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White Paper – WISeSat

# Seal SQ
# Providing secure and seamless IoT connectivity in remote areas for agricultural sensors



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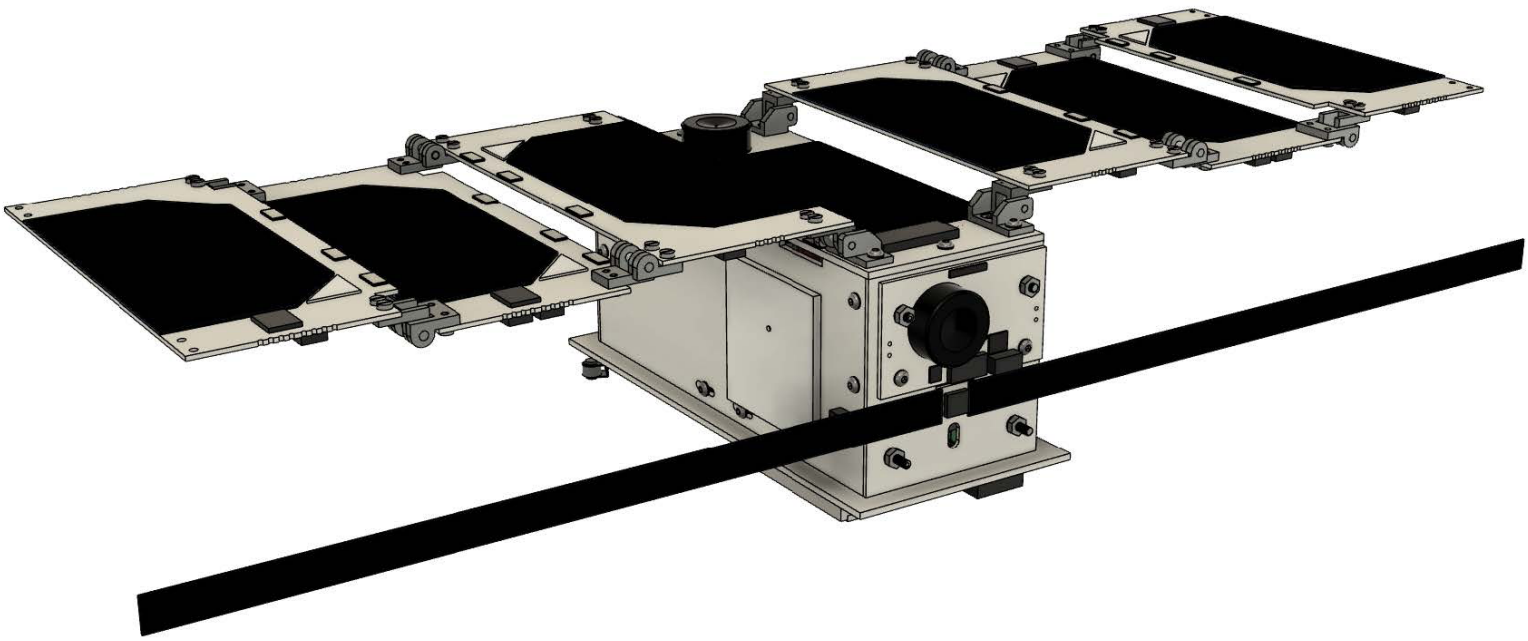
## WISeSat

### Democratizing access to space and IoT communications

WISeSat is the first cost effective and secure IoT connectivity solution anywhere on Earth using picosatellites and low-power sensors. Its aim is to answer the needs of any large IoT deployment in AgTech, Energy, Logistics and more.



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## Problem Overview

### Globally, more than 50% of the world does not have access to Internet

The IoT and Big Data market is expected to grow exponentially. In 2020 there were around 8.7 billion of IoT connected devices, and this number is expected to increase up to 25.4 billion in 2030. Our increasingly interconnected world will require the coverage of sensors which provide IoT communications. However, about 80% of the surface of the planet is not offering any connectivity today, resulting in a major challenge for agriculture, energy, logistics, maritime and many other industries to monitor assets located in remote or harshenvironment areas.

In addition, examples of public, industrial or commercial systems being hacked are growing exponentially as the surface attack increases, resulting in billions of losses among other dangers. It is therefore becoming more and more critical to ensure that the data being produced, exchanged, and processed is accurate and can be trusted. That requires providing a trusted digital identity to each sensor and enabling ecosystems with robust hardware and software security features to ensure that sensors and systems have not been tampered with or impersonated, and data has not been corrupted, modified or intercepted at any point. To solve these two challenges of secure and seamless IoT connectivity across remote areas, and implement a trusted IoT Network in Spanish territory for Smart Farming applications, SEALS SQ joined forces with FOSSA Systems to develop WISeSAT: an innovative solution based on a secure network of picosatellites and a secured architecture for sensors. Miniaturization enables cost reduction so that any company can afford dedicated satellites to provide connectivity to any size of ecosystems. FOSSA and SEALS SQ provide the satellite platform, launch, integration, ground station services and even nodes as part of the turnkey SaaS solution for low-power and secure space-based IoT connectivity. This reduces the complexity of the communication link for the end customer and sets the benefits of space technology and embedded security within the reach of every IoT business.

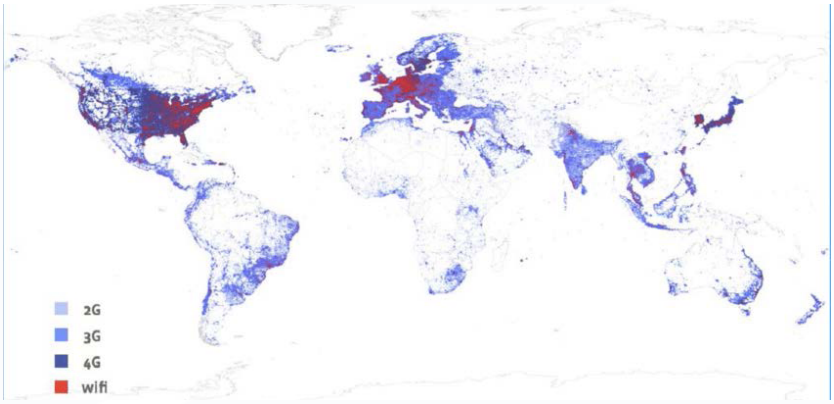
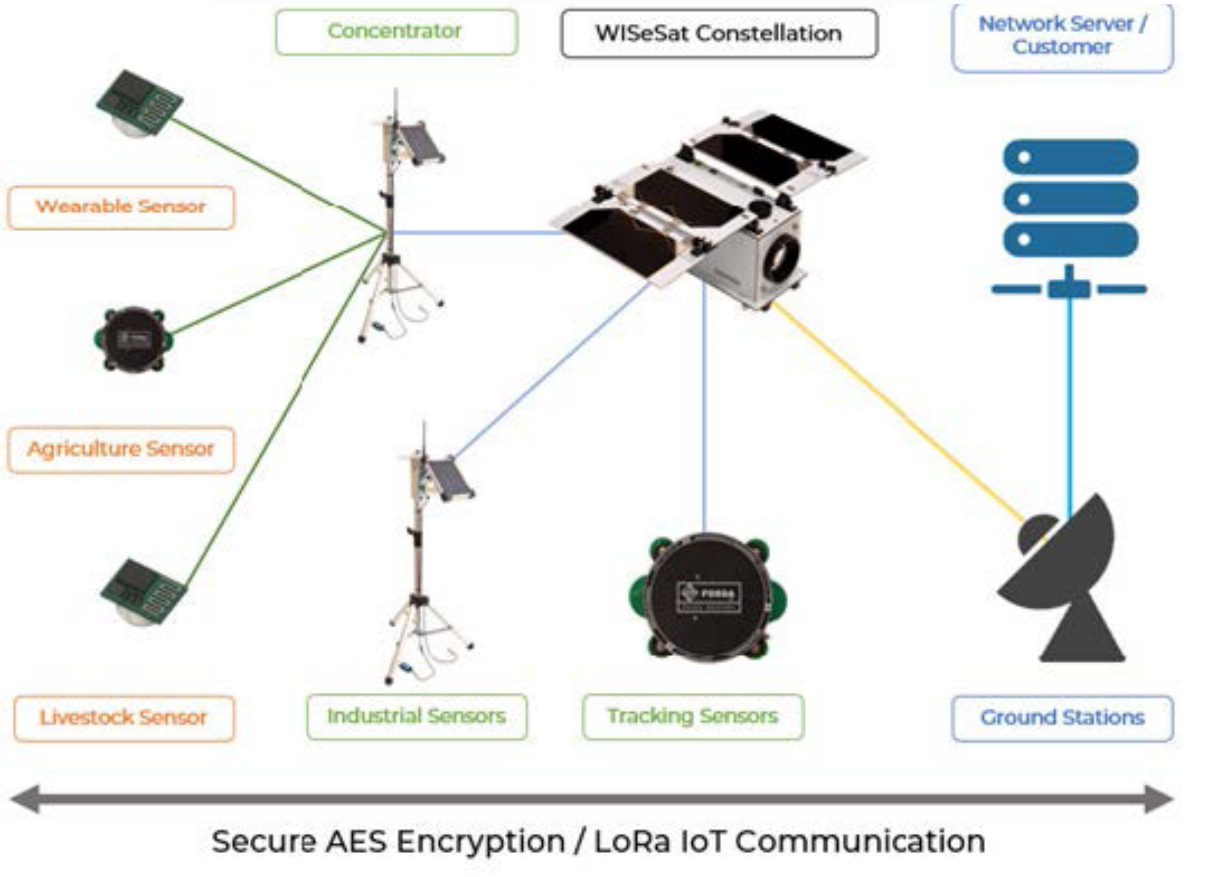



*Figure 1. Cellular & Internet Coverage, 2018*

## Deployment objective and requirementsConnectivity (UN), limiting the expansion

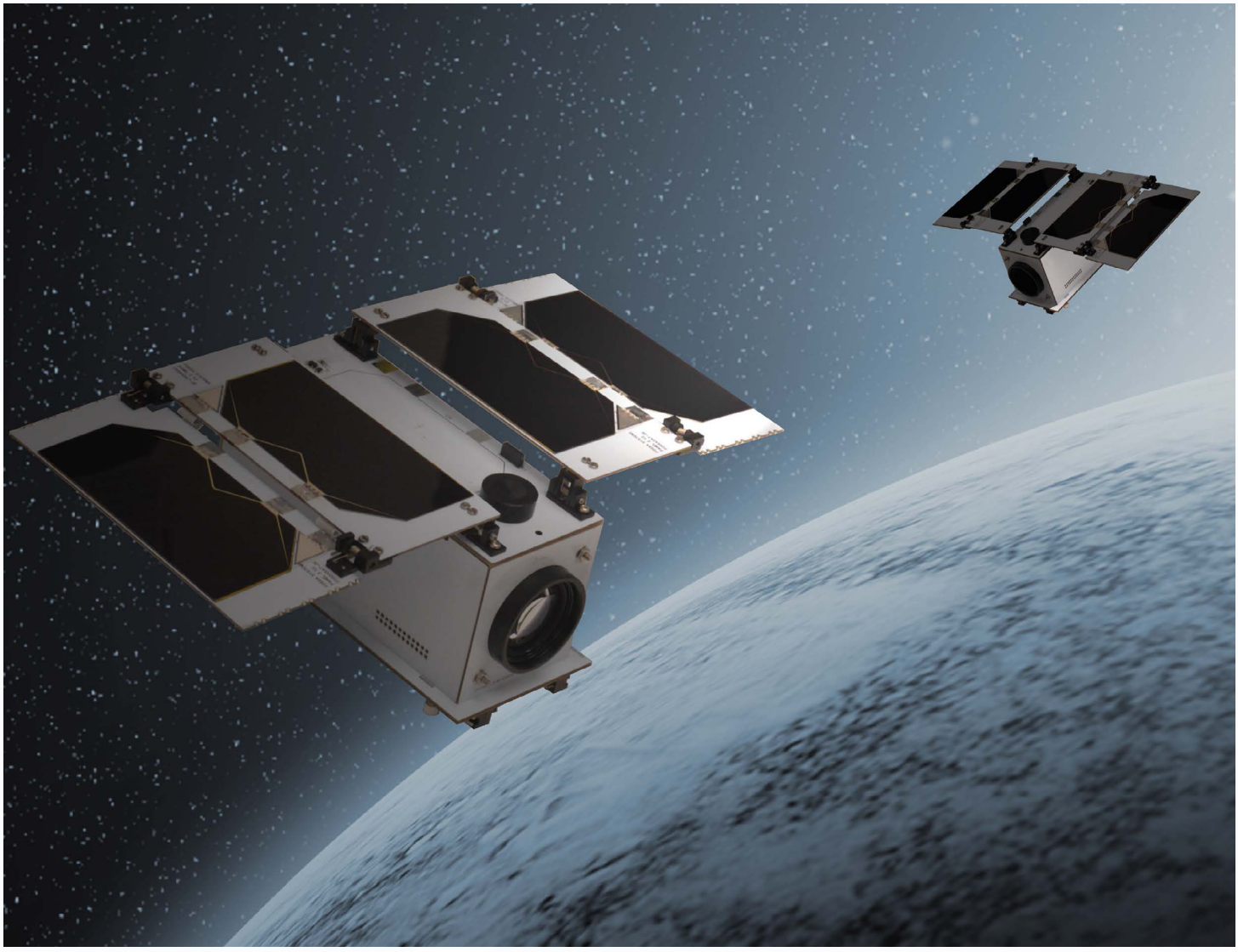
The objective is to create an IoT communication network based on the spread spectrum modulation system “LoRa” for the connectivity of low-power devices and sensors. Initially, the implementation refers to a number of 200 ground-based gateways to presumably span a large coverage area with distributed nodes. There is no definition of a number of sensors that should be monitored, nor the review / latency time required to receive information. The initial implementation considers the deployment of a ground network, involving a fair quantity of hubs / gateways. This ground deployment only covers areas with existing GSM / 3G - 4G / NB-IoT connectivity, but not areas that are isolated or difficult to access. Being a project focused on Smart Farming, it is also necessary to feature several repeaters to support the use of LoRaWAN technology. Also, cost-competitiveness of the solution in comparison with major existing “ground” IoT providers is a key aspect. A trade-off analysis has been carried out to reach an ultimate cost of 4.5€ per device per month..




## Featured Solution

Based on the requirements detailed previously, and with the objective of a nation-wide deployment, the proposed solution is a secured network of picosatellites, concentrators and sensors communicating under LoRa protocol, which offers communication links with sufficient margin to establish contact with low-orbiting satellites successfully.

Miniaturized satellites using fully commercial-off-the-shelf components combined with mass production techniques reduce costs for distributed networks of dozens or hundreds of satellites, and makes it a smart and affordable solution for virtually any application.

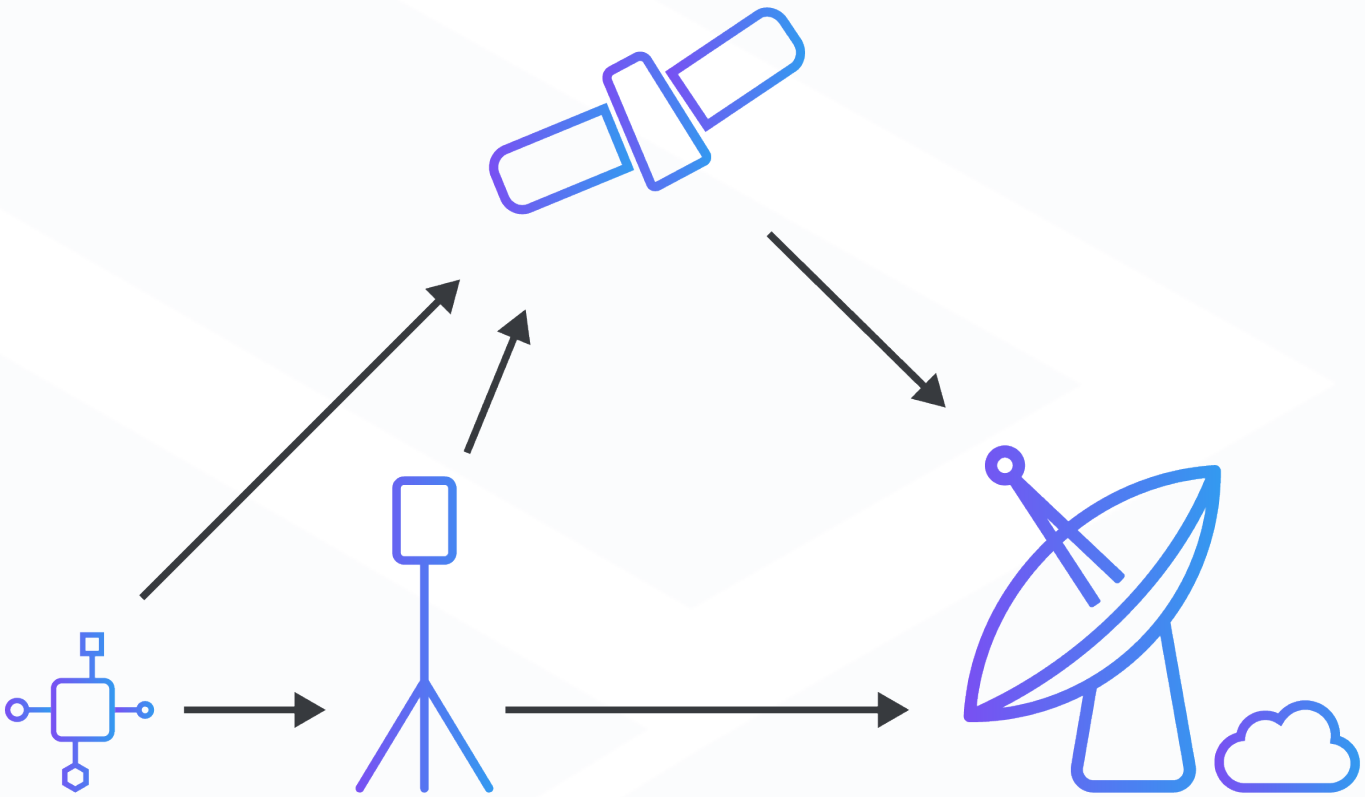


## WISeSat description and capabilities

WISeSat is a 5x5x10cm Picosatellite, developed by SEALS SQ and FOSSA Systems, dedicated to Secure IoT connectivity.

Each picosatellite acts as a hub for sensors and ground-based nodes, acting as a direct gateway to a cloud database and an API for integration with additional services. Satellites can download the information immediately or store it. Ground-based nodes can communicate directly with a satellite without the need for highly directional antennas or extra power. For areas of high concentration, the sensors can be concentrated in ground-based gateways that centralize the communications with the satellite.

Additionally, the platform boasts a fully-fledged Linux computer connected to a SEALS SQ Secure element and can execute complex cryptographic calculations used to enable PKI technology based trusted identities and robust data encryption. WISeSAT will use this platform for IoT service delivery using a proprietary security protocol on top of LoRa modulation.



## Security

Satellites, nodes and sensors all feature hardware security by design incorporating a VaultIC® 4XX secure element providing FIPS 140-3 level 3 and Common Criteria EAL 5+ Certification. The secure element is provisioned with a trusted identity using SEALS SQ's VaultITrust secure provisioning services. It enables authentication of the sensor and data encryption, under the framework of a PKI based security architecture.

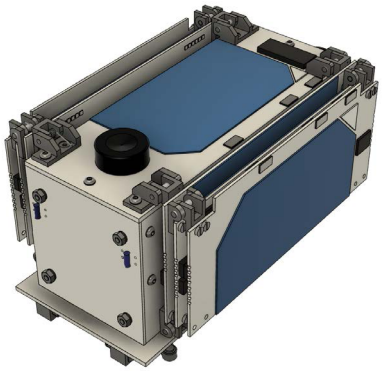
Additionally, SEALS SQ Certificate Management Systems (INeS) can provide the user interface and automation features to handle on-boarding, commissioning and life-cycle management of the devices and sensors. This complete device-to-cloud suite provided by SEALS SQ is the state-of-the art today in IoT security architecture and is unique in that it is a seamless vertical service provided by one single company.

### Pin Point Precision

3-axis active stabilization,
3RWs + Magnetorquers Inertial unit with fine and coarse sun sensors, pointing accuracy <5º

### Standardized but flexible

32 bits microprocessor
Data buses: UART, I2C, SPI
Linux capable dedicated payload controller
Dedicated payload memory



### Maximizing power

Up to 9W solar power generation, with MPPT capabilities
5v and 3.3v, regulated buses
Up to 10Wh energy storage

### Communications Pin

High data rate, 1Mbps
Nominal 9,6 kbps backup
Dedicated antenna for uplink communications from low-power ground devices

## IoT Nodes

WISeSat is compatible with existing LoRa devices and only requires a firmware update and antenna change of these devices for proper operation. Thus, a wide range of sensors can be immediately available for direct connectivity with satellites.

WISeSAT features an ecosystem of nodes, specially developed to provide satellite connectivity to ecosystems involved in Smart Farming or Industrial applications.
The nodes are based on an 868MHz circular polarized antenna for uplink capabilities in Europe, and a UHF band connection for satellite downlink, allowing two-way communication to receive and send data from anywhere on Earth.

The nodes and gateways will have the following specifications:

**FOSSA - XL**

| | |
|---|---|
| Function | Acts as a secure, independent and autonomous industrial solution to exchange data both ways between satellites and its on-board sensors. It is also a secured gateway for FOSSA-S IoT nodes in concentrated networks. |
| Security | Security is embedded by design with a VaultIC® 4XX secure element providing FIPS 140-3 level 3 an Common Criteria EAL 5+ certification. |
| Sensor Capabilities | GPS, Temperature, Humidity, Salinity, Chemical Composition, Air Quality and standard RS485 interface. |
| Battery | 5W solar panel, long-lasting 12V battery for long-time operation. (Sustainable battery life). |
| Size and Mass | 10x30x30 cm, 2.5 kg. |

Example application:

An industrial sensor requires two-way communication with the satellite from remote locations and a long life without maintenance or a gateway. This solution can stand alone or serve as a gateway for smaller devices that cannot reach the satellites directly, serving as a link for a massive deployment of animals, agricultural sensors, etc.

**FOSSA - M**

| | |
|---|---|
| Function | Acts as a standalone secure sensor solution to send encrypted messages directly to the satellites from its embedded sensors without the need for any gateway. |
| Security | Security is embedded by design with a VaultIC® 4XX secure element providing FIPS 140-3 level 3 an Common Criteria EAL 5+ certification. |
| Sensor Capabilities | GPS, Temperature, Humidity, Salinity, Chemical Composition, Air Quality and standard RS485 interface. |
| Battery | Battery life 12-18 months. |
| Size and Mass | 7x7x2.5 cm, 150 g. |

Example application:

a sensor requires one-way communication with the satellite from remote locations outside of the range of a FOSSA-XL gateway. It can collect asset data from livestock, agriculture, maritime tracking, or land measurements, information on a hard-to-reach sensor that is self-contained.

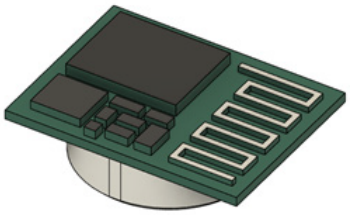
*Note: Sensor is shown without end casing and final measuring device.*


**FOSSA - S**

| | |
|---|---|
| Function | It acts as a standalone secure sensor solution to send and receive messages to the satellites from its integrated sensors through the FOSSA-XL gateway. |
| Security | Security is embedded by design with a VaultIC® 4XX secure element providing FIPS 140-3 level 3 an Common Criteria EAL 5+ certification. |
| Sensor Capabilities | GPS, Temperature, Humidity. |
| Battery | Battery life 12-18 months. |
| Size and Mass | 5x4x2.5 cm, 30 g. |

Example application:

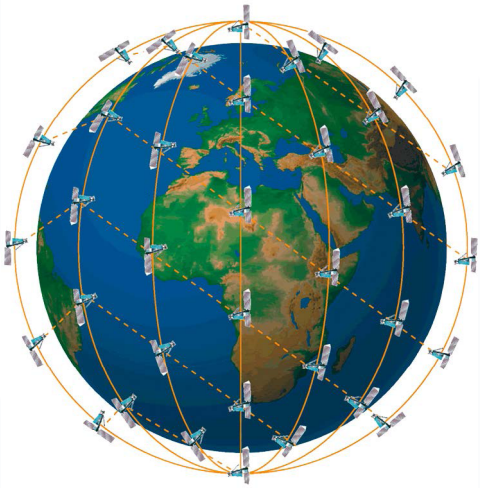
a sensor requires one-way communication with the satellite from remote locations inside the range of a FOSSA-XL gateway. It can collect asset data from livestock, agriculture, maritime tracking, or land measurements, information on a hard-to-reach sensor that is self-contained.
Note: Sensor is shown without end casing.

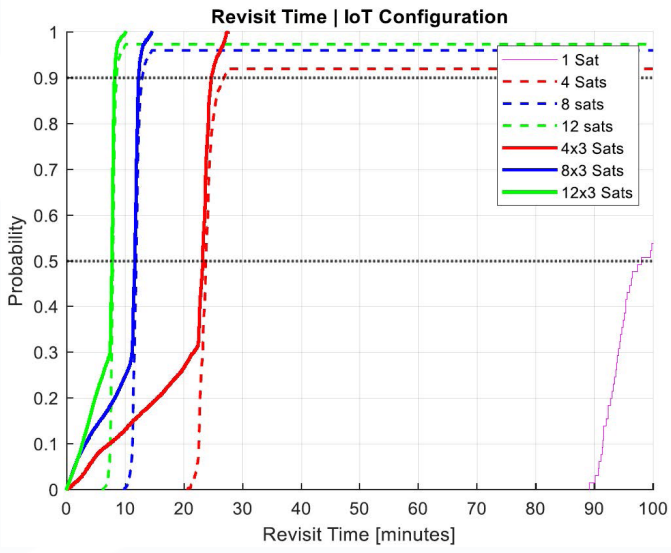


## Technology Performance

## Scope of Coverage and Network Capacity

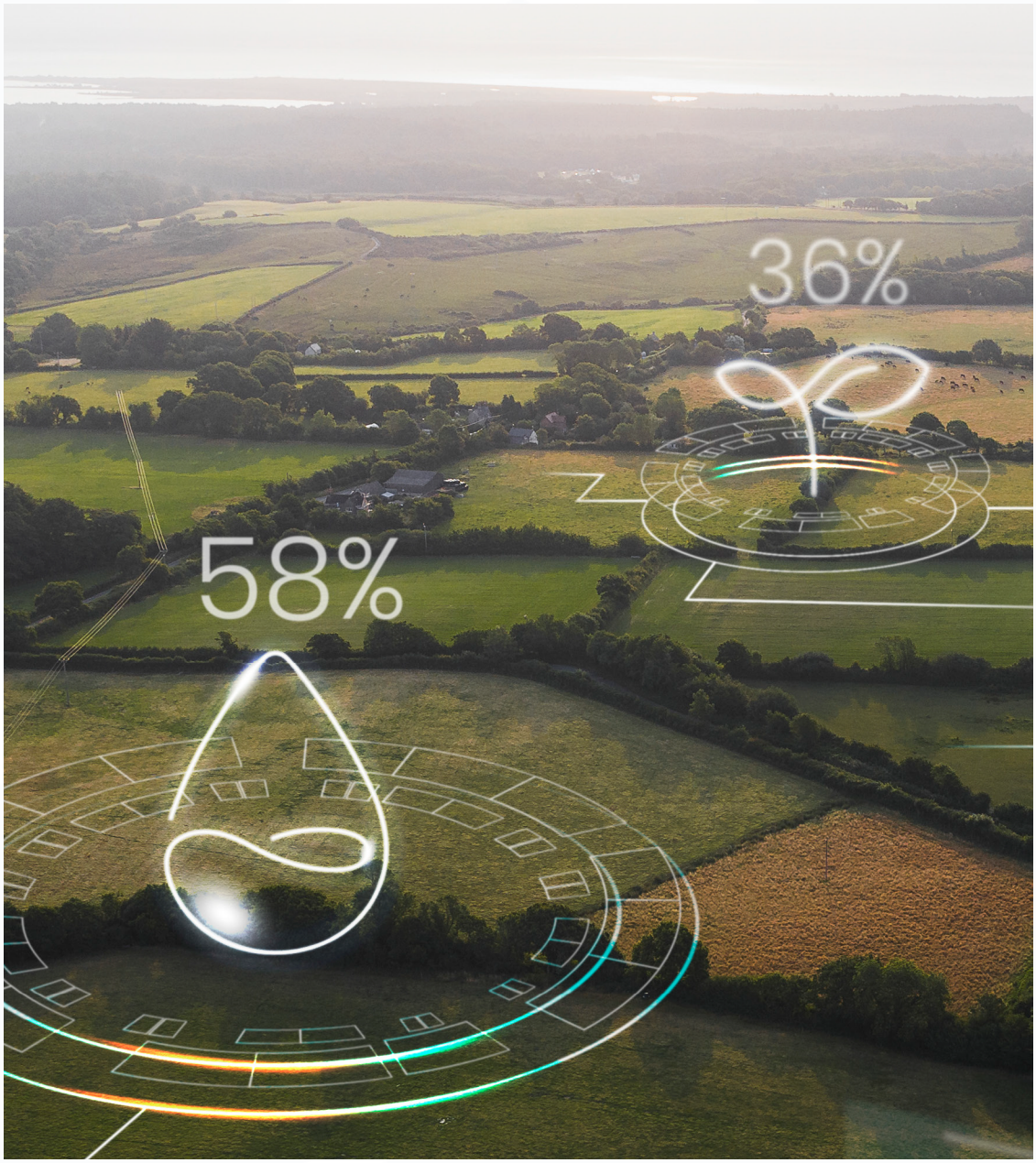
Due to the launch in Low Earth Orbit (LEO), the satellites are not geostationary and rotate around the Earth 15 times a day. This provides coverage of the entire Terrestrial surface, despite the intention to focus solely on the Iberian Peninsula during the project's current stage. In this way, each satellite has 2 passes a day of 8 minutes each. Each WISeSat has a capacity of 500,000 messages / nodes per day considering SF11, a packet size of 40 bytes and a distributed broadcast of the transmissions. The minimum launch of 2 satellites is recommended to obtain redundancy in the event of a potential failure or maintenance. In the case of 8 satellites in orbit, in the geographical area of study, this would lead to a revisit time of less than 11m 90% of the time worldwide, giving added flexibility to critical applications and increasing the daily capacity of the network. As the number of satellites increases, the revisit time between each pass decreases.





## Conclusions

With the implementation of this project, we will be able to provide affordable secure IoT connectivity to Spanish agriculture and farming by supporting the development of a massive network of independent, secure, and autonomous IoT sensors across wide areas of remote “unconnected” land.



Thanks to WISeSat's satellite technology, we can provide real-time reliable and trusted data on cattle and crops such as soil moisture, temperature, height of the crops for detection of pets, among others. The security and encryption ensure that the data remains trustable and private so that only the farmer and authorized partners can access it.

- Depending on the type of crop, an excess or deficit of Nitrogen can lead to overgrowth or vulnerabilities to pests and diseases.

- It indicates the acidity of the soil, the level of mobility of the nutrients, the most advisable varieties, toxicities, microbial activity, etc

- Monitoring the level of water stress and humidity in the bulb provides valuable information on how much and when to water.

- We can measure the level of the different nutrients that influence the evolution of our crops, such as sodium levels, active limestone, total carbonates or soil salinity.

- Generally, more light equates to higher levels of photosynthesis. However, as light intensity increases, the rate of photosynthesis eventually peaks and does not increase.

The data feeds Smart Farming applications that supports farmer's critical decision making traceability, predictability, and optimal action taking resulting in improved yield, cattle health, reduced environmental impact and better profitability