Several airlines have now fully implemented EFBs & ETLs and have gained a few years experience of them. While installing an EFB & ETL solution incurs high investment and requires a lot of effort from several airline departments, many benefits follow as a result.

The proven benefits of EFBs & ETLs

Airlines have been slow to take up electronic flight bags (EFBs) and electronic technical logs (ETLs), because the cost of installation and implementation outweighs the benefits. The number of applications that can be used by EFBs has grown, however, and they can also be used for other purposes, such as new avionic systems and ancillary revenue generation. Many airlines are now enjoying the benefits of EFBs, and interest in retrofitting aircraft with EFBs is growing, as is interest in ETLs.

EFB classes

There are three classes of EFBs. Class 1 systems are standalone computers used on the flightdeck, which are not connected to systems outside the aircraft. As they cannot be used above 10,000 feet, they can only be used when the aircraft is on the ground.

Class 1 EFBs have autonomous software applications that help flightcrews with their form filling, reporting and performance calculations. They do not replace or work together with aircraft systems. Data can be sent from Class 1 EFBs to a user's ground systems when the aircraft is on the ground via a data link.

Class 2 EFBs are laptops that receive data from the aircraft's avionic systems, such as the flight management system (FMS), so that the EFBs can be used for performance calculations. They are also connected to the user's ground-based systems, and can be used in all phases of flight, so they require approval by the user's aviation authority. Their software and systems also replace the paper technical manuals, navigation charts and operating manuals used on the flightdeck.

Class 3 EFBs are fully integrated on the flightdecks of the latest generation aircraft, including the 777, 787 and A380. They are interfaced with the aircraft's avionic systems, so that pilots can use them together. Class 3 EFBs are either provided by the original equipment manufacturers (OEMs), or by a third party, referred to as PMA Class 3 EFBs. A Class 3 EFB is a permanent display on the flightdeck, to the side of the main instrument panel and below the side flightdeck windows.

The complete integration with aircraft systems means that Class 3 EFBs can be used to receive and report technical faults, as well as to replace all paper systems.

EFB functionality

EFBs replace the manual form- and report-filling, performance calculations, and accessing operations and technical manuals, carried out by pilots, and reduces the number of items they have to take on the aircraft, and the number of manuals that must be kept on board. EFBs can also simplify an airline's maintenance of the library of manuals and documents, since all paper can be removed and replaced with electronic data that can be updated quickly.

The most simple forms and reports that flightcrews have to complete were initially carried out on basic software such as Word on the earliest EFBs. These include flight logs, cabin logs, pilot reports (PIREPs), crew duty reports, technical reports and air safety reports. Pilots used to handwrite these reports before EFBs, and give copies to ground staff upon landing. The data from these handwritten reports had to be recorded and archived by the operator, so they were manually keyed into their operations and maintenance IT systems.

This information can be transmitted wirelessly from Class 2 and 3 EFBs to the user's flight operations, maintenance control centre (MCC) and line maintenance departments, greatly reducing the labour and time used for data input.

EFBs can also accurately record, report and transmit fuel consumption data. This is now a legal requirement for airlines affected by the European Union's (EU's) Emissions Trading Scheme (ETS).

EFBs also cover aircraft operations, flight preparation and planning, and flight performance and operation, including providing notices to airmen (NOTAMs) as part of flightcrew briefing.

The library of aircraft manuals includes: the aircraft operating and flightcrew manuals; airways and navigation charts; aircraft performance manuals; weight and balance manuals and loadsheets. The technical manuals used by the flightcrew and line mechanics are: the aircraft maintenance manual (AMM); fault isolation manual (FIM); and troubleshooting manual (TSM). These are kept electronically on all classes of EFBs.

Less time and labour are required to update these forms, manuals and charts in electronic format, than when using a traditional paper system. The process is complicated because some manuals, or changes within them, only apply to certain tail numbers, and so do not affect an airline's entire fleet, while updates and changes to navigation and airways charts only become effective after a particular date. The flight operations librarian is responsible for ensuring that enough copies of an update arrive in time for each pilot's manual, and that all other copies of the manual used by the airline are updated on the right date. If the update is a new standard instrument departure (SID) chart at a particular airport, the librarian has to ensure all pilots and other holders of the particular manual have installed the new SID chart, and on the correct date, before making sure that all the old SID charts have been removed from the manuals.

Manually maintaining the library and auditing that all updates have been made correctly is a large task for an airline's flight operations department. It is simpler, faster, and more accurate when all charts and files are replaced with electronic ones.

EFBs also have moving map displays to aid taxiing. An interface is needed with the aircraft's global positioning system (GPS), but airport ground charts are not needed.

The use of an ETL within an EFB is a special group of functionalities. The ETL is

One clear benefit of an implemented EFB & ETL system is the elimination from many or even all flightdeck tasks. This not only applies to flightcrew, by line mechanics when dealing with technical faults during line maintenance.

an entire system that replaces the paper technical logs and PIREPs used for reporting technical faults to the airline's MCC and line maintenance department. This is part of the process of correcting technical defects and keeping each aircraft and the fleet airworthy.

Technical defects that arise during operation either: generate fault codes in the central maintenance computer (CMC) and are transmitted in real time to the airline's ground station; or do not generate fault codes, and must be written up in technical logs. The flightcrew enters these faults into the ETL, which then transmits the fault to the user's MCC and line maintenance department while the aircraft is in flight.

EFB & ETL implementation

A few modern aircraft types have Class 3 EFBs available as a buyer's option when they are ordered. Airlines are free, however, to use PMA Class 3 EFBs as an alternative to OEM Class 3 EFBs.

Most aircraft types have a choice of Class 1 or 2 EFBs. "Class 1 EFBs are standalone laptops, and cannot be used below 10,000 feet. This limitation means they are a supplement to all the manuals and paperwork on the aircraft, rather than a replacement," explains Bud Sittig, president at Flight Guidance. "The advantage of Class 2 EFBs is that they have connectivity between the aircraft and the ground. This involves more equipment and expense, but it allows EFBs to replace manuals and paperwork, so all the possible benefits and savings they offer can realised.

"In all cases, two EFBs are needed on the aircraft, as well as all the different software applications an EFB can use," continues Sittig. "In terms of communications between the aircraft and the ground, there are two types of connectivity: when on the ground, the aircraft transmits via an antenna, using a cellular or WiFi signal; at the homebase, the operator can use its own antenna, and at outstations it can use an existing cellular connection, subject to negotiating a contract with a service provider.

"In the air, the aircraft needs a satellite communication capability," continues Sittig. "An Iridium system can be used, but this has a narrow data pipe and is used while the aircraft is airborne and present at outstations. This means that every aircraft needs to be equipped with SatCom, which increases the expense. Long-haul aircraft now have this equipment as standard, but short-haul aircraft have to be retrofitted. If the aircraft are equipped, however, the airline can generate revenue by offering passengers the use of in-flight phones, the internet and shopping opportunities. Use of an ETL system will reduce line maintenance cost and turnaround times, and improve technical reliability, so the overall benefit to the airline can justify investing in the equipment. The hardware to establish this connectivity includes several line replaceable units (LRUs) and antennae for transmitting the signals."

Sittig estimates the overall investment for all hardware and software to be at least $100,000-125,000 per aircraft. The figure could be up to 25% lower if a fleet of more than 20 aircraft is retrofitted.

Class 2 and 3 EFBs can also incorporate auto-dependent surveillance broadcast (ADS-B) and controller-pilot data link communications (CPDLC) hardware. These devices will eventually replace radar systems on aircraft when the new air traffic control systems in North America and Europe come into effect. ADS-B and CPDLC equipment will therefore be necessary on aircraft, and they can be incorporated in EFBs, providing a further benefit. "This affects the aircraft in a number of ways," explains Sittig. "The first is the use of most types of software in flight operations. The second is the use of an ETL system in line maintenance. The third is installing ADS-B and CPDLC equipment for future use in flight operations, and the fourth is providing cabin signals to generate ancillary revenues via mobile phones and other devices."

Implementing the entire EFB/ETL system can take up to two years across an airline's fleet, and is completed in three phases: acquisition of all relevant hardware and the IT infrastructure; installation (usually during a C check, since this type of check provides the necessary downtime); and training of flightcrew, cabin crew, flight operations and flight despatch staff, line mechanics, and MCC and IT staff.

"Regulatory approval is important," says Mark Leather, continuing airworthiness manager at BA Cityflyer. "From the start of the approval process, it is prudent to involve the airline's local aviation authority, which should be provided with an implementation plan by the airline. Our IT and engineering departments achieved full implementation in eight months, including the training of line mechanics employed by third-party maintenance providers at outstations."

Airline experiences

Air Berlin

Air Berlin has had a Class 1 EFB system implemented on its fleet of 145 737NGs and A320s since 2005. "We implemented the EFB system because we needed all our operating manuals, charts and other paperwork to be in an electronic format," says Benjamin Goetze, manager of flight operations at Air Berlin. "We needed a platform for this, both in the flight operations department and on board the aircraft. The connection between the two is the simple use of USB sticks, which are individually identified for each pilot. We have a dedicated website that each pilot logs onto in the crew room when

Class 2 EFBs have the ability to receive data from aircraft data buses and the FMS. As a consequence, the EFB can be used to make performance calculations. This has the benefit of reducing engine wear and increasing payload carried, for example.

preparing for each day's flight(s). This website has all the documentation, operations manuals and NOTAMs relevant to the flights to which the pilot has been assigned. All documents are published electronically on the website, and the pilot downloads all relevant information onto his USB stick, which is then carried to the aircraft, and uploaded onto the EFBs.

"All performance calculations are done on the EFB laptop device on the flightdeck, and stored on the USB stick, which is carried to the operations department after the flights and transferred to the main system, for quality assurance purposes," adds Goetze. "The USB device therefore provides simple two-way communication. Another benefit is the AIRAC cycle for updating navigation charts every 28 days, so that any changes to charts are done on the same day across the industry. With a paper system, the AIRAC cycle updates were part of the library management process and completing them required a lot of capacity in the operations department. The AIRAC cycle update can now be done automatically. As well as the main system, all the EFB systems on the flightdeck need updating. The USB stick is ideal for this.

"The main benefit of the EFB system is that charts do not have to be changed manually in the library management process. This saves a lot in terms of staff and logistics," continues Goetze. "The electronic system saves space, and 50-60 kg per aircraft because the manuals are gone. Updating the system with a change now just takes a few clicks with a mouse. We are changing to a Class 2 EFB supplied by NavAero, since this will be cheaper overall than maintaining the Class 1 EFBs."

Norwegian Airlines

Norwegian Airlines is the third largest low-cost airline in Europe, and now operates a fleet of 54 737s. It completed its implementation of a Class 2 EFB system in late 2009. "We have equipped all of our 737s with NavAero's T-Pad 2000 EFB," says Christian Melhus, director of flight operations at Norwegian. "We use the 3G cellular system to transmit data between the EFBs and the airline's flight operations department. The 3G system allows two-way communication, but only permits data transfer while on the ground. We now fly to about 100 destinations, most of which are in Europe, and it is possible to communicate to 70% of these with 3G. We revert to manual procedures at the rest.

"We do not yet have the ability to transmit data while the aircraft is in the air, but we will be modifying our aircraft with Ku-band SatCom equipment so that we can offer passengers WiFi on board," continues Melhus. "The Ku-band system will allow us to transmit EFB data while in the air, and allow us to use an ETL system.

"We use the EFB system to run several types of software, which enables us to operate paperlessly," continues Melhus. "The applications include electronic charts, operating manuals, weight and balance, performance calculations, and a system to record data for the EU's ETS. We are also able to provide weather and flightplan updates, which the new Ku-band system will allow while the aircraft is in the air."

Melhus says the savings are both direct and indirect, and so hard to identify and quantify in some cases. "The overall savings are so significant, however, that we expect to make a return on our investment in as little as 18 months," says Melhus. "Benefits include improved safety and reduced pilot workload, and greater accuracy which results in reduced engine wear through higher de-rates as a result of electronic performance calculations. This preserves engine condition and life, reduces maintenance costs and improves fuel burn by 1%.

"On-time performance has improved because of quicker weight and balance calculations. Weight data and information are now sent to the pilot by SMS message, instead of a paper document being carried to the aircraft," continues Melhus. "The system also gives us greater operational control, in that we now know the status of the documents, charts and manuals at the push of a button. The system has also reduced the manpower needed to maintain and manage the documentation, since we now operate a larger fleet with the same number of flight operations staff. We also have lower distribution costs for manuals and charts, increased payload due to precise performance calculations, increased control over fuel uplift, and an increased volume of statistics for quality assurance."

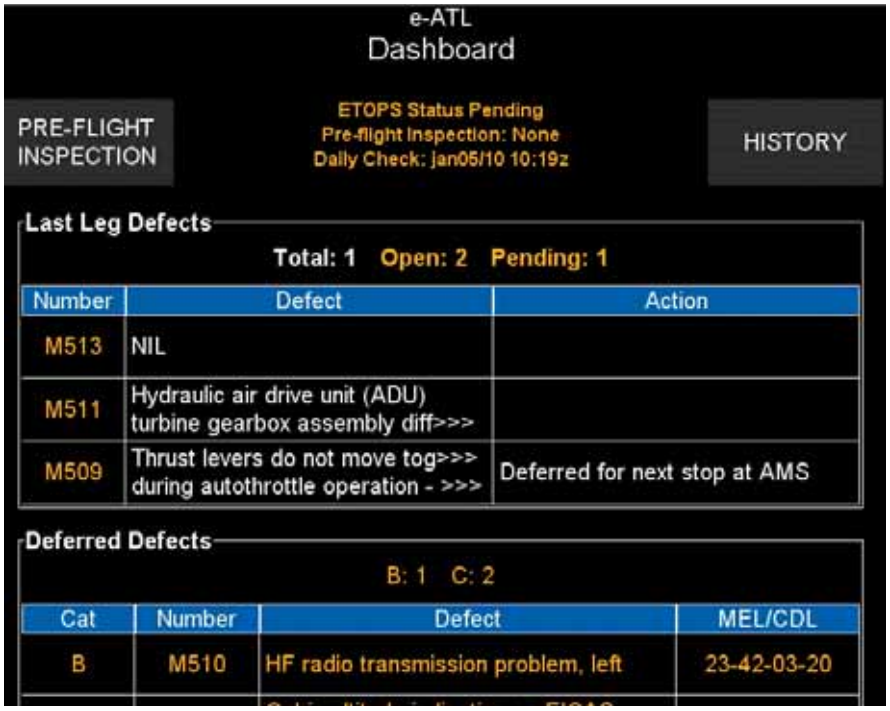
ETLs

ETLs have been less accepted than EFBs. Airlines that have opted for ETLs include Finnair, KLM and BA CityFlyer.

Finnair

Finnair has implemented ETLs for its fleet of 62 aircraft, across five aircraft types. Its Skypaq ETL is the only ETL to be used across an entire airline's fleet.

Skypaq is a software provider, and offers an e-technical log and a system for transmitting data from the aircraft's EFB into the airline's IT systems. This allows data to be fed from Skypaq to Finnair's maintenance and engineering (M&E) and other IT systems. "The first benefit of an ETL system is that rectifying the average defect involves only one visit to the aircraft, compared to three when reporting or dealing with a technical defect manually," explains Richard Mckenna, chief executive officer at Skypaq. "Using the manual systems to rectify technical faults it is possible to have four paper slips stored to report each defect, which can involve eight physical visits to the aircraft. Four manual inputs are also required to transfer data to different IT systems, so information on a defect has to be entered



An ETL system has multiple benefits. These include faster fault reporting, more up-to-date technical logs, reduced manual input of aircraft faults into an airline's M&E system, and faster rectification of outstanding defects and faults.

the same number of times. Finnair has reduced the direct labour used for dealing with defects by 30%. It has also improved its airworthiness management of the fleet."

The system was implemented by 2008, and Finnair has since completed more than 300,000 flights. "The additional benefits are that because the defect, FH and FC data are all digitised, the airline knows exactly when the deferral time on each defect will expire. This makes it easier for it to manage the airworthiness of its fleet. The real-time input of the technical defect data also means there is no time lag or delay of data being entered into the user's M&E system," says McKenna.

Finnair's connectivity is global, so the Skypaq ETL system is used across its entire route network, to the extent that line mechanics at outstations on long-haul routes use it to clear Finnair's aircraft for service. The technician clears the defect on the ETL on the aircraft flightdeck, and the information is transmitted back to Finnair's Helsinki base via a GPRS signal. "Our data integration module is the system which transfers data from the ETL to the flight operations and M&E systems," says McKenna. "The system is also very good for collecting fuel data for the ETS."

KLM

KLM implemented an ETL system for its 777-300 fleet. "When technical faults are manually reported and entered into the M&E system, data are often lost and misinterpreted by line maintenance and MCC departments," says Donald van Tongeren, solution architect at KLM Engineering & Maintenance. "The laboriousness of entering defect and fault data means that data-entry clerks make short cuts, and time delays inevitably occur.

"The 777-300s that were delivered in 2008 were e-enabled, so they have the infrastructure and the server needed to make an EFB and ETL fully workable, and provide all the wiring required to make a paperless flightdeck possible. The aircraft is also able to provide internet signals within the aircraft cabin," says van Tongeren.

KLM selected the Ultramain ETL, and developed and approved the whole system within 12 months. The ETL is used at KLM by the pilots, cabin crew, MCC department, and line maintenance department. There are two EFB terminals on the flightdeck for the pilots, as well as an M&E workstation and a cabin terminal for flight attendants. These terminals are all connected to a printer on the aircraft, and generate a fallback copy of any report, which is effectively the golden report required in the event of a loss.

The data are transmitted to the airline's ground servers. All defects are reported electronically, and the system allows faults to be analysed in flight, so that parts are requisitioned, and problems can be analysed in advance. "Technical defects are issued correctly, and the lead time to prepare for their rectification means turnaround times and maintenance costs are reduced, and aircraft utilisation is increased," says van Tongeren. "The better technical despatch reliability and airworthiness management also improves revenue. There is an increase in warranty claims, a faster analysis of complaints, and a saving of 30 minutes in labour time for each turnaround between flights."

BA Cityflyer

British Airways' subsidiary BA CityFlyer operates a small regional network primarily from London City Airport (LCY), but also from Edinburgh. The airline's main base, for historical reasons, is at Manchester airport (MAN). The airline operated Avro RJs, which it replaced with Embraer E-170s and -190s. "When we ordered these aircraft, we decided to improve the reliability of our operation by using an ETL system," says Leather. "Our problem was that BA CityFlyer's engineering administration is at MAN, more than 100 miles from LCY, so we were scanning technical defects, PIREPs and all technical reports before e-mailing or faxing them to MAN. Upon receipt, all the information in these reports had to be manually keyed into our M&E system, (Commsoft's OASES), so we had a time lag between defects occurring and their being entered into the M&E system. This time lag was the main driver for acquiring an M&E system, since it was hard to maintain the airworthiness of the fleet with operations at LCY and engineering administration at MAN.

"Our system uses a Panasonic toughbook on board each aircraft," continues Leather. "This acts as the aircraft's techlog, but it is a Class 1 system, so it is not integrated with the aircraft's systems. We chose the OSYS system software, and currently the data are transmitted over a mobile phone network. This means the system only works on the ground, and is sent to the OSYS server. The data go to BA's IT network, and hard copies of the technical logs are printed, for use by data-entry clerks to put the information into OASES. There is functionality for the data to be loaded automatically into OASES, but this is not working yet, and has to be approved by the Civil Aviation Authority (CAA), since there needs to be an audit process in place to ensure that data are not lost. The data and list of outstanding technical defects are also available on an OSYS-hosted website.

"The main benefit of an ETL system is that information on technical faults is transmitted in real time, so we can be more pro-active in managing and rectifying defects," adds Leather. "This improves aircraft technical dispatch reliability, although a comparison with the Avro RJs is hard, because they were operated using a manual paper techlog system." AC