



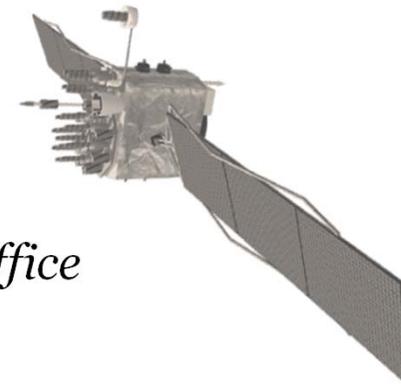
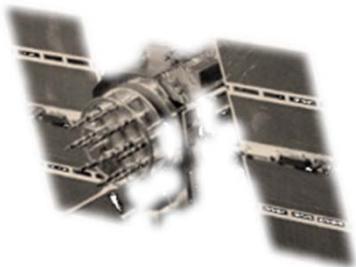
# ***U.S. Space-Based Positioning, Navigation and Timing Policy and Program Update***

***8<sup>th</sup> International Committee on GNSS***

***10 November 2013***

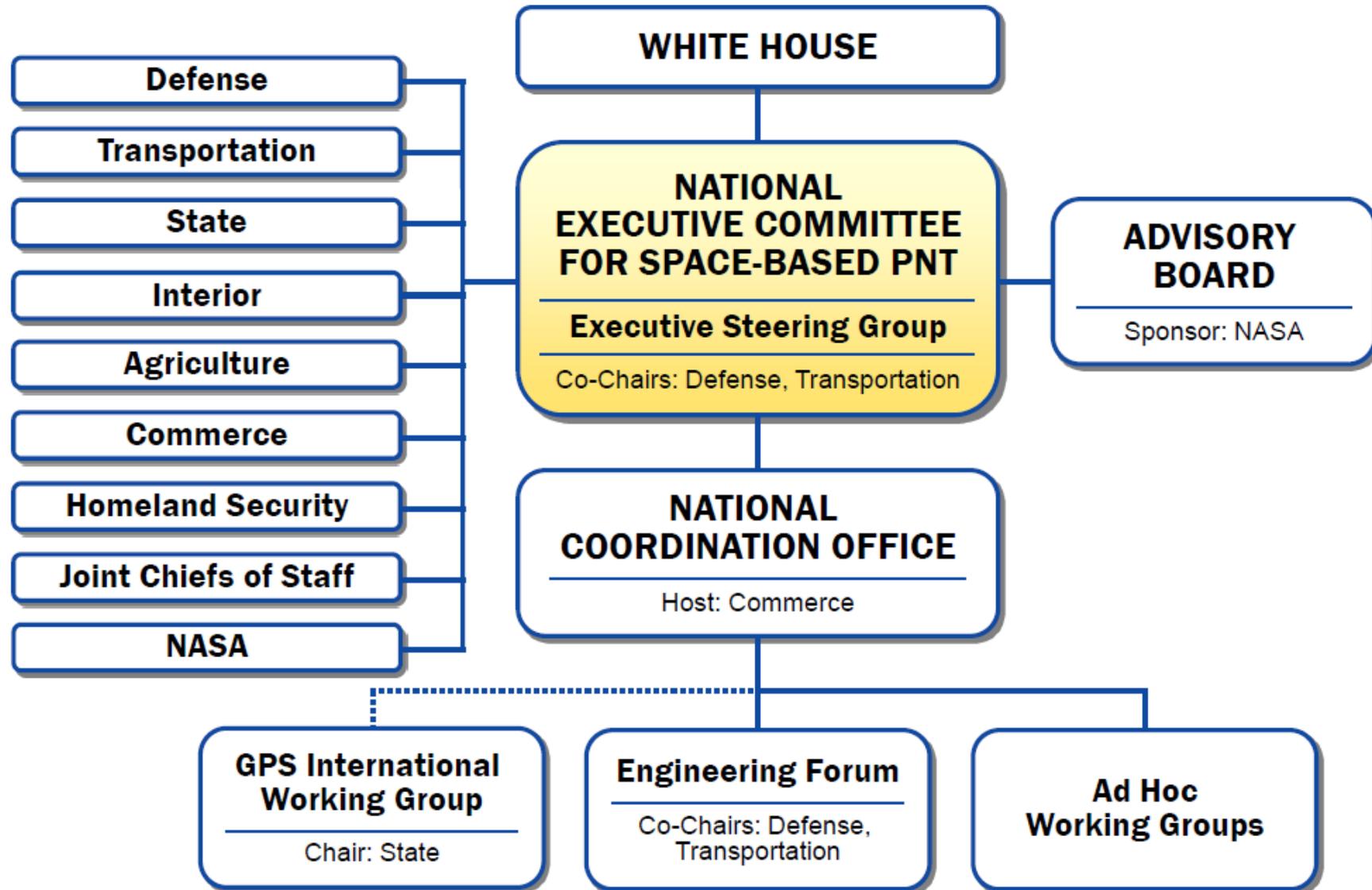
***Harold W. Martin III***

***Deputy Director, National Coordination Office  
United States of America***





# National Space-Based PNT Organization





## *U.S. Policy*



- Provide continuous worldwide access for peaceful uses, free of direct user charges
- Encourage compatibility and interoperability with foreign GNSS services and promote transparency in civil service provisioning
- Operate and maintain constellation to satisfy civil and national security needs
  - *Foreign PNT services may be used to complement services from GPS*
- Invest in domestic capabilities and support international activities to detect, mitigate and increase resiliency to harmful interference



## *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
  - Primary focus on the common L1C and L5 signals
- Ensure a level playing field in the global marketplace

*Pursue through Bilateral  
and Multilateral Cooperation*



## *Keys to Successful U.S. Program*



- Policy Stability
- Transparency
- Program Stability
- Sustained Performance and Credibility
- Continuous Improvement

*Policy stability and transparency improve industry confidence and investment*



## ***GPS IIF-4 Launch***



- **Launched on 15 May 2013**
- **Satellite Vehicle Number 66**
- **PRN 27**
- **Set healthy 21 June 2013**





## *GPS IIF Status*



- 4 total GPS IIFs on orbit
  - Enhanced GPS clock performance
  - Transmits the L5 signal in addition to the L1, L2 and L2C signals
- 8 more GPS IIFs in the pipeline
  - SV-3 (IIF-5) launch planned for late 2013
  - SVs 6-9 are in storage
  - SVs 10-12 are accepted pending testing





# *GPS Constellation Status*



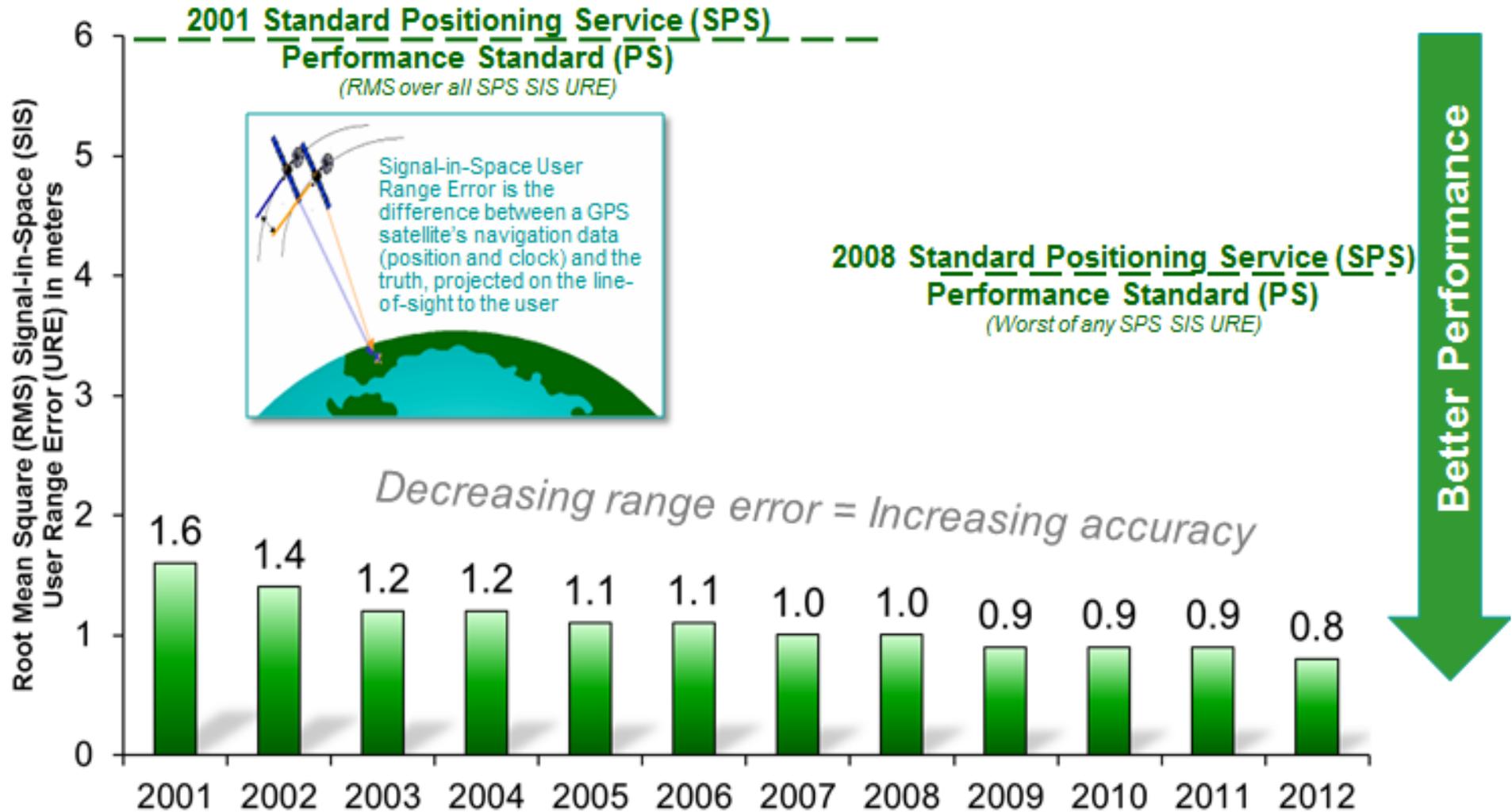
*36 Satellites (31 Operational)  
(Baseline Constellation: 24+3)*

- 8 Block IIA
- 12 Block IIR
- 7 Block IIR-M
  - Transmitting new second civil signal
- 4 Block IIF
- 4 Additional satellites in residual status,  
1 in test status
- Global GPS civil service performance  
commitment met continuously since  
December 1993





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



**System accuracy exceeds published standard**



# GPS Modernization Program



**Legacy Block IIA/IIR**

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

**Block IIR-M**

- 2<sup>nd</sup> Civil Signal (L2C)
- M-Code (L1M & L2M)

**Block IIF**

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

**Block III**

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

**Legacy OCS**

- Mainframe system
- Command & Control
- Signal monitoring

**AEP**

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

**OCX Block 1**

- Fly constellation + GPS III
- Control L2C and L5 signals
- Upgraded information assurance

**OCX Block 2**

- Control L1C signal
- Capability On-Ramps
- GPS III evolution



**Increasing System Capabilities - Increasing User Benefit**



# Modernized Civil GPS Capabilities



- Second civil signal “L2C”
  - Designed to meet commercial needs
  - Available since 2005 without data message
  - Currently 11 satellites broadcasting L2c



## Third civil signal “L5”

- Designed to meet transportation safety of life requirements
- Uses Aeronautical Radio Navigation Service band
- Currently 4 satellites broadcasting L5

- Fourth civil signal “L1C”
  - Designed for GNSS interoperability
  - Specification developed in cooperation with industry
  - Launches with GPS III in 2015
  - Improved tracking performance



*Urban Canyons*

Improved  
performance in  
challenged  
environments



# *Wide Area Augmentation System (WAAS) Architecture*



WAAS is a combination of ground based and space based system that augments the GPS Standard Positioning Service (SPS).

WAAS provides the capability for increased availability and accuracy in position reporting, allowing more time for uniform and high quality worldwide air traffic management.

WAAS provides service for all classes of aircraft in all phases of flight - including en route navigation, airport departures, and airport arrival.



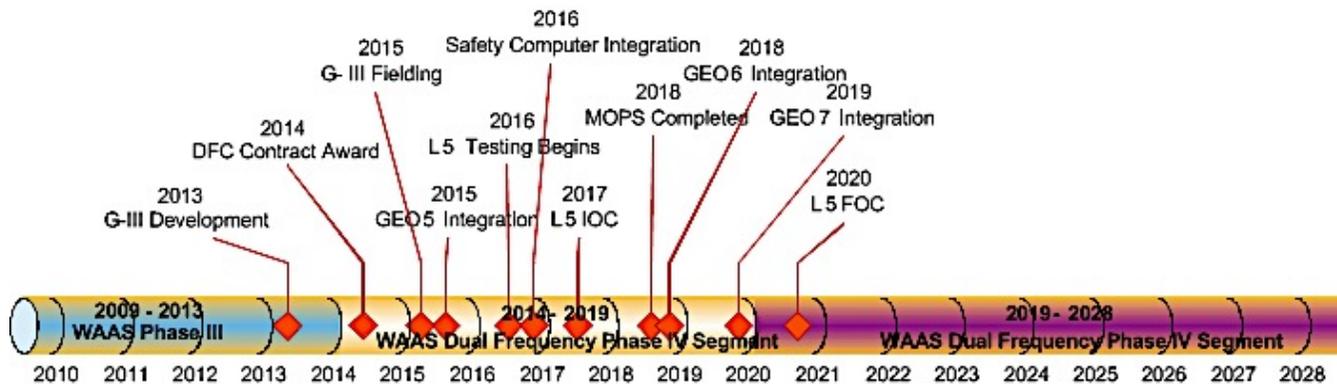
Sponsor: Federal Aviation Administration



# WAAS Transition Strategy



Implement 2<sup>nd</sup> Civil Signal L5  
Integrate 5<sup>th</sup> & 6<sup>th</sup> GEOs  
Develop Dual Frequency MOPs  
Evaluate Multi-Constellation



3 Wide-area Master Station  
38 Wide-area Reference Station  
6 Ground Uplink Station  
2 O&M Console

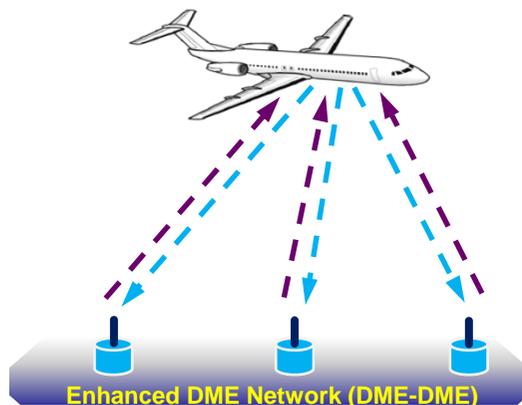


# Alternative Positioning, Navigation & Timing (APNT)

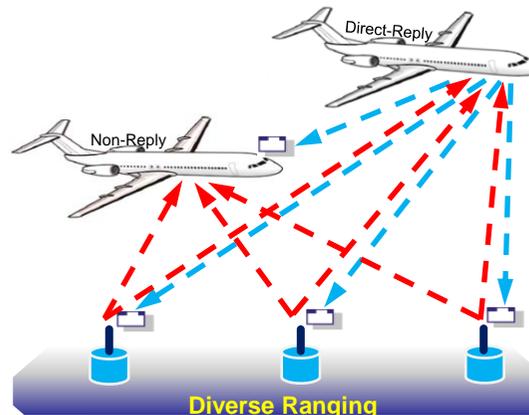


- National Policy requires FAA to provide a backup in the event of GPS interference or outage
- Today's legacy systems will not support the NextGen operational improvements, provides limited function for Area Navigation (RNAV), and no function for Required Navigation Performance (RNP) or Trajectory Based Operations (TBOs)
- The FAA is in the process of designing an APNT system, various alternatives are being discussed

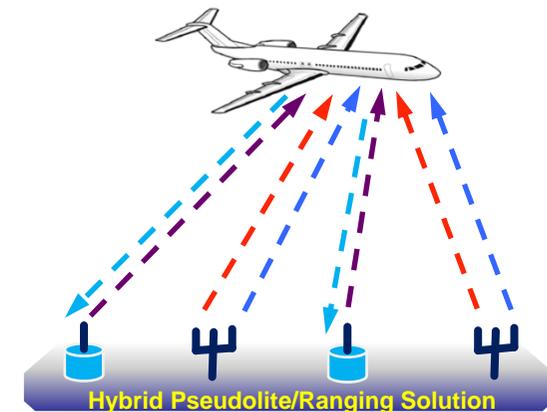
## Alternatives under evaluation



- Leverages Existing DME/DME Technology
- RNAV Today; Impacts to Avionics to realize RNP
- Evaluating means to support both IRU and non-IRU aircraft



- New Concept
- Uses Ground and Aircraft-based emitters for coverage
- Leverages Planned and Existing ADS-B Technology and Air/Ground Infrastructure
- Provides precise time to aircraft
- Has an impact to Avionics



- New Concept
- Leverages DME/GBT Infrastructure
- Provides precise time to aircraft
- Has an impact to Avionics

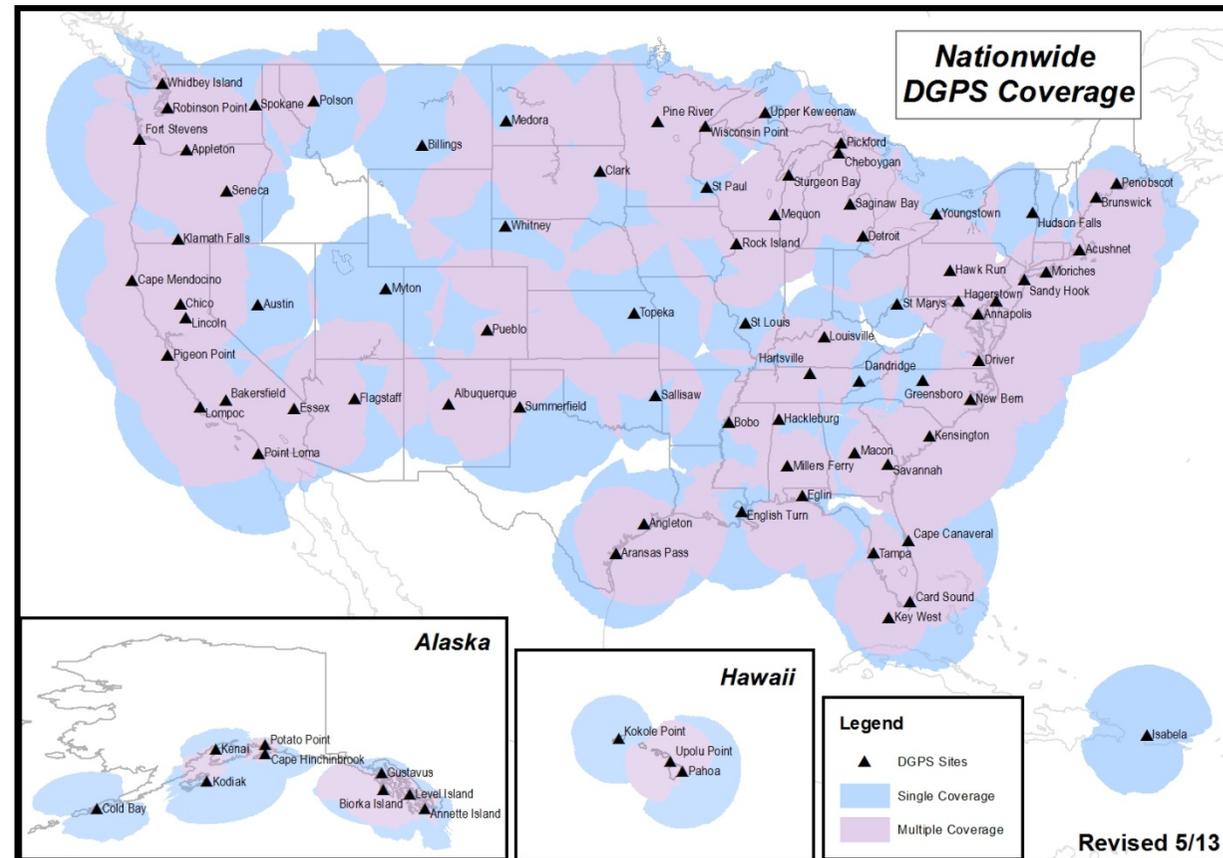


# Nationwide Differential GPS (NDGPS)



Sponsors: U.S.  
Coast Guard &  
Department of  
Transportation

- 80+ sites
- Broadcasts  
GPS correction  
signals
- Improved  
accuracy &  
integrity





## *Assessment of Future of NDGPS*



- **Joint U.S. Coast Guard & Department of Transportation Federal Register Notice 16 April 2013**
  - Assessment driven by many factors: from policy to technology
  - Asked how NDGPS is used, impact/alternatives if discontinued
  - Few comments received; Docket still open for additional comments
- **Next Steps: Identify and assess alternatives**
  - Continuation/partial decommission/transfer/hybrid
- **Decision timeline: No earlier than summer 2014**
  - Supports investment decisions in 2016
- **Continue uninterrupted NDGPS service to users as currently provided until future decision reached**
- **Public/user community information/ involvement in decision processes and next steps**

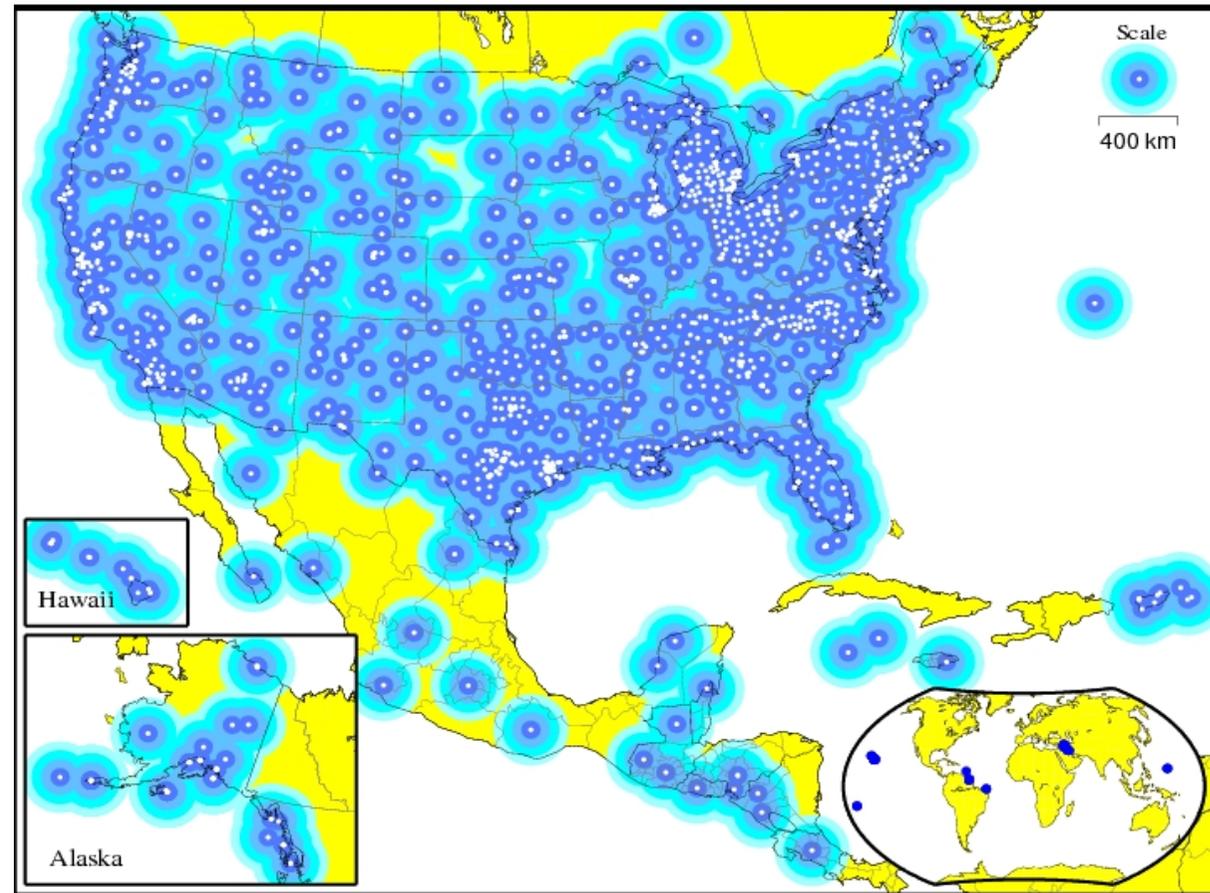


# *National Continuously Operating Reference Stations (CORS)*



Sponsor: National Oceanic and Atmospheric Administration

- 1,900+ sites
- Operated by 200+ academic organizations
- Enables highly accurate, 3-D positioning





## *Summary*



- The U.S. supports free access to civilian GNSS signals and all necessary public domain documentation
  - GPS.gov -- official public resource for U.S. Government (USG) information about GPS and related topics
- GPS is a critical component of the global information infrastructure
  - Compatible with other satellite navigation systems and interoperable at the user level
  - Guided at a national level as multi-use asset
  - Acquired and operated by the Air Force on behalf of the USG
- The U.S. policy promotes open competition and market growth for commercial GNSS

*GPS continues to provide  
consistent, predictable, dependable performance*



***Thank You !***



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