Global Positioning Systems Directorate

GPS Status & Modernization Progress: Service, Satellites, Control Segment, and Military GPS User Equipment

ICG-10, Boulder CO

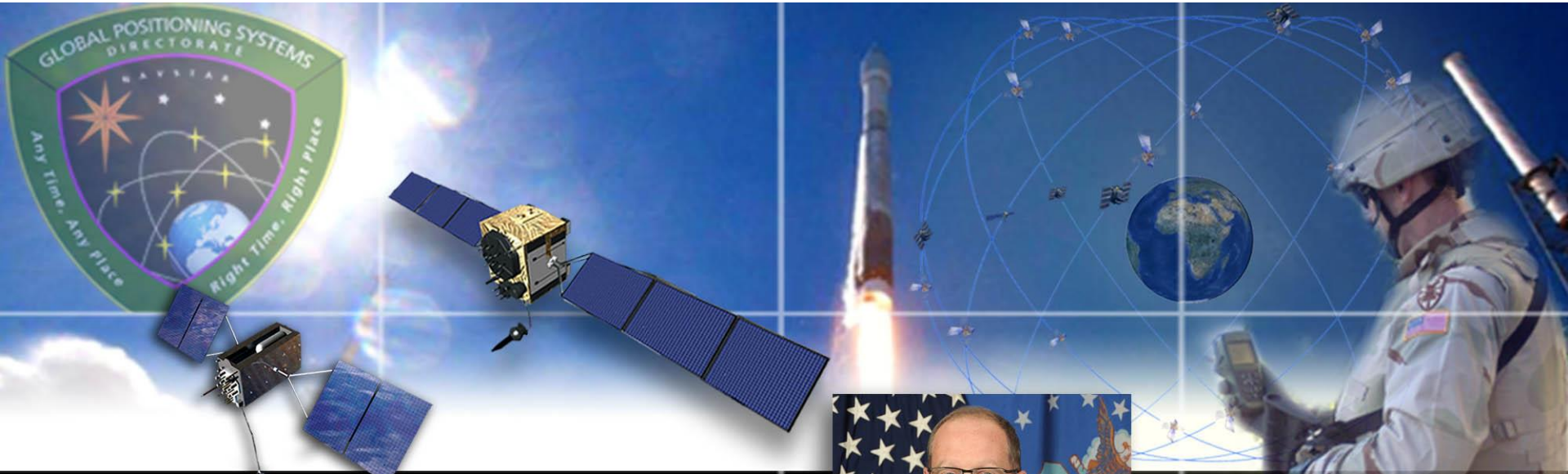
2 Nov 15

Col Shawn M. Brennan

GPS Transition Director

Global Positioning Systems Directorate

Global Positioning Systems Directorate



"We are... the Green Monsters!"

Col Steve Whitney
Director

Mission:

Professionals aquiring, delivering and sustaining reliable GPS capabilities to America's warfighters, our allies, and civil users

GPS Overview

Civil Cooperation

- 1+ 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)

39 Satellites / 31 Set Healthy
Baseline Constellation: 24 Satellites

Satellite Block	Quantity	Average Age	Oldest
GPS IIA	2	23.4	24.8
GPS IIR	12	13.7	18.2
GPS IIR-M	7	8.2	10.0
GPS IIF	10	2.1	5.3
Constellation	31	9.3	24.8

AS OF 1 OCT 15

Department of Defense

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

Maintenance/Security

- All Level I and Level II
  - Worldwide Infrastructure
  - NATO Repair Facility
- Develop & Publish ICDs Semi-Annually
  - ICWG: Worldwide Involvement
- Update GPS.gov Webpage
- Load Operational Software on over 970,000 SAASM Receivers
- Distribute PRNs for the World
  - 120 for US and 90 for GNSS

Spectrum

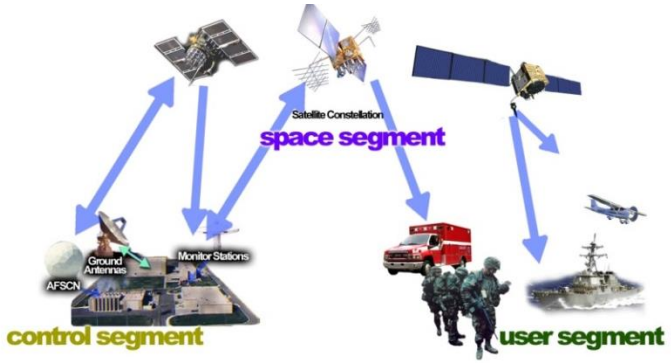
- World Radio Conference
- International Telecommunication Union
- Bilateral Agreements
- Adjacent Band Interference
- International Committee On Global Navigation Satellite Systems (GNSS)

Department of Transportation

- Federal Aviation Administration

Department of Homeland Security

- U.S. Coast Guard



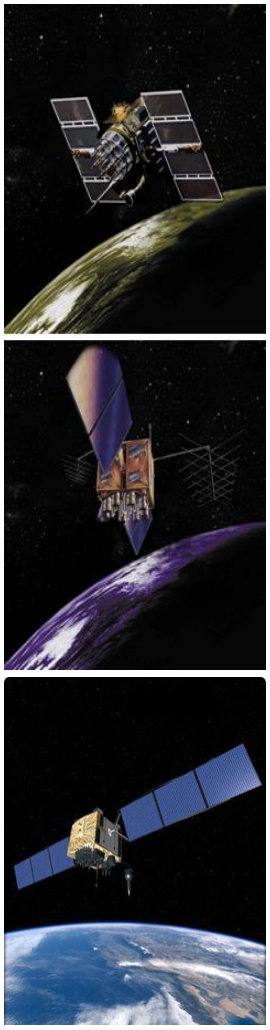
International Cooperation

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

Constellation Snapshot

- **Block IIA satellites, 2 Operational, 7 Spare**
- **Block IIR satellites, 12 Operational**
- **Block IIR-M satellites, 7 Operational, 1 Spare**
- **Block IIF satellites, 10 Operational**
- **Oldest Satellite is SVN23; will be 25 Yrs Old, Nov 15**
- **U.S. Government continuously assessing constellation optimization to determine launch need**

*Current as of 23 Oct 15



GPS IIF

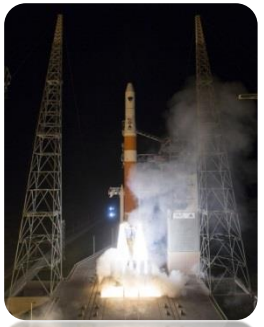
- 10 total GPS IIFs on-orbit
- Mission IIF-11 launch planned for 30 Oct 15
- Mission IIF-12 launch planned for 7 Oct 15

20 Feb 14: IIF-5

16 May 14: IIF-6

1 Aug 14: IIF-7

29 Oct 14: IIF-8



25 Mar 15: IIF-9

15 Jul 15: IIF-10

Most aggressive GPS launch schedule since 1993

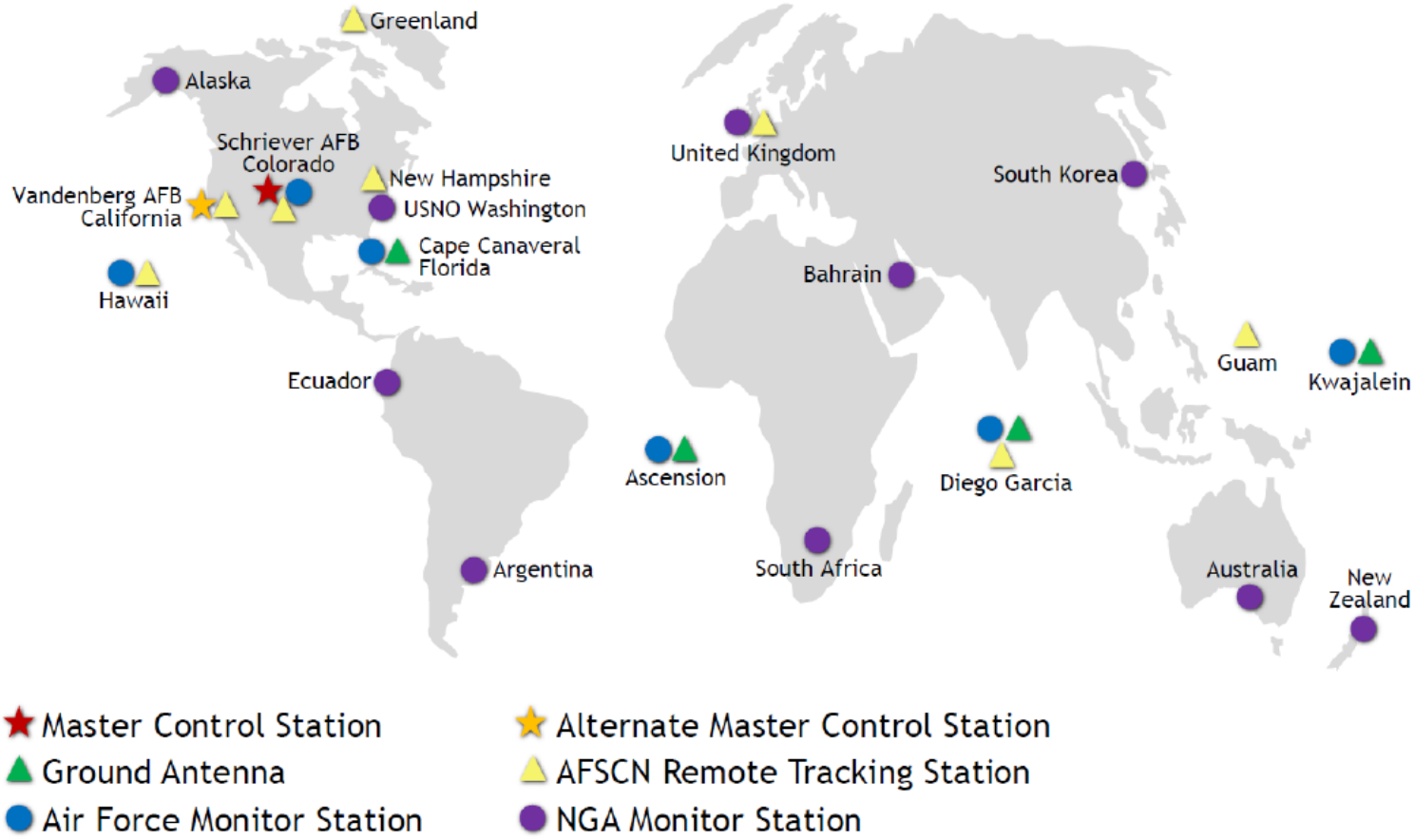
GPS III

- **GPS III is the newest block of GPS satellites**
  - 4 civil signals: L1 C/A, L1C, L2C, L5
    - First satellites to broadcast common L1C signal
  - 4 military signals: L1/L2 P(Y), L1/L2M
- **SV01-SV08 on contract; SV09 & SV10 approved**
  - 2 year delay due to technical challenges w/ payload
- **SV01 System Module Core Mate completed 7 Apr 15**
- **Mission Data Unit software qualification complete 6 Aug 15**
- **SV-level thermal vacuum started Oct 15**
- **SV01 "available for launch" Aug 2016**

GPS III SV11+

- **Competing GPS III SV11+ Production**
  - Drive down space vehicle costs by promoting effective competition
  - Mitigate reliance on single navigation payload vendor
  - Reduce production cost and schedule risk with minimal design phase
- **Two-phase acquisition approach allows contractors time to mature designs**
  - GPS III SV11+ Production Readiness Feasibility Assessment (Phase 1)
    - Gain insight into contractor-funded space vehicle and navigation payload production design maturity and risk
    - Full and open competition
    - Up to 3 Firm-Fixed Price contracts, $6M per source (incl/ options)
    - Request For Proposal release 1QFY16 with contract awards in 3QFY16
  - GPS III SV11+ Follow-on Production Competition (Phase 2)
    - Acquisition strategy to be informed by Feasibility Assessment performance and results
    - Notional full and open competition for up to 22 satellites
    - Projected award in FY18

Ground Segment



Ground Segment

- **Architecture Evolution Plan (AEP)**
  - Day-to-day command and control of up to 31 satellites
  - 4 dedicated Ground Antennas and AFSCN capability
  - 6 dedicated and 10 NGA Monitor Stations

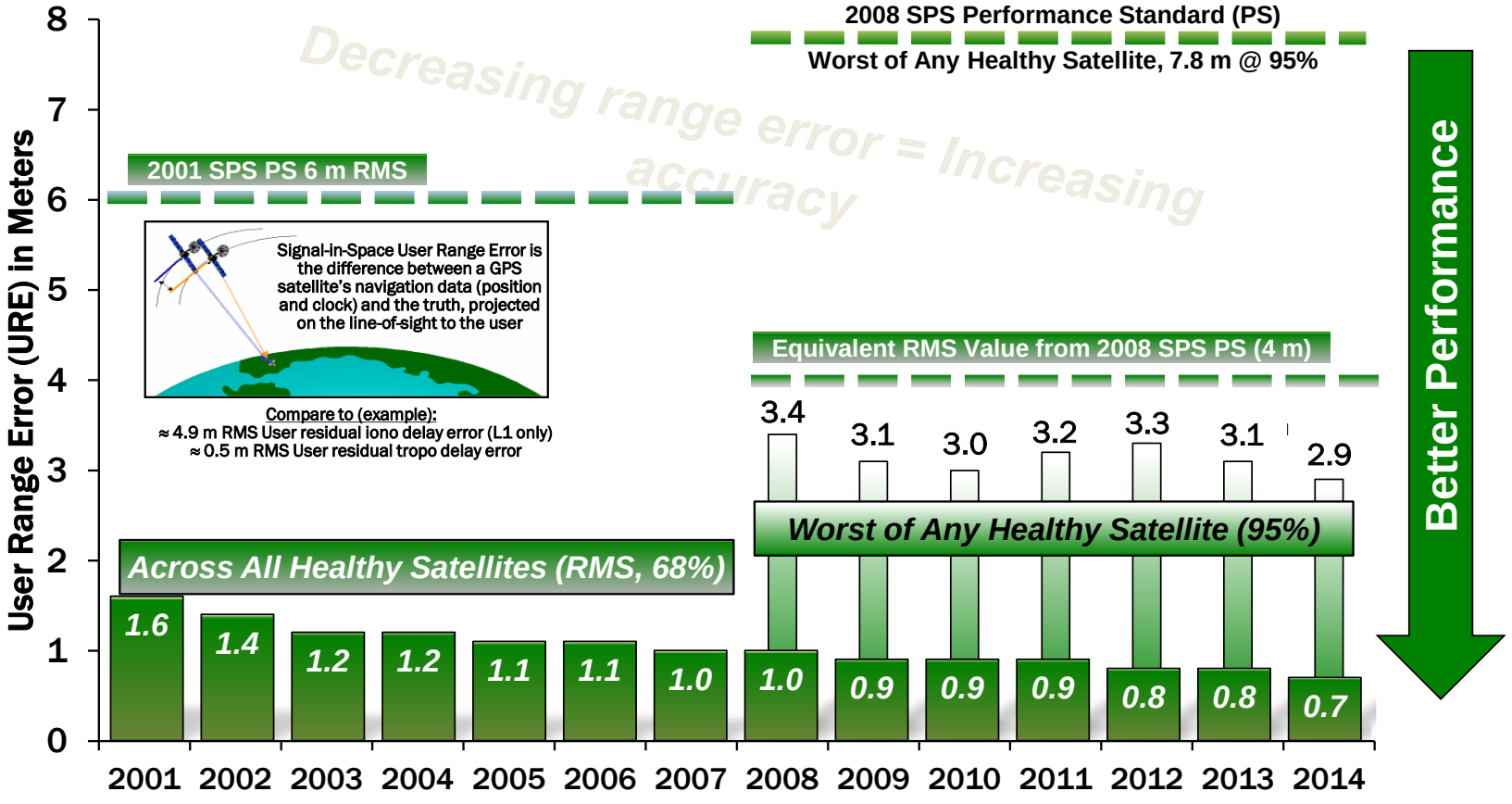
- **Launch, Anomaly Resolution, and Disposal Operations (LADO)**
  - Day-to-day command and control residual satellites using AFSCN
  - State-of-health monitoring
  - Leverage for some vehicle emergencies
  - Launch prep and initial post-launch operations
  - Satellite end of life disposal operations

GPS Next Generation Operational Control System (OCX)

- **Modernized command & control system**
  - GPS III command & control
  - M-Code
  - Robust cyber security infrastructure
  - Modern civil signals & monitoring
  - Improved PNT performance
- **Prime: Raytheon (Aurora, CO)**
- **OCX Block 0: launch & checkout for GPS III**
  - Currently in test
  - Successfully completed seven launch exercises/simulations
- **OCX Block 1: replaces AEP, adds modern features**
  - Currently in design and risk reduction testing prior to restart of coding
- **OCX Block 2: adds advanced NAVWAR and Civil Signal Performance Monitoring capabilities**

Accuracy: Civil Commitments
Standard Positioning Service (SPS) Performance Standard

Standard Positioning Service (SPS) Signal-in-Space Performance



System accuracy better than published standard

Civil Navigation (CNAV)

- **CNAV is being broadcast today!**
  - L2C CNAV set Healthy, 18 SVs by the end of the year
  - L5 CNAV set Unhealthy, available for test
  - Intended to support modernized civil receiver development

CNAV message types currently being broadcast		
Type	**Title**	**Description/Function**
10	Ephemeris 1	Keplerian orbital parameters
11	Ephemeris 2	Keplerian orbital parameters
30	Clock, IONO & Group Delay	SV Clock correction parameters, ionospheric and SV group delay correction parameters
33	Clock & UTC	SV Clock correction parameters, Coordinated Universal Time parameters

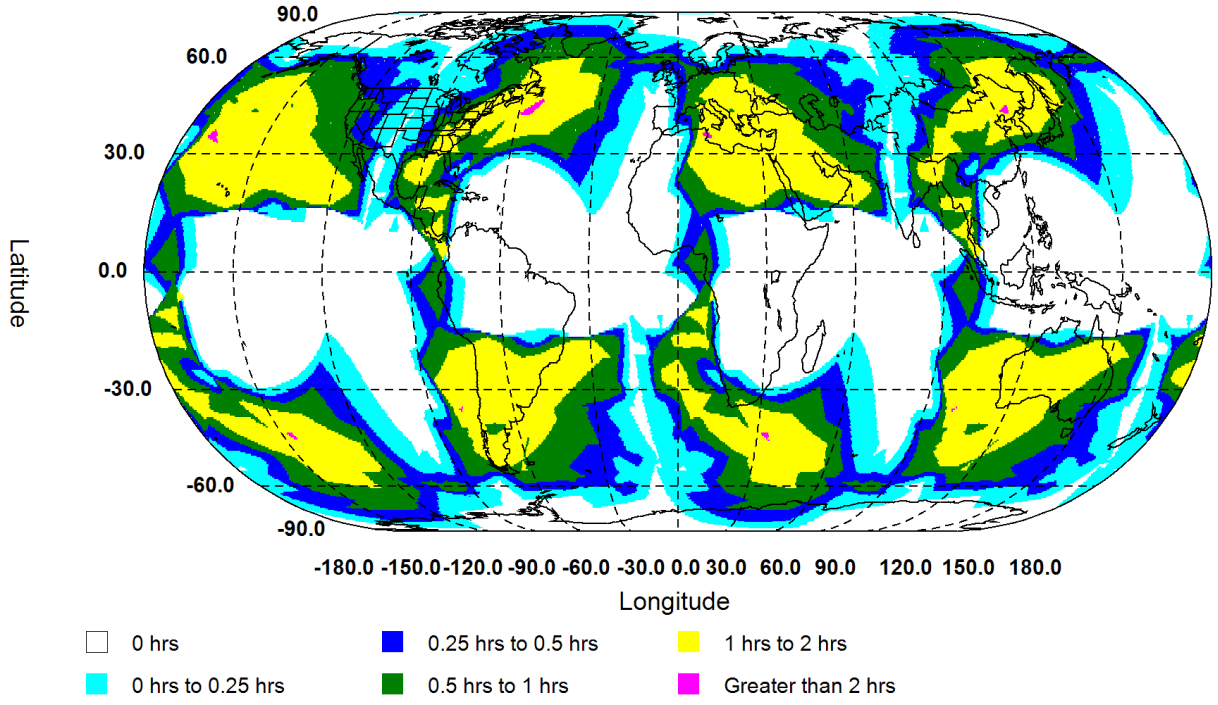
- **Collaborating on GPS/GNSS Time Offset (GGTO) test plan with Civil community**

CNAV Broadcast is performing as expected.

Civil Signal Coverage

Current Constellation – L2C – 4 Fold Visibility Gaps

1 October 2015 - No Failures



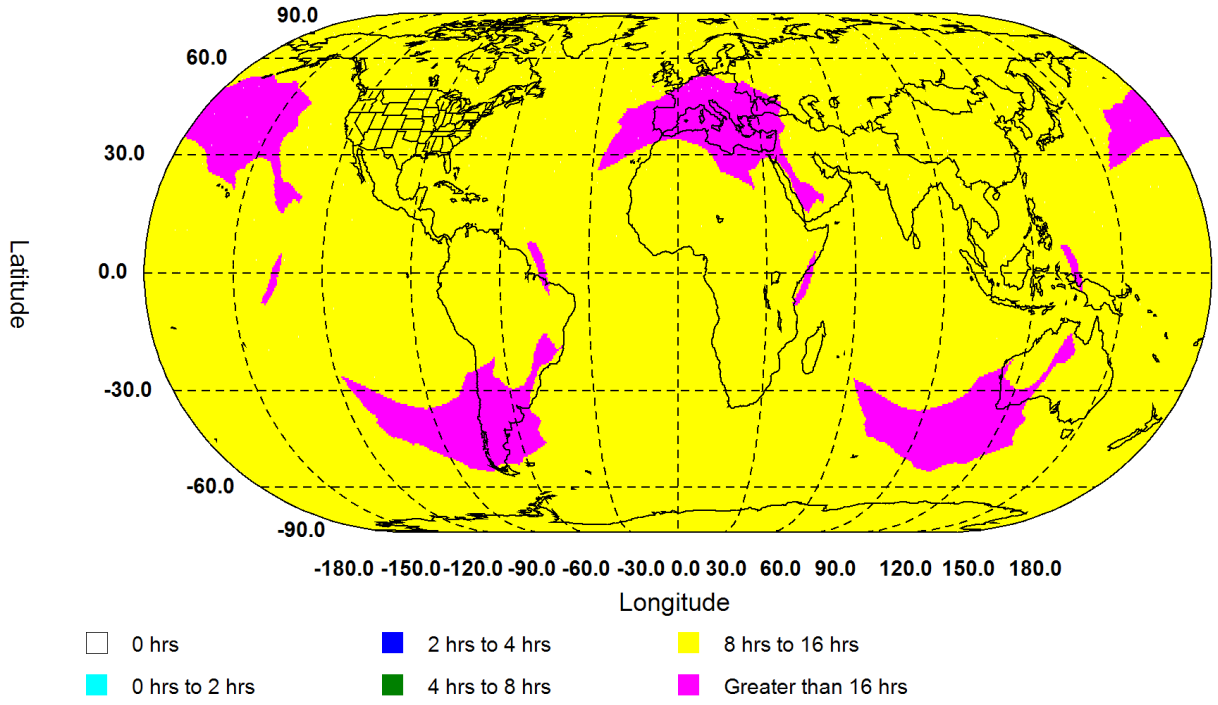
Tuesday, October 20, 2015 5:04:51 AM

AEROSPACE

Civil Signal Coverage

Current Constellation – L5 – 4 Fold Visibility Gaps

1 October 2015 - No Failures



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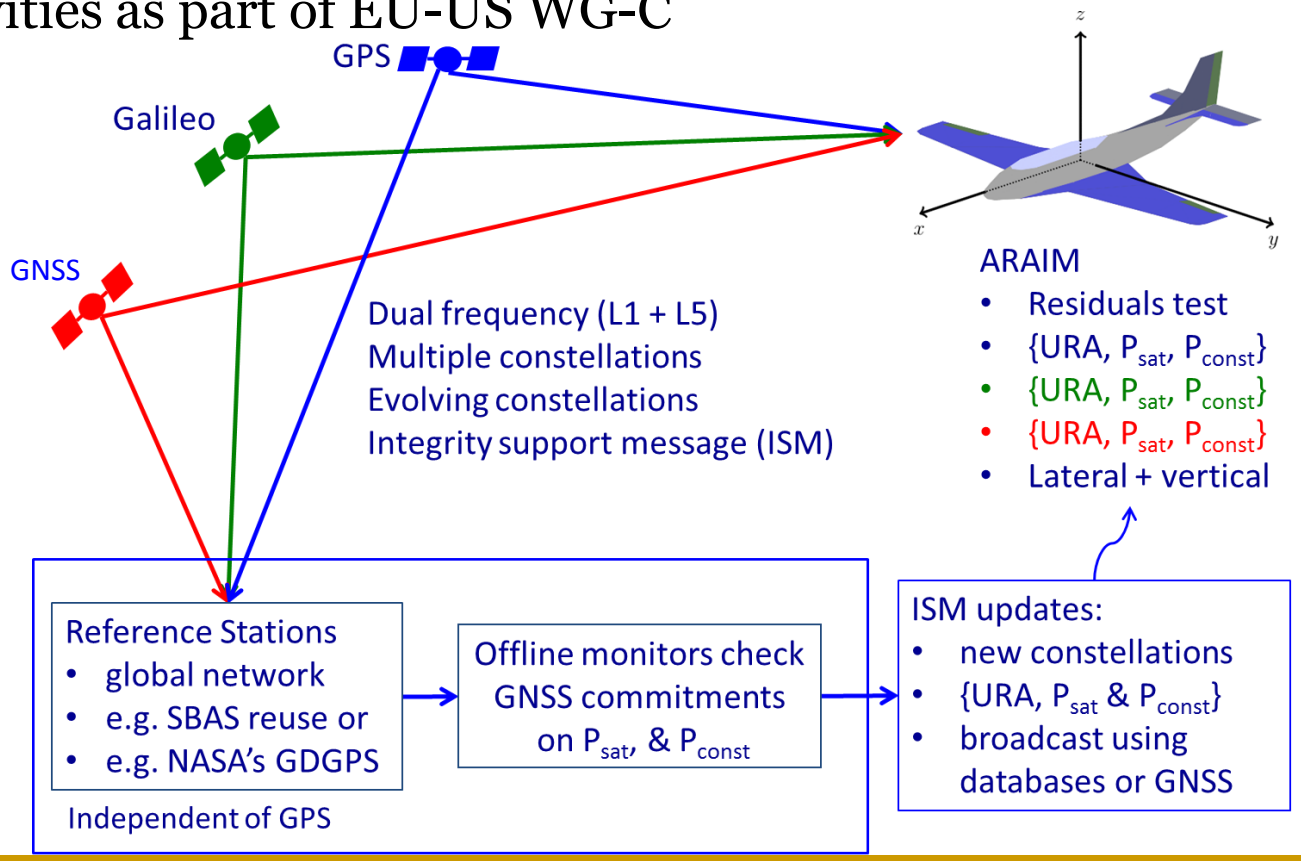
Advanced Receiver Autonomous Integrity Monitoring (ARAIM)

- The GPS Directorate is actively supporting ARAIM development activities as part of EU-US WG-C



ARAIM May Enable Multi-GNSS Use by Safety-of-Life Applications!