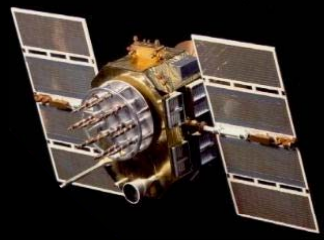

GPS Policy & Plans

28 April 2004

David A. Turner

IGEB Executive Secretariat

OVERVIEW

- Background & Policy
- System Status & Modernization
- IGEB Projects
- Summary

- System Status & Modernization

Background & Policy

- IGEB Projects

- Summary

GPS Background

- Active program for 30 years
  - Created from separate programs in 1973
  - Developmental satellites began launch in 1978; operational satellites in 1989
  - Initial Operational Capability in 1993; Full Operational Capability in 1995
- Designed as a dual-use system
  - Military applications for US and Allied use
  - Civilian applications for worldwide use
- Consistent U.S. National Policy from both Executive and Legislative branches
  - Presidential Decision Directive - March 1996
  - U.S. Public Law - December 1997
- IGEB to manage GPS as a national asset -- increases user trust in GPS as a dual-use system

Policy Principles

- **No direct user fees** for civil GPS services
- **Protect** the current radionavigation spectrum **from disruption and interference**
- **Open public signal structure** for all civil services
  - Promotes equal access for user equipment manufacture, applications development and value-added services
  - Ensures **open market** driven competition
- Use of GPS time, geodesy, and signal **standards**
- **Global compatibility & interoperability** of future systems with GPS
- Recognition of **national and international security** issues and protecting against misuse

International Cooperation Summary

- **U.S. goals**
  - Support GPS Policy Principles
  - Promote Peaceful Civil, Commercial, & Scientific Uses of GPS Worldwide
- US is continuing to work with interested nations on the adoption of safety-of-life augmentations
- US is cooperating with **Japan** in developing the QZSS under the auspices of the 1998 US-Japan Joint Statement
- No recent discussions with **Russia**
- Negotiations with the European Commission on **Galileo** continue
  - Tentative agreement reached on signal structures compatible with **National Security**
  - Other contentious issues are being addressed and an overall **cooperative agreement is nearing completion**

Compatibility/Interoperability
GPS and QZSS

- Common standards
  - System plans to use GPS L1, L2, and L5 civil signal structures (but probably not L1 C/A-code)
  - Control segment linkages to be discussed
- QZSS will improve performance in urban canyons and mountainous regions
- Joint Japan-U.S. Technical Working Group has been established

Compatibility/Interoperability
GPS and Galileo

- Two independent systems
  - Compatibility is essential
  - Interoperability is achievable at the user level
    - Different coordinate reference systems – but within ~ 2 cm
    - Different system times – but with broadcast corrections
    - Different signal structures – but with two shared frequencies
- U.S. Goal is to provide the greatest possible benefit to the largest number of users
  - Simplified, inexpensive receivers
  - Increased availability (greater number of satellites in view)

U.S. & Europe have agreed to a common baseline L1 open civil signal that can become a global standard and is compatible with national/allied/NATO security

- Background & Policy

System Status & Modernization

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Constellation Performance
January 1-September 11, 2002

Specification values from the Standard Positioning Service Performance Standard, October, 2001

PDOP Availability

Specification - PDOP of 6 or Less, 98% of the time
Actual - 99.9%

Horizontal Service Availability

Specification - 95% Threshold of 36 meters, 99% of the Time
Actual – 3.53 meters

Vertical Service Availability

Specification - 95% Threshold of 77 meters, 99% of the Time or Better
Actual – 5.01 meters

User Range Error

Specification - 6 meters or Less, Constellation Average
Actual - 1.43 meters

System accuracy and availability far exceed current specifications, but not current requirements

Why Modernize

- For **civil users**, new signals provide:
  - More robustness against interference
  - Compensation for ionospheric delays
  - Wide-laning/tri-laning -- Resolves integer ambiguities caused by cycle slips during precise carrier phase measurements
- For **military users**, new spectrally separated signals provide:
  - **Protection** of friendly use
  - **Prevention** of adversary exploitation
  - **Preservation** of civil use outside area of operations
- For both civil/military, **system improvements** in accuracy, availability, integrity, and reliability

L2 Civil (L2C) Signal

- **Benefits of L2C versus L2 C/A**
  - **Overcomes some limitations of L1 C/A**
  - **Improved Tracking Capability (~ 3dB higher)**
  - **Better Cross Correlation Protection due to longer codes**
    - **Two Codes Separated by time (e.g. TDMA)**
  - **Improved data structure for enhanced data demodulation (5 dB better than C/A)**
  - **Coherent carrier component favored for high precision applications – longer integration possible**
  - **Improved protection against continuous wave (CW) interference**

Third Civil Signal (L5)

- New signal structure for enhanced performance
  - ~ 6 dB Higher power relative to L1 (minus 154-155 dBW)
  - 20 MHz (minimum) broadcast bandwidth
  - Longer code
  - Higher chipping rate

Ground Control Modernization

- Upgrade monitor stations and ground antennas with new receivers and computers
- Replace existing Master Control Station mainframe computer with a distributed architecture
- Add Accuracy Improvement Initiative
- Build fully mission capable Alternate Master Control Station (AMCS)
- Add IIF command and control functionality
- Add direct civil code monitoring

GPS III Civil Goals

- Significant increase in **system accuracy**
- Assured and improved level of **unaugmented integrity**
- Improved availability of **accuracy with integrity**
- **Backward compatibility** with existing receivers
- **FOC for new civil signals** in combination with IIR-M & IIF satellites
- Smooth transition from **GPS Block II to Block III**

- Background & Policy

IGEB Projects

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Interagency GPS Executive Board

Defense

Transportation

Commerce

State

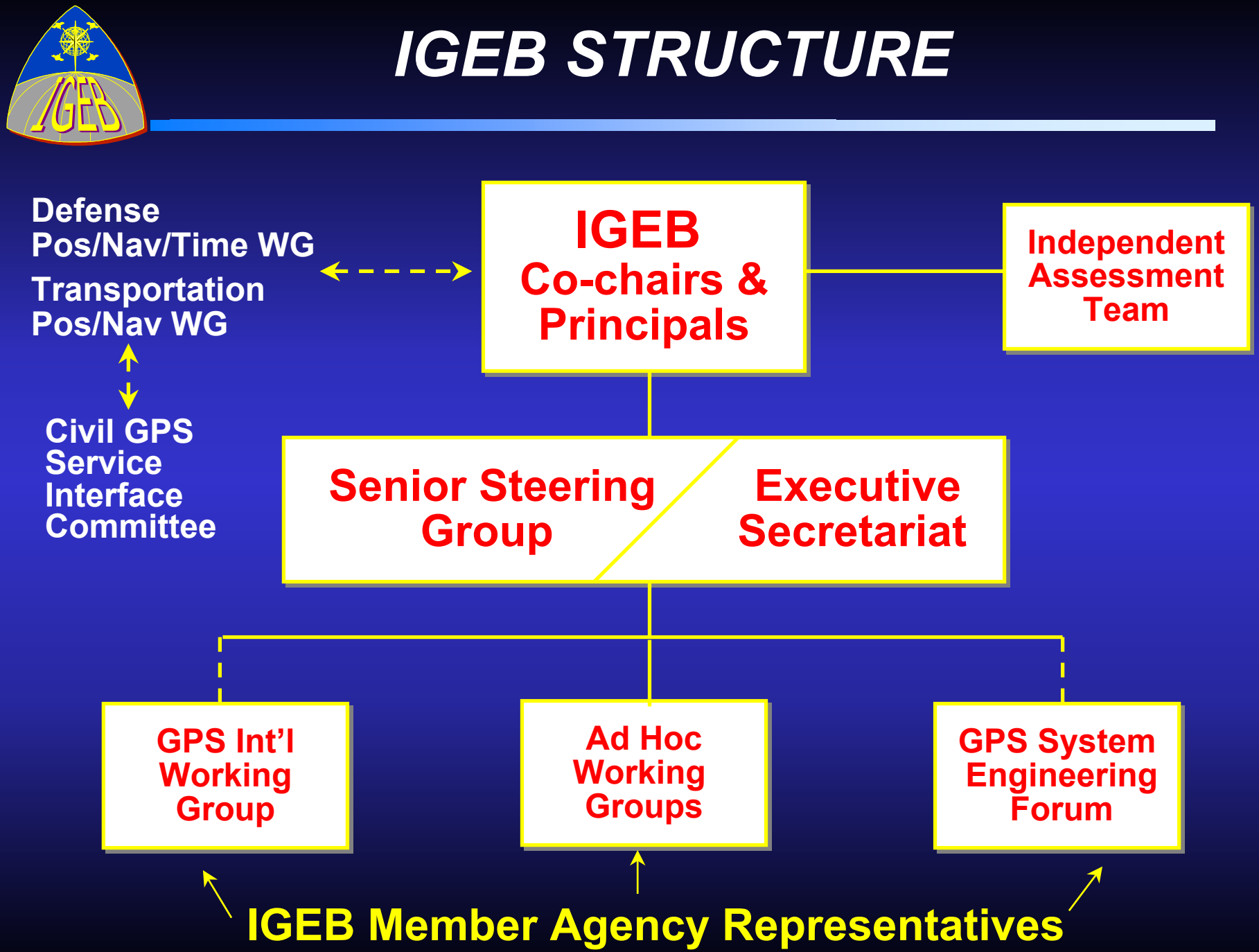
Interior

Agriculture

Joint Chiefs of Staff

NASA

IGEB STRUCTURE



GPS STEWARDSHIP FUND

- **Selection criteria for Agency-proposed projects:**
  - **Clear, national-level benefit**
  - **Priority to projects reflecting dual-use nature of GPS**
  - **Expenditures must fall outside normal agency budgets and benefit two or more IGEB member agencies**
  - **Agency Cost Sharing is encouraged**

Stewardship Funds Currently Support Several Projects Important to GPS Modernization

L1 Civil Signal Modernization

- **Joint military and civil study to assess the benefits of an additional civil signal at L1, known as *L1C***
  - L1 C/A will continue to transmit indefinitely
- **Outreach to GPS community to determine needs and requirements**
  - Feedback will be documented and form basis of signal design
- **Potential benefits are significant**
  - Increased robustness and potentially accuracy for civil users
  - Complementary to modernized GPS L2C and L5 signals
  - Compatible with next generation Galileo and QZSS

For additional information contact: **L1C_GPS@USGS.gov**

Civil GPS PNT Analysis of Alternatives (AoA)

- In general – an AoA provides a reliable, objective assessment of the options for meeting user needs
- For GPS – will provide the tools to effectively identify and validate GPS requirements vs. PNT requirements
  - Effectiveness and Cost Analysis to compare the allocation of systems
    - GPS Signal from Space
    - Augmentations
    - User Equipment
    - Other Systems or Operational Procedures

Civil Signal Monitoring

- **Global Dual Monitoring System (GDMS) Study**
  - Explore use of existing resources
  - Identify Performance Measures
  - Develop architecture and algorithms
  - Demonstrate data collection and processing
- **Modernized Monitor Station Receiver Element (MMSRE) – civil component**
  - First Full Monitoring of Civil Signals by the GPS Master Control Station from 5 Air Force Monitoring Stations
  - Improved Civil Signal Accuracy
- **GDGPS**
  - Explore the feasibility of using the NASA differential GPS network (a subset of the IGS network) as an integrity monitor

- Background & Policy

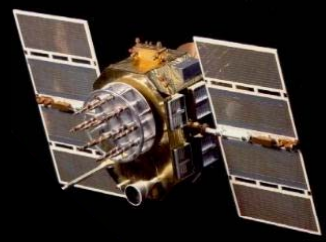
Summary

- System Status & Modernization

- Interagency Projects

SUMMARY

- **Consistent GPS Policy** combined with a dual-service system exceeding performance standards has resulted in tremendous benefits to civilian and military users
- **Modernization** is underway to steadily improve both civil and military services
  - **New signals** are the primary focus of civil GPS modernization
  - Several **IGEB-funded projects** are underway that should make important contributions to modernization
- Encouraged that GPS/Galileo should be **compatible and interoperable**
  - Greater satnav capabilities for civil users worldwide
  - **Spectral separation** of civil and military GNSS signals facilitates preservation of peaceful civil use



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