AEROSPACELAB

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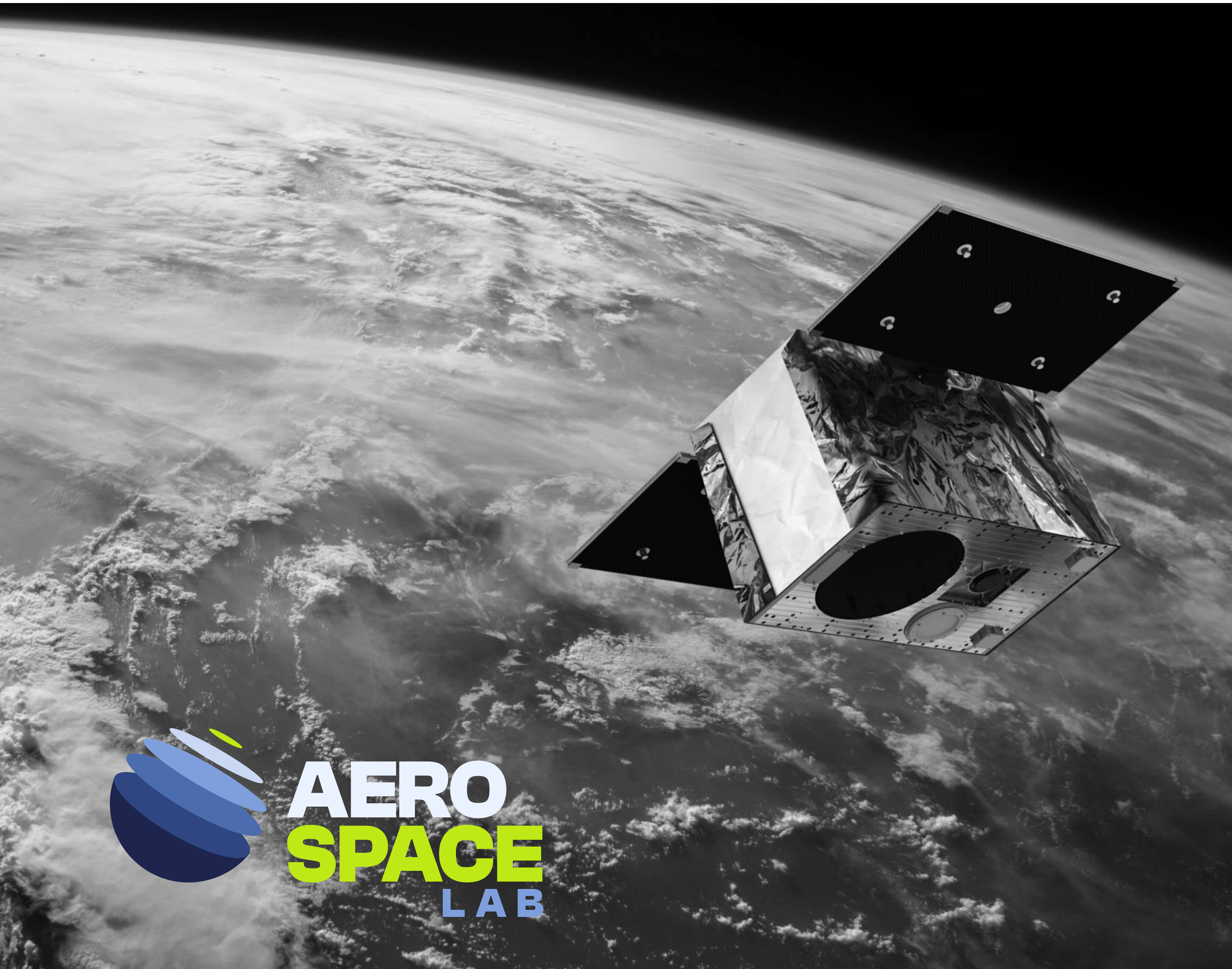
Radio Frequency Sensing

How can radio frequency detection enhance Earth Observation capabilities?

May 6, 2024

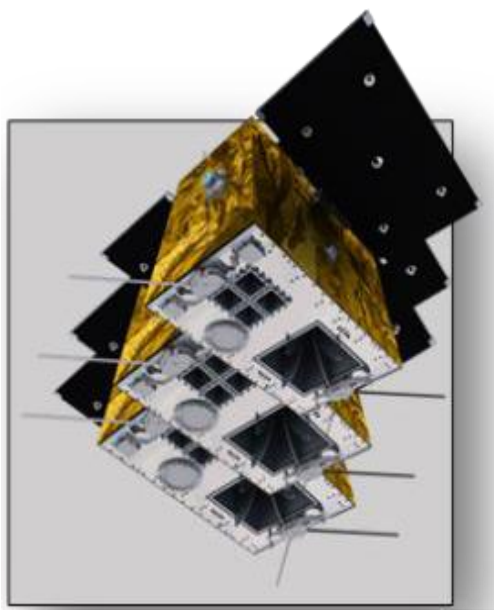


Introduction

The radio frequency spectrum forms the basis of today's modern wireless communications. Vital technologies and services including mobile calling, broadcasting, GPS, Wi-Fi, ship navigation, and airport traffic control all operate in the radio frequency bandwidth between 30 kHz and 300 GHz.

Monitoring these radio frequencies from space can unlock novel insights about activity across the Earth's surface. While traditional Earth Observation methods, such as optical imaging, face limitations due to lighting and atmospheric conditions, radio frequency antennas can continuously track the presence of radio frequencies regardless of rain or cloud coverage.

Radio Frequency Sensing Payload

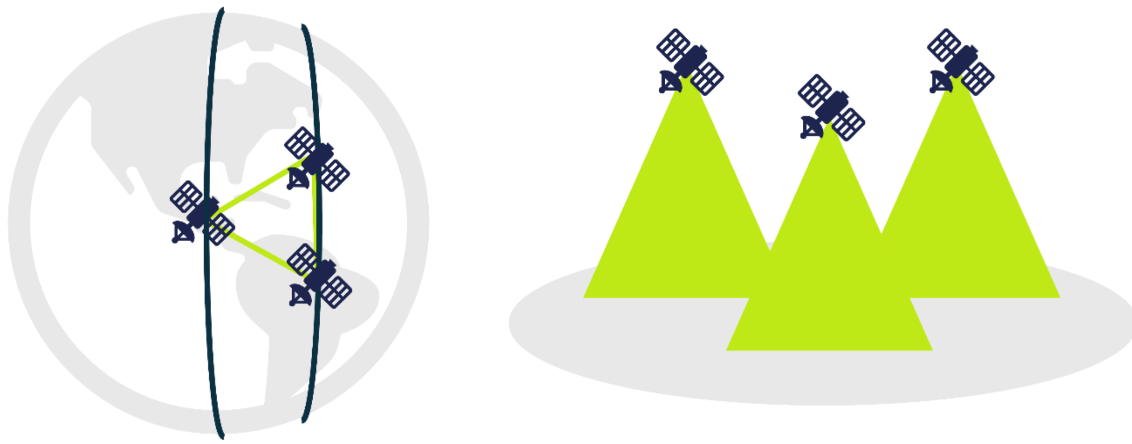


Trio of Aerospacelab RFS Satellites

Aerospacelab is excited to add radio frequency sensing to its Earth Observation capabilities. Its radio frequency sensing (RFS) payload features several types of antennas that can identify and characterize radio frequency emissions. A trio of satellites equipped with RFS payloads were launched in March 2024. Individually, each satellite collects and locates RF signal data, and by flying in a triangular formation, the set provides enhanced geolocation of emission sources. The triad will augment a fleet of Very-High Resolution and Multispectral satellites and will demonstrate the versatility of satellite platforms developed by Aerospacelab to carry the most demanding optical or radio frequency payloads.

The RFS payload is comprised of multiple antennas connected to dedicated units performing radio frequency amplification, analogic-to-digital conversion, and other computations. The antennas are designed to detect frequencies between 0.1 GHz and 18 GHz, which include signals from radars, satellite phones and radio, aircraft communications, and emergency broadcasts, among others. The payload is synchronized using a local oscillator based on a pulse-per-second signal from the platform and an embedded GPS disciplined oscillator generates a precise clock for quality and timestamping purposes. The payload is also able to store over 1 TB of data in solid-state drive (SSD) mass storage.

Operators can capture data through targeted and continuous frequency detection. An Aerospacelab RFS satellite can actively observe a specified geographical area and frequency over an acquisition period or passively monitor a set of frequencies over time. The collected data includes timestamp and spacecraft information used to geolocate a signal's source and direction: one satellite can use an Angle of Arrival (AOA) location method, while a trio can use Time Difference of Arrival (TDOA) and Frequency Difference of Arrival (FDOA) for improved positioning accuracy. The raw signals are then processed on-board and on-ground through spectrum, de-channelization, and demodulation analyses to generate additional insights.



__Radio Frequency Sensing Satellites Flying in Formation:__ Riri, Fifi, and Loulou fly in a triangle formation, spaced out by around 100km. The trio is shown from a birds-eye view (Left), and from the side (Right).

RF Payload Use-Cases

Radio frequency monitoring can generate actionable intelligence on human activity and communications patterns across land, water, and air. Sustained observation across frequencies allows for quick and confident identification of anomalous behavior. This information can be invaluable to identifying business opportunities, protecting against security risks, enforcing international regulations, and catching illegal activities. Some illustrative use-cases are listed below:

On the Ground

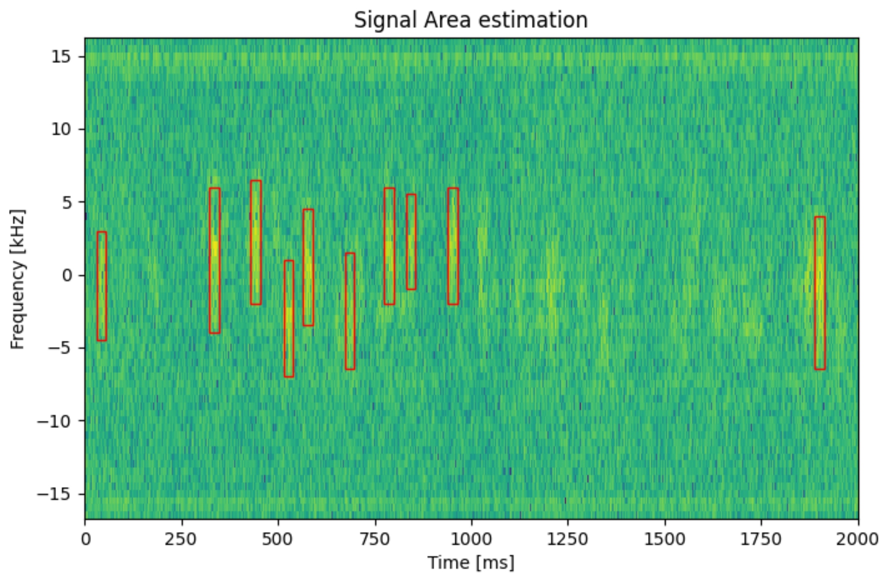
1. **Identifying Signal Interference**: By building a map of every frequency, signal jamming, spoofing, and other signal interference events can be detected.
2. **Locating Ground-Based Radar**: Quick characterization of the unique signal profiles of ground-based radar can support the identification of military asset deployments.
3. **Expanding Cell Phone Tower Networks:** Signal density maps allow ground networks operators to find optimal future cell tower locations.

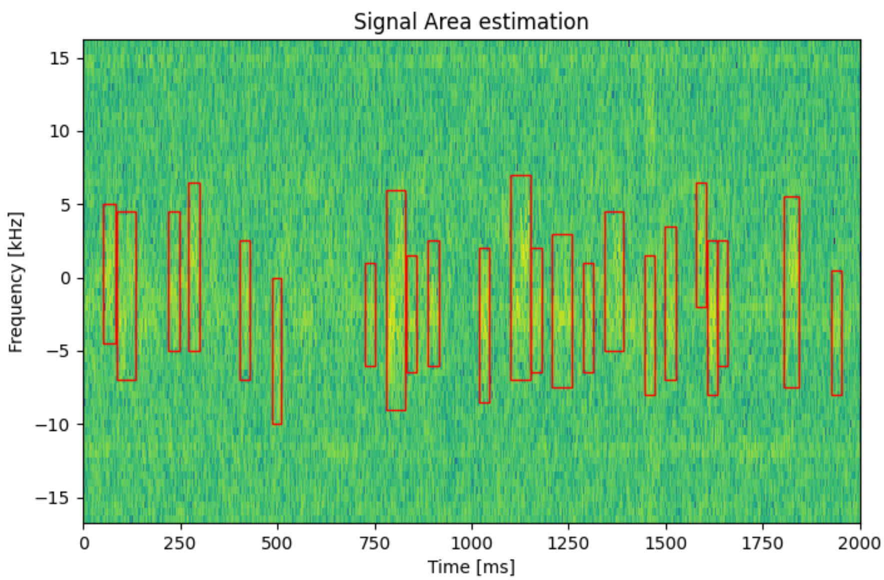
In the Water

1. **Tracking Suspicious Ships**: Vessels engaged in illegal activity can be located by comparing the geolocation of the ship navigation radar with the location and content of its Automatic Identification System (AIS) signals and messages. The image below shows Aerospacelab's satellites capturing AIS signals around the world.
2. **Improving Supply Chain Analyses:** Collecting regular information about transport vessels provides data for supply
estimation, shipping route optimization, and port activities.
3. **Maritime taxes collections:** Monitoring the exclusive economic zones of island countries for recreational ships supports the collection of tourism taxes.

Around the Globe

1. **Expediting Search and Rescue Operations**: Rapid reporting of emergency beacon position and content can save lives.
2. **Protecting the Environment:** Endangered and protected areas can be followed for threatening or dangerous behaviour such as illegal hunting or fishing.
3. **Detecting Aircraft:** Precise geolocation of aircraft supports air traffic management and analyses on airline competition and unscheduled flights.





Aerospacelab Radio Frequency Sensing Satellites Capturing Data: *Riri, Fifi, and Loulou captured radio frequencies centered around 162 MHz to capture AIS signals from ships in Greenland (Left), and the coast of Angola (Right).*

Data Fusion for Deforestation

Combining radio frequency monitoring data with other data sources such as Aerospacelab's Very High Resolution (VHR) and Multispectral Instrument (MSI) satellites provides a comprehensive picture of various scenarios and informs the best course of action for stakeholders.

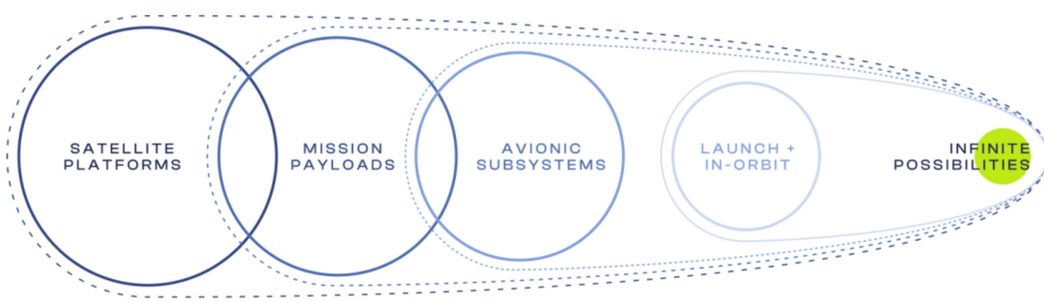
The fusion of data collection methods can be invaluable for complex applications such as the monitoring of deforestation in the Amazon rainforest. The RF sensing payload acquires information about on-the-ground activities by locating radio frequencies related to human communications or logging vehicles and machinery. VHR satellites takes detailed images of the rainforest to identify specific logging methods such as clear-cutting or selective logging. The imagery may also capture the presence of logging roads or machinery. MSI imagery enables tracking changes that may be otherwise obscured by clouds or other atmospheric conditions, such as the health and density of vegetation. When used together, the three types of payloads can effectively follow deforestation, study the health of the ecosystem, and identify illegal logging.

Conclusion

Much of human communication occurs on radio frequencies. The Aerospacelab RF payload can characterize and geolocate these frequencies and when combined with other Earth Observation data, Aerospacelab can survey human activity regardless of uncontrollable factors such as weather. Speedy and accurate detection of frequency anomalies can benefit many industries by minimizing risks, uncovering dangerous behavior, and providing unique economic insights.

About Aerospacelab

Founded in 2018, Aerospacelab is an emerging figure in the aerospace sector, showcasing a remarkable achievement of eight satellites successfully deployed in orbit. We pride ourselves on our dedication to vertical integration and TRL9 implementation, solidifying our commitment to driving innovation in the space industry. With our operations strategically placed in various locations, including the US, Aerospacelab remains steadfast in its mission to deliver pioneering solutions for our diverse customer community.



Contact US

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