NAS
Navigation Strategy
Executive Summary

Presented by: Deborah Lawrence, AJM-32
Presented to: The National Space-Based Positioning, Navigation, and Timing (PNT) Advisory Board
Date: May 2018
FAA Navigation Strategy Purpose

• Plan to provide Navigation Services to support
  – NAS Efficient, Streamlined Services (NESS) initiative
  – Lighting Systems initiatives
  – Next Generation Air Transportation System (NextGen) Goals
Navigation Strategy Goals

• Provide resilient navigation services for the PBN NAS Strategy–2016
  – GPS and WAAS enable all PBN operations and ADS-B
  – NextGen DME Program will provide an RNAV backup to mitigate for the loss of GNSS
  – VOR Minimum Operational Network (MON) Program will repurpose VORs to provide a backup for non-RNAV aircraft.
  – Legacy conventional NavAids must be sustained to provide a resilient NAS infrastructure

• Rationalize infrastructure to meet the NESS initiatives
  – Discontinue redundant VORs to establish the MON
  – Rationalize ILS at airports where LPV provides redundancy

• Innovate navigation services to enable new capabilities
  – Multi-Constellation GNSS
  – LED technology, etc.
# FAA Navigation Programs Portfolio

<table>
<thead>
<tr>
<th>Legacy Navigation Infrastructure</th>
<th>VOR TACAN DME</th>
<th>VOR TACAN DME NDB</th>
<th>VOR TACAN DME NDB</th>
<th>ILS/LOC RVR VOR / DME / TACAN / NDB GSNS MALSR ALSF-2 REIL PAPI/VASI</th>
</tr>
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<tbody>
<tr>
<td>LOC RVR GNSS</td>
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<tr>
<td>Future Navigation Infrastructure</td>
<td>GNSS DME / TACAN VOR</td>
<td>GNSS DME / TACAN VOR</td>
<td>GNSS DME / TACAN VOR</td>
<td>GNSS ILS/LOC RVR DME / TACAN VOR MALSR ALSF-2 REIL PAPI</td>
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<tr>
<td>GNSS LOC RVR</td>
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Note: **NavAid system listed first in each cell is the preferred navigation service**
• GNSS is the primary enabler for all PBN (RNAV and RNP) and ADS-B accuracy & integrity for all separation levels
• DME/DME provides an RNAV alternative
• VOR MON can be used by aircraft that are not DME/DME RNAV equipped
• CAT-I ILSs will be retained as needed to support safe recovery in the event of a GNSS outage
En Route and Terminal Strategy

NextGen DME Program

IARD FID FID
DME/DME (No IRU) to Class A DME/DME (No IRU) to NSG 1-2 Airports

924 DMEs
~ 124 New DMEs Installed
~ 100 DMEs Discontinued

Approximately 948 DMEs

231 Q/T Routes

NextGen DME will provide unrestricted RNAV to enable implementation of Q/T Routes and cancellation of Jet Routes and Victor Airways

301 Jet Routes

NextGen DME and VOR MON will enable replacement of conventional SID/STAR/ODPs with RNAV

669 Victor Airways

857 Conventional SID/STAR/ODPs

907 RNAV SIDs and STARs

957 VORs

VOR MON Program

Phase 1

Phase 2

FID
FID

883 VORs

649 VORs

Removal of VORs will require Jet Routes, Victor Airways, and SID/STAR/ODPs to be replaced with PBN, if required

The number of DMEs added or discontinued is subject to change

IARD
FID
FID

JRC Decision Milestone
PBN NAS Navigation Strategy Commitment

Navigation Programs Strategy
May 2018

Federal Aviation Administration
En Route and Terminal Strategy

• New DMEs will be implemented to enable DME/DME RNAV (without IRU) in Class A airspace and at busy airports as a backup to GNSS
  – Fill coverage and add redundancy for en route airspace
  – Rationalize the DME network to remove unneeded facilities

• PBN Route Structure (PBNRS) will provide structure where needed and direct point-to-point navigation where structure is not necessary
  – Most Jet Routes and Victor Airways will be removed and replaced with RNAV Q/T Routes

• VORs will be discontinued to a Minimum Operational Network (MON)
  – Conventional SID/STAR/ODPs will be cancelled and replaced with RNAV SID/STAR/ODPs, where needed
### Approach Strategy (except ILS CAT-I)

<table>
<thead>
<tr>
<th>Year</th>
<th>VORs</th>
<th>RNAV(GPS) with LP or LNAV/VNAV</th>
<th>RNAV(RNP)</th>
<th>NDB Approaches</th>
<th>VOR Approaches</th>
<th>CAT-II/III ILSs</th>
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<tr>
<td>2015</td>
<td>957</td>
<td>3547</td>
<td>720</td>
<td>694</td>
<td>2170</td>
<td>120</td>
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<td></td>
<td></td>
<td>LPVs to all qualifying runways</td>
<td></td>
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<tr>
<td>2020</td>
<td>883</td>
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<tr>
<td>2025</td>
<td>649</td>
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<tr>
<td>2030</td>
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Where needed, VOR / NDB approaches will be replaced with RNAV(GPS) approaches.

LPVs to all qualifying runways

LPVs replace LPs

TERPs for LPVs at additional runways

Metro-Plex and PBN Single Sites projects will add new RNP AR approaches, where beneficial.

Instrument approaches tied to discontinued VORs will be cancelled.

**FID - 1**

VOR MON Program

**FID - 2**
**Instrument Approach Strategy**

- Retain existing CAT-II/III ILSs for commercial aircraft operating in low/zero visibility
- Publish LPV approach procedures to satisfy new requirements for CAT-I vertically guided approach service
  - Provide LPV approaches to all qualifying runways
  - Modify design criteria to qualify additional runways for LPV approaches
- VOR, ILS and LOC approaches will be retained at MON airports to provide a backup to GNSS outages
- NDB and redundant VOR approaches will be cancelled
- CAT-I ILSs will be rationalized to identify systems that can be discontinued
NavAids Sustainment
NavAids Sustainment

- VOR, DME, TACANs, and ILSs will be rationalized, but the remaining systems must be sustained
- TACAN requirements must be coordinated with DoD
  - No acquisition strategy in place currently
- Lighting systems will be sustained and gradually refreshed to use LED technology
## NavAids System Age Data

### As of May 2017

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<tr>
<th></th>
<th>VASI</th>
<th>VOR</th>
<th>TACAN</th>
<th>LOC</th>
<th>HP DME</th>
<th>GS</th>
<th>MALSR</th>
<th>REIL</th>
<th>ALS</th>
<th>RVR</th>
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<td><strong>Total</strong></td>
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<td>949</td>
<td>474</td>
<td>1259</td>
<td>469</td>
<td>1134</td>
<td>884</td>
<td>718</td>
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<td>305</td>
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NavAid Programs Next Steps

- **NextGen DME Program**
  - Install approximately 125 DMEs to provide resiliency during GNSS disruptions

- **VOR MON Program**
  - Discontinue 74 VORs and prepare for an investment decision in 2020

- **DME/VOR/TACAN Sustainment**
  - Complete DME/VOR/TACAN Supportability Study
  - Coordinate with DOD to identify TACAN requirements
  - Follow AMS process to develop acquisition strategy for DME, VOR, and TACAN to systems

- **ILS**
  - Continue to sustain Category-I ILSs at selected sites
GNSS Programs Next Steps

- Integrate 6th GEO and establish procurement strategy for 7th GEO
- Continue 2nd civil signal L5 implementation
- Continue development of Dual-Frequency MOPS
- Evaluate Multi-Constellation and Advanced Receiver Autonomous Integrity Monitoring (ARAIM)
- Develop strategy for TDM to IP
- Continue technical refresh activities
Lighting Programs Next Steps

• Continue procurement planning activities for REIL and RVR
• Continue evaluating LED technology for approach lighting systems

ELVO Next Steps

• Complete implementation of Enhance Low Visibility Operations (ELVO) Phase II
Innovation Initiatives

• Support Multi-Constellation GNSS and ARAIM standards development and program coordination through ICAO, RTCA, EU, and ANSP organizations

• Explore the feasibility of achieving WAAS CAT-II precision approach service (w/ single & dual frequency GPS)

• Support operational approval activities for WAAS LPV CAT-II enabled by Enhance Flight Vision Systems (EFVS)
Challenges

• Leveraging the benefits of LED technology without unacceptable impacts to current operational capabilities
• Use of the satellite navigation spectrum by commercial terrestrial communication service providers without impact to GPS and Iridium
• Establishing harmonized standards for DFMC SBAS and ARAIM with benefits to incentive users to equip
• Addressing Congressional interest in a service-based contracting approach for DME, VOR and TACAN service
Summary

• Navigation Strategy provides the infrastructure to support
  – Transition of the NAS to PBN operations
  – Rationalizing existing Navaids that are being replaced by GNSS
  – Sustaining conventional NavAids to provide resiliency

• Planning for the future
  – Lower approach minimums with WAAS and EFVS
  – Advanced Receiver Autonomous Integrity Monitoring (ARAIM)
  – Implementing LED technology