



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



Space-Based PNT Advisory Board
December 6, 2023

Future of Transportation

What Goals Are We Trying to Achieve?

- **Zero Fatalities**
 - Advance a future without transportation-related serious injuries or fatalities
- **Resilient Supply Chains**
 - Create a multi-modal freight system that can withstand and rapidly recover from severe disruptions
- **Equitable Mobility for All**
 - Create an equitable transportation system that provides safe, affordable, accessible, and convenient mobility options for all users
- **Net-Zero Emissions**
 - Create a transportation system that supports an economy with net-zero greenhouse gas emissions
- **Transformation**
 - Develop connected intelligent infrastructure that provides people-centered mobility

U.S. DOT and RD&T Strategic Plans FY2022 – FY2026



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.

Space Policy Directive 7

Key DOT Responsibilities

To implement SPD-7, DOT responsibilities are grouped under the following categories:

- Space-Based PNT Requirements for Civil Applications
- Space-Based PNT Management and Modernization for Civil Applications
- Performance Monitoring and Interference Detection for Civil Space-Based PNT Services
- PNT Resiliency
- Space-Based PNT Data and Signal Authentication
- International Engagement

Updated DOT/DOD MOA on Civil Use of GPS Signed August 28, 2023

<https://www.transportation.gov/pnt/memorandum-agreement-between-department-defense-and-department-transportation-civil-use-global>

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**

- 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**

Assured PNT: Embrace PTA Principle

- **Protect**

- Ensure performance monitoring of space-based civil PNT services
- Implement interference monitoring capabilities to identify, locate, and attribute PNT threats
- Prevention of harmful interference
- Facilitate international coordination for development of monitoring standards

- **Toughen**

- Authenticate signals and cyber-harden user equipment
- Utilization of CRPA Antennas

- **Augment / Adopt**

- Implement and utilize GPS augmentations and Complementary PNT services
- Facilitate adoption of Complementary PNT into end-user applications

DOT University Transportation Centers on PNT

Center for Automated Vehicle Research with Multimodal Assured Navigation (CARMEN)+ - Led by The Ohio State University

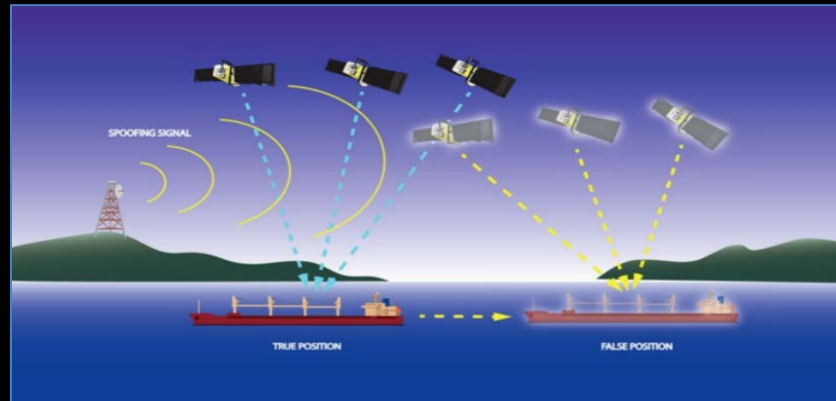
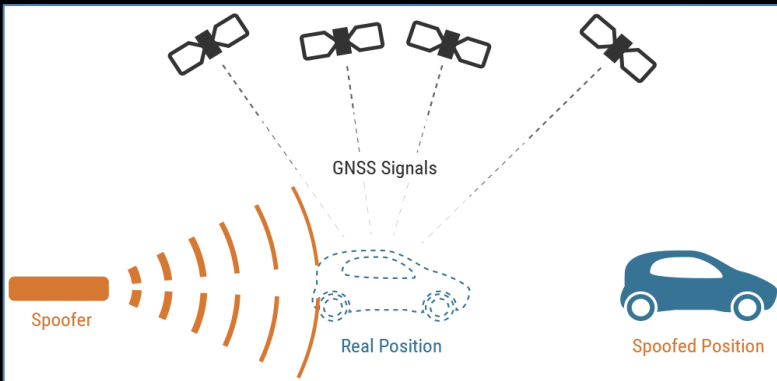
- University Consortium Members:
 - North Carolina A&T State University
 - University of California Irvine
 - University of Texas Austin

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

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

- Vulnerability Assessment / Testing – Aviation, Maritime, Rail, Automated Vehicles
- PNT Profile Development – NISTIR 8323
- Maritime Pilot Program
- National R&D Plan on PNT Resilience
- Resilient PNT Conformance Framework Working Group
 - IEEE standards development
- Development of PNT Resilience Contract Language



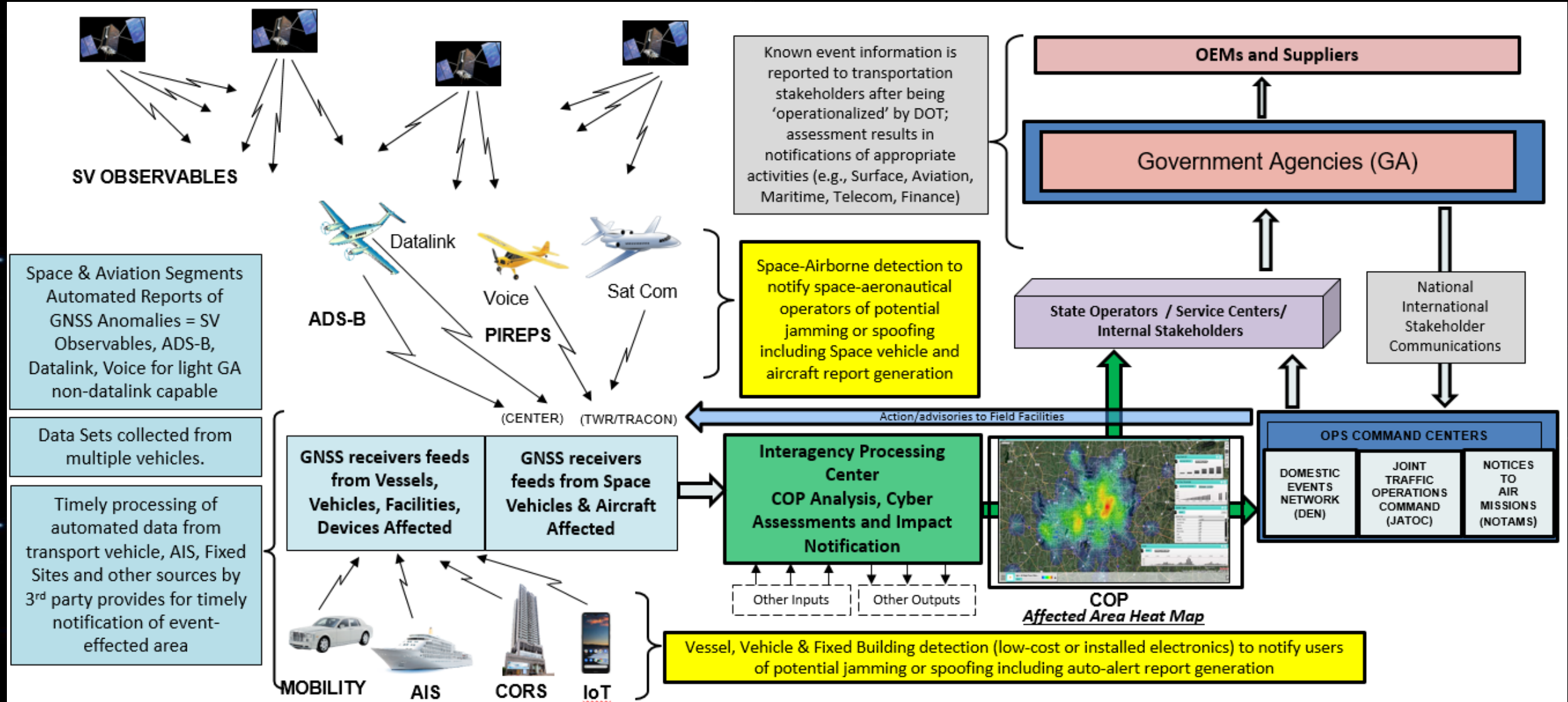
“Responsible use of PNT services” means the deliberate, risk-informed use of PNT services

US DOT SPD-7 High-Level PNT IDM Strategy

- **Actively Detect and identify L-Band Interference Emissions**
 - Focus on In-Band and Adjacent Band Interference
 - In Partnership with other Federal Departments/Agencies
- **Leverage Space, Ground, Fixed, Transportable, and Mobile**
 - Sensor Equipment Already in Operation | System-of-Systems
 - Adapt/Enhance Technologies to Cover GNSS Interference
- **Joint Federal, State and Local – Civil, Military**
 - Establish Multi-Federal-State MOA & CONOPS & SOP
- **State and Local Law Enforcement Involvement**
 - Focused for Critical Ports and Infrastructure Protection



Interagency PNT IDM Joint 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

- **Domain agnostic datasets:**

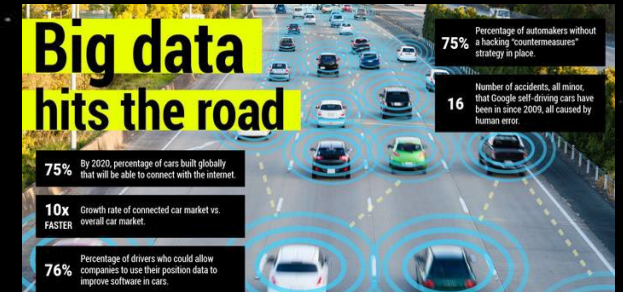
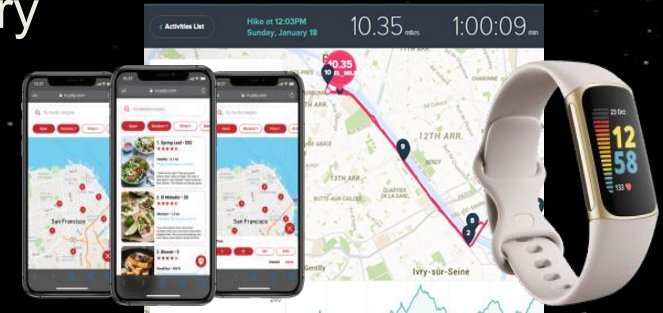
- Broad coverage, classification of events, and confidence in reporting (AIS, ADS-B, IoT, SIGINT); Multi-source-Multi-Vote

- **Mixture of rule-based and ML analytics:**

- Performance verification unsupervised clustering models

- **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?



Complementary PNT

- In 2020, DOT conducted a complementary PNT (CPNT) field demonstration of candidate PNT technologies that could offer complementary PNT service in the event of GPS disruptions
- In 2021, a Complementary PNT and GPS Backup Technologies Demonstration report was delivered to Congress
- In 2022, DOT held a CPNT Industry Roundtable - Stakeholders were invited from across the PNT enterprise, which included both providers of PNT services and critical infrastructure owners and operators
- National Space-Based PNT Executive Committee for Space-Based Positioning, Navigation, and Timing (EXCOM) requested that DOT develop an action plan from the CPNT Industry Roundtable
- FY'22 & 23 omnibus appropriated \$30M in funding to support development of standards and widespread adoption of CPNT technology for critical infrastructure owners and operators

DOT Complementary Action Plan and RFI

September 12, 2023

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:

<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 Complementary PNT Action Plan

Continued Stakeholder Engagement

Specifications and Standards
Development

Instrument Field Trial & Test Range

Establish a Federal PNT Services
Clearinghouse

OST-R Focused Support
for CPNT Buyers

- **Shift in DOT posture from technology discovery to service provisioning**
- **Drive CPNT adoption across the Nation's transportation system and within other CI sectors**

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

DOT eLoran RFI

October 3, 2023

eLoran RFI Sought Feedback to Determine:

- 1) If there is interest from private entities in offering a U.S. commercial enhanced Long Range Navigation (eLoran) service to the general public in the United States on a fee-for-service basis without any federal investment, subsidy, procurement commitment or other commitment of credit or budgetary resources.
- 2) If respondent has an interest in offering a U.S.-based commercial eLoran service on a fee-for-service basis, identify what impediments stand in the way of respondent offering a U.S. commercial eLoran service. If lack of access to any federally-controlled assets and non-budgetary assistance related to utilizing such federally-controlled assets are identified as impediments to offering such a service, a subsequent Request for Information may be issued to obtain additional data.

<https://www.transportation.gov/pnt/eloran>



Questions?