



SPACE-BASED POSITIONING
NAVIGATION & TIMING
NATIONAL COORDINATION OFFICE

GPS Constellation, Modernization Plans and Policy

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United States of America

USTTI Seminar

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Overview



- **Introduction**
- **Global Positioning System**
- **Modernization Plans**
- **U.S. Policy**

GPS enables a diverse array of applications



Satellite Operation



Surveying & Mapping



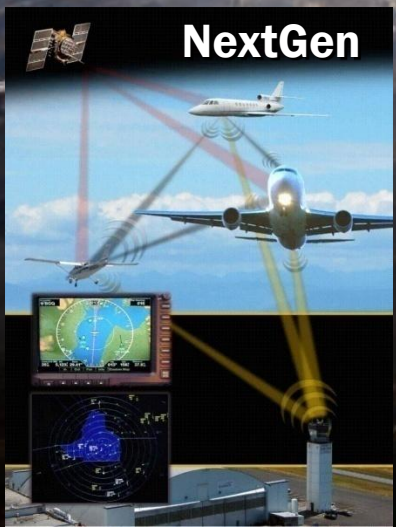
Power Grids



Precision Agriculture



Transit Operations



NextGen



Disease Control



IntelliDrive



TeleComm



Trucking & Shipping



Personal Navigation



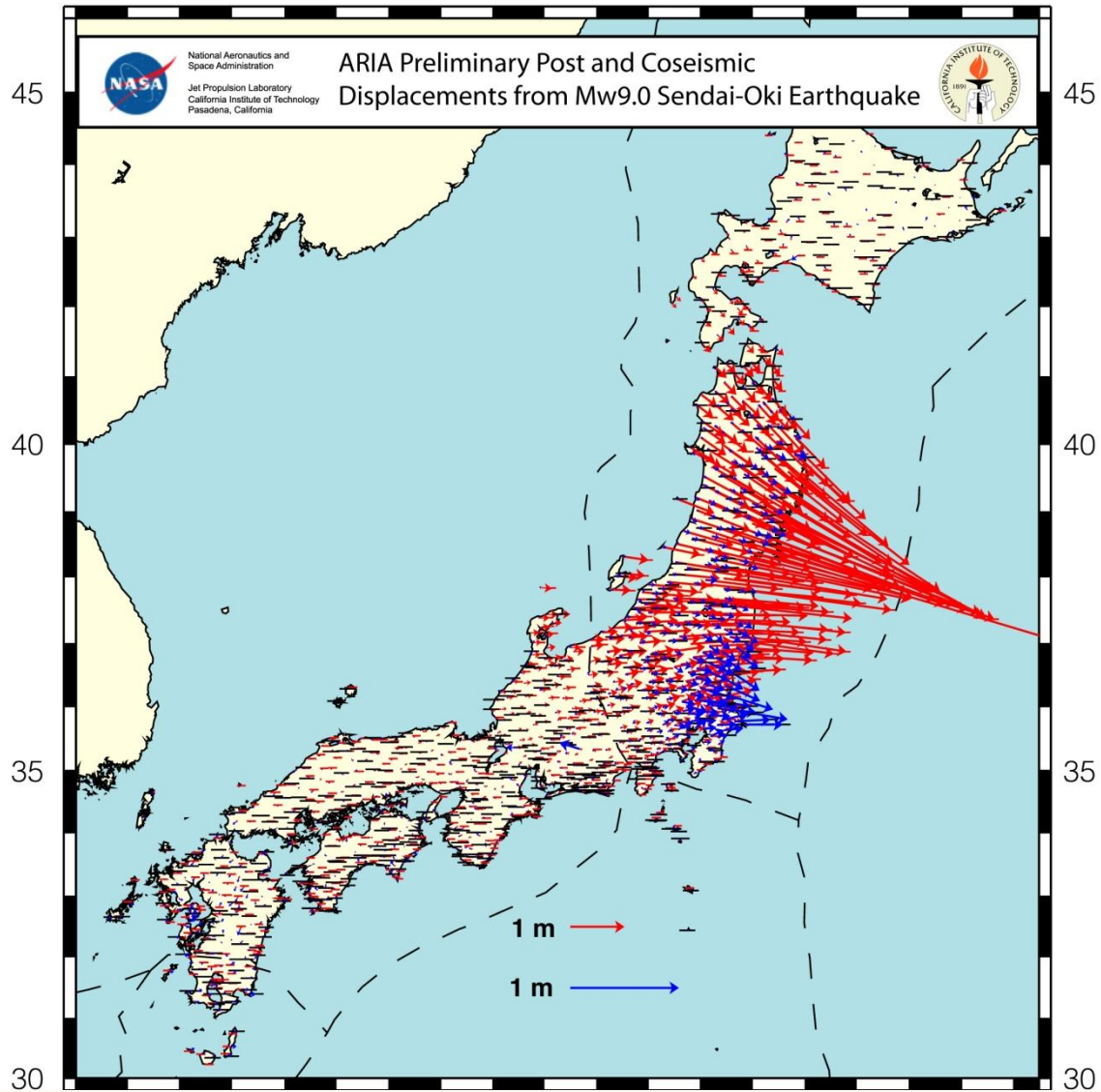
Oil Exploration



Fishing & Boating



GPS in Disaster Relief





Overview



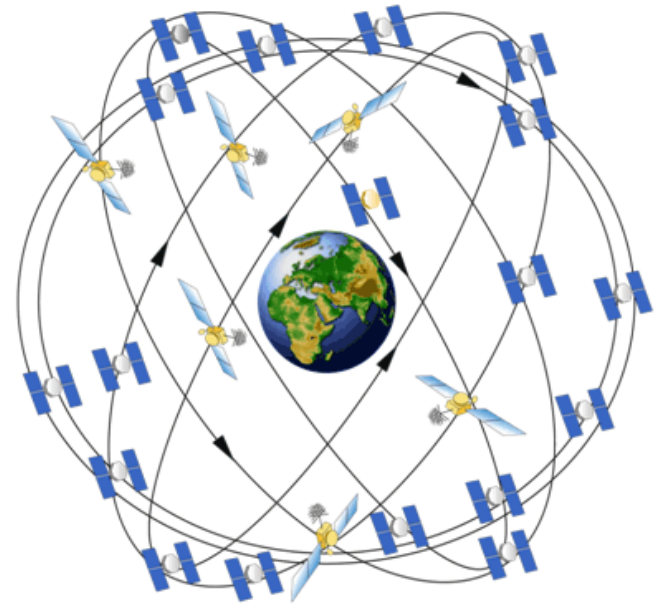
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The Global Positioning System



- **Baseline 24+3 satellite constellation in medium earth orbit**
- **Global coverage, 24 hours a day, all weather conditions**
- **Satellites broadcast precise time and orbit information on L-band radio frequencies**
- **Two types of signals:**
 - Standard (free of direct user fees)
 - Precise (U.S. and Allied military)
- **Three segments:**
 - Space
 - Ground control
 - User equipment



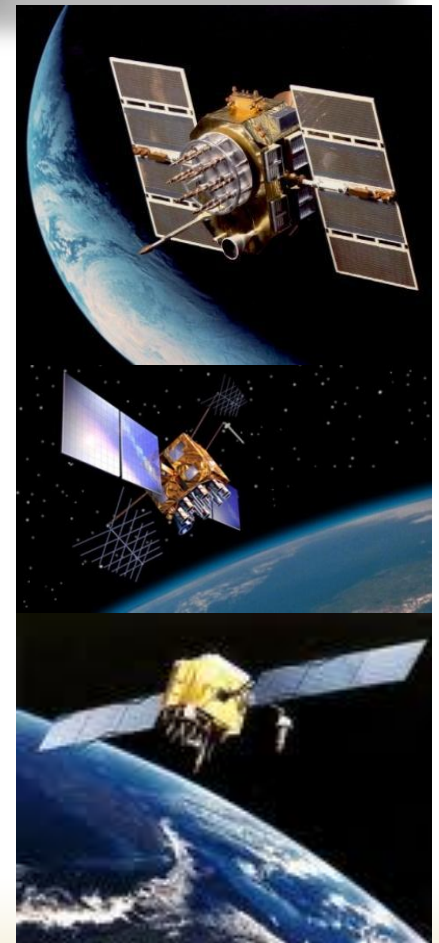


GPS Constellation Status



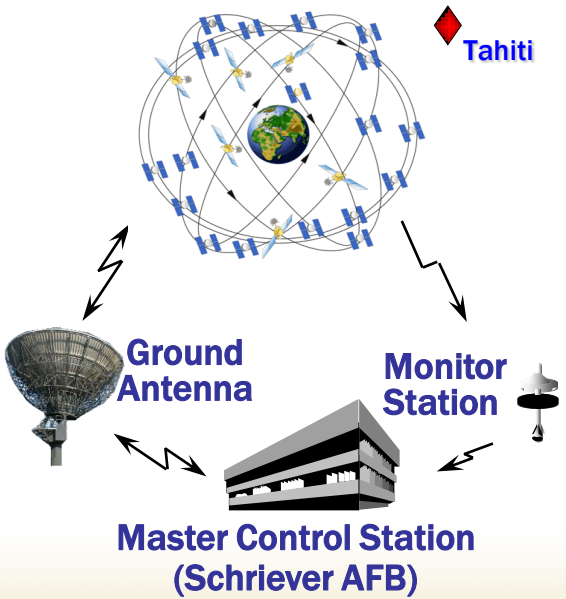
30 Operational Satellites (Baseline Constellation: 24+3)

- **10 Block IIA**
- **12 Block IIR**
- **7 Block IIR-M**
 - Transmitting new second civil signal
 - 1 GPS IIR-M in on-orbit testing
- **2 Block IIF**
- **Global GPS civil service performance commitment met continuously since December 1993**





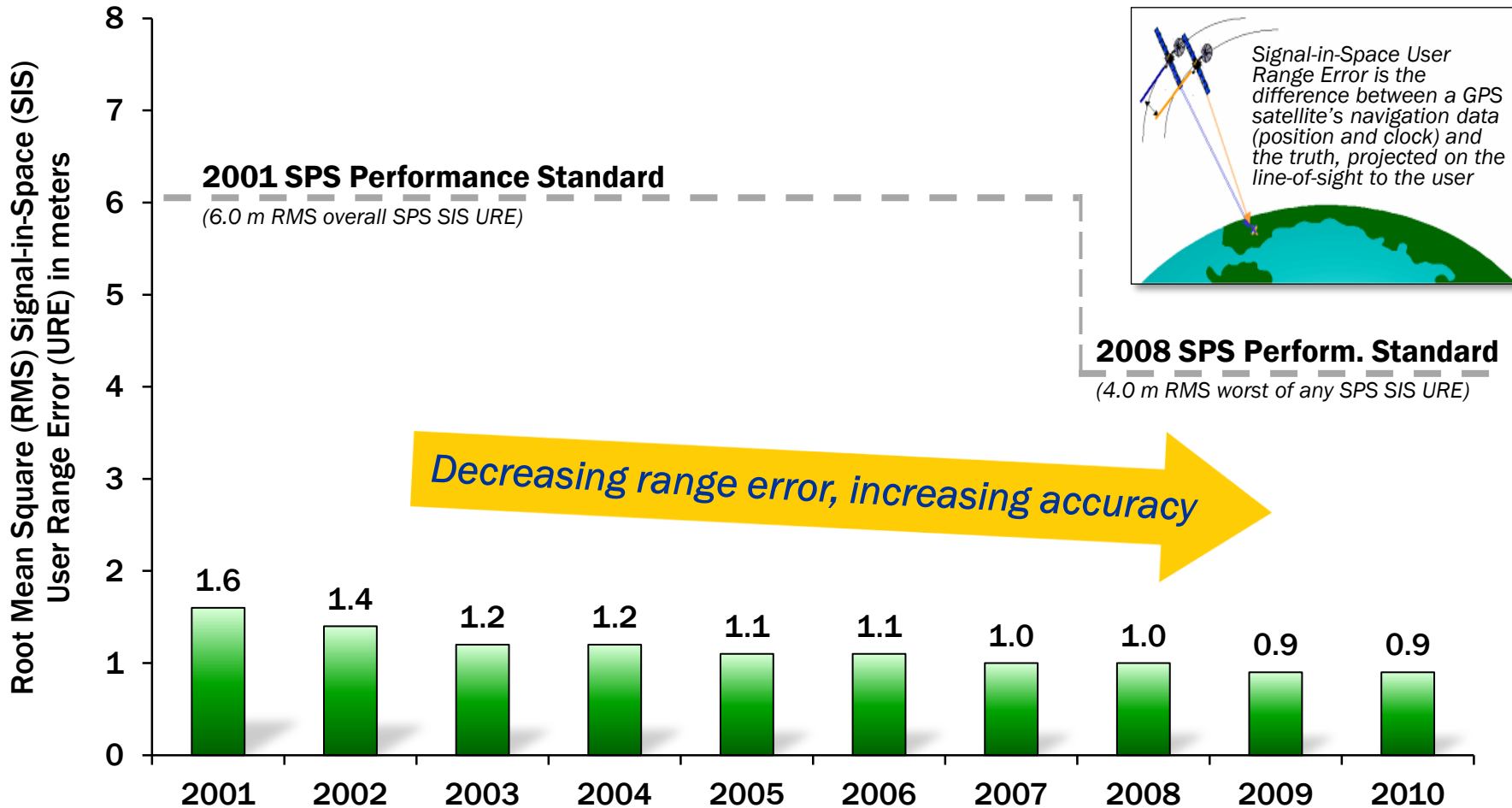
GPS Operational Control Segment (OCS)



- Master Control Station
- Alternate Master Control Station
- Ground Antenna
- Air Force Satellite Control Network
- OCS Monitor Station
- NGA Monitor Station



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



System accuracy exceeds published standard



U.S. Air Force Receives Award



- The International Astronautical Federation bestowed its 60th Anniversary Award to the U.S. GPS program at a ceremony held October 4, 2011 in Cape Town, South Africa.



Awarded for “Benefits to Humanity”



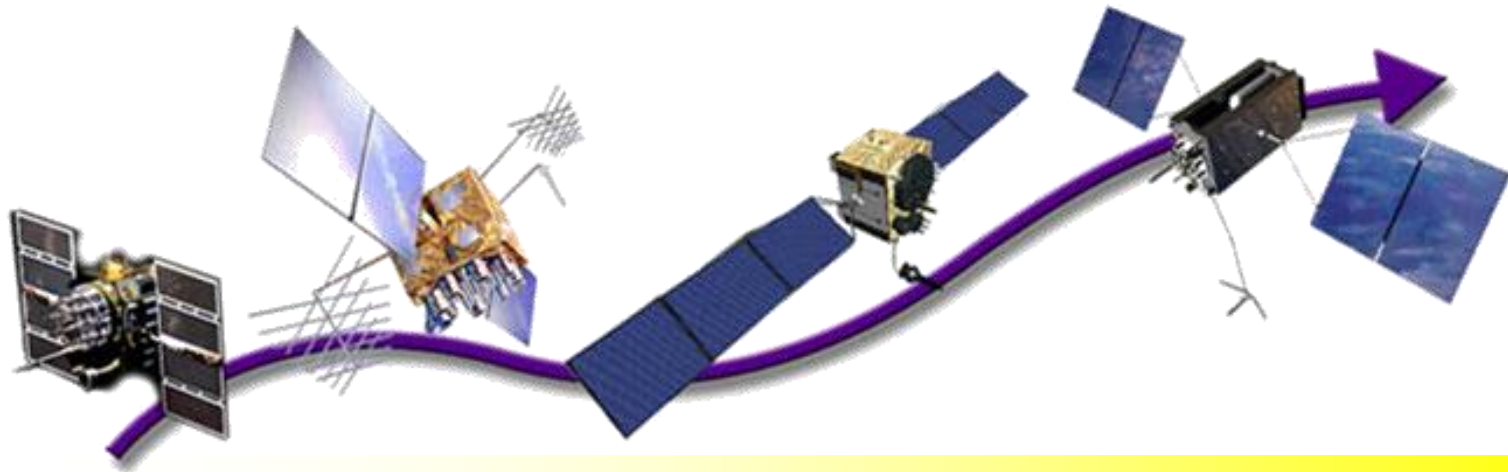
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GPS Modernization Program



Increasing System Capabilities ♦ Increasing User Benefit

Block IIA/IIR

Basic GPS

- Standard Service
 - Single frequency (L1)
 - Coarse acquisition (C/A) code navigation
- Precise Service
 - Y-Code (L1Y & L2Y)
 - Y-Code navigation

Block IIR-M, IIF

IIR-M – Basic GPS capability plus

- 2nd civil signal (L2C)
- M-Code (L1M & L2M)

IIF – IIR-M capability plus

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

Block III

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



Second Civil Signal (L2C)



- **Designed to meet commercial needs**
 - Higher accuracy via ionospheric correction
 - Expected to generate over \$5 billion in user productivity benefits
- **Available since 2005 w/o data message**
 - Currently transmitted from 7 IIR-Ms and 2 IIFs
- **On 24 satellites by 2016**



Benefits existing professional receivers



Increases accuracy for consumers



Supports miniaturization, possible indoor use



Third Civil Signal (L5)



- **Designed to meet demanding requirements for transport safety**
 - Uses highly protected Aeronautical Radionavigation Service (ARNS) band
- **May also enable global, sub-meter level accuracy using new techniques**
- **Opportunity for international interoperability**
- **On-orbit broadcast 10 Apr 2009 on IIR-20(M)**
 - Secured ITU frequency filing
- **24 satellites by 2018**





Fourth Civil Signal (L1C)



Under trees

- Designed with international partners for interoperability
- Modernized civil signal at L1 frequency
 - More robust navigation across a broad range of user applications
 - Improved performance in challenged tracking environments
 - Original signal retained for backward compatibility
- Launches with GPS III in 2014
- On 24 satellites by ~2021



Inside cities



– GPS Modernization – Semi-codeless Transition



- **GPS receivers attain very high accuracy by using "codeless" or "semi-codeless" techniques that exploit the encrypted military GPS signals without actually decoding them**
 - Techniques will no longer be necessary once the new civil GPS signals are fully operational
- **U.S. Government published a notice for users to transition to GPS civil-coded signals by 31 December 2020**
 - Provided time for an orderly and systematic transition
 - Based on launch schedule and projected budget
- **U.S. Government led community-wide collaboration on this transition plan**
- **U.S. is committed to continually improving GPS services as users complete a timely transition to dual-coded civil GPS equipment**



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U.S. Policy History



- **1978: First GPS satellite launched**
- **1983: U.S. President offers free civilian access to GPS**
- **1996: U.S. policy establishes joint civil/military GPS management**
- **1997: U.S. Congress passes law that civil GPS shall be provided free of direct user fees**
- **2000: U.S. President set Selective Availability to “Zero”**
- **2004: U.S. President issues Space-Based PNT Policy**
- **2007: Selective Availability removed from GPS III satellites**
- **2010: U.S. President issues new National Space Policy**



Latest U.S. Policy



- Provide continuous worldwide access for peaceful uses, free of direct user charges
- Encourage compatibility and interoperability with foreign GNSS services
- Operate and maintain 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

U.S. Objectives in Working with Other GNSS Service Providers

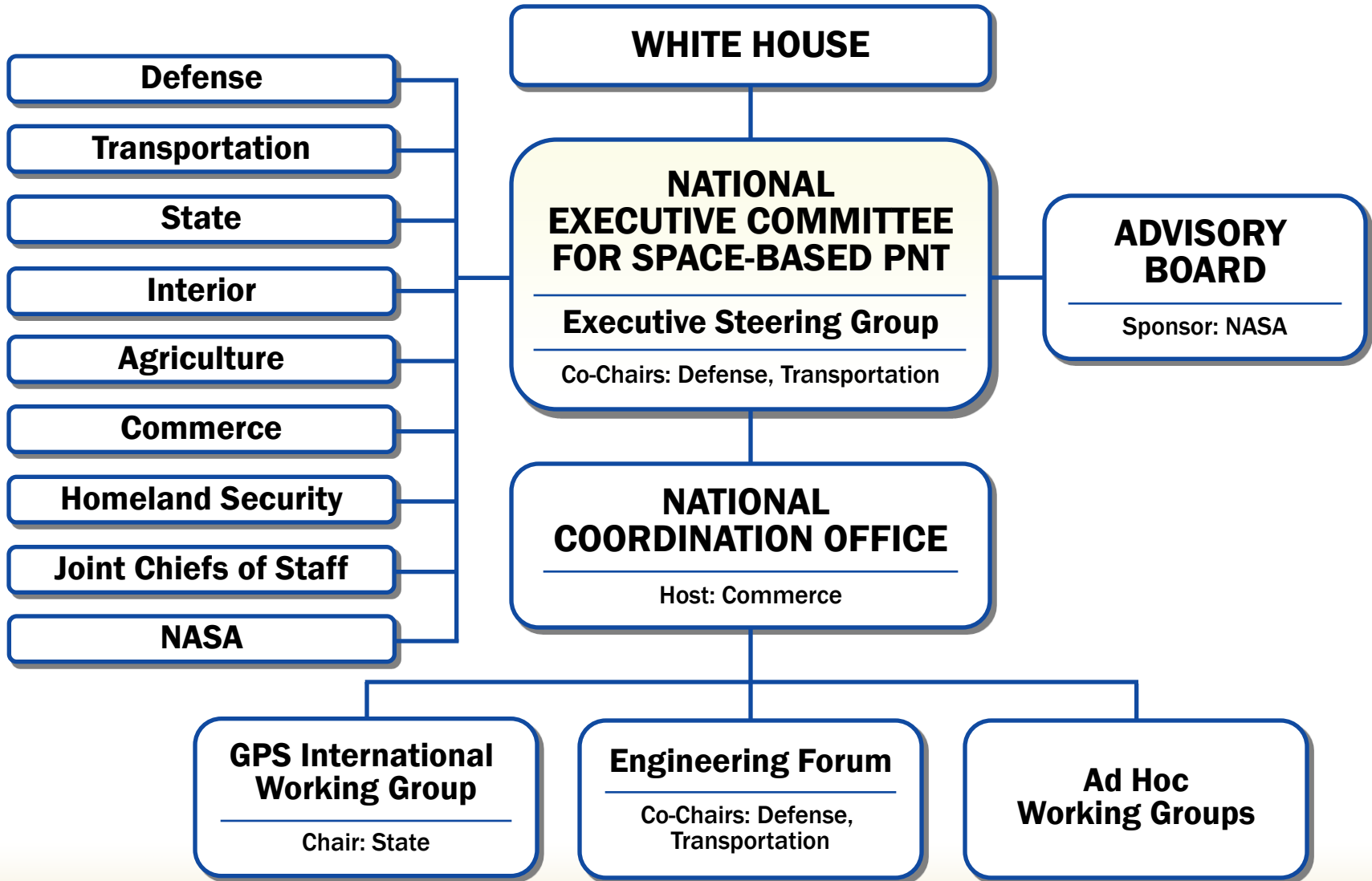


- Ensure **compatibility** — ability of U.S. and non-U.S. space-based PNT services to be used separately or together without interfering with each individual service or signal
 - Radio frequency compatibility
 - Spectral separation between M-code and other signals
- Achieve **interoperability** – ability 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

Pursue through Bi-lateral and Multi-lateral Cooperation



National Space-Based PNT Organization





Summary



- **GPS use is more prevalent and diverse than ever**
 - Reliance on has grown among critical sectors
- **GPS performance is better than ever and will continue to improve**
 - New civil GPS signal available now
 - Many additional upgrades scheduled
- **U.S. policy encourages worldwide use of civil GPS and augmentations**
 - Stable, consistent policy bedrock of GPS success
 - Foreign PNT may be used to strengthen resiliency



For Additional Information...



GPS.gov

PNT.gov



Contact Information



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**This presentation and other GPS information:
www.pnt.gov**



Backup



U.S. Space-Based PNT Policy



Maintain and Enhance Space-Based Positioning, Navigation, and Timing Systems.

The United States must maintain its leadership in the service, provision, and use of global navigation satellite systems (GNSS). To this end, the United States shall:

Provide Continuous Worldwide Access

Provide continuous worldwide access, for peaceful civil uses, to the Global Positioning System (GPS) and its government-provided augmentations, free of direct user charges

Engage Foreign GNSS Providers

Engage with foreign GNSS providers to encourage compatibility and interoperability, promote transparency in civil service provision, and enable market access for U.S. industry

Operate and Maintain the GPS constellation

Operate and maintain the GPS constellation to satisfy civil and national security needs, consistent with published performance standards and interface specifications. Foreign positioning, navigation, and timing (PNT) services may be used to augment and strengthen the resiliency of GPS

Mitigate Harmful Interference

Invest in domestic capabilities and support international activities to detect, mitigate, and increase resiliency to harmful interference to GPS, and identify and implement, as necessary and appropriate, redundant and back-up systems or approaches for critical infrastructure, key resources, and mission-essential functions