Electronic Flight Bags (EFBs) in the Airline Industry

"A Sales Manager's Perspective"

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Dipl.-Ing. / BEng (Hons) / MRAeS

Business Development - Goodrich Corporation
Munich

Photo: Andreas Ritter - Lufthansa

Content

Goodrich Corporation – A Company Overview

- 2009 sales - $6.7 billion
- **Broad product portfolio**
- One of the largest global aerospace and defense suppliers
- **New technology** on modern fleets drives growth
- Strong focus on **operational excellence**
- Operating history of 140 years
- 24,000 employees
- More than **80 locations worldwide across 17 countries**

Diverse Portfolio of Products

Corporate Organization

Marshall Larsen
Chairman, President and Chief Executive Officer

Actuation and Landing Systems Jack Carmola Segment President	Nacelles and Interior Systems Cindy Egnotovich Segment President	Electronic Systems Curtis Reusser Segment President
Landing Gear	Aerostructures	Sensors and Integrated Systems
Aircraft Wheels and Brakes	Interiors	Engine Control and Electrical Power Systems
Actuation Systems	Customer Services	ISR Systems
Engine Components		

Content

Situation today

Up to 50-60 kg per a/c manuals

✈ **Navigation charts….**

needs to be up-dated every **28 days** in accordance to the AIRAC cycle (Aero-nautical In-formation Regulation And Con-trol Cycle)

Airline Transformation

Paper Charts and Documents

Digital Information Solutions

EFB display unit – for fight deck

EFB computing unit – avionics bay

Definition & Guidance Literature

- **FAA's AC-120-76A - FAA** (Advisory Circular) "Guidelines For The Certification, Airworthiness, And Operational Approval of Electronic Flight Bag Computing Devices
- **EASA's TGL36 - JAR-OPS/EU-OPS** (Temporary Guidance) "Approval of Electronic Flight Bags (EFBs)
- **AC20-140A - FAA** (Advisory Circular) "Guidelines For The Design Approval of Aircraft Data Link Communication Systems Supporting Air Traffic Services (ATS)

Copyright: Antti Salo– AIRLINERS.NET

- The definition of an Electronic Flight Bag (EFB), according to the FAA's Advisory Circular (AC-120-76A), **is an electronic display system intended primarily for cockpit / flight deck or cabin use**.
- EFB devices can **display a variety of aviation data** or perform basic calculations (e.g. performance data, fuel calculations etc.).
- One of the major motivators for using an EFB is to reduce or eliminate the **need for paper** and **"clutter"** in the cockpit.
- In short, an EFB is an electronic information management device that helps flight crews perform flight management tasks more **easily and efficiently**, in a less-paper environment.

Many routine processes are historically evolved, still paper based, inefficient & expensive

EFB Classifications - Hardware

Cass 1 - Laptop

Class 2 - Boeing 737NG

Class 3 - Airbus A380

Hardware is based on its level of sophistication & integration with the aircraft systems

✈ **Class 1** EFBs are Portable Electronic Devices (PEDs) such as Laptops, handheld electronic devises or iPads (COTS – Commercial-Off-The-Shelf). Must be stowed during critical flight phases, (taxi, take-off and landing operations).

✈ **Class 2** EFBs are also referred to as Portable Electronic Devices (PEDs), which range from modified COTS equipment to purpose-built devices. Typically mounted in the aircraft with the display being viewable to the pilot **during all phases of flight**! Display mounts and computing mounting require **design approval (STC*)**. Class2 EFB can be connected to the aircraft power & data sources via **ARINC429** (read only) or the **ARINC717** interface.

✈ **Class 3** EFBs are fixed, installed equipment and, therefore, require installation design approval (STC). The hardware often designed in accordance with RTCA/DO-160E** requirements. There may be DO-178B requirements for software.

STC* - Supplemental Type Certificate
RTCA/DO-160E** - Environmental Conditions & Test Procedures for Airborne Equipment

EFB Classifications - Software

Operational Approval "only" – do not require AIR* design approval

A

Pure Paper Replacement → Non-critical Flight Phases → 6 months EFB + paper backup → Principal Inspector (PI) Approval

Applications include: Aircraft Flight Manual (AFM), Flight Operations Manual (FOM), Minimum Equipment List (MEL), Aircraft Flight Log, Pilot Flight Log, etc. (files in pdf, XML, HTML-format)

Aircraft documents

B

Interactive data → Critical Flight Phases, taxi, T/O & LDG → 6 months EFB + paper backup → (PI) Approval & Aircraft Evaluation Group AEG

Applications include: Take-off, en route, approach & landing, missed approach, go-around etc. performance calculations, Weight & Balance Calculations, powers settings for reduced thrust, runway limitation, Cost Index modeling, Weather Data, Video Surveillance (CDSS) etc.

Interactive charts

Operate on Certified O/S per RTCA/DO-178B such as Deos™ e.g.

C

Interactive functions → ARINC 429 read & write → Certified O/S per RTCA/DO-178B → ADS-B in/out CPDLC

Applications include: CPDLC (Controller Pilot Data Link Communication), ADS-B solutions for in Cockpit Display of Traffic Information (CDTI) such as EnRoute traffic (ITP), M&S, & AMM.

Full airworthiness and operational approval process, requires AIR design approval / AEG evaluation / PI

ADS-B applications on Class 3 EFB**

AIR* - Aircraft Certification Service (FAA)
ADS-B** – Automatic Dependent Surveillance - Broadcast

Deos™ is a proven, full featured DO-178B Level A certifiable real-time operating system (RTOS)

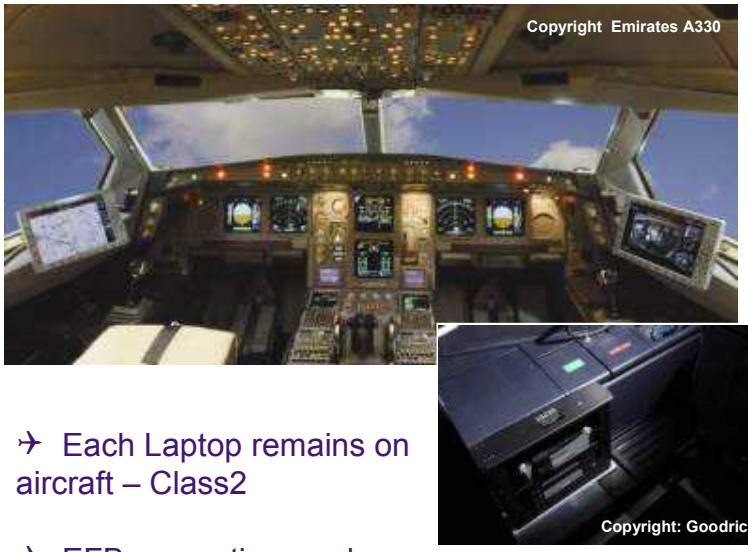
Personalized EFB vs Aircraft related EFB concept

Personalized EFB

- Each Pilot with a Laptop – Class1, stand alone solution
- Each Pilot with a Laptop – Class2, with laptop docking station (LDS) on flight deck

Major advantage: the updating process is for free !

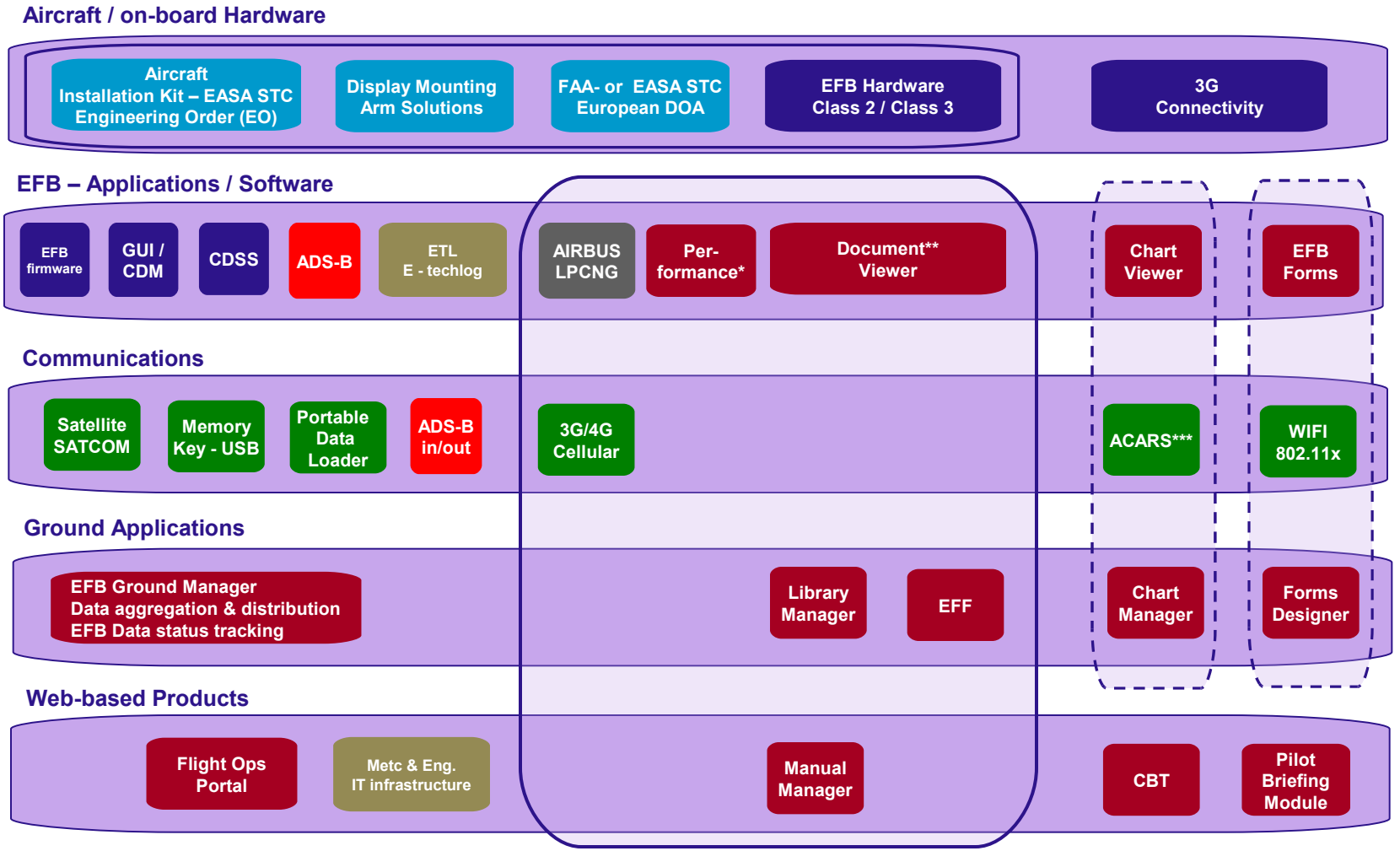
Aircraft related EFB



- Each Laptop remains on aircraft – Class2
- EFB computing- and display device remains on the aircraft Class2/Class3

Major advantage: less maintenance

Turnkey end-to-end EFB solutions



Key:
Performance* - T/O - & LDG Perf, In-flight Perf, Loadsheet
Documents** - FCOM (Flight Crew Operating Manual), MEL, Ops Library
ACARS*** - Airborne Communications Addressing & Reporting System

Content

Airline's Business Case – Electronic Flight Bag (EFB)

18 month return on investment (pay back)

- **Reduce paper** in the cockpit, which decreases weight and cuts down "clutter"
- **Reduce cost and workload** required to update documents
- Keep **information up-to-date**, enabling easy document
- ight reports **quickly and effectively**, ng issues to be addressed more rapidly
- **Reduce fuel and maintenance costs** by using accurate take-off and landing calculations and using ITP – In Trail Procedures
- **Improve safety** with onboard performance calculations, Airborne Traffic Situational Awareness (ATSAW) & Runway incursion
- **Increase payload** with real-time performance calculations
- **Improve routing decisions** by accessing real-time weather information

Airline's Business Case / "Four Steps" approach for implementing an EFB

CPDL* Controller Pilot Data Link (CPDL) - method by which air traffic controllers can communicate with pilots over a datalink system

Fourth Step

- Providing cabin signals to generate ancillary revenues via mobile phones, advertising & other devises & services.

Third Step

- Upgrade to installing ADS-B and CPDLC* equipment for future use in flight operations and on the airport, Class3 & Type A, B & C software.

Second Step

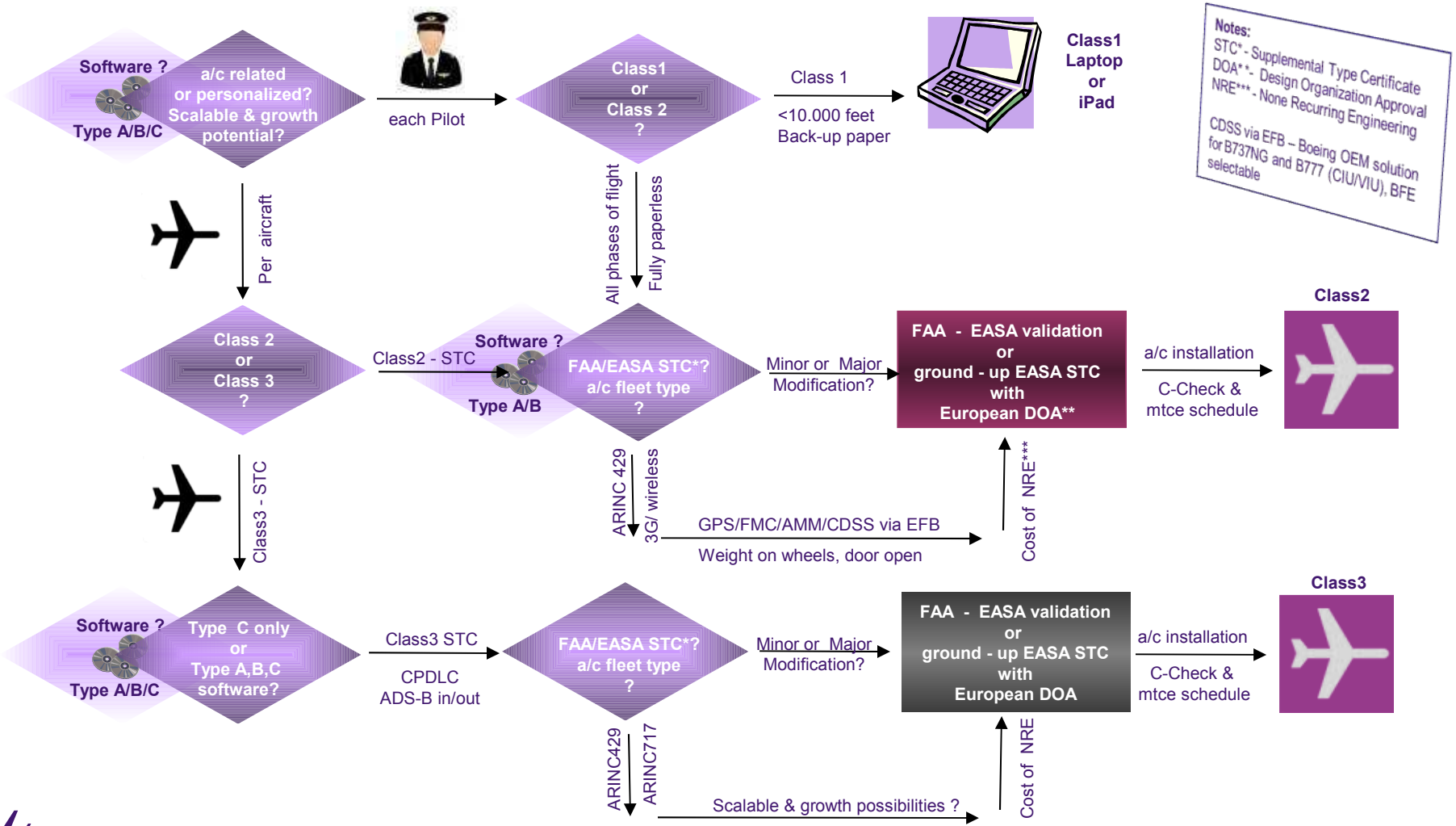
- Upgrade to a Class2 with Type A & B, a/c connectivity & communication. **etechlog (ETL)** system in **line maintenance**. **Cost Index (CI)** module for tactical decision making and fuel consumption reduction.

First Step

- Entry level EFB, e.g. Laptop, iPad, Class1 with type A & B software available for **Flight Operations.**

*"CI optimization of planned speeds will **yield savings from 2 to 3% and in some cases as much as 10%** when a flight is restricted to a low altitude or in unusually strong winds"*

The basic Sales Process (retrofit) – what are the Airline's requirements?



Software Applications & Benefits

Applications	Benefits	Class1 EFB	Class2 EFB	Class3 EFB
Electronic charts	✈ eliminate paper ✈ efficient distribution	✓ very limited, not during Taxi, T/O & LDG!	✓	✓
CBT (Computer Based Pilot Training)	✈ eliminate paper ✈ efficient distribution ✈ flexible usage	✓	✓ Personalized Pilot Class2 only!	X
eFF (electronic Flight Folder)	✈ eliminate paper ✈ efficient distribution ✈ flexible usage	✓	✓	✓
Documentation	✈ eliminate paper ✈ efficient distribution ✈ flexible usage	✓	✓	✓
Performance Calculation	✈ Flexible & cost efficient adoption of operational needs	✓	✓	✓
eTechlog EFL (electronic technical log Book)	✈eliminate paper ✈ efficient distribution ✈ flexible usage	✓	✓	✓
Cost Index (CI) mainly CRJ	✈ save time & fuel ✈ lowering fuel burn and emissions	(X) ✓	✓	✓
AMM (Airport Moving Map) – ADS-B in/out	✈ Improve situational awareness	X	✓	✓
Merging & Spacing (M&S) – ADS-B in/out	✈ safe time & fuel ✈ increasing capacity & efficiency within the terminal airspace	X	X	✓
ITP (In Trail Procedures) Oceanic – ADS-B in/out	✈ flexible procedure ✈ desired flight level (turbulences/winds) ✈ lowering fuel burn & emissions	X	X	✓

X not possible!

Source: Andreas Ritter , Lufhansa German Airlines, ADS-B & CI included Gondeck

Content

Goodrich EFB evolution - hardware

EFB Video Server VIU or CIU

- Boeing Class III EFB accessory
- 450+ Units Flying Since 2003
- ARINC 429
- Ethernet Switch
- Air Berlin VIU selected for B737NG
- SCIU on B787

airberlin, KLM, WIZZ, Ethiopian, AIR FRANCE

Traditional EFB – Class2

- tuifly.com, Sukhoi SSJ100, Bombardier Global Express/XRS/5000 platforms
- Avionics Hardware: full RTCA DO-160 qualification
- Part 25 Certified
- ARINC 429
- Video Surveillance
- 115VAC and 28VDC
- Integrated Communication

SUKHOI, АЭРОФЛОТ, TUIfly.com, myair.com

Laptop Docking Station EFB – Class2

- Lufthansa, Emirates, Embraer 190/195, Augsburg Airways, Eurowings (CRJ700/900)
- Avionics Hardware: RTCA/DO-160 qualification
- Part 25 Certified LDS and Display
- ARINC 429

Emirates, AUGSBURG AIRWAYS, eurowings, Air Tahiti Nui, AirDolomiti, Swiss AviationTraining

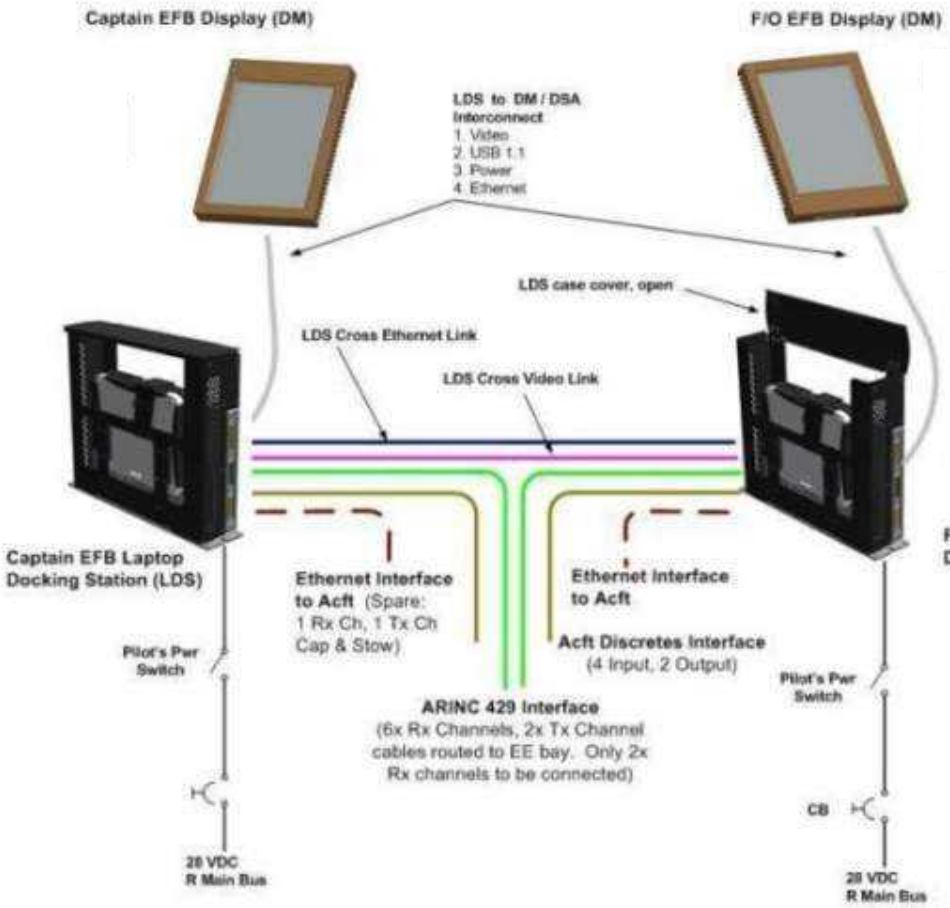
SmartDisplay® Class2 or Class3

- US Airways A320, A330
- United Airlines B744
- Sun Country B737NG
- Computer & Display one unit
- EFB Interface Unit (ARINC 429, Ethernet Switch, Memory, additional I/O)
- Part 25 Certified
- Fast/Simple Installation
- Modular & upgradable

АЭРОФЛОТ, Monarch, US AIRWAYS, UNITED, sun country airlines

2003	2004	2005	2006	2007	2008	2009	2010/2011

LDS EFB – Class2 architecture for A320, A330, A340 aircraft



Lufthansa

Lufthansa Systems

Lufthansa A340-600 LDS-EFB installation

Lufthansa Systems

A320 family EASA STC - LDS

European Aviation Safety Agency

SUPPLEMENTAL TYPE CERTIFICATE

10016410, REV. 2

This Supplemental Type Certificate is issued by EASA, acting in accordance with Regulation (EC) No. 216/2008 on behalf of the European Community, its Member States and of the European third countries that participate in the activities of EASA under Article 66 of that Regulation and in accordance with Commission Regulation (EC) No. 1702/2003 to

ROSEMOUNT AEROSPACE, INC
14300 JUDICIAL ROAD
BURNSVILLE 55306-4898
USA

and certifies that the change in the type design for the product listed below with the limitations and conditions specified meets the applicable Type Certification Basis and environmental protection requirements when operated within the conditions and limitations specified below:

Original Product TC Number:	**EASA.A.064**
TC Holder:	**AIRBUS**
Model:	**A318-111/-112/-113/-114/-115**
Model:	**A318-121/-122/-123**
Model:	**A320-111/-211/-212/-214**
Model:	**A320-231/-232/-233**
Model:	**A321-111/-112/-131**
Model:	**A321-211/-212/-213/-231/-232**
Original STC Number:	**FAA STC ST02849CH**

EASA Certification Basis:
Certification Basis in accordance with EASA Type Certificate Data Sheets A.064
The Certification Basis for the original product and the following additional or alternative airworthiness requirements are applicable to this certificate/ approval:
1. CRI F-01 "Installed Resources for EFB Class 2 Provisions"
2. CRI H-01 "Enhanced Airworthiness Programme for Aeroplane Systems - ICA on EWIS"
The certificated noise and/ or emissions levels of the original product are unchanged and remain applicable to this certificate/ approval

Description of Design Change:
Installation of Rosemount Aerospace 8700C2-4 Laptop Docking Station
- Electronic Flight Bag (EFB) System Provisions.

See Continuation Sheet(s)

For the European Aviation Safety Agency,

Date of issue: 21.06.2010

Heiko HONERT
Project Certification Manager
Large Aeroplanes

Copyright: Lufthansa

Lufthansa

A319CJ – German Ministry of Defense (MOD) – LDS EFB

- 2x AIRBUS A319CJ for German Ministry of Defense (MOD)
- Goodrich delivered LDS-EFB LRUs
- Goodrich delivered Engineering Data Package (EO)
- Goodrich provided permission letter, for the purpose of utilizing existing EASA STC engineering data package
- Lufthansa Technik (LHT) integrated Goodrich Laptop Docking Station EFB

A319 CJ of German Government

Boeing B777 - LDS-EFB installation – Class2

Copyright: Emirates

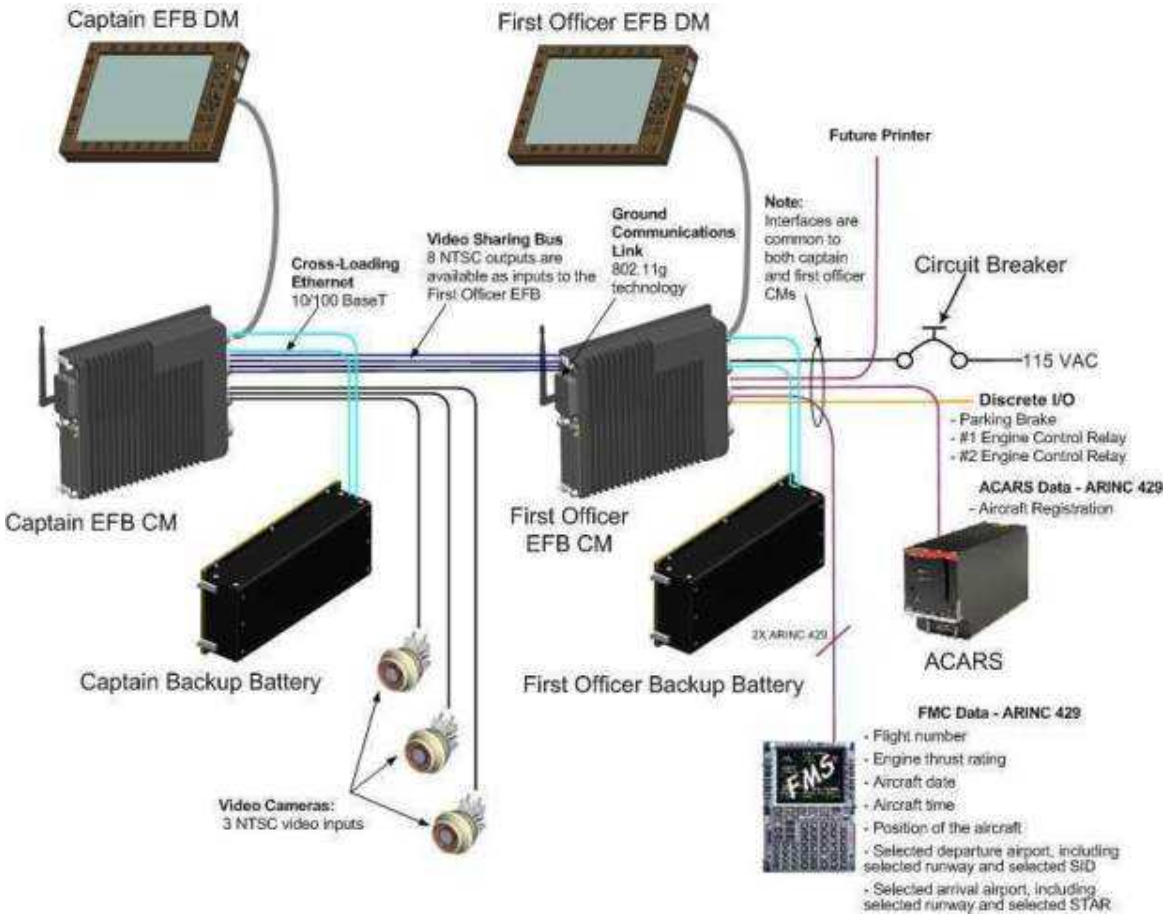
Laptops remains on board - aircraft related concept

CRJ700 & CRJ900 - LDS-EFB installation – Class2

Lufthansa CityLine
eurowings

- CRJ700/900 (Lufthansa Cityline)
- CRJ900 (Eurowings)
- Lufthansa Flight Training Berlin
- Global 5000 and Global Express via BJAC in Canada - traditional EFB
- CRJ700 (myair) – traditional EFB

Tuifly.com B737NG – Class2 installation



TUIfly.com

Graphic: courtesy tuifly.com

Tuifly.com B737NG – EFB Class2/3 installation

Mr. Sebastian Franz – Pilot & EFB - Programme Manager

EFB **ON/OFF** location in overhead panel

Sukhoi Superjet100 – Goodrich BFE selectable

GOODRICH

FLIGHT DECK
Thales is responsible for the Superjet100 avionics suite, including displays, communication, navigation and surveillance systems. Goodrich supplies the **Maintenance Access Terminal – MAT (SFE)** for e-techlog (ETL) and the **Electronic Flight Bag – EFB (BFE)**, both computer modules (CMs) and touch screen display modules (DMs).

GOODRICH

CDSS
Goodrich's computer module (CM) does have CDSS capabilities available, which can be utilized via the EFB

АЭРОФЛОТ Российские авиалинии

Notes:
SFE = Seller Furnished Equipment
BFE = Buyer Furnished Equipment (OEM optional list often dual options!)

GOODRICH
LANDING GEAR
Superjet100 is fitted with Messier-Dowty retractable twin-wheeled tricycle-type landing gear with a Sukhoi braking system and Goodrich wheels and brakes. Four-wheel bogies are offered as an option for the main landing gear units.

Embraer 190/195 – Goodrich BFE selectable & ARINC 828 compliant

AUGSBURG AIRWAYS

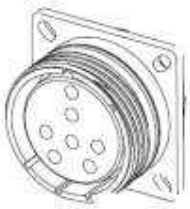
Copyright: Goodrich

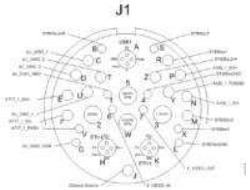
Laptop Docking Station (LDS)
Electronic Flight Bags – BFE (optional)

ARINC 828 compliant

Copyright: Goodrich

Copyright: Goodrich





Embraer 190/195 – Goodrich BFE selectable & ARINC828 compliant

- Embraer ERJ 190/195 BFE optional & OEM installed
- ERJ 195 (Lufthansa Cityline)
- ERJ 195 (Augsburg Airways)
- ERJ 195 (Air Dolomiti)
- ERJ 195 (Swiss Aviation Training)
- Goodrich Engineers part of the AEEC - EFB Task Force
- Active Development of ARINC 828 & ARINC 840 standards

Content

Automatic Dependent Surveillance Broadcast , ADS-B in/out

- **Automatic**
  - Periodically transmits information with no pilot or operator input required
- **Dependent**
  - Position and velocity vector are derived from Global Positioning System (GPS/GNSS)
- **Surveillance**
  - A method of determining position of aircraft, vehicles, or other assets
- **Broadcast**
  - Transmitting information available to anyone with the appropriate receiving equipment

Video ADSB_1.0_2,5MB.wmv EUROCONTROL

FAA Capstone - Programme

The **Capstone** Program is an **FAA** funded safety program located in Alaska, primarily focusing on rural areas of the state. The program concentrates on increasing safety in aviation through technology and making the process of integrating that technology more efficient. Some of the systems currently being developed in **Capstone** includes GPS Receivers, Data Link Transceivers, ADS-B, Multi-Function Displays, Flight Information Services, Moving Maps, and Terrain Databases.

EUROCONTROL CASCADE - Programme

The **CASCADE** programme co-ordinates the European implementation of ADS-B (Automatic Dependent Surveillance Broadcast), a surveillance technique that relies on aircraft broadcasting their identity, position and other aircraft information. This signal can be captured on the ground for surveillance purposes ***(ADS-B-out)*** or on board other aircraft for air traffic situational awareness ***(ADS-B-in)*** and airborne separation assistance. ADS-B-out has reached initial operational capability status in 2008, ADS-B-in for air traffic situational awareness in 2011.

(Single European Sky ATM Research)

Standards development take place in the Requirement Focus Group, a joint venture between EUROCONTROL, the FAA, EUROCAE and RTCA* with participation of Airservices Australia, NAV CANADA, the Japanese Civil Aviation Board and many industrial partners.

RTCA* - Radio Technical Commission for Aeronautics – Washington D.C. USA

The main Benefits for ADS-B in/out

- **low cost** when compared to other surveillance alternatives (up to 1/10 of a radar system with system coverage),
- its **high accuracy**, and
- the support of **airborne surveillance** applications which will enable many future **safety** and **capacity benefits**.
- ***ADS-B-out*** has safety and capacity benefits in areas where there is **no surveillance today** or where the separation minima applied is large due to surveillance deficiencies.
- ***ADS-B-out*** has also significant **economic benefits** when used to replace part of a radar infrastructure.
- ***ADS-B-in*** has primarily **safety benefits** by increasing the situational awareness of pilots, but it also enables to provide **capacity benefits** when spacing and separation applications will be introduced.

Copyright: Eurocontrol

SafeRoute™ - Merging & Spacing and SAMM

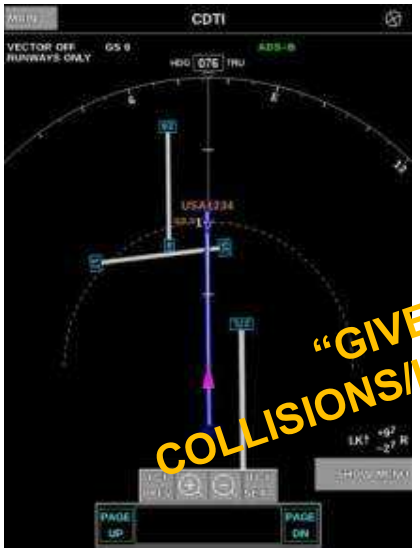
Surface Area Movement Management (SAMM)

ACSS An L-3 Communications & Thales Company

SafeRoute™

- Eliminates up to 99% of Runway Incursions
- Provides moving map display of the airport surface and position of participating nearby traffic (aircraft and ground vehicles), relative to own ship

  Provides display of Intruder information, i.e. Flight ID, Ground Speed & Intent.
- Utilizes ADS-B technology which is basic building block of Next Generation Air Transportation System



"GIVE IMMEDIATE WARNINGS OF PROBABLE COLLISIONS/INCURSIONS DIRECTLY TO FLIGHT CREWS IN THE COCKPIT"

Representation of Indicating & Alerting sample, respectively Runway Status Indication or RSI (Blue), Caution (Yellow), and Warning (Red)

The CDTI Images displaying ACSS SafeRoute™ are provided courtesy of ACSS & Astronautics Corporation of America.

Source: www.acss.com

SafeRoute™ - Merging & Spacing

ACSS Merging & Spacing
An L-3 Communications & Thales Company

SafeRoute™

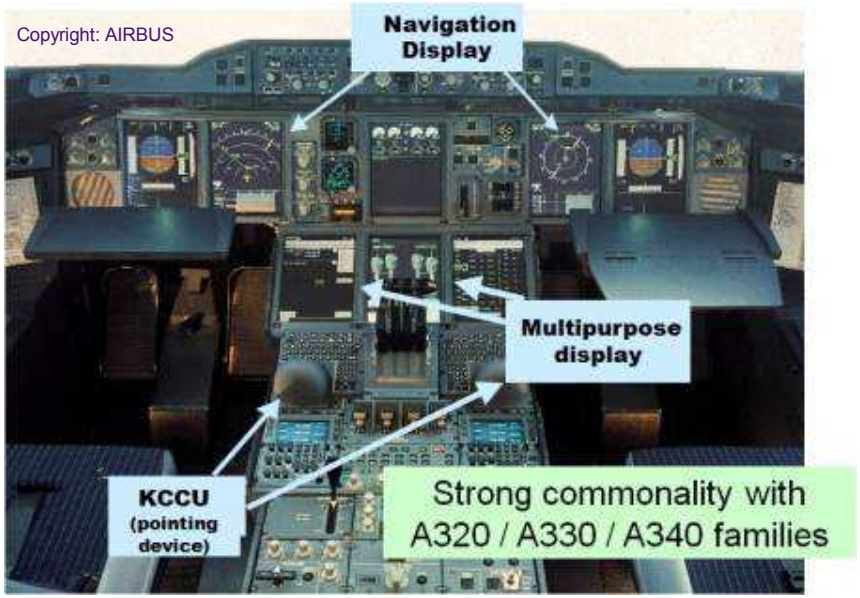
Note the **aircraft** on the far left. It was given instructions to vector off course because it did not have the proper spacing from the **lead aircraft** for approach. This procedure wastes time and fuel. With the **Merging & Spacing** functions, aircraft will be spaced far from the destination aircraft so when the they come to the merge point, they will have the proper spacing.

The **Merging & Spacing** function makes use of onboard aircraft surveillance to provide flight deck spacing commands that allow aircraft to follow one another at the safest, most efficient interval possible from cruise altitude to the runway. These applications ensure more consistent aircraft spacing while increasing capacity and efficiency within the terminal airspace.

The CDTI Images displaying ACSS SafeRoute™ are provided courtesy of ACSS & Astronautics Corporation of America.

Source: www.acss.com

CASCADE Programme Scope



Integrated display system (Navigational Display) – OEM installed

Retrofit EFB Class3 of some 10.000 aircraft

EUROCONTROL **Source: www.eurocontrol.int**

Content

Goodrich NextGen SmartDisplay® EFB – Class 2/3

CDM – Cockpit Data Management Solutions™

Turn-key solutions for a paperless cockpit with integrated EFB hardware, software, and support services

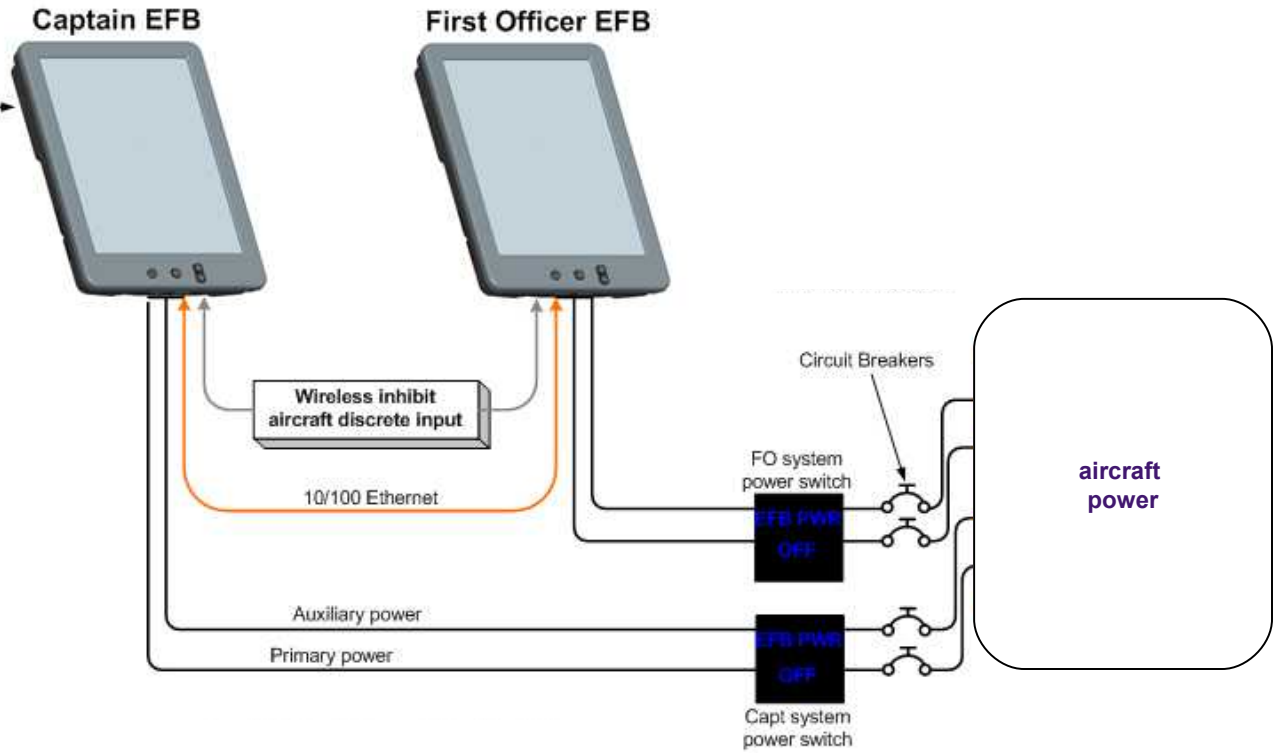
SmartDisplay® with Lufthansa Systems LIDO Enroute Chart

OSYS etechlog

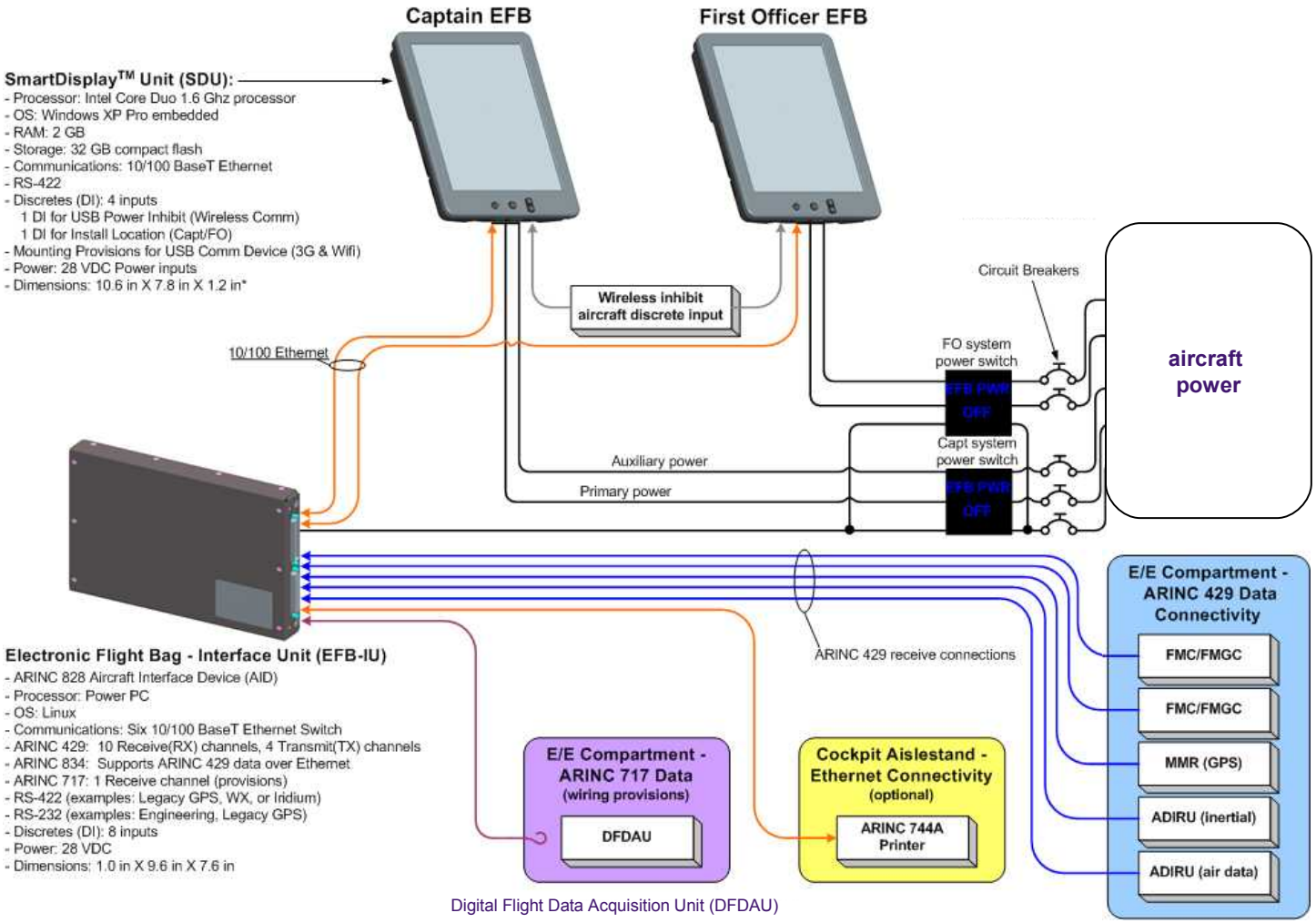
EFB computing unit – avionics bay

SmartDisplay® EFB – "Entry Level " Class 2

SmartDisplay™ Unit (SDU):
- Processor: Intel Core Duo 1.6 Ghz processor
- OS: Windows XP Pro embedded
- RAM: 2 GB
- Storage: 32 GB compact flash
- Communications: 10/100 BaseT Ethernet
- RS-422
- Discretes (DI): 4 inputs
  1 DI for USB Power Inhibit (Wireless Comm)
  1 DI for Install Location (Capt/FO)
- Mounting Provisions for USB Comm Device (3G & Wifi)
- Power: 28 VDC Power inputs
- Dimensions: 10.6 in X 7.8 in X 1.2 in"



Uppgrade to SmartDisplay® "*plus*" EFB - Class3



SmartDisplay® CDM – Cockpit Data Management Solutions™

Cass2, Type A & B

Airline Benefits

- Business process integration / Back Office
- Versatility & flexibility to host self-developed, OEM & 3rd party applications
- Hardware maintained & upgraded
- Communication capabilities
- Multiple redundancies within architecture
- Growth path for ADS-B and CPDLC
- Usage during all phases of flight

New Technology

- ADS-B in/out
- CPDLC
- 3G/4G com.
- AIRBUS LPCNG
- FAA NextGen

Business Drivers

- IT - Back Office integr.
- Business process integr.
  - Flight Ops
  - Eng. & mtce.
  - Commercial
  - IT-Dep.

FAA / Eurocontrol Objectives

- Increase airspace & airport capacity
- Greater precision & reliability
- Emission & Noise
- Safety, capacity, efficency

Cass3, Type A, B & C

Goodrich SmartDisplay® Class 3 EFB displaying the ACSS SafeRoute™ Merger & Spacing (M&S) CDTI

Airline Benefits *plus*

- Truly integrated solution
- Business process improvement
- Improved operational efficiencies
- Improved turnaround times
- Safety benefits due to superior integration
- Fuel cost savings & time
- Emission reduction
- Noise footprint reduction
- Lower maintenance costs
- HUMS integration with ADS-B out
- Obsolescence management
- Technology refresh cycle