Electronic Flight Bag:
Real-Time Information Across an Airline's Enterprise

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The Boeing Electronic Flight Bag (EFB) system has been expanded to include ground software components that enable airlines to turn airplanes into nodes on their information network. This expansion allows airlines to implement a Boeing Electronic Logbook (ELB) application that resides both on the airplane and on multiple ground components. It also allows the future implementation of airborne and ground applications that will enable the airline to operate more efficiently as a business. This new application will be implemented first on the 777 and will be available for the Next-Generation 737, 747-400, 757, 767, and 747-8. It will be basic on the 787.

An airplane in the air is an asset. An airplane that cannot meet its next departure cannot generate revenue. That reality was the impetus behind the Boeing ELB application. Because airplanes can only produce revenue when they are flying, the aviation infrastructure exists to keep them operating safely and efficiently. When an airline is forced to cancel a flight, the revenue from that flight may be lost and the disruption costs affect the airline bottom line. Yet airplanes are basically out of touch with the airline operations (except for some system messages and voice reports) most of the time. The system-generated failure messages many times do not provide enough information for airline mainte-nance to provide a solution in the time necessary to support the next dispatch. Pilot workload many times precludes using voice to communicate problems. As airlines increase airplane utilization and reduce airplane turn time, information to resolve issues becomes more important.

The Boeing ELB connects the airplane systems to the airline information technology infrastructure, providing data to the appropriate departments that allows them to strategically react to airplane problems. This knowledge helps the airline schedule the airplane operation so that all deferred faults can be resolved during a time when the airplane is available, thereby reducing costs.
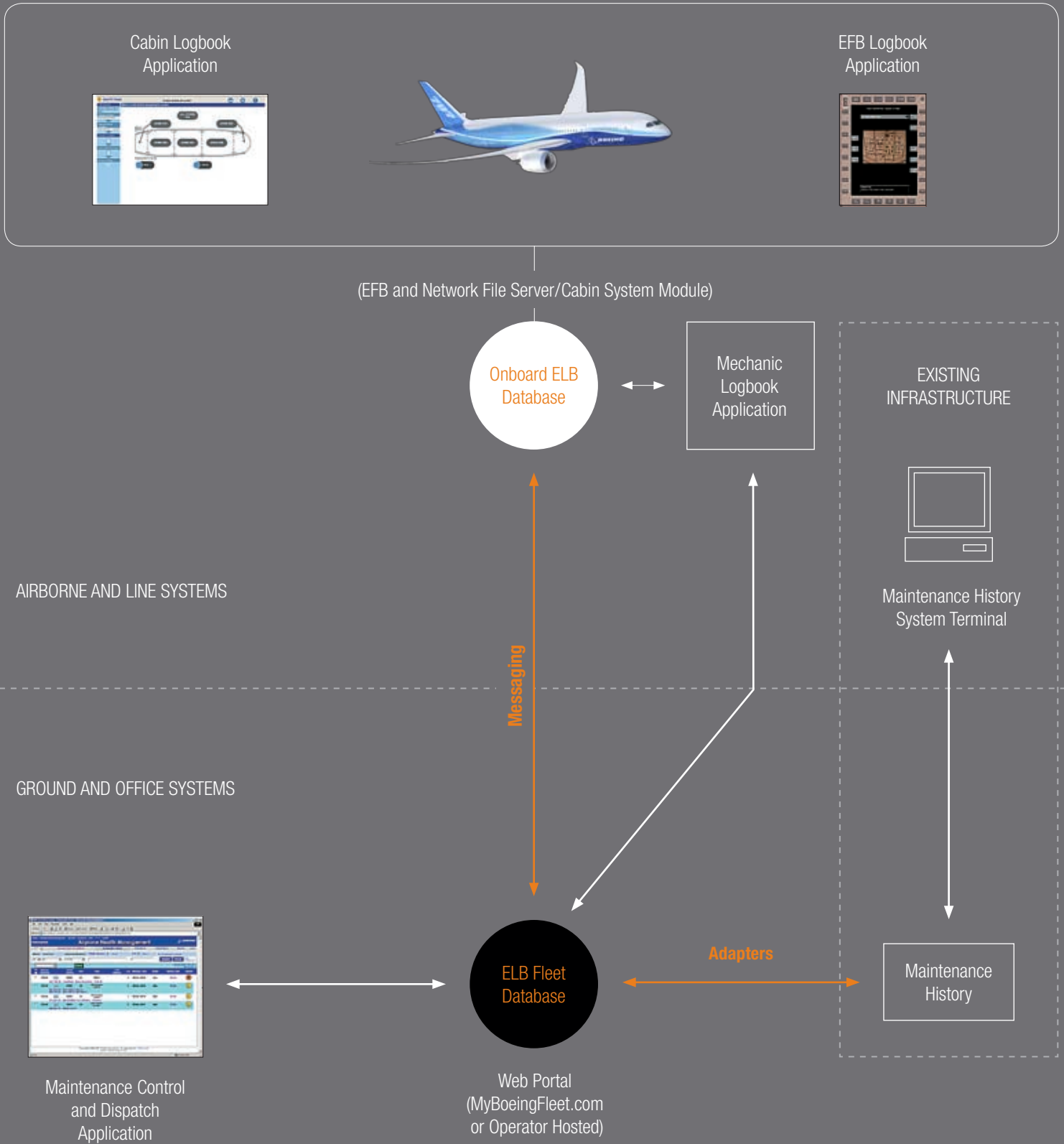
This article discusses the evolution of the Boeing EFB, the definition and benefits of a Boeing ELB, the advantages of connecting airplanes in flight with ground systems, and the infrastructure required to support this kind of connected system.

THE EVOLUTION OF THE BOEING EFB

When first introduced in 2003, the Boeing EFB was seen as a major step toward e-enabling the entire air transport system — from the flight deck to the cabin, maintenance, and the airport.

(See "Electronic Flight Bag," *AERO* third-quarter 2003.) EFB benefits included reduced fuel and maintenance costs through precise, accurate takeoff speed calculations; improved taxiway safety; flight-deck entry surveillance; and elimination of paper from the flight deck and access to digital documents.

Nearly five years later, the Boeing Class 3 EFB has evolved from a simple flight bag replacement to a generalized computer system that can link information provided by airplane systems, flight crews, and cabin crews to the airline when the airplane is remote from the airline home base. Integrated with the Boeing ELB, it provides real-time administrative information from the airplanes to the airline so that the airline can make high-value operational decisions. Administrative information is that information which helps the airline manage its business and is not associated with the flight currently in progress. For example,

Cabin Logbook Application

EFB Logbook Application

(EFB and Network File Server/Cabin System Module)

Onboard ELB Database

Mechanic Logbook Application

EXISTING INFRASTRUCTURE

AIRBORNE AND LINE SYSTEMS

Messaging

Maintenance History System Terminal

GROUND AND OFFICE SYSTEMS

ELB Fleet Database

Adapters

Maintenance History

Maintenance Control and Dispatch Application

Web Portal (MyBoeingFleet.com or Operator Hosted)

ELECTRONIC LOGBOOK SYSTEM OVERVIEW
Figure 1

By connecting airplanes in flight with ground systems, an electronic logbook provides continual, real-time communication about the airplane's status and possible maintenance requirements, making possible new levels of maintenance efficiency and airplane availability.

Boeing ELBs

EFB Technical Electronic Logbook	Includes fault reporting and logbook database containing flight log, fault reports, maintenance actions, deferrals, release and servicing records — all synchronized with a ground database.
EFB Cabin Electronic Logbook	Includes cabin crew fault reporting form for cabin and in-flight entertainment faults, which are synchronized with the EFB Technical Electronic Logbook. These critical faults (such as an inoperable cabin public address system) are flagged to the flight crew, which does not see all of the other cabin faults.
EFB Ground Module	Consists of a database hosted locally by the airline and/or by Boeing that contains fleet logbook history. An interface is provided into the database for use by ground personnel, such as maintenance control and dispatch. This function allows the entry of maintenance action and release information remotely from the airplane.
Mechanic ELB Application	Provides visibility of new faults to be worked and allows entry of maintenance action and release information on the airplane itself.
	Boeing EFB and ELB products are available to operators of most Boeing models as options. An EFB and the ELB application will be standard on all Boeing 787 Dreamliner models. The standard 787 implementation will include the Technical Logbook, Cabin Logbook, MyBoeingFleet.com-hosted ground application, and the Mechanic ELB Application.

if an airplane has a deferred fault that needs to be resolved, but the required downtime exceeds the current turn time on the schedule, the airline can use this information to swap airplane route assignments to ensure that it has the time necessary to resolve the issue before the airplane needs to dispatch again.

DEFINITION AND BENEFITS OF AN ELB

Airlines use a number of paper-based logbooks, including flight, technical, airplane maintenance, cabin, ground, and system-specific logs. These logs are used to record technical problems and maintenance resolution, provide flight crews with airplane status, and comply with regulatory recordkeeping requirements. But paper logbooks have a number of limitations. The paper logbook entries record the flight crew interpretation of the problem. These can vary widely depending on the

flight crew. There is often no correlation to the fault code identification, and entries can be difficult to match with the system-generated fault messages. The Boeing ELB correlates entries automatically and provides standard nomenclature for problems.

An ELB system replaces paper logbooks with computer-based logs that can be easily stored and shared — even if users are thousands of miles apart (see fig. 1). At a minimum, an electronic logbook should do everything paper logbooks do today while making pilots' logging tasks simpler and faster by providing easy-to-use, standardized fault-reporting tools. Regulatory and legal requirements mandate signoff of the log by the flight and maintenance crews. The Boeing ELB provides a U.S. Federal Aviation Administration (FAA)-approved method for this signoff, which does not require processes that might include a universal serial bus (USB) token or real-time validation.

An electronic logbook also may enhance an operator's ability to plan unscheduled maintenance before the airplane arrives, coordinate logbook data with airplane-generated maintenance messages, and extend Airplane Health Management (AHM) capabilities beyond the central maintenance communication function to other types of faults. While AHM is not required for the ELB implementation, the combination of AHM and the ELB increases the value to the airline. (See "Remote Management of Real-Time Airplane Data," *AERO* third-quarter 2007.) The system should enhance flight crew and mechanic work management and reduce the impact of nonroutine maintenance needs and the resulting schedule delays.

Boeing's objective in developing electronic logbooks is to ensure coordinated data between flight and ground staff and increase maintenance efficiency. The integration of the system-generated

ELECTRONIC LOGBOOK ACCESSED THROUGH ELECTRONIC FLIGHT BAG
Figure 2

The flight crew uses the Boeing EFB to access the Boeing ELB. A touch screen and graphical user interface enable crews to enter information quickly and accurately. The ELB can minimize ground delays by providing flight crews with instant access to airplane status, deferred maintenance items, information on recurring faults (i.e., fault history), and other vital information.

faults with the pilot-reported faults could also reduce the no-fault-found (NFF) removals by providing additional information necessary to isolate the actual problem.

REGULATORY APPROVAL

The introduction of an electronic replacement for the paper logbook is a significant change. Boeing has been working closely with the FAA and the European Aviation Safety Agency (EASA) during development. While FAA and EASA guidance on approval of EFB applications include the ELB (Advisory Circular 120-76A/TGL36A), many of the details (such as revisions, signatures, and data retention) are not specifically covered. Boeing provides support for the operational approval of the ELB application. This includes the airborne- and ground-provided components.

THE ADVANTAGES OF CONNECTING AIRPLANES IN FLIGHT WITH GROUND SYSTEMS

Traditionally, maintenance teams have had to wait for the airplane to land to gather enough information to begin their "parts and planning" to make repairs. Today, by integrating ground-based and airplane-based systems, information can be received and decisions made in real time.

For example, if a flight deck effect fault occurs in flight, the pilot enters the fault information into the Boeing ELB, which then automatically enters the fault code into the fault recording form (see fig. 2). The system is designed to allow the pilot to easily enter the initial fault; additional information can be added during a low workload phase of flight. As soon as the captain electronically signs the fault, the ELB transmits an accurate fault description to the ELB ground control system in the maintenance center and to any other airline

organizations that need the information. (Because the fault is automatically correlated to the fault code, the deferral status is automatically available.) Even though the airplane might still be several hours from landing, the airline can have people, parts, and equipment prepositioned and ready to make any needed repairs when the airplane arrives.

This system offers operators a number of additional advantages, including:

Maintenance efficiency. The ELB system allows the pilot to choose faults from a codified list of fault descriptions without typing or writing. Due to flight crew workload, many times the standard fault code is not entered into the paper flight log. The automatic inclusion of standard faults and their fault codes will reduce the rate of NFF removals. The accurate and immediate data the ELB provides can reduce troubleshooting and improve communication throughout the enterprise, helping optimize the maintenance operation.

Additionally, by providing a history of Fault Reports and Maintenance Actions, the Boeing ELB allows airlines to analyze fleet trends to proactively address system or component issues.

Operational efficiency. An ELB system can reduce downstream delays through fault forwarding of pilot eLogbook reports, translating into a reduction of maintenance delays and missed air traffic control slots.

Reduction or elimination of paper documents. Boeing estimates that a Boeing EFB/ELB system can reduce labor costs associated with gathering and maintaining paper forms, as well as data entry costs associated with typing logbook entries into airline maintenance planning or history systems.

AN E-ENABLED INFRASTRUCTURE

The Boeing ELB offers the most value when it is part of an overall e-enabled infrastructure. The ELB application links flight crew fault reporting to Boeing-provided ground applications (such as AHM), an airline ground-hosted logbook application, and airline ground systems, such as Maintenance Control.

This type of system provides the airline with a solution that can transform its maintenance operation. It also provides the framework for future implementations that can support other cost-reducing functions leading to a paperless dispatch of an airplane.

A comprehensive e-enabled infrastructure is complex (see fig. 3), and airlines may need to develop new resources to support it. But it provides a framework that can readily integrate future productivity improvements. Boeing offers a variety of implementation and support services. Figure 3 depicts a full installation, which includes a locally hosted ELB Fleet Database and connection to airline back-office systems. Boeing offers a scaled implementation that uses MyBoeingFleet.com for the primary fleet database for airlines that do not require back-office integration.

SUMMARY

The efficient operation of an airline's fleet depends on reliable technical communication between the airplane and airline ground stations. The Boeing EFB/ELB system provides real-time administrative information from air to ground, allowing airlines to make high-value operational decisions.

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E-Enabling Interfaces

AIRPLANE

Portable Maintenance Access Terminal

Flight Deck Entry Surveillance

Linux — Windows — Electronic Flight Bag

Input/Output

Multi-Mode Receiver

Very High Frequency Radio

Airplane Information Management System

Data Communication Management Function

L-Band Satellite Communications

Flight Management Function

Terminal Wireless LAN Unit (LAN=Local Area Network)

Airplane Discretes

Network File Server

Network File Server Input/Output

Flight Network Interface Card

Flight Deck Printer

Network File Server Processor

High Speed Data

In-flight Entertainment File Server

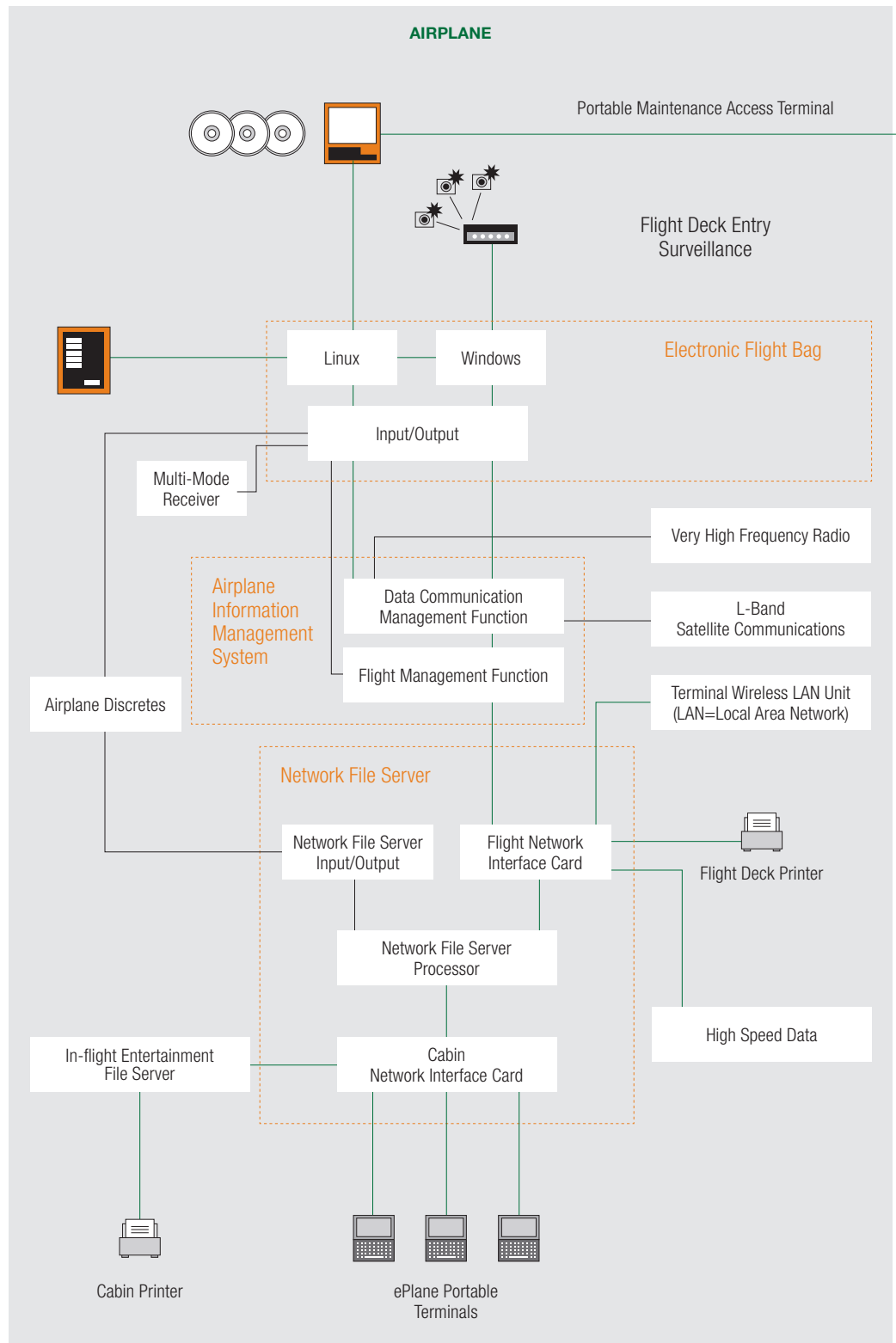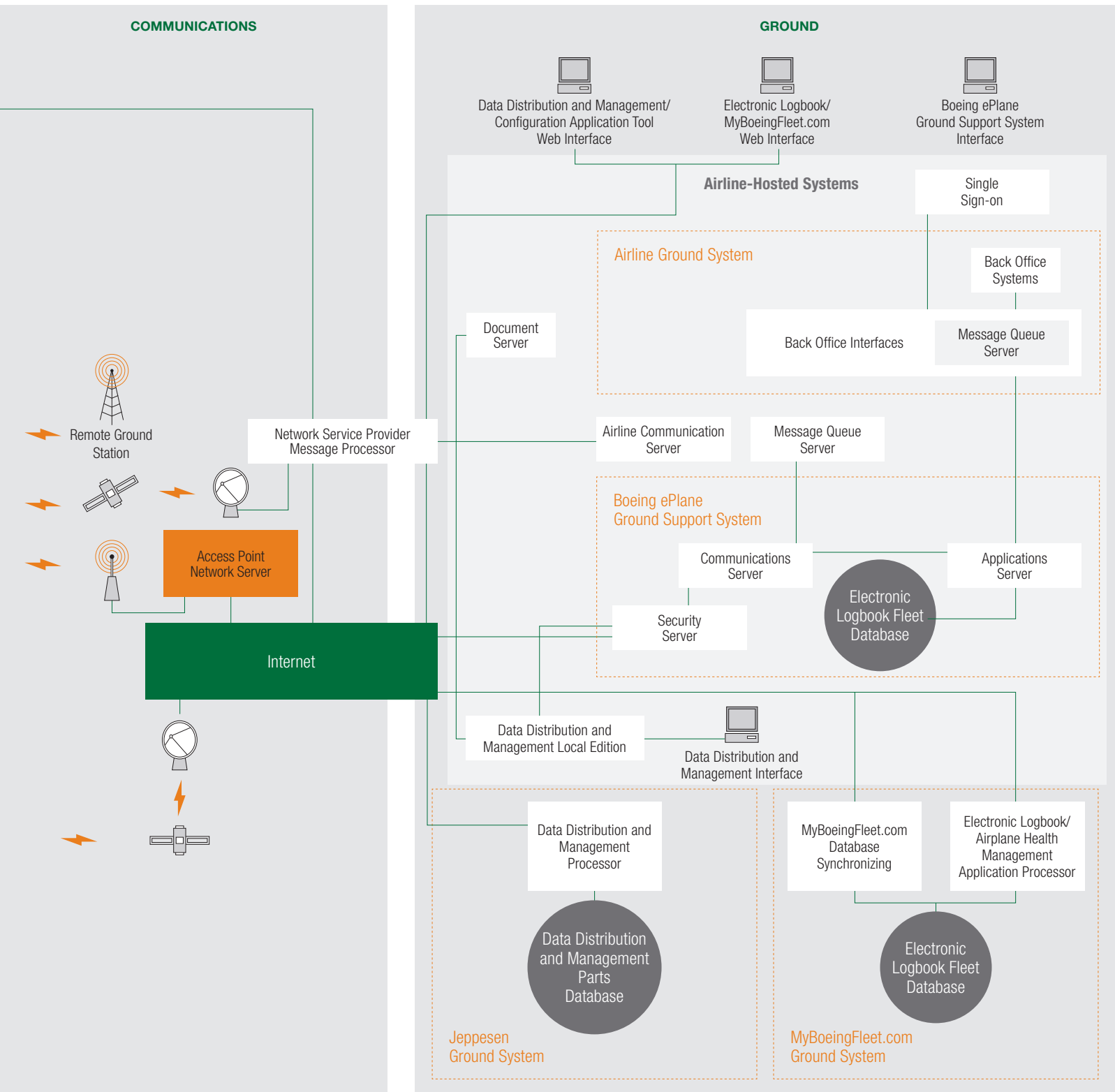Cabin Network Interface Card

Cabin Printer

ePlane Portable Terminals

In a network-centric, e-enabled airline, airplanes are always connected, sending and receiving valuable information. This real-time monitoring allows the airline to be predictive rather than reactive, which can increase revenues by improving overall operating efficiency.

COMMUNICATIONS

GROUND

Data Distribution and Management/ Configuration Application Tool Web Interface

Electronic Logbook/ MyBoeingFleet.com Web Interface

Boeing ePlane Ground Support System Interface

Airline-Hosted Systems

Single Sign-on

Airline Ground System

Back Office Systems

Document Server

Back Office Interfaces

Message Queue Server

Remote Ground Station

Network Service Provider Message Processor

Airline Communication Server

Message Queue Server

Boeing ePlane Ground Support System

Access Point Network Server

Communications Server

Applications Server

Security Server

Electronic Logbook Fleet Database

Internet

Data Distribution and Management Local Edition

Data Distribution and Management Interface

Data Distribution and Management Processor

MyBoeingFleet.com Database Synchronizing

Electronic Logbook/ Airplane Health Management Application Processor

Data Distribution and Management Parts Database

Electronic Logbook Fleet Database

Jeppesen Ground System

MyBoeingFleet.com Ground System

Class 2 EFB

In addition to its Class 3 EFB, Boeing offers Class 1 and 2 EFB support through its subsidiary Jeppesen. A Class 2 EFB is generally a commercial off-the-shelf computer that has been optimized for airborne use (i.e., made more rugged, featuring sunlight-readable screens, and having touch screens). In some cases, the screen is connected to a remotely mounted computer; in other cases, the computer and screen are combined into one unit.

Class 2 EFBs are mounted on the flight deck and approved for use during all phases of flight and ground operations. They use ship's power and can receive inputs from the airplane's systems, such as position data to drive moving maps; however, they cannot send data to the airplane.

Class 2 EFBs are less integrated with the airplane than Class 3s, and therefore their functionality is more restricted. Class 2 EFBs offer a retrofit option for airlines with large fleets of existing airplanes, in which a fully integrated Class 3 system may not be viable. The market continues to evolve with some airlines moving toward a mix of Class 3 EFBs that are forward-fit as part of a new airplane order, and a combination of Class 2 and Class 3 EFBs that are installed in phases as a retrofit solution.