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EMBRAER OPERATORS CONFERENCE

CHINA

Supporting
you on the ground
to keep you
in the air



CNS / ATM

Agenda

Introduction

China Roadmap

PBN Basic Concepts

RNP AR

LPV

ADSB

CPDLC

Benefits

Next Steps



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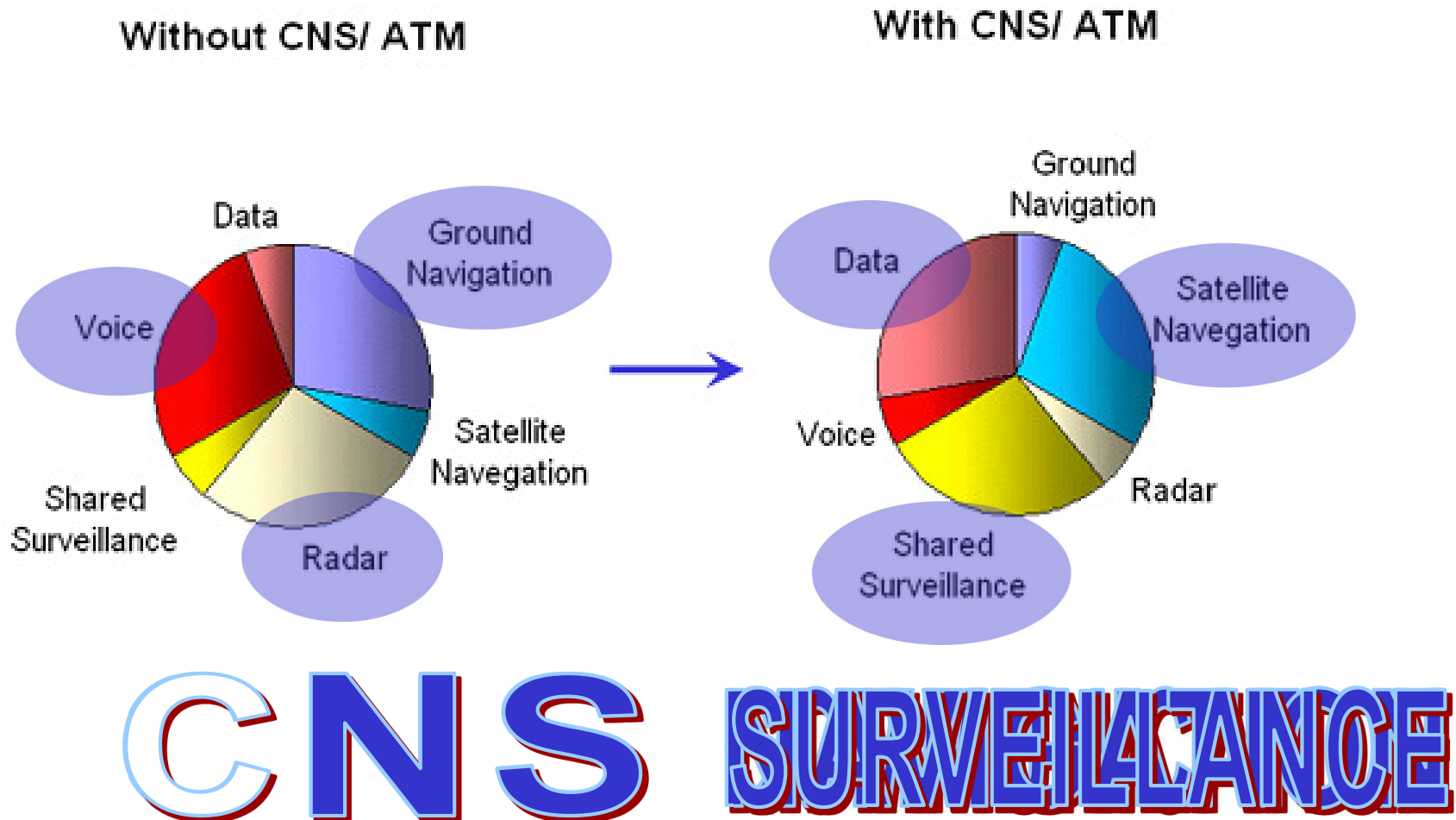
Benefits

Next Steps



Communication Navigation Surveillance / Air Traffic Management

- Focus on the optimal use of the airspace in terms of time, safety, airline and ATC operations



World Air Traffic



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Next Generation



USA

Single European Sky ATM Research



Europe



ICAO Role is Harmonization



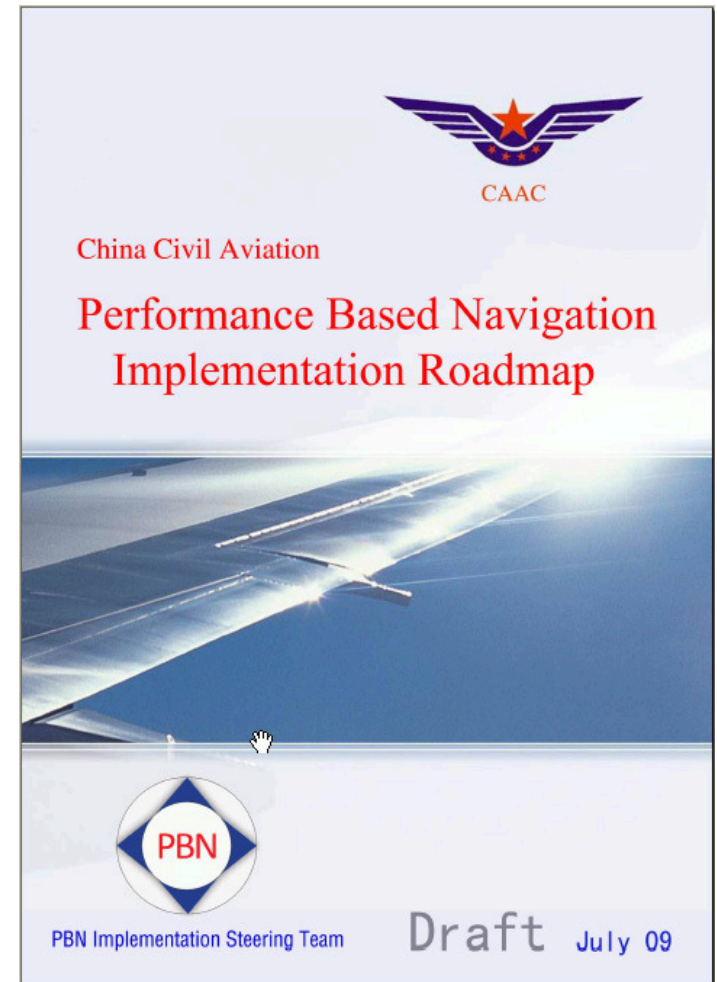
Brazil



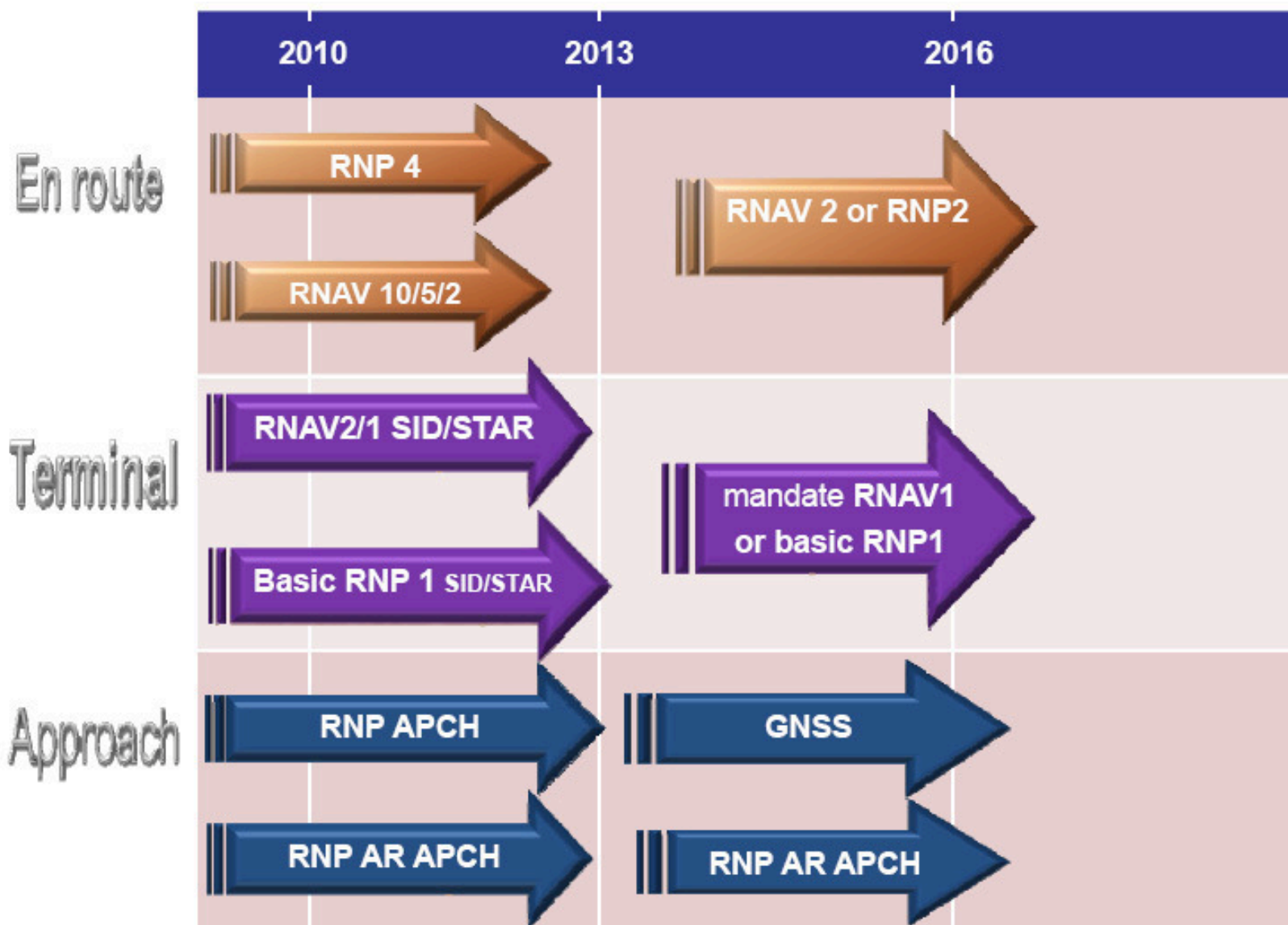
China

CAAC (Civil Aviation Administration of China)

- China develops the PBN Roadmap to ensure consistency between RNAV and RNP operations in China and the concept of PBN.
- Provide guidance on PBN implementation for the regulatory authorities, air operators, air navigation service providers and airports.
- Offer the planning of future navigation development for the whole industry, and assist the stakeholders in making their transition plans and investment strategy.



CAAC PBN Roadmap



CAAC PBN Roadmap

Near term (2009-2012) *		
Airspace	Recommended navigation specifications	Acceptable navigation specifications
Route - ocean	RNP-4	RNAV-10
Route - remote continental	RNP-4	RNAV-10
Route - continental	RNAV-2	RNAV-5
Terminal area - arrivals and departures	RNAV-1 (Radar coverage and sufficient navigation aids) Basic RNP-1 (No radar coverage)	
Approach	RNP APCH(with Baro-VNAV)at some airports RNP AR APCH to be implemented at the airports with operational requirements	RNP APCH

CAAC PBN Roadmap

Medium term (2013-2016)		
Airspace	Recommended navigation specifications	Acceptable navigation specifications
Route - ocean	RNP-2*, RNP-4	RNAV-10
Route - remote continental	RNP-2	RNAV-2, RNP-4, RNAV-10
Route - continental	RNAV-1, RNP-2	RNAV-2, RNAV-5
Terminal area - arrivals and departures	RNAV-1 or RNP-1	
Approach	RNP APCH (with Baro-VNAV) RNP AR at airports with operational benefits Introduce landing operations using GNSS and its augmentation systems	
* The CNS requirements and operation procedures related to RNP-2 application are to be determined		



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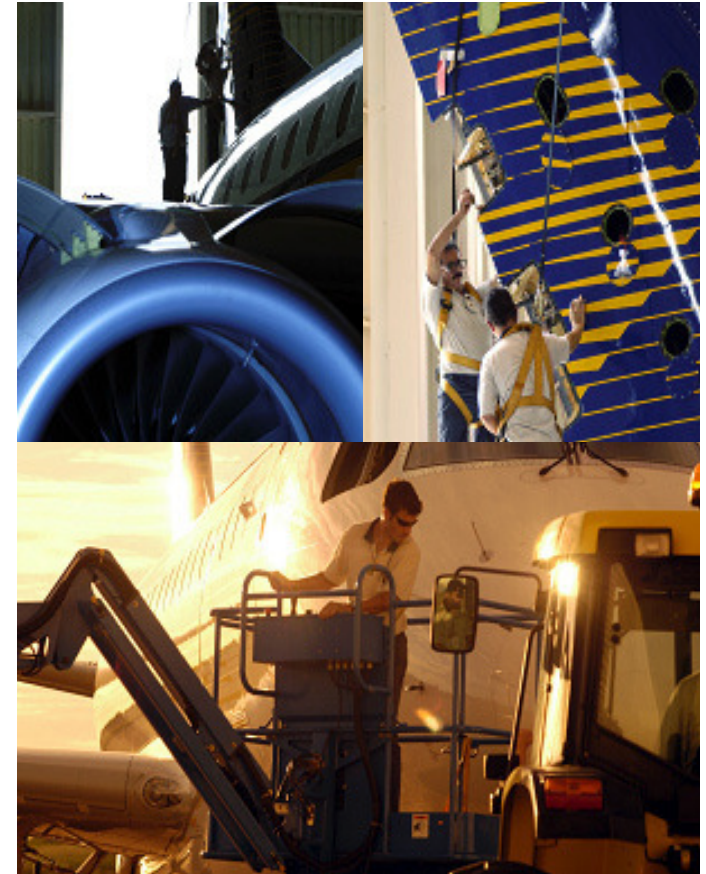
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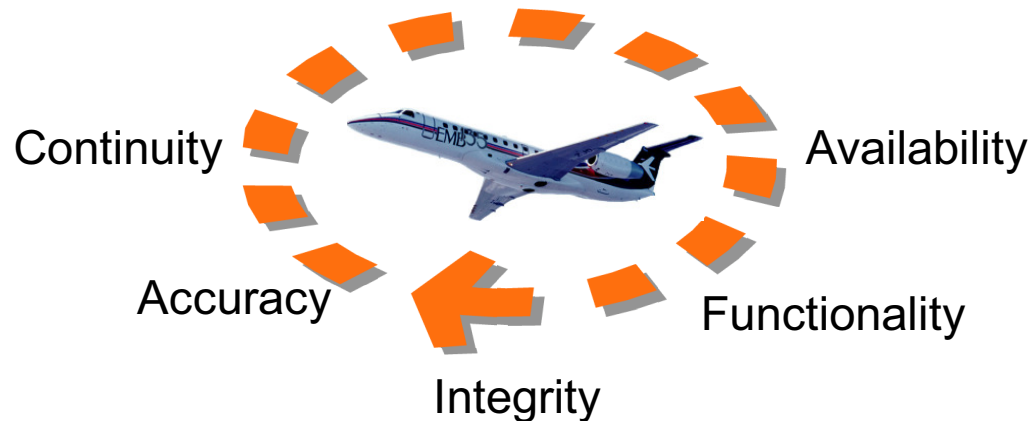
Benefits

Next Steps

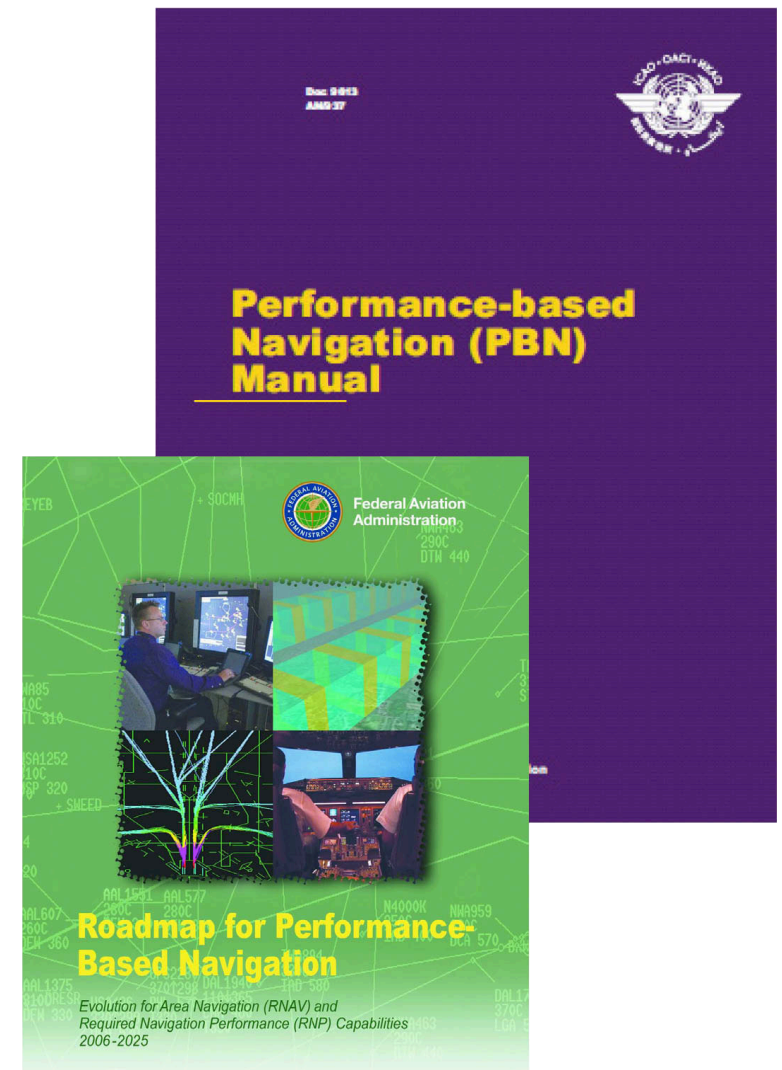


Definition

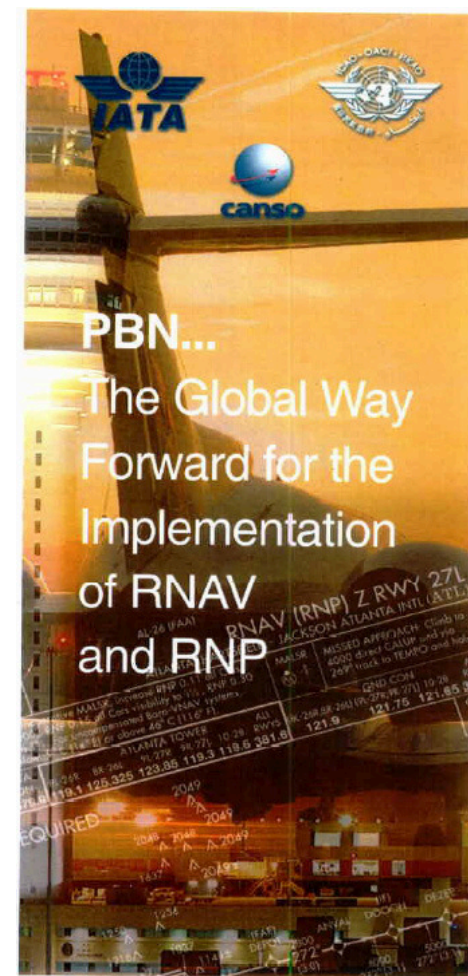
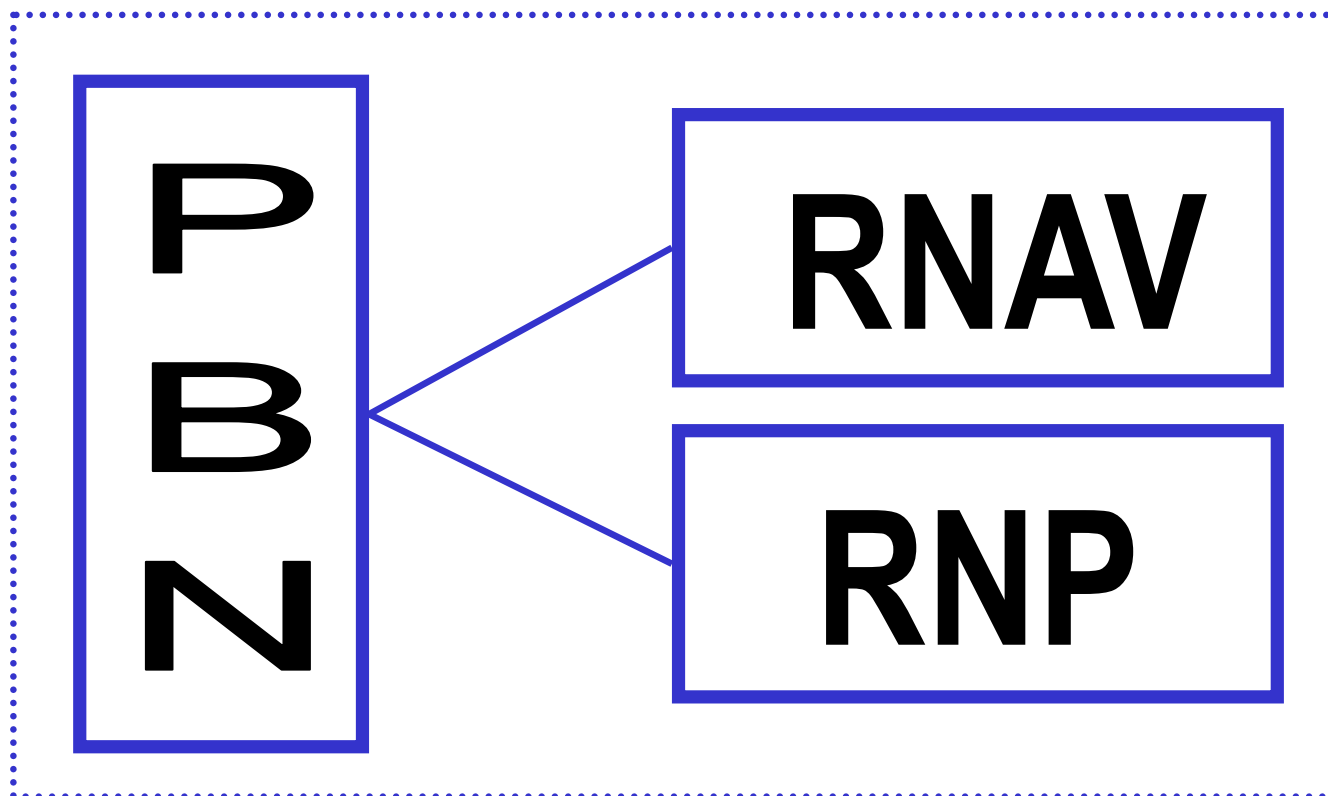
- PBN defines a navigation performance specification which an aircraft must comply



- It provides a simple basis for the design and implementation of automated flight paths and for airspace design, aircraft separation and obstacle clearance

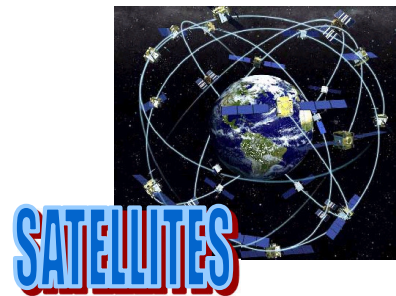
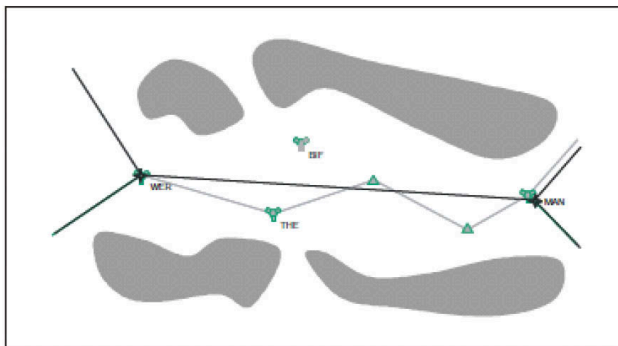
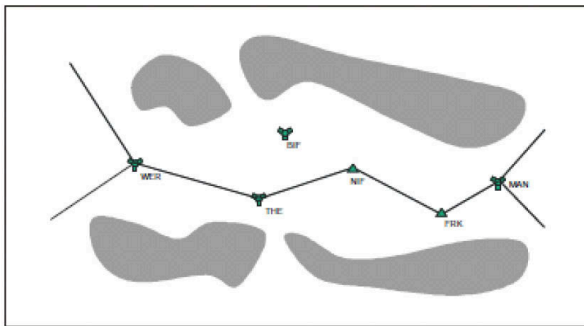


PBN: RNAV and RNP



RNAV definition

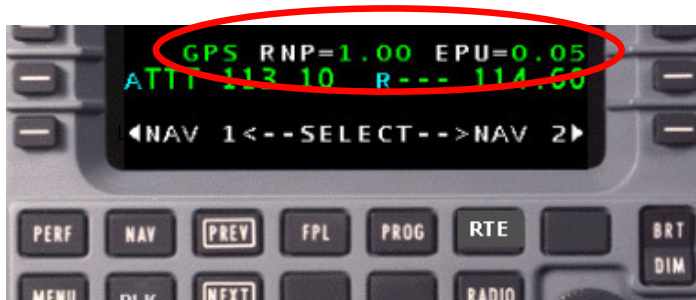
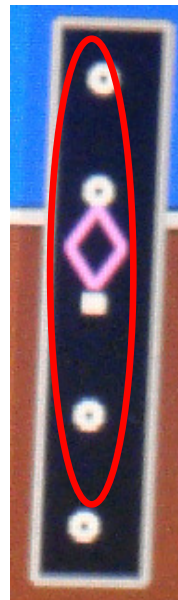
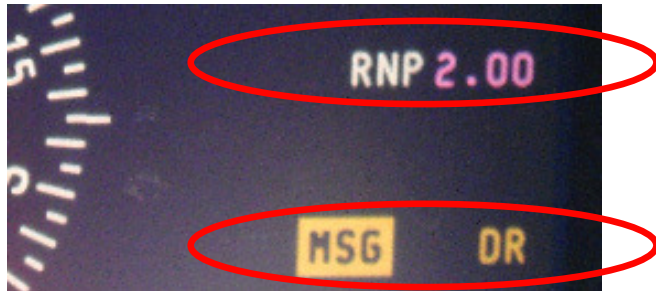
- RNAV is a **method** of navigation that permits aircraft operation on any desired flight path within the coverage of station-referenced navigation aids or within the limits of the capability of self-contained aids.



RNP definition

- RNP is a RNAV which supports on-board performance monitoring and alerting.

$$\text{RNP} = \text{RNAV} +$$



PBN Deployment Today.....



Source: Naverus PBN Summit, 2008

Nomenclature

- Global efforts to embrace the ICAO PBN manual nomenclature



The New RNAV/RNP Values

Area of Application	Nav Accuracy (NM)	Nav Specification (current)	Nav Specification (new)
Oceanic/Remote	10	RNP 10	RNAV 10 (RNP 10 label)
	4	RNP 4	RNP 4
En route/ Continental	5	RNP 5 Basic RNAV	RNAV 5
En route /Continental and Terminal	2	US RNAV type A	RNAV 2
	2	N/A	RNP 2
Terminal	1	US RNAV type B P RNAV	RNAV 1
	1	N/A	RNP 1
Approach	0.3	RNP 0.3	RNP 0.3
	0.3-0.1	RNP/SAAAR	RNP 0.3-0.1 (RNP/AR)

Nomenclature

- These are the achieved certifications for the ERJ 145 Family



The New RNAV/RNP Values

Area of Application	Nav Accuracy (NM)	Nav Specification (current)	Nav Specification (new)	
Oceanic/Remote	10	RNP 10	RNAV 10 (RNP 10 label)	✓
	4	RNP 4	RNP 4	✗
En route/ Continental	5	RNP 5 Basic RNAV	RNAV 5	✓
En route /Continental and Terminal	2	US RNAV type A	RNAV 2	✓
	2	N/A	RNP 2	✗
Terminal	1	US RNAV type B P RNAV	RNAV 1	✓
	1	N/A	RNP 1	✗
Approach	0.3	RNP 0.3	RNP 0.3	✗
	0.3-0.1	RNP/SAAAR	RNP 0.3-0.1 (RNP/AR)	✗



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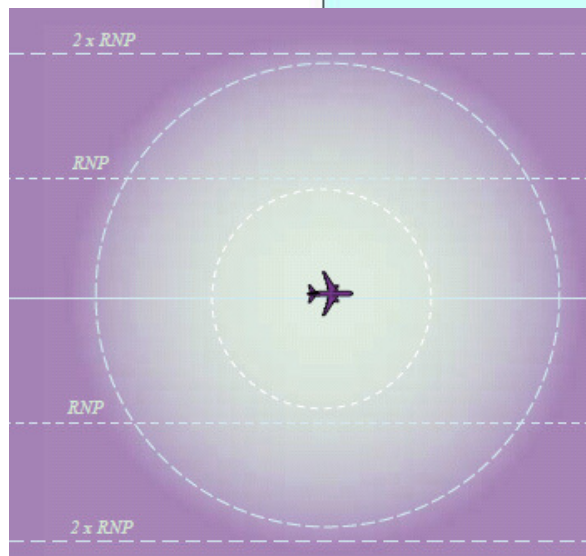
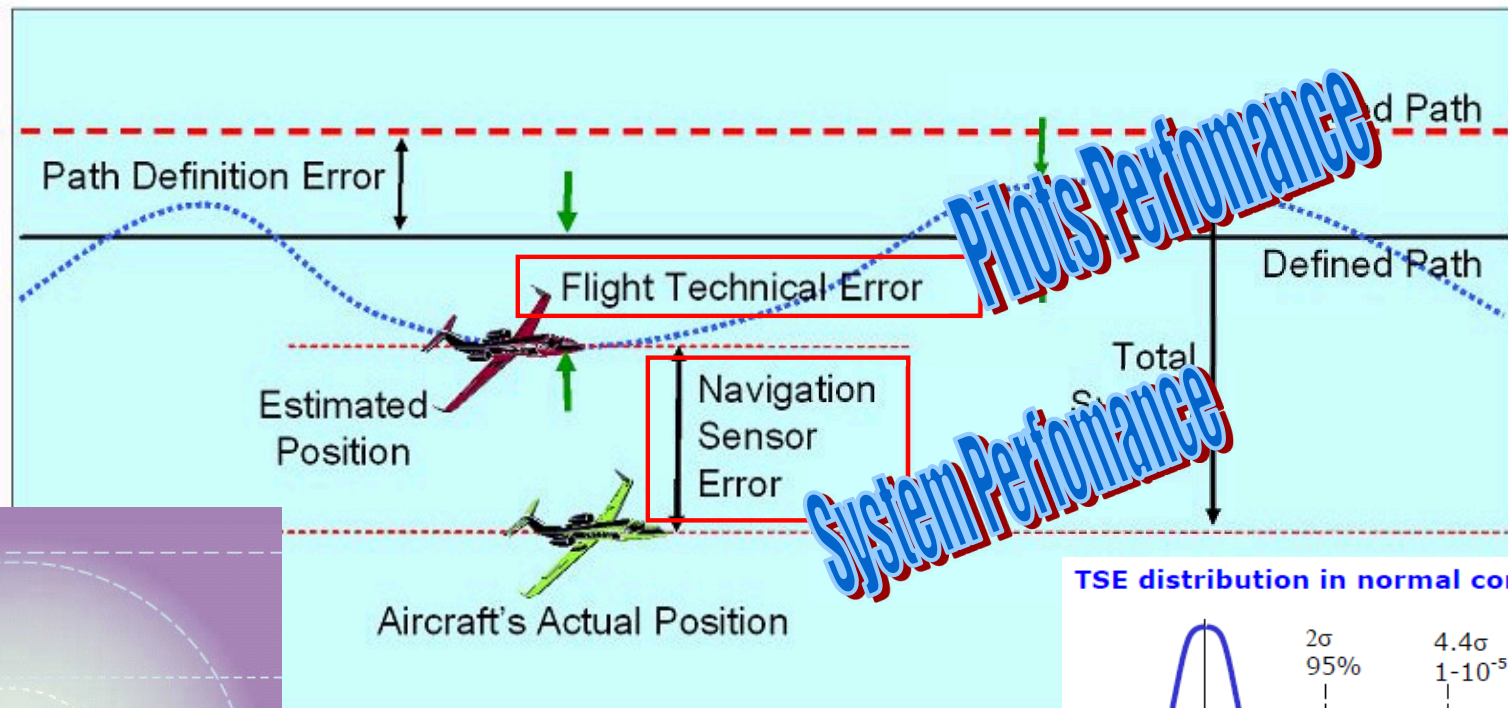
CPDLC

Benefits

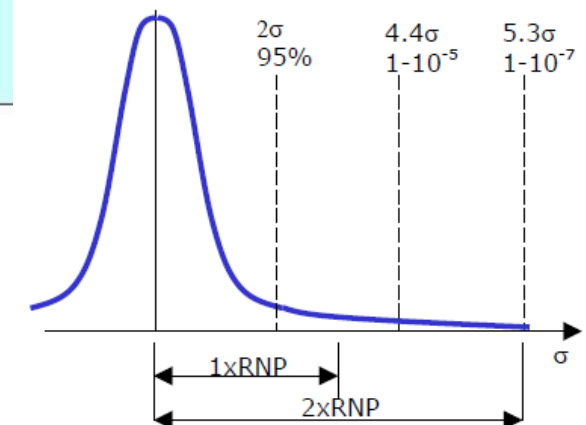
Next Steps



Position Reliability



TSE distribution in normal conditions





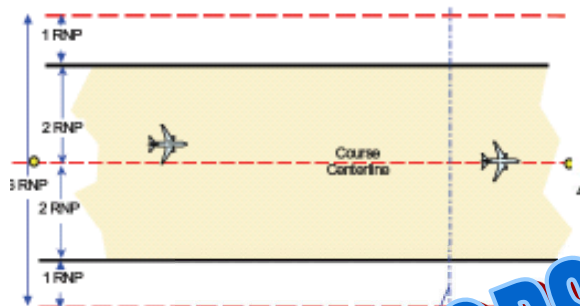
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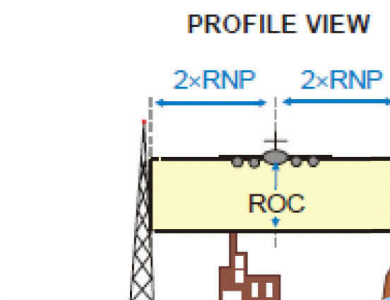
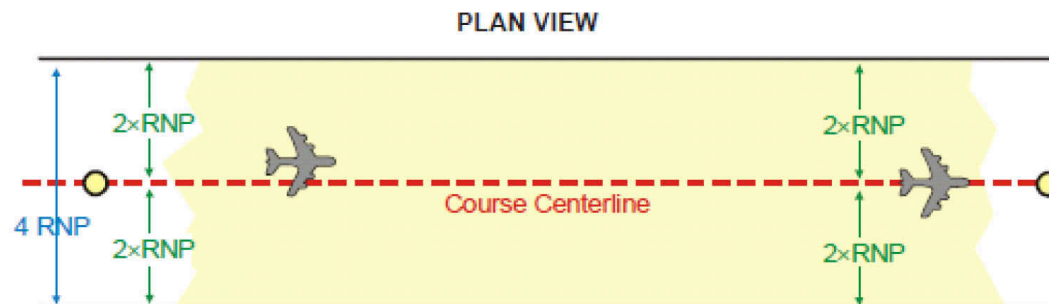
RNP AR

Description

- The special characteristics are.....
 - No buffer margins:



RNAV (GPS)



RNP AR



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RNP AR



Description (cont.)

- The special characteristics are.....
 - Can go until a minima of 0.1 RNP



Description (cont.)

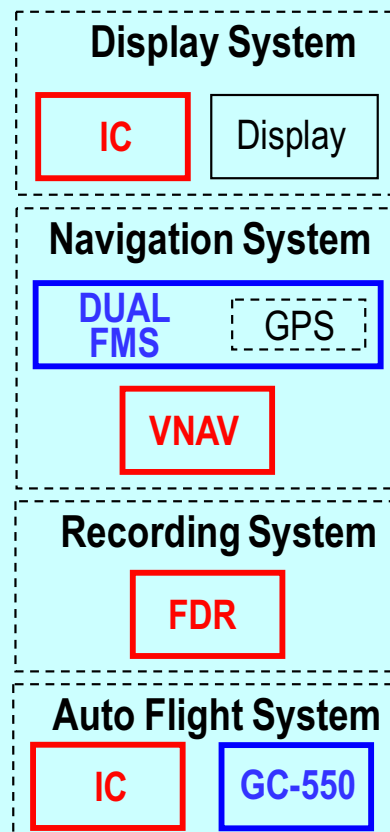
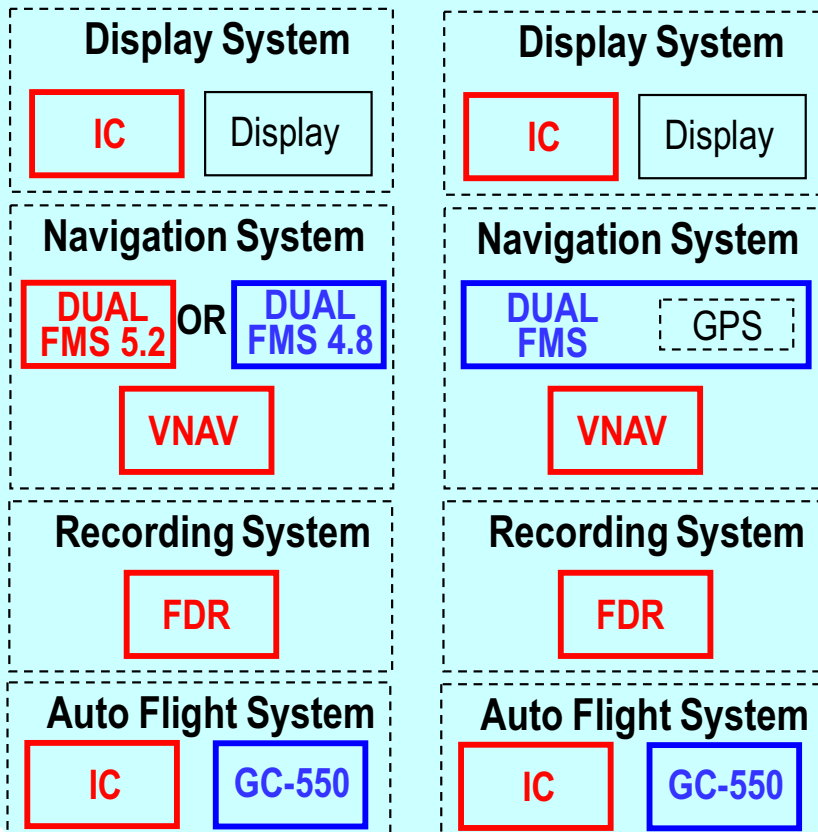
- The special characteristics are.....
 - Use of RF (Radius-to-fix), even in the final approach segment



RNP 0.3 AR (AC 90-101)

Honeywell

Universal



RNP 0.3 (AC 90-105)

Honeywell

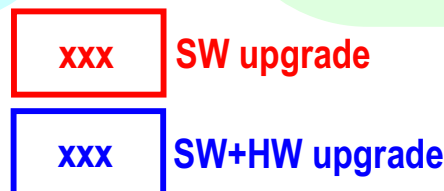
Universal

Baro VNAV is optional (LNAV or LNAV/VNAV lines of minima)

RFleg is optional (if not compliant, procedures with RF legs cannot be flown)

Dual FMS is not Mandatory

Legend:



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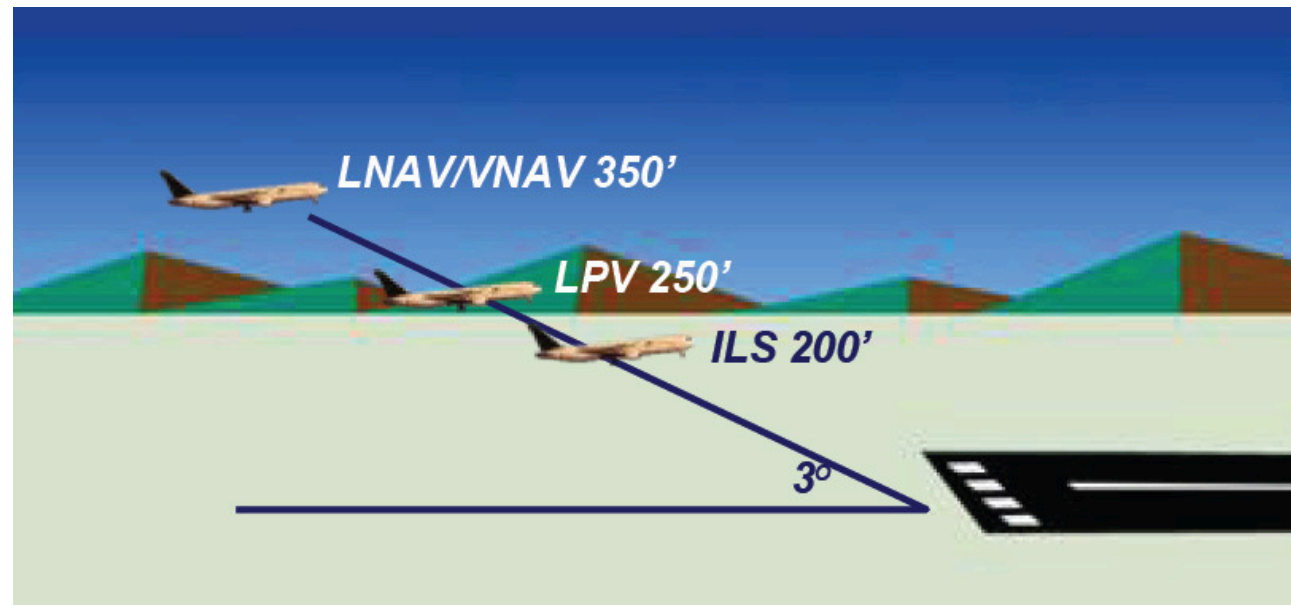
Benefits

Next Steps



Definition:

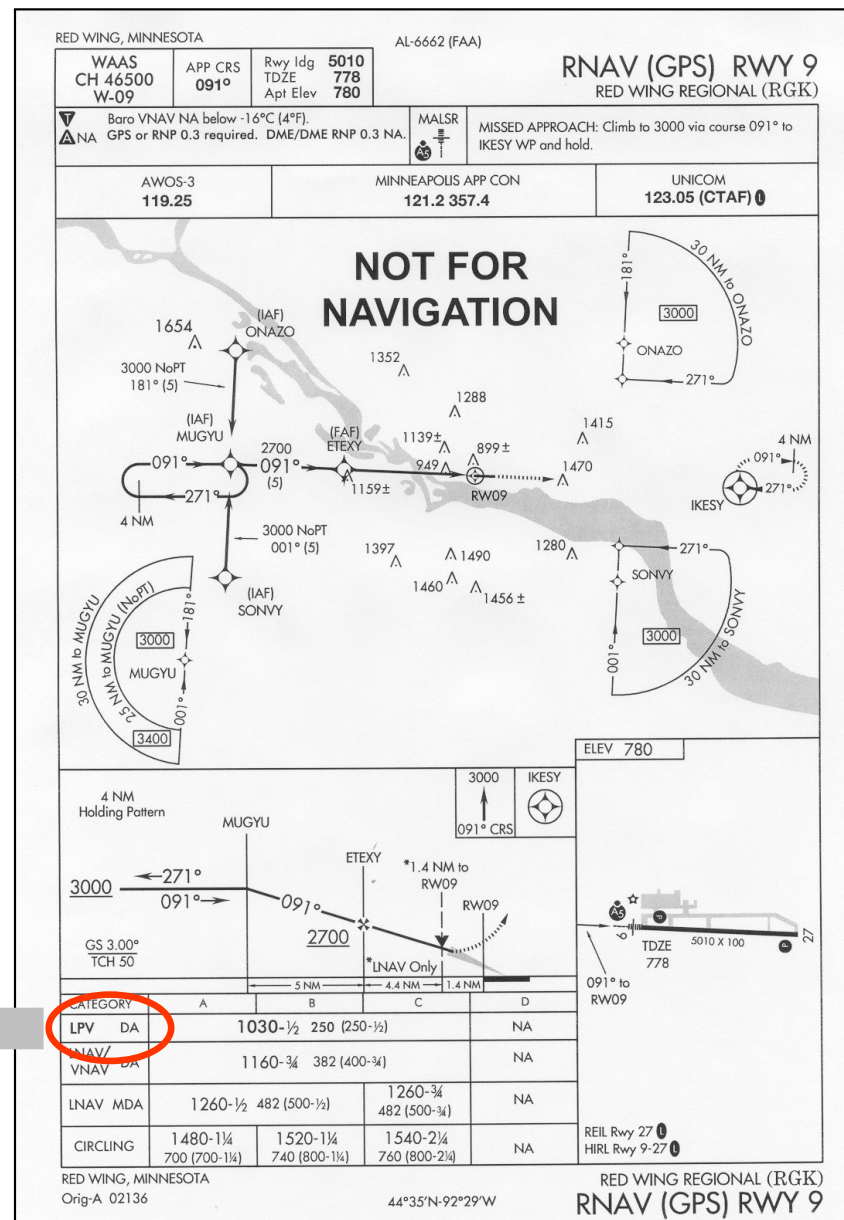
- LPV (Localizer Performance Vertical Guidance):
 - Two tri-dimensional GPS points aligned with the runway centerline defining a track and a glide path;
 - New mean of performing a landing with no need for ground infrastructure;
 - Provide guidance using Horizontal and Vertical Bars on the PFD: similar to an ILS approach but less precise;
 - WAAS (Wide Area Augmentation System) improves precision in LPV approaches.



Advantages

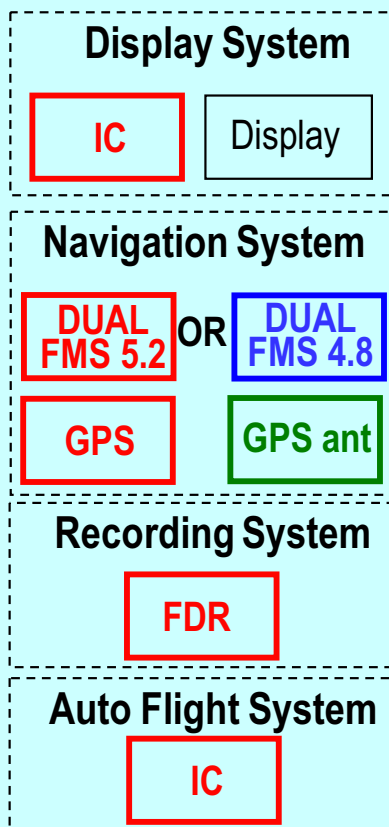
- Provides stabilized approach: may reduce incidents compared to “dive and drive”;
- Increase runways landing capacity allowing parallel procedures;
- Fuel savings (more direct approaches);
- Not dependent on ground infra-structure availability;
- Reduced Minimums.

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

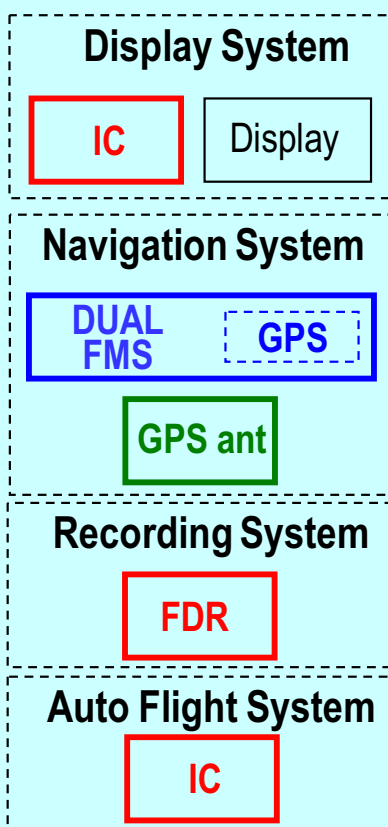


LPV

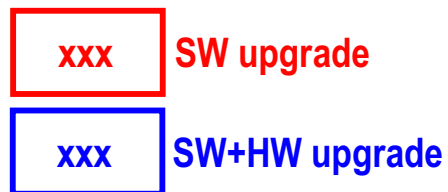
Honeywell



Universal



Legend:



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ADS-B



Definition:

- ADS-B – Automatic Dependent Surveillance Broadcast
- Periodically transmits information with no pilot or operator input required
- Position and velocity vector are derived from the Global Positioning System (GPS)
- Transmitted information available to anyone with the appropriate receiving equipment

Applicability:

- A/C with MTOW > 5,700Kg or Max cruising TAS > 250 kts

Categories:

- ADS-B Out: Periodically broadcasts the aircraft's location (GPS) and others required information
- ADS-B In: Used to receive information transmitted by other aircraft equipped with ADS-B Out. (expected to be not mandate)



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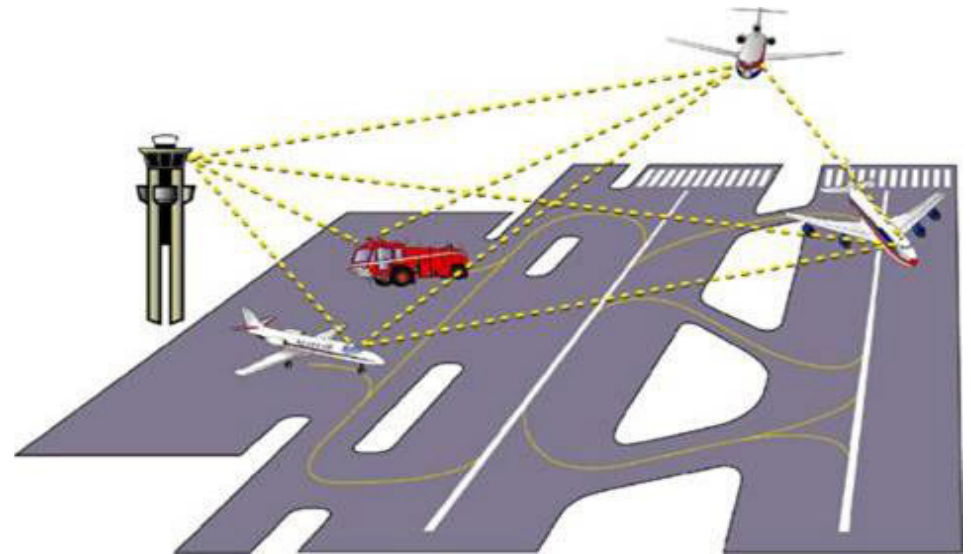
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ADS-B



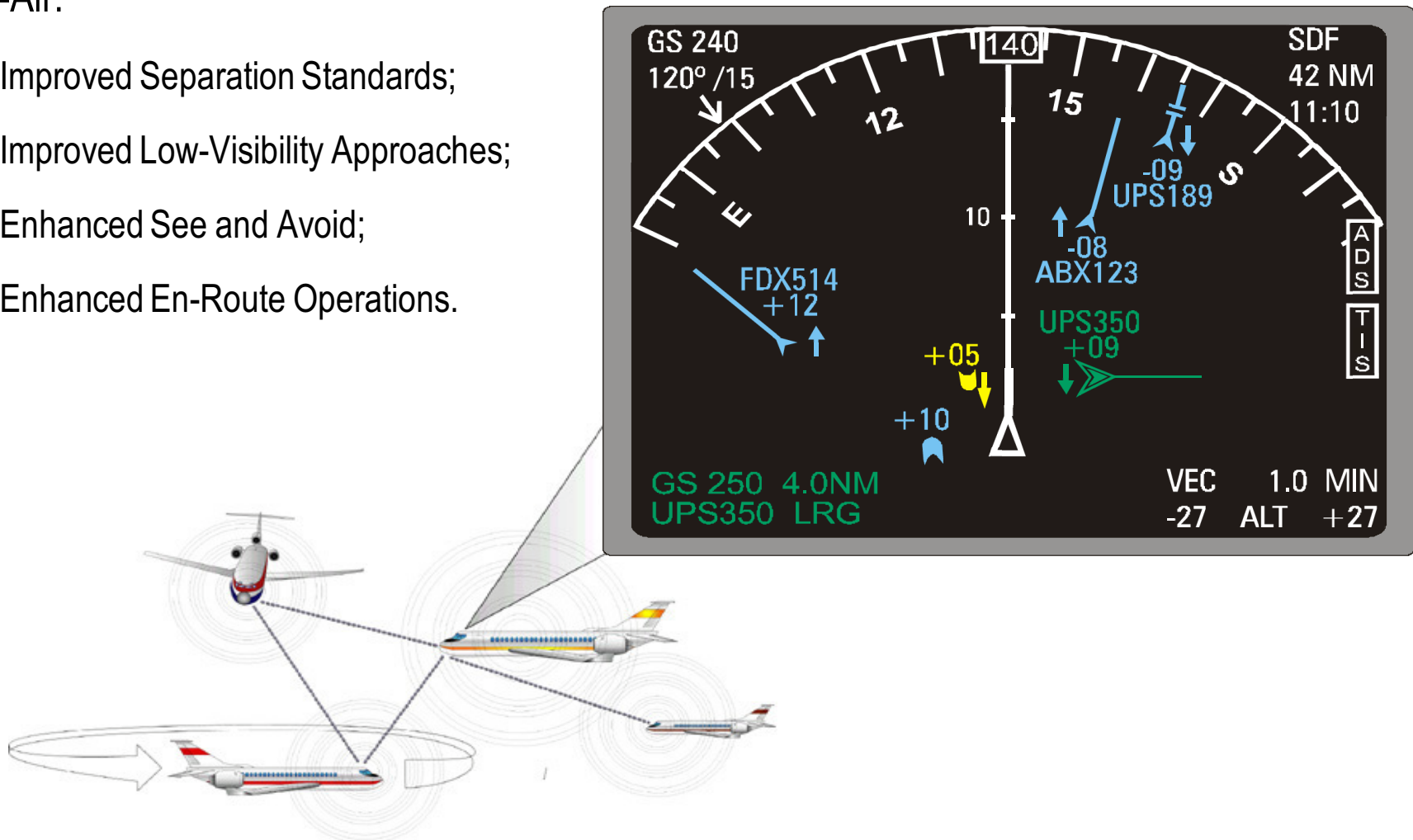
Benefits

- ADS-B can make flying safer and can allow more efficient use of airspace.
- Air to Ground:
 - Surveillance Coverage in Radar / Non-Radar Airspace.
- Ground to Ground:
 - Improved Navigation on Taxiways;
 - Enhanced Controller Management of Surface Traffic.



Benefits (cont'd)

- Air-to-Air:
 - Improved Separation Standards;
 - Improved Low-Visibility Approaches;
 - Enhanced See and Avoid;
 - Enhanced En-Route Operations.



Surveillance

Mode S Enhanced:

Mode S Elementary:

Mode S:

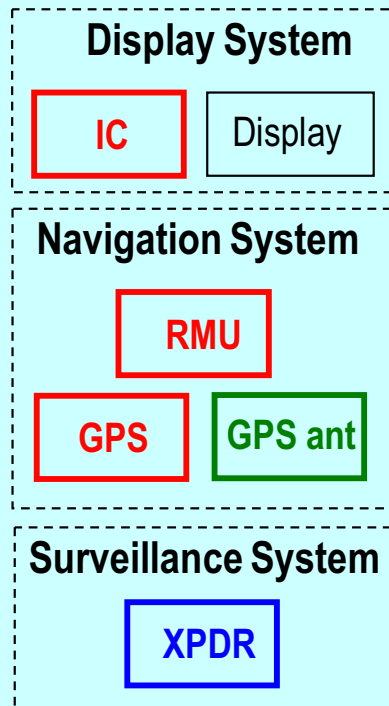
- Altitude
- Address Code
- Flight ID
- SI Code
- RA Downlink
- Selected Altitude
- Mach
- Mag Heading
- Roll Angle
- Track Angle
- Track Angle Rate
- True Airspeed
- Indicated Airspeed
- Ground Speed
- Vertical Speed

Mode S Extended Squitter: (ADS-B Out)

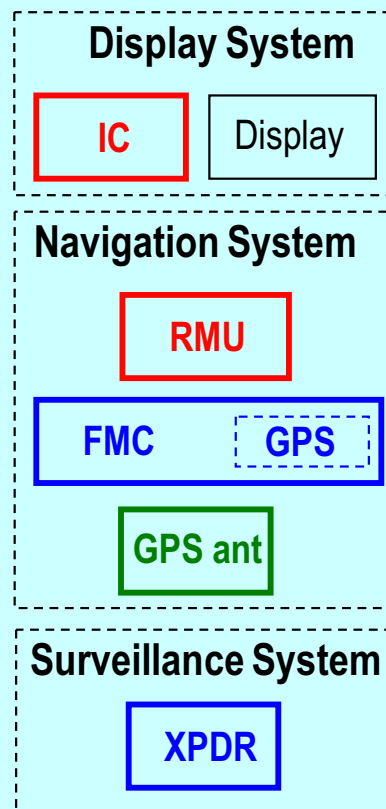
- Aircraft Length / Width
- Latitude / Longitude
- Geometric Velocity
- TCAS II Operational
- Receiving ATC Services
- Emitter Category
- CDTI Operational
- Geometric Altitude (HAE)
- NACp – Nav Accuracy for Position
- NIC – Nav Integrity
- SIL – Surveillance Integrity Limit

ADS-B Out

Honeywell



Universal



Legend:



SW upgrade



HW upgrade



SW+HW upgrade



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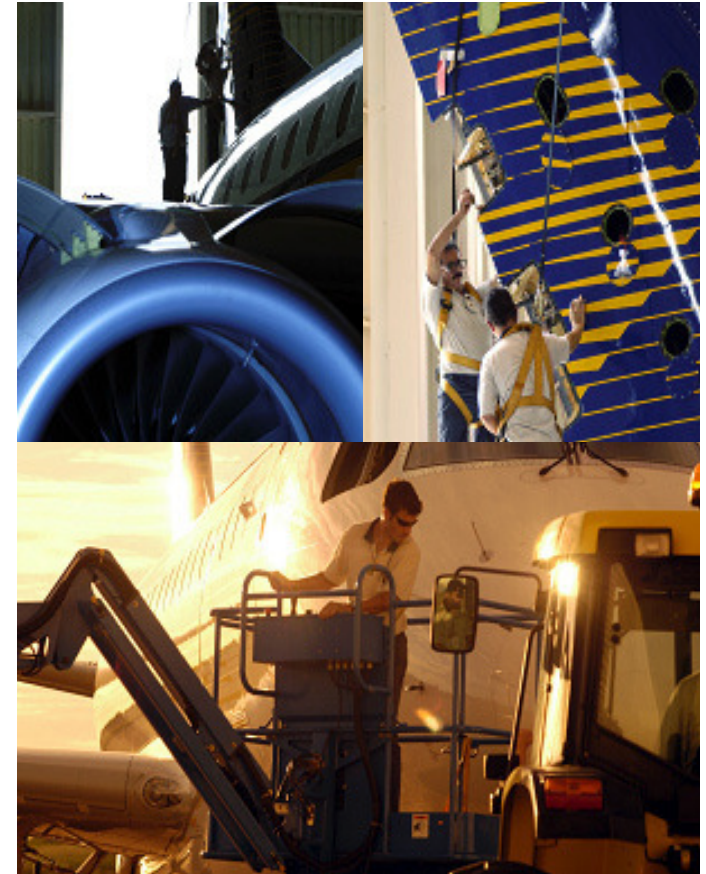
LPV

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CPDLC



Definition:

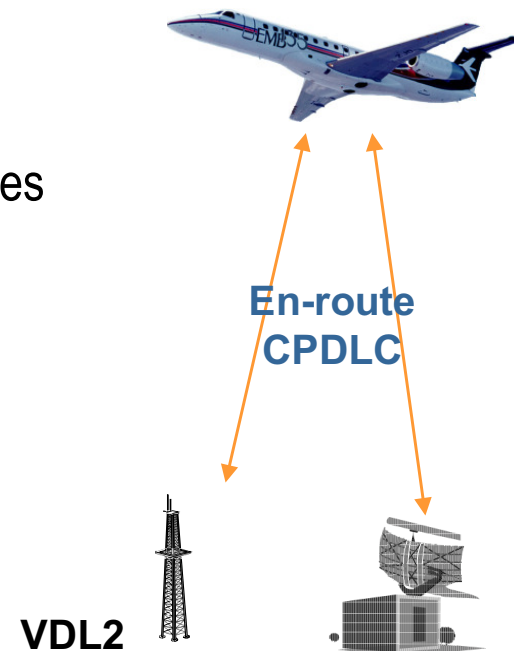
- Controller Pilots Data Link Communication (CPDLC) is a datalink application used by controllers and flight crews as a supplement to voice communications.
- This tool uses VDL Mode 2 (VHF digital link) and it's coverage is provided by ARINC or SITA stations.

Benefits

- Reduces congestion in VHF voice communication using datalink
- Allows automatic uplink/downlink of specific messages Advantages
- Higher transfer rate;

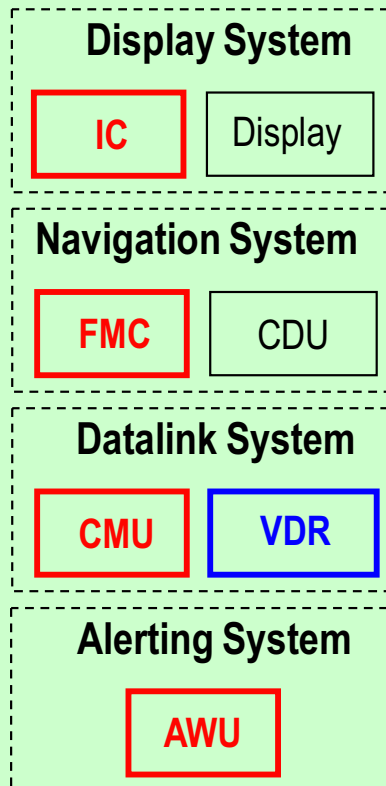
Applicability:

- All airplanes flying above FL285
- ATN CPDLC – Employ VDL Mode 2 Data link. Used for ATC en route and terminal in continental areas

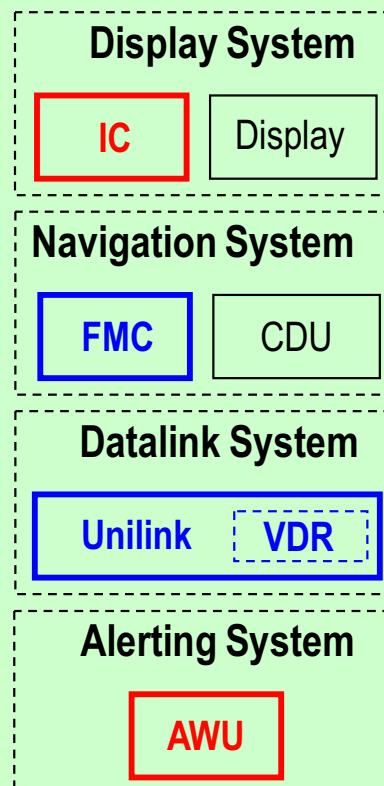


ATN CPDLC

Honeywell



Universal



Legend:

xxx SW upgrade

xxx SW+HW upgrade

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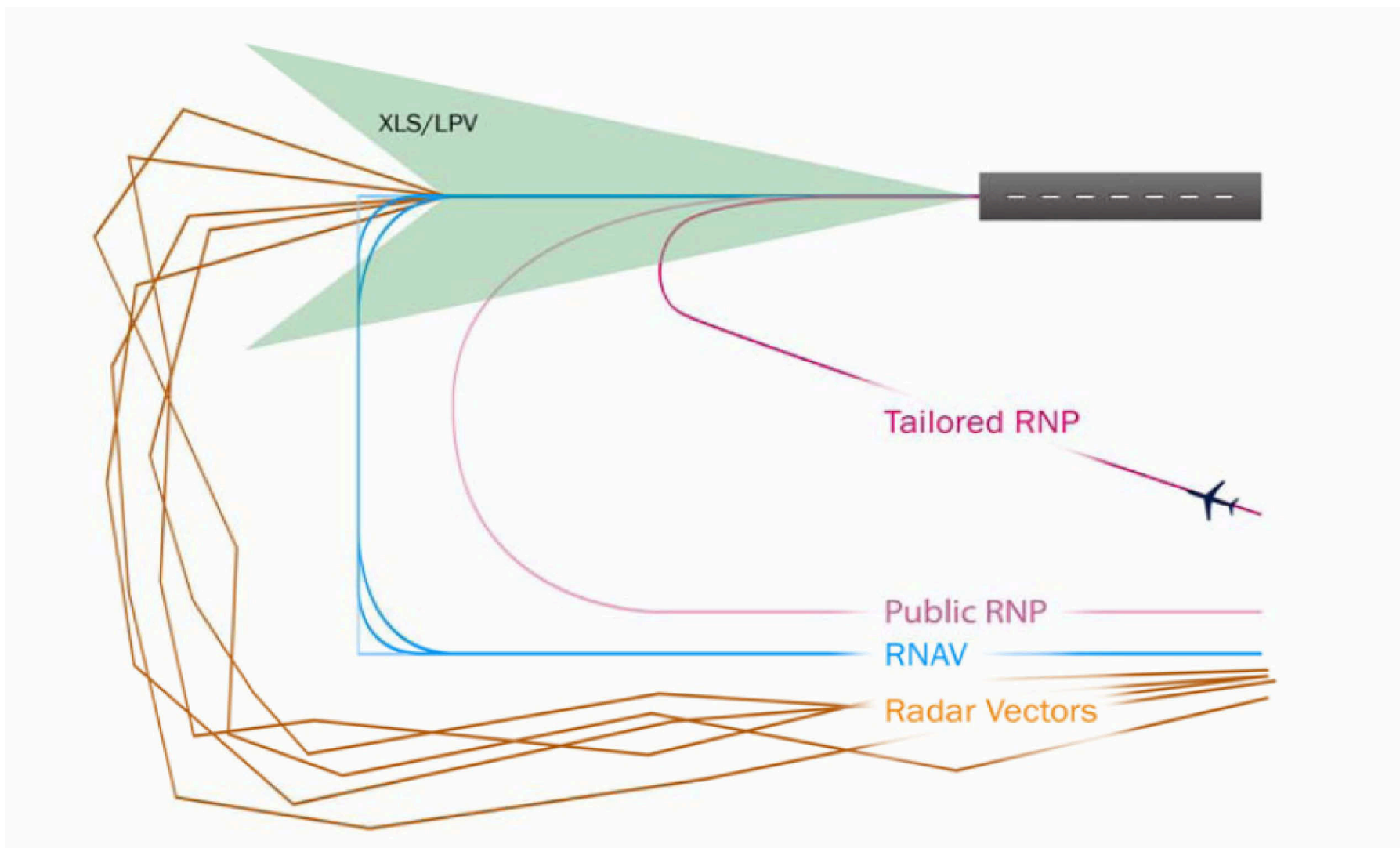
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Benefits



RNP





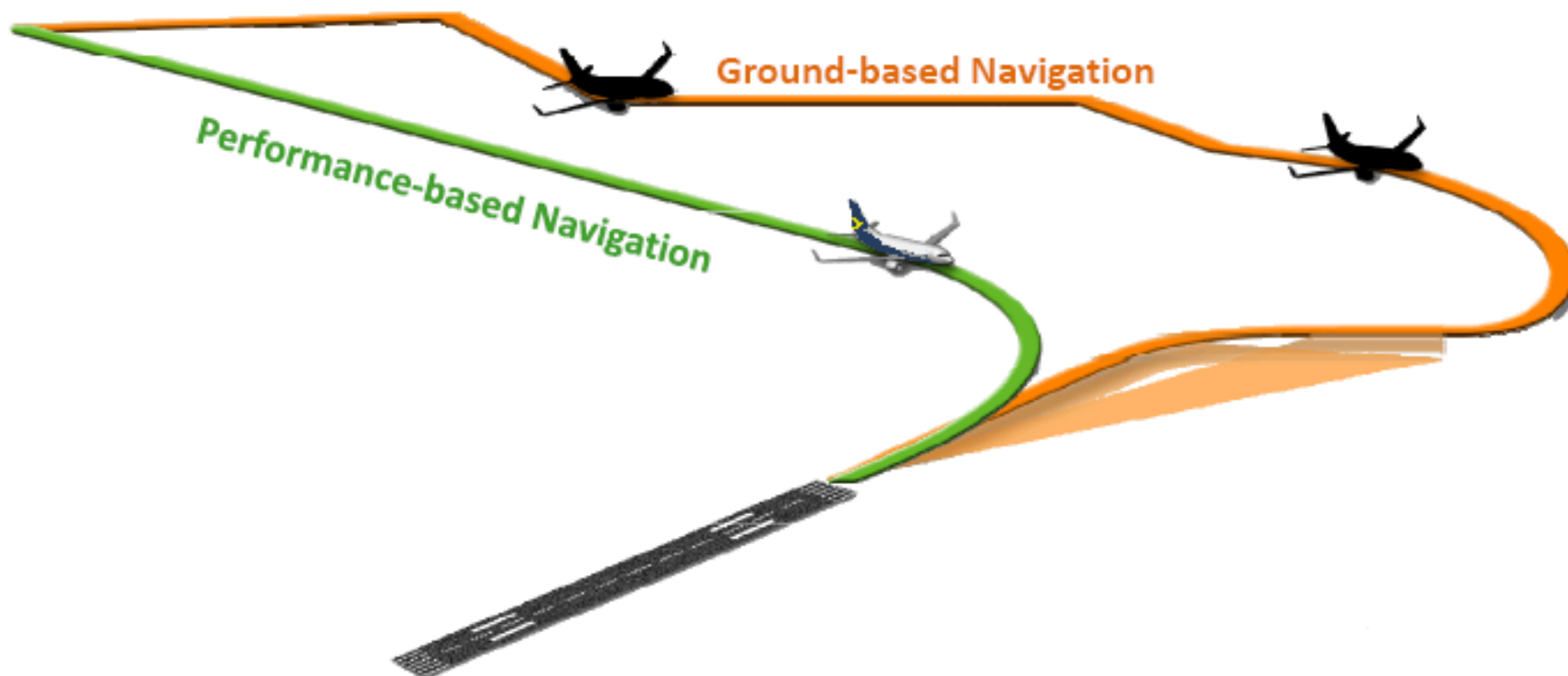
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Benefits



Improving ATM



RNP

- Enables Lower Curved approaches:

- Fuel savings per RNP approach X
- Number of approaches X
- Percentage of approaches with low RNP values (<1.0)

**USD 27,000.00
airplane / year**

=> 30kgs

=> 2000 flights/year

=> 9%

- Enables Fewer Diversions

- Number of diversions X
- Percentage of diversions due to low minima X
- Percentage of approaches feasible with low RNP X
- Cost per diversion

=> 7 flights / year / airplane

=> 30 % => 2 flights / year / airplane

=> 9% => 0.18 flight / year / airplane

=> USD 33,000.00

- Enables fewer delays

- Additional holding fuel X Holding time (average delay) X Number of approaches with RNP
- Average delay X hourly delay cost **=> 15kgs/min X 10min X 9% flights + 130USD/hour X 0.17h**



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Benefits



LPV

- Enables Fewer Diversions in non-ILS airports

- Number of diversions X
- Percentage of diversions due to low minima X
- Cost per diversion

**USD 25,000.00
airplane / year**

=> 7 flights / year / airplane

=> 30 %

=> USD 33,000.00

- Enables closer alternate airports for flight planning purposes

- Fuel savings due to lower alternate fuel X
- Number of flights

=> 15kgs / flight

=> 2000 flights X 50% X 80%

- Enables more direct approaches:

- Fuel savings per approach X
- Number of approaches X
- Percentage of approaches using LPV procedures

=> 30kgs

=> 2000 flights

=> 50% X 80%

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RNP and LPV developments

- Embraer is conducting a preliminary study to evaluate technical solutions for these functionalities – 2Q/10.
- Customers to inform the Account Managers of their interest in pursuing the development of these functionalities.

CPDLC and ADSB

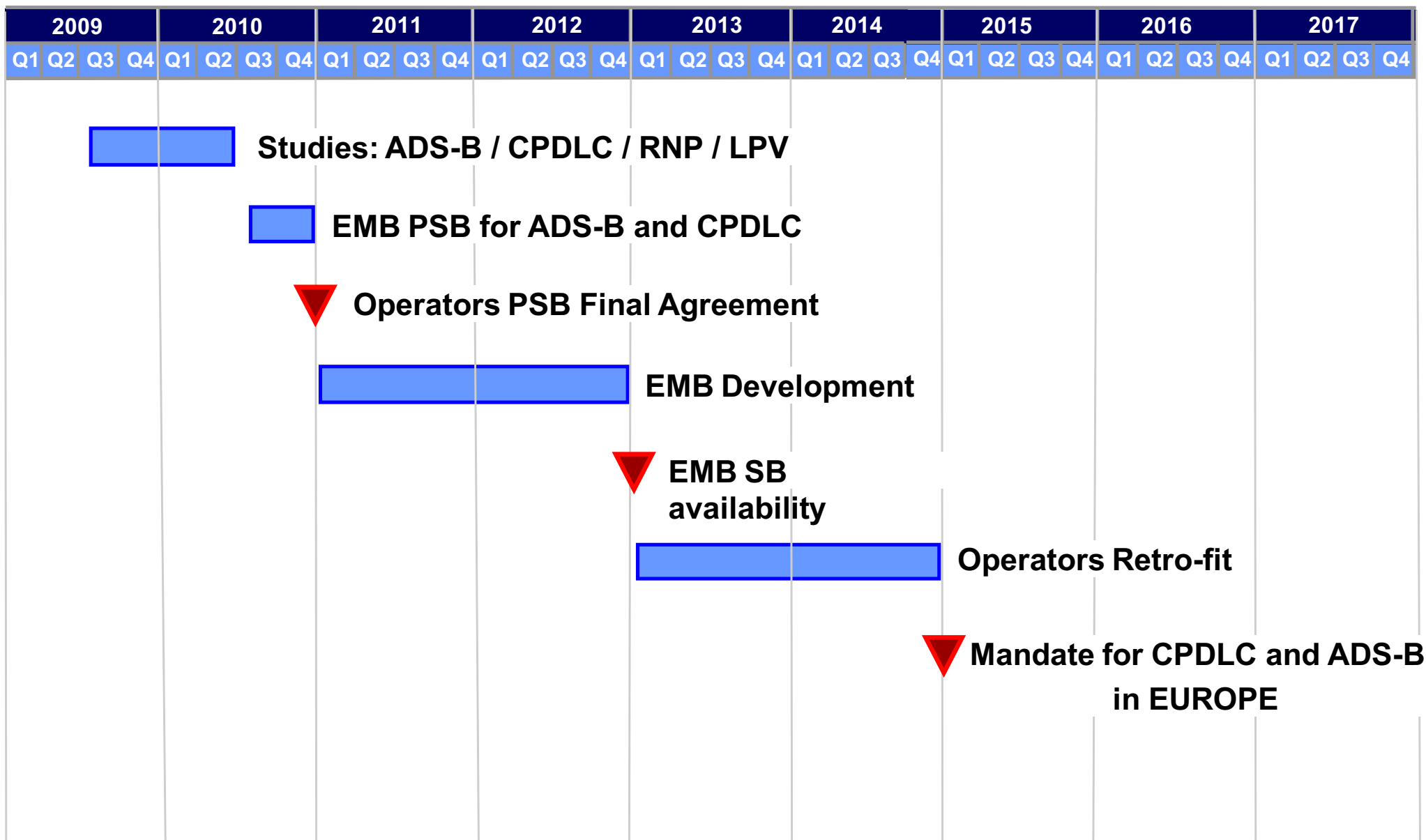
- Embraer is conducting a study to evaluate technical solutions for these functionalities.
- PSBs to be provided – 3Q/10.



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