Navigation Programs and Instrument Landing System (ILS) Rationalization

Presented to: Aeronautical Charting Meeting

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Agenda

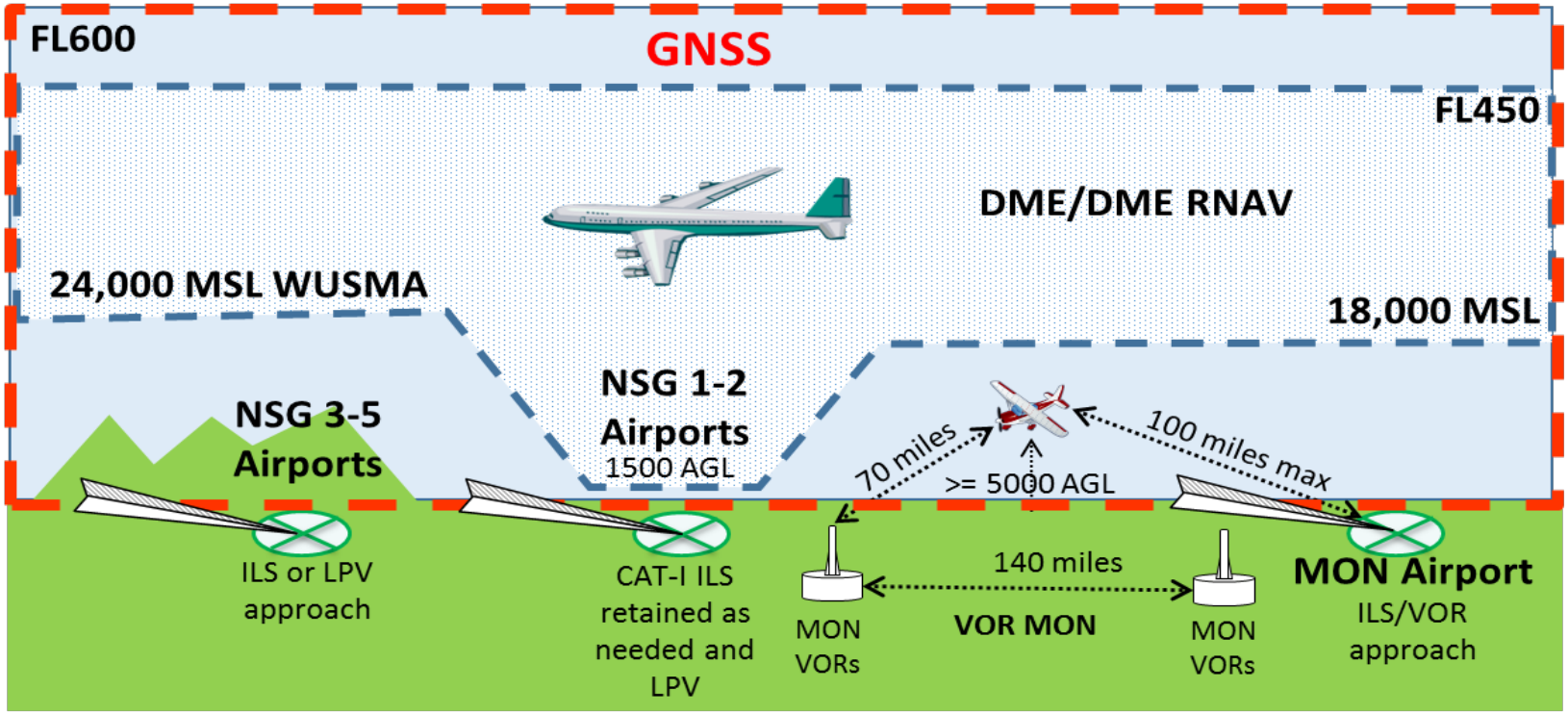
- **Navigation Strategy**
  - Resilient Navigation Services
- **ILS Rationalization**
- **Summary**

Navigation Strategy

FAA Navigation Strategy

- **Provide resilient navigation services to enable transition of the NAS to PBN operations**
  - GPS and WAAS enable all PBN operations and ADS-B
  - DME infrastructure supports PBN operations in the event of GNSS service disruptions
  - VOR MON Program will repurpose VORs to provide a backup for aircraft that lose RNAV during a GNSS outage
- **Rationalize infrastructure to improve efficiency**
  - 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.

Resilient Navigation Services

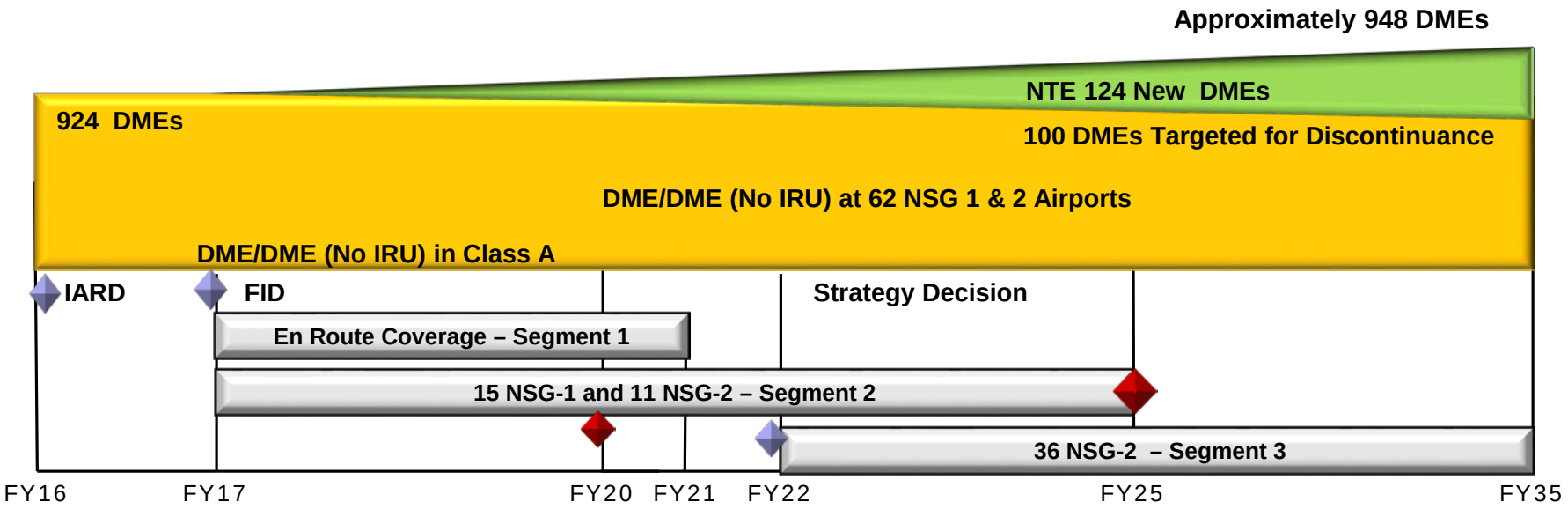


- **GNSS is the primary enabler for all PBN (RNAV and RNP) and ADS-B accuracy & integrity for all separation levels**
- **DME/DME provides an RNAV alternative**
- **VOR MON can be used by aircraft that are not DME/DME RNAV equipped**
- **CAT-I ILSs will be retained as needed to support safe recovery in the event of a GNSS outage**

Navigation Resiliency

- **DME/VOR/TACAN service is required for the foreseeable future as part of a resilient navigation infrastructure**
- **DME infrastructure supports PBN operations in the event of GNSS service disruptions**
  - NextGen DME Program being implemented
    - Established interim siting criteria
    - 100 DME targeted for discontinuance
    - New DMEs not-to-exceed 124
- **VOR MON has discontinued 42 VORs to date; 74 planned for Phase 1 ending in 2020.**
  - Next phase strategy decision anticipated in 2020; current plan for next phase is to discontinue 237 VORs
- **ILS Rationalization placed on hold in 2017; initiative is planned to commence in 2019**

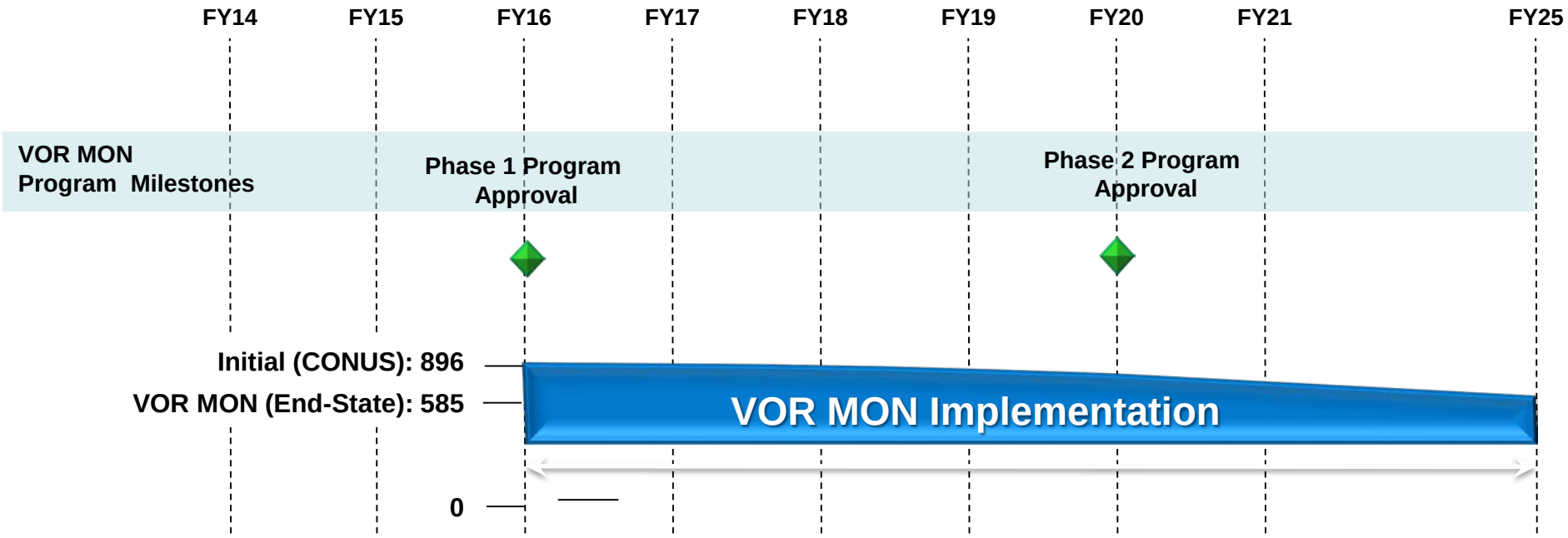
NextGen DME Program Timeline



- **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* Goals**
Acquisition Decision Milestones

VOR MON Program Timeline



The VOR MON Program will be completed in 2 phases:

Phase 1: FY16 – FY20

Phase 2: FY21 – FY25

- 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)

- Continue IFP work
- Discontinue Phase 2 VORs (237)

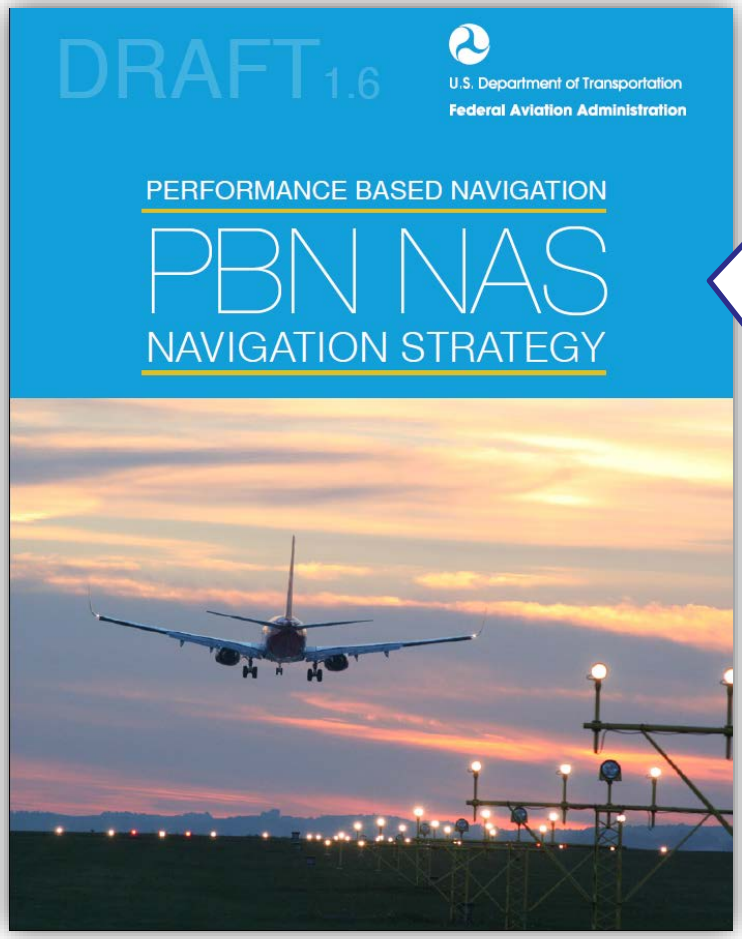
As of September 7, 2018

DME/VOR/TACAN Sustainment

- **Supportability Study**
  - Evaluated all FAA-owned systems to determine supportability through 2045
  - Completed Final Report in July 2018
  - Summary of results:
    - Infrastructure not supportable through 2045 without modernization investment strategy
    - Engineering modifications and improved integrated logistics support approaches required to sustain existing infrastructure in the near term until full system replacement is implemented
- **Next Steps**
  - Address Near-Term Operational Needs (antennae and oscillators)
  - Proceeding with DME/VOR/TACAN Acquisition Strategy

ILS Rationalization

Performance-Based Navigation (PBN) National Airspace System (NAS) Navigation Strategy



Near term (2016-2020): "The need to retain current ILSs at each individual location and runway will be assessed…Rationalization activities will be confined to Cat I ILSs at NSG 4 and 5 airports"

Mid term (2021-2025): "ILS rationalization will continue at NSG 4 and 5 airports"

Far term (2026-2030): "Completion of ILS rationalization at NSG 4 and 5 airports; Evaluate NSG 1, 2, and 3 airports for potential rationalization"

ILS Rationalization Strategy Activities

FY15

- Gained stakeholder concurrence on DRAFT ILS Rationalization Criteria and DRAFT ILS Rationalization Communication Plan

FY16

- **Developed a quantitative analysis**
  - APO-300 developed a specialized ILS Rationalization Benefit Cost Model
- **Conducted qualitative analysis**
  - Navigation Programs (AJM-32) applied FY15 criteria to NSG 4 & 5 airports
- **JRC Approved ILS Rationalization Strategy Decision**
  - Planned for Rationalization of Cat I ILSs at NSG 4 and 5 airports between 2020 and 2030
  - Efforts for investment decision were put on hold

FY17-18

- Program on hold

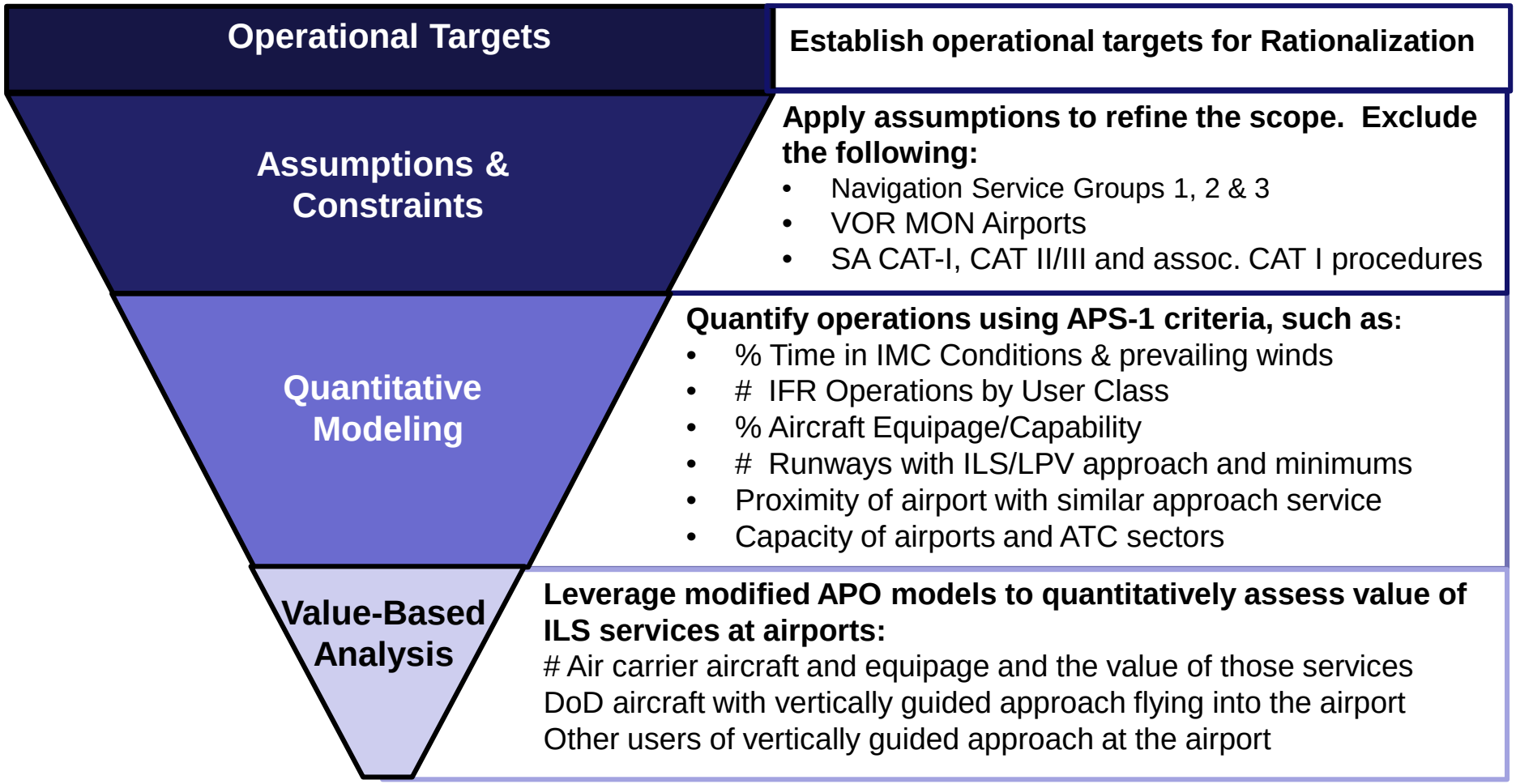
FY19

- Planning to reinitiate program
  - Strategy decision for ILS Rationalization in Q4 CY19

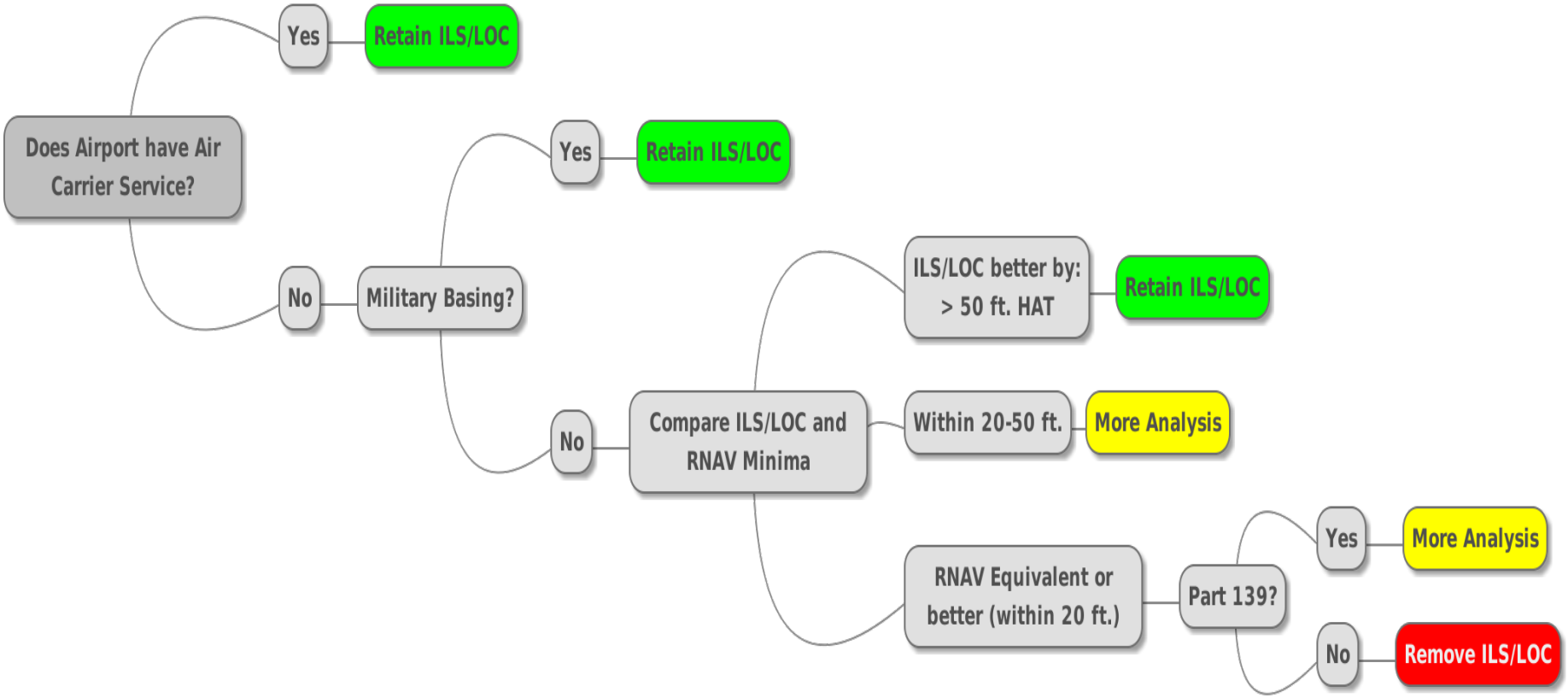
Instrument Approach Strategy

- **Retain existing CAT-II/III ILSs for commercial aircraft**
- **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 as to provide a backup during GNSS outages**
- **NDB and redundant VOR approaches will be cancelled**
- **CAT-I ILSs will be rationalized to identify systems that can be discontinued**
  - ILS Rationalization placed on hold in 2017; initiative has been reinitiated and is being commenced in 2019

ILS Rationalization Criteria *September 2016



Qualitative Analysis *September 2016



Initial Value Assessment *September 2016

Approximately 402 ILS at NSG 4 & 5 Airports

Category	Qualitative	Quantitative
Likely to be Retained	110	109
More Analysis Needed	95	126
Likely to be Removed	197	167

Range of Candidates for Removal	
Low Estimate[1]	167
High Estimate[2]	292

[1] *Quantitative Likely to be Removed*
[2] Sum of Qualitative *More Analysis Needed (95) + Likely to be Removed (197)*

Assumptions/Constraints *September 2016

- Consumers of vertically guided approach services include Air Carrier, Air Taxi, General Aviation and State Owned Aircraft
- Rationalization will consider operational factors and value of the service provided for the users of the system
- Runway ends that currently have vertical guidance must retain vertical guidance
- ILSs at Minimum Operational Network (MON) Airports will be retained to support safe recovery in the event of a GPS outage
- Lighting Systems (MALSR and ALSF-2) and Runway Visual Range (RVR) will not be considered for rationalization
- In lieu of ILS, LPV procedures will be published for newly qualified runways for Cat-I operations
- There are no personnel or training costs due to the ILS Rationalization

Operational Targets *September 2016

- Provide vertically guided instrument approach services to the lowest practical minima at qualified instrument runway ends (per ATO/ARP/AVS designation)
- Provide lateral guidance to the lowest practical minima if vertically guided approach is not available
- Enable aircraft to navigate to a non-Global Navigation Satellite System (GNSS) (i.e., ILS or VOR) approach within 100 miles during a GPS outage
- Maintain approach guidance to support State Owned Aircraft
- Maintain suitable ILS infrastructure to minimize impacts to aircraft and air traffic operations at all weather conditions
- Minimize impacts to pilot and controller workload
- Align the provision of vertically guided approach services to locations based on user equipage. Match service provision to user equipage, wherever practical

Re-initiating ILS Rationalization

- **Review Benefits-to-Cost model**
- **Revalidate Qualitative Analysis**
- **Coordinate strategy internal to FAA**
- **FAA Strategy Decision in Q4 CY2019**
- **Conduct Stakeholder Analysis and Outreach**
  - Publish Federal Registry Notice (FRN)
  - Consider comments and feedback
- **Approval of Rationalization Criteria**
- **Activity to identify and discontinue ILSs would start no earlier than 2020**

Summary

Summary

- **Navigation Strategy focuses on providing resilient navigation services**
- **ILS Rationalization Strategy Decision planned for late 2019**
  - Strategy and criteria planned for internal review prior to Strategy Decision
  - Public feedback will be sought after a Strategy Decision
  - Socialization with stakeholders will be critical
  - Site identification would start no earlier than 2020 and would likely extend beyond 2032.

Questions?

Backup

Stakeholder Organizations

AJV-5, Aeronautical Information Services	AJI-3, Directorate for Policy & Performance
AJW-1, Operations Support, Technical Operations	AML-7000, FAA Logistics Center, Nav/Landing/Weather Product Division
ANG-B1, NAS Enterprise Architecture & Requirements Services Division	ANG-B2, NAS Enterprise Planning & Analysis Division
ANG-B3, Enterprise Safety & Information Security Division	AFS-400, Flight Technologies and Procedures Division
AFS-470, Performance-Based Flight Systems	AIR-131, Navigation and Flight Deck Technology
AJV-54, Instrument Flight Procedures Group Quality Control	APP-400, Airport Planning & Programming
AJV-72, ATO Operational Concepts Group	AJV-14, Performance Based Navigation, Aeronautical Information Services
USAF, DoD NextGen Lead Service Office	APO, Office of Aviation Policy and Planning
NATCA	

Final 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
  - Proximity of airport with similar approach service

*** Used in FY16 Qualitative Analysis*

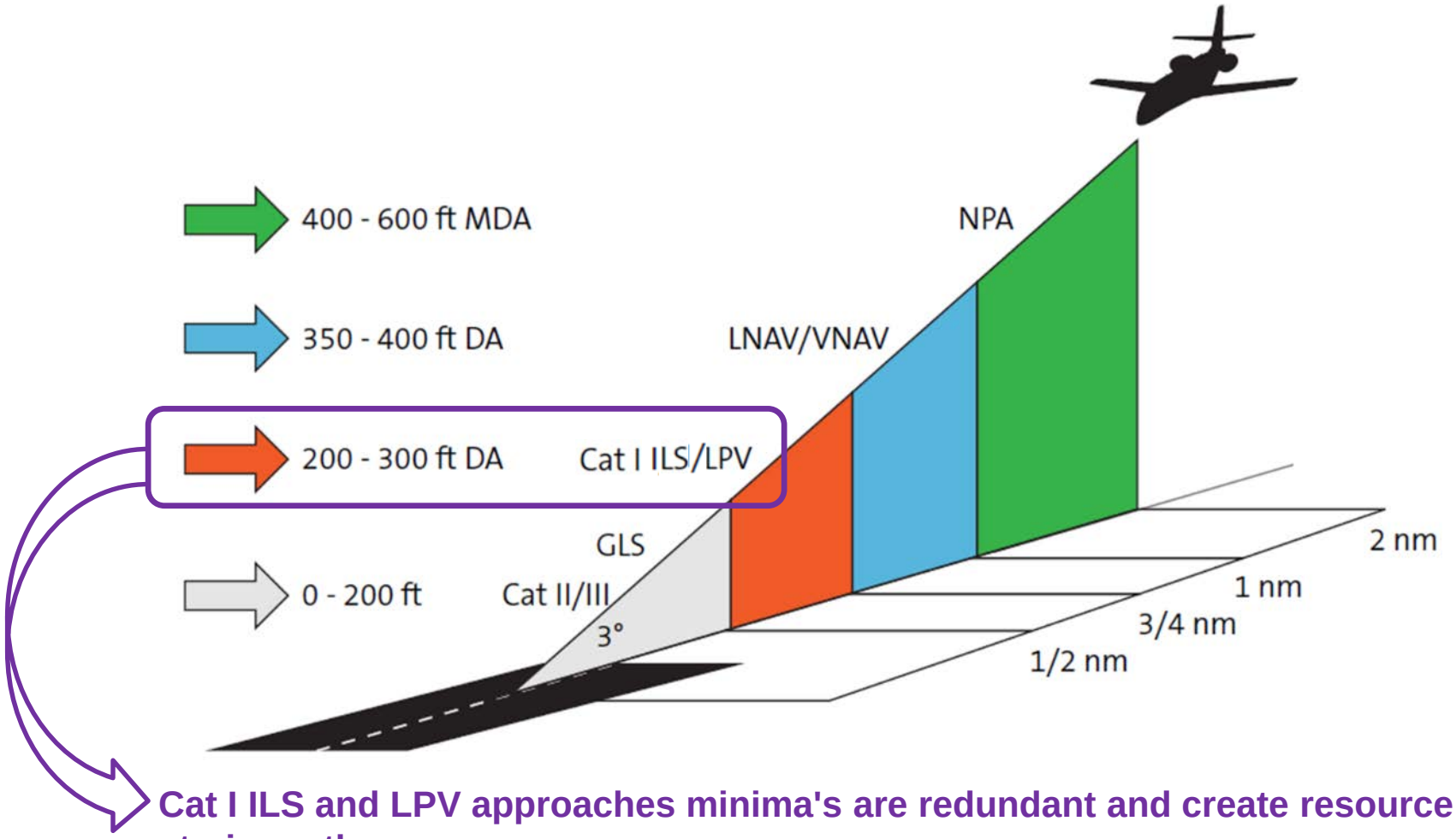
Final Criteria (2 of 2)

- Capacity of airports in proximity
- Capacity of ATC sectors providing air traffic services to airports considered for continuance of ILS service
- Impact to pilot and controller workload
- **Part 139 Certificate
- **Air Carrier Operations

- **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

*** Used in FY16 Qualitative Analysis*

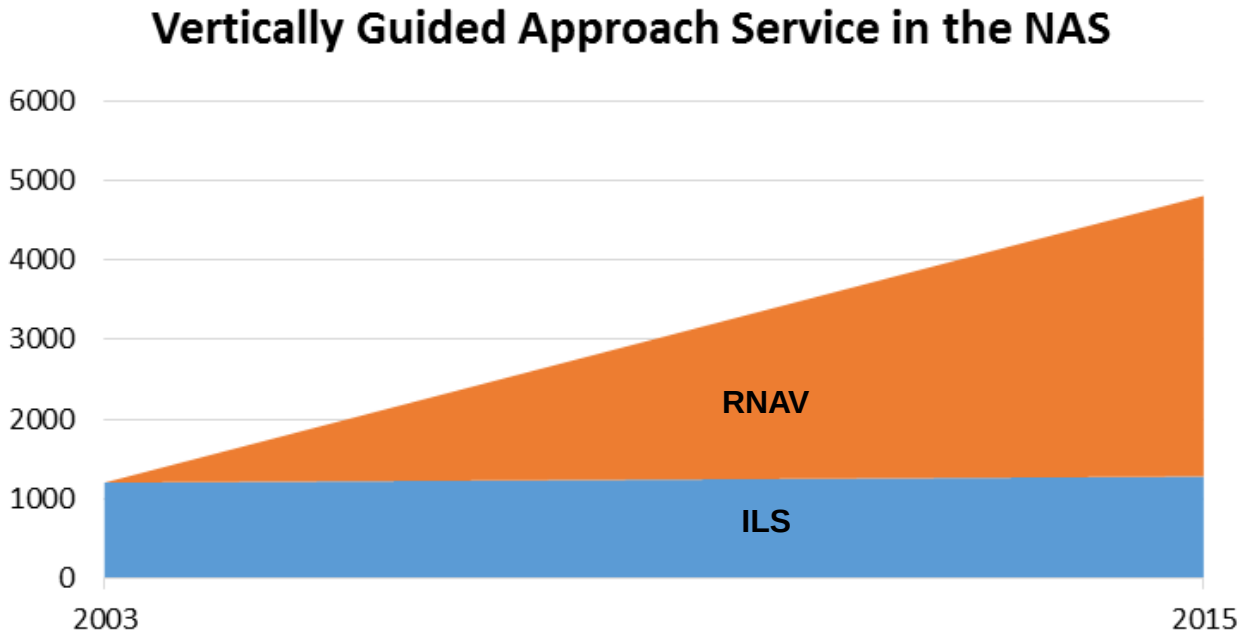
Background



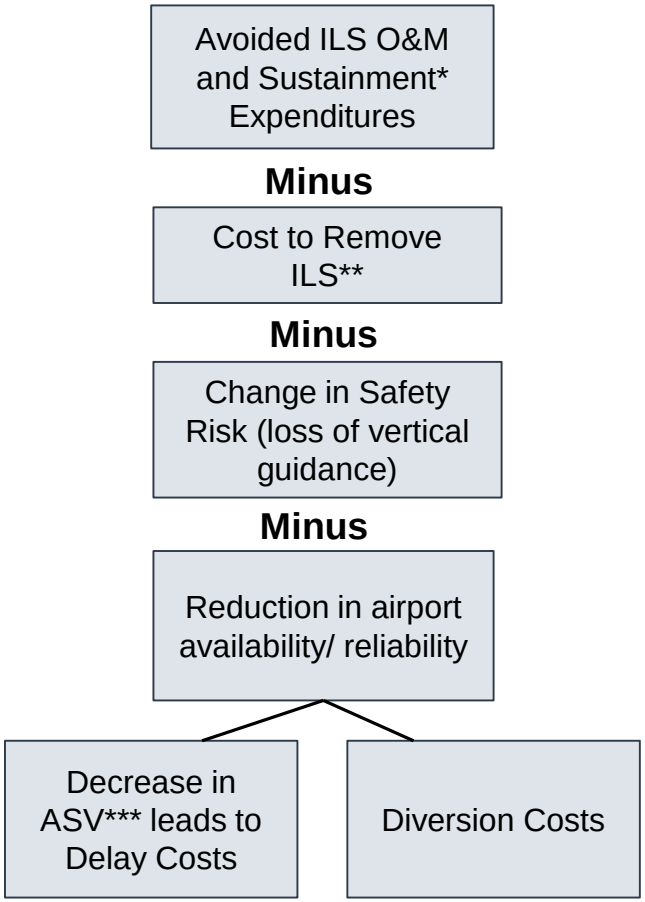
Cat I ILS and LPV approaches minima's are redundant and create resource strain on the agency

Background

- **The FAA owns and operates 1,113 ILS systems that serve 1557 Category-I, 40 Category-II, and 120 Category-II/III approach procedures**
- **The FAA maintains 3,726 Localizer Performance with Vertical Guidance (LPV) approaches and 3,585 LNAV/VNAV approaches**



Quantitative Benefit-Cost Model



The BCA model estimates the monetized net value of vertically guided approaches at specific airports, taking account of:

- Mix of traffic
- Equipage/capability of operators
- Weather/ wind exposure
- Navaids available on specific runways
- Minima including vertical guidance by Navaid and runway end
- Alternate airports

Monetized valuation of:

- Operator costs
- Safety impacts
- FAA O&M and sustainment costs
- Deactivation or decommissioning costs

*Sustainment expenditures will be 20-30 years from last swap date for each ILS considered
**Decommissioning costs assumed to be $100K per ILS
***Annual Service Volume model suitable only for smaller NSG 4 and 5 airports; another method will be required for larger airports

Initial BCA Results for NSG 4 and 5 Airports

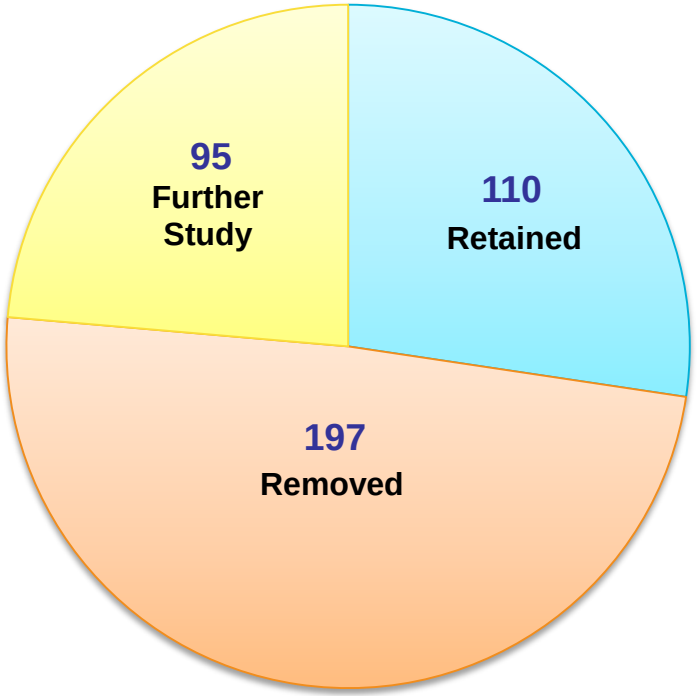
(402 ILS/LOC Approaches)

	Retain	Possibly Retain	Remove
	B/C Ratio <=1	B/C Ratio 1-2	B/C Ratio >2
ILS Runways	**109**	**126**	**158**
Avg. Annual IFR Flights	6,842	2,338	1,743
Avg. Flights using Vertical Guidance	6,223	2,046	1,455
After ILS Closure:			
Avg. Flights Losing Vertical Guidance	1,585	441	114
Percent Losing Vertical Guidance	25.5%	21.6%	7.9%

B/C ratio >1 means the benefits of removing an ILS exceed the costs – i.e. remove or do not retain

Summary of Qualitative Results

- **Total Fed-owned in NSG 4 & 5 ILSs or LOCs:** 402
- **ILS/LOCs retained:** 110
- **ILSs where more study is required:** 95
- **ILS/LOC candidates for removal:** 197



Qualitative Analysis Approach

- **Data was gathered to support the rationalization criteria**
- **Primary criteria were selected for analysis**
  - The primary criteria was sufficient to identify ILSs that are strong candidates for retention and those that are candidates for removal
  - Remaining ILSs require further analysis
- **Secondary criteria will be used for further analysis of the remaining ILSs**

Initial Value Assessment with ROM Estimates

Approximately 402 ILS at NSG 4 & 5 Airports

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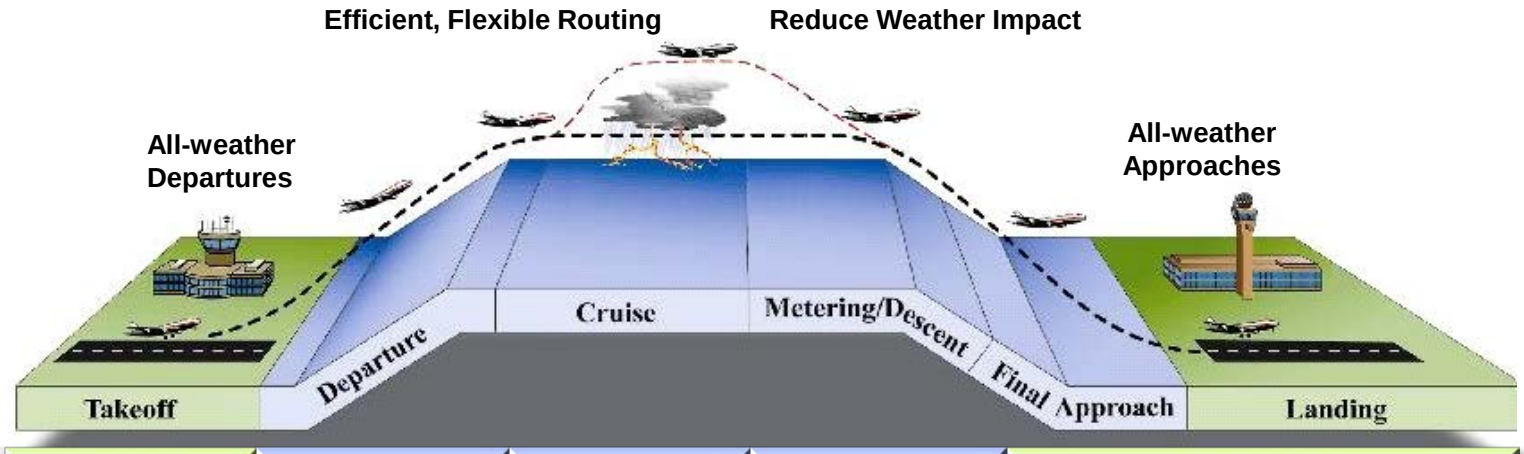
Preliminary Economic Analysis	Low Est.	High Est.
ROM Cost $128k per removal ($BY16)	$21M	$37M
Cost Avoidance $80k per year for 20 years ($BY16)	$267M	$467M

[1] *Quantitative Likely to be Removed*
[2] Sum of Qualitative *More Analysis Needed (95) + Likely to be Removed (197)*

PBN Strategy Goals by Benefit Area

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

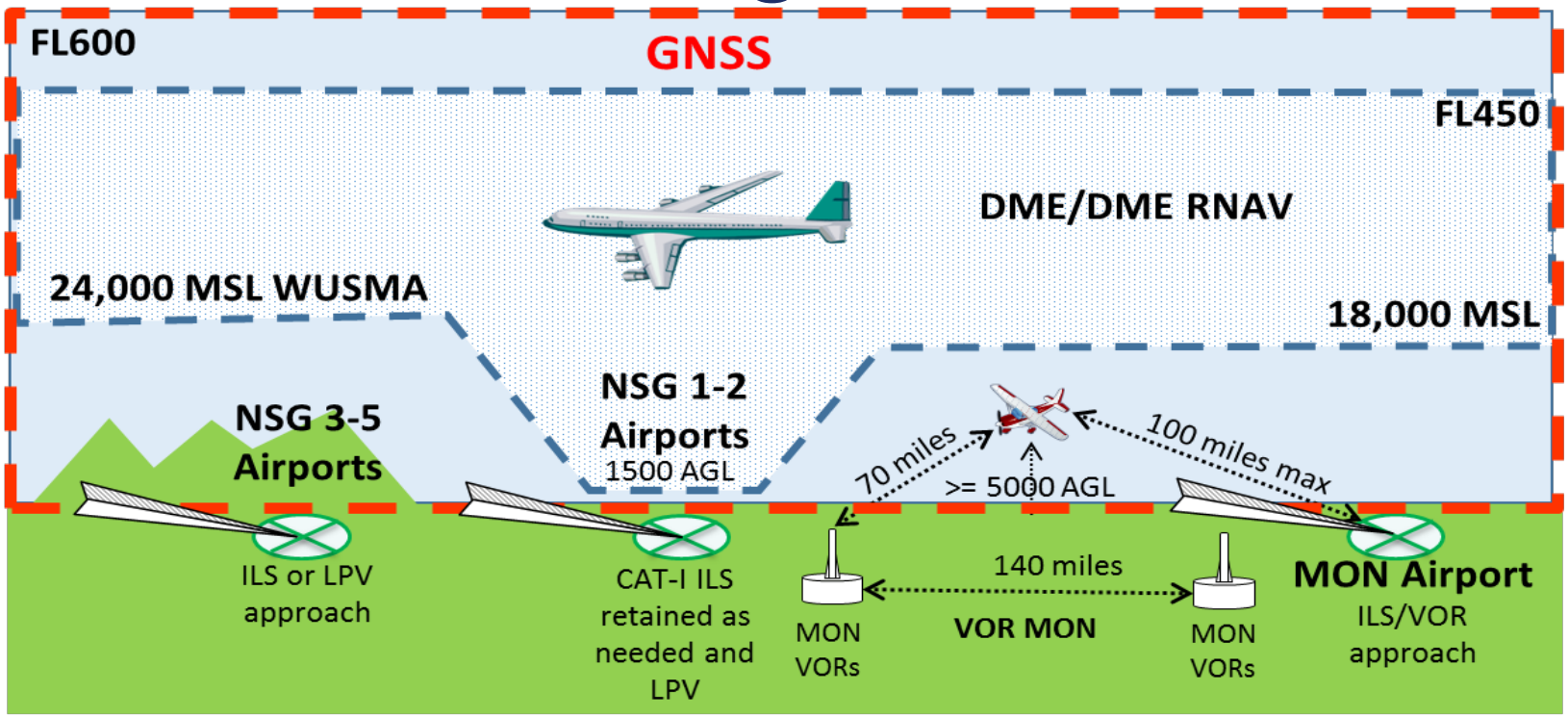
FAA Navigation Programs Portfolio



	Takeoff	Departure	Cruise	Metering/Descent	Final Approach / Landing
Legacy Navigation Infrastructure	LOC RVR GNSS	VOR TACAN DME GNSS	VOR TACAN DME NDB GNSS	VOR TACAN DME NDB GNSS	ILS/LOC RVR VOR / DME / TACAN / NDB GNSS MALSR ALSF-2 REIL PAPI/VASI
Future Navigation Infrastructure	GNSS LOC RVR	GNSS DME / TACAN VOR	GNSS DME / TACAN VOR	GNSS DME / TACAN VOR	GNSS ILS/LOC RVR DME / TACAN VOR MALSR ALSF-2 REIL PAPI

Note: NavAid system listed first in each cell is the preferred navigation service

Resilient Navigation Services



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- 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