

Space and Missile Systems Center



GPS Update for PNT Advisory Board

10 December 2014

Colonel William T. Cooley

Director

Global Positioning Systems Directorate



GPS Constellation Status

SPACE AND MISSILE SYSTEMS CENTER

30 Operational Satellites (Baseline Constellation: 24+3)

- **Robust operational constellation**
 - 4 GPS IIA – L1 C/A, L1 P(Y), L2 P(Y) signals
 - 12 GPS IIR – same signals as IIA
 - 7 GPS IIR-M – adds L2C, L1M, L2M signals
 - 7 GPS IIF – adds L5 signal
- **8 additional satellites in residual/test status, and 1 in early orbit test (IIF-8)**
- **Global GPS civil service performance commitment met continuously since Dec 1993 (IOC)**
 - Best performance **46.2 cm** User Range Error (URE) 17 Nov 2014; best weekly average **55.2 cm** URE 17 Nov 2014
 - Performance improving as new satellites replace older satellites



39 Satellites / 30 Set Healthy
Baseline Constellation: 24 Satellites

Satellite Block	Quantity	Average Age	Oldest
GPS IIA	4	21.5	24.0
GPS IIR	12	12.9	17.4
GPS IIR-M	7	7.3	9.2
GPS IIF	7	1.9	4.5
Constellation	30	10.2	24.0

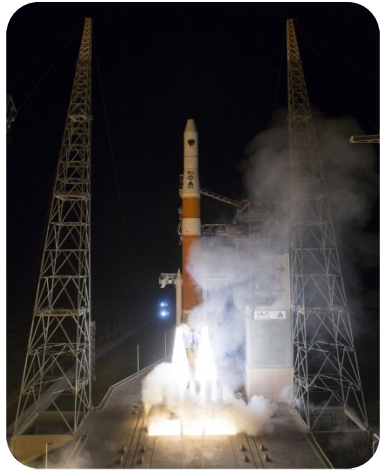
AS OF 19 NOV 2014

2014 Banner Year for GPS IIF

4 Successful Launches!

SPACE AND MISSILE SYSTEMS CENTER

- 8 total GPS IIFs on-orbit
- 4 more GPS IIFs in the pipeline
 - SVs 10, 11, and 12 are in storage
 - SV-9 is in production testing



20 Feb: IIF-5

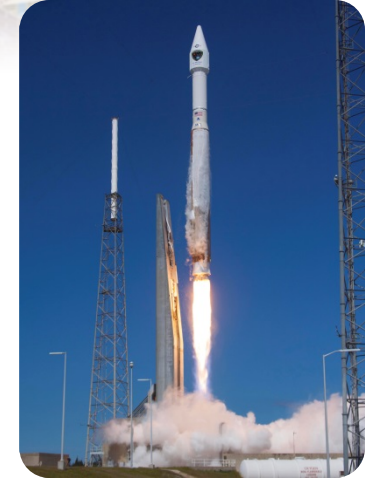


16 May: IIF-6

SVN 66 thru 69



1 Aug: IIF-7



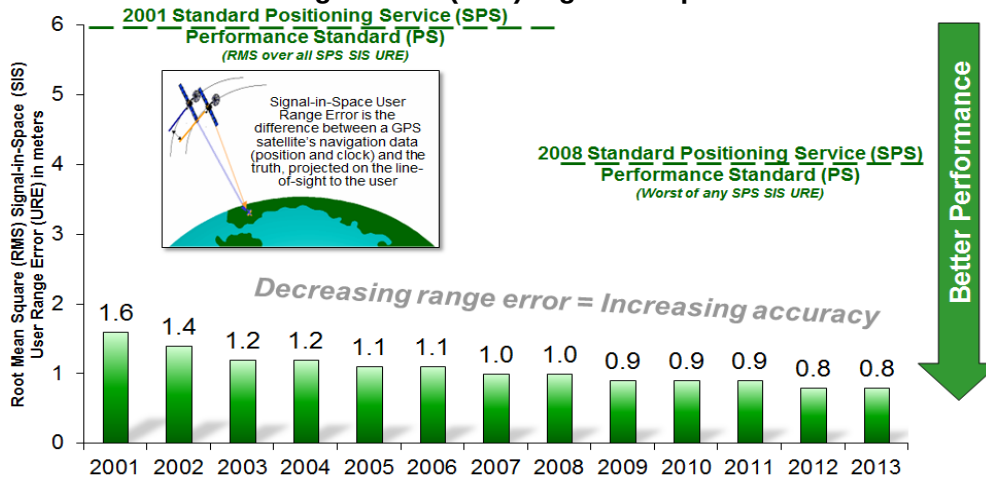
29 Oct: IIF-8

Most GPS launches in a single year since 1993

GPS Signal-in-Space Performance

SPACE AND MISSILE SYSTEMS CENTER

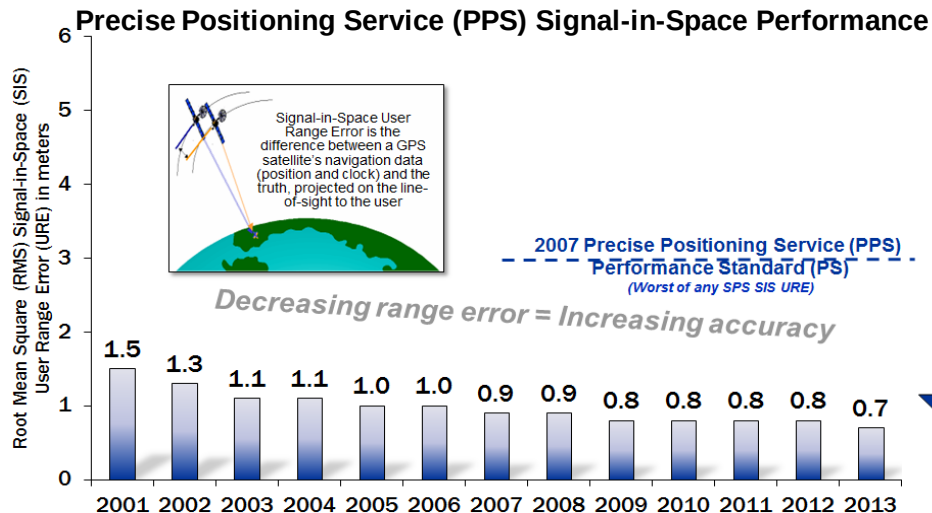
Standard Positioning Service (SPS) Signal-in-Space Performance



- US Law: (10 U.S.C. § 2281)
“SecDef shall provide GPS for both military & civilian purposes”

- The Standard Positioning Service (SPS) Performance Standard defines commitment to civil users and is approved by PNT EXCOM

- Information is for the user community – in particular, aviation users for receiver certification
- Last updated in 2008



System accuracy exceeds published standard



GPS Modernization Program

SPACE AND MISSILE SYSTEMS CENTER

Legacy GPS IIA/IIR

- Single Frequency (L1)
- Coarse acquisition (C/A) code
- Y-Code (L1Y & L2Y)

GPS IIR-M

- 2nd Civil Signal (L2C)
- M-Code (L1M & L2M)

GPS IIF

- 3rd civil signal (L5)
- 2 Rb + 1 Cs Clocks
- 12 year design life

GPS III

- 4th civil signal (L1C)
- 4x better User Range Error than GPS IIF
- Increased availability
- Increased integrity
- 15 year design life



Legacy Operational Control Segment (OCS)

- Mainframe system
- Command & Control
- Signal monitoring

Architecture Evolution Plan (AEP)

- Distributed architecture
- Increased signal monitoring
- Security
- Accuracy
- Launch and disposal ops

Next Generation Operational Control System (OCX) Block 0

- Launch & On-Orbit Checkout of GPS III

OCX Block 1

- Transition to OCX for all GPS command and control operations

Increasing system capabilities - Increasing user benefit



GPS III Status

SPACE AND MISSILE SYSTEMS CENTER

- 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
 - Three improved Rubidium atomic clocks
- SV07/08 contract awarded 31 Mar 14
- SV09/10 planned to be purchased under current Lockheed contract
- Navigation payload panel began space environment testing at Lockheed Martin's Colorado facility Sep 14
- GPS III Non-Flight Satellite Testbed accomplished launch processing at Cape Canaveral; reduced risk for integration & test and launch processing
- GPS III SV01 available for launch CY 2016



Lockheed-Martin (Waterton, CO) – Prime



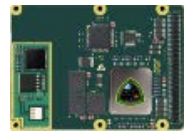
Military GPS User Equipment (MGUE)

SPACE AND MISSILE SYSTEMS CENTER

- Building next-generation of military GPS receivers that incorporate M-Code (required in statute by FY17)
- Direction from USD(AT&L) to accelerate MGUE Increment 1
- Requirements approved by JROC July 2014
- Successfully completed Preliminary Design Reviews for MGUE Increment 1 contractors Aug-Sep 2014
- Security Certification Underway
- Updated Lead Platforms
 - Army: Raven to DAGR Distributed Device (D3)
 - Air Force: F-15E to B-2 Spirit (B-2)



MAGR-2K



Ground-Based Card



Aviation/Maritime Card



Ground Segment

SPACE AND MISSILE SYSTEMS CENTER

- Current system Operational Control Segment (OCS)
 - Flying GPS constellation on Architecture Evolution Plan (AEP) and Launch & early orbit, Anomaly, and Disposal Operations (LADO) software systems
 - Cyber security enhancements in progress
- Next Generation Operational Control System (OCX)
 - Modernized command & control system with M-Code, modern civil signal monitoring, info assurance infrastructure and improved PNT performance: Raytheon (Aurora, CO) - Prime
 - Successfully completed four GPS III launch exercises
 - OCX Block 0 supports launch & checkout for GPS III; currently in integration & test; delivery expected Jan 2016
 - OCX Block 1 supports transition from OCS in 2019
 - Civil Signal Performance Monitoring capability scheduled for OCX Block 2 in 2020



Monitor Station



Ground Antenna



Now on The Air: Modernized Civil Signals

SPACE AND MISSILE SYSTEMS CENTER

- U.S. initiated continuous CNAV message broadcast (L2C & L5) on 28 Apr 2014; began with twice-a-week uploads and moving to daily (nominal) uploads on 15 Dec 2014
 - Position accuracy not guaranteed during pre-operational deployment
 - L2C message currently set “healthy”
 - L5 message set “unhealthy” until sufficient monitoring capability established
- User-Range Error (URE) CNAV Performance
 - CNAV URE within 3 meters of LNAV performance with 3x per week uploads
 - Daily uploads consistent with or exceed LNAV performance
- Currently 14 L2C- and 7 L5-capable satellites on orbit



GLOBAL POSITIONING SYSTEMS DIRECTORATE

