



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



Supporting Federal Policy Governing PNT Programs for Civil Applications
DSI Assured PNT Summit May 17, 2024

GPS Enables EveryDay Life



- Aviation
- Search and rescue
- Surveying & mapping
- Trucking & shipping
- Agriculture
- Offshore drilling

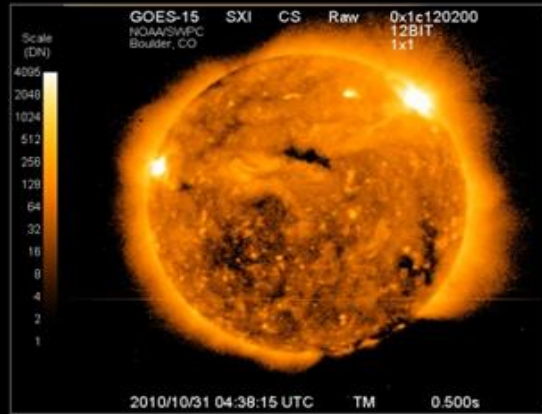
- Fishing & boating
- Military
- Scientific
- Timing
- Tracking
- Exploration



GPS is a "Global Utility"

Challenges for Safe and Reliable Transportation

Solar Storms



High Accuracy with Integrity



Timely Notification of Misleading Information



Urban Canyons



Reliable and Secure Connectivity



Underground/Indoors

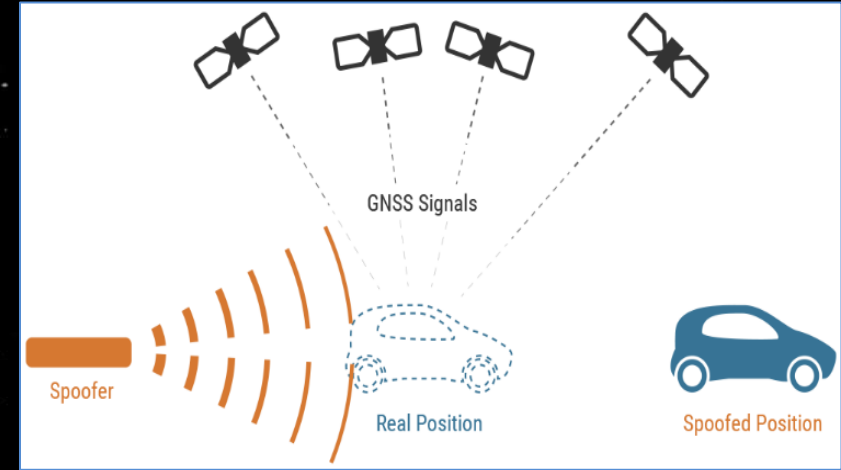
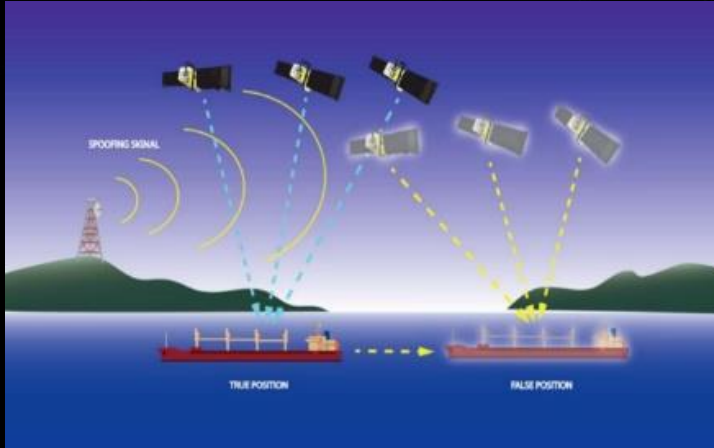


High-Definition Maps

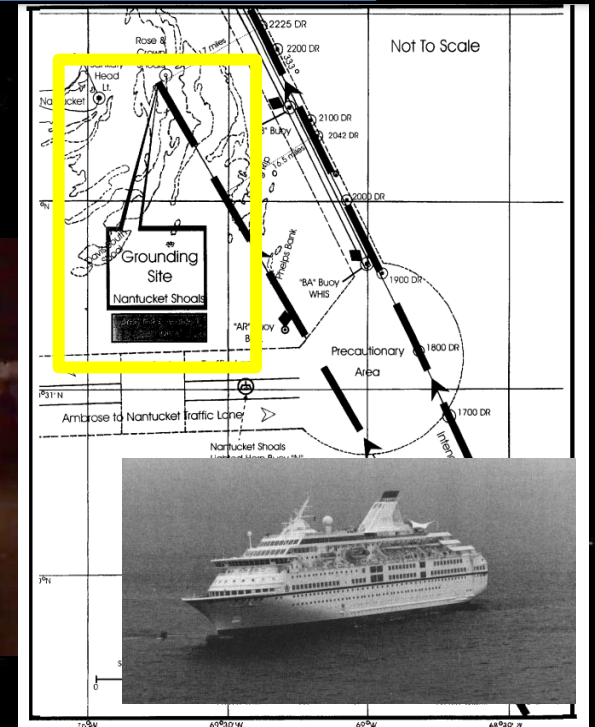


Need for Situational Awareness

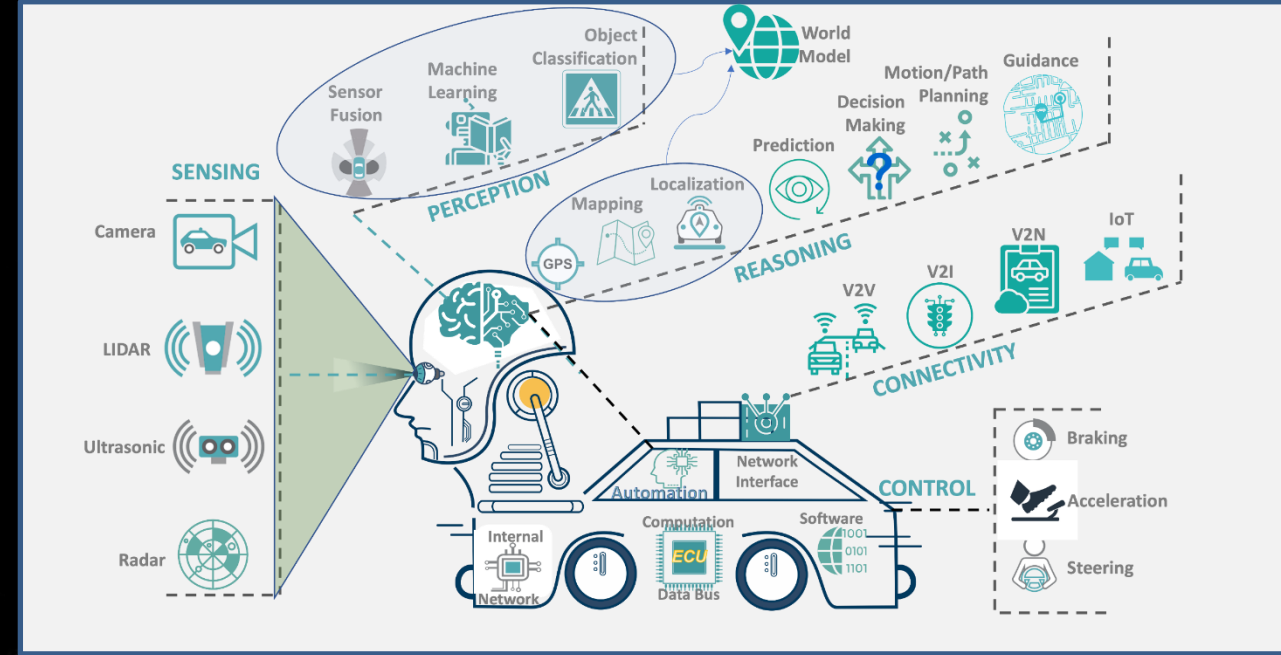
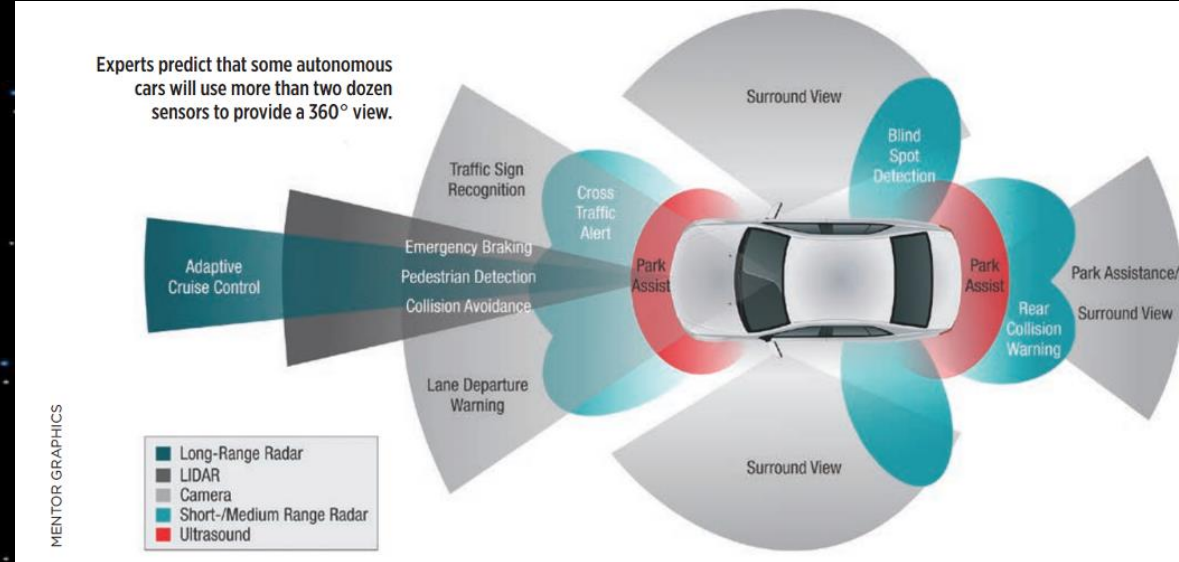
GPS Jamming / Spoofing



Dangerous Navigation - Need User Situational Awareness



What Happens When We Don't Have a Human Driver?



Development of DOT PNT Strategic Plan

Advance PNT Capabilities and Services

Advance and evolve leading-edge PNT capabilities and services through research and development to meet current and future safety-critical requirements and ensure that trusted PNT data is available to a wide range of civil users.

Build Resiliency into PNT Services and Capabilities

Incorporate resiliency throughout the current and future PNT ecosystem to ensure continuity of services and operations, employing the principles of prevent, respond, and recovery through diversity of equipment, assessment of risk tolerance, and prioritization of application criticality.

Address PNT Cybersecurity

Build cybersecurity protections and mitigations into current or emerging PNT services, applications, and devices.

Ensure Spectrum Availability and Protection for PNT Services

Ensure spectrum availability for current and future PNT capabilities and protect PNT services from harmful interference, including implementation of Interference Detection and Mitigation (IDM).

Lead U.S. Civilian PNT Coordination

Lead U.S. civilian PNT coordination and participate in the national and international planning and execution activities with U.S. Government Departments and Agencies, as well as interface with industry stakeholders and users.

US DOT PNT Research Priorities

• GNSS Civil Signal Performance Monitoring

- Full Civil Monitoring Performance Specification on Civil GPS Signals (L1C, L2C, L5, and L1 C/A)
- GPS Integrity Support Message (ISM) for Advanced Receiver Autonomous Integrity Monitoring (ARAIM)
- Monitoring and Assessment of GNSS L-band Broadcasts

• GNSS Interference Detection and Mitigation (IDM)

- Monitoring, Localization, and Attribution of Interference
- Establishing Key Government Partnerships to develop a joint automated IDM capability
- Create a Nationwide IDM Common Operating Picture for All GNSS Stakeholders

• GPS Signal and Data Authentication

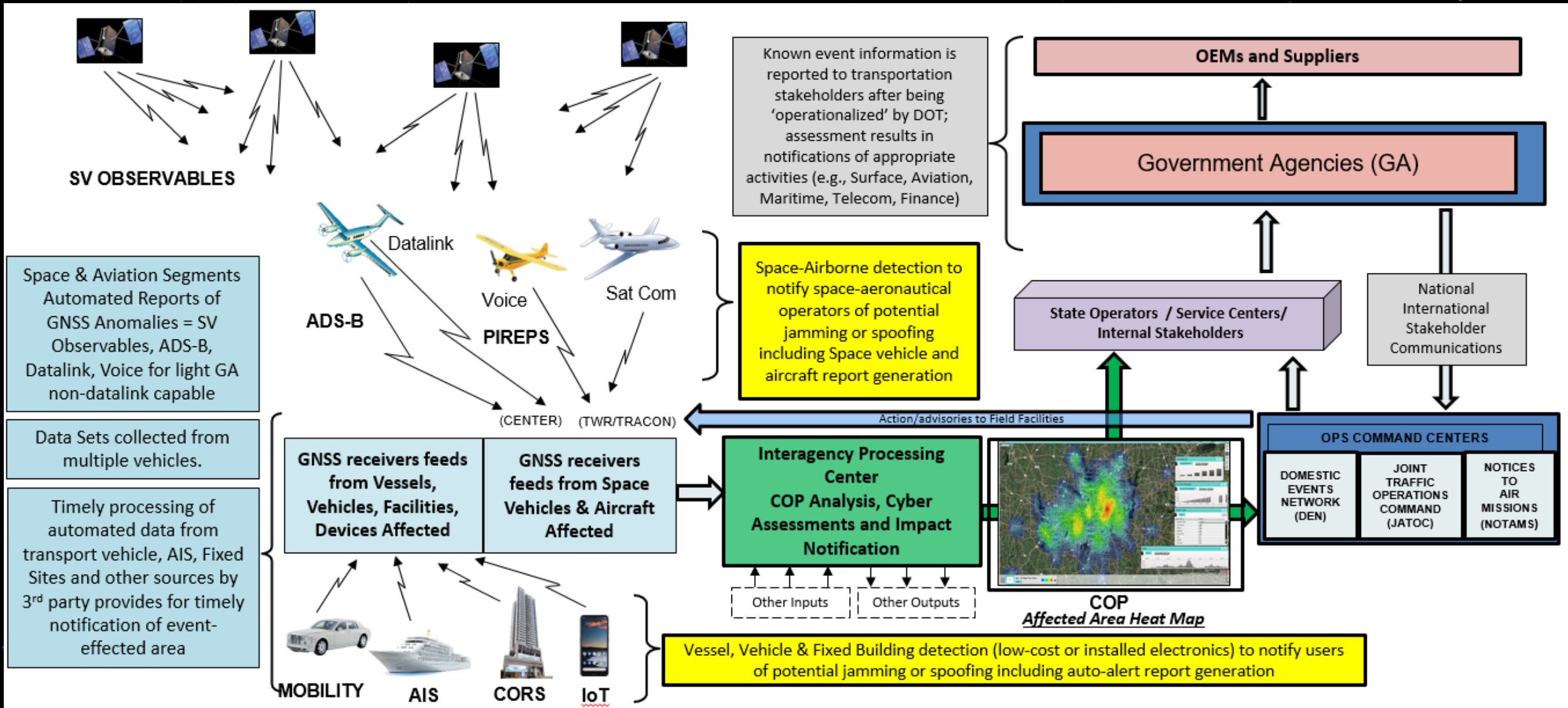
- Out of Band and In Band Authentication

• Implementation of Complementary PNT Demonstration Recommendations

- Facilitate Adoption of CPNT Technologies
- Establish PNT Standards, Requirements & Conduct Vulnerability Testing and Analysis
- Engagement with PNT Technology Vendors and Critical Infrastructure Sectors

• EO 13905 Implementation

GPS Interference Detection Concept of Operations



DIU Harmonious Rook Vision – Ideal for DOT IDM

• Turn the Vulnerability Into a Solution:

- Billions of distributed, networked GNSS devices act as sensor discovery for PNT disruptions
- Inform the use of custom, hardware centric solutions with timely classification and attribution

• End-to-End Unclassified Workflow:

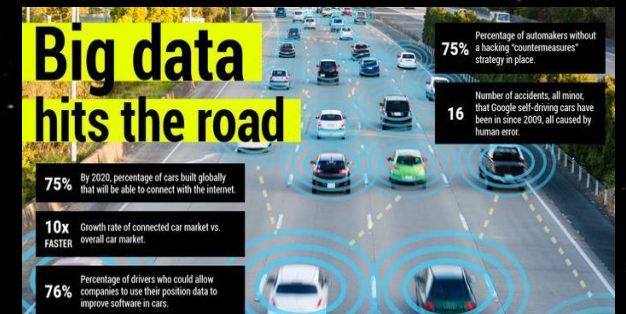
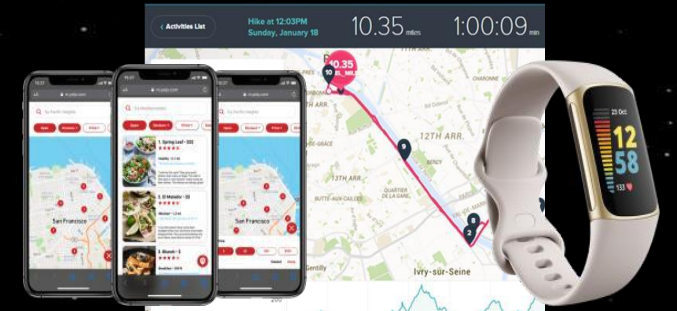
- Maximize discretion for sharing and dissemination with civil agencies, allies and public

• Validation of M/L With Multiple Feeds

- Fixed Site GNSS & Timing Data Feeds
- Mobility GNSS Data Feeds
- Surface Vehicle Data Feeds
- Maritime AIS Data Feeds

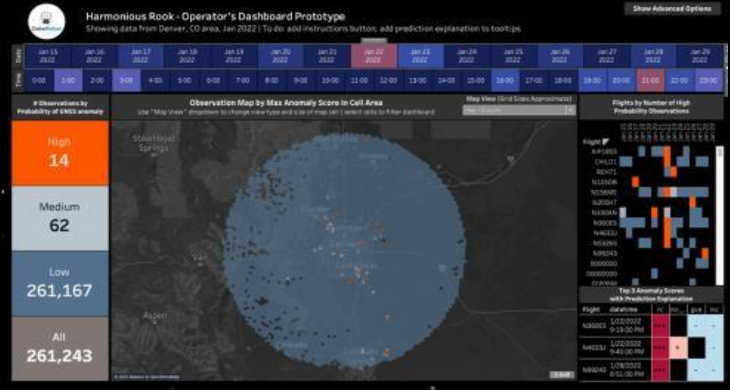
• Actionable insight to both the analyst and the operator:

- Operator View: Can I expect degraded PNT on this mission?
- Analyst View: Is there a new anomaly in my AOI?



U.S. Harmonious Rook - GOAT Visualizations

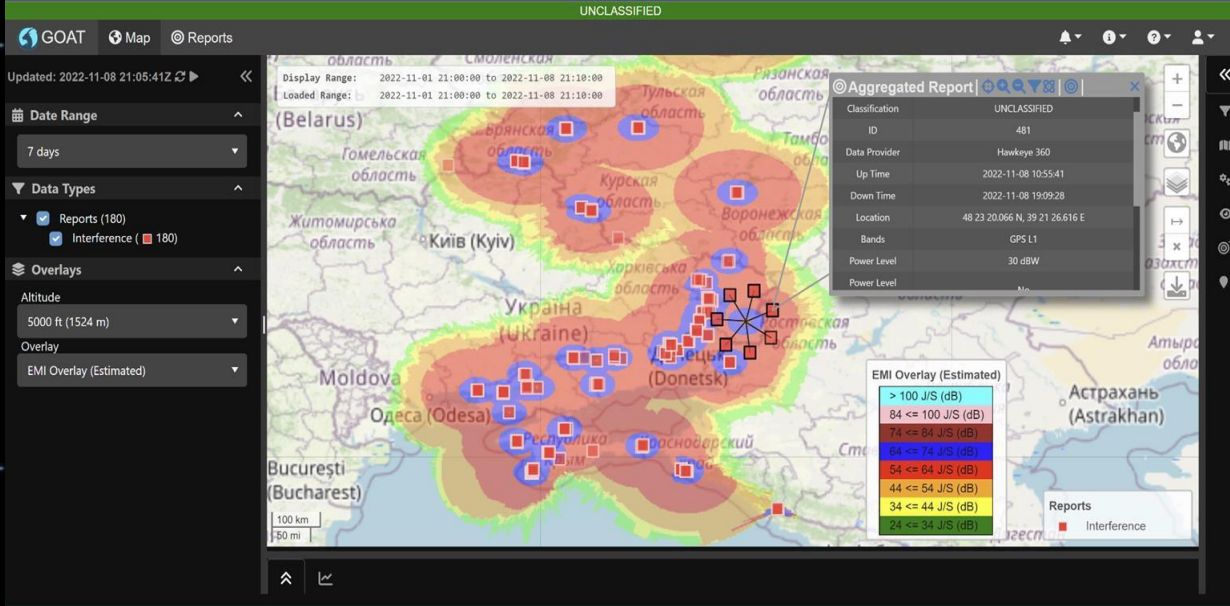
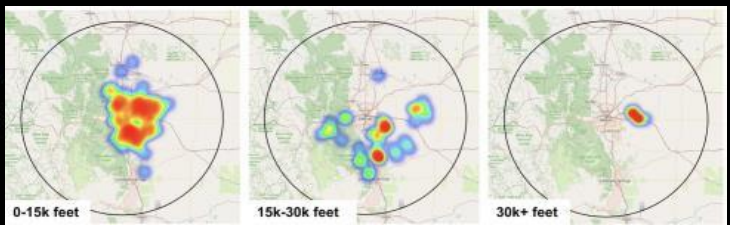
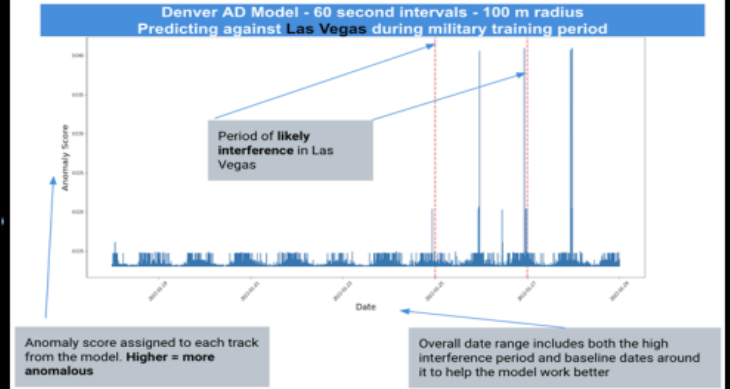
GPS Operational Awareness Tool (GOAT)



Detection Models



Exports anomaly detection; affected user heat maps, and estimated geolocation to external tool



GOAT Emerged From Joint Urgent Operational Need (JUON) CC-0575. Currently Displays:

- Commercial RF sensing & geolocation of EMI
- RF propagation models at user defined altitudes

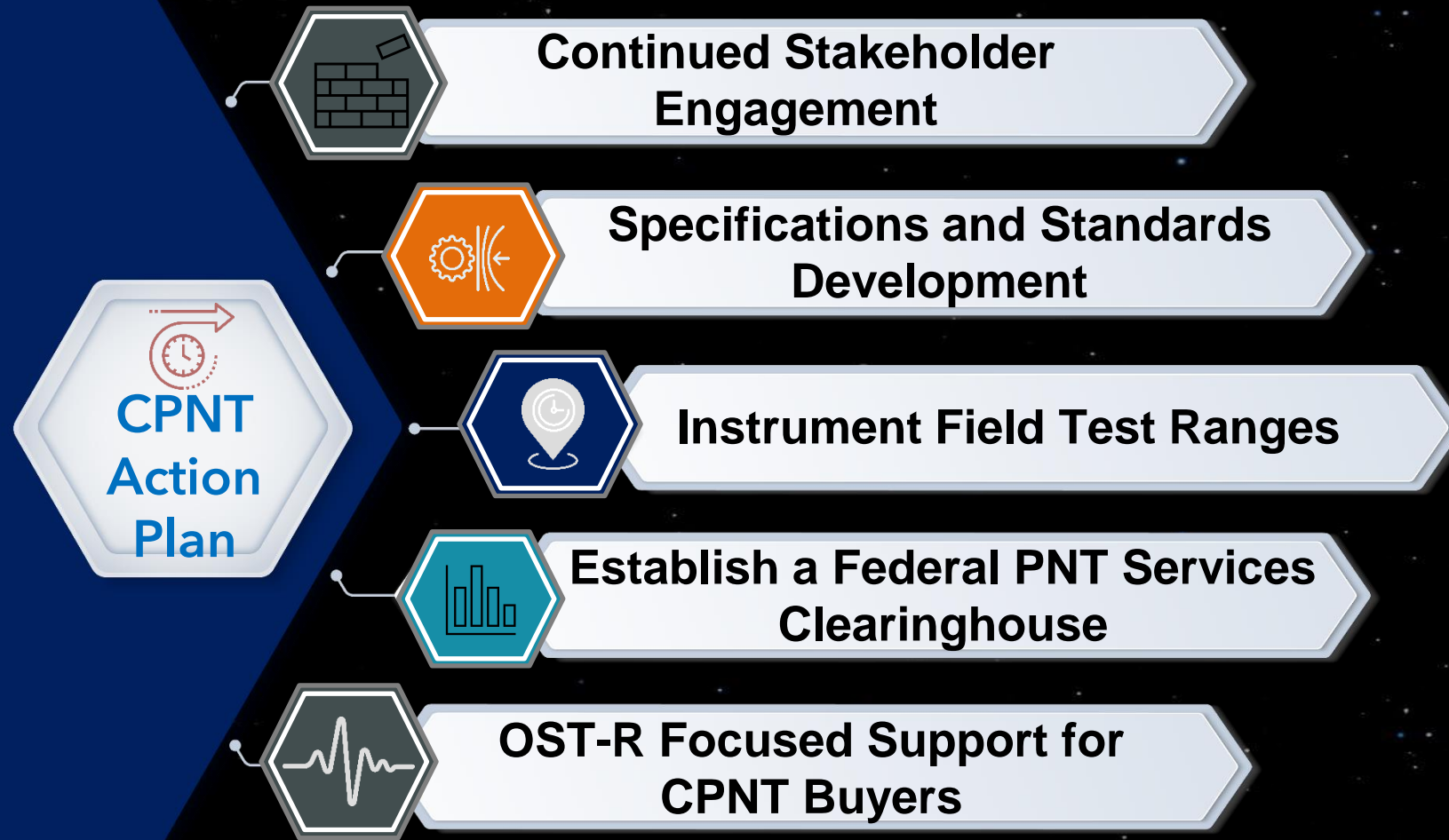
Could Ingest

- Harmonious Rook "Affected Users & Geolocation Data"

Could Enable

- Unclassified detections to COP tools
- LOS Analysis from Affected Users for JX geolocation

DOT Complementary PNT Action Plan



Rapid: initial phase, conduct field trials (user needs and threat vectors)

Continuity: second phase, leverage broader range of field trial platforms (also lessons learned)

Gap fill: Overlapping phase, address challenging applications

- Expansion of DOT scope to service provisioning discovery to technology development, implementation, and service provisioning.
- Drive CPNT adoption across the Nation's transportation system and within other CI sectors

DOT Complementary Action Plan, RFI, and Solicitation

Release of DOT Complementary PNT Action Plan:

<https://www.transportation.gov/sites/dot.gov/files/2023-09/DOT%20Complementary%20PNT%20Action%20Plan.pdf>

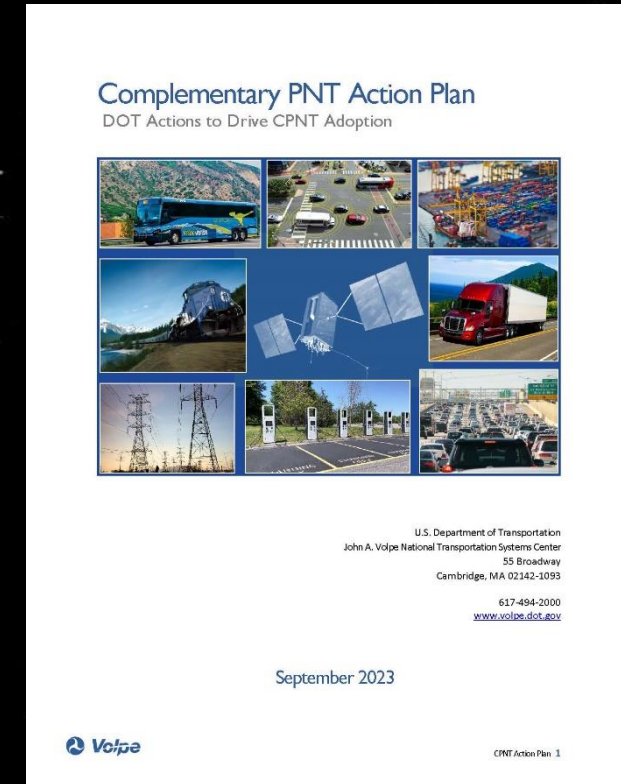
DOT/Volpe Center Complementary PNT Sources Sought / RFI Issued:

<https://sam.gov/opp/6350a17e5b8a4419b4029b17cb2d9b3f/view>

“The Volpe Center is issuing this RFI seeking information from industry about availability and interest in carrying out a small-scale deployment of very high technical readiness level (Technology Readiness Level (TRL)≥8) CPNT technologies at a field test range to characterize the capabilities and limitations of such technologies to provide PNT information that meet critical infrastructure needs when GPS service is not available and/or degraded due environmental, unintentional, and/or intentional disruptions.”

DOT/Volpe Center Complementary PNT Solicitation

<https://sam.gov/opp/5d3764f0f0794a57b83c257d4caf2248/view>



DOT Complementary PNT Test Range Strategy

Federal test ranges: Initial site to be located on Joint Base Cape Cod (JBCC), one of the two test ranges used for the 2020 DOT CPNT Demonstration

Critical infrastructure test ranges: Test ranges that have a government affiliation (including Federal, State, and local) either through partnerships or contractual relationships

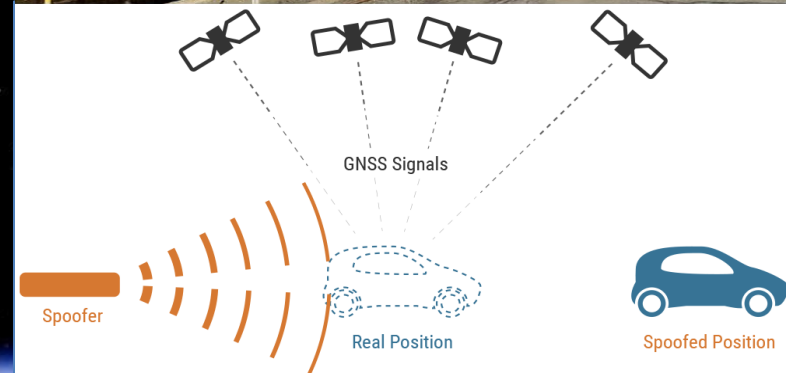
Commercial/vendor-provided test ranges: Test ranges will be used when the other two models are not appropriate and/or beneficial

- CPNT technologies require costly installations requiring numerous transmitters over large areas
- Vendors already have built operational installations, and it may be more cost effective and time efficient to utilize these existing test ranges

Executive Order 13905: Key Actions for DOT (In Conjunction with DHS)

- Vulnerability Assessment / Testing
 - Aviation, Maritime, Rail, Automated Vehicles
 - Recent Participation in NAVFEST and Planned Participation in the DHS GPS Equipment Test for Critical Infrastructure (GET-CI)
- PNT Profile Development – NISTIR 8323
- Maritime and Rail Pilot Programs
- National R&D Plan on PNT Resilience
- Resilient PNT Conformance Framework Working Group
 - IEEE standards development
- Development of PNT Resilience Contract Language
- Implementation of DOT Complementary PNT Action Plan

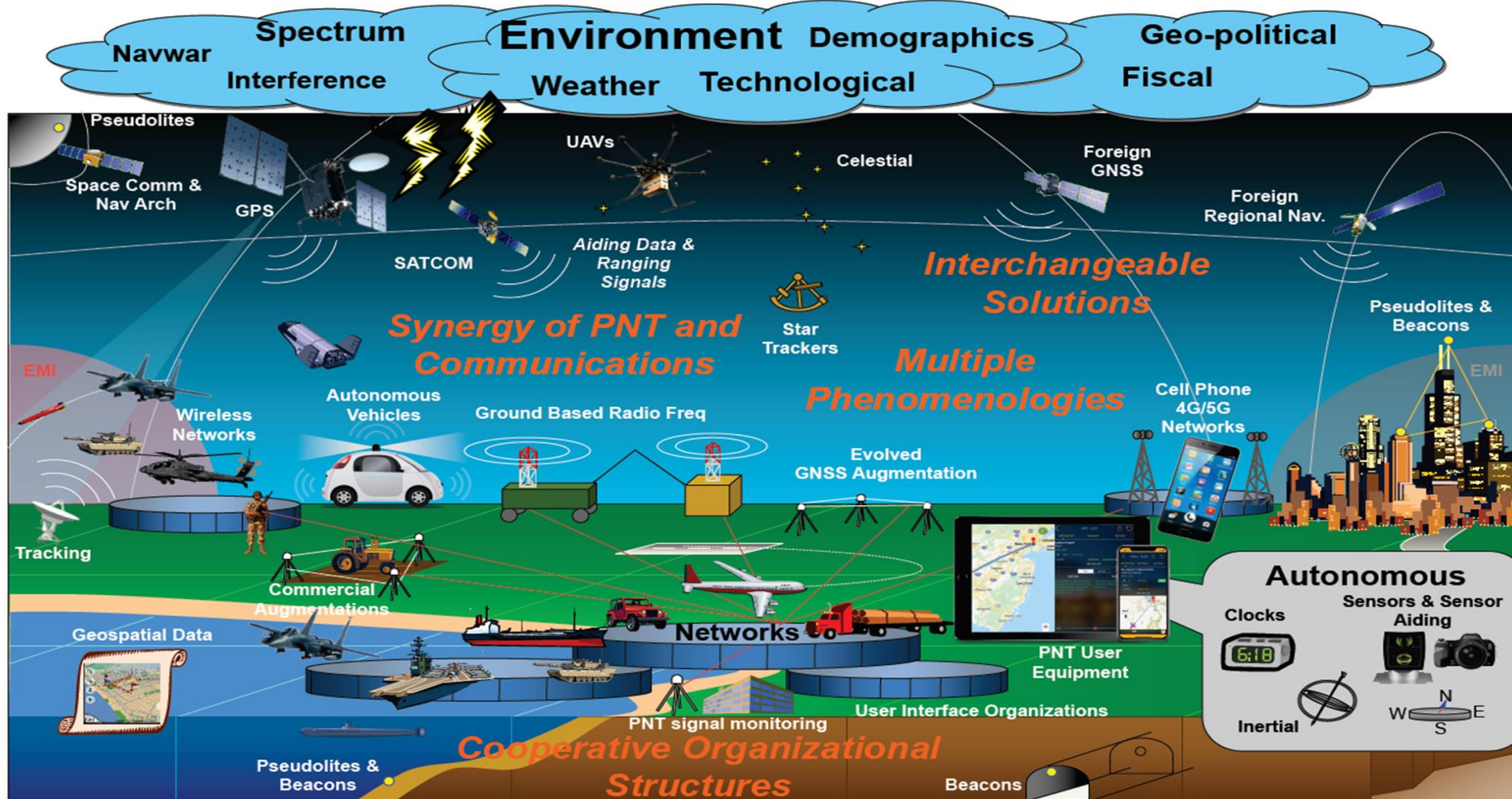
“Responsible use of PNT services” means the deliberate, risk-informed use of PNT services



DOT University Transportation Centers on PNT

- **Center for Automated Vehicle Research with Multimodal Assured Navigation (CARMEN)+ - Led by The Ohio State University**
 - University Consortium Members:
 - North Carolina A&T State University
 - University of California Irvine
 - University of Texas Austin
- **Center for Assured and Resilient Navigation in Advanced Transportation Systems (CARNATIONS) - Led by the Illinois Institute of Technology**
 - University Consortium Members:
 - Chicago State University
 - Stanford University
 - University of California Riverside
 - Virginia Polytechnic Institute and State University

National PNT Architecture



Standards	Reference Frames	Cryptography	Science & Technology	USNO	NIST	NGA	NGS
Star Catalogs	Launch Modeling	Mapping/Charting/Geodesy	Laser Ranging Network	NSA	Industrial Base	Policies	Testing
Electro Optical Info.							

Questions?