FAA Navigation Programs Update

Federal Aviation Administration

Presented to: Civil GPS Service Interface Committee

Presented by: Deborah Lawrence,
Manager, Navigation Programs

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Agenda

- **FAA Navigation Programs Strategy**
- **GPS Civil Update**
- **Wide Area Augmentation System (WAAS) Update**
- **Navigation Resiliency**
  - DME/VOR/TACAN Sustainment
  - NextGen DME Program Update
  - VHF Omni-directional Range (VOR) Minimum Operational Network (MON) Program Update
  - Tactical Air Navigation (TACAN) Rationalization to a Minimum Operational Network (MON)
  - Instrument Approach Strategy and ILS Rationalization
- **Summary**

FAA Navigation Programs Strategy

- **Provide resilient navigation services to sustain operations during potential GNSS disruptions**
  - GPS/WAAS provide navigation for all Performance Based Navigation (PBN) and Automated Dependent Surveillance Broadcast (ADS-B)
  - NextGen DME Program provides an Area Navigation (RNAV) backup for aircraft equipped for DME navigation
  - VOR Minimum Operational Network (MON) Program provides a backup for aircraft that are not equipped for DME navigation
  - DME/VOR/TACAN (DVT) Sustainment program will replace conventional systems retained for resiliency
- **Rationalize conventional navigation systems**
  - Discontinue unneeded VORs to establish the MON
  - Reduce TACANs to a Minimum Operational Network (MON) for military
  - Consider ILS Rationalization based on outreach to stakeholders
- **Innovate navigation services to enable new capabilities**
  - Support Multi-Constellation GNSS and Advanced RAIM (ARAIM)
  - Continue transitioning Approach Lighting Systems (ALS) to LED technology

GPS Civil Update

Support to National Space Policy

- **Space Policy Directive 7 (SPD-7)**
  - Replaces NSPD-39 to maintain the free and open use of GPS
  - Establishes National PNT governance and the implementation of E.O. 13905 to reduce the vulnerability of critical infrastructure from GPS disruptions
  - Commits to implement modernized signals
  - Develops requirements and funding strategy to implement data and signal authentication for GPS and WAAS
    - FAA investigating data and signal authentication for WAAS
    - FAA MOU with AFRL on Navigation Technology Satellite 3 demonstration of authentication
    - Monitor, identify, locate and mitigate disruption of space based PNT
    - FAA exploring low-cost monitoring capabilities for airports

Executive Order 13905 "Responsible Use of PNT/GPS"

- **FAA implementing Resilient Navigation Infrastructure to sustain operations during GPS disruptions (jamming)**
  - Resiliency is provided by VORs and DMEs, and ADS-B relies on primary and secondary radar for backup positioning
  - Backup timing services to be provided as part of telecommunications services
- **GPS disruption and signal manipulation (jamming and spoofing) is a concern to aviation**
  - DOT/FAA establishing government and industry partnership to mitigate impacts at systems and applications levels
  - FAA investigating potential to monitor and detect jamming and spoofing by leveraging data available through the ADS-B system
  - FAA investigating COTS portable electronic devices to alert potential GPS spoofing; GNSS receivers, telephony signals (e.g., 5G), and SDRs
  - FAA purchased next generation receivers to validate new standards and test potential mitigations for spoofing

GPS Modernization Support

- **FAA Co-Chair of the National Space-based PNT Systems Engineering Forum (NPEF)**
- **FAA Tri-Chair of GPS PMR**
- **Civil Signal Operational Capability Intergrated Product Team (CSOC IPT)**
  - Enterprise – preparing for joint use declaration of L2C and L5
  - Requirements – investigating the feasibility ARAIM and Authentication
  - Civil Signal Monitoring - implementing Civil Monitoring Performance Specification
  - Test – Supporting OCX integrated systems test and planning for 4 SV test
- **Support implementation of OCX**
  - Supporting development of GPS P_{const} failure mitigations
    - Signal monitoring to detect anomalies in a timely manner
    - Pre-check to verify satellite uploads prior to implementation
- **Conduct Position Signal Integrity Continuity Assurance (PSICA) activities with DOD to assure safety**

Complementary PNT (CPNT)

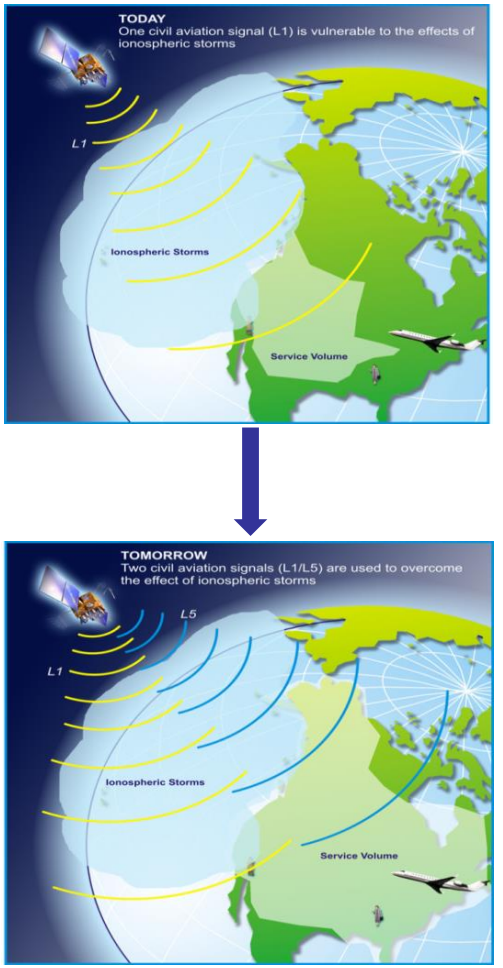
- **DOT leading initiative to identify Complementary PNT (CPNT) alternatives to reduce the civil impact of GPS outages**
  - Demonstrations of candidate technologies were conducted to identify potential solutions to provide resiliency during GPS radio frequency interference events
  - CPNT Action Plan briefed to PNT Advisory Board highlighting potential acquisition strategies for various CPNT vendor technologies
- **DOT/FAA working closely with other OAs to investigate potential CPNT technologies for aviation to mitigate potential disruption to the National Airspace System (NAS) and other transportation sectors.**
- **Establishing a workgroup to develop a Complementary PNT Strategy**

WAAS UPDATE

WAAS Celebrates 20 Years

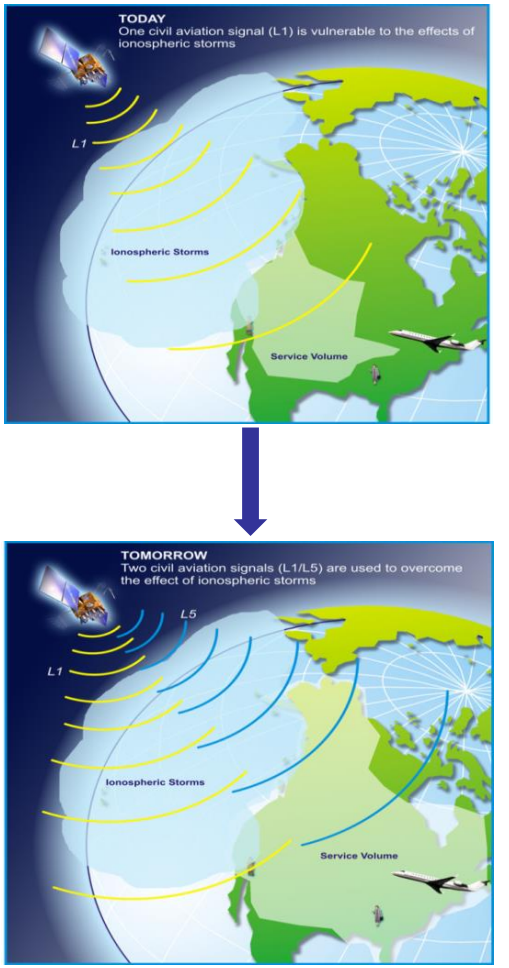
WAAS Phase 4 Status

- **Phase 4A (2014-2019)**
  - Combination of infrastructure improvements and tech refresh in support of operational system and future incorporation of dual frequency
  - Incorporated two new GEOs for WAAS constellation sustainment replacing two legacy GEO services.
- **Phase 4A/B Transition (FY20-22)**
  - Release 6 improves WAAS by correcting anomalies to the O&M, Test Support Software and network critical message logging capabilities; Fielding completed March 2021
  - Release 7 integrated GEO 7 into WAAS and integrated new signal generators at ground uplink stations (GUS) to include retrofitting at legacy GUS sites.
- **Phase 4B (FY22-31)**
  - Introduces WAAS Dual Frequency services using L1 and L5
    - WAAS DF Initial Operational Capability (DF IOC) ~ 2027
    - WAAS DF Final Operational Capability (DF FOC) ~ 2028
  - WAAS Technical Refresh
    - Processor replacement coupled with transition to Linux-based operating system
    - GUS receiver refresh
    - Conversion of existing ground telecommunication circuits to IP based circuits



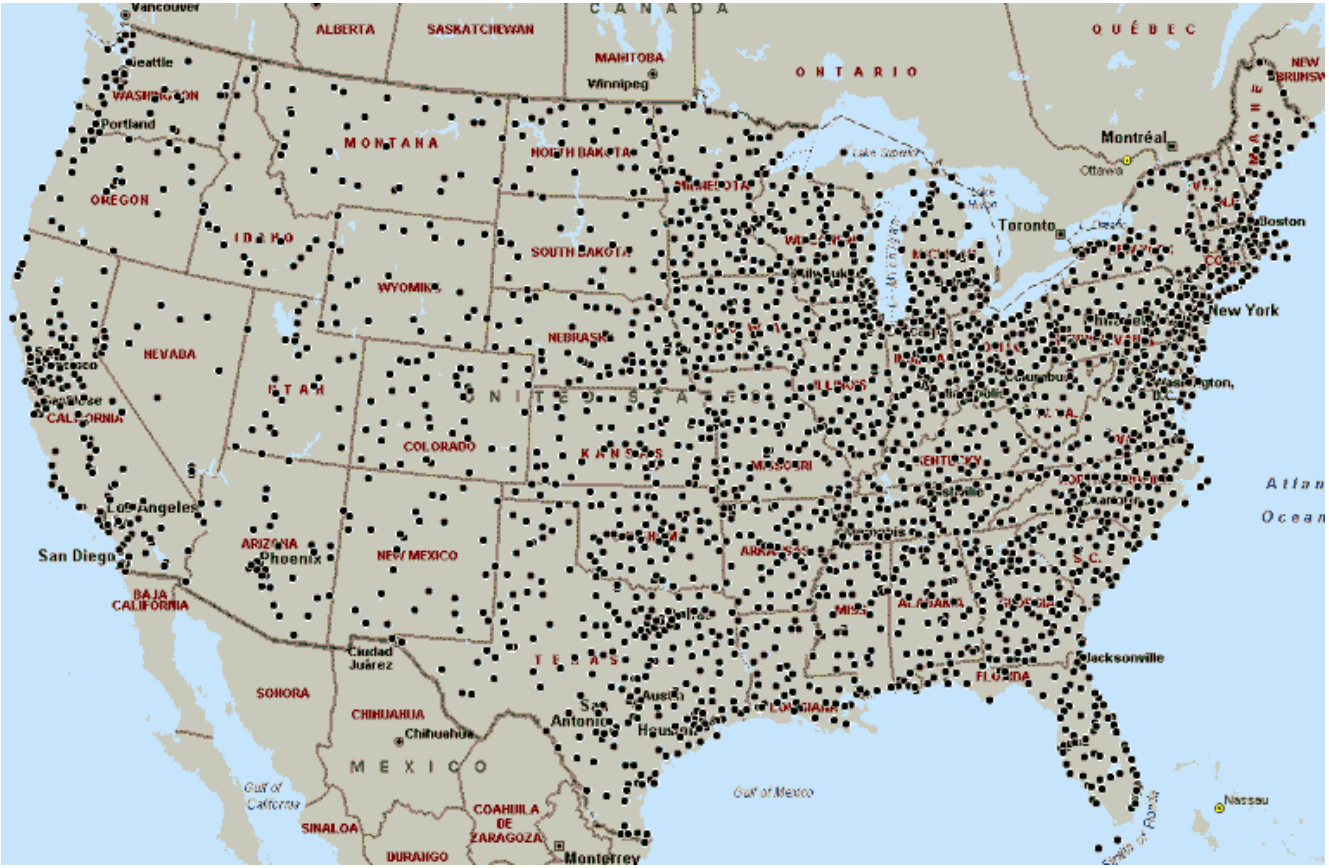
WAAS Phase 4 Dual Frequency Operations (DFO) Status (cont')

- **Dual-Frequency Multi-constellation Capability (DFMC)**
  - Standards development progressing
    - GPS L5 and DFMC SBAS SARPs published in Amendment 93
    - RTCA and EUROCAE working a joint DFMC SBAS MOPS, expect to complete in 2025
  - WAAS assisting IWG with providing SBAS perspective on DFMC capability
- **Advanced RAIM (ARAIM)**
  - ARAIM algorithm development continuing in standards group for multi-constellation GNSS capability
  - Integrity Support Message for GPS broadcast working through the GPS change process
  - ICAO Navigations Systems Panel produced initial requirements for horizontal navigation (H-ARAIM) in January
  - RTCA and EUROCAE working a joint DFMC SBAS MOPS, expect to complete in 2025



Airports with WAAS LPV/LP Instrument Approaches

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

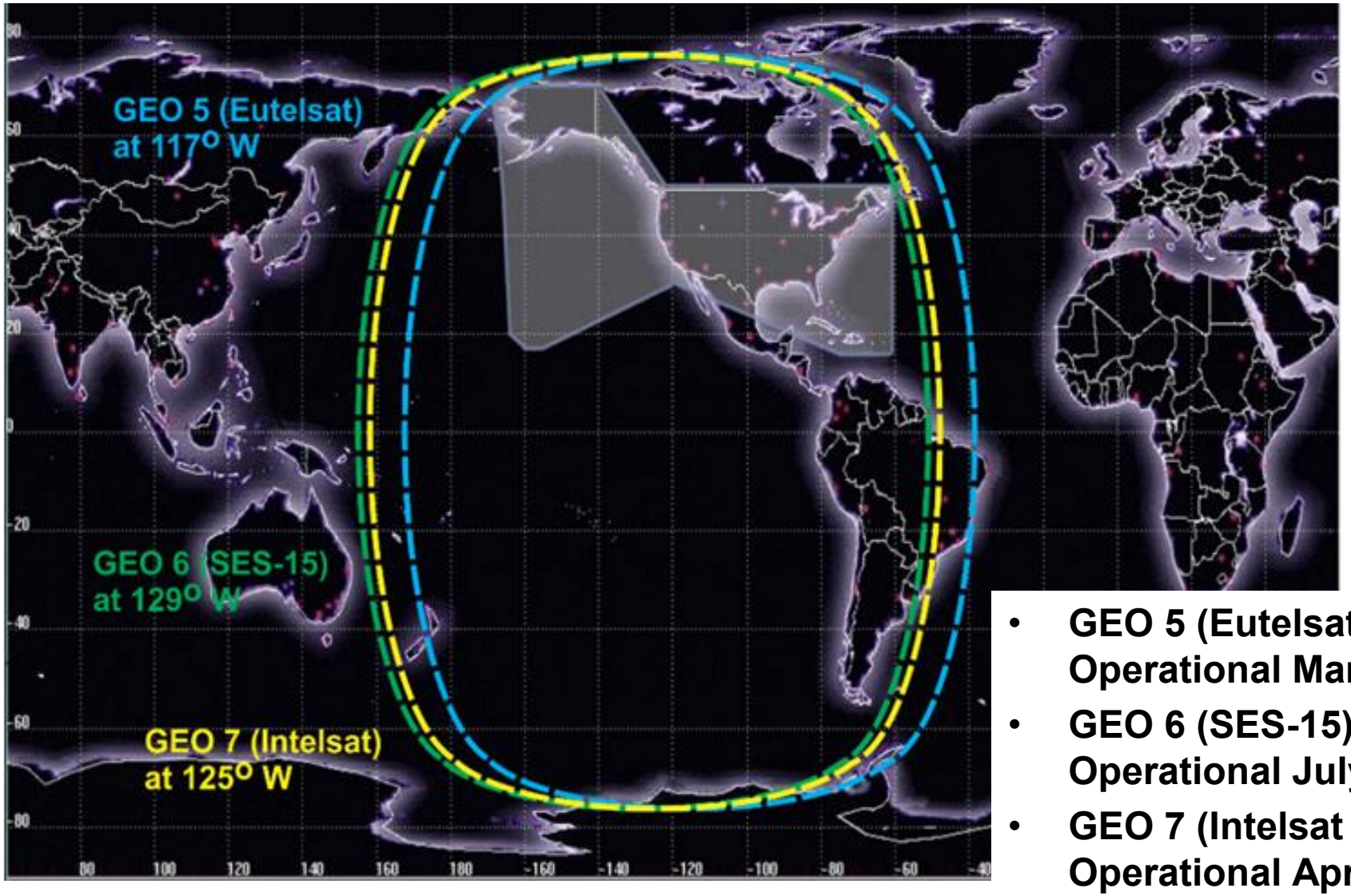


- **As of Sept 2023 there are currently 1,612 ILS procedures while WAAS has 4,861 LPV/LP procedures published**

WAAS Avionics Equipage Status

- **Over 154,952 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), CMC
- **Since 2006, aircraft equipage has increased each year**
- **All classes of aircraft are served in all phases of flight**
- **Enabler for NextGen programs**
  - Automatic Dependent Surveillance Broadcast (ADS-B)
  - Performance Based Navigation (PBN)

WAAS GEO Constellation



- **GEO 5 (Eutelsat 117WB) Operational March 2018**
- **GEO 6 (SES-15) - Operational July 2019**
- **GEO 7 (Intelsat G-30) – Operational April 2022**

Navigation Resiliency

Navigation Resiliency

- **DME/VOR/TACAN [DVT] service is required for the foreseeable future as part of a resilient navigation infrastructure**
- **DME supports continued Area Navigation (RNAV) during GPS service disruptions**
  - NextGen DME Program is adding approximately 123 new DMEs
  - 100 DMEs not needed for PBN may be targeted for discontinuance

Navigation Resiliency (cont')

- **The VOR MON will provide conventional navigation service during unplanned GPS outages in the Contiguous United States (CONUS)**
  - Navigation: new VOR Standard Service Volumes (SSVs) are being published to establish coverage starting at 5,000' Above Ground Level (AGL). This will allow VOR-to-VOR navigation
    - 301 out of the planned 499 facilities have new SSVs
  - Landing: MON airports will support a conventional approach within 100 nautical miles
  - VORs that do not meet criteria are being discontinued. To date, 164 out of the planned 303 VORs have been discontinued
- **ILSs are being retained to support continued operations at the busiest airports during GPS outages**

DVT Sustainment Program

- **Most DVT systems are 30+ years old and becoming unsustainable**
- **VOR MON and NextGen DME Programs do not sustain DVT systems**
- **Procurement contracts are not available to replace VORs or TACANs**
- **A TACAN Antenna procurement planning is underway to address urgent, short-term needs**
- **DVT Sustainment completed Investment Analysis Readiness Decision in September 2020**
- **Anticipated DVT system inventory:**

VOR Single System	VOR/DME	DME Single System	VORTAC	TACAN Single System	LPDME Systems	TOTAL
21	404	96	407	14	677	1619

- **Next Steps**
  - Continue procurement activities for the TACAN Antenna
  - Reach Final Investment Decision

DVT Sustainment Phased Approach

IARD for the Program – Sept. 2020

FID for Phase 1

Strategic

NavAid procurements
New technology
Qualification
Rapid supply chain
Key sites

Tactical

Equipment obsolescence
Facility conditions
Long lead-time repair items
Site assessments

TACAN Antenna

Market Survey

Specification SIR

Contract Award

Testing Qualification

Critical Sites

DVT Planning

Congressional Communications

Specifications Approvals

SIR Development

Vendor Engagement

Prioritization

PHASE 1 ~ 2025–2031



DVT Contract Award (multiphase)

Testing and Qualification

DVT Implementation at Key Sites (first articles)

Planning—FID for Phase 2

TACAN Antennas

In-Service Decision & Deployment

Tactical

Additional identified needs based on Sustainment Analysis

PHASES 2–4 ~ 2031–2047



FID for Phase 2

Implementation at n# Sites based on priorities

Pre-planned Product Improvement

Planning—FIDs for Phases 3–4

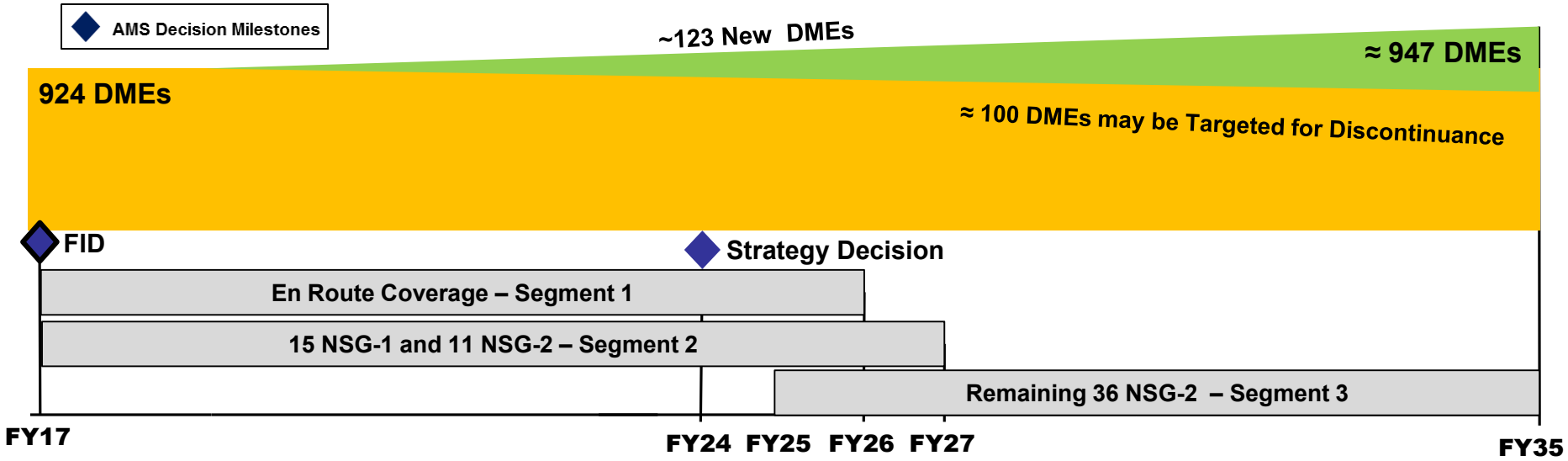
TACAN Antennas

Coupled with DVT Implementations

Tactical

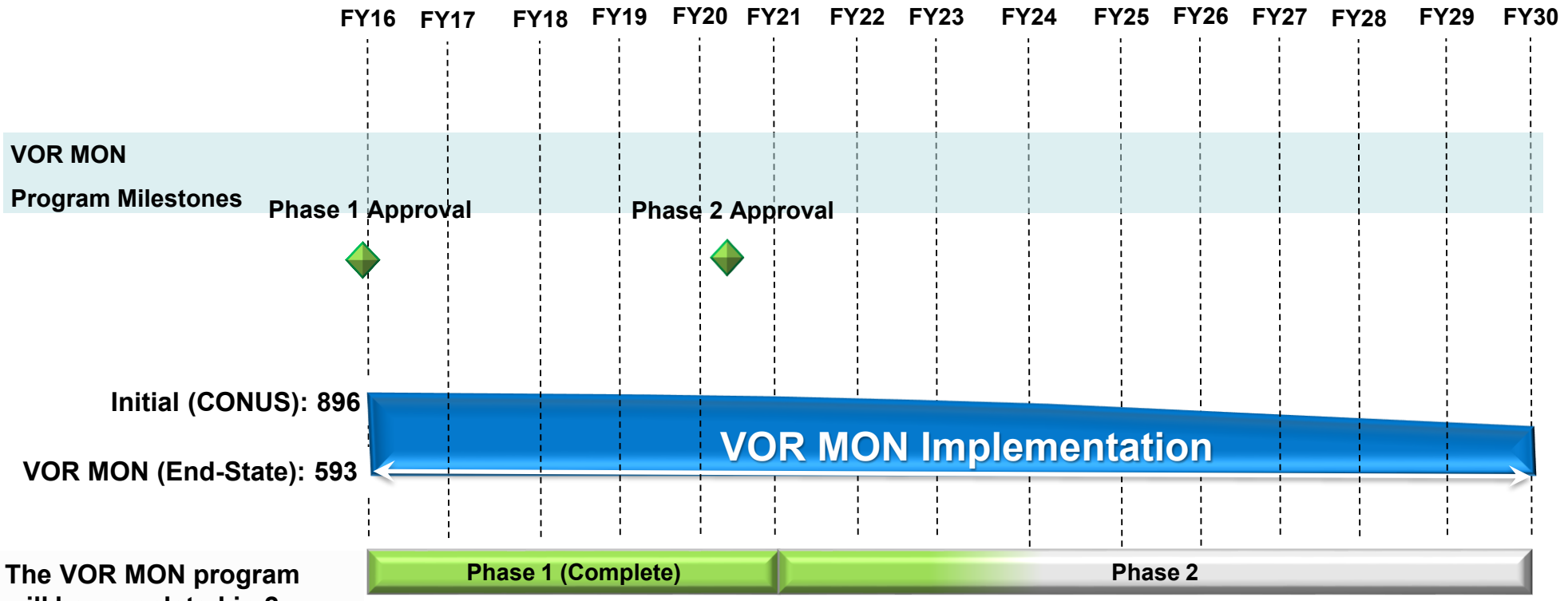
Additional identified needs based on Sustainment Analysis

NextGen DME Program Timeline



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

VOR MON Program Timeline



The VOR MON program will be completed in 2 Phases:

Phase 1: FY16 – FY20
Phase 2: FY21 – FY30

- Published Final Policy FRN: *"Provision of Navigation Services for the Next Generation Air Transportation System (NextGen) Transition to Performance Based Navigation (PBN) - 07/26/2016*
- Removed, Replaced, Amended affected Instrument Flight Procedures (IFPs)
- Discontinued 82 VORs

- Received Phase 2 Program Approval - *03/18/2020*
- Continue IFP work
- Plan to discontinue approximately 221 VORs
  - As of 8/10/2023, discontinued 82 VORs

TACAN Minimum Operational Network (MON) Concept

- **Retain TACANs needed for instrument approach procedures (IAP) and feeder routes at military and civil airports needed for safe recovery during outages.**
- **Significant numbers of military airports have closed reducing the need for TACANs**
- **Expanding the TACAN service volume enables additional TACANs to be removed**
- **Approximately 122 of 407 existing TACAN sites are being assessed for removal**

TACAN MON Status

- **Draft Program Plan is being coordinated with Public Board on Federal Aviation (PBFA)**
  - Plan will form basis for Memorandum of Agreement (MOA)
- **Continuing development of new TACAN standard service volume (SSV)**
  - Expands coverage so fewer TACANs will be needed to provide required coverage
- **FAA Joint Resource Council recommends a similar approach to VOR MON**
  - Variable Quantity 2 (VQ2) Acquisition Category (ACAT)
  - Investment Analysis Readiness Decision (IARD)
  - Final Investment Decision (FID)
- **Developing artifacts required for investment decision**

TACAN MON Next Steps

- **Continue development of new TACAN service volume**
  - Analyze flight check data to validate new TACAN Standard Service Volume (SSV)
  - Address SSV integration with NASR and avionics databases
  - Support analysis of TACAN coverage with new SSV to identify candidates for discontinuance
- **Begin coordination and vetting between FAA and DoD of individual TACAN candidates for discontinuance**
- **Develop project work plan to discontinue unneeded TACANs**
  - Integrate with VOR MON and NextGen DME program schedules for flight check and implementation of new SSV

Instrument Landing System (ILS) Approach Strategy

- **Retain existing Category I, II, and III ILSs at airports where commercial aircraft operate.**
- **Publish RNAV(GPS) charts with Localizer Performance with Vertical guidance (LPV) minimums to satisfy new requirements for Category-I vertically guided approach service**
  - 4,861 LPVs currently published
  - Design criteria changes add additional qualifying runways for LPV
- **ILS, LOC, or VOR approaches will be retained at MON airports to support recovery during GPS outages**
- **Rationalize Category-I ILSs at small airports where most aircraft are equipped to fly LPV**
- **Redundant NDB and VOR approaches will be cancelled**

Status for ILS Rationalization

- **The FAA Joint Resources Council (JRC) approved proceeding with strategy in Dec 2022**
  - Approval is to conduct stakeholder outreach and analysis rather than approving initial rationalization criteria
  - JRC approval will be required for proceeding further with rationalization criteria
- **Approach for stakeholder outreach was briefed to the FAA Management Board in February 2023**
  - Focus is on conducting more stakeholder outreach and analysis rather than approving initial rationalization criteria

ILS Rationalization Next Steps

- **Brief FAA Airport District Offices (ADOs)**
  - Review objectives, timelines, and process to establish the ILS Rationalization policy and address concerns
- **Engage with Airport managers and industry groups**
  - Inform program strategy and solicit feedback
- **Develop Proposed Policy Federal Register Notice (FRN) for internal coordination and public comment**
  - Assess stakeholder readiness based on internal and public comments
- **Based on stakeholder input, seek FAA Joint Resource Council (JRC) approval to initiate a program**
- **IF the JRC approves ILS Rationalization as a program, then FAA will proceed in accordance with JO 7400.2, Procedures for Handling Airspace Matters**

Summary

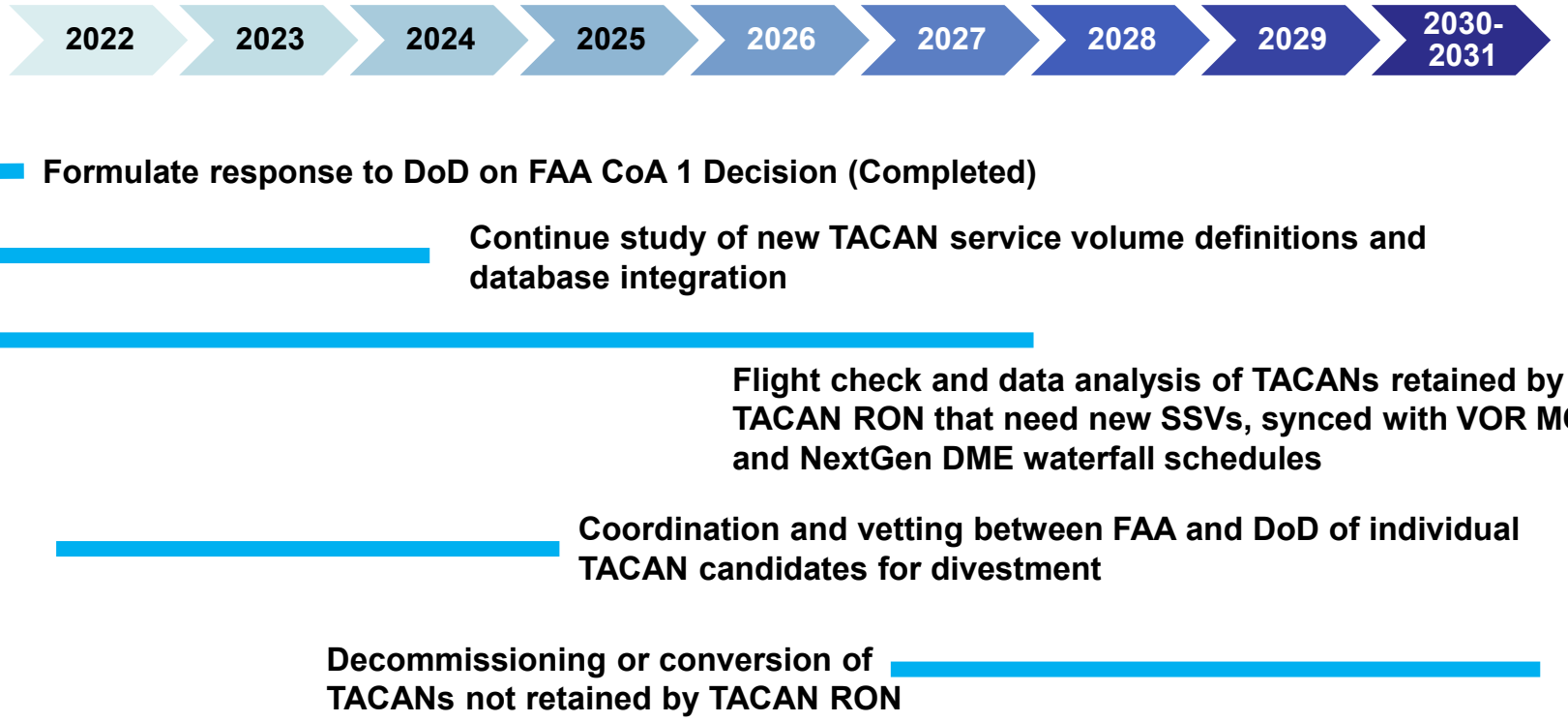
Summary

- **FAA is supporting GPS Modernization and coordinated efforts around National Policy**
- **WAAS is implementing dual frequency service and addressing obsolescence of components**
- **FAA continues to support Cat I GBAS operations**
- **Resiliency**
  - DME/VOR/TACAN (DVT) Sustainment Program is planning for Final Investment Decision in November 2023
  - NextGen DME Program implementation is underway
  - VOR MON program – 301 VORs have new SSVs and 164 VORs have been discontinued
  - TACAN MON Program Planning is in early stages and being coordinated with DoD PBFA
  - ILS Rationalization Strategy for communication and outreach was approved by the FAA Management Board in February 2023

Questions?

BACKUP

TACAN MON Notional Timeline



ILS Rationalization
Communication & Outreach

- **Internal Stakeholder Coordination**
  - Aviation Safety (AVS), AFS-400, AIR-100
  - Airports (ARP)
    - Airport District Offices and Regional Managers
  - Aviation Policy Office (APO)
  - Air Traffic Organization (ATO)
    - Mission Support Services (AJV) Operations Support Groups (OSGs),
    - Flight Procedure Team (FPT), Aeronautical Information Services (AIS)
    - Flight Operations (AJF), Technical Operations (AJW)
  - DoD Policy Board for Federal Aviation (PBFA)
- **External Outreach**
  - NBAA, A4A, RAA, AOPA, NAC, ACI-NA, NASAO, AAAE, ACC, etc.
  - Congress, DoD, and the OEMs