CNS/ATM Seminar/Workshop
Institutional & Economic Considerations

Global Positioning System (GPS)
Institutional Considerations

David S. Burkholder

International Research and Acquisitions Division
U.S. Federal Aviation Administration

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Overview

- CNS/ATM Concept Review
- GPS Today
- GPS Augmentation Status (WAAS/LAAS)
- Aspects and Considerations of a Satellite Navigation Implementation Effort
- Regional Cooperation in Support of Institutional Aspects
- Summary and Additional Information

CNS/ATM
Concept Review

- **Communications, Navigation and Surveillance (CNS)**
- **Technologies Include, but not Limited to:**
  - GPS/GNSS and its Augmentations (GPS/WAAS/LAAS)
  - Aeronautical Data Link (CPDLC)
  - Automatic Dependent Surveillance (ADS-B)
- **Enhance and Modernize Aging and Out-Dated Regional and Global Air Traffic Management Systems of Today to:**
  - Transcend National Boundaries;
  - Support Future Domestic and International System Demands;
  - Permit Worldwide System Compatibility and Interoperability;
  - Support a Cohesion of ATM Operating Environments; and
  - Provide Greater System Safety & Efficiency for the Public.


FEDERAL AVIATION
ADMINISTRATION


SATNAV
SATELLITE NAVIGATION

GPS Today

Global Positioning System (GPS)

Why Satellite-Based Navigation?

- Improved Aviation System Safety
- Fewer Disruptions
- Increased Capacity
- Increased Fuel Savings
- Low Operations Costs
- Low Avionics Cost

Juneau, Alaska

Runway 8 IFR Arrival: 1000+ Feet and 2+ Miles
Runway 26 IFR Arrival: None

Kodiak & Sitka, Alaska

GPS Current International Capability

- **Benefits of the basic GPS service are attainable today and can provide enormous benefits for very little investment.**
- **Any nation can fully utilize GPS today through the following steps:**
  - Complete WGS-84 surveys including obstacle clearance data
  - Approve GPS as a supplemental or primary navigation aid
  - Develop, validate, and publish GPS approaches
  - Equip aircraft with properly certified GPS receivers
- **By taking these steps in the near-term, countries will allow for a quicker and more efficient transition to GPS augmentation services in the future**

GPS Background

- **Active Program for Over 25 Years**
- **Operational Satellites Began Launch in 1989**
  - Initial Operational Capability: 1993
  - Full Operational Capability: 1995
- **Open Civil Navigation Service**
  - Available for use NOW and has WORLDWIDE coverage
  - Multiple transportation & civil applications
  - Cost effective resource for areas with limited air navigation capabilities
  - U.S. Policy since 1983 to provide GPS signals to civil users worldwide free of direct user fees.
  - There are no plans to change this policy
  - Managed by the Interagency GPS Executive Board (IGEB)

Interagency GPS Executive Board (IGEB)

Defense (co-chair)

Transportation (co-chair)

Commerce

State

Interior

Agriculture

Joint Chiefs of Staff

Justice

NASA

GPS Standard Positioning Service (SPS) Performance Standard

- **Defines the levels of performance the U.S. Government commits to provide to domestic and international civil GPS users**
- **Not a requirements document**
- **It is a "GPS Service Commitment"**
- **Current edition published October 2001**
  - Updated performance as a result of discontinuing Selective Availability

GPS Performance Standard Metrics

GPS Performance Standard Metric	2nd Edition SPS Signal Specification June 1995	SPS Performance Standard October 2001	Representative Performance
Global Accuracy All-in-View Horizontal 95% All-in-View Vertical 95%	 100 meters 156 meters	 13 meters 22 meters	 4 meters 6 meters
Worst Site Accuracy All-in-View Horizontal 95% All-in-View Vertical 95%	 100 meters 156 meters	 36 meters 77 meters	 6 meters 10 meters
Time Transfer Accuracy All-in-View Time Transfer User Solution 95%	340 nanoseconds	40 nanoseconds	7-10 nanoseconds
Constellation RMS User Range Error	NONE	6 meters	1.6 meters
Geometry (PDOP ≤ 6)	95.87% global 83.92% site	98% global 88% site	99.9% global 98% site
Constellation Availability	NONE	95% Probability of 24 Operational Satellites	25-28 Healthy Satellites
Service Reliability Service Failure Threshold Service Failure Rate Service Failure Duration	99.97% global 99.79% worst site 500 m Horizontal Error 3/Year Up to 6 Hours/Failure	99.94% global 99.79% worst site 30 m SIS URE 3/Year Up to 6 Hours/Failure	100% global 100% worst site (28 July 2001 PRN22 Failure almost 2 hours of URE > 30 m

GPS Augmentations Status (WAAS/LAAS)

GNSS Augmentations

Satellite Based Augmentation Systems (SBAS) *(Wide Area Augmentation System)*

- Averages GPS Corrections Over a Large Area (Region)
- More Reference Stations Equates to Better Error Averaging (More Precise Service Capability)
- Provides Correction Signal Via GEO Satellites

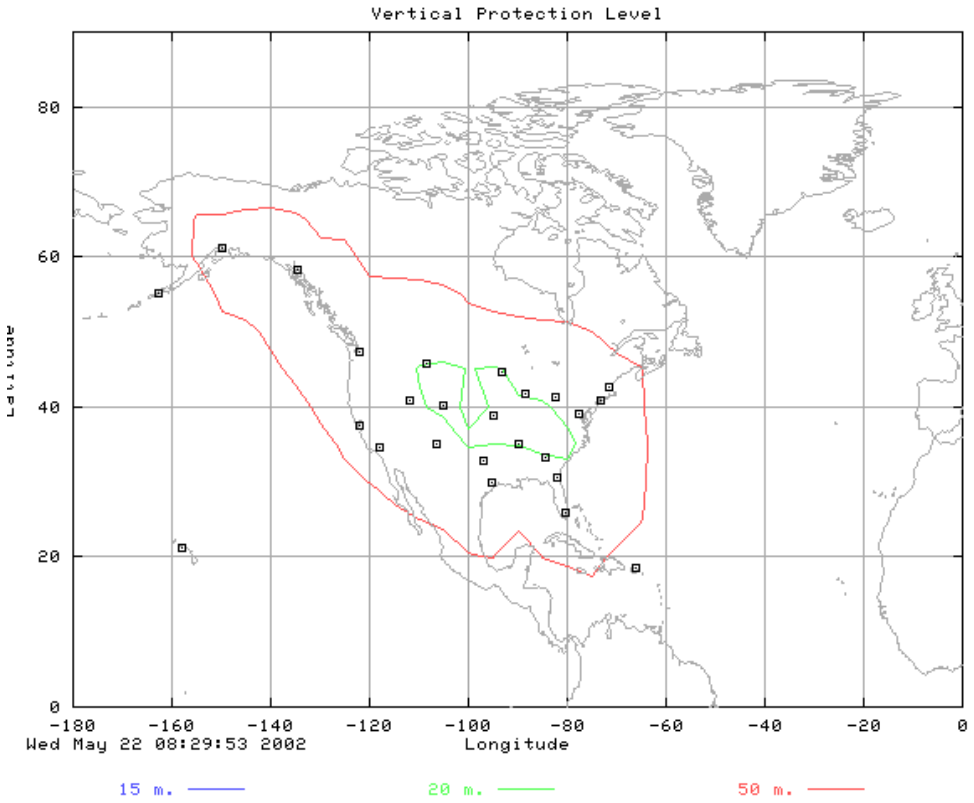
Ground Based Augmentation System (GBAS) *(Local Area Augmentation System)*

- Corrects GPS Inaccuracies for Smaller Areas (Terminal)
- Provides Precision Approach Capability Including “Zero” Visibility Landings (CAT-IIIb)
- Provides GPS Error Corrections Directly to Aircraft

WAAS Development
Initial IFR

- **Will Provide IFR Service To Large Portions Of U.S. National Airspace System**
  - **HAL 40 Meters***
  - **VAL 50 Meters***
  - **Over More Than 90% Of CONUS**
  - **Portions Of Alaska And Caribbean**

*** Supports LNAV/VNAV & LPV**



WAAS Development Strategy

- **WAAS Is Using An Incremental Strategy To Provide Improvements To Users Before And After Initial Delivery**
  - **Present**
    - **Develop Procedures (LNAV/VNAV) For Use By WAAS And Other NAS Users**
    - **WAAS Signal-In-Space For VFR And Other Non-Safety Users**
  - **Before Commissioning**
    - **Permit Use Of WAAS Avionics For IFR Use Prior To System Commissioning (En Route – Non-Precision Approach)**
  - **Commissioning**
    - **LNAV/VNAV Approach**
      - **LNAV/VNAV Nominal Minimums – 350/1½**
    - **En Route**
    - **Departure**
  - **Within 6 Months of Commissioning**
    - **Improve Precision Approach Capability To Users Through TERPS Optimization To LPV**
      - **LPV Nominal Minimums – 250/ ½***

*** With Lights**

WAAS
Schedule Overview

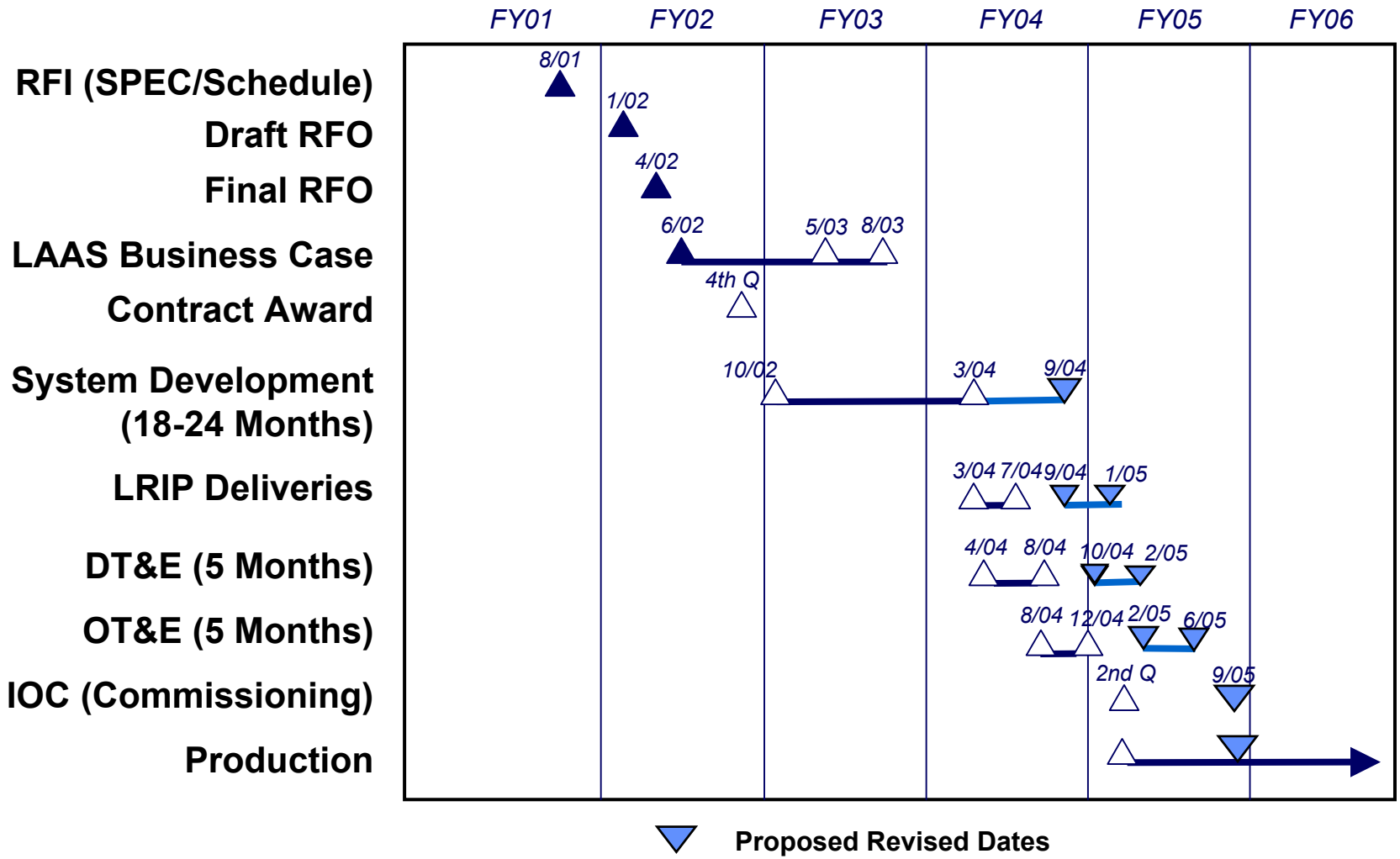
SIS Available for Some Aviation and All Non-Aviation Uses Since 24 August 2000

- **System Operating 24 hours a day / 7 days a week**
- **99.99% Availability**
- **Accuracy:**
  - 1 Meter Horizontal
  - 2 Meters Vertical (Nominal)
- **WAAS Commissioning (IOC) December 2003**

LAAS Development/Acquisition

- **Phase I (April 1999 - September 2005)**
  - Government Industry Partnership (GIP) to Develop Non-Fed CAT-I System Under FAA Type Acceptance (TA) Process (Honeywell, Raytheon, Thales)
- **Phase II (September 2002 - September 2005)**
  - FAA Full-Scale Development (FSD) and Production of Fed CAT I Systems
  - Development of Advanced Procedures
- **Phase III (October 2002 - September 2004)**
  - Research & Development (R&D) to Mitigate Technical Design Risk

LAAS CAT I Program Schedule



Aspects and Considerations of a Satellite Navigation Implementation Effort

SatNav Implementation

- Technically understand the capabilities
- Operationally understand the capabilities
- Address implementation considerations (Institutional, Technical, Operational)
- Develop a user support base: educate and involve in solutions and applications
- Each country and/or region will have different needs and requirements, and thus solutions

Aspects of a SatNav Transition Effort

- **Technical**
  - R&D activities (TESTBED for trials and studies)
  - Provide advanced technology familiarization and training
  - Outline feasibility studies, capability assessments, and final system architecture
  - Determine optimal mix of GNSS technologies (GPS/SBAS/GBAS) to meet current & projected needs
  - Determine final configurations for SBAS/GBAS architectures (number and location of reference stations)
  - System specification development
  - Identify and address potential system interface issues
  - Include users to define user requirements

Aspects of a SatNav Transition Effort (cont.)

- **Operational**
  - Prepares air traffic control systems for new technology
  - Prototypes system performance and reliability
  - Gains experience in procedure design and development
  - Experience with flight inspection and certification
  - Tests prototype avionics prior to operational debut
  - Training ground for pilots and controllers
  - Development of transition plans for phasing-in new SatNav systems and decommissioning older ground-based navaids

Aspects of a SatNav Transition Effort (cont.)

- **Institutional**
  - Establishment of GNSS implementation programs
  - Internal government coordination (leverage costs)
  - External government coordination
  - International coordination and cooperation
  - Mission needs determination, including cost benefit analysis, investment analysis, and business cases
  - Development of an acquisition strategy, including budget and funding requirements and sources
  - Resolves Issues for Consensus for Government Implementation
  - Political and legal issues respective to each country

ICAO Regional Project for Latin America RLA/00/009

ICAO Regional Project RLA/00/009
Overview

- Established in GREPECAS Conclusion 8/35 Calling for a "Regional GNSS Augmentation Trial (CSTB)"
- UNDP/ICAO Technical Cooperation Project Being Implemented Through a Memorandum of Understanding (MOU) Between the FAA and ICAO
- GNSS Augmentation Test Bed (CSTB) Capability is Based on U.S. WAAS/LAAS Prototype Technologies
- CSTB Architecture Consists of Individual Test Bed Equipment Sets in Brazil, Chile and Panama, and Additional FAA-Provided Equipment Sets in Argentina, Bolivia, Colombia, Honduras (COCESNA), and Peru.

ICAO Regional Project RLA/00/009
Overview (cont.)

- GREPECAS States to Assess Regional Requirements and Determine Regional Solutions
- Develop Technical Expertise in Satellite Navigation and Augmentation Technologies and Systems through participation in Technical Training Provided by the FAA
- Ionosphere Research and Modeling
- After Determining Regional Solutions, GREPECAS States, with Continued FAA Support, to Begin Transition Activities Towards an Operational GNSS System Architecture
- Flight Tests, Data Collection and Analysis to be Conducted by GREPECAS States with FAA Support

ICAO Regional Project RLA/00/009
Architecture

SATNAV
SATELLITE NAVIGATION

ICAO Regional Project RLA/00/009
Objectives

- **Address Specific Institutional Issues**
  - Establishment of GNSS implementation programs
  - Internal government coordination (leverage costs)
  - External government coordination
  - International coordination and cooperation
- **Answer Questions Regarding GNSS Implementation and Operational Use in Latin America and its Member States**
- **Support Both Individual and Regional Transitions to Operational GNSS Use in Latin America**

ICAO Regional Project RLA/00/009
Objectives (cont.)

- Create a Seamless GNSS Navigation Capability Throughout Latin America and on Transition Routes to North America and Other International Destinations
- Conduct Research and Analyses on Data Sharing and Interoperability Between Independent GNSS Augmentation Systems
- Investigate the Shared Use of SBAS Geostationary Communication Satellites (GEOs)

Summary

- Worldwide Implementation of GPS and Its Augmentation Systems Continues to Grow
- The FAA is Committed to Furthering the Creation of a Single, Global GNSS Architecture (Including SBAS and GBAS Augmentations)
- ICAO Regional GNSS Implementation Projects Continue a Positive Momentum Towards a Global Architecture
- Safety, Efficiency, and Cost Savings Opportunities for all Worldwide Partners in This Effort
- Project already addressing many of the institutional aspects like internal government and international coordination
- Results and experience will provide great benefits to the operational implementation process through lessons-learned

Additional Information

For Additional Information on CNS/ATM Technologies and U.S. Implementation Programs, Please Visit the Following Websites:

GPS Operational Status Information

http://www.navcen.uscg.gov

GPS Performance Standard Specification

http://www.navcen.uscg.gov or http://www.igeb.gov

FAA International Research and Acquisitions Office

http://www.faa.gov/asd/international/

FAA Global Positioning System (GPS) Product Team

http://gps.faa.gov/