

EFB

Boeing brings a new level of digital information delivery and management to the flight deck with the Jeppesen Electronic Flight Bag, which is a major step toward the e-enabled airline. This modular, integrated hardware and software package calculates performance figures, displays charts, improves taxi positional awareness, provides video flight deck entry surveillance, and allows electronic access to documents. A scalable offering of three configurations — portable, semiportable, and installed avionics — provides airlines with flexibility in choosing their solution. The Electronic Flight Bag will help airlines reduce costs, improve taxiway and flight deck safety, and establish convenient access to digital documents.

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TECHNOLOGY/PRODUCT DEVELOPMENT

ELECTRONIC FLIGHT BAG

MET ▲
 DIM ▼
 VIEW ← MENU CHK EWS PREV LOW BAT PWS

LOG SUMMARY
 FLIGHT LOG
 FAULT REPORT
 FIND IT

Select a Panel:
 [Dropdown menu]

Select a Fault:
 AP amber warning annunciator light
 AT amber warning annunciator light
 Aileron
 Does not go back to neutral
 left
 right
 left and right
 Air conditioning compartment light
 Air inlet door, for the APU
 Air mode
 Air outlet, feet
 Air outlet, windshield
 AIR TEMP indication
 AIR TEMP indication not correct
 Airspeed display

RESET PANELS
 BACK
 EXPAND LIST
 COLLAPSE LIST
 REFER TO LOG

BICAS MSOS
 OBS FAULTS
 MAINT

ENTER ↓ ↑ ← → ENTER

Avionics



B

oeing offers airlines e-enabled solutions that put innovative, valuable information technology on board airplanes. A prime example is the Jeppesen Sanderson, Inc., Electronic Flight Bag (EFB). The EFB is a major step toward e-enabling the entire air transport system—from the flight deck to the cabin, maintenance, and the airport.

The EFB is offered in three configurations: portable, semiportable with mount, and installed avionics. Common software for all three types will allow airlines to implement any combination in their fleets while maintaining common training and operating procedures. This article describes the installation and operation of the Class 3 EFB system, which is the initial system being certified.

Through its unique combination of modular content, applications, and services that integrate the data generated by an entire flight operation, the EFB will provide key, meaningful information to pilots, flight attendants, operations workers, mechanics, and other personnel (fig. 1).

The EFB display integrates well with the look and feel of other flight deck instrumentation and is consistent with the flight deck design philosophy and operation (fig. 2).

Airlines will realize many benefits with the EFB, including

- **Reduced fuel and maintenance costs through precise, accurate calculations.** Current takeoff and landing calculations are conservative and often are based on early dispatch weight and balance information, which adds delay and cost to each flight. The EFB will save airlines costs while increasing payload by providing more accurate calculations based on real-time



information. These calculations can result in lower thrust ratings, which reduce engine maintenance costs.

- **Improved taxiway safety.** The taxiway environment can be challenging for pilots, especially when visibility is limited or during the night at unfamiliar airports. The Class 3 EFB enhances pilot runway and taxiway situational awareness by integrating onboard georeferencing equipment (e.g., Global Positioning System [GPS] technology) with Jeppesen electronic airport taxi maps. Pilots have greater awareness

of position—from the runway to the gate—which improves safety and reduces taxi time. (The Class 2 EFB presents a moving map of the airport but does not indicate current airplane position.)

- **Flight deck entry surveillance for compliance with current International Civil Aviation Organization recommendations.** Class 2 and Class 3 EFB displays can host cabin-to-flight deck video feeds, providing airlines with flight deck entry surveillance.
- **Future integration capabilities for e-enabled airlines.** Initial

FIGURE



implementations of the EFB will allow connectivity through the terminal wireless local area network unit. The system also can integrate with the ARINC 763-compliant CoreNet Connexion by BoeingSM server to provide seamless wideband airline administrative connectivity on the ground or in the air.

- **Elimination of paper from the flight deck and access to digital documents.** Eliminating paper from the flight deck saves weight and reduces clutter. For example, without the EFB, a single 777-200ER flight requires

77 lb of paper. Accessing digital documents on the flight deck is an efficient, convenient way for pilots to quickly obtain the information they need. Configuration-

controlled documents such as aeronautical charts, fault reporting and operations manuals, minimum equipment lists, and logbooks are available at the pilots' fingertips. The distributed data management (DDM) system provides an airline logistics system to ensure that all airplanes will have up-to-date information.

Future EFB upgrades will support real-time updates of time-sensitive data such as in-flight weather reporting, notices to airmen (NOTAM), and an onboard electronic checklist (for non-777 airplanes). Boeing is working with Jeppesen to install Class 2 and Class 3 EFB systems on Boeing airplanes, both in production and through retrofit. Class 1 portable EFB systems, which also are available, do not require installation. The first EFB implementation will be a Class 3 system on a production 777-200ER airplane for KLM Royal Dutch Airlines.

This article describes

1. EFB applications.
2. EFB communications and data management features.
3. EFB architecture and certification.

Right-side EFB installation, 777 cab



1 EFB APPLICATIONS

The current EFB applications are

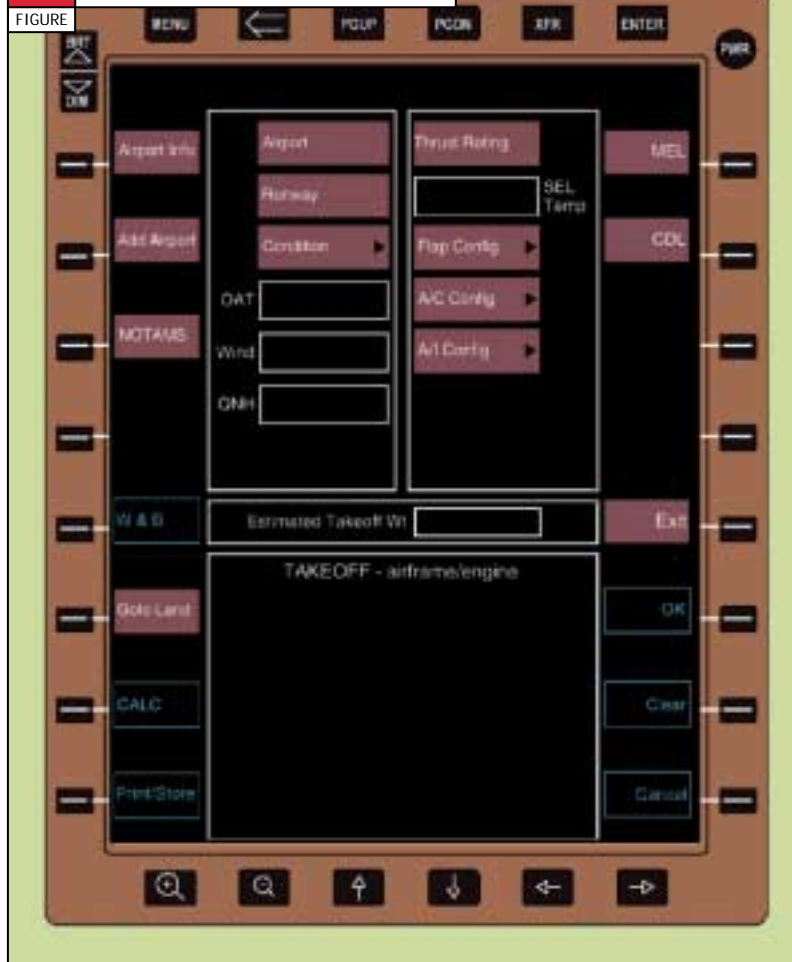
- Performance.
- E-documents.
- Charts.
- Taxi positional awareness (airport moving map).
- Video surveillance.

Performance

The performance application calculates precise takeoff and landing performance figures for each airplane under any conditions (fig. 3). The calculations are based on a combination of preloaded and pilot-entered data.

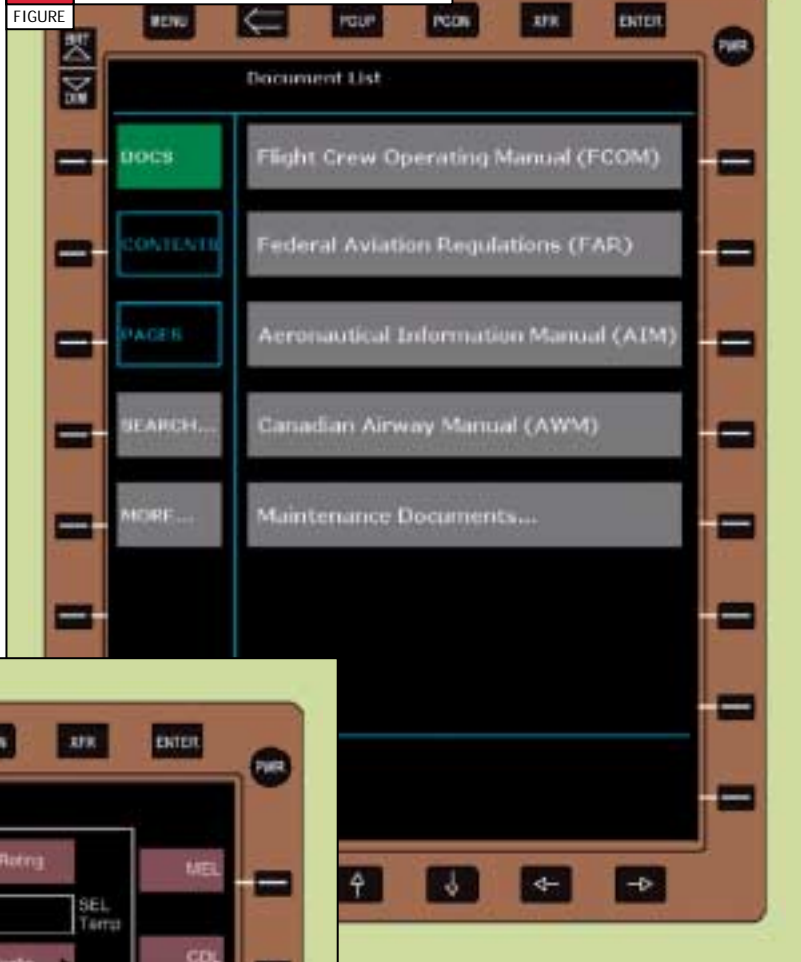
3 EFB PERFORMANCE APPLICATION

FIGURE



4 EFB E-DOCUMENTS APPLICATION

FIGURE



Preloaded data include

- Airport characteristics (e.g., elevation, runway data, obstacle data).
- Airplane data (e.g., tail number, engine type and rating, flap configuration).
- Airline policy information (V_1 type used or menu items).

Pilot-entered data include

- Current runway conditions.
- Current environmental conditions (e.g., outside temperature, wind velocity).
- Specific airplane configuration (e.g., flap position, airplane status).
- NOTAM data that may affect performance.
- Deferred maintenance items (e.g., minimum equipment list, configuration data list) that affect performance.

E-Documents

The e-documents application allows flight crew members to view and search current electronic documents on the flight deck (fig. 4). Available documents include the flight crew operating manual, U.S. Federal Aviation Regulations, and the *Aeronautical Information Manual*.

Airlines also will be able to use the e-documents application to author and host documents. Documents are best viewed as XML format, which supports searching and text wrapping. The e-documents ground administration tool can convert structured and unstructured PDF files into HTML documents for viewing. E-documents also accept scanned images (which are shown as pictures) in GIF, JPG, TIF, and CGM formats.

Charts

The charts application allows flight crews to view terminal procedure charts, airport origin and destination charts, and arrival and departure charts (selection aided by data provided by the flight management system) (fig. 5). Additional charts can be accessed through the browse and search capabilities.

The ChartClip function allows flight crew members to preselect charts for quick access to all charts in the ChartClip list. An en route chart access capability is planned for a near-term upgrade.

Taxi Positional Awareness

The taxi positional awareness (TPA) application is a set of highly accurate airport maps that graphically portray runway, taxiway, and other airport features to support taxi operations (fig. 6). (TPA also is referred to as airport moving map and taxi situational awareness.)

For the Class 3 system, the GPS provides an “ownship” position that is portrayed on the taxi map along with the heading from the inertial reference system. Class 2 systems center the map based on GPS position but do not indicate an ownship position. Flight crews use TPA to identify, by external visual references, their location in relationship to runways and taxi holding



points, taxi turn points, or gates. The TPA should be used in conjunction with U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 120-74, *Flightcrew Procedures During Taxi Operations*, which requires outside visual references and controller instructions.

Video Surveillance

The video surveillance application allows airlines to leverage their video surveillance investment with operational improvements enabled by the EFB (fig. 7). The video surveillance application uses installed buyer-furnished equipment (BFE) (i.e., camera, camera interface unit).

The EFB receives digital video through an Ethernet connection from the camera interface unit. Users can select output from the installed

cameras and display it on the screen. After the airline and its BFE supplier decide on the number and location of cameras, Boeing will integrate the system and make the video surveillance application available.

2 EFB COMMUNICATIONS AND DATA MANAGEMENT FEATURES

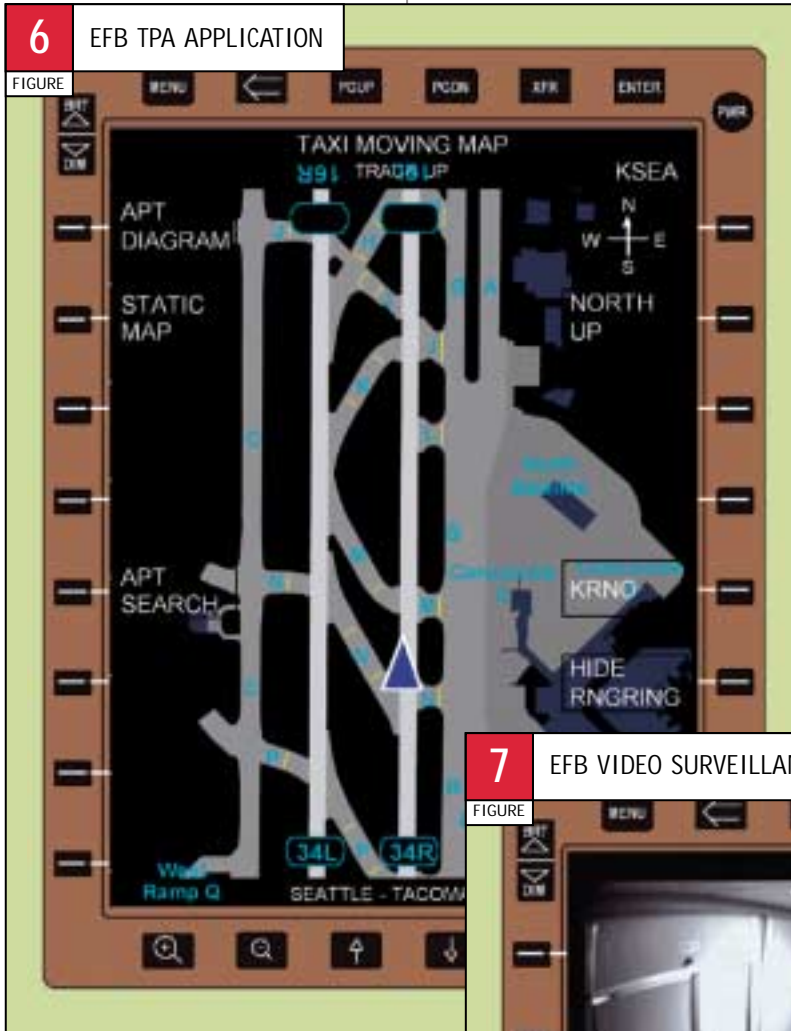
In addition to the performance, terminal charts, e-documents, TPA, and video surveillance applications, the EFB provides communications interfaces and data management capability between the EFB and the airline operational control.

Communications Interface

The EFB system uses a communications management function to interface with the airplane communications subsystem, which will allow airlines

6**EFB TPA APPLICATION**

FIGURE



to specify the preferred communication for each EFB application. For 777 airplanes, an airplane information management system update is required to allow access to the existing cabin terminal port. For other airplanes, this involves connecting the EFB to the airline airplane communication addressing and reporting system and communications management units cabin terminal port.

Boeing also will offer a direct connection to a terminal wireless gatelink system, which will provide an IEEE 802.11b high-bandwidth link to an airport terminal server. EFB applications will have access to this link and will provide staged data loads that can be initialized later by maintenance personnel.

The EFB is designed to integrate with the CoreNet and Connexion by Boeing system. This integration allows

EFB applications to use the integral data router and Connexion by Boeing link.

Distributed Data Management

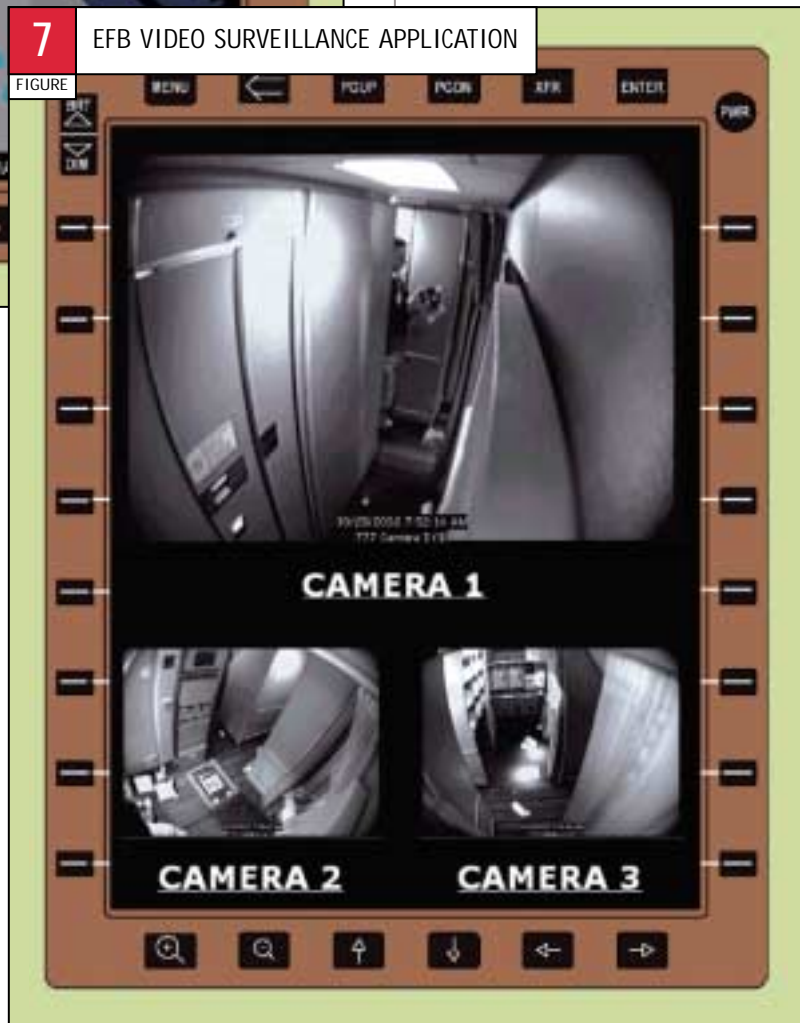
The DDM service will allow airlines to automatically manage and schedule content delivery to airplanes. The content can be copied from CD-ROMs or directly from the DDM system into a compatible ARINC 615A data loader and then can be loaded into the EFB. The service also can send data through the terminal wireless gatelink, which allows data loads to be staged incrementally. A completely staged data load can be an installed action by appropriate airline personnel.

3**EFB ARCHITECTURE AND CERTIFICATION****Class 1 Architecture**

The Class 1 EFB is a commercial off-the-shelf laptop computer that

7**EFB VIDEO SURVEILLANCE APPLICATION**

FIGURE





EFB location in 737 cab

can host the following applications:

- Performance calculations.
- Electronic documents.
- Charts.

This system can use airplane power if that option has been installed. The portable computer must be stowed during the takeoff and approach phases of flight. The current Boeing Laptop Tool for performance calculations will migrate to this Class 1 offering.

Class 2 Architecture

The Class 2 EFB architecture comprises a portable pen tablet computer installed in a crashworthy mount. This EFB can be removed from the mount, which provides a power interface for the system, without maintenance action.

An airline may choose installation of an airplane interface module that will provide read access to various avionics systems (which can provide data for EFB applications) and data link

capability for various EFB applications. Because the EFB is installed in a crashworthy mount, it can be used during all phases of flight.

Class 2 EFB applications include

- Performance calculations (with automatic field updates enabled by airplane interface).
- TPA moving map (without ownship position).
- E-documents.
- Charts, including approach charts.

Class 3 Architecture

The open architecture of the EFB Class 3 system will allow airlines (or third-party suppliers) to develop software for the Microsoft Windows® processor using a software development kit provided by Boeing and Jeppesen. The software development kit will include application programming interfaces that will provide access to onboard communications

and the flight deck printer.

The EFB Class 3 architecture has two flight deck-mounted display units (DU) and two electronic units (EU) mounted in the main equipment bay (fig. 8). The EUs provide the display to the DUs, which show the selected applications, allow transfer of display between the two DUs (so flight crew members can view each other's display), and control unit brightness.

The first EFB implementation will be a Class 3 system on a production 777-200ER for KLM.

An EU contains two single-board computers, each with a dedicated, atmospherically sealed disk drive and memory. One computer runs the Linux operating system (OS), which is certified through DO-178B. That computer controls the TPA display, TPA activation, and the applications on the other computer, which runs the Windows OS. The Windows applications are operationally approved. Six Ethernet ports

on each EU provide communication between the EUs.

EFB installation on the 777-200ER uses existing side display provisions as installation sites (fig. 9).

Certification

The EFB follows guidance set forth in AC 120-76A, *Guidelines for the Certification, Airworthiness, and Operational Approval of Electronic Flight Bag Computing Devices*.

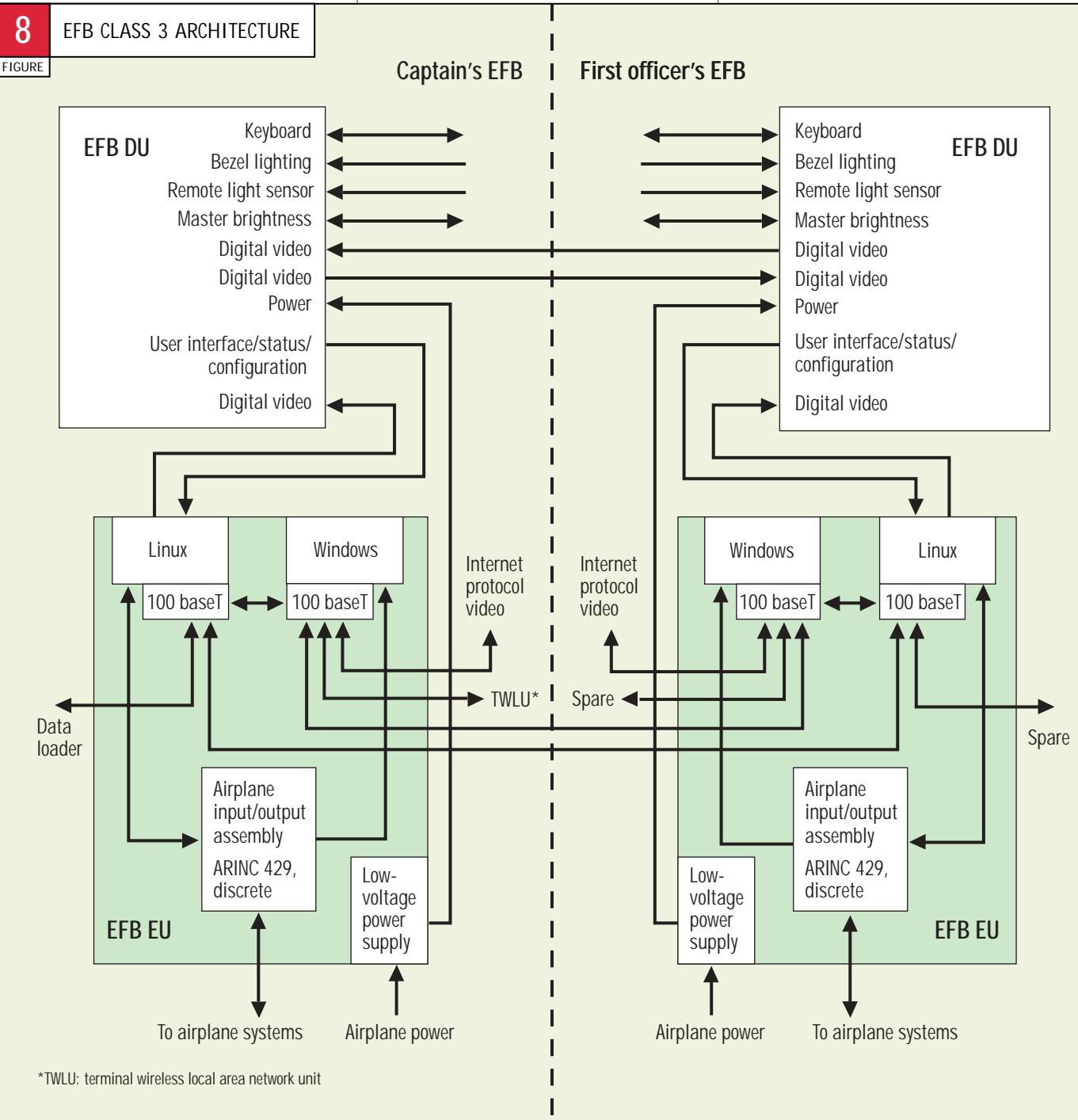
For the Class 3 EFB, installation of the DUs, EUs, and associated wiring will be certified through an amended type certification.

The Class 3 Linux OS will be certified through the same amended type certification. The TPA function will be certified on the Linux side as part of the same amended type certification. The remaining applications on the Windows processor will be operationally

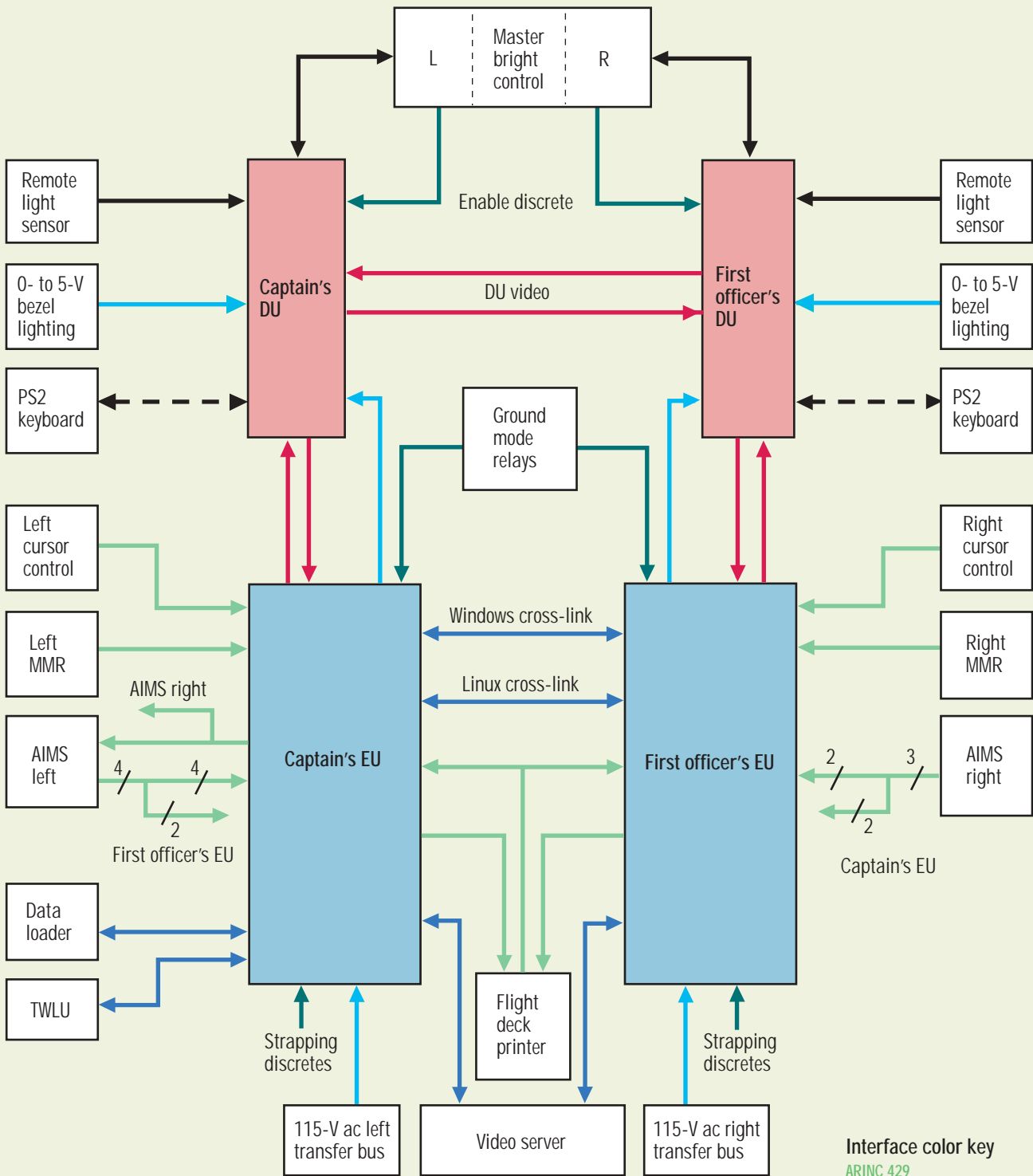
approved using the guidance provided in AC 120-76A.

Class 2 EFB Part 25 certification is limited to the mounting device and airplane system interfaces. The Class 2 computer itself will be operationally approved along with the applications.

Class 1 EFB systems are operationally approved only.



FIGURE



Interface color key

- ARINC 429
- 10/100 baseT Ethernet
- 1000 baseSX (digital optical)
- Discrete
- Power
- Analog
- Serial digital (---)

Definitions

- AIMS: airplane information management system
- MMR: multimode receiver
- TWLU: terminal wireless local area network unit



SUMMARY

The Electronic Flight Bag is a major step toward e-enabling the air transport system for all airplanes. Through its integrated, modular applications, the Electronic Flight Bag brings a new level of digital information delivery and management to the flight deck. Airlines will realize flight operations and maintenance cost savings, improved safety, and enhanced document accessibility and configuration control.

Editor's note: For more information about the Electronic Flight Bag, call Jim Proulx, Boeing Crew Information Services, at 206-766-1393.



EFB location in 747 cab



structure. During his 25 years with Boeing, David has worked on avionics software and hardware projects and was project engineer

About the Author

David Allen oversees the development and installation of the Electronic Flight Bag and its supporting infra-

structure. During his 25 years with Boeing, David has worked on avionics software and hardware projects and was project engineer on the Future Air Navigation System, which integrated airplane avionics with satellite communication and navigation for air traffic control. He has been a software and systems-designated engineering representative of the U.S. Federal Aviation Administration and received the International Air Transport Association Global Navcom Laurel Award for communications, navigation, and surveillance functions in commercial aviation.