SPACE-BASED POSITIONING
NAVIGATION & TIMING
NATIONAL COORDINATION OFFICE

U.S. Space-Based Positioning, Navigation and Timing (PNT)

Munich Satellite Navigation Summit 2017
Munich, Germany

15 March 2017

Harold W. Martin III, Director
National Coordination Office

GNSS Enables and Enhances Everyday Life





Applications:

- Aviation
- Agriculture
- Search & rescue
- Surveying & mapping
- Trucking & shipping
- Fishing & boating
- Scientific
- Timing
- Tracking
- Exploration
- Offshore drilling
- Military




GNSS provides Worldwide Utility

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)

37 Satellites / 31 Set Healthy
Baseline Constellation: 24 Satellites

Satellite Block	Quantity	Average Age	Oldest
GPS IIR	12	14.9	19.4
GPS IIR-M	7	9.4	11.2
GPS IIF	12	2.9	6.5
Constellation	31	9.0	19.4

AS OF 2 DEC 16

Department of Defense

- Services (Army, Navy, AF, USMC)
- Agencies (NGA & DISA)
- U.S. 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

Spectrum

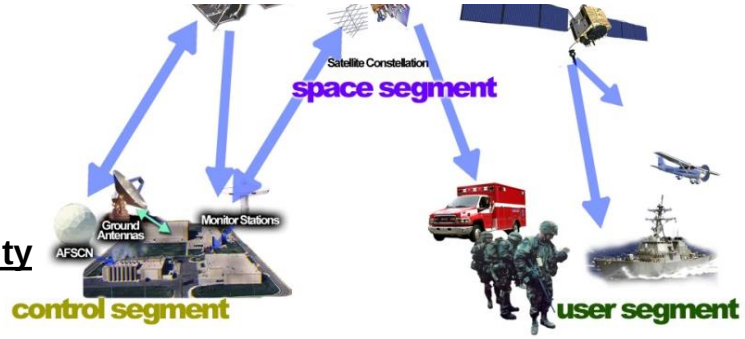
- World Radio Conference
- International Telecommunication Union
- Bilateral Agreements
- Adjacent Band Compatibility

Department of Transportation

- Federal Aviation Administration

Department of Homeland Security

- U.S. Coast Guard



International Cooperation

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

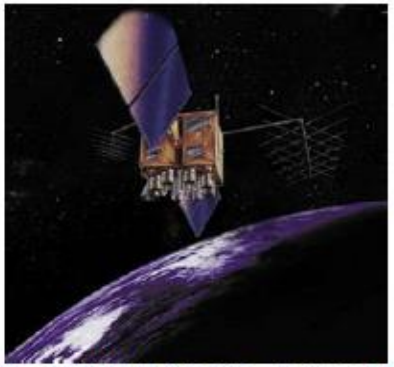
Constellation Snapshot

Four Generations of Operational Satellites

- Block IIA - 5 Residual
  - 7.5 year design life
  - Launched 1990 to 1997
- Block IIR - 12 Operational
  - 7.5 year design life (oldest operational satellite is 19+ years old)
  - Launched 1997 to 2004
- Block IIR-M - 7 Operational, 1 Residual
  - 7.5 year design life
  - Launched 2005 to 2009
  - Added 2nd civil navigation signal (L2C)
- Block IIF - 12 Operational
  - 12 year design life
  - Launched 2010 to 2016
  - Added 3rd civil navigation signal (L5)

*** Current as of 2 Dec 16**

Block IIA Satellite – Designed & Built by Rockwell International



Block IIR/IIR-M Satellite – Designed & Built by Lockheed Martin

Block IIF Satellite – Designed & Built by Boeing

GPS Signal in Space Performance Scoreboard

GPS SIGNAL IN SPACE (SIS) PERFORMANCE (CM)

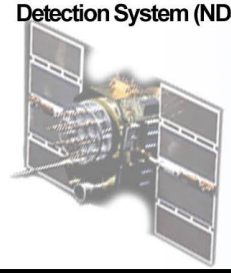
	BEST WEEK		BEST DAY		WORST DAY	
	ENDING	SIS	DATE	SIS	DATE	SIS
ROLLING YEAR	14 APR 16	45.3	11 MAY 16	36.5	19 DEC 15	70.3
BEST WEEK EVER			14 APR 16		45.3	

RMS across all healthy satellites

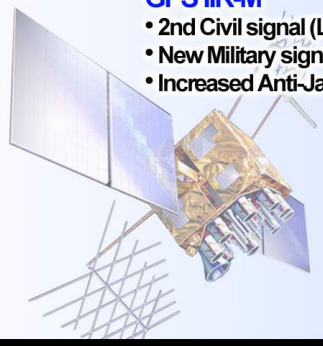
GPS Modernization

Space System (Satellites)

Legacy (GPS IIA/IIR)
- Basic GPS
- NUDET (Nuclear Detonation) Detection System (NDS)

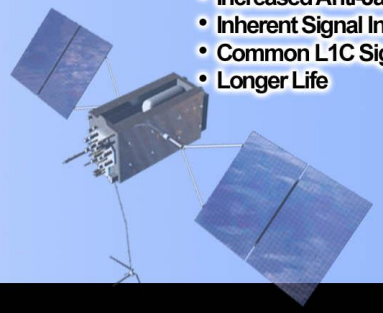


GPS IIR-M
- 2nd Civil signal (L2C)
- New Military signal
- Increased Anti-Jam power



GPS IIF
- 3rd Civil Signal (L5)
- Longer Life
- Better Clocks

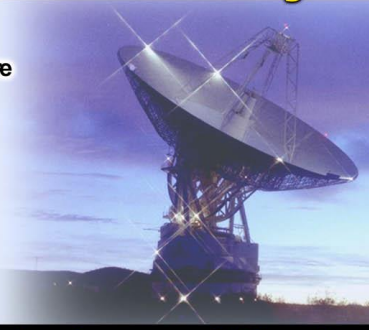
GPS III
- Accuracy & Power
- Increased Anti-Jam power
- Inherent Signal Integrity
- Common L1C Signal
- Longer Life



Ground System

Legacy (OCS)
- Mainframe System
- Command & Control
- Signal Monitoring

AEP
- Distributed Architecture
- Increased Signal Monitoring Coverage
- Security
- Accuracy
- Launch And Disposal Operations



OCX Block 1
- Fly Constellation & GPS III
- Begin New Signal Control
- Upgraded Information Assurance

OCX Block 0
- GPS III Launch & Checkout

GPS III Contingency Ops (COps)
- GPS III Mission

OCX Block 2+
- Control all signals
- Capability On-Ramps
- GPS III Evolution

User Equipment System (Receivers)

Legacy (PLGR/GAS-1/MAGR)
- First Generation System

User Equipment
- Improved Anti-Jam & Systems
- Reduced Size, Weight & Power

Upgraded Antennas
- Improved Anti-Jam Antennas

Modernized
- M-Code Receivers
- Common GPS Modules
- Increased Access/ Power with M-Code
- Increased Accuracy
- Increased Availability
- Increased Anti-Tamper/ Anti- Spoof
- Increased Acquisition in Jamming

GPS IIF

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

31 Oct 15: IIF-11

5 Feb 16: IIF-12

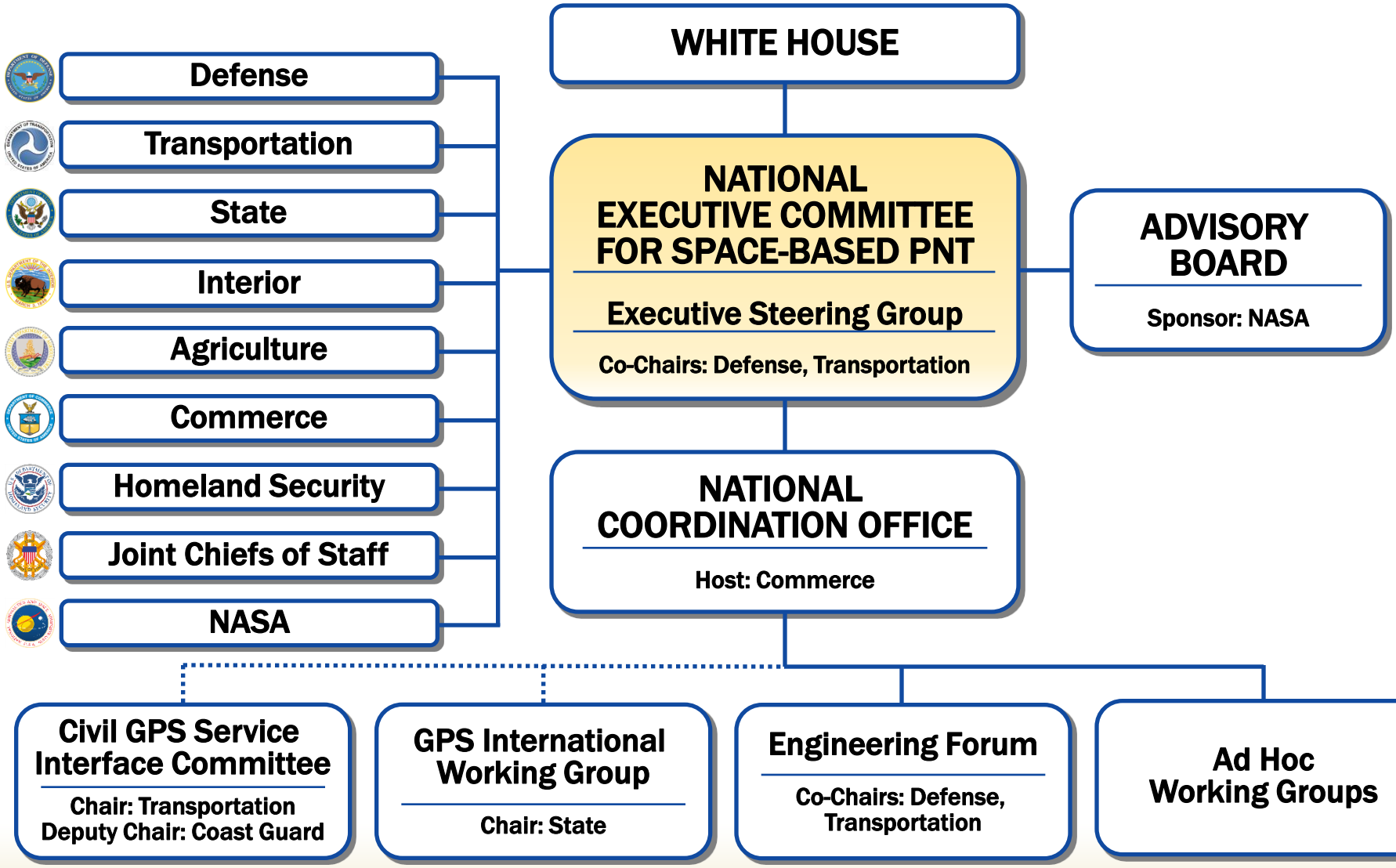
8 Launches in 24 Months – Most aggressive GPS launch schedule since 1993

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
  - 3 improved Rubidium atomic clocks
- SV01-SV10 on contract
  - Resolved technical challenges with payload
  - SV9-10 same requirements baseline as SV01-08
- Current Status
  - SV01 In Testing Flow
    - Baseline thermal vacuum testing completed 23 Dec 15
    - Electromagnetic Interference (EMI) test completed 14 May 16
  - SV02/03 In Assembly and Integration
  - SV04 thru 08 in box level assembly

First GPS III Launch Spring 2018

National Space-Based PNT Organization



GPS Summary

- The U.S. supports free access to civilian GNSS signals and all necessary public domain documentation
- GPS is a critical component of the global information infrastructure
- The U.S. policy promotes open competition and market growth for commercial GNSS
- Modernization milestones: Multiple launches and new Civil Navigation messages broadcast

GPS: Accessible, Interoperable, Precise

Thank You

GPS B·U·L·L·E·T·I·N

Information for Policymakers from the National Coordination Office for Space-Based Positioning, Navigation, and Timing (PNT)

May 3, 2016

Space Bill Addresses PNT

On April 14, Rep. Jim Bridenstine (R-OK) introduced the American Space Renaissance Act.

Section 103 of the bill is titled "Positioning, Navigation, and Timing." According to the Congressman, the provision "Expresses a sense of Congress on the importance of positioning, navigation, and timing (PNT) for national security and economic prosperity. Requires the Secretary of Defense to provide a strategy to ensure DOD PNT leverages the best available signals from alternative PNT systems. The strategy will address issues associated with monitoring and verifying accuracy, integrity, availability, security, and reliability of foreign PNT signals."

Section 104 cites the National Executive Committee for Space-Based PNT as a model for establishing a new National Executive Committee on Weather.

Learn more at GPS.gov

DHS Demonstrates Precision Timing Technology at NYSE

On April 20, DHS announced the successful demonstration of Enhanced LORAN (eLoran), a precision timing technology, for financial transactions at the New York Stock Exchange (NYSE). Recognizing the challenges of space-based signals and the importance of having multiple timing sources, eLoran is one technology being considered to provide a complementary timing solution to existing GPS technology.

Precise and synchronized timing of financial transactions is critical to markets worldwide and is mandated by regulation in the European Union and is increasingly required in the United States. Today, precision timing capabilities are provided primarily by GPS. However, GPS's space-based signals are low-power and susceptible to possible disruptions. GPS signals are also difficult to receive indoors and in urban canyons.

The live demonstration at the NYSE was hosted by Juniper Networks, Harris Corporation, and UrsaNav, under a cooperative agreement with DHS. Over 60 industry and government representatives attended, including senior officials from DHS, DOT, DOD, Treasury, and DOE. The ensuing discussion highlighted the over-reliance upon GPS for precise timing, the threat of a loss of civil GPS services, possible impacts to the U.S. critical infrastructure and the economy, and a common interest in developing resilient timing solutions for our nation's critical infrastructure.

View press release at DHS.gov

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