



# Maritime IDM for GNSS



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The Global Leader in Resilient PNT

Providing the world's most critical applications real-time, accurate, reliable positioning, navigation, and timing data.

Safety, Security and Reliability



# GNSS (GPS) NAVIGATION

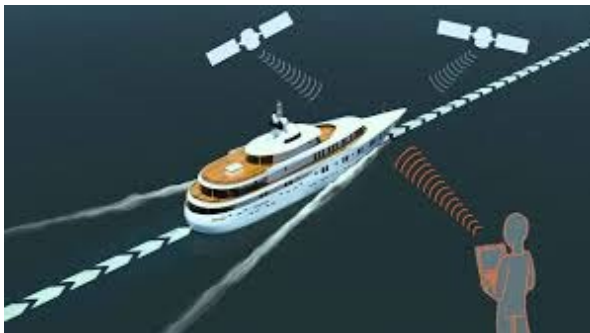
**Good news:** Accurate, available worldwide, free

**Bad news:** weak signal is easily jammed, open (unencrypted) signal can be spoofed (faked)

*Black Sea*

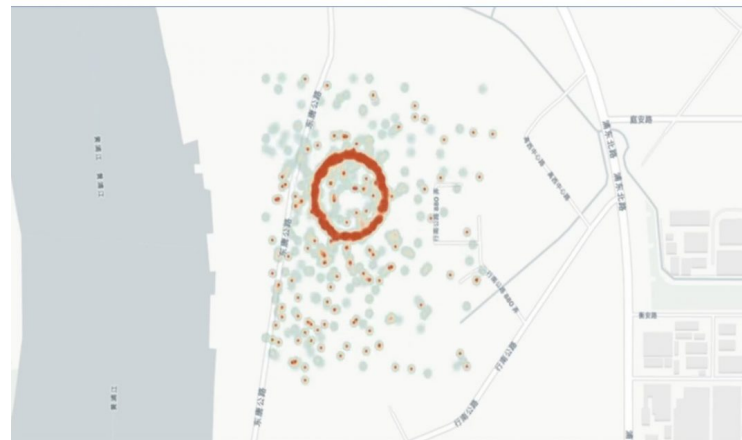


*U. Texas Mediterranean Demo 2013*



## Numerous Incidents of GPS Spoofing and Jamming

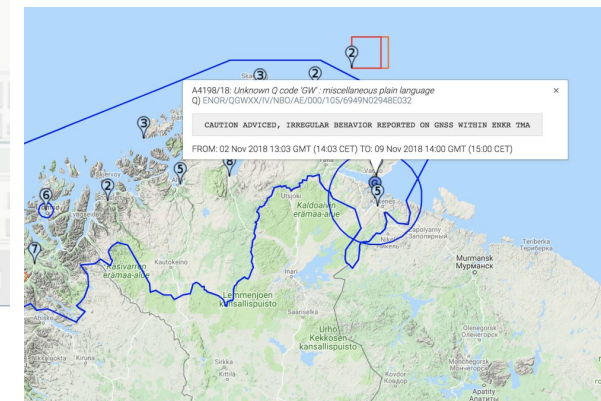
*Port of Shanghai*



*Eastern Mediterranean*



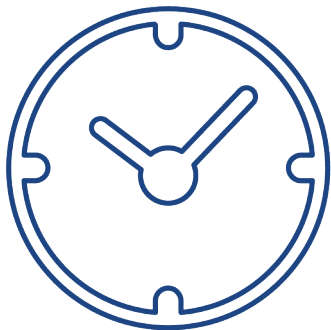
*Northern Finland*



# Layered Protection for Critical Ship & Shore Navigation Signals

## M-SecureSync Solution

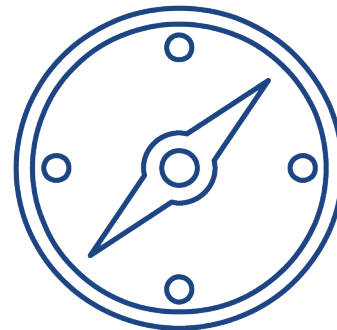
Precision GNSS



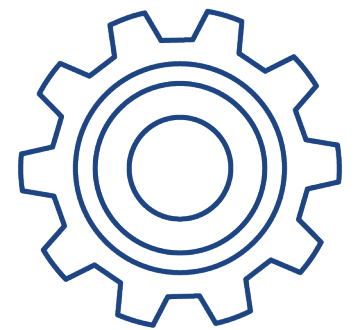
RF Threat Detection & Alerts



GNSS Augmentation

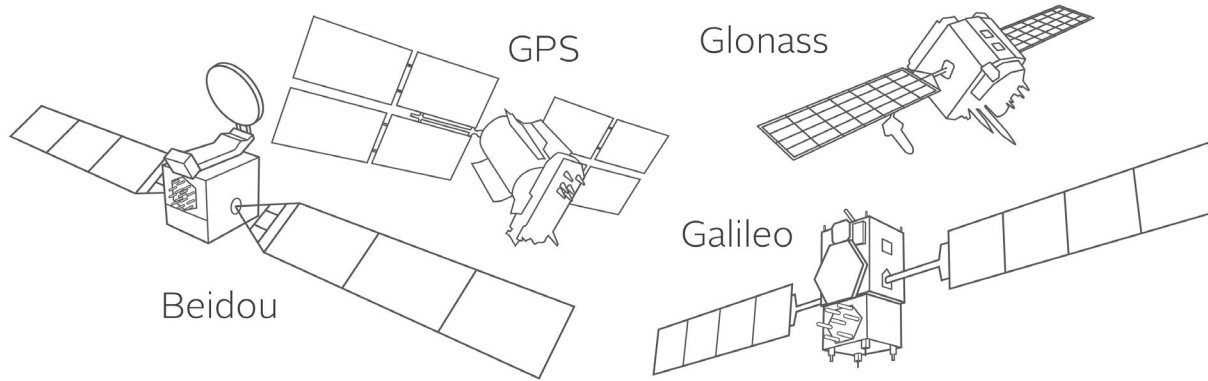
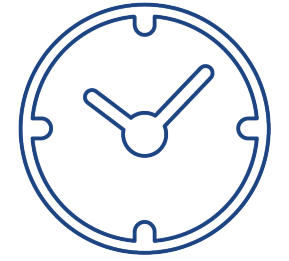


Signal Protection





# Precision PNT Source

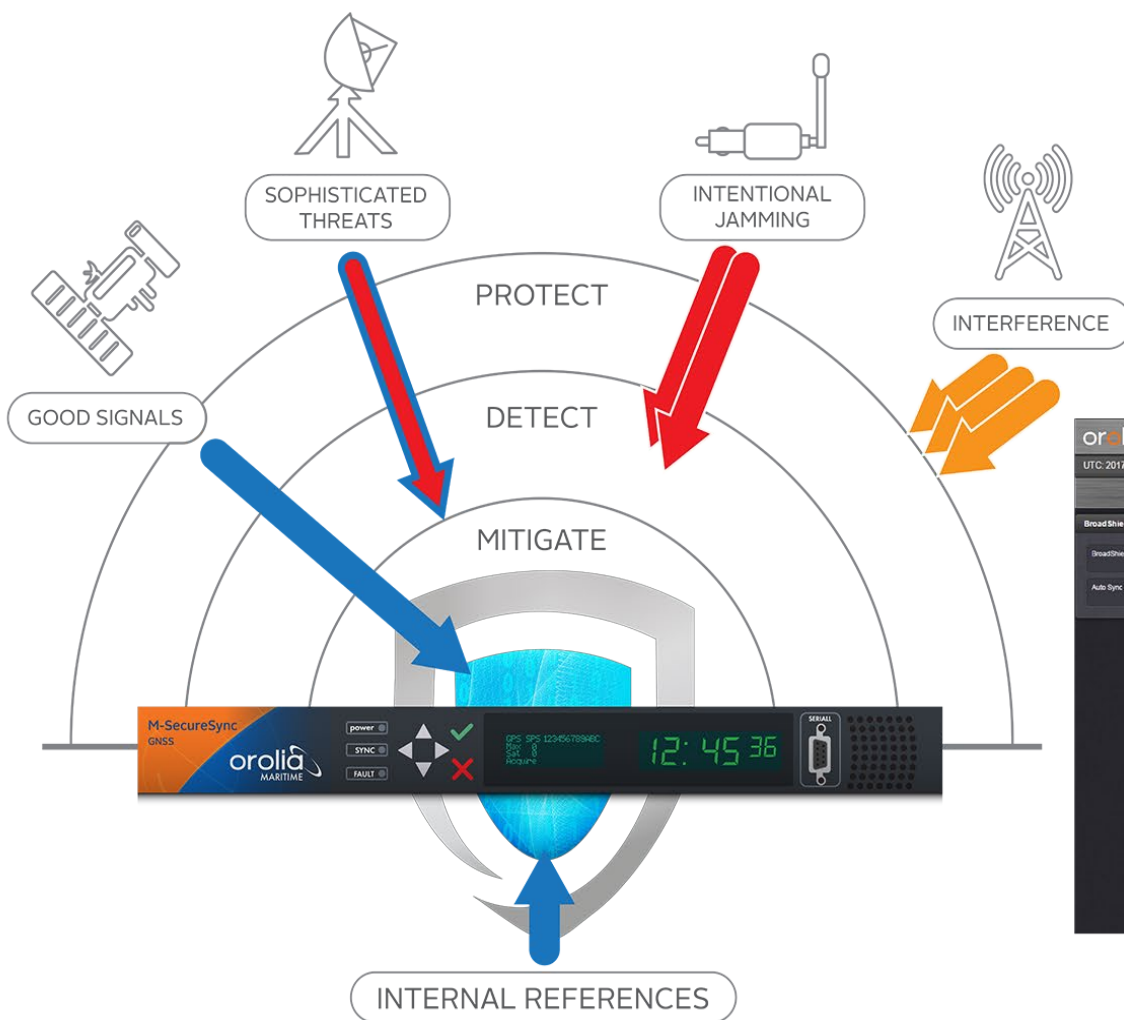


Ultra precise time server that allows multiple configurations, including

- **GNSS Comparison Source**
- **Platform for Navigation Security Signal Monitoring**
- **Time stamped transactions**
- ***GNSS Weather* indication, highlighting disruption or malicious attacks can be detected and corrective action taken**



# RF Threat Analysis & Alerts



**Interference Detection and Mitigation (IDM) Suite**  
**Unintentional interference**  
**Malicious attacks**

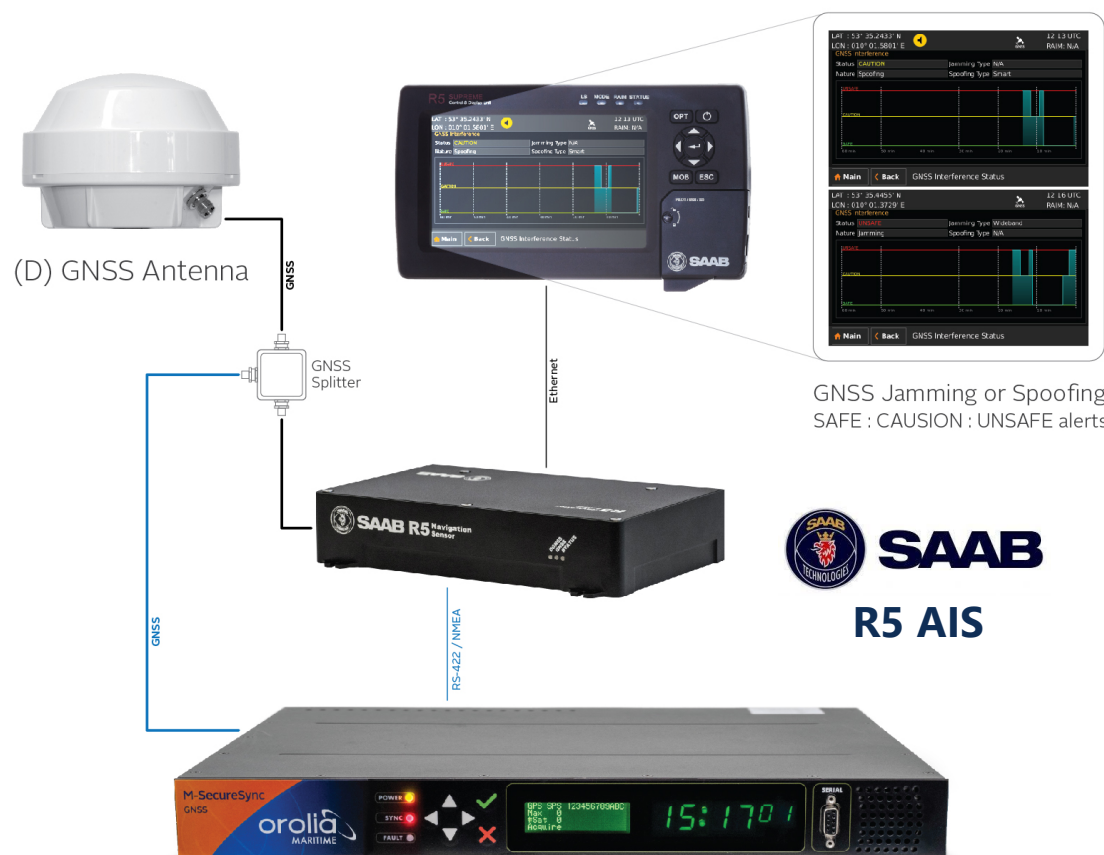


# RF Threat Analysis & Alerts



The **IDM** component of M-SecureSync detects advanced Spoofing and Jamming techniques

# RF Threat Analysis & Alerts



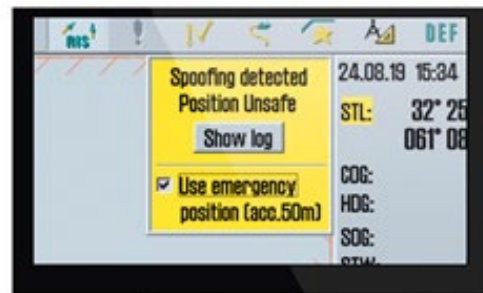
Orolia and SAAB have partnered to create the **worlds first GNSS system with integrated navigation Cyber security alerts**

M-SecureSync has been added to SAAB's R5 system to help inform the ship's bridge of potential position spoofing and deliberate jamming.

# RF Threat Analysis & Alerts



(D) GNSS Antenna



Spoofing Warning



TECDIS  
TELKO



M-SecureSync

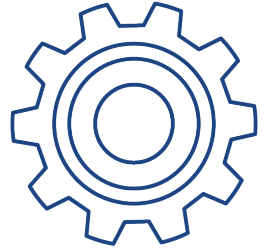


Orolia and Telko have partnered to create the **world's first ECDIS system with integrated navigation Cyber security alerts**

M-SecureSync has been added to Telko's TECDIS system to help inform the ship's bridge of potential position spoofing and deliberate jamming.



# Signal Protection with Anti-Jam Antennas



Orolia 8230AJ



infiniDome  
Two-port CRPA



GAJT 710MS

Anti-Jam Antenna helps to prevent jamming by signal saturation at ports or on vessels

- Most interference come from land sources
- Anti Jam removes *on the horizon* interference by rejecting signals from a lower elevation angle
- Allows only signals from satellites to be received

# HORIZON BLOCKING TECHNOLOGY

Unique antenna shape generates radiation pattern to reject low elevation signals

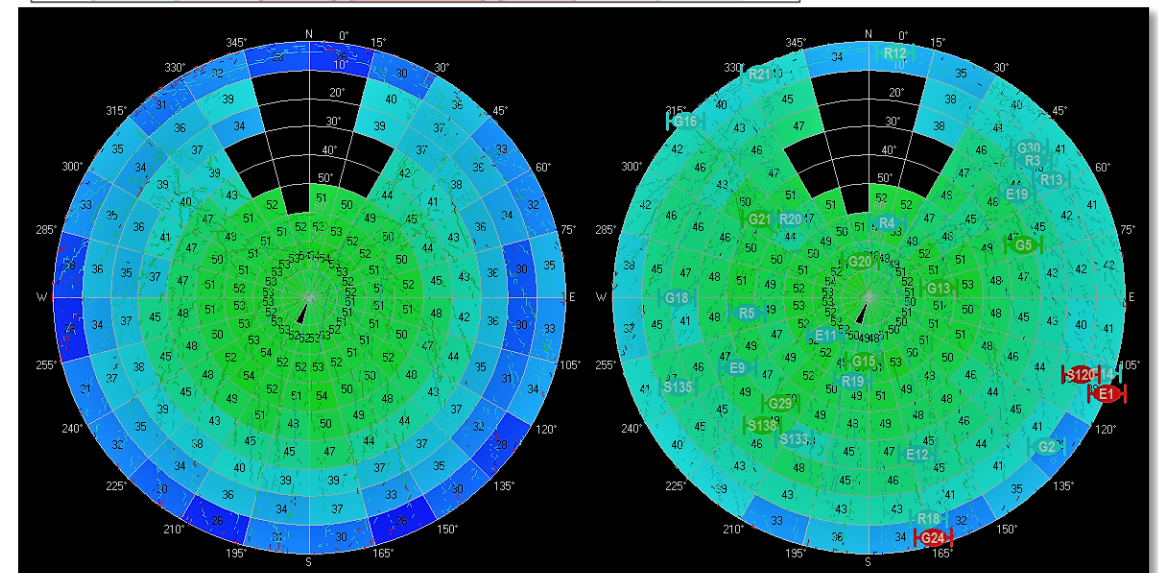
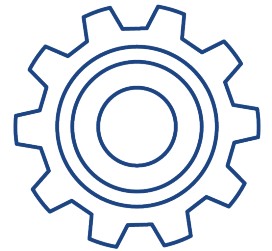
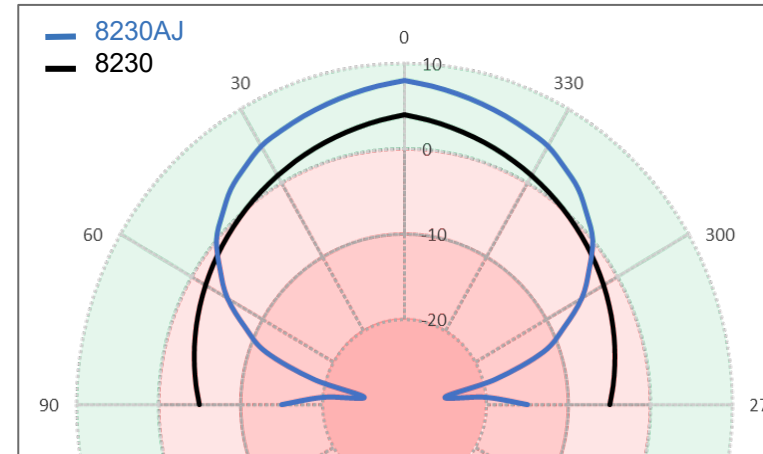
- No expensive active anti-jam processing
- Still includes high gain active LNA

Provides >20 dB attenuation from zenith to signals at <20° elevation

- 13-25 dB better attenuation of signals vs standard 8230



Radiation Pattern (RHCP)



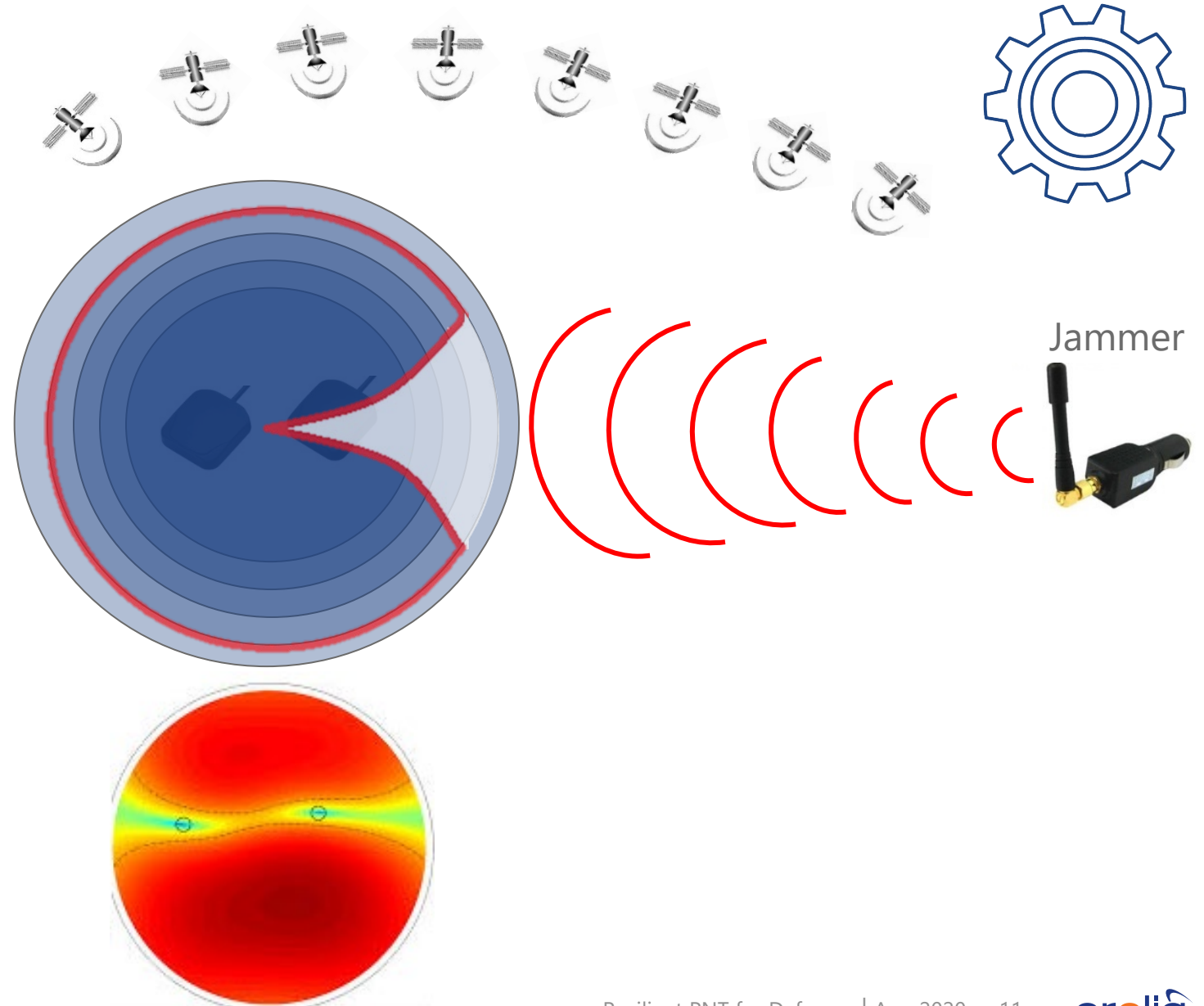
8230AJ

8230

# CRPA TECHNOLOGY

## Null Steering Algorithm

- Detects and analyzes interference direction
- Merges patterns from two antennas which enables nulling of an interference from one direction
- Protects downstream receiver and maintains lock to signal
- Patented architecture supports RF manipulation in real time introducing a small (100ns) constant delay in the RF chain



# COUNTERMEASURES – INTERFERENCE DETECTION AND MITIGATION

## Protect

Anti-jam antennas and advanced receiver techniques to detect jamming and spoofing and filter out when possible.



## Alert

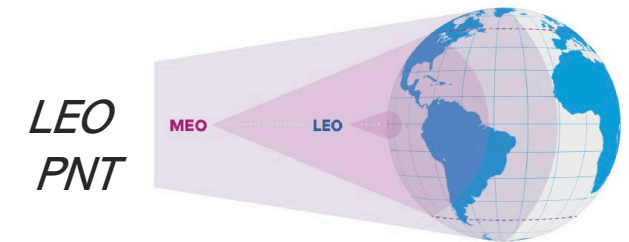
Display on ECDIS, AIS, BAM. Share warnings with other ships on Sea Traffic Management and other networks.



## Other Nav Sources

Augment GNSS with other signals, not originally designed for navigation

### Signals of Opportunity



LEO  
PNT

5G  
For  
harbor  
&  
littoral



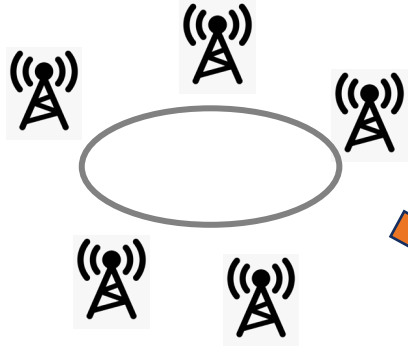
eLoran





# GNSS WEATHER REPORTING™

## CROWDSOURCED DETECTION



*Network of IDM  
detectors on ships  
and at ports providing  
interference reports to  
a central repository*



*Shared via a Vessel Traffic Mgmt System*

## INTERFERENCE REPORTING

U.S. process starts with problem report to NAVCEN, FCC or FAA:

- Different than ITU form
  - Problem Report vs. After Action Report
- Service Center triage to confirm problem
- Initial interagency conference call to provide for a coordinated government response/discussion on way forward
- Priority assigned will determine level of response and agencies involved

**Purpose:** The Coast Guard Navigation Center will use this information to investigate reports of navigation outages, issues or discrepancies in accordance with DHS/MLL-002, Department of Homeland Security, and DHS/USCG-013, Marine Information for Safety, June 25, 2009.

**Disclosure:** Furnishing this information is voluntary; however, navigation safety related information.

\* Denotes a required field

1) \* Your Name:

2) \* Email Address:

3) \* Telephone number: (e.g. - (703) 313-5900)

4) Preferred method and time to be contacted if additional information is necessary:

5) \* What was the start time and date of the GPS disruption?  Date:  Zone:

6) \* Is the GPS disruption ongoing?  Select:

7) \* Where did the disruption occur? (LAT/LONG, Nearest City or landmark)

8) GPS user equipment make and model (receiver manufacturer and model, antenna type, etc.)

9) GPS installation type (aviation, marine, surveying, agriculture, transportation, timing?)

10) What was the elevation of the GPS antenna?

11) What GPS frequency are you using? (press Ctrl while selecting to select multiple satellites)  L1 (1) L2 (1)

12) How many satellites were being tracked at the time of the disruption?

13) Which satellites were being tracked at the time of the disruption? (press Ctrl while selecting to select multiple satellites)  Don't SVN SVN

14) What was the GPS receiver being used for at the time of occurrence?

15) Summary (Please provide any additional information)

## DISTRIBUTION TO USER COMMUNITY

GNSS  
Weather  
Reports

## CENTRALIZED DATA COLLECTION / REPORTING

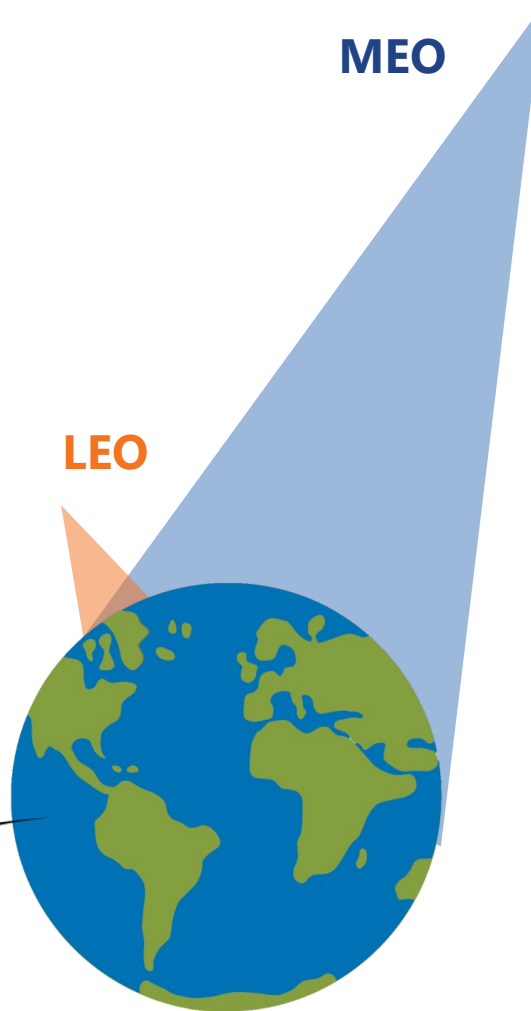
# LEO VS MEO FOR PNT – POSITION, NAVIGATION, AND TIMING

## LEO – Low Earth Orbit

- ~30 dB **stronger signal**
  - 1000x than GNSS, harder to jam
- Poor geometry for Navigation
  - need 100s satellites to cover the globe
- geometry optimized for Communications
- **Encrypted for secure links**
  - Inherently anti-spoof
- First generation of LEO PNT less accurate because not purpose-built: PNT function added after launch

## 2<sup>nd</sup> Gen Communications Constellations

- Wide bandwidth, 100s of satellites
- **Accuracies will rival GNSS**



## MEO - Mid Earth Orbit

- Weaker signal, far from earth
- **Excellent geometry for Navigation**
  - 24 satellites cover the globe
- Poor geometry for communications

## GNSS Constellations

PNT purpose built with high precision atomic clocks providing excellent accuracies but are vulnerable to jamming and spoofing.

### GNSS – Global Navigation Satellite Systems



GPS



GLONASS

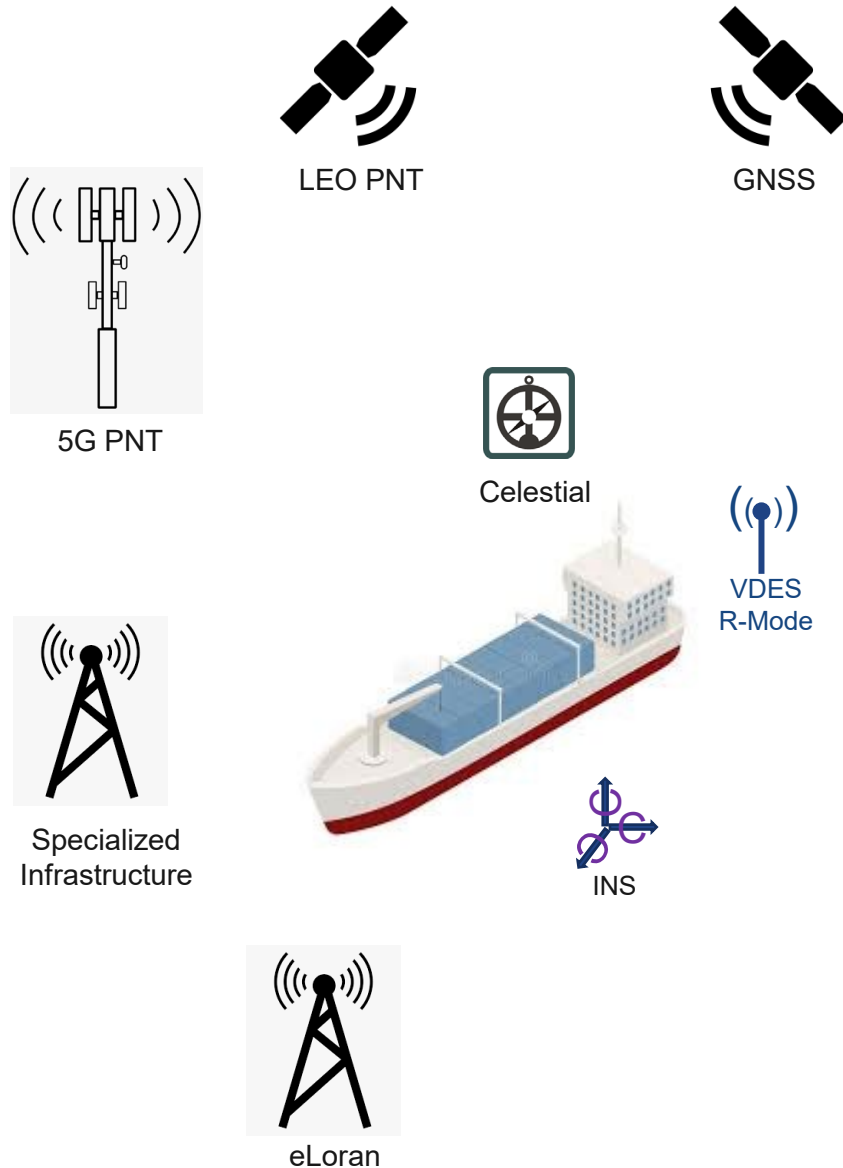


Galileo



Beidou

# OTHER ALTERNATIVE NAVIGATION



## ***VDES R-Mode***

- Low accuracy, needs >3 stations for independent solution
- 10 – 100m single range **INS updates** can limit drift

## ***Sensor Fusion & Crowd-Sourced Location***

- AIS + R-Mode + Radar + INS + magnetic
- Network sharing tracks + proximity => ***infer*** own position
- Celestial – camera automated star tracking for night, sky polarization mapping for day

## ***Specialized Shore-based Positioning Infrastructure***

- Multiple installed basestations at ports can achieve meter or better accuracy – Locata, NextNav, etc.
- eLoran – availability?

## ***5G PNT***

- in development for ~1m accuracy will eventually rival GNSS

# Summary

- GNSS Interference Detection & Mitigation
  - **Protect** against jamming and spoofing
  - **Alert** when integrity is compromised
  - Use **alternative PNT** sources
- No single source alternative to GNSS yet
  - Use **multiple sources for High Integrity**
  - **New emerging sources** for the future

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