

Airbus technical magazine

August 2016

#58

FAST

Flight Airworthiness Support Technology

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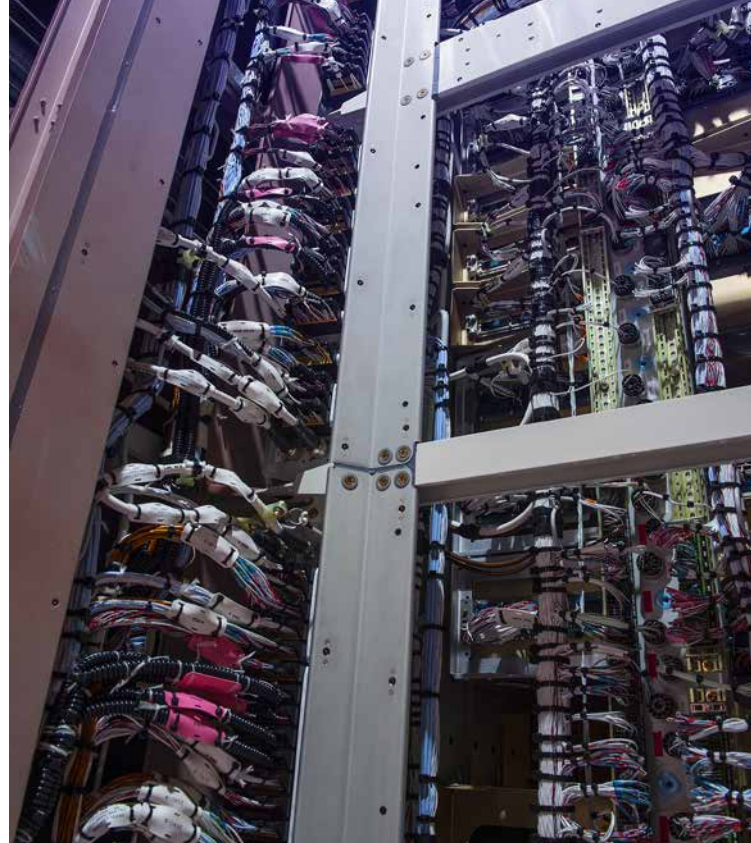
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Flight Airworthiness Support Technology



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Where you see these icons, videos or slide shows are available on the iPad, Android & Windows app versions of FAST magazine.

Celebrating 25 years of flight operational commonality between Airbus fly-by-wire aircraft

With the inception of the A320, Airbus laid the foundation for a truly integrated family of aircraft with synergies in the area of flight training and operations. The application of a coherent cockpit design philosophy and the use of fly-by-wire technology throughout have been key in achieving this. Airlines that operate several members of the family are thus able to reduce flight training expenditure and to increase pilot productivity, gaining a competitive edge over operators of disparate fleets.





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A brief history of Airbus flight operational commonality

When, four years after the A320, the A340 took to the sky in 1991, it became possible for the very first time to benefit from extensive cockpit, systems and handling commonality between a short-range 150 seater and a long-range widebody aircraft twice its size. Until then, so-called flight operational commonality had been a design feature of aircraft of comparable configuration and mission capability only, such as the A300/A310 Family or 737 series.

The A340 incorporated the A320's pioneering digital fly-by-wire controls and glass cockpit layout with side sticks instead of yokes. Airbus has used this technology in all subsequent programmes as well, offering a consistent man-machine interface across the A320, A330, A340 families, A350 XWB and A380.

The importance of fly-by-wire and ECAM

Airbus fly-by-wire aircraft have electrical rather than mechanical signalling of primary flight controls:

- The pilot's input to the control surfaces is sent via a side stick and rudder pedals through computers that use control laws
- Control laws convert this input into an aircraft response and largely determine the aircraft's handling characteristics

Fly-by-wire enables handling and procedures similarity between aircraft as far apart as the two-engine A320 and the seven times heavier four-engine A380.

Pilots receive systems information through an Electronic Centralised Aircraft Monitor or ECAM, the heart of any Airbus glass cockpit. If a malfunction occurs, the ECAM displays the fault and lists the actions required of the crew. The read-and-do approach that follows facilitates the harmonisation of abnormal and emergency procedures, even though systems behaviour may vary somewhat from one aircraft type to another.

Same Type Rating and Single Fleet Flying

Flight operational commonality between a basic aircraft model and its lengthened/shortened fuselage variants can be virtually total. A good example is the single-aisle A320 Family comprised of the A318, A319, A320 and A321. In addition to sharing the same Type Certificate, these models have been assigned a Same Type Rating (FAA designation) or single pilot licence endorsement (EASA terminology).

True for any two Airbus models sharing a Same Type Rating, pilots qualified on one of them need only a few hours of e-learning to fly the other model as well. Neither full flight simulator sessions nor a Type Rating check are mandatory in this case.

One pool of pilots flying multiple Airbus models under a single licence endorsement is referred to as Single Fleet Flying (SFF). SFF is both practical and cost effective since:

- Take-offs and landings in one model count towards recency of experience on all when it comes to satisfying the regulatory requirement of at least three take-offs and landings at the controls over a 90-day period
- Recurrent training, proficiency checks and line checks in one model are valid for all

STR

Same Type Rating

A single licence endorsement for related aircraft sharing the same Type Certificate.

SFF

Single Fleet Flying

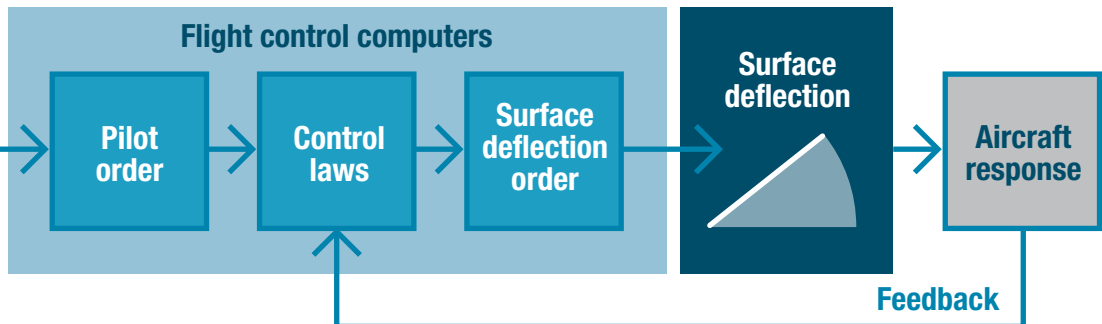
One pool of pilots flying related aircraft under a single licence endorsement.

Flight operational commonality due to a con



Electronic Centralised Aircraft Monitoring (ECAM)

Fly-by-wire



CCQ

Cross Crew Qualification

Shortened instead of full transition training to acquire an aircraft Type Rating.

MFF

Mixed Fleet Flying

One pool of pilots flying related aircraft that require separate licence endorsements.

Cross Crew Qualification and Mixed Fleet Flying

Flight operational commonality between Airbus aircraft having separate Type Certificates and requiring separate Type Ratings varies from 40% for the A320-A380 to 90% for the A330-A340 combination, measured as a reduction in pilot transition training days relative to a standard Type Rating course duration.

The remaining transition training from one Airbus type to another is known as Cross Crew Qualification (CCQ). It consists of a reduced ground phase and a limited number of full flight simulator sessions (handling phase) followed by a Type Rating check. An A320 pilot needs five simulator sessions to qualify on the A380, for instance, whereas pilots without previous Airbus fly-by-wire experience typically have nine sessions.

CCQ may lead to Mixed Fleet Flying (MFF). Airbus defines MFF as the operation of multiple aircraft types – requiring separate licence endorsements – with a pool of multi-qualified pilots. MFF with Airbus aircraft is also practical and cost effective since:

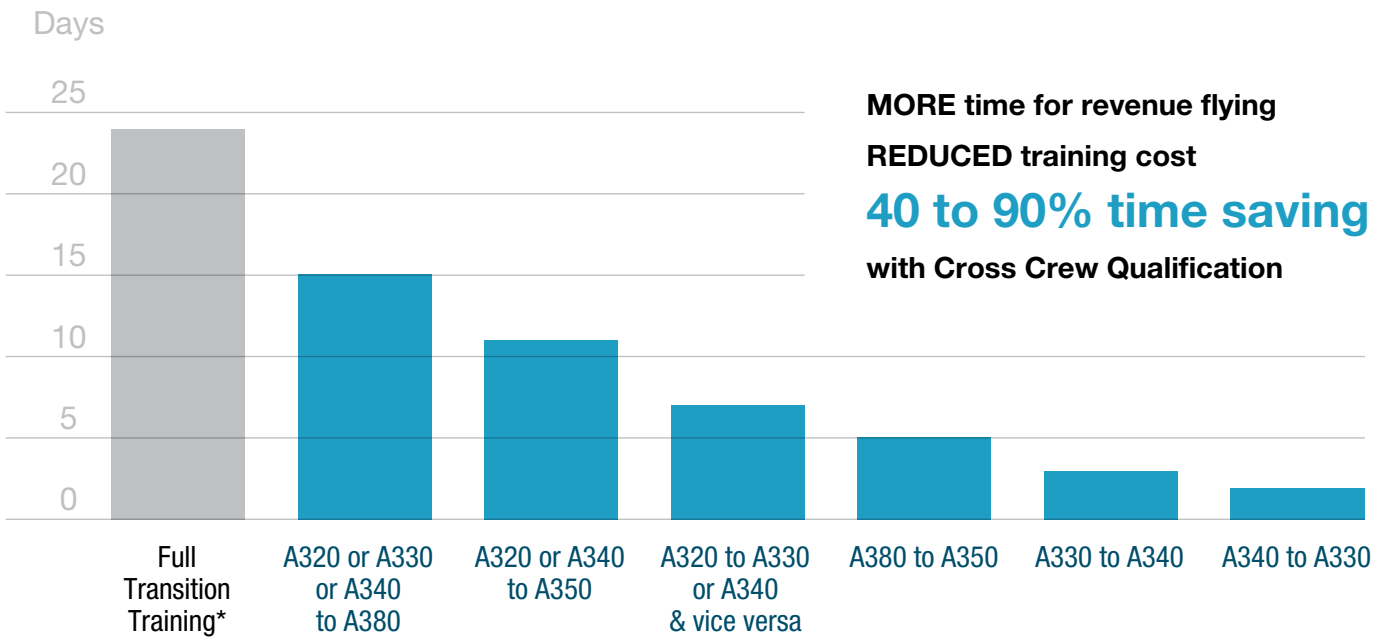
- Take-offs and landings in one type count towards recency of experience on other types, provided that one take-off and landing is performed in each type every 45 days (the A330-A340 combination does even better => only one take-off and landing in one and two in the other every 90 days)
- Recurrent training, proficiency checks and line checks may alternate between types

Consistent man-machine interface across types



The length of Airbus Type Rating courses

Flight Crew Licensing (FCL) compliant training and exam days
(base training not included)



* 23 days for A350, 25 days for A380

All courses include full flight simulator sessions and a Type Rating check

CTR

Common Type Rating

A single licence endorsement for related aircraft having separate Type Certificates.

Common Type Rating and Single Fleet Flying

The A330 and A350 have separate Type Certificates, but their handling characteristics are so similar that they have been granted a Common Type Rating (FAA designation) or single licence endorsement (EASA terminology).

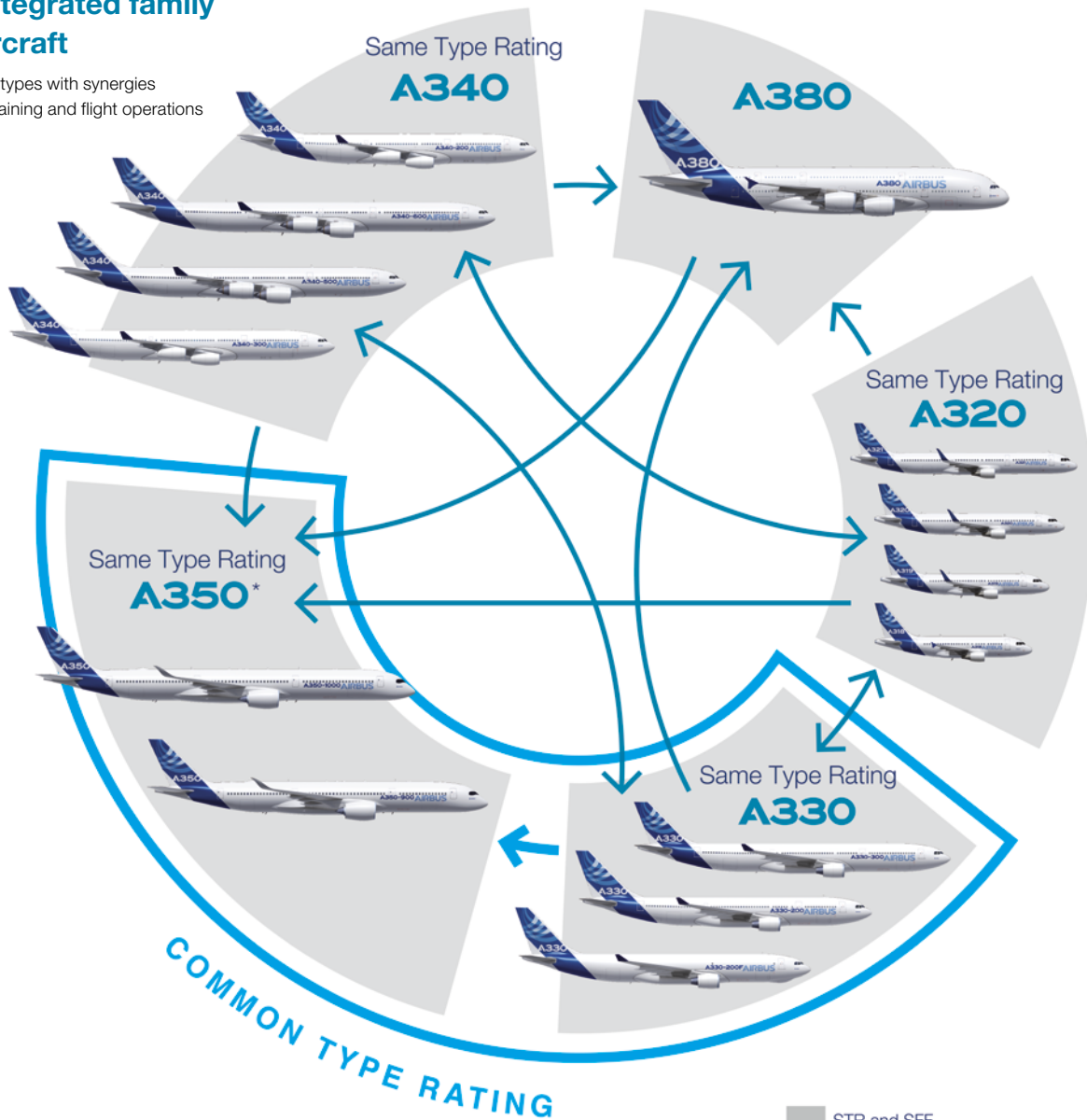
Nevertheless, pilots qualified on the A330 need differences training for the A350, essentially because of the increased functionality and interactivity that the A350 cockpit offers. It involves four days of laptop based systems knowledge acquisition and procedures training plus four sessions in a non-moving Flight Training Device (EASA Level 2, FAA Level 6). Expensive full flight simulator sessions are not mandatory and neither is a full Type Rating check. That is why flight operational commonality between the A330 and A350 is expressed both in terms of pilot training days reduction (65%) and tuition savings (80%), relative to a standard A350 Type Rating course.

The A330 and A350 may be operated by one pool of pilots under a single licence endorsement (SFF) with the following credits:

- Take-offs and landings performed in any A330 or A350 count towards recency of experience on both
- Line and proficiency checks in any A330 or A350 are valid for both, provided that differences have been addressed in recurrent training

An integrated family of aircraft

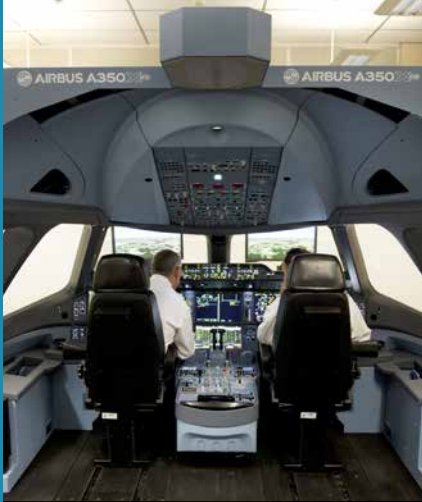
5 aircraft types with synergies in flight training and flight operations



■ STR and SFF
 ■ CTR differences training and SFF
 — CCQ paths and MFF combinations

* Subject to regulatory approval

A350 flight training device for differences training



A330 to A350 training may be done with an FTD2* instead of a full flight simulator, which reduces the training media investment significantly.

Equipped with full size cockpit panels and all controls, switches and knobs that physically replicate the aircraft.

* Non-moving Flight Training Device (EASA Level 2, FAA Level 6)

Regulatory aspects

Pilots qualified on one Airbus (a 'base' aircraft) can be trained on another Airbus (the 'candidate' aircraft) based on system and manoeuvre comparisons presented in Operator Difference Requirement (ODR) tables. Differences for each aircraft combination are listed and graded from A to E level according to their severity, which determines the corresponding training and checking needs. Airbus ODR tables are available upon request.

Regulations and recommendations with regard to the use of ODR based training programmes, such as CCQ courses, and the implementation of SFF and MFF can be found in Operational Suitability Data (OSD) documents published by Airbus and approved by EASA. Since the introduction of a new rule in Part 21 pertaining to OSD, EASA no longer publishes operational evaluation results as Operations Evaluation Board reports. Existing reports disappeared from the EASA website at the end of 2015; from that date those with an Airbus content are managed by Airbus and released to operators on an ad hoc basis, as is the case for approved OSD documents today.

The FAA equivalent of Operations Evaluation Board reports and now OSD documents is the Flight Standardization Board (FSB) report. FSB reports continue to be published on the FSIMS website of the FAA.

A pilot's perspective on flight operational commonality

The skills and experience accumulated in one Airbus aircraft can be carried over to another one, which enhances proficiency. Pilots benefit from greater mobility too: an airline looking for, say, A330 qualified pilots may also invite A320 pilots to apply, since the cost of A320 to A330 CCQ is relatively low.

Those who practise SFF and/or MFF gain access to a larger part of the network, so their work environment is more varied. This could mean alternating long haul with short haul trips, which provides more take-off and landing opportunities and may lead to a better balance between work and private life compared with purely long haul flying. Complacency is less likely and motivation tends to improve as well.



The value of flight operational commonality

Generally, airline pilots get to fly various aircraft models and/or types during their professional life, because of:

- Career incentives that make them move to bigger equipment and change from the right- to the left-hand seat
- Aircraft replacement initiated by their employer
- A change of employer
- A combination of the above

It is not uncommon for a pilot to experience six to eight equipment changes in total at a typical retraining cost of US\$30,000 per event in 2016 economic conditions. Add around one-and-a-half months of downtime for each change and it becomes obvious that this is costing the airlines collectively several billions of dollars every year. Those with an Airbus fleet, however, can reduce pilot retraining cost by two-thirds on average when using ODR based training programmes.

In addition to that, airlines can take advantage of SFF and MFF in many ways:

- From creating an integrated fleet management structure and multi-qualifying their flight instructors/examiners...
- To using single-aisle first officers as augmentation pilots on long-range widebody aircraft or even multi-qualifying reserve crews and ordinary line pilots at large

SFF and MFF offer rostering flexibility, which results in greater pilot productivity. Smaller airlines benefit from powerful economies of scale that were the privilege of big operators before. Depending on the mix of fleet and the nature of an airline's flight operations, annual revenue flying time per pilot may increase by 5 to 15% with SFF and MFF.

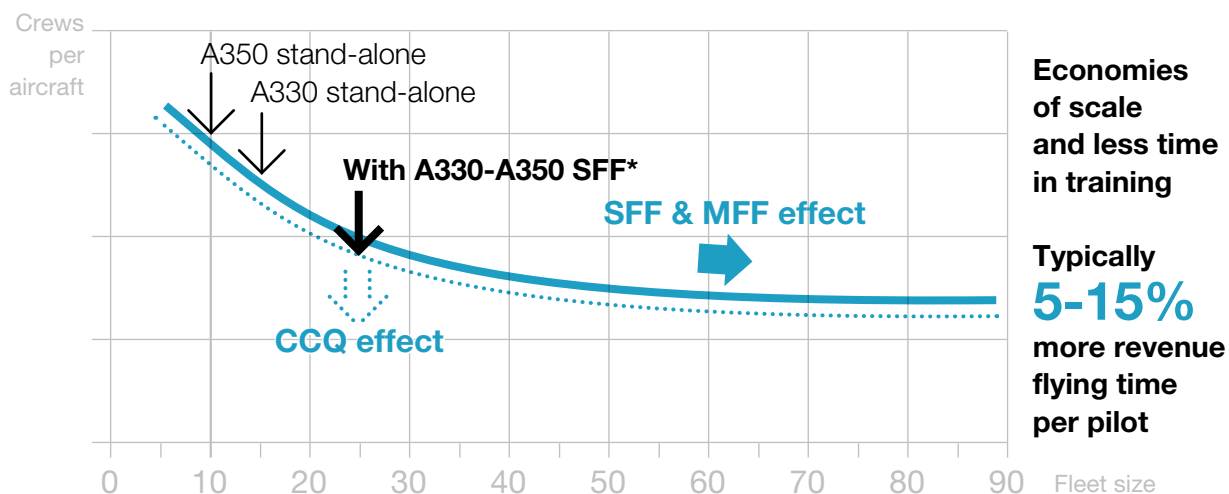
Airbus flight operational commonality has been demonstrated to save up to US\$8 million per aircraft in present value terms over a 15-year period.

Recent developments

The integration of the A350 into the Airbus family of fly-by-wire aircraft is a fine example of Airbus' ability to combine innovation with commonality. Following regulatory approval of a Common Type Rating for the A330 and A350 as well as CCQ from the A320 Family in 2014, A340 to A350 and A380 to A350 CCQ courses are now available too. Flight operational commonality between the A350 and A380 in particular is an impressive 80%, resulting in a CCQ duration of only five days and a recency of experience requirement in MFF operations equal to that of the A330-A340 combination.

As for the A320neo, EASA and the FAA have concluded that the installation of PW1100G-JM or CFM LEAP-1A engines does not really change the handling characteristics in comparison with the CFM56 or V2500 powered A320ceo. Henceforth, the A320neo can be considered a variant of the A320ceo under a single pilot licence endorsement (Same Type Rating) designated 'A320'.

Greater pilot productivity due to flight operational commonality



Steady state relationship observed at various airlines

* In combination with CCQ from the A320 for instance

Large-scale CCQ and MFF are unique to Airbus and much appreciated by its customers:



One of the attractions of going for MFF was the advantages it would bring in terms of mixing long and short haul flying and this has been very popular with our pilots in terms of maintaining recency and competency

Cathay Pacific Airways

Operating both A320 Family and A330 aircraft does not create any operational difficulties for our pilots but only benefits with regard to crew planning and saving resources

Windsor Airlines

The MFF is most useful for flexibility

Thomas Cook Airlines

Our airline has employed CCQ/MFF for a number of years now, which has turned out to be effective and successful. We took full advantage of the strong functional commonality established by ODR tables and Operations Evaluation Board reports

Gulf Air

CCQ is really a plus and training is facilitated by the Airbus approach

Brussels Airlines

MFF is very beneficial for mid-size companies like ours. We would like to congratulate Airbus on this

Onur Air



CCQ is a reality at more than 60 operators, 35 of which have also implemented MFF. Be one of them!

CONCLUSION

All Airbus fly-by-wire airliners have been designed with flight operational commonality in mind, which has resulted in exceptional handling and procedures similarity between even the smallest and the biggest of those aircraft.

Over the past 25 years, numerous operators around the world have discovered the benefits of this: optimised flight training and unprecedented crew rostering flexibility coupled with enhanced pilot proficiency and motivation.

Airbus remains strongly committed to offering this valuable feature to its customers, as demonstrated by the successful integration of the A350 and A320neo into the Airbus product line. ■■■

Flight recorders data inspection by Airbus



The flight recorders or “black boxes” might be the most famous avionics units in an aircraft. They do not make an aircraft fly; they do not participate to passenger comfort. However, black boxes are well known by the public because they contain something precious: flight data.

Whenever an aircraft accident occurs, an investigation is launched to determine its root causes. For that, investigators need lots of flight data. The more accurate the data, the more precise the investigation results will be and the more benefits will be derived for aviation safety.

This is why black boxes draw so much attention. This is also why it is so important to continuously ensure that flight recorders’ data quality is high at all times.



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Two flight recorders are installed on each Airbus aircraft:

- The Cockpit Voice Recorder (CVR): with a capacity of 30 minutes to 120 minutes of audio data. The CVR records the entire cockpit audio environment on four channels. Three channels are dedicated to the crew members (captain, first officer, third occupant seat) and one channel is dedicated to the Cockpit Ambient Microphone (CAM).
- The Digital Flight Data Recorder (DFDR): with a capacity of 25 hours of continuous recording. The DFDR records up to 88 parameters as required by international regulations. Each of these 88 parameters represents tens of different signals.

Regulation changes requiring periodic data inspection

The regulation authorities, especially the International Civil Aviation Organization (ICAO), the European Commission through the European Aviation Safety Agency (EASA), and the Federal Aviation Administration (FAA) have adopted regulations whereby the flight recorders' data must be inspected at intervals.

Several national aviation authorities have expressed similar requirements in their aircraft operating rules. These requirements usually apply even on flight recorders continuously monitored by On-board Maintenance Systems.

The requirements consist in checking:

- For the CVR: the correct duration of the recordings and the quality of audio data
- For the DFDR: the correct duration of the recording and the reasonableness of recorded parameters

The inspection of flight recorders may require a significant number of engineering hours, in order to:

- Correctly transform the raw data into engineering units
- Analyse the behaviour of each parameter, by comparison with the flight context
- Produce an inspection report
- Define and document procedures in use





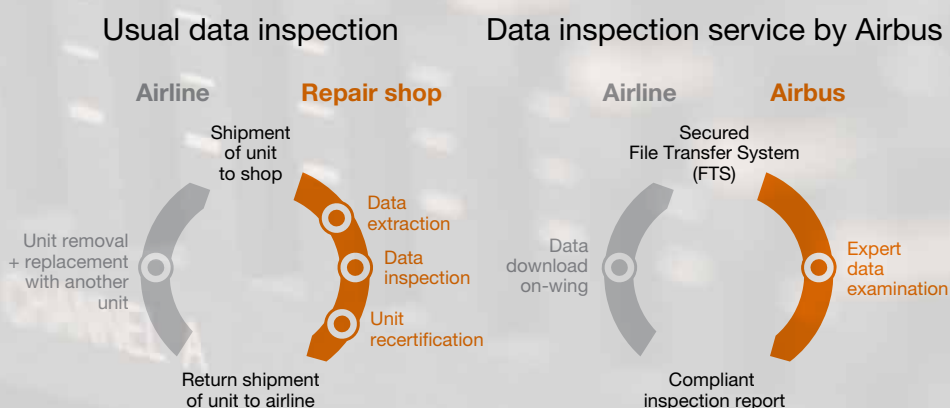
New economical flight recorders data inspection by Airbus

Every year Airbus performs hundreds of flight recorder readouts, either for certification or for aircraft incident analysis purpose. Airbus assets comprise facilities, ground support equipment, proprietary software, and above all: skilled, trained personnel.

Airbus data inspection services include:

- The CVR audio inspection service where an audio inspection report is provided. This service is now proposed in the e-catalogue
- The DFDR data inspection, provided as technical assistance

Since 2016 Airbus offers quick and economic data inspection. Data is transferred to Airbus using a secured File Transfer System (FTS): there is no need to ship the unit to Airbus.



Airbus provides turnkey solutions characterised by concise, compliant reports.

CVR audio inspection

The inspection of CVR audio has to be done at intervals of 3 months to 2 years.

The expected quality of a CVR audio recording depends on different factors such as:

- The type of aircraft
- The technology of the CVR and its peripherals
- The channel being analysed

The CVR audio inspection must therefore be performed by experienced and trained personnel.

DFDR data inspection

The inspection of DFDR data must determine the serviceability of each mandatory parameter recorded by the DFDR.

This check requires a precise knowledge of the aircraft configuration and of the aircraft systems.

For example: let's consider a parameter remaining invalid during an entire flight. This may be a normal situation:

- The parameter may correspond to a function not exercised during this flight
- The parameter may be available only with certain options installed on the aircraft

The DFDR data inspection by Airbus crosschecks the recorded data with aircraft configuration data, and engineering judgement, to produce a turnkey report (no additional engineering hours to be spent to analyse the report).



Advantages of flight recorders data inspection by Airbus

- Turnkey solution: by using Airbus services, an airline minimises the number of engineering hours required for an inspection
- File Transfer Service: no unit shipment is needed; this reduces the number of unit removals, and all ancillary costs (spare installation, shipment, and recertification)
- Advice: in case any issue is found on a flight recorder, Airbus provides precise troubleshooting advice and follow-up to ensure the recorder serviceability
- Expertise: flight recorders data is analysed by expert personnel, who are experienced in analysing data

For more information and prices concerning flight recorder data inspection by Airbus, please contact Airbus customer support through Tech request in ATA 2371 or 3133.

CONCLUSION

Airbus flight recorder inspection services offer a new turnkey solution for airlines. These services are proposed to allow airlines to benefit from Airbus' experience in the area of flight recorders. By selecting Airbus services, an airline minimises the number of engineering hours spent on inspection tasks, and can focus on their flight and maintenance operations. ■

VIP Kit solutions to optimise A330 and A340 aircraft



Article by

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Airbus commercial aircraft cabins are carefully configured to correspond with an airline's most efficient, revenue generating operations.

Responding to the needs of operators with requirements that extend beyond the scope of usual airline full passenger seat arrangements, Airbus has its own division dedicated to equipping its aircraft with highly customised VIP cabins.

In order to offer airlines additional flexibility and opportunities for creative, optimised use of their aircraft, Airbus Corporate Jets (ACJ) now offers a VIP Kit solution for A330 and A340 aircraft.

This VIP Kit transforms the central part of a standard full passenger seating cabin into a luxurious corporate jet compartment.

New cabin products

In this very competitive market, airlines are obliged to develop strategies to capture the maximum of business. A key factor differentiating the services of one airline to another is the level of comfort and amount of amenities aboard the aircraft.

In addition to the operation of an Airbus fleet composed of the most modern aircraft in the world, airlines are continuously updating their cabins to provide maximum comfort and value-for-money for their passengers.

Airlines also benefit from the economic advantages that refurbished cabins bring: weight saving, increased technological reliability, reduced maintenance costs and good levels of product support, warranty and spares availability from the suppliers of the innovative systems and furnishings.

Cabin renewal gives the airline a chance to keep up with industry trends and to adapt to route changes and company strategy. Attractive, comfortable and modern cabins enable airlines to compete for increasingly discerning passengers.

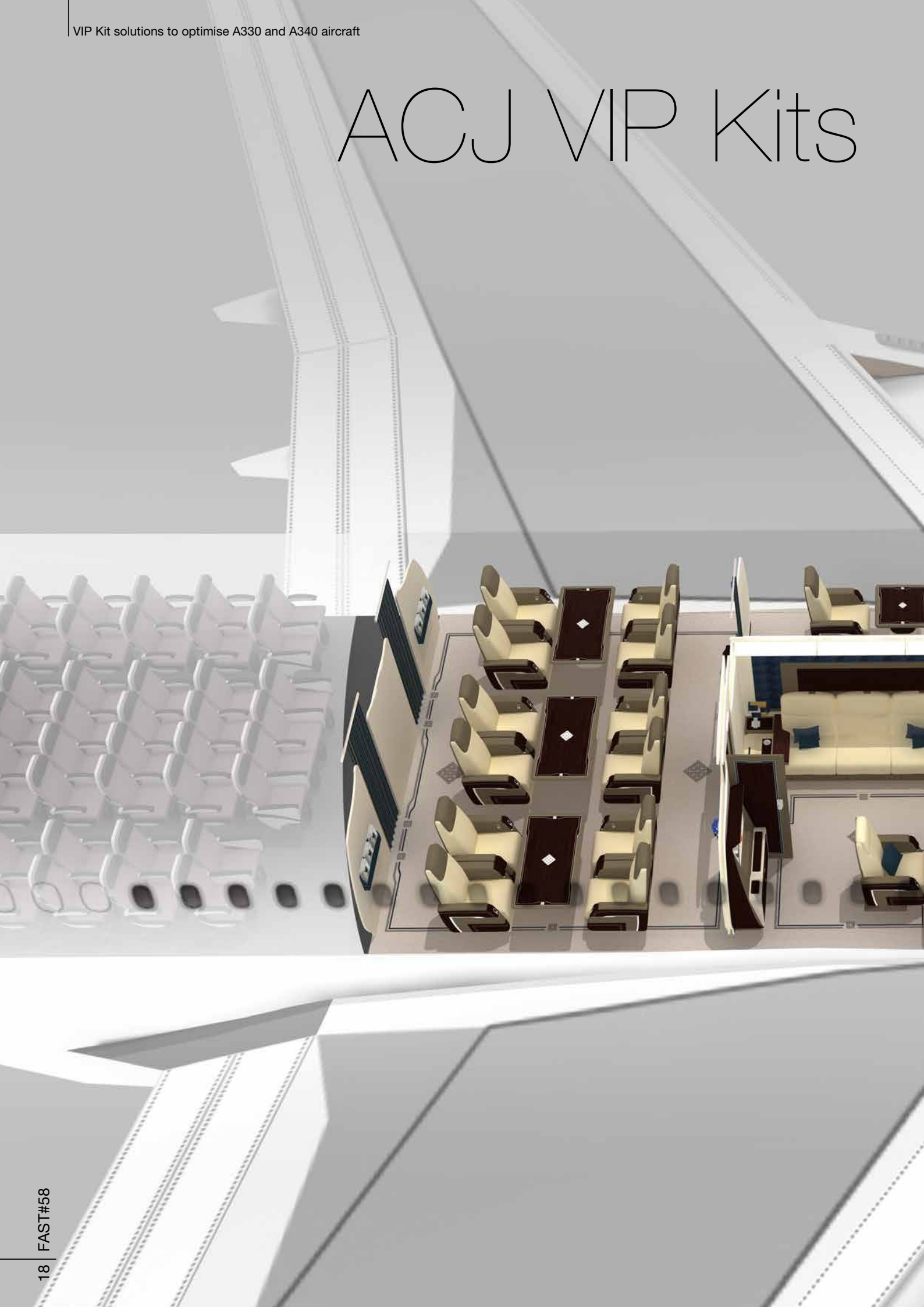
Seat suppliers are responding to this continuous cabin upgrade trend by producing new style hi-tech and ergonomic products. The old style reclining seats are being replaced with horizontal full-flat beds enclosed in private cocoons and packed with the latest IFE. Today's premium economy class rivals many of yesterday's business classes, and today's business class is more luxurious than yesterday's first class.

However equipping a cabin with the most up-to-date and comfortable seats is no longer enough – some airlines are going even further by offering passengers their own individual compartments in the form of mini-suites while others offer ultra-high-end amenities such as bars, relaxation lounges, showers and entire private apartments in the skies.

The appearance of corporate jet style luxury inside a commercial airline cabin is making the headlines with Hollywood A-list personalities seen travelling in style in the TV commercials for some Airbus operators. Not only is such exposure providing a lot of publicity for the airline, but passengers are prepared to pay premium fares for the privilege of VIP travelling.



ACJ VIP Kits



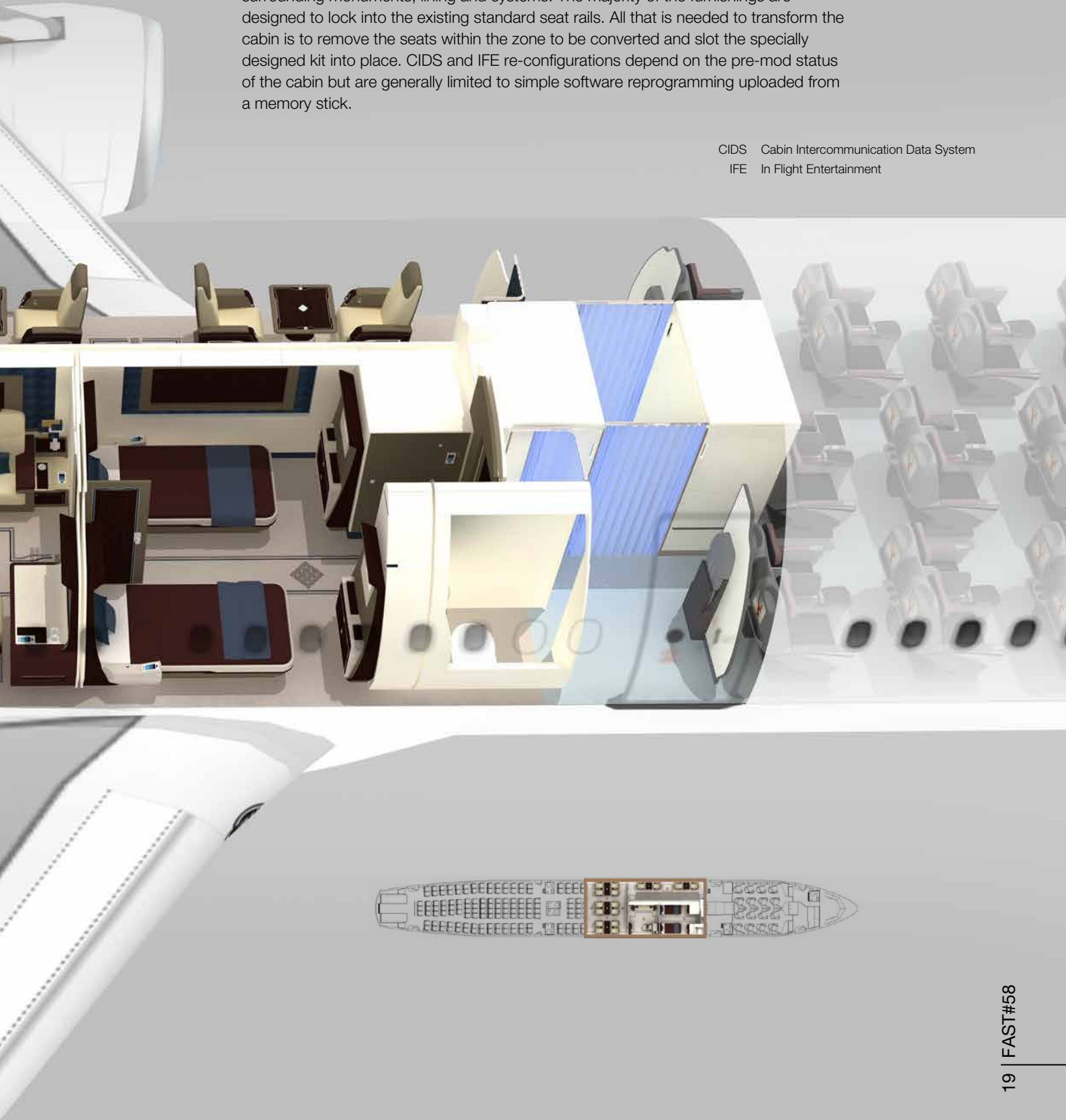
Combining luxury and flexibility

While airline ultra-first class arrangements are a fixed and permanently installed feature on an aircraft and will fly regardless if booked or not, ACJ introduces a new concept of temporarily installed quick-change VIP amenities into a standard cabin by retrofit.

This concept referred to as a 'VIP Kit' opens up a world of possibilities to airlines seeking to optimise their operations by using the same aircraft for a multitude of missions and to target a full range of passenger profiles according to demand, season, special events and specific company strategy.

The ACJ VIP Kit is a set of modular furnishings (seats, beds, tables, divans, partitions...) that can be retrofitted into the standard airline cabin with minimum impact to the surrounding monuments, lining and systems. The majority of the furnishings are designed to lock into the existing standard seat rails. All that is needed to transform the cabin is to remove the seats within the zone to be converted and slot the specially designed kit into place. CIDS and IFE re-configurations depend on the pre-mod status of the cabin but are generally limited to simple software reprogramming uploaded from a memory stick.

CIDS Cabin Intercommunication Data System
IFE In Flight Entertainment





Example of ACJ340 Conference room



Protocol/Security area



Example of ACJ340 Office

Airbus Corporate Jets

When it comes to corporate jet style luxury, Airbus has its own division dedicated to equipping its aircraft with the finest VIP cabins. ACJ is unique amongst commercial aircraft manufacturers in providing a complete range of services from marketing, sales, cabin installation, entry-into-service and after-sales support, maintenance and cabin rebuild for very specific aircraft interior configurations.

ACJ's capability ranges from the full furnishing of an A340-600 VVIP aircraft for a private individual, to highly appointed A318 aircraft destined for luxury business jet charter operations. The division has built A320 cabins for efficient governmental transport and A319s have been equipped as comfortable company shuttles.

ACJ VIP Kits are designed to be a plug and play solution

Depending on the configuration of the kit which is individually designed for each customer, cabin conversion can take between 8 hours for two tables and 8 armchairs on an A320 to a few days for a full section of A330 VIP corporate jet furnishings including bedroom, lounge and office.

An ACJ VIP Kit will enable the operator to respond quickly to fluctuations in passenger demand, can help utilise the same aircraft on different routes, can be a powerful promotional feature and overall will provide the flexibility to optimise flight operations. Airbus is the first to offer "two-for-one" high comfort commercial cabin quick-change configurations.

The process of custom definition, manufacture and entry-into-service of an ACJ VIP kit follows a similar pattern to that of the original cabin but at a reduced scale, to a quicker timeframe and with a greater degree of design flexibility. As ACJ is part of Airbus, ACJ guarantees full certification and airworthiness compliance plus the usual high level of after-sales support our customers expect for their fleets.

ACJ A330/A340 VIP Kit

Flying to new heights in aircraft dual utilisation

Further to providing the possibility to install a section of quick-change ultra-first class furnishings into a commercial aircraft, an ACJ VIP Kit can also completely transform the entire aircraft for very special missions.

In line with the "two-for-one" concept, an ACJ VIP Kit may be particularly attractive to governmental customers wishing to utilise a long range aircraft from their national carrier for worldwide summit meetings and intercontinental state visits. The utilisation of the same A330/A340 aircraft for commercial revenue flights plus for private state use makes good economic sense. When not used by the ministry, the aircraft is flying with the country's airline.

Another clever application of an ACJ VIP Kit can be for charter operators of Airbus A330 and A340 aircraft seeking to broaden the scope of the services they offer by proposing different cabins on the same aircraft according to customer needs.

The generous cabin space of at least 216m² on an A330 and A340 can easily accommodate a full ACJ VIP Kit comprising several private rooms. Sufficient passenger seating in business class and economy class level is maintained in the aircraft for entourage, journalists and associated staff for a total passenger count of about 200.

In order to provide the quickest solution to transform an all-passenger aircraft into a corporate jet, ACJ has taken the initiative to pre-engineer a VIP kit that can be installed into a part of the constant section of any in-service A330 and A340 aircraft.

Based on its extensive experience of VIP jet furnishing this specific ACJ A330/A340 VIP Kit offers a comprehensive layout arrangement over almost 60m² comprising a generously sized and luxuriously finished executive seating area (14m²), conference/dining room (22m²), private office (9m²) and a bedroom (13m²).

High-end local IFE (video screens and Blu-ray players) is also included in the kit that fits perfectly into existing linings under the overhead stowage compartments.

The seats and divan are all certified to 16G requirements and are qualified for occupation during Taxi, Take-Off and Landing. A total of 19 passengers can be accommodated in the ACJ A330/A340 VIP Kit.

Each of the individual seats is located adjacent to a separate full size table for comfortable working and spacious dining. The executive seating, in particular, is located in its own zone and can be used for guests or for protocol and entourage staff.

Not only does the ACJ A330/A340 VIP Kit offer luxurious seating but for night flights the seating positions can be transformed into a total of 11 full length horizontal flat beds, of which 3 are at least 1m x 2m size single beds of the best comfort in 2 separate private rooms.

Working is facilitated by the spacious conference room that spans the entire 5.3m width of the A330 and A340 cabin. Equipped with a 42" video screen, presentations can be easily shared amongst the 12 participants. By laying beautiful linen on the working tables, the conference room is transformed into an exclusive dining area.

A fully enclosed private office is also included, comprising a convertible 3-seater divan, a convenient desk and an armchair. The 30" video screen mounted onto a pivoting arm can be viewed from both the armchair and the divan, enabling the office to be also used as a cinema lounge.

Finally, the ACJ A330/A340 VIP Kit offers the privilege of having a fully separate calm and quiet bedroom in the cabin. This room features 2 full size 1m x 2m single beds, each equipped with its own IFE screen and stowage console in addition to the existing overhead compartments.

As a majority of the ACJ A330/A340 Kit components are already produced, the lead time to design and manufacture a section of VIP cabin on an A330 or A340 is an impressive 50% less than compared to a 20-month standard lead time for a comparable product.

Example of
ACJ340 Office





Example of
ACJ319 Club 2 and divan
with consoles

Finalisation of the ACJ A330/A340 VIP Kit to the pre-defined configuration and trim and finish is expected to take only 10 months. However, adaptation and fine-tuning to the precise pre-mod status of the customer aircraft may need additional lead time. Customer special requests and additional customisation will also impact lead time, to be studied on a case by case basis.

ACJ is here to guide operators through each step of the customisation process and ACJ's highly specialised engineers and designers are ready to respond to the customers' every need.

Once the ACJ A330/A340 VIP Kit is finalised and a small amount of aircraft provisions installed (some load-bearing hardpoints and power connection sockets only), it takes about 4 days to convert the airliner cabin into a VIP jet. Another 3 days is all it takes to restore the cabin back to its former standard configuration.

All ACJ VIP Kit parts are designed with appropriate split lines to fit through the cabin doors. As a bonus, the ACJ A330/A340 VIP Kit components can also be packed and stowed in the cargo hold in special boxes (included) for transportation to an outstation if needed. This gives operators the added freedom to convert the dedicated aircraft in a qualified maintenance centre wherever it may be in the world, without any need to fly back to the home base.

Cabin design and illustrations
courtesy of Plus 33 Design Studio

CONCLUSION

ACJ enables operators to enhance their cabins with luxurious furnishings and also with ACJ VIP Kits for quick cabin conversion in the race for best comfort and optimisation of aircraft usage.

The ACJ A330/A340 VIP Kit solution presents a unique opportunity to easily and temporarily upgrade the full A330 and A340 passenger cabin into a corporate jet in less than a week to use the aircraft for special missions.

There is currently one pre-engineered ACJ A330/A340 VIP Kit immediately available on the market. This is an exceptional chance to benefit from the expertise of ACJ and be the first to secure an innovative and powerful tool for 'two-for-one' operations of Airbus A330 and A340 aircraft.

For further information, contact the ACJ sales team:

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OPTIMA

Optimisation of Performance by Task Interval Maintenance Assessment



Article by (left to right)

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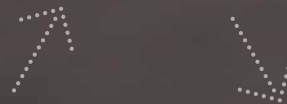
The optimisation of maintenance programmes, together with planning activities, play an important role for aircraft performance; reducing Direct Maintenance Costs (DMC) and enhancing aircraft availability.

This article gives a glimpse of the Airbus engineering approach to implementing an optimisation of the maintenance programme at the Maintenance Review Board Report (MRBR) level as well as for operators' customised maintenance programmes.

The Optimisation of Performance by Task Interval Maintenance Assessment (OPTIMA) is not an Airbus tool but a process developed by Airbus and accepted by EASA, FAA and Transport Canada with the objective to optimise maintenance requirements (including tasks, procedures and task intervals) from the maintenance programme without compromising safety and ensuring reliable and cost-effective aircraft operations.

The maintenance programme optimisation with the OPTIMA process monitors the maintenance programme's efficiency throughout a cycle that involves three major interlaced cornerstones: Optimisation assessment, In-service data, and Optimisation implementation.

**Optimisation
assessment**



**In-service
data**

**Optimisation
implementation**

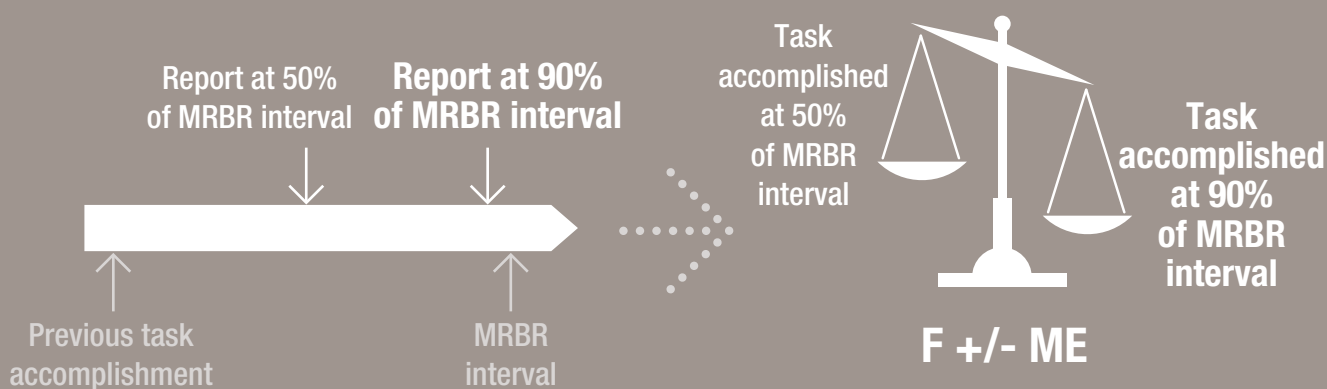
The OPTIMA process consists of a series of steps to ensure the best results:

- Capturing and processing relevant aircraft in-service data
- Analysing the failure effects and related faults on the aircraft systems and operations
- Assessing the consequences of a functional defect occurring during operations
- Using engineering judgement and statistical methods on the data to estimate how long operations can continue with hidden defects
- Effectively implementing the assessment results in the maintenance programme
- Measuring the efficiency of the optimisation by analysing the data after implementing the changes in the MRBR or in the operators maintenance programme

The OPTIMA process can be applied to MRBR evolutions or for the optimisation of operators' customised maintenance programmes. For the optimisation of the MRBR, the quality of the data is just as relevant as the quantity.

Only fully reported maintenance tasks represent the "data sample". This data sample reaches a 95% confidence level, only once reasonable levels of data quality and quantity are met. Airbus introduced a statistical mathematical model in order to take full benefit of the reported scheduled maintenance in-service data.

The principle is to estimate the whole Fleet Finding Rate "F" and the associated Margin of Error "ME", with a confidence level of 95%, using iterative algorithms and integrating a method that will attribute a weight to each report depending on the task accomplishment interval. Even in the case of customised optimisation for a specific operator where all the relevant data of the operators' fleet is available (the data sample will therefore be equal to the fleet), the Fleet Finding Rate will be computed to give weight to each report depending on the task accomplishment interval.

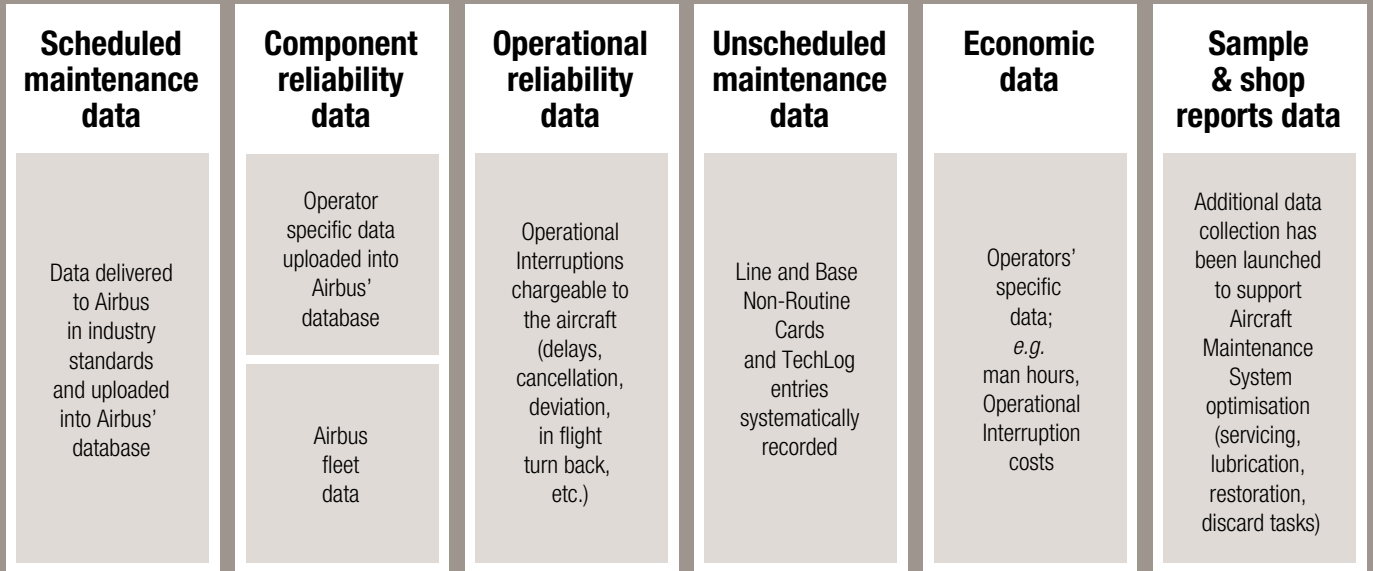


Unscheduled maintenance and replacement data either related to a specific maintenance requirement or that could later trigger new requirements is a key element of the in-service data collected. Not only are the operational interruptions considered in the analysis but also any minor finding or unscheduled event recorded by the flight crew, cabin crew and/or maintenance crew during the aircraft operation.

Data sample reports and new shop reports are included in the collection of in-service data for those tasks where no Non-Routine Card (NRC) findings from scheduled events are expected (e.g. Discard tasks, Lubrication tasks, etc.).

Economic data for scheduled and unscheduled events are also part of the in-service data required for the optimisation. These are considered as part of the economic assessment of the effectiveness of maintenance requirements. **Economic data is excluded for the optimisation of safety-related maintenance tasks.**

Figure 3



Data is uploaded to Airbus' database in order to optimise maintenance programming and allow the final data to conform with e-Business SPEC2000. Airbus is then able to manage different data formats and upload them for the operator into the Airbus "In-service Data On-Line Services" IDOLS. (Figure 3)

The quality of the final data is ensured through OPTIMA engineering data validation. The data packages are scrutinised to determine a correlation with the impacted maintenance requirement and/or determine potential new requirements.

OPTIMA assesses the data and recommends task intervals, task procedure and/or task adaptation

The OPTIMA assessment makes full use of Airbus' specialist "engineering judgement" and a "risk analysis" on the relevant validated data. The OPTIMA process focuses not only on the analysis of scheduled maintenance data but it also gives the same relevance to all in-service data, Airbus' worldwide fleet experience and Airbus' first-hand design knowledge (Figure 4). This, together with the further development of statistical formulas, is a significant complementary step to the general approach maintained throughout the years by the industry and regulatory entities for optimisation exercises.

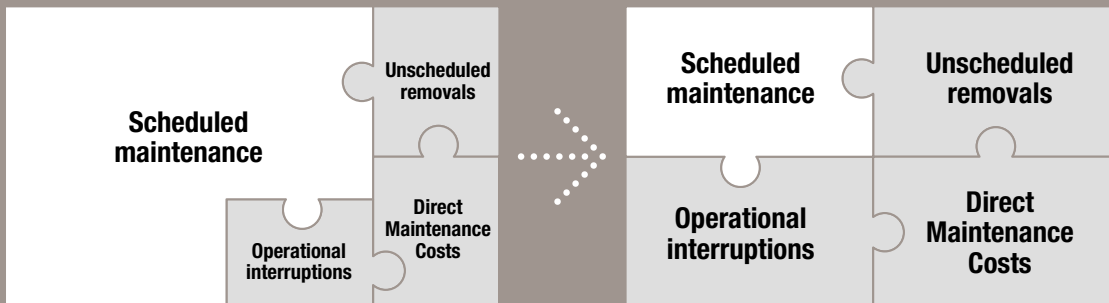
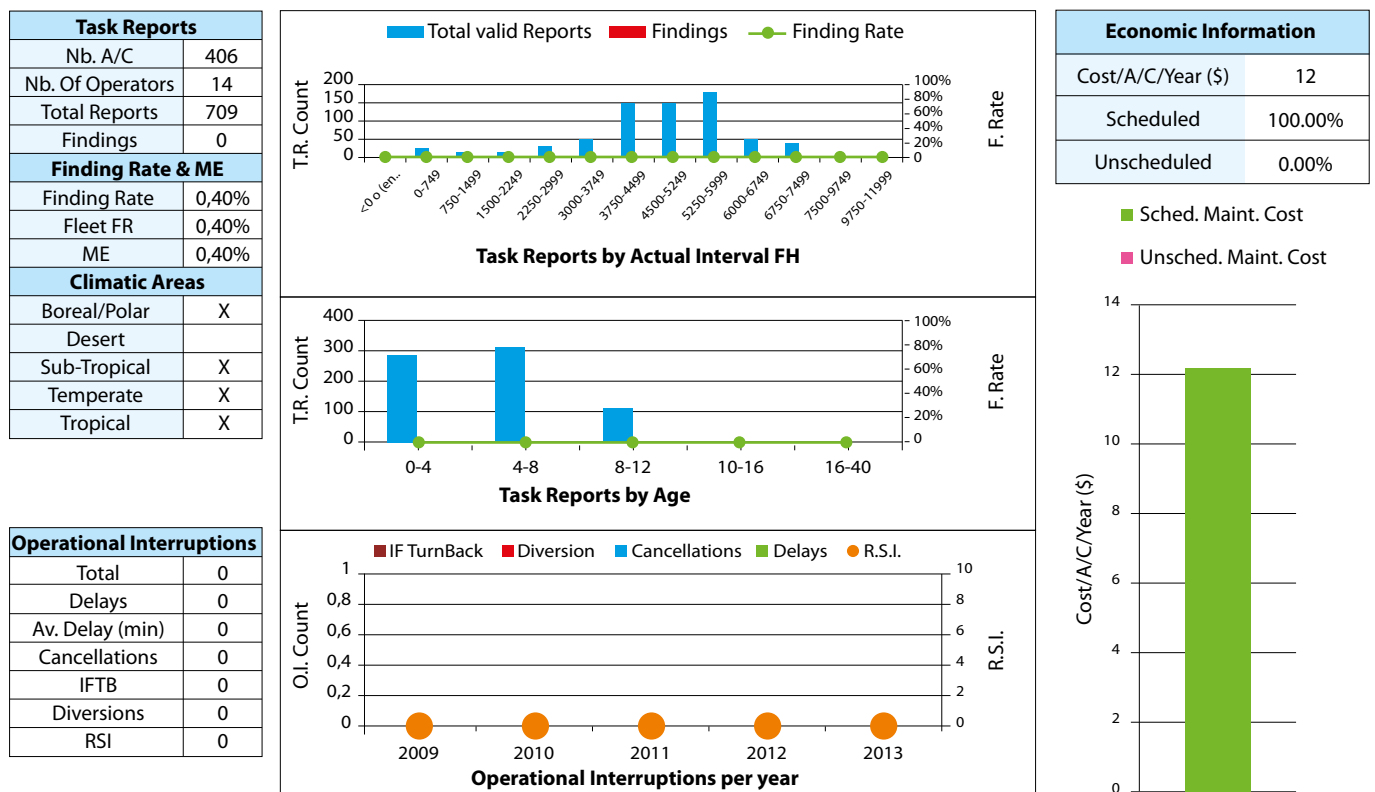


Figure 4: OPTIMA gives the same relevance to all in-service data, Airbus' worldwide fleet experience and Airbus' first-hand design knowledge



The assessment's objective is to determine the most optimised interval for a specific maintenance requirement. This optimised interval should be understood as a value within a "corridor" where the higher limit (maximum risk) will represent an increased probability of an unscheduled maintenance event taking place and the lower limit (minimum risk) will represent the first opportunity for preventive maintenance. The results of the data assessment and the computed values from the mathematical model/formula are represented in a dashboard (Figure 5).

Figure 5: Dashboard



This dashboard consolidates all the relevant data and is the backbone of the assessment for Airbus specialists when performing the engineering analysis.

Once the optimised maintenance requirement (e.g. new/deleted tasks, improved task intervals, modified task procedures) has been established, the planning of the task accomplishment can be scheduled for the aircraft fleet.

Depending on the operators' resources (labour, infrastructure, etc.), operation needs (turn around times, uses), fleet conditions and priorities, the OPTIMA process can be performed in two "directions". The first where the selection of maintenance requirements to be optimised from the maintenance programme is set up to fit the existing fleet maintenance planning (e.g. optimising out of phase tasks only) and the second where an optimisation of the maintenance programme is set up in a new planning.



The OPTIMA process has been applied not only in MRBR recent evolutions (A320 evolution during 2014-2017 and currently A380 MRBR evolution) but it has been implemented as well by operators on their A330 and A380 programmes with full involvement of their local airworthiness authorities. (See FAST magazine #55)

Airbus maintenance engineering is continuously working with IT specialists and data scientists to improve the assessment methodology. To do so, Airbus focuses on defining more accurate performance standards to measure the effectiveness of the maintenance programme for the worldwide fleet or for sub-fleets with specific characteristics like aircraft age or environmental conditions (figure 6 & 7).

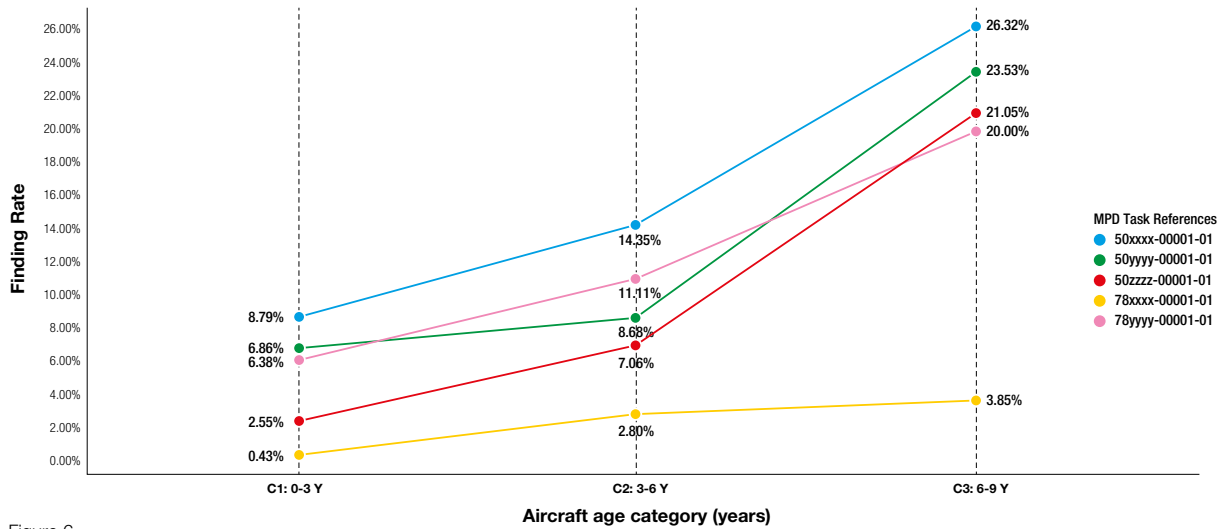


Figure 6

This allows Airbus to zoom into the in-service data and grasp more optimisation opportunities to reduce DMC and enhance aircraft availability. Altogether, this provides a chance for customised maintenance programme solutions.

Finding Rate per ATA2D and Region

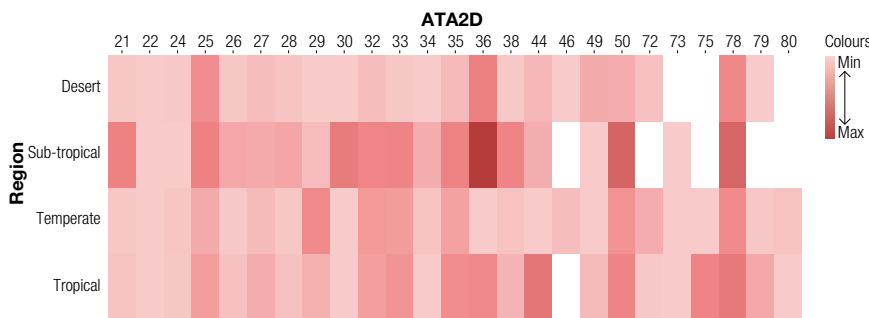


Figure 7

Qantas' OPTIMA exercise

The benefits that OPTIMA can bring to an airline was confirmed by Qantas who conducted an optimisation exercise on its A330 fleet with the assistance of Airbus.

The data collected to enable the OPTIMA process was broken into 6 key elements:

- Scheduled maintenance
- Component reliability
- Economic information
- Unscheduled maintenance
- Operational reliability
- Sample data

Qantas' feedback was the following:

As the Qantas maintenance information system uses electronic certification, all maintenance records for scheduled and unscheduled tasks are readily available for analysis, eliminating the need for what was historically a time-consuming process to gather paper records. This also enabled 100% of relevant data to be analysed in the OPTIMA process and reduced the time to validate and load data into the IDOLS system.

The process considered all relevant data in the analysis of maintenance task performance. Formerly, in optimisation and evolution exercises, results have been skewed to the analysis of scheduled maintenance findings. The OPTIMA process balances the issues and considers the complete asset maintenance by using many data aspects. This may lead to a different conclusion than when considering only the findings of scheduled tasks.

The engineering judgement and risk assessment applied to the analysis for Qantas' customised optimisation exercise allowed both the Airbus expertise (inclusive of the reported world fleet experience) and the unique experience of the operator to be considered in the analysis process. Through the engineering analysis of the data, the results could be considered with respect to their significance on the affected system and given context to the unique aircraft operation, modification status, configuration, and age of the Qantas aircraft fleet and solutions tailored to suit. The operations, planning, resourcing and processes of operators are not identical and these differences are accounted for in a customised optimisation exercise but cannot always be accounted for in the MRBR process.

The process was well defined from the start, and acceptance of it was obtained from the regulator before commencing data collection and analysis. This ensured that the process worked efficiently with very little rework being required as expectation and understanding on both sides were clear. In all, the collaboration and quality of dialogue between Qantas and Airbus was great.

CONCLUSION

The OPTIMA process by Airbus relies on a good balance between in-service data analysis, usage of statistical methods and engineering judgement from Airbus' long and extended engineering expertise. This efficient process results in an optimised maintenance programme for the airlines, which in turn increases aircraft availability for more revenue flights and reduces Direct Maintenance Costs (DMC). ■■■■

SWITS

Smart Wiring Troubleshooting



Article by (left to right)

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With their kilometres of cables, aircraft electrical system checks can be a difficult challenge for airlines and MROs. In order to ease the process of finding a fault and precisely locating it, Airbus is offering a new tool: SWITS. Using reflectometry* and the LCR measurement (impedance, capacitance and resistance), SWITS can detect a fault in a fraction of the usual time.

Finding a fault on the aircraft's electrical system

Troubleshooting can become a complicated task when multiple lines (equipment) are suspected in the Post Flight Report (PFR). Considering that permanent or intermittent faults can appear anywhere in an electrical system, issues can take a long time to locate and fix.

On occasion, intermittent electrical faults that occur in flight can be almost impossible to replicate on ground. These intermittent faults can be caused by very small chafing, corrosion or contact faults that can be difficult to locate, resulting in increased aircraft downtime and increased maintenance costs due to ad-hoc computer and component replacements. Adding to the mechanic's burden is the fact that the cables are routed behind furniture, fittings or structure, so gaining access to wiring can be a large part of the job when troubleshooting electrical faults.

For this reason the Airbus Ground Support Equipment, Support Engineering and BizLab teams have been working closely with airlines in order to simplify the troubleshooting of permanent and intermittent faults found in aircraft electrical systems.

Customer satisfaction and reduction of aircraft downtime are at the heart of this initiative and Airbus is now able to offer enhanced electrical system troubleshooting tools and services using the latest technology.

The SWITS tool (Smart Wiring Troubleshooting)

The SWITS tool is based on standard LCR measurement technology in combination with healthy references of the aircraft's electrical systems. In addition to LCR measurement, the SWITS uses TDR (Time Domain Reflectometry) to determine the fault location. Together, this enables the tool to sequentially test the affected electrical system lines, compare the results to the database of healthy references and automatically identify the nature and location of the fault.

In creating SWITS, Airbus has worked with tool supplier NEXEYA to develop the WIDD 200 (Wire Defect Detection) tool and combined it with aircraft electrical systems references to perform automatic fault detection. This equipment is capable of checking 62 channels sequentially which enables incredibly fast fault analysis. Initially SWITS will be enabled to test ATA 27 (flight controls) and ATA32 (landing gear) electrical systems on the A320 Family, A330 and A340. The functionality will be progressively expanded to all systems on all Airbus aircraft.

One of the tool's main benefits remains the shift between the usual process and the radically simplified and faster SWITS process. The traditional procedure for troubleshooting often involves first replacing the computer for the affected system. If this is not successful in resolving the problem, the second step is to check or replace the end fittings in search of the issue.

The end fittings are equipment connected at the extremity of the computer such as proximity sensors, servo valves, etc. Failing this, it is necessary to perform an inspection of the full wiring loom. Considering that the wiring loom can be more than 100 metres long and concealed by cabin fittings and aircraft structure, this is no easy task. Also by having to replace what could be fully functioning computers or end fittings in search of an issue can result in a high number of No Fault Found (NFF) events, which add unnecessary costs.

By using the SWITS tool, the procedure for troubleshooting will start by placing the SWITS tool in place of the computer thanks to the provided connection cable. The tool will then run an automated test of each line targeted in the GTR (Ground Test Requirement) to easily identify the type of defect (end fitting issue or wiring issue). During this check, the SWITS tool compares the LCR and TDR measurements to the database of healthy references to identify the nature and location of the defect. This will enable maintenance personnel to go directly to the fault, reducing the need for random component replacements or removal of many cabin furnishings and linings in search of the problem. If no fault is found by the SWITS tool, the troubleshooting procedure will recommend replacing the computer as a last step. This will have the benefit of isolating the problem to a wiring, end fitting or computer fault and reduce the number of No Fault Found (NFF) events.



Main characteristics

- 62 channel LCR and reflectometry measurement
- Able to detect the following faults:
 - Short circuit
 - Open circuit
 - Bonding
 - Grounding
 - Intermittent
- Intelligent automatic testing of ATA 27 and 32 electrical systems
 - Applicable to A320, A330 and A340 families
 - No training required
- Intermittent fault finding function
 - Applicable to any aircraft with use of specific connections
 - Specific user training required.
- SWITS includes:
 - WiDD 200 tool
 - Integrated rugged laptop
 - Connection cables
 - GTR

* **Reflectometry** is a measurement technique used to determine the characteristics of electrical lines by observing reflected waveforms. The amplitude of the reflected signal can be determined from the impedance of the discontinuity. The distance to the reflecting impedance can also be determined from the time that a pulse takes to return.

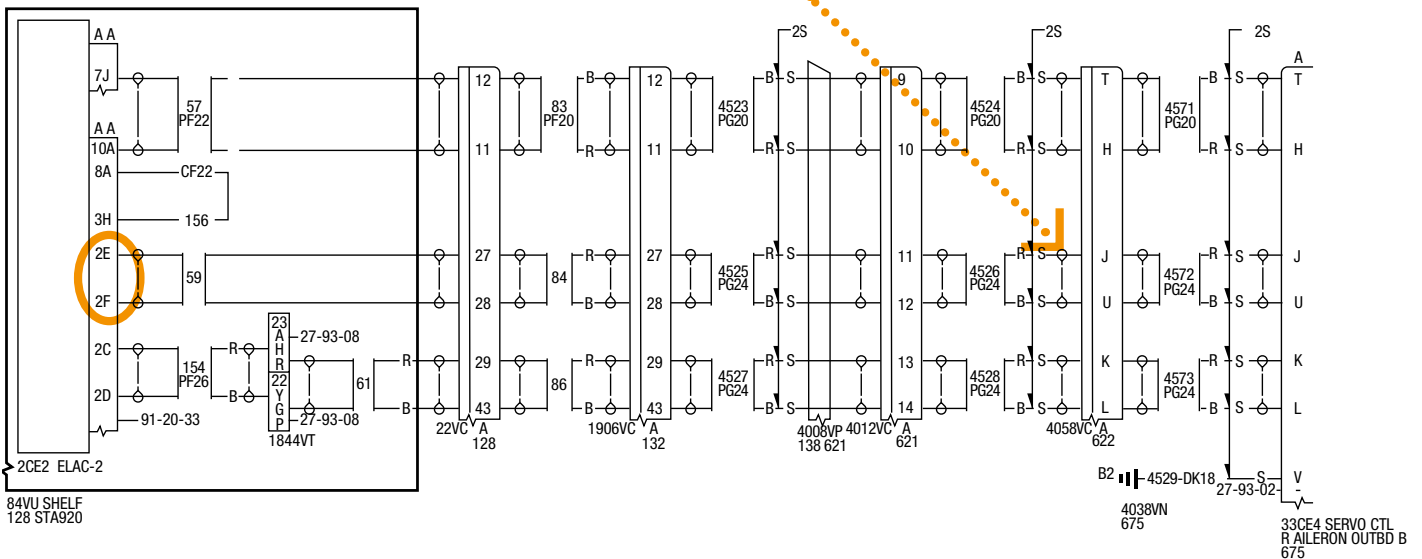
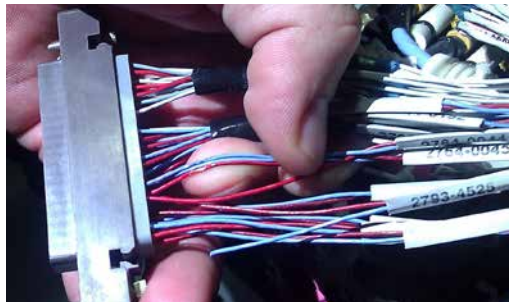
Troubleshooting example in automatic mode

The following example is a clear demonstration of how the SWITS tool works and its efficiency compared to the traditional process. In this example two failures are simulated at the connection between ELAC2 (Elevator Aileron Computer) “2CE2” and the servo valve of the servo control 33CE4:

- an open circuit on the wire 2793-4526
- 33CE4 equipment failure

Following the A320 TSM (Trouble Shooting Manual) task 27-10-00-810-828-A recommendations, the first step is to replace the ELAC2. The second step is to replace 33CE4 and finally a wiring check is performed, which in this case is 62 metres long.

Note: Aircraft Wiring Manual (AWM) shows the connection between ELAC2 and servo control 33CE4 in this wiring the cables are connected to some VC (connectors interface) and one VP (pressure seal).



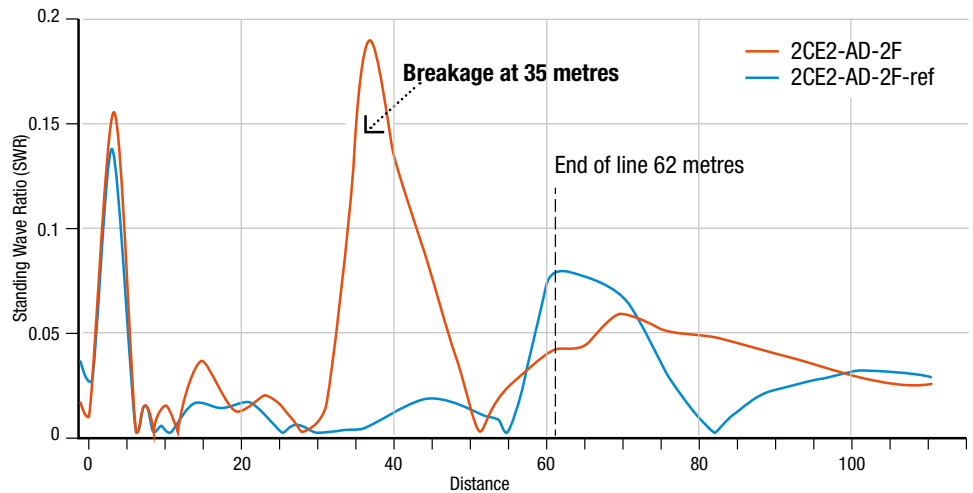
By using the SWITS tool in place of the ELAC2, operators will be able to automatically check the aileron servo control, wiring and connections at the same time. This will save a significant amount of time and enable the operator to focus directly on the 33CE4 failure or wire breakage.

LCR measurement with the SWITS tool connected in ELAC2’s position

Status	High	Low	R (mes)	R (ref)
KO	2CE2-AD-2E	Ground	822.005 kOhm	[LL:447.000 Ohm Ref:490.000 Ohm UL 553.000 Ohm]
KO	2CE2-AD-2F	Ground	822.842 kOhm	[LL:447.000 Ohm Ref:490.000 Ohm UL 553.000 Ohm]
KO	2CE2-AD-2E	2CE2-AD-2F	974.646 kOhm	[LL:447.000 Ohm Ref:490.000 Ohm UL:553.000 Ohm]
OK	2CE2-AD-1G	Ground	419.196 Ohm	[LL:415.618 Ohm Ref:437.493 Ohm UL:459.368 Ohm]
OK	2CE2-AD-1H	Ground	418.429 Ohm	[LL:414.425 Ohm Ref:436.237 Ohm UL:458.049 Ohm]
OK	2CE1-AD-1G	2CE2-AD-1H	422.579 Ohm	[LL:405.339 Ohm Ref:426.673 Ohm UL:448.007 Ohm]

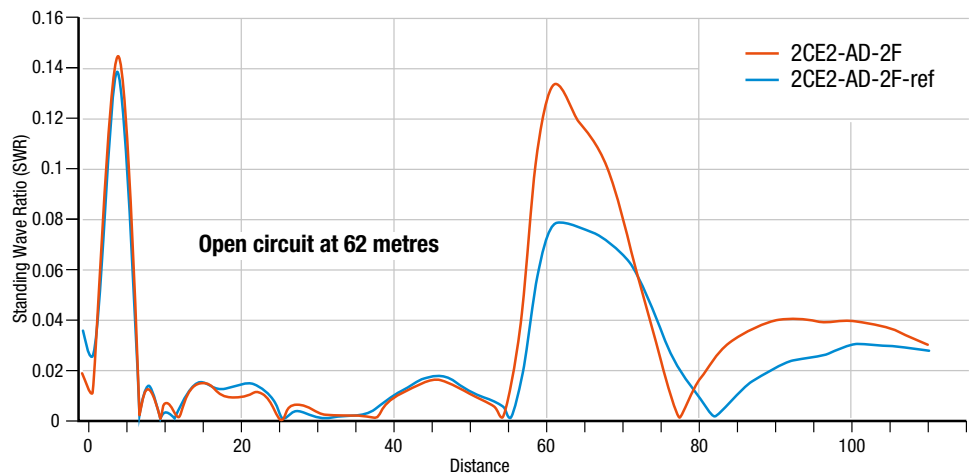
The LCR result shows an open circuit in the line 2CE2 AD 2E/2F as the recorded resistance in the first circle (822 kOhms) is much higher than the reference in the second circle (490 ohms). However, from this result alone we cannot determine if it is the cable that is cut or if it is the end fitting that is defective, resulting in an abnormal electrical load.

Looking now at the TDR result we can see that there is a large peak at 35 metres, in comparison to the reference image (displayed in blue). By taking the LCR and TDR results together we can conclude there is an open circuit (breakage) in the cable at 35 metres (TDR signal after break is not relevant).



Looking at the second example of an end fitting (33CE4) failure, the LCR measurement will produce the same readings as for the previous example.

However looking again at the TDR result, we can see that there is a difference in peak at approximately 62 metres in comparison to the reference image (displayed in blue). From these results we can conclude there is an end fitting failure, as the wiring's full length is 62 metres.



Normal troubleshooting	Troubleshooting using SWITS
E Bay access	E Bay access
Replace ELAC 2	Connect SWITS in place of ELAC 2
Access to Servo CTL panel removal with a platform	If no finding Replace ELAC2
Wiring Check Servo valve	
Wiring Check cables	
Result	Result

The SWITS' Expert mode

An additional function has been added to SWITS for the troubleshooting of difficult or intermittent wiring issues.

This function continuously scans the wiring to be tested in reflectometry mode and is able to detect faults that last as little as 1 millisecond. Therefore, for these intermittent faults the tool scans the wiring while someone gently shakes the cables or connector. If the fault is reproduced only once and for a fraction of a second, the tool will be able to identify which line is effected and where the defect is located.

Intermittent faults are often triggered by very small wiring defects such as pin/socket connection issues, corrosion, wire chafing or ground bonding not well connected. These faults can also sometimes only occur during flight and cannot be replicated on ground. Due to their small size, fault finding and resolution in these cases can be a very difficult and long task. With SWITS however, these faults can be found and solved in a very small amount of time.

This intermittent fault finding mode (Expert mode) is not possible via the automatic analyses function based on the GTR used for ATA 27 and 32. Specific user training is required to be able to correctly configure the aircraft before starting the test, in order to avoid damage to the electrical system, and to be able to correctly interpret the results. This mode has the benefit of being able to be used on any aircraft or any electrical system once correctly configured by the user. In practice, the intermittent fault finding mode will be used after standard TSM tasks have been accomplished and the fault has been identified as an intermittent fault.

The aim of this function is to connect the SWITS tool at one extremity thanks to the provided connection cable, usually by removing the computer, and disconnecting all other end fittings such as proximity sensors. This ensures only the wiring and connectors are connected and analysed. As all end fittings are disconnected, the test is similar to a continuity test.

Locates very small intermittent in-flight wiring defects that are difficult to replicate on ground





Onsite troubleshooting service by Airbus

Airbus Customer Services also proposes the possibility for onsite troubleshooting support for electrical system faults related to wiring issues with a Customer support expert team using the SWITS tool.

The team is trained to use SWITS and is qualified light Part 145, meaning that they are able to disconnect and reconnect electrical items in order to perform the test using SWITS.

As has been proven with a number of customers, the experts are able to define and locate the defect very quickly thanks to the use of SWITS and provide the repair solution.

To benefit from this service, a request can be raised in TechRequest.

CONCLUSION

By incorporating the latest technology, Airbus is now able to offer a tool and on-site service for fast fault finding and troubleshooting of on-board electrical systems.


The SWITS tool will be available from November 2016 and the Airbus support engineering team is currently offering a troubleshooting service which has proven to be very successful at quickly resolving long running issues.

SWITS will be referenced in the TEM (Tool Equipment Manual) and will be introduced in the TSM. The Expert mode will be covered by the introduction of the SWITS in the ESPM (Electrical Standard Practice Manual) and through specific training.

For more information on the SWITS tool, please contact the GSE and Tools team through TRM on AirbusWorld.

For more information on the on-site troubleshooting service, please contact SEEA5 team through TRM. ■

Health monitoring and prognostics



Airbus has combined its extensive knowledge of aircraft with the vast amount of data collected by airlines to offer them the possibility of predicting maintenance needs and maximise their operational efficiency.

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In recent years, aircraft have become increasingly complex, generating vast amounts of data through countless parameters especially since the A380 and A350 XWB.

At the same time, efficiency of operations has never been so important for airlines. Flights are more frequent, the number of destinations increases, and delaying or cancelling a flight due to unplanned maintenance has, more than ever, heavy consequences for airlines.

The main stake for airlines is now to move from a reactive mode to a pro-active mode by turning unscheduled maintenance into scheduled maintenance.

In this context, Airbus offers a complete set of solutions and services that monitor the health of aircraft and can accurately predict their future needs.

The opportunity

Analytical techniques including Big Data are making a difference in many industries and are a source of great potential in aerospace. Analysing data before, during and after the flight enables a better understanding of the aircraft's status and optimisation of its operations.

Leveraging these growing amounts of data represents the ground material for improvements in flight operations, reliability, maintenance and ultimately safety. One concrete outcome for operators and maintenance providers is to be able to anticipate failures before they occur via prognostics.

However, these techniques only deliver value when combined with business knowledge: Airbus' unique knowledge of the aircraft and the airlines' understanding of the aircraft's operations. This winning formula is not only about raising alerts on future issues but also proposing actionable solutions to them.

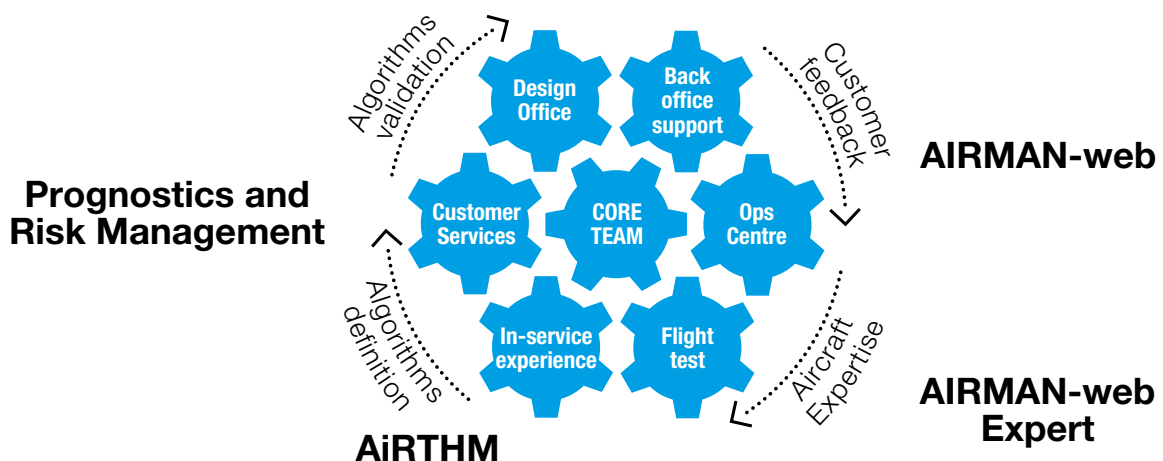
The Airbus difference

Firstly, as a major aircraft manufacturer, Airbus has been gathering extensive experience in aircraft health monitoring, and has privileged access to worldwide fleet and unparalleled understanding of aircraft systems. Airbus owns valuable knowledge on how to optimise aircraft operations through its Support Engineering and Design Office experts, its AIRTAC (Airbus Technical AOG Centre) teams who solve AOG situations, and a continuous improvement process combining Airbus and customers' reviews.

Secondly, with Airbus Smarter Fleet®, Airbus collaborates with IBM to ease data gathering, analytics and processes. Airbus Smarter Fleet® is a unique platform of integrated solutions where all services share valuable information, via Big Data techniques and which can be tailored to specific needs.

In addition to this, particular attention is given to the user experience, which is key to gaining alignment with the customers' expectations and receiving final acceptance from end-users.

Based on this approach, Airbus has been developing applications and services which cover the full aircraft health monitoring value chain, from prognostics to diagnostics and support to troubleshooting.



The Airbus Lab

Composed of all of Airbus' internal skills and the customer's experience, the Lab provides Airbus' customers with maximum value solutions and services.

The objective of Airbus is to provide the maximum contextual information to the airlines' maintenance and engineering teams in order for them to manage in-flight events efficiently and even be able to anticipate their occurrence. Using these health monitoring tools, the airline can avoid operational interruptions.

Diagnostics and troubleshooting support

The first step when a failure occurs is to make a quick and reliable diagnosis in order to ensure fast troubleshooting and reduce delay for the next dispatch.

Used by more than 140 customers on around 7000 aircraft, AIRMAN-web is Airbus' aircraft health monitoring tool. It constantly monitors the aircraft systems' health and transmits faults and warning messages to ground control, providing rapid access to maintenance documents and troubleshooting steps.

In parallel with AIRMAN-web, Airbus offers a service called AiRTHM, dedicated to A380 and A350 XWB operators. In this case an internal Airbus team manages the airline's fleet and provides guidance on optimised maintenance and real-time troubleshooting.

Based on the strengths of both AIRMAN-web and AiRTHM, Airbus has decided to provide the Airbus expertise used for the AiRTHM service through AIRMAN-web to enable airline users to go further in diagnostics and troubleshooting. This new module, called AIRMAN-web Expert, allows the user to get very detailed information on the technical event diagnostics, operational impact and troubleshooting steps to be followed, using the uplinks feature to troubleshoot aircraft in real-time.

AiRTHM service

AiRTHM is the service dedicated to A380 and A350 XWB operators to support them in diagnostics and troubleshooting activities.

This service consists of an Airbus 24/7 dedicated team, located in the AIRTAC centre, which monitors the airline fleet, analyses the aircraft data and, when an event is observed, provides appropriate recommendations to the airline.

AiRTHM currently offers two services, Pre-Departure Check and Flight Watch.

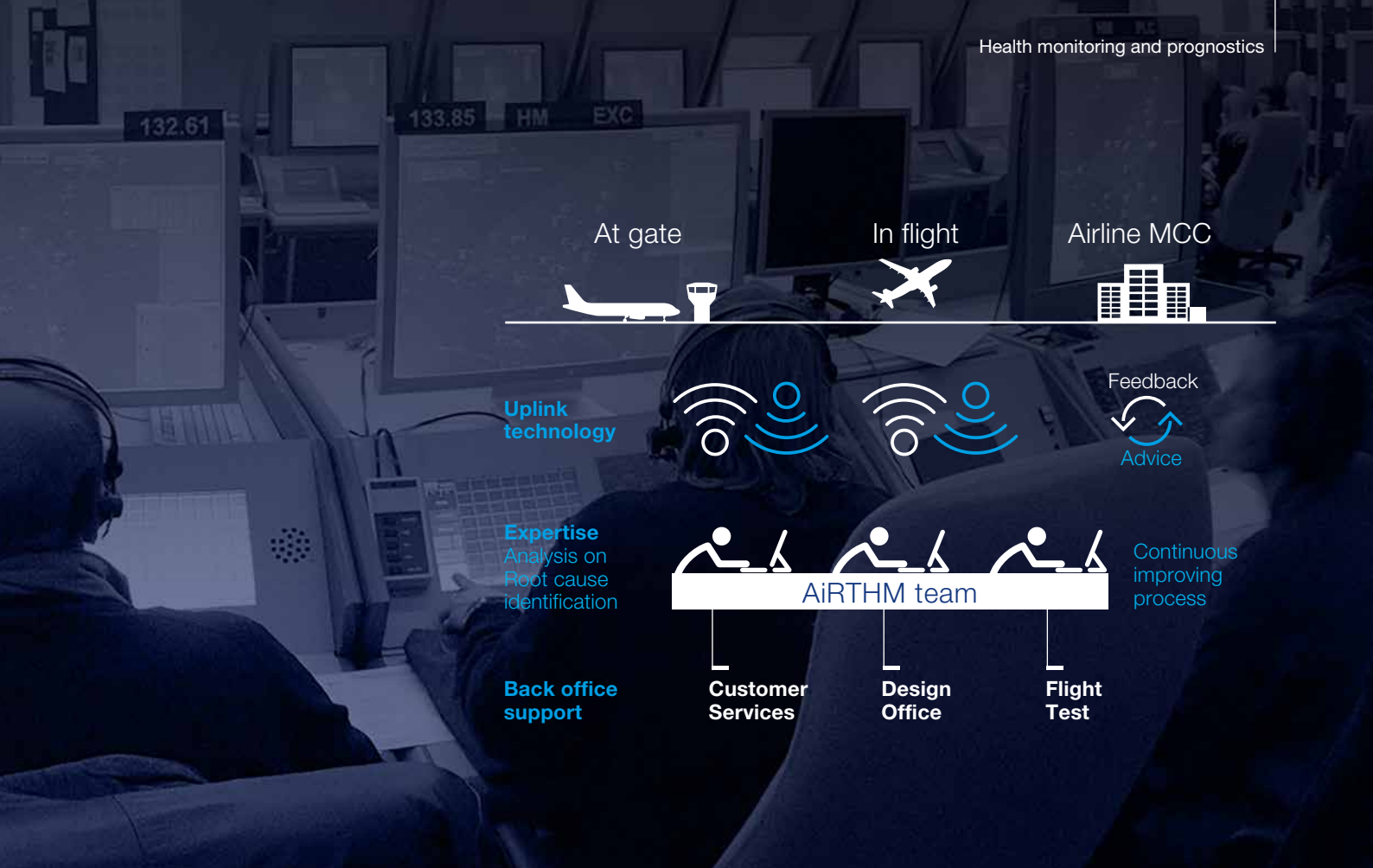
For the Pre-Departure Check, the Airbus team monitors particular systems of the aircraft that may impact the dispatch before it leaves the gate. They particularly look at potential failures during flight preparation, pre-departure delay drivers and provide on-demand assistance in case of a return to gate procedure.

The Flight Watch service provides monitoring of the aircraft during the flight and in this case the Airbus team tracks the ECAM (Electronic Centralised Aircraft Monitor) alerts and fault messages sent by the aircraft.

In addition to the knowledge and expertise of the Airbus engineers, the team is also able to collect additional data such as Aircraft Condition Monitoring System (ACMS) reports, Smart Access Recorder (SAR) and Quick Access Recorder (QAR) files, and do automatic uplinks in real-time. The collected data then allows the Airbus team to perform accurate engineering analysis and provide corresponding dispatch and troubleshooting advice to the airline.

All monitored events are registered in Case Analysis Templates (CAT) files in order to build a knowledge base.

Today, AiRTHM is used by several A380 operators and all A350 XWB operators in the early days after entry-into-service.



AIRMAN-web Expert

AIRMAN-web Expert has been developed to offer a software solution enhancing troubleshooting on A380s and soon also on A350 XWBs.

This solution was born from Airbus' objective to allow customers to benefit from its extensive knowledge of aircraft and from customer requests to optimise information in AIRMAN-web. The objective of AIRMAN-web Expert is to guide the Maintenance Control Centre (MCC) in diagnostics and troubleshooting by providing access to a knowledge database.

This database contains enriched data and features like correlation of multiple fault codes, direct access to necessary technical documentation and ACMS data uplink request capability.

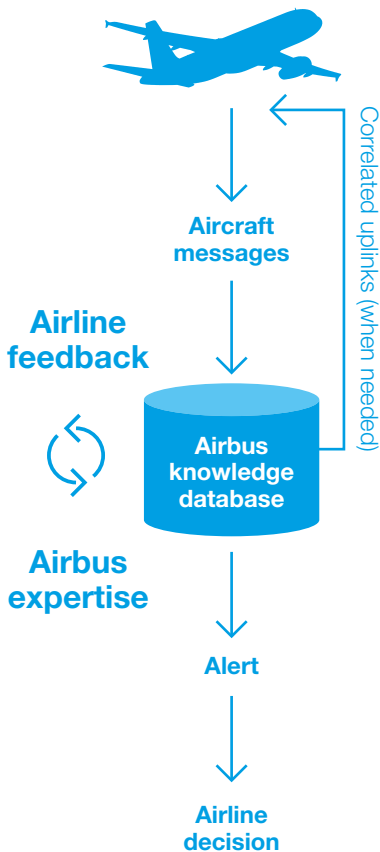
Focusing on complex technical events which have the most impact, the MCC users can base their troubleshooting decisions on Airbus' expertise contained in CAT files.

These files explain all information related to the failure and propose expected remedial actions. They also allow to uplink specific ACMS parameters in order to confirm the fault and determine the root cause.

The knowledge shared in AIRMAN-web Expert is based on AiRTHM expertise and will continuously be enriched with both Airbus' and the airlines' experience.

With this new module, the MCC can speed-up its diagnosis, save time in troubleshooting and so in the end reduce operational interruptions for improved aircraft availability.

With AIRMAN-web Expert and AiRTHM, Airbus provides a complete offer for diagnostics and troubleshooting activities, giving the choice to the airline between a service ensured by Airbus with AiRTHM or the autonomy of its MCC with AIRMAN-web Expert.



Prognostics

In order to be a step ahead of technical events, the airline can use prognostics and in this case the objective is to avoid unplanned events by detecting system failures before they occur.

Airbus has developed an application called Prognostics and Risk Management (PRM) which provides early detection of failures, enhancing aircraft availability and reducing unscheduled maintenance.

A study made on the A330 fleet, revealed that up to 15% of the entire operational interruptions could be avoided using a prognostics solution like PRM.

Prognostics and Risk Management

Thanks to a proof of concept done with 3 airlines between 2013 and mid-2014, the capability to detect in anticipation unplanned failures has been formally demonstrated. This milestone was the start point of the industrialisation of the PRM application. From April 2015 a one year "in-service evaluation phase" was set up in collaboration with Delta Air Lines allowing users to fine-tune the algorithms and features of the application. PRM was born.

Today, with Delta Air Lines as its launch customer, PRM is a chargeable service with fully demonstrated and recognised benefits.

The principle of PRM is quite simple. It uses the Flight Data Interface Management Unit (FDIMU) capabilities and its Aircraft Condition Monitoring System (ACMS) function to record a particular set of data at a very precise timeframe of the flight, that features a specific signature, identified by Airbus Design Office engineers as a weak signal to a future failure.

It is in the ACMS load, a customised database, that all this needed data is defined with its associated recording conditions. This load, delivered by Airbus to PRM customers, has to be fitted onto the FDIMU system of the aircraft monitored by PRM. No software changes are necessary.

At the end of the flight, all the recorded data that has been merged by the FDIMU is made into a unique ACMS report. This report is automatically transmitted to the Airbus server on ground using the ACARS network.

Finally, thanks to algorithms defined by data scientists in collaboration with Airbus Design Office specialists and Airbus Customer Support experts, PRM computes the collected parameters and displays aircraft systems degradation. Based on threshold and target values defined by Airbus, it can then alert the engineering teams that a failure might occur.

Additional data, like ECAM alerts and BITE (Built In Test Equipment) messages from Post Flight Reports, is also used to correlate detections with failures when no preventive maintenance was launched. In this case, PRM brings additional information that can be useful to improve troubleshooting. ECAM alerts can be displayed on the same graph as the prediction trends, hence allowing better customisation of alerting thresholds.

PRM is a web application accessible by any user from any location and only needs an Internet connection to be usable. The application is very easy to use and can be customised by the user. For example, it allows the information to be accessed by the aircraft and/or by ATA chapter. There are also filtering options allowing the user to customise the screen display (by event priority, by aircraft programme, by MSN...). Prediction alerts can be based on either Airbus' pre-defined thresholds or user-defined thresholds according to the airline's strategy of risk mitigation.

PRM is currently available for A330 fleet and will soon be expanding. The 10 existing predictions on A330 aircraft are going to be completed by a new set of algorithms by the end of 2016. An in-service evaluation phase will be launched on the Single Aisle fleet (A319, A320, A321) in October 2016 with a selected number of airlines who have already expressed their wish to experiment with this new concept on their own fleet.

A350 XWB PRM will be available to airlines at the beginning of 2017 and the A380 PRM in the following months.

Example of PRM efficiency in Delta Air Lines

Between April 2015 and May 2016, 11 PRVs (Pressure Regulating Valves) and 1 HPV (High Pressure Valve) were removed in scheduled maintenance visits thanks to the PRM Pneumatics alert before failure. Aircraft operations were maintained without any delays and maintenance activities were properly scheduled and organised.

In this example, all the removed PRV and HPV were later confirmed "faulty" on test bench in the shop.

“

With Airbus' Prognostics and Risk Management, we will leverage the strong expertise of Airbus' design office to provide us with the most effective way to monitor our aircraft systems.

Prognostic alerting will allow our Engineering and Maintenance teams to detect in advance failures on our components and systems to mitigate possible operational interruptions. PRM will also help us maximise our A330 aircraft turnaround and systems' reliability and efficiency and move maintenance events from unscheduled to scheduled.

”

Jim Jackson,
Manager of Predictive Maintenance
Engineering at Delta Air Lines

ACARS Aircraft Communication Addressing and Reporting System

ACMS Aircraft Condition Monitoring System

AIRMAN AIRcraft Maintenance ANalysis

AiRTHM Airbus Real-Time Health Monitoring

BITE Built In Test Equipment

DAR Digital ACMS Recorder

ECAM Electronic Centralised Aircraft Monitor

FDIMU Flight Data Interface Management Unit

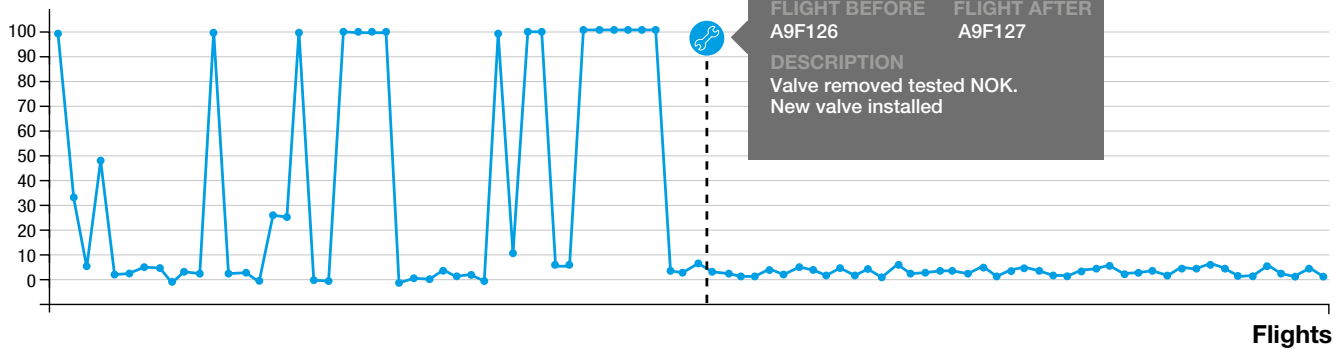
HMI Human Machine Interface

MCC Maintenance Control Centre

PRM Prognostics and Risk Management

QAR Quick Access Recorder

SAR Smart Access Recorder

Engine 2 PRV slow to close (seconds)

Example of ATA36 Event details displaying PRV closure degradation and associated maintenance action (here PRV replaced) allowing the recovery to normal behaviour of the PRV.

New data sources

Airbus looks to the future and constantly generates initiatives to improve the accuracy and relevance of its models and predictions. As more data can be pushed to the ground, it is possible to build more models using Big Data techniques that also allow an improved accuracy of failure localisation.

An experimental phase has been launched, in cooperation with easyJet, where DAR (Digital ACMS Recorder) as well as maintenance data is used to make predictions. DAR data represents several megabytes of data sent to the ground instead of the previously limited few kilobytes. This DAR data collected through WiFi or cellular capabilities gives additional opportunities for Airbus to develop new prediction models in cooperation with external companies such as Palantir or IBM.

Compared to PRM and AiRTHM, these models are built through a different methodology. PRM and AiRTHM models are based on system design and ACMS data, whereas this new approach will analyse aircraft data in a statistical way to find correlations between faults and symptoms and be able to identify prognostic models.

In this context, new HMIs (Human Machine Interface), strongly integrated in the airlines' operational systems have been designed to provide actionable items (pending tools, resources, spares' availabilities) at the best time in order to minimise impact on aircraft operations.

The prototype will be delivered to easyJet by the end of September 2016 for a 6-month "proof of concept" phase during which both Airbus and easyJet will monitor the efficiency of the models, their accuracy, and also assess the benefits of the front end HMI with its strong integration with airline systems.

From systems to...

Today, enhanced troubleshooting or prognostics mainly target systems, whereas other areas such as cabins and airframe are for the moment overlooked. Considering their potential, Airbus has made these areas its next challenge.

As new passive sensors become increasingly available, this new technology promises just the beginning of many benefits and applications.

Airbus Smarter Fleet® is a trademark of Airbus

CONCLUSION

Big Data and connected aircraft are key success factors for enhanced maintenance operations.

Thanks to this consistent approach, continuous development and improvement, Airbus covers all its customers' needs from improved troubleshooting to prognostics. Based on the expertise of its Design Office, and supported by several operators for in-service experience, Airbus is now positioning itself centrally in this very promising market.

Tomorrow's maintenance will be very different to what was done a few years ago. Prognostics is not only a new concept; it is a completely new paradigm for aircraft maintenance in the future.

FAST from the PAST

There wouldn't be any future without the experience of the past.

The Junkers JU 52 had a robust look and feel despite its - literally - 'glass cockpit'*.

The sturdy levers, cranks, taps and dials, as well as its unusual corrugated aluminium alloy skin, earned her the nickname "Iron Annie".

Photos courtesy of Airbus Corporate Heritage

The streamlined, harmonised cockpits found in all Airbus aircraft today are a far cry from the JU 52.

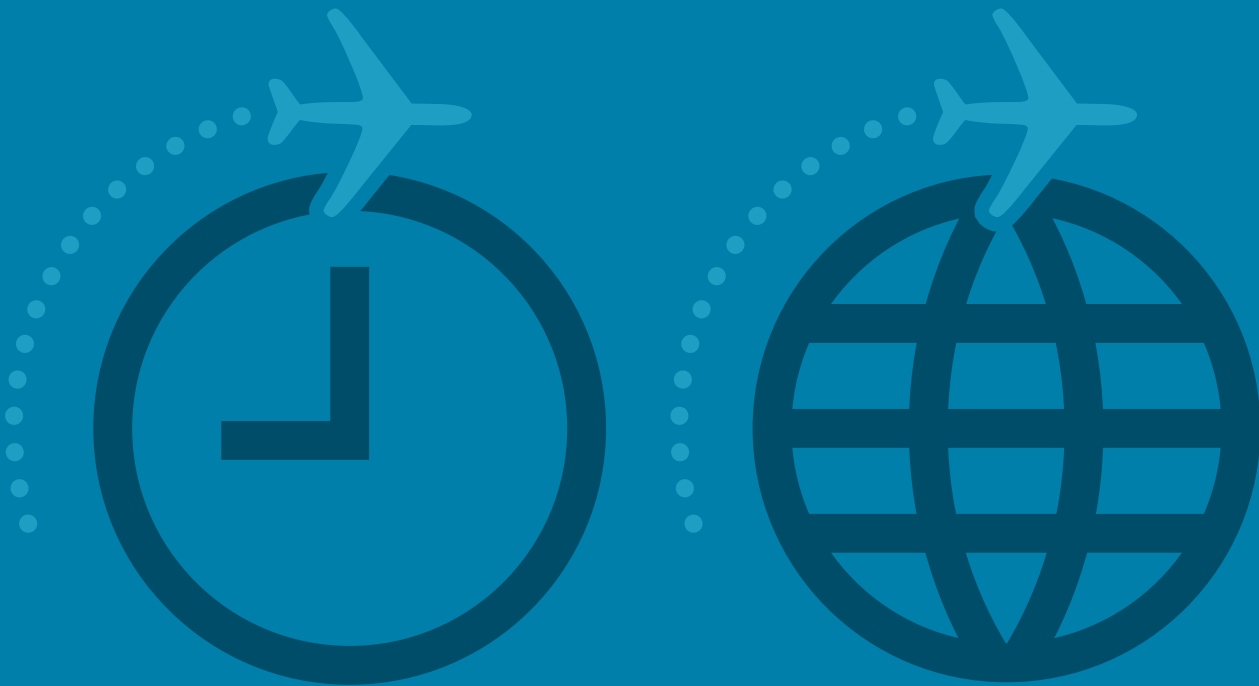
Each Airbus cockpit is ergonomically designed for flying that particular aircraft with ease and efficiency, but the cockpit also consistently adheres to the principles of flight operational commonality (see article page 4).

The flexibility created by a coherent cockpit design and fly-by-wire technology across the entire Airbus fleet reduces training time, increases pilot productivity, and simplifies rostering.

Operational commonality was a conscious commercial decision made with the inception of the A320 and over the last 25 years has been applied to the cockpit of each new generation of Airbus aircraft.

**The term 'glass cockpit' is used to distinguish cockpits using LCD displays.*

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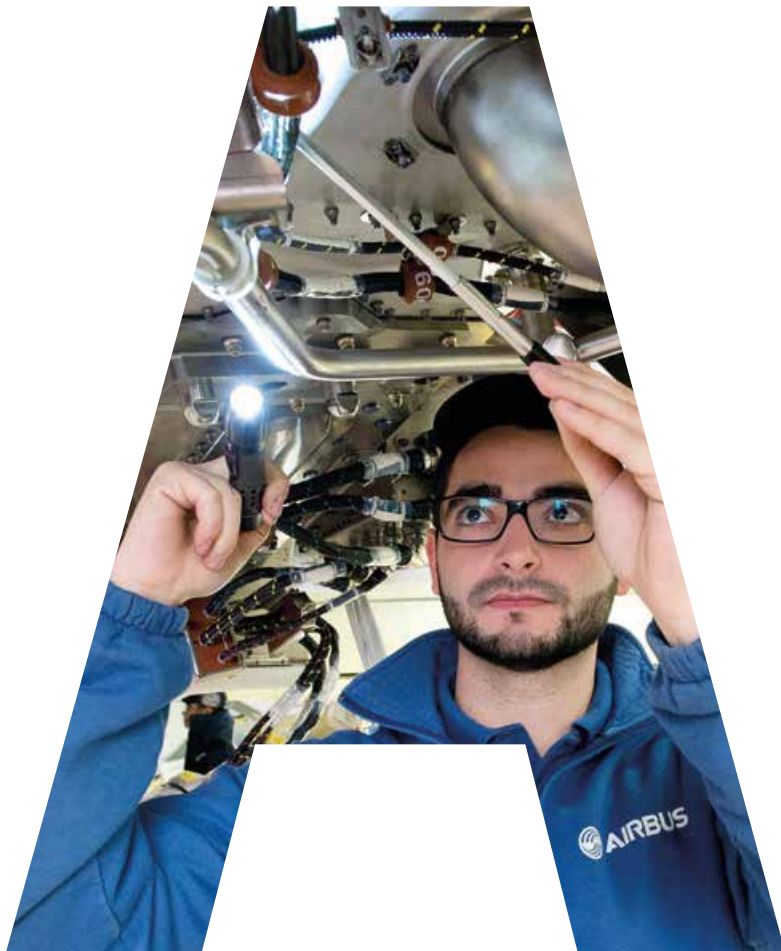
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