GPS Program Update

ICG-13

Xi'an, China

4-9 November 2018

Ken Alexander, National PNT Engineering Forum Co-chair

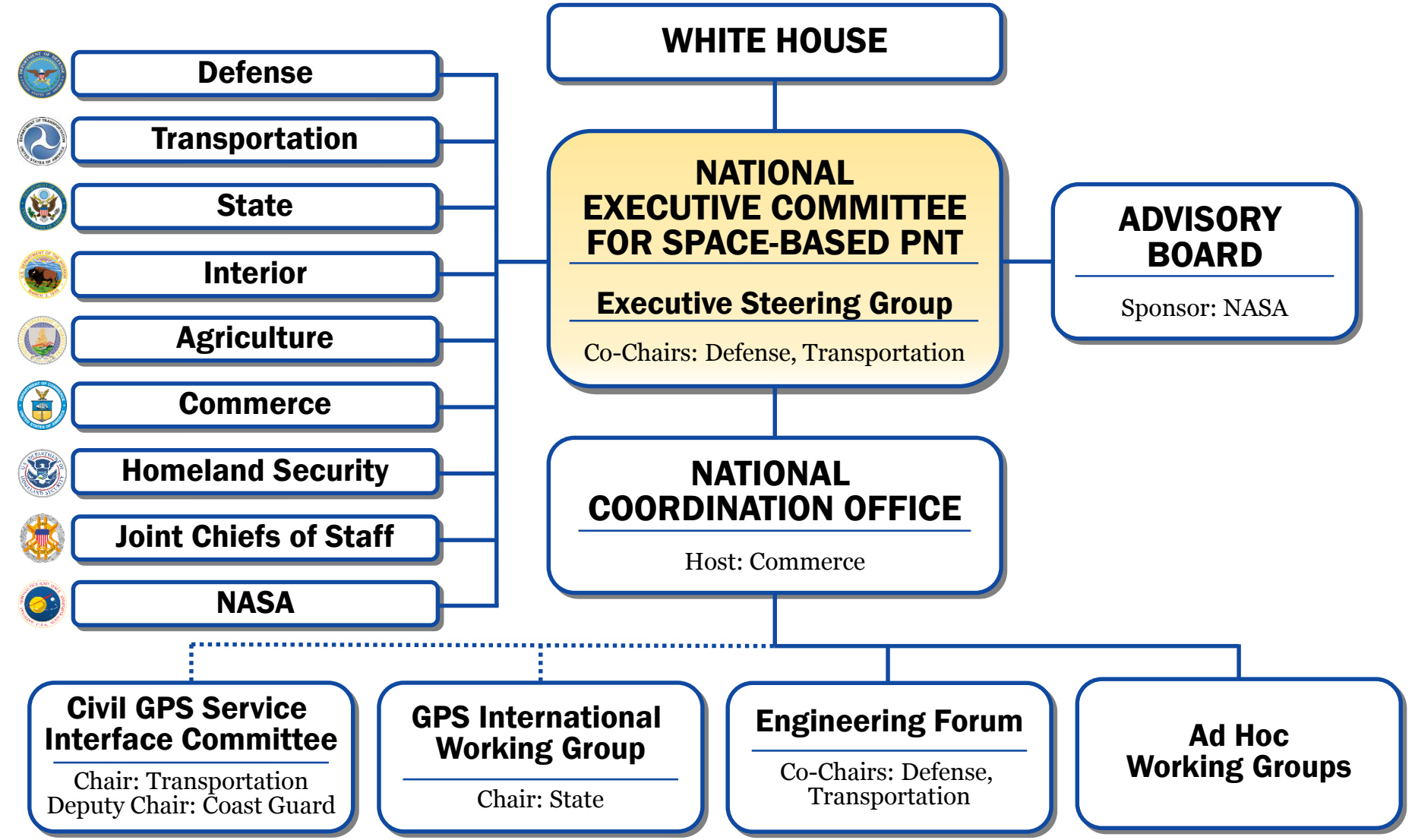
Presented on behalf of
Harold W. Martin III, Director National Coordination Office
United States of America

U.S. National Space Policy

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

- Provide continuous worldwide access to GPS for peaceful uses, free of direct user charges
- Engage with foreign GNSS providers on compatibility, interoperability, transparency, and market access
- Operate and maintain GPS constellation to satisfy civil and national security needs
  - Foreign PNT may be used to strengthen resiliency
- Invest in domestic capabilities and support international activities to detect, mitigate, and increase resiliency to harmful interference

National Space-Based PNT Organization



Executive Committee Strategic Focus Areas

- GPS Sustainment and Modernization
- International Cooperation
- Spectrum Management
- Critical Infrastructure
- PNT Resilience
- Outreach

National Space-Based PNT Advisory Board

- U.S. PNT Advisory Board (PNTAB) is a group of recognized experts in PNT and GPS that provides independent technical & policy advice to the PNT EXCOM
  - NASA has sponsored the board since 2007
  - Consists of up to 25 members nominated by PNT EXCOM Federal agencies, approved by the PNT EXCOM co-chairs, and appointed by the NASA Administrator for a two-year term renewable at the discretion of the Administrator
  - Operates in accordance with the provisions of Federal Advisory Committee Act.
  - Meetings are public and minutes posted within 90 days.

    https://www.gps.gov/governance/advisory/
- Recent Meetings:
  - 21st Meeting held May 16-17 in Baltimore, MD, U.S.
  - Intersession Meeting held Aug. 6. by phone & WebEx
- Latest Recommendations/Deliverables:
  - Aug. 10: RNSS Spectrum Recommendation:

    https://www.gps.gov/governance/advisory/recommendations/2018-08-letter-to-excom.pdf
  - Oct. 1: Topics Paper for Administration Briefings:

    https://www.gps.gov/governance/advisory/recommendations/2018-09-topic-papers.pdf
- Upcoming: 22nd Meeting on Dec. 4-5, 2018, in Redondo Beach, CA, U.S.

Current Membership

Special Government Employees: Experts from industry or academia who temporarily receive federal employee status during meetings	
John Stenbit (Chair), former Assistant Secretary of Defense	Captain Joseph D. Burns, Sensurion Aerospace
Bradford Parkinson (1st Vice Chair), Stanford University	Martin C. Faga, private consultant, retired MITRE
James E. Geringer (2nd Vice Chair), ESRI, former Governor of Wyoming	Ronald R. Hatch, private consultant, retired John Deere
Admiral Thad Allen, Booz Allen Hamilton	Larry James, Jet Propulsion Laboratory
Penina Axelrad, University of Colorado Boulder	Peter Marquez, Partner at Andart Global
John Betz, MITRE	Terence J. McGurn, private consultant, retired CIA
Dean Brenner, Qualcomm	Timothy A. Murphy, The Boeing Company
Scott Burgett, Garmin International	T. Russell Shields, Ygomi
Captain Joseph D. Burns, Sensurion Aerospace	
Representatives: Individuals designated to speak on behalf of particular interest groups, including foreign representatives	
Gerhard Beutler, International Association of Geodesy (Switzerland)	Dana Goward, Resilient Navigation & Timing Foundation (U.S.)
Sergio Camacho-Lara, UN Regional Education Center of Science & Space Technology (Mexico)	Matt Higgins, International GNSS Society (Australia)
Ann Ciganer, GPS Innovation Alliance (U.S.)	Refaat M. Rashad, Arab Institute of Navigation (Egypt)
Arve Dimmen, Norwegian Coastal Administration (Norway)	

GPS Overview

Civil Cooperation

- 3+ Billion civil & commercial users worldwide
- Search and Rescue
- Civil Signals
  - L1 C/A (Original Signal)
  - L2C (2nd Civil Signal)
  - L5 (Aviation Safety of Life)
  - L1C (International)

Department of Defense

- Services (Army, Navy, AF, USMC)
- Agencies (NGA & DISA)
- US Naval Observatory
- PNT EXCOMS
- GPS Partnership Council

Spectrum

- World Radio Conference
- International Telecommunication Union
- Bilateral Agreements
- Adjacent Band Interference

34 Satellites / 31 Set Healthy
Baseline Constellation: 24 Satellites

Satellite Block	Quantity	Average Age	Oldest
GPS IIA	1	25.0	25.0
GPS IIR	11	16.7	21.2
GPS IIR-M	7	11.2	13.0
GPS IIF	12	4.7	8.4
Constellation	31	11.1	25.0

AS OF 8 OCT 18

Maintenance/Security

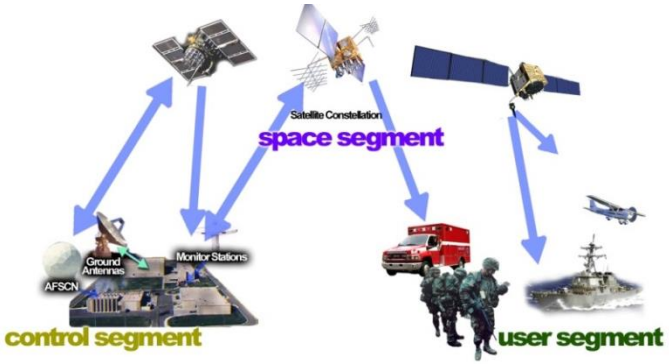
- All Level I and Level II
  - Worldwide Infrastructure
  - NATO Repair Facility
- Develop & Publish ICDs Annually
  - Public ICWG: Worldwide Involvement
  - Materials Available at: gps.gov/technical/icwg
- Update GPS.gov webpage
- Distribute PRNs for the World
  - 120 for US and 90 for GNSS

Department of Transportation

- Federal Aviation Administration

Department of Homeland Security

- U.S. Coast Guard



International Cooperation

- 57 Authorized Allied Users
  - 25+ Years of Cooperation
- GNSS
  - Europe - Galileo
  - China - Beidou
  - Russia - GLONASS
  - Japan - QZSS
  - India – NAVIC
  - Korea - KRNSS

GPS SIS Performance Scoreboard

GPS SIGNAL IN SPACE (SIS) PERFORMANCE (CM)

	BEST WEEK *		BEST DAY *		WORST DAY *	
	ENDING	SIS	ENDING	SIS	ENDING	SIS
ROLLING YEAR	20 SEP 17	48.9	14 MAR 18	37.5	1 DEC 17	77.7
BEST WEEK EVER	29 NOV 16	44.1				

Signal in Space RMS values across all healthy satellites

*ROLLING YEAR

7

GPS III

- GPS III is newest block of GPS satellites
  - 4 civil signals: L1 C/A, L1C, L2C, L5
  - 1st satellite to broadcast common L1C signal
- General characteristics
  - Orbit: Six orbit planes at 55 degree inclination
  - Altitude: 10,898 nautical miles
  - Design life: 15 years, 12 years mean mission duration
  - Launch weight: 8,115 lb.
  - On-Orbit weight: 4,764 lb.
  - Size: 97 in wide, 70 in deep, 134 in high

First GPS satellites to broadcast common L1C signal

GPS III SV01 Road To Launch

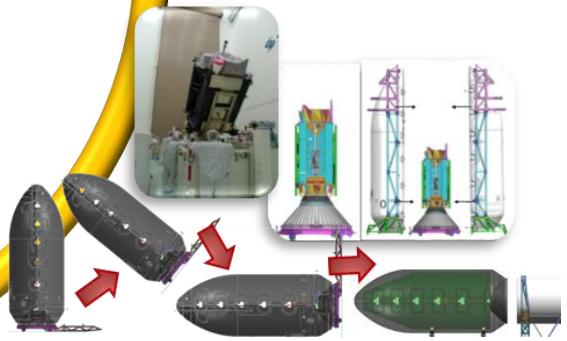
GPS Directorate

Mission Rehearsals

Readiness Tests

Launch 2018

Transport



Launch Integration

The Gold Standard

GPS III SV01 enterprise road to launch – A series of firsts!

Next Generation Operational Control System (OCX)

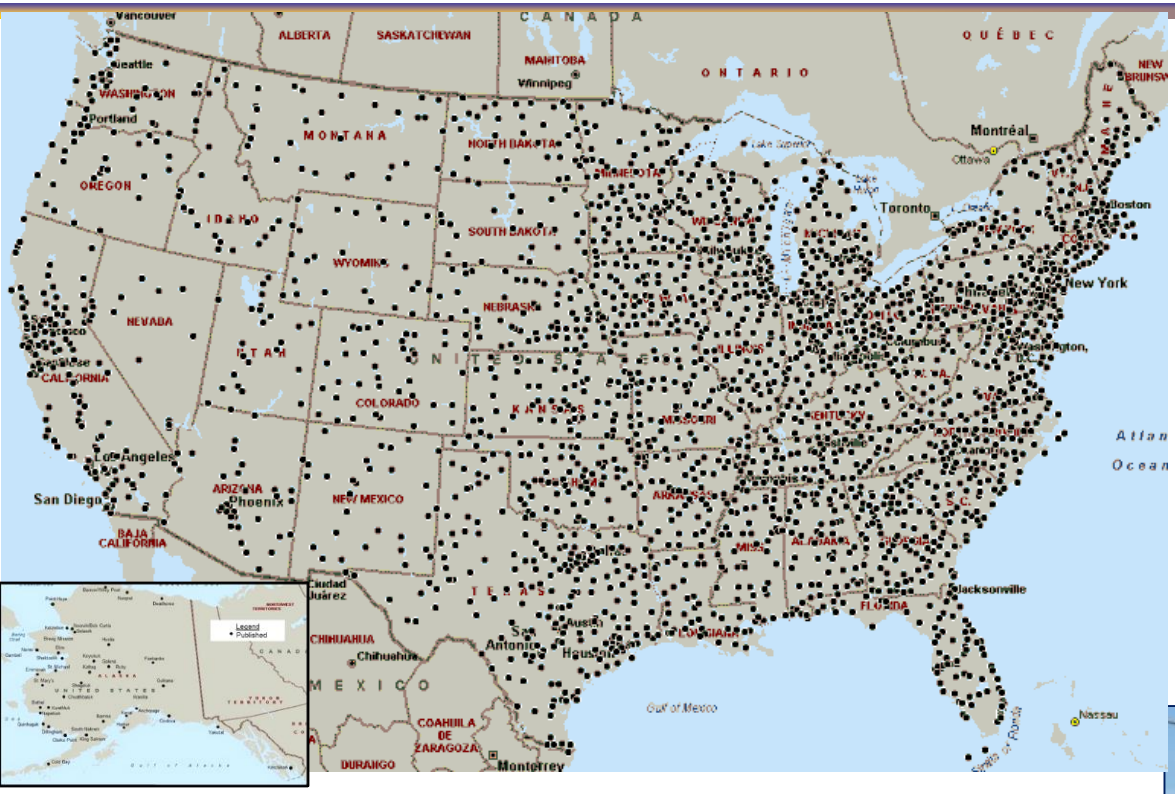
- Next-generation C2 and cyber-defense for GPS
  - Worldwide, 24 hr/day, all weather, Positioning, Navigation, and Timing (PNT) source for military and civilian users
  - Modern civil signals and monitoring
- Incremental Development
  - OCX Block 0: Launch and Checkout System (LCS) for GPS III
  - OCX Blocks 1 and 2:
    - Operate and manage modernized GPS constellation,
    - Add modern features and signals, and
    - Provide Civil Signal Performance Monitoring
- Current Status
  - LCS is ready to support GPS III SV01 launch in Dec 2018
  - Block 1 development continues to meet milestones
    - Ready to Transition to Operations: Apr 2022

OCX program continues to execute and meet schedule

GPS Augmentations

- Wide Area Augmentation System (WAAS)
- Continuously Operating Reference Stations (CORS)
- Global Differential GPS (GDGPS)
- International GNSS Service (IGS)
- Nationwide Differential GPS System (NDGPS)
- Commercial Precision Augmentation Systems

WAAS Procedures and Users



Approach Procedures

- 4,639 WAAS LP & LPV Procedures (Sept 2018)
- 3,956 Localizer Precision Vertical (LPV) procedures
  - Serving over 1,900 airports
- 1,549 ILS procedures

Users

- Over 118,000 U.S. WAAS equipped aircraft
- SBAS is an enabling technology for FAA's NextGen
  - Automatic Dependent Surveillance Broadcast (ADS-B)
  - Performance Based Navigation (PBN)

Bilateral Cooperation

China: GNSS Plenary meeting held May 2018 in Harbin, China

- 3 Working Groups meet as needed
- Public Joint Statement on Cooperation signed November 2017

Europe: GPS-Galileo Cooperation Agreement signed 2004

- Working Group on Next Generation GPS/Galileo Civil Services meets twice per year – Next meeting November 2018
- EU request to waive FCC Part 25 rules discussed by Working Group on Trade and Civil Applications

Japan: Comprehensive Dialogue held in Tokyo, July 2018 and Civil Space Dialogue held in Washington, May 2017

- Technical Working Group (TWG) discussed GPS and QZSS compatibility and interoperability

India: U.S.-India Civil Space Joint Working Group (CSJWG) met October 2017 in Washington and included GNSS discussions

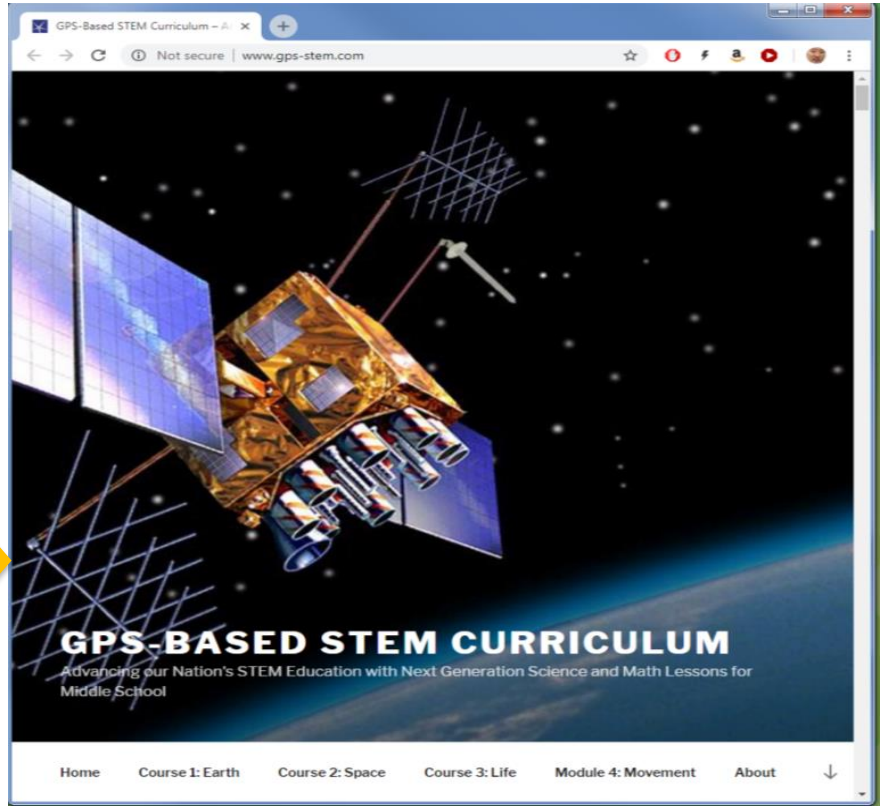
Science, Technology, Engineering and Math (STEM) Education for Global Leadership

Courses	Lessons (3 Per Course)		
Earth	Are we there Yet? Mapping it out with Longitude & Latitude	Do you read me? Radio, Magnets & Information Trnsfer	I'm on my way! Navigation & Global Positioning System
Space	Launching Explorations Satellites & Orbits	Living Weightless: International Space Station	Orbital Rendezvous: Calculating Resupply for ISS
Life	Baby is it Cold Outside? Weather Forecasting	Saving Mother Nature: Environmental Conservation	Feed the World: Agriculture & Precision Farming
Movement	Up Up & Away! Aviation Moves Us	Networks of Power: Energy & Information	Global Supply Chain: Planes, Trains & Automobiles

12 Downloadable and Free Lesson Plans!

Courses/Lesson Plans and Other Educational Materials

GPS.gov/students



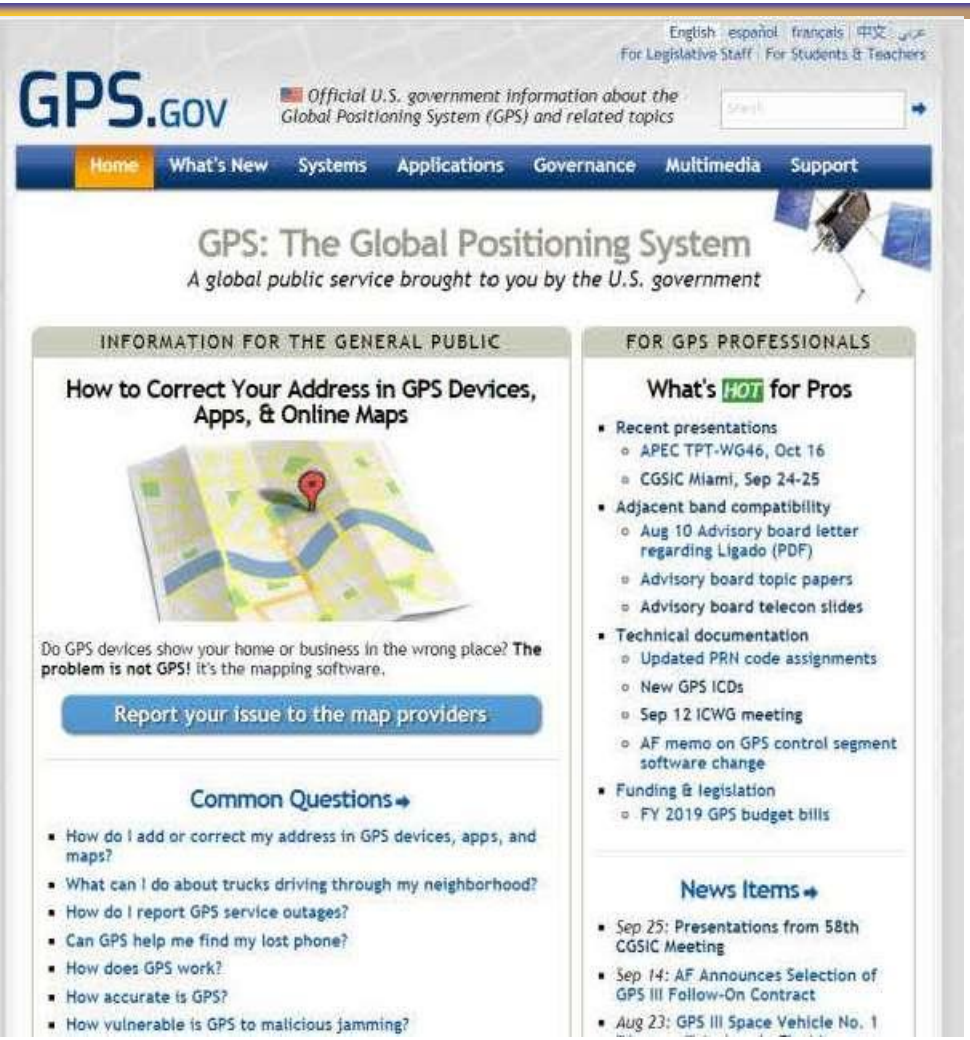
GPS-STEM.com
(temporary URL)

U.S. Policy and GPS Summary

- U.S. supports free access to civilian GNSS signals and all necessary public domain documentation to enable open competition and market growth
- GPS is a critical component of global infrastructure and is compatible with other GNSS systems and interoperable at user level
  - Acquired and operated by U.S. Air Force on behalf of USG
  - Guided at an economy level as multi-use asset
  - Recognize need for robust multi-sensor PNT
- U.S. continues to enhance GPS resiliency by:
  - Addressing near-term needs, Identifying opportunities for resiliency improvements, and Maturing technical capabilities for future use
- Exploring and expanding multi-GNSS potential
- Modernization milestones: New GPS III Follow-on contract and Dec 2018 first GPS III launch

GPS: Continuous improvement, predictable, and dependable positioning performance

Thank You



Stay up to date: www.gps.gov

Providing information pertinent to GPS:

- Including Systems, Applications, Governance, and Multimedia
- You can also find information related to: Frequency Asked Questions, Technical Documentation, Service Reports, International Cooperation, etc.
- Available in: English, Spanish, French, Chinese and Arabic
- Archival information back to 2009

Contact Information:

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