



U.S. Space-Based Positioning, Navigation and Timing (PNT)

China Satellite Navigation Conference

November 2020

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



GPS Constellation Status

36 Satellites • 30 Set Healthy
Baseline Constellation: 24 Satellites



Satellite Block	Quantity	Average Age (yrs)	Oldest
GPS IIR	8 (4*)	18.9	23.3
GPS IIR-M	7 (1*)	13.1	15.1
GPS IIF	12	6.8	10.5
GPS III	3 (1*)	0.9	1.9

*Ops capable; not set healthy

As of 12 November 20

GPS Signal in Space (SIS) Performance

From 07 Nov 2019 to 07 Nov 2020

Average URE*	Best Day URE	Worst Day URE
52.2 cm	38.5 cm (01 Jun 20)	90.2 cm (26 Jul 20)

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



GPS Modernization

Space Segment

GPS IIA/IIR

- Basic GPS

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

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

OCX Block 1

- 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
- 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)

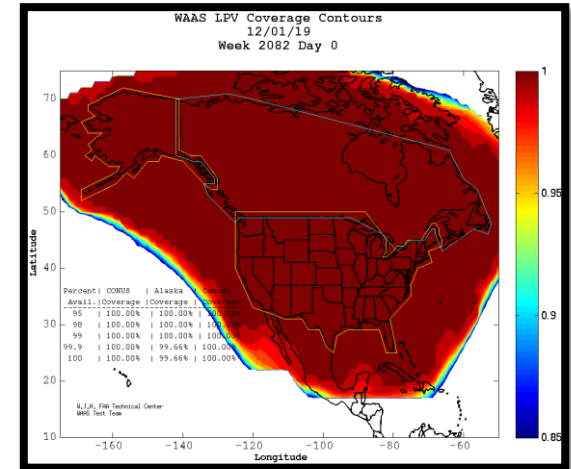


WAAS Current Status

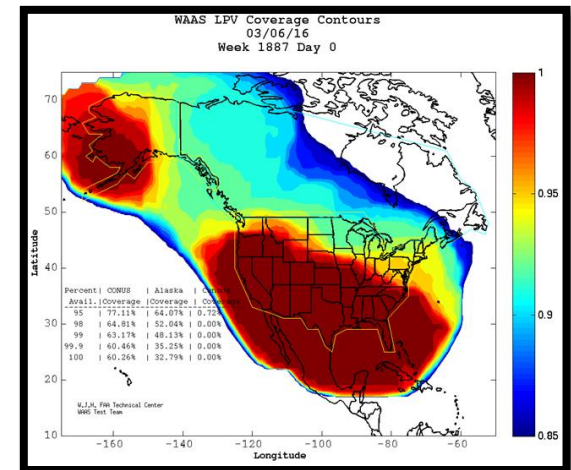


- **Current WAAS provides high availability service to aviation user in North America**
 - 4700+ Localizer Performance with Vertical Guidance (LPV) approaches in the NAS
 - Over 1000 LPVs are LPV-200's which provides CAT I equivalent instrument approach performance
- **Preparing WAAS to take advantage of Dual Frequency service that will be provided by GPS**
 - To continue high availability of WAAS vertical service during ionospheric disturbances
- **GEO Sustainability**
 - Currently maintaining 3 GEO's (Anik F1R [CRE], Eutelsat 117 WB [GEO 5], SES-15 [GEO 6])
 - Developing future GEO's 7/8/9 to replace legacy GEO's upon lease expiration
 - GEO 7 (Intelsat) is expected to be operational in 2022
- **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 131,000 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)





U.S. Policy



The U.S. must maintain its leadership in the service provision, and use of Global Navigation Satellite Systems (GNSS)

- Continuous, worldwide, free of direct user fees
- Encourage compatibility and interoperability with foreign GNSS services and promote transparency in civil service provisioning
- Operate and maintain constellation to satisfy civil and national security needs
 - Foreign PNT services may be used to augment and strengthen the resiliency of GPS
- Invest in domestic capabilities and support international activities to detect, mitigate and increase resiliency to harmful interference



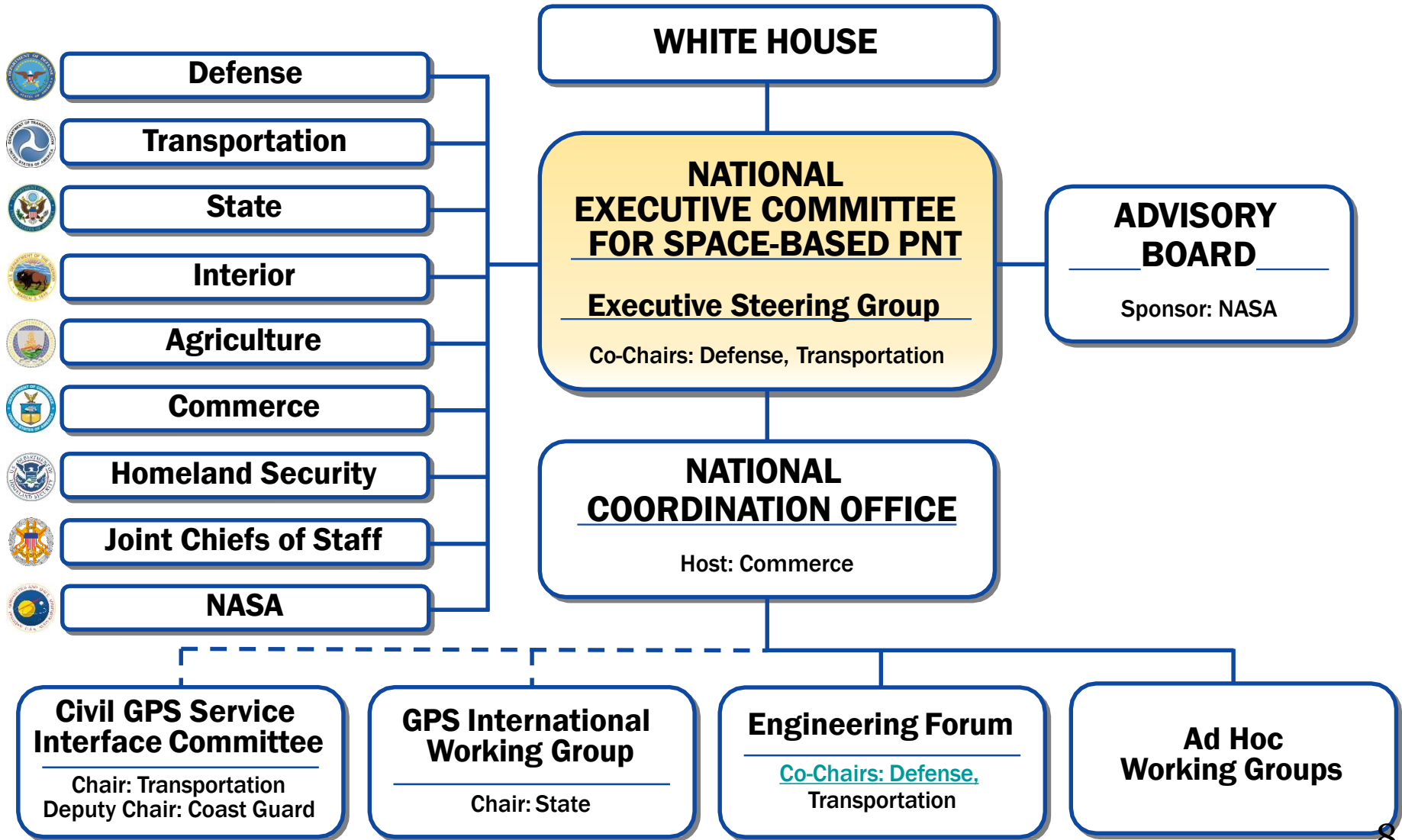
U.S. Policy Updates



- NSPD-39, the Space-Based Positioning, Navigation, and Timing Policy from 2004, is in the process of being updated
- On February 12, 2020, the President signed an Executive Order on Strengthening National Resilience through Responsible Use of Positioning, Navigation, and Timing (PNT) Services.
 - The order seeks to strengthen national resilience by identifying and promoting the responsible use of PNT services by the Federal Government and critical infrastructure owners and operators.



National Space-Based PNT Organizations





Opposition to FCC Ruling on Ligado



- On April 20, 2020, the Federal Communications Commission (FCC) announced that, "it has approved with conditions Ligado's application to deploy "a low-power terrestrial nationwide network in the L-Band that will primarily support 5G and Internet of Things services."
- The Administration (which is separate from FCC) is concerned because Ligado's proposed transmission power exceeds the thresholds established by the GPS Adjacent Band Compatibility study to protect GPS users from harmful interference.



Bilateral International Cooperation



China

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

Europe

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

India

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

Japan

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



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
- 14th Meeting held in Bangalore, India in December 2019
- UN OOSA will host the 15th Meeting in Vienna, Austria in 2021



For Additional Information...



GPS.GOV

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

- Home
- What's New
- Systems
- Applications
- Governance
- Multimedia
- Support

Home » Support » GPS Service Outages & Status Reports

SUPPORT:

Frequently Asked Questions

Address, Route, & Map Problems

Service Outages & Status Reports

Civil GPS Service Interface Committee (CGSIC)

Technical Documentation

External Links

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GPS Service Outages & Status Reports

Users experiencing GPS service problems can get support from one of three federal agencies, depending on their application: civil non-aviation, civil aviation, or military. The responsibilities of the support agencies are documented in an interagency agreement. [VIEW AGREEMENT](#)

Civilian User Support – Non-Aviation

The U.S. Coast Guard Navigation Center (NAVCEN) is the primary point of contact in the government for providing operational GPS user support to the civilian community. The following links lead to pages on the NAVCEN website.



- Check the operational status of the GPS satellites
- Look up planned GPS service disruptions due to interference testing
- Report a GPS service outage or anomaly (non-aviation)
- Receive GPS status messages & user advisories via email

If you suspect a GPS disruption due to illegal signal jamming ([LEARN MORE](#)), please call the FCC Jammer Tip Line immediately at 1-855-55-NOJAM, then submit an outage report to NAVCEN.

谢谢

THANK YOU!

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