



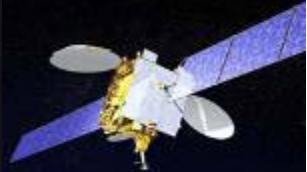
***GPS: Constellation Update
and U.S. Activities Supporting
International GNSS
Interoperability***

**2010 International Symposium
on GPS/GNSS**

Ray E. Clore
Senior Advisor on GNSS
Office of Space and Advanced Technology
U.S. Department of State

October 26, 2010

GPS is Essential to Our Economies and National Critical Infrastructures



Satellite Operation



Surveying & Mapping



Power Grids



Precision Agriculture



Transit Operations



NextGen



Trucking & Shipping



IntelliDrive



TeleComm



Disease Control



Personal Navigation



Oil Exploration



Fishing & Boating



Overview



- U.S. National Space Policy
- GPS Constellation Status
- Compatibility and Interoperability
- International Cooperation Venues
 - Bilateral Cooperation
 - International Committee on GNSS (ICG)
 - APEC GNSS Implementation Team (GIT)
- Summary



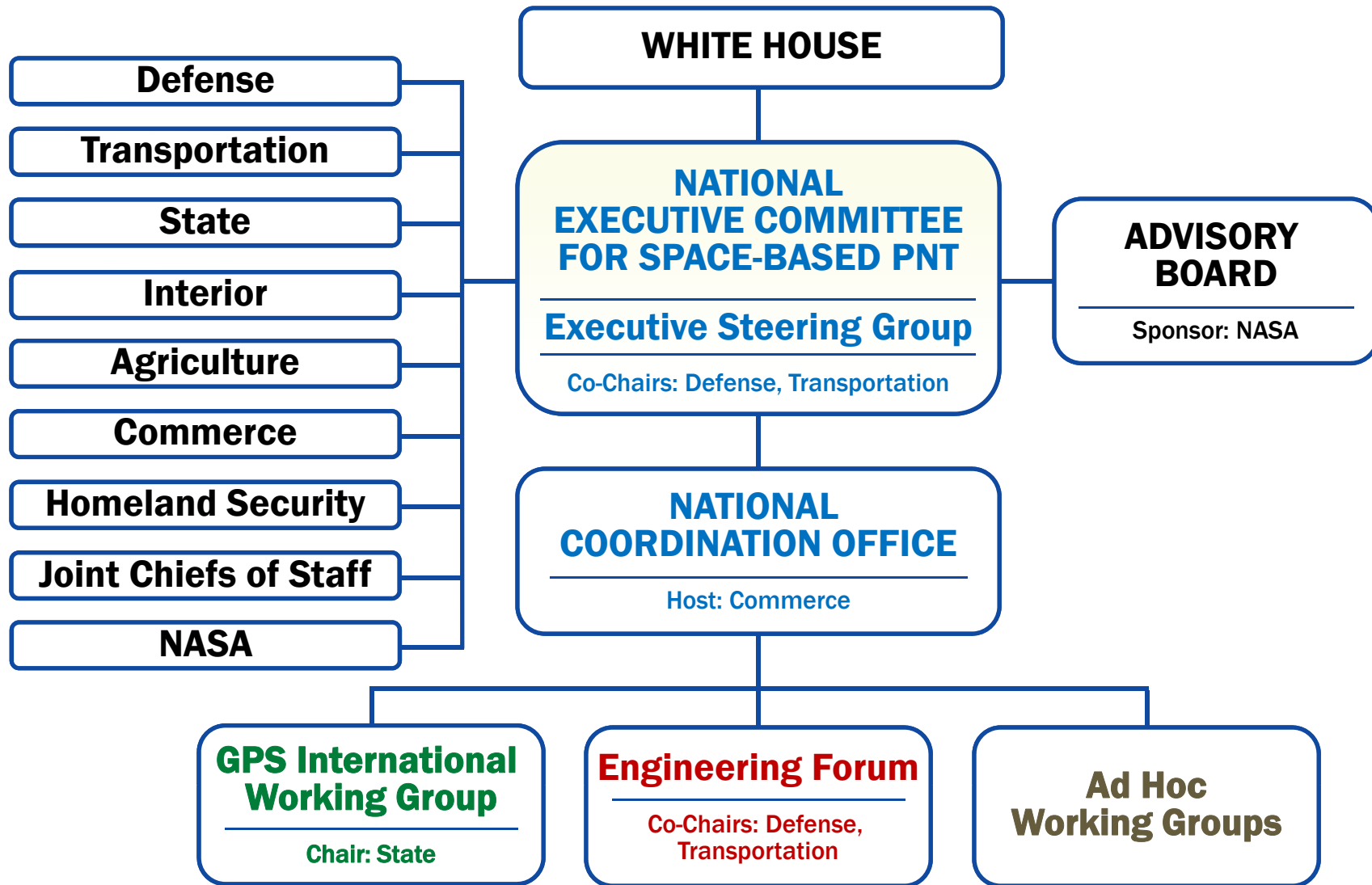
New U.S. National Space Policy

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. National Space-Based PNT Organization Structure





GPS Constellation Status

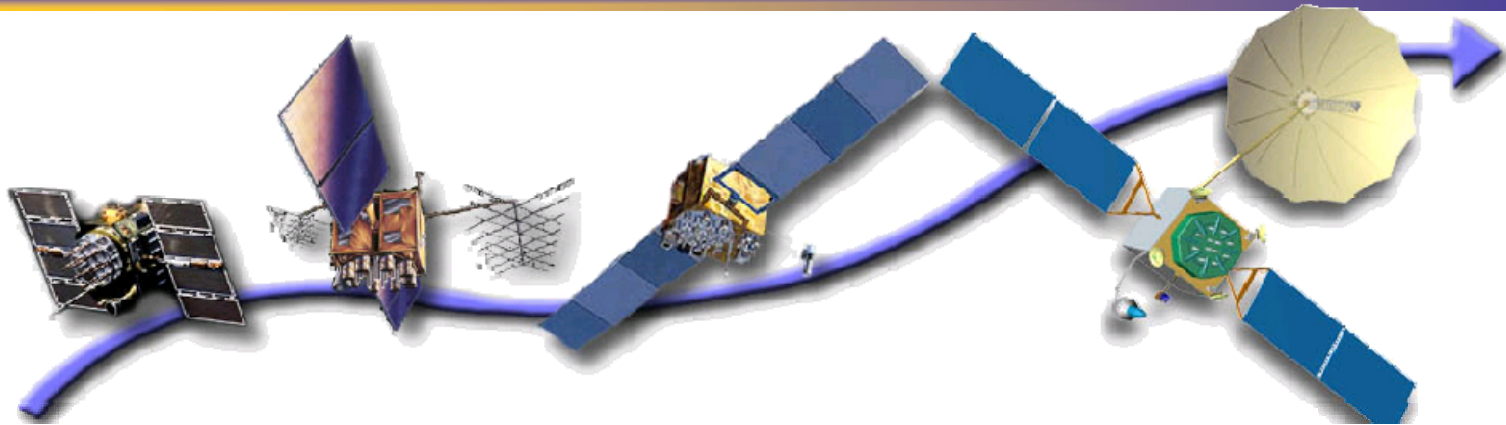
31 Operational Satellites (Baseline Constellation: 24)

- 11 Block IIA
- 12 Block IIR
- 7 Block IIR-M
 - Transmitting new second civil signal
 - 1 GPS IIR-M in on-orbit testing
- 1 Block IIF launched May 27th, 2010
 - First of 12 Block IIF satellites
- 3 additional satellites in residual status
- Global GPS civil service performance commitment met continuously since December 1993





GPS Modernization Program



Increasing System Capabilities ♦ Increasing Defense / Civil Benefit

Block IIA/IIR

Basic GPS

- Standard Service
 - **Single frequency (L1)**
 - Coarse acquisition (C/A) code navigation
- Precise Service
 - Y-Code (L1Y & L2Y)
 - Y-Code navigation

Block IIR-M, IIF

IIR-M: IIA/IIR capabilities plus

- **2nd civil signal (L2C)**
- M-Code (L1M & L2M)

IIF: IIR-M capability plus

- **3rd civil signal (L5)**
- Anti-jam flex power

Block III

- Backward compatibility
- **4th civil signal (L1C)**
- Increased accuracy
- Increased anti-jam power
- Assured availability
- Navigation surety
- Controlled integrity
- Increased security
- System survivability



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
- After 2020 with L2C and L5 online, the USG will no longer support semi-codeless access to military GPS signals
- 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
 - Is operational on 1st IIF (SVN-62)
- Full capability: 24 satellites ~2018



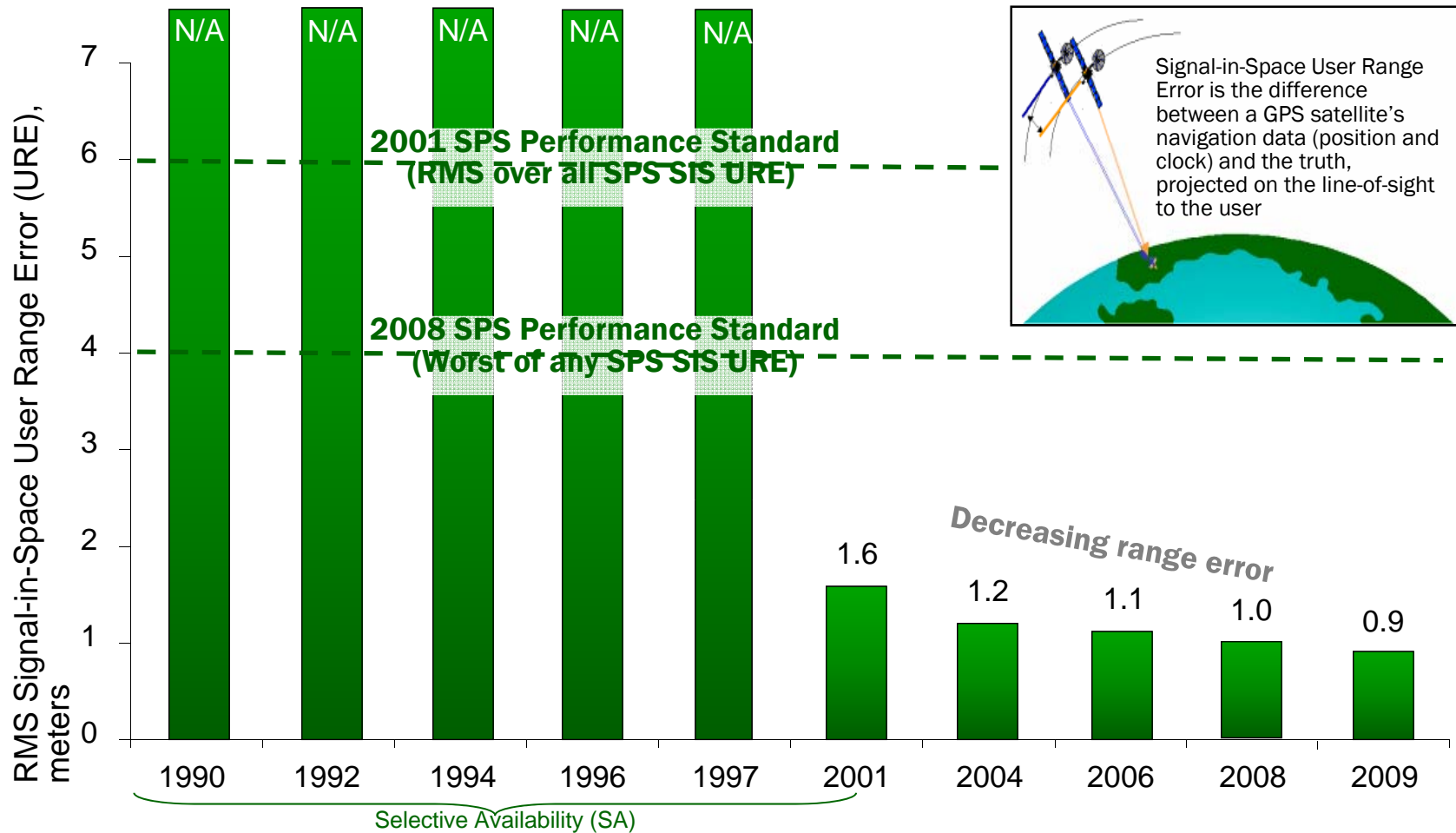
GPS Modernization – Fourth Civil Signal (L1C)



- 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



SPS Signal in Space Performance



System accuracy exceeds published standard



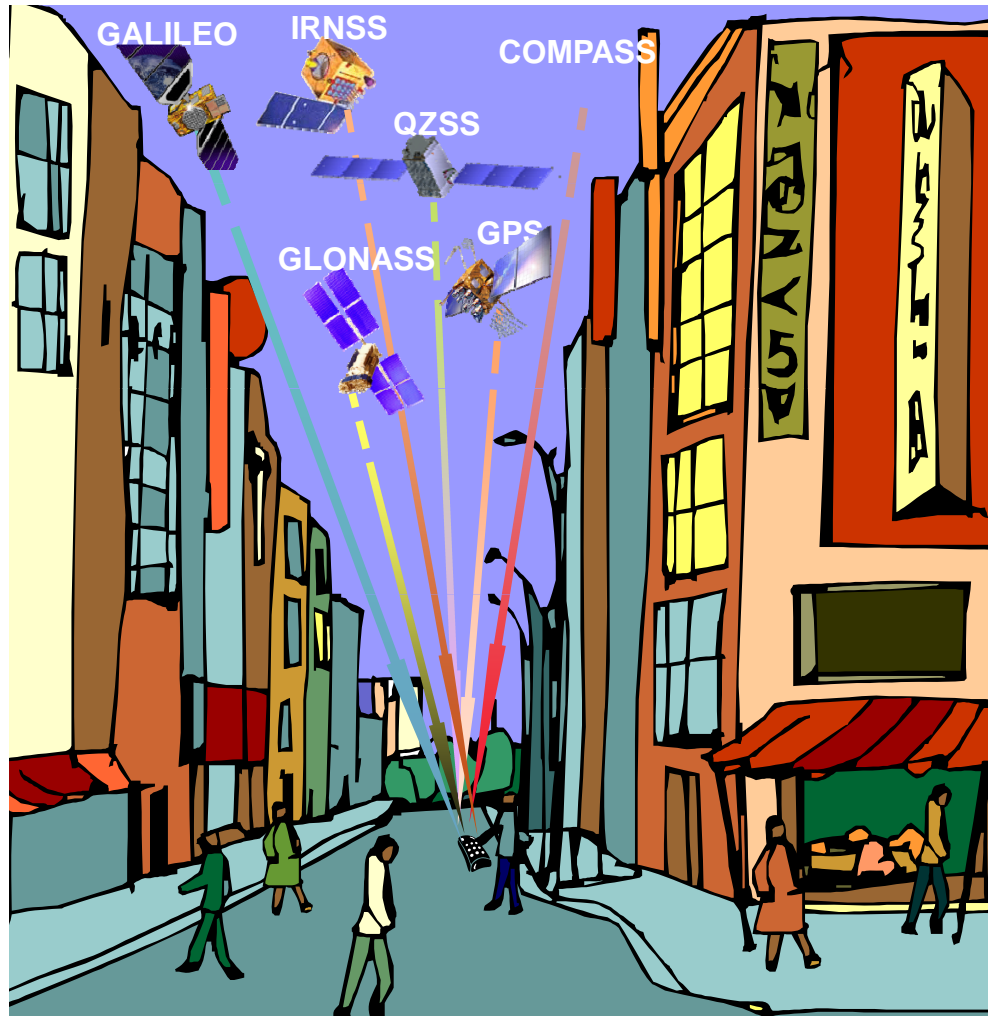
U.S. Objectives in Working with Other GNSS Service Providers

- 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 Bi-lateral and Multi-lateral Cooperation



The Goal of Civil GNSS Interoperability



- Ideal interoperability allows navigation with **one signal each** from four or more systems **with no additional receiver cost or complexity**

Interoperable = Better Together than Separate



International Cooperation Venues

- **Bilateral**
 - China
 - Japan
 - India
 - Australia
 - Russia
 - EU
- **Multilateral**
 - International Committee on GNSS (ICG)
 - Asia Pacific Economic Cooperation (APEC)





Bilateral Cooperation

- **U.S.-China** operator-to-operator coordination under ITU auspices
 - Bilateral Meetings in 2007, 2008, 2009, 2010
- **U.S.-Japan** Joint Statement on GPS Cooperation 1998
 - Annual Plenary Meetings
 - Quasi Zenith Satellite System (QZSS) designed to be fully compatible and highly interoperable with GPS
 - Bilateral agreements to set up QZSS monitoring stations in Hawaii and Guam – stations operating!
- **U.S.-India** Joint Statement on GNSS Coop. 2007
 - Technical Meetings focused on GPS-India Regional Navigation Satellite System (IRNSS) compatibility and interoperability held in 2008 and 2009



Bilateral Cooperation (continued)

- **U.S.-Australia** Joint Delegation Statement on Cooperation in the Civil Use of GPS in 2007
 - Next bilateral meeting in Washington, D.C., Oct. 26-27, 2010
 - USCG NAVCEN posts a daily PDOP report in response to concerns over planned GPS outages
- **U.S.-Russia** Joint Statement issued December 2004
 - Working Groups: compatibility/interoperability, search/rescue
- **U.S.-EU** GPS-Galileo Cooperation Agreement signed in June 2004
 - Four working groups set up under the Agreement
 - Improved new civil signal (MBOC) adopted in July 2007
 - First Plenary Meeting successfully held in October 2008



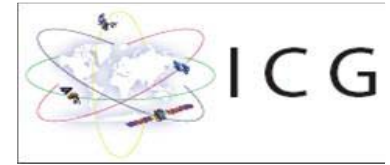
International Committee on Global Navigation Satellite Systems (ICG)

- 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 interested Member States of the United Nations
 - International organizations/associations





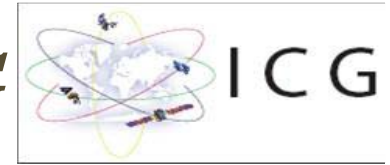
ICG Providers Forum



- Six space segment providers listed previously are members
- Purpose:
 - Focused discussions on **compatibility and interoperability**, encouraging development of complimentary systems
 - Exchange detailed information on systems & service provision plans
 - Exchange views on ICG work plan and activities
- Providers have agreed that all GNSS signals and services must be compatible and open signals and services should also be interoperable to the maximum extent possible
 - Working definition of **compatibility** includes respect for spectral separation between each system's authorized service signals and other systems' signals
 - **Interoperability** definition addresses signal, geodetic reference frame realization, and system time steerage considerations



U.S. Participation in the ICG



- U.S. strongly supports the ICG and Providers Forum
 - U.S. hosted ICG-3 in Pasadena, California, December 2008
 - U.S. contributes to UNOOSA as the ICG Secretariat to support ICG meetings and activities
 - U.S. actively participates in ICG working groups
- U.S. pleased with progress made at ICG-4 at St. Petersburg, Russia
 - Adoption of new **principle on transparency** for open services: *Every provider should publish documentation that describes signal and system information, policies of provision and minimum levels of performance for its open services*
- ICG-5 to be held in October 2010 in Turin, Italy



ICG Executive Secretariat

- UN OOSA is the ICG Executive Secretariat
- ICG provides:
 - Web-based information
 - Information brochures
 - Training/technical workshops for capacity building in developing countries
 - Promoting the use of GNSS technologies as tools for scientific applications



<http://www.icgsecretariat.org>



APEC GIT Cooperation

- The Asia-Pacific Economic Cooperation (APEC) forum facilitates economic growth, cooperation, trade and investment in the Asia-Pacific region for its 21 member economies
- The APEC GNSS Implementation Team (GIT) formerly almost exclusively focused on air traffic control and aviation issues
 - The GIT has broadened its focus to the application of GNSS in all transportation sectors
 - Additional participation of GNSS government and industry experts at APEC GIT-13 at Singapore in July 2009; project proposal made on surface transportation





APEC GIT Cooperation (cont.)

- **APEC GIT-14 meeting successfully held in Seattle, Washington state, U.S.A., June 21-24, 2010**
- Delegates from 13 Asian-Pacific economies participated
- Goal of discussions was to improve adoption of satellite-based positioning, navigation and timing (PNT) signals into all modes of transportation
- Keynote address given by U.S. Department of Transportation Deputy Assistant Secretary for Policy Joel Szabat
- Delegates adopted a strategy paper
- Agreement to consider four projects to help economies better utilize the advantages offered by space-based PNT
- **Next meeting tentatively scheduled for Brisbane, Australia in May 2011**



Summary

- **International cooperation** in the context of U.S. National Space-Based PNT Policy is a **top priority** for the U.S. Government
- The U.S. actively engages in **bilateral, and multilateral cooperation** on satellite navigation issues
- As new and restored global and regional space-based navigation systems emerge, **interoperability** continues to be the key to “**success for all**”



Contact Information

Ray E. Clore

Senior Advisor for GNSS
Office of Space and Advanced Technology
U.S. Department of State
OES/SAT, SA-23, Suite 410
Washington, D.C. 20520
202-663-2394 (office)
clorere@state.gov

<http://www.state.gov/g/oes/sat/>
<http://www.pnt.gov/international/>