

Navigation Programs Update

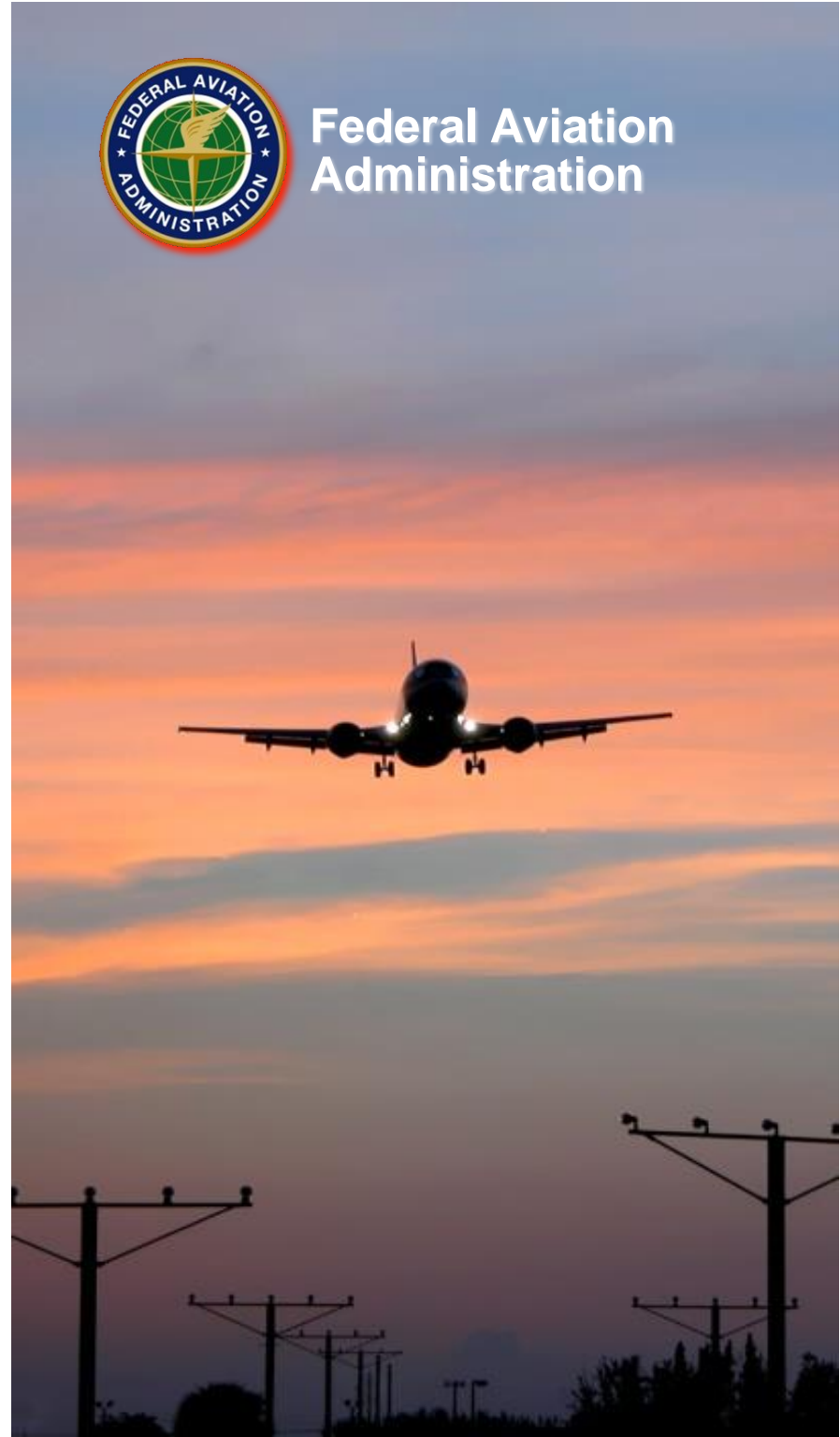
Presented by: Deborah Lawrence

**Presented to: Civil GPS Service Interface
Committee**

Date: September 2015



**Federal Aviation
Administration**



Agenda

- **Performance Based Navigation (PBN) NAS Strategy**
- **NAV Strategy Update**
 - OVERVIEW
 - WAAS Update
 - GBAS Update
- **RESILIENCY**
 - APNT
 - NEXTGEN DME
 - ILS Rationalization Decision
 - VOR MON Program Update
- **Summary**

PBN NAS Strategy

PARC / Ad Hoc PBN Strategy Meeting

- **Timeline**

- The draft PBN Strategy was provided to the RTCA NextGen Advisory Committee (NAC) on June 5, 2015
 - Given the action to circulate the PBN Strategy with aviation industry
- Conducted an Ad Hoc meeting with the Performance-based Operations Aviation Rulemaking Committee (PARC) from August 18-20, 2015
 - The PARC will break into smaller groups to work through six areas of comments
 - A meeting is scheduled for December 7, 2015 for final document review

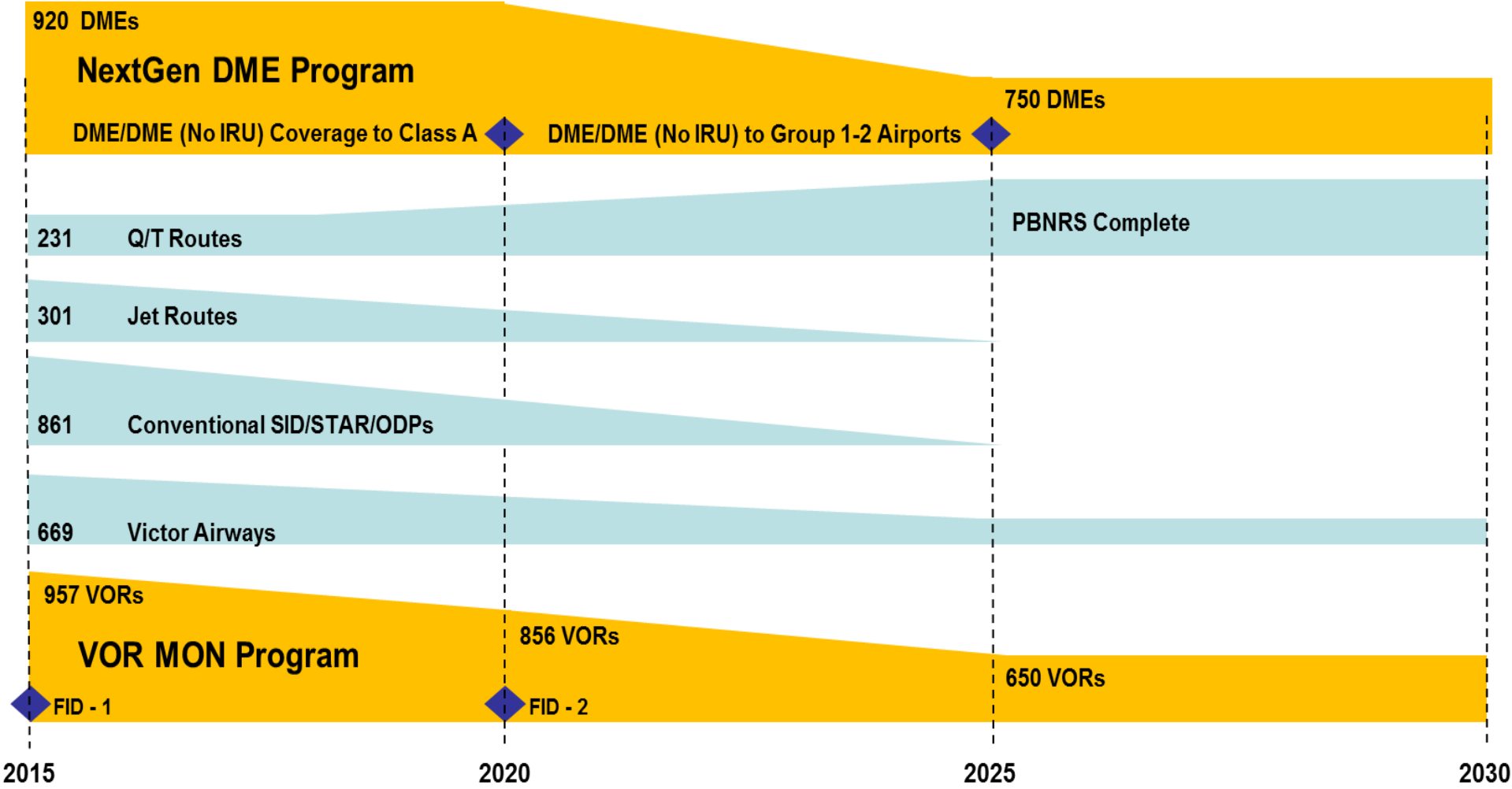
- **Navigation Programs action:**

- To Lead the Resiliency Work Group
 - Provide More Information on NextGen DME

PBN Service	NSG 1	NSG 2	NSG 3	NSG 4	NSG 5
RNAV (GPS) with LNAV minima	Required	Automatically qualifies			
RNAV (GPS) with LP minima	Only if does not qualify for LPV				
RNAV (GPS) with LNAV/VNAV minima	Required (aircraft must be able to fly LNAV/VNAV or LPV)	Automatically qualifies			
RNAV (GPS) with LPV minima	Required (aircraft must be able to fly LNAV/VNAV or LPV)	Automatically qualifies			
RNAV (RNP) to RWY XX (0.3 or lower needed)	Based on proximity to terrain, obstacles, SUA, or airspace/procedure considerations				
RNAV (GPS) to RWY XX (RF required outside FAF)	May require RF	Based on proximity to terrain, obstacles, SUA, or airspace/procedure considerations			
RNP STAR	Required (replaces RNAV STARS)	Curved path (RF leg) to avoid terrain, obstacles or airspace/procedure considerations May automatically qualify in later timeframe	Curved path (RF leg) to avoid terrain, obstacles or airspace/procedure considerations	X	X
RNP SID	Required (replaces RNAV STARS)	Curved path (RF leg) to avoid terrain, obstacles or airspace/procedure considerations May automatically qualify in later timeframe	Curved path (RF leg) to avoid terrain, obstacles or airspace/procedure considerations	X	X
RNP segment to xLS (hybrid) (description: RNP transition as part of an ILS approach procedure)	Required	Where shorter final would be available given EoR criteria and ATC acceptability (need tools to support)		TBD. It's expected that there will be a few qualifying airports	X
RNAV STARS	Uses RNP instead	Automatically qualifies	Based on proximity to a Group 1 or 2 airport with high traffic volume, or based on terrain requirement		
RNAV SIDs	Uses RNP instead	Automatically qualifies	Based on proximity to a Group 1 or 2 airport with high traffic volume, or based on terrain requirement		
ILS (Cat I)	Automatically qualifies		No new ILS (Cat I)		Only provided for VOR MON safe landing airport
ILS (Cat II, III)	Meets APS1 criteria (considers operations and weather)		X		X
LOC only approach	Only if ILS does not qualify for vertical		X		X
VOR approach	Only maintained if there is no ILS and is also a VOR MON safe landing airport				
GLS	Details need to be discussed by a working group				

Navigation Strategy

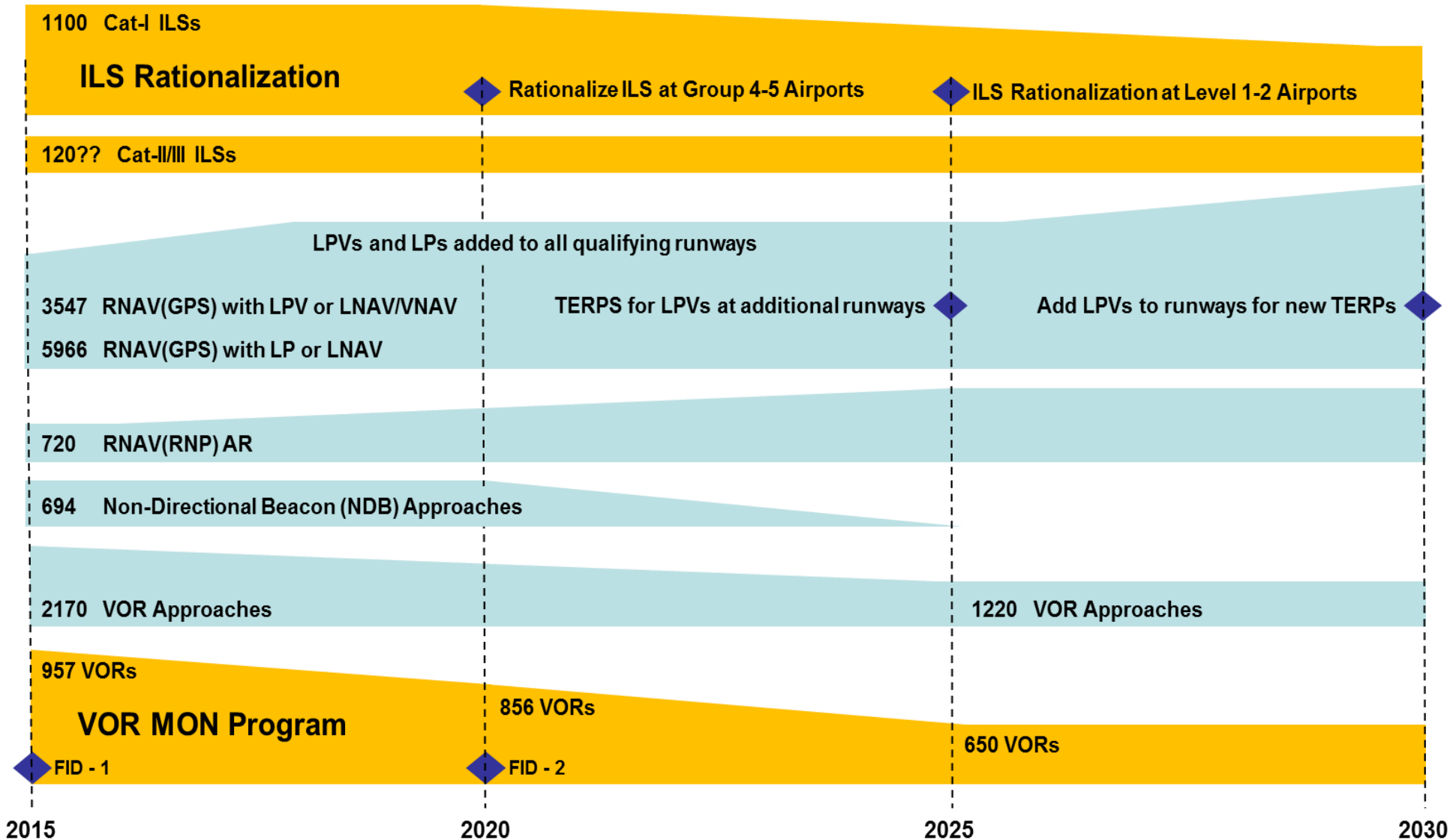
En Route and Terminal Strategy



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 Group 1-2 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/STAR will be cancelled
 - PBN SID/STAR/ODPs will be implemented

Approach Strategy



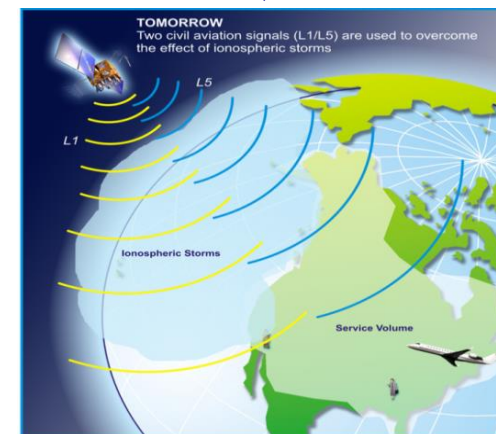
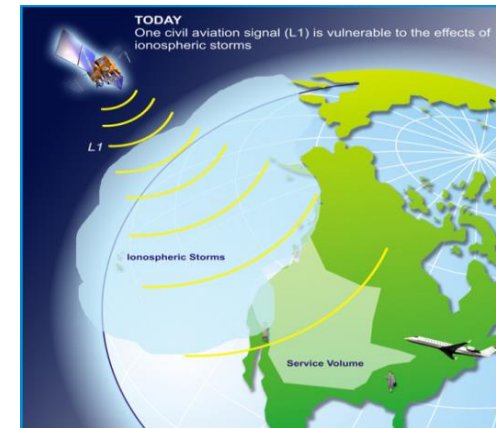
Instrument Approach Strategy

- **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
 - To provide for SA CAT I Enhanced Low Visibility Operations (ELVO) where beneficial
 - The remaining CAT I ILSs will 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**

WAAS UPDATE

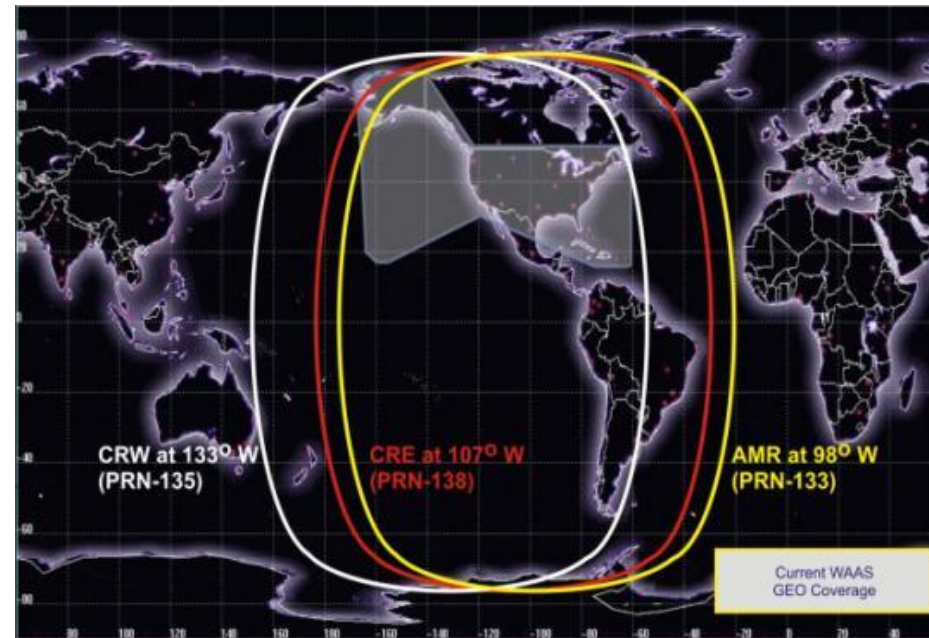
WAAS Phase IV - Dual Frequency Operations (2014-2044)

- **Final Investment Decision for Phase IV Segment 1 (2014-2019) Dual Frequency Operations (DFO) approved**
 - Segment 1 - Develop infrastructure improvements to support L5 & Tech Refresh
 - Segment 2 - 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)**
- **Future considerations**
 - Dual-Frequency Multi-constellation Capability
 - International Focus is on taking advantage of other GPS like constellations
 - International Civil Aviation Organization (ICAO) Navigation Systems Panel (NSP) has developed work plan that supports development of future standards for use of other Global Navigation Satellite Systems (GNSS)
 - ICAO working on CONOPS addressing all DFMC applications (e.g. SBAS, GBAS)
 - 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



WAAS GEO Activities

- **Current WAAS GEO satellites**
 - Intelsat Galaxy XV (CRW)
 - Anik F1R (CRE)
 - Inmarsat I4F3 (AMR) *
- **GEO 5/6 Contract awarded 2012**
 - GEO 5
 - Payload development complete
 - Launch planned late 2015
 - Signal generation system /radio frequency uplink integration 2016
 - Expected Operational in 2017
 - GEO 6
 - Authorization to proceed awarded March 2015,
 - Preliminary design review (PDR) completed June 2015
 - Critical Design Review (CDR) expected Spring 2016
 - Expected Operational in 2019



• *AMR ranging only supports horizontal navigation

WAAS Technology Refresh

- **G-III Receiver Upgrade**
 - Technology update of existing WAAS Reference Receiver, capable of processing all GPS frequencies (Enables Dual Frequency capability)
 - First G-III unit installed September 4th, 2015
 - Complete fielding in FY2016

- **Safety Computer (SC)**
 - Adds significant new capability and support to WAAS dual frequency upgrades
 - SC Unit Application Demonstration initiated, expect completion by end of CY2015
 - Delivery of first production units spring 2016

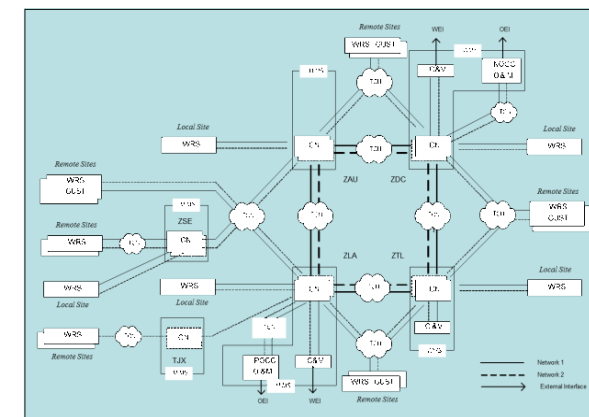
- **WAAS Terrestrial Comm Network (TCN) modernization**
 - Upgrade of Core Nodes, Operational Control Centers, and Networks Complete
 - Upgrading routers at all WRS locations (Domestic and International)
 - First sites installed, currently validating service
 - Expect complete installation and cutover at ALL WRS groups by 3rd Qtr FY2016



•WAAS G-III Receiver

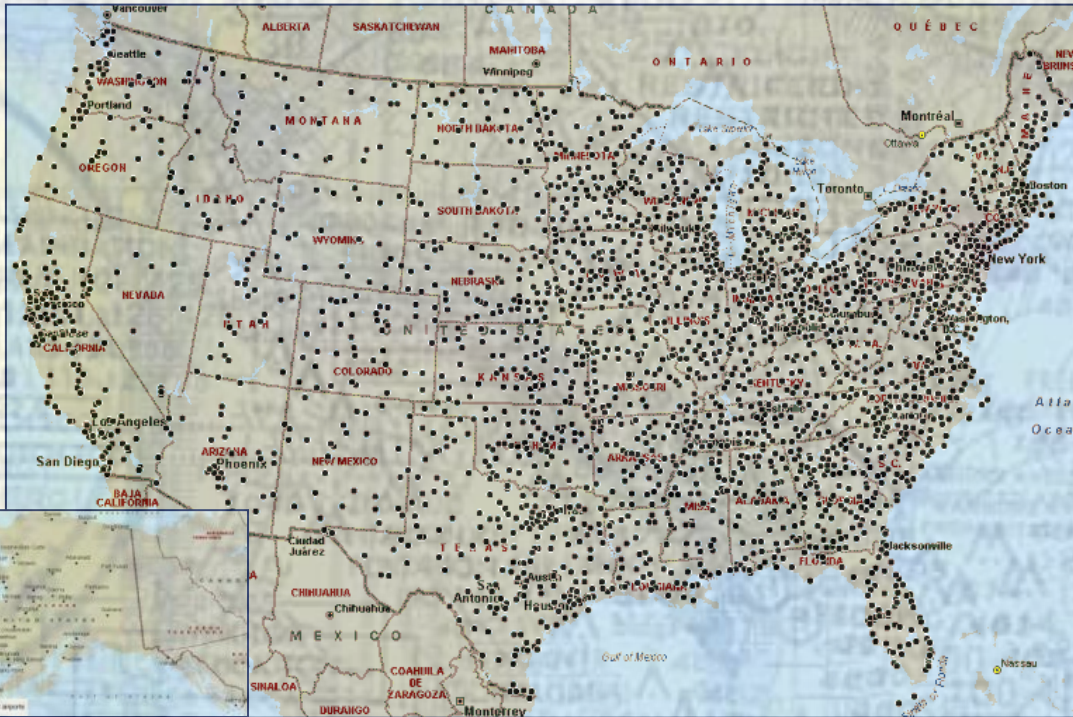


•Safety Computer



•WAAS Terrestrial Communications Network

• Procedures & Users Depending on WAAS



• Procedures

- Currently 4,162 WAAS Procedures published
 - 3,568 LPV criteria
 - 594 LP criteria



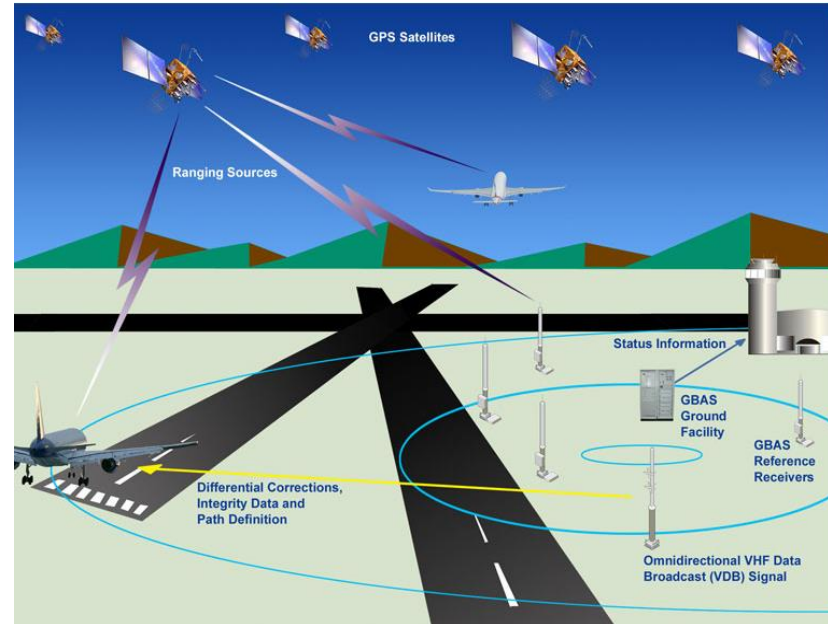
- **Approximately 84,000 WAAS equipped aircraft in the NAS**
 - WAAS receivers provided by companies such as: Garmin, Universal, Rockwell Collins, Honeywell, Avidyne, Innovative Solutions & Support (IS&S), Thales and Genesys Aerosystem (Chelton)
- **Since 2006, aircraft equipage rates has increased each year**
- **All classes of aircraft are served in all phases of flight**
- **Enabling technology for NextGen programs**
 - Automatic Dependent Surveillance Broadcast (ADS-B)
 - Performance Based Navigation (PBN)



GBAS UPDATE

Ground Based Augmentation System 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 (i.e. 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



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)
 - Goal date for Final Close of Validation/Final SARPS acceptance – December 2015
- **System Design Approvals (SDA) for GAST-C Block II and GAST-D systems**
 - SDA for GAST- C Block II update expected Oct 2015 (Modification of the previously approved SLS-4000 Block I configuration intended to enhance availability)
 - SDA for GAST – D expected 2019
- **CAT I implementation support**
 - Newark NJ, Houston TX, Moses Lake WA performance monitoring/service prediction
 - Coordination of user/airlines GBAS activities
- **International Coordination**
 - International GBAS Working Group (IGWG)
 - ICAO, SESAR, International MOUs (Brazil, Australia, etc.)
 - FAA GBAS Implementation Status

RESILIENCY

APNT Update

Alternate Position, Navigation, and Time (APNT)

- The 2015 PBN NAS Strategy recommends deferring APNT research to the 2025-2030 time frame (Far-Term)



- ❖ Leverage existing technology and system
- ❖ Least Impact on Avionics
- ❖ Evaluating technology opportunities

- ❖ Aircraft Use Own-ship Position for Navigation
- ❖ Potential leverage of planned and existing technology and ground infrastructure
- ❖ Some impact on Avionics

- ❖ Unlimited Capacity
- ❖ No existing FAA Standards
- ❖ Highest impact on Avionics
- ❖ Long lead time in implementation

Transitioning to concept phase within NextGen Office

NextGen DME

NextGen DME Overview

- **Navigation Programs has determined 3 options to accomplish the NextGen DME program to provide DME coverage for RNAV operations**
 - PBN Strategy: 100% Class A + 73 Group 1-2 Airports
 - Alternative 1: 99% Class A + 64 Group 1-2 Airports
 - Alternative 2: 99% Class A + 12 Group 1 Airports

Draft Program Schedule

FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27
			Program Planning <ul style="list-style-type: none"> •Establish New DME Standard Service Volume (SSV) •DME Capacity & Interrogation Analysis •Requirements Analysis 									
			Investment Analysis	Acquisition Decision								
			Phase 1 – Implementation DME/DME (No IRU) Coverage in Class A									
			Phase 2 – Implementation DME/DME (No IRU) at Group 1-2 Airports									

ILS Rationalization Decision

Overview

- **ILS, LPV, and LNAV/VNAV all provide vertically guided approach service to airports in the NAS**
 - Not all users are equipped for all procedures
- **Rationalize the need for Instrument Landing Systems (ILS) and associated procedures**
 - Performance Based Navigation NAS Strategy – 2015
 - NAS Enterprise Architecture Roadmap
 - 2016 ILS Decision Point
 - ICAO Working Paper, *Rationalization of Terrestrial NAVAIDS*
- **Navigation Program has begun to circulate draft Criteria and Communication plan**
 - Expect stakeholder concurrence by September 18, 2015

Draft 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

Draft Criteria (2 of 2)

- Proximity of airport with similar approach service
- Capacity of airports in proximity
- Capacity of ATC sectors providing air traffic services to airports considered for continuance of ILS service

• 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

Summary

- **The Performance Based Navigation (PBN) NAS Strategy is adjudicating industry comments.**
 - Targeted Completion Date: December 7, 2015
- **Navigation Programs is updating the NAV Strategy**
 - WAAS is replenishing GEOs, Performing Tech Refresh
 - GBAS feasibility for CAT II/III targeted 2019
 - VOR MON target for FID in September 2015
 - ILS Rationalization Team will provide recommendation on CAT I ILS, 2016
- **Nav Program Resiliency**
 - APNT will Transition to NextGen Office for R&D activities
 - Navigation Program will proceed with Investment Decision for NextGen DME

Questions

PBN Strategy Implementation Plan

- **Class A over CONUS coverage 18,000 MSL and above 100% availability**
- **73 Group 1 and 2 Airports Covered**

En Route DME	FY2018	FY2019	FY2020	FY2021	FY2022	FY2023	FY2024	FY2025	FY2026	FY2027	Total
Existing Site	10	2									12
Airport		20	30	30	15						95
Green Site						10					10
Phase 1 Total	10	22	30	30	15	10	0	0	0	0	117
											0
Terminal DME											0
Existing Site	10	18	10	10	10	10					68
Airport					17	21	41	41	30	10	160
Green Site								0	11	31	42
Phase 2 Total	10	18	10	10	27	31	41	41	41	41	270
											0
Grand Total	20	40	40	40	42	41	41	41	41	41	387
											0
DME Discontinuance				35	55	60	60	70	70	70	420

PBN Strategy Program Schedule

FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27
	Program Planning		<ul style="list-style-type: none"> •Establish New DME Standard Service Volume (SSV) •DME Capacity & Interrogation Analysis •Requirements Analysis 									
	Investment Analysis		Acquisition Decision									
		Phase 1 – Implementation										
		DME/DME (No IRU) Coverage in Class A										
		Phase 2 – Implementation										
		DME/DME (No IRU) at Group 1-2 Airports										

Alternative 1: Implementation Plan

- **Class A over CONUS coverage 18,000 MSL and above 99% availability over the WUSMA**
- **64 Group 1 and 2 Airports Covered**

En Route DME	FY2018	FY2019	FY2020	FY2021	FY2022	FY2023	FY2024	FY2025	Total
Existing Site	5								5
Airport		10	10	10	7				37
Green Site						8			8
Phase 1 Total	5	10	10	10	7	8	0	0	50
									0
Terminal DME									0
Existing Site	10	10							20
Airport			20	20	20	20	20	5	105
Green Site					3	2	10	5	20
Phase 2 Total	10	10	20	20	23	22	30	10	145
									0
Grand Total	15	20	30	30	30	30	30	10	195
									0
DME Discontinuance		40	60	64	70	70	70	70	444

VOR MON Update

Requested Baseline Schedule

4VQ Milestones	4VQ Date	4VQ Duration
Work Package 1: 5 VORs	October 2015	12 Months
Work Package 2: 10 VORs	October 2016	12 Months
Work Package 3: 25 VORs	October 2017	12 Months
Work Package 4: 25 VORs	October 2018	12 Months
Work Package 5: 36 VORs	October 2019	12 Months

VOR MON Support

- VOR MON Program depends on the Mission Support Services (MSS) organization to perform the majority of work required for VOR discontinuance
- Topics of Discussion:
 - Field requires clarity on VOR discontinuance based on previous statement
 - The Planning and Requirements Groups (PRG) from East, Central, and Western Service Areas identified a need for 3 support contractors
 - VOR MON program is working closely with AJV-5 to be efficient in the way procedures work is performed in support of the program. (Touch Once)
 - There are 474 conventional SID, STAR, ODP affected by VOR discontinuance and some of those will likely need to be replaced with RNAVs.