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German airline Condor is under pressure now that Lufthansa has ended cooperation.



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Manufacturers and passenger-to-freighter conversion specialists are confident about air cargo's long-term prospects, despite the short-term uncertainty created by U.S. tariff announcements. Our report by Paris Bureau Chief Helen Massy-Beresford and Senior Editor Guy Norris begins on page 48. Mammoth Freighters photo.

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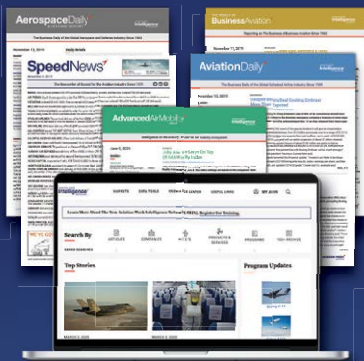
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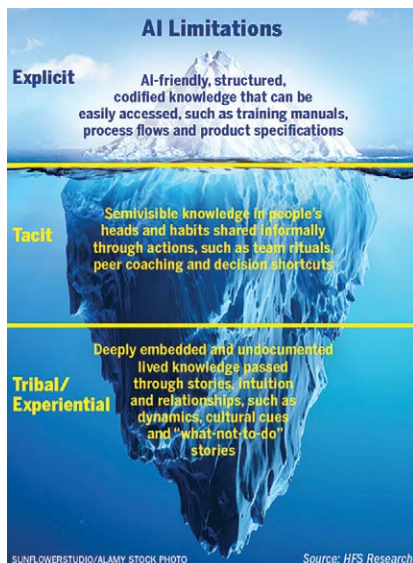
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INNOVATION IS CONFLICT

I could not agree more with Garrett Reim's excellent Quantum Leap column "Hidden Knowledge" (*Aug. 11-31, p. 13*). I was first exposed to artificial intelligence (AI) at an insurance company computer facility in 1954 and was told of both the dangers and limitations inherent in such an apparent panacea.

Not satisfied with their concerns and being young and foolish, I spent years trying to prove them wrong and kept running into the very same problems. AI is limited to what it is told; it is what we used to call a GIGO (garbage in, garbage out) system. It lacks innovation.

The U.S. Coast Guard, Army and Air Force teams I led as a project manager ran circles around other teams because the other teams employed highly educated specialists who typically had no real-world experience. For example, the personnel department might have dismissed an ex-U.S. Navy aviation storekeeper applicant who had only a high school diploma but knew the system as well as airplanes inside out and would steal your eyes if they weren't glued in if they were needed for an airplane. Both the personnel office and AI chose a college-educated logistician before I vetoed it. All my other slots would have been filled similarly had I not intervened.

As Shirley Chisholm famously said, "You don't make progress by standing on the sidelines." Innovation is conflict, and AI avoids it. Human minds are the sum total of everything we have ever experienced—peripherally, in dreams, in books and otherwise.

William Danner, Lompoc, California

A FIX FOR DCA

Your article summarizing the recent NTSB hearings on the midair collision near Ronald Reagan Washington National Airport (DCA) in January ("*Perilous Procedures*," *Aug. 11-31, p. 22*) highlighted the serious issues arising from understaffing in a complex airspace.

I worked closely with airlines and airports for about a decade, mostly at Chicago O'Hare International Airport, but I often traveled to Washington and spent a lot of time watching operations at DCA from the terminal while waiting for flights. I remember seeing the high volume of operations routinely being conducted on intersecting runways and how they slowed things as aircraft had to accommodate each other for separation. It was clearly inefficient and looked dangerous.

To enhance safety and efficiency, I propose eliminating the crossing runways at DCA, adding a new 9,000-ft. north/south runway and redesignating the existing Runway 1L/19R primarily for departures. The new, longer runway would serve as the main landing runway. New "end around" taxiways should be created at the ends of the new runway—such as Hartsfield-Jackson Atlanta International Airport's taxiways V and W that avoid Runways 8L and 9L, respectively—to eliminate intersecting active runways.

These modifications would standardize procedures and operations at DCA and make managing aircraft separation and detecting deviations much more straightforward.

Departing from the runway closest to the terminals would shorten times between gate and wheels up, pleasing passengers, and likely improve overall network performance, since fewer aircraft would have to await departure clearance. And a longer runway dedicated to arrivals could handle much more traffic than the currently used runways combined and reduce the number of "go-around" operations. Closing Runways 4/22 and 15/33 would open up space for other development, perhaps for future urban air mobility operations, new parking structures or terminal or maintenance facilities.

Address letters to the Editor-in-Chief, *Aviation Week & Space Technology*, 2121 K Street, NW, Suite 210, Washington, DC, 20037 or send via email to: awstletters@aviationweek.com Letters may be edited for length and clarity; a verifiable address and daytime telephone number are required.

As for helicopter traffic, once the airfield is reconfigured and parallel helicopter/fixed-wing operations are deemed not problematic, routes could be reevaluated and restored as needed.

In my frequent trips overseas, I discovered that the U.S. has a global "find a problem, fix a problem" reputation. The current situation at DCA is no doubt a problem; here's the fix.

Clayton Bonnell, Fairfax, Virginia

THE PLACE FOR DISCOVERY

In response to the misguided Texas senators attempting to lay claim to space shuttle Discovery (OV-103) ("*Smithsonian Fights Texas Grab For Space Shuttle Discovery*," *July 14-27, p. 21*), none of the orbiter vehicles ever had a home at Johnson Space Center (JSC). The orbiters were all assembled in California from segments constructed by companies across America. All space shuttle launches were from Kennedy Space Center (KSC) in Florida.

I had the privilege of spending my entire engineering career at KSC on the space shuttle program as an electronics engineer. For 15 years, I was the OV-103 lead test project engineer, and I was proud to loan my orbiter to the astronaut flight crews. OV-103 was the orbiter that made the most flights, including both return-to-flight missions, and I was proud that it was selected as the orbiter to go to the Smithsonian.

JSC should be proud of its role in the shuttle program, but it was never home to the orbiters.

Eric A. Baker, Titusville, Florida

ON AVIATIONWEEK.COM, COMMENTING on "YF-23 Designer Weighs In On How Lockheed Martin Could Evolve The F-35" (*Aug. 11-31, p. 14*), PHIL B. writes:

Interesting article. Note that these derivatives of the F-35 should not use "splitterons" for primary yaw control; that would dramatically increase drag, particularly for cruise in a turbulent atmosphere. Instead, the multi-axis thrust vectoring nozzles should be used for primary yaw control to enable the full potentials on range and stealth.

Amit Kshatriya has been named associate administrator at NASA. He has worked at the agency for 20 years, most recently as deputy associate administrator for the Moon to Mars program within the Exploration Systems Development Mission Directorate.



Anduril has named **Matthew Kaplan** chief administrative officer. He had been promoted to senior vice president of corporate operations from vice president of revenue and corporate planning in January. Before joining the



company, he worked at Kayak and William Blair.

Sarah Walter has been hired as chief operating officer of space defense technology company **True**

Anomaly. She was vice president of engineering at York Space Systems and before that was chief technology officer at Aero Gearbox International. Prior to Aero Gearbox, she worked for 11 years at Rolls-Royce.

Business jet aftermarket services provider **Citadel Completions** has appointed **Gregory Colgan** as CEO. He held the same title at MRO Holdings for nine years, before which he worked



at Oliver Wyman's CAVOK aviation services division.

Leo Barella has been appointed chief information officer at **Booz Allen Hamilton**. He brings

experience across pharmaceuticals, healthcare and finance, most recently as chief technology officer at Takeda. Before that, he held senior positions at AstraZeneca and Blue Cross Blue Shield of Michigan.

Mike Lisman is succeeding Kevin Stein as president and CEO of **TransDigm**, effective Sept. 30. Stein will stay on as an advisor through March 31, 2026. Lisman was co-chief operating officer and previously chief financial officer and executive vice president, before which he oversaw several of the company's operating units.

Saxa Vord Spaceport has named **Scott Hammond** CEO, succeeding

Frank Strang, who recently passed away. Hammond was deputy CEO and operations director prior to that. He co-founded precursor company Shetland Space Center alongside Frank and Debbie Strang. **Debbie Strang** succeeds Hammond as deputy CEO while retaining her role as chief operating officer.

Paul Tilghman has been hired as chief technology officer and **Shyamal Patel** as strategic advisor at **Voyager Technologies**. Tilghman was chief engineer of connected warfare at Anduril, before which he worked at Microsoft as senior director of Azure Space. Patel brings over a dozen years of experience at SpaceX, where he



was most recently senior director of Starship operations.

Thomas Reynaert has joined the **International Air Transport Association** as senior vice president of

external affairs. He was vice president of government and regulatory affairs for Europe, the Middle East and Africa at IBM. Before that, he was the founding managing director of Airlines for Europe.

Wheels Up has hired **Tanya Weed** as director of new business and added **Luigi Contessi** to its Air Partner team as director of regional business development and **Maris Kuklis** as business development manager. Weed was senior vice president of sales at VistaJet and before that was sales director at Bombardier. Contessi was sales director at VallJet and founder of Ubefty and has held sales and marketing positions at airlines including Colvair and British Airways. Kuklis was senior sales manager for leisure, travel management company and corporate at JetBlue and prior to that worked at Etihad Airways.

Adam Posar has joined **FlyExclusive** as senior vice president of sales. He was executive vice president of sales at Jet Linx Aviation, before which he held roles at XO Jet Aviation, BreezeLine and Red Bull.

Menzies Aviation has hired **Lawrence Tse** as its inaugural head of e-commerce. He was senior director of global key account management for e-commerce at CEVA Logistics and prior to that worked at DB Schenker and Rocket Internet.

Castelion has named U.S. Navy Capt. (ret.) **Gregory Zettler** its lead for long-range missiles. He had served most recently as program manager for Conventional Prompt Strike in the Navy's Strategic Systems Programs.

Courtney Freeman

has joined law firm **Adams & Reese** as counsel and a member of its aviation and aerospace team. She worked for more than a decade in the FAA's Office of the Chief Counsel's Regulations Division, most recently as manager of the operations law branch.

Patrick Fransen has joined aircraft painting specialist **MAAS Aviation** as general manager of maintenance, repair and overhaul. He held a senior operations position at the European Support Center and before that worked at Flanders Make and Facil.

Rocket engine propulsion startup **Venus Aerospace** has appointed **Pamela Melroy** to its board of directors. She spent four years at NASA as deputy administrator and prior to that worked as an astronaut. Her government experience includes serving at the FAA and as deputy director of DARPA's Tactical Technology Office.

Patrick Ky has joined the board of directors at **Vertical Aerospace**. He is

CEO of the International Centre for Aviation Innovation in Singapore and spent a decade as executive director of the European Union Aviation Safety Agency. Before that he led the Single European Sky Air Traffic Management Research Joint Undertaking and held senior positions at Eurocontrol and the French Civil Aviation Authority. ☪



To submit information for the Who's Where column, send Word or attached text files (no PDFs) and photos to: whoswhere@aviationweek.com For additional information on companies and individuals listed in this column, please refer to the Aviation Week Intelligence Network at AviationWeek.com/awin For information on ordering, telephone U.S.: +1 (866) 857-0148 or +1 (515) 237-3682 outside the U.S.

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DEFENSE

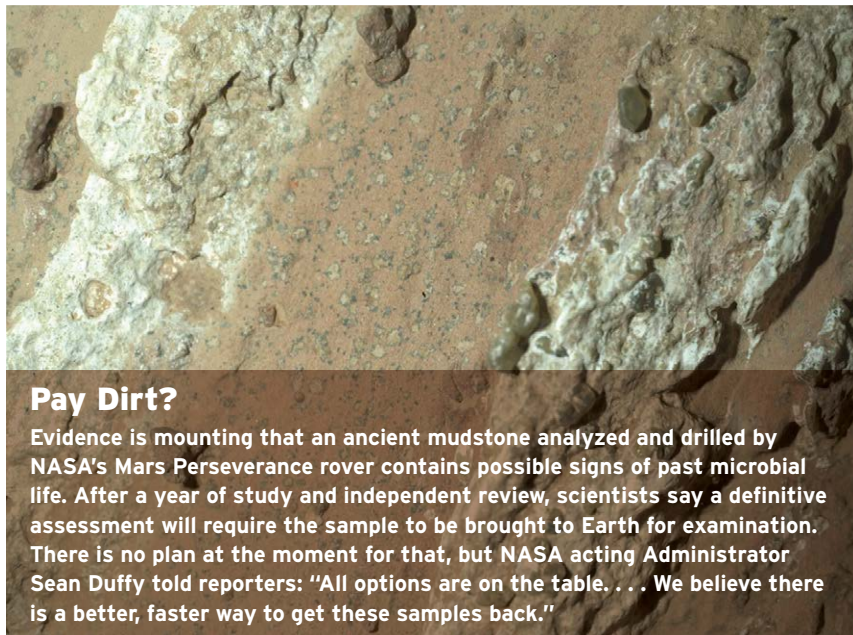
China unveiled two previously unseen uncrewed combat air vehicles and two collaborative combat aircraft during its Sept. 3 Victory Day parade (page 24).

Leonardo UK, Leonardo Italy, ELT Group and Mitsubishi Electric have formed the GCAP Electronics Evolution consortium to develop the Global Combat Air Program sensor and communication suite.

TIBERIUS AEROSPACE



Multinational startup Tiberius Aerospace has secured a UK Defense Ministry contract to test a ramjet-powered 155mm artillery round.



Pay Dirt?

Evidence is mounting that an ancient mudstone analyzed and drilled by NASA's Mars Perseverance rover contains possible signs of past microbial life. After a year of study and independent review, scientists say a definitive assessment will require the sample to be brought to Earth for examination. There is no plan at the moment for that, but NASA acting Administrator Sean Duffy told reporters: "All options are on the table. . . . We believe there is a better, faster way to get these samples back."

NASA/JPL-CALTECH/MSSS

European Union members are set to spend more than €100 billion (\$116 billion) on defense procurement for the first time this year, the European Defense Agency says.

Leonardo has formally offered 32 Eurofighter Typhoon Tranche 5 fighters to meet the Philippine Air Force multirole combat aircraft requirement.

Stratolaunch has recovered its air-launched Talon TA-2 high-speed test vehicle at Vandenberg SFB in California

after a hypersonic test flight on Sept. 3.

France has ordered a laser counter-drone demonstrator developed by MBDA, Safran, Thales and Cilas, with an eye to possible fielding around 2030.

COMMERCIAL AVIATION

Low-cost carrier Avelo Airlines has placed a firm order for 50 Embraer 195-E2s for delivery beginning in 2027, with purchase rights for 50 more, becoming the first U.S. customer for the company's largest airliner.

VIEW FROM BRUSSELS

Clean Aviation Targets Hybrid Power

Europe's Clean Aviation public-private research program has focused on hybrid-electric propulsion in selecting projects under its third call for proposals. Together, the 12 projects announced Sept. 9 are worth €945 million (\$1.1 billion), €378 million of which is coming from the EU.

The winners include the first cooperative project between Canada and the EU. The projects selected for Call 3 are planned to start at the beginning of 2026, and flight tests are expected in 2028-29.

Projects for the ultraefficient short-to-medium-range aircraft theme—likely aimed at an Airbus A320 successor—will receive €199 million. Airbus intends to demonstrate a hybrid-electric architecture, Rolls-Royce an unspecified turbofan and Safran an open-fan engine.

The ultraefficient regional aircraft theme

garnered €144 million. Pratt & Whitney Canada plans to build a hybrid-electric propulsion demonstrator based on the PW127XT turboprop, Safran aims to develop onboard systems for hybrid regional aircraft, and ATR expects to flight-test hybrid propulsion in a modified ATR 72-600.

Clean Aviation allotted €20 million to fast-track projects. These include battery development at France's Ascendance and Germany's Fraunhofer-Gesellschaft, power electronics by Spain's Skylife Engineering and a crashworthy cryogenic hybrid tank by Italy's University of Campania Luigi Vanvitelli.

Another €15 million will support aircraft concept integration and impact assessments led by Airbus and ATR. Clean Aviation aims to cut greenhouse gas emissions by 30% at the aircraft level by 2035.

Investors led by SMBC Aviation Capital and its parent, Sumitomo, are to buy Air Lease Corp., set up by industry veteran Steven Udvar-Házy in 2010 (page 38).

Spirit Airlines is exiting 11 U.S. markets and shelving plans for new services as it pares back its network during its second Chapter 11 restructuring in less than half a year (page 42).

Israel Aerospace Industries has secured the first supplemental type certificate for a Boeing 777 passenger-to-freighter conversion, with U.S. cargo airline Kalitta Air as the launch operator.

AMAZON



JetBlue Airways is the first commercial airline customer for Amazon's Kuiper broadband satellite inflight connectivity. Rollout is slated to begin in 2027.

UK-based venture capital firm Sprints has invested in Flightradar24, which uses a global network of ADS-B receivers to track aircraft movements.

TECHNOLOGY

GE Aerospace has partnered with Beta Technologies to develop a turbogenerator for hybrid-electric advanced air mobility and will invest \$300 million in the startup.

China's XPeng AeroHT has become the latest electric-vertical-takeoff-and-landing developer to fly an aircraft in the United Arab Emirates with tests of its modular X-F3 Land Aircraft Carrier.

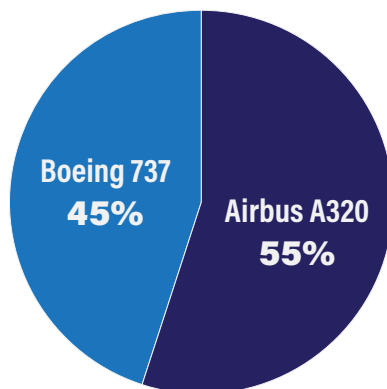
Hyundai subsidiary Supernal has paused development of its eVTOL air taxi to re-evaluate its product and timing to enter the advanced air mobility market.

SPACE

Israel launched its latest surveillance satellite, Ofek 19, on Sept. 2 to augment its space-based intelligence-gathering capability with a synthetic aperture radar system.

Airbus A320 Forecast To Cement Its Lead

**In-Service Fleet* Share
in 2035**



*More than 30,000 units

Source: Aviation Week Network 2026 Commercial Fleet & MRO Forecast.

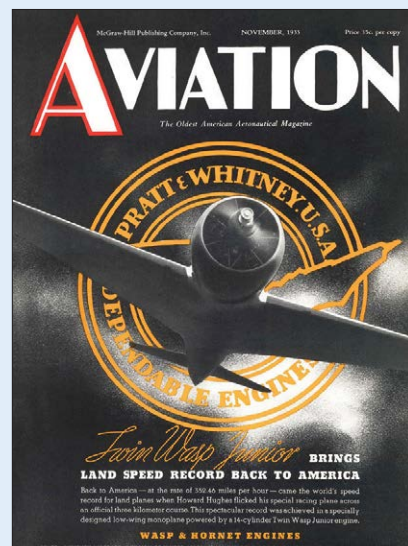
Preliminary data from the Aviation Week Network's 2026 Commercial Fleet & MRO Forecast estimates that the number of aircraft in the Airbus A320 and Boeing 737 families will grow 50% during the coming decade, meaning more than 30,000 will be in service in 2035. Of those, the A320 will hold a formidable 55% market share lead over the 737's 45%, underscoring the fundamental shift in aviation's competitive landscape as Airbus entrenches its lead in a segment once considered Boeing's territory. The full forecast is scheduled to be released in October.



For more about the 2026 Commercial Fleet & MRO Forecast and other Aviation Week data products, go to: [Aviationweek.com/Com-Forecast](https://aviationweek.com/Com-Forecast)

90 YEARS AGO IN AVIATION WEEK

Aviation pioneers Howard Hughes and Richard Palmer designed the Hughes H-1 racer to be the fastest "landplane" in the world. Their ambition was achieved on Sept. 13, 1935, when Hughes flew the H-1 to a new world speed record of 352 mph at Santa Ana, California. Pratt & Whitney, a 10-year-old company that built the 14-cylinder Twin Wasp Junior engines powering the H-1, took out a full-page ad on the cover of our Nov. 1 edition that year to celebrate the feat. The H-1 was designed with two sets of wings: a short wing optimized for speed and a long wing for transcontinental flight. Hughes would go on to break the transcontinental U.S. speed record on Jan. 19, 1937, averaging 332 mph as he flew from Los Angeles to Newark, New Jersey, in 7 hr., 28 min. and 25 sec.



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SpaceX has struck a \$17 billion agree-ment with EchoStar to acquire the rights to 50 MHz of S-band spectrum to support expansion of its Starlink direct-to-cell service.

The Finnish government and local sat-ellite-maker Icyeye have signed an agreement for the country's defense forces to field a synthetic aperture radar satellite constellation. 🌐

UP FRONT

SHARON DeVIVO



HAPPY NEW YEAR—NEW ACADEMIC

year, that is! As students head back to school, many organizations and companies are thinking about reaching out to young

people to grow awareness about the aviation and aerospace industries. It is time for us to accelerate the work being done across the country to address the talent shortage we have now and are likely to have in the future.

The Youth Access to American Jobs in Aviation Task Force (YIATF) submitted its report to Congress in 2022, suggesting how to attract more young people to our industry more effectively. Among its more than 20 suggestions, one of the most important was the identification of the prime time at which to reach youth. The answer: when they are 10 years old. Raising awareness about opportunities in our industry could be done through an event at a local airport, rides in simulators or working on an aviation-related project as part of an after-school club activity.

Unfortunately, unless one's family member or friend is employed or involved in aviation, one tends to have little knowledge of how vast the career options are in the industry beyond piloting. This is even more likely to be the case for someone from an underrepresented community where not many people are involved in aviation as either a career or a hobby.

Regional and local company- and organization-based events and experiences provide families with the chance to learn more. But it is not enough simply to host an event and hope those excited kids pursue aviation after that one interaction. We need a connected pipeline that allows young people to sample and savor all the myriad possibilities in a more thoughtful and planned way.

For instance, at that local airport event parental contact information can be collected and passed to the nearby Civil Air Patrol (CAP) unit (in full disclosure, I am on the board of CAP). The unit could invite children age 12 or older, as well as their parents, to learn about drone flying, safety and more. With nearly 70,000 members nationwide and squadrons in every state as well as Puerto Rico and the District of Columbia, CAP operates the largest single-piston aircraft fleet in the world and one of the largest drone pro-

grams in the nation. These are tools to support their mission of emergency services, aerospace education and cadet programs.

In its 2022 report, the YIATF also included a call for a "one-stop aviation/aerospace information portal" for students, parents, caregivers and educators (including guidance counselors) to learn more about career pathways, connections to regional and national organizations and curricula and to provide them access to an AI counselor to answer questions. During the YIATF's

study, we learned that of the guidance counselors we surveyed, 65% believe the best resources for introducing students to aviation and aerospace careers are on the internet.

An information portal could be a tool to nurture an emerging passion. For example, aviation entrepreneurs Shaesta Waiz and Michael Wildes are creating a one-stop digital career and community platform with real-time job data as well as career pathways and industry opportunities.

What can you and your company or organization do this school year to reach out to young people? First, think about partnering with another organization in your region to co-promote and

co-host an event, especially for groups that are in under-resourced communities. For example, co-host an event with the local Boys & Girls Club, which engages young people with education and career pathways, and the local CAP squadron, which shares information about careers in aviation.

Second, make sure you are reaching middle schoolers. High school is too late to reach young people—they may have already chosen a field or simply decided that aviation is not for them.

If you are not sure how to find the right partner, look at the FAA's STEM Aviation and Space Education Partnerships page on the agency's website and start the conversation in your community with like-minded individuals who know firsthand the transformative effects of our industry. The more connected and broader the outreach, the better chance we have of recruiting great talent. ☺

Sharon B. DeVivo is president of Vaughn College of Aeronautics and Technology in Flushing, New York.

Making Connections

Partnering is key to
expanding the talent pipeline



Vaughn College and Civil Air Patrol co-host an immersive aerospace program for student leaders each summer.

VAUGHN COLLEGE

THE DEW LINE

STEVE TRIMBLE & BRIAN EVERSTINE



THIS IS A BUSY TIME for the U.S. Air Force. Futures planners are trying to balance investing technologically for air wars after 2035 while maintaining readiness for a major

conflict by 2027. The major commands are trying to adapt to a reorganization at Air Force headquarters while implementing a new deployment model for combat units. They are doing all that while modernizing the entire nuclear arsenal at the same time.

So this is not a good time for a crisis at the top of the Air Force's military leadership. But that is what is happening.

The Air Force has lacked a confirmed vice chief of staff since late February, when Defense Secretary Pete Hegseth fired Gen. James Slife. The service also will be short a confirmed chief of staff after Nov. 2, when Gen. David Allvin steps down halfway through his expected four-year tenure.

The Trump administration appears to have successors lined up for both positions, but those plans are now in jeopardy.

Gen. Thomas Bussiere, the original pick to replace Slife as the Air Force's No. 2, is out of the running, as the White House has withdrawn his nomination paperwork, sources tell Aviation Week.

The early favorite of those sources to replace Allvin—recently retired Gen. Kenneth Wilsbach (see photo)—made statements in the past in support of diversity, equity and inclusion policies that now are jeopardizing his candidacy to become the first Air Force chief appointed by the second Trump administration.

That leaves the service's military leadership team stuck in limbo, with the clock ticking toward Allvin's scheduled Nov. 2 retirement date. With no confirmed vice chief of staff, Lt. Gen. Scott Pleus, the Air Force's director of staff, is performing the duties previously assigned to Slife. But it is not clear how much longer Pleus will be in the job, as he has already delayed retirement to fill in as acting vice chief of staff.

Finding alternatives to Wilsbach and Bussiere for

the next chief of staff is difficult. The two officers widely considered as the most obvious picks—Gen. Alexis Grynkeiwich and Gen. Adrian Spain—were confirmed this year by the Senate as heads of European Command and Air Combat Command, respectively. Lawmakers are likely to be reluctant to reconfirm them in new roles and vet their replacements.

So Air Force leaders are casting a wider net for candidates, including three-star

generals and a host of retirees. Lt. Gen. David Iverson, deputy commander of U.S. Forces Korea, is currently the front-runner if the Air Force selects an active-duty officer. Gen. (ret.) Jeffrey Harrigian and Lt. Gen. (ret.) Joseph Guastella are also possibilities, sources say, if the administration bypasses Wilsbach and Iverson.

In the past, selecting either an active-duty lieutenant general or a retiree for the Air Force's top job would have been unprecedented. But the White House elevated Lt. Gen. (ret.) Dan Caine to chairman of the Joint Chiefs of Staff in February after President Donald Trump fired then-Gen. Charles Q. Brown, Jr.

The musical chairs at the top of the Air Force's military ranks comes with unfortunate timing.

Concepts of how to create and wield airpower are being challenged in an era of new threats, such as one-

way attack drones, low-cost cruise missiles and space-based sensing. Rising adversaries are bristling with new equipment: China's Victory Day parade in Beijing on Sept. 3 showcased the Chengdu J-36 fighter and a host of autonomous combat aircraft (page 24).

The jobs of Air Force chief of staff and vice chief of staff are to decide how to organize, train and equip the units today and into the future. For more than a decade, the service essentially has financed an ambitious modernization agenda by mortgaging current readiness, with savings from the retirements of thousands of current aircraft reinvested into upgrades and new platforms. But the Air Force is straining to maintain readiness while it waits for next-generation capabilities.

The time for hard decisions is coming, and the Air Force lacks a decision-maker. 🗳

Shot Down

A leadership crisis risks paralyzing the U.S. Air Force



TECH. SGT. NICK WILSON/U.S. AIR FORCE

AIRLINE INTEL

JENS FLOTTAU



MUCH HAS BEEN SAID AND WRITTEN

about how the Airbus A320neo family has been winning ever more market share from the Boeing 737 MAX since the launch

of both programs early last decade. The A321neo in particular has become so successful that it alone represents about half of Airbus' deliveries and has scored about four times as many orders as the competing 737-10 (AW&ST Sept. 1-14, p. 14). Its long-haul variant, the A321XLR, is offering new opportunities for airlines on secondary long-haul routes.

Yet some low-cost airlines in Europe are taking a different view. Eurowings, Pegasus Airlines and Vueling all have decided to transition from large fleets of A320s and/or A320neos to the 737 MAX, in spite of the enormous effort involved. The carriers will have to retrain pilots and technicians, compile new spares pools, obtain new licenses and build double structures at least temporarily, but they are still switching.

Granted, some of this has to do with bigger-picture aspects. Eurowings parent Lufthansa Group has been operating an all-Airbus narrowbody fleet after retiring its last 737-300 in 2016 and was keen to order Boeing aircraft for at least somewhat of a better balance. Likewise, Vueling owner International Airlines Group (IAG) wanted to move away from an all-Airbus short- and medium-haul fleet. Pegasus started out as a Boeing operator but moved to an almost all-Airbus fleet for many years (except for some remaining 737-800s) and is now going back to Boeing with the MAX.

Vueling has been allocated the 50 737 MAXs (25 737-8-200s and 25 737-10s) that IAG ordered in 2022. The order also included 100 options, so with a current fleet of 140 units, the airline has the opportunity to move entirely to Boeing aircraft, should it wish to do so. Deliveries are expected to begin in late 2026. Eurowings will take the first 40 737-8s that Lufthansa Group ordered and is hoping for first deliveries in 2027; discussions about timing are ongoing with Boeing. There are 60 more options available, and as the Lufthansa affiliate operates about 100 aircraft (plus wet-leases in the summer), it also could move to an all-Boeing fleet over time.

Of the three airlines, Pegasus has placed the biggest order, for 100 737-10s and options for 100 more, and is scheduled to receive the first of the new aircraft in 2028.

At least temporarily, all three will be operating mixed fleets, but of course, the rationale is there to move to a

single type over time. So why is it that some of the big low-cost carriers are moving back toward the 737, the aircraft that launched the industry in the 1970s at Southwest Airlines?

It is fair to assume that Lufthansa, IAG and Pegasus received very good deals from Boeing, given the manufacturer's current market share and the opportunity to flip big customers, so pricing surely played a role. But other than that, many of the same factors that have been pluses for the 737 are at play. The aircraft is simple—simpler than the much more sophisticated A320neo—and reliable. Many airlines with insights into the two types says the 737 MAX's direct operating costs are lower

and that they have to deal with fewer irrelevant nuisance warnings during maintenance. The 737 needs less ground equipment, too. The fact that it is unsuitable for containerized cargo is a problem for airlines that bet big on cargo, but if that part of the business is not so important, Boeing can sell the aircraft more easily. Also, the A320neo has a maximum passenger capacity of 194; the 737-8 is certified for 210.

While the vastly superior range of the A321neo vis-a-vis the not-yet-certified 737-10 has been an

issue in some markets, what tends to be overlooked is that the 737-8 has greater range than the A320neo. For Eurowings, that is an important issue. The airline has been expanding its network to include destinations in the Middle East, such as Dubai and Jeddah, Saudi Arabia, which it is serving from several German airports in the winter. Depending on prevailing winds, the A320neo would be weight-limited when flying back to Germany. The airline firmly plans to move the 737-8 into medium-haul flights.

Pegasus' decision in favor of the 737-10 was mainly driven by pricing and availability, Chairman Mehmet Nane said at Aviation Week's AeroEngines Europe conference in Hamburg on Sept. 10. The airline's selection of the largest version of the 737 largely has to do with runway constraints at its main base, Sabiha Gokcen Airport in Istanbul. If Pegasus wants to grow there, the best way to do it is by increasing average aircraft size.

But Nane and Pegasus are looking beyond the MAX and the Neo. The airline's first 100 737-10s are expected to be delivered by 2035. Its second batch is on option, and Pegasus has built in flexibility so that if Boeing launches a new aircraft or reengines the 737 again, the airline can switch to the new model. ☛

Against the Trend

Three big European low-cost carriers are buying Boeing 737 MAXs



PEGASUS AIRLINES



LEADING EDGE

GRAHAM WARWICK

AS THE FIRST GENERATION OF

quantum sensors moves out of the laboratory and into flight testing and fielding, DARPA is looking ahead to systems that

can bring extremely accurate but fragile quantum sensing to the harsh environments onboard military platforms.

“Quantum sensors offer unmatched precision in detecting magnetic and electric fields, acceleration, rotation and gravity, but their extraordinary sensitivity has made them notoriously fragile in real-world environments,” DARPA states. “Even minor vibrations or electromagnetic interference can degrade performance, limiting their operational use.”

Despite these limitations, the first quantum sensors are in testing and are being prepared for deployment with special operators and other early customers. Boeing, Honeywell, Leidos, Q-CTRL and SandboxAQ are flight-testing inertial and magnetic navigation systems using quantum sensors.

These sensors use quantum phenomena—such as superposition, interference and entanglement—to make precise measurements of acceleration, rotation, magnetic fields and gravity. They can serve as inertial sensors, magnetometers and gravimeters for navigation and anomaly detection.

In 2024, the Pentagon’s Defense Innovation Unit (DIU) launched the Transition of Quantum Sensors project to accelerate adoption of the technology to address the near-term need for alternative position, navigation and timing sources to enable operations in GPS-denied environments. The DIU awarded contracts in March to 18 companies to perform more than 10 field tests of quantum-sensing applications over 12 months.

One of those applications involves the first strategic-grade quantum inertial sensor to fly in space, developed by Honeywell and Vector Atomic and launched Aug. 21 on the U.S. Space Force’s Boeing X-37B reusable spaceplane. Now DARPA has launched the Robust Quantum Sensors (RoQS) project to create inherently rugged systems that reject interference, withstand motion and deliver reliable performance across all domains by rethinking sensor design.

The Pentagon’s advanced research agency has awarded Phase 1 contracts to Boeing, Collins Aerospace, L3Harris Technologies, Q-CTRL, Safran Federal Systems and Twinleaf. The awards cover two technical areas (TA): sensor development and platform integration. Briefing potential bidders in January, DARPA identified “three

enemies” with which to contend when integrating ultrasensitive quantum sensors: electric and magnetic fields from systems on the platform; gradients in those fields across the platform; and vibrations and accelerations from platform motion.

Quantum sensors can achieve extraordinary sensitivity in the laboratory, shielded from fields, gradients and vibrations. The goal of RoQS is to maintain state-of-the-art sensor performance when the sensor is moved from the laboratory into the dynamic environment on a vehicle, ship, satellite or aircraft. DARPA intends to reimagine quantum sensors to overcome the challenges.

Examples include multilevel systems that manipulate more than one superposition state to cancel out unwanted fields. Alternatively, coupling sensors at the atomic level could create an antigradiometer that is insensitive to gradients on the platform but can sense distant fields. On the design level, DARPA says options include creating arrays of vapor cells that can be compared to mitigate fields and gradients or lattices of trapped atoms that are immune to vibration.

Under the 30-month sensor development track (TA1), performers, including Q-CTRL, are to develop prototype quantum sensor systems that fit in a 10-L (610 in.³) box that can be carried on and off a govern-

ment-provided helicopter—chosen for Phase 1 because it is a difficult platform in terms of vibrations, field and gradients. Flight testing is planned for fiscal 2027.

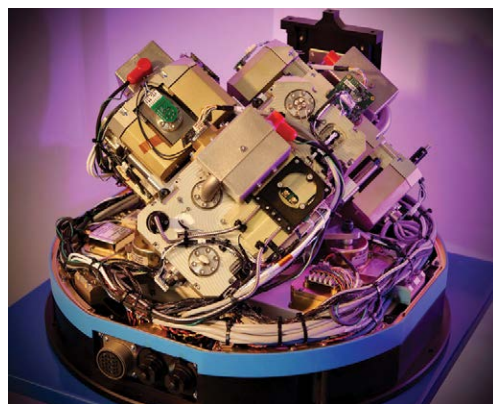
The platform integration track (TA2), involving Collins and L3Harris, is intended to identify programs of record where quantum sensors could deliver strategic value, DARPA says, adding that these could range from vehicles and submarines to satellites and uncrewed aircraft. The companies chosen for TA1 and TA2 are required to team for the planned yearlong Phase 2 of RoQS, expected to begin in fiscal 2028’s second quarter.

Under Phase 2, performers will develop a system with the targeted size, weight and power for demonstration on the selected platform. DARPA is asking organizations responsible for platforms and missions across the services to begin engaging with the RoQS teams.

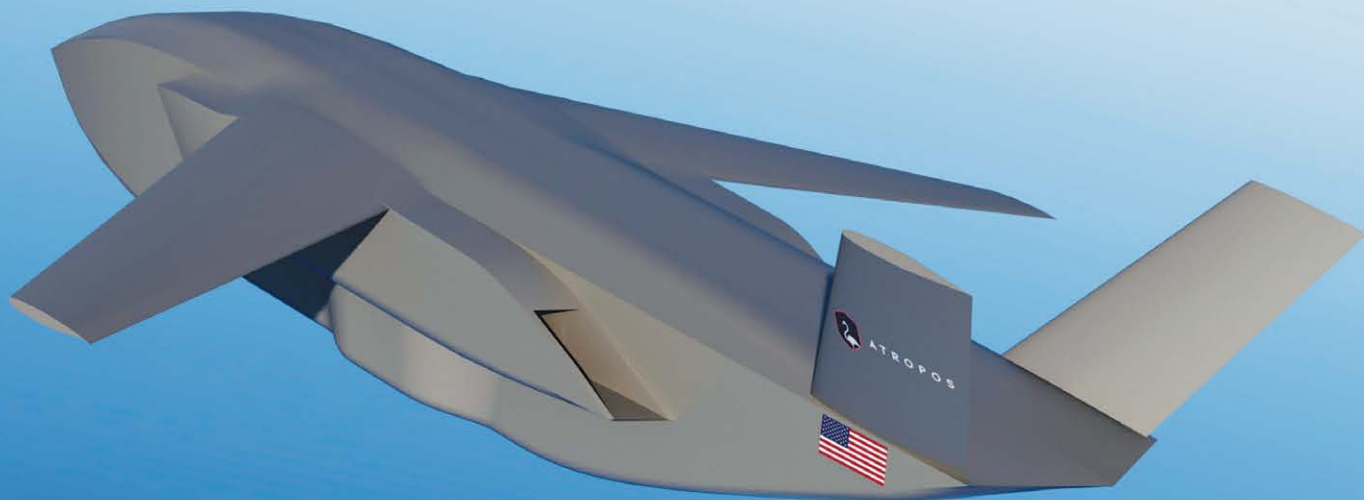
“The sensor technologies we’re developing should apply to a broad range of [Defense Department] platforms—no matter the domain,” DARPA Program Manager Jonathan Hoffman says. “The ultimate goal of RoQS is real-world transition, and that will require strong government partnerships.”

Quantum Prepares for Combat

Taking quantum sensors out of the lab and into the field



DEFENSE INNOVATION UNIT

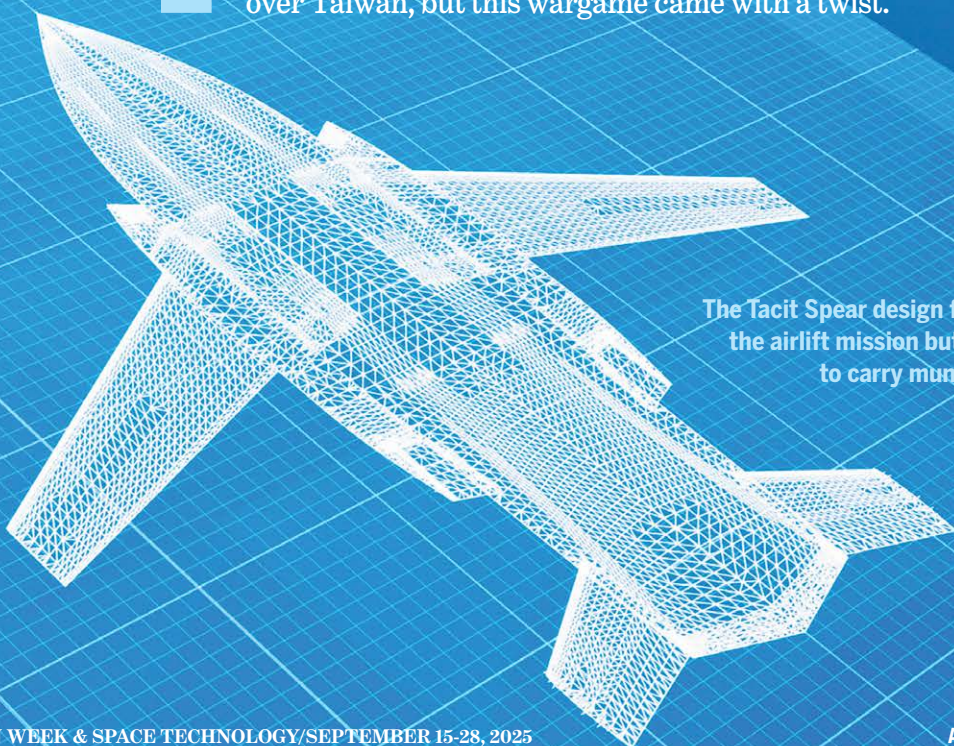


AIRLIFT DISRUPTOR

- > STARTUP AIMS TO DELIVER AN AUTONOMOUS AIRLIFTER FOR USAF BY 2028
- > CONTESTED LOGISTICS TO BE THE INITIAL FOCUS
- > PRIVATE FINANCING PLAN AIMS TO SPEED THE PROJECT

Steve Trimble Washington

Teams of U.S. Air Force and industry planners, operators and technologists gathered in a conference room in 2024 to imagine an air war over Taiwan, but this wargame came with a twist.



The Tacit Spear design focuses initially on the airlift mission but could be adapted to carry munitions and sensors.

The advent of collaborative combat aircraft (CCA)—a family of largely autonomous, jet-powered combat aircraft capable of a wide range of military missions—changed their approach. By basing these CCAs on small airstrips in southern Japan and the northern Philippines, the air war planners found a disruptive new weapon to threaten Chinese air superiority over the Taiwan Strait.

However, a summary produced by the Mitchell Institute for Aerospace Studies, which hosted the wargame, found one problem with that plan: The Air Force lacks an airlift fleet that could resupply the forward bases, which would lie well within the engagement zone of Chinese missiles. Even if enough Lockheed Martin C-130s and Boeing C-17s could be spared for the task, sending them so deep into hostile territory would incur severe risks.

The Air Force should “assess the potential for uninhabited aircraft to provide CCA logistics,” says the report, authored by Col. Mark A. Gunzinger, Mitchell’s director of Future Aerospace Concepts. In other words, someone may soon need to build a large autonomous airlifter with a range and payload relevant to the vast Indo-Pacific theater of operations.

Meet the Tacit Spear, a concept from the Atropos Group, a two-month-old startup based in Arlington, Virginia.

It is an autonomous aircraft designed by Darold Cummings—a former Northrop Grumman aircraft configuration lead and a current Aviation Week contributor—to deliver a Leonardo C-27J Spartan-like payload of about 20,000 lb. with a cargo bay large enough to carry three military-standard 463L pallets. Air-dropped munitions, including mines, are also a payload option. It would come with a ferry range of 2,500 nm, which is long enough to self-deploy to staging bases in the Pacific. With its twin-turboprop, embedded engines and swept wings, Tacit Spear can take off and land from unimproved airfields as short as 5,000 ft.

The aircraft’s sharp chines down the upper fuselage, forward-swept inlets and canted tails are designed to operate in hostile airspace. The concept would add a new capability in air mobility, not a direct replacement for existing aircraft derived from commercial models.

As the timeline for the unveiling sug-

gests, Atropos’ founders are focused on speed. The Tacit Spear is scheduled for a first flight in less than three years. Atropos also plans to develop more products, including commercial variants of the uncrewed airlifter.

“Our first product is a clean-sheet development, test and operation of the aircraft version of the Liberty Ship for the Information Age—unmanned, autonomous, versatile, mass-producible and capable of delivering relevant mass over relevant ranges,” Atropos CEO and co-founder Colin Carroll says.

Atropos is considering a wide range of applications beyond airlift. In addition to delivering or air-dropping cargo, the payload bay can be used to launch munitions or host sensors and data links. But the initial focus is to address the Air Force’s potential need for an airlifter that can reach far-flung bases in the Pacific theater.

“Our focal point mission is a logistics mission for the first design reference mission we are building toward,” Carroll says.

Development of a large, uncrewed cargo aircraft is a new concept in the U.S. defense industry, but not abroad. In the past 12 months, China has revealed two uncrewed logistics aircraft—it unveiled the Air White Whale W5000 in November and flew the larger Aerospace CH UAV Co. Ltd. CH-YH1000 for the first time in May.

Lacking a confirmed requirement from the Defense Department for a similar aircraft, the U.S. defense industry has been slow to respond. But the Pentagon has been looking for options. Transportation Command has been considering launches of intercontinental rockets to deliver cargo to forward bases. DARPA started developing the C-17-size Liberty Lifter, but

China Leads Uncrewed Logistics Race

Graham Warwick Washington

CHINA HAS CLAIMED AN EARLY LEAD IN LARGE UNCREWED CARGO AIRCRAFT, ostensibly for commercial application but with clear military potential. The largest yet, a Tengden design with a 2,000-kg (4,400-lb.) payload capacity and 1,800-km (970 nm) range, flew in August 2024.

Meanwhile, the Air White Whale W5000, with a 5,000-kg-payload capacity, is being readied for flight, and in May, AVIC’s Shaanxi division unveiled plans for the Ibis-60, an uncrewed airlifter resembling the Shaanxi Y-8, a Lockheed Martin C-130-class aircraft that can accommodate a 20,000-kg payload and has a 5,600-km range.

Aircraft in development in China run the gamut of sizes, from AVIC’s single-engine, 500-kg-payload-capacity TP500 and twin-engine, 700-kg-payload-capacity HH-100 to the W5000, which is larger than Cessna’s twin-turboprop SkyCourier.

More aircraft are joining the fray. In March, Yitong flew the TP1000, a copy of the Britten-Norman Islander, with capacity for a 1,000-kg payload. And in May, Chinese uncrewed aircraft leader CASC flew the 1,200-kg-payload CH-YH1000, the latest in its Rainbow series.

Several of China’s uncrewed cargo aircraft are set to enter service in 2026. There are no overt signs of military interest, but many of the developers have links to the People’s Liberation Army.



In May, China flew a large autonomous airlifter, the CH-YH1000, with a payload capacity of about 1,200 kg.

AEROSPACE CH UAV CO. LTD.

abandoned the wing-in-ground-effect aircraft project this year.

To reach such an audacious goal in 2028, Atropos expects to take a different approach to financing and developing a large, autonomous aircraft.

The startup plans to raise about 80% of the financing privately for development. So far, the company has secured \$6 million in pre-seed funding. In an era of intense interest in financing new defense technology, the company's founders—Carroll and Vince Dutcavich—expect to be well-funded by a team of top-tier investors.

For the final one-fifth of the multi-billion-dollar development bill of the Tacit Spear, the Atropos founders are targeting the Defense Department's research, development and test and evaluation budget.

A precedent exists with the \$215 million awarded by the Air Force to JetZero. That contract helps fund the development of a full-scale prototype of the Z4, which is a vision for a blended wing body airliner that could be adapted into a military refueler and airlifter.

The Atropos business plan proposes a different approach. The company plans to certify the airworthiness of the autonomous aircraft on a dual-use basis, then offer the aircraft to the Pentagon as a service. The strategy shifts the financial burden out of the procurement budget and into the operations and maintenance accounts.

Such a strategy also proposes an alternative path to a frequent dead end for largely self-funded new aircraft. Since the 1980s, Northrop's self-funded F-20 fighter and Textron AirLand's self-financed Scorpion have stood as warnings to the defense industry, leaving contractors focused only on concepts that receive full financial support from the Pentagon.

That approach comes with financial guarantees through the Defense Department's annual budgeting process—but often at the expense of long and uncertain timelines. If the system works as intended, the process generally involves a lengthy competitive process, which includes a multiyear technology maturation and risk-reduction phase. That is typically followed by a 5-8-year engineering and manufacturing development phase, leading to operational testing and finally approval for entry into service. 🍷

U.S. Air Force Stress-Tests Itself as It Plunges Into a Time of Change

➤ MASSIVE EXERCISE HIGHLIGHTS GAPS IN LOGISTICS AND OPERATIONS

➤ NEW LEADERSHIP CHANGES ARE RESHAPING PRIORITIES

Brian Everstine Andersen AFB, Guam

The two Boeing KC-135 Stratotankers took off from northern Guam, following a four-ship of Lockheed Martin F-35 fighters preparing to train for a high-intensity conflict in the Indo-Pacific region.

The group was participating in the final day of the U.S. Air Force's largest flying exercise in recent history: More than 400 aircraft participated in the Department-Level Exercise (DLE) for

that required attention. The canceled mission exposed one such deficiency.

"The perfect debriefs are significant shortfalls and gaps defined," Allvin tells Aviation Week. "I know they're there. We know they're there. We're building this in pieces. This is complex. It is new; it is going to be challenging. And it is largely done with a force right now that wasn't built with this fight in mind."

Airlifters and tankers evaluated new communications prototypes as Air Mobility Command presses to be prioritized for modernization.



MASTER SGT. ANDREW PIGOTT/U.S. AIR FORCE

just over a month. The two tankers, among the oldest in the service's fleet, were outfitted with new communications prototypes that aim to modernize the aircraft at a lower cost.

The mission quickly went sideways, however, demonstrating the challenges facing the Air Force. The auxiliary power unit in the tanker Tail No. 59-1459 started to smoke, forcing the Eisenhower-era aircraft to return to Andersen AFB and end the day's mission.

Aviation Week flew along on the attempted mission, part of a series of exercises for the DLE. Air Force Chief of Staff Gen. David Allvin had orchestrated the event with the intention of pushing the service to its operational limits to identify critical vulnerabilities. His mandate was to stress-test the organization to reveal weaknesses

The Air Force in recent years has attempted to reshape itself with an eye toward a high-intensity fight in the Pacific. This shift is central to Allvin's strategy of aligning the force with the realities of great power competition—redefining modernization requirements and developing new operational deployment methods. The service is allocating its funds on new combat systems, most notably the Boeing F-47 and Collaborative Combat Aircraft, while eschewing heavy spending on full, new programs of record for its mobility forces. The exercise—spanning from the continental U.S. and Alaska to Guam and Australia—was a step to assess the progress and make notes for changes.

"We're going to stress the system, and I fully expect that there will be ... a day where maybe all the missions

might not go. Well, why? And we figure that out,” he says.

Much of the DLE was kept relatively hidden from public view, so as not to tip the Air Force’s hand at fighter tactics throughout the island chains in the region. The service invited Aviation Week to come along for the segment called Mobility Guardian, in which dozens of tankers and airlifters practiced their ability to deploy forces to the region and maintain operations.

The service’s mobility forces prioritized testing the new connectivity-focused systems. Air Mobility Command (AMC) has been advocating for new kit to improve situational awareness for airlifters and tankers and enhance interoperability with fighters and bombers. The command says there is new momentum—funding from the One Big Beautiful Bill Act, for instance, has allowed them to buy more systems—as well as positive pushes for more spending in the service’s fiscal 2027 budget.

Lt. Col. Paul Tucker, director of AMC’s Commander’s Initiative Group (CIG), is leading the charge to develop prototypes that are setting the requirements for an upcoming program of record. The main focus is Sierra Nevada Corp.’s Airlift-Tanker Open Mission System (ATOMS)—a relatively small server-rack-looking system that can connect to existing apertures and wiring on aircraft to provide internet protocol connectivity. Aircrews use ATOMS to communicate easily with headquarters and air operations centers to receive updated information in flight. During Mobility Guardian, ATOMS connected to SpaceX’s Starshield, although the system will be input-agnostic.

The exercise also featured the Bor-sight Real-Time Information in the Cockpit system, which has a larger server rack with a multifunction display allowing the crew to use data links to view other aircraft and potential threats in the region. Boeing KC-46s operating in the exercise also used the Northrop Grumman Roll-On Beyond-Line-of-Sight system that extends the tanker’s data links beyond aircraft in the immediate vicinity.

Tucker says AMC’s CIG collaborated with Air Force headquarters to leverage these prototypes in drafting requirements for a program of record in order to secure funding to advance connectivity integration. As

the broader Air Force has prioritized fighters and improvements in connectivity and electronic warfare on combat aircraft, it has moved away from such plans as the Next-Generation Aerial-Refueling System and Next-Generation Airlift airframes. Connectivity is how the command plans to modernize its fleet, at least for the foreseeable future.

Andersen AFB hosted nine tankers from five different wings. In 12 days, the aircraft flew 55 flights, offloading 2.2 million lb. of fuel into 200 receivers, says Lt. Col. Kelsey Payton, who led refueling operations throughout the DLE. Most of these included the new connectivity system.

“This technology is new to tankers,” she says. “This is not something that a tanker pilot is used to, just having all this access. So right now we’re kind of in that crawl phase. I think moving into the walk phase for a lot of our folks is just getting the tactile experience of actually using the systems in a theater that is not over the U.S.”

The Lockheed Martin C-130 tactical airlifters operated with ATOMS. Some of the aircraft were the newer C-130J Block 8.1s equipped with satellite phones, says Lt. Col. Ryan Vanderneck, commander of the 41st Airlift Sqdn. C-130 crews also worked to expand their tactics, including maximum endurance operations. One C-130 outfitted with external tanks flew 40 hr. to Guam, landed for a quick crew rest and then led operations the next day.

F-35s, including the ones launching with the KC-135s on the last day of flying, used their training to focus on mission sets that are key to operating in the region—Agile Combat Employment to surge and fly quickly from austere locations, maritime targeting—including suppression of enemy air defenses—and offensive counter-air over the water, says Maj. Andrew Schloemer, chief of staff of the 354th Fighter Wing, who led Joint Strike Fighter operations in the DLE. Schloemer adds that “various squadrons at various airfields through the second island chain” were operating in diverse weather conditions on different runways.

“We’re just applying those lessons that we take from our training back home, doing [offensive counter-air and suppression of enemy air defenses] missions, now applying those concepts here in the second island chain with

different weather, different ranges, different airfields,” he says.

The Washington-based 121st Fighter Sqdn.’s F-16s also used the event to share newly developed tactics for the fleet. The unit had recently returned from a deployment in the Middle East, where it was among the first to use the Northrop Grumman Litening pod to guide BAE Systems Advanced Precision Kill Weapon System II rockets to take down drones at a much lower cost than typical missiles. Lt. Col. Nathan Skavdal, the squadron’s leader, said the unit’s capability to take down drones and cruise missiles was part of the overall training as the fighters progressed through defensive counter-air, offensive counter-air, counter maritime and long-range strike phases.

“We started right at variety level; there was no kind of . . . warm-up,” he says. “It was mostly just, ‘This is the problem set—straight-up solve it.’”

Pacific Air Forces commander Gen. Kevin Schneider says the extended exercise stressed the command’s operations models at “dramatic speed and scale,” showing how the service needs to go from a tactical fight to a sustained operation over broad distances.

Allvin says the service must follow through on what it learned, although it is unclear how that will progress because the Air Force is in a moment of upheaval. Major initiatives, such as the reprioritization toward great power competition, modernization changes and deployment model shifts, are on pause following the change of administration. Allvin is stepping down this fall, as sources indicate to Aviation Week that the service needs to change its focus more toward near-term threats instead of long-term evolution.

The DLE’s model was largely focused on a new, still mostly classified force design that tiers Air Force operations in different mission areas depending how close they are to threats. All of this will be reshaped under new Air Force Secretary Troy Meink, who has mostly avoided making major pronouncements of change in the service, and a new chief of staff who has yet to be nominated.

“So to understand how in the short term we fill those gaps, we fill those shortfalls, and as we’re developing capabilities, they can mitigate those, or make them less relevant to the fight,” Allvin told Aviation Week in July, before his retirement was announced. 🌐

Australia Boasts Most Advanced CCA Design on the Market

➤ RAAF LEADER LAYS OUT MQ-28 DEVELOPMENT ROAD MAP

➤ OPERATIONAL GO-AHEAD DECISION EXPECTED BY YEAR-END

Steve Trimble RAAF Base Woomera, Australia

Much has happened with the Boeing MQ-28 Ghost Bat on this vast, windswept test range deep in the Australian interior since the prototype autonomous combat aircraft began flying here on Feb. 27, 2021.

class of combat aircraft fits into the service's operations.

RAAF planners have recorded 150 flight hours on 130 sorties by the eight Block 1 prototypes, launched production of a trio of operational Block 2s

fatigue you're saving in a crisis by manning defensive counter-air alert airstrips with uncrewed platforms," Chappell told Aviation Week.

The MQ-28s, powered by Williams International FJ44-4A engines, could take over that strenuous duty from the crewed fighter fleet.

"You can be just sitting there, smoking [Lucky Strike cigarettes] in the control station, with 20 fighters—all of them MQ-28s—not getting tired and fatigued and just sitting there on 24-7 alert," Chappell said. "That frees up a lot of the crewed force for other missions."

An MQ-28 Block 1 equipped with an infrared search-and-track sensor took off during a Sept. 5 demonstration flight.



NICK HAGGARTY/AUSTRALIAN DEFENSE DEPARTMENT PHOTOS

The U.S. Air Force may have coined the term "collaborative combat aircraft" (CCA), but the Royal Australian Air Force (RAAF) is closer to making the concept a real capability with the locally designed and built Ghost Bat.

Pending a final decision from the Australian government, anticipated before year-end, RAAF Air Marshal Stephen Chappell says he expects the unarmed MQ-28 Block 2 to enter service by 2027, beating the scheduled in-service debut of the U.S. CCA by one year.

After the program was launched in secret in 2017 and the first flight was completed four years later, the Block 1 version checked off all flight sciences testing in 2023. The program then shifted focus to integrating payloads and demonstrating how this emerging

and created a long-term road map that envisions armed and more capable Block 3s coming soon. Those could be followed by larger and longer-range Block 4 models.

Chappell already is mapping out specific roles for his future fleet of autonomous fighters. One idea solves the challenge of defending Australia's nearly 3 million mi.² of land with the country's crewed fighter fleet of 72 Lockheed Martin F-35As and 24 Boeing F/A-18Fs.

If a conflict erupts, some of the RAAF's plans call for dispersing those crewed fighters to remote bases around the continent, where a limited pool of pilots must maintain an exhausting regimen of 5- or 30-min. alerts in their fighter cockpits.

"You imagine how much human

To realize that vision, the service still needs government approval from the nine-member National Security Committee, a cabinet-level decision-making body. But the outlook seems bright for a favorable decision.

"I'm not going to get ahead of government decision-making, but I will say that so far, we've been absolutely satisfied that it's been hitting every milestone, and we see a definite role for this in future conflicts," Defense Industry Minister Pat Conroy, a committee member, told reporters here on Sept. 5.

The government's satisfaction stems from recent performance. In early June, the MQ-28 Block 1 fleet wrapped up Capability Demonstration (CD) 25, a series of tests aimed at validating how the Ghost Bat would perform operationally.

To complete CD25, Boeing equipped the fleet with four types of payloads: a European-made infrared search-and-track sensor, the SRC-supplied Generic Multi-Function Array electronic warfare system, an unidentified electronic warfare payload and a classified system.

Weapons, however, have not yet been integrated. The Ghost Bat design includes a weapon bay sized to accommodate small-diameter-bomb-class (SDB) munitions or long-range air-to-air weapons, such as AIM-120 Amraams. Although the space is reserved, the weapon bays have not been installed on the eight Block 1 or the initial tranche of Block 2 aircraft.

The RAAF is still planning a test launch of an air-to-air missile against a live, beyond-visual-range target by year-end. But this AIM-120 captive air test vehicle is to be launched from a pylon attached to the belly of the aircraft, not from within the weapon bay, according to Boeing and service officials.

With the armed version of the MQ-28 still not available, the CD25 series of flight tests focused on three of the six steps in the so-called targeting kill chain.

The CCA concept came of age after air war planners determined more than a decade ago that crewed fighters operating by themselves during an attack on an enemy would be unable to complete the cycle of finding, fixing, tracking, targeting, engaging and assessing. The lower-cost uncrewed and attritable CCAs would augment the crewed fighters.

The CD25 flights focused on the ability of the MQ-28 to assist crewed aircraft with finding, fixing and tracking an aerial opponent. The sensors mounted on the nose of each Ghost Bat helped the CCAs find their assigned targets. And the MQ-28s proved they could relay the tracking data to a human operator onboard an RAAF Boeing E-7A Wedgetail, an airborne early warning and control aircraft.

The missile-firing demonstration in December or early 2026 is to gauge how the MQ-28 performs in the targeting, engaging and assessing steps of the kill chain. The event will show how the MQ-28 can use its sensors, weapons and autonomy control system to shoot down a moving, beyond-visual-range target, Chappell said.

Once the MQ-28 develops a track of the target, the aircraft "will be authorized by a human to engage," Chap-



RAAF Air Marshal Stephen Chappell (left) and Defense Industry Minister Pat Conroy observed MQ-28 flights on Sept. 5 in South Australia.

pell said. "But then its maneuver to get to the [missile launch] point will be [done by] the autonomous system. So it won't just be a simple missile shot by someone flying to the point and then saying, 'Fire, now.'"

As a capability demonstration, the live missile firing by the MQ-28 is expected to validate the ability of an autonomous aircraft to close the full sequence of the targeting kill chain under human supervision. But the demonstrations are not designed to replicate the rigor of a full operational testing process, in which an aircraft must perform the same capabilities while exposed to realistic jamming and kinetic threats of a sophisticated enemy. Operational testing, however, is expected to follow with the Block 2 aircraft, if the decision by the government this year is positive.

"If we move out, then it's Block 2, fast following into Block 3, then the final [operational test and evaluation] phase," Chappell said.

The Block 2 aircraft is being designed to realize the full potential of Boeing's modular concept behind the MQ-28's nose payload bay.

"Block 1 is literally a prototyping platform, so Block 2 is taking the lessons from it and getting the platform and hardware, cabling and so on in a way where we can now basically put in replaceable items into the platform itself and therefore free up the nose for what it's designed to be," Chappell said. "Block 3 would then be a bigger wing and give us more range and payload."

In addition to an activated weapon bay, the RAAF is considering inflight refueling for the Block 3 design.

"That's definitely in the mix," Chappell said. "I have enough gas airborne, I said no air component commander ever. 'And I've noticed enough aircraft,' said no fighter pilot ever. So that's what we want to get."

RAAF and Boeing officials are still determining the final weapon loadout requirement for the Block 3 aircraft.

"We are still going through the final design, but it would be at least a couple of Amraams and/or a swath of SDB-type weapons," Chappell said.

The RAAF timeline calls for fielding of Block 2 immediately, with Block 3 following close behind. In the longer term, the MQ-28 road map also includes expanding the aircraft's capabilities with a larger Block 4.

"A Block 4 may well be a different-size body as well as [the larger] wings," Chappell said. "It would then give us more weapons carriage and more fuel."

Asked if the larger Block 4 would require a twin-engine aircraft, Chappell said the RAAF hopes to avoid that design change.

"There's that fine line with engines and fuel, and so I think we'd look to try and optimize the platform with the fairly modest engine there that gives us a good capability, given the size and weight of this thing," Chappell said. "So we don't [want to] end up building, effectively, a fighter-size aircraft or a fighter-cost aircraft." ☛

F-15



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U.S. Innovation Is Hurrying New Cruise Missiles to Ukraine

> THE NEW MISSILE IS READY FOR USE ON F-16s AND MIG-29s

> U.S. CLEARS SALE OF UP TO 3,550 ERAMs FOR UKRAINE

Steve Trimble Washington

Ukraine is poised to receive an influx of low-cost, long-range, air-launched cruise missiles from the U.S. as the embattled country looks to counter Russia's invasion by hitting high-value targets behind enemy lines.

Deliveries of the Extended-Range Attack Munition (ERAM) not only open a new pipeline of long-range weapons expected to be delivered to Ukrainian and U.S. forces in large

and receive the prototypes, according to Air Force documents obtained by Aviation Week.

The plan now is to deliver a first lot of 840 ERAMs, split between two designs separately produced by Virginia-based CoAspire and California-based Zone 5 Technologies, by the end of October 2026, the documents say. The ERAM also represents a piece of a larger portfolio within the Weapons Capacity Task Force.

subsonic missiles could begin in the third quarter of fiscal 2026.

The Weapons Capacity Task Force's work caught the attention of lawmakers this summer. The House Armed Services Committee passed a defense authorization bill for fiscal 2026 that includes special praise for the Armament Directorate organization. "The Task Force has taken a fundamentally different approach to weapons development by embracing nontraditional vendors with expertise in digital engineering, modular design and the ability to scale up production rates rapidly," a congressional report states.

The yearlong turnaround between contract award to CoAspire and Zone 5 and delivery contrasts with traditional cruise missile procurement. For example, the Air Force launched the Joint Air-to-Surface Standoff Missile program in 1995 and fielded the Lockheed Martin stealthy cruise missile eight years later. But both ERAM designs completed a first flight four months after a Phase 1 contract award in October 2024, Air Force documents state.

The program benefited from leveraging designs developed under the Enterprise Test Vehicle program, which included the CoAspire Rapidly Adaptable Affordable Cruise Missile and the Zone 5 Rusty Dagger.

The ERAM requirement calls for a traditional air-launched cruise missile. The weapon's two lug bolts are loaded onto a standard bomb rack unit, which attaches to a pylon under the wing or inside the weapon bay of a fighter or bomber. The weapon can either be integrated into the host aircraft's mission systems through a universal armament interface or communicate directly with the pilot through a federated system in the cockpit.

The Air Force expects to buy the ERAM, as do at least three foreign military sales customers, including Ukraine. The other two potential foreign buyers have not been identified. A second Air Force requirement for a Family of Affordable Mass Missiles (FAMM) anticipates ordering thousands of cruise missiles that can be loaded onto special pallets and dropped in flight from the rear door of a Lockheed C-130 or Boeing C-17 (AW&ST July 28-Aug. 10, p. 24). Anduril and Zone 5 are competing to produce the 3,010 FAMM units in the Air Force's fiscal 2026 budget proposal. 🌐

COASPIRE CONCEPT



CoAspire has designed this ERAM for the U.S. Air Force.

numbers but also represent a novel paradigm for speed in air-launched weapons acquisition, development and mass production for the Pentagon.

The ERAM has emerged within a mere 14 months since the release of solicitation in August 2024—the prototype air-launched cruise missiles have a scheduled delivery in October. It is the product of a new organization the U.S. Air Force established several years ago within its Life Cycle Management Center's Armament Directorate.

Armed with a \$225 million budget and a fast-track acquisition process, the Weapons Capacity Task Force took a little over a year to release the ERAM solicitations, award contracts to two nontraditional defense companies, demonstrate the weapons on a U.S. Douglas A-4 testbed and a Ukrainian Mikoyan MiG-series fighter

U.S. government officials in late August formally cleared the sale of up to 3,550 ERAMs to Ukraine. The Defense Security Cooperation Agency notified Congress of the export deal, setting up a 30-day deadline for lawmakers to review the proposed sale. The notification confirms that the family of cruise missiles is usable from Ukraine's Lockheed Martin F-16 and MiG-29 fighters.

Although Ukraine is cleared to buy up to 3,550 missiles, the first production run is smaller. The first 10 are scheduled for delivery in October.

The Air Force office is working on other projects, too. Among them are a new class of palletized munitions similar to the ERAM, a potential follow-on buy of low-cost air-to-air missiles and a still-classified project known as Sunrise. Additional prototyping projects for hypersonic and



Arrival of a Second Airworthy B-21 Is Critical Step for the U.S. Air Force

- > NORTHROP GRUMMAN DELIVERED THE AIRCRAFT ON SEPT. 11
- > THE B-2 TEST PROGRAM OUTPACED B-21 AIRCRAFT DELIVERIES

Steve Trimble Washington

U.S. Air Force Lt. Gen. Andrew Gebara anticipates the day when the Northrop Grumman B-21 Raider enters service by arriving at Ellsworth AFB, South Dakota, about 35 mi. up U.S. Highway 16 from one of the country's most patriotic monuments.

"I have these visions in my head of the B-21 flying over Mount Rushmore and circling to land," said Gebara, the service's deputy chief of staff for Strategic Deterrence and Nuclear Integration. "And I can see it happening."

If the B-21's specific arrival date is scribbled on a calendar in Gebara's Pentagon office, the former Northrop B-2 pilot is not telling anyone.

"It's going to happen before we know it, very soon," he said during an Aug. 27 webinar hosted by the Mitchell Institute for Aerospace Studies. "But it isn't there yet. So we all have a lot of work to do to keep it on track and keep it a good news story."

The next step toward the B-21's eventual arrival in South Dakota came on Sept. 11, when Northrop delivered the second flight-test aircraft. It is the fourth completed B-21 airframe, after the first flight-test aircraft and two ground-test aircraft.

"We can now expedite critical evalu-

ations of mission systems and weapons capabilities, directly supporting the strategic deterrence and combat effectiveness envisioned for this aircraft," Air Force Secretary Troy Meink said.

The arrival of the second flying B-21 had been eagerly awaited for several months. U.S. Air Force Gen. Thomas Bussiere, head of Global Strike Command, said in July that the second developmental flight-test aircraft would get airborne "shortly."

Nearly 10 years after Northrop won the engineering and manufacturing development contract in October 2015, Air Force officials and a bipartisan chorus of lawmakers agree that the secretive program is on track and on budget. The B-21 remains scheduled to enter service in the mid-2020s.

"The good news is the B-21 is succeeding," Gebara said.

So far, the only signs of financial pressure on the program have appeared on Northrop's bottom line—not the Air Force budget. Unexpected inflation triggered a \$1.5 billion write-off on the company's losses in 2024 for the first four lots of low-rate initial production. Northrop reported another loss, of \$477 million, this year to fix shortfalls limiting the production system.

But the program has moved at a

Mission systems integration started on the first flight-test aircraft for the B-21 bomber, which is a rarity for a developmental military aircraft. Radars and other sensors are typically not integrated for several years after flight tests start so that crews can focus first on airworthiness and clearing the full flight envelope.

slower pace than the development phase of the B-2 in the 1980s. Both Northrop-built stealth bombers needed about eight years after contract award to achieve first flight, but then the comparison worsens for the B-21. Within two years of first flight, Northrop delivered five B-2 aircraft—two ground-test airframes and three flight-test examples—compared with only three so far for the B-21.

A difference in maturity could partly explain the slower pace for the B-21 program. Air Force officials previously boasted that even the flight-test versions of the B-21 would be delivered with a full suite of mission systems, including the radar and electronic warfare systems, allowing the service to deploy the B-21 test aircraft on operational missions after test equipment is removed.

The sixth and last B-21 test aircraft entered assembly before February 2022, but its status is unclear. All four flight-test and two ground-test aircraft are essential to accelerate the pace of testing.

"I always caution people to say it's early in flight test," Gebara said Aug. 27.

Meanwhile, Northrop continues assembling the first production models. The Air Force awarded the first lot of low-rate initial production in January 2024. Historically, production aircraft are delivered 2-3 years after the order is signed.

Construction crews are proceeding on a \$1 billion bed-down program for the first Raider unit at Ellsworth. Several facilities, including a radio frequency hangar and a weapon-loading building, are scheduled to be complete now. Others, such as a weapons generation facility, maintenance hangar and environmental protection shelters, are slated to open in 2027.

"It's a well-thought-out plan," Gebara said. "Now it's about delivering that plan on time." 🛩️

Chinese Victory Day Parade Spotlights New Weapon Priorities

- NEW CHINESE COLLABORATIVE COMBAT AIRCRAFT BROKE COVER
- AIR-LAUNCHED, NUCLEAR-TIPPED BALLISTIC MISSILE DEBUTED

Chen Chuanren Singapore

During the Cold War, Western intelligence agencies scrutinized every May Victory Day parade in Moscow for a glimpse of the latest Soviet weapons. Today, those agencies look to Beijing's Tiananmen Square, where the People's Liberation Army uses milestone anniversaries to show off its progress and ambitions.

with additions to the Ying Ji (Eagle Strike) family: the air-launched YJ-15, ship-launched YJ-17 and YJ-20 and submarine-fired YJ-19. Cruise missiles making their debut included the stealth-configured YJ-18C and large, extended-range land-attack CJ-1000.

All systems on display are "active, homegrown battle platforms" aligned

DF-21 the YJ-21, aligning it under the anti-ship YJ series. Also debuting was the Jing Lei-1 air-launched nuclear-tipped ICBM, which appeared to be carried on the Xi'an H-6N bomber's centerline belly.

"The level of innovation displayed in a relatively short period of close to six years is impressive," says Thomas Lim, associate research fellow with the Military Studies Program at Singapore's S. Rajaratnam School of International Studies. Although China's claim that all the systems are operational is difficult to verify because of limited information about production levels and operator training, the parade nevertheless lays out Beijing's vision of the emerging warfighting environment, Lim notes.

The event highlighted how the PLA, like many of its Western counterparts, is learning from conflicts in Ukraine and the Middle East and is focusing on uncrewed aircraft systems—both using and countering them. It showed a large mobile microwave defense array and a directed-energy weapon mounted on the Dongfeng Mengshi, China's answer to the Humvee, indicating the military is focused on counterdrone operations at the unit level.

Also present was the naval LY-1 laser system that the Chinese state-owned *Global Times* suggests could counter fast-moving missiles. This emphasis on such systems reflects China's ambition to integrate novel technologies with conventional missile forces in a layered defense-offense approach.

The parade also signaled the PLA's focus on potential conflict in the Taiwan Strait. Chinese leader Xi Jinping has suggested that the PLA must prepare for a potential armed takeover of Taiwan by 2027.

Shu Hsiao-Huang, an associate research fellow at Taiwan's Institute for National Defense and Security Research, says the new operational concepts, structure and technology displayed at Tiananmen Square are directed at undermining the U.S. capacity to project power and sustain operations in the Western Pacific.

Many of these systems would have a direct role in a Chinese effort to invade Taiwan, including the Type 191 modularized rocket artillery. Shu notes that China's mass production of helicopters and advances in tiltrotor and compound rotorcraft technology have clear utility in cross-Taiwan Strait operations. 🇨🇳

GREG BAKER/AFP/GETTY IMAGES



The submarine-fired, hypersonic YJ-19 missile made its debut in the parade.

This Sept. 3 parade marked the most significant in nearly a decade. Beijing showcased the hardware, operational concepts and doctrinal changes underpinning the People's Liberation Army's (PLA) rapid transformation, often developed in great secrecy.

The breadth of equipment unveiled was striking, covering ICBMs, stealthy uncrewed combat aerial vehicles, collaborative combat aircraft, laser and other counterdrone systems and anti-satellite systems like the HQ-29. Beijing also showed an expanded nuclear arsenal, with ICBMs such as the road-mobile DF-61 and DF-31BJ and the longer-range DF-5C. The parade also confirmed the existence of the submarine-launched Ju Lang-3.

China displayed its growing anti-ship hypersonic missile arsenal, too,

with the PLA's new force structure and designed for a "changing state of warfare," Maj. Gen. Wu Zeke, deputy director of the parade's organizing committee, said at a pre-parade press briefing, emphasizing how far China's defense industrial prowess has advanced.

The PLA showcased two new collaborative combat aircraft. One closely resembles the U.S. Air Force's XQ-58A Valkyrie, made by Kratos, that features a swept-wing planform, single dorsal intake and canted vertical tails. The second has a sleeker profile, single dorsal intake and canted fins, but its diamond-shape wings suggest a different aerodynamic approach. A third design observed at the rehearsals did not join the actual parade.

In addition, the PLA officially designated the ship-launched variant of the

U.S. Laser-Link Communications Industry Finds Its Stride

> INDUSTRY TEAM DEMONSTRATES AIR-TO-SPACE CROSS-LINK CONNECTIVITY WITH SDA'S TECHNICAL STANDARD

> THE SUPPLY CHAIN IS RAMPING UP PRODUCTION TO MEET DEMAND

Vivienne Machi Los Angeles

As a SpaceX Falcon 9 rocket launched the U.S. Space Development Agency's first operational satellites in September (page 27), the once-fragile industrial base for optical communications terminals—a key enabler for the agency's constellation—is showing signs of newfound maturity.

velopment Agency (SDA) to demonstrate space-based laser links—which are critical to the transport of missile warning and tactical data across satellites in low Earth orbit (LEO). The Government Accountability Office flagged laser link immaturity as a risk to the program in February and scru-

Gregg Burgess, vice president of space systems at GA-EMS.

The team performed a more complex demonstration this summer: bidirectional air-to-space optical communications between terminals from two separate vendors, where a Kepler spacecraft connected to a GA-EMS terminal that was flying onboard a leased De Havilland Canada DHC-6-300 Twin Otter aircraft outfitted with a General Atomics-built turret. Kepler announced in May that it had also demonstrated space-to-ground optical data relay with French provider Cailabs using full SDA standard data rates.

These tests marked an important milestone for the SDA, showing that its commitment to standardized opti-



PETROVICH/GETTY IMAGES

One year ago, delays in laser-link terminal manufacturing and integration created schedule disruptions for the agency's ambitious proliferated satellite constellation. Now, with hundreds more satellites expected to launch over the next five years, optical communications terminal (OCT) providers are ramping up production and completing demonstrations—including of space-to-ground and air-to-space links.

Production delays, limited vendors and interoperability challenges hampered early efforts by the Space De-

veloped the agency's challenges in producing tangible results for space-based optical communications with its Tranche 0 demonstration spacecraft.

Since then, the SDA and industry partners have tested space-to-ground and air-to-space optical connectivity. In tests starting in February, General Atomics Electromagnetic Systems (GA-EMS) and Kepler Communications linked a Tesat-Spacecom terminal on a Kepler spacecraft in LEO with a ground-based GA-EMS OCT using the SDA's technical standard, says

cal communications is paying off, Burgess says. GA-EMS also is leading an SDA demonstration called Manhattan, which will fly two company-designed OCT systems on GA-75 satellites set to launch in 2026, and the company is building missile and fire control payloads for Lockheed Martin's satellites under the SDA's Tranche 2 Tracking Layer contract.

The demonstrations come at a critical time as the SDA's first 21 operational Tranche 1 spacecraft launched Sept. 10 from Vandenberg SFB, Cali-

fornia. Three additional launches of data communications satellites are expected by year-end, and six more launches should follow in 2026, four of which are to deploy missile warning-missile tracking spacecraft. Once fully deployed, Tranche 1 will boast more than 150 spacecraft across the data connectivity-centric Transport Layer and the missile defense-focused Tracking Layer. Meanwhile, vendors are cutting metal to build the next batch of Tranche 2 spacecraft, slated to launch in 2027.

The optical terminal market is expanding, too, which offers SDA vendors greater flexibility for Tranche 2 spacecraft. German OCT manufacturer Tesat-Spacecom has emerged as a workhorse supplier, delivering terminals for three out of four Tranche 0 satellite providers and providing OCTs for Lockheed Martin's Tranche 1 Transport Layer satellites. Tesat is under contract to supply 56 more units for Tranche 2 vendors.

The company's SCOT80 terminal is the core product used across SDA spacecraft, and its third generation is in development, Chief Commercial Officer Sven Rettig says.

Before the SDA came along, Tesat produced one LCT135 OCT—a precursor to its SCOT135 design—per year for €15 million (\$17.5 million) per unit, Rettig says. Today, it has diversified its terminal offerings for various orbits and applications. A SCOT135 is priced at about one-third of its predecessor's cost. The company builds five terminals per week and expects to ramp up to five units per day by 2026 to support a contract for more than 1,050 terminals for MDA Space, to support Telesat's Lightspeed LEO constellation.

To support this growth, Tesat opened a new production facility in Backnang, Germany, with three vertically integrated floors focused on high-volume OCT production, specialized builds for programs like the SDA's constellation and radio-frequency (RF) terminal manufacturing. Although RF comprises about half of Tesat's business, optical connectivity is the company's clear growth vector, Rettig says.

Still, not all OCT supply issues have been resolved. Mynaric, which has supplied its Condor Mk3 terminal to multiple SDA vendors, has been a headline example of manufacturing challenges. The company has acknowledged that its delays affected

the SDA's launch cadence. Rocket Lab announced its intent in March to acquire Mynaric for \$75 million in cash or shares, contingent on regulatory approval and the completion of Mynaric's restructuring, which was finalized in August. Rocket Lab is using Mynaric terminals for its Tranche 2 Transport Layer satellites.

Mynaric is producing about six optical heads per week but aims to build double-digit optical heads per week consistently through year-end, says Tim Deaver, vice president of global sales and solutions. The company has delivered terminals for York Space Systems and Northrop Grumman's Tranche 1, and it is building units for those two companies under Tranche 2, along with Rocket Lab.

"There were many times when every one of the [SDA] providers was asking one Tier 3 supplier for the same hardware.

They were all standing in line behind each other."

Both Mynaric and Tesat say their systems are now capable of 10-Gbps space-to-space transmission, a substantial leap from the SDA's baseline standard of 2.5 Gbps. Industry officials note that commercial customers are pushing toward 100 Gbps. Tesat is preparing to demonstrate 100-Gbps optical links on orbit under the European Space Agency's HydRON program in partnership with Kepler Communications. The company has achieved a connection of 100 Gbps on a ground-based testbed, Rettig says.

Mynaric has completed an engineering model of the Condor Mk 3.1 capable of data transmission rates up to 100 Gbps and expects flight models to be ready this year, Deaver says.

One company that has lived through the supply chain transformation is Sierra Space, a solar array provider for several SDA vendors. Initially a component supplier, the company has since expanded into full satellite production for the Tranche 2 Tracking Layer.

That experience provided Sierra Space with critical insights as it became one of just two new providers for the Tranche 2 efforts, alongside Rocket Lab. The company built a new high-rate production facility in Broomfield,

Colorado; relocated tooling from its prototyping facility; hired a workforce; and solved unexpected engineering issues—such as a flooring chemical reaction caused by the limestone bedrock beneath the factory, says Erik Daehler, vice president of defense, satellites and spacecraft systems at Sierra Space.

Now Sierra Space produces one solar wing per week and about 30 satellites per year, and it intends to scale to 50 annually within two years. Its Tranche 2 Tracking Layer contract includes 18 spacecraft, and the company recently began production after completing its critical design review, Daehler says.

Lessons learned from observing Tranches 0 and 1 have informed Sierra Space's approach. Daehler notes that the company switched payload providers after the preliminary design review, citing early indicators of schedule risk. The company also diversified its vendor base to avoid overreliance on any one supplier.

"There were many times when every one of the [SDA] providers was asking one Tier 3 supplier for the same hardware," Daehler said. "They were all standing in line behind each other."

With more than 150 Tranche 1 satellites preparing to launch and Tranche 2 production ramping up, the SDA's future carries even greater weight as it faces potential competition from the Pentagon's Milnet satellite constellation.

While the SDA has been forging a multivendor, open-architecture Transport Layer, the U.S. Space Force is weighing whether the Pentagon's future space data backbone should instead lean on SpaceX's vertically integrated Starshield platform. Envisioned as a government-operated, contractor-executed mesh network of approximately 480 satellites, Milnet has drawn criticism from lawmakers, who fear it could put critical military space communications under single-vendor control.

As the fiscal 2026 budget request paused the SDA's Tranche 3 Transport Layer purchases and directed millions toward Milnet technology maturation, the agency's success in Tranche 1 could become an inflection point and proof of whether its model and supply chain can withstand the gravitational pull of an expedient—but potentially monopolistic—alternative. 🌌

SDA Liftoff Marks New Phase in Space-Based Tactical Comms

> FIRST TRANSPORT LAYER LAUNCH SUPPORTS CONNECTIVITY FOR U.S. INDO-PACIFIC COMMAND

> TRANCHE 3 TRACKING LAYER CONTRACTS ARE EXPECTED SOON

Vivienne Machi Vandenberg SFB, California

Forty minutes past sunrise, a SpaceX Falcon 9 rocket lifted off Sept. 10 from the Western Range, propelling through drifting clouds to carry 21 data transport satellites into orbit for the U.S. Space Development Agency.

Once operational, the satellite plane is expected to allow U.S. Indo-Pacific Command (Indopacom) warfighters to access extended Link 16 communications, K_a-band radio frequency and optical connectivity. The space-based relay is expected to enable a user in Hawaii to connect with another in Guam, nearly 4,000 mi. away. Coverage is to expand as monthly launches continue through 2026.

The Space Development Agency (SDA), established in 2019, is building a low-Earth-orbit (LEO) mesh network of satellites called the Proliferated Warfighter Space Architecture to deliver tactical data connectivity, missile warning/missile tracking and beyond-line-of-sight targeting from space.

The Sept. 10 launch is the first of 10 planned missions to field initial capabilities under Tranche 1, which is meant to provide regional coverage from the data-centric Transport Layer and the missile-defense-focused Tracking Layer. Deploying these 21 Tranche 1 Transport Layer satellites, built by York Space Systems, marked a milestone for the SDA. Although the agency originally aimed to launch new capabilities every two years, delays emerged due to challenges with optical communications terminals and laser link demonstrations (page 25).

The launch came shortly after the SDA's first permanent director, Derek Tournear, stepped down Sept. 5 after six years. Deputy Director Gurpartap Sandhoo now serves as acting director.

The Tranche 1 satellites are to provide an initial warfighting capability from 2027, Sandhoo said Sept. 9 in Lompoc, California, 8 mi. south of Vandenberg SFB. He described the launch as the first step toward "fully integrated"

space-based warfare operations.

Indopacom is the first adopter of the Transport Layer, reflecting the Pentagon's focus on the region and the command's vast area of responsibility. The



A SpaceX Falcon 9 lofted the first 21 operational SDA satellites to orbit.

SDA also has personnel embedded with the U.S. European and Space Commands to support integration, Sandhoo said.

The complete Tranche 1 constellation is intended to consist of 154 operational satellites and four missile defense demonstration spacecraft to be launched over the next nine months. York Space Systems, Lockheed Martin and Northrop Grumman are each producing 42 Transport Layer satellites. L3Harris Technologies and Northrop Grumman are supplying 16 Tracking Layer satellites each, including the missile defense demonstrators.

The next launch is targeted for mid-October from Vandenberg, carrying 21 Lockheed-built Transport Layer satellites, Sandhoo said. Lockheed's second satellite plane is expected in the following quarter; Joe Rickers, company vice president of transport, tracking and warning programs, tells Aviation Week.

York is actively producing its next satellite plane, CEO Dirk Wallinger says.

Northrop Grumman expects to launch its first 21 Transport Layer satellites and deliver the second plane by year-end. The company's Tracking Layer production is underway, with the first launch planned for early 2026, a spokesperson says. L3Harris is conducting integration and testing for its Tracking Layer satellites, says Joshua Lovejoy, general manager of proliferated missile defense.

By the time Tranche 2 is deployed, the SDA should be able to provide broad regional coverage for the warfighter, Sandhoo said, although global coverage is not expected until Tranche 3. Tranche 2 is to include 254 satellites, with incumbents from Tranche 1 joined by Rocket Lab in the Transport Layer and Sierra Space in the Tracking Layer. These satellites are in various stages of design review and early production; launches are scheduled to begin in 2027.

The SDA is preparing to award contracts for up to 54 Tranche 3 Tracking Layer satellites in the coming weeks, Sandhoo said. The Tranche 3 Transport Layer is on hold as the Pentagon evaluates its future alongside Milnet, a proposed LEO constellation also focused on data connectivity.

Tranche 3 spacecraft are expected to begin launching in 2029. At that time, the SDA plans to transfer operations of the mesh network to the U.S. Space Force's Space Operations Command, Sandhoo said. Last fall, the Space Force established two detachments for early integration embedded into SDA operations centers at Grand Forks AFB, North Dakota, and Redstone Arsenal, Alabama. After the transfer, the SDA will continue to develop new technologies and integrate them into the constellation's ecosystem, Sandhoo said.

In addition to expanding Transport and Tracking Layers, Tranche 3 may introduce air-moving-target-indication capabilities under the Custody Layer. The Pentagon has tested active radar technology in orbit in the past 6-8 months, and results suggest it is "pretty mature for scaling," Sandhoo said.

With that data, the SDA is refining the Custody Layer's architecture and acquisition strategy, which will depend heavily on the outcome of the fiscal 2026 budget cycle.

"It's hard to predict what we need to go buy and solicit without knowing how much money you have," Sandhoo noted. ☛



John O'Connor
Director of Product &
Market Strategy,
Siemens Digital Industries
Software (DISW)

High-Performance Characteristics Management is Essential for Aerospace and Defense Innovation

Discover Siemens' approach to advancing A&D innovation through cutting-edge characteristics management, as John O'Connor shares insights with Aviation Week.

Q AW: What is characteristics management, and why is it essential in A&D?

A John O'Connor: Characteristics management is a methodology that systematically identifies, defines, and controls critical product attributes that significantly influence performance, reliability, safety, and cost. These characteristics can include specifications such as dimensions, tolerances, or material callouts, as well as properties like electrical resistance or porosity.

Characteristics methodologies ensure products meet stringent requirements, reduce risks, and maintain operational excellence across product lifecycles. They integrate design for manufacturability, failure modes and effects analysis (FMEA), change impact assessment, and design intent capture to ensure that products meet established standards and perform consistently under real-world conditions.

Failures in characteristics management can result in grounded aircraft, missed delivery deadlines, and budget overruns. For example, an overlooked tolerance or material specification could lead to critical quality escapes, causing operational disruptions and financial losses. Despite its importance, implementing a characteristics management process is a challenge for many companies.

Q AW: What are the main challenges in characteristics management through design and manufacturing?

A JOC: The sheer volume of characteristics within a product design makes their management challenging. Tracing high-level requirements into specific product characteristics and then into inspection plans has traditionally been a manual,

time-intensive process. Instead of engineers focusing on developing the product, they spend time documenting characteristics in parallel systems. This can lead to inefficiencies, errors, and costly quality escapes.

Another main challenge is the loss of critical product knowledge when senior engineers retire. Without proper systems to capture this expertise, new engineers do not understand the rationale for decisions that initially drove the definition of specific characteristics.

Q AW: How is Siemens addressing these challenges?

A JOC: Siemens Xcelerator is a digital business platform for product development. Connecting design ideation, management of design data, and production execution, it streamlines the entire development cycle. The platform includes state-of-the-art software like NX, a high-performance 3D CAD/CAM/CAE solution, and Teamcenter Quality, a comprehensive quality management system.

NX enables the digital authoring of a model based definition (MBD), providing the opportunity to define, manage, and trace a product's characteristics in a new and better way. This is the basis for a digital thread within Siemens Xcelerator that supports characteristics management.

Teamcenter Quality works in concert with NX, using characteristics in the digital thread to help quality engineers build their plans using information from the MBD. It enables manufacturers to develop plans more quickly and cost-effectively, while providing a method for execution in accordance with industry standards such as ANSI/DMSC MBC 2024, AS9102, or AS9103.

In addition, Siemens Xcelerator takes the next step to ensure that characteristics management goes beyond design-to-manufacturing workflows. It also “shifts left,” connecting product definitions to system requirements that are driving the design. The platform traces characteristics along the digital thread to a customer’s formal product requirements and systems engineering models. This connectivity tracks revisions and reports them at the characteristics level ensuring identification of changes and their impacts.

This accelerates concept-to-production timelines, enhances communication within product development teams (e.g., systems, design, manufacturing, and quality), and automates inspection planning and quality assurance processes. The superior level of transparency makes management of important product attributes much more straightforward. It also facilitates long-term retention of design “know-how” and for future reuse and innovation.

Q AW: What role does Siemens NX play in managing design characteristics?

A JOC: NX provides a unified approach where design engineers author and manage product data using the CAD system. Manufacturing engineers derive data directly from the NX model, reducing discrepancies and minimizing errors and rework. Using advanced MBD capabilities, it creates a high-fidelity digital twin and connects it to a digital thread through the development process.

NX MBD uses specialized workflows based on industry standards to define and manage critical design characteristics. This ensures consistency and accuracy throughout the development process, from initial design to quality inspections

on the manufacturing floor.

It also provides a potential warning notice within Siemens Xcelerator if critical characteristics change. By monitoring critical characteristics of the design, changes – intentional or unintentional – that may adversely affect performance or cost are indicated for review.

Q AW: How does Siemens Xcelerator streamline the inspection process?

A JOC: The platform enables manufacturers to develop quality plans that adhere to aerospace industry standards like ANSI/DMSC 2024, AS9102 and AS9103, providing comprehensive traceability and quality assurance — key requirements for regulatory approval.

By developing quality plans based on MBD provided by NX, Siemens Xcelerator eliminates outdated, manual steps on paper documents. Quality engineers seamlessly consume MBD using Teamcenter Quality, dramatically reducing the time required to develop inspection plans. This is true whether inspection processes are either automated or manual.

Q AW: What is the future of characteristics management in A&D?

A JOC: The ability to effectively manage characteristics remains a cornerstone of successful program execution in A&D. To stay competitive manufacturers need to automate the entire characteristics management process – not just portions of it. Comprehensive, high performance characteristics management, only from Siemens, will be vital in ensuring success for the next generation of A&D programs and their products.



VAST BETS ON FAST

- > **STARTUP AIMS TO LEAPFROG COMPETITION TO HOST NASA CREWS POST-ISS**
- > **NASA SHIFTS STRATEGY FOR COMMERCIAL STATION ACQUISITION**
- > **THE 15-NATION ISS PARTNERSHIP IS EXPECTED TO END OPERATIONS IN 2030**

Irene Klotz Long Beach, California

Aspiring space station operator Vast figures the best way to get a jump on its competition is to launch early and demonstrate safe, reliable operations before NASA selects one or more commercial platforms to succeed the International Space Station.

Toward that goal, the privately owned startup based in Long Beach, California, has contracted with SpaceX for a Falcon 9 flight to launch its 31,700-lb. Haven-1 station in mid-2026. That mission would be followed by a series of SpaceX Crew Dragon flights, with up to four crewmembers per mission, for a cumulative total of 40 crew days on orbit. “No one has ever done a space station in three

years, which would be our goal,” Vast CEO Max Haot tells Aviation Week.

“This is not going to start with a full replica of the International Space Station [ISS],” he adds. “It’s going to take years to get back to that exact capability.”

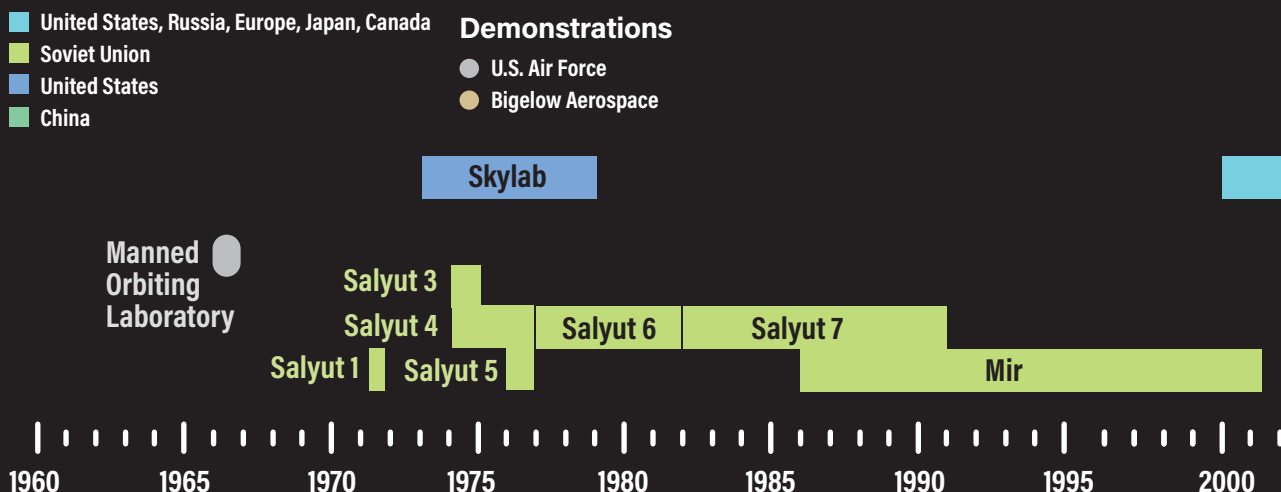
On Nov. 2, the ISS will mark 25 years of continuous human presence in low Earth orbit (LEO), a milestone that also signals the approaching end

of its operational life. In five years, the station is due to be decommissioned and then deorbited. Before that occurs, the U.S. hopes that continued investments in NASA’s Commercial LEO Development Program will allow key ISS experiments and technology demonstrations to transition to at least one new outpost in LEO. Vast is in the running, along with Axiom Space, Orbital Reef—a Blue Origin and Sierra Space project—Starlab Space and perhaps others.

NASA has been wooed by commercial companies and concepts to boost microgravity research opportunities since at least the early 1980s. Spacehab, a Houston-based company, provided the agency with flight services through a commercially developed module that rode inside the space shuttle cargo bay and connected to the crew quarters by an access tunnel. The modules included additional habitable space for experiments and provided logistics transport to Russia’s Mir space station and later to the ISS.

At the same time, another Houston company, Space Services, had a memorandum of understanding with NASA to develop a small space station. The Industrial Space Facility (ISF) would have launched uncrewed

Space Stations Past and Present



Source: NASA, Encyclopedia Astronautica, CentennialOfFlight.net, National Space Science Data Center and N2YO.com

Vast's Haven-1 qualification article completed structural and pressure testing at Mojave, California, in August.

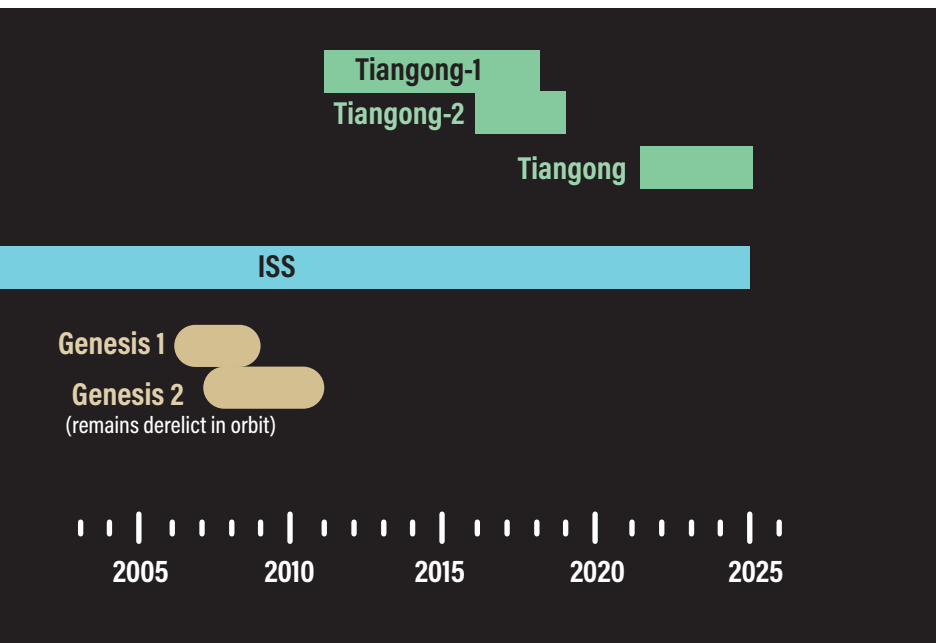


VAST

but would have been regularly serviced by space shuttle astronauts. The ISF was designed to support 31 payload racks and supply 20 kW of power from a pair of 140-m² (1,510-ft.²) solar panels, which was state-of-the-art at the time. The station never flew.

More recently, from mid-2006 to

early-2010, Bigelow Aerospace demonstrated a pair of subscale, expandable prototype space stations named Genesis I and II. The company, owned and operated by real estate tycoon Robert Bigelow, then sold NASA on the idea of attaching an expandable module onto the ISS, where it remains today.



Buoyed by the growth of the commercial space industry and the success of public-private partnerships to fly cargo and crew to the ISS, NASA awarded contracts in 2016 to six companies to build ground prototypes of proposed space habitats. Bigelow was one of six companies selected along with Boeing, Lockheed Martin, Nanoracks (now a Voyager Technologies subsidiary), Orbital ATK (now Northrop Grumman) and Sierra Nevada Corp.

In fiscal 2020, NASA requested \$150 million to kick off the Commercial LEO Destinations (CLD) program and received \$15 million. The following year, the first Trump administration again asked for \$150 million and received \$17 million. The agency awarded a contract to Houston-based Axiom Space to support development of a privately owned station that would start off as an attachment to the ISS and then transition into a free-flyer prior to the ISS' retirement.

Congress warmed to the CLD concept in fiscal 2022 and allocated \$101 million for the program. NASA selected three teams in December 2021 for funded Space Act Agreements, with the goal of introducing competition into the CLD program. Blue Origin and its primary partner, Sierra Space, proposed the Orbital Reef, an ambitious, LEO multimodule complex that does not use SpaceX launch services. Nanoracks—one of the first commercial companies to operate on the ISS—pitched the Starlab, which is now a joint venture owned by Voyager and Airbus. Northrop paired with Leidos' Dynetics in a program built around Northrop's Cygnus spacecraft. That effort folded in 2023, and Northrop joined the Starlab Space team.

NASA in 2023 also signed unfunded Space Act Agreements with seven more companies, three of which—including Vast—are working on commercial space habitats.

CLD funding climbed to \$224 million in 2023, \$228 million in 2024 and is currently funded at \$170 million. The Trump administration is requesting \$272 million for the CLD program for fiscal 2026, which begins Oct. 1. Overall, the White House's projected budget for the CLD program over the next five years is \$2.1 billion. Congress has not yet passed a fiscal 2026 spending plan.

For the next phase of the program, NASA planned to award Federal

Acquisition Regulation (FAR)-based, fixed-price contracts covering certification of at least one commercial space station capable of supporting four-member crews continuously. A draft request for proposals had been expected this summer.

However, on Aug. 4, the agency outlined a new acquisition strategy that postpones certification and scales back CLD capabilities to support monthlong crewed sorties, rather than continuous occupation. Certification would move to a future Phase 3 competition.

In a memo to NASA leadership, acting Administrator Sean Duffy wrote that the changes are intended to reduce the chance of a gap between the end of the ISS and the availability of a commercial LEO outpost, given the president's proposed budget.

NASA also said it would switch the CLD Phase 2 funding from FAR-based, fixed-price contracts to another round of funded Space Act Agreements that include a three-year base period with optional milestones of up to five years. Payments will be made upon completion of milestones, which must include an in-space crewed demonstration, the agency said.

"The request for one-month-duration missions was not meant to imply that will be NASA's long-term need but is based on realistic expectations of schedule and budget," the agency added in a document posted on its procurement website.

The program changes are well suited to Vast, whose Haven-1 space station builds on the capabilities of SpaceX's Crew Dragon. In addition to ferrying crews to the ISS, SpaceX has flown three free-flyer Crew Dragon missions, the longest of which lasted five days. With the capabilities of the Haven-1 station, Vast expects to parlay use of the Dragon's life support, toilet and humidity control systems to support crews for a total of 40 days in orbit. That would be accomplished by launching the Haven-1 with 40 SpaceX-manufactured lithium hydroxide canisters onboard. Once a day, crewmembers would install a new 44-lb. canister in the Dragon to scrub carbon dioxide from the air. "Having these on Haven-1 is a key part of the design," Haot says.

Nominally, a Haven-1 crew would be onboard the station for 10 days, but that plan may be revised in light of NASA's requirement for a 30-day demonstration mission. "Most likely, that is going

to be on another module that will come later, but it can be on Haven-1," Haot says. "We've not yet decided."

"Our recommendation to the U.S. government was that it's not responsible to have just one provider," he adds. "In our view, you don't put all your eggs in one basket until you have a proven partner. Our recommendation to NASA has been that maybe you should procure the first module from two companies. You do that as quickly as you can . . . evaluate who is the best partner with on-orbit performance, not paperwork, and then you purchase additional modules toward full operational capability."



The Vast Haven-1 space station is planned to accommodate docking with SpaceX Dragon spacecraft.

For Vast, full operational capability—FOC, in NASA parlance—would entail launching three or four Haven modules, depending on the agency's power requirements, and connecting them in orbit. "In our design, which is quite different from the ISS, every module has all the solar panels, the batteries, communications, computer and the life support system, but the outfitting might be a bit different," Haot says.

Founded in 2021 by cryptocurrency entrepreneur Jed McCaleb, Vast adopted SpaceX's design philosophy of rapid iteration to build its technical chops. When space station design work began in May 2023, the company initially chose stainless steel for the primary structure. By October 2023, engineers began assessing milled orthogrid aluminum 2219 for the hull, which proved a better option. Vast built a pathfinder structure to verify the manufacturing process in June

2024 and six months later finished a full-scale Haven-1 qualification article.

The company plans to flight-test subsystems and components for the Haven-1 on an 1,135-lb. satellite known as the Haven-Demo, which is expected to launch this year on a SpaceX Bandwagon rideshare mission. Among the hardware to be tested are systems for guidance, navigation and control; communications; solar array and power; and propulsion. "Our current program timeline assumes the demo will succeed," Haot says. "If the demo or other types of tests fail, then the timeline gets disrupted."

The company completed a critical design review in July—a meeting that included in-person participation of five NASA employees, five SpaceX employees and 20 people from Vast plus 120 NASA engineers online, Haot says.

Although Vast so far has not earned any revenue from NASA, the company has access to the agency's test facilities and expertise. "Where we really benefit is from the workforce and the skills that they've created through the Commercial Crew program and through the Dragon program," Haot says.

In August, the qualification article completed a six-month series of pressure and structural tests at the Mojave Air and Space Port in California. In total, the test article was subjected to 53 distinct load cases to simulate forces and pressures that the spacecraft would experience during launch and operations on orbit. "We met all of the objectives," Haot says. "We didn't find any real issues."

The Haven-1 primary structure was nearing completion in early September and was due to be transported to Mojave for testing. It is slated to return to Long Beach for integration this fall, followed by thermal vacuum testing at NASA's Neil Armstrong Test Facility (formerly the Plum Brook Station) early next year. Launch is targeted for May 2026.

After an eight-week checkout on orbit, a four-person Crew Dragon spacecraft would launch to the station and dock for a demonstration mission. "Haven-1 is all about making NASA comfortable with us," Haot says.

The company has not yet named its first crew. In addition to flying future NASA astronauts, Vast is targeting foreign space agencies, among other entities. Competitor Axiom Space has already demonstrated the market

for sovereign-nation crewed flights with private astronaut missions to the ISS for the European, Hungarian, Indian, Italian, Turkish and United Arab Emirates space agencies.

In addition, Vast estimates that privately financed customers will account for 10-15% of the current market for human spaceflight. A commercial space station could also generate revenue by manufacturing pharmaceuticals, producing new materials, selling marketing and sponsorships, among other services, Haot adds.

"None of us can predict how quickly that will grow and how big it will be,

but for it to be meaningful, it needs to be billions of dollars a year," Haot says. "Unlike our competitors, we basically are saying that you can't rely on this new market to be profitable and stable, so you should really make sure you're profitable and stable based on the current market.

"The only way you could do that is if you've raised enough money and built infrastructure," he notes. "By the time we fly Haven-1, we will have invested \$1 billion.

"For just over \$1 billion of revenue, we will be profitable, and I don't think anybody else is . . . because their cost

is higher," Haot adds. "By the time NASA reviews our proposal, we will be proven the low-cost partner. It won't be just a claim."

NASA issued a draft solicitation for the next phase of the CLD program on Sept. 5. A final Announcement for Partnership Proposal is expected Oct. 3, with responses due Dec. 1. The agency plans to award at least two funded Commercial Destinations Development and Demonstration Objectives (C3DO) Space Act Agreements. It expects to have \$1-1.5 billion over the next five years to fund C3DO agreements. Selections are expected in April. 🗞

Sizing Up the Competition

Years before NASA signed an unfunded Space Act Agreement to help Vast with its Haven commercial space station project, the U.S. space agency hired four other companies to design and develop Commercial Low-Earth Orbit Destinations (CLD). One project, headed by Northrop Grumman, folded and joined a former rival's effort. Here is a look at three likely contenders for NASA's follow-on CLD program.



AXIOM SPACE

Axiom Station

Partners: Axiom Space, Thales Alenia Space, Gravitics, Psionic, GU Energy Labs, OHB-System, Skyroot Aerospace, MDA Space

Launch vehicles: TBD

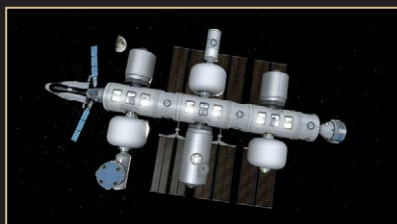
Crew/cargo vehicles: SpaceX Dragon, possibly others

Orbital inclination: Initially attached to the ISS at 51.6 deg., then free-flyer in same orbit

Architecture: Payload Power Thermal Module (PPTM), followed by Habitat 1, an airlock, Habitat 2 and the Research and Manufacturing Facility. The PPTM will first dock with the ISS Node 2 forward port and then detach to become the first module of the free-flying station.

NASA funding: Firm, fixed-price indefinite-delivery, indefinite-quantity contract with a maximum value of \$140 million

Notes: Axiom has chartered four private astronaut missions to the ISS, gaining early experience—and income—from human spaceflight expeditions.



ORBITAL REEF TEAM

Orbital Reef

Partners: Blue Origin, Sierra Space, Boeing, Redwire, Amazon Distribution and Fulfillment Solutions/Amazon Web Services, Genesis Engineering, Arizona State University

Launch vehicles: Blue Origin New Glenn, United Launch Alliance Vulcan

Crew/cargo vehicles: Sierra Space Dream Chaser, Boeing CST-100 Starliner

Orbital inclination: TBD

Architecture: TBD

NASA funding: \$172 million

Notes: In response to NASA's solicitation for the CLD program next phase, Blue Origin says it will finalize the architecture, modules, launch cadence, inclination, business case and facilities for the Orbital Reef. "Our . . . offering will utilize programs at Blue Origin that align with the procurement strategy and requirements provided by NASA, including many of the components developed within our lunar and Blue Ring programs," the company wrote in an email to Aviation Week. "It also takes advantage of New Glenn's fairing capacity and heavy-lift capability to LEO."



STARLAB SPACE

Starlab

Partners: Voyager, Airbus, Mitsubishi, MDA Space, Northrop Grumman, Palantir, Hilton, Ohio State University

Launch vehicle: SpaceX Starship-Super Heavy to deploy Starlab in one flight

Crew/cargo vehicles: Northrop Grumman Cygnus, others TBD

Orbital inclination: 38-42 deg.

Architecture: A service module that provides propulsion and energy from solar panels and a combined habitation-laboratory module with docking ports. The two 26-ft.-dia. modules are attached on the ground and launched together.

NASA funding: \$217.5 million

Notes: Starlab Space is a joint venture of Voyager and Airbus. Voyager also owns and operates the Bishop commercial airlock, among other facilities, onboard the ISS.

RUGGED ROVER

The Raven, a prototype of Lunar Outpost's Eagle LTV, is one of two initial rovers undergoing trials in the company's autonomous vehicle test area in Colorado.



➤ LUNAR OUTPOST OUTLINES ITS MOON ROVER ROAD MAP

➤ RAVEN AND FALCON PROTOTYPES ARE IN TRIALS

➤ SEVEN MORE LTV TEST VARIANTS ARE IN THE WORKS

GUY NORRIS/AW&ST

Guy Norris Colorado Springs

At first glance, there seems to be little to link a windswept ranch in Colorado with the surface of the Moon, but it is here at the base of the Rocky Mountains that space startup Lunar Outpost is putting prototypes of its large-scale Eagle lunar terrain vehicle through their off-road paces.

Viewing the test area from the rim of a nearby mesa, however, it is surprisingly easy to imagine a lunar-like terrain duplicated in the ranch's rugged hills, cliffs, gullies and slopes. Moreover, the topography resembles the challenging lunar south pole region for which the lunar terrain vehicle (LTV) is being designed.

"A lot of people's perception of the Moon is from the Apollo era," says

Justin Cyrus, co-founder and CEO of Lunar Outpost. "Unlike the maria and those kind of nice, flatter areas, the lunar south pole is not like the equatorial regions. It's hills, it's mountains, it's ravines, it's these permanently shadowed craters and tall cliffs. So it's important that these vehicles be able to handle those types of environments."

Work at the autonomous testing facility involves two prototype rovers

and comes 17 months after Lunar Outpost won a commercial LTV concept design contract as part of NASA's Artemis program. Under the effort, for which Intuitive Machines and Venturi Astrolab also received competitive contracts, the agency is seeking to establish a sustainable human presence on the Moon to prepare for human exploration of Mars.

Unlike the single-use Lunar Roving Vehicles of the Apollo era, the 21st-century LTVs are intended as a critical long-term element of the exploratory infrastructure. NASA is expected to select a finalist, or finalists, to place LTVs on the Moon for astronaut exploration, groundwork development

and scientific research. Planned to be autonomous or optionally drivable, the LTVs also are expected to be available commercially when not in use by NASA, which estimates it will spend \$4.6 billion on LTV through 2039.

Located 160 mi. south of Lunar Outpost's headquarters in Golden, the rural Colorado test area includes terrain ranging from crater-pockmarked plains to rocky outcrops—all of which the rover will encounter on the Moon.

"Each serves a different purpose," Cyrus says. "The lunar test facility is for the more extreme obstacles—the craters, the berms, the rocks—that we want to be able to drive over, while the test site toward the back [of the ranch] has some obstacles we don't want to drive over. There are large ravines and cliffs. We want the vehicle to be able to recognize those and make sure that it is always in a safe position.

"The good news is the vehicle has never driven itself into a ravine," he continues. "It's never totaled itself, which is great, but we have learned a heck of a lot doing the long-distance testing at the back of the property and the slope testing that it has done there."

Following completion of the preliminary design review (PDR) in late May, further refinement of the Eagle is continuing under a series of design and analysis cycles. These are based on lessons learned through tests on the first two vehicles, dubbed the Raven and Falcon, and to be incorporated into as many as seven more Eagle LTV prototypes that Lunar Outpost expects to construct between now and critical design review (CDR) in late 2026 or early 2027. Development is being conducted by the Lunar Dawn team, which includes General Motors, Goodyear, Leidos and MDA Space.

NASA says it will evaluate the task order proposals from each LTV vendor and select the demonstration mission by year-end. The first winning LTV is planned to travel to the Moon in late 2029 or early 2030 on Artemis V, the fifth planned mission and the first crewed flight of the Blue Moon lander—made by a team led by Blue Origin and including Astrobotic, Boeing, Draper, Honeybee Robotics and Lockheed Martin.

Resembling a large sports utility vehicle in overall size, but with the wide wheelbase of a Humvee for stability and a low center of gravity for the Moon's one-sixth gravity, the Falcon

has been tested on extended trial runs in the hilly spaces of the ranch. "Falcon goes up to about a 15-deg. slope on shale rock and loose gravel, so it has a lot of slip induced on the vehicle," Cyrus says. "We have to make sure our torque and our motor control are properly calibrated to be able to handle high slopes and to make sure our vehicle is efficient when going up long slopes over notable periods of time.

"It has also navigated 20-deg. slopes, no problem, and we tested it on up to 35-deg. slopes in high-fidelity simulations, and we were still very safe," he adds. "That's the huge benefit of having a lower center of gravity."

subject astronauts in pressure suits to simulated reduced gravity.

"While Raven was our first prototype, the motors we have on it are much more flight-like, so they're sized for the lunar environment," Cyrus says. "The Falcon motors, on the other hand, are very oversize for what you'd need in the lunar environment, but it gives us a good idea of the drive dynamics we'd see on the Moon. That's why Falcon can go up these 20-deg. slopes, where Raven can't."

Confidence in key aspects of the design, such as the 36-in. metallic mesh tires developed with Goodrich, has also grown through early tests at



DAVID DEHON/NASA

NASA astronauts Raja Chari (left) and Randolph Bresnik sat inside Lunar Outpost's Eagle LTV to evaluate the seat configuration.

"Over the last two years, and especially over the past year with the NASA LTV vehicle program, we have done a pretty good job of getting real hardware out into relevant environments," Cyrus notes. "We do tests at the component level, and we have many different subsystems we test with, and then we bring it up to the full-scale vehicle. These are still very early in the life cycle, and a lot will change between PDR and CDR based off astronaut feedback and our continuous testing."

Astronaut feedback follows Lunar Outpost's involvement in NASA's LTV feasibility study. In late 2024, each company delivered a static mockup of their vehicle to Johnson Space Center for rover evaluation inside the agency's Active Response Gravity Offload System test facility. The facility provides an analog environment that can

NASA's Marshall Space Flight Center. Dubbed "quarter-car" tests, the evaluation included running a tire complete with its attached suspension, bearings and seals, for hundreds of kilometers in a thermal vacuum chamber on a bed of simulated lunar regolith. Lunar Outpost has also been testing rover mobility and durability in a regolith facility at the Colorado School of Mines close to its headquarters in Golden.

With the large metallic tires, "we've driven the vehicle up sheer rock faces at over 25 deg.," Cyrus says. "We've driven it up lunar regolith at over 20 deg., and we tested it out here at the ranch time and time again. It's very capable. It gives us good traction and allows us to absorb those shocks."

The large tires and suspension contribute to the Eagle's high ground clearance. "It's more like a trophy

truck suspension,” adds Cyrus, an off-road vehicle enthusiast, referring to a special class of modified high-ground-clearance racing trucks. “The exact clearance is still being iterated on, but it will be well over 40 cm [16 in.]. That’s the minimum clearance we would have, and realistically, it’s going to be quite a bit higher than that.”

Testing of other systems, such as the Eagle’s autonomous 360-deg. electro-optical camera and lidar sensor suite, also has unearthed lessons—some more unusual than others.

“This summer, swarms of grasshoppers have interrupted the autonomous functionality—it thought the crickets were dust,” Cyrus says. “You don’t want electrostatically levitated dust interrupting your guidance, navigation and control [(GNC)] system, and obviously, you don’t have blowing dust like that on the lunar surface, but you do here down at the ranch. So we now have a specific grasshopper software fix, which helps better identify things that are not lunar-like.

“We are testing out all sorts of different sensors including some of the new advancements in radar as well to help mitigate the lunar dust effects on other sensors,” he adds. “We can operate completely with just the visual cameras and the lidar, but we just got through PDR, and we’re still testing. The most important thing is that they are reliable, so the vehicle doesn’t have to have too much maintenance over time.”

A potentially competitive feature of the LTV contest is each company’s proposed solution to meeting NASA’s requirement for autonomous navigation on the Moon—including the ability to localize within 10 m (33 ft.) over 10 years. “We have a suite of software that allows us to localize anywhere on the Moon,” Cyrus says. “That’s a very difficult thing to do, especially without supporting infrastructure.”

Without giving further details, he adds: “We’ve tried to drive our autonomy stack and our localization stack and our whole GNC system to be totally nonreliant on any external infrastructure, which is a pretty unique capability that we’re building.”

Another key challenge is power. The rover is being designed to survive and even operate during the two-week lunar night that sees temperatures as cold as -280F and in daytime temperatures of up to 260F. Initially in 2023, before Leidos replaced Lockheed Mar-



GUY NORRIS/AMAST

Lunar Outpost co-founder and CEO Justin Cyrus showed off versions of the Goodrich-developed metallic mesh LTV tires.

tin on the Lunar Outpost team, the planned battery system was based on GM’s Ultium cell technology, which uses a nickel-cobalt-manganese-aluminum chemistry and requires 70% less cobalt than the cells in the Chevrolet Bolt EV.

“We ended up swapping to a new chemistry over the course of Phase 1, just for reliability purposes, and we wanted to make sure that this is the safest and most reliable thing possible,” Cyrus says. “With batteries on the Moon, you can’t have a high risk. If you lose a cell, it needs to be mitigated to that cell. If you lose a pack, it needs to be mitigated to that pack, and you still must be able to operate.”

Main vehicle power is produced by large, deployable, dual-sided solar panels stowed above the rear flatbed. The dual-sided design means solar power is collected regardless of the vehicle’s direction.

“One thing we’ve learned from all of the mission operations on our early rovers is that power is key,” Cyrus says, referring to the company’s smaller Mobile Autonomous Prospecting Platform (MAPP) design, which landed on the Moon in March aboard Intuitive Machines’ IM-2 Athena. Although the lander tipped over on touchdown, preventing the MAPP from deploying, Lunar Outpost says the vehicle was operating as planned. A second version of the MAPP, dubbed the Lunar Voyager 2, is due to travel to the Moon in early 2026 as part of the Intuitive Machines-3 Nova-C lunar lander mission.

While smaller rovers must collect as much data as possible before dying during the long lunar night, power is “key for LTV for different reasons,” Cyrus says. “It allows us to not only

drive farther and accomplish more science while we’re on the lunar surface but also accommodate more payloads. We can still charge up and perform all our operations at hand, even with a completely full bed.”

The Eagle is designed to carry loads of 2,400 kg (5,300 lb.) plus another 3,000 kg in an unpowered trailer. “That is pretty substantive for a planetary rover, and you need a lot of power to do that,” he notes. The bed also mounts an MDA Space robotic arm dubbed Skymaker.

Designed to accommodate a full range of anthropometric astronaut sizes, from a 1% female to a 99% male, the vehicle’s open driving position is accessed by forward-mounted, lighted steps. The vehicle is controlled by rectangular driving handles large enough to accommodate astronaut gloves and a set of oversize switches. Tools and equipment for experiments, sample collection and support are contained in slide-out container drawers or externally on quick-connect attachments inspired by Molle panels used by off-road enthusiasts.

“Why reinvent the wheel?” Cyrus says. Large fenders, specialized coatings and electrodynamic dust shields are designed to mitigate the buildup of lunar dust, while side- and top-mounted radiators reject excess thermal energy to space.

“We are starting another design cycle right now,” says Forrest Meyen, co-founder and chief science officer. “In between these design cycles, we’re taking our current iteration of our software and autonomy code, and we’re deploying it in the field and getting real feedback to kind of complement and correlate our simulations.”

The rapid vehicle iteration also helps “refine our own assembly integration and test plans, which we’re going to use for the flight vehicle,” Meyen says. “So it demonstrates the readiness of our supply chain and capability for manufacturing tolerances and at scale.”

As for the future of the Artemis program, Meyen says Lunar Outpost remains confident despite recent uncertainty. “What we’ve seen is NASA prioritizing human exploration, and we’ve seen the budgets be focused on that, which is exactly where we specialize,” he says. “So we’re confident in the direction of the Artemis program and how it continues that march to the Moon.” 🌙



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ABOUT

- > UDVAR-HÁZY SELLS AIR LEASE CORP. NEAR BOOM CYCLE'S LIKELY PEAK
- > SMBC AVIATION CAPITAL MAKES BIG BET IN ACQUIRING AIR LEASE
- > THE SALE AIMS TO GIVE STOCKHOLDERS AN "IMMEDIATE PREMIUM AND CERTAINTY IN CASH VALUE"

Jens Flottau Frankfurt

Steven Udvar-Házy made a big decision in June 1990. He sold International Lease Finance Corp., the aircraft lessor that made him famous in the aviation industry, to American International Group for \$1.3 billion but stayed on as CEO. As it turned out, he got the timing right. He sold "15 min. before the market crashed," as Avitas President Adam Pilarski put it. Iraq invaded Kuwait on Aug. 2, 1990, triggering a painful economic recession.

That story from 35 years ago is taking on new relevance these days. Udvar-Házy announced on Sept. 2 that he is selling his second big aircraft leasing company, Air Lease Corp. (ALC), to SMBC Aviation Capital and other investors. SMBC will take over ALC's large orderbook with Airbus and Boeing and will service the existing fleet.

Its relevance lies in the question of whether Udvar-Házy has again gotten the timing perfectly right and been smarter than everyone else by making this deal now, when others are looking to increase their exposure to aircraft leasing by buying big portfolios or entire lessors. That is because aircraft leasing must be very near its peak—and therefore the good businesses in leasing are very near their peak valuations.

How much better can this part of the industry really get, with leased aircraft the only way for airlines to gain access to additional capacity quickly, leading to ever-increasing lease rates? That theme has been carrying leasing for some years. Yet, acquisitions are continuing unabated. To name but a few: Dubai Aerospace Enterprise (DAE) completed the acquisition of Nordic Aviation Capital in May; Saudi lessor AviLease acquired the aircraft portfolio of Standard Chartered in 2023; and industry market leader AerCap is the product of multiple takeovers and mergers, including its 2021 acquisition of GE Capital Aviation Services (GECAS).

Some markets, including U.S. domestic flying, have suffered from consumer caution as the Trump administration's economic policies have triggered higher inflation. Tariffs

TIMING

Steven Udvar-Házy created his first leasing company, ILFC, in 1973. Now he is selling his second, ALC.

may also dampen demand for international business travel over time. Some key economies are struggling—Germany is in recession for the third year in a row. The war in Ukraine and other conflicts are continuing unabated. Spirit Airlines' second Chapter 11 filing will likely return dozens of Airbus A320neo-family aircraft to the market as the airline cuts back on its fleet. In Brazil, Azul is also in restructuring, leaving several lessors' Airbus and Embraer E2 fleets exposed.

How the aircraft leasing market will evolve presents risk for SMBC in the ALC transaction. If the boom continues, buying ALC now may have been a good move. If the market tanks soon, then maybe not so much.

To be fair, there are no concrete signs of the market tanking quickly. And there are other factors to consider. Udvar-



Házy, 79 years old, had stepped down from his longtime role as executive chairman of ALC and planned to retire as nonexecutive chairman in 2026, before the SMBC takeover was announced. John Plueger, Udvar-Házy's friend and business partner and ALC's CEO, is 70. The company's future and leadership transition needed to be defined regardless of whether it was sold.

"Since founding Air Lease in 2010, we have been unwavering in our mission to shape the future of the aviation industry and provide airlines around the world with access to the most modern, fuel-efficient aircraft," Udvar-Házy said in a statement. "After thoughtful consideration, the board has unanimously determined that this transaction represents the best path forward for our company, as it will deliver an

immediate premium and certainty in cash value to our Class A common stockholders."

Udvar-Házy set up ALC in 2010. After leaving International Lease Finance Corp. (ILFC), he originally wanted to buy part of its owned aircraft portfolio as the nucleus of a new lessor. According to Udvar-Házy, American International Group (AIG) President and CEO Robert Benmosche had already promised to sell him 25 aircraft from the ILFC portfolio for \$1 billion to raise cash to repay the U.S. government for bailing it out in 2008. But then Benmosche "reneged on the deal, and I was very upset," he recalled later.

Luckily for Udvar-Házy, he did not have a noncompete clause in his departure deal and was free to do whatever he wanted. "I retired for 5 min.," he later said. "I was still young and thought, 'Why don't we set up another small leasing company?'" He raised \$1.2 billion in equity from banks such as JP Morgan and Credit Suisse, and a year later, ALC raised another \$1 billion on the New York Stock Exchange.

As was the case 20 years earlier, Udvar-Házy got the timing right—this time by reentering at the optimal moment. The industry had begun to climb out of the global financial crisis, demand was coming back, interest rates were low, and fuel was cheap. Airlines needed aircraft quickly, and many could not afford to finance them. This was an ideal scenario for any lessor, but coupled with his deep knowledge of airline business models, networks and aircraft technology, taking advantage of that extended boom cycle was a no-brainer for Udvar-Házy and Plueger, who came back on board a bit later.

At the end of June 2025, ALC owned 495 aircraft and managed an additional 53. It also had 241 aircraft on order from Airbus and Boeing. Only AerCap, DAE Capital, SMBC Aviation Capital and Avolon have bigger owned and managed in-service fleets, according to second-quarter results. With 442 aircraft, Avolon has the biggest incoming fleet. ALC's orders are broadly in line with those of AerCap (279), SMBC (248) and BOC Aviation (351).

Udvar-Házy's second big venture has been up for sale for a while informally. Many people claim to have known, and some dreamed of being able to pick it up. Industry sources say AerCap CEO Aengus Kelly would have loved to buy ALC but realized early on that the board was never going to sell to him. Given all the history and rivalry, that apparently felt like one step too far. A sale to AerCap would have expanded that company's lead over the rest of the industry significantly further.

Udvar-Házy and Plueger did not pursue growth as aggressively as they could have. They decided that it was not a good use of capital to place more orders with Airbus and Boeing, given the current pricing levels and the fact that deliveries would be too far out into the 2030s. Who knows today what the market will be like then and what lease rates will be possible? ALC also decided against more sale-leaseback transactions, which its two leaders considered too competitive for attractive returns, barring some exceptions. In addition, the company did not buy large aircraft portfolios from other lessors.

Essentially, the only growth avenue ALC pursued was what Udvar-Házy and Plueger have always done: buying straight from the final assembly lines. That is a tough business these days, when everything is delayed and growth typically shifts to the right, more often than not involving unpleasant last-minute surprises.

ALC's new owners—Sumitomo, private equity firms

Apollo and Brookfield as well as SMBC Aviation Capital—plan to rename the entity Sumisho Air Lease and are convinced they made the right move. “This transaction is transformational for our business and the leasing landscape,” SMBC CEO Peter Barrett said in a statement. “Investing in Sumisho Air Lease, purchasing their orderbook and becoming servicer to the substantial majority of Sumisho Air Lease’s portfolio will enable us to deploy our financial scale and strength to meet the evolving needs of our customers and take a strategic lead in reshaping our sector.”

“In our sector, economies of scale matter,” Barrett added. “Our industry is evolving at pace and requires significant and diverse pools of capital so that our airline and investor customers can be provided with the products and services they need. As one of the most well-regarded leasing platforms, with a portfolio focused on liquid, in-demand, new-tech aircraft, Air Lease presents an attractive opportunity for the co-investors.”

Udvar-Házy created ILFC in 1973 and was soon in a major rivalry with Irish aviation icon Tony Ryan, who set up Guinness Peat Aviation (GPA) together with Aer Lingus and the Guinness Peat Group in 1975. In a piece of what may be somewhat bitter irony from Udvar-Házy’s perspective, Ireland-based lessors have now bought everything he ever set up. ILFC was picked up by today’s market leader, Aer-

Cap, in 2013 after the AIG collapse, albeit after Udvar-Házy had already left.

AerCap was also built on remnants of GPA that had been reunited through the takeover of GECAS in 2021. GECAS had bought most of GPA’s aircraft portfolio when the Irish company was in financial trouble in the late 1990s.

And now SMBC, also based in Dublin, run by GPA veteran Barrett—but admittedly taken over and backed by Japanese investors since 2013—is buying ALC.

If that aspect is any reason for discomfort, Udvar-Házy may take pleasure in remembering a long-ago episode. At the time, Ryanair, also co-founded by GPA’s Ryan, was on the lookout for some Boeing 737s and, needless to say, it was beyond imagination that Ryanair would lease them from ILFC. But it did.

“They needed jets to fly from [London] Stansted [Airport] to Dublin but

would not do business with me because I was the enemy,” Udvar-Házy recalled. But he did not let that opportunity slip through so easily. He created a paper company in Bermuda called Atlantic Aviation Holdings that was owned by ILFC, a detail that had escaped Ryan. Ryanair leased the aircraft.

Ryanair CEO Michael O’Leary eventually discovered the trick years later. He then sent a signed €20 (\$23) bill to “the poor Hungarian farmer that helped start Ryanair.” Udvar-Házy has kept it to this day. ☺



Udvar-Házy doing what he likes most: buying aircraft, here with Airbus Commercial Aircraft CEO Christian Scherer and ALC CEO John Plueger at the 2019 Paris Air Show.

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Spirit Airlines Buys Tools, Time and Flexibility in Repeat Restructuring

- ▶ THE ULCC WILL KEEP SHRINKING IN A BID TO SURVIVE
- ▶ SPIRIT SAYS A DISPUTE WITH AERCAP LEFT IT WITH “NO CHOICE” BUT TO SEEK CHAPTER 11 PROTECTION

Christine Boynton Boston

Having navigated “intensified” industry headwinds since emerging from bankruptcy in March, Spirit Airlines cited an unexpected dispute with a lessor as the tipping point that forced it to file for Chapter 11 protection again.

down on certain efforts. But what can a second attempt accomplish that the first did not?

“The first bankruptcy did not make Spirit a stronger competitor,” Swelbar-Zhong Consultancy Chief Industry Analyst William Swelbar

In line with the ongoing network optimization, Spirit intends to “significantly shrink” its overall fleet to match capacity with profitable demand. Doing so will “materially lower Spirit’s debt and lease obligations, leading to hundreds of millions of dollars in annual operating savings,” the bankruptcy court filings state.

More than 75% of the ULCC’s fleet is leased. Additionally, only 157 of its 214 Airbus aircraft are in service; 38 are grounded due to Pratt & Whitney geared turbofan (GTF) engine issues, and 19 more are for sale. Spirit expects repairs to ground nearly all 79 of its aircraft powered by GTF engines during the next two years and says that Chapter 11 will allow it “to renegotiate or reject leases on certain of these and other aircraft.”

Should Spirit emerge from its latest restructuring with a better handle on its future, it will still have to contend with broader market forces that are pressuring budget-branded carriers. Industrywide challenges that preceded its prior Chapter 11 filing have only intensified, Spirit’s latest filing states, pointing to overcapacity in domestic leisure markets and softened demand from price-sensitive travelers. Meanwhile, as the ULCC continues to slash unprofitable routes and focus on core markets, other U.S. carriers—including budget rival Frontier Airlines and mainline giant United—are dialing up the pressure by adding flights to several of Spirit’s focus cities.

Looking ahead, the airline intends to assess opportunities for growth once it stabilizes the network, improves profitability and starts taking a volume of aircraft deliveries again, executives told Aviation Week in early August. The carrier is not planning any significant capacity additions until 2027, when the undelivered leased aircraft under dispute with AerCap are scheduled to start being delivered.

In the near term, Spirit’s challenges remain formidable. The company generated a net loss of \$245.8 million during the second quarter of this year, a far cry from its previous projections of achieving a net income of \$252 million in 2025 (*AW&ST* Sept. 1-14, p. 42). Whether Spirit can shrink to survive—or perhaps become more attractive to another carrier—remains to be seen.

“It is hard to come up with an example where shrinking to profitability can easily be defined,” Swelbar tells



Fleet optimization is “critical and time-sensitive,” Spirit Airlines states in a recent bankruptcy court filing.

Spirit’s Aug. 25 notices from AerCap on its leased aircraft were twofold: a termination notice covering 36 undelivered aircraft and another alleging default on 37 leased aircraft within its fleet. The airline disputed their validity and, concerned that mandatory disclosures would prompt reactions from other parties, concluded that it had “no choice but to quickly seek the protections of Chapter 11.”

The South Florida-based ultra-low-cost carrier (ULCC) announced its repeat restructuring four days later, filing its voluntary petitions for Chapter 11 in the U.S. Bankruptcy Court for the Southern District of New York.

Spirit faces a termination fee of \$2.1 million for each undelivered aircraft lease and remains in negotiations with AerCap. In bankruptcy court documents filed on Aug. 31, the carrier says it “stands ready to litigate the validity of the notices and damages that Spirit has suffered as a result.”

The airline will now pursue restructuring less than half a year removed from its last and intends to double

writes in an analysis. “Bankruptcy is not a tool to fix a broken structure; rather, it is a tool to be used to address operating costs or financial costs that are out of market. . . . There are many other issues that can be addressed, but the bankruptcy process is generally all about cost. Today’s issues are more—much more—about revenue.”

As part of its go-forward plan, the carrier appears set to continue shrinking in a bid to survive. During the past 18 months, Spirit has already reduced its workforce, deferred and sold aircraft and scaled back its number of flights. An ongoing network optimization is leaning heavily into markets of strength; Fort Lauderdale, Florida, forms the “linchpin” of that strategy.

Through its latest restructuring, Spirit expects to increase efforts to redesign the network, address its cost structure and expand premium offerings that began to roll out in the summer of 2024. Network cuts will continue: Spirit plans to exit 11 U.S. markets in early October and has canceled plans to serve Macon, Georgia.

Aviation Week. Current networks were effectively built by a series of smaller airlines that grew and acquired other carriers along the way. Over the decades, predominantly point-to-point networks evolved into singular hubs that focused on building regional market strength before consolidation connected them, which created networks with national scope. Spirit's redesign of its point-to-point network will concentrate flying on key markets to provide more destinations, frequencies and enhanced connectivity to certain focus cities.

"Airlines with smaller networks but a strong hub or an international franchise can be attractive to someone bigger," Swelbar says. Spirit's Latin American networks and considerable Fort Lauderdale presence could have some value to another airline, "and in my mind are an asset that could be purchased in court," he notes.

However, "market opportunities for growth over and above economic growth are either not there or will be limited," Swelbar adds. "The [questions are] always: 'Where do I fit in the system?' 'What do I have that is unique and of value?' Spirit struggles to be able to answer those questions."

Since its latest Chapter 11 filing, Spirit has received approvals for first-day motions, allowing the carrier to operate throughout its restructuring. This time around, the company intends to be "far more strategic about our fleet, markets and opportunities," CEO Dave Davis said, gaining more "tools, time and flexibility" to continue discussions with key stakeholders in pursuit of a financial and operational transformation.

"Since emerging from our previous restructuring, which was targeted exclusively on reducing Spirit's funded debt and raising equity capital, it has become clear that there is much more work to be done, and many more tools are available," Davis noted. After evaluating options, considering recent events and market pressures, the ULCC's leadership decided that a court-supervised process is the best path forward.

Its latest bankruptcy filing states, "Once the optimization of Spirit's network, fleet, cost structure and customer offerings is completed, and given cost advantages that almost no other industry participant can match, Spirit will once again be the disruptive maverick that has long challenged—and changed—the U.S. aviation industry." ✎

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Condor's Fight Against Lufthansa Could Involve Further Legal Challenges

➤ THE INDEPENDENT GERMAN AIRLINE IS UNDER PRESSURE AFTER LUFTHANSA ENDS COOPERATION

➤ CONDOR'S STRONG GROWTH ADDS TO ITS EXPOSURE

Jens Flottau Frankfurt

Germany's tourism industry fears its worst nightmare: Condor, the only independent airline of considerable size, would go out of business, pushed aside by the sheer force of Lufthansa's financial power and network, leaving tour operators, hotels and other interested parties

on the Frankfurt-Florence segment. To mitigate some of the effects, Condor is now serving nine feeder routes into Frankfurt with its own aircraft. That number is planned to increase next year to a maximum of 12, since no other viable slots will remain at Frankfurt.



Condor continues to expand its Airbus A330-900 long-haul fleet.

with no choice but to cooperate with a player that can dictate prices to an even greater extent.

This is the context of the latest legal battle involving the two airlines. While this dispute focuses on the question of whether Lufthansa should be forced to offer capacity to Condor on its short- and medium-haul network at preferential terms, the subtext is about a broader issue: Is Lufthansa misusing its dominant market position to eliminate a competitor?

For Condor, the stakes are high. After Lufthansa terminated a special prorated agreement (SPA) on feeder services into Frankfurt that had connected to Condor's long-haul network, Condor was forced to pull out of six transatlantic markets (Baltimore; Edmonton, Alberta; Halifax, Nova Scotia; Minneapolis; Phoenix; and San Antonio). For example, the carrier can no longer offer U.S. passengers service from Phoenix to Florence, Italy, because Lufthansa provides few seats

For the time being, there is no clear legal answer to Condor's most pressing question. A recent court ruling rejected a decision by Germany's competition authority, the Bundeskartellamt, to reinstate the SPA but only because of procedural mistakes. The ruling raised doubts as to whether the Bundeskartellamt was independent from political interference in its initial decision to require Lufthansa to continue the SPA.

Condor's epic fight for survival has been a dominant theme in the German aviation sector for more than six years. Its former parent, European leisure group Thomas Cook, collapsed in 2019, forcing Condor into self-administered insolvency; the carrier narrowly avoided grounding multiple times. After the airline secured government-backed loan guarantees and the worst seemed to be over, the COVID-19 pandemic unfolded, forcing Condor to operate a minuscule schedule for the better part of two years. Polish Aviation Group (PGL), the par-

ent of LOT Polish Airlines, pulled out of a deal in 2020 to buy Condor at the last minute, leaving the airline without an investor. In July 2021, and only after another government-aided rescue, private equity firm Attestor bought 51% of the airline, leaving 49% in the hands of state development bank KfW.

With a new owner, Condor embarked on an overdue multibillion-euro fleet renewal program while still working to pay back COVID-era loans by the end of 2026. The airline replaced its aging Boeing 767 widebodies with 18 Airbus A330-900s in just over two years, and it plans to receive seven more of the aircraft in the coming years. The carrier is also in the process of renewing its narrowbody fleet: Nineteen A320neo family aircraft, 15 of them A321neos, are set to join in the next three years.

Although Condor will phase out the last six Boeing 757-300s by year-end and the remaining first-generation A320s later, the carrier has clearly embarked on an ambitious growth strategy that some observers consider to be very high risk, particularly without proper access to connecting traffic.

As a privately owned company, Condor does not publish detailed financial statements. The carrier halved its loss to €62 million (\$72 million) in the financial year ended Sept. 30, 2024, as revenue grew 15% to reach €2.44 billion. But it has not been profitable since 2019, even in the post-COVID boom years.

Condor's competitive position was further challenged by Lufthansa Group's decision to launch its own leisure long-haul carrier, Discover Airlines, on the blueprint of Edelweiss Air, the group's highly successful subsidiary based in Zurich. Discover jumped onto many legacy Condor routes, leading the incumbent to move much of its capacity elsewhere.

As for the SPA dispute, Condor CEO Peter Gerber says the airline is considering next steps, including further legal action. Another possibility is that the Bundeskartellamt could launch a new investigation. Additionally, a European Commission (EC) review of the A++ transatlantic joint venture among Lufthansa, United Airlines and Air Canada could open up an opportunity for Condor.

There are two precedents for the EC to require access to prorates. As part of its approval of the British Airways-Iberia-American Airlines joint ven-

ture across the Atlantic, the commission required British Airways to put in place prorates for feeder flights to some Virgin Atlantic long-haul services from London's Heathrow Airport, namely to Boston, Chicago and Miami. Virgin does not currently serve the London-Chicago market. Other feeder services that are not linked to the Miami and Boston flights can be provided on an interlining basis, meaning more restricted access to capacity and likely less attractive commercial terms.

The other precedent is the 2013 approval of A++. At the time, the EC was looking at the potential effect on competition and was mainly concerned about the Frankfurt-New York market. United and Continental Airlines had merged prior to the application, eliminating one former competitor on the route.

The commission required an SPA to be put in place for 20 routes with an origin or destination in the Caribbean, Central America, Europe and Israel that connect with the Condor flight between Frankfurt and New York.

For Condor, the current conditions for A++ appear to be a basis for insisting on an SPA but only for services that feed its New York route. Ironically, New York is not Condor's problem. The airline serves John F. Kennedy International Airport daily, partly because it shifted capacity from secondary markets on which it would compete with Lufthansa subsidiary Discover to the trunk route where its broader unit cost advantage vis-a-vis Lufthansa airlines comes into play.

For Condor to obtain broader and more efficient remedies in an A++ review, the scope of the transatlantic routes under investigation would have to be expanded to include competitive effects on secondary routes from one hub rather than just hub-to-hub markets. Traditionally, the EC has mainly focused on hub-to-hub markets. Even Lufthansa pulled out of the Frankfurt-Phoenix route after a short period in the 2000s after the route failed to be sustainable despite the airline's vast feeder network.

Condor's long-term future owner-

ship structure is up in the air. Attestor is proving to be a patient investor for the time being and is supporting management's growth strategy. But industry observers expect that Attestor will eventually sell the airline after the COVID-era loans have been repaid. The big question is: Who could ultimately buy it?

Some analysts suggest that Lufthansa could emerge as a white knight, but that would only confirm the rest of the industry's worst fears. Lufthansa likely would be subject to intense regulatory scrutiny given that the wider Lufthansa Group owns not only Discover but also Eurowings, its lower-cost unit that operates an all-narrowbody fleet. Etihad's flawed investment in now-defunct Air Berlin, for instance, has shown that a combination of ill-fitting airline networks and strategies generates little value. But Turkish Airlines has recently expressed interest in another European airline as it acquired a minority stake in Air Europa. Maybe that was only a first step. 🌐

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- > RUNWAY INCURSION DETECTION ADDED

Graham Warwick Washington

Boeing has conducted demonstrations of experimental, machine-learning-based automated taxi and runway safety systems under a collaborative project with the European Union Aviation Safety Agency to establish the regulatory requirements for safety-related artificial intelligence.

The tests, involving a Boeing-owned Cessna Caravan, were conducted in June under the Beacon project launched in June 2023 through an innovation partnership contract (IPC) awarded to the airframer by the European regulator. The project is now in the final documentation phase.

Beacon's purpose is to assess ways to certify a Level 2 machine learning (ML) application on transport-category aircraft. As defined by the European Union Aviation Safety Agency's (EASA) Artificial Intelligence (AI) Concept Paper, Level 2 systems involve human-AI teaming.

"The objectives of this project were to exercise, test and maybe even challenge the guidance of the Concept Paper for Level 2," EASA Project Manager Giovanni Cima said at the EASA AI Days conference in Brussels on Aug. 28.

Beacon is one of several AI-related IPCs underway, and its results will inform a third and likely final version of the Concept Paper, called Issue 03. A draft is expected to be released for public consultation in the second quarter of 2026, leading to publication in the fourth quarter.

Beacon is focused on a Level 2A automated taxi system involving cooperation between the pilot and the AI-based system. It also has explored a more autonomous Level 3A application in which the AI-based system performs the decisions and actions but can be overridden by the pilot.

While the main focus was on the Level 2A application, Boeing introduced the Safe Runway system during the project, Cima said. This is a different AI application involving detection of objects and intruders on the runway before landing to prevent incursions.

Beacon is one of several partnerships between the airframer and aviation authorities to address industrywide regulatory challenges associated with emerging technologies, Matthew Jahn, associate technical fellow at Boeing Global Safety & Regulatory Affairs, and principal investigator for Beacon, said at the conference.

"When we started this IPC, we were looking, in collaboration with EASA, to establish the regulatory requirements, means of compliance and verification and validation strategy for a machine-learning-based system," Jahn said. "We brought in the Safe Runway system partway through because we thought it would be a good example to look at a few particular aspects of the Concept Paper."



Boeing's automated taxi system receives a taxi clearance by radio from air traffic control (ATC), parses the clearance, plans a taxi route and provides a readback to ATC. The system then autonomously manages speed, turns and braking to execute the taxi plan autonomously using a lidar perception system to locate itself on the airport map and to sense, classify and avoid obstacles.

The system has an ML-based subsystem for dialog management, a symbolic or logic-based AI subsystem for planning and decision-making, and an ML-based subsystem for perception and dynamic obstacle avoidance. The flight crew activates, monitors and can override or disconnect the system at any time.

"We started by looking at the Concept Paper objectives and applying them to the Level 2A version of the system," Jahn said. "We wanted to see which objectives would be applicable to our system, explore if the intent of the objectives was clear and something the applicant could show compliance with, and that the applicable objectives were sufficient to ensure we had a system that was developed in a safe manner."

This review suggested that the objectives may need to be more tailored to each particular system than they are in Concept Paper 02, as the automated taxi system has aspects that could be considered Level 2B—human-AI collaboration rather than cooperation—as the automated readback potentially takes authority away from the human.

"Level 2B requires a shared situational awareness between the system and the end user, but Level 2A does not," Jahn said. "How that works for 2A versus 2B and what

Boeing's Cessna Caravan testbed demonstrated the automated taxi system at NASA Ames Research Center in May.



NASA

that would look like for the end user we thought would be a good topic for future exploration.”

Boeing's Level 3A automated taxi system is different. The system is autonomous, and several aircraft are passively monitored by a multivehicle supervisor in a remote station. The supervisor intervenes if alerted by an onboard safety monitor or if they observe the aircraft exhibiting unsafe behavior. If the supervisor can confirm that the aircraft is functioning correctly, they can resolve the operational issue and reengage the automated taxi system. If not, they will arrange for safe recovery of the aircraft.

“Upon alerting, the human will be allowed to intervene and potentially override,” said Emily Howard, principal senior technical fellow at Boeing. “We all think that is a good thing.” The automation is intended to reduce pilot workload, but workload is not always bad, she explained.

“Human performance and workload are not linearly related,” Howard said. “Very high workload can degrade performance, but very low workload is linked to complacency and distraction. We do not necessarily want to take the human completely out of the loop.”

Human factors become paramount. “We often think of the benefits while we're preventing human error, reducing latency and making things more affordable,” she said. “We don't spend a lot of time understanding the positive contributions that humans make to the safety case.”

The Safe Runway system is designed to detect other aircraft, vehicles, humans and even animals during landing and assist pilots during a high-workload phase of flight. The system uses automatic dependent surveillance-broadcast

(ADS-B) and cameras along with different forms of AI for image preprocessing, object detection, fusion and tracking as well as incursion decision-making and alerting.

The requirement is to detect and alert accurately, eliminating false negatives (missing an incursion hazard) and minimizing false positives to avoid unnecessary go-arounds that could affect airport safety and lead to pilots losing trust and ignoring the system.

Detecting potential incursions is a challenge for computer vision. At 3 km (2 mi.) from touchdown, an airport utility vehicle occupies just 0.001% of the image and barely 0.013% at 1 km. “Deep-learning approaches in computer vision count on texture and geometry,” said Dragos Margineantu, AI chief technologist at Boeing. “There is virtually no texture and minimal geometry there.”

The Safe Runway system is focused on ADS-B “Out” for detection and tracking, but fused with a camera to improve performance and provide redundancy. Boeing tested three levels of sensor fusion: camera-only, ADS-B cueing of image slicing and hybrid fusion, which uses cueing to provide visual conformation of ADS-B detections. “Hybrid fusion is much more robust and accurate,” Margineantu said. “Computationally, it is also the most expensive.”

Boeing tested the Safe Runway system in spring, summer and fall. “Over all our test conditions, we had one false positive and two false negatives at 2,000 m [(6,500 ft.)] and beyond 3,500 m,” Margineantu said. The false positive was caused by the system detecting a distance marker sign. Boeing subsequently added marker locations and made other modeling improvements.

In the critical false negative, an intruder was on the runway less than 3,500 m ahead, but no incursion was declared. The system failed with camera-only, and ADS-B cueing was not fast enough, but full fusion fixed the issue, Margineantu said. In the marginal false negative, the intruder—which was not equipped with ADS-B—was found and then lost, and there was no alert.

At distances beyond 4,500 m, errors were greater. “At long distances, when it wouldn't be a risk even for a 737, we go bad, so we'll have to improve,” he said. The visual object detector showed its ability to spot large vehicles from far away, tracking an airport fire truck parked at the end of the runway at 13 km as the aircraft began its approach. “Even the fire truck, in some situations, was hard, and we had to work to improve the detection,” Margineantu noted.

Risk management will play a central role in certifying AI, said Joshua Neighbor, a machine learning and computer vision engineer at Boeing. The project identified two types of functions: exact, which can be certified using traditional methods, and approximate, which need different assurance approaches.

Approximate functions arise when the underlying problem is computationally intractable and cannot be solved within a reasonable time frame, requiring use of learned models that cannot be exhaustively verified. Identifying and mitigating the risk of approximate functions producing hazardous outcomes is key.

“As we move toward the certification of AI-enabled systems, we need to think about how we define and measure safety,” Neighbor said. “One of the takeaways of this project is safety is not the property of any component—it's an emergent property of the entire system, including its operational environment.”

FREIGHTER FORTITUDE

- LONG-TERM OPTIMISM DRIVES DEMAND FOR NEW CARGO AIRCRAFT AND CONVERSIONS
- CARGO ASSOCIATION HEAD SAYS TARIFF MAYHEM TURNS TO APATHY
- E-COMMERCE IS AMONG THE DRIVERS OF CONTINUING FREIGHTER DEMAND



Helen Massy-Beresford Paris and **Guy Norris** Colorado Springs

The global cargo sector may have experienced short-term turmoil over tariffs, but industry players expect strong air cargo growth to continue in the longer term and fuel sustained demand for both new freighters and conversions.

For now, the uncertainty created by U.S. tariff announcements and the tariffs themselves are having less of an impact than many anticipated—a case of tariff mayhem being downgraded to tariff apathy, says Glyn Hughes, director general of The International Air Cargo Association (TIACA).

“The tariff shock that we saw back in April has not actually materialized,” Hughes says. “The tariff aspect is not really going to significantly impact the long-term growth of air cargo and therefore the long-term future of freighters. The much more important factor for us as an industry is overall economic resilience—global growth.”

The signs are positive in that respect, as the latest International Monetary Fund forecast in July revised up-

ward to 3% global growth for 2025 and 3.1% for 2026, Hughes notes.

“Trade will find a way,” says Tom Crabtree, managing director of Seattle-based Transport Research Advisory, echoing that position and paraphrasing late FedEx founder and Chairman Fred Smith, who spoke about the tariff threat in May at the International Society of Transport Aircraft Trading Freighter Forum in Miami before his death the following month.

“Commerce is like water in a stream; when it finds a rock, it goes around,” Smith said at the forum. “The U.S. cannot manufacture everything that a population with our wealth and per capita income needs, so trade will not stop. It’s just going to move.”

“Air freight is exhibiting more

strength than I would have given it credit for six months ago, with the Trump tariffs and the uncertainty that came from the almost hourly pronouncements of changes in trade policy coming forth from Washington,” Crabtree says. “I don’t care where you fall on the political spectrum, but if you’re a business planner, it’s really hard to work with that.”

Key indicators for the overall health of major international markets that are most likely to be affected by the tariffs show some rebound from the initial depression suffered in May, Crabtree notes.

“The Far East-North America market, both aggregate eastbound and westbound direction over the Pacific, contracted 4.8%, according to [the International Air Transport Association] in June relative to June 2024,” he says. However, this same number was down 10.7% in May. “The contraction was bad in May but basically was halved by June,” Crabtree adds.

Conversely, aggregated routes be-



Conversions are expected to make up two-thirds of the 2,900 freighters that Boeing predicts will be delivered in the next 20 years.

EFW

tween the Far East and Europe grew 13.4% in May, versus the same month in 2024. Growth continued at a lower rate of 10.6% in June. “What that tells me is there was a big pivot, probably from China and Southeast Asia, to move kit through Europe,” he says. “My guess is it might be blended with some other products from the countries that do not have the same tariff regime that the Trump administration has implemented on China to get it through.”

While tariffs will undoubtedly affect flows of goods, Hughes sees the supply chain agility required to cope as reason for optimism for the air cargo sector, and freighters in particular.

“You can’t achieve supply chain agility with passenger bellies—they are fixed, going to and from where the passengers want to go,” he says. “These days of uncertainty and new markets and the need for new trading relationships could actually help drive demand for freighters.”

Amid that demand, including for passenger-to-freighter conversions,

industry players are closely watching the supply of aircraft to meet it.

Supply chain issues in recent years have forced operators to put off fleet renewals, slowing down the availability of passenger aircraft ready for conversion. Elbe Flugzeugwerke (EFW) in Germany, which specializes in converting Airbus A320s, A321s and A330s, has experienced this phenomenon, company spokesperson Richard Weinhold says.

EFW has nine conversions underway. “Aircraft owners are currently delaying their decisions for fleet updates to wait for the current uncertainty in the market to ease,” Weinhold says.

EFW expects rising demand for conversions as more passenger aircraft reach the end of their first lives and feedstock levels increase.

In particular, “the ultra-low-cost e-commerce sector could increase the demand for affordable short-term air cargo capacity, meaning freighter conversions,” Weinhold says. “But it remains to be seen what repercussions the U.S. de minimis stop brings to this sector.”

Demand patterns already have shifted somewhat.

“Comparing pre-2020 and now, we see more point-to-point air freight connections and much more traffic in Asia, especially in China, where we see significant demand for freighter conversions in the coming years,” Weinhold notes. “The other rising market is India. We also see new cargo routes in Middle East and South America.”

Doug Backhus, vice president for cabin, modifications and maintenance at Boeing, says the manufacturer has a solid pipeline of aircraft awaiting conversion. The airframer’s latest 20-year market outlook forecasts that the global freighter fleet will grow approximately 67%, to 3,975 aircraft, in 2044 from 2,375 in 2024.

Boeing projects freighter deliveries will total 2,900 over that time frame, with approximately 45% headed to replace retiring aircraft and the remainder to expand the fleet. Conversions are forecast to account for about two-thirds of the projected figure; 60% are expected to be narrowbodies and 40% widebodies.

Backhus says the Boeing 737-800-BCF is “supported by a large passenger fleet that’s available for conversion,” despite near-term headwinds in the past 12-18 months.

“I think we see that starting to relieve here in the coming months,” he says. “I think we really see that we’re filling the market appropriately to be able to support those conversions.”

Those 737 conversions take 3-4 months and 767 conversions slightly longer, at 4-6 months, Backhus says, noting that conversions have been unaffected by supply chain issues because Boeing ensures “all parts on the ground” for a timely conversion and does not see that becoming an issue going forward. The company expects to have enough feedstock for wide-body conversions as well.

“We’ve looked at a market analysis, and we believe there’s definitely going to be 767 passenger airplanes that are going to be ready to come out of service here over the coming years, and we’re really primed to be able to support that,” Backhus says. “The number of conversions that we’ve already had to date and the demand on converting those airplanes are really strong. As we see the widebody deliveries from the Boeing Co. on 787s, it will help to be able to provide for those 767s to come out of passenger service.”

Crabtree believes the narrowbody cargo market may have swung back to the other extreme due to oversupply of predominantly older converted aircraft. “There are quite a bit of idle Boeing 737-800s that have already been converted, and it’s the same for the Airbus A321 conversions,” he says.

The glut is attributable to the sudden availability of feedstock for the conversion market, which coincided with the COVID-19-triggered collapse of the global air transport business in 2020. “All of a sudden, there were many idle 737-800s, mostly the older versions that at the time were probably on a second lease or maybe even being considered for a lease renewal or as a conversion candidate,” Crabtree says. “A lot of that kit is owned by lessors, and like lemmings heading for a cliff, there were way too many lessors chasing too few opportunities.”

The influx of more efficient, newer 737-800 and A321 aircraft is forcing out older models. Lease rates for 737-300/400s and 757s, for example, have “fallen through the floor,” Crabtree notes.

Hughes expects demand for different types of freighters to remain strong, applying both to conversion and new aircraft. That covers nar-



Elbe Flugzeugwerke has nine Airbus passenger-to-freighter conversions underway.

rowbodies set to operate intraregional routes in such areas as Latin America, where trade is increasing over a wide area, and widebodies needed for longer routes and likely to be in demand in countries such as India, where those types are underrepresented in the fleet and exports are growing.

"The information I'm gathering from TIACA members is that demand for production and conversions both seem really healthy, really strong, and really seem to have a good future going forward," Hughes says.

For the larger freighter market, there is big news—although not yet officially confirmed by Boeing—in the delivery of the 300th "metal-wing" 777F as production continues apace toward its scheduled termination at the end of 2027. Handed over to Emirates on Aug. 8, the landmark aircraft is the 23rd 777F delivered this year.

Perhaps more tellingly, with more than 50 remaining in the backlog, the delivery rate puts the 777F program on track to take the crown from Boeing's storied 747 as the industry's leading large freighter before it is succeeded by the new 777-8F.

"By the time it concludes, the 777F freighter program may deliver more machines of a common configuration than all three variants of the production 747 freighter from 1972 to 2023," Crabtree says. Excluding conversions, production of 747Fs reached 359 aircraft, of which 86 were -200F/

200Cs, 166 were -400F/400ERFs and 107 were -8Fs.

The 777F is on track to achieve this high point in almost a third of the time it took for the 747F to amass a similar tally. Air France took delivery of the first 777F in 2009, and the final handovers are expected in early 2028. That means the twinjet should match the new-build 747 freighter tally in just over 19 years; it took the quadjet 51 years to reach the 359 mark.

But the clock is ticking. To deliver the remaining backlog of 777Fs before an emissions rule from the International Civil Aviation Organization (ICAO) kicks in that will prohibit further manufacturing of the current-generation type, Boeing must move about 2.4 aircraft per month through production by the cutoff date of Dec. 31, 2027.

However, industry insiders say Boeing may have some leeway. The company can still deliver 777Fs into 2028 and officially comply to the letter of the ICAO ruling so long as all airframes are completed prior to the end of December 2027.

Meanwhile, production of the first composite wings for the prototype 777-8F, heir apparent to the 777F, is underway at Boeing's site in Everett, Washington, as the company approaches the 90% design release point for the freighter.

With initial deliveries set to start in 2028, the 777-8F has a payload capacity

nearly identical to the 747-400F's but 30% lower fuel burn, 25% better operating costs per metric ton and a 60% smaller noise footprint, Boeing says.

Following Korean Air's Aug. 26 purchase agreement for eight 777-8Fs as part of a wider order for 103 Boeing aircraft, the backlog for the new twinjet freighter has grown to 67.

Delving deeper into Boeing's market outlook, the company projects a two-thirds increase in the global freighter fleet by 2044, including a requirement over this period for 885 large widebodies.

The airframer forecasts that de-risking and diversification of global supply chains will boost demand in the manufacturing sector for air cargo as supply chains become multi-node across a wider geography. As growing e-commerce and express networks increase traffic, markets in South Asia, China and Southeast Asia are poised for the fastest growth over that time frame, Boeing says.

The Asia-Pacific region is among those that will require the most freighter deliveries, according to Boeing's 20-year forecast, and that dynamic is well underway, Backhus says.

"If we look at the standard-body freighters, we've really seen a pickup in that fleet activity in the Asia region over the past few years," he explains. "So the 737-800BCF really is leading in deliveries to Asian customers across that time, and it's really driven by operators looking to modernize their fleet and the performance of that airplane, its increased efficiency and reduced costs compared to its predecessors."

"Just over one-third of all freighter demand will come from Asia-Pacific carriers, more than doubling the existing fleet," the Boeing report states. "North American carriers will receive another third of projected freighter deliveries, with roughly two-thirds replacing older airplanes."

Airbus, which plans to release an updated global cargo market forecast in October, also expects that expanding markets in the Asia-Pacific region as well as parts of Africa will fuel rising demand in air freight capacities, creating potential for new trade lanes.

On the new freighter side, the manufacturer has pushed back service entry of its in-development A350F to the second half of 2027. French logistics giant CMA CGM is set to be the launch operator for the new freighter. 🌐

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System Testing Adds to VTOL Startup Ascendance's Momentum

- > THE TRIALS INFORMED UNDERSTANDING OF AIRFLOW AND HYBRID-ELECTRIC POWER BALANCE
- > THE MAIN SPAR PASSED THE ULTIMATE LOAD STATIC EVALUATION

Thierry Dubois Muret, France

Ascendance Flight Technologies differs in three ways from Volocopter and Lilium, two other European would-be vertical-takeoff-and-landing aircraft manufacturers.

First, Volocopter and Lilium flew uncrewed full-scale prototypes early in the development phase, while Ascendance—founded in 2018—has yet

Ascendance's approach could provide it a more achievable path to success. Challenges abound, of course, such as compliance with certification standards, weight and noise levels in vertical flight that meet standards. But the Atea's systems and components have passed major tests, some for innovative technologies. Those

Hybrid-electric power reduces reliance on batteries and enables greater range.



to fly its first crewed prototype. Second, Ascendance is offering powertrains to other manufacturers, creating opportunities to gain more experience and customers.

Third, the propulsion of Ascendance's Atea—offering a range of 215 nm when carrying four passengers and the pilot—relies on a hybrid-electric architecture. In contrast to all-electric, hybrid-electric power reduces reliance on batteries, the stagnating performance of which has disappointed many aviation players. Other advanced air mobility actors are gradually moving toward hybrid-electric, the latest examples being Archer and Joby Aviation; the proposed military versions of their aircraft use such systems.

tangible successes might strengthen the company's case when CEO Jean-Christophe Lambert talks to investors, as he has yet to raise the several hundreds of million euros (or dollars) needed to achieve certification and deliveries.

Last spring, Ascendance concluded a two-year series of seven aerodynamic test campaigns on half of a forward wing, including its two shrouded horizontal rotors. "It has enabled us to understand how vertical lift works on the Atea," explains Engineering and Program Director Stephane Viala. "Sometimes, it is counterintuitive. Part of the suction comes from the wing itself. Those assessments have given us confidence to proceed with flights."

Flight testing was postponed this

year to 2026. The first trials will take place in conventional-takeoff-and-landing mode. Viala asserts that the new schedule is perfectly achievable. "Supply chain problems are behind us, and formal testing has started," he says.

Formal testing will help Ascendance earn a permit to fly from the European Union Aviation Safety Agency (EASA). As part of that new phase, engineers are incorporating flight profiles on the powertrain testbed.

The current tests on the powertrain testbed are designed with a focus on conventional flight. Two Safran ENGINEUS motors and accompanying dummy propellers—providing no aerodynamic thrust, which would disturb the testbed—run, relying on a two-channel hybrid control unit. The unit controls the 800-volt network, monitoring for potential electric current leaks and dealing with failures, Viala says. The hybrid operating system, meanwhile, makes the network capable of converting a throttle input into motor speed variation, charging batteries and reconfiguring.

Represented on the testbed, each of the Atea's battery packs will provide continuous power of 334 kW or peak power of 502 kW. At 100 kg (220 lb.) each, they feature a favorable integration ratio of 65%, meaning the battery cells storing the energy account for that proportion of the total pack's weight, Viala says. The aircraft will include four of the packs.

Ascendance conducted a structural test during the week of Aug. 18 just like an established airframer. The front spar of the aft wing broke under a higher stress than expected, passing the ultimate load static test, Viala says. At 50 metric tons, the set threshold represented 1.5 times the limit load, and the spar went beyond that. As required by EASA rules, the engineers had damaged the composite-material part before the test. The idea was to validate performance even after a tool fell on the bonded parts of the component during manufacturing.

The successful evaluation of the most critical part—the one that undergoes the highest loads—means other spars can withstand the loads they will experience, Viala says. Nevertheless, EASA wants Ascendance to prove the entire wing at limit load, he adds. That next step is scheduled to take place by year-end.

This will be part of a carefully de-



Ground testing of the Atea wing (above) has demonstrated its contribution to vertical lift.

vised logistic movement with Duqueine, supplier of the composite-material airframe. Duqueine is finalizing the airframe of the first prototype at its factory near Lyon, Viala explains. In a few weeks, the wings will leave the site for their limit-load test. Final assembly is planned to start late this year at

Ascendance's development and flight-test center here at the Muret-Lherm Aerodrome near Toulouse. Ascendance switched to Duqueine to have a composites supplier closer geographically than the previous one, Airborne, which has production facilities in the Netherlands and the UK. Prox-

imity helps solve problems, Viala says.

Flight testing a smaller variant of the Sterna hybrid-electric powertrain on a Delair uncrewed air vehicle is planned for September. The joint project aims to increase the endurance of the otherwise all-electric military-use drone fivefold, Viala says. 

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German Researchers Produce Carbon Fiber from Algae

Carbon fibers are produced from petroleum, and their manufacture entails significant energy consumption and CO₂ emissions. In a bid to reduce their environmental impact, a consortium of German researchers has developed a process to produce carbon fiber from renewable raw materials.

ANDREAS HEDERGOTT/
TECHNICAL UNIVERSITY OF MUNICH



Biogenic glycerol extracted from active microalgae is used to produce the raw material for carbon fiber.

“With the joint GreenCarbon project, we have taken a major step toward sustainable industrial carbon fiber production,” says Thomas Brück, project coordinator and professor at the Technical University of Munich (TUM). The fibers have the same performance characteristics as conventionally produced carbon fiber, the researchers say.

Carbon fibers are made from acrylonitrile, a raw material that is traditionally produced from petroleum-based propylene. Under the GreenCarbon project, researchers have developed a process to produce acrylonitrile from biogenic glycerol extracted from microalgae.

Through photosynthesis, the microalgae bind greenhouse-gas CO₂ and form algal oils. The TUM School of Natural Sciences then extracted glycerine from these oils using a chemical process. Researchers at the Fraunhofer Institute for Interfacial Engineering and Biotechnology developed a process to catalytically convert the glycerol to acrylonitrile.

Industrial partner and Airbus supplier SGL Global was responsible for producing carbon fibers from the bio-derived acrylonitrile. The company produced 50k heavy-tow fibers, or bundles of 50,000 filaments, that met industry standards for mechanical stability, the researchers say. These were used to produce carbon-fiber-reinforced plastic composite laminates.

As an associate partner in the GreenCarbon project, Airbus conducted a life-cycle assessment. Based on promising results, the company plans to demonstrate the material in an aircraft application. Airbus has previously flown bio-derived composites, including a nose panel made from renewable materials on Airbus Helicopters’ H145 PioneerLab testbed in 2024.

The GreenCarbon project was funded by Germany’s Federal Ministry of Research, Technology and Space. As a next step, the researchers hope to receive funding for a follow-on project to optimize the technology and transition it into industrial use.

GE and Beta Partner on Hybrid-Electric Military Projects

GE Aerospace has joined forces with startup Beta Technologies to develop a turbogenerator for hybrid-electric advanced air mobility applications. GE also plans to make a \$300 million equity investment in privately held Beta.

Based on GE’s T700 turboshaft family and capable of megawatt-class power output, the series-hybrid turbogenerator will be used in Beta’s own electric aircraft and offered to other OEMs—initially for military applications, with plans to certify the powerplant for commercial applications. The companies are not giving a timescale for availability.

The teaming comes amid growing military interest in hybrid-electric propulsion to provide the range and payload required to perform logistics missions in contested environments in the Pacific theater. There also is emerging civil interest in longer-range electric aircraft for missions such as medical transport.

The partnership will bring together Beta’s expertise in high-performance permanent magnet electric generators



BETA TECHNOLOGIES

Now in flight testing, the first VTOL Alia A250 off Beta’s production line sports a military gray color scheme.

with GE’s decades-long experience in turbine engines and power electronics as well as safety certification and large-scale manufacturing.

“The partnership is focused on pairing super-high-reliability redundant power electronics and electromagnetics with an existing platform in a system-level optimization effort,” says Beta founder and CEO Kyle Clark. Beta and GE are “coming together to make something that is fit for flying in military and, in the future, civil aircraft.”

Beta has developed its own electric motors for its Alia electric aircraft, the conventional CX300 and vertical-takeoff-and-landing (VTOL) A250. GE has developed and tested megawatt-class electric and hybrid-electric powertrains with NASA and under other programs.

“We’re taking the best of what each company has to offer and putting it together in a bespoke, optimized system,” Clark says. “We have made hybrid systems before [at Beta], but they are largely disparate and federated systems that allowed us to prove the concepts.

“But take GE’s engineering and certification expertise . . . and marry that to the products Beta has been flying with, and you get the opportunity to put something together that is not just smushing together an engine and an electric machine,” he says.

“From the GE perspective, that is a great partnership foundationally for innovation in the area of hybrid-electric propulsion, which we think is an important evolution in the aerospace industry,” says Darin DiTommaso, vice president of engineering at GE Aerospace Defense and Systems.

“There is a number of mission sets that could be relevant, whether you are talking about cargo, medical transport or military applications,” he says. “When you look at those spaces, you see different vehicles encompassing differ-

ent missions. We want to be positioned to support wherever the market goes.”

While Beta sees a large market for its battery-powered Alia aircraft, Clark says there is a threshold where hybridization allows electric aircraft to meet or exceed the range and payload of existing platforms.

“The military logistics connect market is largely enabled by hybridization of our VTOL aircraft. It’s not incremental. It suddenly crosses a threshold,” he says. “It says, ‘If you want to do logistics connection between the first and second island chains in the Pacific theater, this is the type of technology needed.’”

Flights Will Help Understand Lightning

Lightning strikes are a routine hazard for aviation—on average, a commercial airliner is struck about once a year—but future electric- and hydrogen-powered aircraft could be more sensitive to atmospheric electrical effects, creating the need for a better understanding of lightning.

NLR



NLR’s Cessna Citation will conduct in-situ measurements of cloud electrification and microphysical processes.

A four-year multinational project has been launched to improve understanding of the mechanisms that lead to thunderstorms and lightning. Coordinated by France’s national aerospace research center Onera, the Electri-Fly project (Atmospheric Electricity Characterization Through In-Flight Measurements) also includes researchers from NASA, the Japan Aerospace Exploration Agency, Canada’s National Research Council (NRC) and the Netherlands aerospace center NLR.

Involving flights by NLR’s Cessna Citation II research aircraft over Europe in 2026-27 and NRC’s Convair 580 over North America in 2027-29, the

project will carry out coordinated airborne measurements of cloud electrification and microphysical processes across the two regions.

The project addresses two key gaps in understanding lightning. Previous studies have investigated cloud electrification from the ground, but few have measured the electric fields and particle-level charges inside active storm clouds, the researchers say. Adding such in-situ data is essential to constrain physical models of charge generation and lightning initiation, they add.

The project will couple this with measurements of cloud microphysics. Charging processes depend heavily on the presence and behavior of water and ice particles, but electrical and microphysical measurements are rarely obtained simultaneously, the researchers say. Electri-Fly is designed to overcome this limitation.

The research aircraft will be equipped with advanced sensors and flown through electrically active clouds. Onera has developed two sensors for the project: Ampere will measure atmospheric electric fields and the charge carried by individual particles in real time; Ahdel will quantify the distribution and polarity of charged particles in flight. Microphysics probes will assess cloud structure, including droplet size, type, concentration and ice content.

Sensor data will be compiled into a reference atmospheric database that will help improve physical models of cloud electrification and lightning initiation to support the development of predictive tools for storm activity and lightning risk.

The database will also be used to refine atmospheric simulation models used in aviation risk assessment and trajectory planning. Researchers say the data collected will also improve understanding of lightning-related nitrogen oxide generation and its environmental impact.

Startup Stores CO₂ in Concrete Waste

Swiss International Air Lines has partnered with a startup developing technology to store captured carbon dioxide in concrete from demolished buildings, permanently removing it from the atmosphere.

The strategic partnership will allow Swiss startup Neustark to accelerate development of the technology and expand internationally. Founded in 2019 as a spinoff from Swiss university ETH Zurich, Bern-based Neustark is targeting the removal of hundreds of thousands of tons of CO₂ by 2030.



NEUSTARK

Neustark built its first commercial CO₂ storage plant in Berlin in 2023 with construction company Heim.

Neustark works with biogas plants that separate CO₂ from methane through an upgrading process. The startup captures and liquefies the CO₂ and transports it to nearby demolition waste recycling centers, where it is injected into the finely crushed concrete.

Through an accelerated mineralization process developed by Neustark, the CO₂ then turns into limestone and is bound to the pores and surfaces of the concrete granules. The CO₂-enriched recycled concrete can be reused in road building or to produce fresh concrete.

The construction industry is one of the world’s largest emitters of CO₂, and concrete is the world’s largest waste stream, Neustark says, with more than 1 billion metric tons produced annually. The CO₂ can also be permanently stored in slag and slurry.

Swiss says the startup has demonstrated the viability of its technology. Carbonated recycled concrete has been used in a large residential construction project in Berlin, and planning is underway on more than 30 CO₂ separation and storage sites in Europe.

The partnership with Neustark is one of several decarbonization initiatives by the Lufthansa Group airline. In May 2024, Swiss and Lufthansa became the first aviation customer for Swiss startup Climeworks’ CO₂ direct air capture and storage program. And in July 2025, Swiss become the first airline to integrate its operations with synthetic jet fuel produced by Swiss startup Synhelion using solar energy. ☀

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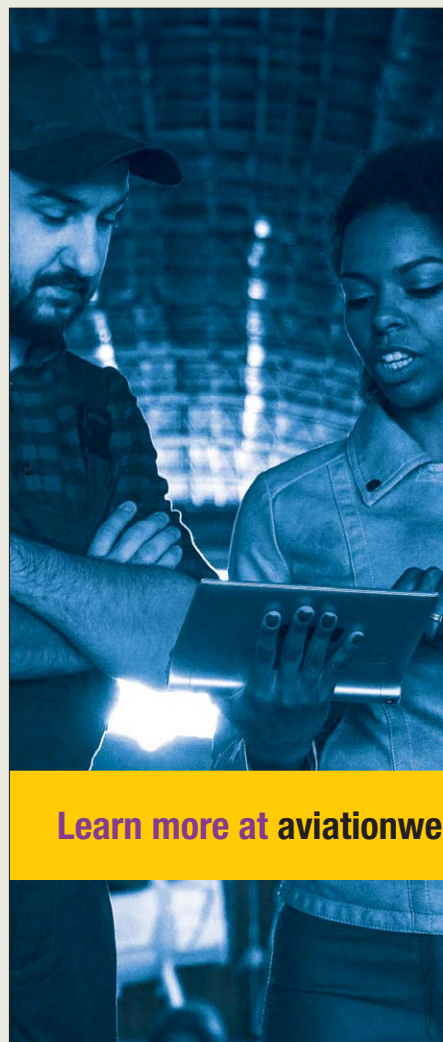
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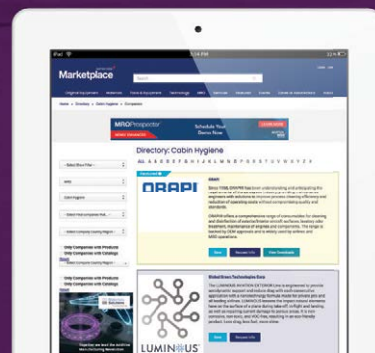
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Is the Airliner Business Model Broken?

By **Jerrold T. Lundquist**

The fundamental design of the Boeing 737 dates back more than 60 years, and its cross-section derived from the Boeing 707 dates back to 1957. Boeing has delivered more than 12,000 737s, making it the most popular aircraft for decades (although now it is being overtaken by its Airbus A320 rival), and the U.S. aircraft-maker still has almost 5,000 on order.

For years, the biggest question in the commercial aerospace industry has been: When will we get something new? At each juncture, when considering the launch of an all-new aircraft, Boeing made the apparently correct economic decision to go with a derivative design, incorporating improved propulsion, avionics, controls and materials technology, resulting in the 737-300, -400 and -500, 737NG and 737 MAX families. Each has been a market success.

Fielding a new aircraft requires deep pockets and patient capital to see through the certification process, market development and reach profitability. As McKinsey & Co. analysts note in “Does a Next-Generation Airliner Make Business Sense?” published on AviationWeek.com in June, costs can easily reach \$25 billion, and the payback could take 10-12 years to materialize.

There are several promising designs seeking investment today that could revolutionize air travel. Boom is developing a supersonic airliner to fly at Mach 1.7 and carry 60-80 passengers up to 4,250 nm. In January, Boom’s XB-1, a one-third-scale demonstrator, broke the sound barrier (AW&ST Feb. 10-23, p. 34). Boom has 130 purchase commitments from the likes of United Airlines, American Airlines and Japan Airlines.

JetZero has departed from the traditional tube-and-wing architecture in developing a blended wing body that offers aerodynamic efficiency, promising a 50% fuel-burn reduction (AW&ST June 30-July 13, p. 48). To speed development and certification and contain development costs, it uses existing components, such as the Pratt & Whitney PW2000 engine. Both Alaska Airlines and United have invested in it.

The fact that money, perhaps more than technology, can be the barrier to introducing a new aircraft is illustrated by Aerion. The company, founded by billionaire Robert Bass, focused on a 10-passenger supersonic business jet. It embraced a natural laminar flow design and developed a “boomless cruise” capability, which did not require an afterburner and could run on sustainable fuel. Aerion secured \$11.2 billion in purchase agreements and

was working on a \$375 million production facility in Melbourne, Florida, before it abruptly shut down in May 2021, citing an inability to raise the \$4 billion needed to proceed (AW&ST May 31-June 13, 2021, p. 18).

Boeing last launched an all-new airliner, the 787, more than two decades ago. It was 3.5 years late, faced numerous quality issues and is estimated to have cost Boeing \$32 billion to develop (AW&ST April 21, 2008, p. 41). The 787 is still poised to become a cash generator, but the pandemic, fatal 737 MAX crashes and 777X development

woes have restricted Boeing’s financial muscle to pursue a new program. Although Boeing’s fortunes appear to be recovering, it will be some time before the company can sustain the development cost of a new single-aisle aircraft.

The situation in Europe is different, but Airbus also has little incentive to upset the status quo, with its A321 decisively winning market share (AW&ST Sept. 1-14, p. 14).

Airlines may bemoan the lack of a new “game-changing” program, but their unwillingness to reward developers adequately for the benefit they create is part of the problem. Just look at the advent of the Airbus A350 and how the cutthroat competition with the 787 has eroded profit margins for the new technology.

That means the only winning formula is to develop an aircraft that is unopposed in its benefits. The Boeing 747 accomplished this early on with its unique size and range, and it funded the company for decades.

Boom aims at a very small market that was last addressed by the supersonic transport, which proved economically unfeasible. JetZero must convince airlines and lessors that its reduction in operating costs is sufficient to merit switching to an aircraft that has neither an installed base nor clear residual value—factors that stunted early sales of the Bombardier C Series and doomed it to an eventual sale to Airbus.

We are past the “knee of the curve” on many technologies, such as propulsion, that would make a good business case for a new aircraft. It is therefore incumbent on aircraft-makers to prove to their shareholders that a design can earn its return in the marketplace. Absent that, we could be consigned to low-risk, somewhat uninspiring derivatives for the foreseeable future. ☛

Jerrold T. Lundquist is managing director of the Lundquist Group, which provides strategic advisory services to senior management and investors in the aerospace and defense industry.



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