Communications between the aircraft flightdeck and the operations and maintenance departments of airlines has traditionally been made with manual paper records. This lacks the speed and accuracy required to maintain a reliable operation. Systems are available to transform this problem.

Systems for air-to-ground communications

A constant challenge for airlines is improving the flow of operational and maintenance data from an aircraft to the airline's operations and maintenance departments on the ground. This was traditionally done manually with paper documents, but airlines now have several electronic options from which to choose.

The advantages of communicating these data electronically include: quicker distribution of documents; instant maintenance status reporting; better tracking of aircraft utilisation and operational status; and improved safety. These instant updates to all departments improve decision-making, and can lead to higher aircraft utilisation, less schedule disruptions and lower spares inventory. Systems for increasing the flow of these data are explored here.

The overall picture

Many airlines still use paper to record and communicate maintenance and operations data after each flight. These data are needed by departments on the ground to update the accumulated usage, in flight hours (FH) and flight cycles (FC), of each aircraft so that maintenance tasks can be accurately forecast and technical records can be kept up to date.

In addition, line maintenance often needs access to reference manuals like the aircraft maintenance manual (AMM) to correct technical log write-ups by pilots, also known as pilot reports (PIREPs). The diagram *(see page 44)* outlines the three business areas of tracking utilisation, filing and using the information from PIREPs, and communicating with flight operations. The diagram shows the points of inter-connection, and how technology can help airlines improve them.

This article explores these three areas and highlights the possible business benefits from applying new technology.

Aircraft utilisation tracking

One of the fundamental requirements for organisation of maintenance is keeping up-to-date technical records for the aircraft, including accurate utilisation data. Many airlines receive these data as paper log pages commonly called journey logs, which need to be typed into computer systems to record details of each flight, including take-off and landing airports, flight and block times and delay information. For operations staff, this information is equally important for tracking the utilisation of flights, which is known as flight following.

Commercial Off-The-Shelf (COTS) software packages for scheduling and flight following come in a number of shapes and sizes to suit all types of operations and budgets. All provide savings by automating aircraft usage updates, usually through an aircraft communication and reporting system (ACARS) wireless downlink or electronic movement message sent from the airline's dispatcher at the gate. Operations staff will have real-time position and status information on each aircraft. Combined with visibility of crew members' status and location, this will help them make better re-scheduling decisions if an aircraft is delayed or unserviceable, and can improve dispatch reliability by several percentage points.

SABRE

Sabre Airline Solutions is a main player in the operations software arena. Sabre's suite provides a flight following system, including interfaces to gather aircraft usage data automatically at the end of each flight. The operations controller can manage daily operations, including swapping tails for scheduled flights, monitoring delays, and analysing and tracking crew allocations against each aircraft. In late 2004 Sabre also acquired RM Rocade, based in Sweden, and now offers both its old Bornemann solution and the Rocade suite, which had been in direct competition.

Both products have interface capabilities to a range of MRO software packages. One of the biggest benefits of Sabre's system is that it keeps short-term maintenance forecasting accurate and automatically logs flight information for technical records.

AIMS

Rivalling Sabre is the AIMS offering from AIMS Inc, which consists of a crew management system for planning and tracking crew duty hours and producing crew allocation rosters for the following month. This is integrated with the aircraft scheduling, maintenance planning, assignment and flight following functions.

AIMS also has an aircraft maintenance schedule planning module. This facilitates the construction of aircraft maintenance plans based on any given annual or seasonal operating schedules. It includes the facility to automatically update individual aircraft hours, cycles, checks and other technical restrictions. It facilitates daily aircraft assignment by registration letters or tail numbers to the flying programme and alerts operations and dispatch to any deferred maintenance actions that might have a detrimental impact on aircraft performance.

There is a problem, however, with placing too much maintenance functionality into an operations software system. Duplicate data entry and lack of referential integrity for the maintenance planning data are two major issues. If the operations system is being used as the core maintenance planning function, it may be out of step with the MRO software planning system, and lead to conflicting decisions. It may also increase

the data entry task by forcing data to be entered into both operations and MRO software.

Big is beautiful

Lufthansa Systems now markets, sells and supports systems developed for Lufthansa to other airlines. It is a 'one-stop-shop', trying to offer complete end-to-end solutions.

The MRO solution offered uses SAP R/3 *(see MRO IT systems for managing ADS & SBs, Aircraft Commerce, April/May 2005, page 43)*. For the operations department, Lufthansa Systems offers NetLine covering flight schedule planning, flight following and crew management. Lufthansa Systems claims that tight integration with NetLine/Crew and aircraft scheduling avoids crew delays, saving 60 to 90 delay minutes per day.

Efficient aircraft flight planning optimises maintenance check utilisation, saving 6-18 maintenance hours per aircraft and year. Enhanced alerting allows daily flight operations control to handle high-density rotations with 10-12 legs per day. Improved ATC slot management avoids missed slots and saves 15-45 minutes in slot delays on heavily slotted days. These are just a few of the many examples cited by its customers of value-added through the use of COTS operational tracking software.

New kid on the block

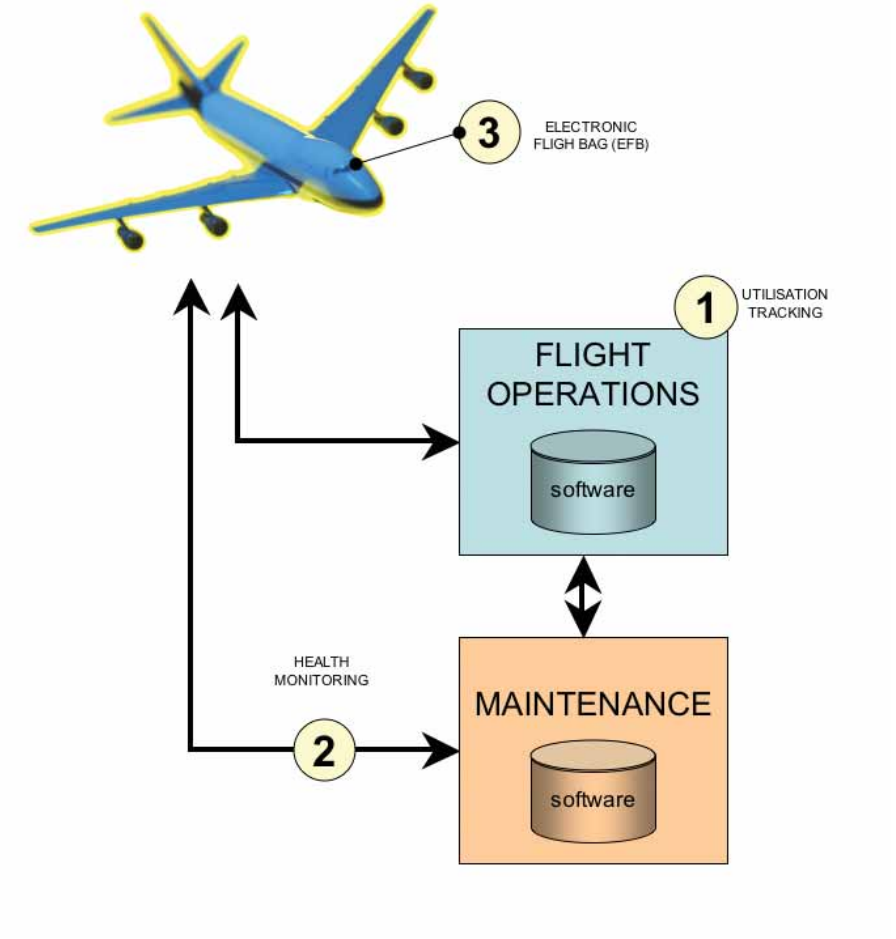
ORTEC, a Dutch operations research company, entered the airline resource optimisation software market over a year ago with BlueOne, a fully integrated flight operations system which links to both the aircraft through ACARS and to the crew planning function. The software is JAVA-based and internet-ready. ORTEC has teamed with a new force in airline systems, MAINTRACK Services, to provide BlueOne as a full Application Service Provider (ASP) solution to serve airlines that are looking for a new business model.

"The ASP model provides airlines with less investment and risk in new IT systems for more profit, cost savings and peace of mind," says Ortec's managing partner Robert Kok. "For aircraft utilisation we offer BlueOne, already integrated with AuRA from MIRO Technologies for MRO.

"There are virtually no start-up costs," says Kok. "No hardware, no software licences, and no maintenance fees. Just a single transparent monthly fee, depending directly upon usage of the IT infrastructure."

An example of integrating utilisation tracking software with MRO software is the recent start-up airline Cargo360 from Seattle. "MainTrack's ASP is the perfect solution to support an entry-into-service start-up airline such as ours," says Brian Smith, senior vice president of operations at Cargo360. "The simplicity of accessing AuRA and Blue One over the internet suits our operations, and the MainTrack ASP model just makes sense to us from a business perspective. It gives us access to world-class IT systems like AuRA and Blue One, without the cashflow burden associated with software licences, servers, or internal IT infrastructure costs. MainTrack takes care of the integration complexities for us, so we can focus on our core business functions."

Already in use by SN Brussels and VLM, Blue One is competing with the traditional players by offering superior functionality in advanced optimisation techniques, commercial flexibility and a different business model that is catching the attention of airlines worldwide.



Healthy aircraft

The second area explored in this article is the application of new technology to improve the data flow from the on-board aircraft systems into the maintenance departments, to assist with trouble-shooting, providing predictive maintenance planning, improving reliability management and enhancing line maintenance productivity. How will this help airlines save money?

Unscheduled maintenance can kill aircraft utilisation rates, and thus damage revenue. There is a physical and intellectual gulf between the aircraft and the maintenance team on the ground that is hard to bridge. Technology can provide that bridge, either in stages or indeed in different forms, and most of these new systems come from the Original Equipment Manufacturers (OEMs) themselves. These new technologies will also reduce aircraft maintenance costs by predicting failures before they happen, and reducing the cost of rectifying a serious mechanical or system failure. Prevention is always better than cure.

FlySMART with Airbus

As we saw in the last issue *(see MRO IT systems for managing technical documents, Aircraft Commerce, June/July 2005, page 50)*, Airbus is evolving the 'FlySMART with Airbus' concept. An element of this is the AIRMAN tool for predictive maintenance and troubleshooting support. Users say it has helped reduce flight cancellations and delays by monitoring onboard systems and predicting if and when maintenance is needed. AIRMAN takes an ACARS feed from the onboard maintenance computers, as well as technical write-ups that are either manually entered on the ground by technical staff or fed through from the cockpit software applications, and looks for trends and patterns emerging in unscheduled faults.

AIRMAN has applications in line and ramp maintenance for trouble-shooting support, in base maintenance for providing comprehensive data on fault histories, and in engineering for enhancing reliability reporting and analysis. The tool tracks the occurrence of particular fault 'signatures' and can spot early degradation in on-board systems by sorting and relating the various fault messages fed via ACARS. Each message is identified and has a priority assigned, depending upon which on-board system generated the fault message and what the fault code is. For example, AIRMAN analyses whether it is a complete failure of an avionics box, or just a warning message that a glitch has occurred. AIRMAN then compares the fault code to other related fault codes reported at the same time to detect whole system failures, or looks back at previous flights for a recurrence of the fault. It can also gather together relevant references from the fault isolation manual (FIM) and present these to the user, to guide them through the trouble-shooting process. All this is done while the aircraft is still in flight, helping line maintenance to prepare to receive the aircraft with more information about likely faults.

When used in combination with the AirN@v suite of tools for technical documentation *(see MRO IT systems for managing technical documents, Aircraft Commerce, June/July 2005, page 50)*, AIRMAN helps focus maintenance staff on the task in hand, and saves them having to run back and forth to the line office to look up the paper manual.

The latest version 8 of AIRMAN was released in June 2005, and a user group of over 30 airlines will meet to discuss further development.

"We will continue to develop additional modules for AIRMAN. For example, a standard interface to a selection of MRO software systems could be considered a module," says Hubert Dehaese, director of marketing and business development at Airbus.

Airbus will soon offer AIRMAN Onboard, which will allow cockpit crews to view the same analysis that is visible on the ground.

Healthy airplanes

Developments at Boeing are a little further behind, but are creating an equal level of anticipation. Similar to AIRMAN in functional scope, Boeing's Airplane Health Management (AHM) is a web-based system that has been evolving since early 2003 with a focus group of airlines. Boeing expects AHM to provide a 15% reduction in schedule interruptions and a 10% or greater lowering of no-fault-found actions by improved trouble-shooting. AHM integrates remote collection, monitoring, and analysis of airplane data to determine the status of an airplane's current and future serviceability. It converts the data into information that an airline can use to make the maintenance deferral decisions that can make the difference between profit and loss. When an on-board aircraft system fault occurs in-flight, AHM allows operational decisions to be made immediately in terms of re-scheduling the next flight if maintenance is required, and to make arrangements for the people, parts and equipment sooner rather than later.

Boeing claims that AHM is not limited to Boeing aircraft and can provide elements of the AHM service, such as fault downlink via ACARS, for Airbus aircraft as well. Depending on the airline needs, it can also receive alerts and notifications through a fax, PDA, e-mail,

or pager system. The mechanics or engineers can then access the information through an ASP tool and reports on MyBoeingFleet.com. The information provided by AHM is prioritised, based on its urgency. The AHM service is billed per flight hour. The cost varies, depending on the level of service the airline selects.

Removing paper

AIRMAN and AHM are moving towards aircraft that self-diagnose in flight. What is still missing is a tool to make human interaction from the cockpit with ground operations and MRO systems easier, smoother and more efficient. Paper, such as PIREP log pages, journey logs, and performance manuals, needs to be removed from the flightdeck, and an 'e-cockpit' to be created.

The solution lies with the electronic flight bag (EFB), which is a computer in the cockpit loaded with a number of software programmes to provide functions for the pilot that replace the pilot's paper-based transactions. These include PIREPs and journey log reports, take-off performance calculations and electronic browsing of manuals and charts on the computer.

All EFBs now follow guidance set out in the FAA Advisory Circular 120-76A, and in JAA/EASA TGL36, 'Approval of Electronic Flight Bags'.

Definitions

Today there are three classes of EFB.

Class 1 includes fully portable COTS-based computers, running basic stand-alone software applications.

Class 2 EFBs are also portable COTS-based systems, which are connected to the aircraft during normal operations, and require an administrative control process for approval.

Class 3 EFBs are fully installed equipment, with installation of the display units, aircraft system interface units, and associated wiring certified through an amended type certification.

The main difference is that Class 3 EFBs are fully integrated into the aircraft cockpit displays, rather than being portable and removable.

Teledyne EFBs

Teledyne combines its full spectrum of Class 1, 2 and 3 EFBs with air-ground link technology through their Wireless Groundlink and Gatelink products, coupled with on-board aircraft file-servers to provide a fully integrated solution. Data can be passed to and from the aircraft at the gate on high-bandwidth solutions that require low infrastructure investment. This means that pilot-reported technical write-ups can be downlinked together with journey logs, data can be refreshed on the on-board systems like the EFB for databases and documents, and line mechanics can use the on-board terminals to communicate in real time with the rest of the back-office systems. Data are now live, dynamic, and without a time lag.

Teledyne has developed a range of EFB software applications to remove most paper from the cockpit. One of the first applications in which airlines are interested is the on-board performance system (OPS), which gives pilots on the flightdeck the tools to calculate aircraft performance, using real-time airport weather, aircraft system, and minimum equipment list/configuration deviation list (MEL/CDL) conditions.

Also on offer are technical log applications for recording and processing maintenance write-ups in flight and on the ground. These can be sent directly into the ground MRO systems to provide faster and more accurate alerts to the maintenance department. Teledyne continues to grab market share, particularly for retro-fit of EFBs on existing aircraft in service.

Data Systems & Solutions

Data Systems & Solutions (DS&S), based in Reston, Virginia, offers a range of predictive maintenance technologies and software. It entered the EFB market with the purchase of CoreData in October 2002.

DS&S's on-board electronic technical log (ETL), called CoreWing, is a system to replace both technical and flight paper log books. Currently housed on a portable touchscreen computer, it can be fully customised to match existing airline processes and forms, which can include journey and cabin reports, check lists and automation of any required flightdeck calculations. CoreWing also offers a two-way communications capability that enables the transmission of crew notices, such as runway restrictions or simply the pilot's e-mail inbox, directly to the aircraft cockpit. The ETL software presents the pilot with a series of tabbed

forms, and includes a signature box that the pilot fills in using a special stylus on the tablet computer touch screen. This replaces the many paper forms that need to be completed and sent around the airline organisation for entry into various other systems.

These systems can be fully integrated into full MRO software systems to provide quicker and more accurate data flow around the airline. Some of these products are still in development or are being used on in-service trials.

The ETL has completed three trials and has been fully implemented by the UK carrier MyTravel, although the airline market has been slow to adopt it. "Our approach to the cockpit environment is slightly different to other providers," says Nick Godwin, marketing director of civil aviation at DS&S. "We believe there is a strong value proposition for the ETL as a standalone solution. Our ETL is offered with a low-cost GSM mobile phone technology link to provide two-way communications to the ground. Data are passed through our web portal solution CoreControl and the software is offered as an ASP application, reducing IT costs further. The tech log data can then be passed into a number of other systems, including our own CoreFleet, and other internal airline maintenance systems to make them work more effectively.

"We believe an airline can see a 40% reduction in technical log management costs," continues Godwin, "which equates to about $19,000 per aircraft per year. This is significant, even for a fleet of 10 aircraft. The knock-on benefits for pilots and ground staff are enormous and the system can be the starting point for a totally paperless cockpit."

AMT provides infrastructure

Aircraft Management Technologies (AMT) is a Dublin-based airline systems provider set-up in 2000. "Our Flightman product is more like a software framework for both on-aircraft and on-ground data communications, rather than simply a product. It enables maintenance reports and journey log data to be entered and processed in real time. In the air, there are of course certification issues to deal with, but we see the strongest value proposition right now for airlines in the electronic tech log and journey log functionality," says Bernard Henessey, chief executive of AMT. "This is because Flightman is replacing a cumbersome paper-based transaction that is repeated many, many times a day and is ripe for automation. It only really delivers the benefit, however, when it is integrated with the ground MRO software. We currently have integration with both the old Merlin and VISAer MRO systems for easyJet. PIREPs are transmitted electronically straight into both."

AMT's philosophy is to work with partners to deliver value to the end customer, and this includes initial discussion with some of the new players like MAINTRACK which offers ASP solutions for airlines. "A good example of partnering is our work with Rockwell Collins at easyJet", continues Henessey. "The EFB solution for the 737 fleet, part of easyJet's Aircraft Information Exchange (eAIE) programme, is designed to increase the airline's operational efficiency. Flightman is delivered as the software component of the Rockwell Collins eFlight information management programme, which will include a Class 2 EFB and a ground-based server and infrastructure. Rockwell Collins is using the Flightman toolkit to configure the customised solution for easyJet."

With regard to communications, the AMT solutions use GSM technology initially, but can also use SATCOM, ACARS and Gatelink. The main benefits, according to Henessey, lie in improved efficiency for line staff, maintenance control centre visibility and decision support of aircraft technical problems, and ultimately reduced spares inventory through improved business processes. When asked about OEMs versus EFB

software and systems suppliers, Henessey is clear. "Airlines will always need choice and flexibility. We are seeing that cross-cockpit commonality of EFBs and software is beneficial and that we need to focus on integration points with the OEM equipment and our solutions."

Airbus

Alongside the AIRMAN system, Airbus also offers its Less Paper Cockpit (LPC) and Technical Logbook. These two products form the Airbus EFB, and can be deployed in different Class 1, 2 or 3 configurations on both its existing systems. It can also be deployed as a Class 3 solution in the new A380 cockpit concept. "With the technical log, PIREPs and journey logs are entered by the cockpit crew, but they still have to sign and that is a regulatory issue," comments Dehaese. "Airbus EFB supports digital signatures or PIN numbers. Our e-technical log can be installed on a laptop as a Class 1 solution, connected to the ground using GSM/GPRS at the gate. In-flight communications using SATCOM are in development. The Class 3 EFB is now developed and is based upon our existing LPC for documentation and performance calculations, navigation charts from LIDO or Jeppesen, and the new e-technical log application. We are aiming at a common look and feel. The solution is integrated into the sliding table in front of the pilot on our single- and twin-aisle aircraft *(see picture, this page)*. On the A380, it is on two large screens beside the tables. Our approach to the EFB can be summarised as providing the right information, at the right time, in the right place for the pilots. The challenge really lies more in the ground inter-connectivity. We are working on studies of a number of MRO software systems to look at integration potential, but whatever happens it will come through AIRMAN, from the EFB, into the ground MRO systems and any feedback will again come via AIRMAN."

Boeing/Jeppesen

Boeing, through its acquisition of Jeppesen in October 2000, entered the EFB market and offers a full range of EFB options, from Class 1 through to fully integrated Class 3 on the 777 and new 787 aircraft.

The Jeppesen EFB offers all the functionality of other EFBs and Boeing is already selling it to 777 customers. It is a standard feature of the 787's new cockpit. Functionality includes airport moving maps for taxi position awareness (TPA) and graphical weather displays en route. The EFB also integrates the cabin video surveillance for increased security.

Software vendors

One of the newer software companies changing airline technical operations is RAMCO Systems. RAMCO has taken a different approach to this area of airline business. In addition to its ground-based MRO software, RAMCO has developed a full EFB. Alongside the maintenance functionality for recording PIREPS and browsing AMMs, the EFB enables the cockpit crew to record and report the operational aspects of each flight.

Currently available on a Panasonic Toughbook, the EFB provides two-way communications between the cockpit and the ground via GSM, GPRS, and SATCOM. "The RAMCO EFB is an integral part of solutions for airlines and aircraft operators," explains Namrata Ahuja, sales manager at RAMCO Systems. "We already have it deployed with PHI in the US which operates over 200 aircraft. It has proved to be a stable and reliable enhancement to cockpit operations, and incorporates a flashcard back-up to further add to operational integrity. It delivers more accurate performance calculations, creating significant savings of time and money, while increasing safety and streamlining the management of flight information and downstream maintenance operations." Reducing turnaround times between flights is a key benefit of the system.

"Discrepancies can be recorded as and when they are observed," continues Ahuja. "Pilots can defer these if they fall under MEL guidelines, and also record their signature against the deferral. Pilots can download the latest maintenance status, aircraft hours, and discrepancy list for the aircraft into the EFB from the maintenance applications for reference. This saves administrative time and makes line mechanics more productive."

Most other MRO software vendors, like MIRO Technologies, are actively avoiding EFB development, preferring to partner with specialist providers. "We want to stay open and flexible to ensure we can integrate with any EFB or air-ground solution," says Mark Ogren, vice president sales and marketing at MIRO Technologies. "A good example of air-ground integration is our project with Scandinavian Airlines. Here we are providing 12 major interfaces to a variety of flight operations systems, to pass the technical status of each aircraft in real time, and maintenance slot planning data synchronised with the flight schedule. We have a commitment to integrate with an EFB when they move in that direction. Our rich integration capabilities and open architecture are bridging the boundary between AuRA and the aircraft."

The future

There is no doubt that technology will eventually make aircraft just another 'node' on an airline's Wide Area Network (WAN). Operations and maintenance control will know absolutely everything about the aircraft, at any second in time, and the aircraft will be self-diagnosing, and even ordering its own parts and scheduling rectification without human interference, or indeed fixing itself by uploading software patches. Savings will come from mechanic efficiency, better maintenance action decision making, reductions in administrative overhead costs and ultimately low spares inventory. Technology continues to evolve and how the ground MRO systems fit into this picture remains unclear. At least the electronic bridges between the air and the ground are partially complete. AC