



Next**GEN**

# GBAS: FAA Status, System Approval Process, and Operational Experience

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# FAA GBAS Overview



# Contributing FAA Offices

- Previously, GAST-C/CAT-I GBAS development and Non-Federal System Design Approval work was funded by the FAA NextGen Office
- GBAS efforts are now managed by the FAA Technical Operations Non-Federal Policy and Oversight Office
  - System Design Approval work
  - Ground system implementation oversight
- Other offices including NextGen, Aircraft Certification, Flight Standards, Air Traffic Services, and the Navigation Programs Office also remain engaged in GBAS efforts



# Key Activities

- System Design Approval Updates for Honeywell SLS-4000 CAT I GBAS
  - Review of vendor documentation, updates to system SRMD, coordination of approval letter to vendor
- CAT-I Implementation Support
  - Participation in implementation meetings held by potential new sponsor-owned sites
- Maintenance of FAA-owned Honeywell SLS-4000 GBAS at Wm. J. Hughes Technical Center
  - Used in System Design Approval update testing, and by government and industry as an accessible GBAS for equipment testing
- Data Collection
  - FAA Ground-Based GBAS Performance Monitors remain deployed at EWR, IAH, MWH, and ACY
  - Data updated in real-time at <http://laas.tc.faa.gov>
- Support of ICAO Navigation Systems Panel (NSP) GBAS Working Group (GWG) and RTCA SC-159 WG 4
  - Tests and analysis to support VDB Ad-hoc group activities
- Co-chair International GBAS Working Group with EUROCONTROL
  - Next meeting will be held June 17-20, 2019 in Denver, CO, USA



# Implementation Scheme

- In the U.S. GBAS is being implemented as a Non-Federal System
  - No FAA acquisition of CAT-I or CAT-III GBAS is currently planned
  - Non-Federal sponsors (i.e. airports) fund system purchase, maintenance, procedure development, etc.
  - FAA retains regulatory authority of GBAS
    - System Design Approval of ground systems
    - Commissioning and periodic flight inspections
    - Commissioning and periodic inspection of ground equipment
  - Deployment is driven by user and sponsor interest and investment
    - No FAA deployment schedule exists



# Future Non-Federal Systems Approval Support

- The FAA has identified a three-phase process to manage and review requests for approval of Non-Federal technologies (not federally owned, funded, or operated) using an Intake, Transition, and Commissioning concept.
- FAA has reached out to industry to validate the process prior to full implementation. As this outreach is currently in its initial stages we cannot elaborate.
- GBAS vendors not previously approved by the FAA will be subject to this process.





# FAA GBAS System Design Approval, Commissioning, and Oversight



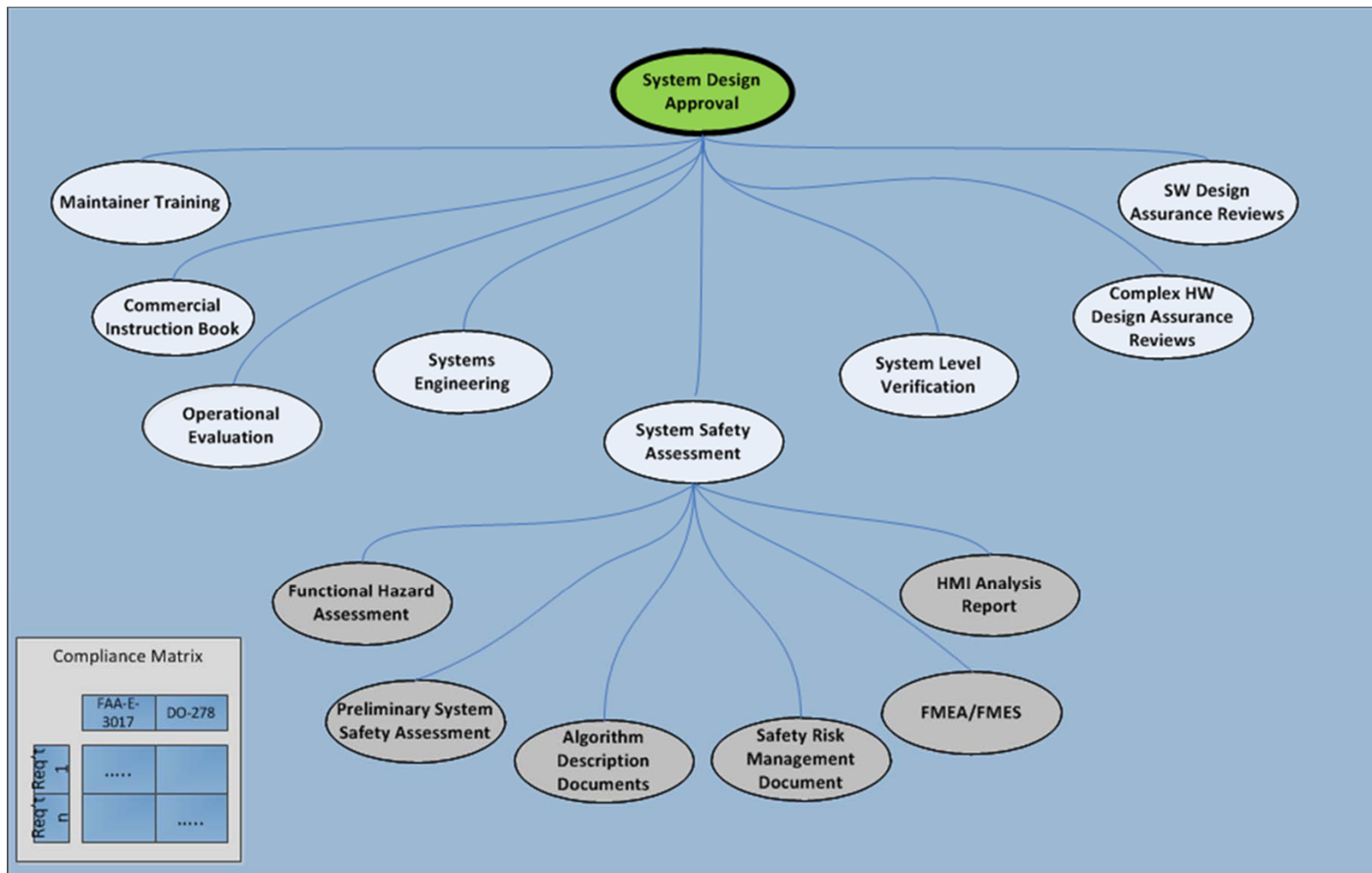


# System Design Approval Overview

- Because GBAS is a Non-Federal system in the U.S., guidelines had to be developed for System Design Approval
- For CAT-I GBAS, an existing specification from an acquisition effort was leveraged
  - Some requirements relating to maintainability, etc removed for Non-Fed applicants
- For CAT-III GBAS no FAA Non-Fed specification is planned
  - Vendor applicants will need to trace their specifications directly to the ICAO SARPS Annex 10 requirements, as well as to the FAA's CAT-I Non-Federal Specification (FAA-E-3017)
  - Additional requirements (for example, Air Traffic Control status display requirements) may be developed



# System Design Approval



# Key Risk Areas

- Algorithm Description Documents (ADDs) and Hazardously Misleading Information (HMI) analysis was required for the following areas of development:
  - Pseudorange Sigma Estimation Process
  - Phase Center Non-Zero Mean Characteristics
  - Pseudorange Sigma Monitor
  - Ionosphere Anomaly Monitor
  - Troposphere Anomaly Monitor
  - Ephemeris Monitor (Failure Modes A & B)
  - GPS Satellite Signal Deformation Monitor
  - GPS Satellite Signal Low Power Monitor
  - Code Carrier Divergence Monitor
  - Excessive GPS Satellite Acceleration Monitor
  - Operation in RFI Environments above the mask levels defined in the FAA Non-Federal Specification



# SDA Updates

- System updates require the vendor to submit a change impact analysis to the FAA
- Delta SDA reviews must take place
  - Impacted documents, software, hardware, training, installation guidance, etc must be reviewed
- System Design Approval letter for update will be sent to the vendor when work is complete and updates are accepted



# Site Commissioning

- For each sponsor-owned GBAS/SLS-4000 site:
  - Non-Federal Technicians must be trained, tested, and verified
  - FAA Inspectors must be trained to provide oversight of maintenance and perform ground inspections
  - Approach procedures must be developed and published
  - Air Traffic Control display systems must be updated to include GBAS status, or Honeywell's Air Traffic Status Unit (ATSU) may be used
  - Air Traffic Control personnel must be trained
  - Sponsor must sign Memorandum of Agreement with FAA which assigns responsibilities for system to sponsor and FAA
  - Sponsor and local ATC must sign Letter of Agreement that describes communication channels between these parties with regards to GBAS (for example, pre-notification when maintenance is required, notification of PIREPs received by ATC, change in system status)
  - Local Safety Risk Management (SRM) Panel must be completed
    - Ensures that details of local operations do not cause a hazard not addressed in national system SRMD (for example, that Loss of Continuity is a 'minor' hazard from the ATC perspective)
  - Commissioning ground inspection must be passed
  - Commissioning flight inspection must be passed



# Ongoing FAA Oversight

- Periodic Ground Inspections
  - Periodic Ground Inspections are due each year on the anniversary of commissioning +/- 60 days
  - Additional ground inspections may be required after system upgrades, before returning a system to service, etc.
- Periodic Flight Inspections
  - First periodic FI due 360 days after commissioning FI
  - Subsequent periodic FIs due every 540 days
- Flight Inspection also required for:
  - New procedures
  - System updates or maintenance that impacts or potentially impacts the VDB antenna or signal strength



# U.S. Implementation & Equipage





# Ground Station Approvals & Sites

- The FAA has completed System Design Approval of the Honeywell SLS-4000 GBAS for CAT-I operations
  - SLS-4000 Block 0 – Original approval, circa 2009
  - SLS-4000 Block 1 – Improved performance in environments where RFI above the mask identified in the FAA specification is encountered, 2012
  - SLS-4000 Block II - June 2015
    - Optional SBAS component for real-time ionospheric monitoring
    - Update to Signal Deformation Monitor
    - Better overall system availability
  - SDA Update to Block II completed February 2017
    - Updates to allow greater flexibility in setting parameters related to Code-Carrier Divergence Monitor
  - New Updates pending approval, expected by summer 2019
    - Optional fiber connectivity from reference stations to central unit
    - Further updates to allow even greater flexibility in setting parameters related to Code-Carrier Divergence Monitor
- Public Operational Sites:
  - PANYNJ Newark Int'l Airport (EWR)
  - HAS George Bush Intercontinental Airport (IAH)

\* Both EWR and IAH SLS-4000s have completed upgrades to the SLS-4000 Block II version with optional SBAS functionality
- Private sites – Boeing:
  - Grant County Int'l Airport (MWH)
  - Charleston Int'l Airport (CHS) – Not commissioned



# Sponsor-Planned Sites

- These U.S. airport authorities are in discussions with Honeywell for installation of SLS-4000 Systems:
  - San Francisco Int'l Airport (SFO)
  - Port Authority of New York & New Jersey
    - John F. Kennedy Int'l Airport (JFK)
    - LaGuardia Int'l Airport (LGA)
  - Seattle-Tacoma Int'l Airport (SEA)



# GBAS System Usage

- Newark, NJ (EWR)
  - United Airlines, Delta Air Lines, British Airways, Lufthansa, Norwegian Air
  - B737, B747-8, B787
  - Over 3000 procedures completed
- Houston, TX (IAH)
  - United Airlines, Delta Air Lines, Emirates, Lufthansa, Cathay Pacific, British Airways, Air New Zealand, Cargolux
  - B737, B747-8, B787, A380
  - Over 2500 procedures completed



# FAA Flight Standards Updates



# Current Approved GLS Operations

- The Honeywell SLS-4000 is currently approved for use to CAT-I minima in the U.S.
- Autoland is currently prohibited; autopilot must be disengaged at Decision Height (DH)
- All implemented public GLS approaches are straight-in procedures overlaid on existing ILS procedures.
- GLS/LPV RVR was previously at 2400'. This was updated to RVR 1800 June 2017.



# Document Updates

- US Aeronautical Information Publication (AIP) (Feb 2019): Published Standardized GLS Approach Service Volume diagram and accompanying descriptive text along with pilot guidance



# Autoland & Approaches to CAT-II Minima on GAST-C GBAS

- FAA is examining operators' request for CAT II and autoland operations
  - Requests are predicated on use of the GAST-C SLS-4000 Block II GBAS with optional SBAS Ionospheric Monitoring capability installed and operating
  - Optional SBAS component was approved in June 2015 during Block II System Design Approval evaluations. When the system is operating in this mode, errors are guaranteed to remain bounded by Protection Level





# Post GAST-C Notes



# CAT-III/GAST-D GBAS

- Standards for GAST-D GBAS were approved by ICAO November 2016 and promulgated November 2018
- GBAS CAT-III MOPS (DO-253D) were completed by RTCA SC-159 WG4 in July 2017
- The FAA has no current System Design Approval effort ongoing for CAT-III GBAS.
- An applicant has approached the FAA requesting support for System Design Approval of their GAST-D GBAS.
  - This request is pending response by the FAA.



# GAST E/F GBAS

- Efforts in requirements development for dual-frequency/multi-constellation GBAS are underway at ICAO and RTCA
- The FAA has no current prototyping or development funding for these systems
- The FAA will continue to participate in ICAO Navigation Systems Panel (NSP) GBAS Working Group (GWG) and RTCA SC-149 WG 4
  - Participants currently from Aircraft Certification, Flight Standards, and NextGen



# For Questions...

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