



SPACE-BASED POSITIONING
NAVIGATION & TIMING

NATIONAL COORDINATION OFFICE

International Developments on GNSS

Disaster Management and Other Societal Benefits

USTTI Seminar 11-343

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Overview

- **U.S. Space-Based Positioning, Navigation and Timing (PNT) Policy**
- **International Cooperation Activities**
- **Applications and GNSS Augmentations for Disaster Management**



2004 U.S. Space-Based PNT Policy

(Excerpts focused on International Relations)



Goals:

- U.S. space-based PNT systems and services remain essential components of internationally accepted PNT services
- Promote U.S. technological leadership in applications involving space-based PNT services

To achieve this, the United States Government shall:

- Encourage foreign development of PNT services/systems based on GPS
 - Seek to ensure foreign space-based PNT systems are **interoperable** with civil GPS and augmentations
 - At a minimum, ensure **compatibility**

The Secretary of State shall:

- Promote the use of civil aspects of GPS and its augmentation services and standards with foreign governments and other international organizations
- Lead negotiations with foreign governments and international organizations regarding civil PNT matters
 - And, as appropriate in coordination with the SECDEF, military PNT matters



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
 - Primary focus on the common L1C and L5 signals

Pursue through Bilateral and Multilateral Cooperation



The Goal of RNSS Civil 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



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U.S. Air Force Receives Award

- **The International Astronautical Federation bestowed its 60th Anniversary Award to the U.S. GPS program at a ceremony held October 4, 2011 in Cape Town, South Africa.**





U.S. - Europe Cooperation



- U.S.-EU agreement signed in 2004 provides solid foundation for cooperation
- EU Parliament approved Agreement on Oct 16, 2011
- EU Council now must adopt a “decision of conclusion” and deposit its entry-into-force note – expected by end of calendar year.





U.S. - Europe Cooperation



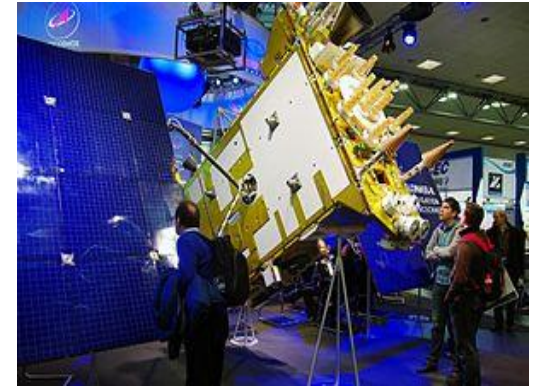
- **May 2011 Video Conference was the most recent “plenary type” meeting with the EU**
- **GPS-Galileo issues discussed at the June 2011 U.S.-EU Space Policy Dialogue in Brussels**
- **WG-A – ITU Operator-to- Operator Coordination meetings in September and planned in December 2011**
- **WG-B – October 2011 Video Conference discussed trade and commercial issues**



U.S. - Russian Federation Cooperation



- **U.S.- Russia Joint Statement issued in December 2004**
 - **Compatibility/Interoperability Working Group established**
 - **Search/rescue working group meeting held in 2011 – technical programs toward NextGen capabilities**
- **Russia provided detailed presentation on SDCM, assignment of GPS L1 C/A PRN codes and GLONASS CDMA plans**
- **Joint statement reaffirming intent to continue to cooperate on GNSS signed in September 2011**

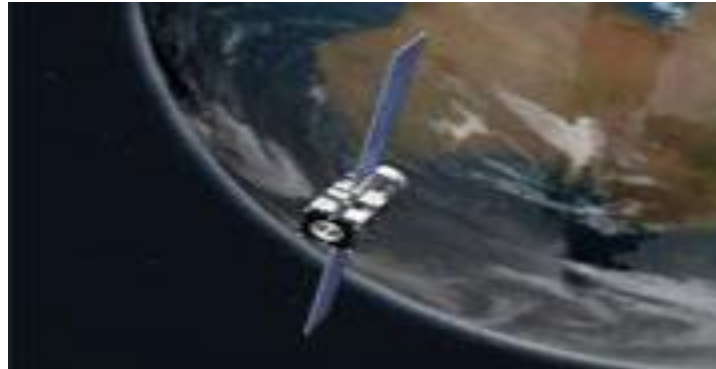




U.S. - Japan Cooperation



- **Japan's status as a world leader in GPS applications and user equipment makes it an important partner**
- **Regular policy consultations and technical meetings on GPS cooperation have been held since 1996 and led to the 1998 Clinton-Obuchi Joint Statement**



- **Both countries have benefited from the close relationship:**
 - **QZSS is designed to be compatible and interoperable with GPS**
 - **U.S. and Japan set up QZSS monitoring stations in Hawaii and Guam**



U.S. - India Cooperation



- **In July, 2011, the U.S. and India convened the third U.S.-India Joint Working Group on Civil Space Cooperation in Bangalore and agreed to resume work on interoperability between GPS and the Indian GPS Aided Geo Augmented Navigation System (GAGAN) and the proposed Indian Regional Navigational Satellite System (IRNSS)**
- **Policy and technical consultations on GPS cooperation underway since 2005, including a U.S.-India Joint Statement on GNSS Cooperation 2007, Bilateral meetings in Bangalore in 2007 and technical Meetings focused on GPS-IRNSS compatibility and interoperability held in 2008 and 2009**
 - **One aim is to ensure interoperability between GPS augmentation system WAAS and India's planned GAGAN augmentation system based on GPS**
 - **Another important topic is ionospheric distortion and solutions**



U.S. - Australia Cooperation



- **U.S.-Australia Joint Delegation Statement on Cooperation in the Civil Use of GPS signed in 2007**
 - The U.S. and Australia will work closely together to facilitate broad and effective use of GNSS augmentation systems that may be considered for use as civil regional augmentations to the GPS.
- **U.S. Coast Guard NAVCEN posts a daily Position Dilution of Precision (PDOP) report in response to Australia's concerns over planned GPS outages**
- **GNSS and applications included in expanded space cooperation, as reflected in 2010 Joint Announcement**



U.S. China Cooperation



- **Government officials from both nations participated in a bilateral U.S. National Academy of Engineering and Chinese Academy of Engineering GNSS workshop held in Shanghai in May 2011**
- **U.S. and China concluded International Telecommunications Union Operator-to-Operator coordination on signal compatibility between GPS and Compass in September 2010**
 - **Bilateral meetings held 2007, 2008, 2009 and 2010**
- **China will host the 7th Meeting of the International Committee on Global Navigation Satellite System in Beijing in 2012**



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





International Committee on Global Navigation Satellite Systems (ICG)



- ICG-2 held in September, 2007, in Bangalore, India
- Established **Providers Forum** to address common issues
- Began implementation of the ICG Work Plan within established working groups:
 - A. Interoperability and compatibility
 - B. Enhancement of performance of GNSS services
 - C. Information dissemination, education, outreach & coordination
 - D. Reference frames, Timing and Applications
- **Next ICG meeting in 2012, China**



ICG Providers Forum



- **Six space segment providers listed previously are members**
- **Purpose:**
 - Focused discussions on **compatibility and interoperability**, encouraging development of complimentary systems
 - Exchange of detailed information on systems and service provision plans
 - Exchange views on ICG work plan and activities
- **Consensus reached at the first meeting on general definitions for compatibility and interoperability**
 - Including spectral separation between each system's authorized service signals and other systems' signals

www.icgsecretariat.org



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Active Organizations

- **United Nations Platform for Space-based Information for Disaster Management and Emergency Preparedness**
 - un-spider.org
- **United Nations Office of Outer Space Affairs**
 - www.unoosa.org
- **International Association of Geodesy (IAG)**
- **International GPS Service (IGS)**
- **African Reference System (AFREF)**
- **Asia Pacific Economic Cooperation (APEC)**



Active International GNSS Monitoring and Assessment



- **Japan: Multi-GNSS Demonstration Campaign**
- **China: International GNSS Monitoring and Assessment System (iGMAS)**
- **International GNSS Service (IGS): Future plans for IGS network upgrades to include multi-GNSS receivers – in support of global monitoring and assessment**
- **Others (Stanford University, DLR, Information Analysis Center of Roscosmos, etc.): Achievements in GNSS signal monitoring and assessment**



UN-OOSA GNSS Action Team



- **Charter for the Action Team on GNSS:**

“Using space applications for human security, development and welfare, action should be taken ... to improve the efficiency and security of transport, search and rescue, geodesy, and other activities by promoting the enhancement of universal access to and compatibility of space-based navigation and positioning systems.”

- **In parallel, Regional Workshops on GNSS organized under UN auspices**

- AFREF concepts addressed, great venue for discussion and planning

- **Report available from UN-OOSA**

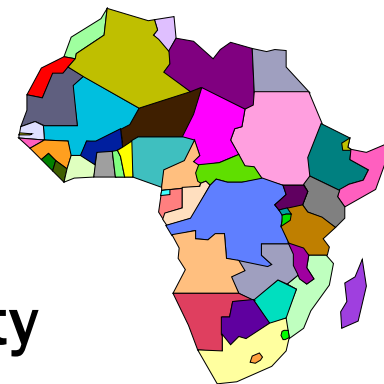
- <http://www.oosa.unvienna.org/SAP/gnss/index.html>



AFREF: Realizing a Continental Reference System for Africa



- **Communication and internet** are critical to success & sustainability of GNSS infrastructure
 - Access to information, global data, products, and technology advances
 - Increase knowledge base, capacity building
- Training, education, access to resources, retention of quality personnel and stability are issues
- Collective approach within African nations
 - Each adopting similar methodologies and technology
 - Permits progress where practical, implementing a network of GPS stations
 - Support and training envisioned by IGS/ITRF - seeking resources





AFREF - African Reference System



- Establish a **continental reference system** – with sustainable technology
- Provides the geodetic infrastructure for development throughout Africa
- Key to modernizing national reference systems through satellite and space geodesy: GPS, SLR, GLONASS, future GNSS (Galileo)
 - Three dimensions, horizontal and vertical, and velocities
- Includes gravity measurements as an essential component
- IGS/ITRF methodology at global and regional scales: EUREF (European), SIRGAS (South America) examples of approach and realization



International Terrestrial Reference Frame



- ITRF is one of the key activities of the International Earth Rotation and Reference System (IERS), an International Association of Geodesy (IAG) Service
- ITRF is defined by combination of technique observations, analysis and products
- Website available, please visit
 - <http://www.ensg.ign.fr/ITRF/>
- ITRF expresses strong support for AFREF
 - Notes the need to integrate existing permanent GPS stations into the International GNSS Service (IGS) Network, the backbone of AFREF



International Association of Geodesy



- **Three pillars of modern geodesy**
 - Geometric shape of the Earth
 - Earth's gravity field, and
 - Orientation of the Earth in space
- **AFREF initiative has strong support of the IAG Executive Committee**
- **IAG is a mechanism to engage and support AFREF**
 - **Commission 1, Reference Frames (Prof. Herman Drewes)**
 - Sub-commission 1.3, Regional Reference Frames (Zuheir Altamimi)
 - Sub-commission 1.3d Africa (Richard Wonnacott)
- **IAG new project the Global Geodetic Observing System (GGOS)**
 - Focuses on importance of long term geodetic measurements as integral component of Earth system science
 - <http://www.iag-aig.org/>



International GPS Service



- IGS was established in **1994**
- **Mission:**

“... committed to providing the highest quality data and products as the standard for global navigation satellite systems (GNSS) in support of Earth science research, multidisciplinary applications, and education. ... as well as to facilitate other applications benefiting society....”
- **200 organizations, 80+ countries, and a 350+ ground tracking network of both GPS and Galileo receivers**
- **Most precise GPS/GLONASS data and products available anywhere, orbits, clocks, station positions**
- **IGS contributions to ITRF enable densification, while further allowing users ready access to the ITRF**
- **See IGS Website: <http://igscb.jpl.nasa.gov>**



IGS and IAG Support AFREF

- The economics of GPS make the measurement technology readily available and globally accessible to **all** users
- The organization and outreach of the IGS enables users to take advantage of data, systems, and products developed cooperatively with the top international GPS/GNSS experts
- Standards are developed and adopted worldwide through the IGS activities
 - Contributing to robust, homogenous reference system
 - Implementing common processes
- IGS is a supporting global foundation for nearly all regional and national GPS and GLONASS geodetic networks, projects, and numerous applications worldwide
- Must ensure appropriate evolution, coordination, and interoperation of multiple GNSS systems for **societal and scientific benefit**
- IGS has long term commitment to AFREF
 - AFREF is for Africa, must be an African led project



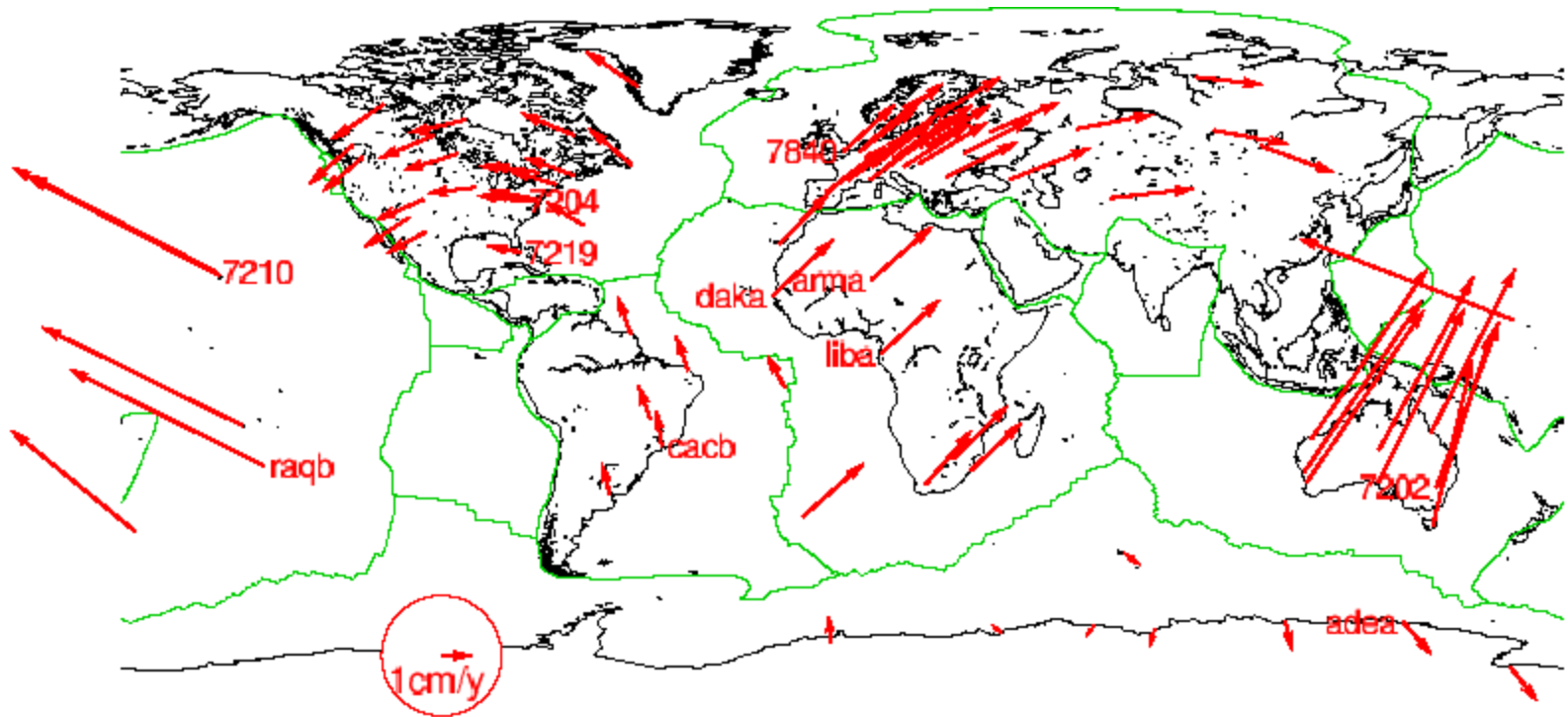
APEC GNSS Implementation Team



- **Established by the APEC Transportation Working Group in 2000**
- **Mission is to promote implementation of regional GNSS augmentation systems to enhance inter-modal transportation, by:**
 - **Expediting the implementation of GNSS in all economies**
 - **Advancing the development of an Asia Pacific approach to GNSS implementation to encourage cooperation that will enhance safety and enhance safety and efficiency**
 - **Seeking from all economies the expertise to ensure the success of GNSS implementation**
 - **Cooperating with non-APEC organizations as necessary to provide for seamless implementation**
 - **Russia hosted a Workshop on “GNSS Applications for Seamless Transport Supply Chain Connectivity in APEC” in October, 2011**



Motion of the Globe's Tectonic Plates





Summary



- **As new space-based GNSS are emerging globally, interoperability is the key to “success for all”**
- **Modernization of GPS will increase accuracy and reliability**
- **U.S. is actively engaged in bi-lateral, regional, and multi-lateral cooperation on space-based navigation issues**
- **International cooperation in the context of National Space-Based PNT Policy principles is a top priority for the U.S. Government**



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