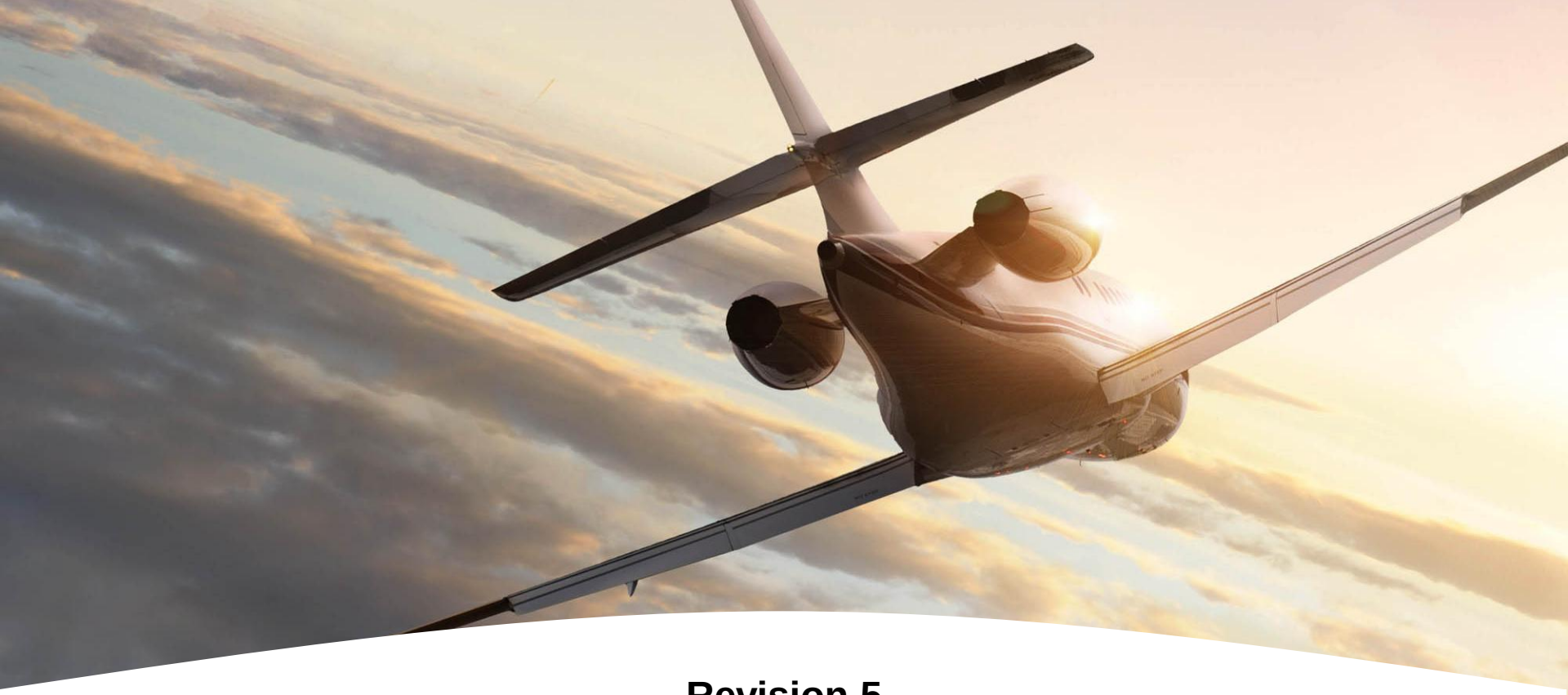

Revision 5

Revision Date: 02/21/2012

NextGen Concepts and Avionics Technology

Honeywell

SBAS-LPV, RNP, CPDLC and ADS

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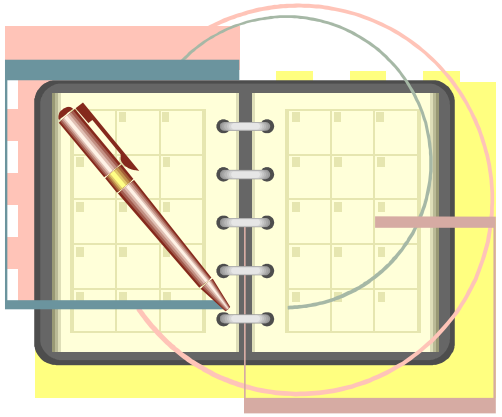
Agenda

- **SBAS – LPV Overview**



Acronyms

- SBAS – Satellite Based Augmentation System
- WAAS – Wide Area Augmentation System
- LPV – Localizer Performance Vertical
- LP - Localizer Performance only (no vertical guidance) minima being developed as well but NOT currently supported by Honeywell platforms
- GBAS(LAAS) – Ground Based Augmentation System
- PBN – Performance Based Navigation
  - Previously exclusionary to RNP only

SBAS Defined

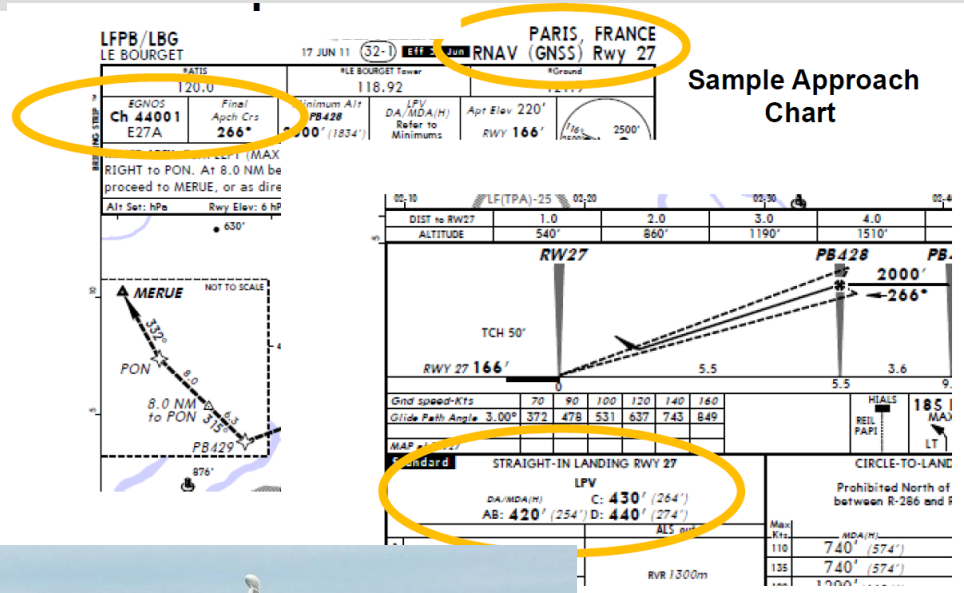
- Provides GPS signal corrections to give better position accuracy comparable to an ILS Category 1 (precision approach) system
- Use of LPV approaches capitalizes on the inherent accuracy of the SBAS signal and will result in lower approach minimums
- Enables vertical approaches at airports where there are no instrument landing systems
- Although system is functionally capable of LP performance, it has not yet received approval

SBAS History

- Prior to SBAS, GPS was not able to provide the accuracy or integrity to CAT 1 minimums
- 2003 - WAAS signal was activated for public use
- 2011 - WAAS LPV approaches now outnumber ILSs more than 2:1 (more than 2700 LPV approaches published)
- 2012 + Plan is to add 500 approaches per year
  - FAA Website (faa.gov)

EGNOS APV Testing and Rollout

- **First LPV approaches with certified EGNOS system tested by Dassault F900 EX (EASy II) March 2011**
- **LPV (APV) approaches to be published in Europe in 2012**
  - **France – 11**
  - **UK – 1**
  - **Switzerland – 2**



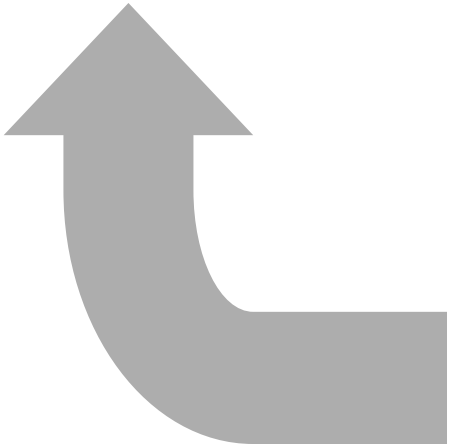
Sample Approach Chart

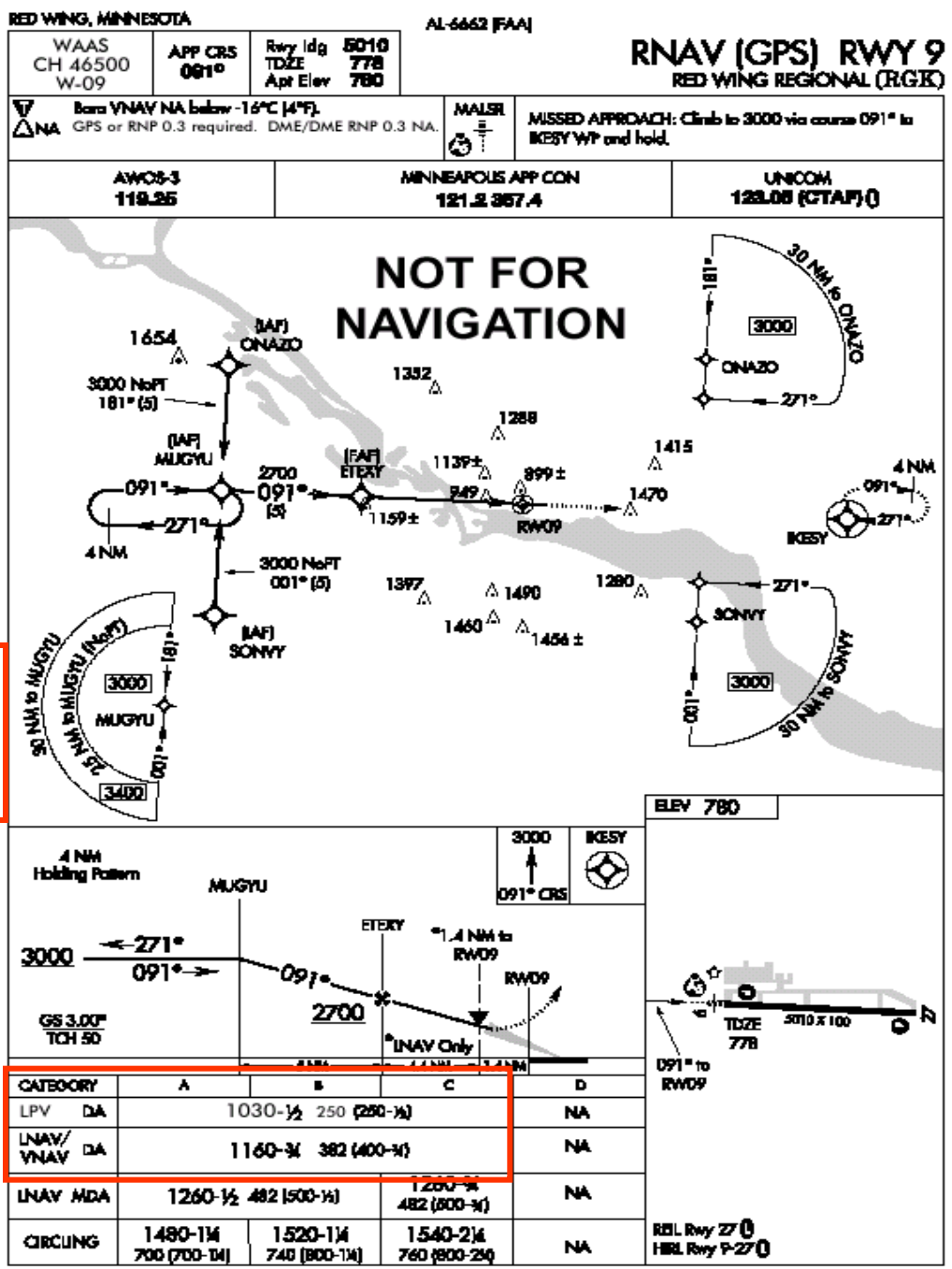
Honeywell

The LPV Approach

- **Currently over 2700 published in the U.S. as of 4Q 2011**
- **Plan is for 500 per year**

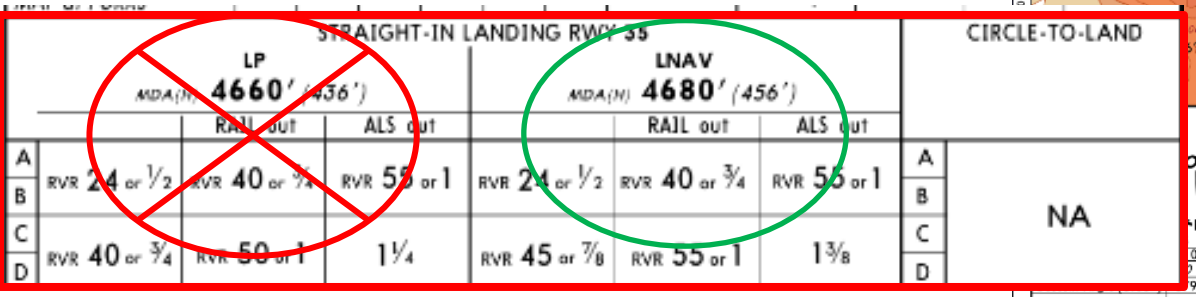
LPV	DA	1030 – ½	250	(250 – ½)
LNAV/ VNAV	DA	1160 – ¾	382	(400 – ¾)

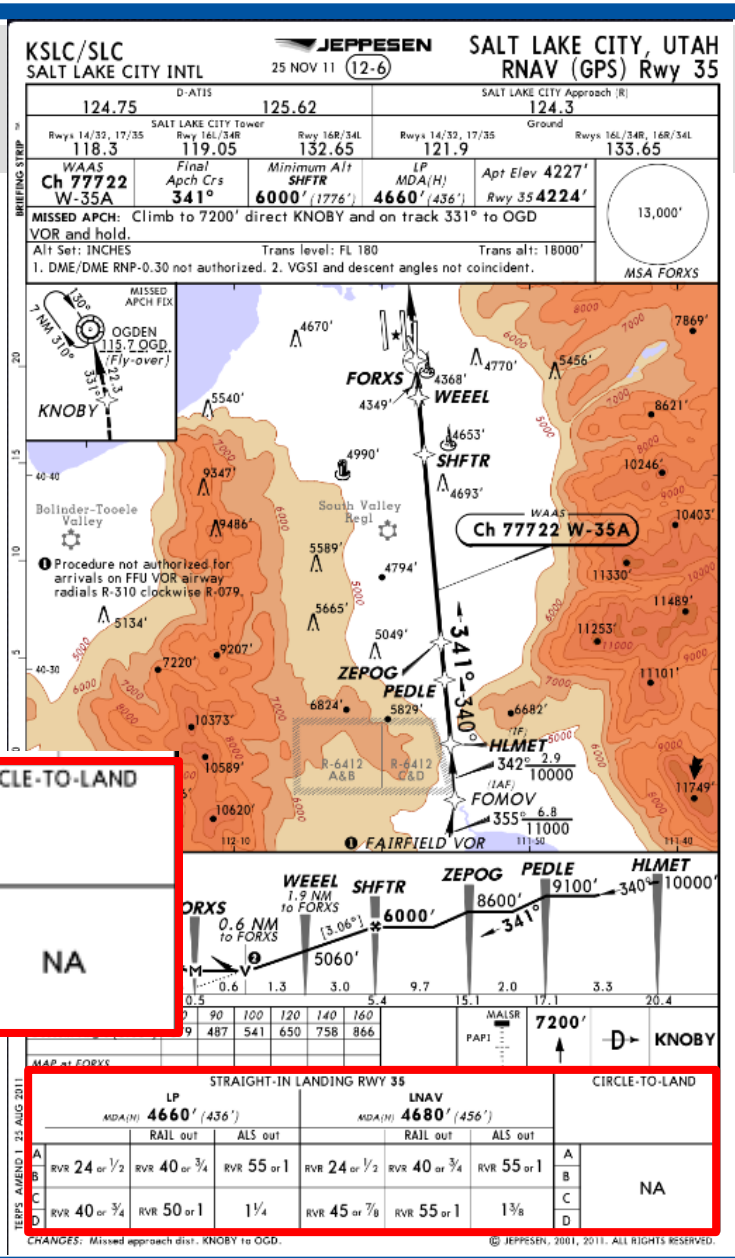




The LP Approach

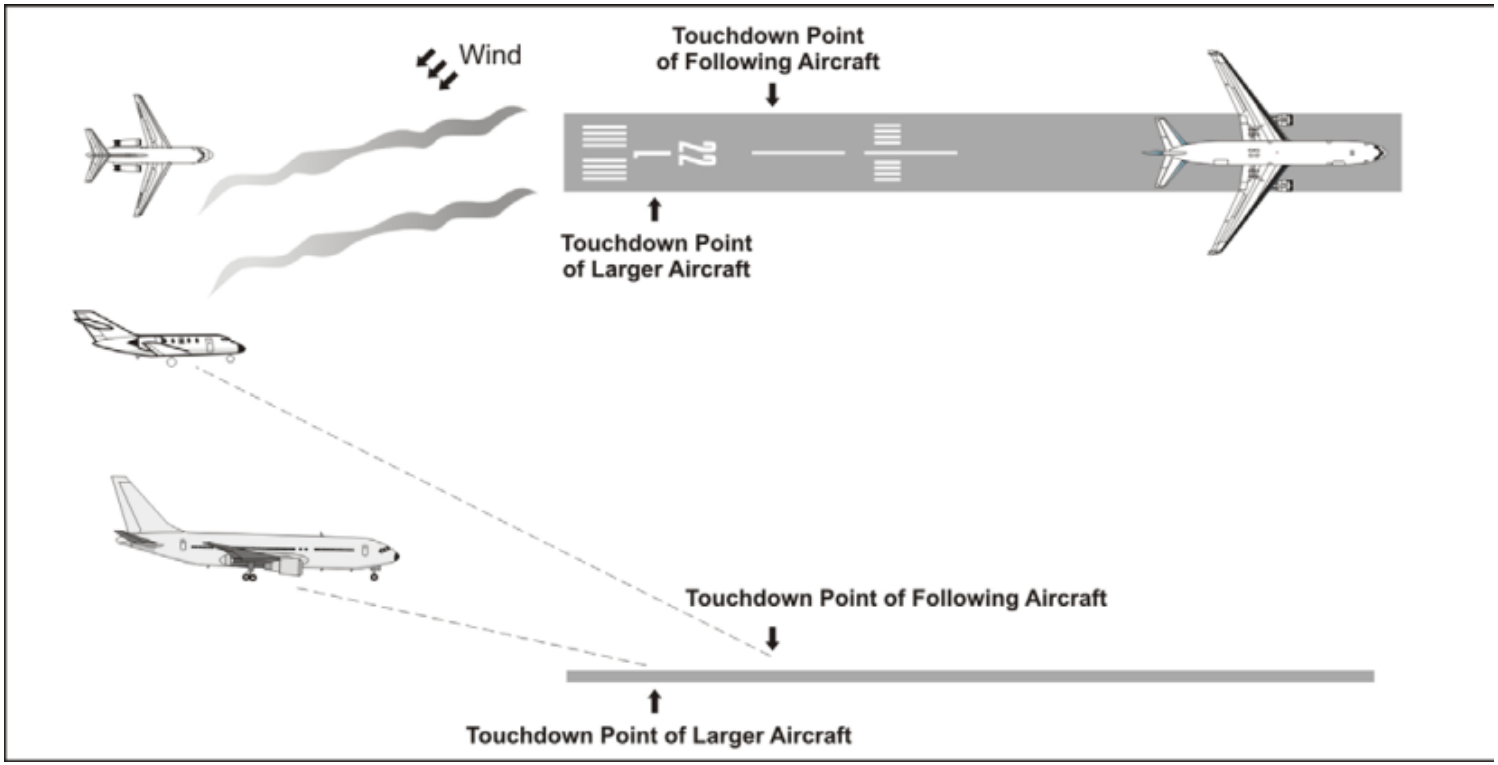
- **Introduced in 2011 in areas that would not support LPV (terrain)**
- **165 in effect**
- **Not supported by Honeywell platforms at this time**





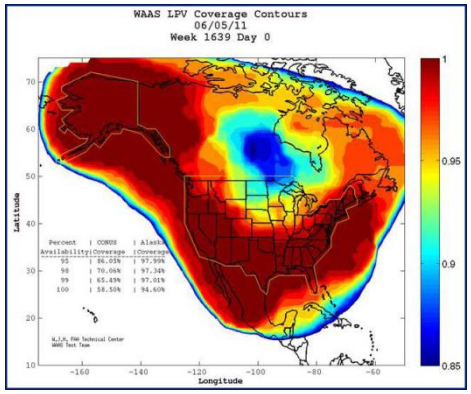
Future of WAAS/SBAS

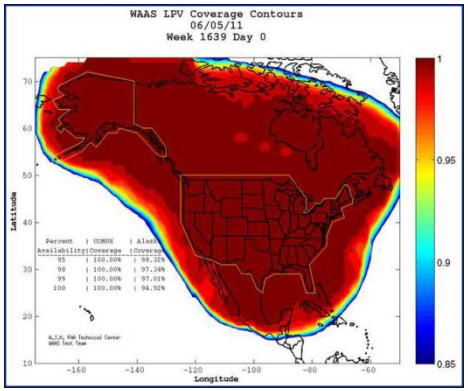
- **Wake turbulence avoidance**



Future of WAAS/SBAS

- **Being upgraded for greater "Iono Robustness"**



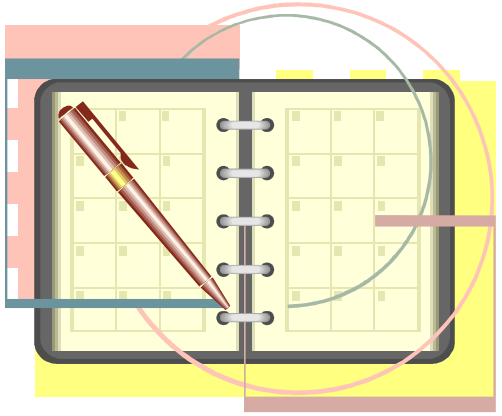


- **Migration to a dual-frequency system by 2018**
  - Will allow receivers to directly measure and correct for ionospheric delays

- **GBAS testing being implemented at IAH, EWR**
  - Part of roadmap to Cat II/III operations

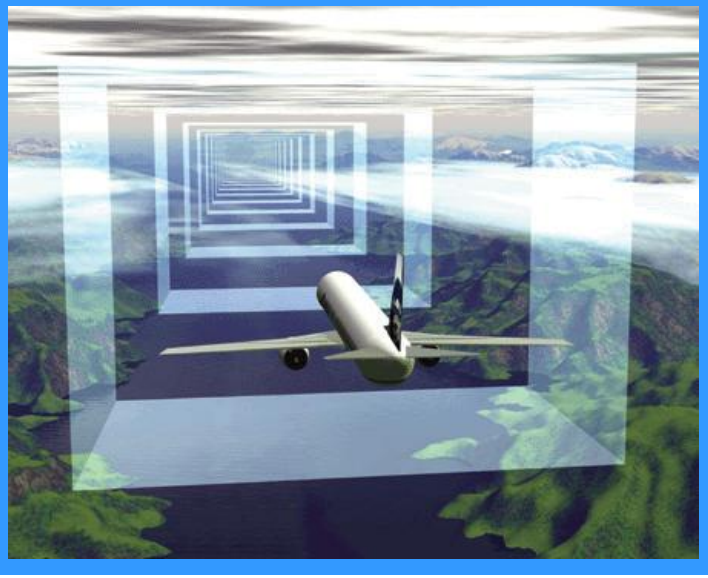
Agenda

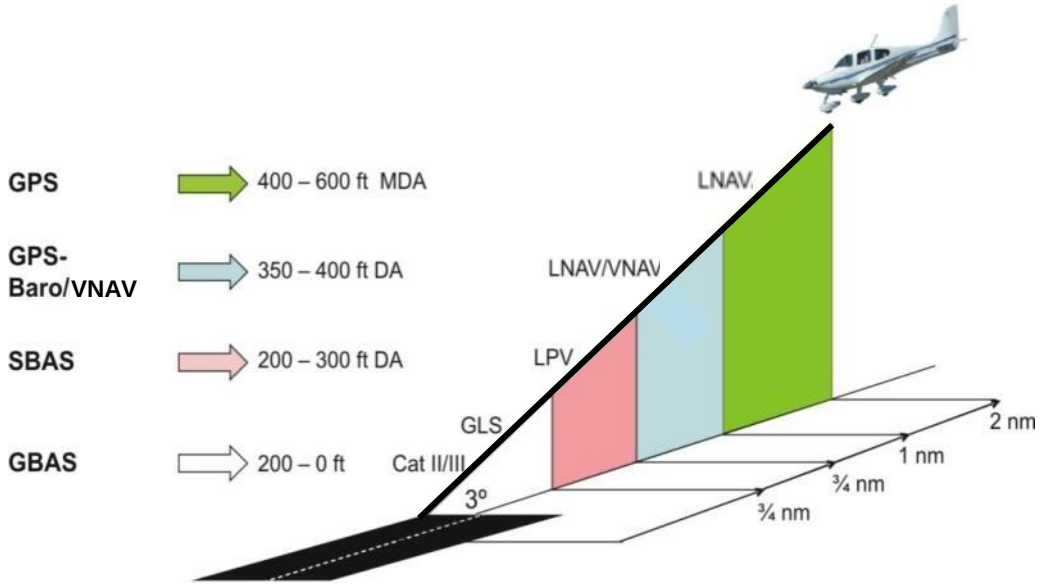
- **Required Navigation Performance (RNP) Overview**



Required Navigation Performance (RNP)

RNP is a statement of the navigation performance necessary for operations within a defined airspace defined in nautical miles

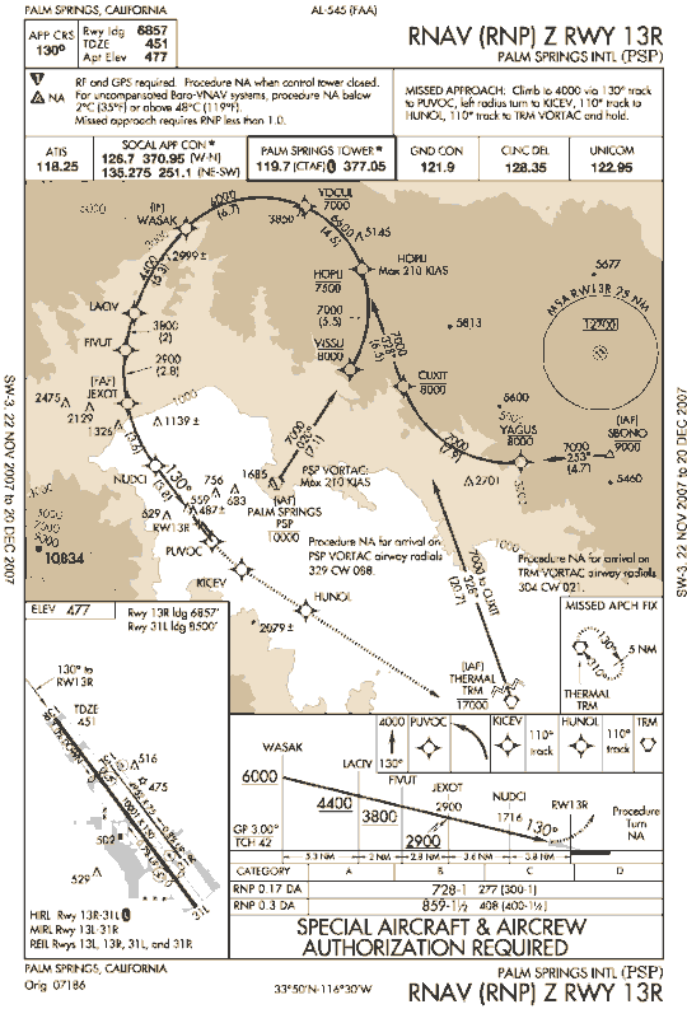




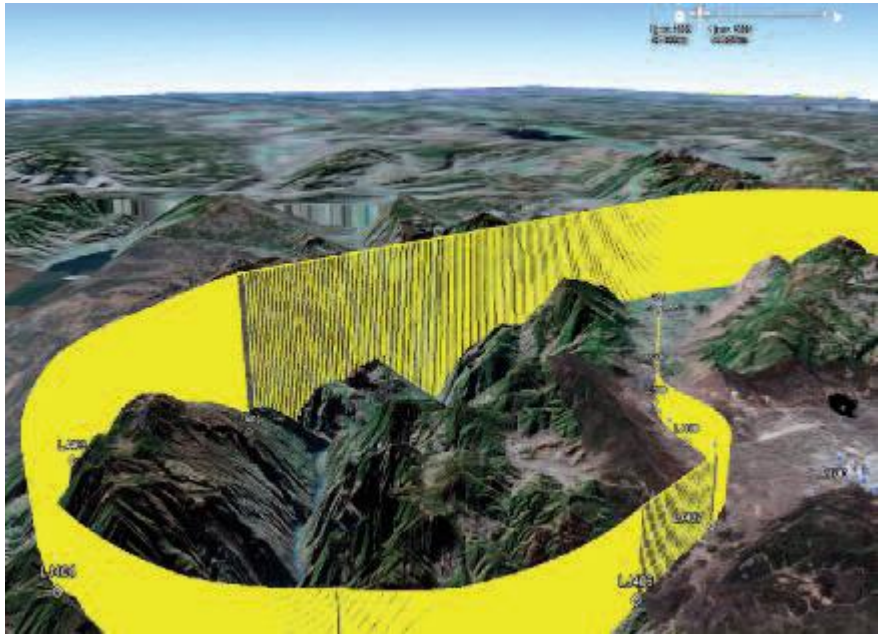
Onboard avionics capable of navigating the aircraft within a tightly specified airspace corridor

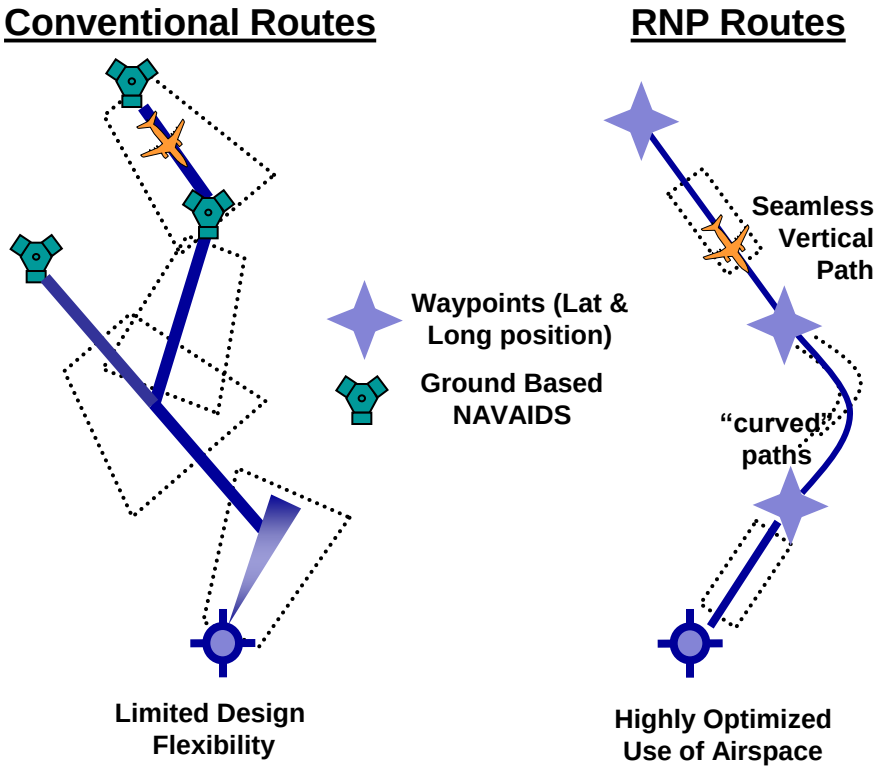
RNP AR Definition

- **RNP AR**
  - Same as SAAAR – Special Aircraft and Aircrew Authorization Required
  - Guidance per AC 90-101A and AMC 20-26
  - Special approaches which require additional LOA and FAA approval
  - Aircraft requires AFM statement detailing compliance to AC 90-101A
  - Pilot training currently being conducted at FSI and CAE as an enrichment course (pilots only need one sign off to fly all approaches)



Conventional vs. RNP Route Comparison





- **New regulatory guidance defines the move to lower RNP**
  - *AC 90-101a – Approval Guidance for RNP Procedures with AR*
  - *EASA NPA 2008-14 / AMC 20-26 RNP- Authorization Required*

RNP keeps aircraft in a tightly defined corridor

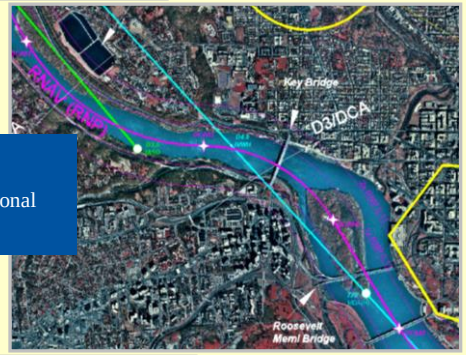
RNP Operational Benefits

- **Improved Access to Airports & Airspace**
  - Obstacle clearance enabling better access to
    - Terrain challenged airports
    - Congested Airspaces
    - Restricted airspace challenged airports
  - Lower minimums

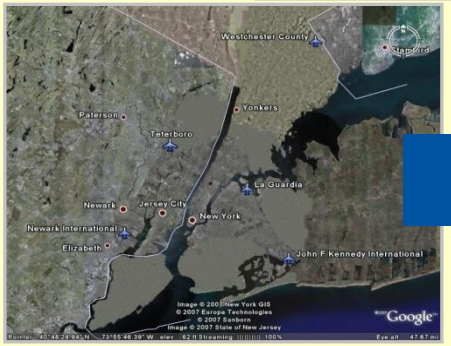
- **Efficiency of Operations**
  - Time savings
    - Shorter routes
  - Fuel savings
  - Improved noise footprint

- **Safety**
  - Clearly defined lateral and vertical flight paths = stabilized approach
  - Enhanced situational awareness
  - Missed approach procedures clearly defined

Terrain
E.g. Juneau, Alaska



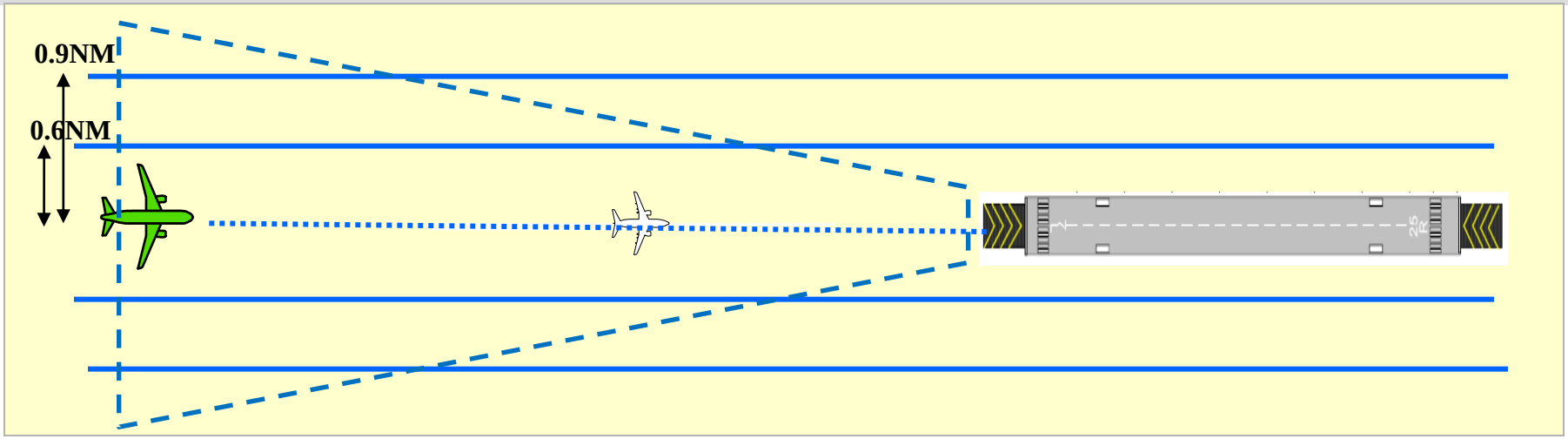
Airspace
E.g. Washington National



Traffic
E.g. New York Area

RNP AR Supports Green Initiatives!

Approach Design Criteria



Approach Design Criteria

- **For RNP AR (AC 90-101A)**
  - Obstacles are assessed within 2 X RNP (2 X 0.3 = 0.6) NM from either side of course
- **For RNAV GPS**
  - Obstacles will be assessed within ~3 X RNP (3 X 0.3 = 0.9) NM from either side of course
  - Similar to how GPS approaches are designed today
- **For WAAS LPV**
  - Obstacles will be assessed with a trapezoidal containment region similar to an ILS

RNAV (RNP) Approaches (Public)

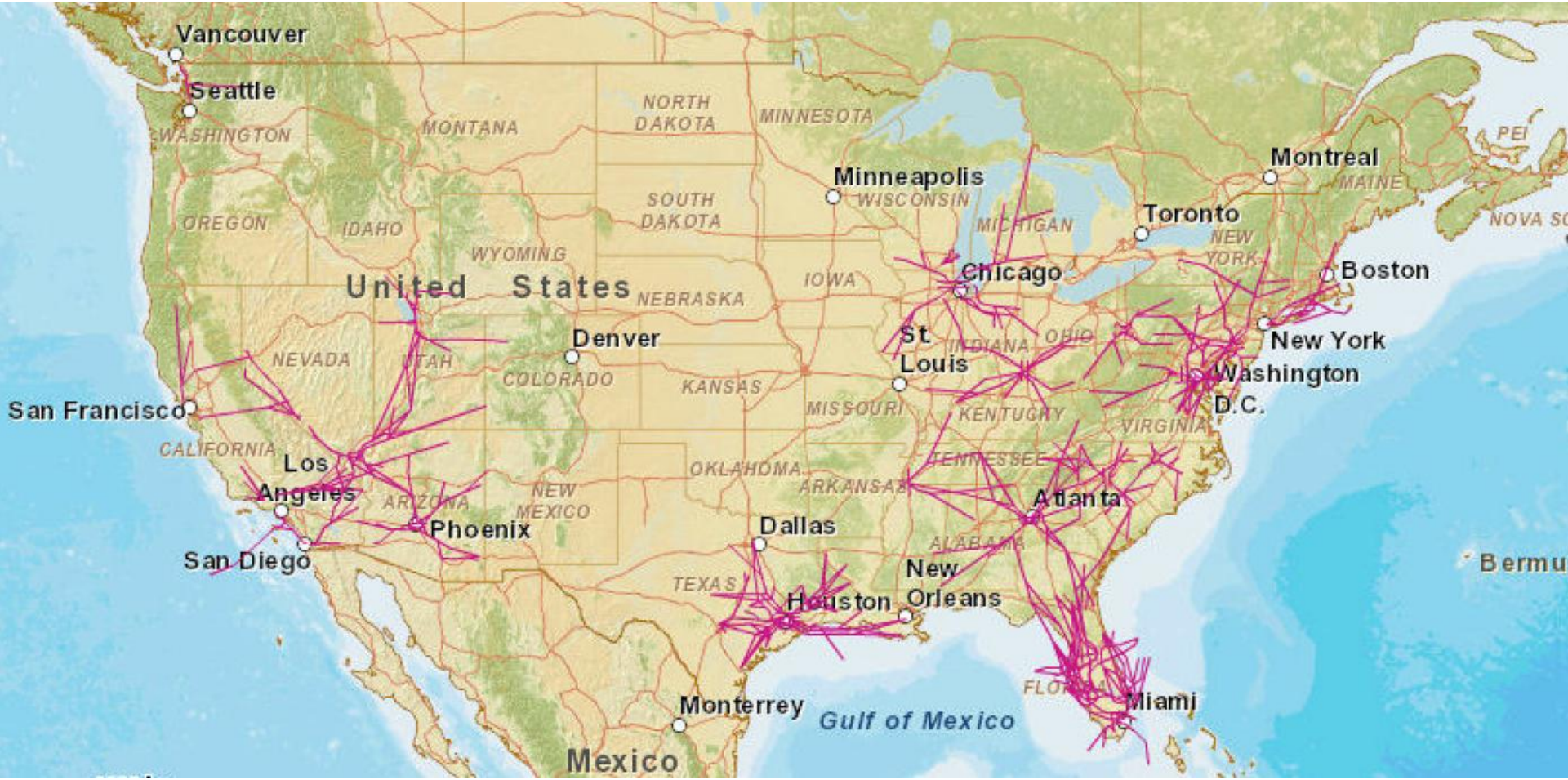
65+ Airports…..289 Approaches

RNAV SIDS

408 SIDS

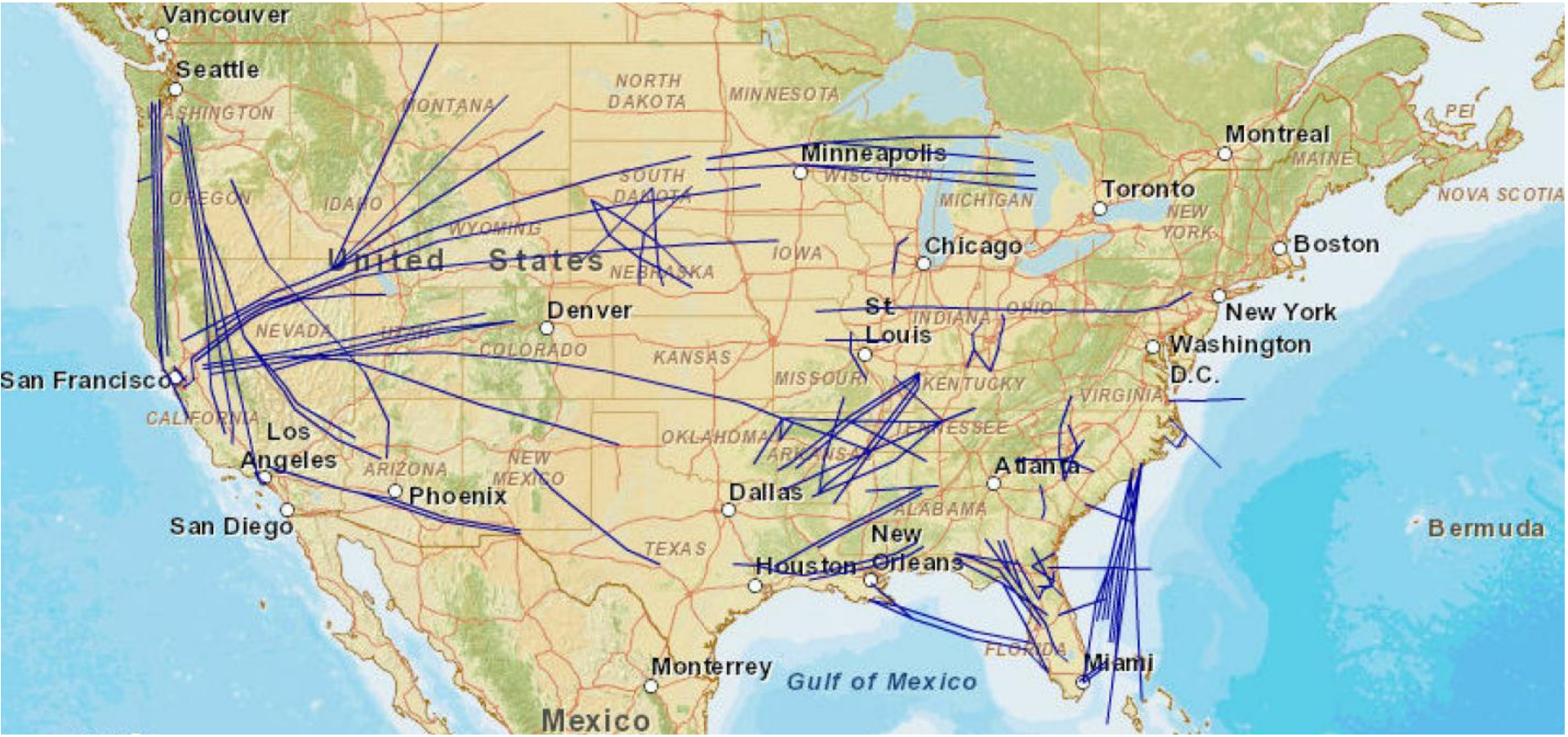
RNAV STARS

367 STARS

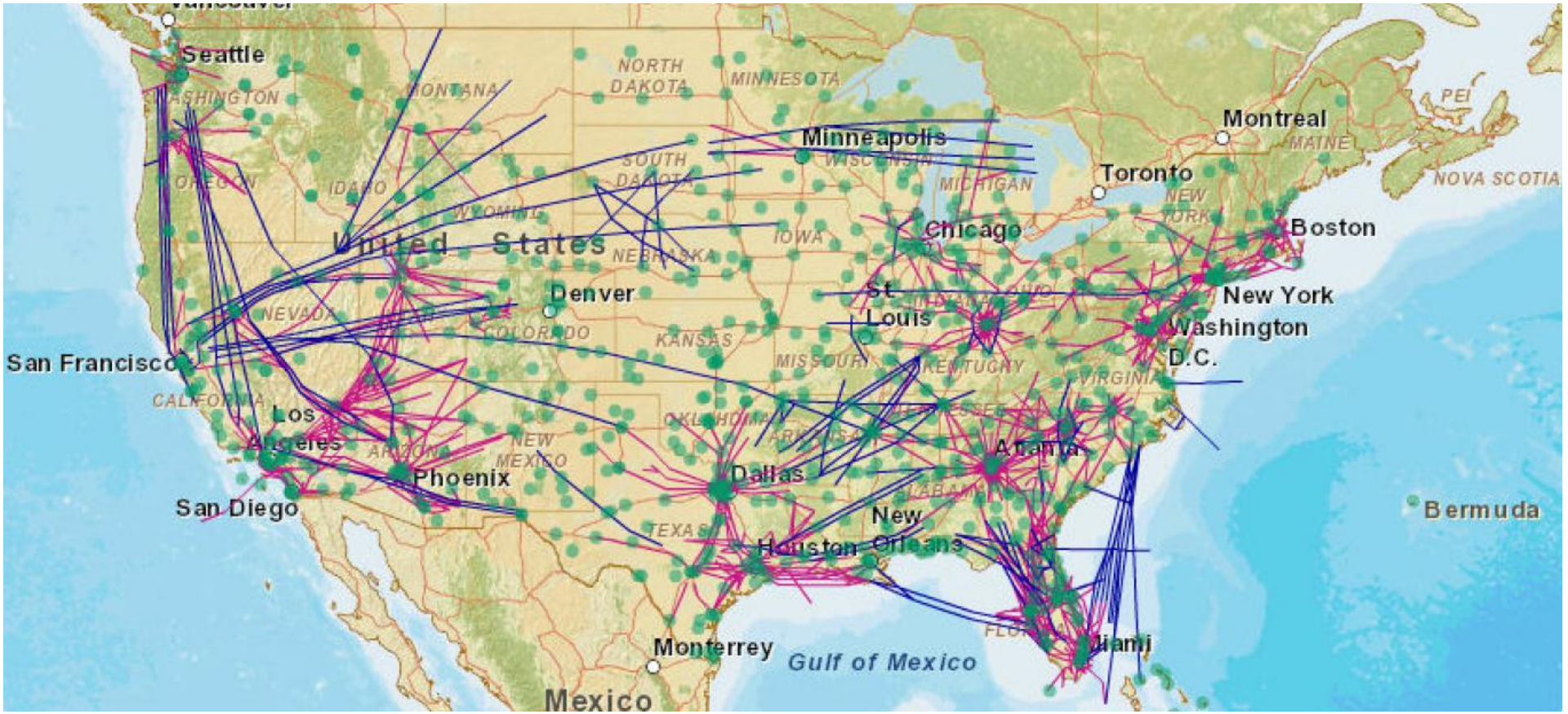


“Q” and “T” Routes

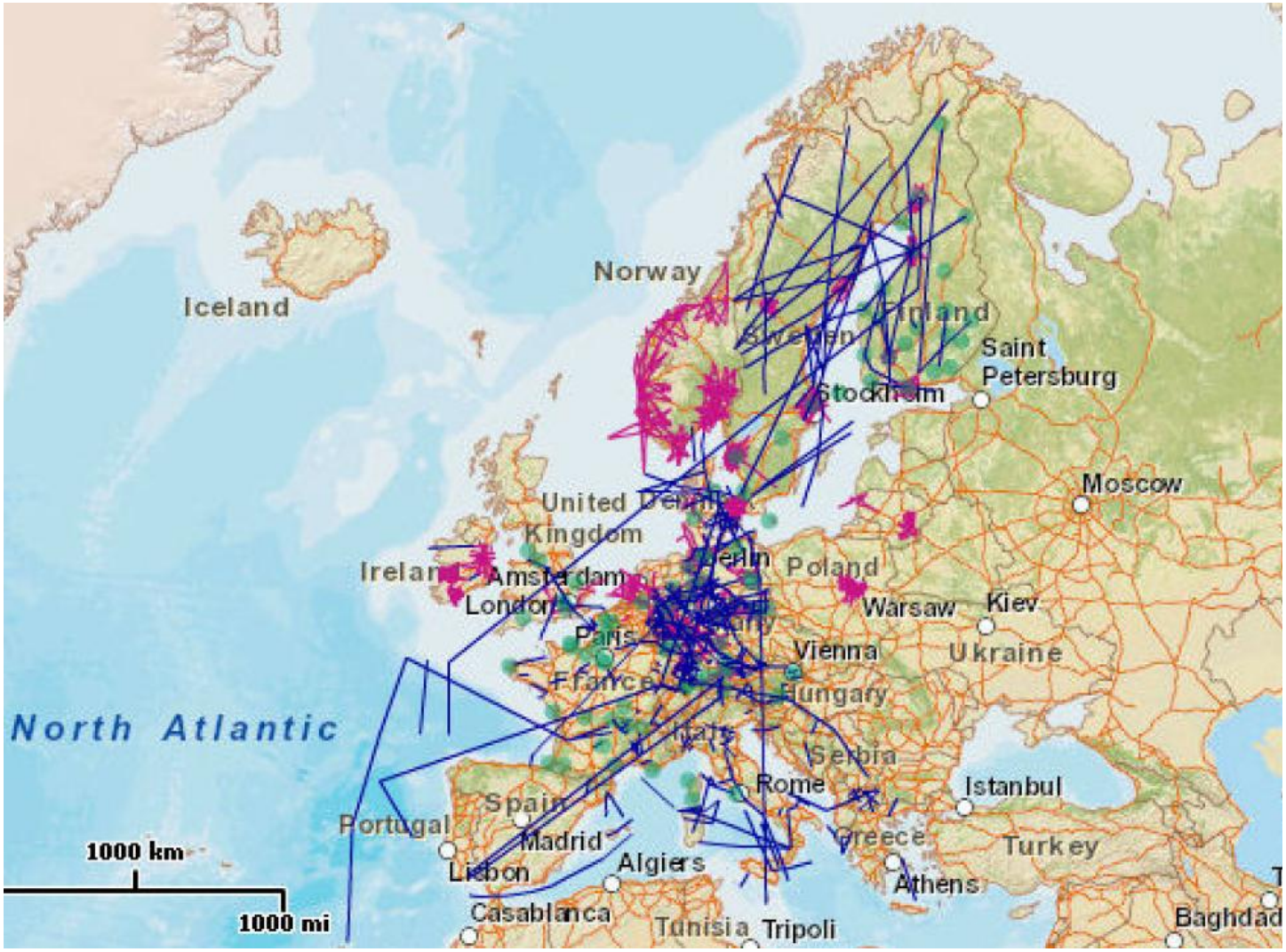
82 Q Routes / 73 T Routes



US all RNAV and RNP



Europe all RNAV and RNP

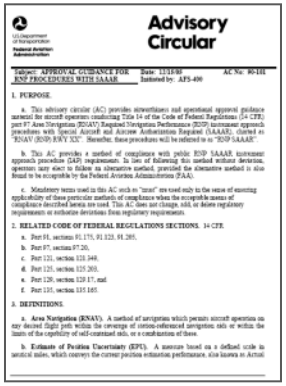


Getting Operational with RNP AR

Aircraft Equipage

- **FMS, IRS, GPS, TAWS**
  - RNP AR 0.3 and <0.3 capability
  - RF Legs
  - Coupled VNAV
  - Single IRS
  - Dual GPS

Operational Approval


Advisory Circular

Subject: APPROVAL GUIDANCE FOR RNP PROCEDURES WITH SAAAR

Date: 1/31/06 Initiated by: AFS-400

AC No: 90-101

1. PURPOSE.

a. This advisory circular (AC) provides airworthiness and operational approval guidance material for aircraft operators conducting Title 14 of the Code of Federal Regulations (14 CFR) part 97 Area Navigation (RNAV) Required Navigation Performance (RNP) instrument approach procedures with Special Aircraft and Aircrew Authorization Required (SAAAR), charted as "RNAV (RNP) RWY XX". Hereafter, these procedures will be referred to as "RNP SAAAR".

b. This AC provides a method of compliance with public RNP SAAAR instrument approach procedure (IAP) requirements. In lieu of following this method without deviation, operators may elect to follow an alternative method, provided the alternative method is also found to be acceptable by the Federal Aviation Administration (FAA).

c. Mandatory terms used in this AC such as "must" are used only in the sense of ensuring applicability of these particular methods of compliance when the acceptable means of compliance described herein are used. This AC does not change, add, or delete regulatory requirements or authorize deviations from regulatory requirements.

2. RELATED CODE OF FEDERAL REGULATIONS SECTIONS. 14 CFR

a. Part 91, sections 91.175, 91.185, 91.205.
b. Part 97, section 97.20.
c. Part 121, section 121.349.
d. Part 125, section 125.203.
e. Part 129, section 129.17, and
f. Part 135, section 135.165.

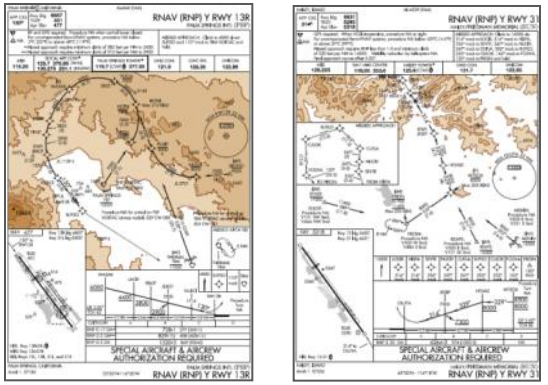
3. DEFINITIONS.

a. Area Navigation (RNAV). A method of navigation which permits aircraft operation on any desired flight path within the coverage of station-referenced navigation aids or within the limits of the capability of self-contained aids, or a combination of these.

b. Estimate of Position Uncertainty (EPU). A measure based on a defined scale in nautical miles, which conveys the current position estimation performance, also known as Actual

- **Consultancy Services**
  - Operational approval submittal package for AMC 20-26 compliance & EASA coordination
  - Timely and efficient integration of requirements into current flight operations
  - Over 20 operators now approved for FAA RNP AR in US

RNP Operations



- **Procedure and Database Validation**
  - Initial validation of all RNP AR procedures
  - Data validation every 28 day cycle

Honeywell Go Direct helps operators get Operational Approval for RNP AR

What does it Cost the Operator

Honeywell offers 3 service pricing options

RNP AR Familiarization Service

Price: $20K

Essential Consultancy

Price: $53K

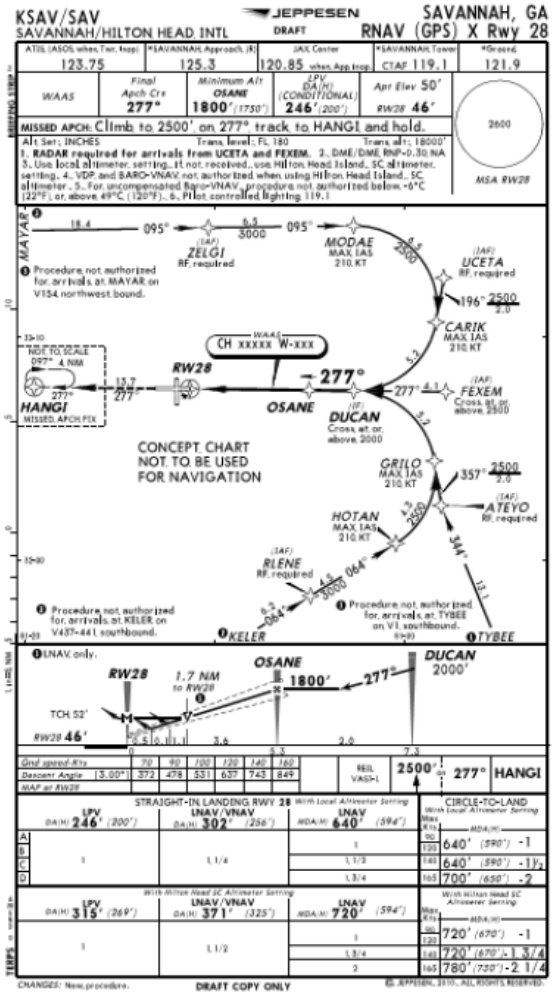
Premium Consultancy

Price: $99K

Contact Honeywell Go Direct

RNP Basic / Advanced

- **New procedures (per AC 90-105) will be developed using basic RNP criteria**
  - Terminal Procedures (SIDs and STARs)
  - Basic Approaches – Virtually identical to current GPS approaches
  - Advanced Approaches – Incorporate curved flight paths
- **Aircraft currently approved for AC 90-100A will automatically comply for RNP Basic / Advanced (with certain restrictions….)**

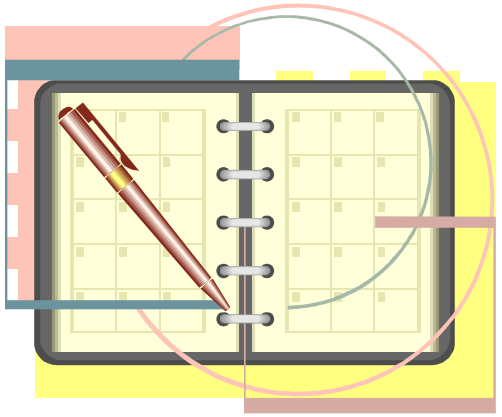


Key Differences

	RNP AR *AC 90-101A*	RNP – Basic *AC 90-105*	WAAS LPV AC 90-107
	Tighter corridors, lower minima, RF Legs	*Practically the same capability you get with GPS today*	*Lower minima, ILS-Like corridors*
Equipment Requirements			
GPS	**Dual**	**Single**	**Single**
WAAS Required	**No**	**No**	**Yes**
IRU Required	**Yes**	**No**	**No**
Operational Requirements			
Curved Paths	**Yes**	**Prior to FAF**	**No**
RNP < 0.3	**Yes**	**No**	**N/A**
Secondary Buffer for Obstacle Clearance	**No**	**Yes**	**Yes**
Operational Approval Required	**Yes**	**No (US Only)**	**No (US Only)**

Agenda

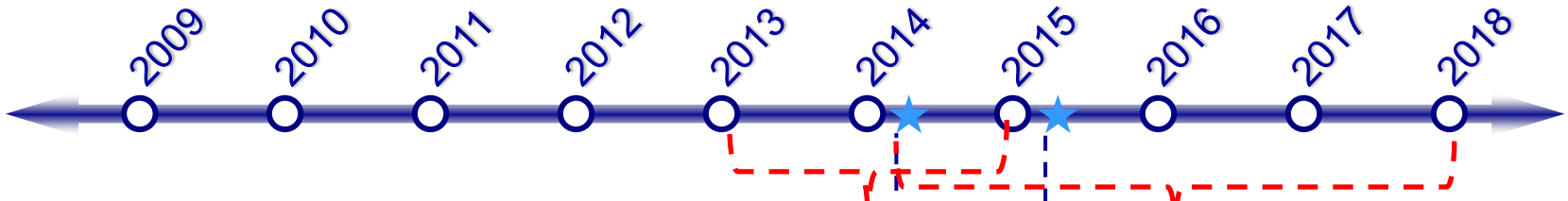
- **Data Link Overview**



Data Link Variants

- **FANS 1/A**
  - Uses an early version of CPDLC (AFN protocol) and has been used for almost 25 years as a version of oceanic surveillance and communication by airliners.
  - Encompasses two main parts:
    - Automatic Dependant Surveillance – Contract (ADS-C)
    - Controller Pilot Data Link Communication (CPDLC)
- **PM CPDLC (Link 2000+)**
  - PM (protected mode) CPDLC is a higher speed data link service using Protected Mode (PM) CPDLC under the ATN protocol and is being tested in Europe today (Link 2000+ trials).
- **FANS 2**
  - Hardware that combines FANS 1/A and PM CPDLC into one unit
  - Supports both FANS 1/A (oceanic) and PM-CPDLC

Data Link Regulatory Time Lines



FANS 1/A NAT
Proposed 2013-15

Eurocontrol PM-CPDLC
End of FANS1/A Exemption
On Forward Fit
January 1, 2014

Eurocontrol PM-CPDLC
Retrofit Date
January 1, 2015

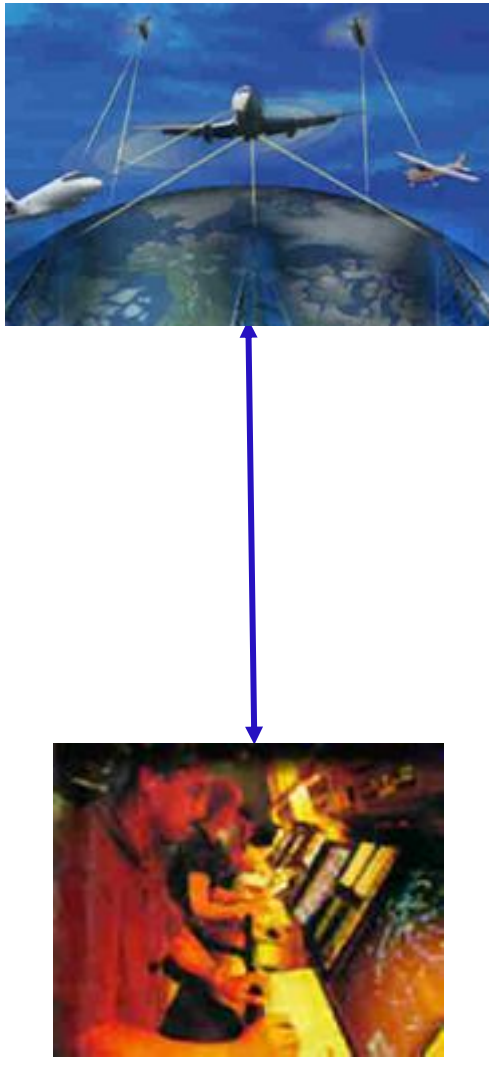
FAA Data Comm.
Segment 1
Work Package 1&2
DATES TBD

Eurocontrol SESAR
DATES TBD

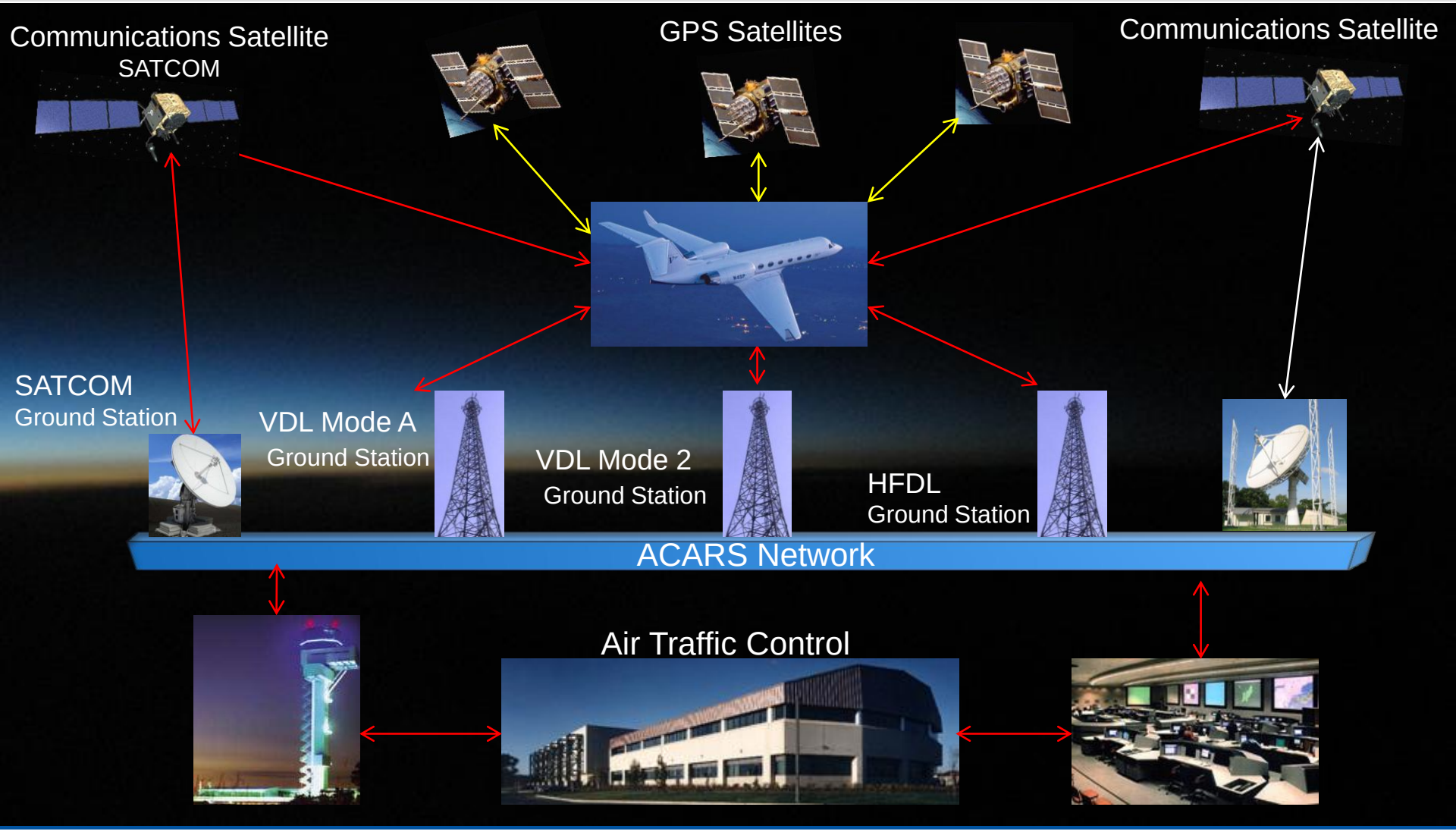
FAA Data Comm Segment 2
Work Package 1&2
DATES TBD (2018+)

FANS 1/A Benefits

- Preferred / more direct oceanic routing
- Reduced separation
- Fully automated position reporting
- Digital data link communication with ATC
- Request / receive clearances on (M)CDU
- Auto acceptance of clearances into flight plan
- HF radio used only as backup - no noisy comm



FANS 1/A – Network Architecture



PM CPDLC (Link 2000+)

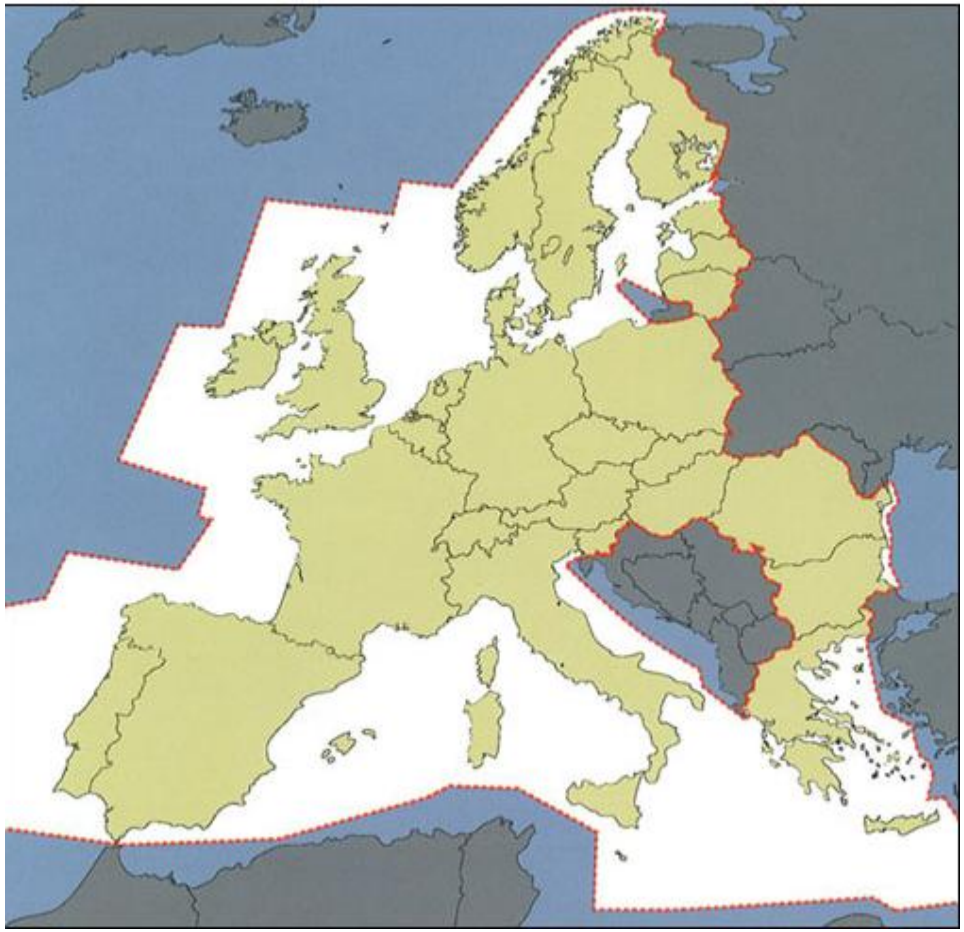
- **Link 2000+**
  - The LINK 2000+ programme is air-ground datalink services implementing ATN to solve sector frequency congestion
  - Protected Mode defines an alternative CPDLC protocol for air/ground applications
  - Stronger processes against miss-delivery
  - Protected Mode (PM) CPDLC is a higher speed data link service in use and being expanded in Europe
- **Benefits**
  - Auto-load specific uplink messages into FMS
  - Downlink complex route clearance request
  - Uplink messages arm FMS automatically
  - Downlink / Uplink messages auto-update Flight Data ground systems
  - Workload reduction for flight crew and controllers

Link 2000 details at: http://www.eurocontrol.int/link2000

Key Dates to Remember

- As of January 1st 2011 all new aircraft operating above FL285 must be delivered with a compliant system*
- After February 7th 2013 flight restrictions can be imposed
- Exclusion of existing aircraft was extended for new aircraft until January 1st 2014
- Retrofit date February 5th 2015 for all operating above FL285

Designated European Airspace Operation at or above FL285



Aircraft Exemptions under Article 14

- **Exemptions for aircraft types**
  - Reaching the end of their production life
  - Aircraft produced in limited numbers
  - Disproportionate re-engineering costs
  - Temporary exemptions only apply to Forward Fit applications
  - Temporary exemptions should not impact DLS provisions
  - Permanent exemptions should not compromise 75% DLS capability
- **Exemption Requests (ERQs)**
  - An Applicant may be an airspace user or manufacturer
  - Any exemption request shall be based on the criteria defined in Article 14
  - ERQ Requirements and Template made available by the European Commission
  - Applicant submits an ERQ to the European Commission either directly or via an appropriate Member State

*www.eurocontrol.int/.../2nd%20Decision%20on%20DLS%20**Exempt***

Article 1 Aircraft Type Exemption List

Model	ICAO	Marketing Name
Dassault Falcon 10 and Falcon 100	FA10	Falcon 10
Dassault Fan Jet Falcon Basic and Series C/D/E/F/G	FA20	Falcon 20
Dassault Mystère-Falcon 200, 20GF and 20- C5/D5/E5/F5	FA20	Falcon 20
Dassault Falcon 50EX and Mystère Falcon 50	FA50	Falcon 50
Dassault Falcon 900, 900B, 900C and 900 EX	F900	Falcon 900
Dassault Falcon 2000 and 2000EX	F2TH	Falcon 2000

Article 1 Aircraft Type Exemption List cont;

Model	ICAO	Marketing Name
Gulfstream GIV and GIV-SP GLF4		Gulfstream IV
Gulfstream G300	GLF4	Gulfstream 300
Gulfstream G400	GLF4	Gulfstream 400
Gulfstream GV	GLF5	Gulfstream V

Article 2 Aircraft Type Exemption List

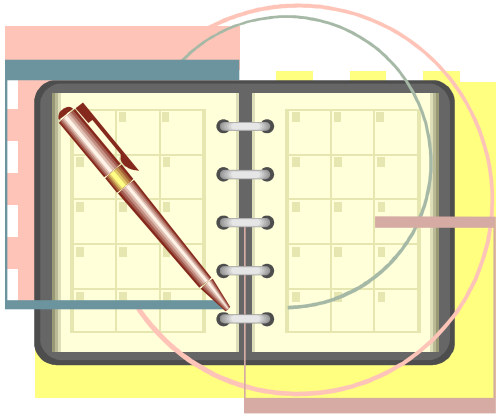
Model	ICAO	Marketing Name	Date
Bombardier LEARJET 60	LJ60	LEARJET 60XR	Dec 31, 2012
Bombardier LEARJET 45 40XR, 45 and 45XR	LJ45	LEARJET 40,	
Bombardier CL-600-2C10	CRJ7	CRJ700	
Bombardier CL-600-2D24	CRJ9	CRJ900	
Bombardier CL-600-2E25	CRJX	CRJ1000	
Bombardier BD-100-1A10	CL30	Challenger 300	
Bombardier CL-600-2B16	CL60	Challenger 604/605 Variant	
Cessna 525A	C25A	Citation CJ2+	June 30, 2012
Cessna 525B	C25B	CitationCJ3	
Cessna 525C	C25C	Citation CJ4	
Cessna 560XL	C56X	Citation XLS+	

Article 2 Aircraft Type Exemption List cont;

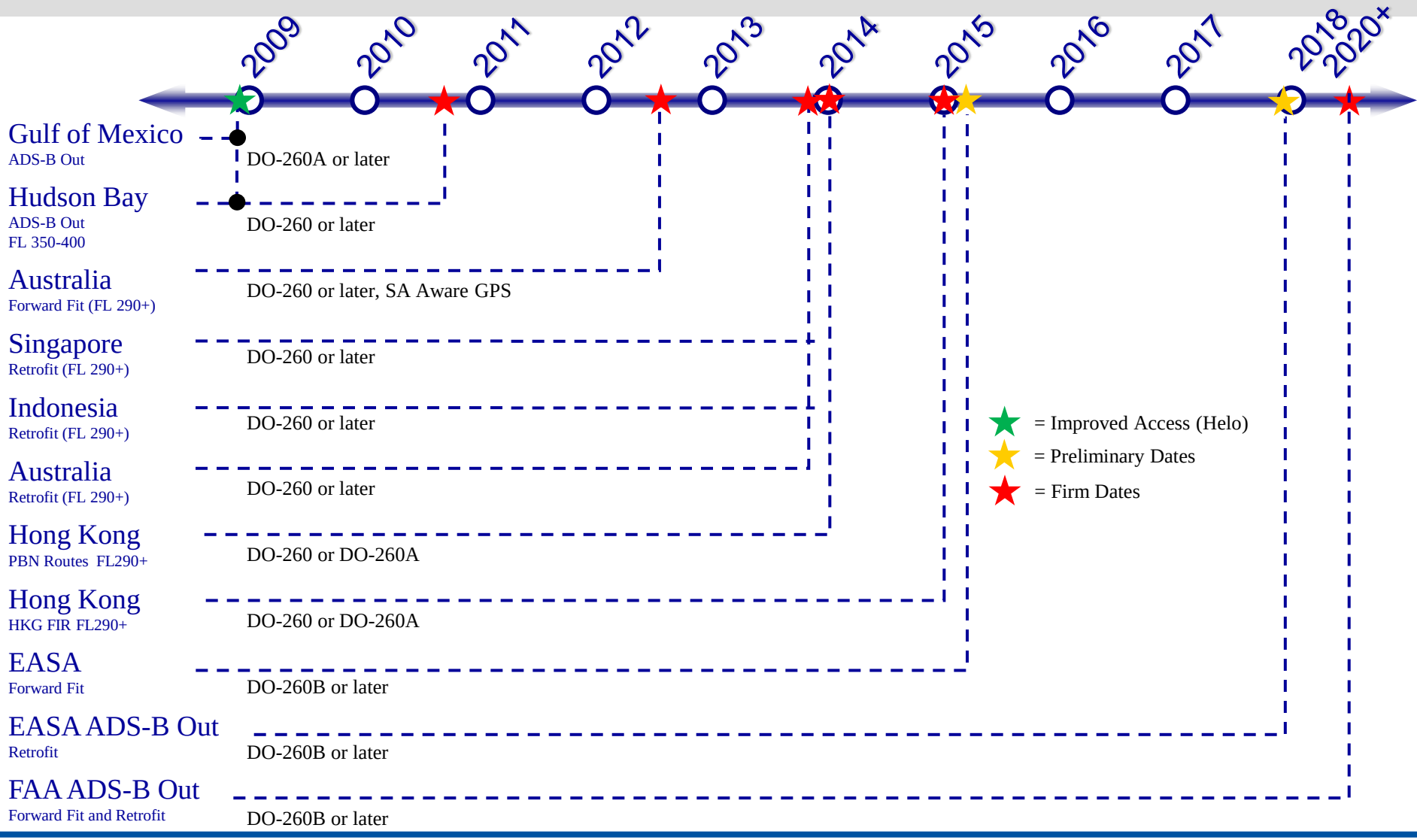
Model	ICAO	Marketing Name	Date
Embraer ERJ 170 – 100LR/ 100STD/200LR/200STD	E170	Embraer 170	Dec 31, 2012
Embraer 190 -100ECJ	E190	Lineage 1000	
Embraer ERJ 190 -100IGW/ 100LR/100SR/100STD/200I GW/200LR/200S TD	E190	Embraer 190	
Pilatus PC-12/47E	PC12	PC-12 NG	
Piaggio P-180 Avanti II	P180		Dec 31, 2011

Agenda

- **ADS-B (Automatic Dependant Surveillance – Broadcast)**



ADS-B Out Timeline



ADS-B Overview

- **What is it?**
  - Intended to replace traditional ATC radar surveillance
  - Aircraft transmits position, velocity and other information to ground-based receivers
- **Deployments**
  - Canada (including oceanic)
  - Gulf of Mexico
  - Australia
  - China

LOA required for US-registered aircraft operating in Canadian ADS-B

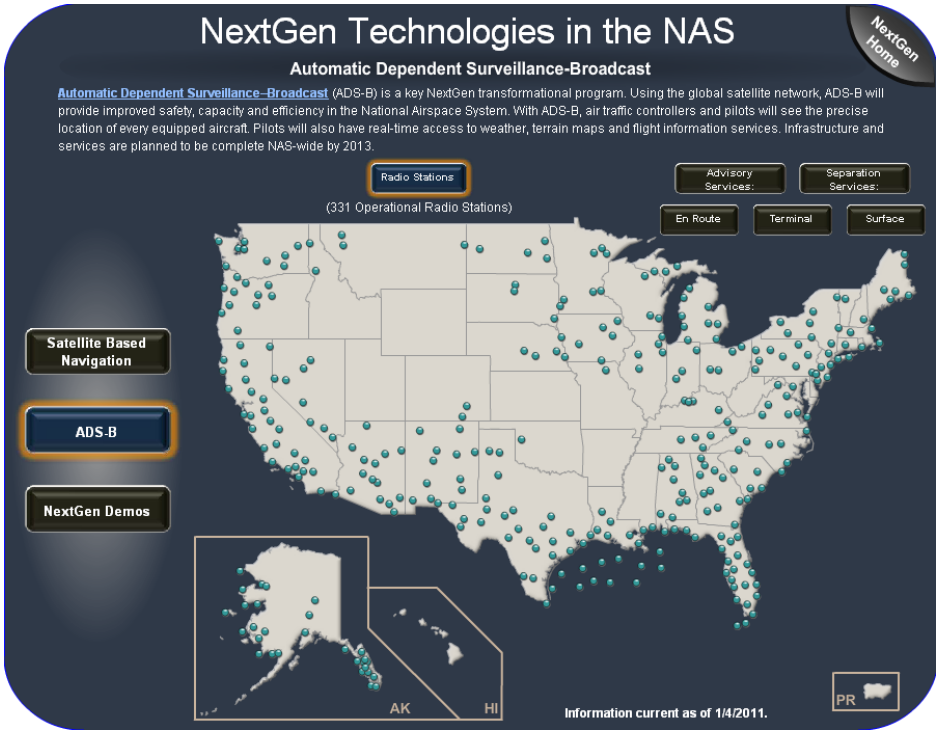
ADS-B Deployments

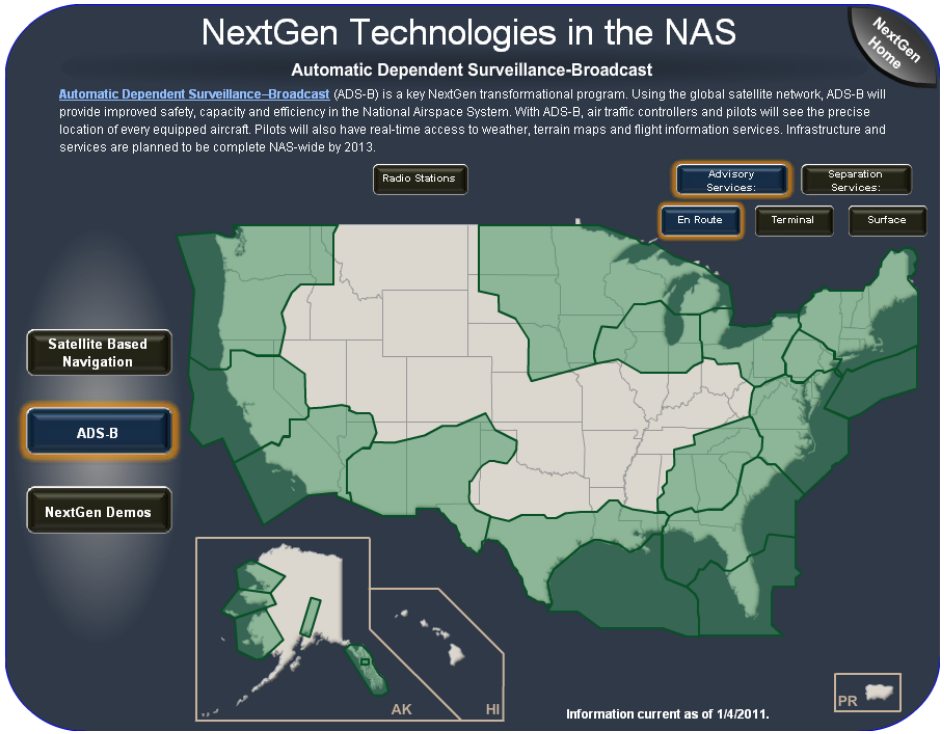
- **Hudson Bay**
  - 35,000 flights per year are participating
  - 5NM lateral separation
  - 20NM vs 80NM in-trail
  - Priority handling and Preferred routes in use
  - Plans to make FL350 to FL400 exclusionary airspace
  - A FAA LOA and Transport Canada OpsSpec is required to operate in this area

ADS-B Deployments

- **Canadian ADS-B Airspace**

USA ADS-B Deployment



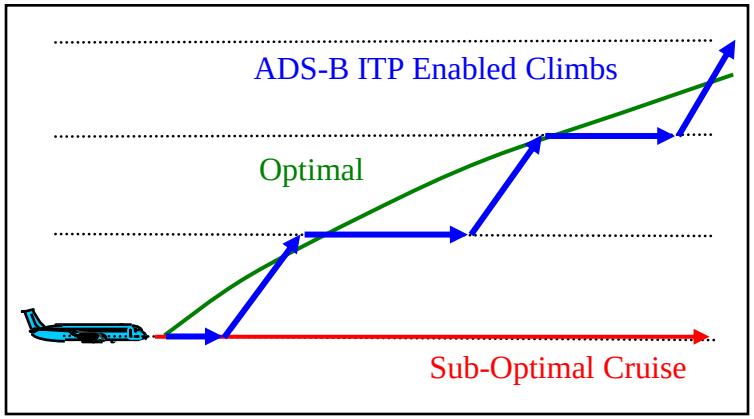


- 331 Operational ADS-B Receivers
- 1/4/2011

- Enroute Services

Successful ITP Trials in SOPAC

- **Joint FAA/UAL/Honeywell Program**
  - Demonstrated operational benefits enabled by the ADS-B In, In Trail Procedures
- **Avionics system consists of:**
  - Honeywell Traffic Computer, TPA-100B with ADS-B In and ITP capability
  - Honeywell Transponder, TRA-67B with ADS-B Out capability
  - Goodrich Class 3 EFB running Honeywell ITP display software
- **United Airlines will operate approximately 12 Honeywell ITP avionics equipped 747-400 aircraft in the South Pacific (SOPAC) route. Successful trials completed. FAA in final stages of approval.**



ADS-B Out Product Planning

Product	Application	DO-260	DO-260A	DO-260B
AESU (A380)	Air Transport	--	Available	In Process
TRA-67A	Air Transport	Available	--	Replace with TRA-100B
TRA-100B	Air Transport	-	-	2013
Epic	Regional, Helicopter Business Aviation	--	Available	In Process
Primus II	Regional Business Aviation	--	--	In Process
MST-67	Regional Business Aviation	--	--	Replace with MST-67B
APEX	Business Aviation General Aviation	--	--	Planned
KT-73	General Aviation	Available (non-diversity)	--	Planned
MILACAS	Military Transport	Available - Military unique solution (planned DO-260 compliance)		

Summary

- **New technologies all have industry mandates and operational benefits coming in the next decade (2010 – 2020)**
  - SBAS-LPV
  - RNP
  - CPDLC
  - ADS
- **Honeywell has planned software and hardware solutions for all of our customers**
  - Classic aircraft retrofit include:
    - Gulfstream IV and V, Hawker 800, Challenger 601, Falcon 900B, 900C/EX, Global Express/G-5000, Embraer Legacy 600/650, Citation X, others
  - Primus Epic aircraft include:
    - Gulfstream 450/550 PlaneView, Falcon F900, 2000 and 7X EASy, Cessna Sovereign, Hawker 4000, others