

PRESSING FORWARD PUTIN'S BOMBER



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ON THE COVER

Tupolev released a patent in March for an engine air intake for an aircraft resembling Russia's PAK DA bomber. The drawing attached to the patent may not show the exact bomber under construction, but the patent and other documents indicate that development of the aircraft continues. Analysis by Piotr Butowski begins on page 20. Tupolev illustration.

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FEEDBACK

TRAINING SUPPORT NEEDED

In response to "Working Your Way Up" (*July 25-Aug. 7, p. 5*), regarding the cost of flight training and the necessity of government support for flight training programs, Mr. Phipps severely underestimates the relative increase in cost of higher education over the last several decades.

According to the National Center for Education Statistics, the average cost of tuition, room and board at a four-year college in the U.S. was \$1,653 per year in 1970. If one were making \$3 an hour (twice the minimum wage in 1970), one could pay for this by working about 14 weeks full-time, or a bit longer than summer break.

For the 2018 school year (the last year for which there are statistics), the average cost at a four-year college was \$24,623. Working a job making \$15 an hour (again, roughly twice the federal minimum wage), this would require a student to work 41 weeks full-time to cover the cost of their education.

Thus, although motivated young people could pay their own way through college and flight training in 1970, it is effectively impossible for them to do so now. Instead, they are forced to take on a large amount of student-loan debt to pay for their education. This is why training-support programs like those suggested by William Swelbar in his Up Front commentary are so urgently needed (*"Wake Up, Washington" June 27-July 10, p. 10*).

Thomas Beatty, Waunakee, Wisconsin

LESSONS FROM UKRAINE

"What Ukraine Can Teach the West About Future Air Wars" (*July 11-24, p. 51*) is an interesting and important article. A few additional points need to be made, however.

For instance, the incredibly dense proliferation of Manpads in the battlespace is not mentioned. Manpads are widely dispersed and therefore represent a threat everywhere. Both sides have resorted to extremely low-altitude flight, by both fixed- and rotary-wing assets, to avoid groundto-air missiles of all types. This has resulted in several controlled flight into terrain losses of aircraft.

Both sides have also changed rotary-wing air-to-ground rocket

deployments from direct to indirect fire, using a "pull-up, toss and scoot" technique. The much-decreased accuracy of this loft method surely hinders their utility.

In addition, the assertion that the effectiveness of Baykar Bayraktar TB-2 drones has been "massively distorted" seems to fly in the face of their use in the recapture of Snake Island and possible role in the sinking



of the Moskva, both of which have helped turn the tide in the control of the western Black Sea. Ukraine has kept operational details close to the vest, but it is likely that the use of the TB-2 in various roles, possibly including breaking up the vaunted 64-kmlong Russian convoy north of Kyiv and cross-border strikes into Russia, will reveal its true value.

Len Meyer, Harwinton, Connecticut

THE GROWLER ADVANTAGE

There is a much more expedient and less expensive way for Germany to gain an effective airborne electronicattack capability than adapting the



Eurofighter ("Germany Seeks Eurofighter Jammer" July 11-24, p. 28).

The U.S. Navy is intending to get rid of its land-based Growler squadrons, so why don't the Germans pick up 30 or so used EA-18Gs from the Navy and save a tremendous amount of time and euros? The country could spend its development capital on the as-yet-undeveloped high-band pod of the Next-Generation Jammer complex. Germany could have a squadron operational in less than a year, if it wanted.

Moreover, the lower landing speed and folding wings of the Growler would give it an advantage over the Eurofighter in dispersing to highway strips, which seems to be the best way to protect your airpower in these days of numerous long-range strike weapons.

Chris Dierkes, Monroe, Connecticut

ENGINEERING EXERCISE

The guest viewpoint by Bain & Co.'s Jim Harris ("Inconvenient Truths About Sustainable Aviation Fuels" July 11-24, p. 98) estimates that it could cost \$10 trillion to transition 100% of aviation fuel to sustainable aviation fuel (SAF) by 2050. For what? With aviation accounting for 3% of all CO_2 emissions, the benefits would be close to zero, even at 100% carbon-neutral. Recall that China alone is building hundreds more coal-fired power plants by 2030. Add more plants built by the rest of the world, and the futility seems obvious. Redirecting that \$10 trillion to build nuclear power plants could reduce man-made CO₂ emissions by perhaps 90%.

I have no doubt that the push for aviation to adapt SAF is a fantastic engineering exercise. It's also a massive waste of engineering talent and money that could be better spent advancing other avenues of research.

Joseph Blake, Wrightwood, California

ONLINE, in response to "New-Look Boom Overture Headlines At Farnborough" (*July 25-Aug. 7, p. 16*), **ANDY.MEEKER.9** writes:

By their very nature, this class of aircraft will have excess takeoff thrust. Rather than number of engines, I'm betting the higher aspect ratio, larger wing, and systems & procedures are the biggest difference-makers for reduced noise. Speaking of, curious there's no discussion of boom regulations, including waivers for flight test. Any developments in those areas?

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.

WHO'S WHERE

Vimal Kapur has been

appointed president and chief operating officer at *Honeywell*. He remains president and CEO of Honeywell Performance Materials and Tech-



nologies. Kapur has more than three decades of experience across various Honeywell businesses including serving as president of the company's building technologies and process solutions business units.

XTI Aircraft has promoted **Mike Hinderberger** to CEO from senior vice president for engineering. He succeeds Bob LaBelle, who has left. XTI is developing the six-seat vertical-takeoff-and-landing Tri-



Fan 600. Angela Martens

has been appointed *Skytrac Systems* vice president of finance and administration. Martens joins Sky-

trac from ClearStream Energy Services, where she was vice president of finance.

Avolon has appointed **Andy Cronin** as CEO designate; he was president and chief financial officer. **Paul Geaney** moves up to Avolon president and chief commercial officer. CEO and founder Domhnal Slattery has retired.

SatixFy Communications has hired **David Ripstein** as CEO. He succeeds Yoav Leibovitch, who will remain the company's chairman and chief financial officer. Ripstein previously was CEO of



Radcom and Green-Road Technologies. Brandon Suarez

has been hired as *Reliable Robotics* vice president of uncrewed aircraft system (UAS) inte-

gration, a new position. Prior to joining Reliable, Suarez was the technical director for UAS civil airspace integration at General Atomics Aeronautical Systems Inc.

Brent David Willis has been named CEO of *Vaya Space*, a privately held hybrid rocket company. He succeeds Grant Begley, who will serve on the board of directors.

Sabre Corp. has hired **Mike Randolfi** as chief financial officer and **Garry**

Wiseman as travel solutions chief product officer. Randolfi was chief financial officer at BFA Industries; he succeeds Doug Barnett, who has retired. Wiseman, who held leadership roles at Dell and Microsoft, among others, succeeds Wade Jones.

Parsons has promoted **Matt Ofilos** to chief financial officer from executive vice president of finance. Ofilos succeeds George Ball. The board of directors also announced two new members: **George Ball** and **Ellen Lord**, the former undersecretary of defense for acquisition and

sustainment.

Brie Carere has been promoted to *FedEx* chief customer officer and to co-president and co-CEO of FedEx Services along

with Rob Carter, executive vice president and chief information officer.

Axiom Space has hired **Jared Stout** as vice president of government and external relations. Stout joins Axiom from Meeks, Butera & Israel, where he was director of congressional and regulatory policy. He previously was deputy executive secretary and chief of staff for the White House National Space Council.

Tamara Jack has been named chair of the *National Defense Industrial Association* finance committee and an executive committee member.



She is chief financial officer, corporate secretary and treasurer for LMI.

JetBlue has named **Jason Lenhart** vice president of technology, overseeing quality assurance, engineering, cloud and infrastructure. He had been Warner Bros. Discovery senior vice president of engineering and operations.

Momentus has hired **Krishnan J. Anand** as vice president of program management for the in-space infrastructure services developer. Anand had worked at Kitty Hawk/Wisk Aero and before that, Lockheed Martin.

Boeing has named **Brian Besanceney** as senior vice president and chief communications officer effective Sept. 6. He has held senior roles at Walmart and Disney.

Crown Consulting has tapped **Philip Soucacos** to serve as vice president for programs and engineering. He has more than 16 years of experience leading large programs for the FAA and other government

agencies.

Mehmet T. Nane

was elected chair of the *International Air Transport Association* (IATA) board of governors. Nane, who



is managing director of Pegasus Airlines, is the first Turkish chairman of IATA, which represents 292 airlines from 120 countries comprising 83% of global air traffic.

Aquila Air Capital, a commercial aerospace finance entity, has hired **Chance Fowler** as vice president of portfolio management. He had been

vice president of aircraft marketing for Vx Capital Partners.

Seyed Miri has been appointed *Spire Global* director of space services for Australia and New Zealand and Elizabeth Wylie as

head of business development for Australia and New Zealand. Miri formerly worked for Airbus Defense and Space-Intelli-

gence and Wylie in data science for the Australian government.

Ben Warner has been named director of applications engineering at data storage provider *Digistor*. Warner formerly worked with Applied Research Solutions at Wright-Patterson AFB, Ohio, on security systems for classified information as well as with cyberdefense contractor Booz Allen.

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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COMMERCIAL AVIATION

Comac announced that its six C919 test aircraft have completed flight-test tasks, paving the way for final type certification of the narrowbody jet by the Civil Aviation Administration of China. The company expects to deliver its first production aircraft this month to launch customer China Eastern Airlines.

Airbus and Boeing are trimming delivery forecasts for 2022. Citing supply chain concerns, Airbus cut its delivery projection by 3%, to 700 aircraft. And Boeing reduced its 737 MAX forecast from 500 to the "low 400s," citing delivery process instability and a lack of access to the Chinese market (page 29).

Southwest Airlines no longer expects deliveries of any Boeing 737 MAX 7s before 2023, the latest sign that the model's regulatory approval timing has not been nailed down amid changing aircraft certification protocols (page 24).

Spirit Airlines agreed to be acquired by JetBlue Airways in an all-cash deal valued at \$3.8 billion, after its shareholders rejected a competing offer from Frontier Airlines (page 25).

The FAA has published a draft rule man-



Passenger fatalities from U.S. airline crashes were on the rise in 1947. "but there is serious doubt whether the crashes of the past seven months warranted the publicity, criticism and investigations that have resulted," Aviation Week reported in our Aug. 11, 1947, issue. One hundred and fifty-two passengers and 12 crew members were killed in domestic crashes during the first half of 1947, compared with 56 passengers and 12 crew members lost in the first half of 1946. But the magazine noted that the number of crashes remained steady at four. The reason for the increase in fatalities was that three of the four aircraft that crashed in 1947 were Douglas DC-4s, which carried many more passengers than the DC-3s involved in the 1946 accidents. The article also pointed out (rather defensively) that 1,706 people were killed and more than 20.000 injured in railroad accidents in the first five months of 1947. "While airplane accidents captured the headlines, a comparison with the railroads' safety record this year is noteworthy," the article read. U.S. airline fatalities are exceedingly rare today: Just two passengers have been killed on domestic flights since 2009.

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dating the installation of secondary cockpit barriers on new Part 121 aircraft flown by U.S. carriers, a move intended to prevent intrusion when the flight deck door is open.

Republicans introduced bills in both chambers of the U.S. Congress to raise the mandatory retirement age for U.S. commercial pilots from 65 to 67 years old to help alleviate a worsening pilot shortfall. The measure received no support from Democrats.

Iran agreed to look into providing maintenance and repair service to Russian aircraft, a move that would help Moscow sidestep Western sanctions imposed after the invasion of Ukraine.



DEFENSE

An L3Harris/Air Tractor team has been selected to supply 75 weaponized versions of the AT-802 crop duster to U.S. Air Force Special Operations Command after winning the \$3 billion contract for the Armed Overwatch program.

U.S. President Joe Biden announced late Aug. 1 that he had ordered an MQ-9 strike in the heart of Kabul that killed al-Qaida's senior leader, Ayman al-Zawahiri. It was the culmination of almost a year of "over-the-horizon" U.S. counterterror operations.

The U.S. State Department has approved two air defense sales-one to Saudi Arabia and one to the United Arab Emirates—worth up to \$5.3 billion.

Poland signed agreements with South Korea to pave the way for the purchase of dozens of aircraft and hundreds of main battle tanks and self-propelled artillery pieces—a deal that could be worth 19.4 trillion won (\$14.8 billion) (page 18).

The U.S. Army has contracted with Wichita State University's National Institute for Aviation Research to develop a digital twin for its Boeing AH-64 Apache attack helicopter.

India's Cochin Shipyard has handed over the country's first indigenously built aircraft carrier, Vikrant, to the

ž



Source: Aviation Week Military Fleet Discovery

The Boeing F-15 Eagle made its first flight 50 years ago on July 27. Despite five decades of service, the type remains one of the most capable fighter aircraft in operation, with enhanced versions continuing to roll off the production line. As of mid-2022, 1,075 aircraft are in service globally with seven operators. Fifteen different versions of the aircraft are flying, with another two due to join the fleet in the coming years. Given that new-build aircraft continue to enter service, the type likely will remain in operation into the 2050s, a remarkable feat for a tactical aircraft.

Indian Navy, which also accepted delivery of the first two Sikorsky MH-60R helicopters from a 24-aircraft contract.

The first of two former UK Royal Air Force Boeing E-3D Sentry airborne early warning aircraft has arrived in Chile for delivery to its air force.

Aero Vodochody has secured type certification for its L-39NG jet trainer, paving the way for deliveries of production-standard aircraft.

BUSINESS AVIATION

Certification of the Gulfstream G700 has been pushed back to 2023, when the company implements an FAA-mandated software modification to G500/G600 fly-by-wire flight controls.

SPACE

NASA unveiled a new Mars Sample Return Mission architecture: reassigning Perseverance to carry sample tubes for a return to Earth, canceling a European Space Agency-provided fetch rover and adding two Ingenuity-class helicopters to retrieve the samples (page 13).

The first of two Blue Origin BE-4 engines earmarked for the debut flight of United

Launch Alliance's Vulcan rocket arrived at the manufacturer's West Texas facility on July 31 for acceptance testing.

OBITUARIES

Tom Poberezny, former Experimental Aircraft Association (EAA) president and chairman and an accomplished aerobatic pilot, died on July 25. He was

VIEW FROM WASHINGTON

787 Deliveries Set To Resume

The U.S. FAA has signed off on Boeing's plan to correct 787 production problems and restart deliveries, a major step toward getting the widebodies flowing to customers again. The company's plan, months in the works, addresses inspection and repair procedures related to myriad issues uncovered by Boeing on 120 787s awaiting delivery. The plan will drive airframe-specific compliance measures that the company will use to show that each aircraft conforms with Boeing's specifications. Once an airframe rework plan is completed, the FAA will validate Boeing's work via predelivery inspections and issue an airworthiness certificate. The FAA signoff puts Boeing on track to resume 787 deliveries in August. Boeing has delivered just 14 of the widebodies in the last two years and none since June 2021.

QUOTED

"THE ONLY THING THAT'S GOING TO SOLVE LABOR AVAILABILITY-I HATE TO SAY THIS-IS A SLOWDOWN IN THE ECONOMY, BECAUSE RIGHT NOW

THERE JUST SIMPLY AREN'T ENOUGH PEOPLE

IN THE WORKFORCE FOR ALL OF OUR SUPPLIERS."



-GREG HAYES, Raytheon Chairman and CEO, speaking on a July 26 earnings call.

75. His father, Paul, founded the EAA.

George Alexander, a space and science reporter who led Aviation Week's coverage of the 1967 Apollo 1 cabin fire that claimed the lives of three NASA astronauts at Cape Canaveral and went on to work for *Newsweek* and *The Los Angeles Times*, died July 24. He was 88. ©

UP FRONT SASH TUSA



VETERAN ATTENDEES OF THE

two big European air shows in the last decade have become used to a plethora of

orders for civil aircraft but rather fewer announcements relating to new orders for military aircraft or changes to the status of existing programs, which more often fol-

low individual countries' defense budget and political cycles. But this year's Farnborough International Airshow was different.

There has not been

a Farnborough with such strong and consistent UK defense news flow since the early 1990s. The key announcement this year was a £2.35 billion (\$2.8 billion) order to upgrade Royal Air Force Eurofighter Typhoons with new computers and active, electronically scanned array (AESA) radars. The order, matching a parallel but slightly different Eurofighter radar upgrade in Ger-

many and Spain, aims to keep the Eurofighter fleet highly capable through the 2030s. It should stimulate further upgrades for export customers in the Middle East as well.

But more strategically important is the intent thereafter to insert the AESA radars spirally into the UK's proposed Tempest future combat aircraft. This development program received the next boost, with further details about the demonstrator aircraft-to fly in 2027, likely to appear at Farnborough in 2028—as well as electronics partner Leon-

The F-35 and Tempest are **gaining momentum**

FCAS, whose military The True 'Euro Fighter' characteristics look close to those of Tempest (and likely also the U.S. Next-

This counterbriefing cannot hide the fact that the

forward to the next stage of development (Phase 1B) with-

out a guarantee of industrial leadership and no transfer

of the company's proprietary flight controls technology.

He set a year-end deadline that was echoed by Airbus

Defense & Space CEO Michael Schoellhorn.

program), is slipping backward as the Tempest advances. Trappier even admitted that the SCAF/FCAS may have lost as much as a decade to its cross-channel rival.

Should politicians, the military and other stakeholders brace themselves for a breakup of the FCAS team? Dassault's recent Rafale fighter export success arguably gives France a far greater degree of confidence to

European Orders Orders From Rest of World 545 494 249 216 162 Eurofighter Dassault Saab Lockheed Martin Rafale Typhoon Gripen F-35* *Europe only Source: Agency Partners go it alone than it would have had even four years ago, when the multinational collaboration was announced. And the United Arab Emirates' recent order for 80 Rafales opens up the possibility that the emirate might be persuaded to act as a financial investor in and future customer of a Franco-German program.

Generation Air Dominance

The relative loser in terms of orders announced at Farnborough was probably Sweden. That country, and Saab, its national contractor, remain partners in the broader UK future combat air studies but

ardo's ambitious Excalibur sensors flying testbed. And tied to all this was the announcement of negotiations with Japan about collaborating on the Tempest or even merging Japan's F-X with the Tempest.

The UK-led Tempest program is intended to develop a sixth-generation system oriented toward air supremacy. The UK and Japanese military specifications for long-range often overwater missile engagements look strikingly close, and combining the two countries' needs, along with those of Tempest partner Italy, could add up to a requirement for more than 300 aircraft. This is probably close to critical mass industrially, and sharing the development costs would be more comfortable for the three financially strong partners.

What a contrast with the rival Franco-German-Spanish FCAS/SCAF fighter program. The week of Farnborough was marked by ever-more-heated public bickering between the heads of Dassault Aviation and Airbus Defense & Space, the industrial representatives of France and Germany, respectively. Dassault CEO Eric Trappier refuses to sign an industrial agreement to take the FCAS

are not a formal Tempest partner. Having moved to join NATO, and with a fundamental defense review to be announced on Nov. 1, Sweden seems more likely to focus on a major expansion of its new Gripen E fighter fleet and defer a future fighter decision until the end of the decade.

The other blow to Sweden, though, was the request by the Czech Republic, a key Central European Gripen operator, to buy the Lockheed Martin F-35. With only six Gripen customers in total, Saab and Sweden can ill afford to lose one and hence the opportunity to upsell the newer E model.

The Tempest and FCAS are intended to be programs that bring Europe together politically and industrially and develop key new European defense technologies. But 11 European countries now either already operate or have ordered the F-35, making it the most widely ordered single fighter aircraft type in Europe by far and, arguably, the true "Euro fighter." 🐼

Aerospace and defense analyst Sash Tusa is a partner at Agency Partners. He is based in London.

How the F-35 Stacks Up in Europe





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COMMENTARY

GOING CONCERNS



THE LAST TWO DECADES HAVE

seen a prolonged period of strong economic growth and a sustained demand super-cycle within the aerospace and de-

fense sector. "Bigger is better" was the growth philosophy for the last two decades. The industry saw unprecedented growth in publicly traded Tier 1 and 2 companies through acquisition and expansion of global business units, with many deals bringing access to adjacent markets.

Since 2019, geopolitics, COVID-19 and the Boeing 737 MAX production stop have created new dynamics that are forcing companies to shift from a "bigger is better" approach to being "strategically focused." Companies

will need to zero in on their core product with refined strategies to prepare for the next supercycle. Realignment is beginning already within Tier 1 and 2 companies.

Private equity groups have long participated in the smaller segments of the supply chain, primarily Tiers 3 and 4. Industry veterans may be reticent to deal with private equity groups due to their record of having acquired, debt-loaded and then run historically good businesses into bankruptcy.

More recently, private equity investors have increased their equity investment in the companies they acquire, boosting their "skin in the game" regarding the success of the

acquired company. Private equity firms have swapped portfolio management from financial managers to industry operators as they have learned to operate effectively in this difficult industry.

Indeed, today's private equity sponsors move more quickly and make business improvements that traditional publicly traded Tier 1 and 2 companies and privately held Tier 3 and 4 companies do not. Embedded bureaucratic business models keep larger companies from changing rapidly, and smaller companies do not have the monetary resources to invest. This is where private equity could step in to refashion the aerospace and defense industry.

Private equity groups have developed three distinct models in their approach to the aerospace and defense sector. The terms I use for these models are: value rebuilding, value creation and value acceleration. While private equity groups have different investment goals and management expertise, the three value models could serve the industry in multiple ways. Here is how private equity groups might use these models to recharge aerospace and defense for the next super-cycle.

Value rebuilding is directed at a distressed company

by private equity investors who specialize in turnarounds. This usually involves investment horizons of less than three years as private equity takes over a company and massively restructures and rebaselines it. Within this model, private equity likely would invest mostly equity, as the businesses are usually in heavy debt already and cannot handle more leverage.

Once stabilized, the sponsor would sell the business to an owner that will further improve it. By virtue of their investment thesis, private equity investors know how to manage through economic downturns and the end of a down cycle. This entails consolidating underperforming business units or spinning off noncore assets

Tailwind for the Next Super-Cycle

How private equity could refashion aerospace and defense



to enable the remaining business to reach more potential.

Value creation is directed at undermanaged or underperforming businesses-usually family-owned small companies. While not distressed, these companies need improvement, from business processes to execution. Private equity groups might change executives, improve systems, develop processes and establish strategic planning. The investment horizon is usually 4-5 years, with a mix of equity and debt. While changes can be stark, they are intended to be proactive in nature and accelerate capital expenditure investment to improve efficiency and productivity.

FIREFLY AEROSPACE

Finally, value acceleration is directed at a company that is operating efficiently and doing well financially but needs additional investment in research, new programs and even capital to expand to new segments and product lines. This is the newest form of private equity investment, typically with a horizon of about five years or more. A company in this category needs "patient capital" to allow for growth plans to mature over timelines longer than the traditional 3-5 years. This can include multiple, focused acquisitions and a strong customer focus on product development and content expansion.

Investors providing patient capital would allow the company's growth plans to fully mature. In turn, the private equity sponsor would benefit most once the company is able to outcompete in the next super-cycle.

After decades of practice, private equity groups have broadened and refined their models in aerospace and defense. The next upcycle will be glad they did. ©

Alex Krutz is managing director at Patriot Industrial Partners, an aerospace and defense advisory firm that focuses on manufacturing strategy and supply chain optimization.

COMMENTARY



THE LAUNCHPAD

NASA HAD HOPED TO ONE DAY

parlay the technologies developed to demonstrate powered flight on Mars into operational missions. But engineers on

the ongoing Ingenuity helicopter program did not expect to do so in the next 18 months.

With the Mars Perseverance rover operating well and its companion Ingenuity rotorcraft awaiting its 30th flight, NASA and the European Space Agency (ESA) want to modify the fleet of vehicles planned for

their joint campaign to return rock and soil samples from Mars.

So far, Perseverance, which landed on Mars in February 2021, has filled and sealed 11 of 43 sample tubes for return to Earth. The rover is exploring an area known as Jezero Crater, which features a well-preserved ancient river delta that may contain evidence of past life on Mars.

NASA and ESA had planned to fly a fetch rover to Mars to pick up Perseverance's cache and transport the tubes to a lander

outfitted with a robot arm, a canister to hold the samples and an ascent vehicle to launch them into Mars orbit. From there, an awaiting orbiter would capture the basketball-size canister and fly it back to Earth.

The new Mars Sample Return (MSR) architecture, unveiled on July 27, reassigns Perseverance as the primary vehicle to transport the tubes of samples to the lander, cancels the ESA-provided fetch rover and adds a pair of Ingenuity-class helicopters to retrieve the tubes in case a technical issue sidelines Perseverance.

The simpler plan saves the cost of building and launching the fetch rover, which would have required a dedicated launch and lander. NASA and ESA are still developing revised cost estimates for the MSR campaign.

"The success of Ingenuity got people thinking," MSR Program Director Jeff Gramling tells Aviation Week. "We had been working the architecture with the sample fetch rover for quite a while, exploring the solution space and thinking of other ways to do things. At some point we started thinking, 'Could we do this [with Ingenuity-class helicopters] and would it possibly be a way to get back to a single-lander architecture?'

"We've demonstrated the technology on the surface of Mars already, so in a sense we're a leg up," Gramling adds. "We're all pretty excited about the ability to take the technology that we've developed and use it operationally for this mission."

Engineers at NASA's Jet Propulsion Laboratory (JPL)

are studying how best to evolve the solar-powered, 4-lb. Ingenuity helicopter into an air transport system. The Sample Return Helicopters (SRH) will include wheels on the landing legs so the vehicles can roll to where a sample tube has been deposited on the ground. They also will be outfitted with a small, arm-like manipulator to pick up a tube and an anchoring system to secure it for flight.

The tubes, which are about the size and shape of a standard laboratory test tube, weigh less than 150 grams (0.33 lb.) when filled.

The SRH also will need

cameras to support sur-

face mobility operations.

Ingenuity has a downward-

facing black-and-white nav-

igation camera and a color

gins where [engineers on]

all of the different sub-

systems are going to ask,

'What are we going to keep versus what do we

change?" says Theodore

Tzanetos, who leads the

what are called 'inheri-

tance reviews' to zero in

"We are going to have

Ingenuity team at JPL.

horizon-facing camera. "Now the fun work be-

Airlift on Mars

Helicopters to join sample-return campaign



NASA/ESA/JPL-CALTECH

on that question, which we do not take lightly," he says. "We highly value heritage, so if you have an example of something that works—a design, a component—you better have a very good reason for making a change to it."

To accommodate the extra gear, Tzanetos expects the helicopter to be slightly larger, up to about 5.5 lb., and include a slightly bigger solar panel to boost available power.

"Just because Ingenuity worked doesn't mean this is going to be easy," Tzanetos adds. "We still need to be extremely lightweight. Every fraction of a gram will still matter."

Ingenuity hovered on Mars for the first time on April 19, 2021, marking the first instance of powered, controlled flight on another planet. Since then, Ingenuity has chalked up 29 flights—24 more than expected. A 30th sortie could happen in August, depending on Martian weather and dust conditions.

The new MSR architecture retains a 2027 launch date for the ESA-provided return orbiter, which includes a NASA system to capture, contain and return the samples. That would be followed in 2028 by the launch of the SRL, onto which the two small helicopters would be attached.

ESA member countries are scheduled to review the plan, which includes ending development of the Sample Fetch Rover. NASA's MRS preliminary design phase is slated to begin in October.



Brian Everstine Albuquerque, New Mexico

he idea of collecting solar power in space and beaming it down to Earth at a large scale is not new—science fiction author Isaac Asimov is credited with popularizing it in "Reason," a 1941 short story, and several nations have been testing relevant technologies and outlining plans in recent decades. The U.S. Air Force Research Laboratory, working with Northrop Grumman, now believes the technology is ready and will launch a capstone demonstration in 2025 aiming to collect and send up to 10,000 kW of energy from orbit to the surface.

While the demonstration, which is in its early stages with relevant systems set to be flown on the International Space Station (ISS), is focused on the idea of beaming power to a military base on Earth, Air Force Research Laboratory (AFRL) officials say the project could have more relevance developing key enabling technology for a more pressing U.S. military mission: moving target-indication radars off of aircraft and into orbit. This goal is now an imperative from Air Force Secretary Frank Kendall, with a budget plan expected to be rolled out next year. Col. Eric Felt, head of the AFRL's

Space Vehicles Directorate, says with his lab demonstrating the enabling technologies, the migration is possible in the near future.

"GMTI [ground-moving-target indication] is easier [to do] from space than AMTI [air-moving-target indication] because of the physics of the situation," he says. "We're working on both. We will try to develop the right technical solutions, I think in the early part of the [next] 5-15 years. To get it at scale, where you have it everywhere, where you can see everything of interest everywhere all the time in real time, that will take a little bit longer. But the basic technologies, the building blocks, will be there."

The AFRL's Space Solar Power Incremental Demonstrations and Research (Sspidr) Project is a key part of these building blocks. The plan is to demonstrate a 600-m^2 (6,500 -ft.²) solar array that will collect power from the Sun and beam it down to a forward operating base, providing energy for troops without the need for potentially dangerous convoys delivering fuel.

The effort started in earnest in 2018, when the AFRL awarded Northrop Grumman more than \$100 million to develop the payload to demonstrate the space solar power system. The company developed a "sandwich tile"—a two-sided, flexible panel that collects energy through photovoltaic cells, converts it to radio frequency (RF) and then beams it out to an antenna.

The tile was demonstrated late last year, successfully converting solar power to RF in a laboratory environment, and the AFRL is planning a three-phase demonstration of its total system. First up is a program it is calling the Spirral (Space-Powered Infrared Regulation and Analysis of Lifetime) experiment. The structure of the solar panels will need to be extremely

> AFRL SOLAR POWER PROJECT COULD GUIDE MOVING-TARGET-INDICATOR PLANS

> FIRST ON-ORBIT TESTS TO START ON ISS NEXT YEAR

FULL DEMONSTRATION TO LAUNCH IN 2025

An Air Force Research Laboratory graphic depicts its Space Solar Power Incremental Demonstrations and Research Project, which aims to develop technologies needed for large-scale collection of solar power to beam back to Earth.

AIR FORCE RESEARCH LABORATORY

large to collect enough energy, so it will experience major temperature changes while deployed. Going from sunlight to eclipses could damage electronics, so the AFRL is testing "variable emissivity materials" that can change surface properties depending on temperatures, says Rachel Delaney, the Sspidr project's communications lead.

These materials will launch to the ISS next year, fly for a year and then return for testing to study how they degraded. Next up will be another experiment the AFRL calls Spindle (for Space-Power Incremental Deployable Experiment). The AFRL has long studied flexible, deployable structures that could fit on launch vehicles and then unfurl in orbit, such as the Roll-Out Solar Array that was tested on the ISS. In 2020, the AFRL cut the ribbon on a new 7,000-ft.² facility at Kirtland AFB, New Mexico, called the Deployable Structures Laboratory specifically for such development work.

Sspidr will need large deployable structures to unfurl enough "sandwich tiles" to collect sufficient energy, so the AFRL is planning a demonstration in mid-2024 of a subscale version of the array.

Last, the AFRL is planning

"Arachne"—not an acronym, just a reference to Greek mythology—its full end-to-end demonstration of launching the system, deploying its solar panels, converting to RF and beaming power to an antenna on the ground. Its launch is planned for 2025.

The AFRL's plan comes as China is developing its own system with the goal of delivering megawatts of electricity from space solar power plants by the mid-2030s. Sspidr is the latest major U.S. effort, after NASA abandoned its own effort, the Solar Power Satellite via Arbitrarily Large Phased Array. Japan is planning to demonstrate space solar power collection in 2025, with other nations, including the UK, announcing research on the topic.

Developments in deployable structures, the increased efficiency of modern electronics, advances in solar cell technologies, low-cost manufacturing and the increased availability of launches all mean the idea is now feasible to be demonstrated, Delaney says. "We're looking at it as kind of like a mini space race almost," she says.

The operational use of these technologies is needed in other arenas as well, specifically to address physics problems that have blocked the movement of operationally relevant target indication from orbit. Felt says the AFRL has been studying this issue for a decade or so, but now Air Force leaders are seeing that it is realistic enough to be included in Kendall's series of "operational imperatives."

"A lot of that is because of the work that's been going on here for a long time, where we were working on those concepts for a decade before we were asked, 'Hey, is it feasible to go for this?" Felt says. "We do think it'll work, so I think [Kendall's] confidence reflects the research that's been done in that area already. And I think his confidence is well justified—but even when you can see that there's no technical barriers, that doesn't mean it's easy."

The Pentagon has looked at this idea before, with canceled projects such as Discoverer II and the Space Radar exploring the possibility. A radar operating farther away than an aircraft needs a larger antenna, more power and a higher pulse rate.

Felt says the Sspidr structure, and the new laboratory at Kirtland, can address the issue of a large, deployable antenna. The large solar cell array can address the power issue, and developments such as the materials being demonstrated in the Spirral phase can address cooling issues. The AFRL's job is to initially develop these technologies, which can then be integrated into a new system to address the operational need.

"That's where the lab can come in. We'll have an incremental approach," Felt says. "What's the No. 1 thing you think won't work? Well, let's go solve that problem. What's the next thing? That's called fail fast, so you pick the hardest thing and you try to prove that won't work. And if you prove that it does work, then OK, you took care of that problem."

There needs to be more dialog between planners, those who have been fixated on aircraft and organizations such as the AFRL's Space Vehicles Directorate, to clearly lay out what could be done in orbit, Felt says. "The air domain guys who have traditionally had this role, they aren't necessarily super familiar with what the space capabilities are, so that's, again, an opportunity for discussion," he says.

The Air Force will lay out its plans for moving target indication "at scale" starting in its fiscal 2024 budget request, to be laid out next spring.

"As soon as we can do GMTI and AMTI from space, the secretary has said we're doing it," Felt says. "That is obviously the solution because you get it globally, at scale, anywhere you want, and you're not flying a big plane around that somebody can shoot down. That is definitely what we want. But, like I said, that is not easy."

Kendall tells Aviation Week that he sees the future MTI mission as a combination of things, including Space Force assets, aircraft and collaboration with other organizations such as the National Reconnaissance Office (NRO). The Air Force and NRO are working closely, since the office has "very, very relevant things that we can take advantage of," Kendall says. The service and the NRO even have an "informal" agreement on cofunding future satellites that can both serve intelligence roles and operational missions, he says. Last, commercial companies also have relevant surveillance and radar systems that the service can buy to help the mission.

"It's not going to be single solutions for the AMTI/GMTI mission," Kendall says. "It's going to be mixes of things that work in concert, but I think we've got a pretty clear picture of how to move forward on that now." ©

Secretive U.S. Space Acquisition Office Ready for First Deliveries

> SpRCO HAS CONGRESSIONAL MANDATE TO CUT RED TAPE

DESPITE OVERLAP, THE SPACE FORCE HAS NO PLANS FOR FURTHER REORGANIZATION

Brian Everstine Albuquerque, New Mexico

he Pentagon has traditionally followed a slow slog to delivery of new space systems, bogged down by requirements reviews, acquisition timelines and red tape. Frustration with this process led Congress in 2018 to create a new Space Rapid Capabilities Office with the order to deliver new projects within five years. And now the office is ready for its first deliveries. double the previous year's enactment.

Kelly Hammett, the office's director, said during a June visit to the headquarters that the office's independence from several regulatory processes, while still beholden to acquisition roles, means it can deliver contracts on average eight months faster than other Pentagon offices. While the predecessor office was fo-

The predecessor to the Space Rapid Capabilities Office focused on technology demonstrations, such as the Tactically Responsive Space-2 mission (pictured), to speed the military's ability to launch payloads to orbit.

The Space Rapid Capabilities Office (SpRCO), a small office headquartered at Kirtland AFB in Albuquerque, New Mexico, that reports directly to the chief of space operations, now has 14 classified projects in its purview that it is legally required to bring to operation in 1-5 years. Created from its precursor, the Operationally Responsive Space Office, the SpRCO is structured like the Air Force's Rapid Capabilities Office (RCO), which oversees projects like the Northrop Grumman B-21 bomber, Boeing's X-37B spaceplane and the Advanced Battle Management System.

The office's charter is the development of low-cost, rapid-reaction payloads, spacecraft buses and launch and launch-control capabilities for on-demand support and reconstitution. The Space Force is planning a large increase in the office's spending for advanced component development and prototypes in fiscal 2023, with a funding request of \$2.9 billion, almost cused on responsive space launch, the SpRCO lets other organizations like Space Systems Command focus on launch while the SpRCO can focus on payloads and other capabilities. The office has a contract authority of \$1 billion, meaning Hammett does not need outside approval for an award until it crosses that threshold.

To speed up its processes, the SpRCO is independent of the Pentagon's Joint Capabilities Integration and Development System—the Joint Staff procedure for reviewing requirements long criticized for bogging down acquisitions. Instead, a board of directors including Air Force and Space Force operational and acquisition leaders reviews proposals and assigns projects; the first such order came from this board in 2020. Requirements are validated by U.S. Space Command. An integration council of Space Systems Command, the Space Development Agency (SDA), Missile Defense Agency, National Reconnaissance Office, Air Force RCO and the SpRCO meets monthly to oversee broad space acquisitions and how the new systems are placed into operation.

Within the past two years, SpRCO has awarded 40 contracts including nine to small businesses. The office made a rare public announcement of a project in May when it awarded a \$1.4 billion contract to BlueHalo for the Satellite Communications Augmentation Resource (SCAR) program. SCAR is a quickly designed program needed for U.S. Space Command to rapidly augment satellite control capacity for its Satellite Control Network, which controls Space Force satellites. The program will use transportable, electronically steerable phased array antennas that can increase communications capacity tenfold for satellites in geosynchronous orbit, the SpRCO said in an announcement.

In previous years, Air Force budget documents outlined other projects that the SpRCO is involved in including: supporting Electro-Optical/Infrared Weather Systems incorporating cloud-characterization and theater-imagery satellite ORS-8, a space-based solar power project and priorities that include missile warning, wideband-protected communication, narrowband communication, data exfiltration, space situational awareness, positioning navigation and timing and battlefield intelligence, surveillance and reconnaissance.

The SpRCO's first deliveries come as the Space Force continues to overhaul its broader acquisition structure, with the SpRCO looking at quick prototypes, Space Systems Command overseeing broader acquisition and launch and the service bringing in the SDA later this year. Frank Calvelli, the new assistant secretary of the Air Force for space acquisition and integration, said despite these overlapping groups, he does not see the need for anymore changes or streamlining efforts.

"I'm actually not looking at it, I'm not a big fan of reorganizing for the sake of reorganizing," Calvelli told reporters in June. "I'm quite happy with what I inherited. Space Systems Command, the Space RCO, SDA, they all have unique attributes, unique strengths and unique authorities that are kind of neat to have to be able to take advantage of."

U.S. Navy Plans Avionics Makeover for Long-Lived E-2D

> 2028 UPGRADE PACKAGE INCLUDES THEATER-WIDE SENSING ABILITY

AUGMENTED CONTROLS ARE BEING CONSIDERED TO SIMPLIFY E-2D CARRIER LANDINGS

Steve Trimble St. Augustine, Florida

he Northrop Grumman E-2 Hawkeye's earliest contemporaries, which include A-4 Skyhawks and Vought F-8 Crusaders, have been retired to museums, as have their replacements. Its production line here is due to shut down in 2028 if no new orders are signed. And it is the last fixed-wing model to operate aboard an aircraft carrier without the assistance of fly-by-wire-enabled, precision landing modes.

Yet 15 years after the first flight of the E-2D Advanced Hawkeye, the modern descendant of the first 1964-vintage E-2A has arguably never been more relevant in naval combat. The airborne early warning and control platform coordinates the carrier battle group's offense and defense, with the power to launch SM-6 and AIM-120 Amraam missiles at targets over the horizon and beyond the sensing capability of their host platforms.

As Northrop comes within a few years of completing the program of record for the latest Hawkeye variant, the Navy is planning the most significant technology refresh for the E-2 platform since the Advanced Hawkeye introduced the rotating Lockheed Martin APY-9 radar to the fleet in 2007.

The UHF-band APY-9 is not being replaced as the E-2D's primary sensor. Although Congress has added funding for two decades to support a UHF Electronically Scanned Array radar, the Navy has no plans to install such a sensor. "We are not looking at that right now for the E-2D program office yet," says Cmdr. Guillermo Carrillo, fielding deputy program manager for the E-2D at Naval Air Systems Command.

Instead, by 2028, the Navy wants to dramatically expand the radar coverage of the E-2D dramatically by networking and fusing the sensor data generated by multiple aircraft, with the output forming a common operational picture of all flying objects across a theater of operations. By 2028 the Navy also wants a new onboard mission computer powerful enough to share that information instantly with the carrier strike group and nimble enough to accept new software applications immediately from companies with no connection to Northrop.

Finally, the Navy wants to use digital



The U.S. Navy wants to create a theater-wide operating picture by networking and fusing the products of multiple E-2D radars.

tools to partially automate the E-2D's mechanical flight controls, helping crewmembers that now—thanks to a recently introduced aerial refueling upgrade—must sometimes land on a carrier at night in bad weather after an 8-hr. mission.

The total package, which is internally named the Delta System Software Configuration (DSSC)-6, represents the most intrusive changes to the E-2D's avionics since the Advanced Hawkeye debuted on Aug. 3, 2007.

So far, only the networking and sensor fusion upgrades to create the Theater Combat Identification capability is funded in DSSC-6. Naval Air Systems Command is still working out the details of how to partially automate a flight control system originally designed in the mid-1950s. The Navy's other fixed-wing aircraft types, such as the Lockheed F-35C Lightning II and Boeing F/A-18E/F Super Hornet, now have the Precision Landing Mode (PLM), which automates glidepath control while the pilot manages speed and descent rate. The technology has pushed the Navy to consider a land-based training jet replacement, leaving future student pilots no opportunity to land on a carrier before moving to operational units. The PLM simplifies carrier landings for the Navy's fighter pilots, but nothing similar exists for the E-2D.

The Navy is continuing to consider design options for an "instrument-landing-mode" upgrade for the Advanced Hawkeye, however. "We're going through that now with some of

> the initial contracts and studies to see what we can do," Carrillo says.

The E-2D program of record for 78 aircraft is now almost complete. The long-term spending plan submitted by the Navy with the fiscal 2023 budget shows no new aircraft orders beyond next year, but the decision may not be final.

In 2019, the Navy approved an unfunded requirement to buy up to 86 E-2Ds, and the service is considering adding funding in the fiscal 2024 budget. Beyond the Navy's order,

six of Japan's overall order for 13 E-2Ds have yet to be delivered, and all three of France's E-2Ds should roll off the production line in 2028.

The international sales pipeline is uncertain. Taiwan and Egypt now operate E-2Cs, but it is not clear if either nation will receive approval to buy E-2D replacements.

The Russian invasion of Ukraine has generated a wave of new defense modernization spending in Europe, however. The E-2D was discussed as Northrop officials met with European military leaders in July at the Royal International Air Tattoo at RAF Fairford in England.

"We're looking at what that opportunity space could be," says Janice Zilch, Northrop's vice president of Multidomain Command and Control. ©

South Korea's FA-50 To Succeed Poland's Soviet-Era Combat Aircraft

NATO MEMBER IS BUYING 48 FA-50s TO REPLACE MiG-29s AND Su-22s

> ORDER IS A BREAKTHROUGH FOR KAI EXPORTS TO EUROPE

Tony Osborne London

Poland has turned to South Korea to help it quickly modernize its armed forces in the face of Russia's invasion of neighboring Ukraine.

Agreements between Warsaw and Seoul signed July 27 pave the way for the purchase of dozens of aircraft and hundreds of main battle tanks and self-propelled artillery pieces—a jackpot for South Korea's burgeoning defense industry that could be worth 19.4 trillion won (\$14.8 billion).

The deal potentially positions South Korea as Poland's second most important defense procurement partner, behind the U.S. and ahead of the rest of Europe. A contract for 48 FA-50 light attack aircraft—a derivative of the Korea Aerospace Industries (KAI) T-50 Golden Eagle jet trainer—crucially secures KAI's first-ever European order and the manufacturer's largest export deal so far, worth around \$3 billion.

KAI's breakthrough in Europe, with an increasingly important NATO member state, could position the company for further opportunities in the region. The company had previously managed to sell KT-1 Woongbi turboprop training aircraft to Turkey.

The OEM is already actively marketing the T-50 to Slovakia. There are also numerous countries in Europe with aging training fleets, which KAI sees as a potential shoo-in for the General Electric F404-powered platform.

But first, the company must deliver. Poland's urgent needs mean KAI must hand over the first 12 FA-50s by mid-2023, possibly with aircraft diverted from South Korean orders. The remaining 36 will be in a bespoke configuration called the FA-50PL, a variant based on the Block 20 version of the aircraft equipped with an active, electronically scanned array radar and integrated with air-to-air and air-to-ground weapons, KAI CEO Ahn Hyun-Ho said at the July 27 contract-signing ceremony in Warsaw.

Along with delivering the aircraft, KAI will cooperate with Polish industry on the creation of a service center to support FA-50s, both in-country and for future European customers.

"It is the beginning of joint cooperation, not simply sales," Hyun-Ho said, adding that any FA-50 buyers could be "potential customers of the future KF-21 [Boramae indigenous fighter]."

"For KAI, the European market is useful but not crucial," says industry analyst Richard Aboulafia, managing director of AeroDynamic Advisory. "They have been doing well enough with an Asian/Middle East/emerging market strategy, but Poland really matters more from the standpoint of

Milestones Set for Turkish Indigenous Fighter Progress

> TF-X PROTOTYPE IS SLATED TO ROLL OUT IN 2023 AND FLY IN 2025

> HURJET JET TRAINER HAS SECURED 12 ORDERS

Tony Osborne Farnborough

n just over 220 days, Turkish Aerospace Industries plans to roll out the first prototype of the country's indigenous fighter aircraft, the TF-X.

The company's engineers are hurriedly working on completing the prototype, aiming to enable an enginesrunning rollout of the fifth-generation, low-observable, supercruise-capable, twin-engine combat aircraft on March 18, 2023—the 108th anniversary of Turkey's victory at the battle of Gallipoli during the First World War.

It should be a significant day for the aerospace manufacturer.

On the same day, Turkish Aerospace Industries (TAI) CEO Temel Kotil wants to have the company's newly developed advanced jet trainer, the Hurjet, also make its first flight. "We like a challenge ... and our young engineers are hungry for success," he told journalists at the Farnborough International Airshow. The TF-X's first flight is planned to follow exactly two years later, on March 18, 2025.

But perhaps the biggest challenge is yet to come, as the Turkish government wants the fighter to be exportable—a jewel in the crown of the country's efforts to become a major defense equipment exporter.

The TF-X prototypes will use the General Electric (GE) F110 engine from the F-16, with several engines already delivered to support the program.

But to be fully exportable, Turkey must have an indigenous engine. Kotil said the aircraft will need one by 2028 when it begins to enter service, though a domestic one is not yet available.

Six years is not much time to develop a new fighter engine—let alone deliver one ready for the front line—yet the Turkish government last month issued a request for proposals to industry to do just that.

Bidders include TRMotor, the TAIowned engine subsidiary tasked with developing the fighter's auxiliary power unit and air turbine start system last year. Other bidders include TUSAS Engine Industries, jointly owned by TAI and GE, which has recently begun developing an indigenous 6,000-lb.-thrust-class turbofan that could power a domestically developed uncrewed aircraft system.

A joint proposal by Kale Group and Rolls-Royce was also expected, Ismail Demir, president of the country's Defense Industry Agency, SSB, told journalists in early July. The companies have not confirmed to Aviation Week whether they have submitted a bid. The two companies worked together on a similar initiative with the TF-X engine in 2017.

Kotil acknowledged that developing an engine in Turkey for the fighter in volume and critical mass rather than as a NATO country endorsement."

The FA-50s will replace Poland's aging fleet of Warsaw Pact-era Sukhoi Su-22 "Fitters" and Russian Aircraft Corp. MiG-29 "Fulcrums" and will equip three air force squadrons. The two Soviet-era combat aircraft are considered obsolete and are increasingly difficult to support and maintain, say Polish defense officials.

The first batches of FA-50s are also expected to support flight training, potentially taking on part of the mission for which Poland purchased the Leonardo M-346, a type officials say has been experiencing availability issues.

Lt. Col. Krzysztof Platek, a Polish defense materiel agency spokesman, told Polish defense journal *Defence24* that the FA-50 had been selected because of its rapid availability. He added that its capabilities, particularly once the more advanced FA-50PLs are introduced, would exceed the capabilities of the MiG-29 and Su-22 and would be "fully complementary" to Poland's Lockheed Martin F-16s and its future F-35 Joint Strike Fighter **Poland's Frontline Combat Aircraft Inventory**

Aircraft Type	In Service	On Order
LOCKHEED MARTIN F-16C/D BLOCK 52+	48	_
RAC (MIKOYAN) MiG-29A/G/GT/UB	24	—
SUKHOI Su-22M4/UM3K	18	-
LOCKHEED MARTIN F-35A JOINT STRIKE FIGHTER	0	32
KOREA AEROSPACE INDUSTRIES FA-50/FA-50PL	0	48

Source: Aviation Week Fleet Discovery

fleet. The FA-50PL could even be armed with the Raytheon AIM-120 advanced medium-range, air-to-air missiles eventually, Platek suggested.

Another likely motivation for purchasing the FA-50 was its acquisition price and operating costs, Aboulafia suggests. "One preliminary lesson of Russia's Ukraine war is that numbers matter," he says.

The agreements with South Korea add to a growing list of major procurements signed by Warsaw, with billions of dollars flowing out the door to pay for uncrewed aircraft systems, surface-to-air missile systems, a bespoke tank destroyer system and a fleet of battlefield helicopters. The Polish government has also approved increases in defense spending to 2.4% of GDP this year, with plans to raise this to 3% of GDP starting in 2023.

Defense Minister Mariusz Blaszczak says the deal with South Korea would "significantly strengthen" the Polish Armed Forces. "This strengthening is extremely important in view of the situation on our eastern border," he says. "We don't have time, we can't wait; we have to arm the Polish Army." ©

Check 6 Aviation Week editors discuss the rise of the South Korean defense industry: AviationWeek.com/Check6

a short period of time represents a significant challenge but said there are now new software design tools to help streamline the powerplant's development. "In terms of computing power, we have no problems," he said.

TRMotor already had preliminary designs for the engine, Kotil said. At the same time, TEI has decades of experience in engine assembly and maintenance and has also accelerated development of the TS1400 turboshaft, which should begin to equip TAI's T-625 Gokbey utility helicopter this year.

Another significant challenge is building up human resources and Turkey's industrial aerospace capability parallel to the fighter's development.

"In Turkey, there is not an aerospace industry like there is in the UK, U.S. or Russia or Europe.... We are building from scratch," Kotil said.

The company has been hiring thousands of engineers every year from Turkish universities as well as experienced engineers from overseas, and local industry is developing sub systems for the aircraft, including flight controls, avionics and sensors as well



(())

The indigenous Turkish fighter program is considered a strategic initiative for Ankara, transforming the country's aerospace capability.

as systems such as landing gear, he added. Pilots are also flying a TF-X simulator that supports development of the flight control system.

BAE Systems is continuing to support the design and development of TF-X through the six-year government-to-government deal between London and Ankara in 2017. Future phases of this work are now under negotiation.

Paving the way for the fighter program is development of the Hurjet, the supersonic-capable, GE F404-powered advanced jet trainer developed with \$1 billion of internal funding. More of a commercial project for the OEM, Hurjet development is a steppingstone and an indicator of the company's increasingly advanced development capability, Kotil said.

"In five years, we have gone from the turboprop Hurkus to the supersonic Hurjet," he said. "What could we do in the following five years?"

The Turkish Air Force has ordered 12 Hurjets as T-38 Talon replacements, with deliveries expected to begin in 2025. ♥

RUSSIAN ADVA

> TUPOLEV PAK DA IS RUSSIA'S ANSWER TO THE B-21 RAIDER
 > LEAKED DOCUMENT INDICATES DEVELOPMENT CONTINUES
 > FULL-SCALE PRODUCTION LIKELY TO FACE DIFFICULTIES

Piotr Butowski Gdansk, Poland

ussia's invasion of Ukraine, subsequent sanctions by the West and embargoes on the supply of aerospace components do not appear to have deterred Moscow from development of its next-generation strategic bomber, the Tupolev PAK DA. In fact, the first flight of a prototype aircraft may come in 2024.

In May, an extremely interesting table showing the production plans of the Ilyushin Aviation Complex for 2022-30 could be found on the internet for just a few days. The numbers for civil aircraft in the table indicated the data was fresh, produced after Russia's full-scale invasion of Ukraine and under current economic conditions.

The Ilyushin Aviation Complex is an executive body for the Beriev Aircraft Co., which deals with special-purpose aircraft, including making parts for Russia's answer to the U.S. Northrop Grumman B-21 Raider, the PAK DA bomber. According to the leaked table, Beriev is to make six sets of aggregate parts for test PAK DA aircraft by 2030: two each in 2023 and 2024, and one each in 2025 and 2026.

From other sources it is known that

three flying test aircraft are planned to be built. Final assembly of the PAK DA bombers is set to be done by the Gorbunov Kazan Aviation Plant, a branch of the Tupolev Co.

The presence of the PAK DA in the leaked document means that the new wartime reality has not changed Russian plans—Moscow has no intention of abandoning this project.

Work on the new Russian strategic bomber has been launched and stopped several times, and for a long time it did not progress beyond projects on paper.

The current PAK DA program was launched in 2007 with the announcement of a design competition among Myasishchev, Sukhoi and Tupolev. Russia chose Tupolev, which won a three-year contract in August 2009 for research work code-named Poslannik, under which the company developed the conceptual design of the Product 80 aircraft. The Tu-160 Blackjack is Product 70. The project was approved by the Russian Defense Ministry in the spring of 2013.

In the next stage, on Dec. 27, 2013, the defense ministry contracted the preliminary technical design of the PAK DA. In May 2014, Viktor Bondarev, then-commander-in-chief of the Russian Air Force, announced that the first flight of the PAK DA prototype would take place in 2019. "In 2023, state acceptance tests will be completed and supplies for the military will begin," he added.

The program was revised in 2014, when, after the annexation of Crimea, Russia was subject to Western sanctions, and world oil prices dropped significantly. At that time, Russia changed its priorities and resumed production of the modernized Tu-160M, judging that program less expensive. The main efforts of the Tupolev design bureau and the Kazan production plant, as well as financial resources, were thrown into modern-





izing and resuming production of the Tu-160M. Meanwhile, the PAK DA program slowed down.

The Russians returned to the PAK DA at the end of 2017. On Dec. 27, 2017, Tupolev won a defense ministry contract for Poslannik-1 research and development work, including completion of the design of the Product 80 aircraft and construction and trials of several test aircraft.

According to this contract, the aircraft was to complete acceptance tests by the end of August 2027. The day before the contract award, on Dec. 26, 2017, Tupolev also received a **Cross-Section**



Tupolev PAK DA Design Specifications

Engines......2 X 23,000 kg (50,706 lb.)

Weights [kg (lb.)]

Max. takeoff weight 145,000 (319,670)

Performance

Range, unrefueled 15,000 km (9,321 mi.)

Source: Piotr Butowski

In this utility model, Tupelov sought to design an engine air intake inside the aircraft that would be rigid and strong enough to provide air to the engine during all flight modes and possible changes in angles of attack.

contract from Russia's Industry and Trade Ministry for the "Tekhnologiya-80" program covering the development of basic technologies including the engine and preparation of serial production of the aircraft.

WHAT IS KNOWN

Quite unusually for a Russian military project of such importance, the basic characteristics of the PAK DA are not secret. Long-Range Aviation Commander Anatoly Zhikharev said in August 2014 that the PAK DA would be a subsonic flying wing capable of reaching a distance of 15,000 km (9,300 mi.) without refueling. According to a less official but still trustworthy Russian source, the Product 80 bomber is planned to weigh 145 metric tons at takeoff and is supposed to be able to carry up to 30 tons of weapons. Thus, the PAK DA is almost half the weight of the Tu-160 (275 tons) and is situated between the 124ton Tu-22M3 and 185-ton Tu-95MS.

This March, Tupolev released a patent for an engine air intake of an aircraft resembling the PAK DA. Of course, the drawing attached to the patent does not need to show the exact bomber under construction. The PAK DA wing likely has a constant leading-edge angle, without the kink, as shown in the patent drawing (see page 21).

After the main contract was awarded, subcontractors responsible for individual PAK DA systems were selected—approximately 100 lower-tier contracts in total. Most are traditional Tupolev partners. The Russians are trying to make the PAK DA a low-risk program, and the use of revolutionary technologies in the bomber should not be expected. Years ago, when resuming production of the Tu-160, then-Deputy Prime Minister Yuri Borisov said that "the maximum number of technological operations will be common" for the Tu-160M and PAK DA. Some of the subsystems and weapons are common to both aircraft.

The PAK DA is slated to be powered by two turbofan engines supplied by the United Engine Corp. (UEC) Kuznetsov. The engines appear to be an upgraded version of the NK-32 used in the Tu-160. Indeed, the new engine is planned to be based on the core (hot section) of the NK-32-02 engine of the Tu-160M and is supposed to provide a maximum thrust of 23 tons (the legacy NK-32 engine has a thrust of 14 tons dry and 25 tons with afterburner). The TA18-200-80 auxiliary power unit for the PAK DA is made by Aerosila.

Notably, the engine program is also code-named MD-80, or "cruise engine for the aircraft 80." This formulation suggests that the aircraft may also use other engines. Indeed, another document includes information about a SD1C takeoff engine intended for the PAK DA; it is a solidpropellant type probably used for rocket-assisted launch.

An integrated avionics system is being designed by Ramenskoye RPKB. The radar system is being developed by the Tikhomirov NIIP Institute that is unusual, as TsNPO Leninets supplies the radars for other Tupolev bombers. The PAK DA will receive an active, electronically scanned array radar based on the one used by the Sukhoi Su-57 fighter. The bomber will also have an optoelectronic sight from an unknown manufacturer.

MNPK Avionika is building the KSU-80 flight control system. The NO-80 navigation suite is designed by Moscow's MIEA Institute. The K36L-80 ejection seats and crew life-support system are being developed by the NPP Zvezda Co. Traditionally, Russian bomber crews are large: the Tu-160 and Tu-22M3 have a crew of four, as does the Tu-95MS—though at times the crew is as large as seven. The PAK DA also likely has a four-person crew, as evidenced by the order for 12 ejection seats for three test aircraft.

The KNIRTI Institute is responsible for the self-defense suite, which is planned to include electronic jammers, directional infrared countermeasures (made by NII Ekran), towed decoys (NII Ekran) and a chaff/flare dispenser system.

Data shows that the basic variant of the PAK DA will carry 12 Kh-BD (longrange) subsonic cruise missiles, most likely placed on six-round rotary launchers in two bays inside the airframe, similar to the Tu-160. This new

"The Russians' mood may be spoiled by the Chinese Xian H-20"

missile is also planned to be the main weapon of modernized Tu-160M bombers. Rotary launchers for firing cruise missiles from internal weapon chambers are made by NPP Start in Yekaterinburg.

On Aug. 28, 2013, Raduga Co. received a contract from the Russian Defense Ministry for a research and development project called Romans, for what is now the Kh-BD (Product 506) missile. According to the contract, the missile was to begin flight tests in 2018 and complete state acceptance trials in 2020. These deadlines appear to have been missed. The plant in Smolensk is being prepared for series production of the Kh-BD. The same facility produces air-launched Raduga Kh-101/Kh-102 (Product 504) cruise missiles, used by the Tu-160 and Tu-95MS, at a rate of approximately three missiles per month.

No Kh-BD missile has ever been publicly presented. There is also no information about its characteristics, except that its range is much farther than for the current Kh-101/102. Considering the dimensions of the Tu-160's internal weapon bay, the crosssection of the Kh-BD missile is likely close to that of the Kh-101/102, which already fully uses the available space. All that remains is to increase the length of the missile body. The Tu-160's weapon compartment was designed in the 1970s to carry a large, 10.8-m-long (35-ft.) Kh-45 missile. That original missile was abandoned, but the weapon compartment still contains a lot of free space, as the Kh-101/102 is about 7.4 m long.

IS THIS REALISTIC?

Anticipating anything in Russia is a high-risk activity these days. It is unknown what will happen in the nation within the next few months, much less years out.

But there are two arguments in favor of the PAK DA program. First, strategic bombers are the most important component of the Russian Air Force. Second, the program is so advanced that relatively little effort is required to complete the construction of several test aircraft.

In addition to its military significance, the PAK DA is important for Russia's public image. During the Army exhibition in August 2021, Industry and Trade Minister Denis Manturov was asked to compare the PAK DA and the U.S. Air Force's B-21. "We set ourselves the task of creating technology that surpasses the technology of other countries in terms of capabilities," he replied.

The Russians' mood may be spoiled by the Chinese Xian H-20, which will most likely be ready to fly earlier than the PAK DA.

Whether the PAK DA will begin series production and service will depend on factors that are difficult to quantify, both within and beyond the Russian aviation industry. Russia is unable to produce all the materials and components necessary for its aviation industry, especially electronics. If the Western embargo on deliveries, introduced after the Russian invasion of Ukraine in February, is effective, it could block aircraft production in Russia.

Another issue—less visible but no less acute—is that production tooling, both hardware and software, are almost entirely foreign to Russian industry. The Russians can use these tools for a while without manufacturer support, but that will become more and more difficult with each passing month.

Bristow Group Eyes Early Adoption of AAM Aircraft

HELICOPTER OPERATOR HAS 400 AAM VEHICLES ON ORDER FROM SIX DEVELOPERS

> LEONARDO AW609 TILTROTOR IS "TECHNOLOGY BRIDGE" TO eVTOLs

Tony Osborne Farnborough

Partnered with no fewer than six of the biggest names in advanced air mobility, helicopter operator Bristow Group is looking to become an early adopter of the technology.

Best known as a helicopter provider to the offshore energy industry, Bristow sees the emergence of electric and wide as well as with infrastructure providers and airport owners.

Last year, Bristow signed agreements with AAM developers Electra.aero, Eve Air Mobility, Overair and Vertical Aerospace. Since then, in the days leading up to the Farnborough Airshow, new agreements were signed with U.S.



hybrid vertical- and short-takeoff-andlanding (STOL) advanced air mobility (AAM) aircraft as a means of diversifying its business in a way that conventional rotorcraft would not allow.

"Through AAM, Bristow can enter new markets that traditional helicopters have been left out of, either because of cost, noise or perception," Bristow Chief Transformation Officer David Stepanek told Aviation Week at the Farnborough International Airshow.

With its offshore operations, Stepanek said Bristow is already a regional mobility provider. Flip that back to onshore, he noted, and the company sees itself performing regional cargo work and working with major cities to provide intra- and interurban transportation.

"We are an air carrier in all major regions of the world already," he added. "We have the licenses; now we just add aircraft to it and get the approval of local authorities and regulators."

Stepanek said the company had meetings with municipalities world-

cargo AAM developer Elroy Air and Germany's Lilium. Bristow will also act as a maintenance, repair and overhaul provider for Lilium's initial network in Florida.

In all, Bristow now has orders, including options, for 400 electric vertical-takeoff-and-landing (eVTOL) and STOL aircraft. And there is more to come, Stepanek hinted, with agreements expected to be signed with two more AAM developers in the coming weeks. He noted that Bristow has been picky about the AAM developers with which it partners. Its strict criteria are applied to not only the use cases but also the team delivering the program.

"Sadly, getting [AAM aircraft] to fly is the easy thing.... But being able to go through a test program and certify the vehicle and then scale production is hard," he said. "We are looking for the teams who can do that, and who will have the funding or the ability to raise the funding necessary to get... through a type certification."

Bristow has also been deliberate about selecting platforms from different national jurisdictions. Some AAM providers will certify through the FAA, others through the European Union Aviation Safety Agency (EASA), while Eve will likely certify through Brazilian authority ANAC. This is a way of "hedging risk," Stepanek said, particularly in light of the FAA's decision to shift the type certification of winged eVTOL aircraft to the powered-lift category (*AW&ST* May 30-June 12, p. 22).

Such changes in the rules and processes for certifying the various AAM platforms will inevitably lead to delays in getting them to market. But Stepanek said the company's approach is to be ready whenever they arrive, whenever that will be.

Besides serving new markets, AAM aircraft could also provide new options to the energy industry in servicing offshore platforms, Stepanek noted. The aircraft could be particularly useful for those closer inshore, such as in the Gulf of Mexico, the southern North Sea and off West Africa.

"Nobody believes we will be replacing heavy helicopters in the North Sea [with AAM] anytime soon," he said. But energy companies are "very excited" about the platforms' potential to reduce their carbon footprint, he noted.

"Some of these aircraft potentially have a range of 100-200 mi. And while they are not carrying 12 or 19 passengers, these aircraft are half or even one-quarter of the price with much lower operating costs, so we may just use more aircraft to move people," Stephanek said. "If we can do that efficiently and safely, that could be a nice synergy for our energy company clients."

Before the first eVTOLs are delivered, however, Bristow is awaiting the arrival of its initial Leonardo AW609 commercial tiltrotor, which Stepanek said will be a "technology bridge" to eVTOLs. Bristow's first planned production-standard AW609 is in assembly. The company's pilots flew an AW609 for the first time in May.

Bristow has been working with Leonardo on potential use cases for the tiltrotor since signing a development agreement in 2015. Stepanek said his company is exploring several missions for the AW609, including rapid donor organ transportation and even long-range offshore missions such as off Nova Scotia or in the far north of Norway. AW609 certification is still needed under the FAA's powered-lift criteria.

Max Pressure

SOUTHWEST AIRLINES WILL NOT RECEIVE 737-7s BEFORE 2023

CERTIFICATION UNCERTAINTY FORCES FLEET PLAN CHANGES

Sean Broderick Washington

S outhwest Airlines executives are no longer expecting deliveries of any Boeing 737 MAX 7s before 2023, the latest sign that the model's regulatory approval timing remains difficult to nail down amid changing aircraft certification protocols.

"Given the current ongoing status of the -7 certification and pace of expected deliveries for the remainder of this year, it is the company's assumption that it will receive no -7 aircraft deliveries in 2022," the airline said in a July 28 release announcing its second-quarter financials.

Boeing's official position is that the 737-7 "is expected to be certified in 2022 and enter service in 2023," the company said in a July 27 financial filing.

Southwest—an all-737 operator and the largest 737-7 customer, with 192 firm orders—entered the year planning to take delivery of 72 737-7s. But uncertainty around when the FAA will approve the model, combined with Boeing's delivery rate instability (see page 29), has forced the carrier to revise its plans.

"There are production is-

sues that are supply chain related, then there are delivery issues that are based on a certification issue with the MAX 7," Southwest Chief Operating Officer Mike Van de Ven said on a July 28 earnings call. "When the MAX 7 is certified, we'll be able to catch [deliveries] up quickly in 2023."

Neither Boeing nor the FAA will discuss the 737-7's status in detail, but flight testing wrapped up in late 2021. Multiple sources with knowledge of the certification program tell Aviation Week that there are no major technical red flags. Rather, changes in how the FAA certifies aircraft—triggered by the fallout of two fatal 737 MAX accidents—and how Boeing is adjusting to the new process are prolonging the agency's review.

The 737-7 first flew in March 2018. A year later, certification work paused following the second of the two fatal 737 MAX accidents—Lion Air Flight 610 in October 2018 and Ethiopian Airlines Flight 302 in March 2019—that triggered the entire fleet's grounding and a comprehensive review of both the 737 MAX and the FAA's product approval process.

When the FAA cleared the fleet to fly again in late 2020, the landscape had shifted. All 737 MAXs now require modified flight control computer software. More significantly, the FAA's certification process was changing rapidly in response to lessons learned and, in some cases, new requirements.

A December 2020 law put new limits on delegation, or work handed to a company's FAA-designated representatives to complete. For instance, work that used to be delegated to Boeing, such as validating certain system safety analyses, is now being handled by the FAA. That adds work in both camps: The FAA has more to do, and Boeing must submit more detailed packages to inform the agency.

Another looming issue is a provision in the law that says air transport aircraft certified after 2022 must comply with current flight-crew-alerting regulations. In short, none of the 737 MAX variants have updated alerting systems—the FAA granted Boeing requested exemptions that maximize flight deck compatibility with the 737 Next Generation family, one of the safest aircraft designs ever, as measured by fatal accident and hull-loss rates (*AW&ST* May 30-June 12, p. 21).

The FAA's reviews of the 737-7 and 737-10 were not expected to drag into 2023. The two-year grace period was inserted to allow approval of both before the law takes effect, but the uncertainty in the FAA's new certification process has made the deadline a factor.

The 737-10's inability to meet the deadline has been quietly acknowledged for months within both Boeing and FAA circles. This stems from the combination of changes to the

aircraft that must be reviewed, such as new landing gear, and its later start on a certification path. Launched five years ago, the 737-10 first flew in June 2021.

Even amid the new certification protocols, Boeing and Southwest did not expect the first 737-7 deliveries to slide well into 2022, let alone 2023. Nevertheless, Boeing insists its focus is on getting both new models approved.

Boeing CEO David Calhoun recently told Aviation Week editors that if the crew-alerting deadline stays in place and

the 737-10 is not certified this year, Boeing is more likely to cancel the program than modify the flight deck and risk safety complications and fleet commonality issues (*AW&ST* July 11-24, p. 15).

Several 737-10 customers have made it clear that they want to see the cockpit remain common with other family variants. If the 737-7 is not approved by year-end, Southwest—arguably the most vocal proponent of 737-family commonality—could add another influential voice to calls to change the law.

Calhoun reiterated Boeing's confidence that both models will be approved with the same alerting system that is on the 737-8 and 737-9.

"We are working constructively with the FAA," Calhoun told analysts on a July 27 earnings call. "We have our heads down. We're working toward certification by year-end on the [737]-7 and the [737]-10. And we believe what we're working on is, in fact, the safe option with respect to all options. And so we're going to just keep plugging away."

Boeing is "working closely with the FAA" on implementation of the flight-crew-alerting legislation "and expect[s] any necessary actions to be defined later this year," the company said in its filing. "If we are unable to achieve certification and/or entry into service consistent with our current assumptions, future revenues, earnings and cash flows will be adversely impacted." ©



Boeing completed 737-7 flight testing in late 2021,

but final FAA approval remains elusive.

Stronger Together?

> SPIRIT AGREES TO JETBLUE MERGER

FRONTIER WOULD BE DOMINANT U.S. ULCC

Ben Goldsteine Boston

he pending acquisition of Spirit Airlines by JetBlue Airways could reshape the competitive landscape in the U.S. domestic airline market—but whether regulators will sign off on the pact remains an open question.

The merger, announced July 28, capped off a nearly fourmonth bidding war that pitted JetBlue against Frontier Airlines in the contest for South Florida-based Spirit. In the end, JetBlue's \$3.8 billion all-cash offer was enough to override the Spirit board's recommendation that shareholders approve the roughly \$2.6 billion mostly stock deal with Frontier, originally announced in February. Spirit's own shareholders defied the board, defeating the proposed Frontier merger in a much-delayed July 27 ballot.

The message from shareholders was clear, and a new merger agreement with JetBlue was announced the next day. The proposed transaction would see New York-based JetBlue pay Spirit's stockholders \$33.50-34.15 per share of common stock,

JetBlue plans to strip seats from Spirit's A320-family cabins to make room for its more premium interiors.

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depending on the length of time it takes to close. JetBlue will also be on the hook for a \$400 million breakup fee if the deal is blocked by regulators.

Spirit will need to hold another shareholder vote to approve the JetBlue offer. That vote likely will take place in the next 60-90 days, according to a client note from Raymond James analyst Savanthi Syth. The two companies said they expect the deal to close no later than mid-2024.

In the meantime, the carriers will continue to operate as separate entities. Should the merger go through, JetBlue CEO Robin Hayes will stay on as CEO of the combined airline. Spirit CEO Ted Christie will remain with the combined company at least through 2023-24 to assist with the transition, although it is unclear in exactly what capacity. Spirit will also owe Frontier \$25 million to compensate for merger-related costs the latter incurred over the last several months.

If approved by shareholders and regulators, the acquisition would leapfrog JetBlue ahead of Alaska Airlines and make it the fifth-largest U.S. airline. But the combined carrier would still be much smaller than the four largest airlines. In terms of scheduled 2022 capacity originating in the U.S., the company would control around 7.1% of the market, compared to 9.4% for fourth-largest Southwest Airlines, according to a July 28 report from Cowen analyst Helane Becker. When measured purely in domestic seats, the gap widens considerably.

The airlines have a combined fleet of 458 narrowbodies, with an orderbook of over 300 more Airbus narrowbodies.

Spirit is an all-A320-family operator, while JetBlue operates A320s and Embraer 190s that are being replaced with A220-300s. JetBlue also has around two dozen A321LR/XLRs on order that will be used for its transatlantic operations.

But while the carriers have a high-degree of fleet commonality, the products they offer with their aircraft are very different. Spirit's ultra-low-cost-carrier (ULCC) business model requires dense cabins with minimal seat pitch and not much of a premium product, while JetBlue's aircraft are roomier and outfitted with large premium cabins.

JetBlue executives have repeatedly referred to plans to "dedensify" Spirit's aircraft cabins—a euphemistic term for pulling out seats. Spirit has 182 seats on each of its A320s and 228 on its A321s, compared to 157 and 178 seats on JetBlue's A320s and A321s, respectively. Removing the Spirit seats will invariably lead to higher fares, a prospect many analysts predict will invite intense scrutiny from the Justice Department.

Acquisition of Spirit—the largest ULCC in the U.S. by market share—would have profound implications for the compet-

JetBlue and Spirit have a combined fleet of 458 aircraft with an orderbook of more than 300 additional Airbus narrowbodies.



itive landscape of the ULCC sector. Somewhat ironically, no competing carrier stands to benefit more from Spirit's exit than its former suitor, Frontier. With its largest rival now out of the picture, Denver-based Frontier would be the largest American ULCC left standing—the "King of the ULCC Hill," as J.P. Morgan analyst Jamie Baker writes in a recent client note.

Baker said he "wouldn't be surprised" to see Frontier look to backfill some of the ULCC capacity that exits the market when Spirit's fleet is assimilated into JetBlue's—either as the result of aircraft "dedensification" or forced divestitures. While he noted that other ULCCs such as Allegiant Air, Avelo Airlines, Breeze Airways and Sun Country Airlines stand to benefit competitively from the merger, Baker said Frontier's "preexisting scale leaves it in an optimal position."

Frontier seems to agree. "Frontier's fares will be even more attractive following a JetBlue acquisition of Spirit, which would eliminate a large ULCC carrier," it said in a July 27 statement.

Whether any of that happens will ultimately depend on whether the carriers can persuade the Justice Department their combination will increase competition by enabling the new entity to better compete head-to-head with the large legacy carriers. JetBlue has argued repeatedly that it is better able to bring down legacy airline fares through its "JetBlue effect" than smaller ULCCs such as Frontier or Spirit can.

But persuading the Justice Department will not be easy. The counterargument—that a merger would remove capacity and raise fares—will hold weight with an administration that has expressed concern repeatedly about domestic airline consolidation.

But should the airlines prevail, the landscape of the domestic industry would drastically shift. A strengthened JetBlue would be able to light a fire under its larger competitors up and down the East Coast. And Frontier would be left the undisputed king of the remaining cohort of fast-growing ULCCs.

Asia-Pacific Airlines Rebuild A380 Fleets

NEARLY 35% OF THE REGION'S A380s HAVE REENTERED SERVICE

SOME OF THE PARKED A380s WILL NOT RETURN

Adrian Schofield

irbus A380s have become a rare sight in Asia-Pacific skies over the past few years, but the recent surge in international demand has seen more airlines bringing A380s out of storage.

Carriers grounded most of their widebody fleets when the COVID-19 crisis hit in early 2020. Being the largest aircraft in operation and therefore the hardest to fill, virtually all A380s in the Asia-Pacific region were put into long-term storage.



A380s have been among the slowest of the widebody models to return, but now many of the region's airlines are gradually reactivating these aircraft. The A380 fleet is rebuilding, although it will not fully return to its pre-pandemic size. Some Asia-Pacific airlines have decided to cut down or even phase out their A380 fleets as a result of restructuring and strategic reviews undertaken during the COVID-19 crisis.

There were 65 A380s in service with Asia-Pacific carriers in January 2020, according to the CAPA – Centre for Aviation fleet database (see chart). Two months later, the in-service total dropped to just four, as most were grounded.

The Asia-Pacific in-service A380 fleet stayed between five and seven aircraft through last October, but it has been steadily growing since then. There were 12 operational in January, and this number has now reached a two-year high of 22, representing an in-service rate of 34.9%. The A380 in-service total will continue to climb through the remainder of the year.

Airlines are reactivating more widebodies due to a rebound in international travel, which picked up in the second quarter. Pent-up demand and smaller fleets are combining to cause a supply shortfall.

Although the proportion of operational A380s is increas-

ing, it is still far lower than that of other widebody models. There are 1,364 passenger widebody aircraft in service now in the Asia-Pacific region versus 322 inactive, an in-service rate of 80.9%.

Singapore Airlines (SIA) is the region's largest operator of A380s, with 10 in service. Two more will be reactivated after retrofits are completed. The carrier had 19 before the pandemic began, although it announced in November 2020 that seven of these would not return to its fleet.

Qantas sent all 12 of its A380s into storage in the U.S. in 2020. Two of them are being retired early and will not reenter the Qantas network.

The Australian airline has reactivated three of the remaining 10, which are used on Sydney-Singapore-London and Sydney-Los Angeles routes. Two more A380s are expected to return to service by the end of August and will be used on Sydney-Los Angeles flights, the carrier tells Aviation Week. A sixth is planned to be activated by the end of December. Qantas has accelerated the timeline for the return of its

A380s. When it first parked these aircraft, the carrier estimated they would remain grounded for at least three years.

Korean Air has 10 A380s in its fleet. It is operating two of these, with the second having returned to service in July. The aircraft are being used for daily flights on the Seoul-New York route and three weekly flights to Hong Kong. The carrier plans to activate a third A380 in September, which will be deployed on daily flights to Tokyo.

The longer-term future of Korean Air's A380s is less certain. Last year, the airline raised the prospect of retiring its A380s within five years, although Korean has since stressed that plans for these aircraft have yet to be confirmed.

Source: CAPA Fleet Database

All Nippon Airways (ANA) resumed flying two of its A380s in July. The carrier ordered three of the model in 2016, to use exclusively on its routes from Tokyo to Hawaii. The first two began commercial operations in 2019. ANA has a third A380 that has been delivered but has not yet entered service. In the meantime, this aircraft has been used for some customer events on the ground, such as a restaurant experience.

China Southern Airlines is operating all three of its A380s. The carrier previously had five, but it cut two from its fleet in the first half of this year. Asiana Airlines is operating two of its six A380s.

Two other Asia-Pacific airlines have A380s in their fleet but have kept them all grounded. These comprise six aircraft each for Thai Airways and Malaysia Airlines.

Malaysia Airlines has said its A380s will be sold and will not return to service with the carrier. The airline is in serious discussions with some parties regarding the disposal of the aircraft, CEO Izham Ismail said recently. Malaysia Airlines expects these aircraft to have left the group by year-end.

Thai Airways has listed two of its six A380s for sale. However, the fate of the other four remains in question, as the carrier has not confirmed whether they will be reactivated or retired.

Avelo Airlines Seeks Out Foreign Pilots Amid Tight Labor Market

PARTNERSHIP WITH ALLIANCE AVIATION IS HELPING TO SOURCE INTERNATIONAL AND DOMESTIC PILOTS

COMPANY PLANS TO GROW ITS FLEET TO 60 AIRCRAFT

Ben Goldstein Newport, Rhode Island

velo Airlines is hunting for pilots to help meet its growth targets, and competition is fierce—at least domestically.

To help meet its staffing needs, the

lies; and regional jets manufactured by ATR and Embraer.

Through its referral program, Alliance recommends first officer candidates who can then apply for possible processed more than 250 pilots this year who have converted foreign licenses to FAA airline transport pilot licenses. "We're talking about pilots with 10,000-15,000 hr. as a first officer with major carriers, so these are people who are exceptionally qualified," Navarro says.

While it is actively seeking both domestic and foreign pilots, Avelo CEO Andrew Levy tells Aviation Week that the company is not facing a shortfall of available pilots, describing the ranks as "fully staffed with a bunch of folks that are still in the training pipeline."

Levy emphasizes the "extremely competitive pay" on offer at Avelo,



AVELO AIRLINES

U.S. startup has expanded its search to include foreign pilots from a variety of nations, made possible through a new partnership with Alliance Aviation, a Fort Lauderdale, Florida-based pilot training organization.

Announced July 21, the new initiative will allow Avelo to source from Alliance's Preferred Referral Network of U.S. and international pilots who have completed the commercial pilot academy's FAA Part 142-certificated training program.

Alliance, which has campuses across the U.S. as well as in Mexico and Colombia, offers training services across a host of popular mainline aircraft platforms including: the Airbus A320; Boeing 737, 757 and 767 famiEB-2 employment-based visas to fly commercially in the U.S. on behalf of Avelo and other participating carriers. The foreign pilots are intended to augment Avelo's staff as it continues to hire domestic aviators.

A spokesman for Avelo says the company hopes that at least 20% of new pilots it hires over the next year will be referred through the Alliance partnership. The carrier, which launched scheduled service in May 2021, employs fewer than 100 pilots, according to the spokesman, but plans to hire as many as 160 over the next 12 months as it grows its fleet with additional used 737-700/-800 jets.

Alliance CEO Federico Navarro tells Aviation Week that the company has which he says is "not even that far" from what the legacies are offering new recruits. In January, the company elevated starting pay by 30% for first officers and 50% for captains. After five years of employment, a captain at Avelo can earn \$220/hr., plus an \$1,800 monthly stipend intended to offset commuting costs—in line with other much larger ultra-low-cost carriers (ULCC) like Frontier Airlines and Spirit Airlines.

Aside from the competitive pay, Levy highlights other perks of flying for an upstart carrier such as Avelo versus a legacy carrier or more established ULCC. Because the company is starting small with a fast rate of projected growth, first officers can advance more quickly from the right seat to the left seat. And Avelo's outand-back flying model means pilots can leave home in the morning and return that same night—a major perk that allows them to spend more time at home with their families.

Levy says the company's startup ethos and hands-on culture serve as a draw for many prospective applicants, too. "It's fun to be in a startup environment where it's small and people know your name," Levy says. "We have an amazing esprit de corps that stems from our values and how we do things. All our senior leaders are executives, but they're also doers. This is an environment where we check hierarchy at the door, and a lot of people really dig that."

Avelo is looking to begin filling first officer openings in October. The carrier has a fleet of 10 737 Next Generation (NG) aircraft and has committed to grow to 14 by year-end. It has no commitments beyond that but hopes to "grow well beyond 60 airplanes" over the next several years, Levy says. The company employs 500 "crewmembers," as Levy calls employees, but plans call to end 2022 with a staff of 700-800.

To be sure, Avelo is not the only U.S. airline that has expanded its hiring efforts to include foreign pilots. Carriers including Breeze Airways, Frontier Airlines and SkyWest Airlines have all taken advantage of the E-3 work visa program to hire pilots from Australia. The E-3 program specifically allows Australian citizens to work in the U.S. in some specialty occupations.

But it is very difficult for larger carriers to hire foreign nationals without running afoul of union contracts. Kit Darby, a former airline pilot who is now president of the eponymous Kit Darby Aviation Consulting, tells Aviation Week that there are "thousands" of foreign pilots who have applied to work in the U.S. using EB-2 national interest visas, which waive the normal requirement that an immigrant worker already have a job offer before entering the country. But he says that only a small percentage of applicants actually have been able to gain employment.

"There's a secret reserve out there that no one is talking about," Darby says. "There is a large supply of wellqualified and experienced international pilots who would love to immigrate to the [U.S.]."

For a startup like Avelo, which does not have to deal with organized labor—at least for now—looking outside the U.S. for pilots can offer a leg up on less nimble competitors that are restricted solely to domestic hires.

"There are fantastic pilots who are born in other countries, and some of them have the ability to come here pretty easily," Levy says. "This was a good opportunity for us to expand the pilot hiring universe, which is something that's important for us. And it's going to be important for all U.S. airlines over the coming years."

Window Seat Aviation Week editors look at bigger-picture issues in the world of commercial aviation: AviationWeek.com/Window-Seat



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Supplier Strain

> SUPPLY CHAIN BOTTLENECKS ARE SLOWING AIRCRAFT PRODUCTION

> ENGINE PARTS ARE THE BIGGEST ISSUE

> PRODUCTION RATE PLANS ARE CHANGING AS A RESULT

Michael Bruno and Sean Broderick Washington

S outhwest Airlines entered the year planning to take delivery of 114 new Boeing 737 MAXs. A revised estimate stands at 66, assuming Boeing will deliver 54 of them in the second half—hardly guaranteed, considering the bigger-picture supply chain issues behind the carrier's fleet-plan reshuffling.

"The change is a big one," Southwest CEO Robert Jordan told analysts on a July 28 earnings call. "But Boeing and GE and others are suffering supply chain issues just like everybody. So I'm not sure that it is completely unexpected."

Such is life during what has emerged as the summer of supply chain discontent, judging by widespread lament from customers and top supplier executives.

Some of Southwest's issues have nothing to do with the supply chain. The bulk of its 2022 deliveries were supposed to be 737-7s, the smallest version of the planned four-variant 737 MAX family. But FAA approval of the model is taking longer than expected (see page 24). Southwest no longer expects to take any 737-7s this year and is swapping 737-7 delivery slots for 737-8s where possible.

Boeing has struggled to keep up and not just with Southwest. After entering the year projecting 500 737 MAX deliveries, it now expects it to be closer to 400. Myriad issues are creating headwinds, ranging from an inability to deliver into China—the 737 MAX has been grounded there since March 2019 due to a combination of safety and, more recently, politics—to needing more time than expected to prepare aircraft that have been idle for months.

Boeing only recently reached its benchmark of producing 31 737 MAX narrowbodies per month—a rate it planned to be at in early 2022. The company is holding off on its next 737 program rate increase, likely to 38 aircraft, until it can crank out 31 consistently every month.

"Month in and month out, we're aiming at stability around 31," Chief Financial Officer Brian West said on a July 27 earnings call. "Some months might be a little lower, some months might be a little higher."

Boeing does not release monthly aircraft rollout figures. Sources with knowledge of the company's activi-

Pratt & Whitney is behind on delivering engines for Airbus A320neos.

ties tell Aviation Week that Boeing's 33 May rollouts represent the only month this year that has seen at least 31 737 MAXs produced.

The company delivered 181 737 MAXs in the year's first six months, with a monthly high of 43 in June. That included 16 from stored inventory that accumulated during a 20-month global grounding and related delivery pause as well as 27 new-build models (*AW&ST* March 22-April 4, 2021, p. 32).

Speaking on the earnings call, Boeing executives cited supply chain constraints as the stiffest headwinds echoing a familiar refrain from recent quarters.

"It's never about any [one] supplier," CEO David Calhoun told financial analysts. "It's about one or two that surprise you, one way or the other."

Engine castings, or parts made by pouring melted metal into molds, are the current pacing item.

"With respect to medium- or longer-term rate increases or changes, yes, it does actually get down to that engine supplier, and it does get down to those castings," Calhoun said. "We have to be confident that they are ready and that we can count on those deliveries."

Analysts asked what it would take to get suppliers responsible for engine castings and forgings—parts made by shaping heated metal with compressive forces—to invest more and increase capacity for aircraft manufacturers. Calhoun speculated that it starts with increased business operating margins of their own. Boeing can help mostly by providing stability and predictability in its own demand and market forecast.

"When those margins get to a point where everyone believes it's worth investing a significant amount of money, that's what they'll do," he said. "I suspect that day will come."

Meanwhile, West said Boeing has increased deployment of its own employees to suppliers to help with kit delivery. It is also establishing task forces to address industry-wide supply shortages as well as tapping internal fabrication operations and managing inventory "safety stock" levels where needed, he said.

Forgings and castings have been top of mind all year, with executives and analysts pointing to the Tier 4 specialty early on as the likely choke point of the next commercial aero-space upcycle (*AW&ST* Feb. 21-March 6, p. 36). Sometimes referred to as investment castings, there has never been enough industry demand to support more than one major supplier.

That supplier is Precision Castparts Corp. (PCC), the forgings and castings giant privately held under Berkshire Hathaway. During annual Pacific Northwest Aerospace Alliance and Aviation Week supplier conferences in February and March, speakers called out PCC, which has not disclosed much publicly about its business since being taken private

in 2016. It is believed to have lost a large portion of its skilled workers during the

Boeing's slowed production and delivery schedules are affecting many 737 MAX customers, including Southwest and Ryanair.

COVID-19 pandemic, and analysts still suspect it is an issue.

"While Boeing CEO

Calhoun wants to see more investment in large-cast engine structures, presumably to increase capacity, we do not think capacity is the issue so much as execution and labor availability, largely because today's targeted volumes are no higher than they were pre-COVID," analyst Rob Spingarn of Melius Research noted July 28. "Castings are an exacting and labor-intensive production process that requires skilled personnel, many of whom apparently left the business during COVID."

Still, practically everyone in aerospace is reporting supply chain issues, and the widespread nature of the challenges facing industry is spurring more candor over what traditionally has been a hushed topic. Tier 1s such as General Electric (GE) and Raytheon Technologies quickly admitted such problems in their own quarterly teleconferences in late July.

"We know our major airframer customers need more engines from us than we are providing, and that will be the case for the foreseeable future," GE Chairman and CEO Larry Culp, Jr., said July 26. "We need to ramp, again, in a predictable, reliable, stable way. That's what they want more than anything so that they can plan the rest of their assembly operations accordingly, and that's where we're focused."

Raytheon Chairman and CEO Greg Hayes mirrored the sentiment the same day. "We continue to deliver geared turbofans behind schedule, and we will not catch up, as I think I said back in February, until the end of the year," he admitted. "This, again, goes back to a single issue around structural castings."

Still, Hayes stressed that Raytheon is not single-handedly holding back



airliner delivery. "We're not holding up the line at Airbus," he said.

Engines might not be the sole reason Airbus is delivering narrowbodies late, but they are playing a major role. Airbus had 26 airframes awaiting engines at the end of June, Jefferies analysts wrote in a July 28 note. Like Hayes, Airbus CEO Guillaume Faury is confident the figure will drop quickly.

"We expect the backlog of missing engines to [go down] moving forward," he told analysts on a July 27 earnings call. "We target to have zero gliders by the end of this year. That relies on what the engine-makers—CFM and Pratt & Whitney—are telling us, and what they've demonstrated in recent weeks [regarding] their ability to deliver engines moving forward." GE and Safran are joint-venture partners in CFM.

The holdups helped convince Airbus to lower its full-year delivery target to 700 from 720. Down the road, its planned ramp-up to 75 A320-family aircraft per month in 2025 remains in place, but supplier uncertainty means interim milestones are changing. The revised plan has the monthly rate hitting 65 in early 2024, about six months later than previously planned.

Beyond castings, Super Tier 1 Raytheon—home to Pratt & Whitney, Collins Aerospace and two large defense primes—is facing difficulties sourcing microelectronics and rocket motors, according to Hayes.

Raytheon executives said earlier this year that they were managing through the issues and expected the worst to pass by year-end. Now they see challenges well into 2023. Hayes said Raytheon has embedded employees at about 330 of its suppliers to help improve their performance. It is also qualifying second, and in some cases third, sources for critical parts as necessary.

On the commercial side, Raytheon also relies increasingly on longterm agreements with suppliers, which requires them to carry buffer stocks. About 80% of its commercial supply involves such deals. "It doesn't always work," Hayes acknowledged. "We talked about structural castings at Pratt & Whitney back in the first quarter—that continues to be a challenge. But for the most part, the commercial businesses have done a better job because of the way we structure those long-term agreements.

"If you look at the defense side of the business, only about 10% of those businesses of Raytheon Missile and Defense and Raytheon Intelligence and Space suppliers are on long-term agreements, and that's not surprising because of government contracting rules," he continued. "The material management system, which dictates how much inventory we can drive in, how soon we can place things on order, really constrains our ability to be flexible on the defense side."

Regardless, labor shortfalls are the heart of the matter, more so than inflation and raw material costs. The collapse of aerospace business due to the COVID-19 pandemic in 2020 led to "a lot of layoffs," Hayes explained.

"Typically, we get about 75-80% of those folks back from layoff," he said. "In this case, what we're seeing in our supply chain is only about 25% of the people are coming back. They have found other jobs, similar jobs. Again, because the labor market is so tight in this country, we just don't have a large pool of resources." ©

Going Solo: Russia Reiterates Plan To Withdraw From ISS

> RUSSIA TO BUILD NEW STATION

> TIMING OF DEPARTURE UNCERTAIN

Aviation Week Staff Cape Canaveral, Houston and Moscow

B some measures, the relationship between Russia and the rest of the International Space Station partners is growing closer.

In September, cosmonaut Anna Kikina is scheduled to become the first Russian in 20 years to join a U.S. crew Borisov himself first voiced the plan in April 2021. A year later, Rogozin used the threat of withdrawal in an attempt to push Western partners to lift sanctions imposed on several Roscosmos subsidiaries following Russia's invasion of Ukraine in February.



for launch from Cape Canaveral. On July 21, European Space Agency astronaut Samantha Cristoforetti teamed with the Russian commander of the

with the Russian commander of the International Space Station (ISS) Oleg Artemyev for the first joint European-Russian spacewalk in 23 years. But back on Earth, Russia has reiter-

But back on Earth, Russia has reiterated plans for a more solitary future in space. "We will definitely fulfill all our commitments to our [ISS] partners, but the decision [about the] withdrawal from this station after 2024 has been taken," Yury Borisov, the newly appointed CEO of Russia's Roscosmos space agency, said during a July 26 meeting with President Vladimir Putin.

Borisov, 56, succeeds former Roscosmos CEO Dmitry Rogozin, who was removed from the post by Putin on July 15. Borisov previously worked as a vice premier, overseeing Russia's defense and aerospace industry.

Russia has repeatedly said it intends to leave the ISS partnership. The July 26 statement is different, insofar as it says the decision has been made—though it appears to be a political consensus among Russian leaders rather than a formal operational directive.

Roscosmos could not give details to Aviation Week about which government body had made the decision. Russia's TASS news agency cited Putin's spokesman, Dmitry Peskov, as saying the decision was made before July 26.

The ISS and its operations are governed by an agreement signed in 1998 by the U.S., Russian, European, Japanese and Canadian space agencies. It allows a participant to withdraw from the program at any time by giving at least one year's written notice. Russia has almost 1.5 years to prepare a formal exit.

"NASA has not been made aware of decisions from any of the partners," Administrator Bill Nelson said in a statement on July 26. The U.S. plans to operate the ISS until at least 2030, but by design the station is dependent on both Russia and the U.S.

"The Russians have been good partners," NASA'S ISS Operations Director Robyn Gatens said on July 26 at the ISS Research and Development Conference in Washington. "We'll be talking more about their plan going forward in the next several months."

Borisov's statement could be part of an attempt to obtain Russian government funding for the development of the country's new space station. Roscosmos unveiled the concept for the Russian Orbital Station (ROS) in April 2021 and awarded its subsidiary Energia Space Corp. a contract to deliver a draft design a year later. But the ROS has not been included in the current federal space program, which means Roscosmos must cover the cost of its work on the project.

European Space Agency astronaut Samantha Cristoforetti works outside the Russian segment of the ISS during a July 21 spacewalk with her Russian commander.

Russia proposes to locate the ROS at an inclination of 96.9 deg., which will enable it to monitor the entire Russian territory. Deployment could begin in 2028 with launch aboard an Angara A5M heavy-lift rocket flying from the Vostochny Cosmodrome in Russia's Far East, Energia chief designer Vladimir Soloviev said in an interview with Roscosmos' corporate magazine published on July 26.

That time frame is three years behind the original schedule laid out for the ROS.

The core element of the ROS is the Science Power Module (also known as NEM), which was initially developed to increase the power supply for the Russian segment of the ISS. It will be joined by a basic module and an airlock for the initial deployment of the ROS, which is scheduled to be completed by 2030.

With a pressurized volume of 217 m³ (7,663 ft.³), the ROS will support two crewmembers who will make occasional visits to install and repair science equipment. Further expansion of the station could start after 2030 with the installation of two more modules, bringing the total pressurized volume to 505 m³. $\textcircled{\bullet}$

Eutelsat Aims To Keep Competitive With OneWeb Acquisition

> PROPOSED TAKEOVER IS LATEST IN INDUSTRY CONSOLIDATION

COMBINED COMPANY IS A COUNTER TO VIASAT-INMARSAT, SPACEX AND OTHERS

Michael Bruno Washington and Tony Osborne London

ndustry consolidation in the spacebased communications market is heating up, with Eutelsat Communications of France announcing July 26 that it will take over OneWeb of the UK in a deal worth roughly \$3.4 billion.

With Starlink satellites proliferating in low Earth orbit (LEO) seemingly by the week, the latest announced merger aims to create a substantial counterpoint to SpaceX, among others. Eutelsat said the companies' combined operations are "highly complementary," including a network of satellites in LEO and geosynchronous orbit (GEO) featuring a common platform and hybrid terminals.

Eutelsat operates a 36-strong fleet of GEO satellites, while OneWeb has 28 of its planned 648 satellites in LEO.

"The combined entity would be the first multiorbit satellite operator offering integrated GEO and LEO solutions and would be uniquely positioned to address a booming \$16 billion (by 2030) satellite connectivity market," Eutelsat said in a July 25 statement, after rumors of the deal emerged over the prior weekend.

"This combination accelerates our mission to deliver connectivity that will change lives at scale and create a fast-growing, well-funded company which will continue to create significant value for our shareholders," said OneWeb CEO Neil Masterson.

Publicly traded Eutelsat owns 23% of privately held OneWeb already. In March, the companies unveiled a multiyear global arrangement for Paris-based Eutelsat to sell capacity on OneWeb's nascent LEO constellation to customers in the aviation, marine, telecommunications, government and other markets.

For OneWeb, the deal marks another twist in the company's dramatic evolution. The UK government was one of two main shareholders who rescued the ailing satellite operator from a Chapter 11 bankruptcy process in the summer of 2020, along with India's



OneWeb in February celebrated the successful launch of its latest 34 satellites by Arianespace from the Guiana Space Center in Kourou, French Guiana.

Bharti Global. Hughes Network Systems also invested soon after. OneWeb entered bankruptcy protection after Japan's SoftBank withdrew its financial support following the financial impact of the COVID-19 pandemic. Still, SoftBank reinvested in OneWeb in January 2021 and was later joined by Eutelsat and South Korea's Hanwha. Together, the partners have invested \$2.7 billion, making OneWeb fully funded with no debt, they have noted.

Under the announced terms, One-Web shareholders would receive 230 million newly issued Eutelsat shares, representing 50% of the combined company. Under its existing name, OneWeb will continue to operate the LEO business, with its headquarters remaining in the UK. Eutelsat will continue to be headquartered in France, listed on the Euronext Paris stock exchange and would apply for trading on the London Stock Exchange. Eutelsat Chairman Dominique D'Hinnin would become ranking chair of the combined company, while OneWeb Executive Chairman Sunil Bharti Mittal would be vice chair. Eutelsat CEO Eva Berneke would be the chief executive.

The UK Business, Energy & Industrial Strategy Department, which holds the government's share in OneWeb, says the deal would give the government a "significant stake in what will become a single, powerful, global space company." British officials further blessed the deal, as it would put One-Web on a "sound financial footing" to compete in the growing global satellite industry. Nevertheless, the UK government will retain its special share and its exclusive rights over OneWeb. The deal also maintains national security controls over the constellation and continues to give the UK first rights over domestic industrial opportunities such as satellite manufacturing.

Eutelsat's interest in OneWeb has been known since it took its initial 23% stake, but the takeover was a "mild surprise" that would further shake up an industry that includes SpaceX's Starlink constellation and Amazon's planned Project Kuiper, according to Quilty Analytics. Any deal would take OneWeb out of play for other potential suitors, one of which is likely Intelsat.

"The announcement adds a new dimension to the already chaotic LEO broadband landscape while also raising the table stakes for current and prospective LEO operators," say Quilty analysts Chris Quilty and Caleb Henry.

Assuming the price is right and other market strategies are proven out, Quilty Analytics says the move makes sense, as conventional wisdom increasingly predicts that the most viable business model will include multiorbit operations. But beyond challenges inherent in a young marketplace, a Eutelsat-OneWeb tie-up would face the historically daunting task of forcing official British-French collaboration.

"The book of successful Anglo-French partnerships is a short read, and the board will likely have its BI hands full sorting out a variety of details related to the merger, including the location of the headquarters, major operations and the future manufacturing site for Gen-2 satellites," the Quilty analysts note.

The Eutelsat-OneWeb deal is expected to close in the first half of 2023. Meanwhile, U.S.-based Viasat is aiming to close on its pending \$7.3 billion takeover of UK-based Inmarsat by year-end. That deal similarly aims to create a hefty multiorbit provider.

OneWeb Ownership Post-Merger



Viasat stockholders approved the deal June 21.

Last November, the companies surprised the space sector with the announcement that Viasat will pay \$850 million in cash, issue \$3.1 billion in new shares to Inmarsat's shareholders and assume \$3.4 billion in debt. At closing, Viasat shareholders would own 62.5% and Inmarsat shareholders 37.5% of stock in the combined company.

"The satellite communications sector is entering a new era of dynamic new market demands," Inmarsat CEO Rajeev Suri said at the time. "It is growing fast, remains highly fragmented and is attracting new entrants who see new opportunities. Given these factors, scale and scope are important, and that is exactly what this transaction offers."

Separately, on July 26, Viasat said its British subsidiary has been selected by

the European Space Agency to study use cases, market segments and technical aspects of future multilayered satcomm systems. Beyond various orbital assets, the review will consider high-altitude pseudosatellites and others, as well as include various frequency bands, satellite operators and network designs.

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Molly McMillin, Michael Lavitt and Matthew Orloff Oshkosh

n 2021, the Experimental Aircraft Association "tiptoed" into hosting the return of EAA AirVenture Oshkosh, the world's largest air show, following its cancellation in 2020 due to the COVID-19 pandemic. This year, organizers went full bore and have not looked back.

The result? EAA AirVenture 2022 at Wittman Regional Airport, under primarily sunny skies, set a record with about 650,000 attendees, up 7% from a year ago. It also drew more than 10,000 aircraft—from the smallest ultralight to the giant Lockheed Martin C-5—as well as more than 800 exhibitors and 5,000 volunteers.

Celebrations included the 75th anniversary of the U.S. Air Force and the 30th anniversary of the Young Eagles program, which provides aircraft rides to young people to spur interest in aviation. Van's Aircraft announced a new high-wing backcountry kit aircraft, the RV-15 taildragger.

New technology was front and center across the massive airfield. Ampaire flew its hybrid-electric EEL demonstrator, based on the Cessna 337 Skymaster, 1,633 nm from Camarillo, California, to Oshkosh, marking the longest flight made by a hybrid-electric aircraft. The Opener BlackFly, an all-electric single-seat personal vertical-takeoff-and-landing vehicle, was on display all week and participated in the evening air show. The carbon-fiber aircraft, introduced in 2018 after nine years in development, has eight props and motors to provide lift at takeoff and landing and forward thrust in cruise. It can fly up to 25 mi.

The Perlan 2 two-seat pressurized high-altitude research glider, on display all week, set a subsonic altitude record of 76,124 ft. in 2018. In 2023, plans are to fly the glider to 90,000 ft. The flight will take place in South America, where officials say they find the best weather conditions.

Besides new technology, the state of the market was on the minds of some exhibitors, given rising interest rates, the Russia-Ukraine war, inflation and fears of recession.

The pandemic has spurred record numbers of new aviation enthusiasts, and many manufacturers report twoyear order backlogs. Over the past 12 months at Cirrus Aviation, for example, 38% of Cirrus SRS customers were new to aviation. Cirrus and other manufacturers have raised production rates to keep up with robust demand.



With economic concerns, however, the conversations with customers are changing, says Ben Kowalski, Cirrus senior vice president of sales and marketing. "We're seeing it soften for sure, just as of very late," he says of the market. However, while demand has deFifty Van's Aircraft RF homebuilts flew in formation over Wittman Regional Airport to celebrate the company's golden anniversary.





ment over the past 12 months. Suppliers have been struggling with the effects of COVID-19, labor shortages and, in some cases, product shortages as well.

In response, Hartzell has taken a "fairly aggressive" approach, Frigge says. It has tried to "go long on many

A Lockheed Martin U-2 reconnaissance aircraft made a low pass over the airfield as part of the celebration of the U.S. Air Force's 75th anniversary.



clined from dramatic highs, it remains well beyond pre-pandemic levels.

At the same time, supply chain conditions continue to be an ongoing challenge. Hartzell Aviation President JJ Frigge says they are its largest challenge, although the company has seen improveof our goods" and has dual-sourced items when possible. The supply chain crunch also has forced the company to look inward, rethink its processes and "work smarter," he says.

The ongoing demand for pilots was also at the forefront at AirVenture, at job fairs, flight schools and airline programs such as United Airline's Aviate.

Boeing held a media conference on its 20-year outlook for pilots and technicians, which forecasts demand for 602,000 new pilots for airlines. There are 26,000 aircraft in service with the world's airlines, a number projected to grow to 47,000 over the next 20 years. Demand in Russia and Central Asia was not included in the outlook. The number of pilots for business aviation was not included, either. Boeing's outlook also forecasts demand for 610,000 new technicians and 899,000 cabin crew during that period.

The biggest impediment to attracting new pilots in the U.S. is the ability to finance the training, says Chris Broom, Boeing Global Services vice president of commercial training solutions. Unlike those wanting to enter other professions, prospective pilots cannot secure federally backed student loans. That needs to change, he says. In addition, the number of students must grow to meet demand.

"We have to expand the pipeline," Broom says. "We have to attract people who never thought it possible."

Diversity is key. When passengers enter an airliner and look to the left inside the cockpit, "they have to see people who look like them," Broom says.

Another issue facing the industry is the need to shift away from 100 low-lead (100LL) aviation gasoline by 2030. A forum presented by the Eliminate Aviation Gasoline Lead Emissions (EAGLE) initiative drew hundreds of pilots. The U.S. Environmental Protection Agency is expect-





ed to issue a draft finding this year declaring that 100LL is a health hazard. In addition to finding an unleaded fuel that has similar combustion properties to 100LL, EAGLE is also considering issues involving refining, transporting and storing the fuel (see page 48).

French-based Daher opened AirVenture by unveiling the Kodiak 900, an unpressurized utility turboprop and a larger, faster version of the rugged Kodiak 100. The nine-passenger Kodiak 900 earned FAA certification July 20 with European Union Aviation Safety Agency certification anticipated soon. Deliveries are expected to begin in 2023.

The aircraft is powered by Pratt & Whitney Canada's 900-shp PT6A-140A turboprop engine and equipped with Garmin's G1000Nxi avionics and an all-new interior large enough for double-club seating. Production will take place at Daher's Sandpoint, Idaho, facility.

Tecnam debuted its P2010 Gran Lusso at AirVenture, a luxury version of its P2010 fourseater. The \$626,750 Gran Lusso—"super lux-





ury" in English—features Italian leather upholstery, carbon-fiber insets and a center full-authority digital engine control power quadrant.

Piper Aircraft announced a partnership with CAE, the Canadian flight training and technology company, to develop a kit for converting in-service Piper Archers to electric power. CAE plans to convert two-thirds of the Archer training fleet and will develop a curriculum for new pilots to train on the operation of the electric aircraft.

Gallery Get an inside view of Boeing's ninth ecoDemonstrator, which debuted at AirVenture: AviationWeek.com/ecodemo9

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Podcast Editors at Air Venture share insights on Oshkosh: AviationWeek.com/BCA-podcast



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> PENTAGON PREPARES FOR FIRST HYPERSONIC SHOOT-DOWN TEST

> UPGRADED SM-6 WILL ATTEMPT HGV INTERCEPT

INDUSTRY AND MILITARY OFFICIALS LOOK BEYOND GLIDE-PHASE INTERCEPTOR

Steve Trimble Washington

n the 62 years since a missile was first used to shoot down another missile, offensive and defensive technologies have continued a steady march of progress. Decoys and maneuvering reentry vehicles are now countered, to some degree, by better sensors and nimbler kill vehicles.

The next great leap in the race between offensive and defensive missiles is the rise of hypersonic glide vehicles (HGV), an offensive technology that has gained traction because of its ability to thwart existing ballistic defenses.

With the Soviet Union's 1960 successful ballistic-missile intercept test in mind, the U.S. Missile Defense Agency (MDA) has laid out a longterm, multistep plan to address the HGV threat.

In 2024, the MDA will attempt to shoot down an HGV target for the first time using an upgraded version of the recently fielded Raytheon SM-6 Block IA short-range interceptor. By the end of the decade, the MDA plans to extend defensive coverage by introducing the Glide-Phase Interceptor (GPI), with Raytheon and Northrop Grumman selected in June to compete for the development contract.

Beyond the 2020s, MDA and industry officials have called for a variety of additional technologies including variable-pulse, second-stage motors; an advanced new divert-and-attitudecontrol system; high-power microwaves; and technologies intended to prevent offensive HGV launches in the first place.

Although dedicated to addressing the HGV problem, the defensive technology upgrades—including a spacebased targeting system and a faster command, control and battle management system—can be carried over to ever-more sophisticated aeroballistic and ballistic threats.

To field the MDA's layered hypersonic defense system, the Defense Department must address a funding plan that industry officials say is too small and technology challenges that congressional auditors have warned are significant. The MDA awards to Raytheon and Northrop for the first phase of the GPI competition, for example, amounted to about \$40 million each.

"That's a drop in the bucket compared to what it's going take to actually develop a counterhypersonic capability," Wes Kremer, president of Raytheon Missiles and Defense, tells Aviation Week.

The HGV threat already exists. Russia added the Avangard HGV to its intercontinental-range nuclear arsenal in 2019. China deployed the medium-range DF-17 with an HGV a year later, threatening land bases and warships in the western Pacific Ocean. The U.S. Army plans to field the HGVtipped Dark Eagle missile developed by the Long-Range Hypersonic Weapon (LRHW) program by the end of fiscal 2023, while a Navy version called the Conventional Prompt Strike (CPS) missile is scheduled to follow two years later on surface ships.

The appeal of this new offensive weapon is simple. An HGV reenters the atmosphere quickly to duck beUpgraded versions of existing interceptors such as the SM-3 Block 1B will form the Defense Department's initial defense against hypersonic glide vehicles.



neath the gaze of space-based sensors and maneuvers in the atmosphere to evade detection by ground- and seabased radars. This combination of high speed and unpredictable glidepath increases the difficulty of establishing a firm track until the HGV reaches the terminal phase, where the incoming round can use a substantial advantage in kinetic energy to outmaneuver existing short-range interceptors, such as the Navy's SM-6 and the Army's Patriot Advanced Capability-3.

An example of the evasive power of an HGV appeared in a September 2021 report by the Naval Postgraduate School, which was commissioned by the Naval Surface and Mine Warfighting Development Center. The report compared a salvo attack of 16 Raytheon RGM-109 Tomahawk Land-Attack Missiles (TLAM) on a defended target to a strike by a single CPS missile with an HGV.

"Due to its exceptional speed, maneuverability and low flightpath, a single hypersonic glide-body missile is likely to be able to overcome an active defensive system that could defeat even a salvo attack of TLAMs," the report says.

An effective HGV may be harder but not impossible to shoot down. In wording careful not to overstate the

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capability, the MDA is adapting the SM-6 and Aegis Weapon System to provide a "limited" capability to shoot down HGVs in the terminal phase in fiscal 2024.

The first test of the Aegis Sea-Based Terminal (SBT) layer of defense against hypersonic threats is slated for fiscal 2023. A scheduled MDA test named FTX-40 will attempt to shoot down a "hypersonic target" with an SM-6 Block 1A, according to MDA Director Vice Adm. Jon Hill's written testimony to Congress on May 18. The target for FTX-40 falls short of an HGV threat, which likely points to a surrogate for a ballistic or aeroballistic missile, such as China's DF-21 and DF-26 systems.

The fiscal 2023 test is intended to lead to the graduation event for the Aegis SBT layer a year later. A scheduled MDA test in fiscal 2024 named FTM-43 is planned to fire two SM-6 Block 1A Upgraded interceptors against an HGV, according to Hill's written testimony in May. The source of the HGV target is not identified, but options include artifacts from DARPA's Tactical Boost Glide program, the U.S. Air Force's Air-Launched Rapid Response Weapon program or the Army and Navy's Common Hypersonic Glide Body, which is used by the Dark Eagle and CPS missiles.

By 2024, the MDA also may be able to test new space-based sensors. In addition to the wide-field-of-view sensors of the Space Development Agency's (SDA) Tracking Layer Tranche 0 constellation scheduled to launch this year, the MDA plans to launch the first two Hypersonic and Ballistic Tracking Space Sensors (Hbtss) with mediumfield-of-view systems in the spring of 2023. The Tracking Layer and Hbtss payloads are designed to provide real-time tracking of maneuvering hypersonic vehicles in the atmosphere, with the targeting coordinates relayed to interceptor batteries by the SDA's associated Transport Layer constellation (AW&ST July 13-26, p. 42).

But the SM-6 Block 1A upgraded interceptors will face a daunting challenge in FTM-43. As terminal-phase interceptors, the SM-6s are facing the HGV during its final dive to the target, when the incoming weapon is at the peak of its kinetic power. Moreover, the Tracking Layer and Hbtss systems offer less of a sensing advantage during the terminal phase, when surface-based radars are able to pick up the incoming HGV as it appears over the horizon.

To maximize the chances of a successful intercept, the MDA wants to attack the incoming HGV during the glide phase with ship-based interceptors. The agency launched the GPI program last year to field an interceptor missile by the late 2020s.

In June, the MDA selected Raytheon and Northrop to compete for the GPI contract, eliminating a bid by Lockheed Martin. Northrop is mainly known in missile defense interceptors for supplying the air-launched, intermediate-range ballistic missile used for shoot-down tests by the Boeing Ground-Based Interceptor. But the company also supplies the pulse-fired Mk. 136 third-stage rocket motor for the Raytheon SM-3 Block 1B. Raytheon, well known for supplying the SM-3 family of theater-coverage interceptors, proposed a new "Hawk" version to the MDA to shoot down HGVs.

The winner of the competition must supply an interceptor that is compatible with the 21-in.-dia. Mk. 41 Vertical Launch System (VLS) on Navy combat ships. The design constraint allows the MDA to field a counter-HGV interceptor by the end of the decade but comes with performance limitations. Indeed, MDA officials say a shoot-down attempt can be effective even if the GPI misses the target, as it weakens the incoming HGV by bleeding off energy before the HGV faces off against terminal-phase interceptors.

For the long-term, the Pentagon and

MISSILE DEFENSE

defense industry officials are looking beyond the GPI program. The future hypersonic defense architectures will include additional layers, including high-power microwaves and new interceptor technologies. A major improvement for interceptors could be variable-pulse or throttleable rocket motors, even if they are too large to fit inside a Mk. 41 launch tube.

"If you think about: What could I do in an unconstrained environment? My second-stage rocket motor—I might want it to be a little bit different than the one I have today, the ones that are available to fit in a Mk. 41," says Raytheon's Kremer. "What you really would want to do in something like this is have the ability to fire multiple pulses. Because what happens is, obviously, you're dragging along the weight of the missile when you're still in the atmosphere. And if you burn it all at the beginning, then you know, the longer it is to intercept, the less maneuver you have at endgame. But if I can coast for a while and then reaccelerate in the endgame, I can have a lot

more divert-and-maneuver available."

DARPA's Glide Breaker program has selected Aerojet Rocketdyne and Northrop to develop competing versions of an advanced divert-and-attitude-control system for a future kill vehicle targeting HGVs in the glide phase.

In public remarks on July 12, Mike White, director of the hypersonic portfolio for the Pentagon's research and engineering branch, said the U.S. military is already looking beyond the Aegis SBT and GPI layers for hypersonic defense.



Tracking Target

SPACE DEVELOPMENT AGENCY AWARDS INFRARED MISSILE-TRACKING SATELLITE CONTRACTS

CAPABILITY IS A DECADES-OLD PENTAGON GOAL

Garrett Reim Los Angeles

o counter China's and Russia's growing arsenals of hypersonic and ballistic missiles, the U.S. Space Development Agency is moving quickly to develop and launch a constellation of missile-detection-and-tracking satellites. The outfit has awarded two prototype contracts worth about \$1.32 billion to teams led by L3Harris Technologies and Northrop Grumman Strategic Space Systems for 28 Tranche 1 Tracking Layer satellites.

The constellation of overhead persistent infrared missile warning and tracking satellites intend to help the U.S. defend against ballistic and hypersonic missiles, the Space Development Agency (SDA) said on July 18.

Conventional U.S. overhead persistent infrared missile warning sat-

ellites were designed to spot ballistic missiles with a relatively straightforward and predictable trajectory. The Tranche 1 Tracking Layer satellites are designed not only to detect but to track hypersonic and ballistic missiles. Boost-glide hypersonic missiles can maneuver unpredictably, making it difficult to calculate where the weapon will land.

"We will not only be able to do the old school mission of missile warning—detect the launch and predict the impact point—but we'll be able to detect [a hypersonic missile] as it's maneuvering and changing its impact point and be able to send that down and be able to tell an interceptor exactly where that missile is headed," SDA Director Derek Tournear says.

Due to the immediacy of the threat of hypersonic missiles, which are being developed and fielded by Russia and China, the SDA awarded contracts about four months after it published the Tranche 1 Tracking Layer satellite solicitation on March 17. Congress gave the SDA an additional \$550 million in fiscal 2022 to accelerate de-

Hypersonic missile threats from China and Russia are driving the SDA to launch the Tracking Layer constellation.

velopment of the Tracking Layer, directing the agency to demonstrate the capability specifically in support of the U.S. Indo-Pacific Command.

The U.S. has relied on sea- or ground-based radar for missile tracking, but new threats require a new approach, says Tom Karako, director of the Missile Defense Project at the Center for Strategic and International Studies.

"Every single presidential administration since the Reagan administration has recognized the need for space-based sensors for missile defense," he says. "And so far, it's been almost exclusively done on paper in terms of the tracking problem. It's high time to get after this."

The SDA will take an initial stab at the problem with its Tracking Layer Tranche 0 constellation, consisting of eight prototype infrared missile warning and tracking satellites. In 2020, SpaceX and L3Harris were contracted to develop four satellites each for Tranche 0. The SDA plans to start launching those in September 2022 and March 2023.

That initial group of satellites is to demonstrate the capability of wide-

Advanced technologies such as a new divert-and-attitude-control system and variable-pulse rocket motors may be added in future layers of the hypersonic defense system.

"We are looking at comprehensive layered defeat strategies of what we might do left and right of launch and kinetic and nonkinetic [capabilities] across the portfolio of options for defense against adversary systems," White said. ©



field-of-view infrared missile warning and tracking from space, reducing risks for future satellite tranches, Tournear says. Tranche 1 is intended to improve on its predecessor satellites with technology enhancements, expanded coverage, increased integration and improved production efficiencies, the SDA says.

As part of the Tranche 1 program, L3Harris was awarded a prototype contract worth about \$700 million for 14 satellites (about \$50 million per satellite). Northrop Grumman Strategic Space Systems was awarded a contract worth \$617 million for 14 satellites (\$44 million per satellite). Both contracts cover all nonrecurring engineering for the satellites' development, construction and operational costs.

The overall Tranche 1 Tracking Layer program is worth about \$2.5 billion, with the remainder of the total paying for space launches, ground operations and integrations and other costs.

The wide-field-of-view infrared satellites are scheduled to be put into orbit across four launches starting in April 2025, Tournear says. Each launch is planned to populate a different orbital plane. The low-Earthorbit satellites are intended to fly at about 1,000 km (620 mi.) in altitude in polar orbits.

The Tracking Layer's infrared sensors are designed to pick up on a hypersonic missile's rocket booster during ascent, as well as the vehicle itself as it maneuvers and heats up in the atmosphere. Tracking data is shared with the SDA's Transport Layer, a constellation of laser communications satellites.

"Our tracking satellites can see [a missile] instantaneously. Those track-

ing satellites detect it, they calculate the 2D track of where that missile is headed and continually update that 2D track," Tournear says. "They will take that 2D track and send that to the Transport Layer, which will send that down in hundreds of milliseconds to the ground station, where they will fuse all of those 2D tracks from multiple tracking satellites together."

The combination of multiple tracks allows for a 3D track to be calculated.

"The 3D track is important because that could actually be used to send to an interceptor to be able to take out that hypersonic maneuvering vehicle," Tournear says.

Maintaining fire-control quality data and not dropping the tracking mission will be critical for the program's future, Karako says. "Make sure it retains connectivity to that missile-defense-centric mission so we don't just admire the problem but can actually do something about it," he says.

Karako adds that there is concern about the future of the Missile Defense Agency's Hypersonic and Ballistic Tracking Space Sensor (Hbtss) prototype satellite, an infrared satellite with a smaller field of view but better sensitivity for fire control that is supposed to work in coordination with the Tracking Layer.

"The Missile Defense Agency is currently budgeted to continue to develop the sensor payload for Hbtss through fiscal 2023. But not after," he says. "There could be a handoff [to another Pentagon entity]. We want to make sure that handoff doesn't become a fumble in terms of the missile-defense-centric mission and the fire-control quality requirement, specifically."

For its part, the SDA also wants

to share tracking data with military personnel on the ground.

"They don't have direct connectivity to all these Tracking Layer satellite data feeds, but they do have direct connectivity to the Transport Layer. The Transport Layer gives them connections via Link 16; it gives them connections via K_a-band downlinks and other bands," Tournear says. "I can send that information down directly into [the] theater so that individuals can know whether they need to take cover or ... whether they can start to engage other radar or weapon systems to intercept that hypersonic maneuvering vehicle."

The SDA plans to add tranches continually to its Tracking Layer, with 54 satellites likely being launched as part of Tranche 2, Tournear says.

"You get in this continual replenish mode because the satellites themselves have a five-year lifetime," he says. "Every five years you're replacing the whole constellation, so that means every year that's 20% of your constellation [being replaced]."

Frequently adding and replacing satellites allows for the latest and greatest technology to be continually put in orbit. The acquisition structure of the Tracking Layer program is such that new entrants—or companies that lost prior competitions—have opportunities to offer the SDA better technology. The SDA wants to avoid getting "stuck in a vendor-lock situation," Tournear said at the Space Symposium in April.

"One of our goals was to create a market," Tournear says. "If you lose on one solicitation, it doesn't mean you're out of the market for good. It just means that in another year or two, you'll be able to bid again, and it will be an open competition." ©

U.S. Supplier Proposes Mass Production for Hypersonic Vehicles

> SPIRIT AEROSYSTEMS AUTOMATES CARBON-CARBON PRODUCTION

> PROPOSAL SUBMITTED TO THE PENTAGON SUPPORTS 50 GLIDE VEHICLES ANNUALLY

Steve Trimble Washington

ichita-based Spirit AeroSystems needs to find work for the huge buildings and thousands of engineers idled by the continuing COVID-19-pandemic-induced slowdown in the commercial widebody aircraft market.

Meanwhile, the U.S. Defense Department needs a supplier with the technical know-how and manufacturing caThe Pentagon's current plan calls for a maximum output of 24 CHGBequipped missiles per year, with a key limiting factor being the industrial capacity to produce the glider's thermal protection system (TPS) at a faster rate.

The proposal included a \$1 million price target per shipset of the TPS material that wraps around a hyper-



Spirit AeroSystems wants to bring commercial-aviation-scale industrial capacity and automated systems to the hypersonic vehicle field.

pacity to quickly and affordably ramp up production of the costly and complex high-temperature metals required for a new class of hypersonic missiles.

A solution to both problems is now being considered by the Pentagon. In May, Spirit AeroSystems submitted a white paper to Mike White, who leads the hypersonic weapons portfolio in the research and engineering branch of the Office of the Secretary of Defense.

The paper included a proposal to build 50 thermal protection systems annually for the Common Hypersonic Glide Body (CHGB), the warhead delivery system shared by the Dark Eagle missile in the Army's ground-launched Long-Range Hypersonic Weapon (LRHW) program and the Navy's shipand submarine-launched Conventional Prompt Strike program. sonic glide vehicle as a heat-resistant blanket, says Joshua Boehm, Spirit AeroSystems' vice president for defense business development and strategy.

As a company mostly known for designing and building structures for subsonic commercial aircraft, Spirit AeroSystems may seem an unlikely supplier for some of the U.S. military's most advanced weapon systems. But it has become an increasingly important player in the defense industry, winning key supplier roles on the Northrop Grumman B-21 bomber and, according to the company's financial reports, multiple classified programs.

Since the COVID-19 pandemic started in early 2020, Spirit AeroSystems' annual revenues have plunged: They were \$3.95 billion last year, a 49.7% decline compared to \$7.86 billion in 2019. The company is a key supplier for the Boeing 787 and Airbus A350, among other commercial aircraft programs, but demand for new widebody aircraft has been slow to recover. Airbus and Boeing also have no new clean-sheet commercial aircraft in development. The result is a huge surplus in production and engineering capacity at Spirit AeroSystems.

The company also has invested in the technical expertise necessary to build hypersonic vehicles. In January 2020, Spirit AeroSystems acquired FMI Metals, a small company in Maine that has produced TPS for decades, with applications including intercontinental ballistic missiles that deploy hypersonic reentry vehicles. FMI had mastered the process of small-batch production of the carbon-carbon composite materials used in some TPS but lacked the capacity and engineering knowledge to scale up delivery rates as the Pentagon sought to buy dozens of hypersonic weapons annually.

In the 2.5 years since the acquisition, Spirit AeroSystems' engineers have developed an automated weaving process for FMI's carbon-carbon composites, says Duane Hawkins, president of Spirit's Defense and Space business. The previously handcrafted TPS can now be scaled up affordably to deliver TPS to the Pentagon's hypersonic glide vehicles, he says.

"We've been able to cut the manufacturing costs down significantly, by just putting in some basic fundamental [automated processes]," Hawkins says.

Spirit AeroSystems also has design capabilities. Although the CHGB Block 1 design is complete, Spirit AeroSystems' designers were able to modify the structure to make it easier to produce in the automated process without reducing performance, Hawkins says. "We've got a technique that we've done with one of our customers," he says. "We prefer to get involved in [the design] on Day 1, but we don't have to be involved at Day 1."

Spirit AeroSystems' proposal caught White's attention. In a July 12 public appearance, White laid out a plan to invest \$500 million in the industrial base to bolster capacity for hypersonic weapons, and he called out Spirit AeroSystems specifically as an ideal supplier.

"I've had some great business and great conversations with companies like Spirit [AeroSystems], which builds the fuselage sections for the [Boeing] 737s and does so in large numbers," White said. "How do we get that commercial high-rate production mentality and affordable production mentality applied to a hypersonic system?"

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- NASA STUDY SEEKS TO IMPROVE AIR-TO-GROUND CONNECTIVITY FOR AIRLINERS
- > THE PROJECT COULD FURTHER THE FAA'S NEXTGEN VISION
- > ADVANCED AIR MOBILITY SECTOR MIGHT BE FIRST TO TAP CLOUD-BASED FLIGHT MANAGEMENT

David Hughes Reston, Virginia

hy should the flight management system on an aircraft's flight deck know more about what is going on than people on the ground who are supporting the flight? A flight management system (FMS) in the cloud—accessed over a secure internet connection (similar to VPN) to a cloud service such as Amazon Web Services or Microsoft Azure—could change this by providing a digital twin on the ground synced up to the one on the flight deck. The ground-based FMS in the cloud would be connected to a variety of data not available on the flight deck, such as higher-resolution weather information.

SmartSky Networks, GE Aviation and Mosaic ATM are working on the second phase of experimentation with NASA, which has funded the companies via a NASA innovation award, to see how an FMS in the cloud might work.

SmartSky, a startup based in North Carolina's Research Triangle, launched initial service with its new air-toground connectivity network in June 2021 in what it calls the Southeast cor-

GE's TrueCourse connected FMS and cloud FMS link a pilot's electronic flight bag (EFB), air traffic control (ATC), air operations centers (AOC) and data analytics programs.

ridor—13 states in the Southeast U.S. including Florida. The service provides bidirectional connectivity for business jets and turboprops. The nationwide rollout was completed at the end of July this year.

Todd Kilbourne, senior program manager for Mosaic, notes that the FAA uses many ground-based automation systems for air traffic control, air traffic management and flight operations. These all use different, customized trajectory models for their calculations. "I have been working on traffic modernization programs for 25 years, and I constantly hear people say, 'I wish we had more information from the aircraft,'" Kilbourne tells Aviation Week.

SYNCING WITH THE GROUND

But as it turns out, what the FMS knows mostly stays on the flight deck. The three partners in this simulation and flight-test program would like to change that.

The first phase of the study was a NASA Small Business Innovation Research program effort in a lab at SmartSky Networks. This phase simulated an FMS on a flight deck syncing up data with an FMS in the cloud located on the ground. Mosaic ATM wrote the software for the feasibility project, and the results were shown to NASA in February 2021. Mosaic ATM of Leesburg, Virginia, is a leading U.S. company conducting research and development of new concepts for air traffic management.

A few months later, the team of Mosaic and SmartSky joined by GE Aviation secured funding for Phase 2. The GE unit in Grand Rapids, Michigan, was acquired from Smiths Aerospace in 2007.

The FMS in the cloud team is now using a new modular GE TrueCourse FMS during simulations and flight tests with a SmartSky King Air. The FMS on the experimental test flights will be used in shadow mode; it will not control the aircraft. The new FMS is about to be certified, and it is planned to enter the airline market first, followed by the military, business aviation and rotorcraft sectors. New modules are intended to be substituted, such as one with a rotorcraft performance database to accommodate the dynamics of helicopters or electric vertical-takeoff-and-landing (eVTOL) vehicles. The modular architecture allows GE to scale the capability of its new FMS up or down to meet the needs of a particular model airframe, while much of the software remains standardized to reduce the cost of customization.

The new FMS, dubbed TrueCourse by GE, is a modular design that meets DO-178 standards developed by the RTCA and the European Organization for Civil Aviation Equipment (Eurocae). The modularity of the functions is enabled by reusable components with their own artifacts that allow for easier updating. The FMS is configured for easy adaptation to new features on different aircraft platforms. A multifunction control display unit and a flight management computer are not needed, as their functions can be included in the touch-screen control.

Gary Goz, senior director of product management for GE Aviation Systems, says that once computing power for avionics is installed on the flight deck, "it becomes antiquated very quickly." This makes it hard to add new capability and functionality to an FMS. So although safety-critical tasks must be performed on the aircraft, non-safety-critical tasks can be moved offboard, as pilots do with flight planning on electronic flight bags (EFB).

TRAJECTORY NEGOTIATIONS

Kilbourne says the first phase of the project showed that the SmartSky network could make a digital-twin FMS in the cloud work. The second phase is focusing on demonstrating trajectory negotiations, with an eye toward the FAA's NextGen vision of implementing trajectory-based operations (TBO).

The cloud FMS concept alleviates the need to download potentially proprietary information such as aircraft weight to a ground automation system to improve trajectory-modeling performance. Simulations of trajectory negotiations are slated to start at a SmartSky lab in Sterling, Virginia, in August. After tests with three simulated aircraft, flight tests with one aircraft and two simulated aircraft are expected to start in the fall. Other use cases are planned to be simulated later.

"The connected solution between the air and the ground is very important, and it can solve a lot of problems," Goz says. "So the cloud FMS concept we're proving out is really part of a larger ecosystem we envision at GE. There are a lot of other things we are looking at."

For example, the company plans to load on pilots' EFBs flight plans that are in the FMS in the cloud. "The pilots will have the same data at their fingertips to make decisions about trajectories and deconfliction," Goz says.

Brit Wanick, vice president of marketing and partnership for SmartSky, says his company's network provides high bandwidth, low latency and bidirectional capability, enabling it to transfer data at equal rates to and from the aircraft. The SmartSky network uses beam-forming technology, which provides a separate connection for each aircraft, delivering more secure and stable performance. The technology has benefits for inflight entertainment as well, providing real-time responsiveness for livestreaming, large file transfers, video conferencing and gaming.

In addition to supplying the network, SmartSky is interested in the FMS in the cloud as a service if it develops into a product. Mosaic is in the business of researching how to use airspace more effectively, and GE is looking for innovative uses for its new TrueCourse FMS.

The FAA aims to institute TBO as the next step in its NextGen airspace modernization. TBO involves the exchange of data on the precise 4D trajectory (latitude, longitude, altitude and time) of each aircraft. Air and ground systems will exchange this data, and aircraft will use performance-based navigation to fly on exact coordinates in space and time. TBO is intended to smooth out imbalances between traffic demand and capacity.

Moving toward the next step in TBO—managing flight plan changes across air traffic control boundaries—a Mosaic ATM team is working with an Embry-Riddle Aeronautical University testbed on multiregional TBO in a project sponsored by the FAA NextGen office, Kilbourne says. This involves TBO tasks in more than one en route sector across more extended timelines.

A key objective of the FMS-in-thecloud experiments is to create a capability for exchanging even more precise trajectory information than is possible with an FMS on the flight deck.

"The FMS in the cloud can process a multitude of variations as well as access data not available on the flight deck," Wanick notes. "The flight deck doesn't have access to information on the other aircraft in the airspace. In addition, the FMS in the cloud has access to significant computing power through Google or Amazon and third-party data that can be synthesized and used in the cloud."

For example, SmartSky already has access to real-time and historic turbulence data that might affect an aircraft's route. This data is available to SmartSky through a partnership with the International Air Transportation Association (IATA). SmartSky is using IATA's Turbulence Aware platform, which measures energy/ eddy dissipation rate (EDR) observed in flight by aircraft of 20 airlines. EDR is a turbulence metric based on the rate at which energy dissipates in the atmosphere.

The EDR measurement characterizes turbulence in the atmosphere to help aircrews find smooth air. SmartSky has exclusive rights to distribute this information to business aviation customers through a product named SmoothSky. If there is not an

AVIONICS

observation on the desired route at a particular time, the user can access a report from the aircraft that was in the area most recently. By alerting aircrews to turbulence, the service helps business jet operators avoid crew or passenger injury while providing a more comfortable ride—ensuring there are no whitecaps on the martinis, as the old business aviation saying puts it.

This sort of data could be synced up with planning a reroute or a request for a different altitude that an airline dispatcher or fractional-jet operations center could transmit to standardized. FMS in the cloud data could provide many types of data needed for routing, planning optimization and rerouting due to events such as a closed vertiport.

One question NASA seeks to answer is how long the digital twin FMS will remain synchronized with the one on the flight deck. That can be determined by observing when the FMS in the cloud provides a different trajectory prediction for the aircraft than the FMS on the flight deck.

The FMS in the cloud is also applicable to business aviation. "There is significant interest in this in business world's internet traffic. Dozens of data centers were built there when rural land was cheap, but now it costs \$1 million per acre. Loudoun County has 1 gigawatt of overall data center capacity, with London a distant second.

GE recognizes the industry's concern around cloud connectivity to the cockpit and the security of EFB systems that can share data with an FMS. Cybersecurity will be a top issue going forward with the FMS in the cloud. GE's product security group is embedded as part of the FMS in the Cloud project team, working to identify and document risks

that need to be addressed. The GE FMS treats data received through the cloud FMS or while connected to an EFB as untrusted data sources that have

The TrueCourse FMS uses two traditional control display units (on the center console) and can also be utilized through touchscreen displays.

to be validated and presented to the pilot, who can accept or reject it.

The FAA plans to employ automation-driven, time-based flight trajectories negotiated

among the agency, aircraft operators and stakeholders. Based on this, it is not surprising that SmartSky, Mosaic and GE are experimenting with FMS in the cloud, which can enable such trajectory negotiations. Goz says the FAA may be interested in FMS in the cloud because of the increased accuracy of trajectory predictions that would provide benefits to a variety of FAA automation systems.

The pilots will be busy flying the aircraft while planners on the ground at an airline dispatch office or business jet fleet managers determine reroutes as needed. And they will have access to vast computing power from the likes of Google or Amazon to crunch numbers, including a lot of data such as more precise weather observations or forecasts not easily digested at 35,000 ft.



the flight deck. Dispatchers could explore different trial flight plans using the cloud version before selecting one and communicating with the pilots in the cockpit to obtain their approval.

ADVANCED AIR MOBILITY

The partners in this project also are focused on the potential to use FMS in the cloud with eVTOL vehicles and other advanced air mobility (AAM) aircraft. The FMS in the cloud might be adopted more quickly in that segment, where everything is new, Kilbourne says. Initially, pilots will be onboard passenger air taxis to monitor systems, but eventually pilots are expected to be remote, and autonomy will be relied on more heavily.

The required command-and-control links for eVTOLs and other AAM aircraft are in the process of being aviation as there is a shortage of pilots," Wanick says. "So being able to augment the capability for aircraft to fly in a dual- or single-pilot configuration will improve safety and utilization of the aircraft, which is important to everyone from a business or private owner up to corporations."

GROUND CLOUD CAPACITY

Goz expects that use of FMS-inthe-cloud services via connectivity will be so widespread that while the FMS will remain on the flight deck as a safety backup, it will be used more like a standby display is today. It will be there, but pilots will only use it in situations where they need it.

The digital-twin FMS in the cloud is maintained at Ashburn, Virginia, in Loudoun County near Washington, where data centers handle 70% of the

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GETTING THE **LEAD**

> THE FAA'S EAGLE INITIATIVE FOCUSES BROADLY ON INFRASTRUCTURE

> UNLEADED AVGAS CANDIDATES ADVANCED THROUGH STCs

> EPA EXPECTS TO ISSUE DRAFT "ENDANGERMENT FINDING"

Bill Carey Washington

hen former FAA Administrator Steve Dickson announced an initiative in February to eliminate the use of leaded aviation fuel in piston-engine aircraft by 2030, he committed government and industry to fixing in eight years an emissions problem the sides have faced for more than a decade already.

Dickson unveiled the Eliminate Aviation Gasoline Lead Emissions (EAGLE) initiative at the annual General Aviation Manufacturers Association (GAMA) media briefing. The initiative requires industry to accomplish the first two of a four-step approach to eliminating leaded aviation fuel, or avgas, within this decade. Those steps entail building the infrastructure and coordinating production of commercially viable unleaded fuels and, second, supporting research and testing of needed piston engine modifications or engine retrofits.

The FAA will perform fleetwide testing and qualification of unleaded aviation fuels of different octane levels. Following an expected "endangerment finding" by the U.S. Environmental Protection Agency (EPA) that piston-engine lead emissions contribute to air pollution and may endanger public health, the EPA, through a rulemaking process, plans to develop a regulatory standard for lead emissions from aircraft engines. The FAA would conduct its own rulemaking process to prescribe standards for the composition of unleaded avgas.

"Our fundamental objectives and goals are to assess and evaluate all candidate unleaded fuels that could be potentially viable as a replacement for 100 Low Lead [avgas]," says Walter Desrosier, GAMA vice president of engineering and maintenance. "In that, there is a primary desire for something that is going to have the minimum impact on the existing fleet; our goal is something that works as seamlessly as possible for as much of the existing fleet as possible. There is a high priority on something that would be at least 100-octane because that we know is one of the factors that a fuel has to have to work for the existing fleet."

Octane, a chemical compound, helps suppress detonation, or an uncontrolled explosion, inside an engine's combustion chamber where the fuel/ air mix is burned. The fuel additive tetraethyl lead (TEL) is used to boost octane rating. The higher the octane rating of a fuel, the higher its resistance to detonation. In the U.S., leaded gasoline was gradually phased out and finally banned in 1996 for use in vehi-



cles other than aircraft, race cars, farm equipment and marine engines.

Piston aircraft that operate on leaded fuel are the largest remaining source of lead emissions into the air, contributing 70% of the lead being emitted annually, the EPA says. Additional sources of lead emissions into the air include ore and metal processing operations, lead smelters, waste incinerators, utilities and lead-acid battery manufacturers.

"Years ago, lead was banned from all road vehicles due in part to the severe health consequences of lead exposure," Rep. Hank Johnson (D-Ga.) said July 13 during a House aviation subcommittee hearing on the state of general aviation. "Today, aviation fuel for piston-engine aircraft is our country's main and primary source of lead emissions, and the link between piston-engine aircraft and blood-lead levels has never been stronger. Recent research shows a correlation between high levels of lead in children's blood in relation to proximity to airports."

Addressing GAMA President and CEO Pete Bunce, one of the witnesses testifying at the hearing, Johnson asked: "Mr. Bunce, are you and the manufacturers you represent confident that the EAGLE initiative will succeed?" Bunce replied: "Yes sir, we are confident."

However, Bunce added: "The FAA has never done this. We've certified



engines to operate on a fuel; the FAA has never certified an actual fuel."

CHARACTERIZING THE FLEET

The EPA cites the FAA as its data source but differs from the FAA-industry partnership when describing the U.S. piston fleet, counting 172,000 piston-engine aircraft, of which it says the vast majority use leaded fuel. The FAA and industry count 167,000 pistonengine aircraft, with fewer, larger twin-engine cargo and commercial aircraft consuming the most leaded fuel.

"Even though it's a smaller number of the fleet percentage-wise, it's a larger volume of the actual [general aviation] flying in the United States," Desrosier says. "We've always had this [30/70] rule of thumb: 30% of the fleet requires 100-octane or high-performance fuel for high-performance engines and airplanes, but they consume about 70% of the avgas. We recognize we have to have better data than that, and that's part of what EAGLE is looking at."

Months before Dickson's announcement, local communities acted on their own to phase out leaded avgas. In December 2021, several general aviation associations asked the FAA to intervene after a "rushed" decision by the board of supervisors of Santa Clara County, California, to ban the sale of 100 Low Lead (100LL) avgas at two airports near San Jose—Reid-Hillview and San Martin—as of January. Companies and groups aligned as the Avgas Coalition argue that removing 100LL avgas prematurely would ground 30% of the piston-engine fleet and increase the risk of pilots misfueling airframes that look visually similar but require different types of fuel. There is also suspicion that communities are using leaded avgas as a hook to close some airports altogether.

"We're very concerned about losing airports," Mark Baker, president and CEO of the Aircraft Owners and Pilots Association (AOPA), told reporters during an EAGLE briefing in March. "Some [communities], notably a couple in California, seem to be using this as an urgency to close their airports, not related to the fuel issue. Those airports have been there for 50-60 years. We have committed publicly as an industry to move away from this fuel by 2030, but it is a point of contention at a few airports."

On Jan. 12, the EPA announced that it will evaluate whether emissions from piston-engine aircraft using leaded fuel endanger public health, a prelude to requiring new fuel performance standards under the Clean Air Act dating to 1970. The agency plans to issue a proposed endangerment finding for public review in October and take final action in 2023.

Environmental groups have long lobbied the EPA to address aviation lead emissions. Friends of the Earth petitioned the agency to conduct a rulemaking on lead emissions from GA aircraft in 2006 during the Bush administration, which the EPA denied in 2012 during the Obama administration. In its petition, the group noted that the Nascar racing organization, with EPA prodding, had committed to phasing out leaded fuel in stock cars in the next two years.

"EPA's concern with removing lead from Nascar fuel indicates the importance of removing mobile-source lead emissions, and yet EPA has not acted to address lead fuel use in general aviation fuel," Friends of the Earth said in its 2006 petition. "Now that leaded gasoline use in Nascar has been addressed, it is time for the EPA to focus on the more important task of removing lead from general aviation fuel."

In 2015, the EPA denied another petition by Friends of the Earth, Physicians for Social Responsibility and Oregon Aviation Watch to reconsider its 2012 decision. At that time, the agency said it would issue a final endangerment finding in 2018. In January of this year, in response to a petition by groups including Alaska Community Action on Toxics, the EPA committed to the current 2022-23 time frame for an endangerment finding.

"The EPA has conducted extensive data collection and analysis to use in evaluating the endangerment finding," the agency stated, when asked to explain the timeline. "In 2016, the EPA had initiated the endangerment finding action and it was subsequently placed in a long-term agenda."

EARLY CANDIDATE FUELS

Industry and the FAA have planned for more than a decade to expedite the use of unleaded aviation fuel. The FAA assembled an Unleaded Avgas Transition Aviation Rulemaking Committee in 2011 that issued recommendations in January 2012. In 2013-14, the FAA formed the Piston Aviation Fuel Initiative (PAFI), a governmentfunded testing program to assess an unleaded avgas "with the least impact on the existing piston-engine aircraft fleet." The ongoing PAFI effort and broader EAGLE initiative are complementary, the parties say.

After conducting a screening information request for proposals, the FAA selected four unleaded fuels for firstphase testing under the PAFI evaluation—two from Swift Fuels and one each from Shell and Total. Ultimately, none of the candidate fuels met the program's criteria. Two of the fuels, from Shell and Swift, advanced to further testing, but Shell eventually suspended work under PAFI, and Swift withdrew from the program.

The PAFI effort has been restructured; it now requires pre-screening of fuels and is open to all candidates. Two fuels are being tested, according to GAMA's Desrosiers: one from a consortium of Phillips 66 and Afton Chemical; the other from VP Racing Fuels and chemical company Lyondellbasell. sons, GAMI elected to not participate in the PAFI process," Engineering Director George Braly wrote in a January 2017 article published by the American Bonanza Society. "One of the primary reasons was that in order to do so, GAMI would have essentially been required to start over with the certification process. And we had already made a lot of progress, including conducting our first 150-hr. on-aircraft endurance test."

At the Experimental Aircraft Association AirVenture Oshkosh in July 2021, GAMI announced that the FAA



In March, Santa Monica Airport in Southern California started offering Swift Fuels UL94 unleaded avgas as an alternative to 100LL.

Data generated through the process would support an FAA fleet authorization, Desrosier says—if a fuel is tested and found to be acceptable for some portion of the piston fleet—as well as an ASTM product specification, which supports the production, distribution and commercialization of a product.

Separately, Swift Fuels and General Aviation Modifications Inc. (GAMI) are each advancing unleaded avgas products through FAA supplemental type certification (STC) efforts. Swift, which supplies UL94, a 94 motor octane number (MON) unleaded avgas, says its 100R 100 MON avgas designed to replace 100LL is undergoing both FAA certification and development of an ASTM specification.

GAMI started work on its G100UL unleaded avgas in 2009 and years later passed on joining the industry-government PAFI program. "For a lot of reahad approved STCs authorizing the use of G100UL for an Approved Model List (AML) of a small number of aircraft and engines. Last October, the FAA expanded the AML to include 611 engines; with the earlier approvals, the list now covers about 70% of the powerplants in the general aviation fleet, according to AOPA consultant Paul Millner.

GAMI was waiting for the FAA to sign off on a further expansion of the AML for using G100UL "to include all of the spark-ignition piston engines in the FAA's type certificate database and all of the aircraft that use any of those spark-ignition piston engines," Braly told reporters at the Sun 'n Fun Aerospace Expo in April. "From our point of view, that is a fleetwide approval."

Desrosier explains that the STC process considers airworthiness requirements of a fuel under the FAA's Part 23 and 33 certification regulations for airplanes and aircraft engines, respectively. The EAGLE initiative is looking beyond minimum airworthiness standards toward infrastructure and environmental aspects of a new unleaded avgas.

"We're looking [at a fuel] from a viability perspective in the areas of production, distribution and of broader environmental interests—making sure that if there are new components [in the fuel], what do those components mean from an environmental perspective, from an [Occupational Safety and Health Administration] perspective in terms of materials safety and handling," Desrosier says. "None of those [factors] are looked at in an FAA STC."

The EAGLE participants, including engine and aircraft manufacturers, fuel suppliers, local and federal government entities, associations and other groups, are also discussing ways to reduce the impact of lead emissions during the transition to a new unleaded fuel—possibly by making more UL94 available and through conducting a pilot program to study lead emissions dispersion at communities near airports.

"There are a lot of airports and communities with a desire to look at opportunities to reduce lead emissions in the near term, so another part of EAGLE is taking a look at how we can help enable, facilitate and support that," Desrosier says. "One of the most important things we want to do is ensure that general aviation can continue to fly safely in the U.S. infrastructure, and we can't have a patchwork of airports with and without 100 Low Lead. That would create an extremely unsafe environment for general aviation in the United States, so we're looking at enabling and facilitating a reduction in lead emissions by making UL94 available and helping to find programs and initiatives that help do that while maintaining availability of 100 Low Lead."

The FAA conducts fuel testing at the William J. Hughes Technical Center near Atlantic City, New Jersey. The agency says it "plans to more than double the funding for its efforts to move toward a lead-free aviation future." The FAA is spending \$5 million in that area in the current fiscal year and has budgeted \$12 million for 2023.

Though EAGLE allows the FAA and

industry eight years to phase out leaded avgas, the effort must narrow its focus on unleaded alternatives sooner than that, Desrosier says.

Former FAA Administrator Steve Dickson (front row, fourth from left) and association executives unveiled the EAGLE program in February.

"We have five 100-octane candidate fuels that we're aware of," including the Swift and GAMI products, Desrosier says. "We need to vet those within the next two years. Are they going to be potentially viable or not? It may take more than two years to get the certification approval for a fleetwide authorization. But within two years we have to know: Are we going down that path or not? Do we have a viable candidate fuel or not? If not, what's our alternative?"

"Within two years, I expect that we will be looking at an initiative in which the stakeholders come together and

AVIATION WEEK



say we have some viable 100-octane candidates that are moving forward," Desrosier adds. "Based on how viable they look, we might decide we need to start investing and working with some of the fuel producers on the best high-octane fuel that we can achieve that might not be 100." ©

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FREIGHTER FLUX

> GLOBAL AIR CARGO DEMAND FELL 8.3% YEAR-OVER-YEAR IN MAY

> BOEING ANNOUNCED FREIGHTER ORDERS AT FARNBOROUGH INTERNATIONAL AIRSHOW

Helen Massy-Beresford Paris

hile the pandemic may be far from over, the air cargo market—a sector that has played a key role amid the upheaval, and which has seen significant changes because of COVID-19—is now looking to the future, with multiple factors set to drive long-term growth even if the short-term picture is more mixed.

The International Air Transport Association's (IATA) most recent data, for May 2022, shows that global demand, measured in cargo ton-kilometers, was 8.3% below May 2021 levels, an improvement on the year-on-year decline of 9.1% seen in April.

Capacity has been severely squeezed during the pandemic due to the ongoing grounding of many long-haul flights, which removed belly capacity from the mix and contributed to a revival of interest in freighters. Capacity rose 2.7% compared with May 2021. "This more than offset the 0.7% year-on-year drop in April," IATA said. "Capacity expanded in all regions, with Asia-Pacific experiencing the largest growth."

IATA noted several factors at play in the equation facing the global air cargo market: Trade activity ramped up slightly in May as Omicron lockdowns in China eased and volumes grew elsewhere, too; new export orders, a leading indicator of cargo demand and world trade, decreased in all markets, except China; and the war in Ukraine continued to impair cargo capacity used to serve Europe, with the removal of several key cargo airlines based in Russia and Ukraine.

"The return of Asian production as COVID-19 measures eased, particularly in China, will support demand for air cargo," IATA Director General Willie Walsh said July 7 as the figures were released. "And the strong rebound in passenger traffic has increased belly capacity, although not always in the markets where the capacity crunch is most critical. But uncertainty in the overall economic situation will need to be carefully watched."

Air cargo specialist Clive Data Services, which is part of Xeneta, says that as global air cargo volumes fell again in June, additional summer airline capacity was continuing to apply a downward pressure on airfreight rates, especially on North Atlantic routes.

"In our analysis of air cargo market performance in May, we said the North Atlantic market could provide 'a test case for the direction of other markets once they also return to their pre-COVID levels,'" says Niall van de Wouw, founder of Clive and chief airfreight officer at Xeneta. "This is still true, and we may see the consequences sooner than we anticipated a month ago."

"While flights [from Asia] to the U.S. and Europe remain relatively full, we are seeing a subdued North Atlantic market, largely due to more capacity," he adds. "We have to consider what will be the knock-on effect of a softening air cargo market? Will carriers deploy their freighters to other markets in Asia-Pacific, Africa, or South America? We are already seeing some freighter redeployment in the market."

BOEIN

Rising COVID case numbers, staff shortages and cost of living pressures could also have an effect.

Looking further ahead, Airbus and Boeing have both issued revised long-term market forecasts in recent weeks that include new projections for freighter demand, both of which foresee slower overall air traffic growth but highlight ongoing demand in the freighter segment over the longer term.

In its market outlook released July 11, Airbus said it expected annual growth of 3.2% in the freight market from 2019-2041, with world international trade set to double in the next 20 years.

The manufacturer expects the express sector, boosted by e-commerce, to outpace overall air cargo growth, with a projected growth rate of 4.9% for express and 2.7% for general cargo over the 2019-2041 period covered by its outlook. Airbus expects the global in-service freighter fleet to reach



Boeing launched the 777-8 Freighter at the beginning of this year and has racked up more than 50 orders.

3,070 by 2041, up from 2,030, translating into demand for 2,440 new-build or converted freighters from 2022-2041 when taking retirements into account. It breaks that projection down into 990 single-aisle aircraft, 890 midsize widebodies and 560 large widebodies.

Boeing said in its latest forecast from July 18 that while overall air cargo capacity has rebounded to 2019 levels, the ratio of main-deck freighter capacity to belly capacity remains high. Across the industry, dedicated freighters are hauling roughly two-thirds of all air cargo while long-haul passenger networks remain constrained by international travel restrictions.

While the manufacturer said it was too early to confirm structural changes, several trends appear likely to persist at least into the medium term, including strong e-commerce growth and a narrowing of the gap between costs for shipping by sea and by air.

For 2022-41, Boeing forecasts that air cargo traffic in revenue ton-kilometers will grow 4.1% annually, an increase from last year's forecast of 4%. Boeing predicts that over the next 20 years the freighter fleet will grow 80% from prepandemic levels, representing 3% average annual fleet growth. It predicts approximately 2,800 production and conversion deliveries, with nearly half replacing retiring aircraft and the remainder expanding the fleet to meet projected traffic growth.

At the recent Farnborough International Airshow, a series of orders highlighted the ongoing need for freighter capacity.

Cargolux Airlines announced that it had selected the 777-8 Freighter, which Boeing launched in January, as the preferred replacement for its 747-400 fleet. Cargolux is Europe's largest all-cargo airline and the largest operator of Boeing widebody freighters in Europe, with a combined total fleet of 30 747-400 and 747-8 Freighters.

"The 777-8 Freighter is ideally suited for operators like Cargolux, creating a more sustainable and profitable future," Boeing said. "With nearly identical payload and range capabilities as the 747-400 Freighter, the 777-8 Freighter will provide 30% better fuel efficiency and emissions and 25% better operating costs per ton as the airplane to replace aging large freighters later this decade."

Lessor BBAM Aircraft Leasing & Management also placed a firm order for nine more 737-800BCFs with Boeing, taking its orders for the type, including those with other conversion providers, to 40. BBAM will be the first customer to take delivery of a 737-800BCF conversion at a new conversion line set to open next year at KF Aerospace, a Canadian maintenance, repair and overhaul provider in Kelowna, British Columbia.

All Nippon Airways (ANA) also has confirmed an order for 20 737 MAX 8s, plus 10 options, and converted orders for two 777-9 passenger aircraft to the 777-8F cargo variant to make the most of cargo growth. "I believe we can expect high growth in cargo business in the post-COVID era," ANA Holdings Chairman Shinya Katanozaka said during a signing ceremony at the air show in Farnborough. ©

AVIATION WEEK'S 65TH ANNUAL LAUREATE AWARDS

March 1,

Metaman Technologies Laser Strike P

Continuing a 65-year tradition of honoring innovators, extraordinary achievements and exemplary leadership in the aerospace, defense and aviation industries, Aviation Week's editors announce the winners of the 2022 Laureate Awards. This year's awards honor 18 individuals, companies and programs in four categories—Commercial Aviation, Defense, Space and Business Aviation—as well as Lifetime Achievement Awards for two exceptional industry leaders.

Gentile

The 65th annual Laureate Awards will be presented at a black-tie gala at the National Building Museum in Washington on Nov. 3. That evening, editors will reveal four Grand Laureates selected from the winners in each primary category.

For more information on attending this year's Laureate Awards Gala, and to view a list of past winners dating back to 1957, go to AviationWeek.com/Laureates.

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Airbus Fello'fly

On Nov. 9, 2021, two Airbus A350s took off for an unusual flight from Toulouse to Montreal, crossing the Atlantic 3 km



(1.6 nm) apart in a formation inspired by migrating birds. Riding the lead aircraft's wake, the following A350 used 5% less fuel during the flight, a culmination of Airbus' Fello'fly project to demonstrate the emission-reduction potential of long-distance formation flying.



Air France-KLM for Sustainability Efforts

To reduce its environmental footprint, airline group Air France-KLM is promoting sustainability goals that go beyond what many competing legacy carriers are willing to adopt, committing not only to relative emissions targets per passenger kilometer but also to absolute volumes that will force it to invest in new technology and cut services that are no longer justifiable.



Spirit AeroSystems

When many other aerospace and defense suppliers retrenched during the COVID-19 pandemic, Spirit AeroSystems jumped at the chance to reinvent itself. The company quickly implemented changes under consideration for years, turning its 20th-century factories into digitally driven lean manufacturing centers. The innovations should position Spirit to ride the resurgence of Airbus and Boeing narrowbody output.



Steve Dickson for Leadership

Steve Dickson, FAA administrator from August 2019 to March 2022, resurrected the U.S. regulator's position as an independent entity in the aftermath of the Boeing 737 MAX crisis. The FAA had delegated too much authority in aircraft certification, and Dickson, a former Delta Air Lines captain, put his weight behind often difficult decisions required to return the MAX to service.



Transport & Environment

Transport & Environment (T&E) is the most influential nongovernment organization in Brussels dealing with the aviation sector. An outspoken critic of the industry, T&E contends that shortfalls should be highlighted but assessments should be constructive and fair. T&E has become an important positive factor in driving needed change toward more sustainable flying.



Autonomous Black Hawk, DARPA and Sikorsky

DARPA and Sikorsky conducted the first fully autonomous flights of a UH-60 Black Hawk with no crew aboard the helicopter. On Feb. 5, the crew landed the helicopter, switched to autonomy, stepped out, and the uninhabited Black Hawk performed a 30-min. preplanned mission using Sikorsky's Matrix autonomy system to navigate a simulated urban environment.



LOCKHEED MARTIN

Afghan Airlift, Air Mobility Command

U.S. Air Force Air Mobility Command led the evacuation of 120,000 people from Afghanistan during a chaotic three-week withdrawal in August and September 2021. It is considered the largest noncombatant military airlift in history: The operation carried 21,000 evacuees in one day at its peak. Aircraft from more than 30 nations ioined the effort, as did the U.S. Civil Reserve Air Fleet.



U.S. AIR FORCE



Vanilla Unmanned, **Platform Aerospace**

The Vanilla Unmanned prototype set a world record for unrefueled. internal-combustion endurance of an uncrewed aircraft with an 8-day, 50-min., 47-sec. flight. Developed with the U.S. Air Force 412th Test Wing's Emerging Technologies

PLATFORM AEROSPACE

Combined Test Force, the Group 3 UAS completed a 12,200-mi. flight over Edwards AFB, California, carrying a communications relay system.



Derek Tournear, Director of the Space Development Agency

Derek Tournear achieved the near impossible. He took over the U.S. Space Development Agency (SDA) in 2019, solidified its vision for an ever-updating constellation of communication, tracking and targeting satellites, and put demonstrations on contract. The SDA's early demonstrations were on orbit by 2021, placing the agency's vision on a path to success.

SPACE DEVELOPMENT AGENC

Korea Aerospace Industries KF-21

On July 19, 2022, South Korea's indigenously developed KF-21 Boramae made its 43-min. first flight, bringing a new class of 4.5-generation fighter to the global marketplace. Local industry, barred from access to key U.S. technologies, has developed its own electronics for the aircraft. including its active array radar and infrared search-andtrack system.





James Webb Space Telescope, **NASA-Northrop Grumman**

After 25 years of development, the James Webb Space Telescope finally launched into space, unfolded into place and, in July, started sending back full-color images and spectroscopic data about the infrared universe. It is delivering the deepest images of the universe ever captured and peering into the atmosphere of exoplanets.



TECHNOLOGIES



ROCKET LAB

Kerry Buckley, Mitre Corp.

Kerry Buckley led the team that created a space risk registry and management system. Simulating the increasingly crowded environment between the ground and outer space, this system calculates the risk to space operators, indicates where government regulation will provide benefit and pinpoints where industry could develop best practices without waiting for government.



Russia-Ukraine War Imagery, Maxar Technologies

In August 2021, months before Russian tanks rolled into Ukraine, Maxar Technologies released satellite imagery showing the buildup of forces, providing evidence to counter Russia's claims that it had no plans to invade. Throughout the war, Maxar, allied governments and scores of other commercial space companies have shared data to assist Ukraine and reveal war crimes and human rights violations.

Peter Beck. Rocket Lab

Peter Beck is not afraid to eat his hat if that is what it takes to adapt and grow Rocket Lab, the space launch and services company he founded in 2006. Rocket Lab's Electron rocket is now the second most frequently launched rocket in the West, and the company is expanding its operations with the medium-lift Neutron rocket, new launch sites, satellite manufacturing and responsive space services.







4AIR for Business Aviation Sustainability

4AIR has developed a framework based on four increasingly progressive levels of action that private aviation owners, operators and users can adopt to create a tailored sustainability program. Each level comes with a rating that simplifies the complexities and standardizes comparability so all industry participants can aim for the same sustainability goals.

RedTail Flight Academy

The RedTail Flight Academy, a **Tuskegee Airmen-inspired** program at Stewart International Airport, New York, launched in September 2021 to enable pilot careers for underrepresented people of color and graduated its first cohort in May 2022. Thousands of volunteer hours from local chapter members developed this program that serves as a blueprint for future Tuskegee Airmen regional flight academies.





Signature Flight Support SAF Utilization

Signature Flight Support became the first fixed-base operator worldwide to offer permanent supplies of sustainable aviation fuel (SAF) at locations throughout its network. In addition, the Signature Renew Book & Claim program allows private aviation operators to purchase the CO₂ reduction of SAF at any airport and receive a report verifying the accredited carbon reduction.

Textron Aviation Cessna 408 SkyCourier

In 2017, Textron Aviation bet that a boom in online commerce and package deliveries would bring demand for a new twin turboprop, the first clean-sheet aircraft in this segment in years. The SkyCourier was designed with input from FedEx Express, which became its launch customer and began taking deliveries in May 2022 following FAA certification.





VRM Switzerland

VRM Switzerland's virtual reality (VR) simulator creates a full-immersion training environment for helicopter pilots to learn high-risk maneuvers, such as slope landing, hovering, tail-rotor transmission failure and autorotation to a full touchdown. The system's VR headset eliminates the domes, projectors and screens of standard flight-training devices.

Philip J. Klass Lifetime Achievement Award

STEVEN F. UDVAR-HAZY

Steven F. Udvar-Hazy is the founding father of a leasing sector that today owns more than half of the global commercial aircraft fleet. Having immigrated to the U.S. from Hungary in the 1950s, he graduated from the University of California-Los Angeles and set up his own



airline consulting business before creating International Lease Finance Corp. (ILFC) in 1973. ILFC, which is now part of AerCap, became one of the dominant forces in global aviation, making Hazy a powerful voice even when it came to the design of new aircraft such as the Airbus A350. After leaving ILFC in 2010, he set up Air Lease Corp., another highly successful venture in the sector. Hazy is also known for his support of the U.S. National Air and Space Museum: He donated \$66 million to the Smithsonian Institution to build what is now the Steven F. Udvar-Hazy Center at Washington Dulles International Airport.

MARC PARENT

Since becoming president and CEO of CAE in 2009, **Marc Parent** has led the Canadian company's growth from a simulation products supplier to the largest provider of civil aviation training services and a global leader in mission support for defense forces. Born in



Quebec, he began his career at Canadair on the Challenger business jet and later became Bombardier vice president of Challenger and CRJ programs before joining CAE in 2005. Under Parent's leadership, CAE adapted rapidly to help its airline customers ensure that thousands of pilots were ready for the post-pandemic recovery in air travel. Now he is leading the company toward the future with a C\$1 billion (\$771 million) investment in innovation, including the use of artificial intelligence and neuroscience, supporting the large influx of new pilots needed over the next decade.



For the latest, go to AVIATIONWEEK.COM

Nanotube Anti-Icing Tests Well

Embraer and Collins Aerospace have flight-tested carbon-nanotube electrothermal ice-protection technology. The system was installed on the vertical stabilizer of an Embraer Phenom 300E business jet. The project is part of an effort to develop technologies for moreelectric aircraft.



Embraer and Collins flight-tested the CNT electrothermal ice protection system on the fin of a Phenom 300E.

The Collins-developed carbon-nanotube (CNT) heater and ice protection controller was tested over 10 hr. of ground and dry-air flight tests beginning in December at Embraer's Gaviao Peixoto facility in Brazil. Flight trials followed more than 500 hr. of icingtunnel testing. Additional ground tests and flights in natural icing conditions to raise the technology readiness level are the planned next steps.

"We are very encouraged by the recent test results, and we are convinced that this innovative technology will meet our ambitious technological and sustainability road map," says Luis Carlos Affonso, senior vice president of engineering, technology development and corporate strategy at Embraer.

Electrothermal ice protection based on highly electrically and thermally conductive CNT technology is lighter, more energy-efficient and damage-tolerant than current metallic heater systems and uses greener manufacturing processes. Major benefits include eliminating the chemical etching process, lowering the energy required by 25% at system level, and minimizing adverse aerodynamic effects caused by ice, the companies said.

RAF Advances Synthetic Fuels

The UK Royal Air Force is advancing its work developing synthetic aviation fuels as it eyes becoming net zero by 2040.

In a new phase in its work with UKbased startup Zero Petroleum, the RAF will explore scaling up the production technologies associated with Zero Petroleum's synthetic aviation gasoline (avgas).

Under Project Martin, the RAF's Rapid Capability Office worked with Zero Petroleum in 2021 to produce the fuel by extracting hydrogen from water and carbon from atmospheric CO_2 using renewable energy. The small amount of synthetic avgas produced was used to power a flight by an Ikarus C42 microlight aircraft in November.

Zero Petroleum's work has now extended beyond synthetic avgas, and the startup has since developed a synthetic aviation turbine fuel. Both can be used as drop-in replacements for conventional fossil fuels.

The RAF now wants to scale up the production process to enable construction of what it calls a "squadron-scale fuel manufacturing capability."

RAF officials say fuel manufactured using this technology could eliminate carbon emissions in flight, reduce the service's reliance on global supply chains and increase its operational resilience.

According to the RAF, Zero Petroleum's technology is a viable substitute for all fossil petroleum demand at scale, without the land-use and scaling limitations of bio- and waste-based pathways.



Zero Petroleum produced 15 liters of synthetic aviation gasoline to power the flight of a microlight aircraft.

The efforts are part of the air force's goal to be net zero in carbon emissions by 2040. "This groundbreaking collaboration with Zero Petroleum is a glimpse of the future for aviation fuel," says Air Chief Marshal Mike Wigston, RAF Chief of the Air Staff.

"It points to how we will crack the net zero challenge as a national and international endeavor, and the leading role the Royal Air Force and UK science and technology can play in that," he adds.

—Tony Osborne in Farnborough

A220 Targeted for Electric Taxiing

In 2011, a team led by L-3 Communications demonstrated electric taxiing at Frankfurt Airport with a Lufthansa Airbus A320. In 2013, Honeywell and Safran showcased electric taxiing on an A320 at the Paris Air Show. Within a few years, both projects had been shelved in the face of record low oil prices.



Green Taxi is targeting modification of the Airbus A220 with a fuel-saving nosewheel electric taxiing system.

The technology is heading back to the market amid soaring fuel prices and rising sustainability pressures. This time the charge is being led by Texasbased startup Green Taxi, founded in late 2021 after having acquired the intellectual property (IP) for the system originally developed by L-3.

Both L-3's GreenTaxi and Honeywell/ Safran's Electric Green Taxi System powered the aircraft's main wheels with electric motors. Green Taxi is redesigning the system to power the nose gear, the approach already taken by Wheel-Tug. And Green Taxi is targeting the Airbus A220 as its first application, although the system is being designed for the torques and loads associated with the larger A320.

By eliminating the need to use the engines for taxiing, Green Taxi estimates the system will save 262,500 lb. of fuel a year on an A220, based on five 15-min. taxi cycles per day. Emissions savings will be 4,380 lb. of CO_2 a year. Electric taxiing will also reduce brake wear, pushback costs and on-ground time.

Both L-3 and Honeywell/Safran demonstrated mainwheel-based electric taxiing because Airbus felt such a system would provide the traction required to taxi on a wet, uphill runway. But this should not be a driver, and the cost-benefit of a lighter nosewheel system makes more sense, says David Valaer, Green Taxi founder and CEO.

"Our conforming prototype we will do on a nose gear system, but we can do mainwheel," he says. Green Taxi argues it will be simpler and cheaper to use the engines to taxi in those infrequent conditions where a nosewheel taxiing system potentially might not provide sufficient traction. "Modifying the main gear is more complex, and harder to certify," he adds.

Armed with the L-3 IP and having assembled an experienced aerospace team, Green Taxi is working to obtain supplemental type certification (STC) of the nosewheel system on the A220 or A320 first, depending on market demand. "Whichever airline steps up will be the first one to go," Valaer says.

"We won't do them concurrently. The A220 is the target. We have contacted A220 operators and had a very encouraging response," he says. But the system will be sized for the A320 to provide a broader range of product opportunity. The Boeing 737, on which WheelTug has already demonstrated its nosewheel taxiing system, is also a candidate for modification.

"Getting to the final STC is 1-2 years away," Valaer says. The company plans to obtain an FAA STC first, followed immediately by European Union Aviation Safety Agency validation. Green Taxi has already partnered with suppliers, including Leonardo DRS for the electric motors, Crane Aerospace & Defense for the inverter/controller, and a gearbox manufacturer.

UK Funds Low-Carbon Aerospace Projects

An Airbus project to test an inflight folding wing is among research programs selected to receive £155 million (\$186 million) in UK government and industry funding. Funded via the UK's Aerospace Technology Institute, the projects focus on enabling low-carbon innovation and economic growth.



An Airbus demonstrator will test inflight folding and other technologies to improve wing aerodynamic performance.

The Airbus-led extra-high performance wing project will receive £19.9 million. A Cessna Citation III business jet is being converted to a scaled demonstrator, fitted with an increased span, semi-aeroelastic hinged wing, gust sensors, pop-up spoilers and multifunction trailing edges that will enable active control to improve the aerodynamics of wings on future commercial aircraft.

Airbus has selected Curtiss-Wright to supply the electromechanical actuation system for the semi-aeroelastic hinge, allowing the outer wing sections to be unlocked to flap upward in response to gusts to minimize wing bending loads in turbulence, reducing weight and improving ride quality.

Receiving £11.1 million in funding, the UToPEA project led by UK electric powertrain developer Yasa will transfer knowledge on high-power, hightorque and lightweight electric motors and power electronics from the automotive sector to urban air mobility. Yasa spun out its aerospace division as Evolito in 2021.

The High-Density Aerospace Solar Power project, led by MicroLink Devices UK, is receiving £6.7 million to develop a high-volume, highly automated manufacturing capability for solar cells in the UK that could be used for electric aircraft.

Also receiving funding, at £5.3 million, is the NGC3 initiative (for Next Generation of Complex Composite Components), which is led by Crompton Technology Group and includes Collins Aerospace, Composite Integration and resin developer Bitrez. The project will help deliver complexshaped composites with a focus on system simplification, weight reduction and cost-competitiveness.

"Through funding for the latest in green technology, such as solar- and hydrogen-powered aircraft, and setting out our vision for the fast-growing market for commercial drones, we are once again placing the aerospace sector directly at the center of our plans to deliver jobs and grow the economy," UK Business Secretary Kwasi Kwarteng said in a statement.

GKN Leads Dutch Research Projects

GKN Aerospace is leading research projects in electrification and thermoplastics as part of a Dutch aerospace consortium awarded funding from the Netherlands' government.

The Luchtvaart in Transitie (Aviation in Transition) program has been awarded a total of €383 million (\$388 million) in multiyear government funding from the Dutch Growth Fund, to be matched by industry investment.

Of that funding, €112 million has been allocated to two research programs led by GKN. An electrification project is focused on high-voltage electrical wiring interconnection systems for sustainable aircraft, while a lightweighting project will develop new thermoplastic materials and processes.



GKN builds the empennage, including thermoplastic composite rudders and elevators, for Gulfstream business jets.

The electrification project will develop high-voltage wiring to distribute electrical power and transport data signals for all-electric, hybrid-electric and hydrogen-electric powertrains, with the goal of reducing weight and volume. The project also involves developing cost-efficient design and assembly automation technologies.

The lightweighting project focuses on developing thermoplastic composite materials and manufacturing processes that are scalable and affordable for high-volume production. Thermoplastics are more efficient to produce than thermoset composites and offer high levels of fire safety and recyclability, GKN says.

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Aerospace Calendar

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Aug. 15-Sept. 30—RTCA Plenary Sessions/Committee Meetings. Virtual or various locations. See rtca.org/content/upcoming-committee-meetings

Sept. 6-8—48th European Rotorcraft Forum. Zurich University of Applied Sciences. Winterthur, Switzerland. See vtol.org/erf

Sept. 7-8-Helitech Expo 2022. ExCeL London. London. See helitech.co.uk/

Sept. 7-8-DroneX Trade Show & Conference. ExCeL London. London. See dronexpo.co.uk

Sept. 12-13—Aviation Africa 2022. Radisson Blu Hotel and Convention Center. Kigali, Rwanda. See aviationafrica.aero/home

Sept. 12-16-World Satellite Business Week. The Westin Paris-Vendome. Paris. See wsbw.com

Sept. 13-14—Defense Exports Conference. St. Ermins Hotel. London. See smi-online.co.uk/defence/europe/defence-exports

Sept. 15-17—Vietnam International Aviation Expo (VIAexpo). Vietnam National Convention Center. Hanoi, Vietnam. See vietnamaviationexpo.vn

Sept. 17-18—Air Force Association (AFA) National Convention. Gaylord National Resort and Convention Center. National Harbor, Maryland. See afa.org/events/national-convention

Sept. 17-20—Airports Council International-North America 2022 Annual Conference & Exhibition. Minneapolis Convention Center. Minneapolis.

See airportscouncil.org/conference/2022-annual-conference-exhibition

Sept. 18-20—ISTAT EMEA. Movenpick Hotel Mansour Eddahbi Marrakech. Marrakech, Morocco. See istat.org/EMEA

Sept. 18-22—International Astronautical Congress 2022. Paris Convention Center. Paris. See iac2022.org

Sept. 19-21—AFA Air, Space & Cyber Conference. Gaylord National Resort and Convention Center. National Harbor, Maryland. See afa.org/events/2022-air-space-cyber-conference

Sept. 20-21—Regional Airline Association Leaders Conference. National Housing Center. Washington. See raa.org/2022-raa-leaders-conference

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Aug. 25-26—CAPA Latin America Aviation & LCCs Summit. Salvador, Brazil. Sept. 7-8—AeroEngines Europe. Dublin.

Sept. 13-14—CAPA Australia Pacific Aviation Summit. Adelaide, Australia.

Sept. 20-22-MRO Asia-Pacific. Singapore.

Sept. 21-22—AeroEngines Asia-Pacific. Singapore.

Oct. 6-7—Aerospace IT. Chicago.

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VIEWPOINT

Why Aeroengine Consolidation Is Inevitable

By Kevin Michaels

eroengine OEMs appear to be poised for good times. Production rates are on the rise, the aftermarket is recovering, and exciting new propulsion concepts dominate headlines. Yet below the surface, fundamental challenges could lead to restructuring.

First, it is becoming more difficult to earn adequate

financial returns. The incremental costs of each 1% of fuel efficiency improvement are increasing dramatically while OEMs garner fewer shop visits (the profit sources) over an engine's life. Clean-sheet engines earn less than yesterday's models.

At the same time, the ac-

celerated push for zero emissions will increase required R&D. OEMs must now place bets on a broad array of potential solutions, from advancements in conventional gas turbines to open rotors, sustainable aviation fuel (SAF) and hydrogen, electric and hybrid-electric propulsion concepts. Aeroengine manufacturers must pivot to become propul-

sion system suppliers, which means significant increases in R&D will be required. However, technology paths have an unprecedented degree of uncertainty. Which technologies and architectures, for example, will be used in large twin-aisles or 70-seat regionals in the 2040s? No one really knows. Uncertainty abounds.

Five OEMs must confront these challenges, which could be the catalyst for long-awaited aeroengine sector consolidation. What are the options for each?

General Electric signaled that the market is changing

when it recently rebranded to GE Aerospace as a \$30 billion propulsion pure play. It has an ambitious sustainability agenda, including the open-rotor RISE program, SAF and a megawatt hybrid demonstrator. Its scale and the enormously successful CFM franchise should ensure cash flow to execute its ambitious plans. What are its options? It could double down on building out its systems capability through acquisitions. Or it could drive consolidation and build out its small propulsion capability—the size favored for hybrid propulsion concepts—by pursuing Honeywell's gas turbine business.

Safran also operates from a position of strength, with its CFM franchise and collaborative relationship with GE providing a strong foundation. It also has robust electrical-systems capability, broad gas turbine coverage including auxiliary power units (APU), a leading nacelle business and access to EU sustainability funding. Safran has the tools and scale to address nearly all the emerging sustainable propulsion concepts. It doesn't need to acquire and should be able to chart an independent course.

Honeywell has intriguing possibilities with its strong APU and small propulsion franchises, enviable aftermarket revenue stream and electrical systems expertise. Its ca-

pabilities are ideally suited to advanced air mobility propulsion. Yet Honeywell has made no secret that it would like to become a high-margin, software-driven company. Where do gas turbines fit into this picture? Its Propulsion and Power Systems business is subscale with revenue of ap-

proximately \$4 billion. How much can it dedicate to R&D? Honeywell International has the market capitalization (\$123 billion) to make a run at Rolls-Royce or GE Aerospace. Or it could divest gas turbines.

Pratt & Whitney boasts several strengths, including its growing geared turbofan installed base, an excellent



military portfolio and broad small propulsion capability. Its Collins Aerospace sister division Raytheon Technologies includes many of the electrical-systems technologies needed for decarbonization and is collaborating with Pratt to create new hybrid-electric concepts. Yet it earns the lowest margins of any Raytheon business, which leads to speculation that it may be spun off. Could a tieup with Rolls follow?

The need for change at Rolls-Royce is the most acute. Its well-documented bet on twin-aisle propulsion has been a disaster. After major invest-

ment in its UltraFan demonstrator, CEO Warren East recently conceded that Airbus might not reengine the A350 until the mid-2030s. With limited electrical systems capability, a diminished aftermarket and a market capitalization of \$8 billion—a modest sum to its better-heeled rivals major change appears inevitable. Rolls recently signaled openness to collaborating with Pratt & Whitney—a dramatic turnaround from the messy divorce from IAE and the V2500 program. Status quo and acquisitions aren't viable options, which means it must sell eventually.

Sustainable aviation cannot happen without healthy propulsion OEMs, so restructuring and consolidation in the aeroengine sector will be necessary to meet the requirements of stakeholders and investors.

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Contributing columnist Kevin Michaels is managing director of Aero-Dynamic Advisory in Ann Arbor, Michigan.

"SUSTAINABLE AVIATION CANNOT HAPPEN WITHOUT HEALTHY PROPULSION OEMS."

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