FAA Navigation Programs Update

Federal Aviation Administration

Presented to: Civil GPS Service Interface Committee

Presented by: Deborah Lawrence,
Manager, Navigation Programs

Date: September 2019

Agenda

- **FAA Navigation Strategy**
- **WAAS Update**
- **Ground Based Augmentation System (GBAS) Update**
- **Navigation Resiliency**
  - DME/VOR/TACAN Sustainment
  - NextGen DME Program Update
  - VHF Omni-directional Range (VOR) Minimum Operational Network (MON) Program Update
  - ILS Rationalization Status
- **Summary**

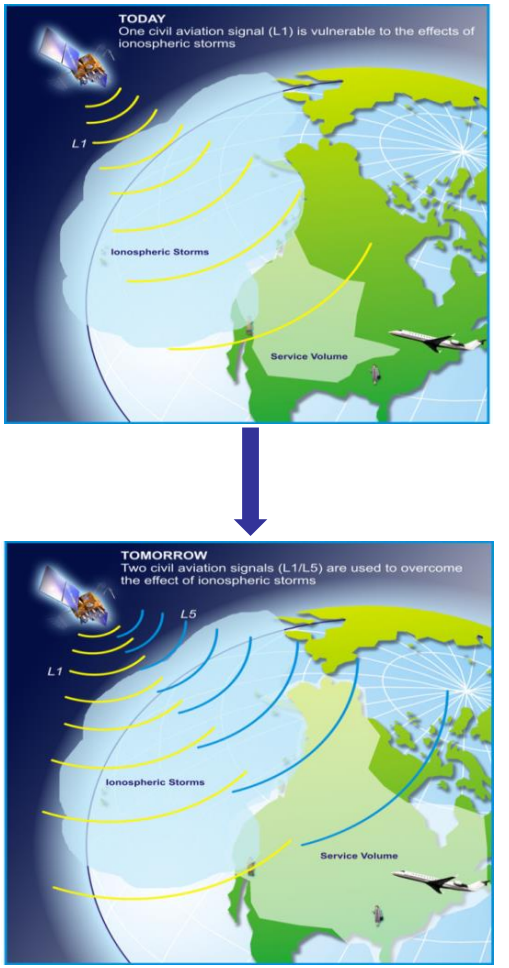
FAA Navigation Strategy 2018

- **Provide resilient navigation services to enable transition of the NAS to PBN operations**
  - GPS and WAAS enable all PBN operations and ADS-B
  - A nominal population of legacy conventional NavAids must be sustained to provide a resilient NAS infrastructure
  - NextGen DME Program supports PBN operations and provides 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
- **Rationalize the legacy NavAid infrastructure**
  - 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.

WAAS UPDATE

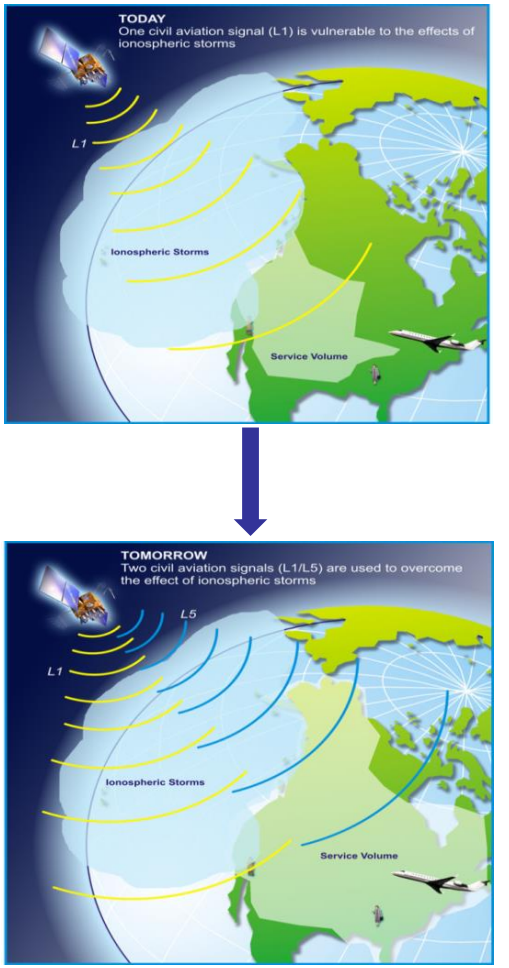
WAAS Phase 4 Dual Frequency Operations (DFO) Status

- **Phase 4A**
  - Combination of infrastructure improvements and tech refresh in support of operational system and future incorporation of dual frequency
- **Five (5) Releases**
  - Release 1 (Processor Upgrades) completed April 2017
  - Release 2 (GEO 5 Integration) completed March 2018
  - Release 3 (GIII Multicast Structure) completed January 2018
  - Release 4 (C&V Safety Computer Validation and Deployment) cutover complete; last installation completed March 2019
  - Release 5 (GEO 6 Integration) became operational in July 2019
- **WAAS Gap Years (FY20-21)**
  - Release 6 will improve WAAS performance enhancements by correcting anomalies to the O&M, TSS and network critical message logging capabilities; planned for September 2021
  - Release 7 will integrate GEO 7 into WAAS and upgrade with new SIGGEN including the retrofitting of new SIGGENs at the GEO 5 and GEO 6 legacy GUS sites. GEO 7 projected to be operational by August 2021.
- **Phase 4B will complete integration of L5 to provide DFO (FY22-26)**



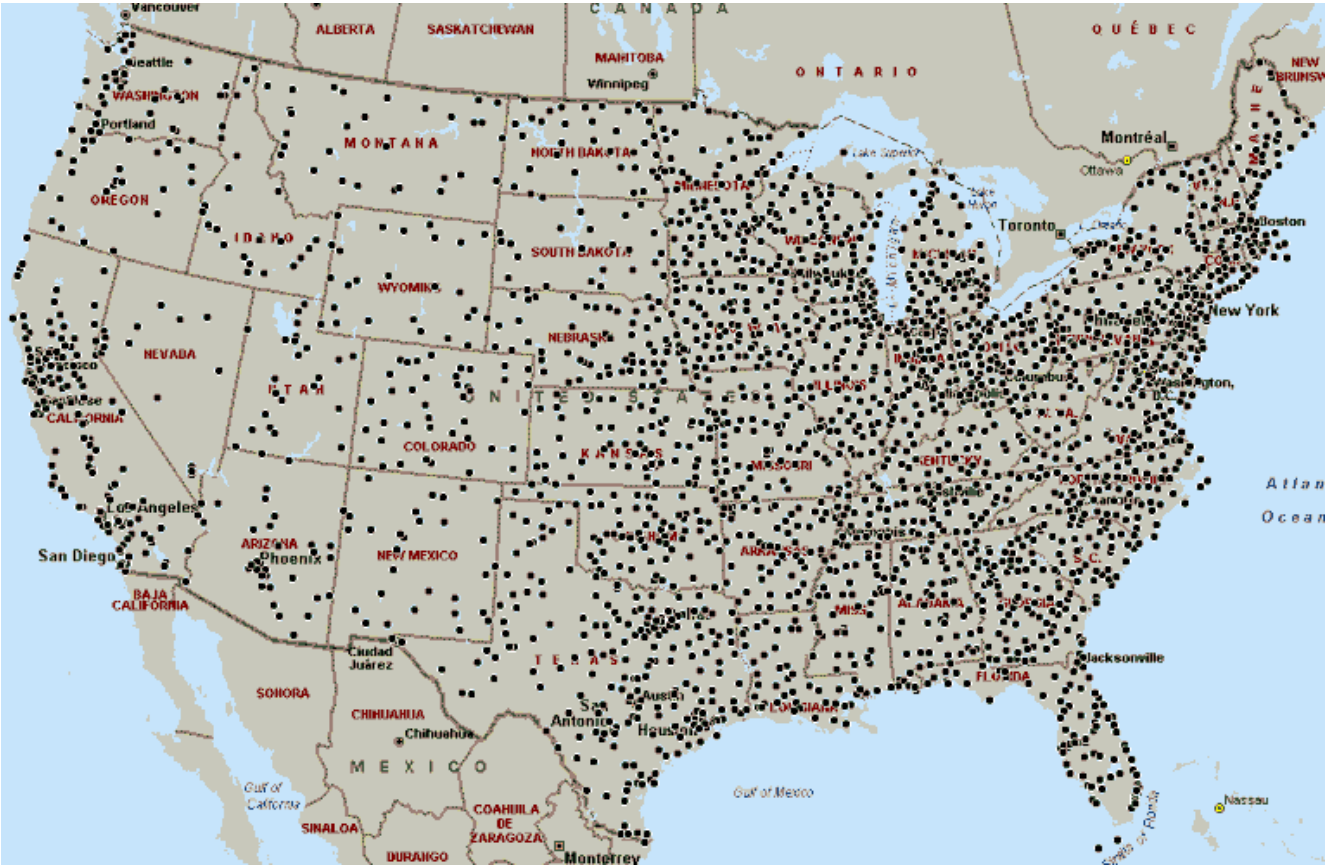
WAAS Phase 4 Dual Frequency Operations (DFO) Status (cont')

- **Dual-Frequency Multi-constellation Capability (DFMC)**
  - MOPS and SARPs development underway, baselined SARPS completed in December 2018. Final SARPS expected in 2020
  - 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 August 2019 there are currently 1,546 ILS procedures while WAAS has 4,703 LPV/LP procedures published

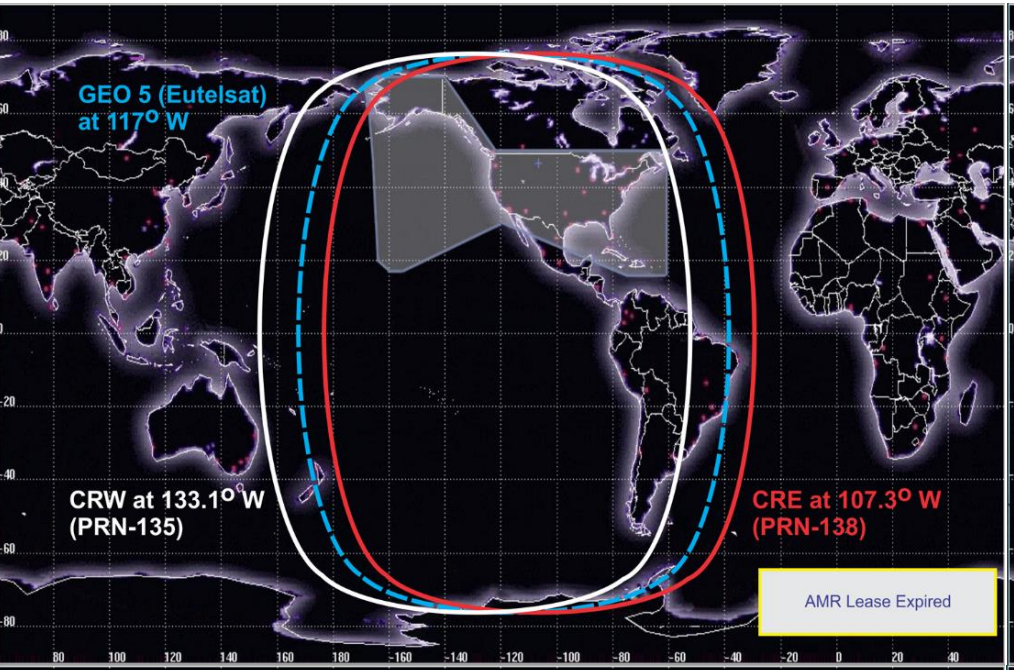
WAAS Avionics Equipage Status

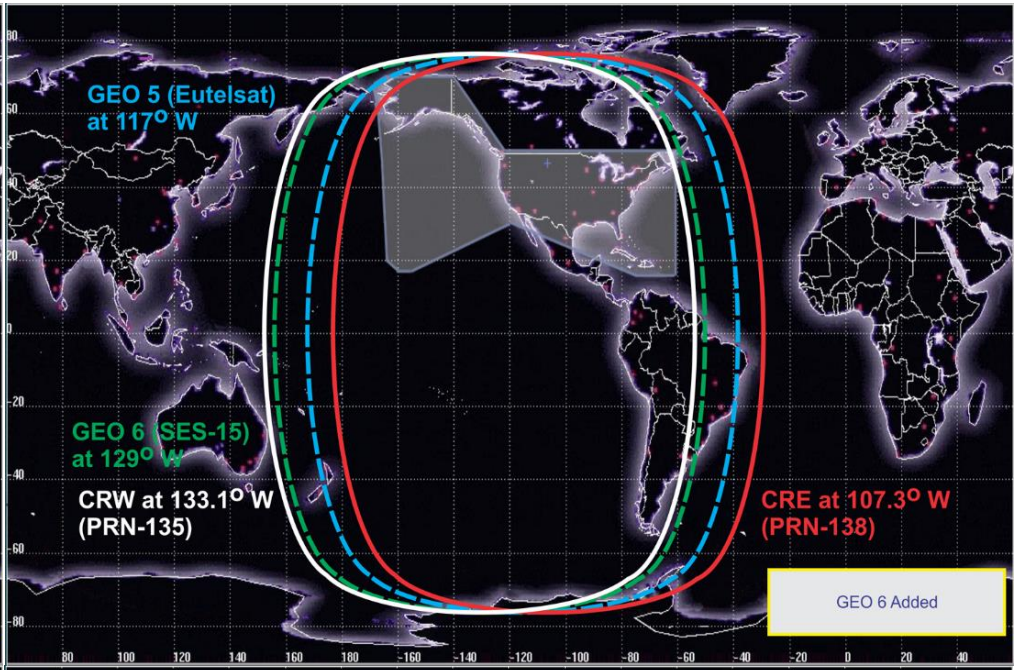
- **Over 125,000 WAAS equipped aircraft in the NAS**
  - WAAS receivers provided by companies such as:
    - Garmin, Universal, Rockwell Collins, Honeywell, Avidyne, Innovative Solutions & Support (IS&S), Thales and Genesys Aerosystem (Chelton)
- **Since 2006, aircraft equipage has increased each year**
- **All classes of aircraft are served in all phases of flight**
- **Only Primary GNSS service enabling NextGen programs**
  - Automatic Dependent Surveillance Broadcast (ADS-B)
  - Performance Based Navigation (PBN)

GEO Sustainment (GEOs 5/6/7)

- **GEO 5/6 Satellite Acquisition**
  - GEO 5
    - Operational March 2018
  - GEO 6
    - Host satellite is SES-15, planned for 129 West
      - Successful launch on 18 May 2017
      - Provides full coverage of CONUS and Alaska
    - Final test and integration completed in July 2019
    - Operational 15 July 2019
- **GEO 7 Satellite Acquisition**
  - System critical design review completed April 2019
  - Initiating design and build-out of new ground uplink systems

Eutelsat 117WB


GEO 5 (Eutelsat)
at 117° W
CRW at 133.1° W
(PRN-135)
CRE at 107.3° W
(PRN-138)
AMR Lease Expired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GEO 6 (SES-15)
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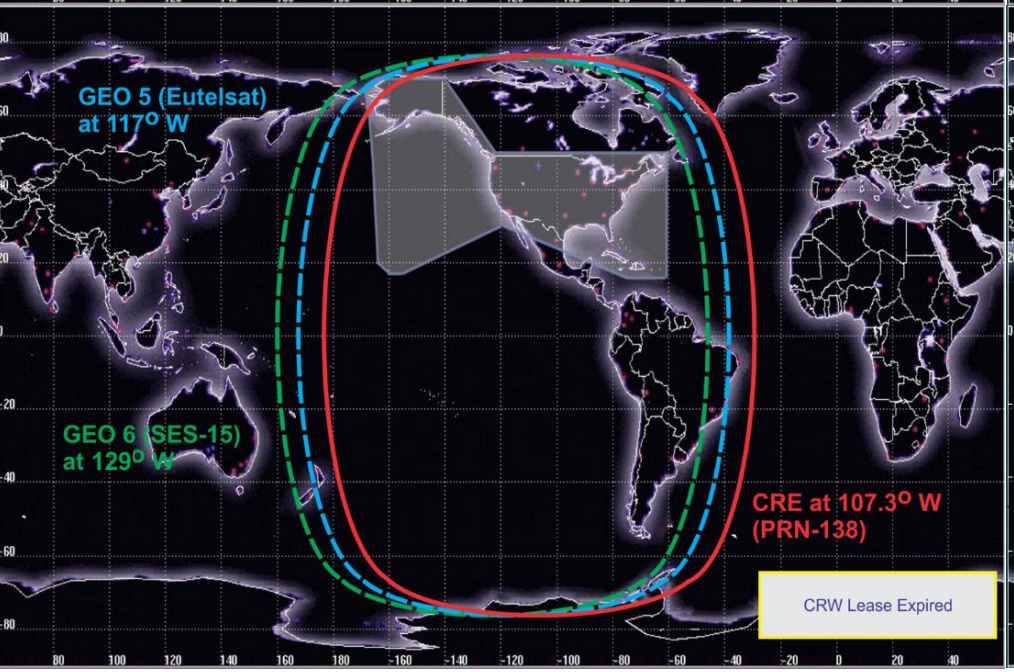
GEO 6 Added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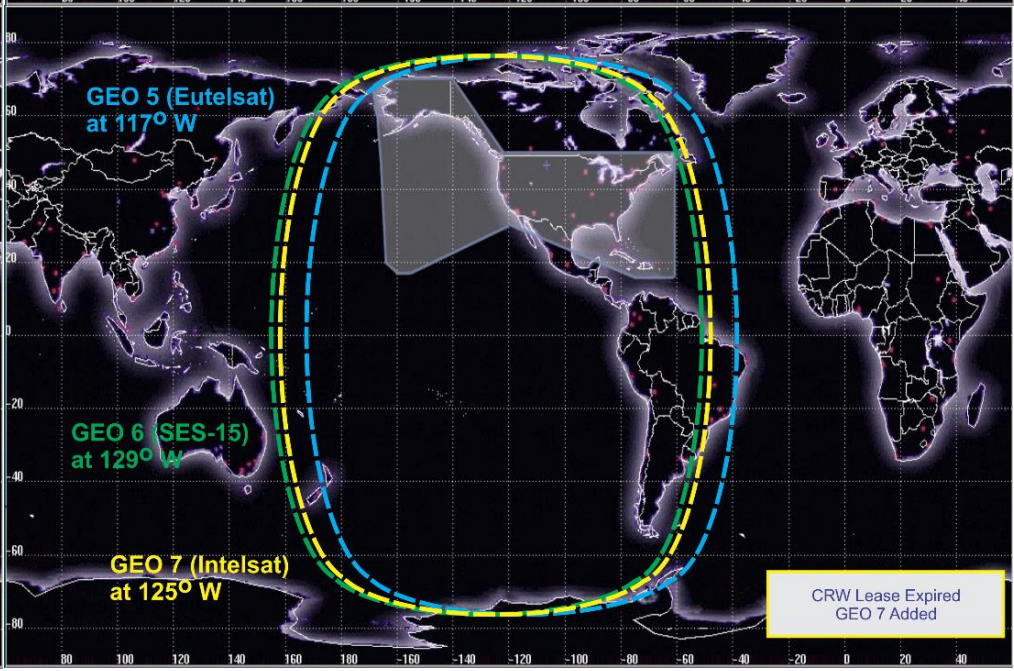
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GEO 6 (SES-15)
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GEO 7 (Intelsat)
at 125° W
CRW Lease Expired
GEO 7 Added

GBAS UPDATE

GBAS Overview

- **NextGen Program Closeout**
  - GBAS is managed by the FAA Technical Operations Non-Federal Policy and Oversight Office, NextGen supports GBAS efforts by means of an FAA-internal Project Agreement
- **Ongoing FAA Activities**
  - ICAO/RTCA standards for VDB signal measurement methods for Flight Inspection
  - Non-Federal Policy & Oversight Office (AJW-1X) has identified a three-phase process to manage and review requests for approval of emerging Non-Federal technologies
  - Honeywell SLS-4000 Block II Updates to “code carrier divergence” for better availability / Upgrade from copper to fiber
  - GBAS status monitoring requirements for Air Traffic Control towers and TRACONS
- **Ongoing Industry Activities**
  - PANYNJ –LGA & JFK GBAS planning (2020/2021)
  - SEATAC GBAS Planning (2020)
  - SFO GBAS Planning (2020)
  - Request for GAST-D (CAT-III) SDA Information from Indra Navia
  - United Airlines and Delta Air Lines request for CAT II approval for GBAS GAST-C system
- **Operational Data & Equipage**
  - 5675 approaches conducted at Newark, NJ and Houston, TX
  - Southwest, United, Delta Air Lines continue GLS equipage

Navigation Resiliency

Navigation Resiliency

- **DME/VOR/TACAN service is required for the foreseeable future as part of a resilient navigation infrastructure**
- **DME infrastructure supports continued PBN operations during GNSS service disruptions**
  - NextGen DME Program being implemented
    - Established interim siting criteria
    - 100 DME targeted for discontinuance
    - Approximately 124 new DMEs will be installed
- **VOR MON has discontinued 51 out of 311 VORs to date; 74 planned for Phase 1 ending in 2020.**
  - Phase 2 Final Investment Decision (FID) planned for 2020 will discontinue the remaining 237 VORs
- **ILSs will be retained, as needed to support continued operations at the busiest airports during GPS outages**

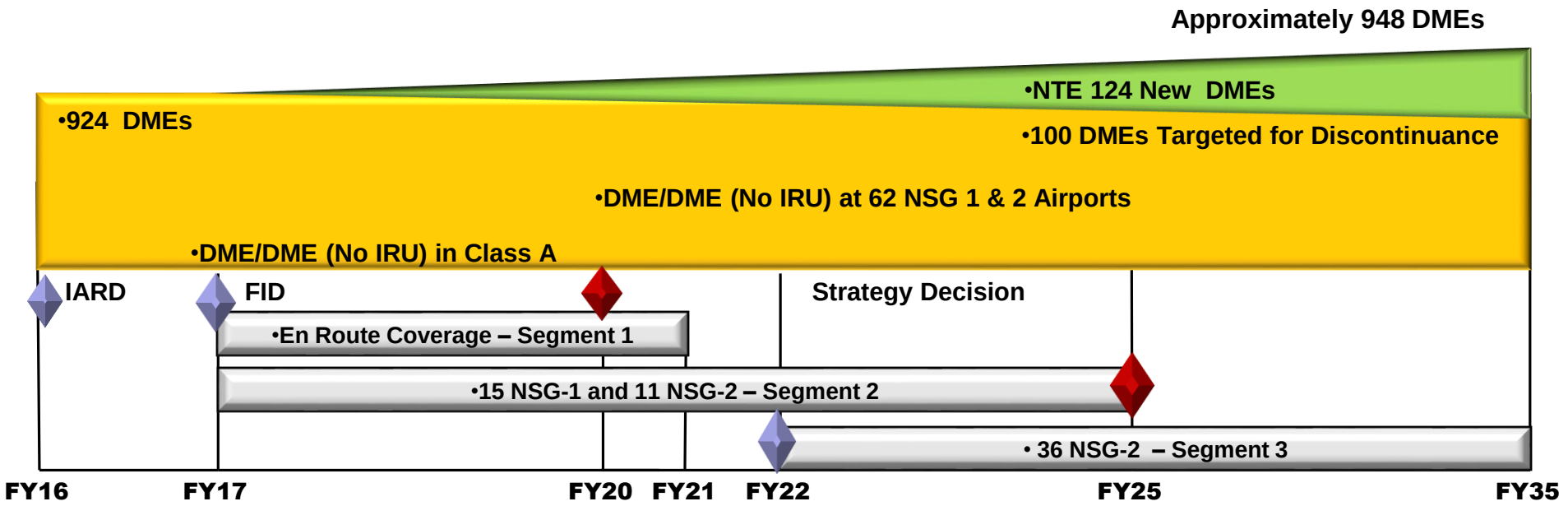
DME/VOR/TACAN (DVT) Program

- **Established in 2018 as an innovative initiative to sustain DVT systems through the year 2045**
  - Most DVT systems are 30+ years old and becoming unsustainable
  - Supportability Study determined DVT systems are not supportable through 2045 without modernization
  - VOR MON and NextGen DME Programs do not sustain DVT systems
  - Procurement contracts are not available to replace VORs or TACANs
  - Short term needs (antennae and oscillators) require immediate attention
  - FAA approved a DVT Acquisition Strategy in June 2019
  - Anticipated DVT system inventory

	VOR	VOR/DME	DME	VORTAC	TACAN	TOTAL
SDPs	17	270	19	381	55	920

- **Next Steps**
  - Continue addressing short-term needs
  - Proceed with Acquisition Strategy

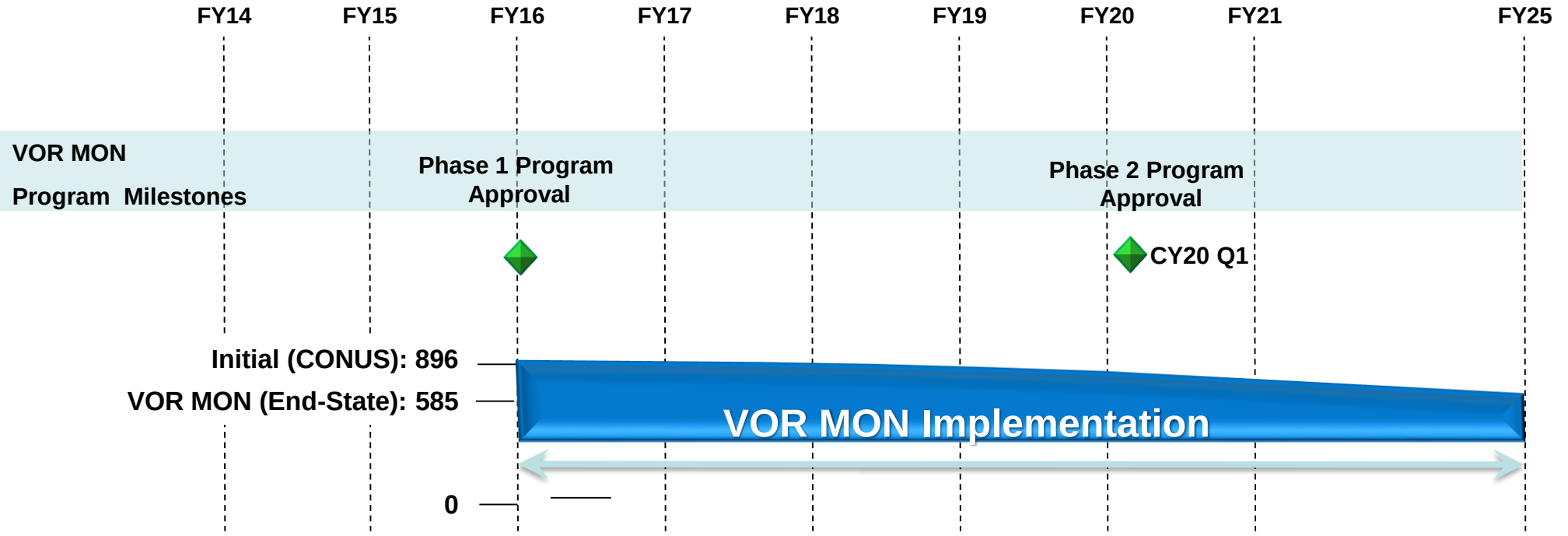
NextGen DME Program Timeline



- **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

Phase 1

- Publish Final Policy FRN: *"Provision of Navigation Services for the Next Generation Air Transportation System (NextGen) Transition to Performance Based Navigation (PBN) 07/26/2016*
- 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 (237)

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, LOC, and Category-I ILS approaches will be retained at MON airports to provide a backup during GNSS outages**
- **Redundant NDB and VOR approaches will be cancelled**
- **CAT-I ILSs will be rationalized to identify systems that can be discontinued**

ILS Rationalization

- **Reinitiating activities after a planned time-out in 2017**
- **Reviewing Benefits-to-Cost model**
- **Revalidating Qualitative Analysis**
- **Coordinating internal FAA strategy**
- **FAA Strategy Decision in December 2019**
- **Conduct Outreach with Customers and Stakeholders**
  - Publish Federal Registry Notice (FRN) to seek feedback from the public on proposed ILS rationalization criteria
  - Consider public comments and feedback
  - Publish FRN to establish final ILS Rationalization Criteria
- **Activity to discontinue ILSs would not start before 2021**

Summary

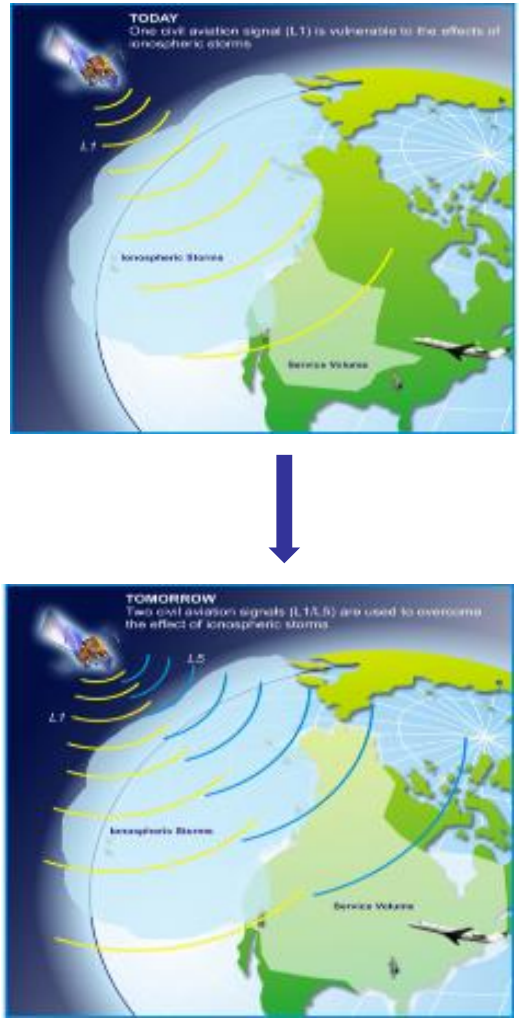
Summary

- **WAAS is replenishing GEOs, Performing Tech Refresh, and planning for Phase 4B to integrate DFO**
- **FAA continues to support Cat I GBAS operations**
- **Resiliency**
  - DME/VOR/TACAN Program achieved Strategy Decision in 2019
  - NextGen DME Program implementation underway
    - Plan to deploy two sites by end of FY2019
  - VOR MON implementation – 51 VORs discontinued
  - ILS Rationalization effort reinitiated for a strategy decision in Dec 2019

Questions?

WAAS Phase IV Dual Frequency Operations Status

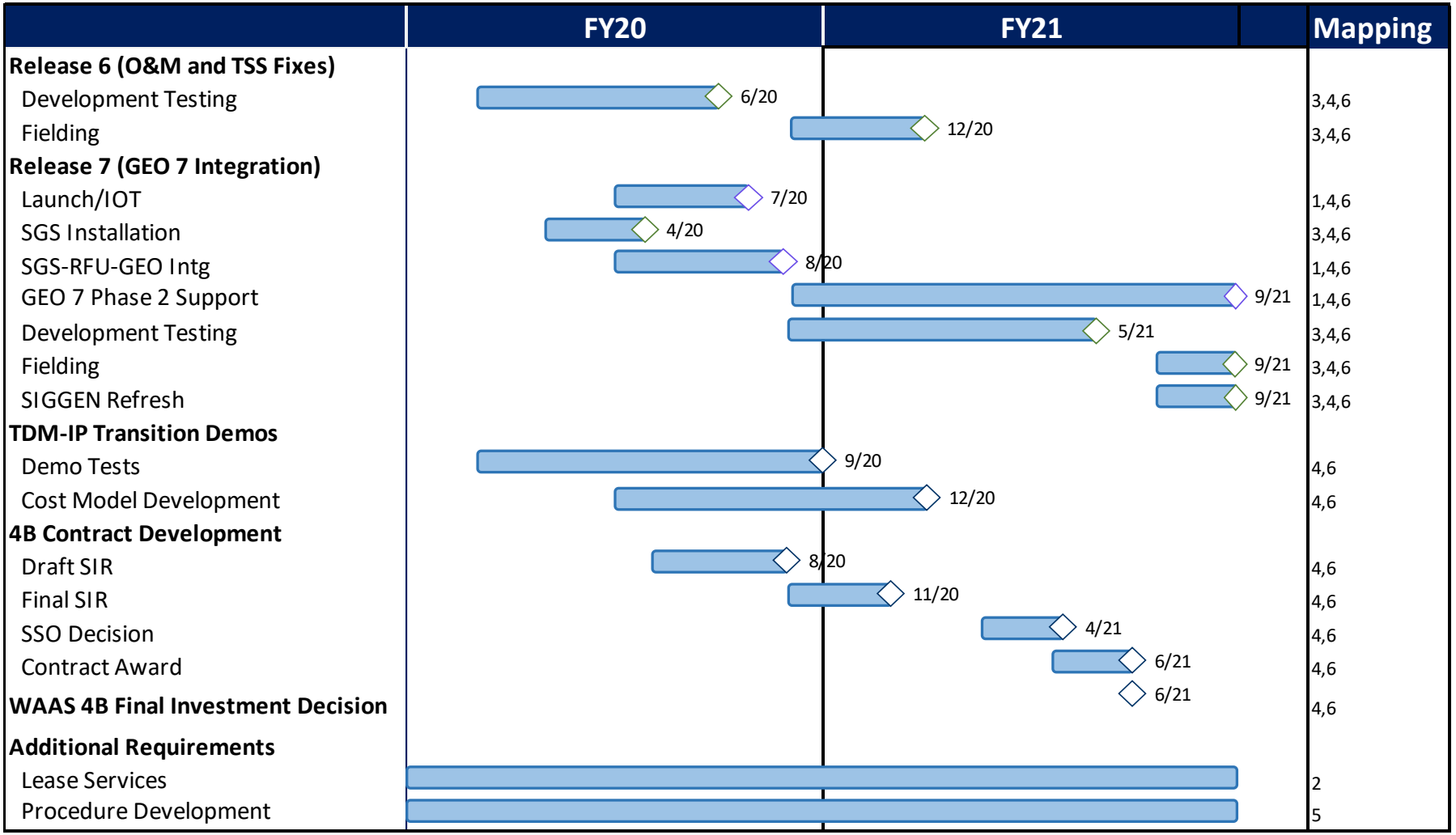
- **Phase IV - A**
  - Combination of infrastructure improvements and tech refresh in support of operational system and future incorporation of dual frequency
  - Focus of the Segment is on the replacement of obsolete system hardware components in addition to integration of three replacement GEO satellites
  - Deployed over the course of seven releases, with approximately one release per year
  - Each release modification is developed by the WAAS prime contractor (DFO) and delivered to NASE who then conducts a final system test before deploying the release into the operational WAAS



Phase IV – A Releases

- **7 Releases**
  - Release 1 (Processor Upgrades) - completed April 2017
    - Replaced obsolete WAAS Reference Station (WRS), WAAS Master Station (WMS) and GEO Uplink Station (GUS) processors which supports processing of future L5 measurements
  - Release 2 (GEO 5) – completed July 2018
    - Replaced the existing AMR satellite with the new GEO 5 satellite. Provides dual coverage over entire service area.
    - GEO 5 payload went operational in April 2018
  - Release 3 (G-III Multicast Structure) – completed August 2018
    - Upgrades the G-III multicast structure
    - Software updated to begin to transmit/process for L5 data
  - Release 4 (Correction & Verification (C&V) Safety Computer Validation and Deployment) – development completed October 2018 cutover March 2019
    - Addresses obsolescence issues and adds additional capacity to support future L5 signals and dual frequency services
    - Updates safety computer within WAAS C&V Subsystem
  - Release 5 (GPT SC Validation & GEO 6) – completed July 2019
    - Integrates GEO 6 and includes an update to the GEO Uplink Station (GUS) design using the new safety computer
    - GEO 6 will be operational July 2019
  - Releases 6 (O&M and Test Support Software [TSS] Updates) and 7(GPT Signal Generator [SIGGEN] Validation) contract effort awarded. Will be executed February 2019 to September 2021
    - Release 6 will improve WAAS performance enhancements by correcting anomalies to the O&M, TSS and network critical message logging capabilities
    - Release 7 will integrate GEO 7 into WAAS and upgrade with new SIGGEN including the retrofitting of new
    - SIGGENs at the GEO 5 and GEO 6 legacy GUS sites. GEO 7 projected to be operational by August 2021.

WAAS FY20/21 Activities



Houston GBAS Operational Status

- **Houston GBAS was upgraded to SLS-4000 Block II w/ SBAS in May 2018**
  - Upgrade error: no approaches were enabled
    - Procedural error during upgrade
    - All approaches have been re-enabled and Honeywell process has been reworked to strengthen return-to-service checks for upgrades
    - FAA ground inspection checklist also being updated to ensure that approach statuses are correct
  - GBAS monitors indicated the system was operating normally
    - HAS personnel were not trained to observe approach status
    - ICMS only shows ‘green’ or ‘red’ at a system level; no approach by approach status shown
  - Issue was not identified for over two weeks, ~16 approaches cleared
- **Due to failures in communication of PIREPs and questions about monitoring, the GBAS has been NOTAM’ed OTS since**
  - OMM, LOA between ATC and HAS being updated
  - ICMS changes may be deemed necessary
  - Local SMS panel will be held before the system is returned to operation