Wide Area Augmentation System (WAAS) – Program Status Update

Presented to: RTCA Working Group 2
By: Jason Burns,
FAA WAAS Space Segment Lead
Date: March 13, 2013
WAAS Architecture

38 Reference Stations
3 Master Stations
6 Ground Earth Stations
3 Geostationary Satellite Links
2 Operational Control Centers
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 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)
Current WAAS RNP .3 Performance

WAAS RNP 0.3 Coverage Contours
03/06/13
Week 1730 Day 3

WAAS Status
March 13, 2013
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

• **Phase III: Full LPV-200 Performance (2009 – 2013)**
  – 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
WAAS Phase III Ground Segment Development

- **WAAS Release 1 Complete**
  - PCU Upgrade

- **WAAS Release 2 Complete**
  - Release 2A included integration of the AMR GEO in November 2010
  - Release 2B upgraded routers in September 2011
  - Release 2C upgraded PRN (Pseudorandom Noise) Mask Update in August 2011

- **WAAS Release 3**
  - Release 3A implemented ionospheric robustness change in December 2011
  - Release 3B included GUST Upgrades to improve reliability in September 2012

- **WAAS Release 4**
  - Software Build Merge & Code Clean up
    - Build Merge completed in September 2012/ Code Clean-up completed January 2013
    - Final Build Generated February 2013
    - Cutover planned for September 2013
**Airports with WAAS LPV/LP Instrument Approaches**

**As of March 7th, 2013**
- 3,512 LP/LPVs combined
- 3,098 LPVs serving 1,552 Airports
- 785 LPV-200’s
- 2,021 LPVs to Non-ILS Runways
- 1,077 LPVs to ILS runways
- 1,357 LPVs to Non-ILS Airports
- 414 LPs serving 300 Airports
- 411 LPs to Non-ILS Runway
- 3 LPs to ILS Runways
WAAS Reference Receiver (G-III)

• WAAS program developing next generation reference receiver (G-III)

• G-III receiver will add significant new capability and 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
  – Software Development and Hardware Development Completed
  – Factory Qualification Review Completed February
  – Final Software Audit March, FCA/PCA in April

• Development currently scheduled to be complete in June
  – ~14 Production Receivers

• Follow-on contract for production receivers expected 3rd Qtr FY13
  – ~165 Production Receivers
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
  – Validate corrections messages generated by DO-178B Level D assured software in the WMS Correction Processors (CPs)
  – Preclude broadcast of Hazardously Misleading Information (HMI) to WAAS users

• Current Status
  – Preliminary Design Review completed September 2012
  – Critical Design Review, December 2012
  – Testing expected to begin in June 2013

• Initial Production SC currently scheduled to be complete in FY2013
  – ~28 Production Safety Computers

• Follow-on contract for production SC
WAAS Communications Upgrade and Dual Frequency Capability

• **WAAS Communication**
  – Planning efforts underway to support additional bandwidth and data associated with Dual-frequency WAAS
    • Dual Frequency Trade Study completed December 2011
  – Execution by WAAS Operations Team
    • Doubling bandwidth
    • Interface upgrade to 4 wire
    • Technology Refresh of hardware

• **Dual-Frequency Capability**
  – Continuing algorithm development
  – Working within IWG on definition document
    • Basis for interface design and MOPS development
  – Capability follows L5 IOC (L5 IOC expected around 2019)
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 Technology Evolution

- **Multi-constellation**
  - Development of DFMC definition document

- **Advanced RAIM (ARAIM)**
  - Avionics-centric approach to dual-frequency multi-constellation
  - ARAIM subgroup developing more detailed concept definition
    - Will be used to coordinate standards development with ICAO, RTCA and EUROCAE

- **South America Expansion**
  - Discussing technical options and feasibility within the WAAS program

- **APNT**
  - Review of alternatives / backup when GNSS is unavailable
    - Safe landing, not necessarily to intended destination
  - Industry day held in May 2012
  - Consideration of WAAS Message Type 12 as potential timing source
    - Might need to update MT-12 guidance material
  - Currently reviewing potential of Joint FAA/DoD program of USAF Ultra High Accuracy Reference System (UHARS)
    - Have an Interagency Agreement with Air Force Institute of Technology
    - Determine how a UHARS-inspired pseudolite-system could be best used to meet APNT requirements
WAAS Avionics Status

• **Garmin:**
  - 79,812+ 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:**
  - 2,688+ WAAS receivers sold as December 5, 2012,

• **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
WAAS STC Aircraft Mar 2012 (Estimate)

- **Garmin** – 59,993 aircraft
  - Covers **most** GA Part 23 aircraft.
  - See FAA Garmin Approved Model List (AML)

- **Universal Avionics** – 1,673 aircraft
  - 121 fixed wing and 12 helicopter types and models
  - Airframes to include (Boeing, de Havilland, Dassault, Bombardier, Gulfstream, Lear, Bell, Sikorsky, etc…)

- **Rockwell Collins** – 950 aircraft
  - 32 types and models
  - Airframes to include (Beechjet, Bombardier, Challenger, Citation, Dassault, Gulfstream, Hawker, KingAir, Lear)
  - Airbus 350 certification pending

- **Honeywell** – 450 aircraft
  - 19 types and models
  - Airframes to include (Gulfstream, Challenger, Dassault, Hawker, Pilatus, Viking)

- **Avidyne** – 190 aircraft
  - 3 types and models (Cirrus, Piper Matrix, and EA-500)
  - 300 IFD 540 WAAS LPV units pre-sold (STC Pending – June 2013)

- **Innovative Solutions & Support (IS&S)** – 200 aircraft
  - Eclipse 550/500
  - Boeing 737-400 (Pending)

- **Cobham (Chelton)** – 211 aircraft
# WAAS High Level Schedule Activities

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Questions