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In space no one can hear the policy gap: barriers to wide scale adoption of satellite based services in Europe

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Abstract

European investments in space are expected to stimulate the development of the downstream value-added sector by boosting the large-scale adoption of satellite-based technologies to foster new, innovative services and deliver impactful socio-economic growth. We often hear how these satellite-based services should be changing the world around us in ways that were scarcely imaginable before, yet, so far their take-up and streamlined adoption has been slow and patchy at best. And while technology push is important to develop capabilities, it remains largely insufficient if not supported by correspondent cross-governmental policy measures. Satellite communication based telemedicine solutions that could address the connectivity needs of medical services and staff shortages in rural and remote areas in Europe, will not be taken-up as long as telemedicine is not legally acknowledge as a medical act. The Advanced Mobile Location (AML) GNSS-based solution for emergency calling which could save the EU 95 billion and 7500 lives over a ten years period, finds itself in similar situation. The technology is already there, yet only 8 EU countries have taken up AML, despite its potential to significantly improve emergency response services. Policy change is thus a crucial factor in bringing about the kind of social change that translates into an effective penetration of satellite services within society. Eurisy, a non-profit association of European space agencies, has been working to understand, from a policy perspective, what hampers satellite-based services adoption. More recently, we took a closer look at two life critical sectors: search and rescue and emergency calling, and health care services. Based on Eurisy's "Satellite Applications for the Alps" and "Satellite Applications for Future Health Services" projects, we thus aimed to identify the most critical policy gaps hindering the diffusion of satellite-based services in these domains. Like many other areas, these too suffer from a serious case of "pilotitis". The technology benefits have been proven time and time again, yet they fail to gain the needed level of diffusion and acceptance to be integrated in national policies. It is thus clear that technology alone and RD driven approaches have not been sufficient in driving adoption. Similarly, top-down measures to stimulate take-up are not enough unless they are accompanied by grassroots support to the potential end-users. But most importantly, policies that allow for the integration of new technologies and practices need to be put in place.

Keywords: Satellite applications, Satellite communications, Telemedicine, Advanced Mobile Location, Galileo, Space Policy

1. Introduction

Between 2014 and 2020 the European investments in space will have amounted to € 6.8 billion for Galileo and EGNOS and to € 4.3 billion for Copernicus, making space a strategic objective for Europe. The strategic importance of the sector was further consolidated through the establishment of a "Space Strategy for Europe" in 2016 and the subsequent establishment of a EU Space Programme.

The Programme aimed at addressing not only key policy areas, such as the Europe's economic competitiveness, climate change, the European Digital Single Market and the sustainable management of our resources, but also reinforce Europe's role as a global player in a rapidly changing sector globally. To meet these key priorities and challenges, the upcoming EU Multi-Annual Financial Framework (MFF) 2021-2027, foresees an increase of EU's Space Programme Budget from its previous € 11.5 billion to € 16 billion, with 3% of the total allocated budget to be distributed for the new Space Situational Awareness Programme and GovSatCom.[1]

The underlining driver for these increased investments in the sector is the expectation that the programmes will deliver significant socio-economic growth through new innovative services and business opportunities for European stakeholders, whether public or private. According to a 2019 Copernicus Market Report, the overall investment of € 8.2 billion which was forecasted for 2008-2020 will have generated economic benefits between € 16.2 and € 21.3 billion (excluding non-monetary benefits) over the same

period, with the highest growth expected in agriculture, forestry and urban and ocean monitoring sectors[2].

Similarly, it is assumed that today about 10% of the EU's GDP – more than € 1 100 billion – is enabled by satellite navigation signals [3]. It is evident that the data and services derived from space systems can contribute to numerous public policies and economic sectors. From using mobile phones to car navigation systems, to environmental protection, precision farming and so on, satellite-based services are ubiquitous and indispensable for our daily lives.

Yet, despite these encouraging numbers and positive trends, the uptake of satellite-based services across user markets, whether these services are fuelled by Earth Observation, satellite communication or satellite navigation technologies, continues to remain slow and patchy across EU Member States.

When 60% of the total revenues of the Earth Observation market is driven by the provision of high and very high resolution (spatial resolution below 1m) private data, one can only question to what extent does the free and open satellite observation data available, such as the 20 Tb of data per day produced by Copernicus, truly responds to user/market needs.

Europe's new Space Strategy recognises that satellite based solutions have not yet been fully exploited. Nor have the wider possibilities offered by space data and signals. More so, the expected socio-economic benefits of these programmes depend on whether professional non-space sector communities adopt and use these innovative tools on a wide scale – operationally and on a long-term basis.

The need to optimise the socio-economic returns that space brings to society and the wider EU economy together with encouraging the uptake of Copernicus, EGNOS and Galileo, takes centre stage within the new EU strategy. So is the need for the space sector to be better connected to other policies and economic areas. As such, the strategy calls for the increase of measures to facilitate the uptake of Copernicus data and Galileo services in a larger variety of economic sectors, as well as to increase use within the research community, third party actors (NGOs, international organisations etc.) and emerging downstream sectors. This need for better cross-sector policy alignment is evident to allow public sector stakeholders - which were expected to be the primary "consumers" of the Copernicus and Galileo programmes - to offer better services to their constituents, but also to create sustainable business opportunities for private actors. On this note, it is important to highlight that private sector stakeholders operate and develop services depending on whether or not business opportunities and respectively, profit potential exists in a certain market. In other words, private sector stakeholders will only use and invest in space solutions if there is a sustainable business model for them to grasp.

Moreover, building a business case requires an understanding of the end-user's organisational and socio-economic context, as well as a change in the end-user's perceptions and attitude towards the new products and/or technology. Within the process of bringing new innovative services to market, the hurdles and setbacks can be many and widely different depending on market or sector. A common cross-sector feature is however found in regulation. Legislation, in particular EU regulations and directives, for the purpose of this paper, can either foster or hinder opportunities for satellite-based services use.

Drawing on Eurisy's observations in our previous work, we can argue that EU regulations and directives create a common reporting framework for both private sector stakeholders and public authorities to abide by and trigger the wide-scale uptake of new technologies.

One such example can be found in the EU's Regulation (EU) 2015/758, which made mandatory fitting of 112-based eCall in-vehicle system on all new types of M1 and N1 vehicles (passenger cars and light duty vehicles) from 31 March 2018 onward. The 112 eCall feature automatically dials Europe's single emergency number 112, in the event of a serious road accident and communicates the vehicle's location to the emergency service, thus leveraging EGNSS (Galileo and EGNOS) technology and EU investments in the area. It was estimated that 112 eCall can speed up emergency response times by 40% in urban areas and 50% in the countryside and can reduce the number of fatalities by at least 4% and the number of severe injuries by 6% . Entering into force in April 2018, the Directive is thus translating the use of space infrastructure into a measurable benefit for European citizens [4].

However, whilst users have not reported particular technological problems in implementing the new service, remaining issues relate to interoperability, updating legislation and/or identifying between fake and actual calls. Another example, this time leveraging Copernicus data and services is the Commission Implementing Regulation (EU) 2018/746 of 18 May 2018 amending Implementing Regulation (EU) No 809/2014 regarding modification of single applications and payment claims and checks [5]. Under the Common Agriculture Policy (CAP), EU member states are required to carry out on-farm checks to ensure that payments made to farmers are correctly allocated and that cross-compliance requirements are respected. The modifications brought to the above EU regulation, will now allow member states to opt for using Copernicus Sentinel satellites data and/or other Earth observation data sets to verify payment claims. Other new forms of evidence such as, geo-tagged photos, information from

drones and relevant supporting documentation from farmers (e.g. seed labels), will also be accepted for the first time. Although not mandatory and countries will be free to choose whether they take-up this new monitoring approach, legislating the use of Earth Observation data is a significant step forward. For CAP it has the power to not only steer public authorities towards legally using these new data sources, but also provide Earth Observation service suppliers with a viable market demand.

Indeed, according to the 2019 Copernicus Market Analysis report, agriculture along with forestry are expected to register one of highest annual growth rates running up to 2020 with € 318 million revenues enabled by Copernicus together with an annual average growth rate of 31% . Although the report does not provide us with a clear correlation as to whether the legislative change has in fact triggered a growth in the use of Copernicus data for agriculture, one can assume that the removal of a legislative hurdle (i.e. satellite data is now recognised as a legal piece of evidence) can only produce a positive snow-ball effect among public authorities in the long-term.

Ecall and the Common Agricultural Policy are just two positive legislative examples, but there is yet much ground to cover to create a favourable regulatory and business environment that incentivises both public and private sector organisations to make full use of the available satellite-enabled services and data. The number of specific user segment hurdles, market access barriers and policy gaps are many, as both Copernicus and Galileo serve various vertical and cross-sector markets. From the need to improve the distribution and access to data and render it usable by non-specialists, to the need for more user-driven products through the stronger involvement of targeted non-space communities, there are numerous challenges which the upcoming MFF programme will need to address. Eurisy's work on this occasion has focused on highlighting how policy alignments, however small, can play a role in reducing the significant gap between the volume of space investments and use of satellite based services in two very particular areas – telemedicine and emergency calling.

Eurisy is a European non-profit association of space agencies and governmental offices dealing with space affairs whose mission is to bridge space and society by promoting the benefits of using satellite-based services to increase socio-economic growth and by providing decision makers with a bottom-up feedback on the barriers hindering the wide scale adoption of such services by non-space user communities in Europe.

As part of its User Programme which debuted in 2007 and which has been supported by a series of activities, including events and market uptake reports, Eurisy has launched user consultation exercises focused on health and emergency calling in 2016 and 2017 respectively. Our direct work with user communities pertaining to the two sectors stands at the base of this paper and the observations and recommendations stemming from it.

2. Objective, methods and working hypothesis

This paper aims to report on Eurisy's work and consultations with user communities, industry and service providers through its two programmes "Satellite Services for Future Health" and "Satellite Applications for the Alps". Under these user focused programmes, Eurisy has organised several conferences and embedded events focused on both health and the needs of alpine communities, in cooperation with its members and/or external partners. Beyond exploring opportunities and challenges, these events in their different shapes and forms, we're also aimed at raising awareness on the available services and technologies and provide support to end-users by matching them with service providers and satellite service experts that could provide a neutral advice on the technology. All along, gathering bottom-up feedback for Eurisy's members on market opportunities and existing gaps.

Eurisy's conference on "Satellite Services for Future Health" gathered confirmed and potential users of satellite-based services covering health care and the environment (e.g. telemedicine, air pollution), as well as experts, private sector representatives and policy makers belonging to both space and non-space communities. In preparation of the event Eurisy held numerous interviews with numerous stakeholders focusing on what the end-users needed to achieve in the framework of their organisations and socio-economic environment. The interviews have also helped us narrow down our working topic to focus on applications for telemedicine. For this study we'll refer to telemonitoring and prevention are the predominant types of intervention for telemedicine solutions, along with teleconsultations. As the healthcare systems in Europe are facing new challenges such as, an increasingly ageing population and increased mounting budgetary pressure, telemedicine emerged as market sector where satellites can have a clear added value role and where uptake can be correlated with the surge of information technologies in Europe as the main driver for its diffusion.

The "Satellite Applications for the Alps" project consisted of a study on user needs for Alpine search and rescue services where satellite applications may apply, two conference and several embedded sessions.

Between 2016 and 2017, Eurisy has contacted 18 search and rescue organisations and civil protection agencies working at the regional levels in 6 different Alpine countries, including Austria, France, Germany, Italy, Slovenia and Switzerland. Based on the expressed interest of the rescue organisations interviewed, as well

as the recommendations made by experts, the project looked at three main areas where satellites provide a unique value: emergency calling, team coordination and Earth Observation data use for risk mapping and mitigation efforts.

The current paper draws on the observations obtained through these open-ended interviews which provided Eurisy with insights into end-user's needs in relation to emergency calling, as well as, into the challenges encountered by these communities when adopting a satellite-based solution [6].

Subsequently, our research has been complimented by desk research and consultations with pan-European associations, respectively the European Emergency Number Association for emergency calling and the European Connected Health Alliance and Agir pour la Telemedicine in France for telemedicine.

Whether through events, interviews or formal and informal consultations, Eurisy's activities with user communities have not focused on the technology itself but on what end users needed to achieve within their mandate and what legislative frameworks underpin their daily responsibilities. The current document reflects on the main non-technical barriers identified, impeding or slowing down the adoption and long-term use of satellite--based telemedicine solutions and satellite enabled accuracy for emergency calling.

3. Case study: telemedicine uptake in Europe

Today people live longer, more urban lifestyles and the trend is only going up. By 2060, one in three Europeans will be over 65 years old. In the workforce, the ratio of four active to one inactive individual is expected to go down to 2 to 1. A rising demand of health, social and informal care services is estimated to increase public health and care budgets on average by 1-2% by 2060 [7].

In addition, according to the World Health Organization (WHO), over 85% of deaths in the EU are due to five major chronic diseases (diabetes, cardiovascular diseases, cancer, chronic respiratory diseases, and mental disorders) [8]. These dire trends are found at the intersection with yet another - the current health care sector human resource deficit in the European Union which is at a critical level. On average, there are currently only 3.5 physicians available per 1,000 inhabitants in the EU, thus affecting not just the quality of care, but also the reach of medical care services. Moreover, as a result of urbanisation and shrinking rural populations, "medical deserts" areas - defined as inhabited areas located more than 60 minutes away from properly-equipped hospitals - add to the challenge of providing high quality services for a growing elderly population suffering from chronicle diseases [9].

Drawing on these challenges and many others, introducing digitalisation into medical operations has increased these past years, due in part to world-wide IoT and digitalisation trends, but also due to the proliferation of Start-ups and companies providing alternative solutions to the classical "one-on-one" in-person doctor-patient meetings. In 2016, 79% of EU residents between 16 and 74 years old accessed the Internet using a mobile phone or smartphone [10]. This ubiquitous connectivity of mobile networks and the proliferation of smartphones, in combination with more demanding patients who are more attuned with their right and the risks of medical faults, have acted as a catalyser for the emergence of eHealth applications.

For example, according to a study by Research 2 Guidance, in 2017 there were 325,000 mobile health apps and 84,000 mHealth app publishers making healthcare mobile app development, one of the fastest-growing areas with a tremendous 32.5% compound annual growth rate (CAGR) [11]. Europe accounts for 30% of the global market and is the fastest-growing segment with a CAGR of 61.6% [12].

3.1 Defining telemedicine

Telemedicine solutions, described as services and products designed to utilise technology to improve and coordinate patient care, are part of a wider eHealth trend which spans across various medical sectors, institutions, products and services, involving many and diverse stakeholders (telecommunication companies, ICT tools and electronics manufacturers, device manufacturers, pharmaceutical industry companies, and start-ups).

Many definitions of telemedicine exist, ranging from very broad to specific, highlighting it as an open domain constantly evolving. According to Wootton, telemedicine can be defined as "*an umbrella term that encompasses any medical activity involving an element of distance*" [13]. Shaw defines it as the "*use of telecommunications technology for medical diagnostic, monitoring, and therapeutic purposes when distance separates the users*" [14].

Meanwhile, the World Health Organisation has adopted the following description: "*the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities*"[15] .

According to market figures provided by Statista, the global telemedicine market is expected to reach more than €37 billion by 2021 at a CAGR of 14% during that period. The numbers reflect a dynamic sector that has the potential to drastically influence the

delivery of healthcare solutions at sometimes lower costs for public authorities [16].

3.2 Bottlenecks to telemedicine adoption

Satellite communications can play a key role in contributing to the successful deployment of these new services. Moreover, given Europe's physical geography, with many islands and remote areas, one could argue that there is a clear case to be made for using satcom powered solutions, as the technology is not depended on pre-existing terrestrial infrastructure and its robustness and reliability has been proven for decades through numerous pilot projects undertaken by several space agencies, such as the European Space Agency, CNES, NASA etc.

One look at the European Space Agency's numerous projects funded under its Advanced Research in Telecommunications System (ARTES) programme confirms the technology's market readiness. Yet, few of these have gone beyond demo and/or pilot stages to be taken up by end-users or transformed into a sellable product by private stakeholders. Through its "Satellite Services for Future Health", Eurisy sought to understand by liaising with end-user communities why is this the case and what are the barriers impeding the adoption and long-term use of satellite-based health services.

A recurring message emerging from our user consultations hints that barriers to the adoption of satellite-based services in the health sector are not technology-related. The lack of supporting policies, customer reimbursement schemes, the lack of awareness on the available tech solutions, healthcare professionals' payments, availability of adequate training and digital literacy seem to play a much more critical role in this sector. And so does interoperability and the users' perceptions. An online study carried out in 2016 within the ICARE4EU project, a EU Horizon2020 research project, with 58 care programme managers from 24 European countries, reinforces our findings:

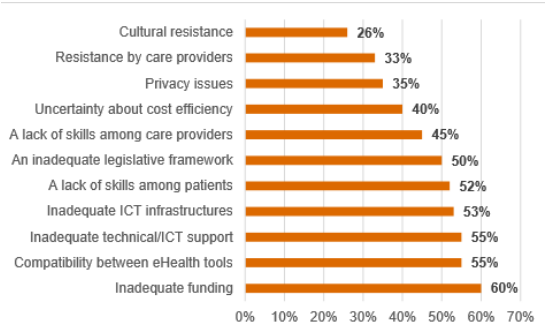

Fig 1: Barriers hampering the use of eHealth tools included in the programs (% agreeing) [17]

Most importantly, most EU countries lack a precise legal framework to regulate telemedicine practices, while existing laws can be misaligned with recent technological innovations. Despite numerous initiatives taken at a European level there is a continued lack of uniform norms to regulate telemedicine services.

Achieving an aligned set of rules and regulations presents itself as a gargantuan task as the approach to telemedicine varies immensely in between the European countries. While some states approached telemedicine from the perspective of laws in the field of ITC technologies, others regulated it under healthcare delivery or even under the social security domain. In other countries, the physical presence of the patient and the health professional at the same time and in the same place, is needed for a medical act to be legally valid (e.g. Poland). Thus, completely shunning out telemedicine from being considered a medical act and in return preventing private companies from developing and including such services in their portfolio.

Where telemedicine is regarded as a legal medical act, the lack of reimbursements schemes prevent both doctors and patients from signing up for such services. In almost all countries, reimbursement schemes of tele-consultation or other telemedicine services to patients are vague, non-transparent or non-existent and the slow pace of legislation change is not helping solve these problems.

Contrary to other EU members, France is however paving the way in terms of legislation in an attempt to fill existing gaps in medical coverage in parts of the country lacking doctors. As of October 2018, after 10 years of feasibility studies, telemedicine consultations can now be legally covered by both public and private healthcare providers. A much awaited legislative change that nonetheless took 10 years to enter into force, due in part to the consistent advocacy efforts of medical and patient associations. But even here, not all telemedicine acts are included, as only tele-consultation and tele-expertise services have been legally recognised for reimbursement through the national Health Insurance Fund.

Nonetheless, the expansion of telemedicine in France opens up new opportunities for the various health sector stakeholders and private sector actors to propose satcom-based solutions especially in areas with low connectivity.

Unlike other sectors, healthcare is strongly regulated and very much evidence-driven. As such, there is a need to increase the base of evidence on the benefits of telemedicine services at a large scale, as the deployment of such services remains sporadic and ad-hoc.

Telemedicine and other eHealth services also create a complex situation with regards to liability, in particular the liability - on one side of healthcare professionals who use the technological tools and - on

the other the liability of providers which supply them. If your Uber fails to show up, it's inconvenient at best, but not life-threatening. Launching a new service in a highly regulated market as healthcare, is however a completely different matter. As follows, many healthcare professionals are reluctant to adopt new technologies or change their practices, especially when legislation does not provide clear liability and accountability rules for practitioners in telemedicine.

For example, although telemedicine is recognised in the Netherlands, due to the lack of legislative clarity, healthcare professionals are fearful of using telemedicine tools because they deem the nature of remote care could expose them to the risk of malpractice. As such, the liability aspect of such services could also profit from more legal clarity, at a national or European level.

Resistance to change, translated into a lack of acceptance of new technologies is not limited to healthcare professionals, but extends also to patients. Reluctance to use telemedicine can also be linked to the low level of digital literacy which can be an important factor for weak end-user adoption of telemedicine solutions. In return, providers looking to sell their products in this sector might find themselves in need to spend a considerable amount of time and resources educating their clients. Time and resources which might be unaffordable for small companies looking to scale-up.

Going beyond digital literacy, the lack of adequate IT infrastructures in hospitals and medical centres that can integrate telemedicine solutions also undermines their deployment and use. And while the technology is there, users might not have the know-how to translate their needs into technical requirements when the opportunity to procure such a service would arise. In addition, the technical jargon associated to satellite-based services can make such technologies inacceptable to non-experts, whether they are health care practitioners or policy makers.

Consequently, these user communities will be unwilling to make swift decisions on legislation change, reimbursement schemes or funding when they do not have a clear understanding or sufficient evidence on the benefits of using a new technology, be it satellite powered or not. In turn, this affects market players who cannot scale up their products and thus might find themselves in need to keep prices high.

The perception of costs, especially when it comes to satellite-based services being perceived as expensive products continues to remain high among public authorities, despite a constant decrease in prices. At the same time, there is sometimes no understanding regarding what the current costs are (e.g. costs to send and keep a person in hospital), which makes it difficult to evaluate potential savings or additional costs entailed by the adoption of satellite-based services and telemedicine in general. Moreover, we should also consider that different stakeholders have different needs and satellite-based solutions might not fit them. These diverse needs have also led to a fragmentation of solutions, which are usually not interoperable with each other and interoperability is another key challenge that will need to be potentially addressed through the EU's Digital Single Market policy.

Notwithstanding the few operational cases Eurisy has encountered during its research, satellite communication-enabled telemedicine products are few and cannot be rendered cost effective without the development of a wide spread use and/or a solid community of users and stakeholders that would share costs and risks. Moreover, the extreme legislative fragmentation and lack of standards act as a heavy barrier to telemedicine services' adoption and seriously restricts the potential for its widespread use across EU countries, whilst rending companies reluctant to take-on satellite technologies and turn them into business models.

Indeed, the barriers pertaining to the healthcare sector are many and diverse, but ultimately, governance and policy play a key role, if not, a critical one, in the diffusion of satellite-based applications. Data-sharing principles, standards, procurement practices, funding opportunities and healthcare systems structures, all of these continue to vary widely among countries and/or regions. Space sector stakeholders can and should be a viable partner to national decision makers and key institutions in the medical community to help develop and pay for the utilisation of satellite-based technologies and support the growth of this niche market which will potentially create more value than isolated and scattered user cases.

4. Study case: Advanced Mobile Location for emergency services

In 2018 alone, 293.510.378 calls to the emergency services were registered in the European Union. Out of the total, 73% were made from a mobile phone, significantly outweighing calls from fixed lines [18]. Like many other communities, emergency services share common challenges and needs. In many emergency cases, no matter the season or whether these occur in urban, rural or outdoor remote locations, their successful resolution is driven by one key information factor – the emergency caller's location. An accurate caller location in case of an emergency is one of the most significant pieces of information an emergency call-taker can use and every minute counts in these critical situations.

With the exception of a handful of EU countries, an emergency caller's location is, in most cases, determined and communicated to Public Safety

Answering Points (or PSAPs) by local mobile operators based on the information obtained from their cell towers networks. Known as Cell-ID technology, its reported accuracy ranges from 500 to 40000 meters, depending on the density of the network of cell towers, i.e: urban or rural area. When it comes to public perceptions on the accurate localisation of emergency calls, there is however a considerable gap between expectations and reality. In the end, if your Uber driver can quickly find you why emergency services wouldn't?

According to the 2017 European GNSS Market Report, civilians expect to be located at an accuracy of 5-10 m when using a mobile phone to call the emergency services. In reality, the current technology solutions available in EU Member States using mobile Cell or sector ID technology provide numbers not even close to those expectations [19]. And in emergency situations, this wide spectrum of accuracy can be a determining factor for a mission's success.

When the caller's position is inaccurate or too wide, it leads to a delay for the whole emergency services chain, thus increasing not only the time spent on the phone, but also the rescuers' arrival. At times, minutes can turn into days for search and rescue teams and each mission requires considerable team planning, coordination and equipment. In the summer of 2019, three people in three different countries lost their lives due to the emergency services' inability to accurately locate them. The three tragedies have been widely covered by the media at a European level, bringing location accuracy and the gap between user expectations and the weak prowess of the technology in use, into the spotlight.

Another important factor to a successful emergency intervention is time. The time needed for receiving the caller location by the 112 operator is crucial. A European inventory of the state-of-the-art technology conducted in 2016 during the EU funded project Help112, highlights public authorities reporting a variety of timeframes when it comes to identifying a caller's location which can vary from less than 3 seconds to 30 minutes depending on the country, mobile operator and technology in use. Article 26.5 of the European Union's Universal Service Directive states that "*Members states shall ensure that undertakings concerned make caller location information free of charge to the authority handling emergency calls as soon as the call reaches that authority*"[20].

Considering the long response time reported by some member states, the Help112 report brings into question to what extent has this directive, and others, been implemented accordingly. The report takes Greece as an example where the method used by the Public Safety Answering Points to obtain location information from mobile operators, involves a written request from the PSAP to the mobile operator, a request which is sent by fax.

In July 2019, the European Commission announced that it will pursue infringement procedures against five member states (Croatia, Czech Republic, Germany, Greece and Spain) for lack of compliance with EU law in the implementation of "*equal rights*" access to emergency services laid down in the aforementioned Universal Service Directive. It took the European Commission, a decade after the entry into force of this law, to kick-start infringement procedures. The procedures could result in potential financial penalties against these five member states for not adequately facilitating access to emergency services to people with disabilities [21]. For the purpose of this study, we have not found any estimation as to how many lives have been affected by the lack of proper implementation of equal access rights. One can however assume these numbers are not negligible for the infringement mechanism to be triggered.

Since the launch of the Universal Service Directive, the European Union has launched a total 17 infringement proceedings against Member States which have not complied with the relevant requirements related to the implementation of 112. Among the requirements covered, these relate to the lack of the 112's number availability, non-availability of caller location information and the degree of effectiveness for handling and answering 112 calls. No proceeding were triggered for location accuracy since in Europe, despite the existence of legislation to mandate accuracy and reliability targets for locating emergency calls, no member state has set any. As such, it would be hard to argue for triggering infringement procedures related to a call's location accuracy when no targets have been set.

According the European Emergency Number Association, every year about three hundred thousand people who call the emergency services cannot describe their location. This is because they may not know where they are, they might be too young to say, too injured to communicate and so on. And knowing the exact location of the caller is a vital piece of information for operators to promptly respond in these situations. To try and address this challenge, the European Commission proceeded to fund the testing of a new GNSS based solution called Advanced Mobile Location or AML, which was initially developed and tested in cooperation with national authorities and industry in the United Kingdom and tested in several countries [22].

4.1 Introducing AML

Compared to the Cell ID technology in use, the purpose of the AML project was to use the existing inner smart phone technology to pass GNSS or Wi-Fi based location data directly to the emergency services, thus bypassing mobile operator networks. When the

project kicked-off in 2016, it was estimated that each year in the UK there were about 36,000 cases where the emergency services have had to spend a considerable amount of time searching for an incident because a precise location information could not be provided by the caller. After a year spent in development and testing, project results returned very positive data.

	Average radius		
Country	Cell-ID[4]	GNSS	Wi-Fi
Austria	1,550 m	6 m	20 m
Italy	1,377 m	28 m	24 m
Lithuania	5,506 m	21 m	35 m
United Kingdom	1,983 m	14 m	24 m

Fig.2. Accuracy obtained in field tests AML project[23]

In 90% of the cases, AML provided an accuracy location within 50 meters of the caller, with the information received by PSAPs usually being down to between 5-10 meters [24]. In some areas, thanks to AML, accuracy levels were improved up to 4000 times, relying here not only on GNSS data, but supplementing it with Cell-ID and Wi-Fi networks information where available. The Help112 project also analysed costs and benefits for 7 alternative positioning technologies (cellular networks, Wi-Fi and satellite positioning e.g. GPS and Galileo - Europe's satellite navigation system), together with 5 different data transmission technologies (SMS, HTTPS, eCall, IMS, network transmission). In doing so, it identified handset-derived location information using the global navigation satellite system (GNSS) technology as the most effective way to improve caller accuracy.

Project results also estimated that improved emergency caller location could save 800 lives annually and help national, regional and local authorities save up to €100 billion in emergency rescue costs over a decade. Moreover, by ensuring compatibility with the EU's satellite navigation programme Galileo, AML could bring additional net benefits estimated between €240 million and €1 billion over the next 10 years [25].

As Europe's Galileo constellation is expected to enter into full operational capacity starting 2020, Galileo is thus expected to make a considerable contribution to saving lives by improving caller location up to the metre. Besides the considerable socio-economic return estimations and live-saving features, AML has an extra important perk – users don't need to install any apps, nor make any updates to their phones. AML is not an application and its functionality is automatically activated when an emergency call – to 112 in the European Union or to any other national emergency number – is detected inside a mobile phone.

This feature is of most importance, as in Europe we find numerous emergency apps made available by emergency services, PSAPs or commercial companies. While they confirm the need for emergency services to receive accurate caller location, most often than not, these apps are incompatible with one another or present no cross-border functionalities i.e. the app will not transmit an emergency message if a caller is outside its country of origin. Moreover, their success lies on their take-up and download numbers - thus citizens need to be aware of them and remember to use them in emergency situations.

During our user consultations, the question arose on how users can choose between the various apps and digital platforms available to them, and if indeed they should. Deciding on common tools, or on common apps, is complicated because each user that has tested or implemented an application is not keen to convert to one used by a peer organisation [26]. Beyond the lack of standards for user organisations, people also use different phones with different operating systems. The lack of standardised data sharing channels across emergency services and common standards also highlights why AML could make an important step to tackle some of these user challenges. No matter where a caller might be, the network and handset-based location is automatically provided to the most appropriate PSAP directly without any other action being required of the user.

4.2 Bottlenecks to AML implementation

Despite the numerous benefits of AML and the technology being readily available at modest costs, only 17 countries have proceeded to implemented it fully or partially (as of August 2019 AML was implemented in Austria, Belgium, Estonia, Finland, Ireland, Lithuania, the Netherlands, Malta, Slovenia, Denmark, Sweden, United Kingdom). The Commission contributes currently to this development by financing AML deployment in Germany, France, Croatia, Hungary and Portugal). According to the 2018 "*Implementation of the single European emergency number 112 – Results of the twelfth data-gathering round*" report, it is expected that by 2020 more than half of Member State would have fully deployed AML handset-based location technology.

The current national legislations on handling emergency calls (which is a competency pertaining to local governments) are however at the heart of the legislative hurdles and implementation delays. While it is clear to users that the technology helps save lives and adds convenience to emergency response procedures, its implementation is nevertheless hindered. For example, the Swedish 112 & Crisis Management Service Developer, had been ready to deploy Advanced Mobile Location (AML) since 2016, yet the authority did not have the political mandate to change legislation, nor the competences to advocate for it. Like the Swedish public authority, many other local and regional users have put

their hopes in a European Directive that would trigger legislative alignment. It remains to be seen whether at 17, we can argue that the critical mass needed to generate emulation, with more and more countries becoming interested in AML, has been achieved.

While AML is supported by both Android and iOS operating systems, the technology needs to be activated by the OS providers (Google and Apple) on a country per country basis once national authorities are technically and operationally ready to receive such information. In many cases, for this to happen, old legislation still needs to be amended by transferring the responsibility of providing a caller's location information, from mobile network operators to emergency service centres. Depending on the bureaucratic levels of a country, such a change, although minor in perception, could take a considerable amount of time to push through.

To encourage member states to improve their legislative frameworks on emergency calling, the European established the European Electronic Communications Code (EECC) in December 2018 (Directive 2018/1972 of 11 December 2018) which defines the way emergencies, from public warnings to caller location, are to be handled across the EU [27]. This new legislative text is an important milestone for AML because while the previous Universal Service Directive did not specify which method should be used to locate emergency calls (leading to unsatisfactory accuracy levels) the new directive mandates the use of both network-based location information and handset-derived caller location information – hence the Advanced Mobile Location technology [28].

To compliment this Directive, another legislative text will require smartphones sold in the European Union to support the technical solutions that provide accurate handset-derived information to emergency services so as to mitigate critical risks linked to the implementation of AML. This is due to the fact that even if a phone is equipped with a chipset that offers all the latest GNSS features available on the market, the handset manufacturer plays an important role in permitting the use of these features, specifically the use of GNSS, Wi-Fi and sending of SMSs during an emergency call [29]. The directive builds on the European Electronic Communications Code, which compels EU Member States to make network-based and handset-derived caller location information available to the most appropriate PSAP without delay effective from 21 December 2020 [30].

These two new Directives are a most welcomed step forward towards improving citizen safety. Yet, there is much work still to be done as past legislative implementation experiences show. The tragedies unfolding this past summer highlighted how prolonging their full implementation can make a considerable difference in the number of people saved and how time and accuracy are of essence in life-threatening situations. And the benefits of implementing AML extend far beyond the European Union, as the technology needs to be activated by global OS providers and is supported by global GNSS systems.

Moreover, the technology can bring a clear benefit to emergency service anywhere, as well as provide decision makers and the general public with a tangible example of how space infrastructures are improving our daily lives. And while most emergency service centres do not have a political mandate, nor the competence to advocate for legislative change, space agencies do. As such, space agencies together with other space sector stakeholders can and should, play an active role in advocating for taking up AML and facilitation cross-sector cooperation within their countries.

6. Conclusions

Through the "Satellite Services for Future Health" and "Satellite Applications for Search and Rescue", Eurisy has had a unique opportunity to obtain a valuable insight into the end-user communities' needs and challenges within the healthcare and emergency sectors and analyse whether these are technology driven or not.

Eurisy has frequently reported and claimed in the past, that barriers to the user uptake of new services are seldom due to limitations to the technology itself. Also due to our role which extends further to that of an observer, by taking a stance on promoting the benefits of satellite-based applications and advocating their use, our results and recommendations can be considered as biased. This paper is also by no means conclusive and does not set out to address all the questions and challenges arising from using satellite-based technologies within the two sectors. Rather, Eurisy, sought to highlight that challenges, such as, integrating new solutions to existing workflows, digital literacy, political and legal questions, are more likely obstacles to the diffusion of satellite services among user communities. Furthermore, we sought to showcase two concrete examples where legislation, not technology, has and is playing a considerable role in either blocking or supporting the take-up and use of new technologies or services, be they satellite powered or not.

Legislation, be it national or European, has also the potential to either enable service demand and cluster needs or hinder this exercise all together. And the case of telemedicine in Europe and AML are exponential in this context where due to the diversity of national legislations, a top-down approach to overcome regulatory barriers would be useful to ensure interoperability and service quality standards. Harmonising legal frameworks to make services compatible and enable cross-border practices and

business opportunities, should be at the heart of this top-down approach, as well as a much needed cooperation.

Cross-sector cooperation between space and non-space stakeholders should be encouraged at all levels and consolidated, for decision-makers to have a comprehensive understanding of all the existing and future technologies at their disposal. Because while satellites are an important component facilitating daily services for citizens, their use and role is frequently overlooked in policy making. For example, a 2018 Market Study on Telemedicine commissioned by the EU Commission Directorate-General for Health and Food Safety has no mention of the available satellite powered tools that can foster telemedicine service in remote or low covered broadband areas. The document however covers mobile and makes reference to future 5G networks. Such cross-sector exchanges can range from ad-hoc meetings, such as the inter-service group for Galileo between DG GROW, who is in charge of the programme's management and its "customers" DG MOVE, DG CONNECT, DG HOME and DG AGRI, to more institutionalised recurrent ones. For telemedicine, pan-European user organisations, such as the European Connected Health Alliance or the International Society for Telemedicine and E-Health, the World Health Organisation and others, should also be engaged to help cluster user needs and disseminate knowledge and good practices. This should be the case also with emergency and rescue services with the European Emergency Number Association or any thematic sector for that matter.

Whether we're talking about health, energy, agriculture and so on, establishing such cross-sector cooperation networks, which can be an effective ground for peer-to-peer exchanges, could act as a catalyst for enhancing the diffusion of satellite services. Through its "User Programme" Eurisy will continue to act and be at the forefront of these cross-sector exchanges in pursuit of its mission to bridge space and society.

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