Navigation Programs Update

Presented by: Deborah Lawrence

Presented to: Civil GPS Service Interface Committee

Date: September 2015
Agenda

• Performance Based Navigation (PBN) NAS Strategy
• NAV Strategy Update
  – OVERVIEW
  – WAAS Update
  – GBAS Update
• RESILIENCY
  – APNT
  – NEXTGEN DME
  – ILS Rationalization Decision
  – VOR MON Program Update
• Summary
PBN NAS Strategy
PARC / Ad Hoc PBN Strategy Meeting

• **Timeline**
  – The draft PBN Strategy was provided to the RTCA NextGen Advisory Committee (NAC) on June 5, 2015
    • Given the action to circulate the PBN Strategy with aviation industry
  – Conducted an Ad Hoc meeting with the Performance-based Operations Aviation Rulemaking Committee (PARC) from August 18-20, 2015
    • The PARC will break into smaller groups to work through six areas of comments
    • A meeting is scheduled for December 7, 2015 for final document review

• **Navigation Programs action:**
  – To Lead the Resiliency Work Group
    • Provide More Information on NextGen DME
<table>
<thead>
<tr>
<th>PBN Service</th>
<th>NSG 1</th>
<th>NSG 2</th>
<th>NSG 3</th>
<th>NSG 4</th>
<th>NSG 5</th>
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<td>RNAV (GPS) with LNAV minima</td>
<td>Required</td>
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<td>Automatically qualifies</td>
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<td>RNAV (GPS) with LP minima</td>
<td>Only if does not qualify for LPV</td>
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<td>RNAV (GPS) with LNAV/VNAV minima</td>
<td>Required (aircraft must be able to fly LNAV/VNAV or LPV)</td>
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<td>Automatically qualifies</td>
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<td>RNAV (GPS) with LPV minima</td>
<td>Required (aircraft must be able to fly LNAV/VNAV or LPV)</td>
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<td>Automatically qualifies</td>
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<td>RNAV (RNP) to RWY XX (0.3 or lower needed)</td>
<td>Based on proximity to terrain, obstacles, SUA, or airspace/procedure considerations</td>
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<tr>
<td>RNAV (GPS) to RWY XX (RF required outside FAF)</td>
<td>May require RF</td>
<td>Based on proximity to terrain, obstacles, SUA, or airspace/procedure considerations</td>
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<td>RNP STAR</td>
<td>Required (replaces RNAV STARs)</td>
<td>Curved path (RF leg) to avoid terrain, obstacles or airspace/procedure considerations</td>
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<td>RNP SID</td>
<td>Required (replaces RNAV STARs)</td>
<td>Curved path (RF leg) to avoid terrain, obstacles or airspace/procedure considerations</td>
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<td>RNP segment to xLS (hybrid) (description: RNP transition as part of an ILS approach procedure)</td>
<td>Required</td>
<td>Where shorter final would be available given EoR criteria and ATC acceptability (need tools to support)</td>
<td>TBD. It’s expected that there will be a few qualifying airports</td>
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<td>RNAV STARs</td>
<td>Uses RNP instead</td>
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<td>Based on proximity to a Group 1 or 2 airport with high traffic volume, or based on terrain requirement</td>
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<td>RNAV SIDs</td>
<td>Uses RNP instead</td>
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<td>Based on proximity to a Group 1 or 2 airport with high traffic volume, or based on terrain requirement</td>
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<td>ILS (Cat I)</td>
<td>Automatically qualifies</td>
<td>No new ILS (Cat I)</td>
<td>Only provided for VOR MON safe landing airport</td>
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<td>ILS (Cat II, III)</td>
<td>Meets APS1 criteria (considers operations and weather)</td>
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<td>LOC only approach</td>
<td>Only if ILS does not qualify for vertical</td>
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<td>VOR approach</td>
<td>Only maintained if there is no ILS and is also a VOR MON safe landing airport</td>
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<td>GLS</td>
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<td>Details need to be discussed by a working group</td>
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Navigation Strategy
En Route and Terminal Strategy

NextGen DME Program

- 920 DMEs
- DME/DME (No IRU) Coverage to Class A
- DME/DME (No IRU) to Group 1-2 Airports
- 750 DMEs

PBNRS Complete

- 231 Q/T Routes
- 301 Jet Routes
- 861 Conventional SID/STAR/ODPs
- 669 Victor Airways

VOR MON Program

- 957 VORs
- 856 VORs
- 650 VORs

FID - 1
FID - 2

2015 2020 2025 2030
En Route and Terminal Strategy

- GNSS is the primary enabler of En Route and Terminal Navigation
- The DME network will be improved to enable DME/DME RNAV (without IRU) in Class A airspace and Group 1-2 Airports
- PBN Route Structure (PBNRS) will provide Q/T Routes where needed and direct point-to-point where structure is not necessary
- VORs will be discontinued to a Minimum Operational Network (MON)
  - VOR Airways will be removed, where not needed
  - Conventional SID/STAR will be cancelled
  - PBN SID/STAR/ODPs will be implemented
Approach Strategy

1100 Cat-I ILSs

**ILS Rationalization**

- Rationalize ILS at Group 4-5 Airports
- ILS Rationalization at Level 1-2 Airports

120 Cat-II/III ILSs

**LPVs and LPs added to all qualifying runways**

3547 RNAV(GPS) with LPV or LNAV

5966 RNAV(GPS) with LP or LNAV

**TERPS for LPVs at additional runways**

Add LPVs to runways for new TERPs

720 RNAV(RNP) AR

694 Non-Directional Beacon (NDB) Approaches

2170 VOR Approaches

1220 VOR Approaches

957 VORs

**VOR MON Program**

FID - 1

FID - 2

856 VORs

650 VORs

2015 2020 2025 2030
Instrument Approach Strategy

- **LPVs will provide new CAT I vertically guided service needs**
  - By 2016, WAAS LPV approaches will be available at all qualifying runways
  - New qualifying runways will only receive LPVs
- **CAT I ILS approach service will be retained where needed**
  - To support safe recovery at VOR MON Airports in the event of a GNSS outage
  - To provide for SA CAT I Enhanced Low Visibility Operations (ELVO) where beneficial
  - The remaining CAT I ILSs will be rationalized to retain systems where needed
- **CAT II/III ILS will be retained**
  - Retain for the foreseeable future to support commercial aircraft
- **Explore the feasibility of achieving:**
  - WAAS CAT II precision approach service (w/single & dual frequency GPS)
  - WAAS CAT I/II Autoland
- **VOR and LOC approaches will be retained as needed to provide a backup in the event of a GNSS outage**
- **NDB approach procedures will be discontinued**
WAAS UPDATE
WAAS Phase IV - Dual Frequency Operations (2014-2044)

- Final Investment Decision for Phase IV Segment 1 (2014-2019) Dual Frequency Operations (DFO) approved
  - Segment 1 - Develop infrastructure improvements to support L5 & Tech Refresh
  - Segment 2 - Implementation of L1/L5 user capability
- Planning to transition from use of L2 P(Y) to L5 within 2 years of GPS L5-signal Full Operational Capability (FOC)
- Future considerations
  - Dual-Frequency Multi-constellation Capability
    - International Focus is on taking advantage of other GPS like constellations
      - International Civil Aviation Organization (ICAO) Navigation Systems Panel (NSP) has developed work plan that supports development of future standards for use of other Global Navigation Satellite Systems (GNSS)
      - ICAO working on CONOPS addressing all DFMC applications (e.g. SBAS, GBAS)
  - User Equipment Standards for Dual-Frequency Operations
    - FAA working with Interoperability Working Group (IWG) on definition document that provides the basis for interface design and MOPS development for L1/L5 and multi-constellation
WAAS GEO Activities

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

- **GEO 5/6 Contract awarded 2012**
  - GEO 5
    - Payload development complete
    - Launch planned late 2015
    - Signal generation system /radio frequency uplink integration 2016
    - Expected Operational in 2017
  - GEO 6
    - Authorization to proceed awarded March 2015,
    - Preliminary design review (PDR) completed June 2015
    - Critical Design Review (CDR) expected Spring 2016
    - Expected Operational in 2019

*AMR ranging only supports horizontal navigation*
WAAS Technology Refresh

- **G-III Receiver Upgrade**
  - Technology update of existing WAAS Reference Receiver, capable of processing all GPS frequencies (Enables Dual Frequency capability)
  - First G-III unit installed September 4th, 2015
    - Complete fielding in FY2016
- **Safety Computer (SC)**
  - Adds significant new capability and support to WAAS dual frequency upgrades
  - SC Unit Application Demonstration initiated, expect completion by end of CY2015
  - Delivery of first production units spring 2016
- **WAAS Terrestrial Comm Network (TCN) modernization**
  - Upgrade of Core Nodes, Operational Control Centers, and Networks Complete
  - Upgrading routers at all WRS locations (Domestic and International)
    - First sites installed, currently validating service
    - Expect complete installation and cutover at ALL WRS groups by 3rd Qtr FY2016
• Procedures & Users Depending on WAAS

• Procedures
  – Currently 4,162 WAAS Procedures published
    • 3,568 LPV criteria
    • 594 LP criteria

• Approximately 84,000 WAAS equipped aircraft in the NAS
  – WAAS receivers provided by companies such as: Garmin, Universal, Rockwell Collins, Honeywell, Avidyne, Innovative Solutions & Support (IS&S), Thales and Genesys Aerosystem (Chelton)

• Since 2006, aircraft equipage rates has increased each year
• All classes of aircraft are served in all phases of flight
• Enabling technology for NextGen programs
  – Automatic Dependent Surveillance Broadcast (ADS-B)
  – Performance Based Navigation (PBN)
GBAS UPDATE
Ground Based Augmentation System Overview

- The Ground Based Augmentation System (GBAS) augments the Global Positioning System (GPS) signals to support terminal, and precision approach procedures in the NAS.
- GBAS will provide all-weather approach capabilities to aircraft within line-of-sight distances from airports using GPS error corrections and integrity information.
- A single GBAS system is capable of providing precision approach capabilities to multiple runways at an airport.
- GBAS will satisfy the all-weather approach and landing capability with significant improvements in service flexibility (i.e. capacity), safety, and user operating costs.
- High quality navigation services will be provided with a minimum investment in ground facilities compared to existing technology.
- Aircraft operators will benefit from reduced fuel expenses due to more efficient terminal area routing (RNP to GLS) and improved access to airports during extremely low visibility operations (reduction of ILS critical areas).
- Variable glide path and displaced threshold capability provides service flexibility for wake avoidance and noise abatement procedures.
FAA GBAS Program

• Validation of ICAO SARPS for the baseline set of GBAS Approach Service Type D (GAST-D) / CAT III Requirements
  – FAA validation efforts included producing commercial prototypes (Avionics/Ground)
  – Goal date for Final Close of Validation/Final SARPS acceptance – December 2015

• System Design Approvals (SDA) for GAST-C Block II and GAST-D systems
  – SDA for GAST-C Block II update expected Oct 2015 (Modification of the previously approved SLS-4000 Block I configuration intended to enhance availability)
  – SDA for GAST – D expected 2019

• CAT I implementation support
  – Newark NJ, Houston TX, Moses Lake WA performance monitoring/service prediction
  – Coordination of user/airlines GBAS activities

• International Coordination
  – International GBAS Working Group (IGWG)
  – ICAO, SESAR, International MOUs (Brazil, Australia, etc.)
  – FAA GBAS Implementation Status
RESILIENCY
APNT Update
Alternate Position, Navigation, and Time (APNT)

- The 2015 PBN NAS Strategy recommends deferring APNT research to the 2025-2030 time frame (Far-Term)
NextGen DME
NextGen DME Overview

- Navigation Programs has determined 3 options to accomplish the NextGen DME program to provide DME coverage for RNAV operations
  - PBN Strategy: 100% Class A + 73 Group 1-2 Airports
  - Alternative 1: 99% Class A + 64 Group 1-2 Airports
  - Alternative 2: 99% Class A + 12 Group 1 Airports
# Draft Program Schedule

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Program Planning</th>
<th>Investment Analysis</th>
<th>Acquisition Decision</th>
<th>Phase 1 – Implementation</th>
<th>Phase 2 – Implementation</th>
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<tbody>
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<td>FY15</td>
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<td>Establish New DME Standard Service Volume (SSV)</td>
<td>DME/DME (No IRU) Coverage in Class A</td>
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<td>DME Capacity &amp; Interrogation Analysis</td>
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ILS Rationalization Decision
Overview

- ILS, LPV, and LNAV/VNAV all provide vertically guided approach service to airports in the NAS
  - Not all users are equipped for all procedures
- **Rationalize the need for Instrument Landing Systems (ILS) and associated procedures**
  - Performance Based Navigation NAS Strategy – 2015
  - NAS Enterprise Architecture Roadmap
    - 2016 ILS Decision Point
  - ICAO Working Paper, *Rationalization of Terrestrial NAVAIDS*
- **Navigation Program has begun to circulate draft Criteria and Communication plan**
  - Expect stakeholder concurrence by September 18, 2015
Draft Criteria (1 of 2)

**Operational Factors**

- Number of ILS installed at airport
- Number of runways that qualify for LPV at airport
- Number of runways that have both ILS and LPVs installed
- Peak traffic levels for the airport
- Number of Instrument Flight Rule (IFR) Operations by User Type
- Percent of time airport experiences IMC conditions
- Prevailing winds for the airport
- Special operations (training)
- Difference of approach minima between LPV and ILS and how often the lower ILS minima is beneficial
Draft Criteria (2 of 2)

- Proximity of airport with similar approach service
- Capacity of airports in proximity
- Capacity of ATC sectors providing air traffic services to airports considered for continuance of ILS service

• Value Factors
  - Number of air carrier aircraft and equipage flying to the airport and the value of those services
  - DoD aircraft flying into the airport and their equipage for vertically guided approach services
  - Other essential or critical services dependent on vertically guided approach at the airport
Summary

• The Performance Based Navigation (PBN) NAS Strategy is adjudicating industry comments.
  – Targeted Completion Date: December 7, 2015

• Navigation Programs is updating the NAV Strategy
  – WAAS is replenishing GEOs, Performing Tech Refresh
  – GBAS feasibility for CAT II/III targeted 2019
  – VOR MON target for FID in September 2015
  – ILS Rationalization Team will provide recommendation on CAT I ILS, 2016

• Nav Program Resiliency
  – APNT will Transition to NextGen Office for R&D activities
  – Navigation Program will proceed with Investment Decision for NextGen DME
Questions
### PBN Strategy Implementation Plan

- **Class A over CONUS coverage 18,000 MSL and above 100% availability**
- **73 Group 1 and 2 Airports Covered**

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<th>En Route DME</th>
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<th>FY2021</th>
<th>FY2022</th>
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# PBN Strategy Program Schedule

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### Alternative 1: Implementation Plan

- Class A over CONUS coverage 18,000 MSL and above 99% availability over the WUSMA
- 64 Group 1 and 2 Airports Covered

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<tr>
<th>En Route DME</th>
<th>FY2018</th>
<th>FY2019</th>
<th>FY2020</th>
<th>FY2021</th>
<th>FY2022</th>
<th>FY2023</th>
<th>FY2024</th>
<th>FY2025</th>
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VOR MON Update
# Requested Baseline Schedule

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<th>4VQ Milestones</th>
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<tbody>
<tr>
<td>Work Package 1: 5 VORs</td>
<td>October 2015</td>
<td>12 Months</td>
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<tr>
<td>Work Package 2: 10 VORs</td>
<td>October 2016</td>
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<tr>
<td>Work Package 3: 25 VORs</td>
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<tr>
<td>Work Package 4: 25 VORs</td>
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<tr>
<td>Work Package 5: 36 VORs</td>
<td>October 2019</td>
<td>12 Months</td>
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VOR MON Support

– VOR MON Program depends on the Mission Support Services (MSS) organization to perform the majority of work required for VOR discontinuance

– Topics of Discussion:
  
  • Field requires clarity on VOR discontinuance based on previous statement
  
  • The Planning and Requirements Groups (PRG) from East, Central, and Western Service Areas identified a need for 3 support contractors
  
  • VOR MON program is working closely with AJV-5 to be efficient in the way procedures work is performed in support of the program. (Touch Once)
  
  • There are 474 conventional SID, STAR, ODP affected by VOR discontinuance and some of those will likely need to be replaced with RNAVs.