

# *Embraer Civil Product Status: Datalink Communications*



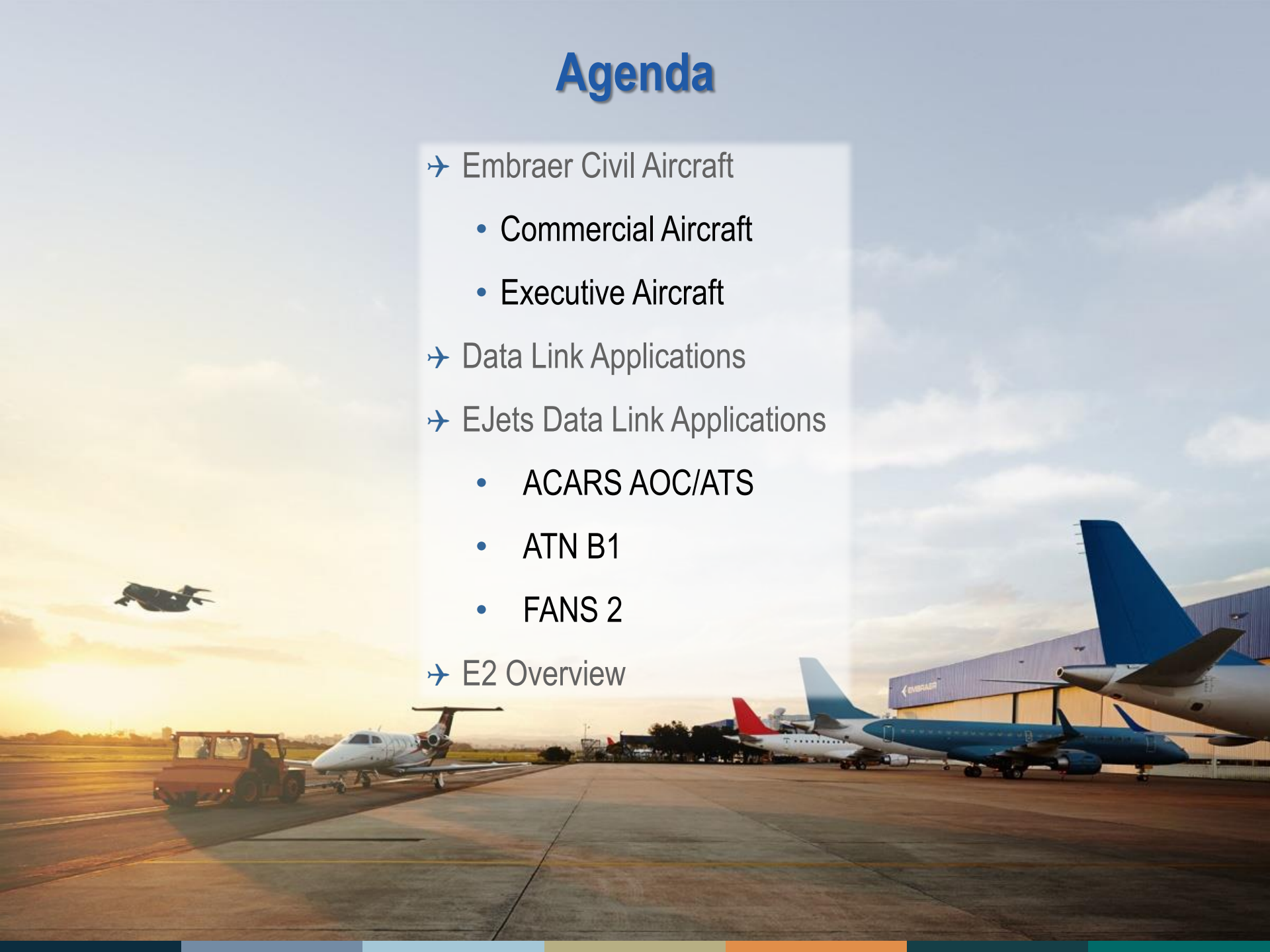
*Seminar on Data Link Communications - Recife/PE – Brazil*

*March 16-18, 2016*

**Fernanda C. R. Vilarinho – Communications Engineer**

# Agenda

- Embraer Civil Aircraft
  - Commercial Aircraft
  - Executive Aircraft
- Data Link Applications
- EJets Data Link Applications
  - ACARS AOC/ATS
  - ATN B1
  - FANS 2
- E2 Overview



# COMMERCIAL AIRCRAFT



**ERJ 135**



**ERJ 140**



**ERJ 145**



**ERJ 145 XR**



**EMBRAER 170**



**EMBRAER 175**



**EMBRAER 190**



**EMBRAER 195**



**E175-E2**



**E190-E2**



**E 195-E2**



# ERJ Family

## ERJ 135

MODEL YOUR BUSINESS. YOUR WAY.



37

Rolls-Royce AE3007

1,750 nm

Mach 0.78

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## ERJ 140

CUSTOMIZED CAPACITY



44

Rolls-Royce AE3007

1,650 nm

Mach 0.78

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## ERJ 145

MISSION VERSATILITY WITH 50 SEATS



Rolls-Royce AE3007

50

Mach 0.78

1,550 nm

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## ERJ 145 XR

THE XR GOES THE DISTANCE



Rolls-Royce AE3007

50

Mach 0.78

2,000 nm

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## Honeywell Primus 1000

Available FMS Systems:

- Universal 1K
- Honeywell NZ-2000

# EJets Family

## EMBRAER 170

REGIONAL  
REDEFINED



General Electric  
CF34-8E engines -  
LR and AR

70 - 78

2,100 nm

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## EMBRAER 175

MORE SEATS. MORE REVENUE.  
LOWER UNIT COST.



General Electric  
CF34-8E engines -  
LR and AR

70 - 88

2,000 nm

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## EMBRAER 190

REPLACE. RENEW. REDISCOVER.



General Electric  
CF34-10E engines -  
LR and AR

98 - 114

2,400 nm

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## EMBRAER 195

MODEL YOUR BUSINESS. YOUR WAY.



General Electric  
CF34-10E engines -  
LR and AR

108 - 124

2,200 nm

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Honeywell Primus Epic

# E2 Family

## E175-E2

BEHOLD THE POWER OF 2



80 - 88



GTF PW1700G engines

1,920 nm



## E190-E2

BEHOLD THE POWER OF 2



97 - 106



GTF PW1900G engines



2,800 nm

## E195-E2

BEHOLD THE POWER OF 2



118 - 132



GTF PW1900G engines

2,000 nm



**Honeywell Primus Epic**

# COMMERCIAL AVIATION



AIRLINES

**90** +

COUNTRIES

**61** +

AIRCRAFT IN OPERATION

**1.6** +  
THOUSAND

\* E-Jets families and ERJ only; scheduled and non-scheduled airlines.



# EXECUTIVE AIRCRAFT



PHENOM 100E



PHENOM 300



LEGACY 450



LEGACY 500



LEGACY 600



LEGACY 650



LINEAGE 1000E





# Phenom 100/300

**PHENOM® 100E**  
ENTRY LEVEL



5 - 7  
1 - 2  
1,178 nm



**PHENOM® 300**  
LIGHT



1 - 2  
7 - 10  
1,971 nm



MOST AWARDED 2014  
MOST WANTED 2014  
PHENOM 300

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[Garmin G1000/3000](#)  
[Prodigy Flight Deck 100/300](#)

# Legacy 450/500

## LEGACY® 450

MIDLIGHT



2  7-9 

2,500 nm 

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## LEGACY® 500

MIDSIZE



8-12  2 

3,125 nm 

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Rockwell Collins  
Pro Line Fusion

# Legacy 600/650

**LEGACY® 600**  
SUPER MIDSIZE



13 - 14  
2  
3,400 nm

The Legacy 600 is a super-midsized business jet. The image shows the aircraft from an exterior perspective and a view of the cabin interior with two rows of seats. The cabin features leather upholstery and large windows. The aircraft is shown in flight against a blue sky.

**LEGACY® 650**  
LARGE



13 - 14  
2  
3,900 nm

The Legacy 650 is a large business jet. The image shows the aircraft from an exterior perspective and a view of the cabin interior with two rows of seats. The cabin features leather upholstery and large windows. The aircraft is shown in flight against a blue sky.



Honeywell  
Primus Elite

# Lineage 1000



Honeywell  
Primus Epic

# EXECUTIVE AVIATION



JETS  
DELIVERED

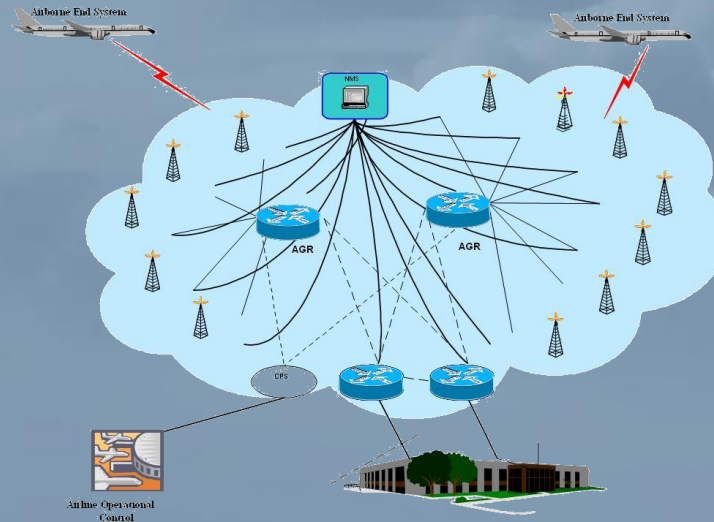
900 +

COUNTRIES

60

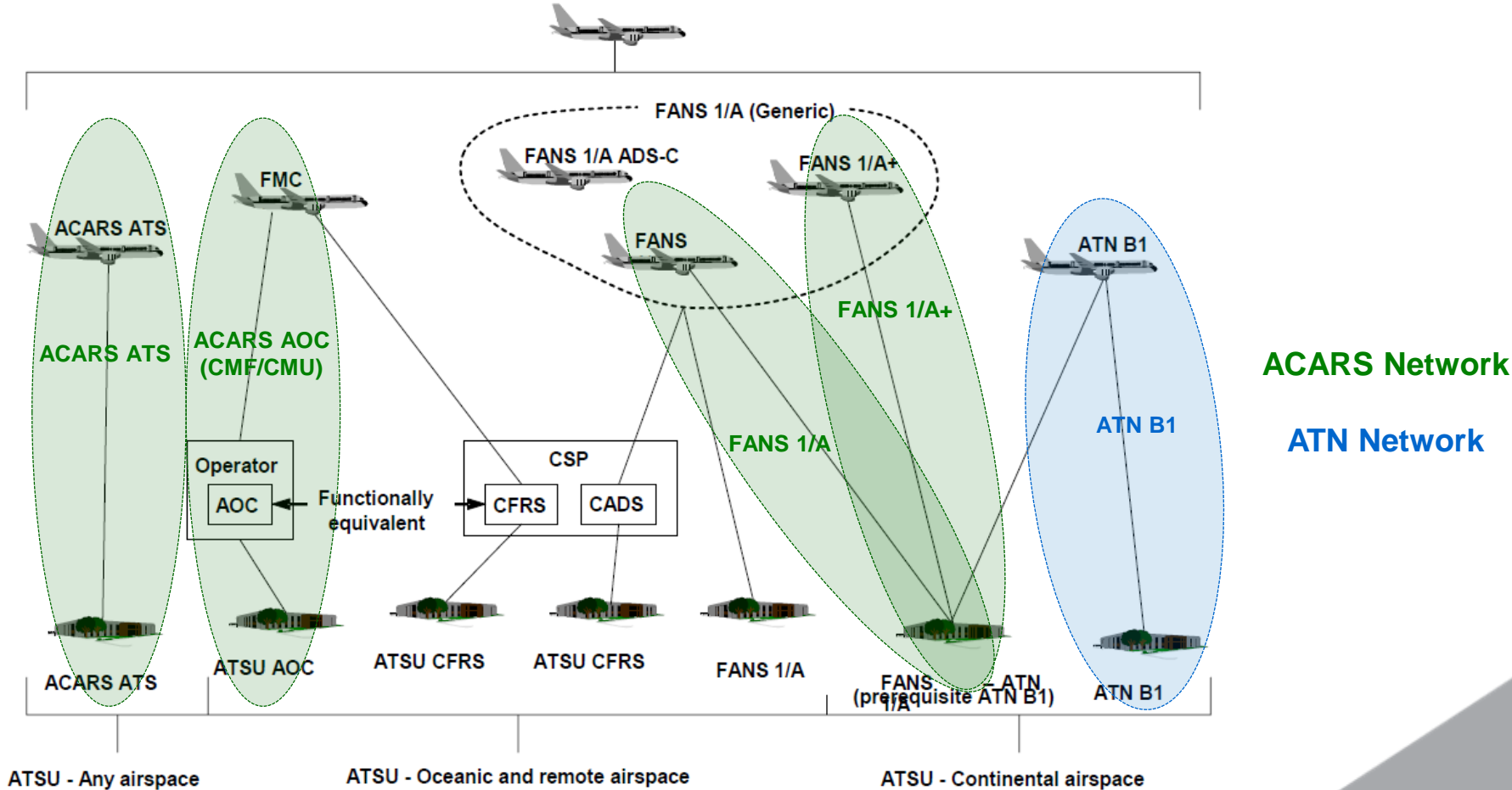


# DATA LINK APPLICATIONS



# Data Link Applications

Aircraft with multiple types of data link systems



# Data Link Applications Status

Data Link Application - Sub-network		Phenom 100/300 Garmim G1000/3000	Legacy 450/500 Rockwell Collins Pro Line Fusion	Legacy 600/650 Honeywell Primus Elite	Lineage Honeywell Primus Epic	ERJ Honeywell Primus 1000	Ejets Honeywell Primus Epic	E2 Honeywell Primus Epic
ACARS AOC / ATS	VDL Mode A							
	VDL Mode 2							
	Inmarsat							
	Iridium							
FANS 1/A (w/ ADS-C)	VDL Mode A							
	VDL Mode 2							
	Inmarsat							
	Iridium							
ATN B 1	VDL Mode 2			*1		*1		
	VDL M2 Multi Frequency			*1		*1		



Available



Obsolete



Under Certification



Under Development



Under Customer Request



Not available

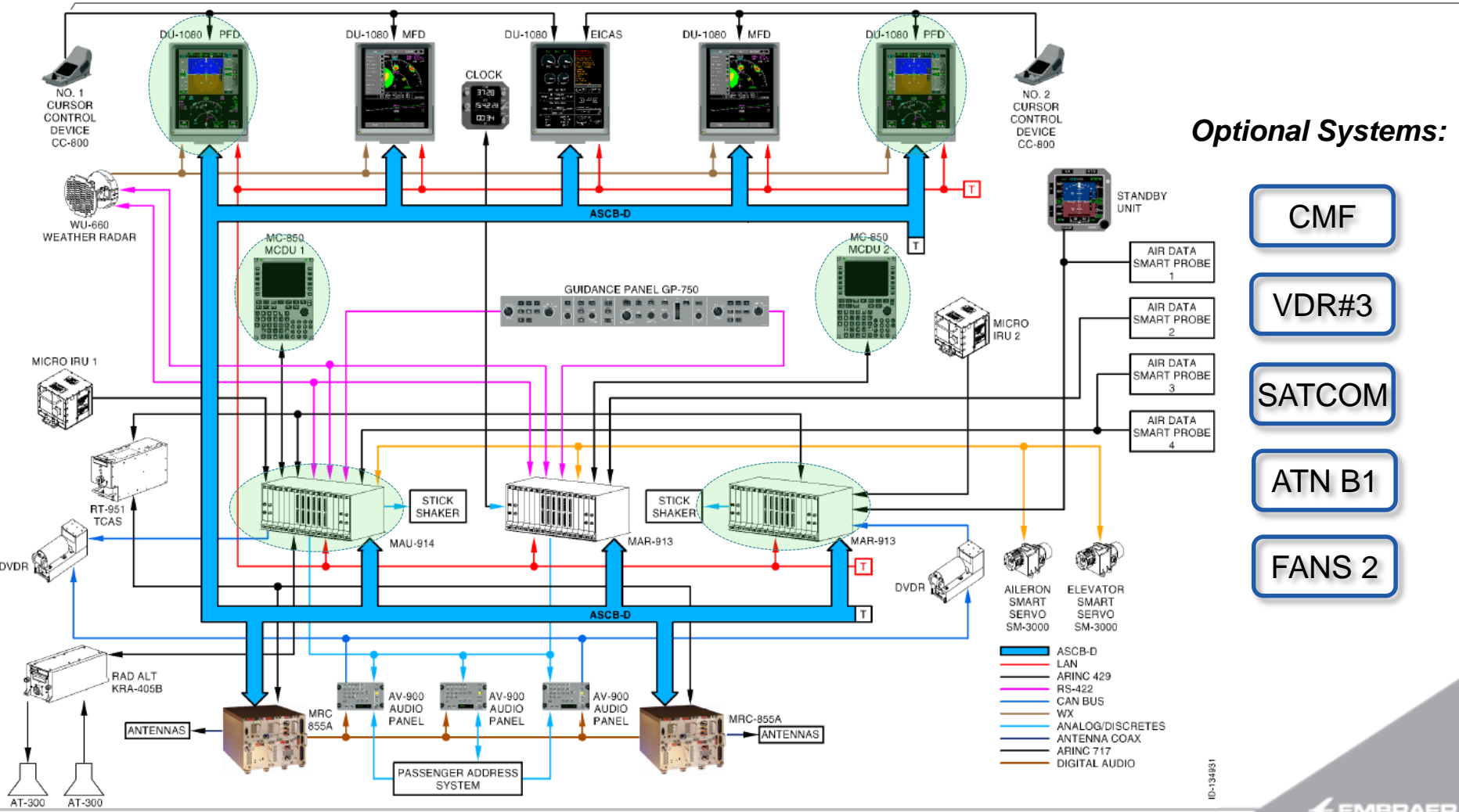
\*1 Permanent Exemption



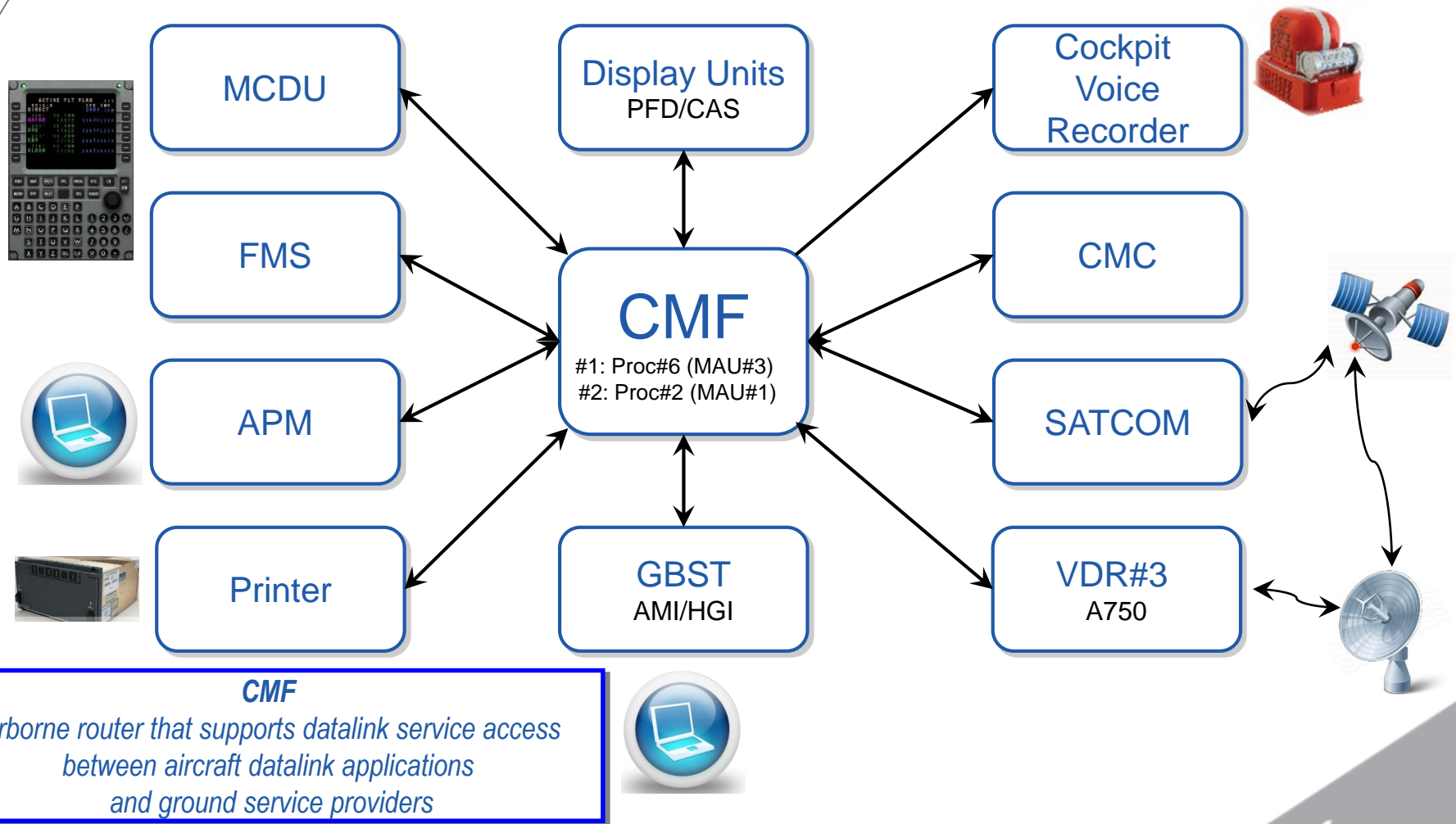
# EJETS DATA LINK APPLICATIONS



# EJets – Avionics Suite Block Diagram



# EJets – Communication Management Function (CMF)



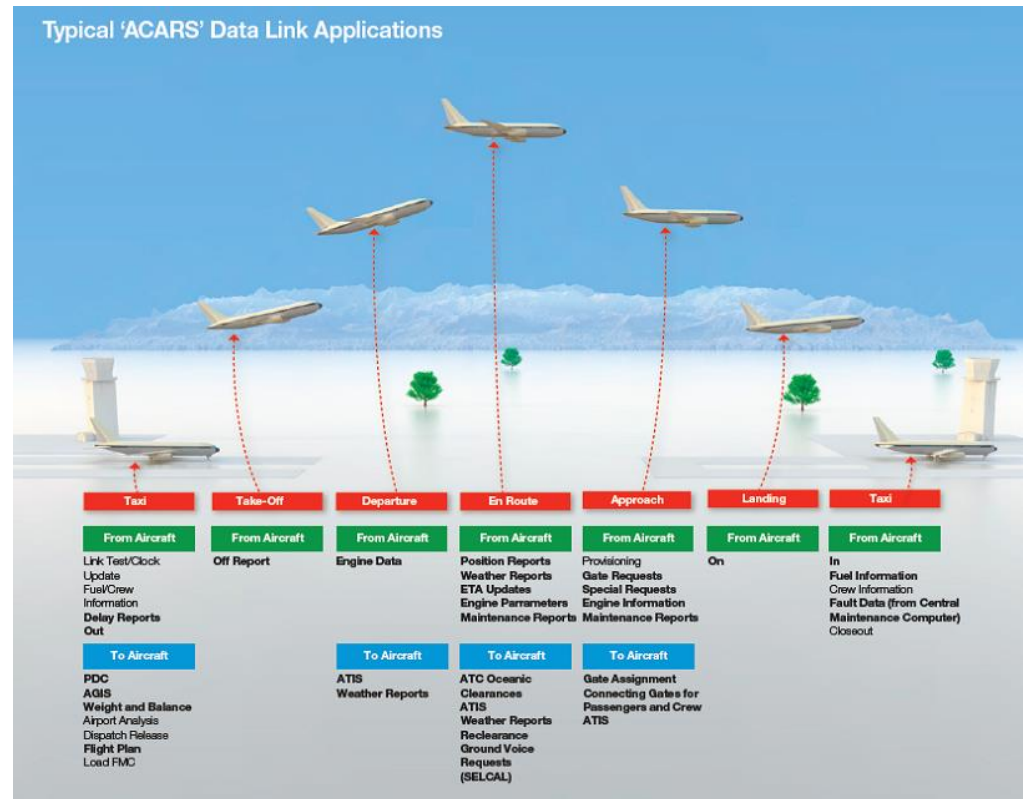
# EJets – ACARS AOC / ATS Applications

## → AOC Services:

- Reports: OOOs, delay, ETA, diversion, post flight
- Free text messages
- Vox Contact messages
- Flight Initialization
- Weather
- Flight plan / Winds
- **Meteorological Reports**
- **Maintenance Messages (AHEAD)**

## → ATC Services (A623):

- ATIS
- Clearances: departure, expected taxi, oceanic, pushback
- TWIP



# EJets – ATN B1 (ATC Partition in CMF SW)



## Specifications / Guidelines for implementation:

- European Commission Regulation (EC) No 29/2009 of 16 January 2009
- **ANAC FCAR HSI 52 CPDLC Means of Compliance**
- **EASA CRI F-40 Data Link Services for Single European Sky**
- **FAA AC 20-140A (Guidelines for Design Approval of Aircraft Data Link Communication Systems Supporting Air Traffic Services (ATS))**
- EUROCONTROL-SPEC-0116
- DO-280B / ED-110B Interoperability Requirements Standard for Aeronautical Telecommunication Network Baseline1 (ATN B1 INTEROP Standard)
- DO-290 / ED-120 Safety and Performance Requirements Standard for Air Traffic Data Link Services in Continental Airspace (Continental SPR Standard) including change 1 and change 2
- DO-200A / ED-76 Preparation, Verification and Distribution of User-Selectable Navigation Databases

# ATN B1 (CMF) – Human Machine Interface



- Visual Alert: “ATC” flag on the PFDs
- Aural Alert: “Message ATC”
- CAS message to indicate fail of CMF ATC Partition

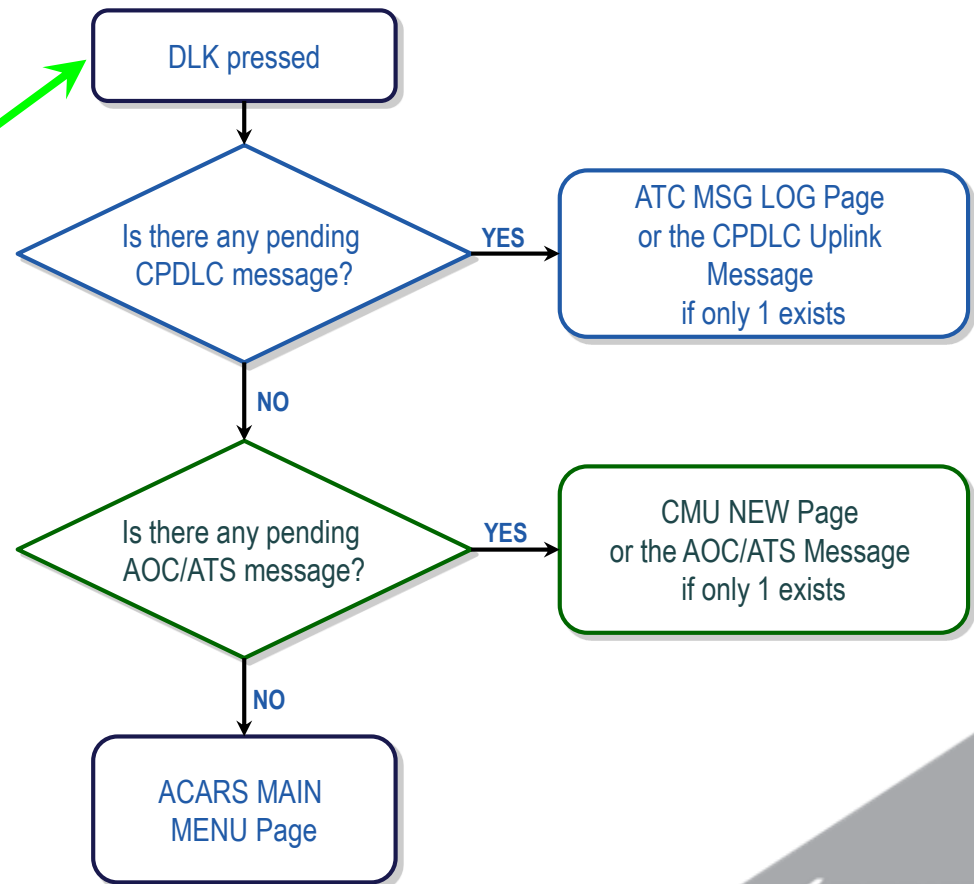
## ATC 1(2) DATALINK FAIL

- MCDU Pages: ATC MENU prompt (LSK 5R) on ACARS MAIN MENU page



# ATN B1 (CMF) – Human Machine Interface

Display of Uplink Messages: one button push required



# ATN B1 - Performance Issues Europe

## Two main technical issues observed in the ATN B1 deployment in Europe:

- **Provider Abort (PA):** it corresponds to a sustained loss of ATN connectivity greater than 6 minutes leading to the loss of CPDLC connection between the a/c and the ATC
  - Industry Requirement: below 1%
  - Best observed rate: 5% (some a/c that are in the White List)
  - EPIC observed rate: 20% (not only EJets)
- **Transmission Delays:** it corresponds to transmission delays in the CPDLC messages between the a/c and the ATC; it does not cause PA but leads to operational impact
- Since Nov 2013 some ANSPs introduced a White List with aircraft authorized to log on the ATN network. The EJets are not currently included
- The European Commission requested EASA and SESAR Joint Undertaking to conduct technical investigations



# EASA Investigation Results (Apr 2014)

(Technical Issues in the Implementation of (EC) No 29/2009 Data Link Services Implementation Rule (DLS IR) – Version 1.1)

- PAs cannot be attributed to a single cause
- PAs happen in a “random” way, at different locations, with different avionics, ANSPs, ACSPs (SITA/ARINC), and at different times of the day
- PAs occurrences could be attributed to a combination of the following factors:
  - Use of a single frequency (CSC – 136.975 MHz) for network management and data
  - Concurrency of AOC and ATN traffics over this single frequency channel, leading to an excessive channel usage level compared to the ATN protocol needs
  - The VGS networks are mainly driven by AOC needs, leading to a saturated and non-optimized VGS network for en-route (over FL 285) purposes
  - The resulting RF complex environment (where there are many VGSs in view) introduces some unexpected demands on the VGS handover logic at airborne level
  - Increase of the Radio Frequency congestion leading to delays in data transmissions or disconnections

***EASA considered the “Undetected design errors in airborne equipment”  
as a technical issue with low contribution for PA***

# Honeywell / Embraer Investigation (Mar/Nov 2014)

## Flight Test Campaigns in Europe airspace flying an Embraer 170:

- Data from these tests highlighted the high level of PAs e TRTDs
- Graphical presentation of traffic from various layers of ATN stack received
- Google Earth map to show ground station coverage, handoff, provider aborts, stale messages
- Ground issues were observed and discussed with Eurocontrol, Data Link Service Providers and other stakeholders
- Root causes were identified and are being implemented in the Primus EPIC loads



***The Flight Test Campaign pointed out a high channel utilization as the main contributor of PAs and Transmission Delays***

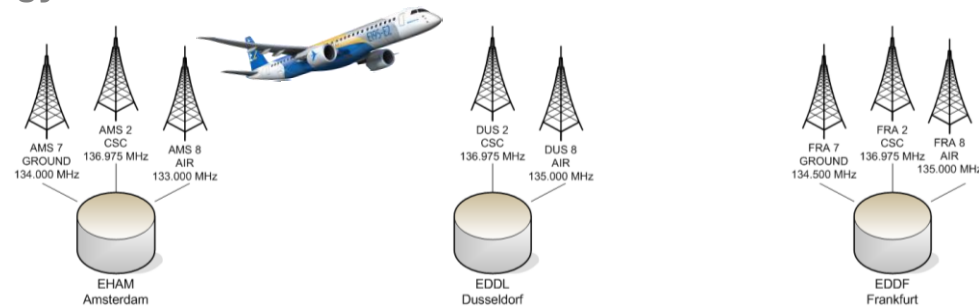
# European Commission: EU 2015/310 (Feb 2015)

- **Forward and retrofit mandate for aircraft: 5 February 2020**
- The improvements in Primus Epic (CMF) will be available before that:
  - The flight test campaign of Nov/14 performed with these improvements demonstrated satisfactory results (CMF 3.X)
  - The inclusion of EJets in the White List is expected

# SJU Investigation (Nov 2015)

(VDL Mode Capacity and Performance Analysis)

- VDL M2 over one single frequency (SSC) would already reach its capacity limits in 2015. Therefore, Multi-frequency deployment in Europe is a “MUST” as of today (2015)
- **A 4 frequencies implementation is a minimum requirement to support VDL M2 deployment until 2025 in high density area**
- Further optimization options under investigation by ELSA (VDL Mode 2 Measurement, Analysis, Testing and Simulation Campaign) may extend the viability of VDL M2 over 4 frequencies beyond 2025 in high density area
- **It is highly recommended to anticipate the evolution of the European datalink infrastructure in the ATM masterplan and to prioritize the development of the next generation datalink technology within SESAR**



# EJets – FANS 2 (CPDLC integrated w/ NG FMS)

→ FANS 2 = FANS 1/A+ and ATN B1 data link applications

→ FANS 1/A+ network: ACARS. Viable sub-networks:

- VDL Mode A
- VDL Mode 2
- SATCOM Iridium (under certification)

→ ATN B1 network: ATN. Viable sub-network:

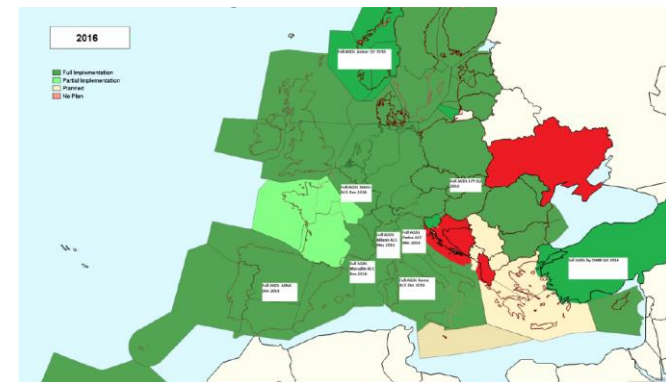
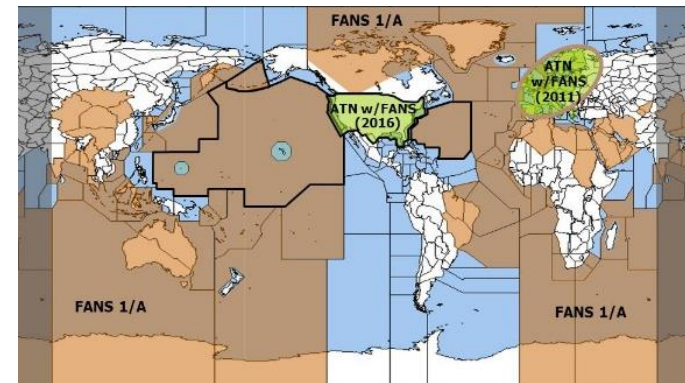
- VDL Mode 2 with multi-frequency

→ Automatic ATC Transfers:

- FANS 1/A ↔ FANS 1/A
- ATN B1 ↔ ATN B1
- FANS 1/A ↔ ATN B1

→ FANS 1/A and ATN B1 messages harmonization:

- Same display / same alerts



# EJets – FANS 2 (CPDLC integrated w/ NG FMS)

## Specifications / Guidelines for implementation:



- EASA CRI F-40B Data Link Services (equivalent with CS-ACNS)
- FAA AC 20-140B Guidelines for Design Approval of Aircraft Data Communication Systems Supporting Air Traffic Services (ATS)
- DO-280B / ED-110B Interoperability Requirements Standard for Aeronautical Telecommunication Network Baseline1 (ATN B1 INTEROP Standard)
- DO-258A / ED-100A Interoperability Requirements for ATS Applications Using ARINC 622 Data Communications (FANS 1/A Interop Standard)
- DO-290 / ED-120 Safety and Performance Requirements Standard for Air Traffic Data Link Services in Continental Airspace (Continental SPR Standard) including change 1 and change 2
- DO-306 / EUROCAE ED-122 Safety and Performance Standard for Air Traffic Data Link Services in Oceanic and Remote Airspace (Oceanic SPR Standard)
- DO-305A Future Air Navigation System 1/A – Aeronautical Telecommunication Network Interoperability Standard (FANS 1/A – ATN B1 Interop Standard)
- DO-200A / ED-76 Preparation, Verification and Distribution of User-Selectable Navigation Databases
- ARINC 622-4 ATS Data Link Applications over ACARS Air-Ground Network

# FANS 2 (NG FMS) – Human Machine Interface



PFD:  
ATC  
Flag

**Aural Alert: “MESSAGE ATC”**

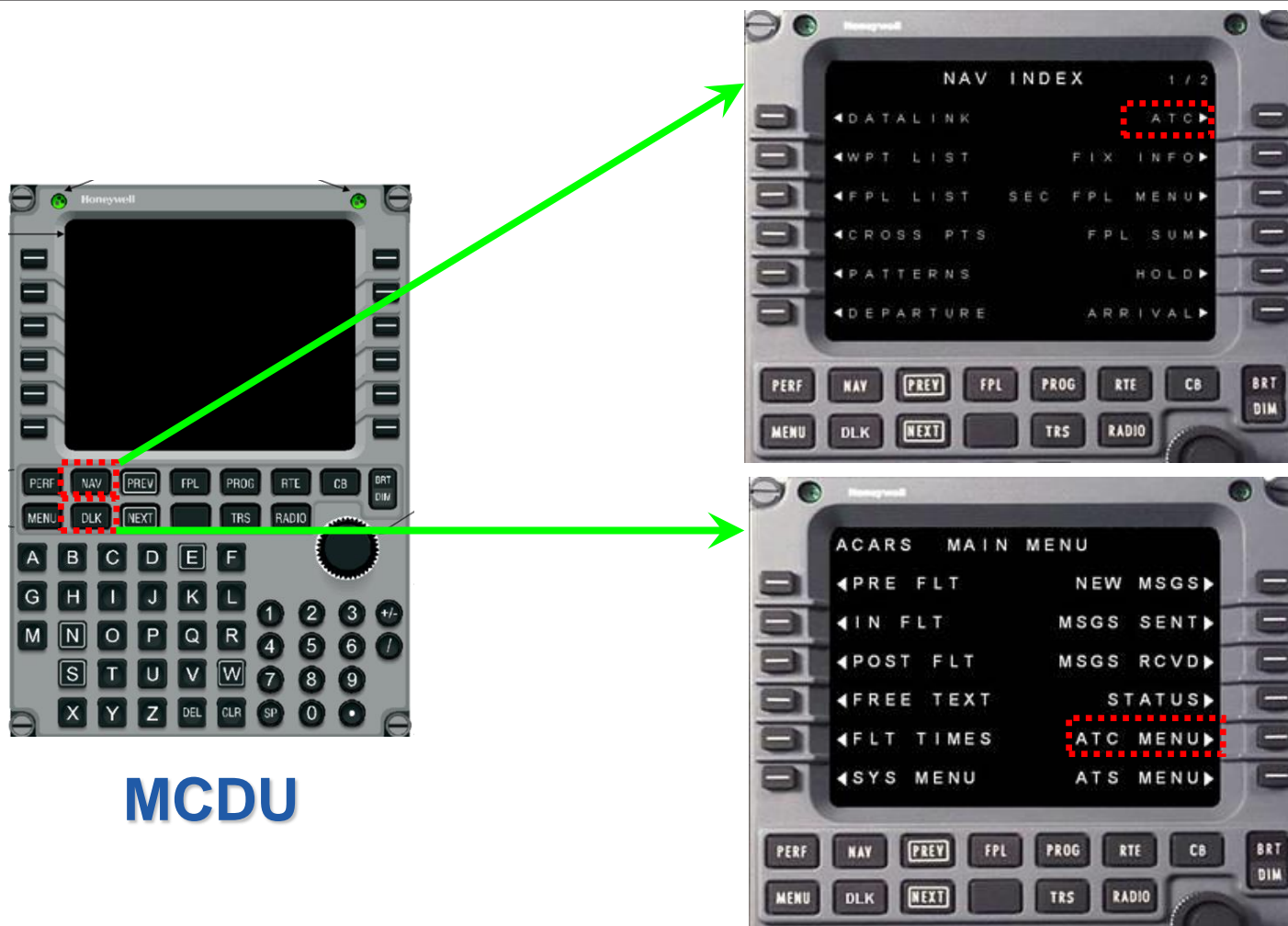
**PFD**



PFD:  
ATC Flag  
for  
FANS 1/A  
A/D  
Messages

**Aural Alert: “ATC ATC ATC...”**  
The aural will stop only when the  
message changes from NEW to OPEN

# FANS 2 (NG FMS) – Human Machine Interface





# FANS 2 (NG FMS) – Human Machine Interface



# E2 CPDLC IN BOX



# E2 – CPDLC In Box (PFD)

The image shows a Primary Flight Display (PFD) for an Embraer E2 aircraft. The display is divided into several sections:

- Flight Information (Top Left):** Tail Number: EJETS E2, Flight ID: BR549, XPDR: 1234, SELCAL: ABCD, Date: 11-OCT-2013, UTC: 10:12:13, ET: 00:00:00, CHR: 00:00.
- ATC Uplink (Left, Red Dashed Box):** ATC Uplink: EDDY ATN. Message: 10:27Z EDDY OPEN MAINTAIN PRESENT SPEED THEN DESCEND TO FL250 DUE TO TRAFFIC THEN EXPECT FL290.
- LPV (Top Center):** TO SPD, AP AT, ROLL LOC, FPA GS, 4300 M, 14000.
- Vertical Scale (Left):** Altitude scale from 60 to 130, with a current reading of 95.
- Vertical Scale (Right):** Altitude scale from 6000 to 6500, with a current reading of 1860 M and 26100.
- Baro (Bottom Right):** BARO 2000, STD 29.92 IN.
- Speed and Heading (Bottom Left):** GSPD 104 KT, HDG 029, VOR1.
- Compass (Bottom Center):** Heading indicator showing 010.
- COM1 (Bottom Left):** COM1 135.500, 114.000.
- NAV1 (Bottom Right):** NAV1 130.000, 113.300.
- Other Indicators:** CRJ 023, OME1, MSG.

*Thank You*



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