



# **U.S. Space Based PNT Policy and GPS Modernization**

***Session 2: Policies and strategies for promoting sustainable development***

**United Nations/Zambia/ESA Regional Workshop on  
the Applications of Global Navigation Satellite System Technologies  
in Sub-Saharan Africa**

***26 June 2006, Lusaka, Zambia***

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# Overview

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- GPS Today
- U.S. Policy
- GPS Status and Modernization Program
- Summary



# GPS Today

- GPS is a global utility with GPS providing a solid foundation for global positioning, navigation and timing
  - Consistent, predictable, dependable performance
  - Facilitating efficiency, safety, environmental, public security, scientific and many other innovations
- Like the Internet, GPS is now a critical component of the Global Information Infrastructure
  - Augmentations improving performance of safety services free of direct use charges
  - Scalable applications enabling untold, new capabilities
  - Toolkit — plug in, use what you need, add what you want

**Available Now--Empowering the Future**



# GNSS Advancing

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- Sep 2005 – 2<sup>nd</sup> civil GPS signal
- Dec 2005 – first Galileo test satellite
- Dec 2005 – 3 GLONASS satellites
- This year – European EGNOS operational
- Japan preparing for MTSAT ops in 2007 and QZSS
- India moving forward with GAGAN

**Interoperability key to seamless global operations**



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# U.S. Policy

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- 1996 policy introduced GPS as a dual use system and presented vision for use of GPS
- 2004 U.S. Space-Based Positioning, Navigation, and Timing (PNT) Policy recognizes changing international conditions and worldwide growth of GNSS applications based on GPS



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# Policy Objectives

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- Provide space-based civil PNT services free of direct user fees on a continuous, worldwide basis
  - Civil, commercial, homeland security and scientific use
- Commits to continued modernization of GPS and its augmentations - improving global services
  - Ensure civil requirements are met and civil services exceed, or are at least equivalent to, those of other international civil space-based PNT services
  - Improve resistance to interference for civil, commercial, homeland security, and scientific users
  - Provide uninterrupted access to space-based PNT for U.S./Allied national security use



# Policy: Objectives (cont'd)

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- Open, free access to information needed to use civil GPS and its augmentations
- Improve capabilities to deny hostile use of PNT without unduly disrupting civil and commercial access
- Maintain GPS as component of U.S. Critical Infrastructure (multiple sectors)
  - Plan for backup capabilities and services
- Work to ensure other international PNT systems are interoperable with GPS and its augmentations
  - Or, at a minimum, are compatible





# Policy Implementation

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- National Space-Based PNT Executive Committee
  - Chaired by Deputy Secretaries of Defense and Transportation
  - Membership: Deputy Secretaries of State, Commerce, Homeland Security, JCS, and NASA
- National Space-Based PNT Coordination Office
- National-level Planning and Coordination
- Interference Detection and Mitigation
- Federal Advisory Board



# GNSS International Cooperation

- Agreement in 2004 between U.S. and European Union (EU) on GPS and Galileo recognizing benefits of interoperable systems for all parties
- EU and U.S. agreed to implement a common, open, civil signal on both Galileo and future GPS III satellites
- Cooperative relationship with Japan on GPS and ; U.S. looking forward to Japan's progress on a GPS-compatible augmentation known as QZSS
- On-going consultations with India on development of GAGAN
- On-going consultations with Russia on potential cooperation, as well as compatibility and interoperability, between GPS and GLONASS



June 26, 2004 Press Conference at US-EU Summit in Shannon, Ireland (left to right: US Sec. of State Colin Powell, Irish Foreign Minister Brian Cowen, EU Vice-President Loyola De-Palacio) 10



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# U.S. Policy: Summary

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- U.S. Government commitment to improving GPS and its augmentations for all stakeholders (Domestic and International)
- Framework for public and private decisions
- Coordinated planning and activities
- United States does not intend to ever implement Selective Availability again and is committed to preventing hostile use of PNT through regional denial of service
- Promotes common standards for worldwide interoperability
- Creates basis for meaningful dialogue between global service providers and end users



# Overview

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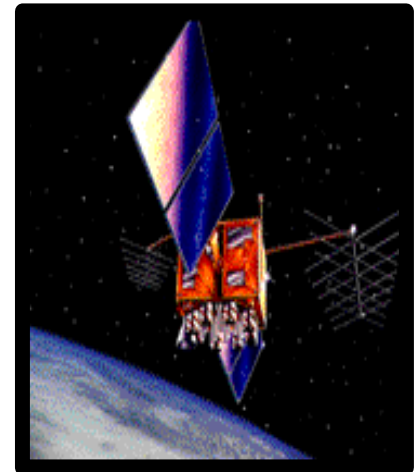
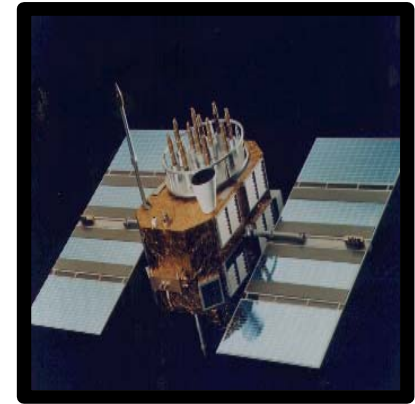
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# GPS Constellation Status

28 Operational Satellites  
(Baseline Constellation: 24)

- 15 Block II/IIA satellites operational
- 12 Block IIR satellites operational
  - Modernizing 8 Block IIR satellites
- 1<sup>st</sup> Block IIR-M transmitting (25 Sep 05)
  - Set operational 16 Dec 05
- Continuously assessing constellation health to determine launch need
  - Next launch (Block IIR-M): 14 Sep 06
- Global GPS civil service performance commitment met/exceeded since Dec 93



# Civil GPS Performance (2005)

- GPS SPS Performance Standard – October 2001
  - Defines performance U.S. Gov't commits to provide to civil GPS users
  - Identifies standards U.S. Gov't uses to manage GPS

GPS Performance Standard Metric	GPS Performance Standard October 2001	Representative Performance
<b>Global Accuracy</b> All-in-View <b>Horizontal</b> 95% All-in-View <b>Vertical</b> 95%	<b>13 meters</b> <b>22 meters</b>	4 meters 6 meters
<b>Worst Site Accuracy</b> All-in-View <b>Horizontal</b> 95% All-in-View <b>Vertical</b> 95%	<b>36 meters</b> <b>77 meters</b>	6 meters 10 meters

- In support of the service availability standard, 24 operational satellites must be available on orbit with 0.95 probability (averaged over any day)
- At least 21 satellites in the 24 nominal plane/slot positions must be set healthy and transmitting a navigation signal with 0.98 probability (yearly averaged)



# Recent GPS Improvements

- 1st modernized satellite (IIR-M)
  - Set operational Dec 16, 2005
  - Broadcasting civil L2C and military M-Code
- Accuracy Improvement Initiative
  - 6 additional monitor stations integrated into GPS operational network
  - 5 more follow by end of year
  - Doubles amount of data for signal integrity and constellation performance monitoring;
  - More data improves accuracy 10-15%
- GPS Ops Center (GPSOC) on-line
  - Supporting customers worldwide



**GPS continuing to improve its global services**



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# Ground Control System Expansion Accuracy Improvement Initiative (AII)



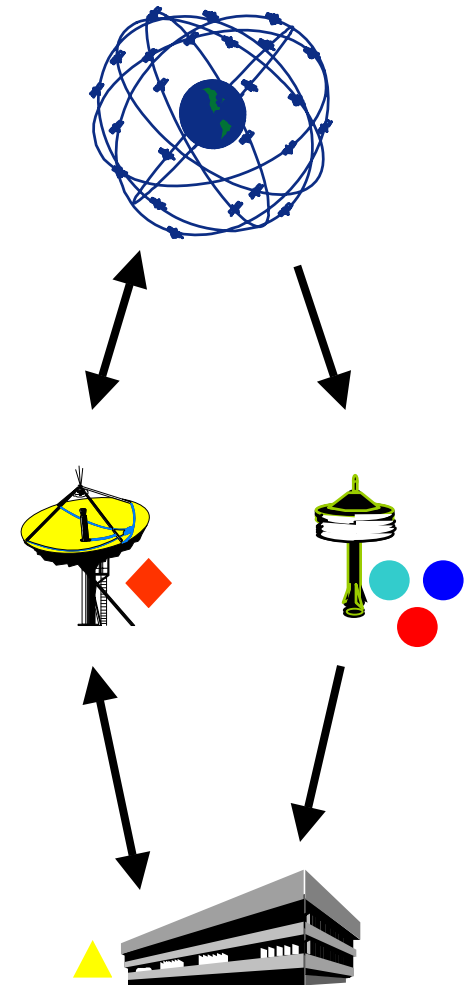
**▲ ▲** Master / Backup Control Stations: Provide navigation estimation (ephemeris and clock), control the satellites, control the operations network, and schedule missions

**● ● ●** GPS / NGA monitor stations / upcoming NGA monitor stations: Monitor navigation messages to collect system performance metrics, collect environment data, send data to OCS to calculate accurate satellite uploads

**◆** Ground antennas: Transmit navigation data / commands and collect telemetry



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# Why Modernize?

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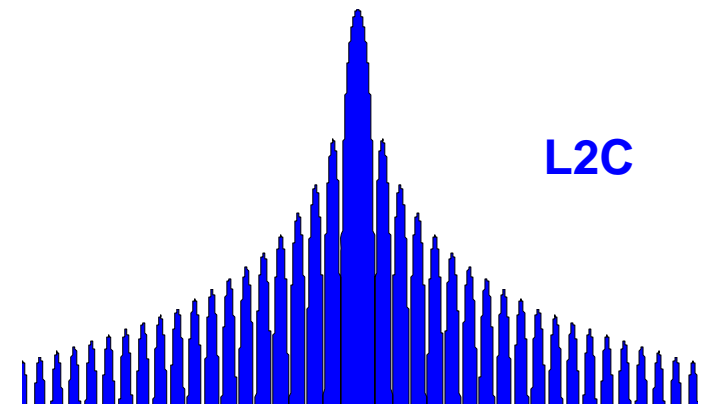
- For civil users, new signals provide:
  - More robustness against interference
  - Compensation for ionospheric delays
  - Wide-laning/tri-laning – more precision
  - Interoperability between constellations increases capability to users with reduced satellite visibility (urban canyon, forest canopy, etc.)
- For military, new spectrally separated signals provide:
  - Protection of friendly use; Prevention of exploitation
  - Preservation of civil use outside area of operations
- For both civil and military, system improvements:
  - More accuracy, availability, integrity, and reliability



# Second Civil Signal (L2C)

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- Improves service for ~ 50,000 current scientific/commercial dual-frequency users
- Civil users now get dual-frequency
- Higher accuracy when combined with legacy civil GPS signal (L1 C/A)
- Less susceptible to interference--potential indoor use
- New data structure improves precision
- Signal defined in IS-GPS-200

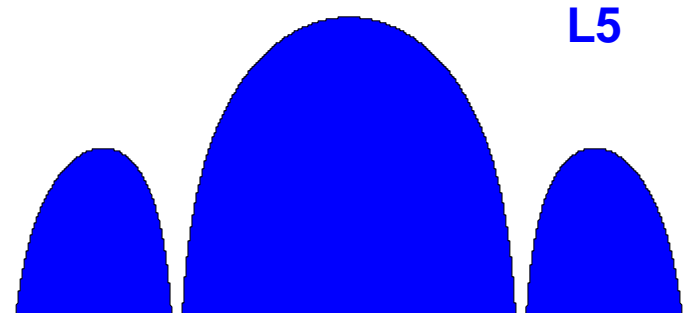


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# Third Civil Signal (L5)

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- Higher power than other GPS civil signals
- In Aeronautical Radionavigation Service Band
- Wider bandwidth improves resistance to interference
- New signal structure for enhanced performance
- Interoperable with Galileo's E5a
- Signal defined in IS-GPS-705



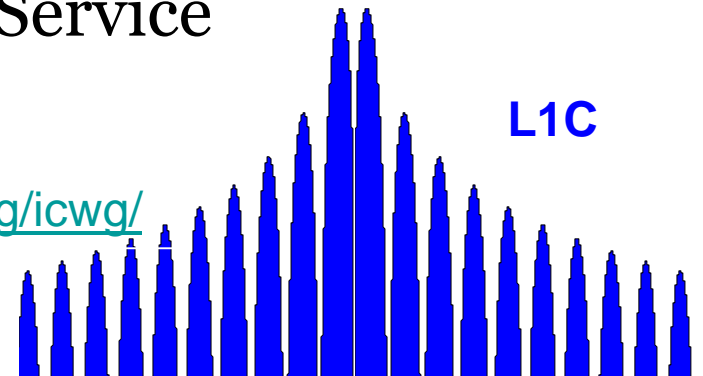
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# Fourth Civil Signal (L1C)

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- Modernized L1 civil signal on GPS Block III
  - L1 C/A retained for backwards compatibility
- Internationally defined civil signal
- Improved code and carrier tracking
- New message structure
- In Aeronautical Radionavigation Service Band
- Common use with Japan's QZSS
- Interoperable with Galileo's Open Service
- Possibility for GLONASS?

For more info: <http://gps.losangeles.af.mil/engineering/icwg/>



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# GPS Modernization Summary

Activity	Implementation Date
<b>Selective Availability (SA) set to zero</b>	May 2000
<b>GPS IIR-M Enhancements</b> - <b>New L2 Civil (L2C) Signal</b> - <b>M-code on L1 &amp; L2</b>	1 <sup>st</sup> satellite operational December 16, 2005
<b>GPS IIF Enhancements</b> - <b>New L2 Civil (L2C) Signal</b> - <b>M-code on L1 &amp; L2</b> - <b>Adds L5</b>	1 <sup>st</sup> launch currently scheduled for 3 <sup>rd</sup> quarter 2008
<b>GPS III Enhancements</b> - <b>Adds L1C</b> - <b>Adds M-code with increased power</b>	1 <sup>st</sup> launch ~ 2013
<b>OCS Enhancements (with All)</b>	On-going



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# Summary

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- Space Based PNT key element of global infrastructure
- U.S. Space-Based PNT Policy benefits global users
- Civil services continue to exceed performance standards
- Modernizations ongoing
  - Control Segment Accuracy Improvement Initiative - completes 2006
  - First new GPS civil signal deployed; Enhancements continue through GPS III
- Augmentations are integral component of Space Based PNT services—utilization increasing
- Compatibility and interoperability GNSS systems critical to service providers and global users



# Contact Information

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# Backup



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# Questions and Answers

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- Isn't GPS controlled by the U.S. military?
- Has GPS ever been turned off by the military?
- Will the United States ever reactivate Selective Availability, since there is a war?
- Has the U.S. Government thought about privatizing GPS? If so, what would that mean for the existing free access to GPS?



# Isn't GPS controlled by the U.S. military?

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- GPS is owned by the United States Government and paid for by the U.S. taxpayer
  - United States Government acquires, maintains and operates GPS through the United States Air Force as a dual use, civil and military system.
  - The Air Force has successfully developed and operated GPS as a multi-use system for the international community since 1972
- Outstanding performance of GPS over decades has earned the confidence of millions of civil and military users worldwide.
- Management improvements and modernization efforts directed by the President in his 2004 continue this support for multi-user applications.



# Has GPS ever been turned off by the military?

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- No. Since it was declared operational in 1995, the Global Positioning System has never been deactivated, despite U.S. involvement in wars, anti-terrorism, and other military activities.
- Millions of users around the world have been monitoring and recording real-time GPS performance on a continuous basis since its inception. If the civilian GPS service had ever been interrupted by its operators, the evidence would be obvious and widespread. No such evidence exists.

Doesn't President's 2004 policy call for deactivation of GPS during national security crises?

- No. The President's policy does not include anything about deactivating GPS. In fact, the policy declares GPS to be an element of the nation's critical infrastructure that must be protected against disruption.



# Has GPS ever been turned off by the military? (continued)

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Policy reaffirms U.S. intent to deny hostile uses of space-based PNT through Navigation Warfare. Navigation Warfare involves **protecting** U.S. and Allied use of GPS while simultaneously **preventing** hostile forces access to space-based PNT services and **preserving** peaceful civil GPS use outside of an area of military operations. The U.S. is committed to fielding a range of necessary denial options to prevent hostile use of space-based PNT through regional denial of service, minimizing impact to peaceful users outside the area of conflict.



# Will the United States ever reactivate Selective Availability, since there is a war?

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- Prior to development of Navigation Warfare, GPS employed a feature called Selective Availability, which degraded civilian accuracy on a global basis. Selective Availability was discontinued in 2000 and the United States has no intent to ever use it again
- The United States does not intend to ever implement Selective Availability again and is committed to preventing hostile use of space-based PNT through regional denial of service, minimizing the impact to peaceful users



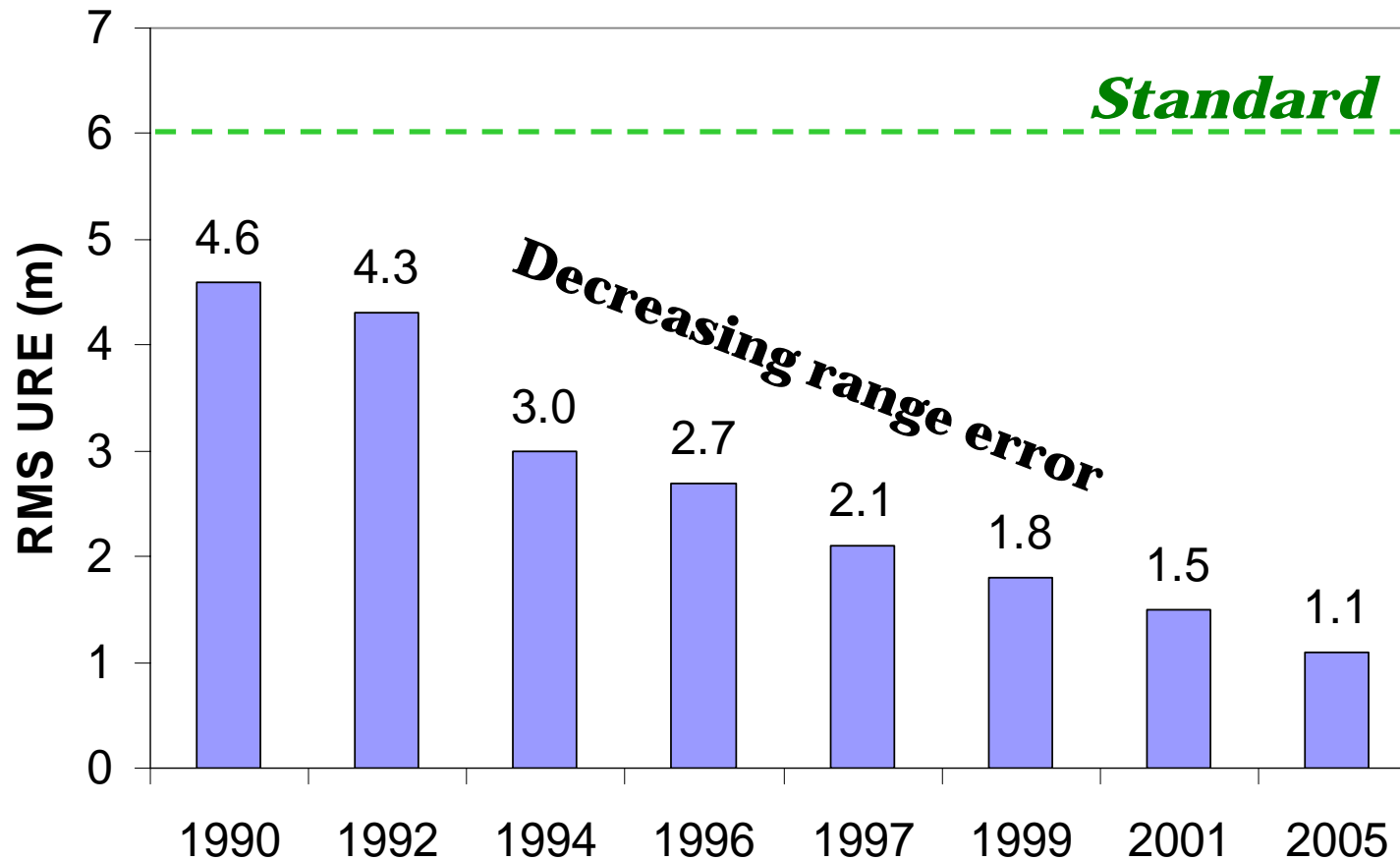
# Has the U.S. Government thought about privatizing GPS? If so, what would that mean for the existing free access to GPS?

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- There are no plans to privatize GPS
- President's 2004 policy
  - Established new management framework for GPS and its augmentations
  - Reaffirmed U.S. Government will provide on a continuous, worldwide basis civil space-based, positioning, navigation, and timing services free of direct user fees for civil, commercial, and scientific uses, and for homeland security through the Global Positioning System and its augmentations, and
  - Provide open, free access to information necessary to develop and build equipment to use these services



# GPS Single Frequency Performance



Signal in Space RMS URE: Root Mean Square User Range Error

**System accuracy far exceeds current standard**



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