AP/ATM/10
WP/22
20/04/05

International Civil Aviation Organization
UNDP/ICAO Regional Project RLA/98/003
Transition to the CNS/ATM Systems in the CAR and SAM Regions

Tenth Meeting/workshop of Air Traffic Management (ATM) Authorities and Planners of the CAR and SAM Regions (AP/ATM/10)

(Lima, Peru, 10 to 14 May 2005)

Agenda Item 1: RNAV Routes Implementation in the CAR/SAM Region

Overview of the U.S. Performance-Based National Airspace System

(Presented by the United States)

SUMMARY

This Working Paper presents background information on the implementation of RNAV and RNP in the U.S

1. Introduction

1.1 There is a great demand by aircraft operators and service providers to increase airspace capacity and airport access via performance-based area navigation (RNAV). Performance-based navigation is defined as navigation along a route, in a procedure or in airspace within which aircraft must comply with specified Required Navigation Performance (RNP), standards, rather than being required to equip with specific technologies.

1.2 The goal of implementing performance-based navigation is to deliver operational benefits, manage service provider costs, maximize use of aircraft equipage capabilities, and leverage new navigation sources such as GPS and its augmentation systems, which already meet many proposed performance requirements. RNAV and RNP are recognized as key building blocks for the evolution to performance-based navigation in the United States.

2. Discussion

2.1 The U.S. Federal Aviation Administration (FAA) is developing standards for procedure design, aircraft approvals and operational approvals for RNAV and RNP implantations. The FAA is also in the process of implementing RNAV enroute and terminal applications, and RNP in the approach domain.

2.2 The presentation shown in **Appendix A** of this WP/IP provides information on FAA activities to implement RNAV and RNP in the U.S. National Airspace System (NAS).

3. Actions

3.1 The meeting is invited to note the information provided in this Working Paper.

AP/ATM/10
WP/NE-22
Appendix/Apéndice A

ato
AIR TRAFFIC ORGANIZATION

Overview of the U.S. Performance-Based National Airspace System

Briefing to
Tenth Meeting/Workshop of ATM Authorities and Planners in the CAR/SAM Regions
(AP/ATM/10)

10-14 May 2005

Lima, Peru

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Required Navigation Performance Division
Federal Aviation Administration

Overview

- What is Performance-Based Navigation?
- FAA Roadmap for Performance-Based Navigation
  - Concepts, Implementation Considerations
  - Implementation Activities
    - Enroute
    - Terminal
    - Approach
- International Harmonization Activities

What Is "Performance-Based" Navigation?

- An end-to-end system of concepts and applications based on performance standards and metrics rather than specific technologies and equipment
  - Aviation authorities specify the ***aircraft capabilities*** and ***performance requirements*** necessary to operate in a given airspace or use a given procedure
    - Instead of specifying required technologies or specific avionics
- Recognizes the ability of aircraft to operate safely and efficiently using a variety of on-board systems
  - In conjunction with a variety of external signals provided by ground-based, space-based, and other aircraft-based systems

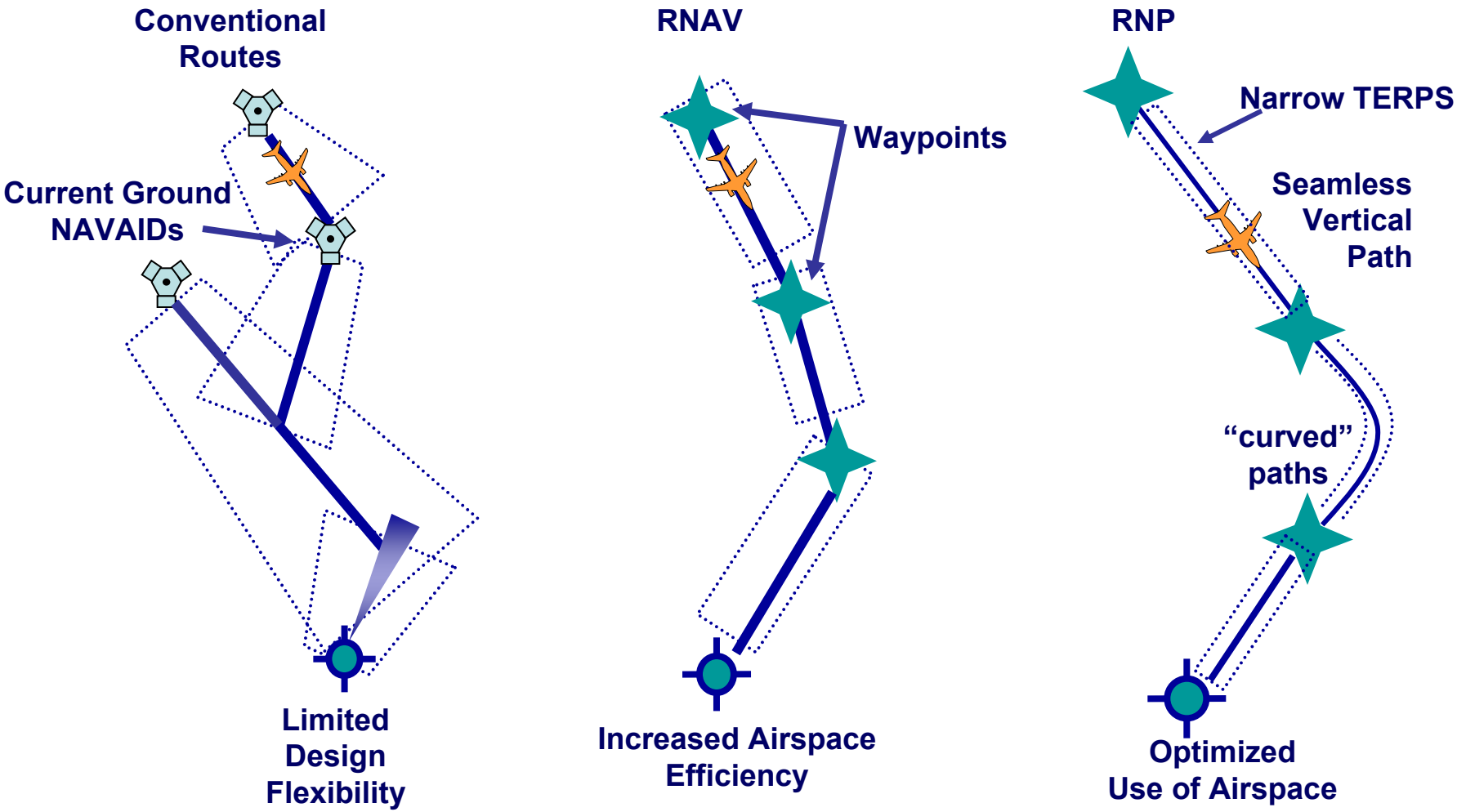
What Is "Performance-Based" Navigation? continued

- Performance-based Navigation includes
  - Area Navigation (RNAV)
  - Required Navigation Performance (RNP)
- Specified navigation standards for
  - Performance
  - Functionality
  - Capability
- Standards allow the flexibility to develop more efficient airspace and instrument procedure designs
- Benefits
  - Improved safety
  - Increased Access
  - Additional Capacity
  - Better Flight Path Predictability
  - Operational efficiency
  - Reduced environmental impacts

Objectives for Performance-Based Navigation

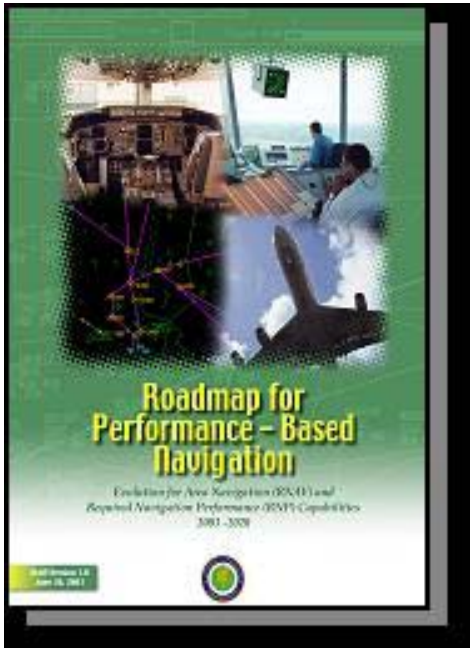
- **Cost-effective navigation services with the necessary performance and operational capabilities to provide:**
  - RNAV and RNP where beneficial
  - Vertically guided approaches where appropriate for safety and improved access
- **Cost-effective performance-based navigation to produce measurable improvements in:**
  - Safety
  - Airport and airspace access
  - Capacity
  - Efficiency
  - Environment

Moving To Performance-Based Navigation



FAA's *Roadmap for Performance-Based Navigation*

- **Collaborative effort among aviation industry stakeholders**
  - Performance-based Operations Aviation Rulemaking Committee (PARC)
- **Aligned with the Operational Evolution Plan (OEP) and FAA *Flight Plan***
  - Near-term 2003 to 2006
  - Mid-term 2007 to 2012
  - Far-term 2013 to 2020
- **Focuses on operational capabilities in:**
  - En route domain
  - Terminal domain
    - Standard Terminal Arrivals (STARs)
    - Standard Instrument Departures (SIDs)
  - Approach domain



http://www.faa.gov/ats/atp/rnp/roadmap.pdf

Definition: RNAV

- RNAV is a method of navigation that enables aircraft to fly on any desired flight path within the coverage of referenced NAVAIDS or within the limits of the capability of self-contained systems, or a combination of these capabilities

- Routes and procedures using RNAV provide improved access and flexibility through point-to-point navigation and are not restricted to the location of ground-based NAVAIDs

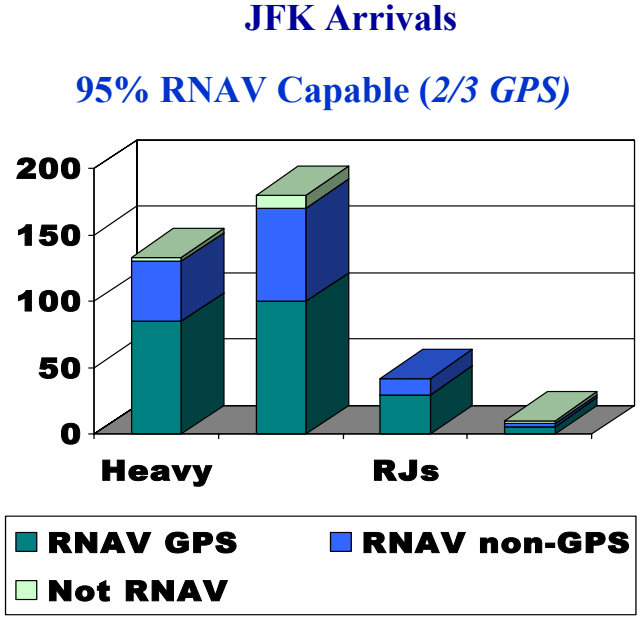
- The overall safety of the RNAV operation is achieved through a combined use of aircraft navigation accuracy, air traffic control intervention (via radar monitoring, automatic dependent surveillance (ADS), multilateration, communications) and/or increased route separation

Definition: RNP

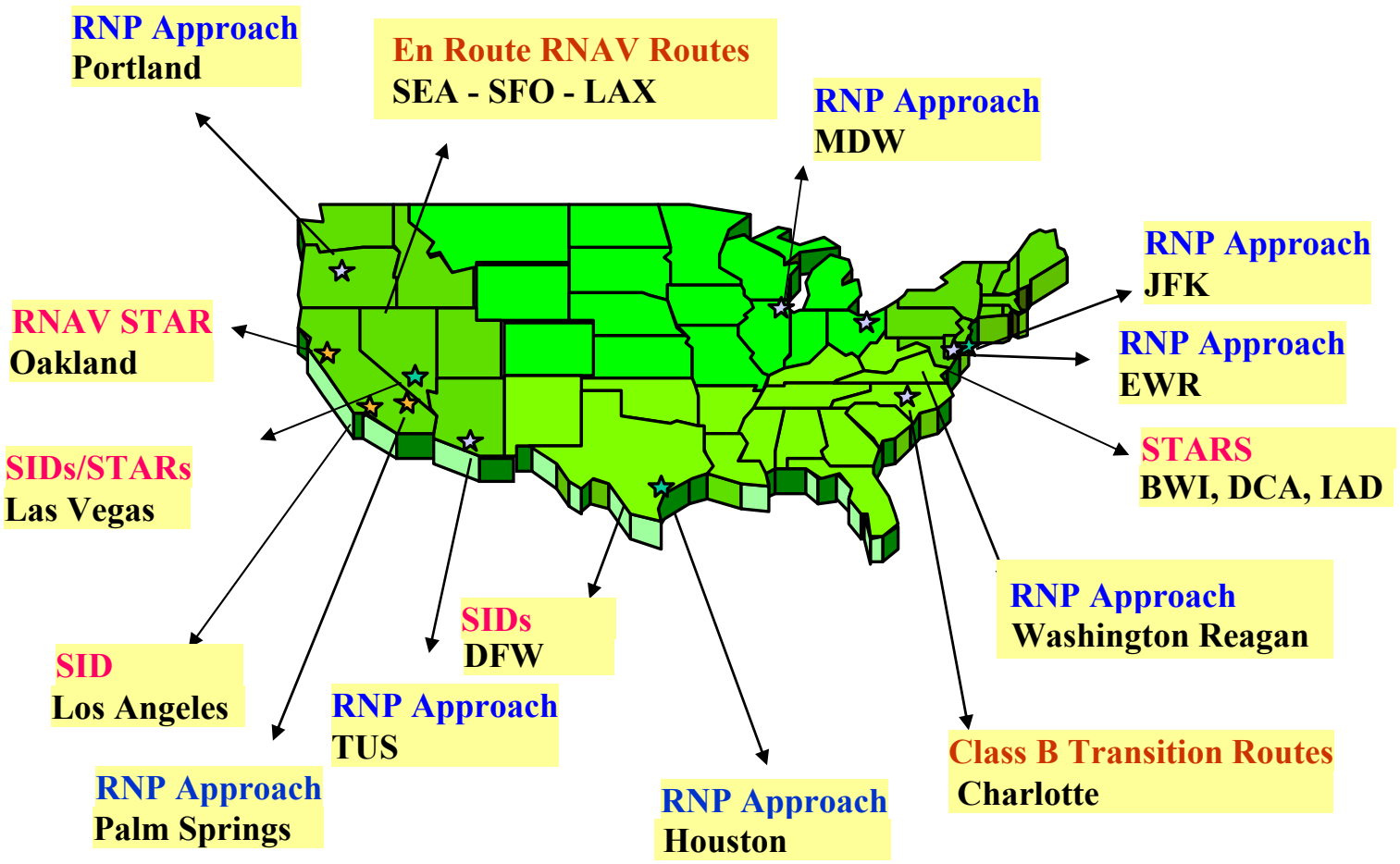
- RNP is RNAV operations with on-board navigation containment and monitoring
- A critical component of RNP is the *ability of the aircraft navigation system to monitor its achieved navigation performance, and to identify for the pilot whether the operational requirement is, or is not being met during an operation*
- This on-board monitoring and alerting capability therefore allows a lessened reliance on air traffic control intervention (via radar monitoring, automatic dependent surveillance (ADS), multilateration, communications) and/or increased route separation to achieve the overall safety of the operation
- RNP capability of the aircraft is a major component in determining the separation criteria to ensure that the overall containment of the operation is met
  - This is a distinguishing feature of RNP

Implement RNAV or RNP?

- Fleet Equipage Mix
  - Current
  - Projected
- Airspace Infrastructure
  - Radar Coverage
  - Communications Coverage
  - Route Density
- NAVAID Infrastructure
  - GPS only?
  - DME/DME?
  - DME/DME/IRU?
- Controller Workload

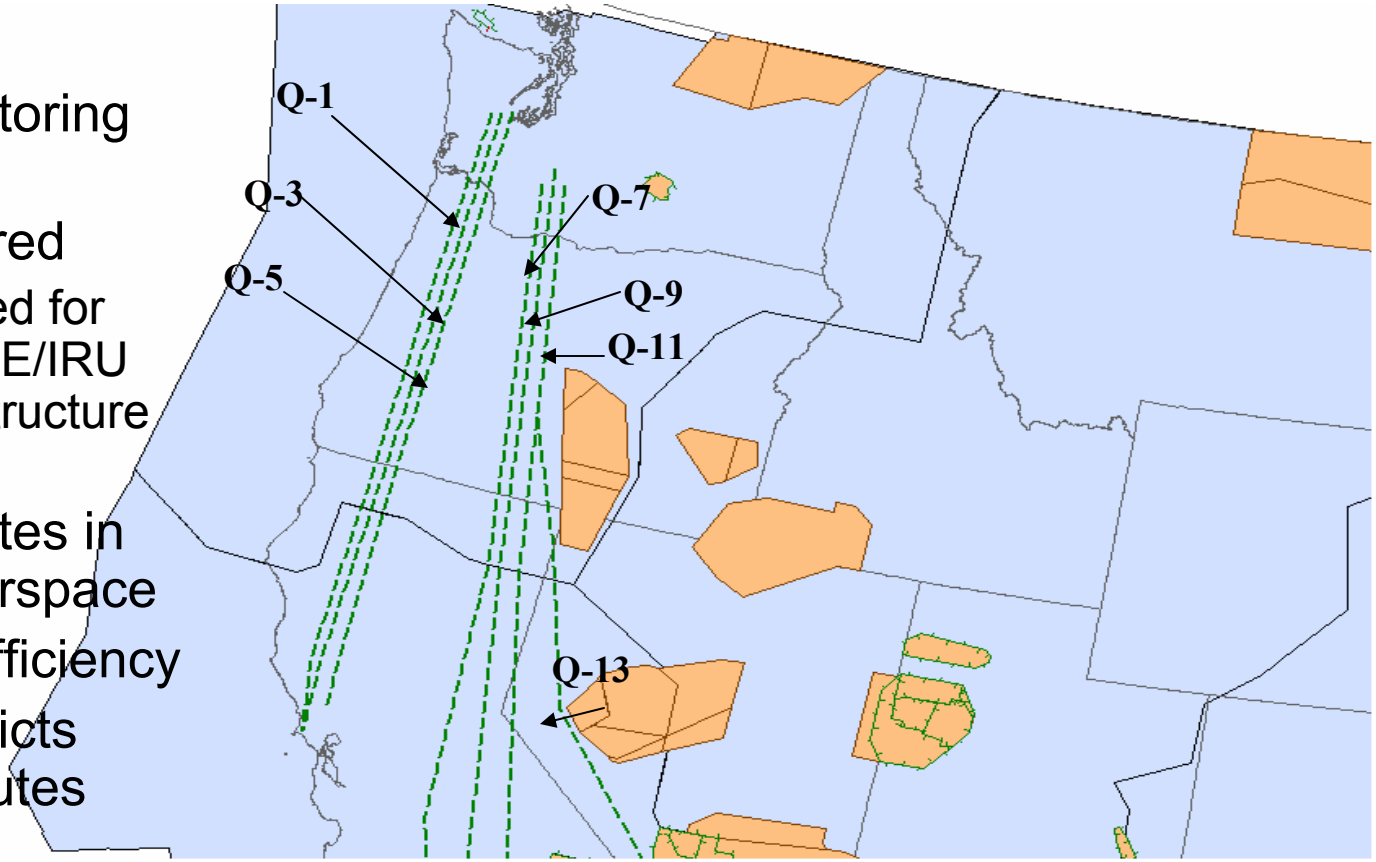


RNAV and RNP Procedures Implementation (2004-2005)

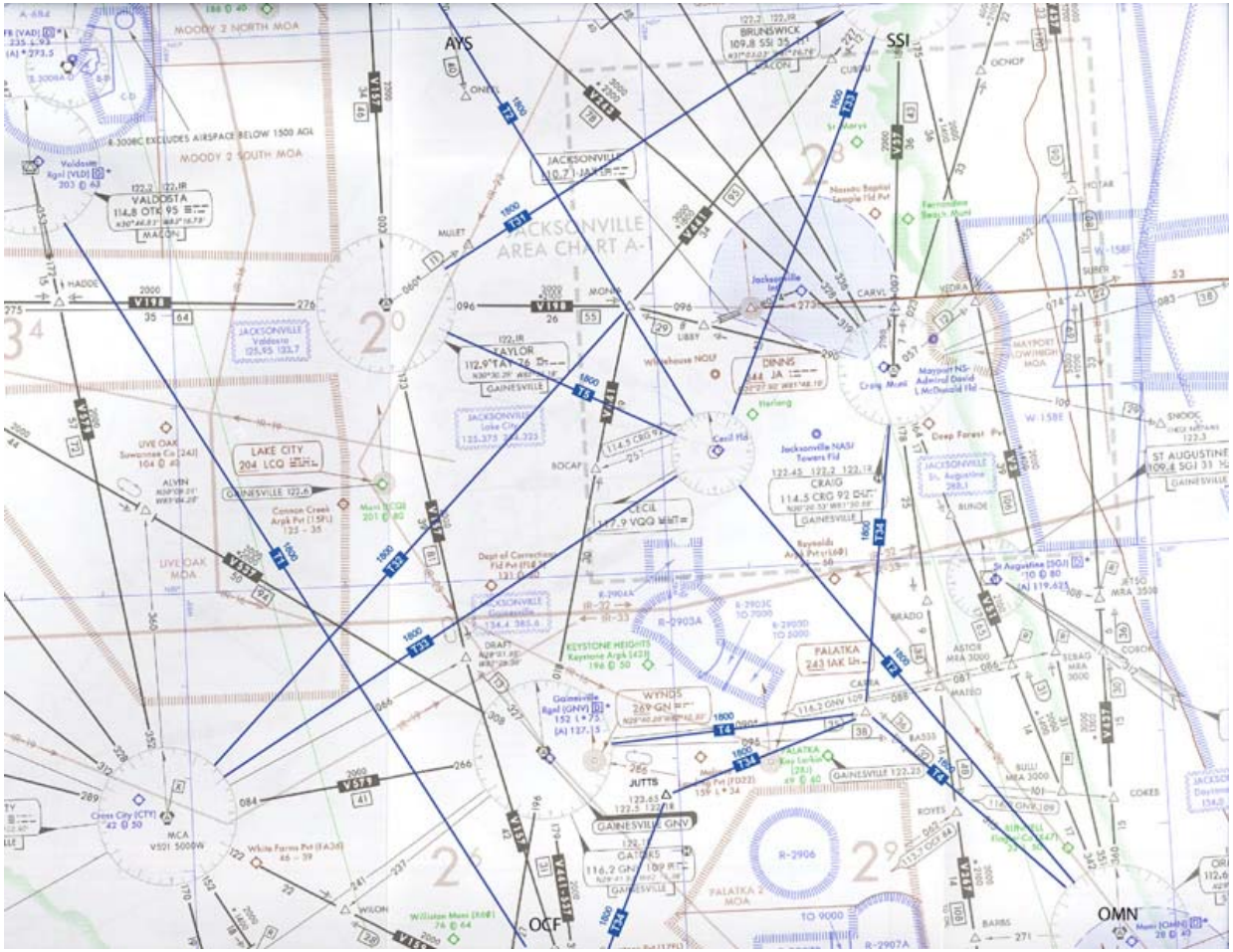


Q-Routes
(RNAV routes FL 180 and above)

- Radar monitoring required
- GPS Required
  - Authorized for DME/DME/IRU as infrastructure supports
- Multiple routes in the same airspace
- Improved efficiency
- Fewer conflicts between routes



T – Routes:
RNAV IFR Terminal Transition Routes
(RNAV Routes below FL 180)

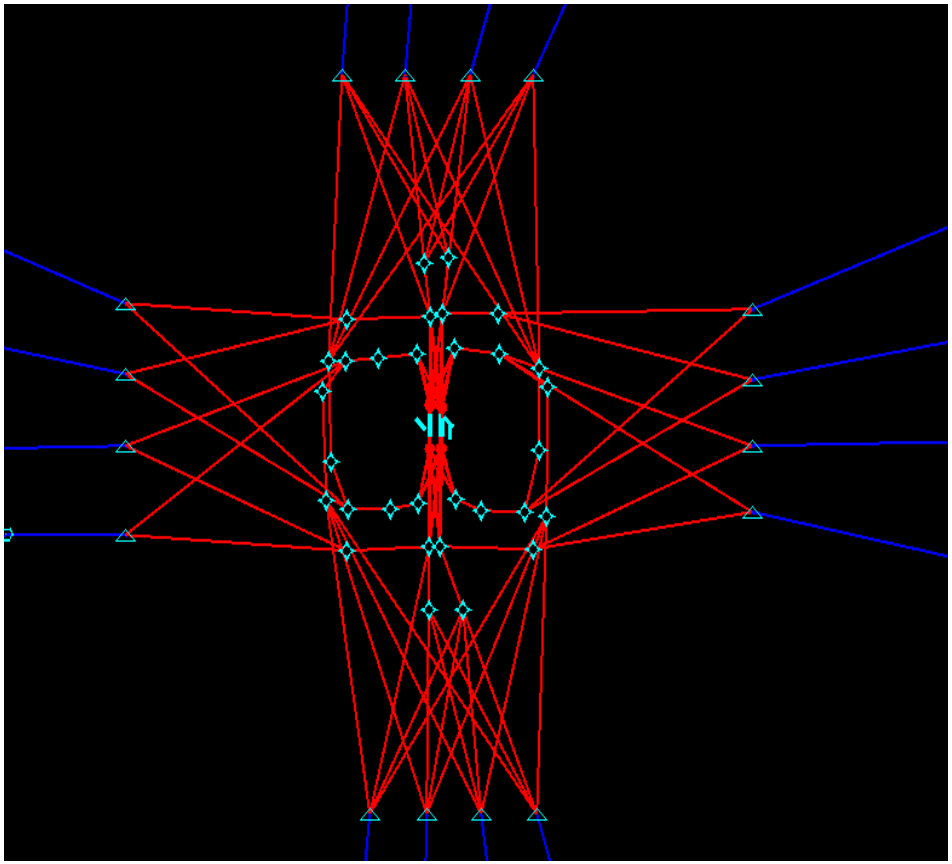


Q-Routes	Status	Publication Date
Q 1, 3, 5 – FL 290	Published	9/30/04
Q 7, 9, 11 – FL 290	Published	11/25/04
Canadian Routes 500, 502, 503, 504 – FL240	Published	11/25/04
Q 1, 3, 7, 9 – FL 240	Scheduled for publication	5/12/05
Q 5, 11 – FL 260	Scheduled for publication	5/12/05
New Florida Routes Q 104, 105, 106, 108, 110, 112, 116, 118	Comment period closed 3/24/05, Awaiting Final Rule	9/1/05
Q 13 Q 15	Redesigned GPS Required GPS Required	TBD
7 New Southwest/Texas Q-Routes	Under initial development	TBD

T-Routes	Status	Publication Date
Charlotte (CLT) **- 4 Routes (T 200, 201, 202, 203)**	**Final Rule expected 06/05**	**9/1/05**
Jacksonville (JAX) **- 7 Routes (T 204, 205, 206, 207, 208, 210, 211)**	**NPRM in pre-publication legal review**	**Early FY-06**
Cincinnati (CVG) **- 4 Routes (T 212, 213, 215, 217)**	**NPRM in pre-publication legal review**	**Early FY-06**

- RNAV IFR Terminal Transition Routes (RITTRs)
  - Will be published on low-altitude en route charts as T-Routes
    - Routes will be identified as T200-500
- FAA Orders for RITTR development to be published in 2005

Terminal Procedures (STARs, SIDs)

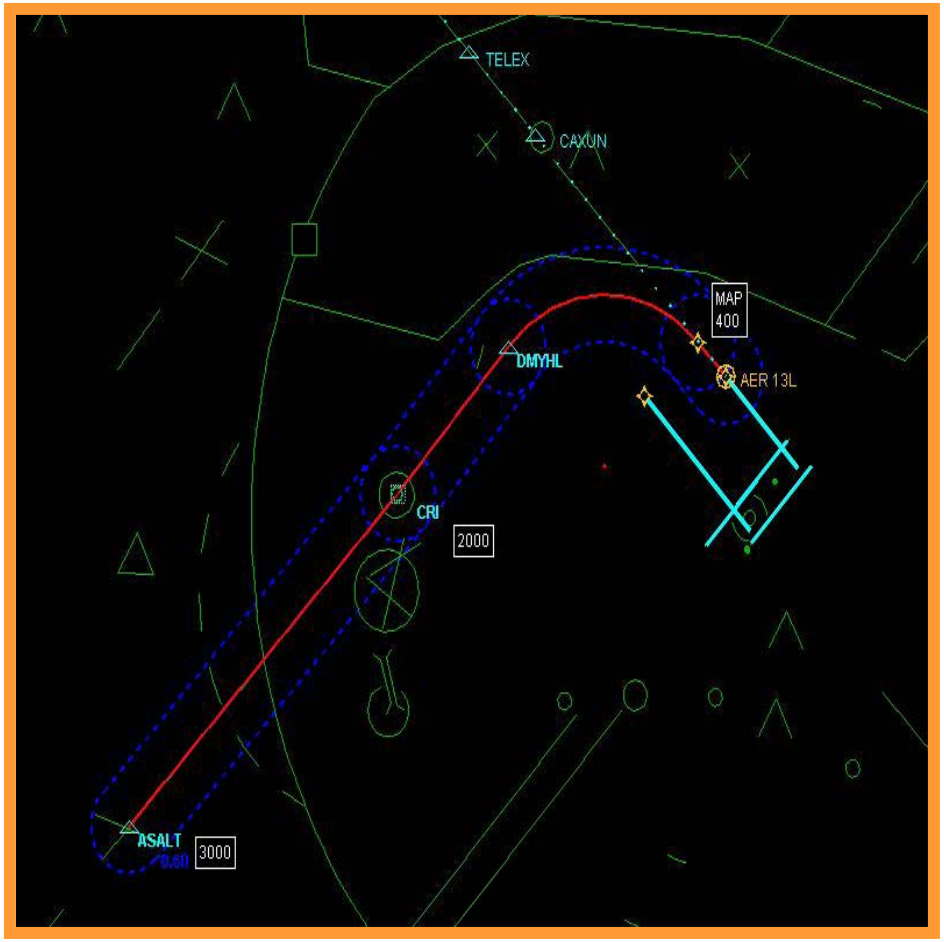


Benefits

- Increased arrival/departure throughput and efficiency
- Increased predictability
- Decreased departure delays
- Decreased taxi-times
- Reduced track distances
- Reduced voice communications & vectoring
- More efficient vertical profiles
- Reduced fuel consumption

Terminal Procedures	Status	Publication Date
Dulles (IAD) - 4 RNAV STARs	Published	1/20/05
Portland (PDX) - 2 GPS SIDs	Published	1/20/05
Atlanta (ATL) - 4 RNAV STARs/13 RNAV SIDs	Published	3/17/05
Las Vegas (LAS) - 5 RNAV SIDs	Published	3/17/05
Philadelphia (PHL) - 2 RNAV STARs	Published	3/17/05
Providence, RI (PVD) - 1 RNAV STAR	Scheduled for publication	7/7/05
Anchorage (ANC) - 2 GPS STARs	Scheduled for publication	7/7/05
Dallas/Fort Worth (DFW) - 16 RNAV SIDs	Scheduled for publication	7/7/05
Minneapolis (ZMP) - 1 RNAV STAR	Scheduled for publication	9/1/05
San Francisco (SFO) - 1 RNAV STAR	Scheduled for publication	9/1/05
Houston (IAH) - 1 RNAV STAR	Scheduled for publication	9/1/05

Approach Procedures (RNP SAAAR*)



Benefits

- Better access to runways with terrain/airspace conflicts
- De-conflicting traffic flows (e.g., converging runways, adjacent procedures)
- Improving safety by eliminating circling maneuvers
- Simplifying training by eliminating NPAs without sacrificing access
- To solve problems not solvable with other approach surfaces

*Special Aircraft and Aircrew Authorization Required

RNP (SAAAR)

- SAAAR: **S**pecial **A**ircraft and **A**ircrew **A**uthorization **R**equired
- SAAAR procedures are typically public procedures
  - ILS CAT II/III
- FAA is implementing convertible *special* RNP SAAAR procedures to provide initial operational capability for participating air carriers

Operational Attributes of RNP SAAAR Approaches

(not all attributes required for every procedure)

SAAAR Attributes

Narrower lateral TERPS
(e.g., RNP-0.3 or less, no secondary)

Guided turns/Lower RNP on missed approaches
(RF and RNP-0.3 or less)

Curved segments anywhere along the approach
(RF legs)

Reduced obstacle clearance
(VEB – Vertical Error Budget)

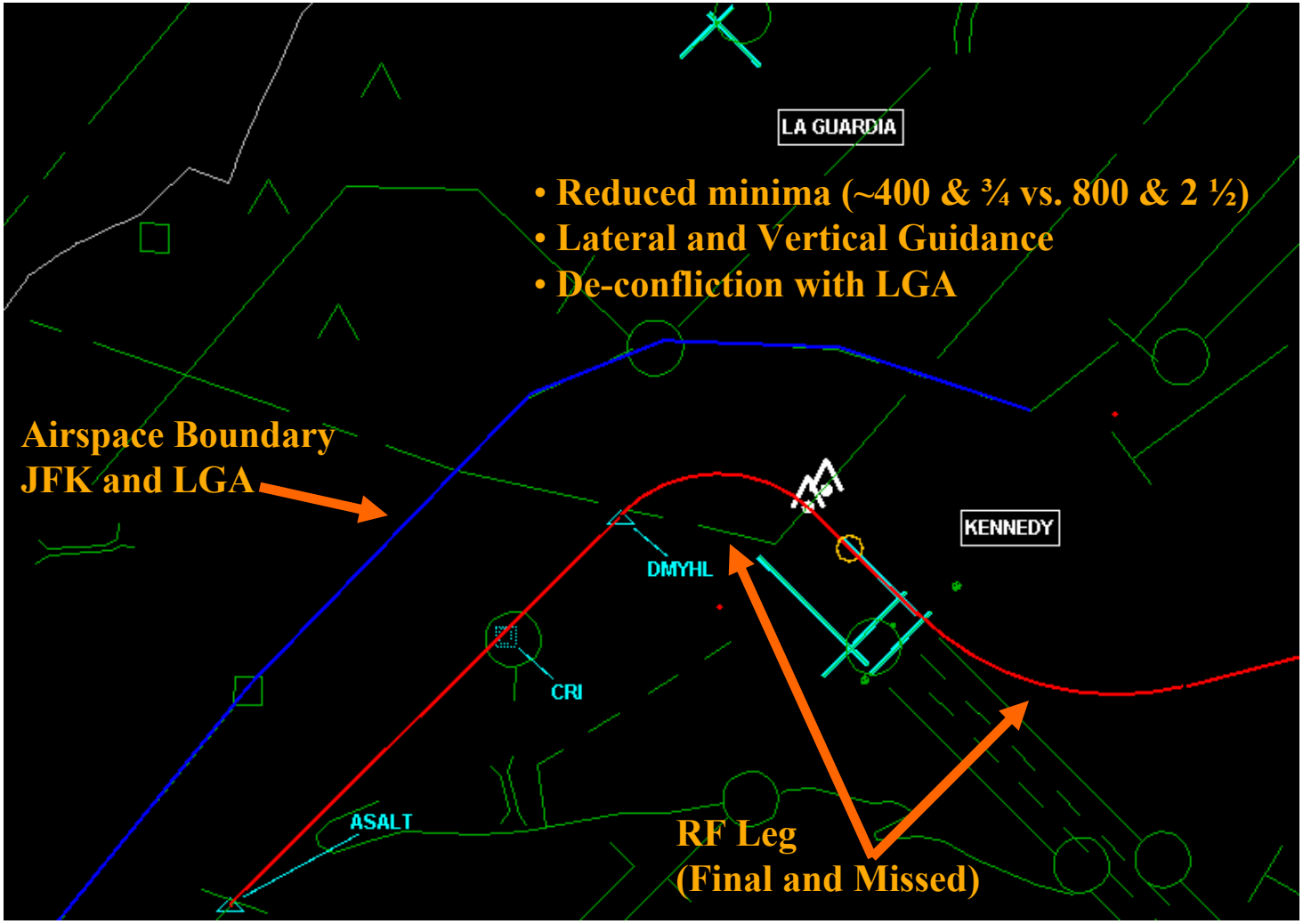
RNP SAAAR Implementation: An FAA National Initiative

- Implementation of the “Top Ten” RNP SAAAR projects is considered a national initiative
- Implementation concept
  - Initial 10 projects implemented as “Special” procedures using FAA Notice 8000.287
  - FAA Notice 8000.287 provides
    - Procedure development criteria (TERPS)
    - Aircraft evaluation requirements
    - Operator approval requirements
- Top Ten Specials to be converted to public procedures when “public criteria” agreed & published in 8260-series Orders
  - Public criteria expected May 2005
  - Once public, procedures remain SAAAR (similar to ILS CAT II/III)
  - Aiming for public RNP SAAAR procedures in CY 2006

RNP SAAAR "Top Ten" Initial Implementation Projects

RNP SAAAR Sites			
Site	**Runway**	**Proponent**	**Package Status**
Palm Springs CA (PSP)	31L, 13R	Alaska Airlines	In review
Houston, TX (IAH)	08R, 27	Continental Airlines	In review
NY Kennedy (JFK)	31L, 31R	JetBlue	Submission expected 31 Mar 05
Portland, OR (PDX)	28L, 28R	Horizon Air	Submission expected 31 Mar 05
Reagan National (DCA)	19	Alaska Airlines	Awaiting design resources
Newark, NJ (EWR)	29	Continental Airlines	Kickoff meeting 22 Feb 05
Chicago Midway (MDW)	13C, 22L	FAA	Procedure designs in progress
Newark, NJ (EWR)	04R, 22L	Continental Airlines	Kickoff meeting 22 Feb 05
Philadelphia, PA (PHL)	09	US Airways	Kickoff meeting June 2005
Tucson, AZ (TUS)	11	Alaska Airlines	Kickoff meeting June 2005

RNP SAAAR - JFK Example



Basis for Harmonization Activities

- The ultimate aim of the aviation community is the seamless transition of aircraft through global airspace
  - Via RNAV and RNP implementations that optimize aircraft capabilities
  - To realize benefits for both aircraft operators and service providers
- Different needs in each State may result in different priorities for implementation
- Harmonization of standards is the key to ensuring that differing implementation priorities are accommodated within a joint effort

U.S. Harmonization Activities
(with ICAO Headquarters)

- ICAO RNP Special Operational Requirements Study Group
  - To consider RNAV (no on-board containment) and RNP (on-board containment with alerting)
  - 8 April 2005 Secretariat letter to ICAO Regional Offices on revision to RNP concept (i.e. new implementations to include containment / alerting)
  - Rewrite ICAO Doc 9613, *RNP Manual*

- Key FY05 FAA objective: FAA & Eurocontrol will harmonize TGL-10 and AC 90-100 (USRNAV)
  - 95% harmonized; working to near 100%
  - FAA/Eurocontrol will develop proposed ICAO RNAV Standard by May 05 for submission to RNPSORSG Secretariat
    - To be formally reviewed by appropriate Panel(s)

AC 90-100 Expands Upon TGL-10

TGL-10

- Requires specific approval for operations listed
- Where radar is used the requirement for radar service is identified in the AIP
- Specific points for operators and manufacturers to demonstrate compliance with requirements
- Permits use of Fix to Altitude (FA)
- RNAV System failure indicator, including associated sensors, in pilot's primary field of view
- Defines aircraft characteristics to ensure Navigation Service Provider assessment of infrastructure is valid
- Requires use of an approved database supplier

AC 90-100

- FAA does not require specific approval for operations listed
- Radar is required for all RNAV operations unless the procedure specifically requires GPS or GNSS
- Provides greater detail for operators and manufacturers on how to comply with requirements
- FA legs are not allowed
  - Use Heading to Altitude (VA) legs instead
- Does not require the pilot to monitor conventional ground—based NAVAIDs (unless required by AFM)
- Defines aircraft characteristics to ensure Navigation Service Provider assessment of infrastructure is valid
- FAA does not require approved data suppliers

NOTE: FAA AC 90-96A (13 Jan 05) specifies requirements for US operators to receive FAA approval to fly B-RNAV and P-RNAV procedures in Europe

U.S. Harmonization Activities
(with ICAO Headquarters) continued

- Harmonized criteria for RNP 0.3- 0.1 approaches
  - US will propose its RNP SAAAR public procedure criteria for possible ICAO adoption
    - Via Obstacle Clearance Panel (OCP) and
    - For Regional adoption via ICAO GREPECAS
  - US public criteria is being developed in TERPS
    - FAA will draft in PANS-OPS for submission to ICAO groups

U.S. Harmonization Activities (Region)

- Drafting a proposed Canada-Mexico-U.S. Joint *Strategy for Performance Based Navigation* document
  - Emphasis will be primarily on Standards, vice site-specific implementations
  - Agreed strategy to be embodied in update to existing CANADA-MEXICO-USA CNS/ATM IMPLEMENTATION AND TRANSITION PLAN”
- Intent to pursue harmonization with CAR/SAM Region, primarily via ICAO GREPECAS
  - CAR/SAM Region CNS/ATM Implementation Plan

Further Discussion

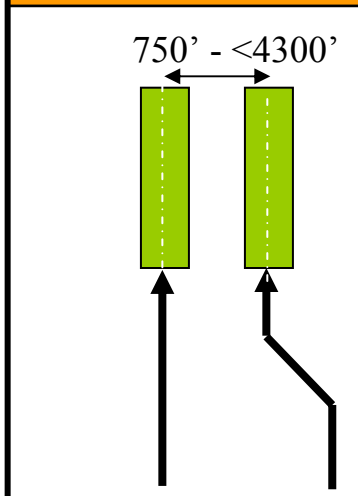
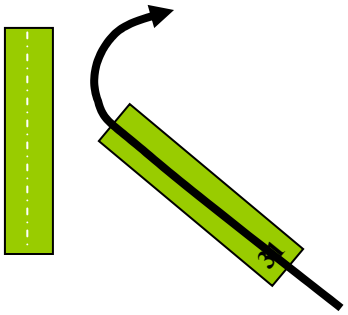
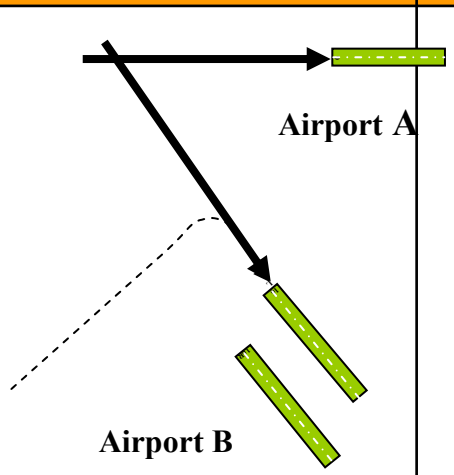
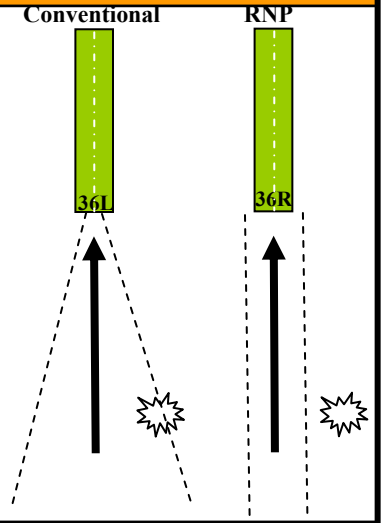
Visit our website at:

http://www.faa.gov/ats/atp/rnp/rnav.cfm

Back Up Slides

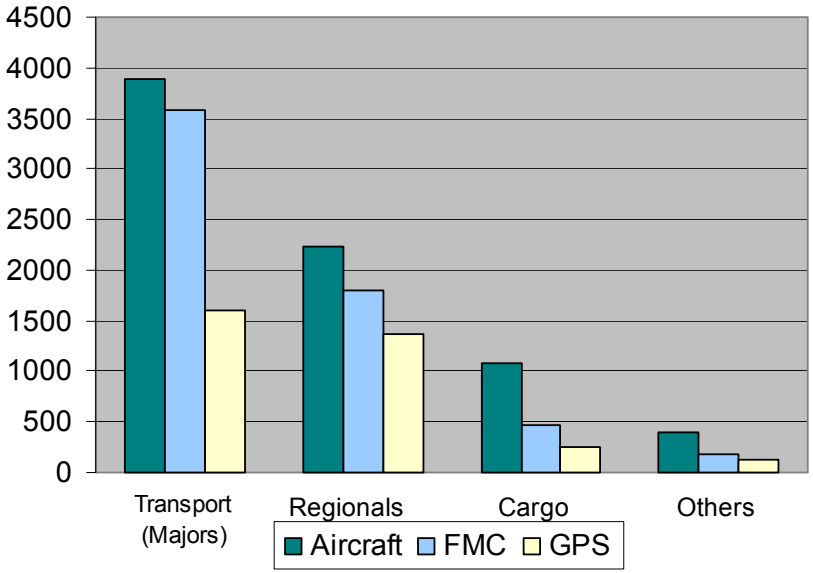
Applications of RNP Criteria

Preliminary Analysis at Top 100+ Airports

Parallel Operations	Converging Operations	Adjacent Airport Operations	Single Runway Access
			
10 to 15 Top Airports	**15 to 20 Top Airports**	**10 to 15 Top Airports**	**Several hundred runway ends**
Arrival capacity gains up to 60% over single runway operations	**Arrival capacity gains up to 50% over single runway operations**	**Increased arrival and departure rates for adjacent airports involved**	**Approach minimums lower than existing minima**

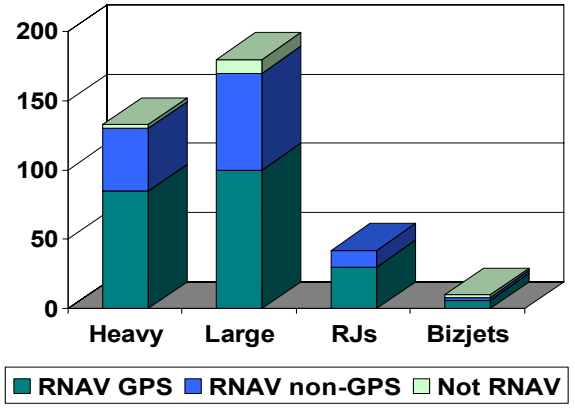
Analysis of Equipage Levels

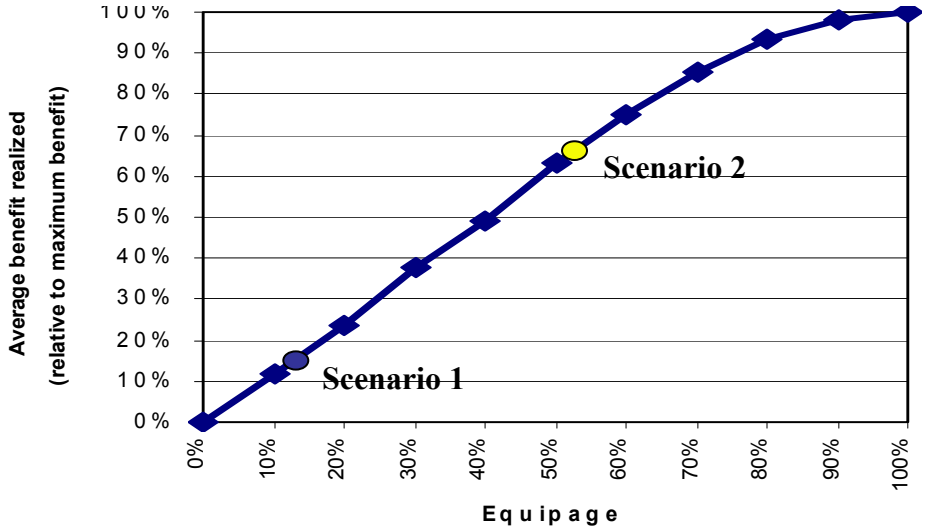
NAS: Approximately 7600 Registered Transport and Regional Aircraft in U.S.



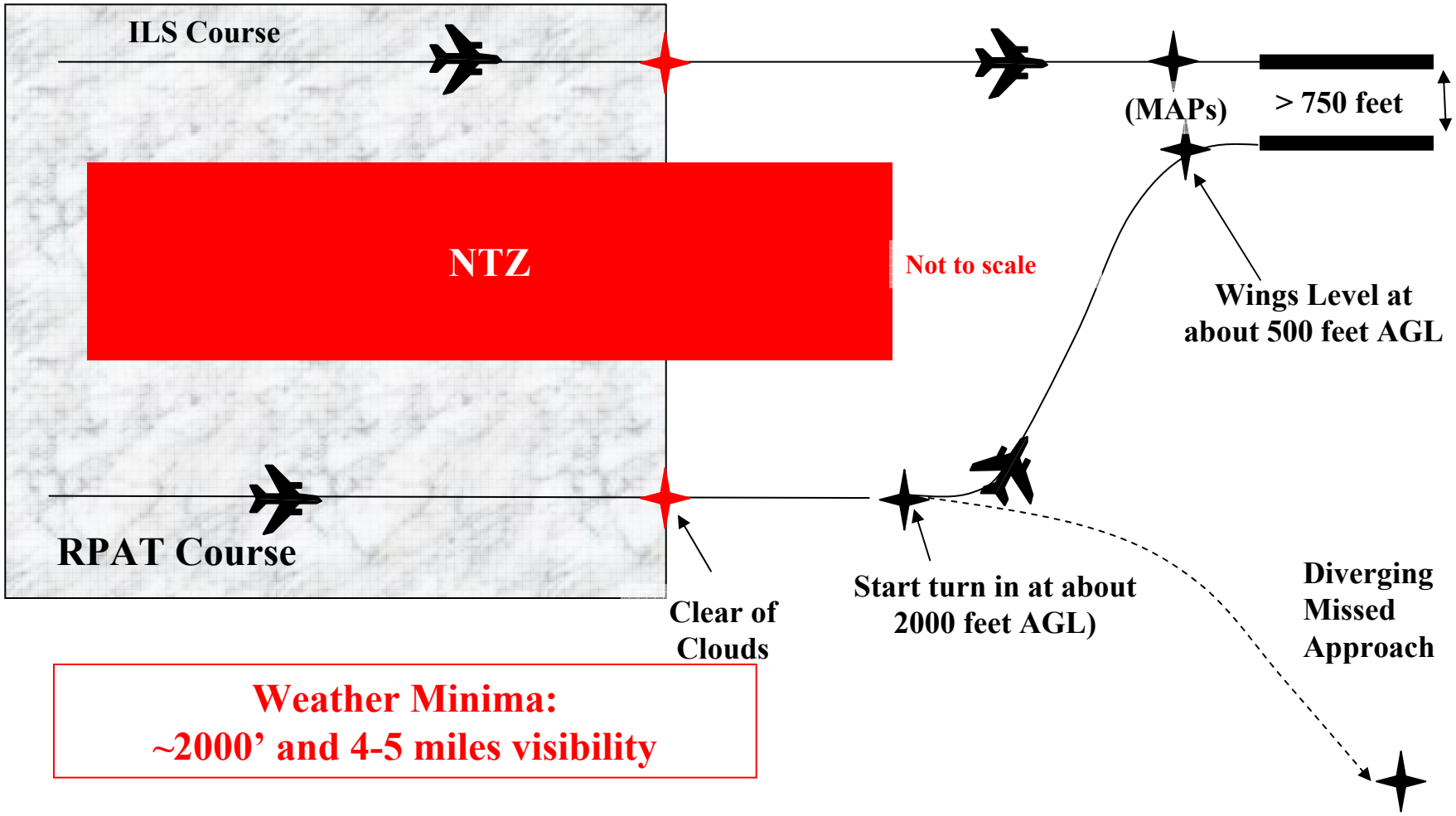
JFK Arrivals

95% RNAV Capable (*2/3 GPS*)





RNP Parallel Approach Transition (RPAT)



Weather Minima:
~2000' and 4-5 miles visibility