Remote Management of Real-Time Airplane Data

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Operators are reducing flight delays, cancellations, air turnbacks, and diversions through an information tool called Airplane Health Management (AHM). Designed by Boeing and airline users, AHM collects in-flight airplane information and relays it in real-time to maintenance personnel on the ground via the Web portal MyBoeingFleet.com. When an airplane arrives at the gate, maintenance crews can be ready with the parts and information to quickly make any necessary repairs. AHM also enables operators to identify recurring faults and trends, allowing airlines to proactively plan future maintenance.

AHM is a key part of an aviation system in which data, information, and knowledge can be shared instantly across an air transport enterprise. AHM integrates remote collection, monitoring, and analysis of airplane data to determine the status of an airplane's current and future serviceability. By automating and enhancing the real-time and long-term monitoring of airplane data, AHM enables proactive management of maintenance. AHM is intended to provide economic benefit to the airline operator by applying intelligent analysis of airplane data currently generated by existing airplane systems.

This article addresses the following:

- How AHM works.
- Available data.
- Benefits.
- Recent AHM enhancements.

HOW AHM WORKS

AHM collects data (e.g., maintenance messages and flight deck effect [FDE] faults) from the airplane in real-time (see fig. 1). The primary source of the data is the airplane's central maintenance computer (CMC) for the 747-400 and 777 or airplane condition monitoring systems (ACMS) on other models. AHM also collects electronic logbook data from the Boeing Electronic Flight Bag. Data is collected and downlinked via the airplane communication addressing and reporting system.

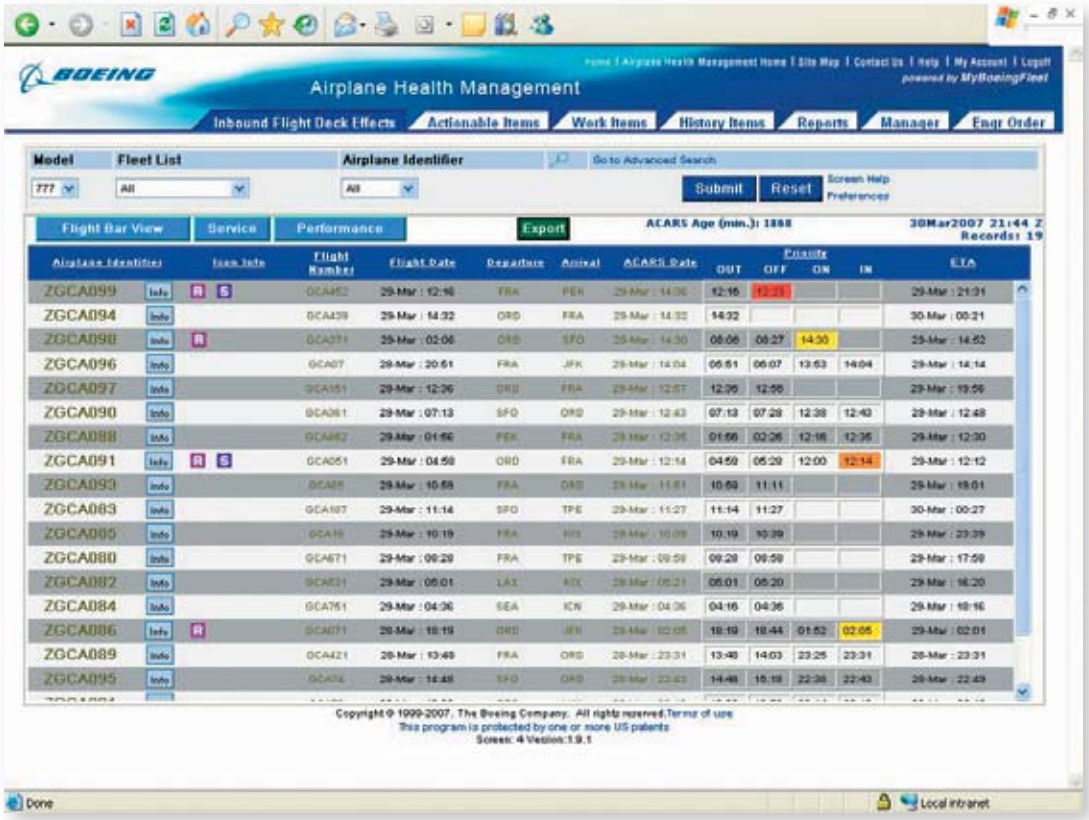
The data received in real-time directly from airplanes is hosted by Boeing within the MyBoeingFleet.com Web portal. If an issue is detected, alerts and notifications are automatically sent to a location specified by the airline via fax, personal digital assistant, e-mail, or pager. Maintenance personnel can then access complete AHM information about the issue through an application service provider tool and reports on MyBoeingFleet.com.

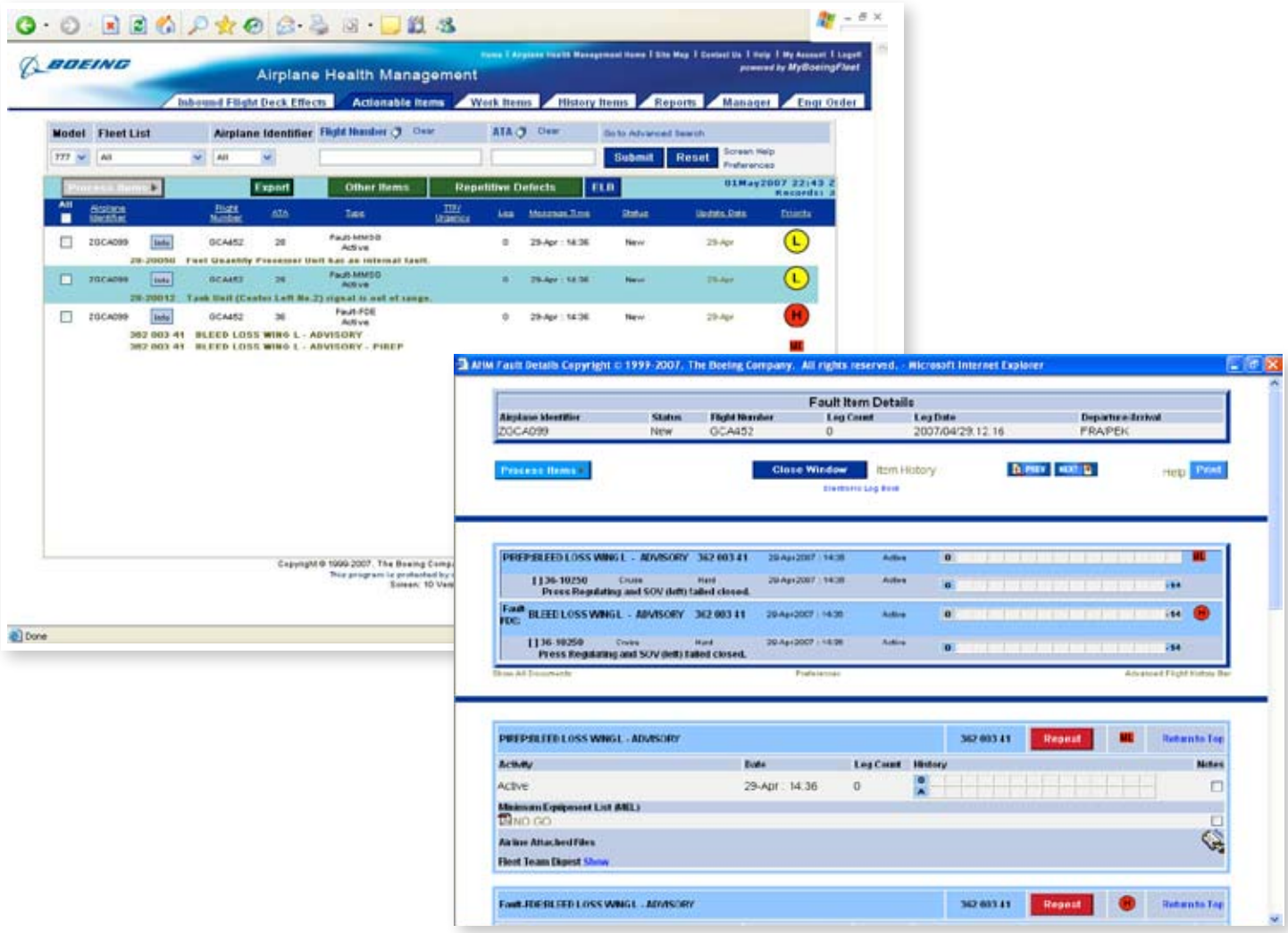
AHM REAL-TIME DATA

Figure 1

AHM automatically collects airplane data and fault information, then prioritizes and organizes the data to assist operators in formulating a plan for repairs.

AHM LEVERAGES BOEING KNOWLEDGE AND FLEET DATA TO PROVIDE ENHANCED TROUBLESHOOTING.





The primary benefit provided by AHM is the opportunity to substantially reduce schedule interruption costs such as delays, cancellations, air turnbacks, and diversions.

Exactly which data will result in alerts and notifications to maintenance staffs is set by individual operators; operators also determine what particular data and information each of their employees can view via AHM, and that information is prioritized, based on its urgency. Having information packages customized to fit the role of each user ensures that users get the particular information they need.

For example, after encountering a flap drive problem en route, a flight crew called in the discrepancy. The AHM notification made it possible for the airline's maintenance control organization to troubleshoot the problem before the airplane landed. Through real-time uplinks, the airline used AHM to interrogate systems information, identify the problem, and prepare the arrival station for repair. The information made it possible for the airline to avoid a flight diversion and the subsequent repair delay was reduced from several hours to a few minutes.

AVAILABLE DATA

AHM facilitates proactive maintenance by providing ground crews with real-time interpretation of airplane data while flights are in progress, and it leverages Boeing knowledge and fleet data to provide enhanced troubleshooting. With AHM, operators can access Boeing engineering knowledge, worldwide fleet in-service experience, and operator-unique knowledge. It also institutionalizes the use of this knowledge in a repeatable manner, allowing the operator to maintain and grow its engineering- and maintenance-usable knowledge.

AHM is currently available for the 777, 777 freighter, 747-400, 757, 767, and Next-Generation 737 airplanes. The type and availability of flight data vary by model. The 747-400 and 777 have a CMC, as will the 747-8 and 787. The CMC allows for fault collection, consolidation, and reporting. AHM relies on other data types, such as ACMS data, on airplanes without CMCs.

BENEFITS

AHM is designed to deliver airplane data when and where it's needed, allowing operators to make informed operational decisions quickly and effectively. The primary benefit provided by AHM is the opportunity to substantially reduce schedule interruption costs. Schedule interruptions consist of delays, cancellations, air turnbacks, and diversions. The three primary ways that AHM reduces schedule interruptions are prognostics, fault forwarding, and prioritization.

Prognostics. AHM helps operators forecast and address conditions before failure, a process referred to as "prognostics." With AHM, operators can identify precursors that are likely to progress to FDE faults, which will affect airplane dispatch and possibly cause schedule interruptions. AHM provides an operator's engineers with the information they need to make sound economic decisions regarding these precursors, so that the operator can perform maintenance on monitored faults on a planned basis, rather than having to react to unexpected problems with unplanned maintenance.

Fault forwarding. When a fault occurs in-flight, AHM allows the operator to make operational decisions immediately, and if maintenance is required, to make arrangements for the people, parts, and equipment sooner rather than later. This enables operators to substantially reduce the number of delays (e.g., a delay is prevented altogether) and the length of delays (e.g., a three-hour delay is shortened to one hour — see fig. 2). AHM provides both the information and the context to enable operators to make appropriate decisions while the airplane is still en route.

Prioritization. Information about fuel efficiency, economic impacts, and other performance factors is provided according to its importance to the

Maintenance personnel can get a significant head start in their decision making through the proactive use of airplane data.

AHM ENABLES AIRLINE CUSTOMERS TO MINIMIZE FLIGHT DELAYS AND CANCELLATIONS

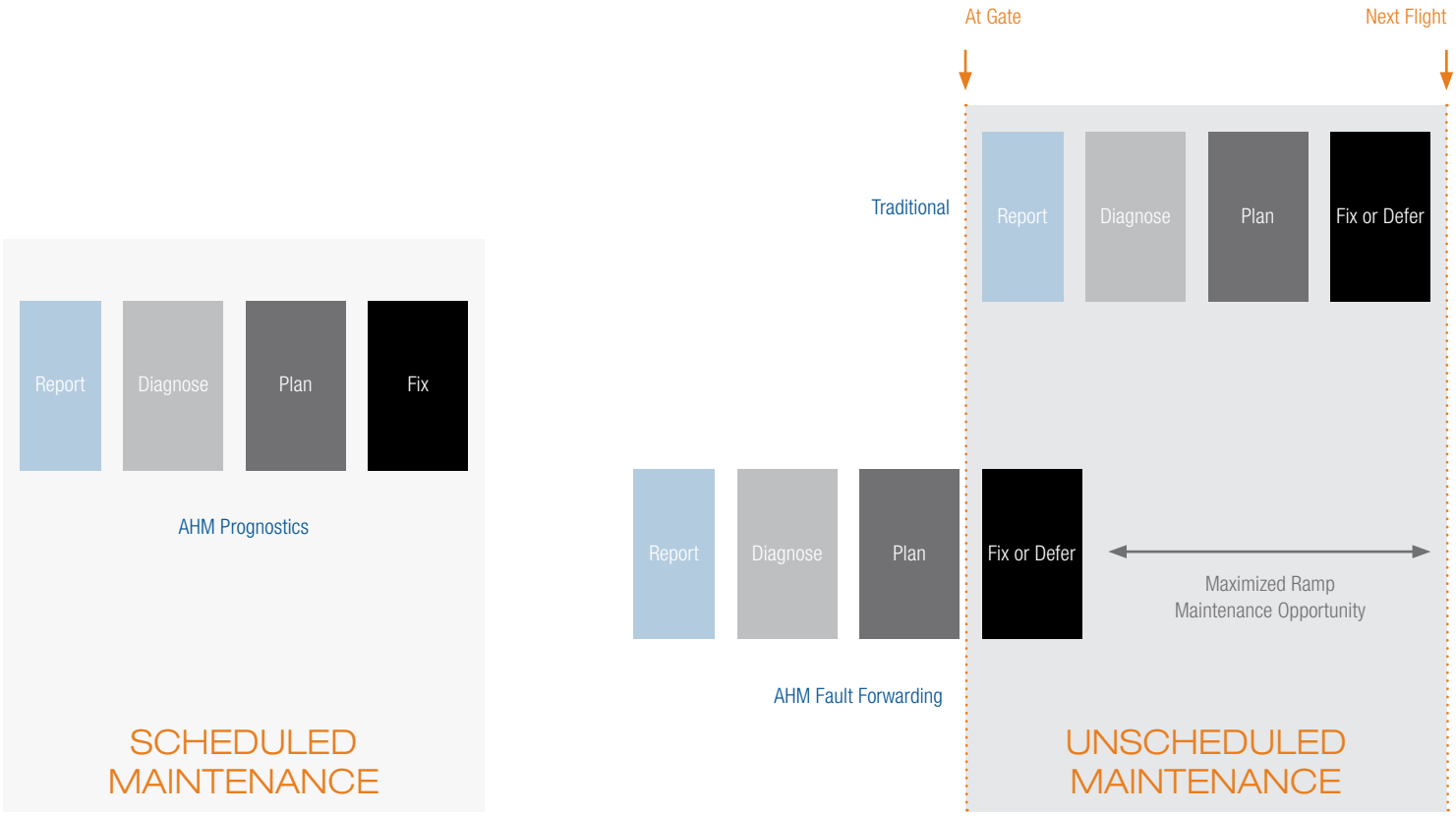
In one instance, a flight experienced a weather radar condition en route. The required part was identified via AHM, ordered, and sent to the arrival airport. As a result of AHM's in-flight notification, the part was replaced immediately after landing, substantially reducing the delay.

In another case, an exhaust gas temperature problem was encountered en route. The crew began an air turnback, but after AHM interrogated the central maintenance computer and investigated the airplane's history, the operator determined that the flight could continue.

In one more example of AHM in use, an airplane experienced an engine control fault en route. Via AHM, which reports engine and engine accessory fault messages, the needed part was identified and sent on a subsequent flight to the airplane's destination airport. The flight departed with minimal delay compared to what it could have been had initial fault notification occurred after landing.

AHM – PROACTIVE USE OF AIRPLANE DATA
Figure 2

AHM enables operators to report and diagnose faults and plan for repairs before the airplane even reaches the gate, maximizing the ramp maintenance opportunity. This deals with conditions which affect airworthiness (i.e., affect next release), and which typically take place in an unscheduled manner. In addition, condition monitoring allows for purely economic conditions to be considered and resolved, thus allowing them to be addressed in a scheduled manner, and reducing in-service interruptions.



operator, allowing the operator to determine the best course of action.

A number of secondary benefits result from the reduced schedule interruptions realized by using AHM:

Reduced down-line disruptions. AHM can be used by operators to calculate the likelihood of down-line disruptions and estimate the cost of such disruptions.

Reduction of missed Air Traffic Control slots. AHM can help operators reduce missed Air Traffic Control slots that result from technical delays.

Improved supply chain efficiencies. With AHM prognostics, operators can better predict line-replaceable unit failures, which means fewer cases of unscheduled removals. That results in fewer parts being borrowed and fewer parts being prepositioned at remote stations.

Reduced No Fault Found (NFF). AHM reduces the likelihood of NFF, which in turn reduces labor and spares requirements.

RECENT AHM ENHANCEMENTS

AHM has recently been enhanced to provide an even greater amount and depth of information. Called the "parametric module," these enhancements comprise four primary components.

Systems condition monitoring. AHM uses available parametric data to assess the condition of airplane systems. It collects airplane system data using existing and new ACMS reports and compares system performance against system models.

Servicing management. By gathering data on monitored systems — including auxilliary power unit oil, engine oil, oxygen, tire pressure, and hydraulic fluid levels — AHM can provide alerts on system conditions approaching operational limits. This data-based remote condition monitoring identifies airplanes requiring system maintenance to enable replenishment prior to exceeding operational limits.

Airplane performance monitoring (APM). AHM calculates airplane performance using the ACMS APM/engine stable reports and allows operators to compare airplanes through a fleet summary view. It also integrates engine health monitoring alerts, displaying engine manufacturer (OEM) alerts of abnormal conditions and automatically linking to the engine OEM system.

ACMS report viewer and data extractor. AHM incorporates an enhanced means for viewing and analyzing ACMS data.

SUMMARY

The vast potential of condition monitoring airplane systems is being realized today through the innovative use of available airplane data. These advances have been fostered through the team efforts of Boeing and commercial operators. This journey continues, with ample areas for new applications and new directions. For more information, please contact John Maggiore at john.b.maggiore@boeing.com.