Wide Area Augmentation System (WAAS) Overview

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Agenda

- WAAS Status and History
- Current Projects
- User Adoption
- Future Efforts
Wide Area Augmentation System

- WAAS is a combination of ground based and space based systems that augments the GPS Standard Positioning Service (SPS)
- WAAS provides the capability for increased availability and accuracy in position reporting, allowing more time for uniform and high quality worldwide air traffic management
- WAAS provides coverage over the entire National Airspace, with a precision approach capability at over 3,000 runway ends
WAAS Development Phases

- **Phase I: IOC (July 2003) Completed**
  - Included Development of a robust safety architecture
  - Included establishment of WAAS expert panel to evaluate potential integrity threats

  - Completed a Safety Risk Management Decision (SRMD) to support LPV-200 (VAL of 35m)
  - Expanded WAAS coverage to Mexico and Canada while modifying the System to address observed ionospheric threats

  - Completed System updates to improve performance during moderate ionospheric activity
  - Supported continuous monitoring of system data that contributes to continued integrity assurance
  - Began transition of Second Level Engineering from contractor based to organic FAA capability

- **Phase IV: Dual Frequency (L1,L5) Operations (2014 – 2044)**
  - Includes the transition from use of L2 to L5 in WAAS reference stations
  - Infrastructure modifications to support future L1/L5 user capability
  - Support sustainment of WAAS GEOs
GEO Satellite Availability Improvements

- **IOC WAAS (Commissioned system) utilized two Inmarsat satellites**
  - Provided single satellite coverage over the majority of the U.S.
  - Removed from WAAS July 2007

- **Replacement satellites launched in 2005**
  - Intelsat (Galaxy XV) - Operational November 2006
  - Telesat Canada (Anik F1R) - Operational July 2007

- **Implemented Gap filler GEO**
  - Inmarsat I4F3 (AMR) - Operational December 2010
WAAS Coverage Improvements

2003 IOC – LPV Coverage in lower 48 states only

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

2014 Coverage - Full LPV 200 Coverage in CONUS (3 Satellites)
GEO Sustainment

- **GEO 5/6 Satellite Acquisition**
  - Awarded GEO 5/6 Satellite Service Lease contract to Raytheon September 2012
  - SatMex 9 satellite will host the WAAS GEO Satellite Payload
    - Orbital slot (117°W) will provide full coverage over CONUS and Alaska
    - Critical Design Review (CDR) completed July 2014
    - Scheduled for operations in the 2017 timeframe
  - GEO 6 Satellite opportunities currently under investigation
Ground Based Updates

• **WAAS Reference Receiver (G-III)**
  - Next Generation (G-III) receiver adds significant new capability and will support WAAS Dual Frequency upgrades in 2014 – 2019 timeframe
    - Tracks up to 18 GPS satellites and 8 SBAS satellites
    - Capable of tracking GPS L1C/A, L1C, L2C, L2 P(Y), and L5 signal types
    - Expandable to support additional GNSS signals in the future
  - Current Status
    - Six G-III test racks installed into the field to support integration activities
    - 100 production receivers delivered to support fielding in FY2015 – 2016
      - Balance of receivers will be ordered in 1stQ FY15

• **WAAS Safety Computer**
  - The SC adds significant new capability and support to WAAS Dual Frequency upgrades
    - The SC will be capable of hosting either WAAS Master Station (WMS) application or the GEO Uplink Station (GUS) without changing the WAAS SC hardware or Infrastructure of software
  - WMS type SCs
    - Preclude broadcast of Hazardously Misleading Information (HMI) to WAAS users
  - Current Status
    - Verification Phase completed
    - Initial Pre-Production units delivered
    - Vendor contract extended to May 2015
    - Testing software and hardware to ensure error free operation

• **WAAS Communication Upgrade**
  - Hardware procurement to address obsolescence at selected WAAS sites
  - Upgraded circuit procurements for Operations Control Center’s (OCC’s) (National Operations Control Center [NOCC] & Pacific Operations Control Center [POCC]) and Core Node
  - Successful Completion of Provisioning Conference (PCA)
Annual LPV and LP Production

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Airports with WAAS LPV/LP Instrument Approaches

As of November 13th, 2014
- 4,069 LP/LPVs combined
- 3,498 LPVs serving 1,718 Airports
- 895 LPV-200’s
- 2,363 LPVs to Non-ILS Runways
- 1,135 LPVs to ILS runways
- 1,611 LPVs to Non-ILS Airports
- 571 LPs serving 416 Airports
- 568 LPs to Non-ILS Runway
- 3 LPs to ILS Runways
WAAS LPV Annual Avionics Sales

Garmin, Universal, Rockwell Collins, Avidyne, Cobham, Honeywell/CMC, IS&S and Thales WAAS Avionics Sales by Year

Data current as of October 31, 2014
Total combined avionics sales (all vendors): 108,614 units
Program office estimate for total WAAS-LPV equipped aircraft: 78,045 (all vendors)
WAAS LPV Equipped Aircraft October 2014

Garmin
- GA Aircraft (See FAA Garmin Approved Model List (AML)). Most GA Part 23 aircraft.

Universal Avionics
- 122 fixed wing and 12 helicopter types and models

Rockwell Collins
- 39 Types and models

Honeywell /CMC Electronics)
- 22 types and models

Avidyne
- 6 types and models (Cirrus SR 20 & 22, Piper Matrix & Mirage, Piper Saratoga NX, and EA-500)
- IFD 540 WAAS LPV - (STC complete July 2014 – AML STC approved for over 1,000 aircraft makes and models)

Genesys Aerosystems (Chelton)

Innovative Solutions & Support (IS&S)
- Eclipse 550/500
- Boeing 737-400 (pending)
- MD-88/90 (pending)

Thales
- Airbus A300-600ST (Beluga)
- Airbus A400M (Military)
- Airbus A350XWB - pending
Transition to Performance Based Navigation

- In September 2008 the number of published LPVs surpassed the number of published ILSs
- As of August 2014 the number of published LPVs are more than twice the number of published ILSs
- In 2013 the FAA policy was to no longer publish any new CAT I ILSs
- In 2016 the FAA has committed to make a decision about the draw down of ILS based on WAAS implementation
WAAS – A Multi User System

- WAAS has become a relied upon utility for a number of non-aviation uses:
  - Shipping
    - Navigation of Harbors
  - Recreational Boating
    - Navigation of Channels
    - Location of Crab pots
  - Mapping & Survey
    - Precise location identification
  - Farming
    - Sub-meter accuracy for spreading, seeding and harvesting
Next Steps

• Dual Frequency (DF)
  – Award a Dual Frequency Contract
  – Development of DF WAAS MOPS capability
  – Maintain legacy Single Frequency availability

• Ground based infrastructure upgrade
  – Safety Computer
  – G-III Receivers
  – Terrestrial Comm upgrade

• Develop Dual Frequency User concepts
  – ARAIM
    • Offline vs Online
  – Dual Frequency Multi-Constellation (DFMC) SBAS
    • Beginning initial research and development
  – Validate concepts and propose standards
Future Applications

• WAAS is an enabler for multiple FAA initiatives
  – Performance-Based Navigation (Area Navigation) (RNAV)
  – Required Navigation Performance (RNP)
    • WAAS meets the requirement for RNP AR as defined in FAA Advisory Circular 90-101A
    • No restriction due to temperature
  – Point in Space (PinS) procedures
  – Automatic Dependent Surveillance Broadcast (ADS-B)
    • WAAS is currently the only technology that meets all of the most stringent requirements for a positioning source for ADS-B
Future LPV-200 Coverage (Dual Frequency GPS)

WAAS
EGNOS
MSAS

Availability as a function of user location

Availability with VAL = 35, HAL = 40. Coverage (99%) = 28.64%
Summary

- WAAS-provided messages improve the accuracy, availability and safety of GPS-derived position information
- WAAS results in safety and capacity improvements in the National Airspace System (NAS)
- WAAS will reduce FAA operations costs by enabling the decommissioning of some ground-based navigation aids
  - All new CAT I Approaches in the NAS shall be WAAS LPV Approaches
  - FAA committed to making a decision on the reduction of CAT I ILS in 2016
- WAAS provides a cost-effective means of integrating a precision approach capability into the cockpit
- Nearly 4,000 WAAS procedures are available with half published at runways that previously had no precision approach capability
- Continued support of International expansion of SBAS and adoption of future standards