Satellite Services for Future Health

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Outcomes from the "Satellite Services for Future Health" conference, held in Belfast, United Kingdom, on 27 June 2017

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Today people live longer, more urban lifestyles and the trend is 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 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 [1].

Health is nonetheless an extensive and complex domain. Spanning across sectors, institutions, products and services, it involves many and diverse stakeholders. From hospitals, to insurance companies, providers, manufacturers, telecommunications and software producers, there is no shortage of potential cross-sector innovation. Space-based solutions are part and parcel of that.

Services, infrastructure and facilities provided by satellite communications, satellite navigation and Earth observation data, as well as technologies developed to support human space flights, can provide public and private health stakeholders with important tools to support this demographic and lifestyle change. Whether they are addressing planning, prevention, early warning or health-care delivery, numerous applications and technologies have been successfully tested in recent years.

Where does the maximum potential for exploiting these tools lie?

Certain sectors, such as oil & gas or insurance, seem to have seized the satellite driven innovation opportunity. Yet, in most European countries, it is especially the public sector that faces the challenge of infinite demand and finite resources. This is particularly true for the health sector, charged with the task of providing efficient services to an increasingly ageing population and stressed budgets.

Whether financial, bureaucratic or human, the entry barriers to including new technologies into the health and social care sectors are many and diverse. Drawing on consultations with local and regional health stakeholders, as well as space sector representatives, Eurisy selected three subthemes to drive discussions during the "Satellite Services for Future Health" conference: remote monitoring of patients, environmental health and ageing.

Confirmed and potential users of satellite based services covering health care and environment (e.g. telemedicine, air pollution), as well as experts, private sector representatives and policy makers belonging to both space and non-space communities, were invited to Belfast to discuss the potential of satellite applications in these sectors. On this occasion, attending delegates took the opportunity to share their experiences, lessons learned and exchange on how future technology-powered health and social care systems might look like. (Access the presentations here)

The current document reflects on some of the lessons learned from the event, highlighting key points from the discussions that took place during the day.

The one-day event did not set out to cover and answer all the questions that arise with regard to innovation in health and care services. Rather, Eurisy sought to open a process where these questions can be taken further by the local and regional stakeholders, with its support. The

event was also an opportunity to identify some of the existing barriers to scaling up the use of satellite based services in these sectors whilst exploring the potential of expanding user communities.

I. Technology NOT an entry barrier for the adoption and long-term use of satellite based health services

In general, the barriers to the adoption and long-term use of satellite-based services in the health sector are not technology-related. The technology has been there for years. One look at the European Space Agency's health projects database confirms that. **The lack of supporting policies, customer reimbursement schemes, healthcare professionals' payments, availability of adequate training and critical infrastructure seem to play a more critical role in this sector.** And so does the perception of cost. According to John Vesey from the UK Satellite Applications Catapult, public authorities continue to have a wrong perception of project costs, generally perceiving the adoption of new technologies as being costly. This perception is particularly strong when it comes to satellite based services, despite a constant decrease in prices. Indeed, a dedicated telemedicine satellite connectivity frequency can be a costly affair. However, in many cases, a constant connection might be unnecessary. Assessing the need of such a connection, as well as the possibility to combine it with other types of solutions should thus be evaluated from the beginning.

At the same time, there is sometimes no **understanding regarding what the current costs are** (e.g. costs to send a person to a hospital), which makes it difficult to evaluate the potential savings or additional costs entailed by the adoption of satellite-based services. Moreover, when it comes to rolling out pilot projects, we should consider that **different stakeholders have different needs**. And satellite-based solutions might not fit with them. Therefore, **collecting as many Key Performance Indicators as possible during the pilot stage for all the different stakeholders, whilst measuring economic impact and return, is a necessary step to ensure service sustainability**. In turn, this would facilitate quantifying costs and benefits for each of them.

The DiabSat project, currently covering France's Midi-Pyrénées region's remote areas, requested an initial investment of € 900K over a period of four years. The service involves Satcom connected vehicles that travel to isolated areas regularly to screen for diabetes' complications. The tests are processed by specialists of the Toulouse Hospital through the satellite connection and the results are sent directly to patients and their personal doctors.

Launched in 2010, this was partially funded by the French Space Agency CNES (50%) and the regional authorities (50%). Since then, over 3 650 patients have been screened for diabetes related conditions (retinopathy, microalbuminury, arteriopathy, neuropathy, etc) with 50% of patients screened presenting anomalies. After completion of the pilot phase, the service was taken up by the regional health authority, which now covers the € 70K needed to run the service yearly. The equivalent to a standard examination' costs for an activity of seven patients per day / 200 days per year. However, despite the project's success, it is still one of the few

operational examples in France, if not in Europe. And even here, it has not been deployed at a nationwide scale.

A similar project addressing diabetes-related screenings in remote areas is currently being piloted in the Scottish Highlands (Rapid Project), but it is too early to tell whether it will be adopted by the UK's National Health Service (NHS) on a longer term. However, one project managed to get into the NHS procurement system: the Mobile Breast Screening Service. Thanks to a Satcom connection, images and patient data are wirelessly transmitted from vans directly back to HQ GPs in 2-3 minutes.

Initially deployed within the framework of the ESA-funded Mercury project (2014), the service was further carried on by the University Hospitals Coventry and Warwickshire NHS Trust following a cost-benefit analysis of the service. This analysis showed that the satellite-based system was **cost-neutral for the user.** Previously, costs included a courier and a car to physically collect and transfer the tests results and patient data from the vans to the reporting centre. More important, in terms of time management the new service greatly improved results turnaround from 14 days to just three. Furthermore, the value of the service does not lie in the satellite connection but rather in its **combination with other types of technologies**. To minimise costs, the vans use both satellite and 3G and 4G connections, depending on their needs.

For the 2017/2018 term, the service is now looking towards nationwide implementation with 2 new trusts and eight new vehicles to be deployed in the UK. Furthermore, a similar programme focused on retinal screening is in the making. While the project has been a success, it has taken several years to get here. Along the way, implementing **change management** so as to move towards a full **commercial direction**, posed significant challenges for the stakeholders involved.

In the case of DiabSat, according to the French MEDES Institute, the challenge of transforming the project into a successful business case spurs from the fact that, except in very specific cases, **telemedicine acts are not reimbursed** by the French social health system. Similar reimbursement models, based on reimbursements by institutional payers and national authorities, are applied across several European states. In addition, considering that national legislations still regard a medical act as being performed within the physical presence of the patient and his doctor, such legislation will continue to prevent the widespread use of tele-medicine solutions. This **policy gap**, renders companies reluctant to take projects over and turn them into business models.

The Ullapool Medical Center, a rural general practice serving 1,500 inhabitants in the remote Scottish Highlands, is currently piloting Hi-CAP, a capsule colonoscopy service. Colonoscopy exams are usually done in hospitals, and are sensitive procedures for patients requiring lengthy and time-consuming preparations. Despite being the largest settlement for many miles around, patients and practitioners need to face significant distances to secondary care, **poor transport** and **communication links**, as well as **lack of advanced diagnostic facilities**. The new service allowed GPs to **drag diagnostics out of the hospital** and bring health care

closer to patients. For them, **care must be patient and community-based** (where possible) and satellites can respond to this need. By using a Satcom connection, the patient's data is sent to hospital specialists, analysed and sent back to the local GP in just a couple of days. A solution that is vastly better than going through hospital appointments' waiting time, which could take weeks.

The **technology works** and patients and staff are enthusiastic despite the challenging **training learning curve.** Patients could also do with clearer information on the service as these might be reluctant to trying new procedures and are not necessarily tech-savvy. If the PillCam device would be produced in a sufficient quantity, the **system could cost half the price of a traditional exam**. Currently no cost-benefit analysis has been undertaken by project partners (Highlands and Islands Enterprise, Satellite Applications Catapult, NHS Highland and Corporate Health Ltd.). The company involved in the project, have also tested the Pill Cam solution in several other communities in Denmark and are expanding their activities to the Scottish Highlands.

Ullapool Medical Center's participation in the project was also facilitated by its autonomy. Compared to bigger NHS trusts, this community provider has ample flexibility to choose its own healthcare provisions, overall budgets, and providers. Its particular status has thus enabled it to be more flexible in trying out or adopting a new service if this proved beneficial for the community.

Notwithstanding the few case studies in the region, **operational services remain limited**. Satellite communication-enabled markets, such as telemedicine and telemonitoring are perceived by experts as **immature, niche markets** in which the services 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**.

II. Overlaying satellite services to existing ones

Talk of how digital and mobile disruptions are transforming the health care system is everywhere. It's consumer-led and it's exploding. The MHealth market is estimated to account for over $23 billion in 2017 alone and countless companies have emerged with a mission to address serious issues, whether they are chronic diseases or the effects of ageing. As healthcare service providers seek to maximise patient outreach while minimising costs, mobile devices and sensors seem as the most adequate go-to solutions to improve cost-efficiency. Moreover, tech companies made wearables trendy. Just think about FitBit's fitness trackers, Apple's smart watch, TomTom, Google and so on. The satellite navigation technology that enables them to track and transmit our data has become so widespread that we take it as a given. And this is good news.

When it comes to Satnav, the innovation aspect does not come from the technology itself, but from its application. Satnav-fuelled applications, such as the Norwegian ABC Hjelp or the U.S.-based PulsePoint services (both index near-by defibrillators and CPR specialists in case of a heart attack), draw their success on the fact that they were integrated with the existing

community emergency dispatch systems. Thus, **instead of disrupting existing services, they became complimentary to them.** Mobile Health could represent up to $370 billion in annual healthcare cost savings worldwide, yet the keyword here is "could". There are thousands of apps, wearable and other connected monitoring devices already on the market. However, they are yet to enter mainstream healthcare provision.

Unlike other sectors, **healthcare is strongly regulated** and very much **evidence-driven**. Thus, healthcare providers and potential users may need a considerable amount of evidence of the new technologies' clinical and economic benefits before they would consider scaling up their adoption. Many may even **lack the incentives** to do so. Why change something that already works? And there is another aspect that we need to consider, and that is, **resistance to change**. When the Slovenian Institute of Gerontology and Intergenerational Relations gave Smartphones and sensors to elderly people in their community so that they may transmit their health indicators directly to doctors from the comfort of their homes, **many refused to use the new system**. The system was greeted by refusal also by some medical practitioners, **fearful that technologies would replace the human element**, so quintessential to their work. Moreover, **the system did not work in remote areas** where broadband and mobile connectivity is poor.

Telemonitoring Northern Ireland faces a similar challenge. Although the system has been in place for more than five years now and remotely connects over 5,000 people suffering from chronic conditions (diabetics, heart failure, respiratory diseases, etc.) with their General Practitioners, **the service is not provided in areas/homes where there is no landline connectivity**. Here too, the service was greeted with resistance from healthcare professionals, who now spend less time visiting people's homes and more time monitoring them remotely. Patients, on the other hand, highly appreciated the service, because they believe they are being monitored all the time. The Spanish Matia Institute Foundation also highlighted the challenge of providing elderly people in rural areas with the medical services they need. To address some of these challenges they set out to build an online community platform that would allow for a community participatory process, by letting residents communicate on areas of improvement in towns and cities. They are also working on the development of a platform where people can geo-locate elderly-friendly places on a map. Most likely, they will be turning towards Google Maps, as they **do not have the technical expertise to create a virtual map themselves.** And they should not be expected to, either. **Users should not be expected to debug or create a tech solution** for their needs. **It is up to service providers to work with them to understand their needs and turn them into services.**

Poor transport connectivity, lack of nearby medical facilities and doctors, together with poor broadband and/or mobile coverage are common to many European regions. Yet, there seems to be no policy to complement these gaps through satellite communication coverage. At least none which we have discovered so far.

Ultimately, **governance and policy play a key role**, if not, a critical one in the diffusion of satellite-based applications. Whether it touches on data-sharing principles, standards,

procurement practices, funding opportunities and healthcare systems structures, all of these continue to vary widely among countries and/or regions.

Due to different regulatory frameworks, market dynamics are also different, not only in terms of development, but also in terms of technology usage. For example, while satellite communication links could be a powerful tool to connect remote communities in the Scottish Highlands, this technology would not make sense in the Netherlands, which ranks as one of the most broadband-connected European countries. Alternative technologies to Satcom should be considered where possible. **A mature niche market can potentially create more value than isolated and scattered user cases.**

III. Many gaps, fewer bridges: disconnected communities

While the current entrepreneurial-based system rewards speed and favours short-term strategies for a quick market access, healthcare requires long-term evidence-based results, clinical validation and liability. Many of the SMEs or Start-ups looking to enter the healthcare market may not have the time and financial resources to collect such evidence. Thus, the **disconnection between the healthcare sector and new technologies**, be they satellite-enabled or not, becomes more and more evident. **Speed does not guarantee success** and as such project cycles tend to be longer and more time and resource-consuming in this sector, not many service providers make it. According to experts, as project funding goes, this should be secured for at least a five years period. This will allow partnering stakeholders to build more trust and gain sufficient confidence in the service. But more importantly, **users should be involved from the start**. They should not be expected to imagine the solution, but rather be continuously consulted on their needs and thus help build a market that is **user-centric** rather than push new technological solutions (that they might not need).

If your Uber fails to show up, it's inconvenient at best, but not life-threatening. A person's life and/or safety is however a completely different matter. As follows, many **healthcare professionals are reluctant to adopt new technologies** or change their practices, all the while bearing the costs for their implementation and service. Moreover, with numerous stakeholders involved along the satellite-based services added-value chain, the liability aspect of such services could also profit from more legal clarity. Let's take the case of remote monitoring of patients. When a device is set up to monitor and follow patients, whether the device fails to send an alarm or a GP fails to respond promptly, can raise different liability challenges that go beyond the healthcare sector, potentially reaching manufacturers, software producers, internet or Satcom providers and so on.

IV. Air pollution: the data is already there

According to the AirNode founder, Gordon Rates, air pollution costs the British economy £ 20 billion, while 40,000 premature deaths are attributed to air pollution in the UK alone. Respiratory diseases and deaths related to air pollution are highest in heavily populated urban areas [2]. Moreover, the NHS Healthy New Towns Study conducted in Bicester, Oxfordshire (UK) in cooperation with UK Satellite Catapult and the University of Leicester, using satellite

imagery and in-situ air measurements, shows that a higher Type 2 diabetes incidence is found in neighbourhoods with higher ambient air pollution [3]. Anticipated health benefits of a self managed diet, medication and activity programmes can be thus compromised by high air pollution exposure for Type2 diabetes patients.

If these increasing cases of illness are translated into numbers of hospital admissions worldwide, these are projected to increase from 3.6 in 2010 to 11 million in 2060 [4]. In other words, air pollution-related illnesses can triple the costs of our already burdened health systems.

The EU Air Quality Framework Directive required municipalities to "ensure that timely information about actual or predicted exceedances of alert thresholds and any information threshold on air pollution is provided to the public". **While such EU Directives have the potential to enable service demand and cluster needs, no indication is provided within the Directive on what types of data can public authorities use to extract information on air pollution.** Thus, the use of satellite-based information (where used) varies greatly not only between countries but also between regions and local authorities. London Boroughs use airText, a satellite-based service provided by Cambridge Environmental Research Consultants (CERC) (we wrote about it here). The project has been implemented by the airTEXT consortium initially under the European Space Agency's PROMOTE programme, then as part of the 7th Framework EU PASODOBLE project, and more recently within the Join Air Quality Initiative INTERREG IVB 'JOAQUIN' project. Here too, **the road from project stage to an operational service was long and winding**. The service currently provides air pollution, UV, pollen and temperature forecasts to more than 20,000 subscribers by email, text or App with text messages related costs being covered by the local authorities. Obtaining a **solid user base**, CERC can now focus on expanding the service to other regions and/or countries. Most recently, it has been working closely with the Riga City Council to elaborate a new Air Quality Information Tool for its residents. The City Council committed to actively support and promote the service during the six-month setup phase and during the 24-months live phase, as well as to **cover the costs** of the text messages to subscribed users. Once the project is completed, its continuity will highly depend on a cost-benefit analysis.

Other environmental-related health issues that would benefit from satellite-based information concerns the recurrence of urban health islands. For Italy's Lazio Regional Health Service, acute health effects of extreme temperatures are an important public health issue. In the summer of 2015, 13% of deaths of individuals aged 65+ were attributed to extreme heat conditions. Due to climate change, this percentage is expected to grow. Thus, for the Health Service, satellite data has become a valuable tool as an alternative source of environmental data. According to them, **the data is already there** and **authorities don't need to spend extra money** on in-situ sensors or other additional modelling. To mitigate the effect of heat waves, the health service set up a national warning system. Daily to weekly forecasts are communicated to other public authorities, as well as TV and radio stations for mass distribution.

V.Conclusions and Recommendations

As mentioned, the day's discussions explored the market's maturity and existing satellite-based services and identify potential growth opportunities and demand. It did not set out to cover all aspects of satellite-based applications in the heath and ageing sectors.

The recommendations for addressing the challenges described above that emerged from the collective contributions can be grouped as following:

Polling demand and sharing risk

End users with similar responsibilities and missions are confronted with challenges that affect them collectively. Thus, **regional clustering of needs, procurement and use** around a single service would drive costs down, making services more cost-efficient. In other words, **mutualise demand to decrease costs**. This would also allow for a better use of financial and human resources in an already over-burdened sector. A stable user community can potentially create more value than isolated and scattered user cases (as it is currently). Serving critical masses of users, with the possibility to include new ones in the future, would help create economies of scale, making new solutions and risk distribution more affordable. Compared to other sectors, the complexity of the health care sector make it as such that the user is not systematically the payer, the beneficiary, the promoter and/or the decision maker. Thus, the deployment of a new service should be accompanied by a multi stakeholder analysis to identify and collect the evidence needed for each type of stakeholder.

Critical in the discussion of polling demand and resources, are also aspects related to data quality and data sharing, data accuracy and interoperability between different stakeholders. Data interoperability, applications and platforms remains a challenge across European countries.

Integration into existing services

As with other sectors, Eurisy has always argued that **the added-value of space technology stems from their integration with other types of technology and information**. As showcased by the Mobile Breast Screening Service, combining (land coverage and satellite communication) technologies has allowed for a decrease in costs without affecting the quality or availability of the service. Moreover, satellite-based technologies have more chances of being adopted by end users when these are integrated into their existing practices. The workload on health professionals and providers is high. As follows, introducing new services can disrupt established workflows and make them apprehensive towards using them. **To reduce impact and help health professionals make the best use of the new services, specific budget lines should be allocated for training from the beginning.**

Supporting policies

Some EU Member States require the physical presence of the patient and health professional at the same time and in the same place, for a medical act to be legally valid (e.g. Poland). In others, while the concept is considered a medical act from a legal point of view, it is not

covered by the social insurance scheme (e.g. France). Moreover, from a regulatory perspective, even the definition of "telemedicine" and what type of services this entails differs among Member States.

Such legal obstacles continue to prevent the widespread use of telemedicine solutions (whether these solutions are satellite-enabled or not). This policy gap prevents both health professionals from using such services in the **absence of regulatory standards**, and patients if such services are **not covered by their health insurance**. While in the case of environmental health, certain European Directives can trigger reporting responsibilities that support the use of new services and data, healthcare, as well as reimbursements, is largely in the competence of Member States. Further efforts should thus be considered to enhance the diffusion of telemedicine solutions, especially in the remotest regions of European countries (Scottish Highlands, Scandinavia, Baltic States, and Islands). These could also include policies to support the reduction of cost of telecommunication and/or satellite services.

Focus on user needs

Last but not least, pilot projects' funding should focus on responding to the needs of a critical mass of users, rather than promote technology push. The technological solution can be revolutionary, but the lack of users might prevent companies from building solid business cases for those services. With the further individualizing of health care, it is expected that the need for more technology powered services will continue to boost during the next decade. This translates into a great opportunity to infuse satellite technology into future market solutions. Furthermore, in a sector that is evidence-driven and resistant to change, building trust is critical for the sustainability of the services.