

Performance-Based Navigation: Area Navigation (RNAV) and Required Navigation Performance (RNP)

Presentation to: ICNS 2007

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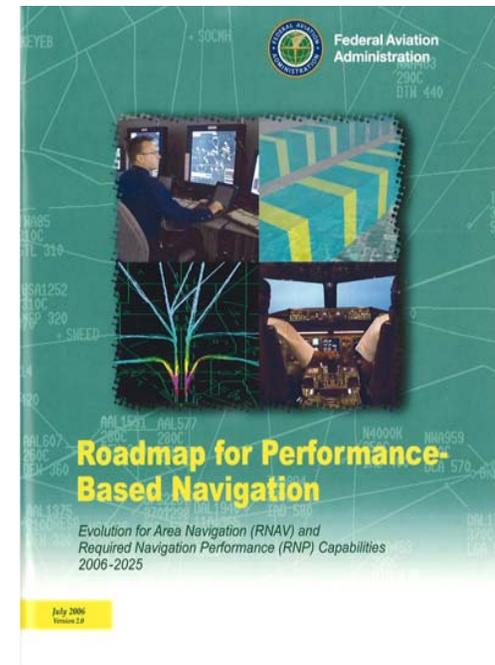


Federal Aviation
Administration



Updated *Roadmap* – August 2006

- Collaborative effort with aviation industry stakeholders via the Performance-Based Operations Aviation Rulemaking Committee (PARC)
- Three Planning Horizons
 - Near-term 2006 to 2010
 - Mid-term 2011 to 2015
 - Far-term 2016 to 2025
- Harmonization considerations
- Focuses on operational capabilities in:
 - En route domain
 - RNAV Q-Routes
 - RNAV Tango-Routes
 - Terminal domain
 - RNAV Standard Terminal Arrivals (STARs)
 - RNAV Standard Instrument Departures (SIDs)
 - Approach domain
 - RNP Special Aircraft and Aircrew Authorization Required (SAAAR)
 - RNP Parallel Approach Transition



Near Term (2006-2010)	Mid Term (2011-2015)	Far Term (2016-2025)
<p>En Route</p> <ul style="list-style-type: none"> <input type="checkbox"/> RNAV Q routes <input type="checkbox"/> RNP-2 routes <input type="checkbox"/> T routes and lower MEAs <input type="checkbox"/> Requirements to incorporate aircraft navigation capabilities into en route automation <p>Oceanic</p> <ul style="list-style-type: none"> <input type="checkbox"/> RNP-10 and 50/50 NM lat/long Pacific <input type="checkbox"/> RNP-10 and 60 NM lat in WATRS <input type="checkbox"/> Expand 30 NM longitudinal/30 NM lateral separation (30/30) in the Pacific <input type="checkbox"/> Explore RNP-4 in NAT <p>Terminal</p> <ul style="list-style-type: none"> <input type="checkbox"/> RNAV SIDs/STARs at OEP airports <input type="checkbox"/> RNP-1 SIDs/STARs where beneficial <input type="checkbox"/> Automation requirements for merging RNAV arrivals <input type="checkbox"/> Concepts for RNAV and RNP with 3D, constant descent arrivals (CDA), and time of arrival control <p>Approach</p> <ul style="list-style-type: none"> <input type="checkbox"/> At least 25 RNP SAAAR per year <input type="checkbox"/> 300 RNAV (GPS) per year <input type="checkbox"/> Standards for closely spaced and converging runway operations based on RNP 	<p>En Route</p> <ul style="list-style-type: none"> <input type="checkbox"/> RNP-2 routes <input type="checkbox"/> T routes and lower MEAs <input type="checkbox"/> Enhanced automation incorporating aircraft navigation capabilities <input type="checkbox"/> At end of mid term, mandate RNP-2 at and above FL290, and mandate RNAV at and above FL180 <p>Oceanic</p> <ul style="list-style-type: none"> <input type="checkbox"/> Limited RNP-4 and 30 NM lat in WATRS <input type="checkbox"/> Increase use of operator-preferred routes and dynamic re-routes <p>Terminal</p> <ul style="list-style-type: none"> <input type="checkbox"/> RNAV SIDs/STARs at many of the top 100 airports <input type="checkbox"/> RNP-1 or lower SIDs/STARs where beneficial <input type="checkbox"/> Airspace redesign and procedures for RNAV and RNP with 3D, CDA, and time of arrival control <input type="checkbox"/> At the end of mid term, mandate RNAV for arriving/departing at OEP Airports <p>Approach</p> <ul style="list-style-type: none"> <input type="checkbox"/> At least 50 RNP per year <input type="checkbox"/> 300 RNAV (GPS) per year <input type="checkbox"/> Closely spaced parallel and converging runway operations based on RNP <input type="checkbox"/> Satellite-based low visibility landing and takeoff procedures (GLS) 	<p>Performance-Based NAS Operations</p> <ul style="list-style-type: none"> <input type="checkbox"/> RNP Airspace at and above FL290 <input type="checkbox"/> Separation assurance through combination of ground and airborne capabilities <input type="checkbox"/> Strategic and tactical flow management through system-wide integrated ground and airborne information system <input type="checkbox"/> System flexibility and responsiveness through flexible routing and distributed decision-making <input type="checkbox"/> Optimized operations through integrated flight planning, automation and surface management capabilities <input type="checkbox"/> Mandate RNAV everywhere in CONUS <input type="checkbox"/> Mandate RNP in busy en route and terminal airspace

RNAV/RNP Accomplishments and Plans

Description	Actual FY05/06	Publication Plan FY07	FY07 Publication Projection
RNAV T/Q-Routes and GPS MEAs	57	12	14
SIDs/STARs	107	50+	68
RNP SAAAR (includes RPAT)	34 Published Add'l 5 Developed	25+	40
NY Helicopter RNAV (GPS)	NA	5	5
Total	198	92+	127

Note: En Route Automation Modernization (ERAM) Implementation Impact under Review



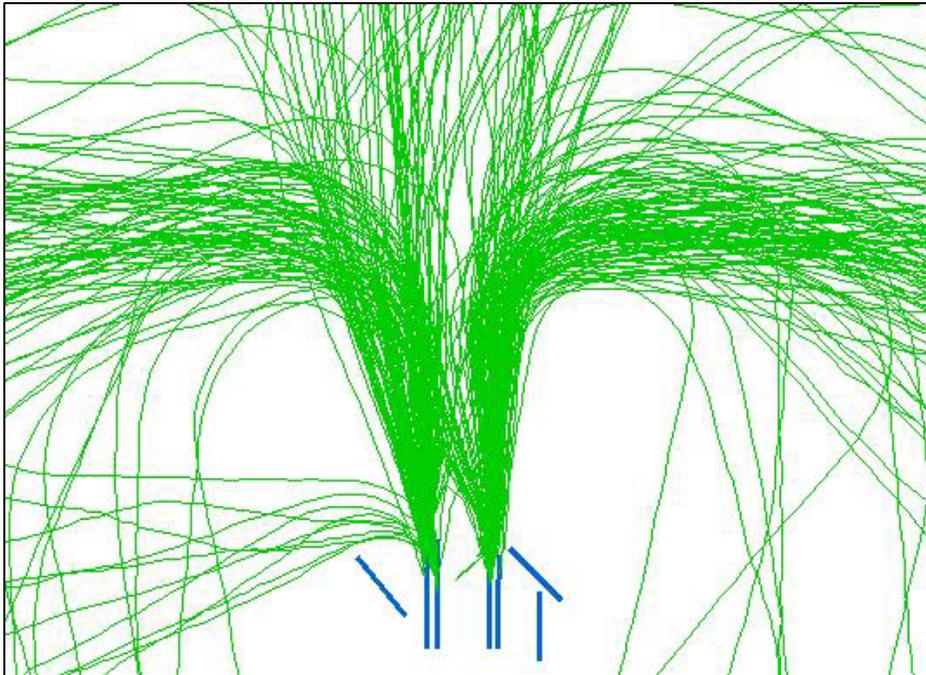
RNAV Production Plan- FY2007

- Anaktuvuk, AL
- Atka, AK
- Baltimore/Washington
- Burbank-Glendale-Pasadena, CA
- Charlotte/Douglas International, NC
- Chicago Midway
- Chicago O'Hare
- Covington/Northern Kentucky, KY
- Fort Meyers, FL
- Glendale, AZ
- Hartsfield-Jackson Atlanta
- Holyoke, CO
- Long Beach, CA
- Los Angeles International
- McCarran International, Las Vegas
- Memphis International
- Minneapolis-St. Paul International
- Newark Liberty International
- Nucla Hopkins Field, CO
- Perryville, AK
- Phoenix Sky Harbor International
- Portland International, OR
- San Diego-Lindbergh Field
- Santa Ana/John Wayne, CA
- Santa Monica, CA
- Seattle-Tacoma International
- Tampa International
- Tucson International



Dallas/Fort Worth RNAV Implementation

KDFW Radar Vector SIDs



KDFW RNAV SIDs



Estimated Benefits to Carriers (fuel savings) at 84 percent RNAV participation

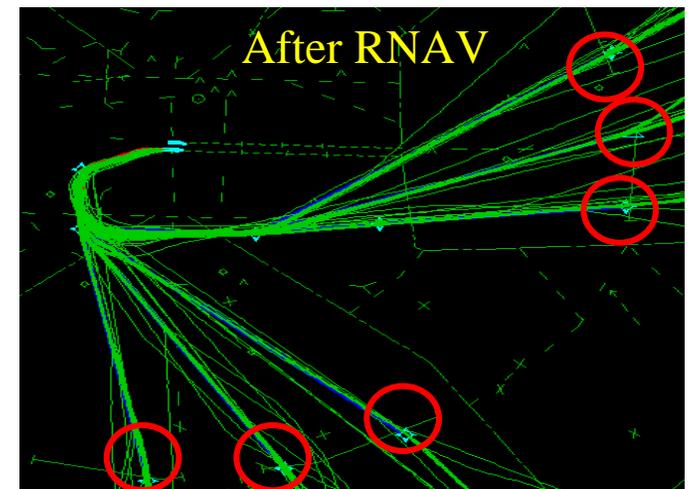
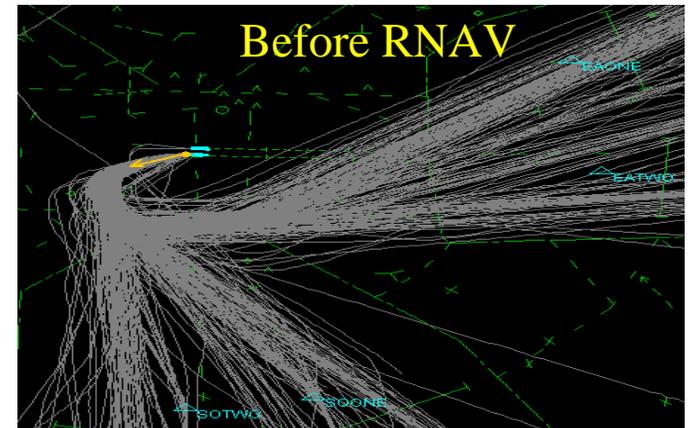
- \$8.5M per year (2005 implementation)
- RNAV participation from 84 to 100 percent

Departure Capacity Benefits

- 11 to 20 additional departure operations per hour

Atlanta RNAV Departures

- 90% of 1350 daily IFR departures RNAV capable
- Structured “lanes” to en route airspace
- Over 4,000 routine daily pilot/controller voice transmissions eliminated (~40% to 50%)
- ATC productivity gains ~ 20% to 30%
- Operator efficiency & fuel savings estimated ~ \$34M in annual savings
 - Decreased taxi times
 - Decreased departure delays
 - East flow est average 2.6 min reduced delay ~ 1 million gal/year
 - West flow est average 4.6 min reduced delay ~ 3 million gal/year
 - Improved flight profiles
 - Reduced distances
- **Departure Capacity Benefits**
 - 10 additional departure operations per hour

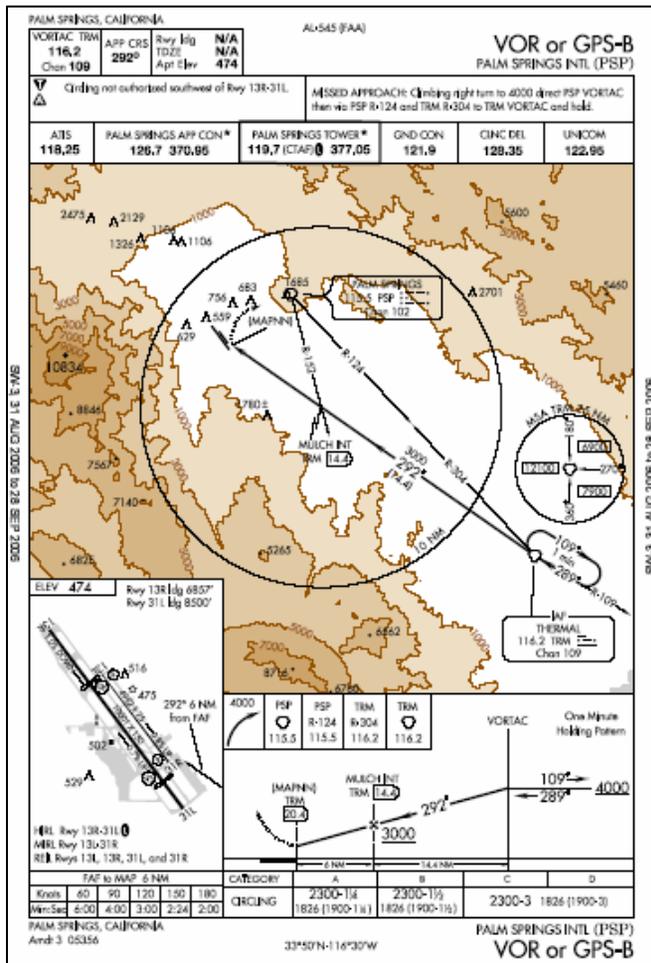


RNP SAAAR Production Sites FY 2007

- Baltimore/Washington Int'l
- Bishop/Eastern Sierra Regional, CA
- Dallas-Fort Worth International
- Dekalb-Peachtree, GA
- Friedman Memorial, Hailey, ID
- George Bush Intercontinental/Houston
- Hartsfield-Jackson Atlanta
- Honolulu International
- Jackson Hole, WY
- Long Beach (Daugherty Field), CA
- Minneapolis-St. Paul International
- New York/LaGuardia
- San Francisco International
- Washington Dulles International
- Will Rogers World, OK

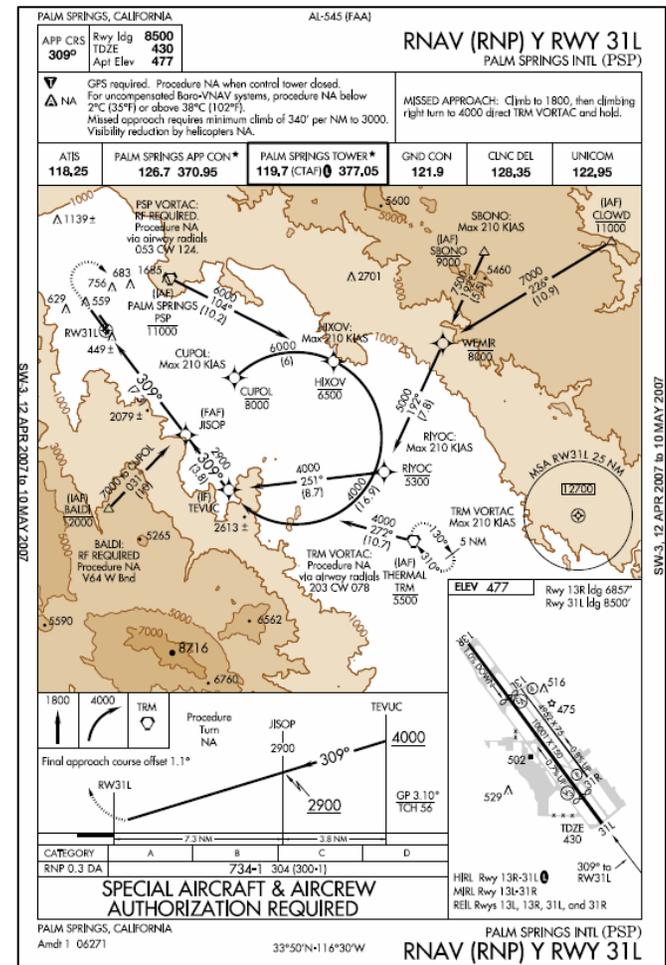


RNP AR Approach Example: Palm Springs, CA (KPSP)



Minima 2300 (1900) -3

- ✓ Replaces non-precision approach into an airport in mountainous terrain – Conventional NAVAID could not support
- ✓ Safety enhanced, with guided, stabilized 3D path to runway
- Minima lowered by 1600 ft & 2 miles



Minima 734 (300) - 1



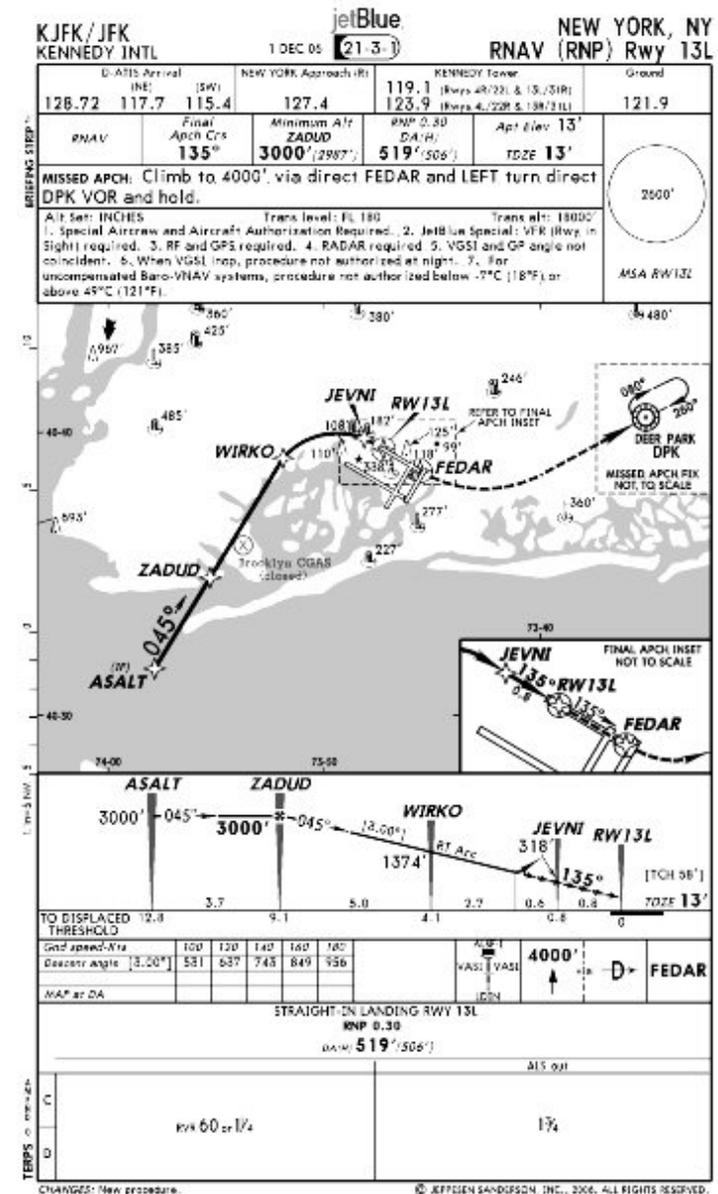


RNP SAAAR

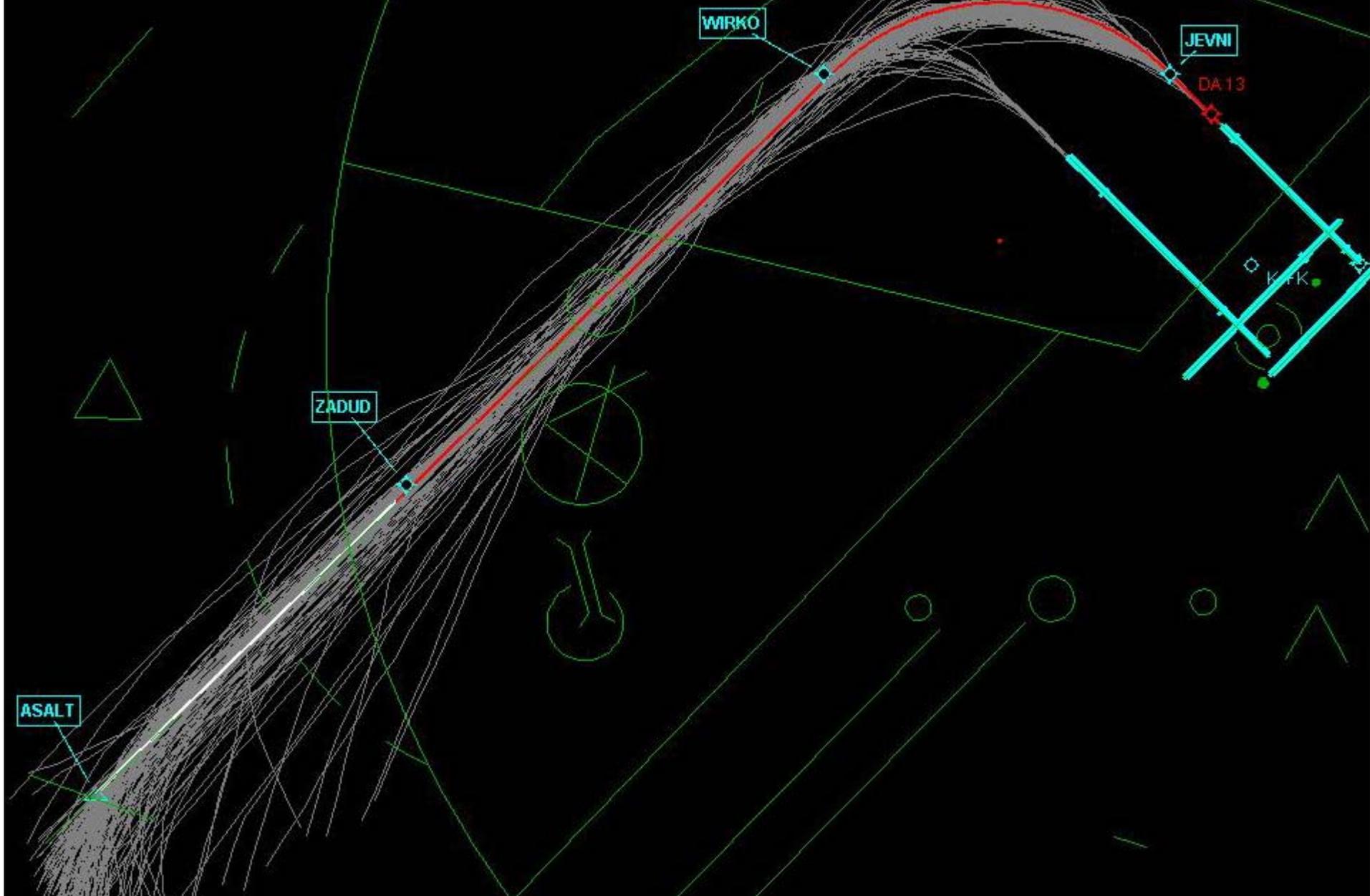
Benefits of Adjacent Airport De-Confliction

Airport	Delays (minutes per year)		Cancellations (per year)		Cost (per year)
	Departures	Arrivals	Departures	Arrivals	
JFK	5,105	1,953	34 more	46 more	\$1,000,000
LGA	10,925	10,051	153 more	151 more	\$2,700,000

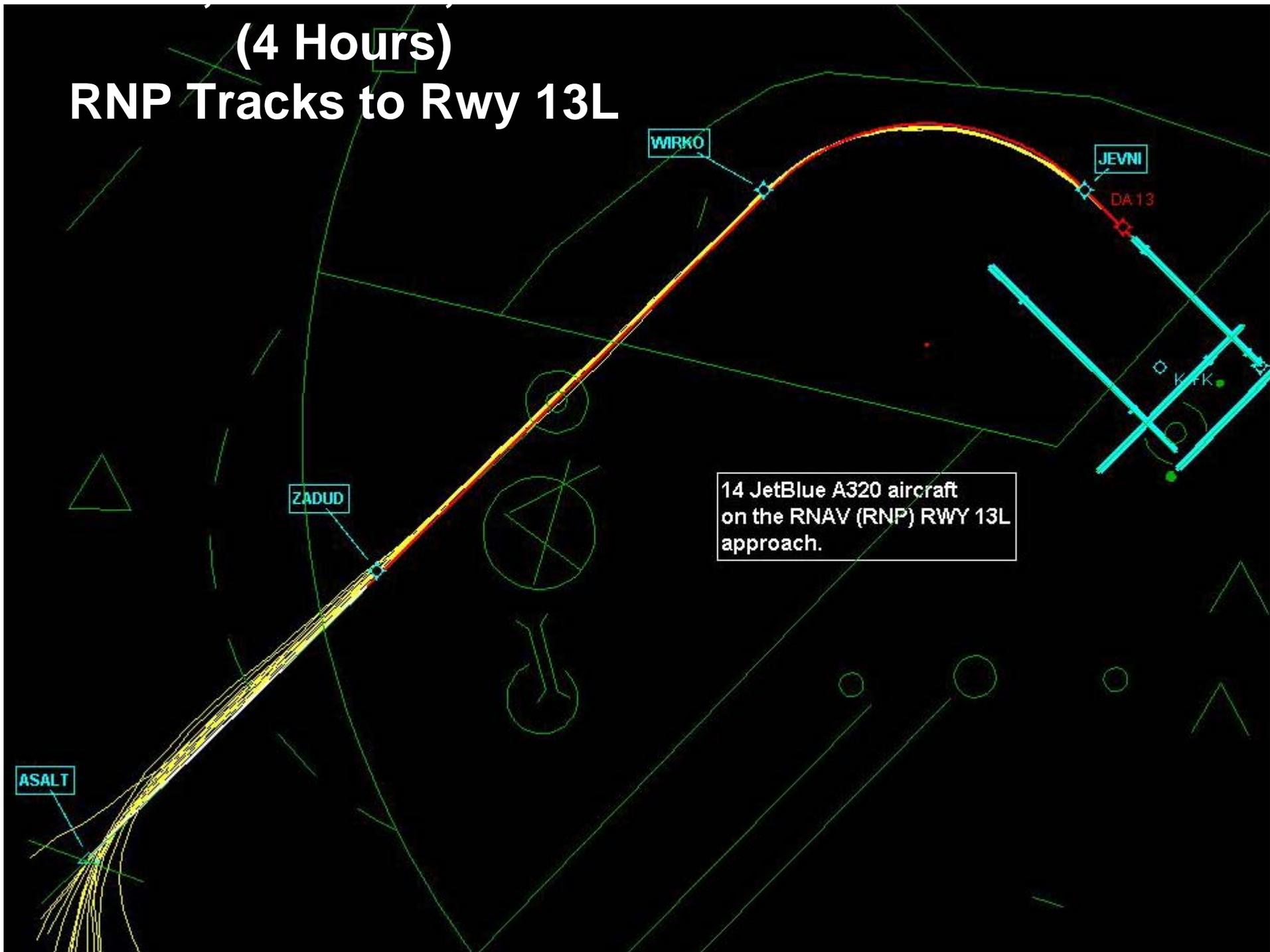
- Results based on analysis of historical records of delays and cancellations (ASPM 2003) during certain weather and wind conditions



(4 Hours) All Radar Tracks to Rwy 13L

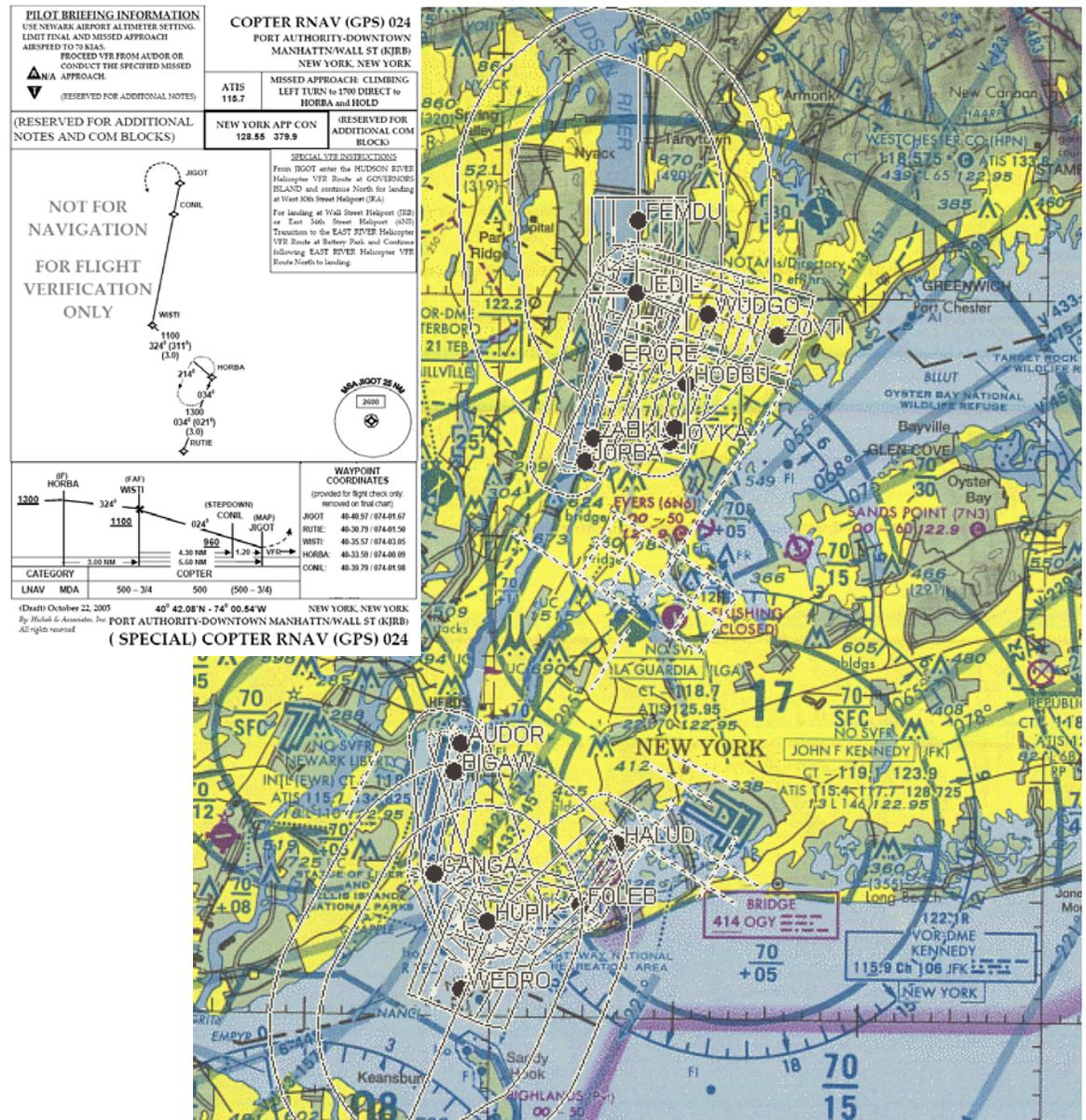


(4 Hours) RNP Tracks to Rwy 13L



PBN: Vertical Flight

- Under development in FAA
 - Identification of Helicopter Stakeholders requirements and priorities
 - Development of design criteria, operations and airworthiness guidance to realize benefits from helicopter unique capabilities
- Pilot implementation project
 - New York City - 5 RNAV (GPS) Point in Space approaches
 - Allows helo traffic to fly to several heliports without entering the fixed wing traffic stream for KJFK or KLGA
 - Expected operational by July 2007
 - Eventual transition to Helicopter RNP criteria now in development



Ongoing Industry Challenges

- **FMS Programming**
 - Initial runway entry
 - Runway changes and verification
 - Entry of en route transitions
- **Databases**
 - Validation
 - Implementation
- **Training**
 - Track compliance/leg and waypoint type
- **Equipage**
- **RNP SAAAR Approval Process**



International Activities

- **ICAO RNP Special Operations Requirements Study Group - primary forum for harmonization**
 - Australia, Brazil, Canada, EUROCONTROL, France, Japan, United Kingdom, United States, IATA, ICCAIA, IFALPA are members
 - Rewrite of ICAO Doc 9613, *Performance-Based Navigation Manual*
 - Globally consistent definitions of RNAV and RNP
 - Harmonized Europe's P-RNAV and US RNAV
 - Performance-Based Navigation implementation considerations & guidance
 - Final draft published on ICAO website

International Activities

- **PBN Manual Familiarization Seminars to be held in all ICAO Regions**
 - Prototype seminar to be held at ICAO in June 2007
 - These seminars will be presented from September 2007 through summer of 2008
 - ICAO will use the feedback solicited through these seminars to determine if any changes to the revised PBN Manual are needed, and then issue a final publication



Guidance Material Update: AC 90-100A (US RNAV to ICAO RNAV 1, RNAV 2)

- New AC provides connectivity with proposed ICAO standards for RNAV 1 and RNAV 2
 - Airworthiness performance issues listed in Appendices 1 (DME/DME), 2 (DME/DME/IRU) and 3 (Functional Requirements)
 - Incorporates operational lessons learned
 - Addresses DME/DME/IRU and GPS systems only
 - Places greater emphasis on data integrity
 - Describes operational expectations for pilots
- Previous predictive-RAIM procedures in effect to March 2008



Questions?

