



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



**Civil GPS Service Interface Committee**  
**September 17, 2024**

# 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

# GPS Interference Detection and Mitigation

**SPD-7:** “The Secretary of Transportation in coordination with the Secretary of Defense and the Secretary of Homeland Security and the heads of other agencies, as appropriate, implement Federal and facilitate State, local and commercial capabilities to **monitor, identify, locate, and attribute** space-based PNT service disruption and manipulations within the United States that adversely affect use of space-based PNT for transportation safety, homeland security, civil, commercial, and scientific purposes.”

## IDM Capability Need

Detection of EMI  
(Spoofing + Jamming)

Geolocation for action

Mitigate/Resolve

Notify in a Timely Manner

Trend Analysis

Awareness at User level

**DoD DIU MISSION** DEFENSE INNOVATION UNIT

DIU is a Fast-Moving, Cross-DoD Organization Focused Exclusively on **Commercial Companies** to Solve National Security Problems.

Elements of DIU Mission	Key DIU Differentiators
Accelerate DoD adoption of commercial technology	Unique project lifecycle from curation to transition
Transform Military capacity and capabilities	Joint force & mandate to scale value across DoD
Strengthen the national security innovation base	Broad and deep integration into key tech ecosystems

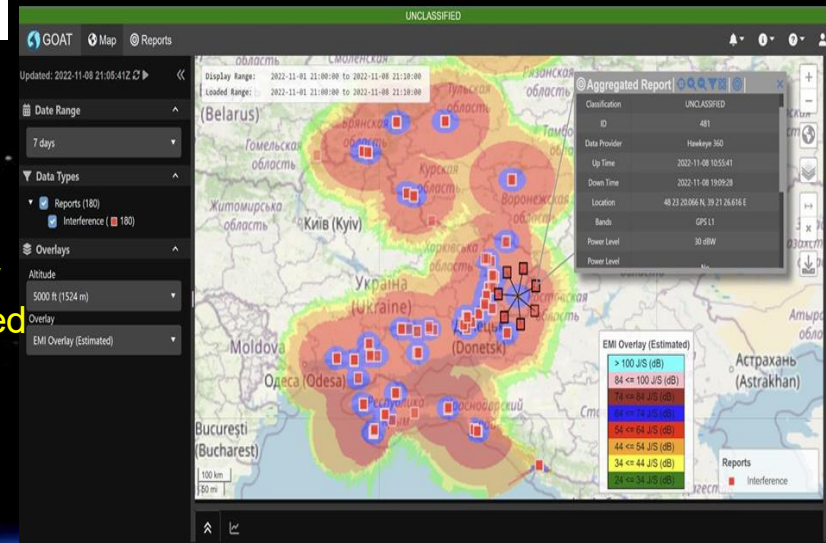
Harmonious Rook  
Discovery, Classification and Attribution with PAI Analytics  
January, 2023

Accelerating Commercial Technology for National Security

**DOT-DoD Partnership:**  
Capability for Alerting and Mitigating Threats to All GNSS Users

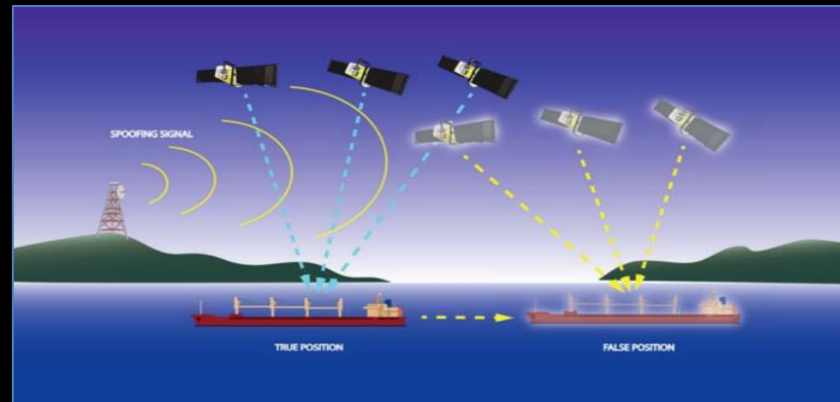
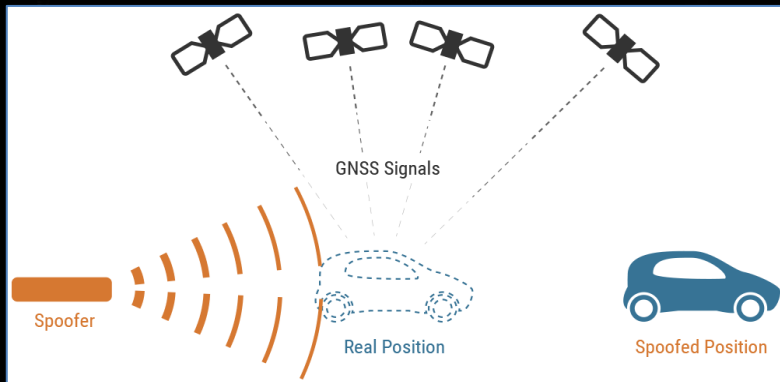


Exports anomaly detection; affected user heat maps, and estimated geolocation to GOAT GIS tool



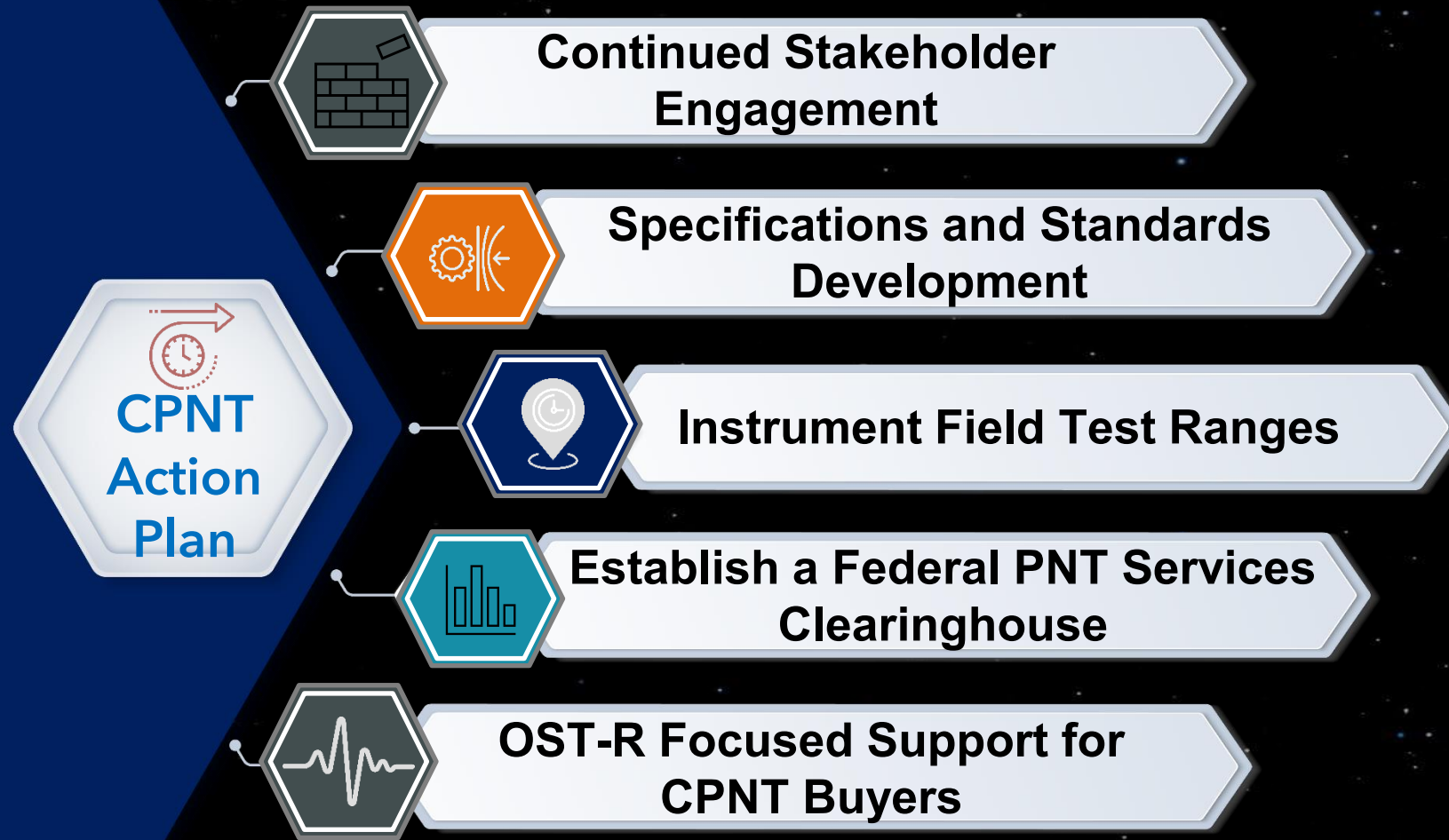
# Executive Order 13905: Key Actions for DOT (In Conjunction with DHS)

- Vulnerability Assessment / Testing – Aviation, Maritime, Rail, Automated Vehicles
- PNT Profile Development – NISTIR 8323
- Maritime 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



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

# 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>

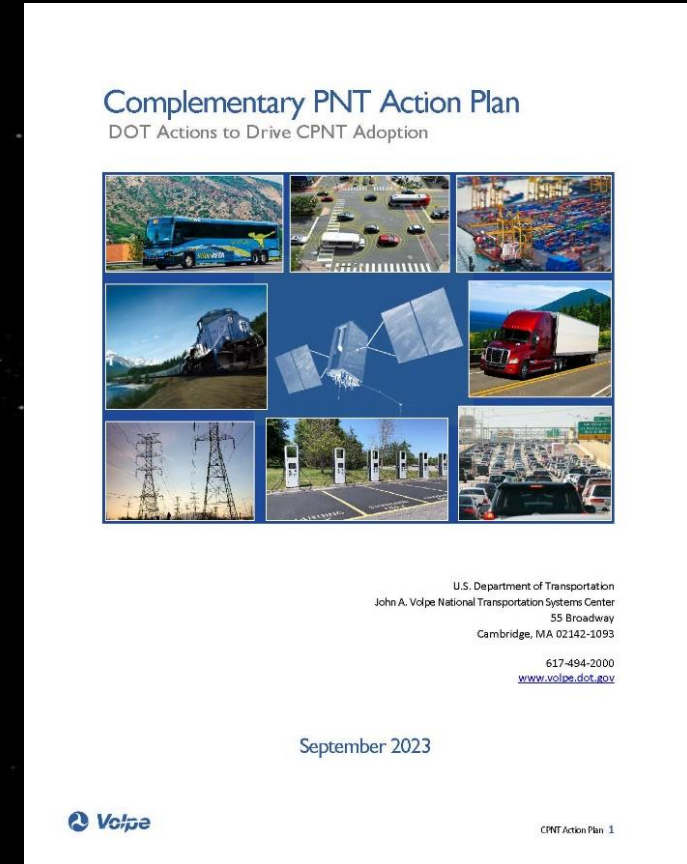
## DOT/Volpe Center Complementary PNT Sources Sought / RFI:

<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 Proposals Selected

## Technology Readiness Level $\geq 8$ ; Instrumented Within 6 Months

Num	Name	Assessed TRL	Test Range	Deployment (Months)	Technology	PNT Service	Test Range Location	Partnerships	Cost Base Year
1	Hoptroff Inc.	9	1	3	Fiber/Timing Distribution (10 PTP timing sources (8 NIST, 1 GNSS, 1 boundary clock))	T	JBCC (connections in NJ)	None	\$934,076
2	NAL Research Corp.	9	1	4	Low Earth Orbit (LEO) (L-Band; Iridium/STL signal)	P,N,T	JBCC	STL	\$144,599
3	Locata	9	1,2,3	5	2.4 GHz Industry, Scientific, and Medical (ISM) Band – Code Division Multiple Access (CDMA) signal	P,N,T	WSMR, Port of LA, and JBCC	USAF	\$778,630
4	Parsons	8	1	1	LEO (S-Band; Globalstar signal)	P,N,T	JBCC	NAB	\$132,416
5	Carahsoft	8	1,2	2	Camera/map matching	P,N	JBCC & Airborne Test	None	\$1,556,247
6	SAFRAN	8	1	4	Fiber/Timing Distribution (White Rabbit Time-Freq. distribution, internal Rubidium clock)	T	Northeast, JBCC	None	\$245,300
7	NextNav	8	3	4	Dedicated: Multilateration and Location Monitoring Service (M-LMS) band only (919.75 MHz – 927.75 MHz) Hybrid: M-LMS band + LTE/5G	P,N,T	San Francisco Bay area	Establishing a partnership with an Advanced Air Mobility company	\$1,876,968
8	Microchip	8	1	6	Fiber/Timing Distribution (virtual Primary Reference Time Clock (vPRTC) Timing Services, internal Cesium clock)	T	JBCC	NIST, ORNL	\$1,498,492
9	TERN AI	8	1	6	On-board Diagnostic 2 (OBD2) sensor/map tracking	P,N	JBCC	IBM Watson X and FedEx	\$51,780
<b>Total</b>									<b>\$7,218,508</b>

Field Test Range descriptions:  
 (1)Federal Government-hosted  
 (2)Critical Infrastructure (CI)  
 (3)Vendor fielded

- **Kickoff Meetings with Vendors Held**
- **Site Visits Being Conducted**
- **Currently Ramping Up for Rapid Phase II Solicitation**



# 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

# 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

# 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.*

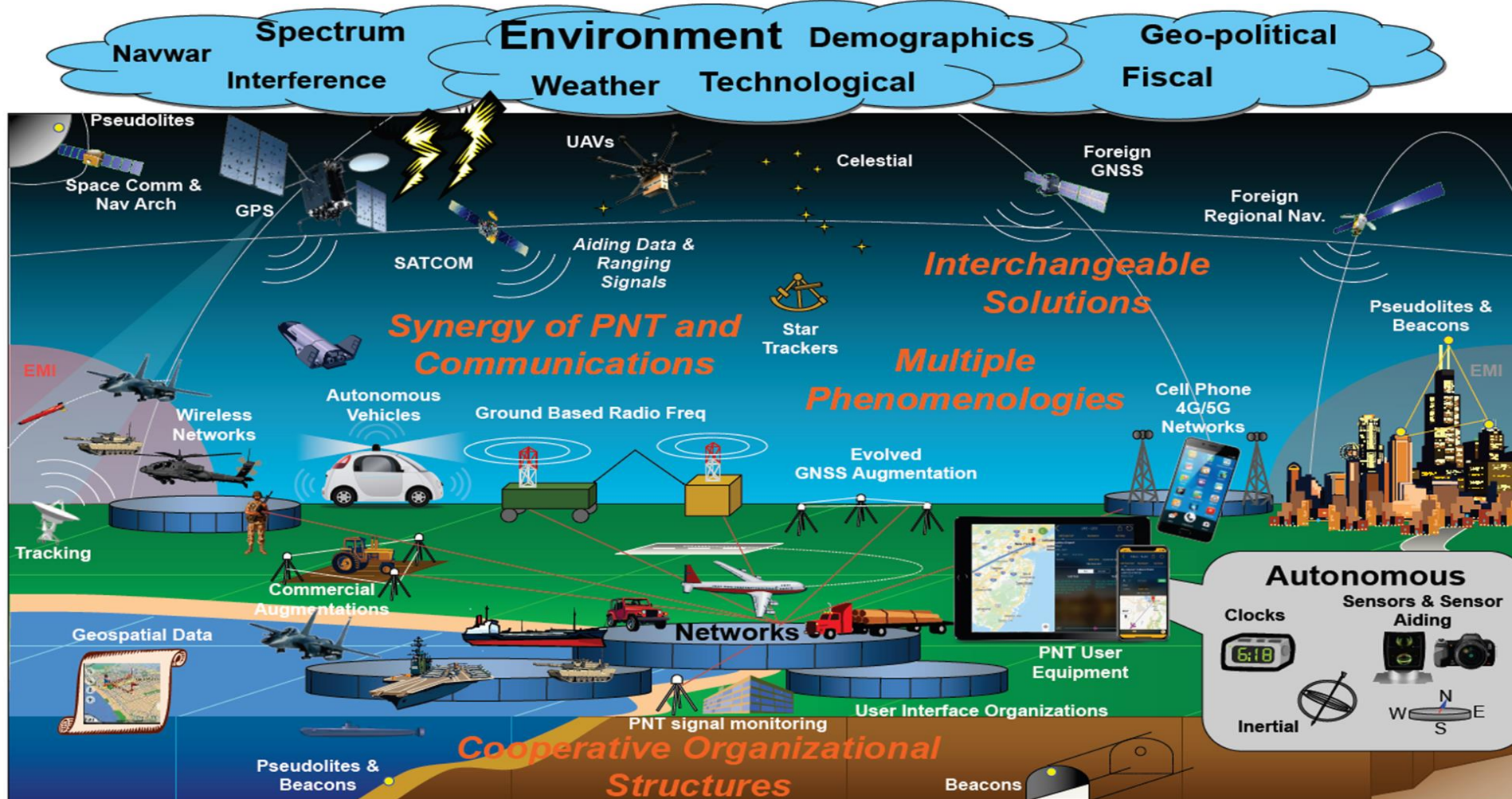
## **Ensure Spectrum Availability and Protection for PNT Services**

*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.*

# 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?**