



***U.S. GPS/GNSS
International Activities
Update***

**Royal Institute of Navigation (RIN)
Baška GNSS Conference**

*Office of Space Affairs
U.S. Department of State*

09 May 2022



U.S. Space-based PNT Policy (2020 NSP & SPD-7)

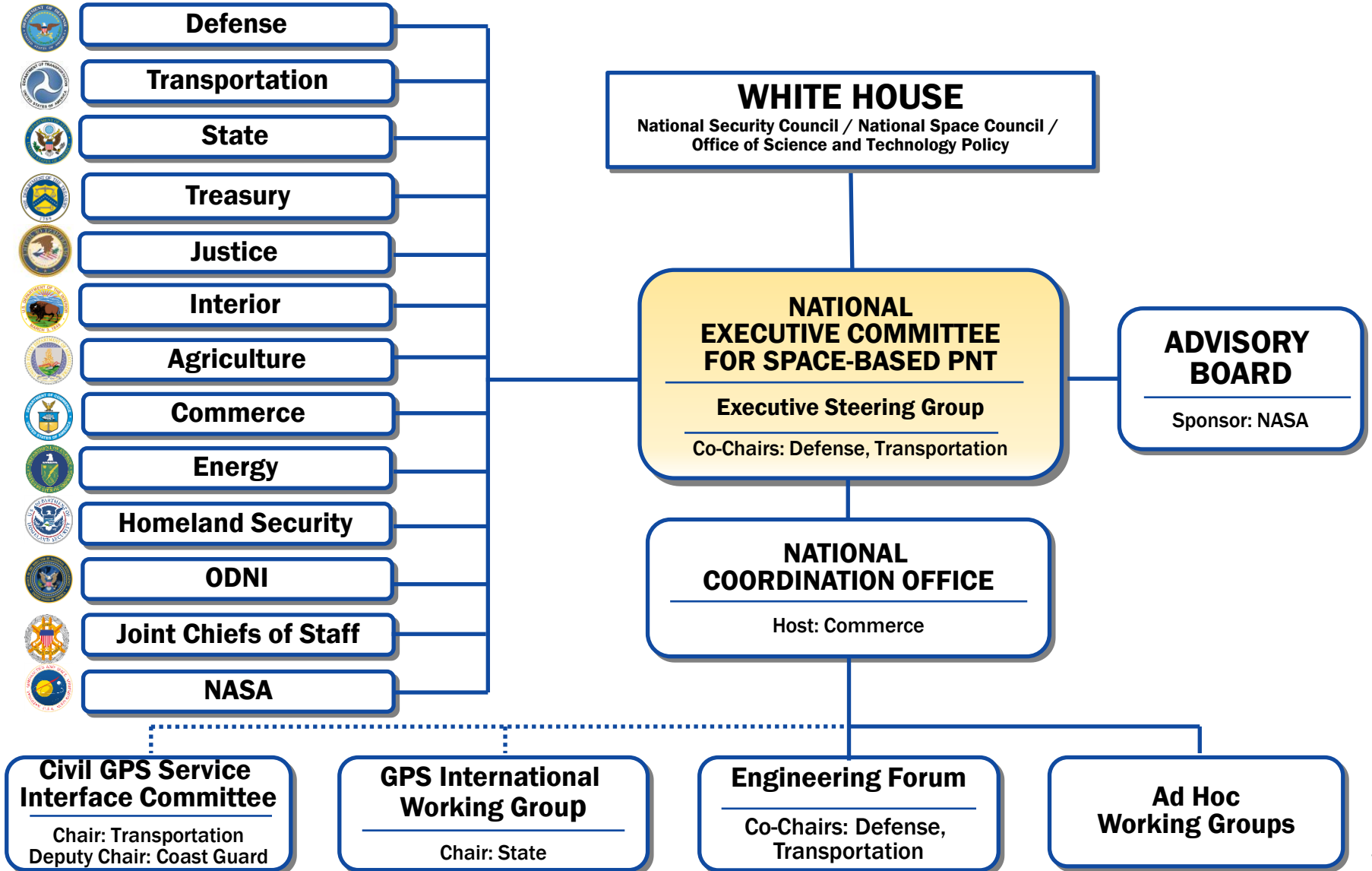


Maintain U.S. leadership in the service provision, and responsible use of GNSS, including GPS and foreign systems

- Ensure **compatibility** – ability of U.S. and non-U.S. space-based PNT services to be used separately or together without interfering with each individual service or signal
- Encourage **interoperability** – ability of civil U.S. and non-U.S. space-based PNT services to be used together to provide the user better capabilities than would be achieved by relying solely on one service
- Promote **transparency** in civil service provision and enable **market access** for U.S. industry
- Promote and support the **responsible use of GPS** as the pre-eminent space-based PNT service
- Foreign space-based PNT services may be used to complement civil GPS service
 - Receiver manufacturers should continue to improve security, integrity, and resilience in the face of growing cyber threats
- Encourage foreign development of PNT services and systems based on GPS
- Support international activities to **detect, mitigate, and increase resilience** to harmful disruption or manipulation of GPS



National Space-Based PNT Organizations





GPS Constellation Status



37 Satellites • 30 Set Healthy
Baseline Constellation: 24 Satellites



Satellite Block	Quantity	Average Age (yrs)	Oldest
GPS IIR	7 (5*)	20.3	24.7
GPS IIR-M	7 (1*)	14.5	16.5
GPS IIF	12	8.2	11.8
GPS III	4 (1*)	2.0	3.3

*Not set healthy

As of 01 April 2022

GPS Signal in Space (SIS) Performance

From 01 April 2021 to 01 April 2022

Average URE*	Best Day URE	Worst Day URE
45.4 cm	31.5 cm (20 Apr 21)	67.7 cm (05 Apr 21)

*All User Range Errors (UREs) are Root Mean Square values



GPS Modernization



Space Segment

SV families provide L-Band broadcast to User Segment

GPS IIA/IIR

- Basic GPS
- Nuclear Detonation Detection System (NDS)

GPS IIR-M

- 2nd Civil Signal (L2C)
- New Military Signal
- Increased Anti-Jam Power

GPS IIF

- 3rd Civil Signal (L5)
- Longer Life
- Better Clocks

GPS III (SV01-10)

- Accuracy & Power
- Increased Anti-Jam Power
- Inherent Signal Integrity
- 4th Civil Signal (L1C)
- Longer Life
- Better Clocks

GPS IIIF (SV11-32)

- Unified S-Band Telemetry, Tracking & Commanding
- Search & Rescue (SAR) Payload
- Laser Retroreflector Array
- Redesigned NDS Payload

Control Segment

TT&C of Space Segment assets & distribution of data to user interfaces

Legacy (OCS)

- Mainframe System
- Command & Control
- Signal Monitoring

Architecture Evolution Plan (AEP)

- Distributed Architecture
- Increased Signal Monitoring Coverage
- Security
- Accuracy

OCX Block 0

- GPS III Launch & Checkout System
- GPS III Contingency Ops (COps)
- GPS III Mission on AEP
- M-Code Early Use (MCEU)
- Update OCS to operationalize Core M-Code for MGUE

OCX Block 1/2

- Fly Constellation & GPS III
- Begin New Signal Control
- Upgraded Information Assurance

OCX Block 2+

- Control all signals
- Capability On-Ramps
- GPS IIIF Evolution

User Segment

Applies Space and Control Segment data for PNT applications

Continued support to an ever-growing number of applications

- Annual Public Interface Control Working Group (ICWG)
- Standard Positioning Service (SPS) Performance Standard Updates
- Precise Positioning Service (PPS) Enhancements
- Sustained commitment to transparency
- Visit GPS.gov for more info

Modernized Civil Signals

- L2C (Various commercial applications)
- L5 (Safety-of-life, frequency band protected)
- L1C (Multi-GNSS interoperability)



Wide Area Augmentation System (WAAS) Current Status

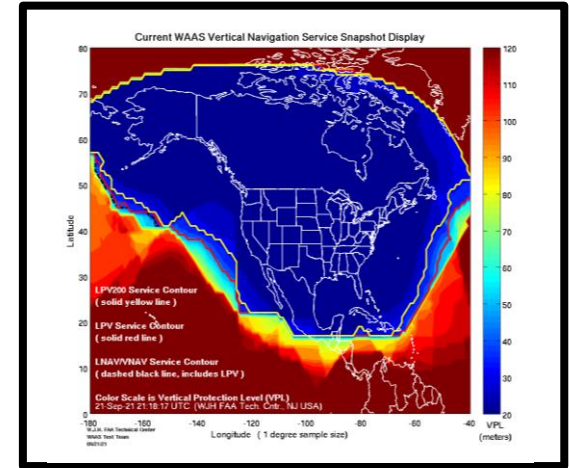


- Current WAAS provides high availability service to aviation user in North America
 - 4,105 Localizer Performance with Vertical Guidance (LPV) approaches in the NAS
 - Over 1050 LPVs are LPV-200's which provides CAT I equivalent instrument approach performance
- Preparing WAAS to take advantage of Dual Frequency service that will be provided by GPS
 - DFO-2 contract proposals under evaluation with an award expected in 2022
 - To continue high availability of WAAS vertical service during ionospheric disturbances
- GEO Sustainability
 - Currently maintaining 3 GEO's (Eutelsat 117 WB [GEO 5], SES-15 [GEO 6], Galaxy-30 [GEO 7]) and removing 1 GEO (ANIK F1R [CRE])

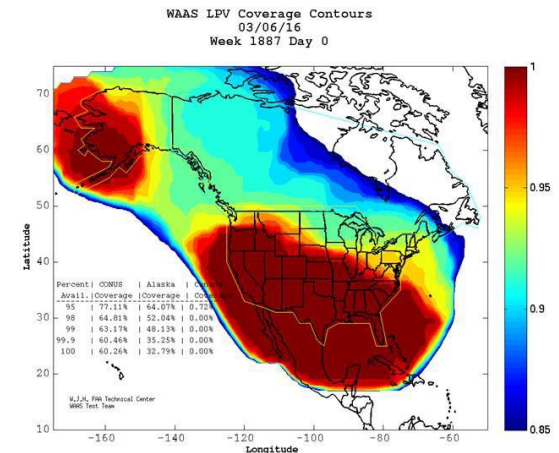
WAAS Modernization Efforts

- Dual Frequency Multi-Constellation (DFMC)
- Advanced Receiver Integrity Monitoring (ARAIM)

Current WAAS LPV Coverage



WAAS LPV Coverage March 6, 2016 Iono event





WAAS Avionics Equipage Status



- Over 152,225 WAAS equipped aircraft in the NAS
 - WAAS receivers provided by companies such as: Garmin, Universal, Rockwell Collins, Honeywell, Avidyne, Innovative Solutions & Support (IS&S), Thales and Genesys Aerosystem (Chelton)
- Since 2006, aircraft equipage rates have increased each year
- All classes of aircraft are served in all phases of Flight
 - Recent STC for Boeing 737-600/700/800 avionics
- Enabling technology for NextGen programs
 - Automatic Dependent Surveillance Broadcast (ADS-B)
 - Performance Based Navigation (PBN)





Bilateral International Cooperation



Europe

- GPS-Galileo Cooperation Agreement signed in 2004
- U.S.-EU Space Dialogue and three Working Groups meet regularly

Japan

- Comprehensive Space Dialogue held August 2020
- Technical Working Group discusses GPS and QZSS compatibility and interoperability

India

- U.S.–India Joint statement on GNSS Cooperation – 2007
- Civil Space Joint Working Group (CSJWG) met November 2019

China

- Three Working Groups and GNSS Plenary meeting held May 2018
- Joint Statement of Cooperation on Civil Signal Compatibility and Interoperability – November 2017



Multilateral International Cooperation



International Committee on GNSS (ICG)

- Pursuing a Global Navigation Satellite System-of-Systems to provide civil GNSS services that benefit users worldwide
 - Promote the use of GNSS and its integration into infrastructures, particularly in developing countries
 - Encourage compatibility and interoperability among global and regional systems
- U.S. priorities include spectrum protection, system interoperability and information dissemination
- 15th Meeting held in Vienna, Austria in September 2021
- UAE will host the 16th Meeting in October 2022



15th Meeting of the International Committee on GNSS (ICG)



- Hybrid format with both in-person and virtual participation
 - More than 300 people will participated
 - All 6 GNSS Providers, as well as other members and observers
- Agenda included:
 - Meeting of the Providers' Forum
 - System Provider Updates
 - Applications and Experts Session
 - Meeting of all four Working Groups





ICG Working Groups



- **Systems, Signals and Services (Co-Chairs: U.S. & Russia)**
 - Focus on compatibility and interoperability, encouraging development of complimentary systems
 - Exchange information on systems and service provision plans
 - Includes spectrum protection and IDM
- **Enhancement of GNSS Performance, New Services and Capabilities (Co-Chairs: India, European Space Agency, China)**
 - Focus on system enhancements (multipath, integrity, interference, etc.) to meet future needs
- **Capacity Building, Education and Outreach (Chair: UN Office for Outer Space Affairs)**
 - Focus on training/workshops, promoting scientific applications, space weather
- **Reference Frames, Timing and Applications (Co-Chairs: IAG, IGS & FIG)**
 - Focus on timing, monitoring and reference station networks



ICG and GNSS Spectrum Protection



- ITU is responsible for international spectrum framework, including the protection of radio services
- Actual implementation of this framework is accomplished by national telecommunication administrations
- National telecommunication administrations work with relevant industries and stake holders
- ICG provides a forum that can facilitate and encourage the protection of GNSS spectrum by its members and participants in a voluntary, non-binding way



Addressing Spectrum Protection and IDM within ICG



- Establishment of Compatibility Subgroup in 2011
 - Focused on compatibility issues to include spectrum protection and IDM
- Establishment of Interference Detection and Mitigation Task Force in 2013
 - Objectives include:
 - 1) Develop a common set of information to be reported to GNSS civil service centers
 - 2) Establish routine communications among the (provider service) centers
 - 3) Develop guidelines for common capabilities to be considered in the development of future national IDM networks
 - Nine IDM Workshops held since 2012



9th ICG Workshop on IDM



- Workshop held virtually on 24 August 2021
- Agenda included:
 - Incorporating Resilience into IDM – Department of Homeland Security, United States
 - Implementation and Definition of Interference Protection Standards at Space Segment for the European Space Agency - European Space Agency
 - Environment-aware GNSS Position Estimation Process Realisation in Software-Defined Radio (SDR) - University of Rijeka, Croatia
 - Air-Ground coordinated RFI detection system in airport - China Research Institute of Radio-wave Propagation
 - Development of the European GNSS Interference Detection Network - European Union Agency for Space Programmes
 - Characterization of ADS-B Performance under GNSS Interference – Stanford University, U.S.
 - Madrid Airport and TMA GNSS RFI Monitoring System (DYLEMA-Madrid) - Spanish Ministry of Transport
 - Interference scenario in S-band: NavIC experience - Indian Space Research Organisation



Other Important ICG Activities



- Interoperability and Service Standards
 - Performance Standard Template
 - “Guidelines” document developed as a template
 - International GNSS Monitoring and Assessment (IGMA)
 - Trial Project with IGS continues
 - Interoperable Time – Focus on System Time Offsets
- Space Service Volume
 - Updated UN booklet “The Interoperable GNSS SSV” published
 - Technical discussions focused on an interoperable space service volume and development of space-based user equipment
- Precise Point Positioning (PPP)
 - Task Force on PPP interoperability formed in 2019 – co-chaired by Australia, Japan and EU



Summary



- U.S. Policy continues to focus on maintaining **leadership in the service provision**
 - Includes the addition of **responsible use of GPS/GNSS**
 - **Compatibility, interoperability, and transparency** remain priorities
 - Pursued through bilateral and multilateral dialogues
- Bilateral cooperation continues with partners
- The work of the ICG, with strong U.S. participation, continues its focus on civil GNSS services that benefit users worldwide
 - U.S. priorities include **spectrum protection, system interoperability and information dissemination**



For Additional Information...



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GPS.GOV

Official U.S. government information about the Global Positioning System (GPS) and related topics

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GPS: The Global Positioning System

A global public service brought to you by the U.S. government

INFORMATION FOR THE GENERAL PUBLIC

How to Correct Your Address in GPS Devices, Apps, & Online Maps



Do GPS devices show your home or business in the wrong place? **The problem is not GPS!** It's the mapping software.

[Report your issue to the software providers](#)

Common Questions →

- How do I add or correct my address in GPS devices, apps, and maps?
- What can I do about trucks driving through my neighborhood?
- How do I report GPS service outages?

FOR GPS PROFESSIONALS

What's **HOT** for Pros

- CGSIC St. Louis, Sep 20-21
- Technical documentation
 - ICD updates for 2021
 - Public ICWG meeting, Sep 29
 - PRN assignments, Jun 2021
- Ligado Networks and GPS
 - Secretary of Commerce letter to Senator Inhofe (PDF)
 - FCC order denying motion for stay
- U.S. Space-Based PNT Policy of 2021
- Recent presentations
- Funding & legislation
 - FY22 GPS funding & NDAA

News Items →

- Aug 18: Innovation is the game, GPS III-5 is the name
- Jul 1: GPS III SV05 receives operational certificate