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AEROSPACE INNOVATIONS

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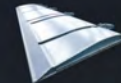
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Aerospace Innovations brings you news, views and analysis of the commercial and defence sectors, in print and online, highlighting the latest innovations, technologies and solutions that are key to the future of the aerospace industry to meet performance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

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The Rise of Cyber Attacks and GNSS Spoofing Incidents

The recent cyber attack that led to significant disruptions at some of Europe's major airports, including London Heathrow, Brussels and Berlin is a stark reminder to us all that airports need more sophisticated and resilient cybersecurity systems put in place, especially as they are deemed to be critical infrastructure in most countries. It was a ransomware attack on the Collins Aerospace MUSE software, which is essential for electronic check-in and boarding systems. The attack was attributed to HardBit ransomware, and the time of going to press, the affected airports were still working to restore normal electronic passenger check-in and boarding operations.

In this packed edition, Alex Preston spoke to several cyber security companies, and with EUROCAE, about the increasing prevalence of GNSS/GPS spoofing incidents and asked them what actions can be taken to help mitigate this unwelcome interference. In his second article in this edition, Alex spoke to some leading satcom providers, and antenna makers, about how the

provision of inflight connectivity (IFC) is becoming more ubiquitous, whether it be multi-orbit or LEO only.

James Careless interviewed several leading avionics manufacturers about the advances being made in LED and LCD technology for avionics displays. In his second article, James spoke with some leading MRO software providers and independent experts about ERP software vs. Best-of-Breed.

In our cover story, Ian Harbison spoke with Pratt & Whitney, Rolls-Royce, GE Aerospace and CFM about their engine durability upgrade packages, which aim to improve Time On Wing (TOW), especially in hot and harsh environments. In his second article, Ian had an exclusive interview with Clyde Buntrock, CEO of AJW Aviation and AJW Technique, about the company's growth plans and its green credentials.

Next up, Mark Robins investigated the subject of aircraft wiring, cables, harnesses, connectors, and interconnects, and spoke with some leading manufacturers about the latest advances in higher voltage, weight reduction, and miniaturisation of these products.

Our first guest article in this issue is written by Integrated Security Service (ISS) and is about lifecycle cybersecurity for defence platforms. Our second guest feature in this issue is written by Alderman & Company and is about military aircraft upgrades, including the B-52, F-35, and Eurofighter Typhoon.

We look forward to meeting those of you who will be participating in the MRO Europe Show in London in October. We also look forward to seeing those of you who will be attending the High Integrity Software Conference (HISC) in Wales in November.

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 or suggestions for us about our publication.

Best regards,
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Panasonic Avionics Launches Next-Generation Wi-Fi Portal to Enhance the Passenger Connectivity Experience

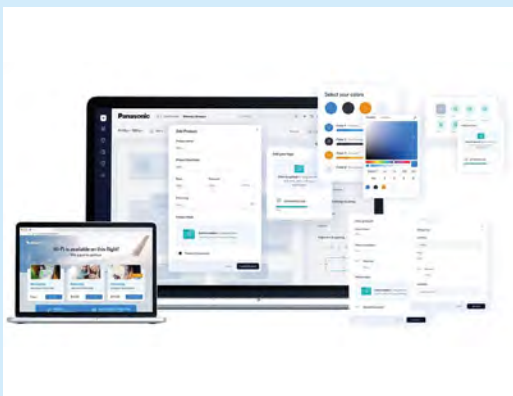
Panasonic Avionics Corporation (Panasonic Avionics) today unveiled its powerful, innovative cloud-native Wi-Fi Portal platform designed to give airlines complete autonomy over their in-flight connectivity experience.

The portal is an agnostic solution which can be implemented on mixed fleets that use multiple in-flight connectivity service providers.

With Panasonic's new Wi-Fi Portal, airlines have full autonomy to customize their portal design without a formal change request or ATP. They can use self-service tools to best align their connectivity offerings with their brand identity, onboard strategy, and overall commercial objectives. For example, an airline can now update content, packages, pricing, and passenger entitlements, such as free or discounted Wi-Fi based on frequent flyer status or cabin class, at their own pace.

The Wi-Fi Portal is also designed to remove the typical friction passengers experience when they purchase Wi-Fi sessions during their flights. First, it takes advantage of Panasonic Avionics' Partnerships with global mobile network operators and lets passengers access their Wi-Fi roaming plans directly from the airline portal at any time. It also provides an elegant and intuitive interface that makes it easier and faster for all passengers to purchase connectivity services.

By integrating with Panasonic Avionics' OneMedia platform, airlines may monetize opportunities through their portal, supporting banner advertising and video sponsorship placements by using the new tool. 



Hexagon Unblocks Aircraft Inspection Bottlenecks with Automated Laser Scanning Innovation

Hexagon's new Leica Absolute Tracker ATS800 is a breakthrough in automated large-structure inspection. The ATS800 combines long-range laser scanning with real-time tracking and automation readiness – cutting inspection times from hours to minutes.



Engineered to meet the demands of faster aircraft production and labour shortages, the ATS800 enables high accuracy feature measurement from up to 40 metres away, without requiring scaffolding or physical target placement. By automating both daytime and overnight "third shift" inspections, the laser tracker frees up skilled labour for more value-added tasks and accelerates throughput.

Powered by TruePoint interferometry, the ATS800 delivers precise, traceable inspection of detailed features from up to 40 metres. With full integration of reflector tracking and real-time measurement feedback, it simplifies high-precision measurement during critical manufacturing tasks such as fuselage assembly and composite layups, and is packaged in a portable, lightweight device that can be repositioned and setup quickly.

The innovative FeatureDetect function accelerates feature recognition from CAD files or panoramic camera feeds, enabling operators to scan holes, slots and edges without manual programming or probe interaction. Compatible with commonly-used software including PC-DMIS, SpatialAnalyzer, HxGN Robotic Automation and third-party metrology and robots, the ATS800 easily fits into both existing and future automated inspection processes. 

Copenhagen Airport Gains New Insights into APU Usage with Assaia's AI-Powered Emissions Monitoring

Copenhagen Airport (CPH) has announced the go-live of Assaia's EmissionsControl technology to monitor aircraft ground emissions from Auxiliary Power Unit (APU) in real-time. The innovative solution tackles an industry challenge that's been holding back aviation sustainability efforts: the difficulty airports worldwide face in taking targeted action to minimize APU usage due to lack of comprehensive data on APU runtime across variable locations and weather conditions.

This implementation marks a global first, making CPH the first airport in the world to deploy this advanced emissions monitoring

capability across the majority of its stands. Thanks to Assaia, CPH now has 24/7, year-round view of APU usage, setting a new standard for airport sustainability and operational insight.

The AI-powered system uses advanced camera technology to track APU usage during aircraft turnarounds, providing CPH with detailed, weather-contextualized data. This enables CPH to better understand real-world APU usage patterns and lays the groundwork for future initiatives aimed at reducing emissions.



Boeing and WestJet Announce the Airline's Largest-Ever Order for 67 Airplanes

Boeing and WestJet have recently announced that the Canadian airline is buying 67 more Boeing jets, bringing its firm order book to 123 airplanes as the carrier plans to expand its fleet and domestic and international networks.

"With the addition of these aircraft, WestJet has the largest order book of any airline in Canada, and will double our fleet of Dreamliners, underpinning our growth plans and our commitment to affordable travel options for Canadians and exciting career paths for our people," said Alexis von Hoensbroech, WestJet chief executive officer. "These highly efficient and comfortable aircraft are critical to the growth and renewal of our fleet and will also significantly improve our fuel consumption."

WestJet began operations in 1996 with three Boeing 737 aircraft. Today, the airline flies nearly 150 Boeing 737s allowing them to comfortably and affordably



connect Canada. WestJet operates both the 787 Dreamliner and 737 MAX on its long-haul routes and with this order, the carrier will add to its fleet of seven 787-9s that connect Canadians with destinations across Europe, Asia and Latin America.

"We are honored that WestJet has once again placed its trust in Boeing with a major investment that builds on our three decades of partnership and solidifies their fleet for the decades ahead," said Stephanie Pope, president and CEO of Boeing Commercial Airplanes. "We look forward to supporting WestJet's exciting growth as they leverage the 737 MAX and 787 Dreamliner to serve even more passengers with great efficiency and comfort."

Honeywell and Redwire Advance Collaboration on Quantum-Secured Communications for Civil and Defense Customers

Honeywell recently announced a Memorandum of Understanding (MOU) that advances a European Space Agency-backed initiative to develop new quantum-secured satellite communication systems.

The MOU, signed with Redwire Corporation, is the latest milestone under the Quantum Key Distribution Satellite consortium (QKDSat), which was launched in 2024 and is being led by Honeywell. It will enable the two companies to explore opportunities to mature and expand the use of quantum key distribution technology as part of the consortium, which operates under the European Space Agency's QKDSat Public Private Partnership.

The aim is to combine Redwire's quantum platform technology with Honeywell's quantum optical payload, creating a fully functional payload and platform by mid-2026. The collaboration aims to advance quantum-secured technologies that could help governments



and defense agencies protect sensitive information from emerging cyber and quantum threats, while also accelerating next generation quantum key distribution services for commercial customers.

The QKDSat project brings together companies from ESA Member States including Belgium, Austria, Canada, Czechia, and the United Kingdom to develop an ultra-secure telecommunications satellite that ensures the secure and private exchange of sensitive information.

In addition to civil and defense-related applications, Honeywell and Redwire plan to demonstrate space and ground-based quantum communications capabilities for commercial organizations such as financial institutions, telecommunications providers, and critical infrastructure companies that generate large volumes of confidential data.

Airbus Commercial Aircraft Appoint New CEO



Lars Wagner, currently Chief Executive Officer (CEO) of MTU Aero Engines AG, based in Munich, will join the Airbus Executive

Committee and succeed Christian Scherer as CEO of the Commercial Aircraft business, effective 1 January 2026.

Lars Wagner will join Airbus from the beginning of November 2025 to ensure a smooth transition with Christian Scherer. Christian remains CEO of the Commercial Aircraft business until 31 December 2025, topping a career spanning over 40 years in several executive roles with Airbus.

Lars Wagner, 50, has held the position of CEO at MTU Aero Engines AG since January 2023. Prior to his appointment as CEO and since joining MTU in 2015, Lars notably assumed the roles of Chief Operating Officer and Executive Vice President in charge of OEM operations. He previously held a number of management positions at Airbus including in Bremen, Hamburg and Toulouse. Lars holds a degree in mechanical and aeronautical engineering as well as an MBA. 

GE Aerospace and Merlin Announce Autonomy Core Initiative for Advanced Aviation



GE Aerospace and Merlin, a leading developer of assured, autonomous flight technology for defense customers, has announced a new effort to pursue autonomy core development. This next-generation autonomy and pilot-assist platform will be designed to bring AI-enabled capabilities to existing and future military and civil aircraft and meet the growing demand for crew reduction and uncrewed flight capabilities. Collaboration will focus on AI and autonomy-focused solutions that enable crew reduction efforts, advancing next-generation autonomous flight for civil and military aircraft.

GE Aerospace's current Flight Management System footprint includes more than 14,000 aircraft globally, creating an opportunity to introduce Merlin's advanced capabilities to legacy military platforms, which will define state of the art technology for next generation aircraft. The autonomy core aims to become the system of record for high assurance aerial systems to satisfy customer needs for reduced crew workload and enable single pilot operations (SPO).

The autonomy core initiative represents a strategic fit between the companies' capabilities and technologies. GE Aerospace's proven expertise in flight management systems and open system architecture coupled with Merlin's autonomy software suite, avionics packages, and Datalink solutions, provides operators with a scalable, certifiable, and future-ready solution to meet the growing demand for crew reduction, SPO, and uncrewed flight capabilities. 

Tap to Fly: Amadeus and Lufthansa Test EU Digital Identity Wallet for Seamless Travel

Travelers to check in, drop bag, board and enroll for biometrics with one click or tap. Amadeus Travel Ready helps airlines accept the EU Digital Identity Wallet to simplify the travel experience.

Services like Apple Pay and Google Pay have transformed the payment experience by allowing consumers to pay online or in person with a single click or tap, executing payments from a card stored in a digital wallet. Now, a similar one-click experience for travel is being tested.

Available to citizens in 2026, EU Digital Identity Wallets (EUDI Wallet) will be provided by Member States to securely store identity documents like passports and national ID cards, as well as payment methods and biometric profiles.

During this summer, Amadeus and Lufthansa, both participating partners of the EU Digital Identity Wallet Consortium Large Scale pilot project, successfully tested

the wallet for online check-in and in-person travel scenarios at the airport, like check-in, bag-drop and boarding. Later in 2025, Amadeus will test the wallet for digital travel credential use cases, such as airport security and border control. 



Toradex and Wind River Partner for Aerospace and Defense Innovation

Toradex and Wind River are partnering with the goal of advancing the pace of aerospace and defense (A&D) innovation by uniting certifiable reliability with rapid development.



Toradex specializes in the design and manufacture of high-quality, reliable, and scalable embedded computing solutions, particularly systems-on-modules (SoMs) and single-board computers (SBCs). The company provides easy-to-use commercial off-the-shelf products and services for industrial and commercial applications.

A&D programs operate in a landscape defined by rigorous certification, uncompromising size, weight, power, and cost (SWaP C) requirements, and intense time-to-deployment pressures. Historically, addressing these challenges forced development teams to choose between prototyping velocity and final certification — a trade-off that ultimately slows delivery of mission-critical systems.

Through this collaboration, engineering teams can combine the certification-ready VxWorks® real-time operating system with the powerful SoMs from Toradex, including its new i.MX 95-powered SoMs. That will enable team members to use the same hardware platform to transition seamlessly from Linux-based rapid prototyping on Torizon to VxWorks, or to host both Torizon and VxWorks in secure, partitioned virtual machines under Wind River® Helix™ Virtualization Platform on the same module. This unified path optimizes resources, accelerates development, and strengthens certification assurance. 

Airbus and Critical Software Explore Strategic Partnership in Embedded Software Development

Airbus and Critical Software have signed a Letter of Intent to create a joint undertaking focused on the development of embedded software for aerospace applications.

The initiative aims to combine the companies' respective capabilities in designing and delivering safety-critical and certifiable software across multiple domains, including avionics, cabin and connectivity systems for current and future aircraft.

The objective is to secure long-term embedded software development expertise, aligned with the growing complexity and digitalisation of aerospace systems.

The potential new structure, which is subject to further assessment and regulatory approvals, would bring together Airbus' aerospace expertise with Critical Software's deep experience in embedded and safety-critical software engineering.

"As embedded software becomes increasingly central to our products, securing the right expertise and capacity is key. This initiative reflects our intent to build robust, long-term capabilities in a highly specialised domain, relying on the world-class expertise of partners like Critical Software" said Sabine Klauke, Chief Technology Officer at Airbus. 

ATEQ Aviation and Pilot John International Announce Global Distribution Partnership

ATEQ Aviation, the global leader in aviation testing equipment, is pleased to announce a strategic distribution partnership with Pilot John International (PJI), a trusted provider of aircraft maintenance tools and ground support equipment. This alliance is set to enhance the global availability of ATEQ's advanced products through Pilot John's established marketplace, which offers top-tier GSE and tooling, avionics test equipment, aircraft parts, consumables, and pilot supplies.

This partnership supports ATEQ Aviation's growth strategy by expanding its reach through specialized distributors in the aeronautical maintenance sector. By reinforcing its international sales network, ATEQ demonstrates its commitment to innovation, adaptability, and delivering exceptional customer satisfaction around the world.

Together, ATEQ Aviation and Pilot John International will provide aviation maintenance professionals—including airlines, OEMs, military organizations, general aviation, and FBOs—access to cutting-edge test solutions wherever they operate.

This agreement bolsters ATEQ's existing global sales network, ensuring clients benefit from both technical excellence and responsive support. 



New High Voltage Programmable Resistor Modules from Pickering Provide a Simple Solution for Applications Requiring Voltage Handling up to 1.2kV

Pickering Interfaces, a leading supplier of modular signal switching and simulation solutions for use in electronic test and verification, has announced a new family of high voltage programmable resistor modules in a compact single-slot PXI and PXIe form factor, model 40-230 (PXI) and 42-230 (PXIe), providing a simple solution for applications requiring voltage handling up to 1.2kV. Part of Pickering's expanding range of programmable resistor modules, the new module is available in 70 standard builds, including four single-channel builds that offer a wide variety of resistance ranges and resolution capabilities, playing a pivotal role in simulating real-world resistive loads and fault conditions for high-voltage DUTs (devices-under-test) across automotive, aerospace, and energy sectors.

The 40/42-230 high voltage programmable resistor module plays a critical role in simulating real-world resistive loads and fault conditions for high-

voltage DUTs such as EV (electric vehicle) power inverters, BMSs (battery management systems), and some aerospace components. Engineers can utilize these modules for critical tasks, including voltage isolation check testing, which ensures the safe functionality of high-voltage systems and compliance with safety standards such as ISO 6469 and IEC 60664.

The module allows engineers to emulate resistance sensor values, such as those from thermistors and RTDs, in high-voltage environments, enabling safe testing without needing the actual sensor hardware. For added test coverage, when used in the HIL (hardware-in-the-loop) simulation testing of ECUs (electronic control units), each channel of the 40/42-230 can be set to short and open circuit conditions to verify the controller's response to a faulty sensor or connection. 



GA-ASI Marks Another Aviation First with YFQ-42A CCA Flight Testing

The YFQ-42A Collaborative Combat Aircraft, designed and developed by General Atomics Aeronautical Systems, Inc. (GA-ASI), is now conducting flight testing in coordination with the U.S. Air Force. This historic achievement continues the company's rapid creation of new, jet-powered uncrewed platforms chartered by the U.S. Air Force (USAF) to achieve air dominance while being designed for rapid production, in large quantities, at an affordable price.

"What a great moment for the U.S. Air Force and for GA-ASI," said GA-ASI President David R. Alexander.

"It's been our collaboration that enabled us to build and fly the YFQ-42A in just over a year. It's an incredible achievement and I salute the Air Force for its vision and I salute our development team for delivering yet another historic first for our company."

The YFQ-42A is GA-ASI's newest uncrewed jet, focused

on air-to-air semi-autonomous operation and based on the genus-species concept pioneered on the XQ-67A Off-Board Sensing Station (OBSS). Using state-of-the-art, model-based

digital engineering, GA-ASI was able to accelerate its schedule while optimizing air dominance capabilities. YFQ-42's autonomy core has been trained across more than five years of flight testing using GA-ASI's jet-powered MQ-20 Avenger®, an aircraft no other company has. The integrated capabilities of a stealthy, air-to-air-focused uncrewed jet, combined with a learned AI autonomy core, provide

warfighters with a definitive advantage in the future fight.

The GA-ASI program has focused on creating a high-rate production environment that enables USAF to reach its goal of producing more than 1,000 CCAs on an accelerated timeline. Ground testing for YFQ-42A began in May. 



AXIS Flight Simulation Showcases Simulator Redesign

Full-flight simulator (FFS) manufacturer AXIS Flight Simulation (AXIS) is unveiling the redesign of its Level D FFS product range. Developed in collaboration with award-winning design firm formquadrat, the new style reimagines the form and function of the simulator cabin to deliver a distinctive, contemporary look and modular structure that aligns with the evolving needs of operators and flight training organisations worldwide.

AXIS's new modular and flexible design delivers lasting value to customers by accelerating setup, simplifying maintenance and enabling visual differentiation. Many non-aircraft specific components – such as the platform – can be pre-manufactured, enabling faster delivery

in more compact packaging. The reconfigured structure improves access for maintenance teams, while the clean external layout creates additional branding opportunities for customers.

Visually, the simulator's design delivers a distinctive, high-end appearance with balanced proportions, quality materials and striking surface contrasts. Clear, intuitive graphics support both user orientation and brand recognition, reinforcing AXIS's identity in every interaction. 



CAE Forecasts 1.5 million Civil Aviation Professionals Needed Over Next 10 Years

An estimated 1.5 million civil aviation professionals will be needed worldwide by 2034, according to CAE's biennial Aviation Talent Forecast, released today at the Paris International Air Show. The comprehensive 2025 edition of the forecast analyzes the need for pilots, aircraft maintenance technicians, cabin crew, and, for the first time, air traffic controllers, predicting that 71,000 controllers will be needed globally over the next 10 years.

The 2025 CAE Aviation Talent Forecast reports that 1,292,000 commercial aviation professionals will be needed – 267,000 pilots, 347,000 aviation maintenance technicians, and 678,000 cabin crew – with the largest percentage required to meet rapidly rising demand in the Asia Pacific region. In addition, 102,000 business aviation professionals are expected to be needed worldwide over the next 10 years, including 33,000 pilots and 69,000 aircraft maintenance technicians.

"The need for 1.5 million new aviation professionals by 2034

is being driven by record demand for air travel and a significant wave of retirements that is expected across all categories. With commercial and business aviation fleets expected to see double digit increases over the next 10 years, the industry must take action to attract, train, and retain personnel. Highly skilled aviation professionals are not just a necessity for the safety of the air transport system, they are the foundation for the successful expansion and resilience of the global aviation sector," explains Marie-Christine Cloutier, Vice-President – Strategy, Performance, Air Traffic Services & Marketing at CAE.

"To meet the demand, the industry needs to be proactive and creative. Adaptability and optimized training will be key to supplying the demand," she says. 



Growing and Green

There are relatively few aviation companies that been around since 1932. AJW Group, which takes its name from its founder, Anthony James Walter, is one of them, although it has evolved and expanded. **Ian Harbison reports.**



AJW HQ, Slinfold, United Kingdom. (Copyright.)



Clyde Buntrock, CEO of AJW Aviation and AJW Technique, says the company is thriving at the moment because of on-going supply chain issues driving strong industry demand. Growth has been possible due to increased operational efficiency, chiefly due to an ongoing digital transformation. By embedding generative AI and large language model applications into its operations, it is optimising inventory management, anticipating repair volumes, and minimising unplanned material holds. An in-house part forecasting model allows it to pre-plan inventory at the most granular level, ensuring the repair cycle is handled with maximum efficiency.

This focus on innovation is matched by investment in people. At AJW Technique, a component MRO facility in Montreal, it is also piloting AI tools to accelerate knowledge transfer between experienced technicians and new recruits. These tools assist with technical report writing, parts selection and training, allowing personnel to scale expertise while adapting to increasingly complex aircraft systems.

He says aviation technology is advancing rapidly, particularly in avionics and next-generation engines, and AJW is committed to continuously upskilling the workforce. A combination of digital intelligence and hands-on expertise delivers smarter, faster and more reliable aftermarket solutions, giving a strong position for long-term growth.

The company is involved in components, MRO, engines, interiors, asset management and supply chain management. None of those core services are slowing and demand across the aftermarket remains strong. It continues to grow its service offering in new platforms such as the Airbus A350 and Boeing 787 and there is increasing appetite for cost-saving solutions such as Used Serviceable Material (USM) and Power-By-the-Hour (PBH) maintenance programmes. Airlines are looking for certainty and flexibility, both of which, he says, AJW is uniquely placed to deliver.

The customer base is also diverse, as shown by two recent PBH contracts, both in April. The first is a long-term programme with South African operator FlySafair, to support an expanding fleet of Boeing 737NGs, the first for AJW in that country. It includes pool access and repair management.

The second is a long-term programme to support the Airbus A321ceo and growing A320neo fleets of Canadian airline Air Transat. The airline has been a customer since 2013, with AJW supporting the Airbus A330 fleet. Under the latest agreement, AJW Group will manage the complete supply, repair, overhaul, and warranty support of rotatable components across the airline's primary base in Montreal and its operations in Toronto and Vancouver. A key component of this contract is AJW Technique, also headquartered in Montreal.

Being close to the customer has many advantages and AJW Group has operational hubs and local offices across Africa, Asia Pacific, China, CIS, Europe, Latin America, Middle East and North America.

That local presence is particularly useful when regions are seeing expansion, such as China, fuelled by a rapid expansion in domestic and international traffic, or the Middle East, with carriers adding new routes and ordering significant numbers of new aircraft to meet demand. These orders will take years to fulfil, so the company has time to strengthen its logistical support in these regions to support the existing fleet.

There is also increased demand in Europe, and, again, it is expanding to match, with a further warehouse to the current warehouse in Malpensa, Italy.

Demand for PBH services is at record levels as airlines look for security and refer repair management and supplier management to AJW, backed by its global inventory pools and repair network. He adds that the company is supporting an ever wider customer base than ever. Part of this is due to the tight control OEMs have on

the aftermarket but often hold insufficient stock.

On the other hand, AJW has invested in inventory, including a package of over 2,500 A350 components, as well as the Boeing 787. In fact, last year, it purchased a complete 787-9 powered by GEnx-1B for its investment portfolio.

It is also making heavy investments into A330 and 777 via teardowns as narrowbody part availability is low. This is a strategic move to position AJW to support worldwide operators and airlines across a broader range of aircraft type.

Of course, increased inventory means tighter management is required and, he reiterates, the application of digital and AI tools ensures parts availability with greater precision, minimises costs, optimises logistics, and supports more sustainable operations.

The company has its own digital team hard at work on automated part fulfilment, digital warehousing and warehouse automation, as well as deploying its in-house AI platform in a wide range of areas, such as repair sourcing RFPs, automated quoting and pricing.

Following a partnership agreement signed with Honeywell in 2021, it has invested in the latest ATEC automated test equipment at AJW Technique, which is now an OEM-approved facility for the HG2030 series Air Data Inertial Reference Units (ADIRU) for the Airbus A320, A330, A340 and A380. This will be expanded later this year to include the latest HG2050 series for later generation Boeing 737NG and 737MAX. The company has been a sole worldwide supplier for this unit since 2022.

Beyond avionics, it has expanded its portfolio with Airbus A220 safety slides and Boeing 787 LED lighting products, reflecting its commitment to supporting operators across both legacy and new-generation fleets. It is also developing bespoke solutions, such as new inspection and repair activities for QEC parts tailored to the needs of local engine MRO customers.

While AJW is not a manufacturer



Clyde Buntrock, CEO AJW Aviation & Technique. (Copyright.)

developing new green technologies, its role as a steward of the aftermarket allows it to drive meaningful environmental impact by combining recycling practices with the power of digital intelligence to deliver long-term value for airlines, lessors, and the wider aviation industry.

Sustainability is embedded in the operations and the core business model effectively acts as an aviation recycling hub, recovering, overhauling, and reintroducing high-value components back into service. This reduces waste, extends asset lifecycles, and lowers the demand for new production, all of which contribute to a more sustainable industry.

A good example is the AJW Technique Europe facility, near London Gatwick Airport, which offers comprehensive battery repair and overhaul services, including deep cycle, top charge, cleaning, and re-blocking for all commercial aircraft main, auxiliary, and emergency power supplies. Last year saw the installation of over 2,500 solar panels, which are expected to generate nearly 800,000 kWh of clean energy annually to

charge the batteries.

The company has shown its commitment to the environment by signing up to the United Nations Global Compact and its goals in 2023. From its MRO facilities, which ensure the responsible reuse and recycling of components, to its global logistics operations: the approach is to repair, reuse, and recycle wherever possible.

Digital innovation is taking this even further. By applying AI and predictive analytics, it can optimise component lifecycles, reduce unnecessary logistics, and minimise surplus stock. These intelligent systems help customers cut both cost and carbon, demonstrating that sustainability and efficiency can go hand in hand.

Buntrock says the biggest challenge to expansion is time. Developing, testing, and implementing new technologies requires careful planning but AJW is at an advanced stage of its digital transformation and is now seeing the benefits with projects already delivering results, and more set to follow in the months ahead. 

By Ian Harbison



Time to reskill and attract next-gen aviation technicians?

AI meets digital to bridge the experience gap.

Read the IFS white paper
ifs.biz/az00



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ERP Systems vs. Best of Breed: Choosing the Right Software for your Needs

As airlines, MROs, and other aerospace organizations digitize their operations, they are faced with a key strategic question: Which software approach is better, ERP or “best of breed”?

To set the context for this debate, ERP stands for Enterprise Resource Planning. It is a software-based management system that combines

all elements of a business — from Accounting and Production to Sales and Janitorial Services — into a single integrated database. ‘Best of breed’ refers to narrowly-focused software systems that only deal with one aspect of the business — like Procurement — and nothing else.

The simplest way to understand the difference between the two is

best summed up by Rob Mather, IFS’s Vice President of Aerospace and Defense. (IFS’ software solutions provide an integrated platform that allows airlines and MROs to manage their maintenance operations more effectively.) “ERP systems tend to try to be everything to everybody,” he said. “Meanwhile, best-of-breed systems try to do one thing really,



really well.”

A more detailed explanation is provided by Chris Clements. He is Senior Sales Representative with Swiss Aviation Software (Swiss-AS). They produce and support AMOS, a comprehensive and fully integrated ERP solution that manages all aspects of aircraft maintenance, engineering, and logistics.

“A single integrated ERP solution is process-based and built on a central database that provides a single source of truth and seamless access to live data,” Clements said. “Updates are instantly reflected across the system, eliminating the need for duplicate manual entries or extensive API connections. In aviation, where managing high-value assets in a safety-critical environment is paramount, such an integrated ERP delivers a stable foundation for operational, compliance, and commercial needs.”

In contrast, “the best-of-breed approach uses multiple solutions, each tailored to a specific business function by different providers,” he said. “The number and scope of solutions vary — from a CAMO-only setup to a full airline operation with in-house and third-party MRO services. This approach offers specialised functionality but requires robust integration to ensure consistent and reliable data flow.”

ERP Pros and Cons

In researching this article, Aerospace Innovations magazine observed general agreement among all parties about the pros and cons of ERP and best-of-breed systems, regardless of the kinds of platforms their own companies offer.

Let’s begin with the pros of ERP solutions for aerospace companies. The first benefit they offer is centralized data storage and simplified data management. This is because all of the data resides in a single system, thus providing a “single source of truth.” As a result, using an ERP simplifies reporting, eliminates the need for duplicate data entry, and minimizes any technical complexities associated



Chris Clements. (Copyright/Credit: Swiss AviationSoftware (Swiss-AS).)



John Stone. (Copyright/Credit: ULTRAMAIN.)

“ERP systems tend to try to be everything to everybody. Meanwhile, best-of-breed systems try to do one thing really, really well.”

Rob Mather, Vice President of Aerospace & Defense at IFS

with third-party integrations. The company only has to manage a relationship with one vendor and one contract, thus reducing administrative and IT expenses.

John Stone is Vice President of Product Management with Ultramain Systems. Their ULTRAMAIN ERP manages all aspects of an aerospace company’s business, save for Finance and Human Resources. (For this reason, Ultramain Systems defines ULTRAMAIN as an Enterprise Asset Management [EAM] system, rather than an ERP.) “A single ERP platform offers a unified data model, consistent user experience, and simplified vendor management,” he said. “It can streamline enterprise-wide reporting and reduce the number of systems IT must maintain. For finance, HR, procurement, and inventory, this ‘one stop shop’ can be efficient and predictable.

ERP systems also provide streamlined workflows for their users. This is because the system’s all-encompassing platform applies consistent processes across different departments.

Monica Badra is the Founder of Aero NextGen. Its online ERP Finder tool helps aerospace companies find

the ERP best suited to their needs.

“End-to-end automation through ERPs reduces manual handoffs, paperwork, and duplicate data entry,” said Badra. “This means fewer errors and less wasted time. Agentic layers and AI agents are becoming increasingly more popular [in ERPs] and are starting to automate manual workflows in Finance, Procurement, Customer Service, and other indirect functions.”

If an ERP system is widespread and well-funded, it will likely offer enhanced security and the ability to scale up easily to keep up with corporate growth. As well, “Leading ERPs are built with large enterprises’ strict regulatory needs in mind, thus making audits and reporting less stressful,” Badra said.

As for the cons of ERP systems? Cost is at the top of the list, because an enterprise-wide software platform must be priced high enough to support its development support costs while turning a profit for its creator. ERP systems can also be quite complex to implement and maintain, because they must be installed across entire enterprises.

Then there’s the generic nature of ERPs. To support their development

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Configuration Management	Line Maintenance	Parts Administration	Supplier Management	Customer Management	Journey Log Entry	Compliance Reporting	Product Data Management	Employee Information	Enterprise Setup	
Maintenance Program	Hangar Maintenance	Warehouse Management	Procurement Administration	Contract Management	Flight Charter Contracting	Quality Audit Management	Planning and Scheduling	Certifications & Qualification	General Accounting	
Technical Records	Engine Maintenance	Material Planning	Repair & Exchange Mgt.	Customer Order Management	Flight Sheet Management	Occurrence Reporting	Manufacturing Execution		Accounts Payable	
AD & SB Management	Shop Maintenance	Stock Management	Loan & Borrow	Quotation and Pricing	Crew Scheduling	Standard Reliability	Engineering Change		Accounts Receivable	
Maintenance Planning	Tool & GSE Management	Physical Inventory & CC	PBH & Consignment	Part Pooling & Exchanges	EFB Central				Management Accounting	
Task Card Management	Dent & Buckle Administration	Inventory Analysis	Claims & Warranty Mgt.	Part Sale Management	Flight Contract Invoice				Fixed Assets	
Library Management	Assignments & Time Tracking	Scrap Management	Goods Receipt	MRO Warranty					MRO Invoice	
e-Publication	e-Signoff	Shipping	Part Kitting & Marshalling					Financial Posting Engine		
Enterprise Add-ons										
Hubs			Mobility		Platforms		In-memory Planning & Optimization (IPO)		Eco-System	
Work Reporting Hub	Procurement Hub	Customer Order Hub	Warehouse Anywhere	Approval Anywhere	Workflow	Integration Gateway (IRIS)	Resource Optimization	Inventory Optimization	SPEC 2000	FedEx
Shop – Quick Actions Hub	Inventory Hub	Fixed Asset Hub	Mechanic Anywhere	Tool Anywhere	Dashboards	MAIL IT	Digitization		Customer Portal	OEM Data Interface
Technical Records Hub	Repair Hub	Accounts Payable Hub	Manage Anywhere	Fly Anywhere (EFB)	AI / ML	BoTs				
Engineering Hub	Demand Hub	Financial closure Hub	Line Anywhere (Offline)	Crew Anywhere	Report Writer	I-Extension Development Kit	Digital Task Card			
Engine Visit Hub	Part Kitting Hub	Fleet Overview Hub	Route Anywhere		E-forms					

(Copyright/Credit: Ramco.)

and support costs, ERP vendors have to sell into as many industries as possible. “ERP modules are generally not aviation-specific,” Stone said. “As a result, meeting regulatory and operational needs often requires significant customization, adding cost, complexity, and long timelines. These customizations can create unique, hard-to-maintain systems that lag in adopting new technology or staying aligned with evolving regulatory requirements.”

Finally, the sheer size and complexity of ERPs can make them difficult to update and modify. Meanwhile, when large-scale upgrades are implemented, they can disrupt the entire organization and devour a great deal of IT support hours.

Best-of-Breed Pros and Cons

Because they don't try to be everything to everyone, best-of-breed systems do not suffer the cons associated with ERP systems. By being intensely focused on a single purpose, or a closely aligned set of associated purposes, best-of-breed systems can do what they do very, very well.

Saravanan Rajarajan is AVP and Head of Consulting for Aviation, Aerospace & Defense at Ramco

Systems. His company's Ramco Aviation Software is an integrated web-based ERP platform for airlines, MRO, defense, and helicopter operator organizations.

“Best-of-breed systems bring in deep domain expertise aligned with industry practices, enabling the solution to be deployed with little to no customization,” said Rajarajan. “As R&D for best-of-breed systems is focused on specific domains, these products get enhanced continuously with respect to regulatory and statutory requirements, facilitating faster adoption of technology enablers for industry-specific problems.”

Being so narrowly focused, best-of-breed systems often address specific industry needs right “out of the box”. As a result, they often need less time and tweaking to deploy than generic ERP systems.

These facts explain why best-of-breed systems are easier to update

and upgrade than ERP systems.

“You have the flexibility to swap out underperforming tools as your needs evolve, without overhauling your entire tech stack,” Badra said.

“Best-of-breed solutions can deliver new features independently, allowing faster adoption in specific areas,” agreed Clements. “However, each change must be integrated with connected systems to maintain data flow and process alignment.”

Conversely, the pros enjoyed by ERP systems translate into cons for best-of-breed systems. A case in point: Because they are narrowly focused, best-of-breed systems cannot do everything for an aerospace company. As a result, this company would have to install a suite of best-of-breed systems to match the enterprise-wide coverage offered by an ERP. Doing so requires these systems to be integrated together — a task that requires a talented IT

“End-to-end automation through ERPs reduces manual handoffs, paperwork, and duplicate data entry.”

Monica Badra, Aero NextGen's Founder

The background image shows a large commercial airplane inside a hangar. The aircraft is white with blue and red accents. Overlaid on the image are various digital graphics, including blue and red lines, circles, and hexagons, suggesting a high-tech or digital theme. The text 'ULTRAMAIN®' is prominently displayed in the upper center, with 'Digital MRO Solutions' below it.

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(Copyright/Credit: Swiss AviationSoftware (Swiss-AS).)

department and risks issues such as data silos, synchronization and data entry issues, and a lack of consistent data flow.

"There are certain benefits that can only be unlocked with tightly integrated processes across different areas of the business," cautioned Mather. "If your best-of-breed isn't crossing those boundaries, you can't unlock those types of benefits, no matter how much effort is spent on integrating the disparate systems. Best-of-breed systems also face challenges due to smaller customer pools resulting in less total product investment meaning that it is harder to innovate at pace and adapt to new technologies."

Add in the time and effort required to manage multiple vendors, contracts, and support teams, plus the fact that employees may have to work with multiple logins and different user interfaces, and best-of-breed systems have their downsides.

Some ERP/Best-of-Breed Offerings

So far we have discussed the pros and cons of ERPs and best-of-breed systems in general. Now it is time to see what the vendors interviewed for this story have to offer.

Let's begin with ERP systems. Ramco's Ramco Aviation Software has been designed to provide aerospace companies with a

comprehensive aviation-specific ERP system. This software has an generic ERP's ability to support various business functions including Finance and Sales, while at the same time providing an aerospace-centric focus across the entire platform.

"This approach has helped us support the end-to-end business process and also enabled the domain specific deep functional requirements unique to the aviation industry," Rajarajan said. "For example, managing the rotatable items from both maintenance and finance perspectives, such as exchanges with customers and suppliers, depreciation, valuation and scrapping, is seamlessly handled within a single system. Third-party integrations are considerably reduced as Ramco's integrated solution covers most business areas — barring HR and flight operations — thereby bringing down the IT cost of ownership."

As John Stone has mentioned, Ultramain Systems describes its ULTRAMAIN system as being an aviation-focused EAM rather than a generic ERP. Still, for the sake of general classification, it fits best in the ERP category.

"As an EAM, ULTRAMAIN can support the maintenance needs of an entire enterprise, even when

operations extend beyond aviation, while still delivering the specialized capabilities required for complex fleet maintenance," said Stone. "We chose this approach because airlines and MROs need the best of both worlds. Generic ERPs and EAMs may offer broad integration, but they typically require heavy customization to meet aviation's regulatory and operational demands. Conversely, traditional best-of-breed point solutions deliver depth but often operate in isolation, making integration and enterprise visibility more challenging."

By designing ULTRAMAIN as an aviation-focused EAM, Ultramain Systems aims to provide operators with a single, fully-integrated platform that covers engineering, materials, planning, execution, and reliability "right out of the box, while maintaining the enterprise integration strengths of an EAM system," Stone said. "This allows ULTRAMAIN to handle aviation maintenance with unmatched depth, while also supporting other business units and asset types within the same organization. The result is faster deployment, reduced integration risk, and a platform that remains current with technology and regulatory changes without costly rebuilds."

Although Swiss-AS sees AMOS as a best-of-breed solution, Clements said that this system's ability to work with other third-party systems makes it a best-of-breed/ERP hybrid. "Swiss-AS



(Copyright/Credit: ULTRAMAIN.)

AMOS. AGAIN.



“To enhance maintenance management efficiency and reduce the risk of human error, STARLUX Airlines has officially adopted the AMOS system. By leveraging this industry-leading Maintenance Information System, we aim to streamline our current task card creation processes. Additionally, the system will enable structured management of our Aircraft Maintenance Program and OEM documents, supporting greater operational accuracy and effectiveness.”

says Project Team, Engineering & Maintenance Division of Starlux.

STARLUX takes off with AMOS.

AMOS will enable Starlux to streamline its documentation workflows, improve cross-functional collaboration, and support regulatory compliance. The solution is expected to bring long-term operational benefits by aligning with the airline’s commitment to innovation and service excellence.

determined very early on that a hybrid approach was the optimal solution to deliver a single integrated solution that is in and of itself best-of-breed whilst integrating with other leading suppliers,” he explained. “As part of the best-of-breed logic the most common integration that all AMOS customers use is the financial suite of APIs. AMOS generates a huge amount of financial data, and this is exported to the customers’ financial ERP solution as well as receiving validations and updates. For the airline customers it is the flight operations solutions that is critical, and AMOS has dedicated APIs for the best solutions on the market as well as generic solutions for other providers.”

As for business areas not covered by AMOS, such as Human Resources? “AMOS can be the parent for data such as staff management, qualifications, shift plans and leave,” replied Clements. “Or it can play the child receiving some or all of this data from best-of-breed external solutions ensuring that the customer retains flexibility to determine the best means of delivering value to each role and the business overall.”

For the record, the AMOS platform does cover the core scope for most airlines and MROs. This includes Engineering, Material Management, Planning, Production, Maintenance

Control, Component Maintenance, Quality Control, Commercial (e.g. providing services to third parties), Human Resources, and Financial Management. Around 65% of Swiss-AS’ customers use AMOS across this full scope.

In recent years, Swiss-AS has become part of the Digital Tech Ops Ecosystem, thereby providing additional decision solutions seamlessly integrated with AMOS. “A key example of this is Aviator’s Predictive Health Analytics,” Clements said. “The Aviator platform is able to deliver support to the customer based not only on their own data but also based on data from other airlines also using the solution, not all of whom use AMOS. Meanwhile, when AMOS customers identified planning optimization as an area of interest, Swiss-AS and Aviator produced LMPO (Line Maintenance Planning Optimisation). It adds another level of automation and support for fleet planners when planning maintenance slots.”

IFS is another vendor that sees its management platform as a hybrid. “IFS has found a way to capture the best of both worlds,” said Mather. “We have focused on just six industries. This makes our product, IFS Cloud, a specialized ERP — but what we’ve done is take best-of-breed level capabilities and embed them in our

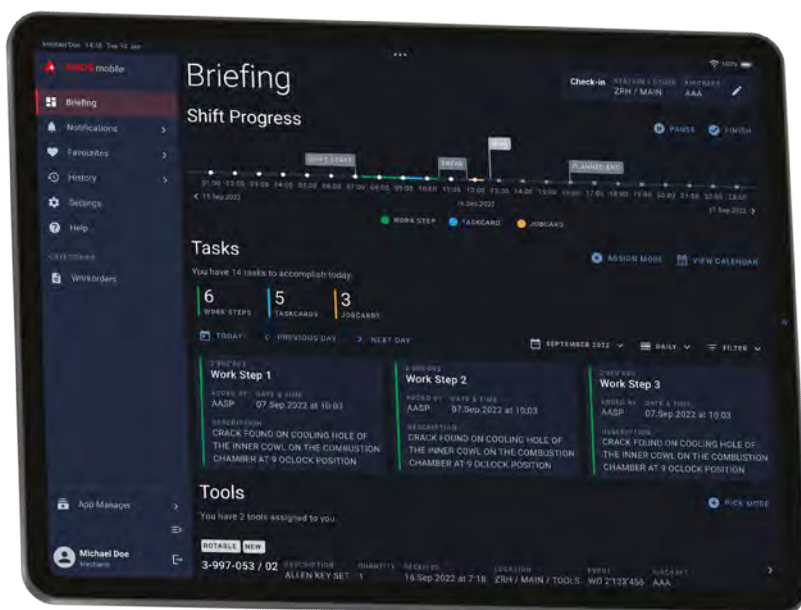


Saravanan Rajarajan. (Copyright/Credit: Ramco.)

expansive configurable platform. In the case of aviation maintenance, we’ve taken the industry-leading best-of-breed product, IFS Maintenix, used by airlines like Southwest, Air France KLM, LATAM, and Qantas, and embedded it in the IFS Cloud platform. We then integrated it to a separate industry-leading solution for engine maintenance and a much more robust supply chain capability. This allowed us to create the IFS Cloud for Aviation Maintenance solution.”

This said, IFS prides itself on being a customer-driven company that supports customer choice. “Recognizing that every customer is different, we’ve enabled the Composable Enterprise, which Gartner describes as an organization that can innovate and adapt quickly by harnessing modular, consumable business capabilities,” Mather said. “In this approach, we’ve made our tightly integrated systems modular. What this means is you can buy our full footprint of ERP and MRO solutions or use our best-of-breed MRO capability exclusively and integrate it into your existing IT landscape.”

Managing all of these choices is why Aero NextGen has found a ready market for its services. “We sit at the crossroads of this ERP vs. best-of-breed debate,” said Badra. “This is why we designed the ERP Finder. We didn’t pick a side — we built a platform that empowers organizations to make the right choice for their unique operational realities. The aviation sector is notorious for its complexity, legacy processes, and ‘square peg, round hole’ software



(Copyright/Credit: Swiss Aviation Software (Swiss-AS).)

deployments. The ERP Finder cuts through this by benchmarking 50+ aviation-specific solutions (ERPs and best-of-breed tools), mapping them to real-world workflows, and delivering tailored, unbiased recommendations. We're independent, deeply specialized, and laser-focused on fit-for-purpose — not vendor hype."

On a related theme, Block Aero is making it easier for both system approaches to function efficiently. To do this, "we are creating digital passports for every aero asset in the world," said Block Aero Founder and CEO Todd Siena. "Every aircraft, every engine, every high-value aerospace component has a story — a history of manufacture, maintenance, ownership, and operation that determines its safety, reliability, and market value. Today, those stories are fragmented across countless systems, spreadsheets, and paper records, making them difficult to trust and costly to verify. Block Aero solves this by creating an immutable digital passport for every aero asset — a Blockchain Aviation Asset (BAA) — secured on our enterprise-grade Aviation Blockchain Network (ABN). These passports consolidate asset identity and provenance into a trusted, portable record that survives ownership changes, company closures, and system migrations."



(Copyright/Credit: ULTRAMAIN.)

Making the Choice

We have examined the pros and cons of ERP and best-of-breed systems and detailed the offerings of the companies interviewed for this article. This brings us to the final question: Which approach is best for your aerospace company?

The answer: "Choosing between these models depends on the organization's business and IT strategies," said Rajarajan. "If the organization places a greater priority on out-of-the-box functional fit over customization or configuration, then the best-of-breed options would be the best choice. But if the organization has already invested in an ERP and would like to leverage

their investment to meet its own business needs or to deploy it to its subsidiaries, expanding the ERP can facilitate process harmonization and enhance reporting."

We close with some words of wisdom from Monica Badra, a person whose business helps people choose the right software systems for their needs. "Don't let technology dictate your strategy," she said. "Let your strategy dictate your technology. The 'right' system is the one that solves your pain points, fits your workflows, and supports your growth ambitions. In aviation, there's no room for generic answers or costly missteps." 📧

By James Careless



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Hang On In There

Aircraft engines have a fixed Time On Wing before being removed for maintenance. Manufacturers usually try and extend that time over the years but some of the latest models were unable to meet the original requirements. **Ian Harbison reports.**



The Pratt & Whitney GTF Advantage engine powering the Airbus A320neo Family aircraft. (Copyright/Credit: Airbus.)

It seems engine manufacturers overreached themselves. The push for higher temperatures and pressures for greater fuel efficiency and the use of more exotic materials did not achieve the expected results, resulting in complex rectification programmes.

CFM

The CFM LEAP engine has been seriously affected by reliability problems. In December, the company received FAA and EASA certification for an updated HPT hardware durability kit for the LEAP-1A engines that power Airbus A320neo family

aircraft. The kit is part of a Durability Improvement Package (DIP) and is designed to more than double Time On Wing (TOW), especially in hot and harsh environments, and includes the HPT stage 1 blade, HPT stage 1 nozzle, and forward inner nozzle support.

To ensure that the improvements

would address durability challenges in those conditions, CFM worked with a team of geologists to engineer dust that mimicked what engines experience in these environments around the world. Using a proprietary dust ingestion system, the company was able to replicate HPT blade wear that operators were seeing in the field. This allowed CFM to design, test and validate improvements to increase the durability and TOW of these parts.

The LEAP-1A durability kit is now incorporated into all deliveries and shop visits and the company is working with Boeing to certify the LEAP-1B durability kit in the first half of 2026.

The company says it has now resolved early reliability issues and LEAP engines are now performing at CFM56 levels, meaning low levels of flight schedule interruptions. The focus is now on two areas that will bring LEAP engines to full maturity: durability, which means longer time on wing (TOW); and mature, low levels of burden, which translates to smoother, more predictable operations.

To reduce the burden, it introduced the reverse bleed system (RBS) to the LEAP-1A last year. This is a cooling system that reduces the need for on-wing fuel nozzle replacements.

RBS has been shipped on new and overhauled engines since mid-2024, with additional retrofits happening in the field. More than 40% of the LEAP-1A fleet is now operating with the RBS, with the system performing as designed. Once the system is fully deployed throughout the fleet, CFM anticipates fuel nozzle replacement to generally occur only during performance restoration shop visits. It is now working closely with Boeing to introduce the RBS to LEAP-1B engines.

Installation training for the RBS is available at four CFM facilities: the GE Customer Technical Education Center (CTEC) in Springdale, Ohio; Safran Aircraft Engines Customer Training Center (CTC) in Montereau, France; Aero Engine Maintenance Training Center (AEMTC) in Guanghan, China; and CFM Aircraft Engine Support South Asia (CFMAESSA) in Hyderabad, India.

The company says these durability enhancements have supported a win rate of over 70% on the A320 family since 2023, but that has come at a price. Announcing the first half year results for Airbus, where the commercial performance in the first half of 2025 had been strong across the company, CEO Guillaume Faury said. "We are producing aircraft in line with our plans but deliveries are backloaded as we face persistent engine supply issues on the A320 programme."

In fact, at the end of June there were around 60 grounded aircraft awaiting delivery, the majority with LEAP-1A engines. This is expected to peak over the summer before it normalises and, said an Airbus spokesperson, the company will continue to work closely with the engine makers to recover in the second half of the year and to deliver on 2025 commitments.

GE Aerospace

The GEnx engine, which was launched in 2011 and powers the Boeing 787 and 747-8, had a durability kit introduced in 2021. This resulted in a more than 2.5 times increase in TOW, with the fleet leader in hot and harsh environments approaching 4,000 cycles and still running. This means customers are keeping engines on wing about five years between shop visits and even longer in neutral environments. The company says that has been a market differentiator, with a 90% plus win rate since 2023.

And durability has become a key feature of engine development. The GE9X, for the Boeing 777X, is most tested engine in GE Aerospace history, with more than 30,000 cycles, the equivalent of six years of commercial flying. Drawing on GEnx and LEAP experience, the GE9X is the first engine to have dust testing completed prior to launch, resulting in a second iteration of the HPT blades.

Speaking at the GE 2Q25 Earnings Call, Lawrence Culp, GE Aerospace - Chairman of the Board, Chief

Executive Officer, commented on the CFM RISE Open Fan project. To date, over 350 tests have been completed with an early focus on durability. This included advancing new HPT blade cooling technology and testing full-size fan blades, along with more than 3,000 endurance cycles.

He added that RISE's Open Fan architecture gains efficiency through the fan system rather than the core. This reduces the need to push the core to higher temperatures as much as a ducted engine, a key driver of today's engine removals.

Pratt & Whitney

Amy Comer, Vice President, GTF Programs, who says AOGs have stabilised and are expected to come down in the second half of the year. The company remains on track for a more than 30% increase in MRO output for the full year, which is a key enabler to reducing AOGs. That increase is a combination of added capacity and improvements in-shop turnaround time, which continues to trend positively.

Part of this comes from continuing investment in the GTF MRO network of 21 global maintenance facilities to support the growing fleet, and it will continue to expand. Announced so far in 2025 have been plans to open a new GTF MRO facility with Sanad in Abu Dhabi, the first GTF MRO facility in the Middle East; an expanded agreement with Delta TechOps for a more than 30% increase in annual GTF overhaul capacity for the PW1500G engine that powers the A220 aircraft; an agreement to expand GTF overhaul capacity across all of MTU's facilities, increasing MTU's annual capacity to up to 600 shop visits across all GTF models; and the addition of ITP as the twenty-first shop in the GTF MRO network and the eighth in Europe.

She adds that the company is in a transformative period for MRO, with the acceleration of new technology applications such as robotics, adaptive machining/welding, additive manufacturing, real-time tooling and material location systems in facilities. One example is the robotic

system at the Eagle Services Asia facility in Singapore that assembles the rotors of the High-Pressure Compressor, maintaining tight assembly tolerances, repeatedly, with key process quality data recorded and trended.

In addition, approximately 40 component repair facilities are in the Global Service Network that complements the global engine centres. The ability to develop and execute innovative repairs at the part level is critical for optimising material flow.

Improvements have also been made in the production process and GTF engines being delivered today are of a significantly improved standard from those early in the program, she notes. MRO also has a role to play. From earlier this year, new hot section parts have been incorporated during shop visits that should provide a significant benefit to TOW, especially in harsh environments. These include an optimised cooling configuration for the combustor and HPT. This new configuration will be installed in production engines from early next year.

New durability ratings are being developed to provide the option for a lower thrust rating to reduce hot section temperatures during climb and extending TOW. Certification is ongoing and the rating will be incorporated with an engine software update in 2026.

In addition to rectification, Pratt & Whitney has also been developing new technology for the GTF. The biggest project is the GTF Advantage engine for the Airbus A320neo Family. This offers significant operator benefits, including: 4% more take off thrust at sea-level airports and 8% more at high-altitude airports; up to two times longer on wing compared to the current engine; better fuel efficiency; and fully intermixable and interchangeable with today's GTF engine model.

It also includes fully redesigned life-limited parts and technology enhancements throughout the gas path. It is fundamentally more durable, with increased airflow



Certification flight testing for the GTF Hot Section Plus is underway on Pratt & Whitney's 747 flying test bed in Mirabel, Canada. (Copyright/Credit: Pratt & Whitney.)

through the core to lower operating temperatures. This has been achieved by taking advantage of the thrust growth capability of the engine and an optimised compressor to cool down the engine.

The hot section enhancements include an advanced airfoil design with improved coatings. The High Pressure Turbine (HPT) and combustor also feature optimised cooling hole size, shape and location, with improved hole drilling techniques to reduce oxidation.

The GTF Advantage test programme incorporated extensive endurance testing to advance product maturity at entry into service and FAA Type Certification was achieved in February. The company remains on track to ship the first production engines to Airbus late this year with entry into service anticipated in 2026.

She says Pratt & Whitney is strategically managing the production cutover for GTF Advantage in a controlled manner and aims to transition the PW1100G-JM production line to the Advantage specification by the first half of 2028.

There is a spin off from Advantage for the current GTF engine, an upgrade option called Hot Section Plus, which brings the GTF Advantage hot section to the current PW1100G-JM engine model. It will capture 90-95% of the GTF Advantage durability improvements with just 35 part numbers, resulting in nearly double the TOW. Certification flight testing of Hot Section Plus is under way on the company's Boeing 747 flying testbed in Mirabel, Canada and it is planned to make the package available to customers for purchase, with incorporation during MRO visits, next year.



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The Rolls-Royce Trent 1000. (Copyright/Credit: Rolls-Royce.)

Rolls-Royce

For Rolls-Royce, the focus is on the Trent 1000 engine that powers the Boeing 787. It recently announced the first of two Durability Enhancement Packages that will more than double the TOW before scheduled maintenance is required.

The first Durability Enhancement

Package includes a 40% increase in cooling to the new HPT blade and updates to the combustion system, fuel spray nozzles and engine electronic controller software.

This has been installed in new engines since January 2025, which will begin deliveries to customers in the second half of 2025, but

it has also been distributed to maintenance facilities globally, and engines are now re-entering the fleet with the Phase 1 improvements in place. Within two years all of the Trent 1000 fleet will have been upgraded.

These upgraded components were originally introduced in 2022

on the Trent 7000 engine that powers the Airbus A330neo. The company says they are performing better than expected and, in some cases, more than tripling TOW.

Phase two of the Durability Enhancement Package is currently being tested at Rolls-Royce's facility in Derby, UK and will bring a further 30% improvement in TOW across the Trent 1000 and Trent 7000 fleets. It features advanced coating on combustor tiles in non-benign environments; cooling and coating changes to high pressure nozzle guide vanes; weight reduction and coating improvements to High Pressure Turbine blades; and a redesigned combustor-to-turbine interface taken from the latest variant Trent XWB-84 EP. This further enhancement will start entering the Trent 1000 fleet from early 2026.

The new technologies are part of a £1 billion Durability Enhancement Programme that is intended to meet



The GE Aerospace dust ingestion system. (Copyright/Credit: GE Aerospace.)

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SCAN TO REGISTER

the company's mid-term targets to increase average Time on Wing across the Trent fleet, which includes the Trent 1000, Trent 7000, Trent XWB-84 and Trent XWB-97. The company announced earlier this year that this target would double from its initial ambition of a 40% average increase to 80% by 2027.

Looking at those other engines, for the upgraded Trent 1000 TEN, also for the 787, Phase 1 includes optimised HPT blade aerofoil shape and cooling, optimised HP NGV cooling and coatings, a new combustor rear inner case and a software update. Phase will introduce advanced coatings on combustor tiles in the hotter part of the engine,

HP NGV film cooling changes and coating optimisation, HPT blade weight reduction and coating optimisation and redesigned combustor to turbine interface based on the Trent XWB-84 style.

The Trent XWB-84 EP, for the Airbus A350, is using lower metal temperatures to improve TOW.

The Trent XWB-97, for the Airbus A350, has a three phase improvement programme. Phase 1 includes increased Turbine Gas Temperature (TGT) margin, seal segment and modification and Turbine Clearance Control optimisation. Phase 2 includes improved coatings for the HPT) blade and seals and a further

increase in TGT margin. Phase 3 sees an optimised combustor, redesigned HPT blades and high pressure nozzle guide vanes (HP NGV), HPT ceramic matrix composite seals and the use of advanced disc materials from the UltraFan demonstrator programme.

Conclusion

It seems the manufacturers have learnt their lesson. While the rectification programmes are delivering benefits and there are further improvements to come, there are still large numbers of aircraft sitting on the ground (**see Table 1**).

By Ian Harbison

Table 1: Storage rates of major narrowbody aircraft, 5 September 2025

Aircraft family	Engine	In service	Stored	Total	% stored
Airbus A320ceo	IAE V2500	2,590	204	2,794	7.3%
Airbus A320ceo	CFM56-5B	3,602	277	3,879	7.1%
Boeing 737 NG	CFM56-7B	6,160	317	6,477	4.9%
Airbus A320neo	Pratt & Whitney GTF	1,239	633	1,872	33.8%
Airbus A320neo	CFM LEAP-1A	2,150	73	2,223	3.3%
Boeing 737 MAX	CFM LEAP-1B	1,936	32	1,968	1.6%
		17,677	1536	19,213	

Source: Cirium Fleets Analyzer via GE Aerospace.

HAMBURG HITS 100

In early September, Lufthansa Technik celebrated the 100th CFM LEAP engine induction into its Hamburg shop. This was a Quick Turn Shop Visit (QTSV) of a LEAP-1B engine from the Brazilian airline GOL Linhas Aéreas. Lufthansa first got its Branded Services Agreement with CFM in February 2018, for the LEAP-1A, with German LBO, EASA and FAA approval following in November 2019. The LEAP-1B agreement followed in 2022, a year that saw Lufthansa Technik become the world's first company to carry out a complete Performance Restoration Shop Visit (PRSV) on a LEAP-1A.

The Hamburg engine shop has

worked on a total of 74 LEAP-1A and 26 LEAP-1B powerplants. Additional MRO capacity for LEAP engines is provided through Lufthansa Technik's global network. In XEOS, the company's Poland-based joint-venture with GE Aerospace, Lufthansa Technik can already utilise extra overhaul capacity for LEAP-1B engines. In the near future, quick turn and test cell capacities for LEAP-1B engines will also be offered through Lufthansa Technik Canada, an entirely new facility the company is building up in Calgary by 2027. By 2030, Lufthansa Technik aims to achieve more than 250 annual LEAP engine inductions

throughout its network.

The company can offer both the Reverse Bleed System (RBS) and the Durability Improvement Package (DIP), which includes the HPT hardware durability kit. The RBS can be installed either during a shop visit or at the customer's location by a Mobile Engine Services Team. So far, more than ten RBS installations have been carried out in Hamburg and more will be installed during current shop visits. The DIP needs to be installed during a shop visit. Since the introduction of the DIP, it has installed on nearly every LEAP-1A that has gone through the Hamburg shop. 

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Advances in Avionics Displays



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Avionics displays are the vital interfaces between aircraft systems and human operators. The data shown on these displays dictates what pilots need to do next, while keeping them informed about aircraft conditions and possible operating issues.

With so much riding on the performance of aviation displays, their manufacturers are constantly improving them to respond to customer needs. In this article, we'll examine the advances driving the development of avionics displays, and the products that manufacturers are bringing to market that incorporate these advances.

Better Pictures, Bigger Screens, More Control

A variety of technological advances are driving the improvement of avionics displays, with manufacturers

successfully translating these ideas into products.

One of these companies is CMC Electronics, an avionics products firm based in Montreal, Canada with U.S. operations in Reston, Virginia and Sugar Grove, Illinois.

Dr. Martin Bitter is an Optical Scientist with CMC Electronics. "Modern cockpit displays have seen significant image fidelity improvements thanks to advances in LED and LCD technology — bringing brighter screens, richer colors, and higher contrast for reliable readability across all lighting conditions," he said. "Improved image quality is the foundation to continuously enhance the situational awareness of the pilots. Prime examples are the implementation of synthetic and enhanced vision systems: SVS overlays 3D terrain, runways, and flight-path visuals, while EVS integrates sensor-

"Modern cockpit displays have seen significant image fidelity improvements thanks to advances in LED and LCD technology."

**Dr. Martin Bitter,
Optical Scientist,
CMC Electronics**



(Copyright: Honeywell.)

derived imagery into displays.

Avionics displays are also trending toward larger and wider formats, with resolutions approaching 4K, unlimited viewing angles, and imperceptible refresh rates. "The so-called large-area displays (LAD) are increasingly more common on new generation aircraft, replacing clusters of smaller screens with a wide format and high-resolution screen," said Dr. Bitter. "This further improves situational awareness by centralizing relevant information close to the pilot's gaze."

Honeywell Aerospace also builds avionics displays, along with cockpit/cabin electronics, power systems, and wireless connectivity systems. Jeffrey Woirhaye is the company's Senior Director Product Management of Cockpit Systems. "When it comes to avionics displays, recent advances include bringing touch-enabled displays to the flight deck, which provides easy access to information and familiarity due to use on consumer devices," he said. "Features which consumers take for granted are now being implemented on avionics. Controls such as multi-touch, pinch zoom and more are becoming standard across our products and expected by pilots."

Woirhaye agreed that displays are getting bigger, but he added that they now have more processing power to integrate information from various sources. This is why primary flight displays now support synthetic vision and 3D symbology to provide

better stabilized approaches, traffic visualizations and flight path awareness. "Features such as track-based synthetic vision have been proven to measurably improve approach flight path accuracy," he noted. "Honeywell has also established strategic partnerships with key hardware providers to ensure that development roadmaps are aligned, which also allows a better integration of hardware and software. This results in better performance and increased capability of the entire system."

"The goal of these advances is to make the display's information presentation more intelligible and understandable," said Arnaud Petitdemange, Thales' Displays & Interactivity Cockpit Equipment Chief Engineer. "For avionics

"When it comes to avionics displays, recent advances include bringing touch-enabled displays to the flight deck, which provides easy access to information and familiarity due to use on consumer devices."

Jeffrey Woirhaye, Senior Director Product Management of Cockpit Systems, Honeywell Aerospace



(Copyright: Thales.)

displays, as well as in consumer electronics, advances focus on enhancing intuitiveness through an improved man-machine interface, making the cockpit a professional and comfortable desktop,” he said. “The introduction of tactile screens, with secure touch interactivity, and larger displays is a key contribution to the crew’s awareness and efficient operations.”

Dror Yahav is Chief Executive Officer of Universal Avionics.

His company has been creating commercial aviation solutions for over 40 years, including advances such as Flight Management Systems, Synthetic Vision Systems (SVS) and Combined Vision Systems (CVS). Universal Avionics has also developed advanced head-mounted displays and multispectral Enhanced Vision Systems (EVS).

“Universal Avionics is advancing avionics displays throughout the cockpit, ranging from flight display systems with connected cloud apps, to pilot-worn displays that enhance head-up operations,” said Yahav. “Just like the most advanced fighter jets, commercial pilots can perform all phases of flight while looking out the window. Enhanced vision systems capture imagery at night and in all weather conditions, overlaid

with 360-degree synthetic vision (SVS) to allow for safe and seamless operations, even when flying in low visibility. This is then intuitively augmented across the pilot’s natural view, supporting situational awareness and operational flexibility.”

By providing pilots with comprehensive visual information, today’s avionics displays enhance flight safety. “When the data collected across these systems is integrated, information can be virtualized in real-time, reducing the cognitive load that comes with interpreting traditional 2D screens,” Yahav explained. “Pilots can perform complex tasks on head-down displays just by looking and pointing at virtual objects. This allows pilots to make faster, more accurate decisions, particularly critical during high-stress operations.”

Dominiek Saelens is Senior Product Manager of Avionics with ScioTeq, which has also spent 40 years designing and manufacturing products for the aviation, air traffic control, and defence and security markets. In addition to noting the trends outlined above — which he views as being driven by consumer electronics and a desire for less clutter in the cockpit — Saelens cites the continuous search for lower weight airborne devices that consume less



CMC CMC's TacView Pro 2-in1 ruggedized avionics tablet PC. (Copyright.)

power as influencing the design of modern avionics displays.

“The reason for this trend is obvious: It allows more features to be installed in the same space,” he told Aerospace Innovations magazine. “Again, this is the same trend as in consumer electronics. Think how small your very powerful smartphone is nowadays with minimal power consumption for extended duration between battery charges. In ScioTeq’s displays, this is made possible by using more



(Copyright: ScioTeq.)

“The goal of these advances is to make the display’s information presentation more intelligible and understandable.”

**Arnaud Petitdemange,
Displays & Interactivity
Cockpit Equipment Chief
Engineer, Thales**

efficient parts in smaller packages, such as mini-LEDs and new LCD technologies that allow for bezel-less displays." As well, Saelens pointed to modular system designs resulting in displays that are physically separated from onboard computers, open-source software being used to break manufacturers' proprietary lock on avionics' operating systems, and the introduction of AI-enabled flight computers to provide even better data to avionics displays.

New Avionics Display Products

Now that we understand the trend and needs driving avionics display improvements, let's consider some of the advanced products that are now on the market.

Asked what is new and different from CMC Electronics, Dr. Martin Bitter cited the TacView Plus portable mission display. Equipped with a small built-in QWERTY keyboard, the TacView Plus is purpose-built

to support electronic flight bags and mission computer capabilities. "This compact 8.4" smart display with NVIS compatibility is designed to enhance situational awareness for military, paramilitary, law enforcement, and civil aircrews," said Dr. Bitter. "Its ruggedized design withstands even the most challenging environments, while advanced cybersecurity protection safeguards sensitive information."

CMC Electronics' third generation Digital Head-Up Display (DHUD) was designed to be a significant advance in HUD technology. To achieve this goal, the DHUD's digital light engine has been built to be brighter and more reliable than the cathode ray tubes (CRTs) used in traditional analog



CMC Electronics' Digital HUD
Information Sheet. (Copyright.)

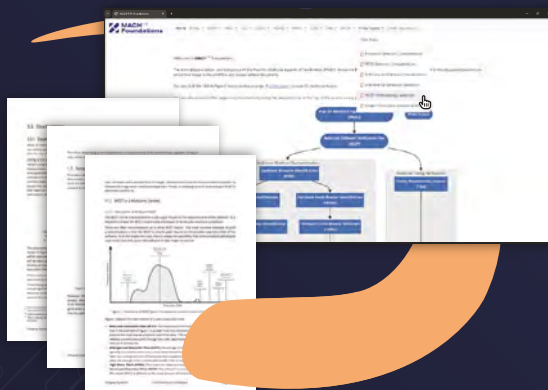
HUDs. "Exceptional image quality across a large field of view is a key differentiator from the competition," Dr. Bitter noted.

Honeywell Aerospace has released numerous new avionics displays that offer simplified and direct touch



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CMC CMC's Digital Head-Up Display (HUD) (Copyright.)

High Reliability and Maintainability

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Digital Light Engine

Fully rastered display with enhanced brightness for exceptional visibility in all environments.

Largest Total Field of View (TFOV)

Optimized TFOV per unit weight, volume, and cost for maximum performance.

Superior Image Quality

High-resolution raster imaging fills the entire field of view with unmatched clarity.



ScioTek MFD-5068 Smart Multi Function Display. (Copyright.)

interfaces. "Displays like our Touch Screen Controller and our 13.1" display unit bring higher resolution synthetic imagery and symbology to flight crews," said Jeffrey Woirhaye. "Honeywell's displays and avionics are also built with connectivity as part of the core technology. With better connectivity, the pilot has better awareness of the surrounding environment, conditions on your destination (or alternate) and the health of the aircraft."

At present, Honeywell is very focused on its Honeywell Anthem integrated flight deck system, which its avionics displays are designed to fit into. "Built upon our Epic product line,

Honeywell Anthem adds additional safety, capability and simplicity to flight operations," he said. "The Honeywell Anthem user interface has been completely redesigned with a modern color palette and a further increase in resolution above Honeywell's current displays, allowing faster recognition of information and simplified data entry."

The Honeywell Anthem integrated flight deck has been built using a "touch-first" design approach. "This means all functionality must be capable of being performed via touch controls while still providing OEMs the flexibility to add physical controls," said Woirhaye. "By optimizing the interface for touch control first, menus and touch targets are optimized and easy to access regardless of their final mode of control. This design approach also ensures the system is not reliant on any physical controls, allowing a growth path towards future automation and autonomy."

ScioTek's approach to sales is to target civil and defence markets at the same time. As a result, "we develop and qualify generic products from which we can easily derive variants," Dominiek Saelens said. "As such, we typically can offer mOTS

(modified Off-The-Shelf) products to customers, reducing time-to-market, development cost and risk for that customer-specific variant. True COTS is a rare thing in the industry."

Over the past five years, ScioTek has brought the following DAL (Digital Assurance Levels) / RDU (Rugged Display Unit) avionics displays to the market:

- RDU-3068: a generic 6" x 8" rugged DAL-A video display with HMI and I/O. configurability. Three RDU-2068 variants are flying, one is in development and several more are in discussion.
- RDU-4208: a generic 20" x 8" rugged DAL-A large area display with HMI and I/O configurability: Five variants are in development for late 2026. A civil variant (FDU-4208) is coming as well sometime in 2029.
- RDU-4047/FDU-4047: a generic 4" x 7" DAL-A video display with HMI and I/O configurability. Both defense and civil variants are available. One variant is flying, four more are in development.
- PU-5200 (matching the trend to split monitors from computers: a generic 5th generation display. The supporting computer is being offered as an open-source platform

through MOSArt. Other variants, including those for the civil market segment, will follow.

Thales has been focusing its attention on large screen touch-enabled avionics displays. "Our first introduction of new generation displays was made on the Airbus A350," said Petitdemange. "This is the culmination of years of development to guarantee that large touch-screen displays provide the same comfort and interactivity as consumer hand-held devices (mobile phone and tablets) while meeting the challenges of the air transport environment and certifications requirements."

These enhancements are central to Thales' next generation FlytX flight deck system. It comes with large, smart touchscreen displays available in 8", 10" and 15" to fit any cockpit size. "The result of in-depth research conducted in cooperation with pilots, ergonomists, physicians, engineers and key technology experts in the field of displays, the FlytX design is focused on intuitive and task-oriented interfaces," Petitdemange said. "The overall philosophy has been to

maximize touch-screen interfaces and make them intuitive notably through contextualization on a map, while keeping the right level of other controls in a multimodal approach."

Compared to legacy avionics displays, Thales FlytX is 30 to 40% smaller in size, weight and power consumption (SWaP) compared to legacy avionics. This reduction has also led to a decreased number of Line Replaceable Units, the virtualization of control panels, and the use of an Integrated Modular Avionic platform to run different avionics applications securely on the same computing platform.

Universal Avionics is the final new product entrant in this story. First on its list is ClearVision, the company's Enhanced Flight Vision System featuring a SkyLens head-mounted display for intuitive out-the-window flight operations. "ClearVision takes in imagery from our EVS-5000 multispectral camera, which enables an unmatched 50% visual advantage and can see LED runway lights that limits the effectiveness of older camera systems," said Dror Yahav. "This EVS imagery, together

with 360-degree SVS, becomes a Combined Vision System that pilots have full control of."

Next is Aperture, an augmented reality (AR) vision system that combines sensors and video cameras with advanced AI Machine-learning processing/analytics and voice recognition for a complete 360-degree composite view of the flying environment. "Obstacles, traffic, weather, taxi instructions, and much more can be intelligently



(Copyright: ScioTeq.)



(Copyright: Thales.)

displayed in real-time, both heads-up with ClearVision and head-down on a glass cockpit like Universal's InSight," Yahav said.

Besides being added to new aircraft, the InSight integrated flight deck system has gained momentum as a retrofit upgrade. It is now certified and flying on Falcon, Hawker, and Citation jets today. Development is ongoing for other aircraft like the De Havilland Canada Dash-8 and CL-215/415/515 Waterbombers.

"With InSight, operators are able to replace old and obsolete equipment, reducing maintenance issues, downtime, and costs for our customers, ultimately allowing them to continue flying their aircraft for another 15 years," Yahav said. "These modern displays give pilots high-resolution digital information — like synthetic vision, terrain awareness, airport maps, and engine data — on integrated screens that are lighter, more intuitive, and help pilots fly simpler and safer. It brings an aircraft at risk of getting stuck in the past to the high-performance standards necessary for efficient operations today."

Some aircraft cockpits are limited in the amount of space available or are unable to upgrade legacy display setups, but still need to add modern functions, such as ADS-B In. In those cases, a head-wearable display like Universal Avionics' SkyLens can overcome this limitation by allowing pilots to access this functionality directly without extensive flight deck modifications.

Easy to Install

Whether selected for new aircraft or retrofitted into old ones, avionics displays require some form of installation. Thankfully, today's flat panel models are easy to put in place.

Better yet, the manufacturers we spoke to have taken steps to make the installation process even simpler to perform. A case in point: "CMC Electronics has established an extensive range of field-proven optical, mechanical, and processing building blocks ready to be customized into solutions," said Dr. Bitter. "The principles of flexible, open architecture are followed to enable a seamless integration into existing and future cockpits. Panels and displays can be swapped or upgraded without redesigning the entire cockpit."

The same is true for Honeywell Aerospace. "Legacy hardware has traditionally required a centralized avionics bay taking up valuable cabin space," Woirhaye said. "Newer avionics are designed to be modular, allowing placement within the aircraft closer to the source of the data or the needs of the equipment. This reduces wiring lengths and also can free up space within the aircraft."

ScioTeq's avionics displays can be DZUS-mounted to center pedestals, bolted to the instrument panel, or ARINC 600 tray-installed. "In most cases, installation requirements are downflowed from the integrator/OEM," said Saelens. "In addition, the transition to ARINC 818 and high bandwidth Ethernet protocols is

simplifying wiring harnesses as well."

Thales' new avionics displays are incorporated in its new FlytX flight deck, so adding them to new aircraft is part of that overall installation process. As for retrofits of FlytX 15" displays into existing cockpits? "The average time to exchange is less than 15 minutes with simple and robust racking systems," Petitdemange replied. "The exchange can even be hot-plug replaced."

Dror Yahav closed this section by noting a salient point for this Universal Avionics product: "A head-worn display system like SkyLens has fewer components installed in the flight deck compared to a fixed HUD, making installation possible in just three days," he said. "For integrated flight decks like InSight, installation typically takes around six to eight weeks. With fewer LRUs than previous systems, installation and maintenance is streamlined and can be completed during a customer's major maintenance check."

What's Coming Next

We have seen how advanced avionics displays have become in recent years. So what advances are on the horizon?

Actually, quite a lot. According to Dr. Bitter, the adoption of cutting-edge display technology from the consumer world has been slow in avionics due to stringent reliability and lifetime requirements. But change is on its way. "As high-resolution LCDs, micro-LED and OLED displays are becoming more mature, CMC Electronics is actively



(Copyright: ScioTeq.)

"Pilots can perform complex tasks on head-down displays just by looking and pointing at virtual objects."

Dror Yahav, Chief Executive Officer, Universal Avionics

(Copyright: Thales.)



working on adopting many of these technologies in their future avionic products," he said. "Improved contrast, clarity, and color fidelity, higher brightness and lower power consumption are the critical design targets."

Dr. Bitter added that CMC Electronics is currently developing the TacView Pro as its next generation portable mission display. "The 10.4" multi-touch display has an increased resolution of 1920 x 1200 pixels and showcases much improved display colors and brightness," he explained. "An increase in processing power with AI capabilities is enabling future AI applications."

Over at Honeywell Aerospace, "we are always thinking ahead," said Woirhaye. "Honeywell has a robust roadmap of display technologies and avionics development. We have solutions for the Advanced Air Mobility, Part 23, Part 25, and Air Transport Markets. AI is truly becoming a game changer. We expect its adoption will need to be measured, but we are already seeing its ability to be used, from testing 'what if' scenarios and refining efficient algorithms for

aircraft performance to maintenance applications."

ScioTeq's avionics unit foresees a future where avionics displays will be customized to fit specific aircraft flight decks, rather than being purchased on a 'one-size-fits-all' basis. "Especially for high-end new platforms, OEMs want to use all available space and not any longer compromise on this by choosing COTS/mOTS solutions," Saelens said. "As such, there is a trend towards more custom glass size development, especially for the high-end platforms. Of course, the ultimate is to use free-form and/or curved LCD glass. This can be enabled by using new display technologies, like micro-LEDs."

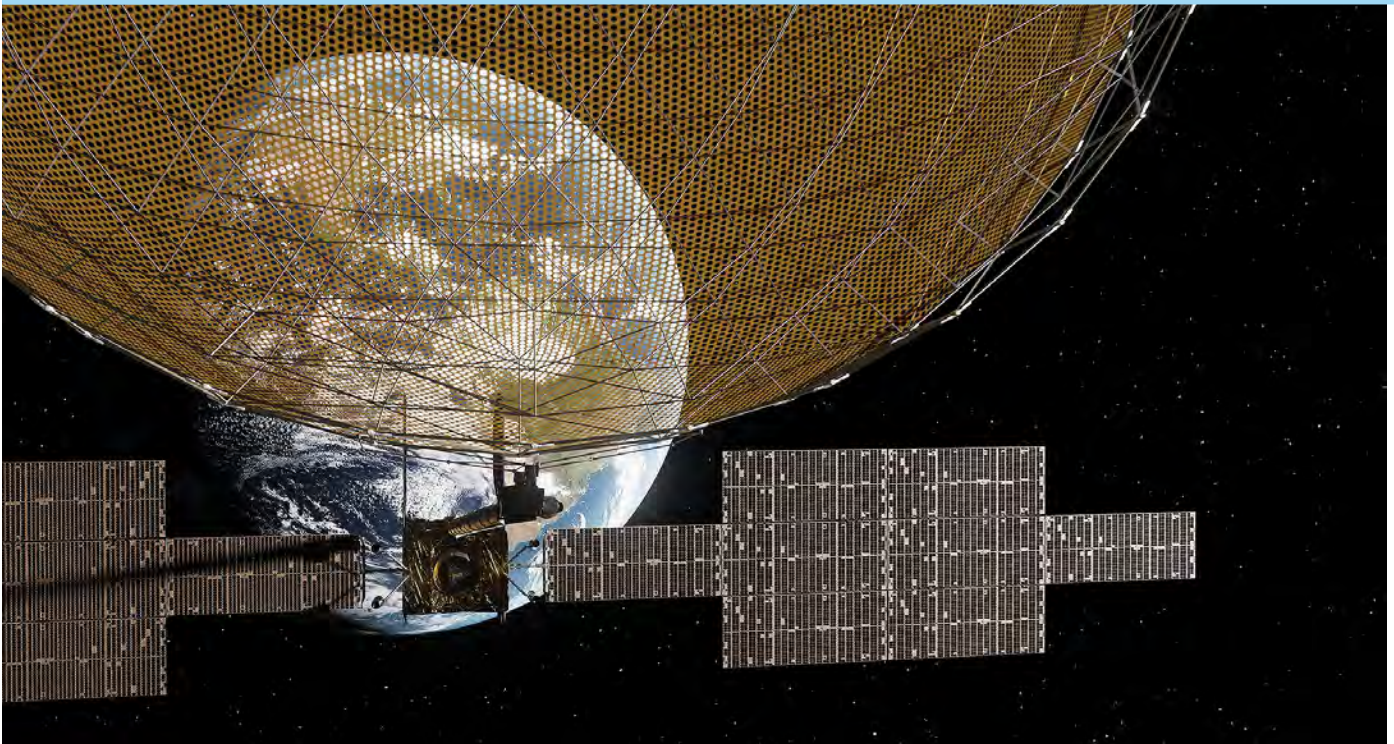
Universal Avionics has a different take on the future. "Displays are reaching their limit in terms of technological hardware advancements, which is why Universal is focused on optimizing the information that is presented on these displays," said Yahav. "Software-based enhancements and system integration helps ensure continuous improvements and enables connections to emerging technologies. The emergence of AI is an integral part of our roadmap

for avionics display development. At the same time, Universal's Aperture AR system is being flight tested on business jets and mission aircraft to fuse real-time video, audio, and traffic data, augmenting this information onto pilot displays. Aperture is expected to be available with visual ATC traffic directions across tablet displays in the next year, with features added to the EFIS and head-up displays to follow in the next three-five years."

As for Thales? "We constantly innovate and improve our existing products," Petitdemange said. "Our aim, for optimum comfort and efficiency, is a full seamless cockpit with large, high integrity displays and interactivity multimodality which uses complementarity between touch, controls and vocal interaction."

In conclusion, avionics displays are shaping up to be some of the most informative, useful, and workload-reducing devices in aircraft cockpits today, and even more so going forward. Such results are a tribute to the power of modern technology, and the innovation of the manufacturers who make these displays. ■

By James Careless



The ViaSat-3 ultra-high-capacity constellation is a highly-advanced global constellation comprised of three GEO ViaSat-3 class satellites and is anticipated to have approximately eight times the capacity of Viasat's current satellite fleet combined. (Copyright/Credit: Viasat.)

Mix and Match

Advances in antenna technology and hardware is helping make the provision of inflight connectivity more ubiquitous. And it doesn't matter if its multi-orbit or LEO-only.

Over the years, the provision of inflight connectivity (IFC) has become less of a halo product - a competitive differentiator for airlines - to more of a hygiene offering, a growing expectation of passengers.

In fact, according to Viasat's *Passenger Experience Survey 2024* published in December last year, 22% of respondents said they won't consider flying long-haul without Wi-Fi, while 1 in 3 said that having no Wi-Fi is one of the most frustrating things about flying today.

Such concerns are being addressed, with Valour Consultancy asserting that for the first time, the majority of the world's in-service fleet is equipped with some form of IFC.

As an illustration, Nick Maynard, Sales Director at Neo Space Group (NSG) reveals that "just one year into operations, NSG, a Public Investment Fund Company, headquartered in Riyadh [Saudi Arabia] has already

secured inflight connectivity selections from a number of airlines in Europe, Asia and the Middle East, and we currently have over 300 aircraft awaiting installation and activation."

Enrique Villaseñor, Vice President at SES, expounds: "Satellite connectivity services are fundamentally reshaping civil aviation by transitioning inflight connectivity from a passenger luxury to an expected core offering, essential for both customer experience and airline operations. Airlines are now able to provide fast, reliable broadband that mirrors on-ground standards, supporting everything from streaming to video calls. More significantly, real-time connectivity underpins operational efficiencies such as predictive maintenance, live weather-based routing for fuel savings, and enhanced crew services. This connectivity allows for new revenue streams through digital advertising and e-commerce and is increasingly integrated with loyalty programs

to deliver personalised passenger experiences."

He believes that in the next 5-10 years, satellite connectivity services are expected to become even more intrinsic to both airline operations and the passenger journey. "Connective footprints will continue to expand, offering even higher speeds, lower latency, and more personalised experiences leveraging AI and advanced data analytics. Hybrid and next-generation satellite architectures will ensure ubiquitous, uninterrupted coverage, including over the poles and other previously hard-to-reach areas," he asserts.

Multi-orbit movers

SES was among the first to bring multi-orbit solutions to market and now offers Ku and Ka band options serving 3,000 aircraft and 30 airlines. In July, the company completed its acquisition of Intelsat, creating a strengthened global

satellite operator with an expanded fleet of 120 satellites across two orbits, including approximately 90 geostationary (GEO), nearly 30 medium earth orbit (MEO) satellites, strategic access to low earth orbit (LEO) satellites, and an extensive ground network.

According to Villaseñor, the evolution of hybrid satellite architectures — combining GEO, MEO and LEO satellite — means that in the near future, you will see multi-orbit satellite providers offering specific bandwidth in GEO, MEO, and LEO orbits toward particular applications, such as video conferencing, streaming, real-time updates, and personalised entertainment, necessitating robust systems that can handle high bandwidth and peak demand. For airline customers, from low-cost carriers to full-service airlines, the flexibility of being able to adjust service levels and coverage enables tailored solutions for varying route structures and business models, such as sponsored Wi-Fi, tiered access, and loyalty integrations, so that connectivity investments translate into both direct and ancillary value.

Indeed, in 2024 SES launched the SES Open Orbits Inflight Connectivity (IFC) Network, a fully interoperable Ka-band platform that combines the multi-orbit and multi-waveform capacity offered by the GEO and MEO satellite networks of SES and regional satellite network operators NEO Space Group (NSG), AeroSat Link (ASL) a subsidiary of China Satcom and Hughes Communications India (HCI).

SES Open Orbits claims to provide internet speeds up to 300Mbps and is available on all production airframes, via Airbus' HBCplus Programme and on Boeing aircraft through Safran Passenger Innovations AeroConnect terminals, including line-fit and retrofit solutions tailored to the airline's requirements.

Already, Uzbekistan Airways has signed up for the service for its upcoming A321neo aircraft from 2026, and Thai Airways for its A321NX and Boeing 777 aircraft, with deliveries beginning in H2 2025, and



On launch, EUTELSAT KONNECT VHTS, was the largest GEO satellite to date in Europe, delivering 230 beams and with a Ka-band capacity of 500Gbps. (Copyright/Credit: Thales Alenia Space.)

its future 787 aircraft, which will be line-fitted with delivery scheduled in 2026. NSG is responsible for delivering the services.

Panasonic Avionics is also among those pursuing a multi-orbit and multi-partnership strategy.

In April this year, the company successfully demonstrated the optimisation of its multi-orbit satellite network following switching between an enterprise-grade LEO network from Eutelsat's OneWeb and a layered GEO network in its flight test program.

The program, which took in Arctic and Equatorial testing, was used to validate the consistent low latency performance of LEO connectivity. Forward link speeds up to 193Mbps and return link speeds of 36Mbps were reported, as social media channels and media rich websites were accessed, video streaming performed as well as enterprise collaboration tools that featured video conferencing.

Following an already deep collaboration, in 2023 Eutelsat merged with Oneweb creating the world's only GEO-LEO operator, with a fleet of 34 GEO satellites and a LEO constellation of more than 600 satellites. The LEO constellation continues under the OneWeb name.

Air Canada is the first commercial airline to deploy the multi-orbit GEO/LEO service, through Intelsat, with additional carriers also beginning installations and commercial flights with multi-orbit solutions on board.

Eutelsat operates the KONNECT VHTS satellite, which entered into service in October 2023 to address the European fixed broadband and inflight connectivity verticals.

With GEO capacity of 500Gbps, KONNECT VHTS features what is stated to be the most powerful on-board digital processor ever put in orbit, offering capacity allocation flexibility, optimal spectrum use, and progressive ground network deployment.

Türksat, which delivers multiple satellite connectivity solutions over its own fleet, as well as third party satellites, recently became an anchor customer of the satellite, following the signing of a new multi-million-dollar, multi-year agreement.

Türksat will leverage multiple beams over Europe to provide services to airlines, in a move Ahmet Hamdi Atalay, General Manager of Türksat said will "enable us to provide more reliable and uninterrupted IFC services for our Aero clients that have so many destinations over Europe. I believe that this cooperation will pave the way for new opportunities that will empower Türksat as one of the leading service providers in IFC market."

Viasat has also formed key partnerships such as its agreement with Telesat to integrate Telesat Lightspeed LEO Ka-band capacity into its multi-orbit network. Commenting upon the agreement, Mark Dankberg,

Viasat Chairman and CEO, observed that a very broad range of mobility customers in every vertical market, whether global or regional, are interested in multi-orbit solutions that are cost effective, offer assurances of high performance, and are resilient to intentional or unintentional service disruptions. "By leveraging our own satellite fleet and its unique advantages, existing national operator partnerships, plus coverage and capacity from leading third-party satellites and constellations, our services are designed to provide customers with the essential capacity density, market access, speed, bandwidth and responsiveness they need. Importantly, we have continued to innovate advanced multi-orbit resource management techniques to reduce costs and expand geographic coverage to better serve the unique needs of each mobility and defense customer."

Others though have eschewed the multi-orbit approach, nailing their colours to the mast as a LEO-only constellation.

Championing LEO

One notable disruptor is the media-shy Starlink for Aviation, which relies on a mesh network of interconnected broadband LEO satellites that have been engineered specifically to provide low-latency, high-bandwidth internet access, with download speeds from 40-to-220 Mbps.

Latency is less than 99ms. Each satellite features a laser terminal, or laser crosslink, which allows the satellite to transmit data to and from another Starlink satellite sustaining a 100Gbps connection per link. This is particularly crucial where no SpaceX ground station is near.

According to the SpaceX, Starlink satellites are designed and built for high reliability and redundancy in both supply chain and satellite design to successfully carry out their five-year design life. Thanks to a rigorous part and system-level screening and testing, SpaceX claims it can reliably build and launch satellites at very high rates.

While United, Air France and SAS have become recent customers of Starlink, JetBlue is betting on Project Kuiper, Amazon's LEO satellite network. JetBlue, the first airline to sign up to the service, will implement Project Kuiper's LEO technology on select aircraft beginning in 2027. In another boost, Amazon will integrate Project Kuiper's connectivity solution into the aircraft catalogue of Airbus.

Emerging from stealth mode, Logos Space Services has secured a US\$50 million Series A financing led by US Innovative Technology, to expediate the build out of a 4,178 LEO satellite constellation. The company, founded by Milo Medin plans to launch its first satellite in 2007, pending US Federal Communications Commission (FCC) approvals.

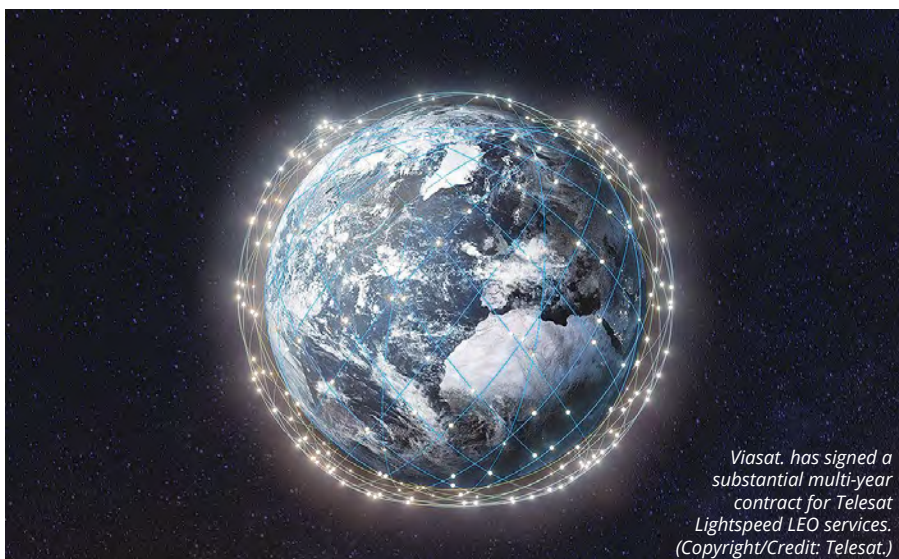
Antenna advances

Villasenor believes that the incorporation of hybrid GEO/ MEO/LEO satellite architectures means airlines no longer have to compromise between coverage and latency, as the combination provides both global reach and instantaneous data transfer, regardless of location or bandwidth congestion.

"The emergence of electronically steered array antennas (ESAs) marks a major leap forward, eliminating the need for bulky and drag-inducing mechanical antennas, slashing fuel consumption, reducing maintenance downtime, and enabling installation on a wider range of aircraft types. Additionally, modular system design and improved manufacturing processes allow for both factory line-fit and swift retrofit installations, reducing aircraft ground time," he says.

Jeff Sare, Chief Commercial Officer, agrees that new hardware advancements at ThinKom are driving down operating costs, improving performance, and giving airlines more flexibility in how they deliver passenger connectivity. He says that by increasing flexibility, such as through Variable Inclination Continuous Transvers Stub (VICTS) which provide maximum flexibility (between orbits and providers) to enable aircraft to seamlessly connect across multiple satellite constellations (GEO, MEO, LEO), switch between service providers or even simultaneously utilise multiple service providers to deliver the highest possible QoE [Quality of Experience] by leveraging the most cost-effective and reliable solution at any given moment, driving down cost per megabit, reducing drag and operational overhead, and enhancing reliability, new IFC hardware is transforming connectivity from a costly passenger perk into a scalable, economically sustainable service model for airlines.

Marco Dorjee, VP Operations LEO & IFE, AirFi shares the opinion. He says that new hardware is making inflight connectivity lighter, cheaper, and faster to deploy. "Smaller antennas and modular systems cut install



Viasat. has signed a substantial multi-year contract for Telesat Lightspeed LEO services. (Copyright/Credit: Telesat.)

and fuel costs, while new terminals unlock low-orbit networks that bring down bandwidth prices and improve performance. The result: connectivity shifts from a costly perk to a baseline utility that delivers both passenger revenue and operational value."

Dorjee says that AirFi is approaching this on two fronts: smarter design to reduce upfront hardware costs, and lifecycle efficiencies through standardised, low- or maintenance-free components. "Our antenna is a low-profile, lightweight, non-intrusive unit with no moving parts, installed within the existing window pocket to minimise drag and maintenance. Leveraging the highly reliable Iridium network, it delivers fit-for-purpose connectivity, perfect for today's requirements, from payment validation to IP messaging services."

According to Sare, ESAs do offer advantages in certain applications. "For instance, a small ESA can provide strong performance with improved [space, weight, and efficiency power] SWaP and lower upfront cost for fleets operating in geographically limited regions where LEO capacity is abundant. In such cases, an ESA optimised for LEO-only service may be the right fit.

However, as he points out, the vast majority of commercial aircraft, and especially long-haul and widebody fleets, regularly cross regions with highly diverse technical and regulatory requirements, served by multiple capacity providers. "For these aircraft, a single-constellation or single-orbit ESA solution can quickly become restrictive, leading to inconsistent passenger experiences and higher operating costs.

"ThinKom believes the most effective long-term approach is enabling aircraft to seamlessly leverage all major satellite networks—GEO, MEO, and LEO—through adaptable, high-performance antenna technology. Just as a mobile phone connects to virtually any network worldwide, aircraft should be able to access the best available capacity regardless of orbit, provider, or geography.



Project Kuiper's aviation-specific customer terminal is based on Amazon's most powerful Kuiper terminal—a full-duplex, Ka-band phased array antenna that can support download speeds up to 1 Gbps on a single device. (Copyright/Credit: Amazon.)

This ensures consistent quality of experience today and scalability as demand continues to grow."

As part of its forward-looking terminal roadmap, Viasat is introducing a proprietary ESA terminal, Viasat Aera. This will unlock simultaneous, dual-beam connections across satellites in GEO, HEO, and LEO, enabling a best-in-class IFC experience to airlines and their passengers with a single antenna. The company says the new terminal is under development and is devised to dynamically adapt connectivity in a way that capitalises on the strengths of all available transmission assets, delivering a streamlined experience for each application in use across the global network.

Expected for commercial service in 2028, upgrading to the new Viasat Aera terminal is designed to be achieved in less than a day by re-using the ARINC 791 antenna attach points with no change to the in-cabin network.

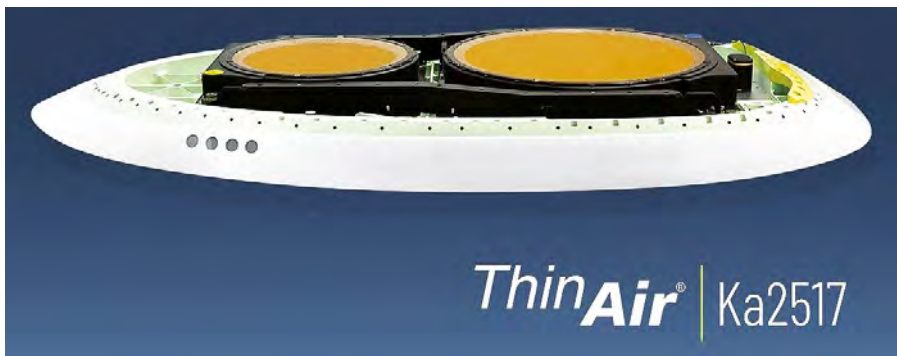
According to Sare, ThinKom's ThinAir open architecture means airlines can adopt new providers or satellite constellations with minimal aircraft downtime, often with just a modem upgrade. "Our network-agnostic approach means once an airline has a ThinAir antenna installed it can remain in service for a decade or more, even as new constellations come online. Keeping planes flying

with the original antenna investment rather than frequently swapping hardware in the hangar is a huge cost-savings move in this industry.

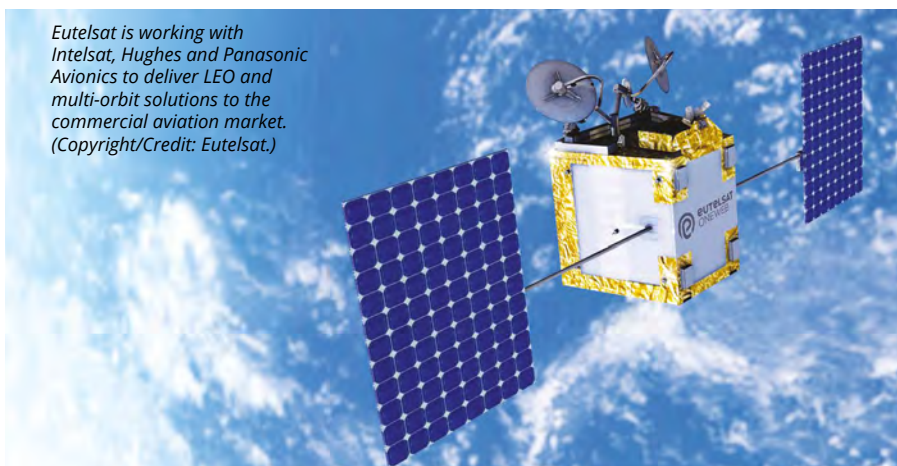
"Ultimately, a ThinAir terminal installed today is also ready for tomorrow's demands."

He explains that by re-using the existing Outside Aircraft Equipment (OAE) such as the adapter plate and radome, airlines may avoid major structural modifications and significantly cut down installation time. In addition, ThinKom antennas use common interfaces for power, data, and network integration allows the new antenna to plug seamlessly into the existing in-cabin network architecture. This minimises downtime, reduces costs, and ensures that cabin systems continue to operate smoothly while the connectivity capability is enhanced.

It's a similar scenario at AirFi. "With the support of our partners, we can complete the full installation, including antenna, cabling, and system components, overnight," states Dorjee. "Thanks to our modular design and simplified mounting, downtime is minimised while installation time is kept to a minimum. The result is a seamlessly integrated in-cabin network, fully connected with our LEO transceiver and delivering a single, cabin-wide IFEC meshing system that supports EFI, Connect Crew, and all other AirFi solutions."



ThinKom and Kontron have partnered to develop a multi-modem terminal capable of supporting multiple constellations across multiple orbital planes. (Copyright/Credit: Thinkom.)



Eutelsat is working with Intelsat, Hughes and Panasonic Avionics to deliver LEO and multi-orbit solutions to the commercial aviation market. (Copyright/Credit: Eutelsat.)

Road ahead

Looking at the market itself, Villaseñor says that the trend towards factory-installed, high-speed Wi-Fi systems is accelerating, and adoption is expected to become standard practice across the aviation industry, not only for long-haul and mainline fleets but increasingly for regional transport aircraft as well, revealing that the new SES multi-orbit satellite inflight connectivity service is now operational on two major North American airlines.

Aircraft manufacturers are making connectivity a line-fit option for many new aircraft models, including those from Airbus, Boeing, and Embraer. He points to the example of the SES ESA system, which is now a line-fit option for Embraer E2 aircraft. "The benefits of having systems installed during production include optimal integration with aircraft systems, reduced installation complexity, and improved time-to-market for new aircraft. Moreover, as regional and short-haul routes experience rising passenger expectations for

connectivity, airlines are extending investment in factory-fit and retrofit Wi-Fi systems to these fleets. The process is further catalysed by advancements in lightweight, low-profile antennas and the scalability of multi-orbit network solutions, which make it technically and economically viable across all segments of commercial aviation. As a result, factory-installed high-speed Wi-Fi is poised to become ubiquitous within the coming years."

Sare says that with airlines talking about speeds greater than 1 Gbs to the aircraft "we believe that a true multi-link, multi-band, multi-orbit solution delivered via a multi-aperture terminal, combining links from different orbits and constellations, best meets that need. The ThinAir Ka2517 Plus supports today's and next-gen ESA antennas on low-latency LEO networks, joining our proven, high-performance, multi-orbit system to create a super-charged, future-proof offering that can meet those demands."

Sare also expects to see new, more

efficient waveforms come online in the future. "Fortunately, ThinAir antennas can handle that evolution with a simple modem upgrade, often delivered over the air. So, as the network delivers more data the ThinAir antenna will adapt seamlessly, growing into future use cases."

He says that ThinKom is advancing its technology to address evolving market demands. Emerging high-frequency bands (Q, V, E, W) will unlock new capacity, enabled by smaller, lighter, and more cost-effective antennas. Wide instantaneous channel bandwidths are essential to realising this potential. "We are also developing dual-beam antennas with selectable multi-spectrum operation, designed for interference-free interoperability under increasingly strict regulations. Looking ahead, airframers will seek fully embedded antenna solutions between frames and stringers, built on highly efficient, capable, and reliable hardware."

Dorjee believes that LEO has already proven its business case for IFC. "Combined with on-edge EFI in a single system, it delivers everything from entertainment to connected services while enabling secure monetisation. Connectivity stability is ensured through the Iridium constellation, embedded at the core of the IFC system. While some use cases may require expansion beyond our current offering, our experience shows that ROI is achieved most effectively when focusing on delivering the essential services first."

Importantly, says Villaseñor, connectivity is anticipated to play a growing role in airline safety, predictive maintenance, real-time environmental monitoring, and regulatory compliance, while enabling innovation in digital services, augmented reality applications, and inflight commerce. "The evolution will support a dynamic, connected ecosystem that continually adapts to changing passenger, operational, and regulatory demands," he says. ■

By Alex Preston



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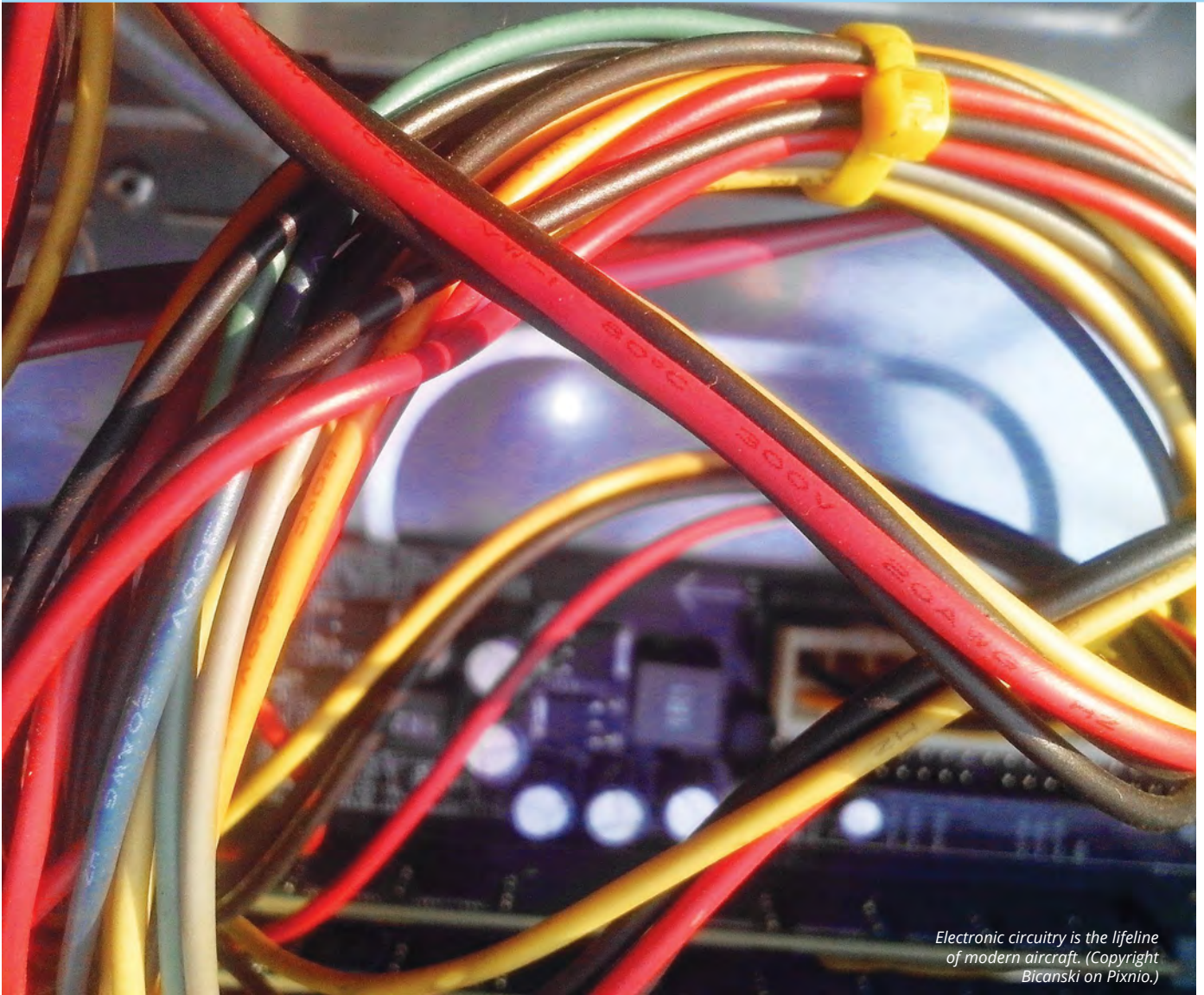
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Electronic circuitry is the lifeline of modern aircraft. (Copyright Bicanski on Pixnio.)

Advances in Aircraft EWIS

Continuing electrical advancements help keep planes flying and systems functioning

Aircraft cables, connectors, interconnects, wires and harnesses are considered to be aircrafts' central nervous system because they interface with a variety of applications on board. Forming an electrical wiring interconnect system (EWIS), they are the lifelines of modern aircraft, enabling the transmission of power, signals and data that keep planes soaring and systems functioning flawlessly. Continuing advancements in these components are contributing to the increasing reliability and performance of aircraft systems.



Gore's existing portfolio of wire and cable is lightweight, durable, and robust, engineered to meet the rigorous electrical, mechanical, and environmental demands of legacy and next-generation aerospace and defense platforms. (Copyright: W.L. Gore & Associates Inc.)

Cables

Cables are an essential component in electronic systems. If a cable goes down, an entire system can fail. Technological advancements are trying to prevent that from happening. The performance requirements for modern aircraft cabling continue to increase at a pace that is driving the need for advanced materials, design and performance evaluation. With a focus in the defense sector on air dominance, there is a need for high-performance RF/microwave cables operating to 40GHz and beyond.

"Microwave cables operating in this band of the electromagnetic spectrum are typically smaller in diameter making durability during and after installation a significant requirement," says Tamera A. Yost, Ph.D., Chief Technologist at W. L. Gore & Associates, Inc., Elkton, Maryland. "This is compounded by the integration of more computing power within the Electronic Warfare subsystems by designing multiple functions with one LRU and thus reducing the number of LRUs. Small, rugged, routable high-frequency cables using advanced low-loss dielectric materials that are inherently designed to withstand the installation and lifetime of the aircraft can reduce development and build time and provide connectivity over the life of the aircraft."

Michael Traskos, President, EWIS DER, Lectromec, Chantilly, Virginia, explains that a recent development in cables/wires has been the heavy investment and focus on addressing the need of high voltage applications. "While meeting the needs of high voltage may seem to be simple (e.g., add insulation), the aerospace segment is weight sensitive and seeks solutions that optimize performance and weight. Other areas that have seen benefits have been the metalized fibers for shielding applications. While this is not a new development, the implementation has increased in the last couple of years taking advantage of the work and research performed a decade ago."

As avionic systems move to digital

The performance requirements for modern aircraft cabling continue to increase at a pace that is driving the need for advanced materials, design and performance evaluation.

infrastructures, low-latency, high-speed interconnects provide the backbone of the avionic architecture. Whether choosing an optical or copper interconnect, the error-free, real-time availability of information being transported, processed and made available to the assets within the mission is required to ensure coordination among all. Within digital interconnect systems, error-free operation is the key to having the information when it is needed to make a critical decision.

"When choosing a digital interconnect, specific attention needs to be placed on not just meeting the specification but having sufficient margin in performance to allow for system performance degradation to temperature fluctuations, vibration and other environmental factors," Yost says.



*An aviation machinist installs a wiring harness on an F-A-18E Super Hornet engine.
(Copyright: Picryl.)*

Connectors and Interconnects

RF and microwave connectors are precision manufactured components. Digital interconnects are now operating in the GHz range and Yost believes connectors for high-speed differential signals will require similar design expertise and manufacturing tolerances to provide impedance controlled transitions from the cable through the connector. "Without impedance-controlled transitions, the interconnect will suffer from reflections that can lead to sub-optimal link performance."

Advancements in high performance digital interconnects start with a well-balanced differential pair cable that Yost says is terminated to an impedance-controlled connector that operates cleanly beyond 5 GHz. "Similar to techniques used for RF and microwave cable termination, skill is required to prepare the cable properly to enable a robust termination to the connector with minimal excursions from the specified impedance."

Elizabethtown, Pennsylvania-based TE Connectivity's MULTIGIG



*Wires and pipes outside the lining of an airplane's turbine engine.
(Copyright: Cloom Tech.)*

HD connector was recently selected by the VITA Standards Organization (VSO) as the Next-Generation VPX plug-in module connector and will Matt McAlonis, Director of Advanced Systems & Architecture and Engineering Fellow for Aerospace, Defense and Marine at TE Connectivity says it will become a defense industry standard. "The redesigned MULTIGIG HD connector builds on the previous variants of TE's MULTIGIG HD product family, while bringing significant technical advances including doubled pin count, 112 Gb/s data rates, increased current capacity and support for rugged environments."

Wires and Harnesses

As is the case with aircraft cables, electronically controlled and powered, high dielectric strength materials for insulation systems enable higher voltage (>600V) power distribution systems to operate at elevated temperature

The shift from large defense aircraft to smaller autonomous vehicles has forced miniaturization of sophisticated electronic warfare systems and a reduction in weight for all materials.

and altitude. These insulation systems require void-free materials with low permittivity to enable partial-discharge free operation well beyond the system voltage to provide a necessary safety margin to account for the drop in partial discharge performance when operating at 50,000 feet and elevated temperatures beyond 200 degrees C.

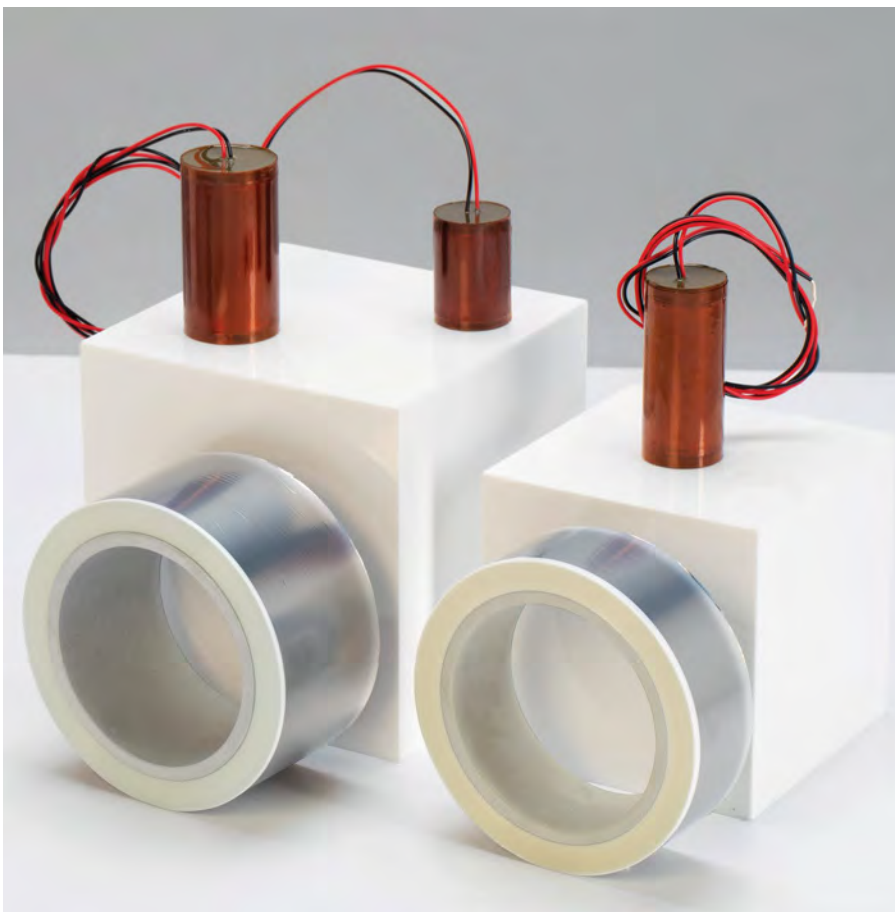
"Routing and installation of these large-gauge power feeder cables can become a challenge as insulation wall thickness is increased and the force-to-bend and amount of spring-back when bent creates

significant stresses on the cable connection and the ability to route the cable," Yost says. "The use of high strand count center conductors can minimize these forces and combined with high dielectric strength materials the wall thickness can be reduced to provide an overall flexible, high voltage power cable that can be easily installed."

For both large and small power wires and cables, abrasion resistance of the insulation system is important when choosing a solution for modernizing and retrofitting existing aircraft. "Not having the freedom to choose the routing puts additional burden on the installer to be able to have a solution that not only fits within the existing airframe but is able to be pulled through without fear of damaging the insulation," Yost says.

Harnesses—a collection of bundled electrical wires that protect and route electrical wiring throughout an aircraft—are vital to aircraft operations and success. There is continuing movement toward custom harnesses, which require an initial investment, but offer significantly reduce maintenance costs over an aircraft's lifespan. Generic wiring cannot keep up with modern bandwidth, power and weight requirements. A well-built custom harness minimizes failures, preventing costly repairs and unscheduled maintenance downtime. They can also improve power efficiency, protecting avionics and sensitive electronics from premature failure.

Developments continue to be discovered for harness protection. New materials for fire protection



GORE High Temperature Film delivers reliable capacitor performance and proven durability in extreme aerospace and defense environments. (Copyright: W.L. Gore & Associates Inc.)

and arc damage protection help OEMs reduce separation in critical areas easing installation challenges.

Lighter Weight

McAlonis says innovators are developing advanced materials and miniaturized electronics to help reduce weight. This will improve fuel efficiency, increase payload capacity and enhance performance. "The demand for electric flight is increasing the need for high-speed battery charging and weight reduction. Special cables, contactors and switches are being designed to handle the high voltages, amperages and temperatures encountered during fast charging. For battery weight reduction, engineers are balancing weight and power to deliver peak power for takeoffs and landings without adding excessive weight to the airframe."

Traskos explains that while some of the economics of flight/space-applications has changed, the push for lighter weight components has always been part of aerospace. "The use of metalized fibers has increased significantly in the last couple of years, primarily with regard to shielding applications. The current carrying capacity is still not comparable to copper. They present challenges for lightning-strike prone areas of aircraft, but there are plenty of aerospace applications where the weight-savings benefits can be realized."

Next-Gen Fiber Optics and Nano Miniature Connectors

Fiber optics and miniature connectors can enable higher data throughput. Fiber optic cables



RayFlite High Voltage Cables.
(Copyright: TE Connectivity.)



An aviation electrician replaces a blade wire harness on an MH-53E Sea Dragon. (Copyright: Picryl.)

can provide more bandwidth than may ever be needed in a single aircraft and provide a tremendous weight benefit.

TE Connectivity has launched several new developments leveraging fiber optics including fiber optic flex cabling and a transceiver, MULTIGIG TRX, and has connectors for VNX+ in development for launch in late 2025. "Our Optical Flex solution effectively offers complex

harnessing with thousands of possible connections and routing capabilities, with drastically reduced space envelope and weight that simply isn't possible with copper, all at the speed and bandwidth of FO," McAlonis says. "We have the FO connectors and transceivers for an immensely robust, high-bandwidth, high-volume throughput, lightweight signal connectivity system."

Yost believes having the



GORE SKYFLEX Aerospace Materials provide lightweight, easy-to-install dry sealants and gaskets that deliver dependable sealing performance and corrosion protection across both primary and secondary aircraft structures. (Copyright: W.L. Gore & Associates Inc.)

aerospace industry get comfortable with using fiber optic cables will take time and training. Additionally, "Having robust and durable jackets for fiber optic cables will enhance handling without damage and speed implementation of this technology. Miniature connectors increase the signal density which equates to more data per square area. High performance computing platforms that process tremendous amount of real-time data for AI algorithms require miniature connectors to provide the signal density required to minimize the overall system footprint and weight."

Higher Voltage

Lectromec supports higher voltages. But Traskos explains

that, "The aerospace sector does not have high-voltage component standards developed at this point and given what has been learned about material degradation at high voltages/frequencies, there is a decent chance it will not for quite some time. The reason for standards is to have common parts and common parts require common needs. Right now, there are so many competing technologies, designs and power systems, each one requires customization and testing to verify the reliability for the application."

A significant level of effort is going into the research, design and testing of wiring system components for high voltage applications. Wire/cables supporting high voltage applications now are assessed for

partial discharge at ambient and reduced atmospheric pressures; something Traskos says was not done in the past. "This has then led to improvements in cable design, termination techniques and inspection/maintenance plans."

Environmental Regulations Prompt Advancements

Regulation provides challenges but also opportunities for innovation. Yost contends environmental regulations have driven the move from fuel-based systems to all-electric or hybrid-electric aircraft and is the largest shift in aviation technology. "The need for electric propulsion has spearheaded the need for improved wire and cabling."

RoHS is the EU's Restriction of Hazardous Substances Directive,

a regulation that limits the use of specific hazardous materials in electrical and electronic equipment (EEE) to protect human health and the environment. It restricts substances like lead, mercury and cadmium. The REACH Regulation is a comprehensive European Union (EU) law that aims to improve the protection of human health and the environment from the risks posed by chemicals.

Traskos says RoHS and REACH are creating problems in the supply chains and it can be in ways that take years to realize. The primary insulation types on aerospace wires/cables are various types of fluoropolymers, which Traskos says are close to being banned. "Not specifically being added to the banned lists, but from attrition from elimination of the supporting chemicals. The advances that are being made now are more related to trying to maintain the same level of performance with an ever-reduced



Boeing 737 MAX production at Boeing's Renton, WA factory. (Copyright.)

set of tools to do it; almost like trying to keep ones footing in a river. At some point, there will be a material restriction that will require reduction of longstanding performance requirements. This may

be something like cable markability, or it may turn out to be more impactful like fluid resistance or flammability." ■

By Mark Robins

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The imitation game

Instances of GNSS spoofing are on the rise, especially near nation-state conflicts, but the threat is spreading to areas of non-active skirmishes.



GNSS jamming and spoofing events present a clear and growing danger. (Copyright: Freepik.)

The use of Global Navigation Satellite Systems (GNSS) enhances performances in aviation. GNSS is the standard generic term for such systems that provide users with positioning, navigation, and timing (PNT) services. GNSS based technologies are now widely used for aircraft navigation for different phases of flight including departure, En Route and approaches.

The term includes the US Department of Defense's Global Positioning System (GPS). Indeed, given its prevalence, GNSS and GPS are used interchangeably, but there are other regional systems including the Chinese government's BeiDou Navigation Satellite System (BDS), formally called Compass, the European Union's (EU) Galileo, the Russian Federation's GLONASS, the Indian Government's IRNSS and Japan's QZSS.

Speaking in January 2024, the then EASA Acting Executive Director Luc Tytgat stated that, "GNSS systems

offer tremendous advantages to aviation in increasing the safety of operations in a busy shared airspace."

However, he also noted that there had been "a sharp rise in attacks on these systems, which poses a safety risk. Countering this risk is a priority for the Agency."

For Mark Watson, Technical Programme Manager at EUROCAE, the recent spike in Radio Frequency Interference (RFI) events, affecting aviation users of GNSS, highlights the vulnerability of the Communication, Navigation and Surveillance (CNS) infrastructure.

"One of the main weaknesses of current GNSS technologies is its low received signal power which are jammed or spoofed daily in some regions of the world. With the increasing usage of GNSS for aviation, it clearly appears that resilience of airborne equipment to such threats is strategical for operations availability and continuity while maintaining the required integrity and accuracy,"

he states. "Beyond that, multiple systems, both in aircrafts and in CNS ground infrastructure, make use of GNSS time outputs, reinforcing the need for resilient GNSS signals."

What's in a name?

As Adam Price, Vice President - PNT Simulation, Spirent Communications, FRIN explains, GPS jamming and spoofing are both classified as forms of interference, but the mechanisms and the impacts can differ significantly. In simple terms, jamming involves overwhelming a receiver with noise, rendering it unable to process the desired signals.

As others note, it is relatively easy to employ and with the low cost of jamming equipment coupled with its diminishing size makes acquiring and delivering jamming devices, including by using inexpensive drones, an increasing concern.

Recently, an EU spokesperson confirmed that the GPS system of European Commission President



GPS interference disrupts satellite navigation signals through two main techniques, GPS spoofing and GPS jamming. (Credit: SkAI Data Services/GPSwise.)

Ursula von der Leyen's airplane was jammed while en route to Bulgaria. Bulgaria's government said the GPS signal was lost as von der Leyen's plane approached the southern city of Plovdiv, prompting air traffic controllers to switch to ground-based navigation systems to ensure a safe landing.

GPS spoofing is the deliberate transmission of counterfeit GNSS signals to deceive GNSS receivers, causing incorrect position, navigation, and timing data.

According to Price, the first thing to state here is that we are talking about spoofing at RF. He says that another form of spoofing, and one that may become more prevalent as RF architecture is hardened, is a man-in-the-middle attacks. This resembles a traditional cyberattack, wherein an attacker gains a device and manipulates the signal processing or receiver output. In this case, no false signals are required at all.

"Looking at the increasingly common and better-understood RF spoofing attacks, these can be broken down into a number of different forms," he explains. "Meaconing is the rebroadcasting of real GNSS signals, where the delay in broadcast causes error in the receiver under attack. Code carrier attacks involve the malicious broadcast of synthetic GNSS signals. An asynchronous (non-coherent) attack is simply a broadcasting of false independent signals in order to manipulate the PVT (Position, Velocity and Timing)

solution of unprotected receivers. Synchronous (or coherent) code carrier attacks synchronise signal timing and navigation data with the real signals before the fake signal is broadcast. This can make them much harder to detect."

Price adds that while there is a clear difference in terms of the attack vector, it should be noted that the impact can sometimes be more grey. "As an aircraft – for instance – moves towards or away from a jammer, there's often a point at which the jammer-to-signal ratio is too high for the receiver to function properly,

but not high enough to completely knock it out," he says. "In such cases, receivers can report behaviour similar to a spoofing attack – outputting inaccurate and misleading data, rather than no data."

And while in very recent years, GNSS jamming and spoofing incidents have increasingly threatened the integrity of PNT services, they are not a particularly new threat to aviation.

Writing in a 2003, Los Alamos research paper (LAUR-03-6163), Jon Warner and Roger Johnston, then members of the Vulnerability Assessment Team at Los Alamos National Laboratory, pointed out that "receivers are generally aware of when blocking or jamming is occurring because they have a loss of signal. Spoofing, however, is a surreptitious attack."

Clear and present danger

Benoit Figuet, Co-founder of SkAI Data Services, which contributed to the OPSGROUP GPS Spoofing workgroup, says the risk is now operationally significant for civil aviation. In a survey by OPSGROUP of nearly 2,000 flight crew, 70% rated their concern over GPS spoofing's impact on flight safety as "very high" or "extreme" with 91%



The plane carrying European Commission President Ursula von der Leyen's on a four-day tour of EU nations bordering Russia and its ally Belarus, was targeted with navigation interference. (Copyright/Credit: European Union, 2025.)

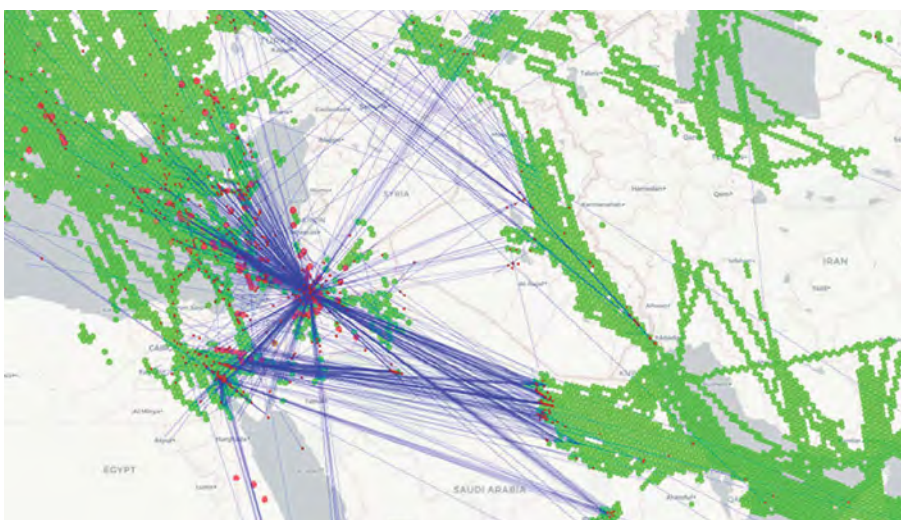
expressing at least moderate concern.

In collaboration with SkaI Data Services, researchers at the Zurich University of Applied Sciences - Centre for Aviation have developed a GPS spoofing tracker, GPSwise, that uses ADS-B data obtained via the OpenSky Network to identify potentially spoofed aircraft. This spoofing tracker displays the position of potentially spoofed aircraft on an interactive world map in real time and enables users to obtain an up-to-date picture of the situation.

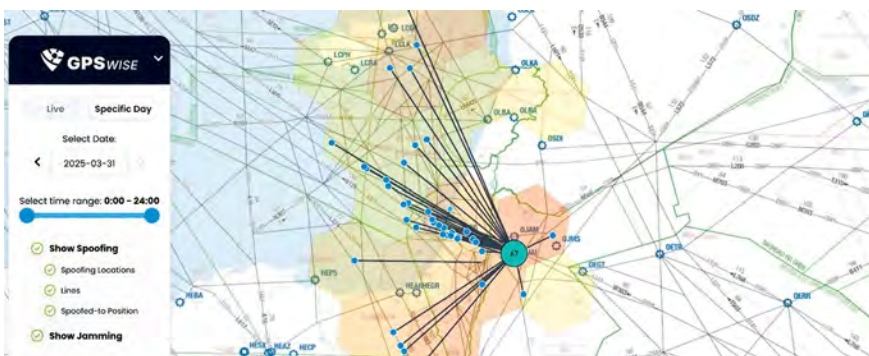
In terms of how serious the risk is, Price says he doesn't want to catastrophise. "For all the talk of autonomous systems, there aren't many navigation systems operating entirely without human oversight. Spoofing alone isn't likely to cause planes to crash into terrain or cars to propel themselves into lakes, but the impacts can be serious. Operational efficiency has been compromised in aviation, and safety-critical systems such as ILS and ADS-B have been rendered unreliable or unusable. Even toilets have stopped operating as a result of GPS interference. Ultimately, the impact of spoofing is that systems we have come to trust and to rely on cease to be trustworthy or reliable."

Although GNSS jamming and spoofing can be encountered anywhere in the world, Figuet says that interference is most often reported around active or latent conflict zones. These include near Russia/Kaliningrad, the Black Sea region, the Middle East (notably near Israel and Syria), the India-Pakistan border, Myanmar, and recently, the Persian Gulf. "But sometimes we observe interference in areas without active conflict like Hong Kong, Mexico or parts of the United States," he says.

The impact of a spoofing attack on equipment can range from obvious to insidious, and as EASA spokesperson Janet Northcote says interference can occur during any phase of flight, leading to re-routing or diversions to ensure safety. Common symptoms of GNSS spoofing include discrepancies in navigation positions, abnormal differences between ground speed



Spirent Spoofing Detection & Alerting Service graphic on aviation spoofing incidences in the Eastern Mediterranean region on September 19, 2024. Blue lines represent the differential between "last known good location" and spoofed locations, while red dots represent detected spoofing incidents. (Copyright/Credit: Spirent.)



Lufthansa Systems integrates GPS spoofing detection from SkaI's GPSwise solution into its Lido charting solutions to enhance navigational safety. (Copyright/Credit: Lufthansa Systems/SkaI Data Services GPSwise.)

and true airspeed, time shifts, spurious terrain awareness and warning system (TAWS) alerts and potential deviations in hybrid positions (inertial reference system (IRS)/GNSS).

Price expands further. "A basic, asynchronous spoofing attack – if successful – would likely show significant jumps in position, and motion patterns that do not align with what a pilot is seeing. For instance, a common attack is what we call "circle spoofing", where the vehicle appears to be moving in a circular motion. Another common attack is to alter the calculated position to a restricted area, such as an airport – useful when drones are targeted, as the geofencing software that many commercial drones run will automatically ground itself if it believes it is in restricted airspace. In these cases,

a pilot should hopefully be able to recognise that they are either not moving in a circle or not flying at low altitude over an airport"

With a synchronous, targeted attack, Price says the signs of being spoofed can be so small as not to be noticed. "The vector involves matching the real signals, so, at first, the spoofed aircraft would continue to show correct position and velocity information. If the false information is applied carefully, it's likely that a number of commercial receivers would not signal an alarm that they are being spoofed, and the changes in course, velocity or time would not be easy to determine for a pilot with no alternative reference data."

He believes that time is the often element overlooked as it is not immediately visible to the pilot or user. As GPS time is often now the reference time source for multiple

transport systems, the timing error from a spoofing attack will often manifest itself in a failure or 'false warning' from another instrument beyond its core navigation. This could be a false aircraft collision warning or a ground proximity warning.

"Thankfully, modern aircraft are equipped with multiple sensors and means to determine position, velocity and altitude. By using a 'multi-layered' approach with PNT systems (for example Inertial, Ground based RF and GNSS together), experienced pilots are equipped to manage many of the interference events they witness. Therefore, one of the key short-term aims is to ensuring safe mitigation procedures and policies are in place for flight crew," he says.

At a general level, Northcote says that EASA has recommended airlines to specifically consider the following: Specific recommendations for air operators

- For **jamming**:
 1. Verify aircraft position using non-GNSS means.
 2. Check critical navigation aids; and
 3. Report irregularities.
- For **spoofing**:
 1. Monitor aircraft position using non-GNSS nav aids.
 2. Closely follow air traffic control (ATC) frequencies.
 3. Apply manufacturer instructions on detecting and dealing with suspected GNSS spoofing; and
 4. Report irregularities.

"While these events can present a challenge to flight safety, there are mitigations in place to ensure safety is maintained in such circumstances," she says. "If GPS fails, or when pilots identify that a signal is being spoofed or jammed, there are other systems both onboard the aircraft and on the ground that pilots can rely on to continue the flight safely."

"By all accounts, the impact of RFI on GNSS is collateral," says Watson. "No conflict party appears to be disrupting air traffic intentionally; instead, RFI is a weapon in electronic warfare, recklessly reducing the safety margins of operations in the

affected areas."

But efforts are being made to tackle the risk specific to incidents of GNSS spoofing and jamming.

Collaborative action

Northcote says that EASA is continually monitoring the situation, particularly using reports provided by air operators on actual situations encountered. In June 2025, EASA and the International Air Transport Association (IATA) outlined a comprehensive plan to mitigate the risks of GNSS interference. This was the outcome of an industry workshop held the previous month in Cologne, Germany.

The workshop concluded that four workstreams are critical:

1. Enhanced Reporting and Monitoring

The workshop resolved to agree on standard radio calls for reporting GNSS interference and standardised notice to airmen (NOTAM) coding, i.e. Q codes. It is also raised the need to define and implement monitoring and warning procedures, including real-time airspace monitoring, and ensure dissemination of information without delays to relevant parties for formal reporting.

2. Prevention and Mitigation

The workshop agreed on the need to tighten controls (including export and licensing restrictions) on jamming devices and to support the development of technical solutions to reduce false terrain warnings; improve situational interference with portable spoofing detectors; and ensure rapid and reliable GPS equipment recovery after signal loss or interference.

3. Infrastructure and Airspace Management

It was decided to maintain a backup for GNSS with a minimum operational network of traditional navigation aid and better utilise military air traffic management (ATM) capabilities, including tactical air navigation networks

and real-time airspace GNSS incident monitoring. In addition, enhancing procedures for airspace contingency and reversion planning so aircraft can navigate safely even if interference occurs.

4. Coordination and Preparedness

Improvements to civil-military coordination, including the sharing of GNSS radio frequency interference (RFI) event data were necessary as were preparations for evolving-threat capabilities, also for drones.

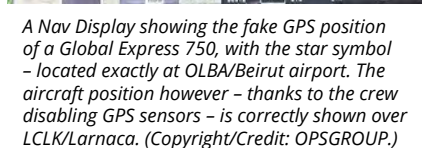
Speaking at the time of the plan's publication, Jesper Rasmussen, EASA Flight Standards Director, stated, "GNSS disruptions are evolving in terms of both frequency and complexity. We are no longer just containing GNSS interference — we must build resilience. The evolving nature of the threat demands a dynamic and ambitious action plan."

Watson highlights the growing number of activities ongoing at EUROCAE, to enhance the resilience of navigation services to GNSS RFI.

This includes the new DFMC SBAS standard (ED-259A "Minimum Operational Performance Standard for Dual-Frequency Multi-Constellation Satellite-Based Augmentation System Airborne Equipment"), developed by EUROCAE WG-62 GNSS, and released in October 2023, which has brought additional robustness against RFI and added new features to detect and report RFI to aviation stakeholders.

He explains that ED-259B "Minimum Operational Performance Standards for Galileo – Global Positioning System – Satellite-Based Augmentation System Airborne Equipment", currently under development, will support the use of dual frequency GPS and Galileo in civil aviation applications including Satellite Based Augmentation System (SBAS) and Advanced Receiver Autonomous Integrity Monitoring (RAIM) augmentation capabilities, with enhanced robustness to RFI and Galileo OSNMA (Open Service Navigation Message Authentication) processing capability.

According to the company, the Shift5 GPS Integrity Module provides advanced, multi-faceted detection and alerting for GPS spoofing and



"For this reason, it is essential that

By Alex Preston



Lifecycle Cybersecurity for Weapons Platforms

In modern warfare, every platform is a weapons platform - from aircraft and naval vessels to satellites and missile defense systems. Each of these platforms is as digital as it is physical, and that means cybersecurity is now as critical as armor or propulsion. If the digital trust of a platform is compromised, so is its mission.

Consider two quick examples. A compromised heads-up display could inject false visual data, misleading a pilot and causing mission failure. A breached weapons control system could disable a missile battery or even redirect its fire. Adversaries no longer need to destroy platforms kinetically - they need only undermine their digital trust.

While advanced cybersecurity technologies defend enterprise networks, few extend to the full lifecycle of a weapons platform - from design and manufacturing through decades of service, to decommissioning. That is a profound

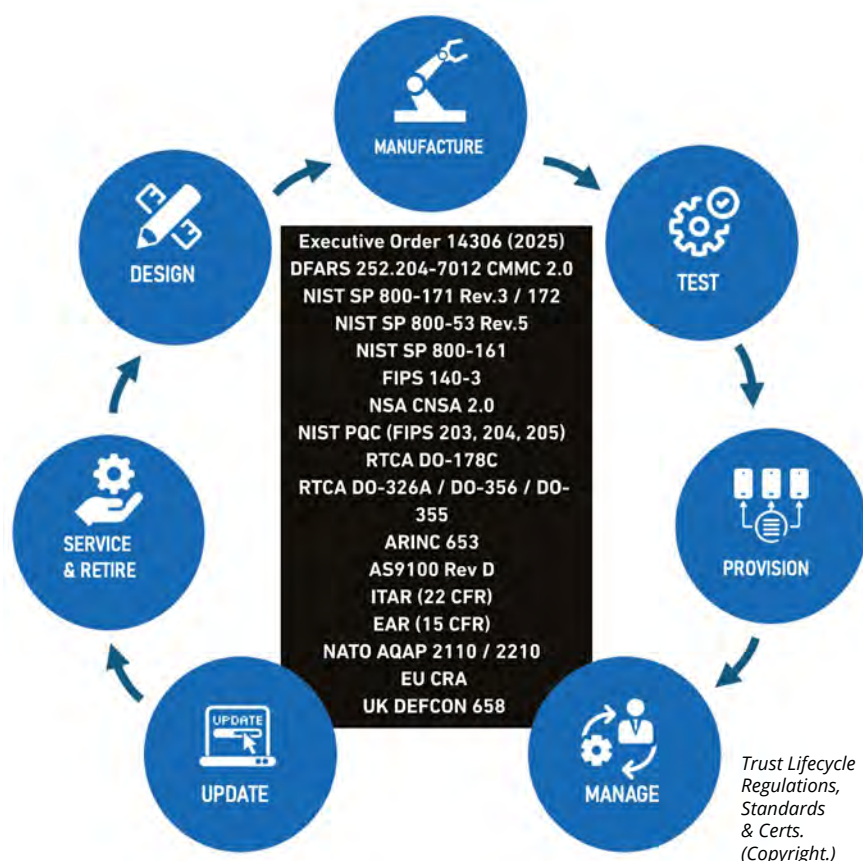


liability, especially as platforms remain in service for 30–50 years. During that time, threats evolve rapidly, and what was secure at rollout can become dangerously obsolete.

The mounting pressure to comply

Governments recognize this urgency. In July 2025, MITRE's report ***Breaking Barriers: Revitalizing National Security Supply Chains*** underscored why the U.S. military must adopt end-to-end supply chain security. Presidential Executive Order **14306** has already mandated cybersecurity for weapons platforms, while new certification frameworks such as **CMMC 2.0** and updated **NIST standards** set the bar for compliance. For primes and suppliers, compliance is no longer optional - it is becoming contractually binding.

Yet meeting these requirements is difficult. Few aerospace and defense



Protecting national investments and IP

Global defense budgets are surging, and with them, the value of intellectual property. That IP must be protected across the lifecycle - from design-stage collaboration with partners, to operational deployment, to end-of-life decommissioning. Even disposable assets, like loitering munitions, must resist reverse engineering years after use.

Lifecycle cybersecurity protects more than just mission readiness; it protects the domestic value of defense innovation, ensuring it cannot be stolen or repurposed by adversaries.

Software assurance and gray market threats

Software is the most valuable and most targeted component of modern weapons platforms. Ensuring code integrity and resisting tampering from design through deployment is vital. The same holds true for hardware, where counterfeit or gray-market components can introduce hidden vulnerabilities. Governments in the U.S. and EU are already pressing for trusted, domestic software and hardware ecosystems to counter this risk.

By embedding a root of trust at the silicon level, platforms can authenticate every update, every data packet, and every operational command for decades.

Data fidelity as mission assurance
 Finally, data itself must remain

firms possess the in-house depth of cryptographic expertise needed, and the growing complexity of standards only compounds the problem. To succeed, contractors need trusted partners who can deliver pre-certified, lifecycle-ready solutions.

Meeting these obligations requires navigating a dense and constantly evolving landscape of cybersecurity standards, certifications, and regulations. From U.S. defense mandates to NATO frameworks and EU directives, aerospace and defense organizations face a complex matrix of requirements that touch every stage of a weapons platform's lifecycle. The table below highlights the key standards most relevant to today's A&D community and illustrates the breadth of compliance now embedded into national defense programs.

Lifecycle risks demand lifecycle security

Because platforms last decades, lifecycle trust is non-negotiable. Hardened components that cannot evolve with the threat environment

create vulnerabilities ripe for exploitation. Emerging threats such as weaponized AI and post-quantum computing promise to upend today's cryptographic protections entirely.

Lifecycle cybersecurity ensures that safeguards are embedded early ("shift left") and designed to adapt over time. With the right lifecycle approach, updates, diagnostics, and cryptographic enforcement evolve continuously to meet new threats - keeping the platform trusted throughout its operational life.





secure across the platform lifecycle - in motion and at rest, whether classified or unclassified. Adversaries target data flows with man-in-the-middle attacks, seeking to alter intelligence, disrupt targeting, or degrade command and control. Protecting data fidelity is essential to ensuring mission outcomes.

The mission objective

To protect weapons platforms across decades of service, A&D organizations must do two things at once: embed lifecycle trust from the start so security evolves with emerging threats, and streamline compliance by working with partners who can integrate requirements at the design stage. In short, mission assurance depends on building in cybersecurity early and managing it continuously, not bolting it on after the fact.

Choosing a path

Large primes may attempt to build in-house capabilities, but the burden of managing lifecycle security across vast supply chains can overwhelm even their resources. For smaller firms, partnering with dedicated experts is the fastest path to compliance and mission assurance.

Whichever route is chosen, one fact is clear: the shift left must happen now. Lifecycle cybersecurity for weapons platforms is no longer optional. It is the foundation for protecting multi-billion-dollar platforms, sustaining national defense advantages, and ensuring mission readiness across domains - air, sea, space, land, and cyber.

ABOUT INTEGRITY SECURITY SERVICES (ISS)

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is how nations keep their platforms uncompromised, compliant, and mission-ready for the battles of today and the wars of tomorrow.

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By Integrity Security Services (ISS)

Standard / Reg / Cert	Description
Executive Order 14306 (2025)	Mandates cybersecurity across U.S. weapons platform supply chains.
DFARS 252.204-7012	Safeguarding CUI and cyber incident reporting for DoD contractors.
CMMC 2.0	Ensuring primes & subs meet DoD NIST cybersecurity controls.
NIST SP 800-171 Rev.3 / 172	Standards for protecting CUI in A&D contractor systems.
NIST SP 800-53 Rev.5	Catalog of security and privacy controls for defense systems.
NIST SP 800-161	Supply chain risk management requirements for defense contractors.
FIPS 140-3	Cryptographic module validation for classified and weapons platforms.
NSA CNSA 2.0	National Security crypto framework transitioning to PQC by 2035.
NIST PQC (FIPS 203-205)	Post-quantum cryptography stds. for future-proofed weapons platforms.
RTCA DO-178C	Airborne software safety certification for defense avionics systems.
RTCA DO-326A / 355 / 356	Airworthiness cybersecurity processes for aviation platforms.
ARINC 653	Avionics partitioning standard ensuring safety-critical time/space separation.
AS9100 Rev D	Aerospace quality management system including cybersecurity requirements.
ITAR (22 CFR)	U.S. controls on defense exports, including cybersecurity-sensitive tech.
EAR (15 CFR)	Export rules for dual-use aerospace technologies, including cryptography.
NATO AQAP 2110 / 2210	NATO quality and cyber assurance standards for defense contracts.
EU Cyber Resilience Act (CRA)	EU cybersecurity lifecycle requirements for defense hardware/software.
UK DEFCON 658	UK MoD supplier cybersecurity compliance requirement.

Reference Table: Regulations, Standards & Certifications Required for Trust Compliance.

Military Aircraft Upgrades: Excellent Opportunities for Middle Market Suppliers

Bruce Andrews, Partner & Troy Medeiros, Vice President
Alderman and Company Aerospace & Defense M&A Bankers



F-35. (Copyright.)

Introduction

The US & Allied militaries have been focused on investing heavily in 5th Generation Upgrades to legacy military aircraft. The objective is to significantly extend the operational life of specific military aircraft programs by investing in technological upgrades in select aircraft that will bring them to 21st century performance without having to start with a completely new design. Such an approach is less costly and time consuming than having to design, develop, test, and qualify new aircraft. While 5th generation upgrades are not universally agreed upon, they frequently involve improving stealth capability, higher aircraft maneuverability, advanced avionics, improved situational awareness for



F-35. (Copyright.)

the pilot, and improved armament. Current examples of aircraft undergoing 5th generation upgrades include the Eurofighter Typhoon, the F-35, and the legacy B-52 Stratofortress, chosen largely for their mission capability and strategic utility. These platforms will serve as the focal points for this article to penetrate the variety of upgrade programs and demonstrate the kinds of opportunities that are available

to the A&D middle market and hence the many avenues potentially available to those companies.

Opportunities for Middle Market Suppliers

For middle-market suppliers, programs such as the Eurofighter, F-35 and B-52 fifth generation upgrades are especially important because they create long-term, recurring opportunities across a wide range of specialties. Companies providing precision machining, electronics, avionics upgrades and integration, specialty materials, or maintenance and repair services all find steady demand as these aircraft are upgraded and sustained over decades. Unlike new development programs, which often favor only the largest primes, modernization

efforts open the door for smaller suppliers to play critical roles in the supply chain. This stability not only helps middle-market firms grow and diversify their revenue streams but also enhances their attractiveness to private equity and strategic buyers who value predictable, program-driven cash flows.

Funding Context:

In the United States, the retrofits of 5th generation platforms, such as the B-52 and F-35, are underwritten by fiscal appropriations for FY2025, totaling more than \$45 billion, routed through both procurement and Research Development Test and Evaluation (RDT&E) budget lines, set and approved under the National Defense Authorization Act (NDAA), annual appropriations processes, and reinforced by defense acquisition plans. These commitments for upgrades of engines, avionics, and sustainment are not abstract—they are visible in line-item funding requests that signal durable federal support. Specifically, the Air Force's FY 2025 budget allocates nearly \$20 billion to modify and sustain legacy aircraft fleets, ensuring that platforms like the B-52, and F-35 remain mission-ready for decades. Targeted programs, such as the B-52 Radar Modernization Program, consistently receive tens of millions in annual funding, demonstrating how modernization is phased and recurring rather than episodic. Separately, the F-35 program continues to draw billions in procurement and sustainment dollars, supported not only by U.S. appropriations but also by international partner contributions. Together, these appropriations illustrate how retrofit, and modernization programs are designed to lock in multi-decade spending horizons—funding streams that provide consistent opportunity across the supplier base.

In Europe, the Eurofighter Typhoon program provides a similarly durable funding horizon, backed by parliamentary approvals and long-term national defense budgets

across Spain, Germany, the U.K., and Italy. Spain's Halcón I and II programs alone allocate more than €4 billion with deliveries scheduled between 2030 and 2035, while Germany has authorized hundreds of millions of euros for Phase 4 Enhancement upgrades, new radar systems, and Tranche 5 aircraft, ensuring output for suppliers through the next decade. The U.K. has committed £2.35 billion for Typhoon sustainment through 2040 and over £200 million for the acquisition of the ECRS Mk2 AESA radar through 2028. These investments are structured through multi-year defense appropriations, special acquisition funds, and consortium-wide contributions, locking in modernization activity to at least 2035 and creating long lead demand cycles that directly benefit middle-market suppliers providing avionics, sensors, materials, and integration services across the Pan-European defense industrial base. Importantly, this sustained funding is also being driven by the pursuit of keeping pace with rising global demand for advanced defense capabilities, as European nations seek to ensure competitiveness and interoperability on the world stage.

The B-52 Stratofortress

While focused on the U.S., The B-52 stands as one of the most enduring aircraft in U.S. Air Force history,

first entering service in 1955 at the height of the Cold War. Originally designed to carry nuclear weapons on long-range deterrence missions against the Soviet Union, the B-52 quickly became a central pillar of American strategic power. Over the decades, it has proven its versatility across a wide range of missions, from Vietnam-era carpet bombing to precision strikes in Iraq and Afghanistan, cementing its reputation in U.S. air operations. The B-52 continues to fly well into the 21st century, with the Air Force planning to keep the fleet of 78 aircraft operational well into the 2050s.

This remarkable longevity has created significant opportunities for modernization. Current retrofit programs include new Rolls-Royce F130 engines, digital avionics suites, radar upgrades, and structural reinforcements designed to extend the bomber's life and improve efficiency. These initiatives represent multi-billion-dollar programs that not only sustain prime contractors such as Boeing and Rolls-Royce but also drive demand throughout the supply chain, particularly the middle-market aerospace and defense suppliers by providing products and services for the sustainment of 5th generation platforms. The B-52 serves as a prime example of how modernization programs create enduring opportunities across the U.S. defense industrial base.



B-52. (Copyright.)

Eurofighter Typhoon Modernization

In Europe, the Eurofighter Typhoon is undergoing significant modernization to remain competitive into the 2040s. Current programs include the integration of the Captor-E AESA radar, advanced electronic warfare defensive aids, and new targeting pods such as the Litening 5. Each of these systems requires new subsystems, antennas, cooling infrastructure, and digital integration—prime opportunities for niche suppliers.

At the same time, production rates are being scaled up, with output expected to nearly double by 2028 as new orders are fulfilled from Germany, Spain, Italy, and export customers such as Turkey. These expansions ripple through the supply chain, generating additional demand for avionics, precision components, and sustainment services.

F-35 Block 4 and “5th Generation Plus”

The F-35 Block 4 program represents one of the most significant upgrade cycles of fighter aircraft for the United States. Key improvements include expanded weapons carriage, next-generation sensors, and advanced mission systems powered by Technology Refresh 3 (TR-3), which delivers twenty-five times the computing power of the previous generation.

These advancements create opportunities for suppliers specializing in processors, displays, wiring harnesses, cooling systems, and mission software integration. Because many of these upgrades are modular, middle-market firms can capture contracts that may otherwise be dominated by large primes.

Lockheed Martin has also introduced a “5th Generation Plus” roadmap, which integrates select technologies from the Next Generation Air Dominance (NGAD) program—such as advanced infrared sensors and autonomous drone-control features. For suppliers, this evolution emphasizes demand for secure software, digital engineering, and modular or interchangeable



Eurofighter Typhoon. (Copyright.)

components (also known as open systems).

Conclusion

For middle-market aerospace and defense suppliers, compelling opportunities are obtainable as the sustainment and modernization of 5th generation platforms continue to proceed. These programs are structured around multi-decade horizons, providing not only revenue stability but also clear pathways for companies that can establish themselves early in the lifecycle. The B-52, and other platforms illustrate a cycle. If suppliers enter at the right stage and demonstrate required capabilities, then they can potentially secure enduring work that extends far beyond initial contracts.

Success begins with building relationships early. By cultivating relationships during the design and qualification phases, middle-market suppliers can position themselves as go-to partners when program funding ramps. However, getting qualified is the next crucial step. Aerospace & Defense procurement is structured to reward persistence. Suppliers that invest in technical certifications, security clearances, and quality systems required by primes are often rewarded with long-term access to contract opportunities. Qualification is not just a barrier to entry; it's a moat that can create durable competitive

advantage for smaller companies.

The development stage frequently requires low-quantity prototype or engineering hardware. This favors nimble suppliers with the flexibility to manufacture small batches of highly complex parts. While margins may be thinner at this stage, it is the proving ground that establishes credibility and trust.

Once a design stabilizes, production opportunities expand dramatically. Suppliers that have already demonstrated capability are well positioned to win larger-scale manufacturing contracts, including replacement parts. These contracts often extend over decades.

Finally, sustainment programs create significant future opportunities for key suppliers on these upgraded components. Suppliers that manufactured these parts are natural candidates to provide ongoing support, creating a recurring revenue stream that extends the lifecycle value of each program.

Taken together, these stages form a durable growth pathway for middle-market aerospace & defense companies. From early engagement through long-term sustainment, 5th Generation platforms lock in demand cycles that reward capability, agility, and persistence, making them one of the most attractive sectors for suppliers seeking to grow, diversify, and capture multi-decade value. 



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