Global Navigation Satellite System (GNSS) Overview

Date: May 15, 2013
Next Generation Air Transportation System (NextGen) Planning

Initiate Trajectory-Based Operations
Increase Arrivals/Departures at High Density Airports
Increase Flexibility in the Terminal Environment
Improve Collaborative Air Traffic Management
Reduce Weather Impact
Improve Safety Security and Environmental Performance
Transform Facilities

Solution Sets

Improved Surface Operations
Improved Approaches and Low Visibility
Improved Multiple Runway Operations
Performance Based Navigation
Time Based Flow Management

Implementation Portfolios

Collaborative Air Traffic Management
Separation Management
On-Demand NAS Information
Environment and Energy
System Safety Management
Wide Area Augmentation System

- 38 Reference Stations
- 3 Master Stations
- 6 Ground Earth Stations
- 3 Geostationary Satellite Links
- 2 Operational Control Centers
WAAS Phases

- **Phase I: IOC (July 2003) Completed**
  - Provided LNAV/VNAV/Limited LPV Capability

  - Improved LPV availability in CONUS and Alaska
  - Expanded WAAS coverage to Mexico and Canada

  - Development, modifications, and enhancements to include tech refresh
  - Steady state operations and maintenance
  - Transition to FAA performed 2nd level engineering support
  - Begin GPS L5 transition activities

- **Phase IV: Dual Frequency (L1,L5) Operations (2014 – 2028)**
  - Complete WAAS transition from L2 to L5
  - Commence dual-frequency, iono-free service
    - Improved availability and continuity, especially during severe solar activity
  - Maintain single frequency SBAS service
  - Other capabilities under consideration (see Technology Evolution slide)
  - Will be completed in two segments
GEO Activities

- **Current WAAS GEO satellites**
  - Intelsat Galaxy XV (CRW)
  - Anik F1R (CRE)
  - Inmarsat I4F3 (AMR) *

- **GEO 5**
  - SIR package released December 2011
  - Contract awarded September 2012

* - AMR is a non-ranging satellite
WAAS Dual Frequency Operations

• ‘Sunset’ of L2 P(Y) compels WAAS to utilize another signal to maintain current service
  – USG Federal Register Notice states ‘sunset’ for L2 P(Y) signal use in December 2020

• New dual frequency L1/L5 service needed to further improve WAAS availability and continuity

• Segment 1
  – Develop of infrastructure improvements to support use of L5
    • 5 to 7 year effort
  – G-III Reference Receiver Integration, Communications Upgrade, Safety Computer Integration

• Segment 2
  – Implementation of L1/L5 user capability
    • 5 to 7 year effort
    • Dual Frequency Messaging

• GEO sustainment will occur during both segments
  – Maintain minimum of dual coverage over WAAS service area
WAAS Coverage

**2003 IOC – LPV Coverage in lower 48 states only**

**2008 Coverage - Full LPV 200 Coverage in CONUS (2 Satellites)**

**2013 Coverage - Full LPV 200 Coverage in CONUS (3 Satellites)**
Airports with WAAS LPV/LP Instrument Approaches

As of April 4th, 2013
- 3,514 LP/LPVs combined
- 3,100 LPVs serving 1,553 Airports
- 785 LPV-200’s
- 2,023LPVs to Non-ILS Runways
- 1,077 LPVs to ILS runways
- 1,359 LPVs to Non-ILS Airports
- 414 LPs serving 300 Airports
- 411 LPs to Non-ILS Runway
- 3 LPs to ILS Runways
WAAS Avionics Status

- **Garmin:**
  - 82,315+ WAAS LPV receivers sold
  - Currently largest GA panel mount WAAS Avionics supplier
  - New 650/750 WAAS capable units brought to market at the end of March 2011 to replace 430/530W units

- **AVIDYNE & Bendix-King:**
  - 190 Avidyne Release 9 units sold to date. Introduced IFD540 FMS/GPS/Nav/Com System with Touch screen
  - Bendix King KSN-770 certification pending

- **Universal Avionics:**
  - 2,987+ WAAS receivers sold as of March 12, 2013

- **Rockwell Collins:**
  - Approximately 2,700 WAAS/SBAS units sold to date

- **CMC Electronics:**
  - Achieved Technical Standards Orders Authorization (TSOA) certification on their 5024 and 3024 WAAS Sensors
  - Convair aircraft have WAAS LPV capable units installed (red label) and received WAAS LPV certification November 2012
  - Canadian North B-737-300 obtained STC for SBAS(WAAS) LPV using dual GLSSU-5024 receivers

- **Honeywell:**
  - Primus Epic and Primus 2000 w/NZ 2000 & CMC 3024 TSO Approval
  - Primus 2000 FMS w/CMC 5024 TSO pending
GBAS (Ground Based Augmentation System)
FAA GBAS Program

• The FAA has indefinitely delayed plans for GBAS acquisition

• The FAA GBAS program focuses on three task areas:
  – GAST-D ICAO SARPs validation
    • FAA CAT III activities focus on single frequency GPS augmentation requirements
    • Produce an commercial prototype for validation testing
      – Vendor could seek NonFed approval
  – Radiofrequency interference (RFI) analysis and mitigation
  – Limited CAT I implementation support
    • Newark NJ and Houston TX operational approval support
    • Gain operational experience with GBAS
GBAS at Newark

• GBAS location

• GBAS location and PPD Jammer example
Project Houston Update

• History:
  – FAA SATNAV team decision to provide a GBAS at Houston yielding a city-pair for GBAS operations
  – Plan included moving Memphis GBAS to Houston, development of advance procedures, and simulation testing
    • This is a non-Fed GBAS installation owned by the Houston Airport System (HAS)

• Activities Completed
  – Remove system from Memphis, GBAS factory refurbishment, site studies including RFI testing, installation, site acceptance testing, flight inspection, non-fed coordinator training, predictive tool training, SDA revision
    • All approval and agreement documentation completed

• Operational Approval April 2013
  – Operational approval for use of GBAS in Houston was awarded on April 22nd 2013 and the first flight to the use approach, United Airlines Flight 1542, landed Runway 27 the same day
GBAS International

• **International Cooperation (FAA MoAs)**
  - Germany, Spain, Brazil, Chile, Australia,
  - FAA Training : India, China

• **International GBAS Working Group (IGWG)**
  - International Service providers (ANSPs), Industry, OEMs, Airlines, Airports, EUROCONTROL, FAA
  - Cooperation and coordination of implementation and development activities
    - RFI, Siting, World Wide IONO, Ops concepts
  - IGWG Website - flyGLS.net
  - Next IGWG June 4-7, 2013 hosted by Boeing

• **GBAS and SESAR**
  - SESAR work packages for GBAS CAT I implementation, Single frequency CAT III, Dual frequency CAT III and multi constellation GBAS
Need for Alternative Positioning, Navigation & Timing (APNT)

- NextGen is dependent on the availability of GPS-Based PNT services and suitable alternate PNT services
  - RNAV and RNP procedures for trajectory-based operations (TBO)
  - Current ATC system cannot be scaled up to handle 2X traffic
  - 2X traffic is more than a controller can handle using radar vectors
  - Procedural separation with Conformance Monitoring will separate aircraft performing trajectory based operations (TBO)
  - Controllers intercede to provide “control by exception”

- TBO Operations may require PNT performance that exceeds DME/DME/IRU

- GPS vulnerability to radio frequency interference (RFI) requires mitigation
  - Waiting for the source of the interference to be located and turned off is not an acceptable alternative
Alternative PNT (APNT) Candidates

- Leverage Existing Technology and System
- Possible Impact on Avionics
- Evaluating Technology Opportunities

- New Concept
- Aircraft-based Position
- Potential Leverage of Planned and Existing Technology and Ground Infrastructure
- Some Impact on Avionics

- New Concept
- Unlimited Capacity
- No Existing FAA Standards
- Highest Impact on Avionics
- Longest Lead Time in Implementation
Summary

• WAAS Continues Development Activities for Dual Frequency Upgrade to Align w/GPS Modernization

• GBAS Cat-I System Design Approved
  – GBAS Operational at Newark and Houston

• GBAS Cat-II/III R&D Underway

• FAA Assessing Candidates for Alternate PNT
Questions?