ID for → Systems

Over its 20 years of existence, one of the leading fields in which the A330 Family has been incrementally developed, both in rhythm and scope, is systems.

During the first ten years of A330 operations, evolution in systems was mainly aimed at improving reliability, saving weight and consequently fuel, or allowing functional growth capabilities at architecture level.

It was in 1998 at the time of A330-200/300 “high growth weight” 230t certification that the first significant step was performed. A centre wing fuel tank was added to the A330-200 definition, increasing range capability, and both A330-200 and A330-300 were the first Airbus aircraft to be fitted with new navigation technologies as Multi-Mode Receiver (MMR), Flight Management FMS2, replacing former equivalent systems, and new FANS A (Future Air Navigation System) solution, supported by SATCOM communications, to improve oceanic and long range operations.

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Five years later in 2003, capitalizing on A340-500/600 technologies on-going development, a second significant step was achieved with the entry into service of the “enhanced” A330-200/300 bringing changes that improved reliability and reduced maintenance costs. Major upgrades were implemented, such as the introduction of LCD (Liquid Crystal Display) screens in the cockpit (replacing EIS1 Cathode Ray Tube displays), ISIS (Integrated Standby Instrument Systems) replacing a set of electro-mechanical standby instruments, a Fly-By-Wire rudder, as well as a new on-board maintenance data system.

During the last ten subsequent years, the A330 Family programme has continuously and increasingly invested in development, improving A330 systems definition, enabling the design office to certify complex and operations-oriented functions.

Using the latest certified techniques, the design office has delivered safety enhancements, fuel and cost savings, reliability improvements, or new capabilities to improve aircraft and cockpit operations and/or passengers’ travel experience.

Major A330 developments on navigation and flight management systems

Airborne Traffic Situational Awareness (ATSAW), took advantage of Automatic Dependent Surveillance-Broadcast (ADS-B) by displaying aircraft information. It enhances the flight crew's knowledge of their surrounding air traffic situation, contributing to fuel savings by identifying the opportunity to climb and optimizing the flight level. In approach ATSAW increases runway throughput by improving identification and information of target aircraft and decreasing pilot workload. ATSAW was certified in 2011.

Traffic Collision Avoidance System Resolution Advisory (TCAS RA) Prevention (TCAP)** aims to reduce the number of TCAS RA occurring during level-off manoeuvres in reduced separation airspaces. It reduces undesired RA by 95% and all RA by 50% and improves passenger comfort, with no fuel penalty for normal operation.

Autopilot/Flight Director Traffic Collision Avoidance System (AP/FD TCAS*) mode is an Airbus solution which combines the autopilot (automatic mode) /flight director (manual mode) and the TCAS to provide vertical speed guidance based on a TCAS target and an optimum avoidance manoeuvre in case of conflicting air traffic (TCAS RA). It avoids or reduces pilot overreaction, enhances safety and increases passenger comfort during manoeuvres. It also allows easier training and a more intuitive flying technique.

On-board Airport Navigation System (OANS) Associated with enhanced Electronic Instruments System EIS2 (LCD displays with video capability, production standard since 2013), track-ball device and Flight Control Unit (FCU) upgrade, the system shows the aircraft's position on an airport map, to improve situational awareness, ease navigation around complex airfields or in low visibility conditions. It similarly helps prevent dangerous errors in surface navigation such as runway incursion or take-off from a taxiway or from the wrong runway.

Required Navigation Performance Authorisation Required (RNP-AR)** The A330 was the first widebody aircraft to be RNP-AR approved. This system allows access to airports in mountainous areas with more flexible approaches and departures, thus enabling time and fuel savings. RNP-AR is certified with 2 levels of RNP-AR operations: 0.3 nm (certified in 2010) and 0.1 nm in approach (certified in 2014).

GBAS Landing System (GLS) provides a state-of-the-art approach method for landing. It is based on differential corrections of GPS positions which are provided by a GBAS (Ground Based Augmentation System) station located at the airport. This function is in line with the ILS system and is fully integrated into the cockpit. GLS CAT 1 autoland was certified in 2014, with growth capability allowing evolution towards CAT II/III autoland. It is an advantage at airports by significantly reducing the effects of ILS signal reflection and providing flexibility for approach design.

FMS Landing System (FLS) is currently a function provided by FMS Thales Release 1A. FLS allows flying a Non-Precision Approach (NPA) along a "virtual" beam computed by the Flight Management System (FMS) with similar display, guidance & alerts as those for precision approach operations (Instrument Landing System - ILS). FLS does not rely on ground assets and provides significant benefits in reducing pilot training time and costs. FLS that will be directly compatible with the Final APP mode and supporting RNP-AR procedures will be available on Honeywell FMS in 2016 and on Thales FMS in 2018.

Continuous Descent Approach (CDA) Conventional Airbus descent procedure is designed to perform a major part of deceleration during level-off segments. The vertical profile of descent and approach complies with altitude constraints as defined in the navigation database or manually entered by the flight crew (from ATC clearance). Continuous Descent Approach (CDA) aims at removing level segment and uses idle thrust as much as possible, providing flight crew with energy management indications by defining flaps/slats configurations.
It is supported by the Flight Management System - FMS Release 2 - from Honeywell to be available early 2016.

Runway Overrun Protection System (ROPS*) is an Airbus-developed response to the growing occurrence of runway overrun incidents, which remain the main cause of aircraft accidents. ROPS provides significant safety enhancement allowing the reduction of insurance fees. (See FAST#55)

Soft go-around function aims at providing an easy way for the flight crew to achieve appropriate thrust for go-around in all cases, avoiding strong acceleration while ensuring a climb rate of approximately 2000 ft/min, vertical stability and pitch. It will be available for GE/PW engines by the end of 2016.

Weather radar
Improved definition of weather radar offers from both suppliers (Honeywell and Rockwell Collins) will be available by the end of 2015. These state-of-the-art technologies which include detection techniques, digital signal processing and weather data memory, improve crew awareness by improving weather threat assessment such as hail and lightning analysis and turbulence detection.

* AP/FD TCAS, TCAP and ROPS will be available early 2016

** RNP-AR FAA certification is expected in 2015.

Operational improvement

ETOPS 240 (Extended-range Twin-engine Operational Performance Standards)

ETOPS provides key operational improvement. In 2009 EASA approved A330 aircraft for ETOPS “beyond 180 minutes”, allowing diversion distance up to a maximum of 1,700 nm, i.e. the equivalent to an ETOPS diversion time slightly higher than 240 minutes.

On some “golden routes”, this can mean reduced distances of up to 500 nm, which is the equivalent of 1 hour of flight, or 10 percent of fuel.

ETOPS 240 certification by the FAA is expected by the end of 2015.

Cabin oxygen system

An Extended Duration Chemical Oxygen System (EDCOS) (generators/containers) will be introduced, providing significant weight saving and easing maintenance. It will enable our customers to change from the current gaseous oxygen system installation and will bring significant benefits to airlines requiring passenger oxygen supply up to approximately 60 minutes. Once this system has been qualified for the A330, it will also be adopted by other Airbus programmes.

Even in this field, the A330 is still “setting the standard” for other aircraft.

Communication systems

Swift Broad Band (SBB) SATCOM Derived from "Swift 64" (64kbps) SATCOM solutions and driven by cabin application needs, such as live internet, mobile phone use and email. Swift Broad Band SATCOM solutions by both Honeywell and Rockwell Collins were certified between 2009 and 2011 providing 2 channels at 432 kbps. They can both be operated with former SATCOM antenna or with the more recently certified antenna (July 2010) which is 25 kg lighter, easy to retrofit, and delivers fuel savings of approximately 100 kg for a typical A330 mission.

IRIDIUM cockpit SATCOM solution, certified in 2014, offers a low cost solution to equip in-service aircraft that are not yet SATCOM equipped, or to replace in-production current SBB (Swift Broadband) SATCOM that will become over-sized for cockpit operation when a powerful cabin SATCOM (Kx band) is selected. This solution provides worldwide coverage, and is easy to retrofit. Capability of the Electronic Flight Bag (EFB) connection will be certified by the end of 2015.

SATCOM voice for ATC communication (certified in 2011), offers increased reliability and better quality of voice communication. It also allows deletion of one High Frequency (HF) system. It does not need any hardware or software upgrade, but requires local ATC approval for long range communication.

A330neo systems
... and beyond

The A330neo has been designed to be fitted with all the above solutions, either as a basic configuration or as options depending on programme policy. It will also benefit from an electro-pneumatic bleed system, which has been the state-of-the-art for new programmes since the A340-500/600.

Beyond the A330neo, the A330 programme is still investing and preparations are being made in order to cope with up-coming regulations and/or new Air Traffic Management rules, such as:

- An upgrade Multi-Mode Receiver (MMR) development was launched mid-2015, as an Airbus cross fleet activity. It will provide architecture compliant with US ADS-B Out mandate by 2018/2019, with growth capacity to evolve to SBAS Landing System (SLS) approach capability and multi GPS constellations management by 2020/2025.
- Development of FANS A+C ATSU was launched in April 2015, to prepare for European ATM airspace (SESAR) operations requirements in 2018 (see FAST#53).

In the long term, as with other Airbus aircraft, new avionics and cockpit developments are being considered. These will consist of a new systems architecture associated with the integration of equipment resulting in less weight and cost while offering new functions.

GLOSSARY

ADS-B Out Automatic Dependent Surveillance - Broadcast Out

ATSU- Air Traffic Service Unit

ATM - Air Traffic Management

FANS A+C - Future Air Navigation System A+C

SBAS - Satellite Based Augmentation System

SESAR - Single European Sky ATM Research

FlySmart with Airbus

The ultimate goal for Airbus' Electronic Flight Bag (EFB) called "FlySmart with Airbus" is to improve airline operational performance by bringing information to the cockpit and tremendously reducing the use of paper documentation. It also provides integrated solutions for efficiently managing that information in-flight and on-ground.

FlySmart with Airbus was started in 2007 with the implementation of an "aircraft attached" EFB (Class 3), with integrated cockpit displays proposed in a front mounted or side mounted configuration, and usable in all flight phase conditions.

For operators preferring portable and connected EFB (Class 2), Airbus will soon propose new options based upon Wi-Fi in the cockpit to connect the pilot's own electronic devices (laptop or tablets) to the aircraft.

By the end of 2015 a Single Docking Station (SDS) solution, embedding a laptop as a Wi-Fi access point will be made available.

The second half of 2016 will bring the EFB Interface Communication Unit (EICU). Like the SDS, the EICU will provide avionics data to EFB, but it will also provide in-flight and on-ground communication capabilities through Aircraft Communications Addressing and Reporting System (ACARS) and Internet Protocol (IP). Both SDS and EICU solutions are the bridge between avionics and pilot electronic devices and are common with Airbus' A320 Family offer.

Head-Up Display

Head-Up Display (HUD) has been available on Airbus aircraft since 2006 (see FAST#46). This visual guidance system has been shown to significantly increase pilots' situational awareness, facilitates Instrument Meteorological Conditions (IMC)/ Visual Meteorological Conditions (VMC) transition, enhances stability of manual approaches and allows minima reductions during take-off and landing.

The HUD shows trajectory related symbols superimposed on a transparent screen in the pilot's forward-field view. Service experience confirms that the HUD provides a very good means to stabilize the aircraft during the approach phase.

The fully digital processing of the HUD system and the dual installation in the cockpit is compatible with future technologies: Enhanced Vision System (EVS) and a Synthetic Vision System (SVS).

Dual HUD function already available on the A320 Family, A350 and A380 was launched for the A330 in 2013. The long range HUD standard will be based on the latest certified single-aisle standard and proposes the latest functionalities to keep the highest symbology and operations' commonality throughout Airbus' fleet. Certification is expected beginning of 2018 (see FAST#56).

Systems hardware

When developing a function, its retrofit capability is a key driver of the design, and generally* these lead to favoured software solutions or simple Line Replaceable Unit (LRU) upgrades. For most functions, once they are certified, the necessary systems provisions become basic in production, and activation of the function is performed by pin-programming, pending RFC/RMO selection.

One key enabler of autopilot/FMS based functions is the last hardware of Flight Management Guidance and Envelope Computer (FMGEC), known as “GENEPI” hardware. It is capable of supporting the two last FMS standards and elaborate auto-pilot based functions:

FMS Release 1A Standards
This FMS standard contributes to several new functions, such as RNP-AR, FLS, GLS, fuel alerts for extended ETOPS, and Take-off Data Securing function. It supports an increased Navigation Database, and high speed A615A software loading.

FMS Release 2 Standards
This FMS standard is the current long term solution from Honeywell and Thales for A320/A330, that supports a world-wide Navigation Database, and a new FM card set with improved throughput performances. The Honeywell card set is basic if selected (since mid-2014). Honeywell FMS will be available first (early 2016) supporting CDA function, then Thales FMS expected in 2018, which will support the i4D function.

Auto-pilot based functions such as AP/FD TCAS, ROPS, Soft go-around, TCAP, FLS, GLS, HUD.

*A notable exception to this was EIS1 CRT displays. Their limited growth capabilities prevented upgrade to the targeted function and enhanced EIS2 LED displays were the right candidates for replacement.

GLOSSARY

AP/FD TCAS Auto-Pilot/Flight-Director Traffic alert and Collision Avoidance System

CDA - Continuous Descent Approach

CRT- Cathode Ray Tube

EIS - Electronic Instrument System

ETOPS - Extended-range Twin-engine Operation Performance Standards

FGE - Flight Guidance and Envelope

FLS - FMS Landing System

FMGEC - Flight Management Guidance Envelope Computer

FMS - Flight Management System

GBAS - Ground Based Augmentation System

GLS - GBAS Landing System

i4D - initial 4-Dimensions

LED - Light Emitting Diodes

MRTT - Multi Role Tanker Transport

MTBF - Mean Time Between Failure

OBRM - On-Board Replaceable Module

RFC/RMO - Request for Change/Retrofit Modification Offer

RNP-AR - Required Navigation Performance - Authorisation Required

ROPS - Runway Overrun Prevention System

TCAP - TCAS Alert Prevention

Airbus Upgrade Services has developed with Thales and Honeywell an attractive retrofit offer to evolve former FMGEC hardware to the GENEPI configuration, allowing the implementation of the above functions within the A330 fleet by OBRM (FGE) or software loading (FMS) upgrade.

Less visible than the above mentioned solutions, A330 programme investment also takes the opportunity to improve hardware MTBF during redesign or by certifying a more recent solution from another programme, increasing reliability and commonality. These incremental developments plus regular monitoring of fleet status, has meant that A330 dispatch reliability is steady at around 99.2 % for the whole A330 enhanced fleet and around 99.4% (rolling) for the last sixty delivered aircraft.

Cockpit evolutions depicted above are compatible with all A330 enhanced Weight Variant, A330-200F (Freighter) and the MRTT (with potential adaptation).

Most of the new cockpit functions and hardware mentioned above are retrofitable across the A330 fleet.

Flight Operations Commonality (FOC)

Cost-saving and better training

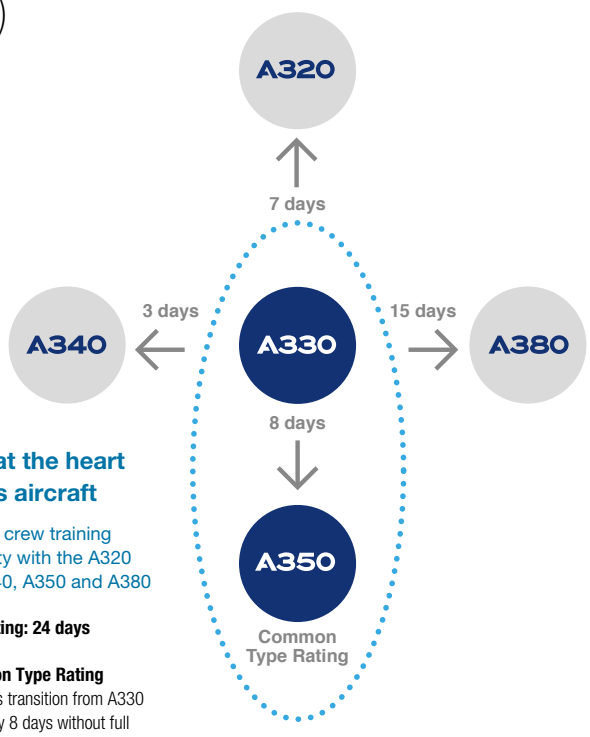
With the A330, Airbus' concept of a true aircraft family with a high level of commonality, comes into its own. Airbus operators may take advantage of shortened pilot training between Airbus aircraft types.

A pilot trained on one Airbus aircraft can control the flight path and handle the systems of any other aircraft with reduced training addressing differences called Cross Crew Qualification (CCQ).

Furthermore, Mixed Fleet Flying (MFF) allows an airline to operate multiple aircraft types requiring different licence endorsement by one pool of pilots.

A330 and A350 will benefit from Common Type Rating (CTR): A330 pilots can qualify on the A350 XWB in eight working days without full flight simulator time and then be able to fly both aircraft under a single license endorsement: Single Fleet Flying (SFF).

Training savings and productivity will be maximized with the possibility to practice A330/A350 and A340 (or A320 or A380) MFF, as MFF limits a pilot to two types of aircraft.



A330 is at the heart of Airbus aircraft

A330 Flight crew training commonality with the A320 Family, A340, A350 and A380

Full Type Rating: 24 days

A330 Common Type Rating
will allow pilots transition from A330 to A350 in only 8 days without full flight simulator sessions.

A330 Cross Crew Qualification (CCQ)
which includes simulator sessions, is available for A320 Family, A340 and A380 pilots with durations of 7, 3 and 15 working days respectively instead of 24 days.

CONCLUSION

A330 systems definition remains flexible in order to incorporate valuable adaptations for our customers. Operation safety enhancements are implemented across programme fleets when they are proven mature and add value to the aircraft and cockpit operations.