Introduction to GPS and US PNT Policy

USSTTI Seminar: GPS Applications for Disaster Management

October 13, 2015

National Coordination Office
United States of America
Overview

• Global Positioning System
• GPS Applications
• U.S. Policy
The Global Positioning System

- Baseline constellation of 27 satellites in medium earth orbit
- Global coverage, 24 hours a day, all weather conditions
- Satellites broadcast precise time and orbit information

- Two types of signals:
  - Standard (free of direct user fees)
  - Precise (U.S. and Allied military)

- Three segments:
  - Space
  - Ground control
  - User equipment
GPS Modernization Program

Legacy GPS IIA/IIR
- Single Frequency (L1)
- Coarse acquisition (C/A) code
- Y-Code (L1Y & L2Y)

GPS IIR-M
- 2\textsuperscript{nd} Civil Signal (L2C)
- M-Code (L1M & L2M)

GPS IIF
- 3\textsuperscript{rd} civil signal (L5)
- 2 Rb + 1 Cs Clocks
- 12 year design life

GPS III
- 4\textsuperscript{th} civil signal (L1C)
- 4x better User Range Error than GPS IIF
- Increased availability
- Increased integrity
- 15 year design life

Legacy Operational Control Segment (OCS)
- Mainframe system
- Command & Control
- Signal monitoring

Architecture Evolution Plan (AEP)
- Distributed architecture
- Increased signal monitoring
- Security
- Accuracy
- Launch and disposal ops

Next Generation Operational Control System (OCX) Block 0
- Launch & On-Orbit Checkout of GPS III

OCX Block 1
- Transition to OCX for all GPS command and control operations

Increasing system capabilities - Increasing user benefit
Modernized Civil Signals

- The U.S. initiated continuous civil navigation message broadcast (L2C & L5) on 28 Apr 14
- L2C and L5 should continue to be considered pre-operational and should be employed at the user's own risk
  - Position accuracy not guaranteed during pre-operational deployment
  - L2C message currently set “healthy”
  - L5 message set “unhealthy” until sufficient monitoring capability established
Accuracy: Civil Commitments
Standard Positioning Service Performance Standard

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

2001 SPS PS 6 m RMS

2008 SPS Performance Standard (PS)
Worst of Any Healthy Satellite, 7.8 m @ 95%

User Range Error (URE) in Meters

Equivalent RMS Value from 2008 SPS PS (4 m)

Worst of Any Healthy Satellite (95%)

System accuracy better than published standard
Overview

- Global Positioning System
- GPS Applications
- U.S. Policy
GPS Enables a Diverse Array of Applications

- Surveying and Mapping
- Power Grids
- Disease Control Mapping
- Trucking
- Personal Navigation
- Shipping
- Oil Exploration
- Fishing and Boating
- NextGen
- Precision Agriculture
- Intelligent Vehicles
- TeleComm
- Space Applications
- Transit Operations
GPS Offers Enormous Value

- Supports a wide range of sustainable development activities including:
  - Agriculture
  - Environmental stewardship
  - Disaster management
  - Surveying & mapping
  - Timing
Agriculture

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

- Climate monitoring
  - Tidal tracking
  - Atmospheric moisture profiles
- Oil and chemical spill cleanup
  - Positioning, modeling of spills to guide remediation efforts
- Commercial fishing
  - Enforcement of fishery boundaries
- Forestry
  - Improves use of fire fighting resources
  - Support efforts to combat illegal deforestation
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
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
  – Accuracy possible with post-mission data processing

• Significant savings in time, cost, labor
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
Overview

- Global Positioning System
- GPS Applications
- U.S. Policy
U.S. Policy

• Continuous, worldwide, free of direct user fees

• Encourage compatibility and interoperability with foreign GNSS services and promote transparency in civil service provisioning

• Operate and maintain constellation to satisfy civil and national security needs
  – Foreign PNT services may be used to augment and strengthen the resiliency of GPS

• Invest in domestic capabilities and support international activities to detect, mitigate and increase resiliency to harmful interference
Governance Structure

WHITE HOUSE

NATIONAL EXECUTIVE COMMITTEE FOR SPACE-BASED PNT
Executive Steering Group
Co-Chairs: Defense, Transportation

NATIONAL COORDINATION OFFICE
Host: Commerce

WHITE HOUSE

Defense
Transportation
State
Interior
Agriculture
Commerce
Homeland Security
Joint Chiefs of Staff
NASA

GPS International Working Group
Chair: State

Engineering Forum
Co-Chairs: Defense, Transportation

Ad Hoc Working Groups

ADVISORY BOARD
Sponsor: NASA
Summary

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

www.gps.gov