

10th Interference Detection and Mitigation Workshop
United Nations Vienna International Center
December 06, 2022





AGENDA

28 different countries attending

- **Opening Remarks (Chair)**
 - **Initiatives in the UN hosted International Committee on GNSS (ICG)**
 - ❖ *Recommendation (adopted): Developing Resilience in critical infrastructure*
 - ❖ *Recommendation (In Review): Public safety review of GNSS testing applications*
- **Use of GPS by U.S. Coast Guard Navigation Center: CAPTAIN Scott Calhoun, Commanding Officer U.S. Coast Guard Navigation Center**
- **Sharing and Crowdsourcing GNSS Data to Monitor and Protect the RF Environment: Mr. Mathieu Joerger, Assistant Professor, Kevin T. Crofton Department of Aerospace and Ocean Engineering, Virginia Polytechnic Institute and State University (Virtual)**

Interference Detection And Geo-Location Capabilities

- **DOT Strategic Plan for GPS/GNSS Interference Detection:** *Mr. James Aviles, Analyst, PNT and Spectrum Management, U.S. Department of Transportation (Virtual)*
- **Critical Infrastructure Dependency on PNT:** *Mr. Michael Roskind, Branch Chief, Strategic Defense Initiatives, U.S. Department of Homeland Security (Virtual)*
- **Use of ADS-B for Interference Detection:** *Mr. Hamdi NASSAR, EUROCONTROL*
- **Characterization of ADS-B Performance Under GNSS Interference:** *Professor Dr. Todd Walter, Director, GNSS Laboratory, Aeronautics and Astronautics Department, Stanford University*
- **Detecting GNSS Spoofing of ADS-B Equipped Aircraft Using INS:** *Professor Boris Pervan, Mechanical and Aerospace Engineering, Illinois Institute of Technology (Virtual)*

Incorporating Resilience into GNSS Interference Detection and Mitigation

Recommendation of Committee Action: ICG-16 Adopted

To increase critical infrastructure resilience to GNSS disruptions and interference, the ICG recommends that Government IDM Policy should reinforce the need for resilience based on a three-prong approach:



1. (Service Aspect): National GNSS spectrum protection and enforcement, and implementation of IDM capabilities;
2. (Hardware Aspect): PNT systems designed with resilient system architectures and systems incorporating cybersecurity principles for holistic approach to threats; and ;
3. (End-User Aspect): End Users plan for and know how to respond to, withstand, operate through, and recover from PNT disruptions and interference, as well as understand and minimize the impact of PNT disruptions in downstream systems.

Testing Approval Public Safety Review

Recommendation of Committee Action: In discussion by IDM Task Force

In the interest of public safety, the members of WG-S recommend that the ICG support the establishment, by all nations, of a standardized and centralized process for each government by which organizations within each government's jurisdiction can apply for authorization to conduct testing on GNSS frequencies.

Further, this **process should institute an internal concurrence process** for each government allowing designated internal agencies to review applications for public or operational safety issues related to times and locations of requested testing.

The process should **culminate in public notification** of authorized testing times and locations and have a means for authorized government authorities to **quickly bring a halt** to testing if these operations are creating safety problems that were not anticipated or expected during the test planning phase.



U.S. Coast Guard Navigation Center

Use of AIS Data at USCG NAVCEN



Homeland
Security

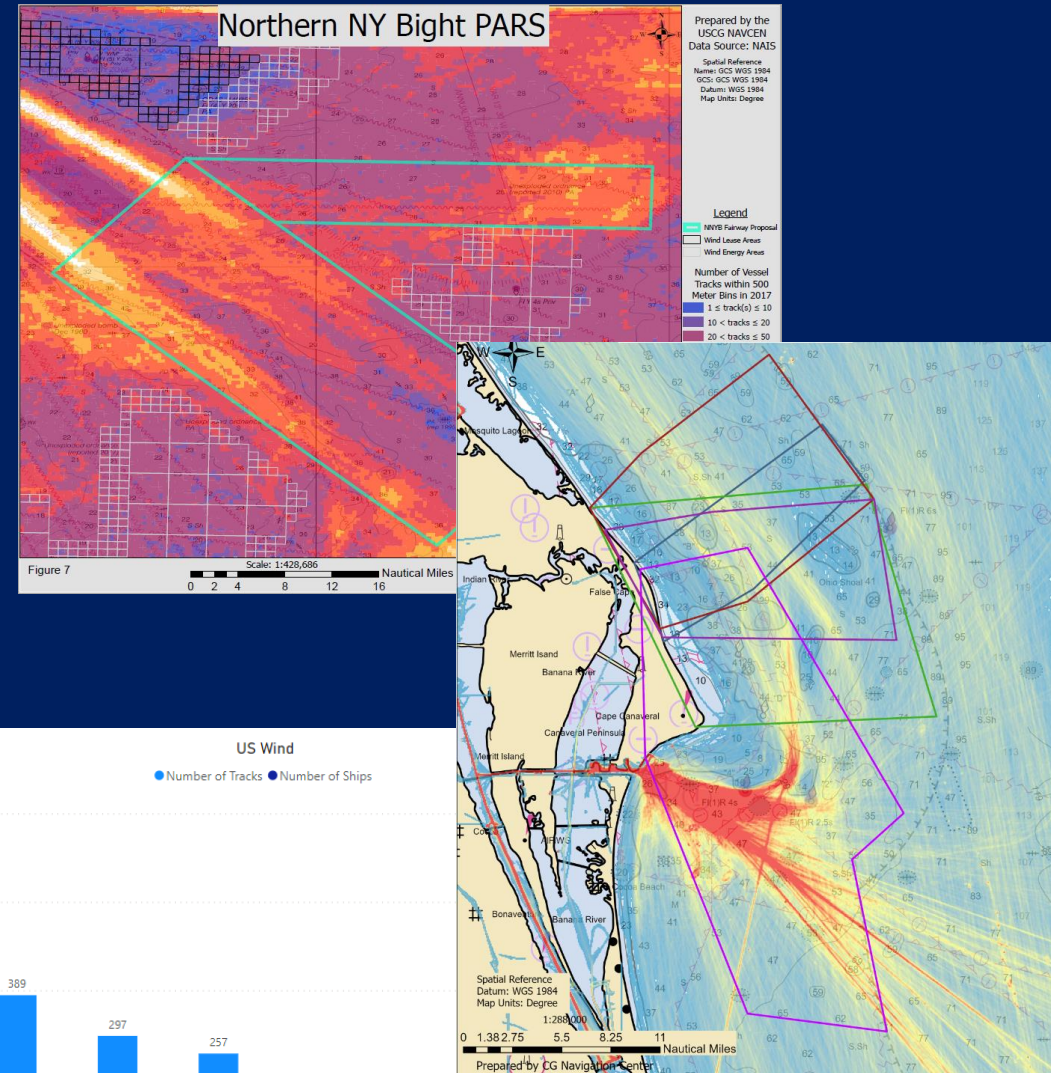
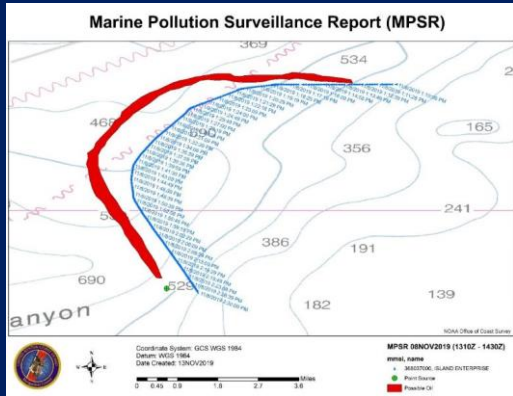
U.S. Department of
Homeland Security
**United States
Coast Guard**



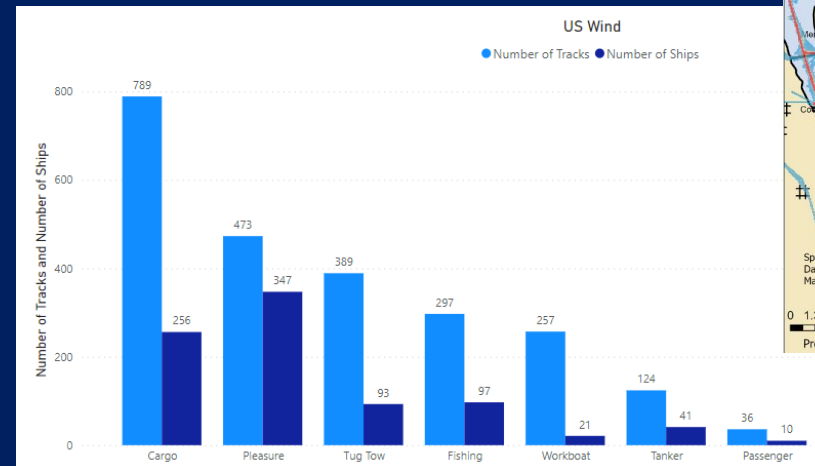


Data Driven Decisions

- Waterways Utilization Studies
 - Port Access Route Study (PARS)
 - Ports and Waterways Safety Assessment (PAWSA)
 - Waterways Analysis Management System (WAMS)



- Adaptable Waterway Analysis
 - Pollution investigations
 - Maritime Accident Investigations
 - Commercial Space Operations
 - 5P Brief to White House Clean Energy Advisor
 - Great Lakes Ice Breaking
 - Field support for OGA coordination



Sharing and Crowdsourcing GNSS Data to Monitor and Protect the GNSS RF Environment

Mathieu Joerger

Assistant Professor of Aerospace and Ocean Engineering

Virginia Tech, Blacksburg, VA

joerger@vt.edu

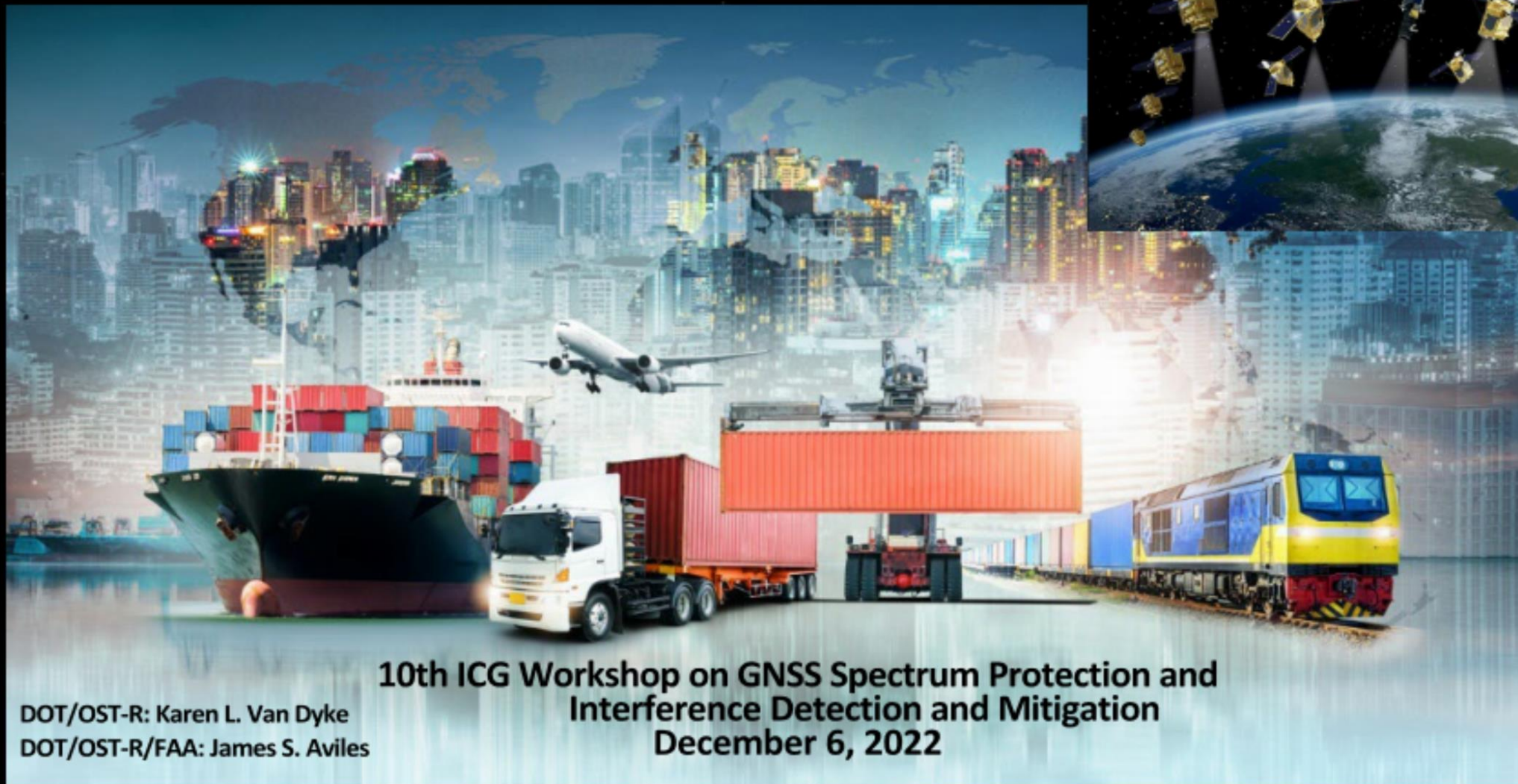
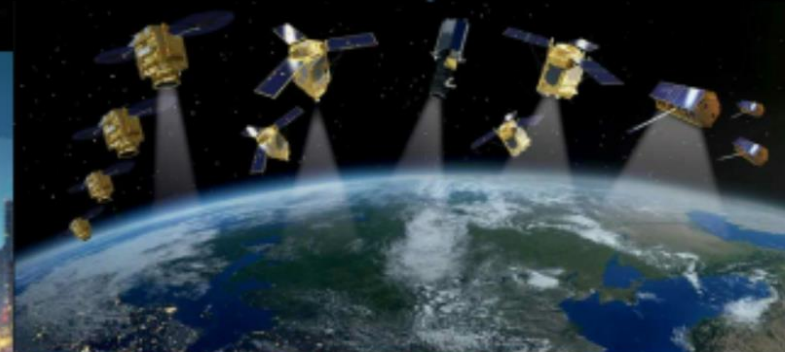
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Way Forward

- There are numerous **connected GNSS receiver networks** that could be leverage for RFI monitoring
 - **traffic management** (ADS-B, AIS, in the near-term future: cars/trucks) and **scientific purposes** (CORS, IGS)
 - **differential GNSS** networks, **cell phone** towers (even cell phone users), etc.
- **Suggestions** --- we would improve GNSS RFI monitoring by:
 - designing messaging standards to include GNSS signal quality data fields (C/N0, AGC, RF front end bandwidth)
 - Radio Tech. Comm. for Marit. Serv.: **RTCM SC-134**, Integrity for GNSS-based High Accuracy Applications
 - **NMEA** (National Marine Electronics Association) – message proposed by Dong Kyeong Lee (UC Boulder)
 - developing **dedicated, robust** data collection and **low-latency sharing** systems
 - **coordinating data-monitoring** efforts and **alerting** system



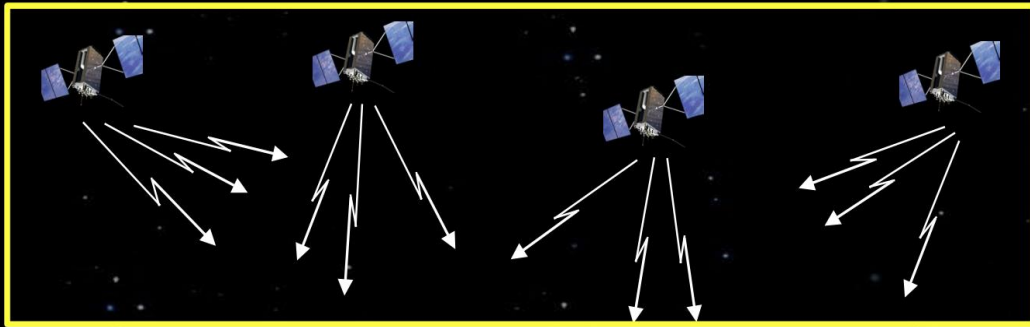
Department of Transportation
Office of the Assistant Secretary for Research and Technology (OST-R)



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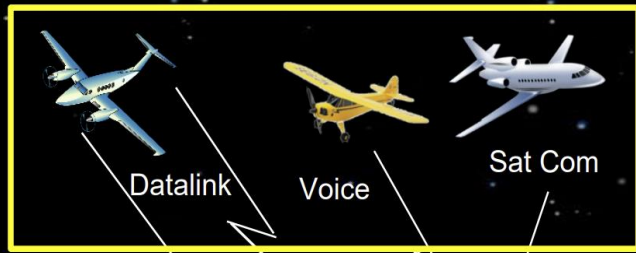
DOT/OST-R: Karen L. Van Dyke
DOT/OST-R/FAA: James S. Aviles

US DOT IDM Joint Concept of Operations



SV OBSERVABLES

Space & Aviation Segments Automated Reports of GNSS Anomalies = SV Observables, ADS-B, Datalink, Voice for light GA non-datalink capable



ADS-B

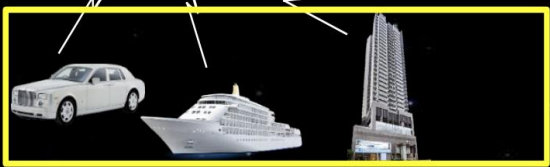
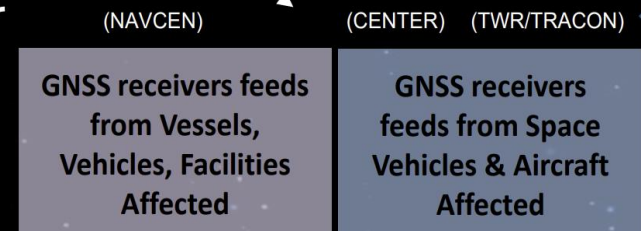
PIREPS

Known event information is reported to transportation stakeholders after being 'operationalized' by DOT; assessment results in notifications of appropriate activities (e.g., Surface, Aviation, Maritime, Telecom, Finance)

Space-Airborne detection to notify space-aeronautical operators of potential jamming or spoofing including Space vehicle and aircraft report generation

Data Sets collected from multiple vehicles.

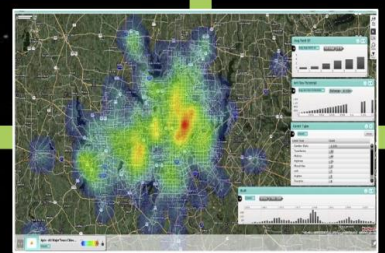
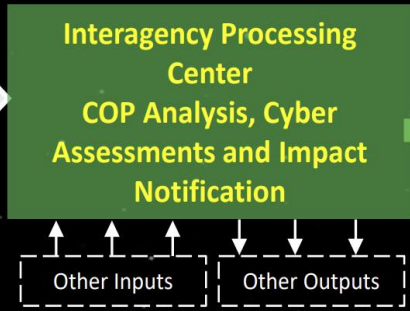
Timely processing of automated data from transport vehicle, AIS, Fixed Sites and other sources by 3rd party provides for timely notification of event-affected area



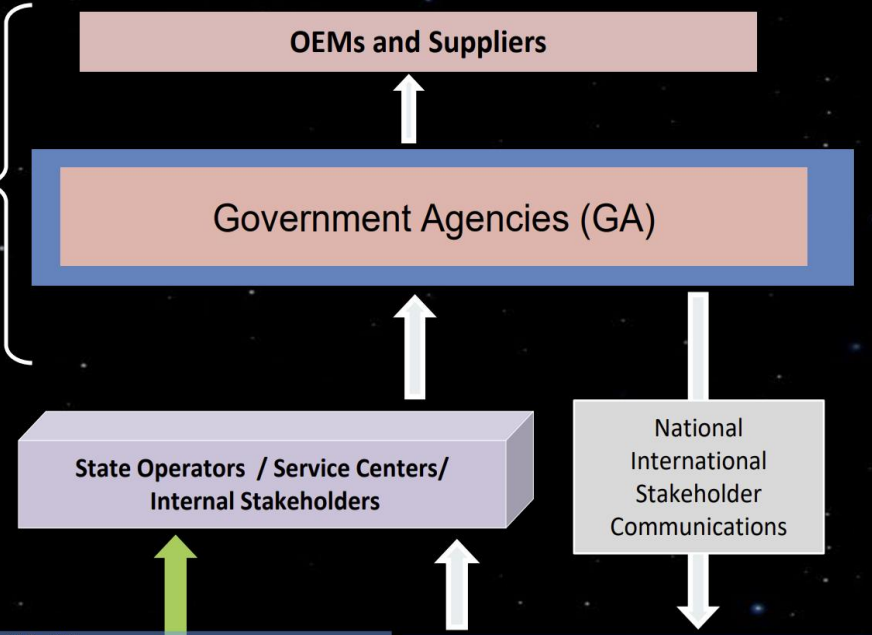
AIS

CORS

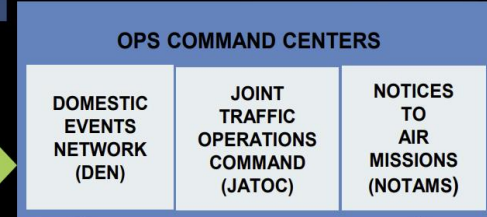
Vessel, Vehicle & Fixed Building detection (low-cost or installed electronics) to notify users of potential jamming or spoofing including auto-alert report generation



COP Affected Area Heat Map

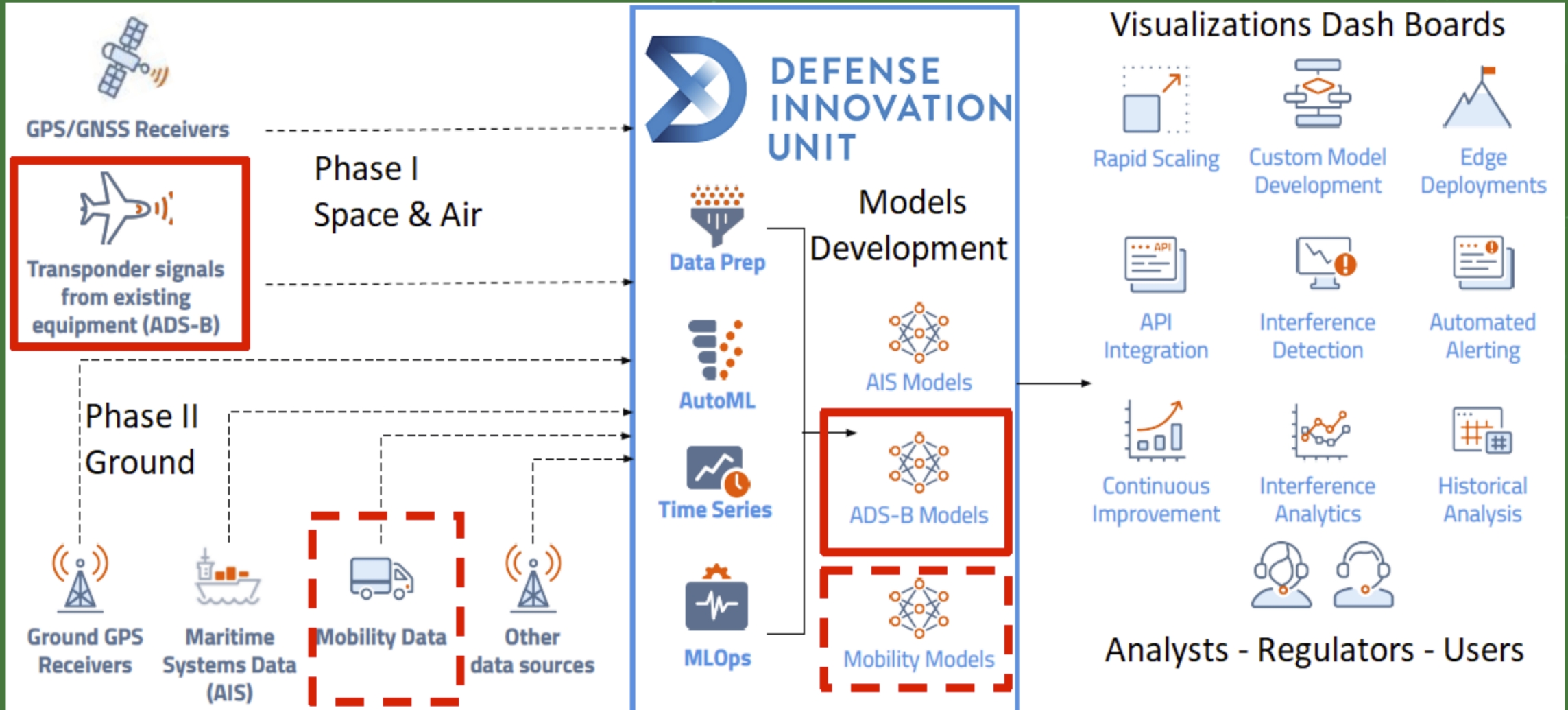


Action/advisories to Field Facilities



US DOT-DOD Joint Harmonious Rook IDM Initiative

Initiating the Interagency Automated Processing Fusion Center



CRITICAL INFRASTRUCTURE TIMING AND DEPENDENCIES

NATIONAL RISK MANAGEMENT CENTER
MIKE ROSKIND
SDI BRANCH CHIEF



**Publication:
August 2022
Version 2
Cybersecurity
and
Infrastructure
Security Agency**



TLP: WHITE



**TIME GUIDANCE
for Network Operators,
Chief Information Officers,
and Chief Information Security
Officers**

Timing Guidance

- Lessons learned from a tabletop exercise
- Designed to help an organization accomplish the Position Navigation and Timing Profile processes
 - Identifying and protecting systems,
 - networks, and assets;
 - Detecting and responding to an anomaly;
 - Recovering from a disruption.



<https://www.cisa.gov/publication/time-guidance-network-operators-cios-cisos>

Use of ADS-B for GNSS RFI Monitoring

IDM WS

Hamdi NASSER, EUROCONTROL
hamdi.nasser@eurocontrol.int
06/12/2022

Supporting
European
Aviation



Summary

- GNSS interferences continue to affect aviation operations and may increase further in the future
 - GNSS testing, CUAS, proliferation of jammers
 - GNSS RFI may escalate beyond “operational nuisance”
 - Importance of **automatic detection and reporting** to the relevant national authorities
- EUROCONTROL is developing monitoring capabilities
 - IOC and weekly updates: RFI detection and localisation using ADS-B
 - Objective is to move to a near real time tool and to combine with other data in order to support ATM ops
 - **Impact on operations** depends on the fleet capabilities and the available infrastructure: Importance of defining suitable contingency procedures taking into account those factors
 - Importance of **continuous monitoring** to enable **timely reaction** to a significant event and implement appropriate mitigation measures
- Exploit multi-mode strengths
 - ADS-B provides indirect **monitor** of GNSS RFI – already today
 - **Additional** aircraft, ground and space **capabilities** can provide independent confirmation
 - **Standards**: Work on going to define the “GNSS RFI detection and status downlink” functions
- Prepare the future
 - Robust **multi-sensor** positioning preventing a single point failure
 - Use of the **RFI downlink** function
- EUROCONTROL guidelines on a process for Civil-military GNSS interference testing – Coordination of state authorized GNSS RFI testing
 - CUAS study could feed the guidelines with recommendations related to the safe use of CUAS (unplanned events).



Characterization of ADS-B Performance Under GNSS Interference

Zixi Liu, Todd Walter, Yu-Hsuan Chen, Sherman Lo, Juan Blanch

GPS Lab, Stanford University

December 2022

Summary

- ADS-B can be useful for identifying and localizing GNSS RFI
 - › Estimation quite accurate for Denver event
- However, many challenges remain when processing the data
 - › Missing data, poorly sampled regions, aircraft that may be relying on a non-GNSS source of determining position, erroneous positions, directional antennas, multiple jammers ...
- Interpolation of position for data gaps associated with drops in NIC provides additional data that is very useful for improving the localization
- Evaluating two methods for localization
 - › Least squares estimator
 - › Bayesian estimator
 - › Both provide accurate estimates for observed Denver event





IIT Armour College of Engineering
ILLINOIS INSTITUTE OF TECHNOLOGY



Detecting GNSS spoofing of ADS-B equipped aircraft using INS

Birendra Kujur, Samer Khanafseh, Boris Pervan

Illinois Institute of Technology

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Vienna, Austria and Online
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- ADS-B increases **spoofing vulnerability** of an aircraft.
- Spoofers with access to ADS-B can easily and accurately track aircraft, enabling generation of **false GNSS trajectories that can go undetected** at aircraft even with INS aiding.
- **Adding modulated offsets to ADS-B Out position** reports can be highly effective anti-spoofing measure for INS-equipped aircraft.
- A **position domain-innovation monitor** can detect spoofed GNSS signals created using the offset ADS-B.
- The **jamming-then-spoofing** scenario is also addressed by ADS-B modulation
- Future work includes evaluating and protecting against potential spoofer countermeasures-e.g., attempts to “de-bias” using random counter-offsets.



Interference Detection and Mitigation (IDM) Workshops

- ▶ 10th Interference Detection and Mitigation Workshop, 6 December 2022, Vienna, Austria
- ▶ 9th Interference Detection and Mitigation Workshop, 24 August 2021, Virtual
- ▶ 8th Interference Detection and Mitigation Workshop, 14 - 15 May 2019, Baska, Croatia
- ▶ 7th Interference Detection and Mitigation Workshop, 8 - 9 May 2018, Baska, Croatia
- ▶ 6th Interference Detection and Mitigation Workshop, 9 - 10 May 2017, Baska, Croatia
- ▶ GNSS IDM Presentation & Recommendations to the COPUOS Scientific and Technical Subcommittee, 7 February 2017, Vienna, Austria
- ▶ 5th Interference Detection and Mitigation Workshop, 17 May 2016, Changsha, China
- ▶ 4th Interference Detection and Mitigation Workshop, 10 June 2015, Vienna, Austria

Our Work

Secretariat of COPUOS

Programme on Space Applications

UN-SPIDER

International Committee on GNSS

Overview

Members

ICG Terms of Reference

Providers' Forum

Working Groups

Working Group S

IDM

Performance Standards

Working Group B

Working Group C

Working Group D

Templates

ICG Annual Meetings

ICG Programme on GNSS

Applications

Resources

ICG Documents