LifeTEC

(Life16 ENV/ES/000559)

atlanTTic research center for Telecommunication Technologies
Universidade Vigo

retegal

XUNTA DE GALICIA | CONSELLERÍA DE FACENDA E ADMINISTRACIÓN PÚBLICA
meteogalicia

IPMA Instituto Português do Mar e da Atmosfera

amtega Axencia para a Modernización Tecnolóxica

The name LifeTEC comes from the Spanish phrase for “The fight against forest fires using tech”

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Lucha contra los Incendios Forestales Empleando TEC

Start	01/09/2017
End	31/12/2021
Coordinator	Universidad de Vigo

Partners

Universidad de Vigo
Dirección Xeral de Calidade Ambiental e Cambio Climático (DXCACC)
Instituto Português do Mar e da Atmosfera (IPMA)
Axencia para a Modernización Tecnolóxica de Galicia (Amtega)
Redes de Telecomunicación Galegas (Retegal)

Budget	1.205.063 €
EU contribution	54,75 %
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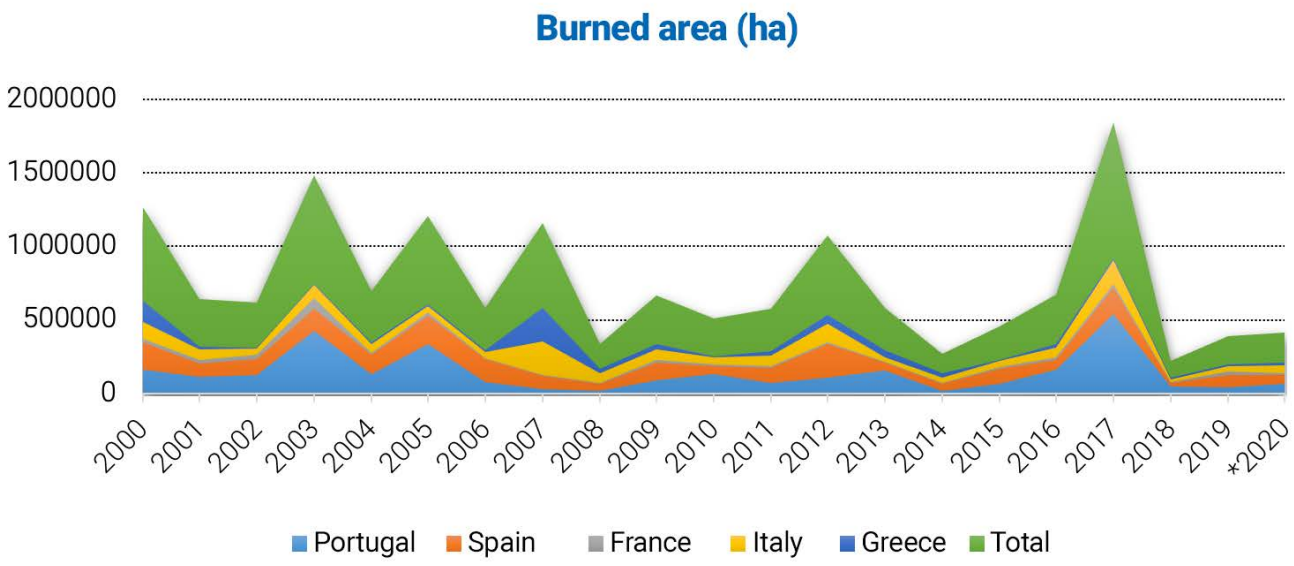
Introduction



Woodlands are important for human life in countless ways. Woodlands are the lungs of the planet. They are a refuge for numerous plant and animal species. The biodiversity of woodlands and the ecosystems that develop within them are a source of resources for medicine, food, industry, and energy. Woodlands provide us with food and raw materials for sustainable development. They protect the soil from erosion, reducing the risk of floods, avalanches or landslides. They help to combat climate change and contain global warming while also favouring precipitations. Woodlands increase people's physical and mental wellbeing. They are also cultural and spiritual reserves and the backdrop for myths and legends. Forest fires destroy woodlands along with the ecosystems they shelter, reducing the biodiversity of the planet. Forest fires put people, their property, their jobs, their livelihoods, and infrastructures at risk. They increase the risk of desertification and impoverish the quality of the atmosphere by increasing greenhouse gas emissions. Forest fires contribute to global warming and climate change. The global incidence of extreme weather phenomena and major forest fires continues to increase, fed by climate change. Of the last 10 most destructive forest fires in the history of California, six have occurred in the last five years; CO2 emissions due to the June 2020 fires in Siberia reached the highest ever recorded value; the average temperature in Europe in 2020 exceeded all previous records; and the surface area burnt in 2020 in Europe was larger than the average surface area burnt in the 10 previous years.

What is LifeTEC? What is its purpose?

Early detection of forest fires and reliable and robust communication and geolocation systems between firefighting brigades and between those brigades and coordination centres are fundamental to ensuring rapid and efficient intervention that minimizes not only the damage caused by fires but also the cost of extinguishing them.

The objective of LifeTEC is to **contribute to the fight against forest fires** by using communications and radar technologies. This objective can be divided into **two more specific lines of action**:

Reducing the detection time for forest fires by analysing signals received from radar. This line of work is based on the great changes in temperature and humidity that are produced in the immediate vicinity of a fire and that affect the propagation of electromagnetic waves. The project therefore develops algorithms that use the signals received from meteorological radars to provide estimates of temperature and humidity changes which can help detect and locate the fires.

Improving the efficiency of fire-fighting brigades. When extinguishing a fire, it is fundamental to have continuous coordination and geolocation of the firefighters involved, both to optimize the result of their actions and to guarantee their safety. Therefore, we are developing data communications equipment based on TETRA (Terrestrial Trunked Radio) and geolocation equipment based on GPS integrated with TETRA.

Who is participating?

LifeTEC is a project **co-funded by the European Commission** within the LIFE programme.

LifeTEC is **coordinated by The University of Vigo.**

Has participation from:

- the **Portugues Sea and Atmosphere Institute** (IPMA),
- the **General Directorate for Environmental Quality and Climate Change of the Xunta de Galicia regional government**,
- the **Agency for Technological Modernization of the Xunta de Galicia**(Amtega)
- **Galician Telecommuncations Networks** (Retegal).

Where is the project being developed?

The project is being undertaken in the **north west of the Iberian Peninsula** (Galicia and the North of Portugal). It used the radars in Cuntis and Arouca, operated by Meteogalicia and the IPMA, and the TETRA communications network operated by Retegal.

Early detection of forest fires

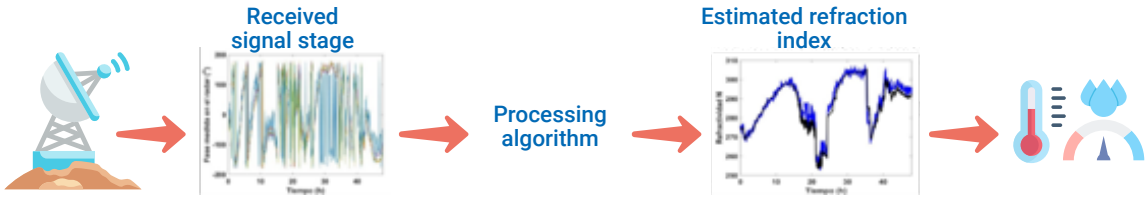
Early detection of forest fires is fundamental as it allows response time to be reduced, which increases the probability of controlling the fire and limiting its effects. Rapid and efficient intervention means there is less risk to human lives, a reduction in the area of burnt woodland and a decrease in emissions of carbon dioxide and greenhouse gases.

Several different methods have been developed with the aim, among others, of detecting forest fires in their initial stages. The detection solutions based on remote sensing by satellite are able to monitor large areas of land but have low resolution in terms of time, in addition to requiring major infrastructure costs. Existing solutions based on land monitoring devices provide good resolution in both time and space but require the installation and maintenance of a large network of sensors in the areas being watched, which limits the size of the land area they can be deployed in. The different features of the various methods mean that it is often necessary to use them simultaneously. The solution for fire detection proposed in LifeTEC presents good resolution in time and space and allows relatively extensive areas to be covered, complementing, therefore, the already existing solutions.

LifeTEC's contribution

1

Forest fires provoke an abrupt decrease in humidity and a large increase in temperatures. This change in local atmospheric conditions gives rise to a significant rise in the refraction index of the atmosphere in the affected area.
This index determines the speed of propagation of an electromagnetic wave through the atmosphere and can be measured using radars. The radars emit electromagnetic pulses that are reflected by elements in the environment. Some of the pulses are reflected back towards the radar, which acts as a receiver. By analysing the pulses received, information can be obtained such as the distance of the object that reflected the pulse or the speed at which that object is moving. The technology developed by LifeTEC allows the refraction index of the atmosphere to be measured by analysing those pulses received by the radar.



LifeTEC uses meteorological radars to measure the refraction index. These radars operate continuously, day and night, allowing measurements of variations to be carried out regularly and very frequently. Meteorological radars were considered because Europe is covered by networks of them, making it possible to monitor for new fires being produced throughout the whole of Europe by using existing infrastructure.

2

3

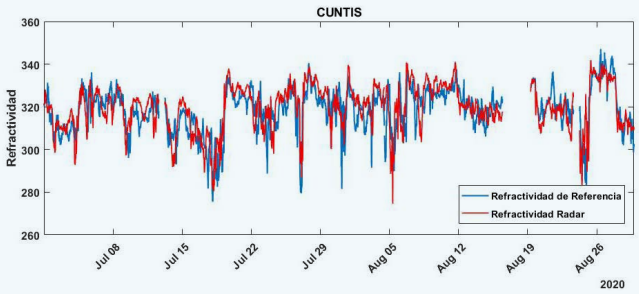
Given that the refraction index decreases significantly when the temperature rises and the humidity falls, the measurement of abrupt drops in the refraction index is an indicator of a forest fire starting.

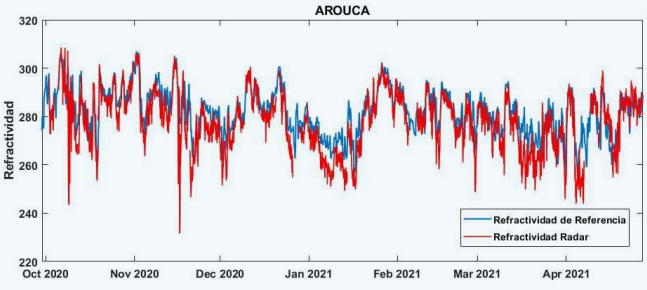
Results

Within the LifeTEC project, real-time monitoring of atmospheric refractivity was carried out by using measurements provided by the meteorological radars in Cuntis, in Galicia, operated by Meteogalicia, and in Arouca, in Portugal, operated by the IPMA.

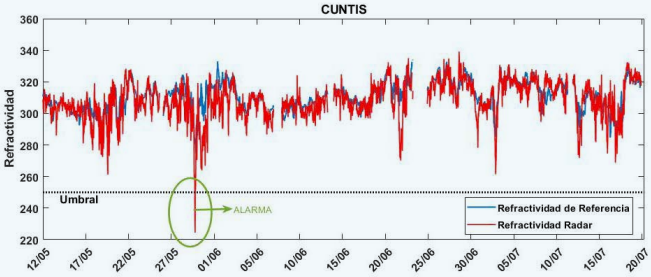
The radars in Cuntis and Arouca operate in C-Band and have magnetron-based transmitters.
The majority of meteorological radars currently operating in Europe work in C band and S band and are based on klystron or magnetron type transmitters. In order to easily implement the algorithm with any radar in Europe, different versions of it have been developed that mean it can be implemented both in klystron radars and magnetron radars regardless of whether they are working in S band or C band.

The following graphs show the refractivity measurements that have been obtained with the radars in Cuntis and Arouca. They also show, for reference, the refractivity measurements obtained from weather stations located in the area of the radar or from other forecasting methods. It can be seen that there is a high level of agreement between the measurements from the radar and the reference ones.





If the refractivity reading drops below a set threshold during radar monitoring, an alarm is triggered. The abrupt fall in refractivity compared to typical values corresponds to sudden increases in temperature when humidity conditions are practically zero and, therefore, can indicate that a forest fire has started. The alarm will allow the means for controlling and fighting forest fires to be activated.



Secure communication and geolocation for firefighters

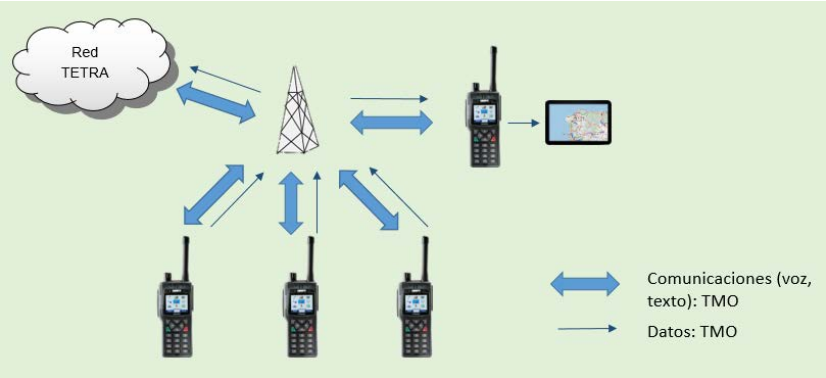
When working to extinguish a fire, it is vital to maximize the efficiency of any action taken and guarantee the safety of the firefighters involved. For that reason, they must have **equipment that allows them to communicate with each other and with control centres**. In addition, it is important to know **where the firefighters are**.

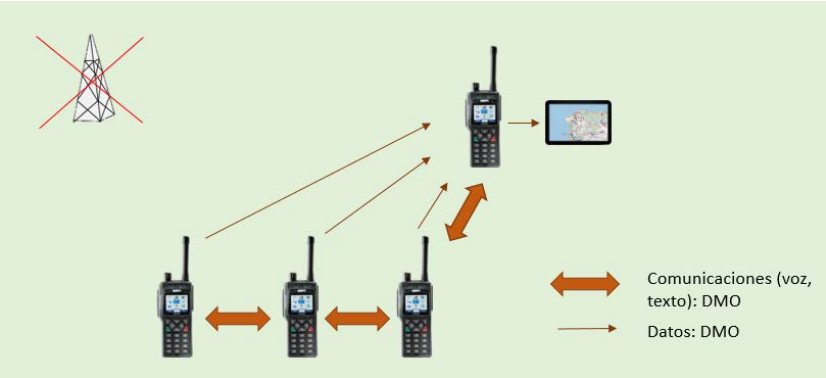
Unfortunately, many forest fires are produced in remote areas with little or no coverage from any communications networks. At the same time, although there are many systems that allow the control room to know the position of a brigade, there are no systems that can determine the location of firefighters from the field of operations itself.

LifeTEC's contribution

At LifeTEC we have developed a system, based on TETRA and an Android app, that makes it possible to access the locations of a whole firefighting team from anywhere.

This system is **ready to work even when there is no communications infrastructure or existing ones are not available**. It ensures communication and location of the firefighters in the field of operations, without the need for anyone to carry any equipment except their radios.



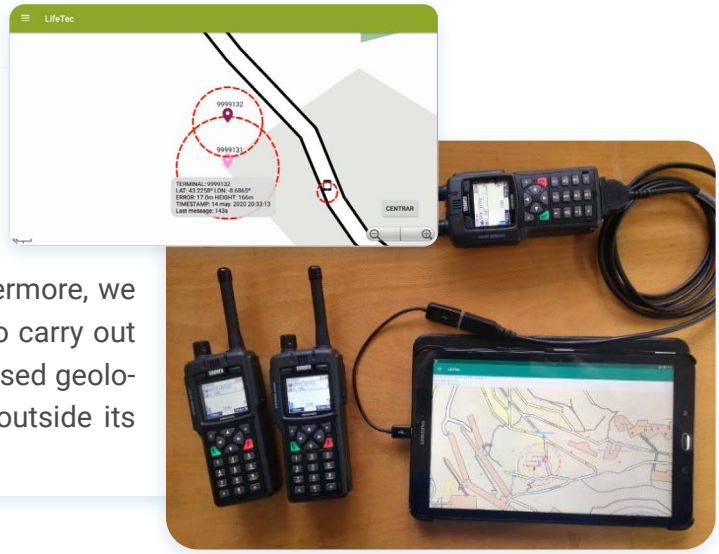


The location and communications system developed has **two operating modes**. In **TMO** mode (truncated mode), the **TETRA network** is **operating** and the **firefighters' devices** are **connected to the control room**. In **DMO mode** (direct mode), the **TETRA network is not available** but **communication is maintained between the devices that are active** in the field of operations.

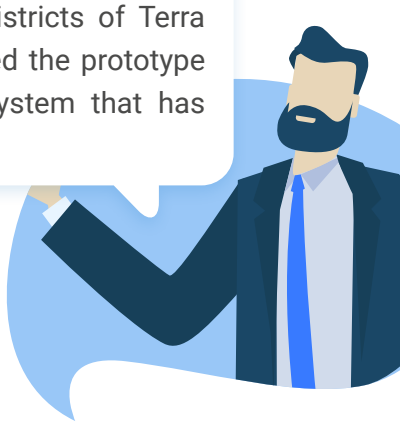
Furthermore, a **tool has been developed to verify coverage of the TETRA RESGAL** network in Galicia. This allows the base to know the coverage level at all times in a specific area and thus determine the operating mode for the handsets.

Results

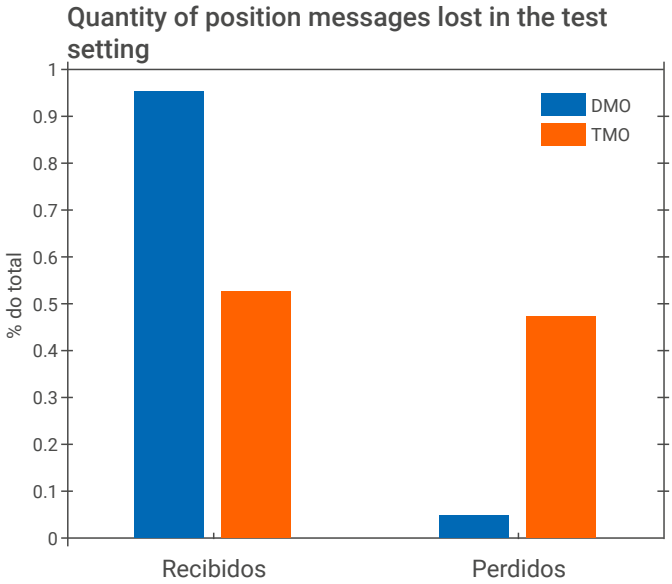
Several prototypes have been developed of the TETRA-based communications and location system. Other communications systems are not needed (telephone networks, WiFi, etc.). Furthermore, we have taken advantage of DMO mode to carry out the first implementation of a TETRA-based geolocation system that can fully function outside its network coverage.

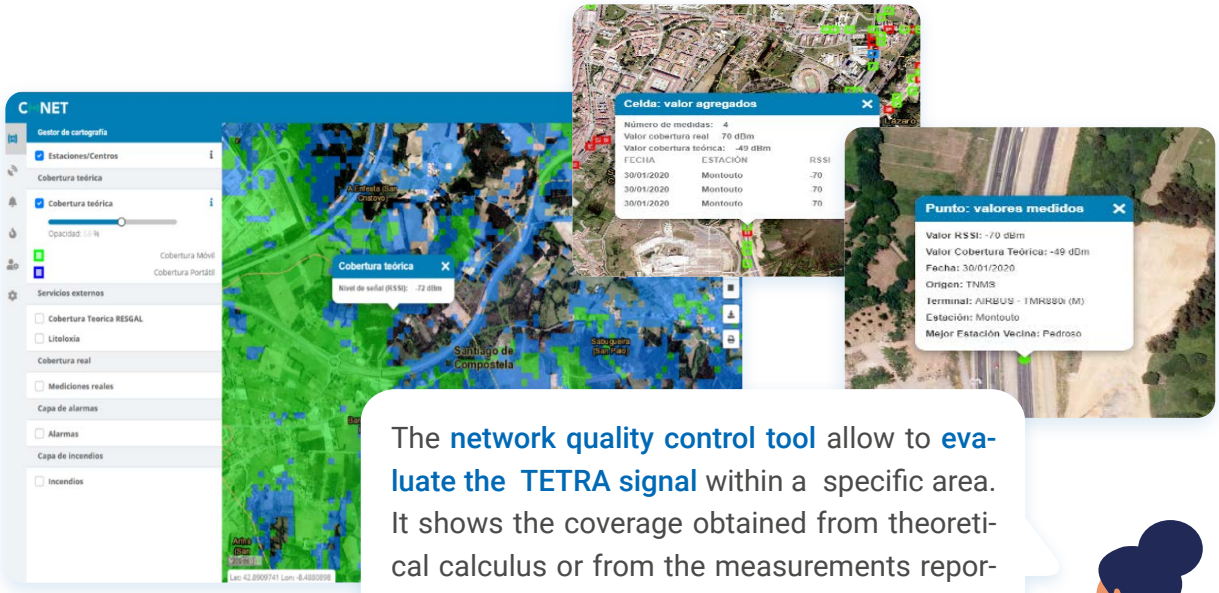


The firefighters of the brigade in the Deza and Tabeirós districts of Terra de Montes have tested the prototype of the geolocation system that has been developed.



By enabling DMO operating mode in LifeTEC, we have managed to improve the time during which the location of firefighters is kept updated, avoiding problems of lack of coverage caused by the lie of the land in DMO mode.





The **network quality control tool** allow to **evaluate the TETRA signal** within a specific area. It shows the coverage obtained from theoretical calculus or from the measurements reported by the operating equipments.

Finally, there has been collaboration with the **Military Naval School** to carry out **experiments on the effects of fires on a radio link**.

The fight against forest fires and their devastating effects is a complex problem that has to be tackled from different angles with the aid of many tools. The tools developed in LifeTEC, based on telecommunications and radar technologies, help to reduce the negative effects of forest fires—both from an environmental and a socio-economic point of view—through early detection and intervention from firefighters.

The tool developed to manage and locate human and material resources has been tested by the firefighters of the Consorcio Contra Incendios y Salvamento de las Comarcas de Deza y Tabeirós-Terra de Montes, demonstrating its full operating capacity in the field of operations. The **most outstanding advantages** of the tool are:

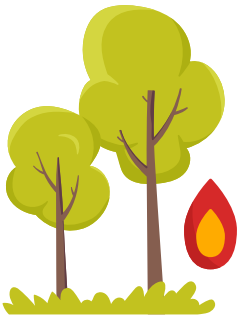
Availability of geolocation information in the field of operations

Does not require base stations

Economical solution

Easy to replicate worldwide

Possible uses for other emergency services



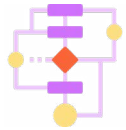
The algorithm that has been developed to detect fires using radar data has been tested on magnetron-based radars working in C band: specifically, the radars in Cuntis and Arouca operated by Meteogalicia and the IPMA, respectively. To make this easier to replicate in the maximum number of radars possible, the algorithm has been prepared to also work in S band with Klystron-based radars. At a time like this, when climate study and monitoring is fundamental in order to minimize the socio-economic and environmental costs of climate change and extreme weather events, the algorithm developed—which provides tropospheric refractivity measurements and their gradients—can help to increase considerably the total amount of data for numerical forecasting models to assimilate. This algorithm will be of interest to the different meteorological agencies that operate radar networks as it increases the returns from them with no need for additional hardware, which makes it much easier to replicate and implement in operation.

What next?

To preserve and extend the results and knowledge obtained, the project partners will continue with the following actions:

01

Keep the **algorithm for fire detection** operative in the radars at Cuntis and Arouca during the seasons of high fire risk.



02

Seek **collaboration with radar operators**, particularly in areas of great ecological value and/or high fire risk, in order to extend implementation of the algorithm.

03

Analyse the **viability of incorporating estimates of tropospheric refractivity and its gradient**, generated by the developed algorithm, in numerical forecasting models.

04

Analyse the **potential of the estimates for refractivity and its gradient** in short-term forecasting and detection of extreme weather phenomena.

05

Keep **the quality measurement tool operative** in the Retegal network.

06

Continue with **diffusion, publication and transfer of the results** obtained.

Dissemination activities

Website

lifetec.uvigo.es

Information panels

Explanatory leaflets

Videos explaining the project

https://www.youtube.com/watch?v=1bhbE41qIV8

Articles in specialized journals

Presentations at congresses

URSI AT-RASC 2018. Gran Canaria. España, 28 May – 1 June 2018

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IEEE AP-S/URSI 2021. Marina Bay Sands. Singapore. 4-10 December 2021

Diffusion in local and regional communications media.

Participation at events

1st LifeTEC Dissemination Event 2018

Uvigo Technology Forum 2018

AtlanTTic Open Day 2019

2nd LifeTEC Dissemination Event 2021