

# New developments for resilient GNSS navigation and timing

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## Abstract:

This paper introduces the ALLSAT Jamming Detection System (AJDS), designed to protect critical infrastructure from security-relevant disruptions caused by GNSS interference and jamming. The system combines precisely coordinated GNSS receivers and antennas with advanced software components to enable the reliable detection and localization of both intentional and unintentional GNSS interference sources.

At its core, the system employs three high-performance Controlled Reception Pattern Antennas (CRPA), which ensure robust GNSS signal reception, even in highly disturbed environments. These antennas are particularly suitable for applications in critical infrastructure, defense and aviation.

Each CRPA integrates four antenna elements within a single housing, allowing the determination of both azimuth and elevation angles of interference sources at each deployment location. Through networked operation and integration with the ALLSAT GLOMON software platform, the system generates real-time alerts that include precise jammer location estimates within a local coordinate framework.

This approach enables, for the first time, the accurate localization of a wide range of GNSS jammers, including both ground-based and drone-borne sources, thereby significantly enhancing the protection of critical infrastructure such as airports.

**Key words:** GNSS, Jamming Detection System, ALLSAT GLOMON, JAVAD GNSS, Calian CRPA GNSS Antenna

## Introduction

Global Navigation Satellite Systems (GNSS) are essential for modern critical infrastructure, yet they are increasingly vulnerable to interference and jamming, which can degrade positioning performance and compromise safety. Existing monitoring approaches typically detect signal degradation but provide limited capability for accurately localizing interference sources.

This paper presents the ALLSAT Jamming Detection System (AJDS), an integrated solution for real-time detection and localization of GNSS interference. The system combines three Controlled Reception Pattern Antennas (CRPAs) with advanced software processing in the GLOMON platform. Each CRPA enables the estimation of azimuth and elevation angles of interference sources, while the networked

architecture allows for multi-station data fusion and precise jammer localization.

By correlating directional measurements across multiple sites, the AJDS enables accurate positioning of both ground-based and airborne interference sources. This approach significantly enhances situational awareness and contributes to improved protection of GNSS-dependent infrastructure, particularly in safety-critical domains such as aviation.

### CRPA Antenna CALIAN CR8894SXF+ [1]

The Calian CR8894SXF+ is a powerful GNSS four element Controlled Reception Pattern Antenna (CRPA) technology and is ideal for safety-critical applications. It enables reliable detection and suppression of interference and jamming signals in both the lower (1189–1254 MHz) and upper GNSS band (1559–1591 MHz). Thanks to three nulls per band, interference sources are selectively suppressed.

The antenna supports the essential frequencies of global satellite Systems: GPS L1/L2, Galileo E1/E5B, GLONASS G2/G3, BeiDou B1/B2b

The key feature used for this system is situational awareness. The antenna detects azimuth and elevation angles of interference sources along with the frequency range.



Fig.1. CALIAN CR8894SXF+ Antenna

### JAVAD Receiver DELTA-3S [2]

The JAVAD DELTA-3S is a versatile GNSS receiver that is deployed as a reference station. Within this system, the receiver is configured to transmit raw GNSS measurements as well as jamming and spoofing detection data to the GLOMON software at 1-second intervals, ensuring continuous and reliable monitoring.

The receiver supports 874 GNSS channels, covering all major global navigation satellite systems: GPS L1/L2/L5, GLONASS: G1/G2/G3, Galileo E1/E5A/E5B/E6, BeiDou B1/B2/B3, QZSS L1/L2/L5/L6

The JAVAD DELTA-3S incorporates integrated algorithms for jamming and spoofing detection, enabling reliable identification of interference sources directly within the receiver.



Fig.2. JAVAD DELTA-3S

This receiver represents the optimal second protection level in this system, alerting for spoofing or jamming that cannot be mitigated by the antenna, particularly in applications where signal integrity and resilience against interference are critical.

### ALLSAT GLOMON software platform [3]

The GLOMON software platform processes data streams from three AJDS reference stations and continuously evaluates the GNSS fixed solution status. This enables early detection of potential

GNSS interference or degradation in positioning performance.

In parallel, jamming messages from three CRPA antennas are acquired, logged, and analyzed in real time. For each antenna site, both the azimuth and elevation angles to a detected interference source are estimated in real time. By correlating these directional measurements across multiple antenna locations within the GLOMON framework, the system facilitates network-based localization of GNSS jammers.

The tight integration of sensing and processing components within the GLOMON platform enables an automated alarm mechanism, which is triggered upon detection of interference. Notably, the system can reliably identify jamming events even if only a single CRPA antenna reports interference. When directional observations from at least two reference stations are available, an initial three-dimensional position estimate of the jammer can be derived. If all three stations detect the interference source, a high-precision localization becomes feasible through the application of an advanced adjustment algorithm, which refines the jammer coordinates.

An additional advantage of the system is its capability to express the estimated jammer position within the local coordinate system of the monitored site, facilitating direct integration with site-specific protection and mitigation frameworks.

The principal benefits of the AJDS approach include early warning capabilities enabled by automated GNSS performance monitoring. Alarm thresholds and trigger conditions can be flexibly configured, and localization results can be automatically transmitted to external protection systems to support rapid mitigation of interference sources.

The concept presented here leverages a fundamental property of CRPA-based anti-jamming technology, namely that real-time knowledge of jammer direction is required for adaptive null-steering. By exploiting this information not only for interference suppression but also for geolocation purposes, the system extends the functionality of conventional CRPA solutions.

Finally, the GLOMON architecture is inherently scalable, supporting the integration of multiple monitoring stations as well as the parallel processing of multiple projects. This enhances situational awareness for critical GNSS-dependent infrastructure, including applications in aviation and port operations.

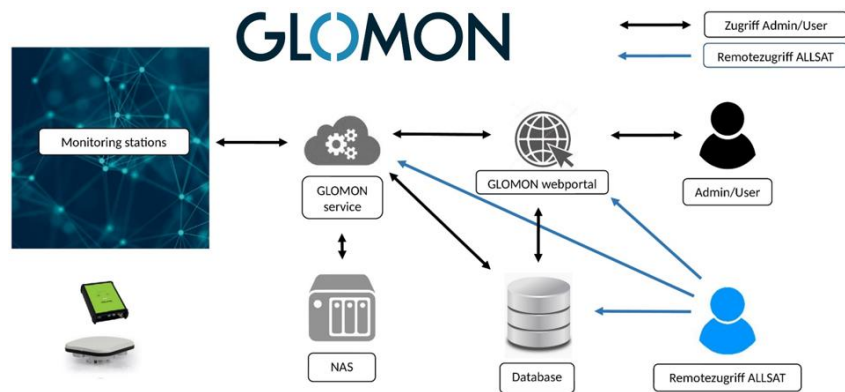


Fig.3. GLOMON Overview

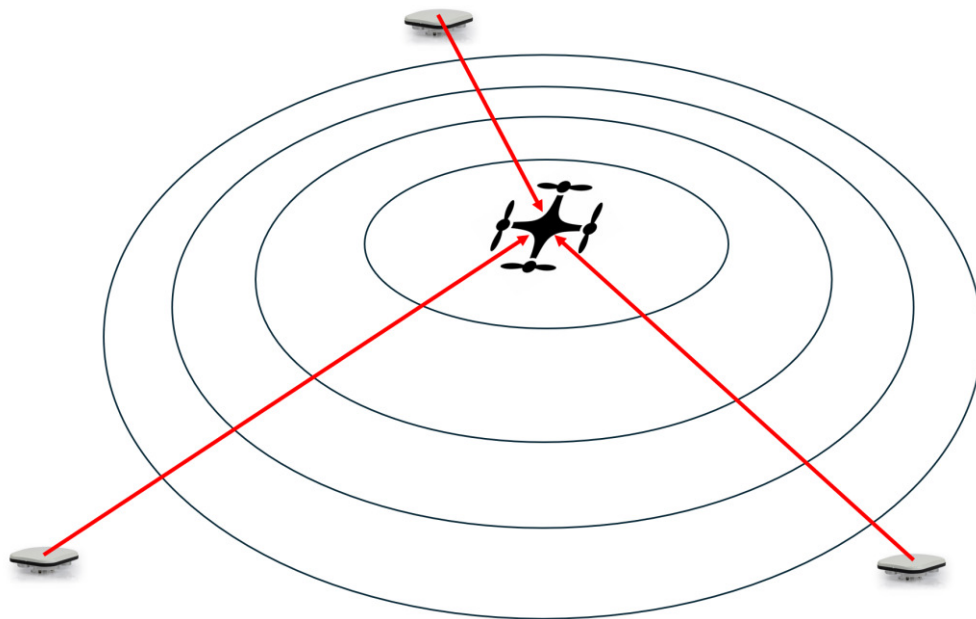


Fig.4. AJDS drone scenario



Fig.5. AJDS Live Map

## Conclusion

This paper presented the ALLSAT Jamming Detection System (AJDS), a novel and integrated approach for the detection and localization of GNSS interference in critical infrastructure environments. By combining CRPA-based directional sensing, high-performance GNSS receivers, and the GLOMON software platform, the system enables reliable real-time monitoring and precise geolocation of interference sources.

The results demonstrate that the fusion of azimuth and elevation measurements from multiple antenna sites allows for accurate 3D localization of both ground-based and airborne jammers. The system further provides early warning capabilities, even under conditions where interference is detected by only a subset of sensors, thereby increasing robustness and operational reliability.

A key contribution of this work lies in extending CRPA technology beyond interference suppression to network-based geolocation, enabling enhanced situational awareness and rapid response capabilities. The scalability of the architecture and its compatibility with local coordinate systems make it particularly suitable for deployment in safety-critical applications, such as aviation and airport environments.

Future work will focus on further improving localization accuracy, integrating additional sensor modalities, and validating system performance in large-scale operational scenarios. Overall, the AJDS represents a significant advancement in protecting GNSS-dependent infrastructure against evolving interference threats.

## References

- [1] <https://www.calian.com/advanced-technologies/gnss/>
- [2] <https://www.javad.com/>
- [3] <https://glomon.de/>