Boeing Position on Automatic Dependent Surveillance-Broadcast (ADS-B)

CAAC-Thales ADS-B Flight Operation Seminar June 2010

Beijing, China

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Topics

- Airplane Equipage for ADS-B-Out

- ADS-B-Out Implementation Planning

- Global Harmonization

- Airplane Equipage for ADS-B-In

- ADS-B-In & Runway Safety Implementation Planning
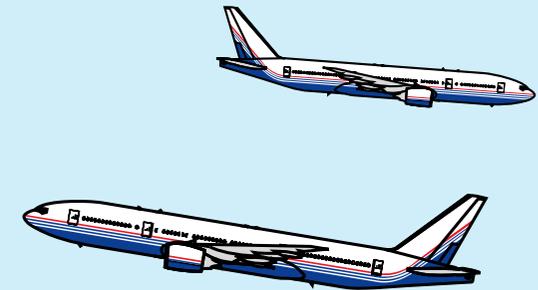
- Conclusion
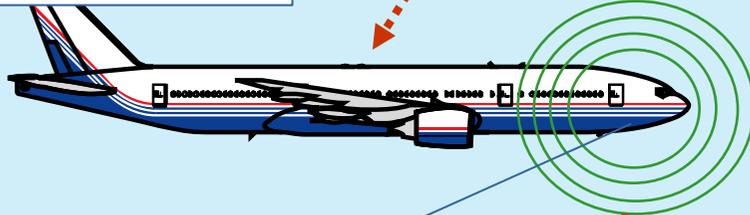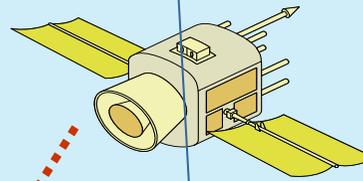
Airplane Equipage for ADS-B-Out

**What Automatic Dependent Surveillance – *Addressed* (ADS-A) Means
Also Known As Automatic Dependent Surveillance – *Contract* (ADS-C)**

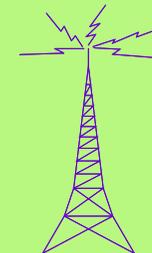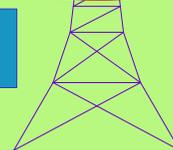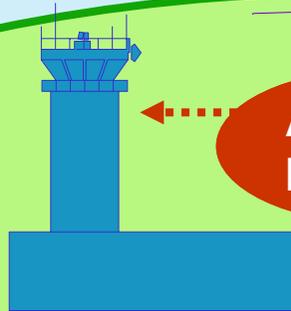Surveillance data ***addressed/contract:*** point to point to only the ground recipients that have a contract to receive the data.

Global Navigation Satellite System

FANS datalink over ACARS

ADS-A/C Receiver

4
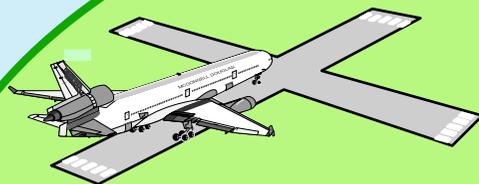
Airborne Components for ADS-B-Out: What an Aircraft Needs to Transmit a Signal-Out

Global Navigation
Satellite System
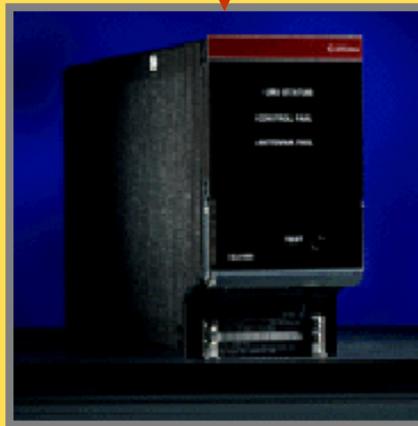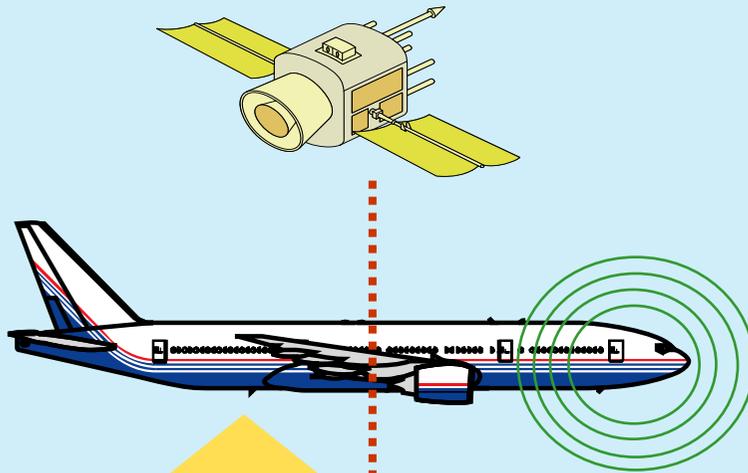
GNSS Receiver/Antenna   ATC Transponder/Antenna

ADS-B-Out Applications

- Non-Radar Airspace (NRA)
  - The use of ADS-B as the sole source of real-time surveillance data (for example, in so-called 'non-radar airspace'). This includes not only oceanic and remote airspace, but also operations at airports without terminal area radar and below the coverage of longer-range radars.

- ATC Surveillance for Radar Airspace (RAD)
  - The use of ADS-B as the primary surveillance data source in airspace with radar surveillance as a fused or backup source of surveillance data.
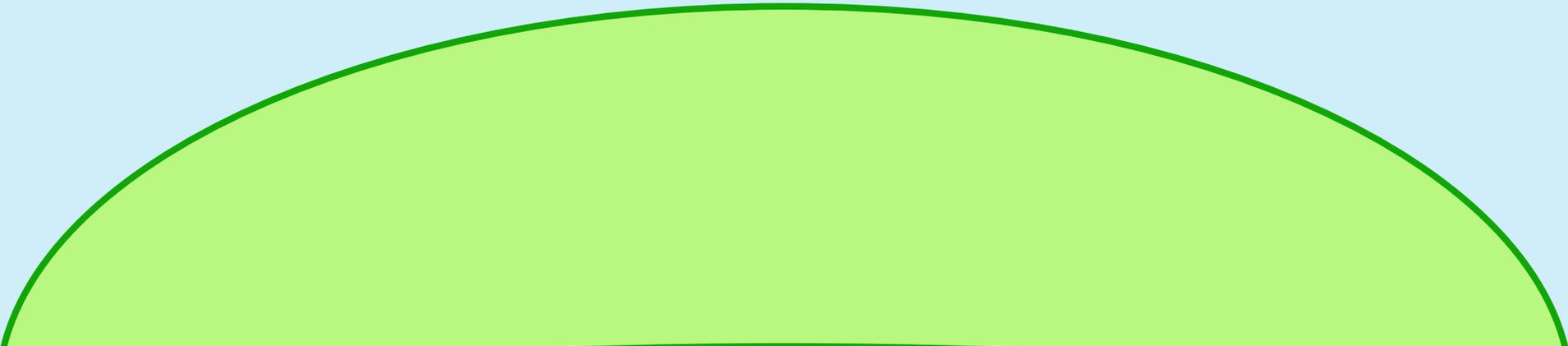
Boeing Production Evolution: Mode A/C, Mode S

Mode S

Interrogated data

Mode A/C
Mode S

Altitude
Code
Aircraft
Address

In the beginning….

Production Configuration
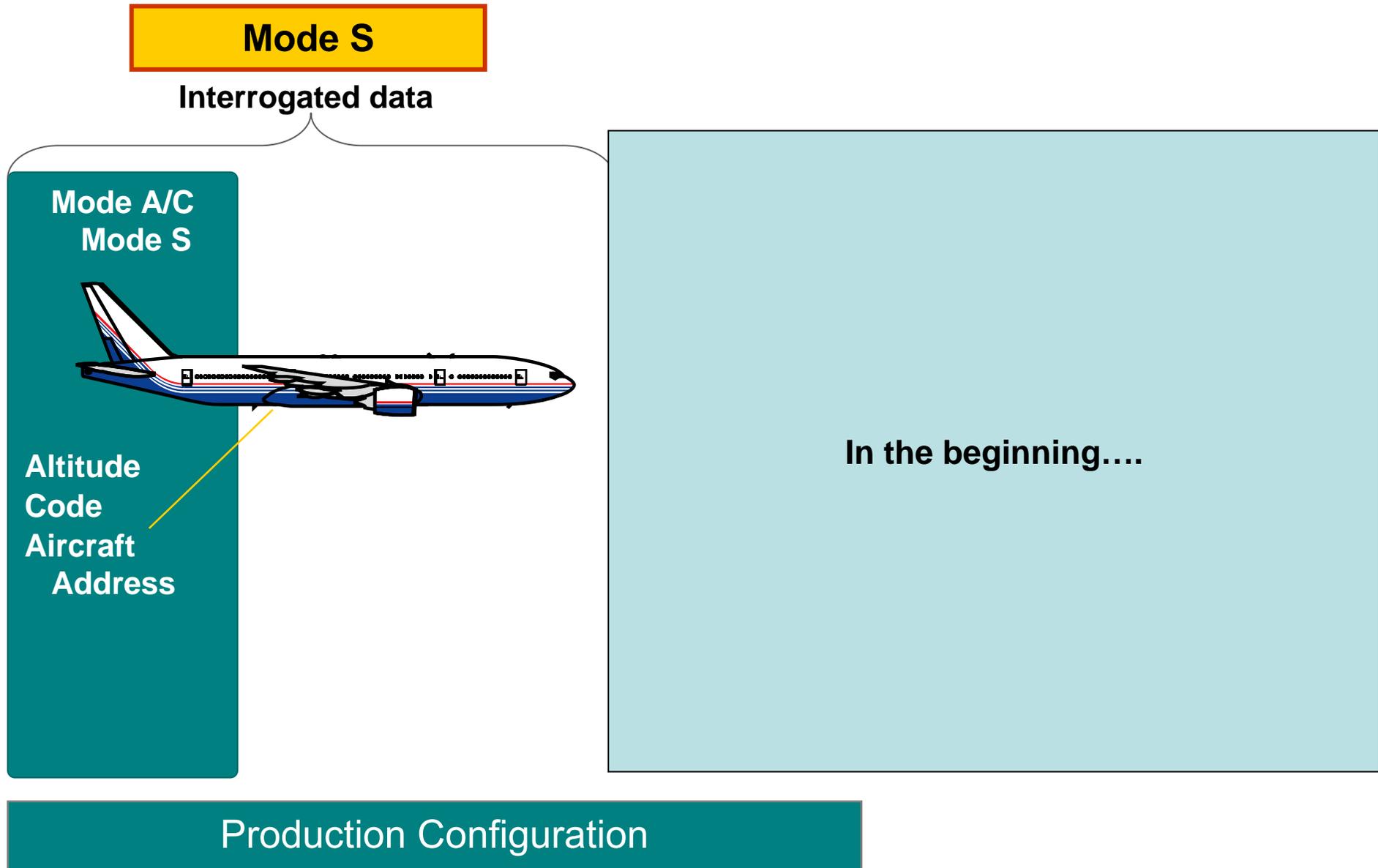
Boeing Production Evolution: Elementary and Enhanced Mode S

Mode S

Interrogated data

Mode A/C
Mode S

Elementary and
Enhanced Mode S

Altitude
Code
Aircraft
   Address

Flight ID
Selected Alt   **TAS**
Mach Number   **IAS**
Magnetic Heading **GS**
Roll Angle   **VS**
Track Angle
Track Angle Rate
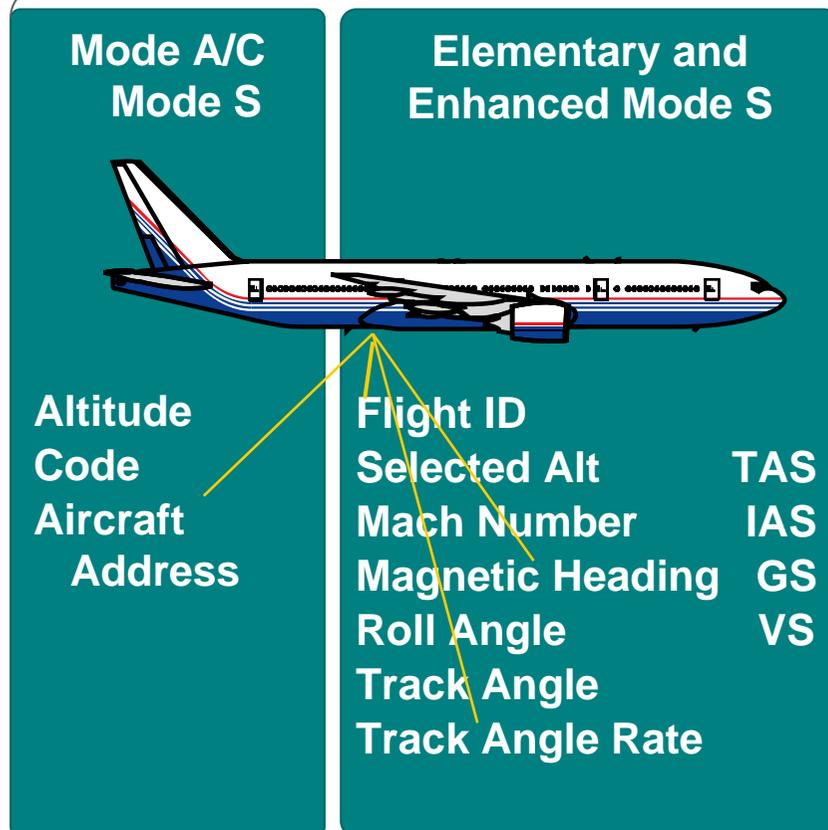
European Mandate 2004
- **Interrogated Data**

Production Configuration

Boeing Production Evolution: DO-260

Mode S	ADS-B-Out
Interrogated data	**Broadcast data**

Mode A/C Mode S

Elementary and Enhanced Mode S

DO-260-like Extended Squitter

Position
Velocity
Flight ID

Altitude
Code
Aircraft
Address

Flight ID
Selected Alt   TAS
Mach Number   IAS
Magnetic Heading   GS
Roll Angle   VS
Track Angle
Track Angle Rate

Production Configuration
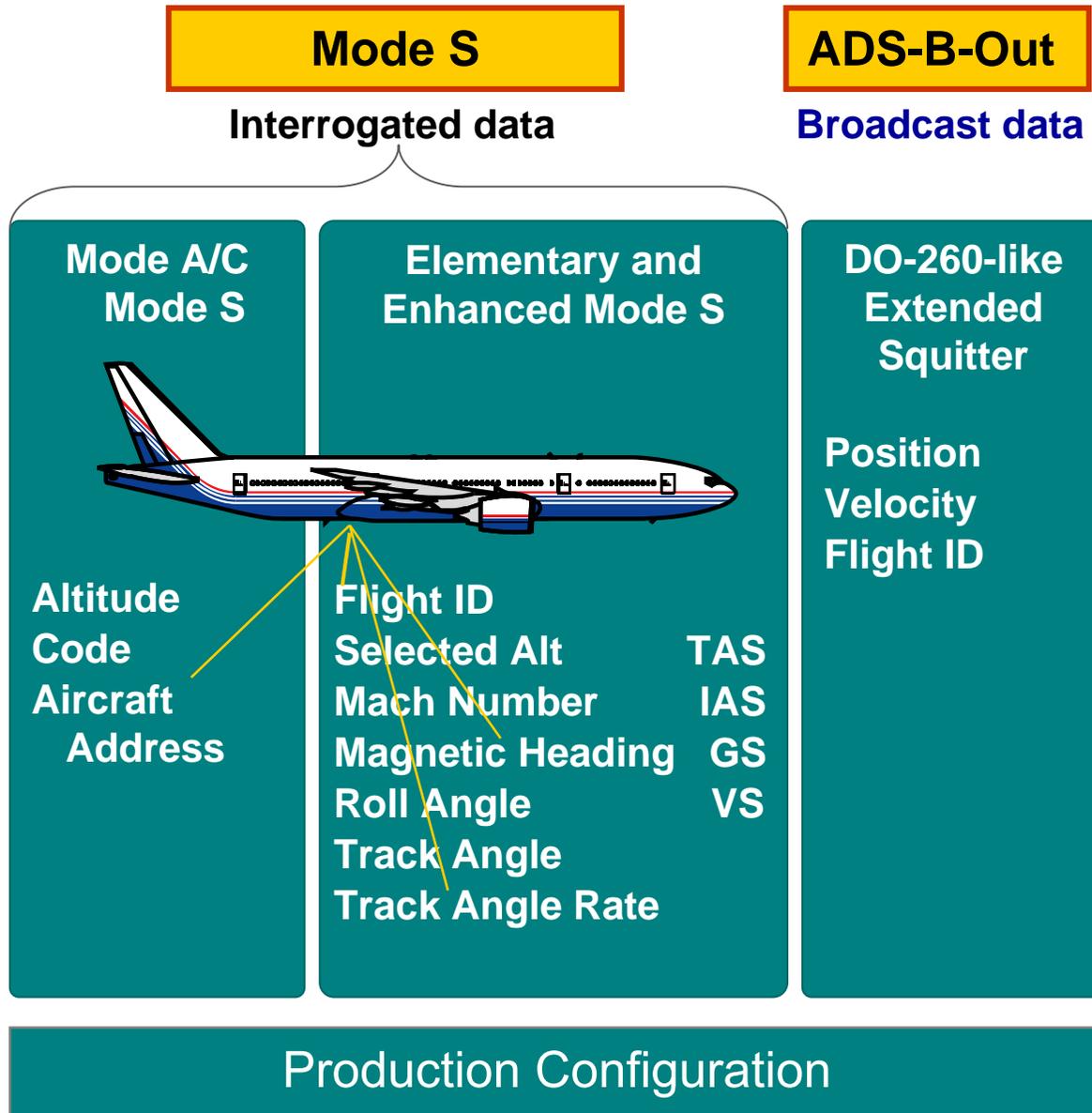
ADS-B-Out was added, even though DO-260 was immature

Single parameter used for accuracy and integrity reporting (NUC)

Supplier implementations had differences due to immature standard

Boeing certified system on non-interference basis only because regulatory certification guidance did not exist

EASA issued AMC 20-24, allowing Boeing to certify use of this equipage for NRA application

Boeing AFM Updates provided:
• No testing or airplane changes
• Free of charge to customer

ADS-B-Out Implementation Planning

Boeing Production Evolution: Latest standard DO260-B

Mode S

Interrogated data

ADS-B Out

Broadcast data

ADS-B Out

Broadcast data

Required for "RAD" application

Separate parameters for integrity and accuracy reporting (NIC/NAC)

Reporting parameter additions and changes

Mode A/C Mode S

Altitude
Code
Aircraft
    Address

Elementary and Enhanced Mode S

Flight ID
Selected Alt   TAS
Mach Number   IAS
Magnetic Heading   GS
Roll Angle   VS
Track Angle
Track Angle Rate

DO-260-like Extended Squitter

Position
Velocity
Flight ID

DO-260B

Position
Velocity
Flight ID
Integrity
Accuracy
Length/Width code

Production Configuration

Not yet in production

ADS-B-Out Production Status

- DO-260B was released 4Q2009

- TSO C-166b was released 4Q2009

- Suppliers and Airplane Manufacturers require approximately 2-3 years from release of TSO to production equipage upgrades.
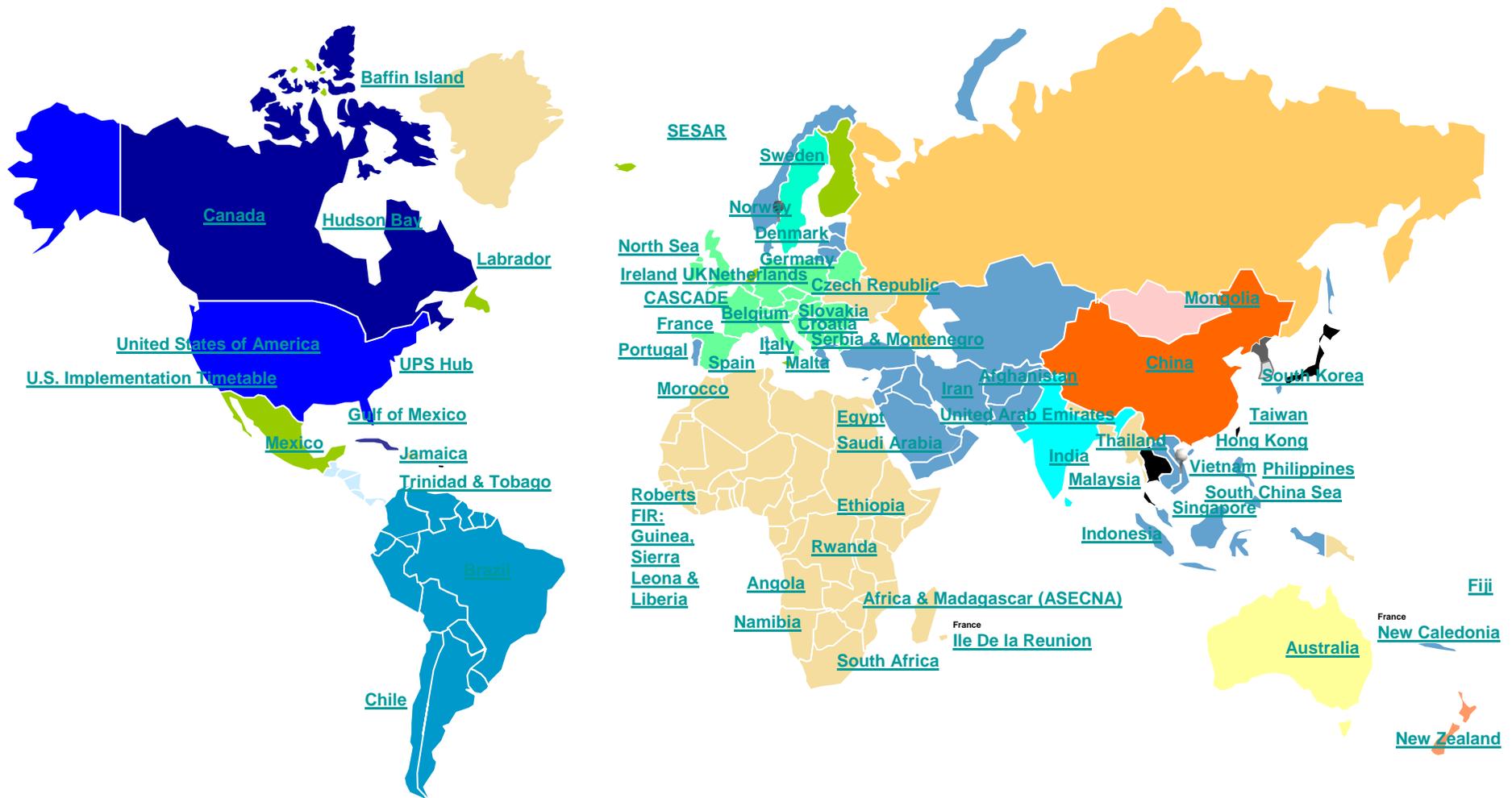
- Per current schedule DO260B should be in production 4Q2012 and retrofit 4Q2013

Global Harmonization

# ADS-B Worldwide 1090MHz/Mode S Installations/Plans

ADS-B-Out Mandate Timeframe Summary

- Nav Canada is mandating ADS-B Out for Hudson Bay between FL350 and FL400 inclusive in Nov 2010
  - Current production equipage meets requirements
- Eurocontrol/EASA <u>draft</u> rule mandates ADS-B Out in production on 10 Jan 2013 and for entire European airspace (retrofit) on 5 Feb 2015
  - Requires new transponder standard (DO-260B)
- CASA (Australia) rule mandates ADS-B Out for upper airspace (≥FL290) in Dec 2013
  - Current production equipage meets transponder requirements
  - SA-Aware GPS receiver will be required in production 28 June 2012
- FAA draft rule mandates ADS-B Out (DO-260B) for airspace on 1 Jan 2020
  - Requires DO-260B and possibly SA-Aware GPS Receivers
  - FAA final rule published in May 2010

Airplane Equipage for ADS-B-In

Airborne Components for ADS-B-In: What an Aircraft Needs to Receive a Signal-In From an ADS-B Equipped Aircraft and See Display

Global Navigation Satellite System
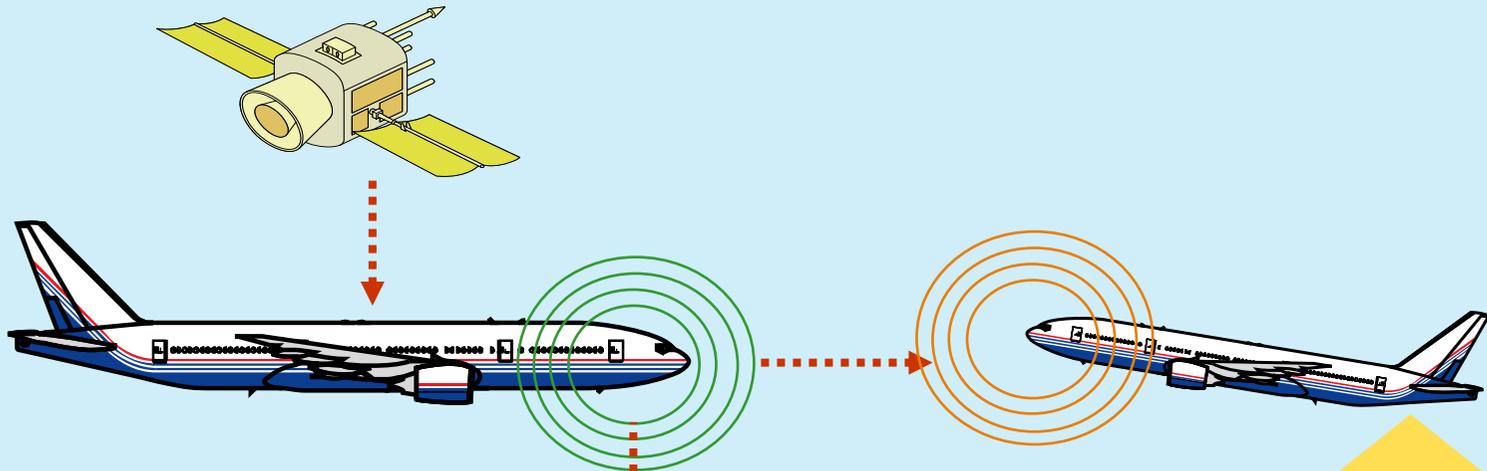
ATC Transponder/Antenna or ACAS/TCAS/Antenna

Cockpit Display of Traffic Information (CDTI)

ADS-B-In Near-Term Applications

- **Airport Surface Situational Awareness**
- **Final Approach Runway Occupancy**
- **Enhanced Visual Acquisition**
- **In-Trail Procedure**

ADS-B Receiver
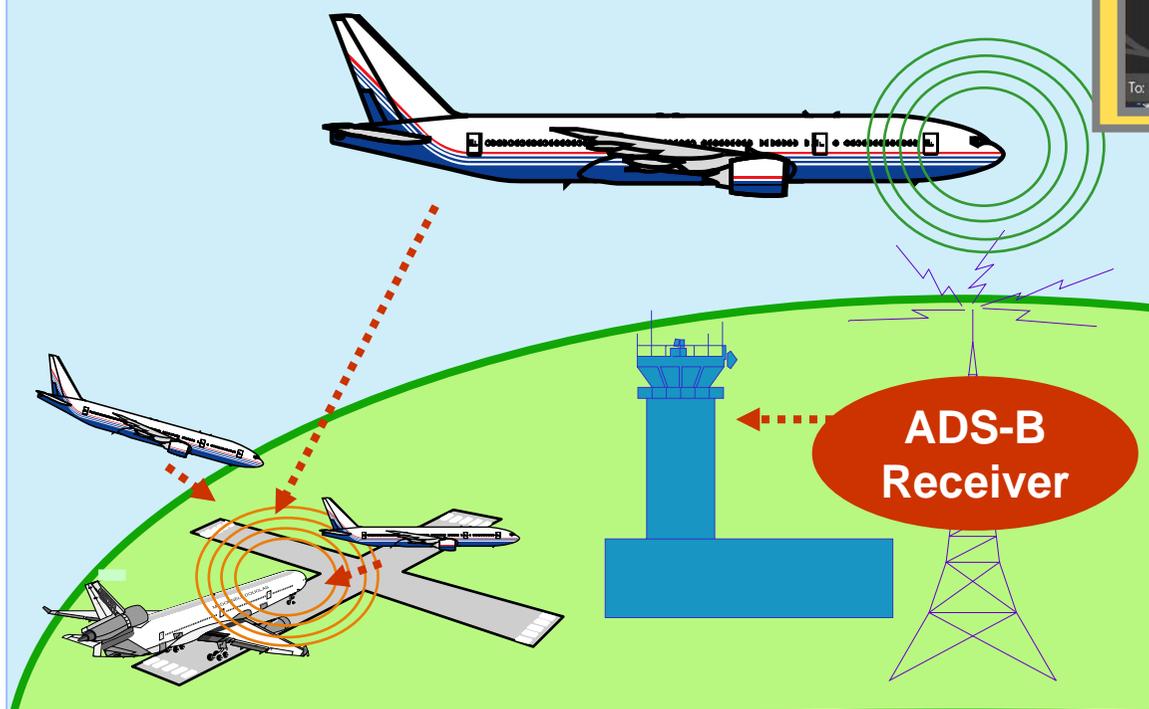
Airport Surface Surveillance

Airborne Situational Awareness

ADS-B-In Mid and Far-Term Applications

- **Surface Indication and Alerting**
- **Interval Management**

- **Airborne Conflict Management**
- **Approach Spacing for Instrument Approaches**
- **Independent Closely Spaced Parallel Approaches**

ADS-B Receiver

ADS-B-In Implementation Planning

Boeing Production Evolution

Mode S	ADS-B-Out	ADS-B-Out	ADS-B-In
Interrogated data	Broadcast data	Broadcast data	

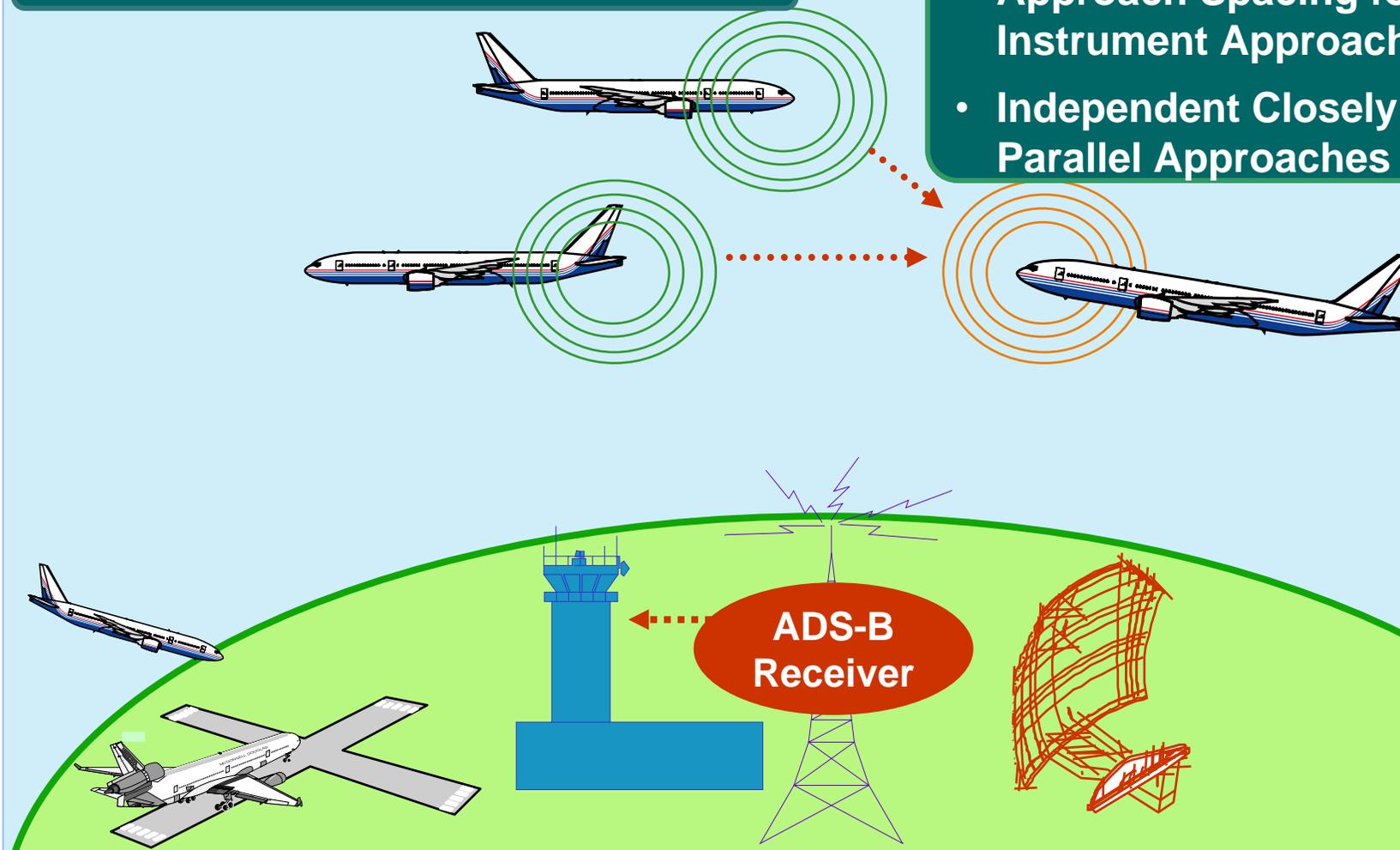| Mode A/C Mode S	Elementary and Enhanced Mode S	DO-260-like Extended Squitter	DO-260B	ADS-B/CDTI Applications
Altitude Code Aircraft Address	Flight ID Selected Alt TAS Mach Number IAS Magnetic Heading GS Roll Angle VS Track Angle Track Angle Rate	Position Velocity Flight ID	Position Velocity Flight ID Surveillance Integrity Length/Width code	

Production Configuration

Not yet in production

ADS-B-In

- There are no mandates foreseen for ADS-B-In.
- Mature standards and ANSP operational procedures are required for airlines to achieve benefit.
- Operational procedures for ADS-B-In applications are in the trial phase.
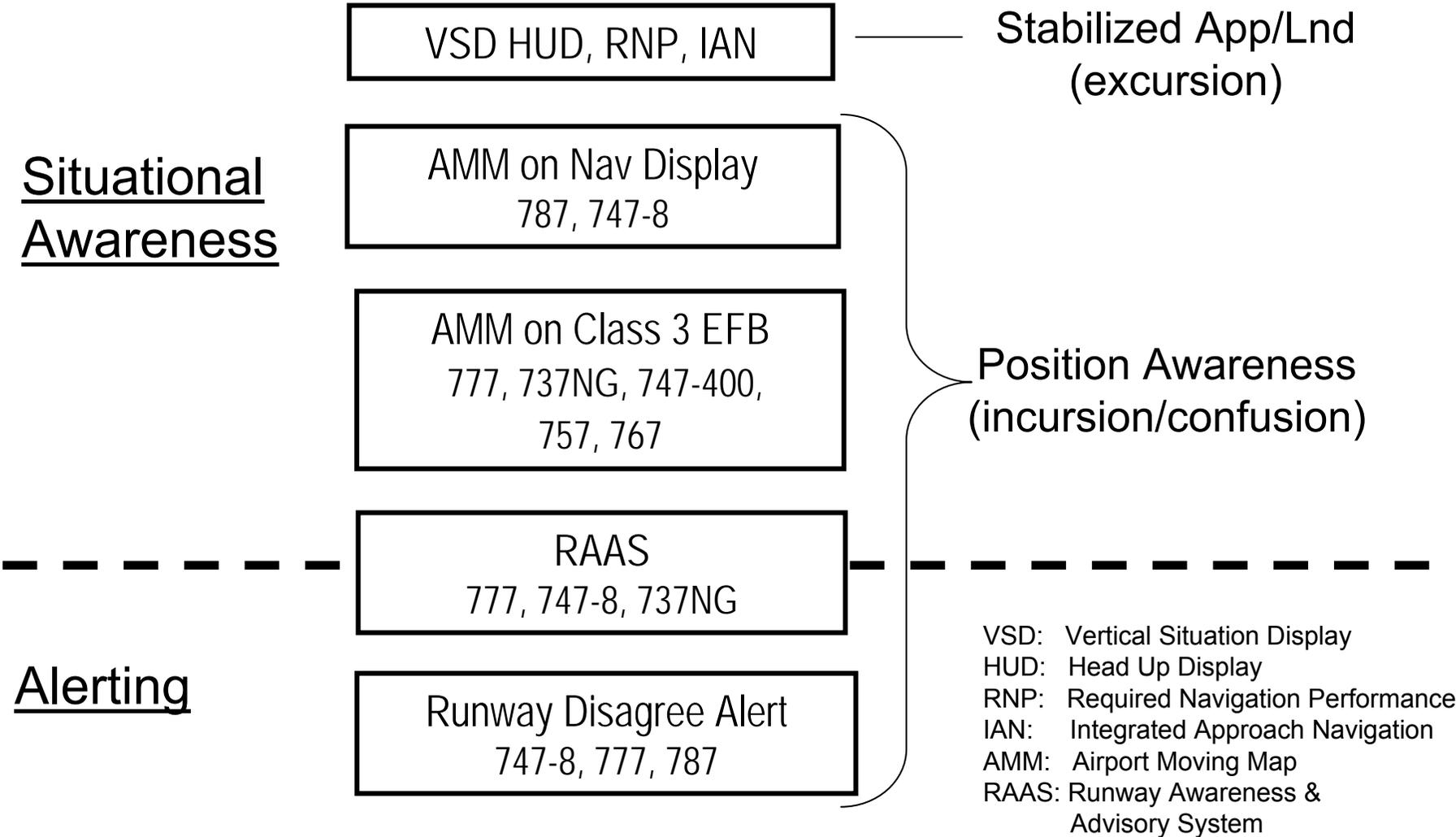- Boeing strategy is to ensure equipage architectures with ability for growth.
- We believe this to be the most economic and technically sound approach for our customers.
- Boeing flight deck human machine interface requirements are near completion.
- Research and Feasibility Studies are on-going:
  – 787 program for Cockpit Display of Traffic Information (CDTI) applications starting with the 787-9.
  – Other production models for (CDTI) applications on Electronic Flight Bag (EFB) and Forward Displays.
  – Retrofit solutions for non-production models are also being explored.
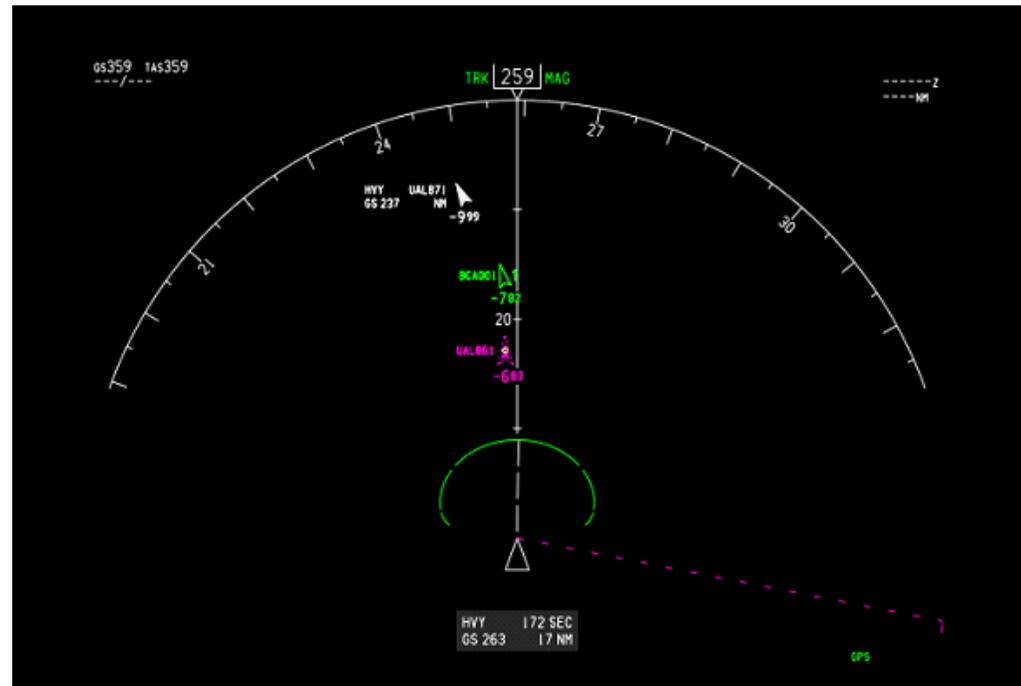
ADS-B-In and Runway Safety Current Equipage Status

<u>Situational Awareness</u>

| VSD HUD, RNP, IAN | —— Stabilized App/Lnd (excursion) |

| AMM on Nav Display 787, 747-8 |

| AMM on Class 3 EFB 777, 737NG, 747-400, 757, 767 | Position Awareness (incursion/confusion) |

| RAAS 777, 747-8, 737NG |

<u>Alerting</u>

| Runway Disagree Alert 747-8, 777, 787 |

VSD: Vertical Situation Display
HUD: Head Up Display
RNP: Required Navigation Performance
IAN: Integrated Approach Navigation
AMM: Airport Moving Map
RAAS: Runway Awareness & Advisory System

Current Program Equipage

**Airport Moving Map on
Navigation Display**
787 and 747-8
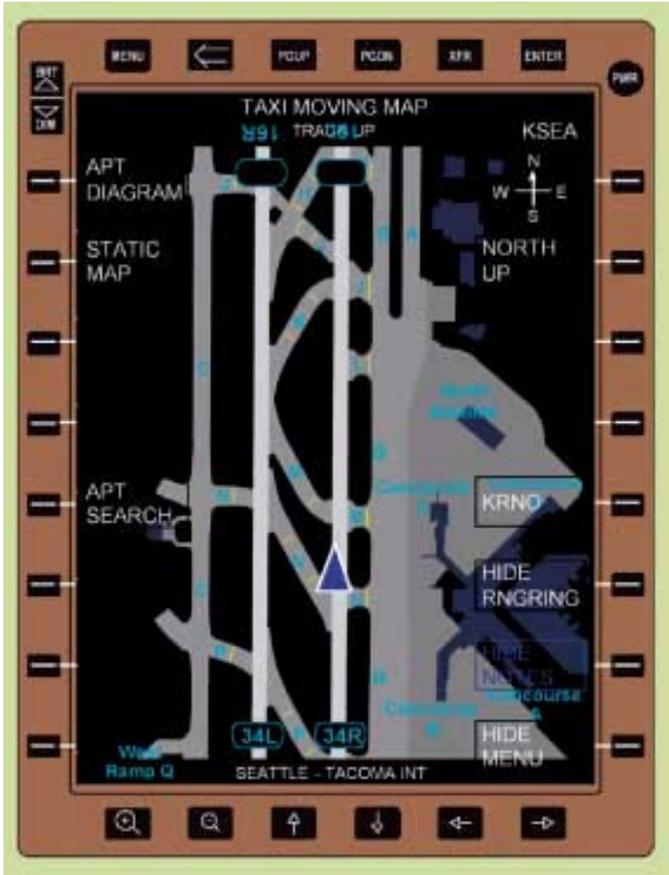
**Airport Moving Map on
EFB Side Display**
737NG, 747-400, 747-8,
757/767, & 777

Current Program Equipage

"On Runway Zero-Nine Left"

"Approaching Zero-Nine Left"
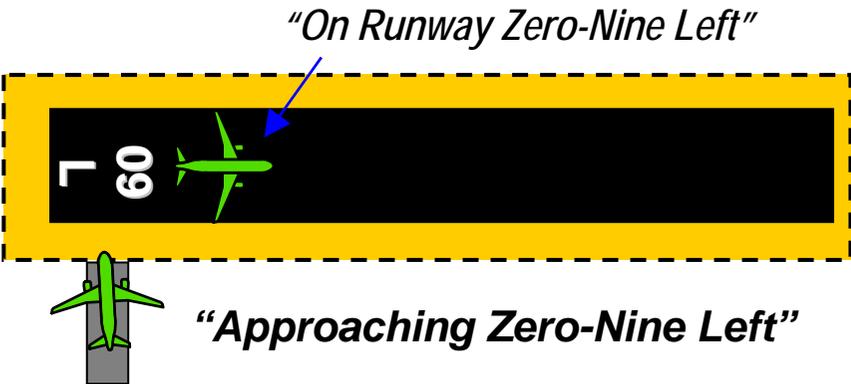
Runway Awareness & Advisory System

(737NG, 777, & 747-8)

CAUTION

FMC RUNWAY DISAGREE

Runway Disagree Alert

(777, 787, 747-8)

Current Program Equipage

Head-Up Display
737NG, 787

Integrated Approach Navigation
737NG, 787
Navigation Performance Scales
737NG, 777, 787

ADS-B-In and Runway Safety Future Equipage Studies

Situational Awareness

Surface CDTI
Taxi Route
737NG Class 2 EFB with AMM – Window Sill
Runway Status Indications

Position, Performance, Taxi Route, & Traffic Awareness

• HUD Traffic, Taxi Route, & Runway Status • Approach/Landing Monitors & Alerts

Alerting

Surface Traffic Conflict Alerts

Unstable Approach, Long Landing, Predicted Overrun & Traffic Conflict.

Future Equipage Studies - AMM

Airport Moving Map with:
- Taxi Route
- Traffic
- Runway Status Indications
- Traffic Conflict Alerting
- T/O & Landing Perf Info
- Optimized Runway Exiting
- Long Landing Alerting

Future Equipage Studies -- HUD

- **Taxi Route**
- **Traffic**
- **Runway Status Indications**
- **Traffic Conflict Alerting**
- **T/O & Landing Performance Info & Alerting**
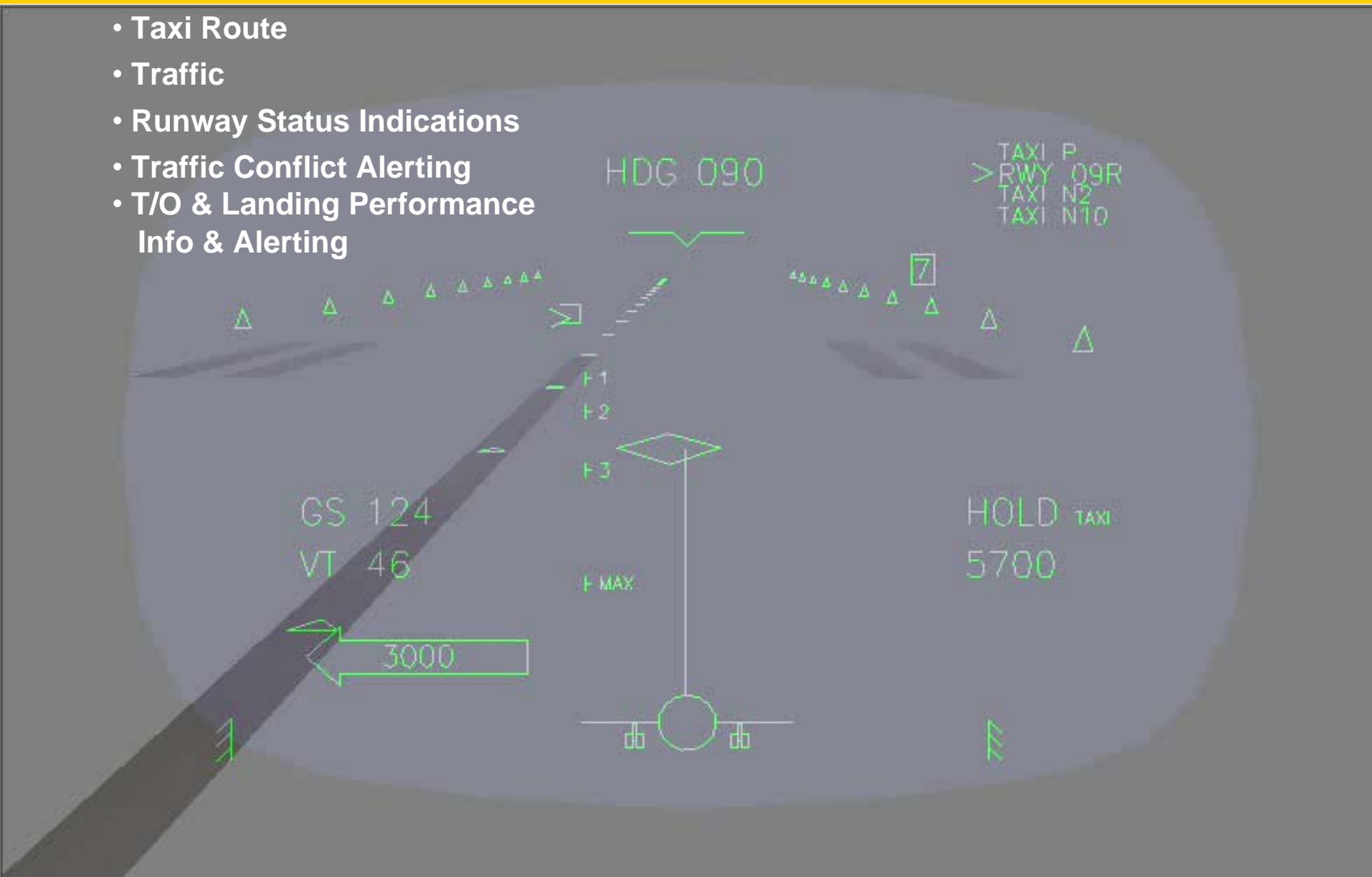
ADS-B-In & Runway Safety Equipage Timeline
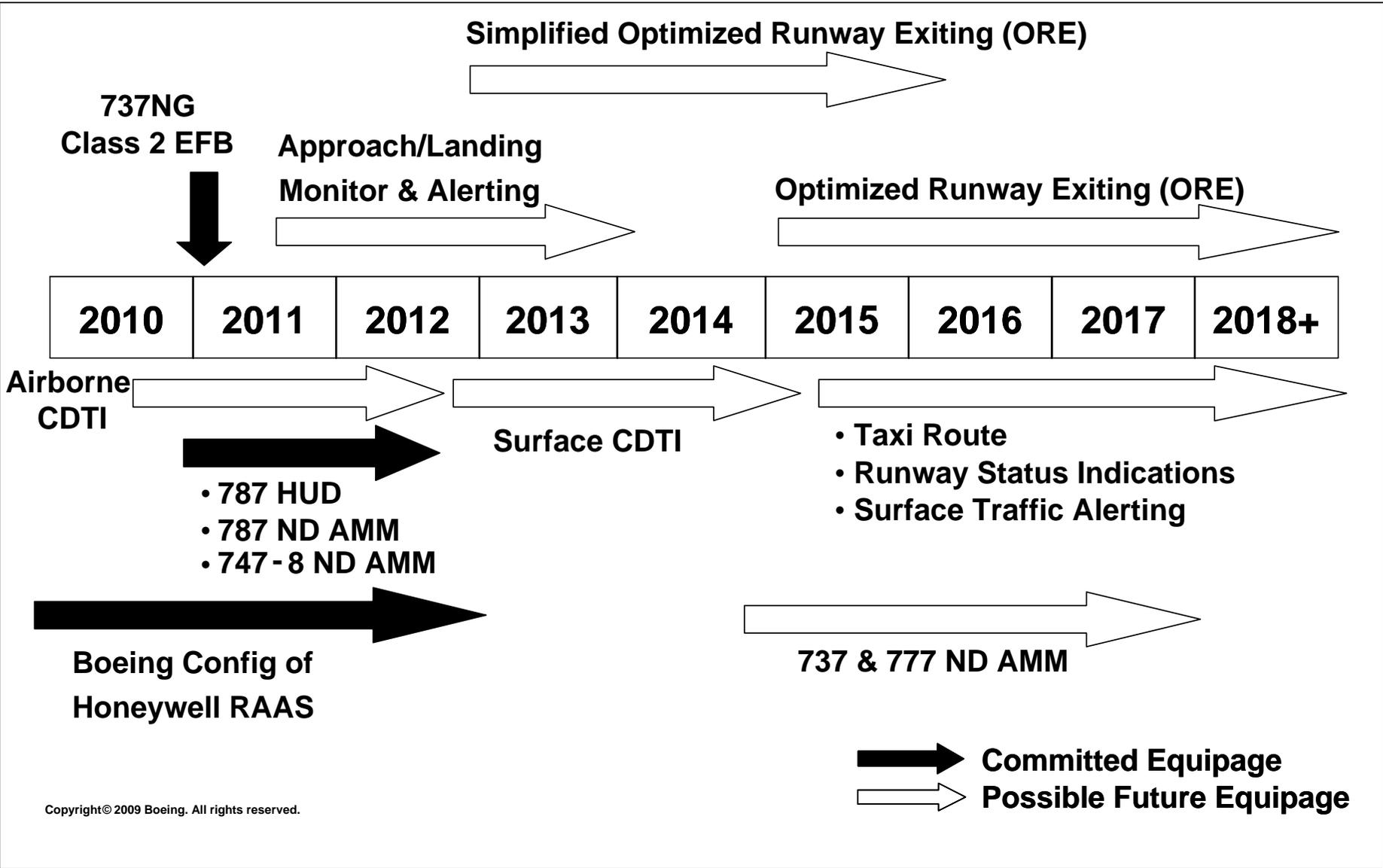
Simplified Optimized Runway Exiting (ORE)

**737NG
Class 2 EFB**

**Approach/Landing
Monitor & Alerting**

Optimized Runway Exiting (ORE)

2010	2011	2012	2013	2014	2015	2016	2017	2018+

**Airborne
CDTI**

Surface CDTI

- **Taxi Route**
- **Runway Status Indications**
- **Surface Traffic Alerting**

- **787 HUD**
- **787 ND AMM**
- **747‑8 ND AMM**

737 & 777 ND AMM

**Boeing Config of
Honeywell RAAS**

Committed Equipage
Possible Future Equipage

Conclusion

Boeing Position on ADS-B

- Support ADS-B Out. We will meet ADS-B Out mandates.

- Support ADS-B In. We must maximize the value of equipage solutions, while recognizing that retrofit equipage upgrades are complex and expensive.
    - We are conducting forward fit studies on ADS-B-In to ensure requirements compliant cost-effective architectures with growth capability
    - We are evaluating retrofit display solutions, including Class 3 EFBs

- Coordinate with Air Navigation Service Providers (Canada, Australia, Europe, US) to ensure common airborne requirements global harmonization

- Actively support DO-260B standards installation.

- Engage with airlines and industry partners on rulemaking around the world.

- Continue industry standards support.

Boeing Aero Magazine Article on ADS-B:
http://www.boeing.com/commercial/aeromagazine/articles/qtr_02_10/2

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