Help112 II

Contract No 629/PP/GRO/SAT/17/9889

Deliverable D4.2

Cost Benefit Analysis - Synthesis

Coordinating person: Laurent ARZEL, Telespazio France

Participant No*	Participant organisation name	Country	Acronym
A	Telespazio France (**Coordinator**)	FR	TPZF
B	European Emergency Number Association	BE	EENA
C	Creativity Software	UK/IE	CS
D	PTOLEMUS Consulting Group	BE	PTO
1	Croatian Ministry of Interior (previously represented as DUZS)	HR	MoI
2	Danish Greater Copenhagen Fire Rescue Department	DK	GCFD
3	French Ministry of Interior	FR	DGSCGC
4	Integrated Control Centre of Freiburg	DE	ILSFR
5	National Infocommunications Service Company	HU	NISZ
6	Portuguese Ministry of Internal Administration	PT	SGAI
7	SOS Alarm	SE	SOS

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LIST OF ABBREVIATIONS

AML – Advanced Mobile Location for emergency services

CAD – Computer-aided dispatch

CBA – Cost Benefit Analysis

CAGR – Compound Annual Growth Rate

CTI – Computer Telephony Integration

CAPEX – Capital expenditures

COCOM – Communications Committee

D&A – Depreciation & Amortisation

DDoS – Distributed Denial of Service

EC – European Commission

EECC – European Electronic Communication Code

ELS – Emergency Location Service

E-NBL – Enhanced Network Based Location

ETSI – European Telecommunications Standard Institute

EU – European Union

GDPR – General Data Protection Regulation

GIS – Geographical Information System

GNSS – Global Navigation Satellite System

GPS – Global Positioning System

HTTPS – Hypertext Transfer Protocol Secure

NG911 – Next Generation 911

NHS – National Health Service

NPV – Net Present Value

MNO – Mobile Network Operator

NBL – Network-based location

OPEX – Operating Expenditures

OS – Operating System

PSAP – Public Service Answering Point

SICAD – Service d'information et de communication de l'arrondissement

SMS – Short Message Service

UI – User Interface

WP – Work Package

EXECUTIVE SUMMARY

In the case of an emergency, the location of the caller is the most important piece of information for emergency services (both for first responders and the rescue team). Ensuring it is accurate, reliable and timely will save lives and significant emergency services resources. Not having it will mean longer calls to understand the position of the victim, delayed arrivals of rescuers at the scene, a shortage of ambulances and sometimes fatal consequences.

The HELP112 project (2016-2017), funded by the European Commission, studied and evaluated the merits of different caller location solutions and concluded by proposing the use of handset-based technologies to improve the location of emergency callers. HELP112 also evaluated the deployment of AML, a handset-based caller location method, in 4 European countries.

The HELP112 II project supports the deployment of AML in 7 new European countries (Croatia, Denmark, France, Germany, Hungary, Portugal, and Sweden) and analyses its effectiveness in improving emergency response. As part of it, **Work Package 4 consists in an economic analysis of the AML roll-out in 6 EU Member States that have already deployed it: Austria, Belgium, Estonia, Finland, Lithuania and the UK.**

After **18 months of analysis and information exchange with the PSAPs of each country**, we learned that AML brings significant benefits at a cost for emergency services of less than €120,000 per country.

PTOLEMUS has found that:

- In all countries save Austria, at least 50% of the mobile emergency calls benefited from AML during 2019;
- AML improved the precision of the location by 460% in Lithuania and up to 1790% in the UK;
- Depending on the country, AML saved between 14 and 45 seconds per mobile emergency call each year.

Thus, PTOLEMUS estimated that, over a 10-year period:

- AML will save 236 lives in Estonia and up to 5,276 in the UK during the first 9 after the deployment;
- On average, the number of lives impacted by AML (i.e. either when lives were saved or when the seriousness of the injury was mitigated) will range from 5.3 in Lithuania to 18.7 in the UK out of every 100,000 relevant[1] calls during the first 9 years after the deployment;
- AML will generate a very significant Net Present Value per country, from €349 million for Estonia up to €11.1 billion for the UK.

Assuming that the results obtained for the analysed countries are representative of an EU-wide AML deployment[2], we estimated the potential benefits by 2024[3] in terms of lives impacted[4]. We did so under 2 different scenarios: *Same adoption rate* and *Faster adoption rate.*

[1] *Calls benefiting from AML that lead to a dispatch*

[2] *Assumptions for the analysis are explained in section 5.2.2*

[3] *2024 is a good benchmarking year since we expect to see similar or better benefits to those we have today, assuming that all countries without AML start deploying it in the next 2 years*

[4] *Lives saved and injury seriousness mitigated*

- In scenario 1 (*Same adoption rate),* 875 lives will be saved each year at EU level while with scenario 2 (*Faster adoption),* 1,070. Moreover, considering a 10-year perspective from 2024, **AML could potentially save between 8,750 and 10,700 lives in total in the EU.**
- In scenario 1 (*Same adoption rate)*, 8,836 lives will be impacted each year at EU level while with scenario 2 (*Faster adoption rate)*, 10,464. Moreover, considering a 10-year perspective from 2024, **AML could potentially positively impact between 88,000 and 105,000 lives in total in the EU**.

Table 1 - Summary of key AML figures in the analysed countries

Key findings	Austria	Belgium	Estonia	Finland	Lithuania	The UK
% of calls benefiting from AML (2019)	17%	58%	70%	74%	64%	56%
AML precision improvement per call (vs. base case scenario)	17.67x	7.31x	6.27x	12.6x	4.61x	17.86x
Average time saved per call (seconds)	39	27	19	38	14	45
Number of lives saved and injury seriousness reduced (10 years period)	1,090	1,069	236	1,532	379	5,276
Number of lives impacted every 100,000 calls benefiting from AML that lead to dispatch (average during the analysed timeframe)	16.44	10.92	8.40	15.35	5.30	18.67
AML CAPEX (€ thousand)	113	63	15	93	58	97
NPV per country (€ million)	2,628	2,375	349	3,604	548	11,102

Source: PTOLEMUS estimates

We can conclude that the implementation of AML has been successful in all 6 countries:

- Today, all countries have or are in the process to have iOS and Android supporting AML in their country;
- All emergency services benefit or are in the process of benefiting from AML;
- The AML deployment has been cost-effective everywhere, as it has leveraged existing systems (i.e. smartphones, Cell ID networks, GNSS constellations, Wi-Fi and fixed broadband connections, PSAPs' call handling and GIS systems and smartphone's positioning sensor fusion software),;
- At the same time, we forecast the benefits to be significantly higher than the investments and operational costs.

Table 2 - Summary of AML implementation results in the analysed countries

Completed Partial Not completed

Key findings	Austria	Belgium	Estonia	Finland	Lithuania	The UK
AML was quickly deployed	✗	~	✓	✓	✓	~
OS providers support AML	~	✓	✓	✓	✓	✓
Emergency services are effectively using AML	~	✓	✓	✓	✓	~
Emergency numbers are AML-enabled	~	~	✓	✓	~	✓
AML-enabled roaming calls	✓	✗	✗	✗	✗	✓
HTTPS as additional location transmission method	✓	n.a.	n.a.	n.a.	n.a.	n.a.
AML leverages the existing infrastructure	~	✓	✓	~	✓	✓
Cost effective AML implementation	✓	✓	✓	✓	✓	✓

Source: PTOLEMUS

Moreover, we have identified certain **best practices** that permit PSAPs to have smoother implementations and to obtain full benefits from day 1.

- 112 as the unique emergency number;
- A lean PSAP structure to manage the end-to-end AML data related processes;
- The involvement of PSAPs internal IT teams in the development of AML instead of full outsourcing;
- The development of a system to monitor the performance of AML;
- Setting the solution so as to trigger multiple location messages for each call;
- The inclusion of additional communication channels (HTTPS) to transmit the location.

1. INTRODUCTION

1.1 PLACE OF THIS DOCUMENT AND OBJECTIVES

The HELP 112 II project is aimed at assessing the deployment of AML from different angles and providing vital support and guidance for its deployment in Europe. Work Package 4 (WP4), led by PTOLEMUS with the support of 3 other HELP 112 consortium members (Telespazio France, EENA, and Creativity Software) performs an economic analysis of AML in 6 EU Member States where AML has been already deployed, namely Austria, Belgium, Estonia, Finland, Lithuania and the UK.

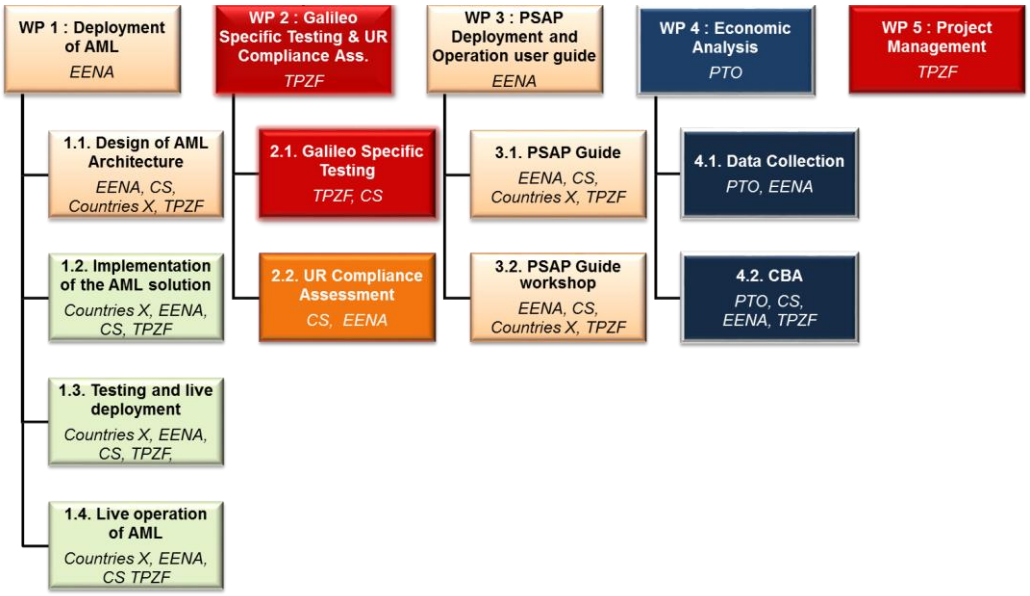
This document covers the deliverable identified as D4.2 in the list of project deliverables. It is generated as part of contract 629/PP/GRO/SAT/17/9889 with the European Commission.

The deliverable D4.2 leverages the methodology and the content of the country specific cost benefit analysis (CBA) identified as D4.1 in the list of the project deliverables.

The key objectives of this document are to:

- Present the general landscape of the AML deployment in the analysed countries;
- **Carry out a synthesis of the analysis of public benefits of AML performed for the 6 Member States within the scope of WP4**;
- Summarise the analysis of the costs incurred to implement AML in each of the analysed countries;
- Compare the outputs of the country specific CBAs;
- Validate that the user requirements as outlined in HELP112 project abide by the appropriate legal standards of the EU and those countries/regions;
- Individuate best practices to deploy AML.

Figure 1 - HELP112 II project flow chart



1.2 APPLICABLE DOCUMENTS

Table 3 - Applicable documents

AD	Title of the document & reference
AD1	Contract 629/PP/GRO/SAT/17/9889
AD2	Help112 II Consortium Agreement

1.3 REFERENCE DOCUMENTS

Table 4 - Reference documents

RD	Title of the document & reference
RD1	Help112 II Technical, Management & Financial Proposal TPZF/BUSO–T2017–PP–0695 on 27/11/2017
RD2	HELP112 project – Cost Benefit Analysis on 26/07/2017
RD3	Help112 II AML/GNSS Test Plan – Deliverable D2.1

2. THE LANDSCAPE OF THE AML DEPLOYMENT

In this section, for each analysed Member State, we describe the:

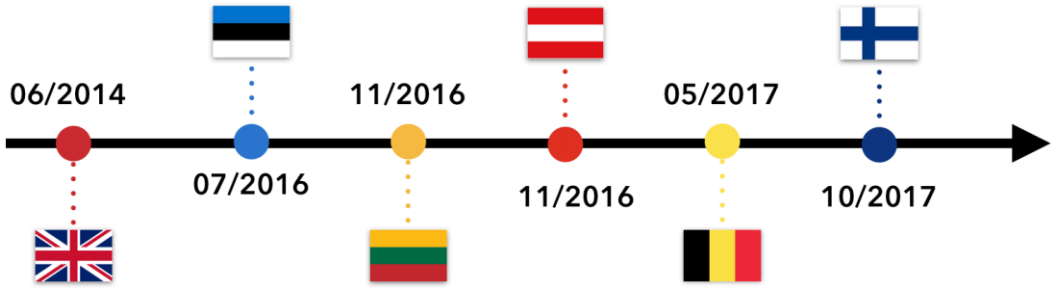
- Context of the AML deployment,
- Structure of the Public Safety Answering Points (PSAPs) and available emergency numbers,
- Existing network location technology,
- Access to emergency services for individuals with disabilities and
- Regulatory landscape.

2.1 CONTEXT OF AML DEPLOYMENT IN THE ANALYSED MEMBER STATES

In **June 2014**, **the Advanced Mobile Location** (AML) system was first **introduced in the UK** thanks to the initiative of BT, in partnership with HTC (handset manufacturer) and EE (British mobile network operator) to supplement network-based caller locations with a highly accurate handset-derived location during emergency calls.

After this first successful deployment, several other European countries deployed AML and among them, Austria and Lithuania rolled out the solution during the HELP112 phase I project.

Figure 2 - AML deployment timeline



Source: PTOLEMUS

In 2016, Google integrated AML to smartphones with Android OS through the development of the Android Emergency Location Service (ELS). This generated a considerable increase in the penetration of AML technology in smartphones and a consequent growth in the volume of calls benefiting from AML. Finally, **in March 2018, Apple started supporting AML on its OS too**.

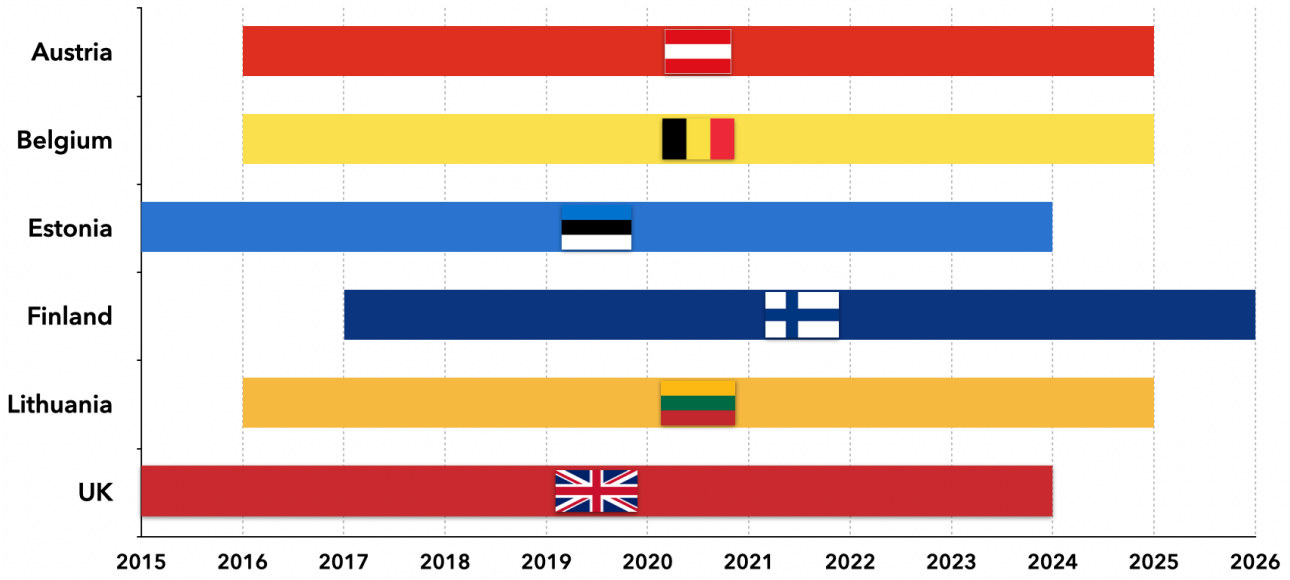
In light of the above, it is important to take into account a relevant timeline in terms of AML technology evolution and the consequent amount of calls benefiting from it.

We considered, for each analysed Member State, a timeframe of 10 years starting from the year before the deployment of AML, i.e. generally the year when the investment was made. However, we performed some adjustments:

- The UK deployed AML in the middle of 2014, but the high AML adoption rate was in 2016, the year of the launch of ELS, so we took 2015 as the starting year;
- In other analysed countries where the service commenced in the last months of the year such as Lithuania, we considered the beginning of the following year as the starting point to assess the benefits.

In Figure 3, we show the timeframe adopted for the CBA for each Member State.

Figure 3 - CBA timeframe



Source: PTOLEMUS

2.2 STRUCTURE OF THE PSAP SYSTEM AND AVAILABLE EMERGENCY NUMBERS

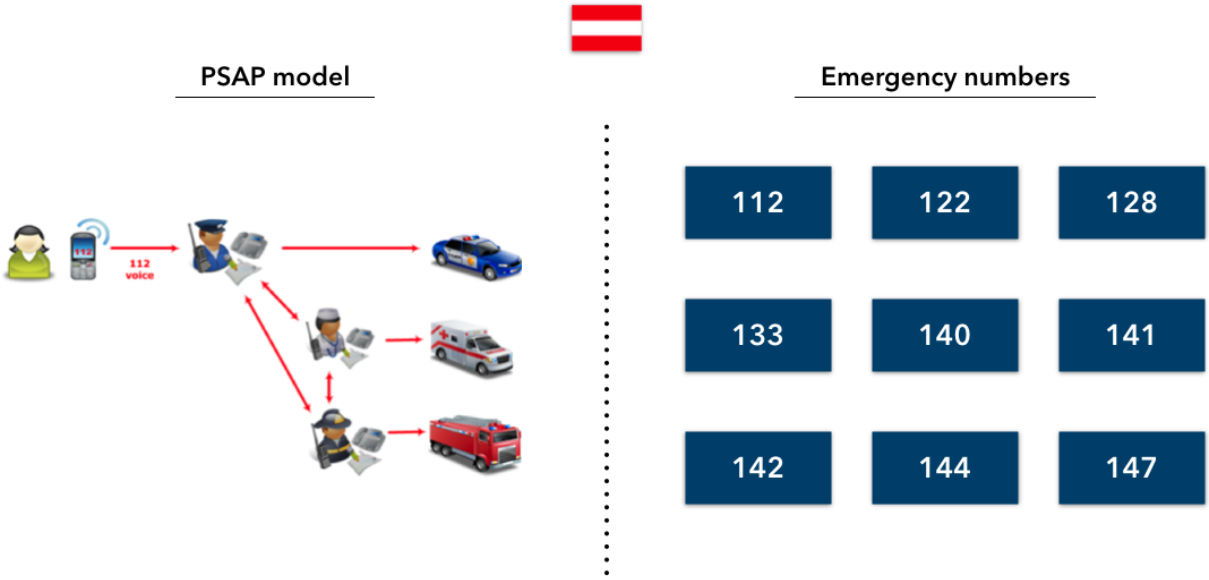
The organisation of PSAPs, the emergency numbers available and the AML location transmission technology in a Member State play a key role in the AML implementation as we will further analyse in section 3.1.5 and 3.1.6.

From the PSAPs' perspective, it is critical to have the IT infrastructure capable of receiving, sharing and leveraging the AML caller location information effectively. Moreover, we have detected that the national PSAPs' organisation model directly influences the speed and efficiency of the AML deployment. **The more complex the PSAP structure is, the harder it is to set up a convenient IT infrastructure to manage and share the AML information** among emergency services stakeholders.

Moreover, we observed that the number of emergency numbers has a direct influence on the PSAPs organisation and the AML coverage of emergency calls. Indeed, **the more emergency numbers available in a country, the slower the adoption of AML**.

We analyse below the situation in each of the 6 countries.

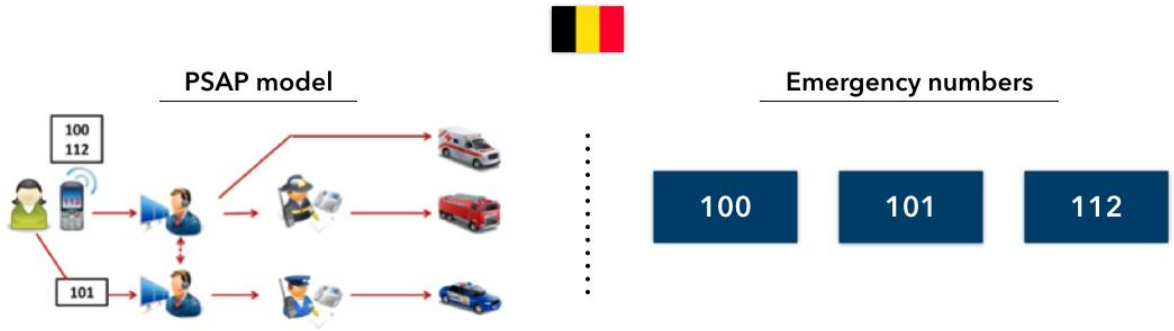
Figure 4 - Austrian PSAP model and available emergency numbers



Source: Public Safety Answering Points Global Edition – December 2018 – by EENA

Austria has a PSAP structure that follows a hybrid model. PSAPs are divided into 112 and non-112. As of today, the police response centre manages all 112 and 133 calls at national level while non-112 PSAPs manage all the other emergency numbers. The police PSAPs follow a variant of the model 1[5] in which the Emergency Response Organisations (EROs) handle emergency calls. On the other hand, non-112 PSAPs follow a model 5 in which the ERO independent PSAP handle both call-taking and resources' dispatch.

Figure 5 - Belgian PSAP model and available emergency numbers

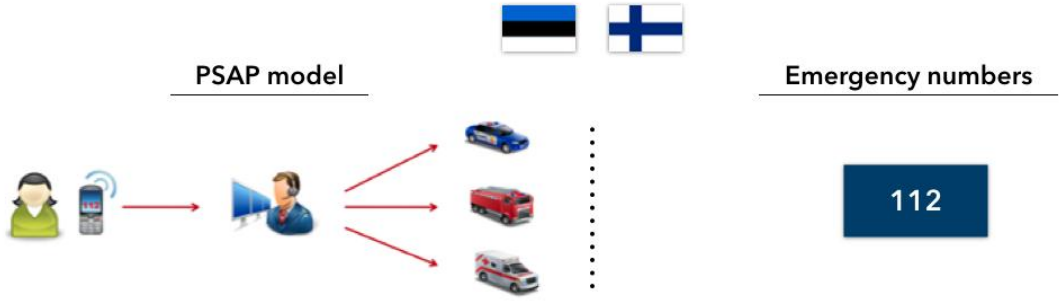


Source: Public Safety Answering Points Global Edition – December 2018 – by EENA

Belgium has a PSAP structure that follows a hybrid model. There are 112 PSAPs and Police PSAPs. The 112 PSAPs manage all calls placed to 100 and 112 and then dispatch ambulances or forward the call to FRS's dispatch centres or forward 112 calls requesting the police intervention to the police PSAPs. Conversely, the police PSAPs manage the calls to 101 and then forward them to the dispatch centre.

[5] *See Appendix 1) for additional information*

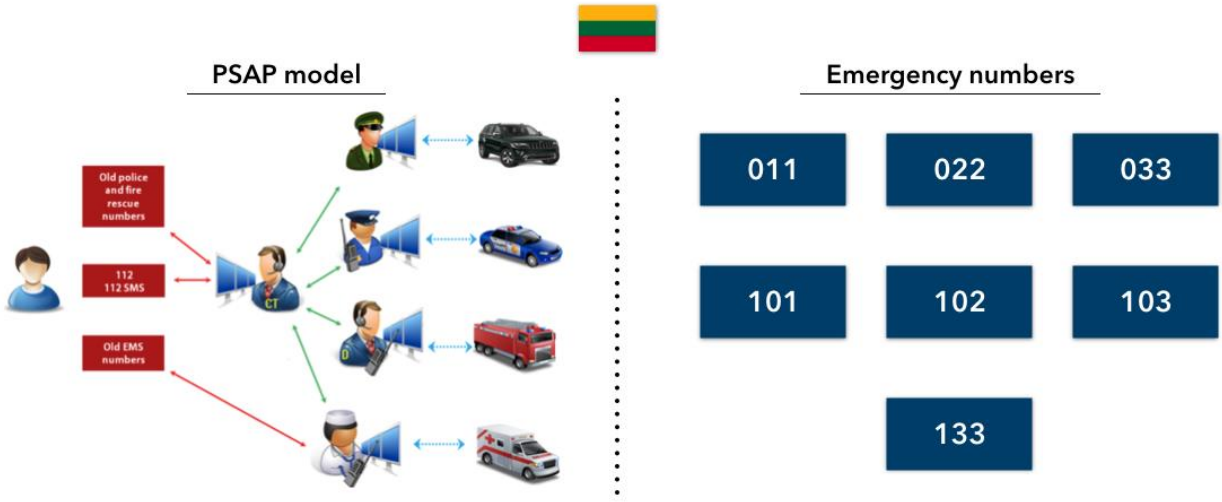
Figure 6 - Estonian and Finnish PSAP model and available emergency numbers



Source: Public Safety Answering Points Global Edition – December 2018 – by EENA

According to EENA, Estonia and Finland have a PSAP structure that follows model 5, and they have just 112 as an emergency number. Thus, the ERO independent PSAPs are responsible for the call-taking and the resources' dispatch.

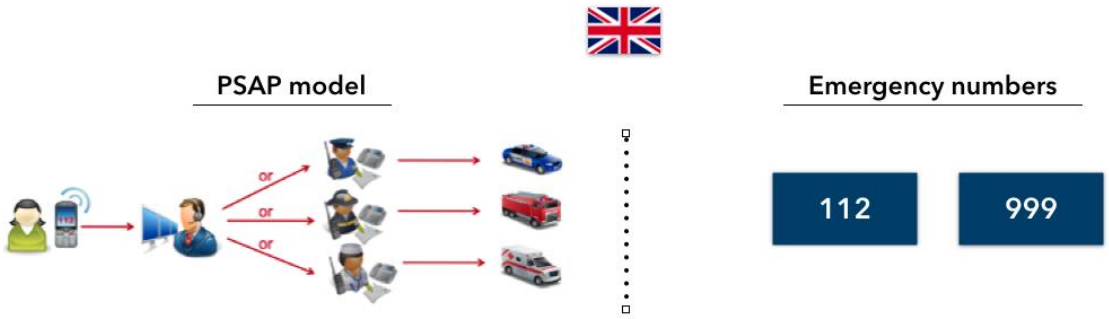
Figure 7 - Lithuanian PSAP model and available emergency numbers



Source: Public Safety Answering Points Global Edition – December 2018 – by EENA

Lithuania follows a hybrid model. There are 112 PSAPs managed by the ERC (Emergency Response Centre) and Emergency Medical Services (EMS) centres. The call takers and fire dispatchers belong to the ERC. Even though EMS still handles old EMS numbers, ERC will integrate them and will become a single PSAP for all types of emergencies. Moreover, as of 2021, Lithuania is planning to make 112 the unique emergency number.

Figure 8 - British PSAP model and available emergency numbers



Source: Public Safety Answering Points Global Edition – December 2018 – by EENA

According to EENA, the UK follows model 2 for both emergency numbers. Thus, there is an independent Stage 1 PSAP that filters and forwards calls to the appropriate EROs. The ERO performs the data gathering and dispatch of resources.

Table 5 - Summary of PSAP models and available emergency numbers in the analysed Member States[6]

Key findings	Austria	Belgium	Estonia	Finland	Lithuania	The UK
PSAP hybrid model	✓	✓			✓	
PSAP model 2						✓
PSAP model 5			✓	✓		
112 as unique emergency number			✓	✓		
112 + 1 national number						✓
112 + 2 national numbers		✓				
112 + more than 2 national numbers	✓				✓	

Source: PTOLEMUS based on Public Safety Answering Points Global Edition – December 2018 – by EENA

The **AML location transmission method** is another variable to be considered. It **can impact the share of AML messages with no location, the infrastructure investments**, and, as analysed in the CBA of HELP112 phase I, **the operational costs**.

[6] *For the definition of PSAP hybrid model, model 2 and model 5 refer to Section 2.2 and appendix 1)*

As we show in Table 6 below, all 6 countries use the SMS as transmission method and only Austria relies on HTTPS as an additional solution.

Table 6 - AML location transmission method

Key findings	Austria	Belgium	Estonia	Finland	Lithuania	The UK
SMS as AML location transmission method	✓	✓	✓	✓	✓	✓
HTTPS as additional AML location transmission method	✓					

Source: PTOLEMUS based on "AML report card June 2019" – by EENA

Moreover, Android OS allows to configurate the AML software to send more than one AML message during the emergency call.

Table 7 - Number of AML messages sent during a mobile emergency call

Key findings	Austria		Belgium		Estonia		Finland		Lithuania		The UK	
	Android	iOS	Android	iOS	Android	iOS	Android	iOS	Android	iOS	Android	iOS
One AML message per call		n.a.		✓	✓	✓		✓	✓	✓	✓	✓
Several AML messages per call	✓	n.a.	✓				✓					

Source: PTOLEMUS based on "AML report card June 2019" – by EENA

From Table 7, we can learn that in 3 countries, more than one AML message is sent during the emergency call.

In addition, we underline that:

- in Austria, ELS (Android AML software) is configurated to send one SMS and one HTTPs message per each call;
- in Belgium, Android smartphones send one message at the beginning of the call and another one 20 seconds after the start;
- in Finland, ELS sends a message every 30 seconds.

The number of AML messages sent during each mobile emergency call is relevant since it influences the amount of information received by emergency services operators and influences the costs borne by MNOs (as we describe in section 4).

2.3 NETWORK LOCATION TECHNOLOGY

Our economic analysis compares the benefits and costs associated with the deployment of AML against the base case scenario. In this CBA, we defined the base case scenario as the location technology in use before the AML implementation.

In most European Member States, the base case scenario is a situation where emergency services use Cell ID or improved Cell ID to locate emergency calls. Improved Cell ID refers to Cell ID enhanced by other technologies to improve the location precision of the emergency call. Hence, **in countries with improved Cell ID, we expected the benefits brought by AML to be less evident than in a country that starts from a Cell ID solution**.

From Table 8 below, we can notice that 3 of the 6 countries deployed an improved Cell ID system.

Table 8 - Existing network location technology

Key findings	Austria	Belgium	Estonia	Finland	Lithuania	The UK
Network Cell ID	✓	✓				✓
Improved Cell ID			✓	✓	✓	

Source: PTOLEMUS based on Public Safety Answering Points Global Edition – December 2018 – by EENA

2.4 ACCESS TO EMERGENCY SERVICES FOR USERS WITH DISABILITIES

The current regulatory framework in the EU requires Member States to "ensure that access for disabled end-users to emergency services is equivalent to that enjoyed by other end-users"[7]. Therefore, in the 6 selected countries, we analysed the solutions currently deployed for citizens with disabilities and if they are supported by the AML caller location.

Table 9 - Solutions for users with disabilities that trigger AML

Solution for people with disabilities triggering AML	Austria	Belgium	Estonia	Finland	Lithuania	The UK
Mobile app	✓	✓		✓	✓	✓
SMS to 112		✓	✓	✓	✓	✓
Approximate number of communications per year	700	27	13	200	122	5,000

Source: PTOLEMUS and COCOM's report (Implementation of the single European emergency number 112 – Results of the thirteenth data-gathering round)

As shown in Table 9, it is worth noting that:

[7] *Directive 2002/22/EC, amended by Directive 2009/136/EC*

- All analysed countries except Estonia, deploy a mobile app available for both major OSs that includes solutions for user with disabilities and that triggers the AML caller location;
- In all 6 countries, apart from Austria, the SMS to 112 is supported by the AML location technology on Android smartphones;
- The number of emergency communications received per year from the two solutions varies quite significantly among the analysed countries since not all of them have been able to provide the most recent figures (i.e. Belgium provided PTOLEMUS with the data from the first year of the solution deployment) or because we expect these figures to be influenced by the number of tests performed to verify the functioning of the solution.

2.5 KEY REGULATORY CONCERNS AT EU LEVEL

The regulation remains vital to the success of the AML deployment because each Member State has to comply with EU and national personal data protection laws.

Therefore, we identified the legislation relevant to AML operation and reviewed whether user requirements, as defined in Help112 phase I, comply with EU and country legal standards.

In particular, in the context of the enforcement of GDPR, compliance with privacy laws raises significant potential risks for the deployment of AML. We reviewed the relevant EU and Member States privacy regulations and analysed how each country implementation complied with both.

Table 10 - The AML call timeline and the regulatory implications at EU level

Emergency call timeline and events	• Emergency call made • PSAPs receives the AML message During the call	• Alarm to rescue services • Rescue services operations • Rescue work ends THE END After the call
Main concerns from a legal and regulatory point of view	• Obtain **location and identification** data **without prior consent** of the caller • **Caller location available free of charge** for involved "actors" • **Share location and identification** data among AML "actors" • Foster the availability at EU level of GNSS enabled smartphones	• **Where** is the **data obtained from the call going to be stored**? • Who can have access to the call data and how? • **For how long** the data **storage** is allowed? • Who is in charge of the **security of the stored data**? • How to manage eventual **data processing**?
Which are the laws regulating emergency calls today?	• **The ePrivacy Directive** 2002/58/EC - Art. 10 • **The Universal Service Directive** 2002/22/EC, as amended by Directive 2009/136/EC - Art. 26	• **General Data Protection Regulation** (GDPR, Regulation 2016/679)
Which are the laws regulating emergency calls in the near future?	• The European Electronic Communication Code **(EECC)** 2018/1972 - Art. 109 • **The Commission Delegated Regulation** 2019/320 - Art. 1	
Which are the laws that may regulate emergency calls in the future?	Regulation on Privacy and Electronic Communication	

Source: PTOLEMUS analysis

2.5.1 Current EU regulatory framework

The requirements related to the access to emergency services and to 112 are set out in **Directive 2002/22/EC**[8]**, amended by Directive 2009/136/EC**[9]. Article 26 of the said directive mandates that the caller location must be "available free of charge to the authority handling emergency calls as soon as the call reaches that authority". Caller location shall be made available for calls to 112 by telecom operators free of charge with the discretion for each Member State to extend such obligation to national emergency numbers.

In addition, the Directive sets the obligations born by Member States:

- "Ensure that access for disabled end-users to emergency services is equivalent to that enjoyed by other end-users";
- "Calls to the single European emergency call number "112" are appropriately answered and handled in the manner best suited to the national organisation of emergency systems."

Article 26, paragraph 1:

> *"Member States shall ensure that all end-users of the service referred to in paragraph 2, including users of public pay telephones, are able to call the emergency services free of charge and without having to use any means of payment, by using the single European emergency call number "112" and any national emergency call number specified by Member States."*

Article 26, paragraph 2:

> *"Member States, in consultation with national regulatory authorities, emergency services and providers, shall ensure that undertakings providing end-users with an electronic communications service for originating national calls to a number or numbers in a national telephone numbering plan provide access to emergency services."*

Article 26, paragraph 3:

> *"Member States shall ensure that calls to the single European emergency call number "112" are appropriately answered and handled in the manner best suited to the national organisation of emergency systems. Such calls shall be answered and handled at least as expeditiously and effectively as calls to the national emergency number or numbers, where these continue to be in use."*

Article 26, paragraph 4:

> *"Member States shall ensure that access for disabled end-users to emergency services is equivalent to that enjoyed by other end-users. Measures taken to ensure that disabled end-users are able to access emergency services whilst travelling in other Member States shall be based to the greatest extent possible on European standards or specifications published in accordance with the provisions of Article 17 of Directive 2002/21/EC (Framework Directive), and they shall not pre vent Member States from adopting additional requirements in order to pursue the objectives set out in this Article."*

Article 26, paragraph 5:

> *"Member States shall ensure that undertakings concerned make caller location information available free of charge to the authority handling emergency calls as soon as the call reaches that authority. This shall apply to all calls to the single European emergency call number*

[8] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02002L0022-20160430

[9] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1568104340750&uri=CELEX:32009L0136

"112". Member States may extend this obligation to cover calls to national emergency numbers. Competent regulatory authorities shall lay down criteria for the accuracy and reliability of the location information provided."

Furthermore, Article 10 of the **ePrivacy Directive 2002/58/EC**[10] **allows electronic communication services to override, on a temporary basis,** the elimination of the presentation of caller line identification and **the absence of consent of a subscriber or user for the processing of location data**. EU Member States are responsible for guaranteeing the transparency of all procedures governing these exceptions.

Member States may restrict the users' and subscribers' rights to privacy with regard to:

- Calling line identification where this is necessary to trace nuisance calls;
- Calling line identification and location data where this is necessary to allow emergency services to carry out their tasks as effectively as possible.

For these purposes, Member States may adopt specific provisions to entitle providers of electronic communications services to give access to calling line identification and location data without the prior consent of the users or subscribers concerned.

Article 10 states that:

*"**Member States shall ensure that there are transparent procedures** governing the way in which a provider of a public communications network and/or a publicly available electronic communications service may override:*

*a) **the elimination of the presentation of calling line identification**, on a temporary basis, upon application of a subscriber requesting the tracing of malicious or nuisance calls. In this case, in accordance with national law, the data containing the identification of the calling subscriber will be stored and be made available by the provider of a public communications network and/or publicly available electronic communications service;*

b) ***the elimination of the presentation of calling line identification and the temporary denial or absence of consent** of a subscriber or user for the processing of location data, on a per-line basis for organisations dealing with emergency calls and recognised as such by a Member State, including law enforcement agencies, ambulance services and fire brigades, for the purpose of responding to such calls."*

2.5.2 Evolution of the EU regulatory framework

Changes in the electronic communications market and new technology developments require a regulatory framework fit for purpose. To ensure that, recently adopted legislative acts integrate more specific and comprehensive provisions, thereby giving room for the implementation of a broader scope of technologies.

The **European Electronic Communications Code - EECC (Directive (EU) 2018/1972)**[11] sets the framework for emergency communications, as it will be applicable starting from 21st December 2020. **The Code has replaced the Universal Service Directive** (amongst other legislation) and entered into force on 20th December 2018. **It has to be transposed by all Member States by 21st December 2020**. The code sets a new conceptual framework and amends the legislative framework through Article 109.

The EECC opens the scope by **replacing "emergency calls" with "emergency communications"**. The term, as described in the Recital 285, includes "not only voice

[10] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32002L0058

[11] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L1972&from=EN

communications services, but also SMS, messaging, video or other types of communications, for example real time text, total conversation and relay services."

Recital 285:

> *"End-users should be able to access emergency services through emergency communications free of charge and without having to use any means of payment, from any device which enables number-based interpersonal communications services, including when using roaming services in a Member State.*
>
> *Emergency communications are a means of communication that includes not only voice communications services, but also SMS, messaging, video or other types of communications, for example real time text, total conversation and relay services.*
>
> *Member States, taking into account the capabilities and technical equipment of the PSAPs, should be able to determine which number-based interpersonal communications services are appropriate for emergency services, including the possibility to limit those options to voice communications services and their equivalent for end-users with disabilities, or to add additional options as agreed with national PSAPs. Emergency communication can be triggered on behalf of a person by an in-vehicle emergency call or an eCall as defined in Regulation (EU) 2015/758."*

As in the Directive 2002/22/EC, amended by Directive 2009/136/EC, the EECC establishes that the Member States must provide access to "112" to all end-users. It also specifies that "all emergency communications to the single European emergency number '112' are appropriately answered and handled in the manner best suited to the national organisation of emergency systems".

Article 109, paragraph 3 states that:

> *"Member States shall ensure that all emergency communications to the single European emergency number '112' are appropriately answered and handled in the manner best suited to the national organisation of emergency systems. Such emergency communications shall be answered and handled at least as expeditiously and effectively as emergency communications to the national emergency number or numbers, where those continue to be in use."*

The new framework provides that the obligation to implement caller location rests with the Member States and not specifically with the mobile network operators nor the PSAPs. It is the Member States that have to ensure, laying down relevant obligations on the entities concerned, that:

- Caller location information is made available to the most appropriate PSAP without delay;
- Both network-based and **handset-derived location** information are made available;
- The establishment and transmission of the caller location information is free of charge for both the end-user and the PSAP.

Article 109, paragraph 6 states that:

> *"Member States shall ensure that caller location information is made available to the most appropriate PSAP without delay after the emergency communication is set up. This shall include network-based location information and, where available, handset-derived caller location information. Member States shall ensure that the establishment and the transmission of the caller location information are free of charge for the end-user and the PSAP with regard to all emergency communications to the single European emergency number '112'. Member States may extend that obligation to cover emergency communications to national emergency numbers. Competent regulatory authorities, if necessary after consulting BEREC,*

shall lay down criteria for the accuracy and reliability of the caller location information provided."

The **Commission Delegated Regulation 2019/320**[12]**, supplementing the Radio Equipment Directive - REC** (**Directive 2014/53/EU**[13] establishing the regulatory framework for placing radio equipment on the market) was adopted on 12th December 2018. **It will be binding for all smartphone vendors in the EU internal market from 17th March 2022**.

It establishes **that "new mobile devices should be capable of providing access to Wi-Fi and GNSS location information in emergency communications and the location positioning feature should be compatible with and interwork with the services provided by the Galileo programme."**

Recital 11 states that:

"For the reasons set out, mobile devices should also fall within the category of radio equipment which supports certain features ensuring access to emergency services referred to in Article 3(3)(g) of Directive 2014/53/EU. New mobile devices should be capable of providing access to Wi-Fi and GNSS location information in emergency communications and the location positioning feature should be compatible with and interwork with the services provided by the Galileo programme."

Article 1, paragraph 2 adds that:

"Compliance with paragraph 1 shall be ensured through technical solutions for the reception and processing of Wi-Fi data, data from Global Navigation Satellite Systems compatible and interoperable with at least the Galileo system referred to in Regulation (EU) No 1285/2013, and for the making available of that data for transmission in emergency communications."

A third regulation applies at European level. The General Data Protection Regulation – GDPR (REGULATION (EU) 2016/679)[14] **specifically** applies to the management of personal data after the call has been processed**.** It adds key provisions regarding:

- The data anonymisation and pseudonymisation;
- The data storage;
- The data processing;
- Transparency;
- The confidentiality of the entire data management process.

In particular, we can underline **the importance of the storage of the caller location** since data that "permits identification of data subject" shall be kept "for no longer than is necessary for the purposes for which the personal data are processed" as stated in Article 5 paragraph 1(e):

"Personal data shall be:

a) processed lawfully, fairly and in a transparent manner in relation to the data subject ('lawfulness, fairness and transparency');
b) collected for specified, explicit and legitimate purposes and not further processed in a manner that is incompatible with those purposes; further processing for archiving purposes in the public interest, scientific or historical research purposes or statistical

[12] https://eur-lex.europa.eu/legal-content/EN/TXT/?toc=OJ%3AL%3A2019%3A055%3ATOC&uri=uriserv%3AOJ.L_.2019.055.01.0001.01.ENG

[13] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014L0053

[14] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2016.119.01.0001.01.ENG&toc=OJ%3AL%3A2016%3A119%3ATOC

purposes shall, in accordance with Article 89(1), not be considered to be incompatible with the initial purposes ('purpose limitation');

c) adequate, relevant and limited to what is necessary in relation to the purposes for which they are processed ('data minimisation');

d) accurate and, where necessary, kept up to date; every reasonable step must be taken to ensure that personal data that are inaccurate, having regard to the purposes for which they are processed, are erased or rectified without delay ('accuracy');

*e) **kept in a form which permits identification of data subjects for no longer than is necessary for the purposes for which the personal data are processed**; personal data may be stored for longer periods insofar as the personal data will be processed solely for archiving purposes in the public interest, scientific or historical research purposes or statistical purposes in accordance with Article 89(1) subject to implementation of the appropriate technical and organisational measures required by this Regulation in order to safeguard the rights and freedoms of the data subject ('storage limitation');*

f) processed in a manner that ensures appropriate security of the personal data, including protection against unauthorised or unlawful processing and against accidental loss, destruction or damage, using appropriate technical or organisational measures ('integrity and confidentiality')."

In a nutshell, all players involved must be GDPR-compliant unless otherwise provided by other specific dispositions.

Finally, it is reasonable to expect that the proposal for a Regulation on Privacy and Electronic Communication[15], repealing Directive 2002/58/EC, **will have a major impact on the implementation of AML.**

It suggests specific exemptions on the compliance with privacy law of subjects involved in emergency services. For example, the possibility to receive and process the location and the identity of a caller, even if he / she has prevented the calling line identification and in case of denial or absence of consent in all EU Member States during emergency calls. The proposal was released on 10th January 2017 and it is currently being discussed by the co-legislators. The final version of the text may be subject to changes.

As it will be a regulation, **this legislation will directly apply to all Member States without the need for a transposition**. Therefore, if the above-mentioned exemptions are confirmed in the final provisions, there will be no more need to analyse the privacy regulation at country level. It will only be necessary to verify the compliance with the EU Regulation of the stakeholders involved.

2.6 COMPLIANCE OF AML IMPLEMENTATIONS AND THE HELP112 USER REQUIREMENTS WITH EU & NATIONAL DATA PROTECTION REGULATIONS

To appraise the compliance of AML implementations, we have discussed with country PSAPs the relevant legislation impacting AML deployment and operation in the analysed Member States.

We have identified in each country the relevant laws impacting AML deployment and operations during emergency calls.

[15] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52017PC0010

Table 11 - National laws impacting AML

Austria	Belgium	Estonia
• **Telecommunications Act 2003** - Art. 20 - Art. 93 - Art. 98 - Art. 104	• **Loi du 13 Juin 2005** - Art. 107 • **Loi du 29 Avril 2011** - Art. 4 • **Loi du 14 Novembre 2011** - Art. 2 • **Loi du 10 Juillet 2012** - Art. 65 • **Loi du 27 Mars 2014** - Art. 24	• **Electronic Communication Act** - Art. 88 - Art. 96 - Art. 108 • **Rescue Act** - Art. 13
Finland	**Lithuania**	**The UK**
• **Information Society Code (917/2014)** - Section 86 - Section 108 paragraph 14 - Section 132 - Section 278 - Section 321 - Section 323 • **Emergency Response Act (692/2010)**	• **Law on Electronic Communications** - Art. 34 - Art. 64 - Art. 68 • **Law on Emergency Response Centre** - Art. 7 - Art. 8	• **Communications Act 2003** • **The Electronic Communication and Wireless Telegraphy Regulations 2011** • **Review of the General Conditions of Entitlement 2017** • **Calling Line Identification Facilities Guidance 2019**

Source: PTOLEMUS based on Member States laws

In Table 12, we analyse the key variables affecting the AML ecosystem and the regulation at country level in each of the analysed countries.

Table 12 - Regulation at country level impacting AML

Key findings	Austria	Belgium	Estonia	Finland	Lithuania	The UK
Access to 112 free of charge for mobile subscribers and actual users	✓	✓	✓	✓	✓	✓
Access to national emergency numbers free of charge for mobile subscribers and actual users	✓	✓	n.a.	n.a.	✓	✓
Caller location information free of charge for both caller and emergency services	✓	✓	✓	✓	✓	✓
Permission for the institutions serving the emergency calls to identify the calling line	✓	✓	✓	✓	✓	✓
Permission for the institutions serving the emergency calls to identify the location of the calling line	✓	✓	✓	✓	✓	✓

Source: PTOLEMUS based on Member States laws

As observed in the table above, **the countries are aligned in terms of provisions thanks to EU regulation.**

Additionally, where applicable, countries have settled communications and location information, related to national emergency numbers, to be free of charge as suggested by article 26 of the Directive 2002/22/EC[16], amended by Directive 2009/136/EC[17], recital 285 and article 109 of the European Electronic Communications Code - EECC (Directive (EU) 2018/1972)[18].

In section 3 of the country-specific cost-benefit analysis (CBA), documents identified as D4.1X in the list of the project deliverables, we provide a more detailed analysis of the regulatory landscape and the analysis of the user requirements.

[16] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02002L0022-20160430

[17] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1568104340750&uri=CELEX:32009L0136

[18] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L1972&from=EN

3. EVALUATING THE BENEFITS OF AML IN THE 6 COUNTRIES

In this section, we appraise the expected benefits of the deployment of AML within the timeframe defined in section 2.1.

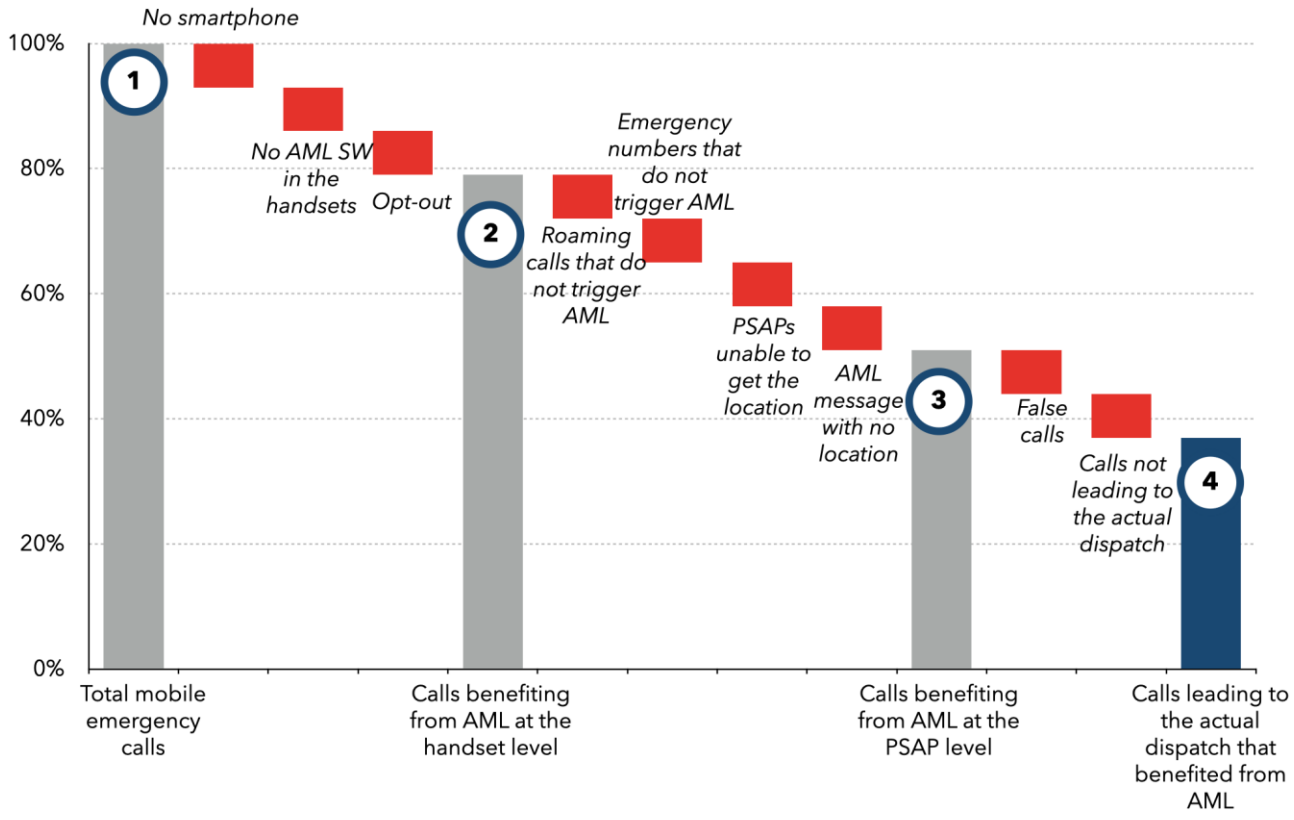
In order to estimate the economic and social benefits of the AML deployment, we used the same 5-step approach in each country:

1. Estimation of the **addressable calls** benefiting from AML;
2. Analysis of the caller **location precision improvement** of AML;
3. Assessment of the **time saved** thanks to the more precise caller location;
4. Estimation of the **value of the time saved in response time**;
5. Evaluation of the **economic and social benefits**.

3.1 ESTIMATION OF THE ADDRESSABLE CALLS BENEFITING FROM AML

To start with, we estimated the number of addressable calls benefiting from the deployment of AML. Even when emergency calls are placed by mobile phones, only a fraction of them benefit from AML operation and eventually the caller. Our methodology to estimate the number of addressable mobile emergency calls is detailed in Figure 9 below.

Figure 9 - Breakdown of emergency calls[19]



Source: PTOLEMUS

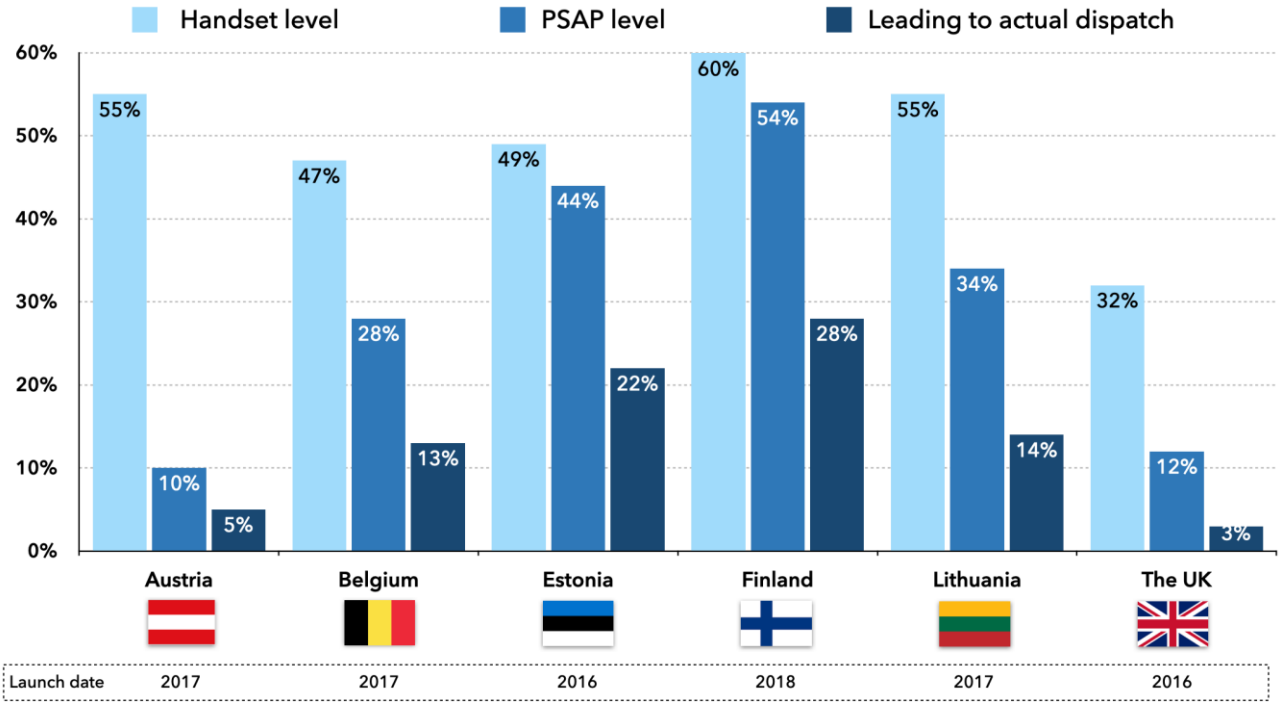
[19] *The detailed definition and rationale of each variable of the breakdown is presented in Appendix 2)*

Starting from the total number of mobile emergency calls[20], **we assessed the number of addressable mobile emergency calls at 3 levels**:

- **Handset**: we analysed the variables impacting AML at caller level, i.e. the penetration of smartphones in the population, the penetration of the AML software in the handsets and the share of users opting out of AML;
- **PSAP**: we assessed the variables that can prevent PSAPs from receiving the AML SMS, i.e. roaming calls that do not trigger AML, emergency numbers that do not trigger AML, PSAPs unable to receive the location due to an old IT infrastructure and the share of AML messages with no location[21];
- **Dispatch**: we estimated the number of calls leading to an actual dispatch benefiting from AML. At this stage we consider the share of false calls[22] and the genuine calls not leading to the actual dispatch[23] as calls not generating AML benefits.

In Figure 10, we present the breakdown of calls benefiting from AML at each of these 3 levels in the first year of the AML deployment.

Figure 10 - Emergency mobile calls benefiting from AML - 1st year of deployment[24] (%)



Source: PTOLEMUS estimates

During the first year of its AML deployment, the UK was the country with the lowest share of calls benefiting from AML at the handset level. The main reason is the high market share of handsets with iOS, which in 2016 did not support AML. On the other hand, in Finland, 60% of the mobile emergency calls benefited from AML at the handset level because in 2018 the smartphone penetration was higher than in other countries at the moment of the AML deployment. Additionally,

[20] *For additional details we refer to the Appendix 3)*

[21] *Defined as an AML message that is received by the PSAP, but it contains no location*

[22] *Defined as calls that do not correspond to a real emergency situation, i.e. fake calls, wrong dialling*

[23] *Defined as calls that do not lead to the dispatch of emergency squads even if they were placed with genuine intentions (i.e. there can be several calls placed for the same emergency event)*

[24] *First year of deployment defined as in section 2.1*

in Finland, both major handset OS providers were supporting AML from the first year of deployment while in the UK in the first year only Android smartphones supported it. In the UK in 2016 we estimated the smartphone penetration to be at 71% while in 2018 in Finland we rated it close to 85%.

At PSAP level, we can notice that in Austria, only 10% of mobile emergency calls reached PSAPs with a valid AML caller location. It is not surprising because a significant share of Austria's emergency numbers was not AML-enabled. Moreover, several Austrian 112 PSAPs could not receive AML locations. In 2016 in the UK, the stage 1 PSAP was ready to receive AML messages, but most stage 2 PSAPs were not. Conversely, **thanks to a lean PSAP structure and a single emergency number, 112, in Finland and Estonia 54% and 44% of calls reached the PSAPs with a useful AML position during the first year of deployment**.

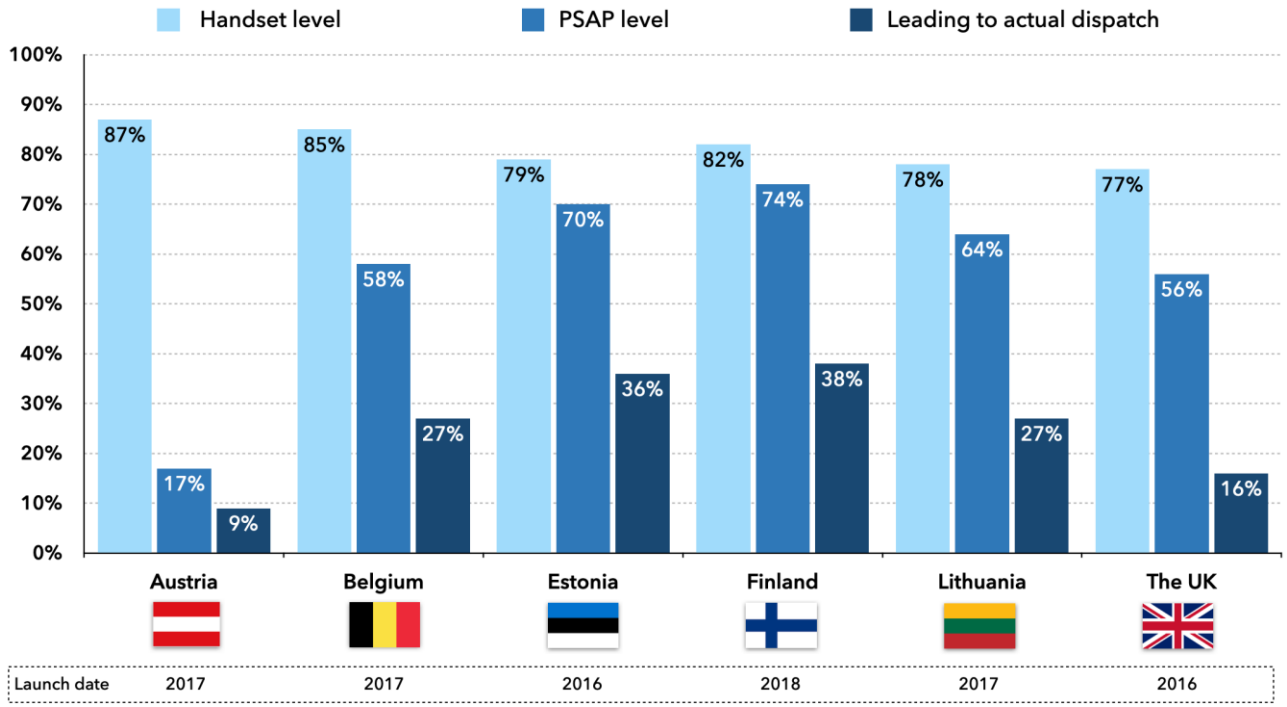
The share of calls leading to an actual dispatch that benefited from AML is influenced by variables not directly impacted by the AML technology. The number of false calls and the number of calls leading to dispatch are dependent on:

- the share of fake calls,
- wrong dialling or
- the number of genuine calls placed for the same emergency event.

Countries that have a high share of false calls, such as Lithuania, are conducting awareness-raising campaigns to reduce this phenomenon.

Figure 11 below shows the progress made by the 6 countries between the first year of launch and 2019.

Figure 11 - Emergency mobile calls benefiting from AML - 2019 (%)



Source: PTOLEMUS estimates

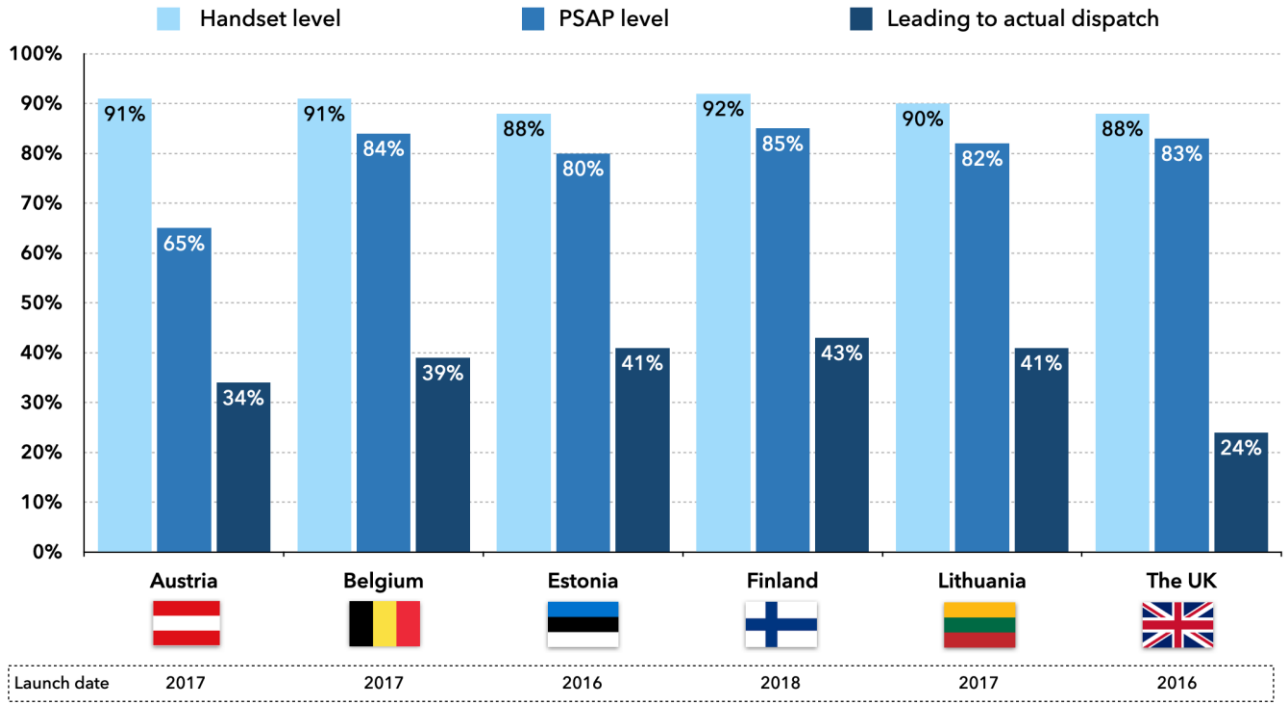
In all analysed countries, we observed significant improvements. The main reasons explaining the higher share of AML-enabled calls at each of the 3 levels are: the increased smartphone penetration, the higher penetration of the AML software in the handsets, a lower share of emergency numbers not triggering AML and a smaller share of PSAPs not able to receive the AML location.

Austria had the lowest share of calls benefiting from AML at PSAPs level due to two main factors:

1. Not all emergency numbers were AML-enabled and
2. 112 PSAPs did not have the required IT infrastructure to use AML.

Finally, as presented in Figure 12, we anticipate a significant increase in the share of calls benefiting from AML at both handset and PSAP level 9 years after the deployment.

Figure 12 - Emergency mobile calls benefiting from AML – 9 years after deployment
(%)



Source: PTOLEMUS estimates

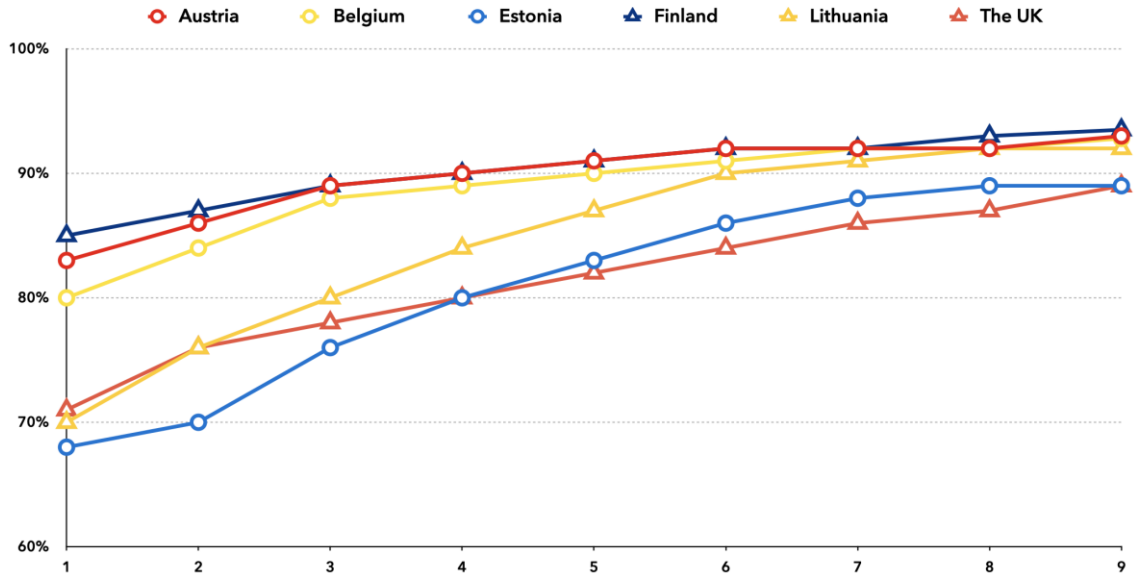
This progress is driven by an improved technological environment at all levels and the individual actions of each country, resulting from the collective learning of AML best practices.

In the following sub-sections, we analyse the evolution of each of the variables that determine the share of calls benefiting from AML.

3.1.1 SMARTPHONE PENETRATION

For this project, we assumed that only smartphones, defined as mobile phones with an operating system capable of running downloaded apps, can support AML. Thus, to estimate the number of calls placed from smartphones in the total number of mobile emergency calls, we evaluated the penetration of smartphones for each of the analysed countries. As shown in Figure 13, **we expect that, after 9 years from the AML deployment, in all countries, the smartphone penetration will be close or above 90% of mobile phone users.**

Figure 13 - Smartphone penetration over the years after AML deployment (%)



Source: PTOLEMUS estimates based on OFCOM and on Deloitte's Global mobile consumer trends and Mobile consumer survey

3.1.2 PENETRATION OF AML SOFTWARE IN THE HANDSETS

The adoption of AML software in the handset is a critical variable to determine how many emergency calls are benefiting from handset derived location.

OS providers play a vital role in the availability and scalability of the AML software in smartphones.

According to StatCounter GlobalStats[25], the 2 leading mobile OSs (Android, iOS) represented 99% of all smartphones in the analysed countries in 2019. As Windows Mobile and Blackberry have negligible market shares and currently do not support AML, we only considered Android and iOS in our analysis.

Google announced the release of its Emergency Location Service (ELS) in Android in 2016, with the feature supported on 99% of Android devices[26,27]. Apple enabled AML from iOS 11.3 onwards in March 2018. The share of Apple phones running iOS 11.3 and above was close to 96% in 2019. Such penetration is highly likely to reach 100% in the following years.

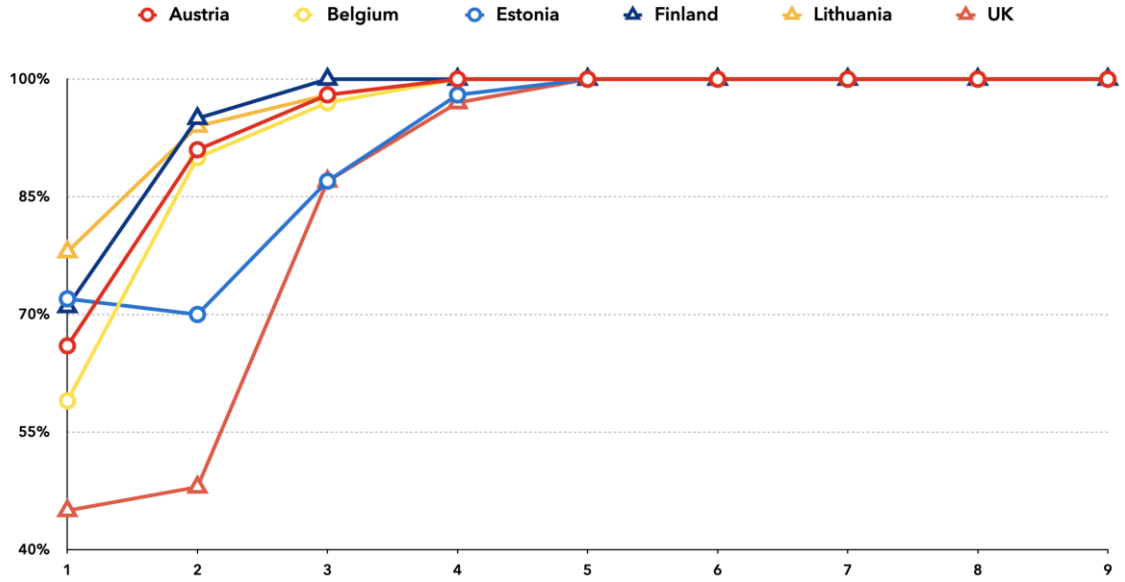
Therefore, we expect that the full penetration of the AML software in the handsets will be reached between 3 and 5 years after the AML deployment in all the analysed countries. In other words, **we estimate that the full penetration of the software will be achieved at the end of 2020.**

[25] https://gs.statcounter.com/os-market-share/mobile/europe/#yearly-2019-2020-bar

[26] https://eena.org/aml-in-android/

[27] https://crisisresponse.google/emergencylocationservice/how-it-works/

Figure 14 - AML software penetration over the years after AML deployment (%)



Source: PTOLEMUS estimates

Based on the observation of OS market trends in Europe and the complexity of launching a new OS, we expect that Google and Apple will continue to lead the OS market.

In theory, a new big OS provider could of course enter the market in the next 5 years. This is the attempt that Huawei is making at the moment. We will address this topic in the risk analysis (section 6.1.1.2).

3.1.3 "OPT-OUT" OF AML

AML is switched on by default to automatically send its location when dialling 112, or any other AML-enabled emergency number, in any EU Member State. However, handset users are also at liberty to "opt-out" from the feature in the 'security/privacy & location' settings. As a result, the number of calls addressable by AML would decrease.

Discussions with different stakeholders have led to the conclusion that the case of "opt-out" is still uncommon. Since the "opt-out" feature only became available in 2019, handset users are rarely aware of the choice. Besides, the perceived benefit of AML is unlikely to encourage them to opt-out. To sum up, we have assumed that the opt-out rate will slowly rise as public awareness of such choice grows but not exceed 1.5% over the forecast period.

3.1.4 ROAMING CALLS NOT TRIGGERING AML

As reported by ETSI[28], for emergency calls placed by roaming users, the AML SMS reaches the home country's SMS centre instead of reaching the SMS centre of the country where the emergency event occurred. Thus, the appropriate PSAP does not receive the AML location of the caller.

However, two of the analysed countries, Austria and the UK, have already implemented the SMS to a long number[29] to enable roaming calls with AML. Moreover, we have learnt from countries' PSAPs

[28] *ETSI TS 103 625 v1.1.1 (2019-12)*

[29] *From ETSI TS 103 625 v1.1.1 (2019-12) - Long number: a full length E.164 number including country code, e.g. +44NNNNNNNNNN (N representing digits in a normal UK telephone number), which although it looks like a normal mobile phone number is a "virtual mobile number" as it doesn't terminate on a mobile phone, but can be routed by the hosting mobile network to a network termination point, in this case a PSAP.*

that they are all testing solutions to enable AML for calls placed by foreign numbers, starting from the end of 2020 or the beginning of 2021.

In particular, according to Astrid SA/NV (Belgian PSAP), Belgium is planning to integrate roaming calls to AML. Instead of using the long number option as in the UK, Belgium is running pilots for alternative approaches[30]. The tested solution is the modification of the SMSC (Short Message Service Centre) number of the roaming call with the CC (country code) of the visited country. Thus, a call to 112 by a roaming device in Belgium would be +32112 leading to a correct functioning of AML.

Table 13 - AML availability for roaming calls

Key findings	Austria	Belgium	Estonia	Finland	Lithuania	The UK
Roaming calls AML-enabled at the end of 2019	✓					✓
Roaming calls AML-enabled from the end of 2020/ beginning of 2021	✓	✓	✓	✓	✓	✓

Source: PTOLEMUS

3.1.5 EMERGENCY NUMBERS NOT TRIGGERING AML

In section 2.2, we have presented the available emergency numbers in each country. In this section, we analyse which numbers were, are and will be enabled with AML.

In order to enable a number with AML, it is crucial to obtain the participation of:

- **OS providers**: the smartphone operating system must have a software capable of triggering AML when the emergency number is dialled. Nowadays, we know that both Android and iOS smartphones are AML-capable. However, a smartphone has to recognise the 112 call and, when applicable, the national emergency numbers to trigger AML functionalities. Thus, OS providers need to reach an agreement with the other 2 key emergency services stakeholders i.e. Mobile Network Operators (MNOs) and PSAPs;
- **MNOs**: they must have the IT infrastructure to recognise the AML message and share it with the appropriate PSAP;
- **PSAPs**: they must have the IT infrastructure to receive and handle the AML message.

As shown in Table 14, the **countries that have 112 as their unique emergency number, such as Estonia and Finland,** or that have 112 and only one additional national number, such as the UK**, have had a clear advantage in enabling AML. They benefit from a greater share of calls benefiting from AML at PSAP level.**

On the other hand, countries such as Austria and Lithuania have not enabled all emergency numbers with both OS providers yet. In Austria, the 112 PSAPs are still under reorganisation and modernisation, making them a bottleneck for AML's reach. According to NNOE, Lower Austria's non-112 PSAP, Austrian authorities and emergency services stakeholders are still negotiating with Apple its collaboration to support AML on iOS. Thus, they expect that the process will still require several years.

[30] ETSI TS 103 625 v1.1.1 (2019-12) – Emergency Communications (EMTEL); Transporting Handset Location to PSAPS for Emergency Calls – Advance Mobile Location

In Lithuania, emergency services authorities have decided to abandon all national emergency numbers and to adopt only 112 as the unique emergency number from 2021. Thus, Lithuania will reach a full AML coverage of its emergency numbers as soon as 2021.

Table 14 - Emergency numbers and AML support for each phone OS

AML-enabled | Some AML-enabled | Not AML-enabled

Key findings	Austria		Belgium		Estonia		Finland		Lithuania		The UK	
	Android	iOS	Android	iOS	Android	iOS	Android	iOS	Android	iOS	Android	iOS
112 AML-enabled from the first year of deployment	✗	✗	✓	✗	✓	✓	✓	✗	✓	✗	✓	✗
112 AML-enabled at the end of 2019	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
112 AML-enabled after 9 years of deployment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
National numbers AML-enabled from the first year of deployment	~	✗	✓	✗	n.a.	n.a.	n.a.	n.a.	~	✗	✓	✗
National numbers AML-enabled at the end of 2019	~	✗	✓	~	n.a.	n.a.	n.a.	n.a.	~	✗	✓	✓
National numbers AML-enabled after 9 years of deployment	~	✗	✓	✓	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	✓	✓

Source: PTOLEMUS based on PSAP information

3.1.6 SHARE OF PSAPS UNABLE TO RECEIVE THE LOCATION

As shown in Table 15, PSAPs in Austria are currently not able to receive the AML-derived caller location. As already mentioned in sections 2.2 and 3.1.5, the 112 PSAPs in Austria are restructuring their organisation and IT infrastructure. Thus, Police PSAPs and relative dispatch centres do not leverage AML in their operations.

According to NNOE, the PSAPs' renovation process is expected to be complete in 2022. Thus, only from 2022 will the Austrian 112 PSAPs be able to receive and leverage the AML information during an emergency event.

Table 15 - PSAPs capability to receive the AML location

All Some

Key findings	Austria	Belgium	Estonia	Finland	Lithuania	The UK
PSAPs able to receive the AML location in the first year of deployment	Some	All	All	All	All	Some
PSAPs able to receive the AML location at the end of 2019	Some	All	All	All	All	Some
PSAPs able to receive the AML location 9 years after the deployment	All	All	All	All	All	All

Source: PTOLEMUS based on interviews of countries' PSAPs and "AML report card June 2019" by EENA

In the UK, as described in section 2.2, the PSAP structure follows EENA's model 2, i.e. there is one Level 1 PSAP and several Level 2 PSAPs. The Level 1 PSAP, which is managed by BT (British Telecom), is AML-capable. On the other hand, Level 2 PSAPs, which are managed by emergency services, are not all AML-capable, as we can see in Table 16. According to BT, from the end of 2021, all Level 2 PSAPs will have the necessary IT systems in place to use the handset-based location effectively.

Table 16 - Emergency services that are actively using AML at the end of 2019

All Some None

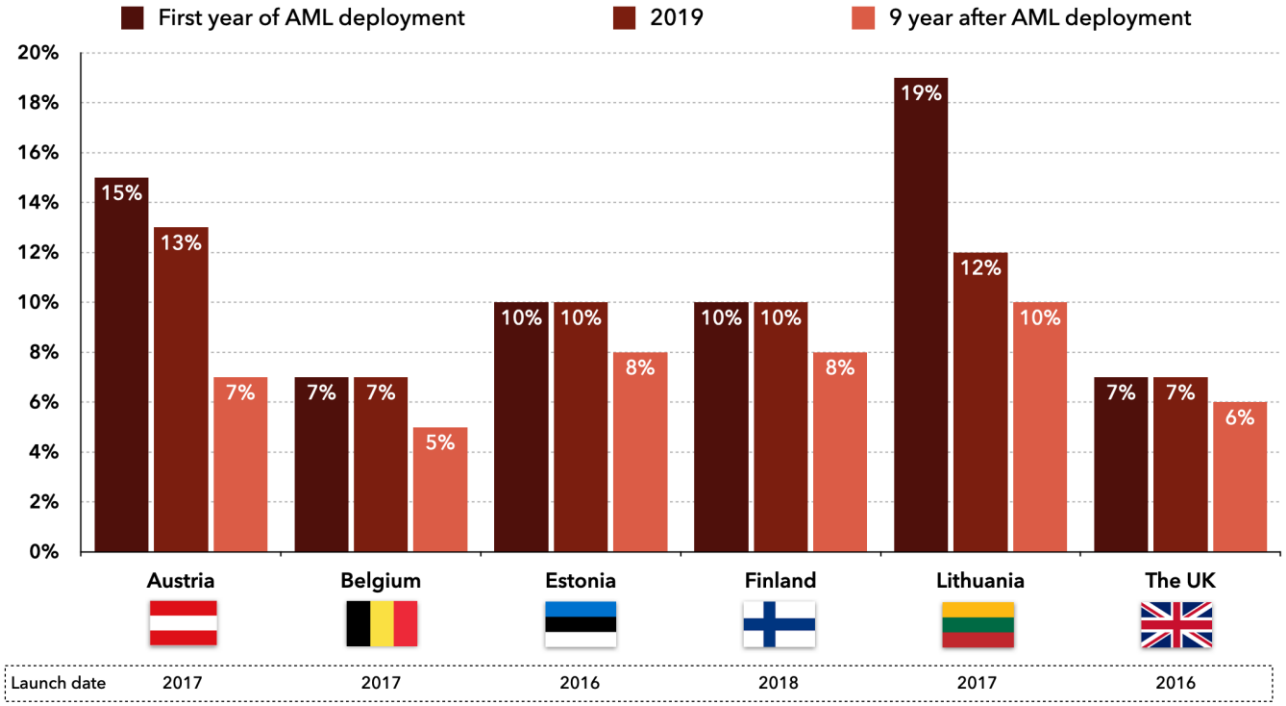
Key findings	Austria	Belgium	Estonia	Finland	Lithuania	The UK
Police	None	All	All	All	All	Some
Emergency Medical Services (EMS)	All	All	All	All	All	Some
Fire and Rescue Services (FRS)	All	All	All	All	All	Some

Source: PTOLEMUS based on interviews of countries' PSAPs and "AML report card June 2019" by EENA

3.1.7 MESSAGE WITH NO LOCATION

Thanks to the information that PTOLEMUS has received from PSAPs, we have been able to estimate the share of AML messages that reaches the PSAPs without providing a location.

Figure 15 - AML message with no location (%)



Source: PTOLEMUS

Lithuania and Austria, in their first year of AML implementation, had a figure significantly higher (19% and 15% respectively) than other analysed countries.

Overall, we expect this rate to decrease as a result of an improvement in handset technology (i.e. better antennas, multi-frequency and multi-constellation chipsets, more sophisticated OS to determine the device location) and network infrastructure (i.e. higher density of Cell-IDs and more advanced antennas).

In Austria, given its AML data transmission setup (described in section 2.2), we consider:

- SMS or HTTPS messages with no location and
- the share of HTTPS messages that have a valid location but cannot be matched with the relative voice call and hence are not useful[31].

In Lithuania, during the first year of deployment, the system of the 112ERC, the public institution responsible for the 112 emergency calls handling, detected that 19% of AML SMS displayed the message "no location SMS". After an internal investigation, the IT department of the 112ERC discovered that the SMS platform did not display all SMSs tagged with "no location SMS" to the call takers. However, in some cases, these messages had a correct caller location.

The platform was considering as SMS with no location those calls for which there was a location, but in which the system was not able to determine the technology that provided such location.

3.1.8 SHARE OF FALSE CALLS AND SHARE OF CALLS NOT LEADING TO THE ACTUAL DISPATCH

It is worth noticing that **not all emergency calls are leading to the dispatch of emergency squads**. Hence, they should not be considered in the estimation of AML benefits.

[31] *For further information we refer to the HELP112 phase II deliverable D4.1.3 and ETSI TS 103 625 v1.1.1 (2019-12) – Section 6.3.8 Limitations of HTTPS*

We have identified two main categories of calls that do not lead to a dispatch:

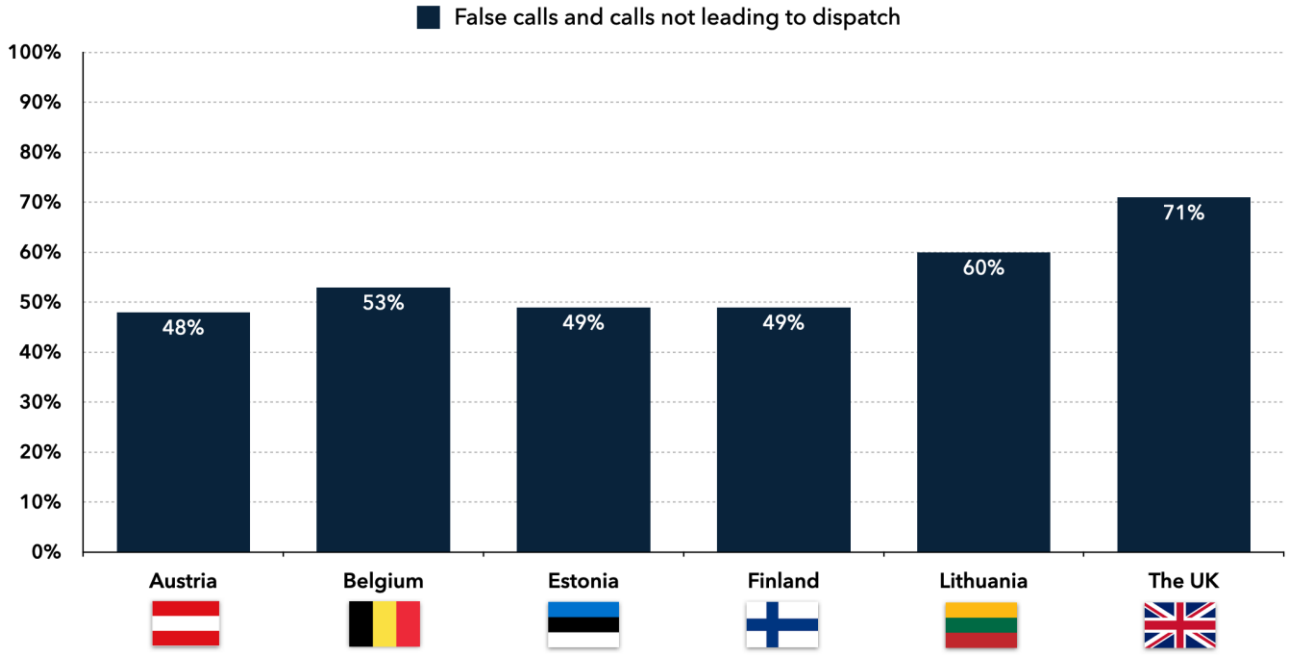
- False calls and
- Genuine calls where the dispatch of emergency teams is not required to respond to the emergency.

Interestingly, some calls are not placed with the intention of an emergency. They are either fake calls or wrongly dialled calls. We consider these calls as "false calls".

In addition, many genuine emergency calls do not lead to the actual dispatch. For example, there can be multiple requests related to the same emergency event (i.e. multiple testimonies of a car accident call emergency services or a victim calls several times emergency services to provide additional details about the event). We define these calls as "calls not leading to dispatch".

In Figure 16, we present the share of the total calls that do no not lead to dispatch either because they are false calls or genuine calls not leading to dispatch.

Figure 16 - False calls and calls not leading to dispatch (%)



Source: PTOLEMUS with PSAPs data

These statistics show that:

- **Austria is the country that has the lowest share of false calls and genuine calls not leading to dispatch**. According to Notruf Niederösterreich (Lower Austria's PSAP), Austrian authorities took severe measures (i.e. stiff fines) and led awareness-raising campaigns to reduce the number of false calls considerably.
- In Lithuania, 60% of the emergency calls do not lead to an actual dispatch of emergency squads. The competent authorities are taking measures to fine transgressors placing fake calls and also at the regulatory level, the Emergency Response Centre is required to adopt measures to reduce the number of false emergency requests[32].
- In the UK, 40% of the calls that reach stage 1 PSAP are filtered as false calls. At stage 2, PSAPs do not dispatch 60% of the calls considered as genuine at stage 1. Thus, 71% of the total emergency calls placed are not leading to a dispatch.

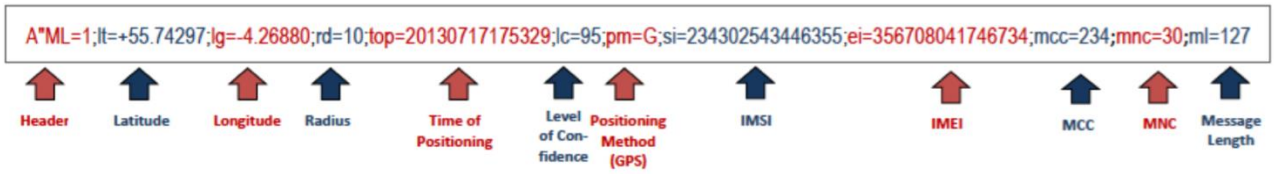
[32] *The Law on Emergency Response Centre No IX-2246, art. 8 par. 11*

3.2 ANALYSIS OF THE CALLER LOCATION PRECISION IMPROVEMENT OF AML

To assess the improvement in the accuracy of positioning brought by AML compared to mobile network-based positioning systems (described in section 0), we analysed the databases of AML SMSs from real emergency calls placed in the analysed countries.

In Figure 17 is shown the dataset contained in an AML SMS. It is important to note that to comply with personal data protection regulations, PSAPs only shared with us anonymised data and not personally identifiable information (PII). Thus, the dataset did not provide personal information such as the IMSI (International Mobile Subscriber Identity) and the IMEI (International Equipment Subscriber Identity).

Figure 17 - Example of AML SMS with location data



Source: HELP112 phase I Deliverable D1.2-EENA-020

The positioning method in the AML SMS **displays the dominant technology used by the handset to calculate its location.** Using parameters such as signal strength, number of GPS or Galileo satellites in view, number of visible Wi-Fi hotspots, etc. smartphones perform a fusion of GNSS-, Wi-Fi-, and Cell ID-derived locations to determine their geographic position.

In the above SMS, GNSS has been selected as providing the most reliable and accurate position.

Knowing that the improvements of the location technologies could significantly change depending on the environment, we analysed the AML performance for emergency calls in 3 environments:

- Urban
- Suburban
- Rural

We used the latitude and longitude coordinates of all messages to locate the emergency calls in each environment. To do so, we used Eurostat's territorial typology definition[33].

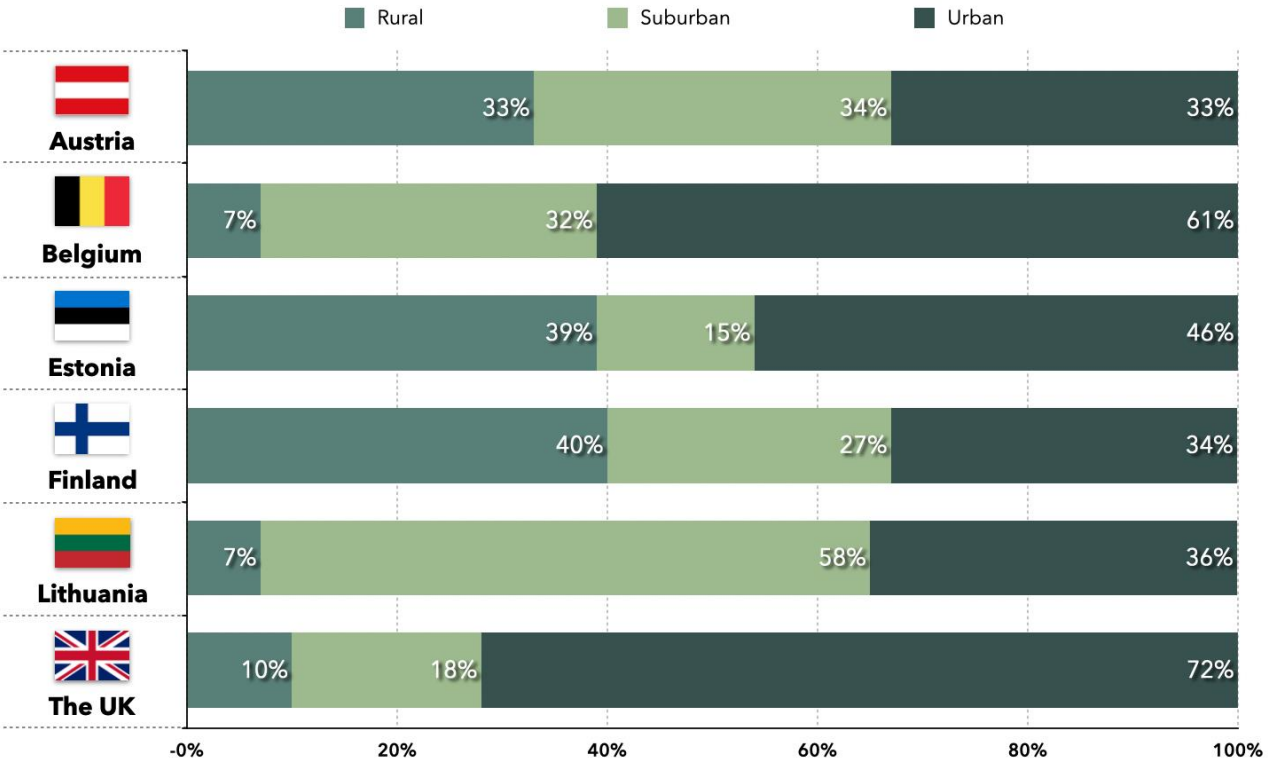
3.2.1 DISTRIBUTION OF THE EMERGENCY CALLS BY ENVIRONMENT

Based on the methodology described above, we have been able to determine the emergency call distribution in each environment category in the analysed countries.

From each country analysis, we learnt that the precision of the network-derived location is strongly correlated with population density. The higher the population density, the higher is the mobile network cell density and consequently, the precision of the network measurement. Therefore, **network location is less precise in rural areas than it is in urban areas**. Thus, **rural areas benefit the most from the AML deployment** as GNSS and Wi-Fi location data generated in the phone and triggered by AML, offer a precise location regardless of the population density.

[33] *Methodological manual on territorial typologies — 2018 edition, January 2019, Eurostat*

Figure 18 - Emergency call distribution by environment (%)



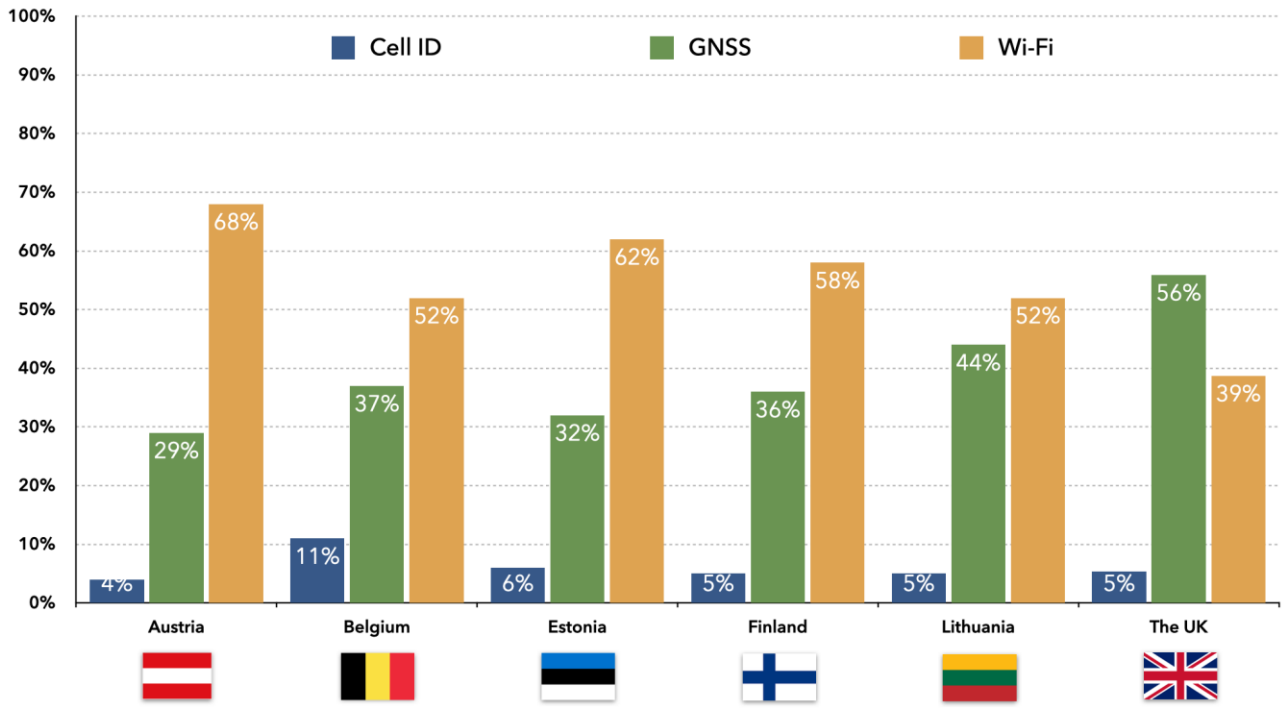
Source: PTOLEMUS based on country specific AML datasets analysis

Thus, *ceteris paribus*, countries with a high share of rural inhabitants such as Austria, Estonia and Finland will benefit more from the deployment of AML than countries such as Belgium and Lithuania.

3.2.2 DISTRIBUTION OF THE PREDOMINANT AML LOCATION TECHNOLOGY

Based on the analysis described in section 3.2, we determined the distribution of the predominant AML location technology in each of the analysed countries.

Figure 19 - Distribution of the predominant AML location technology (%)



Source: PTOLEMUS

As shown in Figure 19, **Wi-Fi is AML's most triggered technology to determine the caller position in the majority of the countries**. We can explain this result mainly as a result of the high proportion of indoor calls, either at home or office, and the widespread availability of public Wi-Fi areas in open spaces.

As an exception, in the UK, the share of GNSS-derived location is higher than the Wi-Fi one. We believe that one of the possible factors is the high penetration of high end smartphones. As reported during the testing phase of HELP 112 phase I[34], high end handsets generate a higher share of GNSS locations and more precise radiuses. This is probably the consequence of more sensitive GNSS receivers.

For example, in the UK, Apple's smartphone market share ranged between 41% and 61% during the period from January 2016 to February 2020[35].

Interestingly, Cell-ID represents a very low share of calls in all analysed countries.

3.2.3 LOCATION PRECISION IMPROVEMENT FOR EACH SCENARIO

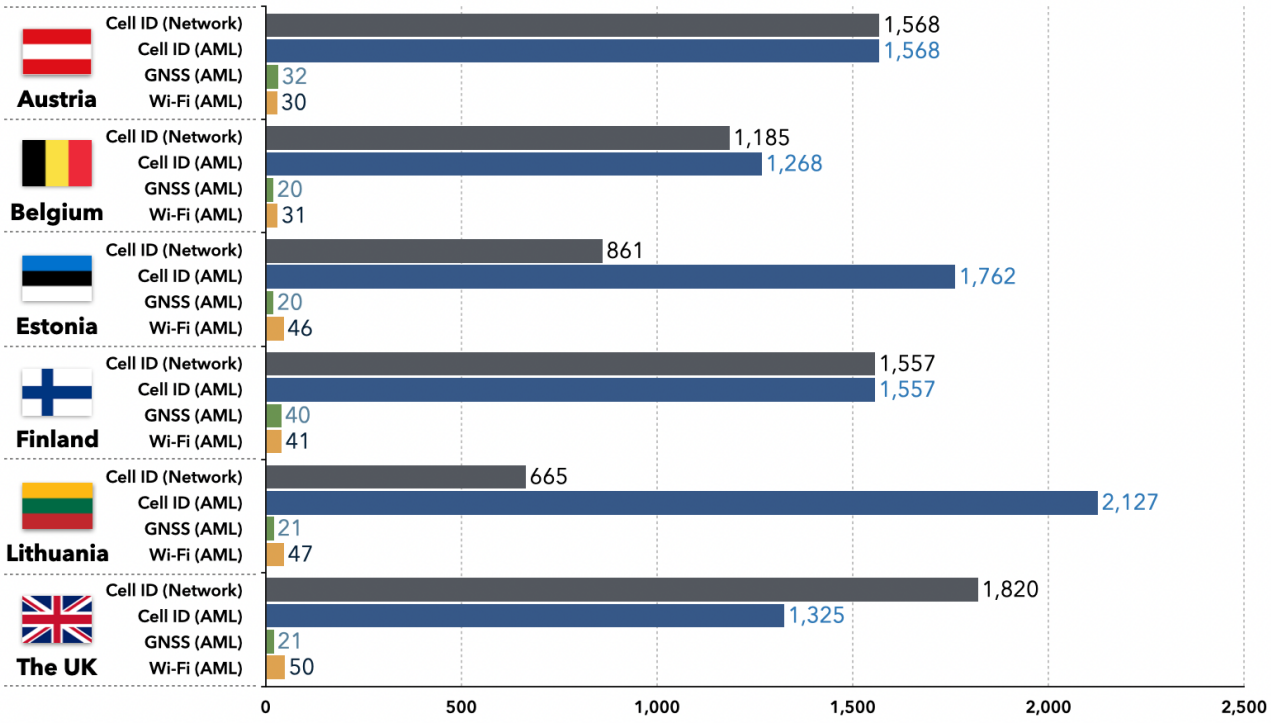
Following the same process used to obtain the distribution of the predominant AML location technology, we calculated the average radius of each predominant location technology. Then, we compared AML's performance with the base case scenario in each country, i.e. either network Cell ID or improved Cell ID as described in section 0.

As shown in Figure 20, **GNSS and Wi-Fi bring a considerable improvement to network-based location in all countries. On average, the GNSS and Wi-Fi radiuses are 56x and 35x more precise than the network-derived radius**.

[34] *Deliverable D4.3 UK Pilot Help112 phase I*

[35] https://gs.statcounter.com/vendor-market-share/mobile/united-kingdom/#monthly-201601-202002

Figure 20 - Average radius by predominant location technology (metres)



Source: PTOLEMUS

As mentioned in section 0, Estonia and Lithuania have implemented enhanced Cell ID. They have a significantly more precise network radius compared to countries that did not upgrade their Cell D system. Still, AML offers much more precise radiuses in all cases (31x GNSS, 14x Wi-Fi).

Moreover, it is interesting to note that Austria is the only country where the average Wi-Fi radius is more precise than GNSS. When the transmission method is HTTPS, Wi-Fi is the primary source of location information (74% of the times) with an average radius of 24 metres, compared to 28 metres for GNSS. On the other hand, when the transmission method is SMS, Wi-Fi is still the primary source (53% of the times), but the precision is 42 metres compared to 39 metres for GNSS.

Overall, we can expect that the bigger the improvement of the AML radius is vs. the network-derived radius, the higher will be the benefit per addressable call. Indeed, the smaller the radius, the easiest it will be for the emergency services to locate the caller.

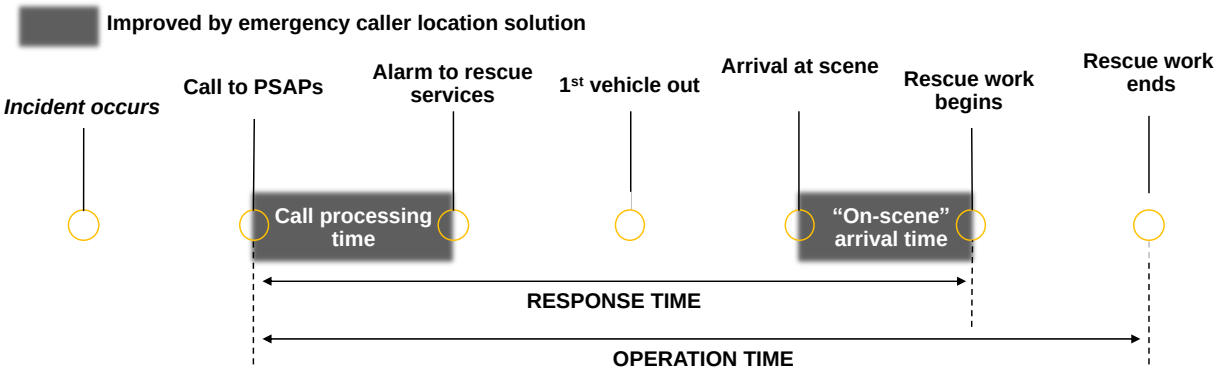
3.3 ASSESSMENT OF THE TIME SAVED DUE TO A MORE PRECISE CALLER LOCATION

To determine the time saved per addressable call thanks to a more precise caller location, we analysed the impact of AML in the emergency call chain of events. For each step, we determined the degree of its impact, if any, and the resulting benefits per addressable call.

3.3.1 RESPONSE TIME SAVED

Our analysis of the emergency call chain of events enabled us to identify the **2 steps that will benefit from improved emergency caller solutions**: **the time to process the call** ("call processing time" in Figure 21) **and the time to arrive at the scene of the event** ("On-scene arrival time" in Figure 21)**.**

Figure 21 - The emergency call chain of events



Source: PTOLEMUS based on Swedish Rescue Services Agency

Our reasoning is explained below for each step:

- **Call processing time**

An improved emergency caller location solution is likely to impact the call processing time by **reducing the time needed to identify the caller's location**, especially when the caller is a foreigner, is lost or cannot talk due to his current health condition or others.

We assumed that the benefits in call processing time are considered for 100% of addressable calls since we have learnt from PSAPs call takers that the AML location has always a significant impact on the level of stress on both the caller and call taker and consequently reduces the processing time (as we will further describe in section 0).

- **Mobilisation time**

The mobilisation time is the time taken for the allocated resource to prepare and depart the base, and begins when the notification to mobilise is sent by the emergency dispatcher[37].

We assumed that emergency caller location solutions would not bring a meaningful reduction in the mobilisation time.

- **Driving time**

In the context of the HELP112 project, we defined driving time as the time between the moment the first emergency vehicle is out and the time they arrive at the centre of the location received from the automated caller location solution.

We conservatively assumed that emergency caller location solutions would not bring significant benefits in the driving time. Indeed, it is as likely that an optimal positioning solution would send the ambulance to a closer location than a more remote one.

- **"On-scene" arrival time**

The "on-scene" arrival time is the time taken for the emergency workforce to move from the centre of the location received from the automated caller location solution to the actual location of the emergency. This time interval can be null if the location received is fully accurate or be very lengthy otherwise (for instance in the case when a 5 km Cell ID location range is received).

Thus, **improving the location precision significantly reduces the "on-scene" arrival time.**

- **Emergency intervention**

The emergency intervention starts at the moment when the emergency workforce has reached the actual location of the emergency. The intervention ends as soon as the rescue work ends.

[37] *EENA Operations document, "Assessing meaningful response time", 21-07-2014*

The intervention time only depends on the rescue work and not on the location precision.

Once defined the steps of the emergency call chain of events benefiting from an improved caller location solution, we have developed two equations to determine the relationship between precision of the caller location and the response time.

Based on the information obtained from PSAPs, we have detected that the relationship between the precision of the caller location and additional **call processing time follows a linear equation**[31]. On the other hand, the relationship between the location precision and **the "on-scene" arrival time follows an exponential equation**[38].

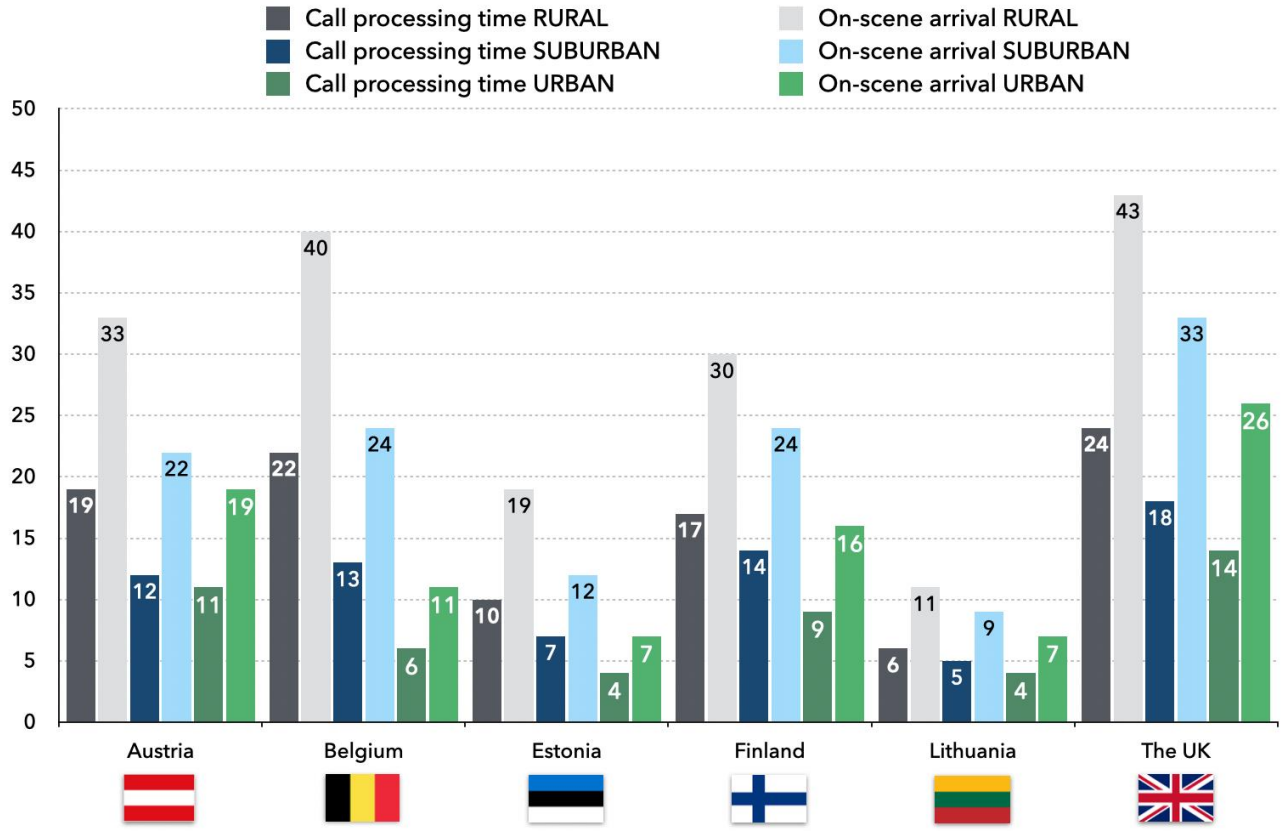
3.3.2 AVERAGE TIME SAVED PER ADDRESSABLE CALL

Thanks to the above-described analysis, we determined the average time saved per addressable call per country in each of the 3 environments (urban, suburban and rural).

Our main findings are that:

- **Calls placed in rural areas are the ones that benefit the most from AML;**
- **Countries that deployed an improved Cell ID solution, such as Estonia and Lithuania, have a lower time benefit (from AML) per addressable call;**
- Thanks to AML, for a call placed in a rural area in the UK, on average, 67 seconds will be saved in the response time (24 in the call processing and 43 in on-scene arrival).

Figure 22 - Average time saved per addressable call (seconds)



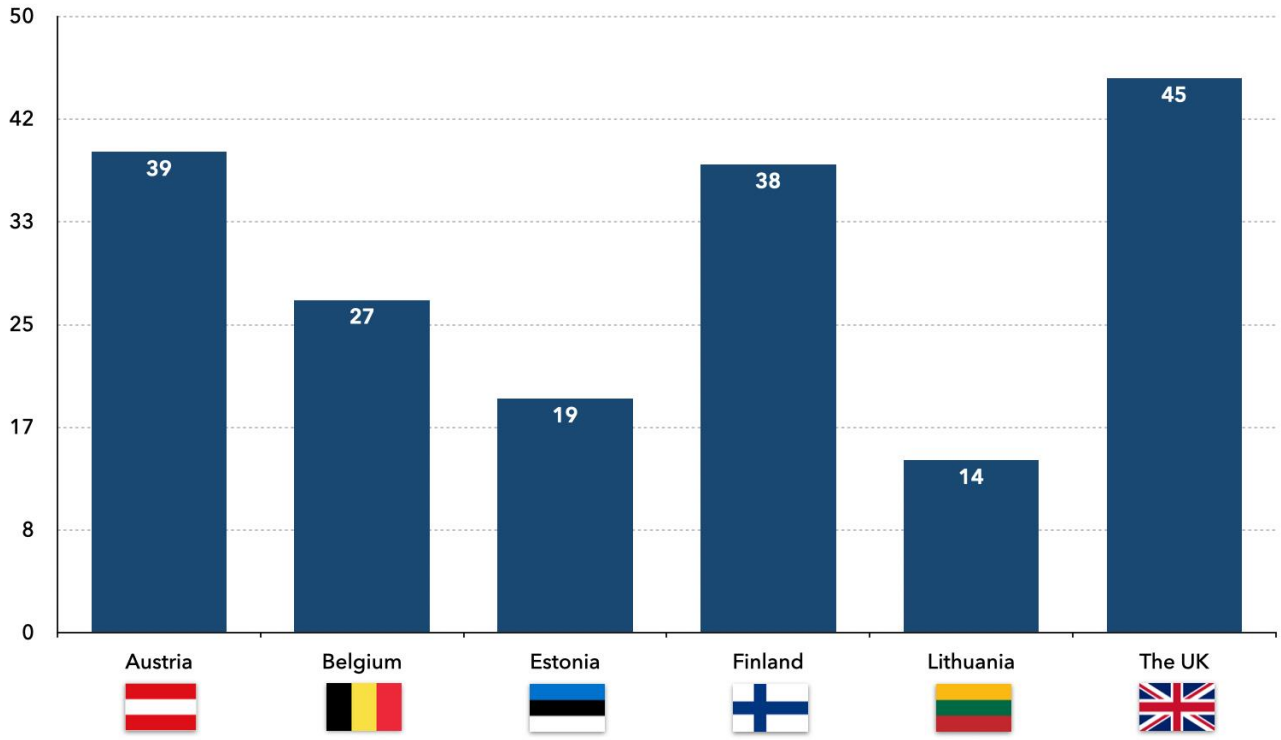
[38] *For additional information we refer to sections 2.3.3.1 and 2.3.3.2 of the Deliverables D4.1 of Help112 phase II and the Appendix 4)*

Source: PTOLEMUS

To compare more easily the average time saved per addressable call between the countries, we have multiplied the time saved showed in Figure 22 by the distribution of the calls shown in Figure 18. Thus, we have obtained a weighted average of the time saved per addressable call in each country.

From Figure 23, we can appreciate that timewise the UK is the country that benefits the most from AML per addressable call. Lithuania is the country that obtains the least benefits.

Figure 23 - Average time saved per addressable call (seconds)



Source: PTOLEMUS

3.4 ESTIMATION OF THE VALUE OF A MINUTE SAVED IN RESPONSE TIME

To estimate the value of time saved in an emergency event, we relied on a research conducted by the Swedish Rescue Services Agency[39]. The purposes of this research were to:

- determine the effect of the response and rescue time factor in the operations of the fire and rescue services in Sweden;
- determine the monetary value of this time factor;
- present results useful for a cost-benefit analysis.

The study evaluated the impacts of time reduction during the operations of fire & rescue teams for different types of emergency events (i.e. fire in building, drowning, landslide). It did so by identifying how deaths, injuries and property damages were reduced thanks to a faster intervention. The analysis estimated the economic value of a life saved, of an injury reduction and property damage

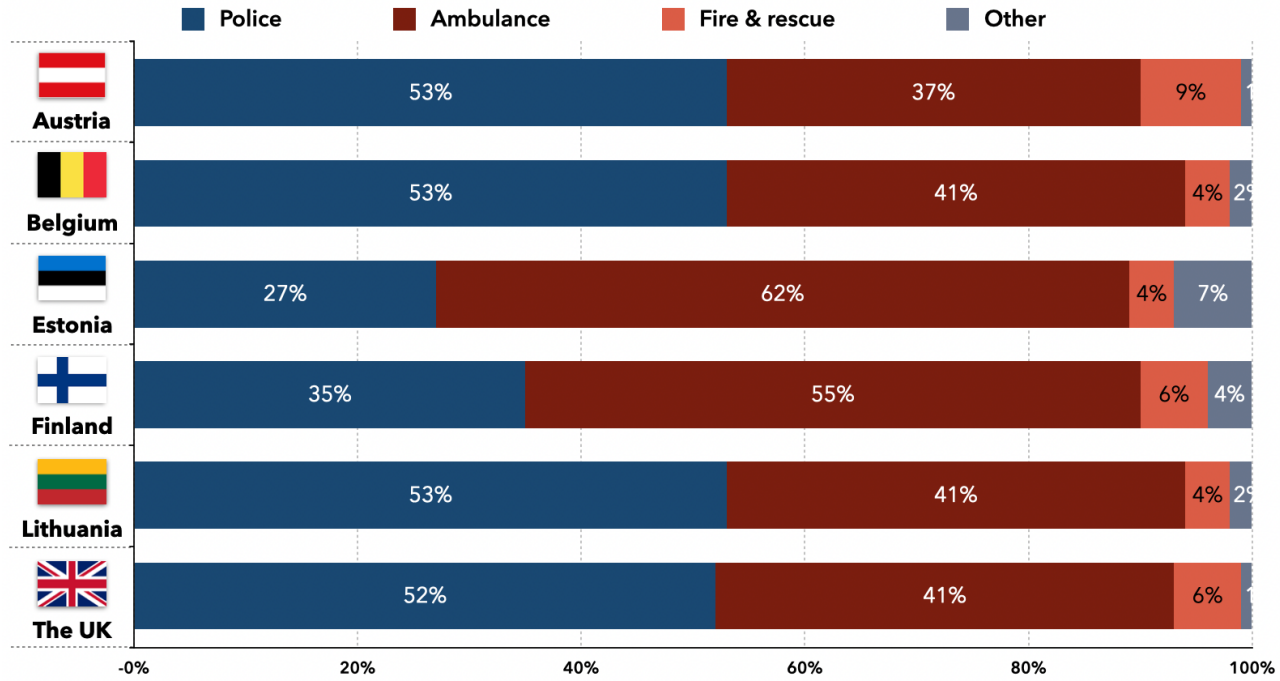
[39] *THE IMPORTANCE OF THE TIME FACTOR IN FIRE AND RESCUE SERVICE OPERATIONS IN SWEDEN, Swedish Rescue Services Agency, 2004 edition, by Henrik Jaldell*

in relation to time. Finally, it determined the value of a minute saved during fire and rescue operations.

Using data from other EU countries, we extrapolated the results of this study to estimate the time value of a minute for Ambulance and Police emergencies. We assessed the share of injuries, the share of property damage and the value of time reduction.

These estimates relied on the Swedish study's same inputs but we adapted the value of time reduction to each country's GDP per capita at Purchasing Power Parity (PPP). Finally, we took each country's frequency of emergencies based on information collected from the PSAPs as shown in Figure 24.

Figure 24 - Distribution of cases by emergency service (%)



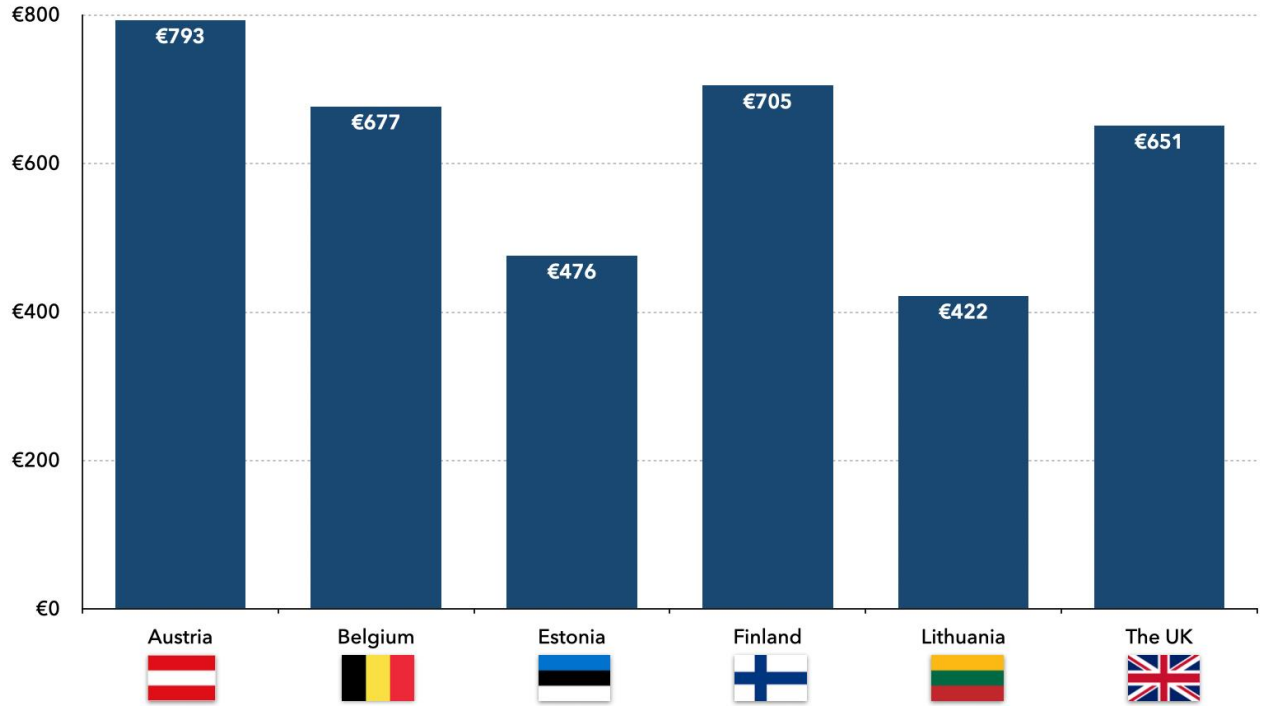
Source: PTOLEMUS based on PSAPs and EENA information

Based on the share of injuries and property damage, the value of time reduction for each type of emergency (Police, Ambulance, Fire and rescue and others) and the frequency of each emergency, we computed the time value of a minute in each country.

As a result, we estimated that **87-89% of the time value of a minute in an emergency is attributable to human-related costs.**

Figure 25 shows the time value of a minute saved in response time (at PPP) in the 6 countries.

Figure 25 - Time value of a minute saved in response time (€, PPP)

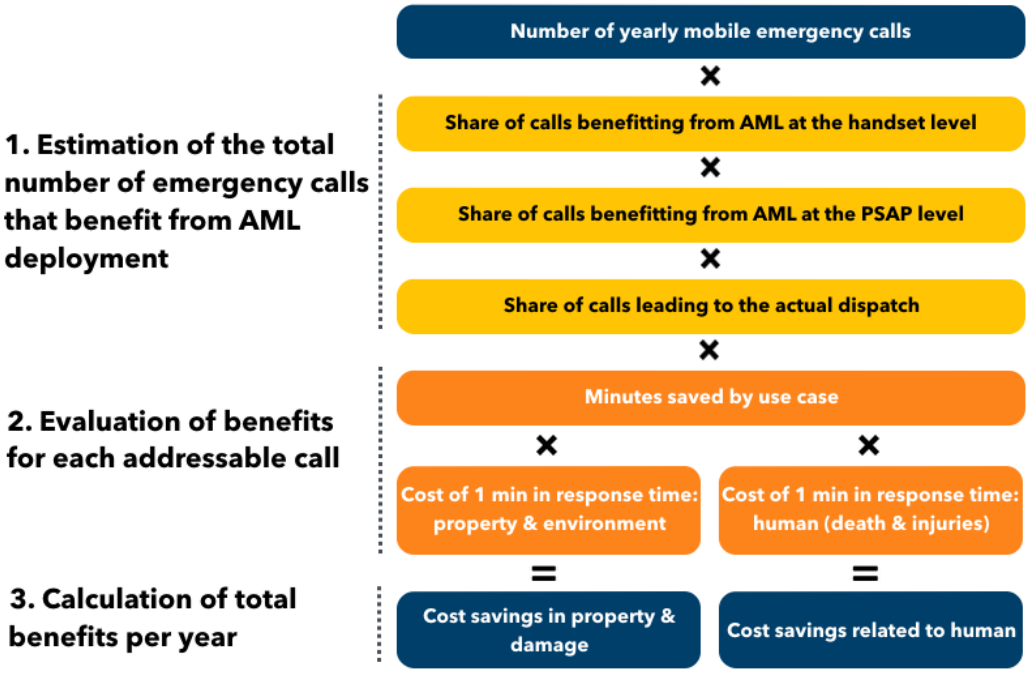


Source: PTOLEMUS

3.5 EVALUATION OF THE ECONOMIC AND SOCIAL BENEFITS

Based on the addressable calls, location improvement, time saved per addressable call and value of time saved, we estimated the economic benefits. In this section are presented the results of the economic benefits, the third step of a process shown in Figure 26.

Figure 26 - High level process to estimate AML economic impact



Source: PTOLEMUS

3.5.1 TOTAL ECONOMIC BENEFITS

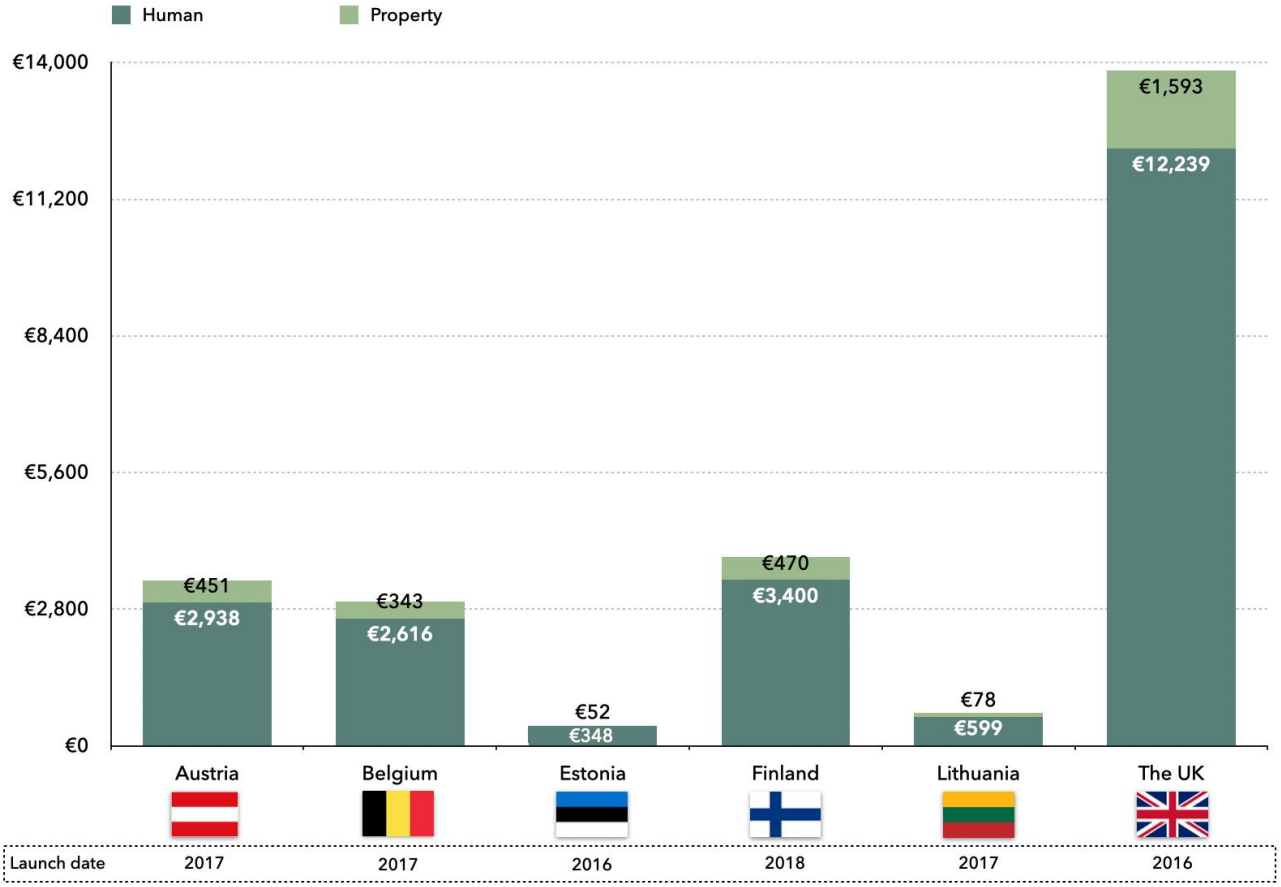
Our estimate of the economic benefits are presented in Figure 27.

As mentioned in section 3.4, almost 90% of the benefits are attributable to human-related costs saved in all countries. Either lives saved or injury seriousness reduction.

In this section, we focused our analysis and comparison between countries on the number of lives saved and reductions in injury seriousness. In section 5.1, we analysed the economic benefits at present value. In section 5.2.2., we put into perspective the economic benefits deriving from the reduction in property damages.

Figure 27 - Total economic benefits

(€ million at PPP, not Present Value, in the 9 years following the deployment of AML)



Source: PTOLEMUS

3.5.2 TOTAL LIVES SAVED

For each of the analysed countries, using the cost savings related to human lives, we obtained the number of lives saved and the level of reduction in injury seriousness based on:

- **the country-specific statistical value of a life**: we based our country-specific value of a life from the study of *Bickel et al* (2006)[40] using the recommended values of human lives at PPP.

[40] *See appendix 5)*

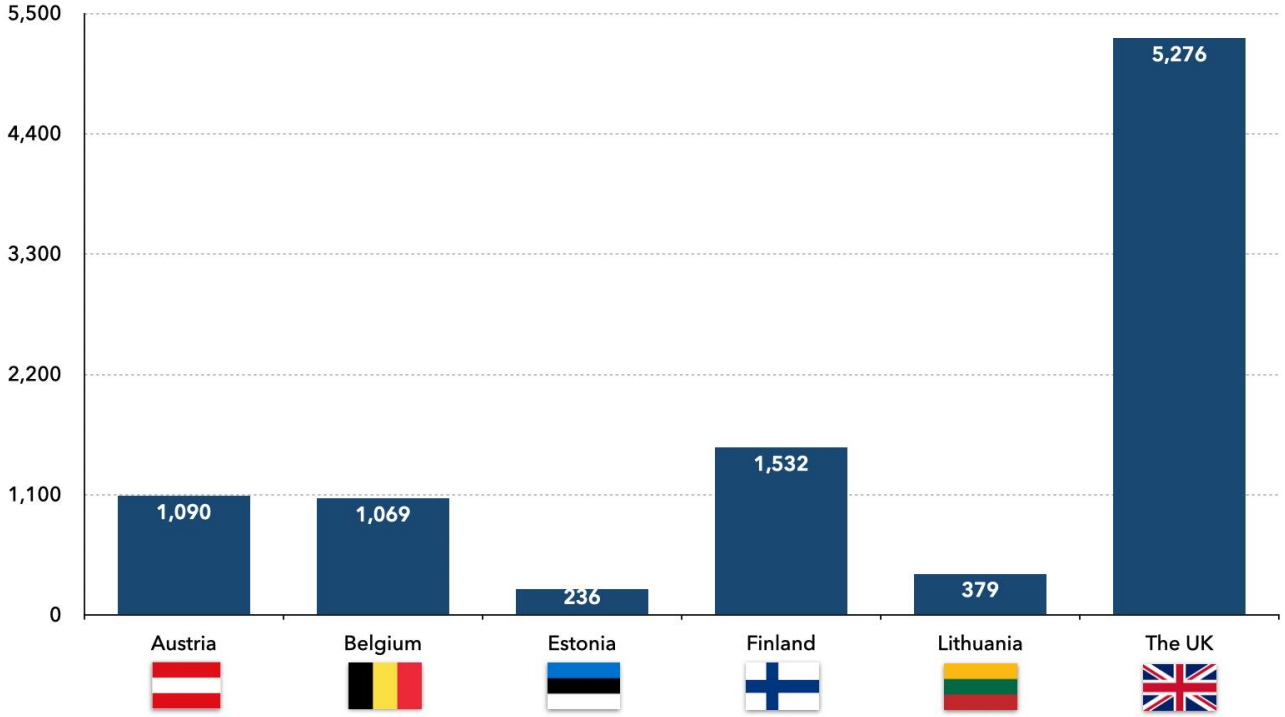
Since the study provided 2002 values, we updated them by applying the growth in the GDP per capita at PPP[41] from 2002 to the year of the AML investment in each country;

- **the ratio of lives saved to injury seriousness reduced** obtained in the eCall impact assessment. We estimated the ratio of lives saved to injuries mitigated at about 10%[42].

For example, **in the UK**, throughout the first 9 years of AML operation, **we estimated that a total of 5,276 persons will benefit from it. Either because their life will be saved, or they will suffer from diminished injuries**.

Figure 28 - Number of lives saved and injury seriousness reduced

(first 9 years after the deployment of AML)



Source: PTOLEMUS

During the 9-year timeframe, we estimated that AML will save:

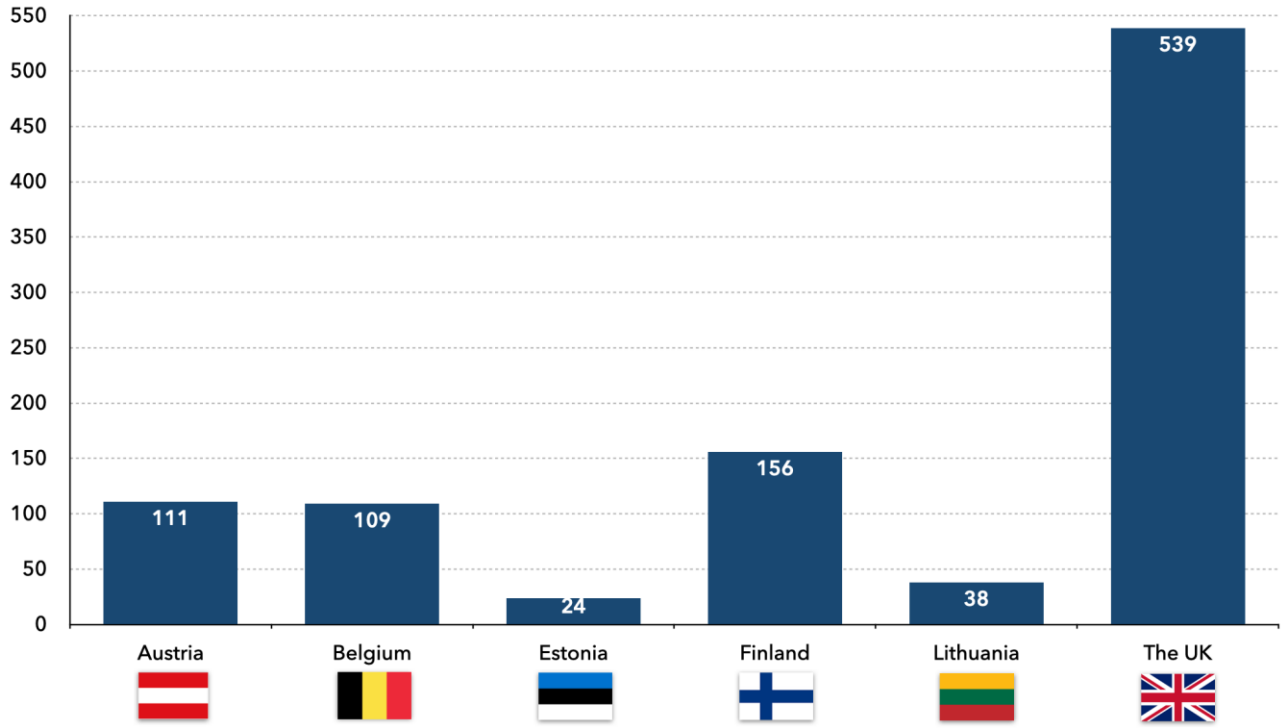
- 539 lives in the UK,
- 156 lives in Finland,
- 111 lives in Austria,
- 109 lives in Belgium,
- 38 lives in Lithuania and
- 24 lives in Estonia.

Clearly, the total values are in line with the population of each country. However, as we will see in the following sections, several factors affect the per capita benefits.

[41] *Based on World Bank data – GDP per capita, PPP – World Bank, International Comparison Program database, see appendix 6)*

[42] https://ec.europa.eu/digital-single-market/en/news/ecall-impact-assessment

Figure 29 - Number of lives saved (first 9 years after the deployment of AML)

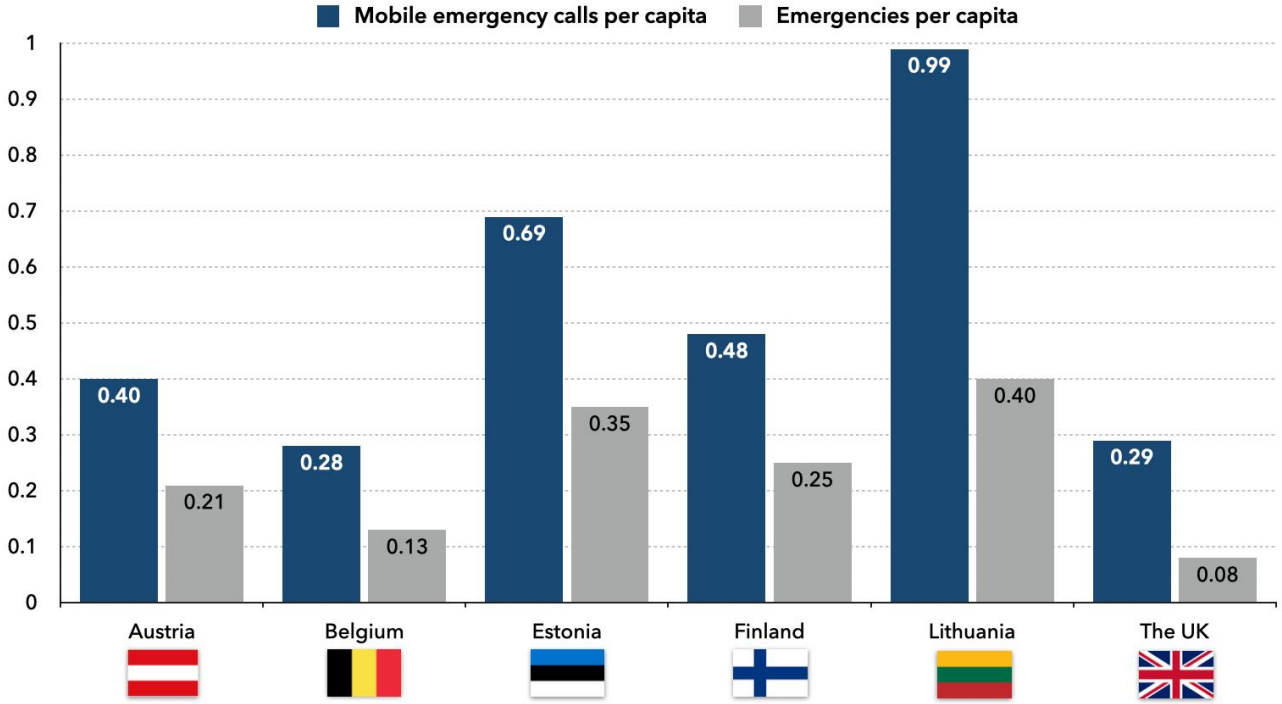


Source: PTOLEMUS

When comparing the results in terms of lives saved and reductions in injury seriousness between countries, we should be aware that the following elements play a crucial role:

- **The total number of mobile emergency calls varies quite significantly between countries, in line with their population**;
- **Not all countries have deployed AML in the same year hence the analysed timeframe is not always the same**;
- **Not all countries have deployed AML at the same pace** due to a complex PSAP structure, multiple emergency numbers to be enabled with AML or difficulties encountered in involving OS providers in the AML deployment;
- **The benefits obtained per addressable call are largely driven by the performance improvement brought by AML location vs. network location**.

Figure 30 - Mobile emergency calls and emergencies per capita (in 2017)



Source: PTOLEMUS based on EENA and Eurostat

As shown in Figure 30, the **frequency of mobile emergency calls and emergency events handled by emergency services significantly vary among countries**. Therefore, when comparing AML benefits, these differences should always be taken into account.

For example, the UK had more than 24 times more inhabitants than Lithuania but just 7 times the number of mobile emergency calls in 2017.

Moreover, given that these 6 countries did not deploy AML at the same pace, to compare the number of lives saved, we have to juxtapose:

- the number of emergency calls benefiting from AML that lead to an actual dispatch and
- the time saved per addressable call.

If we consider the **example of Belgium and Finland in 2019**:

- We computed that in Belgium 867,000 emergency calls benefiting from AML led to an actual dispatch against 1,021,000 in Finland;
- We estimated that 10 and 16 human beings were saved thanks to AML respectively;
- In Belgium, on average, AML saves 27 seconds per addressable call vs. 38 seconds in Finland, as shown in Figure 23.

We performed the following operation:

Number of lives saved in Belgium * (Calls benefiting from AML leading to dispatch in Finland/Calls benefiting from AML leading to dispatch in Belgium) * (Average time saved by AML per addressable call in Finland/Average time saved by AML per addressable call in Belgium) = Number of lives saved in Belgium adjusted to AML performance in Finland

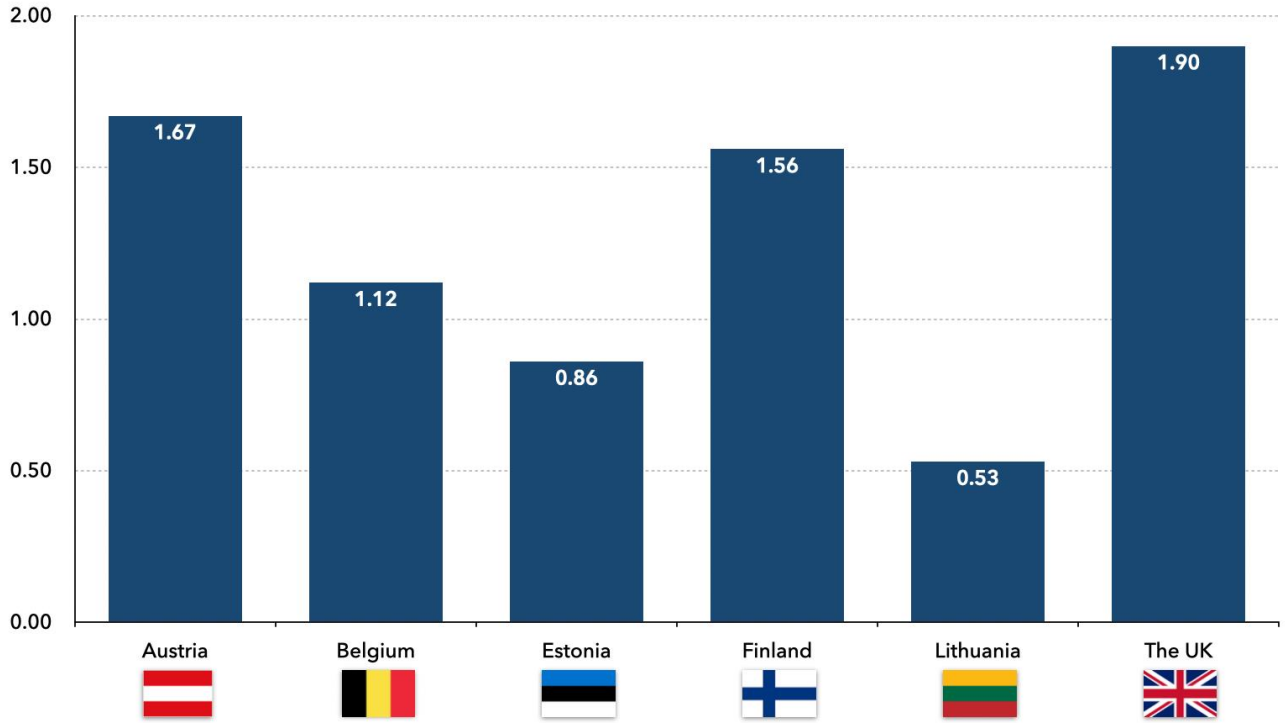
From this comparison, we learned that **Belgium obtained less benefits from AML than Finland in 2019** for the following reasons:

- Belgium had twice as much inhabitants than Finland but just 1.2 times mobile emergency calls;
- In 2019, in Belgium not all emergency numbers were AML-enabled;

- On the other hand, in Finland, 112 was the only emergency number and it was enabled with AML;
- Thus, **Belgium had a lower share of calls benefiting from AML at PSAP level** (58% vs. 74% of the total calls placed);
- Belgium had a higher share of false calls and calls not leading to dispatch than Finland, resulting in a **lower share of calls leading to dispatch that benefited from AML** (27% vs 38% of the total calls placed);
- **The time saved per addressable call by AML was lower in Belgium than in Finland because of a more precise network location** (27 seconds vs. 38 seconds saved per addressable call).

To better appreciate the benefits in terms of lives saved, we calculated the average number of lives saved for every 100,000 dispatches that benefited from AML in the analysed timeframe. We obtained the figures showed hereafter by computing the number of lives saved presented in Figure 29 and the number of emergency calls benefiting from AML that lead to a dispatch, the latter obtained starting from the total number of emergency calls[43] and by applying the findings estimated in Figure 10, Figure 11 and Figure 12.

Figure 31 - Number of lives saved per 100,000 dispatches that benefited from AML location (average during the first 9 years after deployment)



Source: PTOLEMUS

We found that **the number of lives saved per 100,000 dispatches** (that benefited from AML location**) is clearly driven by the time saved per addressable call** shown in Figure 23.

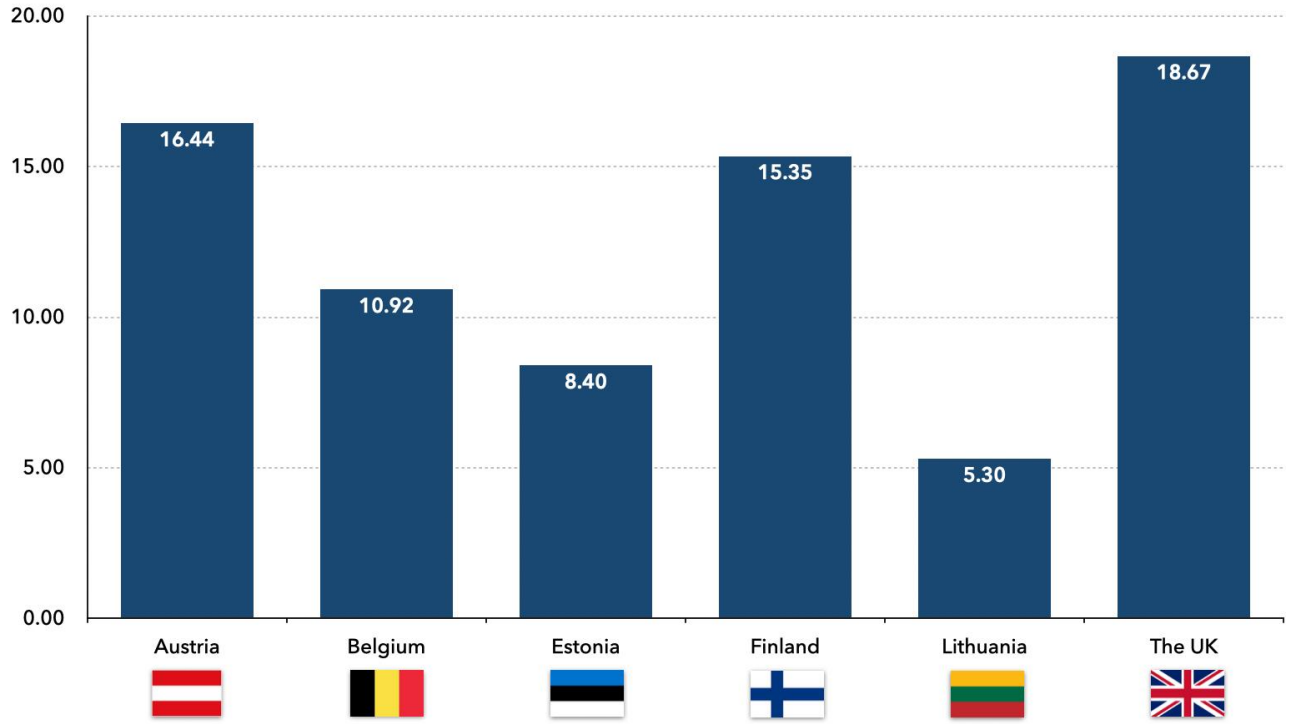
Indeed, **the UK has the highest life benefit since it is the country that saves the highest number of seconds in the response time per addressable cal**l. Lithuania ranks as the least benefiting country in terms of lives saved because the time benefit per addressable call is the lowest among the analysed Member States. In other words, **since Lithuania had the best emergencies**

[43] *For additional details on the estimated total number of mobile emergency calls we refer to Annex 3)*

location system before AML, it is the country that benefits the least from it. Nonetheless, as our analysis shows, the benefits are still very meaningful.

In Figure 32, we show the total number of lives impacted by AML (either because their life will be saved, or they will suffer from reduced injuries).

Figure 32 - Number of lives impacted per 100,000 dispatches that benefited from AML location (average during the first 9 years after deployment)



Source: PTOLEMUS

In section 5.2.1, we further analysed the human-related benefits obtained from AML.

4. OVERVIEW OF THE ESTIMATED AML COSTS

4.1 ESTIMATION OF AML COSTS IN THE ANALYSED COUNTRIES

In this section, we estimate and analyse the costs of deploying (Capex) and maintaining AML (Opex) in each analysed country. We estimate the costs incurred up to now and those expected until the last forecast year. We did not take into account the sunk costs of the existing infrastructure required for AML to operate (e.g. mobile network base stations or core networks or existing PSAP telecommunications costs).

In the cost analysis, we measured the total costs of deploying AML in each country in order to compare them against the total benefits estimated in section 3.

To estimate these deployments costs, we proceeded in 4 steps:

1) First, we identified the cost factors for all key stakeholders in the emergency process chain;
2) Then we conducted primary and secondary research to estimate the investment costs (Capex) and operational expenditures (Opex) for each stakeholder category;
3) We assumed a useful life of 10 years to amortise Capex;
4) We estimated the total costs incurred over a 10-year timeframe in all countries.

We broke costs down between the different stakeholders of the emergency call value chain. In all countries, the impacted stakeholders are:

- OS providers,
- Mobile Network Operators,
- PSAPs.

The key variables affecting the costs are as follows:

- **Number of Mobile Network Operators (MNOs):** We considered the MNOs that are supporting AML in each of the analysed countries.
- **Number of mobile phone OS providers**: According to StatCounter GlobalStats[44], the 2 leading mobile OSs (Android, iOS) represented 99% of all mobile phones in the analysed countries in 2019. As Windows Mobile and Samsung OSs have negligible market shares and currently do not support AML, we only considered Android and iOS in our analysis.
- **Costs related to SMS**: Even if they are not charged to emergency callers and the relevant emergency services, SMS have a cost for the MNOs. Based on the information exchange with relevant AML stakeholders and on information from the EC[45], we determined the cost of transmitting the location by SMS and conservatively assumed that the cost per SMS for an MNO is €0.02. In order to estimate this cost, we used the weighted average termination rates in Europe and discounted from it the average operating margin of the industry in Europe[46].
- **Discount rate**: We followed the European Commission's recommendations related to impact assessments and used a 4% discount rate for the Net Present Value (NPV).
- **Inflation rate**: We expect that the inflation rate will continue to remain small in Europe and our costs and benefits were estimated in current currency terms.

[44] https://gs.statcounter.com/os-market-share/mobile/europe/#yearly-2019-2020-bar

[45] *BEREC - Termination rates at European Level – July 2018 and for additional information we refer to the Appendix 7)*

[46] *Average operating margin for the largest telecommunication operators in Europe in 2018 (13%)*

- **Depreciation & amortisation**: We assumed a period of 10 years to amortise the investment in AML systems.

4.1.1 COST ANALYSIS PER COUNTRY

In Table 17 is shown a summary of the components of the costs incurred by AML stakeholders in the analysed countries.

Table 17 - Cost components to deploy AML per stakeholder

CAPEX OPEX

Stakeholder		Cost component	Austria	Belgium	Estonia	Finland	Lithuania	The UK
	OS providers	Help 112 Software	CAPEX OPEX	CAPEX OPEX	CAPEX OPEX	CAPEX OPEX	CAPEX OPEX	CAPEX OPEX
		Local database	OPEX	OPEX	OPEX	OPEX	OPEX	OPEX
	Mobile Network Operators	Data re-routing	CAPEX					
		SMSC programming	CAPEX	CAPEX	CAPEX	CAPEX	CAPEX	CAPEX
		SMS messages	OPEX	OPEX	OPEX	OPEX	OPEX	OPEX
		SMS gateway	OPEX	OPEX	OPEX	OPEX	OPEX	OPEX
	PSAPs	SMS platform development	CAPEX OPEX			CAPEX OPEX		
		SMS platform adjustment		CAPEX OPEX				CAPEX OPEX
		SMS app integration		CAPEX OPEX				
		Location analysis software and database					CAPEX	CAPEX OPEX
		National location server for HTTPS data	CAPEX OPEX					
		UI development			CAPEX			

Source: PTOLEMUS based on interviews of PSAPs in the 6 countries

First of all, we can notice how OS providers incurred the same cost components in all of the analysed Member States. This is because **we estimated the OS-related costs at EU level**, but the resulting cost estimate was then broken down by country using a population proxy. Currently, two smartphone Operating Systems (OS) providers enable AML: Android and iOS. Based on secondary research and an interview with the Beta80 Group, which developed the 112 app in Italy, we estimated that these OS providers collectively bear CAPEX of €300,000 and an annual OPEX of €20,000 pertinent to the 112 operation, including testing, in EU. This estimate is in in line with what Google estimated for the development of their Emergency Location Service (ELS). Approximately requiring two software engineers in 2 months working part-time.

Moreover, we can appreciate that **all MNOs incurred in the same cost components either CAPEX or OPEX** i.e. SMSC programming, SMS messages and SMS gateway **apart from Austrian MNOs**. Austria is the only analysed country where the AML location is sent either through SMS or HTTPS thus, Austrian MNOs were required to bear the cost of the data re-routing system to manage the HTTPS messages.

Additionally, it is interesting to highlight that **PSAPs were required to make different investments since the existing infrastructure and the chosen AML configuration varied quite significantly among the analysed countries.** For example, in Estonia, the SMS platform and location server were already in place thus the AML deployment only required updates to the

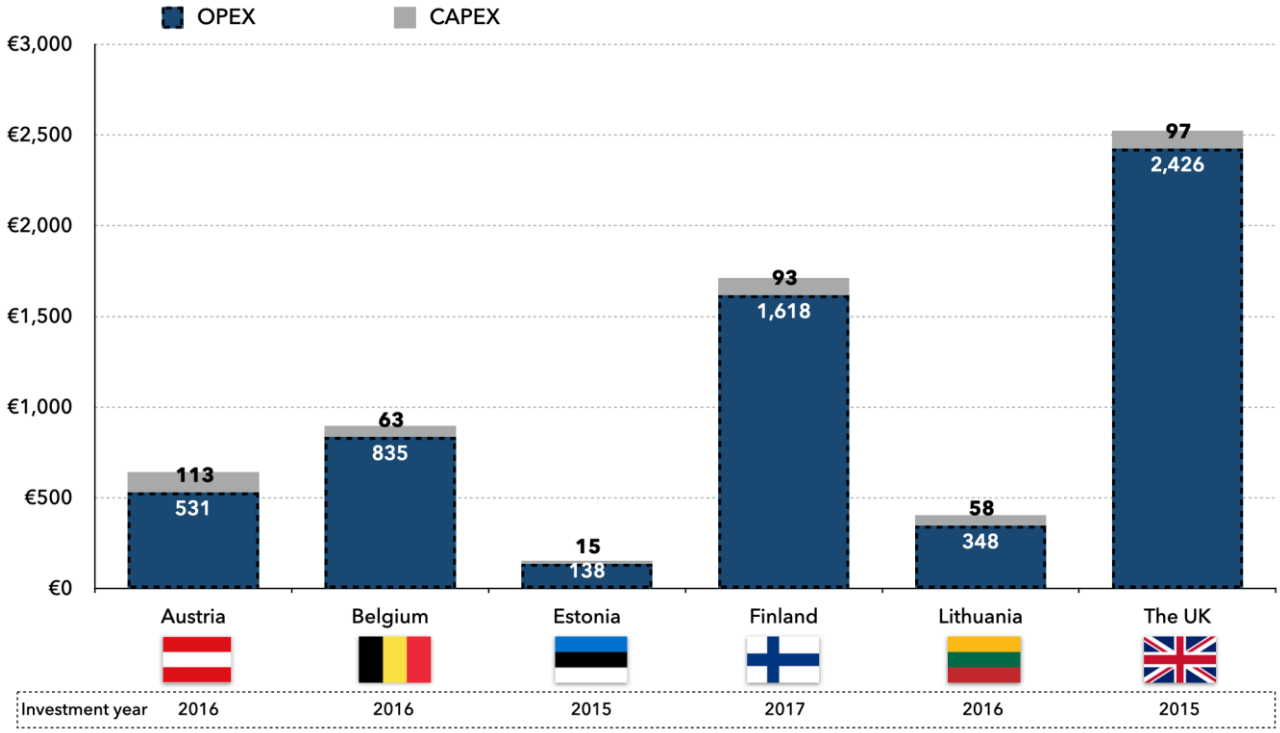
User Interface (UI) of the PSAPs IT systems. Conversely, in countries such as Austria and Finland, investments were necessary to develop the SMS platform to receive and handle the AML information.

It is worth underlining that for the purpose of this study, we considered the CAPEX and OPEX incurred by PSAPs to deploy and operate AML at Stage 1 level. Indeed, we did not consider the CAPEX and OPEX required to install and manage the IT tools, such as the Computer-Aided Dispatch system (CAD) and the Geographic Information System (GIS), necessary to leverage the AML information at Stage 2 PSAPs. We considered the implementation of IT systems at PSAP Stage 2 as separate projects.

Therefore, we did not take into account additional expenses for Austria and the UK that have some Stage 2 PSAPs still lacking the infrastructure to benefit from AML (as reported in Table 15).

As shown in Figure 33, AML estimated costs over 10 years remain reasonable in each country.

Figure 33 - Breakdown of AML-related CAPEX and OPEX (€ thousand, 10 year timeframe starting from the year of investment)



Source: PTOLEMUS based on interviews of each country's PSAPs

As a result of the different characteristics of the AML deployment, we can appreciate how the deployment in Estonia required minimal investments while in Austria more onerous expenses were incurred by national AML stakeholders. In OPEX terms, the UK obtained the highest expense due to the highest number of AML SMS received by PSAPs.

Overall, neither of the analysed countries was required to perform very large investments or to cover significant operational costs, in particular in light of the benefits brought by AML described in section 3.

In the next section, we deeply analysed the costs per stakeholder per country.

4.1.2 COST ANALYSIS BY STAKEHOLDER

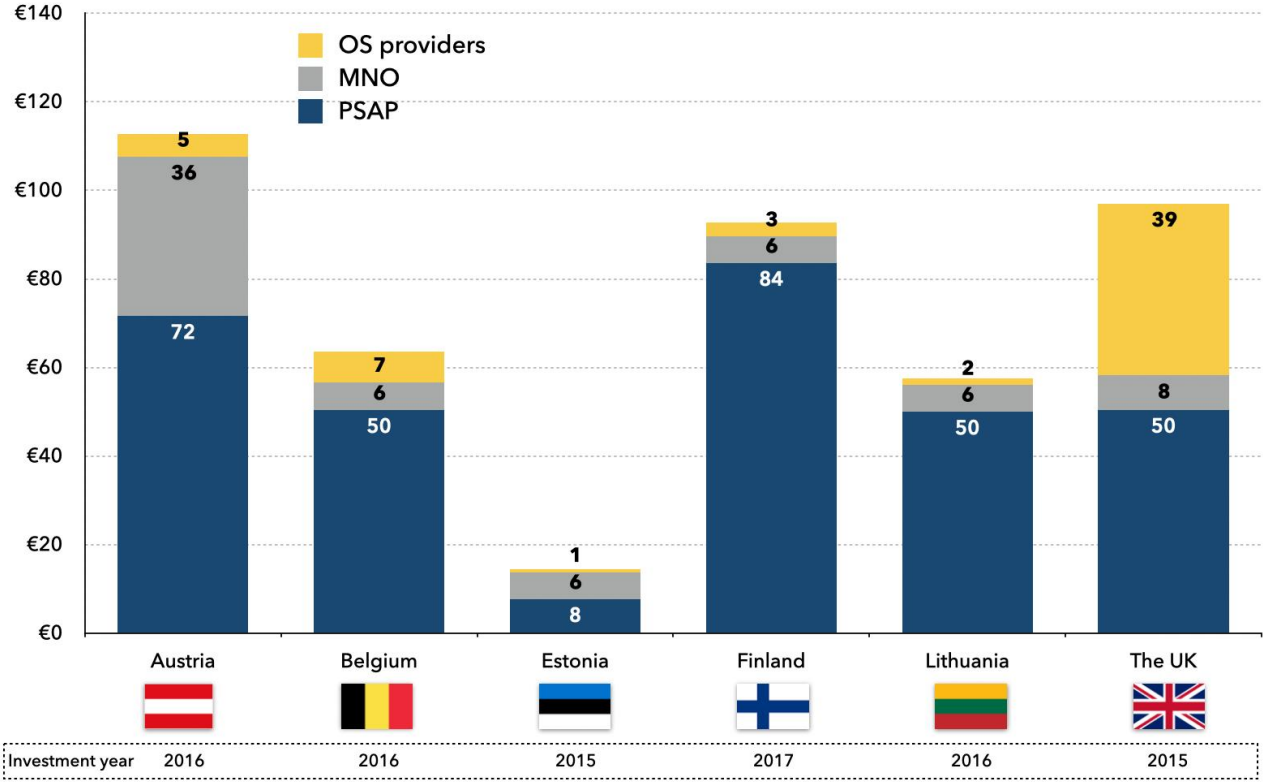
In this section, we analysed the estimated expenses incurred by the 3 categories of AML stakeholders in each of the 6 countries.

We obtained a number of key insights:

- In all countries, **PSAPs have the largest investment to deploy AML**;
- Finnish PSAPs incurred the biggest investment due to the lack of a platform capable of receiving and managing SMSs;
- In Austria, the usage of HTTPS as an additional AML information transmission method resulted in a sizeable investment to develop a national location server for HTTPS data;
- **MNOs' investment was minimal in all countries apart from Austria**, where they had to invest in an AML data re-routing system due to the usage of HTTPS;
- The UK obtained the highest costs for OS providers, on our estimate of OS-related costs at EU level and the resulting cost estimate that was broken down by country using population as a proxy (as described in section 4.1.1);
- **Estonia was the country with the lowest AML-related CAPEX thanks to its already existing infrastructure** (i.e. an existing SMS platform for PSAPs).

In Figure 34 is shown the total CAPEX borne by each stakeholder category in the 6 Member States.

Figure 34 - Total CAPEX breakdown per country and stakeholder category (€ thousand)



Source: PTOLEMUS based on interviews of PSAPs in the 6 countries

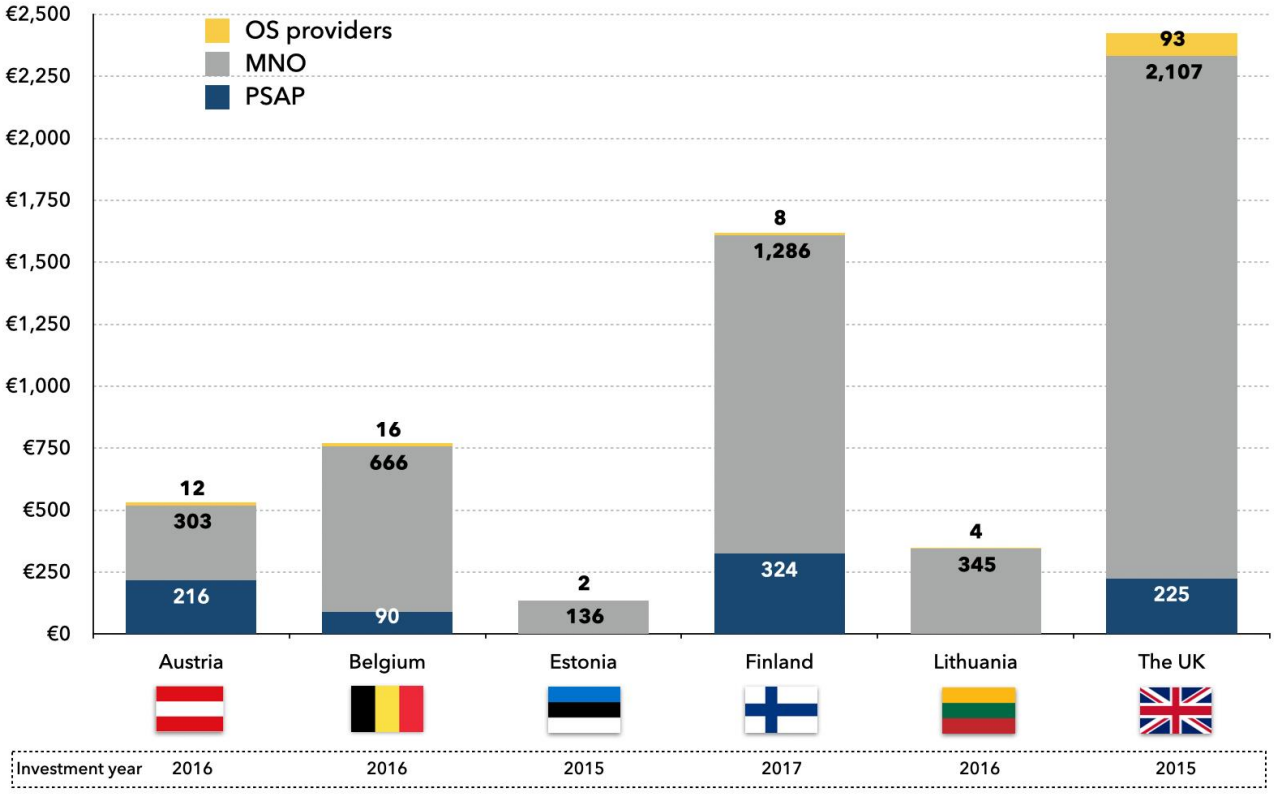
We conducted the same analysis for OPEX across the 10-year period and found that:

- In all countries, **MNOs have the highest running costs** as they assume the cost of transmitting AML SMSs;

- British MNOs in particular carry the highest cost due to the largest volume of AML SMSs, followed by Finnish MNOs which have a high number of AML messages per emergency call - as presented in Table 7;
- **The implementation of AML is not expected to require additional operational costs for PSAPs in Estonia and Lithuania since** neither additional personnel was required to run the new IT solutions nor additional maintenance was expected;
- Finnish PSAPs are expected to generate the highest OPEX due to high maintenance costs for their new AML SMS platform (€36,000 every year);
- **We expect OS providers to bear between 1% and 2% of the total operational AML costs** during the analysed period.

The details of OPEX assumed by each stakeholder category is shown in the next chart.

Figure 35 - Total OPEX breakdown per country and stakeholder category in 10 years from the date of investment (€ thousand)



Source: PTOLEMUS based on interviews of PSAPs in the 6 countries

5. RESULTS OF THE COST-BENEFIT ANALYSIS AND OPERATIONAL IMPACT OF AML

5.1 NET PRESENT VALUE PER COUNTRY

Using the European Commission's recommended 4% discount rate, we estimated the **Net Present Value** (NPV) **of the AML deployment**. As mentioned beforehand, in each country, we started counting costs from the year of the initial investment made by AML stakeholders.

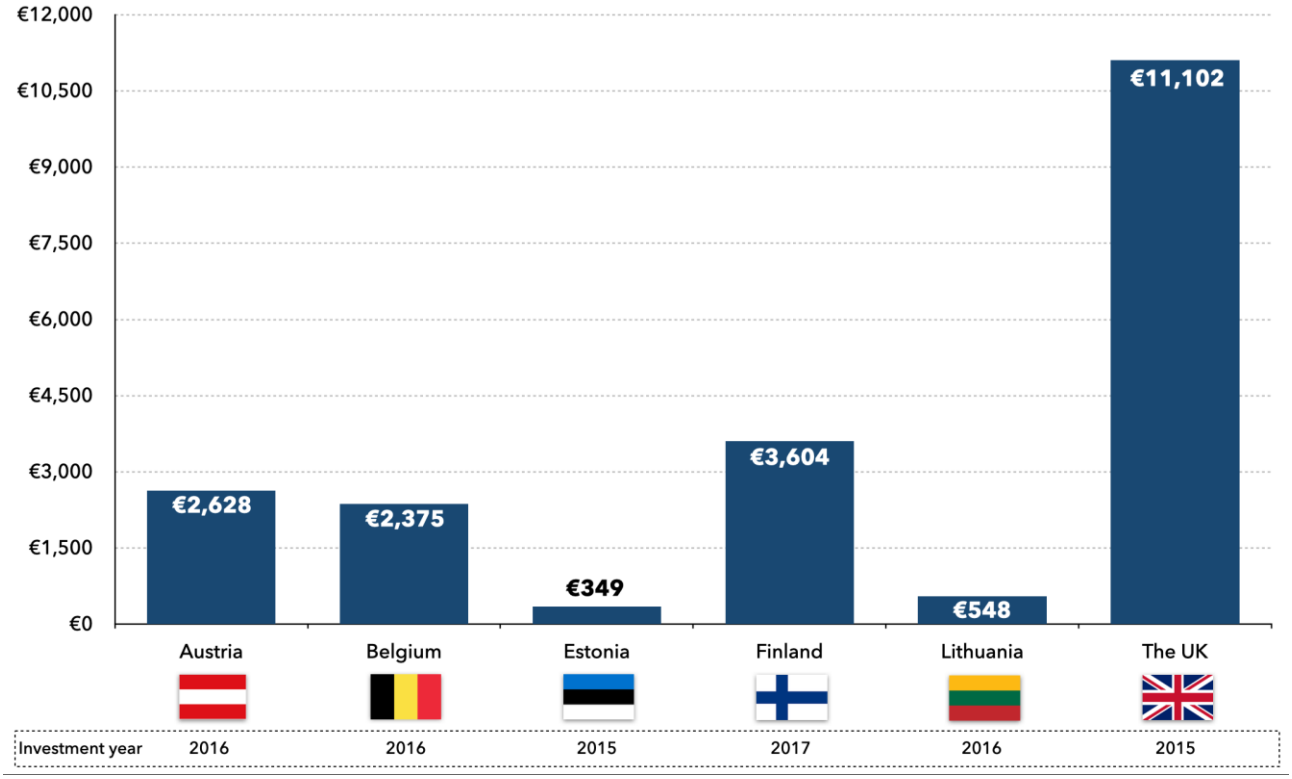
We expect the benefits generated to significantly outweigh the investments and operational costs for 2 main reasons.

1. When we analyse the benefits, we refer to **social benefits**, i.e. lives saved as well as the reduction in injuries and property damage. While they are real, tangible and significant, contrarily to the costs, they are not directly reflected in the cash flow statements of AML stakeholders. Yet, they bring benefits at the national level.
2. **The costs generated by the deployment of AML remain low because AML technology leverages existing systems** (i.e. smartphones, cellular networks, GNSS constellations, Wi-Fi and fixed broadband connections) **and requires minimal spending** (i.e. the Lower Austria PSAP successfully developed the SMS and HTTPs platform to receive AML derived locations in house). By comparison, the implementation of eCall also included the cost of the line-fitment of a black box with connectivity in each car.

Figure 36 below details the NPV obtained in each country.

Figure 36 - NPV per country

(€ million, first 9 years after the AML deployment)



Source: PTOLEMUS

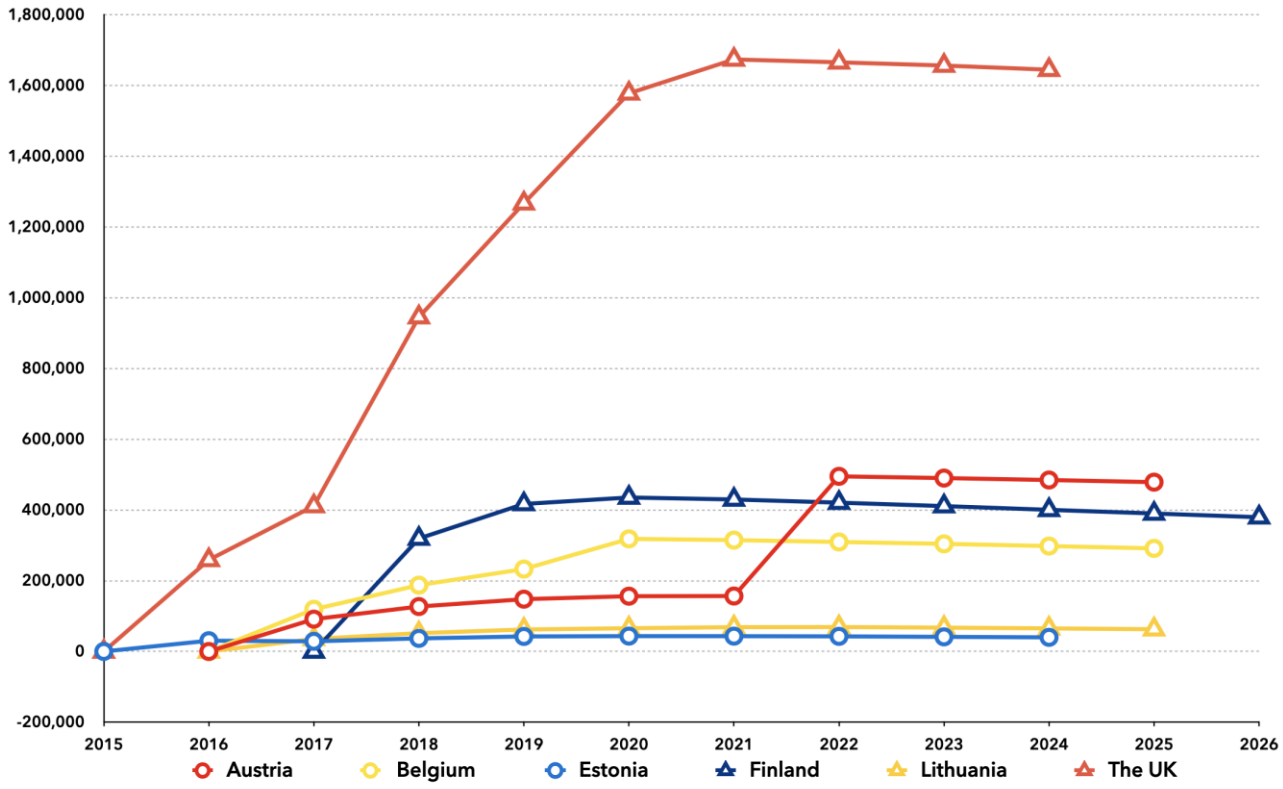
As already mentioned for Figure 29, when analysing figures between countries, we need to take into account that:

- **The number of mobile emergency calls varies quite significantly between countries and is in line with the country's population**;
- **Not all countries have deployed AML in the same year hence the analysed timeframe is not always the same**;
- **Not all countries have deployed AML at the same pace** i.e. due to a complex PSAP structure, numerous emergency numbers to be enabled with AML or difficulties encountered in involving OS providers in the AML deployment;
- **The benefits per addressable call depend on the performance improvement of AML location vs. network-based location**.

As is usual when comparing NPVs, **due to the time value of money, the impact of the pace in the deployment plays a key role in the total NPV. In other words, the faster the deployment, the higher the NPV.**

We analysed the growth of the yearly net benefits generated in each country to understand the pace in the deployment of AML. Figure 37 shows the AML net benefits discounted each year, starting from the initial investment year in each of the analysed countries.

Figure 37 - Discounted net benefits from AML per year per country (€ thousand)



Source: PTOLEMUS

The net benefits are directly driven by the number of calls benefiting from AML that lead to a dispatch of emergency squads.

Therefore, we can recognise several valuable inputs:

- The UK is expected to have the fastest rise in benefits, exhibiting a CAGR of 26% (31% with non-discounted values) mainly attributable to the growth in the AML coverage of emergency dispatch centres (stage 2 PSAPs);

- Finland's 2% CAGR is the lowest (6% with non-discounted values) due to a fast deployment that from the first year of implementation benefited from AML for more than 50% of the mobile emergency calls at PSAP level;
- In Austria, we predicted a dramatic growth in benefits in 2022 due to the enablement of iOS smartphones and the emergency number 112 with AML;
- In all countries, for the last analysed years, the growth of net benefits is less than the time value of money, i.e. from 2021 to 2024 in the UK, from 2020 to 2025 in Belgium;
- **In all countries, the effect of Apple's iOS starting to support AML on its smartphones is substantial**; In the UK in particular, the benefits "jump" from 2017 to 2018 because iOS represents approximately 50% of the country's smartphone market[47].

5.2 PUTTING THE RESULTS INTO PERSPECTIVE

5.2.1 NUMBER OF LIVES SAVED AND NUMBER OF LIVES IMPACTED BY AML FOR EVERY 100,000 MOBILE EMERGENCY CALLS IN THE ANALYSED COUNTRIES

In section 3.5.2, we analysed the statistics on the estimated lives saved and injuries seriousness reduced. In this section, to put the results into perspective, we presented the number of lives saved and lives impacted (either lives saved, or injuries seriousness reduced) thanks to AML for every 100,000 mobile emergency calls.

To take into account the different timeline of the AML deployment in the 6 countries, we considered the common 2018-2024 period to compare benefits for all countries. We obtained the figures presented hereafter by computing the number of lives saved and reduced injuries presented in Figure 28 and Figure 29 and the estimated total number of mobile emergency calls in each country[48]. Thus, **we estimated that on average, thanks to AML, 0.37 life will be saved for 100,000 mobile emergency calls placed**. **Further, we estimated that on average, 3.69 lives will be impacted by AML every 100,000 mobile emergency calls made.**

We forecast that in 2024, in the 6 analysed countries:

- AML will be deployed for all the available emergency numbers and for roaming calls;
- All PSAPs will have the IT infrastructure to leverage AML;
- Almost 90% of the mobile emergency calls will benefit from AML at handset level;

The average number of lives saved for every 100,000 mobile emergency calls placed is expected to grow to 0.45, while the average number of lives impacted by AML for every 100,000 mobile emergency calls is expected to reach 4.37.

5.2.2 NUMBER OF LIVES SAVED AND NUMBER OF LIVES IMPACTED IN AN EU-WIDE AML DEPLOYMENT SCENARIO

To estimate the potential benefits generated from an EU-wide deployment of AML, we analysed:

- The number of total emergency calls placed in the EU and
- The share of mobile emergency calls reported by the COCOM reports published in 2018, 2019 and 2020.

Using COCOM data and interviews of the PSAPs in the analysed countries, we found that:

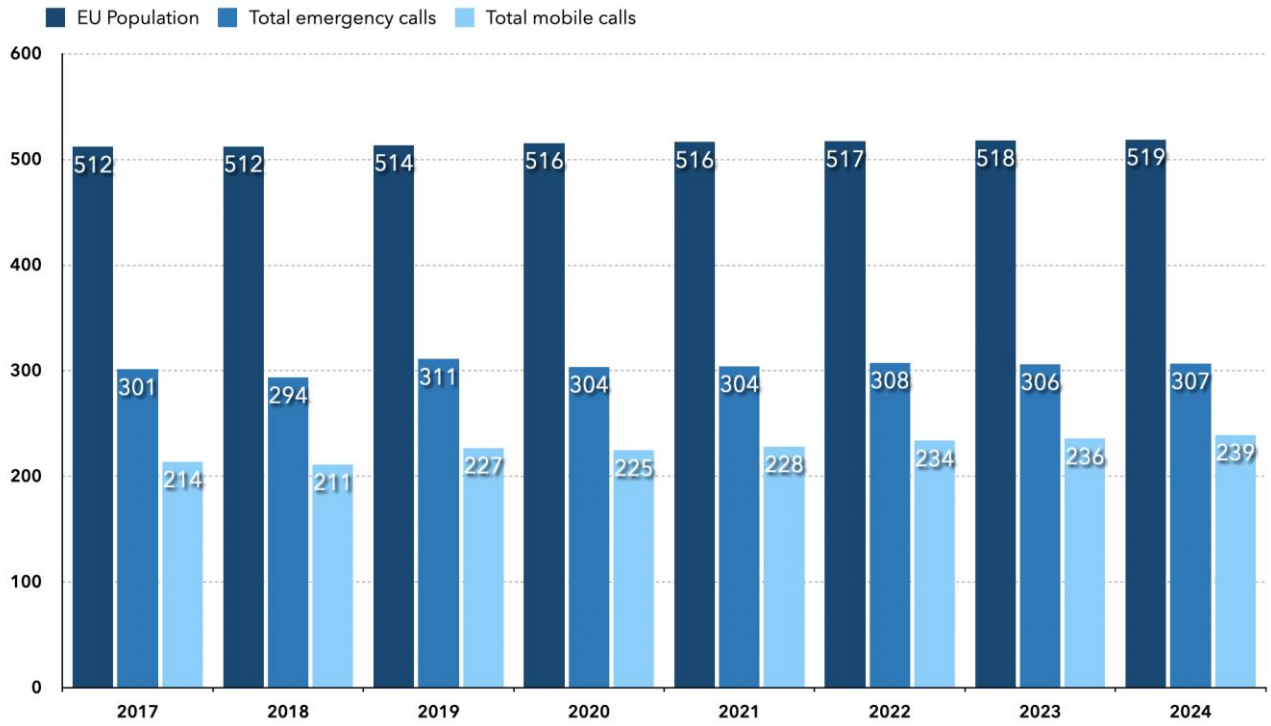
[47] https://gs.statcounter.com/vendor-market-share/mobile/united-kingdom/#monthly-201706-201912

[48] *For additional details on the estimates of the total number of mobile emergency calls we refer to Annex 3)*

- The number of emergency calls highly correlates to the total population;
- The number of emergency calls per capita has been relatively stable between 2017 and 2019;
- At EU level, the share of mobile emergency calls in all emergency calls rose by 1% per annum.

Therefore, we obtained the following forecast:

Figure 38 - Emergency call volume forecasts in the EU (million, 2017-2024 period)



Source: PTOLEMUS based on Eurostat (EU Open Data Portal) and COCOM Implementation of the single European emergency number 112 reports 2017, 2018, 2019

Assuming that the results obtained for the 6 countries are representative of an EU-wide AML deployment, we estimated the potential benefits by 2024[50] in terms of lives impacted[51].

We did so under two different scenarios:

- **Scenario 1 (*Same adoption rate)*:**
  - All the Member States that still have to deploy AML, follow a similar implementation to that followed by the 6 analysed countries,
  - They reach in 2024 an **average number of lives saved, for every 100,000 mobile emergency calls, of 0.37 and an average number of impacted lives, for every 100,000 mobile emergency calls of 3.69** as was the case of the analysed countries in 2019;
- **Scenario 2 (*Faster adoption)*:**
  - Leveraging the experience and best practices shared by the countries that have already implemented AML as well as the findings of the HELP112 projects, the other

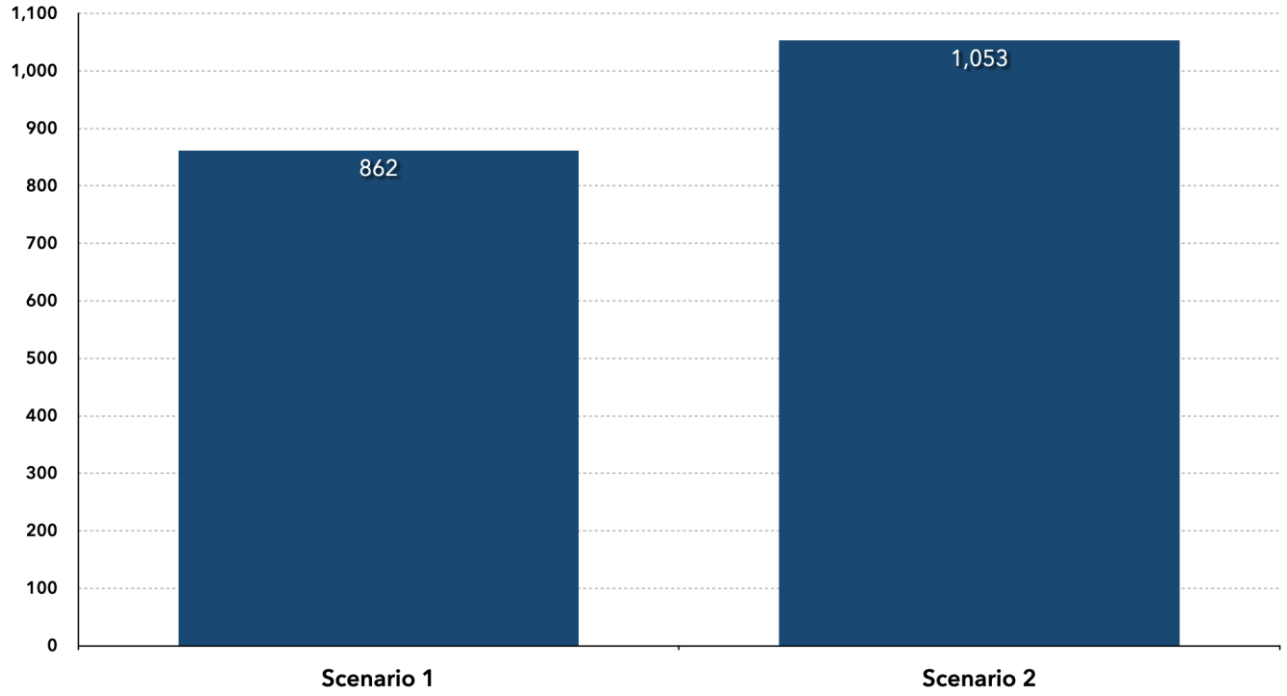
[50] *2024 is a good benchmarking year since we expect to see similar or better benefits to those we have today, assuming that all countries without AML start deploying it in the next 2 years*

[51] *Lives saved and injury seriousness mitigated*

Member States deploy the handset-derived location technology faster than the 6 analysed countries and reach the same performance faster, in 2024;

- **The average number of lives saved for every 100,000 mobile emergency calls is 0.45 and the average number of lives impacted every 100,000 mobile emergency calls is 4.37.**

Figure 39 - Estimated number of lives saved thanks to AML in the EU in 2024



Source: PTOLEMUS

Therefore, with scenario 1 (*Same adoption rate),* 862 lives will be saved each year at EU level. To be compared with 1,053 lives in scenario 2 (*Faster adoption)*.

Moreover, considering a 10-year perspective, from 2024 until 2033, AML could potentially save between 8,620 and 10,530 lives in total in the EU.

Similarly, as a result of the assumptions above, with scenario 1 (*Same adoption rate)*, an estimated 8,836 lives will be impacted each year at EU level. And 10,464 in scenario 2 (*Faster adoption rate)*. Moreover, considering a 10-year perspective from 2024 until 2033, AML could positively impact in between 88,360 and 104,640 lives in total in the EU.

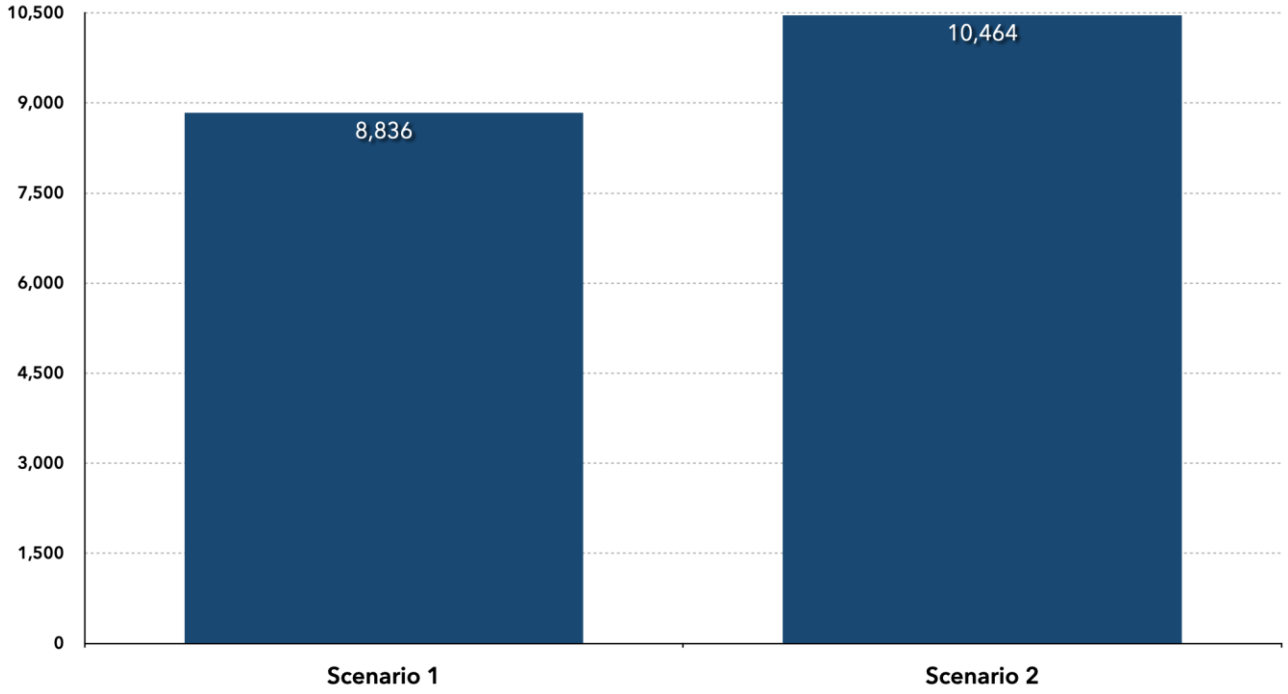
If we assume that roaming calls at EU level:

1. Represent between 1% and 5% of the total emergency calls (rates observed in the analysed countries), and
2. Follow the same distribution assumed in our 2 scenarios (*Same adoption rate and Faster adoption*)

If all EU Member States implement AML for emergency roaming calls, in 2024:

- Between 88 and 442 will be impacted under the assumptions of scenario 1 *(Same adoption rate)*
- Between 105 and 523 will be impacted under the assumptions of scenario 2 *(Faster adoption)*

Figure 40 - Number of lives impacted in the EU in 2024



Source: PTOLEMUS

5.2.3 THE CASE OF FINLAND

To put into perspective the impact of AML, we selected the outputs of the analysis performed for Finland. We believe that the Finnish AML deployment is one of the most interesting in terms of the speed of implementation, efficiency and benefits obtained.

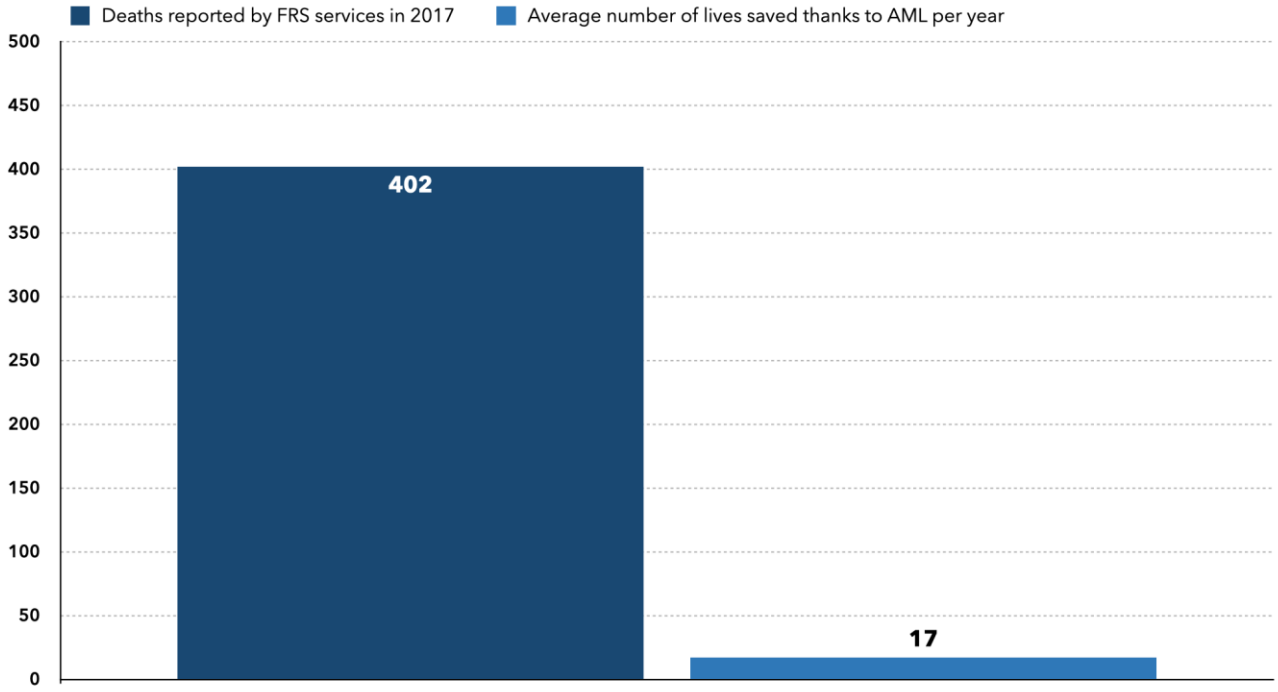
Moreover, the Finnish Rescue Services (FRS) published a detailed analysis[52] based on the data registered during their operations from 2013 to 2017.

Before comparing the FRS figures with the estimated AML benefits we found, it is important to note that:

- In section 5.2.3, we have identified that "only" 2 steps of the emergency chain of events will benefit from improved emergency caller solutions: the time to process the call and the time to arrive at the scene of the event;
- Not all the deaths, injuries and property damages reported during emergency events can be saved/reduced thanks to a faster emergency services intervention;
- The figures reported by the FRS do not include statistics of deaths related to emergency events that required Police and Medical Services intervention;
- The figures reported by the FRS include deaths and injuries occurred during building fires, wildfires, vehicle fires, other fires, traffic accidents and human rescue activities (i.e. water rescue, rescue from shaft).

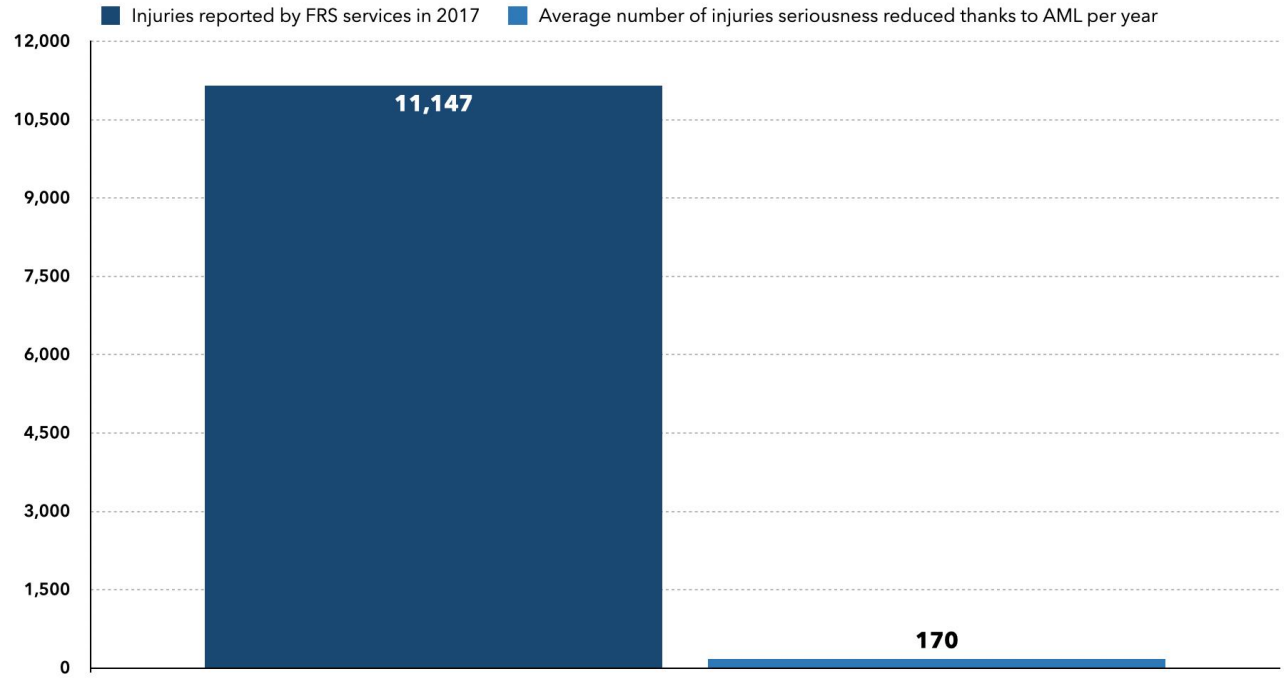
[52] *Finnish Rescue Services' Pocket Statistics 2013-2017 by J. Ketola and E. Kokki, see appendix 8)7) for detailed figures*

Figure 41 - Deaths reported in emergencies attended by FRS in Finland (2017) **and average number of lives saved thanks to AML per year**



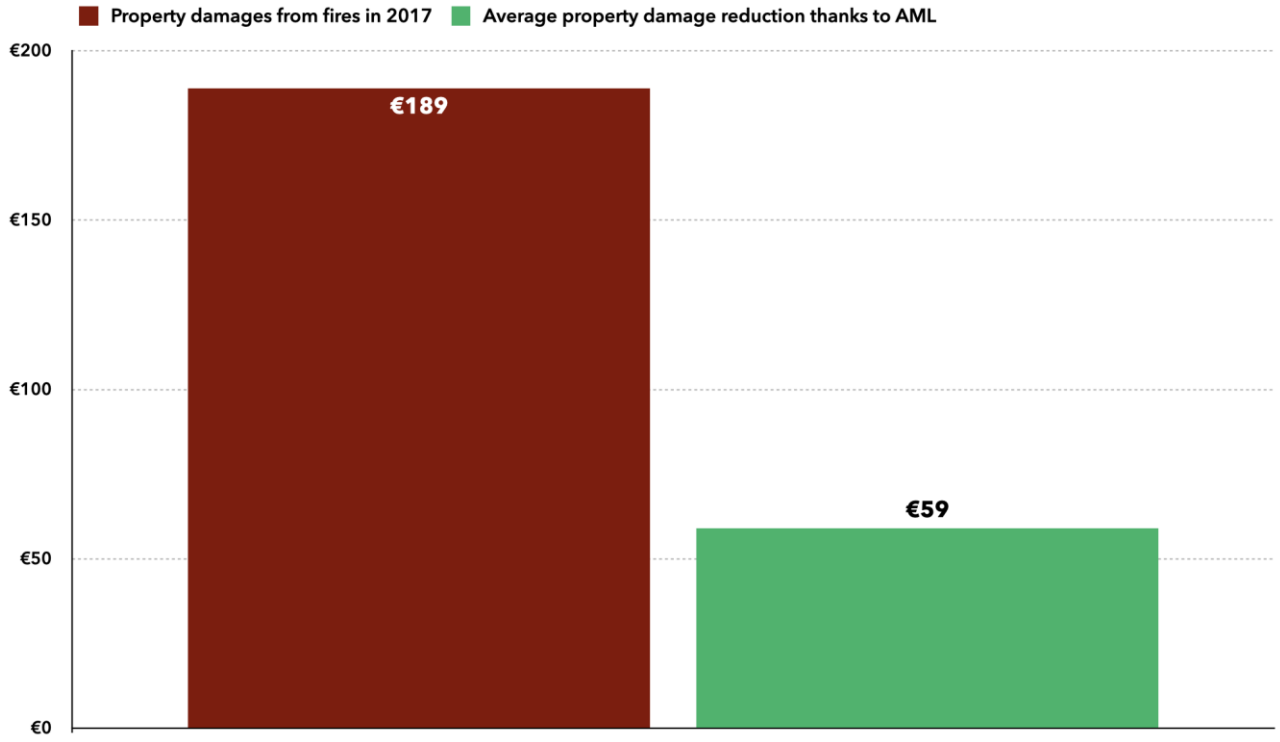
Source: PTOLEMUS, Finnish Rescue Services

Figure 42 - Injuries reported in emergencies attended by FRS in Finland (2017) **and average number of injuries seriousness reduced thanks to AML per year**



Source: PTOLEMUS, Finnish Rescue Services

Figure 43 - Property damages reported during emergencies attended by FRS in Finland (2017) **and average property damage reduced thanks to AML per year** (€ million)



Source: PTOLEMUS, Finnish Rescue Services

From the figures presented above, we can conclude that:

- The estimated number of lives saved and reduced injuries by AML compared to the number of deaths and injuries reported by the FRS, in 2017, is significant since AML is generating benefits in 2 steps of the emergency chain of events and the intervention of emergency services cannot impact a considerable amount of deaths and injuries;
- Every year fire-related emergencies damage €189 million, we estimate that AML could reduce the damages by 30%.

Finally, we can appreciate how the estimates of the CBA are in line and consistent with ground data figures reported by the Finnish Rescue Services.

5.3 KEY SUCCESS STORIES

The PSAPs of the analysed countries shared with PTOLEMUS and EENA a number of real cases where AML had a positive impact, 3 of which we present below.

We believe that AML has 3 main "roles":

- **AML is a game changer, it saves lives**

  Notruf Niederösterreich (Lower Austria PSAP) reported to PTOLEMUS a real life case that demonstrates the significant and tangible benefits of AML. The emergency occurred in 2019, and involved a person willing to commit suicide. The caller took a considerable amount of medicines before dialling the emergency number. During the call, he expressed the intention to speak while awaiting the lethal effect of the ingested drugs. The call taker tried to obtain information about the address, but the caller refused to provide details. Thanks to the AML derived location, the call taker was able to immediately dispatch the emergency services to stop the suicide attempt and save the person. As a result of the precise Wi-Fi position and

altitude information, the dispatched police squad was able to reach the apartment of the caller and precisely locate the apartment to intervene on time. The caller was found and saved.

- **AML is useful to reduce stress in emergencies**

  The Lithuanian Emergency Response Centre shared with PTOLEMUS an example of a real case, occurred on 15th September 2019 in a forest in southern Lithuania, where AML has proven its positive impact.

  A family with two kids (9 and 4 years old) went off the road for mushroom hunting and got lost. They did not know the name of the forest, nor they could provide any landmarks or references. The Cell ID returned by the network had a radius of almost 10 km while AML returned a GNSS-derived radius of 6 meters. Thanks to this precise AML location information, the family was quickly found (~30 minutes from the call). With such a network location, it might have taken hours or even days to find them. Although there was no immediate danger to their life and health, the costs savings for the PSAPs were obvious and the family avoided the trauma of a long, unplanned stay in the forest.

- **AML significantly helps call takers**

  Finnish call takers have reported an improvement related to the address determination during emergency calls. Finland is a bilingual country. Hence there can always be an uncertainty about the name of a street spelling leading to potential dispatch mistakes. Thanks to AML and the new IT system, call takers can now see the exact location on their workstation's screens. This improvement not only avoids wrong dispatches but also allows to reduce the time needed to handle a call, the stress for both caller and call taker.

  In Austria, the call takers of the Notruf Niederösterreich consider AML so reliable that they are not using network Cell ID to locate callers, except for a very few cases.

6. ANALYSIS OF RISKS AND OF HOW TO MAXIMISE BENEFITS

6.1 MAIN RISKS RELATED TO AML DEPLOYMENT

Taking into account the historical evolution of AML and the expectations of the different stakeholders involved, we expect that AML will become broadly available in the analysed Member States.

Nevertheless, a number of risks exist that could disturb our assumed deployment rate.

We analysed the main risks in terms of:

1. The probability that they will happen,
2. The impact of their consequences on the net benefits of AML.

Moreover, during our analysis, we distinguished:

- EU-wide risks: risks that are dependent from macro-trends affecting the EU,
- Country-specific risks: risks that are specific to each country's deployment.

6.1.1 EU-WIDE RISKS

6.1.1.1 Unexpected increase of the "opt-out" rate

In section 3.1.3, we assumed that the "opt-out" rate will remain insignificant. In this CBA, we estimated that the rate will not exceed 1.5%.

However, privacy concerns could push a bigger portion of the population to opt-out, generating a risk that such rate increases to levels that could have a major impact on AML's functioning.

We believe that customers deciding to opt-out *en masse* remains a relatively low-probability event. Thus, we estimate the hypothetical peak of the "opt-out" rate at 10%, which results in a moderate impact on the net benefit.

6.1.1.2 Potential risk of Huawei fallout with Android

In 2019, the US imposed a trade ban on US companies partnering with Huawei to prevent its flagship smartphones from using Android. Whereas the US eased some restrictions in late June, Huawei worked on alternative plans to replace Android[53].

The world's second-largest smartphone manufacturer announced its new Harmony OS in August 2019. Huawei highlighted that only smart speakers and watches would include its OS. Yet, some articles noted that Huawei had secretly prepared a pilot-test of Russia' Aurora OS on its handsets[54] [55]. The articles also made conjectures that it could first launch this OS on handsets in the Chinese and Russian markets.

In this risk analysis, we acknowledged the potential risk of Huawei's decoupling with Android.

[53] https://www.cnet.com/news/huawei-ban-full-timeline-and-why-the-5g-mate-30-pro-might-not-use-android/

[54] https://www.bbc.com/news/technology-49291481

[55] https://www.forbes.com/sites/zakdoffman/2019/08/27/new-huawei-os-shock-confirmation-of-russian-software-for-mobile-devices/#34f2958f79c8

According to Statcounter GlobalStats[56], Huawei accounted for 19% of the EU's mobile phone market in the last 2 years (2018-2019). The possible end of Huawei's use of the Android OS could cause a drop of up to 19% in the projected adoption rate of HELP112 software in handsets.

Would Huawei eventually stop producing Android phones, we can predict 2 paths:

1) Huawei users would switch to other Android phones (i.e. Samsung, Sony, LG, etc.). In such a case, the share of Android phones in the domestic market and the overall AML benefits would remain largely unaffected.
2) Huawei buyers stay loyal to the brand regardless of the OS. In that case, the AML addressable market share would significantly decline because new Huawei phones are likely not to benefit from AML, at least at the beginning, thereby cutting out a significant share of the estimated AML benefits.

While Huawei will also have the possibility of implementing AML, it may take time to integrate it to its operations.

We reckoned that the outcome will lay somewhere in between these 2 scenarios. In our risk analysis, however, we decided to present a conservative measure of the worst-case scenario starting from 2021.

6.1.1.3 No AML at OS level

Currently, there is no regulation in place mandating the support of AML by OS providers in the European Union. It is fair to argue **that the success of AML deployment depends on the goodwill of Google and Apple**, which has been the case in 5 out of the 6 analysed countries.

In the most extreme scenario, both companies could cease to support AML on their mobile OSs as early as next year (2021). **While the probability is very low, the consequences for AML of such a situation would be enormous.**

While AML could alternatively be deployed at handset level, the efforts to coordinate all handset suppliers could take several years.

6.1.2 COUNTRY-SPECIFIC RISKS

6.1.2.1 Austria

Today, in Austria, iOS is not yet collaborating with the relevant stakeholders to include AML software in its smartphones.

In section 3.1.5, we forecast that iOS will support AML for 112 from 2022. In this section, we estimated the risks related to this scenario if it does not occur.

The risk could negatively impact net benefits by 7% and with a high probability of happening. Globally, we highlight the role of Apple as a necessary key actor for the full deployment of AML in Austria.

In our model, we considered that the 112 and 133 emergency numbers will be AML-enabled from 2022 thanks to:

- the police force PSAPs' modernisation and reorganisation, and
- the MNOs' collaboration.

[56] https://gs.statcounter.com/vendor-market-share/mobile/lithuania/#monthly-201801-202001

Therefore, we analysed the potential effect of a failure in the 112 PSAPs restructuring process leading to 112 and 133, not AML-enabled.

The potential unfavourable impact of this scenario is very large because the impact and probability of occurrence are both very high. Therefore, we consider as vital to proceed with a time-effective 112 PSAP restructuring to avoid harmful delays.

6.1.2.2 Belgium

From September 2019, Apple started to support AML on 112 emergency calls but it is still not supporting the other national emergency numbers 100 and 110. We made the assumption that from middle 2020, all emergency numbers will be AML-enabled for iOS smartphones.

In this section, we analyse the potential impact of a 4-year delay in the implementation of AML for Belgian emergency numbers on iOS. Even if we reckoned that the risk has low probability, the impact can still be significant since almost 50% of the total emergency calls are placed to 101.

6.1.2.3 Estonia

We did not identify specific risks for Estonia.

6.1.2.4 Finland

We did not identify specific risks for Finland.

6.1.2.5 Lithuania

In 2017, in almost 20% of all emergency cases, Lithuanian citizens called numbers that were not AML-enabled. As mentioned in section 2.2, Lithuania will adopt 112 as a unique emergency number from 2021.

Since Android does not support old EMS numbers and iOS only covers 112, if the migration does not happen and OS providers do not integrate these other numbers, the number of addressable calls after 2021 will be affected.

We estimated that the probability of a delayed migration is low. Would it happen, it affects the net benefits by almost 16.9% because it will impact all calls placed by Android to EMS and by iOS to non-112 numbers.

6.1.2.6 The UK

In section 3.1.6, we mentioned the inability of some Stage 2 PSAPs to use AML-derived location. We forecast that by the end of 2021, all Stage 2 PSAPs will have implemented AML.

However, we estimated the impact of a potential 3-year delay in this process. This delay would reduce the benefits because it profoundly impacts the share of calls leading to a dispatch benefiting from AML. We believe that this scenario has a 50% probability of happening and a potential negative impact of almost 6% on total net benefits.

6.1.3 RISK ASSESSMENT: IMPACT ON BENEFITS AND PROBABILITY

In this section, we analysed the impact and the probability of the risks that we have identified for the analysed countries.

Table 18 - Probability and impact of major risks on AML benefits in the 6 countries

Risks	Austria		Belgium		Estonia		Finland		Lithuania		The UK	
	Impact	Probability	Impact	Probability	Impact	Probability	Impact	Probability	Impact	Probability	Impact	Probability
1 Opt-out rate will significantly increase												
2 Huawei adopts its own OS without AML												
3 Existing OS providers stop supporting AML												
4 Not all emergency numbers AML-enabled												
5 PSAPs unable to obtain AML location												

Source: PTOLEMUS

The analysis shows that:

- **Risk 1** (Opt-out rate will significantly increase) **has a moderate impact and a low probability to happen,** as described in section 6.1.1.1.
- **Risk 2** (Huawei adopts its own OS without AML) **has the highest probability to happen** and a variable impact, depending on Huawei's penetration in each market.
    - **The biggest impact would be in Austria** where only Android OS is AML-enabled today and Huawei holds a 28% share of Android phones.
    - On the other hand, **the UK is the less impacted by this scenario** in terms of benefit reduction, as the market share of Huawei was just 7% in the 2018-2019 period.
    - Moreover, **Finland is the country that has the lowest probability** since Huawei has already collaborated with the Finnish AML stakeholders[57] and it seems that an eventual Huawei OS could be enabled with AML without significant delays or issues.
- **Risk 3** (Existing OS providers stop supporting AML) **has the most significant impact on the AML benefits generated in all countries but the probability of this to happen remains low**. Currently, OS providers are collaborative and are supporting AML in 5 out of the 6 analysed countries (AML is not yet operative on iOS smartphones in Austria).

  Moreover, the Delegated Regulation 2019/320 plays a mitigation role for risk 3, since from March 2022 all handsets sold within the EU must be designed to support the features required for access to emergency services. The compliance in this regard "shall be ensured through technical solutions for the reception and processing of Wi-Fi data, data from Global Navigation Satellite Systems compatible and interoperable with at least the Galileo system referred to in Regulation

[57] *Information obtained during the interview of the Finnish Emergency Response Centre Agency*

(EU) No 1285/2013, and for the making available of that data for transmission in emergency communications."

Therefore, in the case when OS providers stop supporting AML, the handset manufacturers would be responsible for ensuring AML capabilities on the smartphones sold in the EU.

Nevertheless, as mentioned in section 6.1.1.3, the efforts to coordinate all handset suppliers in the deployment of AML at handset level without the support of OS providers could take several years.

- **Risk 4** (Not all emergency numbers AML-enabled) **could affect 3 of out of the 6 analysed countries**. As one may expect, the countries exposed to this possibility are all countries that have more than 2 emergency numbers.
    - In Austria, as described in 6.1.2.1, there are numbers not enabled with AML due to the lack of Apple co-operation and because the entire Police PSAPs system is being restructured; We believe that Austria faces the highest impact and probability;
    - On the other hand, the other two Member States affected by this risk, Belgium and Lithuania, are already quite advanced in the coverage of emergency numbers with AML; Consequently, we believe they are both subject to a low (10-15%) probability of failing and with a similar negative impact on benefits;
    - From this risk, we can appreciate how countries with a smaller number of emergency numbers not only have benefited from a faster AML deployment, but are also subject to less risks.

  Moreover, we underline the mitigation role of Article 109 of **European Electronic Communications Code - EECC (Directive (EU) 2018/1972)**[58] for risk 4.

  The article requires Member States to "*ensure that all emergency communications to the single European emergency number '112' are appropriately answered and handled in the manner best suited to the national organisation of emergency systems. Such emergency communications shall be answered and handled at least as expeditiously and effectively as emergency communications to the national emergency number or numbers, where those continue to be in use.*"

  Therefore, in light of the regulation mentioned above, we expect Austria to enable 112 calls with AML as is already the case for other national emergency numbers such as 144.
- **Risk 5** (PSAPs unable to obtain AML location) **could affect 2 out of the 6 analysed countries**. In both Austria and the UK, we believe the probability of a delay in the implementation of AML at PSAP level is high due to the complexity of the task and the high number of stakeholders involved. In particular, Austria is exposed to a potential dramatic reduction in the benefits since all Police PSAPs would be impacted and consequently 50% of the emergency calls handled in the country.

6.2 CONCLUSIONS FROM OUR ANALYSIS

In light of the analysis performed, we identified the following best practices to deploy AML:

- **112 as the unique emergency number**

As already mentioned in section 2.2, we have observed that the number of emergency numbers has a direct influence on the PSAPs organisation and the AML coverage of emergency calls. Indeed, the more emergency numbers are available, the harder it is to enable them with AML and to manage their related calls information. Indeed, in section 3.1.5, we identified that **countries that have 112**

[58] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L1972&from=EN

as the unique emergency number, such as Estonia and Finland, or that have 112 and one additional national number, such as the UK**, have a clear advantage in enabling emergency numbers with AML and a consequent higher number of calls benefiting from AML at PSAP level.**

- **Lean PSAP structure and information management**

It is critical that PSAPs are capable of receiving the positioning data from AML-enabled emergency calls and read it correctly. A lean PSAP structure allows an efficient and effective AML data management since it has less data channels and data repositories than complex PSAPs structures. For example, as described in section 3.1.6, countries such as Finland and Estonia, which have a PSAP model 5, were able to reach a full coverage of PSAPs with AML in the first year of deployment.

Moreover, as mentioned in section 2.2, we have learnt that Lithuanian PSAPs are changing their structure. A level 1 PSAP will now manage all emergency calls under the control of the Emergency Response Centre (ERC). We believe that this solution, together with a reduction in the number of emergency numbers available, will reduce the complexity of the AML implementation at the PSAP level and thus increase the benefits.

Thus, the countries willing to implement AML will obtain full AML benefits from year 1 if they simplify their PSAP structure.

- **Involve internal teams in the development of AML**

In many countries, PSAPs needed to adapt the existing infrastructure to implement AML. However, in some cases such as Austria, PSAPs had to set up new IT solutions to effectively deploy AML.

According to Notruf Niederösterreich (NNOE), the PSAP for Lower Austria, the AML deployment was conducted in a cost-efficient manner as the PSAP heavily leveraged its internal IT department. Austria opted for two AML location transmission methods (SMS and HTTPS). NNOE made a €30,000 investment to build the platform and it now securely shares the HTTPs-derived AML location datasets at national level. Moreover, the solution was successfully integrated into the existing IT systems and widely accepted by the operators. Internal IT departments have already dealt with operators' requirements and have a thorough understanding of their specific needs.

- **Leverage existing infrastructure**

Following our country-specific analysis, we can state that all the implementations have been able to reuse the existing infrastructure substantially. For example, according to the Lithuanian PSAP, AML deployment was conducted in a cost-efficient manner as PSAPs mainly relied on existing infrastructure. Several adjustments had to be made to the existing platform, i.e. an upgrade of the SMS reception and filtering system and the implementation of a software and location database. These modifications led to a total investment of just €50,000. Leveraging the existing infrastructure clearly reduces the cost of the application.

- **Develop a monitoring system of AML performance**

In addition to their standard KPIs, we believe that PSAPs should monitor:

- Number of emergency calls received,
- Number of mobile emergency calls received,
- Share of emergency calls for which AML messages with location were received at PSAP level,
- Share of emergency calls for which AML messages without location were received at PSAP level,
- Share of false calls,
- Share of calls leading to dispatch and
- Share of calls leading to dispatch that benefited from an AML message.

The availability of data can significantly help all the stakeholders of AML in the countries where it has been already deployed to generate even more benefits and help other countries implement AML.

- **Reduce the number of AML messages with no location**

The monitoring of the recommended KPIs and a specific investigation of the causes behind technical issues can be the key for an action plan to eliminate AML faults. As mentioned in section 3.1.7, we expect the share of AML messages with no location to decrease over time thanks to technological improvements both at handset and network level. Still, as was the case in Lithuania, some failures can caused by the configuration of the SMS platforms at PSAP level. Moreover, other failures can derive from solvable issues either at handset level (i.e. wrong set-up of AML software or other applications installed on the smartphones in conflict with AML) or at network level (i.e. potential set-up issues within the SMS platforms of MNOs).

- **Trigger multiple location messages for each call**

As of today, as showed in Table 7, 3 of the analysed countries have configured AML to send more than one message.

We believe that triggering multiple AML messages during a single mobile emergency call can bring additional benefits to the emergency services stakeholders and society.

Even though more than one AML message can generate higher costs for the MNOs such as in Finland, the additional information brought by several messages being sent every 30 seconds or more during the call, can lead to substantial benefits since the call takers are then able to obtain the most recent position of the caller. Therefore, emergency services can dispatch their teams to the most updated caller position and potentially reduce the on-scene arrival time even more.

7. LIMITATIONS OF THIS COST BENEFIT ANALYSIS

The analysis presented in this document has some limitations, which we list below:

- **Section 2.5 Key regulatory concerns at EU level**
  - This section is not a regulatory analysis of the emergency services legislation;
  - The objective of the regulatory review is to understand the extent to which user requirements, as outlined in HELP 112 I, comply with the appropriate legal standards of:
    - the EU and
    - those countries/regions in which AML has already been deployed.
  - In particular, we have assessed whether these requirements comply with EU and Member State privacy (including, but not limited to data protection) laws.
- **Section 3.1 Estimation of the addressable calls benefiting from AML**
  - The forecast of emergency calls benefiting from AML does not consider the COVID-19 pandemic because we performed the analysis before it happened, limited relevant data is available, and its future impact remains uncertain;
  - As smartphone penetration data was not available for Estonia and Lithuania, we performed a benchmark analysis of similar countries with existing historical data to derive our estimates;
  - False calls and calls not leading to actual dispatch are variables that do not have a standard official definition among the analysed countries, and while we provided one and validated our figures with the country PSAPs representatives, their interpretation could lead to small variations from one country to the other.
- **Section 3.2 Analysis of the caller location precision improvement of AML**
  - The timeframe and number of calls contained in the country-specific AML databases varies between the analysed countries,
    - The share of technologies can change depending on the weather conditions and seasonality (e.g. in winter, people tend to place more calls indoors than outdoors, leading to a higher utilisation of Wi-Fi vs. GNSS);
    - Our results, therefore, could vary slightly depending on the seasonality and the timeframe of the AML database;
  - Still, for all analysed countries, we have reviewed that:
    - the AML databases are representative of the population distribution and
    - the outputs are in line with those of other countries with more complete databases and larger timeframes.
- **Section 3.3 Assessment of the time saved due to a more precise caller location**
  - As PSAPs did not always have ground truth data on emergency services operation and response time before and after the AML implementation, the figures utilised to estimate the time saved are based on:
    - Secondary research of response times from emergency service operation in European countries,
    - Interviews of emergency services executives in the analysed countries and other countries who have deployed AML, and
    - PTOLEMUS analysis;

- We have assumed that the relationship between location improvement and call processing & on-scene arrival time follows the same pattern across the analysed countries;
- While we found that such difference is not significant, we are aware that response time patterns can slightly change between the analysed countries and regions;
- In any case, the main variable to estimate the time saved thanks to the "location improvement" is based on actual values extracted from the AML databases of each analysed country.

- **Section 3.4 Estimation of the value of a minute saved in response time**
  - We based our analysis on a study that assesses the value of a minute saved during the operations of Swedish fire brigades;
    - Using relevant data from emergencies in other countries, we performed an extrapolation of the Swedish study to estimate the time value of a minute for police forces and ambulances emergencies;
    - While the PSAP representatives validated the figures obtained, the value of a minute is a high-level estimation based on a bottom-up analysis of all types of emergencies rather than a measurement from actual operations;
  - In addition, we assumed that the breakdown of emergencies that Police, Ambulances and Fire & rescue handle is the same in the 6 countries, and while in general, it is the case, each state has its criteria to assign emergencies to the different entities.
- **Section 3.5 Evaluation of the economic and social benefits**
  - The lives saved/ reduced injuries ratio is extrapolated from the eCall impact assessment; thus, it may not perfectly match all the other emergency typologies.
- **Section 4.1 Estimation of AML costs in the analysed countries**
  - We performed both primary and secondary research to estimate the different cost items; in particular, we reviewed such figures with the PSAPs, but did not audit the amounts expressed.
- **Section 5.2 Putting the results into perspective**
  - The 2 scenarios designed in section 5.2 were not based on a specific country-by-country analysis at EU level, but were simple extrapolations based on the statistics obtained from the 6 countries assuming country conditions (e.g. smartphone adoption, PSAPs IT characteristics) and an AML deployment path comparable to the 6 countries.
- **Section 6.1 Main risks related to AML deployment**
  - PTOLEMUS did not interview Huawei representatives to deeply assess the risks related to the potential replacement of Android in Huawei handsets.
- **PSAPs inputs**
  - PTOLEMUS performed several interviews and had meetings with the PSAP representatives of the analysed countries, but had no chance to monitor and analyse live operations neither to perform due diligence of their AML and IT systems;
  - Therefore, we based our results on the inputs received from PSAPs.

8. LIST OF SOURCES AND INTERVIEWS

8.1 SOURCES

In order of appearance:

1. Public Safety Answering Points Global Edition – December 2018 – by EENA
2. AML report card - June 2019 – by EENA
3. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02002L0022-20160430
4. https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1568104340750&uri=CELEX:32009L0136
5. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32002L0058
6. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L1972&from=EN
7. https://eur-lex.europa.eu/legal-content/EN/TXT/?toc=OJ%3AL%3A2019%3A055%3ATOC&uri=uriserv%3AOJ.L_.2019.055.01.0001.01.ENG
8. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014L0053
9. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2016.119.01.0001.01.ENG&toc=OJ%3AL%3A2016%3A119%3ATOC
10. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52017PC0010
11. Communications Market Report – August 2018 – by OFCOM
12. Global mobile consumer trends, 2nd edition – by Deloitte
13. https://gs.statcounter.com/os-market-share/mobile/europe/#yearly-2019-2020-bar
14. https://eena.org/aml-in-android/
15. https://crisisresponse.google/emergencylocationservice/how-it-works/
16. ETSI TS 103 625 v1.1.1 (2019-12) - Emergency Communications (EMTEL); Transporting Handset Location to PSAPs for Emergency Calls - Advanced Mobile Location – by ETSI
17. Law on Emergency Response Centre No IX-2246 - https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.279445?jfwid=f4nne7rls
18. *HELP112 phase I Deliverable D1.2-EENA-020*
19. Methodological manual on territorial typologies — 2018 edition, January 2019, Eurostat

20. https://gs.statcounter.com/vendor-market-share/mobile/united-kingdom/#monthly-201601-202002

21. Deliverable D4.3 UK Pilot Help112 phase I

22. EENA Operations document, "Assessing meaningful response time", 21-07-2014

23. Deliverables D4.1.X of Help112 phase II

24. THE IMPORTANCE OF THE TIME FACTOR IN FIRE AND RESCUE SERVICE OPERATIONS IN SWEDEN, Swedish Rescue Services Agency, 2004 edition, by Henrik Jaldell

25. World Bank data – GDP per capita, PPP – World Bank, International Comparison Program database

26. https://ec.europa.eu/digital-single-market/en/news/ecall-impact-assessment

27. https://gs.statcounter.com/os-market-share/mobile/europe/#yearly-2019-2020-bar

28. BEREC - Termination rates at European Level – July 2018

29. Average operating margin for the largest telecommunication operators in Europe in 2018 (13%)

30. https://gs.statcounter.com/vendor-market-share/mobile/united-kingdom/#monthly-201706-201912

31. COCOM Implementation of the single European emergency number 112 - report 2017, 2018, 2019 - by DG CONNECT

32. Finnish Rescue Services' Pocket Statistics 2013-2017 - by J. Ketola and E. Kokki

33. https://www.cnet.com/news/huawei-ban-full-timeline-and-why-the-5g-mate-30-pro-might-not-use-android/

34. https://www.bbc.com/news/technology-49291481

35. https://www.forbes.com/sites/zakdoffman/2019/08/27/new-huawei-os-shock-confirmation-of-russian-software-for-mobile-devices/#34f2958f79c8

36. https://gs.statcounter.com/vendor-market-share/mobile/lithuania/#monthly-201801-202001

8.2 KEY INTERVIEWS AND MEETINGS WITH ANALYSED COUNTRIES' PSAPS

Austria

- 02/04/2019 – First call between PTOLEMUS and Notruf Niederoesterreich representatives to validate the methodology of the CBA and to gather key inputs and data for the Austrian CBA document
- 27/02/2020 – Call between PTOLEMUS and Notruf Niederoesterreich representative to validate the first draft of the D4.1.3

Belgium

- 26/02/2019 – Astrid SA/NV sent initial figures and AML information to PTOLEMUS
- 04/04/2019 - Meeting with Astrid SA/NV representatives to validate the methodology of the CBA
- 16/09/2019 – Meeting with Astrid SA/NV representatives to validate the first draft of the D4.1.1
- 25/09/2019 – Interview of a call taker of the Belgian PSAP of Liege to validate the figures adopted to compute the equations for call processing time and the on-scene arrival time mentioned in section 3.3.1

Estonia

- 14/03/2019 – First contact between PTOLEMUS and the Estonian Emergency Response Centre (EERC)
- 26/09/2019 – Meeting with the EERC to validate the first draft of the D4.1.2

Finland

- 14/03/2019 – First contact between PTOLEMUS and representatives of the Emergency Response Centre Administration to gather initial inputs about the implementation of AML in Finland
- 05/03/2020 – Call between PTOLEMUS and representatives of the Emergency Response Centre Administration to validate the CBA first draft and gather additional information regarding the AML technology performance in Finland
- 15/05/2020 – Call between PTOLEMUS and a representative of the Emergency Response Centre Administration to validate the outputs of the analysis of the AML messages database

Lithuania

- 19/03/2019 – The Lithuanian Emergency Response Centre sent initial figures and AML information
- 26/02/2020 – Interview with a representative of the Lithuanian Emergency Response Centre to validate the first draft of the D4.1.6

The UK

- 02/03/2019 – Call with a representative of Stage 1 PSAP operated by BT to validate the methodology of the CBA
- 04/03/2020 - Call with a representative of Stage 1 PSAP operated by BT to validate the first draft of the document D4.1.7

Additionally to these key interviews and meetings, we had several exchanges with the PSAPs representatives to:

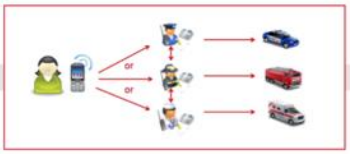
- Better understand their operations, organisational structure and AML deployment history;
- Explain the key variables of our methodology;
- Obtain key figures and data about the AML performance such as the AML SMS databases;
- Gather real-life examples of the AML efficacy.

APPENDIX

1) 112 PSAPs MODELS BY EENA

1 – EROs handling emergency calls

- Calls to national numbers and 112 redirected to Emergency Response Organisations (EROs).
- If the intervention of a different ERO is required, call and/or data about the emergency situation are forwarded to the most appropriate ERO.
- Dispatch from the intervention resources done by the ERO operators.
- In a variant, two EROs are colocated and contacted via the same number.



2 – Filtering Stage 1 PSAP and resource dispatching Stage 2 PSAPs

- Independent Stage 1 PSAP receives all emergency calls and then forwards it to a local ERO.
- Call-takers only ask the caller with which emergency service he/she wants to be connected to.
- Stage 1 PSAP forwards the call to the appropriate local ERO. Detailed data gathering and dispatch of the intervention resources are done by the emergency response organisation.

3 – Data gathering Stage 1, resource dispatching by Stage 2

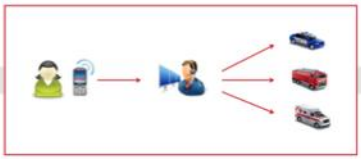
- Also in two levels. The difference is the role played by the independent organisations.
- Civilian call-takers classify the call and makes a parallel dispatch of the calls to EROs. In some cases police, EROs' specialists are available to support the call-takers.
- Dispatch of the intervention resources done by EROs.

4 – Data gathering Stage 1, resource dispatching by Stage 2 in an integrated control room

- Also in two levels but civilian call-takers and EROs are in the same location.
- Civilian call-takers are in charge of classifying the call and make a parallel dispatch of the calls to the most appropriate EROs if needed. In some cases, EROs' specialists are available to support call-takers.
- Dispatch of the intervention resources done by EROs.

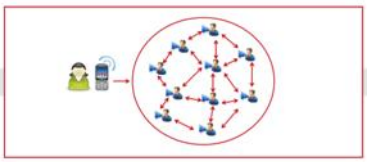
5 – ERO independent PSAPs

- Civilian call-takers handle both call-taking and intervention resources' dispatch. In some cases, EROS' specialists are available to support.
- The same PSAP is in charge of classification of calls, data collection and dispatching the intervention resources to the incident.



Variant – Interconnected PSAPs

- PSAPs of different regions can be interconnected. If no call-taker is available, the call can be redirected to another PSAP.



Source: Public Safety Answering Points Global Edition – December 2018 – by EENA

2) DEFINITION OF THE VARIABLES OF THE EMERGENCY CALLS BREAKDOWN

Variable	Definition	Forecast rationale
No smartphone	We assumed that mobile phones without an open operating system (OS) cannot run AML, thus we removed so-called feature phones	Expected evolution of the penetration of smartphones in the total number of mobile phones in use
No AML software in the handsets	Old iOS versions and other OSs (i.e. Windows) that do not support AML	Expected evolution of the OS market share
Opt-out	The share of handset users that switch the AML function off	Expected growth of opt-out rate
Roaming calls that do not trigger AML	The share of roaming calls placed that do no trigger AML	Expected to decrease as soon as OS providers start covering roaming calls in their AML application
Emergency numbers that do not trigger AML	Some national emergency numbers do not trigger AML	Expected deployment of AML
AML message with no location	An AML message is registered, but the location is not provided	Expected improvement of historical failure rate as a natural consequence of system review and improvement
PSAPs unable to receive the location	% of PSAPs that cannot receive the AML location	Expected adoption as a consequence of investments in improving regional PSAPs' technology
False calls	Calls that do not correspond to a real emergency situation, i.e. fake calls, wrong dialling	Expected evolution of false calls
Calls not leading to actual dispatch	Share of calls that do not lead to a dispatch	Expected evolution of the share of calls that do not lead to a dispatch

Source: PTOLEMUS

3) ESTIMATES OF TOTAL MOBILE EMERGENCY CALLS

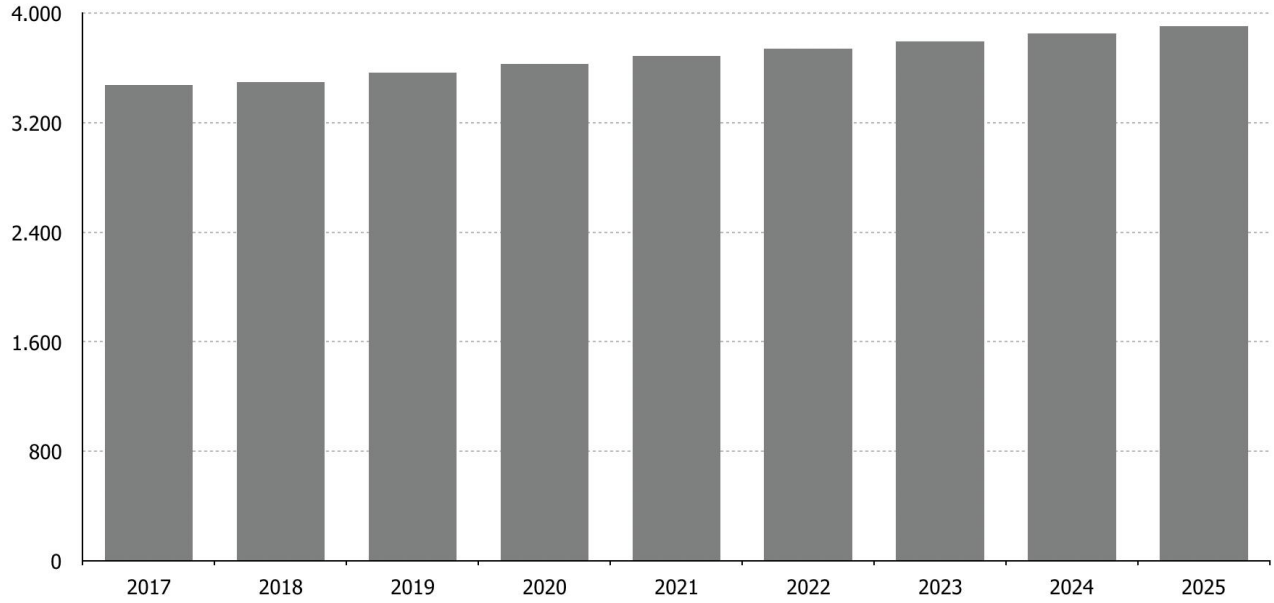
Austria

To identify the number of addressable calls, we forecast the number of mobile emergency calls in Austria over a 10-year timeframe. Based on the interview of the Notruf Niederoesterreich (NNOE) and an analysis of the historical number of emergency calls, we learnt that:

1. The number of mobile emergency calls is highly correlated to total population
2. There are no major changes in the number of emergencies per capita

As a result, we expect that the number of mobile emergency calls will increase from 3.48 million in 2017 to 3.96 million by 2025, which corresponds to an annual growth of 1.47%. The upward trend is in line with the increasing population of Austria.

Figure 44 - Annual number of mobile emergency calls in Austria (2017-2025, thousand)



Source: PTOLEMUS estimates based on data from EENA and interview of NNOE

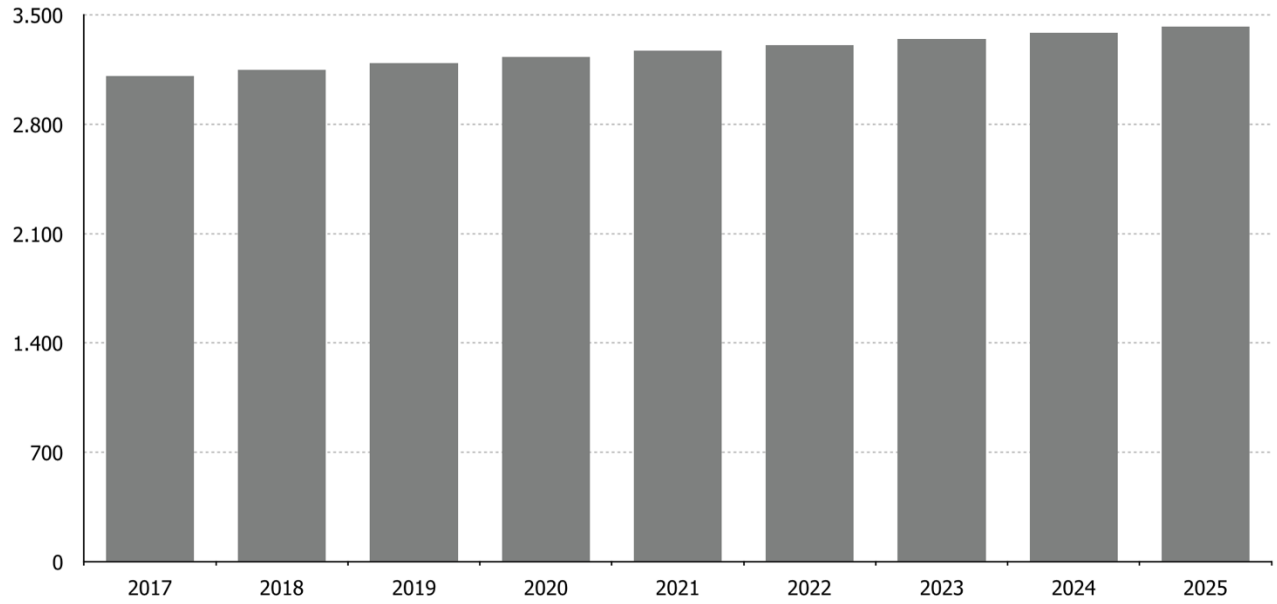
Belgium

To identify the number of addressable calls, we forecast the number of mobile emergency calls in Belgium over a 10-year timeframe. Based on the interview of Astrid SA/NV and an analysis of the historical number of emergency calls, we learnt that:

1. The number of mobile emergency calls is highly correlated to total population
2. There are no major changes in the number of emergencies per capita

As a result, the number of mobile emergency calls is projected to steadily grow from 3.1 million in 2017 to 3.5 million by 2026, which corresponds to 1.2% growth per year.

Figure 45 - Annual number of mobile emergency calls in Belgium (2017-2025, thousand)



Source: PTOLEMUS estimates based on data from EENA and interview of Astrid SA/NV

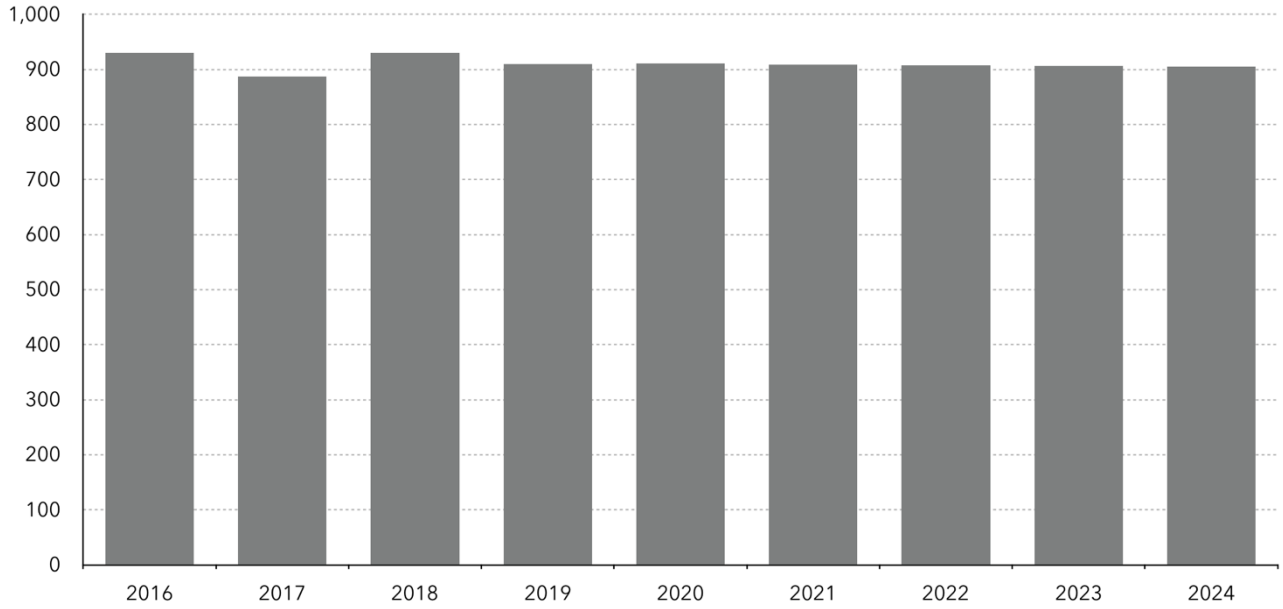
Estonia

To identify the number of addressable calls, we forecast the number of mobile emergency calls in Estonia over a 10-year timeframe. Thanks to an interview of the Estonian Emergency Response Centre (EERC) and an analysis of the historical number of emergency calls, we learnt that:

1. The number of mobile emergency calls is highly correlated to total population
2. The are no major changes in the number of emergencies per capita

As a result, the number of mobile emergency calls is projected to steadily dwindle from 0.98 million in 2016 to 0.9 million by 2024, which represents annual -0.3% decrease. The downward trend is in line with the decreasing population of Estonia.

Figure 46 - Annual number of mobile emergency calls in Estonia (2016-2024, thousand)



Source: PTOLEMUS estimates based on data from EENA and interview of the Estonian PSAP

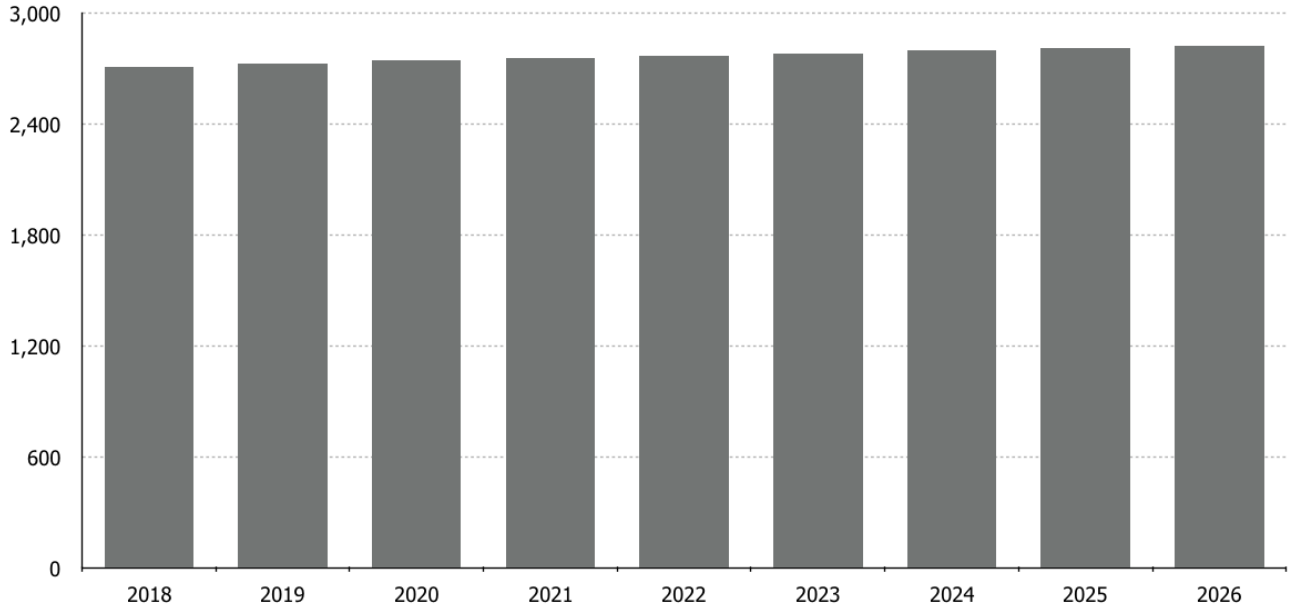
Finland

To identify the number of addressable calls, we forecast the number of mobile emergency calls in Finland over a 10-year timeframe. Thanks to an interview of the Finnish Emergency Response Centre Administration and an analysis of the historical number of emergency calls, we learnt that:

1. The number of mobile emergency calls is highly correlated to total population
2. There are no major changes in the number of emergencies per capita

As a result, we expect that the number of mobile emergency calls will grow from 2.71 million in 2018 to 2.82 million by 2026, which corresponds to an annual increase of 0.5%. The upward trend is in line with the increasing population of Finland.

Figure 47 - Annual number of mobile emergency calls in Finland (2018-2026, thousand)



Source: PTOLEMUS estimates based on data from EENA and interview of the Finnish PSAP

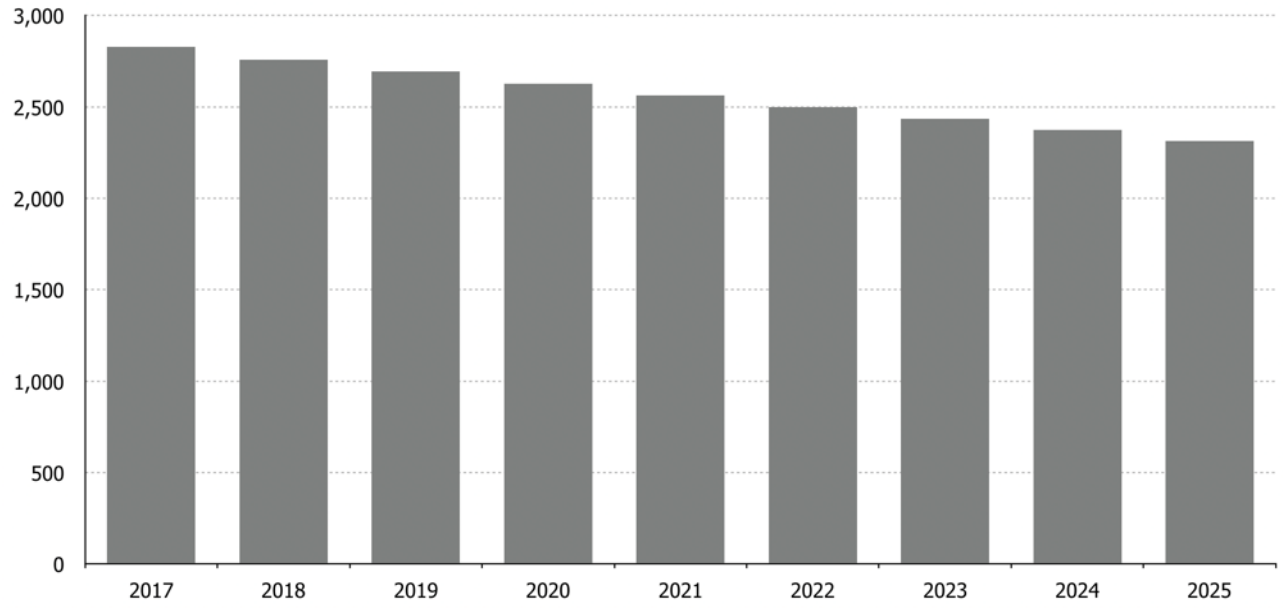
Lithuania

To identify the number of addressable calls, we forecast the number of mobile emergency calls in Lithuania over a 10-year timeframe. Thanks to an interview of the ERC (Emergency Response Centre), the Lithuanian PSAP, and an analysis of the historical number of emergency calls, we learnt that:

1. The number of mobile emergency calls is highly correlated to total population;
2. The number of false calls is decreasing thanks to awareness-raising campaigns.

As a result, we expect that the number of mobile emergency calls will drop from 2.83 million in 2017 to 2.25 million by 2025, which corresponds to an annual decrease of 2.5%. The downward trend is in line with the decreasing population of Lithuania and the forecasted decline in the volume of emergency calls per capita.

Figure 48 - Annual number of mobile emergency calls in Lithuania (2017-2025, thousand)



Source: PTOLEMUS estimates based on data from EENA and interview of the Lithuanian PSAP

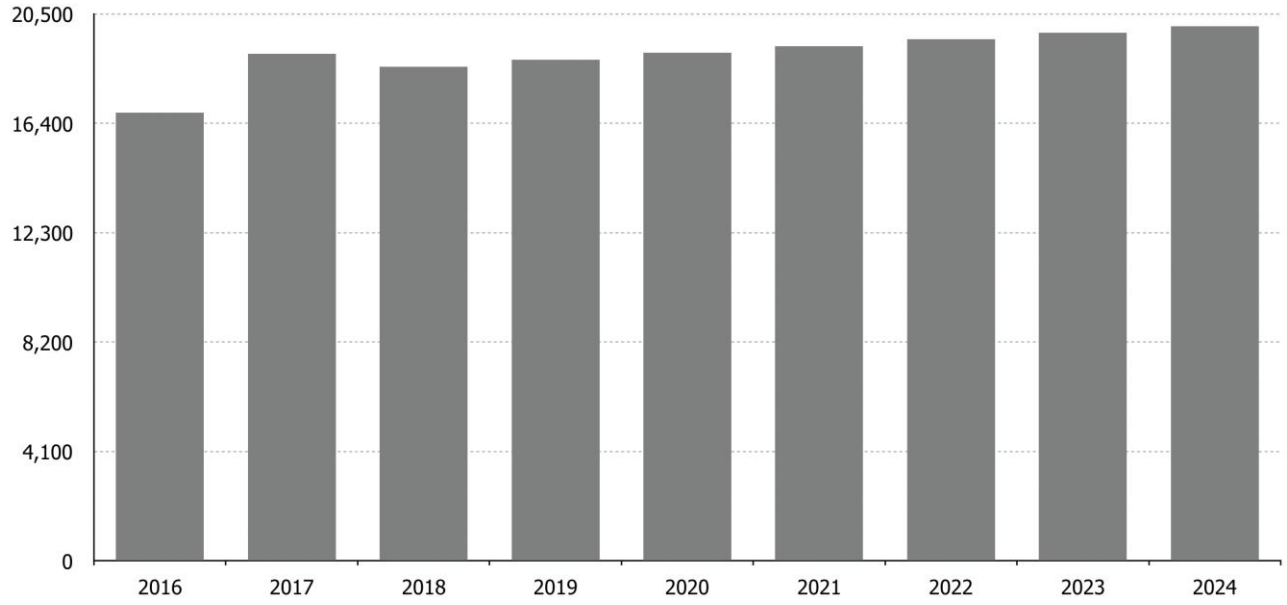
The UK

To identify the number of addressable calls, we forecast the number of mobile emergencies calls in the UK over a 10-year timeframe. Thanks to an interview of BT (Stage 1 PSAP) and an analysis of the historical number of emergency calls, we found that:

1. The number of mobile emergency calls is highly correlated to total population
2. There are no major changes in the number of emergencies per capita
3. The number of calls placed from landline is decreasing in favour of mobile calls

As a result, we expect that the number of mobile emergency calls will increase from 16.8 million in 2016 to 20 million by 2024, which corresponds to an annual growth of 2.2%. The upward trend is in line with the increasing population of the UK and the increasing rate of emergency calls placed from mobile phones.

Figure 49 - Annual number of mobile emergency calls in the UK (2016-2024, thousand)



Source: PTOLEMUS estimates based on data from EENA and interview of BT

4) ADDITIONAL CALL PROCESSING TIME AND ADDITIONAL "ON-SCENE" SEARCH TIME INPUTS TABLES

Since none of the countries analysed has measured the actual call processing time saved as a result of improved caller location, we have based our analysis on:

- The analysis of the East of England ambulance services (NHS) and reported by British Telecom (the entity managing the British stage 1 PSAP)[59]
- Interviews of executives of PSAPs that have already implemented AML.

According to an analysis made by East of England ambulance services (NHS), **it takes 30 seconds more for the call taker to handle the request and obtain the location of the emergency when compared to landline/fixed calls**. Since landline/fixed calls provide the exact location, this information is very useful to estimate location precision improvements. Additionally, it takes more than **$3^{1/2}$ minutes of additional time when victims are stressed and / or injured** (about 10% of the calls).

We have also learnt that in Iceland the call processing time was reduced by 25 seconds on average per call as a consequence of AML implementation, which is in line with previous observations as the average improvement of AML to Network location is between 1000 and 3250 meters.

Based on these facts and exchanges with PSAPs, we have built a connection of the different datapoints and identified that the relationship between location precision and the additional call processing time follows a first-order linear equation.

Additional call processing time

Precision (m)	**5000**	**3250**	**1000**	**275**	**35**	**5**
Additional processing time (in seconds)	52.8	30.0	12.8	5.3	3.1	2.9

Source: PTOLEMUS estimates based on data from various PSAPs

Similarly, to the call processing time, we gathered insights and interviewed PSAPs to estimate the time saved during the "on-scene" arrival phase.

First of all, we learnt that on average, benefits to the "on-scene" arrival process apply to only 0.4% of addressable calls, since they correspond to:

- The share of calls for which the caller is not able to give a location at all,
- The share of calls for which the caller provides a location that it is not useful.

To compute this figure, we used information gathered from the PSAPs of the UK and Lithuania. We then validated these figures by interviewing the other PSAPs involved in phase II of the Help112 project and the PSAPs in Iceland and Italy (AREU).

In the UK for instance, it has been reported that 33,000 events over a year involved a search time longer than 30 minutes. Those cases will most benefit from the increase in precision enabled by an improved caller location solution. Also, several cases in Italy and Lithuania involved several hours of search.

Based on the information provided, we also learnt that the relationship between the location precision and the time to find the actual location of the event would follow an **exponential equation**.

[59] *More Precise Locations for Mobile 999 Calls - 12 December 2017 – Cambridge Wireless Limited - British Telecommunications plc based on BT & DCMS 999/112 Liaison Committee*

Indeed, the area that needs to be searched by rescue services follows a second-order relationship with the radius defined by the precision of the location. We also assumed an average search speed per square meter of emergency operations staff that increases proportionally to the precision radius. This takes into account both the number and type of resources deployed to undertake the search (number of staff, types of vehicles, etc.).

As a result, the following inputs were considered:

Additional "on-scene" search time

Precision (m)	**5000**	**3250**	**1000**	**275**	**35**	**5**
Additional search time (in hours)	3.93	3.16	0.63	0.05	0.03	0.00

Source: PTOLEMUS estimates based on data from various PSAPs

5) VALUE OF A LIFE FROM BICKEL ET AL (2006)

Country	Fatality	Severe injury	Slight injury	Fatality	Severe injury	Slight injury
	(€2002, factor prices)			(€2002 PPP, factor prices)		
Austria	1,760,000	240,300	19,000	1,685,000	230,100	18,200
Belgium	1,639,000	249,000	16,000	1,603,000	243,200	15,700
Cyprus	704,000	92,900	6,800	798,000	105,500	7,700
Czech Republic	495,000	67,100	4,800	932,000	125,200	9,100
Denmark	2,200,000	272,300	21,300	1,672,000	206,900	16,200
Estonia	352,000	46,500	3,400	630,000	84,400	6,100
Finland	1,738,000	230,600	17,300	1,548,000	205,900	15,400
France	1,617,000	225,800	17,000	1,548,000	216,300	16,200
Germany	1,661,000	229,400	18,600	1,493,000	206,500	16,700
Greece	836,000	109,500	8,400	1,069,000	139,700	10,700
Hungary	440,000	59,000	4,300	808,000	108,400	7,900
Ireland	2,134,000	270,100	20,700	1,836,000	232,600	17,800
Italy	1,430,000	183,700	14,100	1,493,000	191,900	14,700
Latvia	275,000	36,700	2,700	534,000	72,300	5,200
Lithuania	275,000	38,000	2,700	575,000	78,500	5,700
Luxembourg	2,332,000	363,700	21,900	2,055,000	320,200	19,300
Malta	1,001,000	127,800	9,500	1,445,000	183,500	13,700
Netherlands	1,782,000	236,600	19,000	1,672,000	221,500	17,900
Norway	2,893,000	406,000	29,100	2,055,000	288,300	20,700
Poland	341,000	46,500	3,300	630,000	84,500	6,100
Portugal	803,000	107,400	7,400	1,055,000	141,000	9,700
Slovakia	308,000	42,100	3,000	699,000	96,400	6,900
Slovenia	759,000	99,000	7,300	1,028,000	133,500	9,800
Spain	1,122,000	138,900	10,500	1,302,000	161,800	12,200
Sweden	1,870,000	273,300	19,700	1,576,000	231,300	16,600
Switzerland	2,574,000	353,800	27,100	1,809,000	248,000	19,100
United Kingdom	1,815,000	235,100	18,600	1,617,000	208,900	16,600

Source: Bickel et al. (2006)

6) WORLD BANK GDP PER CAPITA AT PPP

GDP per capita at PPP	2002	2003	2015	2016	2017	2018
Austria	31.179 USD	32.109 USD	49.879 USD	51.810 USD	53.937 USD	55.455 USD
Belgium	30.282 USD	30.899 USD	46.213 USD	47.855 USD	50.221 USD	51.408 USD
Estonia	11.670 USD	13.123 USD	29.397 USD	30.913 USD	33.675 USD	35.974 USD
Finland	28.605 USD	29.019 USD	42.535 USD	44.016 USD	46.735 USD	48.417 USD
Lithuania	10.494 USD	12.068 USD	28.824 USD	30.334 USD	33.315 USD	35.461 USD
Sweden	30.751 USD	31.583 USD	48.975 USD	49.423 USD	51.879 USD	53.209 USD
United Kingdom	29.069 USD	30.262 USD	42.510 USD	43.544 USD	45.379 USD	45.974 USD

Source: PTOLEMUS based on World Bank, International Comparison Program database

7) COST OF AN SMS (TERMINATION RATES AS OF JULY 2018)

Country	Average SMS TR per country (eurocents)
AL	0,7442
AT	3,1100
BE	4,9600
BG	Confidential
CH	3,9789
CY	0,5439
CZ	Confidential
DE	N/A
DK	N/A
EE	2,2861
EL	Confidential
ES	2,6365
FI	N/A
FR	1,0000
FYROM	0,4867
HR	N/A
HU	4,5196
IE	3,1700
IS *	3,3460
IT	3,1207
LI	4,7205
LT	0,9081
LU	N/A
LV	2,1300
ME	1,0000
MT	2,1654
NL	N/A
NO	3,6641
PL	1,1900
PT	0,8300
RO	2,3000
RS	1,6924
SE	N/A
SI	B&K
SK	2,5000
TR	0,1117
UK	1,9476
Average (S)	2,3641
Average (W)	2,0453

* Not updated

Source: BEREC - Termination rates at European Level – July 2018

8) FINNISH RESCUE SERVICES STATISTICS

TOTAL PROPERTY DAMAGES FROM FIRES

	2013	2014	2015	2016	2017
Burnt Floor Area in Residential Building Fires (m^2)	73 592	75 394	66 363	75 142	67 445
Damage to Building, Furnishings in Building Fires (MEUR)	120	141	103	142	167
Property in Danger in Building Fires (MEUR)	4 104	2 838	2 969	2 920	3 150
Burnt Land Area (ha)	743	1 325	308	558	788
Burnt Forest Area (ha)	469	888	146	322	470
Vehicle Fire (MEUR)	20	26	20	23	17
Other Fire (MEUR)	26	9	10	8	5

AVERAGE PROPERTY DAMAGES FROM FIRES

	2013	2014	2015	2016	2017
Burnt Floor Area in Residential Building Fires (m^2)	23	23	22	24	22
Damage to Building, Furnish-ings in Building Fires (€)	20 705	23 413	19 527	25 350	31 132
Burnt Land Area (ha)	0,26	0,36	0,19	0,27	0,35
Burnt Forest Area (ha)	0,31	0,52	0,19	0,33	0,52
Vehicle Fire (€)	8 310	11 655	8 698	9 685	7 754
Other Fire (€)	9 965	3 809	4 290	3 473	2 073

Source: Finnish Rescue Services' Pocket Statistics 2013-2017 by J. Ketola, E.Kokki

DEATHS

	2013	2014	2015	2016	2017
Building Fire	50	85	69	80	58
Wildfire	1	1	0	0	1
Vehicle Fire	1	2	5	4	2
Other Fire	1	0	1	2	2
Traffic Accident	268	249	265	270	233
Oil Spill	0	0	0	0	0
Hazardous Material Accident	0	3	0	0	0
Explosion, Risk of Explosion	2	1	0	0	0
Collapse, Risk of Collapse	1	3	0	1	0
Human Rescue	125	159	133	128	106

INJURED

	2013	2014	2015	2016	2017
Building Fire	563	772	588	678	617
Wildfire	5	36	4	20	22
Vehicle Fire	43	29	50	72	50
Other Fire	10	14	13	25	7
Traffic Accident	9 764	10 103	9 781	9 472	9 651
Oil Spill	19	16	14	8	7
Hazardous Material Accident	25	29	69	121	71
Explosion, Risk of Explosion	11	12	9	5	9
Collapse, Risk of Collapse	9	1	4	4	12
Human Rescue	644	599	627	635	701

Source: Finnish Rescue Services' Pocket Statistics 2013-2017 by J. Ketola, E.Kokki

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