

FAA Navigation Programs Update

Presented to: Civil GPS Service Interface Committee

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Date: September 2022



Federal Aviation
Administration



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 Resilient Operational Network (RON)
 - Instrument Approach Strategy
- **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 Resilient Operational Network (RON) for military
- **Innovate navigation services to enable new capabilities**
 - Support Multi-Constellation GNSS and Advanced RAIM (ARAIM)
 - Continue transitioning Approach Lighting Systems (ALS) to LED technology
- **The Navigation Programs Strategy update published in June 2022**

GPS Civil Update

GPS Modernization Support

- **FAA supporting National PNT Engineering Forum (NPEF)**
- **Supporting implementation of OCX**
 - Civil Signal Monitoring
 - L5 and civil signals navigation messages
 - Supporting safety assessment for GPS RAIM (P_{const})
 - Signal monitoring to detect anomalies in a timely manner
 - Pre-check to verify satellite uploads prior to implementation
- **Supporting Position Signal Integrity Continuity Assurance (PSICA) activities with DOD to improve reliability**
- **Reimbursable agreement with Air Force Research Lab (AFRL) for the Navigation Test Satellite (NTS) 3**

National PNT Policy



- **National Timing Resiliency and Security Act (NTRSA) 2017**
 - Requires DOT to establish, sustain, and operate a complementary backup timing system if GPS timing signals are corrupted or otherwise unavailable
- **National Defense Authorization Act (NDAA) 2017 and 2018**
 - Requires demonstrations of Complementary PNT technologies that could provide resiliency during GPS outages
 - Develop requirements and analysis of alternatives for complementary PNT
 - Navigation Programs supports DOT by providing technical expertise
- **Executive Order (E.O. 13905), February 12, 2020**
 - Protects the reliable and efficient functioning of National critical infrastructure from disruption due to jamming and spoofing of GPS
- **Space Policy Directive 7 (SPD-7), January 15, 2021**
 - Establishes National PNT governance and the implementation of E.O. 13905 plan to reduce the vulnerability of critical infrastructure from GPS disruptions

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

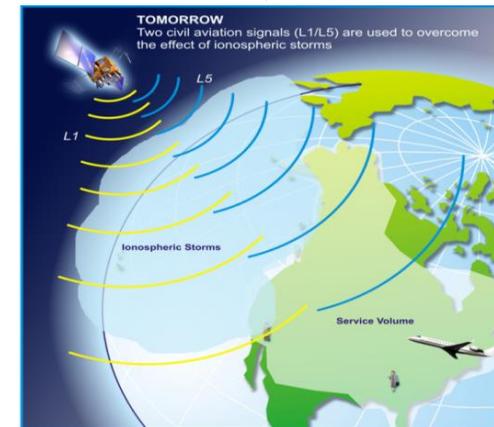
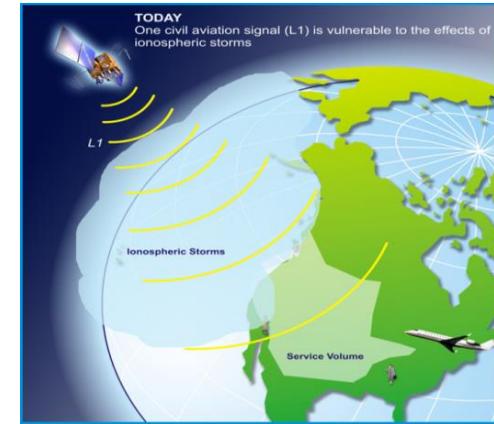
Support to National Space Policy

- **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, and requires implementation of data and signal authentication for GPS and WAAS
 - FAA investigating data and signal authentication for WAAS to mitigate interference
 - FAA supporting DOT interference detection and mitigation initiatives in protection of radio frequency environment for uninterrupted GPS PNT signal reception
 - FAA investigating the use of WAAS Reference Stations to perform RFI detection using COTS components

WAAS UPDATE

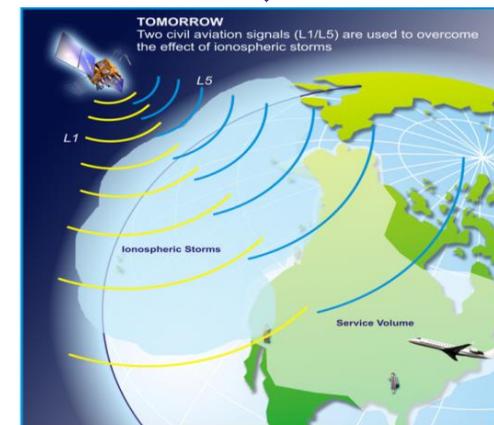
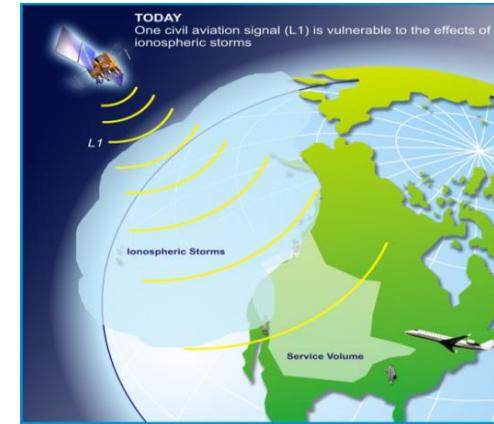
WAAS Phase 4 Status

- **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 will integrate GEO 7 into WAAS and integrate new signal generators at ground uplink stations (GUS) to include retrofitting at legacy GUS sites. GEO 7 projected to be operational by June 2022.
- **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



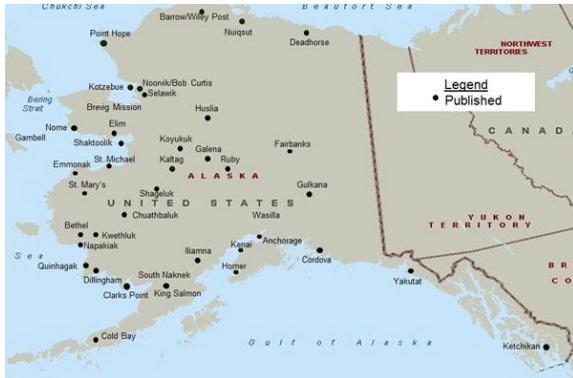
WAAS Phase 4 Dual Frequency Operations (DFO) Status (cont')

- **Dual-Frequency Multi-constellation Capability (DFMC)**
 - Standards development progressing
 - GPS L5 and DFMC SBAS SARPs material was prepared for Navigation Systems Panel and approved November 2020
 - RTCA and EUROCAE working a joint DFMC SBAS MOPS, expect to complete in 2022
 - 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
 - FAA focusing on development of initial requirements for horizontal navigation (H-ARAIM)

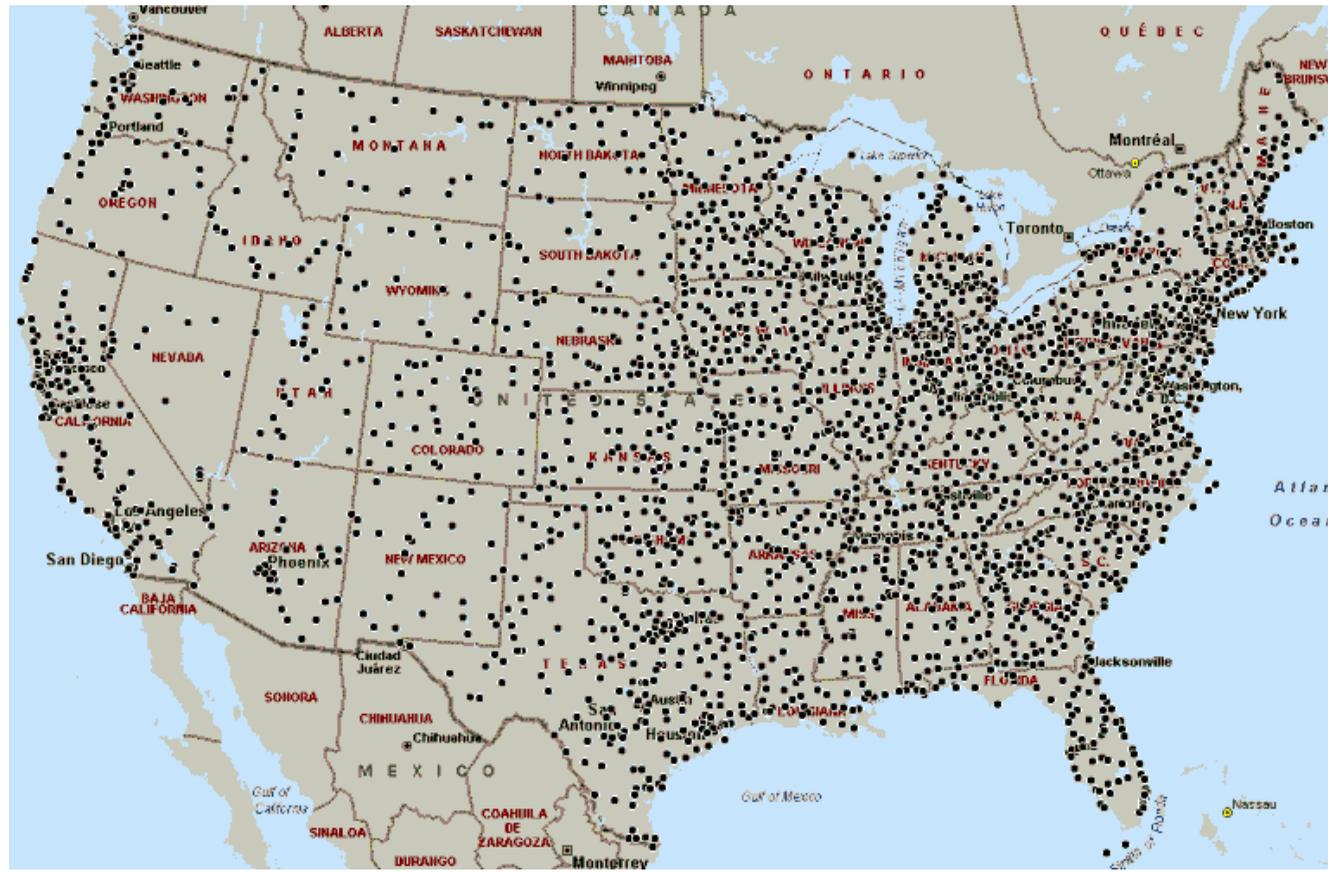


Airports with WAAS LPV/LP Instrument Approaches

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



- As of Sept 2022 there are currently 1,612 ILS procedures while WAAS has 4,825 LPV/LP procedures published



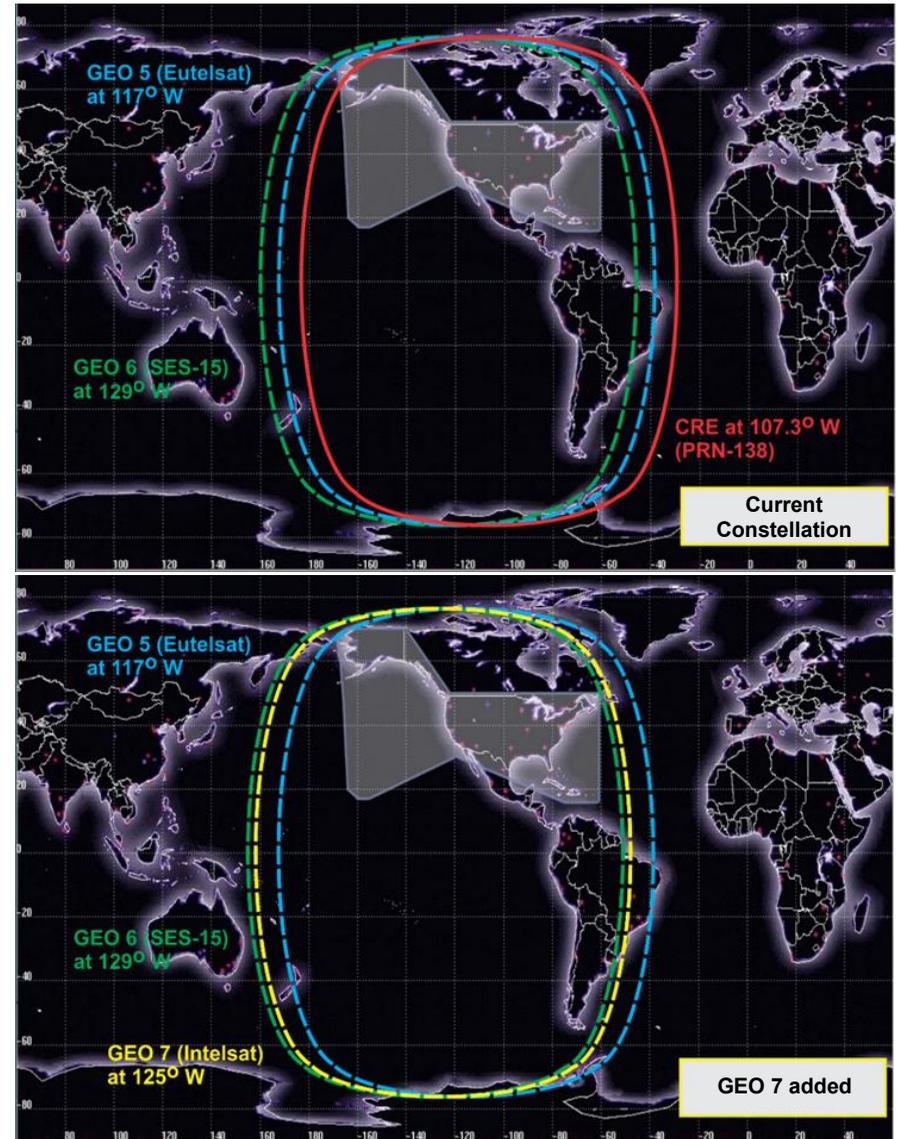
WAAS Avionics Equipage Status

- **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
- **GEO 7 Integration**
(integration of ground segment with the GEO)
occurred in June 22



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 are 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
 - 130 out of the planned 491 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, 135 out of the planned 306 VORs have been discontinued
- **ILSs are being retained to support continued operations at the busiest airports during GPS outages**

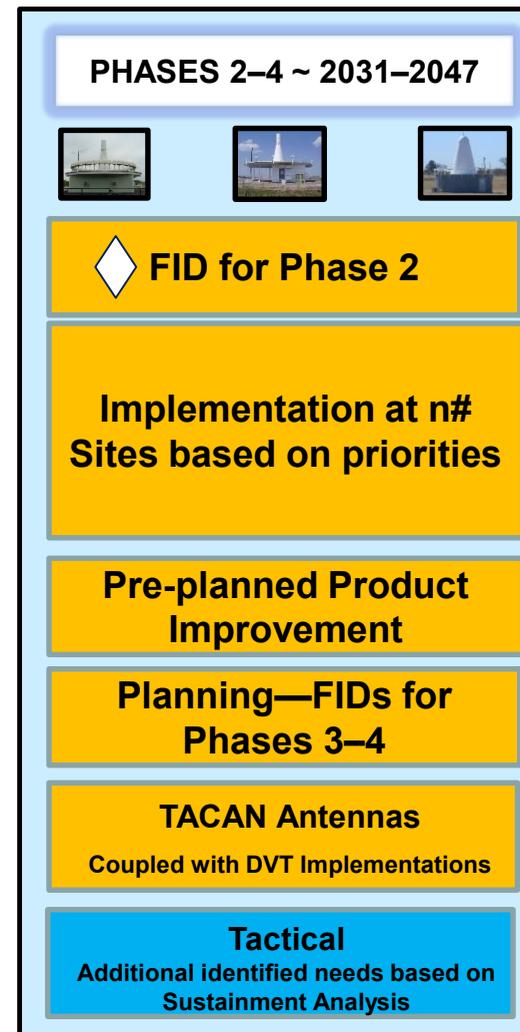
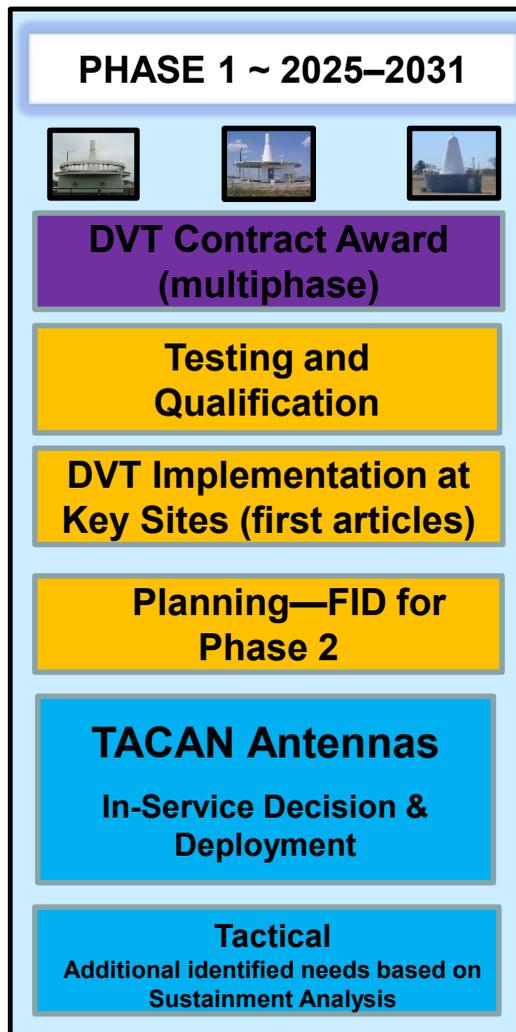
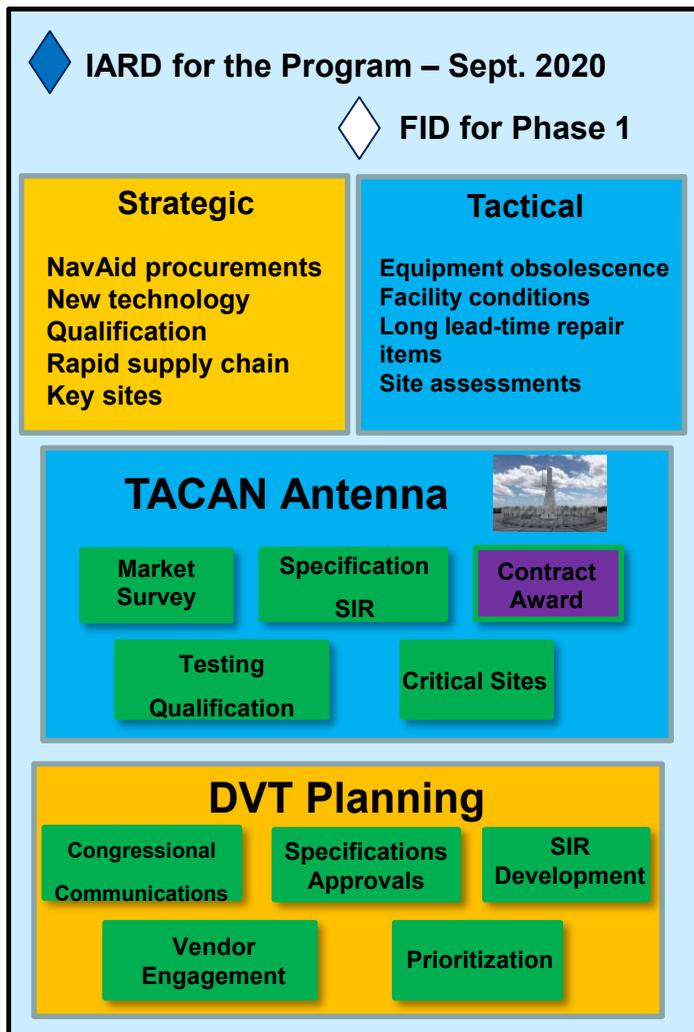
DVT Sustainment Program

- 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:

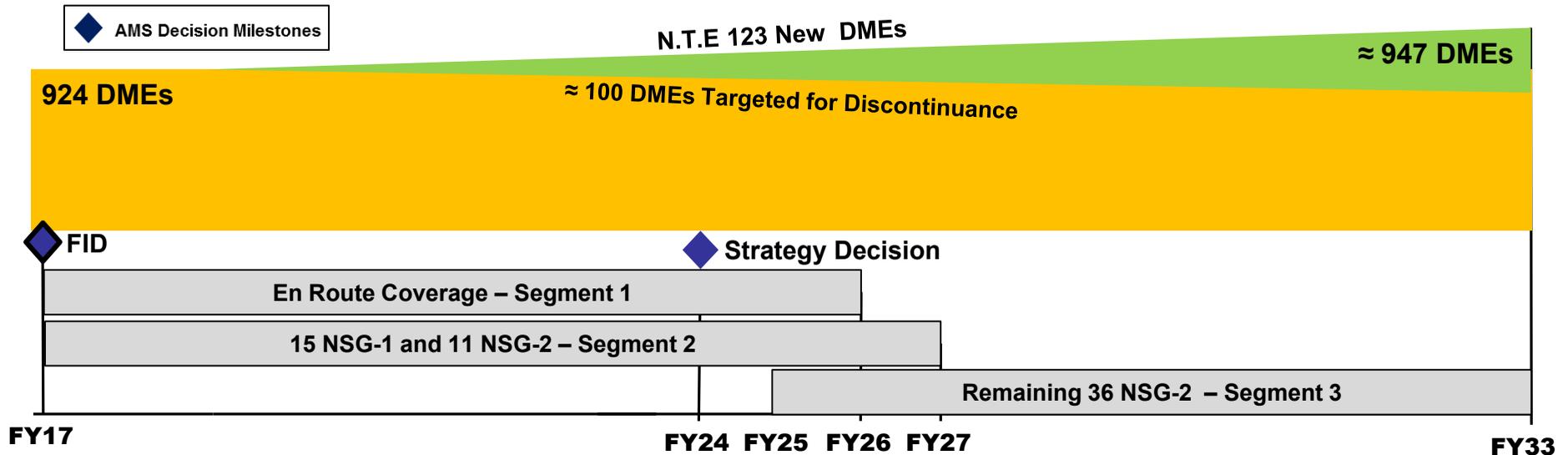
VOR Single System	VOR/DME	DME Single System	VORTAC	TACAN Single System	LPDME Systems	TOTAL
21	404	96	407	14	677	1619

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

DVT Sustainment Phased Approach

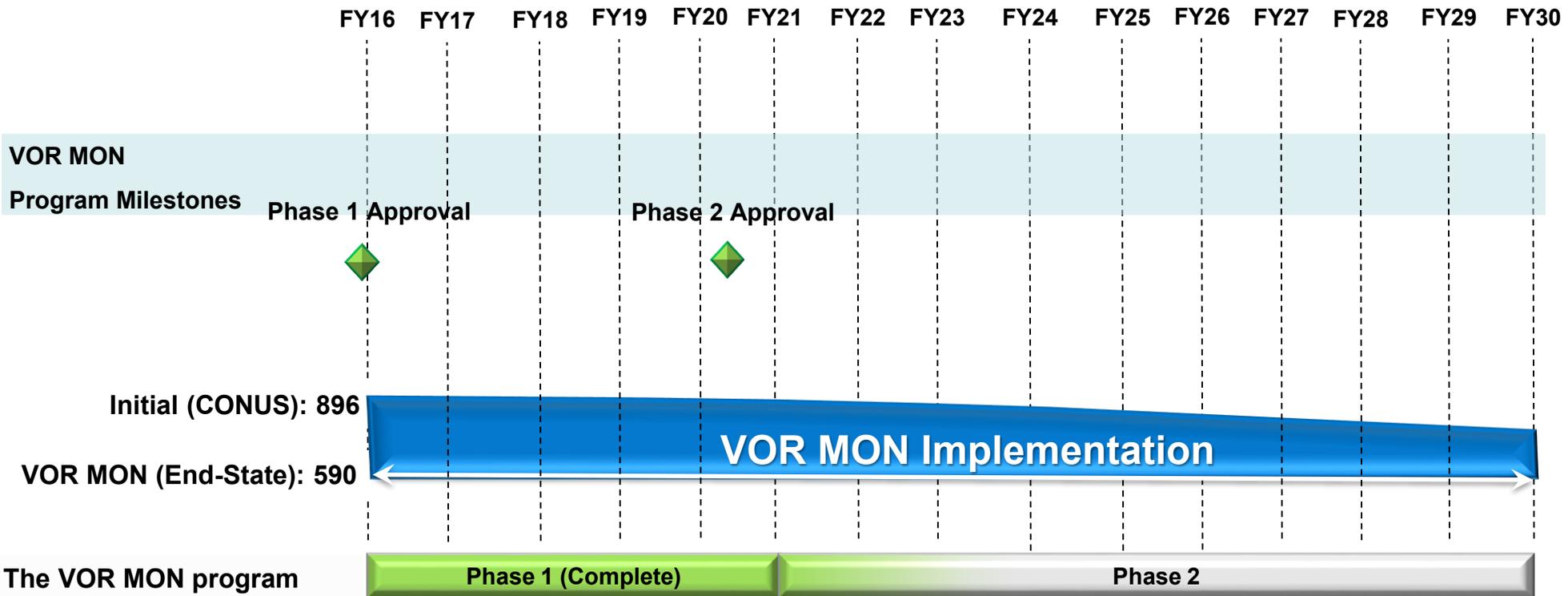


NextGen DME Program Timeline



- **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 224 VORs
 - As of 9/9/2022, discontinued 53 VORs

TACAN Resilient Operational Network (RON)

- **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 can be removed to establish the MON**

Instrument Approach Strategy

- **Retain existing CAT-II/III ILSs for commercial aircraft**
- **Publish RNAV(GPS) charts with LPV minimums to satisfy new requirements for CAT-I vertically guided approach service**
 - 4092 LPVs currently published
 - LPVs will be published at all qualifying runways
 - Design criteria changes add additional qualifying runways for LPV
- **VOR MON replacing conventional routes and procedures as VORs are discontinued**
- **Category-I ILS, LOC, or VOR, approaches will be retained at MON airports to support recovery during GPS outages**
- **Redundant NDB and VOR approaches will be cancelled**

Summary

Summary

- **FAA is supporting GPS Modernization and coordinated efforts around National Policy**
- **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 (DVT) Sustainment Program is planning for Final Investment Decision in September 2023
 - NextGen DME Program implementation is underway
 - VOR MON program – 130 VORs have new SSVs and 135 VORs have been discontinued
 - TACAN Rationalization Course of Action has been coordinated with DoD PBFA and is in early stages of planning
 - ILS Rationalization has been on hold; Strategy Decision to be revisited in December 2022

Questions?

BACKUP