U.S. International GNSS Activities Update

National Space-Based Positioning Navigation and Timing (PNT) Advisory Board: 19th Meeting

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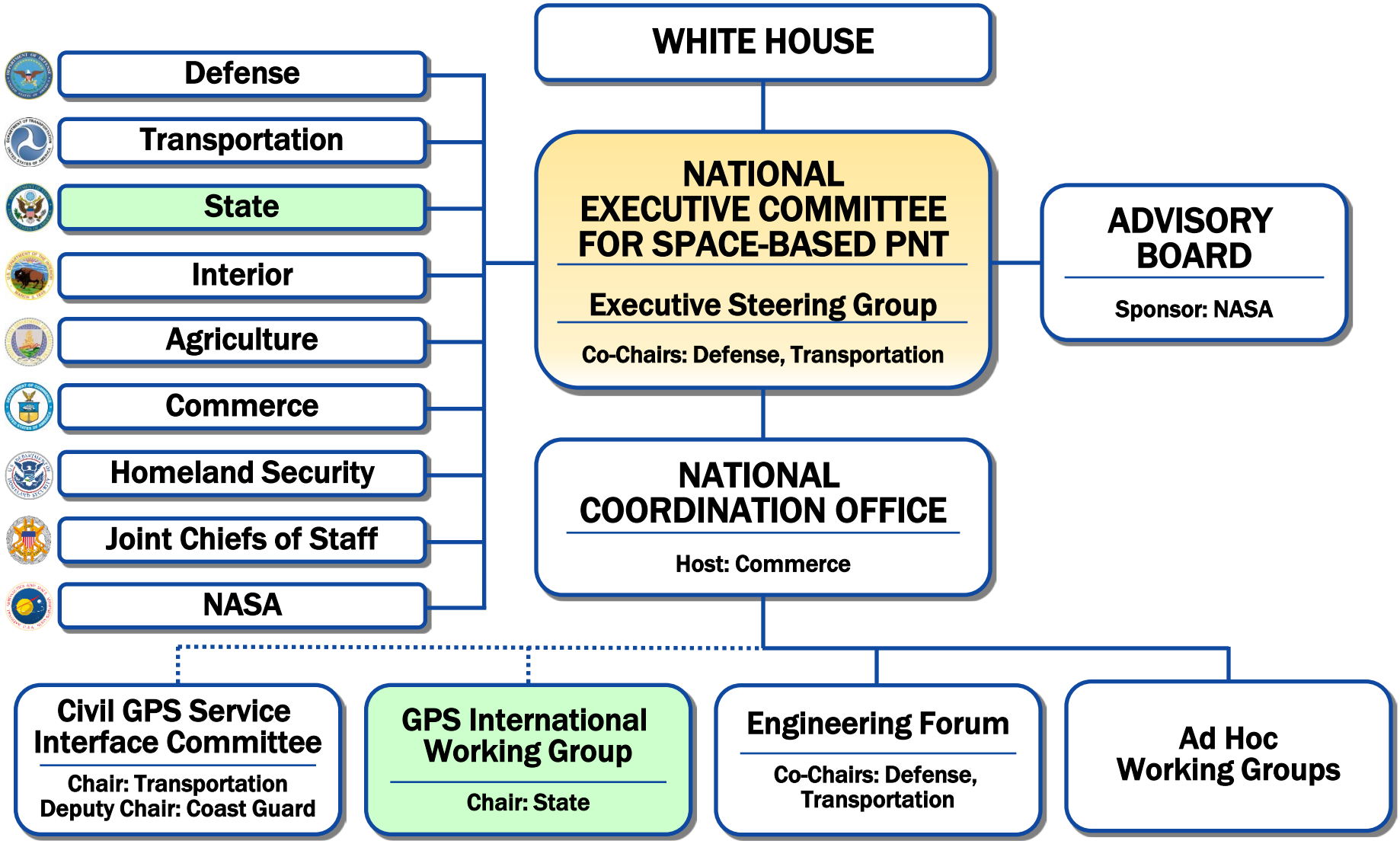
U.S. National Space Policy

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 augment and strengthen the resiliency of 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

National Space-Based PNT Organization



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

Bilateral GNSS Cooperation

- *Europe:* GPS-Galileo Cooperation Agreement signed 2004
  - Working Group on Next Generation GPS/Galileo Civil Services meets twice per year – most recent meeting in April 2017
  - EU request to waive FCC Part 25 rules discussed by Working Group on Trade & Civil Applications
  - PRS access negotiations are under way
- *China:* Most recent civil GNSS Plenary held in June 2015
  - Sub-group on compatibility and interoperability met September 2016 in Portland and June 15-16 in Los Angeles
- *Japan:* Space Dialogues held May 15-16 in Washington, D.C.
  - Technical Working Group and Plenary-level meetings to discuss GPS and QZSS compatibility and interoperability
- *India:* Civil Space Joint Working Group Meeting in Bangalore, September 2015
  - Discussed NAVIC and GPS civil and commercial use issues

U.S. Federal Communications Commission (FCC) Part 25 Rules

- FCC rules require licensing of receive-only Earth stations (receivers) operating with Non-U.S. Licensed Space Stations
  [47 CFR § 25,131(j)(1), 25.137]
  - Established in 1997 when opened market for non-U.S. licensed satellites under WTO Basic Telecom commitments
    [IB Docket No. 96-11, 12 FCC Rcd 24094 (1997) (*DISCO II Order*)]
  - Applies to non-Federal users only
- NTIA (on behalf of Executive Branch) has outlined criteria it will apply in recommending waiver of these rules (2011)
  - Process for considering waiver request from foreign government initiated through consultation with U.S. Department of State
  - FCC could also consider non-gov't requests through established licensing/waiver procedures

No FCC licensing or waiver of Part 25 rules to date for use of multi-GNSS receivers in the U.S.

FCC Part 25 Rule Evaluation Criteria & EU Galileo Waiver Request

- Considerations (criteria):
  1. Grant of a waiver is in the public interest
  2. System complies with United Nations Space Debris Mitigation guidelines
  3. Grant of a waiver is consistent with U.S. international trade and other treaty obligations
  4. Waiver request is limited to receive-only RNSS (which includes positioning) and standard time and frequency satellite services
  5. Operation of the RNSS signals offered by the foreign RNSS system has been found compatible with U.S. government systems operating in the specified RNSS frequency bands
- EU Waiver Request Submitted to State **in 2013**
  - NTIA submitted the EC's request to the FCC, on behalf of the Executive Branch, **in 2015** and recommended granting the request
  - FCC issued a public notice on **06 January 2017** inviting interested parties to comment on the waiver request
    - 13 Comments - closed 21 February
    - 4 Reply Comments - closed 23 March

Additional Bilateral Dialogues

- *Canada:* Civil GNSS meeting held in Ottawa – May 2015
  - U.S. participated in Federal GNSS Coordination Board Workshop on GNSS policy, vulnerabilities and mitigation, October 2016 in Ottawa
  - Follow-on bilateral dialogue under discussion
- *Republic of Korea:* 2nd bilateral Civil Space Dialogue held in Seoul – April 2016
  - Discussion about Korea's development of their SBAS
- *Australia:* Joint Delegation Statement on Cooperation in the Civil Use of GPS in 2007
  - Last formal space bilateral meeting held in Oct. 2010
- *Other bilateral civil space dialogues:* Vietnam; United Arab Emirates; Ukraine; [United Kingdom]

GNSS: A Global Navigation Satellite System of Systems for Civil Use

- Global Constellations
  - **GPS (24+3)**
  - GLONASS (24+)
  - GALILEO (24+3)
  - BDS/BEIDOU (27+3 IGSO + 5 GEO)

- Regional Constellations
  - QZSS (4+3)
  - IRNSS (7)
- Satellite-Based Augmentations
  - **WAAS (3)**
  - MSAS (2)
  - EGNOS (3)
  - GAGAN (2)
  - SDCM (3)

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

ICG International Committee on Global Navigation Satellite Systems

http://www.unoosa.org/oosa/en/ourwork/icg/icg.html

ICG Meetings

Past ICG Meetings

- ICG-1: UN Vienna, Austria – November 2006
- ICG-2: Bangalore, India – September 2007
- ICG-3: Pasadena, CA, USA – December 2008
- ICG-4: St Petersburg, Russia – September 2009
- ICG-5: Turin, Italy – October 2010
- ICG-6: Tokyo, Japan – September 2011
- ICG-7: Beijing, China – November 2012
- ICG-8: Dubai, UAE – November 2013
- ICG-9: Prague, Czech Republic – November 2014
- ICG-10: Boulder, CO, USA – November 2015
- ICG-11: Sochi, Russia – November 2016

Future Meetings

- ICG-12: Japan – December 2017
- ICG-13: China – 2018
- ICG-14: India – 2019
- ICG-15: UN Vienna, Austria - 2020

http://www.unoosa.org/oosa/en/ourwork/icg/icg.html

11th Meeting of the International Committee on GNSS (ICG-11)

- More than 100 participants
  - Representatives from 21 countries/organizations
  - Representation from all 6 GNSS Providers
- Agenda included:
  - Meeting of the Providers' Forum
  - System Provider Updates
  - Applications and Experts Session
  - Meeting of all four Working Groups

ICG International Committee on Global Navigation Satellite Systems

11th MEETING SOCHI ICG 2016

PNT Advisory Board Participation in ICG-11

- Dr. Parkinson Made a Plenary presentation on Advisory Board Activities
  - Focused on adjacent band interference issue
  - Renewed push for other GNSS Providers to consider similar advisory board arrangements of their own
- Dr. Rashad participation representing the Arab Institute of Navigation

Advisory Board Member participation at ICG Meetings is welcome and helps to underscore the importance of the advisory board concept!

ICG-11: Significant Accomplishments and Recommendations

- Interference Detection and Mitigation (IDM) & Spectrum Protection
  - Recommendation for Providers to promote the implementation of protection measures of GNSS operations around the world
  - Proposal for ICG Secretariat to deliver a communication to select members of the UN Committee on the Peaceful Uses of Outer Space (COPUOS) - Focused on National Efforts to protect RNSS Spectrum, with a request for member states to report their regulations and report on efforts to mitigate interference
  - 6th IDM workshop to take place in May 2017 in Croatia
- International Multi-GNSS monitoring (IGMA)
  - Recommendation for an ICG workshop to be held in May 2017 to discuss the multi-GNSS monitoring trial project established in 2016 between the ICG and IGS, and discuss the need for GNSS signal quality monitoring
- Interoperability – Timing
  - Recommendation for ICG expert level workshop to be held in 2017 to further discuss GNSS system time offsets among the systems

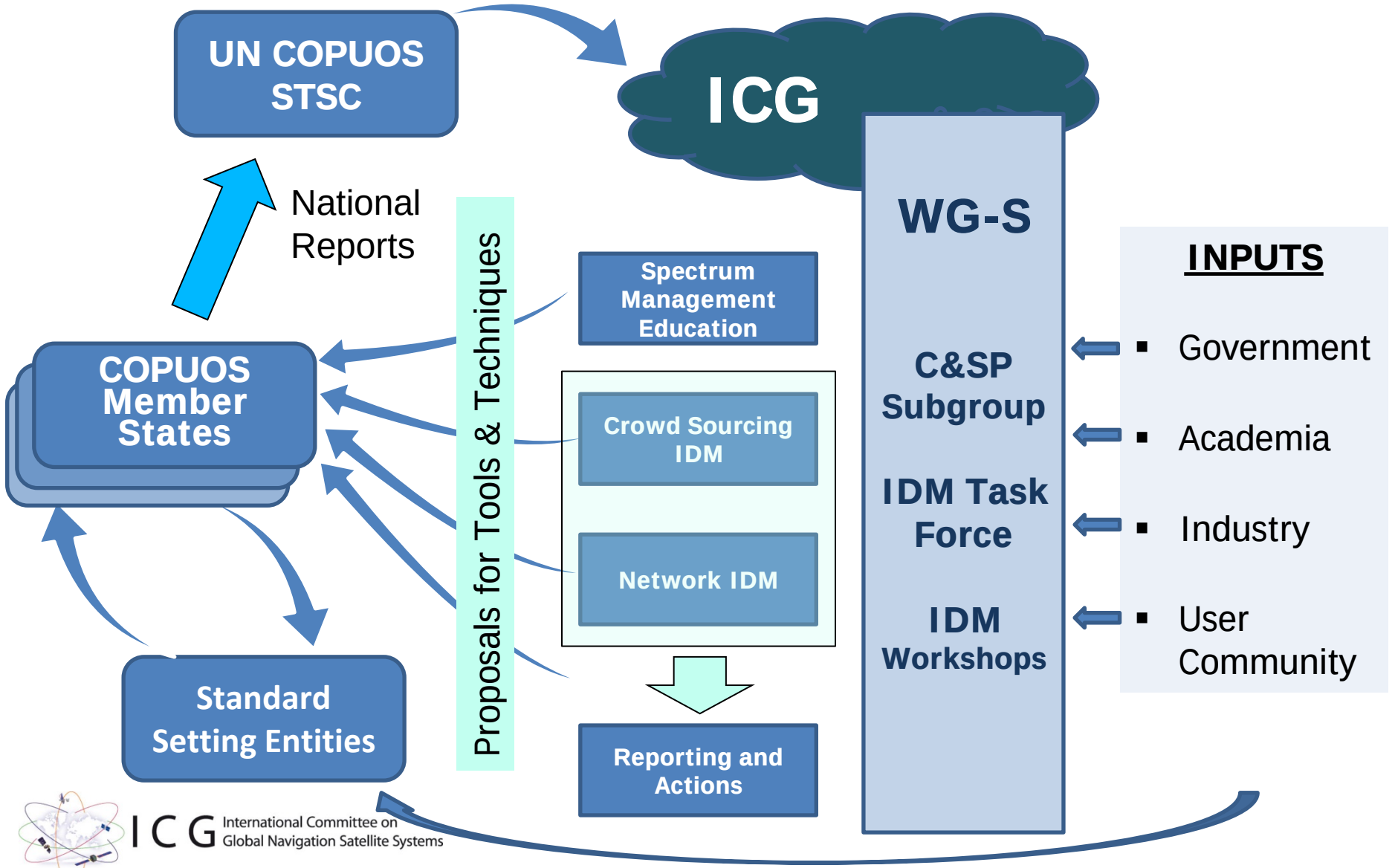
ICG-11: Significant Accomplishments and Recommendations

- Interference Detection and Mitigation (IDM) & Spectrum Protection
  - Promotion of protection measures for GNSS operations around the world: **On-going with great interest in the U.S. ABC Study results**
  - National Reporting on Efforts to protect RNSS Spectrum and mitigate interference – **Conference Paper published at the 54th Session of the UN COPUOS Scientific and Technical Subcommittee – invites member states to report under the subcommittees GNSS agenda item**
  - 6th IDM workshop **was held May 9, 2017 in Baska, Krk Island, Croatia**
- International Multi-GNSS monitoring (IGMA): **Workshop was held in Shanghai, China, May 22, 2017**
- Interoperability – Timing: **Expert level timing workshop taking place on July 7, 2017 in conjunction with the annual IGS Workshop in Paris**

GNSS Interference and Spectrum Protection: A Multilateral Effort

- ICG Core Area of Focus since its inception
  - *"Develop a strategy for support by the International Committee of mechanisms to detect and mitigate sources of electromagnetic interference, taking existing regulatory mechanisms into consideration"*
  - Primarily discussed within the Working Group on Systems, Signals and Services (WG-S)
  - Subgroup on Compatibility & Spectrum Protection - 2010
  - Interference Detection and Mitigation (IDM) Task Force - 2013
- Recent and Near Future Activities
  - Two Seminars on Spectrum Protection (2015 and 2016) **– Outreach and Education**
  - Reporting by COPUOS Member States on Spectrum Protection and IDM **– National-level Action and Accountability**
  - IDM Workshops **– Discussion on tools and techniques**

DRAFT - ICG Spectrum Stewardship Life-Cycle



Additional ICG-11 Accomplishments and Recommendations

- Signal Patents
  - Recommendation for nations to ensure that open signal structure patents are discouraged and not used for the collection of royalties
- Space Service Volume (SSV)
  - SSV Booklet to be released in early 2017 – results of completed simulations used to develop definitions and assumptions for an interoperable SSV
  - Outreach activities scheduled in 2017 to highlight the importance of the ICG work taking place and the benefits of an interoperable SSV
- Search and Rescue (SAR)
  - Presentations from 3 GNSS providers on SAR implementation status – recognition by providers of the importance of having interoperable SAR services
- Space Weather
  - Discussion about ionospheric models – will be discussed further at future ICG meetings

Open Service Information

- From the current work plan of the ICG Working Group on Systems, Signals, and Services:
  - Consistent with the principle of transparency in the provision of open services, each individual Provider will strive to publish and disseminate all signal and system information necessary to allow manufacturers to design and develop GNSS receivers
  - The Interoperability and Service Standards Sub-Group will develop a template:
    - To promote common terminology and definitions in individual GNSS Open Service Signal Specifications
    - That each individual GNSS provider may consider using in their publication of signal and system information, the policies of provision, and the minimum levels of performance offered for open services

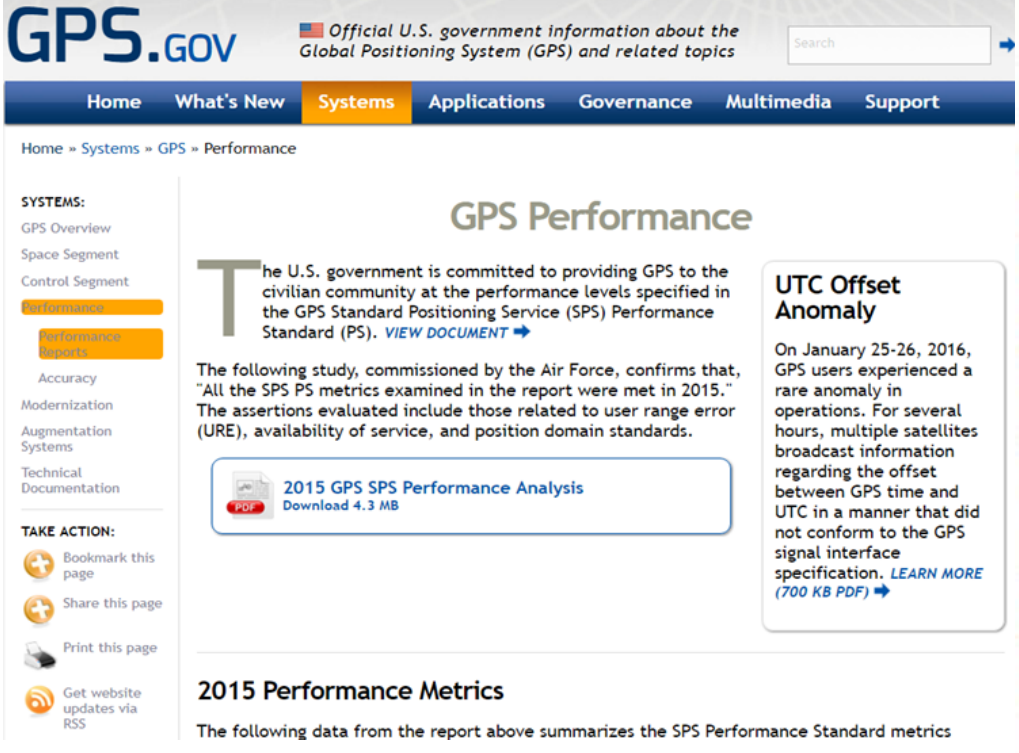
Status of GNSS ICDs and Open Service Performance Standards

	GPS	GLONASS	BDS	Galileo	IRNSS	QZSS
Interface Control Documents/ Specifications	✓	✓	✓	✓	✓	✓
	IS GPS 200-H, 705D, 800D	ICD 5.1 for L1 & L5	ICD 2.0	ICD 1.2	ICD 1.0	ICD 1.6
Open Service Performance Standards	✓	Draft under review	✓	✓	X	X
	SPS PS 4th edition (L1-only)	Provided to WG-S	OS PS 1.0	OS SDD v1.0		
Web Access	GPS.gov		en.beidou.gov.cn/	https://www.gsc-europa.eu/system/files/galileo_documents/Galileo-OS-SDD.pdf	irnss.isro.gov.in/	qz-vision.jaxa.jp/USE/is-qzss/index_e.html

Each System Provider has identified a POC for the ICG Subgroup on Compatibility and Performance Standards

GPS Performance Report Card

- 2015 report now available on gps.gov
  http://www.gps.gov/systems/gps/performance/
- This report measures GPS performance against GPS SPS Performance Standard



2015 Performance Metrics

The following data from the report above summarizes the SPS Performance Standard metrics examined for 2015. Document references are linked to corresponding pages in the SPS Performance Standard (1.7 MB PDF). ✓ means "Met."

DOCUMENT SECTION	PERFORMANCE METRIC	2015 STATUS
3.4.1 SIS URE Accuracy	≤ 7.8 m 95% Global average URE during normal operations over all AODs	✓
	≤ 6.0 m 95% Global average URE during normal operations at zero AOD	✓
	≤ 12.8 m 95% Global average URE during normal operations at any AOD	✓
	≤ 30 m 99.94% Global average URE during normal operations	✓
	≤ 30 m 99.79% Worst case single point average URE during normal operations	✓
	≤ 388 m 95% Global average URE after 14 days without upload	not eval.
3.4.2 SIS URRE Accuracy	≤ 0.006 m/s 95% Global average at any AOD	not eval.
3.4.3 SIS URAE Accuracy	≤ 0.002 m/s^2 95% Global average at any AOD	not eval.
3.5.1 SIS Instantaneous URE Integrity	≤ 1×10^{-5} Probability over any hour of exceeding the NTE tolerance without a timely alert	✓
3.6.1 SIS Continuity - Unscheduled Failure Interruptions	≥ 0.9998 Probability over any hour of not losing the SPS SIS availability from the slot due to unscheduled interruption	✓
3.7.1 SIS Per-Slot Availability	≥ 0.957 Probability that (a.) a slot in the baseline 24-slot will be occupied by a satellite broadcasting a healthy SPS SIS, or (b.) a slot in the expanded conguration will be occupied by a pair of satellites each broadcasting a healthy SIS	✓
3.7.2 SIS Constellation Availability	≥ 0:98 Probability that at least 21 slots out of the 24 slots will be occupied by a satellite (or pair of satellites for expanded slots) broadcasting a healthy SIS	✓
	≥ 0.99999 Probability that at least 20 slots out of the 24 slots will be occupied by a satellite (or pair of satellites for expanded slots) broadcasting a healthy SIS	✓
3.7.3 Operational Satellite Counts	≥ 0.95 Probability that the constellation will have at least 24 operational satellites regardless of whether those operational satellites are located in slots or not	✓
3.8.1 PDOP Availability	≥ 98% Global PDOP of 6 or less	✓
	≥ 88% Worst site PDOP of 6 or less	✓
3.8.2 Position Service Availability	≥ 99% Horizontal, average location	✓
	≥ 99% Vertical, average location	
	≥ 90% Horizontal, worst-case location	

KYOTO, JAPAN
DECEMBER 2017

12th Meeting of the International Committee on Global Navigation Satellite Systems

HOME

Welcome to ICG-12

ICG-12 will be held in Kyoto, Japan from 2nd to 7th December, 2017.

Japan will host the twelfth Meeting of the International Committee on Global Navigation Satellite Systems (ICG-12) 2-7 December, 2017.
The meeting will be co-organized by the Cabinet Office, Government Of Japan and the Ministry of Foreign Affairs of Japan.
The details of the meeting including venue, program, accommodation, etc. will be posted on this website in due course.

Japan. Endless Discovery.

Progress at ICG in GNSS Civil Service Provision

- ✓ Providers Forum
  - ✓ Providers Forum System Report
    - ✓ Principles of Compatibility, Interoperability, and Transparency
      - ➢ Templates for Performance Standards (and ICDs)
        - ➢ Postulated Performance Standards for future services
          - ➢ ***Service Assurances or Commitments***
            - ➢ Monitoring of service performance
              - ➢ Interference monitoring

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Summary

- U.S. policy encourages the worldwide use of civil GPS services and cooperation with other GNSS providers
  - **Compatibility, interoperability, and transparency in civil service provision** are priorities
  - Pursued through bilateral and multilateral dialogues
- The ICG, with strong U.S. participation, continues to pursue a **Global Navigation Satellite System-of-Systems** to provide civil GNSS services that benefit users worldwide
  - Priorities for the U.S. at ICG-12 will include continued focus on Civil Service Protection, Definition, and Information Dissemination

THANK YOU !

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