Navigation Programs Update

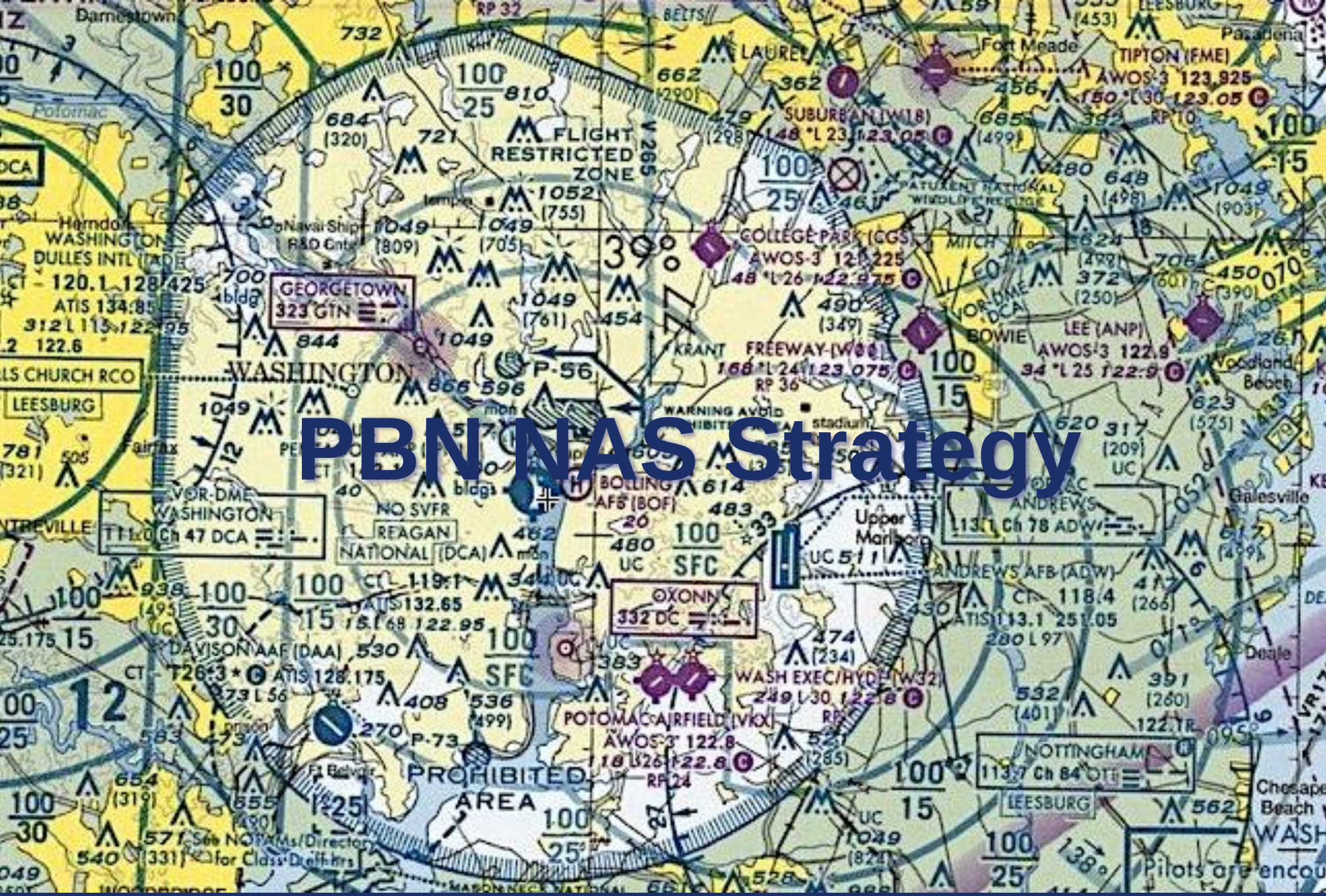
Presented by: Deborah Lawrence

Presented to: Civil GPS Service Interface Committee

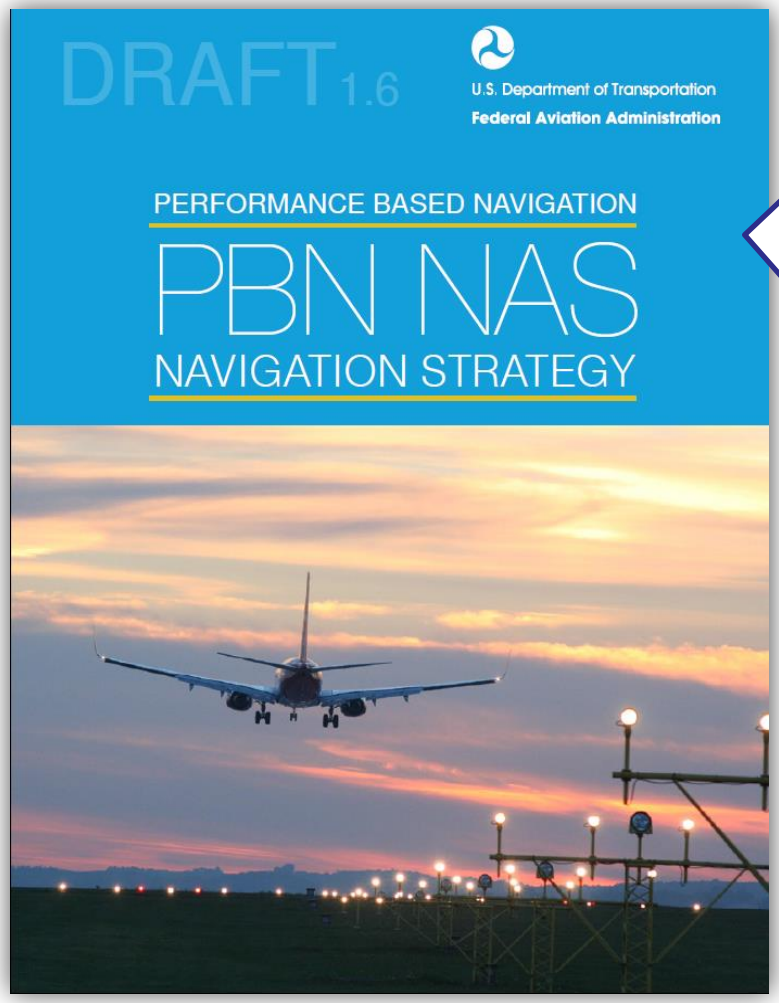
Date: September 2016

Agenda

- **Performance Based Navigation (PBN) NAS Strategy - 2016**
- **Wide Area Augmentation System (WAAS) Update**
- **Ground Based Augmentation System (GBAS) Update**
- **Resiliency Programs**
  - NextGen Distance Measuring Equipment (DME) Program
  - VOR MON Program Update
- **Summary**

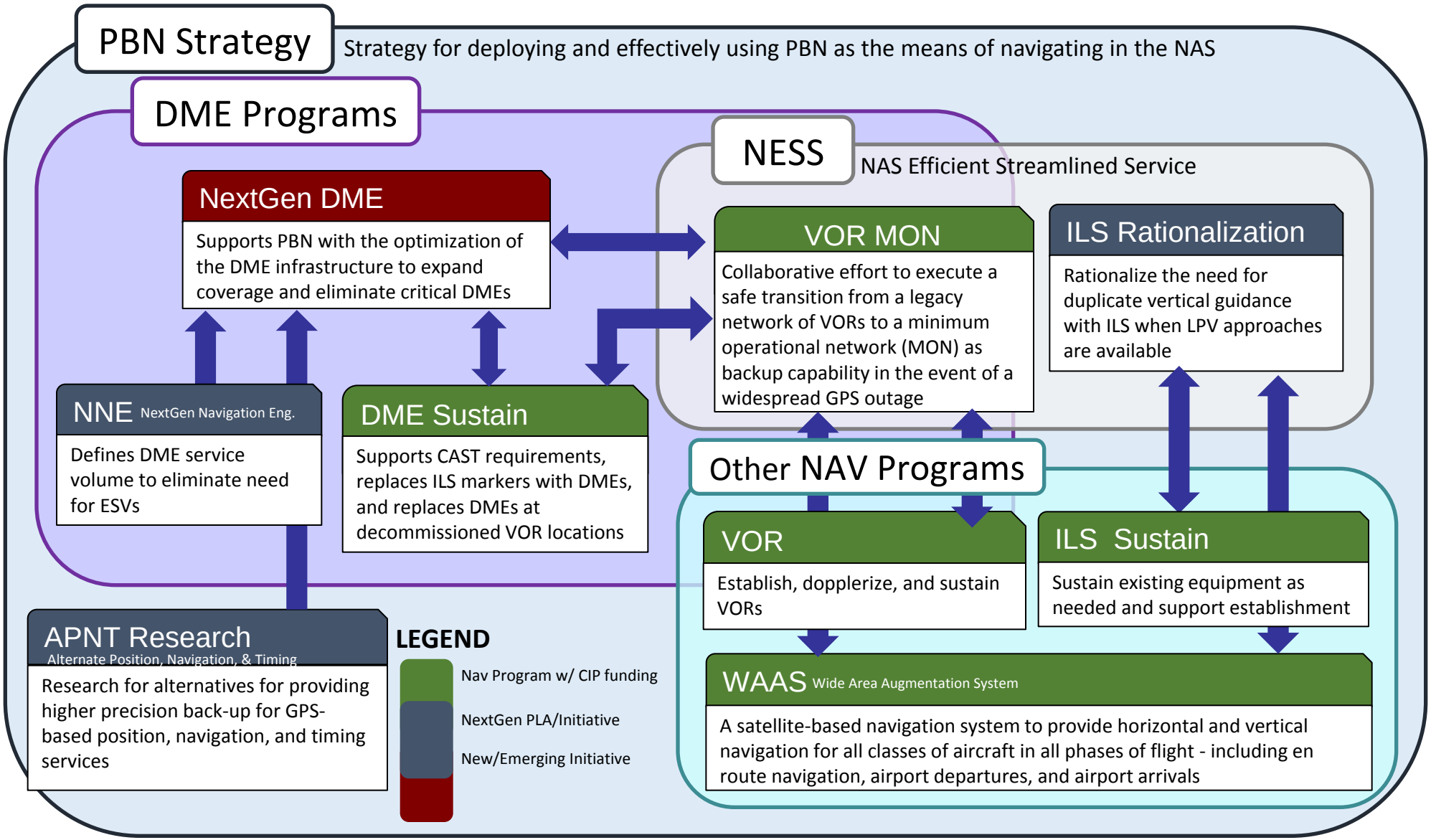

PBN NAS Strategy
WASHINGTON
FLIGHT RESTRICTED ZONE
PROHIBITED AREA
GEORGETOWN
323 GTN
VOR-DME WASHINGTON
Ch 47 DCA
REAGAN NATIONAL (DCA)
DAVISON AAF (DAA)
POTOMAC AIRFIELD (VKX)
WASH EXEC/HYDE (W32)
COLLEGE PARK (CGS)
FREEWAY (W66)
BOLLING AFB (BOF)
ANDREWS AFB (ADW)
TIPTON (FME)
LEE (ANP)
OXONN
332 DC
NOTTINGHAM
LEESBURG
DULLES INTL (IAD)
NO SVFR
Pilots are encou

Background



- 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
- Currently under review by the FAA Administrator, to be signed within weeks

PBN Strategy – Nav Programs Alignment

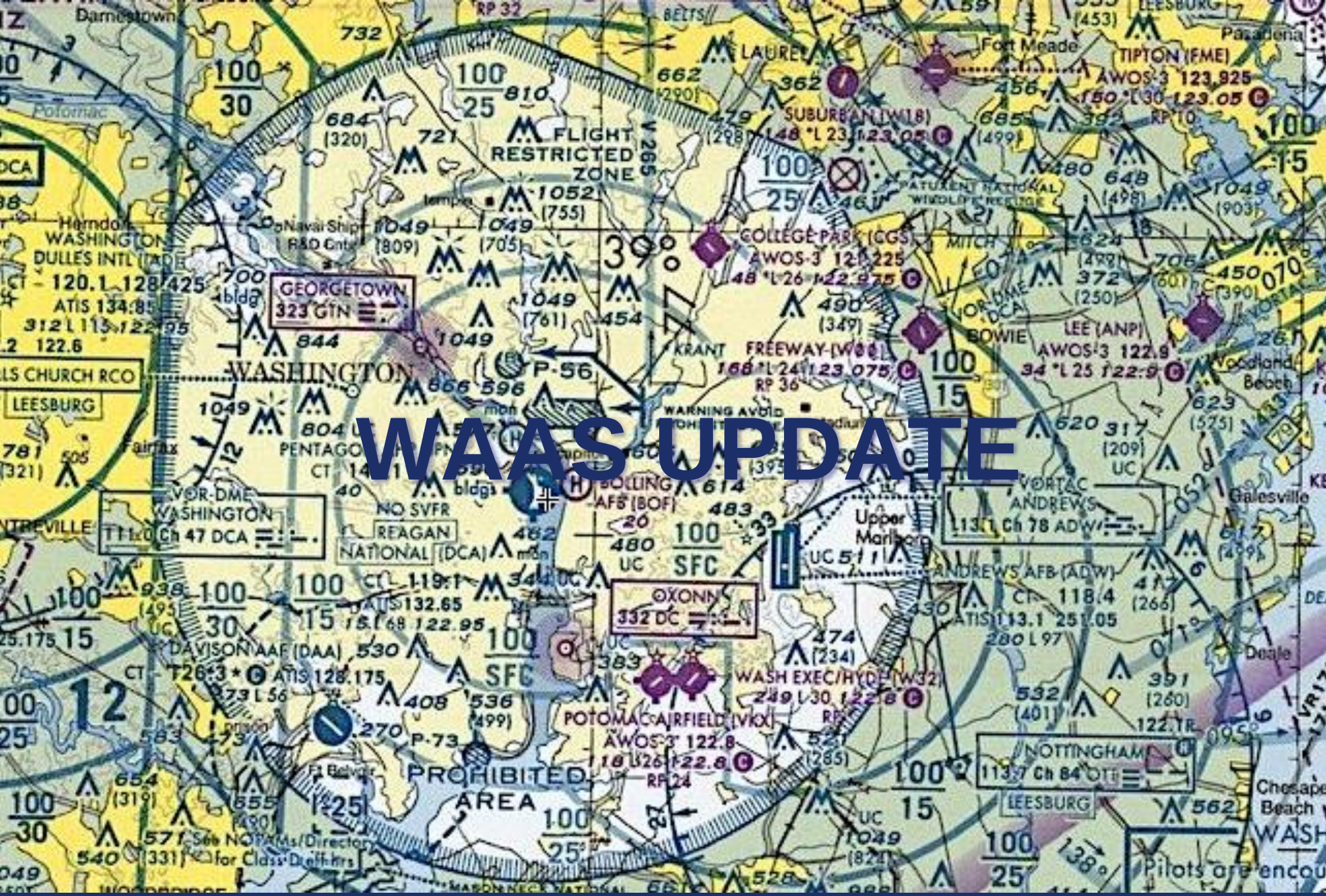


PBN Strategy Goals by Benefit Area

Near-Term	Mid-Term	Far-Term
•**RNAV(GPS) with LPV and LNAV/VNAV approaches at qualifying runways end**	•**Vertically guided RNAV(GPS) approaches at runways meeting new TERPS criteria**	•**Vertically guided RNAV (GPS) approaches at qualifying airports with an IAP**
•Revised TERPS criteria to increase number of qualifying runways for vertically guided approaches	•ELSO at sites supported by cost-benefit analysis	•A-RNP procedures at sites supported by cost-benefit analysis
•Expand use of ELSO at first two sites	•EoR at sites supported by cost-benefit analysis	•Transition to dynamic UPRs where supported by operator capability
•Expand use of EoR at first site	•Leverage A-RNP at key sites	•Complete the transition to PBN procedures
•Demonstrate A-RNP at first site	•Leverage reduced separation standards to further expand UPRs	
•Expand trans-Pacific User Preferred Routes	•Expand use of RNAV (GPS) approaches with LPV and LNAV/VNAV) with RF turns	
•Use of PBN approaches with visual separation standards	•Continue replacing conventional approaches, SIDs and STARs with PBN procedures	
•Implement OPDs at airports using RNAV STARs	•Transition to PBN-based point-to-point navigation	
•Transition from Minimum Performance Specification to PBN in the ICAO North Atlantic Region	•Replace conventional Jet routes and Victor airways where structure is needed	
•Continue replacing conventional approaches, SIDs, and STARs with PBN procedures		
•Initial transition to improved PBN-based point-to-point navigation		

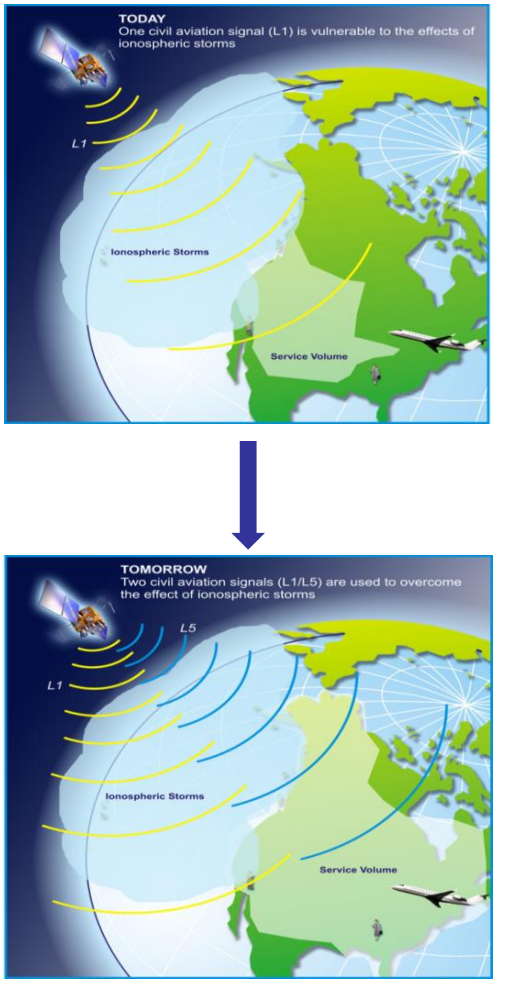
PBN Strategy Goals by Benefit Area

	Near-Term	Mid-Term	Far-Term
Improved predictability		• Key airports transitioned to time and speed-based management	• NAS transitioned to time and speed-based management
More cost effective & agile service delivery	• Shorten development and implementation time for new ATS routes by removing rulemaking requirement • **Begin ILS Rationalization at Navigation Service Group (NSG) 4-5 airports**	• Develop integrated procedure design tools • Digital delivery of navigation chart data • Develop automation for periodic review of procedures • **Continue ILS Rationalization at NSG 4-5 airports**	• **ILS rationalization complete at NSG 4 and 5 airports** • **ILS rationalization analysis for NSG 1, 2, and 3 airports**
Increased access	• Update regulations to allow SVGS for qualifying approaches • Update regulations to allow EFVS operations to touchdown • **Criteria for SA CATI/1800 RVR and SA CATII for LPV**		
Improved resiliency	• **DME/DME coverage expanded for NSG 1 and 2 airports based on site-specific evaluations** • **Class A airspace is covered by DME/DME (IRU not required) redundancy**	• **DME/DME coverage expanded for NSG 1 and 2 airports based on site-specific evaluations**	• **Re-evaluation of need for remaining VOR facilities**

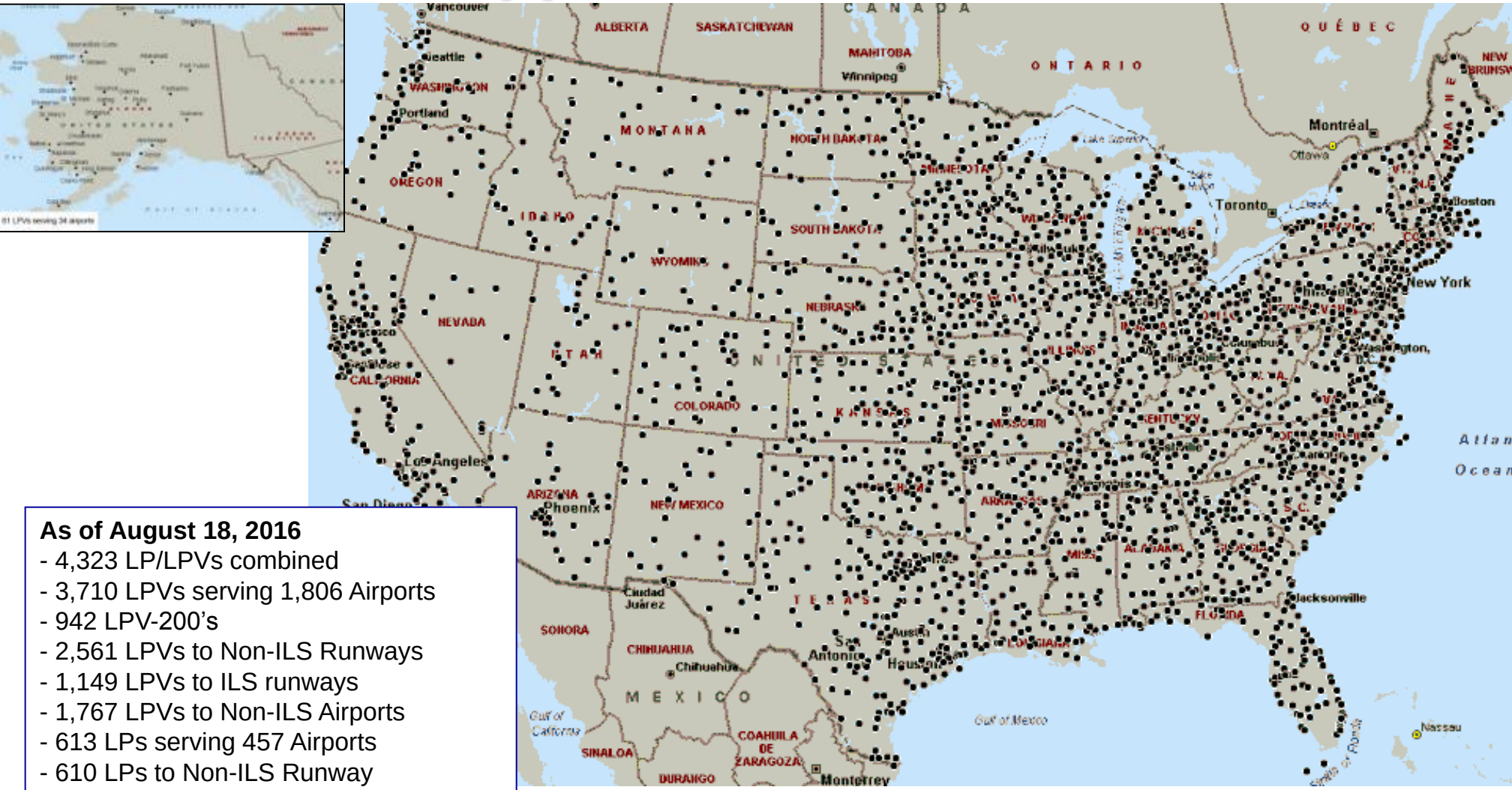

WAAS UPDATE

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 (2014-2019) - Develop infrastructure improvements to support L5 & Tech Refresh
  - Segment 2 (2019+) - 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)**
- **GEO sustainment will occur during both segments**
- **Future considerations**
  - Dual-Frequency Multi-constellation Capability
    - International Focus is on taking advantage of other GPS like constellations
  - 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
  - Advanced RAIM (ARAIM)
    - Avionics-centric approach to dual-frequency multi-constellation



Airports with WAAS LPV-200/LPV/LP Instrument Approaches

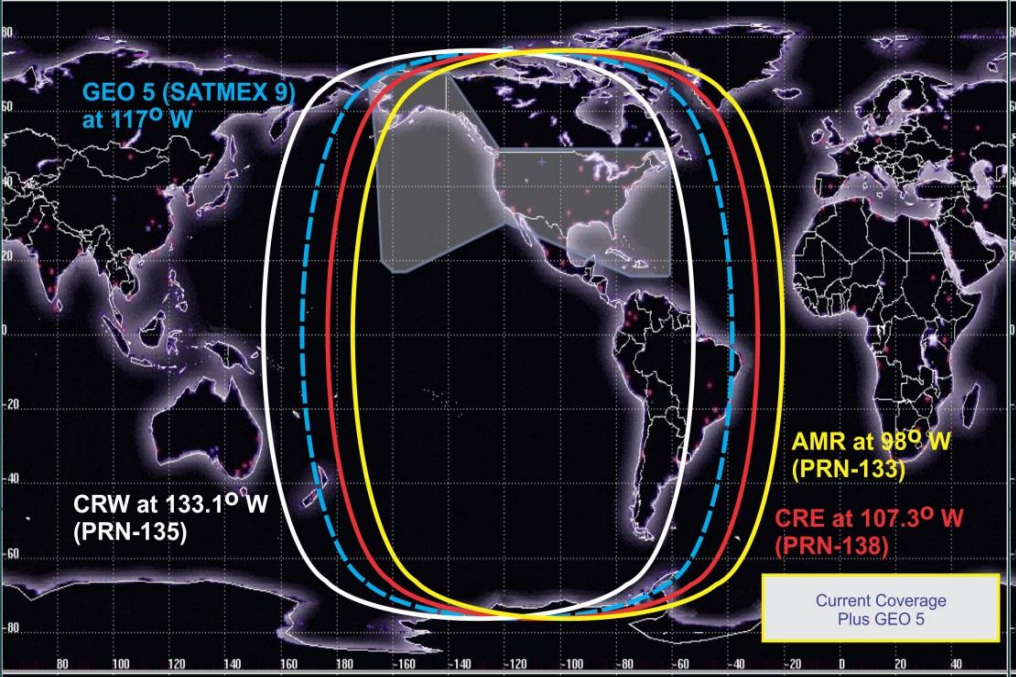


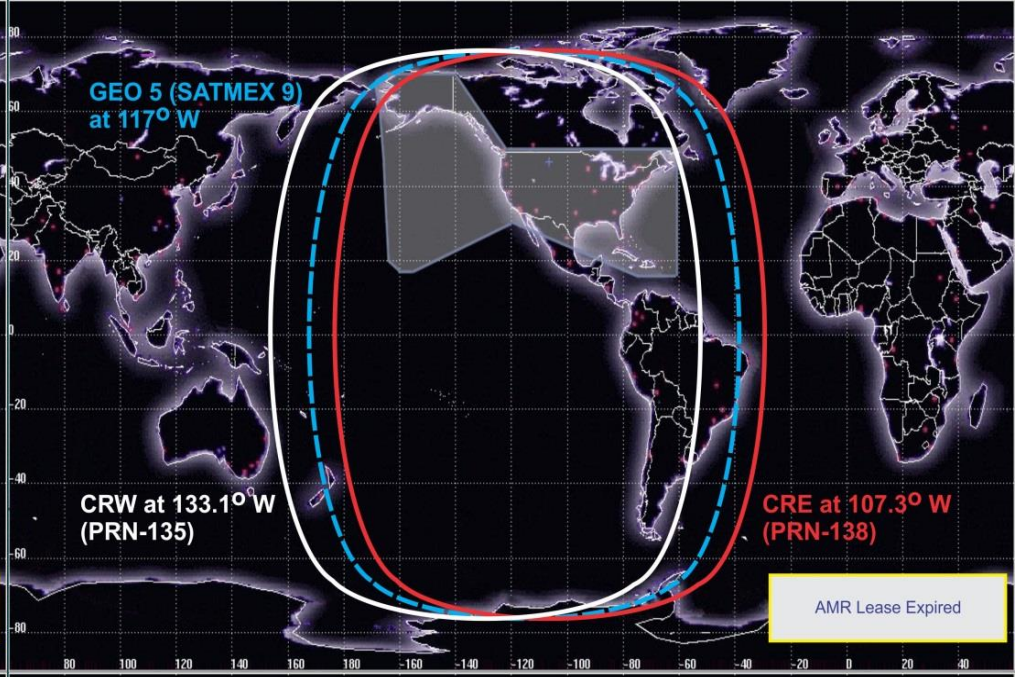
As of August 18, 2016
- 4,323 LP/LPVs combined
- 3,710 LPVs serving 1,806 Airports
- 942 LPV-200's
- 2,561 LPVs to Non-ILS Runways
- 1,149 LPVs to ILS runways
- 1,767 LPVs to Non-ILS Airports
- 613 LPs serving 457 Airports
- 610 LPs to Non-ILS Runway
- 3 LPs to ILS Runways

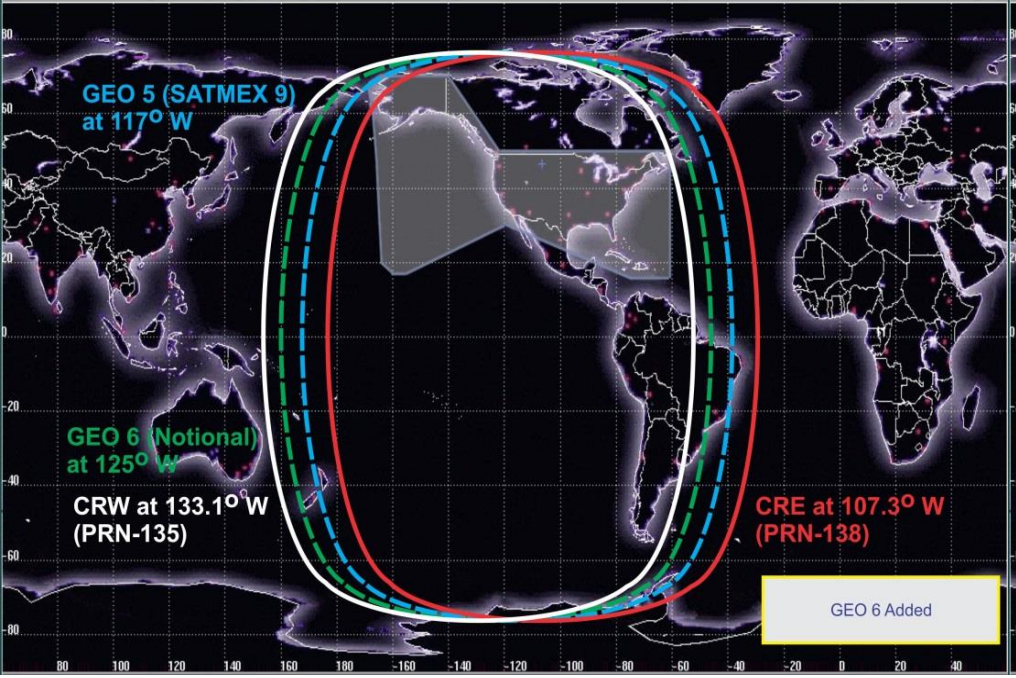
GEO Sustainment (GEOs 5/6/7)

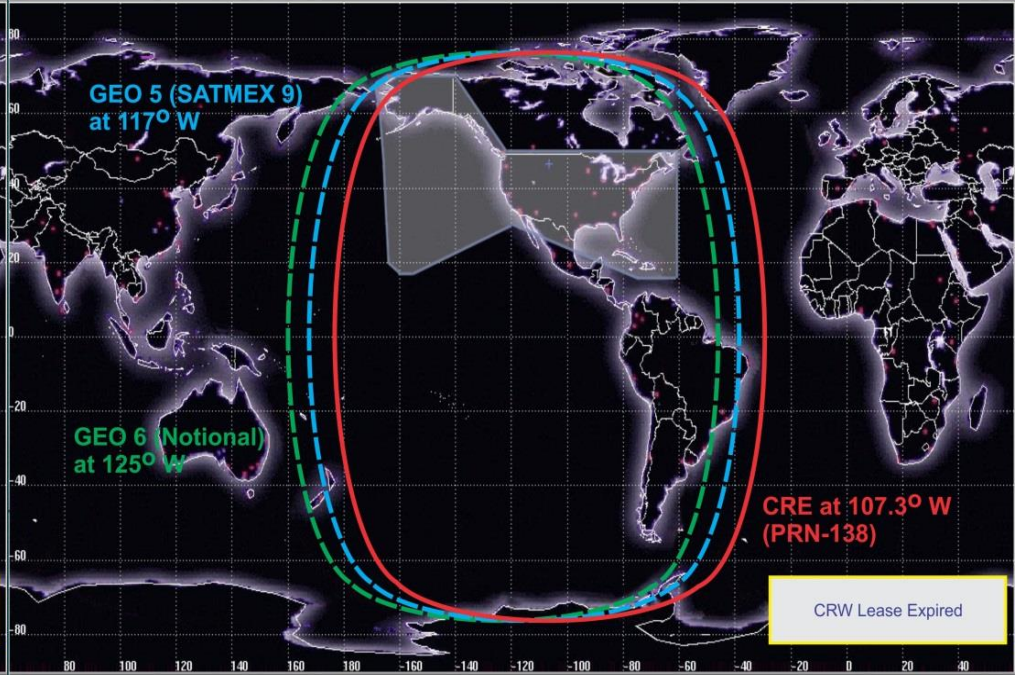
- **GEO 5/6 Satellite Acquisition**
  - GEO 5
    - Payload development complete
      - EUTELSAT 117 West B (ex SatMex 9) satellite
        - » Located at 117 West, provides full coverage of CONUS and Alaska
    - Launch planned June 2016
      - Date affected by Space X Falcon 9 launch failure June 2015
    - Completed Ground Uplink Subsystems installation, integration and checkout April 2016
    - Signal in Space Testing in to begin early CY2017
    - Expected operational in 2018
  - GEO 6
    - Preliminary Design Review (PDR) completed June 2015
    - Critical Design Review (CDR) completed February 2016
    - Host satellite is SES-15, planned for 129 West
      - Provides full coverage or CONUS and Alaska
    - Expected Operational in 2019
- **GEO 7 Satellite acquisition**
  - Targeting 2019 for a contract award

Eutelsat 117WB


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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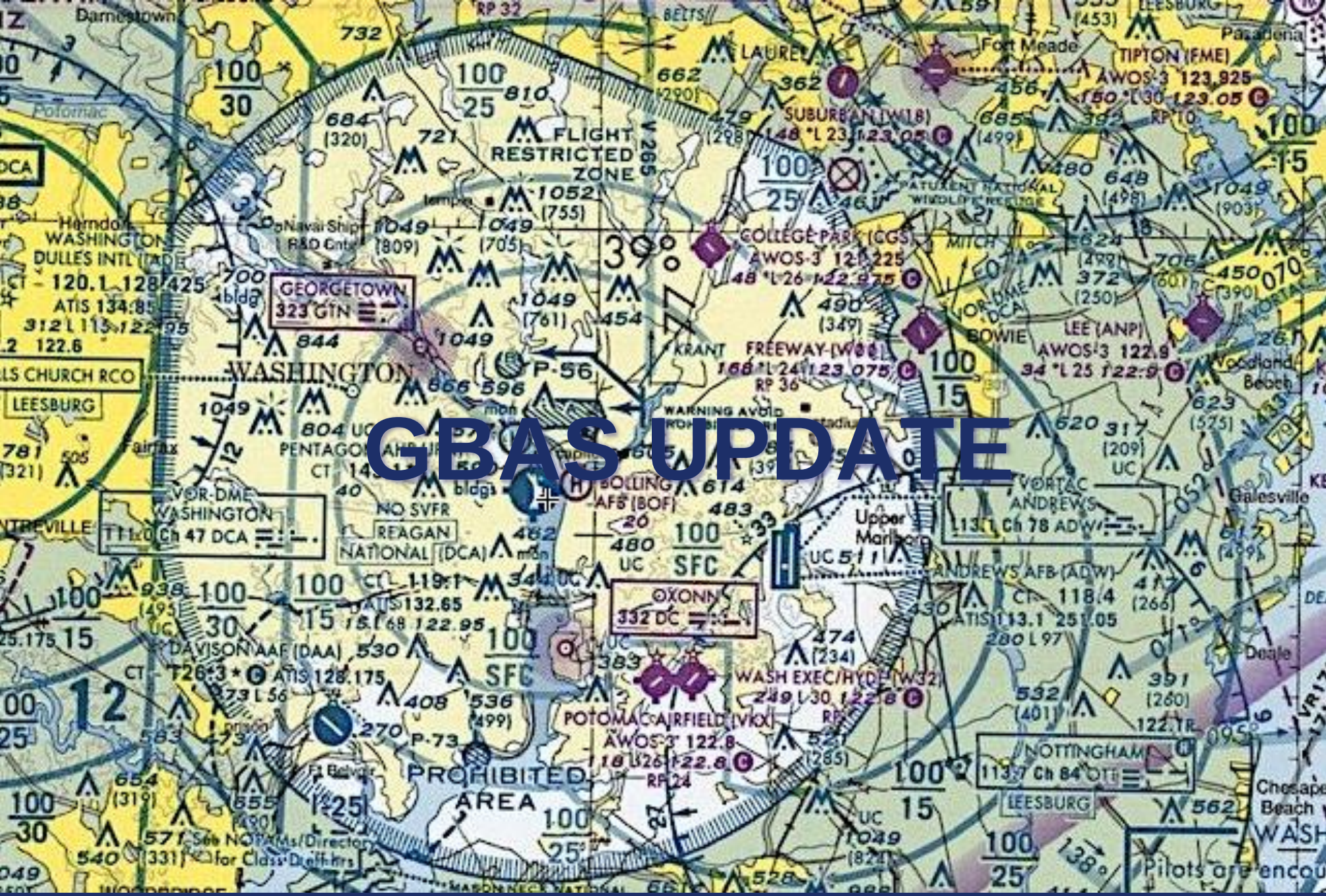
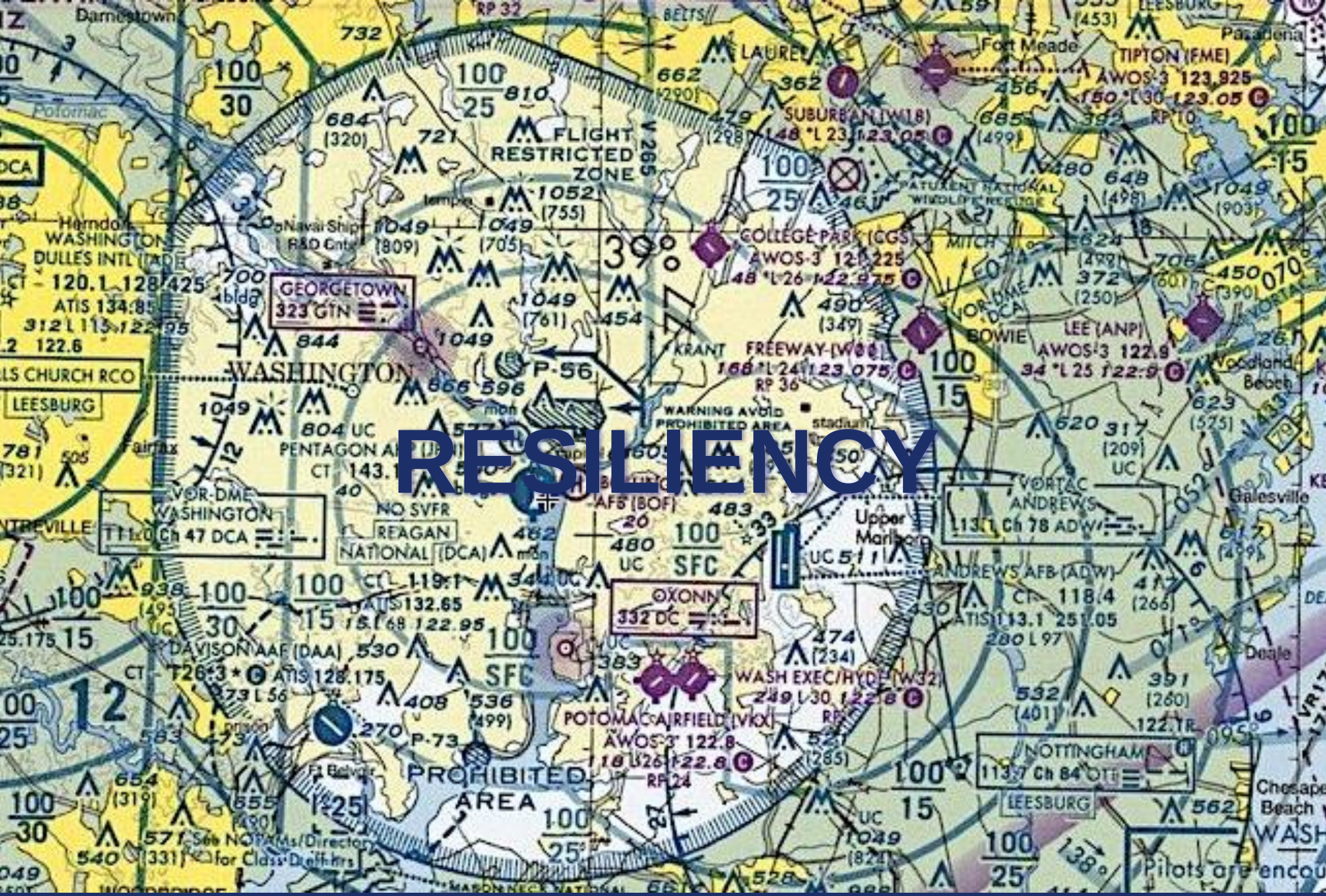
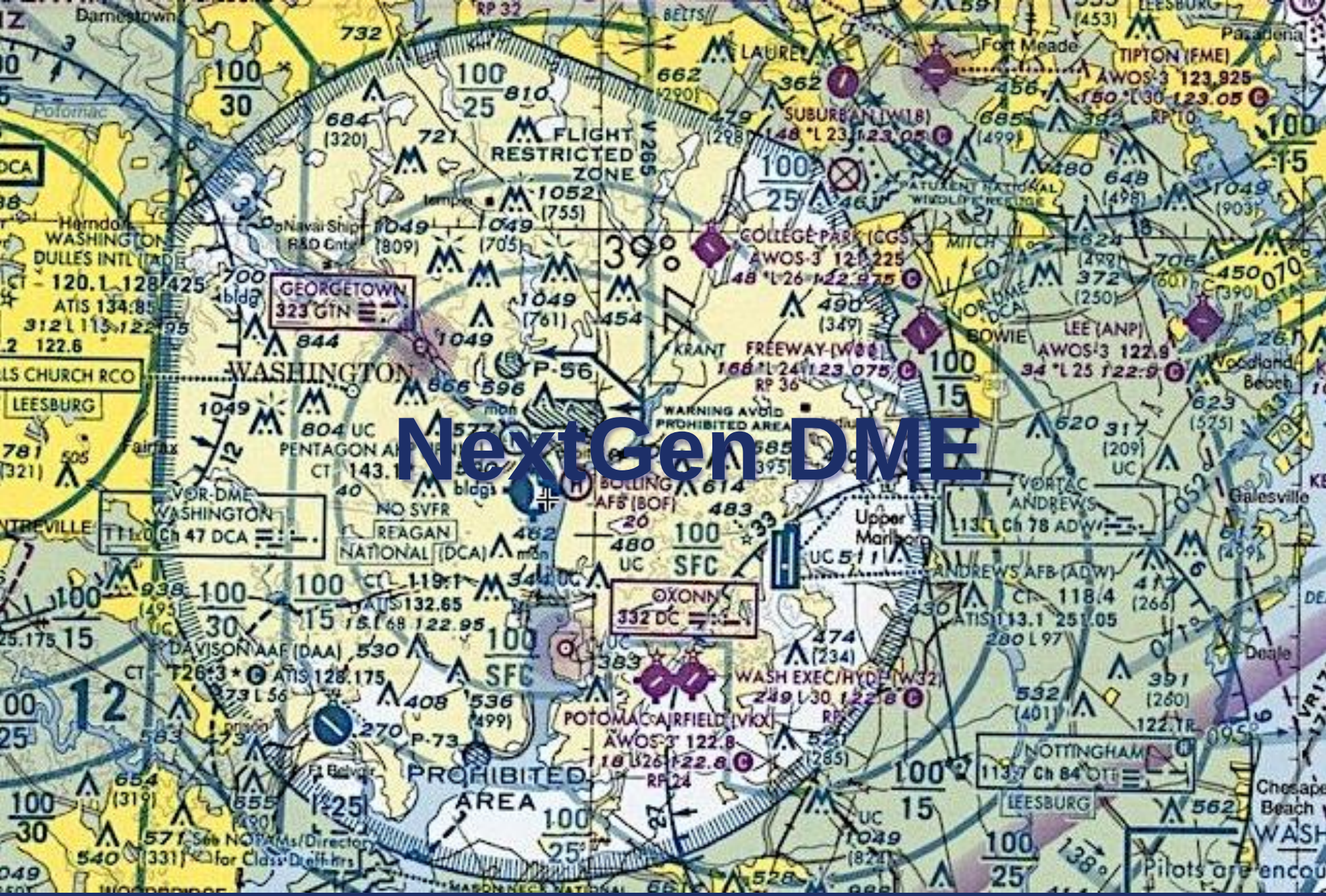

GBAS UPDATE
WASHINGTON
FLIGHT RESTRICTED ZONE
PROHIBITED AREA
P-56
P-73
GEORGETOWN
323 GTN
VOR-DME WASHINGTON
Ch 47 DCA
REAGAN NATIONAL (DCA)
NO SVFR
DULLES INTL (IAD)
120.1 128.425
ATIS 134.85
LEESBURG
DAVISON AAF (DAA)
ATIS 128.175
POTOMAC AIRFIELD (VKX)
AWOS-3 122.8
OXONN
332 DC
BOLLING AFB (BOF)
ANDREWS AFB (ADW)
VORTAC ANDREWS
Ch 78 ADW
COLLEGE PARK (CGS)
AWOS-3 121.225
FREEWAY (W88)
LEE (ANP)
AWOS-3 122.9
TIPTON (FME)
AWOS-3 123.925
SUBURBAN (W18)
NOTTINGHAM
Ch 84
WASH EXEC/HYDE (W32)
Fort Meade
Patuxent National Wildlife Refuge
Pilots are encou

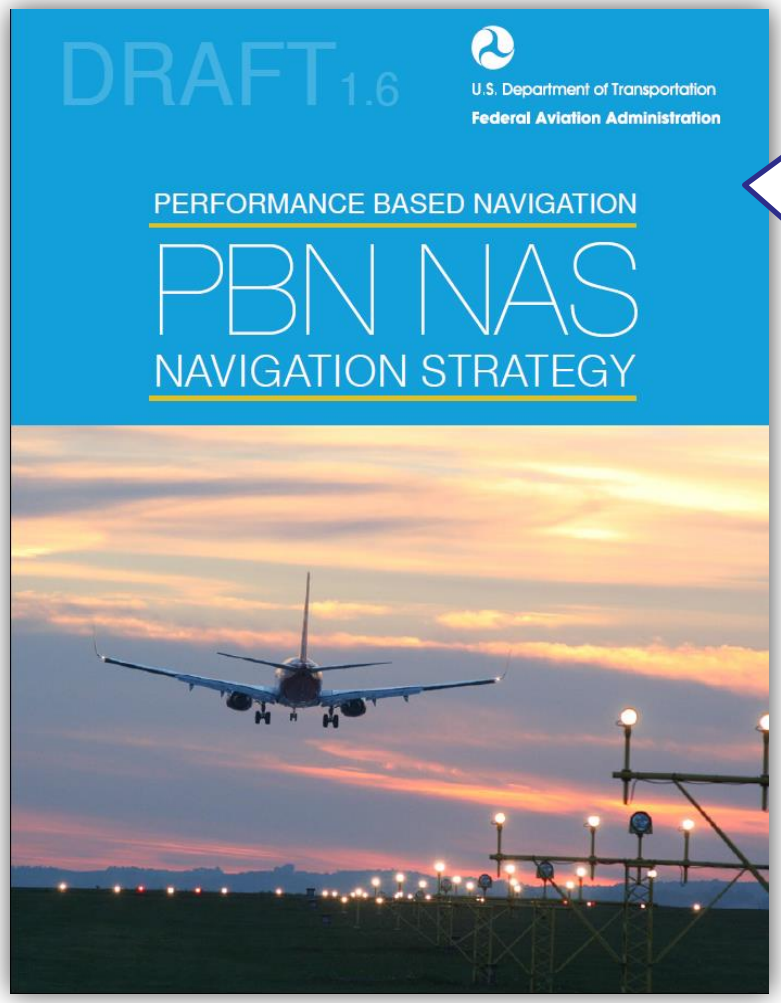
FAA GBAS Program

- **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)
  - Date for Final Close of Validation/Final SARPS acceptance – December 2016
- **System Design Approvals (SDA) for GBAS GAST-D (CAT III) systems**
  - FAA system design review for Honeywell SLS-5000 started, GAST-D SDA expected 2019 (depending on Honeywell schedule)
- **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
  - Moses Lake, WA and Charleston, SC are operational as Boeing private systems
  - FAA provides performance monitoring/service prediction for Newark, Houston, Moses Lake
  - Operators using GBAS at Newark and Houston include United Airlines, Delta Airlines, Lufthansa, Emirates, Cathay Pacific, British Airways, Cargolux
  - Over 3,300 GBAS approaches as of August 2016
  - Successful demonstration of GBAS advanced capabilities (RNP to GLS, noise abatement, variable glidepath, displaced threshold..) at San Francisco, August 2016
- **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

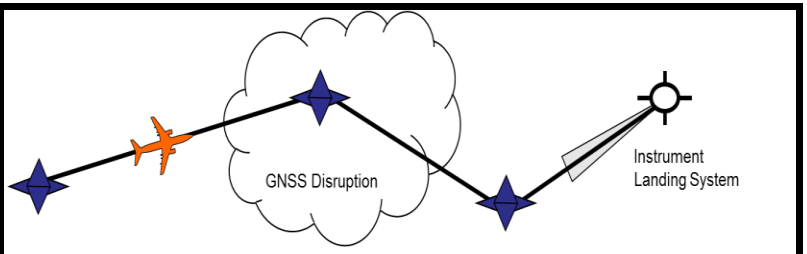
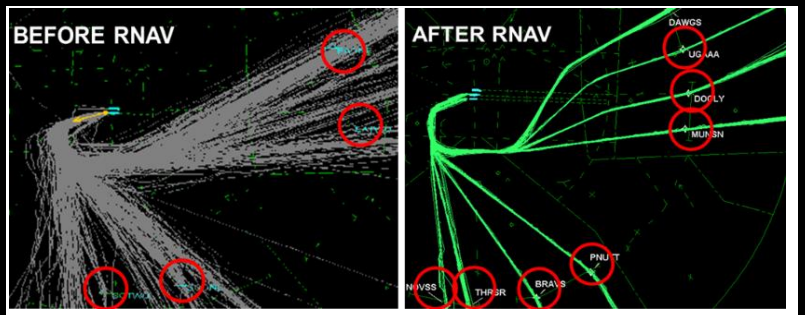
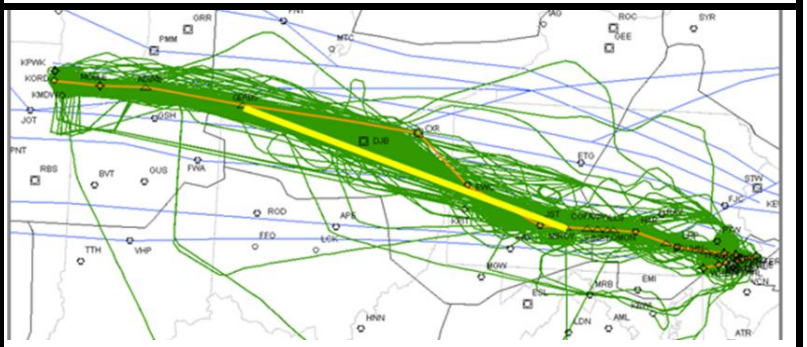
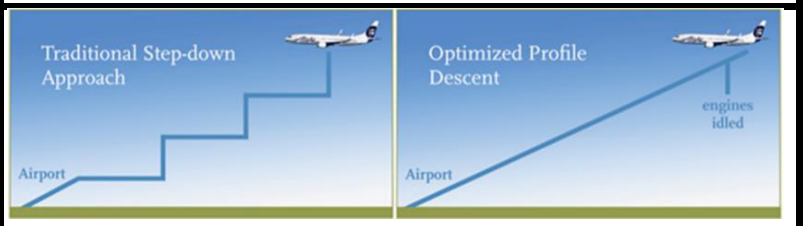
NextGen DME Background



Near-term (2016-2020): "DME/DME coverage expanded for NSG 1 and 2 airports based on site-specific evaluations…Class A airspace is covered by DME/DME (IRU not required) redundancy

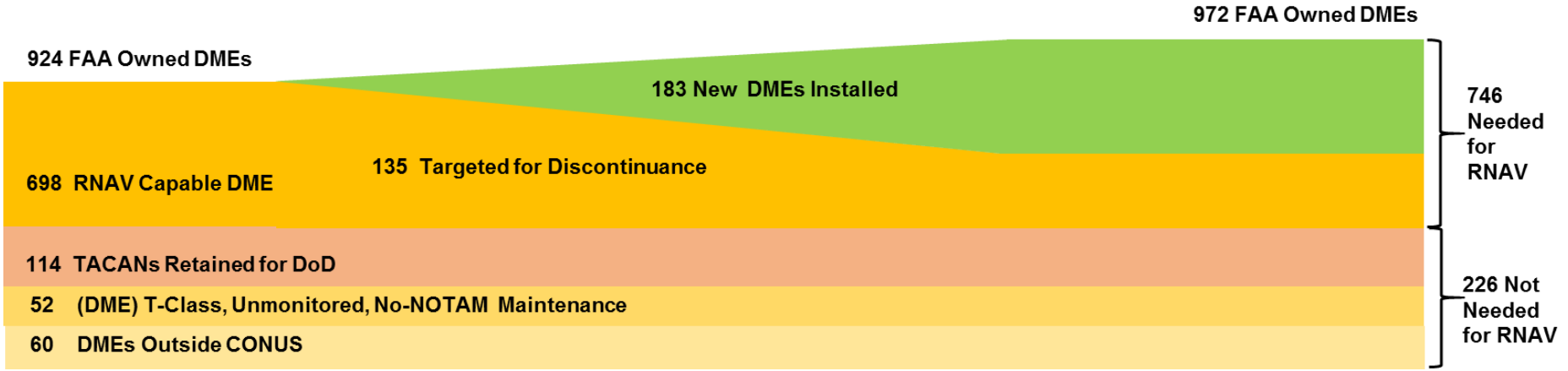
Mid-term (2021-2025): "DME/DME coverage expanded for NSG 1 and 2 airports based on site-specific evaluations"

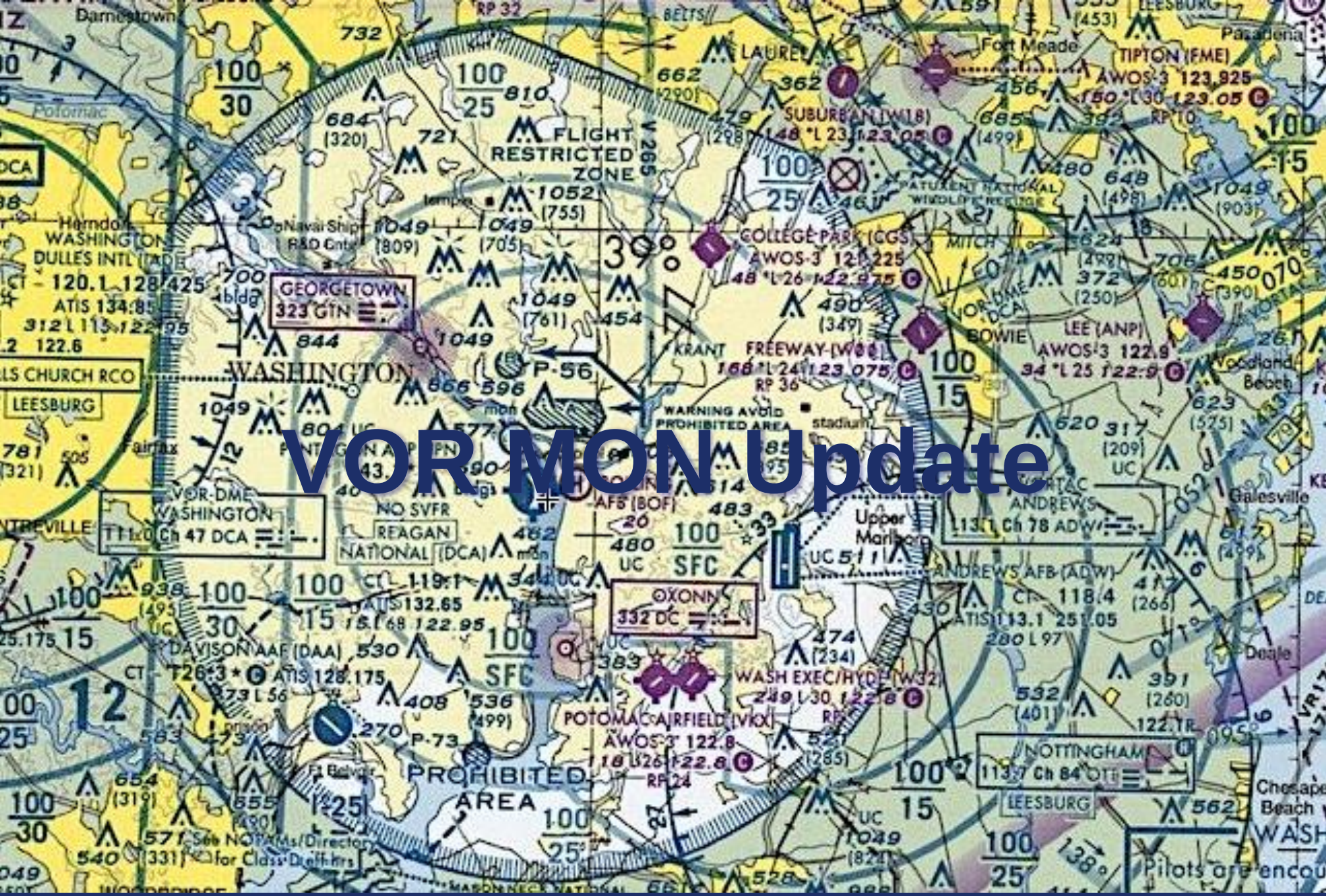
Benefits

Access	Enables aircraft to continue PBN operations to an ILS approach during Global Navigation Satellite System (GNSS) disruptions.	
Capacity	Increased capacity in transition airspace for arrivals and departures.	
Efficiency	More efficient point-to-point routing Decreased pilot/controller communications	
Environmental	Reduced emissions and fuel burn through the use of Optimized Profile Descents (OPDs)	

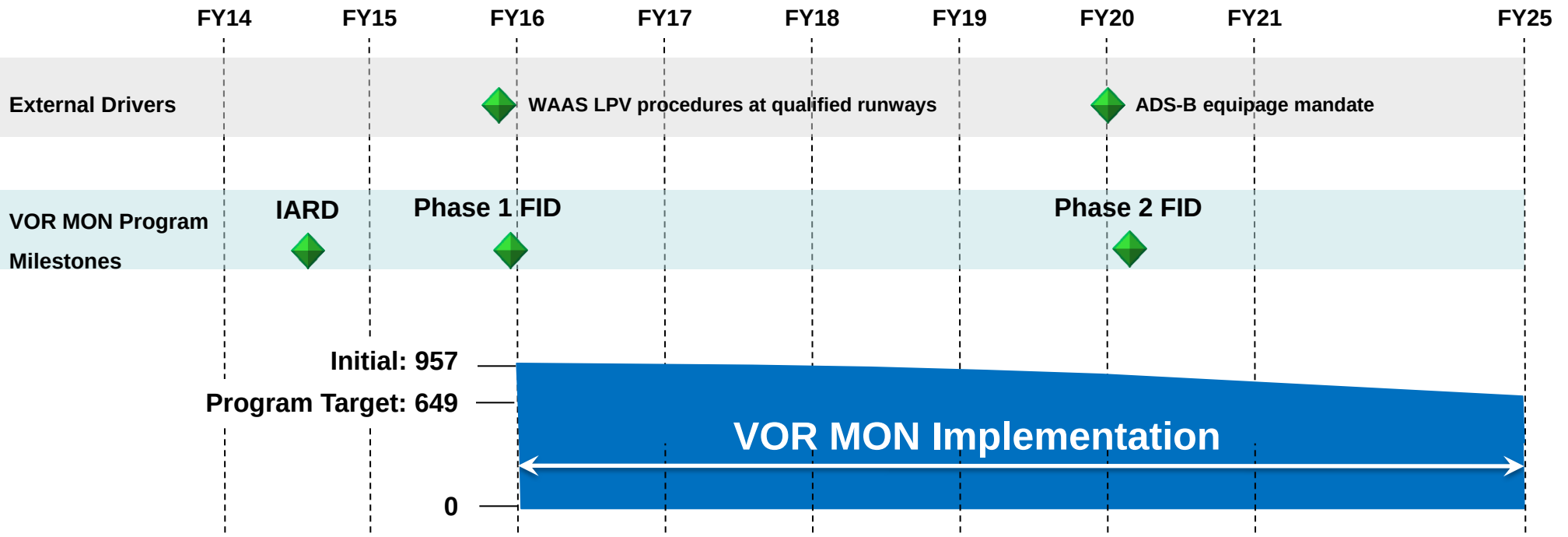
Description and Scope of Initiative

- New DMEs will be installed to fill coverage gaps and eliminate single points of failure (Critical DMEs) to provide a backup to GNSS as part of a resilient navigation infrastructure
- Existing DMEs with limited capacity will be replaced, and select DMEs not needed for RNAV will be targeted for discontinuance
- DME systems will be procured using the existing DME contract
- The baselined DME Specification will not be changed




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

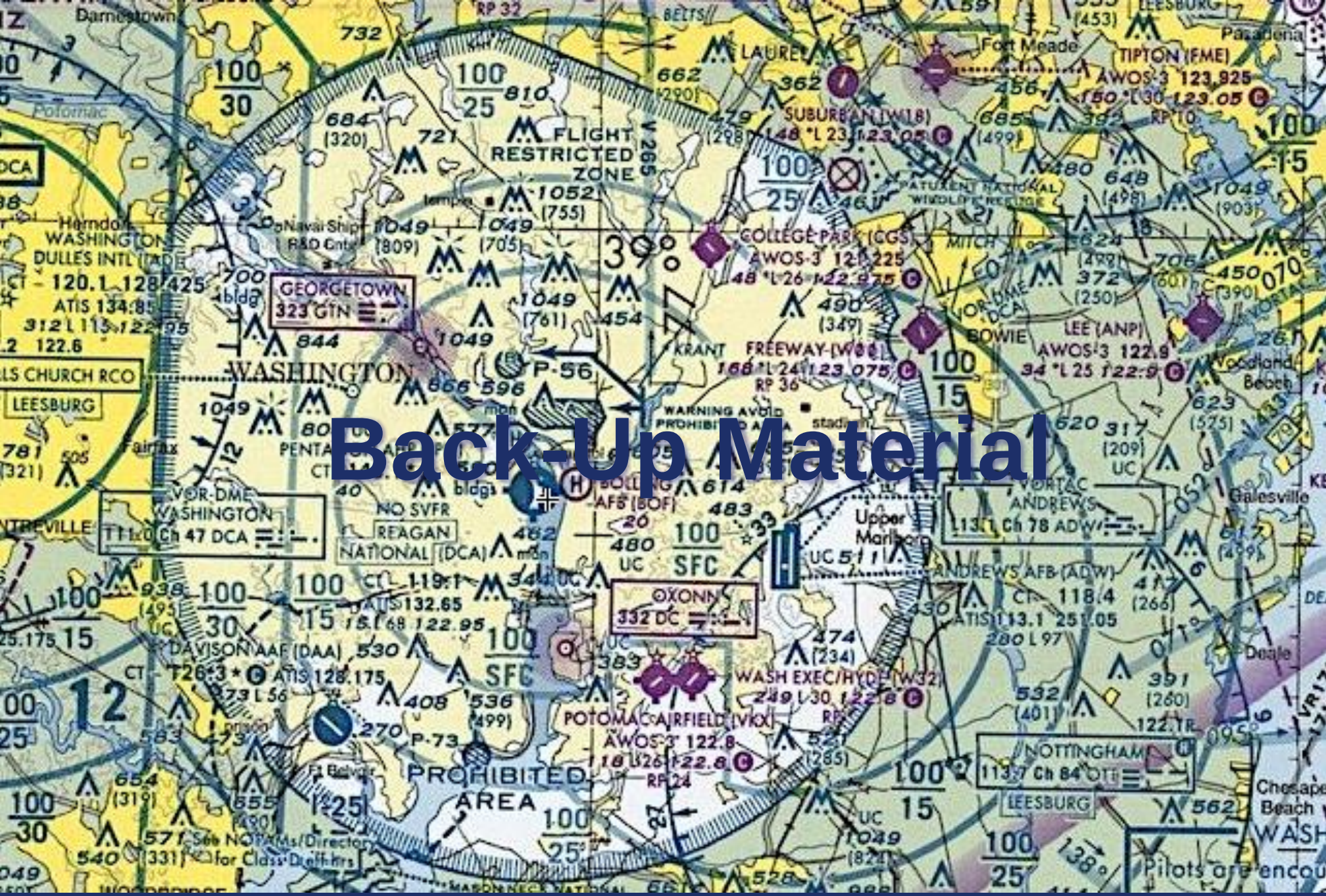
- Publish Final Policy FRN: *"Provision of Navigation Services for the Next Generation Air Transportation System (NextGen) Transition to Performance Based Navigation (PBN)"*
- Remove, Replace, Amend affected Instrument Flight Procedures (IFPs)
- Discontinue Phase 1 VORs (74)
- Plan for Phase 2 Final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

Phase 2

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

Summary

- **The Performance Based Navigation (PBN) NAS Strategy is awaiting FAA Administrator signature**
- **Navigation Programs is updating the NAV Strategy**
- **WAAS is replenishing GEOs, Performing Tech Refresh**
- **GBAS feasibility for CAT II/III targeted 2019**
- **Resiliency**
  - VOR MON implementation underway (3 VORs Discontinued to date)
  - NextGen DME in program approval process


Back-Up Material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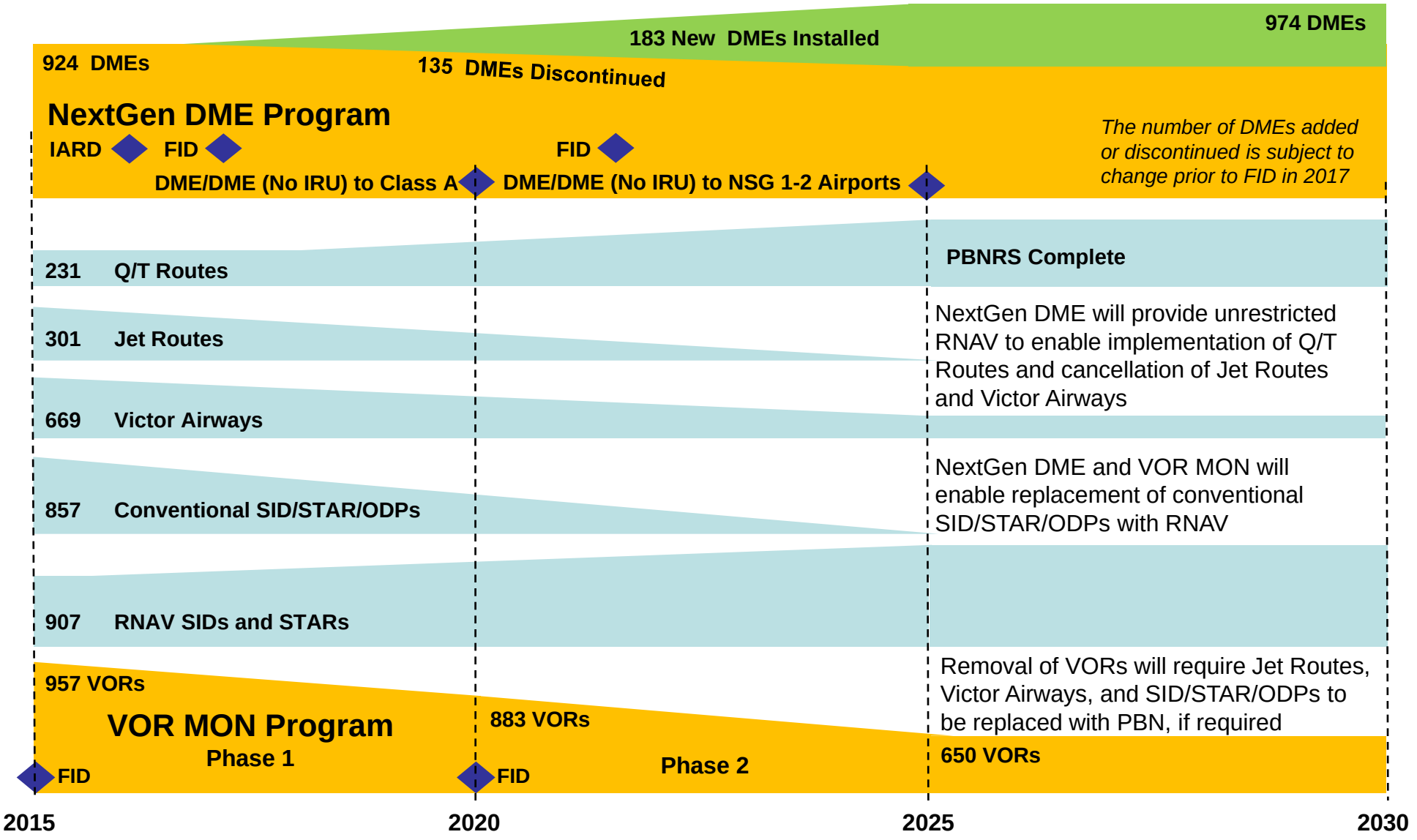
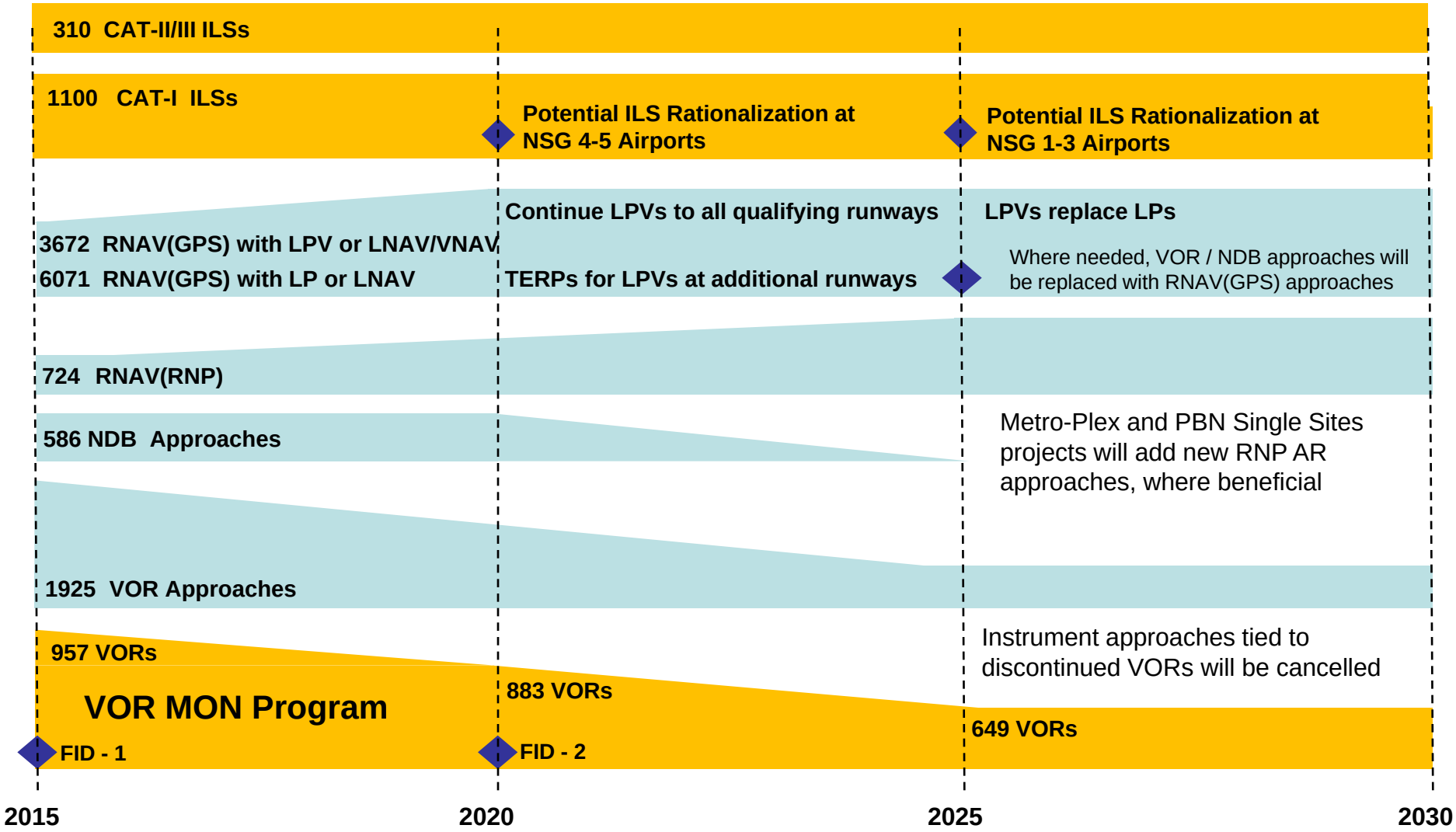
En Route and Terminal Strategy



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 all NSG 1 airports and select NSG 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/STARs will be cancelled
  - PBN SID/STAR/ODPs will be implemented

Approach Strategy

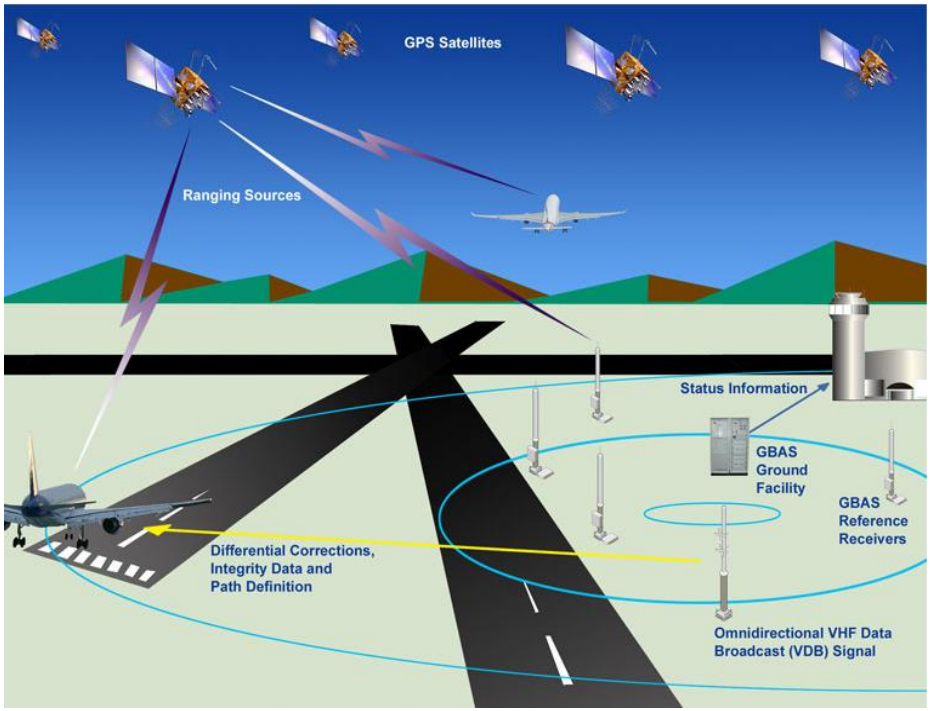


Instrument Approach Strategy

- **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
  - Potential for CAT I ILSs to 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**

GBAS 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; 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