



SPACE-BASED POSITIONING  
NAVIGATION & TIMING  
NATIONAL COORDINATION OFFICE

# GPS Constellation, Modernization Plans, and Policy

**Jason Kim, Senior Advisor**

**USTTI Seminar: GPS Applications for Disaster  
Management and Societal Benefits**

**November 7, 2014**



# Overview



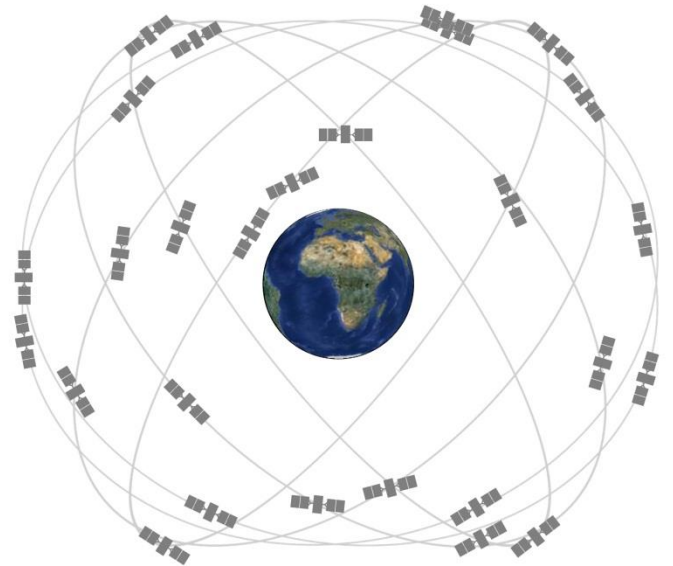
- **Global Positioning System**
- **GPS Applications**
- **GPS Modernization Plans**
- **U.S. Policy**



# 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



## **39 Satellites (30 Operational)**

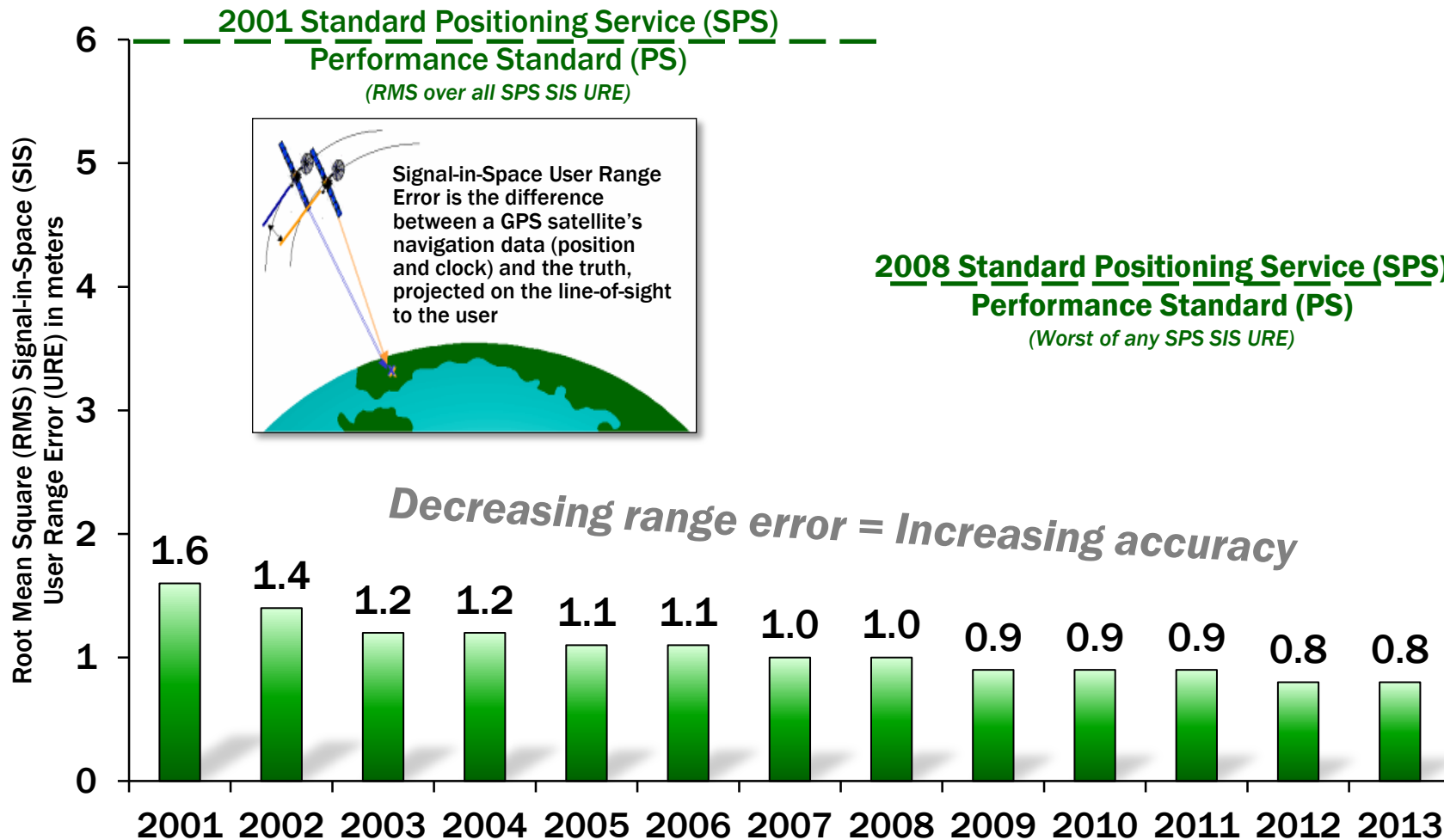
*Baseline Constellation: 24+3*

- **11 Block IIA**
  - 7 on-orbit in residual status
- **12 Block IIR**
- **8 Block IIR-M**
  - Transmitting new second civil signal
  - 1 in on-orbit testing
- **8 Block IIF**
  - Transmitting new safety of life signal
  - 1 in post-launch checkout
- **Global GPS civil service performance commitment met continuously since December 1993**





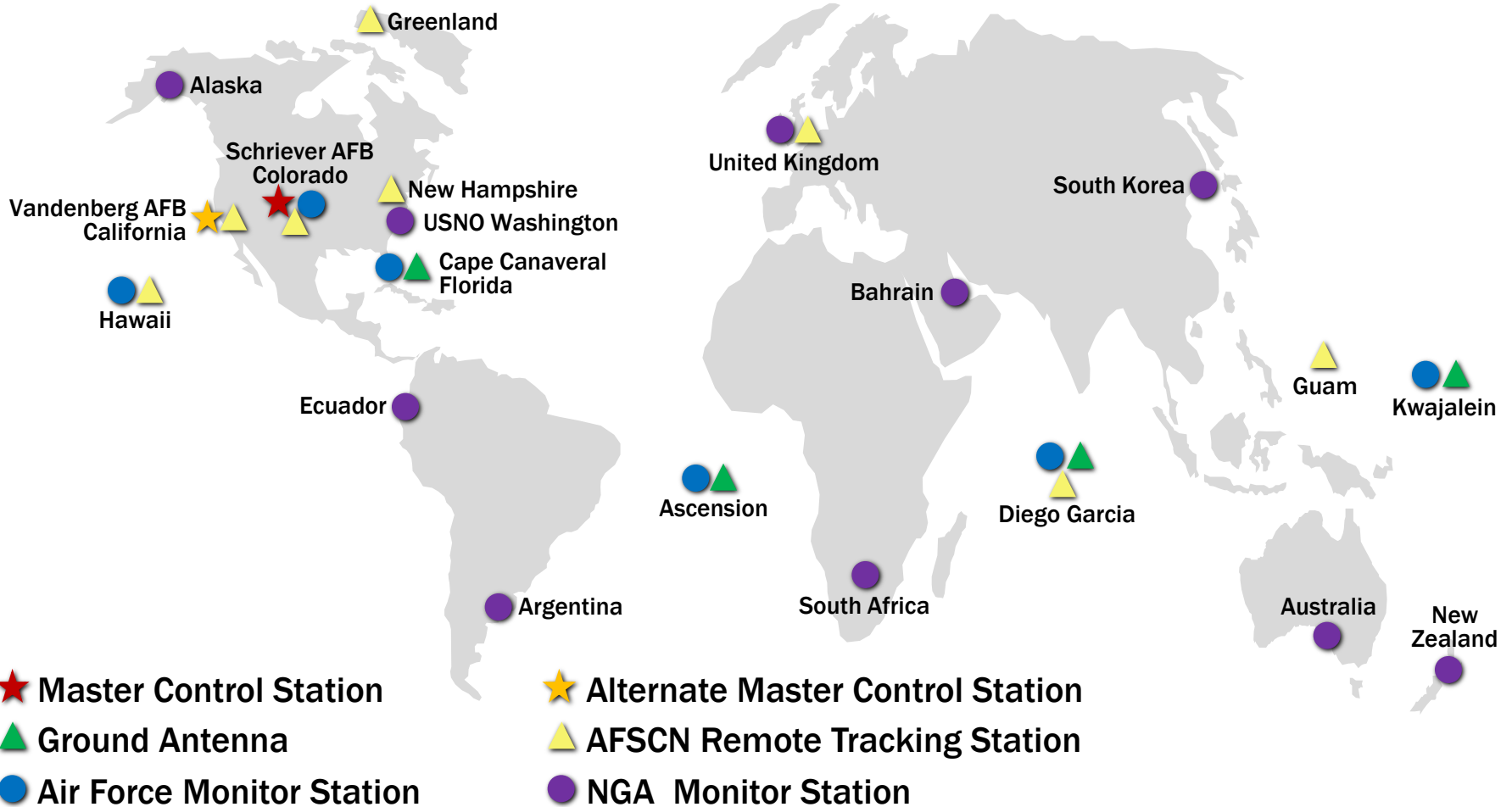
# GPS SPS Signal in Space Performance



**System accuracy exceeds published standard**



# GPS Control Segment





# Overview



- **Global Positioning System**
- **GPS Applications**
- **GPS Modernization Plans**
- **U.S. Policy**



# U.S. Economic Benefits of GPS



*Excerpts from 2011 NDP Consulting report commissioned by the “Save Our GPS” Coalition:*

- “We estimate that the value to the U.S. economy of the productivity gains and input cost reductions alone amounts to **between \$68 billion and \$122 billion per year....**”
- “In addition, GPS technology creates direct and indirect positive spillover effects, such as emission reductions from fuel savings, health and safety gains in the work place, time savings, job creation, higher tax revenues, and improved public safety and national defense.”
- “Today, there are more than **3.3 million jobs** that rely on GPS technology....”





# GPS Offers Enormous Value to Developing Nations



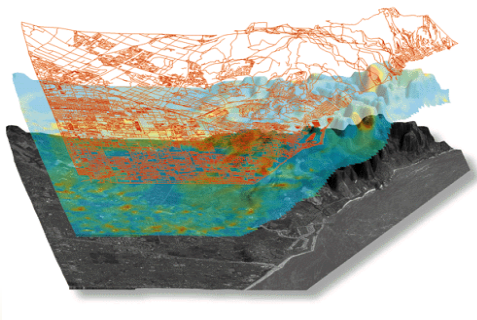
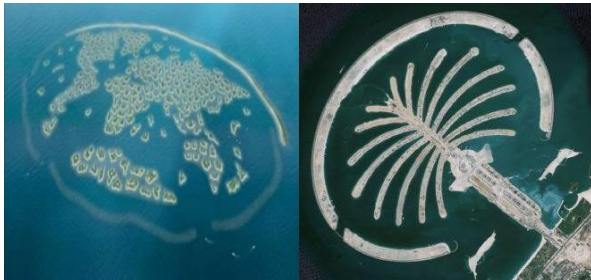
- **Obviates need to develop terrestrial infrastructure for positioning, navigation, and timing**
- **Supports a wide range of sustainable development activities including:**
  - **Surveying, mapping, GIS**
  - **Construction, mining**
  - **Agriculture**
  - **Timing for telecom, banking, power grid management**
  - **Disaster management**
  - **Environmental stewardship**



# Surveying, Mapping, GIS



- **Surveying is essential to development**
  - Real estate
  - Power lines, telecom towers, pipelines
  - Dams and bridges
  - Port dredging
- **GPS enables 2-5 cm real-time positioning accuracy**
  - Mm-level accuracy possible with post-mission data processing
- **100%-300% savings in time, cost, labor**
- **Stakeless, paperless surveys**

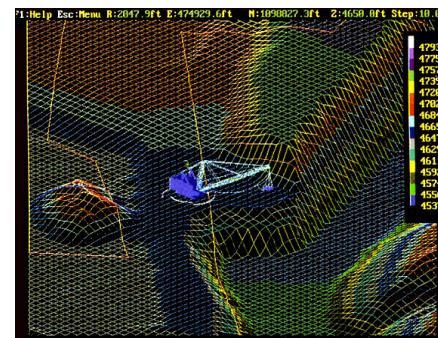




# Construction & Mining



- **Faster site preparation**
- **Enhanced management of assets, equipment**
  - More efficient asset utilization
- **Precise machine control**
  - Up to 70% increased job site productivity
  - Saves time, fuel, and emissions
  - Reduces maintenance
  - Prevents accidents
- **Automated, wireless job tasking**
  - Smaller, more empowered workforce





# Agriculture



- **Greater crop yields, profit margins**
- **Optimized placement of crop rows, seeds, and nutrients**
- **Enhanced monitoring of crop yields and soil fertility**
- **Automated, 24-hour operations using lighter equipment, less fuel, less labor**
- **Plant-specific applications of water, fertilizer, pesticides, herbicides**
- **Environmental benefits**





# Timing



- **GPS provides precise time needed to synchronize large networks**
- **Telecommunications**
  - Wired and wireless
- **Finance**
  - Stock exchanges
  - ATMs
- **Power grids**
  - Load balancing
  - Fault detection, location







# Disaster Management



- Assists in disaster planning efforts such as flood plain mapping
- Helps relief workers navigate disaster areas devoid of landmarks
- Facilitates containment and management of wildfires
- Enables disaster warning systems
  - GPS-equipped buoys for tsunami warnings
  - GPS ground networks monitor crustal motion, earthquakes

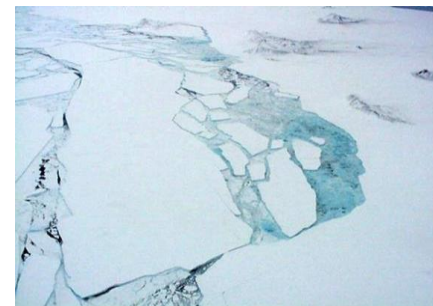




# Environmental Stewardship



- **Climate monitoring**
  - Sea level rise measurements
  - Ice sheet change observations
  - Atmospheric moisture profiles
- **Reduced greenhouse gas emissions**
  - Efficient routing of aircraft, trucks, and other vehicles
  - Reduction of vehicle fleet idle times
- **Oil and chemical spill cleanup**
  - Positioning, modeling of spills to guide remediation efforts
- **Commercial fishing**
  - Enforcement of fishery boundaries
- **Forestry**
  - Monitoring of illegal deforestation





# Overview

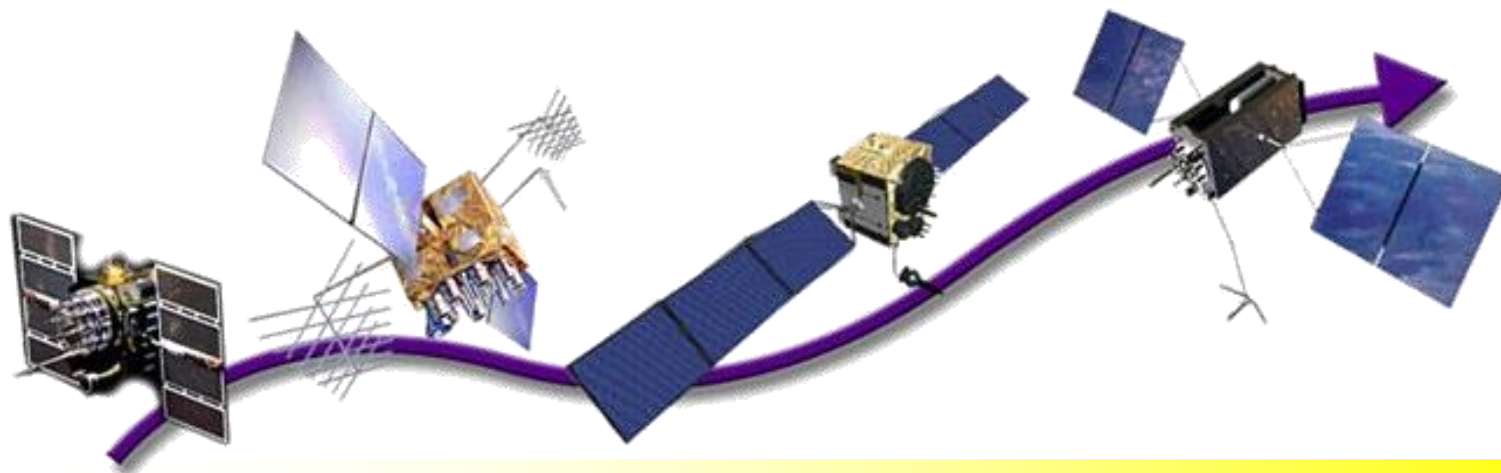


- **Global Positioning System**
- **GPS Applications**
- **GPS Modernization Plans**
- **U.S. Policy**





# 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



# New Civil GPS Signals



Signal	Benefits	# of Satellites Broadcasting Now	Availability on 24 Satellites
L2C	Meets commercial needs for ionospheric correction, higher effective power, etc.	14	~2018
L5	Meets requirements for safety-of-life transportation; enables triple-frequency positioning techniques	7	~2021
L1C	GNSS interoperability; performance improvements in challenged environments	Will start with GPS III + OCX	~2026

***New civil navigation message (CNAV) for L2 and L5 began broadcasting in April 2014***



# Status of GPS III and OCX



- **GPS Block III**
  - Non-Flight Satellite Testbed completed testing
  - First 8 satellites now in production
  - Future satellites to add **search and rescue payload (SAR/GPS)** and satellite laser retroreflectors
  - Studying options for cost savings
- **Next Generation Operational Control System (OCX)**
  - Block 0 (GPS III launch and checkout): **2015**
  - Block 1 (L1 C/A, L2C, L5, P-Code): **2018**
  - Block 2 (L1C and M-Code): **2019**



# Overview



- **Global Positioning System**
- **GPS Applications**
- **GPS Modernization Plans**
- **U.S. Policy**



# U.S. Policy Promotes Global Use of GPS Technology



- **No direct user fees for civil GPS services**
  - Provided on a continuous, worldwide basis
- **Open, free access to information necessary to use civil GPS and augmentations**
  - Anyone can develop applications, user equipment, and value-added services
  - Encourages market-driven competition
- **Global compatibility and interoperability with GPS**
- **Service improvements for civil, commercial, and scientific users worldwide**
- **Protection of radionavigation spectrum from disruption and interference**



# National Space Policy

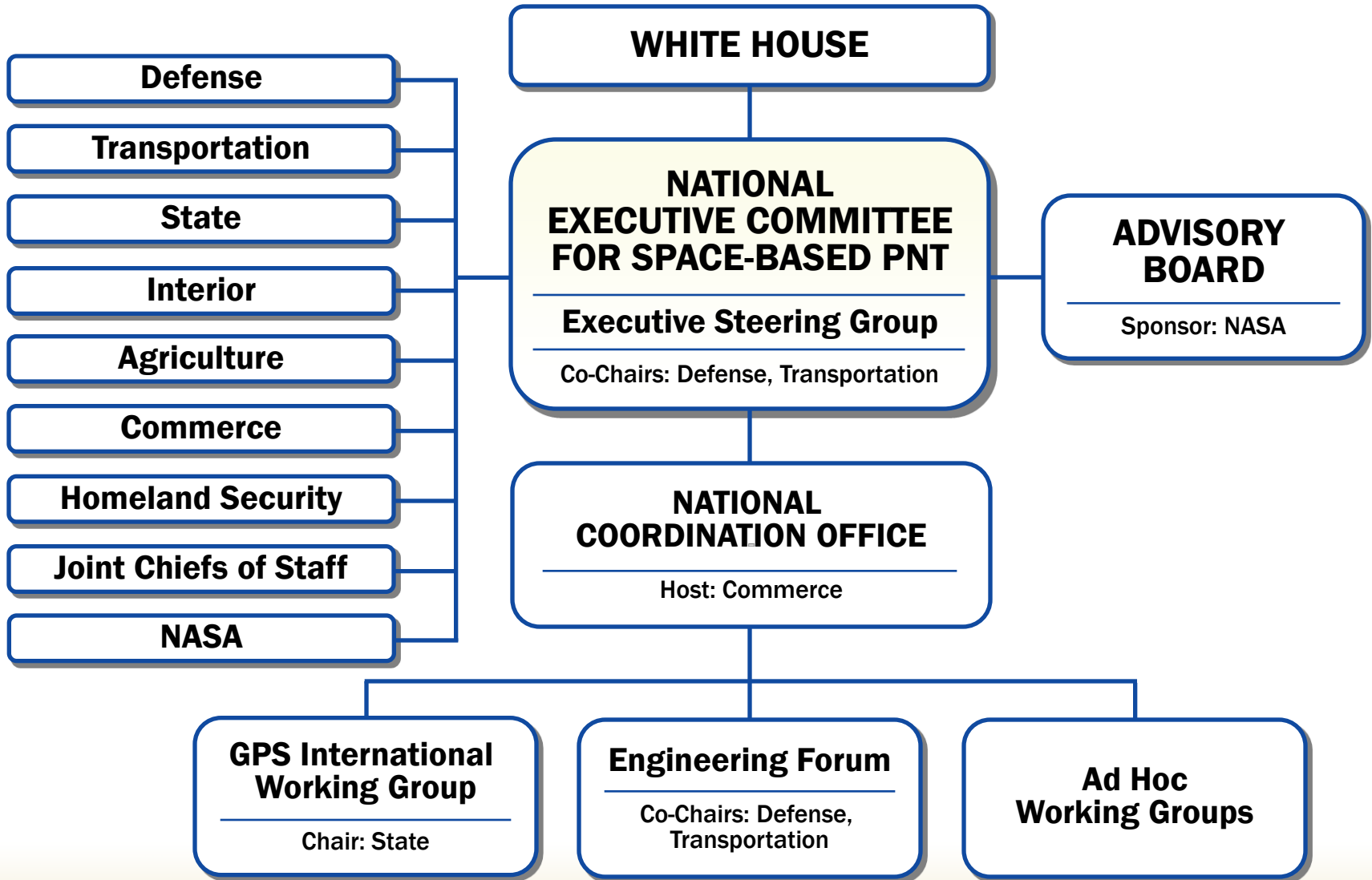


***“The United States must maintain its leadership in the service, provision and use of global navigation satellite systems (GNSS).”***

- Provide continuous worldwide access to GPS 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



# Governance Structure





# Summary



- **GPS enables many applications that support sustainable development**
- **GPS performance is better than ever and will continue to improve**
- **U.S. policy provides a stable foundation for international GPS use, trust, and cooperation**





# For More Information



The screenshot shows the GPS.gov website interface. At the top, there is a language selection menu with options for English, Español, Français, 中文, and العربية. Below this is the main navigation bar with links for Home, What's New, Systems, Applications, Governance, Multimedia, and Support. A sidebar on the left contains links for various user groups: For General Public, For News Media, For Congress, For Internationals (circled in red), For Professionals, and For Students. The main content area features a map with the headline "Get Help with Wrong Directions, Missing Locations, etc., on GPS Devices" and a "GET HELP" button. Below the map are "Feature Stories" including "Oct 29: Fourth GPS Satellite Launch Success of 2014", "FCC Proposes \$34.9M Fine for Signal Jammer Manufacturer", and "Attention Truckers: Do Not Use Consumer GPS Devices". There is also a "New Additions to GPS.gov" section with a list of recent updates and a "Common Questions" section.

[www.gps.gov](http://www.gps.gov)

- This presentation
  - Contact info
  - Multi-language content
  - International cooperation
  - GPS program & policy info
  - Spectrum & interference
- ...and much more!