



**Airbus technical magazine**  
October 2019

#64

# FAST

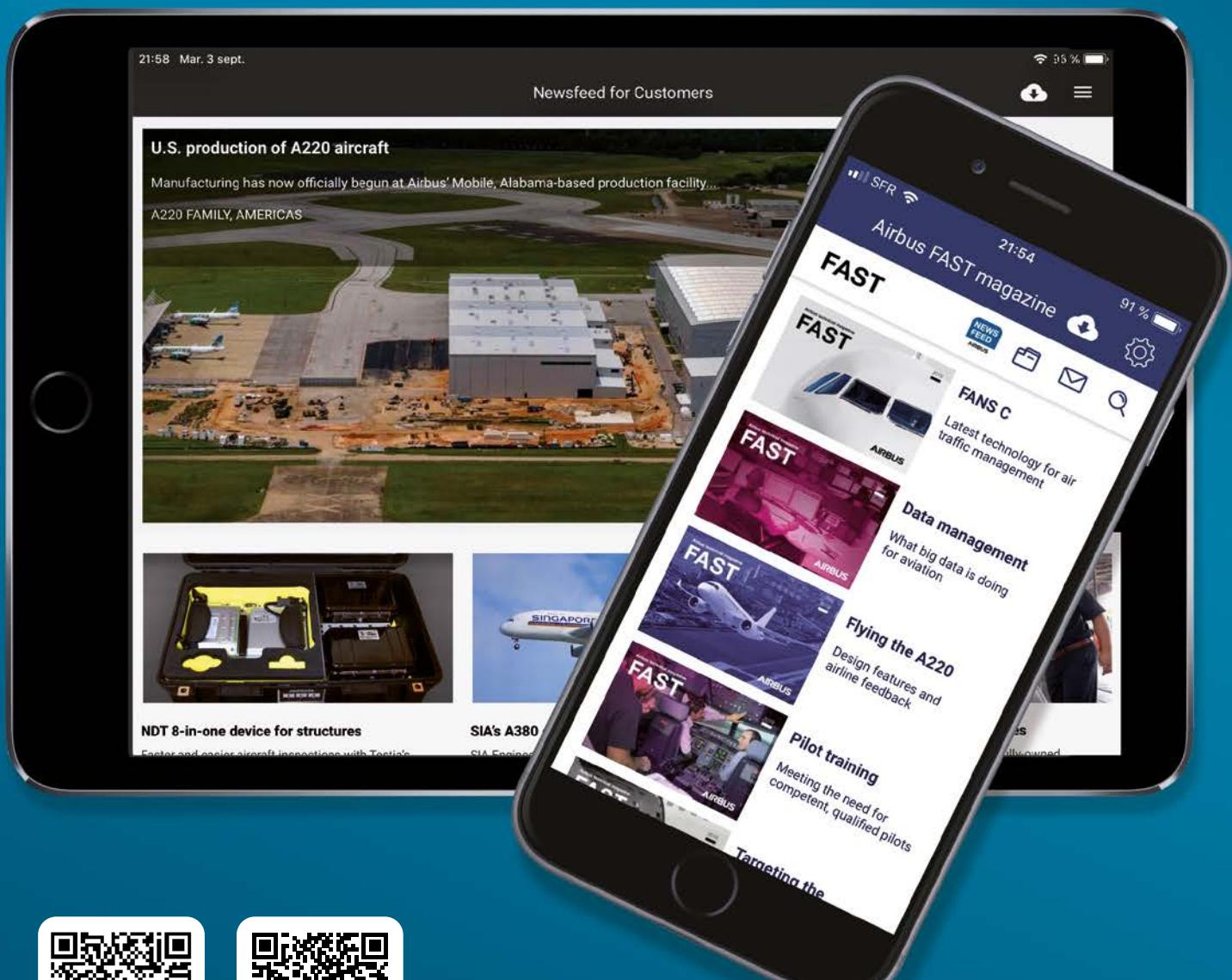
Flight Airworthiness Support Technology



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#64

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Flight Airworthiness Support Technology

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**Deborah BUCKLER**  
Chief Editor

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# Undesired aircraft state

Training pilots to prevent and recover

In an effort to investigate and mitigate loss of control in flight, the International Civil Aviation Organisation (ICAO) published in 2014 a series of recommendations for Upset Prevention and Recovery Training (UPRT).

In line with ICAO, the US Federal Aviation Authority, the European Aviation Safety Agency and other national aviation authorities have introduced new UPRT requirements. New requirements for Flight Simulation Training Devices have also been issued to enable more effective and realistic training.



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*\* The Threat and Error Management model is a conceptual framework that focuses on understanding the inter-relationship between safety and human performance in dynamic and challenging operational contexts.*

Airbus has taken part in UPRT industry and rule making initiatives for many years. Results of this involvement include the first two editions of the Airplane Upset Recovery Training Aid (AURTA), published by the Flight Safety Foundation. Edition 1 was issued in 1998; Revision 2 was published in 2008.

More recently, in 2017, Airbus actively contributed to a revised edition of the Airplane Upset Prevention and Recovery Training Aid (AUPRTA). This document, available on the ICAO website, promotes a new definition of upset as no longer characterised by pitch, bank or speed values exceedance. Rather, it assimilates upsets to undesired aircraft states, which are a component of the Threat and Error Management (TEM)\* model. As a result, more importance is given to prevention and early detection of undesired aircraft states and the TEM model is used to address the root causes of potential upsets.

Airbus has already integrated the new UPRT approach into its pilot and instructor training. The training emphasises the prevention and early recognition of undesired aircraft states. The objective is to develop skills and reinforce pilot confidence to achieve a good level of resilience.



## What is an undesired aircraft state and why does it happen?

An undesired aircraft state is characterised by unintentional divergences from normal operating parameters. It may involve pitch and/or bank angle divergences, as well as inappropriate airspeeds for the conditions.

Deviations from the desired aircraft state will become greater until action is taken to stop the divergence. Return to the desired state can be achieved through the aircraft's static or dynamic stability, auto-flight system response or pilot intervention.

Airbus believes that flight crew engagement combats complacency through active monitoring. This makes active monitoring critical in ensuring awareness and avoidance of undesired aircraft states and provides the strongest counter-measure against startle\*\*. An engaged crew is in the best position to cope with undesired aircraft states.

From the early stages of training, pilots should acquire knowledge, skills and attitudes to perform active monitoring throughout all operations and phases of flight. This should become part of the competent pilot's DNA.

*\*\*As defined by ICAO, startle is the initial short-term, involuntary physiological and cognitive reaction to an unexpected event that commences the normal human stress response.*

## Training recommendations for prevention and recovery

Airbus has recently published training recommendations for undesired aircraft states prevention and recovery training in a specific Operations Training Transmission (OTT). They also appear in the new Flight Crew Training Standards (FCTS), a manual dedicated to course designers.

These two documents include recommendations related to the training methodology, training exercises and training media to be used.



# Prevention and early recognition

Pilots should be able to identify a developing undesired aircraft state. The competency focus should be on situation awareness (SA) and knowledge.

Practical training related to undesired aircraft states prevention should include:

- Understanding of the flight control law principles and protections;
- Exploration of the normal flight envelope\* (low and high speeds, low and high altitudes), with a specific emphasis on angle of attack awareness;
- Energy management at low and high altitude;
- Manual handling skills reinforcement in normal and reconfiguration flight control laws at low and high altitude;
- A reminder of AP/FD (Auto Pilot/Flight Director) and A/THR (Auto Thrust) specificities (engagement and disengagement, operating limits, mode reversions, etc.).

*\*Flight envelope: the operating parameters in which a given aircraft type is aerodynamically stable. The envelope is defined in terms of altitude, attitude, airspeed and load.*

Active monitoring should be encouraged during training. Airbus promotes the use of ICAO core competencies for pilot assessment. Consequently, observable behaviours related to each core competency should include elements of active monitoring.

Years of experience have demonstrated that automation has significantly improved safety and operational efficiency. However, in very rare cases of abnormal conditions, automation may become inoperative. This is why it is important to remind pilots of basic flying techniques across the whole flight envelope that enable the avoidance of undesired aircraft states.

Moreover, barely ten per cent of a commercial aircraft's flight envelope is used in everyday operations. Training flight crews to explore the full envelope is seen as key in UPRT, including performance at low and high speed and altitude and, importantly, awareness of angle of attack.

In parallel to improving manual flying skills, Airbus recommends that pilots receive regular 'refresher' training on the auto flight system to master its full functionality and impact on aircraft behaviour.



# Recovery

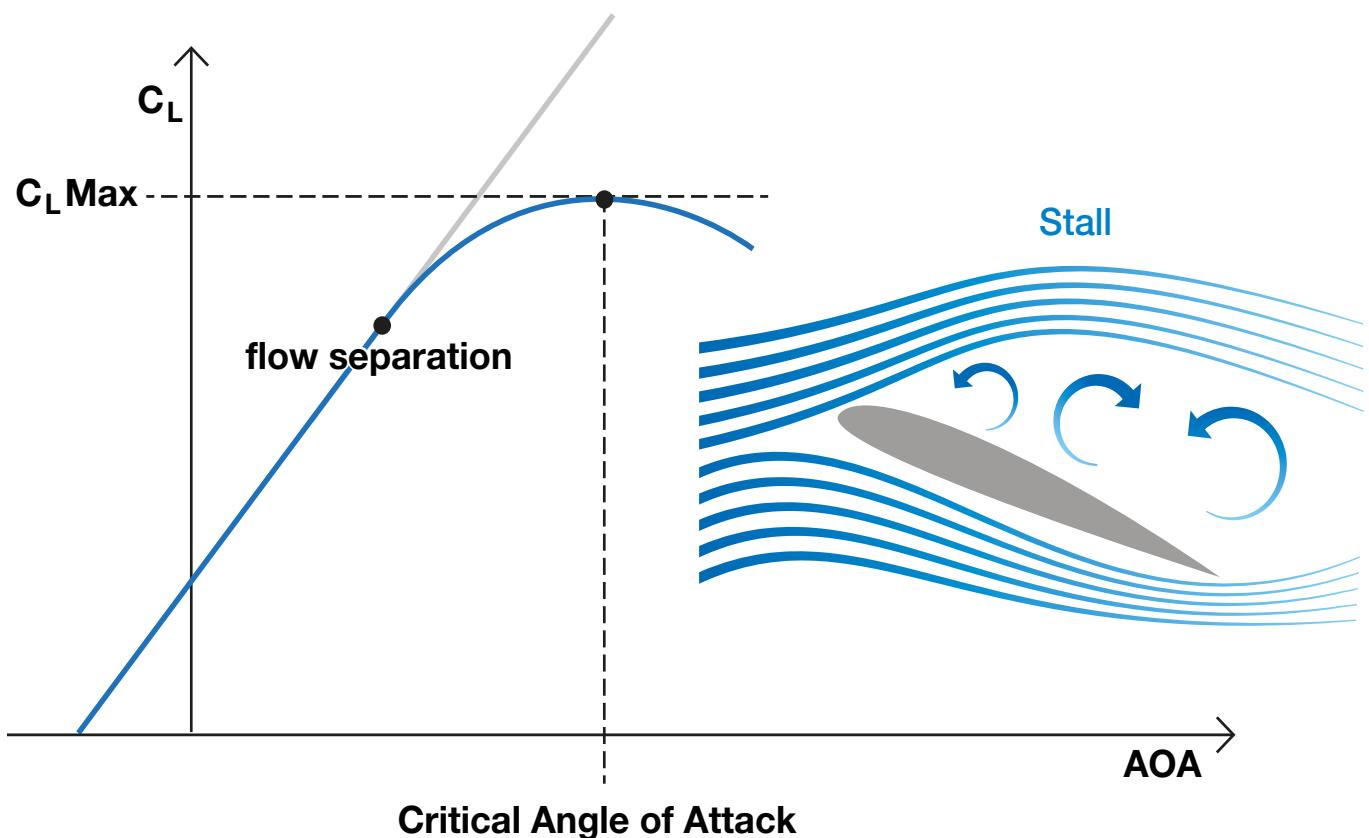
When the flight crew recognises an undesired aircraft state, it should be able to apply the correct procedure or technique to exit the state. The competency focus should be on Flight Path Management – Manual Control (FPM) and Flight Path Management – Automation (FPA).

The practical training related to undesired aircraft states recovery should include:

- Recovery from speed excursion, particularly at high altitude.
- Recovery from unusual aircraft attitude at low and high altitude.
- Approach to stall at low and high altitude.

Approach to stall training assumes that the pilots react to the first stall cue, which may be a stall warning or a stall buffet - whichever occurs first. However, some National Aviation Authorities such as the FAA mandate full stall training. FAA advisory circular AC120-109A advises that “upon pilot recognition of the impending stall, the instructor will encourage the further increase of angle of attack to reach full stall while highlighting the impending stall cues.”

## Beyond the critical angle of attack



‘Negative learning’ is when trainees risk developing bad habits during training by deliberately flying beyond the aural warning or ignoring the stick-shaker to create a ‘hands-on’ stall. To counter the risk Airbus recommends the use of a function called Automated Stall Entry (ASE), which may be implemented on the Instructor Operation Station (IOS) whereby at the press of a button the instructor can induce a stall. This functionality is valid for all Airbus A320, A330, A350 and A380 Family aircraft. It enables the replication of a real Airbus aircraft stall without pilot intervention until the trainee decides to take over.

## New requirements for Flight Simulation Training Devices and corresponding simulation package (SimPack)

Recent revisions to Flight Simulation Training Device (FSTD) regulations specify enhanced modelling requirements with regards to stall (EASA: CS-FSTD (A) Issue 2; FAA: 14 CFR Part 60 change 2), in relation to the new Undesired Aircraft State Prevention & Recovery Training (JASPART) requirements.

The FAA and EASA-mandated training requires updates to FSTDs in order to enhance models and to provide feedback to the instructor on the Instructor Operator Station. Airbus has developed a compliant SimPack that can be integrated by the training device manufacturers.

The SimPack for UPRT and Stall Training is composed of simulation models, documents and Qualification Validation Source Data (QVSD).

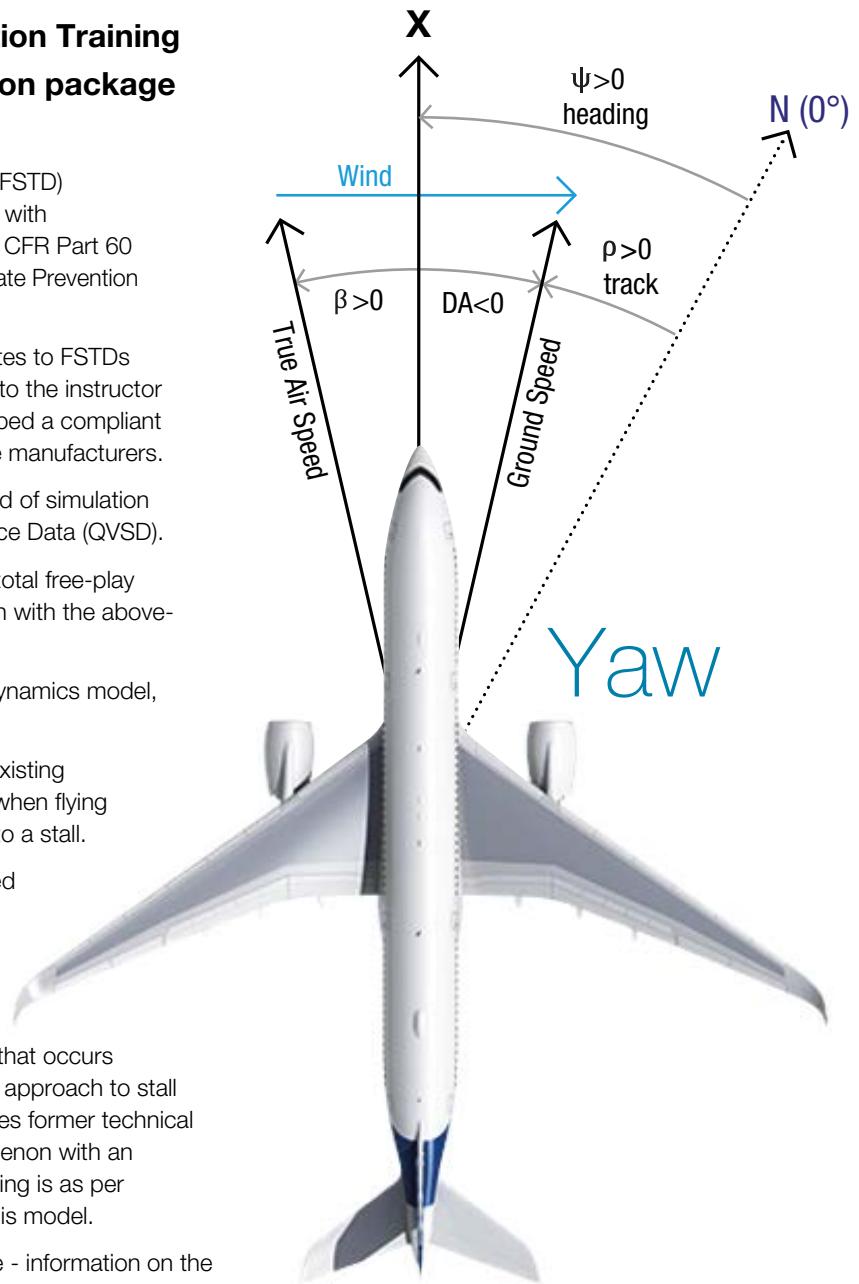
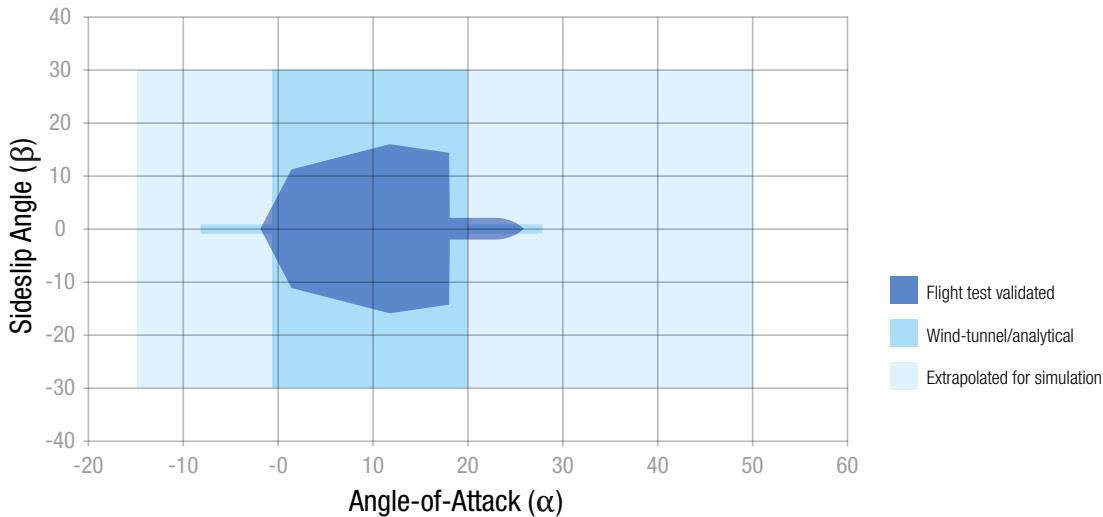
It contains enhanced simulation models that provide total free-play capabilities. These models can be used in conjunction with the above-mentioned Automated Stall Entry IOS feature.

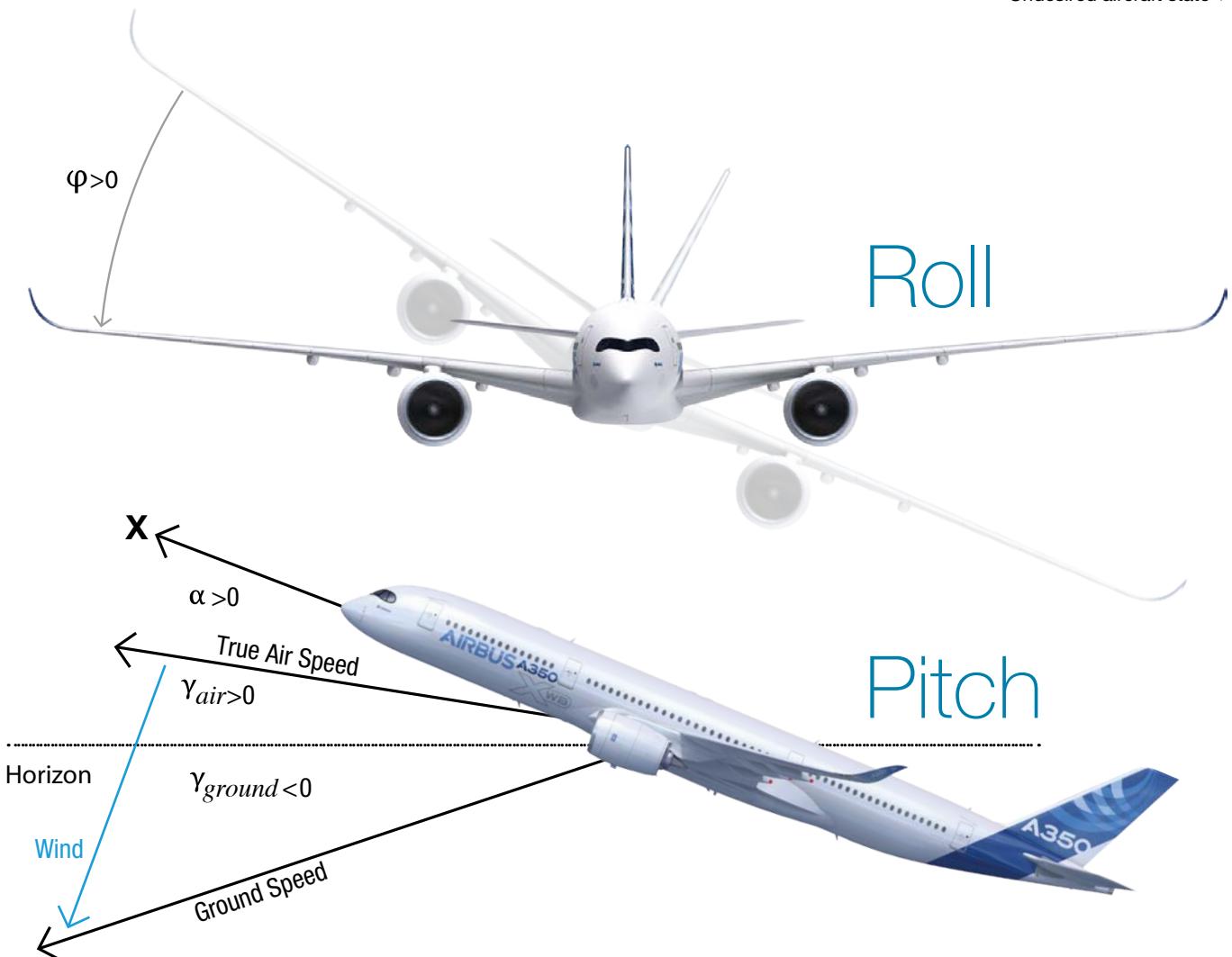
The simulation models consist of an enhanced aerodynamics model, a stall buffet model and a roll-off model:

- **The aerodynamics model** is an evolution of the existing model that simulates additional features occurring when flying at a high angle of attack in approach to stall and into a stall.
- **The roll-off model** accounts for the uncommanded acceleration in roll and yaw that may occur when flying into a stall. This feature is to be triggered and monitored by the instructor. This is a new model.
- **The stall buffet model** accounts for the vibration that occurs and amplifies when the angle of attack increases in approach to stall and stall situations. This is a new model that replaces former technical documents. The purpose of modelling this phenomenon with an Airbus-designed model is to ensure that the modelling is as per aircraft and consistent among all FSTDs that use this model.

The documents include the FSTD Validation Envelope - information on the origin of the data used by the models (flight tests, wind tunnel, extrapolated). They provide a status of compliance of the models (information on the modelling techniques), as well as the result of stall characteristics assessment by Airbus subject matter experts.

### Example of FSTD Validation Envelope





The QVSD is the flight test reference data required for the objective validation of the FSTDs (the 'Qualification Test Guide (QTG)' tests). These elements are available for the A320 (CEO and NEO), A330, A350, A380 and A300-600.

Airbus delivers a comprehensive description of these elements to customers, as well as a rollout schedule, in a Simulation Product Operators Transmission (SPOT) referenced S00500102 – SimPack for Upset Prevention and Recovery Training (UPRT) and Stall Training.

### Glossary

**AUPRTA** Airplane Upset Prevention and Recovery Training Aid

**QVSD** Qualification Validation Source Data

**UPRT** Upset Prevention and Recovery Training

**UASPR** Undesired Aircraft State Prevention & Recovery Training

**TEM** Threat and Error Management

**SimPack** Simulation Package, the Airbus offer encompassing a data package, simulation software package and cockpit hardware. It is used to design FSTDs representing an Airbus aircraft.

## CONCLUSION

Airbus has long supported collaborative international initiatives aimed at mitigating the risk of loss of control in flight. The shared objective is to increase pilots' ability to recognise and avoid situations that can lead to an undesired aircraft state; and to improve their ability to quickly recover full control in the event of a flight upset.

Finally, as an Approved Training Organisation Airbus has already integrated regulation-compliant Undesired Aircraft State Prevention & Recovery Training (UASPR) into the majority of its recurrent programmes for the primary purpose of improving aviation safety.

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# Sky control

## Rethinking air traffic management

Innovative technology alongside effective change management have helped safely manage air traffic at the second busiest airport in South America



Since its airspace was designed in the 1990s, Colombia's El Dorado Airport in Bogota has seen rapid growth. Now the second busiest airport on the South American continent behind Sao Paulo's Guarulhos Airport, passenger numbers increased by over 70% at El Dorado from 2010 to 2016 while the number of flights (operations) grew by 30%.

Colombia's ANSP (Air Navigation Service Provider), Aerocivil, recognised that changes needed to be made to accommodate this growth and commissioned the International Air Transport Association (IATA) to establish what could be done to manage the airspace above Bogota more efficiently. In 2015, IATA partnered with Airbus flight operations and air traffic management subsidiary, NAVBLUE, to develop and implement solutions supporting the overall airspace management.

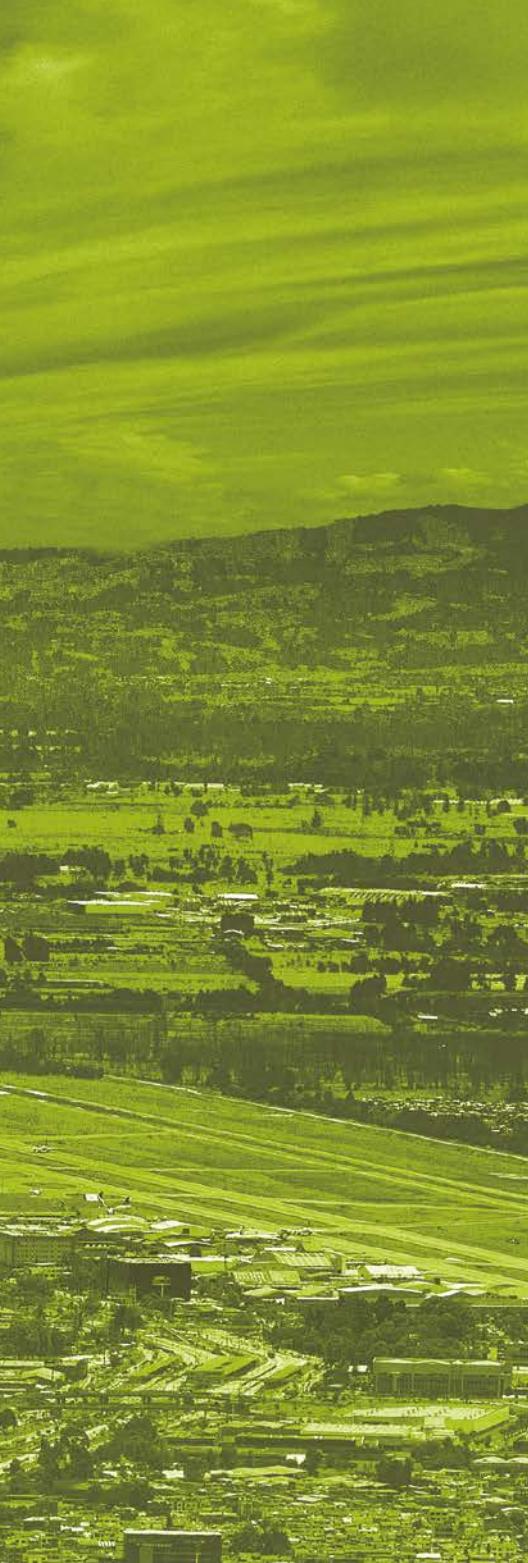
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Radar tracks showing vectored approaches and departures in Bogota

To improve the efficient use of the airspace, ensuring safe future use that could be effectively managed by air traffic control operators, NAVBLUE designed a new concept of operations (CONOPS).

*"We had an international cooperation agreement with IATA on this project. This was the first airspace for a full TMA (Terminal Manoeuvring Area) project delivered by NAVBLUE and we were responsible for delivering the CONOPS, implementation and training. We started work in April 2015, with the CONOPS deployed on 12 October 2017."*

## Congestion in the skies

Dated air traffic management procedures alongside continuously increasing traffic combined to cause excessive holding times for operators at El Dorado, and a very high workload for the ATC (Air Traffic Controllers) controlling arrivals and departures across the airport's two runways.

*"The rapid growth at El Dorado was beyond the airport's planning. Airspace is not indefinite – you can make airports bigger on the ground, expand runways and terminals, but airspace is limited. So if you put more aircraft into the airspace, unless you have a CONOPS designed to move aircraft in and out efficiently, you will have delays, holds, challenging ATC workload and other difficulties. That is what happened in Bogota."*

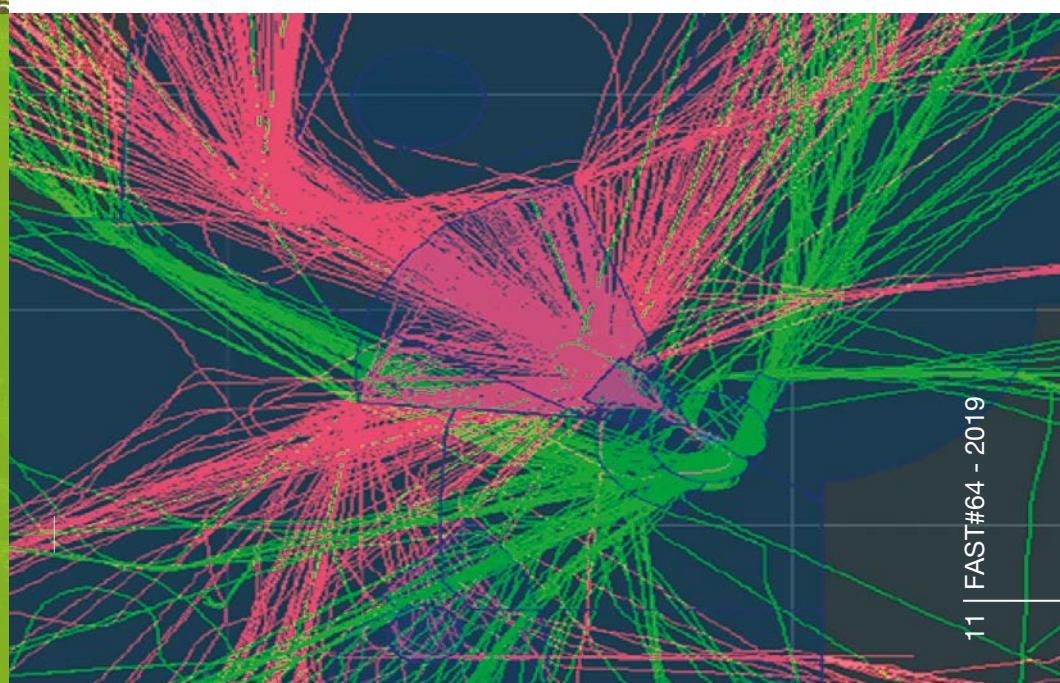
Flight planning at El Dorado was also difficult for ATC because all aircraft were vectored in (separating aircraft by a specified distance, to aid the navigation of flights) for arrivals, requiring frequent radio communications.

*"El Dorado airspace was working at its limits, with technology and procedures that they had been using for 15-20 years. They needed a change and wanted advice on available solutions from experts in airspace design."*

## What does NAVBLUE do?

Airbus services subsidiary NAVBLUE provides solutions for flight planning and aircraft performance, and is dedicated to Flight Operations and Air Traffic Management solutions.

- Services include digital cockpit operations, Operations Control Centre (OCC) systems, Performance Based Navigation and ATM consultancy
- It has developed hundreds of procedures to optimise airports capacity and efficiency around the world. From airports handling over 300,000 movements to remote and challenging airfields, it aims to improve access to airports and increase capacity



## Mountains and military

As well as the historic ATC processes used at Bogota, there were further challenges at the airport that complicated air traffic management.

*"The airport is located in challenging terrain. It's high up and hot. And to the north a significant section of the BOGOTA TMA airspace is used for military activities and closed to commercial aircraft."*

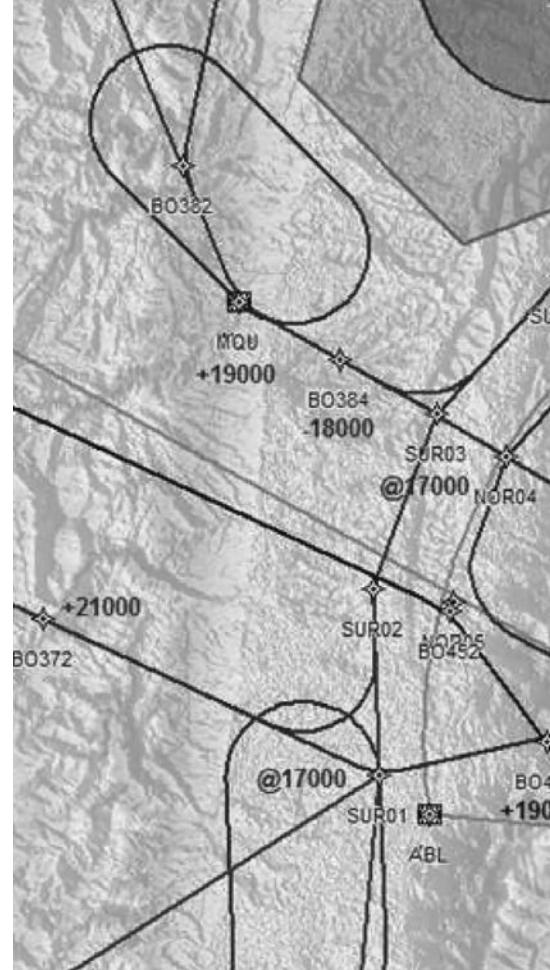
*In a parallel challenge to the project, we worked with the military on the flexible use of airspace – where together we defined specific procedures for crossing through the military airspace that could be used by civilian aircraft under certain conditions. For example, as a start this airspace could be made available during specific times of the year such as Christmas, when the airspace wasn't in use. Or at night.*

*The military was very keen to help."*

The mountainous terrain surrounding the airport ultimately affected the CONOPS that could be implemented.

*"There were challenges with crossing the mountains and altitude. The main runway configuration of operations at El Dorado is 13; when aircraft depart, they have to go left or right of the mountains, as it's not possible to cross them directly."*

*Bogota wanted an airspace that worked for a long time. And it wanted 90 operations per hour on the runway 13 configuration (see diagram below). That was a huge challenge, as 90 operations per hour means close to the maximum capacity managed by other airports with two runways and although Bogota has the same two runway configuration, it also has the terrain challenge."*



El Dorado airport is surrounded by mountains and a significant section of the northern Bogota TMA airspace is used for military activities

## Limited space

The capacity at El Dorado airport was also constrained by several factors:

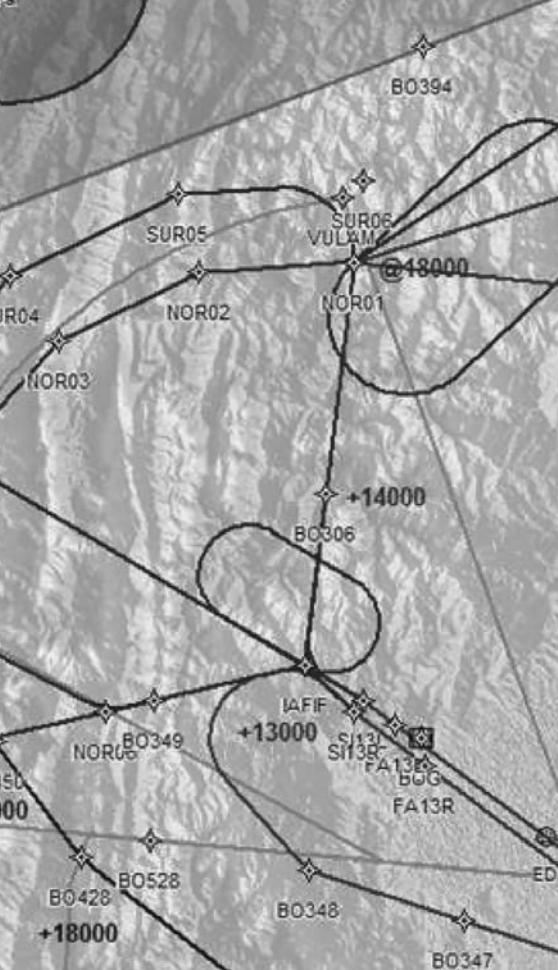
- Airspace limitations
- Runway capacity
- Ground operations
- Processes and control standards
- Manuals (SOPs or documents which instruct and guide ATC on how to operate the airspace) and regulation

Its airspace management solution needed to address ATC vectors (where air traffic controllers manually keep aircraft separated by a combination of distance, altitude and/or speed), holding patterns and bottlenecks at VOR (navigation beacons). The airport's procedures were causing problems for air traffic management including different sectors and excessive radio communications.

### Did you know?

**Runway numbers** are based on the magnetic compass direction they are oriented to and consist of two numbers. If the magnetic direction is 132°, you would round it down and drop the last digit leaving you with Runway number 13. When an airport has multiple parallel runways with the same orientation, a letter is assigned after the runway number: L (Left), C (Centre), R (Right). The opposite side of the runway has the reciprocal magnetic compass orientation, which in this example would be 31. As a result the orientation of the runway is referred to as 13/31





## The solution

One solution was to redesign the airspace and optimise airside capacity at El Dorado airport.

*"This project was about changing the airspace design to create a more orderly flow of aircraft, but also to implement this through change management. We wanted to position Bogota El Dorado international Airport as one of the most efficient international terminals in Latin America by increasing its capacity and airspace efficiency, keeping in mind safety as the top priority."*

The aim was to do this by:

- **Introducing Performance-Based Navigation (PBN)**
- **Reducing aircraft separation within the TMA**
- **Implementing independent and simultaneous parallel runways operations**
- **Improving ground operations**
- **Updating regulations and operations manuals**  
(SOPs or documents which instruct and guide ATC on how to operate the airspace)
- **Enhancing ATC capability with theoretical, and practical on-the-job training.**

*"Before building the CONOPS, we worked closely with Aerocivil and IATA to fully understand their requirements. We then refined the CONOPS to make it acceptable to all the different stakeholders."*

By observing ATC, interviewing operators, the Colombian Air Force and other stakeholders, NAVBLUE identified the airspace design constraints and ATC resourcing issues that needed to be addressed.

*"We found that 100% of arrivals were vectored, including speed, altitude and headings. That meant a lot of radio communications. In fact there were so many, it was difficult for people to get onto the radio because it was always busy."*

*To create spacing between arriving aircraft, controllers were forming arcs (instead of sending them direct to the runway) of aircraft. The planes were sent to the VOR (similar concept to a 'point merge') where the aircraft come off the arc and to a point where they start their final approach to the runway.*

*Technology at the time for point merge was used by few airports, but we thought it could work at Bogota. With this technology the approach is coded into the database and aircraft are positioned automatically. This reduces the amount of communications between controllers and the aircraft.*

*So today, instead of flying to a normal conventional nav-aid for procedures, the airspace at Bogota is designed on PBN technology."*

From its observations, NAVBLUE created a Current Situation Assessment and a Gap Analysis Report. These two activities allowed NAVBLUE to baseline operations at El Dorado and model them with simulation software.

*"From the Fast Time Simulation we got a theoretical 93 operations per hour in the airspace."*

With this baseline in place, a new CONOPS could be designed and compared against the current situation and against other likely operational scenarios, including an increase in traffic growth.

The CONOPS to be developed included:

- **Using RNAV and balancing sector ATC workload to improve access and efficiency**
- **Reducing the requirements to vector aircraft and reduce workload by creating a point merge system**
- **Helping reduce ATCO workload and improving predictability for pilots**
- **Implementing procedures to separate flight trajectories, reducing conflicts and allowing for efficient flight climb and descent trajectories**
- **Separating arrival and departure trajectories to allow runway 31 arrivals and runway 31 departures to operate simultaneously**
- **Concentrating arrival aircraft on two main flows to reduce complexity.**

CONOPS timeline

2015	2016	2017
Data survey, conceptual design	Detailed design, Performance analysis, testing and validation, approval and publishing, training of ATC	

## The implementation

Once the CONOPS was agreed by all key stakeholders, the team were then able to begin implementation. This included detailed procedure design and testing, training, cultural change management, documentation updates and awareness raising.

*"The navigation technology we brought in at Bogota included both RNAV (area navigation) and RNP AR (Required Navigation Performance Authorisation required). It was a challenge getting operators to adopt the systems, but they said they would do it if it improved efficiency.*

*There are aircraft that fly into Bogota that are not capable of RNAV. So Aerocivil are retaining some conventional procedures for these aircraft when they come in and out. Today there is a balance, 'mixed separation', where most of the aircraft fly the RNAV/PBN systems, but those that don't have the technology or operational approvals can still use the airport.*

*The good thing about PBN is that it's predictable, controllers know that the majority of traffic will be flying the same procedures. Controllers can concentrate on aircraft that don't have the technology and vector it. Because the other aircraft all have predictable altitude, speed and trajectory."*

## Creating order

Before the CONOPS, there were occasional aircraft conflicts at Bogota.

*"When aircraft were vectored coming in, they were descending at a manual speed, while the departures were RNAV. What happened at selected waypoints was that some aircraft were descending at increased vertical speeds and others taking off at the right speed, and conflicts were created. But by having the departing and arrival trajectories separated or coded with specific altitudes for separation, this 'dance' could be avoided.*

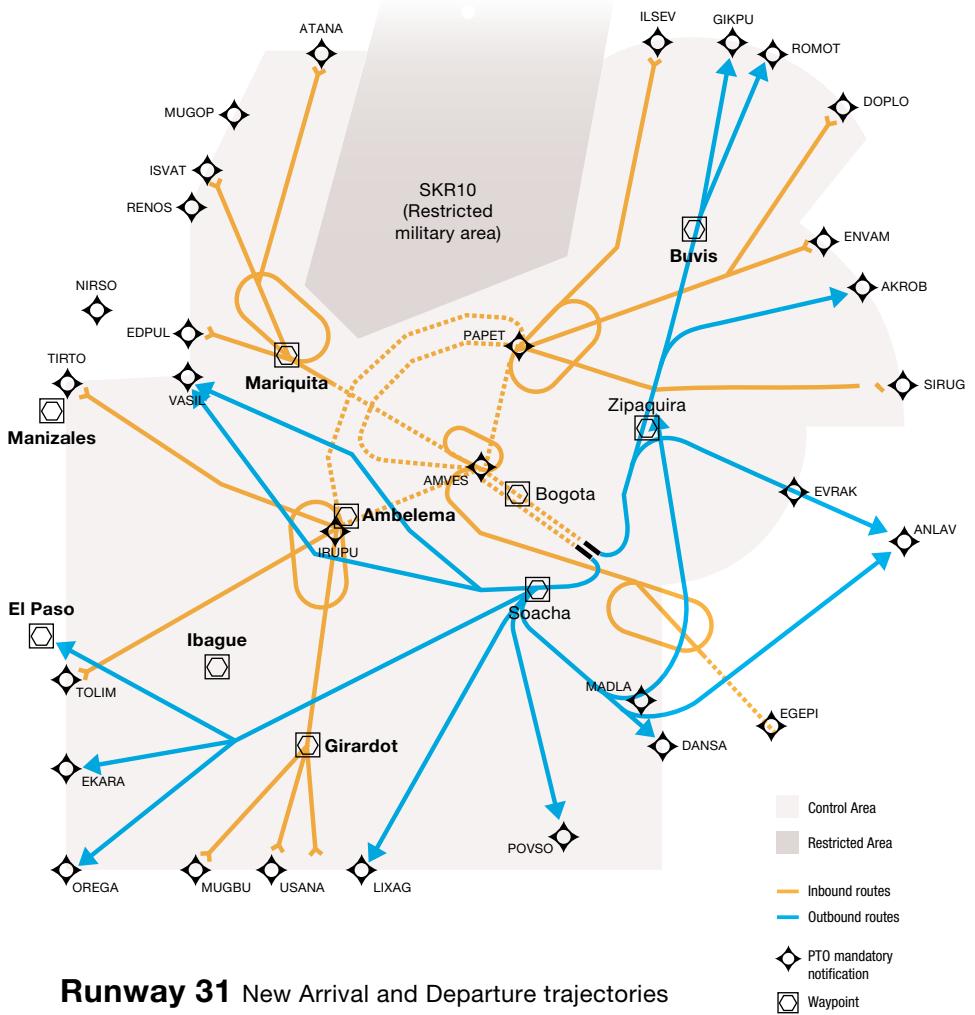
*So we entered into Continuous Descent Operations or Continuous Climb Operations. That meant putting in some altitude windows that would allow, for example, a departing aircraft to be kept at a certain altitude and the controller could look to see there was no conflict of aircraft arriving, they could then ascend all the way to the cruising altitude. Or when they were descending, they could do so uninterrupted."*

Another issue the CONOPS addressed was creating a system to efficiently switch between runway configurations when needed.

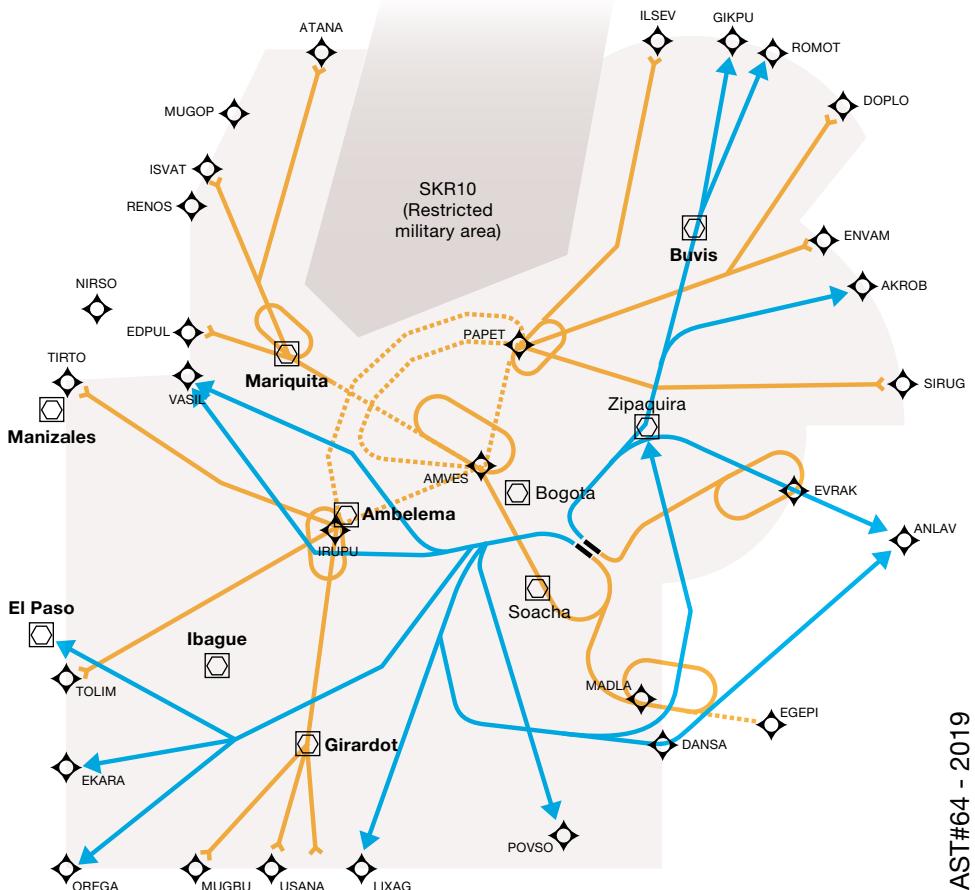
*"If you are coming into runway 13 configuration, ATC might need to change runway configuration because of the wind, but runway 31 had a big challenge because everyone was coming in through the same waypoint. The capacity of the airport would therefore be reduced, and changing runway configuration was chaotic and lengthy."*

Consequently, **we introduced ARCs in the CONOPS that are exactly the same for either runway 13, or runway 31 configuration.** The only thing that changes are the altitudes at the point merge. If they needed to switch between runway configurations, it would thus only take around 15-20 minutes. Because of the altitude separations for departing and arriving trajectories, this dramatically increased the runway 31 operations – they went from 50 to approximately 70 operations per hour. Bringing it up to almost the same capacity of 74 operations per hour managed for the runway 13 configuration. For the controller it means regardless of what runway configuration you fly, they used the same STARs, ARCs, and SID transitions."

## Runway 13 New Arrival and Departure trajectories



## Runway 31 New Arrival and Departure trajectories





## View from the Air Navigation Service Provider

Colonel Edgar SANCHEZ, formerly working for Aerocivil as Deputy Director, talks about the successes of the project...

### What was your involvement?

*"I led air traffic control procedures and aeronautical information, as well as being directly responsible for the implementation of the new CONOPS allowing the operational increase of the most important airport in Colombia."*

### What changes have resulted at the airport since the project was implemented?

*"The operational capacity has increased, going from 70 operations per hour to 90 operations per hour. The flight times were also reduced considerably, which has reduced fuel consumption and CO<sub>2</sub> emissions, so it has benefited the airlines, passengers and environment. Previously, when due to wind conditions the track was changed for approach and takeoff, the capacity of the airport was reduced by almost 50%, but now there is no capacity reduction."*

### What do you see as the main successes?

*"The increase in capacity of air operations from 70 to 90 per hour from the air side and the increase of safety standards for air traffic control and stabilised approaches."*

## Balancing workloads

Before the CONOPS, sector workloads by controllers were very unbalanced.

*"There were sectors that were very challenging and busy for the controllers. We needed a re-sectorisation for controllers to bring more balance. Pilots were telling us before the CONOPS, that they had little information about what to expect, they didn't know which runway they were going to get, so they had to brief both runways and expect landing clearance just before the final approach. The new system is easy for the pilots to fly and for the controllers to manage. It's more predictable which allows early preparation, raises awareness and safety."*

## Clear information on obstacles

Before the CONOPS, there was limited published information on obstacles (man-made obstacles or vegetation) at Bogota.

*"We carried out a partial data survey to provide information on the obstacles pertinent to departure and arrival trajectories, to be put in the aeronautical publications."*

*"The obstacles are very important, because if they are public, airlines can carry out performance assessments – for example, working out departure weight depending on where the obstacles are. We provided all the obstacle information through Electric Information Systems (EIS)."*

## Training programmes

To ensure smooth implementation of the project, the participation of ATC teams was critical, so NAVBLUE oversaw a thorough training and change management programme using classroom, simulator and on-the-job training techniques. This 'train the trainer' approach has meant that knowledge transfer has become self-sustaining.

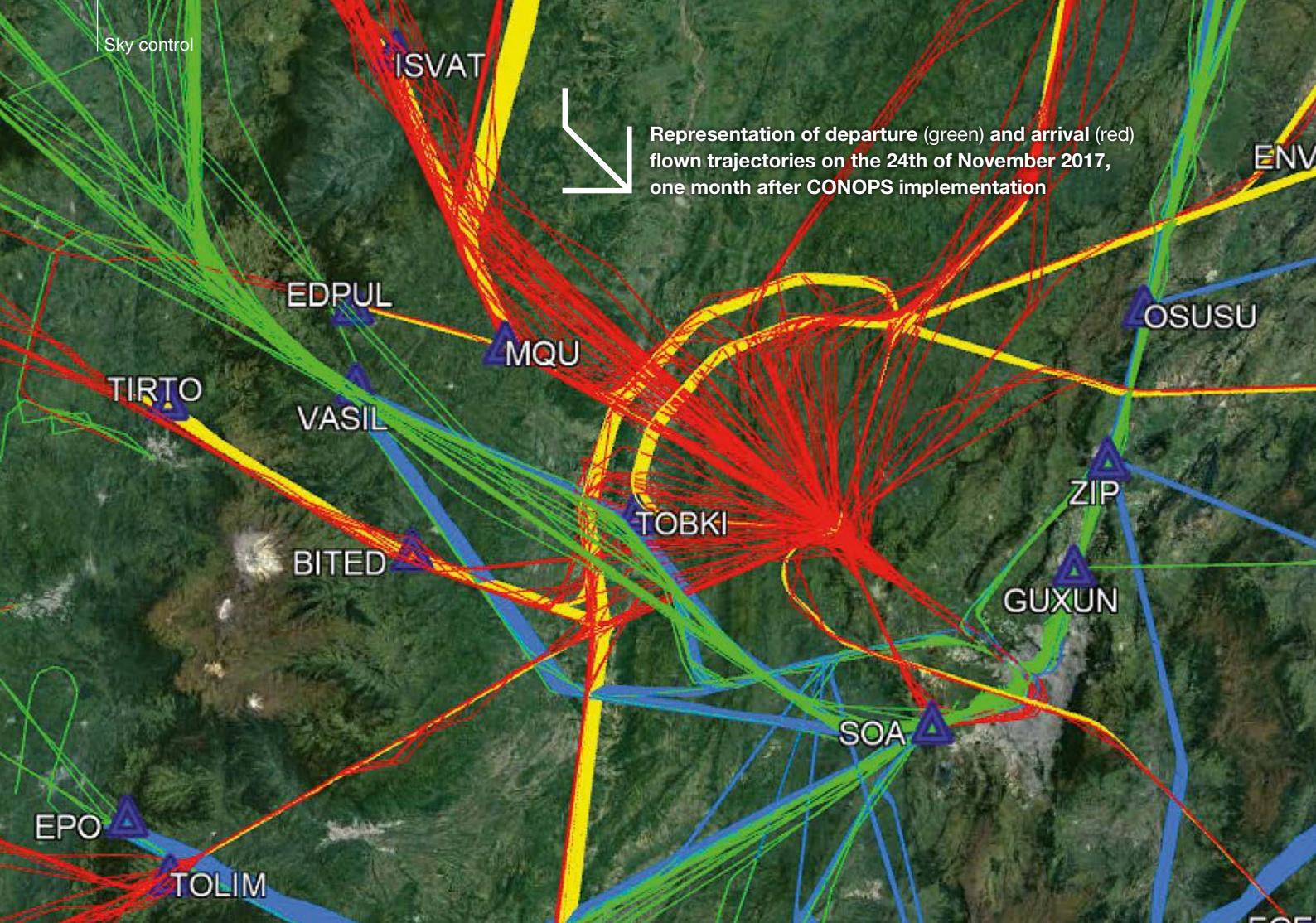
*"Once the project was launched, the challenge was how to make it operational. Aerocivil was very good at planning the start of operations with the required time in advance, so we planned it months in advance, with all operators aware of the changes and of the date of transition to the new CONOPS."*

*"Part of the success to be able to do this was the training of aircraft controllers. We worked with Aerocivil, coding all the procedures inside their training radar facility, running different training scenarios. All of the controllers were trained."*

*"We developed the curriculum and ground training simulators. We trained an initial batch of ATC instructors and a group of controllers, and after that IATA continued to repeat that training with the remaining controllers."*

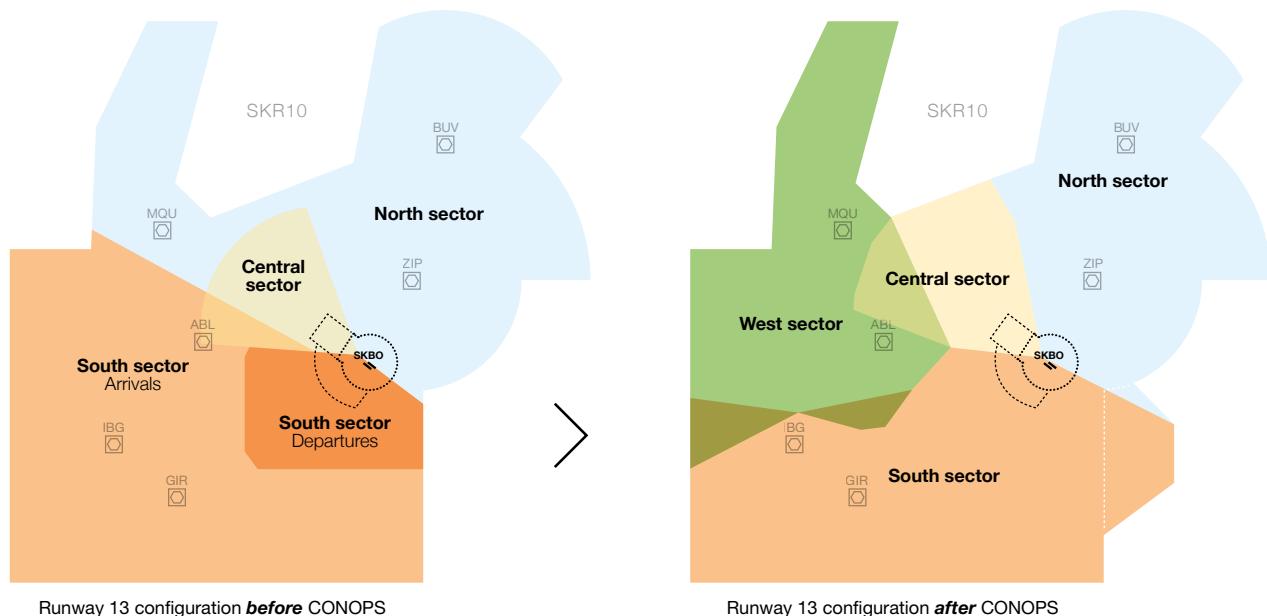
*"A year after implementation, we reviewed with controllers and operators how they were doing and what the challenges were, providing a report based on their feedback (2019) for further improvements."*





#### Balanced TMA sectors

Due to increased inbound and outbound aircraft operations in the Bogota TMA, ATCO workload was not balanced and needed adjustment. After studying the flown city pairs, along with peak traffic and the new point merge arrival strategy, updated TMA sectors were proposed to balance the ATCOs workload and make the airspace capacity more efficient.



# Making a difference

The project has resulted in multiple benefits for El Dorado airport:

## Landing and take-off capacity

- Increase in airspace potential capacity – runway 13 has increased by 29.2% from 74 operations per hour up to a theoretical 93, while runway 31 has increased by 40% from 50 operations per hour to 70

## Efficiency

- A reduction in ATC work rate, mainly in radio communications which were significantly reduced (60% fewer communications per aircraft)
- Controllers (focus on management of aircraft separation and speed instead of manually vectoring aircraft direction, altitude and speed)
- Pilots (fewer communications to deal with: 3 to 4 per landing instead of previous 7 to 8)
- Passengers feel the benefit from reduced delays and holding
- Improved climb locations
- Procedures to allow the flexible use of military airspace
- Parallel independent runway operations as required
- Peak sector workloads have been reduced so they are more balanced. Today ATC have a base line, so if the sectors get busier in the future they can change some of their procedures to balance sector workflow

## Glossary

**ATM** Air Traffic Management

**ATC/ATCO** Air Traffic Controllers

**CCO** Continuous Climb Operations

**CDP** Continuous Descent Operations

**CONOPS** Concept Of Operations

**RNAV** a method of flight navigation that allows an aircraft to choose any course within a navigation network of beacons

**RNP** Required Navigation Performance

**RNP-AR** Required Navigation Performance with Authorization Required

**PBN** Performance-Based Navigation

**STAR** Standard Arrival Route

**SID** Standard Instrument Departure Route

**TMA** Terminal Control Area

**VOR** Very High Frequency Omni-Directional Range, the most standard air navigation system

## Economics

- The project is forecasted to bring financial efficiencies up to US\$100m per year

## CONCLUSION

*"Implementing a new CONOPS is an art and a science. We're implementing a mixture of proven technology and innovation methods, but nothing would work without the buy-in of the stakeholders. With a diverse team of ATC, pilots, instrument flight procedure designers, expert project managers you can overcome the trepidation of the stakeholders so they can become partners. Without their willingness to take on the challenge, it would have been impossible for Bogota Airport to imagine a significant reduction of holding time and ATC workload coupled with an increase in capacity and efficiency."*

Bogota Airport now has a baseline CONOPS that will continue to improve over time.

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# Cabin Communication

## Architecture, functions and troubleshooting



For all Airbus aircraft types, it is the CIDS (Cabin Intercommunication Data System) which is the key system for the aircraft cabin and enables management of cabin lighting, passenger service system functions, EVAC (evacuation) signals, cabin interphone and cabin system monitoring.

How does it work, what does it control and how can operators get the best system performance?

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## The backbone of cabin communication

The CIDS is the central digital data system for cabin crew to manage all cabin functions. It is quintessential in keeping passengers well informed and contributes to their overall comfort and safety. The CIDS allows control of cabin lighting, service interphone, EVAC signals and all functions of the passenger service system: passenger lighted signs, reading lights, passenger calls, automatic announcements, boarding music and the passenger entertainment system. The flight crew can monitor all cabin systems via a central interface.

### System architecture and functions

The 'classic' CIDS was first introduced in 1988 for the A320 and has been installed in more than 2000 single aisle aircraft, many of them in operation today. This was the first time a single system integrated all cabin functionalities by connecting the crew, cockpit, cabin systems and passenger service. The core system architecture has remained robust and effective over 30 years of operation, while allowing for a seamless integration of updates and new functionalities like the SDF (Smoke Detection Function) due to its modular set-up. The adaptability of the system ensures viability for various aircraft types without major changes in hardware and with minimal training effort for its operators.

The system is typically managed by 2 Directors. They are the central computers of the CIDS. One operates in active mode and one in stand-by, so it can take over in the unlikely event of a complete failure of Director 1. The crew can control the cabin functions via the FAP (Flight or Forward Attendant Panel) or by using cockpit switches. Communication between the Director and the cabin, passenger and crew systems is handled via a number of DEUs (Decoder-Encoder Units). They pick up the information across the cabin and convert it into binary code for the Director. Binary code received back from the Director is then decoded. The DEUs are the interpreters enabling information transfer between the Directors and the cabin systems. They are spread along the cabin on top lines (DEU A) and middle lines (DEU B).

The system architecture is similar for all Airbus aircraft models.

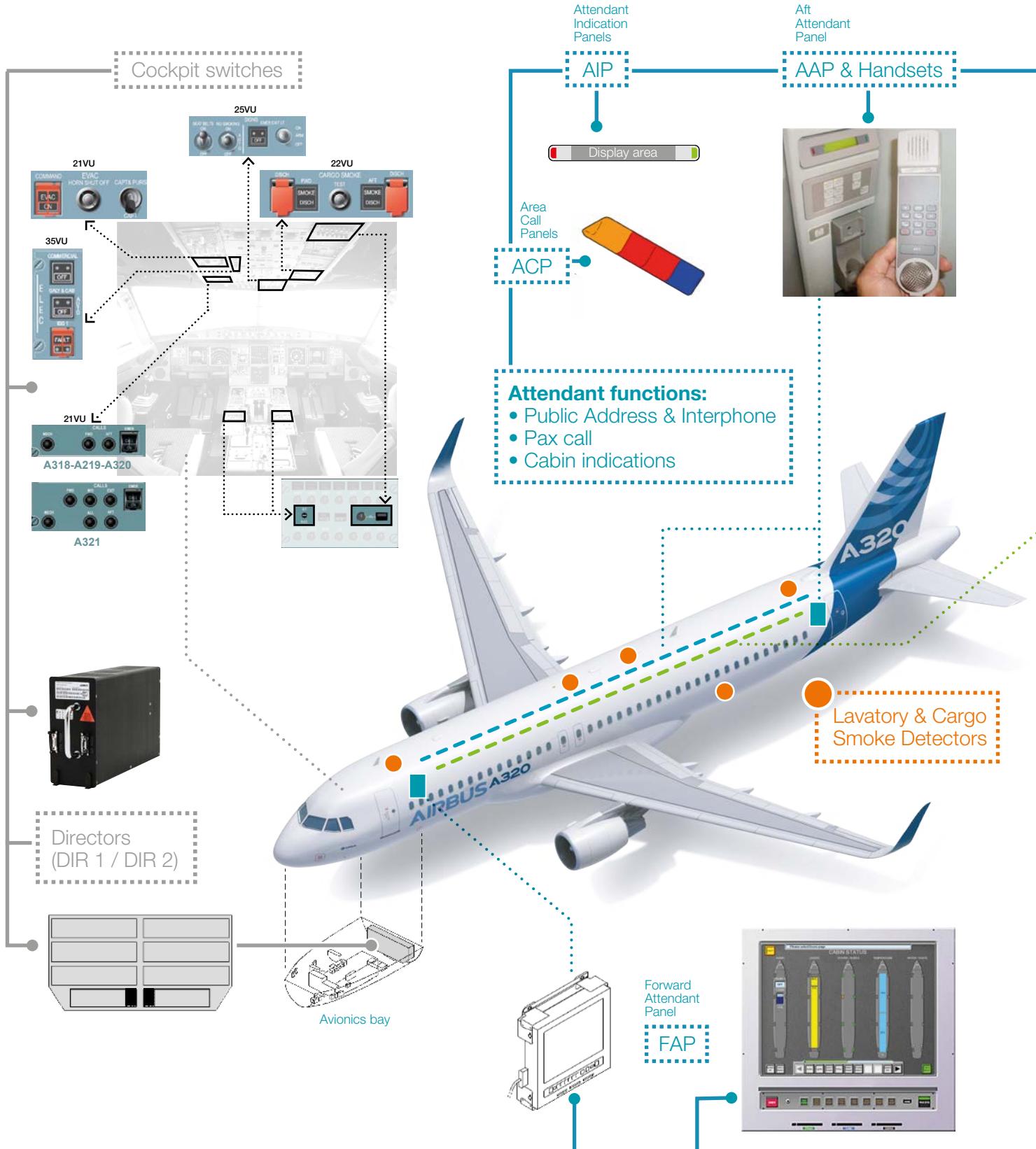
The PTP (Programming and Test Panel) allows programming of the CIDS and running of functional tests. The system update for the A318 features no PTP as its functions have been integrated into a new touch screen FAP. The introduction of this enhanced CIDS on the A318 has been the starting point for its implementation on other models.

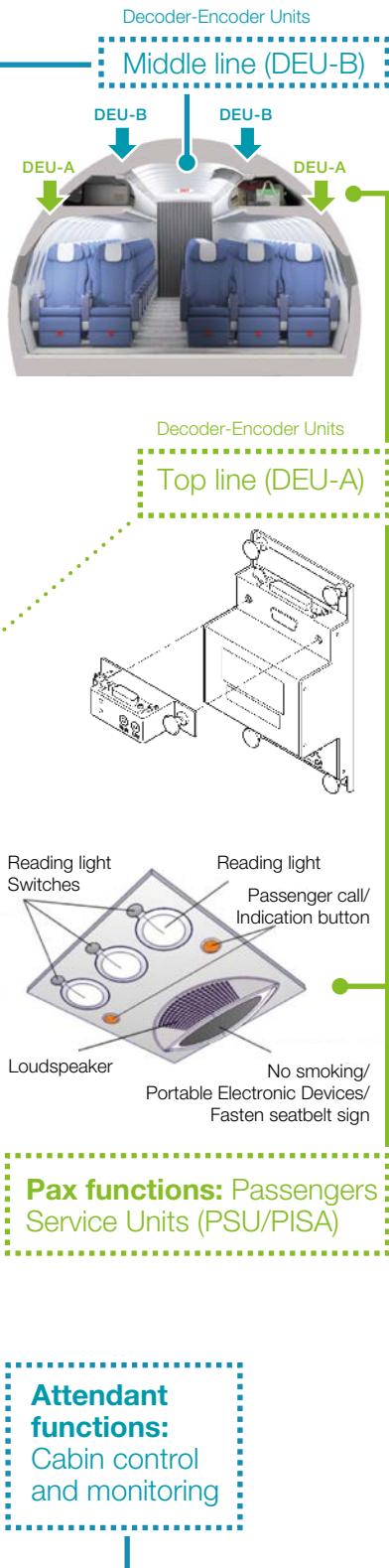
The FAP comprises the CAM (Cabin Assignment Module), the OBRM (On Board Replaceable Module) and the optional IPRAM (Integrated Pre-recorded Announcement Model) in compact flash card format. The IPRAM contains pre-recorded announcements and boarding music audio data that can be played in the cabin to passengers in accordance with operational requirements. The CAM defines all the modifiable system properties and cabin layout information for the CIDS. Each CAM is programmed according to the airline's request, so the CAM is unique to every individual airplane. The OBRM contains the CIDS software. Major changes of the CIDS functions are executed by the replacement of the OBRM.

The 'no smoking' and seat belt signs are controlled directly from the cockpit while the cabin functions related to passenger service (for example, cabin lighting, temperature control and passenger calls) are managed by the cabin crew via the FAP.

A number of additional aircraft systems can be managed via the CIDS' panels (FAPS, AAP etc.): emergency light, door bottle pressure monitoring, door closure status, slide armed/disarmed status, water and waste tank quantities, air conditioning and smoke detection. Starting with the enhanced CIDS, the SDF (Smoke Detection Function) has been embedded into the CIDS Director.

# CIDS standard architecture





Even though the CIDS is not safety-critical itself, it remains important for flight safety. Prior to its introduction there was no communication system that handled operational and service-related data in an integrated data network. The reporting of information relevant to flight operations relied on the more or less effective verbal communication between cabin crew and cockpit. Today, awareness about communication cultures has been raised considerably, and an integrated cabin management system like the CIDS now helps flight attendants to report operational information, as there are sensors in place which already detect and communicate information to the CIDS. As an example, an EVAC warning is automatically issued without any potential for human error through overlooking, misjudgement or miscommunication.

## An evolving system with a classic core

- 1988: Launch of A320 aircraft with classic CIDS
- 1993: 700 aircraft of A330 and A340 model ranges
- 2003: 1500 aircraft equipped with enhanced CIDS for A330s and A340s
- 2006: Enhanced CIDS for single aisle, 8500 A318s, A319s, A320s, and A321s
- 2007: Adaption of CIDS for A380
- 2009: Enhanced 2nd Generation CIDS for A330 with integrated SDF function
- 2014: CIDS for A350

A resilient, adaptable and scalable original design allowed for integration of different standards for various aircraft types while keeping the classic system architecture intact.

## Troubleshooting & maintenance for CIDS

Over its 30 years of operation, the CIDS has proved to be a highly reliable system for managing the increasing amount of cabin data and related cabin equipment. In case of a system fault or equipment malfunction event, there is a standard troubleshooting practice in place, which has to be followed. For the cabin crew this can happen when the system is used for passenger announcements or cabin interphone. The cabin crew then informs the flight crew, who performs a system reset according to the FCOM (Flight Crew Operating Manual) reset table.

If the initial event is not cleared by this standard reset the flight operator's MEL (Minimum Equipment List) has to be consulted for a relevant item. The MEL will either identify the event as non-crucial to flight operations or provide an expiration date for deferred troubleshooting and fix. In case there is no applicable MEL item, or the event is classified as crucial to flight operations, a BITE (Built-in Test Equipment) test needs to be performed to confirm the fault and on-ground maintenance staff need to be involved.

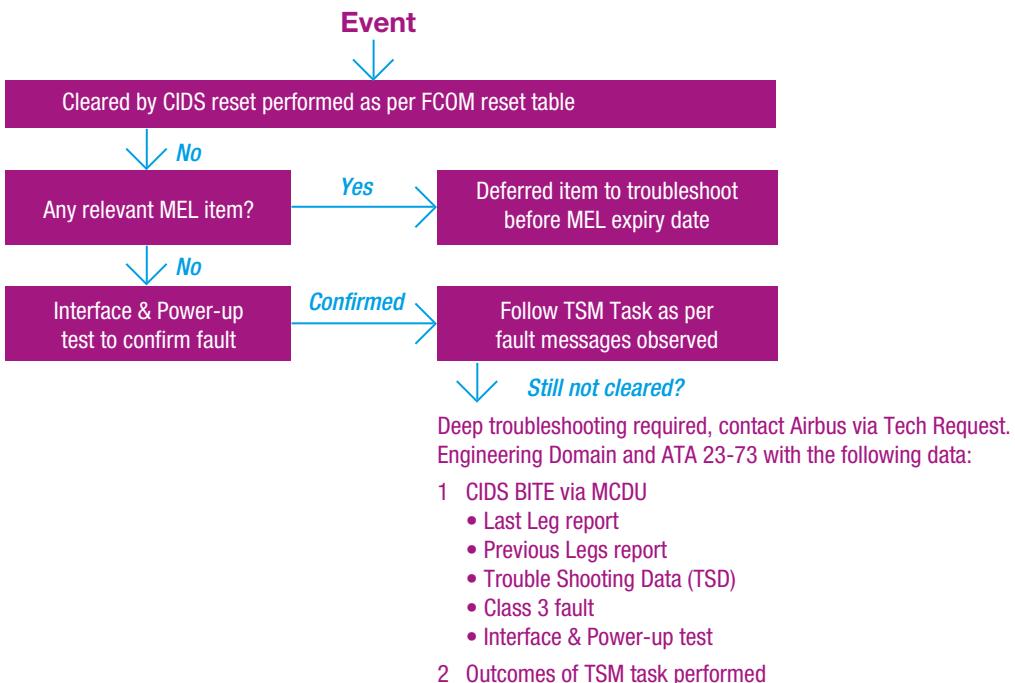
The CIDS has an extensive self-monitoring capability. Failure messages related to CIDS units are sent to the CFDS (Central Failure Display System) or CMS (Centralised Maintenance System). Failure message reports are stored automatically in a CIDS BITE dedicated memory within the directors. Through three MCDU (Multipurpose Control and Display Unit) interfaces or OMT (On-board Maintenance Terminal) this information can be accessed from the cockpit. CIDS BITE enables interactive interrogation of the system by maintenance personnel.

The TSM (Trouble Shooting Manual) or AFI (Aircraft Fault Isolation for A350) will list the tasks to be followed for the observed failure message.

If the event is still not cleared, the issue requires deeper troubleshooting. At this point, contacting Airbus via Tech Request (Engineering Domain and ATA 23-73) is key for the required deep troubleshooting. A mobile app Tech Request was developed to facilitate reporting and feedback by the operators.

Reporting failure messages through Tech Request necessitates data from the CIDS BITE including the Last Leg report, Previous Leg reports, Troubleshooting Data (TSD), the Class 3 fault and the results of the Power-up test, in addition to the outcomes of the TSM task performed.

## Standard troubleshooting practices



For general information ISI (In Service Information) reference guides are available for all CIDS versions ranging from the classic system for the A320 Family to the enhanced system for the A350 Family with the incorporated SDF function. The latest ISI guides can be obtained through the Resident Customer Support Manager or accessed via login to Airbus World.

Model	ISI	
A320 Classic	23.73.00095	Operators should note that these reference guides are frequently updated, nevertheless the AMM (Aircraft Maintenance Manual), TSM (Trouble Shooting Manual), FCOM (Flight Crew Operating Manual) and MEL remain the sole source of instructions during maintenance and operation of the CIDS.
A320 Enhanced	23.73.00093	
	23.73.00094	
A330 Enhanced	23.73.00097	
A380	44.11.00013	Operators can request an onsite engineering workshop for CIDS users to increase operational reliability. The outcome of these workshops usually
A350	44.11.00012	ends up with a 50% improvement on CIDS operational reliability immediately after imparting the instructions. Such workshops, together with regular follow-ups within the airlines, can be a valuable means to ensure the CIDS is used to its full capacity and all troubleshooting procedures are followed in case of failure messages.

Operators are encouraged to report any issue with the system for continuous improvement. Currently a new analogic handset is being developed for the A320 and A330, thanks to such user feedback.

### What will the future of CIDS look like?

The farthest-reaching impact on the future of cabin communication will be brought about by the new Decoder-Encoder Units DEU 4.0 linked with the Airbus data-integration platform, Skywise\*. The (DEU) manage the information flow between the Director and the various cabin systems. The new DEUs 4.0 enable connectivity to the Internet of Things (IoT) and empower the CIDS for the digital transformation and ongoing fourth industrial revolution (Industry 4.0). It will pave the way for the wireless cabin, the ability to connect wireless equipment to the CIDS, and eventually create full digital connectivity for all CIDS related equipment. Data lake solutions will unleash an unprecedented potential for optimisation and customisation through real-time data management.

The future cabin management system will feature a simplified architecture, digitally connected equipment, customer feedback and data analysis tools.

\*More about Skywise in FAST 63

The increased availability of data will not only help to further improve the systems operational reliability and facilitate handling, it will also unlock a great deal of relevant operational information for the airlines and allow for a new level of passenger service. Preferred lighting and seat settings from previous flights could be retrieved and reinstated and the In-Flight Entertainment (IFE) service could be targeted based on the passengers' prior choices. Also, maintenance and troubleshooting in case of malfunctioning devices will be further facilitated, as enhanced more complete maintenance data will be accessible and directly presented in real-time.

The estimated release date for DEU 4.0 is 2023.

## Glossary

- AAP** Aft Attendant Panel
- AFI** Aircraft Fault Isolation for A350
- BITE** Built-in Test Equipment
- CAM** Cabin Assignment Module
- CFDS** Central Failure Display System
- CIDS** Cabin Intercommunication Data System
- CMS** Centralised Maintenance System
- DEU** Decoder-Encoder Unit
- EVAC** Evacuations
- FAP** Flight or Forward Attendant Panel
- FCOM** Flight Crew Operating Manual
- IFE** In-Flight Entertainment
- IPRAM** Integrated Pre-recorded Announcement Model
- MEL** Minimum Equipment List
- MCDU** Multipurpose Control and Display Unit
- OBRM** On Board Replaceable Module
- OMT** On-board Maintenance Terminal
- PTP** Programming and Test Panel
- SDF** Smoke Detection Function
- TSM** Trouble Shooting Manual
- TSO** Troubleshooting Data

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## CONCLUSION

Since its introduction in 1988, the CIDS digital cabin management system has undergone several upgrades and adaptions for new aircraft types. Technical documentation is available to assist operators in improving operational reliability of the CIDS and onsite workshops have already proven to improve the reliability rate.

In the light of the upcoming link to Skywise and the advances in full digital connectivity and intelligent data management, the CIDS original system architecture remains relevant as an integrated single-system solution for cabin communications. The connection of the cabin systems to the Internet of Things and Skywise data lake will break new grounds in cabin communications, boost the CIDS' self-monitoring capacity and open up new possibilities for creating and managing the passenger experience of the future. ■

# Structural blind fasteners

**Strong, easy and efficient new fastening system**



**Airbus is ramping up its use of a new structural blind fastener. Improvements in design enable faster installation and a broader number of uses, leading to significant time and cost savings for maintenance and repair procedures.**



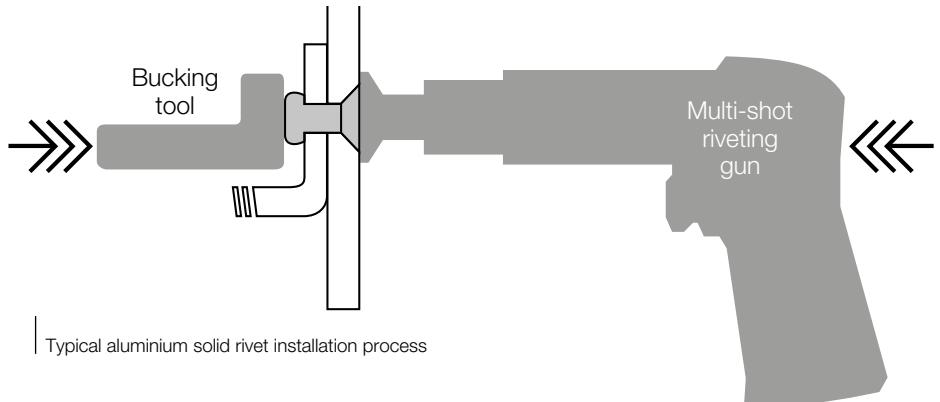
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Solid rivets are permanent mechanical fasteners – the ‘glue’ that holds an aircraft structure together. Tens of thousands of solid rivets are used on each aircraft, from the fuselage to the wings and tailplanes. Installing them, however, is not always a simple process. A traditional solid rivet is most commonly made from aluminium alloy and combines light-weight with medium strength. It consists of a smooth cylindrical shaft with a pre-formed head (either protruding or countersunk) and a tail on the other.

During installation on an aircraft, the rivet is inserted in a drilled hole from one side, while the tail is ‘bucked’ (deformed), either by hand or with a pneumatic tool. The tail expands and holds the rivet in place like a nut does with a bolt. Once installed, the rivet completely fills the hole – unlike a bolt – and creates a secure joint.



But to achieve this, technicians must have access to both sides of the structure. In areas such as the cockpit or avionics bay, this is a difficult and time-consuming process, while in some parts of the aircraft, it is impossible to access both sides. The solution is to use a blind rivet, which can be installed without the need for access on both sides. To do this, the stem is pulled back into the rivet body using an installation tool, deforming the body and clamping down on the joint until the stem snaps off at an engineered weak point and the fastening is formed.



Blind rivet seen from the interior

However, blind rivets do not fill holes in the same way a solid rivet does, making their joint performance slightly inferior. Consequently, they cannot be used in areas subjected to vibration and high loads. Instead, they are used on parts like brackets, closed boxes or flaps, as well as temporary repairs on the fuselage. Blind rivets cannot be reused like nuts and bolts, so must be drilled out and replaced if they or the panel they are holding together is damaged, for example during lightning strike. As only one technician is needed to carry out the installation using blind rivets, the process is quicker than with solid rivets. The aircraft will still need to be grounded again at a later date to carry out a permanent repair solution with solid rivets or bolts.



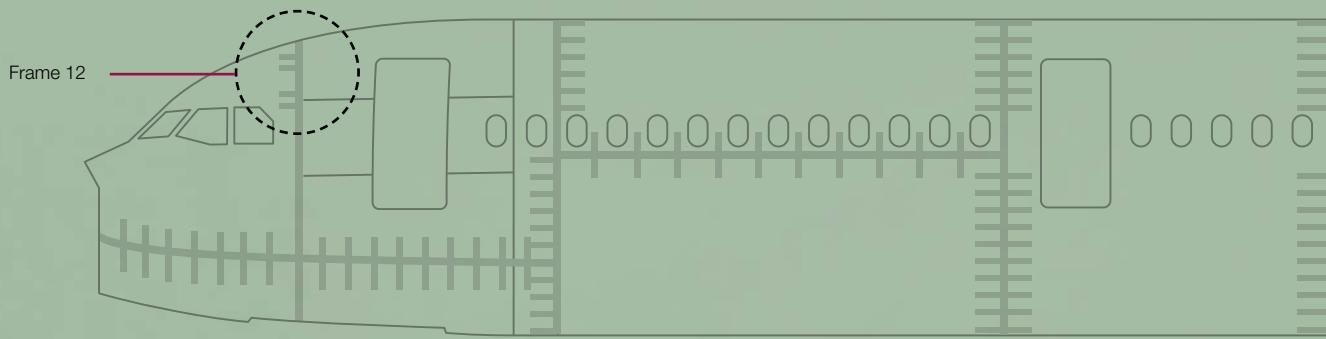
## Major reductions in fastener installation time

To overcome these issues, Airbus worked with a leading fastener manufacturer to improve existing blind fasteners to address maintenance needs. The improved structural blind fastener offers numerous advantages over traditional blind and solid rivets.

Because they are blind fasteners, they can be used in areas that are difficult to access. Installation is performed by one technician rather than two, making it quicker, cheaper, more efficient and quieter to install than solid rivets due to its ergonomic design. But unlike traditional blind rivets, they are made from titanium 6Al-4V alloy and A286 corrosion-resistant steel with a threaded core and sleeve and a unique self-locking mechanism to act like a crimped system on a structural nut. This gives them superior mechanical performance in shear, tensile and fatigue, enabling their use in high-load-bearing structural parts of the aircraft, which the traditional blind rivets cannot. They can also be used as permanent repair solutions when non-destructive testing is used to confirm a secure installation. Consequently, temporary repairs are no longer necessary – the work can be carried out in one procedure, significantly cutting maintenance and repair downtime.

The new structural blind fasteners achieve further time-saving in several other areas. Some aluminium alloy rivets require heat treatment prior to installation, either to achieve the required level of strength or to soften the rivet to prevent cracking on installation. But titanium fasteners do not need to be treated beforehand. In addition, the unique breaking stem creates a clean break, so no additional reworking is required to achieve a smooth surface. Overall, the new structural blind fasteners offer a minimum of 65 percent time saving in comparison to solid rivet installation, for example around Frame 12 just behind the cockpit, on brackets around the cargo bay or other areas where solid rivets could be used.

Superior mechanical performance in shear, tensile and fatigue, enabling their use in high-load-bearing structural parts of the aircraft





The new structural blind fasteners offer a minimum of 65 percent time saving in comparison to solid rivet installation

### When will the fasteners be installed?

On the A320 Family the structural blind fasteners are now being used in place of solid rivets around Frame 12, just behind the cockpit, and have been tested on selected commercial flights since February 2019. Serial implementation on Frame 12 at the Airbus Saint Nazaire final assembly line began in mid-June, with full rate expected to follow in the near future. Use of the rivets in other areas of the aircraft is being explored.

The fasteners can currently be used for maintenance on metallic joints in all areas of the aircraft, excluding fuel boundaries until further tests have been carried out. Examples of fasteners that can be replaced with the new solution include (but are not limited to): aluminium solid rivets (e.g. ASNA2051); aluminium lockbolts (e.g. EN6100); and traditional blind rivets (e.g. ASNA0077). The new fastener has the same grip overlap capability at either end of the grip range and accommodates back side slope of up to 5° angle as standard rivets. The installation and removal processes are already documented in the structural repair manual SRM 51-42-11, while SRM 51-43-00 includes identification of alternative fasteners and the fuselage SRM 53-00-00 has also been amended. The standard of the new structural blind fastener is ABS2322. ABS2322 and its alternative are available to be procured by customers as required.

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### CONCLUSION

Further developments in the future include a greater selection of diameters, including an oversize range, as well as a flush 100° reduced head, 130° head and protruding head. Eventually, the structural blind fastener is expected to be used on both metal and composite material applications on all areas of all Airbus aircraft, bringing further improvements to installation efficiency and product rationalisation.



**+ As Airbus celebrates its 50th anniversary, FAST looks back on how innovation and developments have contributed to the evolution of customer operations.**

**Fast forward to page 36 to see examples of how Airbus continues to shape the future of flight.**

**1969**

Paris Air Show  
29 May 1969,  
France and Germany  
make a pioneering  
agreement to create the  
Airbus A300, the world's  
first twin-engine wide-  
body airliner.



**1970's**



#### **A300B EIS with Air France**

- For short to medium-haul passenger operations and for freight.
- Composites on structures, electrical signalling for secondary controls, drag-reducing wingtip fences and centre of gravity control.
- World's first twin-engine wide-body for commercial aircraft,
- Economic and operational performance.

#### **Wingtip fences**

A300 and A310 outfitted with wingtip fences, arrow-shaped vertical attachments that extended above and below the end of the wing.

- ✚ Reduced fuel burn during cruise without altering aircraft handling.
- ✚ Lower noise emissions by improving take-off performance.





### Field Service stations

The first Airbus Field Service Representatives team was deployed in Paris to support Air France for the A300.

- + On-site or local Airbus point of contact for technical assistance. (Over 140 stations worldwide today)

### Forward Facing Crew Cockpit

A300 FFCC EIS with Garuda, the first twin-aisle aircraft that could be piloted by a two-man crew: all systems traditionally displayed on the flight engineers' side panel were now in front and overhead of the two pilots.

- + Improved cockpit layout, reduced flight crew to operate the aircraft.

### CIDS Cabin Intercommunication Data System

The system controls and displays the cabin functions for passengers and crew. (See article page 20)

- + Facilitates management by crew, contributes to passenger comfort and safety.

1980's

### Envelope protection philosophy and technology

The pilot's commands to the control surfaces are monitored to ensure the aircraft is kept within a safety margin, called the 'flight envelope protection'.

- + The flight envelope protection prevents the aircraft from performing outside its operational limits.

### Mixed Fleet Flying (MFF)

With commonality, pilots can be current on more than one Airbus fly-by-wire aircraft type at a time. This is known as Mixed Fleet Flying.

- + Allows operations by a common pool of pilots, opens new crew scheduling possibilities and offers pilots a mix of flying opportunities.
- + Common Type Rating and Mixed Fleet Flying concepts also result in significant benefits for airline profitability (flexible scheduling, less training so lower costs).

### Cross Crew Qualification (CCQ)

Possible thanks to flight operational commonality between Airbus fly-by-wire aircraft. CCQ is available for all combinations of Airbus fly-by-wire aircraft in service.

- + Savings in time and cost, thanks to reduced transition training.



### Fly-By-Wire and commonality

- Fly-by-wire (electrical signalling instead of cables and pulleys) introduced the fourth - and latest - generation aircraft, enabling technologies such as flight envelope protection, thus further enhancing safety
- Operational commonality - almost identical cockpit designs and handling characteristics across Airbus aircraft - is a fundamental design criterion.
- + Fly-by-wire brought weight savings, lower maintenance costs, improved flight controls.
- + Commonality brought reductions in time and costs to crew training.



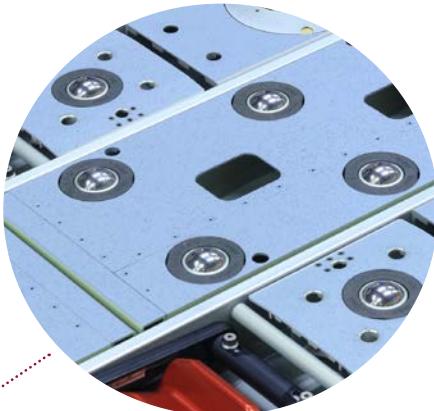
### A340 EIS with Lufthansa

- The A340 Family spans 295-380 seats
- Superior passenger comfort, economy and operational flexibility.
- + For longest and most demanding routes, with superior operating economics – even in challenging “hot and high” conditions – and high passenger comfort.
- + Quiet cabin



### Cargo Loading System (CLS)

- The A320 CLS option for loading pallets and containers on the lower deck.
- EIS of the first A320 CLS with Air France.
- + The outward-opening cargo doors and large cargo compartment cross-section maximises the usable cargo volume.



1980's



### A320 EIS with Air France

- First civil aircraft to pioneer fly-by-wire technology.
- One aircraft in four sizes (A318, A319, A320 & A321)
- A320 Family seats from 124 to 244 passengers
- + Allows operators to match aircraft size to demand, covering the entire market from low to high density routes to longer range.
- + With the widest single aisle cross section, the A320 Family offers containerized cargo as an option, allowing operators the unique flexibility to choose between bulk or container capability.

### Additional Centre Tank

Option to incorporate 2 additional centre tanks (ACT) on A310-300. Available on A319, A320 and A321.

- + Increased operational flexibility with extended aircraft range or increased payload.



### Electronic Centralised Aircraft Monitor

ECAM monitors aircraft functions and produces messages detailing failures, lists procedures to undertake to correct the problem.

- + Enables reduction to 2 flight crew members.



## Cabin innovations

- State-of-the-art In-Flight Entertainment (IFE).
- Comfortable and private rest areas for crew without removing space for passengers, ambient lighting option for passenger comfort, and adaptable to airline branding and colour scheme.
- Airbus Airspace cabin with quality ambience, comfort, service and design; providing airlines with a tool to differentiate.
- 2017: Smart Onboard Wheelchair, giving increased independence for passengers with limited mobility.
- Improved comfort for passengers and crew, efficient operations for cabin crew.



## Composite materials

Progressively replacing aluminium alloys. Benefits include strength, low weight, corrosion-free quality and superior durability.

- More cost-efficient aircraft, reducing costs of maintenance.

1990's

2000's

## Final Assembly Lines (FALs)

Airbus has nine final assembly lines (FALs) at five locations worldwide:

**Toulouse**, France (four FALs)  
A320, A330, A350 XWB families / A380

**Hamburg**, Germany  
A320 Family

**Tianjin**, China  
A320 Family

**Mobile**, United States (two FALs):  
A320 Family / A220 Family

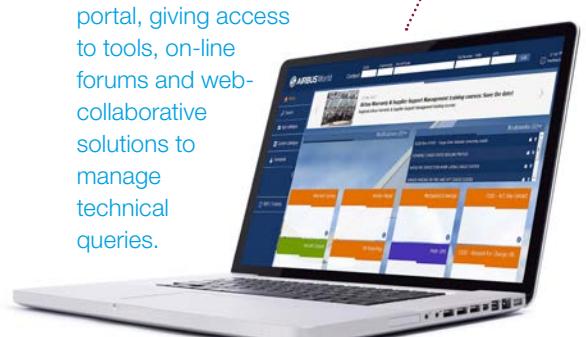
**Mirabel**, Canada  
A220 Family



## AirbusWorld portal

An internet-based support environment for customers.

- Fully personalised portal, giving access to tools, on-line forums and web-collaborative solutions to manage technical queries.



## AIRMAN (now AIRMAN-web)

AIRcraft Maintenance Analysis is a health-monitoring tool for aircraft maintenance.

- Simplified and optimised maintenance, with early detection of anomalies to enable anticipation.



### A380 EIS with Singapore Airlines

- The world's first full-length twin-deck aircraft
- Over 500 seats
- Range of up to 8,000nm/ 15,000km, allowing it to fly non-stop between Europe and Asia.
- + Highest passenger capacity**
- + Passenger comfort with more personal space, premium products, and quiet cabin.**
- + Unique features (bar, business areas and social areas).**

### AIRTAC

The state-of-art Airbus Technical Aircraft-on-ground Centre (AIRTAC) offers dedicated, specialist engineers to support airlines in case of urgent issues during operations.

- + Global 24/7 assistance for all Aircraft-On-Ground matters to minimise time for troubleshooting or repairs.**

### Extended Service Goal

(now LoV) ESG enables A320 Family aircraft to fly beyond their original limit of flight cycles.  
**+ Allows an increase in the operational lifetime of aircraft in terms of flight hours and flight cycles, bringing up to 10 years or more of additional revenue service.**

### Less Paper in Cockpit (LPC)

Flight crews can access flight-critical information from a laptop. Along with FlySmart and the On-board Information System (OIS), LPC provides advanced digital software solutions for the Electronic Flight Bag (EFB).

- + Replaces paper-based manuals and instruction procedures in the cockpit.**
- + Easy locating of operational information for flight and maintenance crews.**
- + Optimised performance and weight-and-balance computations.**

### Brake to Vacate (BTV)

BTV allows pilots to visualise the point where the aircraft will reach its runway exit point during the approach and landing phases.

- + Optimises braking energy and Turn Around Time.**
- + Guarantees to vacate at the assigned exit.**
- + Optimises runway occupancy time.**

## 2000's

AirN@v - Microsoft Internet Explorer provided by Airbus

**AirN@v**  
Customer Advanced web-  
Database technology tool  
Rev. date May 2021  
Effectivity  
Table acquisition and distribution including the principle maintenance manuals (eg AMM), an interactive aircraft troubleshooting aid and a web server.  
**+ Helps operators to maximise use of aircraft maintenance documentation, thereby reducing costs.**

### Flight Hour Services (FHS)

Provides component support, line and base maintenance, as well as fleet technical management services. Options include on-site stock and a mutualised pool access service, as well as state-of-the-art repair services.  
**+ Operational reliability and fleet performance.**



### Head Up Display (HUD)

The Head Up Display system presents flight information and guidance on a glass plate mounted behind the windshield in the pilot's field of view.

- + Contributes to increasing pilot situational awareness, particularly during approach and landing.**

### Runway Overrun Prevention System

ROPS\* provides a real-time crew alert in case of detected runway overrun situation at landing.

- + It contributes to increasing pilot situational awareness, particularly during approach and landing.**

\*Navblue an Airbus subsidiary, provides customers with flight operations and air traffic management solutions.



50  
YEARS

- pioneering,
- innovation
- development



### Spares management

Airbus Managed Inventory (AMI), automatic replenishment service for Airbus proprietary material. Satair (Airbus subsidiary) provides customers with material and logistics management, while offering a wide worldwide distribution network.

- + Reduced procurement costs, consolidated shipments and real-time inventory management. Reduced replenishment cycles, minimizing inventory holding.

### A350 XWB EIS with Qatar

- Evolutionary adaptive wing design
- Airspace cabin (wider seats, high ceilings, ambient lighting, quietest cabin on a twin-aisle aircraft, high air quality)
- + Maximum aerodynamic efficiency by optimising wing loading, reducing drag, lowering fuel burn.
- + Lighter, more cost-efficient, reducing maintenance requirements.
- + Passenger comfort.
- + Flexibility from regional to Ultra-Long-Range.

### Sustainable fuel

Since 2016, Cathay Pacific's A350s have been delivered with a 10 percent blend of sustainable jet fuel in its tanks.

- + Customers can choose to have delivery flights with sustainable fuel.

### Skywise

- Aviation data-sharing platform.
- Additional modules such as Skywise predictive maintenance and Skywise reliability.
- + Allows airlines to improve operational performance, optimise maintenance, engineering and flight operations decision-making, reduce costs.

### A350-900ULR with Singapore Airlines.

Furthest-flying commercial aircraft in service (up to 9,700 nautical miles).

- + No additional fuel tanks required - just an adaptation of the existing tank.
- + Possibility of flying over 20 hours non-stop.

2010's

2019



### A320neo EIS at Lufthansa

Two new engine options: Pratt & Whitney's PurePower turbofan and CFM International's LEAP-1A.

- + Airspace cabin.
- + 20% improvement in fuel burn per seat.
- + 50% reduction in noise footprint and NOx emissions 50% below CAEP/6 standards.

### A330neo EIS

#### with TAP Air Portugal

- Lowest seat-mile cost for mid-size wide-body.
- New-generation engines, an advanced high-span wing, new materials across the wing including titanium pylon and composite nacelle.
- + Reliable and versatile 30 minutes to over 15 hours.
- + Improved aerodynamics.
- + Lower fuel burn per seat.
- + Airspace cabin.



### Ab-initio flight training

Airbus Pilot Cadet Training Programme, delivered by the Airbus Flight Academy Europe and by independent partnering flight schools.

- + Equips cadets to become operationally-ready pilots, with key pilot competencies.
- + Helps meet future high demand for pilots.



### A220 Family

- State-of-the-art technologies
- Wider economy seats
- Lightweight structure and advanced systems
- 100-150 seat.
- + Fuel efficiency.
- + Passenger comfort.
- + Reduced noise footprint and NOx emissions.



# FAST FORWARD

**Airbus is powered by innovation to redefine and shape the future of flight**

## Finding inspiration in nature: AlbatrossOne takes flight

When the albatross seabird soars for long distances, it “locks” its wings at the shoulder. But when faced with wind gusts, it unlocks them to better navigate the sudden, brief increase in wind speed. This flight technique inspired Airbus engineers in Filton to develop AlbatrossOne, a small-scale, remote-controlled aircraft demonstrator that has “semi-aeroelastic” hinged wing-tips. *“The concept of hinged wing-tips is not new,”* explains Airbus engineer Tom WILSON. *“Military jets employ them to allow greater storage capacity on aircraft carriers. However, AlbatrossOne is the first aircraft to trial in-flight, freely flapping wing-tips—which account for up to a third of the length of the wing.”* In comparison, a conventional wing on an aircraft transmits huge loads to the fuselage during turbulence. This requires the base of the wing to be heavily strengthened, thus adding weight to the aircraft. By allowing the wing-tips to react and flex to wind gusts, load is significantly reduced. The AlbatrossOne project aims to provide new insight on how to reduce drag, and relieve the effects of wind gusts and turbulence. It recently concluded a 20-month development programme. The next step is to conduct further tests to combine the two modes, allowing the wing-tips to unlock during flight and to examine the transition.



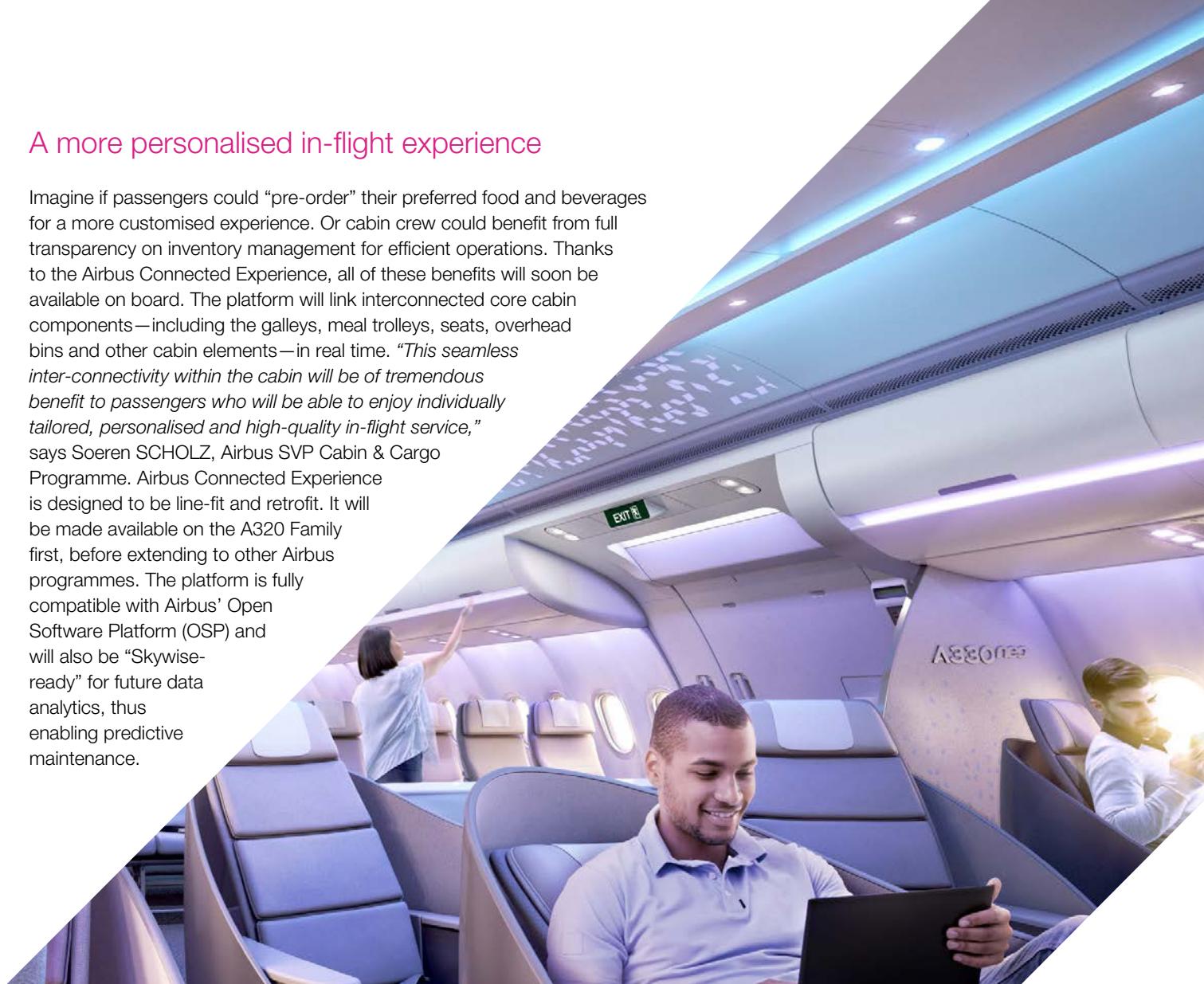
## Computer vision to power more autonomous flight

What if an aircraft could taxi, take off and land by itself? This is the idea behind the Autonomous Taxi, Take-off and Landing (ATTOL) project. ATTOL leverages computer vision technologies and techniques to enable commercial aircraft to navigate and detect obstacles during taxi, take-off, approach and landing. *“Many aircraft are already able to land automatically,”* Sébastien GIULIANO, ATTOL project lead, explains. *“But they’re reliant on external infrastructure like Instrument Landing System (ILS) or GPS signals. ATTOL aims to make this possible solely using on-board technology to maximise efficiency and to reduce infrastructure cost.”* Autonomous flight tests are expected in mid-2020.



## A more personalised in-flight experience

Imagine if passengers could “pre-order” their preferred food and beverages for a more customised experience. Or cabin crew could benefit from full transparency on inventory management for efficient operations. Thanks to the Airbus Connected Experience, all of these benefits will soon be available on board. The platform will link interconnected core cabin components—including the galleys, meal trolleys, seats, overhead bins and other cabin elements—in real time. *“This seamless inter-connectivity within the cabin will be of tremendous benefit to passengers who will be able to enjoy individually tailored, personalised and high-quality in-flight service,”* says Soeren SCHOLZ, Airbus SVP Cabin & Cargo Programme. Airbus Connected Experience is designed to be line-fit and retrofit. It will be made available on the A320 Family first, before extending to other Airbus programmes. The platform is fully compatible with Airbus’ Open Software Platform (OSP) and will also be “Skywise-ready” for future data analytics, thus enabling predictive maintenance.



## Lift, tilt & fly: Vahana's full transition flight validates design

Only a few years ago, Vahana—Airbus’ electric vertical take-off and landing (eVTOL) vehicle demonstrator—was merely a sketch on a napkin. Today, Vahana is a full-scale flying aircraft that recently completed its full transition flight. During the flight, Vahana’s wing and canard rotate to the full cruise configuration before accelerating to a speed of up to 168 Km/h. *“This flight marks a major engineering milestone,”* says Zach LOVERING, Vice President of UAM Systems. *“It represents everything we set out to achieve when we began our flight test campaign: to confirm the technical viability of the vehicle we first sketched out on a napkin years ago.”*

The full transition flight marks Vahana’s 66th flight since flight testing began in 2018. Vahana is one of two eVTOL demonstrators Airbus is working on.

The lessons learned from Vahana will contribute to developing a future market-ready vehicle that is expected to help make urban air mobility possible within the mid-2020s timeframe.



# FAST FROM THE PAST

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



Focke-Wulf F19 Ente (1927)

*"This is your captain speaking"*

In the early days of commercial aviation, on this Focke-Wulf F19 Ente (canard), the pilot sat just in front of the 2 or 3 passengers.

Cabin communication\* should in theory have been easier... except the pilot was outside.

\*see cabin communication article page 20



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