



U.S. GPS Policy, Programs & International Cooperation Activities



中国卫星导航学术年会

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Overview

- **U.S. Space-Based PNT Policy**
- GPS & Augmentation Programs Status
- International Cooperation Activities
- Summary



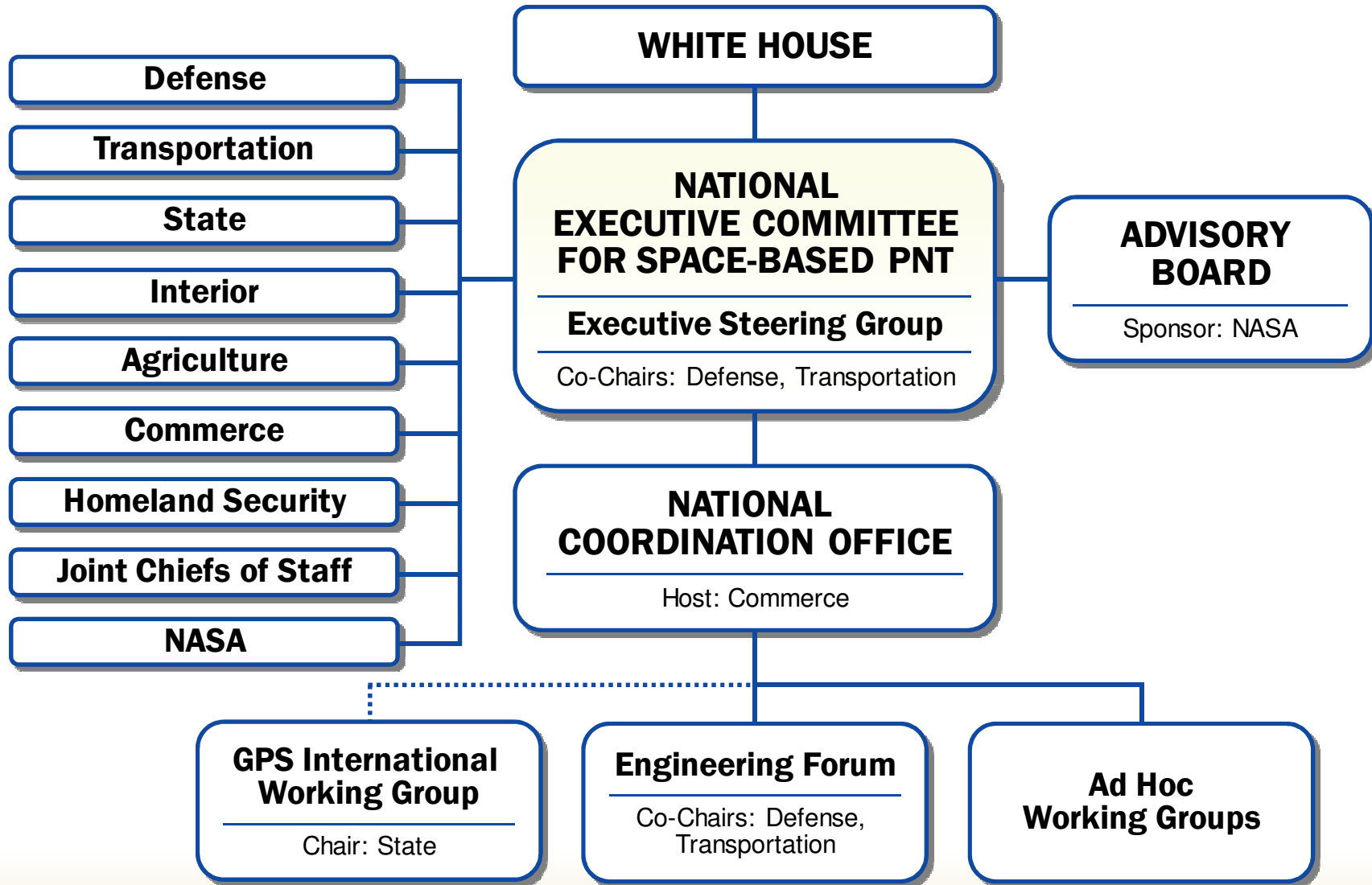
U.S. National Space Policy

Space-Based PNT Guideline: Maintain leadership in the service, provision, and use of GNSS

- Provide civil GPS services, free of direct user charges
 - Available on a continuous, worldwide basis
 - Maintain constellation consistent with published performance standards and interface specifications
 - Foreign PNT services may be used to complement services from GPS
- Encourage global ***compatibility*** and ***interoperability*** with GPS
- Promote transparency in civil service provision
- Enable market access to industry
- Support international activities to detect and mitigate harmful interference



U.S. Space-Based PNT Organization Structure





U.S. Policy Promotes Global Use of GPS Technology

- No direct user fees for civil GPS services
 - Provided on a continuous, worldwide basis
- Open, public signal structures for all civil services
 - Promotes equal access for user equipment manufacturing, applications development, and value-added services
 - Encourages open, market-driven competition
- Global compatibility and interoperability with GPS
- Service improvements for civil, commercial, and scientific users worldwide
- Protection of radionavigation spectrum from disruption and interference



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GPS Constellation

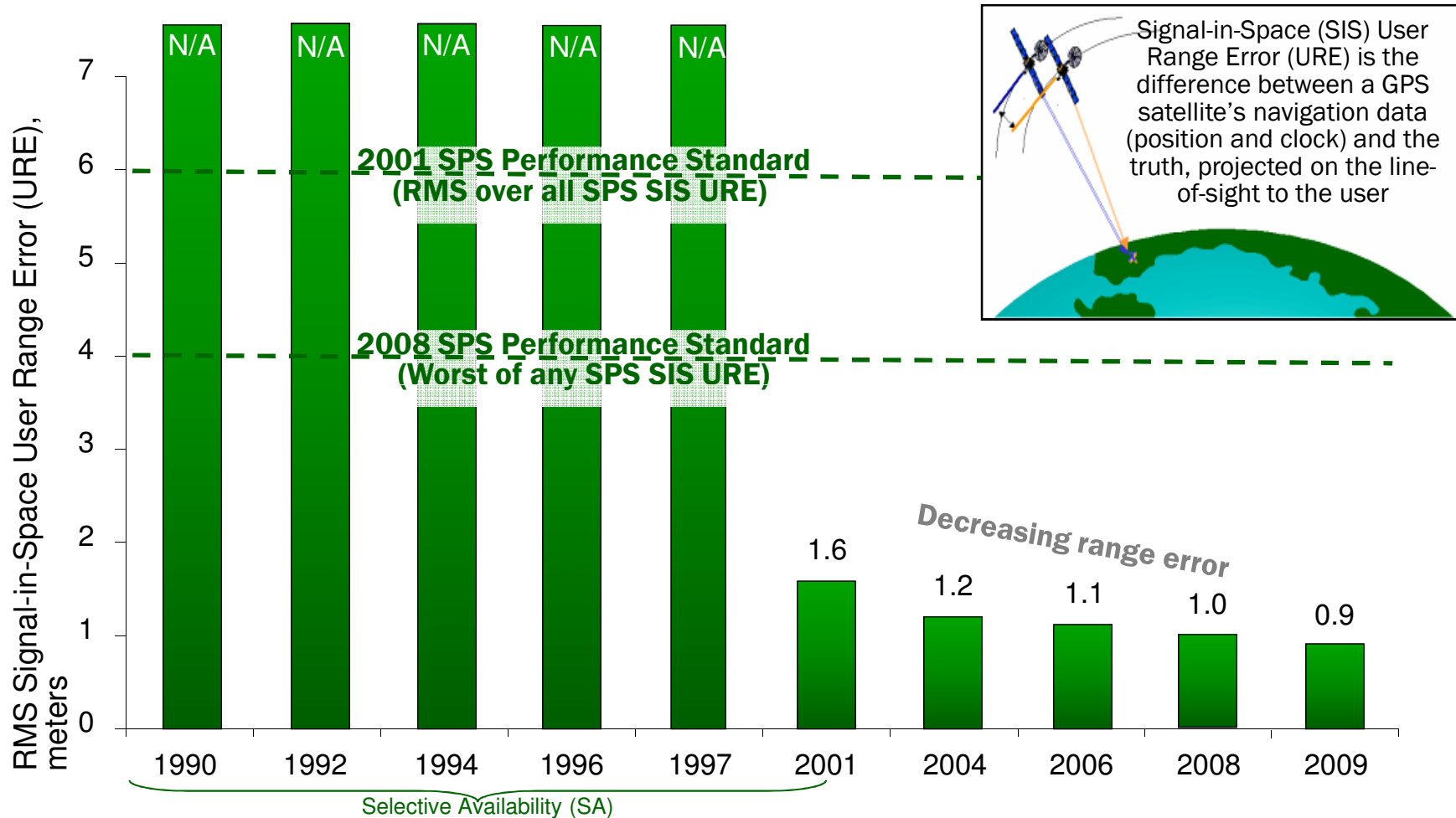
- 31 space vehicles currently operational
 - 11 GPS IIA
 - 12 GPS IIR
 - 7 GPS IIR-M
 - 1 GPS IIF
- 3 additional satellites in residual status
- IIF SV-2 scheduled to launch in July 2011
- IIIA SV-1 scheduled launch 2014
- Continuously assessing constellation health to determine launch need



Global GPS service performance commitment met continuously since December 1993



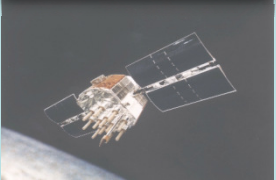



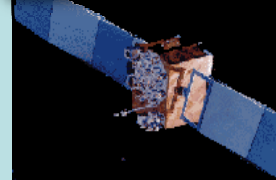

GPS SPS Signal in Space Performance



System accuracy exceeds published standard



GPS Modernization Program

1978 - 1985	1989 - 1997	1997- 2004	2005 - 2009	2010 - Present	2014 - 2024
					
Block I	Block II/IIA	Block IIR	Block IIR-M	Block IIF	Block III
11 (10) Satellites	28 Satellites	13 (12) Satellites	8 Satellites	12 Satellites	32 Satellites
Demonstration system	Basic GPS Provides Initial Navigation Capabilities		IIA/IIR Capabilities "Plus"	IIR -M Capabilities "Plus"	IIF Capabilities "Plus"
<ul style="list-style-type: none"> • L1 (CA) Navigation signal • L1 & L2 (P Code) Navigation signal • 5 Year Design Life 	<ul style="list-style-type: none"> • Standard Service <ul style="list-style-type: none"> • Single Frequency (L1) • C/A code navigation • Precise Service • Two frequencies (L1 & L2) • P (Y) -Code navigation • 7.5 Year Design Life 		<ul style="list-style-type: none"> • 2nd Civil Signal L2 (L2C) • Earth Coverage M-Code on L1/L2 • L5 Demo • Anti-Jam Flex Power • 7.5 Year Design Life 	<ul style="list-style-type: none"> • 3rd Civil Signal L5 • Reprogrammable Nav Processor • Increased Accuracy requirement • 12 Year Design Life 	<p>IIIA</p> <ul style="list-style-type: none"> • Increased accuracy • Increased Earth Coverage power • 15 Year Design Life • 4th Civil Signal (L1C) <p>IIIB</p> <ul style="list-style-type: none"> • Real-time Communications <p>IIIC</p> <ul style="list-style-type: none"> • Navigation Integrity • Spot Beam for AJ

Increasing Space System Capabilities - Increasing Military/Civil User Benefits 



GPS Modernization – New Civil Signals

Second civil signal “L2C”

- Designed to meet commercial needs
- Higher accuracy through ionospheric correction
- Available since 2005 without data message
 - Currently, 7 IIR-Ms transmitting L2C
- Full capability: 24 satellites ~2016



Third civil signal “L5”

- Designed to meet demanding requirements for transportation safety-of-life
- Uses highly protected Aeronautical Radio Navigation Service (ARNS) band
- On orbit broadcast 10 APR 2009 on IIR-20(M) secured ITU frequency filing
- Full capability: 24 satellites ~2018



GPS Modernization – Fourth Civil Signal



Under Trees



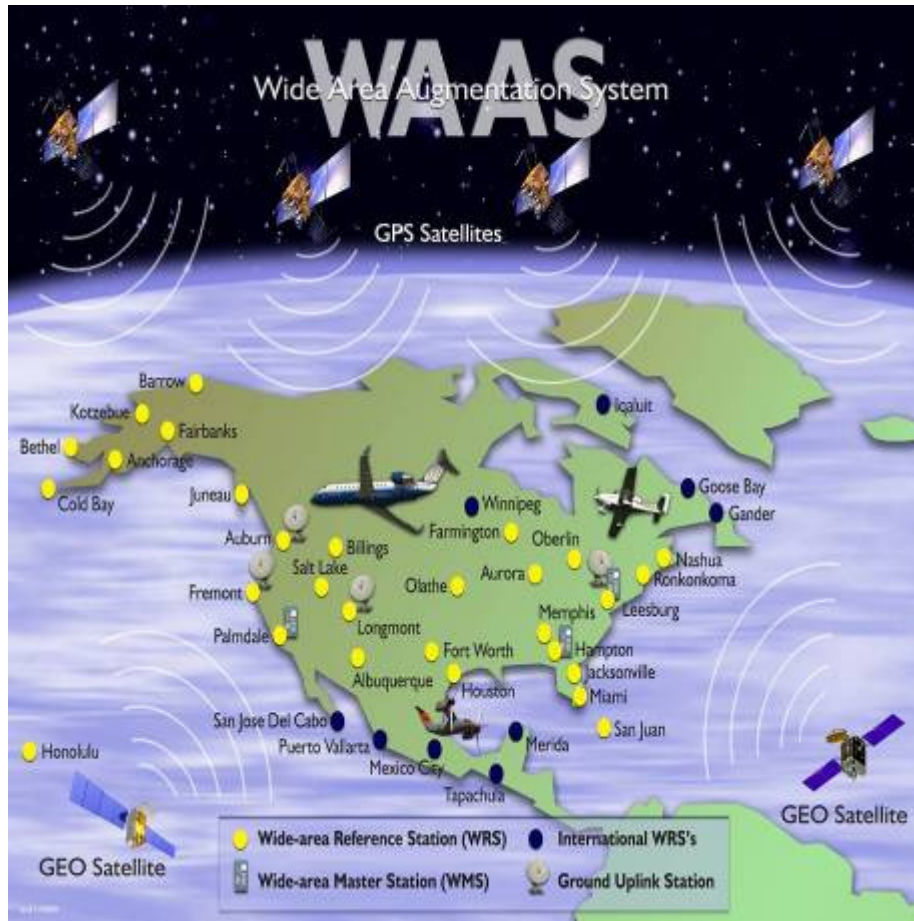
Urban Canyons

Fourth civil signal “L1C”

- Designed with international partners for interoperability
- Modernized civil signal at L1 frequency
 - More robust navigation across a broad range of user applications
 - Improved performance in challenged tracking environments
 - Original signal retained for backward compatibility
- Specification developed in cooperation with industry recently completed
- Launches with GPS III in 2014
- On 24 satellites by ~2021



Wide Area Augmentation System (WAAS) Architecture





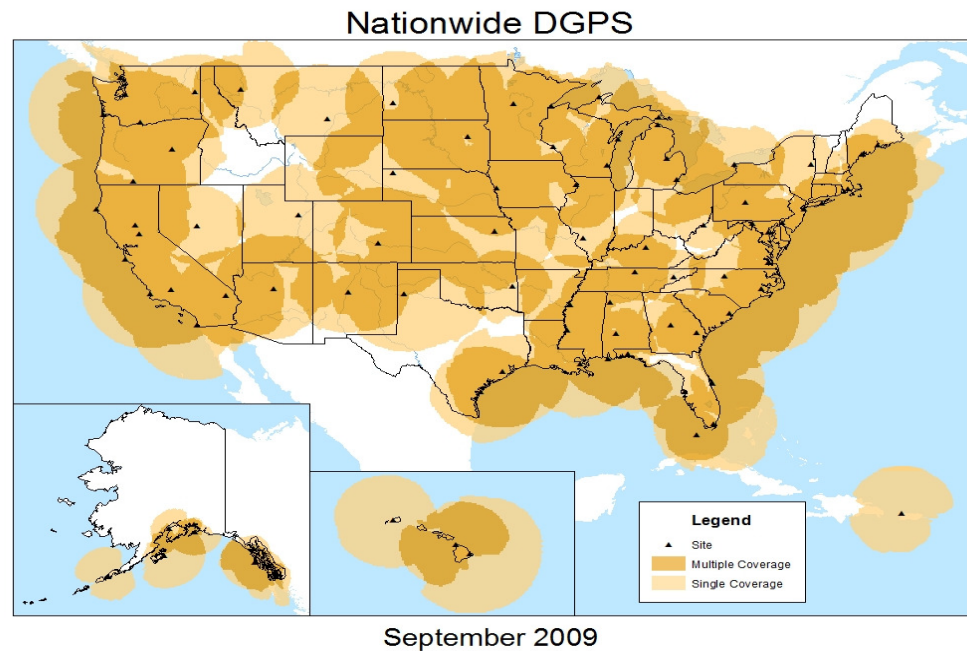
WAAS Phased Upgrades

- Phase I: IOC (July 2003) Completed
 - Provided LNAV/VNAV/Limited LPV Capability
- Phase II: Full LPV (FLP) (2003 – 2008) Completed
 - Improved LPV availability in CONUS and Alaska
 - Expanded WAAS coverage to Mexico and Canada
- Phase III: Full LPV-200 Performance (2009 – 2013)
 - Software enhancements, hardware upgrades
 - Steady state operations and maintenance
 - Transition to FAA performed 2nd level engineering support
 - Begin GPS L5 transition activities
- Phase IV: Dual Frequency (L1,L5) Operations (2013 – 2028)
 - Complete GPS L5 transition
 - Will significantly improve availability and continuity during severe solar activity
 - Provide additional protection against GPS interference
 - Will continue to support single frequency users



Nationwide Differential GPS

- Expansion of maritime differential GPS (DGPS) network to cover terrestrial United States
- Built to international standard adopted in 50+ countries
- System Specifications:
 - Corrections broadcast at 285 and 325 kHz using Minimum shift Keying (MSK) modulation
 - Real-time differential GPS corrections provided in Radio Technical Commission for Maritime Services (RTCM) SC-104 format
 - No data encryption
 - Real-time differential corrections for mobile and static applications

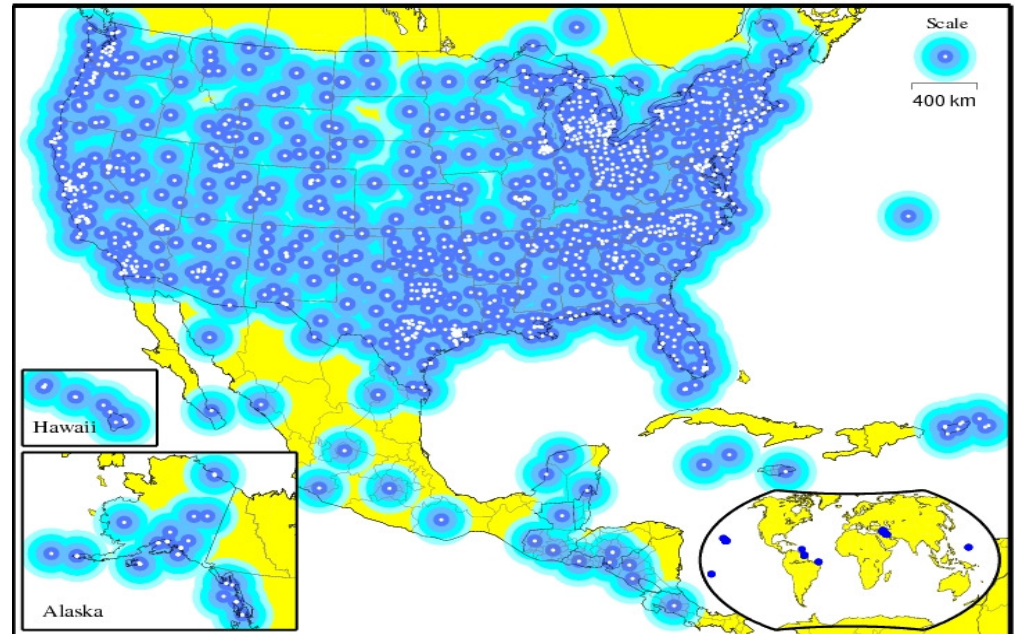


Single coverage over 92% of Continental United States (CONUS); double coverage over 65% of CONUS



National Continuously Operating Reference Stations (CORS)

- Enables highly accurate, 3-D positioning
 - Centimeter-level precision
 - Tied to National Spatial Reference System
- 1,200+ sites operated by 200+ public, private, academic organizations



- NOAA's Online Positioning User Service (OPUS) automatically processes coordinates submitted via the web from around the world
- OPUS-RS (Rapid Static) declared operational in 2007
- NOAA considering support for real-time networks



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U.S. Objectives in Working with Other GNSS Service Providers

- 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
 - Radio frequency compatibility
 - Spectral separation between M-code and other signals
- Achieve **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 or signal
- Promote fair competition in the global marketplace

Pursue through Bilateral and Multilateral Cooperation



International Cooperation Venues

- Bilateral to include:
 - Japan
 - Europe
 - Russia
 - India
 - China
 - Others (Australia)
- Multilateral:
 - Asia Pacific Economic Cooperation
 - International Committee on GNSS





U.S. Bilateral Cooperation with China

- Operator-to-operator coordination under ITU auspices
 - Geneva, Switzerland - June 2007
 - Xian, China - May 2008
 - Geneva, Switzerland - October 2008
 - Hainan, China – December 2009
 - Coordination completed in Chengdu, China in September 2010
- U.S. is interested in engaging in further bilateral discussions with China on civil GNSS services and applications



International Committee on Global Navigation Satellite Systems (ICG)

- Emerged from 3rd UN Conference on the Exploration and Peaceful Uses of Outer Space July 1999
 - Promote the use of GNSS and its integration into infrastructures, particularly in developing countries
 - Encourage compatibility and interoperability among global and regional systems
- Members include:
 - **GNSS Providers** (U.S., EU, Russia, China, India, Japan)
 - Other Member States of the United Nations
 - International organizations/associations





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Summary

- **GPS performance is better than ever and will continue to improve**
 - Augmentations enable even higher performance
 - New civil GPS signal available now
 - Many additional upgrades scheduled
- U.S. policy encourages **worldwide use of civil GPS and augmentations**
- **International cooperation** is a priority
 - In pursuit of systems **Compatible** and **Interoperable** with GPS



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