone if the handset location service is set to use device sensors only.
- WiFi and Cell-Id if the handset location service is set to “battery saving” mode
- A-GNSS if the handset location service is set to “high accuracy” (Mainly A-GPS)

In each of these three types of location solution, the location result will also rely on the local environment of the caller and the capacities of the location device of the handset (outdoor/indoor, satellite coverage, constellations and assisted data handled by the handset, density of the WiFi access points, density of the cellular network, etc).

In this architecture, an E112 call follows the following steps:

- Somebody calls 112 emergency services using his mobile handset.
- A first coarse location is immediately sent to the PSAP in the SIP-INVITE message header of the VoIP session using the geolocation header.
- As soon as a location solution using GNSS is computed by the handset or after the HELP112 configured timeout, a new SIP-INVITE message is sent to the PSAP that caught the emergency call. The header and body of this SIP-INVITE message contains the HELP112 location MSD.
- The SIP-INVITE message is decoded by the PSAP to get the HELP112 location information and display the caller’s location data on the call taker CAD.
- The Call taker is then able to dispatch the emergency resources based on this location information.

The chart below shows the architecture of this solution:
Figure 8 - Architecture 5: Handset based hybrid positioning method + Automated activation + IMS SIP transmission

6.6.2 I/F description

First of all, the handset that makes the emergency call shall embed an IMS HELP112 software. The HELP112 automated activation process and IMS transmission process for HELP112 have been described in section 5.1.1 and 5.2.4.

At the handset level, the HELP112 software interfaces with the location services of the android system of the handset, and also with its VoIP services:

- As soon as the HELP112 software is triggered by the E112 emergency call or SMS, it activates the location devices of the handset (location services, GNSS chipset, WiFi connectivity) according to the location settings of the user (High accuracy mode, Battery saving mode, Device sensors only mode) and the battery power level of the handset.

- Once the location calculation is performed by the handset using all the location methods available in parallel, or/and after the configured timeout, the HELP112 software gets this location and pass it to the VoIP services in order to format the “HELP112 SIP-INVITE message” and send it to the same PSAP call-taker who handled the call. This is possible by using the same PSAP URI to route the SIP-INVITE message, than the one determined by the LoST thanks to the coarse location (geolocation header) in the first SIP-INVITE message that initiated the voice call. The HELP112 SIP-INVITE message has not been specified yet, but it should at least contain the HELP112 MSD, and follow the rules described in the document tools.ietf.org/html/draft-ietf-ecr-it-recall.

The PSAP that receives the call has to be IMS HELP112 compatible. This PSAP is then able to detect that this is an HELP112 IMS emergency call by recognising the specific URN for this type of IMS emergency call.

The PSAP software/system extracts the HELP112 MSD from the SIP-INVITE header and body and then displays the information for the call taker. The call-taker’s CAD shall have the capability to display all the information provided in the HELP112 MSD.
This architecture can be seen as the method to transmit location to the PSAP in future full Packet Switched (IP) communications when they will be widely extended and Circuit Switched communications will be dropped.

6.6.3 Covered requirements

- **Accuracy requirements**
  In this solution, the SIP INVITE message conveys a confidence radius of the location measurement in meters. So it is compliant with ACCU_001 requirement.

  In the case of an automated activation process (see section 5.1.1), all the location methods available at the time of the call at the handset level (A-GNSS, GNSS standalone, WiFi, Cell-Id) are used on condition that the battery power level is sufficient. Besides, precision of latitude and longitude transmit into the SIP INVITE message is up to 5 decimal places which will equate to 1.1 meters precision on the ground. Therefore the compliance to the accuracy/precision requirements relies on the location method and have already been described in section 4.1.2 and 4.2.4.

  In the case where the handset only manages to compute a simple Cell-Id location solution, this architecture is not compliant with all the accuracy/precision requirements.

- **Response time requirements**
  From the handset point of view, the response time of a WiFi Positioning System is less than 5 seconds and the response time of A-GNSS is most of the time under 30 seconds. So these two solution should be compliant with RESP_002 requirement.

  On the other hand, a standalone GNSS location might take several minutes (worst case – cold start) and this solution would not be compliant with RESP_002 requirement in this case. Nonetheless this solution could still be used to provide, later to the PSAP, a location of the caller more accurate than the one calculated by another location method (less accurate than GNSS) during the first seconds of the call.

  In this architecture using an automated activation process, the location estimate is sent to the PSAP when the configured timeout is reached (or even before the timeout for a GNSS-made location). HELP112 solution could re-use the AML timeout, which is set by default to 20 seconds.²⁰

²⁰ ETSI TR 103 393, « Advanced Mobile Location for emergency calls », Section 6.2 page 8
Therefore, in the case an A-GNSS, GNSS standalone, or WiFi location solution has been computed during these 20 seconds, this architecture solution is compliant with RESP_002 requirement.

On the other hand, if only a simple Cell-Id location estimate or even worse no location has been computed during the HELP112 configured timeout, this architecture solution is not compliant with RESP_001 requirement. Nonetheless, most of PSAP already retrieve a location estimate based on simple Cell-Id by making a request to the network GMLC less than 5 seconds after the call taker answers the voice call.

- **Presentation of the caller’s location to the PSAP**

PSAP that are already compliant with IMS emergency call (3GPP TS 23.167) will have to be updated to handle the HELP112 MSD embedded in SIP-INVITE message. Since the way the HELP112 location data will be included in the SIP-INVITE message has not been defined yet, the modification needed at the PSAP level cannot be described here. Nevertheless, the location information will still be displayed on the PSAP operator GIS if available and the process to extract location data from the SIP-INVITE message should be automated and made invisible to the call-taker. This architecture is therefore compliant with PRES_001 and PRES_002.

PRES_003 is not applicable to this architecture since no location server is involved.

In this solution the caller’s location and the confidence circle determined by the handset are communicated to the PSAP using a WGS84 latitude/longitude measured in decimal degrees and a radius measurement in meters. This information is included in the SIP-INVITE message by value and is not modified during its transmission to the PSAP. This solution is therefore compliant with PRES_004 requirement.

- **Privacy requirements**

The HELP112 automated activation method is enabled to switch on the location device of the caller’s mobile phone during the emergency call, and then at the end of the call, set all location devices back to their state prior to the call. This architecture is therefore compliant with PRIV_001 requirement.

In this architecture, the coverage of requirements PRIV_002 and PRIV_003 is handled by the PSAPs on the basis of their operating policies and each national or regional data protection legislation.
In the AML solution, no record of the location SMS data is available to the caller during or after the emergency call\(^\text{21}\), and it is therefore recommended that HELP112 solution re-uses this functionality. By following this recommendation, this solution is compliant with PRIV_004.

• **Acceptance of the solution requirements**

WiFi positioning systems are available on all recent mobile phone that are WiFi enabled. In the same way all recent smartphone have an embedded GNSS chipset and most of them are A-GNSS enabled. Concerning the transmission to the PSAP, this solution relies on the caller having an UMTS-PS/LTE enabled handset, a data subscription with an enabled and sufficiently reliable data connectivity at the time of the call, and using VoIP to call emergency services. This therefore leave aside numerous of potential E112 callers who have not a handset with such capacities. This architecture is therefore compliant with ACCE_001 requirement from the location method point of view but not compliant with it concerning the transmission method.

Concerning the activation of the location estimate and transmission, the solution presented in this architecture is entirely automated, so this solution is compliant with ACCE_002 requirement.

It is recommended that HELP112 solution process should be entirely invisible to the caller, and therefore this architecture should be compliant with ACCE_003.

Since the HELP112 automated activation method checks if the battery power level is sufficient before using any location method, and transmits the location data in the signalling part of the voice call without disturbing the vocal communication, it is compliant with ACCE_004.

• **Security requirements**

In standalone GNSS mode, no network transmission is needed so this method is compliant with SECU_002 requirement. Concerning WiFi and A-GNSS, if a network equipment is used to compute the location or to provide the necessary data to do it at the handset level, the security issues are transferred to the MNOs and no threat is currently known at the network level concerning the A-GNSS process.

Besides, in this transmission solution, entities that are a party to the SIP signaling (such as proxy servers) will have access to it and need to protect it against inappropriate disclosure. An entity that is able to eavesdrop on the SIP signaling will also have access to the location data. Mechanisms that protect against eavesdropping (such as Transport Layer Security (TLS) version 1.2 or later) should be preferentially used whenever feasible. (This requirement is not a "must" because there is an existing deployed base of clear-text SIP, and also because, as an emergency

\(^{21}\) ETSI TR 103 393, « Advanced Mobile Location for emergency calls », Section 6.2 page 8
call, it is more important for the call to go through than for it to be protected; e.g., the call must proceed even if the TLS negotiation or certificate verification fails for whatever reason.)

- **Method of estimating the location information requirements**

In the table hereafter are described the different cases where these requirements are covered by this architecture.

<table>
<thead>
<tr>
<th>Requirements</th>
<th>GNSS Standalone</th>
<th>WiFi + Cell-Id</th>
<th>A-GNSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCA_001</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>LOCA_002</td>
<td>OK in the case where the handset’s GNSS chipset is Galileo enabled</td>
<td>✗</td>
<td>OK in the case where the handset’s GNSS chipset and assistance data provider are Galileo enabled</td>
</tr>
<tr>
<td>LOCA_003</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>LOCA_004</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
</tr>
</tbody>
</table>

**Table 14 - Compliance of architecture 5 with location method requirements**

One major information to take into account concerning requirement LOCA_002 is that GNSS chipsets manufacturers are going to flood the mobile phone market with Galileo enabled chipsets in the coming months. The first Galileo-ready smartphone is expected to be available from October 2016.

Regarding the providing of Galileo assistance data (E-GNSS), it might take some time to make the facilities of each assistance data provider with Galileo assistance data.

- **Battery life requirements**

In this solution, a check is made to know if there is sufficient battery life for a short (5 minute) voice call before switching on any location devices likely to consume appreciable battery life. Equally should any location devices already be switched on when an emergency call is made, and likely to jeopardise a short voice call, they should be switched off. This makes this solution compliant with BATT_001 requirement.
Since the level of battery life needed to use one location method or another depends on the handset capacities, the BATT_002 is transferred to handset, battery and chipset manufacturers. Nonetheless, some GNSS message need a lot of power to be decoded in standalone mode, and therefore the use of A-GNSS or E-GNSS will decrease the battery consumption when compared with GNSS standalone.

- **Incurring charges**

If the data connection is deactivated on the caller's handset, this type of location data transmission will not be used. On the contrary, if the data connection is enabled and a transmission via the data channel is used, the caller will be charged in accordance with his data subscription. Therefore it is compliant with CHAR_001.

CHAR_002 is not applicable to this architecture since no SMS is involved.

- **Data transmission requirements**

This solution is usable with a VoIP enabled device and on a full IP network, therefore it is compliant with TRAN_001.

Since this solution depends on the availability of the IP channel, it will be compliant with TRANS_002 if and only if a fall-back solution that does not use the IP channel (e.g.: SMS) exists on the handset.

- **Roaming requirement**

All the handset based solutions to estimate the caller’s location are available to a caller from a country A that makes the call from another country B. Besides, the PSAP to which the call is routed depends on the location of the caller’s handset embedded in the SIP-INVITE message, and therefore if a user makes an emergency call using SIP in a foreign country, the call will be routed to a PSAP in this country. This architecture is therefore compliant with ROAM_001.

### 6.6.4 Covered user scenarios

The table below shows, for this architecture, the location methods available for each user scenario.
<table>
<thead>
<tr>
<th>User scenarios</th>
<th>A-GNSS</th>
<th>Standalone GNSS</th>
<th>WiFi + Cell-Id</th>
<th>O-TDOA (3G/4G)</th>
<th>RF Pattern matching (RFPM) (2G/3G/4G)</th>
<th>CITARX (2G)</th>
<th>Cell-Id + TA (2G/4G)</th>
<th>Cell-Id + RTT (3G)</th>
<th>Cell-Id (2G/3G/4G)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural countryside with GNSS available but no WiFi available</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities. Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>Rural building with all location methods available</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities. Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Available</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>Rural car with GNSS available but no WiFi available</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities. Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Available but potentially poor signal reception</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>Urban with GNSS available but disrupted and WiFi available</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities. Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Available but poor signal reception</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>Motorway or Dual Carriageway with GNSS available but no WiFi available</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities. Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>House location with all location methods</td>
<td>Available. E-GNSS availability relies on handset’s chipset capacities.</td>
<td>Available</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>Available</td>
<td>Assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office location with WiFi available but no GNSS available</td>
<td>Not available</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban with mobile data disabled</td>
<td>Not available</td>
<td>Available, but the transmission method needs a data connectivity</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available, but the transmission method needs a data connectivity</td>
<td></td>
</tr>
<tr>
<td>Abroad and urban with mobile data disabled</td>
<td>Not available</td>
<td>Available, but the transmission method needs a data connectivity</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available, but the transmission method needs a data connectivity</td>
<td></td>
</tr>
<tr>
<td>Caller’s handset in battery saving mode</td>
<td>Not available</td>
<td>Available</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
<td></td>
</tr>
<tr>
<td>Caller’s handset in privacy conscious settings</td>
<td>Not available</td>
<td>Available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available</td>
<td></td>
</tr>
<tr>
<td>SIMless user</td>
<td>Not available</td>
<td>Available, but the transmission method needs a data connectivity</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>Available, but the transmission method needs a data connectivity</td>
<td></td>
</tr>
</tbody>
</table>

**Table 15 - HELP112 architecture 5 vs User Scenarios**
6.7 ARCHITECTURE 6: HANDSET BASED HYBRID POSITIONING METHOD + AUTOMATED ACTIVATION + INBAND MODEM TRANSMISSION

6.7.1 Architecture

This architecture is using the eCall in-band modem technology to transmit the location estimated by the handset to the most appropriate PSAP. We will describe here the case where a specific eCall flag exists for Personal eCall. This type of eCall flag has not been yet standardised by 3GPP. Besides, in this architecture, the HELP112 MSD is transmitted automatically to the PSAP after a configured timeout (e.g: 20 seconds).

In this solution, according to the user's settings, the location solutions available are the following:

- GNSS standalone if the handset location service is set to use device sensors only or if the data connectivity is not available at the time of the emergency call.
- WiFi and Cell-Id if the handset location service is set to “battery saving” mode.
- A-GNSS if the handset location service is set to “high accuracy” (Mainly A-GPS).

In each of this three types of location solution, the location result will also rely on the local environment of the caller and the capacities of the location device of the handset (outdoor/indoor, satellite coverage, constellations and assisted data handled by the handset, density of the WiFi access points, density of the cellular network, etc).

Once the configured timeout is reached, the HELP112 MSD is formatted as described in section 5.2.1, and sent by the in-band modem using voice channel to the PSAP. The HELP112 MSD is receive by the in-band modem at the PSAP level and then displayed on the call-taker CAD.

The chart below shows an example of such an architecture:
6.7.2 I/F description

This architecture is based on the in-band modem technology. This technology deals with a modem pair (consisting of transmitters and receivers at handset and PSAP level) that operates full-duplex and allows reliable transmission of HELP112 MSD from mobile phone to PSAP via the voice channel of the emergency call through cellular network.

In this architecture, an HELP112 software embedded in the mobile phone:

- Is triggered by a 112 emergency call or SMS.
- Activates the location estimate based on the handset capacities.
- Formats the HELP112 MSD.
- Connects the handset in-band data modem to the input of the speech codec after the configured timeout. During the transmission of the MSD, the HELP112 software mutes the voice call between the caller and the PSAP operator.

The HELP112 MSD is conveyed on the voice channel to the PSAP in-band modem.

At the PSAP level:

- When the HELP112 MSD is detected, the outgoing speech path is muted and the signal demodulator detects the incoming data symbols.
- Once the MSD is decoded, it is provided to the PSAP operator and displayed on its CAD.
6.7.3 Covered requirements

We are going to describe below the compliance with all applicable requirements of the architecture presented above.

- **Accuracy requirements**

  In this solution, the HELP112 location MSD conveys a confidence radius of the location measurement in meters. So it is compliant with ACCU_001 requirement.

  In the case of an automated activation process, all the location methods available at the time of the call at the handset level (A-GNSS, GNSS standalone, WiFi, Cell-Id) are used. Therefore the compliance to accuracy/precision requirements relies on the handset based location method and have already been described in section 4.2.4.

  In the case where the handset only manages to compute a simple Cell-Id location solution, this architecture is not compliant with all the accuracy/precision requirements.

- **Response time requirements**

  In the architecture presented here, to transmit the Personal eCall MSD, the connection between the in-band modems at the handset and PSAP levels is triggered after a configured timeout. If this timeout is below the 30 seconds required, this architecture will be compliant with RESP_002.

  In the case the handset location method only returns a location based on a basic Cell-Id method, this architecture will not be compliant with LOCA_001.

- **Presentation of the caller location to the PSAP**

  This architecture follows the well standardised eCall technology to present the location information to the PSAP. All these requirements will therefore be covered by this architecture as long as:

  - The PSAP is already ready to receive eCall.
  - The automatic process that extract eCall MSD data is improved in order to handle HELP112 MSD.

- **Privacy requirements**

  The HELP112 automated activation method is enabled to switch on the location device of the caller’s mobile phone during the emergency call, and then at the end of the call, set all location devices back to their state prior to the call. This architecture is therefore compliant with PRIV_001 requirement.
In this architecture, the coverage of requirements PRIV_002 and PRIV_003 is handled by the PSAPs on the basis of their operating policies and each national or regional data protection legislation.

The HELP112 MSD transmitted via the in-band modem technology shall not be stored on the caller’s mobile phone. In this case, this solution will be compliant with PRIV_004 requirement.

Besides, eCall is already standardised at many levels and privacy is handled in eCall in the same way as in other E112 calls. This work of standardisation shall be used to facilitate the implementation of this architecture re-using eCall in-band modem technology.

- **Acceptance of the solution requirements**
  Concerning the transmission to the PSAP, this solution needs an in-band modem compliant with eCall requirements at the handset level. Such an in-band modem should therefore be embedded in each handset in Europe, which could be a serious impediment to the acceptance of this solution, and is currently not compliant with ACCE_001 requirement.

  The “Personal eCall” process as it is described in section 5.2.5 and in this architecture is entirely automated, and the MSD exchanged between the caller’s handset and the PSAP is invisible to the caller, therefore this architecture is compliant with ACCE_002 and ACCE_003.

  Since during the transfer of the HELP112 MSD, the voice call is lost, this solution is not compliant with ACCE_004 requirement.

- **Security requirements**
  This architecture shall be based upon the eCall standardisation to cover these requirements.

- **Method of estimating the location information requirements**
  In the table hereafter are described the different cases where these requirements are covered by this architecture.
<table>
<thead>
<tr>
<th>Requirements</th>
<th>GNSS Standalone</th>
<th>WiFi + Cell-Id</th>
<th>A-GNSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCA_001</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
</tr>
<tr>
<td>LOCA_002</td>
<td>OK in the case where the handset’s GNSS chipset is Galileo enabled</td>
<td>x</td>
<td>OK in the case where the handset’s GNSS chipset and assistance data provider are Galileo enabled</td>
</tr>
<tr>
<td>LOCA_003</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>LOCA_004</td>
<td>x</td>
<td>x</td>
<td>✓</td>
</tr>
</tbody>
</table>

Table 16 - Compliance of architecture 6 with location method requirements

One major information to take into account concerning requirement LOCA_002 is that GNSS chipsets manufacturers are going to flood the mobile phone market with Galileo enabled chipsets in the coming months. The first Galileo-ready smartphone is expected to be available from October 2016.

Regarding the providing of Galileo assistance data (E-GNSS), it might take some time to make the facilities of each assistance data provider with Galileo assistance data.

- **Battery life requirements**

  By considering a HELP112 automated activation process, this architecture will be compliant with the “Battery life” requirements.

- **Incurring charges requirements**

  eCall emergency calls are already free of charge for the user. It has to be extend to personal eCall.

- **Data transmission requirements**

  Since this solution does not use the IP channel, TRAN_001 is not applicable here.

  This architecture does not use the data connectivity so it is not compliant with TRAN_002.

- **Roaming requirements**
This architecture is based on eCall concept that benefits from its direct prioritized emergency link to the appropriate PSAP through the existing 112 mechanisms and is therefore independent from the location of the caller (inside his home country or in a visited country). ROAM_001 is then covered by this solution.

### 6.7.4 Covered user scenarios

The table below shows, for this architecture, the location methods available for each user scenario.
<table>
<thead>
<tr>
<th>User scenarios</th>
<th>Positioning methods</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A-GNSS</strong></td>
<td>Standalone GNSS</td>
</tr>
<tr>
<td>Rural countryside with GNSS available but no WiFi available</td>
<td>Available</td>
</tr>
<tr>
<td>Rural building with all location methods available</td>
<td>Available</td>
</tr>
<tr>
<td>Rural car with GNSS available but no WiFi available</td>
<td>Available</td>
</tr>
<tr>
<td>Urban with GNSS available but disrupted and WiFi available</td>
<td>Available</td>
</tr>
<tr>
<td>Motorway or Dual Carriageway with GNSS available but no WiFi available</td>
<td>Available</td>
</tr>
<tr>
<td>House location with all location methods</td>
<td>Available</td>
</tr>
<tr>
<td>available</td>
<td>Office location with WiFi available but no GNSS available</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>assistance data for Galileo and EGNOS availability relies on assistance data provider</td>
<td>Not available</td>
</tr>
<tr>
<td></td>
<td>Not available</td>
</tr>
<tr>
<td>Not available</td>
<td>Available</td>
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<tr>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>Not available</td>
<td>Available</td>
</tr>
</tbody>
</table>

Table 17 - HELP112 architecture 6 vs User Scenarios