Transformational PBN NAS

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Topics

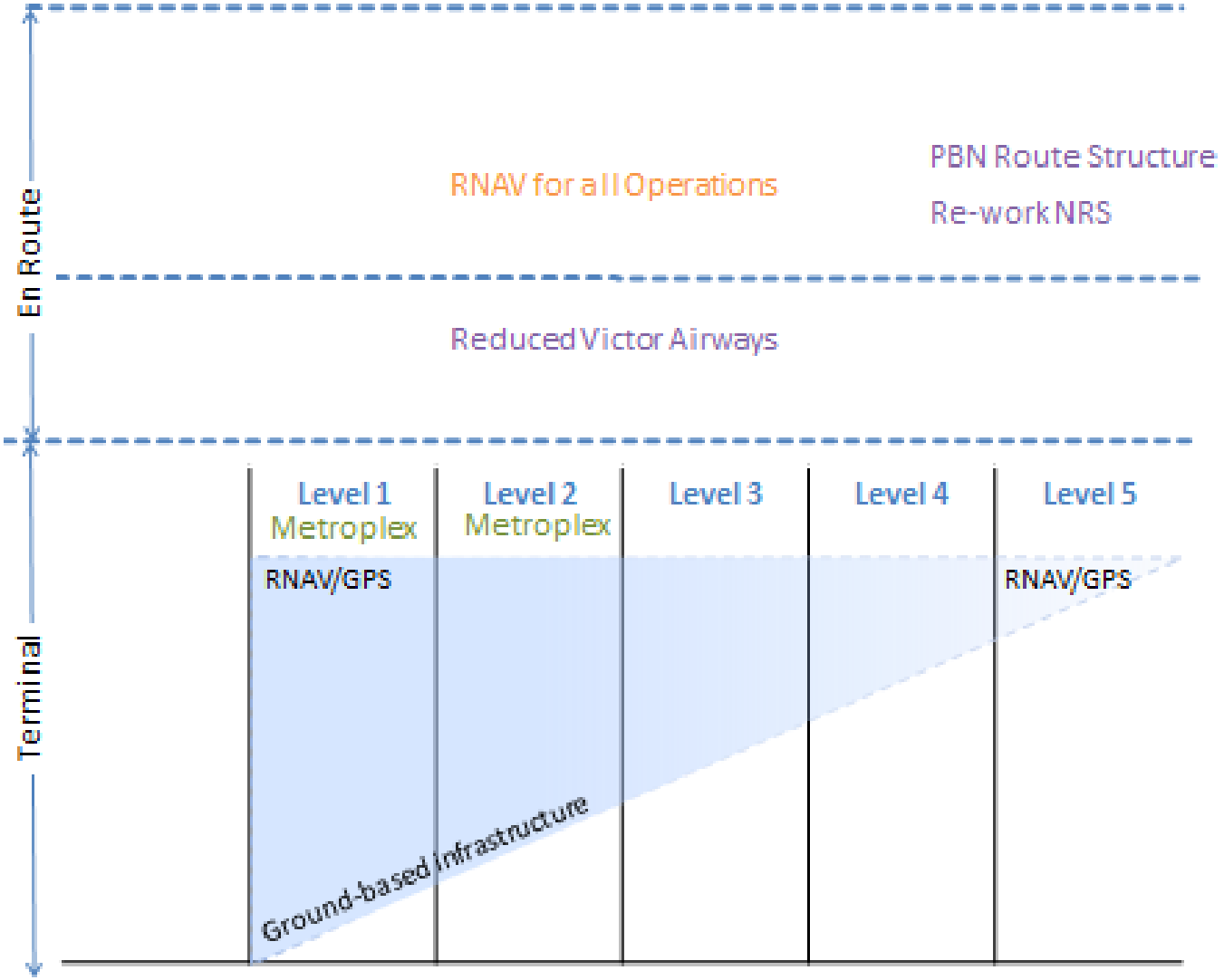
- Performance Based Navigation (PBN) Strategy
- Wide Area Augmentation System (WAAS) Update
- Ground Based Augmentation System (GBAS) Update
- VOR Minimal Operational Network (MON)
- Instrument Landing System (ILS) Rationalization
- GNSS Intentional Interference & Spoofing Study Team (GIISST)
- Satellite Operations Coordination Concept (SOCC)
- Questions

Performance Based Navigation (PBN) Strategy

The 2025 Vision

- **Four Focus Areas**
  - **Creating a PBN NAS**
  - **Decision Support Tools to enable better PBN utilization**
  - **Agile Above and fixed below 10,000 feet**
  - **Align legacy infrastructure to supplement PBN**

Developing the Vision - 2025 NAS



Challenges Still Being Addressed

- **Standardize and execute training and education for pilots and controllers**
- **Make what we have built work better, using lessons learned and available expertise**
- **Establish tools and policies to manage equipage and capability differences, if mandates will not be pursued**
- **Clear priorities to insure resources are used for the best value**

PBN Accomplishments

More than double PBN procedures since 2009

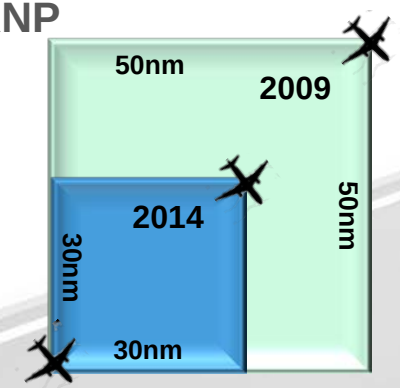
	RNAV STARs	RNAV SIDs	RNAV/RNP Approaches	RNP-AR Approaches	Q-Routes	T-Routes
2009	100	175	2,321	137	45	28
2014	309	416	4,648	384	122	61

Of Public Airports with published IAP:

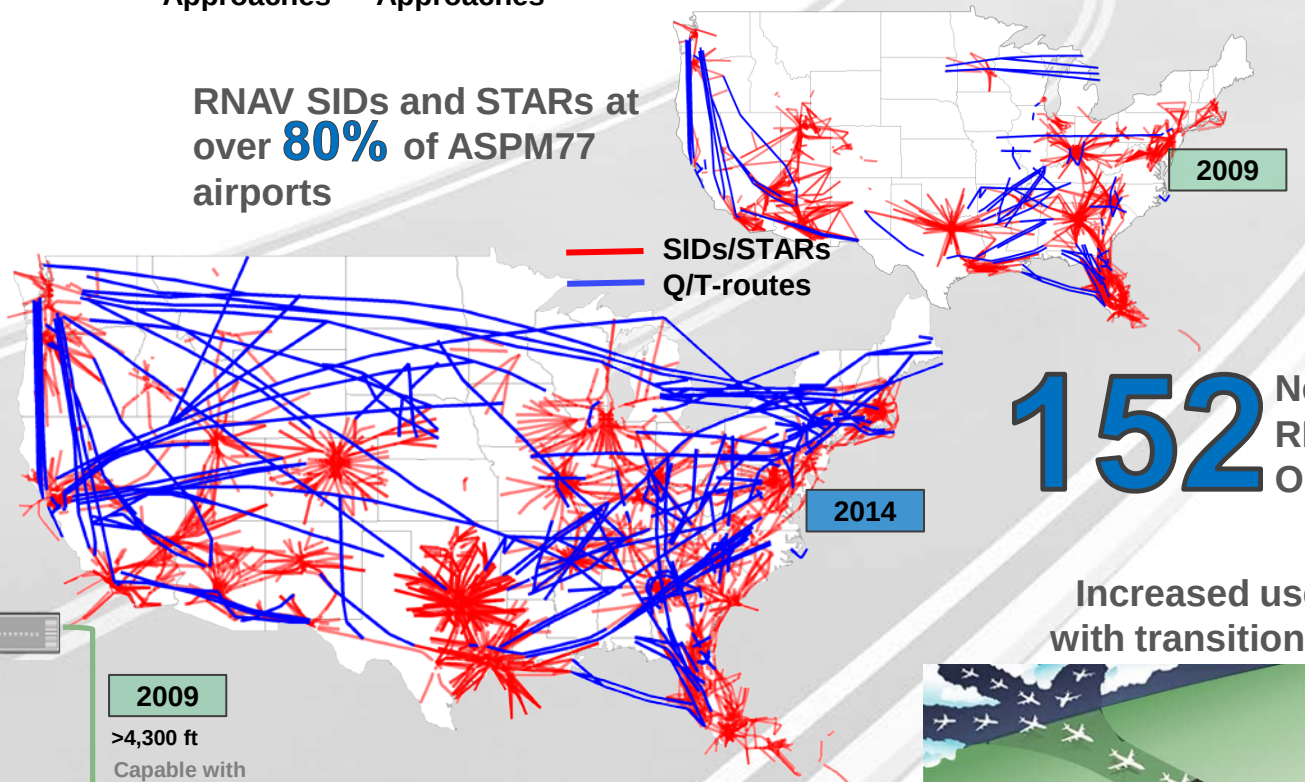
98% have a PBN IAP

25% with *only* PBN IAP

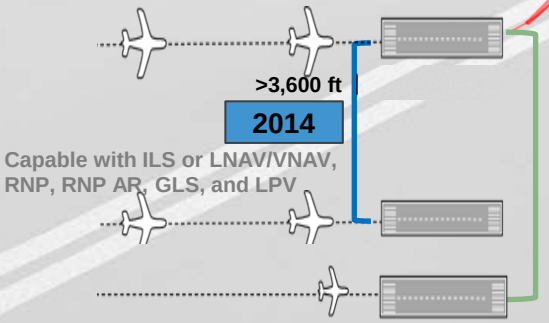
Oceanic separation standards reduced with RNP



RNAV SIDs and STARs at over 80% of ASPM77 airports



152 New RNAV OPDs



Reduced, separation standards for closely-spaced approaches

Increased use of TMA with transition towards TBFM

Creating a PBN NAS

Leverage PBN for operational improvements in VMC and IMC, while maintaining a resilient navigation capability. Simplest PBN tool for the job.

2025 Vision

- **Policy:**
  - Guidelines for which tools will be used when
  - Clear guidelines for performance levels across a range of situations
- **Operation:**
  - All approaches are vertically guided
  - Overlay program for departures and arrivals
  - Implement PBN Route Structure
  - Final WAAS procedure deployment
- **Infrastructure:**
  - PBN infrastructure with required resiliency
  - NDB/VOR procedure draw down
- **Culture:**
  - Address barriers to utilization, specifically training and resource availability

5 Year Focus

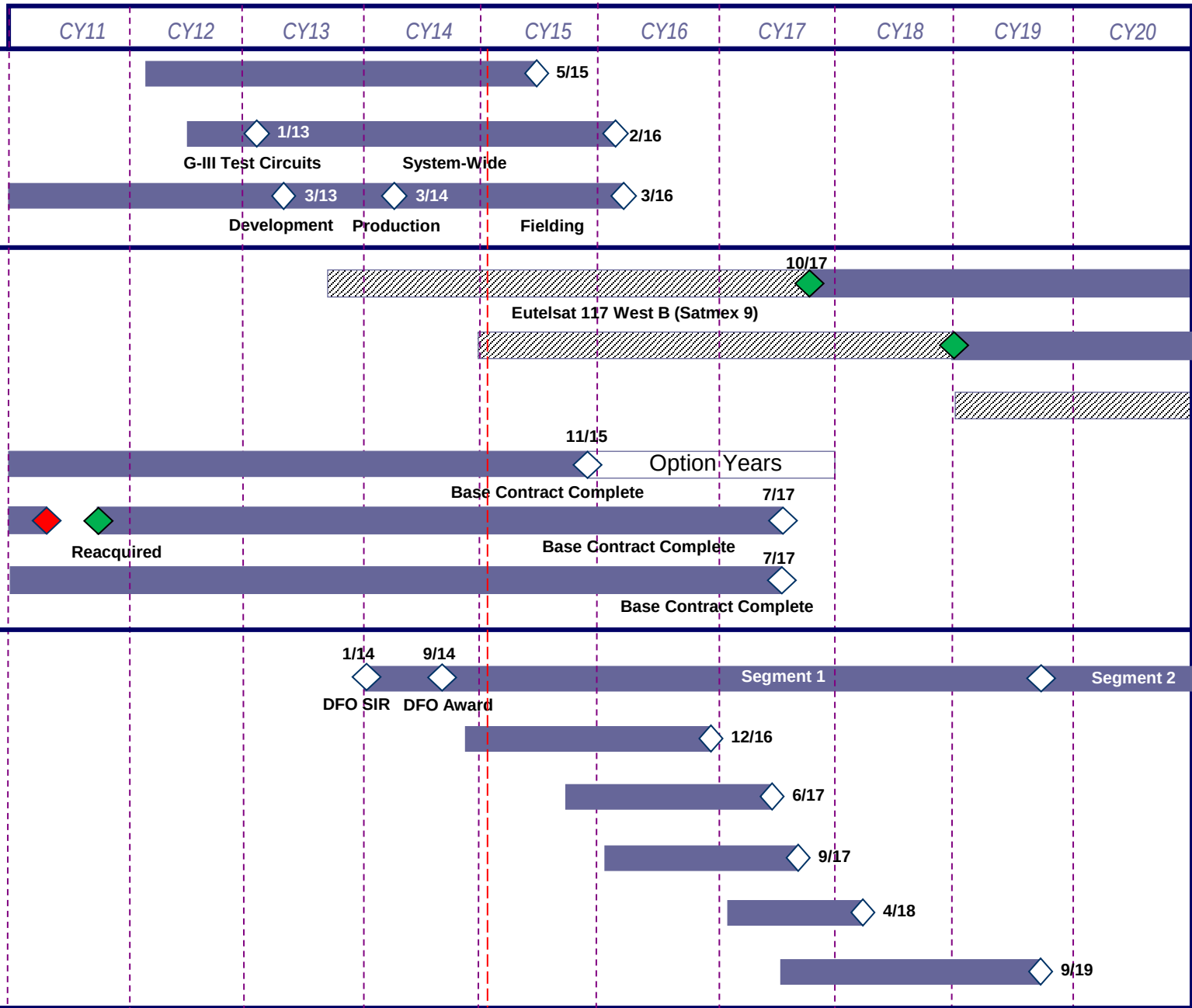
Wide Area Augmentation System (WAAS)

WAAS Development Phases

- **Phase I: IOC (July 2003) Completed**
  - Included Development of a robust safety architecture
  - Included establishment of WAAS expert panel to evaluate potential integrity threats
- **Phase II: Full LPV (FLP) (2003 – 2008) Completed**
  - Completed a Safety Risk Management Decision (SRMD) to support LPV-200 (VAL of 35m)
  - Expanded WAAS coverage to Mexico and Canada while modifying the System to address observed Ionospheric threats
- **Phase III: Full LPV-200 Performance (2009 – 2013)**
  - Completed System updates to improve performance during moderate ionospheric activity
  - Supported continuous monitoring of system data that contributes to continued integrity assurance
  - Began transition of Second Level Engineering from contractor based to organic FAA capability
- **Phase IV: Dual Frequency (L1,L5) Operations (2014 – 2044)**
  - Includes the transition from use of L2 to L5 in WAAS reference stations
  - Infrastructure modifications to support future L1/L5 user capability
  - Support sustainment of WAAS GEOs

WAAS Schedule

Legend	
◇	Milestone
◆	Service Ended
◆	Service Started
▨	Satellite Development



Ground Based Augmentation System Update (GBAS)

FAA GBAS Program

- **Validation of ICAO SARPS for the baseline set of GBAS Approach Service Type D (GAST-D) Requirements**
  - GAST-D to support approach and landing operations using CAT III minima by augmentation of single frequency GPS (L1)
  - Validation includes work producing commercial prototypes (Avionics/Ground system)
  - SARPS Validation – April 2015
    - Likely that close of validation will be conditional on completion of IGM work (and possibly resolution of VDB issues)
  - Final Close of Validation – Fall 2015

- **SLS-4000 GAST C Block II Schedule**
  - Modification of previously approved SLS-4000 Block I configuration intended to enhanced system availability
  - Block II System Design Approval (SDA) is expected summer 2015

Recent Accomplishments

- **Airport Operations (Status: Jan 2015)**
  - **Total 1277 approaches / Average 90/month**
  - Newark, NJ / 582 Operations (737/787)
  - Houston, TX / 695 Operations (737/787/A380/B747-8)

November 2014 - Over 1,000 GBAS landings by United Airlines

- **US Airlines**
  - United Airlines Equipage
    - B 737 – 97 aircraft / B 787 – 14 aircraft
  - Delta Airlines
    - B 737 – 34 Aircraft / Total order of 112
    - Planning to equip also Airbus fleet (A350, A321)

December 2014 - Delta at Houston

February 2015 Delta at Newark

- **106 Boeing customers with GLS**
  - B737 67 airlines / 900 aircraft/3660 provisioned
  - B747-8 10 airlines / 84 aircraft
  - B787 29 airlines / 235 aircraft

Recent Accomplishments

- **Coordinated International Airline Operations in the US**
  - Newark (since Sept 2014)
    - British Airways - B787
      - 138 GLS approaches

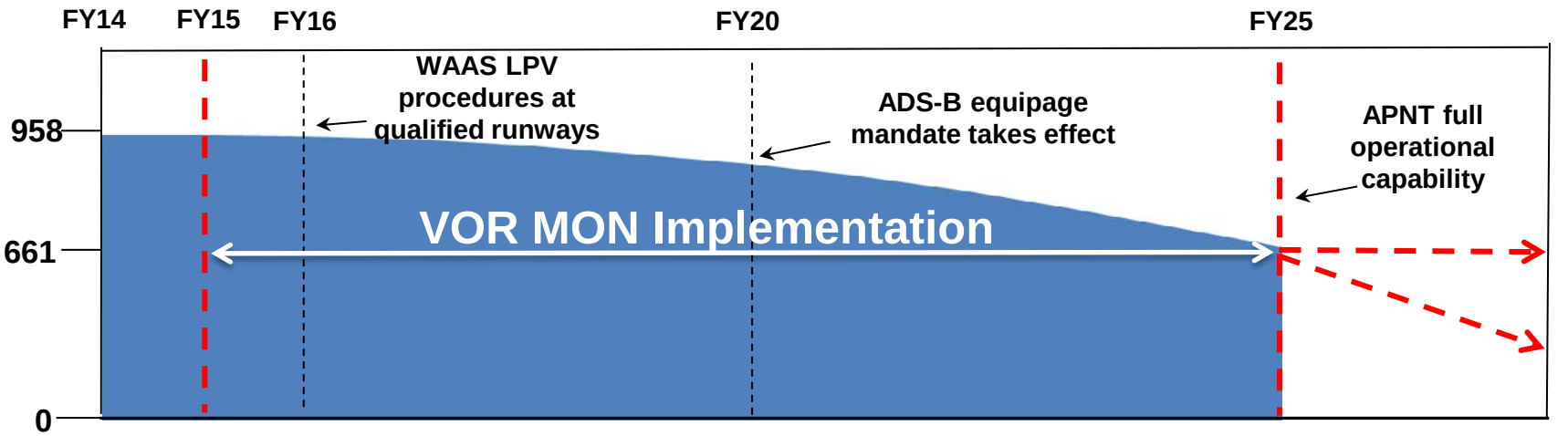
  - Houston (since Dec 2014)
    - Emirates - A380 (11 GLS approaches)
    - Lufthansa - A380 (9 GLS approaches)
    - Cathay Pacific - B747-8 (7 GLS approaches)

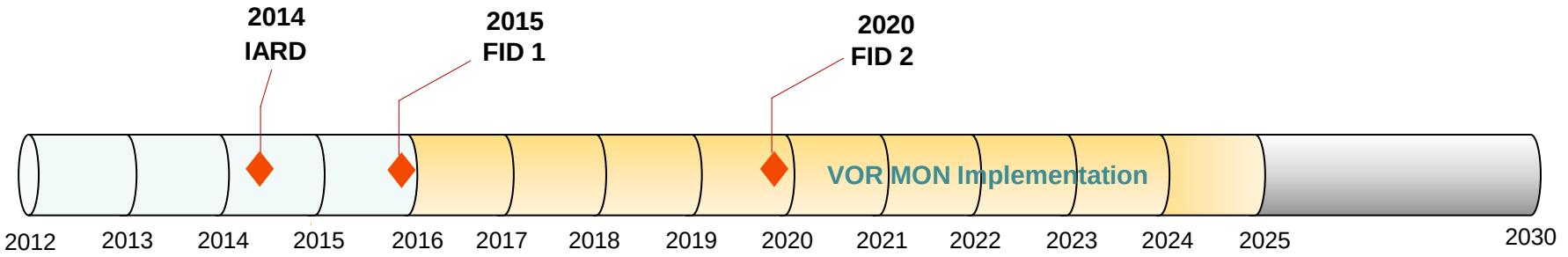
VOR Minimal Operational Network (MON)

VOR MON Program Overview

- **The FAA will transition to Performance-Based Navigation (PBN) from the conventional VOR-defined routes and procedures**
  - Improved Efficiency and Capacity
- **The Transition to PBN provides an opportunity to reduce the aging unneeded infrastructure**
  - The FAA currently has ~958 federally-owned and operated VORs (including VORTACs and VOR/DMEs), Most are **30+** years old
  - Few aircraft are actually using VOR to fly the VOR Airways
- **The VOR MON Program plans to discontinue approximately 30% of the VORs in the National Airspace System (NAS) by 2025**
  - VOR MON will provide a conventional backup coverage during a GPS outage as well as basic navigation for VOR-only aircraft
  - Supports FAA NAS Right Sizing Initiative

VOR MON Strategy and Notional Timeline





Instrument Landing System (ILS) Rationalization

Overview

- **The Instrument Landing System (ILS) Rationalization is a NAS Efficiency Streamlining Services (NESS) initiative for the FAA to strategically remove ILS infrastructure within the NAS without impacting safety, efficiency, or operations.**

RATIONALIZATION OBJECTIVE

- **Maximize cost savings while retaining airport access and safety benefits of vertically guided approaches**
  - Rationalize the need for Category I ILS where the runway end has duplicate capability
    - ILS, LPV,LNAV/VNA
  - Including Operation during GPS Outages
    - Continued operations for airliner aircraft
    - Safe Landing for all aircraft

Preliminary Assumptions, March 2015

- **Timeframe for Rationaization:2018-2030**
- **All ILS that provide CAT II/III service will be retained**
- **Retain vertical guidance at all runway ends that currently have vertical guidance**
- **Decision does not encompass removing Approach Lighting or Runway Visual Range**
- **CAT I services will be reassessed based upon current and projected aircraft equipage**

GNSS Intentional Interference & Spoofing Study Team (GIISST)

GIISST Background

- **GNSS is vulnerable to intentional interference and spoofing**
  - Intention and capabilities exist to adversely impact safety, security, and capacity of the NAS
  - Topic is subject of growing public awareness
- **FAA Navigation Programs and Aircraft Certification established GIISST in Oct. '12 to**
  - Examine threat assessments, studies, and data
  - Develop specific, actionable recommendations

Threat Scenarios

Scenario	Examples of Experienced Events
Low Power Mobile Interference	Interference at airport caused by personal privacy devices in vehicles on adjacent roadways
Low Power Stationary Interference	Interference at airport caused by stationary personal privacy device in aircraft operations area
High Power Interference	Misuse or unplanned use of military equipment results in jamming
Unintentional Re-radiator	Improper use of aviation GPS test equipment
Pinpoint Spoofing Attack	Partially demonstrated (research, test for hovering UAV with non-aviation grade equipment and pre-determined knowledge of vehicle position/time)
Coordinated Spoofing Attack	No known event for civil, approved, aviation applications
Coordinated Interference and Spoofing Attack	No known event for civil, approved, aviation applications

GIISST Summary

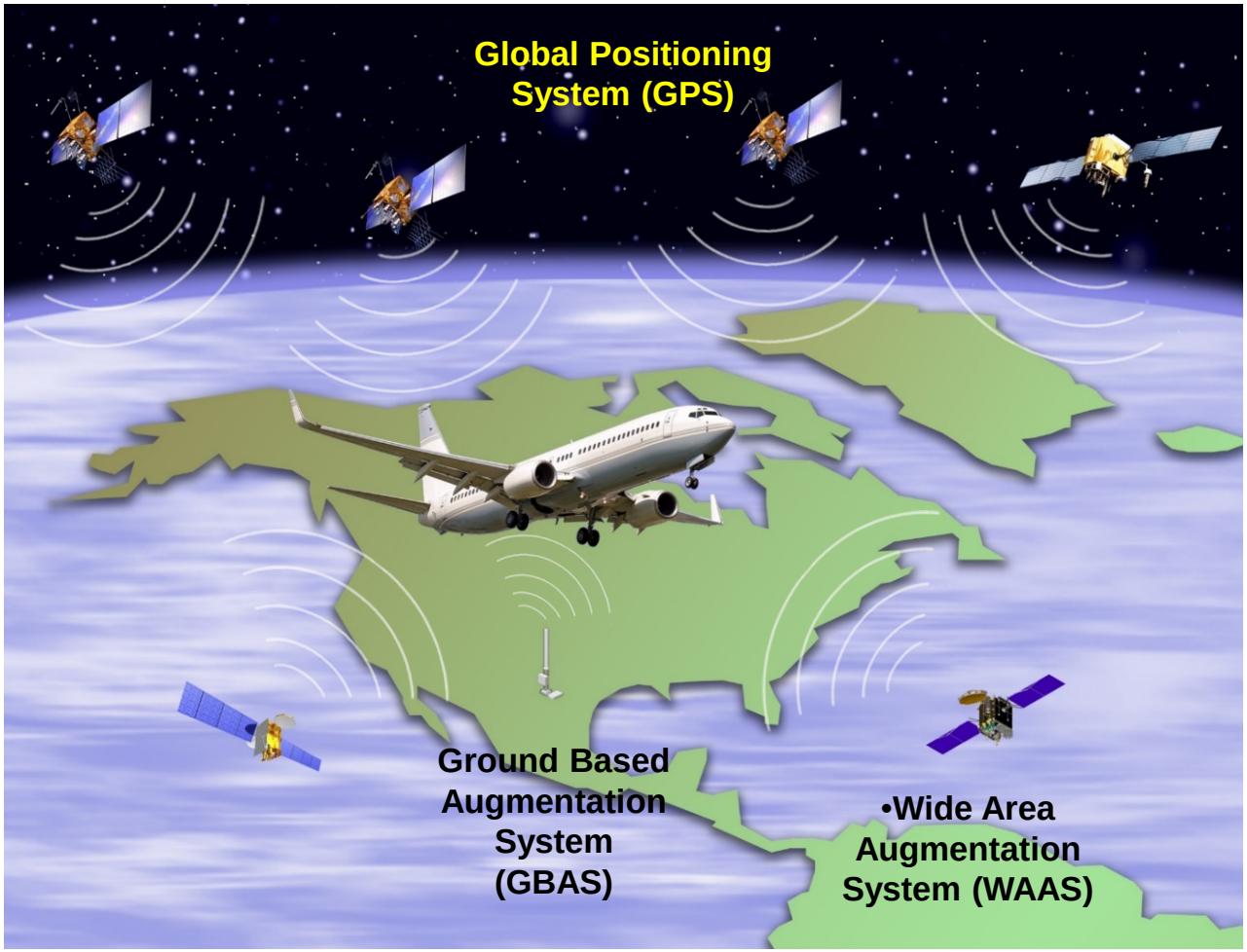
- **GNSS is vulnerable to intentional interference and spoofing**
- **FAA's GIISST has developed recommendations to address this vulnerability**

Next Steps

- **Provide recommendations to aviation community**
  - RTCA SC-159
  - PBN Aviation Rulemaking Committee (PARC)

Satellite Operations Coordination Concept (SOCC)

As the transition to a PBN and ADS-B NAS continues to expand, reliance on the GNSS will increase.



What would result if an anomaly in the GNSS caused it to be unavailable for a portion or all of a flight?

The Role Envisioned for the SOCC

- **Monitor all available sources of the GNSS for anomalies and outages**
- **Assess the impact to determine which routes, and instrument flight procedures are affected**
- **Provide Air Traffic authorities with an impact statement**
  - Enhance situational awareness resulting in improved traffic flow management
- **Disseminate information to other users and stakeholders in the NAS**

Benefits

- **Provide detailed information on affected routes, route segments, instrument flight procedures and ADS-B based surveillance**
- **Minimize the effect and allow for improved traffic management and less delay**
- **SOCC automation will reduce the time to process and disseminate critical information**
- **The SOCC will complement the use of the Alternate Positioning, Navigation and Timing (APNT) system**
  - Knowledge of where APNT will be needed will allow air traffic authorities to adjust traffic flows to accommodate possible reduced separation standards in the affected area

Questions