US DOT Developments on PNT Resiliency

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PNT Resiliency Policy

• **US Public Policy**
  – Presidential Policy Directive 21, “Critical Infrastructure Security and Resilience Policy” places responsibility jointly with DHS and DOT for civil and commercial applications

• **Space-based PNT Executive Committee**
  – Spectrum protection has been the focus for the last 5+ years, taking up cybersecurity and complementary PNT
  – PNT Advisory Board guidance: Protect Spectrum, Toughen Infrastructure and User Equipment, and Augment Services (so-called PTA)
PNT Resiliency Initiatives

- **Department Collaborations**
  - DOD/DHS/DOT GPS Backup Demonstration
  - DOD/USAF Spectrum Protection (Adjacent Band, ITU, PRN assignments)
  - DHS Best-practices Guide for Critical Infrastructure for commercial entities
  - DHS Conformance Framework development as “Responsible Use of PNT Services” prep

- **DOT Initiatives**
  - Modernized GNSS Open Signals and Specification
  - Complementary PNT Services
    - Encoding new & improved standards, e.g. GNSS specifications, service level agreements
    - Government investment in infrastructure, National Timing Resiliency and Security Act of 2018
  - User Equipment Guidelines and Standards
    - Transportation modal initiatives: FRA, MARAD, FAA, NHTSA/ITS-JPO
Taxonomy of PNT Resiliency Mechanisms

• **US Government Infrastructure Investment**
  – Complementary PNT Services
  – PNT Signal Authentication
    • Specifications and trust framework
    • In-band and out-of-band transmission
  – Sponsoring of Standards Bodies Participation and Technology Initiatives
    • Nav: ICG, ICAO, IMO, RTCA, EUROCAE, SAE, etc.
    • Comm: 3GPP, V2X, etc.
    • Technology for monitoring, user notification, and threat detection/enforcement

• **End User Equipment Investment (Industry, Academia, Government)**
  – Sensor Fusion, Clock, and Antenna Techniques
  – Out-of-Band Data Channels for GNSS Assurance
  – Diversity of Services and Adoption/Development of Standards
GPS Enterprise Baseline Activities

• GPS Enterprise Baseline Support
  • Boarded RFC-413 (ISM for ARAIM), Sep ‘19
  • Oversight on OCX implementation of CSM (RFC-067b) and PSICA Working Group
  • Re-invigorated AFSPC liaison support
  • Assisting navigation message and ranging authentication development

• Civil Signal Operational Capability IPT
  • Focus on modernized (civil) signal operational declarations
  • Coordinating L2C early-use initiative DOT
  • Leading on GPS Enterprise requirements (GPS IIIF & OCX CDDs)

• GPS SPS PS draft 5th ed. & CMPS 3rd ed. redlines
• OCX Independent CSM Development (DoD and FAA TC partners)
• WG-C cooperating with RTCA and EUROCAE to develop MOPS material
  • Possible 2020 MOPS publication, likely to be deferred to 2022 publication cycle
  • Example FAA airborne algorithm (v3.1) provided to standards groups for review and consideration. Intent to publish on www.gps.gov.
  • Focus shifting to industry led activity through RTCA and EUROCAE with WG-C support

• WG-C also developing proposed ICAO SARPS for Service Providers
  • Draft requirements have been proposed and under discussion
  • Significant validation material still required, potential to follow SBAS message authentication
  • Process will derive requirements for GPS CNAV ISM (e.g. minimum transmission rate, ISM re-certification rate)
ARAIM FAA Prototyping and Testing

• Avionics
  • EU has multi-year program to develop avionics with multiple vendors
  • FAA planning market survey in FY20 to developing flight test platform with ARAIM function

• Integrity Status Message Generator (ISMG)
  • EU primary efforts conducted under ARTEX project
    • Prototype algorithms for ISM bounding. Results published in 2019 ION and ICAO papers.
  • US prototype implementations in FAATC tool suite
    • Test ISM results planned for publication Jul 2020
    • Methods evolving in support of standards validation and service provider commitments

• No immediate plan to prototype FAA-to-GPS ISM interface, tracking with GPS RFC-413
Related Civil Signal Coordination

- AFSPC/50\textsuperscript{th}/2SOPS partnership on constellation management and monitoring needs
- Space-based PNT Executive Committee and Advisory Board input
- International Coordination at ICG, ICAO, IMO, and WG-C levels
- Forward-look and watch items
  - IFOR requirements traceability to the GPS Enterprise (GPS IIIF)
  - Achieving L5 suitability: operational declaration(s) and performance
  - GPS SPS Performance Standard 5\textsuperscript{th} Ed publication
  - 2019 Federal Radionavigation Plan
  - L2C Early Use declaration process
  - Progress to L2C & L5 IOC/FOC
Congressional Motivation on Resilient PNT

- Sequential Legislation on Backup/Complementary PNT Service
  - Needs Established for PNT: **FY17 NDAA**
  - Demonstrate PNT Technologies: **FY18 NDAA ($10M)**
- FY17 & FY18 NDAA joint responsibility for DOD/DHS/DOT
  - Appropriation through DOD to DHS & DOT
  - Joint reports on needs & technologies to congressional committees
- LoBiondo Act Places Procurement on DOT
  (P.L. 115-282, Sec. 514; 4 DEC 2018)
NDAA PNT Demonstration Work Plan

• Government Team: Nine organizations, five field sites, four test platforms, 28+ personnel

• Executed two acquisitions (govt support & PNT vendors), three field campaigns, preparing PNT demonstration report, and coordination with DOT Extended Pos/Nav

• Awarded PNT vendors (11) with high TRL on rapid acquisition purchase orders

• Output products:
  • Demonstration performance report and recommendations to DOT leadership
  • Draft briefing for Space-based PNT Executive Committee
Complementary PNT Demo (JBCC)

150 Acres
Volpe Test Facility
Complementary PNT Demo (LaRC & IIHS)

NASA Langley

IIHS Ruckersville

15 Acres

22 Acres

7 Acres

230 Acres
Example RF Transmitter (Fixed—Wildwood LSU)
Example RF Transmitter (Fixed—LaRC)
Example Terrestrial RF Transmitter (Portable)
Summary

• **Working the Core of PNT Resiliency**
  – GPS as the pillar of PNT: standards, performance, monitoring, authentication
  – DOT/FAA-AFSPC/SMC Integrated Product Team operational declarations
  – Tracking PNT Policy Developments
  – Supporting State Department on international and bi-lateral service provider coordination

• **Demonstrating Complementary PNT for Increased Resiliency**
  – Broad range of technologies across geospatial and spectrum diversity
  – Incorporating cross-departmental practices and guidance
  – Preparing decision framework for government investment in PNT
Questions?

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