Q2 MAY 2026

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Aerospace Innovations brings you news, views and analysis of the commercial and defence sectors, in print and online, highlighting the latest innovations, technologies and solutions that are key to the future of the aerospace industry to meet performance and sustainability goals.

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GCAP – The Future of Air Dominance?

In our cover story, Jon Lake looks at the current status with the GCAP programme. The UK, Italy, and Japan, have signed a £686 million development contract with Edgewing (the GCAP design authority) to keep the programme moving through June 2026. This is as a bridge contract while the UK resolves a £28B defence budget shortfall, which aims to ensure design and engineering work continues without slipping past the target date. Japan is increasingly concerned that UK budget delays could push GCAP beyond the 2035 EIS date, especially as the U.S. Boeing F47 (NGAD) programme accelerates.

The first GCAP demonstrator is already in build stage, and Edgewing (BAE Systems, Leonardo, JAIEC) is designated the sole responsible design authority, replacing fragmented national structures. This centralisation is intended to avoid the pitfalls of earlier European fighter programmes. Industrial activity is accelerating, and Canada is in talks to join GCAP, as observer status, gaining access to technical data without committing to procurement.

In his first article in this edition, James Careless interviewed leading experts about multicore processors and ask them about advances being made in architecture and performance. In his second article, James had a roundtable with several leading training simulation companies about remote pilot training. In his third article, James spoke with some aviation spare parts providers about the art of mastering inventory management.

In his first article in this issue, Alex Preston looks at next-generation engine advances and finds out what the engine OEMs are doing to disrupt current propulsion technologies. In this second article, Alex talked with several hybrid-electric aircraft manufacturers about the status of their programmes. In his third article, Alex spoke with some MRO software providers about the importance of mobility and apps for the mobile mechanic. In his fourth article, Alex looked at software integrity and authenticity with avionics data loaders. Next up, Ian Harbison interviewed several leading air data testing companies and asked what developments have been made.

Our first guest feature in this edition is written by Azita Hajihassani, Founder of consultancy company, Leading Disruption. Part II in this series of articles, Azita talks about scaling intelligence in aerospace manufacturing. Our second guest article is written by Troy Medeiros, at Alderman & Company. Troy looks at the crisis in global engine supply and how it is affecting the global aviation supply chain.

Aerospace Innovations is proud to be an official media partner of the Airspace World show in Lisbon, May 26-28. We hope to see those of you who will be attending it. Registration for our own Avionics & Testing Innovations Conference 2026 is still open. So, secure your delegate place now by registering online at: www.avionicsandtesting-innovations.com/registration

We are grateful to our expert journalists, to our contributors, to our readers, and of course to our loyal advertisers – without whom publications like ours would not be possible. As always, we hope you enjoy reading this edition of Aerospace Innovations magazine, and we would be delighted to hear from you if you have any comments to suggest to us for the improvement of this publication.

Best regards,

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Airbus leads national industry launch of Spain's new combat training system

An Airbus-led group of Spanish companies has presented the industrial programme of the Spanish Air and Space Force's new Integrated Combat Training System (ITS-C). The programme, for which a contract was awarded in December 2025, will replace the current fleet of F-5 aircraft and will include a 60% participation of national industry.

The ITS-C programme, based on a co-development agreement between Airbus, as the prime contractor, and Turkish Aerospace (TA), as the manufacturer of the HÜRJET training aircraft, covers the entire advanced training process for Spanish fighter pilots. This ranges from the Spanish-specification customisation of the 30-aircraft fleet—designated nationally as the SAETA II—to the provision of an integrated suite of operation and maintenance services.

In addition to the conversion and integration of new equipment in the aircraft, Airbus will lead the redesign of the Fighter and Strike school Training Centre at the Talavera la Real Air Base in Extremadura, Spain. The centre, which will include state-of-the-art simulators developed in collaboration with Indra, will provide logistical support for operations and maintenance of both the aircraft and synthetic training systems to ensure maximum fleet availability.



easyJet and Rolls-Royce complete successful 100% hydrogen aero engine test, advancing sustainable flight technology



easyJet and Rolls-Royce have announced the successful completion of a major testing milestone using hydrogen as an aviation fuel, marking a significant step in efforts to reduce aviation emissions.

In an industry first, the companies tested a modified Rolls-Royce Pearl 15 aircraft engine reaching full take off power while running on 100% hydrogen, at NASA's Stennis Space Center, near Bay St. Louis Mississippi.

The significant milestone is the result of a four-year programme between Rolls-Royce, easyJet and global partners to explore hydrogen as a potential aviation fuel and generate engineering insight for future propulsion applications. easyJet has played a central role in supporting the development of hydrogen gas turbine technology as part of its long-term decarbonisation ambitions. Rolls-Royce's expanded partnership with TCS helped accelerate progress towards its technology goals by adding capability and capacity across critical engineering workstreams.

During this phase of the testing programme, engineers demonstrated that a modern jet engine, scalable to power a narrowbody aircraft, can safely operate on gaseous hydrogen across a fully simulated flight cycle, including start-up, take-off, cruise and landing.

The Rolls-Royce programme followed an incremental, technology-led approach to prove the fundamental technologies. Progressing from early engine testing at Boscombe Down in the UK in 2022, the technology was scaled and further developed through a UK and European programme of component and system rig tests, including the development of a full-scale hydrogen test facility at the HSE, before moving to full integration into a hydrogen fuelled demonstrator engine. Earlier modifications also focused on adapting the engine to replace traditional jet fuel with hydrogen while considering both carbon and non-CO2 impacts through an expansive combustion programme.

The programme has delivered valuable insights into hydrogen combustion, fuel systems and engine integration, supporting the potential for future hydrogen-powered aircraft to help significantly reduce carbon emissions across European and UK aviation while complementing Sustainable Aviation Fuel to support future growth – as reinforced by research published in the report Enabling Hydrogen in the European Aviation Market.



Air India Selects Panasonic Avionics As IFE MRO Provider For 74 Aircraft

Panasonic Avionics Corporation (Panasonic Avionics) has announced that Air India has selected Panasonic Technical Services' (PTS) Total Care Package to maintain the airline's in-flight entertainment (IFE) systems across 74 aircraft.

The systems are installed on aircraft across Air India's fleet including the Boeing 787-9, Airbus A350-1000, A350-900, and A321neo.

Under the agreement, PTS will provide end-to-end maintenance and support for the airline's IFE systems provided by Panasonic Avionics, including Astrova and X Series linefit and retrofit programs.

Air India has chosen the Total Care Package as part of its comprehensive fleet renewal and modernization strategy to ensure a premium, reliable passenger experience. PTS will deliver this by optimizing system performance, reducing operational downtime, and maintaining predictable maintenance costs across its widebody and narrowbody aircraft.

To ensure the highest levels of support for Air India's existing and future aircraft, Panasonic Avionics is making new, long-term operational investments in India and opening two new line maintenance stations in Mumbai and New Delhi. These strategic sites will enable insights and fleet monitoring to translate directly into real-time, on-aircraft maintenance actions.



Milan Aircraft unveils new performance data for the electric trainer MA-2 with two-hour useful endurance

Making electric flight truly practical – combining quiet operation, low operating costs, and a real two-hour endurance. That is Milan Aircraft's goal. At the AERO Friedrichshafen event, the Swiss start-up is presenting the latest update on its development program.

In November 2025, Milan Aircraft first introduced the concept of its electric training aircraft, highlighting a target of two hours of usable flight time.The company is now unveiling additional technical details of the battery-electric four-seat aircraft.

The key updates are contained in the freshly printed data sheet available at the stand. Milan Aircraft's core differentiator – two hours of real-world usable flight time – remains unchanged. However, new figures are attracting strong interest, for example the low noise level of just 59 dB(A) during take-off. This makes the aircraft especially relevant for noise-sensitive aerodromes.

Embraer and Jazz Ink Contract for Collaborative Inventory Planning for E-Jets operating in Canada

Embraer, a global aerospace industry leader, and Jazz Aviation LP ('Jazz'), the largest regional airline in Canada and the primary operator of Air Canada Express, have announced a spare parts inventory support agreement for all the E-Jets in the airline's fleet. Jazz currently operates 25 E-175 jets and will be the first customer of the Embraer Collaborative Inventory Planning (ECIP) program in Canada. ECIP is Embraer's collaborative, data-driven inventory planning program, in which Embraer covers most of the spare parts investment and manages materials to help reduce airline downtime.

"The new contract shows the fast pace at which Embraer Services & Support is growing in North America, home of the world's largest E-Jets footprint. We look forward to supporting Jazz, our first customer in Canada, and helping them reduce downtime and strengthen their performance," says Carlos Naufel, President and CEO, Embraer Services & Support.

ECIP offers several advantages to customers. First, most of the inventory investment is covered by Embraer, substantially reducing it from airlines significantly. Also, fixed yearly pricing for each part allows customers to balance costs more precisely and increase inventory efficiency with predefined lead time attached to guaranteed performance levels by Embraer Services & Support. Moreover, the operation is data-driven, with a weekly ordering recommendation based on customer usage and stock level data, created using advanced software and Embraer's planning expertise shared collaboratively. Finally, all airlines participating in ECIP benefit from Embraer's materials management expertise and a global logistics network with best-in-class performance.



ConRo Announces Acquisition of Aerospace Chemical Supplies (ACS)



ConRo has announced the acquisition of Aerospace Chemical Supplies Ltd (ACS), strengthening its capability to support customers across aviation, aerospace, MRO, and OEM environments, as well as other high-reliability industries.

This development brings together two established businesses that are very much aligned in their customer-centric, solutions-driven approach, delivering a broader, more resilient, and better-supported supply solution—combining technical expertise, increased scale, and enhanced infrastructure.

ACS customers will continue to receive the same service, from the same team, now supported by additional stock, systems, and infrastructure. The combined strength of ConRo and ACS enhances the overall customer offering, with a clear focus on improving availability, access, and service across aviation, aerospace, MRO, and OEM supply chains.

Supporting Customers Through Scale and Investment Conor Ash, Managing Director of ConRo, commented, "By combining our strengths, we are increasing availability, improving access to key materials, and enhancing the supply chain solutions we provide. Importantly, customers will continue to work with the people and service they know, now supported by greater stock, stronger systems, and expanded capabilities."

TCI Aircraft Interiors, Türksat and Neo Space Group Establish Multi-Orbit In-Flight Connectivity Framework



TCI Aircraft Interiors, Türksat Uydu Haberleşme Kablo TV ve İşletme A.Ş. (Türksat), and Neo Space Group (NSG) has announced the signing of a tri-party agreement to establish a collaborative framework for next-generation in-flight connectivity (IFC).

The agreement brings together complementary capabilities across satellite capacity, multi-orbit connectivity and onboard systems, enabling the delivery of integrated IFC solutions for airlines.

The collaboration is primarily focused on supporting the Turkish aviation market, while establishing a framework that can be extended to additional airline programmes in other markets by combining GEO, MEO and future LEO satellite networks, the partners will deliver high-performance connectivity solutions designed to provide seamless global coverage and a consistent passenger experience across different routes and regions. As the primary System Integrator, TCI Aircraft Interiors will bridge the gap between space infrastructure and the aircraft cabin, ensuring that airlines are no longer tethered to a single orbit.

The framework is designed to support both commercial and business aviation, across linefit and retrofit programmes, offering flexible deployment models aligned with airline fleet strategies and operational requirements.

Leveraging a shared technical architecture and interoperable networks, the solution will enable high-throughput connectivity, with the first aircraft expected to enter into service from Q1 2027.

Airbus and partners sign NH90 Block 2 architecture study contract

The NATO agency in charge of the NH90 programme, NAHEMA, has signed a contract with NHIndustries (a consortium between Airbus, Leonardo and GKN Aerospace) to launch the NH90 Block 2 architecture study. The Block 2 upgrade will include key structural improvements to the aircraft such as modular avionics, greater configuration commonality, improved maintenance and performance, as well as new capabilities in the fields of collaborative combat, connectivity and crewed-uncrewed teaming.

"The NH90 has recently reached 500,000 flight hours, a testimony to its maturity and operational relevance, as well as its continuously upgraded capabilities. The Sea Tiger and the NH90 Standard 2 are establishing themselves as the state-of-the-art benchmark for naval and tactical operations and we are already preparing the midterm evolution of the NH90 with the Block 1 upgrade. The signing of the Block 2 contract now marks a decisive step in ensuring the NH90 remains at the forefront of European defence for decades to come," said Matthieu Louvot, CEO of Airbus Helicopters. "As NATO and its member nations define the future of vertical lift, Airbus and its partners are committed to evolving this proven platform to meet the most demanding operational challenges of the future battlespace," he added.

This two-year architecture study will ensure industrial continuity by building upon the achievements of the Block 1 programme while evolving the platform for the 2040+ operational environment. Guided by high-level requirements defined by NAHEMA and the participating nations, the study will run in parallel with the European Next Generation Rotorcraft Technologies (ENGRT) initiatives. The goal of the architecture study is to deliver the critical technical outputs necessary for NAHEMA and the nations to evaluate and select the upgrade design options that best align with their long-term sovereign capability needs.

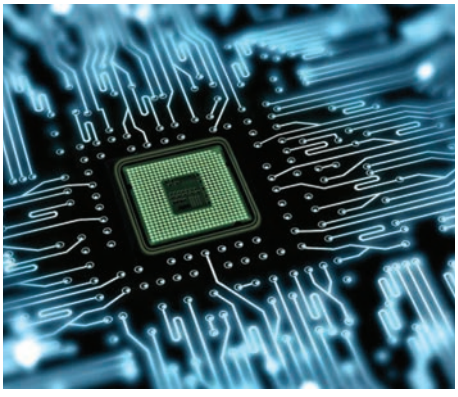


CCE Group Announces The Acquisition Of InTech Aerospace To Strengthen Its Aerospace Ecosystem

CCE Group, a Hivest Capital Partners portfolio company and a leading aerospace platform specializing in cabin and cargo equipment solutions, has proudly announced the acquisition of InTech Aerospace, a renowned specialist in cabin repair, refurbishment, fabrication, and aftermarket support services.

Headquartered in Houston, Texas, InTech Aerospace has built a strong reputation for technical capability, craftsmanship, and reliable execution in one of the most practical and demanding parts of the aircraft environment: cabin interiors. Its work supports airlines with the expertise required to maintain, repair, and upgrade key cabin elements that affect both daily operations and passenger experience.

With this acquisition, CCE Group adds another meaningful layer to its ecosystem and expands its capabilities in the cabin. InTech Aerospace brings recognized MRO expertise, deepening the Group's relevance to airlines and operators where maintenance, refurbishment, and operational reliability are critical.



AirAsia places landmark order for 150 A220s



Malaysia's AirAsia has placed an order for 150 latest generation A220-300 aircraft. The purchase agreement is the largest single firm order placed for the A220 and propels the programme beyond the 1,000 firm order milestone, underscoring the aircraft's global market appeal.

The contract was announced at a ceremony at the Airbus facility in Mirabel attended by Tan Sri Tony Fernandes, Chief Executive Officer of Capital A and Advisor to AirAsia Group and Lars Wagner, Chief Executive Officer Commercial Aircraft at Airbus.

The purchase agreement makes AirAsia a new customer for the A220. The airline also becomes the launch customer for the aircraft's new cabin configuration of 160 seats. The increase in capacity, adding 10 seats, is made possible by the addition of an extra overwing exit on each side of the aircraft.

The A220 complements AirAsia's existing Airbus fleet and will play a key role in advancing the Group's network and growth. The aircraft will service destinations across ASEAN and into Central Asia, freeing up larger aircraft to fly longer routes.

Acron Technologies Acquires Alereon, Inc.

Acron Technologies, a portfolio company of TJC, L.P., has announced the acquisition of Alereon, Inc., a fabless semiconductor company focused on ultra-wideband (UWB) solutions for the defense electronics market.

The acquisition strengthens Acron Technologies' rapidly growing defense technologies portfolio by adding personal area networking for real-time, low-power, high-bandwidth communications. As the government pushes forward to remove additional cables, offer lower power, and provide instant connectivity for warfighters on the ground, ISW solutions are being rolled out across many platforms.

Alereon's NIST and NSA-certified modules allow for quick integration into mission-critical applications, while the commercial solutions are gaining international acceptance as a standard for short-range, reliable video. Alereon's modules feature superior anti-jamming technology, preventing it from being compromised in virtually any environment.

AEEC | AMC Conference

The 2026 AEEC | AMC Conference brought aviation stakeholders together in Rome, Italy, to align on the technologies and standards accelerating connected-aircraft operations. Across technical sessions and symposia, participants focused on advancing new capabilities while sustaining safety, interoperability, and regulatory confidence. Discussion was organized around five themes—Regulatory Aspects of Artificial Intelligence, Cybersecurity 201, Resilient Navigation, GPS Spoofing, and Connected Weather—collectively reinforcing the imperative to build operational resilience and enable faster, higher-quality decisions in an increasingly data-driven, networked environment.

In Regulatory Aspects of Artificial Intelligence, speakers addressed how the industry can operationalize AI-enabled functions without compromising predictability or certification rigor. They emphasized the need for credible assurance evidence for data-driven systems, including training-data integrity, robust verification and validation, and demonstrated performance in edge conditions. Panelists underscored defining system boundaries, failure modes, and deterministic fallback behaviors so crews and operators understand how AI responds when inputs drift or the operating context changes. Human oversight, traceability, and disciplined documentation emerged as non-negotiable enablers for airworthiness findings and operational approvals.

Cybersecurity 201 reinforced that expanding digital connectivity is reshaping the threat landscape and elevating the need for aviation-specific, outcomes-based security. Speakers called for tighter alignment across FAA/EASA/OEM guidance and Safety Management Systems, rather than relying on generic IT control sets. Roberto Russo (Boeing Italia) advocated an "assume breach" approach focused on detection, containment, and rapid recovery, supported by an eight-step resilience playbook. Patrick McTernan (Shift5) highlighted the value of trust zones to make security assumptions explicit and enforce boundaries across mixed-criticality systems and new connectivity pathways. Marcie Wise (Delta Air Lines) proposed an ARINC Cybersecurity Standards Series to consolidate guidance, keep it current, and accelerate coordinated industry action. The clear takeaway: cyber resilience is a prerequisite for modernization and must be embedded across the aircraft lifecycle—from introduction and maintenance to operations and digital transformation.

Resilient Navigation and GPS Spoofing centered on a growing operational reality: positioning, navigation, and timing (PNT) must remain trustworthy when satellite signals are degraded by interference, jamming, spoofing, or environmental disruption. Presenters emphasized that resilience is inherently layered—combining complementary sensors, cross-checking, and integrity monitoring to detect anomalies and sustain safe performance. Because GNSS underpins trajectory-based procedures, surveillance, and cockpit decision aids, continuity is critical for both safety and efficiency. Discussion highlighted multi-sensor integration, improved detection and response to inconsistent solutions, and the continued value of terrestrial aids such as DME. The takeaway: trusted navigation in contested environments will require coordinated standards, validation methods, and operational practices across the ecosystem.

In Connected Weather, the conversation moved from data collection to dependable, real-time delivery and information sharing. Speakers demonstrated how connectivity can push timely updates directly to pilots—improving situational awareness as conditions change en route or near destinations and alternates—and supporting continued safe operation when onboard radar is degraded with known weather ahead. Participants stressed that value depends on more than availability: connected weather requires consistent formats, reliable links, and cockpit integration that aligns with pilot workflows and decision timelines. As airlines and service providers scale connected operations, the group emphasized harmonizing performance expectations and interoperability so crews receive the right information, at the right time, in a form they can trust and act on.

Across the symposiums, AEEC | AMC delivered a consistent message: emerging capabilities must be introduced with the same discipline applied to legacy avionics—clear requirements, interoperable standards, and well-defined operational concepts. Whether certifying AI-enabled functions, sustaining navigation through GNSS disruption, strengthening cybersecurity as connectivity expands, or delivering actionable weather over connected networks, the priority was building trust through verification, resilience engineering, and cross-industry collaboration. Maintaining that alignment between technology and governance will be essential to scaling the next generation of connected-aircraft services safely, globally, and at pace.

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Norway Takes the Next Step as an International Test Arena with Bristow Group and Electra

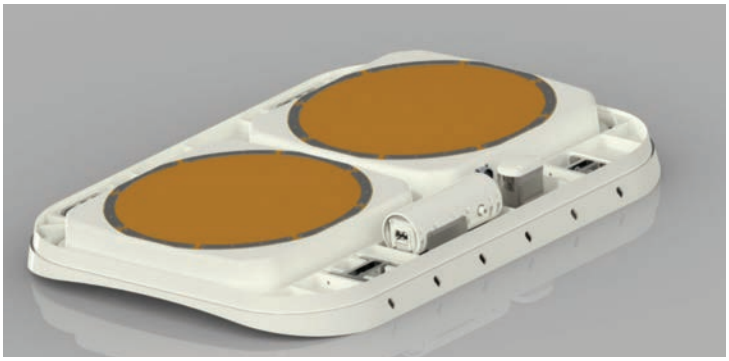
Project tests will showcase Electra's hybrid-electric Ultra Short aircraft, which can take off and land in as little as 50 meters, transforming the way people travel to hard-to-reach, regional destinations

Bristow Group Inc., Electra, Avinor, and the Norwegian Civil Aviation Authority announced the launch and contract signing of a second international test project for zero- and low-emission aviation. The project builds on Norway's established international test arena and aims to generate operational, regulatory and market knowledge supporting the introduction of electric and hybrid-electric aircraft.

Electra's hybrid-electric airplane operates from ultra-short access points, the size of a football pitch/soccer field, and dramatically reduces travel times by flying directly across terrain and waterways that make surface transportation frustrating and slow.

Under the agreement, Electra and Bristow will conduct demonstrations involving Electra's hybrid-electric Ultra Short aircraft. The goal is to examine the possibilities of novel aircraft operations to transform regional mobility networks, unlocking capabilities not possible with a conventional aircraft or even a helicopter.

ThinKom Unveils Space-optimized ThinAir Nexus Aircraft Antenna



A new generation of multi-orbit inflight connectivity is ready to fly, with the introduction of the ThinKom ThinAir® Nexus, a compact antenna rewriting what is possible for airlines. Sitting at the crossroads of efficiency, size, power, and flexibility, Nexus offers industry-leading, flight-proven performance in a package size similar to single-orbit electronically steered antenna (ESA) solutions.

Nexus matches the size and installation simplicity of ESAs, while besting them in performance and capabilities. Multi-orbit, multi-constellation, multi-provider flexibility is built in. Airlines can confidently choose Nexus knowing that it supports gigabit performance for GEO, MEO, and LEO constellations today, with flexibility to add new networks in the future with a simple modem swap.

"Airlines demand and deserve flexibility and reliability as they invest in inflight internet solutions," explains Jeff Sare, ThinKom's chief commercial officer. "Our new ThinAir Nexus solution delivers the most efficient and reliable multi-orbit, multi-constellation antenna to ever fly, now space-optimized for a smaller installation footprint."



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GCAP – The Future of Air Dominance?

Two main issues face the Global Combat Aircraft Programme in 2026. A long-running campaign to present the F-35 Joint Strike Fighter as a viable alternative to GCAP continues, while there are conflicting needs to keep the programme on track to meet ambitious timelines, but also to think about bringing new partners on board to make the sums add up.



The Global Combat Aircraft Programme (GCAP) is a joint venture by the UK, Italy and Japan, whose aim is to develop and produce a next-generation combat air platform for the three partners and for export customers. A manned 'sixth generation' combat air platform will lie at the heart of a wider 'system of systems', augmented by unmanned adjuncts (UCAVs) and effectors (weapons), and integrated with other platforms and systems across the military domains. But the partners will each pursue their own systems of systems outside the GCAP construct.

Though it is often referred to as a 'fighter', the core manned aircraft within the GCAP system of systems will have formidable air dominance capabilities, but will also be a long-range strike aircraft, an ISR platform and a significant contributor to the information dominance fight. In Britain, at least, it will continue to be called Tempest.

The GCAP programme has its roots in the Anglo-Italian Future Combat Aircraft System and the separate Japanese FX/F-3 programme, both of which date back many years. These efforts started to come together from 2017, as the three nations realised that they had broadly similar and compatible requirements, and timescales. It soon became clear that any programme to develop a viable aircraft (and its supporting system of systems) would be prohibitively expensive for a single nation to develop.

The programme partners quickly realised that existing fifth generation aircraft would be inadequate to meet emerging requirements, and that there was no existing off-the-shelf solution that would meet their military requirements. A new aircraft and supporting system of systems promised to provide next generation Combat Air capabilities, and would deliver the military capabilities, strategic relevance required, while also delivering sovereignty and prosperity advantages

The 'high level' benefit of producing a new, cutting edge combat air system of systems independently – rather than simply buying one from the US – lies in the operational advantage of having genuinely sovereign freedom of action, freedom of modification, the ability to integrate one's own choice of weapons, and to iterate and upload sovereign mission data with agility. These will be key to keeping pace with a rapidly evolving threat.

Perhaps the greatest 'threat' to the GCAP programme comes from Lockheed Martin's F-35 Joint Strike Fighter, and the energetic lobbying campaign that has been mounted in that aircraft's favour.

For many years there has been a determination in some quarters to pursue 'harmonisation' with the US forces, operating exactly the same equipment in exactly the same way. This has been accompanied by a prejudice against locally developed equipment, and programmes, which are often perceived to be afflicted by delay, severe cost increases, technical difficulties and failures,

producing a disappointing end result. By contrast, US programme difficulties and failures are minimised or ignored.

The F-35 is undeniably the most effective and capable combat air platform in service today, and it brings a tremendous capability to its operators, representing a quantum leap by comparison with today's '4th generation' fighters. The F-35 has the most advanced sensor suite of any fighter in history, providing unmatched situational awareness, while the aircraft's LO (Low Observable) capabilities allow it to operate effectively in contested environments, and to survive in an enemy IADS (Integrated Air Defence System).

In 2026, no other in-production, in-service combat air platform can offer the same capabilities as the F-35, although it suffers from very poor availability and very high support and sustainment costs. It also imposes a very high degree of reliance on the US, US-dominated supply chains and US-operated support and logistics infrastructure. This results in a real lack of operational sovereignty. As the US becomes a less and less reliable ally, there are real fears that non-US F-35s could effectively be rendered ineffective or inoperable at the whim of the US government.

And the F-35 is not a new design. It is more than a quarter of a century since the X-35 made its maiden flight on 24 October 2000, and it is 20 years since the first F-35A made its maiden flight in December 2006. The world has changed in that time, and the threat is continuing to change, at an accelerating pace.

Jonathan Smith, VP Capability and CTO, Future Combat Air (GCAP), for Leonardo UK's Electronics Division is eminently well equipped to understand what is required in a 'sixth generation' manned combat air platform, since he is one of the few men to have flown both the F-22A Raptor and the F-35B Lightning II operationally.

Smith was the RAF's second ever F-22 exchange pilot, before becoming the UK F-35 Lightning II Tactics and Development Staff Officer. He then converted onto the F-35B in October 2015 subsequently becoming the Executive Officer and later Commanding Officer of No.17 Test and Evaluation Squadron, the UK's Test and Evaluation Squadron for the F-35B, at Edwards Air Force Base, California. Returning to the UK, Smith became the UK F-35B Requirements Manager, Air Capability, until April 2020, when he joined Leonardo and the Tempest project.

Smith's career has given him an unparalleled insight into the capabilities of fifth generation combat air platforms, their strengths and their weaknesses, and a real understanding of what the next generation of combat air will need to 'bring to the table'.

Smith is clearly something of an enthusiast for the F-35, today, calling it: "A tool designed for a job and one that does that job very well." But while the F-35 can do the job in the context it is sat in right now, he believes that: "The ability of the F-35 to do that job in a future context is going to be



The latest Tempest concept has a massive Delta wing, accommodating a really significant volume of fuel. (Photo: BAE Systems)

significantly challenged. Yes, the F-35 is very good, but it was designed to do something in a constrained epoch that we're now moving out of."

"FCAS, Tempest, whatever we want to call it is, is a tool being designed for a job in a different threat context in a different epoch. That's the space, that's the capability gap that we're designing the Tempest to fill," Smith says.

Many believe that while the F-35 will remain relevant, it will be most relevant and most effective when operating within a combat air ecosystem that is populated by what Smith calls "additional tools, like the FCAS, Tempest and NGAD."

"When you look at the F-35, yes, it's a fantastic platform, but it will increasingly have its limits and where those limits appear, we have to have something that can fill those capability gaps. There's no doubt about it," Smith insists, pointing out that tomorrow's contested environment will make today's operating environment look almost benign.

The F-35 will be the 'low end' platform in tomorrow's high:low mix, augmenting the new 'sixth generation' platforms. Smith says that these are being "designed and developed to meet a specific challenge in a specific time that maybe you can't quite iterate an F-35 up to. You can't continually expect your current platforms to meet to meet the threat context and meet the performance levels that you need as time goes by." A generational shift in platform system capability will be required if mission success is to be ensured.

Smith believes that: "the threat is going to evolve, is going to get harder and it's going to evolve and get harder faster." The answer is not be to design and deploy a more capable fighter aircraft – which would itself soon be outpaced by the ever-developing threat.

Smith says that while the solution will initially be a new and more capable platform, it will be a new kind of platform, more capable, but also more capable of being upgraded and adapted to meet the developing threat, keeping up with that change and continuing to "deliver those levels of lethality, survivability and information dominance."

Reiterating why procurement of

The Tempest has a challeging timetable if it is to start to enter service in 2035, as planned. (Photo: BAE Systems)





The Tempest manned fighter is a classic Low Observable (stealthy) design, with edge alignment and internal weapons carriage. (Photo: BAE Systems)

the F-35A would be a poor choice for FCAS, Smith pointed to the ongoing US NGAD development programme, and insisted that: "All the people that say we should just buy American should perhaps learn the lessons that the Americans themselves are learning - you can't continually patch things to do the job. You could then start to get into arguments about the national value framework and things like that, but certainly from my point of view as a technician, as an operator, I don't really need to have those sort of arguments although they are absolutely valid."

And as well as being operationally essential, a new combat air system of systems also promises considerable industrial and economic benefits.

Could Trilateral become Multi-national?

The three national Prime Ministers announced the establishment of the Global Combat Air Programme in December 2022, aiming to jointly develop a next generation fighter. At an industrial level BAE Systems, Leonardo and Mitsubishi Heavy Industries announced a trilateral collaboration agreement the following September.

The British, Italian and Japanese Governments signed a treaty to establish an international agency to manage the GCAP programme, the GCAP International Government Organisation (GIGO). It was agreed by the three governments that the resulting next generation combat aircraft would be delivered by 2035.

BAE Systems, Leonardo and JAIEC announced their agreement to set up a proposed Joint Venture Agreement in December 2024, and the Edgewing joint venture company was launched in June 2025.

To develop and deliver a next generation manned combat air platform by 2035 represents an extremely ambitious timescale, and the consortium cannot afford any delays. For this reason, the partners have publicly dismissed any chance of allowing new partner nations into the development programme, since this would inevitably mean re-opening workshare negotiations.

In April 2026, a team of Financial Times reporters, including Lucy Fisher and Sylvia Pfeifer in London, Leo Lewis and Harry Dempsey in Tokyo, and Ilya Gridneff in Toronto reported that officials in Tokyo and London had said that an 'observer status' mechanism had been devised to create a pathway into GCAP that would avoided complicated and time-consuming processes to expand the core trio of the UK, Italy and Japan.

Japan's timescales are particularly pressing, as the JASDF urgently needs to replace its ageing Mitsubishi F-2s and Boeing F-15Js, and so cannot afford the delays that would result from any nation joining the development phase of the programme. On the other hand, spreading costs between more partners, and leveraging a larger order book would be extremely welcome. Sir Grant Shapps, British Secretary of State for Defence from August 2023 to July 2024, observed that the GCAP aircraft "can only be truly successful if the market is greater than the UK, Italy and Japan."

Financial pressures are already hitting the programme, with delays to the UK's defence investment plan (DIP) limiting recent funding to a three-month interim, stop-gap £686mn contract for key engineering and design work, that will run only to the end of June. It is hoped that the DIP (which sets out UK defence spending priorities over a 10-year period) will unlock larger, longer-term investment.

Observer status would allow a new potential customer/partner nation access to some confidential project information prior to deciding whether to participate in the production phase, or to simply buy the system as a customer. Saudi Arabia could be a potential observer (though it has a little known FCAP programme with the UK that is based on some Saudi participation in FCAS/GCAP), and Poland, Sweden, Australia, and Singapore have all been mentioned



Leonardo UK's Electronics Division's VP Capability and CTO, Future Combat Air (GCAP), Jonathan Smith, is an ex F-22 and F-35 pilot, giving him a unique perspective on the need for Tempest. (Photo: via Leonardo UK)

as potential partners. The threat of the Franco-German-Spanish SCAF project collapsing in acrimony and recrimination could potentially lead to Germany (and perhaps Spain) joining GCAP as customers or industrial partners.

The FT reported that Canada is lobbying to be admitted to GCAP programme, in an effort to "diversify defence procurement and grow partnership with like-minded allies," reflecting a growing dislocation with the US. It was said that Canada had sent a formal request to the UK and that letters to Japan and Italy would follow shortly.

There were early concerns as to Japan's attitude to defence exports, after decades of stringent restrictions. Shapps noted that it would be "helpful if Japan were to revise, carefully and sensibly, the three principles governing its defence technology exports." In April 2026, the Japanese government announced that previous restrictions (effectively limiting exports to non-lethal systems for transport, surveillance, warning, rescue, and minesweeping) were being relaxed to allow weapons systems to be exported to those 17 countries with which Japan has defence agreements.

Tempest will offer unprecedented air dominance capabilities but at a cost, and not all operators will need all of those capabilities. BAE Systems is known to have undertaken studies of a potential 'second core manned aircraft' within the FCAS system of systems, probably based on the so-called Concept Class 5, probably using the same sensors/mission systems and perhaps the same powerplants with a different role emphasis. This offered a smaller, cheaper, aircraft more focused on air superiority, and less on payload and ultra long range. This would be more 'exportable' than the full-up Tempest, for less wealthy nations but also to allow Tempest operators to achieve significant combat air 'mass'.

Tempest described

A refined Tempest concept was unveiled at Farnborough in 2024, with a new Delta wing that promises good turn performance, low drag in cruising flight, and massive internal fuel volume. This would potentially give the Tempest a longer combat radius on internal fuel than most current combat air platforms can achieve with external fuel tanks. It may also confer an unusual degree of agility for so large an aircraft. The design is clearly optimised for low observability (radar stealth) with significant internal weapons carriage.

The aircraft that does eventually enter service in 2035 may look nothing at all like the model displayed at Farnborough, or illustrated in dozens of GCI artworks and videos. Some details of the current concept have likely been 'finessed' for security reasons while the concept shown represents no more than an illustration of what UK concepting to date shows could meet today's UK requirement. And digital techniques (including computational fluid dynamics) allow concepting to be undertaken at a previously unimaginable pace, resulting in large numbers of different configurations being assessed and analysed.

BAE Systems' managing director of Future Air Combat Systems, Herman Claesen ackowledged that the design would continue to be to tested and

evolved ahead of the Trinational Joint Design and Development phase, launched last year, when Italian and Japanese requirements might have been expected to start to shape the design. This may not be the case, as BAE Systems' concepting was based on one requirements document, as Claesen explained: "All the requirements managers from the three countries have established one single set of requirements, and our engineers are currently concepting against that requirement set, and you can see a physical product outside."

Broad hints were dropped that we may be closer to seeing a definitive GCAP design than has sometimes been realised.

"We are rapidly homing in on the final configuration, and the outer mould line of the aircraft is always one of the big milestones that we need to be achieving," Claesen said.

But what is inside GCAP is every bit as important as what the aircraft looks like on the outside.

The philosophy of the Tempest design is based around an open architecture, which will make it easier and quicker to enhance and upgrade capabilities so as to keep pace with the threats. For this reason, Tempest insiders suggest that the aircraft will not have an FOC (Final Operational Capability) date, instead being constantly updated and upgraded throughout its service life.

The aircraft features an advanced Integrated Sensing And Non-Kinetic Effects and Integrated Communication System (ISANKE/ICS). ISANKE has been compared to a 'spider's web' of capability sitting across an aircraft, with integrated systems rather than separate sensors. It will also incorporate inputs from offboard sensors across all domains. This will give the Tempest a fully integrated fused sensing capability, providing the pilot with a greatly enhanced view of the battlespace and conferring an unparallelled situational awareness picture, maximising survivability and unlocking the full potential of sixth generation sensing.

The MRFS (Multi-function Radio Frequency System) will provide capabilities beyond those normally associated with a traditional radar, collecting and processing unprecedented quantities of data (claimed to be equivalent to the internet traffic of a large city). Development of Tempest's ISANKE & ICS builds on existing and new technology, including the ECRS. Mk 2 radar under development for the Typhoon and the universal radio frequency sensor, known as JAGUAR, being developed as a research tool and demonstrator by the UK (Leonardo) and Japan. Two demonstrators will be built, one in each country, with the work and learning shared to maximise national expertise. The ISANKE system will also incorporate significant electronic warfare capabilities, making it more resilient in tomorrow's congested and contested battlespace.

The Infrared and Electro-Optical system combines Infra-Red Search and Track, Electro-Optical Targeting and Distributed Electro-Optical systems, and provides passive detection and tracking of threats. It is the deep integration of these onboard and offboard sensors that makes Tempest a true '6th Generation' platform. This deep integration is also exactly what will enable allied air forces to quickly and accurately locate targets, while also denying adversaries' surveillance technology.

Tempest's Integrated Communication System (ICS) will connect the ISANKE system into the wider FCAS system-of-systems. ICS therefore incorporates vehicle and tactical datalinks, with Beyond Line Of Sight (BLOS) capabilities. The system will dynamically self-optimise to operate to best advantage in any given tactical situation, and to enable ISANKE to operate as an adaptive mesh across formations of widely separated manned and unmanned aircraft.

The various elements of ISANKE-ICS will be tested on board a dedicated large aircraft testbed, based on a converted Boeing 757. This aircraft, known as Excalibur, has received aerodynamic modifications, and is now waiting for the installation of Tempest sensors and systems.



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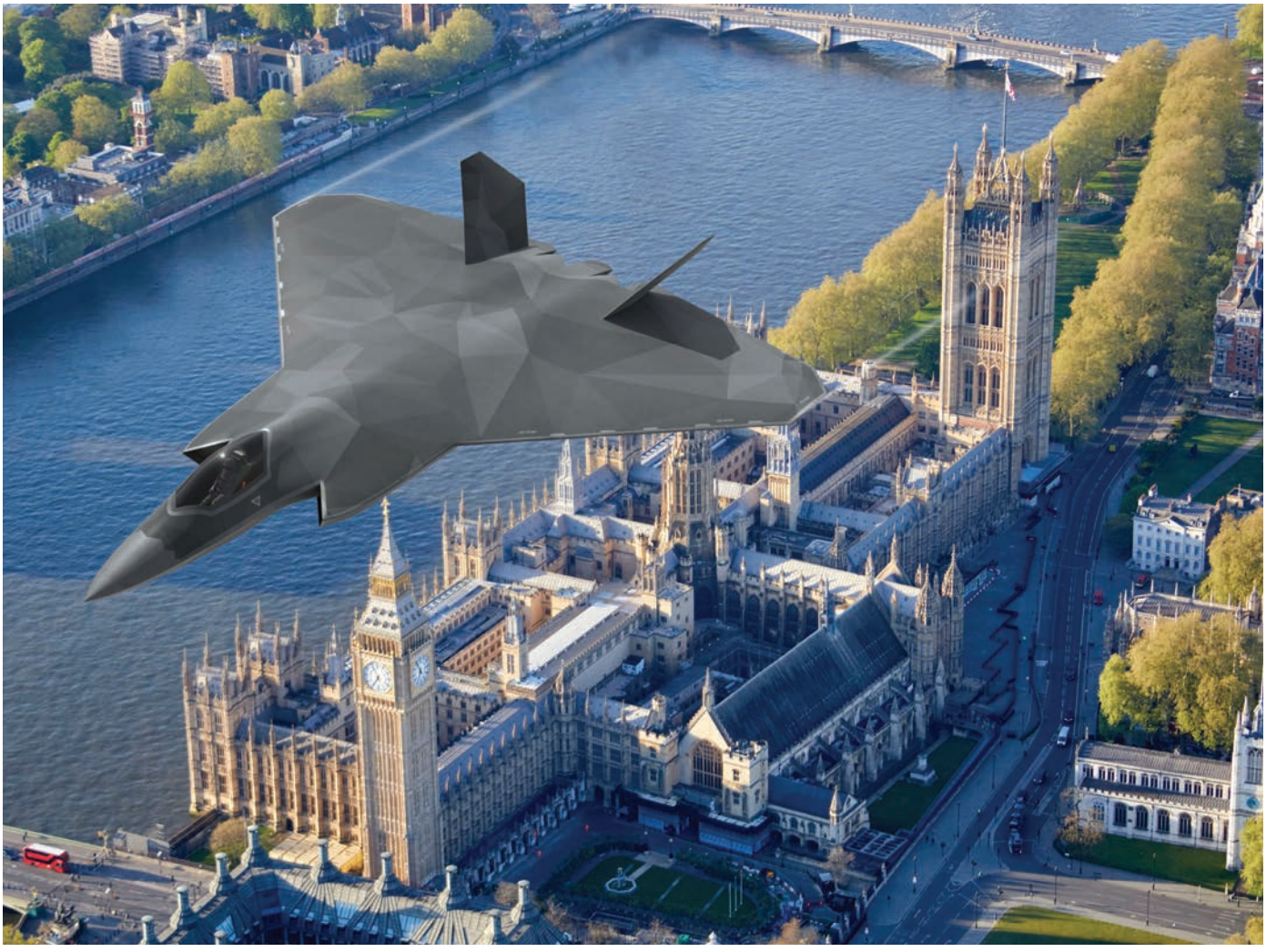
A quite separate Combat Air Flying Demonstrator (previously known as the Crewed Combat Air Demonstrator, and before that as the Flying Technology Demonstrator) is in production. This is not a Tempest prototype, but will be used to develop both technologies and to develop the SQUEP (suitably qualified and experienced personnel) that the GCAP programme will require. It is, after all, several decades since UK industry last developed a 'clean sheet' combat air aircraft, and the Combat Air Flying Demonstrator will provide personnel with invaluable skills and experience, 'rehearsing' for GCAP/Tempest.

As the Farnborough air show draws near, many expect big news from the GCAP programme. Aerospace Innovations will bring you the full story.

By Jon Lake



A Combat Air Flying Demonstrator is already in build at BAE Systems' Warton factory. This will be a technology demonstrator, but also a means of bringing on a workforce that has not done this for many years. (Photo: BAE Systems)



The GCAP programme has enjoyed significant political support, reflecting its vital importance both to UK defence, and to UK industry and the national prosperity agenda. Some worry that ensuring adequate funding as it is required may become an issue. (Photo: BAE Systems)

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Part II: Scaling Intelligence in Aerospace Manufacturing



From Intelligent Factories to Intelligent Production Systems

In Part I of this series, we explored how robotics, artificial intelligence (AI), and advanced automation are reshaping the aerospace factory floor. Across commercial and defense programs alike, manufacturers are integrating these technologies to increase precision, improve process capability, and stabilize production at historically unprecedented rates.

Yet deploying robotics or AI inside a single factory does not, by itself, create a transformative industrial system. The real shift occurs when intelligence extends beyond isolated production cells and becomes embedded across programs, facilities, and supply chains.

In this sense, the intelligent aerospace factory is only the beginning. The larger transformation is the emergence of the intelligent aerospace enterprise—an integrated production ecosystem where digital technologies connect engineering, manufacturing, logistics, and lifecycle support into a continuously adaptive system (Kagermann et al., 2013; Deloitte, 2023).

For aerospace manufacturers confronting rising production demands, volatile supply networks, and stringent regulatory requirements, scaling this intelligence is becoming essential. The factories of the future will not simply produce aircraft; they will operate as dynamic systems capable of learning, adapting, and optimizing in real time.

Digital Twins and the Rise of the Virtual Factory

One of the most powerful technologies enabling this shift is the digital twin, a virtual representation of a physical system that continuously reflects real-world conditions through operational data.

Digital twins are not entirely new to aerospace. The concept originated decades ago in spacecraft



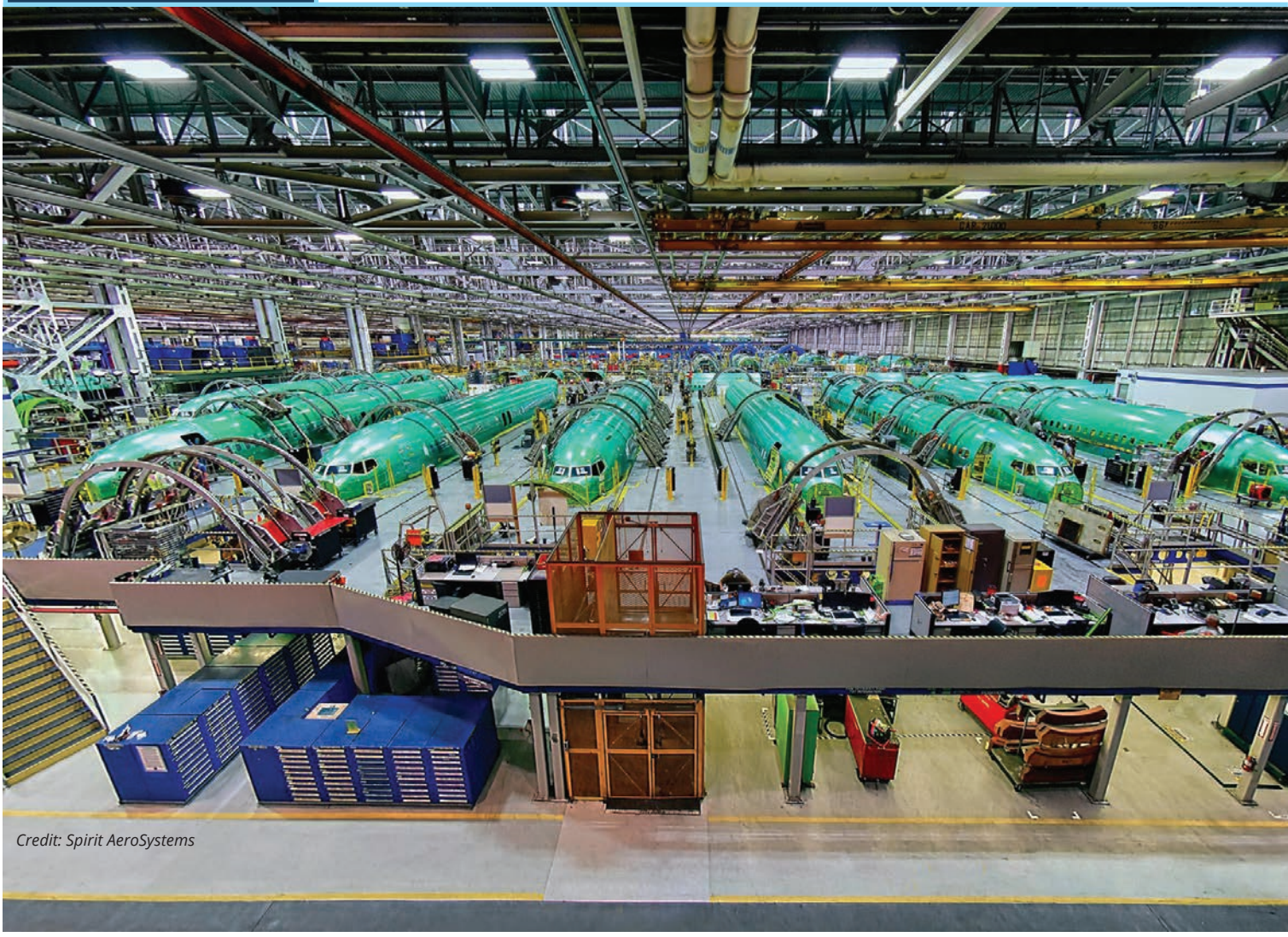
development, where engineers simulated vehicle behavior long before hardware was launched. Today, advances in computing power, data integration, and sensor technology have expanded this concept dramatically. Entire production lines, and even entire factories, can now be modeled digitally and synchronized with their physical counterparts (NASA, 2021; SAE International, 2022).

In practical terms, digital twins allow manufacturers to simulate and optimize production environments before physical systems are installed. Engineers can evaluate line layouts, identify potential bottlenecks, and test production-rate scenarios without disrupting ongoing operations.

Robot paths can be validated digitally to prevent collisions and inefficiencies. Human–machine workstations can be evaluated for ergonomics and safety. Material flow can be simulated to determine the optimal placement of logistics nodes and workstations.

Perhaps most importantly, digital twins connect product design with manufacturing execution. By linking product lifecycle management (PLM) systems with manufacturing execution systems (MES) and enterprise resource planning (ERP) platforms, companies establish a continuous digital thread that traces design intent through production and into operational performance (Porter & Heppelmann, 2014).

This level of digital continuity allows engineering and manufacturing teams to collaborate more effectively while reducing ramp-up risk during new program launches. In an industry where production delays can cascade across global supply networks, the ability to validate manufacturing systems virtually before implementation represents a major strategic advantage.



Credit: Spirit AeroSystems

Production Readiness as a Living Capability

For decades, aerospace programs have relied on milestone-based readiness reviews. Equipment is installed, operators are trained, work instructions are released, and first article inspections are completed. Once these steps are verified, production is considered ready to proceed.

While this framework has supported the industry's rigorous safety culture, it struggles to keep pace with the complexity of modern aerospace manufacturing.

In intelligent production environments, readiness is no longer treated as a static checkpoint. Instead, it becomes a continuously monitored capability that reflects the real-time condition of processes, assets, materials, workforce qualifications, and quality systems.

Process capability, for example, can now be monitored through continuous statistical analysis of critical manufacturing parameters. Instead of waiting for periodic quality reports, engineers can observe trends in real time and intervene before variation exceeds acceptable limits.

Similarly, predictive analytics allow manufacturers to monitor the health of critical equipment. By analyzing vibration, temperature, torque, and performance data, AI-driven maintenance systems can identify early indicators of equipment degradation, allowing maintenance teams to intervene before failures disrupt production (McKinsey & Company, 2022).

Material traceability has also advanced significantly. Digital systems can now track raw materials, components, and assemblies across the entire manufacturing lifecycle, providing instant visibility into potential supply risks or compliance concerns.

Workforce readiness is evolving as well. In intelligent factories, digital training systems link operator certifications directly to production tasks. If a certification expires or required training has not been completed, the system prevents the operation from proceeding until compliance is restored.

Quality systems benefit from similar integration. Nonconformance reports, corrective actions, and audit findings can be analyzed collectively, enabling organizations to identify recurring patterns and prioritize systemic improvements.

The result is a dynamic readiness profile—one that provides leadership with a continuously updated picture of operational stability rather than relying solely on historical documentation.



The Human Dimension of Intelligent Manufacturing

Despite rapid advances in automation and AI, the aerospace factory remains fundamentally human-centered. In fact, the effectiveness of intelligent manufacturing systems depends heavily on how well they augment human expertise.

As automation expands, the nature of work on the factory floor is evolving. Operators increasingly supervise automated cells rather than performing repetitive manual tasks. Maintenance technicians must be capable of diagnosing both mechanical issues and digital control systems. Engineers must interpret large volumes of operational data and translate those insights into actionable improvements.

These shifts are driving the emergence of new workforce skill profiles. Mechatronics expertise—combining mechanical, electrical, and software knowledge—is becoming increasingly valuable. Data literacy is also critical, enabling engineers and technicians to interpret analytics dashboards and machine learning outputs.

Equally important is the cultural transformation required to support intelligent manufacturing. Connected production systems generate unprecedented transparency through real-time dashboards and analytics-driven insights (Porter & Heppelmann, 2014).

Organizations must cultivate cultures where this visibility is used constructively—to identify opportunities for improvement rather than assign blame. When employees trust that data-driven insights will support collaboration rather than criticism, adoption accelerates dramatically.

In this environment, automation becomes a partner rather than a perceived threat. Human judgment and machine precision reinforce one another, enabling factories to achieve higher levels of safety, quality, and productivity than either could accomplish alone.

Why Many Smart Factory Initiatives Stall

Despite the promise of intelligent manufacturing, many digital transformation initiatives struggle to progress beyond early pilot programs.

The reasons are rarely technological. Instead, they typically stem from architectural or organizational challenges.

One of the most common obstacles is fragmentation. Companies may deploy automation solutions or analytics platforms in isolated departments without establishing a unified digital architecture. While these projects can deliver local improvements, they fail to generate the system-level benefits required for large-scale transformation (Deloitte, 2023).

Another challenge is excessive customization. Highly tailored software solutions may address



Credit: Smart Factory production team working together to deliver innovative production

specific operational needs but become difficult to replicate across facilities or programs. Without standardization, scaling intelligent manufacturing across an enterprise becomes prohibitively complex.

Data quality presents another significant barrier. Artificial intelligence and advanced analytics depend on consistent, reliable data streams. If foundational data governance is weak—due to inconsistent naming conventions, incomplete records, or incompatible systems—confidence in analytics deteriorates quickly.

Cybersecurity is also a growing concern as operational technology networks converge with enterprise IT systems. Aerospace manufacturers must protect sensitive intellectual property while maintaining the connectivity required for intelligent production environments.

Finally, regulatory alignment remains critical. Aerospace production must comply with stringent standards such as AS9100 and NADCAP, and digital manufacturing systems must support these frameworks by providing traceable documentation, auditable records, and robust configuration control.

Organizations that address these challenges early—by establishing clear digital architectures, governance frameworks, and data standards—are far more likely to



Digital twin technology is revolutionising aircraft engineering processes

achieve successful transformation.

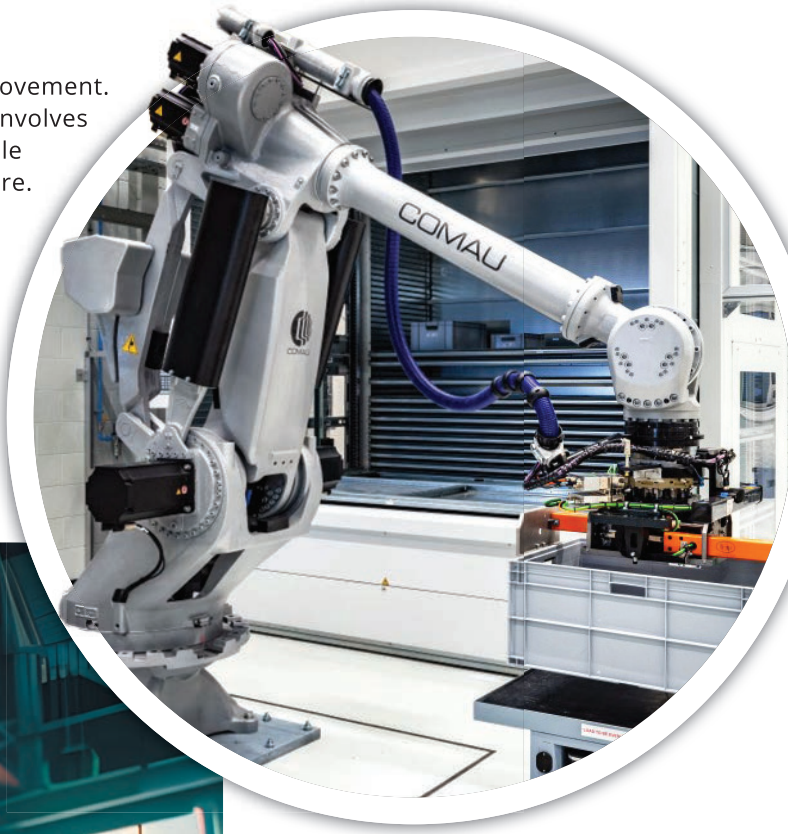
Building a Practical Roadmap to Intelligent Manufacturing

For aerospace companies seeking to advance toward intelligent production systems, progress typically begins with a candid assessment of current capabilities.

Understanding where operational bottlenecks exist—and where data visibility is limited—provides the foundation for meaningful improvement.

The next step involves defining a scalable digital architecture. Integration between PLM, MES, and ERP systems forms the backbone of the digital thread that connects engineering decisions with manufacturing execution (Porter & Heppelmann, 2014).





BAE Systems Factory-of-the-Future

Rather than attempting enterprise-wide change immediately, leading organizations often begin with model areas—pilot production environments where new technologies and workflows can be validated under controlled conditions.

These model areas allow teams to refine processes, evaluate technologies, and demonstrate measurable value before scaling successful approaches across additional facilities.

Workforce development must evolve in parallel. Investments in robotics, automation, and AI require complementary investments in training programs that equip employees with the skills needed to operate, maintain, and improve these systems.

Finally, intelligent factories must be treated as living systems. Continuous improvement programs, disciplined governance structures, and cross-functional collaboration ensure that technological investments translate into sustained operational performance.

The Strategic Ripple Effect Across the Supply Chain

As intelligent manufacturing systems mature, their influence extends well beyond individual factories.

Original equipment manufacturers increasingly expect suppliers to participate in digital ecosystems that support traceability, quality monitoring, and real-time production visibility. These expectations are driving digital transformation throughout the aerospace supply chain.

Connected manufacturing systems also enable new forms of collaboration. Production data can be shared with engineering teams to refine designs, while maintenance organizations can use manufacturing insights to anticipate operational reliability issues (Porter & Heppelmann, 2014).

Even regulatory oversight is evolving. Digital production records provide regulators with richer, more reliable evidence of compliance than traditional paper-based documentation.

In this way, the intelligent aerospace factory becomes more than an internal efficiency initiative. It becomes a strategic platform that connects the entire aerospace ecosystem—from design and manufacturing to operations and lifecycle support.

The Intelligent Aerospace Enterprise

The aerospace industry has always balanced innovation with discipline. Aircraft must push technological boundaries while meeting uncompromising safety and reliability standards.

The intelligent aerospace factory reflects this same balance. Robotics, AI, and automation provide powerful technological capabilities, but their true value emerges only when they are integrated with strong governance, skilled workforces, and disciplined operational practices.

When these elements align, manufacturing evolves from a reactive system into a continuously learning one—capable of adapting to disruptions, scaling production, and improving performance over time.

For aerospace manufacturers navigating rising production demands and increasing complexity, the question is no longer whether intelligent manufacturing will reshape the industry. That transformation is already underway (McKinsey & Company, 2022; World Economic Forum, 2023; Airbus, 2022; Boeing, 2022; Spirit AeroSystems, 2022).

The organizations that successfully scale these capabilities will not simply produce aircraft more efficiently. They will define the next era of aerospace industrial performance.

By Azita Hajihassani, Ph.D., MBA

www.LeadingDisruption.net

Author bio:

Azita Hajihassani, Ph.D., MBA is a manufacturing and quality systems leader with extensive experience in aerospace, advanced manufacturing, and industrial operations. Her work focuses on production readiness, supplier quality, digital manufacturing, and the integration of robotics, AI, and automation in complex manufacturing environments. Azita Hajihassani, Ph.D. writes on manufacturing innovation, intelligent factories, and industrial transformation, helping organizations bridge the gap between advanced technology and practical operational performance.

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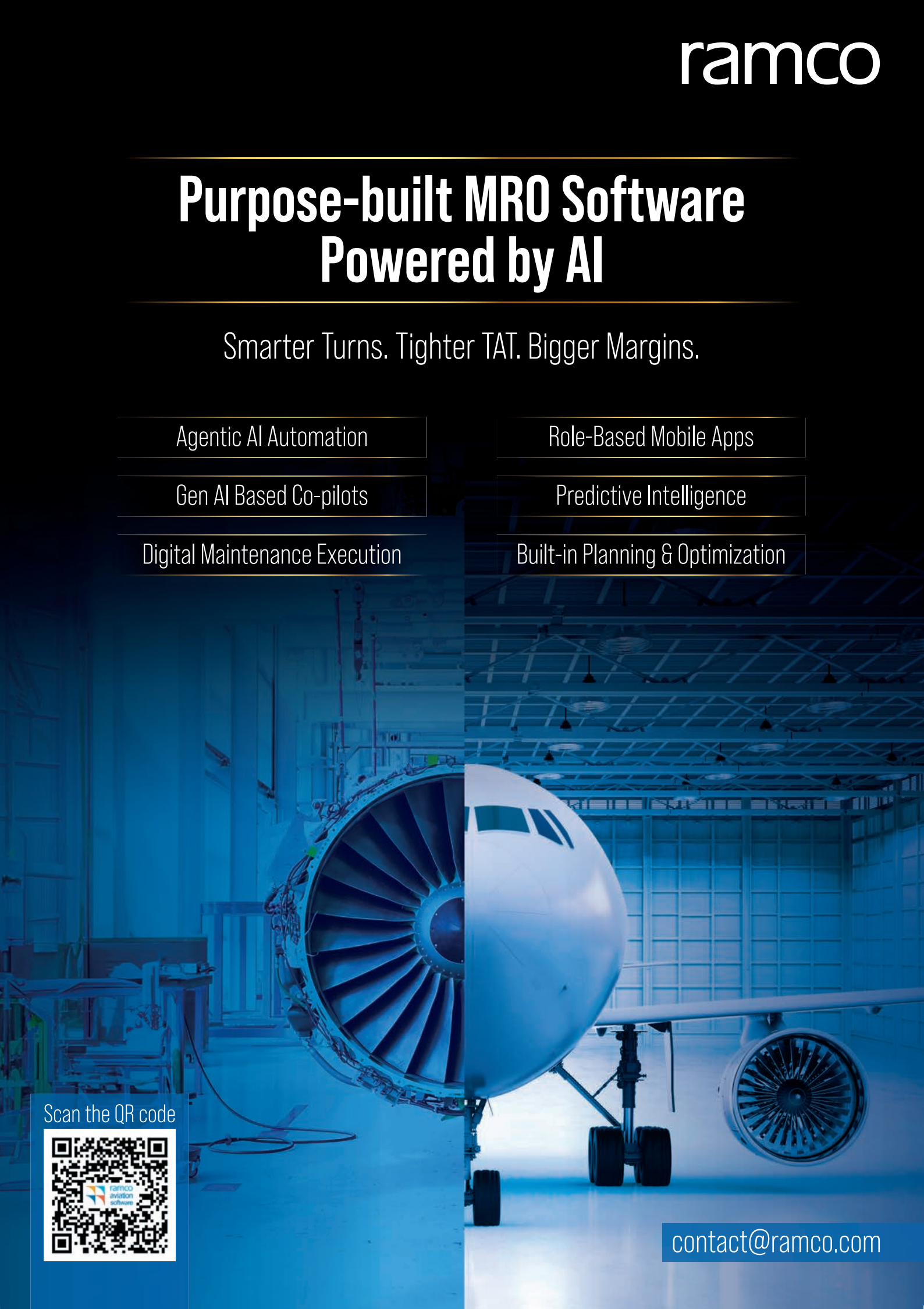
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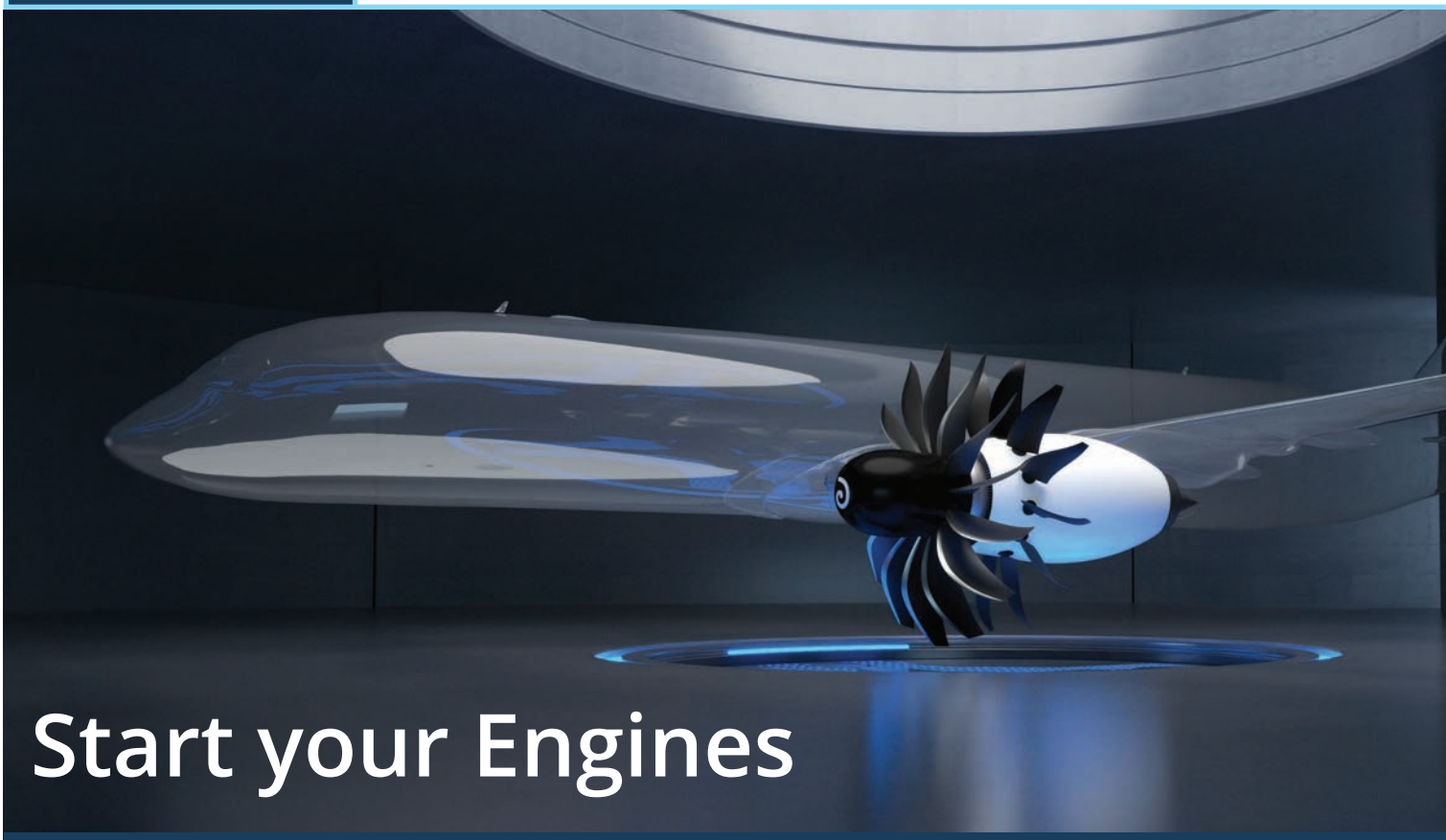
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Start your Engines

Aircraft engines are undergoing a step change as numerous programmes seek to disrupt current propulsion technologies.

To passengers, they are the familiar rumble powering aircraft across the skies. For aircraft operators, engines are a critical component in a variety of metrics such as safety, operational and economic performance, and environmental efficiency.

To improve these characteristics, airframers are working closely with numerous stakeholders to develop cutting-edge propulsion technologies that will power the next generation of aircraft. These include open fan, hydrogen, electric and hybrid-electric propulsion systems, all of which aim to achieve increased performance (i.e. in efficiency, load, range, energy consumption), and reduced climate impact, such as through reduced emissions, noise footprint, contrails etc.

Additionally, durability, reliability and safety of equipment will continue to play a large role, as will lifecycle considerations such as maintenance, repair and overhaul requirements.

The consequences of not meeting these is being felt publicly at the moment, with Airbus CEO Guillaume Faury acknowledging the company was "facing significant Pratt & Whitney engine shortages."

Presenting Full-Year (FY) 2025 financial results, Faury said of the A320 Family, that "Pratt & Whitney's failure to commit to the number of engines ordered by Airbus is negatively impacting this year's guidance and the ramp-up trajectory."

The issue lies with the recall of Pratt & Whitney's (P&W) PW1000G geared turbofan engine, which came about following the discovery of a powder metal contamination affecting high-pressure turbine (HPT) and high-pressure compressor (HPC) components manufactured between the fourth quarter of 2015 and the third quarter of 2021. This led to mandatory inspection and replacement requirements - up to 800 GTF engines as of 2026 have been affected.

The timeline for completing these removals has pushed back with forecasts now projecting full recovery in 2027 or later. The primary driver behind this delay is an increase in shop visit turnaround times. This was initially projected to last 60 days, but has spiralled to 300–360 days per engine.

Several airlines, as well as Airbus, have sought or are pursuing financial compensation from Pratt and Whitney for the disruption caused by the issue. This includes ITA Airways, which reported grounding 28% of its fleet in November 2025 due to the ongoing global recall.

The stakes for next generation engine technology are therefore high.

Iteration or innovation?

MTU Aero Engines says it is pursuing a clear course: cleaner, quieter, more economical. According to a spokesperson, with its Claire (Clean Air Engine) technology agenda, it lays out innovative concepts for sustainable commercial aircraft engines.



TAKE OFF aims at pushing the technologies forward for the Open Fan engine architecture. This architecture was unveiled in 2021 as part of the CFM RISE technology demonstration program. Credit: CFM International

"To do so, we take a two-pronged approach: one is evolutionary development of the gas turbine based on the geared turbofan (GTF), and the other is the development of completely new, revolutionary propulsion technologies, such as the Revolutionary Turbofan and the Flying Fuel Cell (FFC)," they say.

Sustainable aviation fuels and hydrogen play a key role, and the company is already working on an liquid-hydrogen fuel system for the FFC, while also building two state-of-the-art test stands for it on its premises in Munich.

"We have teams working on the engineering development of such concepts, as well as specialists in material sciences, new part and component designs, innovative production technologies, testing and MRO to ensure all the above-mentioned needs are met and reliable technological development achieved," the spokesperson tells Aerospace Innovations.



UltraFan 80 is Rolls Royce's blueprint for the next generation of widebody applications. Credit: Rolls-Royce

Rather than develop a new powerplant, Pratt & Whitney is hoping to banish its woes by furthering the evolution of its GTF engine with the GTF Advantage.

According to the company, over 2,700 GTF-powered aircraft have been delivered to more than 90 customers worldwide to date, with demand for the GTF remaining strong, with over 13,000 engine orders and commitments in total across all platforms.

For Rick Deurloo, president of Commercial Engines at Pratt & Whitney, "the GTF engine delivers the lowest fuel consumption for single-aisle aircraft."

Quoted in a recent press release, Deurloo stated that, "The GTF Advantage engine extends that lead—offering up to double the time on wing and enhancing aircraft capability—providing even greater value to operators of A320neo family aircraft."

Pratt & Whitney claims the GTF Advantage will deliver 4-8% more take-off thrust, enabling higher payload and longer range, unlocking new destinations for airlines. As the manufacturer explains, fully intermixable and interchangeable with today's GTF engine model, GTF Advantage will become the production standard, with full cutover expected in 2028.

In addition, customers operating the current GTF engine model will have the opportunity to realise up to 90-95% of the GTF Advantage's durability benefits with the GTF Hot Section Plus (HS+) upgrade option for the PW1100G-JM engine, available later this year for incorporation during maintenance visits. HS+ includes only about 35 part-numbers.

Advantageous designs

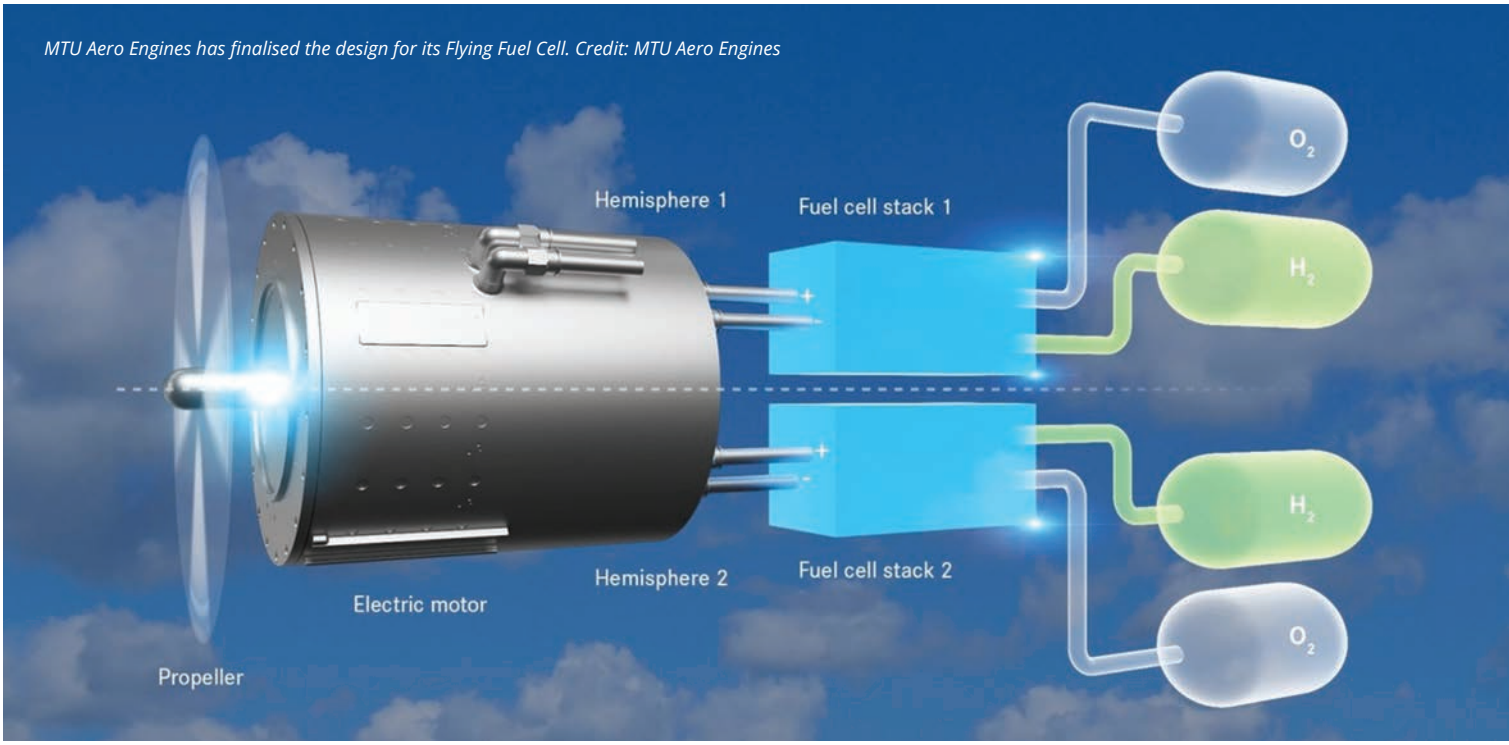
The GTF Advantage features the most state-of-the-art hot section in the single-aisle market. During GTF Advantage development, MTU supported its partners by utilising fleet experience and advanced design and measurement methods to systematically increase the engine's robustness and efficiency further. It also contributed a significantly improved design for the high-pressure compressor blades combined with an optimised protective coating for use in demanding environmental conditions. MTU's unique compressor test facility in Munich enabled an early validation of the new high-pressure compressor's aerodynamics. Additionally, the high-speed low-pressure turbine received an optimised active clearance control system achieving even higher efficiency.

The high-pressure turbine (HPT) and combustor also feature optimised cooling hole size, shape and location, with improved hole drilling techniques to reduce oxidation.

MTU contributes the high-speed low-pressure turbine to the GTF, one of its key components. It is also responsible for the forward four stages and Pratt & Whitney for stages five to eight. The innovative compressor is a 100% blisk construction. Blisks (blade integrated disks) are a high-tech rotor design in which the disk and blades are produced as a single piece, eliminating the need for blade roots and disk slots. This lowers weight. MTU also manufactures brush seals and integrally bladed rotors made of nickel for high-pressure compressor components beyond its design responsibility. MTU's total program workshare in the GTF is up to 18%.

MTU is also responsible for a third of all PW1100G-JM engine assemblies and will assemble GTFA engines in future too.

For the second generation GTF, IAE International Aero Engines (IAE), a multinational consortium comprised of Japanese Aero Engines



MTU Aero Engines has finalised the design for its Flying Fuel Cell. Credit: MTU Aero Engines

Corporation (JAEC), is investing in a range of technologies including advanced materials, cutting edge aerodynamics enabled by high-performance computing, a small high-speed core and hybrid-electric propulsion to enable required levels of performance.

The GTF Advantage engine has received type certification by both the US Federal Aviation Administration (FAA) and European Aviation Safety Agency (EASA) EASA validated the engine's type certification, with the latter recently certifying the engine for the A320 neo family aircraft.

The goal of the second generation GTF is to further reduce the fan pressure ratio, thereby increasing the bypass ratio. The thermal efficiency of the core engine can also be further improved through approaches such as integrating the design of compressor and turbine components. This forms the first stage of MTU's new version of Claire– which follows the first iteration, released in 2007.

The goal of the second step, to be completed by 2035, is to have not only the next-generation GTF, but also a Water-Enhanced Turbofan (WET)– driven by SAFs or hydrogen – ready to use in all thrust categories, along with the Flying Fuel Cell for shorter, regional flights. A GTF powered by hydrogen is also conceivable during this phase.

Part of the Sustainable Water-Injecting Turbofan Comprising Hybrid-Electrics (SWITCH) project, and using a hybrid-electric GTF powertrain, the WET concept recovers water vapor from the engine exhaust and re-injects it into the combustion chamber to significantly improve fuel efficiency, reduce NOx emissions, and lessen contrail forming emissions.

Led by MTU Aero Engines, SWITCH has the participating support of Airbus, Pratt & Whitney, Collins Aerospace and GKN Aerospace.

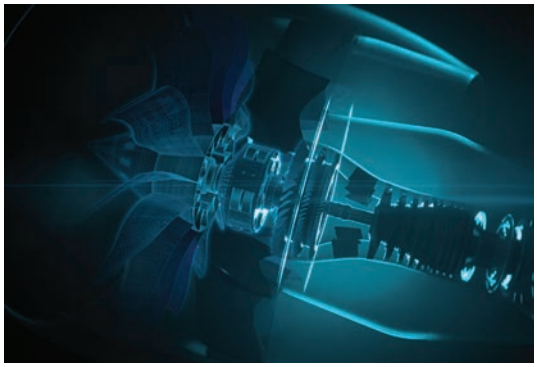
2050 marks the third Claire stage. Here, MTU's goal is to further improve overall efficiency both for the GTF and for the WET engine. MTU says that near drop-in fuels – SAFs with chemical adjustments – can be used to achieve maximum reductions in climate impact. If the WET engine is operated with hydrogen, this would not only have further advantages with regards to climate-related emissions, but they claim would additionally have the potential to reduce weight and the air resistance of the engine thanks to more-compact design and construction.

Only Fans

Another project under the auspices of the European Union's Clean Aviation Joint Undertaking is TAKE OFF (Technology And Knowledge for European Open Fan Flight), which aims bring the first Open Fan engine to flight before the end of the decade.

The Open Fan engine architecture was first presented in 2021 as part of the CFM RISE technology demonstration programme, which seeks to develop propulsion technologies capable of delivering significantly improved environmental performance. The concept is designed to achieve approximately 20% greater fuel efficiency compared with current engine technologies for the next generation of aircraft expected to enter service in the mid-2030s.

As the consortium leader, Safran Aircraft Engines will coordinate collaboration among leading aerospace companies, universities and research institutions. The project includes participation from major industrial partners such as Airbus, Avio Aero and GKN Aerospace, alongside academic and research



With its Ultrafan 30 demonstrator, Rolls Royce ambitiously targeting 20% fuel burn improvement relative to current in-service engines for narrowbody aircraft. Credit: Rolls-Royce



OFELIA will gather a large European consortium – led by Safran Aircraft Engines – to contribute to the RISE technology demonstration. Credit: Safran Aircraft Engines

organisations contributing to technological development across multiple disciplines.

TAKE OFF builds on the Clean Aviation OFELIA (Open Fan for Environmental Low Impact of Aviation) project, which aims to demonstrate at Technology Readiness Level 5 (TRL5) the RISE Open Fan architecture, for the small-medium range (SMR) aircraft to achieve or surpass the Air Transport Action Group's goals on the way towards carbon neutrality by 2050.

The engine is key in this effort and Clean Aviation believes that the Open Fan engine architecture is the most promising solution in terms of fuel efficiency to both achieve environmental goals (20% emissions reduction versus 2020) and target a rapid Entry into Service, as early as 2035.

To this end, OFELIA will focus on the high TRL full scale demonstration of the engine architecture and on the development of key enablers for the Open Fan. OFELIA will allow installation of an increased fan diameter on a conventional aircraft configuration, thanks to innovative turbomachinery technical solutions. Following the architecture definition, this project will perform a large-scale Open Fan engine ground test campaign, deliver flightworthy propulsive system definition, and prepare an in-flight demonstration, planned for an Airbus A380, for the phase 2 of Clean Aviation,

As María Calvo, Head of Unit Project Management at Clean Aviation has remarked, "TAKE OFF must now demonstrate the viability of the disruptive Open Fan engine concept at a higher maturity level, in line with the flight test campaign expected for 2029."

All RISE

Launched in 2021, the CFM RISE program aims to improve fuel efficiency by more than 20% compared with current engines, by combining disruptive technologies with the development of an Open Fan architecture that removes the traditional casing, allowing for a larger fan size with less drag

RISE will use adaptive engine technologies, also known as variable bypass architecture, to boost performance while allowing safe and efficient operation at every stage of a flight.

The project is -engineering a lightweight compact core, which houses the compression and combustion modules, to be smaller and optimize thermal efficiency, with an advanced cooling system and materials that can withstand extremely high temperatures. The core is being designed for compatibility with next-generation fuels, including unblended sustainable aviation fuel (SAF) and hydrogen, as well as with hybrid electric systems for the next generation of commercial narrow-body aircraft.

The pace of the programme is impressive. It has already seen over 350 component and module tests completed to date, including major tests conducted by Safran on the low-pressure turbine and compressor, bearing systems and equipment for the new pitch control functions of the Open Fan.

Safran has also recently tested three fan blade configurations as part of a demonstration of the mechanical integrity of the components in an unducted architecture and to validate improvements in aerodynamic and acoustic performance. The fan blades, which are over 1.6 meter in length, underwent over 175 ingestion and endurance tests at the test facilities at Safran's Villaroche center, which were specially configured to accommodate large-scale components, in addition to the 300 hours of wind tunnel tests on a scaled-down Open Fan model at ONERA (France) and DNW (Netherlands), in partnership with Airbus.

Further collaboration has been agreed as the Civil Aviation Authority of Singapore (CAAS) and Airbus seek to study the impact of Open Fan and other RISE program technologies on airport operations to develop a comprehensive readiness framework that serves as the global blueprint for airframers, airports, and airlines worldwide.

Under an MOU, the parties will co-develop a comprehensive readiness framework to integrate Open Fan engines for the next generations of aircraft, into existing airport operations, including aircraft system and design considerations, infrastructure modifications if any, operational procedure changes, safety standards, and regulatory procedures. They also plan to conduct operational trials of the RISE programme's Open Fan engine demonstrators at Singapore Changi Airport or Seletar Airport to test and validate the readiness framework and assess operational feasibility of this new technology.

The Ultra way

In the UK, Rolls-Royce is advancing the UltraFan which it unveiled publicly in 2014. As the firm explains, UltraFan is a fundamentally different design architecture to that within

the approximately 4,200 Rolls-Royce Civil large engines currently in service, as it incorporates a geared design that no other industry player has produced at this size before – at one square metre it can produce over 50MW - enough to power 500 family cars.

The planetary design of the power gearbox is designed to allow the turbine at the rear of the engine to run at a very high speed while the fan at the front runs at a slower speed.

The widebody variant, Ultrafan 80, aims to deliver 25% more fuel efficiency than first generation Trent – the Trent 700, and 10% more fuel efficiency than the Trent XWB, which is seen as the most efficient aero-engine in service.

The first phase of testing took place in 2023 at Rolls -Royce's £90 million purpose-built facility – Test Bed 80 – in Derby using 100% sustainable aviation fuel. Following forensic strip and inspection, a second build of the UltraFan 80 demonstrator has been defined with further testing planned later in 2026.

Rolls-Royce has recently been confirmed as the lead of the UNIFIED - Ultra Novel and Innovative Fully Integrated Engine Demonstrations – consortium. Backed by €64million funding, the project will focus on maturing and advancing next-generation propulsion technologies for future narrowbody applications, supporting planned ground testing of the UltraFan 30 demonstrator in 2028 and helping establish a credible pathway toward future flight test.

With the UltraFan 30 demonstrator, Rolls-Royce says it is committed to providing a ducted geared solution for the narrowbody segment in partnership. The demonstrator is targeting 20% fuel burn improvement relative to the current in-service engines.

Issuing a fact sheet, the company says the "UltraFan 30 demonstrator takes what we've learnt in creating world leading widebody and business aviation engines to the narrowbody market, using technology from proven and safe architectures."

Features include the same architecture and technology as found within the Ultra80 demonstrator, namely new engine core architecture to deliver maximum fuel burn efficiency and reduce emissions; advanced manufacturing, materials and technologies such as Additive Layered Manufacturing (ALM) to save on waste and allow for more intricate designs and CMC materials to withstand higher temperatures, and a geared design which will deliver efficient power for the high-thrust, high-bypass ratio engines of the future (although not on the same scale as Utrafan 80).

Also featured is Carbon-Titanium (CTi) composite fan system and a composite casing developed by the University of Bristol.

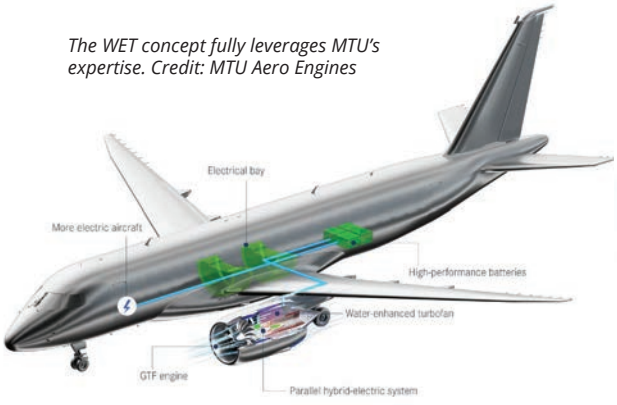
While carbon-fibre reinforced composites have many useful properties for aerospace applications, particularly in terms of reducing weight and fuel consumption, such laminated structures can be susceptible to delamination of the fibre-reinforced layers under impact.

To achieve a commercially viable composite fan system solution, Rolls-Royce's development has drawn on two key research areas facilitated by the ongoing partnership with the University. The first was a new approach to numerical modelling that can predict the occurrence of delamination and ensure that designs mitigate the effects of delamination damage under various impact loads.

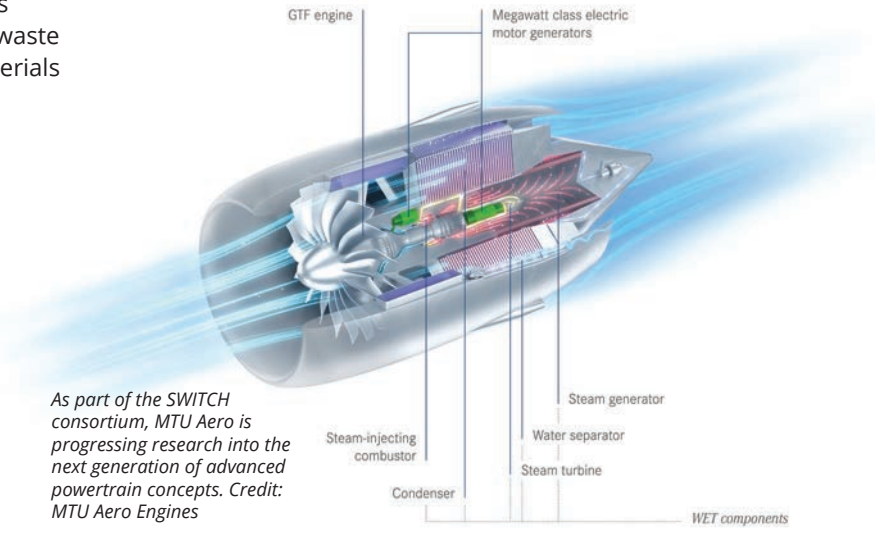
The second development was a new Direct Insertion manufacturing method for through-thickness reinforcement (TTR) of the fan blades, achieved by inserting pre-cured carbon fibre rods into the composite laminate. This enables the reinforcement of thick laminates with far higher accuracy and fewer process-induced defects than any other existing means. TTR is essential for managing any potential impact damage. Following the invention of the Direct Insertion method at the University of Bristol, the technology was scaled up at the National Composites Centre, before being implemented by Rolls-Royce at their Composites Technology Facility in Filton.

The aviation industry is moving forward with a shared ambition to make aviation more sustainable. Projects such as those covered above are helping to shape the sector's future, showcasing the competitive benefits of architecture in terms of energy efficiency and acoustic performances.

By Alex Preston



The WET concept fully leverages MTU's expertise. Credit: MTU Aero Engines



As part of the SWITCH consortium, MTU Aero is progressing research into the next generation of advanced powertrain concepts. Credit: MTU Aero Engines

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In the Mix

Hybrid-electric aircraft gain traction

Electra's nine-passenger EL9 Ultra Short unlocks new opportunities for regional mobility via Direct Aviation. Credit: Electra

If the Ian Dury and the Blockheads hit song, Reasons to be Cheerful, Part 3, were to be updated, hybrid-electric aircraft could well be added to the list, given the positive sentiment pervading the sector.

Alessandro Sgueglia, Referent Future Projects and R&T engineer, and technical coordinator of HERACLES at ATR, says the company has all the reasons to be optimistic, citing its turboprops as the ideal test bed for this as they are already a proven benchmark in regional aircraft efficiency.

"Over the past decade, we've seen major breakthroughs in electric motors, power electronics, thermal management, and battery systems. These developments now make it possible to integrate hybrid electric propulsion into a regional aircraft platform to demonstrate its performance and safety," he says.

ATR is the lead for the HERACLES project (acronym for Hybrid Electric Regional Aircraft Concept for Low EmissionS), part of the Clean Aviation Programme, the European Joint Undertaking dedicated to advancing breakthrough technologies for emission reduction. The primary objective of HERACLES is to define and design the Ultra Efficient Regional Aircraft (UERA) concept. The UERA is an innovative aircraft concept targeting a 30% reduction in CO2 emissions compared to the current ATR 72-600. This performance ambition is enabled through the integration of several technologies, such as hybrid electric propulsion incorporating batteries, an advanced airframe, and innovative integrated aircraft systems.

"The whole industry is investing to make the hybrid electric technology a reality, and to ensure that the solution will be viable for future concepts. We're not relying on hypothetical future technologies; we're building on components that exist today and are progressing rapidly," Sgueglia asserts.

A shared confidence

Michael Derman, CEO of EVIO, which is developing the EVIO 810, a regional aircraft for the 50–100 seat market, agrees that the optimism is genuine—not as a distant concept, but as something quickly becoming practical and economically viable.

"At its core, a 'strong hybrid' approach like EVIO is pursuing represents the most feasible path forward for airline economics in regional aviation. Fuel is the single largest operating expense for most airlines, so reducing fuel burn through electrification directly improves route economics," Derman says.

As Jérémy Caussade, President and Co-founder of Aura Aero, states, "Hybrid-electric is not a compromise solution; it is the technology that can bring cleaner commercial aviation to market first." Aura Aero is developing ERA, which will be available in four versions: Passenger (16 to 19 seats), Exclusive (8 to 9 seats), Cargo (up to two tons of payload), and Medevac, for medical evacuation.

Electra, the company behind the EL9 Ultra Short aircraft, is also unsurprisingly optimistic. "We're on the cusp of introducing a whole new way to travel with hybrid-electric aircraft," the company says.

"What we've done at Electra is harness blown-lift and hybrid-electric architecture to build an aircraft with novel capabilities, including the ability to take off and land in 150 feet or less," Marc Allen, President & CEO, Electra explains.

"We've been flying our EL2 technology demonstrator for two years, with nearly 200 flights under our belt. The platform is both transformative and practical. And it will open the door to Direct Aviation, which means flying from where you are to where you want to be.

"Hybrid-electric power, combined



with blown-lift, is the unlock to transforming the way we travel, and it's exciting to see it becoming a reality. It's not science fiction. It's here."

For Derman, the opportunity is not just here, it's getting bigger. "This is just the beginning of the value curve. As battery technology continues to improve, operators will gain even greater flexibility in how they deploy our aircraft, whether that is extending electric-only range, optimising routes, or increasing payload efficiency.

"Those improvements translate directly into additional operational savings and new route opportunities, reinforcing the long-term economic case.

"From a design standpoint, the focus has to remain on what works in real service—aircraft that integrate seamlessly into existing networks while improving cost, performance, and experience. Hybrid-electric systems strike that balance today, while positioning operators to capture even greater benefits as the technology continues to advance," he states.

For ATR's Sgueglia, the ecosystem is aligned like never before. "Clean Aviation brings together airframers, engine manufacturers, research centres, and regulators around a shared objective. This collective effort accelerates development,



Aura Aero sees hybridisation as the most practical way to meet real transport needs. Credit: Aura Aero



Aura Aero's EVA leverages serial hybrid flexibility through an augmented flight planning and mission management routine, driven by the propriety Aura Aero Digital Ecosystem. Credit: Aura Aero



The clean-sheer EVIO 810 has unique attributes for both cargo and defence missions. Credit: EVIO

reduces risk, and ensures that certification pathways evolve in parallel with the technology. This alignment is one of the strongest reasons to be optimistic."

Challenges to overcome

According to Electra, the future of the Advanced Air Mobility sector can be evaluated through the Rule of Six.

To succeed at scale the company says, AAM aircraft must deliver expanded access, quiet aviation, meaningful payload, practical range, and uncompromising safety at an affordable price. Only by meeting all six of these requirements will AAM earn trust, serve communities, and connect people reliably and safely.

Electra's EL9 Ultra Short addresses the range and infrastructure limitations that have hindered the advancement of fully electric AAM aircraft. "Our aircraft is best suited for trips between 50-500 miles and is able to carry 3,000lbs of cargo. Because we can take off and land in under 150 feet, we don't need new specialised facilities. The EL9 Ultra Short aircraft uses unique access points like existing runways, parking lots, and soccer-sized fields," says Allen.

As it matures, the sector is entering an important phase that requires continued progress in areas such as technology maturation, ecosystem development and affordability.

"Ongoing advancements in battery technology will continue to unlock new levels of performance and economic value for operators, while innovations in system integration are enhancing reliability and simplifying maintenance and certification pathways," says Derman. "At the same time, EVIO is actively advancing thermal management and safety systems, while contributing to the development of robust infrastructure and regulatory frameworks—laying a solid foundation for scalable, widespread adoption.

"At EVIO, we are actively driving this transition forward. Our approach centres on a highly integrated propulsion system, combining targeted innovation with proven, off-the-shelf components. This strategy minimises risk, accelerates certification, and enables faster deployment—positioning hybrid-electric aviation as a practical, scalable, and economically compelling solution today, with even greater potential ahead."

ATR says it will also focus on the integration of thermal and electric systems. "There is more to hybrid propulsion than adding a battery to an engine. It requires to completely rethink power distribution, thermal management, safety architectures, system redundancy, and certification pathways," says Sgueglia

"It also means new weight-distribution strategies, new operational profiles, new maintenance philosophies. This is why demonstrators like ours are essential; they validate the architecture at aircraft level, not just component level."

Sgueglia also points out that certification of the hybrid electric propulsive system will require close collaboration with EASA." We are working with them to progress on the certification pathways for these new technologies. EASA is on board the HERACLES and DEMETRA projects for this purpose: understand and grow the Certification Readiness level of new technological bricks and of the



The EVIO 810 taps into the need for a next-generation regional aircraft that is more efficient and commercially viable. Credit: EVIO

integrated aircraft as a whole."

"Later down the line, aircraft economics and customer profitability remain the number one market driver for regional operators," Sgueglia continues. "As a result, any new technology that will be integrated into the aircraft will need to deliver clear economic value and remain affordable to ensure broad applicability.

Caussade believes that the challenges are also both technological and structural.

"On the industrial side, like many entrepreneurs in France, we face two major hurdles. First, there is still a lack of entrepreneurial culture, which should be more strongly embedded in engineering education. Second, and more critically, there is a significant shortage of industrial-scale financing. This gap is both surprising and detrimental to long-term value creation, and it clearly requires a collective response at national and European levels," he says.

"Beyond financing, another key challenge is ensuring that innovation addresses real operational needs. In many parts of the world — especially islands and remote regions — aviation is not a luxury, but a necessity for connectivity, safety and economic development. The world does not revolve around major capitals, and regional aviation plays a vital role.

"This is exactly where ERA comes in. Designed as a 19-seat hybrid-electric aircraft, it directly responds to these essential mobility needs. In many ways, regional aviation operates like a taxi service: short routes, frequent rotations — a perfect match for hybrid propulsion."

Not just green

The case for hybrid-electric aircraft goes beyond environmental sustainability, to a broader idea of business and industry vitality.

Sgueglia believes that hybrid-electric propulsion could significantly reduce fuel consumption and operating costs, especially on short regional sectors where conventional engines are less efficient. "This translates into lower direct operating costs, as well as reduced exposure to fuel price volatility and improved profitability on thin or marginal routes, provided key technologies such as the batteries reach expected performance matched by significant improvements costs. This is exactly what our regional operators are asking us in order to meet their own decarbonisation targets. For them this is a major competitive advantage," he says.

Sgueglia confirms that ATR's electrification strategy is still under definition. "Depending on how and when electric propulsion is used, it could reduce noise during take-off, climb and approach. This could translate into extended operating hours at noise-constrained airports, new routes closer to urban areas, and improved passenger comfort. Noise is becoming a strategic constraint for aviation, and hybrid-electric aircraft could offer a real solution."

For airlines, Derman says the key motivation is commercial viability. "The EVIO 810 aircraft is designed to restore route profitability and expand regional networks by reducing maintenance requirements and improving overall operational cost-efficiency. The design also brings significantly lower costs for cargo variants while our high electrical

power supply on board the aircraft may find defence and surveillance applications that conventional or even "mild hybrid" aircraft cannot offer."

Electra's Allen cites additional motivations and interests in hybrid-electric aircraft including the ability to integrate ultra-short access points seamlessly into communities, delivering on the promise of Direct Aviation.

He contends that Electra's EL9 Ultra Short addresses the range and infrastructure limitations that have hindered the advancement of fully electric AAM aircraft. "Our aircraft is best suited for trips between 50-265 miles and is able to hold 3,000lbs of cargo. Because we can take off and land in under 150 feet, we don't need new specialised facilities. The EL9 Ultra Short aircraft uses unique access points like existing runways, parking lots, and soccer-sized fields.

"And with a small and efficient turbogenerator used for cruising and batteries used for take-off and landing, the EL9 Ultra Short delivers a reliable and safe service with quiet operations," he says.



ATR is exploring the next evolution of its aircraft family with its 'EVO' concept. Credit: ATR



ATR plans for further developments by leveraging the ATR EVO's readiness to incorporate disruptive technologies when available. Credit: ATR

Programme progress

With over 2,200 pre-orders from more than 60 commercial customers worldwide, including both airlines and helicopter operators, Allen claims the EL9 Ultra Short is already one of the most in-demand aircraft in the advanced air mobility sector and the only one to offer the benefits of Direct Aviation.

The EL9 Ultra Short can carry up to nine passengers and luggage (50lbs each), or up to 3,000lbs of cargo and has a ferry range of up to 1,100 nautical miles, with in-flight battery recharging that eliminates the need for ground charging stations. The hybrid-electric system, which involves distributed electric propulsion and blown lift to enable ultra short take-offs and landing, uses a turbogenerator for cruising and batteries for take-off and landing.

Electra expects to begin test flights for the EL9 in 2027, with certification and commercial service entry anticipated in late 2029 and into 2030.

Electra is also participating in the US Administration's inaugural Advanced Air Mobility and Electric Vertical Takeoff and Landing Integration Pilot Program (eIPP) where it will work with partner states to advance the integration of AAM aircraft into existing systems and accelerate their safe deployment.

The EVIO 810 is a clean-sheet hybrid-electric regional aircraft designed specifically for the 50–100



seat market with unique attributes for airfreight and the defence communities. The baseline aircraft is configured for 76 seats, with a higher-density 88-seat option also being considered. The company has secured conditional purchase agreements and options for 450 aircraft from major undisclosed airlines.

The target for first flight is around the turn of the decade, with entry into service in the early 2030s.

In terms of mission profile, the EVIO sees under 500 nautical miles as a strong fit for the aircraft in hybrid operation, while all-electric capability is focused on shorter missions.

This approach delivers several important benefits: lower fuel consumption, improved operating economics, reduced noise and lower emissions, especially around airports. It also creates a pathway for increasing value over time as battery technology continues to improve.

"Because this is a purpose-built strong-hybrid aircraft, the propulsion architecture influences the design from the outset. It shapes system integration, energy storage, power distribution, control systems and overall mission optimisation," notes Derman.

The company is collaborating with Pratt & Whitney Canada in support of that propulsion architecture and enjoys investment and technical support from Boeing.

"We are currently in the final stages conceptual design phase and expect to announce additional partners and suppliers soon, who are actively involved in progressing development activities in support of our Integrated Propulsion System efforts," Derman advises.

Aura Aero says it is building a highly advanced smart platform that happens to be an incredibly efficient regional aircraft. "We are integrating technologies typically reserved for top-tier commercial airliners or advanced defense platforms, scaling them perfectly for the 19-seater regional market to drive down operating costs and maximise safety," says Caussade.

Its ERA aircraft uses a serial hybrid propulsion system. Power and propulsion are decoupled: while propulsion is fully electric and is ensured by eight motors from Safran Aircraft Engines US, distributed over the wing, power generation is hybrid and is assured by a combination of four battery packs and two turbogenerators. Such decoupling allows power generating units to work at their optimal point, regardless of the operating point for propellers and electric motors, and vice versa.

The choice of the number of engines is motivated by technology specificities: for electrical engines, in fact, there is no advantage of scale in increasing power concentration, in sharp contrast with thermal engines. There are however disadvantages associated with such concentration, including the need for complex cooling systems, which can be avoided by using many smaller engines. Furthermore, distributing many smaller engines over the wing enables a better aero-propulsive integration.

As Caussade explains, batteries are installed on-board through a modular architecture that enables improved safety and upgradability: in the future, whenever technology improvements will enable it, AURA AERO will be able to propose its customers upgrades based on more energy dense modules, to be installed in place of the existing ones, hence allowing the aircraft to improve its performance over program life.

As Sgueglia explains, the studies, maturation activities and demonstrations conducted across HERACLES and its associated projects will inform the feasibility of EVO, ATR's next-generation

aircraft concept which is targeting an entry into service around 2035, and which envisions a major leap in efficiency, cost-effectiveness and environmental responsibility. The powerplant represents the most impacting system, accounting for 20% of the overall CO2 reduction. It will be developed by Pratt & Whitney Canada, together with Collins Aerospace for the electric engine and Ratier Figeac for the propeller.

Sgueglia says that the main reason behind the choice of the ATR 72-600, the "cherry on the cake" of the programme, as a testbed platform is the representativeness: to validate the maturity of hybrid-electric technologies (up to Technological Readiness Level 6), the hybrid powerplant needs to be tested on a representative platform in a representative environment. "Since the UERA concept is designed for the 50-100 passenger segment and uses the ATR 72-600 as a reference point to quantify improvement targets, the selection of this aircraft was a natural and coherent choice." Additionally, the ATR 72-600 represents around 75% of the ATR total in-service fleet, making it the most representative platform of its class.

"More broadly, regional CS-25 aircraft provide the first commercially relevant scale at which low carbon propulsion architectures can be validated under real airline operating conditions. Testing hybrid-electric technologies at this level is a critical step in the innovation chain: it ensures that technology pathways remain aligned with the operational and economic realities of airlines, while generating insights directly transferable to future larger aircraft concepts, including next-generation Short/Medium Range (SMR) aircraft," states Sgueglia.

Eliminating bottlenecks

Hybrid-electric aircraft rely on new components; batteries, high-voltage systems, power electronics.

To secure production rates, ATR is partnering with multiple suppliers to mitigate risks, aligning roadmaps with European industrial capabilities, ensuring that critical technologies remain manufacturable at scale. This is essential to avoid the supply-chain fragilities seen in other sectors.

EVIO is also building the supply chain with rate in mind from the outset—partnering with experienced suppliers, leveraging existing aerospace ecosystems, and avoiding bottlenecks tied to novel or capacity-constrained components.

Derman says the company is designing the program from day one around scalability and manufacturability, not just performance.

"A core part of our strategy is selective innovation. We are focusing our engineering effort on the integrated propulsion system, where we see the most differentiation, while incorporating proven, off-the-shelf components across the rest of the aircraft wherever possible. This reduces development risk, simplifies the supply chain, and shortens lead times. Where we see value in innovating, such as in the integrated propulsion system, we have identified leaders in their respective fields to collaborate with and ensure the concepts consider all costs, from development to production, logistics, maintainability, and aftermarket support.

"This aircraft is designed specifically for a segment that is very cost sensitive."

According to Derman, the EVIO 810 architecture supports lower operating and maintenance costs over time, which reinforces adoption and allows production to scale more efficiently as demand grows.

"Overall, our approach is to balance innovation with industrialisation—ensuring we can move quickly from development into high-rate, cost-effective production that supports broad market uptake."

Aura Aero is working closely with several small and big companies in its supply chain, such as Safran, Thalès and many others.

Caussade says the ERA program is progressing as planned — naturally, with its share of challenges. "INTEGRAL E, which shares several innovative components with ERA, has helped us further de-risk the program.

"We reached a major milestone in early 2025 with the technical validation and the signing of key supplier contracts, and we're set to cross another critical step by the end of the year. In between — meaning within the next few weeks — we'll begin manufacturing parts for the first prototypes, with a first flight now expected in less than two years."

The company has secured 700 aircraft on letters of intent for ERA, representing more than USD12bn in potential value. A few weeks ago, the first firm order was confirmed by Pan Europeenne. Caussade reveals ERA now has 20 confirmed orders.

To meet this, Aura is scaling up its industrial capacity to meet demand and ensure on-time delivery for its customers. In Toulouse, it has obtained the building permit for a new 50,000m² industrial site, the Aura Factory, which is expected to begin operations in 2029. "We plan to employ around 1,600 people there and reach an annual production rate of 150 aircraft, including 100 ERA and 50 INTEGRAL," says Caussade.

"At the same time, we are also expanding in the US. Our future ERA assembly plant in Daytona Beach, Florida, is scheduled to open before 2030 and will employ around 1,000 people. This facility will support deliveries to the North American market, which already represents more than 50% of the commitments received so far for ERA."

"Looking ahead," he adds, "we are convinced that before 2030, there will be no larger fully decarbonised aircraft than this category."

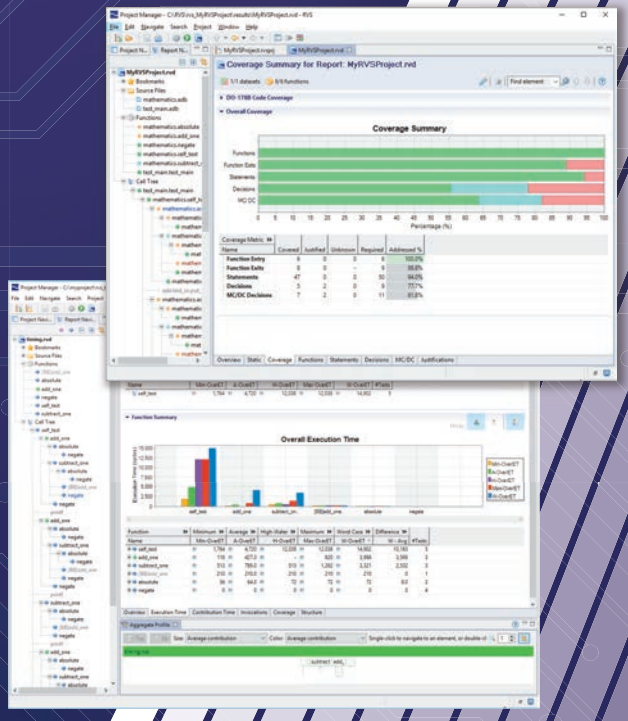
As Electra's Allen sums up, "We are at a transformational moment for the AAM industry." Government and regulatory support "enables companies like Electra to demonstrate how hybrid-electric propulsion works at scale, to reimagine how we use the skies, and to change the way that people get to where they want to go."

By Alex Preston

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AVIONICS AND TESTING INNOVATIONS

Conference and Exhibition

2nd-3rd June 2026
London, UK









Preliminary Conference Programme and Guide

Join us at **Avionics & Testing Innovations Conference & Exhibition** in London on 2nd-3rd June 2026, the premier event for industry professionals shaping the future of flight, flight deck and cockpit capabilities for the commercial and defense sectors.

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AVIONICS AND TESTING INNOVATIONS

2nd-3rd June 2026

London, UK

Dedicated Conference & Exhibition for the Avionics and Testing Community

Avionics and Testing Innovations delivers a premier platform for the international avionics, testing and certification industries, across commercial and defence aviation, to learn, network and source new information, products and services at one unique annual event.

Single European Sky (SESAR 3 JU – a key enabler of the European Commission's Sustainable and Smart Mobility Strategy) and NextGen continue to dominate the aerospace industry, with targets of ensuring the utilisation of technology to increase traffic, improve aircraft and control communications whilst enhancing safety in an ever increasingly busy sky. Safety in all aspects of aviation is something we encourage active discussion and information sharing at the conference.

With many platforms currently in use, how does the industry ensure consistency, integration and reliable communication between and across these platforms to meet these objectives?

Avionics and Testing Innovations offers a leading conference programme, with excellent content and discussions, which includes strategic and technical details, delivering high level and quality presentations for both the commercial and defence sectors, fixed wing and rotorcraft.

- The premier event for the international avionics, testing and certification community in Europe.
- For the latest in SESAR3, NextGen and performance based navigation.
- For what the Pilot wants, the Aircraft needs and Industry must have.
- From aircraft to the ground and all communications and technologies in-between.

Avionics and Testing Innovations will discuss topics and issues of the day and demonstrate and showcase new products, developments, technologies and services available on the market, and also key elements of the upgrades and retrofits market, as well as research and innovations delivering the transformation to the Digital European Sky.

This Preliminary Conference Guide, provides you the information you need to plan your participation at the event.

We invite you to join us and the Avionics, Testing and Certification community in London, UK from 2nd-3rd June 2026, for the latest gathering of avionics, testing and certification professionals.







Register Online at www.avionicsandtesting-innovations.com

AVIONICS AND TESTING INNOVATIONS

2nd-3rd June 2026

London, UK

Who is it for?

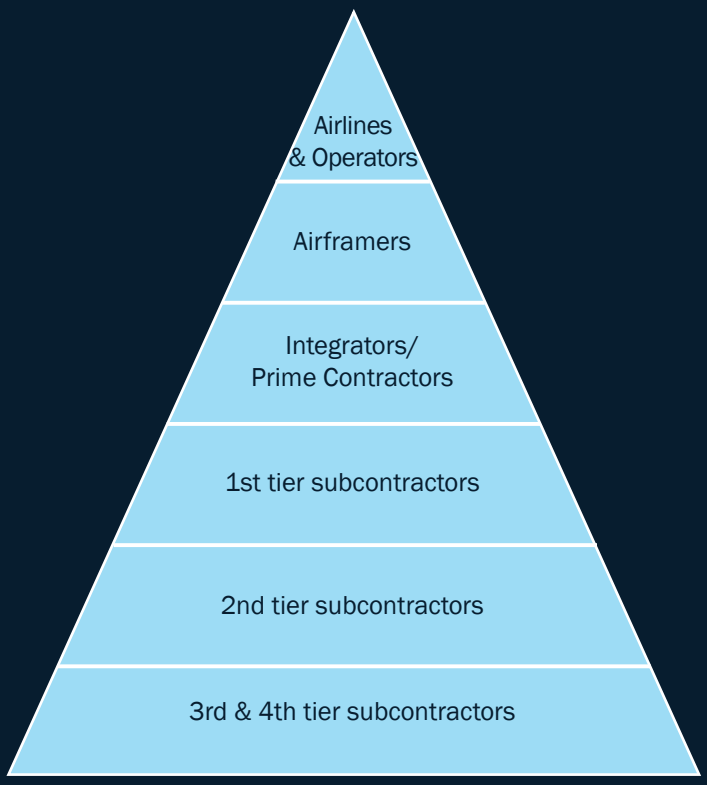
Avionics and Testing Innovations is designed for a broad representation from civil, government and military organisations, of senior management, project leaders, senior engineers, executives and decision makers who have the authority to purchase, or influence the purchase of products and services, from the following sectors:

- Airlines and Operators
- End users
- Airframers
- Integrators
- Prime contractors
- Design & Planning
- Aviation electronics and avionics manufacturers, fixed wing and rotorcraft
- Testing and Certification
- International Defence Agencies / Ministry of Defence
- Armed Forces

Delivering a complete value – added chain:

- **Airlines, Operators, End Users & Airframers**
- **Integrators/Prime Contractors** – design (develop) and assemble or manufacture complete units that have a direct contractual relationship with the Original Equipment Manufacturer (OEM)
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- **2nd tier subcontractors** - make various subassemblies and sections to Tier 1 suppliers, specialising in specific components or technologies
- **3rd tier subcontractors** - produce machine components and sub assemblies, focusing on basic materials or manufacturing processes
- **4th tier subcontractors** – specialising in production of particular components and specific processes

Testing and **certification** are integral parts of the aerospace supply chain. Specialised testing facilities, often operated by Tier 1 suppliers or independent testing organizations, ensure that components and systems meet rigorous quality and safety standards.









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AVIONICS AND TESTING INNOVATIONS

2nd-3rd June 2026

London, UK

Why Attend?

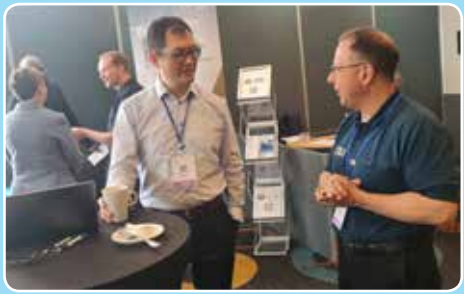
Avionics & Testing Innovations is the premier platform for the international avionics and aviation electronics industry to learn, network and source new information, products, technologies and services at one unique annual event.

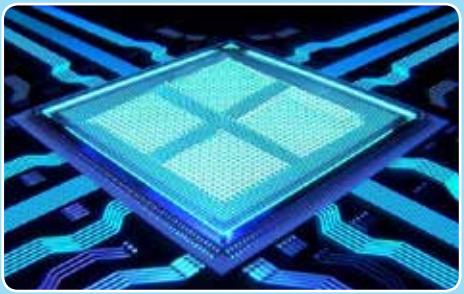
1. Keep up-to-date with the latest issues, challenges and discussions in avionics and aviation electronics
2. An insight into more technical discussions and approaches for ideas and practical solutions.
3. The only avionics event with conference discussions and training for enhanced learning and information gathering
4. Connect with senior engineers, program managers, OEMs, suppliers, regulators, and technology providers shaping the future of aerospace innovation.
5. Explore the exhibition floor featuring advanced tools, software, hardware, and testing solutions designed to enhance efficiency, safety, and performance.
6. Develop and forge relationships with potential suppliers/customers
7. Leave with actionable strategies to address current regulatory challenges, reduce development risk, accelerate validation processes, and future-proof your programmes.

Job Titles (Examples of):

- Avionics Supervisors
- Avionics Programme Managers
- Director/Head of Avionics
- Senior Avionics Engineers
- Senior Avionics Systems Engineers
- Avionics Engineers
- Avionics Software Engineers
- Avionics Technicians
- Design Engineers
- Senior Avionics Hardware Test Engineers
- Avionics Systems Specialists
- Nav and Comms Engineers
- Certification Managers
- Senior Certification Engineers
- Certification Engineers
- Director/Team Lead of Certification
- Certification and Compliance Engineers
- Avionics Testing Engineers
- Senior Test Engineers
- Director/Head of Testing
- Flight Test Engineers
- Cybersecurity Engineers
- Project & Programme Engineers
- Simulation & Modelling Engineers
- Research & Development Engineers
- Validation Engineers
- Systems Integration Engineers
- Embedded Software Engineers
- Validation and Verification Engineers
- Safety-Critical Software Engineers
- Software Architects
- IT Systems Engineers







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AVIONICS AND TESTING INNOVATIONS

2nd-3rd June 2026

London, UK

Key Growth Drivers for Avionics & Software Testing

Rising Complexity of Avionics Systems:
Modern aircraft increasingly rely on integrated digital systems, flight controls, navigation, communication, surveillance, and power/data management. As these systems become more software intensive, the need for rigorous testing grows proportionally.

Regulatory Pressure for Safety & Certification:
Aviation authorities (FAA, EASA, etc.) continue to tighten certification standards (e.g., DO 178C). Compliance requires extensive testing cycles, boosting demand for specialized avionics software testing solutions.

Expansion of Commercial & Military Aviation Fleets:
Both commercial airlines and military operators are expanding or modernizing their fleets. More aircraft → more avionics → more testing requirements across OEMs, MROs, and airlines.

Growth in UAVs and Next Gen Platforms:
Unmanned aerial vehicles (UAVs), business jets, and next gen aircraft introduce new avionics architectures and mission critical software, all of which require robust testing frameworks.

Shift Toward Automated and Cloud Based Testing:
The aerospace software testing market is seeing a shift from manual to automated testing, and from on premises to cloud deployments. Automation reduces cost and time, while cloud platforms support scalability and remote collaboration driving adoption.

Digital Transformation Across Aerospace:
The industry's broader digitalization, predictive maintenance data analytics, AI, IoT, robotics, connected aircraft - drives investment in software ecosystems and, by extension, testing environments to ensure reliability and cybersecurity.

Increasing Adoption of Advanced Avionics Software:
Growth in flight control, navigation, and communication software, especially embedded and modular open systems drives demand for validation and verification tools. The push for more intelligent, data driven avionics also expands testing needs.







Register Online at www.avionicsandtesting-innovations.com

AVIONICS AND TESTING INNOVATIONS

2nd-3rd June 2026

London, UK

How To Register

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Early Bird delegate rate deadline is 1st May 2026

Register online today to ensure you receive regular event updates and keep informed of the latest conference developments.

Visit **www.avionicsandtesting-innovations.com/registration** for conference delegate fees, discounts and to register online.

Military/Defence, Airlines & Public Sector – Discounted Places

If you work for and Airline/Operator, the Armed Forces (Air Force, Army, Navy) as a Government official (MOD, DOD, etc) or directly for a government agency or public body, you are entitled to apply for the special Military/ Defence & Public Sector discounted delegate pass.

Research/Student/Academia – Discounted Places

If you work for, or a Student at, a Research Institute or University, you are entitled to apply for the special Research/Student discounted delegate pass.

Delegate Packages include lunch and refreshments for the 2 day conference, and access to the Exhibition and Networking Reception

All Access Delegate – Commercial & Industry	All Access Delegate – Military/Defence & Public Sector	All Access Delegate – Research/Student
~~£ 695~~ £ 495	~~£ 295~~ £ 195	~~£ 295~~ £ 195
Early Bird Rate £495 + VAT (Standard Rate £695 from 1st May)*	Early Bird Rate £195 + VAT (Standard Rate £295 from 1st May)*	Early Bird Rate £195 + VAT (Standard Rate £295 from 1st May)*

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Through our Supporting Organisation, you are able to gain great discounts on conference delegate fees. Ask your organisation's contact for the Promo Discount Code and benefit from £££ savings:



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AVIONICS AND TESTING INNOVATIONS

2nd-3rd June 2026

London, UK

Schedule of Events

Tuesday 2nd June

	AVIONICS TRACK	TESTING TRACK	FACE TRACK
9.00am-10.30am		Joint Opening Keynote	
10.30am-11.00am		*Networking Coffee Break*	
11.00am-12.30pm	Latest in Regulations and Mandates	AI and ML in Testing	FACE Standards and Global Alignment
12.30pm-2.00pm		*Networking Delegate Lunch*	
2.00pm-3.30pm	Modernizing CNS: Bridging Technology and Stakeholder Needs in Evolving Airspace	Model-Driven Testing and Certification: Digital Twins, Tools, and Languages for Next-Gen Avionics	Open & Modular Architectures
3.30pm-4.00pm		*Networking Coffee Break*	
4.00pm-5.30pm	Cybersecurity in Connectivity and the Cockpit	Panel Discussion: Meeting Certification Standards – Barrier to Entry?	Data Modelling for Faster Integration: The FACE Approach
5.30pm-7.30pm	*Networking Reception in Exhibition Hall, sponsored by Wind River*		

Wednesday 3rd June

	AVIONICS TRACK	TESTING TRACK	MULTICORE TRACK
9.00am-10.30am	AI/ML and Autonomy in Avionics	Validation and Certification Challenges in Complex Aerospace Systems: From Mixed-Critical Architectures to Fit-to-Fly Testing	Standards, Regulations and Mitigation Challenges for Multicore
10.30am-11.00am		*Networking Coffee Break*	
11.00am-12.30pm	Obsolescence management - Legacy Systems & Fleet Modernization	Cybersecurity in the Testing Environment	The Roadmap for Multicore Hardware
12.30pm-2.00pm		*Networking Delegate Lunch*	
2.00pm-3.30pm	Human-Machine Teaming	Environmental Testing	Architecture and Software Development & Certification
3.30pm-4.30pm		*Walk the Exhibition Floor*	







Register Online at www.avionicsandtesting-innovations.com

AVIONICS TRACK DAY ONE PROGRAMME
Tuesday 2nd June

9.00 - 10.30am

JOINT OPENING KEYNOTE
Chair: Alex Preston
Helen Leadbetter, Technical Strategy Lead Zero Emissions Flight, UK CAA
Andrew Kinniburgh, Director-General, Make UK Defence
Zahid Sultan-Khan, Chief Pilot Boeing 777, Silk Way West Airlines

10.30am-11.00am **Networking Coffee Break in Exhibition Hall**

11.00am-12.30pm **Latest in Regulations and Mandates**
As Europe implements the SES2+ regulation and the new set of EASA-led interoperability rules, manufacturers and ANSPs face deadlines for certifying equipment, aligning to harmonised performance requirements, and integrating emerging technologies such as drones and eVTOLs. SESAR 3 is central to delivering the Digital European Sky, with efforts to advance automation, AI integration and virtualised ATM services. Aligning system architectures to new conformity standards is critical. Meanwhile, evolving U-space, drone, and eVTOL regulations demand parallel adaptation across airspace users and infrastructure providers. What are the latest updates on regulations and mandates that will impact the development and deployment of new technologies and systems?
Chair: Marijan Jozic
ATM standardization and regulatory updates - Nikos Fistas, Head of Standardisation, EUROCONTROL
ATM/ANS conformity assessment framework update (WG-130) - Andrea Trimarchi, Technical Programme Manager, EUROCAE
CIV-MIL interoperability item to be detailed - Jorge Pereira, Head of Communication, Navigation, Surveillance and Security Unit, EUROCONTROL
Title TBC - Enrico Parini, Director Europe Affairs, CANSO

12.30pm-2.00pm **Networking Lunch in Exhibition Hall**

2.00pm-3.30pm **Modernizing CNS: Bridging Technology and Stakeholder Needs in Evolving Airspace**
The evolution of Communication, Navigation, and Surveillance (CNS) systems is essential for Trajectory Based Operations (TBO) and broad adoption of 4D Trajectories. Modern airspace operations rely on secure, resilient, real time data exchange using ADS B, Mode S, VHF, SATCOM, and scalable digital architectures to support rising traffic and new unmanned systems. At the same time, GNSS jamming and spoofing threaten navigation integrity. This session examines how advanced digital CNS capabilities—multi constellation navigation, interference detection and mitigation, APNT solutions, and robust PNT architectures—integrated with 5G/6G and LEO/GEO satellites can strengthen resilience, ensure safety, and enable future data driven airspace management.
Chair: Alex Preston
The multi-link advantage: Why combining satcom and VDL unlocks the full potential of future flight operations - Alex Holt, Regional Director, Business Development (EMEA), Flight Safety, Viasat
GNSS Interference - Emilio Pérez, Research Fellow Navigation, DLR & Chair, EUROCAE WG-133
Title TBC - Joe Darden, Director of Aviation, Iridium Satellite, USA
5G wireless quick access FDRs - Murray Skelton, Vice President Business Development , Firan Technology Group (FTG)
Modernizing CNS: Emerging Technology Enablers for Airspace Evolution - Professor Paul Febvre, Professor of Space Systems Engineering, Cranfield University

3.30pm-4.00pm **Networking Coffee Break in Exhibition Hall**

4.00pm-5.30pm **Cybersecurity in Connectivity and the Cockpit**
Cybersecurity in aviation faces critical challenges including GNSS vulnerabilities such as jamming, spoofing, and interference, compounded by increasing connectivity. Avionics systems are increasingly networked and the integration of Electronic Flight Bags (EFBs), often consumer devices like iPads, introduces risks of data manipulation through two-way gateways to the flight deck. Maintenance tools and cabin systems pose additional threats if uncertified, risking malware introduction. Emerging 5G interference challenges demand resilient aircraft systems. New regulatory focus, such as CAA NIS-D, emphasizes data integrity alongside availability, mandating comprehensive cyber risk management. Protecting end-to-end data integrity, akin to navigation database standards (DO-200/ED-76), and DO-326A/ED200-2A compliance is essential to prevent upstream contamination, aviation systems security and ensuring safety.
Chair: Paul Hart, DEA Group
Security in Avionics Systems - Gary Gilliland, VP Marketing, DDCI
Cyber risk assessment aligned with latest aviation specific regulations - Dr. Thaddeus Eze, Cyber Security Consultant and Auditor, Airbus Protect
The increasing threat of GNSS Interference and Spoofing and the potential effects on Aviation - Andrew Addy, Technical Lead, PNT Assured
Quantum-Ready Avionics: Embedded DTLS and Secure Boot for the Next 30 Years - Andrew Hutchings, Senior Software Engineer, wolfSSL

5.30pm-7.30pm **Networking Reception in Exhibition Hall** WNDRVR

TESTING TRACK DAY ONE PROGRAMME
Tuesday 2nd June

9.00 - 10.30am

JOINT OPENING KEYNOTE
Chair: Alex Preston
Helen Leadbetter, Technical Strategy Lead Zero Emissions Flight, UK CAA
Andrew Kinniburgh, Director-General, Make UK Defence
Zahid Sultan-Khan, Chief Pilot Boeing 777, Silk Way West Airlines

10.30am-11.00am **Networking Coffee Break in Exhibition Hall**

11.00am-12.30pm **AI and ML in Testing**
The evolving landscape and digitalisation of avionics hardware and software testing and certification AI and ML are emerging in aerospace and avionics, raising complex testing and certification challenges, presenting significant verification and validation challenges. AI use cases are broadly categorized into narrow/specialized AI (e.g., object detection) and generative models, which pose greater unpredictability due to non-deterministic outputs. Current architectures favour non-safety-critical, passive AI/ML systems operating in parallel with primary avionics functions—supporting anomaly detection, predictive maintenance, and decision support. In light of limited data availability, what methods are most appropriate for testing and validating? How do you approach verification and validation of non-deterministic AI systems within the constraints of deterministic safety standards like ED-324/DO-178C? Where will EUROCAE technical standards (WG114) support the development of systems and the certification of aeronautical systems implementing AI-technologies?
Chair: Marc Gatti, Thales
Accelerating Airworthiness: Automation's Role in Faster Verification for ED-12C / DO-178C Certification - Paul Butcher, Head of Dynamic Analysis, AdaCore
Agentic Simulation for Accelerated Virtual Avionics System Development and Testing - James Hui, System Simulation Product Manager, Wind River
Joint standard ED-XXX/ARP8644 Automation of Aircraft Inspections - Gary Brown, Principal Safety Engineer & Ai Referent, Airbus Operations, France
Shadow Testing: The Secret AI Adoption Already Happening in Your Supply Chain - Adam Mackay, Head of AI Research, QA-Systems

12.30pm-2.00pm **Networking Lunch in Exhibition Hall**

2.00pm-3.30pm **Model-Driven Testing and Certification: Digital Twins, Tools, and Languages for Next-Gen Avionics**
Advanced avionics systems demand a shift in how we test and certify software. This session explores the rise of model-driven approaches—spanning digital twins, simulation, and model-based testing—alongside emerging tools and languages like Rust and CHERI. These technologies promise improved scalability, security, and assurance, but also raise new challenges for validation and certification. How can simulation, virtualization, and automation shape the verification processes, and how are standards like ED-12C/DO-178C and ED-215/DO-330 adapting to support tool qualification and digital validation? How do we validate digital models? What qualifies as a certifiable toolchain? This session explores the convergence of advanced testing technologies and modern certification frameworks.
Chair: Matt Jackson, PACE Aerospace
Simulation-Driven Validation for Mode 5 Certification and CMS Testing: A Dual Approach Using SkyRF Moving Target - Domien De Ruyck, Managing Director, Intersoft Electronics
The Strategic Shift in Avionic Validation - Towards the Testing Ecosystem - Franco Alfonsetti, Head Of Test Solutions Engineering, Leonardo Electronics
Emergence of Rust Testing - Jose Ruiz, Product Manager, AdaCore & Antoine Colin, CTO, Rapita Systems
Model-Driven Testing and Certification - Ashish Sethi, Senior Director, PAVE360 Technical Programs, Siemens EDA & Dr Edward Jinks, Digital Strategy Lead A&D, Siemens UK

3.30pm-4.00pm **Networking Coffee Break in Exhibition Hall**

4.00pm-5.30pm **Panel Discussion: Meeting Certification Standards – Barrier to Entry?**
While certification standards safeguard safety and reliability, their rigidity and escalating costs may deter innovation and small-market participation. Inconsistencies across commercial, military, VTOL, and UAV certification frameworks further complicate compliance. Limited data sharing also hinders assurance for advanced cockpit systems, as more tech is introduced to support the pilot. In the wake of the 737 MAX crisis, stricter oversight—such as CS-25 Amendment 28 and EASA's conservative stance—has intensified regulatory caution. This panel discussion explores whether adopting DER-like delegated authority frameworks or reverting to simpler, lower-complexity technologies could streamline certification, reduce cost and time, and help sustain innovation without compromising safety, or whether regulators are hindering the industry by over protection.
Chair: Alex Preston
- Alex Milns, Technical Programme Manager, EUROCAE
- Gary Brown, Principal Safety Engineer & Ai Referent, Airbus Operations, France
- Michael Mustillo, Head of Flight Control, Vertical Aerospace
- Jon Forde, Technical Director / Chief Engineer, Assured Intelligence
- Senior Representative, SPHEREA Test & Services*

5.30pm-7.30pm **Networking Reception in Exhibition Hall** WNDRVR

FACE TRACK DAY ONE PROGRAMME
Tuesday 2nd June

9.00 - 10.30am

JOINT OPENING KEYNOTE
Chair: Alex Preston
Helen Leadbetter, Technical Strategy Lead Zero Emissions Flight, UK CAA
Andrew Kinniburgh, Director-General, Make UK Defence
Zahid Sultan-Khan, Chief Pilot Boeing 777, Silk Way West Airlines

10.30am-11.00am **Networking Coffee Break in Exhibition Hall**

11.00am-12.30pm

FACE Standards and Global Alignment
As aviation systems adopt open architectures, aligning the Future Airborne Capability Environment (FACE) with NATO and other international standards is essential to achieving global interoperability. This session explores how the FACE Consortium—now an international community—is promoting a common approach to software portability and integration while encouraging broader international engagement in standards development and alignment. Discussion will focus on how FACE aligns with related initiatives such as MOSA and SOSA, and how collaborative efforts among governments, industry, and regulators are shaping the next generation of open standards—driving consistency, reuse, and accelerated capability delivery across allied airborne and mission systems.
Chair: Kirk Avery, Lockheed Martin
Latest on FACE Standards - Alicia Taylor, FACE Director
EU-MOSA: A Strategic Framework for Modular Open System Architecture in European Defense Aviation - Mauro Baldassarre, Avionic System Engineer, Leonardo
Thales FMS200 FACE Conformance Journey - Jean-Philippe Amouroux, Embedded Software Architect, Thales Avionics
Alignment of MOSA Standards with Mixed-Criticality Approaches to Cost Reduction - Clifford Bilbrey, Software Engineer, Qt Group

12.30pm-2.00pm **Networking Lunch in Exhibition Hall**

2.00pm-3.30pm

Open & Modular Architectures
Avionics is shifting from monolithic systems to open, modular architectures guided by the Future Airborne Capability Environment (FACE) standard. FACE defines common interfaces and data models to enable software portability, reuse, and faster integration across airborne platforms—principles now embedded in UK programmes such as PYRAMID and Team Tempest. While shared compute and software-defined functionality increase flexibility, they also raise challenges in interface control, integration testing, and verification across heterogeneous processors (GPUs, FPGAs, AI accelerators). Emerging technologies like Time-Sensitive Networking (TSN) and FACE I/O Services support deterministic, certifiable communications. This session examines how adopting FACE-aligned open standards delivers technical interoperability, reduced lifecycle cost, and accelerated capability delivery for both industry and government programmes.
Chair: Alicia Taylor, FACE Director
Technical Alignment between PYRAMID and FACE Technical Standard - Jon Forde, Technical Director / Chief Engineer, Assured Intelligence
MOSA for Software Architecture - Gary Gilliland, VP Marketing, DDCI
Software Defined Defense Systems: Best Practices for Developing and Verifying Safe and Secure Modular Software - Stephen Di Camillo, Technical Marketing and Business Development Manager, TASKING
The API Language Choice Challenge in FACE: Impacts on Integration and Reuse - Jean-Philippe Amouroux, Embedded Software Architect, Thales Avionics

3.30pm-4.00pm **Networking Coffee Break in Exhibition Hall**

4.00pm-5.30pm

Data Modelling for Faster Integration: The FACE Approach
Open architectures and emerging technologies are reshaping how avionics systems are integrated. Within the Future Airborne Capability Environment (FACE), data modelling—through the Open Universal Domain Description Language (Open UDDL)—provides a common, extensible method for defining and exchanging data. By eliminating ambiguity and supporting model-based engineering, Open UDDL accelerates integration and enables greater reuse of COTS and software components. This session explores how FACE data modelling improves interoperability, speeds capability delivery, and aligns with advances in AI-driven data analysis and system management—ensuring integration is faster, more reliable, and adaptable across next-generation airborne and mission systems.
Chair: Alicia Taylor, FACE Director
UDDL (Introduction and Use-Case Overview) – Gordon Hunt, Chief Architect, Skayl; Domain Interoperability Working Group Chair, Open Group; CAPT USN (Ret)
FACE technical standard and data architecture - Kirk Avery, Senior Fellow and the Mission Systems and Autonomous Technologies Chief Architect, Lockheed Martin
SOSA Technical Standard and Data Architecture - Nick Borton, SOSA Director, The Open Group
How Can Data-Centricity Accelerate and Simplify Verification and Validation for Next-Gen Open Avionics? - Paul Tingey, Senior Field Application Engineer, EMEA, RTI

5.30pm-7.30pm **Networking Reception in Exhibition Hall** WNDRVR

AVIONICS TRACK DAY TWO PROGRAMME
Wednesday 3rd June

9.00am-10.30am — **AI/ML and Autonomy in Avionics**

Artificial Intelligence (AI) and Machine Learning (ML) are increasingly integrated into avionics systems and safety-critical environments to enhance capabilities. AI/ML is being used at the aircraft, not just in it, including sensor fusion, target recognition, predictive maintenance, flight control, adaptive mission systems, and autonomous UAVs. EUROCAE WG-114 is formalizing the first AI-specific aviation standard (target release: mid-2026) to support regulatory alignment. WG-132 is concurrently developing joint guidance with SAE for ML-enabled automated aircraft inspections using UAS and robotics. How can AI continue to develop to assist avionics technology developments? How do we develop AI/ML and usage standards, ensuring ED-12C/DO-178C and ED-215/DO-330 compliance, when there is a lack of data?

Chair: Gary Brown, Airbus

ED-324 / ARP6983 - Integration of AI/ML into Aircraft and non-aircraft Avionics - Dr Fateh Kaakai, Safety Expert and AI Assurance Researcher, co-chair of EUROCAE WG-114, Thales

Title TBC - Mark Roboff, SkyThread

Enabling ATM-U-space Interoperability: Validation of Digital Coordination Services - Sergio Ruiz, ATM Innovation Expert, EUROCONTROL

- Senior Representative, Collins Aerospace*

10.30am-11.00am — **Networking Coffee Break in Exhibition Hall**

11.00am-12.30pm — **Obsolescence management - Legacy Systems & Fleet Modernization**

Managing obsolescence in aerospace involves extending the life of 1st/2nd generation systems, often without full documentation or original engineers. Legacy avionics remain common, but retrofitting them to meet modern standards is complex and costly. Integration of new hardware/software with outdated architectures requires deep understanding of original design rationale. Key technical challenges include sourcing end-of-life components, mitigating the risk of counterfeit parts, and maintaining or refactoring legacy codebases. How do we retain engineers with domain expertise in legacy systems and manage compliance and safe system modernization.

Chair: Alex Preston

Why Is Aviation Concerned By Obsolescence - Marijan Jozic, Managing Director, Jozic Engineering

Title TBC - Rob Picken, Senior Vice President, Digital & Partnerships, Sourceability International Institute of Obsolence Management

Title TBC - Luke Fitzpatrick, Rochester Electronics

The Continuity Principle - Karen Salmon, CEO, Force Technologies

12.30pm-2.00pm — **Networking Lunch in Exhibition Hall**

2.00pm-3.30pm — **Human-Machine Teaming**

As AI, automation, and virtual systems transform flight decks, the relationship between pilots and machines is being redefined. We explore the evolution from traditional interfaces and autopilots to true human–machine teaming, where the pilot remains central "in the loop." How can intelligent systems generate and communicate scenarios, assist decision-making, and how emerging technologies—such as AR-enabled displays, adaptive interfaces, and virtual copilots— can enhance pilot performance and trust. It will also look at the balance between innovation, human factors, and regulatory constraints to ensure safety and usability remain at the core of next-generation cockpit design.

Chair: Hannes Griebel, CGI

Title TBC - Marc Gatti, Deputy Scientific Director & Academics Relationship, Thales Avionics SAS

Title TBC - Carlos Sequeira, Airline Pilot, Psychologist, and Human Factors Expert, Ryanair

Title TBC - Matt Jackson, Technical Product Manager HMI and Embedded Systems PACE Aerospace

The Future Flight Deck Based On Human-Centric Design - Wen-Chin Li, Director on Safety and Human Factors in Aviation & Dr James Blundell, Senior Lecturer in Aviation Human Factors, Cranfield University

3.30pm — **Conference Close**

4.30pm — **Exhibition Close**

**invited*

Register Online at
www.avionicsandtesting-innovations.com

TESTING TRACK TWO PROGRAMME
Wednesday 3rd June

9.00am-10.30am

Validation and Certification Challenges in Complex Aerospace Systems: From Mixed-Critical Architectures to Fit-to-Fly Testing

The drive to reduce SWaP (Size, Weight and Power) through integrating mixed-critical functions on shared architectures demands rigorous testing of fault, time, and space isolation between safety-critical and non-critical partitions, including worst-case execution and interference scenarios in compliance with EASA CS-25 and ARINC 653. Concurrently, VTOL and UAV platforms require system-level validation of performance, autonomy, and safety functions within controlled sandbox environments. EUROCAE WG-112's "fit to fly" criteria guide certification efforts, addressing airworthiness, flight dynamics and system integration, for these new aircraft types. This session explores how evolving standards and advanced testing strategies ensure robust, certifiable systems operating safely in complex aerospace environments.

Chair: Alex Preston

Novel avionic integration methodologies - Gennaro Bottino, Software Engineer, Leonardo

Designing and Testing Complex FPGAs for High-Integrity Applications - Jack Sampford, Chief Firmware Engineer, Phixos

Shift Left: Accelerate Development by frequent E/E testing on multiple integration levels - Jakov Sprljan, Business Development, Schleißheimer Soft- und Hardwareentwicklung GmbH

Taking 'real-time' requirements seriously - Peter Gliwa, CEO, GLIWA GmbH

Timing - how well do you understand it? - Dr Adriana Gogonel, Product Director, Vector

10.30am-11.00am

Networking Coffee Break in Exhibition Hall

11.00am-12.30pm

Cybersecurity in the Testing Environment

Cybersecurity requirements are now integral to the verification and validation (V&V) process for avionics and embedded systems, driven by mandatory compliance with DO-326A / ED-202A series under EASA Part 21 and FAA Special Conditions for connected systems. With increased network exposure (e.g., ACARS, ADS-B, SWIM, onboard Wi-Fi), system-level cybersecurity testing is prioritized alongside traditional safety assessments. Key activities such as threat modeling, penetration testing, secure boot validation, and verification of isolation in mixed-criticality environments provide unique challenges. How does the industry focus on tooling and methodologies that support combined safety and security certification—positioning cybersecurity as a top priority?

Chair: Philippe Lievin, Thales

Aeronautical Systems Security - Dr. Stefan Schwindt, Senior Principal – Aerospace Cyber Security, GE Aviation, and member of EUROCAE's WG-72

From Point-in-Time Certification to Continuous Assurance: Integrating Product Security into V&V for Aerospace and Defence - Vitor Monteiro Correia, Senior Business Development Manager, Critical Software

Requirements-Driven Cybersecurity: Connecting Secure Design to the Testing Environment - Victor Lancien, Sales Account Manager Europe, Visure Solutions

Integrating Security into Safe Airborne Software Development - Carsten Beck, Head of Product Development PikeOS, SYSGO

12.30pm-2.00pm

Networking Lunch in Exhibition Hall

2.00pm-3.30pm

Environmental Testing

Environmental testing ensures avionics systems perform reliably under diverse operational conditions. Methods such as signal integrity, functional, modular, and simulation testing help identify failures early by validating system behaviour under stress, isolation, and real-world scenarios—including faults and extreme environments, such as extreme temperatures, humidity, and pressure. These tests are critical for safety and cost-effective development. EUROCAE WG-14 is updating ED-14G to ED-14H / DO-160, revising environmental categories, test procedures, and guidance to reflect modern technologies and expanded use cases, including UAS ground stations. Alignment with RTCA standards and updated guidance (ED-234A) will reshape qualification strategies, requiring teams to revise compliance approaches.

Chair: Alex Preston

Main evolutions of the ED-14H - Eric Delesalle, Senior Expert EMI & Lightning indirect effect Compliance Verification Engineer (CVE), Safran Aircraft Engines

ED-14 / DO-160 / MIL-STD testing for avionic units - Paul Hart, CTO, DEA Specialised Airborne Operations

The Shadow Standard: Tribalism and inherited inefficiencies in Safety Certification: A Focus on ED-80 / DO-254 - Bruno Chaves, CEO (Product & Strategy) Critical Manx

6th Generation Test Environments - Paul Wilkins, Chief Engineer, Leonardo UK Ltd & Timothy Oswin, Systems Engineer, Leonardo, UK

3.30pm

Conference Close

4.30pm

Exhibition Close

**invited*

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MULTICORE TRACK DAY TWO PROGRAMME
Wednesday 3rd June

9.00am-10.30am

Standards, Regulations and Mitigation Challenges for Multicore
Multicore processors are key to the future of avionics, offering greater performance, reduced SWaP, and support for advanced real-time applications. This session will provide an overview of the certification landscape shaping multicore avionics systems. Gain clarity on evolving standards—ED-12C/DO-178C, ED-80/DO-254, CAST-32A, and AMC 20-193—and their impact on safety, determinism, and interference mitigation. The discussion aims to highlight regulatory expectations, risk management approaches, and compliance strategies critical to delivering certifiable multicore solutions. Understand the challenges for standards bodies, certification tools, regulators and the supply chain shaping the future of multicore avionics compliance.
Chair: Hannes Griebel, CGI
- Senior Representative, Rolls Royce*
Multicore Certification Beyond ANC 20-193 - Karl Thyssen, Senior Multicore Engineer, Rapita Systems
- Senior Representative, NXP*
Title TBC - Senior Representative, DDC-I Inc

10.30am-11.00am

Networking Coffee Break in Exhibition Hall

11.00am-12.30pm

The Roadmap for Multicore Hardware
The multicore hardware roadmap focuses on delivering deterministic, safety-certifiable processors that meet escalating performance requirements without sacrificing reliability. Hardware designers must implement robust spatial and temporal isolation, minimize core and shared resource interference, and comply with ED-80/DO-254, CAST-32A, and AMC 20-193 standards. Critical questions remain: Is current hardware sufficiently mature for safety-critical certification? How are suppliers ensuring long-term availability, configurability, and comprehensive toolchain support? What future and upcoming technologies can provide complete or partial solutions to these challenges? As performance demands grow and costs rise, can hardware innovation keep pace with the avionics industry's stringent needs for predictability, traceability, and certifiability?
Chair: Matt Jackson, Pace TXT
Title TBC - Amador Rafiq , Embedded Solutions Engineer - Aerospace & Defense, Microchip Technology
Freedom From Interference for Multi-core Processor Systems - Michael Chapman, CEO, Cortus
Managing Memory Interference on Heterogeneous MPSoC: Challenges and Industry-oriented Approaches - Andrea Bastoni, CTO, Minerva Systems
Is Robust Partitioning achievable with a multi-core system? - Olivier Charrier, Principal Technologist - Functional Safety, Wind River & Karl Thyssen, Senior Multicore Engineer, Rapita Systems

12.30pm-2.00pm

Networking Lunch in Exhibition Hall

2.00pm-3.30pm

Architecture and Software Development & Certification
Most software development complies with standards like ED-12C/ DO-178C and AMC 20-193, prioritizing determinism, partitioning, and interference mitigation. How can hardware-software co-design enable robust scheduling, partitioning, and interference management, ensuring deterministic system behaviour. Furthermore, what does verification and certification truly entail for multicore avionics platforms, considering the complex interplay between hardware and software in safety-critical environments?
Chair: Gary Gilliland, DDC-I
Intel and Avionics - Powering Avionics Safety & Accelerating Safety Certification - Maurizio Iacaruso, Functional Safety Software Architect, Intel Corp
Leveraging multi-core processors for Safety-Critical Applications on IMA platforms - Damien Chabrol, VP Innovation & Strategy, Asterios Technologies
Importance of Control Coupling and Data Flow Analysis in Certifying Multicore Systems - Mark Richardson, Lead Field Application Engineer, TASKING
Multicore Certification with Bare-Metal Ada - Jose Ruiz, Product Manager, AdaCore

3.30pm

Conference Close

4.30pm

Exhibition Close

**invited*

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AVIONICS AND TESTING INNOVATIONS

2nd-3rd June 2026
London, UK

Networking Reception

Networking Reception Sponsor:

WNDRVR

Tuesday 2nd June 2026
5.30pm-7.30pm
Exhibition Hall

We invite you to joins us at the end of the day on Tuesday 2nd June 2026, for the networking reception on the Exhibition floor at the Radisson Red Heathrow, *sponsored by Wind River*, which will see the avionics and aviation electronics community gather for this informal reception – and the opportunity to join and network with members from the commercial and military/defence. aerospace and testing community with the Avionics & Testing Innovations Networking Reception.

With the opportunity to meet colleagues and peers you can build relationships with colleagues, peers, new customers and old, in a relaxed and friendly atmosphere.

The Networking Reception is open to industry professionals.

We look forward to welcoming you.

Venue

Radisson Red London Heathrow
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Heathrow UB7 0DU



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AVIONICS AND TESTING INNOVATIONS

2nd-3rd June 2026

London, UK

How to Get There

Radisson Red London Heathrow
Bath Road Building B
West Drayton
Heathrow UB7 0DU

How to get to the Radisson Hotel & Conference Centre London Heathrow:

Address - Bath Road (Building A), West Drayton, Heathrow, London UB7 0DU, United Kingdom (closest terminal is 2&3)



By airport shuttle:

"Hotel Hoppa" buses stop outside London Heathrow Terminals 1, 2, 3, and 5 between 4:15 am and 10:00 pm. Travel time is between 20-30 minutes. Tickets cost GBP 6.80 one way.

To reach us from Terminals 2 and 3, take the Hotel Hoppa H2B and H2C.

From Terminal 5, take Hotel Hoppa H5B.

For the latest and most up-to-date information, please check the "Hotel Hoppa" Timetable website directly.



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From terminal 5: bus 423 (7 stops to Nene Road)



Elizabeth Line from Heathrow also has quick access to/from Central London.







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AVIONICS AND TESTING INNOVATIONS

2nd-3rd June 2026

London, UK

Conference Advisory Committee

Avionics & Testing Innovations would like to thank the conference committee members for their valuable contribution and experts views helping to deliver a first class, cutting edge conference programme:

AIRBUS
Gary Brown
Principal Safety Engineer & AI Referent

EMBRYA
Jacques Gatard
Co-Founder and CEO

EUROCONTROL
Nikos Fistas
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RAPITA SYSTEMS A DANLAW COMPANY
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AVIONICS AND TESTING INNOVATIONS

2nd-3rd June 2026
London, UK

Floorplan and Exhibiting Opportunities

Exhibiting Investment

The cost of exhibiting at the Avionics and Testing Innovations requires a minimum of 6 sq.m.

Half Height Shell Scheme - £895/ m²

We've calculated for your convenience:
6sq.m = £5,370
9sq.m = £8,055
12sq.m = £10,740

Package includes: floor space, full 2.4m height back wall, 3ft high side walls, furniture (table and 2 chairs), 2 x lights, 1 x power socket, 2 exhibitor delegate passes with lunch and coffee breaks included, listing in the official event guide and website. (Additional Delegate Passes can be purchased at special rates).

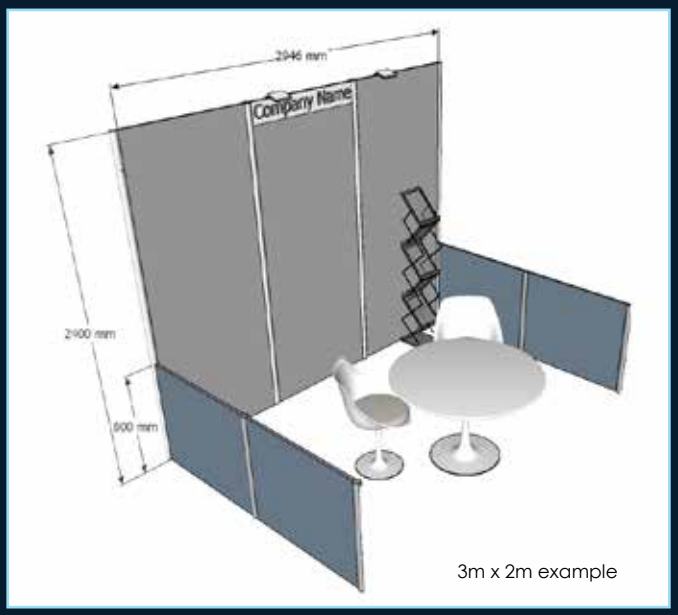
Space only (for self build only) - £745/ m²

We've calculated for your convenience:
6sq.m = £4,470
9sq.m = £6,705
12sq.m = £8,940

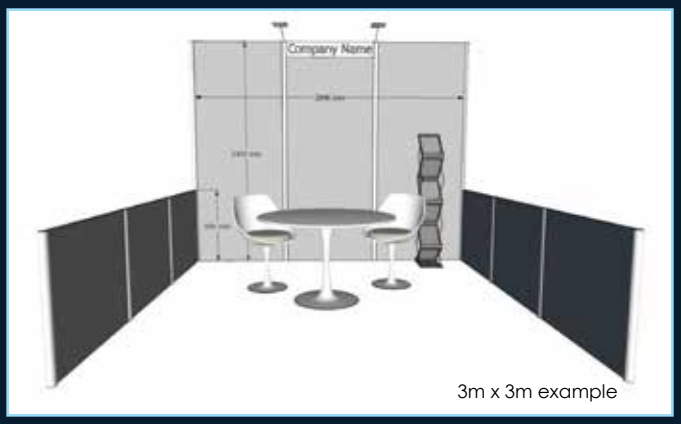
For self build stands (not suitable/allowed for pop-up booths), including 2 exhibitor delegate passes with lunch and coffee breaks included, listing in the official event guide and website.

Additional Exhibition Booth Passes (excludes conference access) can purchased at a cost of £195 each, which includes lunch and coffee breaks for the two days.

Half Height Shell Scheme



3m x 2m example



3m x 3m example

Disclaimer: Furniture shown in this image is not actual furniture style supplied but an example of booth style.







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AVIONICS AND TESTING INNOVATIONS

2nd-3rd June 2026

London, UK

Sponsorship Opportunities

A limited number of opportunities exist to organisations wishing to be involved with the conference and exhibition and the opportunity to meet and gain maximum exposure to a key and influential audience.

Some of the sponsorship package opportunities are highlighted below. Packages can be designed and tailored to meet your budget requirements and objectives.

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Positive Brand Association: By associating your brand with Avionics and Testing Innovations, you can enhance your brand image and reputation. Aligning yourself with a well-respected event can help you attract new customers and partners, and build trust with your existing audience.







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The March to Multicore Processors Continues

In the June 2025 issue of Aerospace Innovations, our story entitled "Multicore Processors: Why They Are Becoming Standard Equipment in Modern Avionics" explored the aircraft industry's migration to these CPUs and away from single-core processors.

One year later, the migration to multicore has picked up speed. In this article, we see how multicore processors are being used in aircraft today, the issues that still have to be resolved with this technology, and how well multicore processors will support the advanced aerospace and defence applications of tomorrow.

The Single-Core Drought

"The primary catalyst driving the aviation industry's shift from single-core right now is lack of availability of single core parts," declared Jay Thomas, Director of Field Engineering at TASKING, a company that provides embedded software development tools that support multicore systems across aerospace and other safety-critical industries. "Traditional processors used in aviation are shifting away and almost all of the newer generation are multicore."

Gary Gilliland is Vice President of Marketing at DDC-I, a company that helps customers design, develop, and deploy critical avionics systems utilizing multicore processors. "Certainly, the lack of supply and the fact that all processor technological advances are going into multicore processors has an influence, but the avionics industry has considered multicore an attractive approach to improve upon processing performance and reduce system packaging wattage and cost for a long time," he told Aerospace Innovations magazine. "Beyond the trail blazing by early multicore adopters in the aviation industry, recent accelerated multicore embrace is due in part to the industry's understanding that tooling and software features can greatly simplify and reduce the complexities of multicore processing. These software features often also greatly improve upon real-time system performance—which then makes multicore processing even more appealing."

It isn't just supply problems that are driving the move away from single-core processors—it's obsolescence. "A significant number of avionics functions and multi-function systems, including graphics systems, can still operate effectively on single-core processors," said Olivier Charrier, a Principal Functional Safety Specialist at Wind River, a company that works with multicore processors in the aviation industry. "However, the phaseout of such architectures by silicon vendors means that multicore designs are now the only sustainable



Credit: Wind River



Gary Gilliland. Credit: DDC-I



Michel Chabroux. Credit: Wind River



Olivier Charrier. Credit: Wind River



path forward. At the same time, multicore architectures present valuable opportunities to enhance existing avionics functions and extend capabilities toward greater autonomy. Advanced flight control, autonomy, and sensor-fusion workloads simply exceed what a single core can support."

Reality Check: Multicore Today

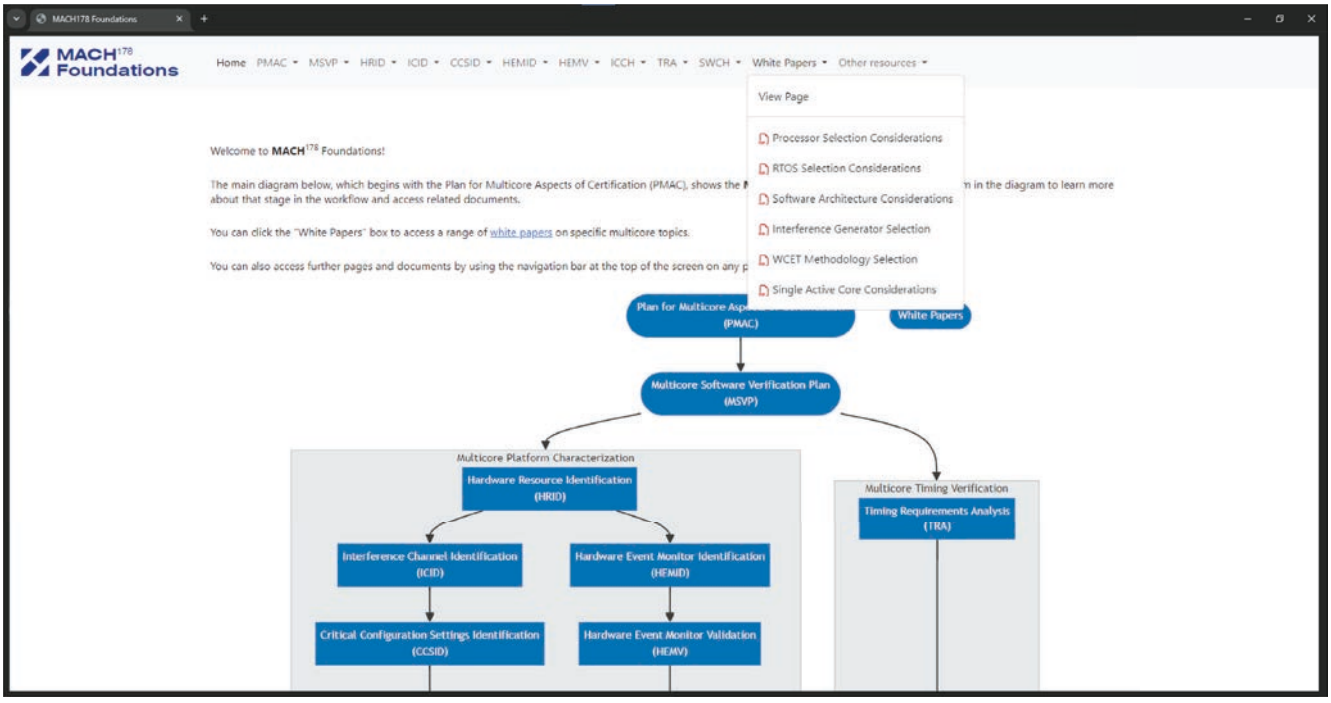
"Today, multicore processors power mission computers, flight control systems, and high-performance compute nodes used for autonomy and advanced cockpit functions," said Michel Chabroux, Wind River's Vice President of Product Management. "The hardware and software capabilities are mature and continue to be refined. Basically, all aspects of avionics are moving to multicore to be able to consolidate functionality and/or add capabilities."

In fact, "Multicore processors are already ubiquitous in both civil and defence aircraft systems, but the majority of these have only a single active core," said Dr. Sam Thompson, Multicore Engineering Team Lead at Rapita Systems, a company that delivers multicore engineering projects for its customers. "This is because using only one core per processor avoids a multicore certification process with EASA (AMC 20-193) and the FAA (AC 20-193). "This is an expensive, complex, and time-consuming process," he told AI. "By taking a multicore chip and disabling all but one core, it behaves exactly like a legacy single-core processor. With no internal traffic jams to worry about, the safety certification process becomes exponentially easier and cheaper."

From an engineering standpoint, it may seem wasteful to "dumb-down" multicore processors so that they act like single-core processors. However, "there can be a powerful advantage to employing a multicore processor in a single core application," said Gilliland. "Once installed in the aircraft, the multicore processor can provide expanded processing capability in the future if the needs arise. We have cases where customers only need to modify the processor initialization and configure the RTOS's multicore scheduler and off they go. They don't even need to recompile their applications when converting their target from single-core to multicore processing. That's a huge advantage."

Proving Determinism in a Multicore World

Except during takeoffs and landings, computers fly modern aircraft. As a result, aircraft sensors, engine



Credit: Rapita Systems. Foundations-02 MACH178.

management systems, and flight controls all rely on Real-Time Operating Systems (RTOS) where a computer's timing is just as important as its mathematical accuracy. If the Autopilot system calculates the correct adjustment for a flight control surface but delivers that command a fraction of a second too late, the result can be catastrophic.

This is why regulators like the FAA and EASA demand determinism from all onboard computers—the guarantee that a system will consistently complete a task within a strictly defined time limit. Avionics engineers must mathematically guarantee that a critical computer application will always hit its deadline, even under the absolute heaviest processing load. This metric is known as the Worst-Case Execution Time (WCET), and onboard computers must operate within it or better.

With legacy single-core processors, proving determinism was easy. This is because a single core has an uncontested single-lane road to the processor's memory and data buses.

Because they share memory buses (the road), multicore processors can suffer traffic jams. When Core A (running a critical flight control task) and Core B (running a non-critical graphical display task) try to access the shared memory bus at the exact same microsecond, a traffic bottleneck occurs. Core B has to wait until Core A's signal has gone down the lane. This wait time is referred to as "interference".

Because interference creates unpredictable delays, the FAA and EASA cannot simply assume a multicore chip will act predictably. This is why AC 20-193 and AMC 20-193 certification processes exist, to prove to regulators that specific multicore processors running two or more cores simultaneously don't suffer delays that could compromise critical avionics applications.

> **"The primary catalyst driving the aviation industry's shift from single-core right now is lack of availability of single core parts."**
>
> **Jay Thomas, TASKING's Director of Field Engineering**

"Traditionally, the largest hurdle for multicore certification is viewed as 'solving multicore interference'," Dr. Thompson said. "However, this easily overlooks the less obvious but equally hard challenge of presenting the results of some very complex analysis in such a way that an airworthiness regulator can understand and have confidence in them. Doing this requires gaining access to sufficiently detailed documentation on the processor to facilitate analysis, at a time where there is a misalignment between different airworthiness regulators on acceptable means of achieving objectives."

According to Thomas, the biggest hurdle to proving determinism and mitigating interference when certifying a multicore processor for onboard use is "understanding who owns what piece of the problem," he said. "AMC 20-193 and its FAA counterpart AC 20-193 lay out clear objectives: Identify your interference channels, mitigate them, and prove through measurement that your mitigation works. However, they're deliberately not prescriptive about how you do it. That flexibility is good,

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Seamless Integration in Safety Ecosystem

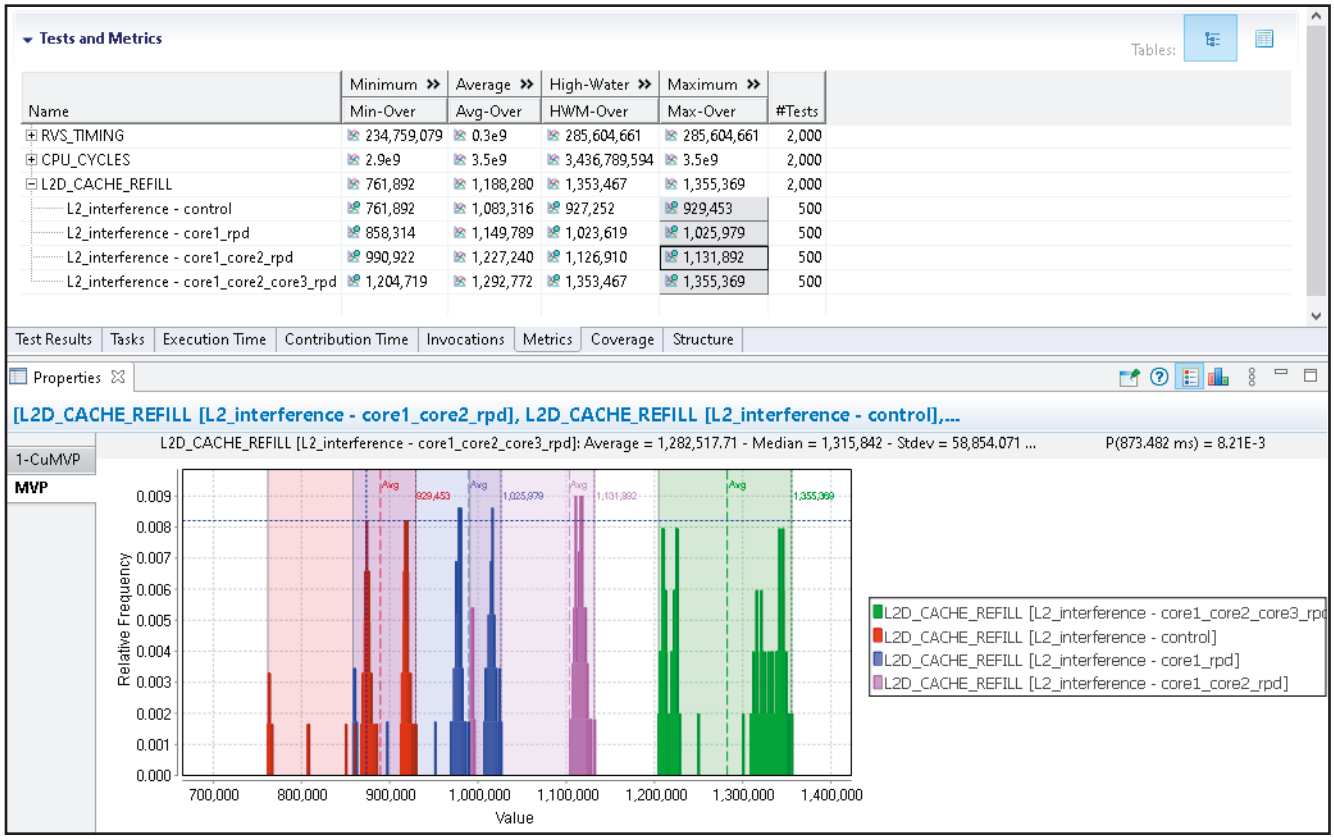
- Rapita RVS
- LDRA ToolSuite
- VectorCAST
- Parasoft C/C++ Test
- and more...

Speed-Up Certification

- Analyse multicore-CPUs according to CAST-32A guidelines
- Timing analyses incl. WCET



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Credit: Rapita Systems. metrics_tab_etps (1) MACH178.

but it means every program needs to figure out its own approach, and that's where teams get stuck."

"The industry is overcoming this challenge through shared responsibility and better partnerships across the stack," he continued. "Silicon vendors like Microchip with PolarFire are building hardware-level mitigation (i.e. TCM, core-local memory) directly into the processor. RTOS vendors like DDC-I and SYSGO provide temporal and spatial partitioning at the platform level. And tool vendors such as TASKING and its LDRA tool suite provide the measurement and analysis to verify that it all actually works, from WCET analysis, data and control coupling across cores, and traceability back to requirements."

Single-Core on Death Watch?

Given the migration to multicore processors in avionics, are legacy single-core processors officially on a death watch? That's a hard question to answer.

To do so, "We need to differentiate between 'single core microcontrollers' and 'high performance processors'," said Dr. Thompson. "Basic, low-power single core microcontrollers have been on aircraft—and everywhere else, for that matter—for decades, and will likely still be common when the eventual heat death of the universe rolls around. But for applications that require more processing throughput, every industry other than aviation migrated to multicore many years ago. So I don't think it's hyperbole to suggest that the high-performance single core processor is dead and buried in 2026."

> **"Traditionally, the largest hurdle for multicore certification is viewed as 'solving multicore interference'."**
>
> **Dr. Sam Thompson, Multicore Engineering Team Lead at Rapita Systems**

"Single-core processors aren't entirely gone, but they're increasingly limited to narrow, low-complexity roles—usually legacy hardware or systems with extremely simple compute needs," Chabroux said. "They persist where determinism is trivial and there's no incentive to re-architect. Still, their long-term viability is shrinking as suppliers discontinue single-core lines. Wind River continues to support these legacy environments, but the momentum is clearly toward multicore platforms for anything forward-looking or performance-critical."

"Today, truly single core processors are rare and will become niche over time," said Thomas. "However, lock step matched processors where you have two cores and they can detect failed states provide value and act much like single core processors from the point of view for AMC 20-193/CAST 32A compliance. It is important to

note that according to the standard, these should be treated as single cores, as both cores access memory simultaneously, and thus multicore contention is not possible."

Powering the eVTOL Revolution

Electric Vertical Takeoff and Landing (eVTOL) aircraft are the Next Big Thing in Advanced Air Mobility (AAM), with many models being designed to be flown autonomously without human pilots. Achieving autonomous flight will require a tremendous degree of onboard computing power, and multicore processors will play a big role in supporting it.

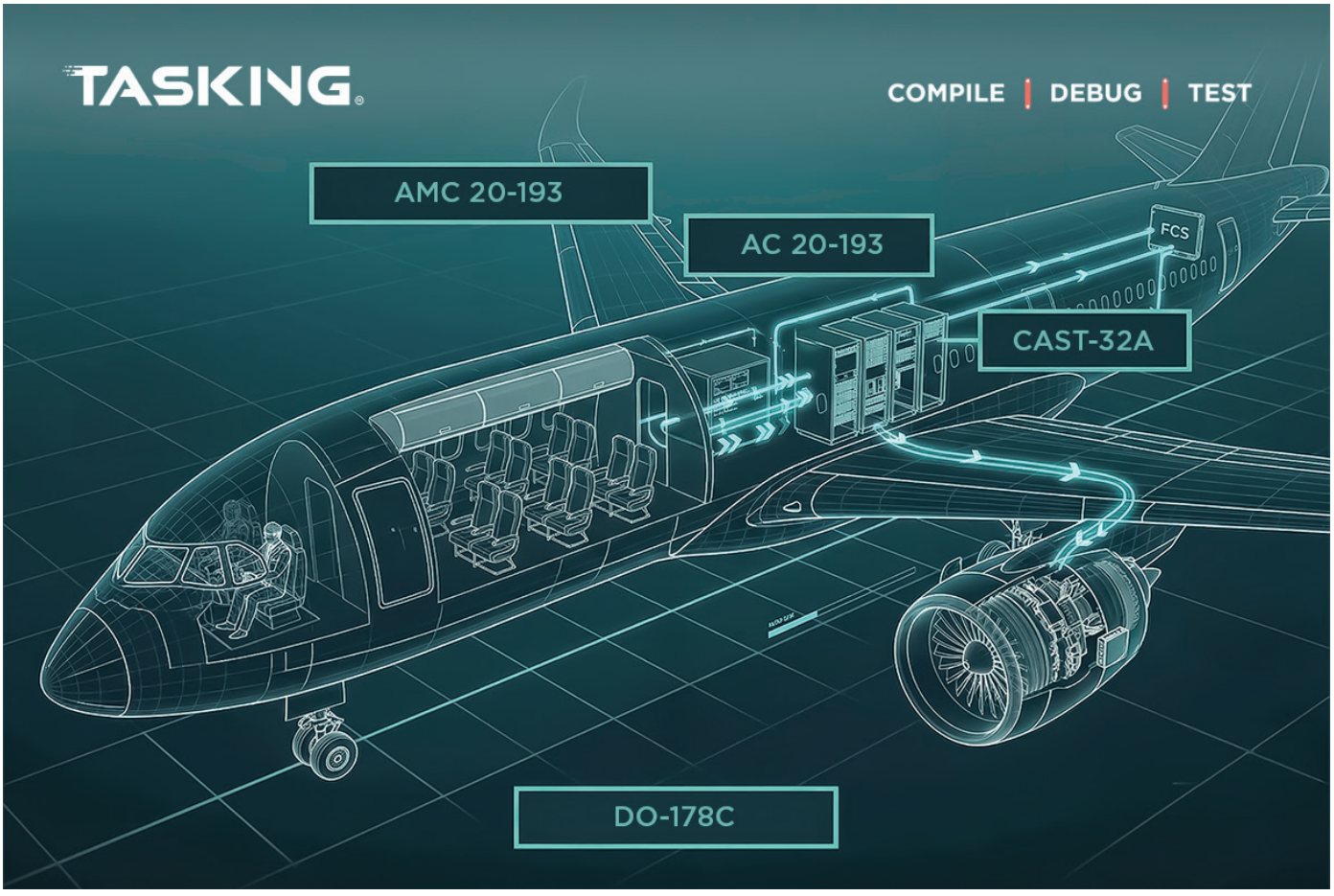
"Multicore processing is not just important to AAM and eVTOL, it is a foundational architectural requirement without which the core safety case for these platforms cannot be constructed," Gilliland said. "For autonomous operations, the sensor suite required for safe low-altitude flight, LiDAR, radar, cameras, GPS, et cetera generates continuous high data rate streams that are combined in real time to produce a reliable environmental picture for flight control decisions. Each sensor system operates at a different data rate and requires independent processing before fusion. Assigning these workloads to separate cores under ARINC 653 spatial and temporal partitioning is the only architecture that meets both the throughput requirement and the interference isolation required for DAL certification."

"It's essentially a prerequisite," said Thomas. "Advanced Air Mobility (AAM) and eVTOL platforms are software-intensive by nature—you're talking about fly-by-wire on vehicles that in many cases are inherently unstable without active flight control, plus you're layering on battery management, power distribution, autonomy functions, and eventually detect-and-avoid for urban airspace. That's a lot of compute for platforms where SWaP-C (Size, Weight, Power, and Cost) is absolutely critical because every gram and every watt affect range. You're not going to meet those demands by strapping together a bunch of single-core boxes."

The good news is that multicore technology allows eVTOL manufacturers to consolidate functions onto fewer processors, which directly supports the weight and power budgets these vehicles need to be commercially viable. "The challenge for AAM is that many of these companies are newer entrants who don't have decades of DO-178C experience, and now they're jumping straight into multicore with AMC 20-193 on top of it," Thomas said. "That's a steep learning curve. But the alternative of trying to build these platforms on legacy single-core architectures simply isn't realistic given what's available in the market and the performance these systems require."

Meeting the AI Mandate

AI and machine learning applications are making their way into aviation, to enable autonomous flight, support

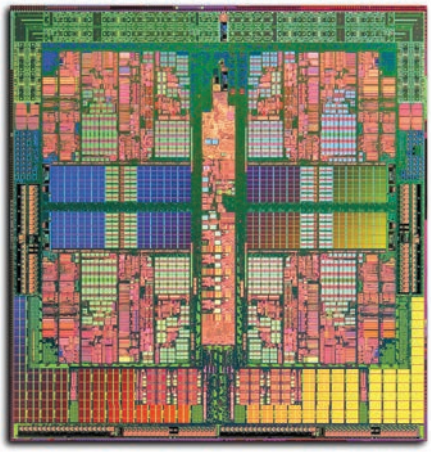


predictive maintenance by analyzing aircraft sensor data in real-time, and reduce the in-flight workload of human pilots. Once again, this mission cannot be fulfilled without the use of multicore processors.

"AI and machine-learning applications thrive on parallel processing, making multicore a natural fit," said Chabroux. "Whether performing local inference, real-time sensor fusion, or predictive diagnostics, these workloads demand significant compute horsepower. Multicore provides that capacity while enabling isolation between AI tasks and safety-critical control loops."

"Multicore is almost always inherent in AI applications," Thomas added. "These cores could be a GPU or could be a CPU. In these high performance, memory intensive applications, multicore interference with potentially hundreds of GPU cores becomes impossible to characterize. Instead, what we have seen is more of a system view of the interference, motivating designers to adopt redundancy to characterize interference and improve reliability. Because the interference becomes inherently stochastic (driven by random probability rather than predictable math) with this many cores, using multiple instances of the same system for AI processes is a good way to make sure that it can provide an answer in a bounded amount of time."

Dr. Thompson tempered this enthusiasm by touching on three key concerns. First, "how many years elapsed between the first commercial multicore processor and the first civil certification of one at DAL A (Design Assurance Level A)?" he asked. "About two decades. So we shouldn't be surprised that the majority of the interest we see in flying machine learning models is at DAL C/D, or largely experimental and speculative. Second, while a multicore processor is far better-suited to hosting these large matrix-based models than a single-core, they are eclipsed by general-purpose graphics



The above AMD Opteron™ is a quad-core processor. Credit: Advanced Micro Devices

> **"AI and ML applications thrive on parallel processing, making multicore a natural fit."**
>
> **Michel Chabroux, Wind River's Vice President of Product Management**

processors, and more recently by dedicated hardware acceleration modules. Most current projects we have using large machine-learning models are depending upon such hardware accelerators rather than multicores. And third, while airborne machine learning at high criticality is still some way from reality, these technologies are being actively investigated and deployed across the industry to accelerate existing workflows and provide efficiencies."

The Elephants in the Hangar

So far, we have examined the trends and possibilities driving aviation's migration to multicore processors. But what issues is the aviation industry not talking about when it comes to multicores and modern aircraft? What are the 'elephants in the hangar'?

"The non-technical aspects," replied Dr. Thompson. "I can design the most sophisticated battery of tests for a multicore processor, but 'tis all for nought unless I can report the results in a human-readable way. I can throw the best engineer on the planet at a multicore processor, but they're incapable of progress if the right NDAs to allow them access to the right information aren't in place."

"One topic not often discussed is the long-term sustainment complexity associated with multicore," Charrier told AI. "As hardware evolves rapidly, keeping a certified configuration stable for decades is a major challenge, particularly when hardware acceleration via GPUs or NPUs is introduced. While most SoCs provide mature hardware mechanisms for multicore CPU partitioning, equivalent isolation and partitioning support is often lacking for GPUs and NPUs. As a result, these accelerators are typically constrained to a single virtual machine or guest, which further complicates system architecture, integration, and long-term certification sustainment."

Perhaps the biggest elephant has to do with solving the multicore processor determinism and interference questions once and for all, through a concerted, open, and industry-wide effort.

"We need to move past treating multicore as a science project," concluded Thomas. "There are programs out there that have spent years in open-ended interference research, characterizing every possible interference scenario, exploring every theoretical edge case, and all without ever converging on a bounded, certifiable solution. That kind of unbounded analysis can consume enormous amounts of time and budget, and at the end you still don't have a shipping product. The question shouldn't be, 'can we fully characterize every interference channel in the abstract?' It should be, 'can we define a practical mitigation strategy, measure it, demonstrate compliance, and get this system certified?'"

By James Careless



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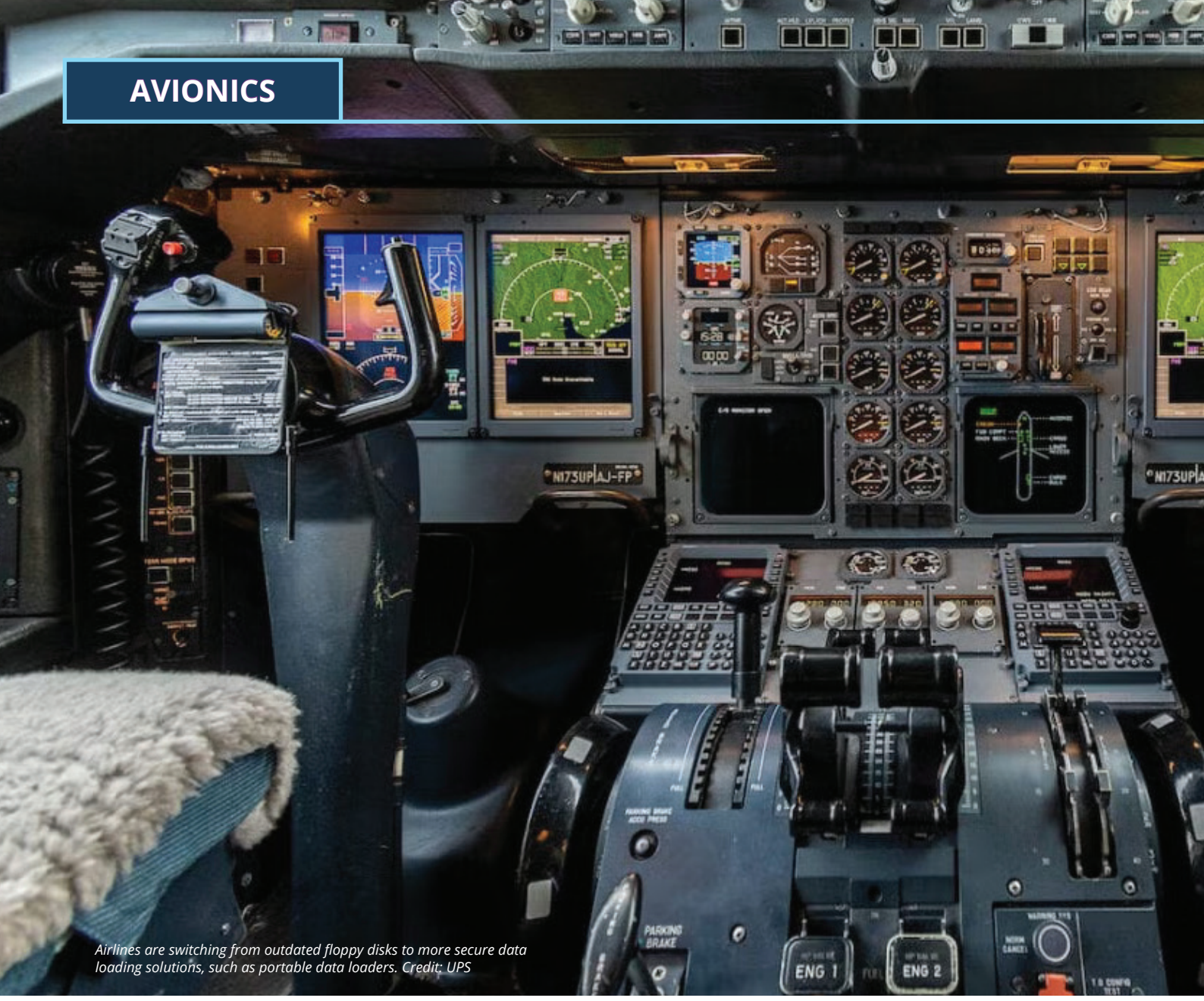
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Airlines are switching from outdated floppy disks to more secure data loading solutions, such as portable data loaders. Credit: UPS

Data Transfer Security

Maintaining software integrity and authenticity

The SAE succinctly defines the primary purpose of data load as to upload loadable software parts, such as navigation databases and operational programs, to airborne computers. A secondary function of data load is downloading data from airborne computers. This can be achieved by the use of an Airborne Data Loader (ADL) for installation on aircraft to perform onboard loading, or through a Portable Data Loader (PDL) for loading equipment on the ground or carried onto aircraft to perform onboard loading.

These PDLs support loading data from various sources, such as floppy disks, hard drives, USB devices, CDs, DVDs, and wired or wireless network locations.

PDLs, as Donald van Tongeren, a consultant with MBS Electronic Systems, explains, have been in use for a long time.

"Even aircraft such as the DC-10 had onboard components that were "updated" using PDLs, with software distributed via diskettes," he tells *Aerospace Innovations*. "Later, PDLs were introduced that connected via networks to servers hosting the software parts, eliminating the need for physical media. However, this introduced security risks—specifically, whether software parts could be altered during transmission over the network.

"At that point, several industry standards were developed and published. When followed, these ensure the integrity of Loadable Software Aircraft Parts (LSAPs).



The use of PDLs, in all their forms, is widespread. The so-called "dematerialisation" (i.e. the elimination of physical media), driven by improvements in operational efficiency, was a key factor behind this, now well established, trend, says van Tongeren.

According to the Civil Aviation Cybersecurity Subcommittee of Aerospace Industries Association of America (AIA), PDL manufacturers have played a major role in continuing to advance PDL technology to strengthen the security mechanisms implemented in the data loader devices.

"These advancements not only provide protection against tampering of the PDL and ADL devices but are also designed to protect software parts that are installed on-board and software at-rest," they write in a 2023 recommendation paper.

'Data at rest' is data currently in storage and contrasts with 'data in transit' — also called 'data in motion' — which is the state of data as it travels from one place to another. It also contrasts with 'data in use' — data loaded into memory and actively in use by a software program.

"ARINC 645-1 establishes security hardening requirements for PDLs and ADLs. It was updated throughout 2020 and issued in August 2021. In addition to making the loading devices more robust from a security standpoint, these devices are also aiming to a help make the verification of digital signatures on-board seamless to minimise and simplify additional steps operators and software loading personnel have to follow," AAI add.



The mini PDL-Pad from MBS Electronic Systems is compatible with any Airbus and Boeing aircraft. Credit: MBS Electronic Systems

The standard specifically developed for PDLs is ARINC 645, which introduced the commonly used term "ARINC 645-compliant PDL." The most recent evolution is the Airborne Data Loader (ADL), a device installed in the aircraft that performs tasks traditionally handled by PDLs. Both PDLs and ADLs must comply with increasingly stringent standards to ensure end-to-end security for LSAPs. The introduction of EASA Part-IS has recently brought significant attention to data loading security."

Part-IS establishes the regulatory framework, regulations enacted between 2022 and 2023, for the oversight and implementation of Information Security Management Systems (ISMS) for EASA-approved organisations.

As the UK CAA notes, Part-IS supports resilience to cyber threats, ensures continuity of aviation services, and aligns with the broader cybersecurity legal framework. As of 2025, authorities and service providers must demonstrate compliance through robust governance, threat identification, incident response, and oversight capabilities.

Digital sign-off

One security feature that provides integrity assurance and software authenticity to users is a digital signature. The AIA advocate for a signature being applied by the software delivery source and validated upon receiving software into a company.

ARINC 835 provides two options for applying a digital signature, following established methodologies already in use within the aviation industry. Secure data loaders are also expected to be capable of verifying ARINC 835 and ARINC 827 signed software parts.

For example, Teledyne's PMAT XS data loader checks digital signatures upon import and prior to load via ARINC 827 crates – used by its Loadstar Server Enterprise 3 (LSE 3) software module, to protect parts in transit and at rest – and ARINC 835 software part signatures. Launched in 2020, Full access to LSE 3 is entirely under airline control, and only encrypted communications from authenticated clients can gain access to it. The system also tracks the delivery and provides reports for all software parts



Only applications/bootloader approved by local security policy are allowed to run on Teledyne's PMAT XS data loader. Credit: Teledyne Controls

loaded on aircraft and helps collect and return aircraft downloads from the field.

The MBS Data Loading concept from MBS Electronic Systems is compliant with ARINC 827 and ATA Spec 42 for crate format and long-life digital signature, as well as ARINC 835. Developed from the security benchmark of the mini PDL-Pad, its Secure Maintenance Device (SMD) is a DO-335aED-204, ARINC 827, ATA Spec 42, ARINC 835 and ARINC 645-1 complaint data loader for browser-based data loading and OEM Windows App based data loading.

As the company explains, operators have used, and continue to use, Windows laptops and OEM's applications to load LRUs in a server client configuration.

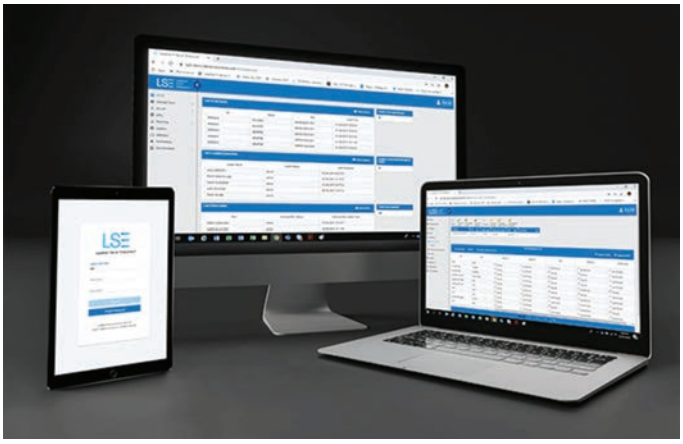
These types of devices are open, configurable by the user and have inherent security risks that require significant IT overhead to maintain patches and security updates.

However, with the issue of Boeing Instructions for Continued Airworthiness (ICA) Requirements and industry focus on data security such laptop use is unlikely to be compliant for much longer.

Joining up the COTS

"When referring to general-purpose or Windows-based devices, these may introduce certain challenges," says van Tongeren. "Such solutions are typically based on commercial off-the-shelf systems (COTS) hardware, requiring the airline to maintain and regularly update these devices. The hardware, operating system, and application must remain aligned, and in practice this combination can introduce integration and maintenance challenges, requiring ongoing attention and effort from the operator.

"From a security perspective, this also increases the complexity of maintaining compliance with standards such as ARINC 645 and related guidance, as the overall



Teledyne LS3 maximises regulatory compliance by providing automated load reporting and software part distribution. Credit: Teledyne Controls

system integrity depends on multiple independently managed components. An alternative approach (as applied in our solution) is to provide an integrated combination of purpose-built hardware and dedicated software (comparable to the Apple approach). This allows full control over the platform, ensuring that security mechanisms such as secure boot, certificate validation, and Public Key Infrastructure (PKI)-based processes remain consistently implemented and compliant.

"In this model, device maintenance, updates, and compliance with applicable regulations and standards (e.g. ARINC 645/667 and EASA Part-IS) are managed in a controlled and consistent manner. This significantly reduces operational burden for the airline, while ensuring end-to-end integrity, authenticity, and traceability of LSAPs. We consider this approach to be fully aligned with current security requirements and a significant improvement over both legacy and general-purpose solutions."

The company's mini PDL-Pad complements its SMD and supports ARINC 429, ARINC 615, and ARINC 615A. AFDX functionality is coming soon. Compatible with any

The New Era of Secure Dataloading



Meet today's OEM requirements and regulatory guidance for secure dataloading

Fully compliant with ARINC 645-1 security standards, Teledyne's new generation data loaders PMAT *XS* and eADL *XS* facilitate the distribution, onboard storage, and management of software parts and databases across an airline's operation. Built from the ground up with secure dataloading in mind, both loaders ensure the total integrity and authenticity of software parts during transfers, and protect against unauthorized access at every stage.

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AIT's PLS solutions include comprehensive security features such as the checking of software part digital signatures upon import and prior to load operations and encrypted storage of software parts. Credit: AIT

Airbus and Boeing aircraft, it has PKI functionality, supporting Boeing, Airbus and Carillon ARINC 835 signed software parts and Airbus ARINC 641 formatted media sets.

Towards the end of last year, Avionica and AIT (Avionics Interface Technologies) formed a strategic partnership to develop a fully integrated Secure Airborne Data Loader (ADL) ecosystem.

The agreement will see AIT's Secure ARINC 615 and 615A data loading capabilities, as well as its ARINC 645-1/2 and 835 compliant technologies, natively hosted on Avionica's aviONS airborne platform.

Additionally, Avionica's cloud-based digital distribution service, avSYNC, will enable airlines to remotely deploy loadable software parts (LSAPs) directly to the aircraft. The ecosystem will be further enhanced with the integration of AIT's Fleet Data Command Center (FDCC-SaaS), creating a closed-loop, end-to-end solution that supports both PDLs and airborne systems.

Speaking at the time of the announcement, which aims to give aircraft operators a scalable, secure, and COTS-ready pathway to digital aircraft modernisation, Edward Gorman, Vice President of Engineering at Avionica commented that, "By integrating AIT's secure data loader technologies into our aviONS platform and leveraging our avSYNC cloud architecture, we are giving operators a seamless, modern, and cybersecurity-focused pathway to manage loadable software across the entire aircraft lifecycle. Together, Avionica and AIT are raising the bar for efficiency, security, and digital enablement across the industry."

Troy Troshynski, General Manager of AIT, said customers would now be able to deploy loadable software parts more efficiently and more securely, leveraging its industry-leading cloud-based LSAP distribution system across all data loader form factors.

Moving to 645-1

As the AAI observe, ARINC 645-1 compliant PDLs and ADLs are becoming more readily available to the aviation industry. They write these loaders are designed to the security requirements specified in ARINC 645-1 which help deter tampering with the loading device, contain security-based logs which can be helpful in investigations and cyber forensics efforts, and have capability to validate ARINC 835 based digital signatures of the software parts to be stored in the PDL/ADL and loaded onto the aircraft LRUs. Transitioning from standard data loading solutions to ARINC 645-1 compliant secure data loaders provides additional safety measures in ensuring the correct and desired software part is loaded onto aircraft LRUs. Shop load tools and processes should also ensure that digitally signed parts are used for shop loading of LRUs. Generally, ARINC 645-1 loaders should also be used for shop loading.

At MBS Electronic Systems, van Tongeren says their system is designed to ensure the integrity, authenticity, and traceability of Loadable Software Aircraft Parts (LSAPs), in full compliance with ARINC 645/667, ATA Spec 42, Boeing ICA, and EASA Part-IS guidance material.

"It uses secure communication channels, PKI for validation, and encryption of LSAPs at rest. All our LSAP loading tools are implemented as secure boot platforms based on embedded Linux operating systems. Any unauthorised modification of the system image prevents the device from starting. The devices are fully locked down and restricted to their intended function—software loading operations. Local administrative access is not permitted. Assigned loading tools (e.g. the Mini PDL) initiate communication with FLS-Desk. When new software parts become available, the Mini PDL verifies the crate certificate. If invalid, the software is rejected and logged; if valid, it is stored in the local repository. When a software part is selected for loading, the certificate is verified again. If invalid, loading is prevented. These mechanisms have been independently evaluated and validated by Boeing and GE."

AIT PDLs data storage system leverage data-at-rest encryption to protect all Field Loadable Software (FLS) on the PDL as well as data retrieved from the aircraft.

AIT says that if an attacker were to open one of its PDLs and remove the storage to examine it with intent to maliciously tamper, the storage media would be unintelligible. The encryption keys are stored securely on the Trusted Platform Module embedded in the motherboard of the PDLs.

In addition to secure storage of PDLs, it is important to maintain traceability of usage (i.e. who uses the device and when) and to regularly analyse log files.

Weakest link

As van Tongeren observes, an often-overlooked risk factor is personnel, including employees and contractors.

They have direct access to safety-critical systems and may unintentionally or deliberately bypass technical controls, he says. "Training and clear procedures are essential to mitigate risks and ensure correct system usage. Awareness is a key objective of EASA Part-IS," he states.

He adds that in addition to employee awareness training, unsigned or legacy software should be treated as new software parts if these were to be reused. These should be thoroughly validated (e.g. via incoming goods inspection processes) before being introduced into the new secure system. The involved hardware is normally already under strict control, and any remaining software is deleted from the devices before leaving the controlled premisses of the airline.

According to the AAI, to ensure secure software loading devices are the only ones used for aircraft LRUs, it is important for all industry groups to decommission standard PDLs and ADLs once they have completed replacements with secure data loaders. This includes shop loaders. “Operators may wish to convert ADL airplanes to PDL connections if secure PDLs are more available or if this makes sense economically. Each aviation entity with ownership of ADLs and PDLs should incorporate a plan for decommissioning the standard loading devices. As part of the decommissioning process these entities should also include a data purging step that removes all stored software parts, LRU downloaded data, and any other potential data of proprietary nature,” they write.

It is important to ensure software remains protected from its origin to the final step of being loaded onto an LRU or Integrated Modular Avionics (IMA).

MBS Electronic Systems actively participate in industry committees involved in the development of standards and regulatory changes.

“For example, our PDL is already aligned with the upcoming ARINC 645-2 standard,” says van Tongeren says. “Another important topic is the evolution of PKI. SHA-2 (or higher) is currently the recommended standard within the industry and under ATA Spec 42. While there is no immediate indication that SHA-256 is at risk, the potential need to transition to new cryptographic approaches—including post-quantum cryptography—is being actively considered across the industry. We are closely monitoring these developments and preparing accordingly,” he remarks.

A stark warning comes from Dmitrijs Terentjevs, a hardware/software engineer at DTech SIA. “In my experience 95% of operators or users who deal with data loading and PDLs, do not understand threats and risks and have no idea how to avoid them. This starts from airlines (especially smaller ones) and ends [with the] PDL operator. Existing security measures will not work until all elements of chain understand [the] whole process.”

By Alex Preston



The Future of Remote Pilot Training: An Aerospace Innovations Roundtable





Remote learning using XR (Extended Reality, a mix of Augmented Reality and Virtual Reality) headsets and related equipment is the Next Big Thing for pilot training. Thanks to their ability to combine 3D computer graphics with haptic feedback—which allows a pilot wearing a headset to physically "feel" the click and resistance of the knobs and switches in their simulated cockpit—XR training units are the perfect solution for teaching students in any remote location. Add in the highly portable, locally processed XR simulators that can be sent to these sites, and remote pilot training is an effective, affordable way to get more student pilots prepared for their first flights.

For this Aerospace Innovations virtual roundtable discussion, we brought together three experts in remote pilot training to discuss its opportunities and challenges. Col (Ret) Tim "TJ" Moser is a retired US Air Force Colonel and Account Executive at Varjo Technologies, which supplies high-fidelity, deployable VR/XR headsets. Fabi Riesen is the Founder and acting CTO of Loft Dynamics, which builds highly realistic VR flight simulators. Nacho Navacerrada is the Sales Director at Entrol, which produces XR-certified professional flight simulators.

Aerospace Innovations: How do VR, AR, and MR systems support remote pilot training today, including yours?

Nacho Navacerrada: XR technologies, such as VR and MR, help expand the capabilities of traditional simulators and are particularly useful for visual mission training. In our case, we use mixed reality (MR) goggles to complement the simulator's visual system. This allows pilots to look downwards or backwards and better perceive distances to the ground, which is especially important during operations where having a vertical reference is critical, such as hoist rescues, external load operations, or search and rescue (SAR) missions.

These technologies are also used to incorporate other crew members in the same synthetic training environment as pilots, for example, hoist operators, rescue swimmers, or medical personnel. This makes it possible to recreate complex scenarios in which the entire crew can train together, improving coordination, communication, and decision-making during critical missions.

Fabi Riesen: Let's split this into two parts. First, there are traditional dome simulators—the gigantic, full-flight simulators that definitely cannot be used at home. They use a traditional projected visual system, so if you move your head, the perspective doesn't shift; it is just a flat projection.

We replaced that with virtual reality. To do this, we had to make a massive technological leap to make the human body visible in VR, allowing pilots to operate physical buttons and switches with tactile feedback. To achieve this, we built all of the software in-house.

This led us to a realisation: if we can use VR to make gigantic simulators smaller and more realistic, we can also put them on stand-alone devices, like an Apple Vision Pro or similar VR headsets. We can run our software on these stand-alone devices. You get the exact same software experience as a real simulator, just without the physical tactile feedback; instead, you use your hands and gestures to interact with the virtual cockpit.

That is how we achieved full immersion. We started by making large simulators smaller, and then we transferred the software to a small device you can use anywhere. This is how we enabled VR systems to support remote pilot training, which was simply not possible before.

TJ Moser: As a retired USAF fighter and training aircraft instructor, I personally witnessed the evolution of flight training from traditional domes to deployable and remote systems. My tenure at 19AF (2019-2022) coincided with the COVID pandemic, during which we successfully demonstrated the feasibility of delivering world-class training remotely to students without the need for the instructor's physical presence. This was achieved through the utilisation of networked connections and Extended Reality (XR), enabling us to preserve training days while many of the education and training sectors were largely shut down. This feat would have been impossible in traditional domes.

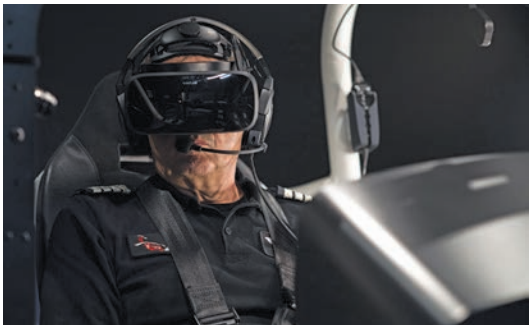
Varjo XR-4 headsets integrated into training devices accomplish this without compromising the resolution and precision required for training. Students can wear these headsets and retain the tactile feel of switches, knobs, and buttons while viewing a high-fidelity cockpit with legible dials, screens, and Heads-Up Displays (HUDs). The Out the Window (OTW) experience is remarkably realistic, providing human-eye clarity for long-range visual scans and formation flying, which are traditionally challenging in a domed simulator.

During and after the COVID pandemic, XR systems like Varjo









headsets enabled Remote Simulation Instruction (RSI). This allowed students to be located in remote locations, where instructors may or may not be physically present. The compact and portable nature of the simulator enables it to be positioned closer to the point of need. In remote areas like Del Rio, Texas, the Air Force faces challenges in hiring Civilian Simulator Instructors due to its remote location. However, XR simulators were connected to instructors stationed at Randolph AFB (a much larger and more desirable location outside San Antonio, TX), providing a solution that increased instructor capacity without relocating instructors.

Aerospace Innovations: How do your XR simulators handle poor internet connections, latency, or complete off-grid situations in remote locations?

Nacho Navacerrada: Our simulators do not rely on a constant internet connection to operate. All critical systems of the simulator, such as the software, visual databases, and training scenarios, are installed locally on the device itself.

This means that training can be carried out even in environments where connectivity is limited or non-existent. In many cases, operators prefer to keep the simulator disconnected from the internet during training sessions.

In terms of latency, our simulators meet all the necessary requirements to ensure a realistic training experience, with virtually non-existent latency during the simulation. The internet connection is typically only used for specific tasks such as software updates or remote maintenance connections, but it is not required for the normal operation of the simulator.

TJ Moser: Flight simulation is computationally demanding, so the "heavy lifting" is performed locally on the workstation connected to a Varjo XR-4 Series headset to deliver the best visuals. XR simulators operate on local PC power, utilising the best-in-class GPUs, ensuring that the flight physics and visuals are not reliant on a cloud connection.

For remote instruction, devices only need to transmit thin streams of telemetry and voice data to maintain concepts like RSI at a lower bandwidth. Furthermore, when the system is offline, it functions as a stand-alone trainer, enabling pilots to maintain their proficiency and "muscle memory" even without an active link to an HQ or even without an instructor in "free play".

Fabi Riesen: This relates to what I explained earlier. We do not stream the entire simulation from the cloud to these stand-alone devices.



Nacho Navacerrada,
Sales Director at Entrol Simulators



Col (Ret) Tim "TJ" Moser,
Account Executive at Varjo Technologies



Because we built all the software in-house, it can run directly on small devices, whether that is a mobile phone or an Apple Vision Pro.

This means the most critical elements, like button responses, run locally on the VR headset itself. As a result, we only need to rely on the cloud for a few minor things, while the heavy graphics processing is handled directly by the VR device. By setting it up this way, everything that is sensitive to lag or latency runs locally. That is how we made it work.

Aerospace Innovations: How easy is it to pack up, transport, and physically set up your simulators in the field compared to traditional, bulky training rigs?

Nacho Navacerrada: We are used to working with customers all over the world, so logistics and installation are a regular part of our projects. The simulators are usually transported in containers, and we work with international logistics companies that handle the delivery of the equipment to the customers' facilities. Once the simulator arrives, our team travels to the site to carry out the installation, commissioning, and certification of the device.

This approach allows operators in different regions to have their own simulator tailored to their aircraft and operational requirements, without relying on external training centres. In addition, having the simulator installed at their own facilities makes it easier to conduct more training sessions and improve pilot availability.

TJ Moser: A traditional "legacy" simulator requires a dedicated building, HVAC system, and a team of contractors, and the footprint can be up to 80% larger. Conversely, XR systems can be set up in a typical office setting.

Initially, at 19AF, we planned to send an XR training rig home with every student. In practice, this concept proved impractical due to costs and liability, but it guided our thinking about the potential uses of immersive training devices (ITDs). Although we could not send the student home with the device, our compromise was to bring the training closer to the student. Consequently, we embedded over 60 ITDs at each Undergraduate Pilot Training (UPT) base, typically within the flying squadron itself.

In some instances, a VR rig (headset, laptop, and controls) could fit into one or two ruggedised Pelican cases. We named these devices portable Immersive Training Devices (pITDs). For classified environments, the secure version of Varjo XR-4 Series headsets is TAA-compliant and can be configured with no radio frequency (RF) components, making it safe for use in the "skin" of a ship or other high-security, air-gapped zones (Secure Compartmented Information Facilities, or SCIFs). Security does not have to be compromised for portability.

Aerospace Innovations: Can remote pilots officially log flight training hours using XR training systems, and how are aviation regulators responding to this tech?

Nacho Navacerrada: The current CS-FSTD Issue 2 does not cover the use of technologies such as virtual reality (VR) or mixed reality (MR) in pilot training. XR certifications are done via Special Conditions. EASA published a document entitled "FSTD Special Conditions development and assessment process" in March 2023 to clarify the roadmap to achieve XR certification, after some devices were previously certified as FTD 3 by EASA.

In general, regulatory authorities are open to discussing the potential of these new technologies. However, there is still some caution when it comes to applying them within the Part-FCL, as the potential and limitations of XR technologies greatly depend on the training tasks, helicopter model, and whether they are single or multi-pilot operations.

Fabi Riesen: That process will take a while. Whenever you want to officially qualify something new, you first need to get the technology in place.

For example, when we transitioned from gigantic traditional simulators to ones using stereoscopic virtual reality, we achieved the world's first qualification back in 2021. We started







working with EASA at the end of 2018, so it took about three years to get that first qualification done. It took another two and a half years to get it adopted by the FAA. Now, that is a done deal.

We are taking the same approach with these remote training devices. First, we get them in place and into the hands of pilots, operators, and airlines. By having people use them first, we can collect data and validate that the devices actually produce good training results. Then, in the second phase—which hasn't happened yet for remote devices—we take it to the regulators for official qualification. In a nutshell, while it isn't a traditionally qualified flight simulator (an FSTD) yet, it can already be used to complement training and be embedded into an existing syllabus.

Remember, not all flight training is done in top-tier Level D simulators; you have classroom portions and other parts of the syllabus that use unqualified devices. Not every single training hour needs to be officially logged and credited in a logbook.

TJ Moser: In the civilian sector, regulators are shifting towards Competency-Based Training and Assessment (CBTA) over pure flight-hour accumulation. If a pilot can demonstrate a check-ride-quality manoeuvre in a qualified XR simulator, that proficiency is increasingly recognised by authorities.

Varjo works together with global regulators (FAA/EASA) and industry integrators to qualify XR-based systems for FAA Part 60 Level 4–7 Flight Training Device (FTD) equivalency, as well as Basic and Advanced Aviation Training Device (BATD/AATD) certifications. Under EASA, our technology enables FTD Level 2/3 and Flight Navigation and Procedures Trainer (FNPT) qualifications, bringing professional-grade training to the point of need.

Aerospace Innovations: What is the real cost difference between deploying an XR setup to a remote base versus flying pilots back and forth to a central training hub?

Fabi Riesen: On one hand, we have what you could call "home training kits" that you can use anywhere. You could even have a dedicated unit for each individual pilot. Because the training is remote, pilots do not have to travel to a classroom, which means travel expenses are completely eliminated.

On the other hand, we have our full simulators. Because they are powered by virtual reality, they are much smaller, more realistic, and more affordable than traditional setups. This creates far more opportunities for training.

Nacho Navacerrada: Training with simulators has a significant impact on the operational costs of pilot training. Sending pilots to external simulation training centres can involve travel costs, limited simulator availability, and long waiting lists. For this reason, many operators choose to have their own simulator, which allows them to conduct more training hours and improve operational safety. Having an in-house simulator, such as an FTD installed at the operator's facilities, makes it possible to replicate the real aircraft configuration more accurately. This not only reduces logistical costs but also improves the overall quality of the training.

TJ Moser: The return on investment (ROI) for travel and flight hour costs is significant. Traditional sims with large footprints and high operating costs can be significantly more expensive than XR flight simulators.

A single flight hour in a modern fighter jet can cost between $20,000 and $40,000 or more. A complete XR setup costs less than a single flight hour in many airframes. By offloading 20–30% of the syllabus events to XR, the savings can reach into the millions of dollars annually.

Aerospace Innovations: Finally, what forms of pilot training still have to be done in-person and in the air? And will that ever change?

TJ Moser: The "Last Mile" training still requires being in the air or on the ground. High-G manoeuvres and the "fear factor" of actual flight or driving cannot be fully replicated in a chair. The specific smells, vibrations, and "seat of the pants" feel of a stall are best taught in-cockpit or the equivalent for vehicles and tanks. As technology advances, this gap will narrow, but for the foreseeable future, the final "stamp of approval" will be obtained in the air or on the ground in the aircraft or vehicle. Additionally, it's crucial to get reps and sets on an easily accessible platform.

Nacho Navacerrada: Simulation has evolved significantly in recent years and today it allows pilots to train a wide range of procedures and operational scenarios with a very high level of realism. Thanks to simulators, pilots can practise emergencies, complex scenarios, or specific mission profiles as many times as needed and in a completely safe environment.

That said, the experience of flying a real aircraft remains a fundamental part of the training process. During the early stages of training, pilots need to become familiar with the real behaviour of the aircraft and develop sensations and references that can

only be acquired in actual flight.

For this reason, the industry understands simulation as a complement to real aircraft training. Simulators allow pilots to practise procedures, cockpit management, crew coordination, and emergency situations in a safe and efficient way, while real flight provides the practical experience needed to consolidate those skills.

Looking ahead, simulation will likely continue to gain importance as technologies such as visual systems and immersive environments continue to improve. However, the most realistic scenario is that pilot training will continue to combine both worlds: simulator-based training and real flight experience.

Fabi Riesen: That is a very good question. It could almost become philosophical, but I don't want to go down that path.

Speaking as a hobby pilot myself, we can make a simulator increasingly realistic, but ultimately, it is always good to have real, hands-on experience. You don't necessarily need it in every single aircraft type, but you need to experience the basics in a real aircraft to truly understand them.

Let me be more specific: for private or commercial pilot licences, certain hours still must be completed in a real aircraft. There are so many minute details that we simply won't be able to perfectly simulate for decades to come.

So, to your question about whether real flight time can be totally removed: I think not, and that is a good thing, because at the end of the day, we are still flying real aircraft. Nevertheless, the gap between the simulator and the real aircraft is getting smaller and smaller. They are blending together so well, and the immersion provided by these new technologies is becoming so deep, that it will soon be very difficult to tell the difference. That is the goal we are working towards—pushing the simulation to be as close to the real aircraft as physically possible.

By James Careless

PACE's Take on Remote Pilot Testing

PACE is a part of the TXT Group. WEAVR is PACE's Extended Reality (XR) training platform. It allows training organizations to quickly and easily produce, deploy, and manage engaging XR experiences, with no coding skills required.

"WEAVR is a platform consisting of three primary product modules—WEAVR Creator, WEAVR Player, and WEAVR Manager—which together form a complete solution for industrial-scale extended reality," said Fabrizio Sillano, Head of Training Solutions XR & AI at PACE GmbH. "The WEAVR platform supports remote training, enabling instructors to assign content to users, groups, and classrooms, as well as monitor student performance. The WEAVR Manager provides instructors with various dashboards offering different levels of data granularity. Instructors can monitor sessions live or via recorded videos. The platform can be used in the cloud or on-premises."

Mindful that some remote training locations face poor internet connections, latency, and even complete off-grid situations, PACE's WEAVR platform can be deployed on-premises using an internal LAN. "If an internal LAN is also unavailable, content can be deployed directly to the headset via the WEAVR Player," Silano said. "An internet connection is not necessary during runtime. All tracking data for students is recorded locally and can be synchronised later if necessary."

PACE offers a range of simulators in various sizes. "The setup depends on the type of training the customer requires," said Silano. "We can achieve maximum portability with a fully VR experience running on a single headset and HOTAS [Hands On Throttle-And-Stick] setup, or a complex simulator linked to external simulator frameworks and an image generator, which requires an on-premises setup. All tracking data can be recorded on the headset. If an internet connection is available after the sessions, the data can be synchronised with our WEAVR Manager. If an internet connection is unavailable, instructors can display an in-app scoring system and dashboard."

As for serving new forms of aviation training in the same way? "Thanks to our 30 years' experience in the training and simulation sector, we can apply the same concept to drones and eVTOLs, and our technology is fully agnostic," Silano replied. "We also cover other areas of aviation training. For example, we are working on a major project with Lufthansa Aviation Training on cabin crew training. We also provide training content for airports, such as airside training and de-icing simulators."







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Check Ride

Air data testing is a vital maintenance task to ensure that pilots are presented with accurate speed and altitude information. Aerospace Innovations spoke to a pair of leading specialists in the field



An aircraft's pitot static system combines a forward facing pitot tube and a static port. The pitot tube measures the dynamic pressure of the air entering it, or the difference between the ambient air pressure and the force of the air caused by the aircraft's forward movement. The greater the force, the greater the airspeed. The static port measures the ambient air pressure and so is located out of the airflow. As pressure decreases with altitude, the system can determine altitude and the rate of climb or descent. A pitot static tube combines both functions.

The system is relatively simple and very effective, so there has been little change over the years. The most significant development happened between between 1997 and 2005, with introduction of Reduced Vertical Separation Minima (RVSM). This was intended to increase upper airspace capacity between FL290-410 by allowing aircraft to fly 1,000ft above or below each other, a halving of the previous requirements,, However, it was mandatory to have two independent altitude measurement systems; an altitude alerting system; an automatic altitude control system; and a transponder with altitude reporting system that connected to the altitude measurement systems.

ATEQ

ATEQ Aviation is one of the four divisions of the ATEQ Group (which celebrated its 50th anniversary in 2025), says Sandra Kadded, Marketing & Communication Manager - Aviation division. The main markets served are OEMs and MROs, airlines, business aviation FBOs and military and defence. She adds that general aviation is another key market, especially in the USA, where demand is high. The Aviation division of the ATEQ Group is constantly rethinking and evolving its offering to meet market expectations. This resulted in the acquisition of Cobra Systems based in the USA in 2018. The integration of this brand has enabled it to expand the ADTS offering. It now has a wide range of pitot adapters and kits compatible with more than 400 types of commercial, civil and military aircraft and helicopters. She notes that, given the current global situation, an increase in demand from the military market is more than likely.

The company has a worldwide sales team, as well as a global after-sales service network that is constantly adapting to developing markets and customer demand for proximity and responsiveness. To further expand access to customers, the company has added distribution partners to its sales strategy in certain markets, such as general aviation in the United States. Distribution partners also support sales teams around the world in getting referenced in Aircraft Maintenance Manuals (AMMs).

Technical Development and innovation is led by a team based in France. New developments often start with customers coming to ATEQ looking for an expert and reliable partner to help them with a specific application, which, by building on that experience with customers and partners enables continuous improvement.

The company launched a secured service cloud platform a year ago, initially with two products (battery testers), but the intention is to add more over time. This platform allows centralised fleet management, enhanced traceability and compliance as well as integrated support and service documentations. This is the case for customers who are increasingly considering the digitalisation of processes and have to keep up with the work. The test results are recorded and stored in the cloud for further analysis. Customers also have access to technical and calibration certificates.



ATEQ provides test sets for over 400 types of aircraft and helicopters, from commercial widebodies (left), through military and business jets, to general aviation (above). Credit: ATEQ

In March, ATEQ Aviation acquired the T-RX avionics test solution from CCX Technologies. to expand its avionics offering. The combination of ADTS and T-RX allows maintenance organisations to more efficiently perform comprehensive tests for compliance with 14 CFR 91.411 and 91.413 standards for aircraft certification and continuity of airworthiness.

Druck

Chris Roberts, Test & Calibration Product Leader at Druck, says the company is the market leader for military multi-channel ADTS systems, particularly in the US. The commercial product uses similar technology and is used for widebodies and narrowbodies, with single channel units for business jets, helicopters, trainers and light aircraft. The product was part of Baker Hughes' Precision Sensors & Instrumentation (PSI) line until it was sold to Crane Company in June 2025.

He notes that technology requirements are generally driven by manufacturers, and, being risk averse, they have a tendency to stick to tried and tested methods. However, Jonny MacGregor, VP Technology, points out that the company's TERPS (Trench Etched Resonant Pressure Sensor) technology, which uses a resonating silicon MEMS (Micro Electro Mechanical Systems) pressure sensor technology is 10 times more accurate and stable than traditional pressure measurement technologies. Indeed, Roberts says it can calculate a person's height based on the change in air density from their head to their feet.

This is the general approach, to add value to the product to reduce operational times for customers. An example is to combine several test routines onto one test card. Last year, it teamed with VIAVI to combine ADS-B, transponder and pitot static testing in a single solution. The units have also become smaller and more portable.

Another example is the addition of Bluetooth. The test set generally sits on the apron next to the aircraft, connected to the pitot static system by hoses and adaptors. The technician will then go into the cockpit to carry out the procedures,



The ADTS 405 has proven itself in harsh military environments, including aircraft carriers, where huge air defence radars could cause interference. Credit: Druck/US Navy



Chris Roberts, Test & Calibration Product Leader. Credit: Druck



Jonny MacGregor Druck Technology Leader. Credit: Druck

which means cables from the test set running in through the cockpit window or up the stairs. By getting rid of the cables, the time is reduced. Having said that, the company had to overcome some challenges, since the fuselage acts like a Faraday cage, blocking external electric fields and electromagnetic radiation. However, he says clever design in various aspects of the product means that the industrial Bluetooth system that is used is more stable and reliable than wifi systems used by some competitors.

The wide range of customers means the company can learn from operational experience – with the military, robustness is top of the list – and transfer it back into product design. Part of this requirement is because of forward deployments. Commercial operations are generally hangar-based, but units can be deployed in the field in widely different climatic conditions. Another challenge that was overcome was deployment on aircraft carriers, where huge air defence radars were a source of interference.

MacGregor says a significant advantage for Druck is that it is first and foremost a sensor manufacturer, so products are designed for a specific application, rather than taking an existing sensor and trying to adapt it to meet the requirements. A good example is the PACE Tallis Transfer Standard Calibrator, that was introduced last year, with an accuracy four times that of ADTS.

He explains that calibration usually requires a dead weight, a piston gauge or a laboratory instrument. These are notoriously difficult to set up properly, requiring training and some knowledge to ensure success. That is clearly not practical in the field, nor is shipping units back for calibration, whereas PACE Tallis weighs just a few kilos, making it simple to deploy.

By Ian Harbison



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Mobility Matters

A mobile-first design approach to MRO can unlock benefits both quantifiable and intangible.

The aircraft hangar can be a juxtaposition of technologies – where the last generation of aircraft are serviced by maintenance engineers and technicians using physical manuals, endless paper task cards.

A significant proportion of line maintenance operations still rely on paper-based processes or partial digitisation, with engineers completing work on paper and re-entering it into systems later," says Scott Wells, Managing Director at MRO Professional Consulting.

These conventional methods often introduced inefficiencies such as paper-intensive workflows, information silos on the floor, reactive troubleshooting, and training and knowledge transfer limitations.

But in an industry notoriously slow in adopting new technology, things are changing.

"We are seeing a clear shift toward tablet-based workflows, particularly in organisations looking to improve efficiency, compliance, and commercial control. Across our own customer base, mobile device usage is becoming standard rather than exceptional, particularly for line maintenance activities.

"The direction of travel is very clear — smart devices are becoming the primary interface for engineers," he asserts.

A mobile-first design approach to MRO means designing the maintenance workflow around the engineer at the point of task. The objective is that an engineer can stand at the aircraft, in the hangar, or at the component, with a tablet in hand, and complete the work, capture the evidence, and progress the record there and then.



Mobile-led apps make it easy to manage processes and reduce heavy expenses associated with paper trail audits. Credit: British Airways

As Wells explains, in MRO, mobile-first is not simply a desktop system reduced to fit a smaller screen. "Engineers, planners, compliance teams and finance users all work in very different ways. In practice, the most effective approach is a dedicated engineer-facing mobile application connected to a wider desktop/web platform for planning, compliance, stores, commercial and management workflows. Both sit on the same live data model, but they are designed for different environments.

"The key components are intuitive task-led workflows, point-of-use access to data, structured capture of work completed, integrated photo/document capture, digital signatures where approved, and real-time synchronisation into the wider MRO operation. The real value is that data is captured live at source, where it is most accurate, rather than reconstructed later from memory or paper notes," he remarks.

Helping hands

Mobile-led MRO is best suited to any activity that takes place at the point of maintenance. This includes:

- line maintenance work order completion.
- defect (NRC) capture and reporting.
- digital task cards and check completion.
- parts, tools and consumables tracking.
- photo and document capture.
- AOG reporting and communication.
- mobile stores transactions (receipt, issue, dispatch).
- time booking and job clocking.
- digital signatures and record sign-off.

Wells adds that alongside this, it is important that mobile solutions are complemented by access to technical data platforms such as OEM

The aviation industry has long been defined by precision, discipline—and paper. For decades, clipboards, handwritten logbooks, and stacks of maintenance records were as essential to flight operations as the aircraft themselves. That reality is rapidly changing. As airlines and maintenance, repair, and overhaul (MRO) providers face increasing pressure to improve efficiency, ensure compliance, and operate in real time, the shift to paperless technology has become not just inevitable, but essential. At the forefront of this transformation is ULTRAMAIN.

What distinguishes ULTRAMAIN is not simply its ability to digitize paper, but it's understanding that true transformation requires rethinking how work gets done. Across airline operations and third-party MRO environments—whether airframe heavy checks, engine overhauls, or complex component repair—paper-based processes have historically created delays, inefficiencies, and gaps in visibility. ULTRAMAIN addresses these challenges by embedding digital workflows directly into the operational fabric.

At the center of this approach are solutions like ULTRAMAIN's Electronic Logbook (ELB) and Mobile Mechanic. The ELB replaces traditional paper logbooks in the cockpit, enabling pilots to capture defects, delays, and operational data digitally and in real time. That information flows instantly to maintenance teams, eliminating manual handoffs and ensuring that issues identified in flight are immediately actionable upon arrival.

For maintenance organizations—both airline line maintenance and base maintenance, and third-party MRO providers—Mobile Mechanic extends paperless capability to the hangar floor and shop environment. Technicians can access work packages, task cards, and engineering instructions directly on mobile devices, record work performed, and complete sign-offs at the point of execution. In heavy maintenance and overhaul settings, where documentation volumes are significant and processes are highly controlled, this eliminates redundant data entry, reduces turnaround times, and improves overall workflow efficiency.

The impact is tangible across the entire maintenance ecosystem. Airframe overhaul teams gain real-time visibility into task progression. Engine and component shops benefit from more accurate tracking of disassembly, inspection, and reassembly steps. Airlines experience faster aircraft returns to service, supported by tighter coordination between flight operations and maintenance. In every case, the shift from paper to digital creates a continuous, connected flow of information.

Equally critical is the role of digital systems in compliance and traceability. Aviation remains one of the most highly regulated industries, particularly within MRO environments where detailed records are essential. ULTRAMAIN's MRO solutions provide structured, time-stamped, and fully traceable data that supports regulatory requirements while simplifying audits. For overhaul providers managing complex assemblies and life-limited components, this level of control and visibility is essential.

Adoption, however, depends on more than functionality. ULTRAMAIN places strong emphasis on usability, ensuring that its applications are intuitive for pilots, technicians, and inspectors working in demanding, time-sensitive environments. This focus accelerates implementation and drives consistent usage across both airline and MRO operations.

Looking ahead, paperless technology is only the starting point. By capturing high-quality, real-time data across line maintenance, heavy maintenance, and overhaul activities, ULTRAMAIN enables organizations to move toward more predictive, data-driven operations—improving planning, optimizing capacity, and enhancing long-term asset performance.

In an industry where efficiency, safety, and reliability are paramount, ULTRAMAIN is not just supporting the transition to paperless—it is helping define the future of connected aviation operations across airlines and the global MRO community.



With a mobile device, engineers and technicians can react much more quickly to maintenance issues. Credit: Lufthansa Technik

documentation systems (e.g. Airbus and Boeing portals), so engineers have both execution capability and reference material available in the same environment.

Implementing a mobile-first approach to MRO empowers maintenance engineers and technicians with intelligent tools and connected information, creating an environment where maintenance is more proactive, precise, and integrated,

The primary benefit of such an approach can be distilled down as data accuracy at source. "When engineers complete records after the fact, there is always a degree of loss — missing items, incomplete detail, or incorrect transcription," says Wells.

"From a quantifiable perspective, we consistently see revenue leakage in traditional processes due to delayed or incomplete data capture. In our own implementation experience, this is often in the region of 5–15% of potential revenue, with some organisations significantly higher prior to digitisation. This is typically linked to missed chargeable items, incomplete records, and delays in invoicing," he states.

Mobile-first workflows remove that latency. Data is captured once, at the point of maintenance, and flows directly into reporting and invoicing. This improves revenue capture and cash flow, speed of invoicing, auditability and compliance and customer confidence in reporting quality.

Beyond the financials, there are strong qualitative benefits — improved engineer experience, reduced administrative burden, better traceability, and a more transparent operation overall.

Better by design

According to product designer, Amira Elbana, modern MRO apps should be designed with mobile devices in mind, offering responsive interfaces that adapt seamlessly to different screen sizes. Technicians need to access information and complete tasks on the go, whether they're in the hangar or on the flight line.

She says navigation needs to be intuitive. "Say goodbye to endless menus and cryptic commands. A well-designed app features clear, logical navigation, allowing technicians to quickly find the information they need, when they need it. Think clear visual cues, intuitive icons, and a streamlined information architecture."

MRO-PRO is a cloud-based, mobile-first MRO platform designed specifically around the engineer workflow.

At the core is a dedicated iOS and Android application used by engineers to capture and complete maintenance activity live at the aircraft or component. This includes line maintenance work orders completed in real time at the aircraft, digital record capture using device cameras, tracking of man-hours, parts, tools, services and equipment, defect and aircraft on ground (AOG) reporting, digital "sign-on-glass" capability, and automatic generation and distribution of maintenance reports to customers.

Wells explains that this mobile layer is fully integrated with a broader web-based platform that manages tasks including planning and resource forecasting, compliance, competency and recency monitoring, procurement, stock and logistics, workshop and base maintenance operations, invoicing and financial reporting.

"The system is designed so that engineers capture data once, at source,



and that data then flows through the entire organisation — from compliance to finance — without re-entry," he says.

With solutions like Ultramain Mobile Mechanic, traditionally paper-based maintenance execution can be performed and captured 100% digitally at the point of work.

At a high level, Ultramain Mobile Mechanic is designed to digitise maintenance execution without forcing organisations to redesign their entire operation, says John Stone, Vice President of Product Management at Ultramain Systems

"For many MROs, the starting point is still paper or PDF-based work packages, and one of the key strengths of the solution is the ability to import and execute those packages fully digitally with regulatory confidence. Ultramain provides tools to rapidly ingest, structure, and package this content, eliminating days of manual preparation and enabling maintenance teams to move from paper to paperless without radically changing existing planning or engineering processes.

"On the hangar floor, Mobile Mechanic acts as a single, centralised workspace for technicians and inspectors. It goes well beyond task card execution to support the full scope of maintenance activity—digital stamps and signatures, parts requests and changes, non-routine creation, shift handovers, time capture, and even training-related workflows. By consolidating these activities into one mobile experience, the solution reduces fragmentation, improves real-time visibility, and ensures that all maintenance actions are captured digitally. The result is a fully paperless execution ecosystem that supports compliance, improves efficiency, and produces high-quality data without adding complexity for frontline teams," says Stone.

For Elbana navigation needs to be intuitive. "Say goodbye to endless menus and cryptic commands. A well-designed app features clear, logical navigation, allowing technicians to quickly find the information they need, when they need it. Think clear visual cues, intuitive icons, and a streamlined information architecture."

OASES Lumina is OASES' brand-new



Mobile devices, such as smartphones and tablets help technicians managing the MRO complexity of modern passenger aircraft. Credit: Ultramain Systems

maintenance and engineering platform. With fully web-native access, users can securely access the full platform from any browser, on any device. Whether it's a desktop in the office or a tablet on the hangar floor, teams have the same responsive interface.

According to the company, every screen, list, and icon has been reimagined, prioritising speed, clarity, and ease of use. The app has also been rebuilt to offers native device capabilities, including offline access. With offline access, the new app ensures technicians can keep working without interruption. Once reconnected, updates synchronise automatically.



MRO-PROs app, available on iOS & Android, frees engineers and stores staff from a desk allowing data to be collected and transmitted in real time live at the aircraft/task. Credit: MRO-PRO

Maintaining compliance

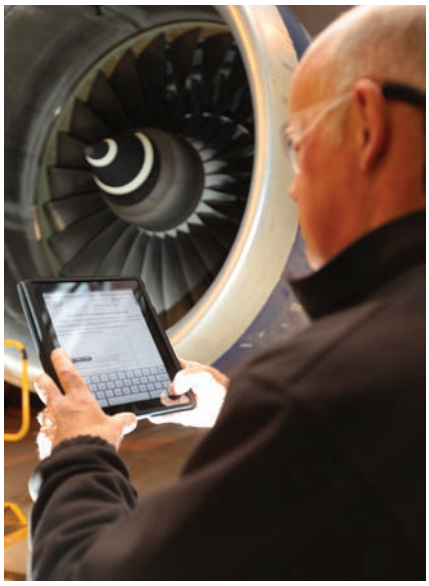
In a recent whitepaper, Impresa noted that many aviation MRO providers continue to rely on outdated compliance processes. "Manual recordkeeping with paper logs or spreadsheets is error-prone and time-intensive, creating risks of missing data, transcription errors, and delays in updating critical records," they wrote.

As they remarked, the move from manual compliance to digital MRO solutions is no longer optional—it's essential. Modern aircraft MRO software platforms enable providers to maintain accurate, real-time records across every component, tool, and process, eliminating inefficiencies and embedding compliance directly into MRO workflows.

From an operational perspective, the MRO-PRO platform includes a full compliance framework covering user competency, recency, authorisations, procedures, audit management and safety reporting. This ensures that mobile workflows remain fully aligned with regulatory requirements.

From a data protection and hosting perspective, our approach aligns with recognised security standards, including ISO-aligned policies and Cyber Essentials Plus certification. Data is securely hosted in controlled cloud environments, with appropriate access control, encryption and monitoring in place.

Stone says that cyber security and data protection are foundational to how ULTRAMAIN designs and delivers its solutions, particularly in highly regulated aviation environments.



British Airways engineers have a mobile-led MRO strategy, adopting MRO-PRO's cloud-based platform to maintain aircraft. Credit: British Airways

"Ultramain Systems is certified to ISO 27001 and AS9100, which means our information security and quality management systems are independently audited and aligned with internationally recognised standards. ISO 27001, in particular, focuses on establishing a systematic framework for managing information security risk-covering policies, controls, monitoring, and continuous improvement-so data is protected throughout its lifecycle.

"Beyond certification, security is reinforced through ongoing internal and external penetration testing, as well as AI-assisted code reviews that help ensure secure development practices are consistently applied. Within the software itself, Ultramain supports role-based access controls, digital authentication, and built-in multi-factor authentication, with the ability to integrate seamlessly with corporate or cloud-based identity management systems. From a data protection standpoint, all data is encrypted both in transit and at rest. Together, these measures ensure that maintenance data remains secure, traceable, and compliant—while still being accessible to the right people at the point of work."

Device management is a critical component of any mobile-first strategy.

Best practice typically includes centralised device management (MDM), particularly for larger organisations, standardised device configurations across the business, remote wipe and reset capability, restricted application environments to control usage, secure authentication and access controls, and clear policies on personal vs company-issued devices.

The most effective organisations remove complexity from the end user by centrally managing devices, ensuring consistency, security and ease of support.

Overcoming reticence

Given the benefits of mobile-led MRO



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and the transformative advantages of its implementation, why has adoption been so historically low?

"In our experience, the primary barrier is not technology — it is organisational change," says Wells.

Findings from a 2024 McKinsey & Company survey backs this up. Its Aircraft MRO 2.0: The digital revolution found that more than 80% of respondents consider data limitations to be the most significant barrier to digital adoption at their organisations. "This sentiment could result from the MRO industry's reliance on physical recordkeeping (in large part due to regulatory mandates requiring paper records), which can create fragmented data collections that are difficult to transfer into digital databases," the survey authors posited.

The survey also purported that airline MROs are 25% more likely than their industry peers to believe that digital will be critical in the implementation of future strategy. "Because their airline parent companies are consumer-facing and tend to be comparatively tech-forward, airline MROs might be more likely than their peers to have witnessed the benefits of digital transformation firsthand," the authors suggest.

"The tools now exist, and they are proven," asserts Wells. "The challenge is typically the time and focus required within leadership teams to implement change across operations. There is often a perception that transition will be disruptive or resource intensive.

"In reality, implementations are usually more straightforward than expected. Engineers tend to adopt well-designed mobile systems quickly, particularly when they reduce administrative burden. The larger challenge is organisational prioritisation — making the decision to move and committing to it," he says.

One airline to have embraced mobile-led MRO is British Airways.

The airline says that mobility is important to help its engineering team run operation more effectively. iPhones and iPads are now in use in the working environment allowing aircraft manuals, read and sign, engineering procedures, material availability, action tasks, declare serviceable, and fit/remove components applications to be viewed on the devices.

The UK flag carrier has rolled out MRO-PRO's Line Maintenance functionality to its engineers, enabling the capture of live data via mobile tablets while working on aircraft – ensuring greater accuracy, efficiency, and real-time visibility. The project covers over 30 international stations – including major hubs such as Miami (MIA), New York (JFK), Boston (BOS), Chicago (ORD), Barcelona (BCN), Madrid (MAD), Sydney (SYD), Delhi (DEL), Manchester (MAN), and London Gatwick (LGW).

Ramco Systems has embarked on providing a next-gen mobile strategy for its customer base back in 2016, collaborating with its customers to launch Anywhere Apps on mobile for Mechanics, Supervisors, Customers, Pilots & Storekeepers.

The Mechanic Anywhere application simplifies the daily operations of a line Mechanic/ Engineer. The application directs the mechanics/supervisors to know pending/next actions through an intuitive dashboard and enables the line mechanic to perform scheduled maintenance activities and also record defects over an 'E-Log' on the fly. While carrying line maintenance actions, the app facilitates the line mechanic to request parts, perform component replacements, labour recording, parts consumption, discrepancy reporting, review attachments and perform sign off at ease through smart and touch actions.

Air Asia Company Limited (AACL), Taiwan's first privately-owned aircraft maintenance company catering to aircraft maintenance of commercial aircraft, has been using the Mechanic Anywhere mobile app since 2022, and Korean Air has recently activated the app on behalf of over 400 mechanics and engineers, who are using it for performance maintenance execution digitally, at the airline's Engine Maintenance Center in Seoul.

Act now

For others considering adopting mobile-first workflows and MRO, Wells has some simple advice, "Start."

"Many organisations spend too long evaluating options or waiting for the "right time". In practice, the benefits — both operational and financial — are realised quickly once systems are in place.

"Cost is often perceived as a barrier, but in reality, improved efficiency, better revenue capture and faster invoicing typically outweigh implementation costs. The longer organisations delay, the longer they continue to operate with avoidable inefficiencies.

"Our experience is that once implemented, organisations do not go back," he says.

Once there, what is next?

Wells believes the next phase of mobile-first MRO will be driven by AI and data intelligence.

"There are two key developments," he says. "First, the pace of software development is accelerating, allowing new features and improvements to be delivered much faster.

Second, AI is becoming embedded within the operational data itself. This will enable intelligent task and defect prediction, automated planning and forecasting of man-hours, parts and tools, more intuitive search and interaction with maintenance data, and AI-assisted workflows that guide engineers and planners in real time.

"We are already seeing the emergence of AI assistants within MRO platforms," says Wells. "When properly integrated, these act less like generic chatbots and more like an experienced system expert sitting alongside the user, helping them navigate processes and extract value from the system.

"Over the next few years, this combination of mobile-first execution and AI-driven intelligence will significantly change how MRO organisations plan, execute and analyse maintenance activity."

By Alex Preston

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Mastering Spare Parts Management

Having enough spare parts is a never-ending concern for OEMs and MROs. This is because the shortage of parts stretches back a long, long way.

"From the end of the 2008 financial crisis to the beginning of the pandemic, the commercial aviation sector dealt with an unprecedented 12 years of growth," said Robert Mather, Vice President of Aerospace & Defense at IFS, a company that provides specialised ERP platforms and warehouse management solutions for the aviation industry. "Then, when the pandemic hit, instead of bending, the system broke. Today, six years later, we are still dealing with the aftermath."

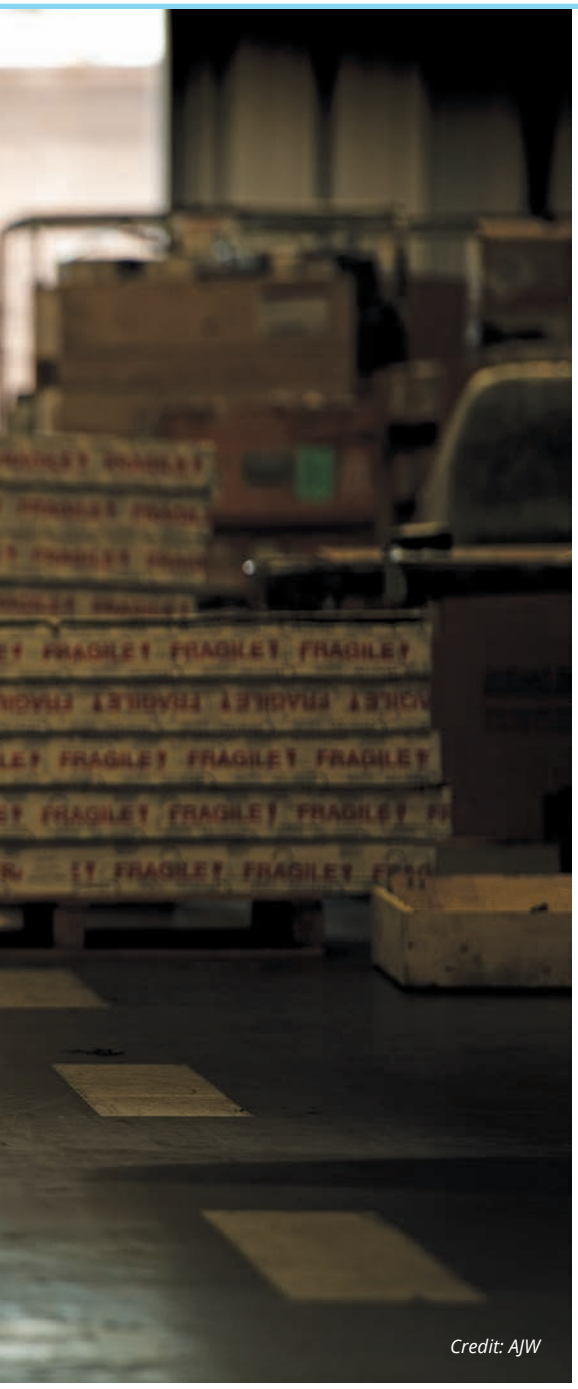
This aftermath is due to the aviation industry trading "lower costs for resiliency, and since 2020, the new normal has been disruption, be it disease, war, or politics," he told Aerospace Innovations. "Furthermore, when a system is under pressure, that's when bad behaviour starts creeping in. When you're scrambling to deliver, you aren't maybe as careful as you might otherwise be about your suppliers. Same thing when you're struggling to find spare parts: you might buy from shadier vendors than you would when times are good out of desperation."

Factors such as these are making it difficult for airlines, MROs, and OEMs to control their spare parts inventories. Thankfully, technology is providing some solutions to ease their pain.

Supply Chain Challenges

When it comes to inventory control, aviation parts managers are facing a long list of supply chain challenges.

"The aviation sector faces two interconnected challenges in spare parts inventory control: unreliable inventory visibility and increasingly complex decision-making demands,"



Credit: AJW

said Chris Clements, a Senior Sales Representative at Swiss Aviation Software (Swiss AS), which produces the AMOS maintenance and engineering software solution for airlines and MROs. "Real-time accuracy is difficult to maintain because parts constantly move between warehouses, hangars, aircraft, and external repair shops, causing digital records to fall out of sync with physical reality. This leads to parts appearing available when they have already been used or remaining physically present but 'invisible' in the system due to delayed or missing updates—resulting in unnecessary emergency


Chris Clements, Senior Sales Representative at Swiss Aviation Software

orders, excess stock, wasted labour searching for components, and even aircraft-on-ground situations."

Beyond the day-to-day physical tracking of inventory, the strategic side of the equation has also grown significantly more complicated.

"At the same time, spare parts management has evolved into a multidimensional decision challenge driven by ageing fleets, volatile demand, longer and less predictable lead times, rising repair complexity, and pressure on capital efficiency," Clements added. "Airlines must now continuously evaluate whether to buy, repair, exchange, scrap, sell or rebalance stock, with each decision directly affecting aircraft availability, operational resilience, and financial performance."

Saravanan Rajarajan is AVP and Head of Consulting for Aviation, Aerospace & Defense at Ramco Systems, a company that develops a web-centric software platform for aviation material planning, demand forecasting, and MRO management. He agrees with Clements that parts visibility is the aviation industry's "first major issue. The second issue is demand unpredictability: Non-routine findings during scheduled checks drive unplanned parts requirements that are nearly impossible to forecast with manual tools. The third issue is compliance complexity: Every rotable and life-limited part carries a traceability obligation under regulators and managing that documentation manually introduces significant error risk."

New parts availability is yet another supply chain challenge, said Bob


Bob Loycano, VP of Supply Chain at FDH Aero

Loycano, VP of Supply Chain at FDH Aero, a global supply chain solutions partner. "Hardware manufacturers have limited capacity and, currently, demand is exceeding supply, draining inventory levels globally," he said. "The lack of capacity has caused lead times to increase dramatically, requiring more inventory on hand to support customer requirements."

Furthermore, delays in new aircraft and engine deliveries mean that airlines are keeping older aircraft in service longer, with the average fleet age having risen to about 15 years. "As a result, these fleets require more frequent maintenance which consumes more spare parts, and with the supply chain constraints and parts shortages tied to raw materials like aluminium, electronics, semiconductors, key components, etc, this puts more pressure on TATs and causes backlogs in service delivery," said Scott Symington, Chief Commercial Officer at AJW Group, an independent provider of component parts, repair services, and outsourced inventory management solutions. "A further issue is the difficulty in hiring enough qualified workers to meet production and maintenance demand. This is exacerbated by an increase in regulatory and quality requirements brought about by events such as those impacting the Boeing 737 fuselage failure in 2024, amongst others."

Coping with Supply Chain Challenges

Ongoing supply chain issues are forcing MROs and OEMs to become creative in their quest for critical, hard-to-source spare parts. "They're

being forced into streamlining their operations and inventory strategies to minimise overstocking and understocking," Symington said. "As an MRO, AJW has adopted a multifaceted approach to its stock management by putting resilience measures in place and improving collaboration with our partners and suppliers. As an example, we've implemented automated inventory tracking systems. These forecasting tools can improve our ability to meet customer needs effectively, reducing errors and delays."

Improved forecasting tools can help, but industry experts say more is needed—including a move away from "just-in-time" minimally-stocked parts inventories to cope with supply chain issues. This is why "the industry has made a decisive shift from just-in-time to just-in-case for most of the critical components," said Rajarajan. "That forces planners to hold deeper safety stock on sole-sourced and hard-to-source items."

"Lean operating models are great, but the prerequisites need to be in place for it to work and one of those prerequisites is stability, a commodity in short supply nowadays, so we need a different answer," Mather said. "That means MROs and OEMs are looking to ensure that they have a minimum amount of stock of critical and long lead time parts on hand at all times, to ensure service levels are maintained."

Unfortunately, longer lead times from OEMs are causing more buffer stock to be held in the pipeline. "Distributors typically hold this



Credit: Swiss AS AMOS mobile

stock," Loycano said. "But with many parts running out completely, and the replenishment taking longer to occur, OEMs and MROs must reconsider stocking their own parts, especially the sole-source and critical items necessary to maintain their production lines."

"It's not always possible, but where it is, MROs and OEMs are looking to avoid sole-sourced parts," observed Mather. "Sole-sourcing can reduce costs through bigger production numbers or volume discounts, and is less challenging to manage, but it leaves you vulnerable. Sharing demand across suppliers helps keep the ecosystem healthy, and we're also seeing near- and ally-shoring used to reduce exposure to geopolitical disruption."

Given these factors, today's minimum stock levels must reflect criticality, lead-time risk, and operational impact rather than purely cost-based optimisation. They must also address fuel cost volatility, which can amplify inefficiencies across technical operations.

"Poorly positioned parts lead to emergency logistics, duplicated infrastructure, and avoidable operational costs, often multiplied across airline groups," said Yannick Hertzog, Swiss AS' Senior Product Lead & Team Lead for Inventory Optimization & Supply Chain Solutions. "AMOS supports advanced inventory concepts such





Jason Lewis, COO of FDH Hardware, a division of FDH Aero



Matthew Tailby, Swiss AS' Senior Product Owner

as multi-location stock control, repairable management, pooling, and group-wide visibility. Material Companion extends this by dynamically reassessing stock targets and proposing stock balancing actions across locations and airline groups. This allows operators to protect availability where risk is highest while avoiding blanket overstocking."

One solution to rising fuel costs is to buy larger quantities of spare parts less often, assuming that large volumes are available to purchase. "As fuel and shipping costs rise, purchasing parts in bulk becomes more cost-effective than relying on just-in-time delivery, since fewer shipments are required and transportation costs are spread across a larger volume of parts," Loycano said. "Customers that have moved to Vendor Managed Inventory (VMI) solutions, such as those offered by FDH Aero, are shielded from these day-to-day fuel and shipping cost changes because the third-party logistics provider holds the inventory until it is needed by the customer."

Why Aviation is Still Struggling to Go Paperless

To navigate the many issues associated with spare parts inventory management, aviation companies are increasingly turning to advanced digital solutions. Platforms like IFS Cloud and IFS Softeon, Ramco Systems' Route Anywhere and Mechanic Anywhere, and Swiss AS' AMOS and Material Companion provide airlines, MROs, and OEMs with comprehensive inventory management capabilities that are vastly superior to legacy methods. So,



Credit: AJW

given the clear advantages of these modern systems, why are so many facilities still reluctant to go paperless?

"The main barrier is operational trust under pressure," replied Hertzog. "In busy shops, teams rely on expedited procurement, substitutions, and cross-station stock balancing. If digital systems do not capture these actions seamlessly, paper persists."

"The most significant hurdles are cost, process change, and organisational readiness," said Jason Lewis, COO of FDH Hardware, a division of FDH Aero that supplies fasteners, fittings, and other small hardware parts to aerospace OEMs and the aftermarket. "For smaller facilities, in particular, the upfront investment in software, hardware, integration, training, and process redesign can be substantial relative to their operating budgets."

Then there's the cultural challenge. Moving from paper-based processes to digital workflows goes beyond system implementation in companies where paper is 'the way we've always done it'. In many organisations, the real barrier is not whether the right paperless technology is available, but whether the workforce is willing to adopt it and leadership is prepared to support it.

"The biggest hurdle is rarely technology — it's trust and habit," Rajarajan said. "Certifying staff have signed paper job cards for decades and understand the legal weight of their signature. Persuading them that an electronic equivalent carries identical regulatory standing requires both regulatory clarity and user experience design that makes the digital process feel more trustworthy. The second hurdle is data migration: Historical records, fleet configuration data, and maintenance programme definitions sitting in paper files or legacy systems must be converted accurately. Any gap creates compliance risk."

If there is a silver lining to this cloud, it is that the retirement of the Baby Boomers is helping to lessen resistance to going paperless. "I used to say that the most significant hurdle was change aversion from the senior staff on the ground, but that's simply not the case anymore," said Mather. "The generational turnover of staff means that it's a more tech-savvy workforce. In fact, the tech is expected and if you're not giving your team modern tools, you're not likely attracting or retaining the top talent."



Inventory management scaled warehouse walkthrough. Credit: xsAviation



Saravanan Rajarajan. AVP and Head of Consulting for Aviation, Aerospace & Defense. Credit: Ramco



Scott Symington, CCO, AJW Group. Credit: AJW

Curing the "Lost in the Hangar" Syndrome

Modern, cloud-based software solutions are now solving the notorious 'lost in the hangar' tracking



problems that plague so many spare parts management systems.

"Cloud-based platforms address this problem by creating a single, real-time source of truth that keeps maintenance teams aligned on parts availability and work progress," Lewis said. "These systems improve visibility into where work stands in the workflow, where parts are located, what tasks are blocked, and what actions need to happen next. In a large maintenance environment, small tracking issues can create delays in multiple areas, so better visibility helps keep work moving and reduces the chances of work stalling for avoidable reasons."

AMOS tackles the persistent 'lost in the hangar' problem by digitising the movement of parts and tools, ensuring every transaction is recorded in real time within a single, tightly integrated system. To minimise the chances of



Project Accounting and Reporting. Credit: Ramco

parts mixups, "every item in AMOS is assigned a unique identifier linked to its serial or batch number, making it nearly impossible for a part to disappear, as each has a last known location and a clearly recorded transaction history," said Swiss AS' Senior Product Owner Matthew Tailby.

"The core problem is that parts exist physically but are invisible to the people who need them," Rajarajan said. "Ramco's cloud platform solves this by tracking the complete movement of every part from the moment it leaves the warehouse shelf, through transit across the hangar floor, all the way to point of use—and critically—through to physical attachment on the aircraft. This end-to-end chain is managed through Ramco's Route Anywhere functionality, which assigns dedicated logistics roles within the facility and records every handoff in real time. Tools are RFID-tagged enabling the system to identify the exact physical location of an item at any point in the process."

As effective as tagging parts is for digitised inventory tracking, it does require some time and effort on the behalf of staff. This is why "the next evolution is computer vision, which has the possibility to eliminate the need for tagging entirely, thereby reducing the costs associated with the process," said Mather. "You still need your system to interact with the physical world – in this case through cameras, but sophisticated AI tools can recognise specific serial numbers visually and can triangulate locations anywhere in view."

Putting Inventory Control in the Mechanic's Hands

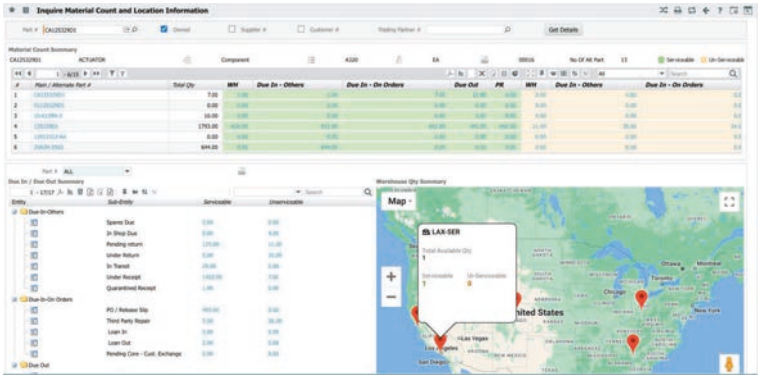
One of the best features of digitised parts inventory management software is its ability to be shared with ruggedised tablet computers. As the experts explain, these units can be distributed to mechanics on the shop floor to order, track, and manage parts in real-time, which can help to reduce aircraft turnaround times (TAT).

"Ruggedised tablets put critical information directly in the hands of mechanics at the point of maintenance," Lewis said. "Instead of leaving the aircraft or work area every time they need to check inventory or request parts, or even review documentation, technicians can access all that information in real-time directly from the shop floor, improving coordination between teams. Mechanics can confirm part availability and request them without unnecessary delay, which also allows the broader team to adjust and sequence work more effectively. As a result, turnaround times are reduced, which is critical in aviation. The goal is to return the aircraft to an airworthy condition and back into revenue-generating service as quickly as possible, and real-time part visibility is a major advantage in that process."

"The simplest TAT improvement comes from eliminating the walk—the trip back to a workstation to check part availability, refer to the maintenance manual, raise a parts request, or sign off a task," said Rajarajan. "Ramco's Mechanic Anywhere app puts all of those actions in the mechanic's hand at the aircraft. A discrepancy can be logged, OEM reference manuals can be accessed, a parts request raised, and the warehouse pick list generated before the mechanic has left the bay. The Route Anywhere app assigns dedicated logistics roles within the hangar—effectively a water-spider function—ensuring that picked parts are delivered to the right work centre and mechanic, rather than waiting to be collected. In operations with mature mobile adoption, this alone can reduce parts cycle time by 30–40%. On a complex heavy check running hundreds of concurrent tasks, those savings compound significantly."

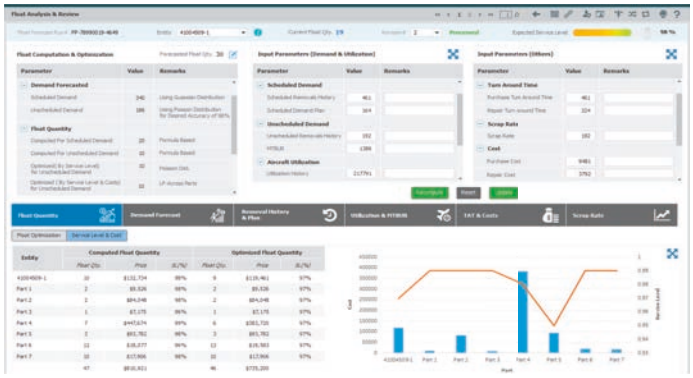
"Enabling production staff to both access and update data in AMOS in

Global Inventory Visibility

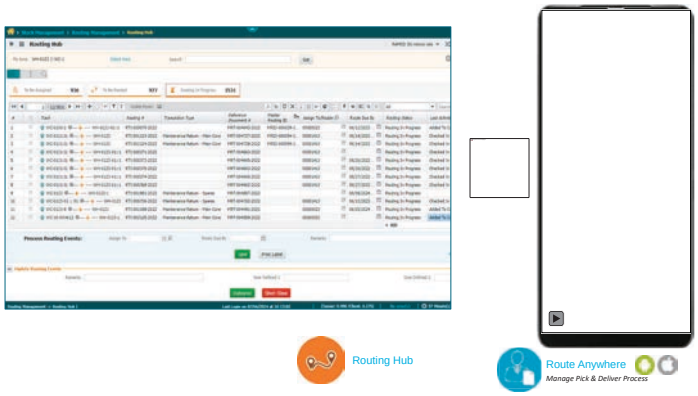


Spare parts inventory management tracking and visibility digital interfaces. Credit: Ramco

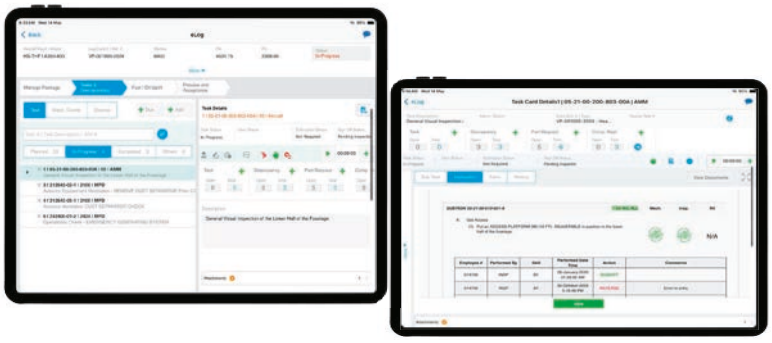
Critical Components Analysis and Optimization



End To End Parts Movement Tracking and Visibility



Digital Enablement of Front-Line Teams



real-time allows them to determine what events can be worked on due to material availability," Clements said. "Removed components can also be processed immediately due to the real-time removals. AMOSmobile/EXEC has been optimised to ensure that the mechanics can perform all their daily tasks directly at the aircraft, from receiving their assigned tasks for the day or shift, to creating findings and electronically signing off completed work, to checking available inventory and requesting additional material."

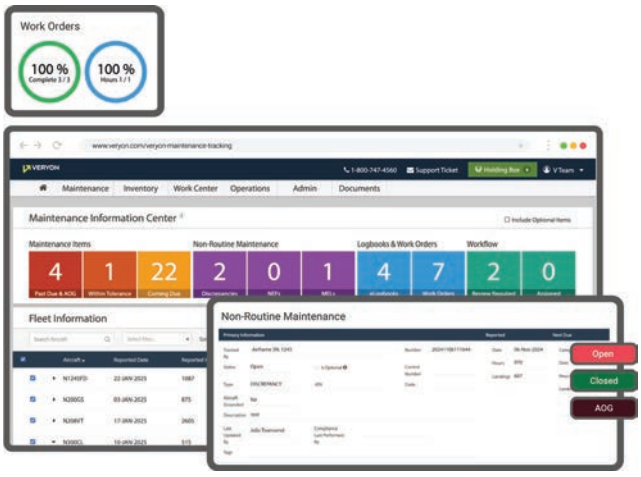
Making the Old Play Nice with the New

When adding digitised parts inventory management systems to an existing shop, it is vital to ensure that 'the old play nice with the new'. So what are the best practices for ensuring that these new mobile inventory apps integrate smoothly with older, established ERP systems?

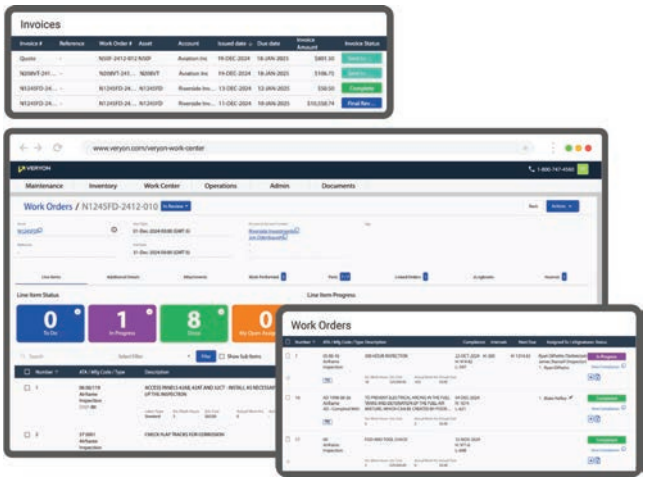
"As with all digitalisation drives, the ability to deliver an intuitive and comprehensive solution relies on integrating the core ERP with mobile devices, as well as the capacity to continuously connect with the ever-expanding solutions and technologies being adopted by inventory teams," said Clements. "These take many forms, such as smart tool systems, vertical storage units, fully automatic warehouse management systems, and robots for inventory delivery."

It's best to connect new mobile tools to legacy ERP systems through a well-structured integration layer, rather than relying on fragile point-to-point customisations. Organisations that stick to this approach can modernise the user experience without disrupting the integrity of core enterprise systems. "None of that works, though, without clean and standardised master data," Lewis said. "Part numbers, locations, serial numbers, units of measure, and transaction rules must align across systems. And system ownership must be clearly defined. The ERP should remain the system of record for core inventory and financial data, while mobile applications can serve as the point of execution for scanning and status updates."

The rollout of such integrations should be phased to avoid catastrophic failures. "A pilot programme in one area of the business can uncover workflow gaps and data issues before broader deployment," said Lewis. "The implementation itself must be designed around the realities of the maintenance environment, from connectivity limitations and regulatory requirements to the need for reliable, user-



Inventory Management. Credit: Veryon



Efficient Aircraft Work Order Management. Credit: Veryon

friendly tools on the floor."

When such integrations are being planned, their potential impacts should be assessed and mitigated across the whole organisation. "Just because one team likes a shiny new solution, doesn't mean that there aren't significant implications to other teams upstream and downstream," Mather said. "You need to understand the needs of each stakeholder throughout the entire process and make sure that every team's needs are accounted for."

The Future of Parts Management

We have seen what digital parts inventory systems can do to address spare part shortages for airlines, MROs, and OEMs. So what improvements are coming next? Here is what the experts had to say.

"The industry is heading toward a fully connected digital thread, where maintenance, materials and compliance data flow through a single environment with full traceability from the point of receipt through installation and record retention," said Lewis. "AI will likely play an increasingly important role, especially in predictive maintenance and inventory optimisation, but also in areas like workflow prioritisation and intelligent search across maintenance records and technical data. These capabilities can help organisations make faster, better-informed decisions while reducing administrative burden. Blockchain also has potential here, particularly for end-to-end traceability



Yannick Hertzog, Senior Product Lead at Swiss AviationSoftware

and secure record validation across multiple parties in the supply chain. It is gaining attention among larger organisations that want greater confidence in component history."

"Two developments will reshape spare parts management in the years ahead," Rajarajan said. "First is agentic AI, which is software that doesn't just recommend actions but executes them within defined guardrails. Ramco's Chia platform, launched in early 2026, is already moving from conversational assistance to autonomous agents capable of raising purchase orders and repair orders without waiting for human initiation. Second, predictive parts forecasting for non-routine maintenance, using AI trained on fleet-wide maintenance histories to anticipate non-routine findings before they occur and feeding that intelligence directly into parts planning. This converts reactive procurement into a structured, forecastable activity."

"We already talked about AI and computer vision solutions that are here today," said Mather. "So are warehouse optimisation systems, part prepositioning optimisation, stock-level optimisation and automated replenishment. These tools continue to get better and better. They just need to get rolled out."

The final word goes to Chris Clements, who sees big possibilities ahead. "Where next? While AMOS already offers integration with automated warehouse solutions, there has been interest in using robots to deliver material to the hangar," he said. "How this might be realised in such a dynamic environment, with many movements already happening in a safety-critical space, will be interesting to see."

Thanks to digitisation, the days of relying on "just-in-time" paper trails and hoping for the best are on their way out. Granted, the aviation supply chain may never return to the predictable stability of the pre-pandemic era, but with the right technology, it doesn't have to. By embracing digitalisation, right-sizing buffer stocks, and looking ahead to AI-driven forecasting, airlines, MROs and OEMs are actively engineering their own solutions to supply chain challenges. The parts themselves might still be hard to source, but managing them doesn't have to be.

By James Careless

The Global Aviation Engine Crisis:

A Generational Opportunity for Tier 2 & 3 Suppliers



The commercial aviation industry in 2026 is facing a clear and persistent problem: there are not enough engines to meet the demand for air travel. What started as a temporary delay in parts and labor after the pandemic has turned into a long-term shortage. This is not a passing phase; it is a fundamental change in how the aerospace economy will work for the next decade. While major airlines and large engine manufacturers (OEMs) are struggling with these delays, this situation has created a significant, long-term business opportunity for Tier 2 and 3 suppliers and smaller, specialized maintenance, repair, and overhaul (MRO) shops. Of note, these Tier 2 and 3 Aerospace & Defense suppliers are the core market of Alderman & Company's Sell Side M&A practice.

One of the primary causes of this shortage is driven by the performance of the latest-generation geared turbofans and LEAP engines, which are experiencing shop-visit intervals significantly shorter than their predecessors. This durability gap is stark; on-wing life for some new-generation engines has been recorded at up to 50% lower than initial projections in harsh environments [1]. Consequently, as of early 2026, the industry is grappling with a backlog of over 3,500 engines awaiting shop visits globally [2], while





> **"As of the writing of this article, this narrative faces potential headwinds from the war in Iran, where a prolonged period of global oil prices above $100 per barrel could trigger a global reduction in air travel demand and a subsequent a sharp decline in the need for new aircraft"**
>
> **Troy, Medeiros**

the average turnaround time for a full engine overhaul has inflated from 60–90 days in 2019 to over 180–240 days in 2026 [3]. For Tier 2 and 3 suppliers, the producers of specialized fasteners, seals, and sub-components—this creates a "perpetual demand" cycle because OEMs cannot produce new parts fast enough to satisfy both the assembly line and the repair shops simultaneously.

As of the writing of this article, this narrative faces potential headwinds from the war in Iran, where a prolonged period of global oil prices above $100 per barrel could trigger a global reduction in air travel demand and a subsequent sharp decline in the need for new aircraft and MRO services

The pressure on Tier 2 and 3 manufacturers is further intensified because the traditional "safety valve" of the industry, the secondary market, has effectively dried up. Historically, the secondary



Credit: IAI Bedek



market allowed engine users to gather spare parts by taking them from retired aircraft to fix active ones. However, the lack of new aircraft deliveries from Boeing and Airbus has forced airlines to keep their aging fleets (like the A320ceo and 737NG) flying much longer than intended. As a result, the availability of Used Serviceable Material (USM) has declined by an estimated 25% year-over-year as retirement rates hit record lows [4]. Without these used parts to scavenge, the supply chain is being pushed to produce brand-new components for nearly every repair.

This reliance on new production has transformed Tier 2 and 3 industry participants from commoditized vendors into critical strategic suppliers. The "Big Three" OEMs (GE Aerospace, Rolls-Royce, and Pratt & Whitney) have now identified Tier 2 and 3 stability as a critical risk that needs to be carefully managed.

The shortage of specialized components is no longer just a nuisance; it is a constraint on global travel and economic growth.

Because of these industry dynamics, Tier 2 and 3 Aerospace and Defense companies now possess significant pricing power. This leverage allows these suppliers to raise prices and demand other important economic terms, such as short payment terms.

We expect to hear more about these shortages and Tier 2 and 3 pricing power at the Farnborough Airshow in July 2026. We expect to see the focus of the show this year to no longer be just about which giant corporation signs the biggest order for new planes. We also expect to hear about which OEMs have the most successful and effective supply chains and which OEMs can keep up with demand. For the independent aerospace and defense company owner, whether you are providing the "release valve" for an overwhelmed OEM or working directly with a leasing company to bypass the waitlist, Tier 2 and 3 suppliers to the commercial aviation industry have become more essential than ever before.

Component Type	2019 Lead Time	2026 Lead Time
Complex Castings	30 Weeks	65+ Weeks
Specialized Fasteners	8 Weeks	22 Weeks

Source: 2025-2026 Aerospace Supply Chain Benchmarking Reports [5].

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By Troy Medeiros, Vice President, Alderman & Company

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- Dr Thaddeus Eze – Cyber Security Consultant and Auditor, Thales Protect
- Alicia Taylor – FACE Director
- Franco Alfonsetti – Head Of Test Solutions Engineering, Leonardo Electronics
- Michael Mustillo – Head of Flight Control, Vertical Aerospace
- Kirk Avery – Senior Fellow and Mission Systems and Autonomous Tech., Chief Architect, Lockheed Martin
- Maurizio Iacaruso, Functional Safety Software Architect, Intel Corp, Italy

Full speaker line up at **www.avionicsandtesting-innovations.com/speakers**

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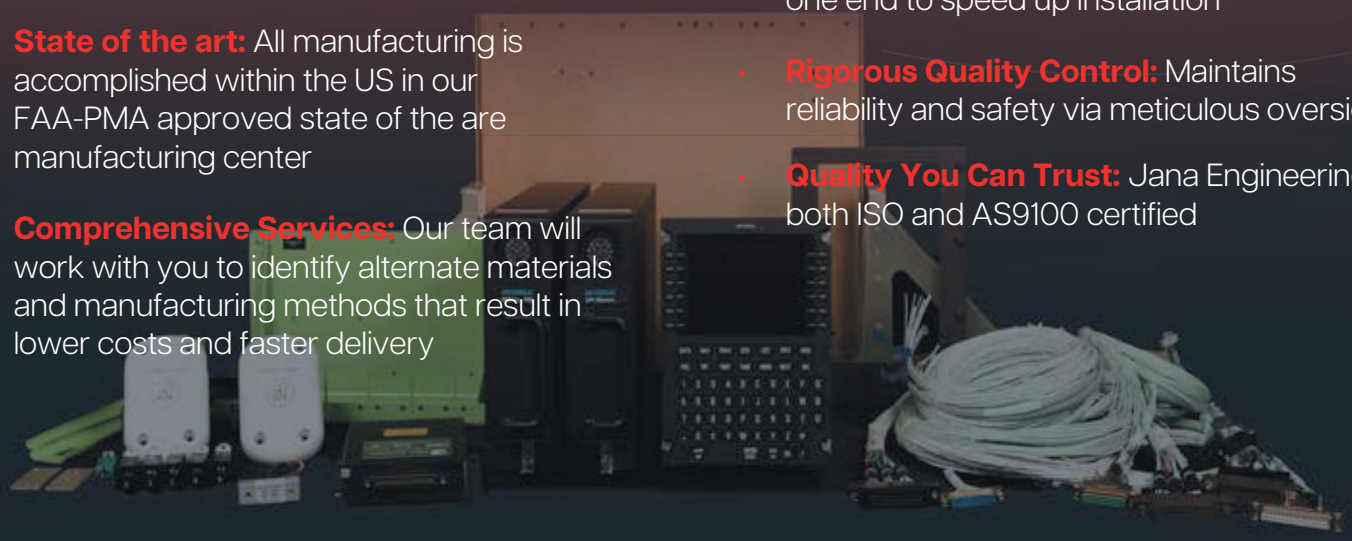
JANA Engineering offers specialized manufacturing services for the aviation industry. This includes PMA Installation Kits and Build-to-Print (BTP) **wire harness and electromechanical assembly** services. All services provided by an experienced and skilled team with an unmatched commitment to quality.

Build-To-Print Services (BTP)

- **Rapid Production Startup:** JANA maintains a multi-million dollar inventory of stocked material, allowing for quick startup and turnaround times
- **Skilled and Professional Team:** All projects are led by a dedicated Project Manager that provides a single point of contact for all technical and commercial issues
- **State of the art:** All manufacturing is accomplished within the US in our FAA-PMA approved state of the are manufacturing center
- **Comprehensive Services:** Our team will work with you to identify alternate materials and manufacturing methods that result in lower costs and faster delivery

PMA Installation Kits

- **Official PMA Certification:** Ensures kits meet and exceed industry standards
- **Detailed Installation Instructions:** Simplify the installation process with clear guidance
- **Organized Components:** Individually shrink-wrapped for easy identification
- **Pre-Terminated Harnesses:** Terminated at one end to speed up installation
- **Rigorous Quality Control:** Maintains reliability and safety via meticulous oversight
- **Quality You Can Trust:** Jana Engineering is both ISO and AS9100 certified



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