FAA Navigation Programs Update

Presented by: Deborah Lawrence

Presented to: Civil GPS Service Interface Committee

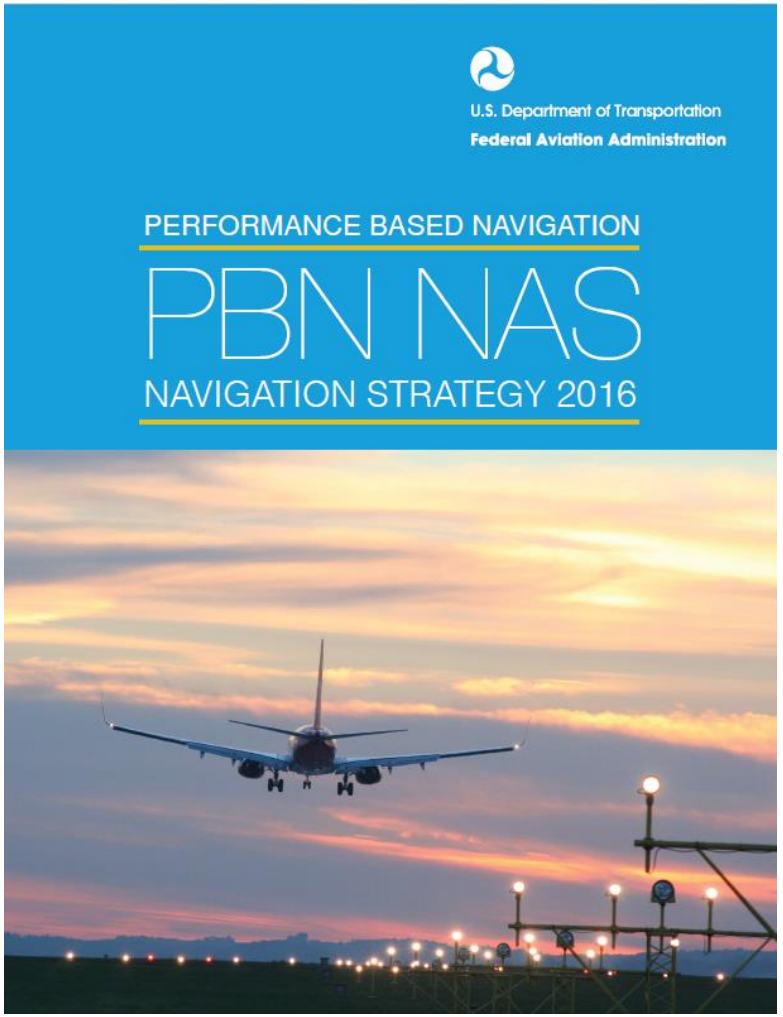
Date: September 2017

Agenda

- **Performance Based Navigation (PBN) Implementation Plan**
- **Wide Area Augmentation System (WAAS) Update**
- **Ground Based Augmentation System (GBAS) Update**
- **Resiliency Programs**
  - NextGen Distance Measuring Equipment (DME) Program
  - VHF Omni-directional Range (VOR) MON Program Update
  - VOR/DME/TACAN Supportability Study
- **Summary**

PBN Implementation Plan

PBN NAS Navigation Strategy



- Published in September 2016
- The PBN NAS Navigation Strategy 2016 builds on the progress of the past decade and refocuses FAA priorities and milestones towards a truly PBN-centric NAS

Link: https://www.faa.gov/nextgen/media/PBN_NAS_NAV.pdf

Navigation Programs Implementation Goals

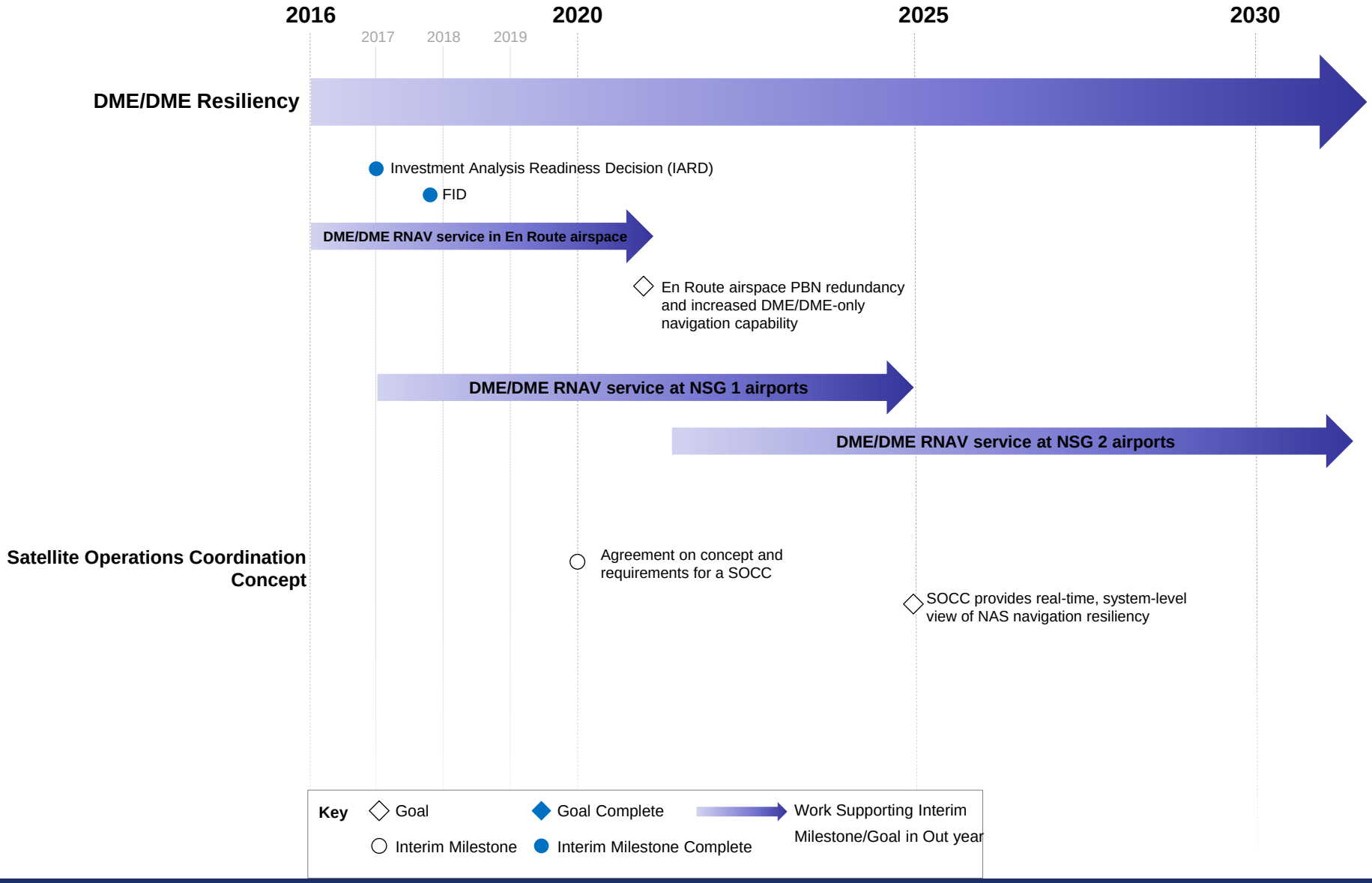
- Primary responsibility for seven goals
- Six of the goals involve other FAA organizations as key stakeholders

P = Primary POC for Near Term Activities x = key stakeholder *Column shading is a visual aid only and has no significance* **Goal**	AJV-1 Airspace Services	AJV-12 Airspace Operations Support	AJV-14 PBN Policy Support	AJV-5 Aeronautical Information Services	AJV-E Eastern Service Center	AJV-C Central Service Center	AJV-W Western Service Center	AFS-400 Flight Technologies and Procedures	AFS-420 Flight Procedure Standards	AJM-2 PMO Air Traffic Services	AJM-3 PMO Enterprise Services	ANG-B NextGen NAS Systems Engineering & Integration Office	AIR-6B0 Aircraft Certification, Systems & Equipment Standards	APO, Office of Aviation Policy and Planning	AIN-200 Internal Security Policy, Standards & Efficiency	AJW, Technical Operations Services	AJW-3 Flight Inspection Services	**Overall Status**
Vertically Guided Approaches			x	x	x	x	x	x	x		P							NT goal Complete; MT: On track
PBN for Helicopters			x	x				x	x		P							NT: On track
Discontinue VORs		x	x	x	x	x	x	x	x	x	P		x	x		x		NT: On track
ILS Rationalization		x	x	x	x	x	x	x	x		P		x	x		x		On hold; gaining experience from the rationalization of other NavAids
DME/DME RNAV Service at NSG 1 & 2 Airports	x		x	x				x	x		P	x	x		x		x	NT: On track to complete; dates impacted by funding limitations
DME/DME RNAV Service in En Route Airspace	x		x	x				x	x		P	x	x		x		x	NT: On track to complete; dates impacted by funding limitations
Satellite Operations Coordination Concept											P							NT: On track

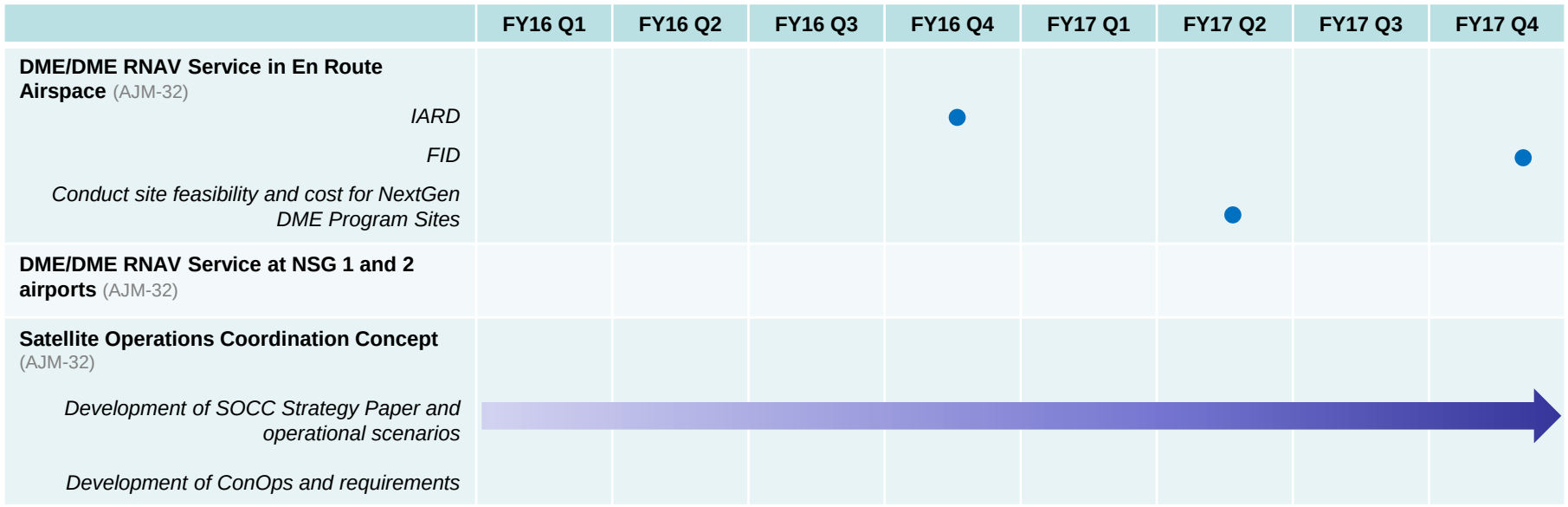
	Near-Term (2016-2020)	**Mid-Term (2021-2025)**	**Far-Term (2026-2030)**
PBN NAS 	✓ Implement RNAV(GPS) with LPV and LNAV/VNAV approaches at qualifying runways TERPS criteria • Expand development of PBN special helicopter approaches to hospitals	• Implement vertically guided RNAV(GPS) approaches at runways meeting new TERPS criteria	• Vertically guided RNAV(GPS) approaches at qualifying airports with an Instrument Approach Procedure (IAP)
More Cost Effective & Agile Service Delivery 	• Discontinue approximately 74 current Very High Frequency Omnidirectional Range (VOR) facilities • Begin Instrument Landing System (ILS) Rationalization at Navigation Service Group (NSG) 4 and 5 airports	• Discontinue about 234 more current VOR facilities • Continue ILS Rationalization at NSG 4 and 5 airports	• Re-evaluate remaining VOR facilities within the far-term system • ILS rationalization complete at NSG 4 and 5 airports • ILS rationalization analysis for NSG 1, 2, and 3 airports
Improved Navigation Resiliency 	• Distance Measuring Equipment (DME)/DME RNAV service expanded for NSG 1 and 2 airports initiated • En Route airspace is covered by DME/DME RNAV service (Inertial Reference Unit [IRU] not required) redundancy • Requirements for a Satellite Operations Coordination Concept (SOCC)	• DME/DME RNAV service expanded for NSG 1 and 2 airports based on site-specific evaluations • SOCC provides real-time, system-level view of NAS navigation resiliency	

See PBN Strategy pages:
- 5-12
- 27-28
- 32-37
- 58-62

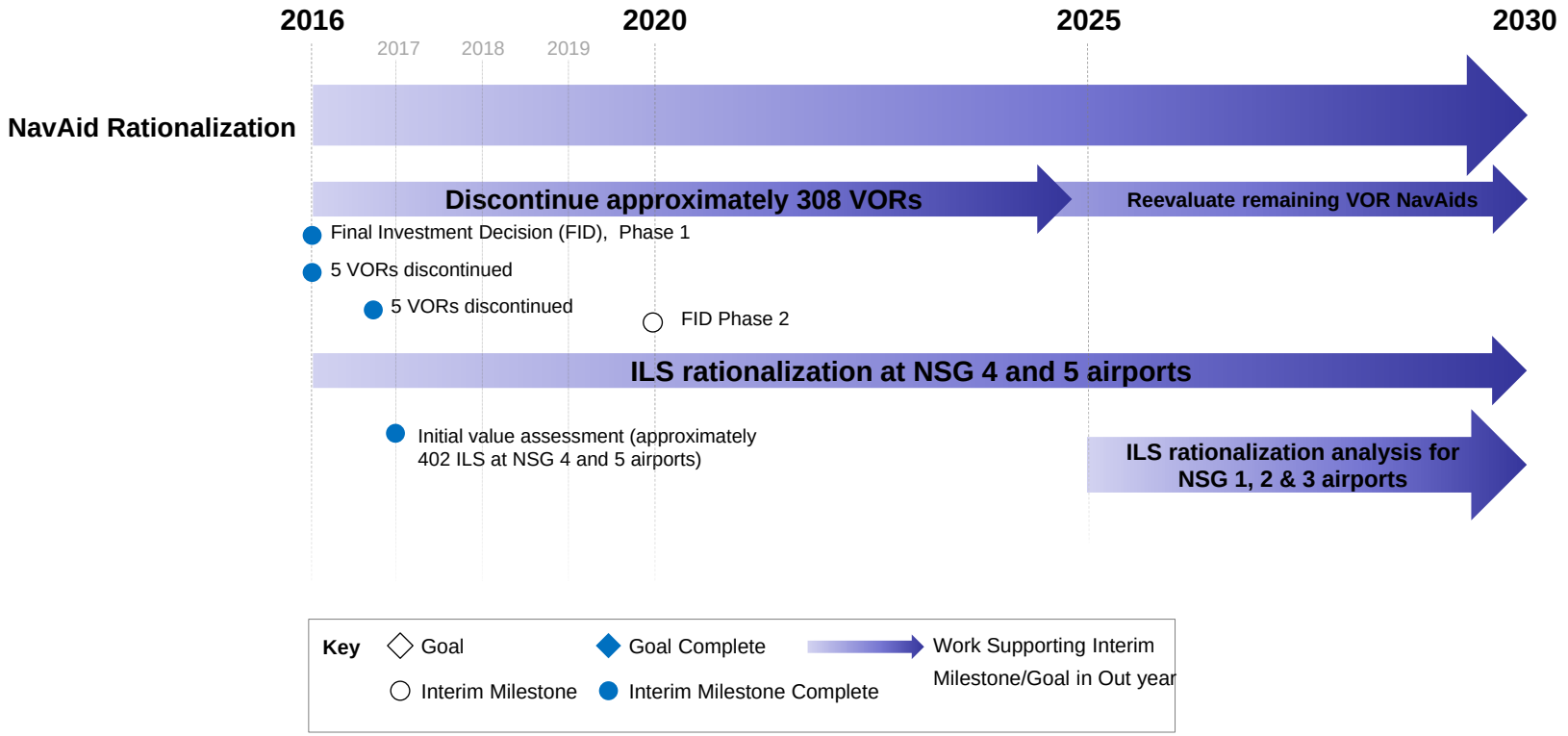
Navigation Resiliency Timeline



Improved Navigation Resiliency FY16-17 Timeline



Cost Effective and Agile Service Delivery Timeline



Cost Effective and Agile Service Delivery FY16-17 Timeline

	FY16 Q1	FY16 Q2	FY16 Q3	FY16 Q4	FY17 Q1	FY17 Q2	FY17 Q3	FY17 Q4
NAVAID Rationalization								
Discontinue VORs (AJM-32) *FID Phase 1*	●							
VORs Discontinued		1 VOR ●		4VORs ●		1 VOR ●	4VORs ●	
ILS Rationalization at NSG 4 and 5 airports (AJM-32) *Initial Value Assessment (Approximately 402 ILS at NSG 4 and 5 airports)*				●				

Key
◇ Goal ◆ Goal Complete → Work Supporting Interim Milestone/Goal in Out year
○ Interim Milestone ● Interim Milestone Complete

WAAS UPDATE

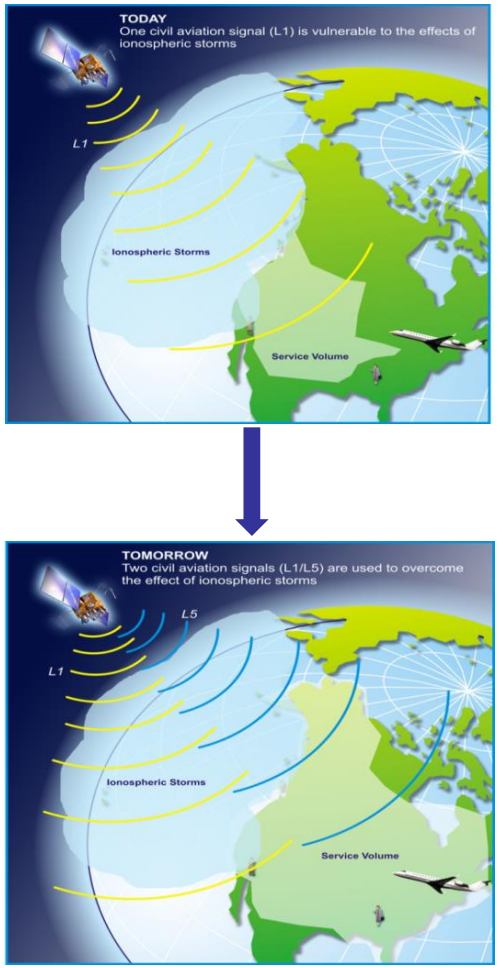
WAAS Phase IV Dual Frequency Operations Status

- **Phase IV Segment 1**
  - Combination of infrastructure improvements and tech refresh in support of operational system and future incorporation of dual frequency

- **5 Releases**
  - Release 1 (Processor Upgrades) completed April 2017
  - Release 2 (GEO 5 Integration) scheduled for cutover by 2nd Quarter CY2018
  - Release 3 (GIII Multicast Structure) cutover including monitoring currently scheduled to complete by 2nd Quarter CY2018
  - Release 4 (C&V Safety Computer [SC] Validation and Deployment) on schedule to complete cutover by the end of CY2018
  - Release 5 (GPT SC Validation and GEO 6 Integration) Software release scheduled cutover complete by 2nd Quarter CY2019. GEO 6 on schedule for cutover by 2nd Quarter CY2019

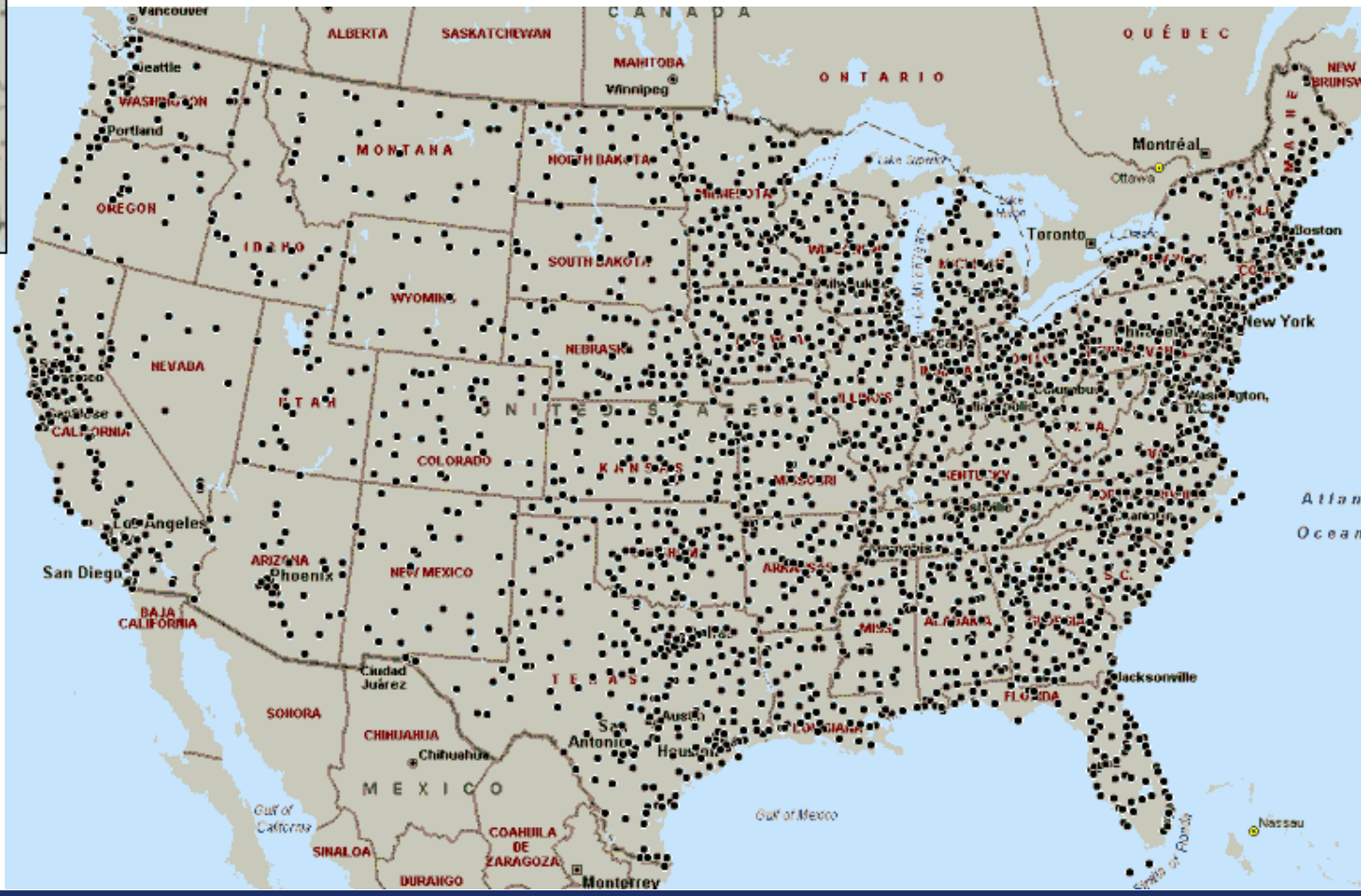
- **Dual-Frequency Multi-constellation Capability (DFMC)**
  - MOPS and SARPs development underway
  - WAAS assisting IWG with providing SBAS perspective on DFMC capability

- **Advanced RAIM (ARAIM)**
  - ARAIM subgroup developing more detailed concept definition in Milestone 3 report to look into avionics centric approach for use of multi-constellation GNSS
  - FAA focusing on development of initial requirements for horizontal navigation (H-ARAIM)



Airports with WAAS LPV/LP Instrument Approaches

- Most of the airports throughout the National Airspace System contain WAAS Procedures



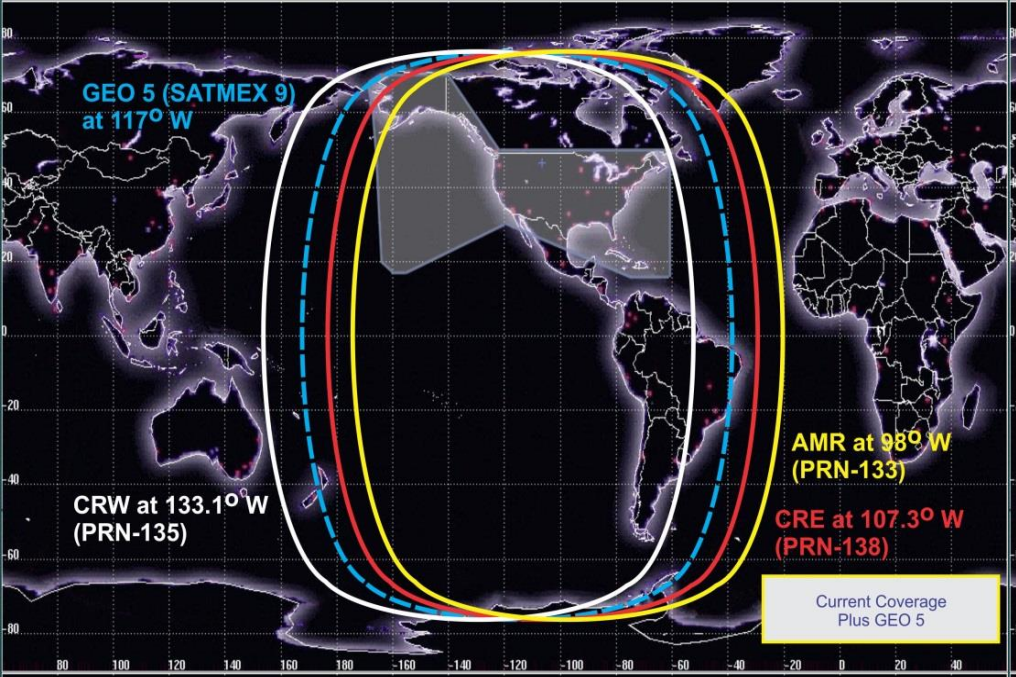
- As of May 2017 there are currently 1,550 ILS procedures while WAAS has 4,422 LPV/LP procedures published

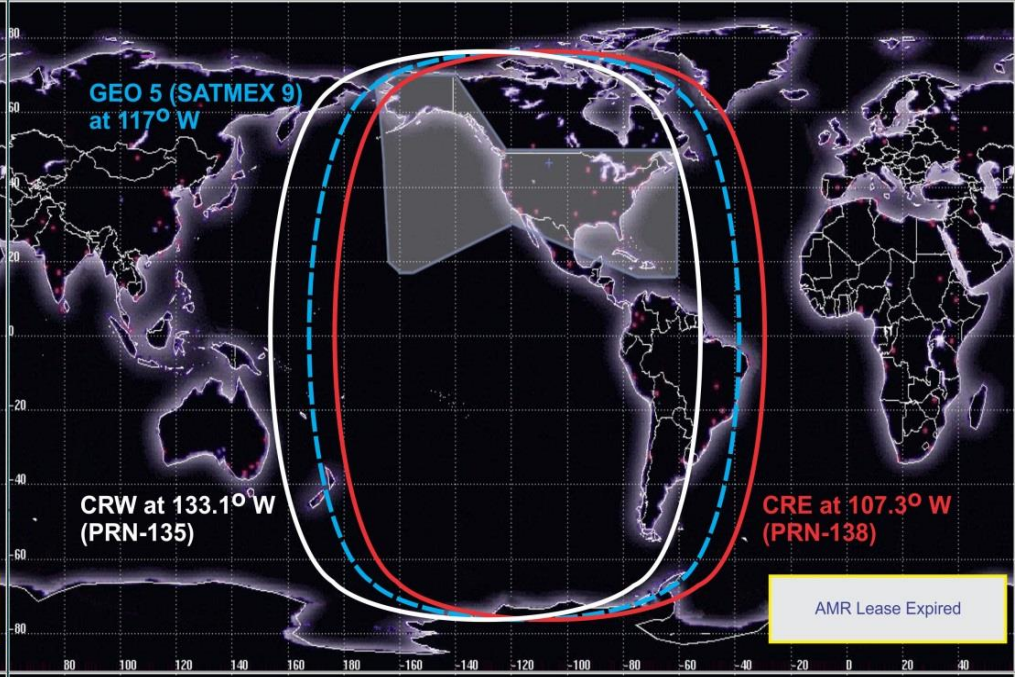
GEO Sustainment (GEOs 5/6/7)

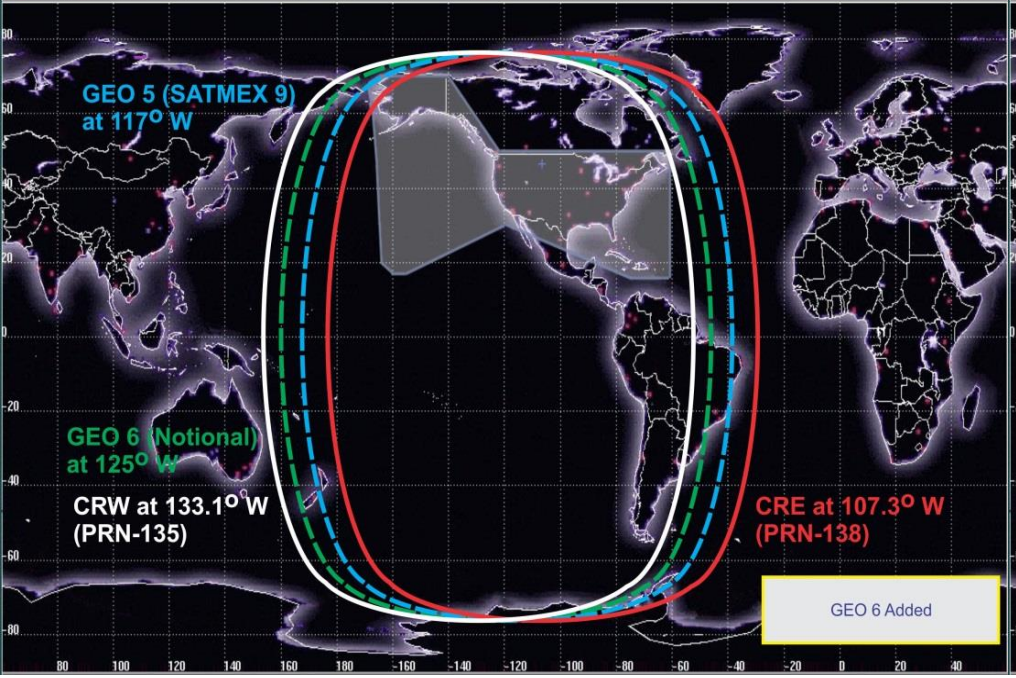
- **GEO 5/6 Satellite Acquisition**
  - GEO 5
    - Payload development complete
      - EUTELSAT 117 West B (ex SatMex 9) satellite
        - » Located at 117 West, provides full coverage of CONUS and Alaska
    - Successful satellite launch June 2016
    - In-Orbit Testing completed January 2017
    - Integration activities underway; expected operational capability May 2018.
  - GEO 6
    - Ground Uplink Station site build out complete
    - Host satellite is SES-15, planned for 129 West
      - Provides full coverage of CONUS and Alaska
      - Successful launch on 18 May 2017
    - Expected operational capability June 2019

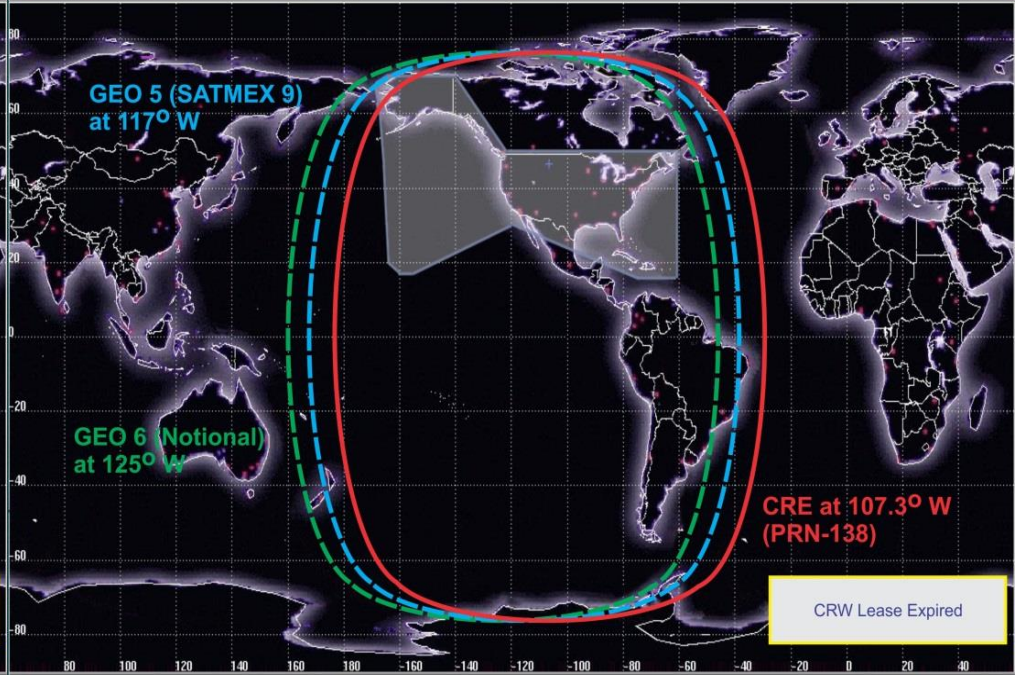
Eutelsat 117WB

- **GEO 7 Satellite Acquisition**
  - Targeting 2017 for a contract award


GEO 5 (SATMEX 9)
at 117° W
AMR at 98° W
(PRN-133)
CRW at 133.1° W
(PRN-135)
CRE at 107.3° W
(PRN-138)
Current Coverage
Plus GEO 5


GEO 5 (SATMEX 9)
at 117° W
CRW at 133.1° W
(PRN-135)
CRE at 107.3° W
(PRN-138)
AMR Lease Expired


GEO 5 (SATMEX 9)
at 117° W
GEO 6 (Notional)
at 125° W
CRW at 133.1° W
(PRN-135)
CRE at 107.3° W
(PRN-138)
GEO 6 Added


GEO 5 (SATMEX 9)
at 117° W
GEO 6 (Notional)
at 125° W
CRE at 107.3° W
(PRN-138)
CRW Lease Expired

GBAS UPDATE

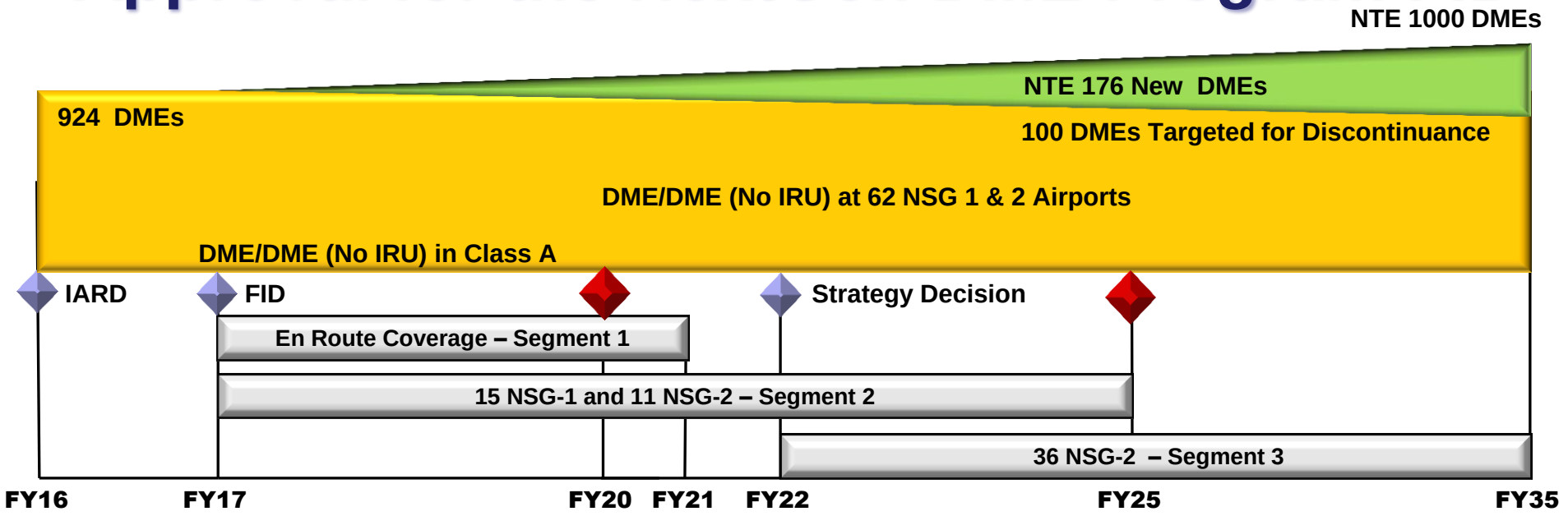
FAA GBAS Program

- **ICAO SARPS to support GBAS Approach Service Type D (GAST-D) / CAT III**
  - Accepted by Navigation Systems Panel (NSP) December 2016
- **RTCA MOPS & ICD to support GBAS Approach Service Type D (GAST-D) / CAT III**
  - Finalized July 2017
- **System Design Approvals (SDA) for GBAS GAST-D (CAT III) systems**
  - FAA system design review of safety documentation for Honeywell SLS-5000 underway, continuing through early 2018
  - Final completion schedule will be at vendor's discretion
- **FAA GBAS CAT I Implementation Status**
  - Honeywell SLS-4000 GBAS GAST C approved for CAT 1 operations and deployed at Newark, NY and Houston, TX for public use as non-Federal systems
    - Updates to most recently approved Block II version SLS-4000 planned for both EWR and IAH in late 2017/early 2018
  - Moses Lake, WA and Charleston, SC are operational as Boeing private systems
  - FAA provides performance monitoring/service prediction for Newark, Houston, Moses Lake
    - Planned for EWR and IAH through September 2018
  - Operators using GBAS at Newark and Houston include United Airlines, Delta Airlines, Lufthansa, Emirates, Cathay Pacific, British Airways, Cargolux
  - Over 4600 GLS approaches to public EWR and IAH SLS-4000s as of August 2017
  - Delta's first A321 GLS landing to EWR August 26, 2017
- **International Coordination**
  - ICAO, SESAR, FAA International MOUs (Brazil, Australia, etc.)
  - International GBAS Working Group (IGWG) – June 2016 IGWG sponsored by Avinor, Norway

RESILIENCY

NextGen DME

Approval for the NextGen DME Program FID



- **Airports grouped into clusters to maximize benefits**
- **Clusters grouped into discrete segments**
  - Segment 1: En Route Coverage
  - Segment 2: Terminal Coverage for 15 NSG-1 and 11 NSG-2 Airports
  - Segment 3: Terminal Coverage for 36 NSG-2 Airports

PBN NAS Navigation Strategy 2016 **Goals**

Acquisition Decision Milestones

NextGen DME Implementation Approach

Segment 1 – En Route Coverage

- Continue as planned
- Close DME/DME coverage gaps to remove IRU requirement with full redundancy*

Segment 2 – NSG 1 & Assoc. NSG 2 Airports Terminal Coverage

- Close DME/DME coverage gaps to remove IRU requirement at NSG 1 and nearby NSG-2 airports
- Provide redundancy* for RNAV procedures as deemed necessary by AJV-14

Segment 3 – Remaining NSG 2 Airports Terminal Coverage

- Close DME/DME coverage gaps to remove IRU requirement at NSG 2 airports
- Provide redundancy* for RNAV procedures as deemed necessary by AJV-14

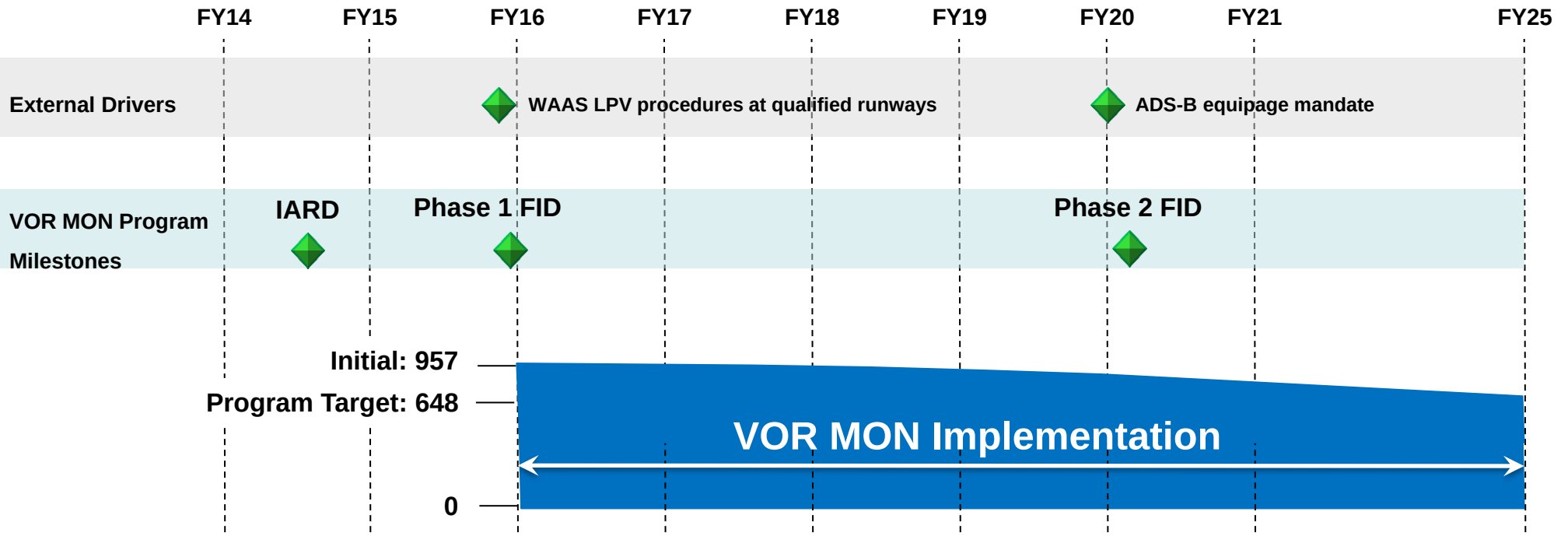
Revised Implementation plan

- Developed in coordination with NextGen, PBN Office, Flight Standards, Frequency Management, IP&A, and the NextGen DME Program Office.
- Will evolve as the program develops
- Expect initial revision in **3 – 5 months**

•*Eliminate critical DMEs

VOR MON Update

VOR MON Program Timeline



The VOR MON Program will be completed in 2 phases:

Phase 1: FY16 – FY20
Phase 2: FY21 – FY25

Phase 1

- Published Final Policy FRN: *"Provision of Navigation Services for the Next Generation Air Transportation System (NextGen) Transition to Performance Based Navigation (PBN)"*
- Remove, Replace, Amend affected Instrument Flight Procedures (IFPs)
- Discontinue Phase 1 VORs (74)
- Plan for Phase 2 Final Investment Decision (FID)

Phase 2

- Continue IFP work
- Discontinue Phase 2 VORs (234)

VOR MON Program

Accomplishments:

- Published the VOR MON Program's FAA.gov website – *April 28, 2017*
  - www.faa.gov/go/VORMON
- Completed the discontinuance of 12 VORs to date:
  - [EDS] Edisto, in Orangeburg, SC – February 4, 2016
  - [BUA] Buffalo, in Buffalo, SD – July 21, 2016
  - [PNN] Princeton, in Princeton ME – July 21, 2016
  - [PLB] Plattsburgh, in Plattsburgh, NY – September 15, 2016
  - [AOH] Allen County , in Lima, OH – September 15, 2016
  - [ABB] Nabb in Nabb, IN – January 5, 2017
  - [SYO] Sayre in Sayre, OK – April 27, 2017
  - [ENW] Kenosha in Kenosha, WI – June 22, 2017
  - [BTL] Battle Creek in Battle Creek, MI – June 22, 2017
  - [HRK] Horlick in Racine, WI – June 22, 2017
  - [HUW] Hutton in West Plains, MO – August 17, 2017
  - [RIS] Riverside in Kansas City, MO – September 14, 2017

VOR/DME/TACAN Supportability

VOR/DME/TACAN Supportability Study

- The scope of the VOR/DME/TACAN Sustainment Study covers the 2nd and 3rd Generation VOR, DME and TACAN equipment, electronic racks, power supply equipment as well as any common sub-systems
- The Sustainment Study will address parts obsolescence, performance, parts demand, operations costs, equipment condition, operational impacts and projected system life. The Study will characterize system supportability and will develop failure rate predictions for each system
- The FAA will utilize the Diminishing Manufacturing Sources and Material Shortages (DMSMS) process. The primary steps of the process include: Data Collection, Data Assessment, Impact Analysis, Mitigation Resolution Options
- Additionally, there is Congressional interest to develop a sustainment plan. Navigation Programs will have to report its progress to Congress

Notional Schedule

Operational Milestones	Date
Initiate Study Development	October 2017
Complete Data Analysis	January 2018
Complete Draft Study	March 2018
Complete Final Study	June 2018

Summary

- **Navigation Programs is supporting the Performance Based Navigation (PBN) Implementation Plan**
  - SOCC requirements are being refined
  - ILS Rationalization on hold, obtaining experience with other NavAid rationalization
- **WAAS is replenishing GEOs, Performing Tech Refresh**
- **GBAS feasibility for CAT II/III targeted 2019**
- **Resiliency**
  - VOR MON implementation underway (12 VORs Discontinued to date)
  - NextGen DME Program approved to begin implementation
  - VOR/DME/TACAN Supportability study will be completed in 2018

Back Up Material

Improved Navigation Resiliency

- *The FAA will pursue the use of DME for DME/DME to maintain PBN operations in Class A airspace and at NSG 1 and 2 Airports in the event of GNSS service unavailability or disruptions.*

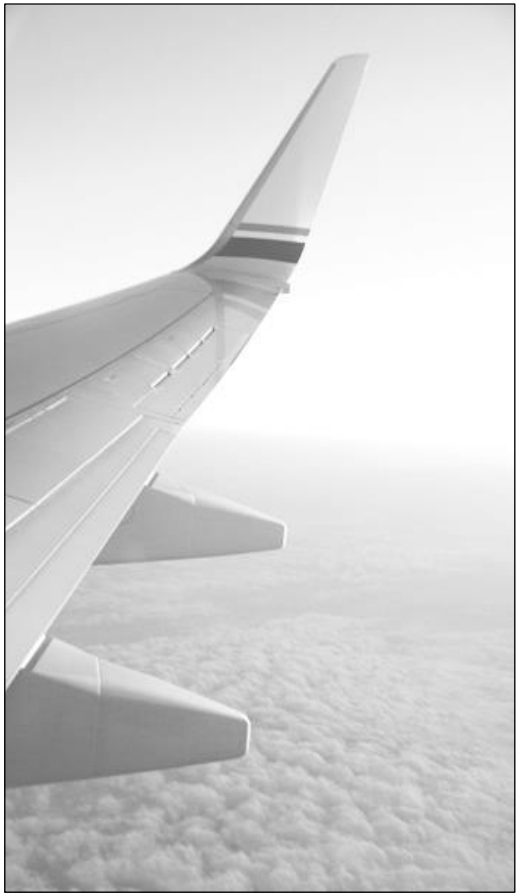
- The FAA's NextGen DME program will expand DME coverage in the en route and terminal domains to provide a resilient complementary system to support PBN operations in the event of a Global Navigation Satellite System (GNSS) disruption. The same system will provide a DME/DME-only navigation capability for some aircraft lacking an installed IRU.

- By 2021, the FAA will establish DME/DME coverage and redundancy (IRU not required) in Class A En Route Airspace over Continental United States (CONUS). This will permit RNAV navigation using DME/DME only capability in most airspace. The Program Management Organization's Navigation Programs Group (AJM-32) is currently preparing for a Final Investment Decision (FID).

- The FID also includes expanding DME/DME RNAV service at high priority NSG 1 and 2 airports, with a goal for completion by 2025. Currently, plans indicate that NSG 2 airports would receive expanded RNAV service by 2035.

- Through the implementation and utilization of a Satellite Operations Coordination Concept (SOCC), decision making authorities at the FAA's Air Traffic Control System Command Center (ATCSCC) will have a real-time system-level view of NAS navigation resiliency as a means to evaluate the impact of GNSS disruptions on PBN and air traffic operations. This will allow Air Traffic Organization decision makers to assess the operational impact of a GNSS outage and manage traffic flows to minimize the impact to air traffic. It will also enable the FAA to make information on the status of the GNSS available to the users, operators and NAS stakeholders and coordinate mitigations to service disruptions.

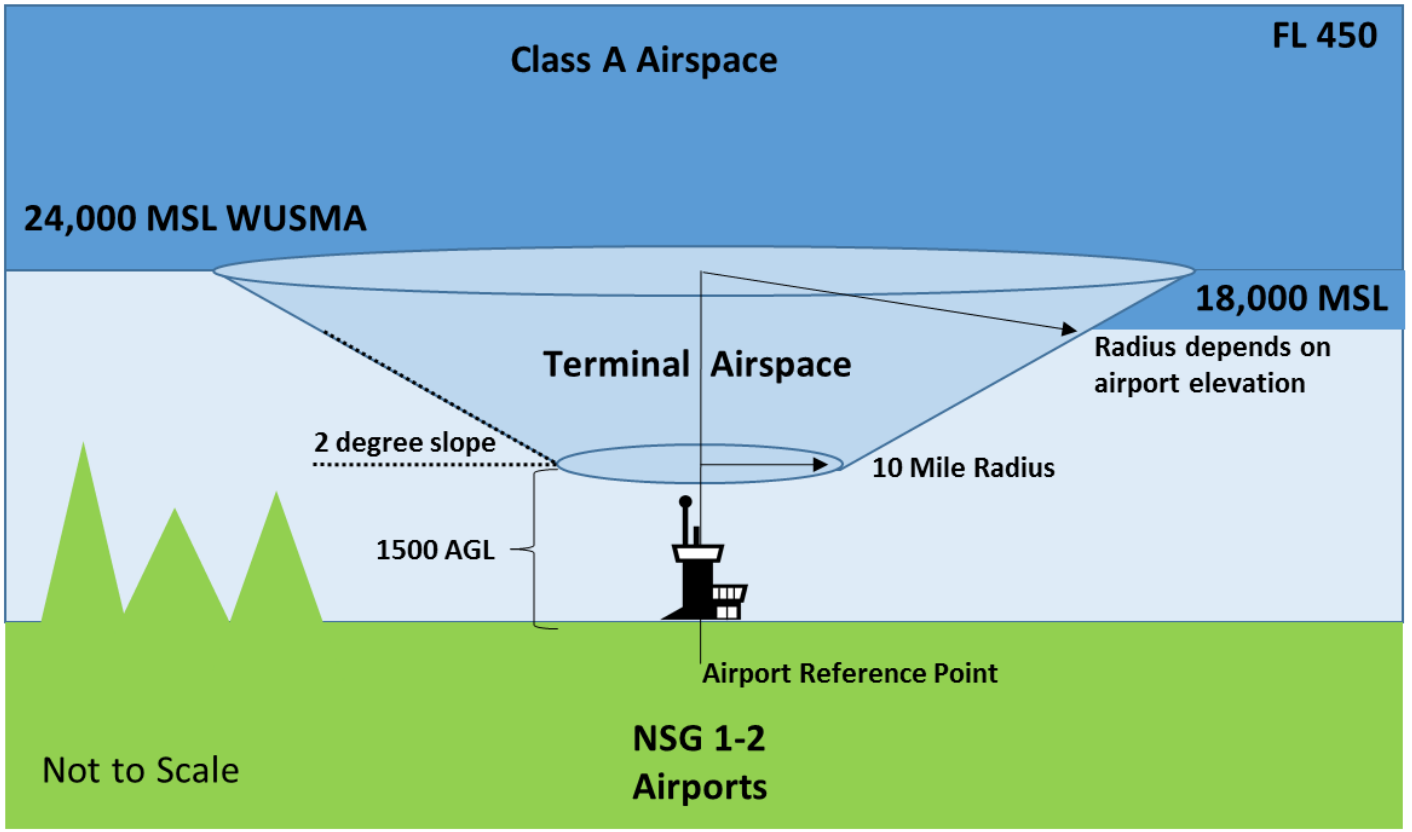
More Cost Effective and Agile Service Delivery



NAVAID Rationalization

- Navigation service requirements and capabilities have transitioned beyond the historic reliance on a VOR-based NAS. The VOR MON program will reduce the legacy VOR infrastructure during the near- and mid-term by approximately one-third, with the remaining VORs providing needed resilience to a subset of NAS users. The MON network of VORs will provide a limited conventional navigation backup system to which aircraft, primarily using a PBN-capable system (GPS/WAAS), could revert when satellite-based navigation services are interrupted or denied, thus increasing resiliency of the NAS.
- As part of the FAA's ongoing ILS Rationalization effort, the need to retain current ILSs at each individual location and runway will be assessed. Once experience with NavAid rationalization is attained, ILS rationalization will be analyzed for Category (CAT) I ILSs at NSG 4 and 5 airports. Completion of ILS rationalization at NSG 4 and 5 airports is expected in the far term. ILS rationalization analysis for NSG 1, 2 and 3 airports will begin after the rationalization of NSG 4 and 5 airports is achieved (i.e., the FAA will evaluate the remaining airports for the possibility of equipment recapitalization).
- *Reduce infrastructure costs where feasible.*

NextGen DME Program - The Proposed Initiative



- **<u>En Route Class A Airspace</u>**: 18,000' Mean Sea Level (MSL) to Flight Level (FL) 450, except over the Western U.S. Mountainous Area (WUSMA), 24,000' MSL to FL450
- **<u>Terminal Airspace:</u>** 1,500' AGL within 10 NM ascending at 2 degrees up to 18,000' MSL or as necessary to enable aircraft to continue RNAV to intercept an Instrument Landing System (ILS) final approach during a GNSS service disruption