



SPACE-BASED POSITIONING
NAVIGATION & TIMING

NATIONAL COORDINATION OFFICE

U.S. Programs & Policy

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U.N./Colombia/U.S.A. Workshop on the Applications of GNSS
Medellin, Colombia
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Overview



- **Introduction**
- **Global Positioning System**
- **GPS Augmentations/Backups**
- **U.S. Policy**

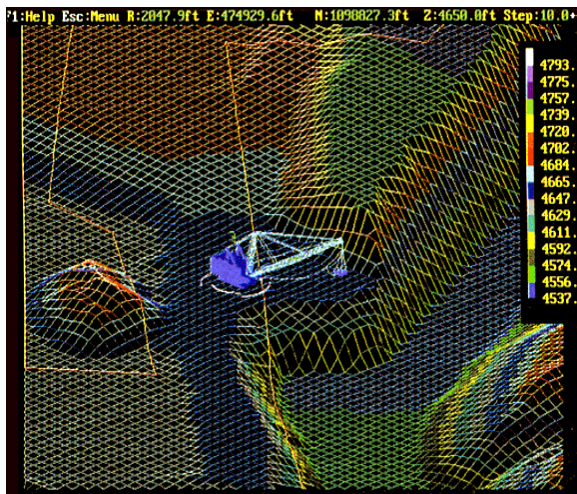


GPS is a Critical Component of the Global Information Infrastructure

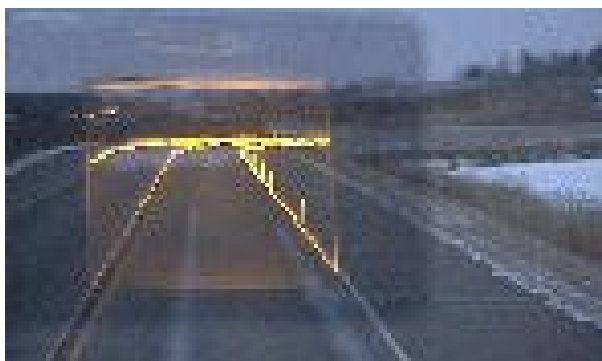




New Applications Evolve Every Day



- Wireless/mobile applications
- Child/pet tracking
- Spacecraft control
- Power grid management
- Open pit mining
- Automatic snowplow guidance





Keys to the Global Success of GPS



- **Program Stability and Performance**
 - Civil service performance commitment met continuously since December 1993
 - Continuity of constellation and signals ensured through Air Force operation and acquisition
 - Continuous improvements in accuracy, availability, etc.
 - Funding through U.S. taxpayers
- **Policy Stability and Transparency**
 - Open access to civil GPS signals, free of direct user fees
 - Open, free, and stable technical documentation
 - Market-based competition worldwide
 - Liberal export controls on GPS user equipment
 - National-level policy coordination including civil and military leaders
- **Commercial Entrepreneurship and Investment**



Overview



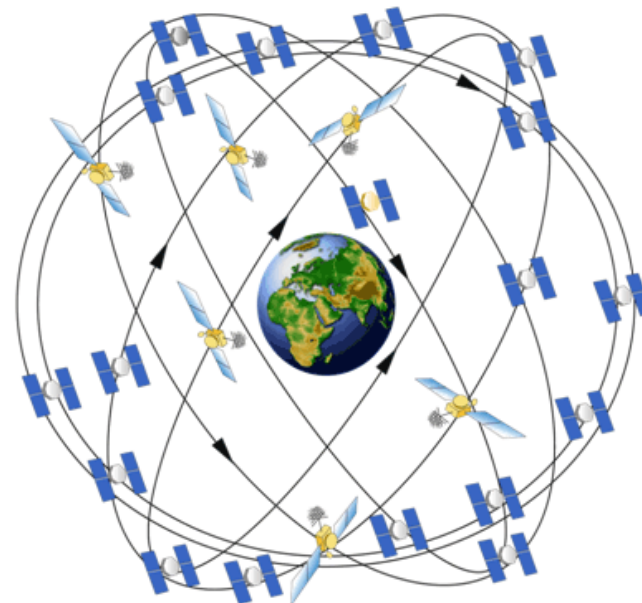
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The Global Positioning System



- **Baseline 24 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





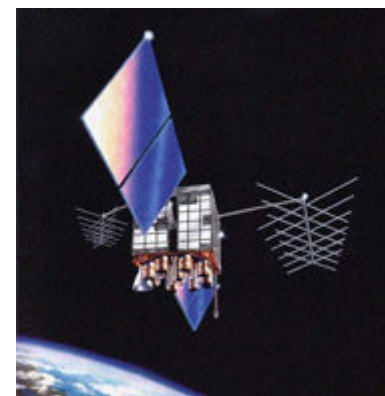
GPS Constellation Status



31 Operational Satellites

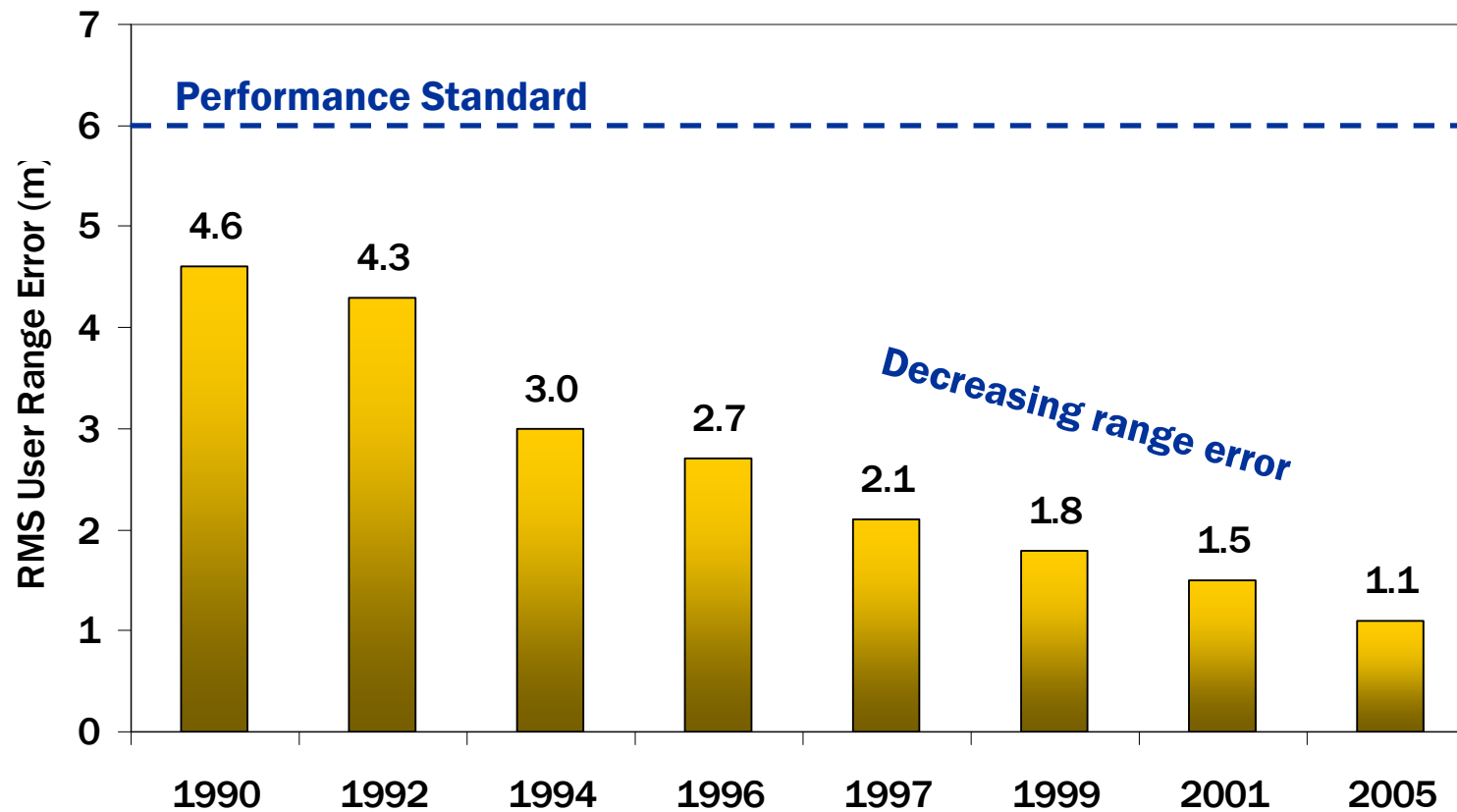
As of June 1, 2008 (Baseline Constellation: 24)

- **13 Block IIA**
- **12 Block IIR**
- **6 Block IIR-M**
 - Transmitting new second civil signal
- **Continuously assessing constellation health to determine launch need**
 - 2 Block IIR-M's remaining
 - Next launch: September 2008





GPS Signal in Space Performance



System accuracy far exceeds published standard



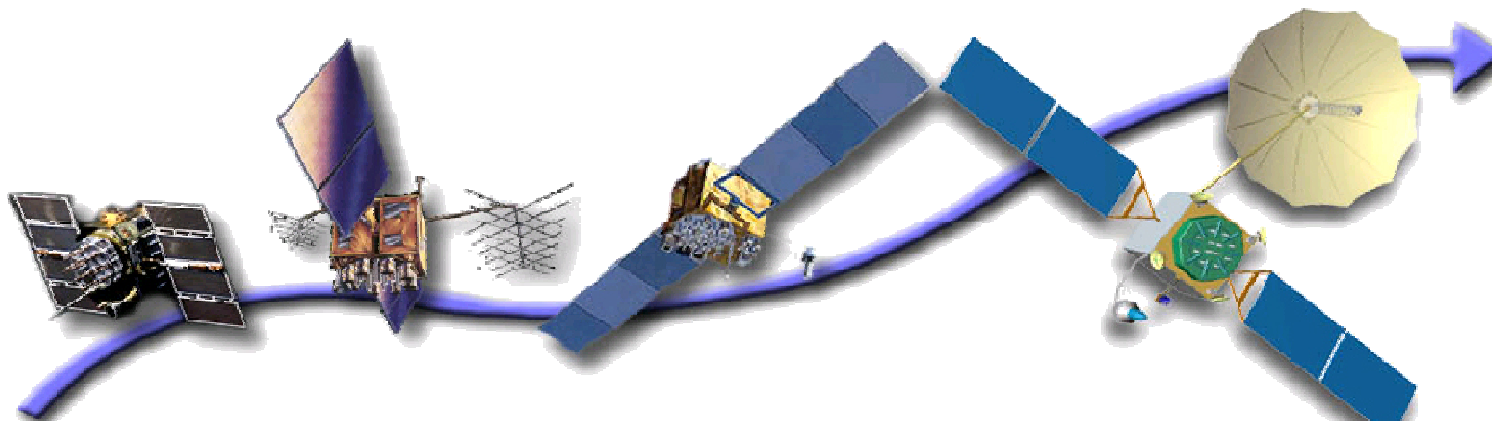
Recent GPS Improvements



- **Launched 3 modernized satellites in past 7 months**
 - Largest GPS constellation size ever
 - Retiring old satellites improves overall GPS accuracy
- **Transitioned to entirely new, modernized master control station**
 - Improved operational flexibility and responsiveness
 - Added backup control station
- **Expanded GPS ground network to triple amount of monitor data sent to control station**
 - 10-15% improvement in accuracy of GPS data broadcast



GPS Modernization Program



Increasing System Capabilities ♦ Increasing Defense / Civil 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: IIA/IIR capabilities plus

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

IIF: IIR-M capability plus

- 3rd civil signal (L5)
- Anti-jam flex power

Block III

- Backward compatibility
- 4th civil signal (L1C)
- Increased accuracy
- Increased anti-jam power
- Assured availability
- Navigation surety
- Controlled integrity
- Increased security
- System survivability



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**
- **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, centimeter-level accuracy using new techniques**
- **Opportunity for international interoperability**
- **Demonstration signal to be launched in 2008**
- **24 satellites by 2018**





Fourth Civil Signal (L1C)



Under trees



Inside cities

- 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



GPS III Update



- **Contract for GPS III-A satellites awarded in May**
 - Selective Availability feature to be eliminated
- **Contracts for Next-Generation Operational Control Segment (OCX) awarded in January**
 - Will implement full functionality of L2C and L5
- **Future increments of GPS III will incorporate additional capabilities**
 - As technology matures and new requirements are validated



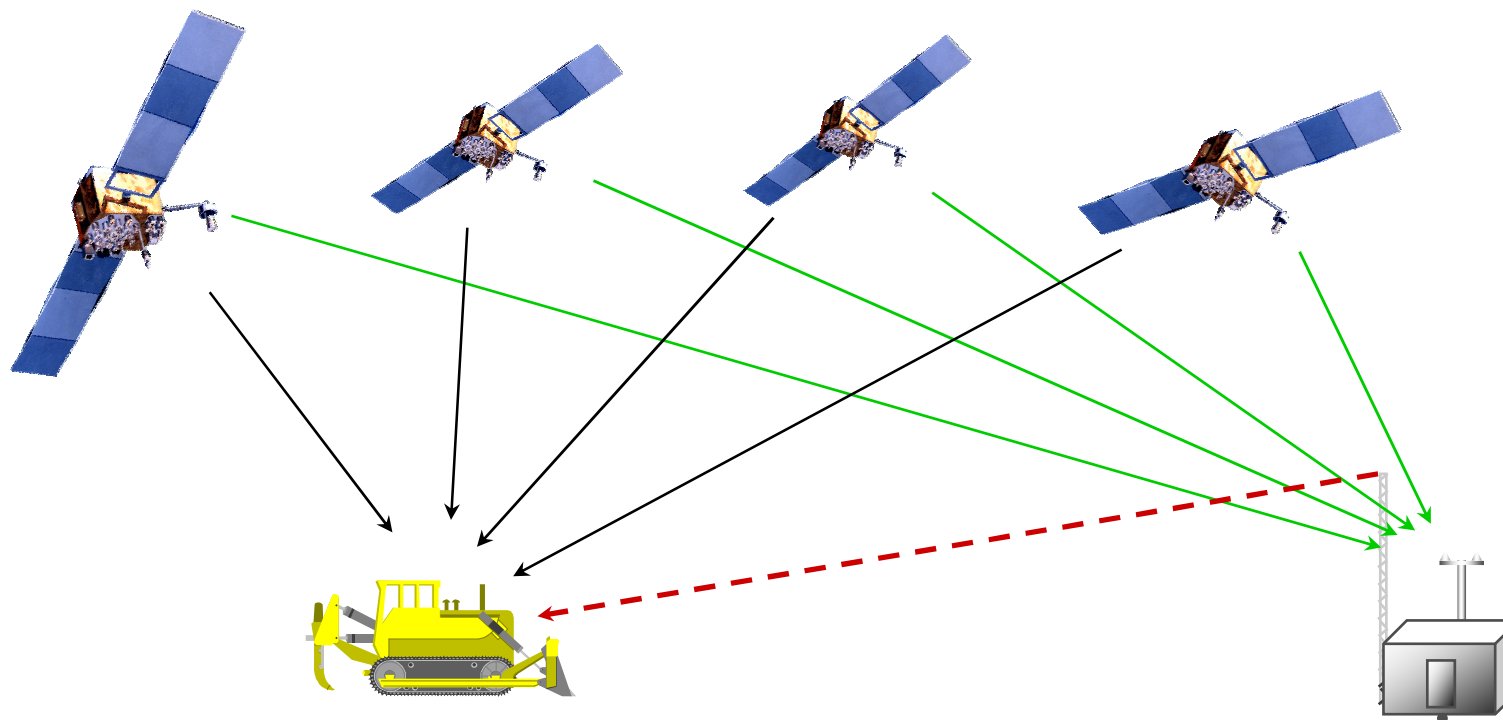
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Augmentations Improve GPS Performance



Enhanced accuracy

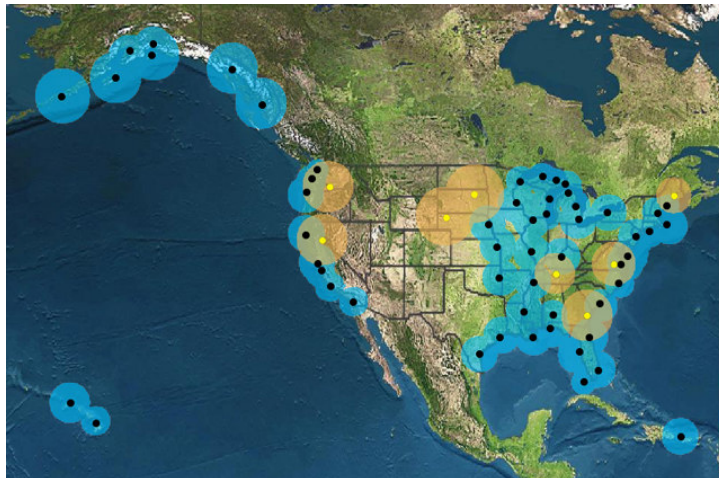
- <3 m vertical accuracy for aviation
- 2-5 cm for real-time positioning, surveying, etc.
- <1 cm for geodesy, geology, etc.

Integrity monitoring

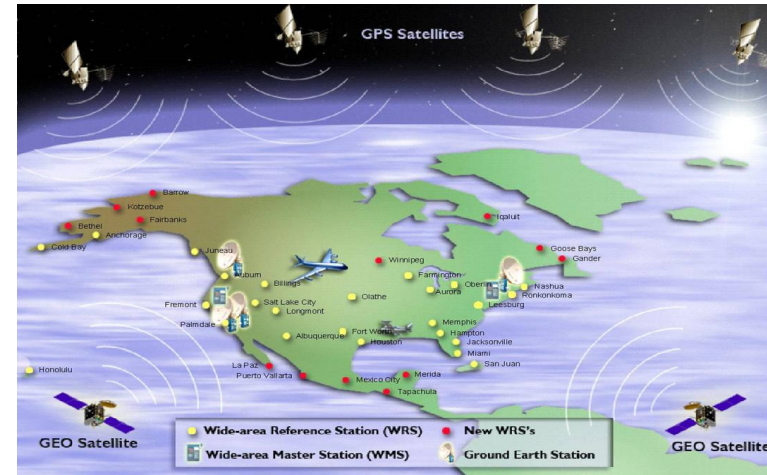
- 6 sec time to alarm for aviation



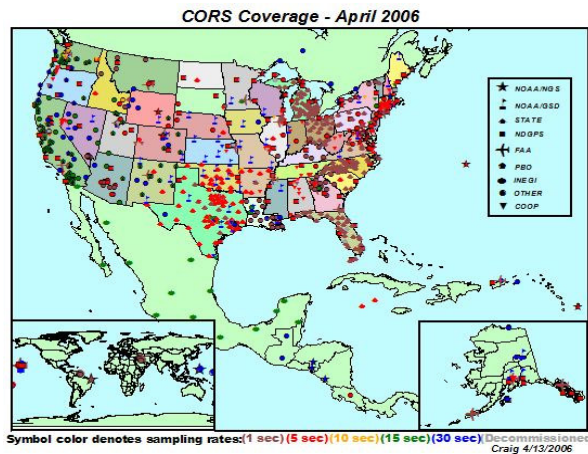
U.S. Augmentations



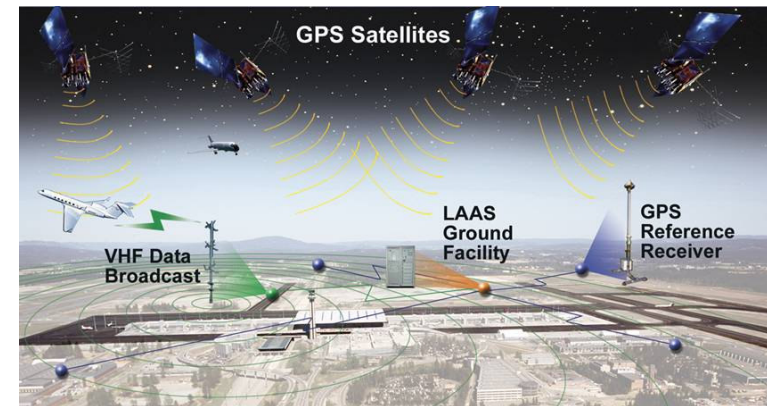
Nationwide Differential GPS



Wide Area Augmentation System



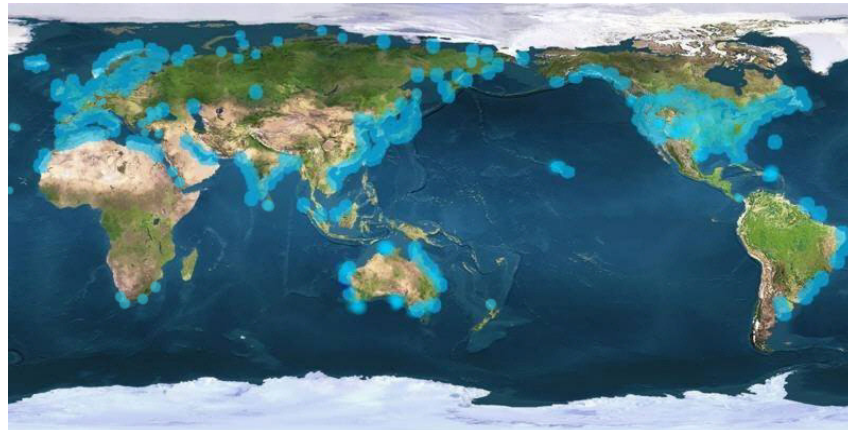
Continuously Operating Reference Stations



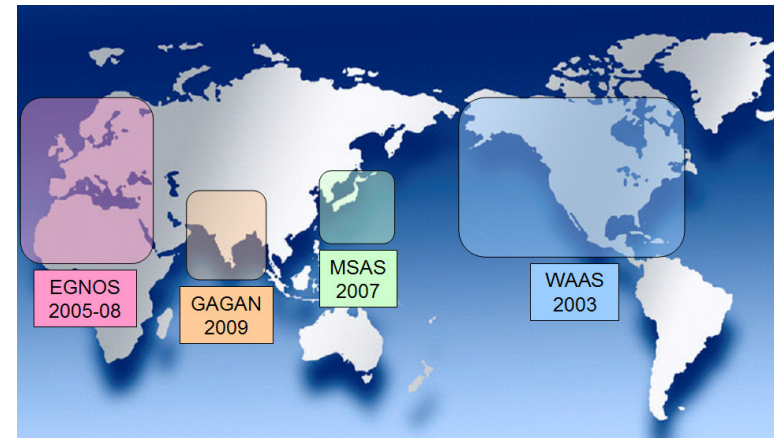
Local Area Augmentation System



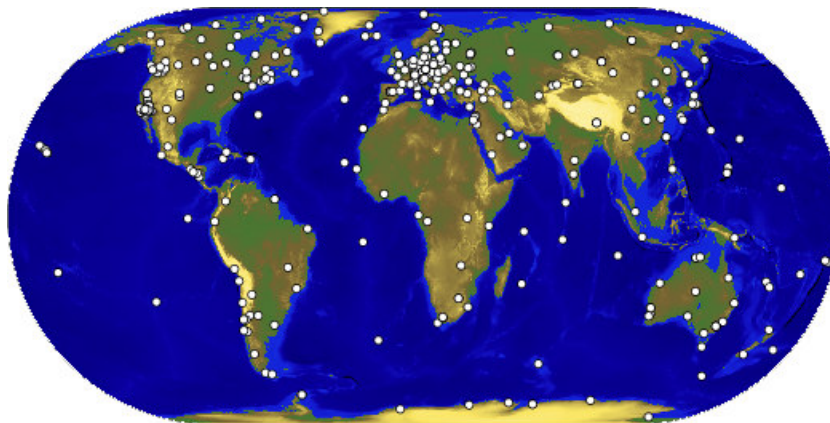
International Augmentations



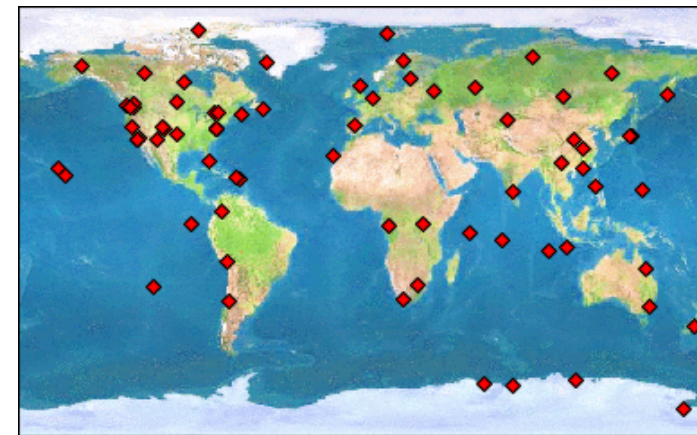
Differential GPS Networks



Satellite-Based Augmentation Systems



International GNSS Service



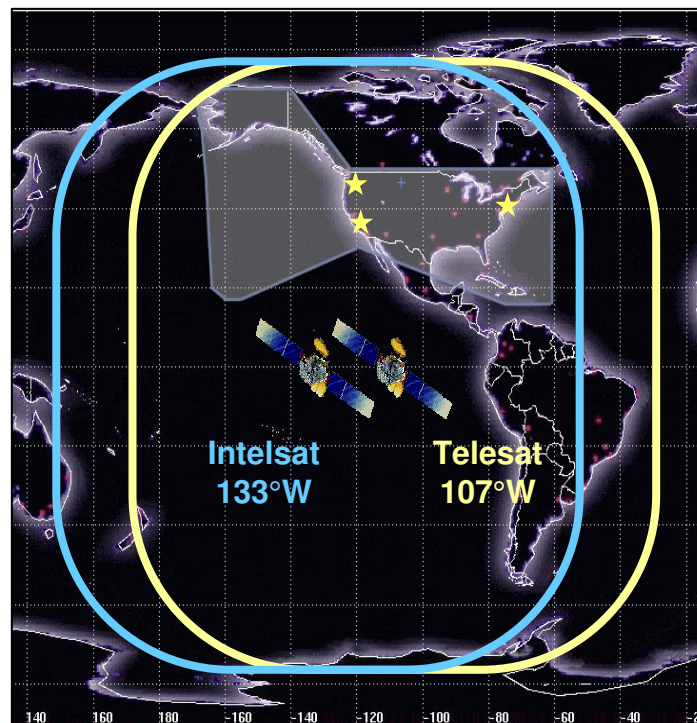
Global Differential GPS System



Wide Area Augmentation System

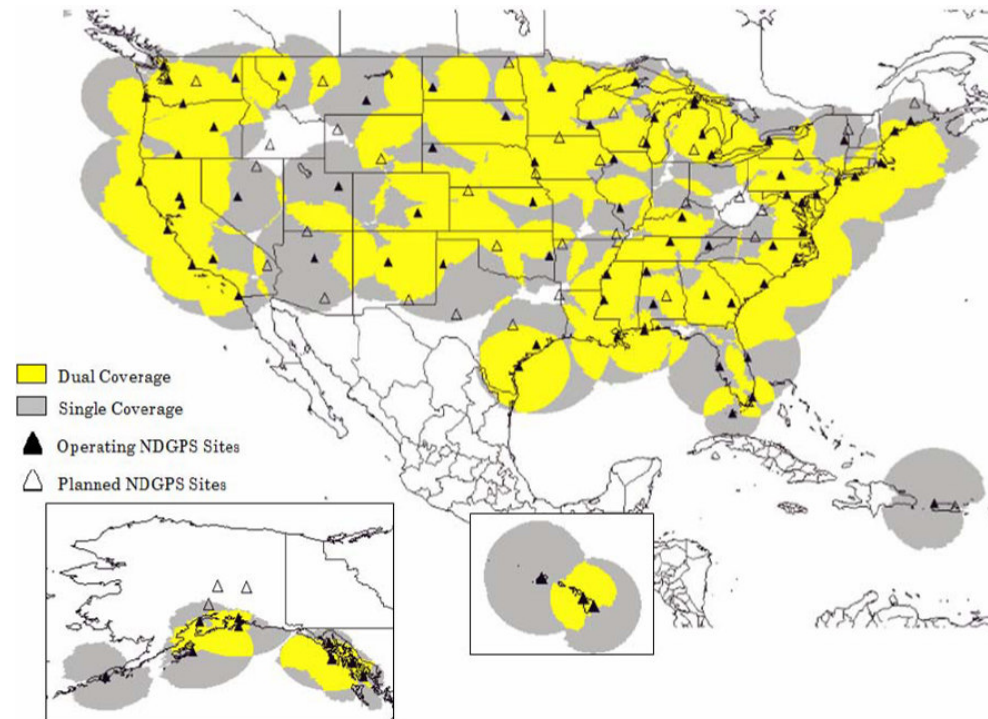


- **Two replacement satellites launched in 2005**
 - Intelsat (Galaxy XV) and Telesat Canada (Anik F1R)
 - Provides dual coverage over United States
- **Service expanded into Canada and Mexico**
 - New reference stations in Mexico (5) and Canada (4)
 - Operational Sep 2007





Nationwide Differential GPS



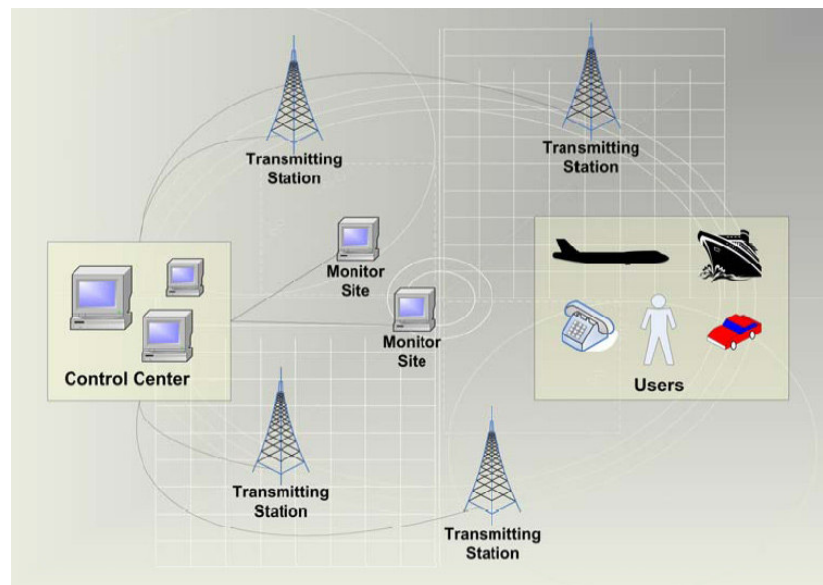
- Expansion of maritime differential GPS (DGPS) network to cover terrestrial United States
- Built to international standard adopted in 50+ countries
- Department of Transportation recently re-committed to continuing inland element of NDGPS



Enhanced Loran as National Backup to GPS



- **Enhanced Loran (eLoran) announced as national backup to GPS for PNT in Feb 2008**
 - As recommended by Independent Assessment Team and National Executive Committee
 - Funded through Department of Homeland Security
- **Will replace legacy Loran-C system**





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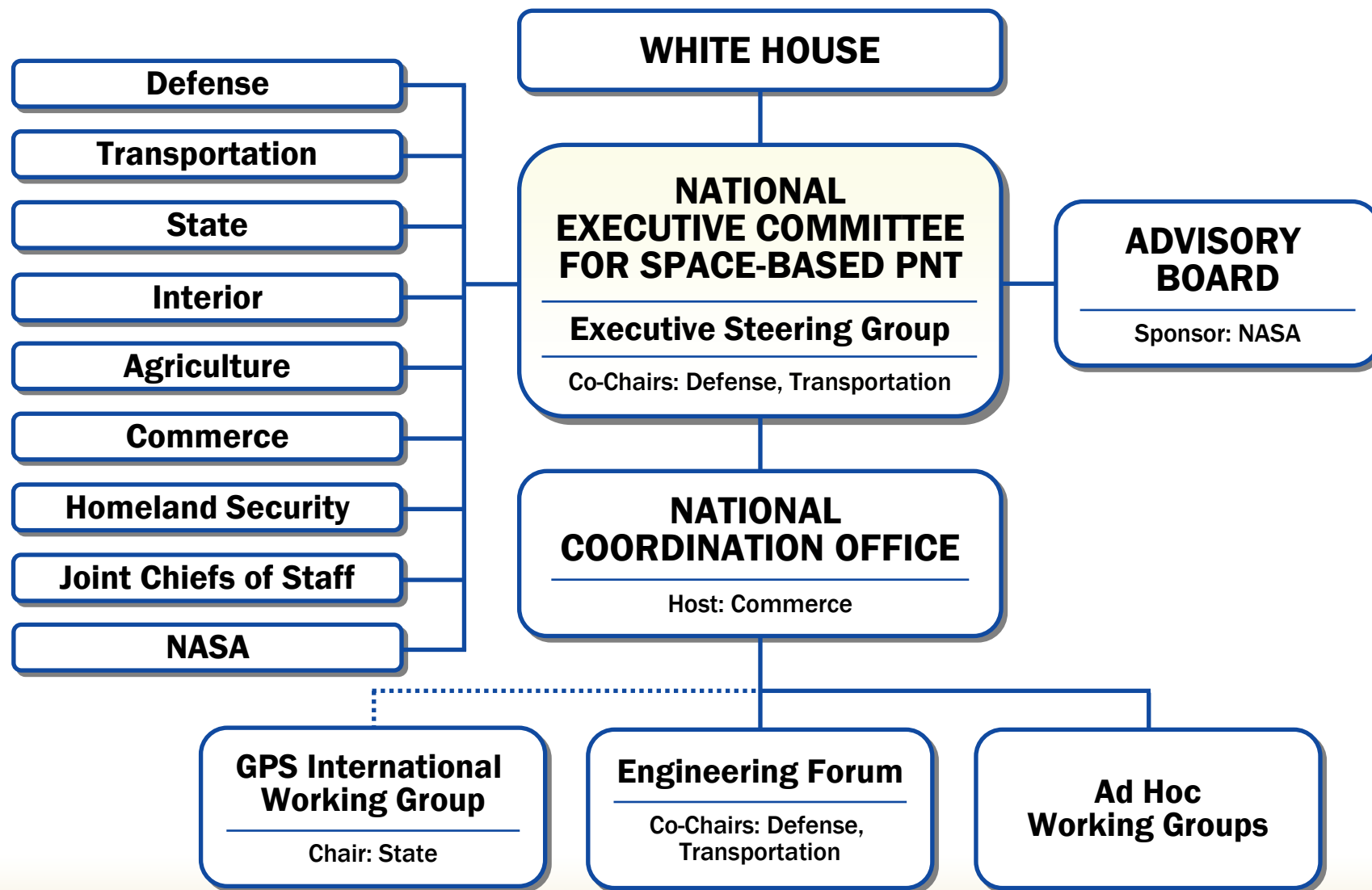
U.S. Policy Promotes Global Use of GPS Technology



- **No direct user fees for civil GPS services**
 - Provided on a continuous, worldwide basis
- **Open, public signal structures for all civil services**
 - Promotes equal access for user equipment manufacturing, applications development, and value-added services
 - Encourages open, 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**



U.S. Space-Based PNT Organization Structure





Executive Committee Activities



- **Program Coordination**
 - Five-Year National Plan
 - National PNT Architecture
 - GPS Modernization
 - Civil GPS Funding
 - Nationwide Differential GPS
 - Enhanced LORAN
 - Distress Alerting Satellite System
- **International Cooperation**
 - Bilateral
 - Multilateral
- **Spectrum Management**
 - Interference Detection and Mitigation Plan
 - Spectrum Protection Plan
- **Outreach**
 - Publications, websites
 - Educational exhibit
 - Conferences, workshops, other venues
 - Coordination of U.S. message



International Cooperation



- **Cooperative relationships established with Europe, Japan, Russia, India, Australia**
- **U.S. goals:**
 - **Compatibility and interoperability**
 - **National security**
 - **Level playing field in global markets**
- **Multilateral cooperation**
 - **International Committee on GNSS**
 - **ICAO, IMO, NATO**





International Committee on GNSS



- Promotes GNSS use and integration into infrastructures, particularly in developing countries
- Encourages system compatibility, interoperability
- Membership: GNSS providers, international organizations and associations
- Providers Forum
 - United States, Europe, Russia, China, India, Japan
 - Focused discussions on compatibility, interoperability
- Next plenary: Dec 2008, California, U.S.A.





Summary



- **GPS performance is better than ever and will continue to improve**
 - Augmentations enable even higher performance
 - New civil GPS signal available now
 - Many additional upgrades scheduled
- **U.S. policy encourages worldwide use of civil GPS and augmentations**
- **International cooperation is a priority**
 - Compatibility and interoperability are critical



For Additional Information...



GPS.gov

PNT.gov

¡Muchas Gracias!



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